Quarterly Activities Report  
April-June 1984

I. Research Progress

1. NOVA Program in Colorado (Phillips)

   The completion of the Madison-Boulder dial-up data exchanging interface has been foundering. Problems have included frequent gaps in the important interpersonal communications among the two key S/W protocol experts (one at each end of the I/F), the diversion of PROFS' S/W protocol expert to many other duties within PROFS due to other key personnel shortages there (this problem has had some bearing on the preceding one) and a somewhat disturbing misunderstanding or misinterpretation of some of the important parameters describing the expected procedures to be implemented at both ends of the communications link (this in spite of the painstaking efforts of many to describe, review and compromise where necessary in spelling these out early-on in the form of a MOU).

   The latest contacts with representatives in Boulder and Madison indicate that some discussion have been taking place recently and that the major problem at this moment is the aforementioned inability of PROFS' communications protocol person to devote sufficient time to this task. Word received was that PROFS' management was to meet with all participants to discuss possible approaches to resolving this issue.

   It should take no more than 4-5 mutual working days of effort by each of the two responsible individuals until this interface is successfully brought up to operating capability. The problem will be their concurrent availability to coordinate their efforts.

2. PROVAS Retrievals (Phillips)

   The cooperative Profiler-VAS (PROVAS) retrieval system project among PROFS and the WPL has completed its first milestone. Atmospheric profiles of temperature and water vapor have been experimentally produced using transplanted software from Wisconsin to produce retrievals from archived VAS data, retrievals developed by the WPL using coincident Profiler observations and the combining of these using newly developed research algorithms. Initial assessments of the results have been positive and the project team seems to be anxiously awaiting the completion of the Madison-Boulder data exchanging communications interface in order to run the system as near to real time as possible.

3. PROFS Exercises (Phillips)

   PROFS has installed another satellite dish and receiver, developed some new VAX decoding software and has interfaced these with a PDP-11/24 ingest computer in order to be able to acquire LFM grid point data from the new NMC

PROFS now has a workstation in real time operation at the Longmont ARTCC as part of their participation in the FAA's CWUS (Central Weather Services Unit) upgrade program. Although used for demonstration purposes, this PROFS progeny is significant in that it is self-contained and ergo, truly portable. While its applications are admittedly limited, it does not require additional computer processing support from the PROFS system in Boulder and is therefore free from the associated contention problems for those resources encountered in the past by previous evolutionary PROFS workstation incarnations at Longmont and at Denver's WSFO.

4. STORM-Central (Phillips)

In support of the STORM-Central Preliminary Program Design effort and at the request of the chairman of the STORM-Central Interagency Team, additional paragraphs to the associated document were provided which discussed NESDIS' intended plans for operating with, processing, and distributing VAS data and its derived information content in the 1987-88 time frame.

I attended the first day of the BASC's two-day Panel on Mesoscale Research meeting at NCAR on July 12. The impression I had afterwards is that a STORM-Central type of program is being championed by some very influential people on Capitol Hill, including members of both houses of Congress. It seems that the devastating tornado outbreak in the Carolinas this spring may have played a role in galvanizing support for such a program.

A key point brought out in the Panel meeting was that agencies at all interested in participating in STORM-Central should not now be complacently "sitting on their hands" awaiting further developments toward the program's official conception. Current FY86 budgetary development efforts should identify areas and degrees of anticipated STORM-Central activities that should be in concert with the above-mentioned program design document. How will/should NESDIS contribute to this program and which groups within NESDIS will actively participate? Are we (NESDIS) taking this program into account in our FY86 budget preparations?

Systems Design and Applications Branch

5. Interactive Retrieval Development

a) NSSFC Processing (Smith, Woolf, Wade)

The operational retrieval algorithm was modified to yield retrievals in low cloud regions with the usual technique of retrieving to cloud base and coupling with the guess profile (from previous retrievals or the LFM grid). This has the effect of increasing the data coverage, but the retrievals are of lower quality and are often removed during the manual editing.

Efforts continued to improve the quality of "images" of stability and precipitable water derived at full (8 km) resolution. The derived parameters are now blended with the cloudy infrared window pixels and smoothed to avoid the "holes" and blocky appearance which proved disconcerting to the users.
Work continues to find color enhancements which highlight the mesoscale information in the images, especially in terms of time continuity. These products have been very favorably received by Kansas City.

b) NHC Processing (Hayden, Lewis, Smith)

Data preparation for the National Hurricane center will be similar to last year but enhanced by products requested by NHC. One operational data set will be provided based on 1200 GMT data (approximately) and products will be delivered by 1430 GMT. A second data set for 0000 GMT will be processed in non-real time. This will be used to investigate time continuity adjustments to the mean steering flow which is the principal product used by NHC. For each time period cloud drift winds (with CO2) height assignment), water vapor winds (with brightness temperature versus global forecast temperature height assignment) and VAS derived gradient winds will be blended with the VAS thermal fields using a variational adjustment technique to provide a mid level steering flow. This will be blended with high level and low level wind analyses to provide the deep layer mean wind.

c) VAS and MSU Retrievals (Smith, Woolf)

A version of the "one step" retrieval program was constructed in which MSU observations coincident in space and nearby in time to the VAS measurements are combined. Preliminary results are very encouraging. This model will be utilized extensively during the next quarter, especially if tropical storms occur.

In support of this activity, software and procedures have been modified to permit extraction from the IBM and transmission to Madison of 1-B data sets of either HIRS or MSU, or both. Previously both had to be obtained, even if only one were needed.

d) Optimal Path Retrievals (Nagle)

Experiments are being conducted using real VAS measurements in this retrieval scheme with encouraging results. The longer term objective of this technique is incorporation of wind shear information during simultaneous retrieval of two profiles. Work on this project will begin in the next quarter.

6. Data Assimilation and Evaluation

a) Wind Height Adjustment (Lewis, Hayden)

The adjoint two level potential vorticity conservation model for coupling data in time did not enjoy as much exercise as anticipated during the VAS support to Kansas City. This is largely because more emphasis was placed on "image" development and because of extreme overloading of the IBM 4341 (replaced as of June 11 by the IBM 4381). The program continues to be used in a research mode for case studies of the NASA special network AVE days.

A one level adjoint vorticity conservation model has been prepared for use with the hurricane support "deep layer mean" flow. This will be used over a 24 hour time step which should prove challenging.
A paper describing the adjoint adjustment procedure (Lewis and Derber) has been completed and will be submitted with a companion paper (Le Dimet and Talagrand) to Tellus. Also, a more general quasi-geostrophic adjoint system is being formulated for testing with simulated data generated by the subsynoptic model.

7. Instrument and Hardware Development

a) NOAA-7/8 Ingest (Howell)

Occasional ingests of TOVS data continued. With the failure of NOAA-8, NOAA-6 data was ingested.

The Multibus Adapter for Multibus/IBM-PC connection was upgraded to a dual port memory size of 32 KB in order to accommodate larger records on magnetic tape. The necessary modifications of SBC-80 and IBM-PC software to utilize this new buffer size have not been made, but should be done during the next quarter.

The TIROS VHF receiving system has been undergoing some maintenance and is ready for tracking, but the SSEC manpower force has dwindled to the point that engineering support for this project is low on the list of priorities.

b) High-resolution Interferometer Sounder

No activity this period.

c) IBM-PC Software Development (Howell, Nagle, Woolf)

The VAS operating system for the acquisition, analysis and evaluation of VAS data has grown to include an automatic communications link with McIDAS as well as numerous applications in image and retrieval analysis. Robert Green of the NESDIS RAMM Branch met with Ralph Dedecker of SSEC and Ben Howell of the SDA Branch at UW for the consolidation of software developed thus far. A similar update is planned for September, and a demonstration of the system is planned for October (at NASA/Goddard Space Flight Center).

d) AVHRR-McIDAS Ingest of L-B Data (Howell, Nagle)

The development of the navigation and calibration algorithms was completed. The use of AVHRR L-B data tapes has increased within the UW-SSEC and Department of Meteorology.

e) TOVS Retrievals (Woolf)

Both statistical and physical ("one-step") TOVS retrieval algorithms were successfully implemented on the PC. While the physical retrieval is presently too slow to permit application to an entire overpass data set, it can be used as an enhancement tool in limited areas. H. Woolf presented a talk on this subject in Graz, Austria at the COSPAR Workshop on Satellite Remote Sensing of Interest to Developing Countries.
8. Earth Radiation Budget

a) MONEX Studies (Herman)

A final report on work done under a CIMSS NSF grant has been completed. Verification of the cloud distributions determined under this grant continues. The Air Force nephanalysis for June 20, 1979 (Box 14) is being compared with the CIMSS product over the Arabian Sea on a 2° by 2° grid. Also, the surface observer reports have been collected. The latter suggest a problem in the CIMSS data with scattered cloud, probably caused by incorrect thresholding of the surface brightness temperature over land.

9. Data Sets

a) Time Composite Sounding (Hayden)

Special data sets were collected on 9 and 14 June when a truncated number of VAS channels were used in a single spin (imaging) mode to obtain five images of seven channels in 50 minutes. These images were used to investigate the concept of "time composite" sounding as opposed to dwell sounding. In essence, the five images are averaged to replicate the "spin budget." Indications are that time compositing is a viable technique for sounding and it offers the advantage of providing frequent imaging as well. A report on this study is available.

b) MCC Data Sets (Hayden)

Special 28 hour, 3 hourly VAS data sets were processed by the Advanced Satellite Products Project on June 21 and 22 in support of the MCC experiment conducted by the Environmental Research Laboratories. In addition, two wind sets have been prepared. For this experiment aircraft data and rapid scan GOES West imagery was collected. The RAMM Branch had real time access to these data via the IBM-PC. If requested, higher temporal frequency VAS retrievals can be obtained.

10. Numerical Analysis and Prognosis

a) Development (Purser)

Developments of the iterative Bayesian optimal analysis scheme have led to a reformulation of the way in which observations are logically clustered within the iterative algorithm. The scheme has been successfully tested on real data at 500 mb. The new formulation is numerically more stable than the previous form. Work is in progress to extend the scheme from a univariate two-dimensional analysis to a three-dimensional multivariate form capable of accommodating a mixture of RAOB data and satellite-radiance data.

A shallow water model has been used to assist in the development of code to produce a non-linear limited area initialization for the ANMRC model. The initialization will use the efficient "multigrid" method for solving the elliptic equations implied by the scheme.

Some extensions have been made to the recursive-filter routines used for an empirical analysis scheme. The changes improve the behavior of the filter
at grid boundaries and remove the small spurious edge effects of the original method.

b) Case Studies (Callan)

Analysis and forecasts were made using the high temporal frequency sounding data for 26 April 1982. As in the Hurricane Debby Case it was found that the VAS soundings and the water vapor and cloud drift winds complemented each other, wind data being present where VAS data is absent. The 67 km grid size used in forecasting was found to be too coarse for the small cut off low which generated most of the day's weather, but a 25 km grid size using all the VAS data could show it. The four analyses were consistent in time, showing the movement of the system. The forecast of these analyses to verification time were consistent with each other and with the verifying analysis. The 6 March 1982 case is being redone using soundings generated by the new one-step algorithm. As with 26 April, the VAS and wind forecast shows considerable improvement over the VAS only forecast.

Regional and Mesoscale Meteorology Branch

11. Training Programs

a) Severe Weather Identification (Weaver)

J. Weaver presented a talk on severe thunderstorm spotting to a group of approximately 50 Larimer County volunteer weather watchers on 7 April 1984.

12. PROFS (Purdom)

In the summer of 1985, PROFS will undertake another real time forecast exercise. Coordination is currently underway between PROFS and RAMMB Branch to determine RAMMB participation during the exercise.

13. Mesoscale Convective Environments

a) Cloud Top Characteristic Studies (Weaver, Purdom)

Data from several case days on which exceptionally severe thunderstorms occurred, and for which CSU has digital satellite data archived has been identified. The data will be used to study warm wakes and overshooting tops associated with those storms.

b) Airborne Investigations of Mesoscale Convective Systems (Purdom, Green, Weaver, Zehr)

The RAMMB Branch is participating in the Environmental Research Laboratory/CSU project AIMCS (Airborne Investigations of Mesoscale Convective Systems). Beginning on June 18, J. Weaver and R. Zehr split the duties of forecasting for RRSD and VAS collection in support of the project. Forecasts were made by teams comprised of members from ERL, CSU, and RAMMB Branch. A total of six RRSD and VAS schedule C days were allocated to the 30-day data collection phase of this project. Airborne data collection was being handled by NOAA P-3 aircraft. R. Green took the responsibility of collecting VAS retrievals from Wisconsin on RRSD days. The final data sets of satellite data
are to contain five minute RRSD imagery from GOES-West, MSI imagery at half hour periods and dwell sounding data from every three hours from GOES-East, plus the VAS retrievals every three hours. On June 21, excellent aircraft data, schedule C satellite data, and special rawinsonde data were collected. Tehran were no other schedule C days in June.

c) Vertical Wind Shear in Severe Convective Environments (Purdom)

Measurements from initial case studies using RRSD data show great promise. A stereo algorithm will be included so that tracer heights may be accurately identified. Future work will focus on the data sets collected for Cloud Top Characteristic Studies and Airborne Investigations of Mesoscale Convective Systems. A paper covering this technique was presented at the satellite and remote sensing conference in Clearwater Beach.

14. Mountain Wave Study (Weaver)

Video loops for several time periods on three case days have been constructed. Each case day had a slightly different mountain wave type develop. Next, J. Weaver will help S. Caplin (ERL/WPL, Boulder) in relating wave behavior to upstream dynamical changes as obtained from and defined by vertical sounder and aircraft data.

15. VAS Data Case Study (Zehr)

Research was completed on the 22 July 1981 case study with hourly VAS images for all spectral bands analyzed on the IRIS display system. Additional work included:

a. The development of various image combination and enhancement techniques, animation of imagery with respect to particular features (storm relative), and thunderstorm development with respect to water vapor image features. These techniques will be used in future work.

b. A "split window" technique was evaluated with the objective of developing a product which uses a simple combination of VAS channels 8, 7, and 6 to portray a low-level moisture "image." These initial results look promising and will be tried on other case.

c. A discussion of this work was included in a paper presented at the satellite/remote sensing conference in Clearwater Beach.

16. Water Vapor Imagery (Zehr)

The routine six hourly water vapor imagery is being displayed and looped in real time on the CSU IRIS system to assess its utility in identifying flow features and to develop image combination products.

17. Research Tools

a. CSU VAS Ingest (Green)

June 21, 1984 was the first non-test mode use of the new VAS hardware and software ingest system at CSU, and all appeared to work well. This was the
first time that five minute RRSD data were collected from the GOES-West interleaved with the ISCCP data collected at CSU. This combination also appeared to work smoothly. On a broader scale, this was the first attempt by NESDIS to operate simultaneously the GOES-East in transparent mode and the GOES-West in rapid scan mode, and from an end user's point of view, the satellite system worked fine. Both CSU and University of Wisconsin stations noted a very weak signal from the GOES-3 satellite for the period 0500 GMT to 1300 GMT. This resulted in no data being collected at Wisconsin and very noisy data at CSU.

b. PC Workstation (Green)

The VAS analysis PC workstation became a more cohesive system this quarter. Additional software was added to analyze individual soundings and plot data on a skew-T log-P graphic. During a visit to Madison in May, R. Green worked with R. Dedecker and B. Howell on designing a standardized menu scheme for selecting and executing the various applications programs. Three main categories of programs are McIDAS communications, VAS retrieval analyses and VAS image analyses. With the end user in mind, all of the programs are written to minimize the amount of typing and of knowledge of the PC's operating system needed to do VAS data analysis.

Future work will concentrate on making a version of this system to work on a single monitor micro, and to add software to objectively analyze any parameter from a meteorological data ("MD") file on the McIDAS.

Several people have shown interest in the PC workstations idea to help solve some of their data processing and display problems. Visitors who have been given a demonstration include Dave Small and Tom Georges (ERL/WPL), Bruce Meyers (Army/White Sands Missile Range), and Bob Steinberg (FAA).

18. March 28, 1984 Carolinas Tornado Outbreak (Purdom)

Data sets from GOES-East and TIROS-N AVHRR are being analyzed for this event. Slides of 15 minute interval visible and infrared imagery (both blocky and smoothed infrared) were provided to T. Fujita, University of Chicago, for his use. TIROS-N sounding data are on order, and mesoscale characteristics of local airmasses in the outbreak area will be examined with that data. This analysis effort will be a joint venture between CIRA/RAMMB and CIMSS/SDAB.

II. Publications

A. Papers Presented


B. Articles Published


III. Meetings/Lectures/Personnel Actions

A. List of Attendance at Meetings and Conferences

Purdom

Purdom
Mesoscale atmospheric processing research program science review. NASA/Goddard Space Flight Center, Greenbelt, Maryland, April 25-26, 1984.

Purdom

Smith


Purdom CSU satellite program review. Colorado State University, Pingree Park, Colorado, June 7-8, 1984.


B. Lectures and Presentations


Assisted with the teaching of a graduate level severe storm forecast and intercept course (AT 681). Fort Collins, Colorado, June, 1984.

Presentation on "Real Time Data Access at CSU" for the AT 681 Severe Convective Storms class. Fort Collins, Colorado, June 28, 1984.

C. Personnel Actions
None.

IV. Visitors

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9. Stephen Munro, Bureau of Meteorology, Melbourne, Victoria, Australia. To further study the software of the McIDAS system to determine complete software parameters and requirements to provide operational support on the Bureau’s FACOM installation and to discuss joint CIMSS/Bureau research project. June 4-5, 1984.


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V. Miscellaneous

1. Ray Zehr completed second year of NOAA’s 20/20 program as a Ph.D. student at the Department of Atmospheric Science, Colorado State University.

2. All of the ODIS equipment was transferred to W. P. Menzel in Madison.
Quarterly Activities Report
October-December 1984

I. Research Progress

1. Program Participation

a) PROFS (Purdom, Green, Weaver, Zehr)

A series of meetings was held between members of RAMM Branch staff and PROFS for the purpose of forming a new working group, tasked with evaluating satellite-related forecast products currently on the PROFS system, as well as those proposed for addition. The new Satellite Product Evaluation Group is chaired by Jim Purdom.

Weaver and Zehr continue studying a series of Displaced Real-Time case studies at PROFS in preparation for the Summer '85 nowcast exercise.

b) STORM (Phillips)

Plans are forming for DL involvement in the PRE-STORM exercise which will take place in late Spring 1985. DL RAMM branch will be providing two TRM PC/XT work stations and scientists from both DL branches and will be on site during the field experiment. PRE-STORM will be connected to the McIDAS data base via a telephone port. Unfortunately, it appears that direct access of AVHRR data at Wisconsin will not be available for this experiment. However, that data will be processed on a delayed basis using tapes from Suitland.

RAMM branch will be coordinating satellite support to the program.

System Design and Applications Branch

2. Interactive Retrieval Development

a) TOVS retrieval (Woolf)

The simultaneous TOVS retrieval was modified to permit retrievals over high terrain in order to extend the Export package for use in Bangladesh. Under the changes, retrievals are attempted with surface pressures as low as 475 mb. The logic dealing with cloudy situations was also modified. An overcast level is sought (by comparing channel 10 with the guess temperature profile) up to 430 mb. If a match is found, channels 5 and 7 are used in the "ratio" method above the overcast level to fine tune cloud pressure and amount.

The TOVS EXPORT software was extensively modified in preparation for installation on a VAX-11/750 computer in support of the Bangladesh AECMP (Agro-Environmental-Climatological Monitoring Project). This is an AID program for which NASA/GSFC is the prime contractor and CIMSS is the TOVS subcontractor.
During a four day trip to GSFC in early December the major part of the TOVS EXPORT system was installed and checked out.

Preparations were made for the launch of NOAA-9, primarily by construction of coefficient datasets for use with the CIMSS and TOVS EXPORT sounding-data processing systems. This effort will be completed when operational flight data allows determination of msu asymmetry corrections.

b) VAS retrieval (Hayden)

Following the demise of GOES-5 on 26 July the VAS instrument was deactivated until 19 November when, after very careful consideration, the data flow was restored.

The VAS retrieval algorithm remained essentially unchanged during this period. A slight modification allows the retrievals to be positioned by weighted averaging of the fov's used to provide the clear radiance estimates, an embellishment which may prove useful in mesoscale applications. Also, the n-star option was re-introduced for the Eastern Pacific processing (beginning on 12 December).

Processing over the Pacific with GOES-5 has introduced the complication of high zenith angles for coverage of the Gulf of Alaska. The transmittance models built for VAS were designed to operate only to 60 degrees of local zenith which is inadequate for the Eastern Pacific processing. A more complete model is being prepared by Art Neuendorfer of the Physics Branch, but until that is ready, the current model is being extrapolated with transmittance assumed to be linear with logarithm of secant angle. This technique was evaluated with the "ping pong" data collected on 6 November 1983 when GOES 5 and 6 were both operated in the VAS mode, thus affording low zenith angle from one satellite at approximately the same time and location as high zenith angle from the other. The extrapolation appears to work sufficiently well to allow its use in the EPAC processing.

c) TOVS AVHRR amalgamation (Hayden, Taylor, Woolf)

Two case studies (27 March and 7 June) are being used to investigate the integration of AVHRR data into the TOVS retrieval processing. Imaging with navigation has been accomplished although the latter leaves a bit to be desired. Programs have been prepared to colocate the AVHRR data with HIRS fov, and these have been verified. These programs borrow from the published work of Aoki who has provided the relative geometry of the two scanning instruments. Routines to detect one or two uniform scenes within a HIRS fov (after the technique published by Coakley et al., 1984) are in preparation. The AVHRR will be used to provide mean radiances for 11 and 3.7 microns for the uniform scenes detected within the HIRS fov and to supply a cloud amount for each fov. The n-star method will apply these parameters to provide clear column radiances for the HIRS measurements.

3. Data Assimilation and Evaluation

a) Wind height adjustment (Lewis)
The variational adjustment procedure which couples cloud vector winds with thickness values retrieved from VAS measurements to produce a mean flow for a single time period has been expanded to include adjoint temporal coupling as well. The program is being used with Hurricane Debby data to prepare data sets for the SANBAR forecast model. One data set, derived with and without the adjoint embellishment has been tested using three consecutive time periods approximately 12 hours apart. The results are encouraging. Using only the variational adjustment, the 72 hour prog was improved over both the operational SANBAR and a forecast which used the satellite data without adjustment. The temporal coupling, however, appears to reduce the forecast skill because of excessive smoothing. It appears that a better use of the adjoint would be to fill in data gaps rather than to operate over the entire field. This approach would have an advantage over a prog-derived filler since the data sets between initial and final analyses are not necessarily well fit by the prog as they are by the adjoint.

b) Raob-Vas coupling (Lewis)

The software necessary to pursue the radiosonde temperature and satellite radiance coupling to (hopefully) improve thermal gradients near frontal zones is nearly complete.

c) Recursive filter (Lewis)

Continuing aggravation over our inability to deal effectively with varying data densities using the Barnes analysis scheme has rekindled interest in the recursive filter approach suggested by J. Purser. The software is being resurrected for use with tropical analysis coupling thickness and shear.

4. Instrument and Hardware Development

a) NOAA-7/8 ingest (Howell)

In addition to the occasional ingest of NOAA-7 data, several ingests were implemented for testing hardware fabricated by SSEC for the NASA/Langley Research Center. The hardware is a duplicate of that now installed in SOCC and SSEC for the ingest of TIP data. Langley will use the new hardware to access the ERBE data contained in the TIP data stream. The nine-track magnetic tape drive is now completely interfaced with an IBM-PC by means of a multibus adaptor, with 32KB of dual port memory, and an Intel SBC-80 microcomputer. Within the next quarter the use of the magnetic tape i/o software will be documented.

b) High-resolution Interferometer (HIS) Sounder (Howell)

Discussions of the software requirements for the HIS ground support equipment (GSE) were held among NESDIS and SSEC personnel. The division of responsibilities in this effort was defined. The University of Denver will do the preprocessing, while the assessment of the data quality and the display of data and statistics, etc., will be performed by UW (SSEC & NOAA). Much of the IBM-PC and mainframe software already developed for other applications will be available for the HIS aircraft tests. During the next quarter the data formats will be finalized, and collection and development of the GSE system software will begin.
c) IBM-PC software development (Howell, Siebers)

The PC VAS work station which has been under development at both the UW and CSU was exhibited at "The Third Conference on Interactive Meteorological Processing" held at the NASA/GSFC in October, and will be again in January at the AMS "International Conference on Interactive Information and Processing Systems for Meteorology, Oceanography and Hydrology" in Los Angeles. As a result of these exhibits, a number of ideas for improvement and expansion of the work station software have been generated. In November, the PC work station was demonstrated to a group of forecasters and administrators in the NWS. Recent additions to the PC software include the acquisition and real-time display of McIDAS-generated graphics, and a speedier version of contour analysis.

d) Orbit simulation (Nagle)

A complete package to display what an orbiting satellite "sees" as it orbits the earth has been prepared for the McIDAS graphics. The package is being used to investigate the feasibility of high eccentricity orbits to approximate both polar orbiter and geostationary soundings from a single satellite. It is also a useful training tool for introducing visitors to the concepts of observations from space.

5. Earth radiation budget

a) ERBS (Herman, Nagle)

A major effort commenced this quarter to prepare for processing of data from ERBS, launched on 5 October, and ERBF, launched with NOAA-9 on 12 December, 1984. Simulated data tapes were obtained from NASA Langley in September corresponding to the three types of data which will be routinely available. These are: Processed Archive Tape (PAT); time/space averaged data for the scanner; and time/space averaged data for the non-scanner. Programs to read these tapes were completed in preparation for real-data tapes which should begin arriving in February 1985.

A number of special programs have been prepared to manipulate the ERBE data on McIDAS. ERBS orbital parameters were added to the data base from which orbital tracks can be traced on the computer graphics. Routines to store scanning data in digital areas appropriate for McIDAS imaging were begun, and a plotting program to draw geography over these images was completed.

The first project anticipated upon receipt of the data is validation. This will entail validation of the navigation via landmark identification and by comparison with other satellite data. Also, the data will be checked for calibration and consistency using other satellite data, especially the VAS data.

Studies planned for the data include: diurnal variation of the ERB; lag correlation of the ERB with mean atmospheric circulation; and tests including the radiation data in the SSM forecast model.

6. Data Sets

a) TOVS-II (Woolf, Schreiner)
The two data sets used for comparison by the International TOVS working Group are being reprocessed with the new simultaneous retrieval algorithm for presentation at the IGIS meeting in February 1985. This data set consists of four orbits over Europe on 4, 5 March 1982 and four orbits over Australia on 28 October 1982. The results will be sent to John LeMarshall of the Bureau of Meteorology, Australia for objective comparison with the results of other retrieval groups.

Because the VAS was not available for the hurricane season a large number of NOAA passes were brought up in real time over the Suitland link and processed locally in support of the DL/NHC hurricane monitoring effort.

b) TOVS/MSU climatology (Woolf)

The collection of NOAA-7 MSU data was terminated on 22 December. The nearly complete dataset, covering a period of three years and almost four months, will be analyzed for evidence of climatic trends.

7. Numerical Analysis and Prognosis

a) Case study (Callan)

The subsynoptic analysis/forecast model was used with the VAS retrievals obtained for the NASA AVE data set of 6 March 1982, to investigate the efficacy of introducing data as a gradient wind rather than a geopotential. Forecasts were made from the 1430 time period to 0000 gmt 7 March. Differences between the forecasts from the two date bases were small, with the 'wind' experiment being slightly better.

A number of forecasts made with the normal mode initialization show that the code appears to be in working order.

8. Satellite-derived Winds (Hayden)

Considerable improvement has been made to the McIDAS wind processing software by both DL and SSEC personnel. A capability for using current temperature structure (rather than climatology) from either retrievals, radiosondes or NWS forecasts is now fully integrated to improve height estimates for cloud-tracer winds. A streamlined procedure for reassigning cloud heights be the slicing method (when VAS is available) has also been prepared. Finally, software to permit radiometric height assignment for water vapor winds has been completed. Using these improvements the capability to produce high density wind data sets from both cloud and water vapor tracers in real time has been demonstrated. Such data sets are being provided through the ASPP to NWS for access by the WWB McIDAS terminal as part of the EPAC exercise.

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9. Training Programs

a) USAF Training (Purdom, Weaver)

J. Purdom prepared all of the synoptic and sub-synoptic analyses and J. Weaver constructed numerous video-loops for a new severe weather training case.
study. The case is for the major tornado outbreak which occurred in the southeast U.S. on 28 March 1984. Material will be presented for the first time at the USAF satellite severe weather course in Omaha the last week in February.

10. Mesoscale Convection Environments

a) Cloud top characteristics studies (Weaver)

Analysis of video-look data from the MCC case of 21-22 June 1984 indicates the IR skin temperature data may provide useful input to hourly surface analysis. Preliminary techniques use a bi-spectral (IR/VIS) scheme to "eliminate" cloud effects from the IR imagery. Resulting "skin-temperature images" are used to help shape air mass discontinuities—although (as one would expect) a time lag (roughly 30 minutes) is found between skin vs. air temperatures.

Detailed statistical analysis of thunderstorm anvil data for two MCC cases indicates that overshooting tops in mesoscale complexes seem to change behavior (number, frequency, etc.) near the time of significant changes in the overall structure of the MCC.

b) Airborne investigation of mesoscale convective systems (AIMCS) (Zehr)

VAS retrieval data sets and GOES MSI imagery were analyzed for 21-22 June and 14-15 July 1984. A meso-convective complex in eastern Kansas and MCC in Iowa were the respective features of the two cases which are being studied by AIMCS (Airborne Investigations of Mesoscale Convective Systems) scientists. The VAS retrieval data has proven very useful for detailed mesoscale air mass analyses. The IBM/PC routine which plots skew-T and does a sounding analysis allows quick comparisons among retrievals. Significant differences are readily apparent when retrievals from different air masses are compared. Boundaries between air masses are often very distinct. Satellite imagery and surface data were analyzed along with the VAS retrievals to produce a detailed 3-D mesoscale analysis. Radiosonde data were used to define the precise vertical structure of air masses which cannot be provided by VAS. The VAS retrievals define the horizontal extent and time changes of air masses which are not provided by the radiosonde data.

6.7 μm (VAS channel 10) water vapor imagery has been enhanced and animated from each of the two cases. Particular features in the imagery and their influences on MCS are being investigated.

c) Vertical wind shear in severe convective environments (Purdom)

PROFS is currently implementing a program to do storm relative motions where radar echo motions are used to re-register satellite data in a storm relative frame. This product should be available for evaluation during the PROFS real-time 1985 experiment. Work is underway at RAMM branch to combine the vertical windshear information in the storm environment with the sounding data from VAS to compute instability parameters.

d) 28 March 1984 – Carolina tornado outbreak (Purdom, Weaver, Lubich)
Work continues on this case. Based on AVHRR data from a pass that occurred at 2054 GMT, TOVS data have been acquired so that soundings could be derived in areas where distinct local airmasses are expected to exist based on interpretation of GOES 1 km resolution data. An extensive cast study will be presented at the training workshop to be presented to the Air Force by RAMM branch in Omaha from 25 February through 1 March 1985.

11. Mountain Wave Study (Weaver, Purdom)

FAA and ERL are looking at the possibility of running a second experiment during February 1985. Satellite data will be a key data set to be collected during this experiment. Comparison of aircraft and satellite data from certain of the cases from the 1984 experiment show a very good correlation between variability in aircraft altitude and orientation of the aircraft flights to the mountain waves.

12. VAS Data Analysis (Zehr, Green)

Work with VAS retrieval analysis has continued. This has been in conjunction with case study analysis reported in 9b.

13. Research Tools

a) CSU VAS ingest (Green)

Further use of the new CSU VAS ingest system was stalled by the termination of operational VAS data. When VAS operations began again in December, the two CSU antennae were committed to viewing the data streams from GOES-5 and GOES-4. Negotiations are underway to resolve the problem of acquiring data from GOES-5, GOES-4 and GOES-6 with only two antennae.

b) PC workstation (Green, Lubich)

The newest software tools and changes were added to the PC VAS workstation system during a visit to University of Wisconsin in October. Ideas were discussed for new software enhancements. These included more automated communication capabilities, better image display, and routines to add cursor operations. The cursor operations were written in the RAMM branch and include an "image dump" routine (the line-element location of the cursor and the value of the pixel at that location), a 2X- and 4X- zoom of an image about a cursor position, and a histogram routine which uses an interactively selected rectangle for data selection. All new routines will be integrated into a demonstration to be given at the AMS conference in January 1985.

II. Publications

Hayden, Purdom Contributions for the silver anniversary book on weather satellites and for an article to appear in Science concerning weather satellite/meteorological results of its 25 years of operation.

III. Meetings/Lectures

A. Meetings and Lectures
Staff

RAMM branch staff met with Jack Johnson of the PROFS program office to discuss RAMM participation in the PROFS 1985 real-time experiment. 24 October 1984.

Purdom

Met with NCAR staff to discuss aircraft penetrations of arc cloud lines in support of the MIST program. 25 October 1984.

Howell, Green


B. Presentations

Green


Purdom

Presented lectures in the satellite meteorology class for the Department of Atmospheric Science. 29-31 October 1984.

Purdom

Presented lecture in an undergraduate class on introductory meteorology concerning uses of satellite data in understanding the weather. 30 October 1984.

Hayden

Presented meteorological colloquium on "The Winds of VAS" to the Meteorology Department. 10 December 1984.

Lewis

Presented a paper on "The Use of VAS Winds and Temperatures" as input to Barotropic Hurricane Track Forecasting. 5 December 1984.

IV. Visitors

A. Magne Lyste, Norwegian Met. Inst., to see W. L. Smith, TOVS data processing, October 8 1984.


D. Delegation from the People's Republic of China visited the RAMM branch personnel for presentations on current research work. 14 November 1984.

E. Lars Moen, Arne Andersson and Jan-Olov Brunsberg from the Swedish Meteorological Institute visited the RAMM branch to review the use of computer systems for mesoscale forecasting and research. 28 November 1984.

F. T. Rialli (NOAA/NESDIS) to see C. Hayden regarding PC algorithm development, 29-30 November 1984.
Quarterly Activities Report
January-March 1985

I. Research Progress

Systems Design and Analysis Branch

1. Atmospheric Sounding

a) TOVS Retrieval (Woolf, Hayden, Schreiner, Purser)

Alpex and Bangladesh case studies were used extensively to check out the simultaneous (temperature and moisture) algorithm. Unexpected problems were encountered with the "microwave only" path, but these were traced to a coding error (as usual). All Alpex data have been reprocessed for perhaps the last time. Significant improvement over previous retrievals were noted, especially with respect to moisture. Results were reported by Smith at the TOVS-II conference at Igls, Austria.

b) VAS Retrieval (Hayden, Schreiner)

No changes were made to the "simultaneous" retrieval algorithm during this quarter and data were routinely processed for the EPAC (eastern Pacific) exercise through 22 February 1985. Normal procedure was to produce an initial data set from dwell sounding radiances taken in two ten-minute periods at 1018 and 1048 GMT. The first guess profiles for these were provided by the latest TOVS retrievals. A second data set (for transmission to NMC) was produced from dwell soundings at 1118 and 1148 GMT. The first guess for these was derived from the first data set. Also, the sea surface temperature analyzed from ship data was updated with skin temperatures derived in the initial data set. The processing was done automatically without operator intervention although NMC retained the right to manually edit the final data set. In general, the data was cordially received by the NMC until 13 February when a "cold bias" (suspected throughout the period) became extreme at upper levels. This incident somewhat diminished user confidence.

Late in the period an attempt was made to deliver soundings for 0000 GMT as well. These turned out to be of poor quality because of a filter wheel heating problem (servo mechanism to control this has failed on GOES-6) affecting the transmittance properties of the filters. The effect could be alleviated by empirically modifying the transmittance adjustment factors, but this was not done because of time/manpower constraints and also because of the difficulty in obtaining ground truth over the Pacific.

The high resolution VAS retrieval program was readied for operational support to the NSSFC at Kansas City. Working with data for late March it was found that large transmittance adjustments were necessary to have the retrieval profiles conform to radiosonde profiles. This was due, presumably, to the long inactive period when the VAS filter wheel cooled. By the end of the reporting
period the daily excursions were reasonably uniform between 25 and 35 degrees. Since the last soundings routinely processed are at 1700 GMT, the effective excursion is only about 15 degrees. This still has a significant influence on the transmittance characteristics, however, and it will effect the "temporal continuity" aspect of the VAS data. At this point, we do not feel that we can make a meaningful empirical adjustment to account for the daily excursion.

At the very end of the reporting period the long-awaited high zenith angle transmittance calculations were obtained from Art Neuendorfer with the help of Mike Chalfant. A new transmittance model will be generated from there to compare with the transmittance extrapolation model which was used during the EPAC exercise.

An alternative method of computing the "foreward" calculation for VAS data has been tried by using a multivariate Taylor expansion of observable radiances in terms of a suitable set of independent variables that represent each atmospheric profile. Preliminary results seem encouraging, although further tests and improvements are needed. If successful, the method may simplify and speed up the algorithms being developed for the simultaneous and mutually consistent retrieval of several VAS soundings.

c) TOVS AVHRR Amalgamation (Hayden, Taylor, Woolf, Smith)

A technique devised by Smith for the use of AVHRR in partly cloudy retrievals of TOVS was implemented for a case study of 7 June 1984. In essence, the AVHRR is used to determine cold and warm scenes within the HIRS FOV. If these are similar in adjacent HIRS FOV, cloud amount in each is determined from these and the HIRS measured radiance. Finally, a clear column radiance is derived by the N-Star method (N-Star being the ratio of the cloud amounts). The key ingredient in this approach is the definition of "similarity" in warm and cold scenes between adjacent FOV. Much more experience needs to be gained in the derivation of these scene temperatures. Nevertheless, good success was achieved in improving the moisture fields for the 7 June case when the AVHRR data were included. These results were presented at the TOVS-II conference at Igs, Austria.

2. Data Assimilation and Evaluation

a) Wind Height Adjustment (Lewis)

Continuing experiments with Hurricane Debby have cast doubt on the effectiveness of using a three level model to derive the mean steering flow since both dropsondes and VAS thermal winds show that shear in the lower layer is not linear. The model is being expanded to all mandatory levels with the intent of producing winds at each level based on two levels of cloud vectors, pressure assigned water vapor winds and shear derived from the VAS gradient wind estimates. All the data for eight periods have been collected (see 6b).

b) Raob-VAS Coupling (Lewis, Purser)

The one-dimensional problem coupling the radiosonde analyzed temperatures with VAS radiances was shown to be identical to the minimum information solution when the variational weighting assigned to the radiances is equivalenced to the "gamma" of the minimum information problem. The variational formulation,
however, allows expansion to include wind observations with a thermal wind constraint, and this area is being actively investigated.

c) SSM (Mills, Callan)

A new code for the subsynoptic model (SSM) was installed on the 4381; a version where entire fields are held in memory (greatly simplifying the coding). The analysis model was parameterized to allow variable dimensions for ease in shifting domain. By the end of the period a complete package; data to forecast output, was available to run on McIDAS with input/output in the McIDAS MD and GRID structure for (easy) display and evaluation.

d) Objective Analysis (Purser)

The recursive filters used as the basis for an efficient empirical analysis scheme have been refined in various ways. A simplified form of consistent end conditions has been devised. Also, a formulation of the filters has been worked out which may enable them to be applied in a polar coordinate system (away from the coordinate singularity) without introducing spurious bias or distortion in the response.

3. Experimental Studies

a) TOVS Ingest (Howell)

Few, if any, ingests were done during this period, and no changes were made in the SDAB requirements for data (i.e., SOCC assumes that SDAB wants the eastern Pacific data from Gillmore Creek).

The nine-track magnetic tape drive serving as a peripheral device for an IBM-PC has been used to transfer data from the mainframe, and a brief description of the tape software modules exists on the PC fixed disk.

b) High-resolution Interferometer (HIS) Sounder (Howell, Woolf)

The graphics display package for the HIS group support equipment (GSE) has been completed. A new streamlined FFT software package was installed on the IBM-PC/XT and tested. The time for one 4096-point FFT is just under six seconds. The software for reading the "3M" digital cassettes will be obtained from the University of Denver in April. The format for the disc files generated from the tapes has not yet been specified, but perhaps this will be done soon by SSEC and NESDIS instead of University of Denver personnel as originally proposed. The HIS instrument is in the process of being integrated with the cooling hardware and electronics, and will soon be capable of generating test data tapes. A new transmittance model for use on the PC has been constructed. This requires far fewer coefficients than the previous full regression model.

4. Earth Radiation Budget

a) ERBS (Nagle, Herman)

The first real data, 24 hours of measurements for 9 November 1984, were received in late February 1985. This has been ingested and imaged on the McIDAS for the purpose of checking landmarks, scene identification and calibration.
Several conclusions have been reached: nighttime scene identification fails in some desert situations; earth location is accurate to one and one-half pixels for both visible and IR; top of the atmosphere longwave values appear to have a cold bias in cases with warm surface temperatures (as judged by GOES). These results were presented at the 15th ERBS science team meeting at Langley in mid-March.

A considerable body of software to manipulate ERBS data on McIDAS has been developed. Navigation and geography for the images is now available in satellite coordinates.

5. Synoptic Applications

a) Satellite Winds (Hayden, Lewis, Veldon)

Wind data sets over the eastern Pacific were produced routinely during this period, once each day. Cloud vector winds were obtained from half-hourly imagery at 1200, 1230, and 1300 GMT; water vapor winds were derived from hourly imagery at 1000, 1100, and 1200 GMT while VAS gradient winds were produced from the 12 GMT sounding. An edited, integrated data set was completed by 1600 GMT. This was transmitted from the McIDAS to the Suitland 9040 for access by NESDIS and NMC.

On many occasions water vapor winds were prepared by three or four different operators. The purpose of this redundancy was to assess individual idiosyncracies. We found that experience definitely pays. Also, neophytes tend to do better with reduced resolution which gives a smoother visual impression. Experienced operators, however, prefer and do better with the highest resolution available.

b) Hurricane Debby Case Study (Lewis, Veldon)

Eight time periods of VAS soundings and winds have been completed. The major effort during this period involved reprocessing the water vapor winds with new software which permits infrared height assignment. Two time periods were tested in the "mean steering flow" experiment in coordination with AOML. Further tests await the more complete analysis model currently under development. Results of this study were presented by Lewis at NEPRF, Monterey, and at NHC, Miami.

c) FGGE 2-b Winds (Callan)

A FGGE 2-b satellite wind formatting routine was prepared. This routine reads a "wind" md file and writes a FGGE 2-b format data file. A preliminary tape was sent to the FGGE office for their evaluation. Because of recent interest in FGGE data, old McIDAS subroutines which read FGGE 2-b format tapes have been refurbished so that they handle various data and scheme types: wind, raob, and aircraft.

6. Mesoscale Applications (Wade, Siebers)

Major emphasis was placed on preparing for the Pre-Storm exercise in Kansas, Oklahoma scheduled for May, June 1985 (see 16 below). The Development Lab will have a member at the field site to operate an IBM PC remote terminal to McIDAS. The access is limited to reading data sets (which can include graphics
pen positions) from prestored arrays. A series of products are generated on the main frame by regular schedule. These include images of visible and infrared as well as VAS soundings. All products are stored in compressed format to minimize communication costs, since access is by commercial telephone/modem.

7. Support to Operations (Woolf)

MSU asymmetry corrections were determined and incorporated into the CIMSS TOVS-coefficient database. They were also provided to Operations, in accordance with our standing agreement to do so for each new spacecraft in the TIROS-N/NOAA series. Errors in filter-functions for HIRS channels 7 and 14 necessitated regeneration of transmittance and limb-correction coefficients, which was accomplished with minimum delay.

Regional and Mesoscale Meteorology Branch

8. Training Programs

a) Severe Weather/Satellite Meteorology at USAF, Omaha (Furdom, Weaver, Zehr)

J. Purdom, J. Weaver and R. Zehr conducted an advanced satellite training workshop in Omaha, Nebraska, February 24 – March 1, 1985. The purpose of the class was to train Air Force weather forecasters in various aspects of satellite data applications, including a detailed VAS case study. There were two, 2-1/2 day classes with about 35 participants in each. Post-training critiques by attendees were extremely favorable, with the only negative comments being directed at the poor ventilation in the training room.

b) Upcoming USAF Training (Purdom, Zehr)

Preparations were begun for an advanced satellite training workshop to be held at Andrews Air Force Base, Washington, DC on May 20-24, 1985.

c) Upcoming PROFS RT-85 Forecaster Training (Purdom)

Satellite training for PROFS RT-85 forecasters will take place on April 4-5 in Boulder. RAMM will be training on the uses of VISSR and VAS data for nowcasting.

9. PROFS

a) Satellite Products Evaluation Group (Purdom, Weaver)

The format for a product description form for satellite products on the PROFS workstation has been finalized. It was agreed that J. Weaver would compile all of the completed product description forms into an illustrated manual for RT-85. A new PROFS/RAMM MOU was discussed and accepted with one minor change.

b) PROFS Summer '85 Nowcast Exercise (Weaver, Zehr)

Weaver and Zehr continue studying a series of Displaced Real-Time case studies at PROFS in preparation for the Summer '85 nowcast exercise.
c) Data Collection for Pre-Storm (Purdom)

Representing the satellite product evaluation group, J. Purdom sent a letter to V. Derr (ERL) regarding PROFS collecting and archiving Pre-Storm data for later DRT testing.

10. Mesoscale Convective Environments

a) Cloud Top Characteristic Studies (Weaver)

Thunderstorm anvil statistics were derived for a storm which produced large hail in Kansas on 21 June 1984. Near the time of hail occurrence, vigorous storm top divergence continued, while overshooting top activity seemed to diminish.

Anvil statistics will be computed for storms in various regions at the same time to study the effects of differing equilibrium levels on thunderstorm anvil behavior.

b) Boundary Layer (Weaver)

Techniques are being developed to use VISSR and VAS data to supplement direct observations of surface temperature and dewpoint fields. The MCC case of 21 June 1984 is being used for initial efforts, and results thus far are mixed.

c) Vertical Wind Shear in Severe Convective Environments (Purdom)

Work continues in this area. PROFS has implemented a program to do storm relative motions with satellite data in a storm relative frame. This capability will be available for evaluation during the PROFS real-time '85 experiment. Work continues at RAMM Branch to combine the vertical windshear information in the storm environment with the sounding data from VAS to compute instability parameters.

11. Mountain Wave Study

a) Mountain Wave Study (Lubich, Weaver)

A program to read Wisconsin SSEC tapes, and assign navigation, was completed by D. Lubich. An IRIS subroutine to move the cursor on the COMTAL to a designated lat-lon position (on a navigated satellite image) was completed by J. Behunek (CSU). A program (plus large data file) to specify lat-lon values for a given 3-letter station identifier was written by J. Weaver and D. Lubich. Together, these programs allow for precise analysis of supplemental data (such as surface obs, aircraft data, profiler readings, etc.) with respect to satellite imagery. Work has now begun on combining air mass analysis with the satellite data from the mountain wave case of 3 February 1984.

RISOP data were collected in support of the mountain wave study on 15 February 1985. The case involved only moderate wave clouds and no strong downslope winds occurred.

12. Mesoscale Analysis Utilizing VAS (Zehr)
Work continued with the VAS retrieval data sets from the 21-22 June 1984 and 14-15 July 1984 case studies.

It was found that VAS retrievals can identify the important differences among air masses for both synoptic-scale and mesoscale features. Radiosonde and conventional data along with satellite imagery helped delineate boundaries, and also indicated the air mass features revealed by VAS retrievals. The VAS data sets provided horizontal detail and time change information not available in the conventional data.

Analysis of various additional time periods and refinements of earlier analyses were complete.

