Trending of Suomi-NPP VIIRS Radiometric Stability with Lunar Band Ratio

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Suomi NPP SDR Product Review
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Outline

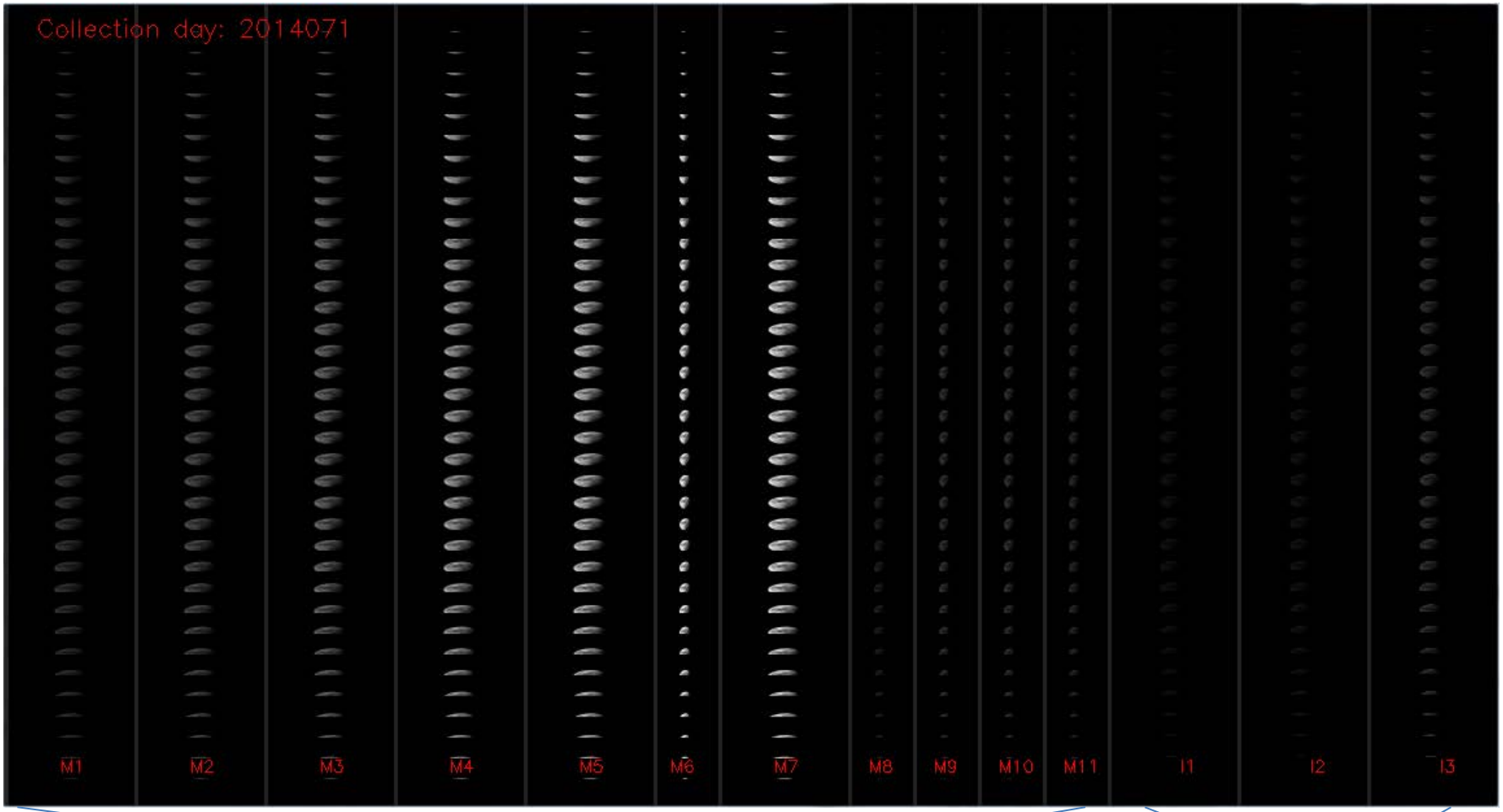
- Scheduled lunar observation by VIIRS
- Deriving Lunar Band Ratio (LBR) from observation
- Overall stability trending of VIIRS with LBR
- Comparison of LBR with F factor trending and discussion
- Summary

List of scheduled lunar Observations by VIIRS

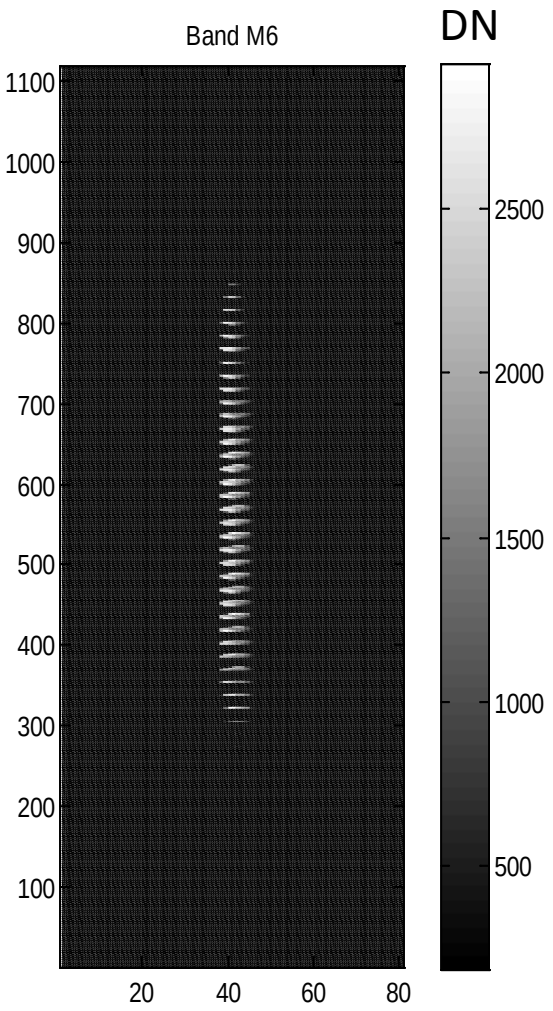
Date	Target time	Roll angle	Date	Target time	Roll angle
4/2/2012	23:05:11	-3.989	10/14/2013	21:39:19	-1.305
5/2/2012	10:20:06	-3.228	11/13/2013	6:57:41	-7.981
10/25/2012	6:58:15	-4.048	12/12/2013	19:35:46	-9.438
11/23/2012	21:18:20	-9.429	1/11/2014	9:59:45	-6.727
12/23/2012	15:00:50	-7.767	2/10/2014	5:34:12	-3.714
2/21/2013	9:31:25	-1.712	3/12/2014	1:11:43	-3.945
3/23/2013	3:29:00	-3.32	4/10/2014	20:53:15	-4.977
4/21/2013	19:47:54	-3.882			

