Preparation of NPOESS CrIS in GSI System

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Introduction

In conjunction with the Advanced Technology Microwave Sounder (ATMS), the Cross-track Infrared Sounder (CrIS) will provide satellite data to improve weather forecast in numerical weather prediction (NWP) models. For direct assimilation of satellite radiances, 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).

Preliminary transmittance coefficients, which are used to calculate the channel radiances (or BTs), are ready in the CRTM for CrIS. The coefficients are in two formats, one is for current operational Compact OPTRAN, and the other is for a new transmittance model called Optical Depth at Pressure Space (ODPS) which additionally include trace gases coefficients.

Preparing the assimilation of the CrIS data in NCEP Global Data Assimilation System (GDAS) is also presented.

Generation of CrIS Channel Coefficients

CrIS Specifications

Band	Spectral range [cm^{-1}]	Spectral range [μm]	Band width [cm^{-1}]	Resolution [cm^{-1}]	MPD [cm]	Channels
LW	650 – 1095	15.4 – 9.1	445	0.625	0.8	713
MW	1210 – 1750	8.3 – 5.7	540	1.25	0.4	433
SW	2155 – 2550	4.6 – 3.9	395	2.5	0.2	159

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.

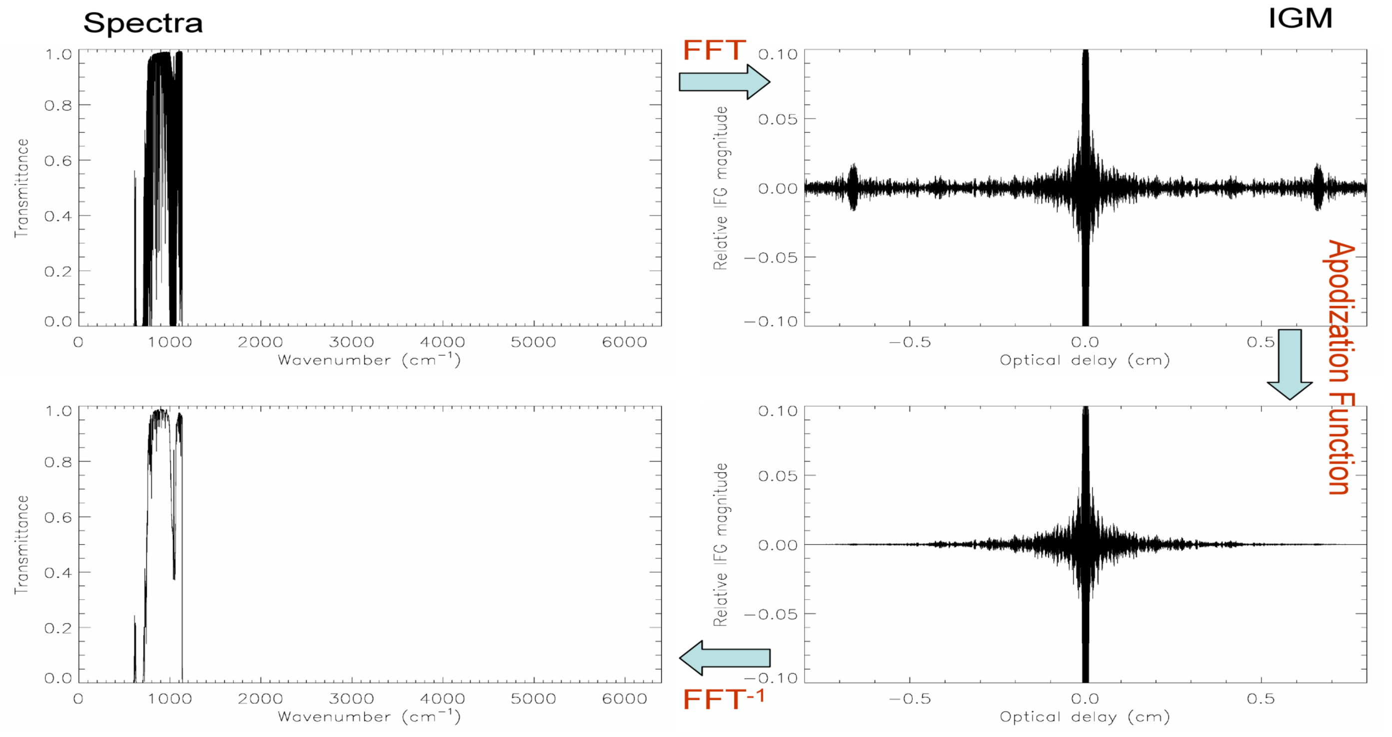
↓

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

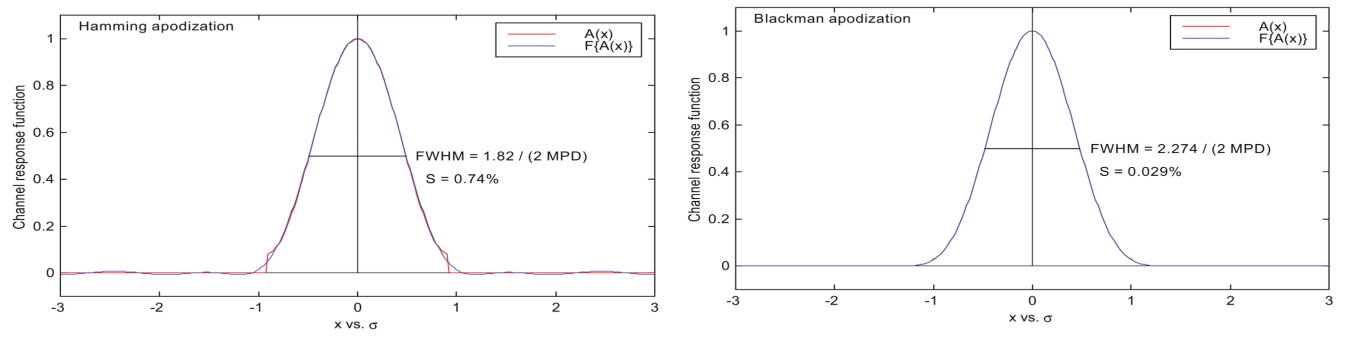
↓

Training the transmittances with optical path transmittance algorithm.

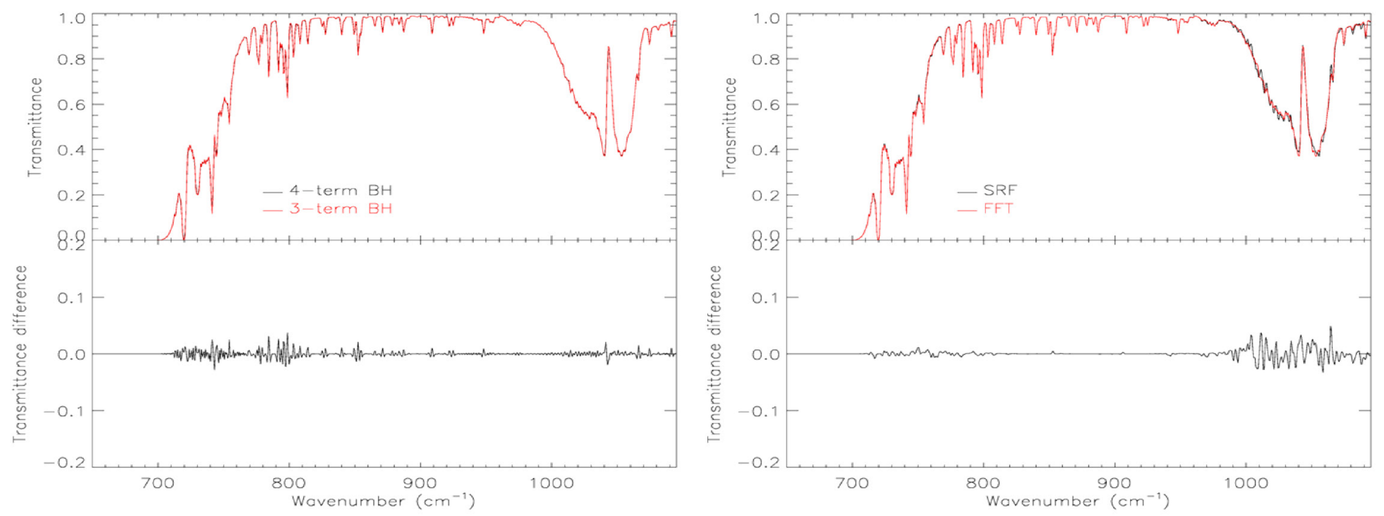
Process of generating CrIS band 1 channel transmittances



