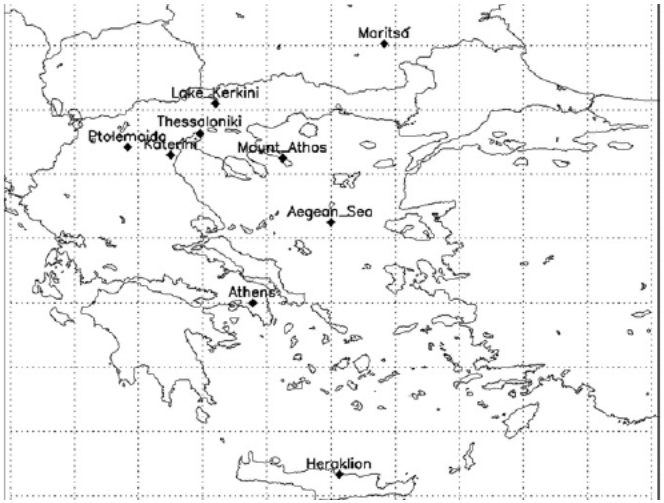
Science Impact of MODIS Terra Calibration Degradation/Polarization Sensitivity (Vegetation and Aerosol Data Products)

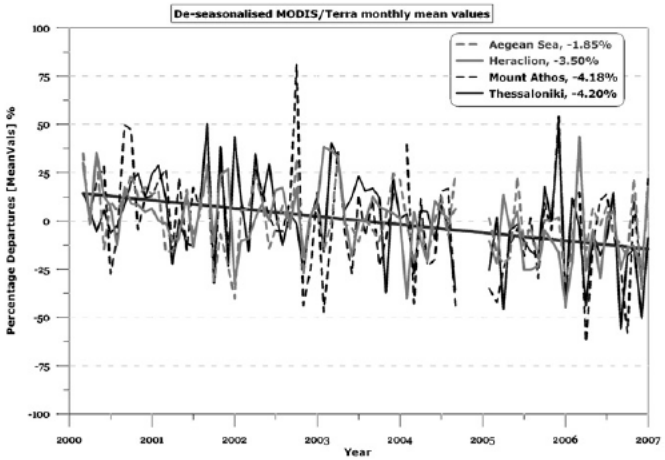
A. Lyapustin, G. Meister, X. Xiong, C. Hsu, R. Levy, *Y. Wang*, and *S. Korkin*

CLARREO SDT Meeting
NASA Goddard Space Flight Center, Greenbelt, MD
January 7-9, 2014

On Trends from MODIS

Koukouli et al., 2010: Signs of a negative trend in the MODIS aerosol optical depth over the Southern Balkans, *Atm. Environ.*, 1219-1228.





Reported 4% annual decrease of AOT from MODIS Terra

Zhao & Running, 2010: Drought-Induced Reduction in Global Terrestrial Net Primary Production from 2000 Through 2009, *Science*, 329, 940-943.

