

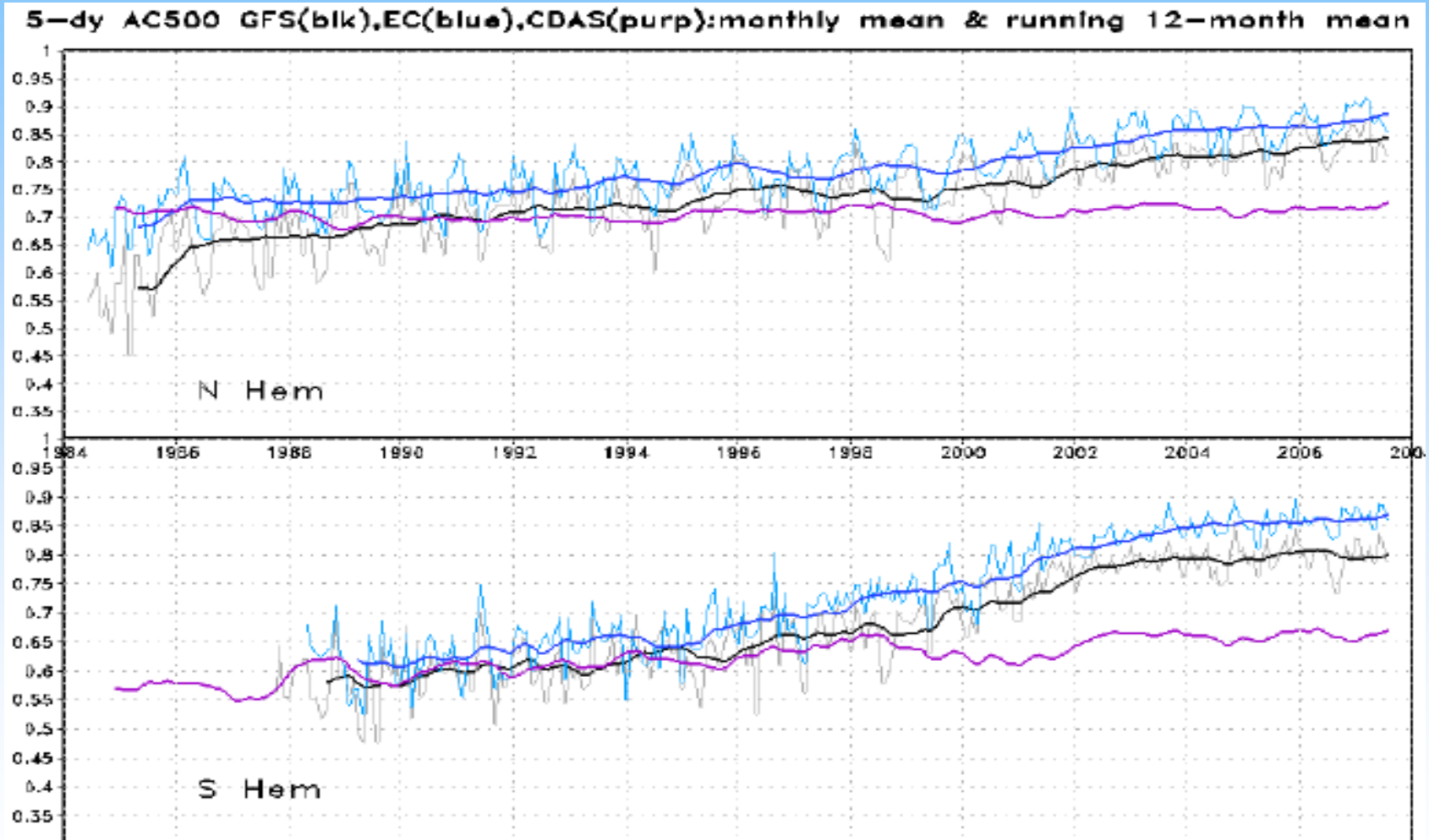


NOAA Satellite Calibration/Validation Program

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National Environmental Satellites, Data and Information Services
National Oceanic and Atmospheric Administration**

