



Preparation for the Distribution of IASI Radiances to NCEP and GMAO

W. Wolf¹, T. King¹, Z. Cheng¹, L. Zhou¹, H. Sun¹,
W. Zhou¹, P. Keehn¹, M. Goldberg²,
J. Woollen³, and C. Barnet²

¹QSS Group Inc, Lanham, MD, USA

²NOAA-/NESDIS/STAR, Camp Springs, MD, USA

³NOAA-/NWS/NCEP, Camp Springs, MD, USA



Outline

- Overview
- Background
- IASI Simulations
- IASI Subsetting and Distribution
- PCA using IASI Data
- Summary



Overview

- Provide calibrated and navigated IASI radiances, reconstructed radiances, principal components, and cloud cleared radiances to NCEP, GMAO, AFWA, and NRL for assimilation within three hours of observation.



Background

- IASI subsetting and distribution system is based off the AIRS processing and distribution system.
- AIRS Near Real-Time System has been operational for three and a half years.

AIRS Near Real-Time System



- Distributes over 95% of the near real-time AIRS data to the NWP centers within three hours of observation.
- Subset AIRS datasets and distribute in BUFR format.
- The AIRS data are used operationally at NCEP, ECMWF and the Met Office.



Preparation for IASI: Simulation System

Purpose of the Simulation System



- To provide a robust data distribution environment for development and testing of the IASI data sub-setting system.
- Allow for a smooth transition of the IASI data processing system from the development environment to the operational environment, during both the integration and test phases of the transition.

IASI Simulation System



- The IASI simulation system emulates the instrumental and orbital characteristics of the IASI instrument on MetOp-1 platform and produces 1.3 million spectra/day.
- The microwave brightness temperature at the IASI observation point are also simulated.

Simulation System Characteristics



- Orbit simulation
 - » MetOp ephemeris data.
- Field of View simulation
 - » All sensor pointing and FOV geo-location.
- Surface properties simulation
 - » The surface radiative properties.
- Atmosphere simulation
 - » Atmospheric profiles.
- Forward model (radiative transfer model)
 - » Simulated observation radiance/brightness temperatures.



Simulation Output

- The output of the simulation system is the IASI Level 1C data in the current EUMETSAT format.
- Simulated IASI granule data is produced every 176 seconds.
- AMSU and MHS data in the current OSDPD Level 1B format.



IASI Level 1C Files

- The subsetting system produces files that are in BUFR format.
- Format was created by Simon Elliot at EUMETSAT.
- Collaboration between NWP centers and EUMETSAT for agreement upon one IASI L1C BUFR format.



Preparation for IASI: Subsetting and Distribution

Incoming Data for IASI Operations



- IASI Level 1C Granule Data (EUMETSAT)
- AVHRR Level 1B Orbital Data (NOAA)
- AMSU and MHS Level 1B Orbital Data (NOAA)

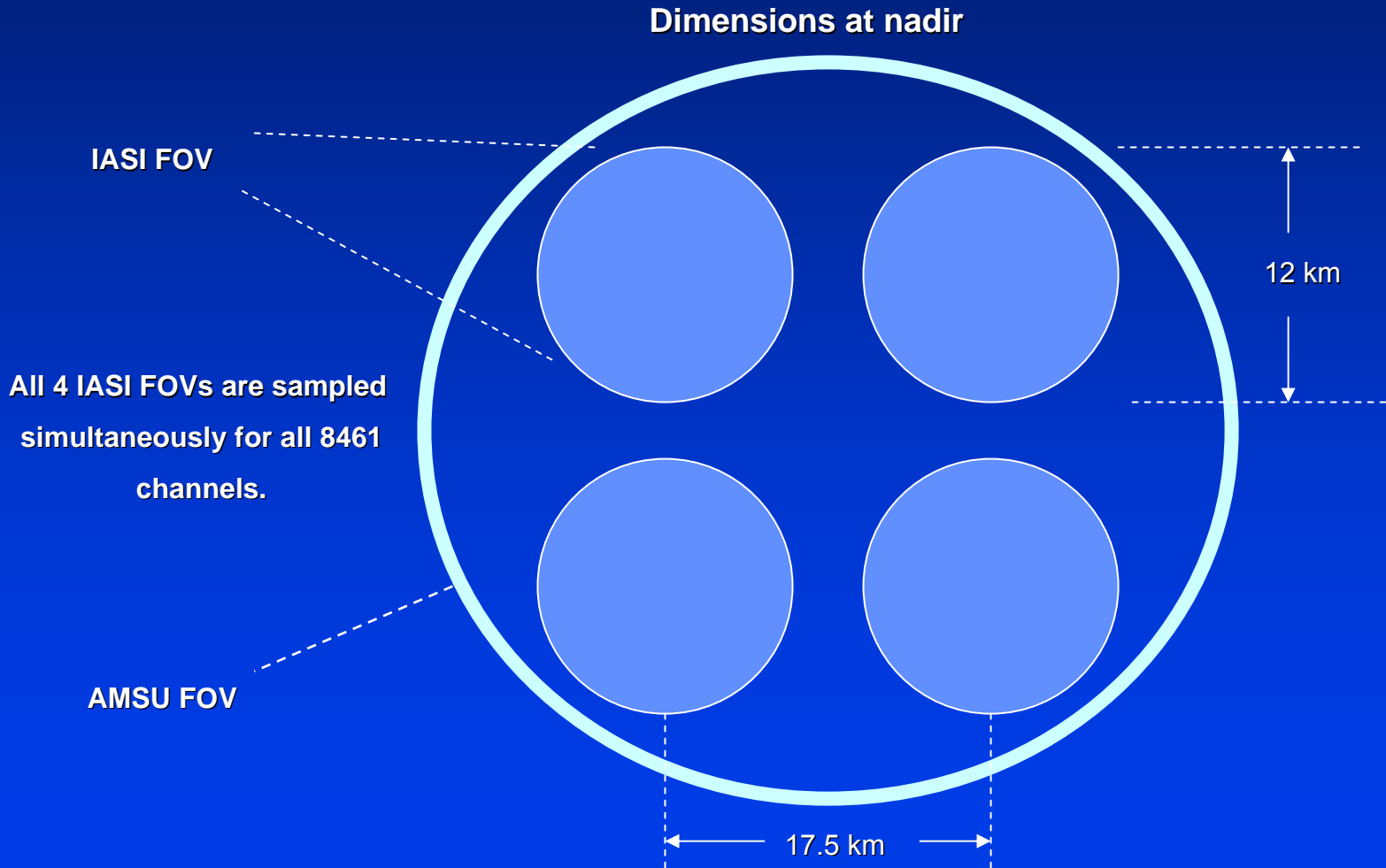


IASI Level 1C Data

- Binary files (~60 MB/granule)
- Granules 176 seconds in length (491 granules/day)
- 22 scans per granule (1 scan/data record)
- 120 IASI FOVs per scan
- 4 IASI FOVs within an AMSU FOV (IASI FOR)
 - » 8700 IR channels with two guard bands around the standard 8461 channel set
 - » Scan geometry
 - » QC flags
 - » IASI image on the IASI FOR
- → Total of 29 GB/daythis is why we subset!



