DSCOVR EPIC & NISTAR Science Team Meeting
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Calibration of the EPIC O2 absorbing bands using full-moon EPIC observations

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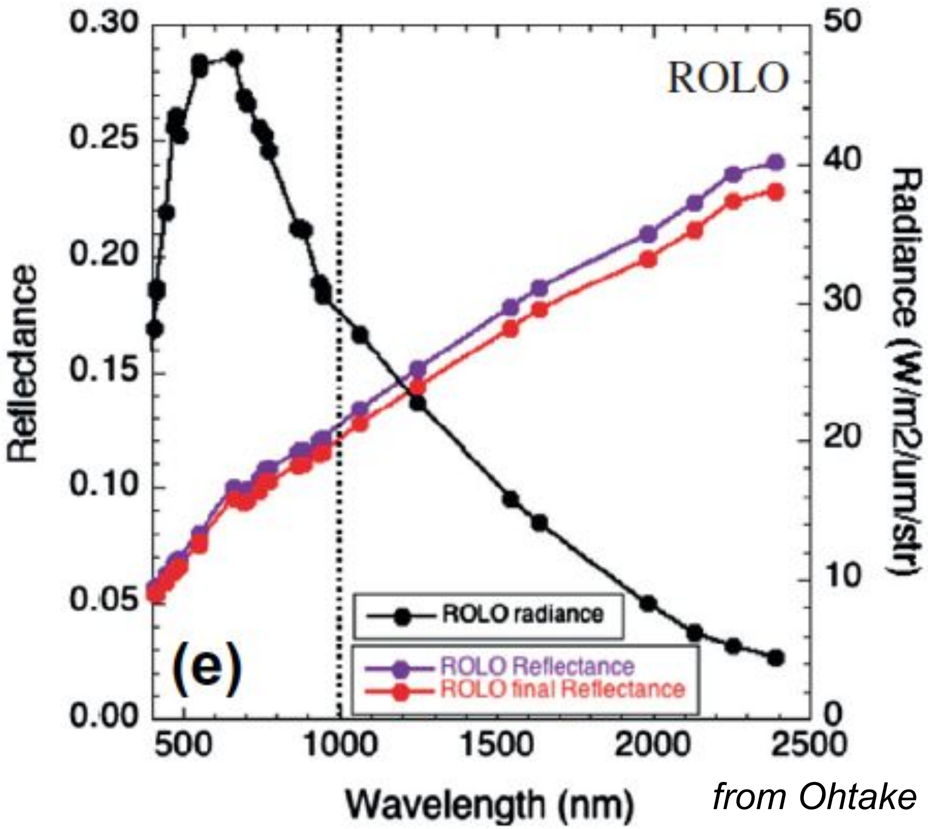
Motivation

- EPIC observes the moon every 2–3 months. Several images acquired for each observation, each containing several hundred individual moon pixels.
- Moon reflectance, R_λ, increases slowly with λ; a 10 nm difference in λ leads to a difference in R_λ in the range of 0.0006–0.0013 or 0.8–1.2 %.



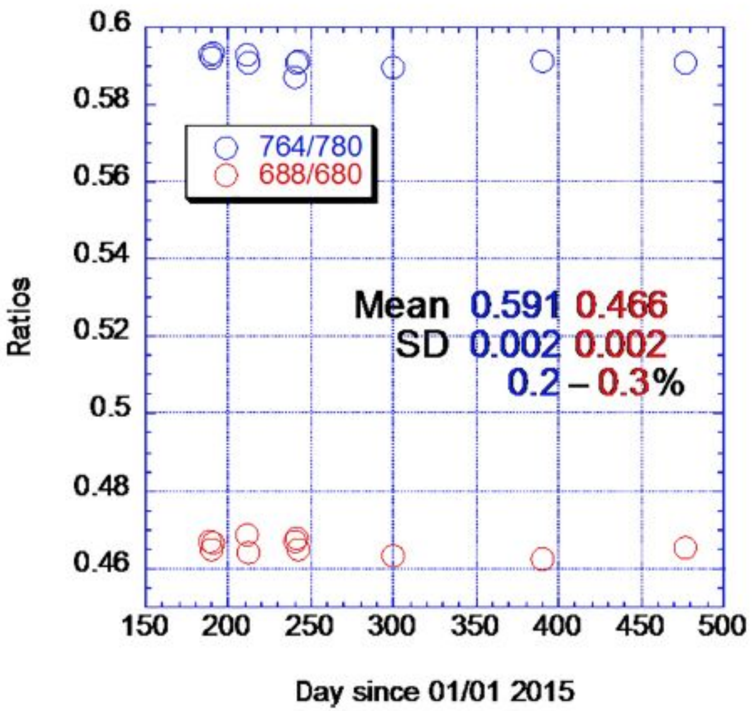
from Ohtake et al., 2013

Theory

The difference in R_λ between the O2 B-band (688 nm) and the "red" (680 nm) channels as well as between the O2 A-band (764 nm) and the NIR (780 nm) will be within 1.6 %.

