UPDATES ON OPERATIONAL PROCESSING FOR NOAA/NESDIS SOUNDING DATA PRODUCTS AND SERVICES

A.K. Sharma (Office Satellite Data and Products Distribution) … OSDPD
Tony Reale (Center for Satellite Applications and Research) … STAR
NOAA/NESDIS Operation Updates

POES Missions and Schedule (ATOVS… METOP … NPOESS)

Road Map for Atmospheric Soundings from IR and MW Sounders

Products Processing Update

Processing Changes

Systems Changes

Instruments Changes

ATOVS Soundings System Changes

Summary
**POES Satellite Launches* Schedules (Calendar Year)**

* Actual launch dates are determined by the failure of on-orbit assets

** Assumes METOP will provide the morning orbit and NOAA-N’ will provide afternoon orbit instruments
Upcoming Launches

- **Metop**
  - Readiness Date: October, 2006
  - Launch Date: Possible Oct 17, 2006
  - Operational Data Distribution – Launch + 90 days

- **NPP Launch Date: 2009**

- **NOAA-N’ Launch Date: March 2008**

- **NPOESS Launch: 2012**

- **Second Metop Launch Date: August 2010**
ATOVS NOAA-15, 16 and 18 systems moved from IBM Mainframe (MVS Operating System) to IBM P570 (Unix System)

ATOVS Metop system is being developed on IBM P570 Unix System… similar to NPOESS
IJPS, IPS
Products Overview

• Level 1 Products Created at NOAA
  – AVHRR
  – AMSU-A
  – HIRS
  – MHS
  – SBUV
  – SEM
  – [A]DCS
  – SAR

• Level 1 Products Obtained from Eumetsat
  – ASCAT
  – IASI
  – GOME
  – GRAS
CrIS/ATMS/VIIRS Product System is part of the NESDIS Advanced Product Roadmap

GOAL:
Integrated hyper-spectral products for improved assessments, understanding and prediction of key climate and weather parameters.

- Migrate AIRS/IASI algorithm to NPP
- Develop NPOESS and GOES-R approaches
- Test concepts with real CrIS/VIIRS radiances
- Install/Evaluate Aerosol Correction and/or Products
- Produce Trace Gas Products routinely (CO, CH4, CO2, HNO3)
- Test concepts with real IASI radiances on METOP-1

System for merging Aqua, METOP, NPP, and NPOESS soundings products
- Temperature, moisture, and trace gas product algorithms for GOES-R (HES & ABI)
- Temperature, moisture, and trace gas product algorithms for Aqua, METOP, NPP, NPOESS advanced IR sounders
- Merged AIRS/MODIS temperature and moisture soundings
- Optimized retrieval algorithm validated with AIRS radiances
Instruments on Metop Used for Soundings

- **AMSU-A**: The Advanced Microwave Sounding Unit A1 and A2
  - Microwave sounder with 15 channels in the spectral range of 23 to 89 GHz.

- **MHS**: The Microwave Humidity Sounder
  - Microwave sounder with 5 channels from 89.0 GHz to 190.3 GHz.

- **HIRS/4**: High Resolution Infrared Radiation Sounder/4
  - 19 infrared channel (3.8 – 15 microns) and one visible channel.

- **AVHRR/3**: Advanced Very High Resolution Radiometer/3
  - 6-channel 1 km visible/IR (0.6-12 microns) imager
Infrared Atmospheric Sounding Interferometer (IASI)

- Fourier Transform Spectrometer based upon a Michelson Interferometer (8461 channels)
  - Highly accurate atmospheric temperature and moisture data
- NESDIS products will include thinned radiances, principal component scores, cloud cleared radiances, carbon products, temperature, moisture, ozone profiles

**Cloud Cleared Radiances**

Typically, less than 5% of a sensor’s Field of View’s (13.5 km) are clear.

Cloud Clearing can increase yield to 50-80%.

*(Thomas King  talk 12.3)*
• The IASI HIRS-like OLR Products would preserve the continuation of the HIRS OLR climate data record from future satellite instruments.

