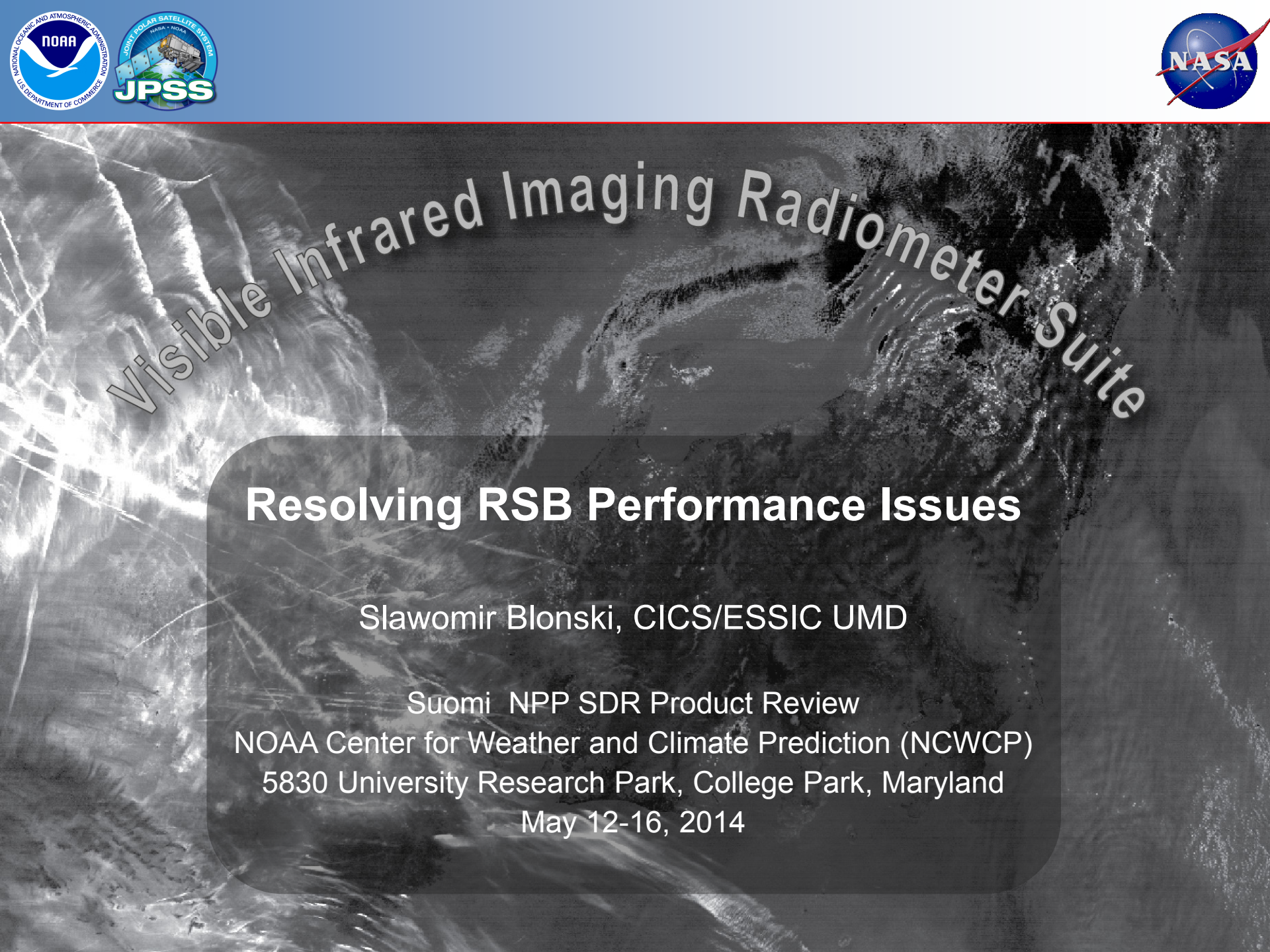

Resolving RSB Performance Issues

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Suomi NPP SDR Product Review
NOAA Center for Weather and Climate Prediction (NCWCP)
5830 University Research Park, College Park, Maryland
May 12-16, 2014

VIIRS RSB Radiometric Calibration

Calibration equation for earth view data:

$$L = \langle F \rangle \cdot (c_0 + c_1 \Delta n + c_2 \Delta n^2) \,/\, RVS \qquad \Delta n = n_{EV} - \langle n_{SV} \rangle$$