13. Research Tools

a) PC Workstations (Green, Lubich)

A focused effort continues in preparing for a reliable operational system for the May/June Pre-Storm experiment. The newest software tools and changes added to the PC VAS workstation included more automated communication capabilities, better image display, and routines to add cursor operations. The cursor operations were written in the RAMM Branch and include an "image dump" routine (the line-element location of the cursor and the value of the pixel at that location), a 2X- and 4X- zoom of an image about a cursor position, and a histogram routine which uses an interactively selected rectangle for data selection. All new routines were integrated into a demonstration to be given at the AMS conference in January 1985.

b) Additional IBM PC Program (Zehr)

Programs were developed to: plot a difference field from any two parameters in the retrieval set; print out the average of a parameter over the entire VAS data set, so that diurnal variations can be evaluated; and plot low level moisture fields based on the "split-window" algorithm (Chesters, et al, 1983) and a similar simplified algorithm. Future research is anticipated to improve low level water vapor fields derived from VAS data.

14. 28 March 1984 - Carolina Tornado Outbreak (Purdom, Weaver, Lubich)

Work continues on this case. Based on AVHRR data from a pass that occurred at 2054 GMT, TOVS data have been acquired so that soundings could be derived in areas where distinct local air masses are expected to exist based on interpretation of GOES 1 km resolution data. An extensive case study was presented at the training workshop presented to the Air Force by RAMM Branch in Omaha from February 25 through March 1, 1985.

15. Kansas/Oklahoma Pre-Storm (Green, Purdom)

The RAMM Branch staff was actively preparing for participation in the Pre-Storm Experiment which is to take place May-June 1985 with the operations center at Oklahoma City airport. The Development Laboratory of NESDIS is in charge of providing satellite data and forecasting support for Field Operations. The four members of the RAMM Branch plus Gary Wade of SDAB will provide continuous coverage for the experiment. Personal computer workstations will
serve as access and display devices for real-time VAS retrievals and VISSR imagery.

16. Product Development with VAS (Zehr)

In search of better ways to apply VAS retrievals to nowcasting, existing IBM-PC software was modified to compute additional parameters with the sounding analysis package and to plot and analyze parameters for an entire data set.

Products such as fields of position buoyant energy which are determined by vertical profiles of temperature and moisture, as opposed to single level parameters, are more useful for convective nowcasting. Product evaluation is ongoing at RAMM and will also take place in Summer, 1985 with the Pre-Storm and PROFS RT85 experiments.

II. Publications

A. Conferences/Technical Meetings


III. Meetings/Lectures

A. List of Attendance at Meetings and Conferences

Woolf  Completed installation of TOVS system on computer for Bangladesh in Washington, DC on January 1-5, 1985.
Lewis

Participated in long-range planning workshop for tropical analysis in Monterey, California, January 2-8, 1985.

Howell


Purdom

Travelled to Madison, Wisconsin from February 3-8 to coordinate Pre-Storm and NOVA activities with SDAB and ASPP. While in Madison, he presented a CIMSS colloquium on uses of satellite imagery and sounding for severe storm studies.

Hayden, Woolf


Hayden, Woolf

Assess hardware/software needs at IMD/NSRA for direct readout TOVS soundings in New Delhi, India on February 23-March 4, 1985. Hayden presented seminar on quantitative data from satellites.

Hayden, Lewis


Purdom

Attended the NOVA meetings and gave presentation on NOVA activities at CIRA on March 12-13 in Washington, DC.

Purdom

Attended the NESDIS R&D Council on March 14 at the World Weather Building. Spoke on Pre-Storm and research activities at RAMM Branch.

Herman


B. Presentations

Green

IBM-PC equipment demonstration the International Conference on Interactive Information & Processing Systems for Meteorology, Oceanography & Hydrology in Los Angeles, California, 4-7 January, 1985.

IV. Visitors

Systems Design and Applications Branch


Regional and Mesoscale Meteorology Branch


2. Robert A. Maddox, NOAA/ERL. To discuss ongoing RAMM Branch research and the Pre-Storm experiment. March 18, 1985.

02/CMH4/30
Quarterly Activities Report  
April-June 1985

I. Research Progress

System Design and Applications Branch

1. Atmospheric Sounding

a) TOVS Retrieval (Hayden, Woolf, Achtor)

To accommodate the Indian Meteorological Department's desire to implement a direct readout TOVS retrieval processing scheme, the statistical "Export Package" was reinvented and provided to Mr. P. Khanna who visited SDAB during April and May.

The failure of the longwave channels on NOAA-9 necessitated preparation of a microwave-only processing system for support to the National Hurricane Center during the summer/fall. Ingest, processing and display systems were all prepared and tested.

Additional Bangladesh case studies were conducted to fine-tune the algorithm for conditions of high terrain, hot ground, and the lack of conventional surface data endemic to that region.

b) VAS Retrievals (Hayden, Wade, Schreiner)

Three modifications were made to the cloud handling of the high resolution VAS processing for Kansas City. First, any observation where channel 12 (4 micrometer window) is colder than channel 8 (11 micrometer window) by four or more degrees in brightness temperature is considered to be cloudy. This change is primarily to identify low stratus cloud before sunrise (i.e., the first sounding period at 1048 GMT). Second, the pressure height assignment of the cloud was changed. Previously, this was found by matching the channel 7 (12 micrometer) brightness temperature to the closest temperature in the 40 level first guess profile. Day-to-day operations suggested that these heights were too high, and a change was made to (arbitrarily) raise the pressure one level. Finally, the practice of saturating the atmosphere at the level of the cloud and blending with the surface dewpoint below was abandoned since cloudy soundings appeared to be consistently too moist. A fourth change was made to improve low level structure for the morning sounding. In normal processing, the surface air temperature (from the surface network) is blended with the first guess profile up to 850 mb. The blending is no longer done for soundings over land before dawn. This usually results in a low level inversion.

The effect of the filter wheel heating of GOES-6 was periodically monitored by examining calculated vs. observed brightness temperatures for the 11, 14, 17, 20 and 2300 GMT dwell soundings. During April and May, the diurnal variation was substantial, cooling the transparent longwave channels and
warming the shortwave. A diurnal adjustment was considered, but not implemented in the retrieval algorithm, because of our desire to maintain a uniform product from day to day. In early June, transparent VAS procedures were changed to turn the filter wheel on earlier in the morning to permit a more uniform temperature during the most important sounding period 11-1700 GMT.

The high zenith angle transmittance calculations received from Neuendorfer and Chalfant were converted into a new transmittance model which was briefly tested and implemented in the operational retrieval model. No definitive study of the effectiveness of high angle retrievals has been accomplished.

2. Data Assimilation and Evaluation

a) Wind Height Adjustment (Lewis)

The recursive filter analysis program provided by Purser has shown itself to be superior to the 2-pass Barnes scheme which has been used in the project. It will therefore be incorporated into the adjustment model which will use it to analyze all wind fields (cloud and water vapor tracers and gradient estimates from the height fields generated from VAS). The adjusted fields will be produced by a least squares fit of the tracers and the gradient shear vectors.

b) Raob-VAS Coupling (Lewis)

As promised, the coupling program has been extended to include winds through the thermal wind equation. The algorithm is formulated as a variational least squares fit to (1) a guess radiance (from analyzed temperatures) and observed radiances, (2) a guess temperature and final temperatures retrieved from the adjusted radiances, and (3) the thermal wind equations relating the unadjusted raob/cloud drift/water vapor winds with the final temperatures. The governing adjustment equations are solved by using optimization methods; steepest descent and conjugate gradient have been tried.

Experiments are currently limited to the infamous 6 March 1982 data set which has not proven satisfactory, despite relatively strong thermal gradients. Large gaps in suitable observed radiances exist in cloudy areas, and there is not a good set of satellite tracer winds to use. Results obtained using VAS with raob are not notably better than using raob alone. Another case is being sought.

c) SSM (Mills, Callan)

The second phase in preparing an assimilation system on the McIDAS has been completed insofar as incremental analysis has been implemented. This has two aspects: (1) interpolate (and add) analyzed changes to the sigma system (to reduce interpolation errors), and (2) keep divergent motion components of the model and re-analyze only the non-divergent portion.

d) Objective Analysis (Purser)

Some modifications have been made to the observation clustering procedure for the Bayesian analysis, and these changes are being tested on simulated satellite data. Changes in the formulation of the empirical recursive filter analysis have led to greater efficiency and may allow the scheme to be extended to a multivariate analysis.
3. Experimental Studies

a) High-resolution Interferometric Sounder (Howell, Woolf)

HIS software development continues to be carried out on the IBM PC to permit portability for flight testing and evaluation. Software development progressed from graphics display, completed by the end of April, to include: reading, auditing and copying of "3M High Capacity" cassette tapes, assembling interferograms from the multiplexed data on cassettes (or disk), computing spectra, co-adding spectra, computing standard deviation of spectra, and the extraction and display of all engineering data. The software for copying the cassettes to nine-track tape should be completed and implemented during July.

Activities for this quarter include integration and testing at SSEC and U-2 flight tests based at Moffett Field, California and Forbes Field in Topeka, Kansas. Following these flights, additional testing and evaluation was done at the University of Denver.

In support of the experimental data, the ability to access raob data from McIDAS and subsequently compute the corresponding atmospheric spectra and interferograms was established. The economical (in terms of coefficient storage requirements) tranmittance model proved to be unstable when applied to arbitrary radiosonde profiles. Consequently, a procedure was adopted in which spectra are calculated from raobs on the IBM/4381 with the full regression model, and transferred to the PC for manipulation and comparison with aircraft data.

b) IBM-PC Software Development (Howell, Wade)

Some modification of software was necessary for the installation of the VAS-PC Workstation Software on the IBM-PC/AT with the enhanced color-graphics. During May and June, a PC workstation for accessing and displaying satellite data was installed by RAMM Branch personnel at the Pre-Storm field experiment Operations Center at the Oklahoma City airport. SDAB was responsible for providing satellite images and retrievals routinely on the McIDAS which could be automatically accessed on a scheduled basis by the workstation. The data were pre-formatted in compressed files which could be accessed via modem in a reasonable efficient manner. RAMM (see 11 and 13b below) provided PC software for a number of displays which included real time looping of visible, infrared window (11 micrometer), and infrared water vapor (6.7 micrometer images as well as plots of satellite sounding values and derived parameters. These displays were all part of the RAMM Branch "sounding analysis" program and were applied to now/forecasting in support of pre-storm activities.

4. Earth Radiation Budget

a) ERBS (Herman, Nagle)

Two new ERBS data tapes were received from Langley for comparison and validation. Scanner data from one of these has been intensively examined, revealing the following problems. (1) The cloud algorithm misinterprets as clear a cloudy area off the west coast of the U.S. (2) Banding seen in the images of long wave unfiltered, filtered, and top of the atmosphere flux values suggests that the offset is incorrectly determined. (3) Short wave top of the atmosphere estimates near the horizon are not adequately adjusted for viewing angle.
The longwave scanner data were compared with VAS channels 7 and 8 (12 and 11 micrometer) MSI on a one degree grid for a tropical and a mid-latitude sample. In spite of the problems mentioned above, a correlation of .9 was achieved between these two data sets although the VAS showed less flux in cold cloud regions and more in warm ocean regions.

5. Synoptic Applications

a) Satellite Winds (Stewart, Hayden, Veldon)

A memorandum written 28 March 1985 discussed the accuracy of water vapor winds generated during the EPAC exercise and also the "operator dependence" on the quality. Unfortunately, this report was entirely too candid and did great damage to the credibility of this valuable source of data. It may be a long road back. The first step has been taken in the preparation of a paper on water vapor winds derived from METEOSAT imagery for a FGGE data set. The paper will be presented at an International Winds Workshop at Columbia, Maryland in late July.

b) TOVS Access (Woolf)

Support for case studies and real time backup involves obtaining the TOVS data from the Suitland computer complex. The transfer of operational TOVS processing from the IBM 360/195 to the NAS-9000 computer system, and the elimination of the TBM as an online storage medium necessitated major re-design of the procedure used to acquire L-B data from Suitland.

6. Mesoscale Applications

a) TOVS AVHRR Amalgamation (Taylor, Hayden)

The method of introducing AVHRR data into the TOVS retrieval was generalized to the point where a file containing scene information for the HIRS FOV can be efficiently preprocessed. The file is accessed by the retrieval program for cloud and surface temperature information. A number of statistical techniques for determining single scene, two scene, and multiple scene FOV have been examined, including methods for isolating the temperature of these scenes. A semifinal (?) algorithm has been developed. The June 7th case previously reported at the TOVS-II conference has been reworked several times and a new case of 28 March has been added. Based on these cases, a preprint has been prepared for the Hydrology Conference to be held this fall. The primary result of the study is that the addition of AVHRR appears to have little effect on retrieval accuracy with respect to depicting the synoptic scale. This is probably the result of heavy dependence on microwave in the retrieval algorithm. At the subsynoptic scale, however, the AVHRR appears to be very useful, especially for retrieving low level moisture.

7. Support to Operations

a) TOVS Navigation (Nagle, Hayden)

At the urging of Dr. Brian Taylor, SDAB has taken a mild interest in the T-BUS IV navigation which has shown a propensity to degrade somewhat more rapidly than it should. A number of memos have been exchanged with the
Satellite Navigation and Sensor Calibration Branch in a still unsuccessful effort to locate the exact source of the error. However, some progress has been made. Interpolation algorithms applied to the NORAD parameters have been exonerated. The problem seems to occur when the interpolated parameters are transcribed to disk.

b) TOVS Longwave Detector Noise (Nagle)

The longwave noise problem observed in NOAA-9 data has been under intensive investigation. Software has been completed whereby the spectra of all 12 longwave channels can be examined on the McIDAS terminal for a composite scene (or calibration). The displayed spectra clearly show the noise in the data (at a wave number of approximately 12), especially in the more opaque channels. Additional software is being prepared to permit the removal of an operator-elected percentage of the signal at any wavelength. This will be used to prepare filtered data which will be inspected as images and as retrieved meteorological parameters.

Regional and Mesoscale Meteorology Branch

8. Training Programs

a) Severe Weather/Satellite Meteorology at Camp Springs, Maryland (Purdom, Zehr)

J. Purdom and R. Zehr conducted an advanced satellite training workshop in Camp Springs, Maryland, 20-24 May 1985. The purpose of the class was to train Air Force weather forecasters in various aspects of satellite data applications, including a detailed VAS case study. There were two 2 1/2 classes with about 35 participants in each. Post training critiques by attendees were extremely favorable.

b) PROFS Real-Time 85 Forecaster Training (Purdom, Weaver, Zehr)

Satellite training for PROFS Real Time 85 forecasters took place on April 4-5 in Boulder. RAMM trained on the uses of VISSR and VAS data for nowcasting. All Real Time 85 forecasters took part in the training, and their critiques were favorable. A letter of thanks was sent by Sandy MacDonald, Director of PROFS to NESDIS.

9. PROFS

a) Satellite Product Working Group (Weaver)

The product description books for satellite products in use on the PROFS workstation which were prepared by RAMM were distributed to PROFS at the April 9 working group meeting. This was done so that the booklets would be available for the PROFS Real Time 85 exercise. In the booklet, each product was described along with an example of that product.

b) PROFS Summer '85 Nowcast Exercise (Staff/RAMM Branch)

The PROFS 1985 real-time (RT85) forecast exercise will run from 15 May to 23 August. The broad objective of this exercise is to evaluate forecaster's
ability to improve short range forecasting and nowcasting using advanced data sets and an interactive forecaster workstation.

The workstation available during the RT85 exercise will incorporate improvements over the past year's workstations. These upgrades include the introduction of VAS data, improved WPL ground-based profiler data, and increased temporal and spatial resolution CP-2 volumetric reflectivity and Doppler radar data. RT85 is further enhanced by the addition of computer guidance for precipitation forecasting, hail detection algorithms, and improved manipulation of raw data by interactive processes. RAMM staff will participate as forecasters during the exercises.

10. Mesoscale Convective Environments

a) Cloud Top Characteristic Studies (Weaver)

Work continues in this area. Selected cases from the Kansas/Oklahoma PRE-STORM Experiment will be included in this effort.

b) Mesoscale Convective Climatology (Weaver)

Arrangements were made for the CSU groundstation to collect a 1700 GMT and 2130 GMT image each day for 45 days beginning on 10 July. The sector will be a 512 x 512 area centered on Denver. The purpose will be to develop improved compositing methodologies with a high quality data set.

c) Boundary Layer (Weaver, Zehr, Purdom)

Mesoscale air mass analysis performed for 21 June 1984 was described and discussed in a paper by Weaver, Zehr and Purdom. The paper will be included in the preprint volume of the upcoming 14th Severe Storm Conference. The technique uses surface observations, VAS, IR and H_2O data and cloud information to construct a detailed boundary layer analysis.

d) Vertical Wind Shear in Severe Convective Environments (Purdom)

Work continues to combine the vertical windshear information obtained using rapid scan satellite data in the storm environment with the sounding data from VAS to compute instability parameters.

11. Kansas/Oklahoma PRE-STORM (RAMM Branch)

The RAMM Branch staff participated in the PRE-STORM Experiment which took place May-June 1985 with the operations center at Oklahoma City airport. The Development Laboratory of NESDIS was in charge of providing satellite data and forecasting support for Field Operations. The four members of the RAMM Branch plus Gary Wade of SDA provided continuous on-site coverage at the PRE-STORM Operations center for the experiment. Several good Mesoscale Convective Systems occurred during the project period with a wealth of data being archived. The use of the Personal Computer workstations for satellite data support worked well in an operational environment, although several minor problem areas were pinpointed which will require further development. The assessment of VAS data utility in an operational, mesoscale forecasting environment pointed to several products and techniques which have prospects for the future.
To aid in follow on research and product development activities, several TIROS data sets have been requested from the Wallops CDA.

12. Mesoscale Analysis Utilizing VAS

a) (Green, Weaver)

Data from a mesoscale convective complex event (from PRE-STORM) on 6 May 1985 were synthesized into a case study for presentation at the 14th Conference on Severe Local Storms in October. Results of the study indicate that VAS data can be used effectively in isolating "threat" areas in certain convective situations. VAS data provide an important supplement to other data sources in terms of locating regions with actual convective potential.

b) Product Development with VAS Soundings (Zehr, Purdom)

Plots of thermodynamic sounding parameters derived from VAS were analyzed for two 1984 case studies and from the data sets collected for the PRE-STORM project. The integrated water vapor in the lowest kilometer from VAS in addition to energy computations based on parcel theory have shown promise of being particularly useful products. Positive area (buoyancy) computed from a parcel mixed through the lowest kilometer and positive area computed from the CCL (Convective Condensation Level) are both used as estimates of convective potential. Negative area (both above and below the LCL) is used to estimate the lift required to trigger convection. Heating energy needed to reach CCL and convective temperature are used as estimates of heating required. How to best apply these parameters to forecasting nowcasting problems and an evaluation of their characteristic values, diurnal variations, etc., are primary research goals during the upcoming months.

c) Product Development with VAS Imagery (Zehr)

VAS MSI data sets were collected for continuing product development utilizing VAS-Channels 10, 7 and 8 (water vapor imagery).

13. Research Tools

a) CSU VAS Ingest (Green)

The ingest hardware and software continue to function as designed to provide archiving of both MSI and dwell sounding data. The display software for the MSI data has been completed with only a few earth location problems to be resolved. The processing of dwell sounding data into a data base suitable for VAS retrieval processing awaits programming resources. Alan Lipton, Ph.D. student in CIRA, is archiving a set of VAS data for use in his research topic.

b) PC Workstation (Green, Lubich)

An operational version of the PC VAS workstation software was completed for the start of the PRE-STORM field project based in Oklahoma City. The final configuration used two identical PC workstations. At power-up, the user could choose one system to run the automatic communications scheduler to provide unattended product acquisition from McIDAS. The other PC was set-up to be the meteorological workstation to display loops of VIS, IR and water vapor imagery,
and to process and display VAS retrieval products. As new products were acquired on the communication system, the user could transfer and update the workstation.

A major hurdle had to be overcome during April when the McIDAS system's programmers installed a new "Data Access Facility" (DAF) to provide easier product access through a dial-up modem. The new DAF software did provide better product access, but had not been thoroughly debugged. The problems caused the dial-in ports to be locked out of the McIDAS system until an operator manually restarted the McIDAS software. This caused many problems at PRE-STORM for satellite data support during nights and weekends.

Other PC developments during the quarter included the delivery to CIRA of an IBM PC/AT, networking hardware for the PC's and new higher resolution graphics adapters. The IBM Professional Graphics Adapter was installed and tested with a demo program the end of June. First impressions indicated that this adapter had significant improvements over the current color card that would improve utility of satellite image display on a PC. It has a 640 x 480 x 8 bit resolution with 256 colors displayable out of palette of 4096. Further evaluation of the new color graphics systems for the PC will be made during the next quarter.

c) CSU/CIRA Interactive Research Imaging System (IRIS) (Green, Purdom)

A major computer system upgrade has been announced which will greatly increase the computing power available for satellite data handling and processing. The ingest PDP 11/34's will be replaced with VAX 11/750's and all computers will be connected via a "cluster" arrangement providing very high speed data sharing. All equipment is to be delivered by the end of 1985 and the ingest systems ready to handle the GOES mode AAS data format. A special ceremony in celebration of the DEC equipment acquisition took place on June 28 at the CSU Atmospheric Science Department.

14. 28 March 1984 - Carolina Tornado Outbreak (Purdom)

Work continues on this case. Based on AVHRR data from a pass that occurred at 2054 GMT, TOVS data have been acquired at CIRA, and soundings have been derived in areas where distinct local airmasses have been found to exist based on interpretation of GOES 1 km resolution data. An extensive case study was presented at the advanced satellite training workshop in Camp Springs, Maryland. Two papers based on this case will appear in the 14th Severe Storm Conference preprint volume.

15. Microburst and Severe Thunderstorm Project (MIST) (Purdom)

The MIST project, under Dr. T. T. Fujita, is designed to study microbursts and severe thunderstorms in the moist environment of the southeast United States. The project is to take place in the Huntsville, Alabama area and will employ multiple Doppler radars, satellite data, mesonet data, mesonet soundings and research aircraft. RAMM will be participating in research aircraft flights to investigate thunderstorm outflow boundaries.
16. Texas Experiment (TEXEX) (Purdom)

TEXEX is an experiment in which satellite, research aircraft and Doppler Lidar data are being used to investigate dry lines and frontal density current structure in West Texas. The field experiment took place during May 1985. RAMM Branch/CIRA is involved in both the field experiment and follow-on research portions of the experiment.

II. Publications

A. Conferences/Technical Meetings


B. Books/Journals


III. Meetings/Lectures

A. List of Attendance at Meetings and Conferences

Lewis

Green, Purdom  
Attended the CSU/CIRA Satellite Project Retreat 19–21 June 1985. Several planning sessions for the coming year were held. R. Green presented a lecture titled "Use of Microcomputers in PRE-STORM Field Studies - 1985." J. Purdom presented a lecture titled "Mesoscale Forecasting Research" and summarized "Short Range Forecasting Including Severe Storms."

Herman  
Attend the 16th ERBE Science Team Meeting in Hampton, Virginia on June 23–26, 1985.

B. Presentations

Purdom  
Attended the Second International Satellite Direct Broadcast Services Conference in Washington, D.C., April 15–19, 1985. At the conference, Jim gave an invited presentation on "Using GOES Imagery and Satellite Sounding Information for the Short Range Forecasting of Thunderstorms and Severe Weather." Several posters illustrating work being done at CIRA that were displayed during the conference drew a positive response.

IV. Visitors

Systems Design and Applications Branch

1. P. N. Khanna, Office of the Director General, Director of Meteorology, New Dehli, India. To study the algorithm for derivation of vertical soundings/direct readouts. April 22–May 31, 1985.

02/CMH8/qrpt.6
Quarterly Activities Report
July-September 1985

I. Research Progress

System Design and Applications Branch

1. Atmospheric Sounding

a) TOVS Retrieval (Hayden, Woolf, Achtor)

Dr. Brian Taylor of the New Zealand Meteorological Service completed his tenure as a visiting scientist. He left the CIMSS with a system for combining the AVHRR data with the TOVS. The system was most recently exercised in processing the 31 May 1985 orbit over Ohio, Pennsylvania and New York for the severe weather outbreak of that date. It has been demonstrated that the AVHRR makes possible reliable single fov TOVS retrievals.

b) VAS Retrievals (Hayden, Wade, Schreiner)

Routine processing for the NHC was conducted during this period. The retrieval algorithms were not changed except to add a capacity for varying the radiance bias vector according to the time of day. This change had been considered during the NSSFC support but not implemented in order to continue a uniform product. It became apparent, however, that at least for GOES-6 a diurnal adjustment is absolutely necessary for compatibility with the radiosondes. Archived data from GOES-5 is being investigated to see if the diurnal variation is common to both satellites or an effect of the broken servo on GOES-6. Early indications are that GOES-5 also suffers from a sun angle dependent bias.

The procedure used to edit objectively the VAS retrievals during the NMC support over the eastern Pacific was investigated for possible application in the NHC processing over the western Atlantic and Caribbean. It did not work well and was not implemented. The subtle gradients of the 1000–500 mb thickness over the tropics are not well suited to the editing algorithm and it is frequently at odds with the opinion of the operator.

The recursive filter objective analysis was extensively tested in parallel processing of the VAS data during this period. Objective analysis is used to provide surface fields (pressure, temperature, dewpoint) and constant pressure geopotential surfaces from which gradient wind estimates are calculated. The recursive filter has demonstrated a clear and consistent superiority over the product achieved with the McIDAS Barnes scheme in operational use. Beginning with the EPAC processing all processing software will be changed to use the recursive filter.
2. Data Assimilation and Evaluation

a) Raob-Vas Coupling (Lewis)

Difficulties which were reported with this project previously have led to a number of changes in the procedures. A more realistic treatment of the boundary term in doing the forward calculation (temperature to radiance) has significantly improved the low level temperature fields. Also, a floating boundary condition during the variational adjustment has permitted a less tortured fit to both wind and radiance observations. However, results obtained with the system remain disappointing in that the satellite radiances observations do not recover temperature gradients which are intentionally smoothed from the first guess fields. The next step will be to simulate high density radiance fields to use in place of the analyses of observed radiance measurements to see if the algorithm can respond to "accurate" measurements.

b) SSM (Mills, Callan)

The SSM has been used on a number of cases to exercise its flexibility prior to introduction in January 1986 as the McIDAS continuous assimilation model. In particular, it was used to make quasi real time assimilation of VAS temperature and cloud and water vapor winds for Hurricanes Bob and Elena. These runs required varying the domain and the model resolution on a day-by-day basis. Very few problems were encountered and the satellite data were shown to have a strong positive impact on hurricane trajectory forecasts made from the model generated forecasts.

c) Tropical Analysis (Lewis, Derber)

The tropical analysis system which blends VAS geopotentials and satellite derived winds into a deep layer mean wind field is being extended to include a barotropic version of John Derber's adjoint adjustment model for time coupling over the six hourly observations made with the VAS NHC processing. John Derber will be working with CIMSS through December at which time the system is expected to be complete.

d) Objective Analysis (Purser, Hayden)

The recursive filter objective analysis program has been modified to allow a background field to enter as observations with the same implicit weight as normal observations. This appears to be an effective if inelegant way of incorporating forecast information.

3. Experimental Studies

a) High-resolution Interferometric Sounder (Howell, Woolf)

Since the end of the last quarter, U-2 aircraft flights have been conducted from NASA Ames Research Center in California over the Pacific Ocean, the valley region of California, the Great Salt Lake and the plains of eastern Colorado. In support of these flights, the PC software for the HFS experiment has grown to include more automatic processing of data from both magnetic cassette and PC disk. The software for copying data from 3M
High Capacity cassettes to 9-track computer compatible tapes has been completed, and used for a small amount of data. The intermittent operation of the (obsolete) 9-track drive has prevented any extensive copying of data tapes. Hopefully, this will either be improved by repair/adjustment of the 9-track drive, or the purchase of a more reliable unit. In the meantime, data transfer software has been developed to encode binary data into ASCII text for transmission to McIDAS. A number of additional software tools have been created to enhance the experimenter's examination, screening, modification and evaluation of data. Some examples are: (1) the zeroing of portions of the raw interferogram in order to eliminate noise and demonstrate the concept of partial scanning; and (2) the conversion of software to process data in the real mode for improved precision.

b) IBM-PC Software Development (Howell, Wade)

During this quarter, most of the PC software development has been done by our visitors from the PRC, namely Hu Yuliang, Wu Shiaoming and Zhou Fengxian. Their efforts have been directed toward the development of menu-driven software for the purpose of acquiring, processing and displaying Profiler and Mesonet data from the PROFS data base. This software package has recently been included in what is now called the MET-PAK, which is the result of the VAS PC workstation software as originally assembled, and the modifications utilized during PRE-STORM. Our emphasis during the latter portion of this quarter has been on the correction and consolidation of our PC software in an effort to arrive at a software package (e.g. MET-PAK) for distribution as well as the establishment of a key person/key computer as a focal point for maintaining the latest version of our PC software. This person is Gary Wade. We expect to be delivering MET-PAK to selected outside users during the next quarter.

c) ERBS (Herman, Nagle)

Langley has released to the science team a second version of the Processed Archive tapes (PAT) for several test days. Raw data from the scanner remains unchanged in the new version, but some of the algorithms used to process the data into "top of the atmosphere" flux have been modified. The modifications have made an improvement, but some problems are still obvious in the imaged product. For example, there is still some banding, parallel to the scan, in parts of the image. Comparisons between scanner, medium fov and wide fov estimates has begun.

4. Synoptic Applications

a) Satellite Winds (Stewart, Sorenson, Velden)

A satellite wind date set was produced routinely, five days a week for NHC support. These include low level winds from the visible and high level winds from both ir and water vapor imagery. Gradient winds from the VAS were also available, but these received little weight in the final edited set because they continue to be unreliable in many situations in the tropics.
5. Mesoscale Applications (Hayden)

The 28 March 1984 case study was completed for single fov TOVS retrievals using the AVHRR. To increase sensitivity, the microwave channels were suppressed for the second pass of the "simultaneous" temperature/moisture solution. It was discovered that the suppression had a significant effect on the retrieved moisture at middle levels of the troposphere. The reason for this is that one of the microwave channels and one of the HIRS moisture sensing channels receive contributions from approximately the same layer of the atmosphere (53.7GHz and 7.3um). The microwave is given a lower a priori noise estimate and its measurement is therefore more closely fit in the retrieval, at the expense of the HIRS measurement if the two happen to disagree. This has the unfortunate result that the microwave, which does not sense water vapor, can have a very significant impact on the moisture retrieval.

6. Support to Operations

a) TOVS Navigation (Nagle, Hayden)

The effort to locate the problem with the TBUS navigation continues without a great deal of success. The Satellite Navigation and Sensor Calibration Branch has assigned the problem to an out-of-house contractor, but we shall continue to work on it in the interest of better understanding our McIDAS navigation prediction model, and also to document precisely the nature of the problem.

b) TOVS Long Wave Detector Noise (Nagle)

The software for man interactive noise removal from the NOAA-9 TOVS was completed and applied to several orbits received from SOC. Visual inspection of the fields of brightness temperature after application suggest that the method is effective. However, there does not appear to be any way to make the technique objective because of the case to case variations in the noise. Thus, the method would not appear to be suitable for routine operations but only for detailed case studies.

c) AMSU (Woolf)

The line-by-line microwave transmittance model provided by Norm Grody and Mike Hill was implemented on the McIDAS and used to generate a "fas" regression model for the AMSU. The algorithm is similar to the McMillin-Fleming-Hill model used for HIRS and VAS carbon dioxide transmittance calculations with additional terms to account for water vapor as well as temperature dependence. Model results agree very well with the line-by-line calculations for a large variety of atmospheric profiles and the range of zenith angles appropriate to a NOAA orbit and scan pattern.

II. Publications

A. Books/Journals

III. Meetings/Lectures

A. List of Attendance at Meetings and Conferences


Woolf  Installation and checkout of TOVS export package in Dacca and training for Bangladesh scientists, July 30 - August 15, 1985.


IV. Visitors

Systems Design and Applications Branch

Quarterly Activities Report
October–December 1985

I. Research Progress

Systems Design and Applications Branch

1. Atmospheric Sounding

a) VAS Retrievals (Hayden, Wade, Schreiner)

Routine processing for the NMC was conducted during this period after GOES 6 was returned to 108W (8 November 1985). Retrieval algorithms were not changed, but some of the ancillary programs were. As reported previously, the success of the Recursive Filter Analysis suggested its substitution for the Barnes. This affects the surface parameter analyses, the objective editing, and the gradient winds (the latter very slightly). Another change, in comparison with the previous EPAC exercises, is the use of the Global Forecast from NMC to provide first guess temperature and moisture profiles. Previously, we have used the TOVS soundings; but with the failure of NOAA 8 these are no longer sufficiently timely. Coverage was expanded to include the Gulf of Mexico since the NMC indicated some interest in monitoring this moisture source.

The requirement for an NMC product as part of the processing has caused a considerable deterioration in our ability to provide timely products. Access of the Global Forecast initiated at 00 GMT from Suitland has been sporadic, and without this the processing cannot begin. The ongoing software/hardware modifications for accessing NMC products continues to be the thinnest bottleneck in the operation.

EPAC retrievals have not been well received at the NMC. They have consistently cooled the troposphere with respect to the first guess (300–700 mb) and consistently warmed the lower stratosphere (100–300 mb). Somewhat the same tendency appears with respect to TOVS data. These features tend to break down ridges and deepen troughs, especially the latter. Since the NMC considers this to be an error, they have chosen not to use the data operationally. The VAS on GOES 6 has a well-documented radiance bias problem and we have monitored the radiances on a daily basis for both 00 and 1200 GMT. The biases at both times, though not the same, have been generally stable. There is no indication that we should change the radiance bias vectors initially implemented at the beginning of the exercise. Thus, we have no explanation for the puzzling "cooling of the guess profile", and we wait to determine that it actually is a serious error.

b) TOVS Processing (Woolf, Velden)

TOVS processing was restricted to supporting NHC during the hurricane season (ending for our purposes on 1 November). The microwave date
continues to prove useful for estimating central pressure and wind velocity, as well as for providing an initial vortex for the VASTRA forecast. However, the software used for this effort has become almost obsolete and needs refurbishing. This will doubtless be accomplished when TOVS processing becomes more routine, given access through a local antenna.

2. Data Assimilation and Evaluation

a) Raob-VAS Coupling (Lewis)

Work continues on the project to couple radiosonde winds and VAS radiances in a variational analysis of temperature at constant pressure levels. The procedure provides for variable weighting on the two data sources so that either radiances or winds can be given precedence. Disappointing results obtained with "winds" only as a geostrophic constraint led to the introduction of a gradient thermal wind constraint which appears to be considerable better. "Radiance-only" (minimum information) results are promising though typical bias problems are evident.

b) SSM (Mills, Goodman, Callan)

The SSM was exercised on a ten day data set to test the assimilation cycle with twice daily data input for the period 8 October to 18 October 1985. The experiment was not run in real time, although it was constrained to be done within a ten day period. The incremental version of the analysis system was used (i.e. changes to forecast temperature and wind are analyzed, primarily to retain the ageostrophic feature of the forecast). Cloud drift and water vapor motions, rawinsondes, and VAS temperature and moisture profiles were used. The assimilation was robust in the sense that there were no failures during the period despite some fairly dramatic data impact. The system will be more extensively exercised in real time support to the Genesis of Atlantic Lows Experiment (GALE).

c) Tropical Analysis (Lewis, Derber)

Although we had hoped to implement a barotropic version of John Derber's non-linear adjoint adjustment model for time coupling over the six hourly observations made with the VAS NHC processing, John has left the CIMSS before completing the project. It will, therefore, be necessary to fall back to the linear version. The National Hurricane Center (NHC) has been very supportive of this work and its completion is a major goal for VAS data utilization.

d) Objective Analysis (Purser, Hayden)

The recursive filter objective analysis program has been further modified with respect to using a background field. Pseudo reports are created from the background field (at optional density). These are assigned a weight (0-1) relative to actual observations. The recursive filter is gradually being introduced everywhere there is an objective analysis in the VAS processing software.
3. Experimental Studies

a) High-resolution Interferometric Sounder (Howell, Woolf)

Most of the software development efforts were concentrated on algorithms involved in the production of calibrated spectra. The most significant improvements were made by the implementation of a process suggested by H. Revercomb of SSEC, involving the retention of all information obtained in the transformation of real data (interferograms) to complex data (spectra) and the subsequent elimination of phase ambiguities and effects of background radiation from within the instrument. A considerable amount of work was devoted to the problem of screening the data, to eliminate those data which were most severely affected by the sample losses by the numerical filter (part of the HIS instrument).

Improvements in the calibrated spectra were significant when some rejection criteria were enforced. The screening process was developed for the 600–1100 wavenumber band, and must be extended or altered perhaps for the other two spectral bands.

Additional software was developed for the transfer of data and program files from the PC to 9-track tape. The venerable 9-track drive and the associated multibus microprocessor system performed well during this quarter, but some conflict exists between the 9-track interface hardware and similar hardware for the 3M cassette playback unit. The presence of the 9-track hardware causes intermittent operation of the 3M cassette drive, thus the transfer of data from the 3M cassettes to the 9-track cannot presently be accomplished directly. Most of the August '85 flight data has been transferred to flexible diskettes and/or 9-track tape.

Temperature retrievals have been obtained from the HIS observations of August 18 over the Pacific Ocean near Oakland, California. The retrievals have used measurements in the 640–960 wavenumber region (15 micron plus window) with literally thousands of "channels" applied to the minimum information solution. They are reasonably successful considering the noise of the measurements.

b) IBM-PC Software Development (Howell, Wade)

Additions to the "MET-PAK" software include the acquisition and color-coded display of manually digitized radar data. This software was contributed by Zhou Fengxian and Ma Zhen-hua, visiting scientists from the People's Republic of China. Automatic communications with the PROFS computer was also added.

The collection and organization of "MET-PAK" software with some documentation, including installation instructions and programs has been significantly advanced by Mr. Wade, and a considerable effort has been made to prepare a smoothly operating system, with many illustrative examples, for demonstration here and at the Miami AMS Conference in January 1986. The software has been distributed to a number of users:
L. Whitney, NOAA/NESDIS
R. Gird, NOAA/NESDIS
F. Zbar, NOAA/NWS
P. Pauley, UW
J. LeMarshall, NMAC Melbourne
G. Rochard, CMS Lannion

c) ERBS (Herman, Nagle)

The ERBS Processed Archive Tapes (PAT) are seen to contain coherent noise in the form of banding in the scanner records. It occurs with multiples of "main frames" which are composed of eight scan lines. It is associated with the high torque mode of the scanner motor when the satellite is in sunlight. Comparisons between the scanner and non-scanner show that mean flux values correspond fairly well. Long wave estimates are generally more similar than short wave for averages over a complete orbit. Estimates from the shortwave degrade with solar contamination, being worst near local noon. This indicates a deficiency in the bi-directional reflectance models used in the calculations.

A PAT suitable for comparison with VAS multi-spectral imaged data was received in late December. Preliminary comparisons between the VAS and ERBS scanner for the 11 and 12 micron data have been made, both yielding correlations of about 0.98.

4. Synoptic Applications

a) Satellite Winds (Stewart, Sorensen, Velden)

Satellite wind data sets (IR and water vapor motion) were produced over the EPAC area for a two week period in early December. Vectors were generated once daily near 0000Z. These data are to be used by NMC to investigate their impact on limited area forecasts.

Code has been prepared to collect "matches" of 6.7 micrometer brightness temperature and radiosonde measured temperature at the "level of best fit" for the water vapor motion as compared to the measured wind speed. A regression relationship obtained from such a sample is currently used to assign pressure heights to the water vapor motions. The dependent data set for this was collected during summer, and there is strong evidence that the relationship is seasonally dependent. The new code should make updating the regression, or at least investigating the seasonal change, quite simple. The major problem is in objectively defining the "best fit".

b) Water Vapor Imagery-Hurricane Applications (Wade, Velden)

Loops of VAS 6.7 micrometer imagery for Hurricanes Elena (27 August to 4 September 1985) and Gloria (25 to 28 September 1985) have been prepared as instructional video tapes. The animation clearly shows the interaction between the tropical storms and the mid-latitude westerlies. In the case of Elena, the imagery qualitatively explains the "erratic" storm track preceding landfall. In effect, a strong shortwave clearly evident in the imagery blocks the northwest progress of the storm until the wave (appears to) splits around the hurricane. Afterward the storm continues on its original track into the Mississippi Gulf.
5. Mesoscale Applications

a) Sounding Energy Package (Hayden)

The "sounding energy" software package was coded for the IBM 4381 compatible with the data structure formats of the McIDAS system. This package was previously adapted by Bob Greene of CIRA from PROFS to the IBM PC for use during the Pre-Storm field exercise of May and June, 1985. Because of the popularity of the package, it seemed appropriate to include it on McIDAS for further evaluation of the VAS retrievals. The feasibility of using parts of the code for creating energy "images" will be investigated as part of the support to the NOVA Kansas City SSFC.

b) VAS Derived Imagery (Wade)

The 12 May 1985 severe weather case in Oklahoma and Texas was presented at a poster session at the AMS Severe Local Storms conference in Indianapolis. Derived imagery of the total precipitable water and the lifted index demonstrated the diurnal trend toward an increase in moisture and decrease in stability in southwest Oklahoma and north central Texas where the severe weather occurred. In addition, the 0.7 micrometer imagery showed the dry intrusion aloft positioned above the moisture instability gradient.

For the upcoming Genesis of Atlantic Lows Experiment (GALE) provisions have been made to generate a daily estimate of the sea surface temperature from the VAS data at 1500 GMT using bands 7, 8 and 12 in conjunction with the VISSR visible data. A running three day composite is planned.

6. Support to Operations

a) TOVS Navigation (Nagle, Hayden)

The effort to locate the problem with the TBUS navigation continues at a fairly low level of effort. Positions obtained from the TBUS parameters have been computed for 0 to 21 days after epoch and compared to our best estimate of the true position. The latter were obtained from the NESDIS Orbital Mechanics Branch using definitive (not predicted) parameters gathered daily over a period of several weeks. Errors associated with the TBUS are exclusively along-track, with the prediction quite uniformly slow. Positions obtained from the TBUS fall behind the true positions at a rate of approximately 3.5-4 km per day.

To further confuse the issue, a separate set of TBUS parameters has been generated locally with a program that extrapolates a set of definitive parameters ahead to the next ascending Equator crossing (similar to the true TBUS). Position errors obtained using this set generally lead the true position and possess an unpredictable scatter comparable to positions obtained from the standard TBUS positions. Since the orbital period is nearly constant, it has been used to develop a simple algorithm to remove scatter by means of a Kalman filter. This algorithm is now undergoing evaluation.
II. Publications

A. Conferences


III. Meetings/Lectures

A. List of Attendance at Meetings and Conferences

Lewis

Chaired session on Remote Sensing and Meteorology and present research paper in Norman, Oklahoma, October 14–17, 1985.

Lewis

Attended Meteorology Applications of Optimal Control Workshop in Norman, Oklahoma, October 18, 1985.

Wade


Hayden

Delivered paper at 14th Conference on Severe Local Storms in Indianapolis, Indiana, October 29–November 1, 1985.

Hayden


Herman

Participated in discussions of ERBE data reduction techniques and validation in Hampton, Virginia, November 20–22, 1985.

IV. Visitors

Systems Design and Applications Branch

1. Dr. William Hooke, Director, NOAA/NESDIS Environmental Group, visited Christopher Hayden to discuss the severe weather initiative. October 24–25, 1985.
Quarterly Activities Report
April-June 1986

I. Research Progress

1. Atmospheric Sounding

   a) VAS Retrievals (Hayden, Wade, Schreiner)

   Routine processing for the NSSFC was conducted during this period beginning March 15. The major change in this operation as compared to earlier years was the production of VAS data every 90 minutes instead of every three hours. In addition, the automation of the processing was increased to include objectives instead of manual editing. The same technique developed for the EPAC processing was used whereby the reports are compared to objective analyses of thickness between 100-700, 700-300, and 300-100 mb. The analyses are produced using the Recursive Filter Analysis operating with the retrievals and a first guess provided by the National Weather Service LFM 12 hour forecast.

   A number of minor changes were made to the retrieval algorithm in the change to NSSFC processing.

   - The first guess profile is not blended with the surface temperature if a surface inversion is expected. One criterion in this decision is the solar zenith angle, and inversions are not permitted if it is less than some nominal value. This value was changed from 80 to 70 degrees.

   - Problems with the retrieval "images" of stability and precipitable water near the coast were observed when cold air temperatures reported by land stations were extrapolated into the Gulf by the objective analysis scheme. The resultant surface air analysis was too cold over the water, and this caused the surface inversion logic to be followed in setting up the guess profile. The erroneous inversion in the guess was not entirely removed by the retrieval and its effect could be seen in the images. This problem was removed by permitting the satellite-derived skin temperature to override the analysis value over water for clear fields-of-view.

   - Large changes in the skin temperature estimate produced in the iteration of the retrieval is a sensitive indication of error in the clear column radiances. The algorithm was changed to reinitialize, assuming cloud, whenever the skin temperature cooled by a fixed amount. Unfortunately, the change greatly increased the execution time, to the point where the system terminated the job, if the tolerance was set fine. The compromise value is 6° K which is certainly too high and causes many of the retrievals to be cloud contaminated.
b) TOVS Processing (Herman, Achtor)

Processing algorithms which employ the AVHRR LAC data for cloud clearing have been developed and demonstrated in the past. However, for global processing of the TOVS only the lower resolution GAC data is available. A project has been started to investigate the value of the GAC. On paper, NESDIS plans for retrievals from NOAA K,L,M include the use of GAC.

2. Data Assimilation and Evaluation

b) SSM (Goodman, Diak, Callan)

Integration of the CIMSS subsynoptic model (SSM) into reprocessing of the GALE data was emphasized during the period. Our intention is to redo the Intensive Observation Period (January 23-29 1986), fullying integrating the retrieval of VAS and TOVS data with short-term forecasts of the SSM. This has proved to be much more difficult than was anticipated, both because of coding errors in the incremental version and because of deficiencies in the precipitation physics and the vertical mode initialization procedure. In essence, the model does not yet provide a forecast guess profile for the VAS or TOVS which is in tune with those retrieval algorithms with the result that the data coverage is quite poor and insufficient to nudge the SSM back on the right path.

c) Tropical Analysis (Lewis, Welden, Van Tyle)

In preparation for support to NHC during the hurricane season, the tropical analysis system which provides a deep layer mean steering flow for trajectory calculations was revisited. For operational processing there are no planned changes from the procedures of last year. Individual level analyses at 850, 400 and 200 mb will be produced with a Barnes-type analysis, and these will be combined into a DLM using a regression relationship provided by the NHC. The resultant fields are integrated into the grid used by the SANBAR forecast system and sent to the Suitland facility where they can be accessed. Work will continue on updating this procedure. A method using Recursive Filter at individual levels and a variational blending to mutually adjust level winds and wind shear has been developed and tested with historical data, and proved to be superior. An objective editing scheme which can be accomplished with the Recursive Filter needs to be further evaluated.

3. Experimental Studies

a) High-resolution Interferometric Sounder (Howell, Woclfl)

In April, a number of flights were made on the NASA U-2 aircraft, from Moffett Field, over California and the coastal waters, and then over Arizona. The flights over Arizona were coordinated with atmospheric transmittance measurements conducted at the Kitt Peak Observatory using the Solar Telescope. Special three-hourly radiosondes were also released during that time from Tucson.

Following the April flights, the main HIS activity was the preparation for and participation in the COHMEX project which was conducted during June,
continuing into July. Participation was coordinated from the Wallops Flight Facility in Virginia. During the period, the HIS was flown on both NASA aircraft (U-2 and ER-2) with other instruments (e.g. MAMS and microwave radiometers). Video observations of the aircraft's track were also collected.

b. IBM-PC Software Development (Howell, Wade)

During this quarter the new developments were:

File transfer via asynchronous communications port using the FASTLINK modems. These modems can transfer data at a rate up to 192 BAUD, the rate depending on the quality of the line. They also include error checking which makes the transfer of binary files more reliable. The data transfer software was extended to include the remote reading of HIS flight tapes.

