



Using DSCOVER EPIC as a Transfer Radiometer to Scale LEO Imagers to the Same Calibration Reference



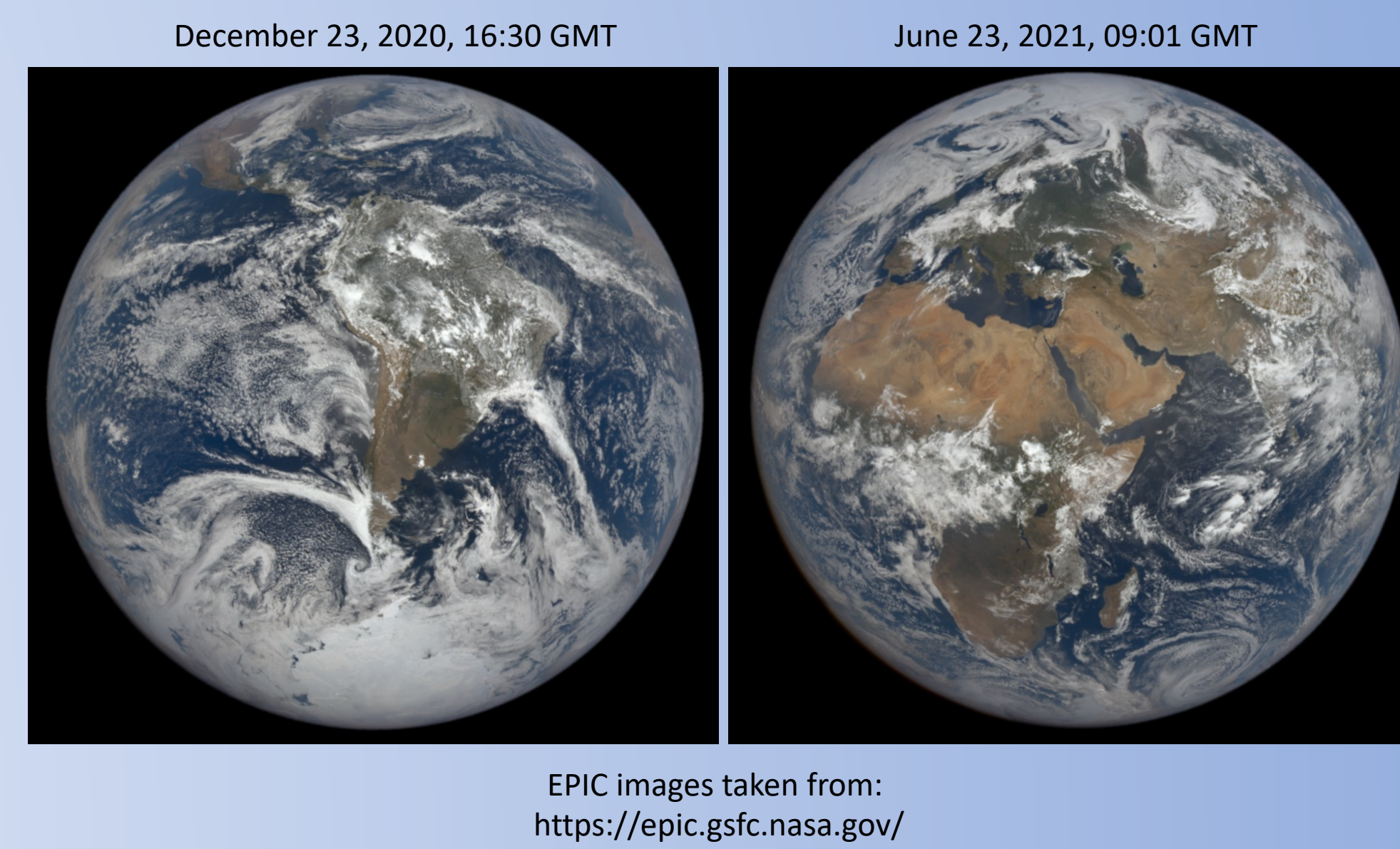
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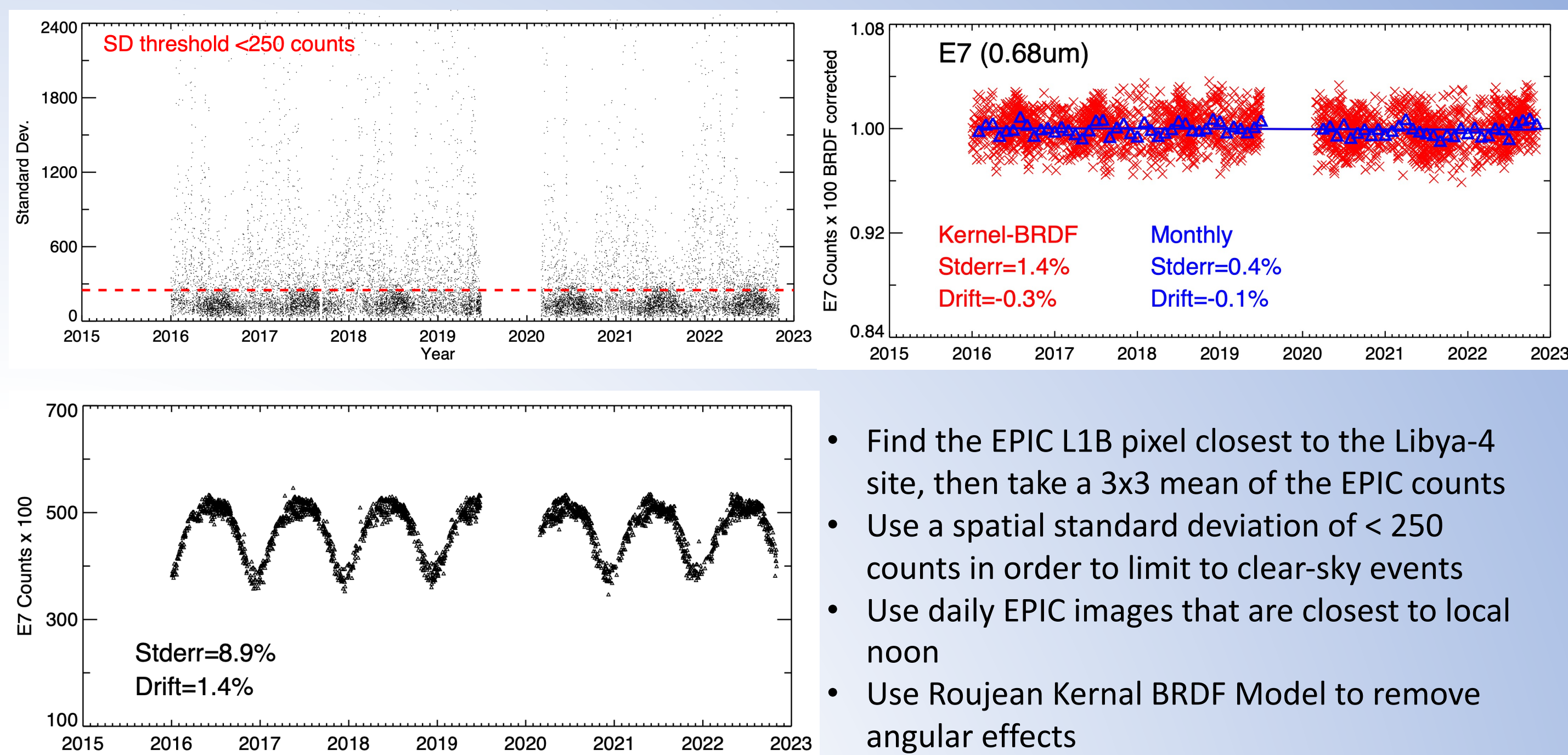
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Introduction

