Preparation of CRTM for NPP/JPSS and GOES-R

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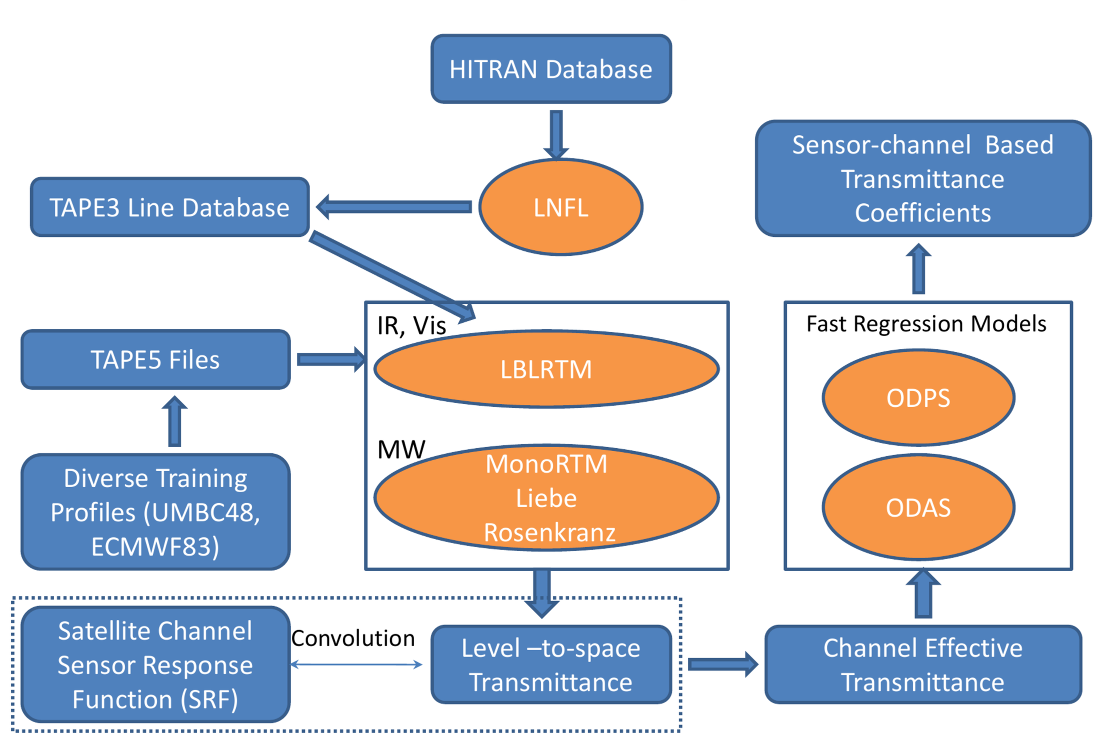
Introduction

Sensors on future national operational environmental satellite systems-Joint Polar Satellite System (JPSS) and the Geostationary Operational Environmental Satellite R-Series (GOES-R) will provide satellite data to improve weather forecasts in Numerical Weather Prediction (NWP) models through direct assimilation of satellite radiances. For this purpose, a fast and accurate Radiative Transfer (RT) model is required. Community Radiative Transfer Model (CRTM) is developed at the Joint Center for Satellite Data Assimilation (JCSDA), providing calculated radiances (or Brightness Temperature (BT)) and the responses of the radiances to the perturbations of state variables (radiance Jacobians, Tangent-Linear (TL), and Adjoint (AD) models). The current CRTM version (v2.0.2) has the capability to simulate visible, infrared, and microwave channel radiances (or BTs) for satellite sensors under various atmosphere and surface conditions.

CRTM readiness for NPP/JPSS and GOES-R is very important for NWP centers to use GOES-R and JPSS data as soon as the new systems launch. Efforts have been made to produce the CRTM transmittance coefficients (both ODAS and ODPS), which are used to calculate the clear sky atmospheric optical depth in CRTM, for the Cross-track Infrared Sounder (CrIS), the Advanced Technology Microwave Sounder (ATMS), and Visible/Infrared Imager/Radiometer Suite (VIIRS) on NPP, and the Advanced Baseline Imager (ABI) on GOES-R. The training statistics are presented for each of these sensors. Channel weighting function and Jacobian calculated from CRTM are also discussed.

Generation of Transmittance Coefficients

CRTM Coefficients Training Process



Process of generating fast model CrIS coefficients

Run LBLRTM to generate the transmittance spectra on a constant wave number basis (0.001 cm^{-1}) from 610 to 2590 cm^{-1}.

