Construction of VIIRS M-band absorption channel radiances based on VIIRS–CrIS data fusion: From research to operations

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Sounder Science Team Meeting
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Project Summary

Goal is to provide decadal continuity in cloud products (among others) across very different polar-orbiting sensors

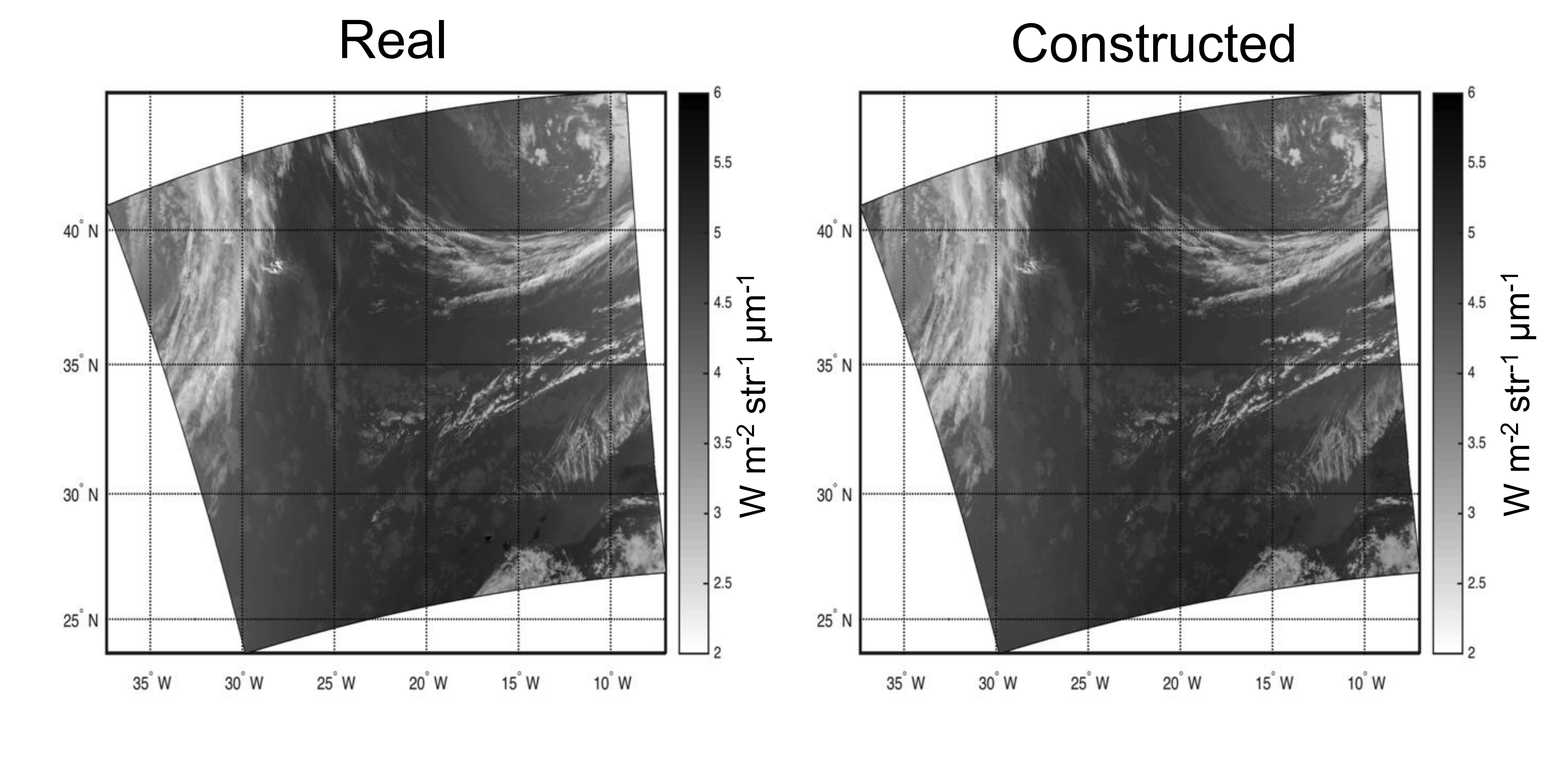
Demonstrate ability to construct high spatial resolution IR absorption band radiances for imagers based on imager-sounder data fusion (VIIRS+CrIS)

Achieve an order of magnitude increase in spatial resolution from sounder to imager at a cost of ~1% increase in noise

Ability to construct radiances for any defined response function, perhaps with lines of strong trace gas absorption eliminated (would simplify forward modeling)

