Addressing MODIS TERRA L1B High Latitude Striping with Empirical Adjustment of Polarization Correction Coefficients

MODIS/VIIRS Calibration Workshop

Yujie Wang and ***Alexei Lyapustin***

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MODIS Terra Update

OBPG' Polarization Correction is the basis of C6 and C6.1 processing:

Using Aqua L3 retrievals (as true), compute expected TOA radiances for Terra view geometry (over open **Ocean**);

Based on that, compute M_{11}, m_{12}, m_{13};

$$L_m/M_{11} = L_t + m_{12}*Q + m_{13}*U$$

L_m: measured TOA radiance (Terra)

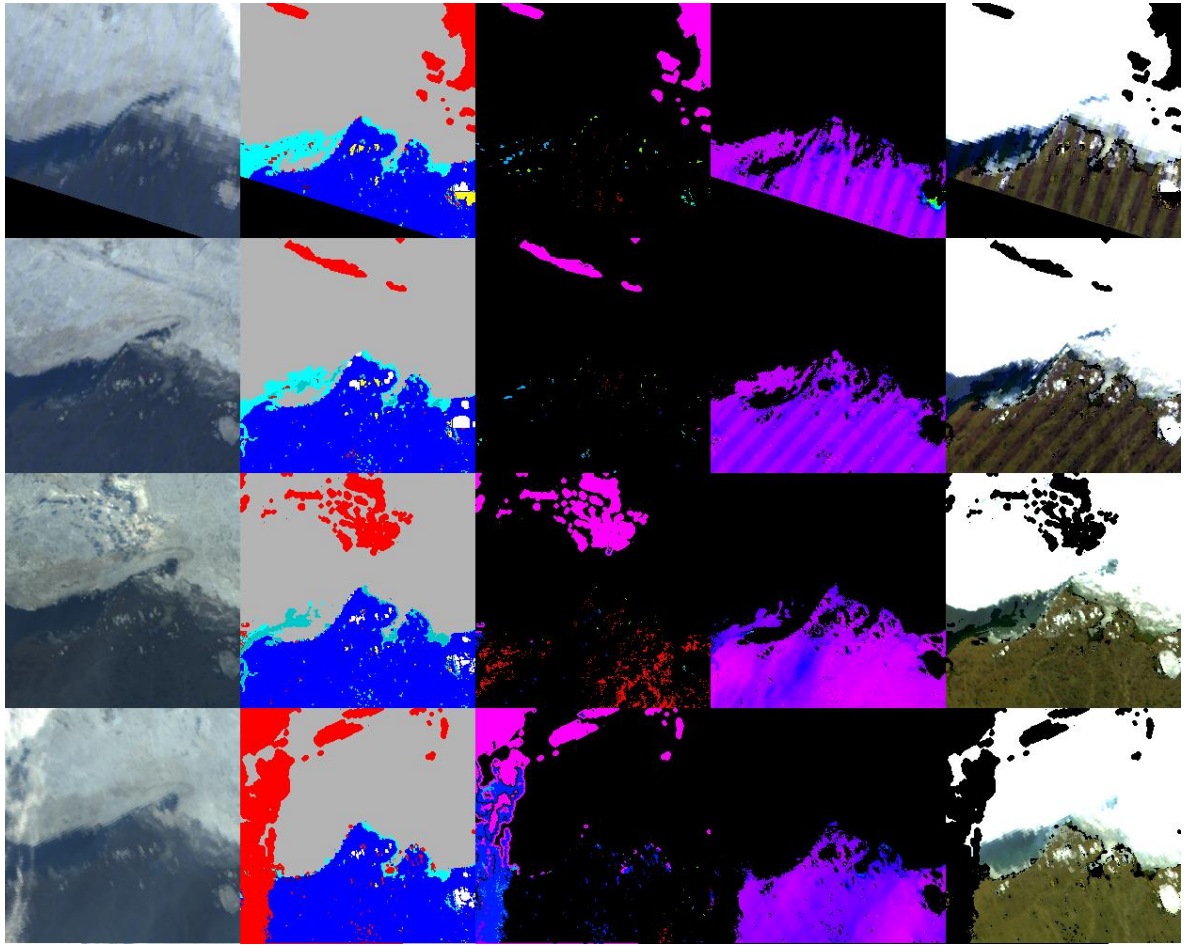
L_t: expected TOA radiance (from L3 Aqua)

Q, U : linear Stokes vector components, modeled from Rayleigh and glint

M_{11}, m_{12}, m_{13} : fitted instrument characterization parameters (depend on band, MS, detector, scan angle)

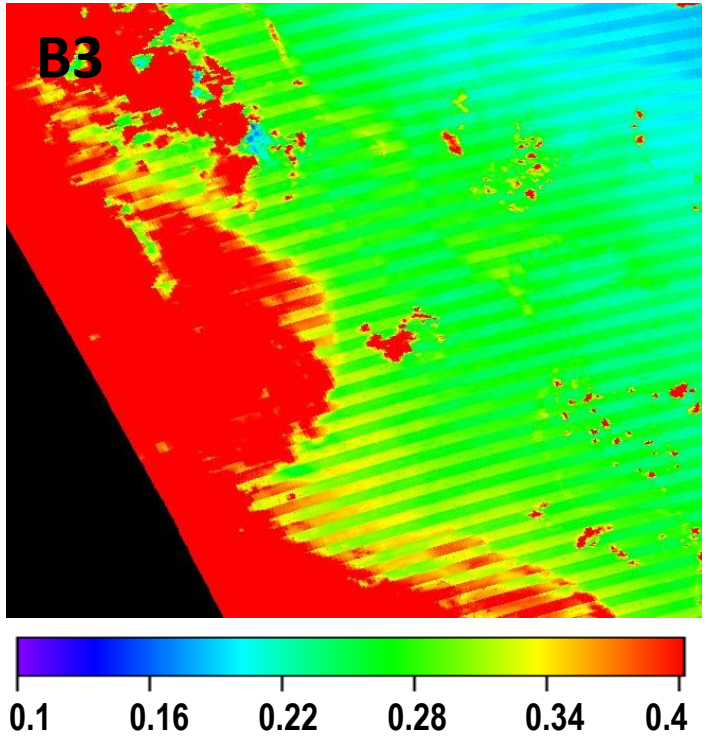
MAIAC Retrieval at Barrow, Alaska (C6.1 L1B, 2015)

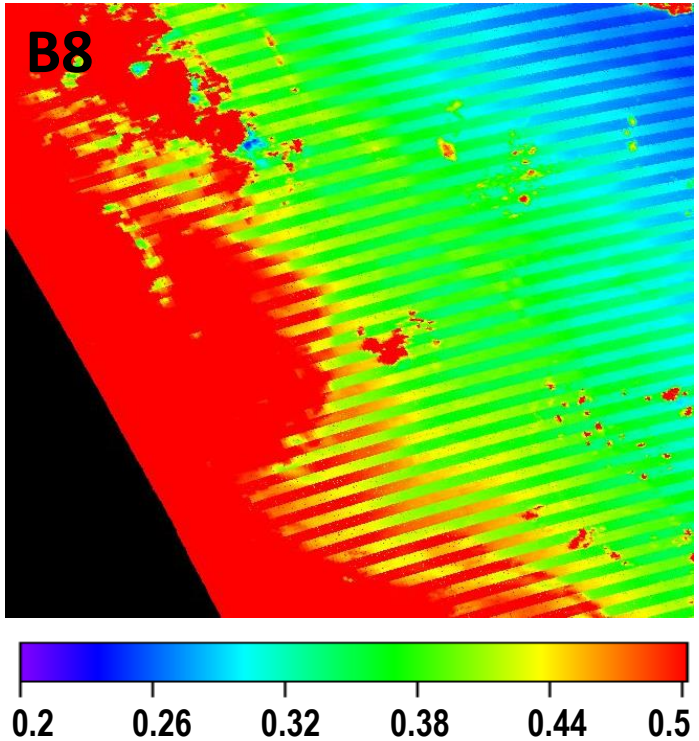
MODIS Terra shows residual mirror-side polarization sensitivity within ~20° of max polarization (scat. angle 90°).

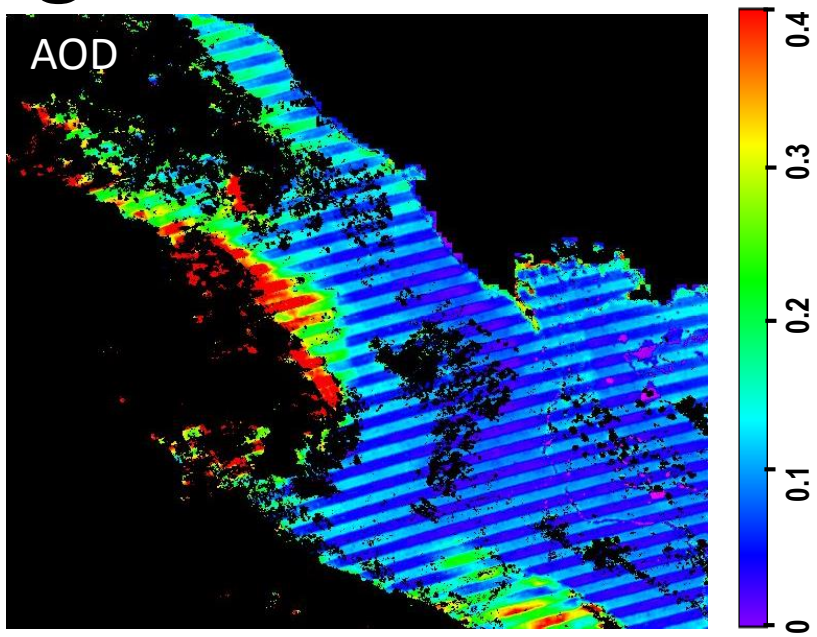


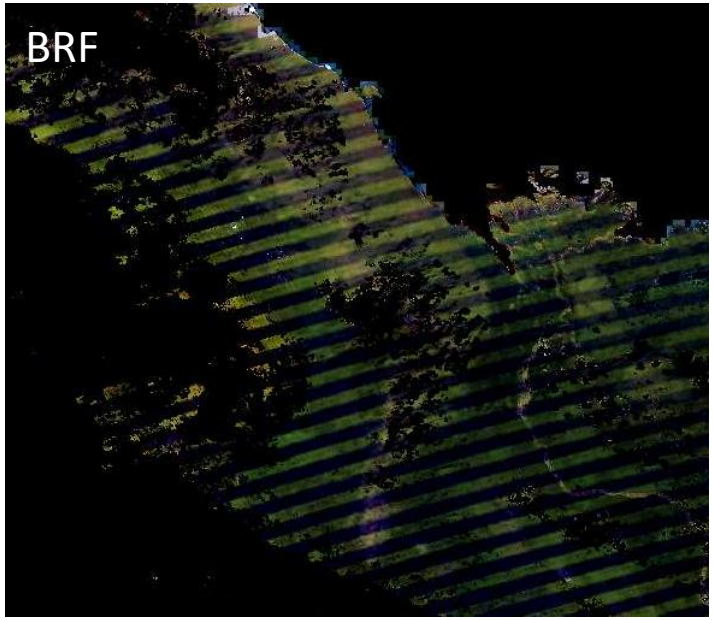
	cSZA	cVZA	AZ	ScatAng
T:	0.408	0.456	75.2	88.8
T:	0.285	0.674	73.1	89.4
A:	0.232	0.869	72.4	93.1
A:	0.350	0.532	74.3	88.2

MODIS Terra L1B Striping at High Latitude



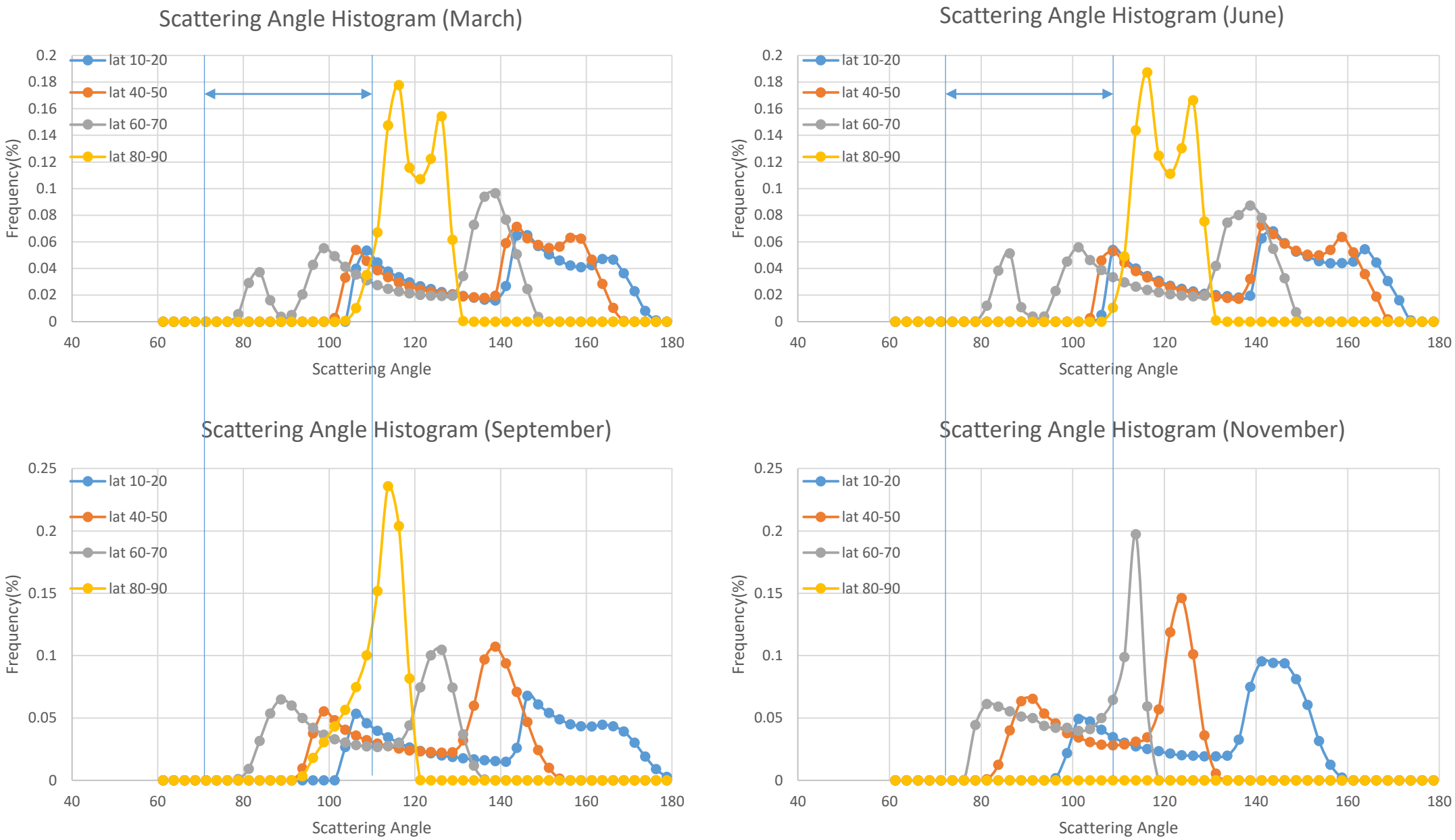






1. Mainly happens when scattering angle between 70-110°
2. At frame number between 800-1340
3. In Blue band (B3) and Deep Blue band (B8)
4. B-side is higher than A-side in B3, but lower in B8