- The DSCOVER satellite is located at L1 about 1.5M km from Earth
- The EPIC imager is a CCD detector array constantly viewing the sunlit side of the Earth in near backscatter
- EPIC has 10 channels ranging from the UV to the NIR, facilitated by a filter wheel, where 10-22 images are taken of the Earth per day
- Although EPIC has no on-board calibration systems, EPIC has been shown to be radiometrically stable
- EPIC's unique constant diurnal view allows it to be ray-matched with sun-synchronous satellites over many local hours
- Many daily views of desert and DCC PICS allows these to be used as invariant calibration targets, and have shown EPIC to be stable even without on-board calibration systems
- Knowing this, then EPIC should be able to be used to validate the stability of the MODIS and VIIRS sensors during EPIC's operational span
- The EPIC imager can then be used to validate simultaneous nadir overpass (SNO) based radiometric scaling factors between MODIS and VIIRS
- The CERES project radiometrically scales Terra-MODIS, NPP-VIIRS, and NOAA-20-VIIRS to the Aqua-MODIS Collection 6.1 calibration reference using SNO-based radiometric scaling factors
- Aqua and Terra have begun to drift out of their orbits, so scaling to Aqua-MODIS using SNOs will become more difficult as time goes on, so using EPIC as a transfer radiometer could become very valuable to CERES



