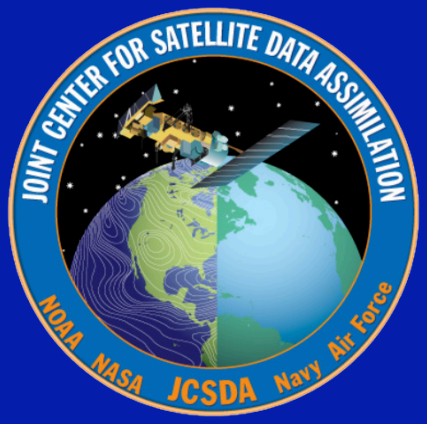


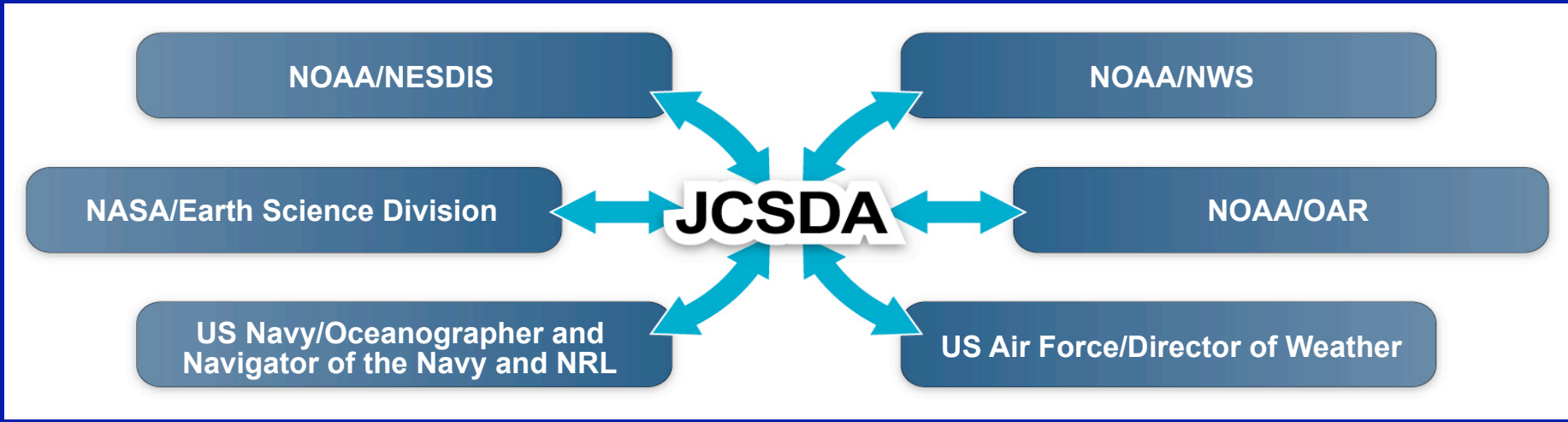
NPP Cal/Val activities in the Joint Center for Satellite Data Assimilation

Lars Peter Riishojgaard, JCSDA

Overview

- JCSDA, NWP and NPP
- Steps toward implementation of new observations
- NWP contributions to Cal/Val
- Summary

JCSDA Partners, Vision, Mission



Vision:

An interagency partnership working to become a world leader in applying satellite data and research to operational goals in environmental analysis and prediction

Mission:

...to accelerate and improve the quantitative use of research and operational satellite data in weather, ocean, climate and environmental analysis and prediction models.

JCSDA Strategic Science Priorities

- Radiative Transfer Modeling (CRTM)
- Preparation for assimilation of data from new instruments
- Clouds and precipitation
- Assimilation of land surface observations
- Assimilation of ocean surface observations
- Atmospheric composition; chemistry and aerosol

Driving the activities of the Joint Center since 2001, approved by the Science Steering Committee

