



Visible Infrared Imaging Radiometer Suite

# VIIRS RSB Validation: AutoCal and Inter-comparison Update

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Suomi NPP SDR Product Review

NOAA Center for Weather and Climate Prediction (NCWCP)

5830 University Research Park, College Park, Maryland

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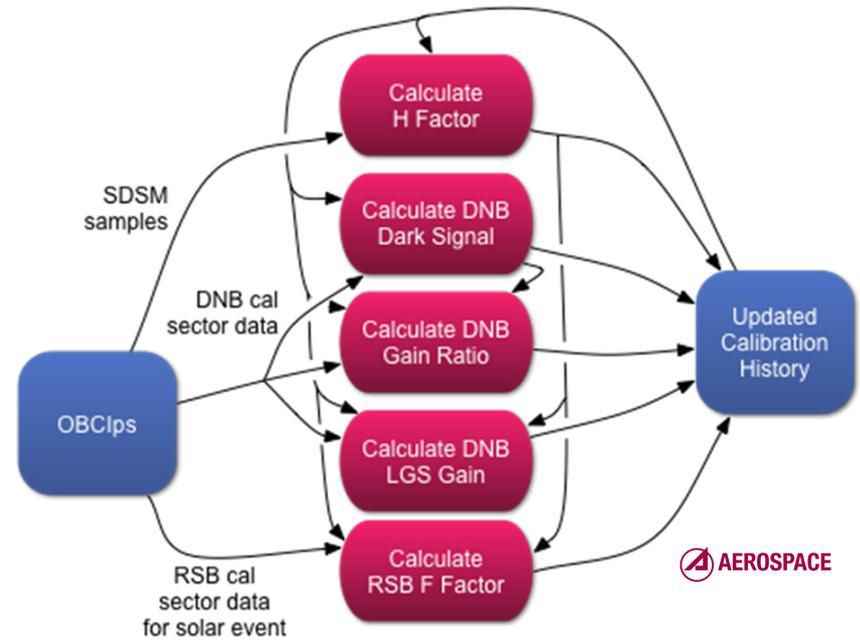
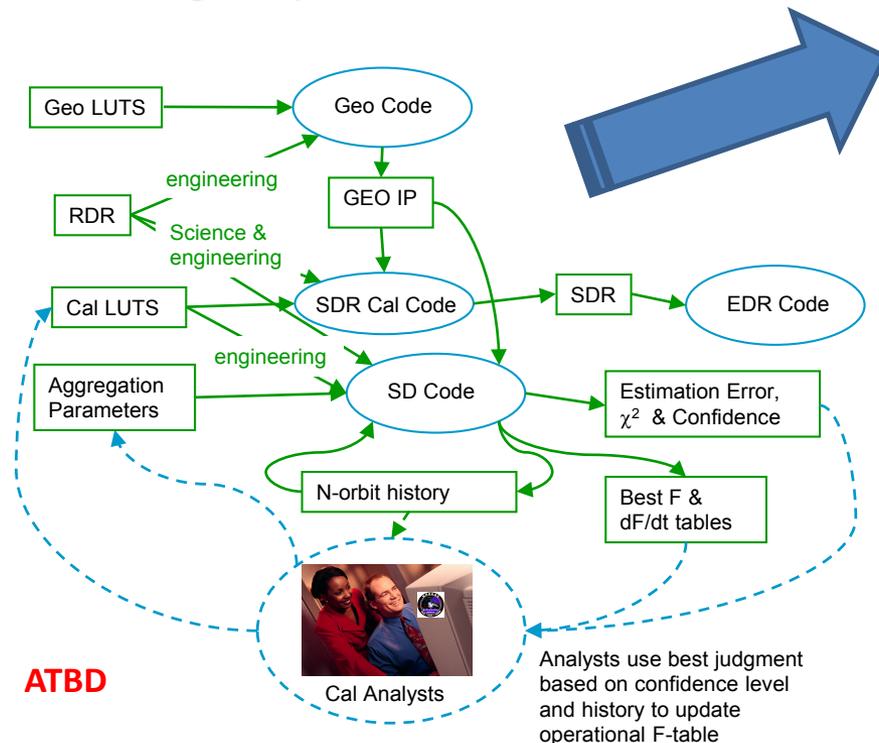
# Outline



- Validation of the VIIRS RSB automated calibration (RSBAutoCal)
  - Testing continuity between the current radiometric calibration coefficients and the future coefficients calculated by the automated procedure
  - Demonstrating use of the RSBAutoCal to improve radiometric consistency between the bands I2 and M7
- Expanding the Simultaneous Nadir Overpass (SNO) comparisons into the second year of the Suomi NPP operations on orbit

Current human-in-the-loop approach replaced by a computational procedure:

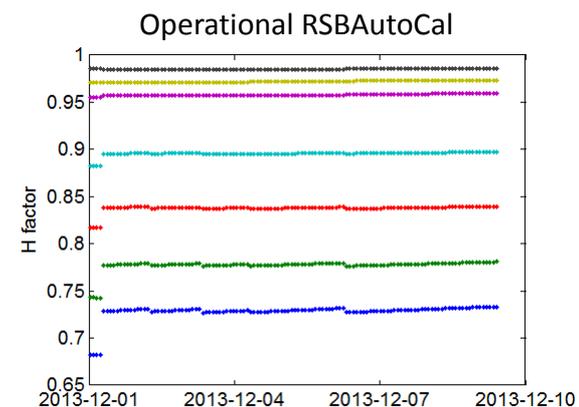
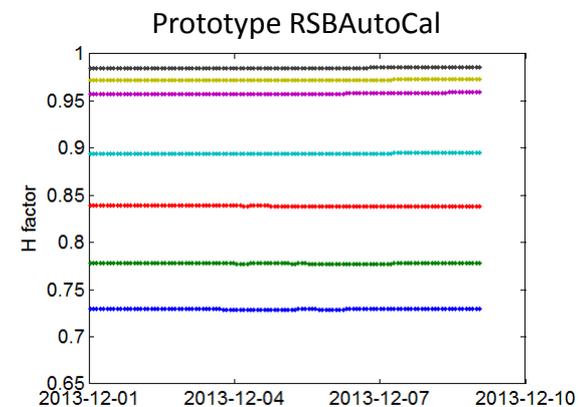
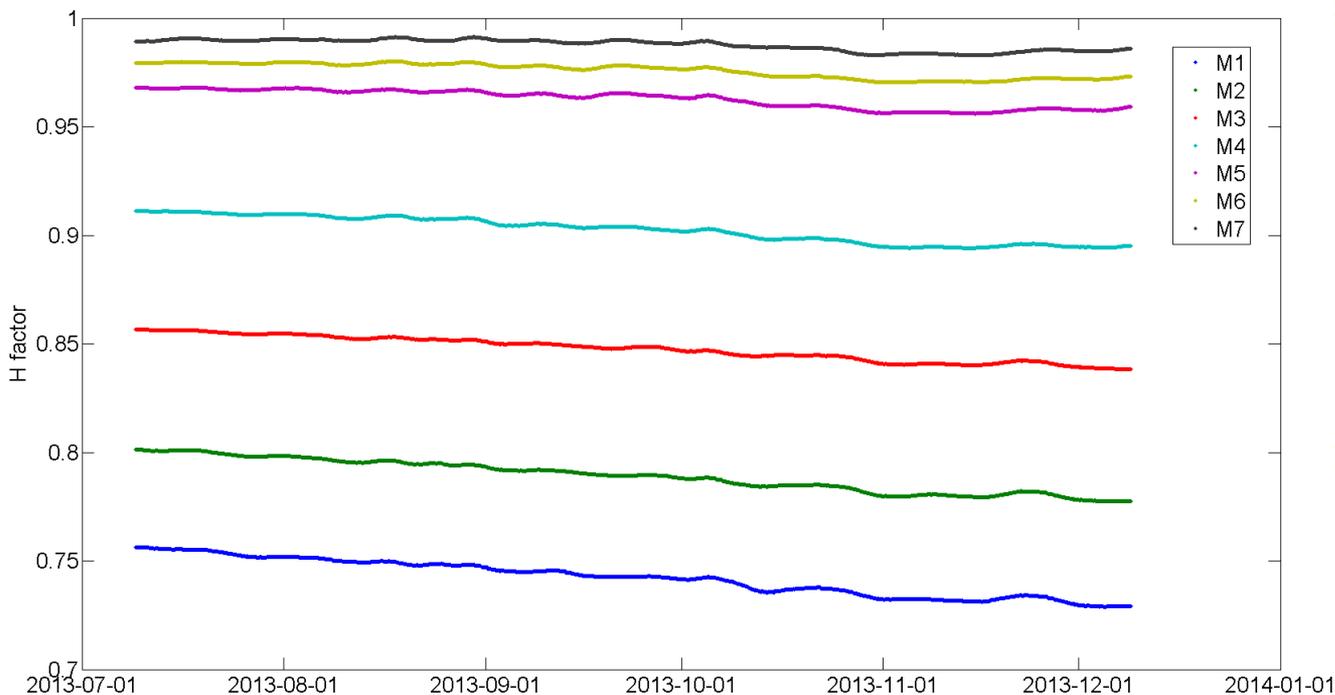
- Implemented in IDPS in November 2013
- Ongoing testing of the calibration coefficients derived by the operational RSBAutoCal
- Application in SDR production planned for 2014 after testing completed