We use the moon reflectance ratios R_{688}/R_{680} = 1.008 and R_{764}/R_{780} = 0.984. Since the absolute calibration (ABSCAL) factors for 680 nm and 780 nm channels are known, we can obtain the ABSCAL factors for the O2 absorbing channels at 688 nm and 764 nm.

Signal ratio, $F(\lambda_1,\lambda_2)$, of the Moon reflectance values measured in counts/sec at λ_1 and λ_2 is very stable; it is 0.461±0.001 for the 688 nm over 680 nm ratio and 0.598 ±0.001 for the 764 over 780 nm.



Theory

$K_{688} = \mathbf{R_{688}} / R^{counts}_{688}$
$= R_{688} / [R^{counts}_{680} * \mathbf{F(680,688)}]$
$= [R_{688} \mathbf{K_{680}}] / [R_{680} * F(680,688)]$
$= [R_{688}/R_{680}] / [K_{680} / F(680,688)]$
$\approx \mathbf{1.008} * [K_{680} / F(680,688)]$

$K_{764} \approx \mathbf{0.984} * [\mathbf{K_{780}} / F(780,764)]$

$\mathbf{K_\lambda}$ is absolute calibration factor at λ
$\mathbf{R_\lambda}$ is reflectance at λ
R^{counts}_λ is measured signal at λ counts/s
$\mathbf{F(\lambda_1,\lambda_2)} = R^{counts}_{\lambda 2}/R^{counts}_{\lambda 1}$

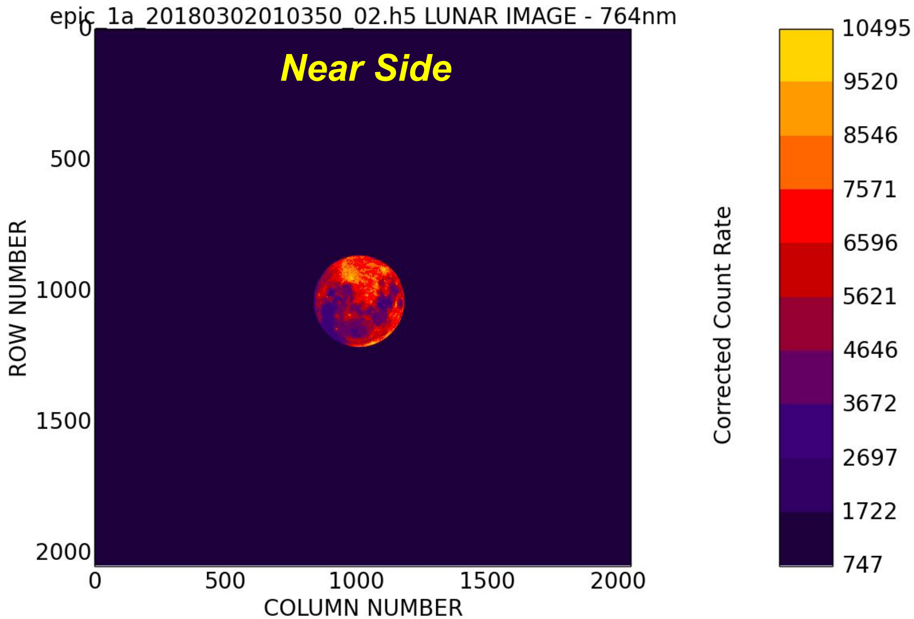
ABSCAL factors, $\mathbf{K_\lambda}$, for the "non-absorbing" channels 680 nm and 780 nm are known from MODIS.

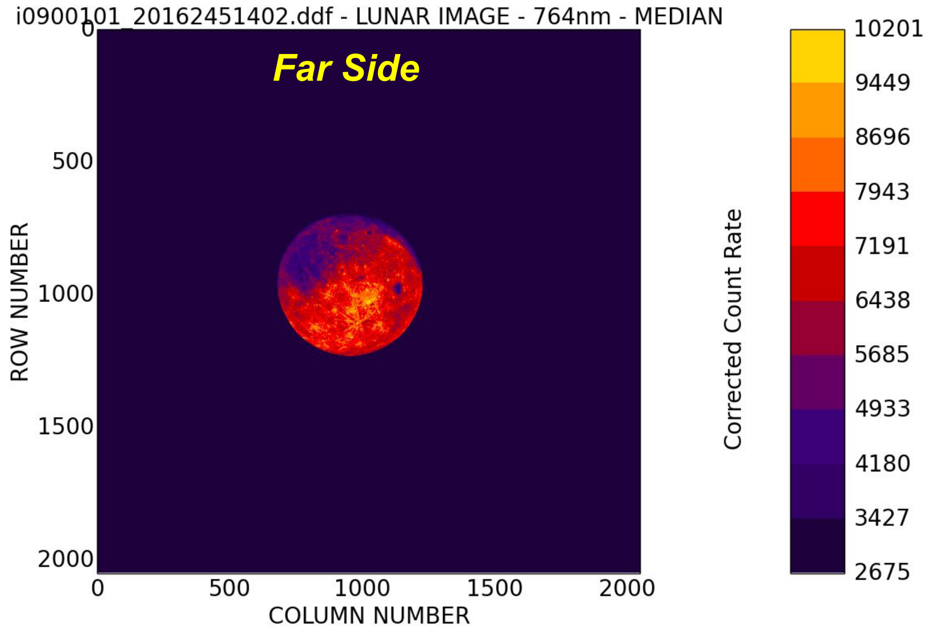
The lunar reflectance, $\mathbf{R_\lambda}$, for the EPIC moon images at 680 nm and 780 nm can be calculated.