EPIC Libya-4 Desert PICS Methodology

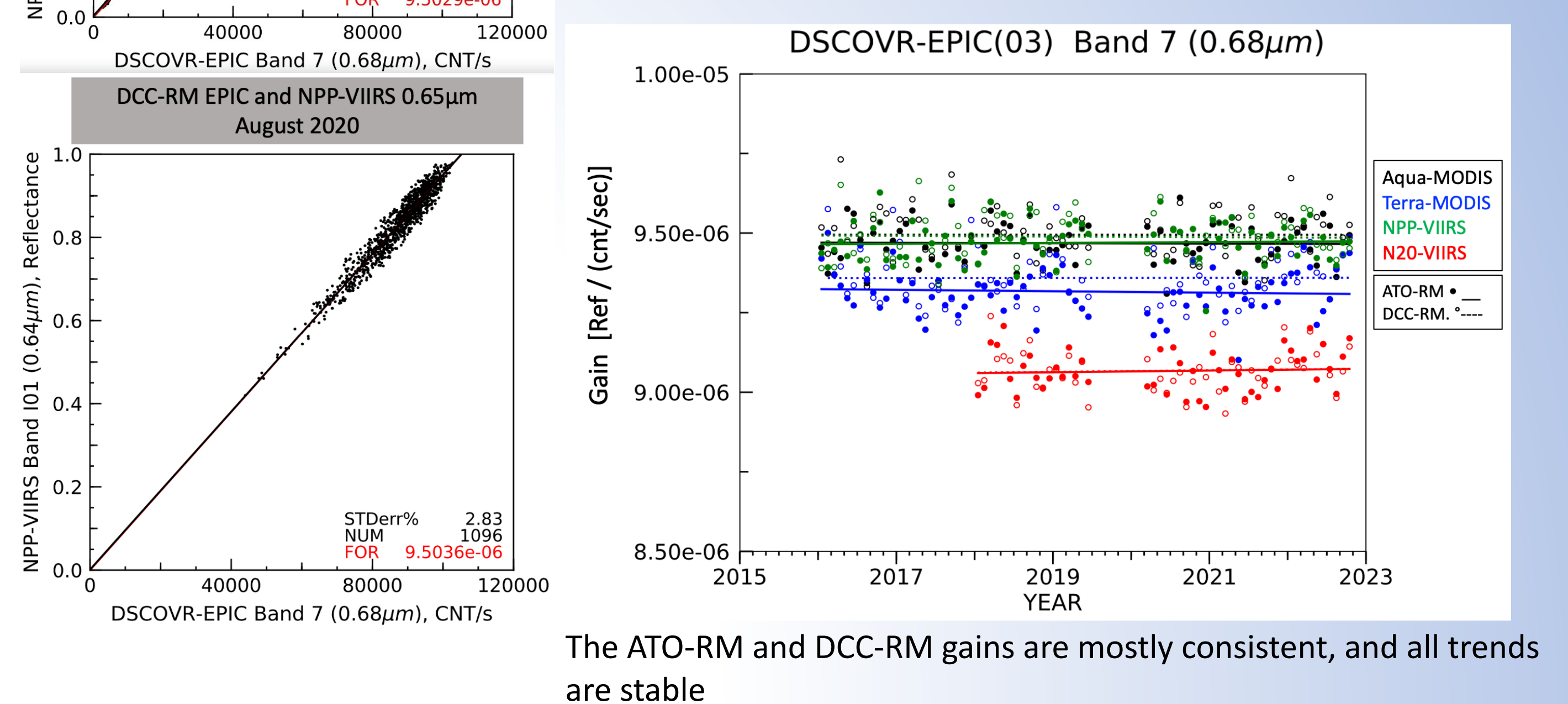


- Find the EPIC L1B pixel closest to the Libya-4 site, then take a 3x3 mean of the EPIC counts
- Use a spatial standard deviation of < 250 counts in order to limit to clear-sky events
- Use daily EPIC images that are closest to local noon
- Use Roujean Kernal BRDF Model to remove angular effects