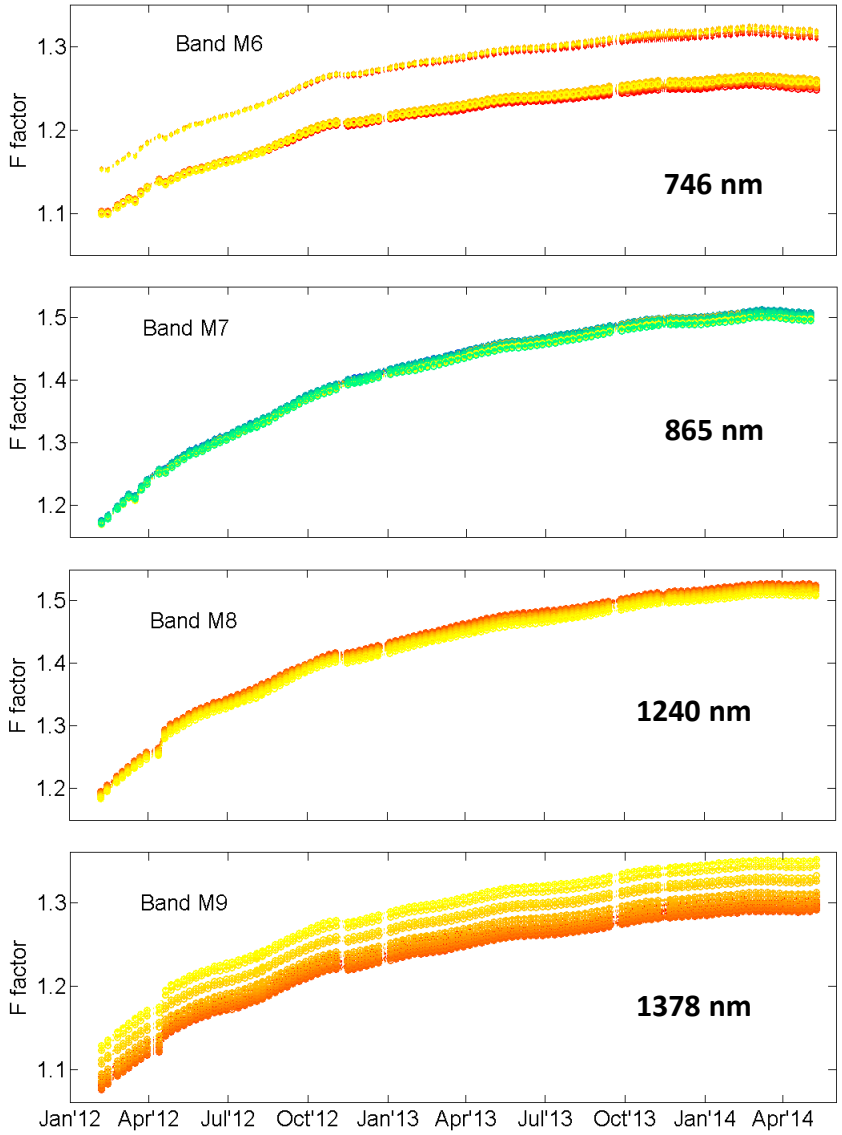
F factor derived from solar diffuser measurements:

$$F = \frac{E_{sun}(d) \cdot \cos AOI \cdot \tau_{SDS} \cdot BRDF_{SD}}{c_0 + c_1 \Delta n_0 + c_2 {\Delta n_0}^2} \qquad \Delta n_0 = n_{SD} - \langle n_{SV} \rangle$$

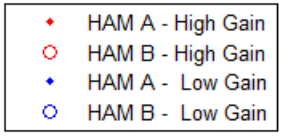
$$E_{sun}(d) = \frac{\int RSR(\lambda) \cdot \frac{\Phi_{sun}(\lambda)}{4\pi d^2} d\lambda}{\int RSR(\lambda) d\lambda}$$

- Solar calibration (F) conducted once per orbit
- Solar diffuser stability ($BRDF$) measured once per day: the H factor
- Calibration coefficients $\langle F \rangle$ updated once per week
- Lunar calibration conducted once per month (except summer) as a consistency check