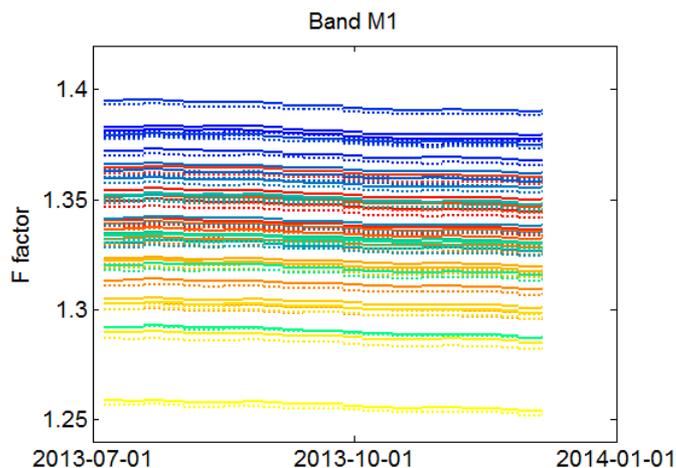
## RSBAutoCal:

- Replaces the SolarDiffuser (SD) code
- Includes 5 separate algorithms
- Updates radiometric calibration coefficients once per orbit for both RSB and DNB
- Predicts the coefficients for each scan until the next solar calibration event

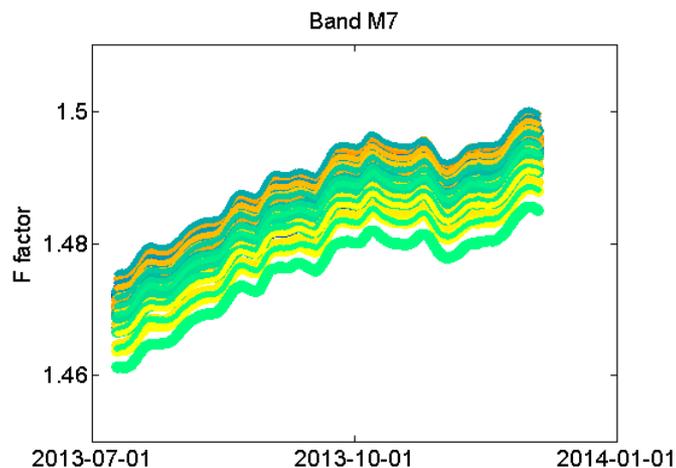
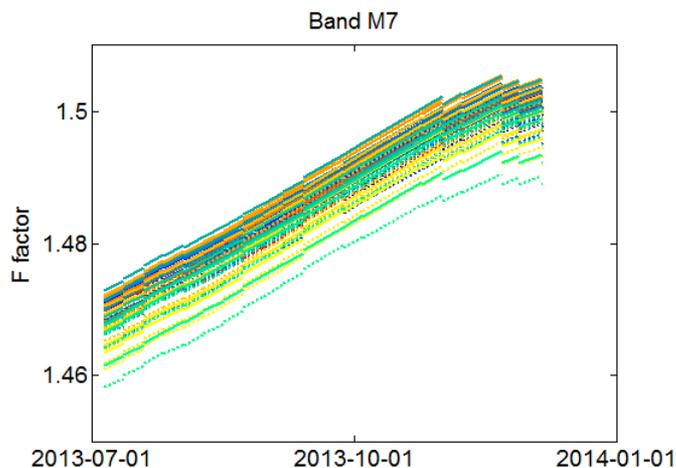
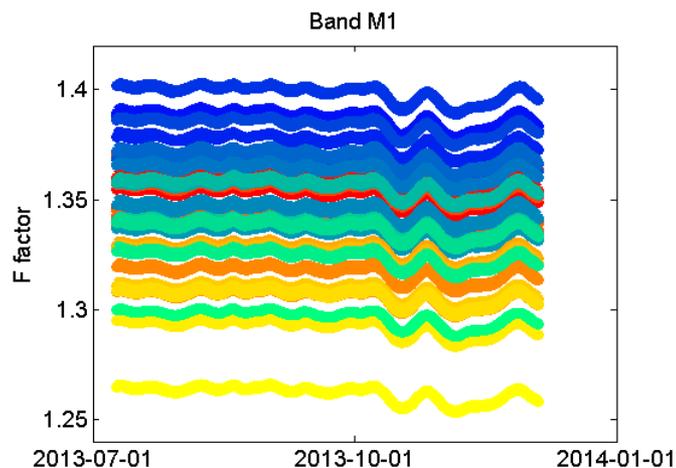
- Conducted long-term testing of the calibration coefficients generated by the prototype RSBAutoCal implemented in ADL
- Observed good agreement between SD monitoring in RSBAutoCal and in the current, off-line procedure
- Preliminary H factors derived by the operational RSBAutoCal in IDPS closely match those from the prototype code