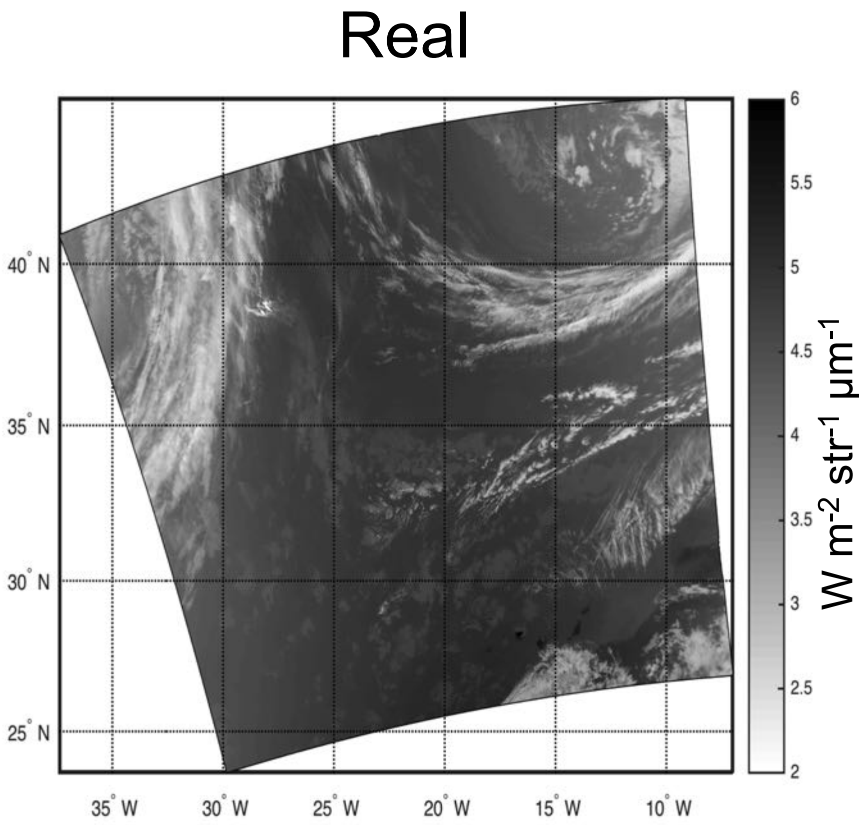
Project: http://stc-se.com/data/bbaum/Baum-DataFusion/

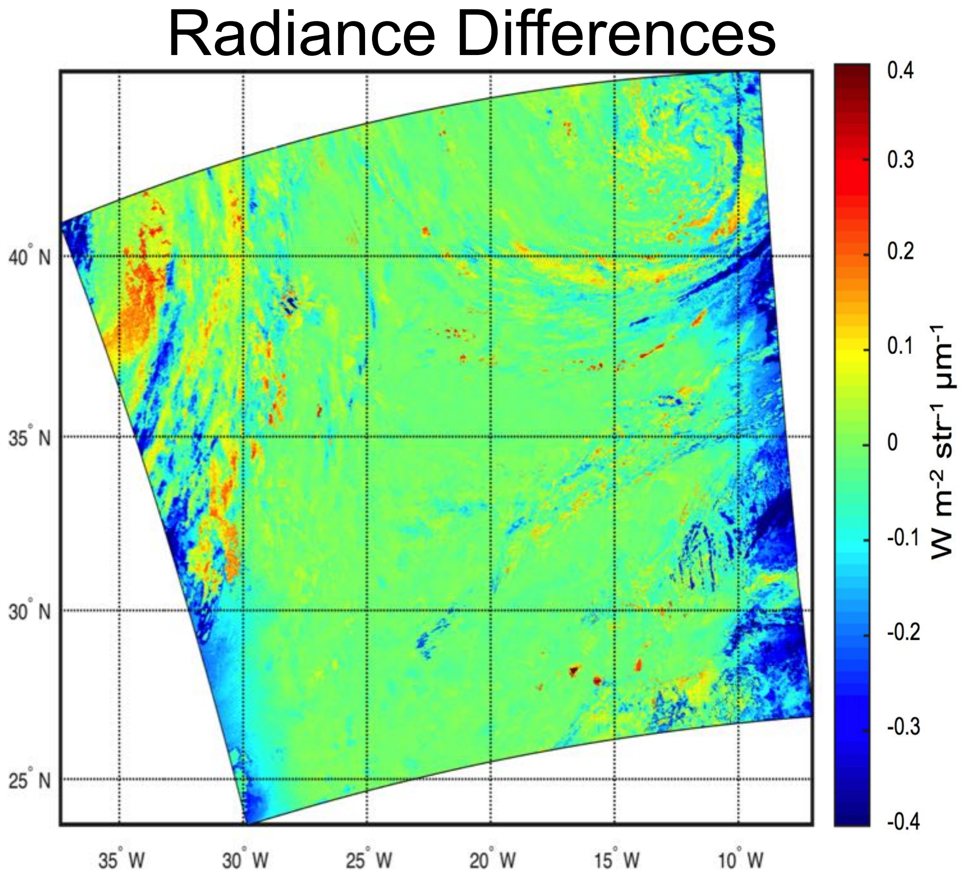
Statistical construction of a high spatial resolution 13.3-μm MODIS channel from AIRS