The IASI Field of Regard



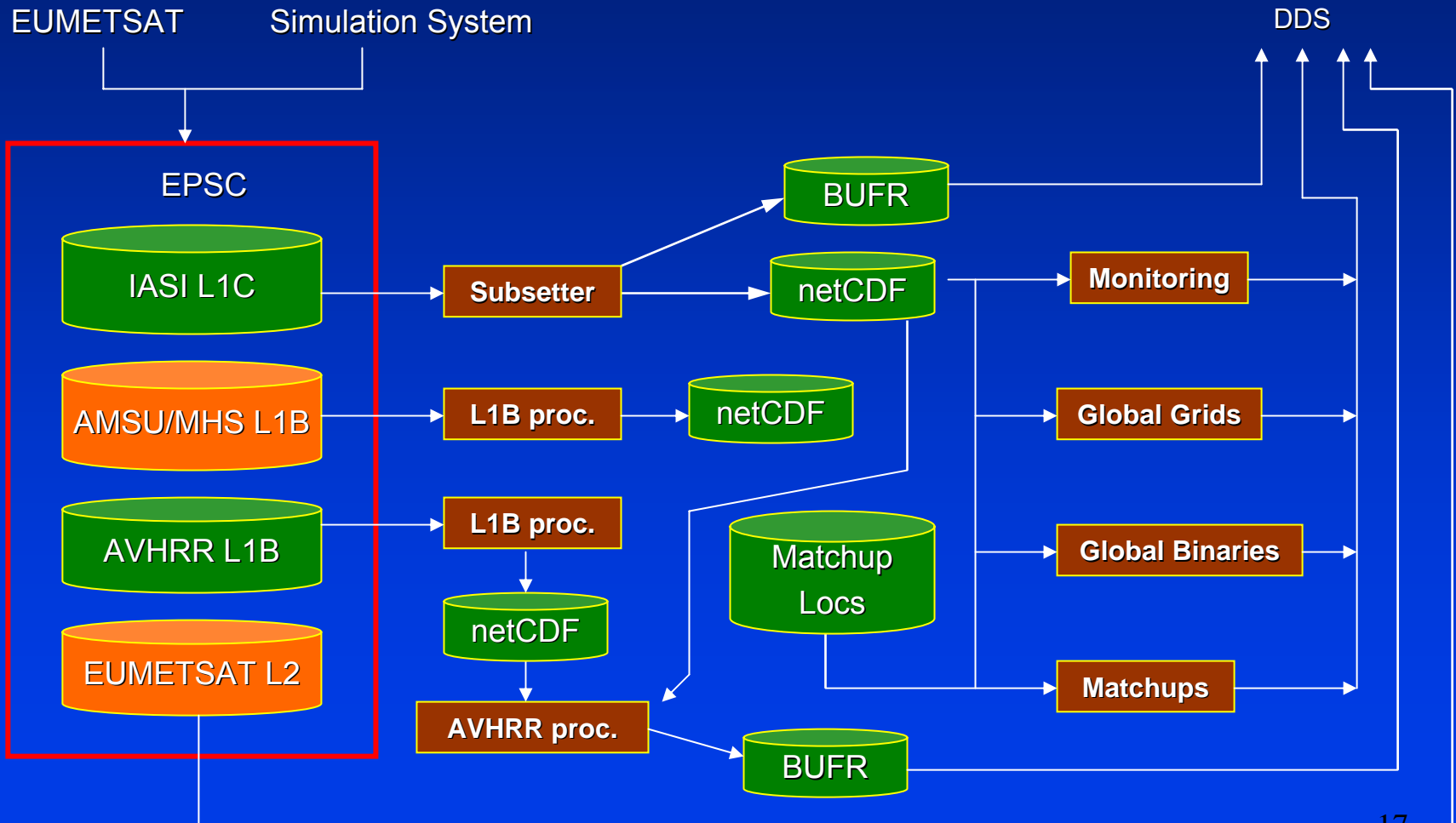


AVHRR Level 1B Data

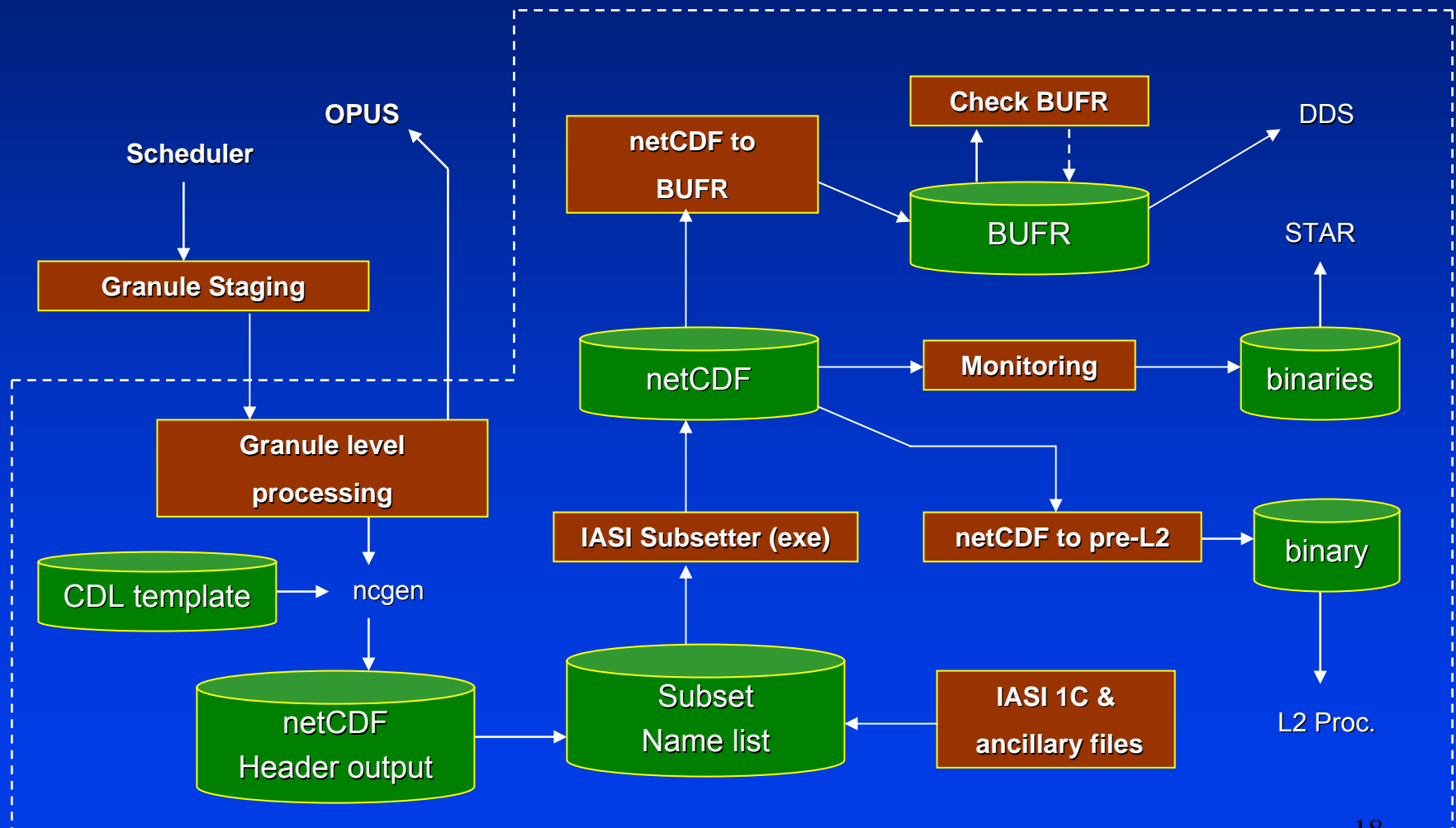
- Global 1 km level 1B from OSDPD
 - » Orbital files
 - » 2048 FOVs per scan
 - » 5 channels of radiances (IR and visible)
 - 6 frequencies, 5 transmitted channels
 - » Scan geometry
 - » CLAVR cloud mask
 - » File size ~58 MB/orbit