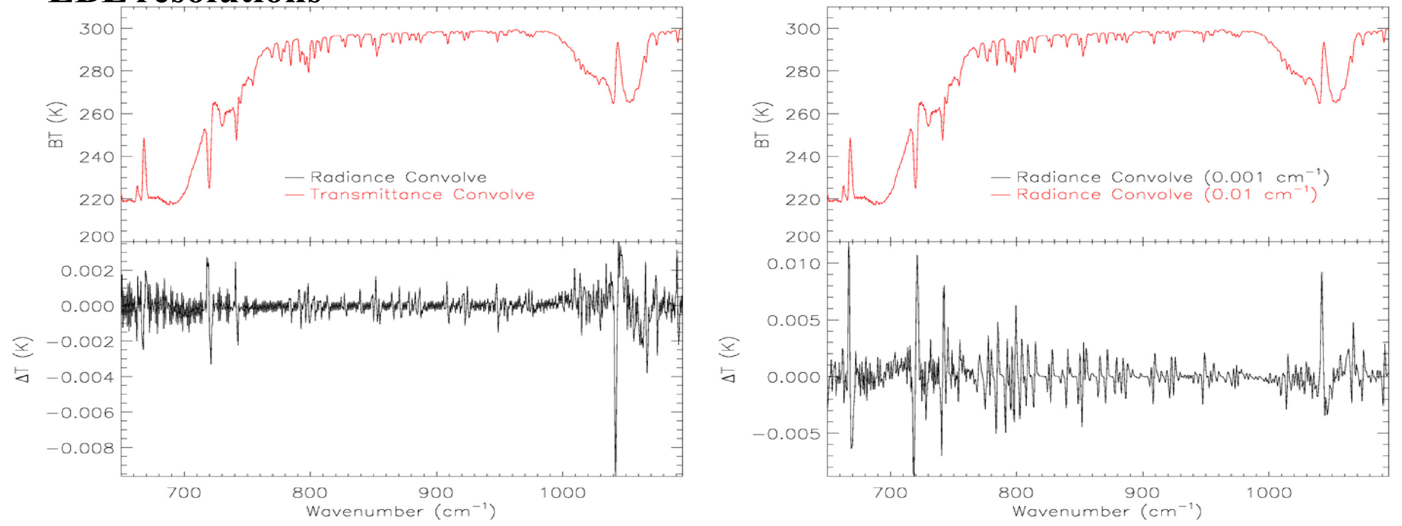
Apodization functions



Comparison results for apodization functions, and convolving with SRF



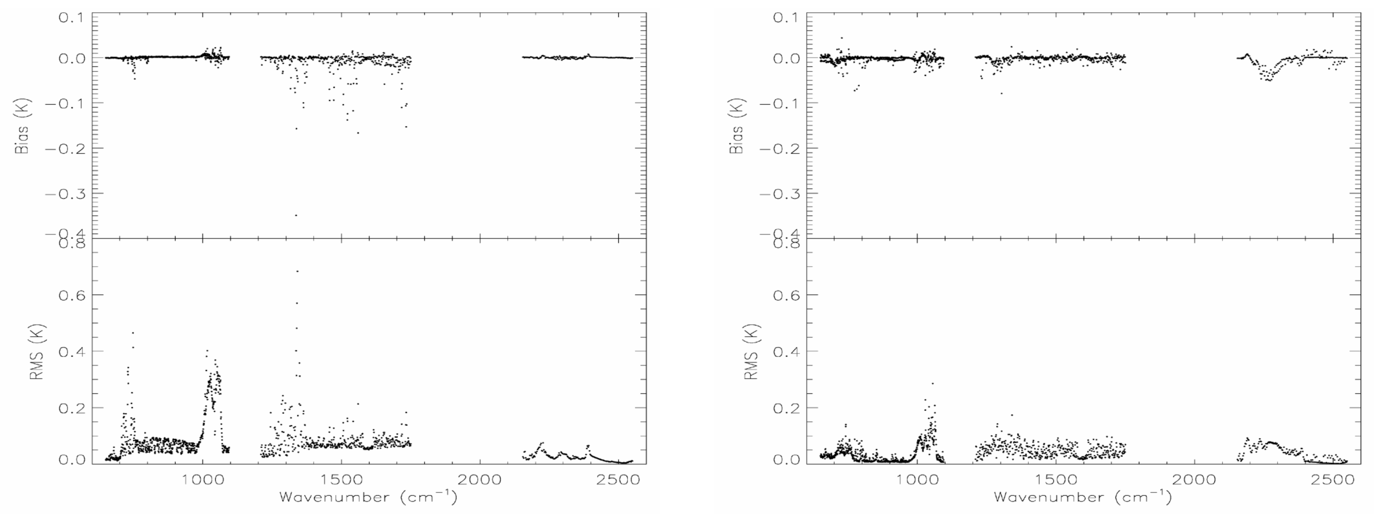
Comparison results for convolving radiance vs transmittance, and different LBL resolutions