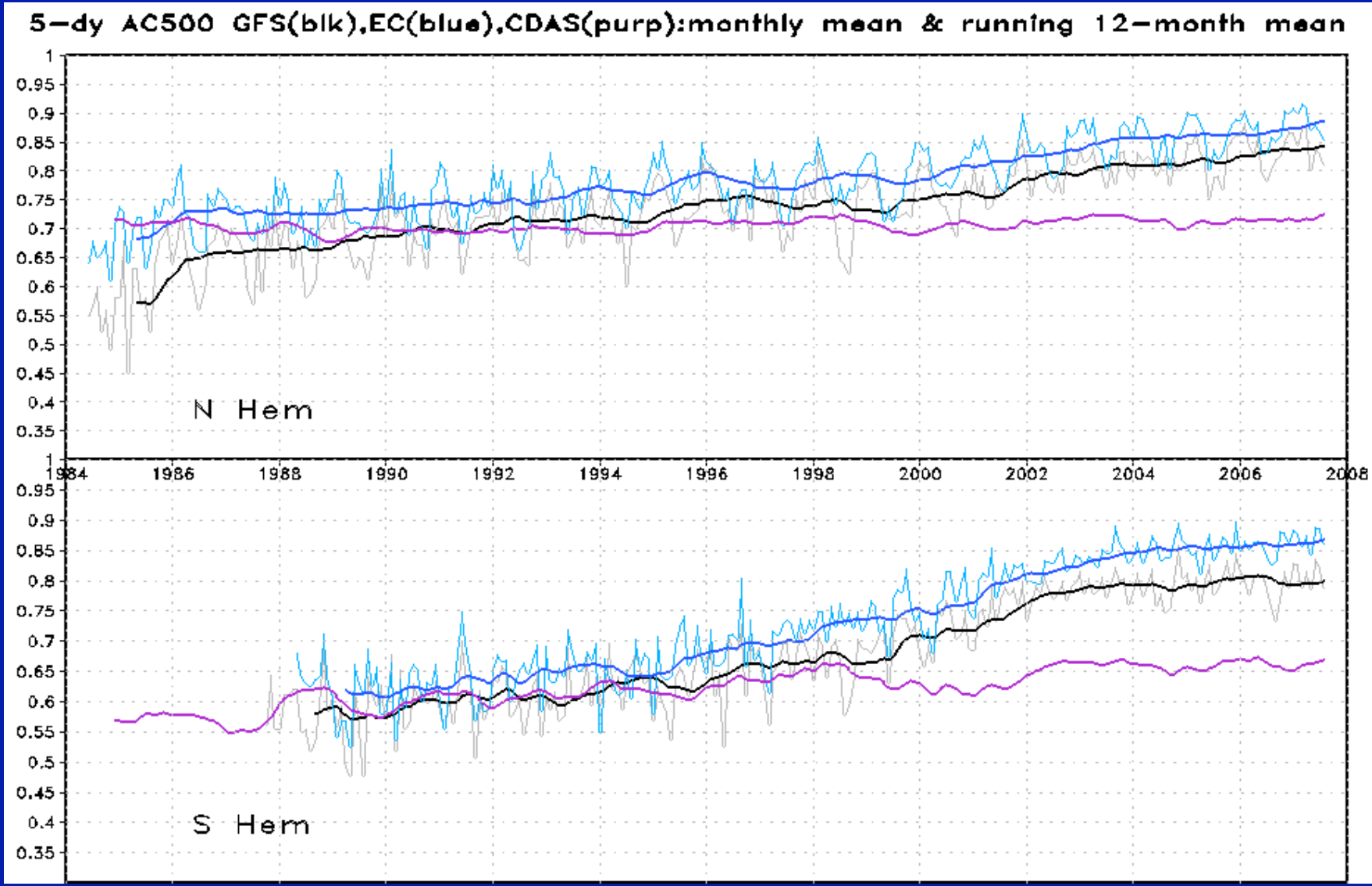
JCSDA short-term goal *(adopted 03/2008):*

- *"Contribute to making the forecast skill of the operational NWP systems of the JCSDA partners internationally competitive by assimilating the largest possible number of satellite observations in the most effective way"*

Why renewed NWP focus?

- Economic impact
  - Weather:~$3 trillion annual impact on US economy
  - Even modest advances in forecast skill lead to huge economic gains for sectors such as agriculture, aviation, energy
  - Avoidance of danger to life and property (hurricanes, severe weather, etc.)
  - “Total value to US economy of NWP activities ~$200M per hour of useful forecast range per year”
- Impact on military operations
- US falling behind internationally in terms of NWP skill

NOAA/NCEP vs. ECMWF skill over 20+ years



Why is the US falling behind?