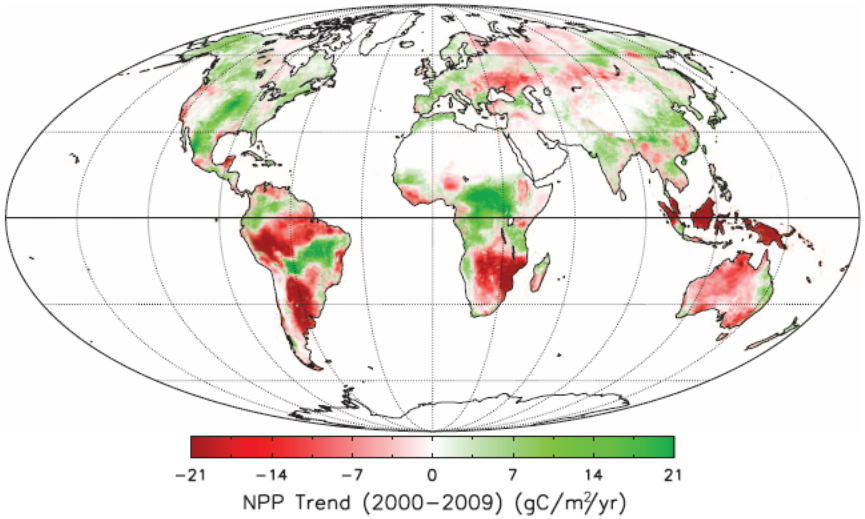


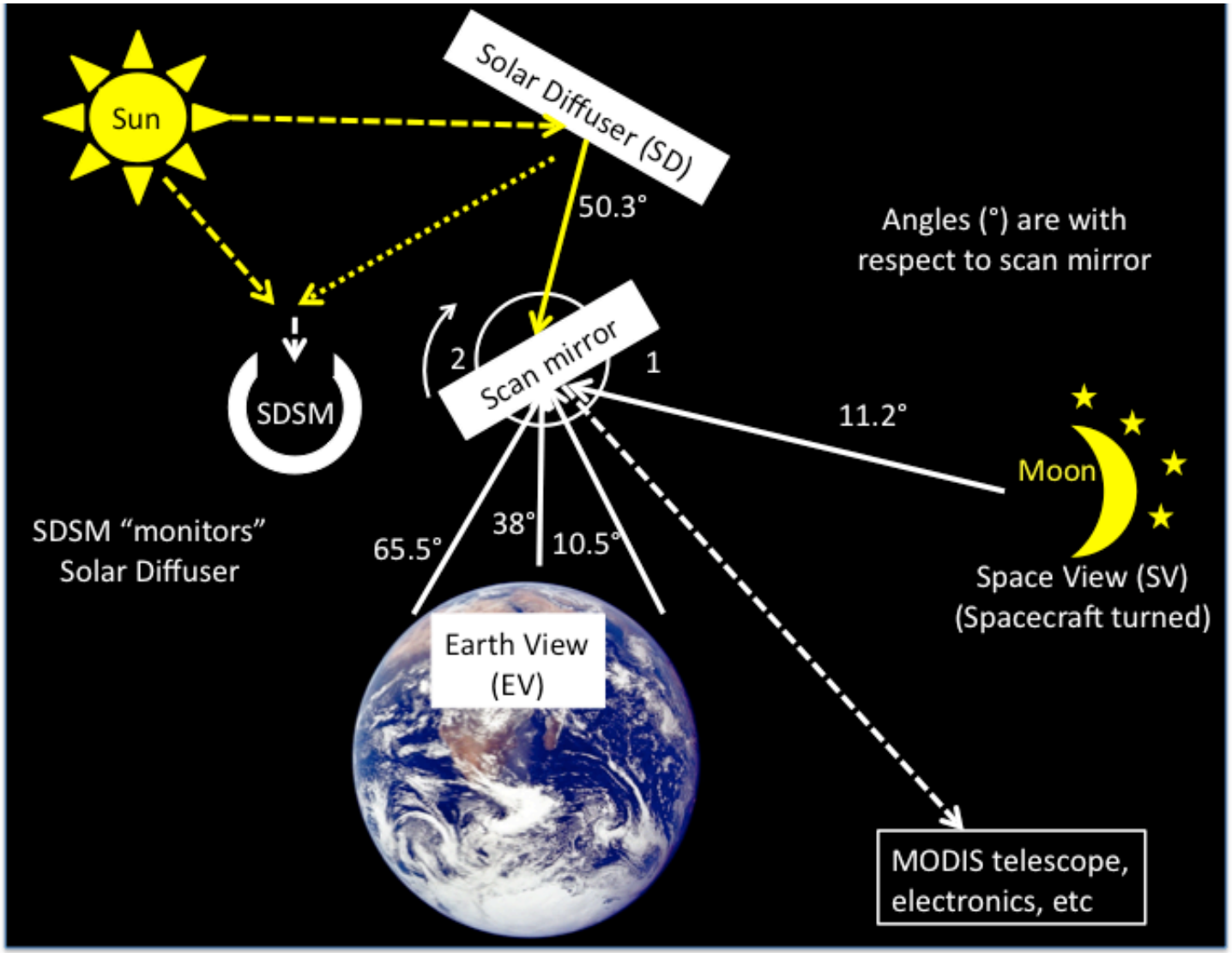
Fig. 2. Spatial pattern of terrestrial NPP linear trends from 2000 through 2009 (SOM text S1) (*8*, *10*).

- Reported 0.55 PgC NPP decrease per decade;
- Tropics explain 91% of global NPP variation;
- Amazon alone explains 61% of global NPP variation;

MODIS Calibration Methodology

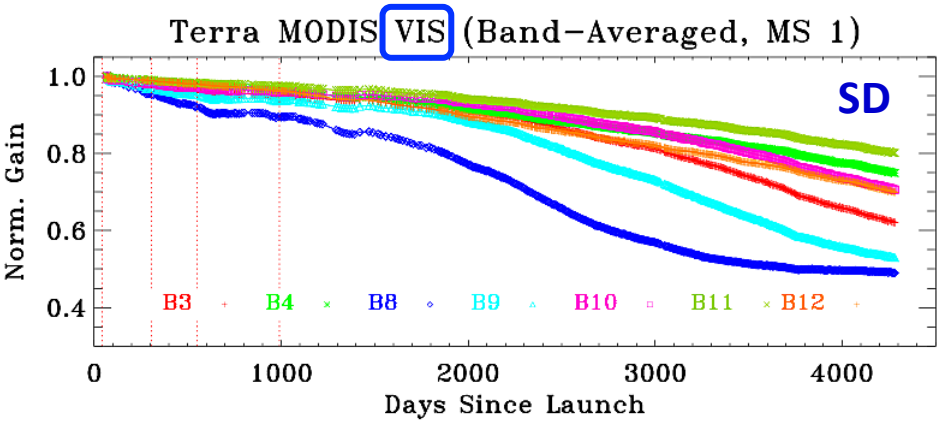
Solar diffuser (SD) and SD stability monitor (SDSM) for reflective solar bands (RSB) calibration

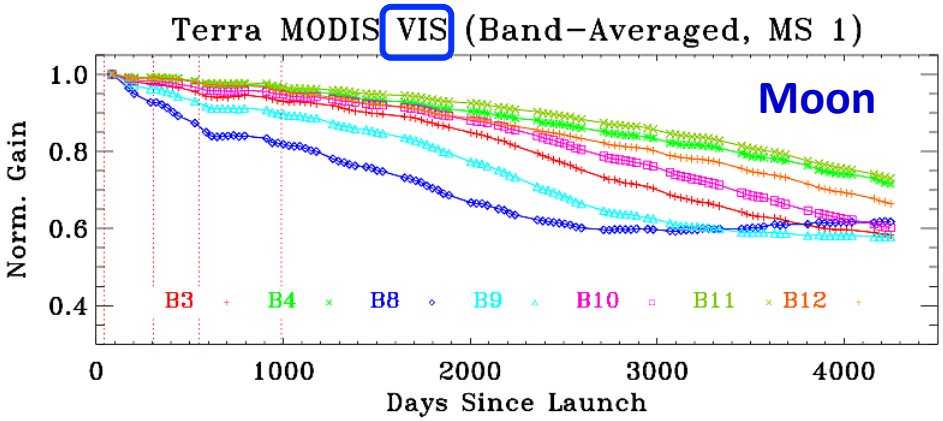
Spectroradiometric Calibration Assembly (SRCA) for instrument spectral and spatial characterization



MODIS RSB RVS Characterization Approach

- Data Sets
  - Response trending from SD (AOI fixed at 50°)
  - Response trending from the Moon (AOI fixed at 11°)
  - Response trending over multiple EV targets (AOIs over a wide range)
    - CEOS recommended calibration reference sites (deserts)
  - Mirror side ratios from OBC and EV