• The improved HIRS OLR will be the longest and continuous high quality satellite OLR product that has climate data record quality and would greatly complement the discontinuous broadband measurements.

• Improved and enhanced the capability in climate monitoring and climate analysis, especially through the implementation of the inter-satellite calibration and diurnal cycle adjustments.

• Improved quantitative accuracy and long-term stability in the Infrared Sounder OLR data record, which enables more accurate description and diagnostic studies of global climate.

• Data consistency can be preserved when AVHRR OLR is less likely available during NPOESS era.

• Data will be made available in December 2008
METOP Pipeline Processing

- Pipeline processing: all data received ~120 minutes after observation
  - Applications with timeliness requirements will process in pipeline mode
- Orbital files generated ~210 minutes after observation

Data age will be ~120 minutes for all granules
NOAA-18 Updates

• MHS has shown improvement over AMSU-B
• N18 HIRS very unstable
• N18 HIRS is Frequently un useable
• HIRS-based operational products are not operationally produced.
• Improved timeliness for NOAA-18 blind orbits.
ATOVS Surface / Sounding Products
(Fuzhong Weng, Tony Reale, Mitch Goldberg)

- **Incorporate MHS**

- Regression Guess replaces Library Search
  - Calculate First Guess Radiance (CRTM)

- **Integrate Microwave Integrated Retrieval System (MIRS) Products**
  - TPW, CLW, Emissivity … (Sid Boukabara talk 11.6)

- Measurement (Radiance) Bias Adjustment
  - AMSU-A
  - MHS
  - HIRS

- **Integrate MIRS Retrieval Solution (CRTM) per sounding**
  - (Paul Van Delst, Fuzhong Weng, Yong Han)
  - based on Guess Temp and Moisture

- **Baseline for NPOESS (… AIRS and IASI )**

- Peripheral Upgrades
  - Limb-adjustment
  - Complete NWP Profile (Srfc data, +/- 90 minutes, 3hr fcst …)
Operational Product Environment to Provide Integrated Validation Datasets and Analysis
Integrated Operational Product Data Validation
(NPOESS IPO Award)

Collocation Database referenced to Operational Polar satellite...

SEARCH / GCC
TOYS / ATOVS
and
Raob ... 1979 ...
(relational)

METOP + IASI

ATOVS

ATOVS w / MIR

other GOES

NASA EOS
Aqua-AIRS

COSMIC

CLOUDSAT

Integrated
Cal / Val
(Weng, Cao...)

EDGE

web

SNO

WG Satellite Sounding Science and Products
(SSSP)

USERS

NPOESS

NOAA
GOES

GOES-R

RAOB

In-situ

Research

NWP

Reference network
NPOESS Mission

• Provide a national, operational, polar-orbiting remote sensing capability

A Tri-agency Effort to Leverage and Combine Environmental Satellite Activities

* Patent Pending
Open Issues

User receipt of IJPS products Granule vs Orbital

Shared Processing requirements

Dissemination of products generated in pipeline mode

Orbital to Granule Processing

Granule Size, Granule Naming convention, Missing Granules, Multiple Strings for operational and backlog processing, Granule Reprocessing, and Data Transmission Problems.
Summary

• POES timelines … ATOVS, DMSP, (AIRS), METOP, NPP, NPOESS

• Advanced Product Processing Roadmap (AIRS, IASI, Cris)

• NOAA will produce IASI-based Level-1 and Level-2 Products … Distribution?... RARS

• ATOVS Operational Product Upgrades (w/ MIRS) and Integrated Product Validation

• Integrated NPOESS products for improved assessment, understanding and prediction of key weather and climate parameters
Extras
IASI Product System

