AERONET Nighttime AOD Product

A summary of method and the end of ‘provisional’ status

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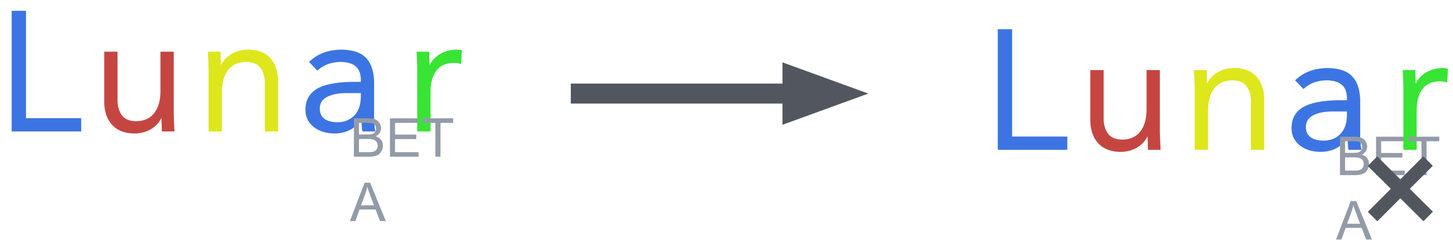
AERONET Exchange
2024

AERONET has been acquiring lunar observations from the majority of model T cimels for many years and producing a night-time AOD data set which currently includes observations at 492 sites dating back as far as 2014 for some locations.

1) How has lunar evolved from original provisional version?

2) Summary of lunar AOD product evaluation?



Updated Empirical Bias Correction

Based on lunar Langleys from MLO and Izaña from 2015-2024

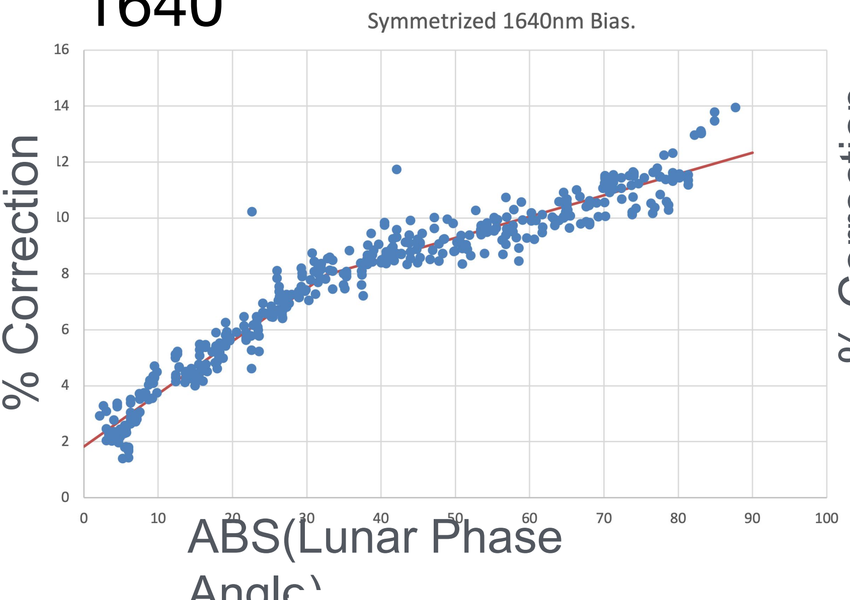
The AERONET approach to address errors in ROLO irradiance has been via comparison of Vo's of high elevation lunar Langleys with solar Langleys at Mauna Loa Observatory (MLO) and Izaña calibration facilities.

For a given instrument, solar and lunar measurements are made with the same optical/electronic path so in principal the ratios of solar to lunar Vo should match the sun/sky gain ratio of 4096. In practice, this is not an option due to errors in the lunar irradiance model.

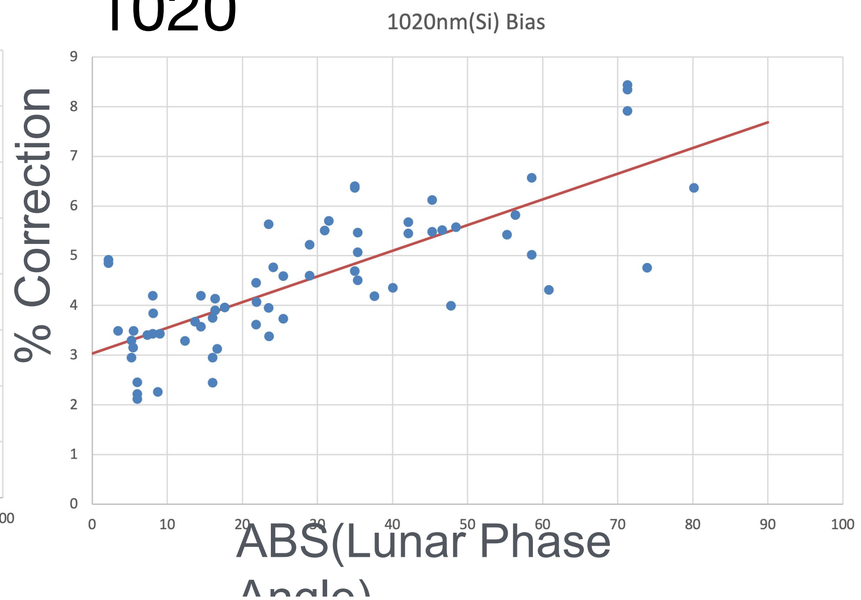
Thus, observed deviations from this nominal value could be determined as a function of lunar phase angle (LPA) and used as an empirical correction factor by which the base ROLO irradiances are modified.

Original analyses based on dozens of solar/lunar Langleys from MLO and Izaña from 20 cimels over 5 years