The lunar reflectance for the same EPIC moon images at the "absorbing" channels 688 nm and 764 nm is obtained by applying small **corrections** based on the wavelength dependence taken from ROLO.

ABSCAL factors ($\mathbf{K_\lambda}$) for the absorbing channels 688 nm and 764 nm are calculated by dividing the lunar reflectance at these channels by the measured signal, $\mathbf{F(\lambda_1,\lambda_2)}$.

Lunar Observations

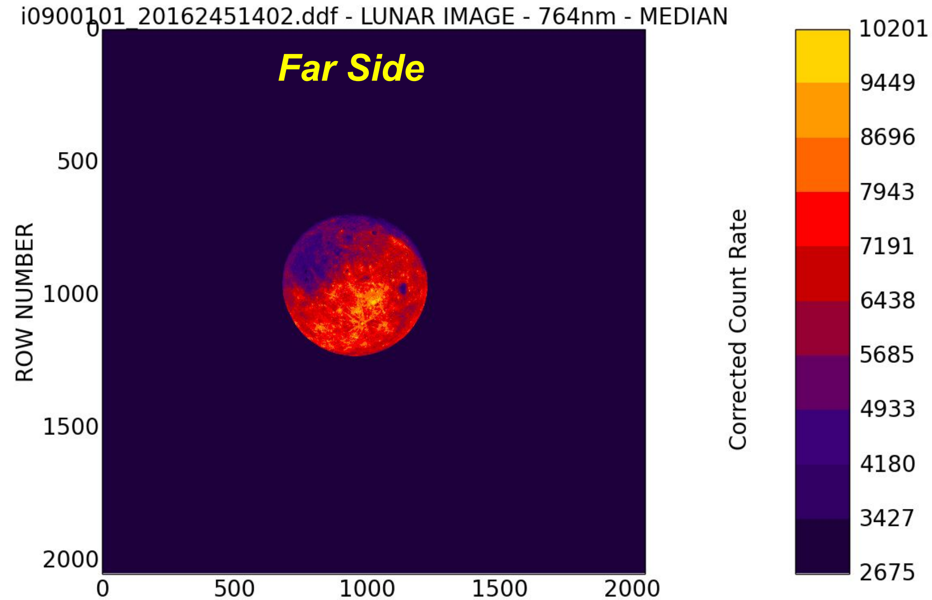




- Sample Moon observations of near side (left) and far side (right).
- Level 1a data includes most up-to-date corrections.
- Software automatically identifies pixels illuminated by Moon for analysis.

Pixel Identification

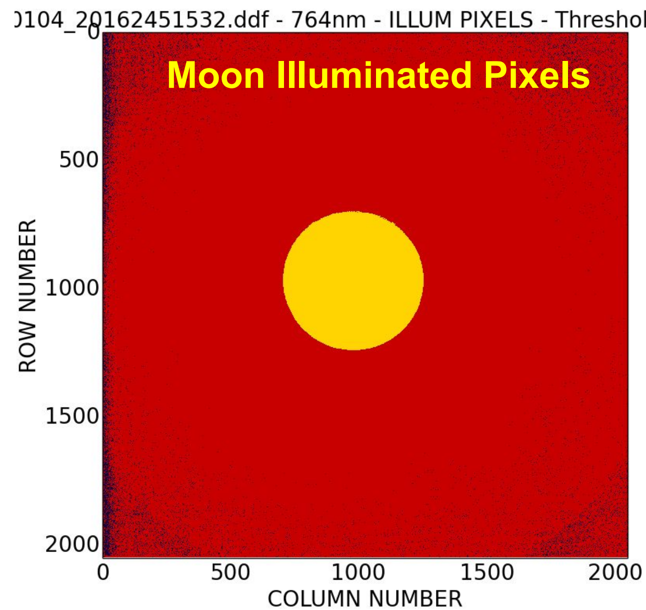
- Software uses a series of signal level and spatial location criteria to identify those pixels illuminated by the Moon.
  - Wavelength dependent signal threshold (50% historical mean count rate)
  - Median position filter



- Moon image edge slopes and cosmic ray hit rejection manually confirmed via inspection.