VIIRS-SDR-F-PREDICTED-LUT



VIIRS-RSBAUTOCAL-HISTORY-AUX

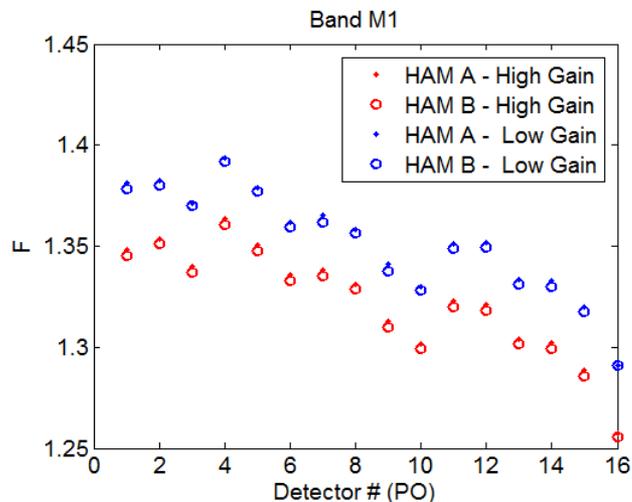


- F factor changes estimated by the RSBAutoCal from the solar diffuser measurements agree with the current off-line estimates
- Some temporal variability appears despite filtering
- A larger uncertainty of the SD stability monitoring in October and November affects both methods of estimating the F factors

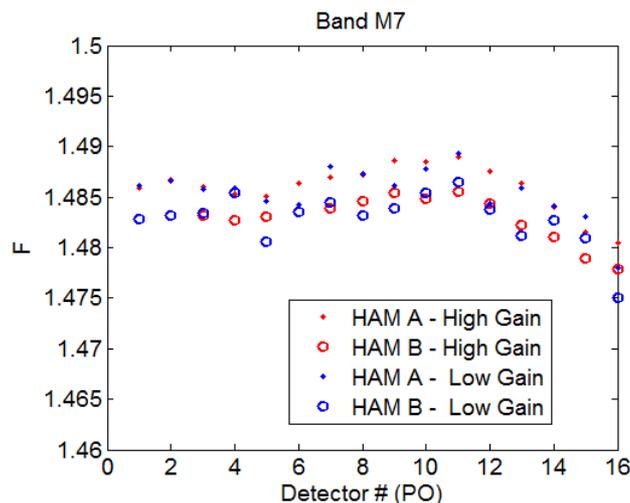
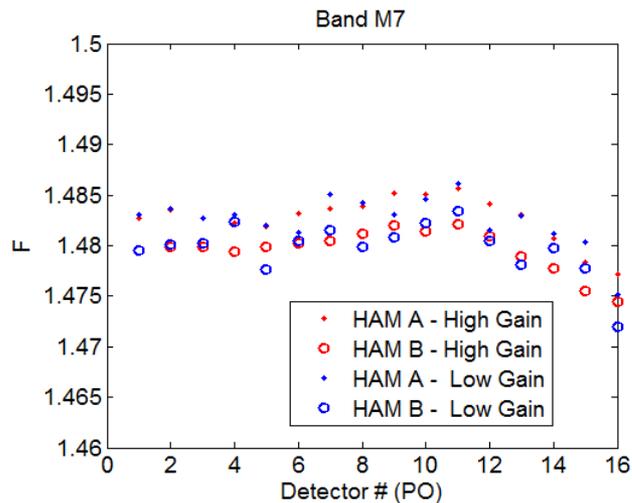
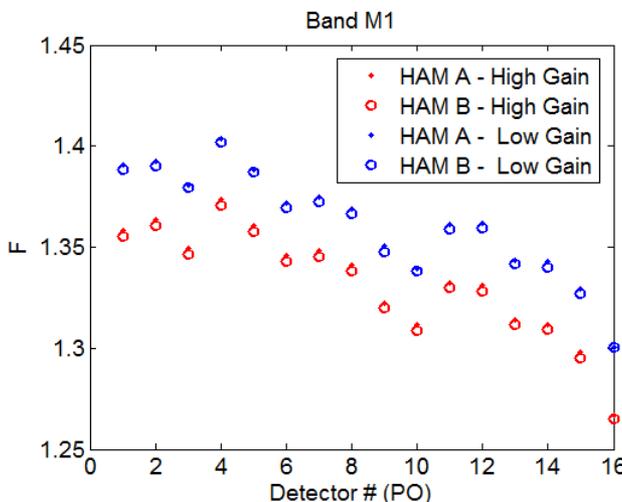
- Values for each detector are shown in a different color
- High and low gains are marked by the warm (yellow-red) and cool (green-blue) colors, respectively
- Dots and open circles (or solid and dotted lines) indicate two sides of the half-angle mirror