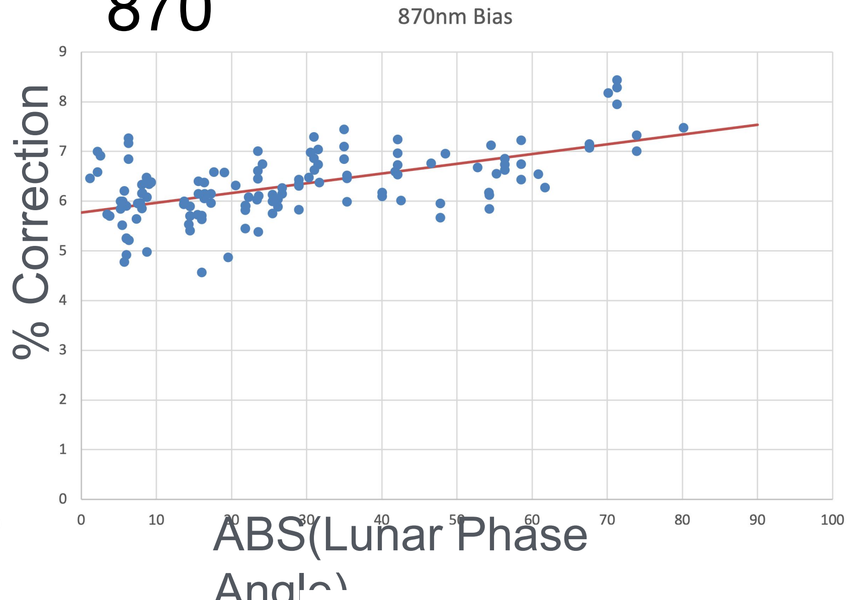
1640



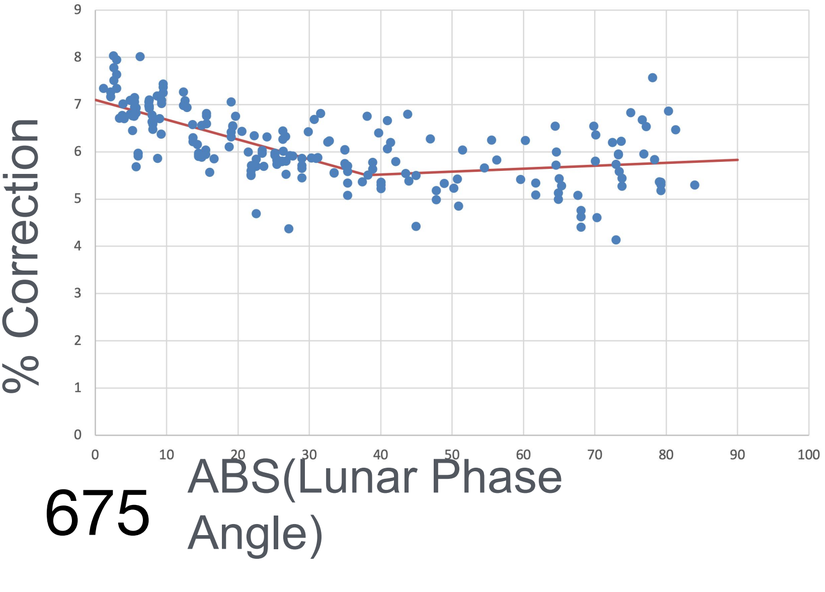
1020



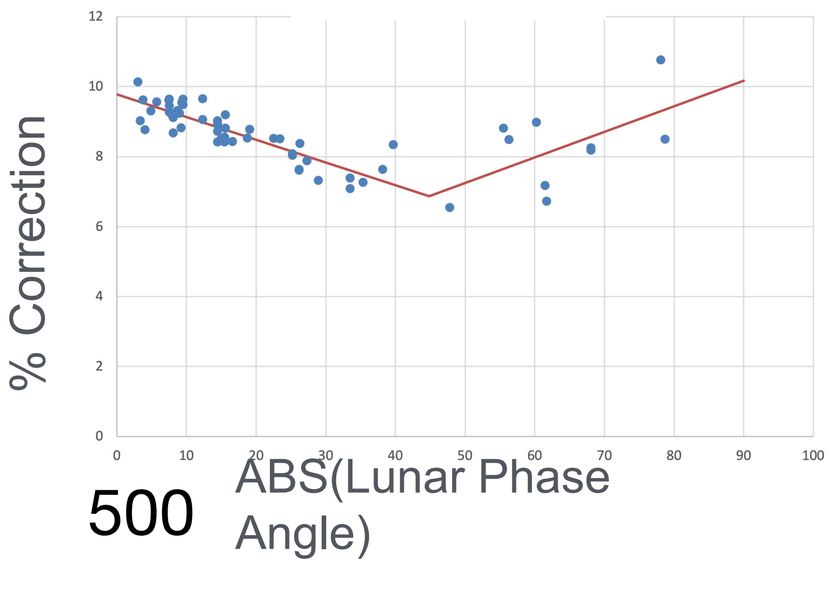
870



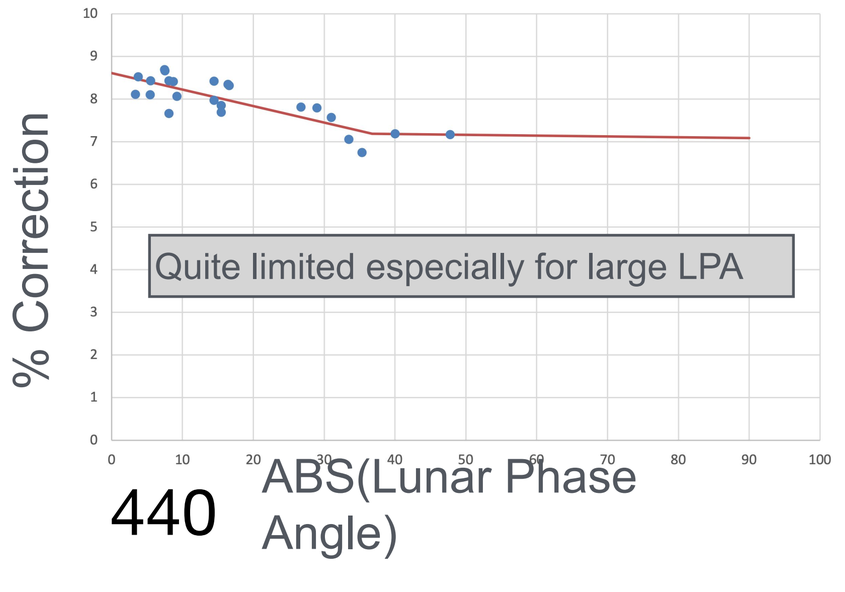
675



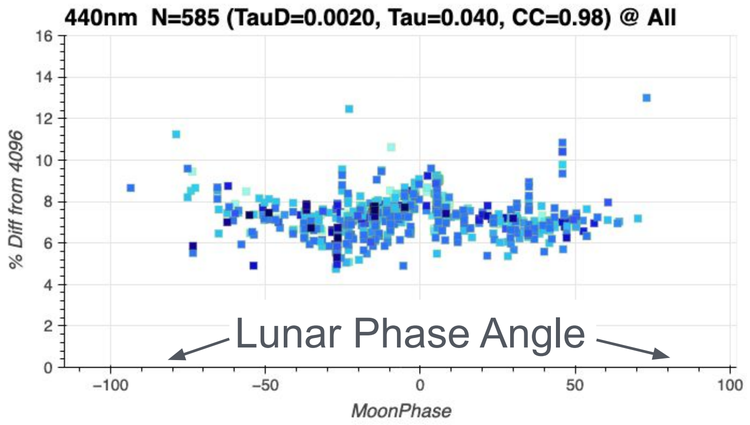
500

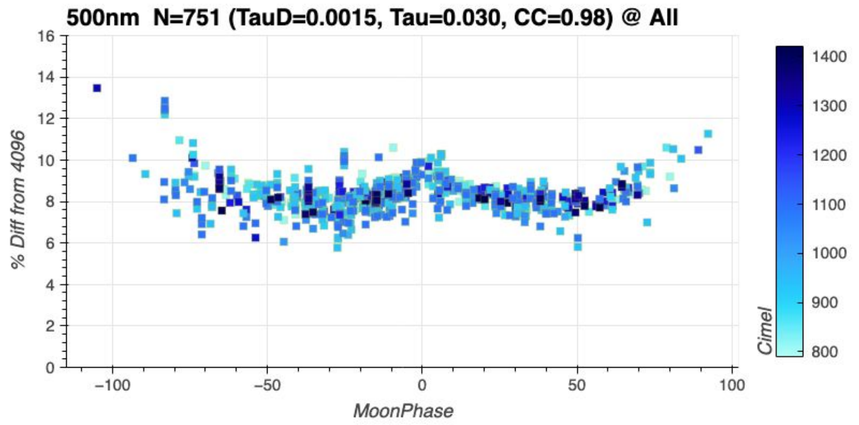


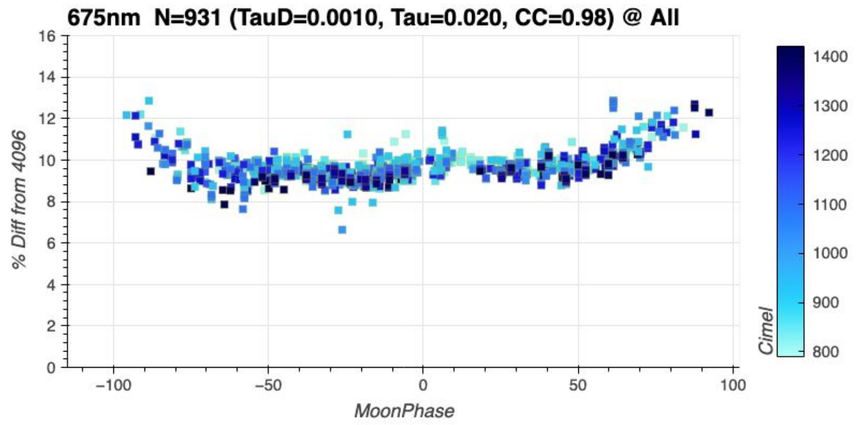
440

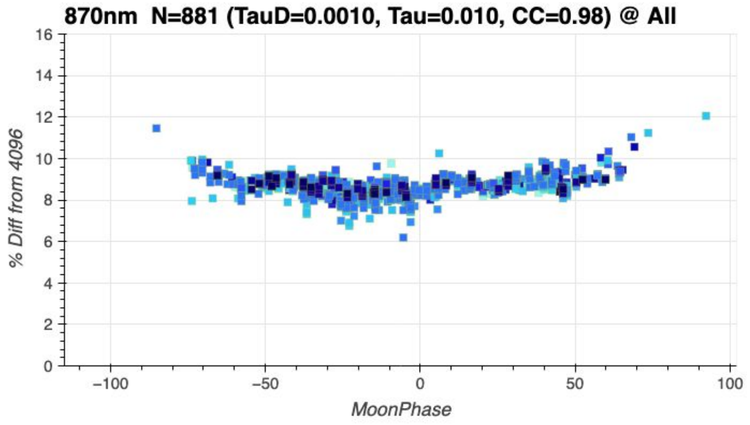


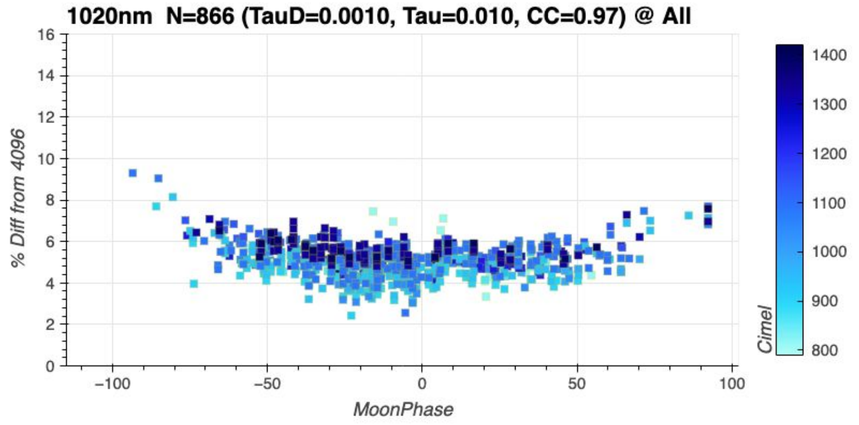
MLO + Izaña Observed Deviation from Nominal sun/sky gain= 4096

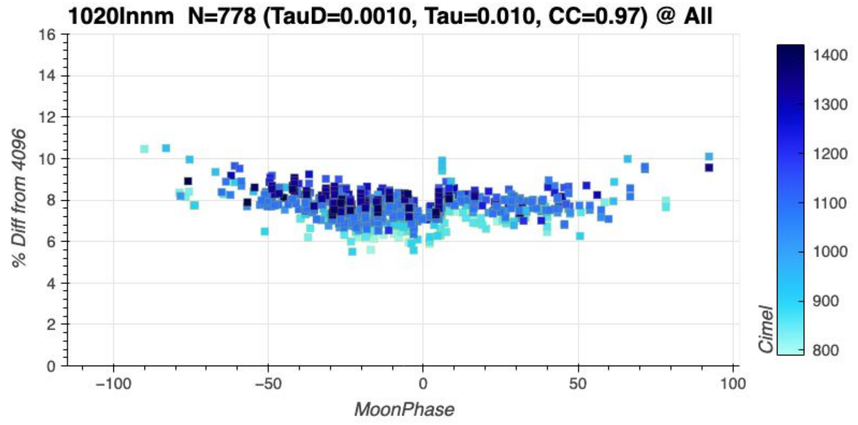


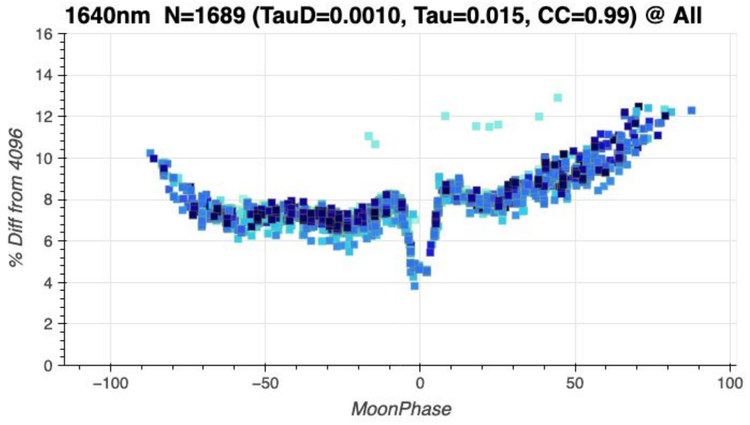












These plots were initially generated with thresholds revised from currently used values

Better, but still limited in LPA range at 440, 500, 1020

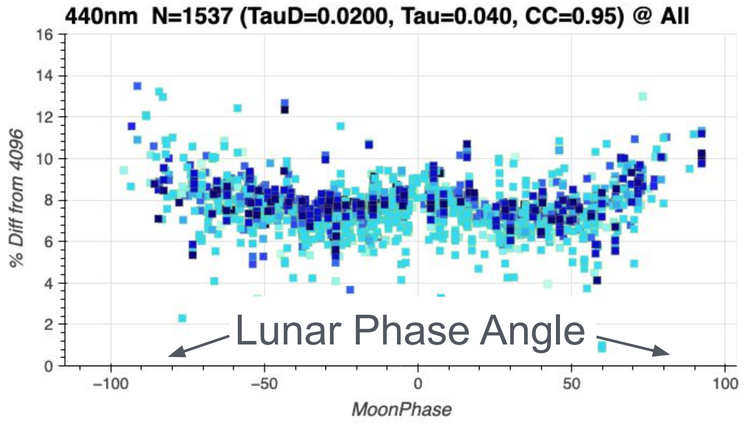
- 1020 : Max Tau = 0.01 , Max diff = 0.001, MinCC = 0.97, N = 866
- 1640 : Max Tau = 0.015 , Max diff = 0.001, MinCC = 0.99, N = 1688
- 870 : Max Tau = 0.01 , Max diff = 0.001, MinCC = 0.98, N = 880
- 675: Max Tau = 0.02 , Max diff = 0.001, MinCC = 0.98, N = 931
- 440: Max Tau = 0.04 , Max diff = 0.002, MinCC = 0.98, N = 585
- 500: Max Tau = 0.03 , Max diff = 0.0015, MinCC = 0.98, N = 751
- 1020In: Max Tau = 0.01 , Max diff = 0.001, MinCC = 0.97, N = 776

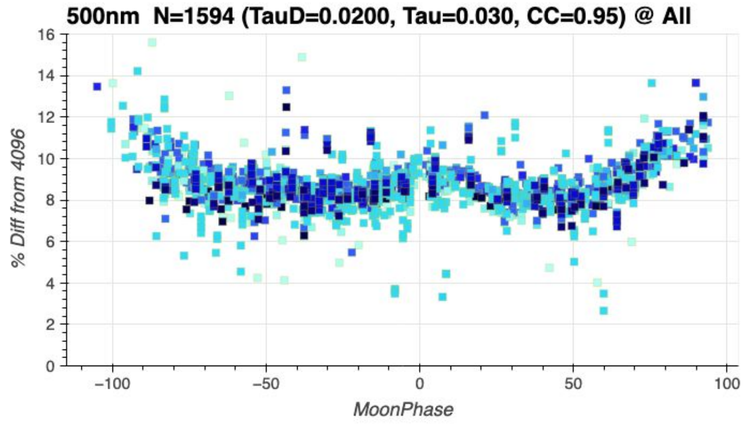
Max Tau= maximum included AOD of Langley

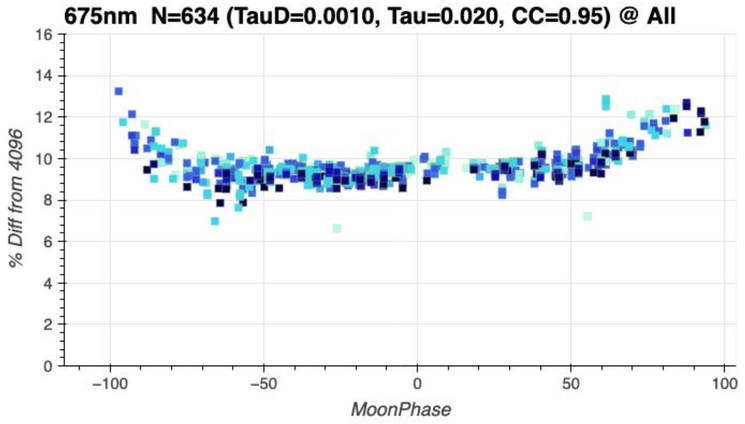
Max diff= maximum diff in AOD btw lunar/solar Langley

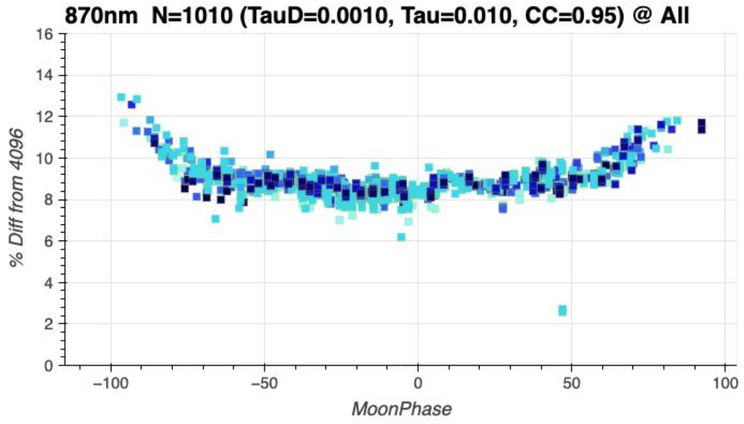
MinCC= minimum corr coef of lunar or solar Langley

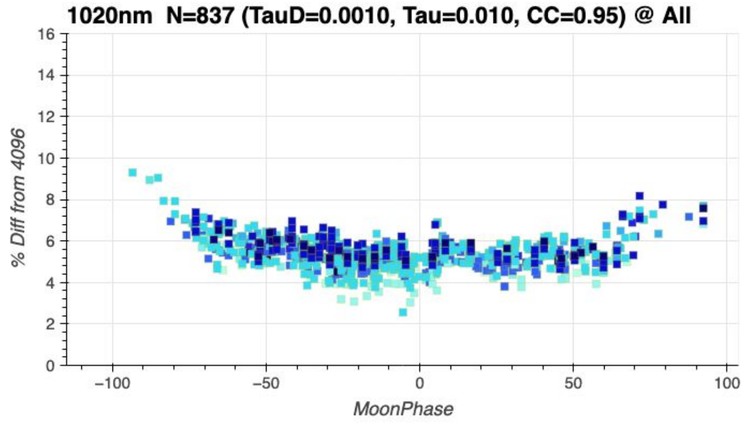
Updated empirical bias data with additional 5 years of Langley observations