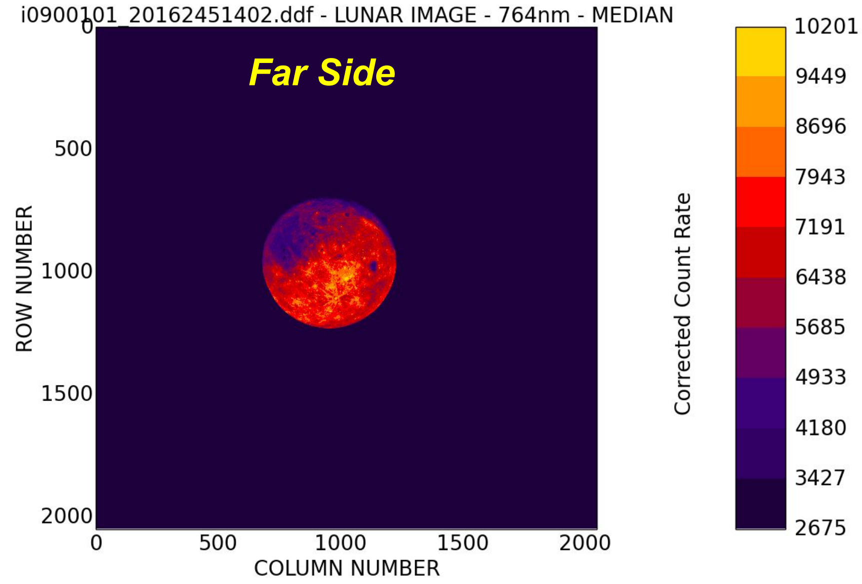
- Lunar disk mean and total signals calculated and used for analysis.

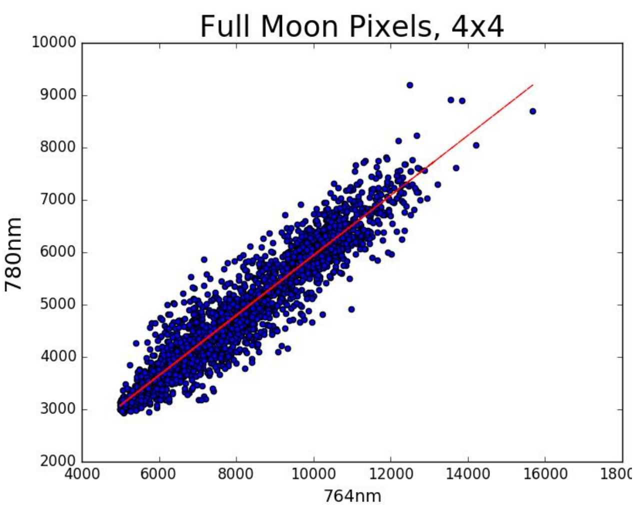
- Lunar disk signal validated with alternative methods.

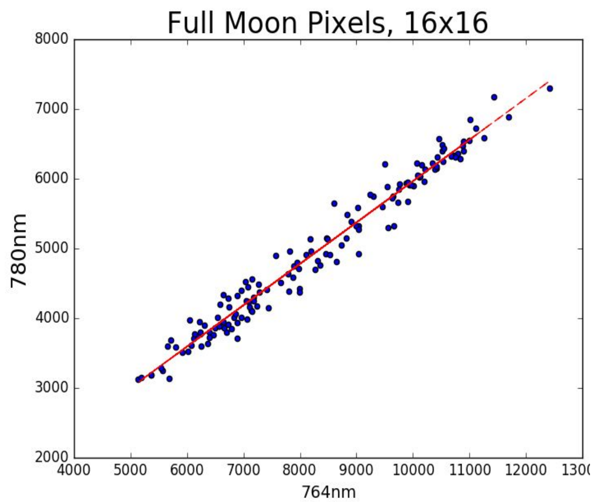


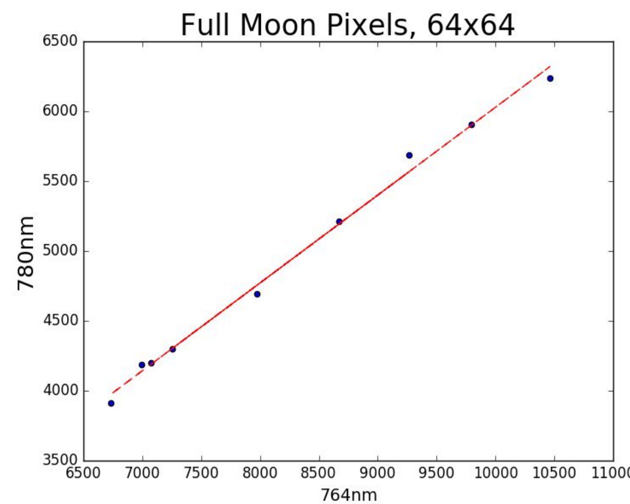
SciGlob Lunar Signal Validation

- Validation consisted of sub-setting lunar disk in different sizes for each wavelength and calculating slope for comparison to full disk signal ratios.
- Consistent A and B band signal ratios found regardless of regional sub-setting.