VIIRS RSB Calibration Updates



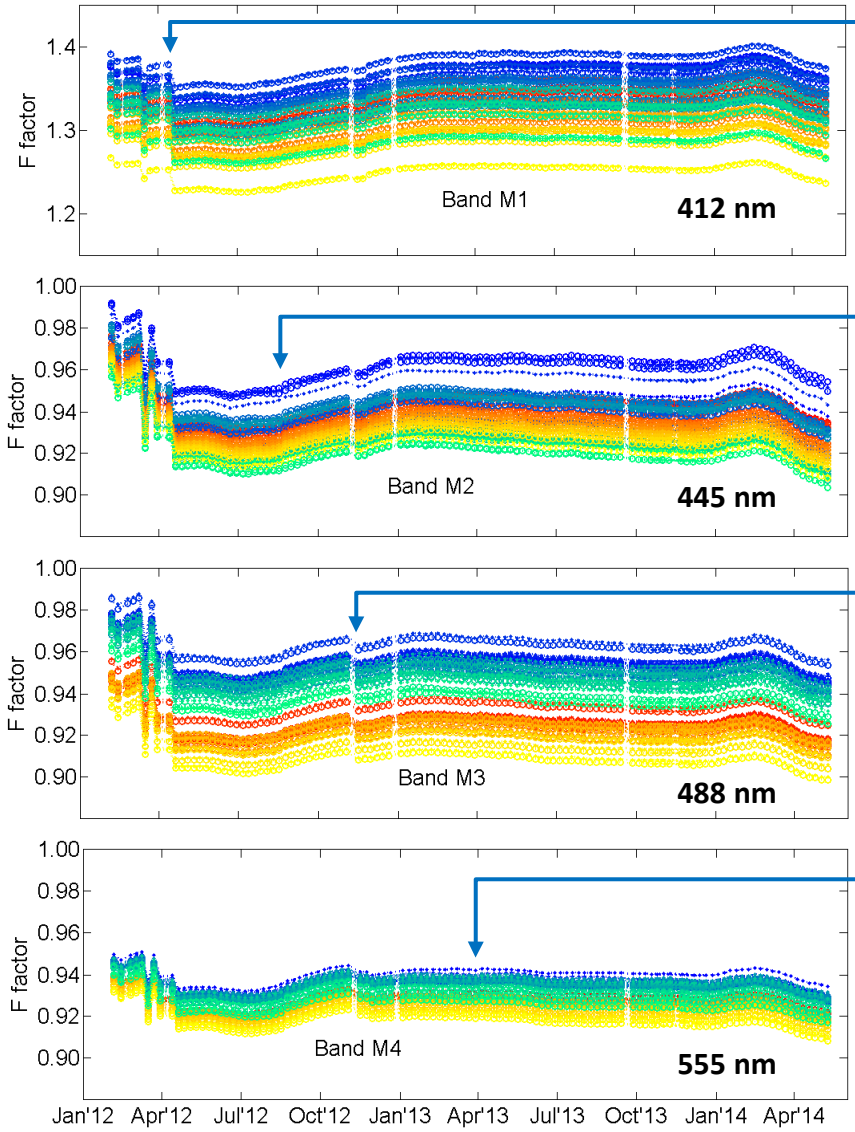
- VIIRS telescope mirrors degradation forced weekly updates of the operational F factors for the reflective solar bands
- The largest changes occurred for the near-infrared (NIR) band M7 and the short-wave-infrared (SWIR) band M8
- The NIR band M6 and the SWIR band M9 were less affected by the degradation
- Even smaller changes due to the telescope degradation occurred for bands M5, M10, and M11
- The F factors trends changed since February 2014 (discussed later)



Red → *Yellow*

Blue → *Green*

Calibration Parameters Changes



Apr'12 – Initial updates of IDPS code and processing parameters completed:
increased short-term stability of the calibration