**CEOS WGCV 28th Meeting
Sanya, China
February 25-28, 2008**

NOAA vs. ECMWF Global Weather Forecast Skills over 20 years





Satellite Data Assimilation in NOAA Global Numerical Weather Prediction Models

~33 instruments are used

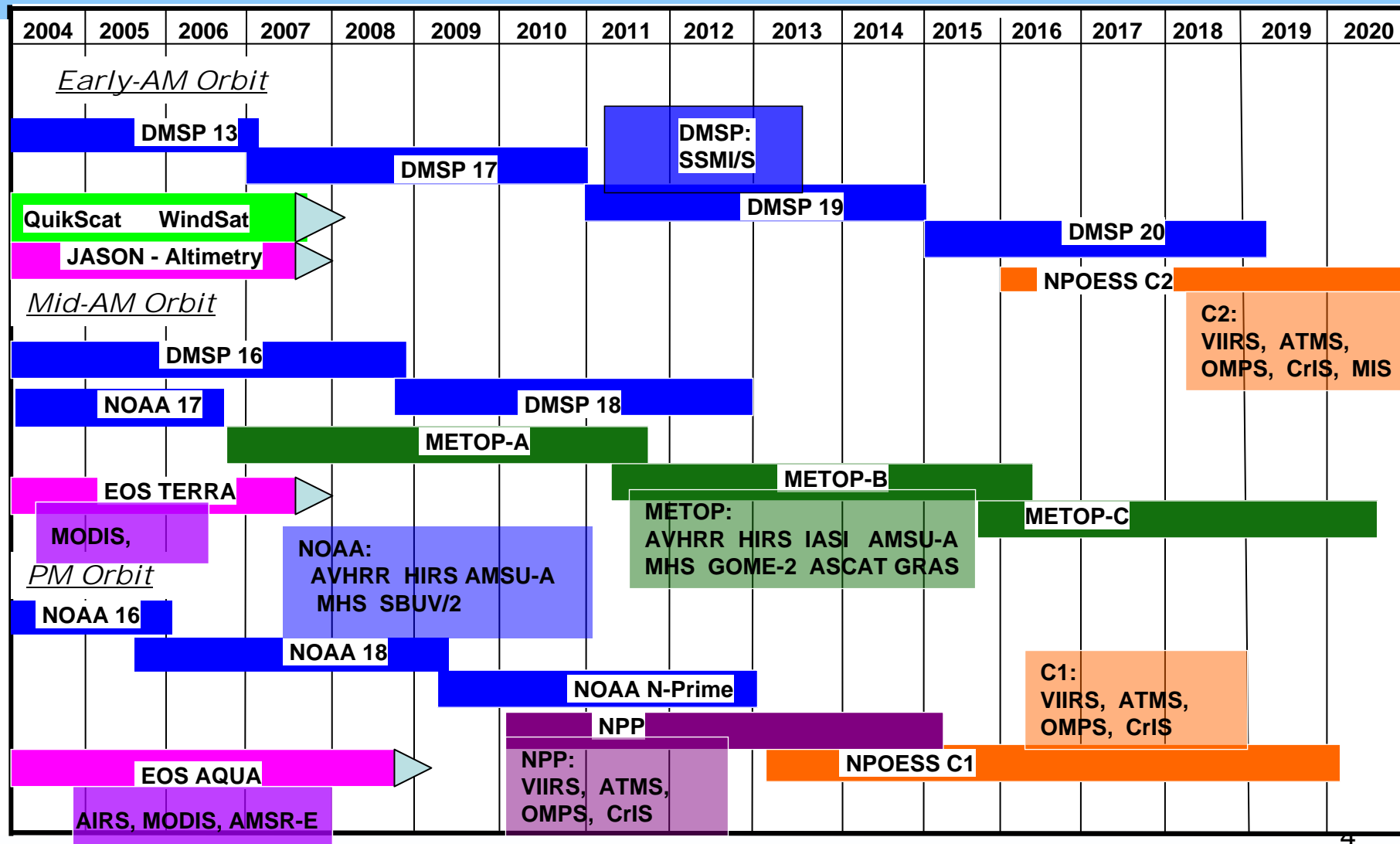
- HIRS sounder radiances
- AMSU-A sounder radiances
- AMSU-B/MHS sounder radiances
- GOES sounder radiances
- GOES, Meteosat, GMS winds
- GOES precipitation rate
- SSM/I precipitation rate
- TRMM precipitation rate
- SSM/I ocean surface wind speeds
- ERS-2 ocean surface wind vectors
- Quikscat ocean surface wind vectors
- AVHRR SST
- AVHRR vegetation fraction
- AVHRR surface type
- Multi-satellite snow cover
- Multi-satellite sea ice
- SBUV/2 ozone profile and total ozone
- Altimeter sea level observations (ocean data assimilation)
- AIRS
- MODIS Winds
- COSMIC

instruments are being tested

- *F16 SSMIS*
- *WindSat EDR, SDR assimilation*
- *OMI total ozone*
- *Cloudsat for CRTM validation*
- *Aura MLS*
- *IASI*
- *ASCAT*
- *GRAS*
- *GOME2*