Scene over eastern Atlantic Ocean on April 17, 2015 at 1435 UTC

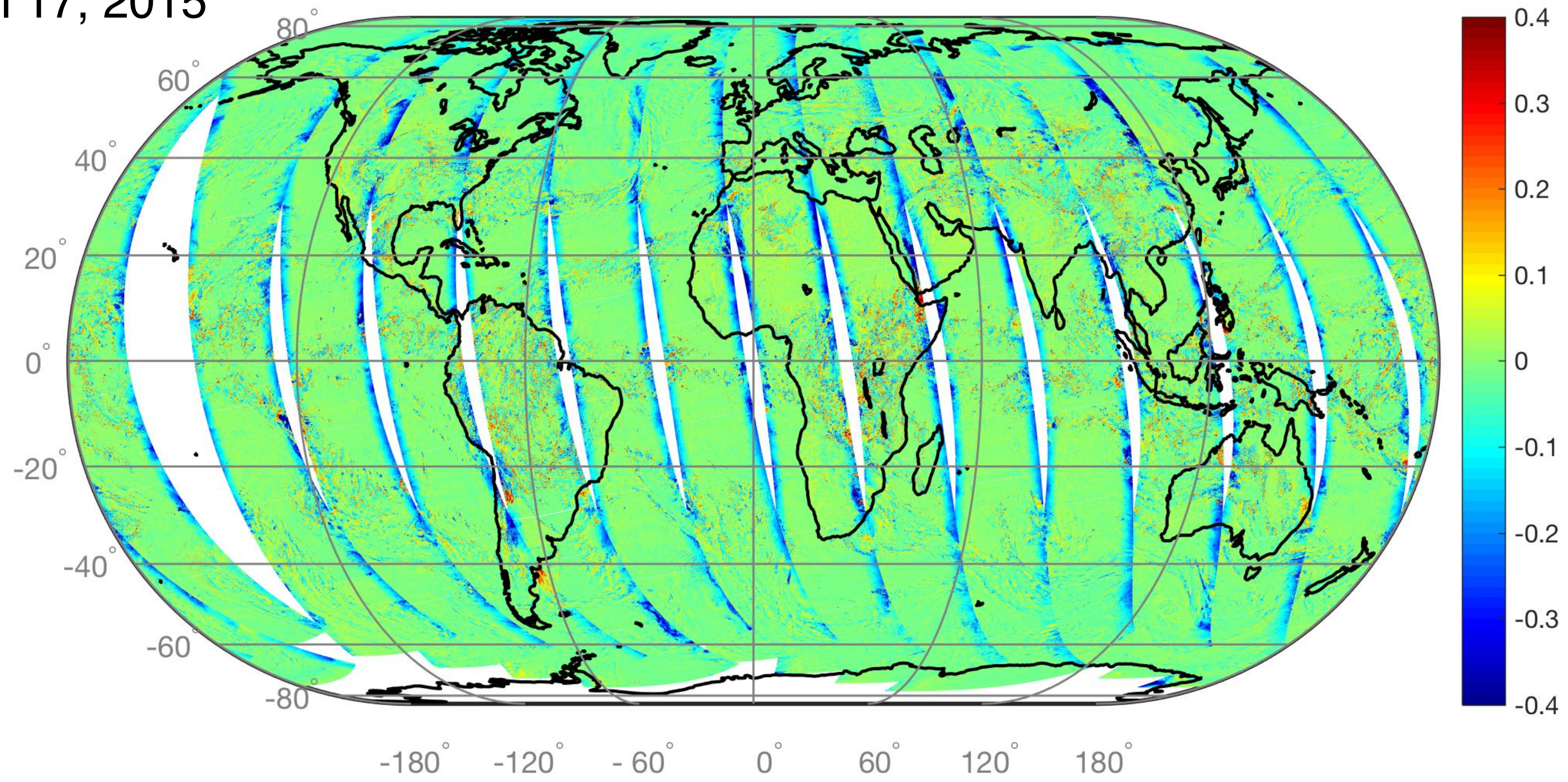
Radiance Differences Between Real and Constructed 13.3-μm channel