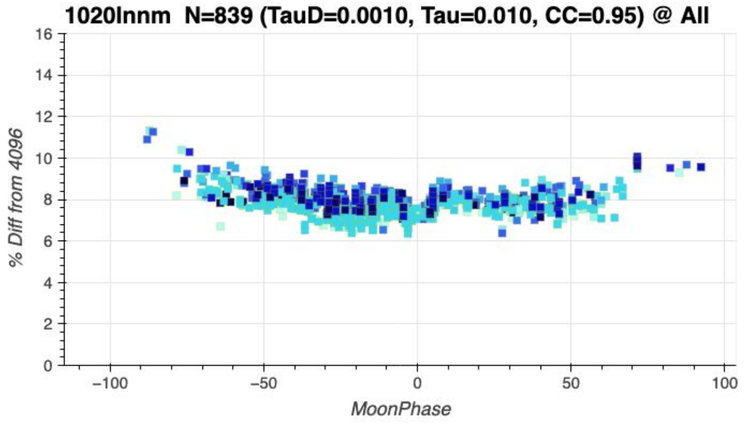


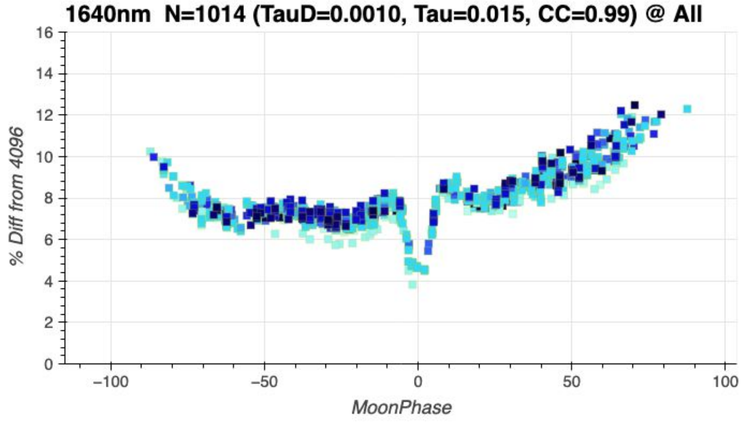










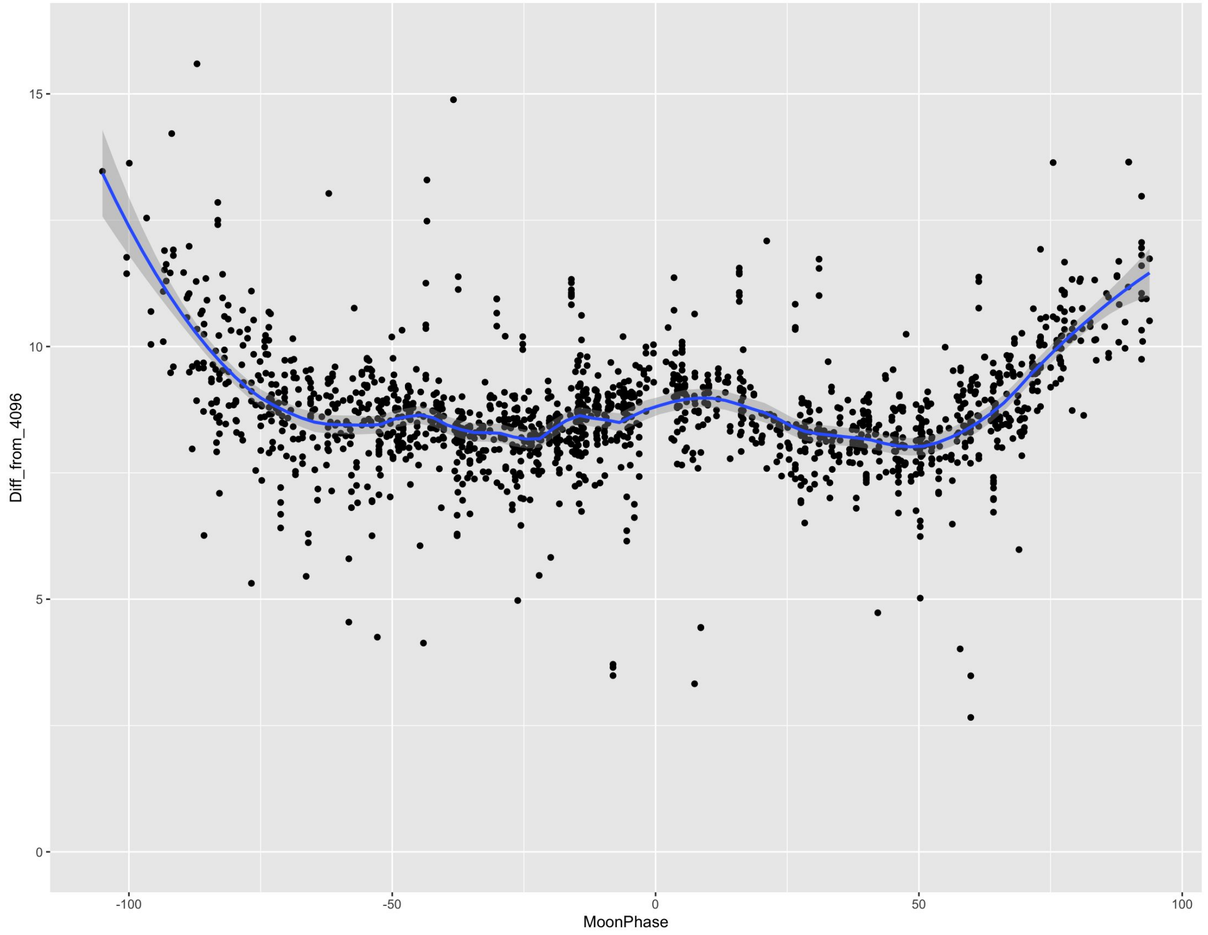


Original comparison thresholds modified to increase data set

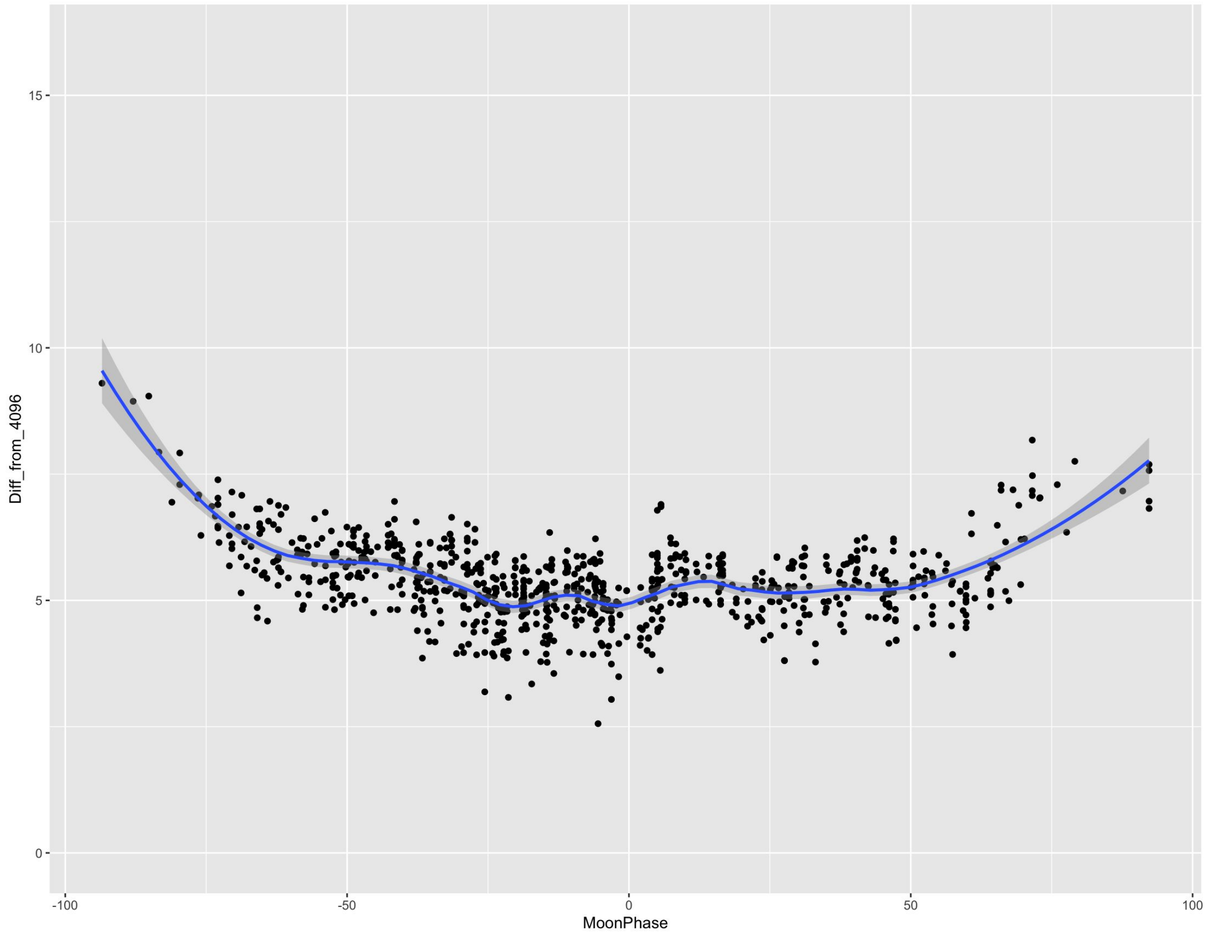
Sufficient data density for robust trends for full MPA range

MLO + Izaña Combined Langley Dataset (LOESS fit)

500nm

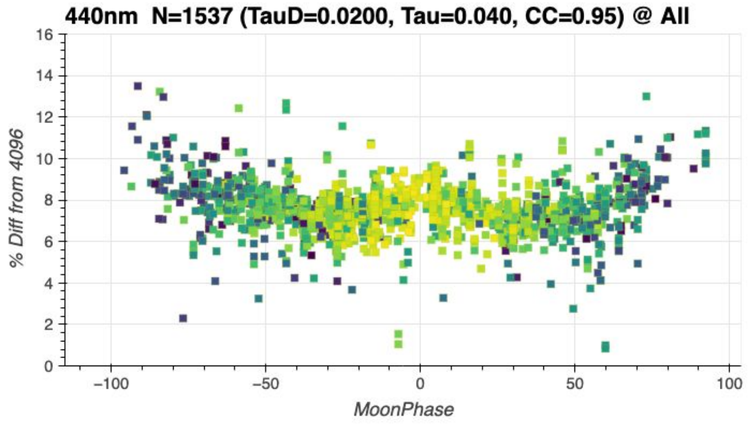


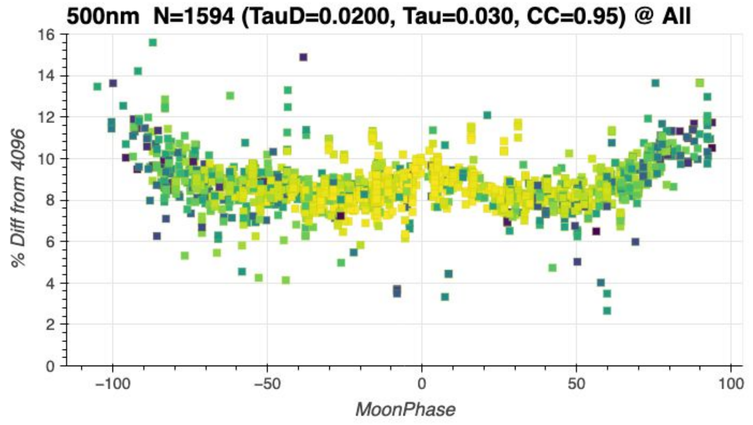
1020nm

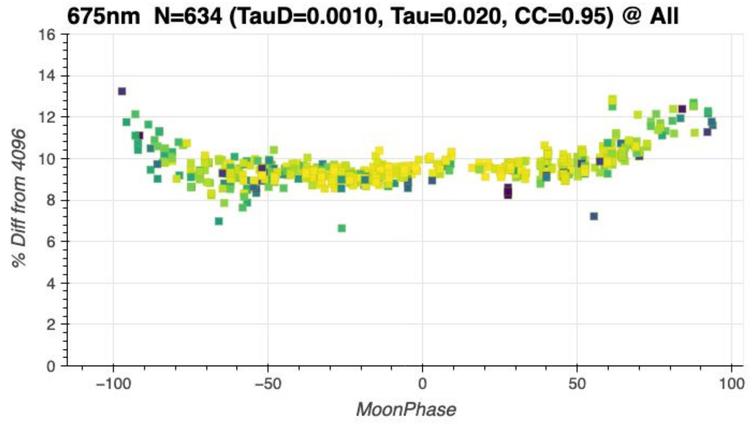


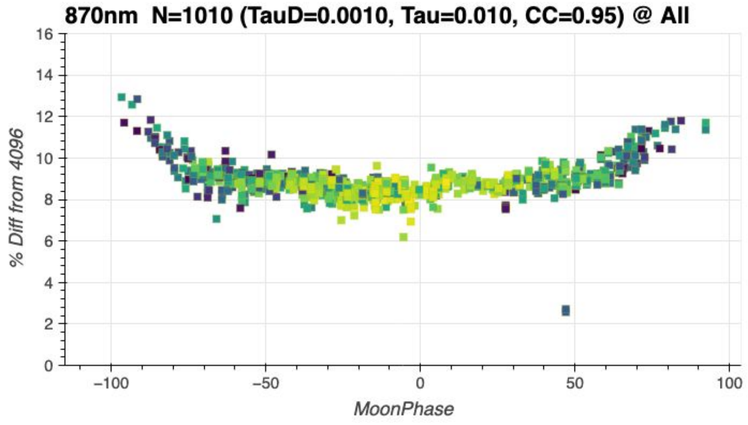

9-12
%
5-8
%

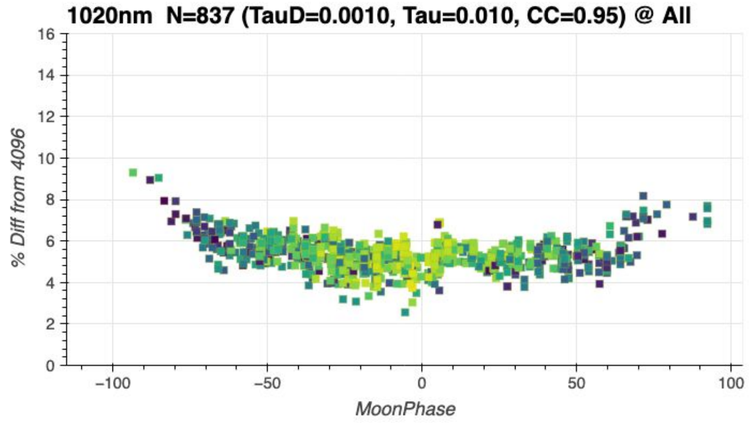
Sensitivity to minimum CC

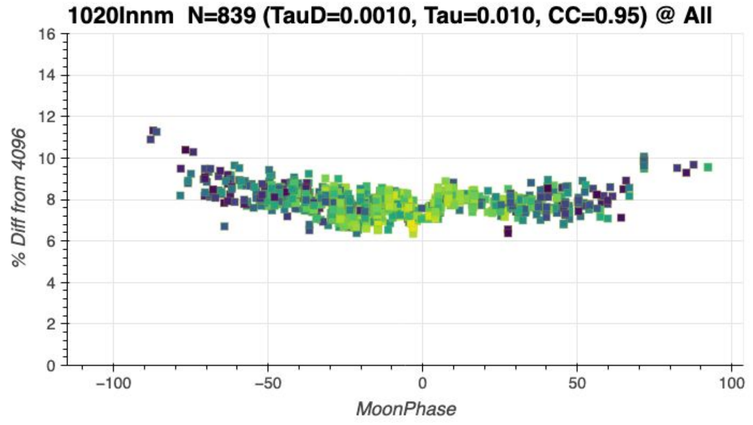


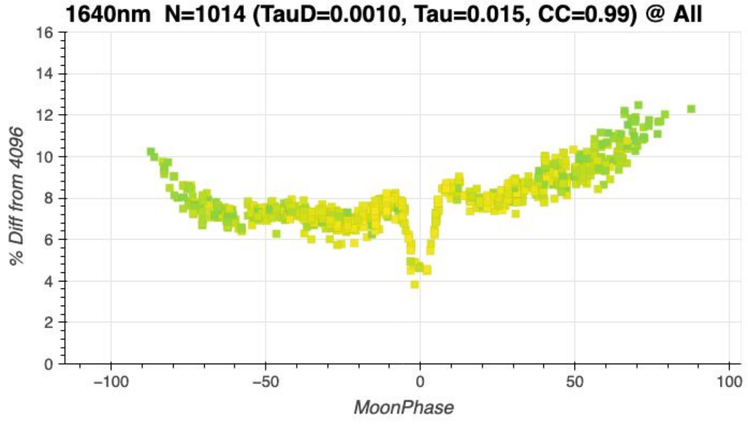








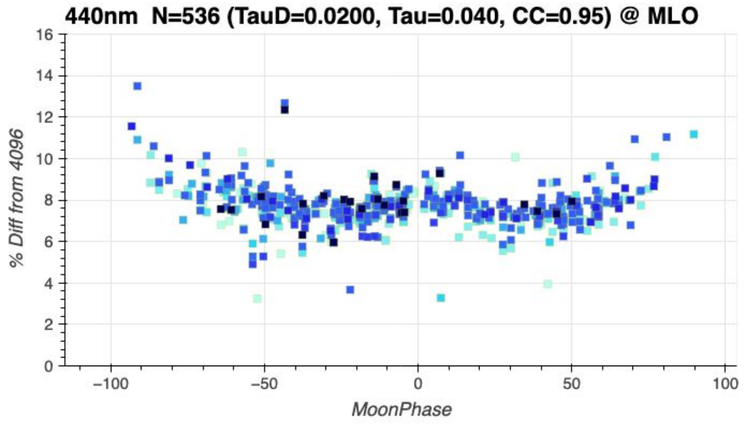


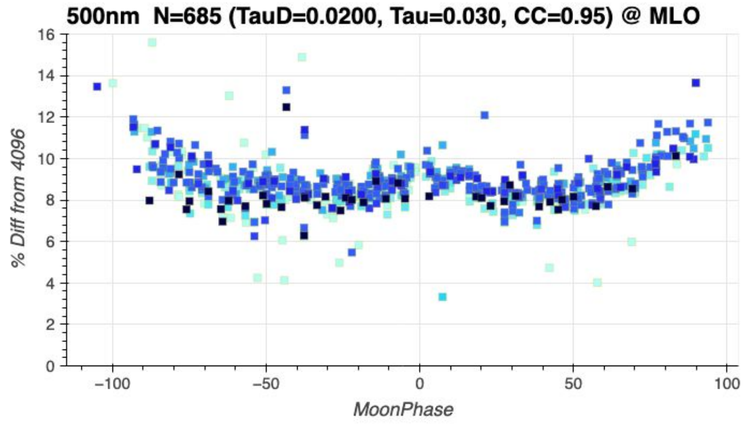


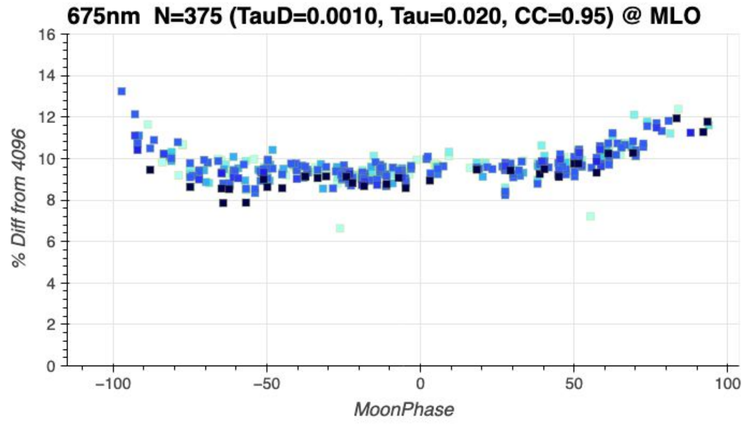
The main goal was to capture more of the large (absolute) MPA