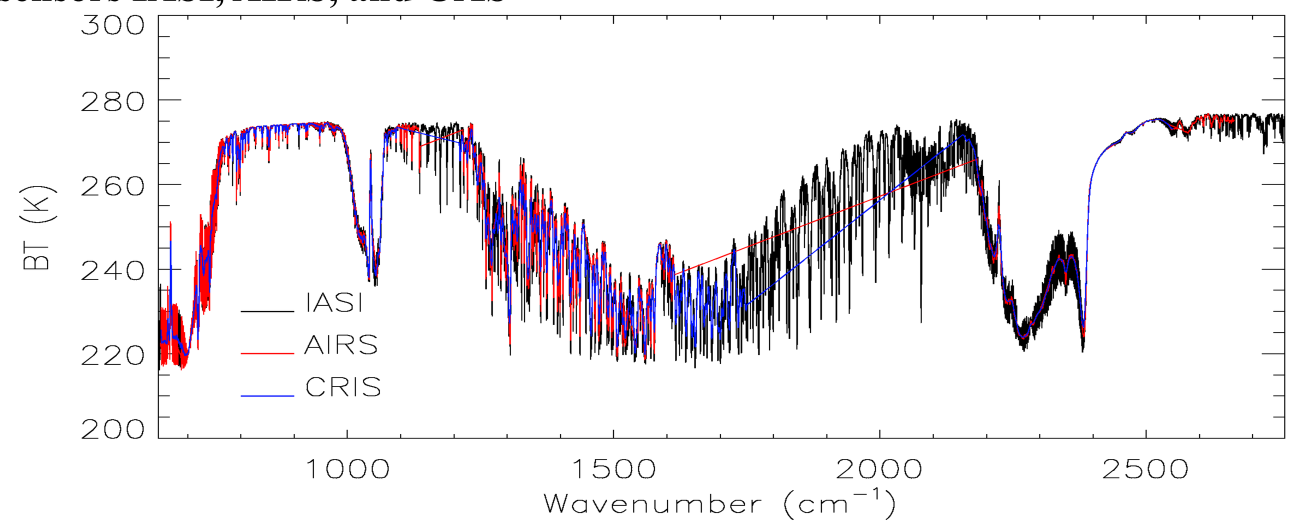
CrIS transmittance ODAS, ODPS training results compared to LBL