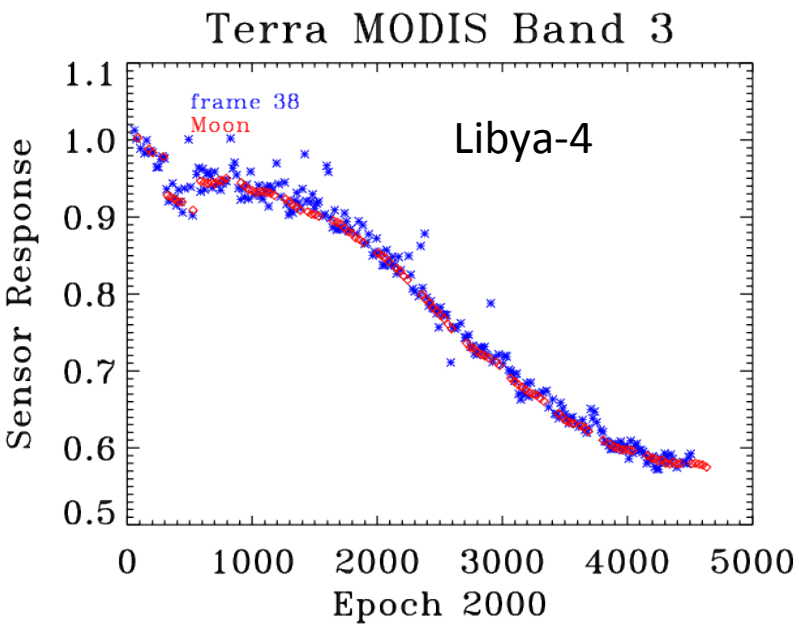


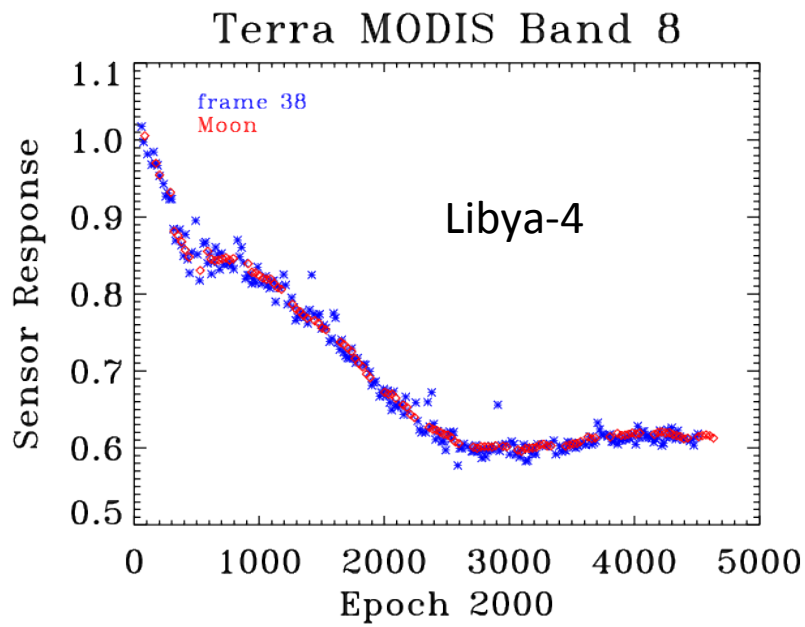
For spectral bands with large changes in responses (gains):
SD and lunar data sets are no longer sufficient

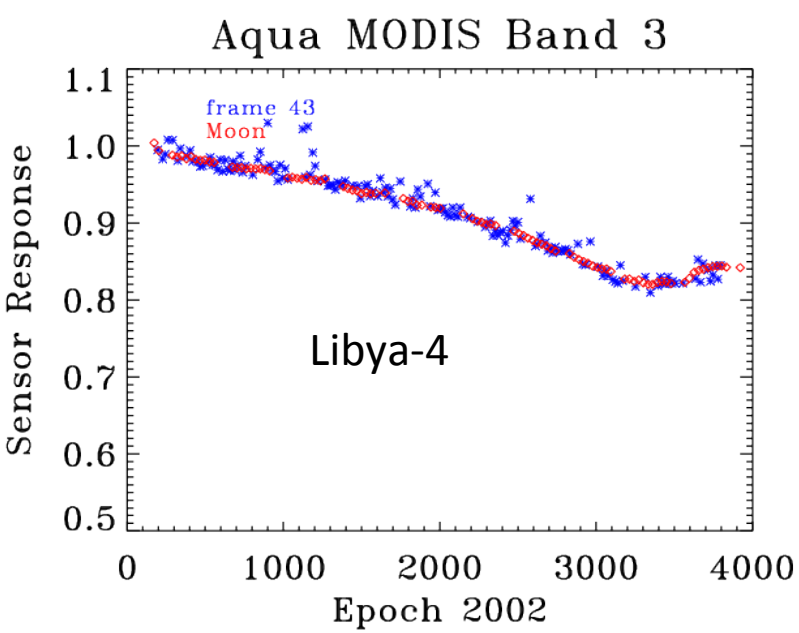
Terra Collection 6 MODIS RSB RVS Characterization Approach

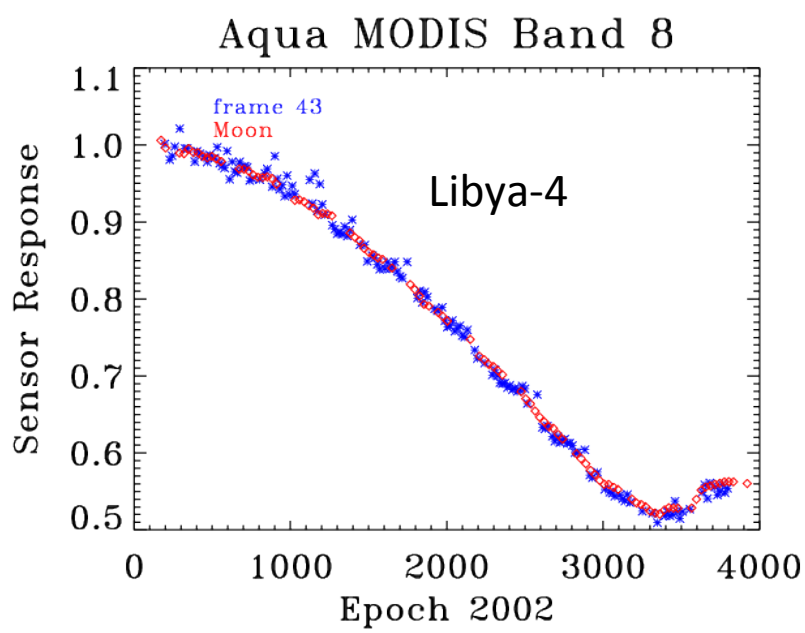
- For bands with no changes in RVS (Bands 5-7, 26)
  - Pre-launch RVS is applied
- For spectral bands with small changes in RVS (Bands 10-19)
  - Use SD and lunar trending for mirror side 1 (MS1) RVS
  - Use SD, lunar, and EV mirror side ratios for mirror side 2 (MS2) RVS
  - Fit each response trending over time, normalize to SD response, and then fit over AOI
- For spectral bands with large changes in RVS (Bands 1-4,8,9)
  - Use lunar and EV trending for MS1 RVS
  - Fit each response trending over time, normalize to lunar response, and then fit over AOI
  - Same approach for MS2 RVS
- For some bands with large detector to detector difference
  - Detector dependent RVS applied for several VIS bands (B3, 8-12)

