Development of the NOAA/NESDIS IASI Product Processing System

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Outline

- Objectives
- Incoming Data for Operations
- System Design and Processing
- Products and Distribution
- Summary
Objectives

- Provide in near real-time the following products to NWP centers in the US
  - Subset IASI level 1C radiances
  - Reconstructed IASI radiances
  - IASI Principal components
  - Cloud cleared IASI radiances
  - Trace gas profiles

- Build an IASI product processing system

- Simulate IASI, AMSU-A, and MHS data to test the product processing system ingestion, product generation, and distribution

- Use the AIRS/AQUA product processing and simulation system as a basis for IASI
Incoming Data for IASI Operations

- IASI Level 1C (EUMETSAT)
- AMSU-A Level 1B (NOAA)
- MHS Level 1B (NOAA)
- AVHRR Level 1B (NOAA)
Data from EUMETSAT

- EUMETSAT PFS files (~60 MB/granule)
- Granules 176 seconds in length
- 22 scans per granule (1 scan/data record)
- 4 IASI FOVs within a field of regard (FOR)
  » 8700 IR channels with two guard bands around the standard 8461 channel set
  » Scan geometry
  » QC flags
  » Calibrated IASI image on the IASI FOR
- → Total of 29 GB/day …..this is why we subset!
Data from NOAA

- **AMSU-A**
  - Level 1B orbital files
  - 15 microwave channels

- **MHS**
  - Level 1B orbital files
  - 5 microwave channels

- **AVHRR**
  - Level 1B orbital files
  - 1 km global coverage
  - 5 channels (IR and visible)
    - 6 frequencies, 5 transmitted channels
  - CLAVR cloud mask
The IASI Field of Regard

- IASI FOV
- AMSU FOV
- MHS FOV

Dimensions at nadir
System Hardware

- IBM Power 5
  - 16 CPUs
  - 2 GB memory/CPU (P5-570s)
  - 8 GB of swap space
  - 3 TB disk space

- 3 of these systems in total:
  - Production machine
  - Backup production/test machine
  - Development machine
Production System Design

EUMETSAT

Simulation System

Used also in monitoring and validation

EPSC
- AMSU-A L1B
- MHS L1B
- IASI L1C
- AVHRR L1B

Granulator

NetCDF
- L2 NOAA Unique
- L2 ancillary
- IASI/AVHRR NOAA Unique

Reformat
- NU BUFR
- L1C BUFR
- L2 NOAA

NetCDF

DDS
IASI Level 1C Processing

NetCDF subset parameters

ncgen

IASI L1C RR

IASI L1C Rad.

Subsetter

NetCDF to BUFR

IASI L1C

DDS

Monitoring
IASI L2 NOAA Unique Processing

- MHS L1B
- AMSU-A L1B
- IASI L1C
- Orbits to granules
- L2 preprocessor
- L2 BUFR
- NetCDF to BUFR
- CCR BUFR
- DDS
- L2
- CCR
- Retrieval to NetCDF
- CCR
- Retrieval
- NetCDF
- Surf press
- IASI L1C
IASI/AVHRR NOAA
Unique Processing

- IASI L1C
- AVHRR L1B

Orbits to granules

AVHRR L1B → Collocation

AVHRR Statistics

Matchup binary

Clear/Cloudy AVHRR on IASI FOVs

IASI L1C BUFR

AVHRR L1B BUFR

NetCDF IASI L1C

Subset AVHRR L1B

 Subsetter

DDS

orbits

Clearest FOV
Subsetting

- Spectral Subsets
  » Chosen using information content studies
  » Extract a set of channels of the original 8461 set
  » Collapse the 8461 channels into a set of principal components

- Spatial Subsets
  » Select specified FOVs from the granule
  » Spatial thinning scheme
  » Clearest or warmest FOV

- The subsetting system uses CDL templates containing all the subset parameters. Modification of a template allows us to quickly change or generate new subsets.
Output File Formats

- **BUFR**
  - The standard format for NWP centers
  - Worked with EUMETSAT and NCEP on tables
  - Level 1C table is complete; the Level 2 table is in progress
  - Simulated near real time IASI BUFR files are currently available to the following NWP centers for evaluation:
    - EUMETSAT, NCEP, GMAO, UK-Met, ECMWF, Meteo-France, CMC (Canada), JMA (Japan), NRL