- **Use of satellite data**
  - Satellite data account for most of the skill at all major NWP Centers (WMO 2008)
  - Transition to operations for new sensors too slow in the US (e.g. IASI, ASCAT)

- Data assimilation methodology; no unified US move toward next-generation (4D-VAR) data assimilation capability
  - JCSDA has no direct control over this, but can facilitate and coordinate collaboration on satellite data among its partners

- Computing resources; lack of code and platform compatibility across JCSDA partners

NPP (NPOESS) readiness

- **NPP is the most important upcoming US satellite mission for operational NWP**

- Scientific readiness; need to understand calibration, observation operators (spatial and spectral sampling characteristics), error modeling
  - Step one: maximize the impact of heritage sensors (for CrIS: AIRS, IASI)
  - Step two: Readiness for Cal/Val of SDRs

- Technical readiness for data flow: data transfer protocols, BUFR formats, data ingest logistics, etc.

Generic task list for implementation of new satelilte observations

1. Set up mechanisms for real-time data flow to NWP users.
2. Set up data conversion/reformatting appropriate for NWP.
3. Develop or revise observation operators, including appropriate modifications to Community Radiative Transfer Model CRTM.
4. Quality control (QC) and data selection software, including bias correction.
5. Short preliminary (pre-launch) analysis experiments using simulated data to test data transfer and processing chain and data ingest.

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6. Off-line assimilation and monitoring of residuals (post-launch cal/val activity)
7. Cycled data assimilation experiments with forecast impact assessment.
8. Operational implementation.