Following the development of software by Ralph Dedecker, of UW/SSEC, for the IBM Enhanced Graphics Adaptor (EGA) and monitor, programs were developed which automatically access satellite images from McIDAS and update the series of images on hand to form an up-to-date animated loop of images. Three products were routinely accessed for the COHMEX experiment:

1) GOES visible 16-level color-coded image
2) GOES infrared 16-level color-coded image
3) Centreville, Alabama radar

The satellite images were displayed for the COHMEX areas (southeast U.S.).

Additional software for the nine-track magnetic tape drive was developed for the purposes of backing up disk files and transfer of text and data files to McIDAS. In preparation for field operations in April (and later, in June...July), software was developed for Master/Slave communications. This arrangement allows remote reading, copying, plotting and evaluation of HIS data directly from the flight tapes as well as transfer of disk files.

c) ERBS (Herman)

Comparisons between scanner data obtained from a PAT tape for 7 February, 1985 and VAS multi-spectral data continued. The primary data area was selected over the eastern U.S. where there was a variety of cloud conditions. Using areas where the local cloudiness appeared uniform, comparison of the MSI vs. ERBS and the Dwell Sound vs. ERBS TOA (Top of the Atmosphere) estimates yielded a correlation of 0.90 in both cases. The standard error of comparison was 5.3 and 4.0 watts/m², respectively. For the dwell sound the error was improved to 3.1 watts/m² when stepwise multiple regression was used. The order of channel selection was the 12 micron window, the 7 micron water vapor channel, and the 11 micron window.

Comparison of scanner with non-scanner data showed an insignificant discrepancy of only five percent. The comparison was achieved by integrating the scanner data over the non-scanner fields-of-view. This permits a
moderate level of confidence in the data, despite lingering concern over the accuracy of the bi-directional models for the angular dependence of the shortwave radiation.

At the May Science Team Meeting, evidence was presented which showed that the striping problem in the scanner data is caused by unexplained shifts in the values of the space clamp. A solution is to discard the space clamp values.

d) Line-by-line Transmittance Model (Woolf)

The FASCOD2 (Fast Atmospheric Signature Code) model, installed during the previous quarter, was debugged and exercised successfully in the desired mode, i.e. calculation of nonchromatic transmittance looking downward. Additional software was developed to transform the results to the spectral resolution of the HIS instrument. Results of an initial test case were encouraging, and construction was begun of a data set to permit the generation of regression coefficients for use in a "faster" model.

4. Synoptic Applications

a) Satellite Winds (Stewart, Sorensen, Velden, Hayden)

The new WINDCO system for deriving winds from motion observed in satellite infrared image loops was fully integrated with the other VAS software in anticipation of its transferral to the Suitland VDUC.

b) 6.7 Micrometer Height Assignment (Stewart)

Historically, the 11 micron infrared imagery has been used to obtain high level cloud motions. Pressure heights for these vectors have been assigned manually where the operator selects a representative target with uniform characteristics (high emissivity) and derives a pressure height from the infrared temperature scaled against a temperature height profile (from climatology or a forecast/analysis). Because the procedure is somewhat cumbersome, a single determination is generally used for a fleet of vectors which appear to have approximately the same physical characteristics. This has led, perhaps, to some inconsistency in the quality of the vectors which has detracted from their credibility. During this quarter, an experimental procedure has been investigated whereby the height assignment is derived from a companion field of 6.7 microm measurements while the vectors are traced on the 11 micron images. Results show that this has the double benefit of producing more accurate height assignments while relieving the operator of the duty to make manual estimates. The technique is being incorporated into routine wind production whenever the 6.7 micron data is available.

5. Mesoscale Applications

b) VAS Sea Surface Temperatures (Wade)

At the request of NHC, SST calculations will be made over the Atlantic, Gulf, and Caribbean during the hurricane support season. Images will be constructed once daily (1800 GMT) and composited/updated.
6. Support to Operations

a) NMC Fields to VDUC (Callan)

Initial plans for the VAS Data Utilization Center (VDUC) at Suitland called for a bulk data transfer system which would receive via microwave NMC data from the main computers. In preparation, NMC software existing on the mainframe was transferred to the McIDAS to prepare a data unpacking and gridding system. Some adaptation was accomplished before it became apparent that the microwave communication would not be available for the day-one system, and this project was put on hold.

II. Publications

A. Conferences


III. Meetings/Lectures

A. List of Attendance at Meetings and Conferences

Howell
Participated in HIS aircraft experiment at Moffett Field, California from April 6-18, 1986.

Woolf
Attending VDUC coordination meeting in Washington, DC from April 8-11, 1986.

Herman
Attended 18th ERBE Science Team Meeting in Richmond, Virginia and participated in AMS 6th Conference on Atmospheric Radiation in Williamsburg, Pennsylvania on May 7-16, 1986.

Hayden

Hayden

Howell
Quarterly Activities Report  
January–March 1986

I. Research Progress

Systems Design and Applications Branch

I. Atmospheric Sounding

a) VAS Retrievals (Hayden, Wade, Schreiner)

Routine processing for the NMC was conducted during this period until March 15 when support was begun for NSSFC. Data sets were provided over the Eastern Pacific at both 12 and 00 GMT.

It was reported previously that EPAC retrievals have not been well received at the NMC. They have consistently cooled the troposphere with respect to the first guess (300-700 mb) and consistently warmed the lower stratosphere (100-300 mb), especially over the centers of major low pressure areas. We continued to monitor the well-known bias problem of GOES-6 and the bias vectors (for 00 and 12 GMT) continued to remain reasonably stable. Therefore, we did not change the biases and instead delivered a consistent product which was not used. Impact studies run by the NMC with data delivered in December were very disappointing.

The changing of the season (to NSSFC support) saw several changes to the VAS processing algorithm. Most of the changes involved the decision tree whereby a temperature/moisture retrieval is failed even though its attendant coefficients are used to generate the stability and precipitable moisture image. One of the tests involves the amount that the skin temperature is allowed to change during the retrieval after an initial "split window" guess. We find that to give reasonable retrieval coverage this needs to be at least 5K, indicating that the original estimate is not very good.

VAS images are comprised of retrieved Lifted Index (or precipitable water) in reasonably clear areas with 11 micrometer cloud images in the cloudy areas. The decision for clear/cloudy for the image is based on the difference between the 11 micron measurement and the surface air temperature estimate. After considerable argument, this tolerance has been set at 18K to minimize the amount of cloud image, even though this number is obviously far too large to avoid cloud contamination in the retrieval. The choice was made because the images are aesthetically pleasing, doubtless due to the accurate first guess retrieval profiles obtained from the LFM forecast.

An attempt to duplicate results for the previous 1985 NSSFC season was successful, but only after taking into account that we have changed the...
algorithm for calculating Lifted Index. Absolute values are quite sensitive though relative values (images) are not.

b) TOVS Processing (Woolf, Velden)

TOVS processing was routinely carried out in support of the Genesis of Atlantic Lows Experiment which extended from mid-January to mid-March. The algorithms for producing these data have not been changed in more than a year, but it did prove necessary to adjust the bias vectors for both NOAA-6 and NOAA-9.

2. Data Assimilation and Evaluation

a) Raob-VAS Coupling (Lewis, Hayden)

Work was completed on the project to couple radicsonde winds and VAS radiances in a variational analysis of temperature at constant pressure levels. The procedure provides for variable weighting on the two data sources so that either radiances or winds can be given precedence, depending on the data availability and quality. The ultimate goal has been to show that observed winds can be used to constrain the temperature retrievals and ultimately improve the depiction of horizontal temperature gradients. Experiments were conducted using both simulated and real radiance information for the 6 March 1982 AVE case. Situations with radiances only and radiances plus winds were tried. In all cases, a relatively good first guess, obtained from the CIMSS assimilation model's three hour forecast was used. Results showed that incorporation of the winds improved the result in both simulated and real data cases; though more so for the former. Results of the study are being prepared for publication.

b) SSM (Goodman, Callan)

The CIMSS sub-synoptic model (SSM) was used during the GALE project for data assimilation. For the two month period, the model was run on an almost daily basis to provide data sets to the field program. Data input included locally-derived retrievals from VAS and the NOAA polar orbiters, wind vectors from cloud motions and from water vapor tracers, as well as the surface and radiosonde data from the conventional networks. The model was run in two modes: cold-start where it is initialized using the NMC global analysis as a first guess; and incremental, where its own forecast is used as analysis input. There are still problems with the second mode. Most serious among these is a tendency to create spurious rainfall over the eastern edge of the grid where the VAS data boundary creates sharp moisture gradients. TOVS data alleviate the problem, but they are not always available. Evidently, the moisture analysis needs to be tuned.

c) Tropical Analysis (Lewis)

No activity during this quarter.
d) Objective Analysis (Purser, Hayden)

A paper describing our recursive filter objective analysis system and its uses in processing VAS data was prepared for the May conference on Satellite Meteorology/Remote Sensing and Applications to be held in May, 1986.

3. Experimental Studies

a) High-resolution Interferometric Sounder (Howell, Woolf)

Additional software for the nine-track magnetic tape drive was developed for the purposes of backing up disk files and transfer of text and data files to McIDAS. In preparation for field operations in April (and later, in June..July), software was developed for Master/Slave communications. This arrangement allows remote reading, copying, plotting and evaluation of HIS data directly from the flight tapes as well as transfer of disk files.

The evaluation of August 1985 HIS data continued, but was terminated when no way was found to improve the quality of the resultant spectra, i.e. we were unable to screen data sufficiently to eliminate the effects of sample loss. The co-adding process was improved by employing complex algebra and a new calibration scheme suggested by H. Revercomb was implemented.

Preparations were made for the April U-2 flights by installing appropriate software on several personal computers to be used in the field.

b) IBM-PC Software Development (Howell, Wade)

The "SATPLUS" (formerly "MET-PAK") software was improved and extended to include the Profiler and Mesonet data access (from PROFS) and display, and the manually digitized radar display both of which were developed by our PRC visitors. Another addition was the access of grids produced on McIDAS for local (PC) contour plotting. This grid access was limited to accessing disk files rather than initiating programs on McIDAS and was part of the package for demonstration at the AMS meeting in Miami, Florida (January).

In support of the Profiler and Mesonet data displays, county boundary data for Colorado and surrounding states was received from ERL and these data were installed in the SSEC PC's for drawing maps appropriate to the PROFS area.

Throughout this quarter, special release radiosonde data were acquired via asynchronous telephone communications in support of GALE. The data archived were for the release times of 3, 6, 9, 15, 18 and 21 hours GMT, and were significant-level data sets. Data acquisition at the onset was from PROFS, but NASA/GSFC soon became and remains the steady source of these data.
c) ERBS (Herman, Nagle)

Receipt of ERBS data on the PAT tape for 7 February 1985 from Langley allowed comparison with VAS multi-spectral imaging. Data were selected for three areas which showed uniform scenes in and around North America. A multiple stepwise regression of VAS 11 and 12 micrometer radiances fit the ERBS Top of the Atmosphere (TOA) values with a correlation of 0.98 and a standard error of 6.5 W/m². Results of this study are being prepared for the Radiation Conference to be held in Williamsburg in May.

30 PAT tapes have been received from Langley for the month of April 1985. A spot check of the first, fifteenth and thirtieth shows that the striping problem in the scanner long-wave channel is still present with errors of as much as 20 W/m². Langley maintains that the problem originates from variations in the space clamp used for calibration.

d) Line-by-line Transmittance Model (Woolf)

The October 1985 version of FASCOD2 (Fast Atmospheric Signature Code) was obtained from AFGL, Bedford, together with the latest (1982) editions of the AFGL Atmospheric Absorption Line Parameters and Trace Gas Compilations (the "McCleachey Tape"). Originally written for a Central Data Corporation machine, the software arrived advertised as configured for "enhanced portability to other computer systems." After expenditure of many tedious man-hours, the software and associated data files were installed, implemented and exercised on the SSEC IBM 4381 (McIDAS) using included test cases. Perhaps the most serious shortcoming of this package is the difficulty in setting up a run. The instructions are complicated and no examples are given. Based on our own record, however, we are hardly in a position to complain about the absence of a "friendly" user interface.

4. Synoptic Applications

a) Satellite Winds (Stewart, Sorenson, Velden, Hayden)

Software for deriving wind estimates from cloud motions or water vapor motions was completely revamped in response to numerous complaints from users who were familiar with versions on both the old Harris McIDAS and the new IBM McIDAS. (In essence the old environment was far more friendly.) The new software has most of the attributes of the Harris "WINDCO" with considerable embellishment. Chief among these is the capability to display a vector derived from a "guess" wind profile interpolated to the pressure level determined for the tracer. The operator may use this as guidance and/or quality control. Since we generally use a model forecast to provide this "guess," we shall no doubt once again be criticized for biasing the satellite data to the forecast. However, it is becoming increasingly obvious that the better use of satellite data is in close harmony with other information rather than trying to make it stand alone. This holds for both temperature/moisture retrievals and tracer vectors.

Code previously prepared to collect "matches" of 6.7 micrometer brightness temperature and radiosonde measured temperature at the "level of best fit" was made operator interactive on McIDAS to facilitate development of an objective algorithm for determining "best fit." Such an algorithm is
now in place which appears to work quite well and the collection can be made either objectively or man-interactively.

b) Water Vapor Imagery-Hurricane Applications (Wade, Velden)

Water vapor winds were made on a daily basis during the GALE period. Both 6.7 and 7.3 micrometer (channels 10 and 9, respectively) were used, the latter in an attempt to assuage the demands of NHC for motion vectors at middle levels of the atmosphere. Preliminary comparisons indicate that the 7.3 winds are indeed assigned at a lower level, but the difference is not large; perhaps 50 mb on the average. Surprisingly, some operators feel that it is easier to follow tracers with the 7.3 as opposed to the 6.7 micrometer imagery (after smoothing and enhancing). Everyone agrees that the capability of displaying a first guess vector is very helpful.

5. Mesoscale Applications

a) Data Sets

Apart from the 90 minute VAS support to NSSFC, no mesoscale data sets were produced during this quarter. Algorithm development is discussed under (1) above.

b) VAS Sea Surface Temperatures (Wade)

For support to the GALE field experiment, SST calculations were made from VAS observations off the southeastern U.S. coast. Creation and testing of processing macros were done in December and early January, with SST generation software obtained from John Bates and William Smith. The times available for the SST were limited to availability of both visible imagery as well as three "windows" from VAS (at 3.9, 11.2, and 12.7 μm). The visible was used for cloud filtering; the windows were used for the statistical calculation of the skin temperature (from previous regression studies with in situ measurements, such as buoys). The times processed were nominally 1500, 1630 and 1930 GMT. Usually only the 1500 GMT data were processed in real time. The data were stored in two formats: a digital area (or image) at full resolution, and an MD file (with quantitative values for each filtered and averaged 5x5 box). The emphasis in real-time was for the images to be displayed on the McIDAS terminal in Raleigh for consideration by the GALE personnel; feedback was basically positive. Improvements through the GALE period included use of the eight versus 16 km nominal loosening of the albedo check (without cloud resolution contamination) for better coverage; inclusion of a 11.2/12.7 μm difference cap (for thin cirrus detection); and an updating scheme (to "write" the most recent image over the previous update image, to provide a more complete image, time weighted to recent data). After GALE, the area of coverage was shifted slightly southward to cover all of the Gulf of Mexico and more of the Caribbean area; personnel at NHC have seen these SST images on their McIDAS terminal, and we anticipate that this hurricane season the VAS SST images will be a routine product for them. Data sets from the GALE IOP's (Intense Observing Periods) will be re-done (for consistency in generation, and for all time periods), and quantitative comparison with buoys and ships will be made.
6. Support to Operations

a) TOVS Navigation (Nagle, Hayden)

The study of the problem with the TBUS navigation was concluded. A technical memorandum has been prepared describing the nature of the errors associated with the TBUS, as well as providing a simple corrective procedure to significantly reduce the error. The precise source of the error was never determined.

b) Transmittance Calculations (Woolf)

The CIMMS version of the HIRS transmittance procedure, as adapted for the IBM PC, was provided to Larry McMillin of the Physics Branch, SRL, for inclusion in the growing library of PC-based remote sounding software. Our high resolution (0.1 cm⁻¹) model, originally prepared for support to the HIS research, has also been adapted for the PC by McMillin and colleagues. The CIMSS AMSU procedure, reported on previously, has been installed on the NCCF NAS-9000 system, for general use by ORA and contractor personnel working on the NOAA K/L/M ground data processing systems.

02/CMH10/08
Quarterly Activities Report
July-September 1986

I. Research Progress

1. Atmospheric Sounding

a) VAS Retrievals (Hayden, Wade, Schreiner)

The VAS processing software was delivered to the World Weather Building VDUC to initiate the transfer of data processing responsibility to NESDIS operations. This is anticipated to be completed in early spring 1987. In the meantime, the ASPP has continued to provide real-time data to NSSFC, and also to NHC as the primary recipient beginning 24 July 1986.

The only change to the retrieval algorithm introduced during this period was to assign a constant value of 0.96 to the surface emissivity over land. The previous assumption of 1. was retained over water. This change has helped to stabilize the retrieved value of the skin temperature.

A change was also made to the gradient wind calculation (as of 26 August) such that the Coriolis force is held constant equatorward of 20 degrees latitude. Previously, the limit had been 10 degrees, but the resultant winds in the tropics have appeared to be too strong.

The VAS retrievals in support of NHC have been seen to put a consistent high pressure area in the Gulf of Mexico which is not supported by other data. This is the result of mid-level warming of the guess. The cause of this warming has not yet been isolated except to note that it appears to be aggravated by the second iteration of the retrieval. This has initiated a study of the utility of the second iteration versus quality of the initial guess.

b) TOVS Processing (Herman, Achtor)

The conversion of TOVS programs to utilize AVHRR GAC in place of LAC data has begun. Programs to access and image the GAC data within the HIRS footprint have been completed, and examples of both real and simulated GAC have been processed and compared with the LAC.

c) SSM/T (Nagle)

The processed SSM/T retrievals prepared at NESDIS are being brought to McIDAS for evaluation. So far, this includes only a simple radiosonde comparison, and an "assimilation" of 1000-500 mb thickness into a SSM/T-only analysis which is run twice per day. The latter effort is complicated by the sporadic processing of the SSM/T and also by format which gives only thickness above the first level above ground (which is usually not 1000 mb over land).
d) High-resolution Interferometric Sounder (Howell, Woolf)

The U2/ER2 flights, and project COHMEX, ended in July. The major effort after that concentrated on: 1) installation of HIS processing software on McIDAS, and 2) the transfer of HIS data from the flight tapes (3M high-capacity cassettes) to McIDAS disk. The data transfer effort utilized software and personnel from the SSEC programming staff, and consisted of communications and data transmission over the PRONET (cable connection) to McIDAS. The data transfer rate is approximately 1/3 MB per minute, and is dependent on the activity on the main frame. At the end of the quarter, most of the processing software, as well as some display programs, are completed, and data from several flights had been transferred. The software design continues to evolve, with minor changes.

Graphics display software for the HIS data was begun by Koji Kageyama, a visitor from the Sony Corporation in Japan. Koji will be with us for one year and will be involved in the HIS project, at first, and then other aspects of McIDAS processing of satellite data.

2. Synoptic Applications

a) SSM (Goodman, Diak, Callan)

The use of the CIMSS subsynoptic model (SSM) in reprocessing of the GALE data continues to be unsatisfactory, insofar as the short term forecasts have not been very useful as first guess profiles for the retrievals. Several errors have been located and remedied, but more serious ones are believed to exist, and the assimilation is being delayed. Dr. Lance Leslie will be visiting from the Australian Bureau of Meteorology in October, and he will bring the current BMRC forecast model to compare and consolidate with the SSM. In the meantime, improvements to the planetary boundary layer and surface physics are being implemented so that derived sea surface temperatures can also be assimilated.

b) Tropical Analysis (Lewis, Velden, Van Tuyl)

Due to the departure of both John Lewis and Andy Van Tuyl in early September, little progress was accomplished in implementing the improved Deep-Layer Mean model which has been developed. Instead, the version used with the NHC support in 1985 was routinely used.

c) Satellite Winds (Stewart, Sorensen, Velden, Hayden)

The new WINDCO system was thoroughly exercised during the support to the NHC and appears to be operationally robust. The only significant change to the software was to speed up the program for deleting vectors (manually). A paper describing the system and some results for water vapor tracer winds from both the 6.7 and 7.2 micrometer measurements was prepared for the preprint volume of the Sixth Symposium on Meteorological Observations and Instrumentation of the AMS which will take place in January 1987.
3. Mesoscale Applications
   
a) IBM-PC Software Development (Howell, Wade)

   A few improvements were made in the EGA (Enhanced Graphics Adaptor) version of the automatic data/image acquisition used throughout COHMEX. These improvements were mostly bookkeeping of images of three sorts, and the maintenance of the three individual loops under various error conditions. A more general approach is planned for the future, in order to permit the same software to be used for any number of prepared products available from the SSEC Dial Access Facility.

   Software for the PC end of the PRONET data transfer was written and linked with the drivers developed by SSEC programmers. This software included transfer of test (PC generated) data and subsequently the transfer of data from the 3M cassette drive to a McIDAS LW file.

b) VAS Sea Surface Temperatures (Wade)

   At the request of NHC, SST calculations have been made over the Atlantic, Gulf, and Caribbean during the hurricane support season. The area of coverage was increased slightly to the North from that used in GALE support. This has permitted coverage of an area with more intense gradient which has allowed a better evaluation of the product. Software is being prepared to include these data in both the SSM initialization and the VAS retrieval. Images were initially constructed daily for 18 UT, but with the inception of mode AAA testing the time was moved back to 14 UT.

4. ERB/Climate
   
a) ERBS (Herman)

   There was no activity in this project during this period.

5. Sensor Calibration
   
a) Line-by-line Transmittance Model (Woolf)

   The FASCOD2 (Fast Atmospheric Signature Code) model was exercised successfully on a set of 13 atmospheric profiles to produce a database of transmittances for use in evaluating and processing HIS aircraft data. A regression model based on the line-by-line results permits rapid calculation of synthetic spectra.

   The FASCOD2 package was also implemented on the Suitland NAS-9000 computer system for the purpose of generating a similar transmittance database for GOES-NEXT and other possible future infrared sounders. At the end of the quarter, initial operating success had been achieved. However, a change in system (NAS) software in late September necessitated modification of most of the input/output logic and reconstruction of a large ancillary data set.
II. Other Activities

1. COHMEX Support

The CIMSS provided operational support to the Cooperative Huntsville Mesoscale Experiment which concluded in July. The support consisted of a McIDAS workstation on site and real-time satellite data and derived products including: standard imagery, derived imagery from VAS radiances, VAS soundings and associated analyses and energy parameters, cloudiness estimates from VAS, cloud drift and water vapor motion winds, and NOAA-6 and NOAA-9 imagery and soundings. These data have been archived at CIMSS and will be available to the COHMEX research community. Further satellite data processing to include AVHRR data and high density, high resolution VAS retrievals will be accomplished on selected case study days.

2. VAS GOES I-M

a) VAS (Menzel, Hayden)

The VAS software was implemented on the Suitland VDUC and a manual of documentation was prepared. A training session was also given in September.

b) GOES I-M

Paul Menzel has agreed to serve on the calibration team for GOES-NEXT. CIMSS through SDAB has submitted to NOAA a proposal to provide Sounding and Wind Algorithm Development support, with implementation on the VDUC, for GOES I-M.

III. Appendix

1. Publications


2. Meetings and Seminars

Lewis  Discussed McIDAS installations at National Severe Storms Laboratory in Norman, Oklahoma from July 20-27, 1986.

Hayden  Visited Environmental Research Laboratory in Boulder, Colorado for coordination of mesoscale research projects on August 21-22, 1986.

Hayden  Participated in Second Meeting of the Atmospheric Sounding Troika in Washington, D.C. from September 3-5, 1986.
3. Visitors

Dr. Kelkar from the IMD, New Dehli, India visited SDAB in conjunction with the Indo-U.S. Science and Technology Initiative Program 1.3 from August 25-29, 1986.

Note: Other activities of the SDAB associated with the Advanced Satellite Products Project have been separately reported. In the future, their activities will be consolidated into a single report covering all activities of SDAB.

02/QAR/04
Quarterly Activities Report
October-December 1986
System Design and Applications Branch

I. Research Progress

1. Atmospheric Sounding

a) VAS Retrievals (Hayden, Wade, Schreiner)

Support to the NWS continued through October with the generation of daily soundings and wind fields. No changes were made to the software which produced this "operational" product.

Experiments were conducted where the two-pass retrieval results were compared to one-pass results. The only area of significant change is in the magnitudes of dewpoints retrieved for the mandatory levels. Since single level dewpoints are known to be highly biased, this discrepancy is of no real concern. Total precipitable water and the gradient of the moisture is only modestly changed. In terms of the extent to which the surface skin temperature is changed during the retrieval, the one-pass appears to be better. The original purpose for the second pass was to iterate the transmittance functions which are derived from the initial guess. This is unnecessary if the initial guess profiles are reasonable accurate, as they usually are when the NWS forecast fields are used to provide them. In the reprocessing of the GALE data sets (see below), the one-pass algorithm will be used.

In the normal processing, the initial guess for skin temperature is obtained from an in-line split window approximation. Several tests were made where this was replaced, over oceans, by an off-line approximation provided by the SST processing which was generated once daily for the NHC. The off-line product helped to stabilize the retrieval, and it certainly appears desirable to make it a regular part of the scheme. This does, however, considerably complicate the logistics.

Plans have been formulated with the NMC to test the impact of the VAS on moisture fields analyzed over North America using the RAFS. A new acronym has been generated for this task; the VAS Model Impact Studies (VMIS). The study will begin whenever the problems with Mode AAA ingest have been sorted out. In preparation for the VMIS, the "first guess" software has been generalized so that it can use model output from the NGM (instead of the LFM) including the additional levels near the surface. The new software is not currently part of the VDUC package, but it will be transferred after suitable testing.

It was observed by the NMC that the VAS retrievals were systematically too cold during the Easter PACific (EPAC) exercise conducted over the winter season 1985/86. Because of this, they
discontinued use of the VAS in operations. During this quarter, a
careful study has been made of the situation for 5 December 1985 using
both VAS and TOVS data to determine that the bias was indeed present and
to investigate its cause. Our conclusion is that the bias was confined
to the northwestern portion of the EPAC region where the local zenith
angle for the GOES (located at 108 W during this time because of the
failure of GOES 5) exceeded 60 degrees. At these angles the bias could
be severe. Evidently, our efforts to extend VAS retrieval capabilities
to such high zenith angles, motivated by the poor coverage otherwise
available, were not successful. For this reason, an EPAC exercise is
not being conducted in the current winter. A brief report detailing our
study and explaining the techniques used to extend coverage to high
zenith angles is available.

b) TOVS Processing (Herman, Achtor)

The conversion of TOVS programs to utilize AVHRR GAC in place of
LAC data continues. Using NOAA-7 and NOAA-9, very good correspondence
was obtained in locating the HIRS footprint in the LAC, GAC and
simulated GAC data.

c) SSM/T (Nagle)

The processed SSM/T retrievals prepared at NESDIS are being brought
to McIDAS for evaluation. So far, this includes only a simple
radiosonde comparison, and an "assimilation" of 1000-500 mb thickness
into a SSM/T-only analysis which is run twice per day. The latter
effort is complicated by the sporadic processing of the SSM/T and also
by format which gives only thickness above the first level above ground
(which is usually not 1000 mb over land).

d) High-resolution Interferometric Sounder (Howell, Woolf)

The transfer of flight data from cassettes to McIDAS disk, and
subsequently to nine-track magnetic tape, continued, but is far from
being completed. Data archived on McIDAS tapes include raw data from as
early as April (Kitt Peak area) to November (Wisconsin, project FIRE).
A number of COHMEX flights have also been processed and archived. The
library of HIS software on McIDAS has expanded to include utility
programs to examine, display and evaluate HIS spectra, as well as a
connected (chained) sequence of jobs which can be initiated with
specified parameters so that subsequent jobs are run without operator
involvement. A major change in the initial processing software was made
to alleviate the shortage of LW file space; the first job now outputs
interferograms into areas instead of LW files. This also allows viewing
of a set of interferograms as an image, which is one means of quality
control.

Statistical and physical algorithms have been developed for the
retrieval of atmospheric temperature and moisture profiles from HIS
spectra, with a modest degree of success attained in both efforts.

Koji Kageyama has contributed significantly to the HIS software,
producing a number of display programs including an isometric ("3D")
display of a time sequence of interferograms or spectra, and the
software necessary to generate a series of virtual graphics frames of HIS spectra which can then be replotted and animated. He has recently produced images of instrument responsivity variations which are quite useful in the evaluation of calibration data.

Allen Huang has also been quite actively working with Bill Smith and Hank Revercomb, processing segments of data from the FIRE flights as well as routinely transferring, processing and archiving some data from COHMEX flights. Several other graduate students have been briefed on the subject of HIS data access, and are engaged in various studies using HIS spectra.

2. Synoptic Applications

a) SSM (Goodman, Diak, Callan, Leslie)

The current Australian BMRC forecast model has been installed on the McIDAS system. This version was given to us because it has been the operational version in Australia for two years and so most errors have been found. The previous version that we had, had many errors and problems with it and we were essentially trying to modify it so that it would resemble our new model. In addition to the new forecast model and post processor, several corrections have been made to the existing analysis-forecast system. The current analysis-forecast system gives much better results compared to the former analysis-forecast system. While some work remains to be done with surface parameters and albedo, the fields needed for TOVS retrievals are satisfactory. In the near future, we will install the forecast model on the Cray vector processor at Marshall Space Flight Center.

b) Tropical Analysis (Merrill)

Dr. Robert Merrill has joined CIMSS as a visiting scientist after serving as a post-doctoral resident at NHC. One of his interest will be in exercising the CIMSS tropical analysis. John Lewis, now of NSSL, has promised to cooperate on this project. NSSL will be obtaining a McIDAS terminal in March to facilitate the cooperation on this and other projects.

c) Satellite Winds (Stewart, Sorensen, Velden, Hayden)

The new WINDCO system was thoroughly exercised during the support to the NHC and appears to be operationally robust. The only significant change to the software was to speed up the program for deleting vectors (manually). A paper describing the system and some results for water vapor tracer winds from both the 6.7 and 7.2 micrometer measurements was prepared for the preprint volume of the Sixth Symposium on Meteorological Observations and Instumentation of the AMS.
3. Mesoscale Applications

a. IBM-PC Software Development (Howell, Wade)

The image acquisition and display software utilizing the Enhanced Graphics Adaptor (EGA) has been modified to more easily adapt to changes in the library of prepared products (on the Dial Access Facility (DAF)). These modifications were accomplished principally by Ralph Dedecker and Lindsay Feuling of SSEC. Now a number of products may be automatically accessed, displayed, archived, cataloged and animated.

Updates in the old "SATPLUS" or "MET-PAK" software, which is limited to the Color Graphics Adaptor (CGA) graphics modes, were made to allow users to take advantage of the most recent transmission protocol ("F-zero") in the access of satellite images and McIDAS-generated graphics. Image products generated on McIDAS were re-organized to provide more of the high resolution images (for the EGA), while retaining a critical set at low resolution (for the CGA). Gary Wade has sent the updates to several users. Requests for SATPLUS were received from various institutions (Woods Hole, University of California at San Diego, New Mexico State University, and ECMWF/England); a statement on policy/philosophy regarding SATPLUS is being written to accompany the requested software and McIDAS/DAF access capability.

In support of the ECMWF desire for the access of VAS retrievals via asynchronous communications, PC software was developed to decode the transmitted data, producing ASCII data files identical to the source files on McIDAS. This will also be used by the RAMM Branch at CSU to access VAS retrievals when they become available. The necessary software will be provided to Bob Green & Co. during the next quarter.

b) VAS Sea Surface Temperatures (Wade)

At the request of NHC, SST calculations have been made over the Atlantic, Gulf, and Caribbean during the hurricane support season. The area of coverage was increased slightly to the North from that used in GALE support. This has permitted coverage of an area with more intense gradient which has allowed a better evaluation of the product. Software is being prepared to include these data in both the SSM initialization and the VAS retrieval. Images were initially constructed daily for 18 UT; but with the inception of mode AAA testing, the time was moved back to 14 UT.

c) TOVS Sea Surface Temperature (Herman)

VAS SST calculations were continued for real-time NHC support through the end of October. Individual images as well as composite images weighted to the most recent data were provided on a routine daily basis. Unfortunately, lack of hurricane activity limited assessment of the application of these SST's to storm forecasting.

Some additional processing of VAS SST's for GALE Intense Observing Periods (IOP) from early 1986 was done; the generation of SST's for all appropriate time periods during the IOP's should be completed in the next quarter.
4. ERB/Climate

a) ERBS (Herman)

Some of the ERBS along-track data for January and August, 1985 was examined in a qualitative manner for gross errors. In the long wave, the limb darkening correction near the horizon has been done reasonably well. In the short wave, the amount of correction could not be determined. For the long wave, line-by-line noise was found amounting to as much as 1.5 w/m sq in the filtered and 5 w/m sq in the top of the atmosphere data. A revised tape for one day in January has been checked, but its revisions do not remove all of the noise.

A preliminary study was made of the effect of minor constituents of the atmosphere on the ERBS long wave data using VAS dwell sounds. There were several problems in matching and comparing the two data sets, including an hour's difference between the observations, resolution differences, etc. An attempt was made to eliminate cloudiness, but it may not have been completely successful. For this first case, the most important terms include the window channel and two water vapor channels.

5. Sensor Calibration

a) Line-by-line Transmittance Model (Woolf)

A satellite-viewing transmittance data base was completed, using the FASCOD2 (Fast Atmospheric Signature Code) package on the NAS-9000 computer system. The resulting data are being used to model potential sounders for GOES-N and; the Polar Platform, as well as GOES-NEXT.

II. Other Activities

1. NOAA KLM (Hayden, Woolf)

The software for graphing radiometric weighting functions of temperature and moisture with the McIDAS was refurbished and expanded to include the TOVS, VAS, SSM/T, Profiler, and AMSU. This effort was undertaken in order to provide figures for a report on the complementary roles of microwave and infrared instruments in atmospheric sounding which is being prepared by Larry McMillin of the Physics Branch.

2. GOES-NEXT (Woolf, Hayden)

A regression transmittance model has been generated and some radiative transfer software has been written to permit us to begin assessing the GOES-NEXT retrieval capabilities through simulations. Line-by-line transmittances have been generated at zero local zenith angle using FASCOD2. These have been convoluted with some idealized filter functions for input to derive the "fast" regression model. Off-nadir transmittances were approximated by raising the zero angle values to the secant of the zenith angle to provide input to the zenith-angle-dependent regression model. Early inspection suggests that this shortcut may not be acceptable.
3. TOVS Support for FIRE (Wade, Woolf)

Routine archival of TOVS (both NOAA-9 and NOAA-10) radiances over the Midwest were coordinated during the FIRE field experiment from October through early November. Most data were transmitted to Madison from the NMC data base within several hours of observation; some data were received in real-time via phone line to SOCC. SSEC scientist/graduate students (Don Wylie, Peter Grimm, Richard Frey) were involved in near real-time production of cloud heights from the NOAA-9 data. Real-time VAS radiances and retrievals were also archived when available.

III. Appendix

1. Publications


2. Meetings and Seminars

Hayden Attend meeting to review NOAA's weather research activities in Washington, D.C. from November 16-19, 1986.


Hayden Visited NOAA/ERL/Wave Propagation Laboratory in Boulder, Colorado to attend Profiler Advisory Committee Meeting from December 14-16, 1986.

3. Visitors

William Hooke (NOAA/ESG), Vernon Derr and Robert Mahler (NOAA/ERL) visited SDAB to review severe weather predictions and receive McIDAS demonstrations on October 22-24, 1986.

John Lewis, Chuck Doswell, Bob Rabin and Dave Stensrud from National Severe Storms Laboratory, Norman, Oklahoma, visited SDAB to formulate joint research efforts focussing on moisture for severe storms; and attend McIDAS demonstrations from December 1-4, 1986.

Dr. P. Krishna Rao visited SDAB to attend CIMSS Council Meeting on December 5, 1986.

IV. Miscellaneous

Gary Wade provided regular McIDAS support for the UW Department of Meteorology fall course: Atmospheric Technology, taught by Professor William Smith CIMSS).

02/CMH11/11
Quarterly Activities Report  
January–March 1987  

Systems Design and Applications Branch  

I. Research Progress  

1. Atmospheric Sounding  

a) VAS Retrievals (Hayden, Schreiner)  

A test was introduced to remove superadiabatic lapse rates in the pixel-by-pixel retrievals used to generate images of the Lifted Index. This resulted in a marked change in the images which seemed qualitatively to be an improvement.  

An additional check (on the change to the guess profile at 700 mb) was introduced for all "cloudy" retrievals in an effort to further reduce cloud contamination.  

Initial processing of a 24 September data set for the NMC VMIS project (see below) revealed that the previous bias adjustments used during the spring/summer for operational support were inappropriate. This led to a decision (aired at the VAS Assessment Meeting) to introduce a step in the retrieval processing whereby the bias vector is re-calculated for every data set, even for the individual pieces which are combined to make up the imaged product. This feature places additional dependence on the initial guess fields which has both good and bad implications. For the application of operational support to NWS, the net effect is advantageous mainly because it reduces the requirement for operator intervention and assessment during the processing. Limited results using this "continuous tuning" are quite satisfactory. The software necessary to implement the method will be transferred to the VDUC in the next quarter.  

b) VAS Processing (Menzel, Wade)  

Testing of the SSEC mode-AAA ingestor with VAS dwell sound and multi-spectral data was done in January and February. Several problems were found, and discussed with SSEC engineers and programmers as well as with NOAA/SOCC and Wallops personnel. Temperature/moisture profiles were first generated with data on 14 January 1987. Other days processed were 11 February and 18 February; the latter was particularly unique, because several dwell sounds were sent in both mode-AAA and -AA. At this point, the most significant problems with the AAA signal and the ingestor, concerning VAS data, have been corrected. Further assessment is continuing with data from 16-18 February 1987.
From the vacuum test data of VAS-H, the calibration and detector geometry coefficients were calculated and formatted for VIP insertion. The prelaunch estimate for the spin budget of VAS-H was 81; the degraded performance of the InSb detectors was noted. From the postlaunch checkout of VAS-H the electronic linearity of the detectors was verified, the detector geometry was recalculated to register images, and the noise performance was evaluated and produced an inflight spin budget of 65. Spin budget were performed during the check-out period of 17-20 March 1987. The checkout revealed a low frequency (roughly 200 Hz) noise of 200 mV amplitude in the high gain spectral bands (1, 2, and 9) immediately after a filter wheel step. The effect on dwell sounding is not thought to be appreciable, and could be eliminated completely by programming an additional spin for band 1, 2, and 9 (to allow the filter wheel to settle). In multispectral images it is noticeable and will affect water vapor tracking to produce winds in band 9 (bands 1 and 2 are rarely imaged). Filtering by the user may be necessary. The checkout also revealed some visible channel saturation in highly reflecting tropical clouds. Gain adjustments are underway to alleviate this. A CIMSS report on postlaunch VAS-H findings is available upon request.

Dwell sounds sent initially had serious problems, and our communications with Wallops on this point was not as timely as it should have been. Nevertheless, good dwell sound data were eventually sent on March 20th, and reasonable retrievals have been generated from these data (after appropriate biases were determined).

c) TOVS Processing (Eyre)

Dr. John Eyre of the British Meteorological Service has joined CIMSS for six months. He is their chief representative to the International TOVS Working Group, and is the spearhead behind operational use of the TOVS in the UK. He will be working on a temperature inversion scheme which does not require cloud-clearing of the infrared measurements as a separate step of the retrieval process, and also microwave processing.

d) High-resolution Interferometric Sounder (Howell, Woolf)

Because of irregularities in the HIS data, the logic for handling time errors had to be rewritten. As an aid in selection of time periods for processing, software was developed to display the time segments of the sounding mode. Modifications were made to the calibration software to output data to areas instead of LW files. This was done to alleviate the scarcity of LW space on the McIDAS disks. Data for COHMEX flight on 6-15-86, were processed and archived, and the same process for the 6-19-86 flight is underway. Emphasis on these two flights resulted from a meeting at Marshall Space Flight center, attended by W.L. Smith, Allen Huang, Gary Jedlovec and Ben Howell. At that meeting it was decided that these flights contained the best combined data sets of HIS and MAMS.

Retrieval effort has focused on the physical (simultaneous) algorithm with slow but steady improvements in accuracy and efficiency.
e) Bomem Upward-looking Interferometer (Howell, LaPorte)

During the FIRE project period, observations were made with an upward-looking interferometer, made by Bomem, which is very similar to the HIS. The data were stored in VAX format, which led to the establishment of a new connection to the VAX computer on the ninth floor of SSEC and to the VAX located across the street at the MACC. We (H. Howell, R. Dedecker, and D. LaPorte) have used this connection to modify Bomem software to: (1) convert data files from Bomem format to FASCODE format; (2) convert data from FASCODE format to ASCII, for transfer to the PC and to McIDAS; (3) transfer data to the PC. Software has been developed on McIDAS to convert the ASCII files to binary, to plot the data, and to compute the FFT of interferograms. These data will be used to augment the HIS data during the project FIRE.

f) MAMS (Menzel, Moeller)

The MAMS effort at CIMSS over the last several months has produced an accurate navigation algorithm for the visible and infrared imagery. RMS errors have been reduced to less than 500 meters. With the capability to collocate other data sources we are now beginning the combined VAS-HIS-MAMS processing to produce high horizontal resolution lifted indices and total precipitable water vapor.

2. Synoptic Applications

a) GALE Case Study (Wade, Callan)

The CIMSS SSM has been tuned to perform the GALE assimilation which will be accomplished when the complete observational data sets are available. A videotape was assembled for the 27 January 1986 GALE data set combining quantitative output from the SSM model with hourly GOES imagery (mostly IR with some visible and VAS water vapor). Graphics displays of forecast fields (such as MSLP, vertical motion, precipitation) were overlain on appropriate images. On this tape, the 24 hour forecast, valid at 00-UT on 28 January 1986, is shown to be markedly different from the analysis at that time; re-initialization of the model using data available at 18-UT yields a much better forecast at 00-UT. Use of the imagery on an hourly basis shows the original model run diverging from what one would expect, given the observed imagery. Significant discrepancy is apparent by 16 to 18 UT. The tape is about 20 minutes long.

b) Tropical Analysis (Merrill)

Dr. Robert Merrill has joined CIMSS as a visiting scientist after serving as a Post-doctoral resident at NHC. One of his interests will be in exercising the CIMSS tropical objective analysis. John Lewis, now of NSSL, has promised to cooperate on this project. NSSL will be obtaining a McIDAS terminal in May to facilitate the cooperation on this and other projects.

c) Satellite Winds (Stewart, Velden, Hayden)

During the past quarter, emphasis has been placed on the development of an automated algorithm for the derivation of cloud motion winds (CMW) using
the 11 micrometer window channel to track and the 6.7 micrometer channel to assign pressure height. The task is divided into two principal sections; a target selection algorithm which selects candidate tracers and a correlation algorithm which derives vectors, using the targets, from three or more images. The initial formulation is complete and the system is undergoing testing on a daily basis. Initial results are encouraging from several aspects. The automatic vectors have been shown to positively impact the global analysis generated by the National Weather Service in test cases. Objective quality control appears to be adequate in deleting unrepresentative vectors. The system is computationally efficient enough to be run on the Suitland VDUC without significantly impacting the efficiency of that resource for other users. However, the system is still considered to be in the development stage. It is readily demonstrated that an operator can enhance the product significantly with manual generation of additional vectors, especially in the thin cirrus cases. Considerable additional testing and evaluation needs to be accomplished before the system is ready for operational application.

d) Kalman Filter (Nagle)

The Kalman filtering assimilation routine has been resurrected to run on the McIDAS to incorporate TOVS, DMSP and RAOB data in analysis of the Northern hemisphere temperatures (1000-100 mb). The assimilation program is run every 102 minutes for TOVS; every two hours for DMSP, and every 12 hours for radiosonde data. BIAS and RMS error statistics are generated at 676 gridpoints for each of the three types of sensor. These statistics are continually updated by comparing soundings from the various sensors with NMC operational analyses. Analyses produced in the assimilation show the typical characteristic of underestimating the gradients by perhaps ten percent as compared to NMC products. Inclusion of the radiosondes (temperature only) does not appear to alleviate this problem.

e) Cloud Statistics (Menzel)

More than one year of VAS data over the extended U.S. has been processed for CO2 cloud top pressure and amount determinations. The statistics date back to November 1985. The geographical distribution of cloud cover is being charted to note seasonal and diurnal dependence. Initial results indicate that cirrus cloud (radiative attenuation less than 80%) occurs 15 to 25% of the time over the U.S.

f) Data Assimilation (Goodman, Diak, Callan, Leslie)

The search is on for a larger computer on which to run the SSM. The model was installed on an IBM vector processor at Palo Alto, California during March. Running time was improved (over the McIDAS 4381) by a factor of ten. However, communication problems make utilization of the California computer intractable. Time has been offered on the Marshall CRAY, but "saturation" use by a NASAQ priority project has so far prevented our accessing it.
3. Mesoscale Applications

a. IBM-PC Software Development (Howell, Wade)

The initial segment of TIP ingest software was rewritten, with Pascal coding replacing some FORTRAN modules. This change resulted in a significant decrease in the time required for preprocessing. Because of the recent improvement in the transfer from McIDAS to the PC, the software which generates the binary coefficient files for the TOVS ingest was modified. To satisfy the need for NOAA-10 TIP data, in which the MSU data is of high quality, we obtained an excellent "1B" TIPX data tape from Stan Brown of NESDIS. Software was written to read the 1B tape and write a specified portion of data to an LW file. A 15-minute portion of data was written to McIDAS LW file and subsequently transferred to the PC for use as a test data set. One of our visitors from the PRC, namely Qu Yanni, and a UW student, John Peterson, have been working to establish an updated version of the TOVS/PC ingest software, from which an improved, more user friendly version will be created. We recently received an update (ver. 4) to the MicroSoft FORTRAN Compiler, and during the next quarter we will be updating the TOVS software to run more efficiently.

No new development occurred with SATPLUS. Some maintenance was needed for remote user support. Copies of code were sent to researchers in New Mexico, California, and Wisconsin.

b) VAS Sea Surface Temperatures (Wade)

Modest progress was made on completing GALE SST's; some SST/buoy comparisons were done.

c) Wind/Radiance Coupling (Hayden)

The procedure for combining wind and radiance observations via variational blending has been described in previous reports. In this quarter, the program (devised by John Lewis now with NSSL) was subjected to rigorous testing and a number of improvements relating to convergence of the scheme was introduced. The technique has been shown to work very well with simulated satellite data from the NASA AVE case of 6 March, 1982. Tests with real satellite measurements are less satisfactory and work continues in this area.

4. ERB/Climate

a) ERBS (Herman)

From a collection of ERBS data made available for research, a sampling was searched for obvious errors. These PAT tapes are the latest and best version of the data to date. The sample consisted of scanner data for three days whose orbits crossed the U.S., twice each day. The problem of striping, which had been found in previous versions of the PAT tapes seems to have been resolved in these re-processed tapes. The remaining problems are with banding and scan line noise, both of which are oriented along the scan lines.
Banding is a subtle problem, especially where natural occurrences of bands orientated parallel with scan lines are extended beyond their true boundaries as determined by comparison with nearly simultaneous GOES pictures. This error is quite small in the longwave filtered data amounting to less than 1 w/m-sq per str.

Scan line noise seems to occur in single lines of noise offsetting the brightness level from other lines. The magnitude of the longwave offset can be 4-5 w/m-sq per str in the filtered and 15-20 w/n-sq in the top-of-the-atmosphere data.

NASA is considering disseminating future ERBE data on optical disks to conserve resources and is studying alternative systems.

5. Sensor Calibration

a) Line-by-line Transmittance Model (Woolf)

A subset of the satellite-view (top-of-the-atmosphere at 0.1 mb) transmittances, transformed to the HIS spectral resolution, was provided to Henry Fleming for use in simulation studies in support of GOES-X and Polar Platform sounder definition studies.