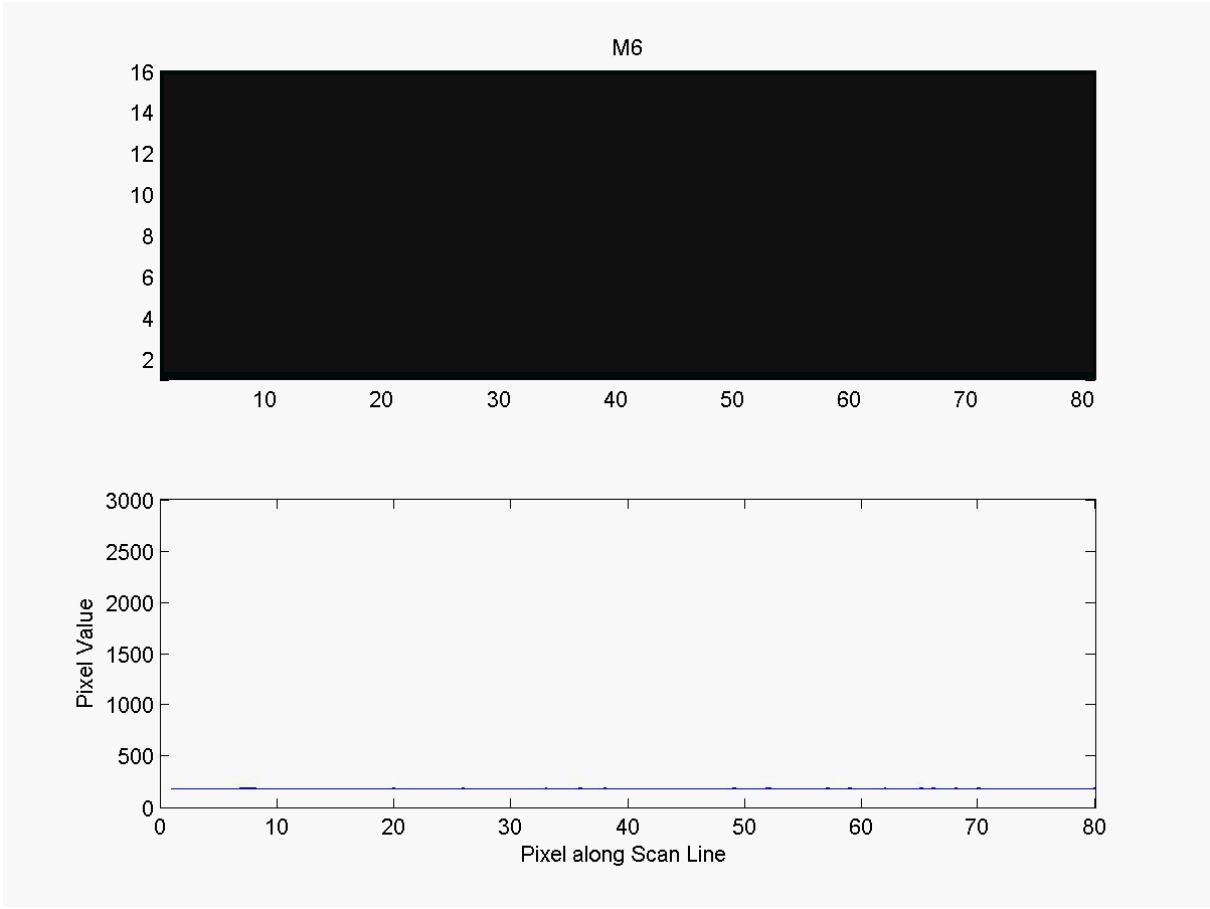
- Raw Data Record (RDR) for lunar observations are collected
- All of events collected at nearly the same lunar phases (-51.3 to -50.3 degree).
- In total, 15 events are analyzed