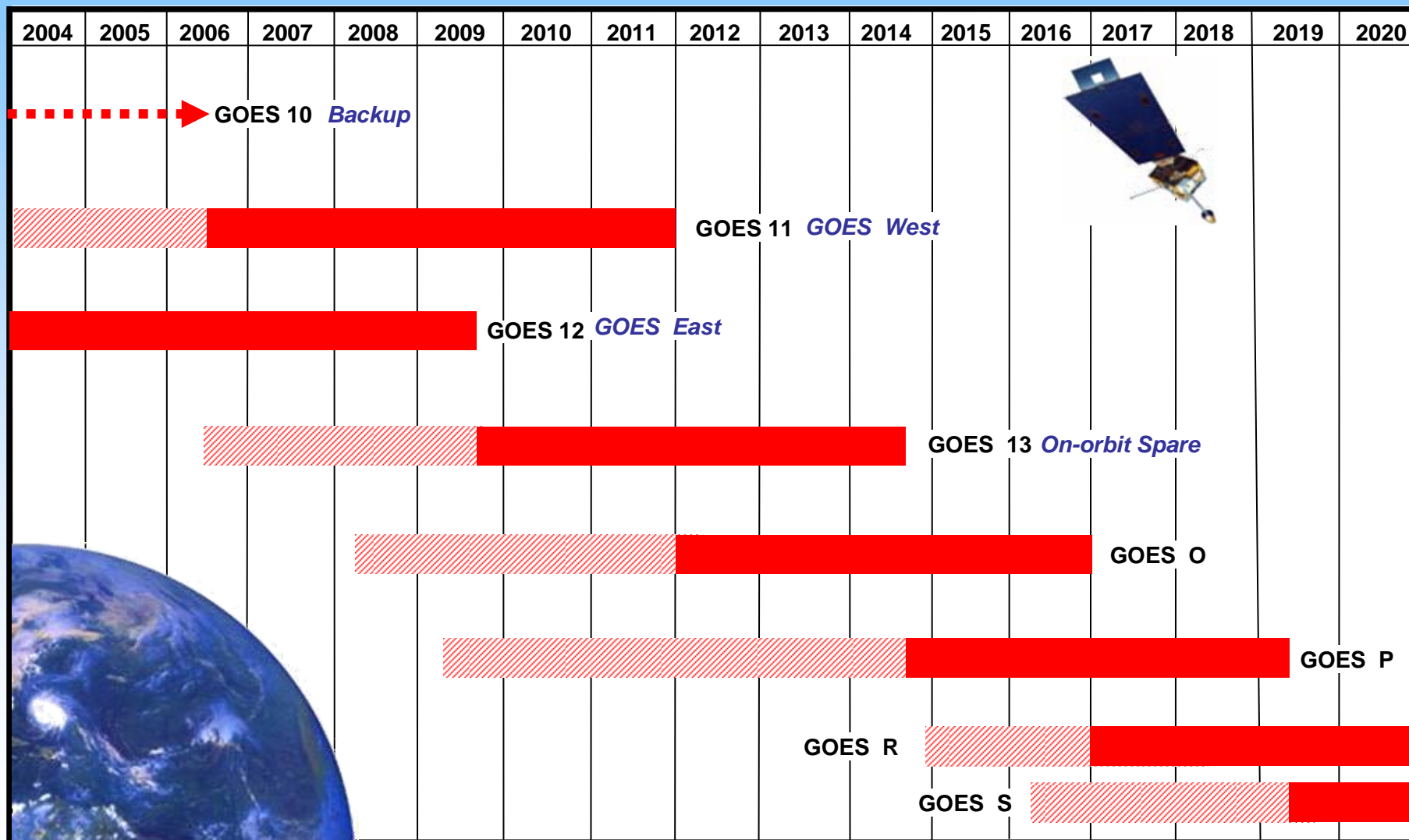


US Planned Missions - Polar





NOAA Planned Missions - Geostationary





Major NOAA Cal/Val Accomplishments in FY07

- **Sustain operational POES&GOES Calibration**
- **Support WMO GSICS (Global Space-based Intercalibration System)**
- **Develop Cal/Val Plans for Future Instruments (e.g. GOES-R and NPOESS)**
- **Inauguration of NOAA Cal/Val Program**



POES and GOES Calibration Update

- **Continue updates of POES and GOES visible and near infrared calibration coefficients**
- **Work on ocean color bands for NPOESS-VIIRS**
- **Further joint work with NIST on MOBY in 2008**



GSICS (Global Space-based Intersatellite Calibration System)

- GSICS is part of the WMO (World Meteorological Organization) space program
- Its main goal is to facilitate the generation of fundamental climate data records
- GSICS will facilitate the development of RSSC-CM (Regional Specialized Satellite Centers-Climate Monitoring)
- Extensive report on GSICS will be provided this Thursday

Support WMO GSICS

- Three informative issues since April 1
- Articles include GSCIS organization and project overviews, science, meeting summaries, personnel, etc.
- Contributions from Germany, Japan, and US
- We need your GSICS–related articles ...
 - Organization and Project Overviews
 - New Science
 - Meetings and Awards
 - Personnel
 - Classifieds





GOES-R Cal/Val Update

- Currently plan focuses on ABI (Advanced Baseline Imager)
- Will refine the plans for GLM (Geostationary Lightning Mapper) and Space weather instruments this year.
- The calibration algorithm theoretical basis documents will be started this year.
- Product cal/val plans will be developed later

ASIC³ Workshop Report Released

- Achieving Satellite Instrument Calibration for Climate Change is officially released
- With more than 150 pages, this will be an important reference document for cal/val specialists
- Recommend to put on the WGCV website and cal/val portal.





NOAA Cal/Val Program

Vision

Satellite observations are intercomparable and tied to international standards for weather, climate, ocean and other environmental applications

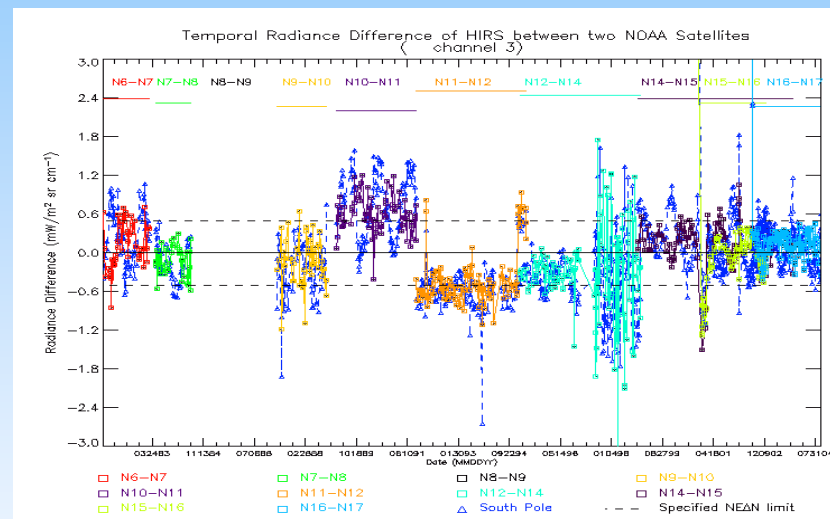
Goals

1. Reduce the uncertainty in climate trend detection and prediction through vigorous calibration and reprocessing
2. Increase accuracy of satellite data for weather and environmental prediction models
3. Smoothly transition new calibration algorithms to operations
4. Develop common practices for calibration of Earth observation sensors
5. Achieve traceability to the International System of Units (SI)
6. Optimize sensor choice and design for achieving these goals

NOAA Cal/Val Program Components

- **Pre-launch**
 - Pre-launch characterization
 - Common standards for vendor calibration
 - Traceability to system international units
 - New calibration models and algorithms
- **Post-launch**
 - Maintenance of operational satellite calibration
 - Inter-and Intra-calibration of satellite sensors
 - Online monitoring system for satellite instrument trending
 - Inter-comparison of satellite observations with simulations
- **Product validation**
 - Existing products from newly launched
 - New products from research satellites
 - Define validation sites
 - Consensus algorithm and error budget models
- **Impact assessment of new cal/val procedures**
 - Climate trend analysis
 - Land cover analysis
 - Severe weather forecast

HIRS Intersensor Biases from SNO



Near-Term Cal/Val Priorities

- Integrated Calibration System for NOAA-18/ METOP-A instruments
- Support to WMO Global Space Based Intercalibration System (GSICS)
- On-orbit Calibration of Satellite Observations
 - Maintenance of operational satellite calibration analyzing calibration target measurements
 - Inter- and Intra-calibration of Satellite Sensors
 - Online Monitoring System for Satellite Instrument Trending
 - Inter-Comparison of Satellite Observations with Simulations