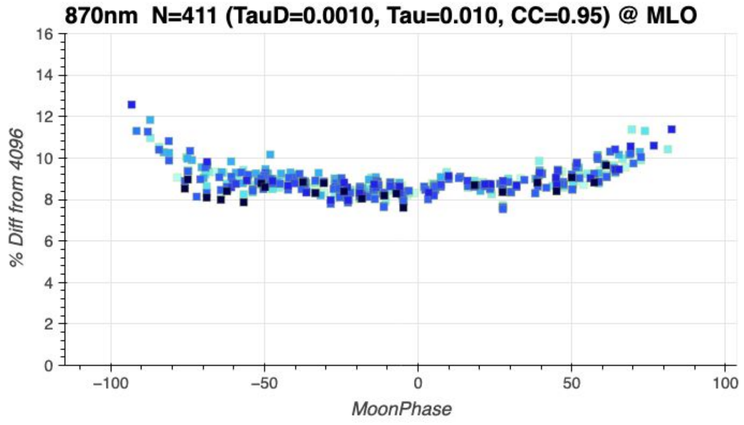
The loss of these observations was mostly due to the CC limit

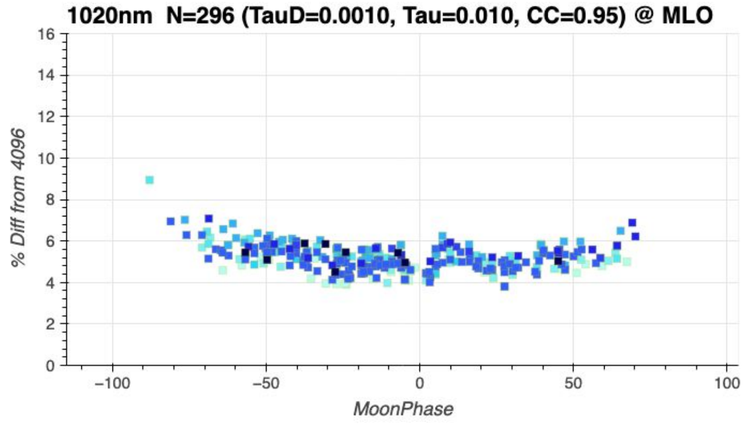
MLO only

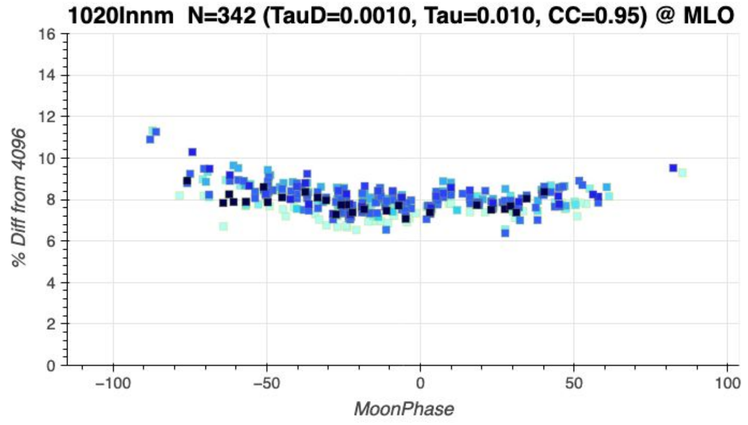


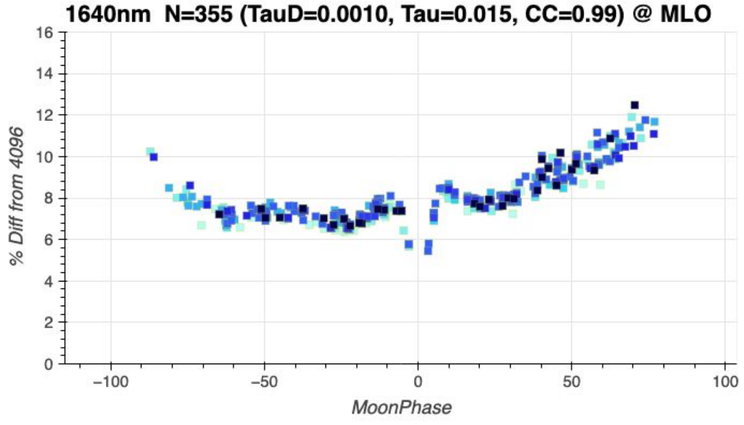




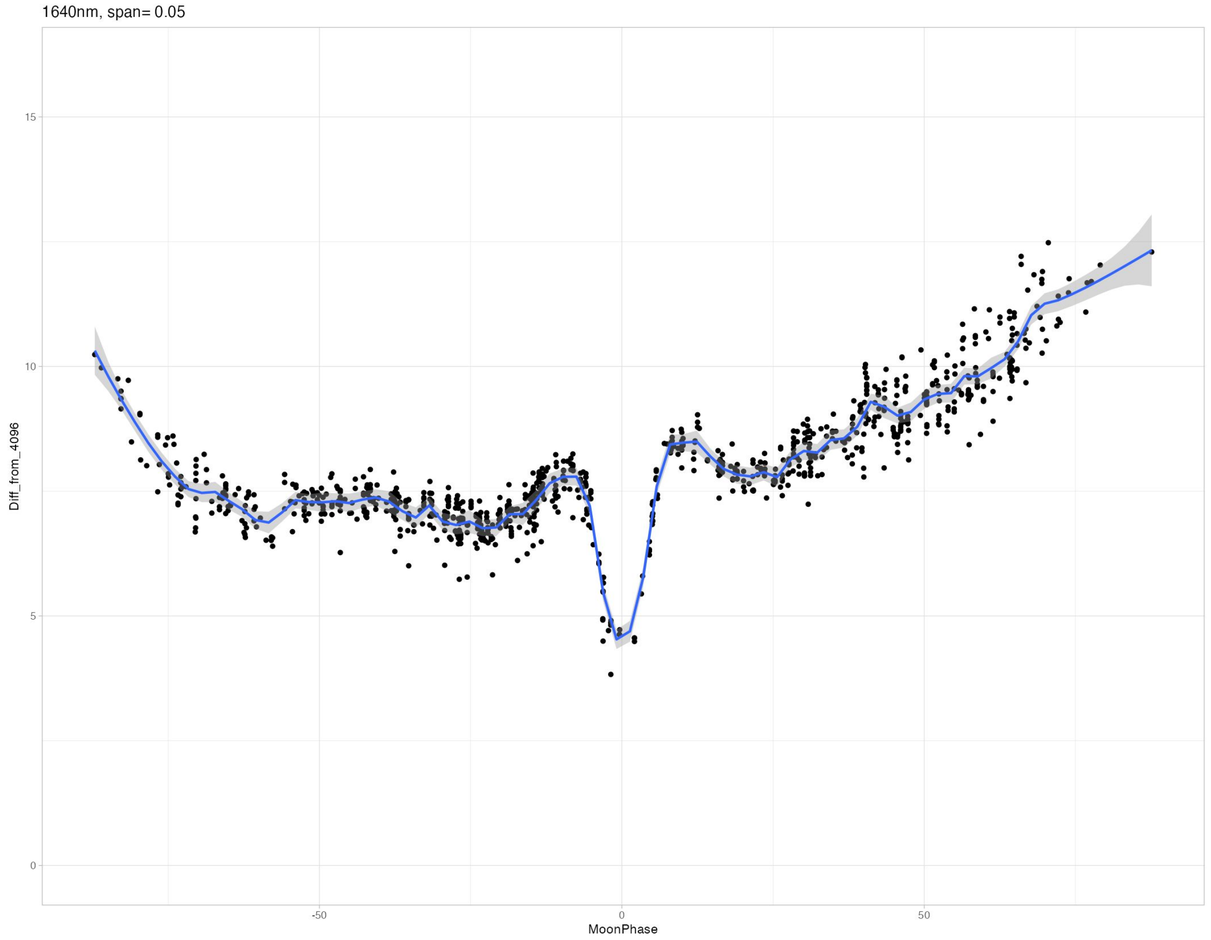


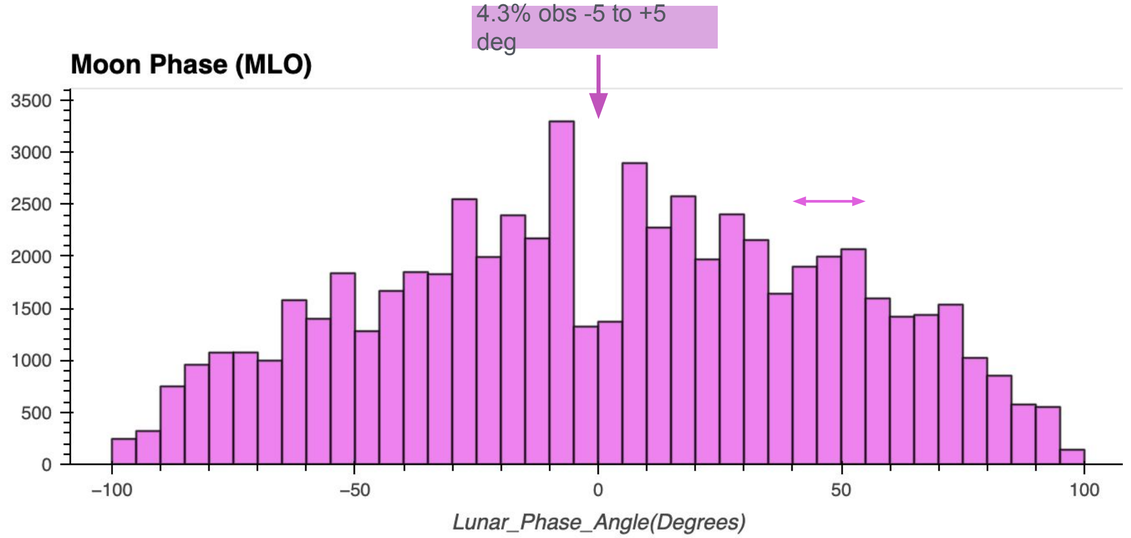


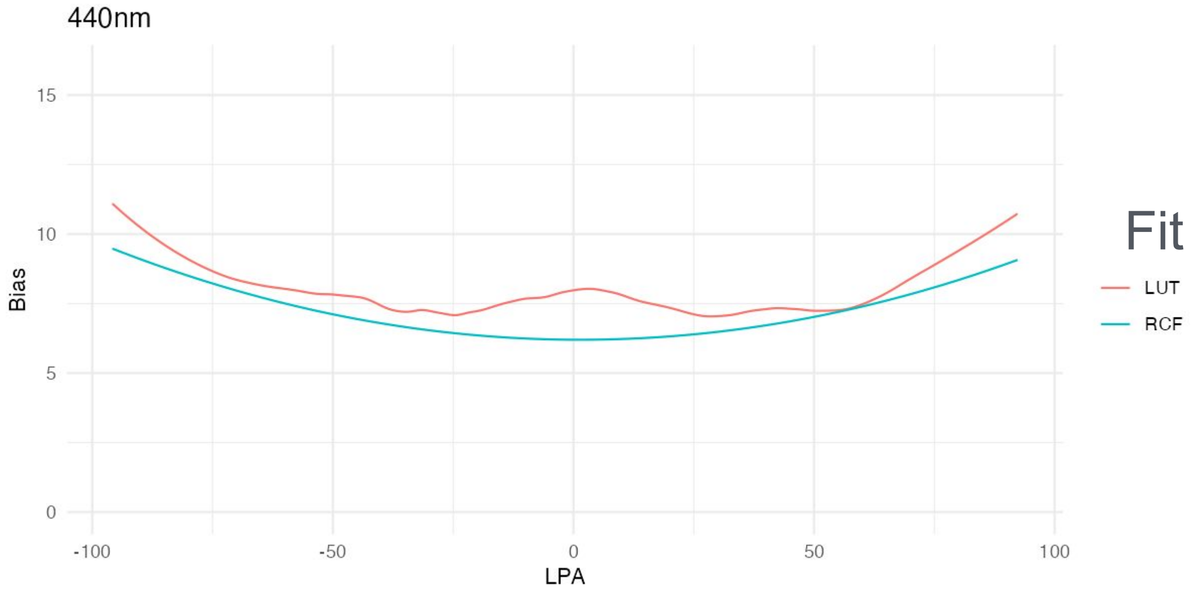


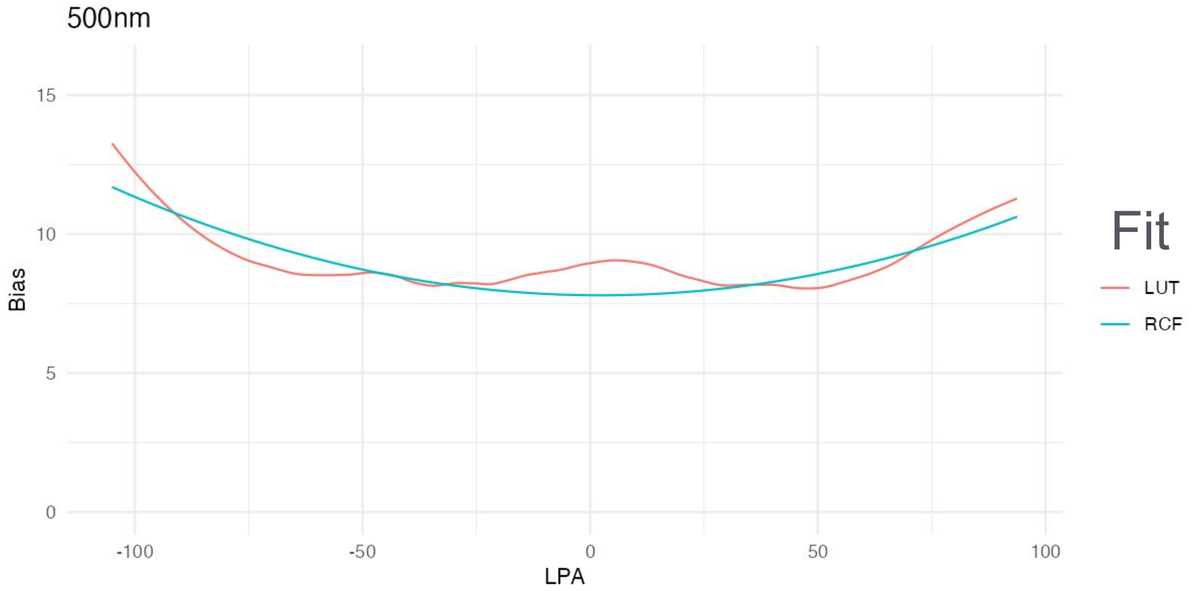


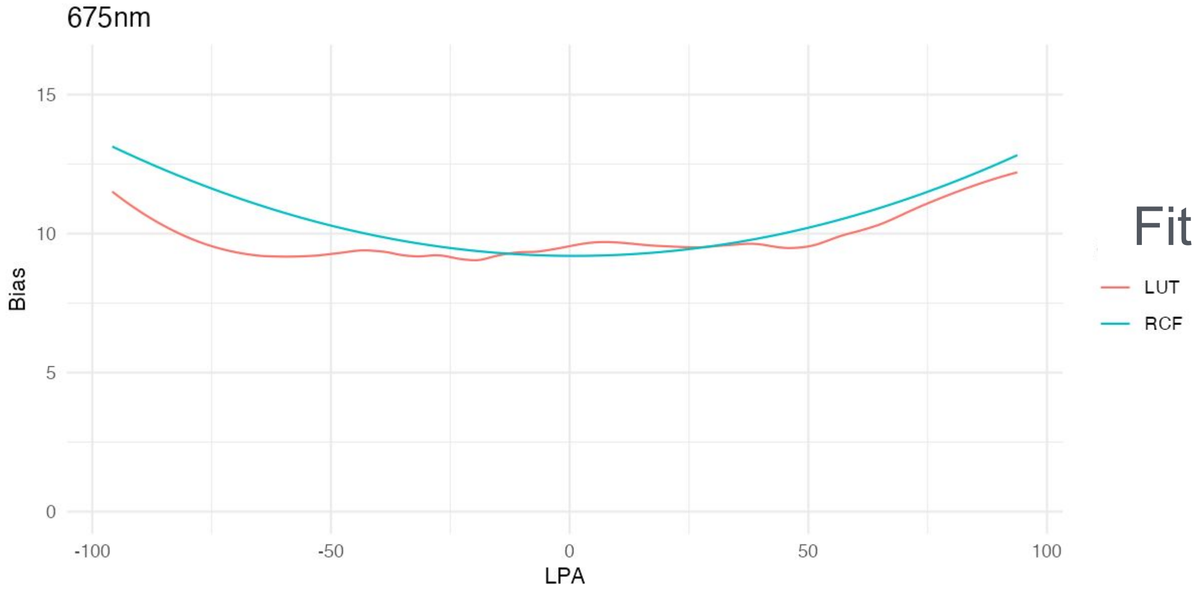
MLO remains a much less variable dataset than Izaña