↓ FFT

Fourier transform of the spectra to the interferogram space.

↓ Apodization Function

Convolution is done in the interferogram space by multiplying the Apodization functions.

↓ FFT^{-1}

Inverse Fourier transfrom of the products to spectra space, resampling the spectra on a constant wave number basis.

↓

Computing effective transmittance for dry, water vapor, and ozone and other gases.

↓

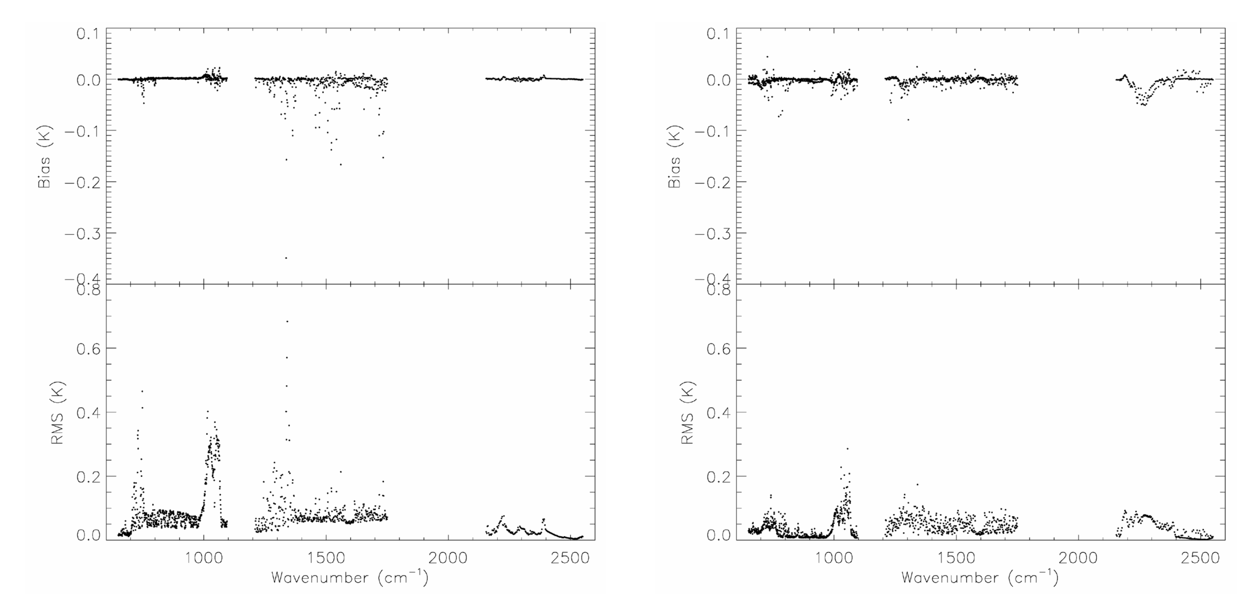
Training the transmittances with optical path transmittance algorithm.

Results

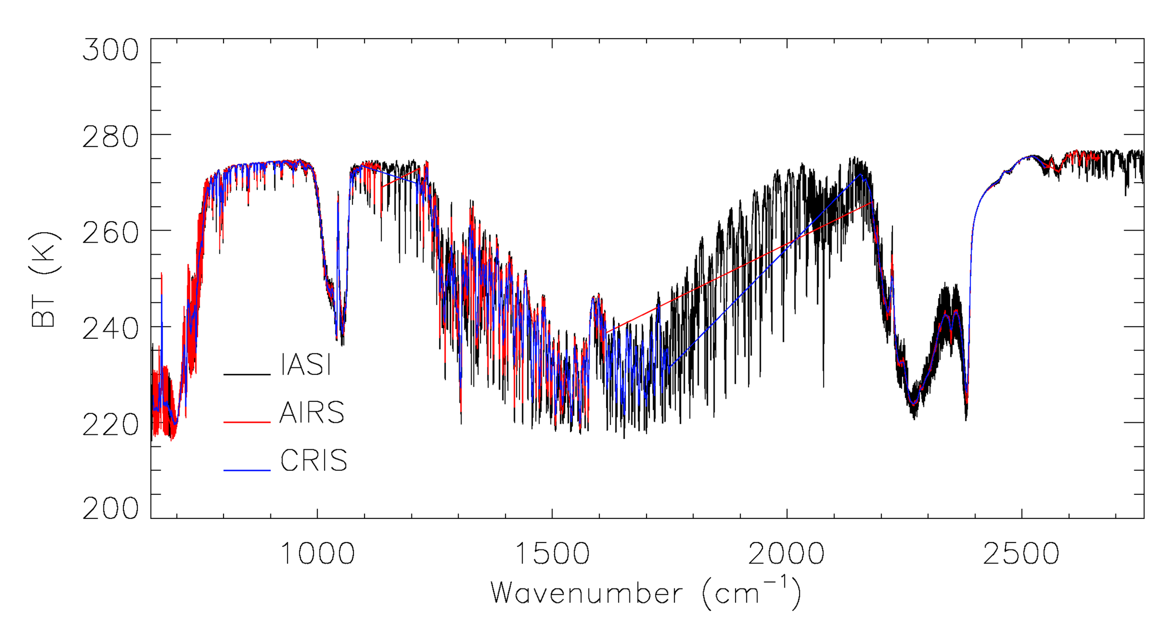
CrIS transmittance ODAS (Optical Depth in Absorber Space, Compact-OPTRAN), and ODPS (Optical Depth in Pressure Space) training results compared to LBL

