JCSDA Unified PreProcessor for SSMIS

10 June, 2008

NRL SSMIS Assimilation Activities

- SSMIS Calibration Anomalies
  - Description
  - Post-Launch Mitigation Strategies
  - Analysis and Verification of Root Causes
  - Path Forward for F-18 through F-20 SSMIS
- SSMIS Unified Pre-Processor Development
- SSMIS Radiance Assimilation
  - Lower Atmosphere Sounding (LAS) Channels
  - Upper Atmosphere Sounding (UAS) Channels

NRL SSMIS Assimilation Activities

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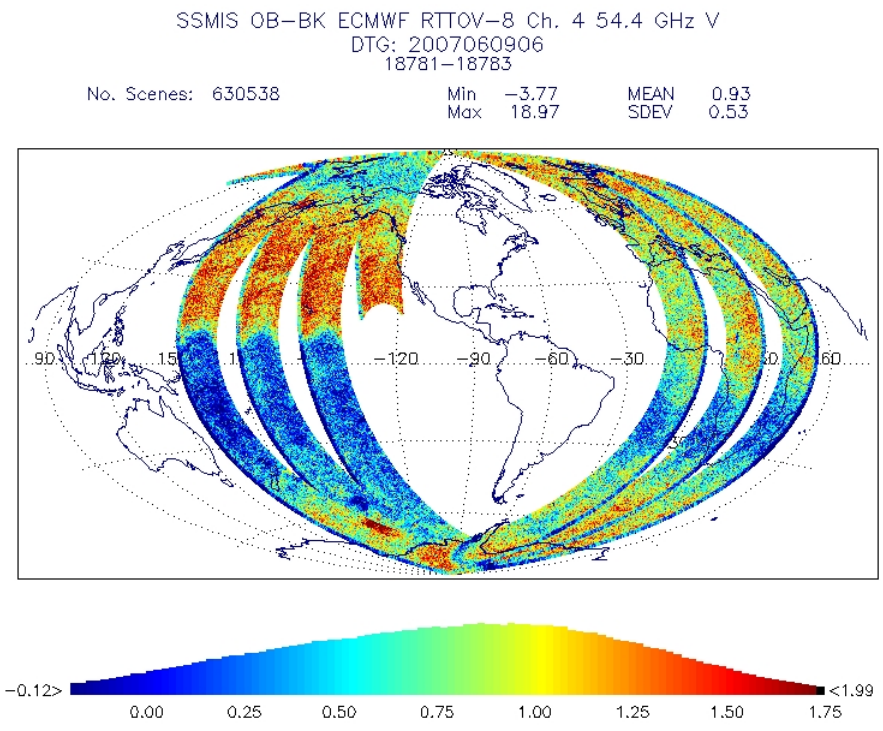
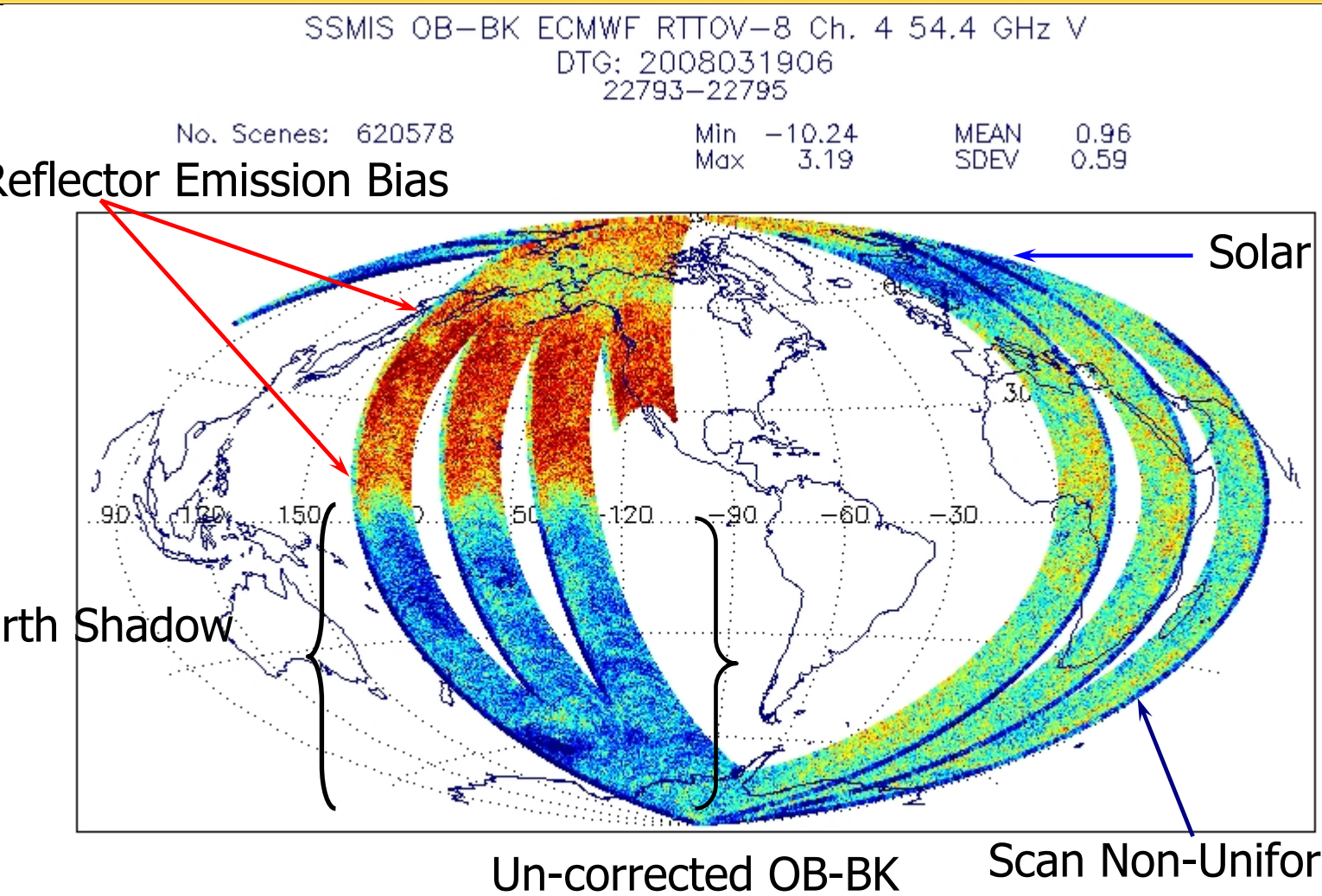
SSMIS Calibration Anomaly Detection