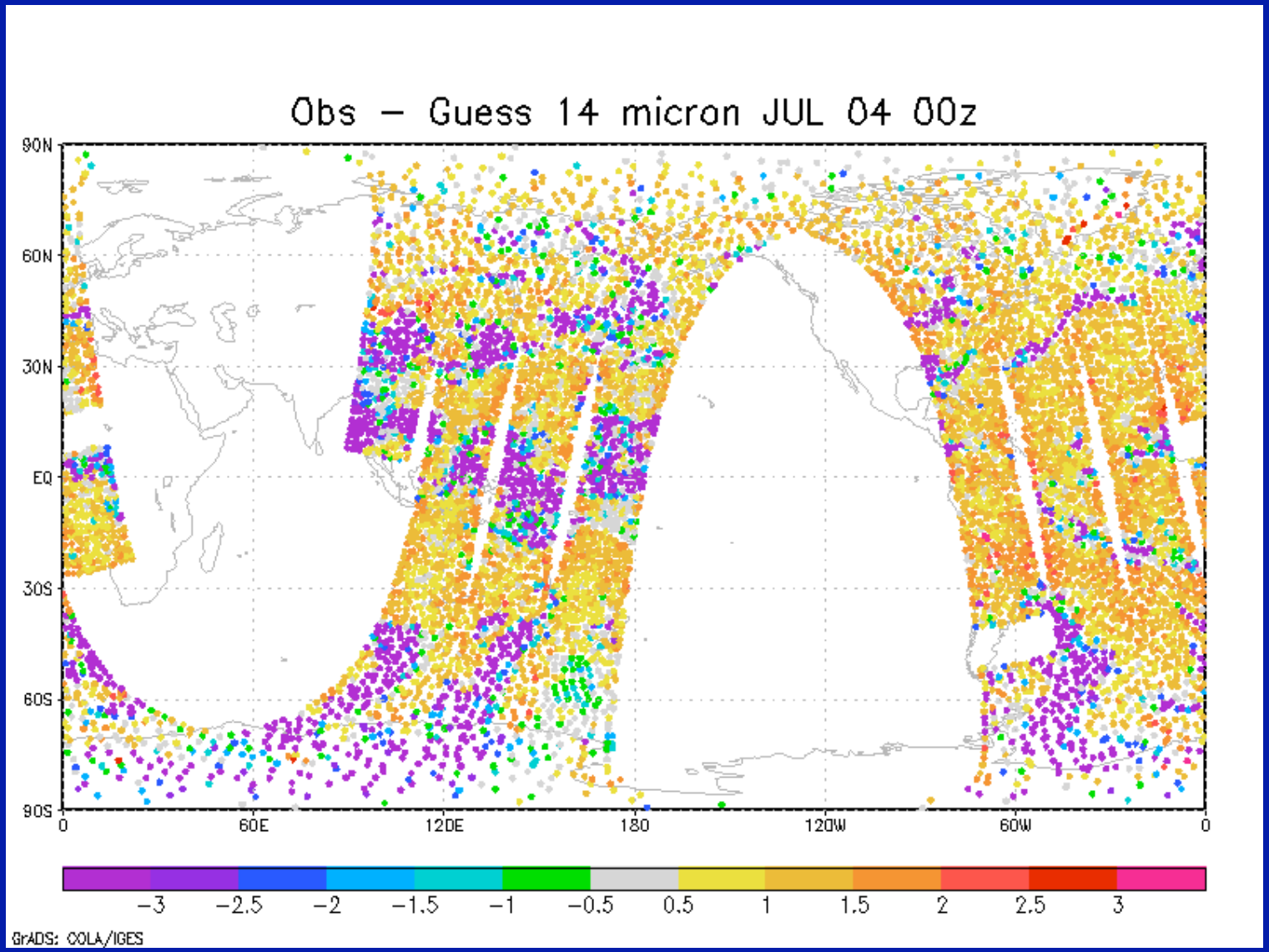
Initial monitoring of new data

- Atmospheric analysis: Goal is to find optimal estimate X_a of the atmospheric state to be used as initial condition for forecast model: $X_a = X_f + K(X_o - HX_f)$
  - X_a is analyzed value, X_f is background, X_o is observation (e.g. satellite radiance), K is gain and H is observation operator
  - 2nd term on RHS is *innovation*; can be calculated also for observations that are not actively used

- During Cal/Val period innovations for new observations are calculated and monitored on par with other observations; however, they are not added to analysis, i.e. new data do not influence forecast

- This amounts to validating new data against the entire GOS

Example of AIRS innovation



NCEP satellite radiance monitoring webpage

Introduction

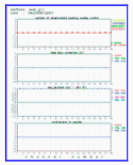
The purposes of monitoring the data assimilation system are to ensure the proper performance of the assimilation system and to diagnose problems with the system for future improvements. Furthermore, it provides statistics for use in the assimilation system. The statistics shown here include the bias correction and the observed-minus-simulated radiance statistics (with or without bias correction).

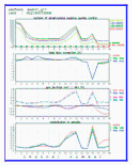
The sources of the departure statistics between the observed and the simulated radiance include: (i) errors in the observed data (ii) errors in the profile obtained from the forecast model, and (iii) errors in the radiative-transfer model used to compute radiance from the forecast.

Some observation numbers may have the decimal points because they are normalized by the cycle numbers.

Summary plots

Click on the thumbnail to see the full image


GOES-11 SNDR(5x5)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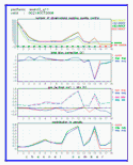
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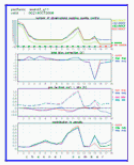
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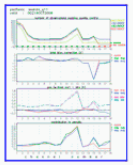
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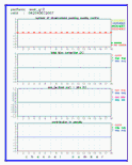
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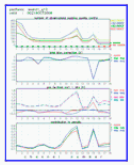
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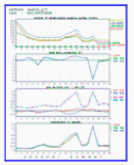
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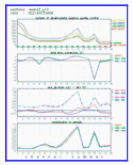
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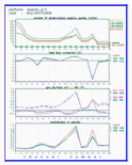
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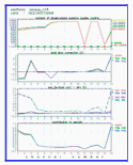
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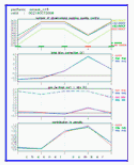
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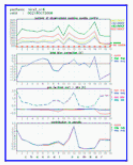
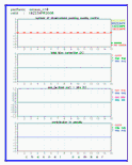

NOAA-16 HIRS/3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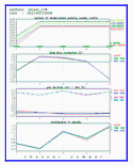
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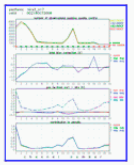
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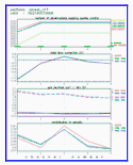
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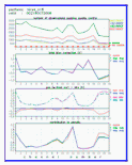
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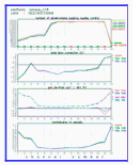
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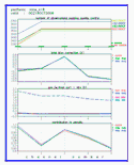
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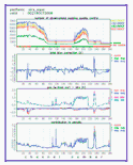
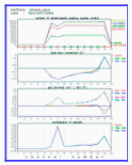