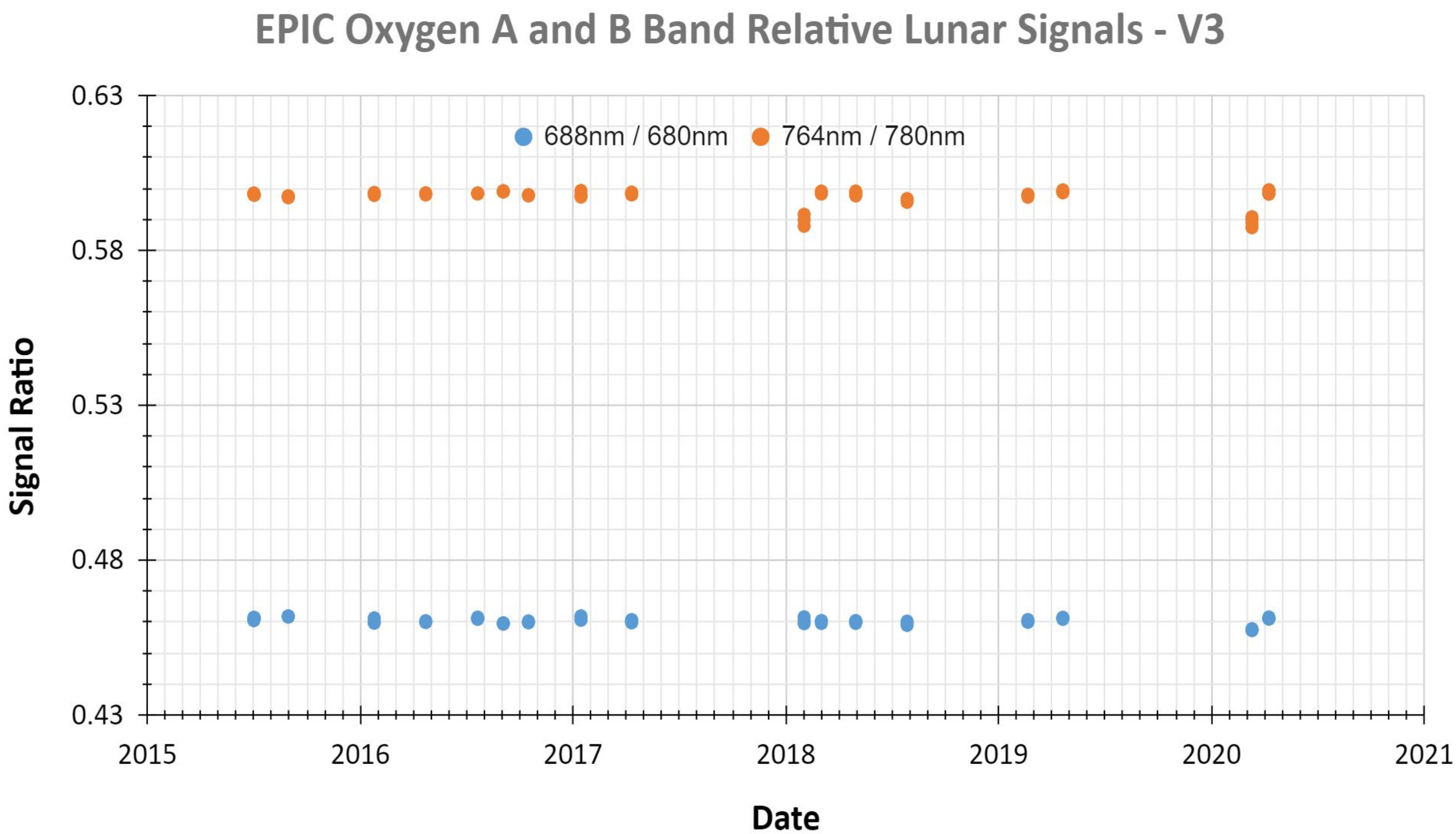




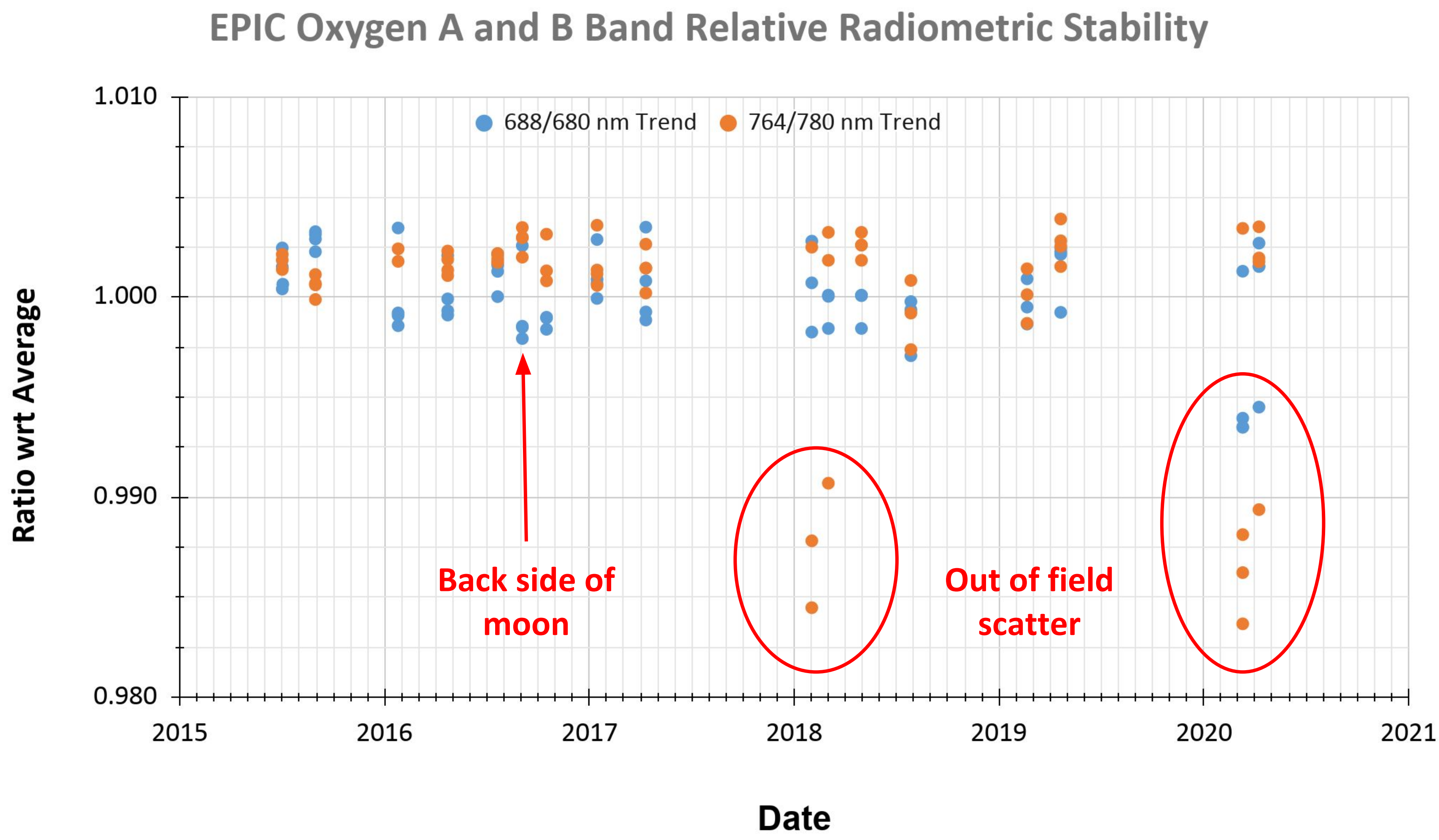




Results

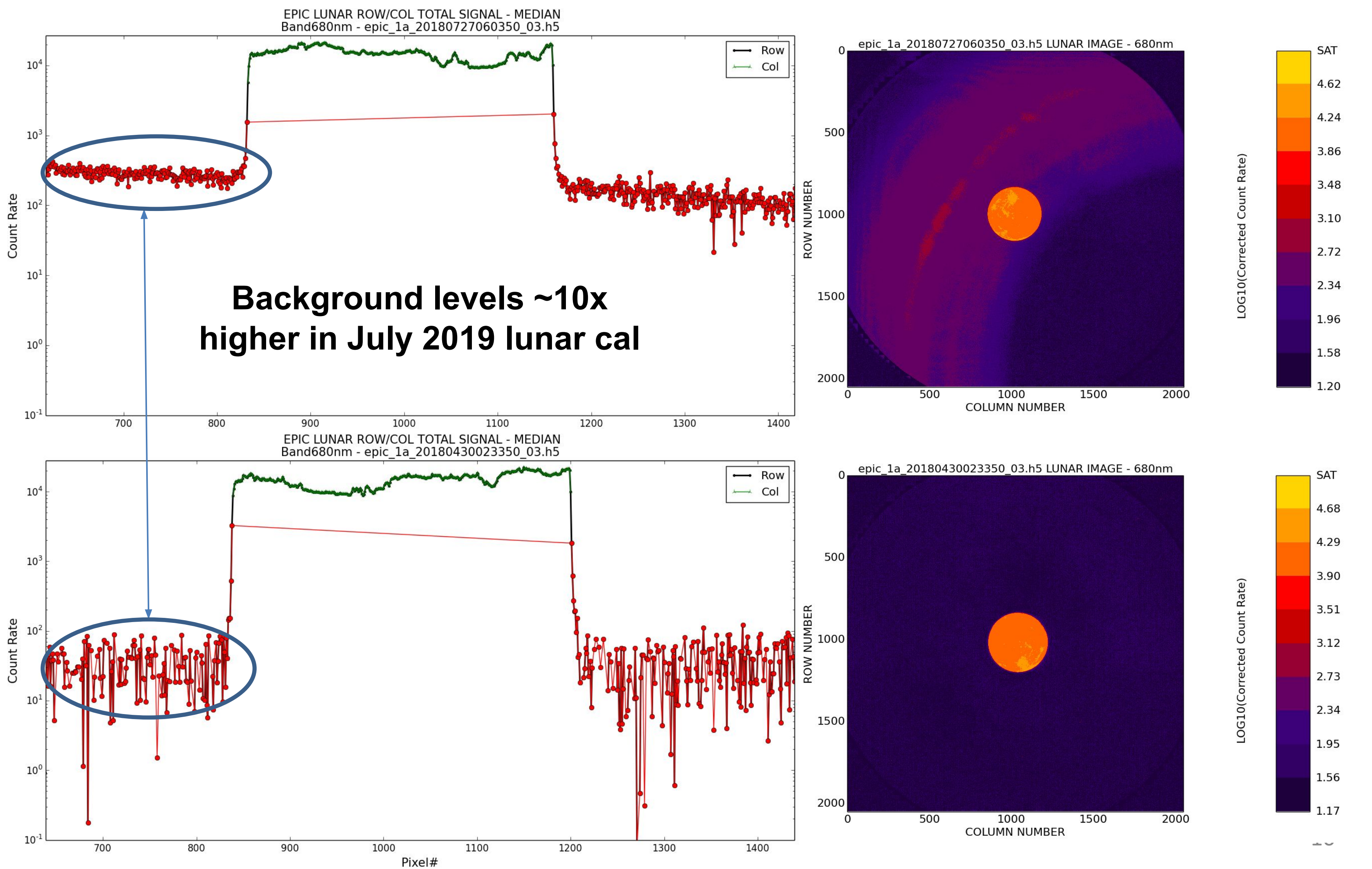

EPIC Oxygen A and B Band Relative Lunar Signals - V3