Lunar images in the reflective solar bands of VIIRS on March 12th, 2014



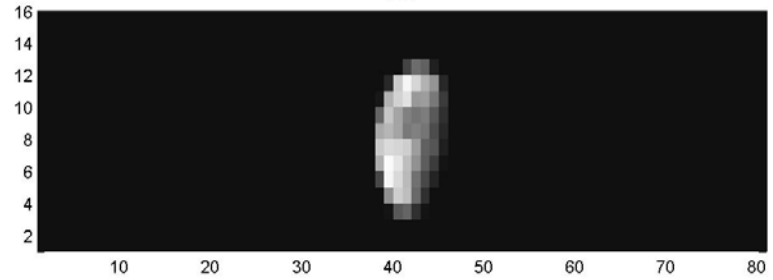
Moon in Earth View for M6

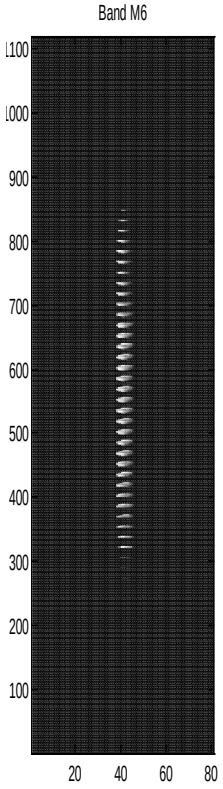




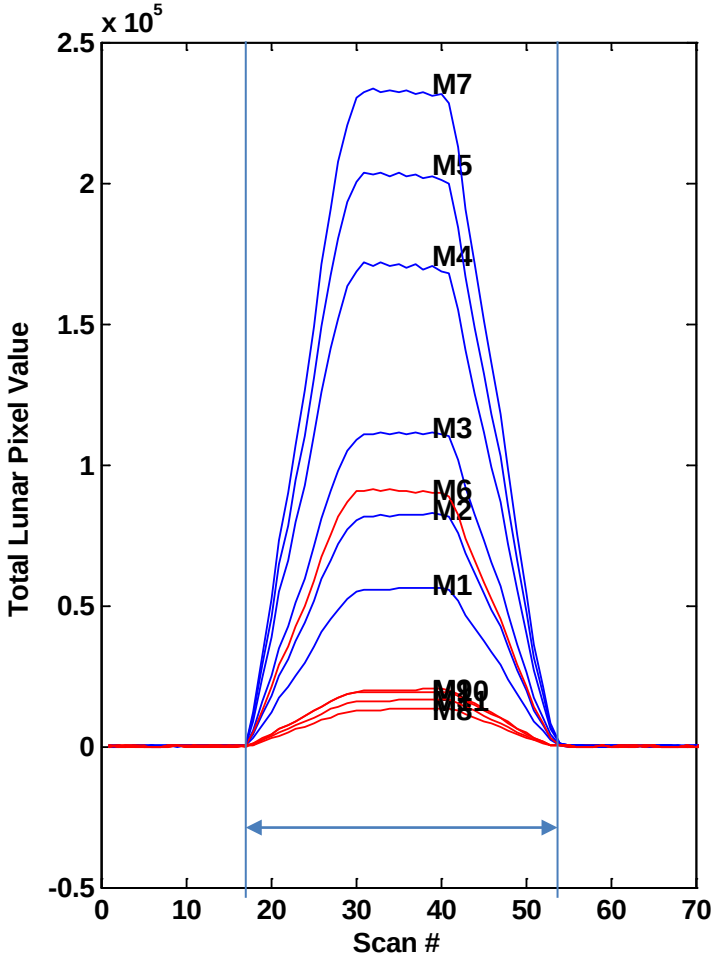
Data Processing: Total Lunar DN

One Scan for M6 Band





Total Pixel Value in the Moon Vs. Scan (with background removed for each detector)



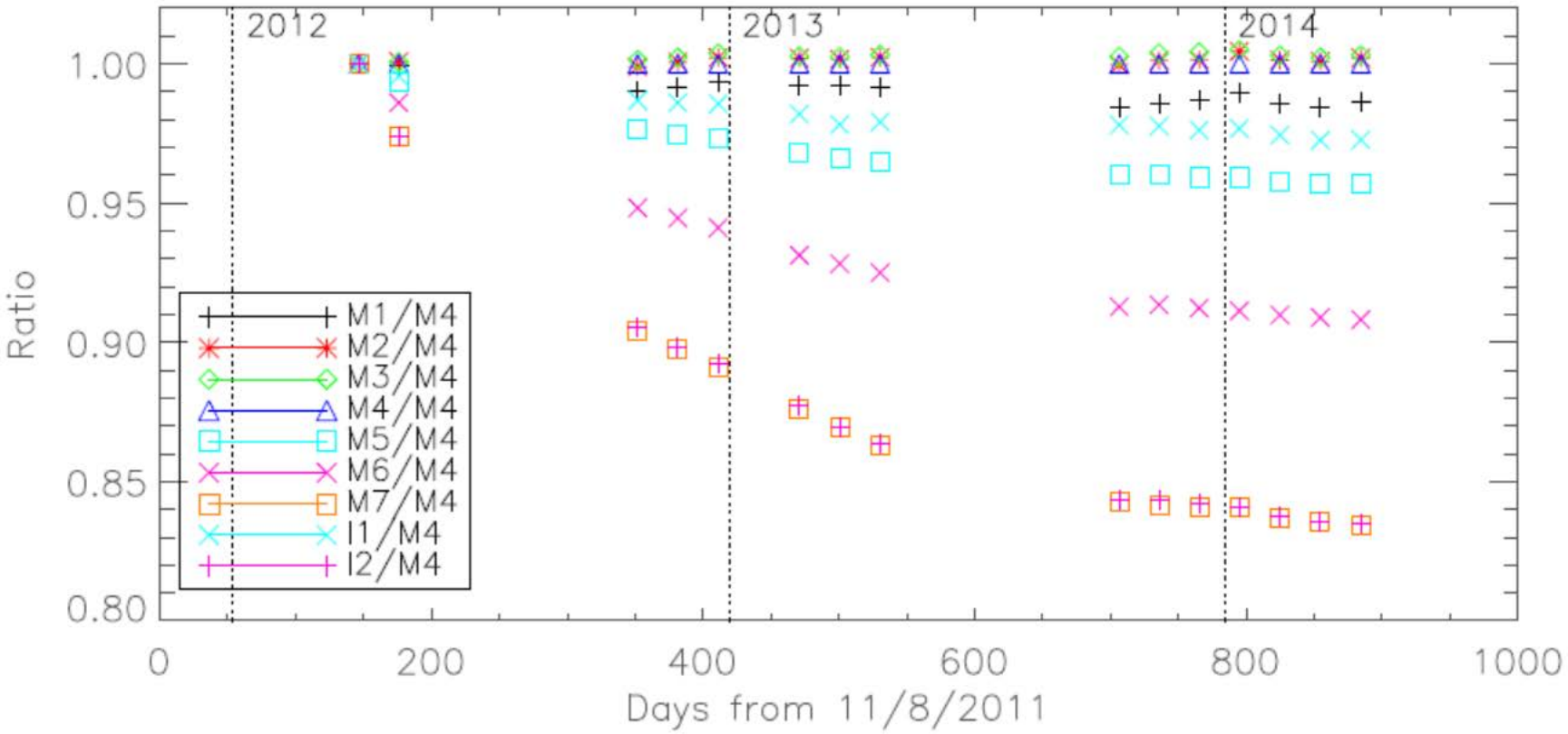
$$Total\ Lunar\ DN(M\ or\ I) = \sum_{Scans\ with\ Moon} \sum_{Pixels\ within\ Scan} DN_{pixel} - DN_{backgrou}$$