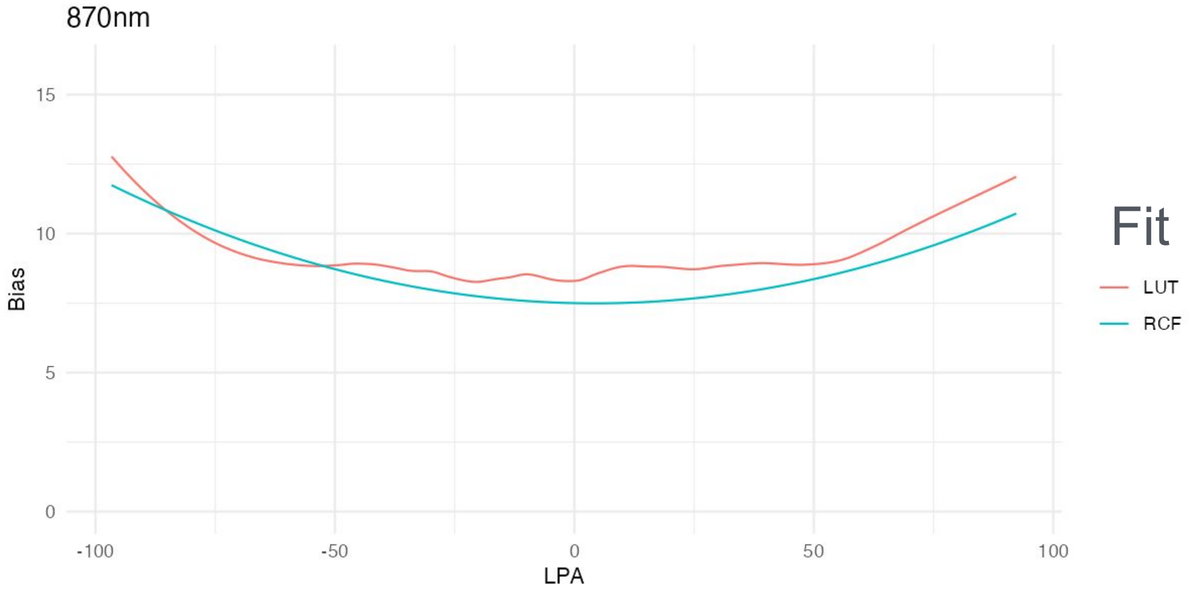

1640nm, span= 0.05
15
10
5
0
Diff_from_4096
-50
0
50
MoonPhase


4.3% obs -5 to +5 deg
Moon Phase (MLO)
3500
3000
2500
2000
1500
1000
500
0
−100
−50
0
50
100
Lunar_Phase_Angle(Degrees)





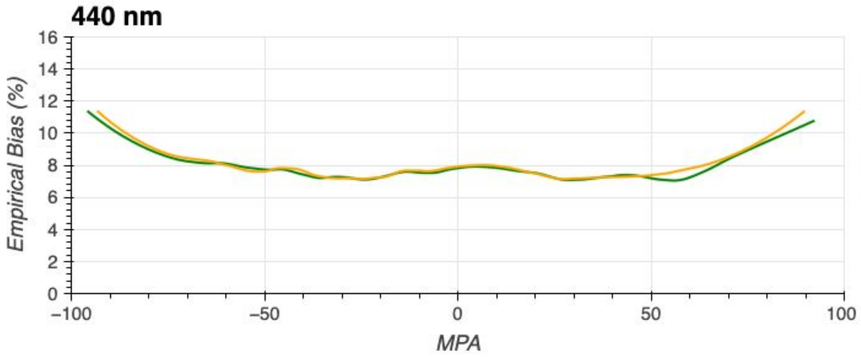


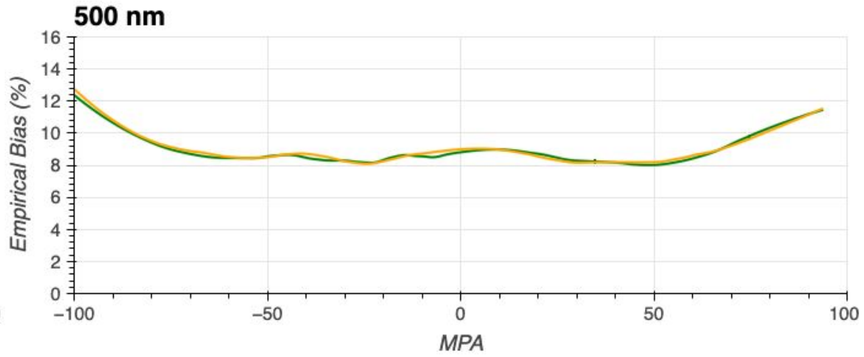


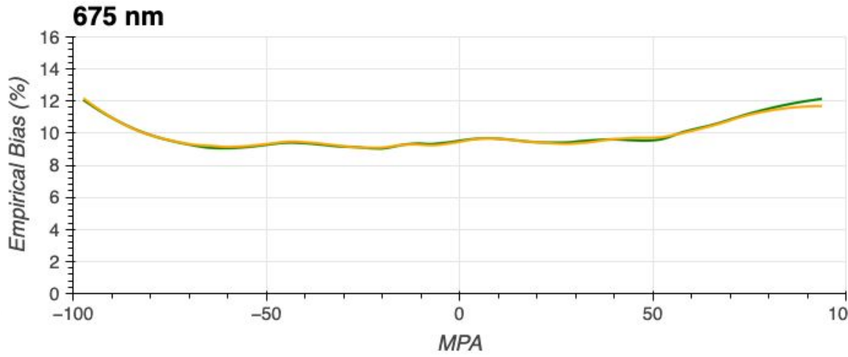
Comparing LUT and RCF Empirical Bias Correction

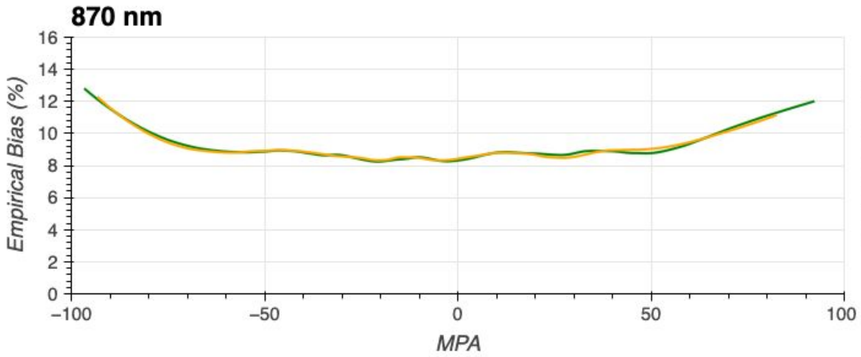
LOESS Fit is quite similar for Combined Sites and MLO Only

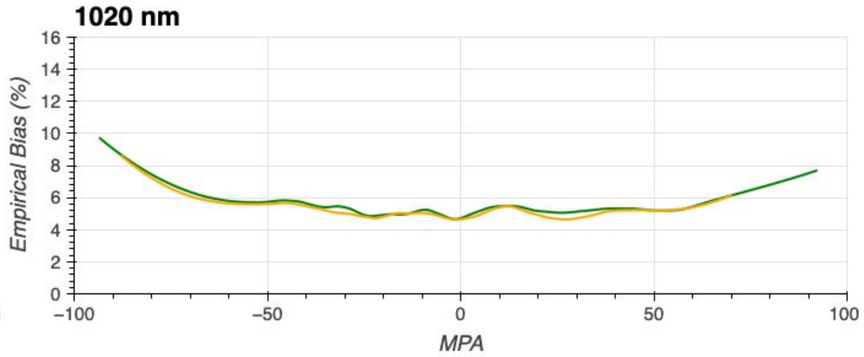
Likewise, the form of the trend is very similar except for 1640nm