SSMIS Calibration Anomaly Detection

- Using OB-BK computed using ECWMF analyses and RTTOV-8 in combination with the DGS software package developed by Mike Werner (Aerospace), the SSMIS Cal/Val team was able to pinpoint the physical mechanisms causing the Calibration Anomalies



F-16 SSMIS Calibration Anomalies



SSMIS Unified Pre-Processor Development

NRL/Met Office SSMIS
Unified Pre-Processor (UPP) Overview

Unified Pre-Processor designed to mitigate the calibration anomalies uncovered during the SSMIS Cal/Val process and produce corrected SSMIS TDR files suitable for radiance assimilation at both global and regional scales.

- UPP V1 included
  - Reflector Emission Corrections
  - Warm Load Solar Intrusion detection and flagging (Gain Anomalies)
  - Spatial Averaging to reduce NEΔT to the 0.1 K level
- UPP V2 includes
  - Uses Operational NGES Fourier Filtered Gain Files to Correct Gain Anomalies
  - Produces ASCII and BUFR TDR output files at reduced resolution
  - Performs Scan Non-uniformity corrections
- UPP V3 Plans
  - Perform Anomaly corrections and produce TDR file at native resolution
  - Allow end-users to define amount of spatial averaging
  - Additional F-17 Calibration Averaging to lower scene noise

NRL/Met Office SSMIS UPP V2 Planned User Community

F-16 UPP V2 is Operational at FNMOC and is being Distributed to NESDIS

UPP V2 includes the required BUFR Format modification Option

- NRL has Transitioned F-16 SSMIS UPP to FNMOC for Radiance Assimilation
- F-17 UPP Modifications Underway
- AFWA currently conducting WRF Radiance Assimilation Trials using the UPP V2 data in for the Southeast Asia window corresponding to the FNMOC/AFWA JEFS/JME demonstration project this past Summer
- EMC conducting GFS Radiance Assimilation Trials using the UPP V2
- Met Office is Operational with SSMIS Met Office PP, and plans to wait for operational distribution of UPP by FNMOC
- EMC, ECMWF, MeteoFrance, and MSC plan on using data from the SSMIS UPP V2 as soon as its available