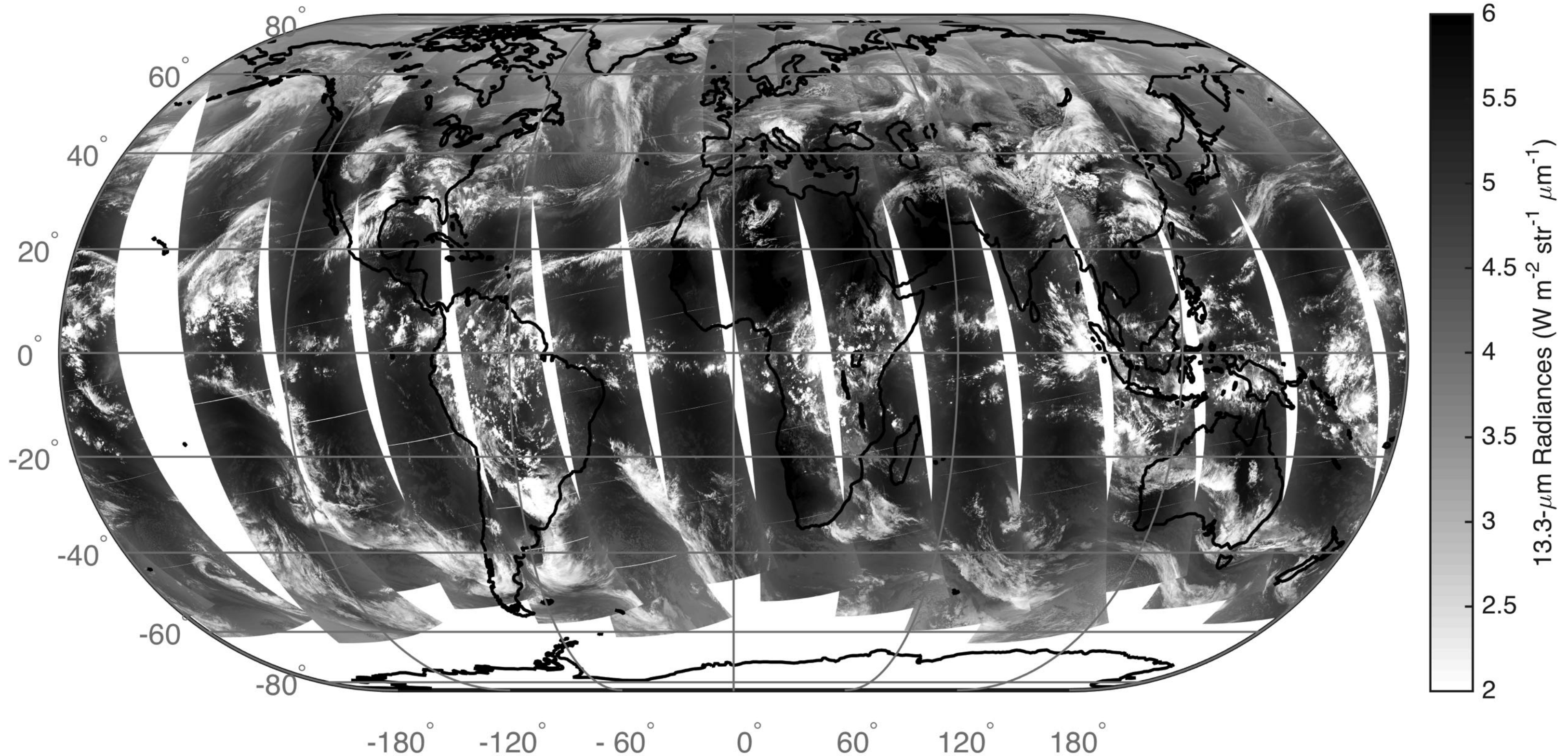
Full day of Radiance Differences Between Real and Constructed (Fusion) 13.3-μm channel MODIS+AIRS