Comparison of Lunar Trending with EV trending at Lunar AOI

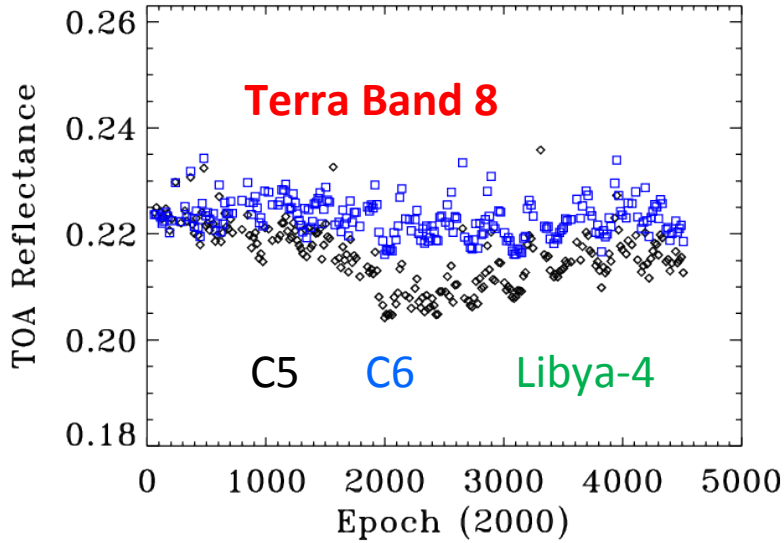


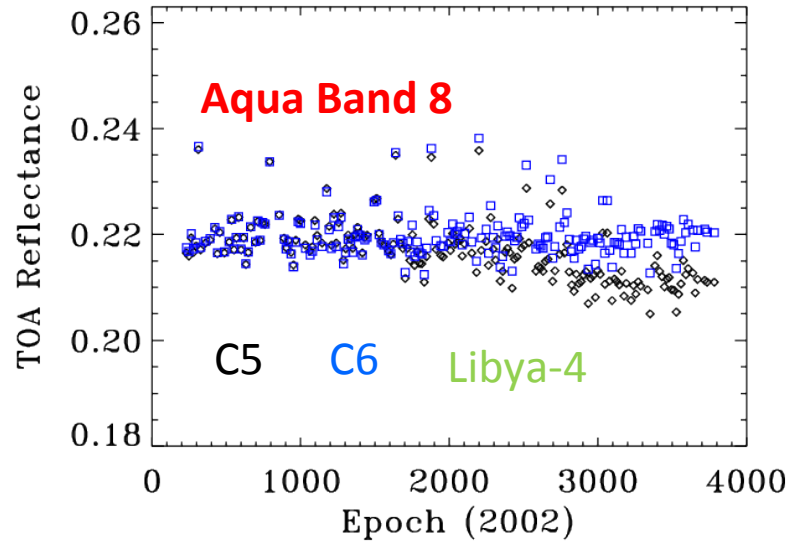




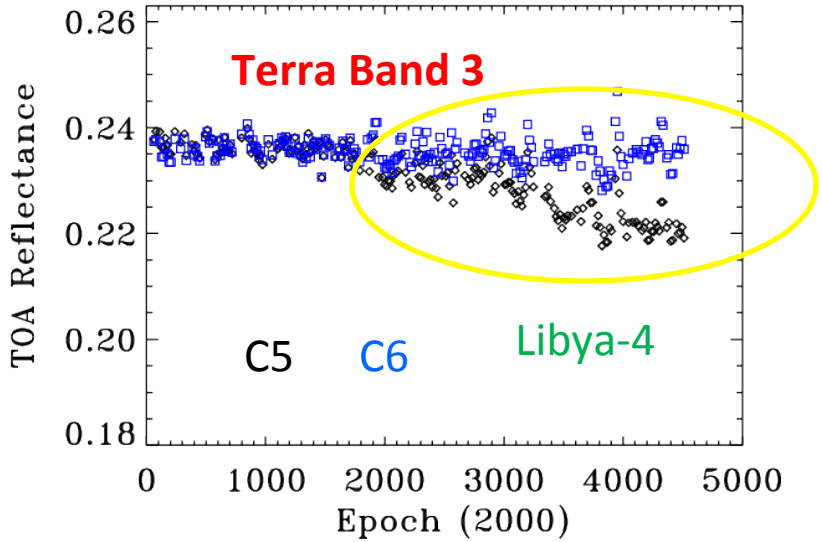


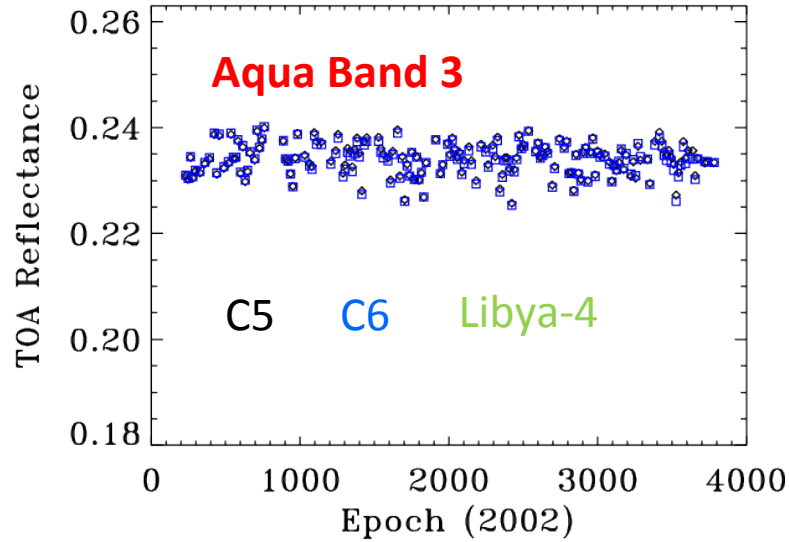
Collection 6 RVS Improvements