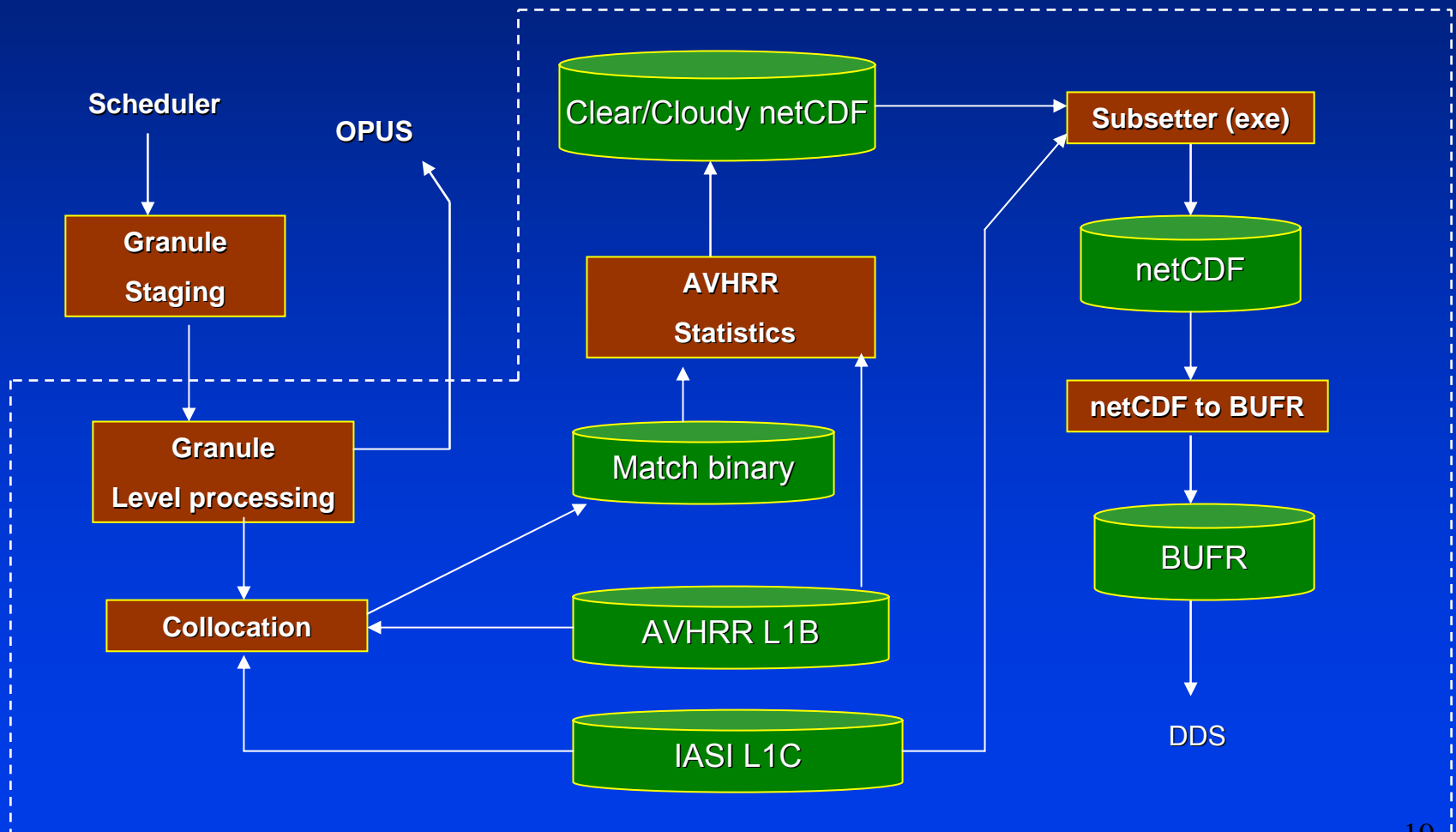
Overall System Design



Subsetter Model For IASI Level 1C Products



Subsetting For IASI/AVHRR NOAA Unique Processing



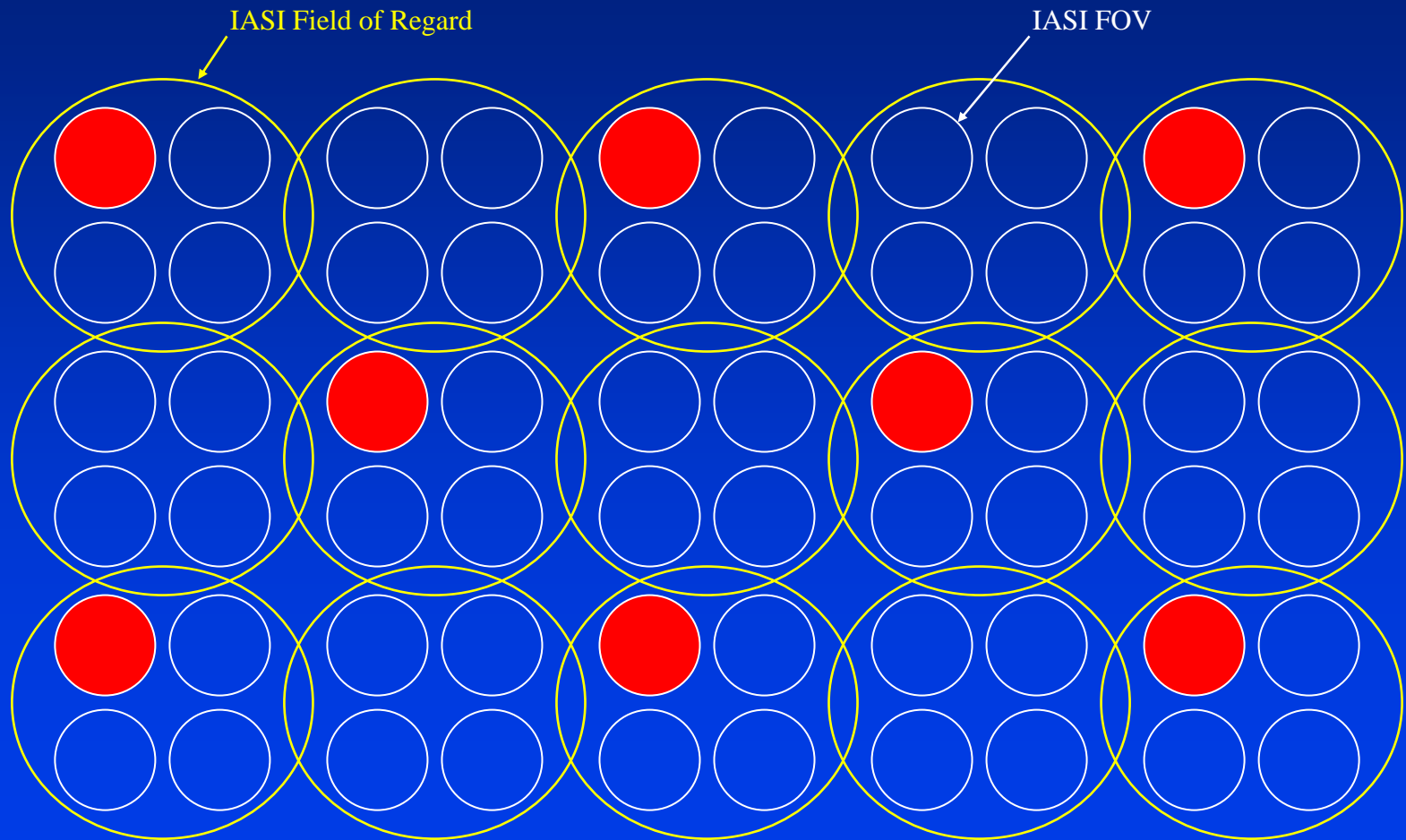


The Subsetting Concept

- 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.



A Spatial Subset Example





Output File Formats

- BUFR
 - » The standard format for NWP centers.
 - » The IASI BUFR file format was developed by working closely with EUMETSAT and other NWP centers.
 - » Simulated near real time BUFR files are currently available to the following NWP centers for evaluation:
 - EUMETSAT, NCEP, GMAO, UK-Met, ECMWF, Meteo-France, CMC (Canada), JMA (Japan)
- 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.



Proposed Products

Instrument	Channels	Data Type	IASI FORs/granule	Subset scheme per scan line	IASI FOV #	Format
IASI	*616	RAD	330	Every other AMSU FOV	1	BUFR netCDF
IASI	*616	RAD	330	Every other AMSU FOV	1,2,3,4	BUFR netCDF
IASI	8461	RAD	660	All FOVs	1,2,3,4	BUFR netCDF
IASI	*616	RR	330	Every other AMSU FOV	1	BUFR netCDF
IASI	200	PCS	330	Every other AMSU FOV	1	BUFR netCDF
IASI (AVHRR)	*616	RAD (warmest or clearest)	330	Warmest or clearest IASI FOV based on AVHRR	1	BUFR netCDF
AVHRR	5	RAD	660	All FOVs	1,2,3,4	BUFR netCDF

PCS - Principal Components; RAD - Radiance; RR - Reconstructed Radiance; FOR - Field of Regard

* 616 channel set determined through a NOAA/ECMWF collaborative effort.