Compact-OPTRAN:
Variable gases: H_2O, O_3
Fixed gas: CO_2, CO, CH_4, N_2O, O_2

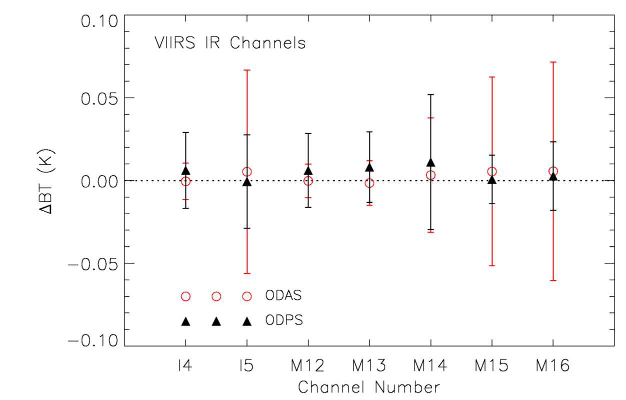
ODPS (with possible ODAS wlo)
Variable gases: CO_2, H_2O, O_3
Fixed gas: CO, CH_4, N_2O, O_2, CFCs and others



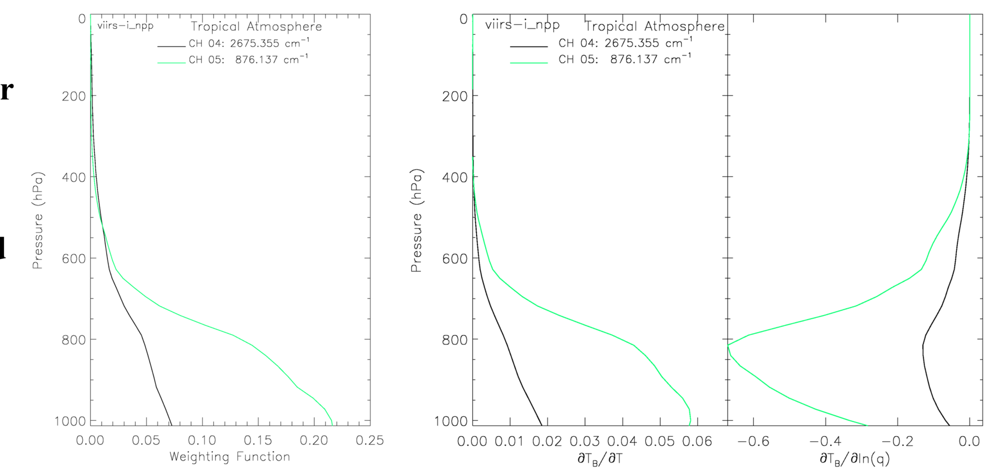
CRTM simulated brightness temperature spectra for hyper-spectral infrared sensors IASI, AIRS, and CrIS