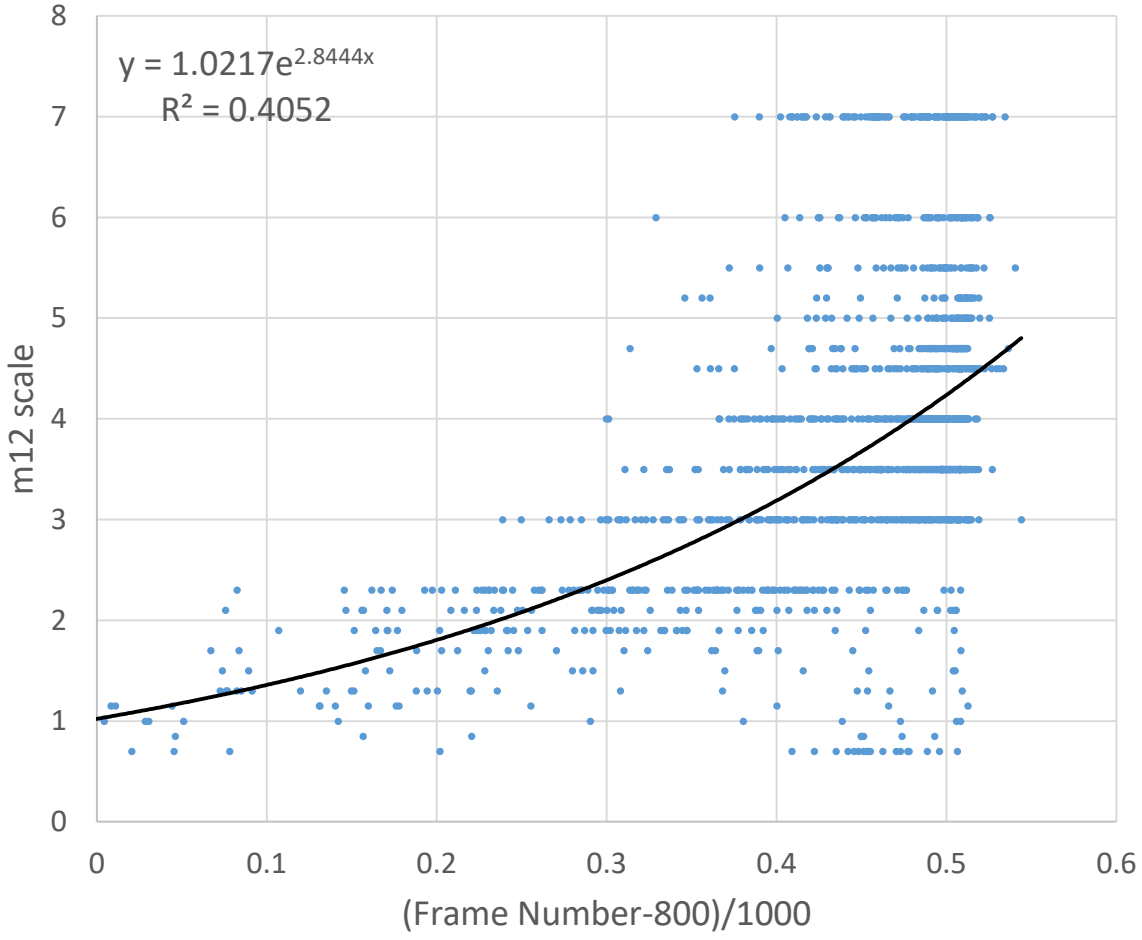
Terra Scattering Angle Distribution with Latitude



Method

- Assumption:
  - Striping comes from the residual polarization. The PC coefficients (m12, m13) may need adjustment.
- Procedure:
  1. Introduce scale factors s^{12} and s^{13}, adjust m12 and m13 to s^{12}*m12, s^{13}*m13 for B-side measurements.
  2. Run MAIAC to retrieve AOD.
  3. Create bins according to scattering angle, in each bin, calculate the AOD difference between A-side and B-side.
  4. Change S^{12} and S^{13}, repeat step 1-3 for a number of (S^{12}, S^{13}) combinations.
  5. Find the (S^{12}, S^{13}) that create minimum AOD difference between A-side and B-side.
  6. Generate model for (S^{12},S^{13}) as a function of frame number.
  7. Apply the model and check result.

Scale Factor Model



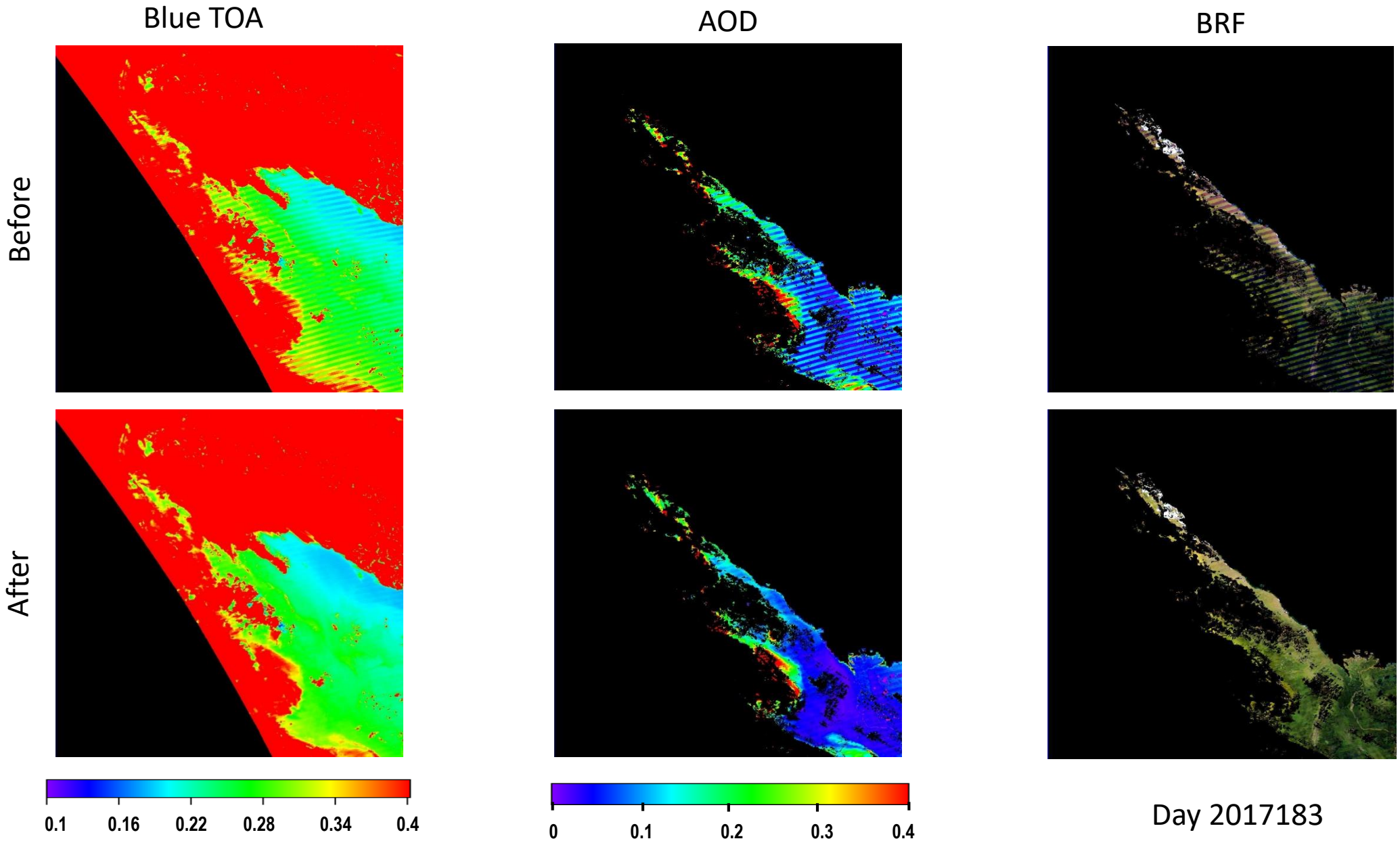
- We did not observe AOD difference sensitivity to the S^{13} factor, so S^{13} is fixed to 1.

- We can derive an empirical model for S^{12}:

$$S^{12} = 1.0217 * e^{2.844(FN-800)/1000}$$

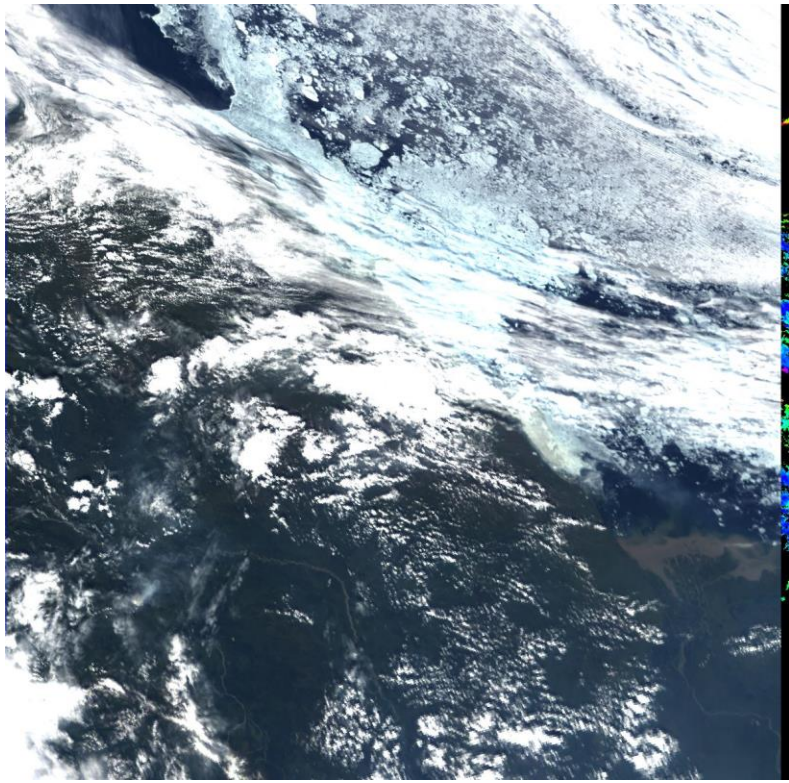
where FN is Frame Number. This model is only applied to frame number above 800 and scattering angle between 70-110 degree.

