Simultaneous Nadir Overpass (SNO) Matchups GOSAT/TANSO-FTS and AQUA/AIRS: TIR Band April 2009 – December 2015

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Intro

The Greenhouse Gases Observing Satellite (GOSAT) was launched in January 2009, to monitor global atmospheric concentration and flux of CO2 and CH4 from space. The TANSO-FTS sensor is an interferometer spectrometer measuring shortwave reflected solar radiation with high spectral resolution in three spectral bands. A bore-sighted band 4 uses the same interferometer to measure thermal infrared radiation (TIR) at the top of the atmosphere. This paper is a comparison of the TANSO-FTS TIR band with coincident measurements of the NASA Atmospheric InfraRed Sounder (AIRS) grating spectrometer. The time and space coincident matchups are at the Simultaneous Nadir Overpass (SNO) locations of the orbits of GOSAT and the NASA AQUA satellite. GOSAT/AQUA SNOs occur at about 40N and 40S latitude. A continuous set of SNO matchups has been found from the start of valid radiance data collection in April 2009 through the end of 2015. UW-SSEC has obtained the time, latitude, and longitude of the SNO location using the ORBNAV software at http://sips.ssec.wisc.edu/orbnav. UW-SSEC obtained the matching AIRS v5 L1B radiances from the NASA archive. JAXA has reprocessed the entire TANSO-FTS TIR band using the previous v161.161 and a new calibration version which includes parameter optimizations. The TANSO-FTS has been reduced to the AIRS spectral channels using the AIRS spectral response functions (SRFs). This paper will show the time series of observed brightness temperatures from AIRS and GOSAT TANSO-FTS TIR observations from the SNO matchups. This poster illustrates the satellite inter-calibration data used to validate the improvements in the GOSAT ground calibration software by providing an independent reference to the AIRS on-orbit calibration accuracy. Improvements in the ground calibration software are expected to lead to improvements in the TIR band Level2 retrievals of CO2 profiles

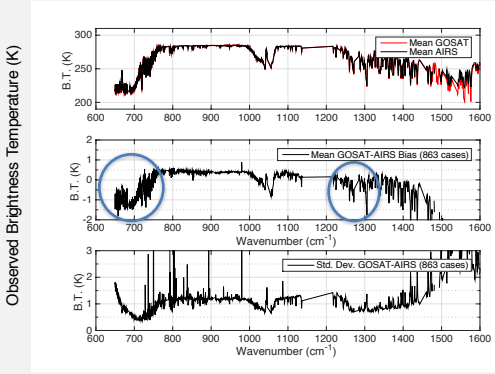
Summary

- The SNO method is used to make a direct assessment of the absolute calibration and stability of the GOSAT TIR spectra.
- The NASA AIRS sensor is used as a reference of comparison due to it's well established calibration accuracy and stability.
- The GOSAT TIR radiance was reprocessed at the Aqua/GOSAT SNOs location for the time period April 2009 – December 2015 using JAXA ground processing version 161.
- The version 161 is seen to exhibit a calibration cold bias at several points in the infrared spectrum including the 15 micron CO2 band.
- A time series analysis shows that the bias is stable from April 2009 through May 2014 when it undergoes a step change to a colder bias.
- The root cause of this bias and the step changes have been addressed in JAXA ground processing version 200+.
- Future work includes validation of v200+ with AIRS & IASI SNOs.

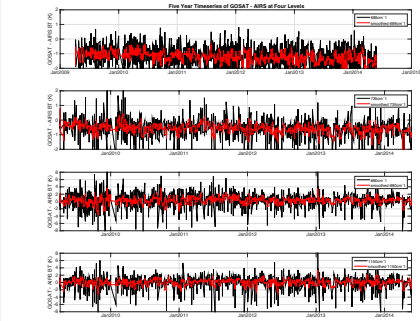
Results

A mean of all SNO cases from April 2009 through May 2014 was used to calculate a mean brightness temperature comparison and a spectral bias of the mean difference. The primary problems appear to be a cold bias in the 15 micron and 7 micron regions in JAXA version 161. This bias is expected to be significantly reduced in JAXA version 200+.