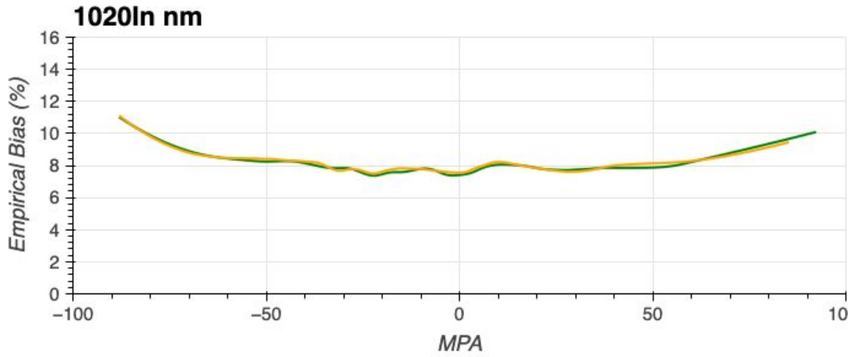


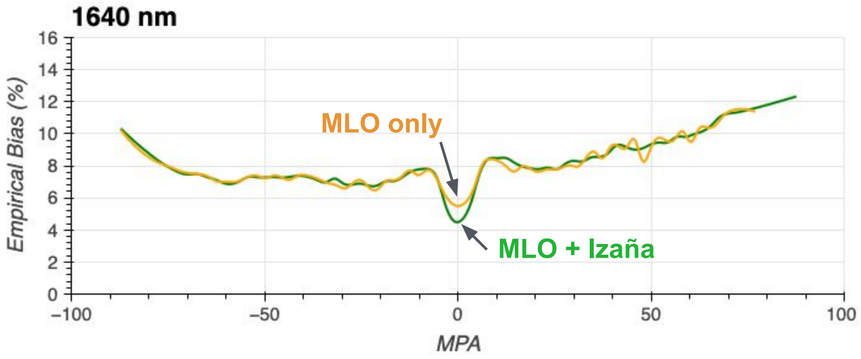






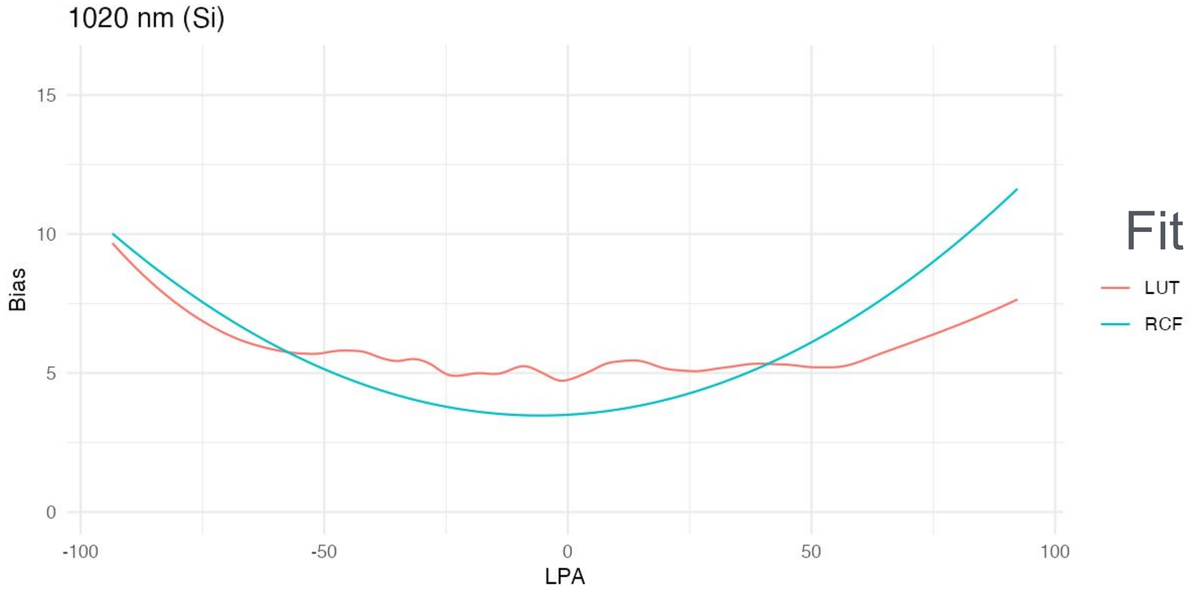


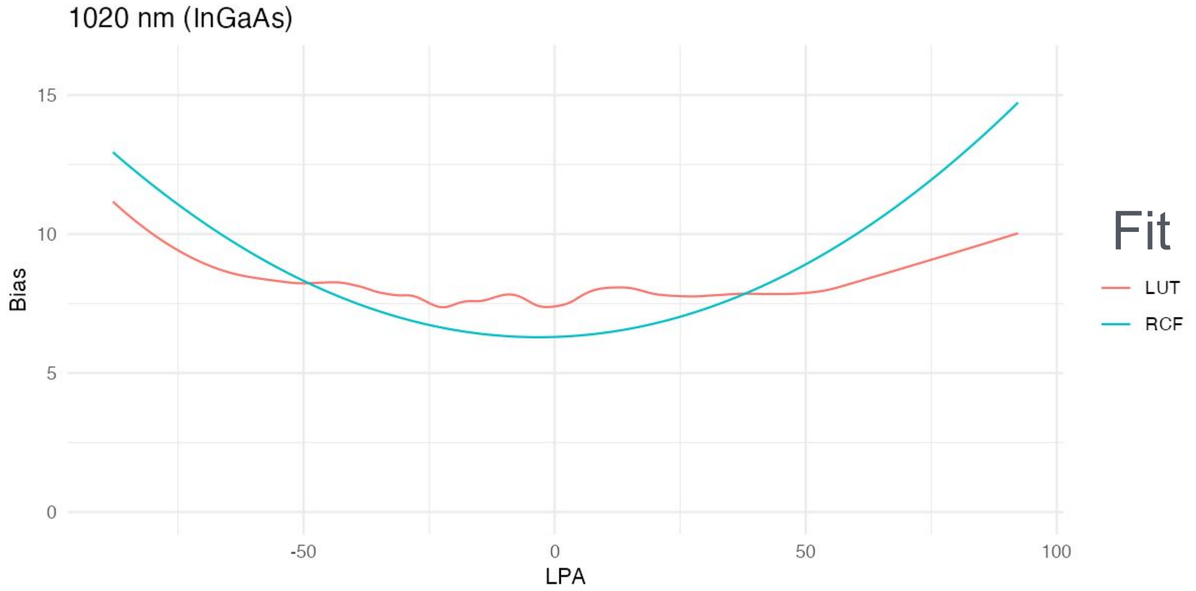


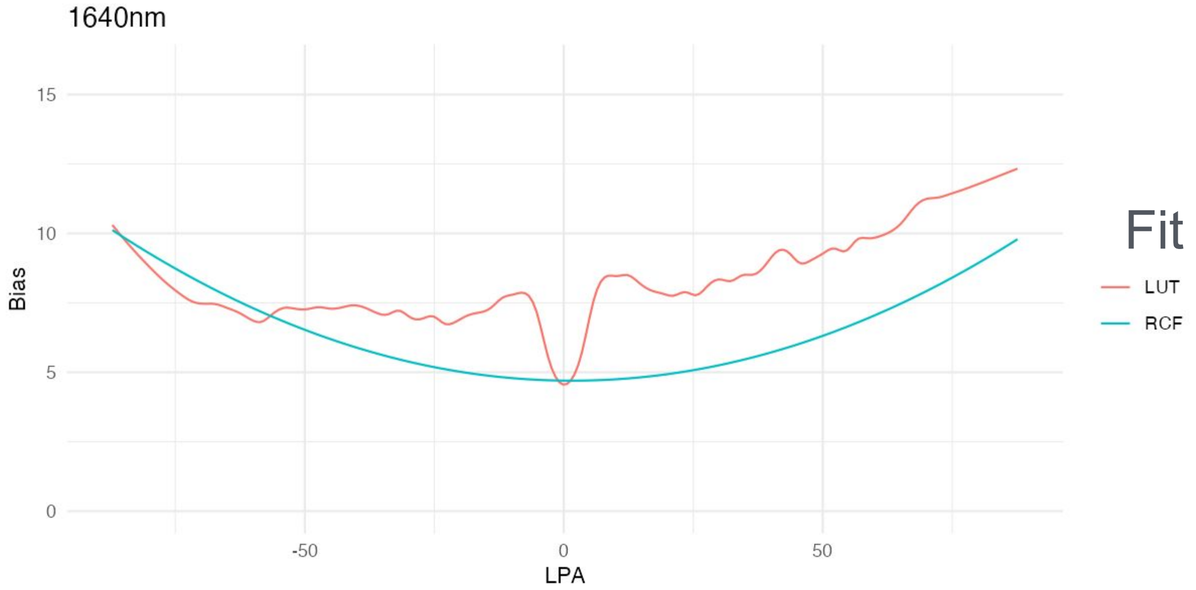


1640nm slightly different near full moon dip

Combined sites data is more resistant to overfitting





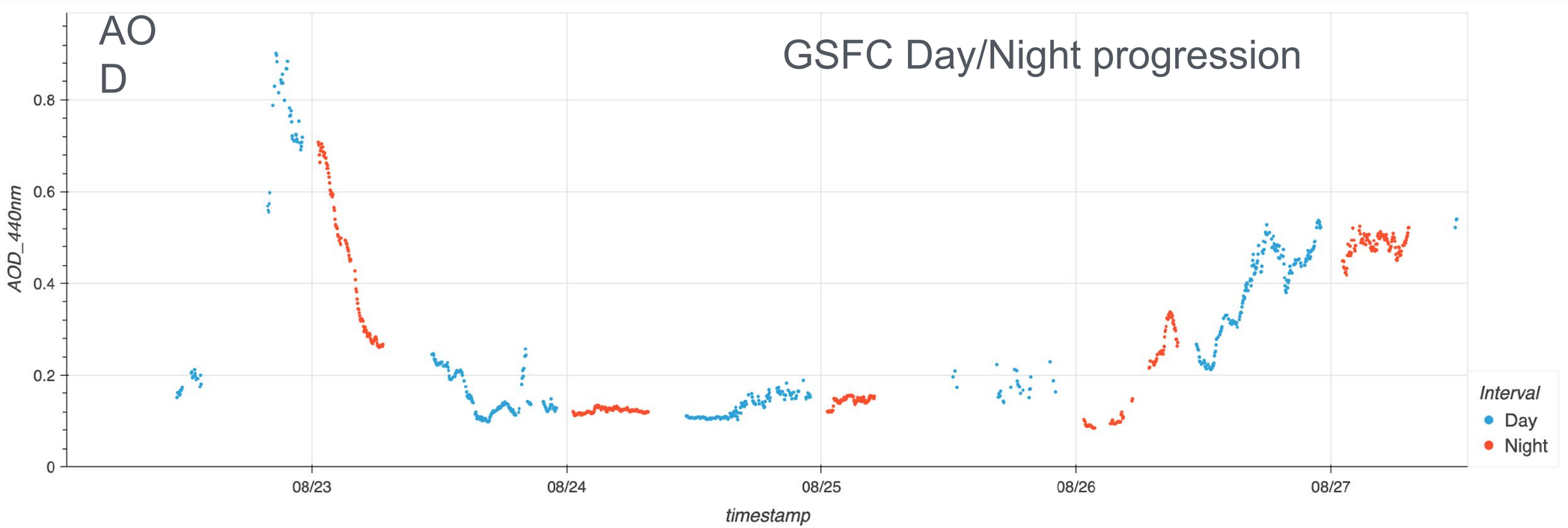


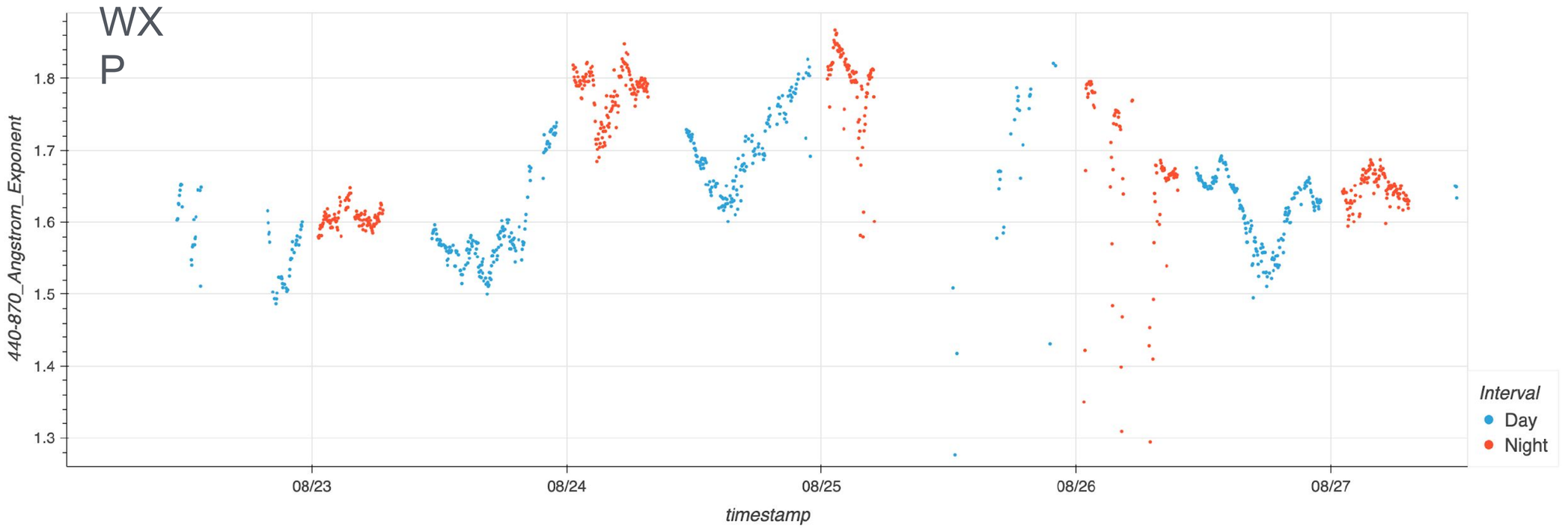
Only 1640nm is notably different (RCF transects dip minimum)

1020/1020In show the same ~2.5% upward translation for LUT and RCF

Comparing LUT and RCF Empirical Bias Correction

Assessment of Lunar Product


AOD
GSFC Day/Night progression
AOD_440nm
0.8
0.6
0.4
0.2
0
08/23
08/24
08/25
08/26
08/27
timestamp
Interval
Day
Night


WXP
440-870_Angstrom_Exponent
1.8
1.7
1.6
1.5
1.4
1.3
08/23
08/24
08/25
08/26
08/27
timestamp
Interval
Day
Night

AOD Differences at Sunrise/Sunset

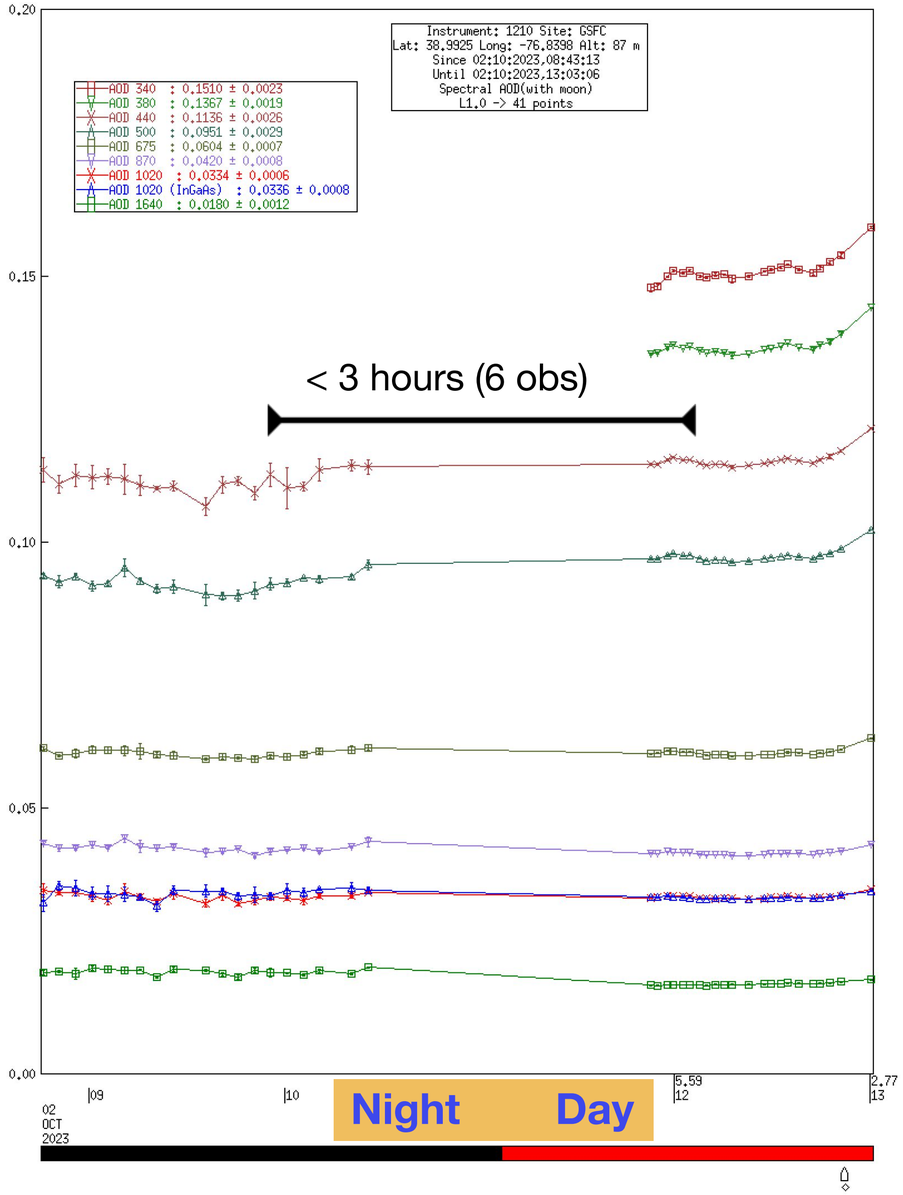
Evaluation of full lunar database based on AOD continuity

Select all sites with Lunar AOD

N= 198 sites (> 5000 obs)