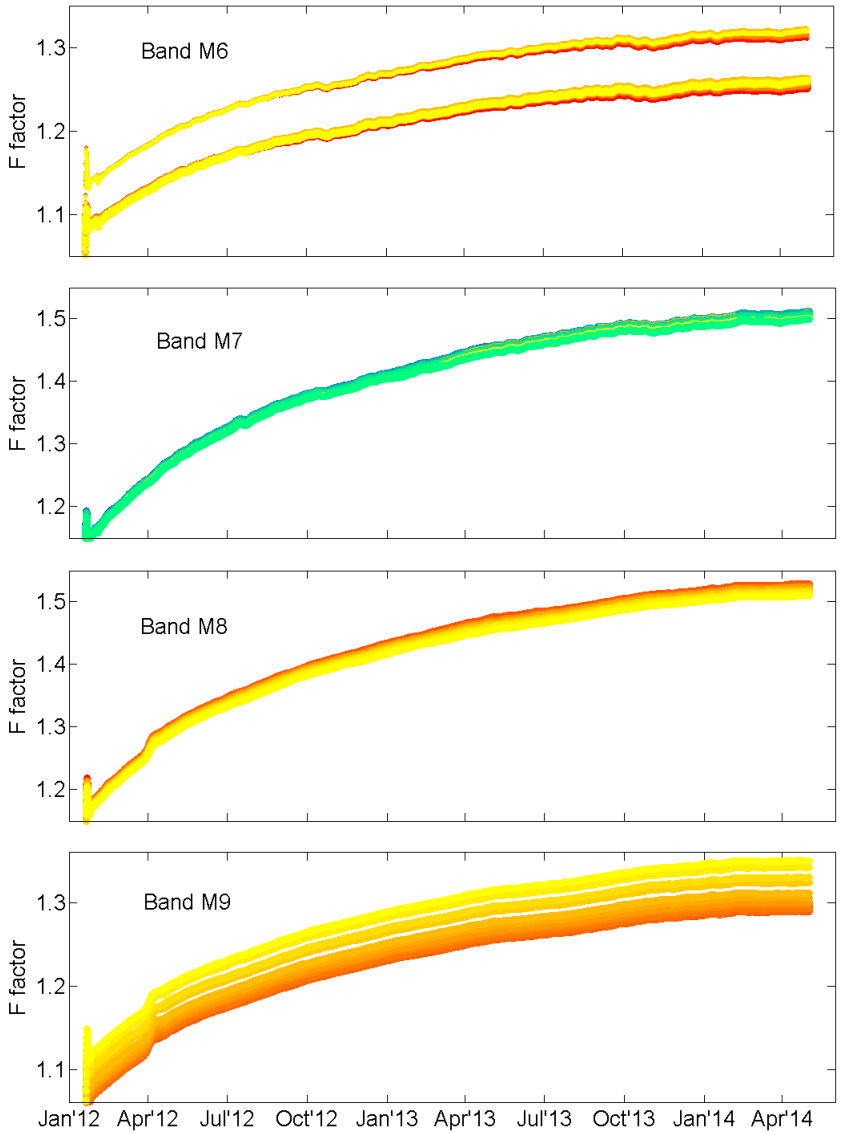
Aug'12 – F factor prediction between updates implemented:
increased calibration accuracy

Nov'12 – Solar diffuser processing parameters updated:
increased long-term stability of the calibration