IT System Architecture

NCEP forecasts, and radiosonde data

Input Data Includes: **NCEP forecasts, and radiosonde data**
<table>
<thead>
<tr>
<th>Satellite Source(s)</th>
<th>Current Capabilities</th>
<th>Requested Capabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIRS (pseudo operational)</td>
<td>IASI</td>
<td>IASI</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Product Name</th>
<th>AIRS Principal Components</th>
<th>IASI Principal Components</th>
<th>IASI Cloud Cleared Radiances</th>
<th>IASI Cloud Cleared PCA</th>
<th>IASI-ozone</th>
<th>IASI CO, CH4, CO2</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Accuracy</th>
<th>n/a</th>
<th>n/a</th>
<th>≤ 1 K</th>
<th>n/a</th>
<th>20%/5-km near tropopause</th>
<th>CO: 40% mid-trop column (w/ 0.2 cm OPD SW band)</th>
<th>CH4: 1% mid-trop column</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Latency</th>
<th>5 minutes after granule data is available</th>
<th>5 minutes after granule data is available</th>
<th>15 minutes after granule data is available</th>
<th>20 minutes after granule data is available</th>
<th>10% total column</th>
<th>CH4: 1% mid-trop column</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Timeliness</th>
<th>3 hours</th>
<th>≤ 3 hours</th>
<th>≤ 3 hours</th>
<th>≤ 3 hours</th>
<th>15 minutes after granule data is available</th>
<th>CO2: 1% mid-trop column</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Coverage</th>
<th>Global</th>
<th>Global</th>
<th>Global – scenes which satisfy cloud clearing assumptions</th>
<th>Global – scenes which satisfy cloud clearing assumptions</th>
<th>≤ 3 hours</th>
<th>15 minutes after granule data is available</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Horiz Resolution</th>
<th>Every 5th AIRS FOV</th>
<th>Per IASI FOR</th>
<th>50 km (One IASI FOV collocated with AMSU FOV)</th>
<th>50 km (One IASI FOV collocated with AMSU FOV)</th>
<th>Global – scenes which satisfy cloud clearing assumptions</th>
<th>≤ 3 hours</th>
</tr>
</thead>
</table>

| Other attributes | 2378 channels represented within 85 PC’s | Compresses 8461 channels into N PC’s. N needs to be determined, but it should be approximately 85 values | Optional QA w/ AVHRR clear masked pixels | 50 km (One IASI FOV collocated with AMSU FOV) | Global – scenes which satisfy cloud clearing assumptions |
ATOVS System-200X

- Online and Offline Systems
  - Incorporate AMSU-B
  - Regression Guess replaces Library Search
  - Calculate First Guess Radiance (OPTRAN)
  - Measurement (Radiance) Bias Adjustment
  - “Unique” Retrieval Solution (OPTRAN)
  - Facilitate Channel Swapping
Regression Coefficients for First Guess Temperature and Moisture using AMSU-A/B
Retrievals Based on Channel Combinations, Predictors (ie, surface emissivity…)
Extended Validation …
   Radiance statistics … including vs NWP
   Product Grids
   Instrument Health
Regression Coefficients for Radiance Bias Adjustment of AMSU-A, AMSU-B, and HIRS
MDB… First Guess and Bias Regressions
Radiance … Gridding
Limb Adjustments
Procured three sets of hardware (three IBM power 5 racks P570 with 16 CPUs in each).

3 TB of disk space for each machine (Operations, Test/Backup, and Development) on the SAN.

STAR is using one machine for development.

The other two will be used by OSDPD for operations and a test/backup.
• New Preprocessor
  – IBM RS/6000 (development) and P570 (operations) AIX platform for parallel processing
  – New Server for Data Distribution (DDS)
  – Processing based on Data Driven Scheduler (OPUS)
  – Processing on a distributed (scalable processor) UNIX platform for parallel operations
  – Preprocessing of blind orbit GAC in pipeline mode
  – Producing common instrument Level 1b’s from Metop in pipeline mode
  – Producing new Level 1b’s for MHS and Full Resolution GAC (FRAC)
IJPS, IPS
Overview of Upgrades for Metop