$$LBR(M\ or\ I) = \frac{Total\ Lunar\ DN\ (M\ or\ I)}{Total\ Lunar\ DN\ (M4)}$$

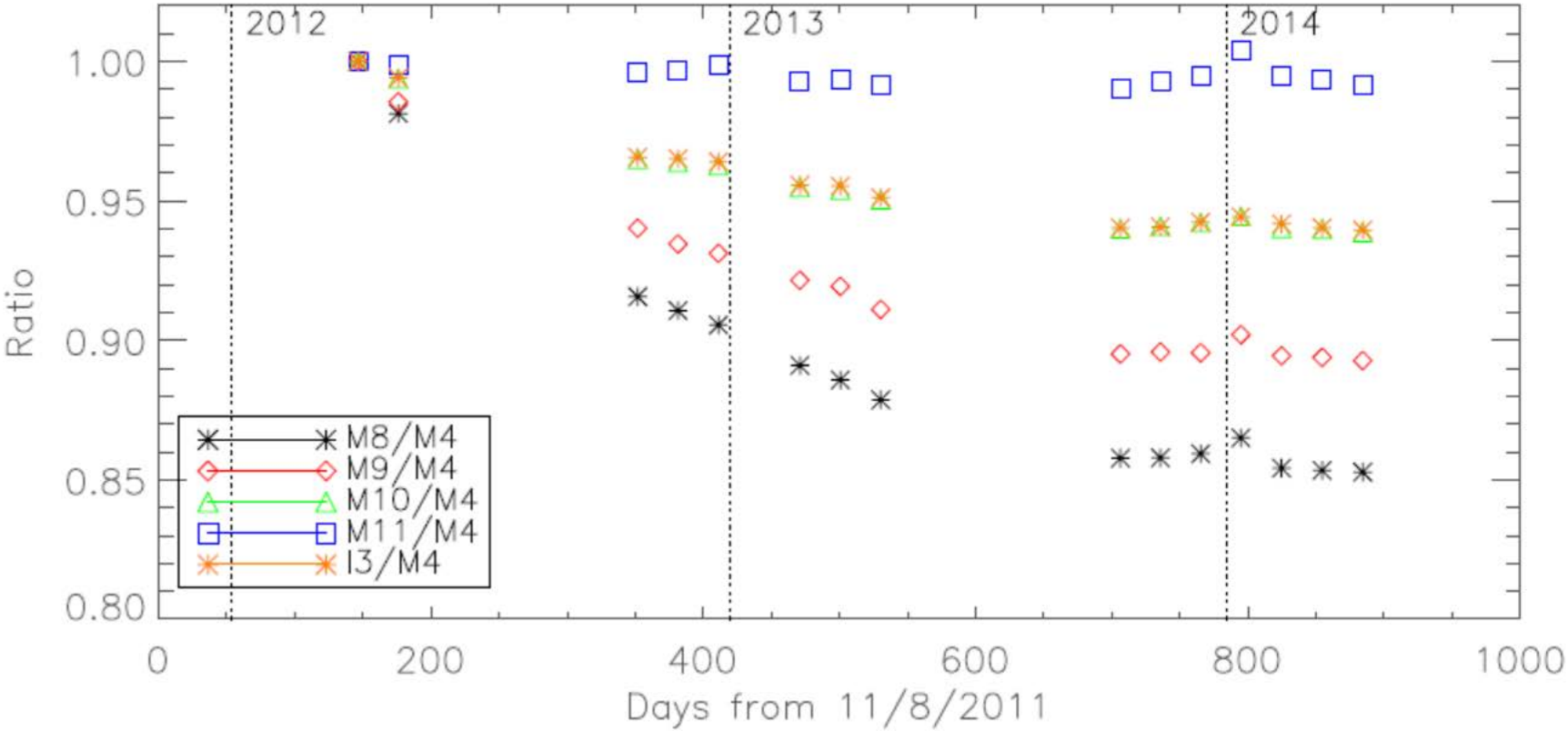
Pros and Cons of LBR Analysis

- Pros
  - Simple calculation and does not rely on lunar irradiance model and not subject to uncertainties embedded in the model
  - Dependences on Sun-Earth and Moon-Earth distances naturally cancel out
  - Especially useful for scheduled lunar observations of VIIRS taken at nearly the same lunar phase and effects of lunar phase cancel out
  - Pure DN ratios and not subject to uncertainty of onboard calibration
- Cons
  - Need to select a stable band as the reference band
  - Can only reveal relative stability of VIIRS