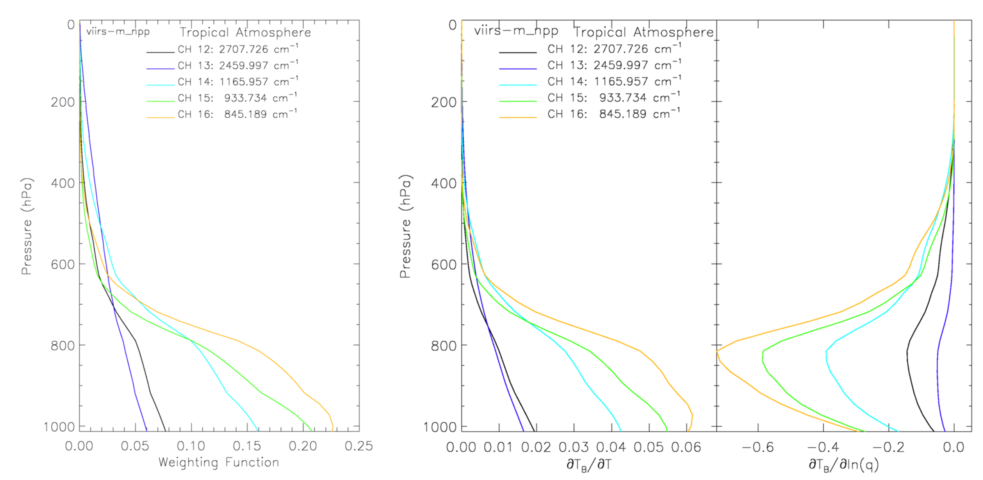
VIIRS IR channel transmittance ODAS, and ODPS training results compared to LBL for dependent profile set (mean difference and standard deviation).



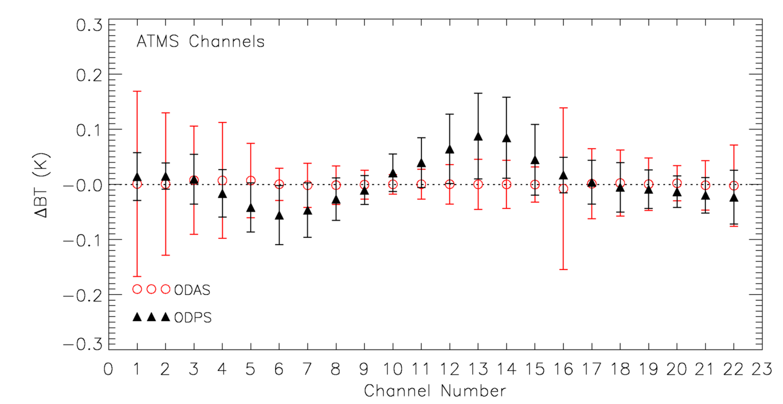
VIIRS imager channels I4, and I5 weighting functions and Jacobians



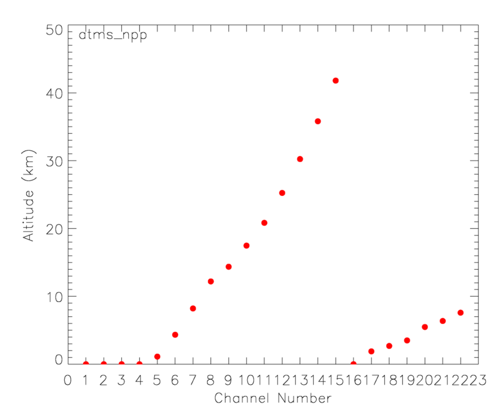
VIIRS moderate spatial resolution sensor channels M12-M16 weighting functions and Jacobians



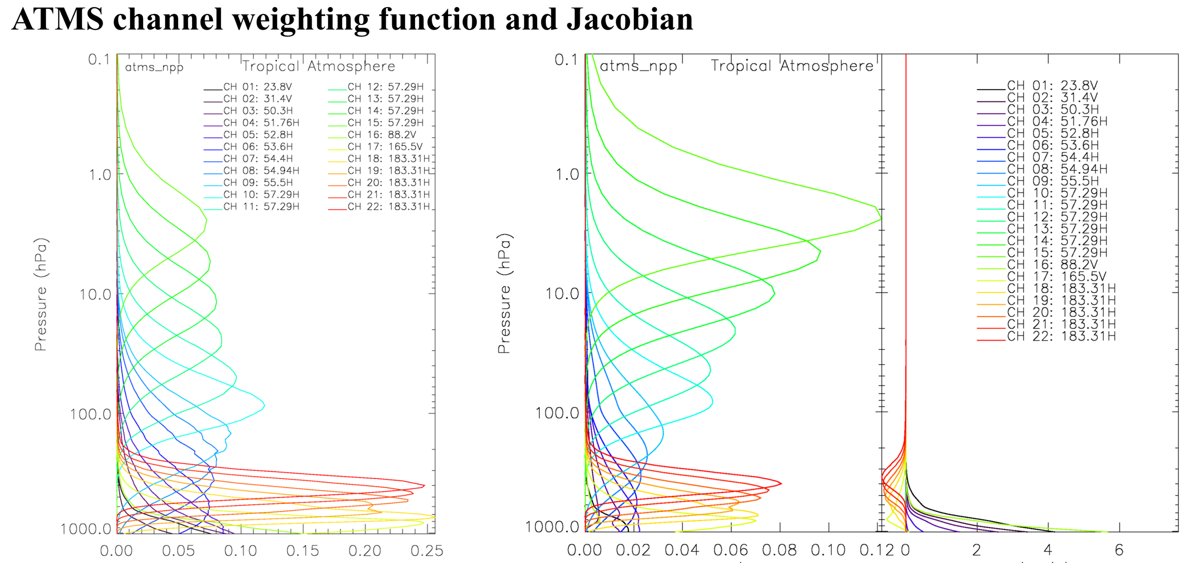
ATMS channel transmittance ODAS, and ODPS training results compared to LBL