II. Other Activities

1. ITOVS (Menzel, Woolf)

In August 1986, the International TOVS Working Group convened in Madison, Wisconsin for the Third International TOVS Study Conference (ITSC-III). In the last quarter, the conference was documented in two reports: (1) the report on ITSC-III which presents the executive summary, the abstracts of the scientific presentations, the working group discussions, ITSC recommendations, and areas of future work, and (2) the Technical Proceedings of ITSC-III which contains the complete text of the scientific papers. Copies are available upon request.

The International TOVS Processing Package (ITPP) has been modified to include: a new file structure permitting "coefficients" for all spacecraft in the ITOVS series to be included as on-line storage; and a new high resolution earth topography requiring only a quarter of the previous disk storage. The new version has been mailed to regular ITPP users.

2. GOES-NEXT (Woolf, Hayden)

Responding to the previous quarterly report Henry Fleming of the Physics Branch suggested that we approximate off-nadir transmittances by raising the zero angle transmittance values to 0.5*(1+sec) rather than just the secant in order to account for the polychromatic nature of the band width. This was tried and the results were much improved. Thanks, Henry.
III. Appendix

1. Publications


2. Meetings


Feb. 14-20 G. Callan attended GALE Conference and IBM/Palo Alto software installation.

March 17-18 B. Howell travelled to Huntsville, AL to participate in COHMEX data analysis.

March 17-19 C. Hayden travelled to Camp Springs, MD to participate in the Satellite Winds Subpanel Meeting and NWS Annual VAS Assessment meeting.

March 17-20 P. Menzel travelled to Camp Springs, MD to participate in the VAS-H postlaunch checkout and the NWS Annual VAS Assessment meeting.

3. Visitors

March 5-6 Pim Chavasante of the NEPRF visited CIMSS to observe the TOVS data processing on McIDAS and to get a PC demonstration.

Feb. 9-13 Roney Sorensen, SAB, and Curtis Holland, IPB, received training on McIDAS for macro programming and wind tracking.

02/QAR/05
Quarterly Activities Report

April - June 1987

System Design and Applications Branch

Part I. Research Progress

1. ERB/Climate

   a) ERBS (Herman)

   Comparisons of ERBS scanner data were made with GOES-6 for six time periods. Attention was focused on the banding, apparent scan line noise, and linear features seen in the ERBS data, and there appeared to be good agreement in the GOES visible images. The ERBS features were qualitatively explainable by topography, vegetation differences, and cloud formations. The same comments apply to comparison of the ERBS long wave data with the GOES infrared, with the exception that some scan line noise in the ERBS remains a possibility.

2. Atmospheric Soundings

   a) VDUV Retrieval Algorithm (Hayden, Schreiner)

   A minor change was made to the radiance filtering algorithm to recognize lines with grossly inaccurate calibration. This change was required in order to use channel 11 with GOES-7 because of a still uncorrected error in the ingester. However, it should also help in normal processing since such lines have been observed occurring sporadically in the past.

   b) Experimental VAS Algorithms (Hayden)

   Since channel 11 (the 4 micrometer channel measuring the upper troposphere) is included in the mode-AAA processing of GOES-7, the benchmark GOES-5 data for 6 March 1982 was reprocessed to examine the impact of that channel with the current algorithm. There seems to be little effect on clear air retrievals, but the channel is useful for quality control of cloud contaminated measurements. It is currently included in the processing of special data sets for the ECMWF (see 2b below), but not in the routine Kansas City processing.

3. VAS Processing (Menzel, Wade)

   In April, check-out of the VAS mode-AAA ingester continued. The GOES-6 data from 18 February 1987 which were sent in both AA and AAA format were used to generate retrievals. The two sets of profiles were generally quite close though differences did exist. The GOES-7 data from 20 March 1987 at 21 UT (during check-out in mode-AA) were used to make retrievals, and these appeared reasonable despite the use of GOES-5 transmittance functions.

   On 4 May 1987, GOES-7 VAS data were transmitted in mode-AAA. The SSEC ingester did not work correctly with VAS dwell sounding and the radiances were found to be too warm (particularly obvious in band-7). Comparison with the ingested data at PROFS convinced us that our problem was a local
A switch from averaging to sampling data within the ingestor yielded reliable radiances and by the 18th, real-time macros were in place and operating, producing retrievals and derived imagery. Because of increased noise in channel 1 (as compared to previous VAS instruments) spotting was observed in the derived imagery. This was cured by replacing single FOV values of channels 1 and 2 with the average of the 11x11 box used to derive the retrieval coefficients.

Images from the GOES-7 VAS show that differences in the upper and lower InSb detectors are not being corrected in the calibration, and this leads to large "noise" in the measurements of the 4 micrometer channels which has a notable effect on the accuracy of the temperature/moisture profiles. In compensation, the InSb channels have been de-emphasized in the retrieval processing until the situation is corrected, possibly by adjusting the thermal nonlinearity coefficients.

Support to the Kansas City NSFC was carried out at CIMSS pending full checkout of the VDUC system. This service began on 22 May. The NSFC is looking at the derived images, the 250-1000 mb thickness, the 500 mb temperature and the 7.2 micrometer image. Retrievals and derived imagery have been delivered routinely on a 90 minute cycle for a 16 hour day. An error in interpolating the first guess moisture field which caused a discontinuity in the imaged products was discovered and eliminated. Otherwise, the products appear qualitatively to be of the same value as was obtained with GOES-6. Meanwhile, the VDUC is processing the VAS data in an experimental mode to increase familiarity with the system. By the end of July, the retrievals at VDUC were fairly close (but not identical) to those at NSFC. The remaining differences are believed to be caused by the use, at the VDUC, of GOES-5 rather than GOES-7 coefficients. Parallel processing is tentatively scheduled for 18 August.

The principal improvements in processing techniques, over the previous year's effort for NSFC, include the calculation, each time period, of radiometric biases based on the first-guess, and use of the NGM (rather than the LFM) for the first-guess which provides better definition at low levels.

7) TOVS Processing (Eyre)

John Eyre of the British Meteorological Service who is visiting CIMSS, has designed an algorithm for including cloudy radiances directly in the TOVS processing. In addition, his approach explicitly includes a knowledge of the error structure of the first guess profile. He will be applying this model to the data collected during the GALE experiment and compare his results to those previously obtained with the CIMSS retrieval algorithm.

8) High-resolution Interferometric Sounder (Howell, Woolf)

New software developed this quarter allows:

1. Editing of HIS spectra on the basis of record numbers, time, latitude/longitude or altitude as well as by scene type (i.e., earth or blackbody).

2. Addition of U2 and ER2 navigation data to HIS data records.
3. Reading and writing of "PUT" tapes, on which HIS data is routinely saved, in order to select, rename and reorder archived LW files, areas, MD files or grids.

4. Writing HIS LW files to magnetic tape for export. The processing of HIS data continued, and was completed for the following days (1986): June 15 and 19, July 5 and November 2. These data have been consolidated and navigated (U2/ER2 navigation data added). The processing of HIS data from COHMEX and FIRE will continue. With the improvement in the PRONET software, the transfer of HIS data to McIDAS was resumed late in the quarter. Data from the flight of June 15 was written to magnetic tape and sent (by W. L. Smith), with documentation, to John Theon.

Sounding retrieval results, in particular for the 15 June COHMEX flight, have been encouraging. Recent activity is aimed at tuning the algorithm to reduce first guess dependence.

f) PC-TOVS (Howell, Woolf, Dedecker)

Interest has revived in this lately dormant activity. Attempts were made to recompile all TOVS FORTRAN code using the new MS FORTRAN Version 4.00, but several problems in the new compiler were encountered, so we have returned to version 3.31. Considerable effort was expended to develop a user interface for the TOVS ingest software. Many improvements were made, and a demonstration package was developed and shown at the Williamsburg conference. Some of the improvements were the addition of menus for selection of display options and for accessing data from the main frame. Additional software development and downloading of data from McIDAS have given the PC-TOVS software the capability of drawing better base maps, for any part of the world, and the use of higher resolution graphics using the SGA graphics modes.

g) Bomem Upward Looking Interferometer (Howell, LaPorte)

Software was developed to produce calibrated spectra from observed interferograms. This software was exercised to archive a small portion of the available data.

h) MAMS (Menzel, Moeller)

Software to navigate the MAMS imagery has been successfully implemented. An archive of navigated COHMEX MAMS data is emerging. Work has started to combine the MAMS and VAS data of 19 June in an attempt to derive high resolution imagery of total precipitable water and lifted index. For a MAMS-VAS product, the high resolution 100 meter MAMS radiances will be used with the retrieval coefficients from a 40 kilometer VAS sounding in a manner analogous to that Smith, Wade, and Woolf (1985) use in their work on VAS atmospheric/cloud imagery. The derived image product will attempt to chart atmospheric changes on the mesoscale.

In late May and early June, the MAMS was flown five times with a full blade mirror. Reduced noise in the infrared channels was readily
apparent. These flights also included a 10 bit digitization of the infrared channel data (visible channel 1 data is replaced by the two least significant bits of the four infrared channels). This enables greater temperature sensitivity in the archived MAMS data. In addition, the capability to switch out the 3.7 and 6.7 micron channels in a modular fashion was tested. The 3.7 micron channel was used for surface investigations over the FIFE (First ISLSCP Field Experiment) region and the 6.7 micron channel was flown over the Raman lidar at GSFC for moisture investigations. These data will be processed and researched in the coming months.

1. Mesoscale Applications

a) IBM-PC Software Development (Howell, Wade)

The communications software was improved to allow better access to the ROFS computer. This software was integrated into a user friendly package and distributed to interested CIMSS personnel for the acquisition of profiler and MESONET data.

Some changes in the image products produced in the DAF on McIDAS for ATPLUS were made once the GOES-7 data were being sent in mode-AAA format. The water vapor (6.7 micron) images were actually obtained from the VAS SI (not the old WV/IR substitution) and were made available every three rather than six hours; the data slicing (into 16 levels) was re-done for the current calibration. The half-tone (black and white) product for an IR m from GOES-7 is no longer available, as that data are stored at 16 bits on McIDAS. (The 16 level color product is still available).

Some interaction was needed with remote users (two new users started to access the DAF, and one user requested some specific historic VAS WV imagery).

b) Wind/Radiance Coupling (Hayden)

A paper describing this technique was submitted and rejected for publication. The reason given for rejection was our inability to demonstrate useful results with actual VAS measurements (as opposed to small improvements obtained in the simulation study). Our failure with real data seems due in part to too simplistic a radiative transfer model and to the use of a case study (6 March 1982) where no retrieval method has demonstrated notable skill.

In simulation mode the model was used to study the effectiveness of several other remote sensing systems (the AMSU, GOES-NEXT, and PROFILER) both individually and in combination. Experiment confirmed that retrievals from GOES-NEXT will not be greatly improved over the VAS; but that important advances could be gained by the inclusion of microwave and specially the radiometric PROFILER. These results were presented at the microwave Conference in Williamsburg.
B. Synoptic Applications

a) GTE/ABLE (Menzel)

VAS data over the GTE/ABLE (Global Tropospheric and Amazon Boundary Layer Experiments) have been archived and partially processed. The VAS was scheduled to dwell sound over the Amazon every three hours beginning in early May. CIMSS and INPE personnel are involved in processing soundings and merging these with special ground-based observations for determining a budget of tropospheric moisture.

b) ECMWF (Menzel, Schreiner, Hayden)

Arrangements were made to process VAS data over the Atlantic near 1200 T for evaluation by the European Center for Medium-range Weather Forecasting. Both winds and soundings were to be processed for a trial period of four weeks beginning 15 June. To date, the winds have been processed (as described in (f) below), but the soundings await a solution to the problems in the radiance data described above. The ECMWF will compare the VAS products with other information in their data base. The European Space Agency will also participate by forwarding their METEOSAT products to the ECMWF for the week of 22-26 June. For this week, the VAS automatic winds will be manually augmented.

c) VMIS (Menzel, Hayden, Schreiner)

VAS soundings over the U.S. and coastal regions at approximately 1200 T were produced routinely and forwarded to the VDUC as part of the VMIS VAS Model Impact Studies) which we are conducting with the NMC. The short-term goal is to eliminate the need for operational moisture bogusings by using the VAS moisture soundings. About 40 data sets were processed. Thanks to lively feedback from the NMC, several changes in the VAS processing have been made: elimination of the blending of the surface view with the first guess moisture profile; increased horizontal resolution in the first guess fields; and output of the VAS retrieval level at 670 mb in place of the 620 mb level.

d) Tropical Analysis (Merrill, Hayden)

Arrangements have been made with Cliff Dey and Mukut Mather of the NMC to use deep layer mean winds prepared at CIMSS in experimental forecasts of hurricane tracks. Gloria will be used as the initial case study. In preparing the wind analyses from the satellite tracers we have been unsatisfied with the direct application of off-level winds and have decided to analyze the "change to the first guess" over a layer with the first guess value interpolated to the assigned level of the wind tracer. The analyzed changes are then used to modify the guess at a particular (high, low or middle) level. A special version of the recursive filter objective analysis system has been prepared to accomplish this.

Three-dimensional Recursive Filter (Purser)

The two-dimensional recursive filter objective analysis system, which has been used in the processing and display of VAS McIDAS products, has
been generalized to three dimensions. Specialized testing has proved the concept, but the algorithm has not yet been integrated into the McIDAS system.

f) Satellite Winds (Stewart, Velden, Hayden)

The algorithm for automated derivation of cloud motion winds (CMW) and water vapor winds (WWW) was run routinely on data obtained between 9 and 1300 UT. Four sets were generated daily from loops of the 11 micrometer (10, 10:30 and 11); the 6.7 micrometer (9, 10 and 11); the 7.2 micrometer (9:30, 10:30 and 11:30); and from the visible (12, 12:30, and 13). The coverage obtained by the automatic processing is generally satisfactory, and the quality of the vectors is generally good. We feel that the system is ready for operational use, though a few areas remain to be improved. Among these: better recognition of mid-level cloud; improved automatic quality control; and increased coverage in areas of thin cirrus.

g) Data Assimilation (Diak, Goodman, Callan)

The attempt to use the IBM vector processor at Palo Alto, California has been abandoned because of the usual difficulties involved with remote IO. There is a good possibility that the Space Science and Engineering Center will obtain an IBM 3090 as an upgrade to the current 4391 used for McIDAS. The Assimilation Model will seize this on arrival.

The modelling activity has continued to concentrate on producing analyses and forecasts of the GALE data obtained for the second intensive observing period in January, 1986. A sequence of analyses is being produced from both conventional and satellite sources. These have inspired several changes to the system, the most significant of which is in the wind analysis/variational blending, making the non-divergent wind more physically realistic. This has reduced model shock in the first few hours of the forecast. Experiments initializing the model with divergent winds have been encouraging in reducing spin-up time. The "incremental" analysis version (dynamic initialization) has also been tested on the GALE asymptotic special data sets and has produced forecasts of good quality (though comparisons between these and the static initialization model remain to be completed).

A mixed layer planetary boundary layer model has been coded and is under test with the intention of having it as a option in the forecast model and also as a test-vehicle for PBL remote sensing experiments.

9. Sensor Calibration

a) Line-by-line Transmittance Model (Woolf)

Separate sets of satellite nadir-view transmittances for uniformly
mixed gases, water vapor, and ozone were completed in order to implement the latest HIS retrieval algorithm.

b) De-navigation (Nagle)

The term "navigation" as used by satellite meteorologists refers to the process of computing from orbital elements the point on the Earth's surface
received by a satellite at any given moment. Because of occasional difficulties in obtaining information on the required orbital elements, we are investigating the reverse problem, that of inferring the orbital elements given the time and earth location at several points. The elements obtained by this "de-navigation" may then be used to predict future positions of the satellite. A program to accomplish "de-navigation" has been written for the McIDAS and is being evaluated.

Part II. Other Activities

1. ITOVS (Menzel)

The fourth study conference convening the International TOVS Working Group of the IRC (International Radiation Commission) is scheduled for 6-22 March 1988 in Innsbruck, Austria. ITSC-IV will discuss sensor calibration, ITPP (International TOVS Processing Package) version 4, AMSU plans, PS processing systems, and applications of sounding data in NWP, the WSE/NA (Operational World Weather Watch Systems Evaluation/North Atlantic) of 1987, and future instruments. New co-chairmen of this group have been elected; they are Alain Chedin and Paul Menzel.

2. GOES I-M (Woolf, Menzel, Merrill)

A suggested hurricane operational scenario for GOES-I-M was drafted. The sounder schedule features soundings at three hour intervals with two attempts per hour to sound in the eye of the hurricane, if one has formed. The Imager performs 15 minute interval coverage over the storm area with an hour of 7.5 minute riso every three hours. Stereo coverage is suggested when possible. A NOAA Tech Memo is forthcoming.

In preparing this scenario, it was discovered that the recent advances in using the 7.2 micron channel for tracking mid-tropospheric motions is not accommodated by GOES-I-M. This channel appears in the Sounder, but not in the Imager, so that frequent interval 7.2 micron coverage over the hurricane area is not possible (only if soundings are scheduled more frequently than needed). Further discussions should be planned to resolve this problem.

The line-by-line transmittance package (see 9a) is being used to generate datasets at off-nadir zenith angles for more accurate modeling of parent path effects.

Part III. Appendix

Publications


2. Meetings and Seminars

April
Hayden Presentation at Hurricanes & Tropical Meteorology Conference in Miami, Florida on April 6-9, 1987.


Menzel Attend Geostationary Platform Steering Committee Meeting in Washington, DC on April 30-May 1, 1987.

May
Menzel Conduct VAS seminar on Satellite Meteorology and Using the VAS for National Severe Storms Laboratory in Norman, Oklahoma on May 6-8, 1987.

Wade Presentation on May 30, 1987 to the Smithsonian Institute on Space Exploration, with Tom Achtor of SSEC, on research for a better SSEC and federal weather forecast.

June
Hayden, Menzel Travelled to Williamsburg, Virginia to attend the Passive Microwave Sounding Conference on June 1-3, 1987.

Menzel Travel to Wallops, Virginia to support MAMS flights over FIFE and the Raman lidar at GSFC on June 4-10, 1987.

4. Visitors

Roney Sorensen of SAB received programmers training at SSEC for use on the VDUC from April 27-29, 1987.

Andrew Hicks, CASC Personnel, visited SDAB to evaluate job descriptions of federal employees on May 22, 1987.

Jong Hon Bong, Director General of the Meteorological Research Institute of the Korean Meteorological Service, visited Paul Menzel to discuss participation in the ITOVS activities.

Joan Jordan from the Division of Atmospheric Sciences of NSF visited Paul Menzel, Dave Martin and Tom Achtor to discuss CTE/ABLE on June 19, 1987.

Dr. Robert Aune, SASC Technologies, Inc., visited SDAB to present seminar and meet with 4-d assimilation group on June 19, 1987.

Hank Schmidt of NWS visited Paul Menzel and Christopher Hayden to discuss navigation and calibration specifications for GOES-I-M.
Quarterly Activities Report
System Design and Applications Branch

Part I. Research Progress

2. ERB/Climate (Ackerman, Herman)

Dr. Steve Ackerman was hired by CIMSS to lead this project. He received his degree from and previously worked at CSU.

Additional data from NASA has been received, including the first NOAA-9 data, and revised ERBS data for the month of April 1985. The NOAA-9 tapes have been sampled and it was found the scanner data has every eighth line missing. The ERBS April tapes will be the first data to be released to the scientific community.

A UW graduate student, Fred Wu, has begun to re-study the relationship between the scanner and non-scanner data. The differences between the integrated scanner data and the non-scanner have been analyzed in terms of latitude, scene type and solar zenith angle.

Another student, Chou Chung, has been examining the relationship between the HIS and the ERBE data. This study is an investigation of the sensitivity of ERBE measured fluxes to spectral variations of the earth-atmosphere system. A case study indicates that largest differences occur with clear skies and are on the order of 2%.

5. Atmospheric Sounding

a) VDUC Retrieval Algorithm (Hayden, Schreiner)

There were no changes to the algorithm during this period.

b) Experimental VAS Algorithms (Hayden)

Case studies for the VMIS and Gulf of Mexico projects have shown that the VDUC moisture algorithm is not working well over the Gulf of Mexico. Several modifications are now being tested to allow more weight for the split-window difference, less weight to the surface moisture analysis in data void regions, and incorporation of independently derived SST data into the retrieval (instead of retrieving this quantity in line).

c) VAS Processing (Wade, Schreiner, Merrill, Stewart, Hayden, Menzel)

During the third quarter of 1987, the ASPP processed VAS data on the UW McIDAS in support of the three national centers until the VDUC was ready to assume this role in September.

For NHC, a 1200 GMT wind set was produced on most working days. These wind sets were generated from visible (1 km) and infrared window (8 km) images with 30 minute spacing and water vapor (6.7 micron at 8km and 7.2 micron at 16 km) with one hour spacing. The 7.2 micron winds were routinely produced for the first time this hurricane season. The average
ght of the 7.2 micron winds is found to be about 100 mb lower in the
osphere than the 6.7 micron winds and therefore offers more information
at the mid-level flow for the hurricane forecaster. All of the wind
ss for NHC were generated using the newly developed autowindco, which
uces the operator time by more than a factor of two. The auto winds,
er some manual editing, appear to be nearly comparable in quality to the
ually generated ones, although they tend to fail in areas of tight
ulation.

For NMC, soundings were produced over the U.S. and coastal regions
r 1200 GMT (from two piece coverage at 1118/1148 GMT) and forwarded to
WB as part of VMIS (VAS Model Impact Studies) (see 8d below). About
data sets were processed.

Real-time processing of VAS retrievals and derived imagery for the
FC in Kansas City continued. The daily monitoring of the VAS products
are two particularly good examples of the agreement between increases in
-derived atmospheric instability and later severe weather. Slides of
ese cases (1 July - east Texas and east slope of Rockies; 5 August - the
otas) are available. On 15 July, the NSSFC processing was reduced from
periods to three (at 13, 16, and 19 UTC) as processing for the NHC
re-initiated. With the inception of VDUC processing on 9 September,
local processing was reduced to one time period (13 UTC) for
patibility study.

VDUC (Wade, Schmit, Menzel)

Parallel processing of the VAS data on the VDUC by SAB and on the
DAS by ASPP was conducted from the beginning of the period until mid-
tember. A number of minor irritations were encountered, discovered and
rected; from differences in the truncation of the background fields to
ferences in the compilers. In mid-August, all adjustments were
pleted and in the following month 20 days were compared. Intercompari-
of radiances (and brightness temperature) values revealed differences of
than .02 degrees centigrade. Temperature and moisture profiles were
ed to be virtually identical. The derived product images of total
cipitable water vapor and lifted index also compared quite precisely.
was concluded from this activity that the initial technology transfe
in the McIDAS to the VDUC is complete.

MAMS (Moeller, Menzel)

MAMS data has been collocated with simultaneous VAS data of 19 June
. Rather sizable biases were found between the VAS and MAMS radiances.
continues on the effort to derive (after adjusting for the bias) high
olution imagery of total precipitable water and lifted index taking
ntage of the multi-channel VAS soundings and the high horizontal
olution of the MAMS. For the MAMS-VAS product, the 100 meter MAMS
iances are used with the retrieval coefficients from a 40 kilometer VAS
ading in a manner analogous to that by which VAS product images are
erated. First results show that the MAMS calibration introduces
ping and further effort will be required to produce an attractive image
th can chart atmospheric changes on the mesoscale.
Navigating and archiving of MAMS data from COHMEX continues. Straight flight segments of 15 and 19 June have been completed. The navigation remains accurate within half a kilometer. 26 June will be completed next. Problems with 5 July may compromise those data. Work has also begun towards compiling an atlas of collocated HIS-MAMS data from COHMEX.

TOVS Processing (Eyre)

Dr. John Eyre has tested his experimental retrieval algorithm on the E data of January 1986, using one morning and one afternoon orbit. His simultaneous solution algorithm treats emissivity and clouds as variables in the solution and deals with uncorrected TOVS radiances. There was surprisingly little difficulty in moving from simulation to the real world, excellent coverage of temperature and moisture profiles was obtained. Method solves for a change to a background profile which in this case provided by short term forecasts using the CIMSS sub-synoptic model. Comparisons with the special GALE radiosondes showed that the retrieved temperatures improved over the background even in the dense data areas, and fields in frontal zones were sharpened. Moisture comparisons were not good, statistically, but seemed qualitatively reasonable.

High-resolution Interferometric Sounder (Howell, Woolf)

HIS spectra were synthesized from a summer mid-latitude subset of the atmosphere data base. Retrieval experiments have focused on this data rather that "real" observations in order to ensure internal consistency and validate procedures for modifying transmittances to account for the SW field-of-view of the instrument.

The software which computes spectra from the interferograms has been modified with the addition of a screening based on the slope of the spectra. The calibration algorithm has been modified to include more stringent requirements for the inclusion of blackbody spectra into the bration data set. Another modification of the calibration software is weighting of calibration sets preceding and following the earth-view. This is necessary for the occasional situation in which noisy blackbody spectra have been rejected leaving an unusually long time period between calibrations.

Data from 15 June 1986 have been reprocessed, and copies of the processed data have been sent to NASA and NESDIS.

PC-TOVS (Howell, Nagle)

A new file structure for the orbital parameters and other auxiliary such as transmittance and limb-correction coefficients has been added. The files are consistent in their coverage of a series of llites from TIROS-N through NOAA-10. With the new file structure, cional software was written to modify and/or display the orbital ents so that this file can easily be maintained.

A new feature of the PC-TOVS software package is the plotting of al tracks on a mercator projection.
One of our visitors from the PRC, Qu Yanni, is working on the development of software for the transformation from earth coordinates to satellite coordinates. This will allow plotting of geography over a TOVS image. With the help of Lindsay Feuling of SSEC, Yanni is also working to expand the user interface software to include the new features.

DMSP Processing (Nagle)

DMSP7/8 sounder data (SSMT) are now used bi-hourly to maintain a Kalman-filtered running analysis of the northern hemisphere. The technique combines NOAA, DMSP, VAS, and raob data, each with its appropriate error characteristics, to maintain a continually updated analysis.

Mesoscale Applications

IBM-PC (Wade, Howell)

Because of budget restrictions, we have had to severely curtail processing of VAS data for the PC user Data Access File (DAF).

VAS Sea Surface Temperatures (Wade)

The program was updated for mode AAA and considerably streamlined for economy. It is being used to test the advantage of separately derived SST for use in the VAS temperature/moisture retrieval algorithm. It is not a part of the initial VDUC software.

Wind/Radiance Coupling (Hayden)

This model was used to study the effectiveness of adding a thermodynamic profiler to the 1990's complement of GOES-IM and the wind profiler. The study showed that it has considerable value for defining the low level temperature structure, but only when deployed at relatively high spatial resolution. The combination of the three instruments appears to be a very effective way of defining the wind and mass fields in three dimensions.

Synoptic Applications

ECMWF (Menzel, Schreiner, Hayden)

Data sets covering the week of 22-26 June were reprocessed for evaluation by the ECMWF. Both soundings and winds over the Atlantic at 000 GMT were archived on tape and sent to G. Kelly for assessment.

Tropical Analysis (Merrill)

Plans made with NMC to study the impact of winds produced at CIMSS in the NMC analysis are still being pursued although one of the principals, Cliff Dey, left the Development Division for the Automation Division. Brad Mullish has assumed his role. Two cases from early October, 1985 have been analyzed at CIMSS. The procedure is to objectively analyze the cloud and vapor drift winds at three levels (250, 500 and 850 mb) using the CIMSS Recursive Filter analysis system. Gridpoint values picked from these
analyses will be sent as data to be used (initially) in the NMC Global Forecast System.

1) Gulf of Mexico Study (Wade, Hayden, Merrill)

A case study from April 1985 had been chosen, in conjunction with John Lewis at NSSL in Norman, for examination of the processes associated with polar air outbreaks over the Gulf of Mexico. The study is a precursor to a field experiment planned for February and March 1988 when a NOAA P-3 aircraft over the Gulf will provide in-situ measurements. SDAB involvement will emphasize satellite observations as well as incorporation of such data in the CIMSS assimilation model. The current activities involved the production and assessment of VAS retrievals and SST's for several time periods from 31 March through 6 April 1985.

A key parameter which is desired from the satellite for the data parse Gulf region is a measure of low level moisture. The VAS offers only that is effectively a "split window" estimate since only two channels sense low level moisture and temperature. The vertical resolution is quite coarse and inadequate, by itself, for boundary layer estimates. However, it could be useful in concert with a boundary layer model. Initial results from the case study have been submitted as a preprint for the 15th Severe Local Storms Conference to be held in February 1988.

2) VMIS (Menzel, Hayden, Schreiner)

VMIS activity has concentrated on a single case study for 3 September, 1987. Siebers, Petersen, and Mostek of NMC have been enthusiastically cooperating in the evaluation of moisture retrievals obtained with the VDUC algorithm for the 1018 thru 1118 dwell sounds on this date. Special emphasis is directed to the "dependency on the first guess", and for their consumption CIMSS has provided retrievals based on a 24 hour forecast, a 12 hour forecast, and the current analysis (all from the RAFS). The study indicates that the dependence is quite strong, and the VMIS is unable to correct errors in (for example) the 700 mb dewpoint when they are present in the guess. The influence of the VAS is quite subtle, and the question of their having a positive impact on the moisture forecast is moot. A report of this project is being prepared for the Eighth Conference on Numerical Prediction to be held in Baltimore in February, 1988.

3) Satellite Winds (Stewart, Velden, Hayden)

The algorithm for automated derivation of cloud motion winds and water vapor winds (WVW) was delivered to the VDUC for operational use. With the implementation of the NHC VAS schedule, small (8 km) detector 6.7 micron imagery became available for the first time, and this was used to derive WV which could be compared with those derived from the large (14 km) detector data. The small detector gives a marked improvement in quantity, specially in the cloud free areas where the WVV are most valuable.

4) Data Assimilation (Goodman, Diak, Callan, Raymond)

The effort has concentrated on assimilating satellite data in the analyses of the GALE data. Little difficulty has been encountered using
TOVS temperature and moisture retrievals, but the VAS have significant bias problems in both parameters. The latter is alleviated by a variational blending technique which uses geopotential and moisture gradients in conjunction with the absolute measurements of the radiosonde. Experiments with the TOVS data have shown that they help to generate the secondary low which was observed on January 28, although the intensity is less and the system is slightly lagged. The VAS retrievals have not been shown to have a beneficial impact.

9. Sensor Calibration

a) Kitt Peak Solar Data (Howell)

New software was written to read the data observed by the Solar Telescope at Kitt Peak Observatory in August 1986. This software assembles a high resolution (0.02 cm⁻¹) solar spectrum with a spectral range of 500 to 2800 cm⁻¹, computes the Fourier transform, truncates the interferogram to match the HIS resolution, computes the FFT of the truncated interferogram and writes the resulting spectrum in the HIS format.

b) Line-by-line Transmittance Model (Woolf)

The compilation of transmittance data sets for off-nadir zenith angles continues.

c) De-navigation (Nagle)

Techniques are now developed and routinely used to obtain the orbital parameters for both NOAA and DMSP polar orbiters. The need to predict orbits for the DMSP series was required for fulfillment of the SSEC contract with the Navy for verification of the SSM/I instrument. The use of such 'de-navigation' also allows simplified models for satellite navigation of the NOAA-x series for which orbital parameters are available. Satellite de-navigation was the topic of a paper given in Boulder 14-16 July.

Part II. Other Activities

1. ITOVS (Menzel, LeMarshall)

A tentative agenda was drafted for the fourth study conference convening the International TOVS Working Group of the IRC (International Radiation Commission), scheduled for 16-22 March 1988 in Igls, Austria. Two new case studies have been selected for distribution to the participants; a severe storm in France and a tropical cyclone in northern Australia: the evaluation of sounding data in NWP is the focus of this new work.

A Report on TOVS Data Retrieval Methods was prepared for the Commission for Basic Systems in the WMO. It summarizes the more relevant ITOVS findings, anticipates future activities, and makes recommendations to the CBS. In the report, the significance of direct readout user services from meteorological satellites is stressed for monitoring and predicting severe local weather; NOAA is urged to continue this service by the ITOVS group. In addition, it is noted that the TIP beacon enables inexpensive
access to the data stream for PC based systems; NOAA is commended for their efforts to support this facility through NOAA-M (and something comparable beyond that?).

2. **GOES I-M (Menzel, Merrill)**

A NOAA Tech Memo was submitted in July which details a probable hurricane operational scenario for GOES I-M. The progress of this report has apparently become moribund in the review process.

3. **High-Level Fortran (Nagle)**

High-Level Fortran (HLF), an outgrowth of Meteorological Fortran, has been further updated to include certain features of the forthcoming Fortran-8x. HLF was the subject of a paper presented to IBM SHARE in Chicago on 27 August 1987.

**Part III. Appendix**

2. **Meetings and Seminars**

**August**

Menzel, Hayden


Menzel


Menzel

Attend the ANZAAS (Australia New Zealand Association for the Advancement of Science) Conference in Townsville, Australia on August 24-28, 1987.

**September**

Rowe, Stewart

Adjust the autowindco and sounding software on the VDUC in Camp Springs, Maryland on September 2-4, 1987.

Howell


Velden, Merrill

Conduct wind training with the SAB on VDUC on September 22-25, 1987 in Camp Springs, Maryland.

4. **Visitors**

Lynn Rose from North Dakota Weather Modification Board (Bismarck, North Dakota) visited SDAB to discuss the use and availability of VAS retrievals via their McIDAS terminal on July 14, 1987.
Ron Weinkauf, from University of Wisconsin at La Crosse, visited SDAB to discuss VAS water vapor imagery request for their case study use on their PC on July 16, 1987.

Roney Sorensen of SAB received programmers training at SSEC for use on the VDUC from July 14-16, 1987.

Dr. Brian Conway from the British Meteorological Office, Bracknell, UK visited the ASPP on August 10, 1987 to learn about McIDAS processing of sounding and imaging data.

Dr. Roberto Ligi from Telespazio, Rome, Italy visited the ASPP and CIMSS to learn about TOVS processing and the International TOVS Processing Package from August 17-21, 1987.

Hans Joachim Lutz from the University of Cologne, West Germany began a one year visit to CIMSS in mid-August to participate in sounding research.

Dr. Elen Cutrim from the University Federal do Para, Belem, Brazil started her two year collaboration with CIMSS scientists in early September to process and evaluate the GTE/ABLE data (particularly the VAS soundings over the Amazon basin).

John Lewis and Bob Maddox from National Severe Storms Laboratory in Norman, Oklahoma visited SDAB on September 8-10 concerning the cooperative activities between NSSL and CIMSS, particularly the upcoming Gulf of Mexico experiment.

Dr. Donald Miller, Director of the Satellite Applications Laboratory, attended the CIMSS Council Meeting on September 11, 1987.

Keith McKenzie (SPD) and Michael Goldberg (MITRE) presented the requirements definition for the GOES Variable Format (CVAR) Ingestor and the GOES Real Time (GRT) Database to Paul Menzel and SSEC on September 15, 1987.

Thomas Pyke (NESDIS) and Shelby Tilford (NASA) attended the Annual CIMSS Board Meeting on September 22, 1987.

Jacques Halle from the Atmospheric Environment Service, Montreal, Canada visited Paul Menzel on September 30, 1987 to discuss transfer of the VAS sounding software to AES.
Part I. Research Progress

2. ERBE/Climate (Ackerman, Herman)

Additional data have been received from NASA which include the NOAA-9 data for the FIRE (October 1986). The Master's thesis work of Fred Wu has been extended and will be submitted for publication. The paper discusses a cross validation between the ERBS scanner and non-scanner data. In summary, the study shows that largest biases occur between the scanner and the wide field-of-view nonscanner. The magnitude of the biases between scanner simulations and nonscanner measurements are related to the relative position of the sun. In the case of the shortwave, the biases are a function of both solar zenith and azimuth angles, while for the longwave the biases are a function of only the azimuth angle. Largest differences (8 watts per meter squared) are associated with the longwave wide field of view comparison. Smaller biases are observed at night.

An optical archival system has been received from NASA. It includes a tape drive, an optical disk drive, a controller, and a video terminal. The system allows data transfer between magnetic tape and optical platter, and vice versa, as well visual monitoring. Data for ERBS April and October, 1985, have been received on optical platters (replacing 65 tapes of two platters). In addition, an IBEIX PCI-100 card/software has been purchased and installed to permit communication between an IBM PC and the magnetic tape/optical disk drives.

3. Atmospheric Sounding

VDUC Retrieval Algorithm (Hayden, Schreiner)

Two changes were implemented at the beginning of the VMIS processing in late November.

The background field for the analysis of the dewpoint over the ocean is now fixed at 5K less than the background surface air temperature which is provided by an NWS forecast. Previously, the forecast 1000 mb dewpoint was used.

The channels used to derive basis functions for deriving moisture retrievals were changed from 7, 9, 10 to 7, 5, 4. The purpose was to permit more structure at low levels and to avoid computational instability when channels 9 and 10 became nearly redundant. However, as the colder, drier season progressed, the functions for 5 and 7 began to give redundancy problems and we reverted to the original set shortly before Christmas.

Experimental VAS Algorithms (Hayden)

Moisture retrievals at low levels continue to be unsatisfactory. Since the beginning of the VMIS processing, we have monitored the
retrievals daily, comparing them to their first guess profiles (derived from the RAIPS forecast) and to nearby radiosondes. Comparisons are made for 850 mb dewpoint, 700 mb dewpoint, and for integrated precipitable water from the surface to sigma = .7 (sigma = p/psfc). In general, the retrievals degrade the first guess, particularly in cold, dry atmospheres. In the hopes of improving on this discouraging result, we are experimenting with:

- the use of Gaussian basis functions to remove the redundancy problem mentioned above.
- an extension from 3 to 4 basis functions for moisture.
- inclusion of the 11 micron window as an observation
- direct retrieval of precipitable water (instead of mixing ratio)
- the use of the logarithm of precipitable water rather than precipitable water itself in the linearization of the radiative transfer equation.

Other suggestions will be cheerfully received and evaluated. In the meantime, it's "hats off" to the RAIPS for the quality of the forecast.

c) VAS Processing (Schreiner, Merrill, Stewart, Hayden, Menzel)

Processing of single, daily VAS retrieval data set was continued. Processing was done in "background" mode, since real-time completion is no longer necessary and our budget crunch calls for every possible economy. (It should be mentioned that this is a short term improvement, since ground rates will surely be raised to cover costs no longer borne by "coregound". That is the way of fixed cost services, e.g., bus companies.) In mid-November, the time period of choice was shifted from 13 to 11 UTC, as the satellite schedule changed from tropical storm to winter storm coverage. Latitude bounds were shifted south, relative to previous winters, to accommodate increased interest in the Gulf of Mexico (i.e., the VMIS and GUFMEX projects; see Section 8).

d) Regression Retrievals (Nagle, Hayden)

In response to continuing complaints that the physical retrieval algorithm consumes too much of the VDUC, a regression solution with coefficients derived from continuously updated, matched satellite/radiosonde observations has been run daily, using the cloud cleared VAS radiances which are part of the physical retrieval package. The physical and regression retrievals are verified against the 12 UTC radiosondes. Results show that the physical retrievals are usually better by about .2 Celsius. We shall stubbornly refuse to adopt the regression method unless it proves clearly superior (which is exactly opposite to the philosophy followed with TOVS operational retrievals.)

e) TOVS Processing (Eyre)

Before leaving CIMSS in December, Dr. John Eyre turned over his experimental retrieval algorithm to Donsoo Kim who will continue testing method when TOVS data become routinely available on the McIDAS.
f) AVHRR (Herman)

The AVHRR cloud clearing software for the TOVS retrievals was resurrected and tested on one orbit of the GALE data set. Results showed little impact from the AVHRR data in terms of synoptic scale temperature patterns. This result corroborates earlier experiences. The utility of the AVHRR is only felt at the subsynoptic scales.

g) PC-TOVS (Howell, Nagle)

The software for computing and plotting orbital tracks was modified to run on a single monitor system. This is part of the effort at SSEC to have a PC version of the ITPP for the next International TOVS Working Group Meeting (March 1988).

h) Direct Readout TOVS (Howell)

For the processing of real-time HRPT data from the SSEC DOMSAT antenna, two programs were written to:

- compute calibration coefficients for the infrared channels of AVHRR.
- Read the TIP area and write an LW file of raw TIP data.

Comparisons with orbital summary data from NESDIS showed the calibration coefficients to be reasonable. Further, more accurate comparisons will be made next quarter by accessing the lb data from Suitland. TIP data generated by this software has been successfully ingested by existing MCIDAS software. A two-dimensional interpolation algorithm was also developed for the non-linearity correction of AVHRR brightness temperatures.

i) High-resolution Interferometric Sounder (HIS) (Howell, Woolf)

Much of the COHMEX data have been reprocessed under the improved calibration and quality control algorithms reported last quarter. Data for the flight of 6/15/86 were written to an ASCII card-image tape and sent to:

1) E. Hurley, NASA/GSFC
2) R. Kakar, NASA Headquarters
3) J. Susskind, NASA/GSFC
4) D. Wark, NESDIS

To alleviate the shortage of MCIDAS file space caused in part by heavy usage by persons using HIS data, two new MCIDAS keyins were written:

1) LWTA, to read a HIS LW file and write data into an area;

2) ATLW, to read an area (in HIS format) and write LW file.

j) In support of the SSEC project to design an interferometric sounder for a geostationary satellite platform, PC software was written to transfer data to and from the variable speed scan controller which is
under development here. The first phase of this software has been tested used for testing of the controller hardware/software.

With the assistance of Robert Knuteson of SSEC, a more rigorous procedure has been developed to account for the instrument's finite field of view in theoretical calculations of transmittance and radiance. The new method, while requiring more computer memory, disk space, and processing time, eliminates much of the discrepancy between calculated and observed spectra which has plagued the data analysis effort. Consequently, sounding retrieval results have improved significantly.

7. Mesoscale Applications

a) VAS Sea Surface Temperatures (Wade)

On 1 December, routine VAS SST generation from the 1831 UTC MSI was begun. Current development involves the use of the previous, composite image to filter out cloud contamination.

Calibration codicils have been added to the SST images to allow display of the data with the normal McIDAS (VUDC) data display key-ins.

b) SSM/I (Nagle)

Attempts to process the DEF Tape containing SSM/I data have not been successful. Failures usually involve bad check sums of logical data words which span the interval between two physical blocks. The DEF format does not appear to allow for recovery from this type of error, so that a failure means that the remainder of the data is unreadable. A letter of complaint on this subject was sent to the Federal Coordinator for Meteorological Services and Supporting Research.

c) MAMS (Moeller, Menzel)

Work has continued on the MAMS-VAS derived product. An adjustment to the retrieval process has allowed the surface quantities (temperature, dewpoint) to fluctuate over the scale of individual MAMS fields of view. Previously, surface quantities were held constant across the entire VAS 24km sounding. The modification has produced a more realistic picture of 100m variation of total precipitable water and lifted index. Comparisons with COHMEX Beta Network raob total precipitable water and lifted index with the MAMS-VAS derived products has shown good agreement for one MAMS flight track on 19 June 1986. It is planned to apply this procedure to three more flight tracks from that day, producing a composite picture of total precipitable water and lifted index variability over the COHMEX region for that day.

In the MAMS navigation and archiving effort, data have now been obtained for 26 June 1986. These data will be scrutinized for any problems and then archived. A tentative composite list of all MAMS COHMEX dates for archival has now been collected. The dates include: June 15, June 18, June 19, June 26, July 3, and July 5. Of these dates, 15 June and 19 June have been archived.
3. Synoptic Applications

1) ECMWF (Menzel, Schreiner, Hayden)

The sounding/wind data sets covering the week of 22-26 June which have been delivered to the ECMWF are still awaiting complete evaluation until the Meteosat wind set is received from ESA. However, Graeme Kelly has looked at the wind sets and is gratified to see that they do not appear to diminish the speed of the jet, relative to the ECMWF analysis, as is commonly observed with the operational satellite-derived wind sets.

2) Tropical Analysis (Merrill)

Plans for insertion of CIMSS wind data into the NMC global analysis were discussed at the Hurricane Analysis Workshop held at NMC in December. NMC management has emphasized the need for accompanying information about the quality of the winds and the analyses prepared from them (see below). Transmission of the October 1987 test cases from CIMSS to NMC via the VDUC will be attempted soon with the cooperation of the Interactive Products Branch.

3) Gulf of Mexico Study (Wade, Hayden, Merrill)

A GUFMEX planning meeting was held in Norman, Oklahoma in October. Current plans call for one aircraft flight over the loop current investigating air mass modification and two, 2-day flights farther to the west to observe return flow. The latter will originate in Miami, but fly over in New Orleans. These will take place in late February or early March. Special CLASS soundings will be released at four sites: Laredo, Texas; the NOAA ship Chapman; a Mobile drilling platform south of Lake Charles; and a Coast Guard vessel which will be operating in the area.

The April 1985 case continues to be used to refine the VAS processing for this experiment. The case will be used to test the SSM assimilation when appropriate boundary conditions are obtained from the NCAR archive.

4) VMIS (Menzel, Hayden, Schreiner)

VAS Model Impact Studies (VMIS) have not been conducted by the NMC because of the disappointing results observed with the VAS moisture retrievals. VAS retrieval evaluation continues under this project and papers have been prepared for presentation at the AMS meetings to be held in Anaheim, California and Baltimore, Maryland in February, 1988.

On the suggestion of Ralph Petersen of NMC, we are beginning to look at the depth of upper level moisture, as detected by the VAS. If this appears to give quantitative information, it may be parameterized into the analysis to improve the radiation exchange within the forecast model.

Satellite Winds (Merrill, Stewart, Hayden)

Improvements are being made in the automated production and quality control of cloud and water vapor motion winds (CWMW's) derived from VAS multispectral imager (MSI). Research is underway to:
- find the best loop interval and resolution for water vapor winds;
- use target variances and tracking correlation magnitudes for quality indices;
- use a three-dimensional recursive filter analysis for simultaneous quality control and analysis of CWMWs.

The goals are to produce the best possible CWMWs using existing sensors and to reduce the amount of time needed for subjective editing of CWMWs.

The current GOES schedule allows three-image MSI loops with images every one-half, one, and two hours. From these, winds can be produced from band 9 (7.3 micrometer) and band 10 (6.7 micrometer) loops for small detector (band 9 only) and large detector (bands 9 and 10). The quantity and quality of winds produced will be investigated to evaluate the optimum time increment and resolution for WMW production. Preliminary results indicate that the superior resolution of the small detector band 9 imagery is more than offset by the greater amount of noise and the results are inferior in both quality and quantity to those from the large detector imagery.

Upgraded software for automatic CWMW production is now being tested. This new software records supplementary quality control information with each wind vector. Mean, range, and variance of target brightness counts and magnitude of correlation from tracking the target will be compared to verification statistics of CWMWs versus rawinsondes and against subjective quality estimates. From these evaluations, an algorithm for assigning a preliminary quality estimate to each wind will be devised. These quality estimates will then be used as initial data weights in the recursive filter analysis, which modifies the data weights at each iteration based on analysis-observation agreement. It is hoped that these better initial quality estimates will largely eliminate the need for time-consuming manual editing of CWMWs.

The algorithm for automated derivation of cloud motion winds and water vapor winds (WWV) was delivered to the VDUC for operational use. With the implementation of the NHC VAS schedule, small (8 km) detector 6.7 micron imagery became available for the first time, and this was used to derive WWV which could be compared with those derived from the large (14 km) detector data. The small detector gives a marked improvement in quantity, especially in the cloud free areas where the WMW are most valuable.