688nm / 680nm
764nm / 780nm
Signal Ratio
0.63
0.58
0.53
0.48
0.43
2015
2016
2017
2018
2019
2020
2021
Date

Results

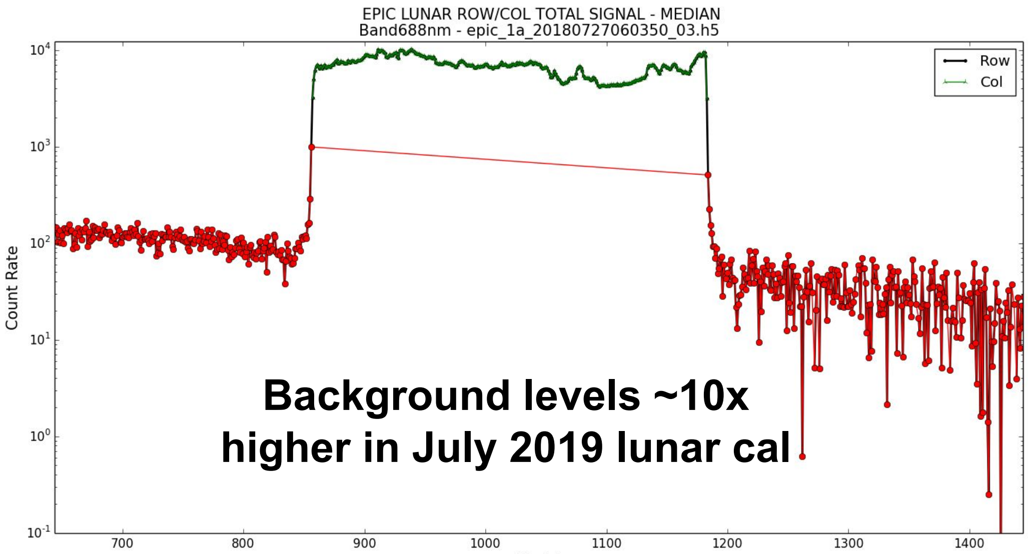

EPIC Oxygen A and B Band Relative Radiometric Stability
688/680 nm Trend
764/780 nm Trend
Ratio wrt Average
1.010
1.000
0.990
0.980
2015
2016
2017
2018
2019
2020
2021
Date
Back side of moon
Out of field scatter