Long-Term Cal/Val Priorities

- Development of new calibration science and standard
 - Prelaunch Instrument Characterization
 - New Calibration Models, Science and Benchmark Sensors
- Development of integrated product validation systems
 - Validation of Operational Products from New Satellites
 - Reference Sites for Product Validation
 - Community Consensus Error Budget Models
- Assessments of impacts from new calibration algorithms
 - Climate Trend Analysis
 - Impacts on NWP Analysis, Forecast and Climate Reanalysis

Recent Accomplishments

- **Improved cal/val techniques as backbone supporting GEOSS**
 - Simultaneous nadir over-passing (SNO) for inter-sensor calibration
 - Uses of hyperspectral instrument as reference for intra-sensor calibration
 - Satellite instrument bias correction algorithms
 - Postlaunch nonlinearity correction from SNO analysis
 - Vicarious calibration for POES/GOES visible and near IR channels
- **Improved satellite imagery and products for severe weather nowcasting**
 - GOES-E/W imagery animation for hurricane track and intensity
 - Flash flood from AMSU and GOES
 - Hurricane potential rainfall from AMSU TPW
- **Improved uses of current satellite data in NWP models**
 - More AIRS data used in NWP models
 - Increased use of AIRS, HIRS, SSMIS, AMSU-A data
 - Uses of MODIS wind products
 - AVHRR NDVI in NCEP NOAA
- **Improved uses of satellite data in climate trend analysis**
 - Reconciled MSU tropospheric temperature trends
 - Better ozone trend



NOAA Integrated Calibration and Validation System

Main Capabilities

- Post-launch instrument noise and telemetry trending,
- Time series of SNO/SCO matched data from a pair of operational satellites
- Time series of updated calibration coefficients with digital access,
- Inter-and-Intra instrument calibrations
- Post-launch instrument response functions with digital access,
- Spatial and temporal distribution of biases of satellite radiances against radiative transfer calculation

Integrated Satellite Instrument Calibration/Validation System - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://www.orbit.nesdis.noaa.gov/smcd/spb/calibration/icvs/newweb/

Getting Started Latest Headlines

NOAA Satellites and Information
National Environmental Satellite, Data, and Information Service

STAR – Center for Satellite Applications and Research
formerly ORA – Office of Research Applications

STAR > SMCD > SPB > Integrated Satellite Instrument Calibration/Validation System

Integrated Satellite Instrument Calibration/Validation System

Introduction
Microwave Sounders >>
Microwave Imagers >>
Infrared Sounders >>
Infrared Imagers >>
Visible & Near Infrared Instruments >
Ultraviolet Instruments >
Projects >>
Publications >>
FAQ and Tools >>

NOAA18/SBUV/2 >>
NOAA17/SBUV/2 >>
NOAA16/SBUV/2 >>
METOP-A/GOME/2 >>
NPP/OMPS >>
NPOESS/OMPS >>
Retrospective Cal.

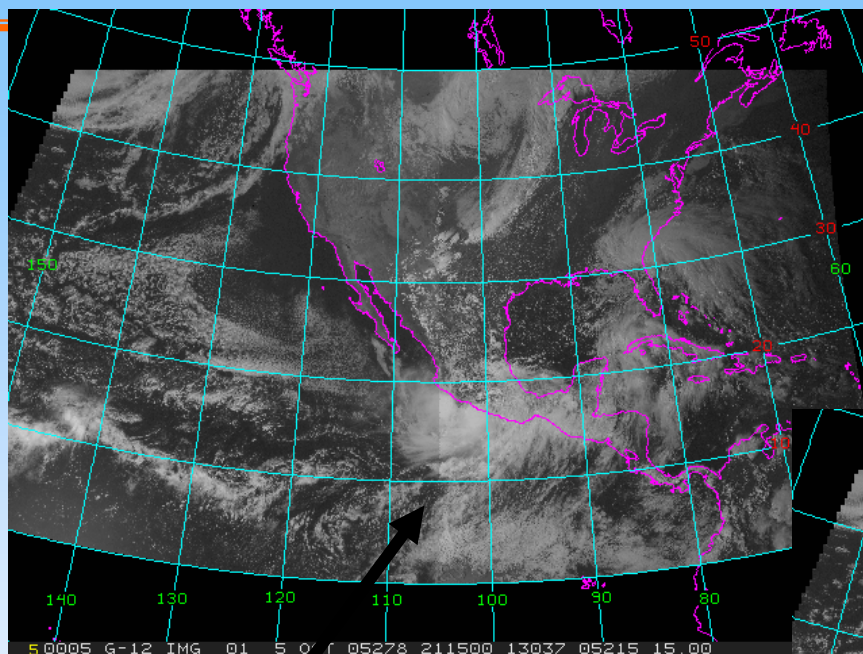
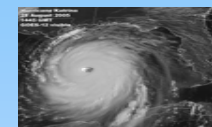
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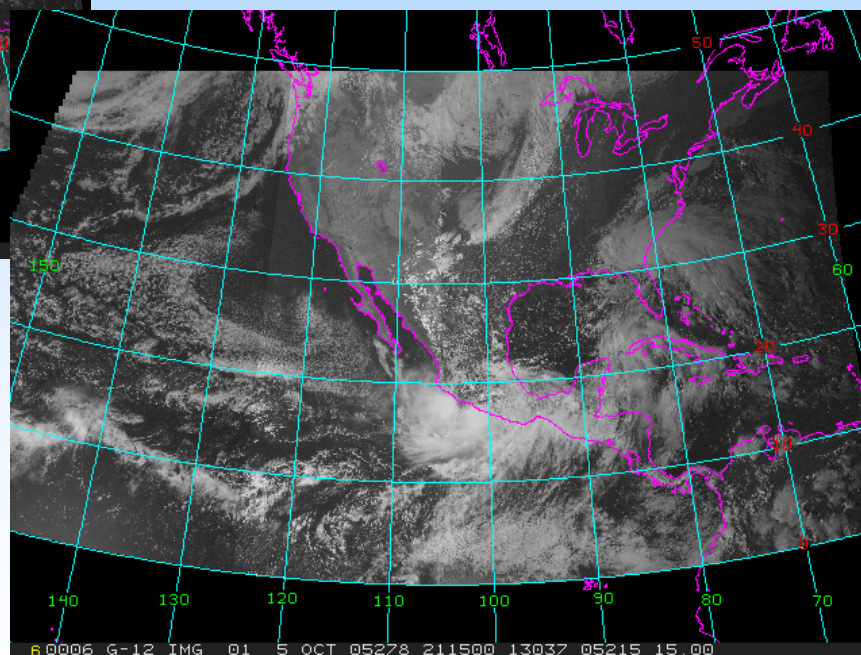