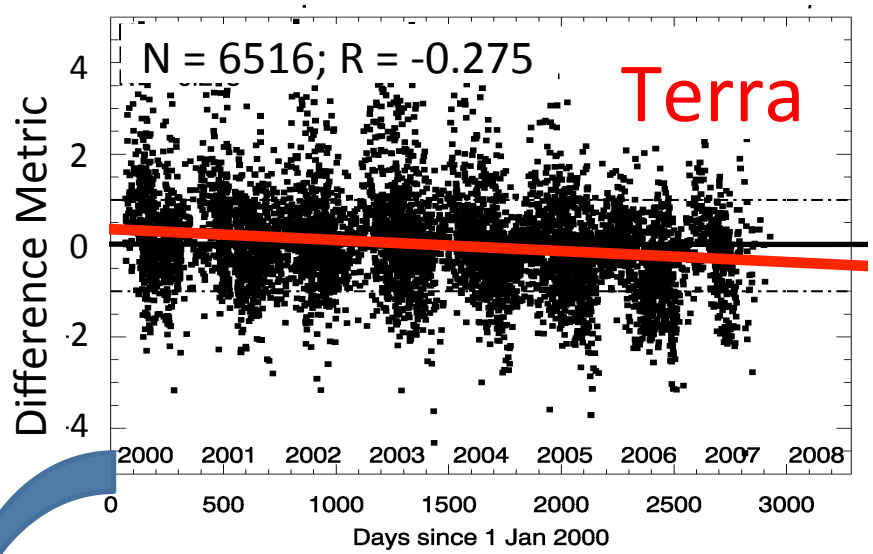
Long-term drift reduced

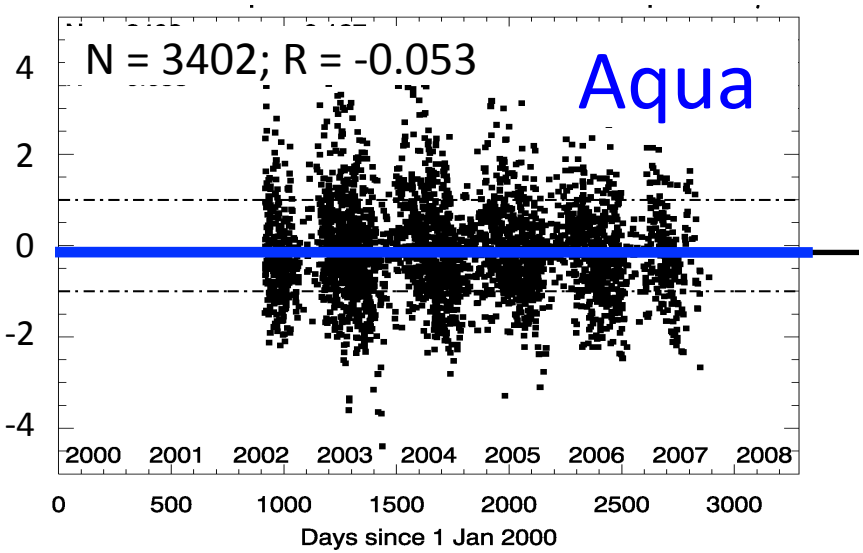


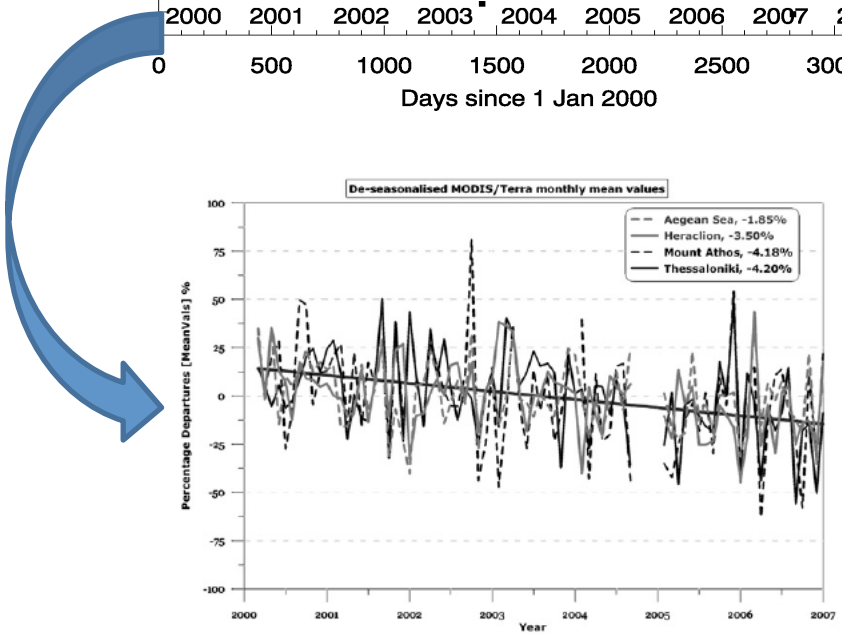


MODIS DT: Comparing MODIS with AERONET

Trends of MODIS-AERONET "agreement" over time (land)