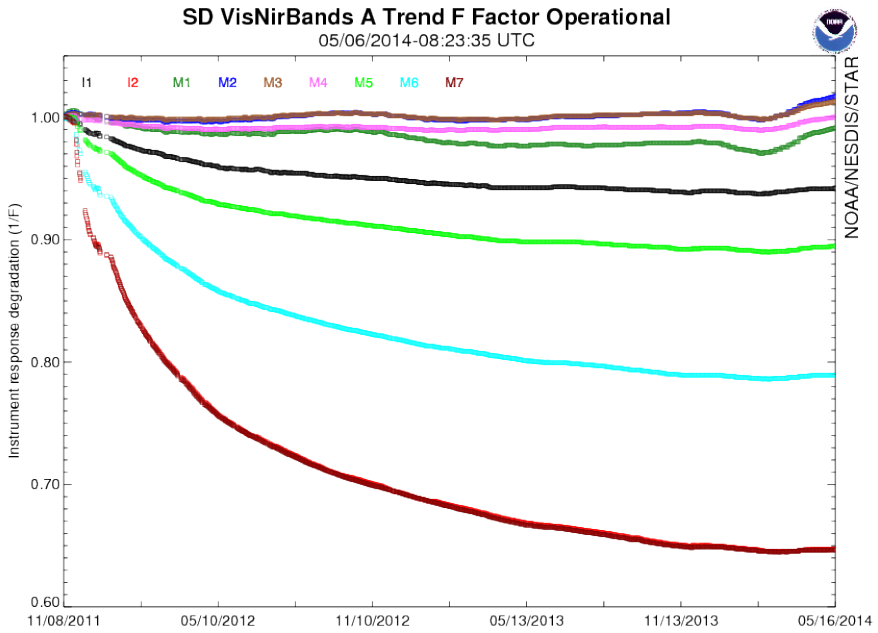
LBR for VIIRS M1-7, I1-2 Bands

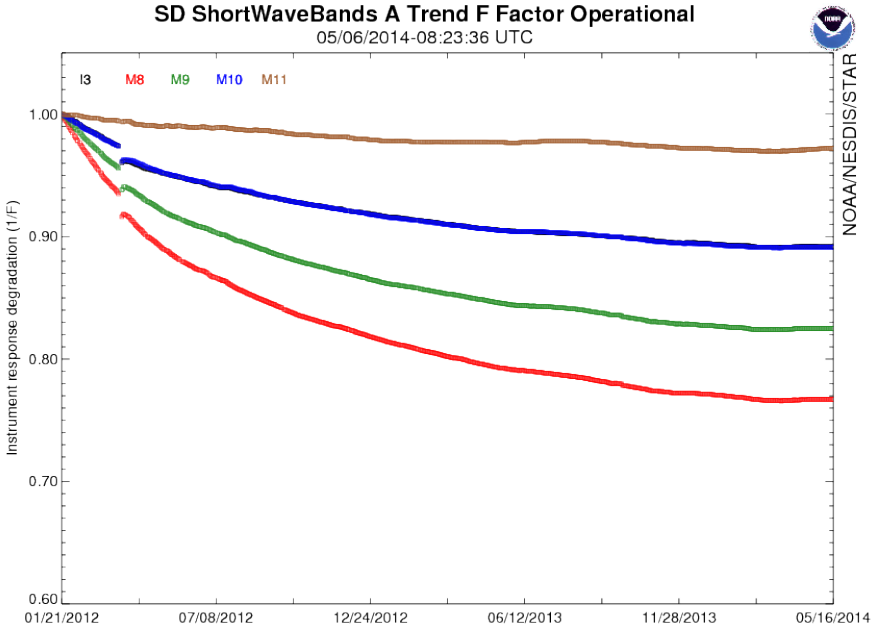


LBR for VIIRS M8-11, I3 Bands



F factors derived from onboard Calibration with Solar Diffuser

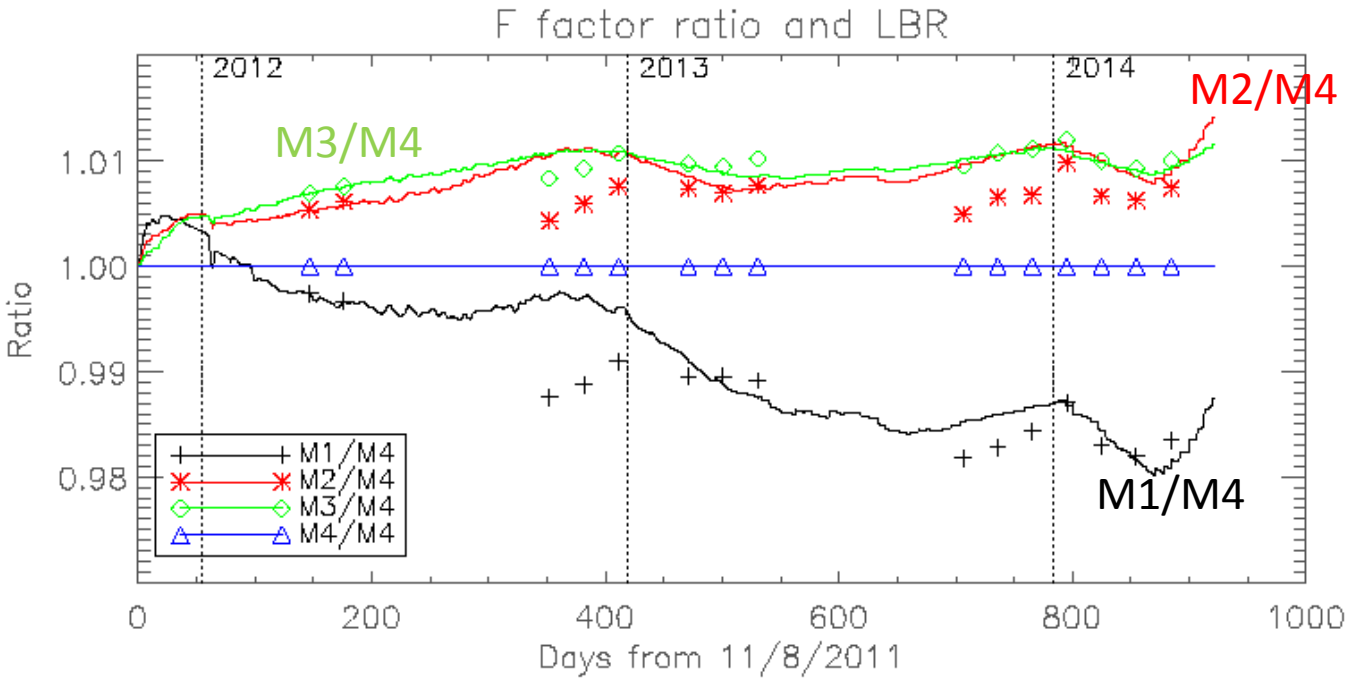




- The band M4 provides stable F factors over the VIIRS lifetime
- The operational F factors are normalized by band M4 and compared to the LBR for VIIRS stability assessment.

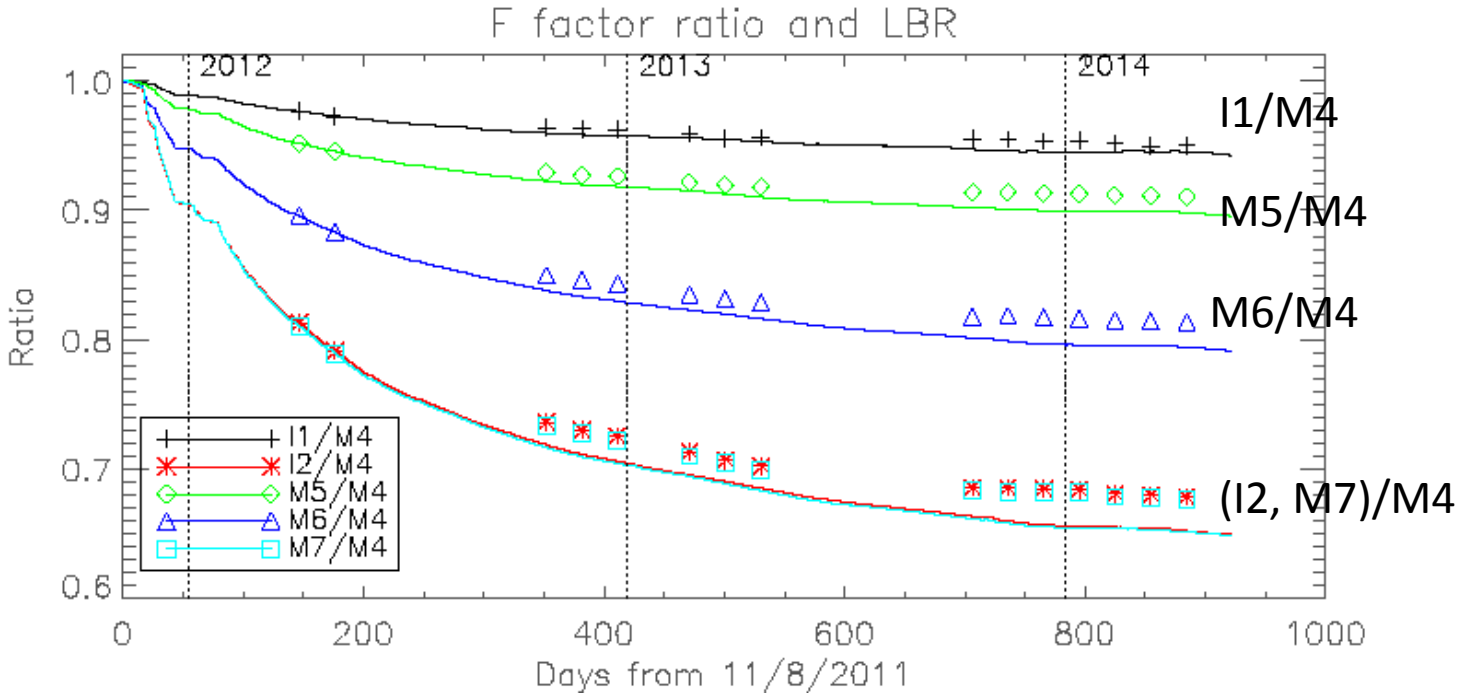
Comparison of LBR with SD F factors for M1-3 Bands