Blue Band m12 Adjustment

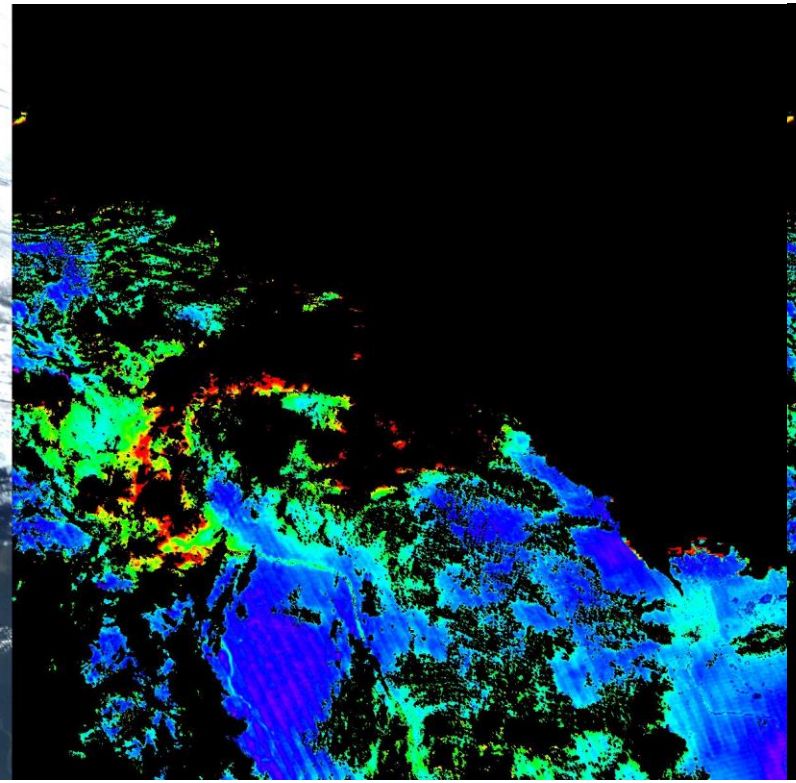


AOD Striping Correction

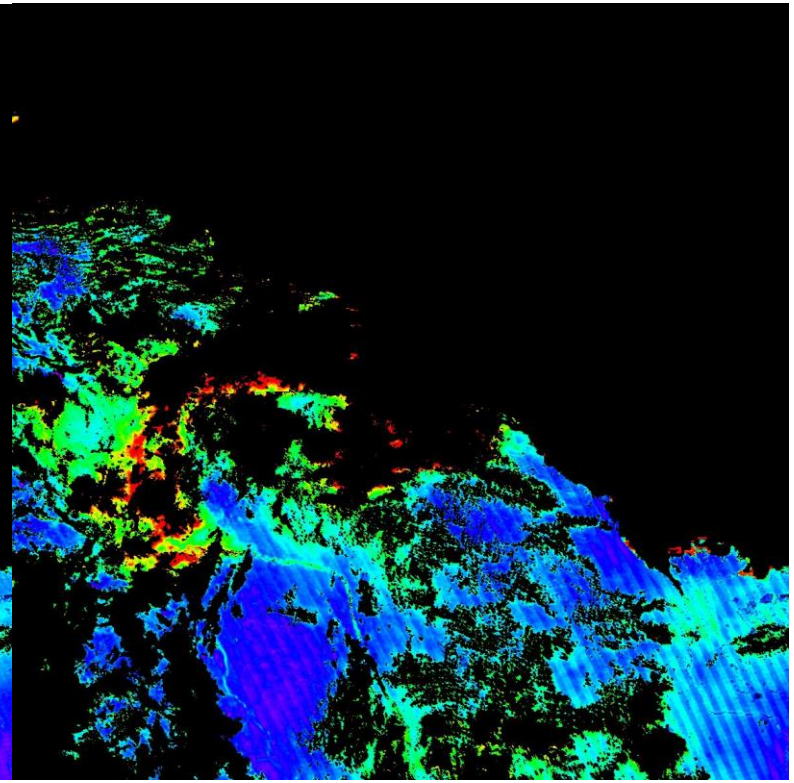
TOA

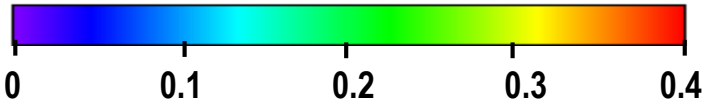


AOD (After)



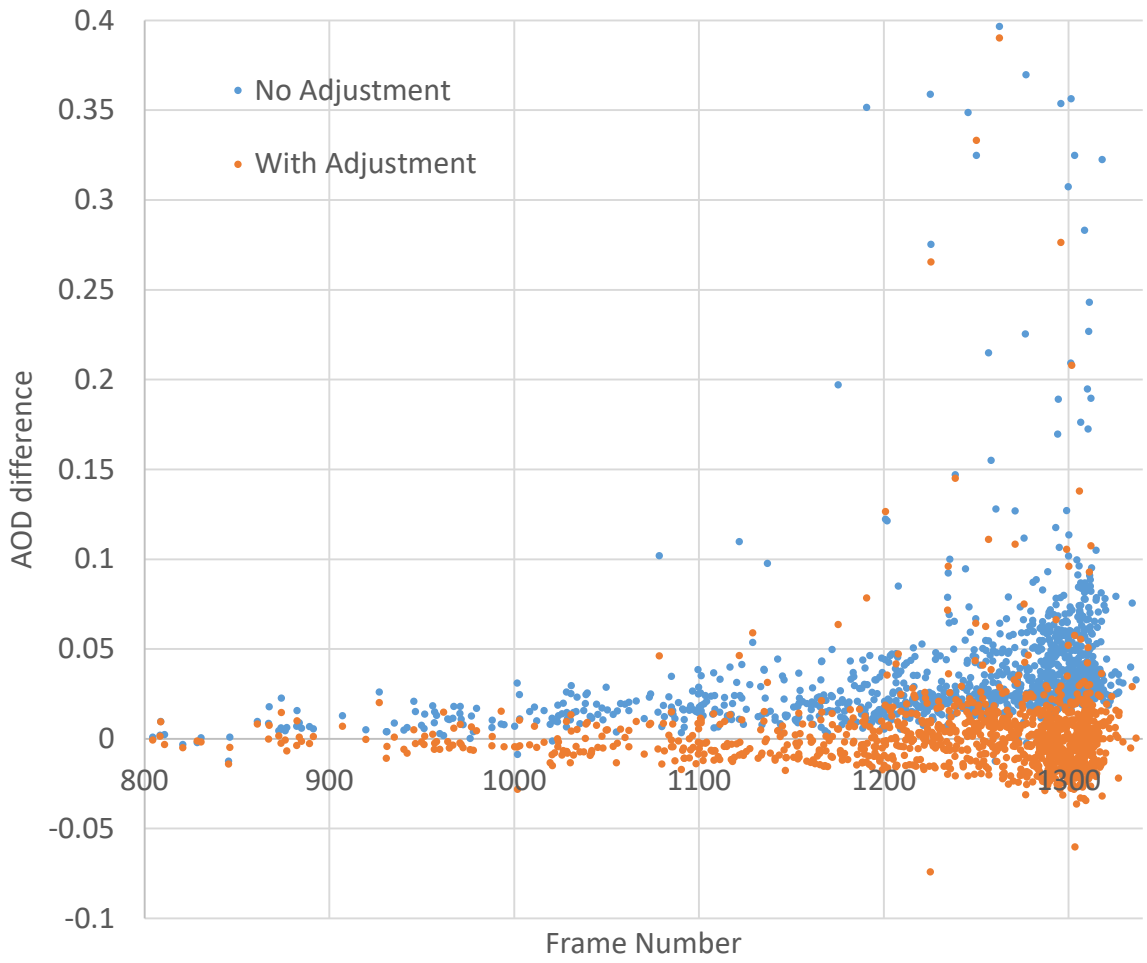
AOD (Before)

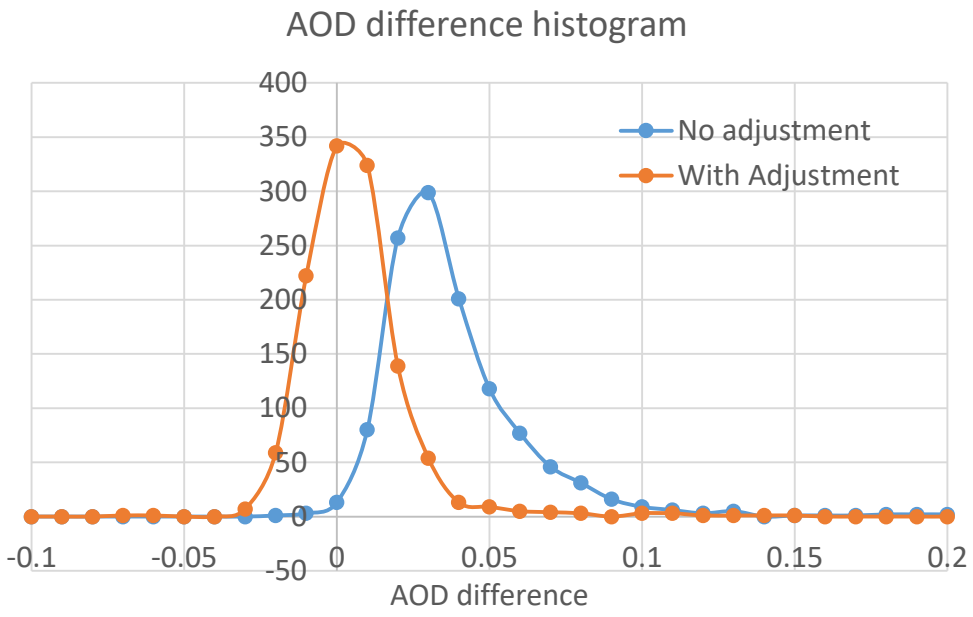




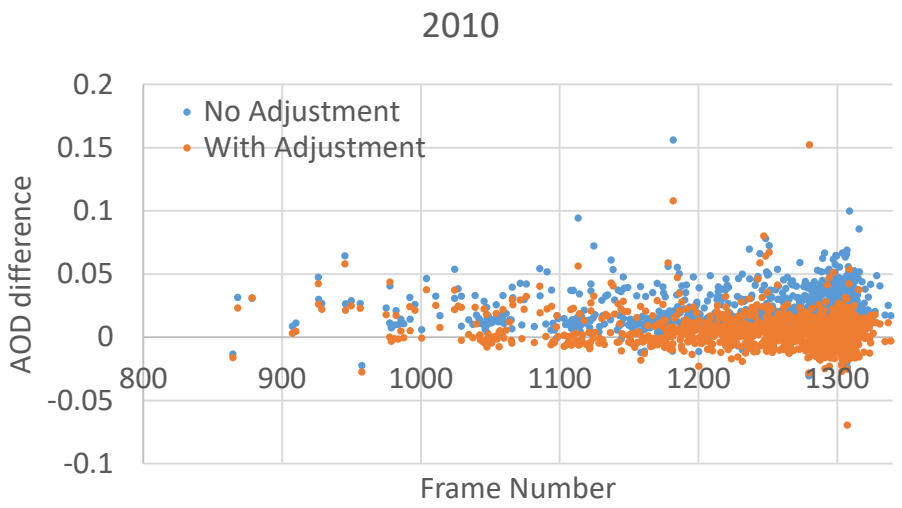
Day 2018204

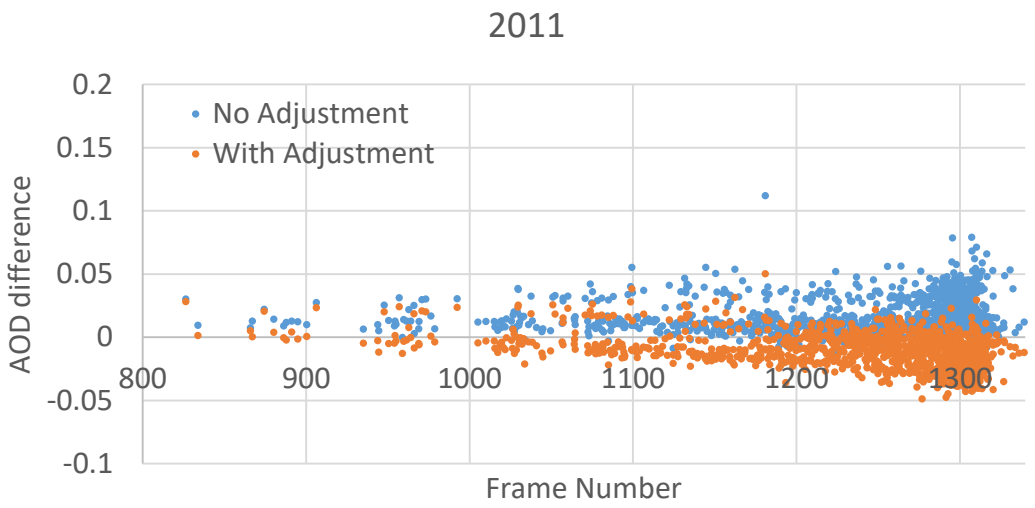
AOD Difference Statistics (2017)

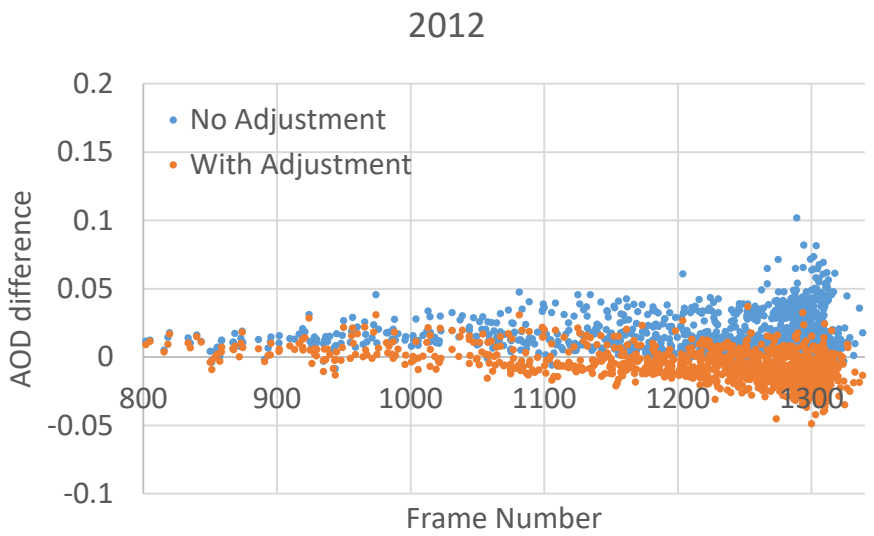


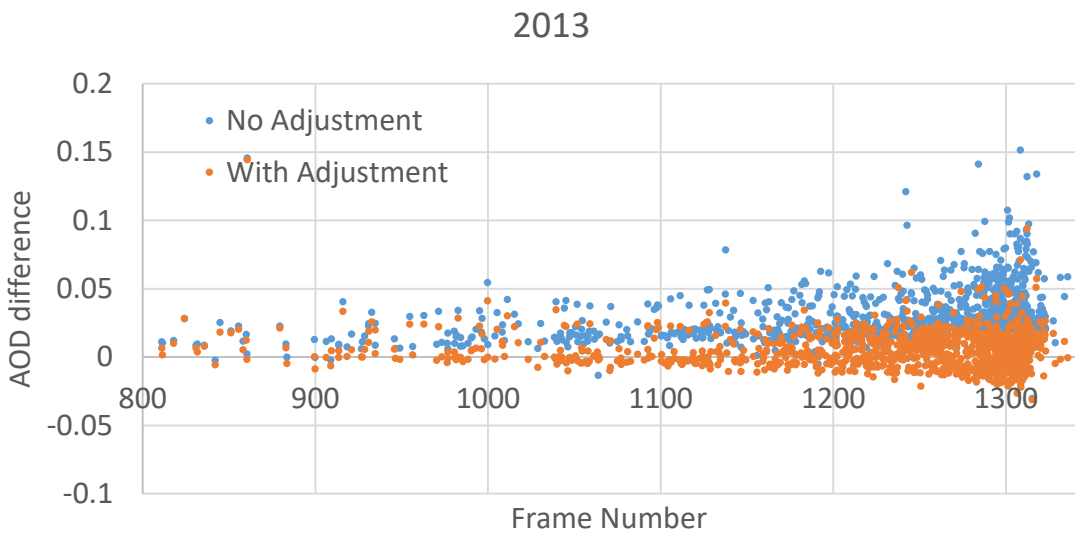


AOD Difference Scatterplots (2010-2013)