GOES Imagery Calibration for Weather Watch

Click Katrina
mosaicked
looping image



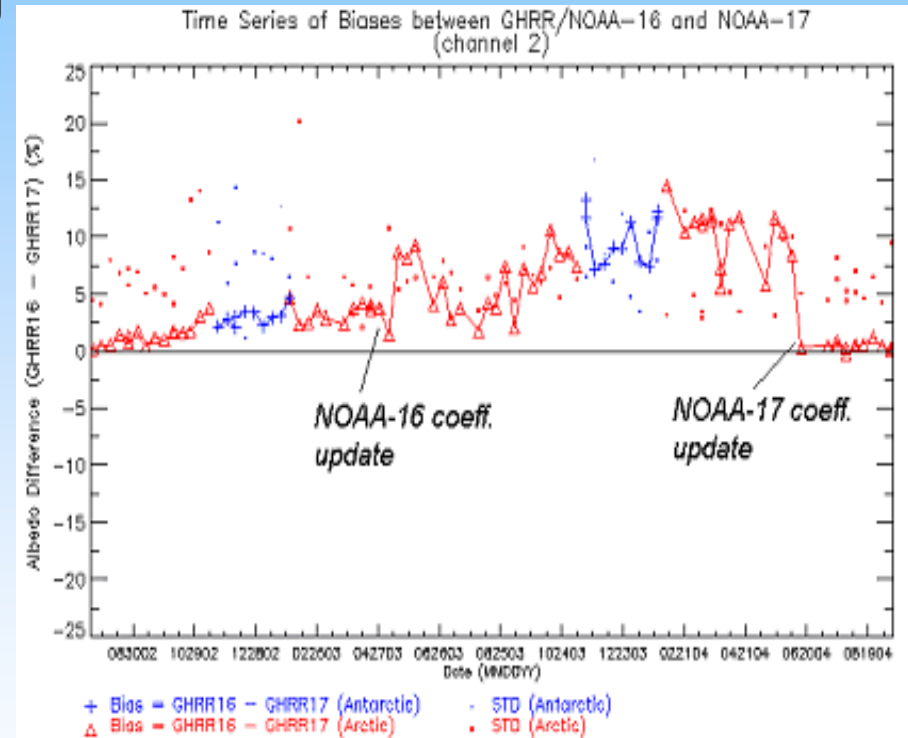
Seam from GOES-
East&West



Removing image artifacts like the seam issue is a core cal/val responsibility to ensure the highest quality products are available for tracking severe storms

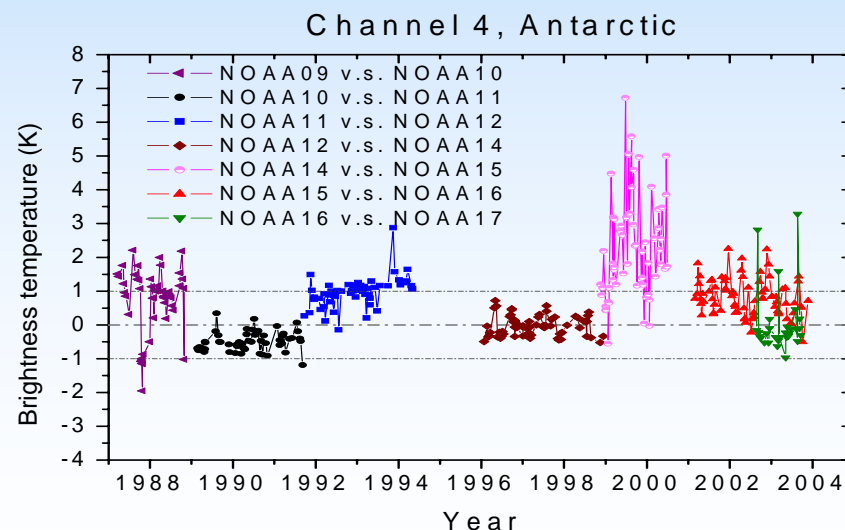
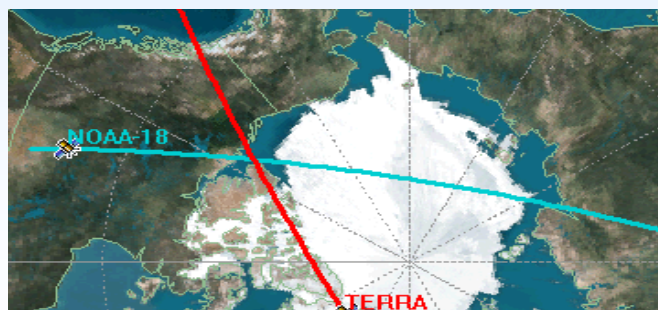
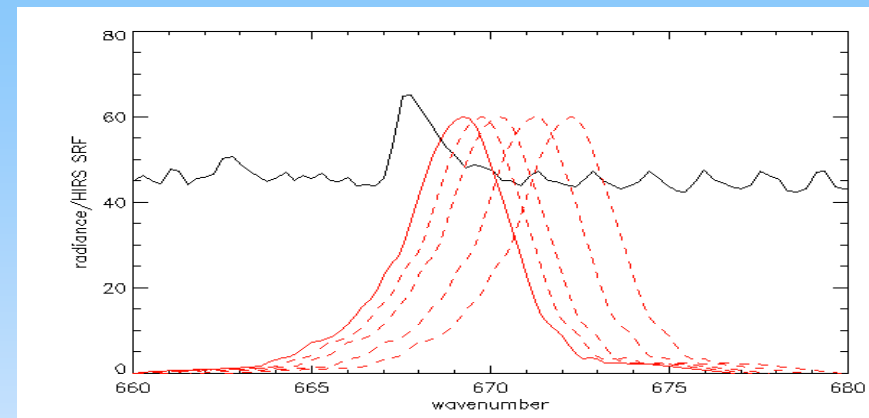
On-orbit Calibration and Verification of Satellite Observations