- VisNIR bands M1~M4 (400 to 600 nm)
  - All the LBRs are normalized by its first point and placed on the F factor ratios.
  - The LBRs are following the annual oscillation pattern but not as strong as F factor ratios.
  - Percent variation range of LBR in band M1 is 1.6%, M2 is 0.6%, and M3 is 0.5%.



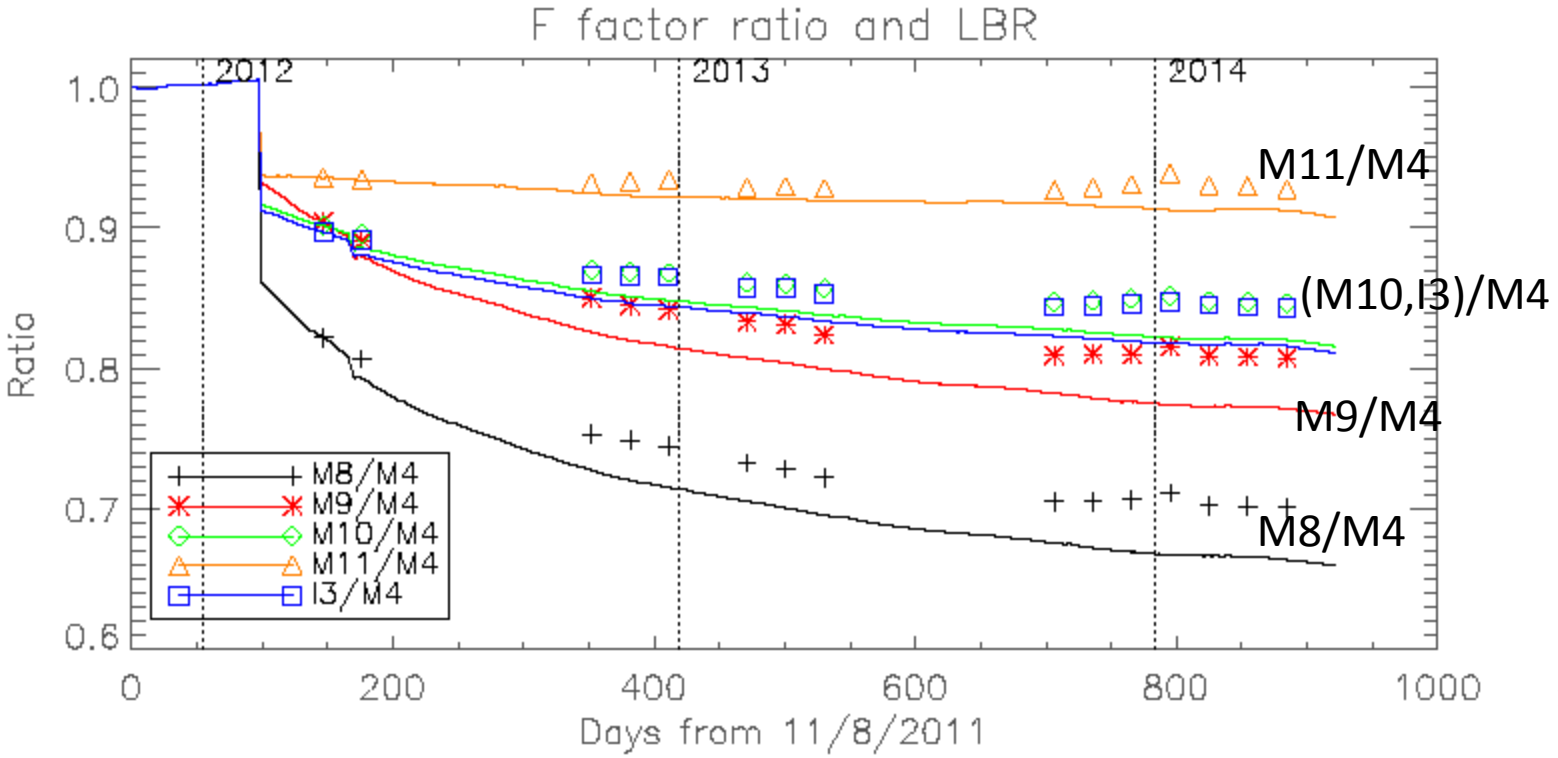
Comparison of LBR with SD F factors for M5-7 and I1-2 Bands

- VisNIR bands M5, M6, M7, I1 and I2 (600 to 900nm)
  - LBRs are following general F factor ratio trends.
  - Differences between LBRs and F factor ratios are growing.
    - With time and center wavelength
  - I2 and M7 ratios are almost identical.