NRL/Met Office SSMIS UPP
Summary and Future Developments

SSMIS Unified Preprocessor Developed to Meet NWP DA Needs

The UPP Produces SSMIS data that Meet the Stringent NWP Radiance Assimilation Accuracy Requirements for Temperature Sounding Channels

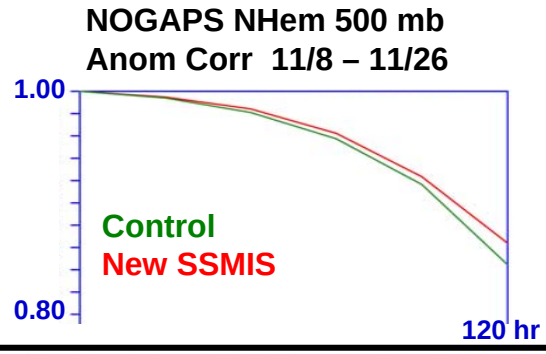
Plans are to allow for user specified Averaging to meet specific application requirements. i.e. Mesoscale NWP

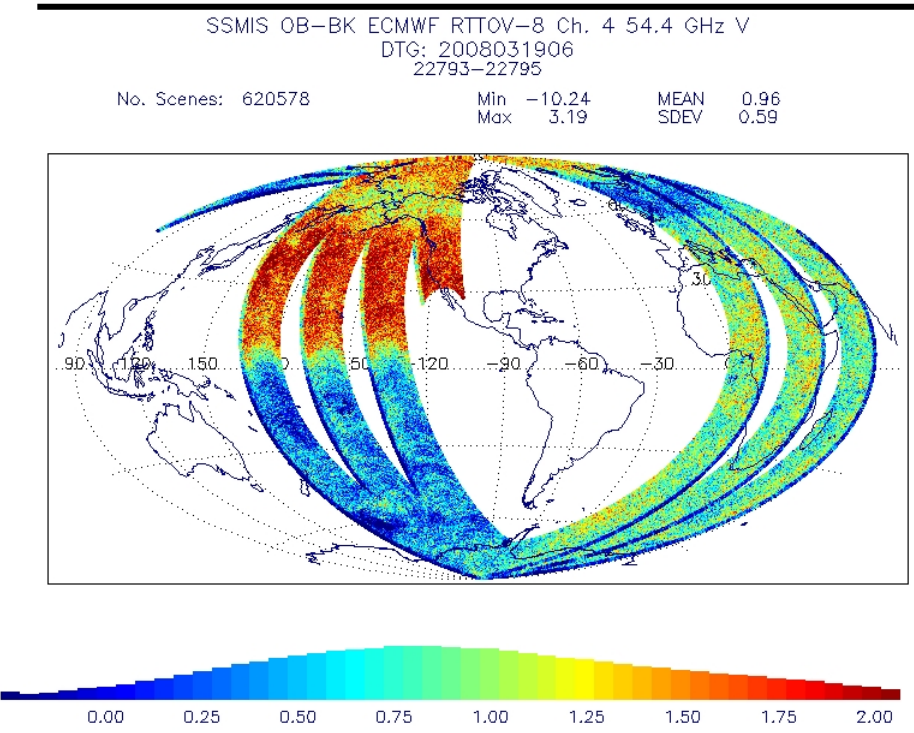
SSMIS UAS Radiance Assimilation will also Require Pre-Processed SSMIS TDR data with the required Geomagnetic Parameters

F-17 SSMIS Data Present an New Challenge for the Radiance Assimilation Community to Produce TDR Data meeting the NWP DA Requirements