# Detector F Factor Comparisons

VIIRS-SDR-F-PREDICTED-LUT  
#55

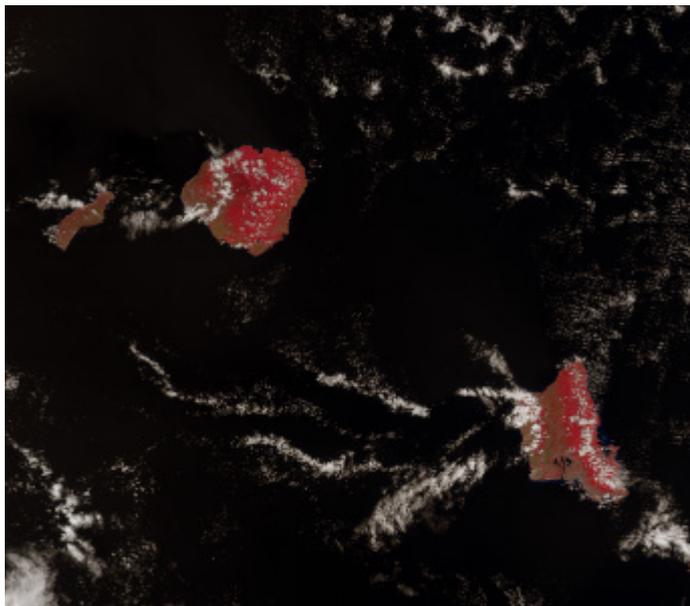


VIIRS-RSBAUTOCAL-HISTORY-AUX  
orbit 9542

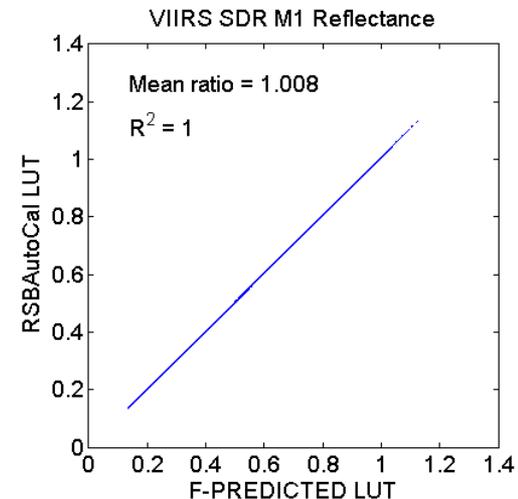
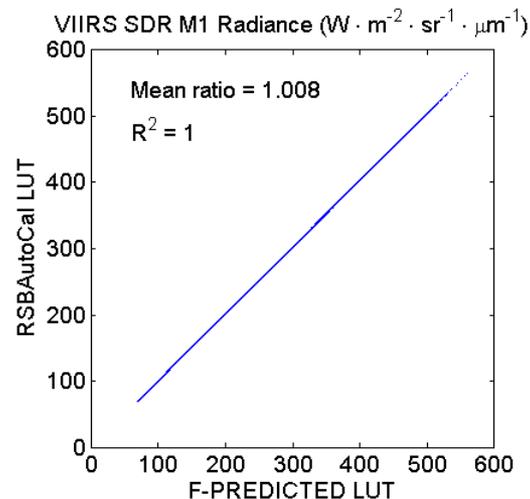
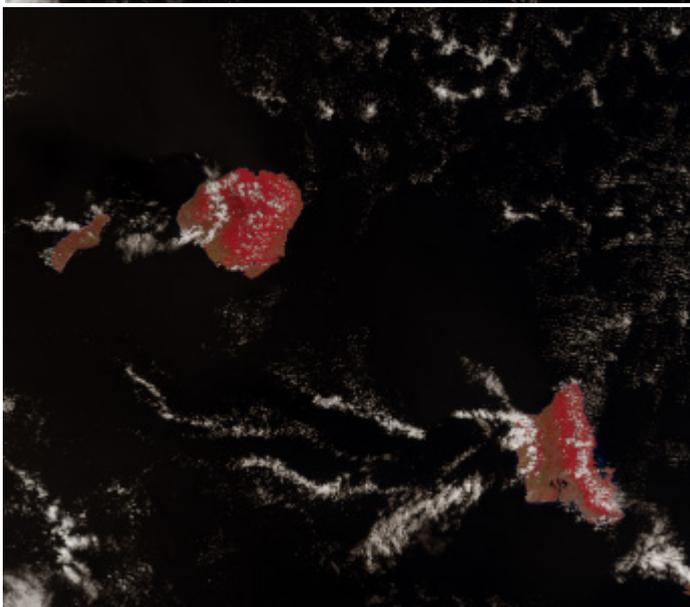


- Comparisons between the F factors calculated by RSBAutoCal for one of the Suomi NPP orbits and the F factors from the F-PREDICTED LUT valid for the same orbit
- For each detector, the F factors calculated by the automated procedure agree well with the F factors predicted from the current off-line calculations

VIIRS-SDR-F-PREDICTED-LUT



VIIRS-RSBAUTOCAL-HISTORY-AUX



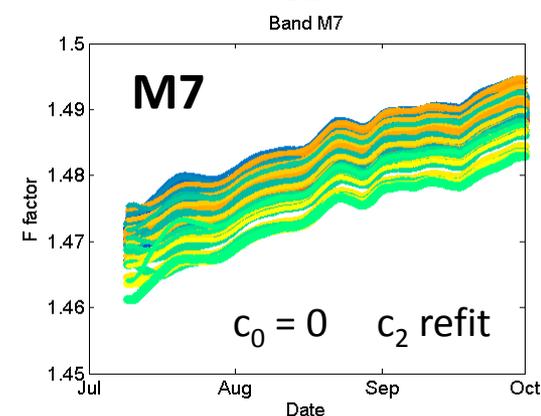
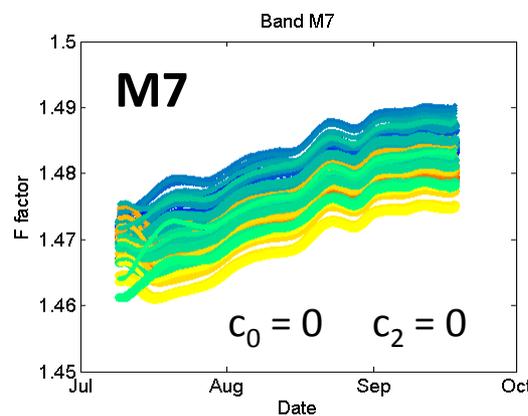
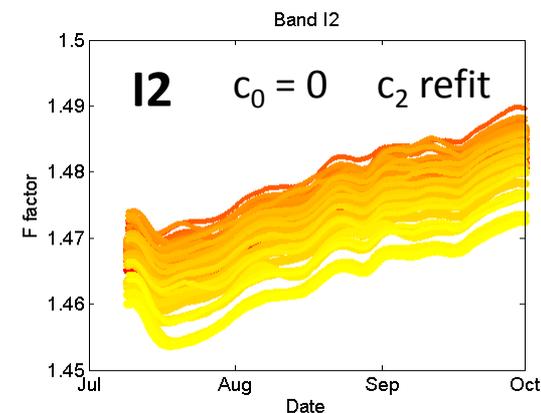
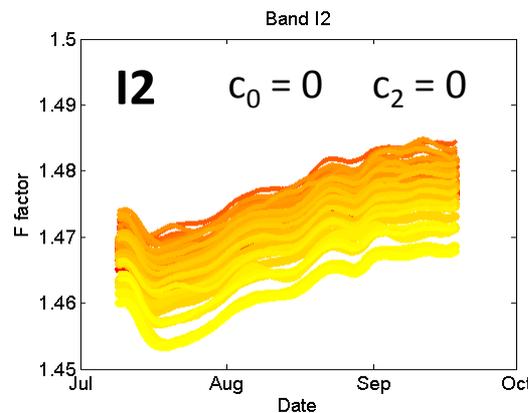
- Compared all pixels from a granule (only a subset shown in the images) for all reflective solar bands (the worst case shown on the scatter plots: band M1)
- For both radiance and reflectance, there is a very good agreement between the SDR products derived using the F-factor LUT calculated by the RSBAutoCal and the corresponding F-PREDICTED LUT

*Granule 2013-08-30 23-57 UTC (orbit 9543)*

- *subset around the Hawaiian islands*

# Improving I2/M7 Consistency

- RSBAutoCal was used in optimizing values of the  $c$  coefficients to improve consistency between radiance measurements in bands I2 and M7
- Imaging band I2 pixels were aggregated to the M7 band pixel size (2x2 averaging)
- RSBAutoCal calculated F factors for two cases:
  1.  $c_0 = 0$  and  $c_2 = 0$
  2.  $c_0 = 0$  and  $c_2$  from refit of pre-launch test data
- Produced SDR for selected granules using the appropriate calibration history files generated by ADL