Apr'13 – Spectral response functions updated:
very small effect

- Unexpected transient F factor increase (up to 1%) in early 2014

Automated Radiometric Calibration

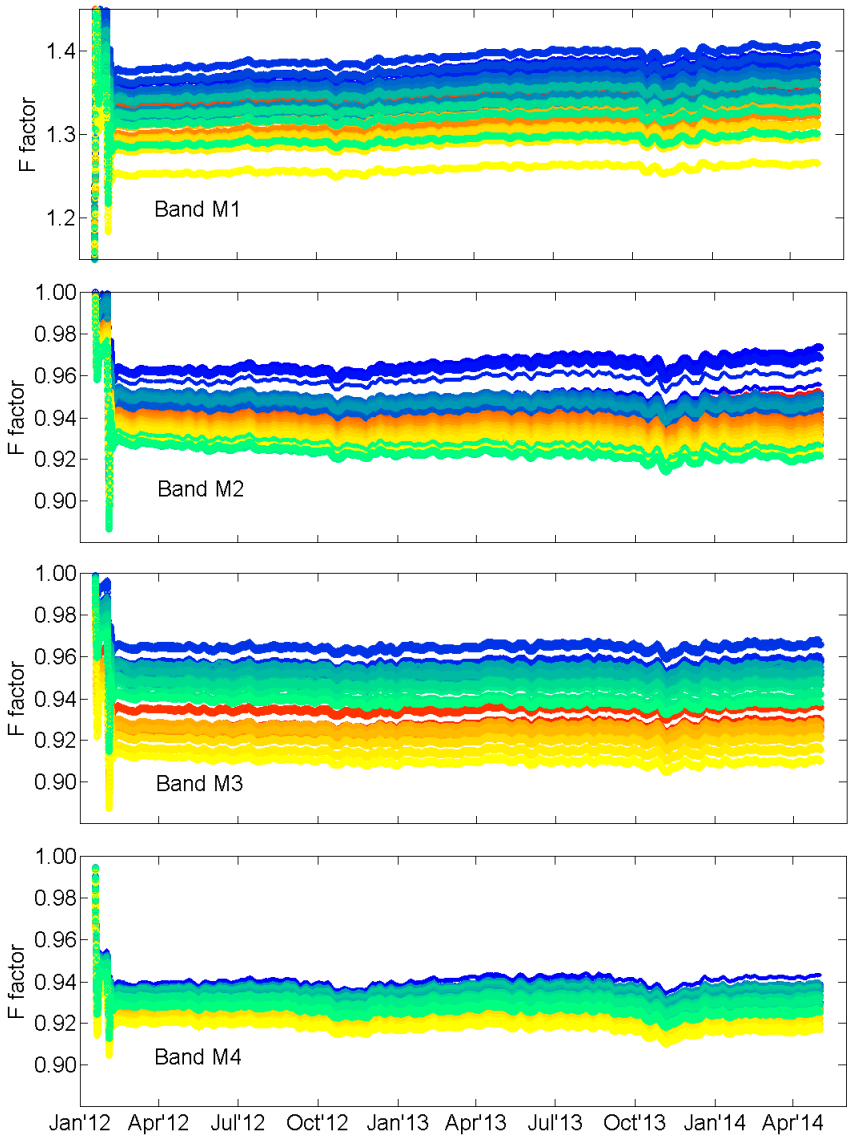


- An automated calibration procedure has been implemented in the IDPS software to update the F factor predictions after every orbit, instead of every week

  Rausch, K., Houchin, S., Cardema, J., Moy, G., Haas, E., De Luccia, F.J., *J. Geophys. Res. Atmos.*, **118** (2013) 13,434-13,442

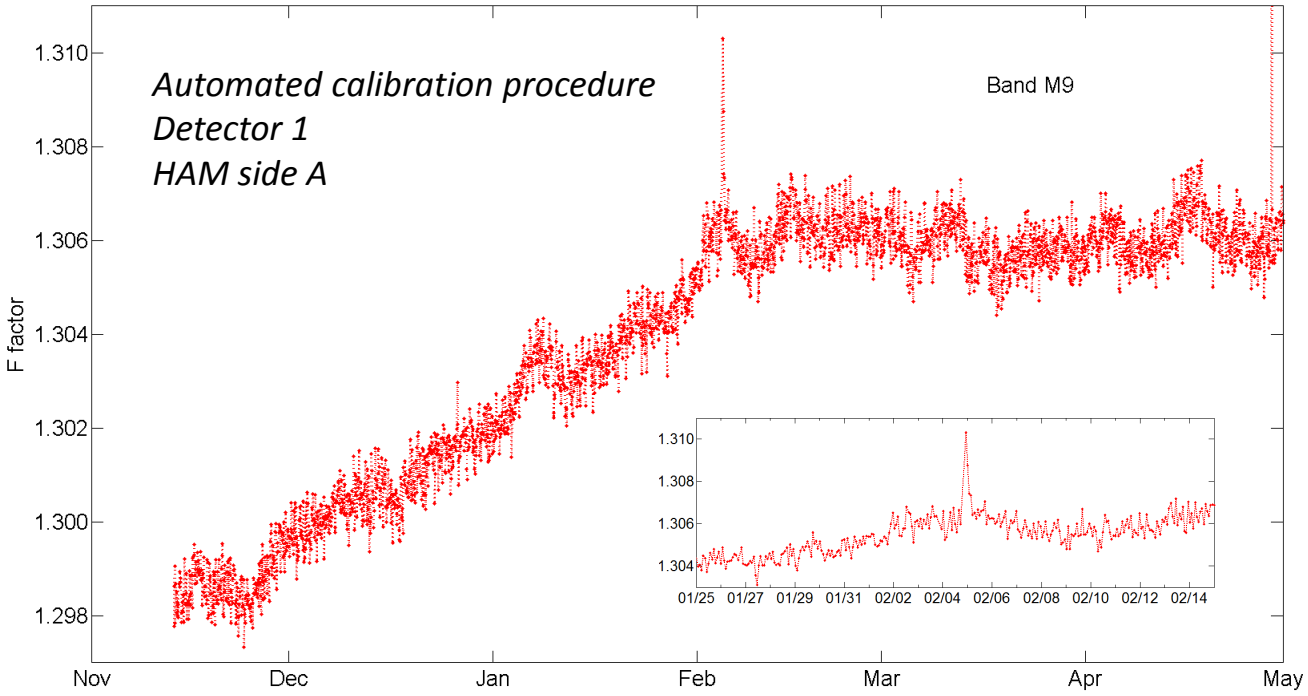
- The F factors calculated by the automated procedure have not been used yet in the operational production of the VIIRS SDR
- We have used the upgraded software to reprocess the solar calibration data from the first two years of the Suomi NPP mission
- For the bands affected by the telescope degradation, the F factor changes predicted by the automated procedure agree well with the operational F factors