Radiometric cold bias is apparent in 15 micron band CO2 and in 7 micron CH4 bands.

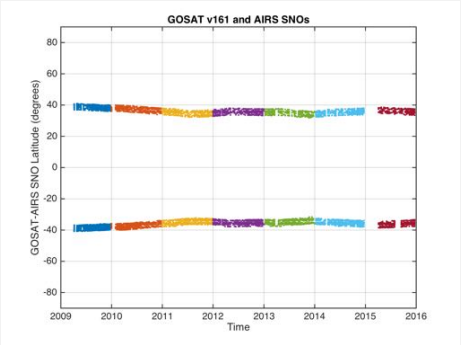


Time series show very stable bias from April 2009 through May 2014 (Five Years)

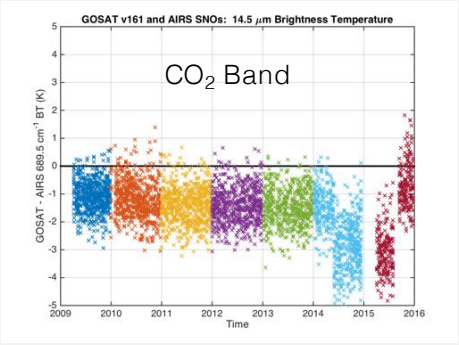


A time series analysis of the GOSAT/AIRS SNOs shows a highly stable bias from April 2009 through May 2014. This indicates very good stability for the TANSO FTS instrument. The step changes in bias in June 2014 and in 2015 are due to loss of satellite solar power causing the TANSO FTS to undergo a cold soaking. After returning to service the TIR detectors were found to have a change in responsivity. This anomaly has been corrected in JAXA ground processing version 200+.

GOSAT/AQUA SNOs Location (+- 40 deg Latitude)

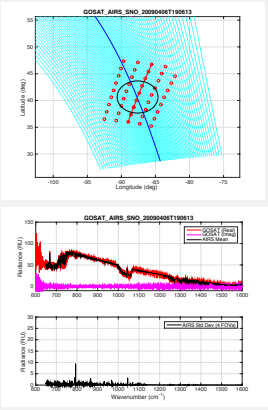


Time Series of SNO bias at 14.5 microns



Method

- Simultaneous Nadir Overpasses (SNOs) identify where satellite nadir ground tracks cross. The solid blue and red lines in the lower left figure show the nadir ground tracks. The blue circles show the swath of the AIRS sensor (90 FOVs per scan line) The red circles show the TANSO FTS fields of view (5 FOVs per scan line at that time) The black circle includes the TANSO FTS and AIRS footprints near the SNO point. A single GOSAT TIR radiance is used along with the four closest AIRS FOVs. The time difference between the GOSAT and AIRS is limited to < 1 hour.
- The mean and standard deviation of the AIRS FOVs is computed for each AIRS spectral channel. The standard deviation is used as a test for scene uniformity
- The GOSAT TIR spectrum is convolved with the AIRS spectral response functions (SRFs) to match the spectral resolution of the AIRS sensor. A quality check is made on the imaginary part of the GOSAT TIR spectrum to confirm the GOSAT calibration has removed the complex phase properly.



Data

GOSAT TIR

GOSAT radiances are from v161 provided by JAXA after consistent reprocessing. TIR radiances were provided only at SNO locations.

AIRS Sounder

The orbit of the Aqua satellite is polar sun-synchronous with a nominal altitude of 705 kilometers (438 miles) and an orbital period of 98.8 minutes, completing approximately 14.5 orbits per day. The satellite equatorial crossing local times are 1:30 a.m. in a descending orbit, and 1:30 p.m. in an ascending orbit. A grating spectrometer is used to produce about 2000 spectral channels with a resolving power of 1200.
AIRS Level 1B version 5 (latest) http://disc.sci.gsfc.nasa.gov/AIRS/

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Acknowledgments

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