- **NetCDF**
  - Intermediate internal format that may be distributed to users

- **Binary**
  - An internal final format for validation and monitoring
  - Format is compact and I/O is simple
  - No toolkits or APIs are necessary, just a reader and a writer are required
<table>
<thead>
<tr>
<th>Instrument</th>
<th>Channels</th>
<th>Data Type</th>
<th>IASI FORs</th>
<th>IASI FOV #</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>IASI</td>
<td>*616</td>
<td>RAD</td>
<td>Every other FOR (330/granule)</td>
<td>1st</td>
<td>BUFR NetCDF</td>
</tr>
<tr>
<td>IASI</td>
<td>8461</td>
<td>RAD</td>
<td>All FORs (660/granule)</td>
<td>1 (warmest)</td>
<td>BUFR NetCDF</td>
</tr>
<tr>
<td>IASI</td>
<td>8461</td>
<td>RAD</td>
<td>All FORs (660/granule)</td>
<td>1,2,3,4</td>
<td>BUFR NetCDF</td>
</tr>
<tr>
<td>IASI</td>
<td>*616</td>
<td>RR (from 200 PCS, 1 band)</td>
<td>Every other FOR (330/granule)</td>
<td>1st</td>
<td>BUFR NetCDF</td>
</tr>
<tr>
<td>IASI</td>
<td>*616</td>
<td>RR (from 200 PCS, 1 band)</td>
<td>All FORs (660/granule)</td>
<td>1,2,3,4</td>
<td>BUFR NetCDF</td>
</tr>
<tr>
<td>IASI (using AVHRR)</td>
<td>8461</td>
<td>CCR</td>
<td>All FORs (660/granule)</td>
<td>1 (warmest or clearest)</td>
<td>BUFR NetCDF</td>
</tr>
<tr>
<td>AVHRR (on IASI FOVs)</td>
<td>5</td>
<td>RAD (clear and cloudy)</td>
<td>All FORs (660/granule)</td>
<td>1,2,3,4</td>
<td>BUFR NetCDF</td>
</tr>
<tr>
<td>IASI</td>
<td>8461</td>
<td>CCR from retrieval</td>
<td>All FORs (660/granule)</td>
<td>1,2,3,4</td>
<td>BUFR NetCDF</td>
</tr>
<tr>
<td>IASI</td>
<td>100 levels</td>
<td>L2 (CO₂, O₃, CH₄, CO)</td>
<td>All FORs (660/granule)</td>
<td>NA</td>
<td>BUFR NetCDF</td>
</tr>
</tbody>
</table>

PCS - Principal Components; RAD - Radiance; RR - Reconstructed Radiance; CCR – Cloud cleared radiance; FOR - Field of Regard; * 616 channel set determined through a NOAA/ECMWF collaborative effort.
Products for Validation/Monitoring

- **Daily Matchups**
  - Radiosondes
  - ATOVS
  - Available for Level 1C and Level 2 data

- **Daily Global Grids for Validation**
  - Gridded data from the IASI level 1C and Level 2 data
  - Gridded forecast (GFS and GDAS) data

- **Daily Global Binaries for Monitoring**
  - Eigenvector generation
  - Monitoring

- **Granule-Level Binaries for Near Real Time Monitoring**
  - Level 1C FOV spectra
  - Level 2 profiles
  - Granule images
The NOAA/NESDIS/ESPC DDS server will be the staging location for product distribution.

Processing scripts and code can only copy (scp/ftp) data to this distribution server. They won’t actually be sending data directly to users.

Therefore, a separate set of scripts, managed by NOAA/NESDIS/ESPC, will handle the distribution server file management and the “pushes” of products to the various users. Or users may “pull” the data from the server.

For DDS access, users will need to contact A.K. Sharma to obtain accounts (Awdhesh.Sharma@noaa.gov).
Current Distribution List

• NCEP
  » Subset level IASI 1C radiances (BUFR)
  » Subset IASI principal components (BUFR)
  » Subset IASI reconstructed radiances (BUFR)
  » Clearest/Warmest IASI FOVs from each field of regard (BUFR)
  » IASI NOAA Unique products (BUFR)

• GMAO
  » Subset IASI level 1C radiances (BUFR)
  » Subset IASI principal components (BUFR)
  » Subset IASI reconstructed radiances (BUFR)
  » Clearest/Warmest IASI FOVs from each field of regard (BUFR)
  » IASI NOAA Unique products (BUFR)
• AFWA
  » A requested products list has been received and a distribution agreement is in progress.

• NRL
  » Product list is yet to be determined

• NESDIS/STAR
  » All level 1C and level 2 NOAA Unique products (BUFR, netCDF)
  » Global grids (binary)
  » Global binaries (binary)
  » Matchups (binary)
  » Forecast global grids (binary)

• NESDIS/NCDC/CLASS
  » Level 1C EPS EUMETSAT and metadata
  » 3 deg latitude x 3 deg longitude global grids and metadata
  » IASI NOAA Unique (L2 and CCR) products and metadata
A simulation system is currently running continuously simulating IASI/AMSU/MHS data.

Status of product IASI product processing system:
» All hardware has been acquired.
» All high level scripts are ready for handling real data.
» IASI L1C subset, RR, PCS code is done.
» IASI L2 NOAA unique product (profiles and CCR) code is done.
» IASI/AVHRR NOAA code currently in development.

All validation products listed are being generated from these simulated data.

These data are available on the AIRS data server in BUFR format (since 10/25/2005).

After launch, these products will be distributed operationally to the NWP centers through the ESPC DDS.
International TOVS Study Conference, 15th, ITSC-15, Maratea, Italy, 4-10 October 2006
Madison, WI, University of Wisconsin-Madison, Space Science and Engineering Center,