Distribution

- The Simulated BUFR data is available on the AIRS data server (nanuk.eosdis.nasa.gov).
- The OSDPD DDS server will be the staging location for product distribution.
- OSDPD will handle the distribution of the near real-time IASI BUFR files.



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)
- 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)



Current Distribution List (cont)

- AFWA
 - » A requested products list has been received and a distribution agreement is in progress.
- NRL
 - » Product list is yet to be determined
- CLASS
 - » All Level 1C IASI data from EUMETSAT (plus metadata)
 - » 3 deg latitude x 3 deg longitude global grids



Principal Component Analysis Using Simulated IASI Data

The use of PCA in processing IASI data



- Simulated IASI data training set
 - For each granule we use:
 - * 2 scan lines
 - * 4 IASI FOV
 - * 8461 channels
- Computed Eigenvectors for all 8461 channels
- For easy computation, divided the 8461 channels into three bands:
 - » band 1: 2261 channels $645\text{cm}^{-1} \sim 1210\text{cm}^{-1}$
 - » band 2: 3160 channels $1210.25\text{cm}^{-1} \sim 2000\text{cm}^{-1}$
 - » band 3: 3040 channels $2000.25\text{cm}^{-1} \sim 2760\text{cm}^{-1}$

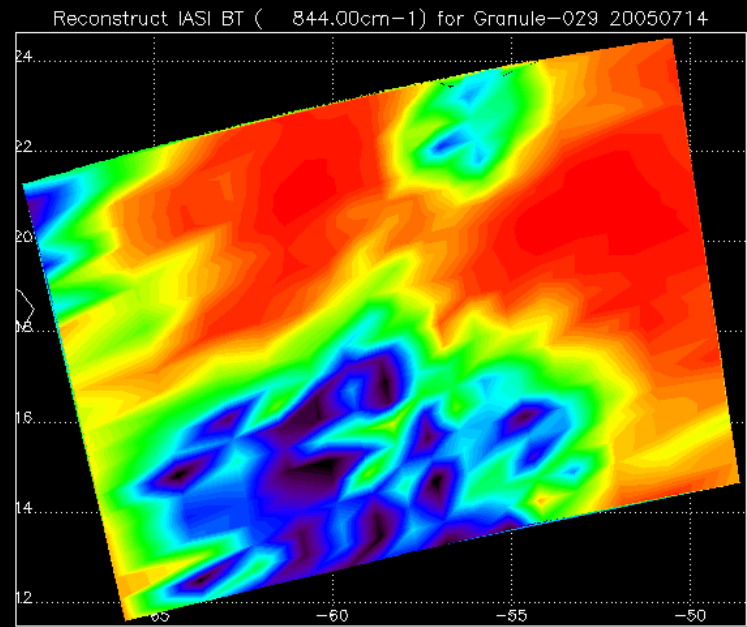
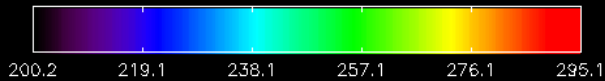
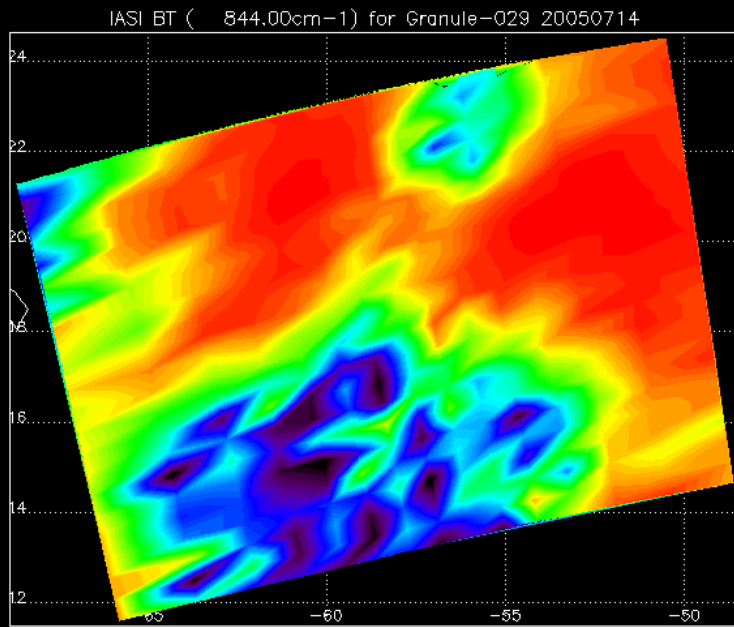
The use of PCA in processing IASI data



