Intercomparison of SNPP/VIIRS Longwave Infrared Channels Using Hyperspectral Radiance from GOSAT FTS and MetOp-A IASI

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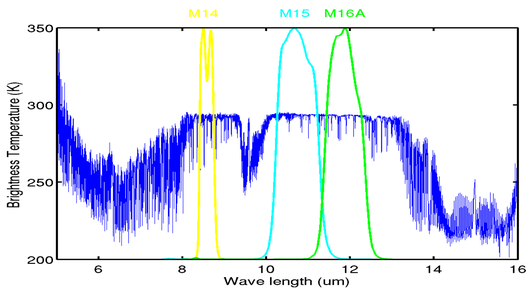
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Introduction:

- The Visible Infrared Imaging Radiometer Suite (VIIRS) onboard Suomi-NPP has four longwave infrared bands(I5, M14, M15 and M16).
- Calibration of VIIRS thermal band radiance has been performed onboard. Inter-comparison between VIIRS and Cross-track Infrared Sounder (CrIS) becomes difficult for M14-16 because CrIS has a spectra gap (8.26um to 9.14um) that does not cover M14, and the Spectral Response Function(SRF) of M15 and M16 are not fully covered.
- The Greenhouse Gases Observing SATellite (GOSAT) is equipped with a Fourier Transform Spectrometer (FTS). The band 4 of FTS measures hyper-spectral radiance (5um-15um). It is feasible to compare the FTS measurements with the VIIRS longwave infrared channels.
- Infrared Atmospheric Sounding Interferometer(IASI) onboard MetOp-A covers a complete hyper-spectra (3.63um-15.5um). It can also be used to compare with VIIRS M14-16 bands.
- In this study, inter-comparison between FTS and VIIRS, between IASI and VIIRS for the three longwave infrared bands are carried out.

IASI	Full Spectra 15.5-3.63um,0.5cm^{-1} Resolution, 0.25 cm^{-1} sampling interval
CrIS	3 Frequency Bands, 9.14-15.38 um (0.625 cm^{-1}), 5.71-8.26 um(1.25cm^{-1}), 3.92-4.64um (2.5cm^{-1})
FTS	Band4: 5.5-14.3um, Sampling interval: ~0.2 cm^{-1}; resolution: 0.27 cm^{-1}

Hyperspectral characteristics for IASI, CrIS and FTS. The CrIS longwave infrared band has a gap of 8.26-9.14um.



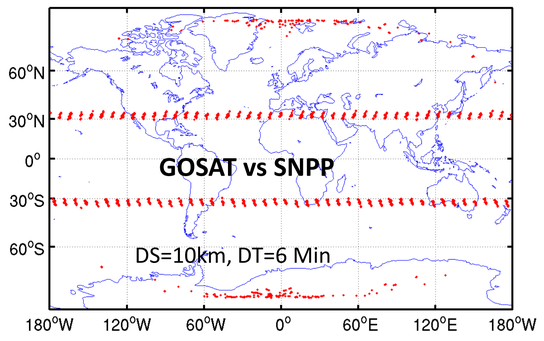
VIIRS M14-16 SRF overlapped with FTS observed hyperspectral brightness temperature.

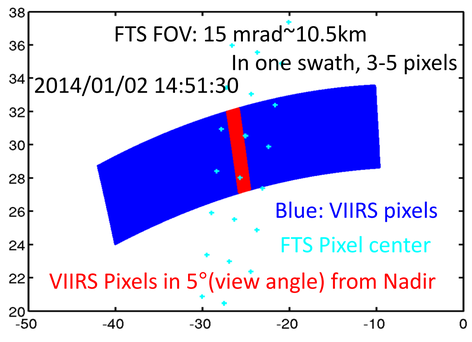
Methods:

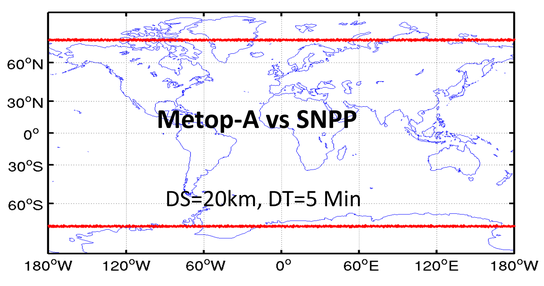
- Simultaneous Nadir Overpass (SNO) locations and time between FTS and VIIRS, and between IASI and VIIRS are determined using orbital model(SGP4) and Two-line-elements data. Collocated pixels are obtained by comparing actual geolocations near the given SNO location and time.
- We use the FTS/VIIRS datasets of 01/2014-06/2014, and IASI/VIIRS datasets of 01/2014-01/2015.
- Convolving VIIRS M band SRF and hyperspectral radiance from FTS and IASI at the collocated FOVs to obtain the simulated VIIRS radiance.

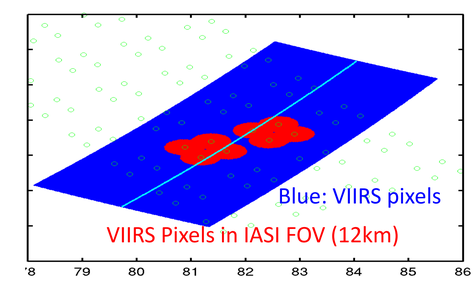
  $R=\frac{\int S(l)\cdot r(l)dl}{S(l)dl}$, where s is SRF, l is wavelength, r is hyperspectral radiance in wavelength.
- Averaging all the VIIRS observations (resolution of 750m) in the FTS (or IASI) FOVs. For FTS, we look at all FOVs falling within VIIRS 5° scan angle. For IASI, we look at the 15th and 16th FOVs.
- Inter-comparison is made between the simulated and observed values. The radiance ratio and brightness temperature difference are calculated.