Libya-4 PICS analysis indicates the EPIC band 6 (0.555μm) may have a significant trend, but other channels show insignificant trends

EPIC ATO-RM and DCC-RM

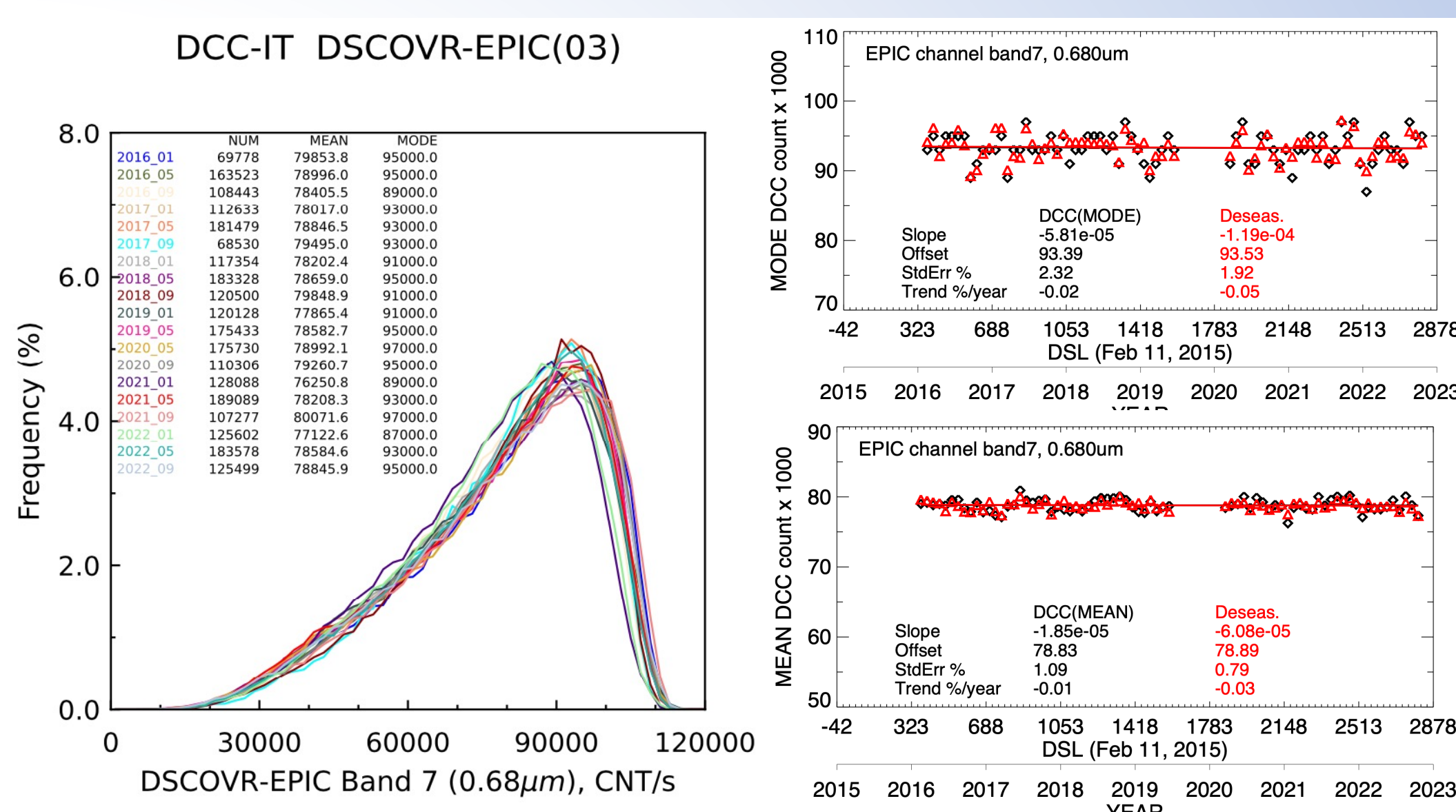
- Ray-match EPIC gridded data with MODIS or VIIRS data in time, space, and angles
 - All-sky Tropical Ocean (ATO) grid to 0.5°, restrict to ocean only, ATO-based-SBAF
 - DCC grid to 0.25°, use both land and ocean, restrict to MODIS or VIIRS 11μm IR BT<220 K, DCC-based-SBAF
- Linearly regress EPIC and MODIS or VIIRS data on a monthly basis, then monitor the gains over time
- SCIAMACHY-based spectral band adjustment factors (SBAFs) retrieved from:
<https://satcorps.larc.nasa.gov/cgi-bin/site/showdoc?mnemonic=SBAF>