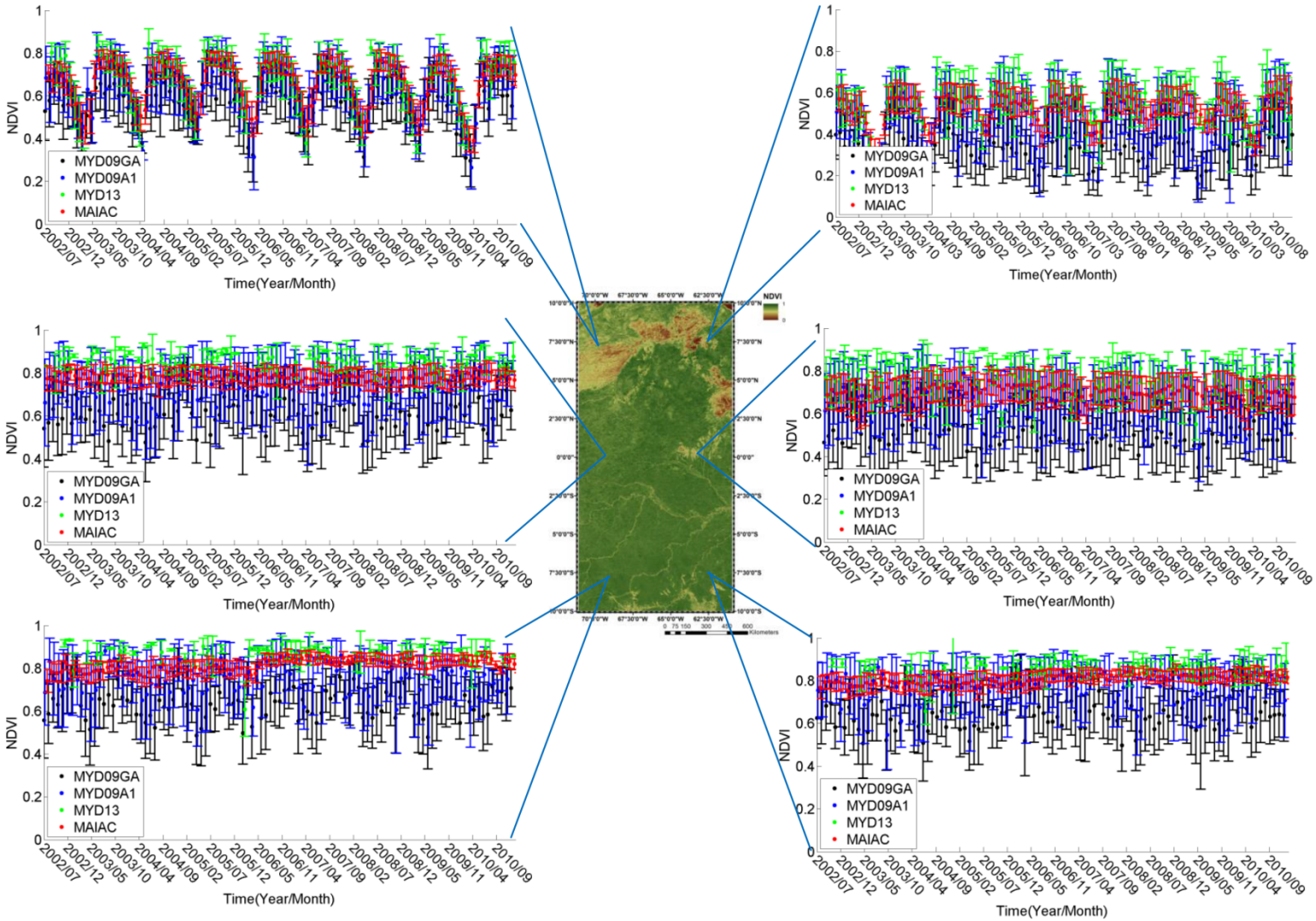




Amazon: MAIAC vs standard MODIS

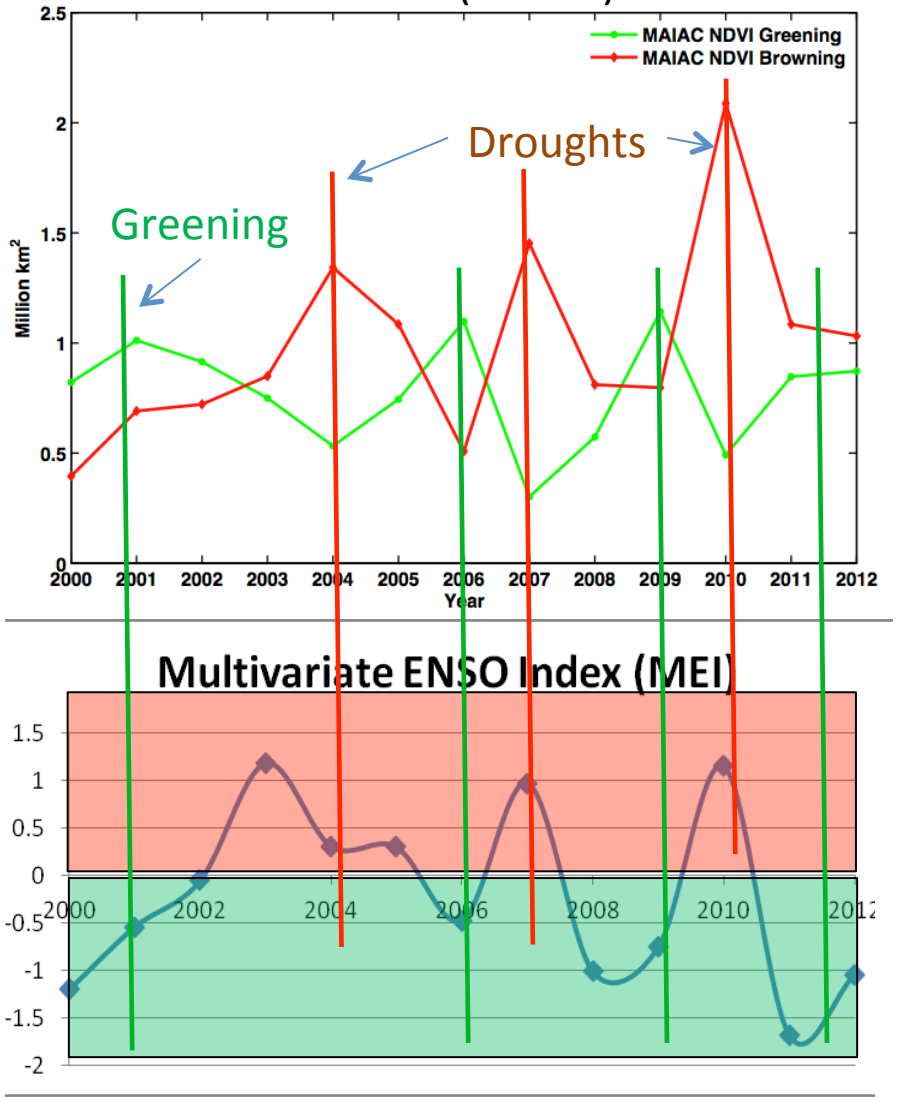
Hilker et al., 2012: Remote Sensing of Tropical Ecosystems: Atmospheric Correction and Cloud Masking Matter, *RSE*.