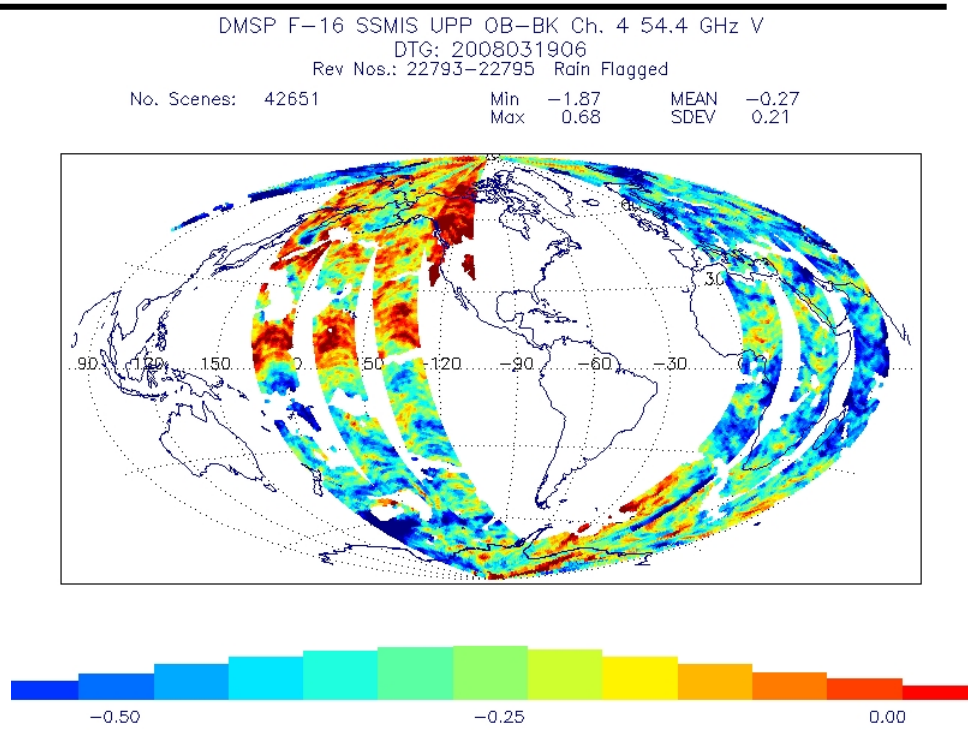
NRL SSMIS LAS Radiance Assimilation

Radiance Assimilation Trials with SSMIS UPP V2 Data and NAVDAS





Un-corrected OB-BK



UPP Corrected OB-BK

NRL SSMIS UAS Radiance Assimilation

Upper Atmosphere RTMs

- Data assimilation requires both the forward RTM and its adjoint (Jacobian)

- Forward RTM computes brightness temperatures from the model background model fields and geomagnetic field parameters with respect to the SSMIS viewing angle.

- The Jacobian maps differences between the observed and background brightness temperatures (i.e., innovation) back to changes in the background temperature profiles (i.e., the correction).

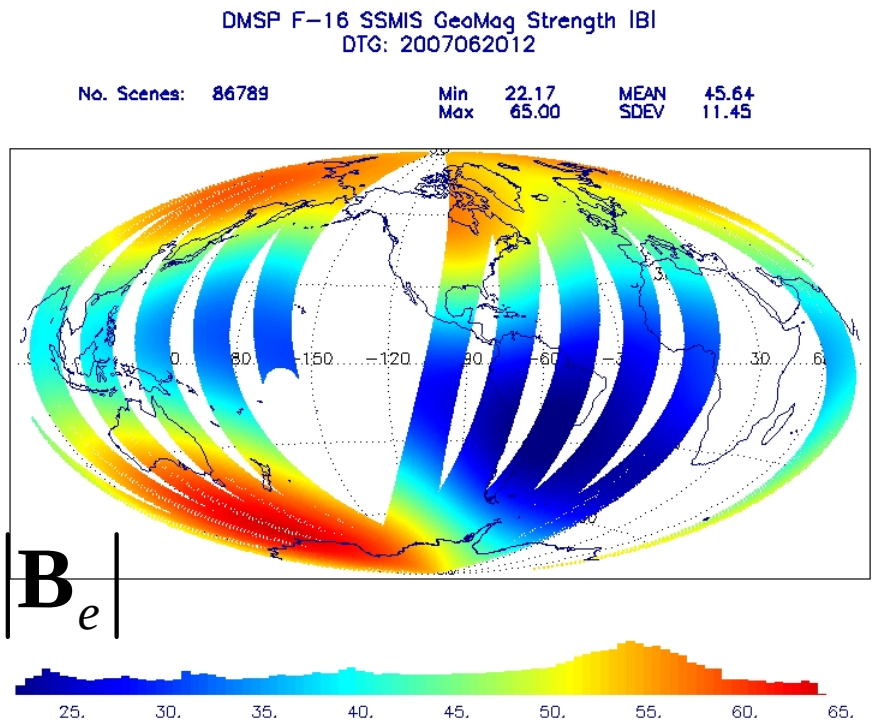
- Operational data assimilation requires a fast and accurate RTM and adjoint -- 6 hours of satellite radiances in under 5 minutes