The ATO-RM and DCC-RM gains are mostly consistent, and all trends are stable

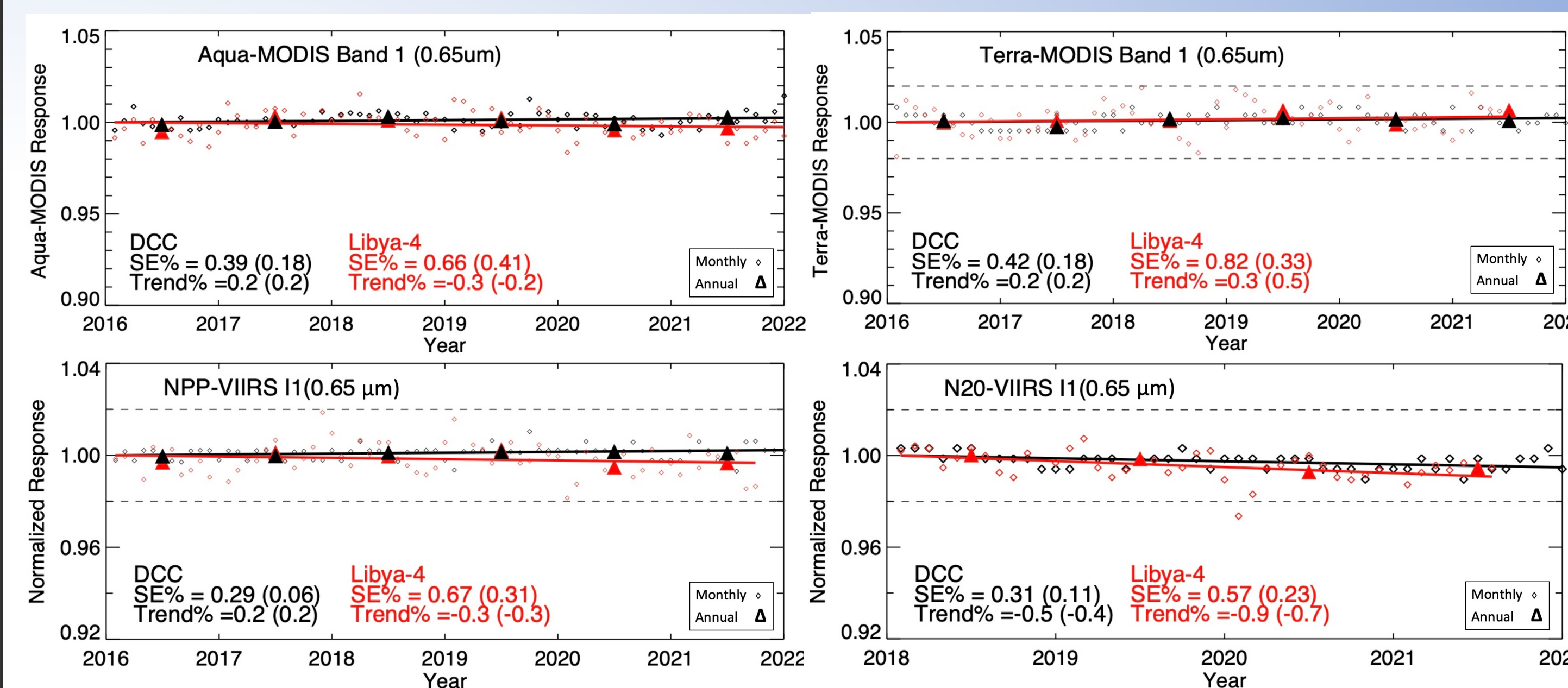
EPIC DCC Invariant Target Methodology

- Use MODIS and VIIRS time-and-angle matched with EPIC 0.25° grid in order to gain access to an 11μm IR BT to use for DCC-IT thresholding
- Identify EPIC DCC targets with BT < 220 K
- Histogram the EPIC DCC grid cell reflectances, and plot the monthly mean and mode over time



- Use mean instead of mode DCC reflectance to monitor stability since it has less scatter
- Deseasonalize the DCC mean counts in order to reduce the time series standard error