Data Assimilation (Goodman, Diak, Callan, Raymond)

The data assimilation effort for the second GALE Intensive Observation Period (IOP) ended this quarter with the completion of the conventional data analysis forecast runs. An analysis forecast run for the 4 March 1982 ALPEX case was attempted, but was delayed because of problems with high terrain at the southern edge of the domain. The problem is in either the forecast code or the post-processor code, but has not been precisely located. A new horizontal filter was installed in the forecast. Several tests were done to determine the optimal vertical mode initialization parameters for the forecast.
Arrangements are being made to install the Sub-Synoptic Model (SSM) on the Cray at Marshall Space Flight Center. Model results will be piped back to the Madison McIDAS. MSFC has already built most of the software required to interface the Cray with their own McIDAS.

g) Kalman Filter Assimilation (Nagle)

The Kalman filter analysis continues to be used for the assimilation of TOVS and DMSP sounding data. A comparison of the geostrophic wind implicit in the analysis with that of the NMC global analysis shows that the satellite product has about 85-90 percent of the gradient. This result is consistent with other studies of the synoptic variance captured by indirect sounding.

h) Three-dimensional Recursive Filter (Hayden, Purser)

The two-dimensional recursive filter objective analysis, which is used in the processing and display of VAS data on the McIDAS (VDUC), has been extended to three dimensions. The principal advantage of the new version is that it can easily accommodate off-level data such as significant level radiosonde reports or satellite-derived winds. The new version retains the option of using a background field and has improved quality control. It will eventually be integrated into the quality control processing of the VAS retrievals and winds. The model currently can use either pressure or sigma levels as the vertical coordinate. Care has been taken to retain efficiency. A paper describing the procedure has been submitted as a preprint to the Eighth Conference on Numerical Prediction to be held in Baltimore, February, 1988.

2. Sensor Calibration

a) Line-by-line Transmittance Model (Woolf)

The compilation of transmittance datasets continues. It is anticipated that this activity will be completed by mid-February, 1988. Interestingly, this CPU intensive project has put enough of a burden on the Suitland Central Computing Facility to be noticed by management.

b) Fast Microwave Transmittance Models (Woolf, Eyre)

The regression model was modified to provide improved accuracy with respect to line-by-line transmittances at off-nadir scan angles. Coefficient files were created for application to AMSU and SSM/T. A paper describing the method has been submitted to Applied Optics.

c) VISSR Calibration (Wade)

SDAB has agreed to provide GOES visible data over White Sands, in SARS format, to Gilbert Smith (Training and Information Branch, SAL). Several images were delivered for November and December.
d) VAS Support (Menzel, Schmit)

The short wave channels on the VAS were investigated for problems with signal saturation over hot targets. It was found that the radiance equation relating counts to radiance needed slope adjustment. New slopes were suggested and implemented. Saturation for bands 6, 11, and 12 are no longer apparent.

Part II. Other Activities

1. ITOVS (Woolf, Menzel)

The VAX version of the ITPP was upgraded and installed on the Laboratory for Oceans VAX 11/750 at GSFC to provide a vehicle for support of the SPARRSO (Bangladesh) system. A similarly upgraded IBM version is also available for distribution.

2. GOES I-M (Menzel, Merrill)

The NOAA Tech Memo, submitted in July, which details a probable hurricane operational scenario for GOES I-M is still floundering in the review process.

3. VDUC (Wade, Schmit, Menzel)

Problems with the VDUC ingestor were diagnosed in the water vapor images; replacement hardware was arranged with SSEC and the ingest of VAS MSI was successfully duplicated on the McIDAS. Disparities in the east and west VAS water vapor images have been noted, but the cause is not known. It was suggested that the VDUC sample rather than average pixels along a line so that cloud features are not smeared and hole hunting for sounding is enhanced. A memo was sent to Gene Legg for the VDUC Users Group summarizing these findings.

4. VAS Seminars in Brazil (Menzel)

Four lectures were presented at INPE (Instituto de Pesquisas Espaciais or Institute for Space Research) in Sao Jose dos Campos, Brazil. These included radiative transfer, TOVS and VAS meteorological applications, early results of GTE/ABLE, and future NOAA satellite plans. Each lecture was attended by thirty to fifty people. In addition, a conceptual design was developed with engineers and scientists from INPE for a Brazilian meteorological instrument (GEOMETBRAS) to be housed on board the EMBRATEL geostationary telecommunications satellite to be launched in 1993.
Part II. Appendix

2. Meetings and Seminars

October

Menzel, Hayden
Presentation to VDUC Users Group on final stages of the transfer of the VAS operation capability in Camp Springs, Maryland on October 1-2, 1987.

Hayden
Participate in STORM Data Assimilation Workshop in Arlie, Virginia on October 5-8, 1987.

Herman

Hayden, Wade
Attend GUFMEX Planning Meeting at National Severe Storms Laboratory in Norman, Oklahoma on October 26-28, 1987.

Menzel
Present GOES I-M science requirements at System Concept Review in Greenbelt, Maryland on October 28, 1987.

November

Menzel
Series of lectures given on geostationary remote sensing of the weather at the Space Research Institute (INPE) in San Jose dos Campos, Brazil on November 13 through December 2.

Visitors

Guy Rochard from CMS, Lannion, France visited the ASPP to discuss the next ITOVS case studies and to see the PC TOVS developments on October 12-15, 1987.

Dr. Erhard Rachke from the University of Cologne, FRG visited the ASPP on October 23 to discuss the soundings in the Antarctic with the TOVS.

Dr. J. C. McKee of the National Research Council visited the SDAB on December 9 to discuss the Research Associateship programs.

Dr. Michael Weinreb visited P. Menzel and T. Schmit on December 10 to discuss GOES I-M calibration tasks.
Quarterly Activities Report
January-March 1988
System Design and Applications Branch

Part I. Research Progress

2. ERBE/Climate (Ackerman, Herman)

The monthly averaged tapes for the NOAA-9, ERBS and the combined NOAA-9 and ERBS products for April 1985 have been received. These data will be considered for archival by the science team at the upcoming April meeting. Our analysis at CIMSS has indicated to proceed with archival, though some difficulties remain. Recent scene identification code modifications by NASA have been incorporated into our software. Also, scan line dropout which in the past has caused problems in the navigation of McIDAS images can now be identified by the software and allowed for. The imaging is consequently improved.

Software has been developed which allows the IBM PC/XT to retrieve and analyze ERBE data from tape or optical platter. The programs developed by Fred Wu have been adopted to the PC and comparisons between the scanner and nonscanner measurements for the month of October 1985 are underway. The results of this cross validation will be reported at the upcoming science team meeting, where the October data will be considered for archival. The ability to perform these intercomparisons on the PC provides a cost effective way of analyzing a large number of days for all ERBE satellites. We therefore plan to continue the cross validation for all available data so that the relationship between the position of the sun and differences in the scanner and nonscanner measurements can be fully explored.

The other major research effort during the past quarter has been an intercomparison between NOAA-9 ERBE scanner measurements and other measurements taken during the FIRE experiment in October 1986. The NOAA-9 measured longwave radiative fluxes were correlated with flux estimates from the GOES-6 VAS measurements. While the VAS fluxes were highly correlated (r=0.9928) to the ERBE measurements, they tended to overestimate the flux at the top of the atmosphere. The VAS estimates were corrected according to a least square fit with the ERBE measurements so that, for clear sky conditions, the VAS flux estimates are within approximately 3% of the NOAA-9 ERBE measurements. The NOAA-9 ERBE data are also being compared with Don Wiley's cloud analysis of the NOAA-9 HIRS data. Cloud amount and cloud top pressure derived from the HIRS data are being compared with the ERBE scene type. While only three days have thus far been analyzed, as expected, under clear sky and overcast conditions the two techniques compare favorably. There are discrepancies in the partly cloudy and mostly cloudy ERBE scenes that will be explored with further analysis. HIS data have been employed to study the inversion from the ERBE filtered measurements to the unfiltered estimates. The HIS high spectral resolution measurements were integrated to simulate longwave fluxes. The HIS data were also integrated, along with the ERBE spectral response function, to simulate actual ERBE longwave measurements. The ratio of these estimates was then made and compared with similar data from the NOAA-9 ERBE data. The two data sets yielded similar results. Finally,
have contacted Dr. Steve Cox of CSU regarding a comparison between the N-9 ERBE measurements and the Saberliner broadband radiative measurements taken during FIRE. He is presently preparing the aircraft data set for the comparison.

5. Atmospheric Sounding

a) VDUC Retrieval Algorithm (Hayden, Schreiner)

No changes were made to the VDUC retrieval algorithm during this quarter.

b) Experimental VAS Algorithms (Hayden)

During this period three experimental algorithms were run in parallel with the VDUC processing of the 11:48-12:18 dwell sounding. These were:

- a version identical to the VDUC except including the additional channel at 4.4 micrometers. The most noticeable effect of this change was an increase in "rejected" soundings which were recognized as cloud contaminated.

- a version using the 4.4 channel and 4 Gaussian water vapor basis functions (instead of the VDUC's three "natural" basis functions). No change in the physics. This version showed improved guess independence and increased local "noise" in dewpoint temperatures.

- a version with four Gaussian water vapor basis functions and a formulation to derive precipitable water directly (rather than mixing ratio). This version proved to give almost the same results as the mixing ratio version. Statistically, as compared to radiosondes, it was slightly inferior.

Experimentation with the method of formulating the rate of change of transmittance with respect to moisture continued, but no notable improvements were reached.

In verifying results achieved with the three retrieval versions mentioned above, we abandoned the comparison of constant pressure level dewpoints in favor of layers of precipitable water. As our principal criterion of comparison we are now using the total precipitable water in the lowest 300 mb. Statistical comparisons between the VAS results versus radiosondes and between the first guess (RAFS forecast) versus radiosondes continue to suggest that the VAS, on the average, slightly degrades the forecast. However, qualitative comparisons of analyzed fields of precipitable water suggest that the experimental algorithm has a positive impact, particularly over the Gulf of Mexico.

Based on our results of this quarter we are proposing to replace the VDUC operational algorithm with the second version discussed above.

VAS Time Composite (Callan, Menzel)
The program to time composite an area of VAS data has been activated. The goal is to remove cloud contamination by combining clear measurements over a (relatively short) time period as the clouds move. The procedure is neither simple nor cheap since the satellite nutates and calibration varies from line to line. Nevertheless, some progress has been made.

d) AVHRR (Herman)

Parameters for deriving AOKI numbers for NOAA-10 have been obtained from Guy Rochard of CMR, Lannion and incorporated in the McIDAS AVHRR software. AVHRR ingestors developed at SSEC have reached the point where data is brought in (via DOMSAT) routinely and can be navigated and displayed.

e) PC-TOVS (Howell, Nagle)

There has been a strong effort on the part of SSEC, NESDIS and visiting personnel at SSEC to create a user-friendly PC version of the International TOVS Processing Package. In support of this the pre-processing software was revised, corrected and updated to use the Enhanced Graphics Adapter (EGA) software developed by SSEC personnel. The resulting menu-driven software was exercised daily for about two weeks prior to the ITSC. Two products were generated on the Dial Access Facility:

1. RT -- raw TIP data
2. PT -- processed TIP data, calibrated and earth-located

These products were accessed during the ITSC to demonstrate the remote access capability.

f) High-resolution Interferometric Sounder (HIS) (Howell, Woolf)

The PC software for communicating with the variable-speed scan controller and display of speed and timing profiles was completed and is now in use.

With the objective of providing HIS users with "pure" data, it was decided to compute unapodized spectra using a "safe" length of each interferogram, i.e., a length which excludes the discontinuities in some blackbody spectra due to the change in scene mirror position. Since then, we have produced some unapodized spectra and software which allows the user to reduce the spectral resolution, with or without apodization, as desired. We will continue to achieve maximum spectral resolution without compromising, by the addition of noise, the resulting spectra. In support of this study, special software was written to allow the calibration of a single spectrum, either earth view or blackbody view, using a pair of blackbody spectra specified by the user.

PC software was developed for plotting the radiosonde data associated with the HIS flights. A collection of spectra, observed and theoretical, and the display programs to plot them, was shown (by W. L. Smith) to some of the persons attending the Iglis International TOVS Study Conference.
Software was developed to aid in theoretical analysis of vertical resolution and retrieval errors to be achieved with interferometric sounders proposed for future geostationary and polar-orbiting platforms.

7. Mesoscale Applications

a) VAS Sea Surface Temperatures (Wade)

No additional research was done on this project. SST were generated daily during the GUFMEX experiment.

b) SSM/I (Nagle)

No progress in this area.

c) Tornadic Thunderstorms Identification from VAS Imagery (Schrab, Wade)

A technique has been developed to identify potential tornadic thunderstorms by observing the characteristic signatures of the emerging anvil from a thunderstorm cell. The anvil outflow strength and the storm relative anvil deviation angle have been statistically regressed against storm strength for case studies including about 40 cells (over 90% of the variance in tornadic intensity is explained). The process is now being adapted for real time application on McIDAS and attempts at nighttime (IR only) determination of storm strength are also being made. The ASPP is participating conducting a pilot demonstration of the technique for NSSFC in the second quarter of 1988.

d) VAS derived product imagery (Hayden, Schreiner)

A major effort was made during this quarter to improve our procedures for producing the VAS derived product images of precipitable water and lifted index. This research is in response to the National Severe Storm Forecast Center's request for more frequent and timely images. The new procedure involves three fundamental changes.

The first change is an algebraic rearrangement of the retrieval algorithm so that the final step in calculating the change to the first guess at any pressure level is simply a multiplication of a coefficient vector by a vector of brightness temperature differences (observed - calculated from the first guess). The rationale for the change is that the coefficient vector and the calculated brightness temperature can be pre-calculated before the observations are available (i.e., as soon as the first guess is received, since they depend only on the first guess. The retrieval in real time then becomes essentially as computationally efficient as a regression retrieval. This gives promise of improving the timeliness of the product.

The second change is to use MSI rather than the dwell soundings. MSI are available every half hour rather than every 90 minutes. Also, each SI covers the entire area of interest in a few minutes. An equivalent requires two dwell sounds separated by a half hour. Thus, this change promises to improve both frequency and timeliness of the product. The penalty is that only three instead of twelve radiance measurements are available for the "retrieval".
The third change is a modification to the retrieval algorithm in order to estimate precipitable water (above each pressure level) rather than mixing ratio (see 5-b above). Using this formulation, total precipitable water can be calculated from a single vector of coefficients appropriate to the surface pressure. A new formulation for the lifted index has also been implemented such that the only temperature retrieved is for the level (layer) immediately above the surface. This, and the modification to the total precipitable water, are used to define the boundary layer "parcel" characteristics. The parcel is "lifted" using Wobus statistical relationships (as before), and compared with the forecast 500 mb temperature to provide the LI.

In terms of logistics, retrieval coefficients and first-guess estimates of the measurements are pre-computed from the 6, 12, and 18 hour forecasts of the NWS RAFS at a density of one degree latitude/longitude. The forecasts provide for temporal interpolation to the VAS observations. Since we are using five measurements (the three MSI radiances and surface temperature and mixing ratio) there are five coefficients required to predict the update of temperature or precipitable water at any level at any time. In order to provide for spatial interpolation to VAS observations 15 objective analyses are made for each forecast; five coefficients for total precipitable water, five coefficients for boundary layer temperature; and five analyses comprising the first-guess estimates. These 45 objective analyses are used at the time of the VAS observations to produce the derived product imagery. The total preprocessing (for a 12 hour period, requires about ten minutes of CPU on the McIDAS IBM 4381.

We are currently processing the VAS MSI on the hour for the period 7 thru 18 UTC daily. At the time of observation, objective analyses of the current surface data are prepared; coefficients and guess grids are interpolated in time; images are calculated. Macros for this procedure have been prepared and are scheduled to initiate automatically at 10 past the hour. Final images are available (and transferred to the WWB VEDC) by 20 past the hour.

The timeliness of the product meets the needs of NSSFC. The products appear to be useful; but final judgement rests with the NSSFC staff.

e) MAMS (Moeller, Menzel)

The combined MAMS/VAS derived product images (precipitable water and lifted index) have been produced at 100 meter resolution with data from 19 June 1986. The PW results compare nicely with the COHMEX beta network raobs for that day; there was subsequent development of low level cumulus whose location agreed quite well with that of the moist air in the MAMS/VAS product. A comparable MAMS/VAS outgoing longwave flux calculation is now being pursued. The methodology will utilize regression relationships between brightness temperature and flux at various levels of the atmosphere; such a technique has already been explored with VAS data alone by Smith and Woolf.

**Synoptic Applications**

a) ECMWF (Menzel, Schreiner, Hayden)
The sounding/wind data sets covering the week of 22-26 June 85 which have been delivered to the ECMWF are STILL awaiting evaluation. The delay has been occasioned pending arrival of a Meteosat wind set from ESA. Since it now appears that the latter may still be six months away, G. Kelly has promised to begin an evaluation of the VAS data.

b) Tropical Analysis (Merrill)

The activity whereby CIMSS hoped to work with the NMC Development division to improve the tropical analysis has encountered heavy weather. One problem has been our difficulty is establishing solid contact, as a number of personnel changes have occurred at the NMC. Another has been some reluctance on our part to push this project since we feel a need to improve the quality of the tropical winds derived from satellite imagery prior to running an impact study.

c) Gulf of Mexico Study (Wade, Hayden, Merrill)

The Gulf of Mexico Experiment field phase which began February 20 continued through March and into early April. Merrill was in Miami from 6-12 March and participated in all four NOAA P-3 flights. These flights were made on 7-8 and 10-11 March and were directed at western Gulf return flow events. Both return flow missions were similar; a high-altitude ferry from Miami to the western Gulf, descent to 500 feet, and execution of a search pattern with occasional "ramp" ascents and descents to 5000 feet, followed by an overnight in Harlingen, Texas. The flight ferried back to Miami on the following day, although an abbreviated 10,000 feet pattern (with omega-dropwind sondes) was flown over the western Gulf on the 11th. C-130 flights conducted as part of the 53rd Weather Reconnaissance Group's training schedule coincided with the P-3 flights on the 7th and the 10th. Special rawinsonde collections likewise coincided with P-3 activity with the exception of 31 Mar-2 April, a "rawinsonde-only" period.

Both cases studied with the P-3 highlight the difficulty of forecasting the timing of a return flow. The 7-8 March case was already quite moist in the low levels when we arrived, with 500 feet Td's of 18-20 C. It was possible to locate a gradient of Td's, possibly the boundary between well-modified polar air and tropical air. The case will be a difficult one for remote sensing, since there were numerous middle and high cloud layers, as well as many thin layers of high humidity even in clear areas. It was also noted that the low-level winds were much weaker over the water (10-15 kt) than over land (30-35 kt on approach into Harlingen).

The 10-11 March case, by contrast, was relatively dry in the low levels and characterized by strong southerly (20-25 kt) winds over water. Despite the strong southerly flow, high humidities remained south of the flight area throughout both days, implying perhaps that the low-level jet was entirely confined to the modified polar air and had no "roots" in the tropical air over the extreme southern Gulf. This case should be an especially interesting one for trajectory analysis and also has high potential for successful satellite soundings as large areas of the region were entirely free of mid- and upper-level cloudiness. The cases of 14-16
22-24 March are also of interest. In the former, a moist return occurred aloft, but not at the surface. The latter, dubbed the "Caribbean Express," was characterized by stronger trade wind flow over the Caribbean Sea, with which the low-level jet connected, drawing moisture rapidly poleward. Dewpoints around 55 F and thunderstorms occurred in southern Wisconsin on the 24th. The various GUFMEX cases of March 1988 raise a new question about return flows: what is the relative importance of the "pull" provided by the approaching mid-latitude disturbance, and the "push" provided by the subtropical ridge east of Florida and the trades over the Caribbean Sea? If the conditions in the deep tropics equatorward of 15-20N and eastward of 75W are of importance, our analysis domain may have to be extended southeastward somewhat.

d) VMIS (Menzel, Hayden, Schreiner)

VAS Model Impact Studies (VMIS) have not been conducted by the NMC because of the disappointing results observed with the VAS moisture retrievals. VAS retrieval evaluation continues under this project and papers have been prepared for presentation at the AMS meetings to be held in Anaheim, California and Baltimore, Maryland in February, 1988.

On the suggestion of Ralph Petersen of NMC we are beginning to look at the depth of upper level moisture, as detected by the VAS. If this appears to give quantitative information, it may be parameterized into the analysis to improve the radiation exchange within the forecast model.

e) Satellite Winds (Merrill, Stewart, Hayden)

Improvements continue to be sought in the automated production and quality control of cloud and water vapor motion winds (CWMW's) derived from VAS multispectral imagery (MSI). Research is underway in three areas: 1) finding the best loop interval and resolution for water vapor motion winds (WWMWs), 2) using target variances and tracking correlation magnitudes as quality indices, and 3) using a three-dimensional recursive filter analysis for simultaneous quality control and analysis of CWMWs. The goals are to produce the best possible CWMWs using existing sensors and to reduce the amount of time needed for subjective editing of CWMWs.

A significant error was recently discovered in the automatic processing program. The corrected version has been forwarded to the VDUC which has been using the package to produce experimental water vapor winds.

A software package to facilitate the comparison of winds (e.g., rawinsonde versus CWMW) was provided to the VDUC at their request.

f) Data Assimilation (Aune, Goodman, Diak, Callan, Raymond)

The CIMSS subsynoptic model was configured for experiments with GUFMEX data. April 3, 1985 was selected as a prototype of the "return flow" situation and a number of control runs have been made to shake down the system. Initially, we will use a low resolution model to keep costs down.
The model is also being used to evaluate the impact of three sets of satellite data; VAS alone, TOVS alone, and VAS plus MSU for seven case studies chosen from the GALE data sets of 1985. This work is being performed under a CIMSS contract with the Navy.

Software to produce three-dimensional trajectories from model output fields was obtained from NASA Goddard and is being interfaced.

A version of the CIMSS model is being modified for use on the new CRAY XMP416 at MSFC. Systems accounts have been obtained and a TELENET account will allow direct access at 1200 baud. The McIDAS 9600 baud line can also be used for data transfer.

g) GTE/ABLE (Menzel, Schmit)

Total atmospheric precipitable water vapor has been estimated from VAS radiance observations over Amazonia during the GTE/ABLE IIb. The simultaneous retrieval technique of Smith has been adapted to the moist Amazonian atmosphere (the temperature basis functions have been decreased to four and the moisture basis functions have been increased to five). For a test day of 5 May 1987, diurnal variations of 20% in the PW are readily apparent and in good agreement with the ground based observations (within 10 mm water). The region of higher PW outlines an area of subsequent cloud formation.

The CO2 technique has been applied to the VAS data also to determine a temporal variation in cloud properties. Over the Amazon basin (again for 5 May 1988) opaque cloud cover is found to increase from 28% at 1100 GMT to 43% at 1700 GMT and then drop off to 33% at 2300 GMT. Cirrus increases from 23% at 1700 GMT to 44% at 0500 GMT the following day as storm blow off occurs. Clear sky observations start at 45% at 1100 GMT and taper down to 23% at 0500 GMT on the following day. These numbers appear to be consistent with afternoon thunderstorms which occurred on this day. These results will be presented at the AGU meeting in May.

2. Sensor Calibration

a) Line-by-line Transmittance Model (Woolf)

The heavy processing load at NCCF, Suitland, was completed in early March. The final data base, contained on tapes at SSEC, consists of transmittances at 0.1 cm⁻¹ spaced over the spectral range from 550 to 2870 cm⁻¹. Calculations were done separately for uniformly-mixed gases (primarily CO₂), water vapor, and ozone for seven local zenith angles (secant = 1.0, 1.02, 1.10, 1.25, 1.50, 1.75, 2.00), for the standard atmosphere and 12 "extreme" profiles selected from the "NESDIS 1200". When spectral response functions for the GOES-I sounder are available this database will be used to generate transmittances for its channels. Fast (regression) models will then be developed for use in simulation studies and, ultimately, in routine processing.

b) GOES I-M Calibration (Menzel, Schmit)

Investigations with the current VAS data have revealed that the radiometric calibration of GOES I-M must be accomplished with a space view
away from the edge of the earth. Radiation scattered from the earth affects the space view out to roughly 300 kilometers from the edge. For example, if a space look at 100 kilometers from the earth edge, as is currently planned for GOES I-M, is used in the VAS calibration, an error on the order of a half a degree results in the infrared window brightness temperature of a cold cloud (at 240 degrees K). Changes in the GOES I-M calibration plan have been suggested and are being considered.

Work is underway to determine the diurnal variation in the VAS calibration; the space view and the blackbody response are being tracked as a function of the time of day. The effect on the slope and intercept of the linear response (radiance versus counts) will be determined.

Part II. Other Activities

1. VAS Seminar in Canada (Menzel)

A seminar on recent progress in processing meteorological information from the VAS data stream was given at the Canadian Meteorological Center (CMC) in Montreal, Canada. The VAS applications software was made available to the Development Division of the CMC who will attempt to use it in their analysis model. Considerable work remains for the Canadians to convert the software to the Control Data environment.

2. ITOVS (Menzel, Lynch)

The fourth meeting of the International TOVS Working Group of the IRC took place in Igls, Austria on 16-22 March 1988. 64 representatives from 17 countries attended. NESDIS was represented by Tony Reale and Hal Woolf. A brief summary of the activities follows. Two new case studies were presented with a eye on model impact studies of the TOVS soundings; the NESDIS Tech Memo 107 in revised form was reviewed and found to be considerably improved; the archive of the Baseline Upper Air Network data from the OWSE/NA is proceeding well but the mechanisms for data distribution have yet to be identified; a PC/TOVS processing and product display capability was demonstrated by CIMSS and the WMO showed considerable interest for distribution to third world countries; a special session was held to discuss the opportunities for an International Geostationary Experimental Satellite with both microwave and infrared sensors, but no concrete plans for future action emerged; and the CIMSS supported International TOVS Processing Package (ITPP) continues to be the framework for most efforts to retrieve soundings from the NOAA polar orbiters (40 users in 32 countries). A Report and Technical Proceedings will be forthcoming in the next quarter.

Part III. Appendix

2. Meetings and Seminars

a. January


b. February

- F. Nagle delivered two paper entitled "Satellite De-navigation" and "Meteorological FORTRAN" at Fourth Interactive Conference in Anaheim, California on February 3-5,


c. March


- C. Hayden participated in Biennial Program Review of the Wave Propagation Laboratory in Boulder, Colorado on March 15-16.


4. Visitors

- Mervyn Lynch, Curtin University, began one-year visit as latest Australian visiting scientist.

- Keith McKenzie, visited SSEC to discuss GVAR ingestor design on March 15.

- Lynn McMurdie, University of Washington-Seattle, visited the Department of Meteorology and presented a seminar on February 16.

- Mike Manton, Bureau of Meteorology Research Centre, discussed BMRC cooperative research on March 10-11.

- John LeMarshall, National Meteorological Analysis Centre, visited CIMSS to learn about recent McIDAS updates on March 24-30.
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Part I  Research Progress

2. ERBE/Climate (Ackerman, Herman)

Dr. Ackerman attended the twenty-third ERBE science team meeting in Langley where the following data were approved for archive: July, 1985 NOAA-9, and November, 1984, January, October and August, 1985 and January, 1986 for the ERBS.

Our activities for this past quarter included a continuation of our comparison study between NOAA-9 ERBE scanner measurements and other measurements taken during the FIRE experiment in October 1986. We have completed the comparison between the NOAA-9 ERBE data and Don Wiley's cloud analysis of the NOAA-9 HIRS data. Cloud amount and cloud top pressure derived from the HIRS data are compared with the ERBE scene type for ten time periods. Comparisons between the NOAA-9 ERBE measurements and the Saberliner broadband radiative measurements taken during FIRE have also been completed. Observations from the Saberliner have also been compared with HIS measurements taken on the ER2 during FIRE. These three comparison studies and the comparison between HIS and ERBE mentioned in the last quarterly report will be presented at the upcoming FIRE meeting in Vail, CO.

The computer program which compares the ERBS scanner and non-scanner instruments is presently being modified for a comparison study of the NOAA-9 instruments. A paper concerning these comparison studies is being prepared by personnel at CIMSS, NASA Langley and Drexel University.

5. Atmospheric Sounding

a) VAS Support (Menzel)

The RISOP schedule has been adjusted in response to NSSFC suggestions. The new schedule features more rapid images and smaller latitude coverage with the three hourly dwell sound. It became operational 26 May. The nominal schedule has also been adjusted to accomplish NSSFC/NHC/NMC support with one schedule it features synoptic time sounding coverage over the southern U.S. and the Gulf of Mexico for NMC moisture studies, five piece dwell sounding coverage from 50 to 1N and water vapor loops for winds at 00 and 12 GMT to support NHC in their dual basin responsibility, and hourly water vapor images and with U.S. soundings every 90 minutes for NSSFC. A preliminary version of the schedule was in place by mid-May; further modifications will be made in July to incorporate the new two small detector MSI capability with GOES-7.

b) VDUC Retrieval Algorithm (Hayden, Schreiner)

Based on an extensive comparison between results obtained at VDUC and a MODIS version employing four Gaussian water vapor basis functions (as opposed to three "natural" basis functions), the operational VDUC algorithm was changed to the four Gaussian version.
c) Experimental VAS Algorithms (Hayden)

At the urging of Bill Smith, a VAS retrieval algorithm employing the new "N-tau" approach was coded and has been run sporadically for comparison with the currently operational VDUC version. While intuition would suggest that the new method should be an improvement, it has not been so demonstrated, at least in terms of the precipitable water comparisons which are run routinely for the VMIS (see 8-d below). The new method solves for any number of "constituent temperatures", though in practice we are currently considering only carbon dioxide and water vapor. The difficulty lies in converting the water vapor temperature into a real moisture quantity (precipitable water or specific humidity) which requires modelling. Deficiencies of the model currently in use appears to obviate any advantage the new algorithm might have. Further work will be done in this area.

d) VAS Time Composite (Callan, Menzel)

A test case using three small sounder files, separated by 90 minutes, has been processed and retrievals have been made from them. To date, only a visual inspection of the composite versus non-composite retrievals, for the same time period, has been made. The time composite data set yielded more retrievals than the non-time composite data set as would be expected. The retrievals from both areas that are collocated seem to agree closely. A statistical comparison between the two types of retrievals as well as comparisons with radiosondes will be accomplished shortly.

AVHRR (Herman, Howell)

Work was begun to implement a method of R. W. Saunders for automatically differentiating between clouds and clear skies using the AVHRR. The technique invokes a series of tests among the five channels using different criteria for land or ocean, day or night. A version for nighttime analysis over land was written and seemed to work well using the recommended thresholds. The same result was not attained with the daytime model, especially for forested regions that were sometimes mis-assigned as cloudy. Our conclusion is that a considerably more complicated version is required for cloud definition over land during the day.

Comparisons of NOAA-10 AVHRR radiances computed at SSEC with the NESDIS 1B data set have been completed. The agreement is excellent; about 0.25% for (noisy) channel 3 and approximately 0.02% for channel 4. The software started earlier was tested, and showed that a running average of five calibrations reduced the channel 3 noise from about 2.2% to about 0.8%.

The software for extracting TIP data from the areas generated by the SSEC ingest was further modified to tolerate the momentary loss of signal.

f) PC-TOVS (Howell, Nagle, Dedecker)

Work on this project was suspended during this quarter.
High-resolution Interferometric Sounder (HIS) (Howell, Woolf)

As an outgrowth of the error-analysis software developed during the previous quarter, the HIS retrieval algorithm has been redesigned to take advantage of the information inherent in covariance matrices of climatological sounding sets. Results from this technique, using Band 1 (longwave) measurements only, have been very encouraging. The software will be modified during the next quarter to handle data from all three spectral bands. The actual retrieval output is in the form of three temperature profiles: "dry," "wet," and "ozone." Algorithms are under development to convert the latter two to traditional representations of the respective physical quantities (see 5b above).

A new approach to the calibration of channel 3 (564.1128 cm\(^{-1}\)) was initiated. This approach detects the signal spike caused by the change in scene-mirror position and uses adjacent blackbody data to eliminate this effect. This allows longer interferograms to be used, thus increasing the spectral resolution. The new approach will also attempt to reduce the noise generated by sample-position error. This work is still in progress.

New HIS demo software for the PC was developed which calibrates and displays individual earth spectra as well as plotting the interferograms and uncalibrated spectra. This software was further modified to include the retrieval software, from MCIDAS, and the display of temperature and dewpoint profiles.

DMSP Retrievals (Nagle)

An extensive comparison has been run involving several sensors and retrieval methods for the month of June 1988. The comparison was made to determine the relative errors among radiosondes, TOVS retrievals, and DMSP retrievals, the latter including both operation (NESDIS) retrievals, and a regression retrieval used locally at SSEC, Madison. Radiosondes were compared with NMC gridded temperature maps. The satellite retrievals were compared both against colocated radiosondes, as well as the NMC grids. The results are summarized below. Operational DMSP statistics are based primarily on over-water observations because the retrievals obtained from NESDIS buiteland have no 1000 mb height unless a 1000 mb surface physically exists, i.e., over water or in or in low-lying coastal areas. Hence, comparisons of DMSP and raobs are mainly in coastal regions. The experimental regression DMSP retrievals were made over both water and continents.

Radiosondes vs. Grids (at 00z):

- **AVG TIME DIFF & NUM OF COMPARISON TO DATE:** .00 5400
- **OVERALL BIAS AND RMS ERROR**
  - .43 1.73

TOVS vs. Radiosondes (at 00z):

- **AVG TIME DIFF & NUM OF COMPARISON TO DATE:** .62 1411
- **OVERALL BIAS AND RMS ERROR**
  - .02 2.20

TOVS vs. Grids (at 00z):

- **AVG TIME DIFF & NUM OF COMPARISON TO DATE:** 1.02 9964
- **OVERALL BIAS AND RMS ERROR**
  - .52 1.98

Rational DMSP-8 vs. Raobs (at 00z):

- **AVG TIME DIFF & NUM OF COMPARISON TO DATE:** .65 2666
- **OVERALL BIAS AND RMS ERROR**
  - .54 2.69
DMSP-8 Operational Retrievals vs. Grids (at 00z):

- **AVG TIME DIFF & NUM OF COMPARISON TO DATE**: 0.71 14926
- **OVERALL BIAS AND RMS ERROR**
  - Bias: -0.99
  - RMS: 2.35

Operational DMSP-9 vs. Raobs (at 00z):

- **AVG TIME DIFF & NUM OF COMPARISON TO DATE**: 0.68 2535
- **OVERALL BIAS AND RMS ERROR**
  - Bias: -0.09
  - RMS: 2.53

Operational DMSP-9 vs. Grids (at 00z):

- **AVG TIME DIFF & NUM OF COMPARISON TO DATE**: 0.64 20052
- **OVERALL BIAS AND RMS ERROR**
  - Bias: -0.84
  - RMS: 2.16

Regression (experimental) DMSP-9 retrieval vs. Raobs (at 00z):

- **AVG TIME DIFF & NUM OF COMPARISON TO DATE**: 1.03 1477
- **OVERALL BIAS AND RMS ERROR**
  - Bias: 0.89
  - RMS: 3.17

Regression DMSP-9 vs. Grids (at 00z):

- **AVG TIME DIFF & NUM OF COMPARISON TO DATE**: 1.32 12373
- **OVERALL BIAS AND RMS ERROR**
  - Bias: 0.20
  - RMS: 2.38

In all comparisons, largest differences are at the lowest levels. General conclusions from this study are that the operational TOVS retrievals are slightly more accurate than the DMSP and that the operational DMSP are more accurate than the retrievals made locally.

### Mesoscale Applications

#### Sea Surface Temperatures (Wade)

The primary effort has been to understand, document, and improve the VAS code left by John Bates. Options to use the split and dual window coefficients were added. Location of the SST values has been verified as correct to within one pixel, but a "shadowing" problem along the coastlines has not been resolved. Problems caused by thin cirrus increased as spring progressed.

John Vande Castle of the UW Environmental Remote Sensing Center (ERSC) has agreed to contribute his experience with AVHRR data over the Great Lakes in setting up an AVHRR SST capability on the McIDAS.

**SSM/I (Nagle)**

No progress in this area.

### Tornadic Thunderstorms Identification from VAS Imagery (Schrab, Wade)

Work continued on the technique to identify potential tornadic thunderstorms by observing the characteristic signatures of the emerging anvil from a thunderstorm cell. Real time case were lacking in the last three months; thus, there were no real opportunities to make predictions as storms developed. The technique was smoothed out further by working on case studies. Statistics for 10 May 1985 over Nebraska and 18 September 1986 over Kansas have been completed. The anvil outflow strength and the storm relative anvil inclination angle have been regressed against storm strength for case studies including about 95 cells (over 90% of the variance in tornadic intensity is explained).
d) VAS Derived Product Imagery (Hayden, Schreiner)

The derived product imagery from the VAS MSI was exercised in a quasi-operational mode during this quarter in support of the Kansas City National Severe Storms Forecast Center. Software improvements were implemented whereby the 12 hourly "preprocessing" now requires only four minutes on the McIDAS (VDUC), and the hourly images are generated in two minutes. A daily schedule of 12 hours of coverage from 7-18 UTC was modified to eight hours from 13-21 UTC, five days/week when it became apparent that our budget could not tolerate the more frequent production. The precipitable water and lifted index images are transferred automatically upon completion to the VDUC where they can be accessed by the Kansas City CSIS.

e) MAMS (Moeller, Menzel)

The MAMS data from 27 January 1988 over the Mississippi River Delta Basin are being processed to determine sea surface temperatures (SST) and suspended sediment concentrations (SSC) in an attempt to chart the geomorphic changes induced in the river delta coast by cold frontal passages during the winter. Variations in SST are associated with shifting shoals and changes in the SSC are used to infer transport of sediment. The January flight is in preparation for a more extensive flight and ground investigation planned for the winter of 1988-89. NASA has been approached with a joint proposal from CIMSS and C3I (the Coastal Studies Institute at LSU) to fund the data evaluation focused on understanding the changes in the Mississippi River Delta Basin caused by these winter storms.

These data have also revealed a swamp fire. The two infrared windows (at 4 and 11 microns) are being used to investigate the extent of the fire and its temperature. The MAMS with its high horizontal resolution enables us to study the accuracy of the technique of Matson and Dozier and to estimate errors in other satellite determinations (VAS, AVHRR) of fire extent and temperature over the rainforest in Brazil.

Moeller and Menzel provided on-site MAMS flight support during the last two weeks of June from Wallops. These flights were intended to study the preconvective environmental over Tennesse/Alabama and geomorphic changes in the Louisiana coast, however, problems with the instrument prevented any science flight. Unreliable blackbody calibration counts, intermittent success with the tape recorder, and failure of the synchronizer unit interfered with the scheduled flights. Attempts are continuing into mid-July to gather these flight data.

f) Profiler (Howell)

Early in this quarter, PROFS was notified by letter that we would like to continue our occasional use of the dial-up facility at PROFS. The software for acquisition of PROFER data was upgraded to accommodate a higher (2400) BAUD rate, the single monitor and EGA graphics. Additional modifications were made to extract radar wind profiles and surface winds only and write more concise binary files. This conversion results in a data volume approximately 1/3 with the volume of a PROFS text file containing all stations and all instruments.
The software for the display of wind profiles was improved to be more readable, to include more profiles per display and to include the effect of additional simultaneous (different resolution) profiles. The height range was also extended to include the highest observed data (about 20 km).

g) River Fog Study with VAS (Raymond, Schmit)

The VAS data of 14 and 25 September 1987 have been studied to understand the occurrence of fog along the Wisconsin and Mississippi Rivers. On these days, ideal conditions of vapor pressure differences between the river surface and the air produced steam fog in the morning that was captured in the VAS visible imagery. VAS was also able to monitor the fog dispersion shortly after 1400 GMT. A short paper has been written and submitted to Weatherwise.

8. Synoptic Applications

a) ECMWF (Menzel, Schreiner, Hayden)

The long awaited evaluation by ECMWF of the CIMSS wind data set for the week of 22-26 June 85 was given by G. Kelly. He was disappointed in the quality of the 11 micron cloud drift winds, and much more so regarding the mid-level winds derived from the 7.2 micron data. We are currently reprocessing one day of the data set and will discuss this with him when he visits in August. Obviously much remains to be done with satellite-derived winds.

b) Tropical Analysis (Merrill)

There has been no activity in this area during this quarter.

c) Gulf of Mexico Study (Wade, Hayden, Merrill)

After the GUFMEX field experiment of last quarter attention has refocused to the analysis phase. In a meeting with John Lewis (NSSL), it was agreed to order priority as the week of 21-26 February followed by 6-11 March 1988. Special observations from the field phase are expected in late summer. A sample of the NSSL format has been obtained from Jerry Ward, and this has been converted to the McIDAS MD format which is used by the majority of the McIDAS (and VDUC) data analysis algorithms. Work to derive satellite products (retrievals, derived images, and winds) for these weeks has begun. A brief announcement and description of the GUFMEX project was submitted to the Bulletin of the American Meteorological Society.

d) VMIS (Hayden, Schreiner, Paris)

For the past several months, the SDAB has attempted to monitor the VAS moisture retrievals on a daily basis, with special attention to the Gulf of Mexico where we hope, eventually, to perform a VAS Model Impact Study (VMIS) with the NMC using the regional forecast model (RAFS). Unfortunately, since the VDUC abbreviated the southern coverage in its support to Kansas City, it has been necessary to run the VAS algorithm locally. This has been done for the 12:48/13:18 pair of dwell sondes for the five day week. For verification, the retrievals are objectively analyzed as layered precipitable water using the three-dimensional recursive filter model. The RAFS 12-hour forecast (from
provides a first guess. (The same forecast is also used to provide first guess temperature and moisture profiles for the retrieval algorithm.) The analysis is performed at ten sigma levels (pressure/surface pressure) from .98 to .3. We have concentrated our attention on the 0.7 sigma layer (i.e., the total moisture in approximately the lowest 300 mb of the atmosphere). This VAS analysis and an equivalent one derived using only the RAFS forecast have been compared to the same layer of precipitable water derived from the radiosonde reports at the radiosonde locations. The intent is to show that the VAS can improve on the forecast, relative to the radiosonde measurements. Statistics have been compiled over the Gulf and eastern U.S., and also over the Gulf only, using island raobs and the ring of reporting stations on the continental coastline.

The radiosondes have been subject to rigorous and sometimes subjective quality control. No station failing to report significant level data is accepted. On occasion, reports which have no obvious internal flaws are rejected if they differ markedly from neighboring radiosondes and/or the VAS retrievals. Usually such reports contain a shallow dry layer at low levels which may be locally correct, but seems unrepresentative of the grid scale moisture.

In the great majority of cases, the VAS analysis appears subjectively to improve on the forecast. Measured objectively, the improvement is difficult to demonstrate on a daily basis (the Gulf sample of radiosondes varies from about 11 to 15), but shows modestly in the aggregate. As the season has progressed, the forecast appears to have developed a dry bias which has permitted the VAS analysis to be consistently better in the RMS sense, even though the correlation between forecast-radiosonde and VAS-radiosonde are often similar. Ever suspicious of positive results, we have lately begun comparing the radiosondes to layered precipitable water derived from the RAFS analysis as well as from the forecast. Surprisingly, although the analysis presumably includes most of the verifying radiosondes, the dry bias is still observed, though considerably reduced in magnitude. Since a thorough examination of the software has not revealed any error, we hypothesize that the bias shown by the RAFS stems from the higher vertical resolution of the radiosondes at low levels. Certainly the integrated precipitable water is quite sensitive to quadrature (hence our insistence on significant level data). The encouraging fact remains, however, that the forecast is drier than the analysis, and the VAS retrievals appear to be correcting this. We hope that our evidence is convincing to the NMC and that we can soon begin with model impact studies.

Toward the end of the period, we began to verify the moisture bogus data which, by a subjective interpretation of the GOES imagery, provide relative humidity input to the NMC models. These data are now available to us daily through the cooperation of the VDUC. The moisture bogus data are processed through the recursive filter analysis to provide a layered precipitable water and verified against the radiosondes just as the VAS data and the forecast are. Early returns indicate that the bogus product is greatly inferior to the VAS product. If this trend continues we shall recommend that the moisture bogus procedure be discontinued in favor of the VAS.
e) Satellite Winds (Merrill, Stewart, Hayden)

Work continues to determine the optimum resolution (small of large detector) and loop interval (1/2, 1, or 2 h) for water vapor winds and to identify indices of wind quality using a sample of eight cases archived under the winter VMIS schedule: 20 Jan, 19 Feb, and 14, 15, 17, 18, 23, and 29 March 1988. All of these cases have been processed and a preliminary verification against rawinsondes completed. Results (based on five of the eight cases) were presented to a NESDIS review team on 17 May, and a complete verification and documentation will be completed in the upcoming quarter. Principal findings to date are:

- A spatial lag range proportional to the loop interval should be used when comparing the quantity and quality of winds obtained from different loops. The spatial lag range constrains each pair of displacements (rather than velocities) to the guess and to each other. With the above effect accounted for, one-hour (between images) and two-hour loops for bands 9 and 10 appear to produce similar quantities of winds, but the latter are more accurate (1 m/s or 10 percent). Winds from one-half hour loops are of similar accuracy to one-hour winds but are 10-15 percent less numerous. However, increasing the lag size for two-hour loops more than doubles the computation time per vector so two-hour loops are more costly and time-consuming.

- Quality control relationships between winds-rawinsonde differences and supplementary information about wind vectors are qualitatively as expected but quantitatively very weak and probably not very useful for identifying "bad" winds. Relationships tested and correlation with wind/raob differences are a) target brightness variance (negative), b) wind correlation magnitude (negative), and c) wind vector pair difference (positive).

- Wind/raob differences are correlated with wind/guess differences at 0.5-0.6. These correlations will have to be refined further as they are necessary for analyzing water vapor winds in an OI scheme.

f) Data Assimilation (Aune, Goodman, Diak, Callan, Raymond)

Forecasts of the April 3, 1985 prototype GUFMEX case have shown numerous deficiencies in the data quality control, analysis, preprocessor, and model subsystems. The majority of the problems resulted from inconsistent handling of observations over high topography. Improved mean sea-level pressure and surface pressure algorithms have been implemented. (Watch out for some stations that report elevation in feet instead of meters.) Bob Seaman has implemented the new BMRC data assimilation system on the McIDAS, incorporating an incremental OI analysis algorithm. For the 3 April case, a comparison shows that the new analysis produces a better result. Pilot forecasts for this case have been run with and without vertical mode initialization and the tangential filtering option. It turns out that VMI and filtering are unnecessary in a 24-hour forecast with no physics, from the OI analysis, but we expect that filtering will be necessary when physics are incorporated. With the old analysis model the VMI and filtering improved the forecast even without physics.
To assist potential users, a model users guide has been written. The
guide lists procedures, source codes, required input and output data sets, and
an explanation of each of the 19 (!) steps required to produce a forecast.
Transfer of the model to Marshall Space Flight Center is currently on hold.

9) GTE/ABLE (Menzel, Schmit)

Correlations between VAS CO₂ derived cloud characteristics and rainfall
estimates have been investigated for 5 May 1987 over Amazonia. The convective
stratiform technique (Negri and Adler, 1987) has been used to assign rain rate and area as a function of the minimum brightness
temperature in convective and stratiform clouds. Fields of view with
effective cloud emissivities greater than 60% are good indicators of the
locations of the rainfall clusters (rainfall in excess of 10mm). When the
cloud emissivity is less than 60%, no substantial rainfall can be found in the
vicinity. These results and the diurnal cycle of cloud cover in Amazonia were
presented by T. Schmit at the May AGU Meeting in Baltimore, MD.

9. Sensor Calibration

a) Line-by-line Transmittance Model (Woolf)

Execution of the FASCODE model and associated post-processing software
continues at SSEC, for selected case studies and creation of additional
regression-model databases. The paper by Eyre and Woolf describing an
improved fast microwave transmittance model has been accepted by Applied
Optics for publication in August 1988.

b) GOES I-M Calibration (Menzel, Schmit)

The diurnal variation in the VAS calibration has been investigated with
data from 7 April 1988 (during eclipse) and 26 April 1988 (a non-eclipse day);
the space view and the blackbody response have been tracked as a function of
the time of day. The slope of the linear response (radiance versus counts) on
the eclipse day changes by about 1.5% and the intercept by about 2.5%; the
temperature of a uniform sea surface during the eclipse day does not change
appreciably (within 0.5 degrees Kelvin), indicating that the spin-by-spin
calibration algorithm is correctly tracking changes in the foreoptics of the
VAS. On the non-eclipse day, the slope changes by about 1.1% and the intercept
by about 0.7%, and the calibration algorithm produces consistent results again.