Improved Calibration Stability



- For the bands not significantly affected by the telescope degradation, the automated calibration procedure improves long-term stability of the predicted F factors
- Even with the current set of the processing parameters (look-up tables), the predicted long-term changes of the F factors are either slow or non-existent
- Periods from October to December of each year are exceptions due to the limited number of valid solar diffuser reflectance measurements
- Although further improvements are still needed, the automated calibration procedure, when applied, would already improve the SDR products

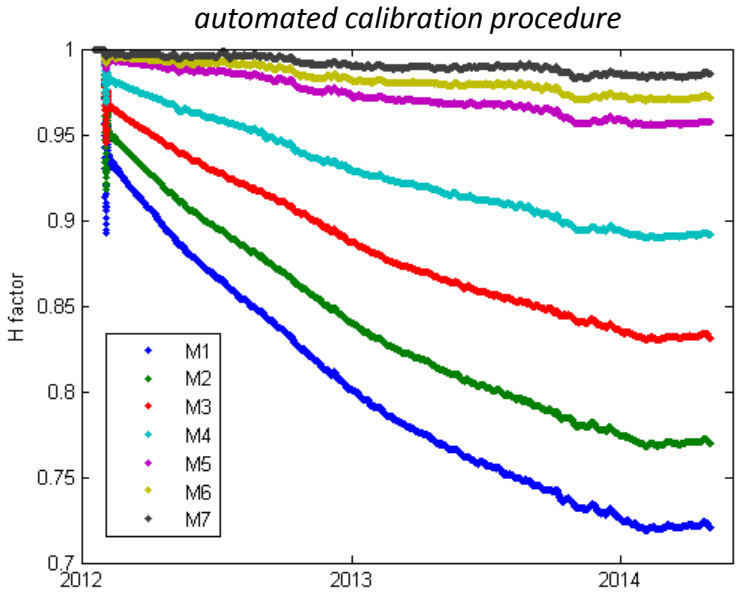
Calibration Trend Change

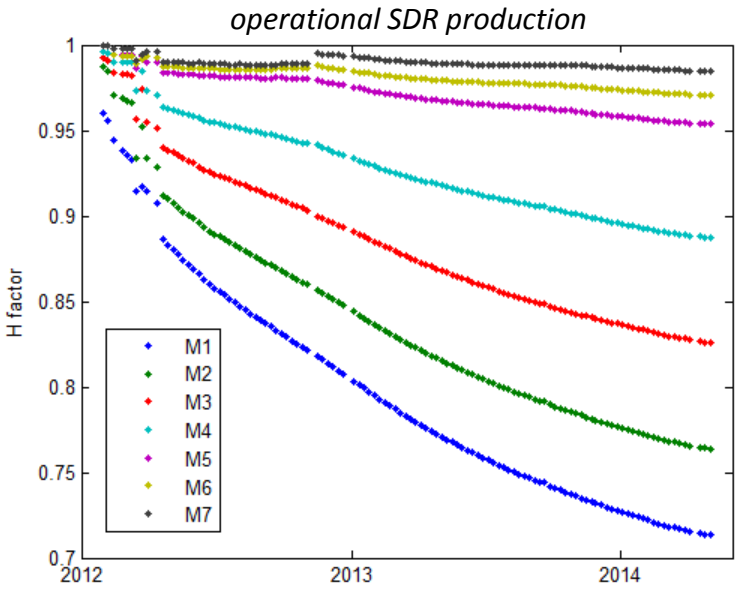


- On February 4, 2014, VIIRS single-board computer lockup anomaly occurred and lasted longer than one orbit
- Following recovery from the anomaly (marked by the spike in the M9 F factors: see the insert graph), the F factor trends have changed