• New Ingestor and Front End Processor (FEP)
  – Ingest of common instrument data, from the GDS as CCSDS VCDUs, in pipeline mode
  – Frame synchronizing and filtering of GDS data at Ingest
  – Receipt and distribution of ASCAT, GOME and GRAS Level 1b and IASI Level 1c products
  – Ingest blind orbit GAC, in pipeline mode
  – Produce instrument (NOAA) Level 1a’s (i.e., for POES data - decommutate the TDM stream)
**Metop Data Storage Requirements**

**Unique EUMETSAT Level 1**

<table>
<thead>
<tr>
<th>File</th>
<th>Size (bytes)</th>
<th>Bytes/Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASCAT 1b</td>
<td>25,060,966</td>
<td>353,359,626</td>
</tr>
<tr>
<td>IASI 1c</td>
<td>2,083,059,139</td>
<td>29,371,133,854</td>
</tr>
<tr>
<td>GOME 1b</td>
<td>582,892,913</td>
<td>8,218,790,068</td>
</tr>
<tr>
<td>GRAS 1b</td>
<td>188,743,680</td>
<td>2,661,285,888</td>
</tr>
</tbody>
</table>

**TOTAL:**

|              | 2,879,756,698 | 40,604,569,436  |

File size and "Bytes/Day" are based on a 102-minute orbit and 14.1 orbits per day.
# NPP RDR Sizing Estimates

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Granule Size (MB)</th>
<th>Granule Size with HDF5 (MB)</th>
<th>Total Size per Orbit (GB)</th>
<th>Total Size per Day (GB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIIRS</td>
<td>38.52</td>
<td>46.22</td>
<td>9.61</td>
<td>136.33</td>
</tr>
<tr>
<td>CrIS</td>
<td>2.66</td>
<td>3.19</td>
<td>2.37</td>
<td>33.62</td>
</tr>
<tr>
<td>ATMS</td>
<td>0.19</td>
<td>0.23</td>
<td>0.17</td>
<td>2.40</td>
</tr>
<tr>
<td>OMPS</td>
<td>1.26</td>
<td>1.51</td>
<td>0.24</td>
<td>3.34</td>
</tr>
</tbody>
</table>

- Numbers are based upon the IDPS Sizing models

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Granules per Orbit</th>
<th>Granule Length (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CrIS/ATMS</td>
<td>761</td>
<td>8</td>
</tr>
<tr>
<td>VIIRS</td>
<td>213</td>
<td>28.58</td>
</tr>
<tr>
<td>OMPS</td>
<td>160</td>
<td>38</td>
</tr>
</tbody>
</table>
Update Product Applications for Pipeline Processing

- Atmospheric Soundings, Real-time Ozone, Hazards, Microwave Surface and Precipitation, CLAVR Cloud Flags
- Applications that plan to use 1-km AVHRR data from Metop are CLAVR cloud flags, Aerosol, Imagery, CoastWatch, Radiation Budget, Sea Surface Temperature, Vegetation, Hazards, Snow/Ice & Significant Event Imagery
- Level 1 Metop Unique Products (IASI, ASCAT, GOME, and GRAS) EUMETSAT will process this data via pipeline mode and transmit 3-minute files as the data becomes available. These data are pushed to NOAA from EUMETSAT through the NOAA Gateway (NRT) in Darmstadt. The NRT will send the Level 1 Metop Unique Products (3-min. files) via FTP protocol to the GFT, which in turn will ship the data to the AIX for processing.
Porting ATOVS from IBM Mainframe to IBM Unix Platform

- Old IBM Mainframe (Amdahl) MVS Operating System
- New IBM P570 (2 nodes) Unix Operating System
  
  Diamond is Operational Production System

Emerald is a test and back system

OPUS Data Driven Scheduler

DDS Data Distribution System

- ATOVS systems running for NOAA Satellites (N15, 16, and 18) and will be extended for EUMETSAT (Metop-2)

- AMSU-B Standalone System is terminated
International TOVS Study Conference, 15th, ITSC-15, Maratea, Italy, 4-10 October 2006
Madison, WI, University of Wisconsin-Madison, Space Science and Engineering Center,