AQUA AIRS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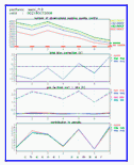
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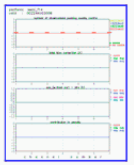
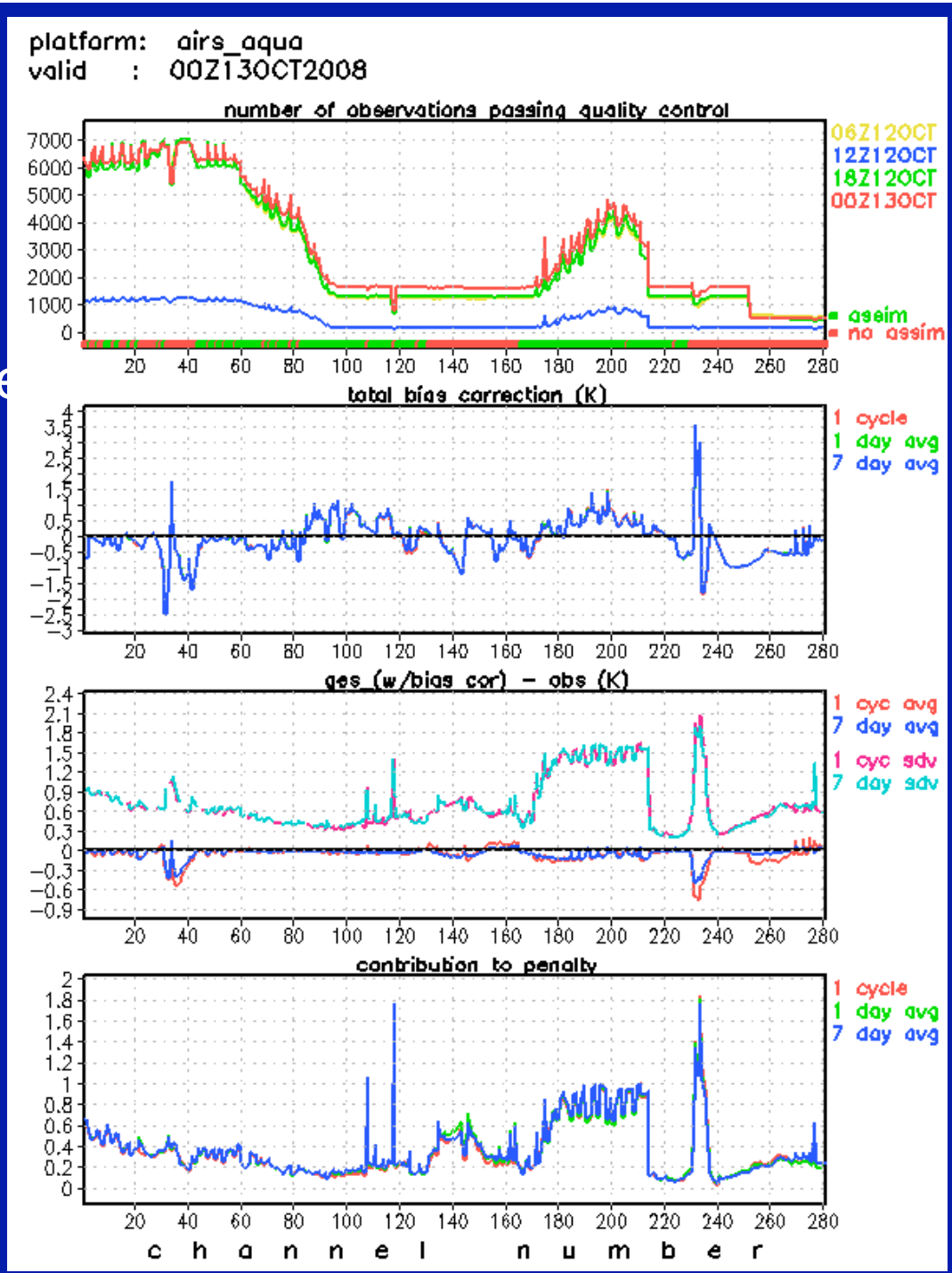
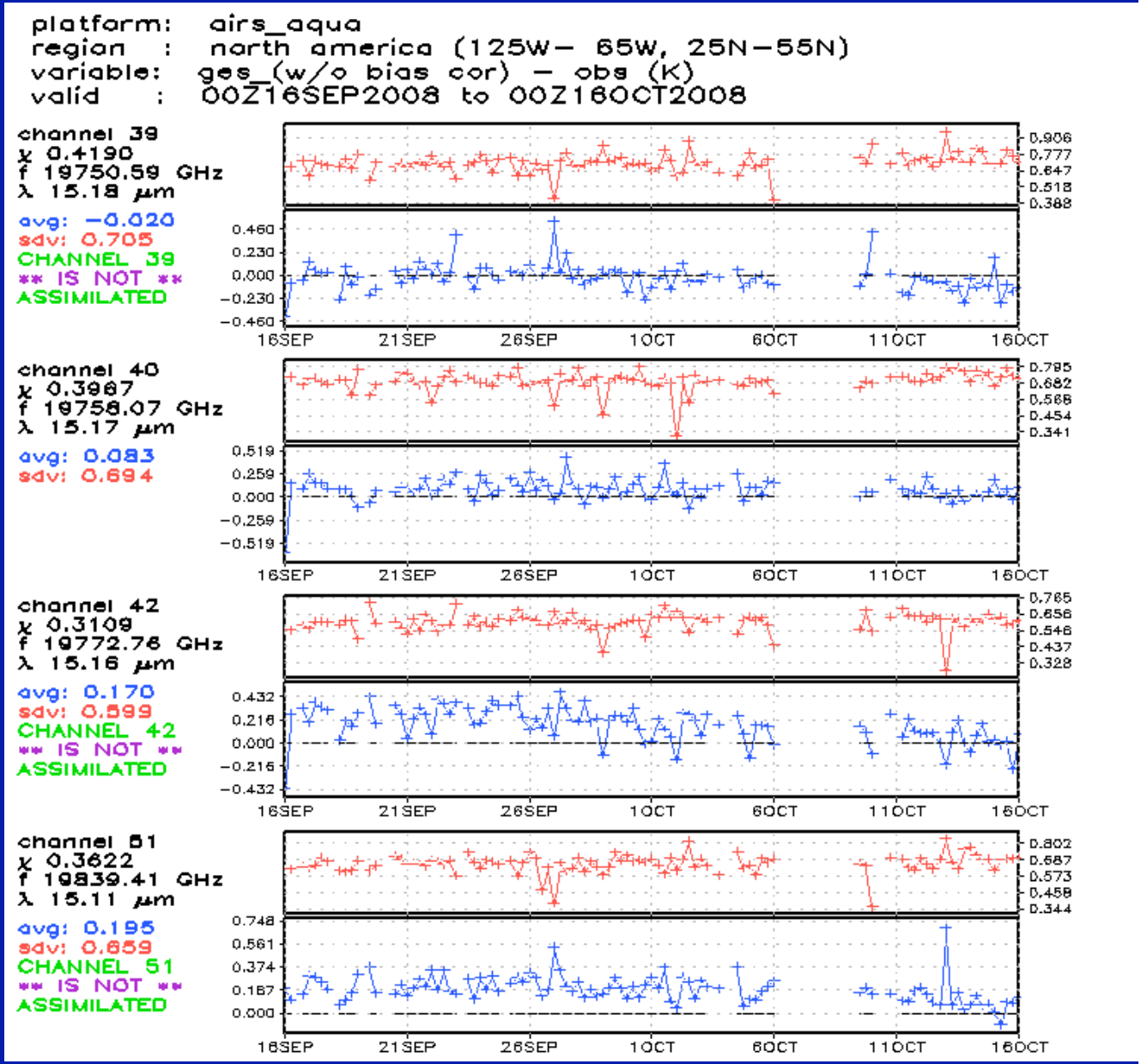