- Derive post-launch instrument noise equivalent delta temperature or radiance through analyzing calibration target measurements,
- Determine the optimal space-viewing of cold calibration target
- Improve calibration algorithms for counts to radiance conversion with updated coefficients,
- Assess instrument geo-location biases and co-registration with recommended solutions for errors in satellite attitudes (e.g. pitch, roll, and yaw),
- Characterize systematic biases in radiances through rigorous forward radiative transfer modeling,
- Provide timeliness diagnostics of any instrument performance analysis with root cause analyses.



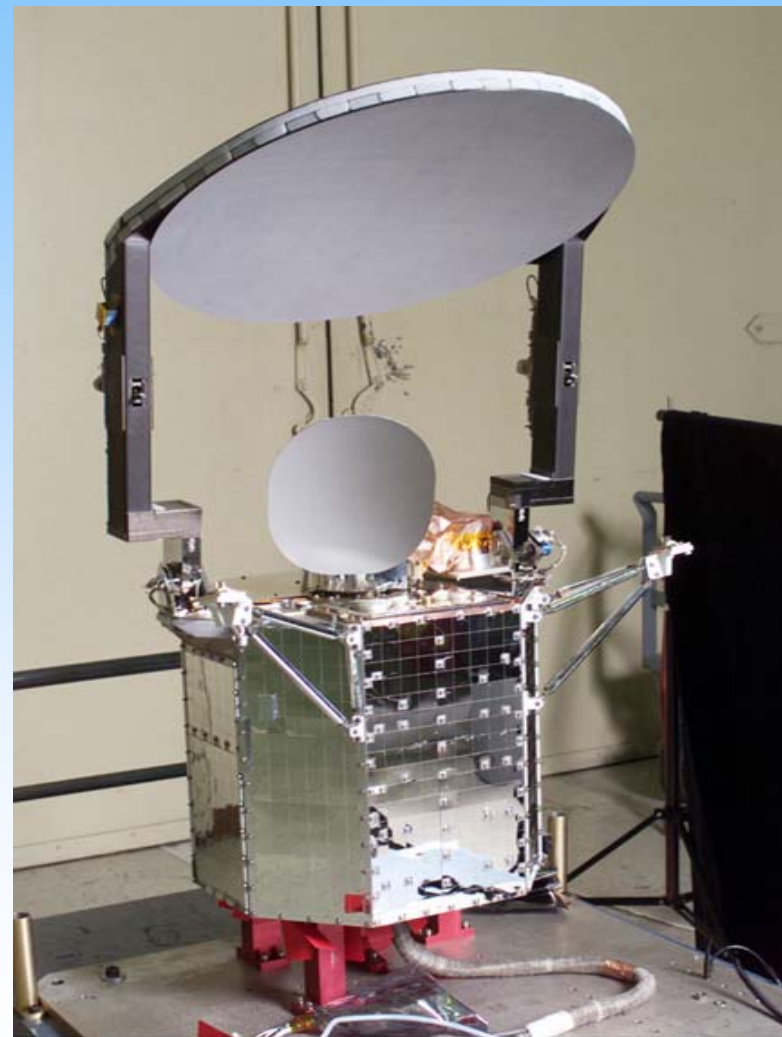
Inter-and Intra-calibration of Satellite Sensors

- Develop improved algorithms that efficiently and effectively extract SNO and SCO pairs from two satellites,
- Design intra-calibration algorithms that can perform optimal spatial and spectral convolution,
- Provide to user communities with the high-quality SNO/SCO data from POES, NPP, NPOESS and Metop, FY-3 Series



SSMIS Antenna System and Calibration

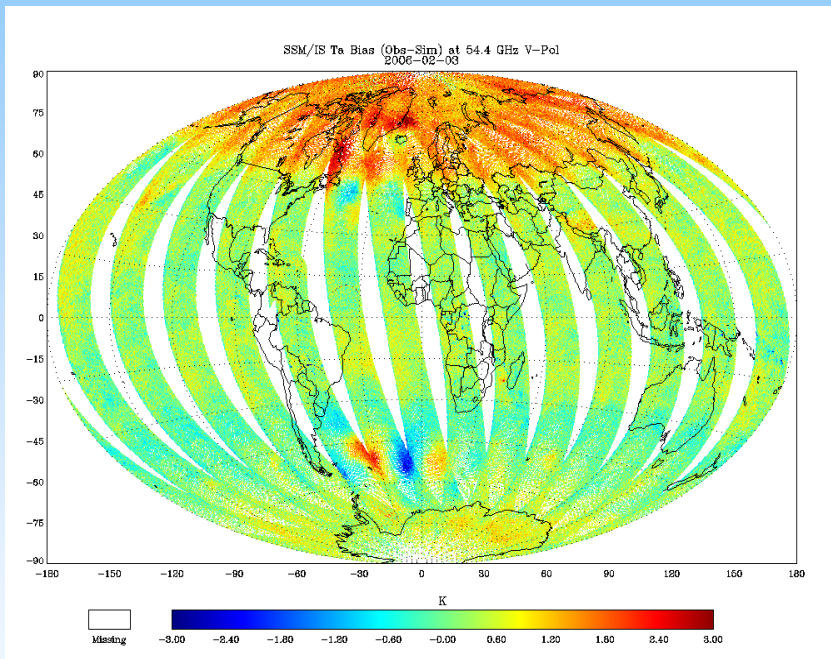
- Main-reflector conically scans the earth scene
- Sub-reflector views cold space to provide one of two-point calibration measurements
- Warm loads are directly viewed by feedhorn to provide other measurements in two-point calibration system
- The SSMIS main reflector emits radiation from its coating material
 - SiOx VDA (coated vapor-deposited aluminum)
 - SiOx and Al VDA Mixture
 - *Graphite Epoxy*
- Warm load calibration is contaminated by solar and stray lights
 - Reflection Off of the Canister Top into Warm Load
 - Direct Illumination of the Warm Load Tines
- Space view is also occasionally contaminated