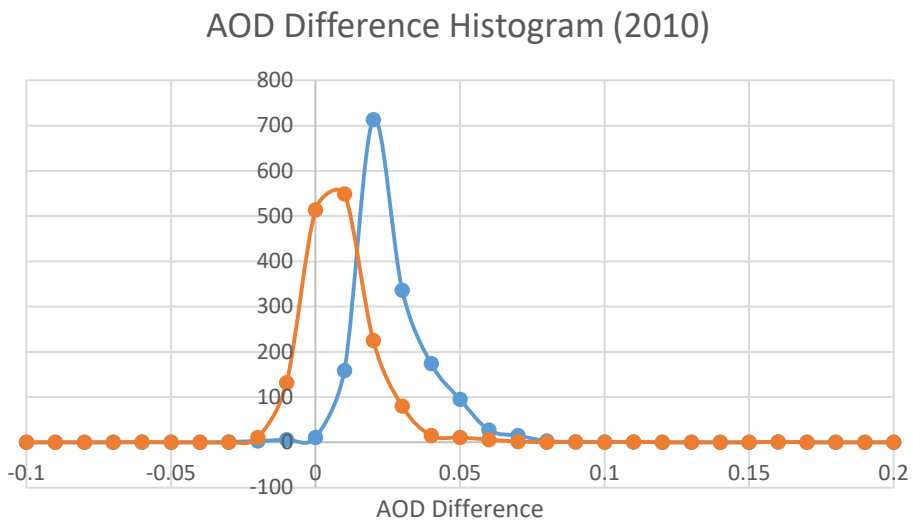


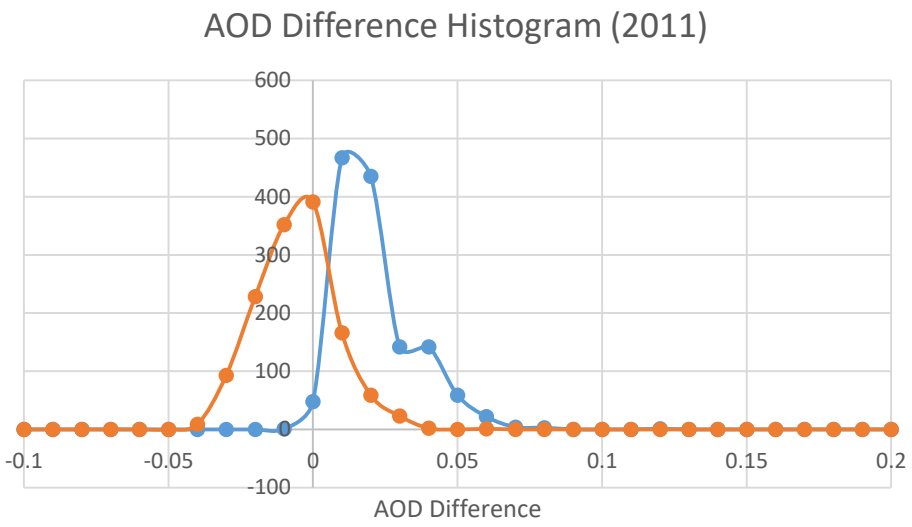


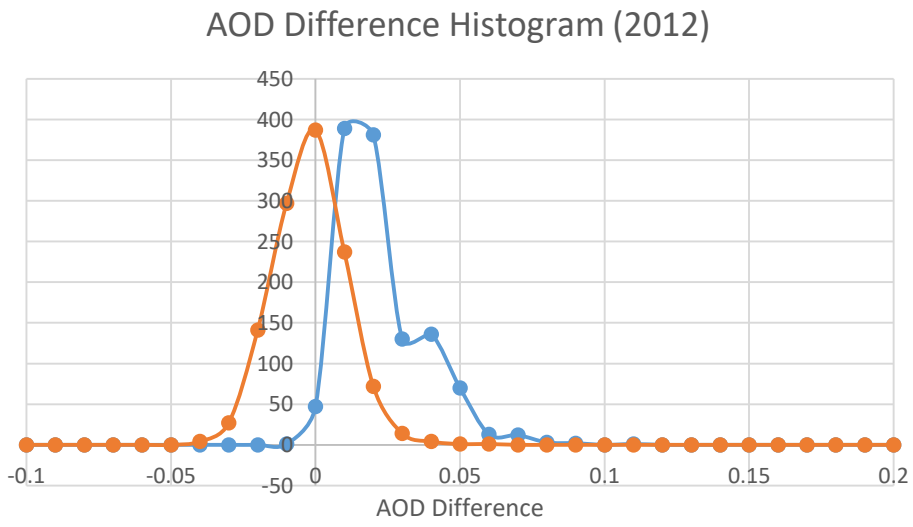


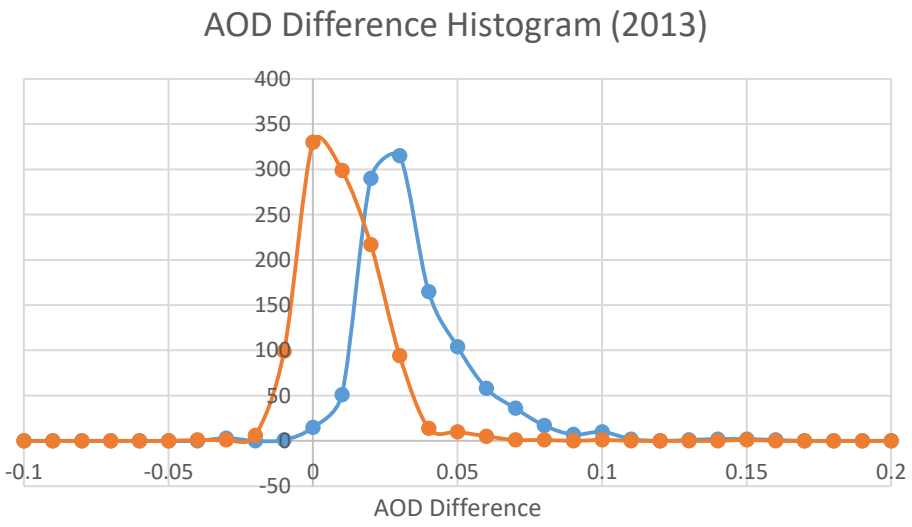


AOD Difference Histogram (2010-2013)

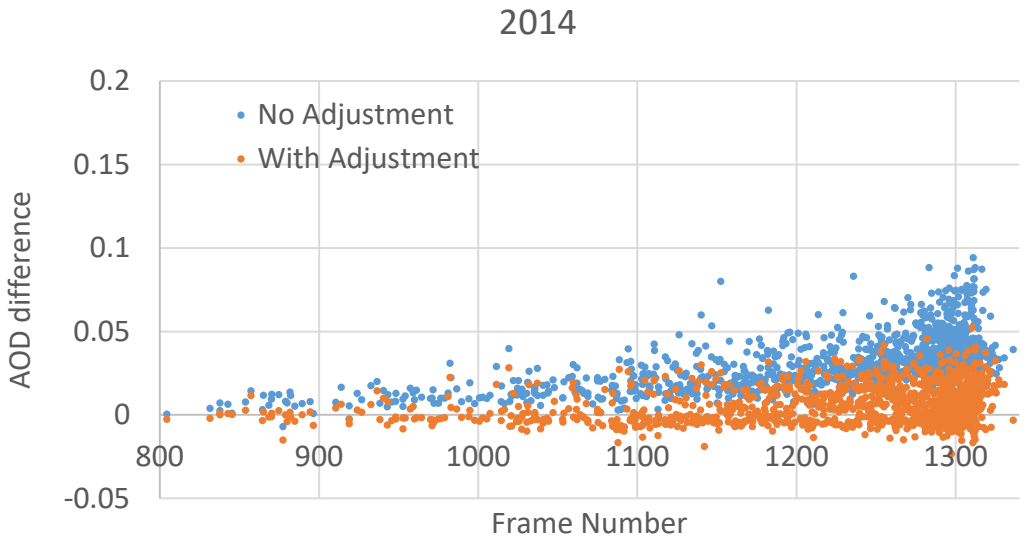


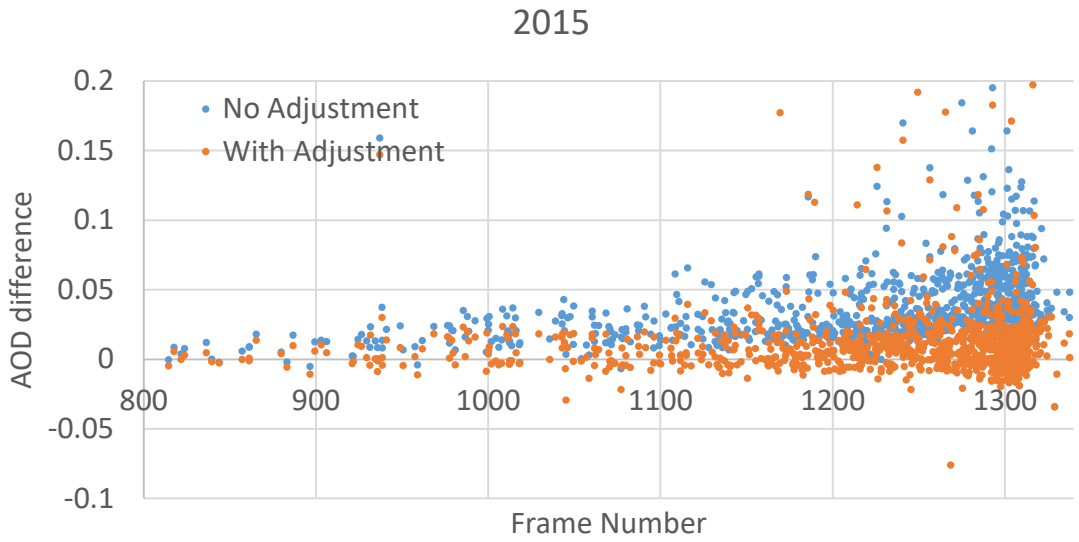


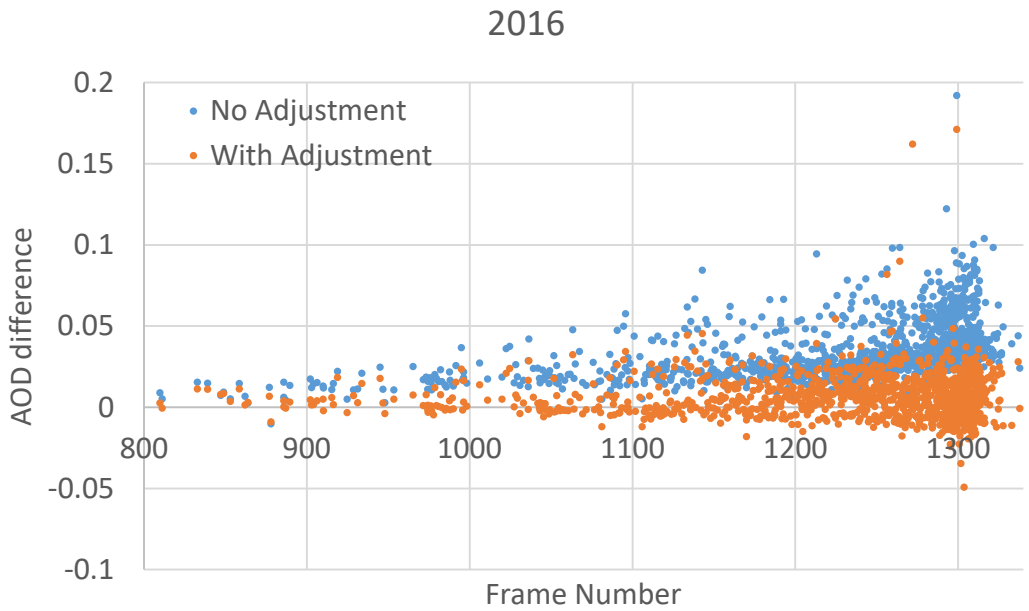


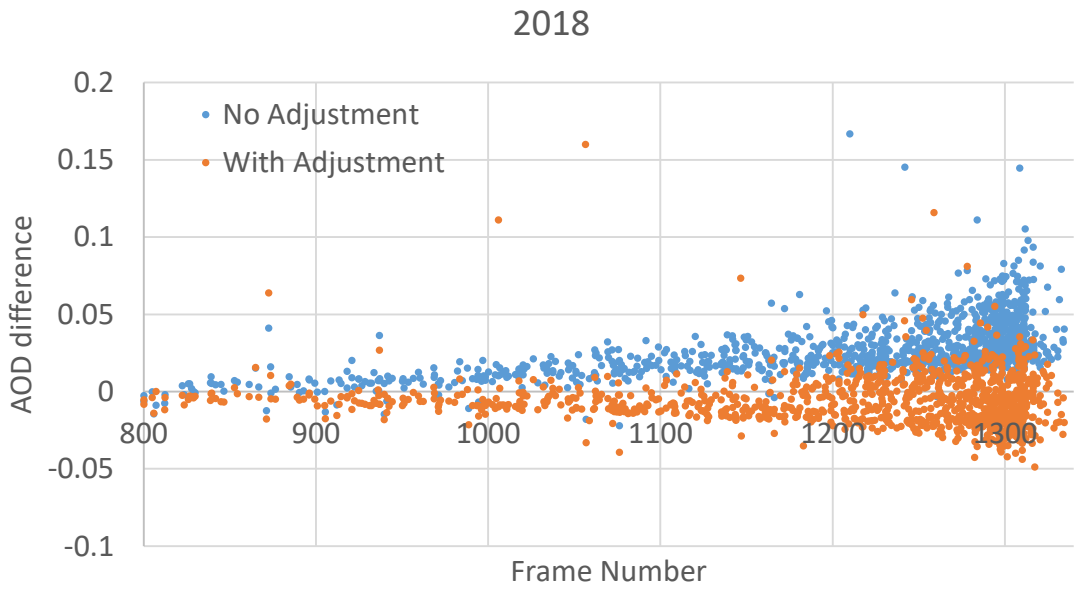


AOD Difference Scatterplots (2014-2018)