DMSP14 SSMI

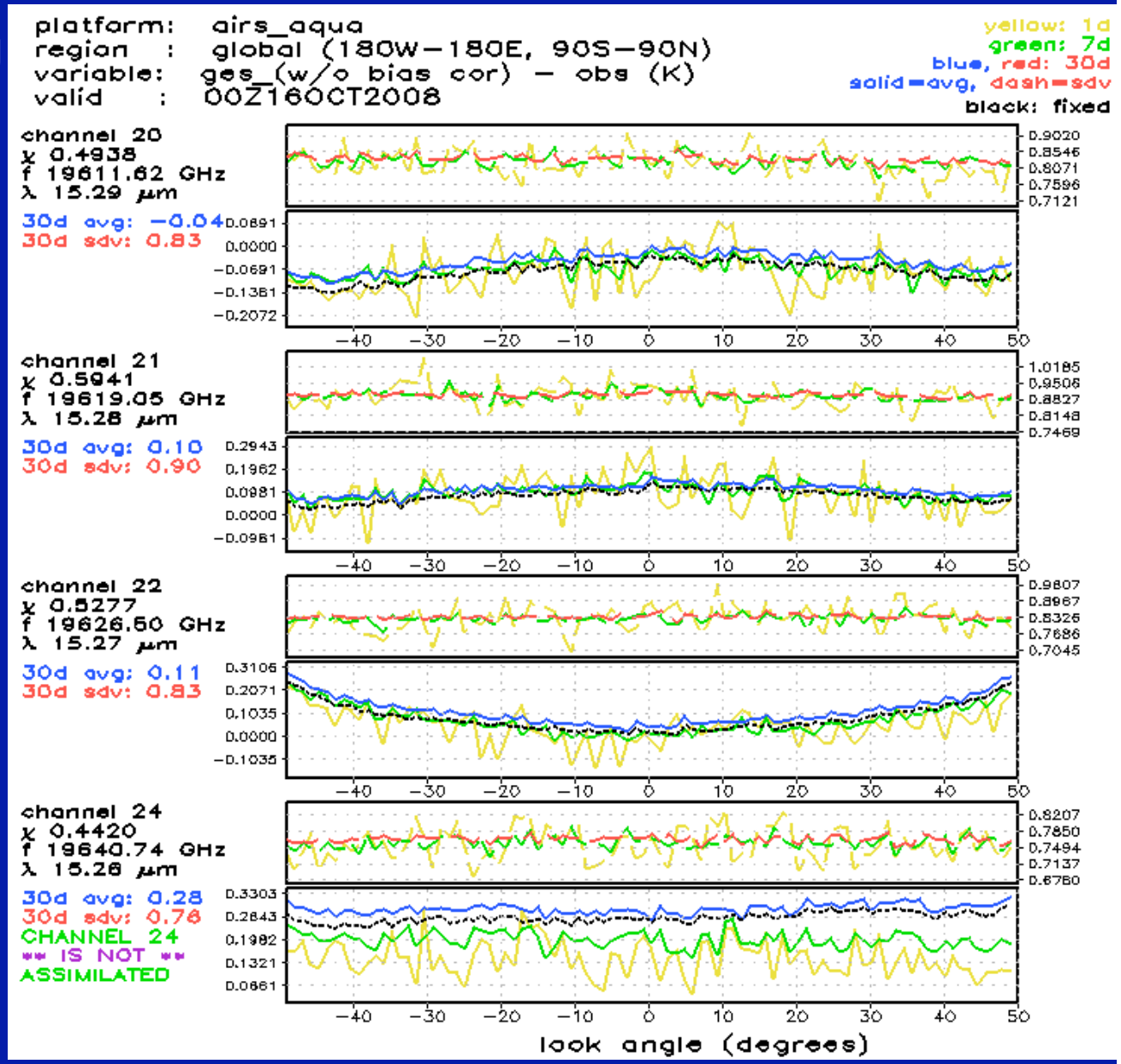
Example of NCEP /EMC monitoring stats for satellite radiances; AIRS averages by channe number