With VAS, the space look and blackbody looks occur every spin (6
seconds). With GOES-I, the space look occurs every two minutes and the
blackbody looks occur every 20 minutes (ten minutes for the imager). It will
be important to interpolate the calibration between space and bb looks by
tracking the temperature of key components in the foreoptics of the GOES-I
telescope. The current plan for the calibration algorithm do this.
11. Land Resources

a) Vegetation Identification (Wade, Raymond)

There is interest in CIMSS in studying a particular geographic feature often seen in the GOES imagery in the Mississippi River basin along the AR/ TX/MS border. Bill Raymond believes this area (approx 200 x 600 km) which is quite bright in visible, but often dark (warm) in the infrared, to be a feature important to regional scale modelling. Temperature differences of 10- 15°C are observed between the warm area near the river and cooler outlying areas. The cotton and soybean farming region in the alluvial soil is markedly different from the wooded region. Both GOES and AVHRR are being used to study this feature.

Part II. Other Major Activities

1. ITOVS (Menzel, Lynch, Dedecker)

The Report on the fourth meeting of the International TOVS Working Group (Igls, Austria on 16-22 March 1988) has been prepared and is being distributed. Copies are available from CIMSS upon request.

The WMO has shown considerable interest in the PC/TOVS processing and product display capability that has been under development at CIMSS. The ITOVS rapporteurs (Menzel, LeMarshall) have been requested to include a demonstration for the PC/TOVS with their presentation at the next CBS in 1990. This will require some additional support to complete the packaging of the PC/TOVS package.

Part III. Appendix

1. Publications


2. Meetings and Seminars

a. May

- C. Hayden travelled to Washington, DC for polar orbiting sounder review on May 3.

- P. Menzel and C. Moeller travelled to Baton Rouge, LA on May 6 to plan collaborative efforts with Coastal Studies Institute, LSU to study geomorphology of the Mississippi River Delta Basin.

- T. Schmit presented paper at AGU Meeting on May 16-20.

b. June

- P. Menzel attended the NASA Geostationary Platform Earth Science Steering Committee Meeting in Huntsville, AL on June 8-10.

- T. Schmit attend GOES-I calibration discussion meeting in Fort Wayne, IN on June 14.

- P. Menzel travelled to Wallops, VA to support MAMS flights on June 16-19 and 23-26.

- P. Menzel chaired session at the Direct Broadcast Users Conference and attend the GOES-IM Post-launch Evaluation Planning Meeting in Washington, DC on June 20-22.

- R. Merrill presented seminar on tropical cyclone winds research at the Naval Postgraduate School in Monterey, CA and CSU in Fort Collins, CO.

3. Contracts and Grants Reports

- Visitors

- James Hollinger, Naval Research Laboratory, visited SSEC/CIMSS on April 12-13 to review the SSM/I Program.

- Levin Lauritson, Marlin Perkins, George Hughes, and Ralph Anderson of NESDIS visited CIMSS on May 11-12 to year of the sounding science developments on the UW contract and to discuss transfer of GOES software to the VDUC.
- Dr. Pedro Silva Diaz from University of Sao Paulo, Brazil visited the GTE/ABLE group on May 23 to present a seminar on the Diurnal Variation of the Tropospheric Circulation over South America and to plan research collaboration with VAS data products.

- Vice Chancellor John R. de Laeter from Curtin University, Perth, Australia visited CIMSS on May 31 to formalize cooperative scientific efforts with a Memorandum of Understanding.

- Dr. Alberto Setzer from INPE, Brazil visited CIMSS on June 3 to present a seminar on the Effects of the Burning of the Amazon Rainforest.

- Art Schwalb, Gus Comeyne, Bill Mazur, Levin Lauritson, Debbie Garr, Bill Shenk, and Ralph Anderson of NASA and NOAA visited SSEC on June 7 to give a briefing on the GOES-IM status to Suomi et al.

- Greg Salotallo, National Transportation Safety Board, visited SSEC on June 14 to receive McIDAS training.

- Richard Augilis, Director, Central Region, NWS and Ed Addison, Meteorologist-in-Charge, NWS (Madison) visited SSEC on June 22 for overview of facilities and McIDAS demonstration.

- David Keller and Jerry Wardias, National Severe Storms Laboratory, visited SDAB for meetings concerning special GUFMEX observations on June 16-17.

5. Miscellaneous
Quarterly Activities Report  
July-September 1988  
System Design and Applications Branch  

Part I.  Research Progress  

2.  ERBE/Climate (Ackerman, Herman)  

During this past quarter ERBE activities at CIMMS have begun to shift focus from data verification to data analysis. To this end we have investigated methods of analyzing/displaying the data from the monthly mean tapes. These methods include displaying the 64 monthly mean values provided on the data tape as well as deriving regional diurnal radiation budgets based on the hour/box values on the monthly averaged tape. To date our approach has been qualitative in nature and we plan to be develop a more quantitative approach in the upcoming quarter. Our focus is on regional and global changes, both monthly averaged values and the diurnal structure, in the maximum and minimum radiation budget components. Other activities have included:  

- additional comparisons with VAS derived fluxes and ERBE estimates have been accomplished.  
- Fred Wu has begun his Ph.D. work which will incorporate ERBE data into a numerical weather prediction model  
- case studies have been selected to analysis the effect of dust on the regional radiation budget.  

NASA has begun releasing data tapes for the ERBS and NOAA-9 on a regular basis. We have examined the first Time-Space Mean tape (April, 1985) which shows a number of climatological features; the eastern Pacific dry zone, the Saharan cloudless region, and marked differences between oceans and continents. Net radiation maps clearly indicate losses near the poles and gains in the tropic, excepting the Sahara region and the South American bight. Global presentations of these data on the McIDAS (which can be transferred to the VDUC) are striking.  

5.  Atmospheric Sounding  

a) VAS Support (Menzel)  

The nominal VAS schedule that supports NSSFC/NHC/NMC has been adjusted in order to incorporate the two small detector MSI, to enable CO2 heights to be part of the cloud tracking process, and to study stratospheric warming at the north pole. The schedule still allows the usual VAS products to be processed in support of the three national centers and still offers dwell sounding coverage over Amazonia every three hours.  

b) VDUC Retrieval Algorithm (Hayden, Schreiner)  

No changes were implemented during this quarter.  

c) Experimental VAS Algorithms (Hayden)
Several attempts were made to improve the water vapor retrieval of the new "N-tau" algorithm as applied to the VAS, but none proved superior to the currently operational algorithm. During this quarter the "N-tau" algorithm for processing HIS was changed to include a regression relationship which retains the linearity of the N-tau approach, but permits the direct retrieval of dewpoint (see 5f below). Initial results with this technique applied to HIS spectra are very encouraging, and we intend to code an equivalent algorithm for the VAS (GOES-IM) in the next quarter.

d) VAS Time Composite (Callan, Menzel, Hayden)

The first test of the time composite technique was completed for the case of 1 June 1988 which showed a strong, back door cold front moving into the northeast U.S. Dwell soundings at 14:18 and 15:48 UTC were combined, and the product further combined with data from 17:18 UTC. Rules for the combination at each pixel are: (1) always average the 3 upper tropospheric channels; and (2) for the other channels average the two if the 11 micrometer radiances for both images is greater than 110 mw and they are within 5 mw of each other, otherwise keep the warmer. Retrievals were made from both the time composited and the original 17:18 UTC sounding files. The time composited measurements produced a significantly higher yield and improved horizontal consistency in the retrieved temperature and moisture values. The meteorology of the time composite product seemed better, especially in terms of total variance, but this could not be verified by comparison to the radiosondes. In conclusion, this technique is very promising and several additional cases will be studied. The research is particularly relevant in view of GOES I/M signal-to-noise difficulties. Navigation of the images for combination does not appear to be a problem for the VAS; it could conceivably be a problem for GOES-I/M.

e) AVHRR (Herman, Howell)

McIDAS software was implemented to ingest TIP from HRPT data and to allow extraction of TIP data from GAC data files as well. This software was transferred to SSEC programmers and operators to assess the quality of data ingested. Non-linearity corrections for the AVHRR calibration algorithms (for NOAA-9 and 10) were also implemented.

f) PC-TOVS (Howell, Menzel, Dedecker)

Work on this project was directed chiefly at seeking a sponsor. Avenues currently being approached are: a contract with the government of Pakistan; a proposal to the Naval Environmental Prediction and Research Facility; and an arrangement with the WMO CBS. There are indications that this project may be revived. Improved technology makes an inexpensive, effective system increasingly viable.

g) High-resolution Interferometric Sounder (HIS) (Howell, Woolf)

A new calibration algorithm was developed and tested which allows higher resolution spectra to be calculated, avoiding the noise spike caused by the change in scene mirror position during calibration.
Experiments were conducted with schemes to represent the calibration spectra as a function of time, but these schemes have been abandoned for now.

With modifications to the PC-to-MCIDAS PRONET software, by SSEC personnel, the transfer of HIS flight data from Project FIRE resumed. For the AIRS proposal, existing HIS processing software was slightly modified to establish a basis for timing the HIS processing in order to estimate the computer power needed for AIRS.

The HIS retrieval algorithm has been revamped yet again. In the current version, linearization of the radiative transfer equation is done in a more explicit manner, through the use of simulated spectra for all three bands. In addition, moisture is retrieved directly in the form of dewpoint temperatures. Results for the COHMEX (June 1986) dataset were very encouraging.

In preparation for the Ground-based Atmospheric Profiling Experiment (GAPEX) to be performed in Oct-Nov 1988, in Denver, new software was developed, existing software was modified, and a collection of software was made for use in the field. Three PC's will be used to: ingest the HIS (raw) data; calibrate these data; compute temperature and dewpoint profiles; and display results. The "uplooking" situation has been applied to measurements taken from the SSEC rooftop in June of this year; results of those tests are promising.

h) DMSP Retrievals (Nagle)

The evaluation of the NESDIS DMSP retrievals continues with no major surprises. In addition, a navigation package for the prediction of the DMSP satellites is in preparation since it is our understanding that one does not exist within NESDIS.

7. Mesoscale Applications

a) Sea Surface Temperatures (Wade)

Real-time processing and archival of a daily (1830 UTC) SST field from VAS radiances over the Gulf of Mexico has continued through the quarter. A yet undiscovered bug remains in the software, occasionally producing some very cold values in limited areas. Fortunately, these erroneous values are usually quite obvious in the product. The passage of hurricane Gilbert in mid-September has shown an interesting cool wake in the storm's path, modifying the generally weak gradient typically observed in the Gulf SST in late summer. However, the previously mentioned spurious cold value problem is effecting a clear depiction of this phenomena.

b) SSM/I (Nagle)

No progress in this area.

c) Tornadic Thunderstorms Identification from VAS Imagery (Schrab, Wade)

The procedure for classifying potential tornadic thunderstorms has
been documented and several additional people have been trained in its use. It is hoped that there will be sufficient resources available next spring to conduct an on site pilot program at NSSFC for a few weeks.

d) VAS Derived Product Imagery (Hayden, Schreiner)

The derived product imagery from the VAS MSI was continued in a quasi-operational mode through August in support of the Kansas City National Severe Storms Forecast Center. The software has been "frozen" and delivered to the VDUC for demonstration purposes. Some documentation and a presentation to the SPRB remain to be done before the VDUC can take over the production for the next severe storm season. It has been suggested that we consider other channels which might have a better signature of the lower atmospheric stability than channels 7 and 10 which are currently used. The possibility is worth investigating, but it has a relatively low priority since the GOES I/M imager is limited to the current choice.

Wade visited NSSFC in Kansas City, to observe and discuss the application of VAS products there. Consensus is that although forecasters are willing to look, and do look, at the VAS derived images (when available), the products usually present little new useful information. We feel that part of the problem may be in the choice of color enhancement at NSSFC which is, in a word, boring. We do agree, however, that it is not easy to improve on perceptions already available to the trained meteorologist using visible and infrared imagery loops. Although the new MSI derived images this spring were produced hourly, and usually within 15 to 20 minutes after the hour, additional (and often fatal) transfers were needed (from McIDAS to VDUC to CSIS). A concerted local effort from July through late August to monitor and document the derived images on a daily basis showed a consistent and reasonable product, and there is no question that they provide better detail of the precipitable water and stability than is available from other sources. There were, however, no dramatic events in terms of additional information regarding unsuspected, developing severe weather. In early September, the MSI products were suspended until the next severe weather season when they will be produced on the VDUC.

e) MAMS (Moeller, Strabala, Menzel)

After two lengthy deployments at Wallops, VA during June 1988 and Topeka, KS during August 1988, five MAMS science flights were successfully completed. The purpose of these flights was to (1) further investigate mesoscale moisture variations over the Tennessee River Valley and accompanying surface fluctuations in relation to cloud formation and thunderstorm activity, and (2) investigate further changes in the Louisiana coastline since the winter storms of 1988. The successful flights were on 10 June, 8 July, 18 August, and 25 August over the Tennessee River Valley and 26 August over the Louisiana coastline.

The MAMS/VAS derived product images of precipitable water, lifted index, and skin temperature have now been processed for all flight tracks on 19 June 1986 over the COHMEX region. The processing is done in a three step procedure: (1) perform a VAS retrieval with all available spectral
radiance and surface data, (2) use this as an initial guess for a retrieval using only the VAS 6.7, 11.2 and 12.7 micron channels plus the surface data, and (3) use the coefficients generated in step 2 with the MAMS 6.5, 11.1, 12.5 micron data at 100 meter resolution. Work will now begin on using the procedure outlined above to derive a MAMS/VAS radiation flux product.

A series of intercomparisons of MAMS radiance with those of the HIS, AVHRR, and VAS have been performed and will be available in an upcoming NASA Technical Memorandum. While the biases of MAMS versus other systems vary from day to day as a result of instrument adjustments, the relative deviations between all the systems are within 1.5 degrees Kelvin rms.

f) Profiler (Howell)

PROFS software was modified to extract only the microwave PROFILER statistical retrieval and output these data to a "standard" sounding (ASCII) file for use in the PC display programs.

g) AVHRR Winds (Herman)

A project has begun to investigate the production of cloud motion vectors at high latitudes. Since the GOES cannot be used reliably poleward of 55 degrees, overlapping orbits of the TOVS AVHRR are being used. In order to adapt the current wind-finding software on McIDAS with minimal change, we will remap the AVHRR into a standard projection. However, the navigation issue is critical to the accuracy of eventual winds, and we have not yet decided on a procedure. We have collected several candidate pairs of AVHRR and the project certainly appears feasible.

8. Synoptic Applications

a) ECMWF (Menzel, Schreiner, Hayden)

Graeme Kelly of the ECMWF visited CIMSS and discussed the verification of cloud drift and water vapor winds provided to him for the week of 22-26 June 1985. We attempted to reprocess these winds prior to his arrival to take advantage of recent developments, but archiving errors made this impossible. Kelly promised to forward new initial guess fields for the automatic WINDCO from the ECMWF model, and these will be used to redo at least one data set. In the meantime, we expect to be improving (see 8e below) the wind finding software.

b) National Hurricane Center Support (Merrill, Velden)

With formal transfer of National Hurricane Center (NHC) real-time support from McIDAS-UW to VDUC-WWB, we assumed an advisory role and limited our participation to overseeing VDUC products and offering comments and suggestions. The main NHC support product is a "deep-layer mean" wind analysis for track prediction which is based on satellite cloud/water vapor motion and VAS retrieval gradient winds. Large-scale winds produced and edited at VDUC have been timely and of adequate coverage. Enhancement of the wind set in the tropical cyclone's near
environment by the NHC staff improved noticeably as the season progressed, especially during Hurricane Gilbert. At season's end, we will be comparing the VDUC analyses (which contain additional satellite information) with the operational SANBAR analyses produced by NHC and offering more comments regarding the quality and impact of this product. We have also collected imagery and dwell soundings for later processing in support of AOML Hurricane Research Division activities, including a VAS-Omega Dropwinsonde comparison on 1 September and a Synoptic Flow Experiment in Tropical Storm Florence on 8 September.

c) Gulf of Mexico Study (Wade, Hayden, Merrill)

Some restaging and reprocessing of VAS data over the Gulf of Mexico for 23 February 1988 was done. Results were slightly different from the real time processing because of the change in water vapor basis functions (see 5a above). We have not yet attempted any verification, awaiting the arrival of the special GUFMEX soundings from NSSL. The sample of the NSSL format for the special observations, obtained from Jerry Wardias, was successfully converted to McIDAS data files and exercised with several data processing algorithms. The full data set should be available in the next quarter.

d) VMIS (Hayden, Schreiner, Paris)

We have continued to monitor the VAS moisture retrievals on a daily basis, with special attention to the Gulf of Mexico where we hope, eventually, to perform a VAS Model Impact Study (VMIS) with the NMC using the regional forecast model (RAFS). Qualitatively, we continue to see a strong positive impact from the VAS on the low level precipitable water (lowest 300 mb of the atmosphere). Statistically, in comparison with the radiosondes around the Gulf, the VAS has a slightly better standard deviation and correlation than the 12 hour forecast, and a much lower bias.

We have also compared analyses of the VAS data with the forecast over the U.S. and over the Gulf. Differences are much larger over the Gulf which suggests that the forecasts are worse in this data sparse area. We have also been monitoring the moisture bogus data which is generated by the NESDIS Satellite Applications Branch to help the NMC define the moisture field over the oceans. For the low level precipitable water, analyses generated using the bogus appear, qualitatively, to be slightly better than the 12 hour forecast but much worse than the VAS analyses. Measured statistically against the radiosondes the moisture bogus does not show any systematic improvement.

A report on the 3-week period in May 1988, which was agreed on with NMC as the VMIS trial period, was issued as a CIMSS report (An Evaluation of VAS Satellite Moisture Retrievals and Moisture Bogus Data in the Gulf of Mexico; A.J. Schreiner and C.M. Hayden). The sample of 15 days is rather small (especially for the moisture bogus which was obtained on only four days), but the general character of the data is shown. A more comprehensive study will be prepared when more varied seasonal statistics have been collected. The complete sample will be considered in selecting forecast model impact studies.
e) Satellite Winds (Merrill, Hayden)

On the advice of John Eyre, who was a visiting scientist at CIMSS during 1987-88, we began experimenting with penalty functions in the determination of both cloud height and displacement in the WINDCO software. For height assignment a regression model was developed using "best fit" relationships between rawinsonde winds and cloud vectors, where both temperature (window brightness temperature in the case of the satellite) and wind velocity were used to determine the best fit. For cloud displacement the radiances variance of the matched target is weighted against a probable displacement error as determined from the NMC global forecast. According to the weights assigned, the final vector can be more or less constrained to the forecast, so a rational for the assignment is being sought.

The apparent "slow bias" in upper level satellite derived winds is of growing concern to numerical modelers, and they have lately decreased the tolerance for accepting the cloud vectors. Because this area needs increased research effort we shall be devoting a higher priority to the problem in the near future.

Work has begun to incorporate the CO_2 cloud heights as the initial height of a cloud wind tracer in the autowindco processing. Initially, the CO_2 heights will be derived from VAS dwell soundings simultaneous with the VAS image loops, but eventually the heights will be derived from VAS MSI (11.2 and 13.3 micron channels) as suggested by the work of Eyre and Menzel.

A seminar on the current state of research on winds was presented by Hayden at the ECMWF Workshop on 4-dimensional assimilation of satellite data.

f) Data Assimilation (Aune, Goodman, Diak, Callan, Raymond)

A number of improvements were made to the CIMSS Analysis/Sub-Synoptic Model (SSM). These include: (1) a filtered topography option that was added to remove the 2-delx mode that occurs in the analyzed terrain elevation field; (2) an evaporation algorithm was added to the grid-scale precipitation routine. (Rain is now allowed to evaporate in unsaturated layers through which it falls. This effectively lowers grid-scale precip totals to more realistic values and increases the stability in the lower layers through evaporative cooling.); (3) a routine that computes gravity wave activity in the model domain has been implemented. (This allows the user to monitor model imbalances resulting from the assimilation of satellite retrievals.)

The new BMRC incremental optimal interpolation (OI) analysis system is now in place. A successful four-cycle (four data inserts at 12 hour intervals) assimilation test was conducted using RAOB data. This system is expected to replace the existing successive corrections package. Software is under development to interface model output grids with McIDAS MD files. This will allow model users to produce cross-sections, trajectories, and skew T plots from model forecast fields with existing McIDAS software.
A version of the CIMSS SSM has been transferred to Marshall Space Flight Center (MSFC). A meeting with visiting MSFC programmers uncovered numerous obstacles involving the transfer of input datasets from McIDAS to the Cray. Alternative procedures will have to be considered before the software can be tested.

Three data-assimilation experiments are currently underway.

* The return flow experiment is a numerical forecast experiment designed to determine: a) what factors affect the composition of the southerly return flow off the Gulf of Mexico subsequent to a cold-air outbreak; b) what model diagnostics are useful in identifying the onset of a return flow; and c) what impact, if any, does the assimilation of satellite temperature and moisture retrievals have on the numerical prediction of return-flow-induced convection. The SSM will be used to construct detailed four-dimensional analyses of two cases from the Gulf of Mexico Experiment (GUFMEX). Diagnostics will be extracted from these fields. A control simulation for the 20-24 Feb 88 case is currently being run.

* Aircraft data assimilation is intended to be a sensitivity study to determine the impact of assimilating automated aircraft wind observations into the SSM. These observations, taken enroute automatically by commercial aircraft, provide a new source of upper level wind information for numerical models. This study will use the new incremental OT scheme.

* VAS + MSU assimilation experiment is a satellite data impact study, funded by the Navy using the SSM to determine the impact of assimilating VAS+MSU data. A 24h control forecasts from seven GALE cases were compared to forecasts incorporating TOVS, VAS, and VAS+MSU data, respectively. Verifications were conducted using RAOB data for all cases. All of the forecasts incorporating satellite data showed a significant impact. The VAS+MSU forecast verified better than the others, especially with respect to moisture. This is most likely due to the improved coverage that the two combined instruments provide. Retrievals from AVHRR, and satellite derived wind vectors will be studied next.

g) GTE/ABLE (Menzel, Schmit)

The VAS retrievals of temperature and moisture at six hourly intervals have been nearly completed for the week of 5 May 1987 to 9 May 1987. Total precipitable water vapor and cloud parameters have been determined for all time periods. Correlations with rainfall as measured by the special network of rain gauges are now underway.

9. Sensor Calibration

a) Line-by-line Transmittance Model (Woolf)

FASCODE datasets have been completed for three additional regression models: uplooking (sea level), uplooking (Denver), and spacecraft ("top of the atmosphere" at 0.1 mb). The paper by Eyre and Woolf describing an improved fast microwave transmittance model was published in Applied
b) GOES I-M Calibration (Menzel, Schmit)

The image degradation caused by within frame jitter was simulated. It is obvious that random pixel to pixel misregistrations of 40 to 60 microradians severely reduce the ability to track low level winds. Additional simulations will be done in this area when the jitter is described more completely.

The calibration of GOES-I has been proceeding. Software has been written to fit the spectral response functions and the Planck radiances; these will be used in the operational implementation of the calibration algorithm. A scene of GOES I sounder radiances has been simulated from VAS derived surface skin and cloud temperatures and the NMC analysis; these will be used to determine the amount of degradation that can be expected in the temperature and moisture profile retrievals when the NEDN of the CO₂ sounding channels is relaxed (more will be available on this in the next quarter). Investigations into the tolerable differences in the response of the four detectors to radiation from space, blackbody, and earth are underway; striping is to be avoided if possible. Questions were raised regarding the GOES-I impulse response function; west to east sampling versus east to west sampling might produce very different images unless the sampling time is much larger than the impulse response function (ITT has agreed to provide more information on this).

The Master Test Plan and the GVAP Format Description were reviewed. Schmit attended the GOES I-M Imager and Sounder Critical Design Review and reported no major concerns with regard to calibration. Another meeting of the GOES I-M Science Evaluation Working Group was attended and UW plans for post-launch checkout of GOES I were presented.

II. Other Activities

1. ITOVS (Menzel, Lynch)

The Report on the fourth International TOVS Study Conference was distributed and the Technical Proceedings are being printed. Copies are available from CIMSS upon request.

2. Forest Fire Imagery (Wade, Prins)

In early September, the spectacular GOES views of the western U.S. forest fires (including the Yellowstone area) were shown on local Madison television stations, using the McIDAS displays. [Some of those pictures are in the process of being submitted for publication].

Part III. Appendix

1. Publications


- Hayden and Merrill, 1988: Recent NESDIS research in wind estimation from geostationary satellite imagery. To be published in ECMWF 4DDA of Satellite Data.


2. Meetings

a. July

- Schmit attended the GOES I-M Imager and Sounder System Level Critical Design Review 12-13 July in Fort Wayne, IN

- Menzel attended the COSPAR XXVII Plenary Meeting in Helsinki, Finland the week of 17 July. He presented a paper on "Cloud Cover Determinations with VAS Multispectral Observations: A Two Year Study".

- Hayden attended a STORM Implementation Planning meeting 25-28 July in Longmont, Colorado.

b. August

- no travel to report

c. September

- Hayden attended the ECMWF Seminar: Data Assimilation and the Use of Satellite Data, 5-9 September at Reading, U.K.

- Menzel attended the GOES I-M Science Evaluation Working Group Meeting on 8 September at GSFC in Greenbelt, MD. He presented the UW postlaunch checkout plans.

- Wade attended the Satellite Workshop at CSU on 21-23 September.

3. Visitors

- Dr. Scott Shipley, S. T. Systems Corp in Vienna, VA, visited CIMSS on 15 August to present a seminar on recent lidar work and to discuss ideas for combining laser and passive radiometer observations for atmospheric sounding.
- Dr. John Lewis, NSSL, visited Wade and Hayden on 18 August to discuss GUFMEX collaboration.

- Graeme Kelly, ECMWF, visited CIMSS for the week of 22 August to share his evaluation of the VAS winds and to plan further collaboration.

- Susan Callis, CIAM, visited the SDAB on 22 August to receive a demonstration of the AVHRR display capabilities of McIDAS.

- Nancy Cobb, OAR, visited SDAB on 26 September for a program review.

- Jean King, AFGL, visited CIMSS on 27-28 September for HIS discussions and a seminar presentation.
Quarterly Activities Report
October-December 1988
System Design and Applications Branch

1. Research Progress

2. ERBE/Climate (Ackerman, Herman)

Work continued on an analysis of regional scale energy budget studies over the Saudi Arabian Peninsula.

The effect of a dust outbreak that occurred during July 5-8 1985 on the hourly energy budget and the monthly mean radiative budget was studied using data from ERBS and NOAA-9.

5. Atmospheric Sounding

a) VDUC Retrieval Algorithm (Hayden, Schreiner)

No changes were implemented during this quarter.

b) Experimental VAS Algorithms (Hayden)

The derived product imagery algorithms have been modified to use (optionally) areas prepared by the VAS SST program. As expected, better cloud definition over the Gulf of Mexico results.

Software development was initiated with the goal of applying yet another new HIS retrieval algorithm to VAS.

Because of large residuals in the moisture sensitive channels, the question of iterating the VAS retrieval was revisited. Residuals are reduced, but accuracy is not demonstrably improved. For reasons of efficiency the single pass retrieval remains in effect.

c) VAS Time Composite (Callan, Menzel, Hayden)

A new navigation-collocation scheme has been written, installed, and checked. Results show a modest improvement over the old method for pixel collocation due to a decrease in round off error through elimination of one step of calculations.

d) AVHRR (Herman, Howell)

CIMSS/SSEC continues to have problems with the calibration of GAC/AVHRR. Information was sought from NESDIS experts to verify the correct order of header data used in the calibration algorithm.

e) PC-TOVS (Howell, Menzel, Dedecker)

Funding from sources in the UK, FRG, and EUMETSAT has been solicited; status of their interest will become clear in January 89.
f) High-resolution Interferometric Sounder (HIS) (Howell, Woolf)

The major activity in HIS development was the GAPEX experiment conducted 10/28 through 11/5 in Denver where the HIS was used as a ground-based sounder. Retrievals were prepared in real time and compared with temperature estimates from the Wave Propagation Laboratory's Radio Acoustic Sounding System (RASS) and the microwave thermodynamic profiler, as well as special CLASS radiosonde releases. To assist in the experiment:

- HIS retrieval software was implemented on an IBM PC.

- Extensive experimentation was conducted via simulation, using a historical set of October and November Denver radiosonde data provided by E. Westwater (WPL).

- HIS/GAPEX data for clear-sky periods on 10/31/88 and 11/1/88, and computed spectra from regression model were used to provide a standard deviation spectra of observed-calculated which will be used on McIDAS in further development of the retrieval algorithm.

- Nine-track tape software was developed for backup archive.

g) GOES I/M Algorithm Development (Hayden, Woolf)

Work towards an operational GOES I/M retrieval processing system began in earnest. By the end of the quarter, retrievals were accomplished from simulated "areas" of GOES I/M measurements. Particular areas of development include:

- Realistic simulation of GOES I/M measurements which can be navigated and imaged on the McIDAS in the format expected with the real data. VAS observations are used to provide cloud contamination and reflected sunlight complications.

- Algorithms were derived for cloud clearing, skin temperature determination, and reflected solar correction.

- The VAS physical, simultaneous retrieval algorithm was adapted to the 19 channel GOES I/M. Output "MD" formatting allows display and analysis of the retrievals in a manner analogous to any sounding data on the McIDAS (VUG).

h) DMSP Retrievals (Nagle)

The DMSP SSM/T retrievals produced by NESDIS continue to be monitored and compared with the operational TOVS soundings.

i) VAS Support (Menzel)

The VAS schedule was enhanced to enable five minute imaging loops of 25 minute duration six times a day for ERICA.
7. Mesoscale Applications

a) Sea Surface Temperatures (Wade)

The cloud detection technique has proved inadequate at night (when no visible is available). To improve on this a first guess clear value from the previous composite area has been added. The local variance of the composite is used to establish tolerances for accepting a new SST.

On 18 November 1988, a second area of coverage was added for the ERICA experiment over the western Atlantic off the east coast of the US and Canada.

A limited number of AVHRR HRPT passes has been archived. These data will be used for intercomparison with VAS MSI SST values.

b) VAS Derived Product Imagery (Hayden, Schreiner)

The SPRB has accepted this product for operations, after a modification was adopted to remove discontinuity caused by changing abruptly from 00 to 12 UTC NMC background fields.

An experiment using the 13.3 micron in place of the 6.7 micron channel was conducted. No improvement was observed, qualitatively, in the imagery (as compared to images derived from full dwell soundings).

c) MAMS (Moeller, Menzel)

A final draft of a NASA Tech Memo entitled "Improved Capabilities of the MAMS" was submitted for publication.

A MAMS/VAS radiation net flux product is under development; net fluxes from COHMEX at 1000, 700, and 300 mb and corresponding cooling rates will be determined from previously developed relationships between VAS/MAMS radiances and simulated radiation fluxes.

A MAMS SSC product using the radiances from the eight visible bands for an overflight of the Mississippi River Delta is being compared to in situ observations; corrections for atmospheric scattering and sun glint have been incorporated.

d) Profiler (Howell)

Software for accessing the microwave profiler data from PROFS was updated.

e) AVHRR Winds (Herman)

GAC data for two cases were used for measuring cloud motion vectors (CMV) in the Arctic where the NOAA-9 orbits cross. Automatic WINDCO was used. The results were very poor, for reasons yet unknown.

Another case was chosen at mid-latitudes where GOES data were available to derive CMV for comparison with those from the GAC data. The
flow patterns obtained from the two different satellites are in good agreement. Statistical comparisons between the GOES and AVHRR yielded an RMS difference of 7 meters per second which is promising in light of time/perspective differences.

LAC data were also used in the mid-latitude case, producing a large number of CMV in the vicinity of a low center near the edge of one orbit. These vectors were nearly of mesoscale density. For the most part, the LAC and GAC vectors agreed quite well. However, full scale, one kilometer resolution LAC is extremely costly in terms of computer time.

8. Synoptic Applications

a) ECMWF (Menzel, Schreiner, Hayden)

Arrangements have been made with Graeme Kelly of the ECMWF to conduct another test of automatic WINDCO at the end of January 1989. ESA will also participate.

b) National Hurricane Center Support (Velden, Hayden)

CIMSS cooperated with the Hurricane Research Division in a field experiment investigating a subtropical cold low on 1 and 2 September. HRD provided Omega dropsonde data and CIMSS provided VAS retrieval coverage. Within their limitations, the VAS retrievals did a respectable job in defining both the temperature and moisture structure.

An attempt to sound in the eye of Hurricane Joan was unsuccessful; while the viewing geometry was favorable and the eye was well formed, the IR view at 7 km resolution was partially cloud contaminated.

c) Gulf of Mexico Study (Wade, Hayden, Merrill)

In late November, the first tape with an extensive set of GUFMEX special radiosonde data (NWS and Mexican), for the week of 20 February 1988, arrived from NSSL. A second tape with the CLASS soundings for the same period was received in December.

Six-hourly VAS MSI, with three window channels, have been used to obtain SST's from 1831 UTC on 20 February through 0031 UTC on 22 February 1988.

A 36h control forecast commencing 21 February 1988 was successfully executed with the CIMSS Subsynoptic Scale Model. This forecast will serve as a benchmark for assessing the impact of assimilating temperature and precipitable water retrievals from VAS. The forecast accurately depicts a cold outbreak/return flow scenario in the Gulf of Mexico. Forecasted temperatures and mixing ratios are currently being verified against observations to determine any deficiencies.

d) VMIS (Hayden, Schreiner, Paris)

Daily monitoring of VAS moisture retrievals and NESDIS moisture bogus values (as layered precipitable water) over the Gulf of Mexico continued.
The VAS data still exhibit an improvement over both NMC RAFS 12-hour forecast and the bogus data.

e) Cloud Motion and Water Vapor Winds (Merrill, Menzel)

Software to compute tracer heights from a CO₂ ratio method has been successfully run on McIDAS using VAS dwell sounding and MSI (5-7-8) data. The code includes area-average, coldest pixel, and cold sampling options.

Experimental wind sets for 00 UTC 9 November and 00 UTC 2 September have been produced with encouraging results. The CO₂ method applied to the coldest 25 percent of the pixels in the target box appears to reduce both the bias and the noise due to height assignment problems in the window channel wind vectors.

Optional tracking algorithms have been installed. These are the functions which are minimized between two images to determine the "best" displacement of a cloud or other feature. A truncated linear difference function (rather than the operational squared difference function) produced qualitatively superior results for water vapor imagery in the 00 UTC 2 September case.

Presentations on the CIMSS winds effort are scheduled for the GOES I-M conference in the Washington area in April 1989, and at the AMS Satellite Meteorology conference in San Diego in May.

f) Data Assimilation (Aune, Goodman, Diak, Callan, Raymond)

Improvements were made to the CIMSS Analysis/Subsynoptic Scale Model (SSM) in the preprocessing, model, and postprocessing areas. These include:

- Filtering was applied (optional) to boundary tendency files to reduce model noise that sometimes forms along the horizontal boundaries of the model domain.

- The MSLP analysis was removed from the analysis package. A test analysis/forecast was conducted using the 1000 mb height field that is routinely available from the NMC Global Spectral Model. A smoother initialization and a reduction in the initial gravity wave noise was observed as compared with a run using the MSLP analysis.

- A routine that objectively analyzes calibrated satellite data from McIDAS images to a model grid is under development. Gridding the data directly from the image allows the resolution of the analysis to be optimally matched to the model grid resolution. This is a key factor when assimilating satellite retrievals in a forecast model.

- A Newtonian nudging algorithm has been implemented in the model. This routine allows a model field (i.e., temperature or moisture) to be dynamically adjusted toward a field that has been updated by more timely observations (i.e., from satellites).
g) TOVS Error Checking (Nagle)

A technique was developed to detect bad satellite temperature retrievals, in real time, based on a McIDAS display of color-coded TOVS retrieval locations plotted over an hemispheric analysis of temperature. The technique incorporates statistical bias and RMS expected uncertainty. It was developed for application on the VDUC at the suggestion of NMC. However, there has been no implementation follow-up.

h) GTE/ABLE (Menzel, Schmit, Goodman)

Effective cloud emissivities (calculated from the CO₂ ratio technique) were compared against the Manaus Rain Gauge Network reports; in raining situations over three-fourths of the clouds showed effective emissivities greater than .8, while in non-raining situations the emissivities were scattered over all values; when used in conjunction with a satellite rainfall estimation technique, the number of rain/no-rain mistakes were reduced by 50% in a sample of 42.

9. Sensor Calibration

a) GOES (Wade)

Full resolution visible data over White Sands (NM) from east and west GOES satellites at one or two selected times each day from 31 October through 23 November 1988 were provided to Gil Smith (NESDIS).

b) Line-by-line Transmittance Model (Woolf)

To improve the efficiency of the upward-looking retrieval algorithm, a regression model was constructed using apodized and truncated line-by-line transmittances, eliminating the need to perform this resolution reduction in-line.

In further efforts to "tune" the algorithms, FASCODE has been applied to a small set of soundings extracted from the Denver climatology, and the results used to generate a Denver-specific regression model, which will be evaluated next quarter.

c) GOES I-M Calibration (Menzel, Schmit)

Investigation of detector response characteristics (both electronic and geometric) revealed that the signal energy of an impulse is distributed over five samples (roughly two fields of view).

For the weighted IFOV response to be invariant under the reflection associated with scan reversal, the distribution must be symmetric; this can be accomplished with careful selection of the sample delay with respect to the impulse.

IR gain and calibration test plans were reviewed in a meeting at ITT in Nov 88; data has been requested from the pre-launch tests; software to process that data is under development.
Postlaunch checkout plans with regard to calibration and navigation were coordinated with GSFC Code 480.

d) MSU Scan Bias (Woolf)

Following the launch of NOAA-11 in late September, generation of a global dataset was initiated. Early in November, after approximately 150 orbits had been processed, statistical analysis was performed, and the resulting scan-bias or asymmetry corrections were transmitted to M. Chalfant for incorporation in the operational TOVS processing system. Data collection was continued until the end of December; reanalysis at 300 and 600 orbits showed the results to be quite stable.

II. Other Activities

1. ITOVS (Menzel, Lynch)

The Technical Proceedings of the fourth International TOVS Study Conference (ITSC-IV) was published as a CIMSS Report and distributed. Copies are available upon request to CIMSS.

ITSC-V will be held in Toulouse, France the week of 24 July 1989.

2. External Relations (Merrill)

The record-setting Hurricane Gilbert of September 1988 continues to generate interest. A complete set of daily GOES "snapshots" of Gilbert was collected on McIDAS. Selected 35 mm slides of GOES imagery have been provided upon request to Dr. Helmut Rott of the University of Innsbruck and Dr. P. K. Rao and Dr. D. B. Miller of NESDIS.

3. Meteosat-Next Collaboration (Menzel, Schmit, Wade)

Marilena Perrone (ESA) participated in a study of optimal additional spectral bands for consideration on the Meteosat Second Generation Imager, during her visit to CIMSS in late November and early December. Information-content studies of VAS observations were performed; a 13.3 micron channel for cloud parameters and a 4.5 micron channel for atmospheric stability were suggested.

4. ASOS (Menzel)

The CO₂ technique was suggested and accepted for the feasibility study of satellite cloud products to support ASOS; a pilot demonstration was proposed for spring 1989 on the McIDAS pending funding support for UW.
Quarterly Activities Report
January - March 1989
Systems Design and Applications Branch

I. Research Progress

2. ERBE/Climate

a) Earth Radiation Budget (Ackerman, Herman, Wu)

- A study of cloud radiative properties from co-located AVHRR, HIRS/2 and ERBE data has begun. The HIRS/2 data are used to detect clouds using the CO₂ slicing technique. The AVHRR data are used to determine the uniformity within the HIRS/2 and ERBE field of view. The AVHRR and HIRS/2 observations are used to classify the cloud by a technique that employs 8, 11 and 12 micron channels. The ERBE data is used to specify the cloud radiative properties.

- Xiangqian Wu has incorporated the ERBE data into the CIMSS sub-synoptic model to improve the diagnosis of clouds. A test case for January indicated that the inclusion of ERBE data significantly improved the model generated OLR fields; however, as clouds are not treated interactively in the model, the only change in the model forecast was seen in the surface temperature field. A second case study is being run for the month of July.

b) VAS Detection of Biomass Burning (Menzel, Cutrim)

- A simplified algorithm has been developed that is less sensitive to smoke. It assumes that the fire is 450 K and relies on the 4 micron channel to estimate the areal extent of the burning. The 11 micron channel is used to help correct for reflected solar contributions. Comparisons with results of the technique of Matson and Dozier have been good. The algorithm offers the opportunity for routine processing of GOES data for burn estimates of South America.

- A paper was presented at the Chapman Conference on Global Biomass Burning in Williamsburg, VA

5. Atmospheric Sounding

a) VDUC Retrieval Algorithm (Hayden, Schreiner)

- No changes were implemented during this quarter.

b) Experimental VAS Algorithms (Hayden)

- A simple model of diurnal heating was introduced to the cloud filtering module to modify surface air temperatures for comparison with window radiances.

- Interpolation of the transmittance to the surface pressure (instead of using the nearest quadrature level) was introduced.
The VAS software was modified to conform, as closely as possible, to the GOES-I/M software.

d) PC-TOVS (Howell, Nagle, Woolf)

- The compatibility of PC-MCIDAS with the local area networks and the Presentation Manager software was investigated. There appears to be no problem with having all three systems installed.

- Improvement in the OS/2 Presentation Manager applications software continued, with the help of SSEC personnel (Dedecker and Knuteson). Skeleton file collections for PM applications were generated for use as a starting point for the development of future applications software.

e) High-resolution Interferometer Sounder (HIS) (Howell, Woolf)

- Spectra computed from transmittances generated by Woolf’s regression model were compared with spectra computed by FASCODE. Very good agreement was obtained.

- Personal computer (PC) software development and M120 data processing continued. Theoretical radiance spectra were computed for CLASS soundings and then used to specify the bias between observed and theoretical spectra.

- Results of the SSEC rooftop, HIS/uplooking sounding experiments have been very encouraging, and it was decided to retrofit the latest retrieval algorithm to the GAPEX dataset collected at Denver in the late fall of 1988. The results are superior to those obtained originally.

- Several MCIDAS/HIS applications were modified to allow overlay of HIS spectral time series with LIDAR data. These applications were then transferred to the PC and with some modification were installed as PC-MCIDAS commands.

f) GOES I/M Algorithm Development (Hayden, Woolf, Schmit)

- A complete restructuring of the GOES-I/M processing software was undertaken to combine imager and sounder into a single file structure similar to the treatment given multiple sounding instruments on the NOAA polar orbiter satellites.

- Simulation software to provide sounder and imager data from VAS measurements and NMC analyses was extended to incorporate CO2 cloud height estimates. This somewhat improved the simulation of the water vapor channels but they are still unsatisfactory.

- A sequence of three GOES-I/M soundings were generated for 1400, 1530 and 1700 UTC on 12 March 90. These will be used to tune the temporal continuity of the proposed GOES-I/M products.
g) Histogram Retrievals (Nagle)

- The method still appears promising, and development is continuing at a reduced pace. However, the RMS comparisons with co-located raobs are actually somewhat worse than more conventional retrievals (physical and statistical). An enormous data sample is needed to avoid histograms which yield falsely high or low conditional probabilities.

h) Transmittance Models (Woolf)

- Implementation of line-by-line transmittance calculations on the MIDAS facility has been deferred until all the hardware for that system is in place and operating.

i) SSM/T (Woolf, Nagle)

- Modified PC-TOVS software for access and display of SSM/T was developed and used to ingest and analyze SSM/T temperatures. Software for the ingest and display of the SSM/T antenna response functions was also developed and tested.

- Software has been developed and implemented on the IBM PS/2 Model to obtain vertical temperature profiles from SSM/T measurements. Functions include limb correction, preretrieval normalization (like limb correction, with angle effects retained and surface effects removed), regression first guess, and physical retrieval using the channel transmittance weighting functions as basis functions. Preliminary evaluation shows promising results.

- The next refinement of the DMSP system will be a three dimensional retrieval algorithm in which the horizontal structure of the antenna pattern is taken into account.

- Software has also been prepared on the PS2 providing for the location and display of raobs in support of DMSP.

7. Mesoscale Applications

a) Sea Surface Temperatures (Wade)

- Comparison of daily VAS SST with NOAA buoys in the Gulf of Mexico was done for 3 weeks in January. The VAS was seen to give a warm bias of almost 1.5 C.

- Eileen Maturi of SAL/PSB visited in late January to coordinate future development of GOES SST. It was agreed that the cloud filtering needs further development, and a capability to locally process AVHRR for comparison was implemented.

b) VAS Derived Product Imagery (Hayden, Wade)

- Daily monitoring of the VDUC processing of VAS MSI products continued. Special attention was given to severe weather situations on 1 and 16 February and 13-14 March. On these days the VAS products did not significantly enhance
the information available from normal imagery and conventional data, but were a useful addition. This has been their history.

- A new, better organized suite of software for VAS derived product imagery (System 90) has been prepared to replace the version running on the VDUC for the last 18 months. Local comparisons of products has demonstrated a definite improvement with the newer version.

- System 90 will probably not be implemented this season at the VDUC because priority has been given to an upgrade of the Windco system. In addition, the VDUC is significantly in arrears in terms of implementing SSEC core upgrades. This incompatibility between the VDUC and the McIDAS systems needs to be corrected before new systems can be effectively introduced.

c) MAMS (Moeller, Menzel)

- The MAMS instrument was in December along the Louisiana coast and captured excellent low tide conditions. At low tide, the preferred paths of backwater transport are observable, helping to understand the exchange of water in tidal areas. In January, data was gathered over the Gulf Stream off the coast of Florida which will be used to generate MAMS SST and to compare with NOAA AVHRR data.

- MAMS SST products have been used to identify spatial and temporal variation of waters along the Louisiana coastline. Using data of March 30, 1989 a significant warming of shallow delta waters (2-3K in 2 hours) is apparent with deeper Gulf waters warming by about 1K over the same period. Also evident is a significant thermal gradient (5K) from the coastal delta waters to the Gulf waters.

- A paper entitled High Resolution Atmospheric and Surface Variability from Combined MAMS and VAS Radiances was presented by Chris Moeller at the Optical Remote Sensing of the Atmosphere Topical Meeting in February 1990. The paper presented 100 meter resolution atmospheric moisture and stability and skin temperature fields produced by combining MAMS and VAS data in a retrieval algorithm.

8. Synoptic Applications

a) ECMWF (Merrill, Menzel, Hayden)

- Preparations for the winds test in April 1990 with NMC and ECMWF were nearly completed with the installation of the improved autowindco on the VDUC in March. A combined CIMSS, SDAB, and SAB team will use this software on VDUC to produce three (0, 12, 18 UTC) wind sets per day, in real time, over the area 10-50 N and 80-150 W.

- Discussions were held with EUMETSAT and ESOC on the concept of an international campaign to intercompare winds sets generated from different satellites with different algorithms. An initial intercomparison of real time operational GOES and METEOSAT winds was suggested for three days in July 1990 for overlapping regions.
b) Gulf of Mexico Study (Wade, Hayden, Aune, Merrill)

- A number of changes were made to the experimental VAS retrieval algorithm to improve the associated derived product imagery. These appear to have had a positive effect, but verification (based on radiosonde and SSM/I precipitable water estimates) is incomplete.

- Reprocessing of the GUFMEX VAS for 9-12 March 88 has been completed for the synoptic times. 06 and 18 UTC periods will also be processed.

c) VMIS (Hayden, Schreiner, Paris)

- A calendar year's statistics of the success of VAS in defining moisture has now been collected and is being analyzed.

d) Cloud Motion and Water Vapor Winds (Merrill, Menzel, Velden, Callan)

- A major effort was made to develop an upgraded automatic wind derivation system for the VDUC to be tested during a two week period in April 1990.

- The principal development of the new Windco is the incorporation of height assignment at the time of target selection rather than during the image correlation step.