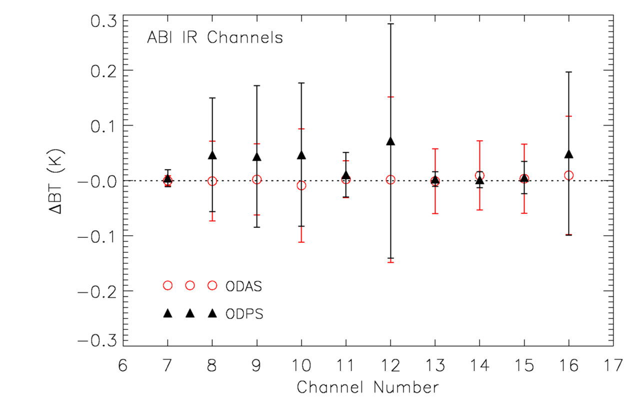
ATMS channel weighting function peak height



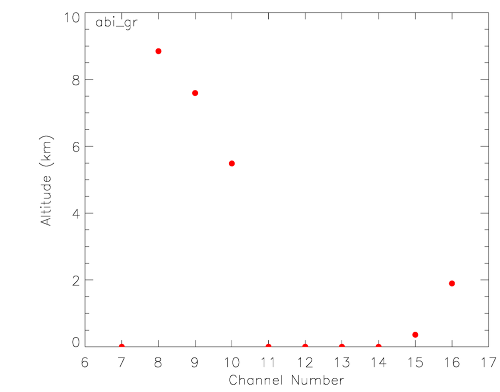
ATMS channel weighting function and Jacobian



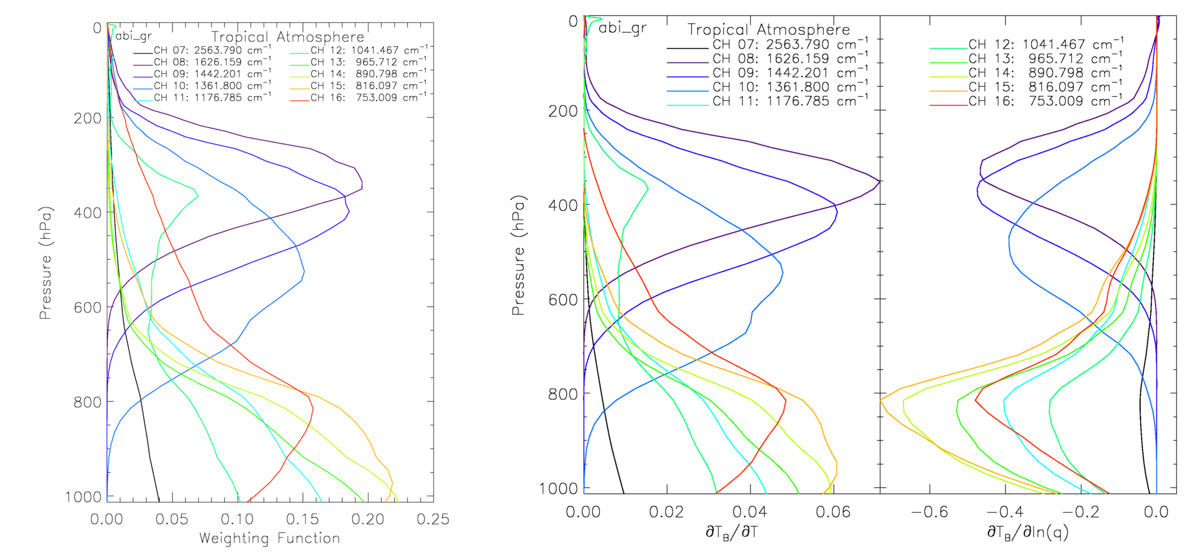
ABI IR channel transmittance ODAS, and ODPS training results compared to LBL for dependent profile set (mean difference and standard deviation).