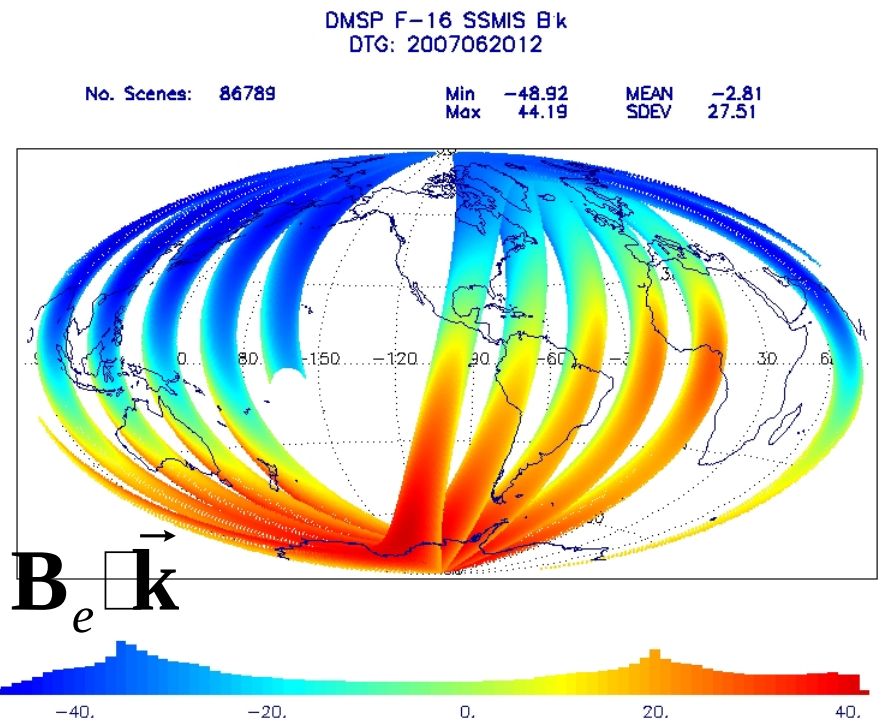
- The fully polarized NRL line-by-line model is computationally intensive. Plans are to use the Community Radiative Transfer Model including the Zeeman parameterization (CRTM-Z), developed by the Joint Center for Satellite Data Assimilation (JCSDA).

NRL SSMIS UAS Radiance Assimilation

Zeeman Effect

- Interaction of O_2 absorption spectrum with geomagnetic field (B_e) leads to Zeeman splitting of absorption lines
- Leads to a shift in peaks of the weighting functions depending on the strength and orientation of B_e