April 17, 2015

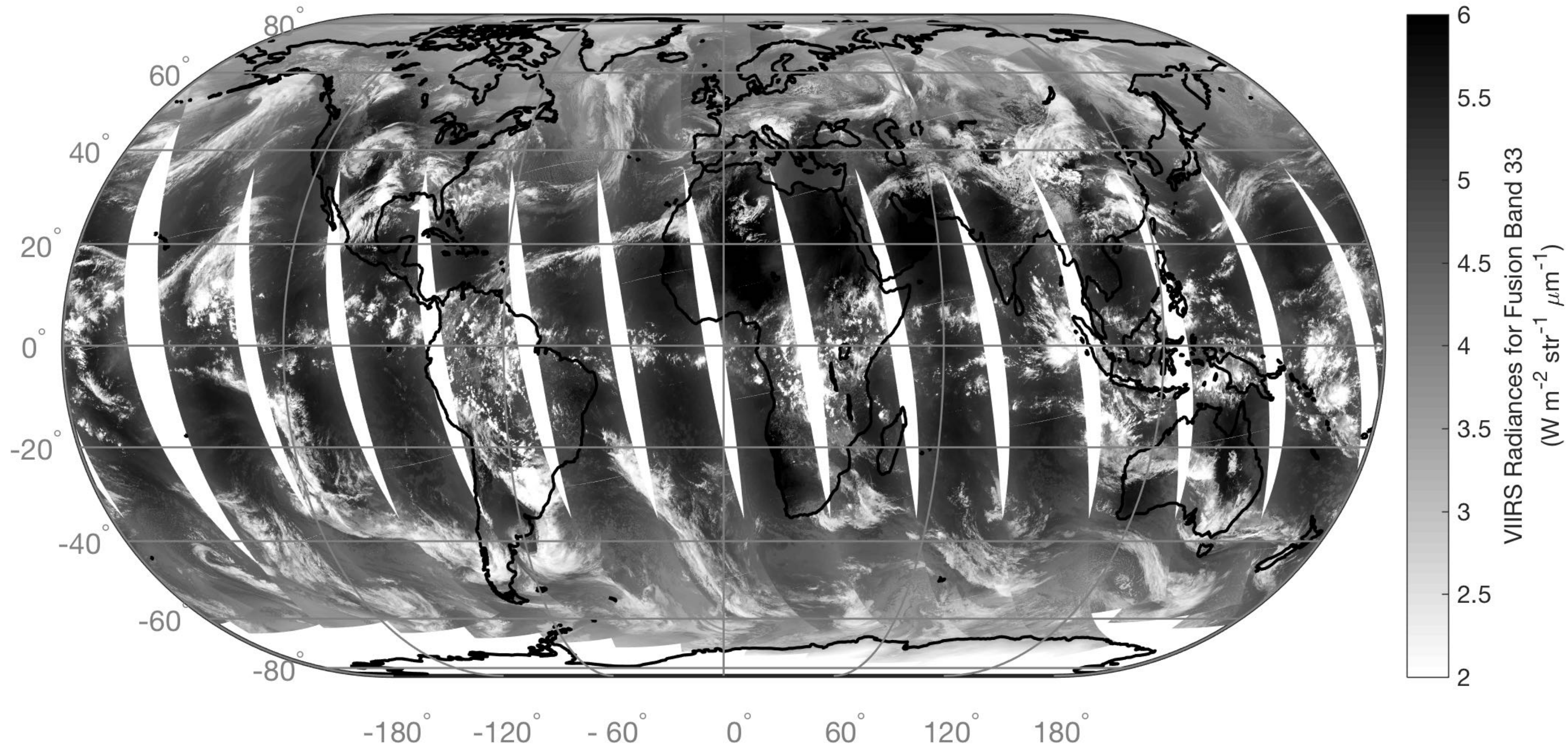


There is no adjustment for atmospheric absorption outside the range of the sounder swath (high scan angles). Results are best within the CrIS swath and degrade modestly outside of it.

Daytime MODIS measured 13.3-μm band radiances
Full swath
17 April, 2015



Daytime VIIRS-CrIS fusion 13.3-μm band radiances
No MODIS data used; only the relevant SRF
Sensor zenith angle ≤ 60°



April 17, 2015

About the statistical construction approach

Pros:

- No detector striping, out-of-band response, or other artifacts
- Spectral response functions same as for MODIS-Aqua, i.e., they are known
- In fact, you can apply any response functions to construct new bands including those where lines of strong trace gas absorption are omitted
- Hyperspectral IR data are well calibrated
- Can apply MODIS retrieval algorithms to any platform with minor changes
- Can extend beyond the sounder swath but need to account for increased water vapor (and trace gas) absorption

Cons:

- Radiance differences increase outside of sounder swath
- Increase in noise around edges of rapidly changing radiance fields
- May have more noise than an algorithm requires for accuracy
- Suspect that surface emissivity might be playing a small role in clear-sky conditions

Radiance differences (MODIS – VIIRS fusion) are on the order of 0.5-1% of the total (~1-3K/typical scene)

Transition to Operations

The relevant Aqua MODIS-like IR radiance channels (MODIS channels 23-25, 27, 28, 30, 33-36) are provided in a VIIRS Level 2 granule (NetCDF4).

Additionally, VIIRS (measured – fusion) brightness temperature differences are included for VIIRS M15 and M16 so a user can assess fusion-based construction errors.

A User's Guide and ATBD have moved through inspection process at GSFC.

Fusion product will be available through LAADS.