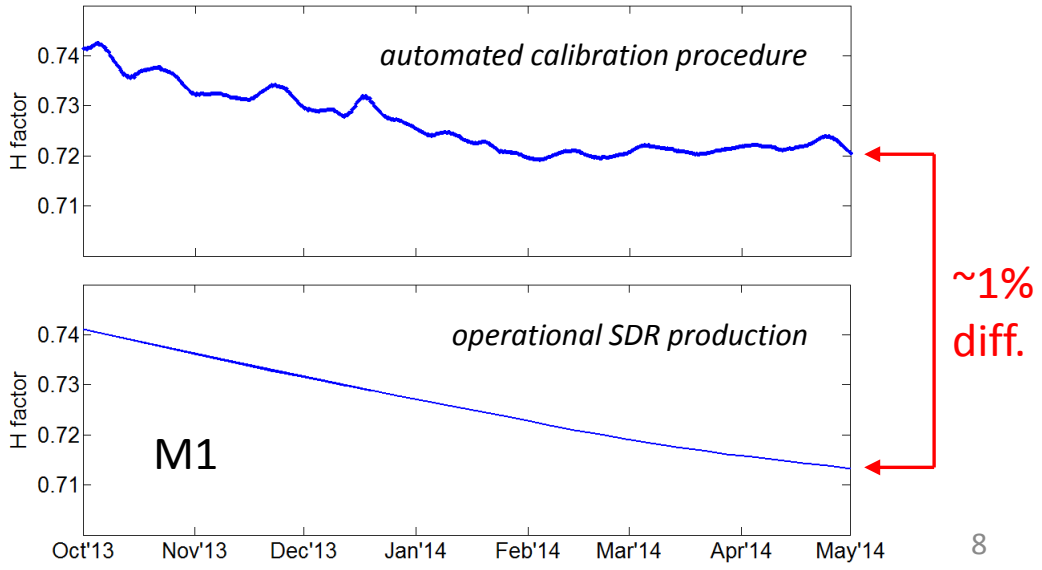
- Despite fluctuations in the calculated F factor values, it is clear that the F factors for the SWIR bands are no longer increasing due to the telescope throughput degradation (note that solar diffuser reflectance is assumed constant for the SWIR bands)
- The telescope degradation may have stopped if during the February 4 anomaly the telescope mirrors temperature increased enough to “bake out” water ice that after the UV photolysis was providing protons for the tungsten oxide color center formation