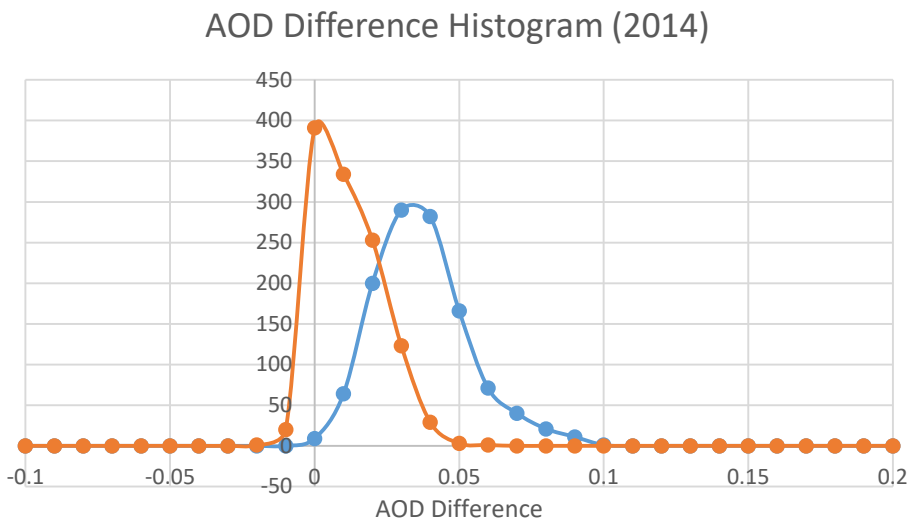


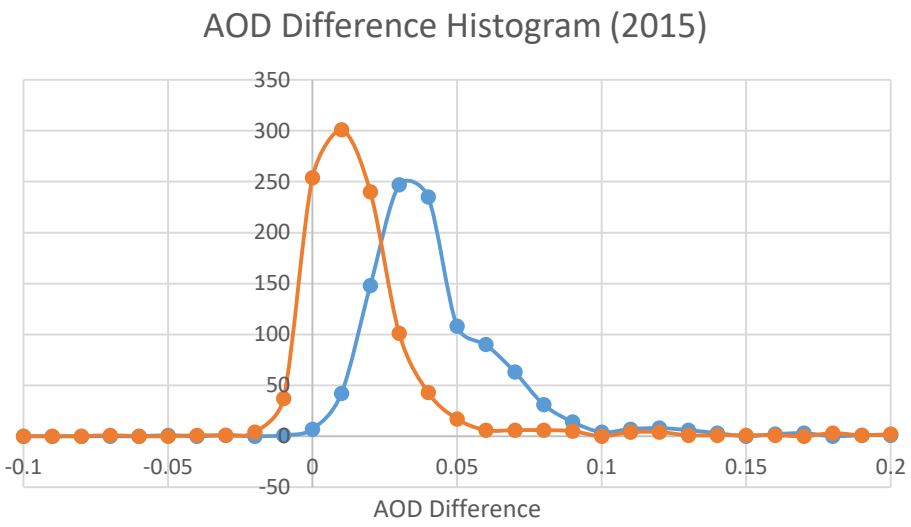


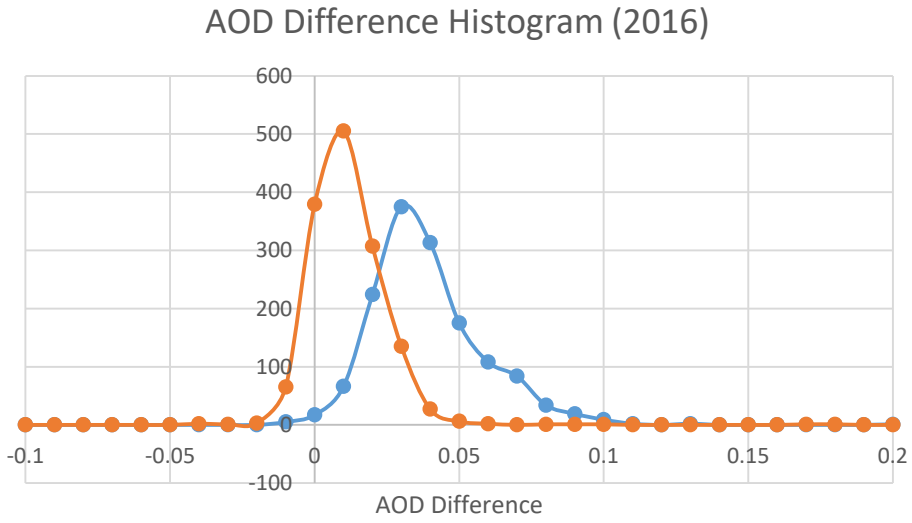


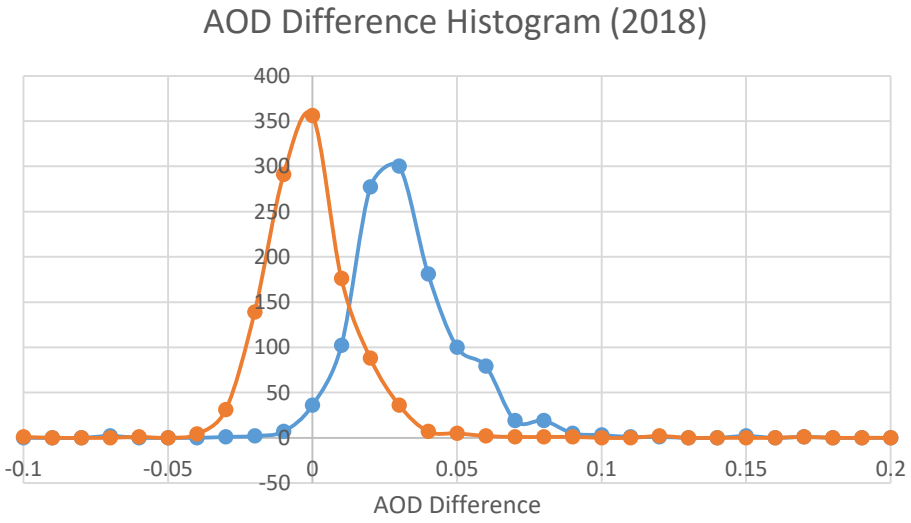


AOD Difference Histogram (2014-2018)

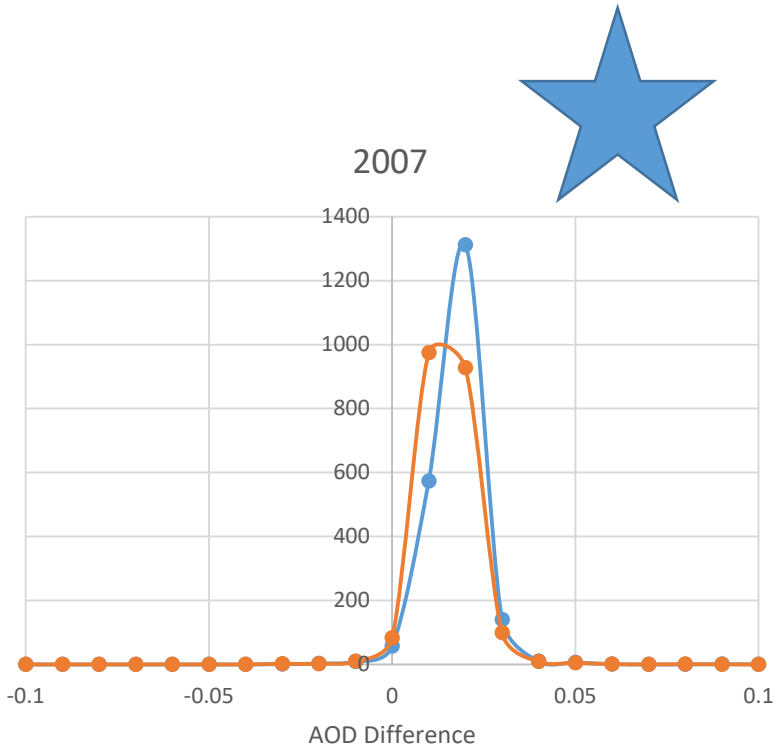


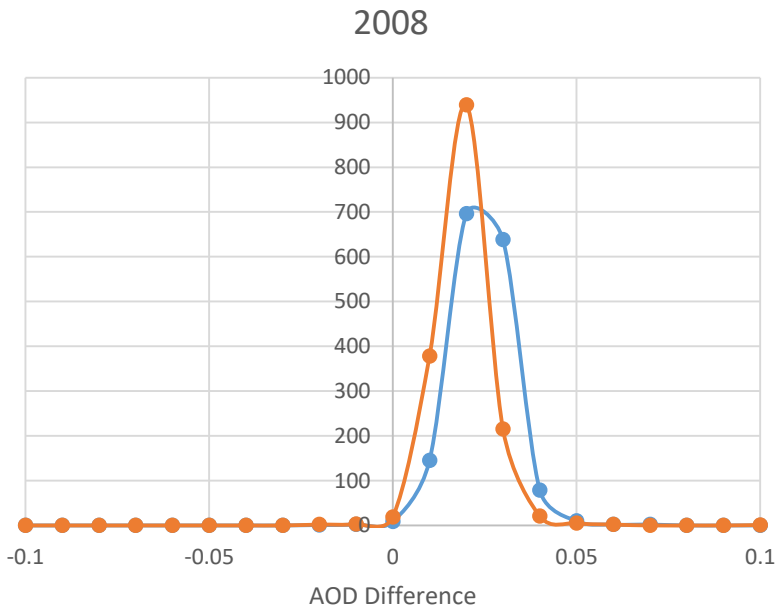


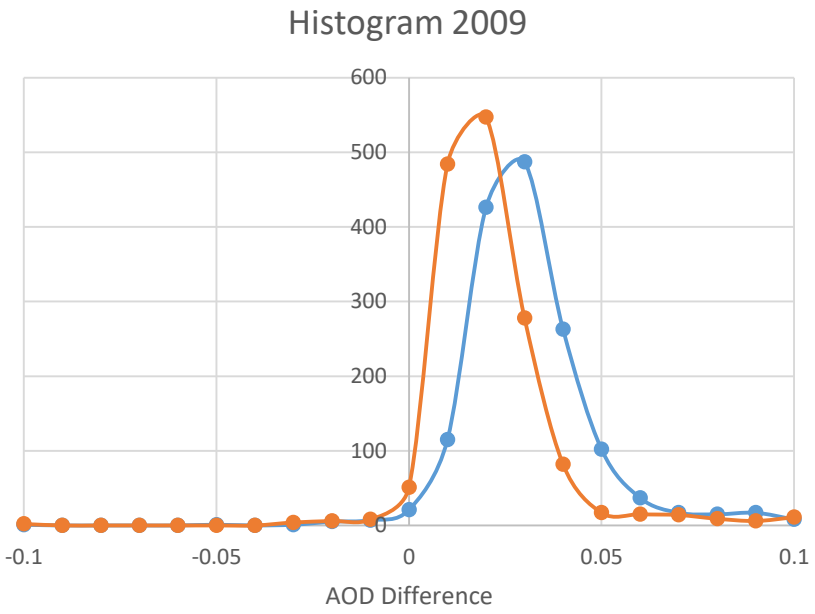




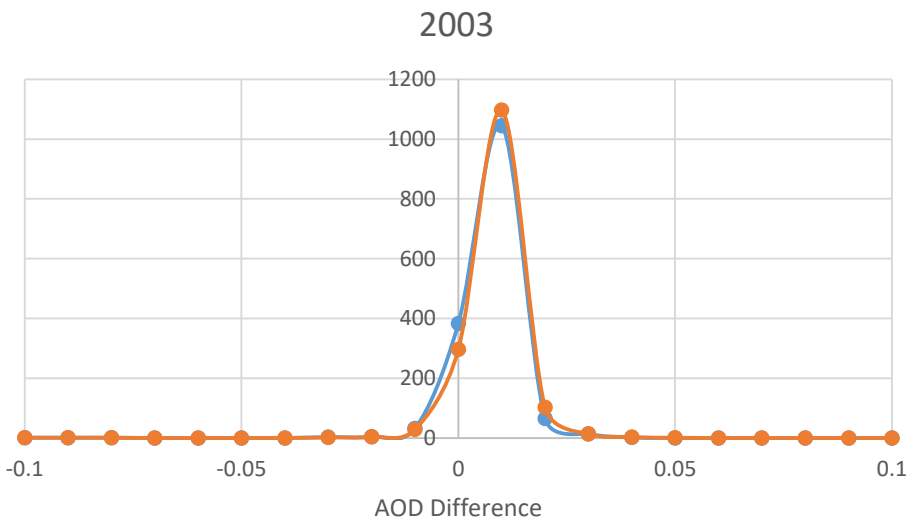
AOD Difference Histogram (2007-2009)