SNO locations and collocation of FOV between FTS/VIIRS and between IASI/VIIRS



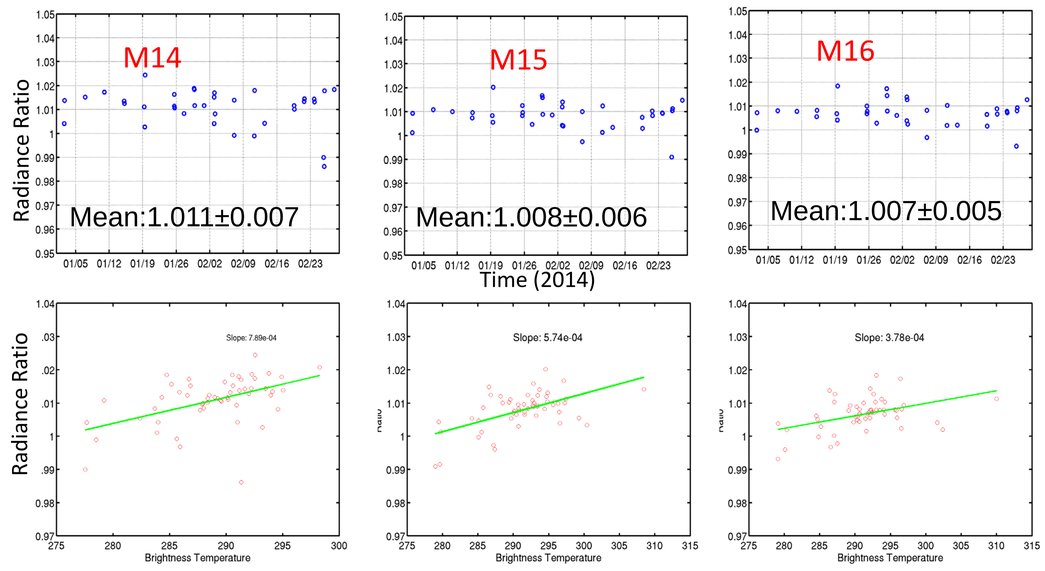




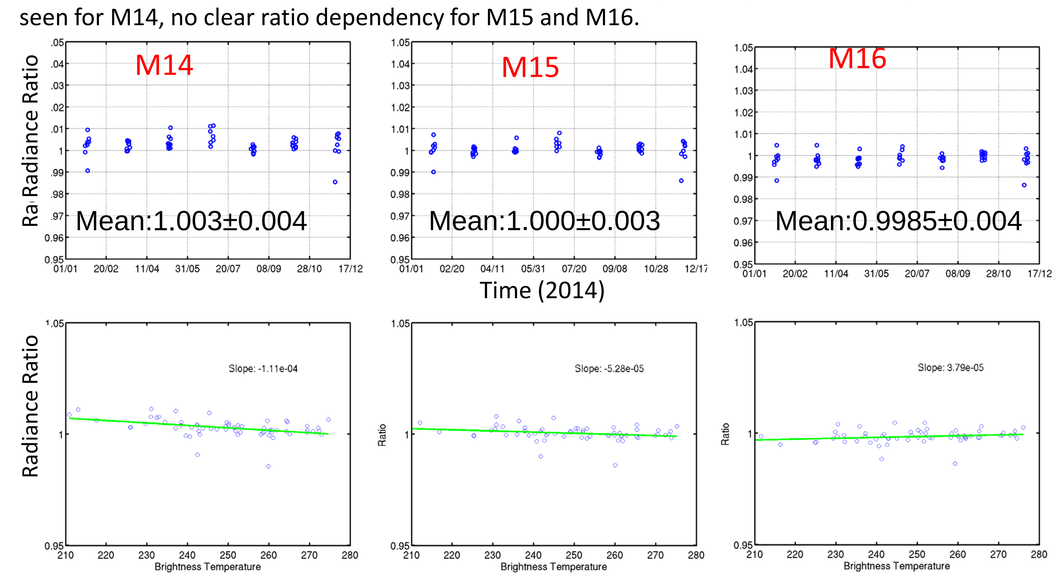


Results:

FTS/VIIRS: The simulated VIIRS radiance is close to observed for all three bands, with the brightness temperature difference of 0.54±0.36K for M14, 0.50±0.35K for M15, 0.46±0.34K for M16 (FTS minus VIIRS). The radiance ratio (FTS/VIIRS) is 1.011 ± 0.007 for M14, 1.0080 ± 0.006 for M15, 1.007 ± 0.005 for M16. The radiance ratio has a weak positive dependency on the brightness temperature for all three band.



IASI/VIIRS: The brightness temperature difference (IASI-VIIRS) is 0.10±0.15K for M14, 0.02±0.15K for M15, -0.07±0.16K for M16. The radiance ratio is 1.003 ± 0.004 for M14, 1.000 ± 0.003 for M15 and 0.9985 ± 0.004 for M16. Weak negative ratio dependency on scene temperature can be seen for M14, no clear ratio dependency for M15 and M16.



Summary:

- Both IASI and GoSAT FTS can be used to compare with the VIIRS M14-16, especially for M14 for which CrIS does not have coverage.
- For comparison between FTS and VIIRS, the brightness temperature of FTS has a higher bias of 0.54k for M14, 0.50K for M15 and 0.46K for M16.
- For comparison between IASI and VIIRS, the brightness temperature of IASI has a bias of 0.10K for M14,0.02K for M15 and -0.07K for M16.
- The higher bias between FTS and VIIRS may be due to the inclusion of FOVs within 5° scan angle of VIIRS since FTS has very low number of FOVs in each swath.

Acknowledgement:

The GoSAT/FTS dataset is from http://data.gosat.nies.go.jp/GosatUserInterfaceGateway/ guig/GuigPage/ open.do. The VIIRS/IASI data are from http://peate.ssec.wisc.edu/flo/search. This project is funded by NOAA/NEDIS/STAR.