- The new height assignment module permits height assignment by as many as four methods according to available measurements. The methods are histogram (window or water vapor), regression (water vapor), or the CO₂ height slicing.

- A new output format has been designed which is intended to replace the 3-4 versions currently awash on the VDUC.

- It is intended that the new Windco be installed in core McIDAS in time for NHC support, summer 90. This will require a very dedicated effort on the part of CIMSS, SAB, and IPB in order to be successful.

- The contrail on 14 September in the CHAMEX has been tracked in GOES data and the estimated atmospheric flow is within 2 m/s of that inferred from the sky camera data by Ted Fujita. Further work is investigating the effect of more images in a loop with data from 16 September.

- The software for routine evaluation of operational winds has been transferred to VDUC; this calculates statistics of vectors over land compared to raobs. Standard deviations of speed biases continue to be 6-7 m/s.

e) AVHRR Winds (Herman)

- During the winter season 33 cases of consecutive passes over the Arctic were studied. Cloud motion vectors were computed in many of these cases and all were saved for future reference.
Vectors obtained by this method would make a significant contribution to improving analyses in that part of the world. Processing would require only slight modification to current McIDAS/VDUC techniques.

Two consecutive passes (instead of the normal three used with GOES) are adequate because most clouds are not conservative during a three hour period and curvature around Arctic cyclones is so great that consistency checks between consecutive estimates frequently discard the vectors.

Further development will probably yield some advantages to 3 picture sequences. This can be accomplished from the pole to approximately 70N.

e) Data Assimilation (Aune, Diak, Callan, Raymond)

Testing of the new 20 level subsynoptic scale analysis is complete. Additional modifications to the analysis software included improved data quality control tests and a user specified data rejection option. The analysis has been successfully tested on the 10 March 1988 GUFMEX case. The subsequent forecast was rather noisy, however, revealing the need to fine tune the model and the model initialization to the higher resolution analysis. Further testing is currently underway using additional cases.

f) VAS Cloud Climatology (Menzel, Wylie)

A paper has been submitted to JAM presenting the results from four years of VAS cloud data and studies of the relationship of cirrus with atmospheric dynamics. While cirrus were present in locations where the dynamic parameters indicate rising vertical motion, considerable cirrus were also found where the dynamics were weak.

g) GTE/ABLE (Menzel, Schmit, Goodman)

A paper is in preparation on the power law relationship between rainfall and infrared window brightness temperature. Three hour data is used with good results; computer processing is reduced by a factor of six. Time evolution studies with half hourly MSI data over selected rain gauge sites throughout the Amazon Basin continue.

h) Data exchange package (Nagle)

The so-called Exchange Packet (EXPACK) format is now working on the NAS 9000, McIdas, and IBM PS/2 PC's. This is a uniform format for soundings and grids, and allows the interchange of these data among the mentioned systems with no processing needed on the receiving system. It is 25% more compact than the older CTF's, needs no repacking, needs no schema, is concatenatable, and faster to unpack than CTF's.

i) Hurricane track forecasting (Velden)

Plans to produce enhanced, high-density satellite derived winds for hurricane analysis and track forecasts this coming season were discussed at the WPOP meeting. Emphasis will be on mid level winds in the area where the hurricane is anticipated to go. Collaboration with NMC was also discussed.
9. Sensor Calibration

a) GOES I-M Calibration (Menzel, Schmit)

- The signal to noise characteristics of the twelve VAS spectral bands were inspected with special dwell sound data from February 1990. Noise characteristics are in good agreement with the earlier post launch performance. Comparisons with Don Hillger's structure function analysis were also undertaken; similar results were found except for the surface viewing channels where surface skin temperature variations may be affecting the analysis.

b) HIRS/HIS Comparison (Woolf)

- The line-by-line transmittance calculations have been completed. A graduate student is presently engaged in detailed analysis of the dataset.

II. Other Activities

1. ITOVS (Menzel)

- The Technical Proceedings of the fifth International TOVS Study Conference (ITSC-V) have been compiled. Plans are to have ITSC-VI in May 1991 at Airlie, VA. More information is available from CIMSS.

2. Geoplat (Menzel)

- Potential configurations for the imager and sounder for Geoplat and the GOES-N phase A studies continue to be proposed and studied.

3. Meteosat-Next Collaboration (Woolf, Schmit)

- Marilena Perrone visited CIMSS to discuss HIS and EUMETSAT plans.

5. ASOS (Menzel)

- Further testing of the VAS algorithms for ASOS occured in February in winter conditions with snow on the ground. Results show 25% of the VAS derived cloud observations agreed with the ground observations, 57% show disagreement with both being correct, and 18% disagreed and were assumed incorrect. Several disagreements were minor and involved characterization of broken as overcast clouds, but several were significant such as falsely identifying ground as low cloud.

- Snow cover did not compromise the satellite observations. In 250 snow situations, comparable performance was realized.
The template appears to be functioning well; there is corroborating or complementary information 82% of the time.

Transfer of software from research must be accomplished when NWS gives a "GO" decision. Data messages are intended for use in hourly roundups issued by the NWS WSPOS.

6. STORM (Hayden)

Hayden participated in a planning session of the NOAA mesoscale initiative in Norman Ok in February.

7. MODIS-N Team Member (Menzel)

Menzel attended the MODIS team meeting in February and accepted prime responsibility for cloud (effective emissivity, pressure, temperature) and atmospheric state (stability, total precipitable water, total ozone content) products. These parameters will be produced routinely for the EosDIS post launch. Execution phase proposals must be resubmitted by end of April.

8. GOES Science Evaluation Working Group (Menzel)

The final draft of the GSEWG plan is in progress with the focus on verifying GOES products and providing the satellite component to STORM in summer 1993.
Quarterly Activities Report
April-June 1989
System Design and Applications Branch

1. Research Progress

2. ERBE/Climate
   a) Earth Radiation Budget (Ackerman, Herman)

   The study of the effects of dust on the top of the atmosphere radiative energy budget has been completed. Over the ocean the presence of dust reduced the monthly mean clear sky longwave radiant exitance by 15 Wm$^{-2}$, but increased the monthly mean clear sky shortwave radiant exitance by 34 Wm$^{-2}$. Over the desert, the presence of dust increased the clear sky shortwave radiant exitance by 5-7 Wm$^{-2}$, while decreasing the longwave radiant exitance by approximately 20 Wm$^{-2}$. These observations are in good agreement with model calculations.

   Methods of deriving monthly mean maxima and minima radiation budget components from the ERBE S-9 tapes have been developed and analysis of these products is underway.

   b) VAS Detection of Biomass Burning (Prins, Menzel)

   An M.S. thesis was completed using VAS data to investigate the diurnal variability in biomass burning in South America. The longwave and short wave infrared windows were used to estimate temperature and area of the burning. Individual fires were followed over a period of 54 hours; many of the fires were not detectable in the late afternoon due to aerosol accumulation. The prime monitoring time was 1500 UTC (local noon); burned area estimates three hours later often underestimate the actual area by a factor of two.

5. Atmospheric Sounding
   a) VDUC Retrieval Algorithm (Hayden, Schreiner)

   No changes were implemented during this quarter.

   b) Experimental VAS Algorithms (Hayden)

   The n-tau algorithm, developed for the HIS, has been adapted to the VAS processing system and parallel testing will soon be implemented.

   Cloud filtering modifications were updated to conform, as closely as feasible, to those used by NESDIS in the operational TOVS processing. Naturally the absence of microwave on the VAS precludes identical treatment.

   The "shrinkage estimator" bias correction version was run in parallel with the VDUC algorithm throughout the period. The new method appears to yield a small improvement. Verification has been done on moisture only.

   c) VAS Time Composite (Callan, Menzel, Hayden)

   Software is completed to add the visible channel to the GOES I-M simulated area (GIMS). Changes to Time Composite were made to a sounder file and a visible area and write to the new area. A new calibration routine was created to handle the McIDAS data
manipulations associated with the new area type. Also changes were made to Time Composite to y a VAS sounder file and a VAS visible image and merge the date into a new type VAS file (type AAAX).

f) PC-TOVS (Nagle)

Data compression work has been coordinated with SSEC (Ray Lord and Tom Whittaker) to facilitate downloading from McIDAS to PC's. Some success has been achieved in compressing MD files to a small fraction of their original volume, and then recovering the original MD file, but the method may not be foolproof, based on checksum comparison.

g) High-resolution Interferometric Sounder (HIS) (Howell, Woolf)

Several graphics utilities were added to the HIS software collection and some experimentation with the algorithm for the up-looking HIS was carried out early in the quarter. Data transfer software was written for McIDAS and the PC to allow easier transfer of REAL data, using Nagle's real-conversion routines. IBM OS/2 was installed on the PS/2 Model 70, and as a consequence a new FFT package was installed to replace the "workhorse" used previously, since that worked only under DOS. The HIS software collection was backed-up on 3.5" diskettes and briefly documented as it existed on June 1, 1989. This was to insure a fall-back position to the latest HIS/DOS applications. Data files and graphics were generated for the comparison of HIS with the Microwave Profiler, the Radio Acoustic Sounding System (RASS) and the Cross-chain LORAN Atmospheric Sounding System (CLASS) for a portion of the GAPEX period (1 Nov 88). These comparisons, a cooperative NCAR/CIRES/CIMSS study, are being prepared for publication in the Bulletin, AMS.

The following software packages were installed on the PS/2 Model 70:
- IBM OS/2, Version 1.10
- Microsoft C, Version 5.1

With R. G. Dedecker of SSEC, a HIS graphics display program was developed using the C programming language and the Microsoft OS/2 Presentation Manager software. This program is the "strawman" for additional experimentation with the OS/2 Presentation Manager as the user interface in HIS applications.

h) GOES I/M Algorithm Development (Hayden, Woolf, Schmit)

A second case study (with less of a "hot ground" problem) was processed to provide simulated GOES I/M measurements. This case was used to test "descope" registration of the channels.

It was found that including realistic first guess moisture profiles above 300 mb (the top level used with current VAS software) significantly improved the simulation of the midwave channels. The 300 mb lid is a carryover from old NMC practices where analyses were produced only up to that level (the radiosondes are inaccurate above). However, the RAFS and GDAS systems now provide moisture estimates up into the stratosphere. The first guess software for GOES I/M is being adapted to accommodate analyses up to 100 mb.

i) Experimental TOVS retrievals (Nagle)

A stepwise regression routine has been used to predict the height of the tropopause (from collocated raobs) given the brightness temperature from all channels of a HIRS
sounder. The regression explains about 86% of the variance in the logarithm of the pressure of the tropopause. The technique is to be used for stratifying brightness temperatures for regression retrievals. An ancillary routine is used to obtain the height of the tropopause from a co-located raob, using the notion of minimum angularity (minimum acute angle at various point along the sounding between the 50 mb level and 850 mb level).

j) TOVS/DMSP Verification (Nagle)

A comparison comparing retrievals from all four orbital sounders (2 DMSP and 2 NOAA) stratified by radiosonde location has begun. The study includes all stations which are visited by a satellite within some time window and within some lat/long window. Statistics included are the biases and RMS differences at ten levels between the satellite and the raob station. The results are too lengthy to be given here, or even printed on a separate document, but are available to interested users on a diskette.

k) McIDAS (ITPP) TOVS (Woolf, Smith, Schreiner)

A new scheme was implemented for 'tuning' the radiative-transfer calculations employed in the physical retrieval. Based on a suggestion of John LeMarshall of Australia, it uses MSU channels 2, 3, and 4 to predict, by regression, the biases for all channels involved in the retrieval, both HIRS and MSU. The regression equations are based on a global 'snapshot' of the NESDIS satellite-radiosonde-match database ('DSD5'). The GAMMA's (transmittance-adjustment exponents), which have been fixed for each current NOAA spacecraft (10 and 11), were obtained from several months of once-weekly analyses of DSD5. Results have been favorable.

The new water-vapor-retrieval scheme, which involves the separation of transmittance into 'dry' and 'wet' components, has also been evaluated extensively with positive results.

These two procedures have been incorporated into both the International TOVS Processing Package (ITPP) and the SSEC/McIDAS TOVS processing system (McTOVS).

1) PROFS VAS Evaluation (Howell, Paris)

The VAS soundings made at PROFS are being compared once daily with those produced locally on the McIDAS.

7. Mesoscale Applications

a) Sea Surface Temperatures (Wade)

No new development has been done with SST's. The VAS MSI at 1831 UTC, with the visible imagery, has continued to be used for SST image generation over the Gulf of Mexico and the waters to its east on a daily basis.

A graduate student, Walt McKeown, under Paul Menzel's direction, has received training in McIDAS use and operation of the VAS SST software, for a study of SST patterns along the Gulf Stream. A period after GALE, in the spring of 1986, is been examined, at which time some special buoy data are available.
b) VAS Derived Product Imagery (Hayden, Schreiner)

The generation of MSI derived image products (precipitable water and lifted index) on the WWB VDUC has been monitored routinely. Images at 1331, 1531, 1731, 1931, and 2131 UTC are scheduled for transfer to McIDAS; a loop is maintained on one McIDAS workstation. Some difficulty with a topography routine was corrected in April. In mid-May, several problems surfaced; releases of software, both at SSEC and VDUC, caused incorrect versions of some programs to run. Nonetheless, the discrepancies were found, and on May 24th, images generated at SSEC matched those made at WWB.

One case to note, that of June 29th, showed interesting destabilization in the western High Plains. Unfortunately, on most days, a clear signal, followed by strong convection, is not found.

c) MAMS (Moeller, Menzel)

MAMS COHMEX data has been used to look at the effect of low level clouds on VAS retrievals. Non-cloudy MAMS data at 100 meter resolution were averaged to simulate the VAS radiance for a field of view (10 km) in the split window. The resulting MAMS/VAS retrieval showed a general increase in moisture in the lowest 400 mb of the atmosphere.

The MAMS SSC algorithm now includes an atmospheric correction for aerosol scattering. SSC and SST over the Atchafalaya Bay reveal an inverse relationship; highly sedimented water is flowing off the continent into warmer less sedimented water in the Gulf of Mexico. High resolution detail is evident in these derived product images.

The MAMS was successfully deployed from Patrick AFB last April. Three flights were accomplished along the Louisiana coast in support of geomorphology studies; pre- and post-frontal conditions were imaged. The final flight featured several overpasses at short time intervals to simulate future Geoplatform capabilities.

Chris Moeller presented a paper (High Resolution Depiction of SST and SSC from MAMS Data) at the Fourth Conference on Satellite Meteorology and Oceanography.

d) AVHRR Winds (Herman)

WINDCO was used at middle latitudes to produce cloud motion vectors from both AVHRR and GOES for nearly simultaneous orbits. A very important step in this process is the careful registration of the infrared pictures with their grids for accurate geographical positioning. Comparison of the AVHRR vectors with those from GOES and with radiosonde winds showed the rms differences in both cases to be less than 5 m/s. A paper presenting these results has been prepared for the AMS 12th Conference on Weather Analysis and Forecasting in October 89.

In attempting to use this result to obtain vectors at high latitudes, it appears that a three picture visible AVHRR sequence is not a good source. This is because in a complex cloud situation during the three and a half hour period of observation the solar illumination changes too much at high latitudes.
8. Synoptic Applications

a) ECMWF (Merrill, Menzel, Hayden)

Results of the two week test of the CIMSS wind derivation were discussed at the ECMWF Workshop on the Use of Satellite Data in Operational NWP. It was noted that these research wind sets generated at the CIMSS are clearly superior to the operational winds.

b) Gulf of Mexico Study (Wade, Hayden, Aune, Merrill)

Post-processing of VAS derived moisture images for the GUFMEX field experiment in early 1988 continued. 12-hourly images of two layers of precipitable water were generated using the "shrinkage estimator" bias correction. These moisture fields were used in the CIMSS subsynoptic scale model in an assimilation mode. Despite the collection of in-situ observations during GUFMEX, the limited coverage of such data still makes verification difficult.

Following the benchmark effort of the February case, the availability of ship, aircraft, and radiosonde data along with the associated weather situations and cloud cover led to selection of the 9-11 March 1988 case as the most promising for further work. 12-hourly moisture images were created for this period in preparation for a traveling GUFMEX workshop trip to NWS offices at San Antonio, Houston, and Slidell the first week in May. The efforts of CIMSS were presented by Merrill and Wade, along with the other research thrusts, represented by John Lewis and Les Showell of NSSL, Gary Grice of NWS Southern Region, and Steve Weiss of NSSFC. Satellite data sets, as well as the derived products currently generated, were shown and discussed with the NWS audiences.

Bob Rabin, a visiting scientist from NSSL, obtained SSM/I microwave data for the March case and has implemented software to derive precipitable water and surface wind speed. Derived images of these products have been generated for the approximately 12-hourly overpasses of the satellite. These show excellent continuity in time and space. The precipitable water images, which are obtained by a simple regression model, will be compared to the VAS moisture fields, which are obtained by a physical technique. One aim is to uncover any bias to the first guess which is expected to exist in the VAS data. Some simple split window imaging of the VAS data is also being attempted, for comparison with the more complicated sounding product and the SSM/I fields.

c) VMIS (Hayden, Schreiner, Paris)

Moisture statistics over the Gulf of Mexico continue to be examined daily for the VAS dwell sounding pair at 12:48/13:18 daily.

A poster describing the VAS moisture retrievals was presented at the Fourth Conference on Satellite Meteorology and Oceanography.

d) Cloud Motion and Water Vapor Winds (Merrill, Menzel)

For two weeks in April 1989 CIMSS conducted a comparison of winds derived from 15 minute interval images with those derived from half hourly images in the infrared window and the visible. The CO₂ height assignment was used for both data sets. When compared against rawinsondes, the 15 minute winds are slightly superior to the 30 minute winds in both average difference and bias. The samples, however, are different since the yield is generally larger in the 15 minute set, so the comparison is not necessarily valid. When
compared against the guess (12 h NMC global prog), the 30 minute winds have a smaller bias at all levels and a lower absolute error especially in the upper levels. This is true of both raw and final (manually edited) wind sets. This unexpected result is not understood at all. A complete analysis will be forthcoming.

Investigations in collaboration with Ted Fujita are starting on the CHAMEX data. Sky camera inferences of cloud motion are being carefully compared to satellite cloud drift winds.

The three-dimensional recursive filter objective analysis system has been modified to provide objective quality control of the auto CMW. Preliminary results show that the editor is only slightly inferior to an operator, and much quicker. A paper describing this research was prepared for the ECMWF Workshop on the Use of Satellite data in NWP. Because of a very laggardly performance by the NOAA travel office in procuring a passport, the paper was not presented.

Presentations on the CIMSS winds effort were made at the GOES I-M conference in the Washington area in April, 1989, and at the 4th Conference on Satellite Meteorology and Oceanography, San Diego, CA in May 1989.

e) Data Assimilation (Aune, Diak, Callan, Raymond)

A poster entitled "Impact of VAS Retrievals on a Simulation of Return Flow in the Gulf of Mexico" was presented at the 4th Conference on Satellite Meteorology and Oceanography, San Diego, CA. A 36h forecast that included multiple insertions of precipitable water retrievals from VAS showed an improvement in the forecast moisture distribution when subjectively compared to horizontal analyses of precipitable water and to raobs. The assimilation technique appears to have achieved its intended purpose of combining asynoptic satellite information and model forecasted fields without degrading the vertical structure generated by the model.

Software to post-process model output from the Department of Meteorology CYBER 930 has been installed on a PC. This will allow for checking of model output fields before they are transferred to McIDAS for further processing.

Data sets to initialize the CIMSS Sub-Synoptic Model have been collected for the 10-12 March, 1988 GUFMEX case. This case will be used in the next assimilation experiment.

A new version of the CIMSS analysis routine has been created to include 20 levels in the vertical (rather than 10). The levels now go from 1000mb to 100mb in steps of 50mb with the addition of 70mb. This change allows for better use of radiosonde significant level data in defining the lower part of the atmosphere. Initial comparisons with the old version show modest differences between them. Comparisons with radiosonde observations show good agreement at all levels.

f) VAS Cloud Climatology (Menzel, Wylie)

Diurnal characteristics of cloud cover in winter and summer are being catalogued with data from the three year VAS CO₂ North American cloud climatology. Summer features include: (1) over the Rocky mountains, cirrus increases by as much as 20% between 18 to 00 UT (a mountain effect); this spreads to the east by 06 UT (as convection normally does). (2) over Florida and the surrounding region, cirrus increases by 10 to 15% between 12 and 18 UT (Gulf moisture initiates convection and satellite notes increase of cirrus debris). (3) over the eastern half of the U.S., the opaque cloud cover increases between
12 and 18 UT (daytime heating initiating cloud development). Winter features include: (4) little change in the cirrus during the day (5) continental U.S. has more cloud cover between 06 and 12 UT (probably due to increased fog and stratus).

These results will be presented in more detail at the IAMAP conference.

g) GTE/ABLE (Menzel, Schmit, Goodman)

A paper was presented at the AGU conference describing the improvement in satellite rainfall estimation when effective cloud emissivities (calculated from the CO₂ ratio technique) are incorporated into the rain/no-rain discrimination. Further work with Rod Scofield is under discussion.

Three papers have been submitted to JGR for the special ABLE 2B edition. They are titled "Estimates of Daily Rainfall over the Amazon Basin", "VAS Water Vapor and Wind Fields over Amazonia", and "Diurnal Characteristics of Cloud Cover over Amazonia".

h) VAS Support (Menzel)

The nominal VAS schedule for summer 1989 was modified to enable wind generation down to 60S in response to a request by the NMC. The dwell soundings have been abbreviated by one minute to allow longer multispectral images.

9. Sensor Calibration

b) HIRS/HIS (Woolf)

The intercomparison of regression and FASCOD2 transmittances, and observed and HIS-derived radiances, for HIRS has entered the evaluation stage. Preliminary results suggest that useful information will be obtained from this exercise.

c) GOES I-M Calibration (Menzel, Schmit)

Temperature influences on the visible - IR offset in the VAS are being investigated. The nominal scanner temperature on the VAS drifts from 15 to 35 °C over the seasons. So far no apparent seasonal changes have been noticed.

Spectral responses for GOES I are still not available; this is slowing down software development.

The GOES-I Navigation Post-launch Test Plan was reviewed in a two day meeting at UW with representatives from Swales, GSFC, and NOAA/NESDIS.

GVAR ingest formats are being discussed with SSEC to assure to availability of calibration and navigation data in the McIDAS (IDUC) imager and sounder areas.

II. Other Activities

1. ITOVS (Menzel)

The fifth International TOVS Study Conference (ITSC-V) will be held in Toulouse, France during the week of 24 July 1989. H. Woolf, W. Baker, and P. Menzel will be representing NOAA.
2. Geoplat (Menzel)

The phase A Geoplat study into the capability of Geoplat to perform NOAA operational observations has started. Presentations by ITT and SBRC have helped to sketch a straw man operational imager and sounder for Geoplat.

3. Meteosat-Next Collaboration (Woolf, Schmit)

Marilena Perrone (ESA) visited CIMSS in June to further investigate the characteristics of the HIS data.

4. ASOS (Menzel)

The demonstration of the VAS CO₂ cloud parameters (cover, height, emissivity) for ASOS has begun. In June, three weeks of comparisons of the satellite derived cloud information with surface observations revealed that the satellite can supplement surface measurements of cloud cover above 12000 feet.

Preliminary conclusions are that (1) above 400 mb the satellite information is more reliable, (2) between 400 and 700 the satellite and ground observations are complementary, (3) below 700 mb the surface observation is preferable. More specifically, several examples are showing that: (1) satellite can successfully distinguish cloud versus no cloud, (2) satellite can see multi-layers above those observed from ground, (3) often the satellite provides important missing data when the ground observers view is obstructed (by night, blowing dust, low cloud cover...).

A one month VAS demonstration with four observations per day over 50 observing sites will proceed in July and August. A report of the findings will be completed by October 1989.

5. STORM (Hayden)

Hayden participated in the STORM Working Group meeting in June at Boulder Co for preliminary planning of the STORM field programs. He and Purdom have been participating in the preparation of NOAA's STORM Initiative.

6. MODIS-N Team Member (Menzel)

Several new requirements for MODIS-N imager were suggested; these include increased dynamic range to 400 (700) degrees Kelvin in the longwave (shortwave) infrared windows using nonlinear A/D conversions, an additional channel for improved thin ice cirrus detection (8.75 microns), and improved specification of the longwave diffraction characteristics.

Several core cloud and atmosphere data products (cloud parameters, ozone content, temperature and moisture retrievals, atmospheric stability) will be produced by CIMSS during the first years of MODIS flight. It has been suggested that McIDAS become a Team Member Computing Facility for the MODIS user community.
Quarterly Activities Report  
July-September 1989  
Systems Design and Applications Branch

I. Research Progress

2. ERBE/Climate
   a) Earth Radiation Budget (Ackerman, Herman)
      - During this last quarter results of our ERBE studies were described at the IAMAP '89 Conference. Three papers were presented: "Maximum and Minimum in the Earth Radiation Budget" by S. A. Ackerman, "The Effects of Dust on the Earth Radiation Budget" by H.-S. Chung and S. A. Ackerman, and "Cloud Cover and Diagnosis for Weather and Climate Models Using the ERBE Observations" by X. Wu and W. L. Smith.
      - Present studies include an investigation of the daily variation of the radiative energy budget at the top of the atmosphere from ERBE. We have also returned to a previous study comparing ERBE and VAS simulated outgoing longwave radiation. The previous comparison was for "instantaneous" observations; now we are considering different time and space scales.

b) VAS Detection of Biomass Burning (Menzel, Cutrim)
   - The VAS investigation of biomass burning in South America continued in September with participation in the BASE-A (Biomass Burning Airborne and Spaceborne Experiment - Amazonia). This is a collaboration with Yoram Kaufman at GSFC and Alberto Setzer at INPE. Estimates of area of burning and the transport of the resulting aerosols in the vicinity of Alta Floresta are being made.

5. Atmospheric Sounding
   a) VDUC Retrieval Algorithm (Hayden, Schreiner)
      - No changes were implemented during this quarter.
   b) Experimental VAS Algorithms (Hayden)
      - A version of the "shrinkage estimator" bias correction continues to be run in parallel with the VDUC algorithm once daily. The small improvement seen during the spring months was not seen during the summer months when the "operational method" was competitive. Evaluation is still confined to moisture retrievals only.
   c) VAS Time Composite (Callan, Menzel, Hayden)
o No significant changes were made this quarter. The program was run on various cases for shakedown purposes. Documentation of the code was begun.

d) PG-TOVS (Howell, Nagle, Woolf)

o Much of this quarter was spent learning the "C" programming language and OS/2 Presentation Manager applications programming techniques. Microsoft FORTRAN 5.0 was purchased and installed on two PC's, and some testing was done.

o As a precursor to the development of a DMSP retrieval system, the VAX version of the ITPP has been implemented on the IBM PS/2 Model 70 under OS/2 using Microsoft Fortran 5.0. A few minor changes at the bit and byte level were required; otherwise, the software transported flawlessly and performs very well.

o After downloading a file of raw TIP data from McIDAS, a 10-minute pass can be processed into soundings in approximately 30 minutes. Software has been developed to permit the utilization of gridded surface data in the retrieval process. In addition, the ITPP retrieval file can be uploaded to McIDAS and transformed into an MD file, facilitating the use of standard applications software for display and manipulation of the results.

o The McIDAS mainframe software for extracting TOVS (TIP) data from ingested areas, was modified to handle the HRPT, LAC and GAC data formats.

e) High-resolution Interferometric Sounder (HIS) (Howell, Woolf)

o HIRS/HIS comparisons are continuing with the selection of several cases with coincident HIRS, HIS, and radiosonde data. Following initial evaluation, it was decided to extend the study from 12 HIRS channels (1-8, 10-12, 18) to channels 1 through 18. All of the FASCOD2 calculations have been completed, and analysis of the complete dataset will begin shortly.

o Several graphics programs were developed using the OS/2 Presentation Manager (PM) Toolkit. Considerable effort went into improvements in the modularity of the HIS PM software and expansion to handle larger spectra, which was required for FASCODE studies and the Bomem Michelson 120 uplooking experiment.

o In response to a request from Bob Knuteson, a program was written to correct HIS spectra for the finite field-of-view. For the Bomem Michelson 120 uplooking interferometer experiment, to be performed in November 1989, PC software was developed to convert the Bomem interferograms to the HIS format, perform FFT, calibrate and display data.

f) GOES I/M Algorithm Development (Hayden, Woolf, Schmit)
After integrating the visible data into the simulated 19-channel GOES I/M data for 9 May 1988, the cloud filtering algorithm was extended to include an albedo check.

To aid in the development of imager data processing procedures, preparation of a suite of sounder-analogous software was begun to permit simulation of imager radiances. A major portion of this effort consisted of the generation of a regression transmittance model for the imager IR channels, using the FASCOD2 0.1-wavenumber dataset. In addition, a regression model was created for the estimation of surface-skin-temperature from imager data.

g) DMSP (Nagle, Woolf)

Brouwer/Lyddane orbital elements are now available for the DMSP, as a result of the SSEC contract with NEPRF for DMSP software development. The parameters are being used to test the NESDIS de-navigation/re-navigation software. The de-navigation package now runs both on PC's and on the NAS 9000 at Suitland.

The McIDAS navigation packages have recently been altered so that a single navigation module now works for both DMSP and NOAA satellites, using orbital parameters in the same format. (This applies to NESDIS software, not to SSEC software distributed as McIDAS core software). Moreover, the new software is the same as that now used on PC's, as are the orbital elements, so that both software and orbital data can be interchanged among PC's, McIDAS, and NAS 9000 using only simple transfer routines.

7. Mesoscale Applications

a) Sea Surface Temperatures (Wade)

A daily SST product at 1831 UTC was routinely archived. Future efforts will include work on the cloud clearing algorithm and updating the regression coefficients (from previous work by Bates). This will be in collaboration with SAL/PSB (at WWB), so that the VAS SST capability may be implemented on the VDUC.

b) VAS Derived Product Imagery (Hayden, Wade)

Modifications were made to the software to reduce image blockiness. These included a pixel-by-pixel interpolation of the surface data and improved handling of the topography. The improvements have not been transferred to the VDUC pending a thorough local shakedown.

The hourly VAS MSI-derived images of moisture and stability, which were produced on the WWB VDUC, were monitored through most of the quarter. Several images were routinely moved to McIDAS on a daily basis and studied (some color hard copies were printed). On a few occasions when the products were not
available, contact was made with SAB users on the VDUC, to note absence of the data sets.

- Animation of the stability and moisture images showed reasonable and consistent patterns of the atmospheric products, but clouds often covered sizeable areas, frequently including the regions of anticipated convection. Communication with NSSFC in Kansas City indicated some, but rather limited, use of the VAS MSI retrieval products.

c) GOES I/M Derived Product Imagery (Hayden, Schmit)

- Day 1 products of the GOES I/M include derived product imagery of total precipitable water and lifted index. Software for this purpose, patterned after the VAS, was completed and successfully demonstrated with the simulated GOES I/M 19 channel data for 9 May 1988.

d) MAMS (Moeller, Menzel)

- The spatial variability in the MAMS/VAS derived product imagery has been investigated in a structure function analysis of COHMEX results. Strong variation at scales between 1 and 30 km was evident in the precipitable water and lifted index; between 30 and 60 km little additional variability was found.

- The MAMS Suspended Sediment Concentration (SSC) algorithm is being tuned to in situ observations provided by the Coastal Studies Institute at LSU.

- Additional MAMS deployments have been planned for Jan-Feb of next year along the Louisiana coast to investigate the impact of cold frontal passages. The CSI will be gathering ground truth data.

e) AVHRR Winds (Herman)

- Additional 3-picture AVHRR sequences have been selected for measuring cloud motion vectors at high latitudes. During a 4-day period in September an Arctic vorticity center was tracked. Preliminary study of this system shows: a) consistency checks in WINDCO discard vectors in the vicinity of a low center due to vector changes between the first and second picture pairs; b) many targets that can be tracked by eye are discarded by WINDCO due to changes in their texture, shape, etc., over the 200 minute time period; c) the first guess possibly causes targets to be discarded that can be tracked visually.

- One case of a plume cloud over northern Greenland was suspected to be a volcanic eruption until further investigation revealed that (a) there are no active volcanoes in Greenland, and (b) clouds of this type are not uncommon in the Arctic.

8. Synoptic Applications
a) ECMWF (Merrill, Menzel, Hayden)

- Plans are underway with NMC and ECMWF to conduct a winds test early next year. McIDAS capabilities for several wind sets per day, in real time, over an appropriately large area are limited and options are being studied.

- The WPOP has expressed interest in comparison of a week of METEOSAT winds produced by NESDIS, UW, and EUMETSAT.

b) Gulf of Mexico Study (Wade, Hayden, Aune, Merrill)

- Processing and analysis of data from the 10-12 March 1988 case study continues. 06 and 18 hour VAS retrieval sets were processed to augment the previously generated 12-hourly data; the initial 36 hour period of interest (12 UTC on 10th through 00 UTC on 12th) was extended to 12 UTC on the 12th, with a retrieval set at that time.

- A simple differencing of the split window channels, from the VAS MSI, near the time of the retrieval sets, was prepared to compare with the derived product imagery from the full soundings. The split window, independent of ancillary information such as an NMC forecast or surface reports, showed the same general features as the retrievals.

- An independent satellite observational data set is available from the DMSP SSM/I measurements. Although available only every 12 hours over the Gulf, the SSM/I patterns are extremely consistent and quite comparable to radiosonde values. In comparison, although the VAS and SSM/I moisture fields show a similar progression during this period, the VAS data are noisier and biased (wet).

c) VMIS (Hayden, Schreiner, Paris)

- This cooperative program to investigate the impact of VAS data on the NMC products is currently inactive.

- A poster describing the VAS moisture retrievals was presented at the Fourth Conference on Satellite Meteorology and Oceanography.

d) Cloud Motion and Water Vapor Winds (Merrill, Menzel, Hayden)

- Modifications to the CO2 height algorithm are being investigated to help with two cloud layer situations (thin cirrus over lower opaque clouds).

- Six days of CHAMEX data have been archived and winds have been processed automatically. Manual enhancement of the satellite cloud drift winds over Key West will precede intercomparison with the sky camera inferences of cloud motion by Ted Fujita.
o Responding to the recommendation of the WPOP, the 3-dimensional recursive filter objective analysis system will be tightened to assure good quality winds at the expense of quantity in the auto cloud motion winds. Some manual enhancement is also anticipated.

o Procedures for routine evaluation of operational winds are being tested with help from SAB, who are producing a few extra vectors over land every day. CIMSS will perform this function for this year and then pass the capability to VDUC.

o CIMSS evaluated the VDUC winds and the DLM produced operationally for the NHC. A summary evaluation was presented to the WPOP. Early problems were resolved and reliable wind sets were mostly found. Some dependence on the shift operator was noted. A very good data set for hurricane Hugo was recorded.

e) Data Assimilation (Aune, Diak, Callan, Raymond)

o The 20 level subsynoptic scale analysis has been put through a one case test to compare with the original ten level version. Fields which are common (e.g., 500 mb) show very minor differences.

o An analysis of mixing ratio was generated for the 12 March CUFMEX case using total precipitable water from SSM/I. The data were assimilated using the same technique used for VAS precipitable water. The data had a positive impact on the analysis. These results were presented in Monterey at the Tropical Cyclone Motion Experiment Data Assimilation Planning Meeting (31 Aug) as a potential source of moisture data in the tropics.

o The CIMSS forecast model has been transferred to the CYBER 930 computer of the UW Meteorology Department. The code has been modified to satisfy the CYBER FORTRAN compiler. Software to exchange gridpoint fields with McIDAS via a PC have been written. Benchmarking will be conducted as soon as modifications to the data I/O routines are complete.

f) VAS Cloud Climatology (Menzel, Wylie)

o Characteristics of cloud cover over the Midwest in the drought summer of 1988 are being compared with the normal summers of 1987 and 1989. Correlations with hot days and rain days are being calculated.

o The diurnal characteristics of cloud cover over North America for the last three years were presented at the IAMAP conference. A paper is available upon request.

o A global cloud climatology from HIRS data for one year is being compiled with separate funding. Comparisons of VAS and HIRS
loos products for three days in July over North America reveal
im. For overall results, but the HIRS has more skill in
identifying mid level (700-400 mb) clouds. Results were presented
at the ITOVS conference in Toulouse, France; a paper is available
upon request.

1) GTE/ABLE (Menzel, Schmit, Goodman)

- The paper "Cloud Characteristics Over Central Amazonia
  during GTE/ABLE 2B Derived From Multispectral VAS Observations" by
  Menzel, Schmit, and Wylie has been accepted after modification by
  GR for the special ABLE 2B edition.

- Estimates of evapotranspiration over the Amazon basin at
  2 and 18 UT for three days of May 1987 were made using VAS
  sounding and wind fields. Values appear reasonable. These
  results are available in the final report to NSF.

2) Objective analysis (Howell, Nagle)

- The recursive filter analysis program (2-dimensional) was
  transferred to the PC, modified slightly, and compiled. Various
  supporting "VAS" software is being collected for transfer. These
  programs are being integrated into PC-McIDAS with the help of Dave
  Santek of SSEC.

- The Kalman filter objective analysis has been transferred
to the PC and successfully compiled. It has not been run.
Several necessary ancillary routines have been written to support
the KF, e.g., routines for generating and concatenating map files
on the PC.

3. Sensor Calibration

a) GOES I-M Calibration (Menzel, Schmit)

- The Imager/Sounder Normalization, Calibration, and
  Alignment Data Interface Document and the GOES-I Navigation Post-
  launch Test Plan (version 3.0) were reviewed.

- GVARS ingest formats are being discussed with SSEC to
  assure availability of calibration and navigation data in the
  McIDAS (IDUC) imager and sounder areas.

- It was recommended by CIMSS that the GOES-I sounder
  detector package should be maintained at 97 K all the year, rather
  than 92 K shifting to 102 K seasonally. This facilitates trend
  analysis of radiances and retrieved atmospheric properties,
  without sacrificing noise characteristics significantly.

IV. Other Activities

1. Hugo Videotape (Wade, Velden)
temperature and moisture retrievals, atmospheric stability) during the first years of MODIS flight. GSFC will also be producing some of these core products in parallel. Funding arrangements are still pending.

8. HLF (Nagle)

  o High Level Fortran (HLF) has been developed and now works successfully for routines using Microsoft vice IBM Fortran as the target compiler. It might be noted in this connection that Microsoft Fortran routines execute 10-20% faster that routines compiled under IBM Fortran. However, MS Fortran is user-unfriendly.
Quarterly Activities Report  
October - December 1989  
Systems Design and Applications Branch

I. Research Progress

2. ERBE/Climate

a) Earth Radiation Budget (Ackerman, Herman, Wu)

   o A comparison of the ERBE measured longwave radiative
     fluxes with flux estimates from the GOES-6 VAS (based on a
     statistical approach (Smith and Woolf, 1984)) indicated that while
     the VAS fluxes (OLR) were highly correlated ($r=.9928$) to the ERBE
     measurements, they tended to overestimate the flux at the top of
     the atmosphere.

   o A statistical correction to the VAS estimates has been
     generated from ERBE measurements taken in October 1986. A
     comparison of the ERBE observed and VAS derived fluxes for the
     month of April 1985 is in progress.

   o CIMSS has also been employing ERBE data to improve the
     diagnosis of clouds in numerical weather prediction (NWP) models.
     It is assumed that the difference between computed and observed
     OLR is a minimum when the cloud distribution is correct. A
     nonlinear method to determine the optimum cloud field is being
     developed and tested using the CIMSS sub-synoptic model and ERBE
     data.

   o Fields of model diagnosed longwave radiation and
     instantaneous ERBE data at 14 hours after coefficient adjustment
     show considerable improvement over the same forecast without the
     coefficient

   o ERBE V-5 data products are also being used to study the
     radiative properties of clouds. Our initial emphasis is on co-
     locating AVHRR and HIRS/2 pixels on the NOAA-9 satellite.

b) VAS Detection of Biomass Burning (Menzel, Cutrim)

   o Intercomparisons of VAS and AVHRR estimates of the areal
     extent of the biomass burning for 24 August 1987 in South America
     reveal that VAS overestimates the burned area by about 50%.  
     Improved correction for atmospheric water vapor attenuation in
     the infrared windows is being implemented in the hopes of
     improving the VAS performance.

   o A paper has been prepared for submission to the
5. Atmospheric Sounding

a) VDUC Retrieval Algorithm (Hayden, Schreiner)

   o No changes were implemented during this quarter.

b) Experimental VAS Algorithms (Hayden)

   o As part of GUFMEX processing a number of changes were made in the cloud filtering to produce fewer, but better clear column estimates of the brightness temperatures.

   o Experiments continue with the "shrinkage estimator" bias correction. Atmospheric moisture retrievals are very sensitive to the procedure, temperature retrievals much less so.

   o Moisture retrievals are also highly sensitive to the use of surface mixing ratio observations. There are not enough radiance measurements to avoid ambiguity without the surface data.

c) VAS Time Composite (Callan)

   o The Time Composite routine has been modified to be able to merge GOES I/M imager data consisting of 4 infrared and one visible area into a single 5 band area. A calibration module was modified to be able to use the new area type.

d) PC-TOVS (Howell, Nagle, Woolf)

   o OS/2 Presentation Manager applications software, for the plotting of HIS spectra, was corrected and improved. This software could easily be used by other applications with slight modification in the input structure.

   o A new FFT was installed and tested. This FFT allows the use of data field lengths which are not necessarily powers of 2. Its efficiency improves as the number of small prime factors in the field size is reduced.

e) High-resolution Interferometer Sounder (HIS) (Howell, Woolf)

   o During most of this quarter, the HIS aircraft instrument and the Bomem Michelson-120 interferometer (M120) were periodically in up-looking operation on the roof of the Meteorology & Space Science building. From November 18 through December 22, over 100 "clear sky" spectra were obtained by the M120. "Ground truth" was provided by CLASS soundings taken from a van one block away.

   o Command files and software modules were developed to permit real time calibration of the M120. Software was developed to extract HIS spectral bands from the M120 spectra and, with appropriate transformations, convert the data to the spectral
spacing and range of the HIS data, thus allowing easy comparisons of HIS and M120 spectra.

- To provide a climatological database for construction of synthetic spectra, radiosonde data from Green Bay, WI, St. Cloud, MN, and Peoria, IL in November and December of 1984 through 1988 were extracted from our archives and reformatted for the upward-looking forward radiative transfer model.

f) GOES I/M Algorithm Development (Hayden, Woolf, Schmit)

- Software for the simulation of GOES I/M imager data was completed and an example for 9 May 88 generated.

- Software to combine the separate data areas of the imager (as they were simulated and as they will be received from GOES I/M) into a single file for use with sounding product software was completed.

- A suite of programs to generate derived product imagery from files of either the GOES I/M imager or sounder data was completed. Images of total precipitable water and lifted index for the 9 May simulation were derived.

- A complete package for processing the GOES I/M sounder or imager data was delivered to the VDUC and demonstrated on 16 November.

- Since delivery of the GOES I/M software we have decided to restructure the programs such that sounder and imager channels are considered as one contiguous set, much as HIRS and MSU are in the TOVS. This is part of the effort to generalize the sounding processing within NESDIS.

g) Histogram Retrievals (Nagle)

- A conditional probability temperature retrieval, based on level temperature vs. brightness temperature histograms collected from colocated satellite and radiosonde measurements has been started. The temperature selected for a level is that for which the sum (over all channels) of the conditional probability of that temperature, given the channel brightness temperature, minus the total probability of that temperature is a maximum. Is this equivalent to simple regression?

h) Transmittance Models (Woolf)

- Work has begun on updating the uniformly mixed gas line-by-line transmittance data base to account for global changes in CO2 since these numbers were initially generated. The current estimat of CO2 concentration has been extrapolated to serve for the next decade.
Due to the high cost of the line-by-line calculations, this project will be moved to the MIDAS at WWB.

7. Mesoscale Applications
   a) Sea Surface Temperatures (Wade)
      - September 1988 (the wake of hurricane Gilbert) and September 1989 (hurricane Gabrielle) were processed.
      - In anticipation of collaborative work next quarter with Eileen Maturi (SAL/SDAB), methods available to assess the accuracy of the current VAS SST products on McIDAS were studied. A limited sample from the Gilbert data showed a small bias (VAS versus Gulf of Mexico buoys), while current data showed a larger warm bias (greater than 1 degree C).
   b) VAS Derived Product Imagery (Hayden, Wade)
      - Select VAS MSI product images, generated on the WWB VDUC, were regularly transferred to McIDAS and monitored on a daily basis.
   c) MAMS (Moeller, Menzel)
      - An atmospheric correction algorithm has been developed for the MAMS visible channel data and water leaving radiance (LW) has been calculated within an estimated error of 40%. LW was converted to subsurface reflectance which was in turn regressed with in situ observation of Secchi disk depth (SD) and Suspended Sediment Concentrations (SSC). Correlations with SD were superior to those with SSC.
      - Comparison of MAMS subsurface reflectance and MAMS split window SST over the Atchafalaya Bay, LA shows pronounced correspondence, possibly due to bay floor topographical features. Images separated by one day and a cold frontal passage (30 March and 1 April 1989) show significant changes in the location of a sediment plume due to the changes in wind direction and speed.
      - MAMS deployments are scheduled for 20 - 27 January 1990 along the Louisiana coast to further investigate the impact of cold frontal passages. The Coastal Studies Institute at LSU will be gathering ground truth data.
      - Liam Gumley finished his MS thesis on SSC estimation with MAMS data in January 1990.

8. Synoptic Applications
   a) ECMWF (Merrill, Menzel, Hayden)
o Plans are underway with NMC and ECMWF to conduct a winds test in April 1990. A combined CIMSS, SDAB, and SAB team will use VDUC to produce three (0, 12, 18 UTC) wind sets per day, in real time, over the area 10-50 N and 70-150 W. This will be preceded by the installation of the improved autowindco on the VDUC in March.

o EUMETSAT has expressed interest in comparison of three cases of METEOSAT winds produced by NESDIS, UW, and EUMETSAT. The WPOP will suggest the use of VAS data instead to allow CO2 heights as an option. Joe Schmetz will visit CIMSS and NESDIS in March 1990 to coordinate this activity.

b) Gulf of Mexico Study (Wade, Hayden, Aune, Merrill)

o Analyses of GUFMEX data sets continued, with emphasis on the 10-12 March 1988 period. Success of general pattern agreement of the VAS moisture fields with the SSM/I data was tempered by the "venetian blind" stripping in the VAS imagery as well as a moist bias in the VAS data.

o A tighter cloud filter and improved radiance bias corrections have reduced the moist bias. However, some thin clouds are not discernable and result in poor moisture retrievals.

o The VAS moisture retrievals appear qualitatively to distribute the moisture changes to the guess in the two layers chosen for future "impact" studies.

o Videotapes of the VAS 6.7 micrometer water vapor imagery for the 21-24 February and 6-12 March 1988 cases were made, for use in later synoptic analyses of the data.

c) VMIS (Hayden, Schreiner, Paris)

o A calander year's statistics of the success of VAS in defining moisture has now been collected and is being analyzed.

d) Cloud Motion and Water Vapor Winds (Merrill, Menzel, Velden, Hayden)

o The CO2 height algorithm is being incorporated into the new version of autowindco. An option for heights from the water vapor channel is also being tested. Manual editing will include the CO2 and H2O height options. Initial code has been written.

o CHAMEX investigations are focussing on tracking a contrail on 14 September and several cloud decks on 16 September. The satellite cloud drift winds have been processed automatically and are now being enhanced manually over Key West. Intercomparison with the sky camera inferences of cloud motion by Ted Fujita are scheduled for February 1990 with his visit to CIMSS.
o Routine evaluation of operational winds has been underway since October with help from SAB, who are producing a few extra vectors over land every day. Standard deviations of speed biases have been found to be 6-7 m/s usually. CIMSS will transfer this capability to VDUC in the next quarter.

o A two week test was conducted in November to ascertain whether bogus height assignments were resulting in a slow bias in upper level winds. The bogussing procedure was turned off and the speed bias did go down by one m/s but rms speed differences of all winds went up by 1.5 m/s. Perhaps bogus heights allow inclusion of more reliable tracers of atmospheric flow (ie. transmissive clouds). CO2 height assignments will hopefully alleviate the apparent need for bogus heights.

e) AVHRR Winds (Herman)

o A revision in the method of handling the first guess winds has resulted in a dramatic improvement in the quality of Arctic cloud motion vectors. Re-computation of prior cases produced remarkably better vectors.

o Timely, nearly operational cases were examined for three weeks in December revealing unusual conditions unique to the wintertime Arctic. Problems confronting the auto windco included clouds that are not chosen as targets because they are much warmer than the surface temperature and viable targets that are not selected because of weak gradients. Navigation did not prove to be as formidable as feared because leads in the ice provided reliable landmarks for a picture series. Gray scale enhancement for the Arctic temperatures are necessary to visually track the clouds.

e) Data Assimilation (Aune, Diak, Callan, Raymond)

o Software to interface NMC spectral model data sets stored on McIDAS to the new 20 level subsynoptic scale analysis has been developed and is currently being tested. The data, available on mandatory levels only, must be interpolated to levels at 50mb increments for use as background fields in the analysis.

o The project to transfer the CIMSS Sub-Synoptic Model to the Dept. of Meteorology CYBER 930 has been terminated due to the unexpected removal of the computer for replacement with a more capable machine. It has yet to be determined whether implementing the model on the new machine will be to our advantage.

f) VAS Cloud Climatology (Menzel, Wylie)

o The accumulation of a global cloud climatology from HIRS data continues. To date six months have been processed; a complete year is the goal.
g) GTE/ABLE (Menzel, Schmit, Goodman)

- Estimates of evapotranspiration using VAS sounding and wind fields over the Amazon basin for three days of May 1987 continue to be adjusted. Values were found to be between 4 and 8 mm/day with an uncertainty of 3 mm/day. These values are consistent with other reports. Kurt Brueske finished his MS thesis with this work.