- The algorithm to generate and apply IASI eigenvectors is same as AIRS.
- Computed 200 principal components for each band.
- Reconstruct the radiances by using principal components.
- Compute the reconstruction scores.

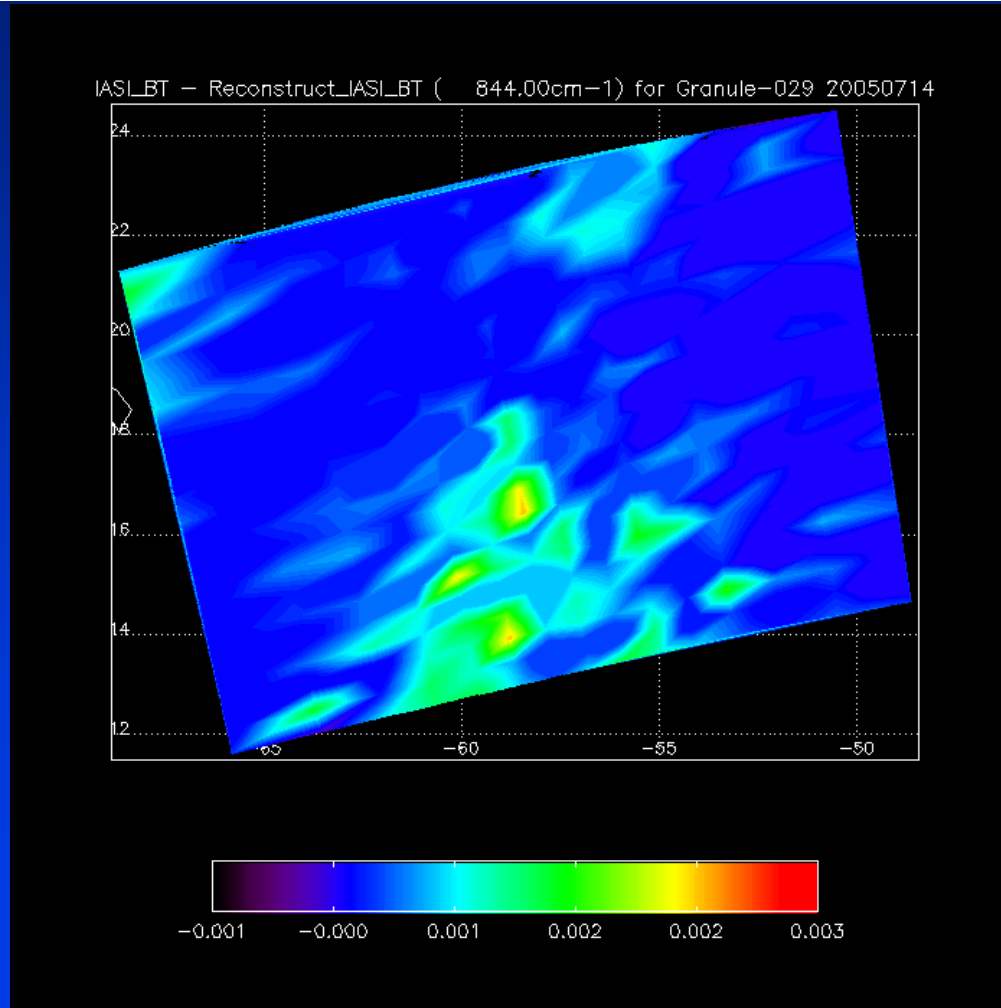


IASI BT and Reconstruct BT





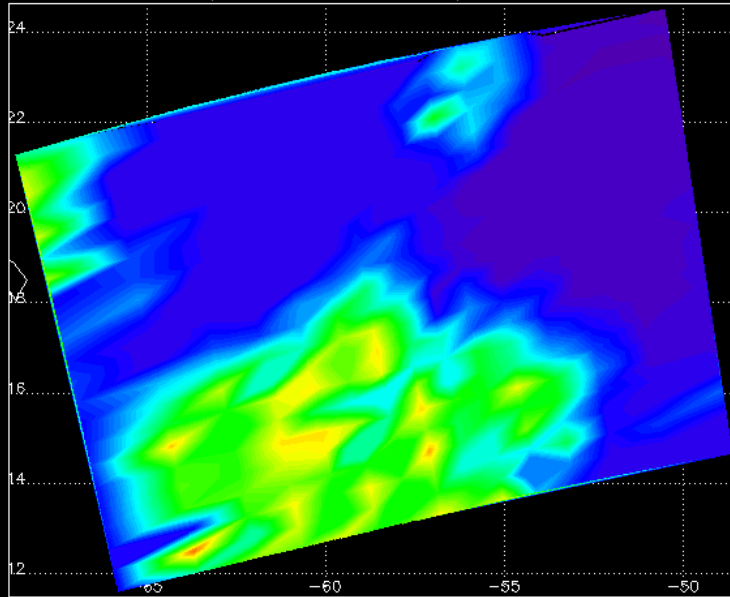