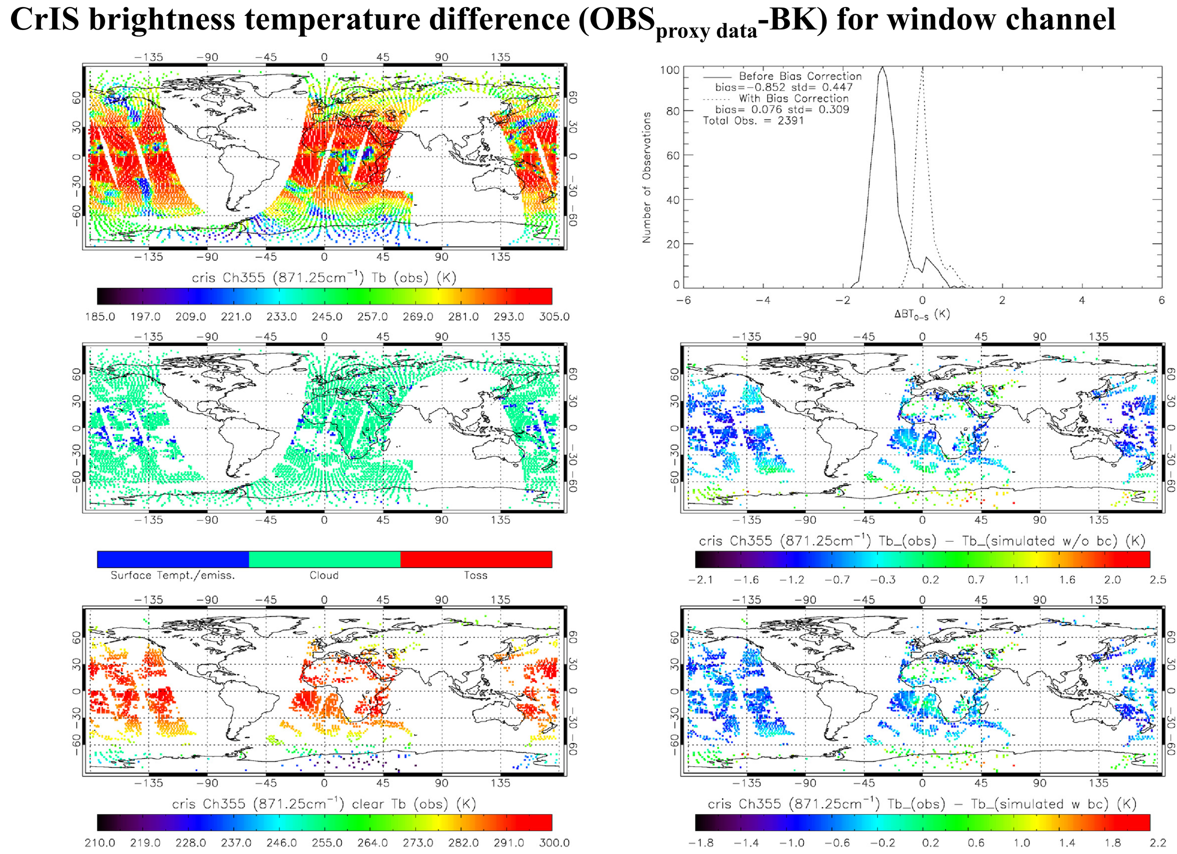
ABI channel weighting function peak height



ABI channel weighting function and Jacobian



CrIS brightness temperature difference (OBS$_{proxy\ data}$-BK) for window channel



Concluding Remarks

Two sets of coefficients are generated in the formats of ODAS and ODPS for infrared and microwave sensors on future satellites NPP/JPSS and GOES-R. CRTM is ready to simulate the channel brightness temperatures as well as the channel Jacobians for sensors CrIS, ATMS, and VIIRS on NPP/JPSS, and ABI on GOES-R. Future work will focus on preparation of the radiance assimilation for these sensors in NCEP Global Data Assimilation System (GDAS) to accelerate the uses of satellite data as soon as the new systems launch.

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