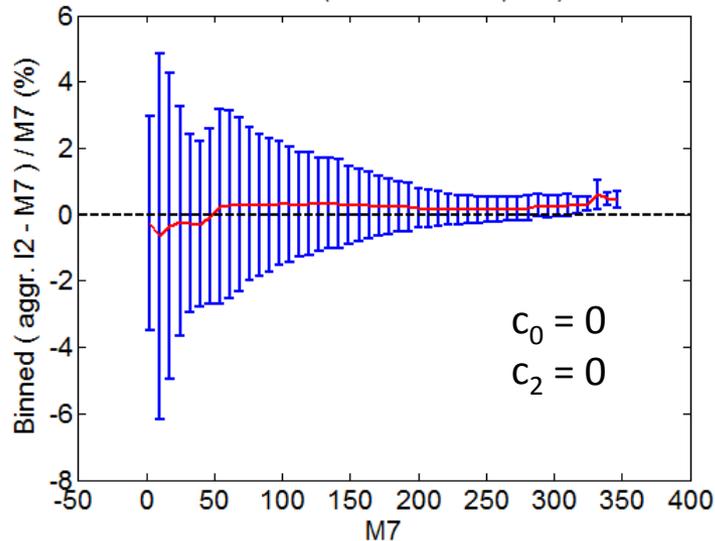


*Transient F factor  
changes until  
August*

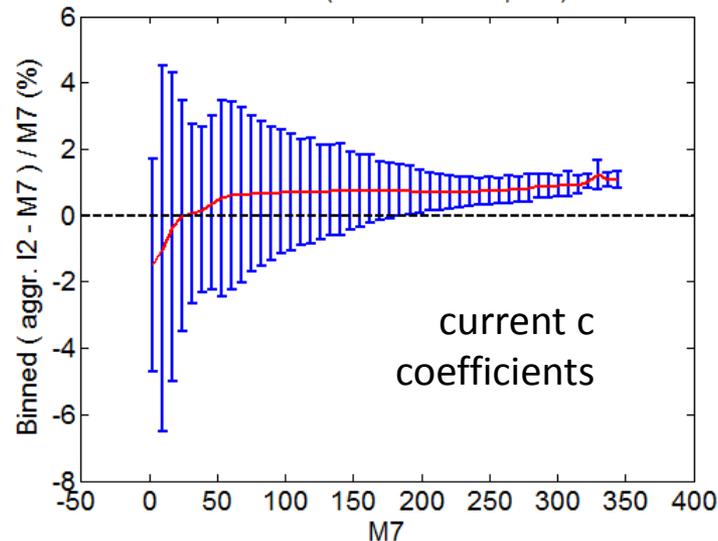
*Granule  
2013-08-30  
23-57 UTC*

# Improved I2/M7 Consistency

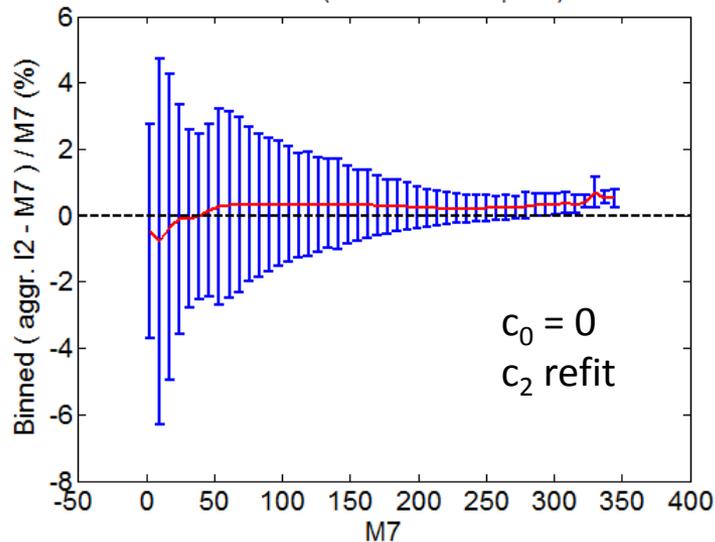
Radiance ( $W \cdot m^{-2} \cdot sr^{-1} \cdot \mu m^{-1}$ )



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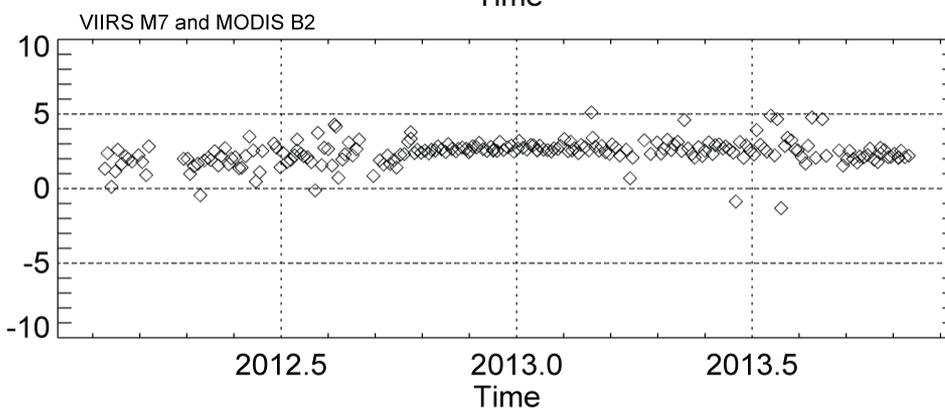
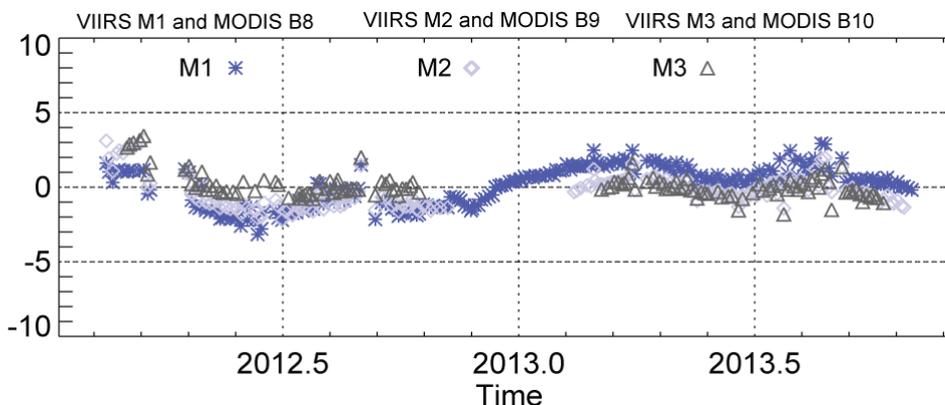
Radiance ( $W \cdot m^{-2} \cdot sr^{-1} \cdot \mu m^{-1}$ )



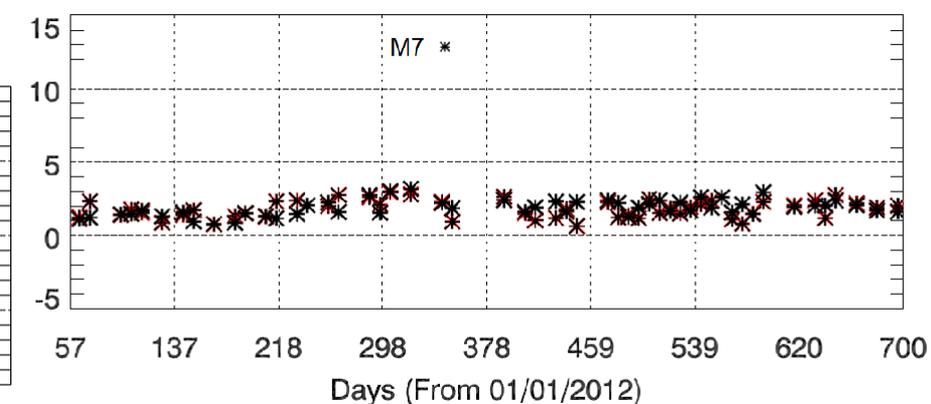
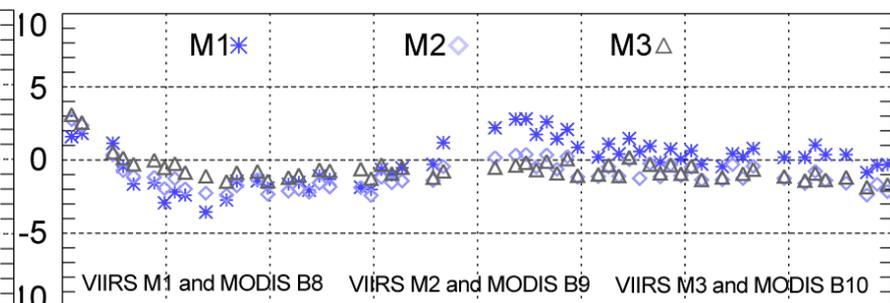
- Ocean scene around Hawaii (2013-08-30 23-57 UTC)
- Comparison of I2 and M7 radiance values for all pixels in the granule
- Setting  $c_0$  to zero reduces I2/M7 differences at low (ocean) and high (clouds) radiance
  - At the low end of the M7 high-gain radiance range,  $c_2 = 0$  is a little better in improving agreement between I2 and M7
  - At the high end of the high-gain range, the  $c_2$  refit is clearly better
  - In the low-gain range,  $c_2 = 0$  seems slightly better