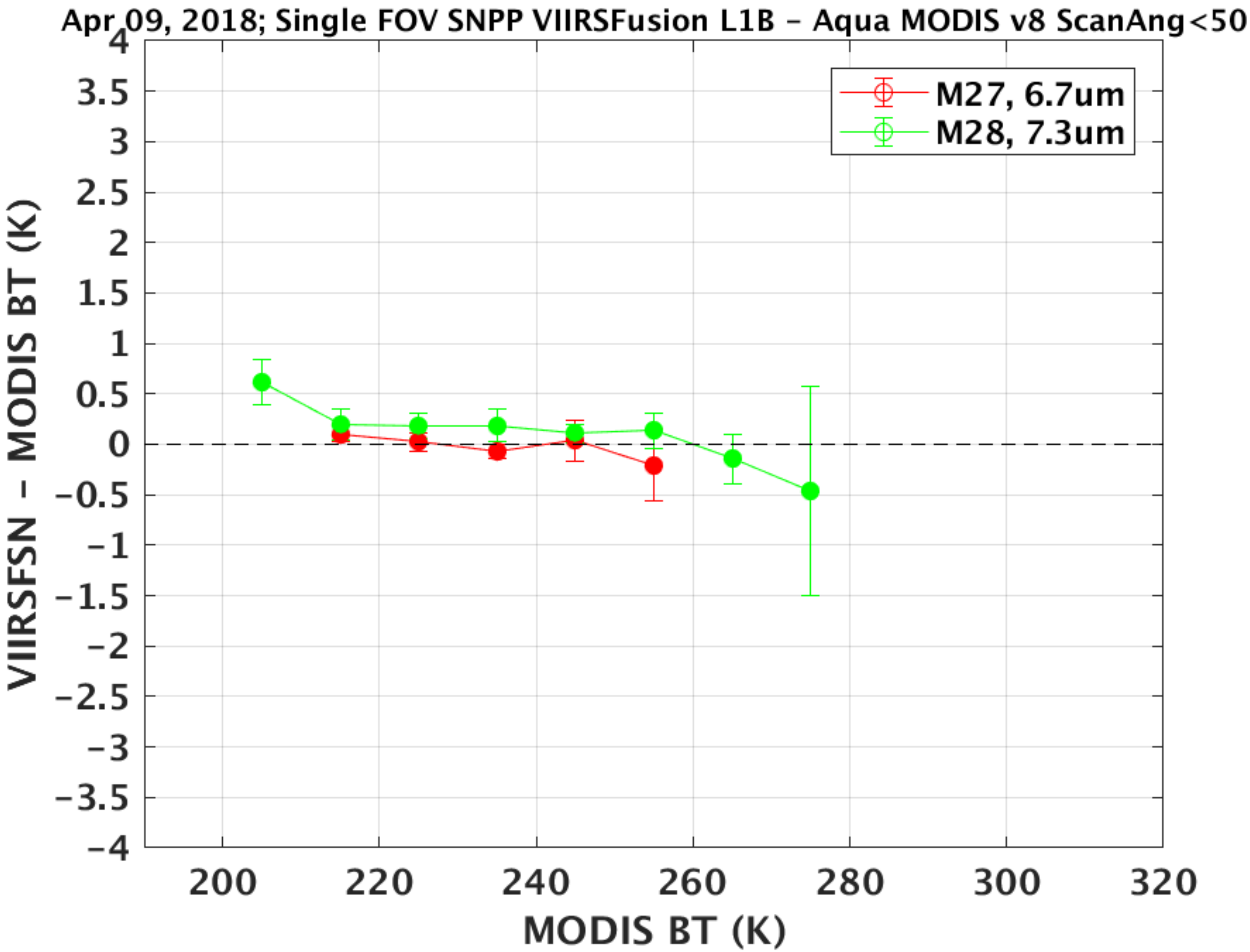
To date, fusion process runs successfully for ~98-99% of granules (a handful of days account for most of the failures)