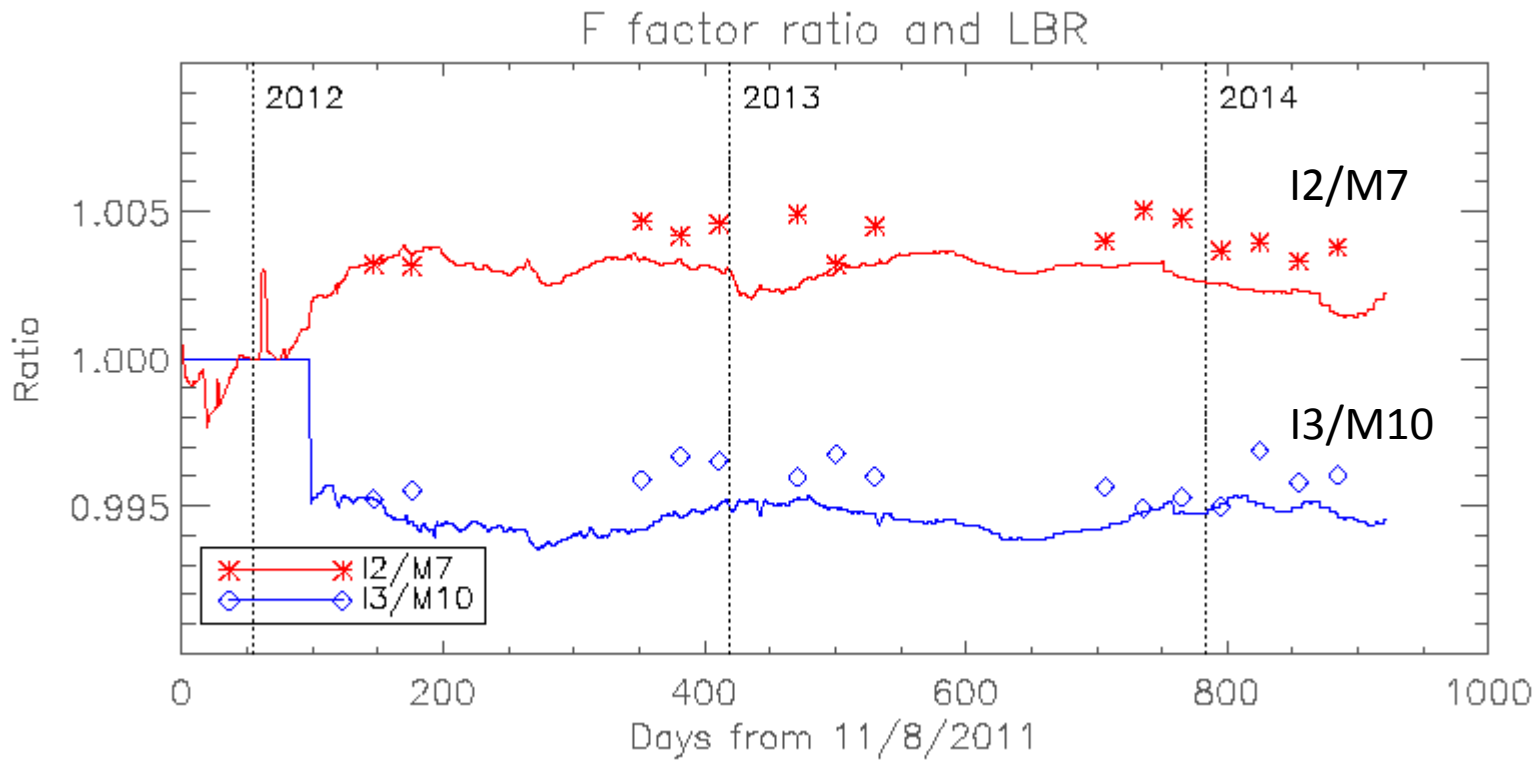
Comparison of LBR with SD F factors for M8-11 and I3 Bands

- S/WMIR bands M8~M11 and I3 (1.2 to 2.5 µm)
  - There is no SD degradation (H factor) applied in these bands.
  - There are differences between F factor ratios and LBR.
  - Trend of M10 and I3 are almost identical