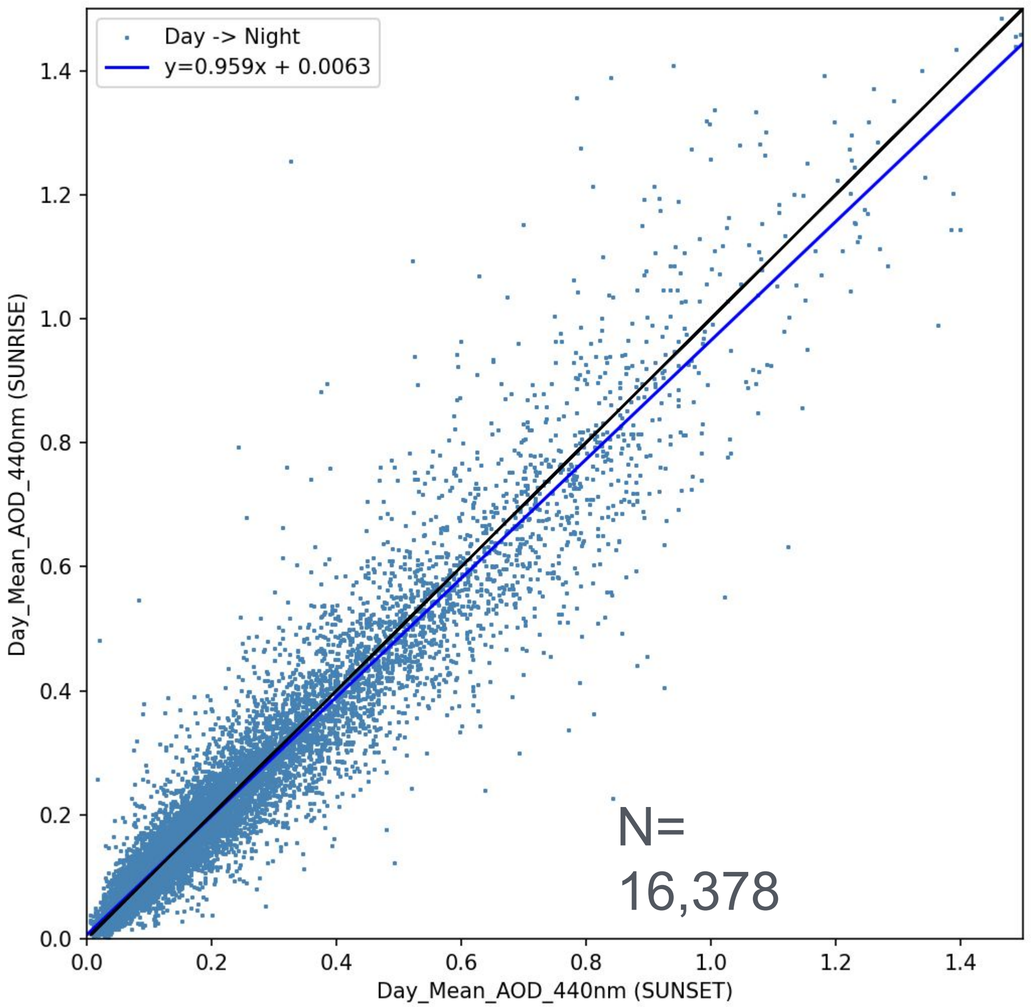
Lunar data record beginning around 2015

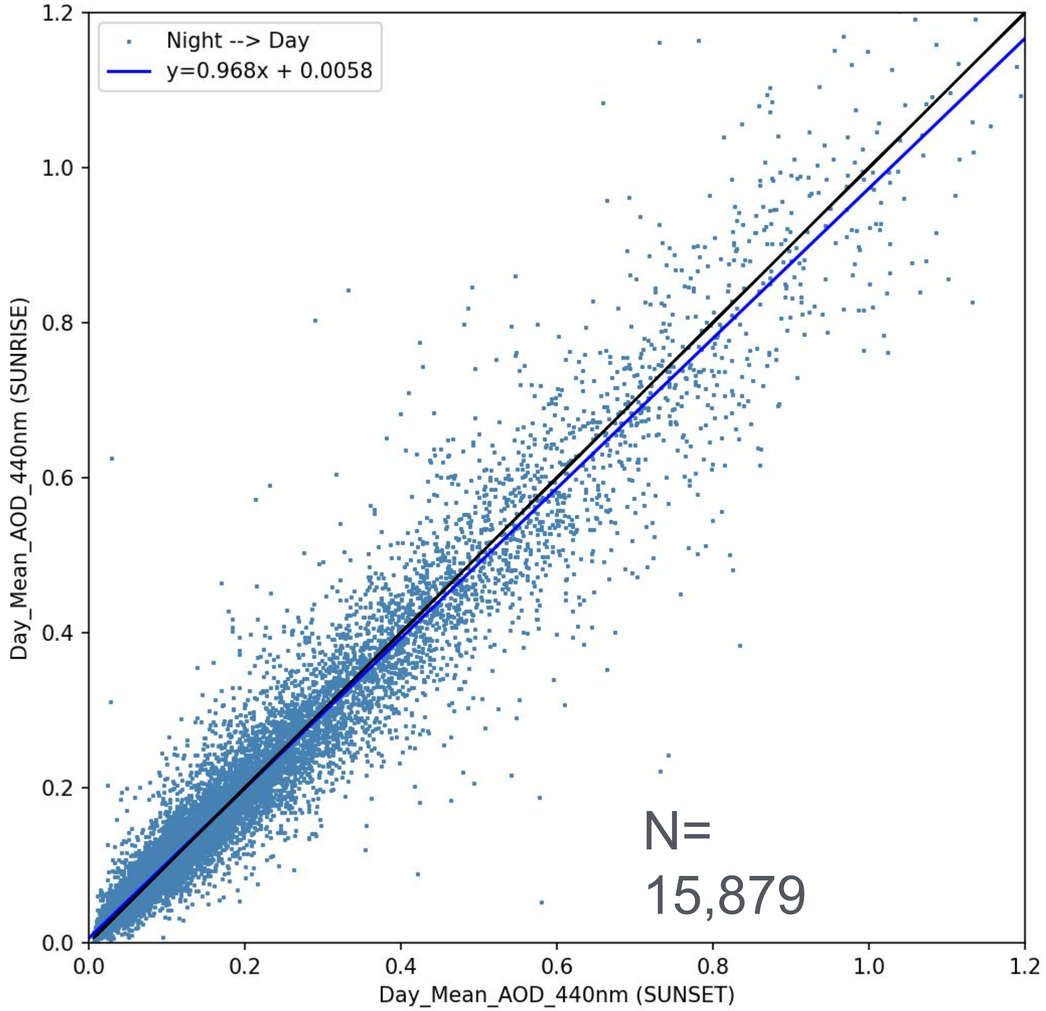
Average AOD from pre-/post-transition with total time span < 180 min



All AOD Transition Interval Comparisons

AOD Differences at Sunrise/Sunset

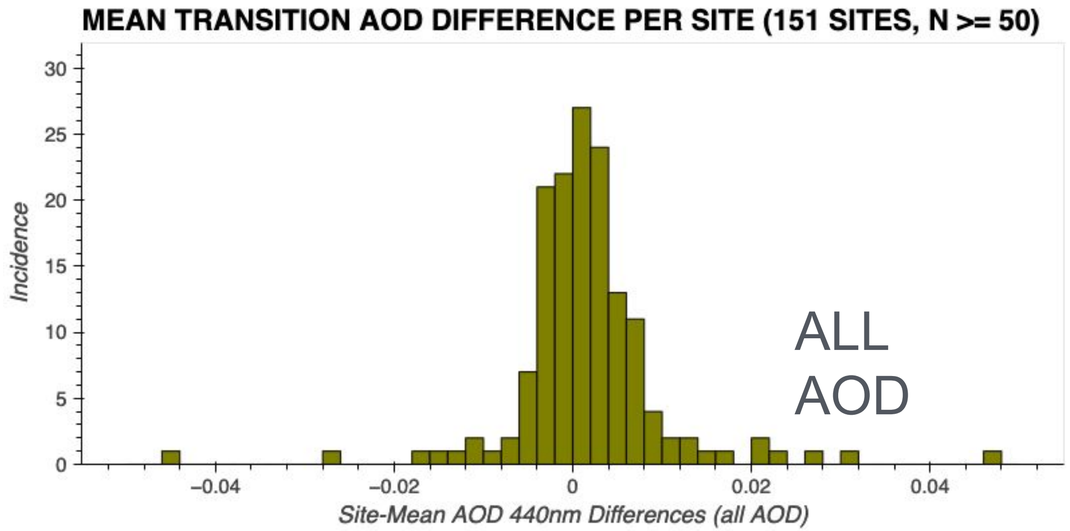


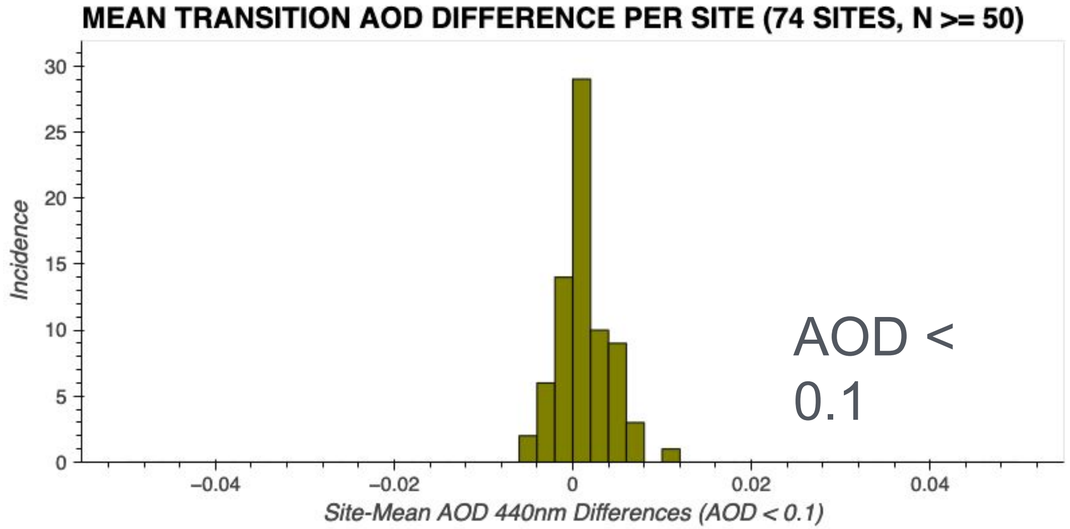


AOD Differences at Sunrise/Sunset

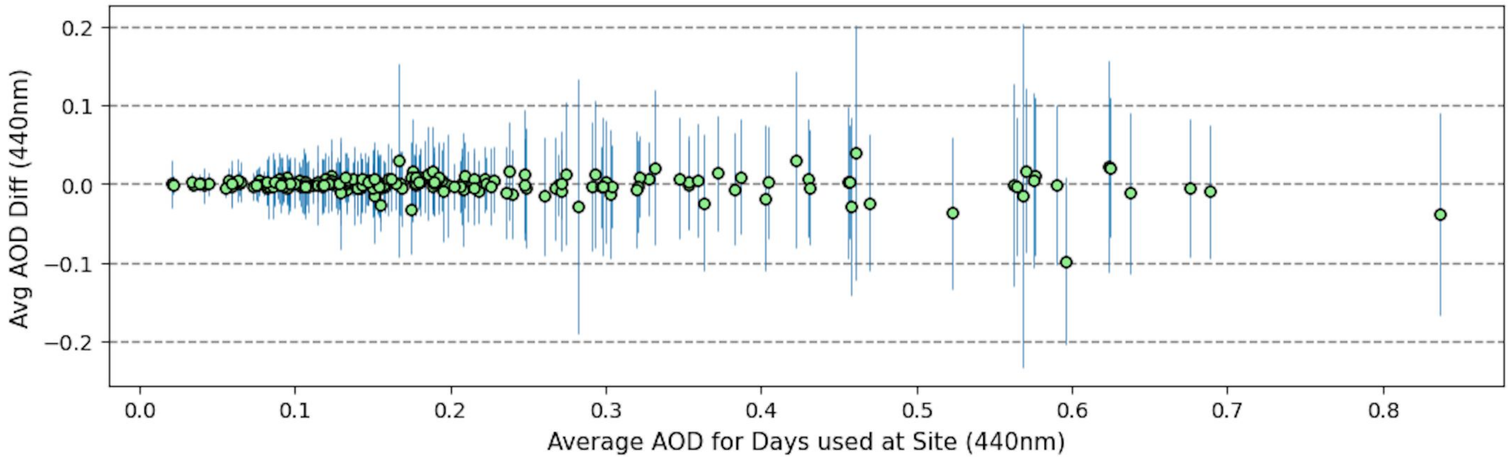
All site aggregated stats for transition interval AOD differences by channel

Channel	mean	std
440nm	0.0015	0.0154
500nm	0.0014	0.0142
675nm	0.0008	0.0133
870nm	0.0004	0.0122
1020nm	0.0003	0.0123
1640nm	-0.00003	0.0103