VIIRS Fusion and Aqua MODIS Matchups
April 09, 2018

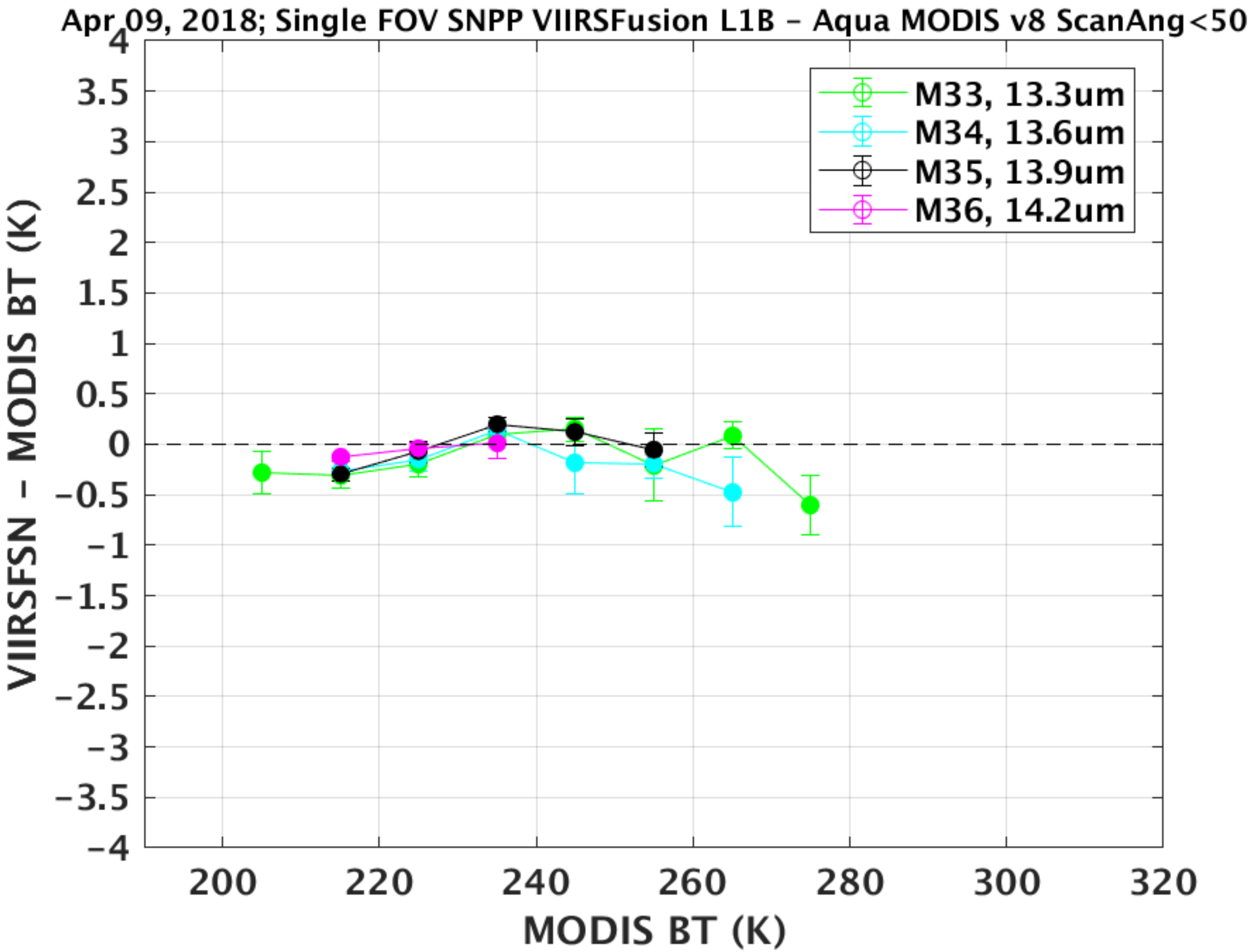
Chris Moeller (SSEC/UW-Madison)

- Global matchups abundant on this day
- Analysis limited to matchups where only one VIIRS measurement falls within the MODIS pixel field-of-view.
- Matchups filtered using cloud mask (99% confident clear only).
- Matchups include day+night, all surfaces

Note: the match-up software was modified for the Atmosphere SIPS and is being tested. Once implemented, radiance match-ups will be provided over the course of the Suomi-NPP and NOAA-20 missions.



Apr 09, 2018; Single FOV SNPP VIIRSFusion L1B - Aqua MODIS v8 ScanAng<50
M27, 6.7um
M28, 7.3um
VIIRSFSN - MODIS BT (K)
MODIS BT (K)
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
200
220
240
260
280
300
320



Apr 09, 2018; Single FOV SNPP VIIRSFusion L1B - Aqua MODIS v8 ScanAng<50
M33, 13.3um
M34, 13.6um
M35, 13.9um
M36, 14.2um
VIIRSFSN - MODIS BT (K)
MODIS BT (K)
4
3.5
3
2.5
2
1.5
1
0.5
0
−0.5
−1
−1.5
−2
−2.5
−3
−3.5
−4
200
220
240
260
280
300
320

Impact on ice cloud height retrievals: Comparison with CALIPSO

Andy Heidinger (NOAA) and Yue Li (SSEC/UW-Madison)

Study underway using PATMOS-x/ACHA (AWG Cloud Height Algorithm; AWG refers to the NOAA Algorithm Working Group)