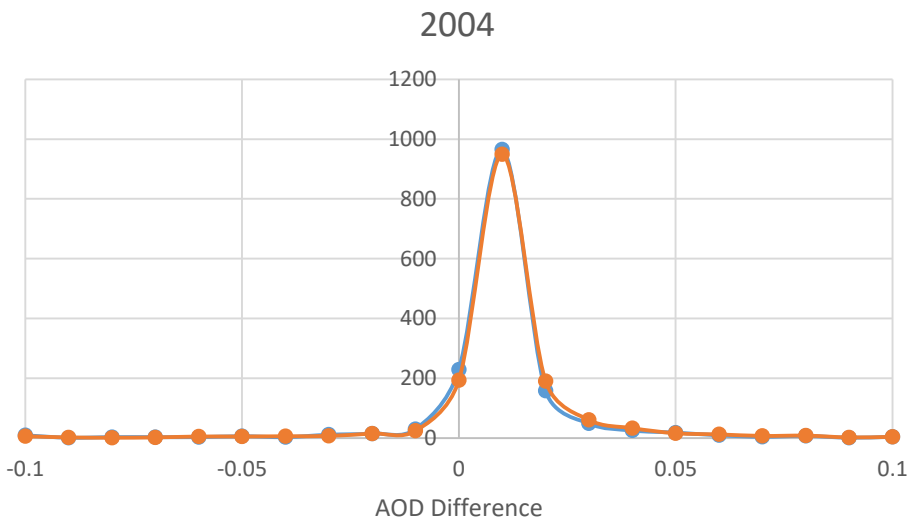


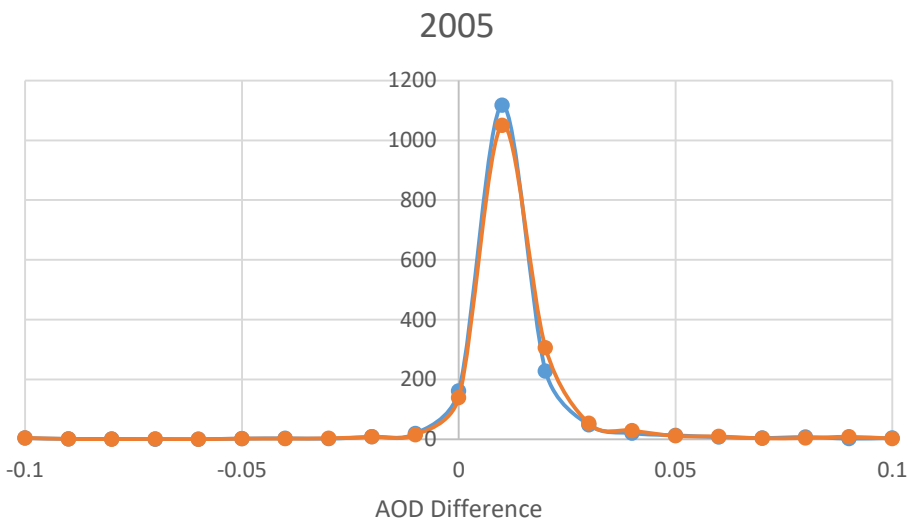


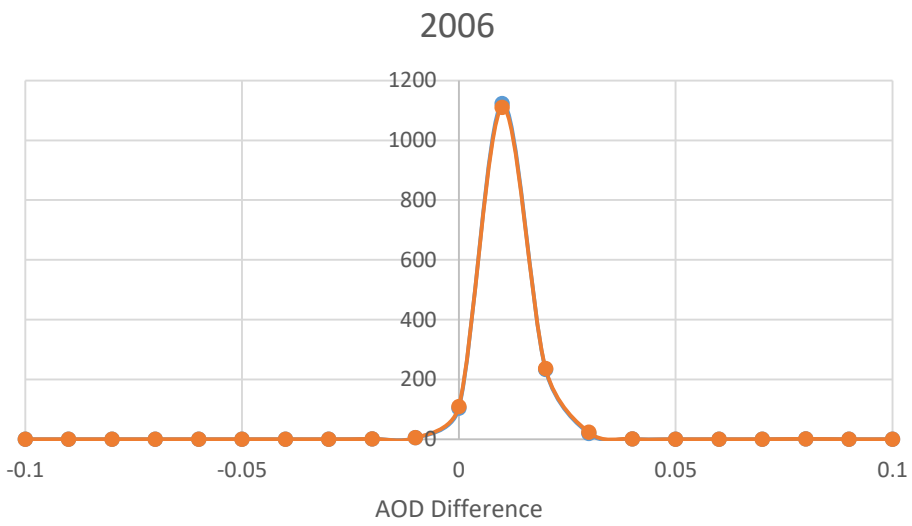


AOD Difference Histogram (2003-2006)

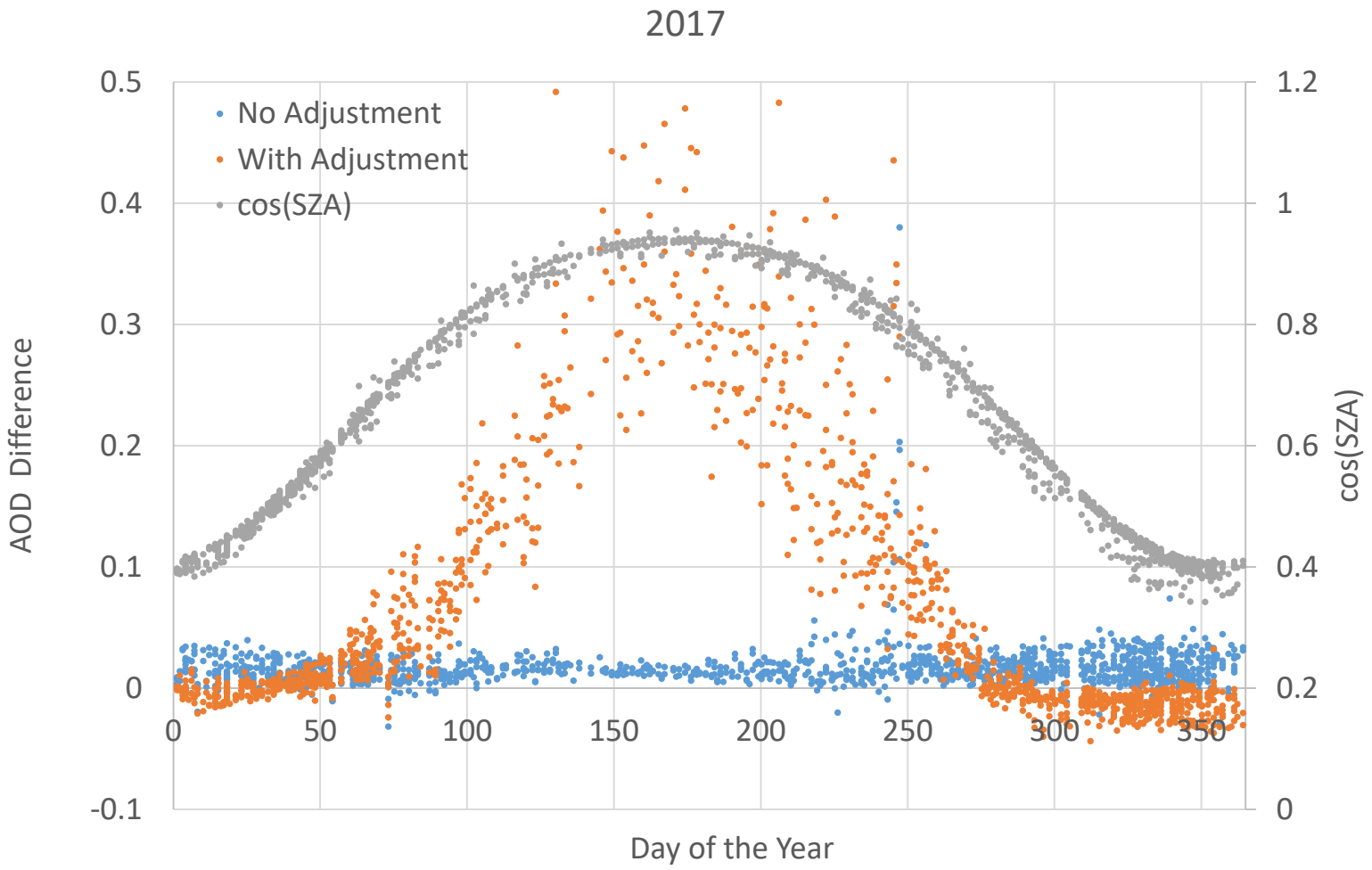






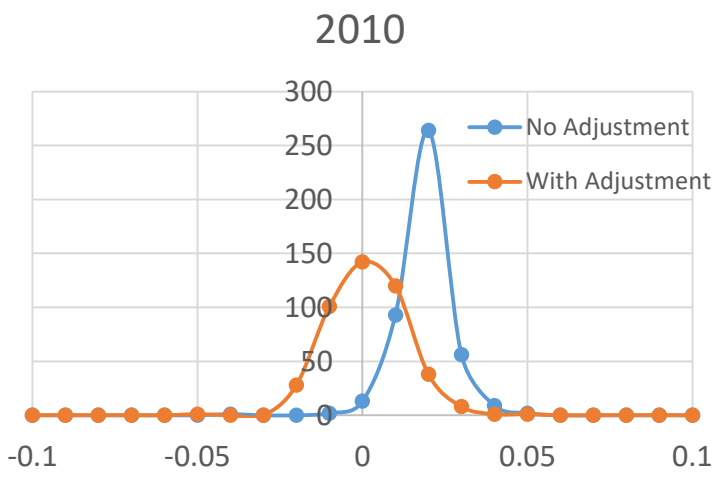


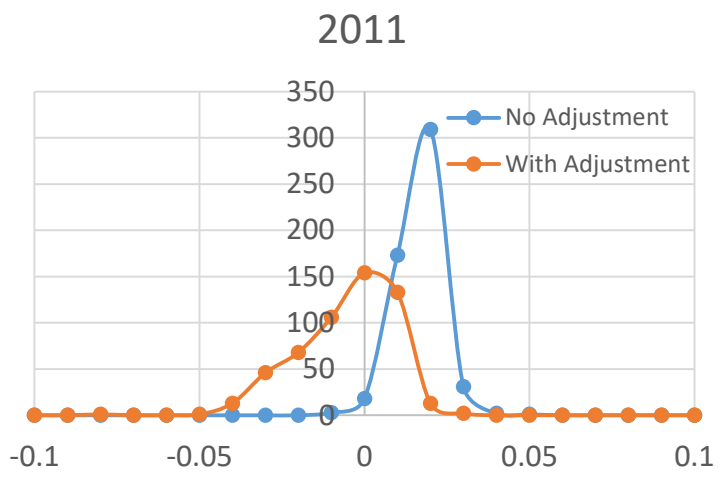
Mid-Latitude Tile

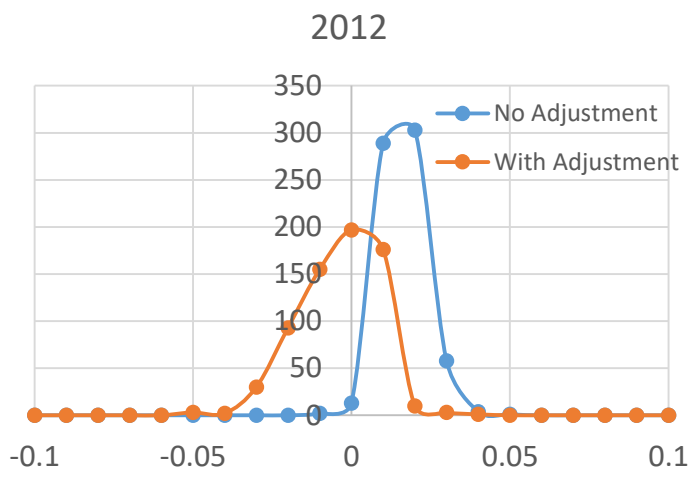


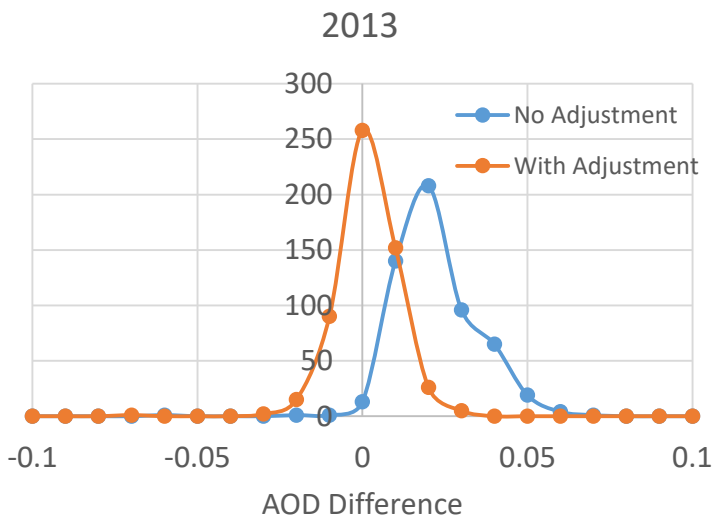
For mid-latitude tile, when solar zenith angle is more than 55 degree, the adjustment model becomes unreliable. However, at this angle, the AOD difference is low, we can limit the adjustment only apply to SZA>55 degree.