- MAIAC improves accuracy of SR/NDVI by a factor of 3-10;
- 80% of improvement comes from CM, which also gives a factor of 2-5 more clear-sky data .

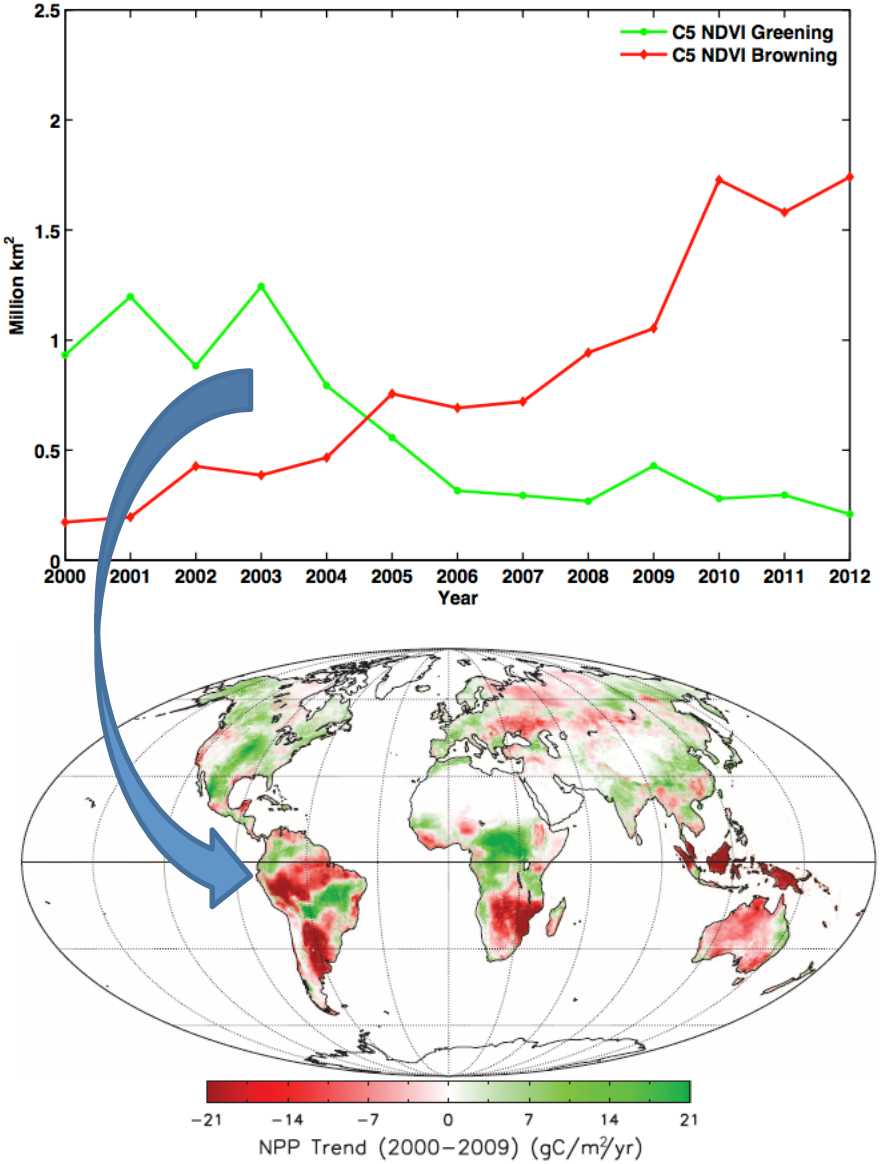


Latest on Amazonia

MAIAC (C6 L1B)



Standard MODIS SR product (C5)



Polarization Correction: Terra-Aqua Xcal
(algorithm developed by ocean color team)

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

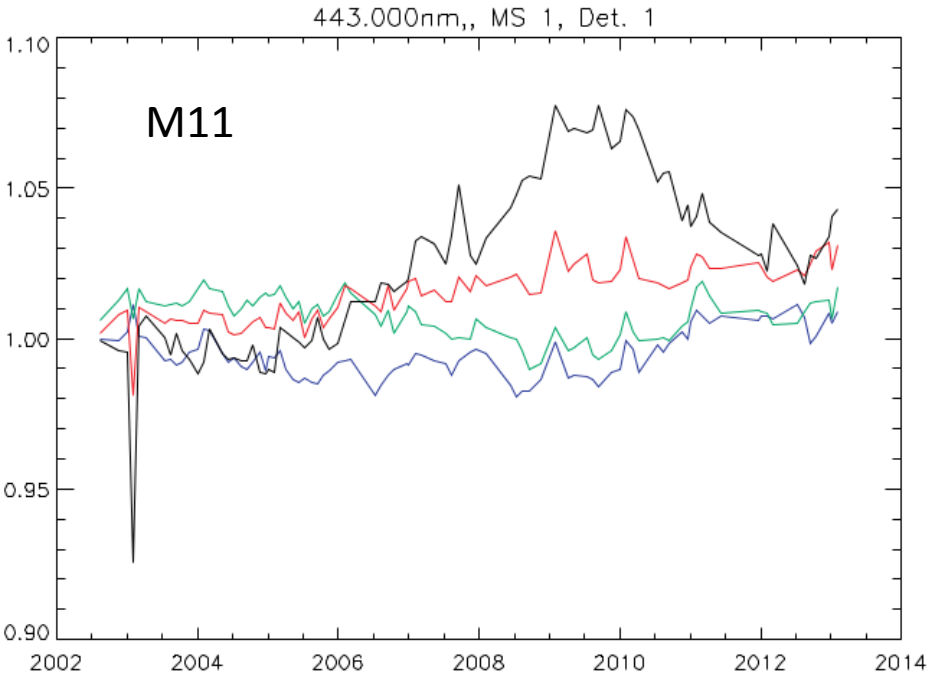
L_m: measured TOA radiance (Terra)