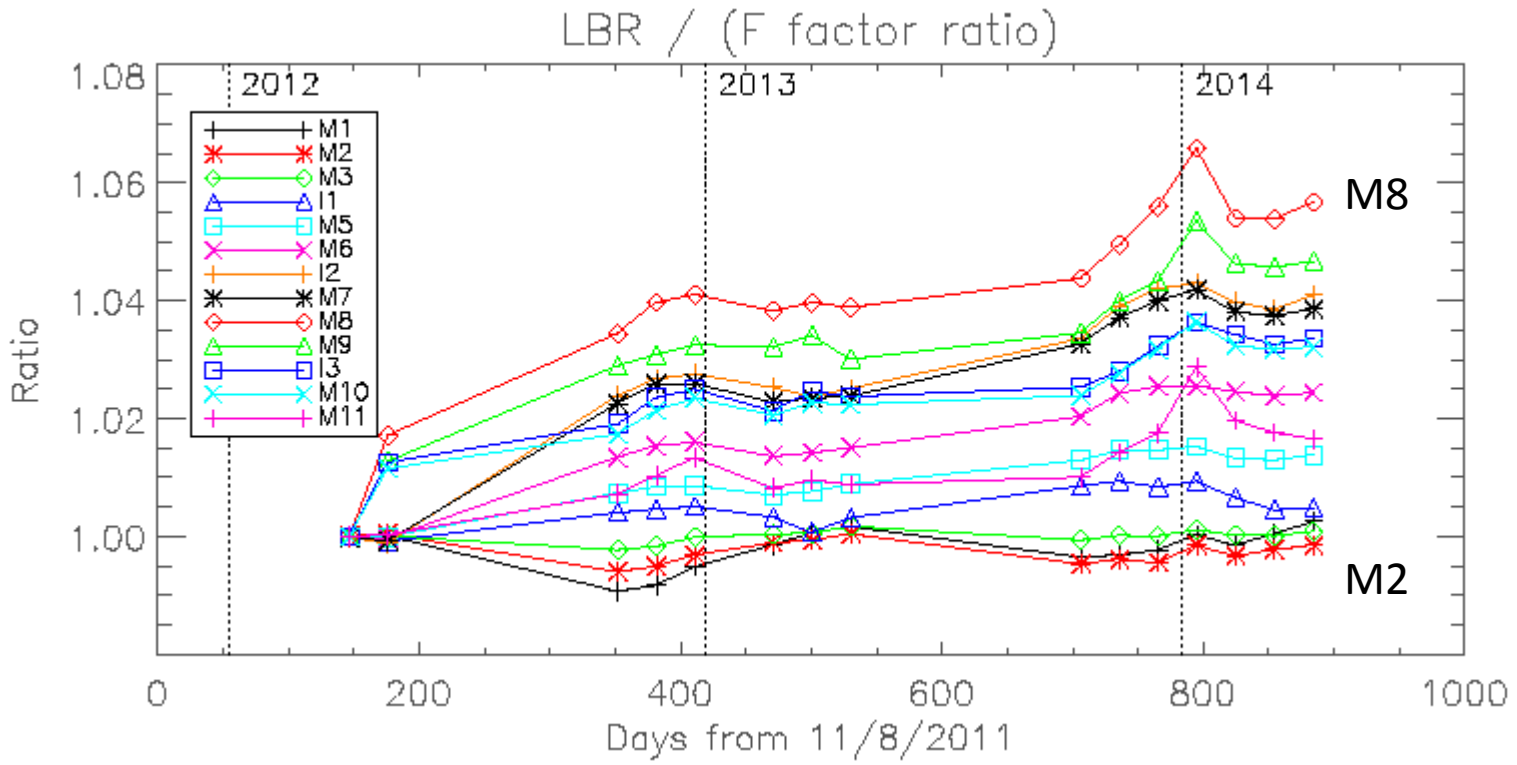
LBR for I2/M7 and I3/M10

- I2/M7 and I3/M10 ratios consistency check.
  - The LBR and F factor ratios are consistent approximately within 0.2%.



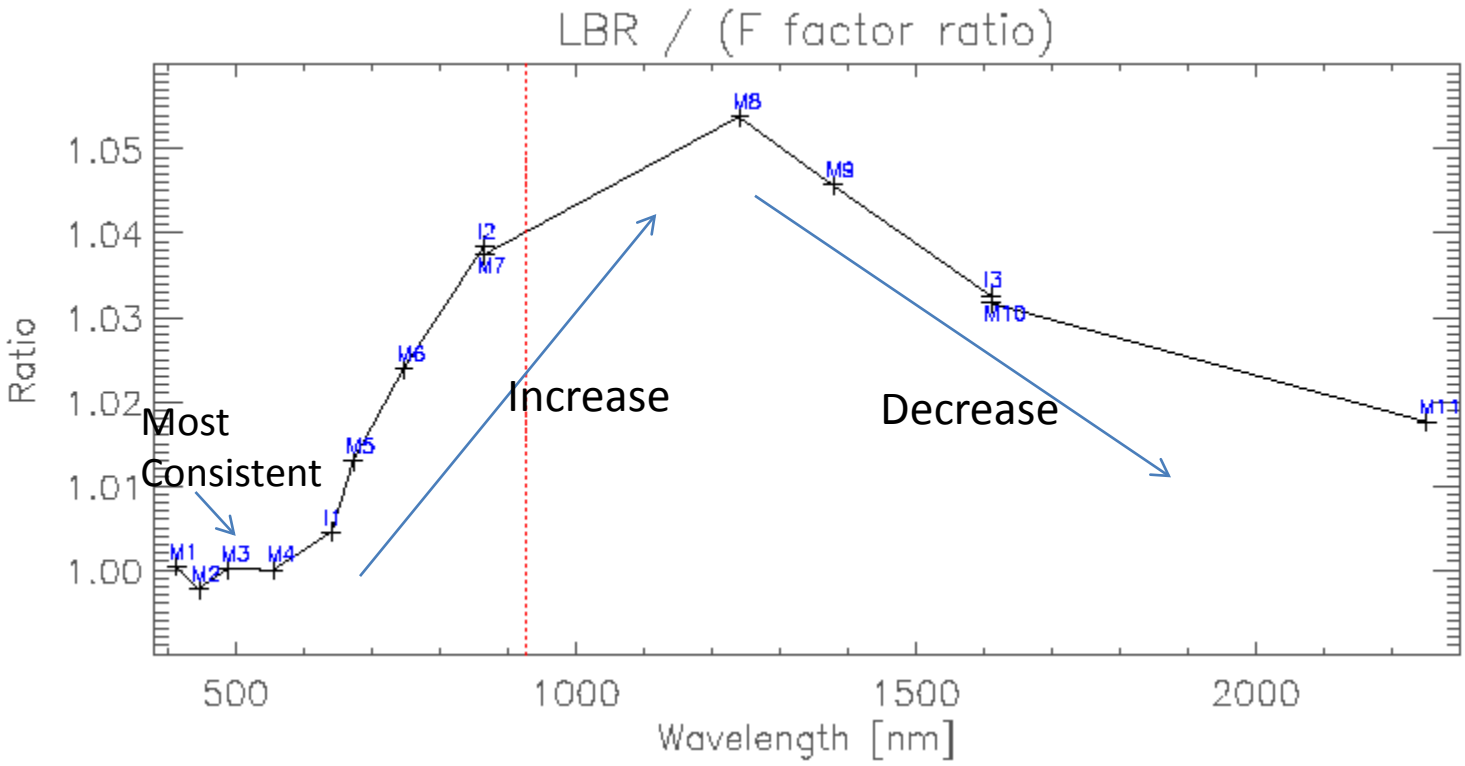
Overall Performance of LBR vs. SD F Factors

- LBR / F factor ratio
  - The differences increase over time.
  - Strong wavelength-dependence



LBR vs. SD F Factor Ratios

- Wavelength dependence of LBR / F factor ratio
  - Using the 3/12/2014 data collection.
  - Most consistent for M1-M4 bands.
  - Ratios increases in the M5 ~ M8 bands.
  - Ratios decreases in the short wave IR (M8-M11) bands.
  - Further analysis are needed to explain the dependence.



Summary

- Demonstrated that LBR can be used to perform long-term stability monitoring of VIIRS solar bands
- Comparison with SD F factors reveals the relative degradation of instruments.
  - Stability of M1-M3 bands, VISNIR (M5-7, I1-2) bands and S/WMIR (M8-11, I3) bands
  - Consistency of I2/M7 and I3/M10 bands
- Reveals the wavelength dependence of LBR vs. SD F Factor Ratios
- Future work
  - Continue to monitor VIIRS stability with LBR
  - Investigate wavelength dependence of LBR vs. SD F Factor Ratios