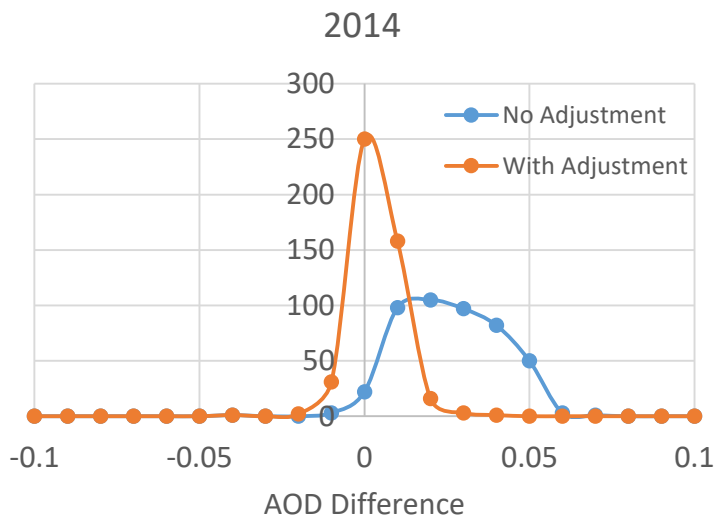
AOD Difference Histogram for Mid-Latitude tile (SZA>55°)

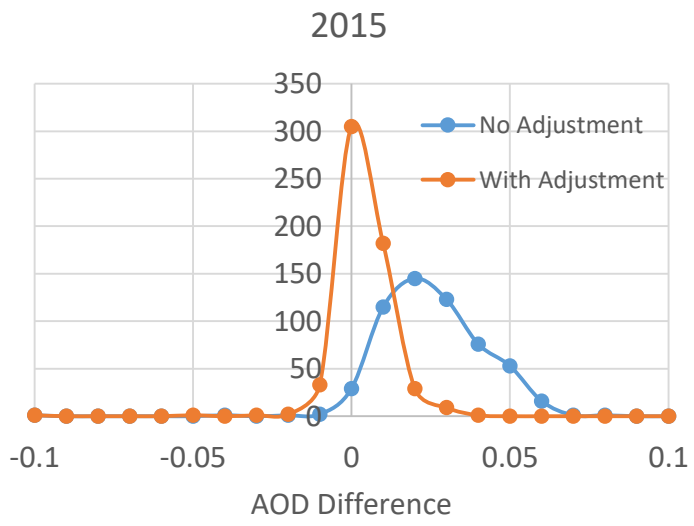




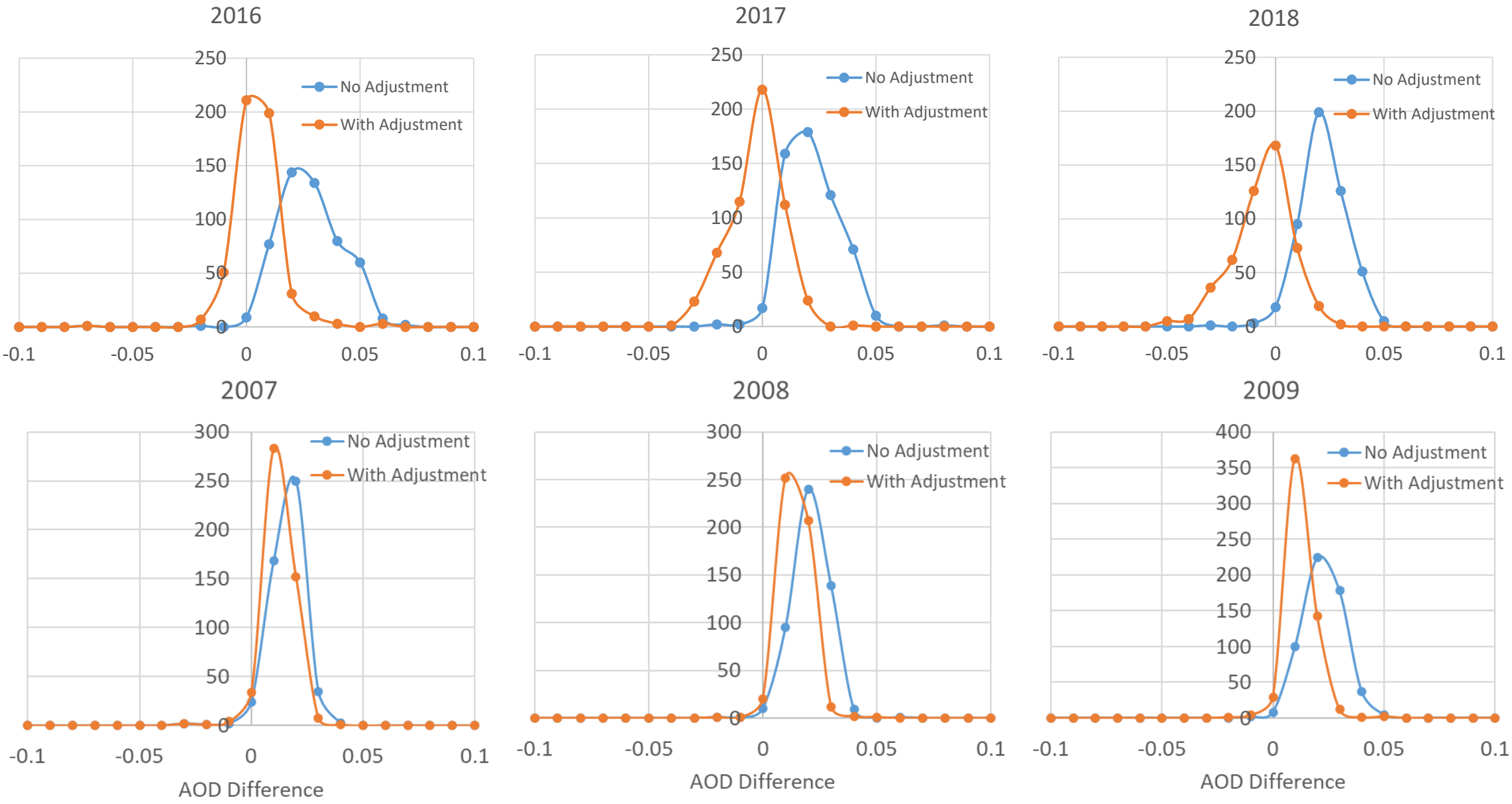








AOD Difference Histogram for Mid-Latitude tile (SZA>55°, cont.)



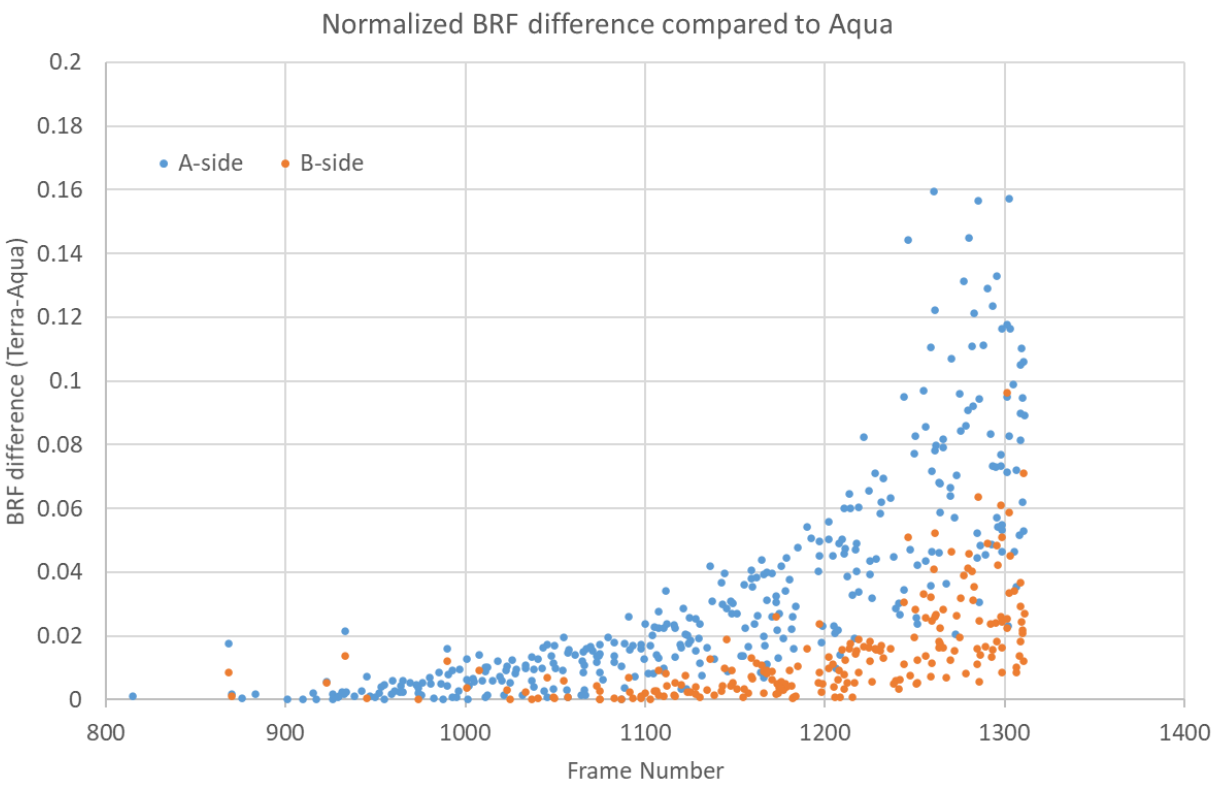
Conclusions

- Empirical adjustment of m12 coefficient can reduce the AOD striping by 50-100%
- The adjustment model is derived from one year (2017) of data, and it works as far back as 2009.
- For Mid-latitude tiles, this correction adds noise when SZA<55°, so the adjustment is only be applied to SZA>55 ° (early spring, late fall – winter).

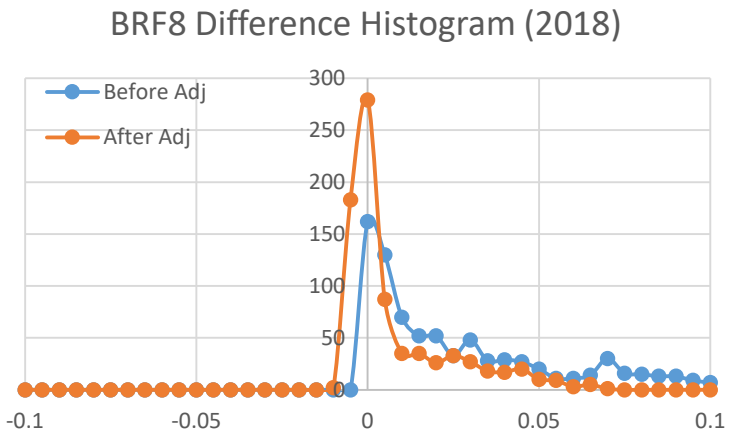
Band 8 Striping Adjustment: Method

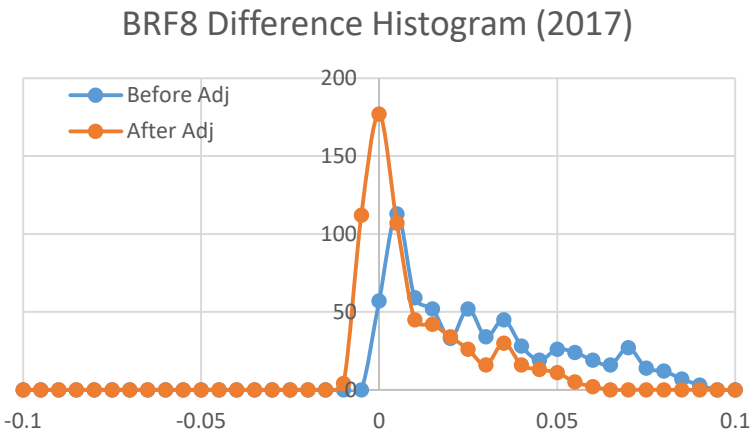
- Similar to Band 3 striping adjustment: but instead of using AOD difference between A-side and B-side, we use the BRF difference between A-side and B-side.

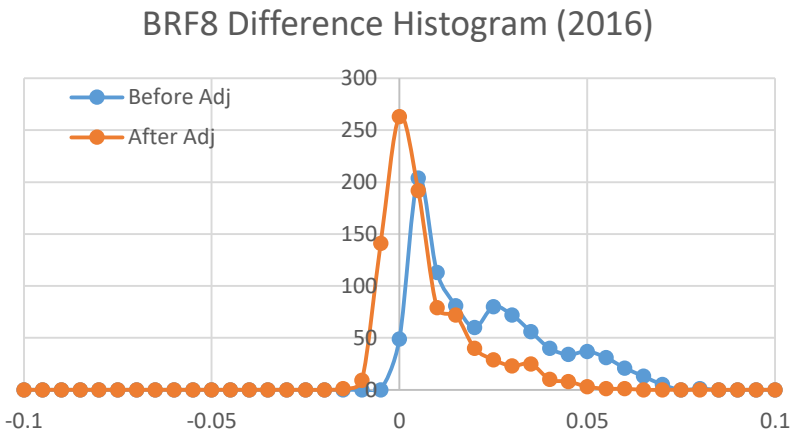
- A comparison of geometry-normalized BRF_n with Aqua on the same day for both A-side and B-side $\Rightarrow$ adjustment is needed for A-side

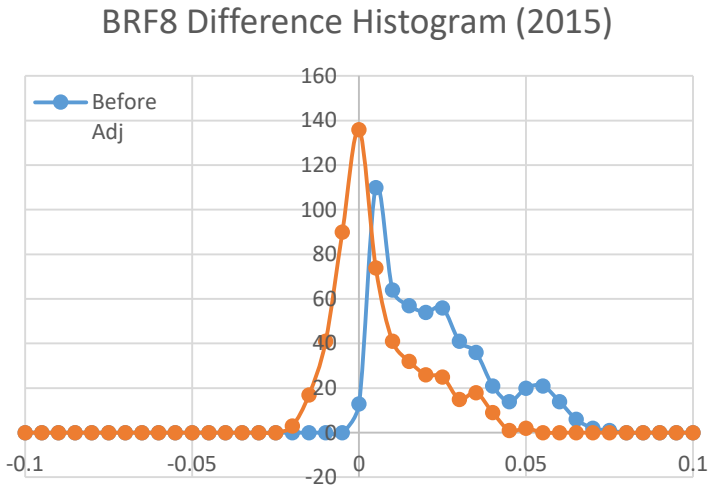


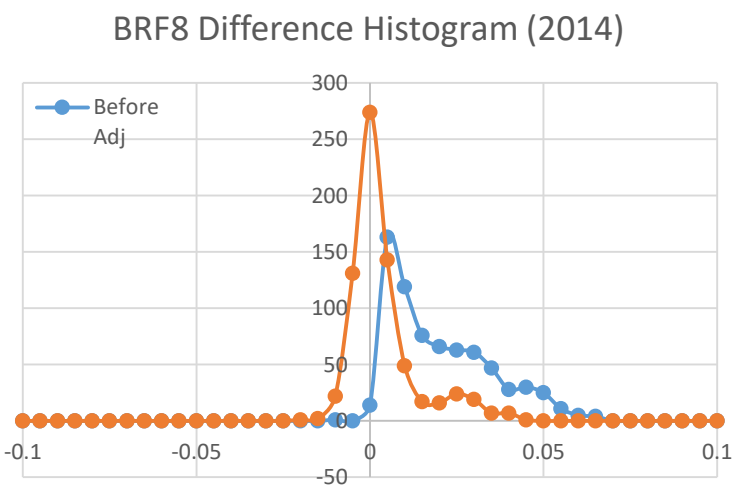
Terra B8 Difference Histogram (A-B side)