ACHA adopts an optimal estimation approach

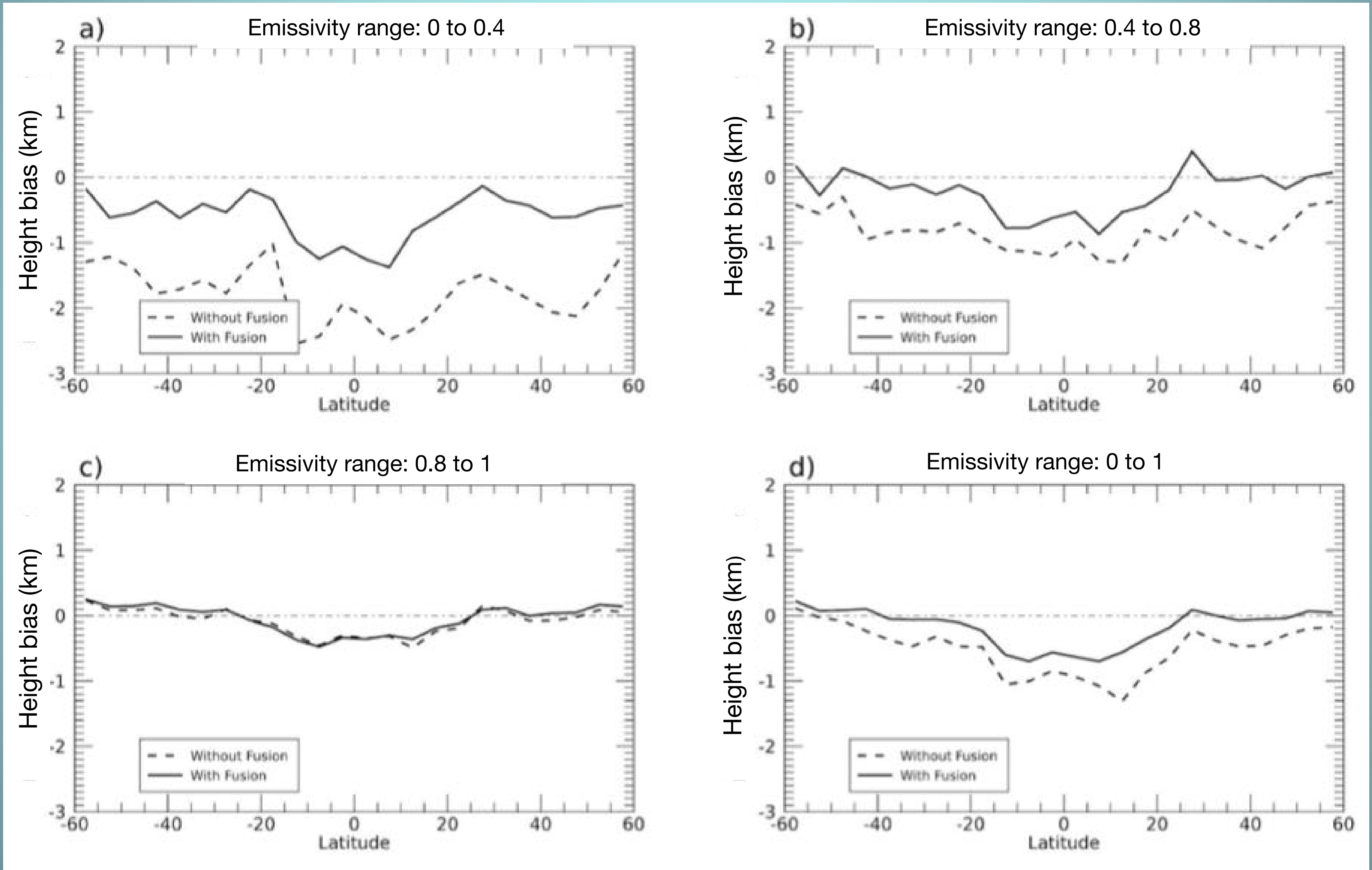
Two weeks of data in April and October in 2018

Collocations between VIIRS and CALIPSO assume time difference < 15 minutes and lat/lon difference < 4°

CALIOP cloud height calculated using the average of base & top heights when base is available; otherwise the true cloud top is used

ACHA is run with **8.5/11/12 µm (without fusion)** and **8.5/11/12/13.3µm (with fusion)**

Zonal averages of CTH differences (VIIRS-CALIOP) between 60˚N – 60˚S for Suomi-NPP



Suomi-NPP ACHA – CALIPSO comparisons

Emissivity		Number of matchups	Bias (km)	Std dev (km)	Mode (km)
0 to 0.4	No fusion	76548	-1.95	3.56	-0.75
	With fusion		-0.76	1.65	-0.75
0.4 to 0.8	No fusion	57790	-0.91	2.20	-0.75
	With fusion		-0.30	1.24	-0.25
0.8 to 1	No fusion	281613	-0.07	1.04	-0.25
	With fusion		-0.03	0.83	-0.25
0 to 1 (Total)	No fusion	415951	-0.53	2.07	-0.25
	With fusion		-0.20	1.12	-0.25

No fusion: 8.5/11/12 μm
With fusion: 8.5/11/12/13.3 μm

Summary

The relevant Aqua MODIS-like IR radiance channels (MODIS channels 23-25, 27, 28, 30–36) will be provided in a VIIRS Level 2 granule (NetCDF4).

The VIIRS L2 granule is 6 minutes; very similar format to Level-1B

Also provide brightness temperature differences (VIIRS – VIIRS fusion) for M-bands 15 and 16 (split window); useful for uncertainty estimates

For Suomi-NPP:
FSNRAD_L2_VIIRS_CRIS_SNPP.A2018283.1206.000.2019214190353.nc

For NOAA-20: FSNRAD_L2_VIIRS_CRIS_NOAA20…

Once this goes into operations and the full records of S-NPP and NOAA-20 are available, we will consider implementing additional channels.

If there are ideas for new channels, please contact us: baum@stcnet.com