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



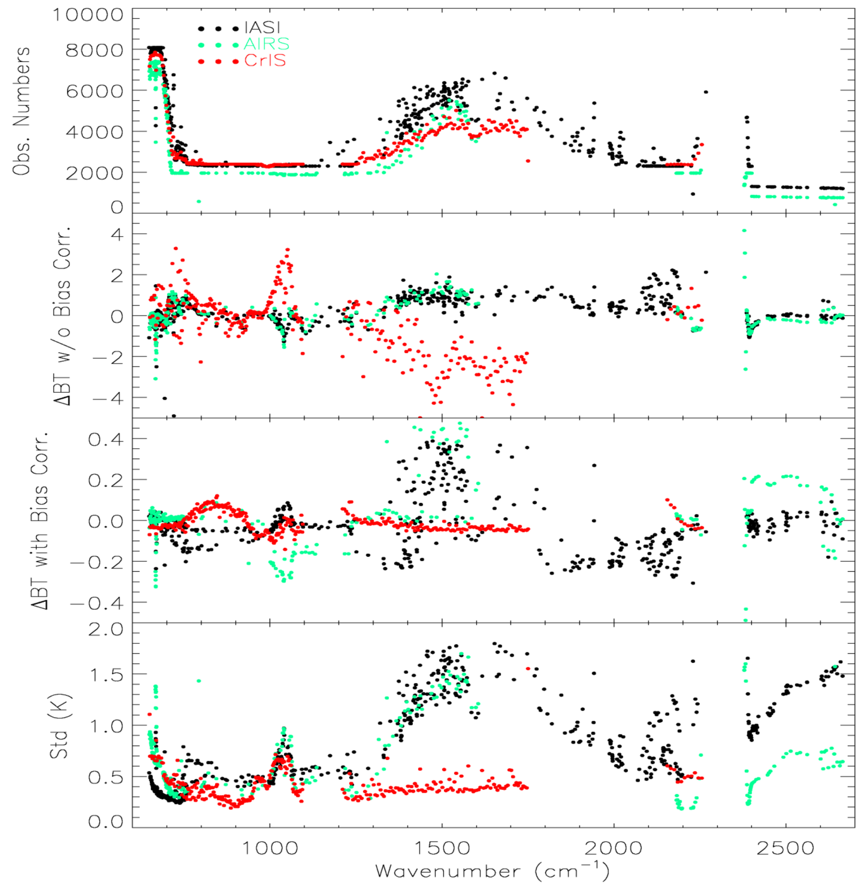
Assimilation of CrIS in GSI system

CrIS "observation data" (proxy data) testing results in GSI

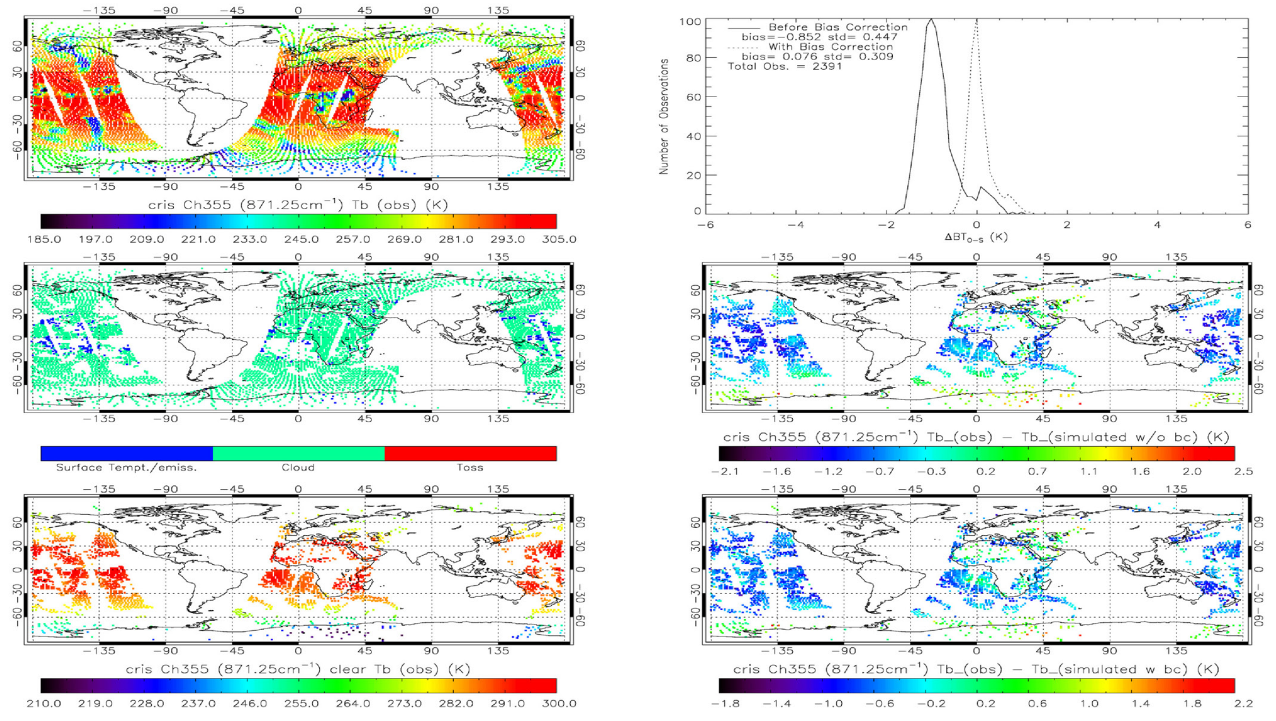
Testing data: About one month of CrIS real-time proxy buffer data generated from NESDIS/STAR are using in GSI from Sep. 22, 2009 to Oct. 31, 2009. In those buffer data, there are 300 arbitrary CrIS channels selected (every 4th channel). Overall, the CrIS proxy data quality is good compared to real AIRS observations.