IASI BT - Reconstruct BT



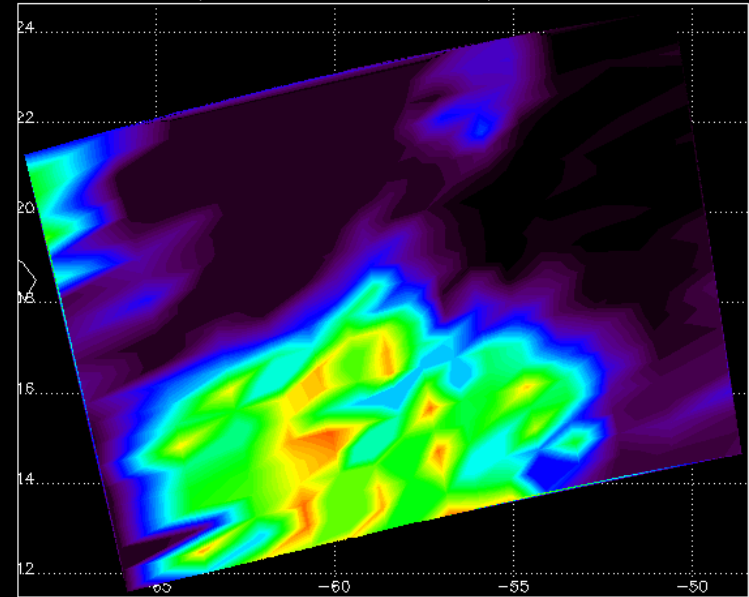
IASI Reconstruction Scores for Band 1 and Band 2



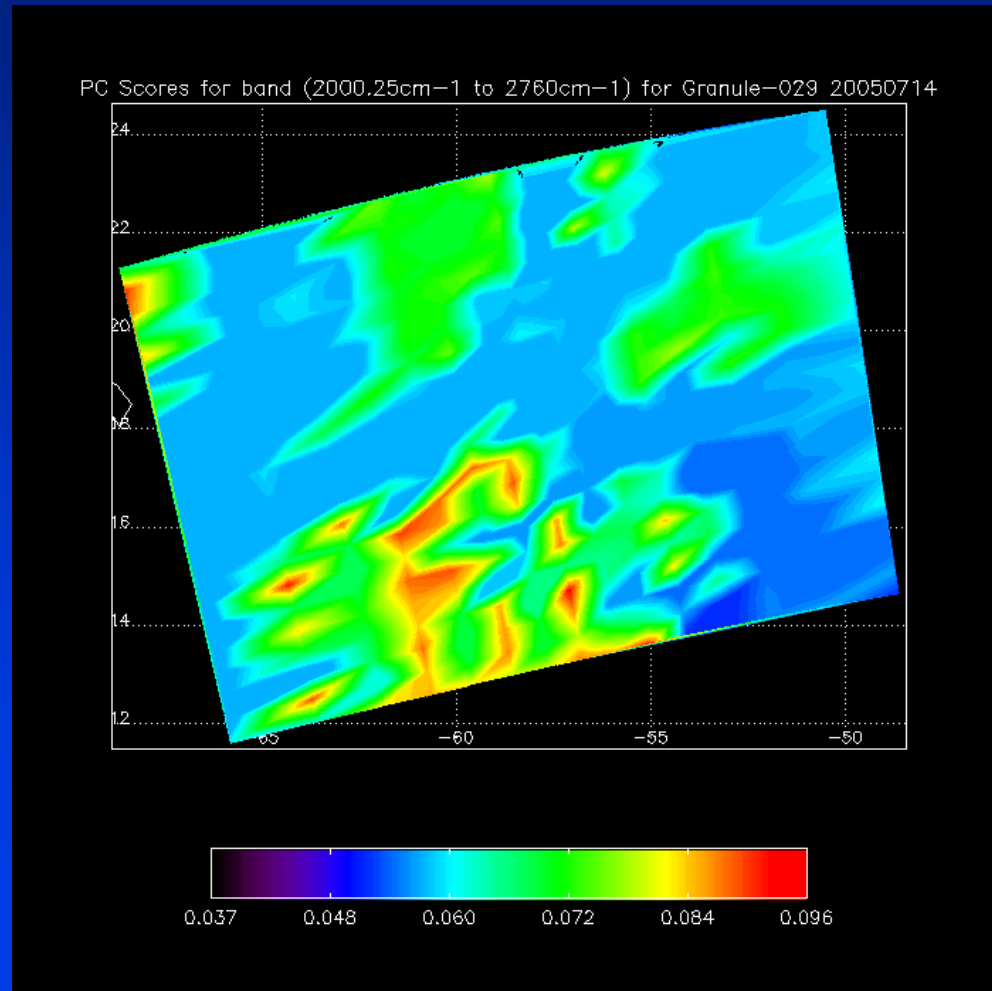
PC Scores for band (645cm⁻¹ to 1210cm⁻¹) for Granule-029 20050714



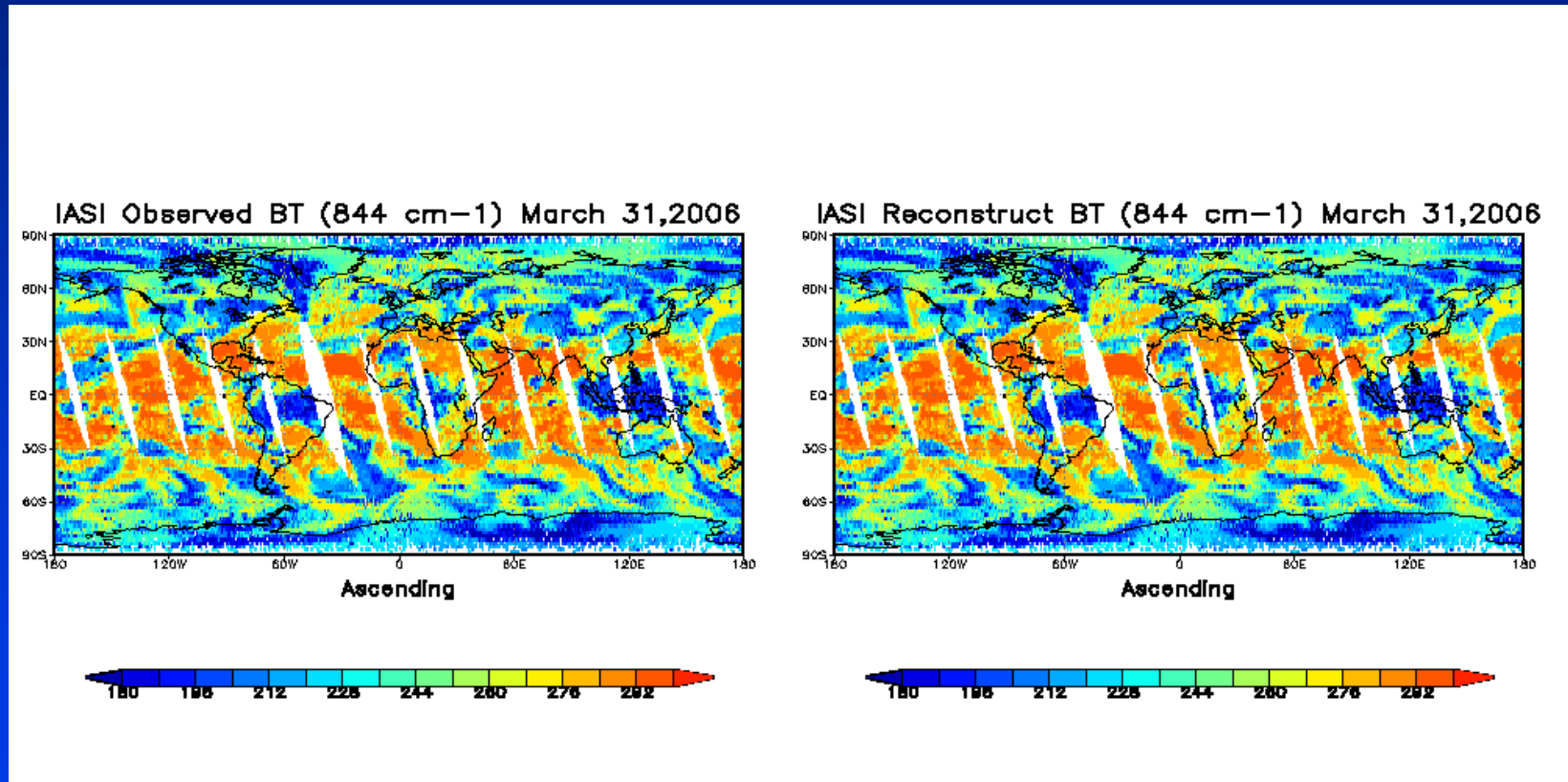
PC Scores for band (1210.25cm⁻¹ to 2000cm⁻¹) for Granule-029 20050714