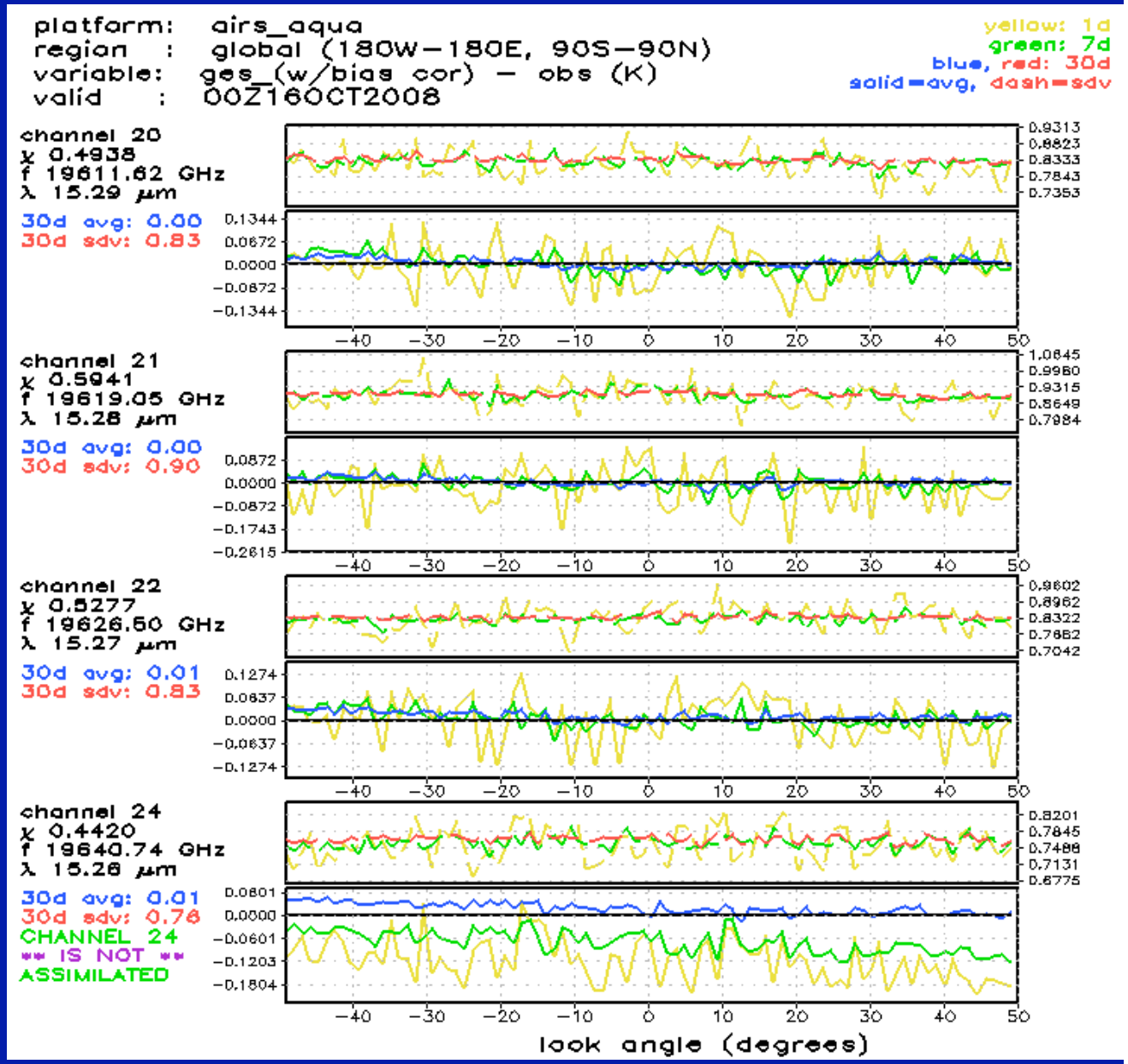
NCEP/EMC monitoring stats: AIRS LW channels against background forecast as a function of time



NCEP/EMC monitoring stats: AIRS LW channels against background as a function of scan angle by; prior to bias correction



NCEP/EMC monitoring stats: AIRS LW channels against background as a function of scan angle by; after bias correction



VI. Summary

- NPP is the most important near-term US satellite mission for NWP; JCSDA readiness is critical for both JCSDA and the NPOESS IPO
- JCSDA and NWP community involvement in SDR Cal/Val will greatly advance the time at which data from sensors can be used operationally
- Prior to NPP launch, JCSDA will
  - Ingest simulated datasets to ensure that file formats and processing chain including CRTM are ready
- Immediately after launch, JCSDA will
  - Start monitoring data quality of CrIS and ATMS against background and analysis fields; diagnostics will be made available to NPP team but not to the general public