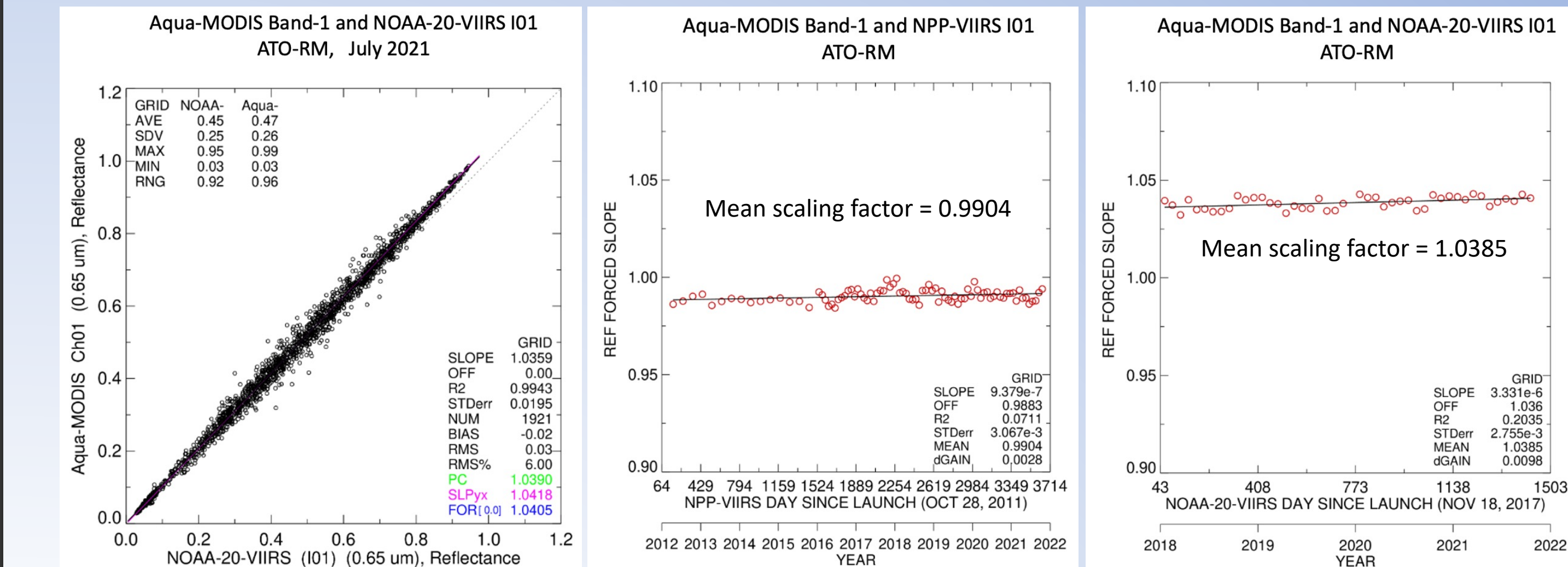
Comparison of Trends with MODIS and VIIRS Stability



The Aqua-MODIS, Terra-MODIS, NPP-VIIRS, and NOAA-20-VIIRS DCC-IT and Libya-4 0.65μm trends agree well with the same LEO-imagers ray-matched with EPIC, except for maybe NOAA-20