- The time evolution of the infrared window brightness temperature observed in cloud tops over a rain situation has a markedly different signature than over a no rain situation. A relation between the area under the curve and the total precipitation has been investigated. For three cases from the GTE/ABLE data set good results were obtained. It remains to specify a proper threshold criterion (i.e. an hourly increase in brightness temperature greater than this amount indicates rainfall) and appropriate area averaging (i.e. perhaps 20 kilometer square areas).

- Half hourly MSI data over selected rain gauge sites throughout the Amazon Basin has been archived since June 1989. Investigations of the power law relationship between rainfall and infrared window brightness temperature will be pursued as well as time evolution studies.

h) Objective analysis (Hayden)

- The 3-d recursive filter analysis program was modified slightly to allow the user to define the vertical coordinate spacing (in pressure) as a key-in.

i) Hurricane track forecasting (Velden)

- The impact of enhanced, high-density satellite derived winds on hurricane analysis and track forecasts was tested on cases of Hurricanes Gabrielle and Hugo.

- The 3-d recursive filter analysis scheme was investigated and found to show a significant improvement over the old analysis method (2-d Barnes scheme).

- Impact results in mean track (barotropic) forecast error show a 5-10% reduction with the inclusion of the enhanced satellite winds. In higher latitude cases it was found that most of this impact comes from VAS gradient wind information. Analysis with and without enhanced winds were done with the 3-d analysis.

j) POES Navigation (Nagle)
Experience with the McIDAS navigation package (which is applicable to either DMSP or NOAA satellites) appears to work better for NOAA than for DMSP owing to better base files on NAS 9000 for NOAA.

k) Retrieval Verification (Nagle)

Monthly comparisons among atmospheric sensors were ended with December 1989. A new study has been running for six months, comparing individual raobs with various satellite sensors, without averaging out the variations.

9. Sensor Calibration
   a) GOES I-M Calibration (Menzel, Schmit)

   - The errors introduced in the VAS calibration by using summer nonlinearity corrections for detector performance in the winter were found to be about .3 degrees Centigrade in the longwave infrared window channel.

   - The signal to noise characteristics of the twelve VAS spectral bands were inspected with December 1989 data and found to be in good agreement with the earlier post launch performance. No degradation was noticed.

   - Radiances from dwell soundings over the North Pole for the past eighteen months have been archived and are being inspected for any signatures indicating stratospheric warming.

b) HIRS/HIS Comparison (Woolf)

   - After evaluation of the original dataset, it was deemed desirable to generate additional cases before performing a "final" analysis. This will be done during the next quarter.

II. Other Activities

1. ERBE Videotape (Wade, Ackerman)

   - A videotape of daily, global ERBE OLR was assembled for March-July 1985.

2. ITOVS (Menzel)

   - The Report on the fifth International TOVS Study Conference (ITSC-V) was distributed. Copies are available upon request from CIMSS.
3. Geoplath (Menzel)

- A briefing was given at the Geoplath Instrument Studies Interim Review on the continued activity with ITT and SBRC regarding potential configurations for the imager and sounder for Geoplath and the GOES-N phase A studies. Complementarity of the two systems rests in part on comparable observing capabilities, continuous duty cycle, and constant observing positions at 75 and 135 W. NASA seems willing to comply.

4. Meteosat-Next Collaboration (Woolf, Schmit)

- No new activity in this area.

5. ASOS (Menzel)

- The utility of VAS CO2 cloud parameters (cover, height, emissivity) for ASOS was demonstrated in several weeks last fall and winter. The ASOS will only report cloud cover information up to 12,000 feet; the satellite derived cloud information augments ASOS by providing information on clouds above 12,000 feet. A template (decision algorithm) was tested to translate the satellite cloud height and effective amount into standard cloud cover nomenclature used by NWS (i.e. clear, scattered, broken, overcast at low, mid, or high levels).

- In over 30 days of comparisons of satellite and ground observations, it was found that there is corroborating or complementary information 80% of the time. The disagreements are split evenly between ground failure to see cloud cover (at night or high thin cirrus) and the satellite falsely identifying cold ground as low overcast (where the asos will be accurate anyway).

- Presentation to the ASOS program office in November was received very well. Transfer of software from research to operations was discussed. These data are intended for use in the hourly roundups issued by the nws wsfos; the automated output from the satellite technique will be available once every hour when GOES-I becomes operational. In the interim three hourly products from the VAS will be demonstrated.

- In anticipation of the transfer of the ASOS software to the VDUC, code was written, tested, and documented with ample comments.

6. STORM (Hayden)

- Hayden and Aune participated in the Winter STORM Working Group meeting in October at Champagne IL. and coordinated with the other NOAA agencies in preparing the NOAA STORM Initiative.
7. MODIS-N Team Member (Menzel)

- Several iterations were made regarding possible spectral channel changes for the MODIS-N. Nothing definitive has happened. Decisions are expected by the January Team Member meeting.

8. GOES Science Evaluation Working Group (Menzel)

- The GSEWG met in November 1989 to hear of recent GOES-I progress and to discuss the activities plan for the combined NASA, NOAA, and university effort. Focus will be on verifying GOES products and providing the satellite component to STORM in summer 1993. The final draft of the plan is due in spring 1990.
Quarterly Activities Report
April - June 1990
Systems Design and Applications Branch

I. Research Progress

2. ERBE/Climate
   a) Earth Radiation Budget (Ackerman, Herman, Wu, Rabin)

      o Two papers will be presented at the 6th Conference on Atmospheric Radiation, July 23-27 in San Francisco: "ERBE and HIS/2 coincident observations of the radiative properties of cirrus clouds", by Ackerman and Wylie, and "observations of the daily radiative energy budget at the top of the atmosphere from the earth's radiation budget, experiment", by Herman, Ackerman, Chen and Wade.

      o Xiangqian Wu has completed his Phd thesis incorporating the ERBE data into the CIMSS sub-synoptic model to improve the diagnosis of clouds. He used a variational technique to adjust the initial cloud distribution, and verified that model estimated clouds in the forecast more closely matched observations, as judged by OLR.

      o A joint NSSL/NESDIS/CIMSS proposal to the NOAA Climate and Global Change Program was submitted to NOAA/ERL for internal review: An Application of satellite data bases to determine the influence of vegetation and soil moisture on clouds and regional energy budgets

b) VAS Detection of Biomass Burning (Menzel, Cutrim)

      o The paper that was presented at the Chapman Conference on Global Biomass Burning in Williamsburg, VA has been submitted for a special AGU publication.

      o A paper by Elaine Prins and Paul Menzel entitled "Geostationary satellite detection of biomass burning in South America" was submitted to the International Journal of Remote Sensing.

5. Atmospheric Sounding
   a) VDUC Retrieval Algorithm (Hayden, Schreiner)

      o A revised algorithm incorporating changes since May 1988 was transferred to the VDUC. The new version will be used for NHC support in the 1990 season.

      o A change in the VAS spin budget eliminating channel 1 caused some temporary hiccoughs in the software, but these were quickly corrected.
b) Experimental VAS Algorithms (Hayden)

- An updated version of the retrieval algorithm was run daily for the month of May before transfer to VDUC.

- Testing of the "average" bias correction vs. the "shrinkage estimator" yielded no conclusive evidence that the latter is an improvement. For the sake of simplicity the new method was not transferred to VDUC.

c) PC-Development (Howell, Nagle, Woolf)

- The Presentation Manager (henceforth PM) software for plotting HIS and M120 spectra was upgraded to accept both existing formats for HIS spectra.

- In support of the current trace-gas study over the COHMEX area, the software on McIDAS for processing the HIS/aircraft data was transferred to the PC and modified as necessary to run in PC-McIDAS.

d) High-resolution Interferometer Sounder (HIS) (Howell, Woolf)

- During April the Bomem M120 interferometer was operated, in the up-looking configuration, with a four-position viewing sequence, i.e. hot blackbody, cold blackbody (liquid nitrogen target), ambient blackbody and sky . Existing calibration software was modified to accommodate this new sequence and most of the data was calibrated in near-real time.

e) GOES I/M Algorithm Development (Hayden, Woolf, Schmit)

- A number of simulation experiments were run on the 9 May simulation data to investigate further degradation in the performance of both the imager and sounder. Results of the tests were documented and sent to OS.

- The GOES I/M software has been brought up on the MIDAS system at Camp Springs. However, because a different (local) transmittance model is used, results are not the same as obtained with the SSEC software. The incompatibility will be resolved by SSEC's accepting the Washington version which is designed to be very similar to the TOVS transmittance package.

f) Histogram Retrievals (Nagle)

- Investigation of histogram retrievals continues. The RMS errors have improved somewhat with increasing data in the histograms, but the results are generally still poorer than operational retrievals in the case of TOVS. In the case of DMSP, the results are competitive with operational data, the number of valid comparisons remains small.

g) Transmittance Models (Woolf)

- Implementation of line-by-line transmittance calculations on the MIDAS facility will require a trip to WWB with tapes; the software and supporting data files are too extensive to attempt to send and install remotely.
h) SSM/T (Woolf, Nagle)

- Software was written to: 1) display a specified 3-by-3 matrix of coefficients related to the horizontal field of SSM/T temperatures and 2) display a color image of SSM/T antenna response functions on SSM/I grid projection

- Development of the three dimensional retrieval algorithm, in which the horizontal structure of the antenna pattern is taken into account, is in progress.

7. Mesoscale Applications

a) Sea Surface Temperatures (Wade)

- The effort to update the VAS SST coefficients, and to compare VAS SST with the AVHRR product has been temporarily put on hold.

- The archive of routinely processed VAS SST data was maintained.

b) VAS Derived Product Imagery (Hayden, Wade)

- The System 90 version of the derived product imagery has been run sporadically to compare with the operational VDUC version. It appears to provide a consistently improved product.

c) MAMS (Moeller, Menzel)

- MAMS derived SST and SSC fields along the Louisiana coastline have been used to identify sources and types shoreline waters. High and low sediment loading and warm and cold temperatures are helping to define waters that flow directly into the Gulf versus those that are filtered by the adjacent marshlands.

- A paper presenting 100 meter resolution atmospheric moisture and stability and skin temperature fields produced by combining MAMS and VAS data in a retrieval algorithm has been drafted for submission to the International Journal of Remote Sensing.

8. Synoptic Applications

a) Winds Test (Merrill, Menzel, Hayden)

- A combined CIMSS, SDAB, and SAB team installed the new auto Windco software on the VDUC and conducted a 10 day, real time test from 8-17 April 1990. They produced three (0, 12, 18 UTC) wind sets per day over the area 10-50 N and 80-150 W. Only one time period was missed.

- The April wind sets were given to the NMC for a parallel analysis/forecast cycle to compare with the operational wind sets. Preliminary indications suggest that the experimental winds were an improvement. Five northern hemisphere 500 mb forecasts were improved by two
anomaly points on the average for the ten days by using the experimental wind sets.

- The April wind sets were sent to the ECMWF for their evaluation.

- Discussions continued with EUMETSAT and ESOC to organize an international winds set intercomparison. Initial efforts will be focused on two weeks in mid August; ESOC winds, experimental SAB winds for NHC, and Spanish wind sets will be intercompared.

b) Gulf of Mexico Study (Wade, Hayden, Aune, Rabin, McMurdie)

- VAS products for this study were completed for 00, 6, 12, and 18 UTC for the 9-12 period. These included retrievals and derived product imagery of precipitable water in two layers.

- Data assimilation efforts for this study continue to encounter severe boundary problems. The domain has been changed several times without complete success. Nesting of the GUFMEX fine mesh domain onto a larger synoptic scale domain is being used to eliminate these problems.

- With considerable difficulty the McIDAS statistics software was adapted to evaluate the VAS and SSM/I images of precipitable water for the 9-12 March GUFMEX case. A paper on the results is in preparation for submission to Weather and Forecasting.

c) VMIS (Hayden, Schreiner, Aune, Paris)

- A tentative agreement has been reached between NSSL, NMC, and SDAB to conduct an impact test of the VAS moisture retrievals in the NMC regional model. Aune would spearhead the effort at Camp Springs in September. The scheduling hangs on local demonstration of the viability of assimilation methods.

- Moisture retrievals with the updated retrieval algorithm are being evaluated daily.

d) Cloud Motion and Water Vapor Winds (Merrill, Menzel, Velden, Callan)

- The upgraded automatic and manual wind derivation system which includes CO2 height assignments was installed on the VDUC in late June. SAB will be using this software to produce special wind data sets in support of the NHC during hurricane season.

- The responsibility for routine evaluation of operational winds has been transferred to IPB; software to calculate statistics of vectors over land compared to raobs was transferred to VDUC earlier.

e) AVHRR Winds (Herman)

- Validation of Arctic cloud motion vectors from AVHRR was done on 5 cases over northern Canada. 78 rawinsonde matches (within 2 deg. latitude)
were obtained. Average vector error for the 5 cases ranged between 4 and 7 m sec⁻¹.

f) Data Assimilation (Aune, Diak, Callan, Raymond)

- A IBM RISC 6000 computer was made available to the SSEC for testing, and the CIMSS data assimilation model was implemented on it. Adaptation of the McIDAS code was reasonably straightforward, and a number of assimilation runs were performed. System performance was excellent.

- Software to transfer model data sets between McIDAS and the RISC 6000 has been developed and tested. In addition, the model preprocessor and postprocessor modules have been transferred to the RISC 6000. The complete CIMSS Sub-Synoptic Model subsystem now resides on the RISC 6000. The analysis subsystem will continue to reside on McIDAS to allow for easy access to multiple data sources.

g) VAS Cloud Climatology (Menzel, Wylie)

- VAS data continue to be processed in the ongoing cloud climatology over North America.

h) Data exchange package (Nagle)

- The data Exchange Packet (EXPACK) has been applied to allow McIDAS users to request DMSP and TOVS operational retrievals directly from the NAS 9000 at NMC by means of a McIDas key-in. The chief purpose of this arrangement is to acquire data files which are immediately down-loadable to a PC or RISC for further use in a low-cost system. A current application is the TCM (tropical Cyclone Motion) experiment.

i) Hurricane track forecasting (Velden)

- Plans to produce enhanced, high-density satellite derived winds for hurricane analysis and track forecasts this coming season were finalized in discussions with SAB. Wind fields at seven levels will be produced from manual IR winds, automated IR winds, automated water vapor winds, and VAS gradient winds. Mid level winds in the area where the hurricane is anticipated to go continues to be the focus of extra efforts.

9. Sensor Calibration

a) GOES I-M Calibration (Menzel, Schmit)

- A summary of the operational VAS calibration was drafted for the background material to be submitted to the Product Advisory Teams.

- VAS radiance biases (with respect forward calculations based on the NMC twelve hour forecast) were tracked for thirty days this spring. General trends are being analyzed.

- Calibration information was supplied to TASC and FSU so that PC based consumption of 8 bit data could accommodate VAS MSI data. This involves
converting the mode AAA radiances to mode A temperatures with conversion tables that account for differing satellites and spectral bands.

b) HIRS/HIS Comparison (Woolf)

  o The line-by-line transmittance calculations have been completed. A graduate student is presently engaged in detailed analysis of the data set.

II. Other Activities

1. ITOVS (Menzel)

  o The Technical Proceedings of the fifth International TOVS Study Conference (ITSC-V) have been distributed. Copies are available from Dr. Alain Chedin at LMD in Paris, France. ITSC-VI will be held 1-6 May 1991 at Airlie, VA. More information is available from CIMSS.

2. Geoplat (Menzel)

  o A draft report discussing possible configurations for the imager and sounder for Geoplat and GOES-N based on the respective phase A studies was distributed.

3. Meteosat-Next Collaboration (Woolf, Schmit)

  o Discussions continued regarding possibilities for measurements with high spectral resolution from the European polar orbiting satellites.

5. ASOS (Menzel)

  o Discussions with NWS have confirmed their interest in the GOES I/M enhancement of ASOS cloud information above 12,000 feet. This will be suggested as a day one GOES I/M product. Plans are underway for software rewriting, transfer to VDUC, and further demonstrations with VAS.

6. STORM (Hayden)

  o Hayden continues to take an active role in the NOAA mesoscale initiative. A planning meeting for the 92 submission was held in Boulder in June.

7. MODIS-N Team Member (Menzel)

  o A confirmation proposal was submitted indicating prime responsibility for cloud (effective emissivity, pressure, temperature) and atmospheric state (stability, total precipitable water, total ozone content) products. These parameters will be produced routinely for the EosDIS post launch.
8. GOES Science Evaluation Working Group (Menzel)

- The GSEWG meeting of June introduced several scenarios for post launch checkout of the GOES I/J that would also support satellite studies in conjunction with STORM. The final draft of the GSEWG activities plan was distributed with the focus on verifying GOES products and providing the satellite component to STORM in summer 1993.

9. McIDAS (Wade)

- SSEC has established a McIDAS terminal for used as an public relations "looper". Feed from the terminal extends within and without the SSEC/meteorology building. SDAB has played a large part in preparing satellite products for display which include normal image loops and a number of daily customized graphic overlays depicting current weather events. Response has been very favorable.
Quarterly Activities Report  
July - September 1990  
Systems Design and Applications Branch  

I. Research Progress  

2. ERBE/Climate  

a) Earth Radiation Budget (Ackerman, Herman, Wu, Rabin)  

   o A method of collocating NOAA-9 AVHRR, HIRS/2  
   and ERBE observations has been completed. The CO₂  
   slicing method is applied to the HIRS/2 data to derive  
   cloud top height and effective cloud cover.  
   Statistics on the variability of the AVHRR pixels  
   within the HIRS/2 FOV are used to assess the uniformity  
   of the HIRS/2 footprint and will be used to improve  
   estimates of CO₂ effective cloud cover.  

   o The AVHRR and HIRS/2 observations are co-  
   located with the ERBE observations. Algorithms are  
   being developed to analyze the radiative properties of  
   clouds using this data set.  

   o A study to determine the impact of deep  
   convective clouds on the regional radiative energy  
   budget (top of the atmosphere) was continued with the  
   The analysis reveals a diurnal trend in cloud  
   frequency similar to that from GOES data from another  
   year. The effects on the daily net radiation budget  
   are very sensitive to diurnal distribution of these  
   clouds. There is a tendency towards a net warming  
   effect due to a nocturnal maximum.  

5. Atmospheric Sounding  

a) VDUC Retrieval Algorithm (Hayden, Schreiner)  

   o An updated retrieval algorithm was delivered  
   to the VDUC on 1 June 1990, and it has been used in  
   deriving gradient wind estimates for hurricane  
   support. Monitoring of the retrievals show an  
   excessive number of "cloudy" assignments suggesting  
   that further refinement of the cloud-clearing  
   algorithm is desirable.  

   o Due to a local CIMSS budget problem daily  
   processing of the 1200 UTC VAS retrievals over the  
   U.S. and the Gulf of Mexico was suspended, as of 1
September 1990. (See below concerning limited generation of VAS retrievals around 00 UTC.)

b) Experimental VAS Algorithms (Hayden)

  o Testing of the "operational" algorithm was moved to 0000 in place of 1200 GMT to determine if it had been too tightly tuned to the single time period.

  o Cool skin temperatures were found to be a problem at 0000 UTC, largely because the hour-old surface air temperature analysis is unrepresentative during rapid heating or cooling. Many clear fov were flagged cloudy.

  o A simple diurnal heating model was introduced into the algorithm to adjust for the unrepresentative surface analysis. This will be tested at all times of day and season and then introduced to the GOES-I processing.

c) PC Software Development (Howell)

  o Periodic additions to OS/2 Presentation Manager (PM) application interface programs were made. The PM program most actively used, and thus most improved because of users' requests is the one used to overlay up to 10 xy-plots of HIS and/or Bomem interferograms or spectra.

  o Skeleton PM programs were written, intended to be a "universal" program interface, to facilitate the execution of any program which follows the procedure of getting its input parameters from a "standard" ASCII file.

  o The SATPLUS system for dial-in access to McIDAS products has been officially terminated. (SATPLUS was the extension of the original PC dial-in access to McIDAS developed during the 1985 PRE-STORM field project in Oklahoma.) PC-McIDAS and UNIDATA have superseded SATPLUS.

d) High-resolution Interferometer Sounder (HIS) and the Bomem M-120 Interferometer (Howell, Woolf)

  o The coding began for a Minimum Information algorithm for the retrieval of temperature and moisture profiles from up-looking HIS and Bomem M-120 data. This development is currently in the simulation phase.
The Bomem M-120 calibration software was revised, to allow calibration of data from any scene-mirror position using data from any other two positions. Other modifications insure a more accurate determination of the ambient and blackbody temperatures at the time of observation.

Software was written to create multi-record files of Bomem M-120 complex spectra. This is in preparation for the development of calibration software for the next interferometer, which may utilize hardware FFT functions to produce complex spectra.

A fast transmittance model was created specifically for Bomem applications. This will result in much greater retrieval processing efficiency (the previous software required that Bomem data be forced into the HIS file structure, which necessitated much extraneous processing).

e) GOES I/M Algorithm Development (Hayden, Woolf, Schmit)

No changes have been made to the day-1 processing algorithm for the GOES-I sounder, except to parallel changes made to the VAS cloud clearing.

The GOES-I sounder spectral response functions are still unavailable, but the imager flight model spectral response functions were received and examined.

f) Histogram Retrievals (Nagle)

Histogram retrievals are now being made based on observed brightness temperatures collocated with synthetic soundings generated from NMC temperature charts. The results are better than those achieved using collocations with raobs, even when compared against raobs, but are still inferior to operational retrievals. (19 Oct 90)

g) Transmittance Models (Woolf)

The GOES I/M line-by-line transmittance calculations have been completed on the McIDAS. As soon as spectral response functions for both sounder and imager become available, the instrument transmittances will be produced and the fast models will be generated.
h) SSM/T (Woolf, Howell)

   o Development of the three dimensional retrieval algorithm, in which the horizontal structure of the antenna pattern is taken into account, is essentially complete and evaluation has begun.

7. Mesoscale Applications

a) Sea Surface Temperatures (Wade)

   o The archive of routinely processed VAS SST data, typically now at 1520 UTC, was maintained. No work was done on updating the VAS coefficients.

b) VAS Derived Product Imagery (Hayden, Wade)

   o Monitoring of the VAS MSI derived product imagery at the WWB VDUC included a few cases of parallel processing, which continues to show the improvement in the SDAB development version.

   o WWB staff were informed that the VAS MSI schedule required a shift in VAS derived imagery processing times, from on the half-hour to on the hour. The shift was accomplished without difficulty.

c) MAMS (Moeller, Menzel)

   o An impact of cold frontal passages on the Louisiana coastline has been identified using MAMS derived SST and SSC fields. Sediment plume outflows from the Mississippi and Atchafalaya Rivers are deflected in response to the wind direction. Short term repeat coverage indicates a potential for tracking water features to provide estimates of water motion. Embayments show an SST response to the atmospheric conditions.

   o A conference paper entitled "Monitoring of Mississippi Delta Coastal Geomorphology Using High Resolution Multispectral Atmospheric Mapping Sensor (MAMS) Data" was presented at the 5th Australasian Remote Sensing conference. The paper described suspended sediment and SST production using MAMS data. Impact of the March 30 - April 1, 1989 cold front passage was also described.
8. Synoptic Applications

a) Winds Test (Merrill, Menzel, Hayden)

- The manuscript describing the combined CIMSS, SDAB, and SAB ten-day, real time test from 18-27 April 1990 has been reviewed and returned by the Bulletin of the AMS as acceptable contingent upon revisions. The revised manuscript is being prepared in consultation with Wayman Baker of NMC.

- Verification of the April wind sets revealed some problems with the new height assignment software and two cases (April 24 and 25) are being redone. Modifications to the code to allow recomputation of heights are presently being tested.

b) Gulf of Mexico Study (Wade, Hayden, Aune, Rabin, McMurdie)

- An article "The evolution of water vapor and surface wind following a cold frontal passage over the Gulf of Mexico from microwave and VAS satellite imagery" was submitted to the Journal and Weather Forecasting. It highlights the utility of SSM/I measurements of precipitable water, particularly in cloudy areas where VAS retrievals are not possible. Intercomparisons are made between VAS, SSM/I, and rawinsonde estimates of precipitable water.

- Atmospheric water vapor in the layers surface 850 mb and 850-250 mb were compared from the VAS retrievals and rawinsondes. The VAS retrievals have more moisture than the rawinsondes for moist soundings. The upper layer has a larger standard error than the surface 850 layer.

- A 72-hr coarse mesh (190km) forecast has been generated for use as 6 hourly boundary conditions for the March 9-12 GUFMEX case. This cured previous problems with the limited area boundary encountered in the fine mesh (75km) forecasts.

c) VMIS (Hayden, Schreiner, Aune, Paris)

- A paper describing 18 months of VMIS results has been completed and will be submitted in the next quarter.

d) Cloud Motion and Water Vapor Winds (Merrill, Menzel, Velden, Callan)
o The upgraded automatic and manual wind derivation system is being used at the VDUC to supply special data sets in support of the NHC during the hurricane season. Difficulties introduced by the latest upgrade package on VDUC have been mostly resolved.

o Research for an automated editor for the CMW was reopened. Several forms of the editor were applied to a four-day set collected during late August. Results are quite promising. A seminar describing the system was presented on 12 September.

o Consideration is being given to making the WINDCO system independent of currently fixed area dimensions. So far, this massive software task has only been scoped.

e) AVHRR Winds (Herman)

o Additional examples of cloud motion vectors in the Arctic have been prepared. The influence of these vectors on high latitude analysis of the wind field will be presented at the January meeting of the AMS in New Orleans.

f) Data Assimilation (Aune, Diak, Callan, Raymond)

o An IBM Series 6000 RISC computer has been installed and is currently being used to run the CIMSS Sub-Synoptic Model/Data Assimilation System. CPU Performance is approximately five to six times that of the IBM 4381 used previously. Forecast turnaround has gone from one per day (overnight) to as many as 15 forecasts per day (not including overnight batch jobs). Available CPU has gone from 8 Megabytes to 64+ Megabytes (virtual).

o The objective analysis subsystem of the CIMSS Assimilation System is in the process of being installed on the RISC 6000. Data transfer of sounding data is also being developed to permit downloading from the IBM-McIDAS mainframe.

o The Assimilation system is currently being used to assimilate VAS precipitable water retrievals into a numerical simulation of return flow in the Gulf of Mexico.

o An abstract entitled 'Impact of VAS Precipitable Water Retrievals on a Numerical Simulation of Return Flow in the Gulf of Mexico' has been submitted to the Fifth Conference on Meteorology and Oceanography of the Coastal Zone, May 6-10, 1991,
Miami, FL. The same paper will be presented at the Air Mass Modification and Air/Sea Interaction Symposium, Galveston, TX, January 7-9, 1991.

g) VAS Cloud Climatology (Menzel, Wylie)

   o one year of global HIRS data has been processed. Seasonal variation of cirrus is observed over Atlantic and Eastern Pacific Oceans in contrast with constant presence of cirrus over most continents. Further investigations are underway.

h) Data exchange package (Nagle)

   o Expack files have been used successfully in the acquisition of both DMSP and TOVS data for the Tropical Cyclone Motion (TCM) experiment, and for archiving these data. Expack files are further being used in transferring data to and from the RISC in modelling studies.

i) Hurricane track forecasting (Velden)

   o High-density satellite derived wind vectors around this seasons tropical cyclones were routinely produced twice a day by SAB beginning in July. The new procedures implemented this year (automated IR winds with CO2 heights, and a seven-level DLM analysis system) were operating smoothly until an upgrade to the VDUC systems software in mid-September resulted in processing problems.

9. Sensor Calibration

a) GOES I-M Calibration (Menzel, Schmit)

   o VAS radiance biases (with respect forward calculations based on the NMC 12-hour forecast) were tracked for 30 days this spring. General trends have been analyzed.

b) HIRS/HIS Comparison (Woolf, Divakarla)

   o This study was the basis for an MS thesis. The results suggest that further research is needed in some key spectral regions, especially in regard to the operational HIRS fast model. Additional studies are being considered.
II. Other Activities

1. ITOVS (Menzel)

   o Rapporteurs report to the Commission for Basic Systems on Satellite Data Retrieval Techniques was presented in September. Collaboration on ATOVS software, re-investigation of the BUAN data set, and help with WMO training workshops were discussed. ITSC-VI will be held 1-6 May 1991 at Airlie, VA.

2. GOES I/M Instrument Support (Hayden, Schmit, Callan)

   o Software to examine the "science" impact of proposed mirror warping was developed. A routine was written to use a full-resolution VISSR visible image as a basis for applying an algorithm to simulate mirror warping (blur). Automatic winds have been generated for both the VISSR and the blurred cases. Results using the software and information supplied by ITT have been presented to NESDIS management and at meetings at ITT, Fort Wayne, IN.

5. ASOS (Menzel)

   o Efforts have begun to make the ASOS satellite cloud information software more robust, to document it, and to transfer it to VDUC. Completion by next summer is planned.

6. STORM (Hayden)

   o No activity this quarter. A draft of the NOAA mesoscale initiative for FY92 was completed.

7. MODIS-N Team Member (Menzel)

   o MODIS team meeting was attended. Initial NASA funding support has been confirmed for algorithm development for MODIS determination of cloud parameters (effective emissivity, pressure, temperature, particle size) and atmospheric state (stability, total precipitable water, total ozone content) products. A field experiment with a modified MAMS instrument (8.5, 11.2, 13.3 micron channels) is planned for November 1991 to simulate MODIS data.

8. GOES Science Evaluation Working Group (Menzel, Hayden)

   o Efforts continue to find funding for the GSEWG within NWS and NESDIS. Several discussions were held
with Shenk and Anderson regarding post-launch science checkout schedules.

9. McIDAS (Wade)

- Major efforts to improve the SSEC "looper" have continued. These included: workstation upgrade to a PC-tower (from the old "dumb" tower), expansion of loops and graphics on display (full disk to 1 km, over Wisconsin, and hourly surface plots), more automation concerning the entire "looper" display, and connection to the University Broad Band Cable Network.

- In addition to campus wide display of NOAA satellite imagery, the "looper" provides expanded real-time quality control of GOES imagery by the McIDAS operations staff, as well as constant exposure to satellite data by UW Meteorology faculty and students.

10. Navigation (Nagle)

- PC software has been generated for inspecting the degradation of orbital navigation with increasing age of orbital parameters, both for Brouwer/Lyddane and for the harmonic FASNAV technique. The results indicate that both B/L and FASNAV have advantages, but that degradation is somewhat less severe with FASNAV.

11. Continuing Education (Wade, Paris)

- Wade has enrolled in the fall semester UW Meteorology course (606) "Radiation in the Atmosphere" taught by Prof. W. L. Smith and Dr. S. A. Ackerman.

- Paris has begun the core Meteorology program at the UW having successfully met the math prerequisites.
Quarterly Activities Report  
October - December 1990  
Systems Design and Applications Branch

I. Research Progress

2. ERBE/Climate

a) Earth Radiation Budget (Ackerman, Herman, Rabin)
   
   o The collocation of NOAA-9 AVHRR, HIRS/2 and ERBE observations has been completed for two geographic regions (eastern and tropical Pacific Ocean) for four months (Mar, Jun, Sept and Dec). Analysis of the HIRS/2 and ERBE data has demonstrated the effect of clouds, and cloud type, on the spectral re-distribution of radiative energy at the top of the atmosphere. Cloud radiative forcing (clear sky OLR minus observed OLR) is being carried out as a function of cloud type (e.g. cirrus versus stratus).

   o Analysis of the ERBE OLR in conjunction with the surface upward LW flux determined from AVHRR sea surface temperature analysis, demonstrated the effect of atmospheric water vapor on OLR. Optimum channels for determining OLR for different type cloud conditions was demonstrated using stepwise regression between the ERBE OLR and the HIRS/2 observations.

   o Analysis of ERBE data in July 1985 over North America was completed in a study to determine the impact of deep convective clouds on the regional radiative energy budget (top of the atmosphere). A draft paper has been prepared. Comparison of results with data from other summer years (1986-1987) is planned in the near future for inclusion in the paper.

5. Atmospheric Sounding

a) VDUC Retrieval Algorithm (Hayden, Schreiner)
   
   o No changes to the operational retrieval algorithm were made during this quarter. Considerable difficulty was encountered in running the system at the VDUC as system upgrades introduced numerous software incompatibilities.

b) Experimental VAS Algorithms (Hayden)
   
   o A simple model for estimating the hourly change in surface air temperature has been incorporated into the cloud clearing algorithm. This is intended to compensate for the fact that the most recent available surface observations can be as much as an hour old when processing the satellite data.

   o The VAS system has been tested at several times of day and the accuracy of the sfc temperature change model has
been found to be critical near sunrise and sunset. Fine tuning is continuing.

- The two channel vs. three channel skin temperature test used in TOVS processing was added to the VAS algorithm. The tolerances for the VAS version are less strict because of the noisy instrument.

c) PC Software Development (Howell, Woolf)

- The use of scalable vector fonts, for annotation of axes and picture titles, was added to the OS/2 Presentation Manager software being developed for the study of trace-gas constituents as retrieved from HIS/aircraft observations.

- The PC-TOVS demonstration package was revived and revised, eliminating the use of the DOS "RESTORE" command in the installation procedure. A copy of the new package was sent to Professor Harold Yates at the Energy Center of the University of Oklahoma, for use in the classroom.

- Software to perform line-by-line microwave transmittance calculations was ported to the PC for use by W.L. Smith in Germany (see below).

d) High-resolution Interferometer Sounder (HIS) and the Bomem M-120 Interferometer (Howell, Woolf)

- Work continued on the minimum-information algorithm for the retrieval of temperature and moisture profiles from HIS uplooking data.

- A modified version of the HIS minimum information retrieval software, for use with the Bomem M120 data in the new format was completed and partially tested.

- The Bomem M120 will be replaced by a new interferometer. For the next instrument the input to the calibration process will be spectra, instead of interferograms, thus requiring some modifications in the M120 calibration software.

- M120 data for the period of November 1989 through April 1990 was restored from archival tapes in order to compute the mean observed spectrum and the standard deviation of (observed - calculated) spectra. These data were needed to compute coefficients for a statistical regression algorithm designed for the Bomem M120 spectra.

- The processing of M120 data for temperature/moisture retrievals was simplified by combining 482..1407 wavenumbers into a single spectrum (previously two bands) with a spectral interval of 0.4821.
o At the request of W.L. Smith who will be spending 6 months in Darmstadt, FRG, programs were written to compute a HIS radiance spectrum for a specified sounding and to compute an effective radiance, brightness temperature, transmittance profile and weight function for a specified spectral interval in the HIS spectral range and for a simple spectral response function (boxcar, triangle or Gaussian). In support of these programs, another was written to extract a specified profile (RAOB) from H.M. Woolf's collection of 1200 profiles. An option to compute similar quantities for a microwave channel was also included.

e) GOES I/M Algorithm Development (Hayden, Woolf, Schmit)

o The cloud filter for the GOES-I sounder was updated to incorporate the changes made in the research VAS software. Parallel modifications were entered for the derived product imagery algorithm which will use the imager or the sounder.

f) Histogram Retrievals (Nagle)

o The results of investigations with histogram retrievals to date must be accounted disappointing. Although the methodology may merit further development, it cannot be shown that the technique is either faster or more accurate than conventional regression or physical methods. Effort has slackened on this task.

g) Transmittance Models (Woolf)

No activity during this quarter

h) SSM/T (Woolf, Howell)

o The SSM/T preprocessing and temperature-retrieval package, including both "one-dimensional" and "three-dimensional" sounding algorithms, was delivered to NOARL.

7. Mesoscale Applications

a) Sea Surface Temperatures (Wade)

o No activity this quarter.

b) VAS Derived Product Imagery (Hayden, Wade)

o Derived product imagery of surface skin minus surface air temperature is being investigated as a candidate to join the operational lifted index and total precipitable water.
c) MAMS (Moeller, Menzel)

- Study has continued on coastal water response to cold front passages. Winds of the cold front event are affecting nearshore circulations in bays and estuaries. These observations will be correlated to water depth data. Shallow water is demonstrating the largest response to the changing atmospheric conditions of the cold front event. Decreases of 2 - 3 K from pre-frontal to post-frontal mode are seen in shallow bay areas and near shorelines. Deeper open waters show very little response, presumably because of larger heat storage in the vertical column coupled with vertical and horizontal mixing in the water.

- The MAMS instrument flew two missions over the Louisiana coastline in December, 1990. Ground truth data was collected by boat teams from the Coastal Studies Institute at Louisiana State University. Data will be processed for analysis over the next quarter.

8. Synoptic Applications

a) Winds Test (Merrill, Menzel, Hayden)

- The manuscript entitled "A report on the recent demonstration of NOAA's upgraded capability to derive satellite cloud motion winds" was accepted by BAMS for early 1991 publication.

- MSFC is processing winds with their code for two days from the test demonstration of last year (April 24 and 25). Results will be compared to the CO2 winds.

b) Gulf of Mexico Study (Wade, Hayden, Aune, Rabin)

- A 72 hr assimilation/forecast of the 12UT 9 March, 1988 GUFMEX case using the SSM on the RISC 6000 has been completed. RAOB data were inserted every 12 hours. Even though the simulation results were resonable, close inspection revealed the data quality control module failed to eliminate various bad reports. The problem has been corrected and the simulation will be rerun.

- Preparation of a presentation at the Symposium on Air-Sea Interaction and Air Mass Modification (set for 7-9 January 1991 in Galveston, TX) included the creation, archival, and hard copy of various displays (4 or 6 panel) of satellite-derived imagery and/or graphics of accompanying conventional data, for two case study periods (10-12 Mar 1988, and 24 Dec 1989 to 4 Jan 1990).

- The paper: Analysis of Gulf of Mexico Return Flow in the Cool Season Using Satellite Imagery (by Rabin, Mc Murdie, Hayden, and Wade) was an extension of the paper submitted to Weather
& Forecasting (in the previous quarter). The Symposium paper emphasizes our attempt to extract vertical information from the VAS moisture data.

c) VMIS (Hayden, Schreiner, Aune, Paris)

- A paper describing 18 months of VMIS results has been submitted to J. Appl Met.

d) Cloud Motion and Water Vapor Winds (Merrill, Menzel, Velden, Callan)

- The automated editor for the CMW was run on VDUC generated (undedited) data sets during December. Results were generally promising and no computational problems were encountered.

- The automated editor for CMW has been extended to include an option for reassigning pressure height, based on consistency with surrounding vectors and the forecast. The reassignment consistently improves the accuracy, as compared to independent rawinsondes. Plans are to provide the user with original and reassigned pressures, as well as the quality flag produced by the editor.

- The decision has been made to rework the automatic WINDCO system to make it independent of currently fixed area dimensions. The goal of a VDUC delivery is 15 March.

e) AVHRR Winds (Herman)

- Animated imagery of an occluded low in the Gulf of Alaska indicated that the storm center was mislocated in the NMC analysis by approximately 3 degrees. Wind vectors produced from the imagery were not sufficient to reposition the center (using the 3-dimensional objective analysis package), even when the automated vectors were augmented manually. The case exemplifies the difficulty of assimilating single level data.

- In the Arctic a case was found where extraneous motion vectors were produced where no clouds were present. It seems the guess displacement matched the surface ice patterns so the vectors were accepted. In the winter, when anticyclones with few clouds predominate, it may prove to be a common occurrence.

f) Data Assimilation (Aune, Diak, Callan, Raymond, Wipple)

- The data transfer from the McIDAS mainframe to the RISC 6000 (where the GIMSS assimilation model is resident) has been streamlined.

- A procedure was developed to move a series of grids from the RISC 6000 to the STELLAR 2000 for animated display in 3-D format. Simulations of 72 hours and 36 hours have been
successfully made at 2 hour and 1 hour resolutions respectively. A Video recording capability is available for producing VHS recordings of the 4D visualizations.

- The objective analysis subsystem of the CIMSS Assimilation System is still in the process of being installed and tested on the RISC 6000.

- A technique to assimilate precipitable water retrievals from VAS into the CIMSS Sub-Synoptic Model has been implemented and is currently being tested. The technique uses a three dimensional calculus of variations approach to blend the fine horizontal structure of the VAS precipitable water data with the high vertical resolution moisture profile simulated by the model. Verification and subsequent fine tuning of the algorithm are underway.

- An interactive software package to display meteorological fields, cross sections and profiles extracted from model output data has been transferred to the IBM RISC 6000, allowing the simultaneous viewing of model data fields on the RISC while the forecast is executing.

- The Kalman Filter assimilation routine developed earlier on McIdas has now been successfully installed on an IBM 50-Z PC. The current method makes no use of the spatial autocorrelation function, and its inclusion is the next logical step. This is the first known use of a Kalman filter for satellite assimilation on a PC.

g) VAS Cloud Climatology (Menzel, Wylie)

- Intercomparisons with the HIRS cloud statistics generated by the Australian Bureau of Meteorology over the Australian continent are planned. The global HIRS data continues to be processed; almost two years of cloud parameters have been generated. A paper is forthcoming.

h) Hurricane track forecasting (Velden)

- The new procedures implemented this year (automated IR winds with CO2 heights, and a seven-level DLM analysis system) were operating smoothly until an upgrade to the VDUC systems software interrupted processing for two weeks. These problems were corrected and products were delivered routinely to NHC through late November. SAB and NHC were generally satisfied with the newly implemented procedures, and a summary of this years efforts, including a statistical evaluation of the winds, will be presented at the AMS hurricane conference in May in Miami.
9. Sensor Calibration

a) GOES Calibration (Menzel, Schmit)

- Polynomial fits (both 2 and 3 order) of radiances to
temperature using the flight model GOES-I imager IR spectral
response (SR) functions were calculated. Also quantified
the difference if the average channel SR function was used as
opposed to the SR for the individual detectors. The average appears
adequate.

- Preliminary GOES-I (imager and sounder) scaling
parameters (slope and intercept) for the GVAR conversion of
counts to radiances were derived. This includes estimating
the maximum radiances value in each channel. The total radiances
range is fit to be within the total available counts range.

- Error induced when GOES-6 IR window calibration
coefficients are used for GOES-7 (as has happened to some
users) was estimated for the direct count to brightness temperature
conversion. Differences ranged from 0.15 to 0.3 degrees,
depending on scene temperature (335 to 210 K).

II. Other Activities

1. ITOVS (Menzel, Woolf, Achtor)

- Organization of the next ITOVS meeting on 1-6 May
1991 at Airlie, VA has proceeded. Prospective attendees should
check with P. Menzel regarding details. Collaboration on ATOVS
software, re-investigation of the BUAN data set, and help
with WMO training workshops will be on the agenda.

- The ITTP has been provided to Hughes Aircraft and
TRW Systems for use in EOSDIS prototyping and benchmarking.

2. GOES I/M Instrument Support (Hayden, Schmit, Callan)

- Software to examine the "science" impact of proposed
waivers from Loral/ITT was expanded to investigate a number
of problems and examples of products were provided to NESDIS
management.

- To date, the only pending waiver expected to
seriously affect GOES-I products is the noise in Imager channel 5.

5. ASOS (Menzel)

- Efforts continue to make the ASOS satellite cloud
information software more robust, to document it, and to
transfer it to VDUC. Completion by next summer is planned.
6. STORM (Hayden)

   o The science specifications for Winter STORM were reworked in a meeting at UW in December.

7. MODIS-N Team Member (Menzel)

   o NASA funding support has been secured for algorithm development for MODIS determination of cloud parameters (effective emissivity, pressure, temperature, particle size) and atmospheric state (stability, total precipitable water, total ozone content) products. A field experiment with a modified Wildfire instrument (with 11.2, 13.3, and 13.7 micron channels) is planned for November 1991 to simulate MODIS data.

8. GOES Science Evaluation Working Group (Menzel, Hayden)

   o Nothing new, although concerns linger about product evolution from day 1 to day 2 form.

9. McIDAS (Wade)

   o The SSEC "looper" has become well established, and only a few new displays were added (such as some surface analyses overlaid on US (4 km) IR imagery three times a day, and incorporation of a larger scale (16 km) VAS water vapor loop over the northern hemisphere for monitoring of incoming winter storms).

10. Continuing Education (Wade, Paris)

    o Wade completed the fall semester UW Meteorology course (606) "Radiation in the Atmosphere" taught by Prof. W. L. Smith and Dr. S. A. Ackerman.

    o Paris completed Meteorology 321, the first core course offered by the department.

11. Other (Wade, Hayden)

    o Several full res GOES visible images from mid-October over White Sands were sent to R. Gallimore at GSFC for some instrument calibration work there.

    o Two data sets of conventional surface and upper air (from the McIDAS real-time archive) were prepared and sent to M. Mogil (NESDIS/TISB). One set covered several dates, for use in the COMET program; the second, 18 Oct 1990, for use with a PSB study.

    o T. Inoue (Japan) visited CIMSS in mid-November and worked with VAS "split window" data.
Hayden presented a paper "Operational Sounding Products from the GOES: Climate Applications" at the OPSAT Conference in D.C., 16 October; and a paper "Humidity Sounding from GOES-I/M" at the GEWEX Workshop in Greenbelt MD on 25 October.

P. Menzel spent the fourth quarter in Perth, Australia as the Haydn Williams Fellow to Curtin University. During his stay he assisted with the formation of an Earth System Science and Applications Centre in Perth, to be supported by the Australian government. Research on clouds and rainfall was also pursued. Additionally, he taught a course in Applications in Satellite Meteorology to twenty students (five were from the Perth forecast office) at Curtin University.

P. Menzel attended the Fifth Australasian Remote Sensing Conference during the week of 8-12 October 1990, where he presented two papers: the first on "NOAA's satellite programs for the 1990's and beyond" and the second was an invited paper on "Investigating the Earth and atmosphere with the NOAA operational satellites". On 5 November 1990, he delivered the Haydn Williams Public Lecture on "Environmental change in Western Australia - a remote sensing perspective" The trends of the past 30 years were summarized in the context of global warming and remote sensing data over WA from the NOAA AVHRR, TOVS, and Landsat were presented. Examples included vegetation monitoring, land salinity detection, Leeuwin current correlations with ENSO, microwave estimation of tropical cyclone strength, cataloging cloud cover, locating volcanic ash, and tracking stratospheric ozone variations.