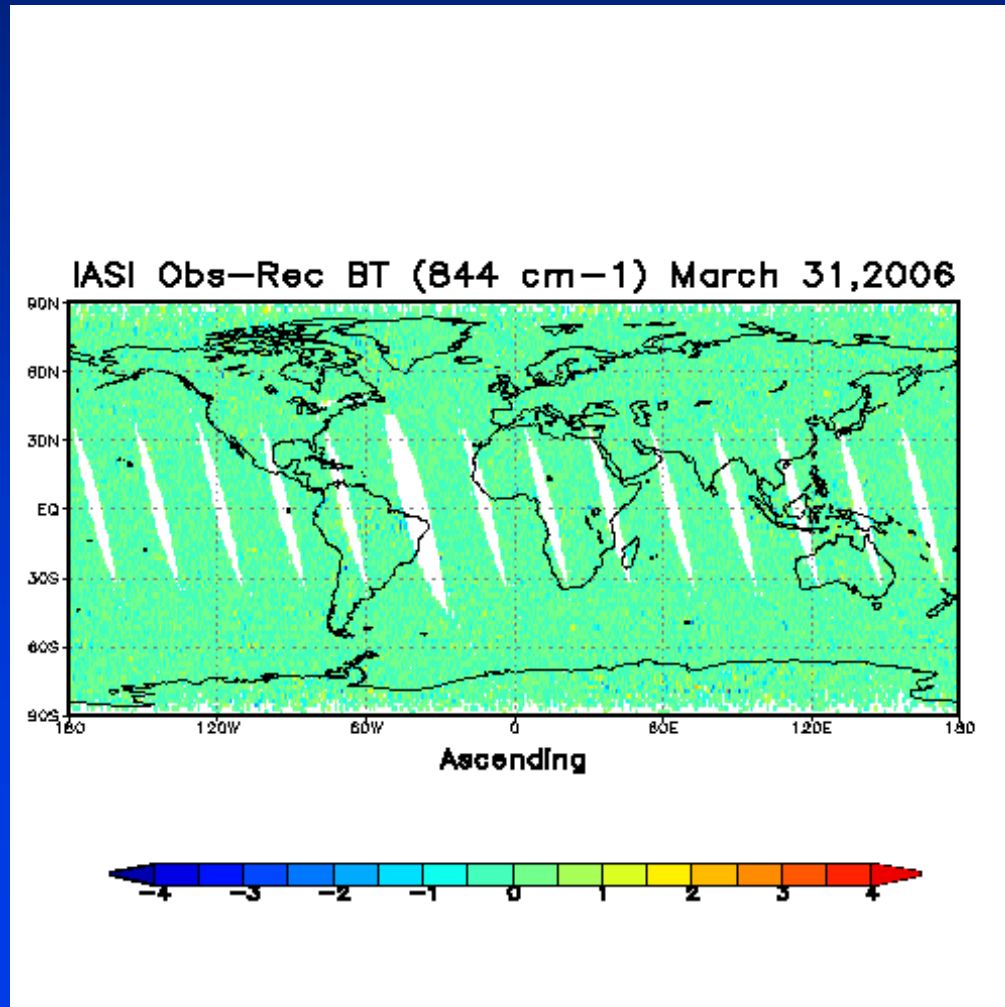
IASI Reconstruction Scores for Band 3



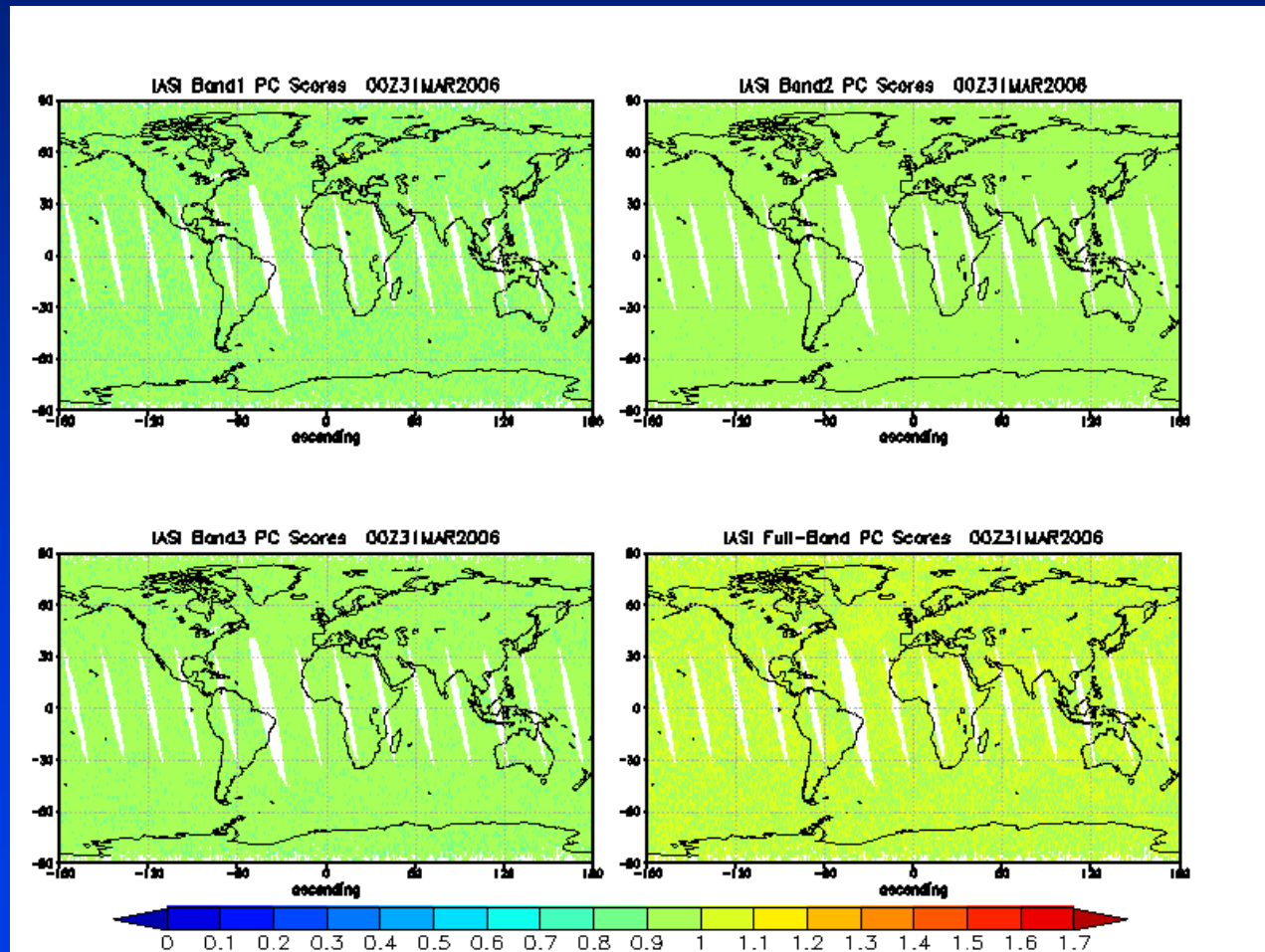
PCA for All Bands with Noise



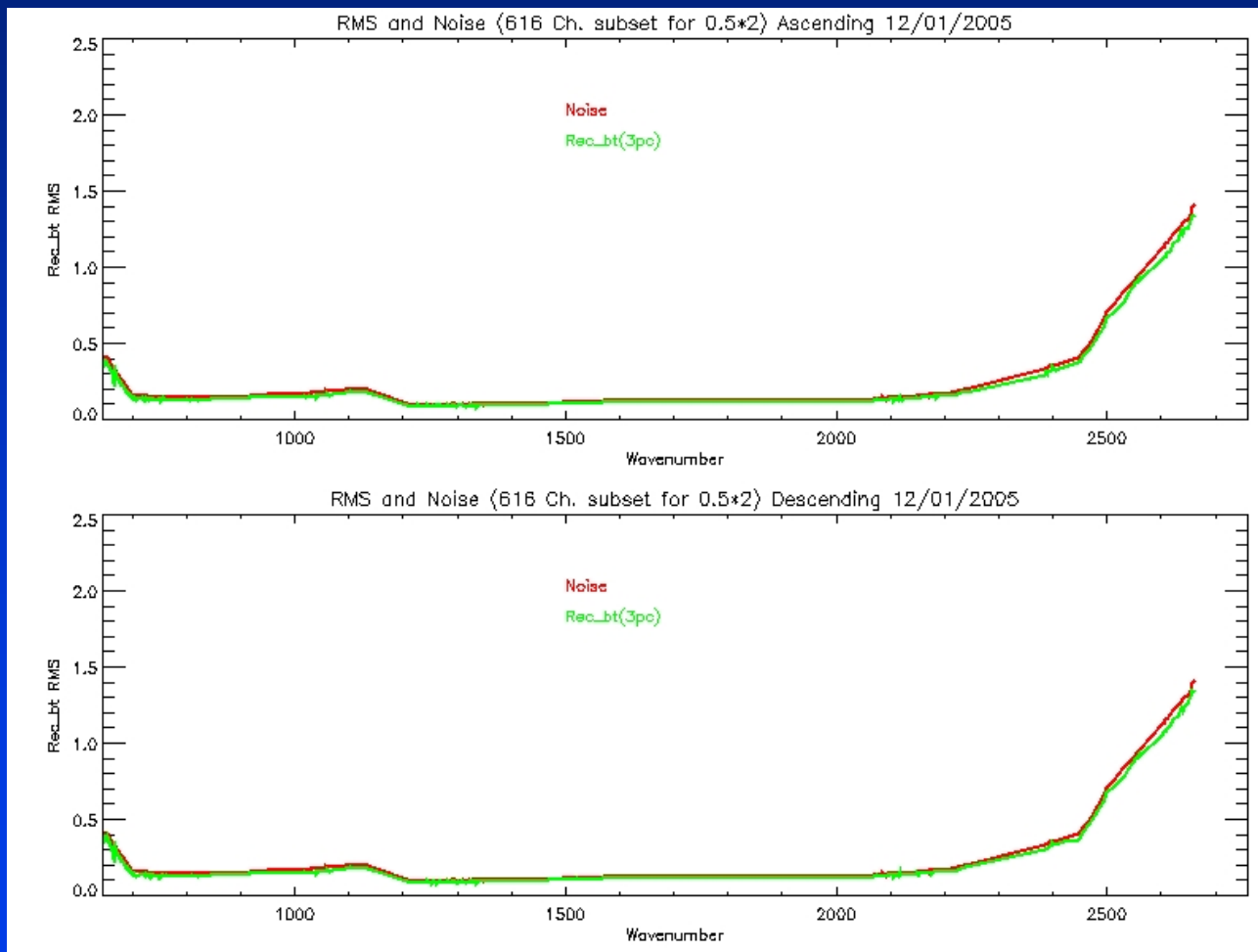
IASI Simulate BT - IASI Simulate Reconstructed BT



PC Scores for 3-Band and Full-Band



IASI Reconstruction Scores and Noise





PCA Usage

- Will create post launch eigenvector set for IASI data from whatever period of time to produce a stable eigenvector set.
- 3 Bands – Monitoring
- All Channels – Monitoring and Distribution



Cloud Clear Radiances

- Producing cloud cleared radiances in near real-time using the AIRS-heritage algorithm.
- Use cloud masked AVHRR radiances, convolved to the IASI FOVs, to QA the IASI cloud cleared radiances.
- Put cloud cleared radiances in BUFR format for distribution.



Summary

- A simulation system is currently running continuously simulating IASI/AMSU/MHS data. This allows STAR to constantly test the ongoing system development.
- These data are being used to produce several spectral and spatial subset products of level 1C IASI 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 NCEP, GMAO, and DOD centers.



Future Work

- Will use our experience with AIRS/AMSU and IASI/AMSU to build a simulation and distribution system for CrIS/ATMS.