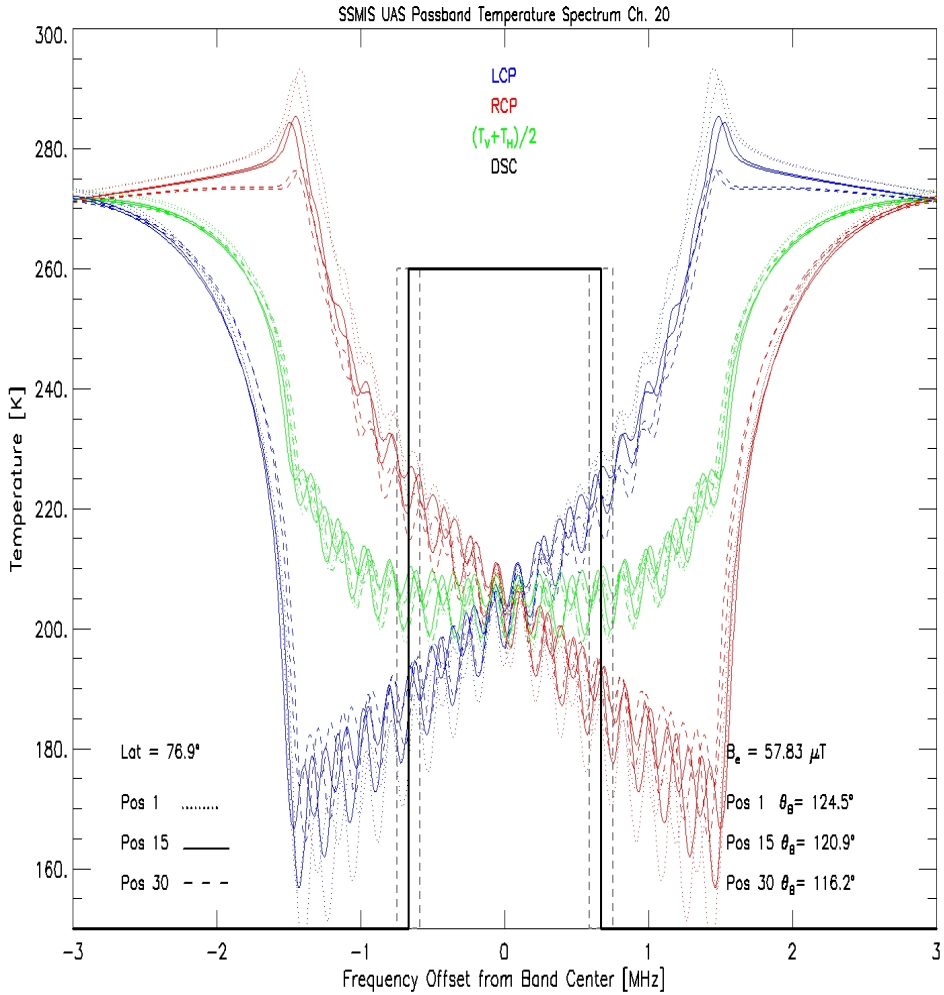




NRL SSMIS UAS Radiance Assimilation

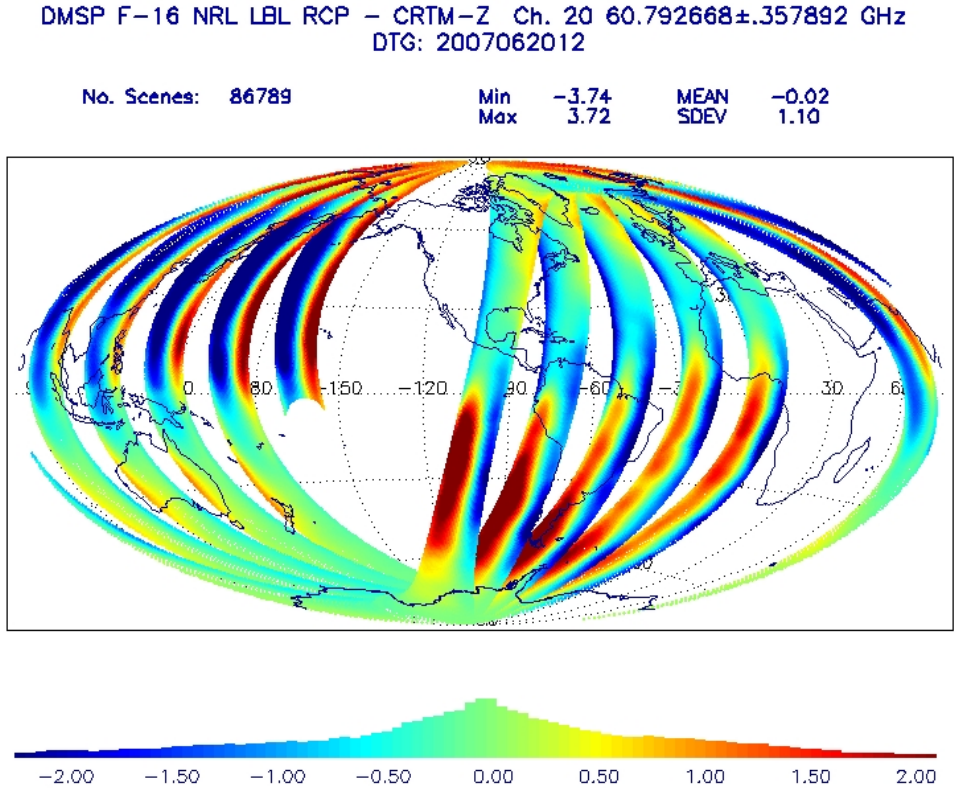
Importance if the Earth Rotation Doppler on Circular Polarized SSMIS UAS TBs

Simulated Brightness Temperature Spectrum for SSMIS Ch 20 for a strong magnetic field case across the channel passband for beam positions 1, 15, and 30 (left, center and right of scan). The slope of the spectrum across passband denotes the greater sensitivity of LCP and RCP to small frequency shifts compared to the $(T_V+T_H)/2$ measurement originally planned for the SSMIS. The dashed line about the passband (black rectangle) represents an uncertainty of 80 KHz about the center frequency.