- SNO (Simultaneous Nadir Overpass) and extended SNO (SNO-x) comparisons were continued through the second year of Suomi NPP on orbit
- Covered a full year of consistent radiometric calibration procedures (except for the spectral response adjustment in April'13)
- Standard deviation of biases remains within  $\pm 2\%$  for all bands

## SNO: Polar Scenes

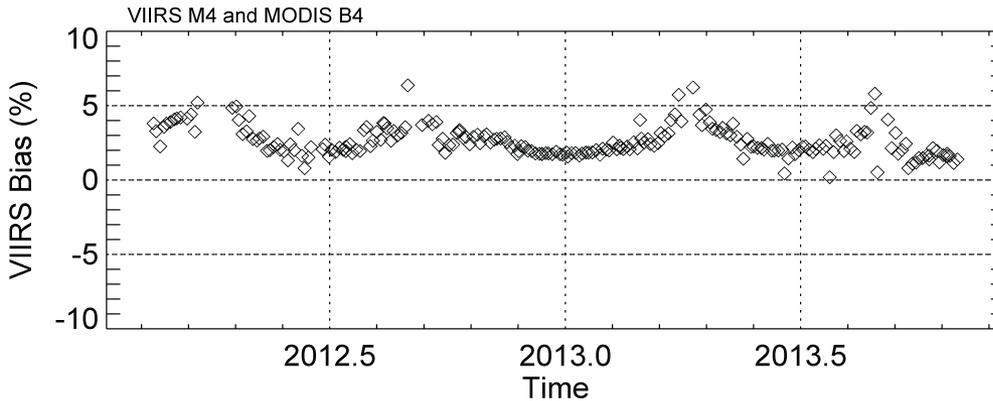


## SNO-x: Desert Scenes

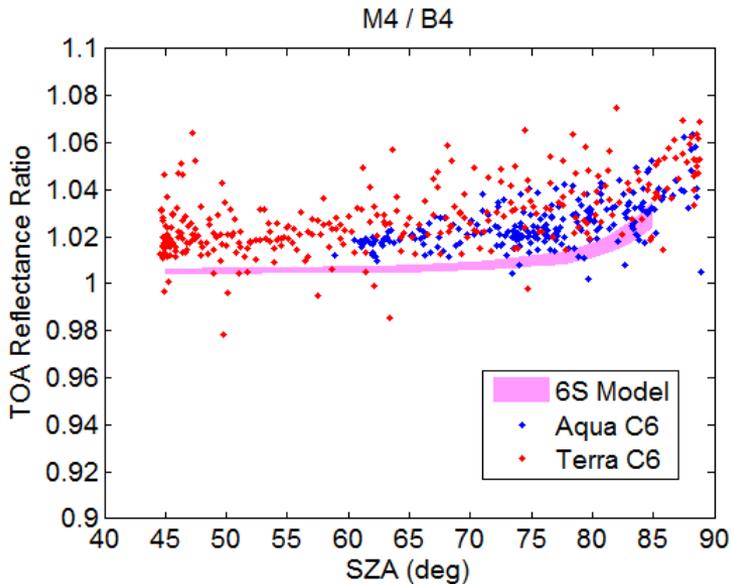
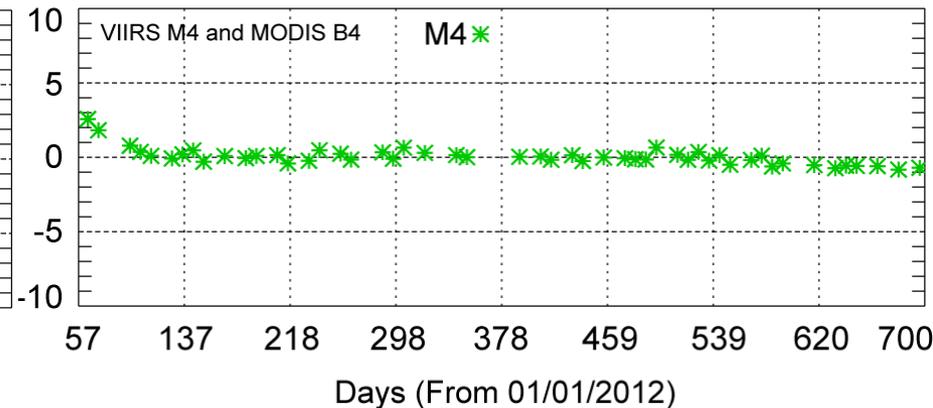