CN600-136-D

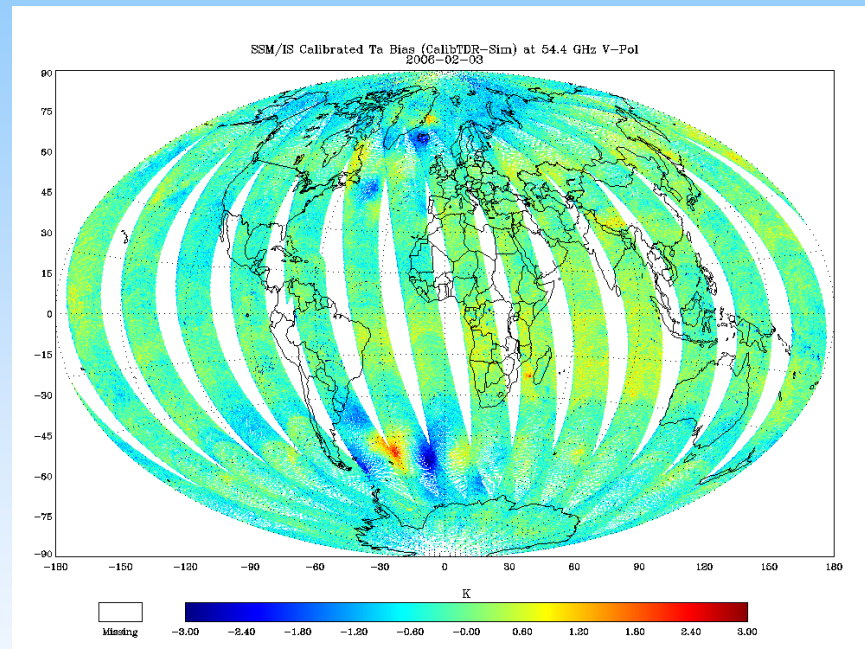
DMSP SSMIS Anomaly Correction

Before anomaly correction



Uncorrected Ch 4 OB-BK (GDAS CRTM)

After anomaly correction

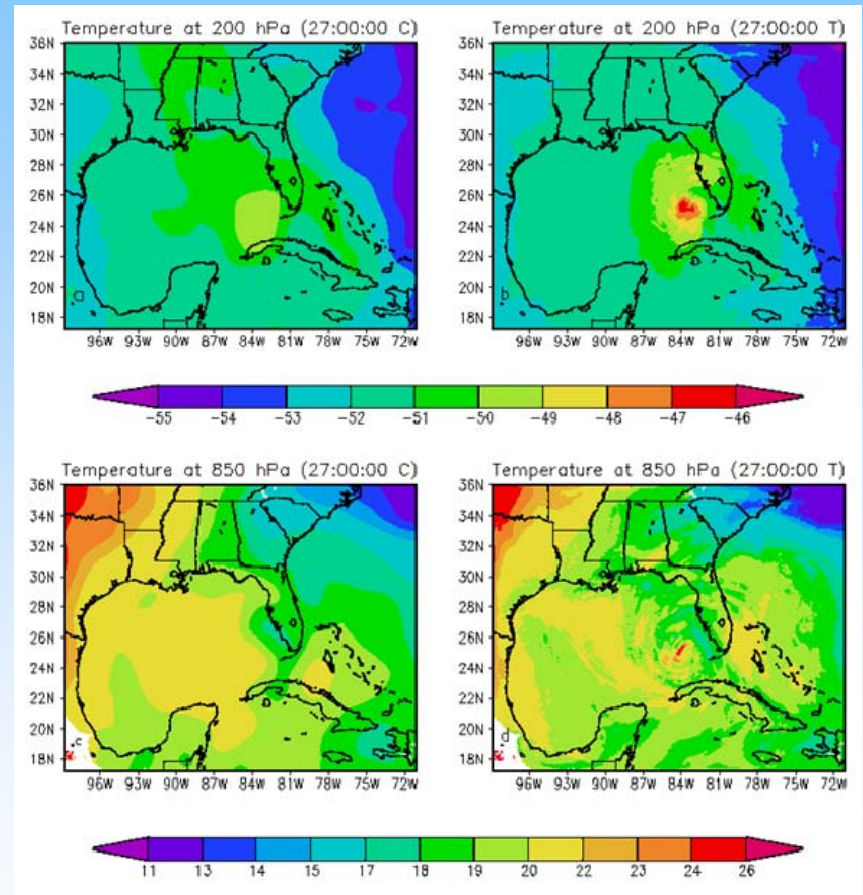


Corrected Ch 4 OB-BK (GDAS CRTM)

Direct SSMIS Cloudy Radiance Assimilation

DMSP F-16 SSMIS radiances is at the first time assimilated using NCEP 3Dvar data analysis. The new data assimilation improves the analysis of surface minimum pressure and temperature fields for Hurricane Katrina. Also, Hurricane 48-hour forecast of hurricane minimum pressure and maximum wind speed was significantly improved from WRF model

Significance: *Direct assimilation of satellite radiances under all weather conditions is a central task for Joint Center for Satellite Data Assimilation (JCSDA) and other NWP centers. With the newly released JCSDA Community Radiative Transfer Model (CRTM), the JCSDA and their partners will be benefited for assimilating more satellite radiances in global and mesoscale forecasting systems and can improve the severe storm forecasts in the next decade*