NRL SSMIS UAS Radiance Assimilation

NRL LBL with Earth Rotation Doppler Shift vs. CRTM-Z without Earth Rotation Doppler



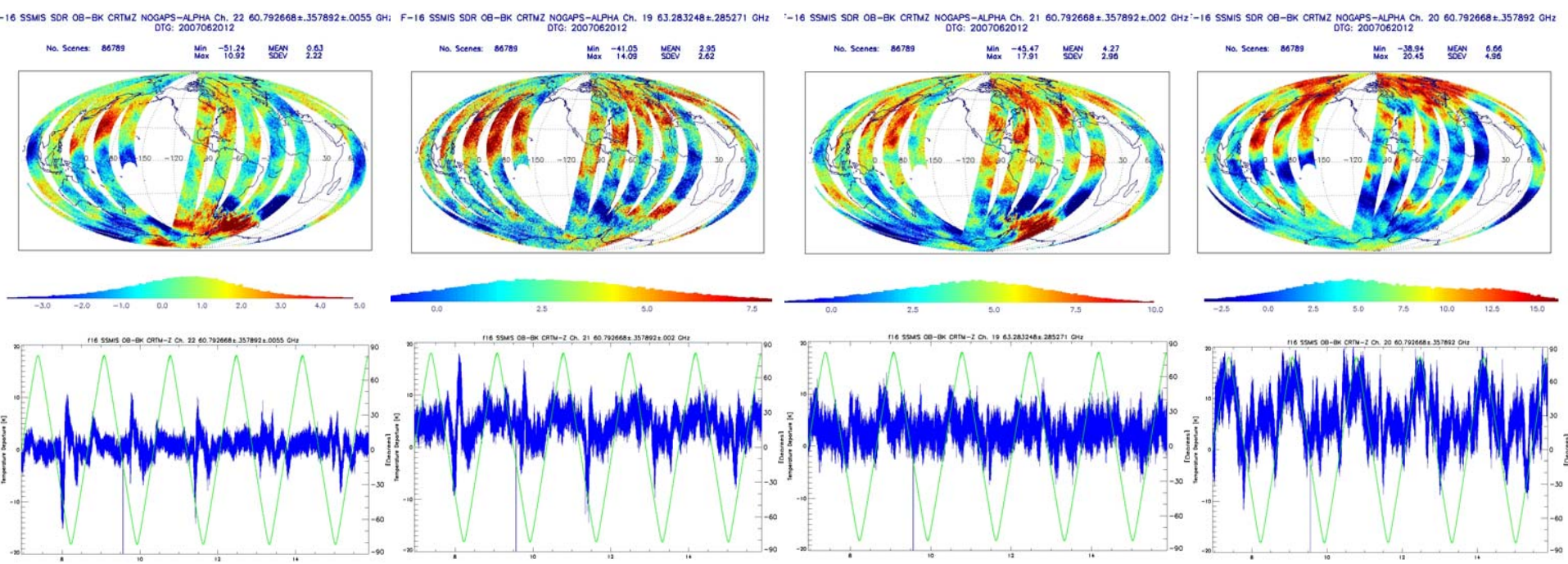
Shift for ascending revs of SSMIS Ch 20 over the western pacific. Differences indicate the importance of including both the Earth Rotation Doppler Shift in the RTM calculations and properly parameterizing the Zeeman effects and orientation of the Earth's magnetic field.

NRL SSMIS UAS Radiance Assimilation

Preliminary Results SSMIS UAS Radiance Monitoring
NOGAPS-ALPHA and CRTM-Z

OB-BK

Ch 22 | Ch 21 | Ch 19 | Ch 20



Time Series of UAS OB-BK

NRL SSMIS UAS Radiance Assimilation

Future NRL SSMIS UAS Radiance Assimilation Efforts

- Further validation of JCSDA CRTM-Z to determine the importance of including the Earth rotation Doppler effects into RTM

- Develop methodology to assimilate the SSMIS UAS TBs into NOGAPS-ALPHA (high-altitude) using CRTM-Z simulations

- Develop and validate NAVDAS-AR assimilation of SSMIS radiances for upper atmospheric analysis and modeling

- Develop and validate NAVDAS-AR assimilation of AIRS, HIRS, and IASI radiances for upper atmospheric analysis and modeling