Validation of MODIS/VIIRS Radiometric Scaling using EPIC

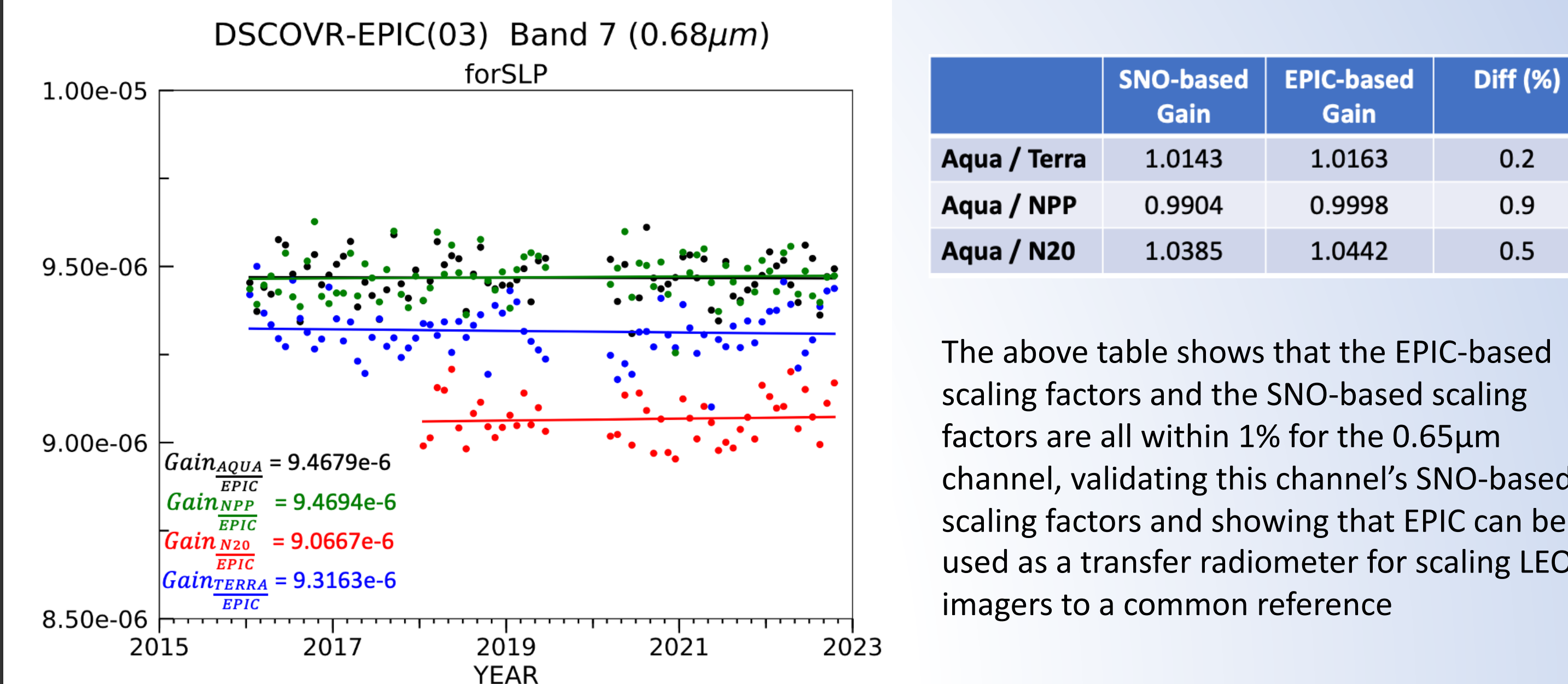
- Terra-MODIS, NPP-VIIRS, and NOAA-20-VIIRS data are scaled to Aqua-MODIS C6.1 for the CERES project
- This is done by performing standard ATO-RM between Aqua-MODIS and Terra-MODIS or NPP-VIIRS or NOAA-20-VIIRS during a simultaneous nadir overpass (SNO)
- The data is matched in time, space, and angles on a monthly basis to get a monthly gain, and is then tracked over time
- This provides coefficients to convert from VIIRS to the Aqua-MODIS C6.1 calibration reference



With these scaling factors defined, we can do a three-way validation of them by using the EPIC ATO-RM mean gains from NOAA-20-VIIRS.

$$\frac{Gain_{AQUA}}{Gain_{EPIC}} = \frac{Ref_{AQUA}}{Count_{EPIC}} \times \frac{Count_{EPIC}}{Ref_{N20}} = \frac{Ref_{AQUA}}{Ref_{N20}} = \frac{Gain_{AQUA}}{Gain_{N20}}$$

If $Gain_{AQUA/N20}$ is close to the mean scaling factors shown in the plots above, then that validates the scaling factors and shows that EPIC can successfully be used as a transfer radiometer. This validation is also performed for Terra-MODIS band 1 (not shown above) and NPP-VIIRS band I01.



The above table shows that the EPIC-based scaling factors and the SNO-based scaling factors are all within 1% for the 0.65μm channel, validating this channel's SNO-based scaling factors and showing that EPIC can be used as a transfer radiometer for scaling LEO imagers to a common reference

Conclusions and Future Work

- The DSCOVER-EPIC sensor can be used as an invariant Earth target due to its stability
 - Stability was <0.6% per decade based on Libya-4 and DCC-IT except for the 0.55μm channel
- EPIC observations can be inter-calibrated with many sun-synchronous satellite imagers across all local hours
- EPIC can be used to monitor sensor stability, and can be used to validate sensor-to-sensor radiometric scaling factors for CERES
- Viability of using EPIC as a transfer radiometer for other wavelength channels needs to be examined

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