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

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• 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

<table>
<thead>
<tr>
<th>Date</th>
<th>Target time</th>
<th>Roll angle</th>
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<td>-7.767</td>
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- 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

![Graph showing Band M6 with DN values and pixel values along scan line.](image)
Data Processing: Total Lunar DN

One Scan for M6 Band

Total Lunar DN (M or I) =

\[
\sum_{\text{Scans with Moon}} \sum_{\text{Pixels within Scan}} \left( \text{DN}_{\text{pixel}} - \text{DN}_{\text{background}} \right)
\]

\[LBR(M \text{ or } I) = \frac{\text{Total Lunar DN (M or I)}}{\text{Total Lunar DN (M4)}}\]
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 M8-11, I3 Bands
• 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.
• 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%.
• 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