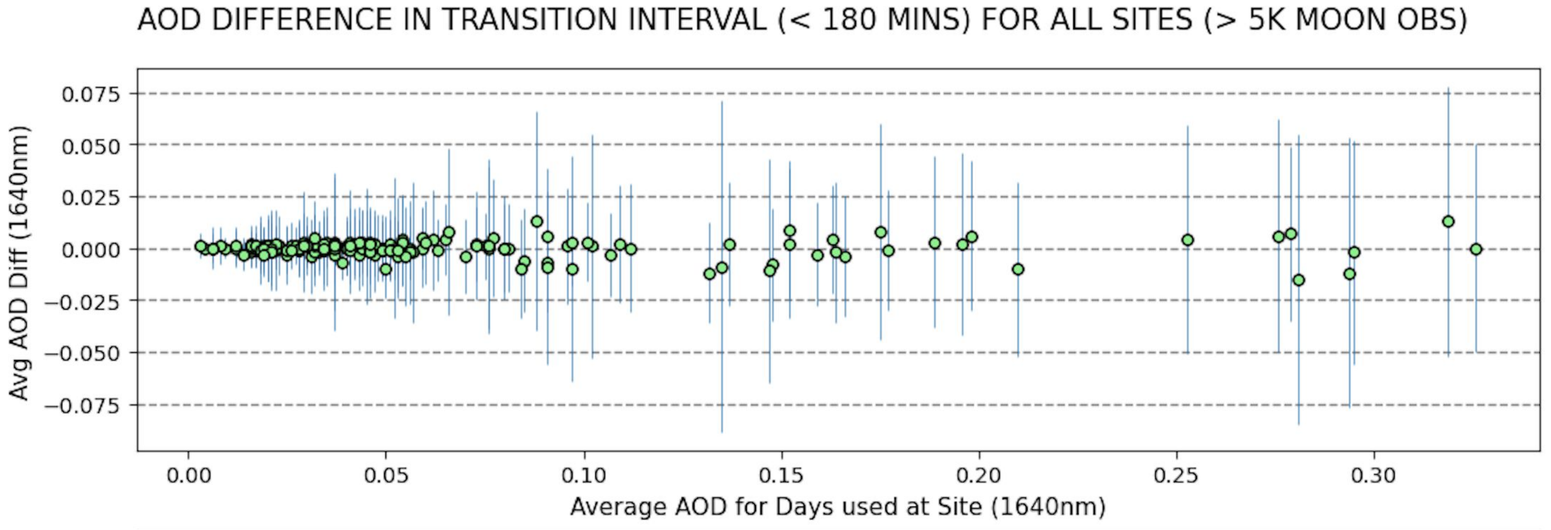




AOD Differences at Sunrise/Sunset



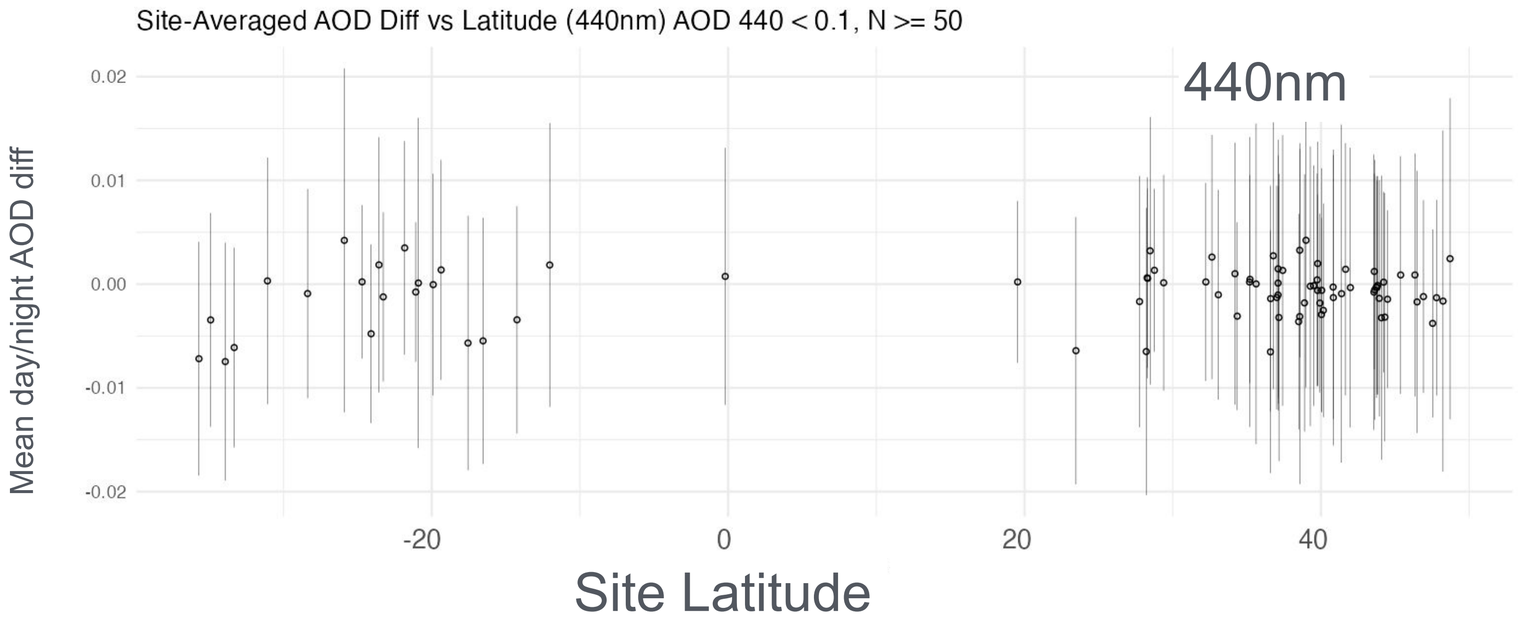
440nm

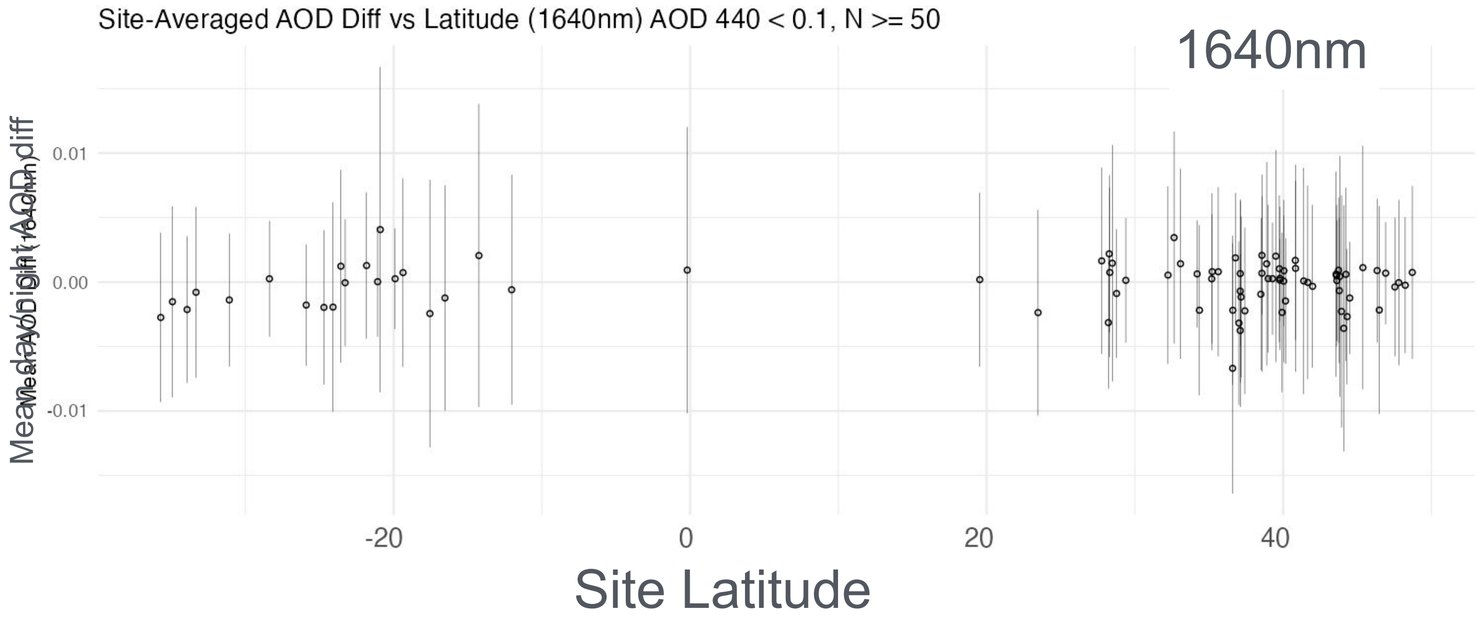


1640nm

Check potential latitudinal dependence since bias defined at MLO/Izaña

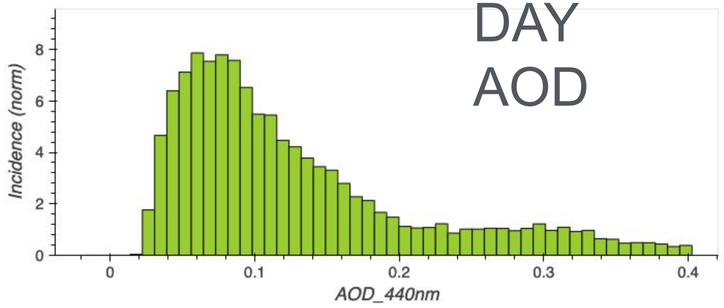
AOD Differences at Sunrise/Sunset

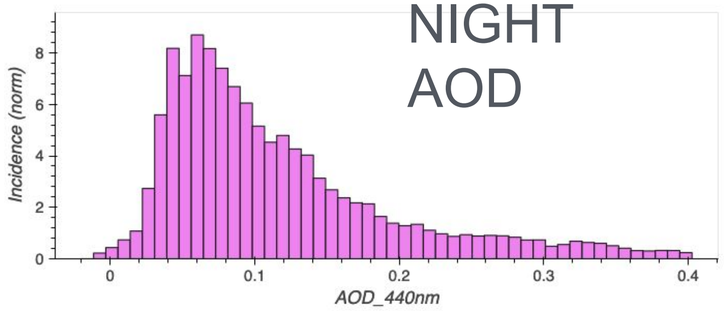




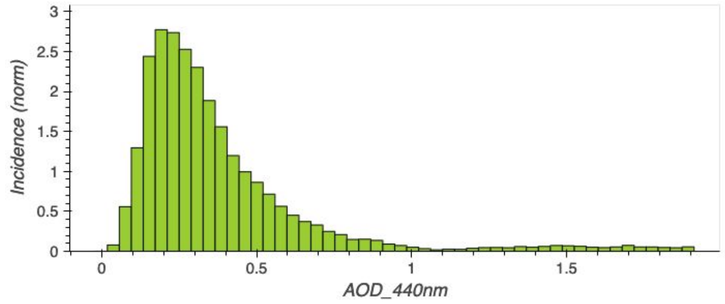
All AOD Observations

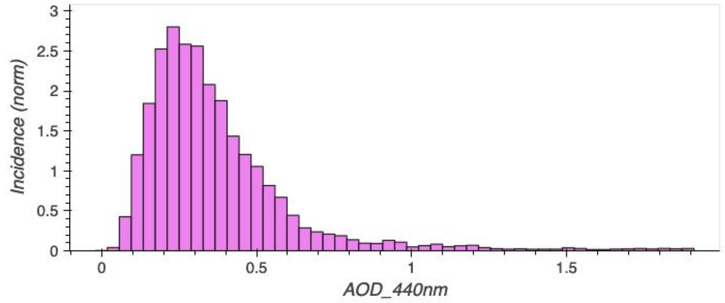
GSFC [Common Days with N > 10 Obs]



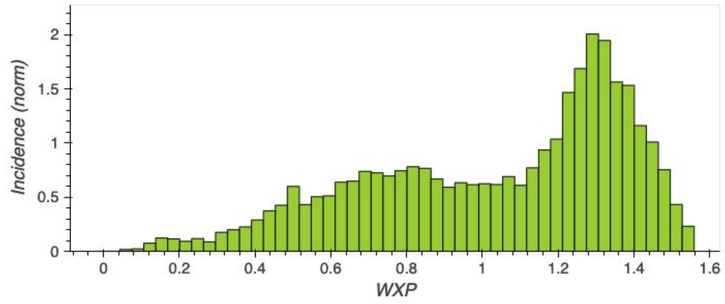


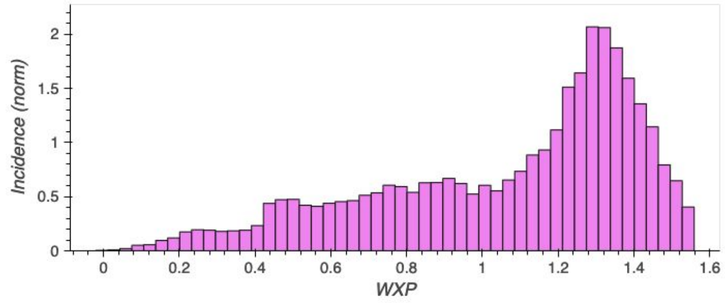
Singapore [Common Days with N > 10 Obs]



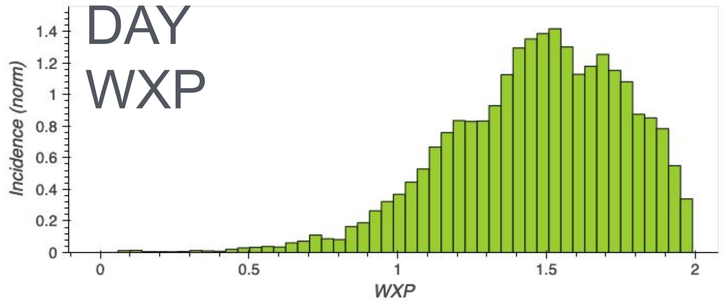


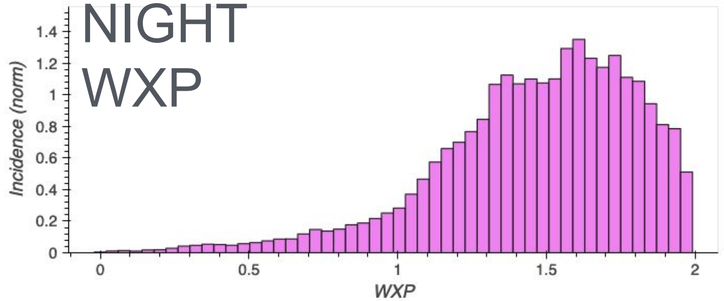
Kanpur [Common Days with N > 10 Obs]



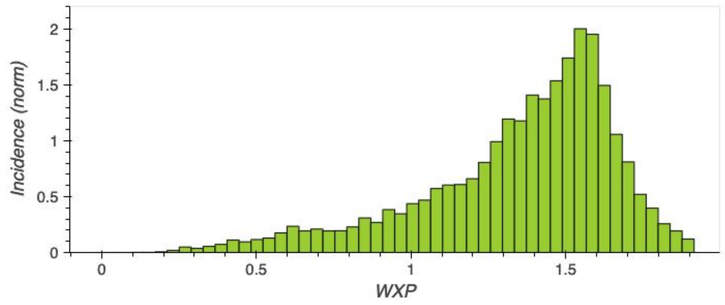


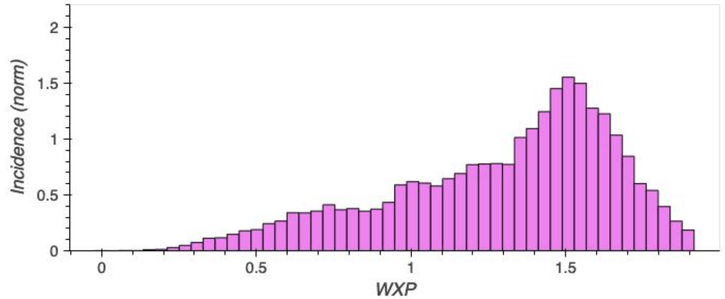
GSFC [Common Days with N > 10 Obs]



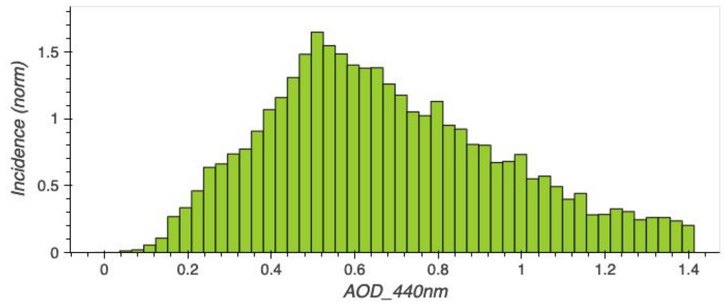


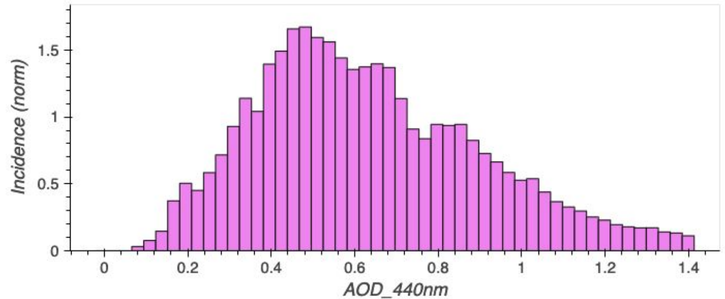
Singapore [Common Days with N > 10 Obs]





Kanpur [Common Days with N > 10 Obs]





Thank you

AERONET Exchange
2024

PAIRED DAY AOD/AE DIFFERENCES PER SITE

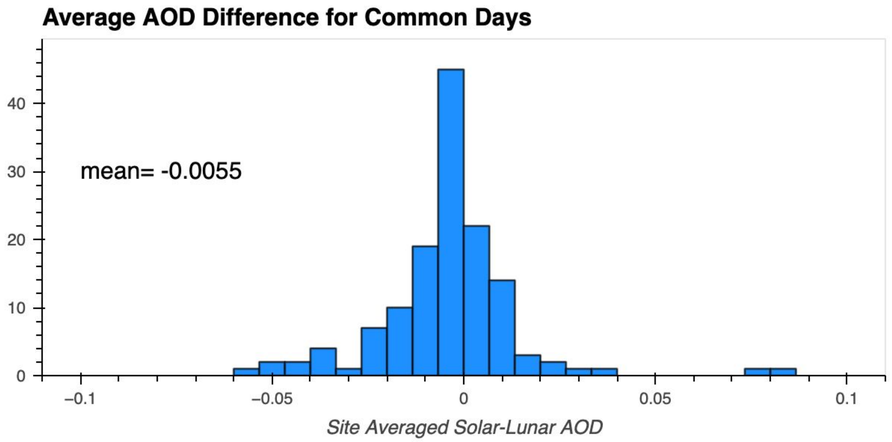
All AOD Observations

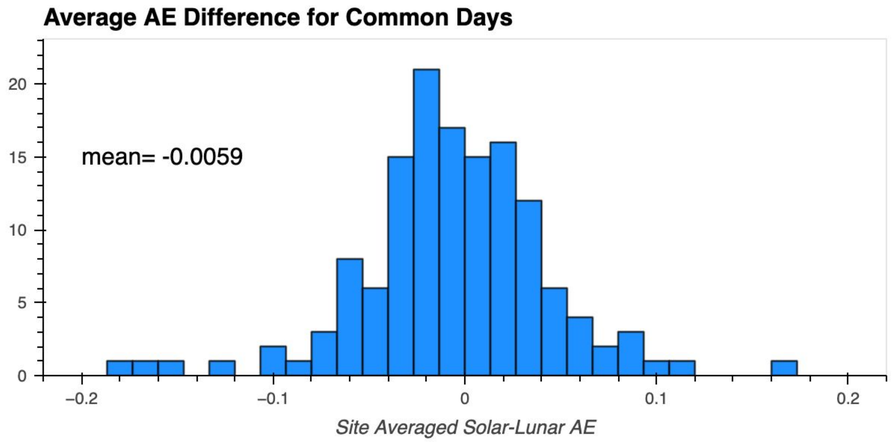
AOD/AE averages computed for each day and only retained

for days with both solar and lunar averages (N >= 3)

For each day, the difference in average AOD and AE was determined

Then, for each site the overall average of all daily differences was found





111 Sites. Average number of day pairs per site= 459