# VIIRS vs. MODIS at 555 nm

## SNO: Polar Scenes



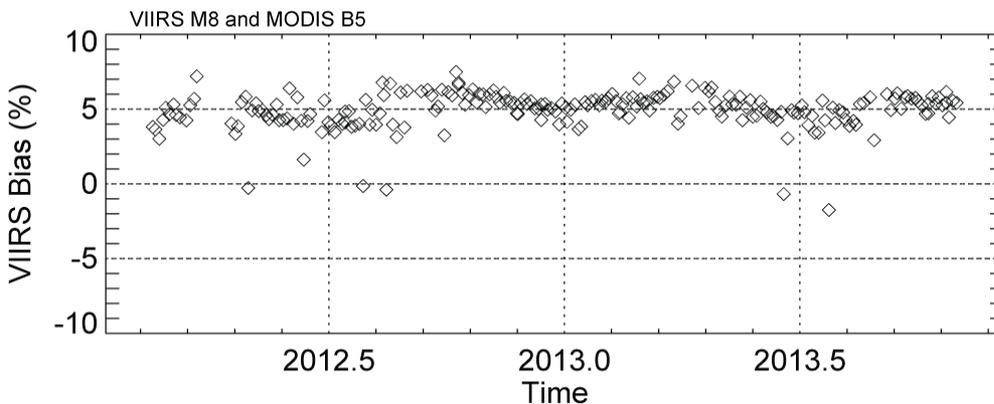
## SNO-x: Desert Scenes



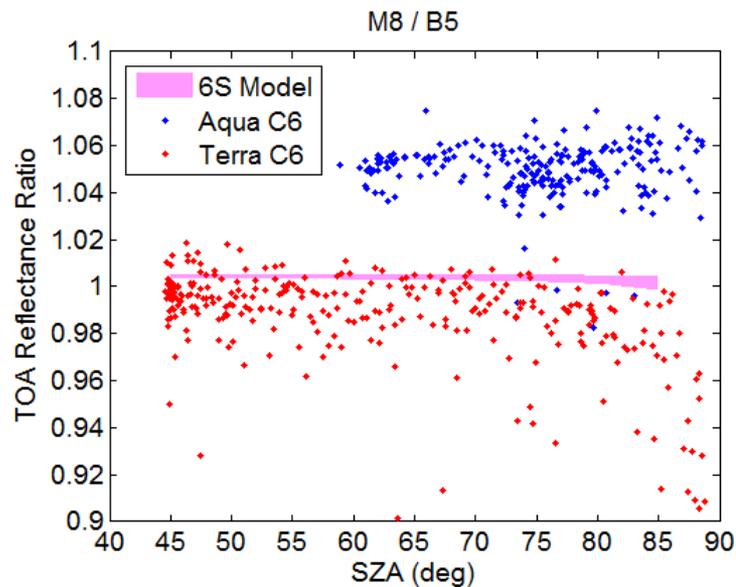
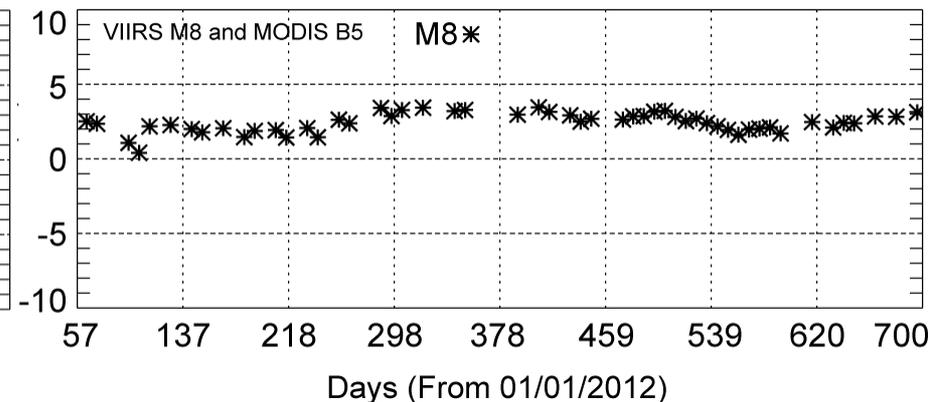
- There is a significant seasonal variability of the SNO biases that is clearly correlated with the SZA (Solar Zenith Angle) changes (as shown by the 6S radiative transfer modeling for the snow land cover type)
- When extrapolated to the smaller SZA values, the residual SNO biases between VIIRS band M4 and MODIS band 4 on Aqua and Terra are approximately 1.5% for the scenes dominated by snow and clouds (after correction for the spectral bias)
- For the desert scenes, SNO-x data show that there is no VIIRS vs. MODIS bias after the spectral bias correction

# VIIRS vs. MODIS on Aqua and Terra

## SNO: Polar Scenes

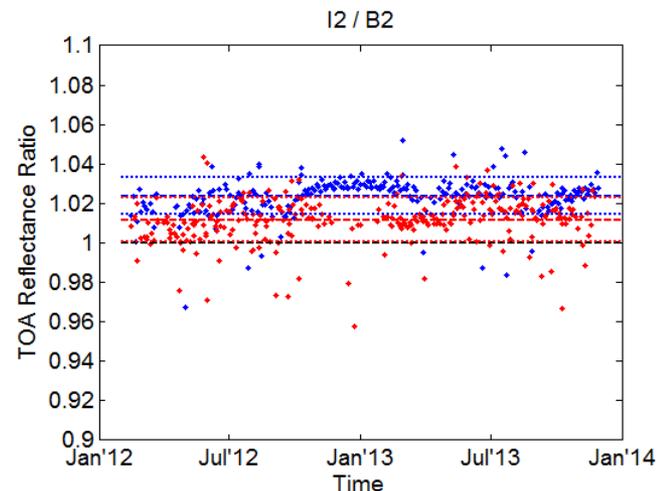
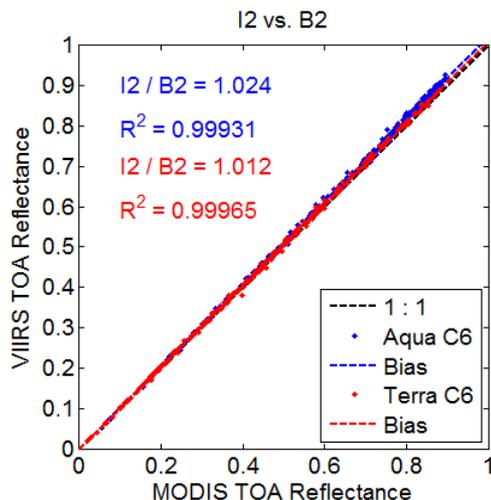
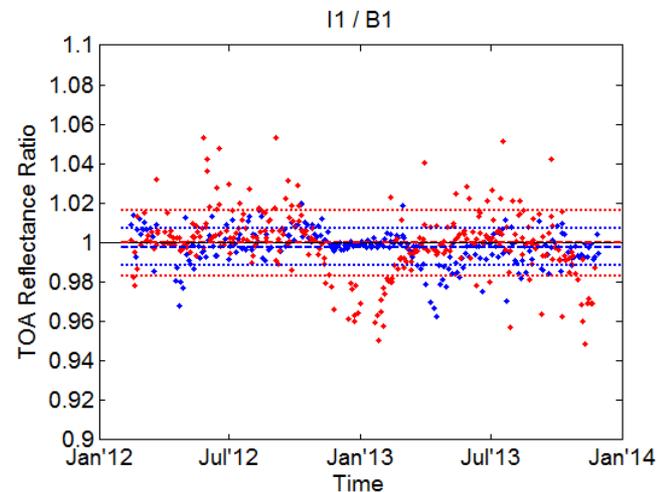
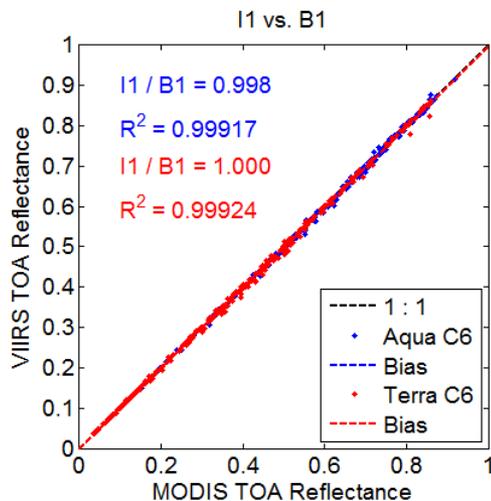