680nm Comparison

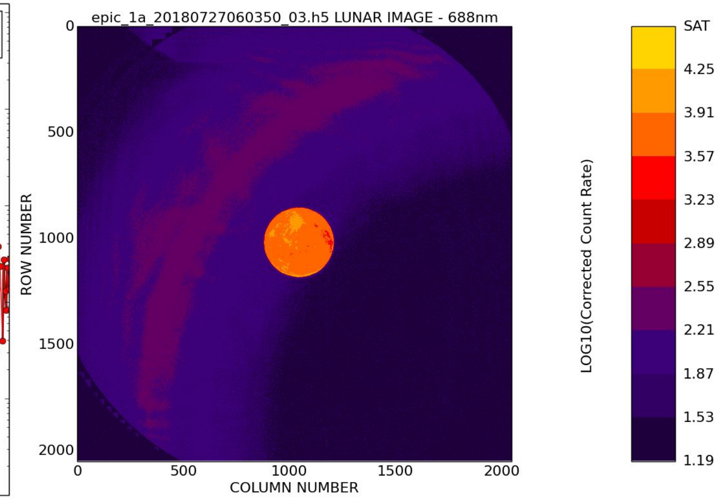
L1a update
DSCOVR EPIC & NISTAR
Science Team Meeting
GSFC, 6 - 8 October 2020

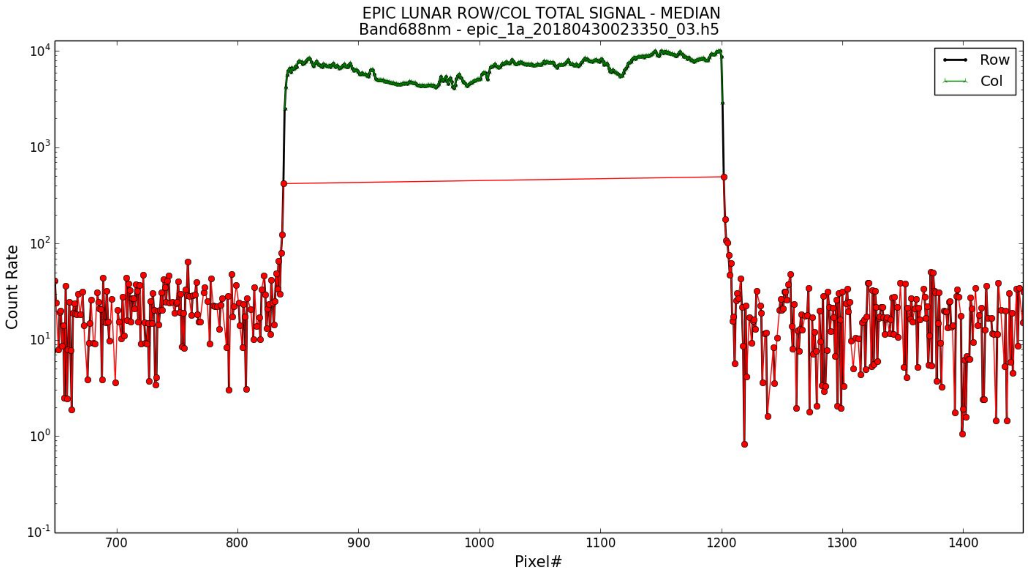


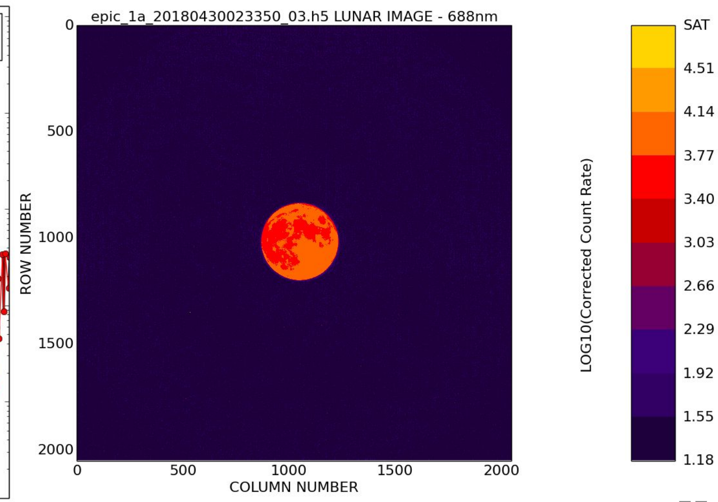
688nm Comparison



Background levels ~10x higher in July 2019 lunar cal







Summary

- O_2 A and B band signal ratios based on EPIC lunar calibration observations have been successfully used in helping to derive calibration constants.

- O_2 A and B band ratios continue to be stable to within the uncertainty of the measurements (~0.2% 1-sigma).

- Verified that no changes have been seen in the V3 O_2 A and B band calibration and stability even with the long duration safe hold late 2019 to 2020.