The purpose here is testing the plumbing in the creation of the CrIS simulated data, as well as in the reading and assimilation processes in the GSI.

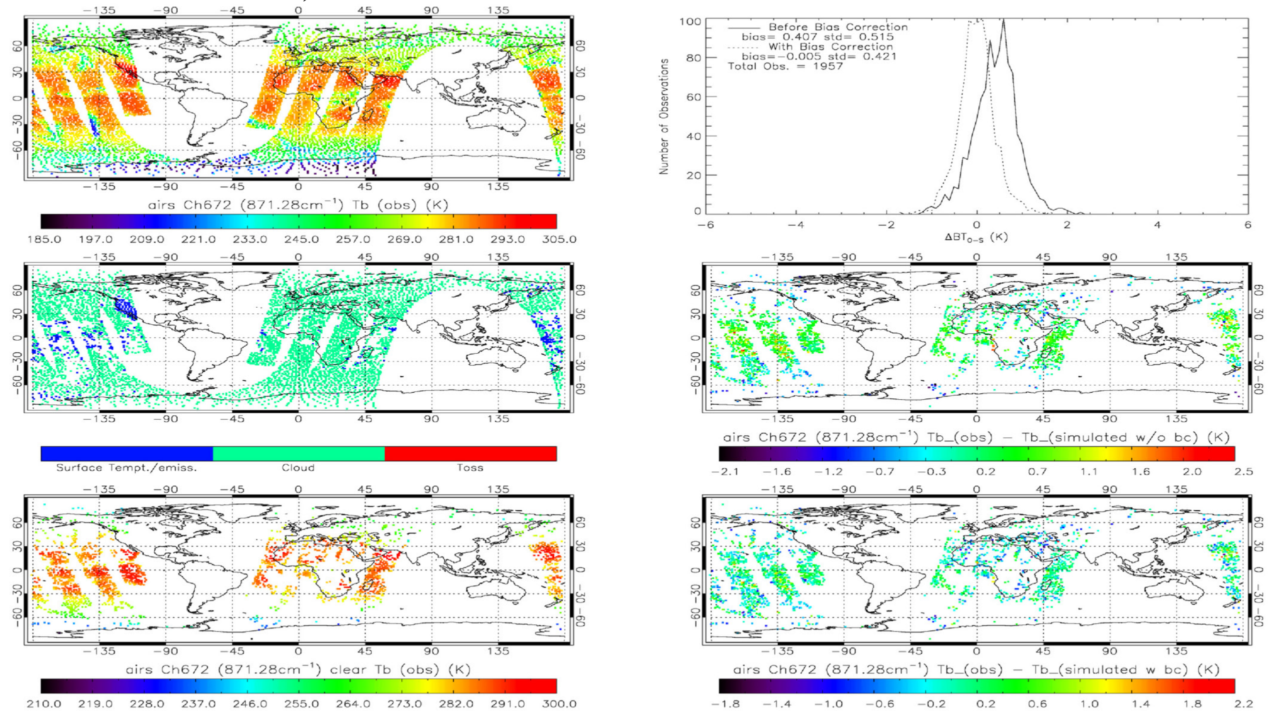
Since CrIS has 30 FORs (field of regard) and each has 9 FOVs, we only choose the 5th FOV data to assimilate in GSI.



NPP CrIS brightness temperature difference (OBS-BK) for window channel



For comparison purpose, AQUA AIRS brightness temperature differences (OBS-BK) for the same wavenumber are shown below



Concluding Remarks

Two set of coefficients are generated in the formats of Compact OPTRAN and ODPS with Hamming apodization function. CRTM is ready to simulate the channel brightness temperatures as well as the channel Jacobians for the CrIS sensor on NPP.

The mechanics necessary for the assimilation of the CrIS "observation" (proxy) data in NCEP Global Data Assimilation System GSI are finished. The preliminary results show that the quality of the CrIS proxy data is good compared to AIRS observations. The module to read and write the CrIS buffer data works properly. The assimilated channel error covariances are currently set to a constant, but should be calculated based on the instrument noises and RT model forward errors with real data. The scan angle bias will also be estimated by processing the diagnostic files for 4-6 weeks using the real data.