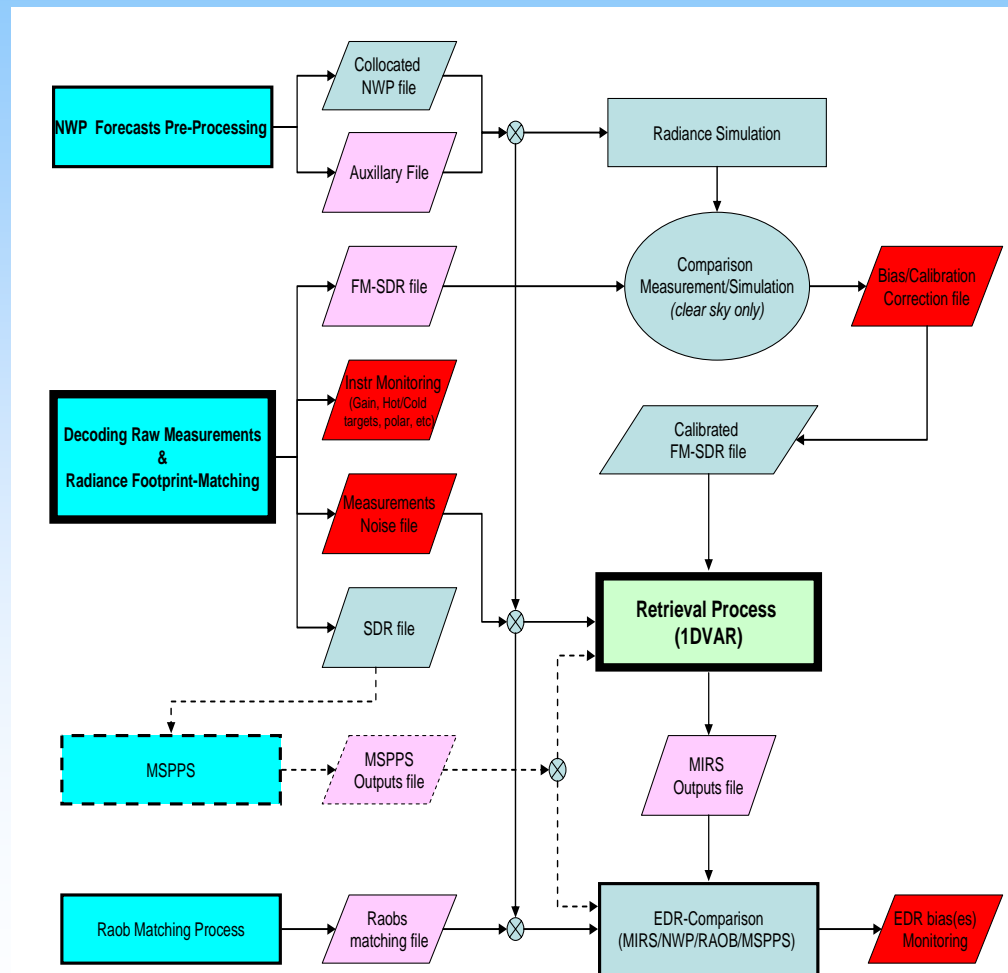
The initial temperature field from control run (left panels) w/o uses of SSMIS rain-affected radiances and test run (right panels) using SSMIS rain-affected radiances



Consensus Satellite Algorithms

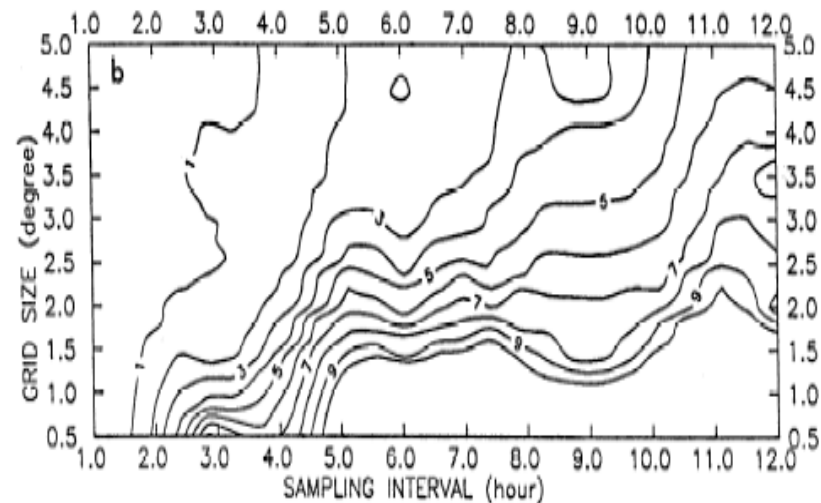
- Develop community algorithm components (e.g. CRTM, 1dvar) for consensus algorithms
- Develop algorithm testbeds to accommodate specific components (footprint matching, ancillary data, covariance matrix)

Prototype microwave testbeds and 1dvar



Unified Validation and Error Modeling

- Develop various unified validation tools for matching satellite and ground truth,
- Determine optimal requirements for space/time matching and areal averaging for various EDR parameters,
- Demonstrate supersite validation results for US and foreign satellites,
- Develop error sensitivity models for reference satellite.



Satellite precipitation errors estimated as a function of areal average and temporal sampling interval (Weng et al., 1994, JGR)



Summary

- **Starting FY08, NOAA satellite cal/val program is appropriated by US Congress for operational satellite calibrations**
- **Our program will**
 - **Turn instrument measurements into accurate environmental parameters**
 - **Ensure high-quality satellite imagery for forecasts (e.g. hurricane tracking and monitoring)**
 - **Deliver accurate products for weather forecasts and environmental monitoring**
 - **Ensure the integrity of the climate data record from satellites**



NOAA Cal/Val Program Road Map (2005 - 2015)