Solar Diffuser Degradation Trend

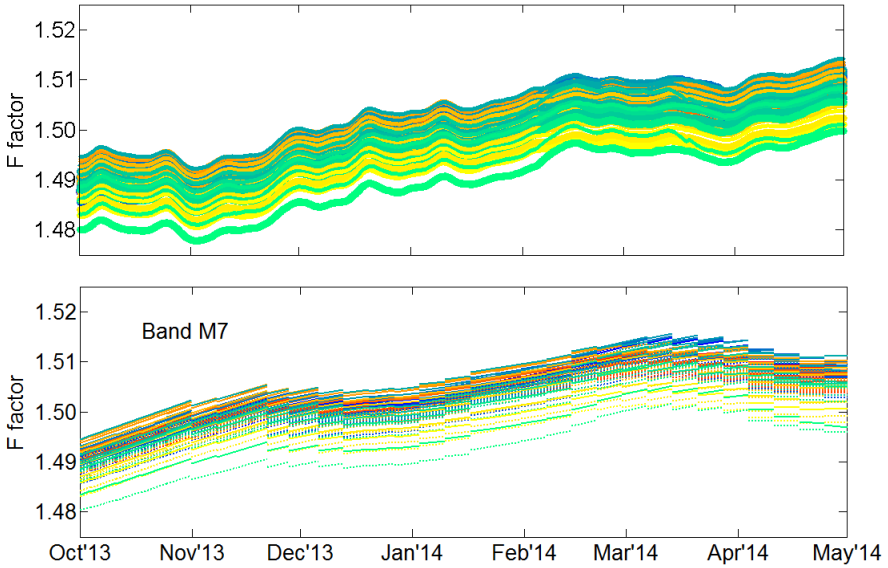


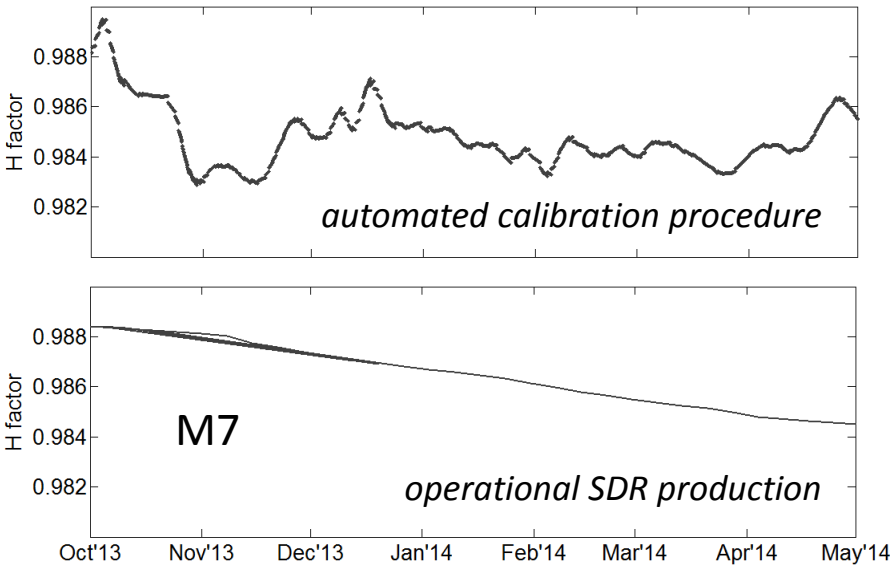


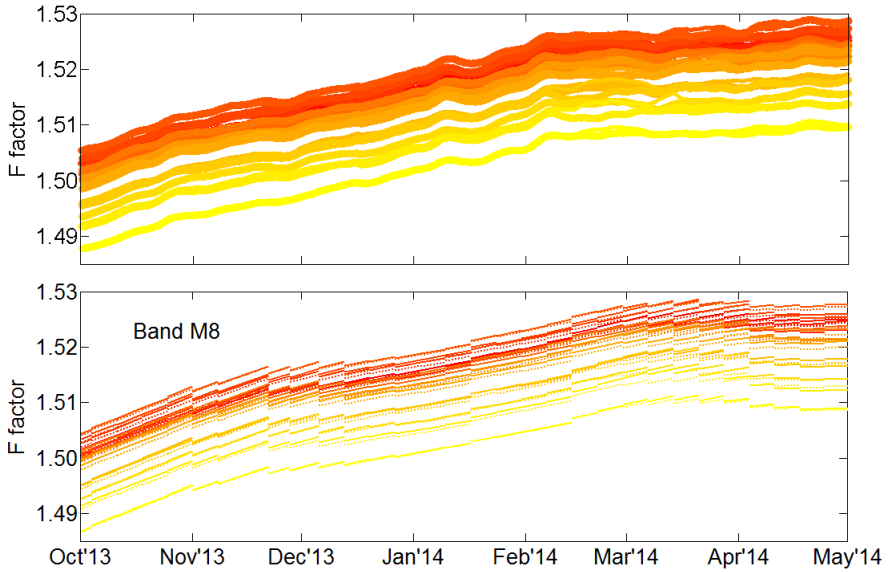
- When the solar diffuser monitoring data are analyzed with the automated calibration procedure, the reflectance degradation trend changes in February 2014: the decrease has diminished
- If during the February 4 anomaly the solar diffuser temperature increased above ~360 K, the hydrocarbons that cause the degradation may have been baked out (in vacuum)



Effects on Radiometric Calibration







- For the bands not corrected by the H factors (SWIR), the automated procedure calibration responded more timely to the calibration trend changes
- Additionally, for the bands corrected by the H factors, the automated procedure responded better to the changes in the solar diffuser degradation

Summary

- Radiometric calibration applied to the VIIRS RSB measurements for the SDR production has been improved several times since the launch of the Suomi NPP satellite: updates of the processing parameters improved stability of the radiometric calibration between 2012 and 2013
- A new, automated procedure derives the coefficients once per orbit from the onboard solar diffuser measurements: calibration coefficients derived by the automated procedure appear even more stable throughout duration of the mission
- Implementation of the automated calibration procedure in the operational SDR production is currently planned for June 2014, but it should proceed as soon as effects of the VIIRS-SDR-DELTA-C-LUT update on May 1, 2014 stabilize
- The automated calibration procedure also appears to provide a better response to the calibration trend changes occurring since February 2014