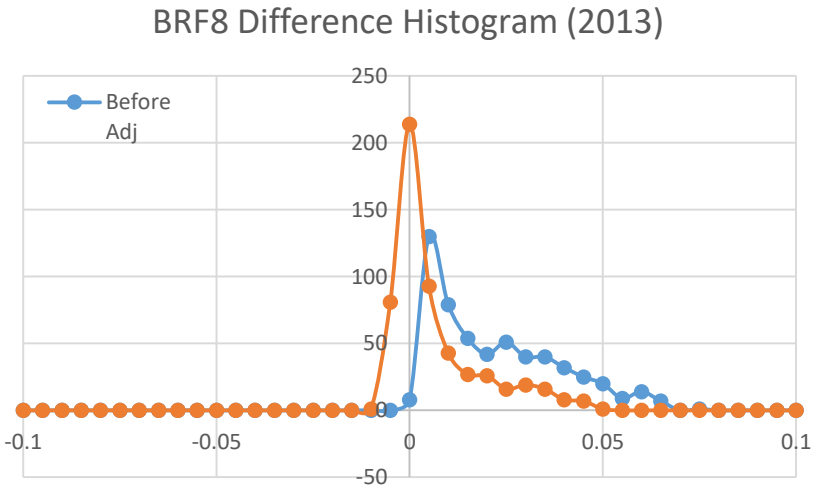




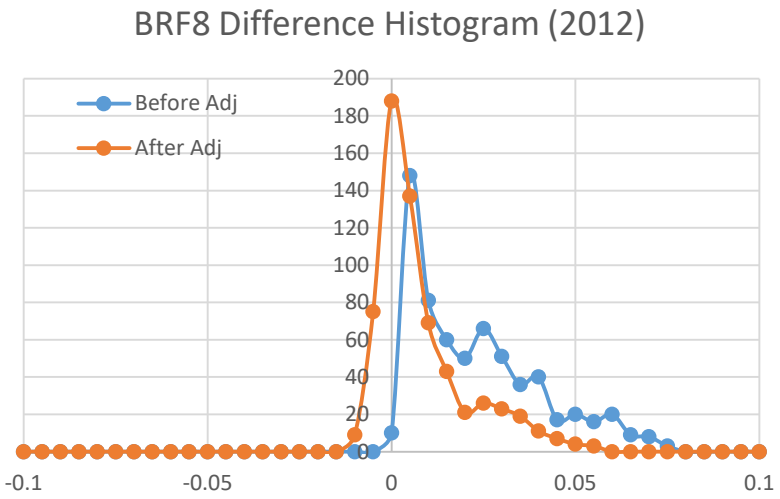


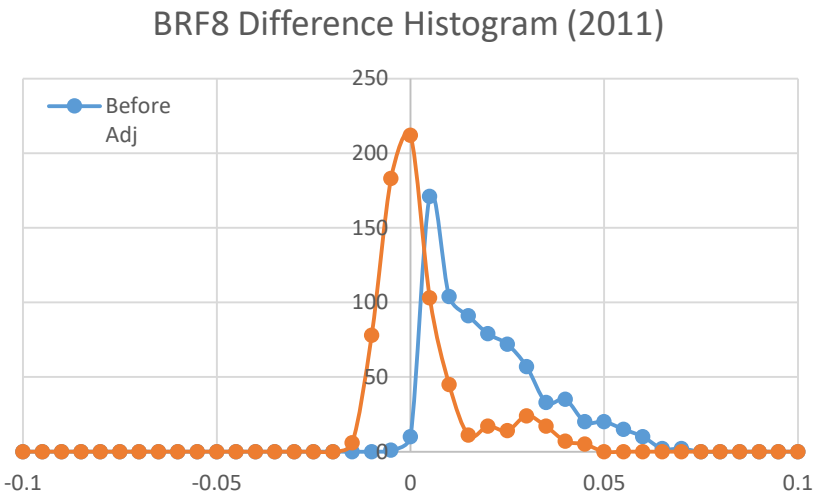


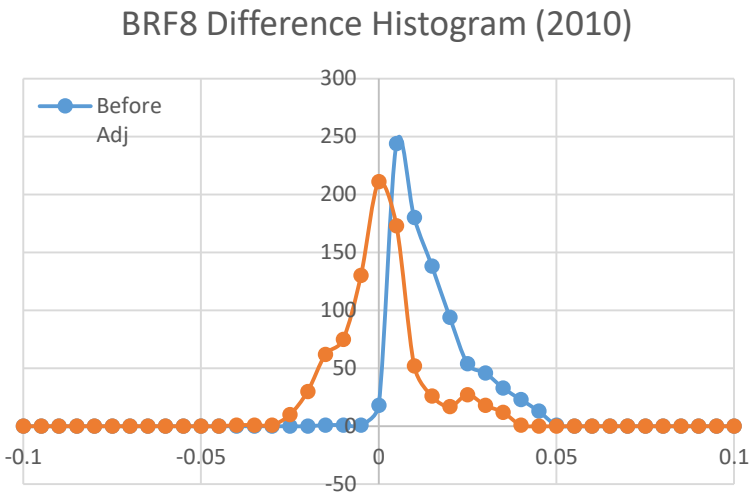
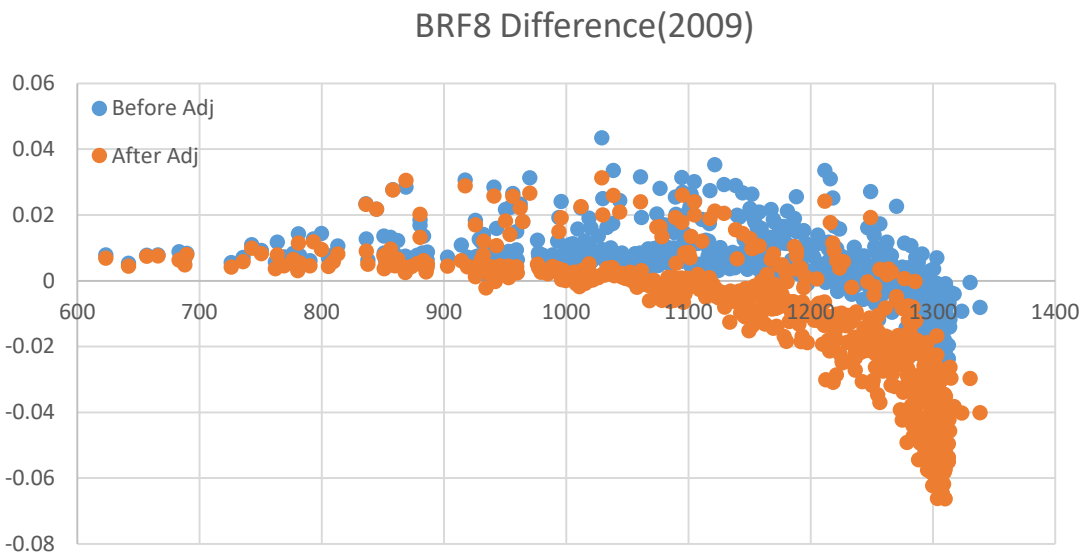
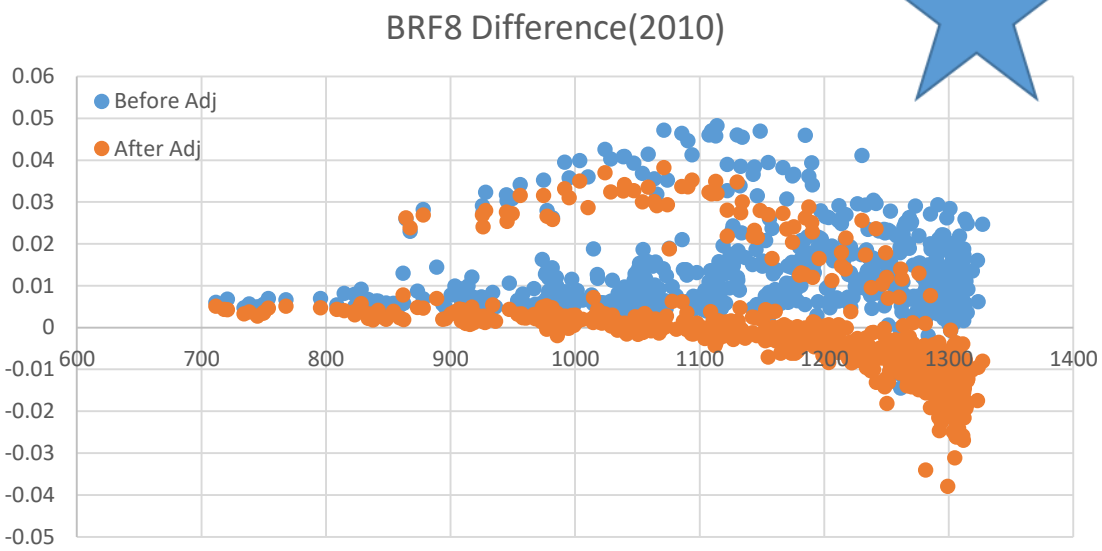
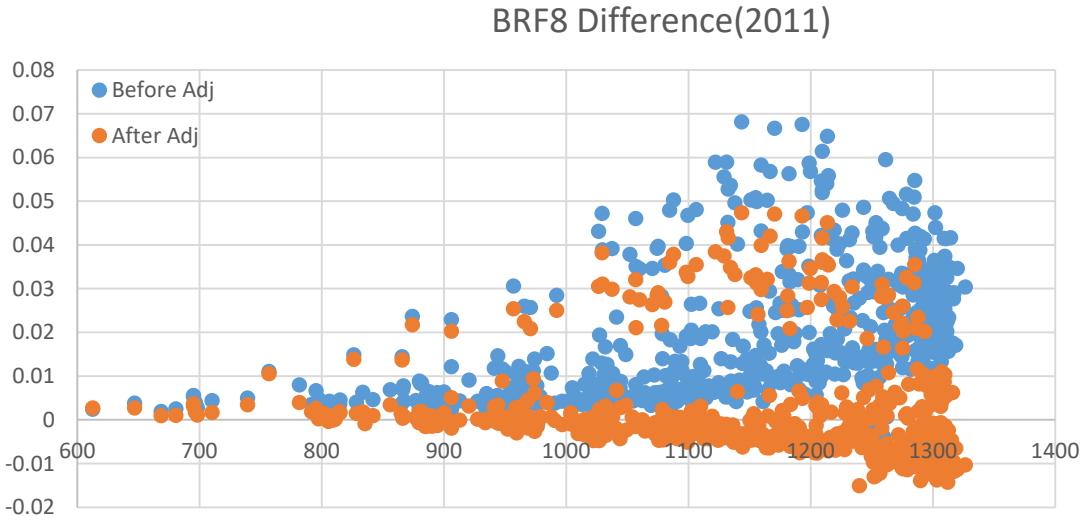
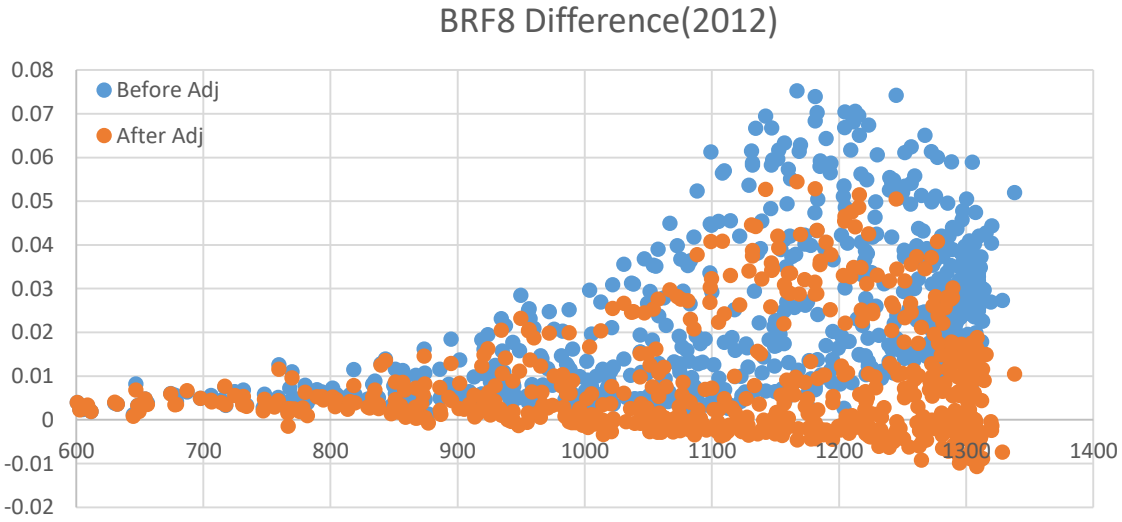




Band 8 Difference Histogram







BRF8 Difference vs. Frame Number