## SNO-x: Desert Scenes



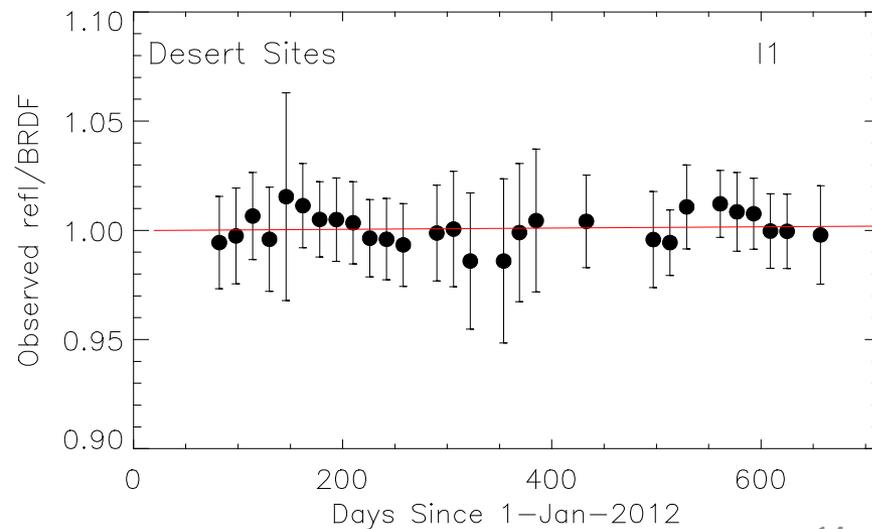
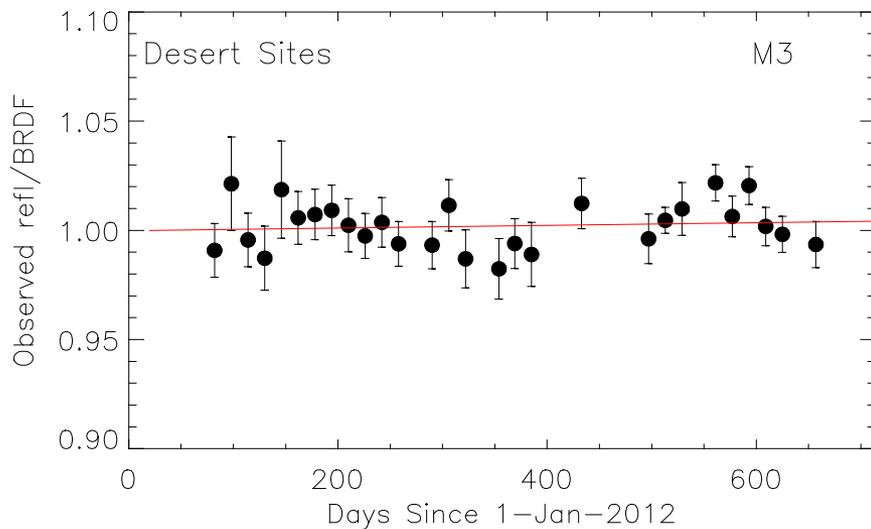
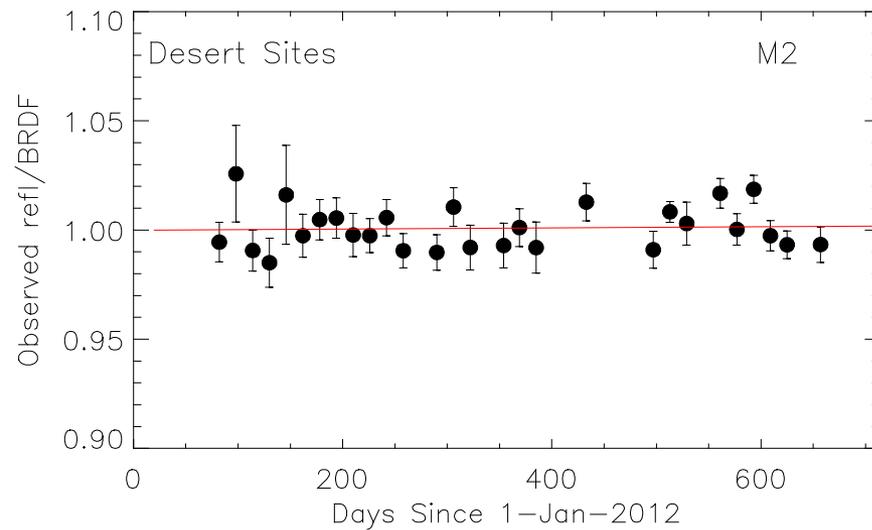
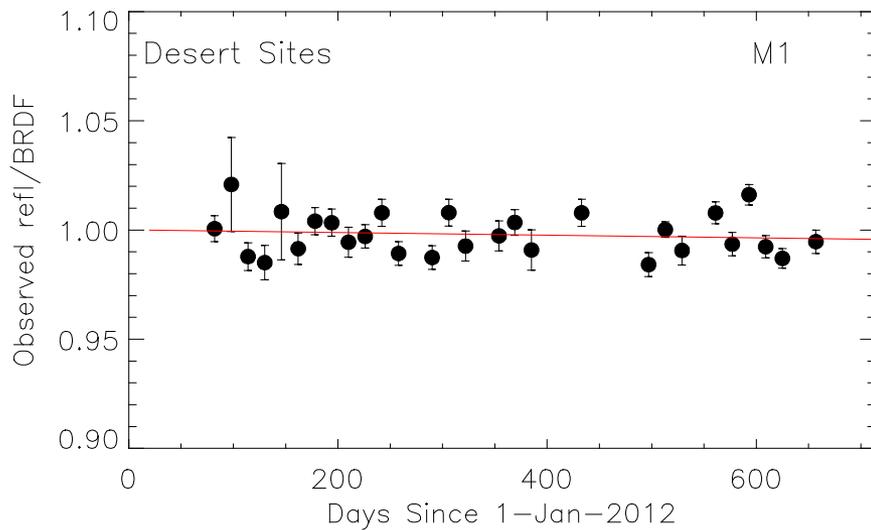
- While the uncertainty of the SNO comparisons for this SWIR band (1.24  $\mu\text{m}$ ) is quite large, the MODIS band 5 measurements from Terra are clearly higher by  $\sim 5\%$  than the data from Aqua
- Since Terra data agree better with VIIRS and 6S, it seems that it is Aqua MODIS that may be less accurate
- SNO-x data show a similar, although smaller, bias for VIIRS band M8 vs. band 5 from MODIS on Aqua

- For the VIIRS VisNIR Imaging bands (I1 and I2) and the corresponding MODIS bands 1 and 2 (used in NDVI calculations):
  - There is no bias when comparing NPP VIIRS band I1 with MODIS band 1 on both Aqua and Terra
  - There are only small biases between VIIRS band I2 and MODIS band 2 on Aqua (~2%) and Terra (~1%)
- Improvements to VIIRS radiometric calibration have generated more consistent SNO comparisons since mid-November 2012
- I2 is one of the bands most affected by the VIIRS telescope throughput degradation (due to tungsten oxide contamination), but weekly updates of the calibration coefficients have provided stability for the radiometric products



# VIIRS Reflectance Trends for Libya-4

Using SDRs reprocessed with calibration coefficients improved by the NASA VIIRS Calibration Support Team



*Normalized to MODIS reflectance (BRDF)*



# Summary



- RSBAutoCal has been implemented in IDPS and is generating calibration coefficients that are consistent with the coefficients derived by the current off-line procedure
- The RSBAutoCal-derived coefficients will be used in the operational SDR production after their testing is completed
- Using the RSBAutoCal, consistency between the radiometric measurements in bands I2 and M7 can be improved by removing the free term ( $c_0$ ) from the calibration equation
- SNO comparisons with MODIS have shown that the implemented regular updates of the radiometric calibration coefficients have stabilized VIIRS radiometric calibration
- Through the second year of the Suomi NPP on orbit operations, the biases between VIIRS and MODIS SNO measurements in the reflective solar bands remained small and mostly within the combined 2% uncertainty requirements for VIIRS and MODIS