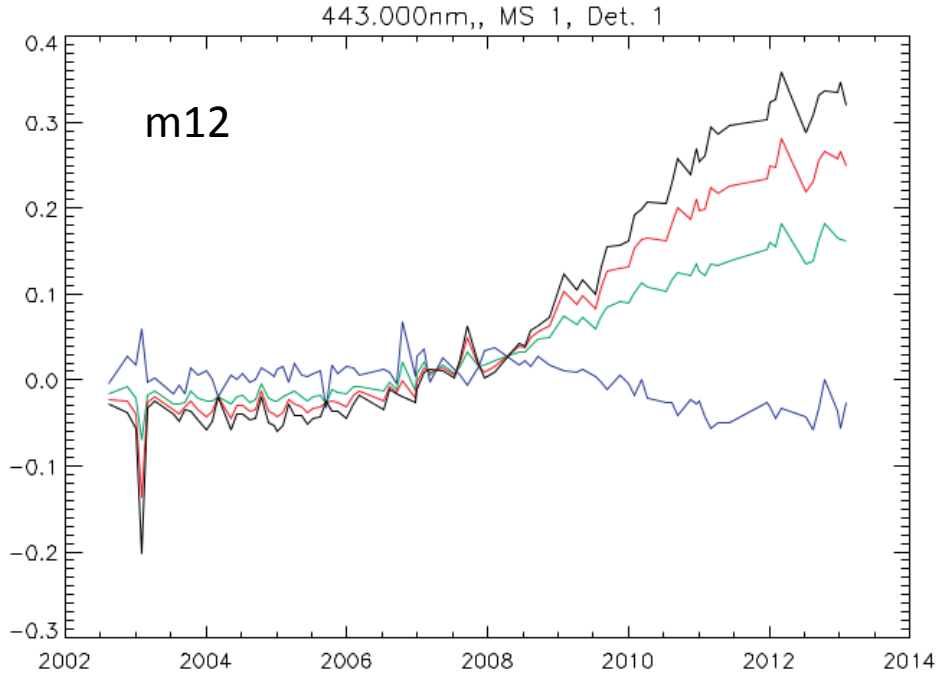
L_t: expected TOA radiance (from L3 Aqua)

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)

Cross-calibration of MODIST to MODISA: correction coefficients for 443nm



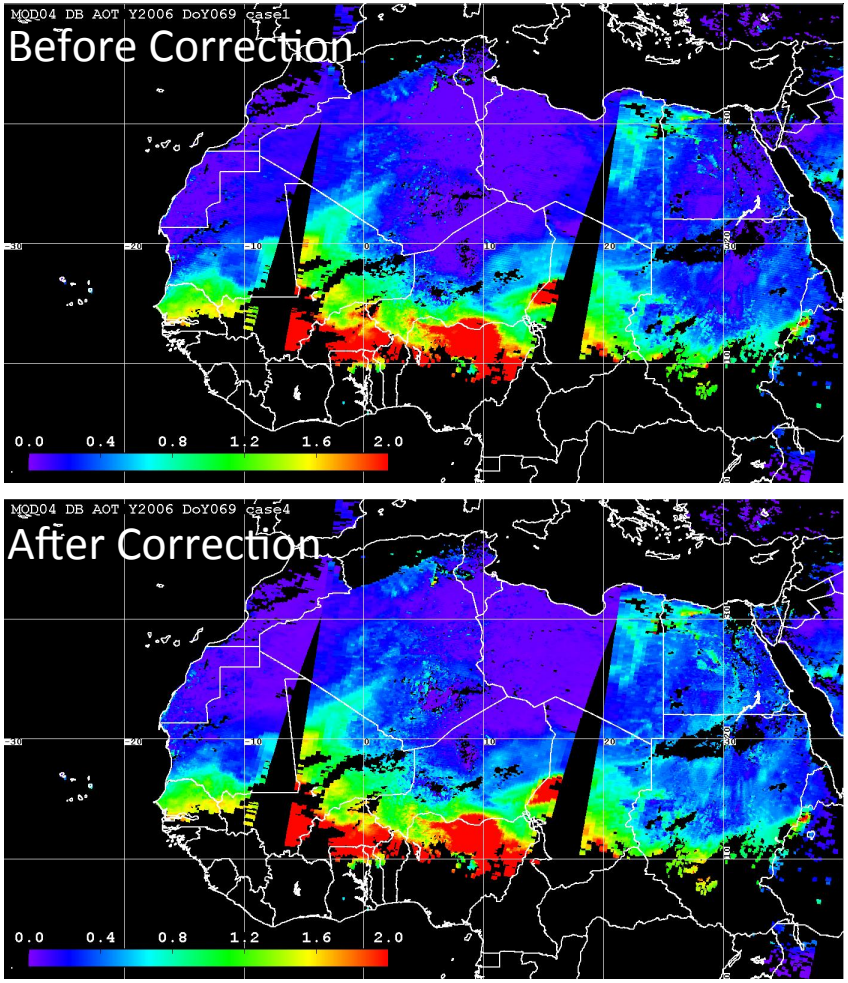


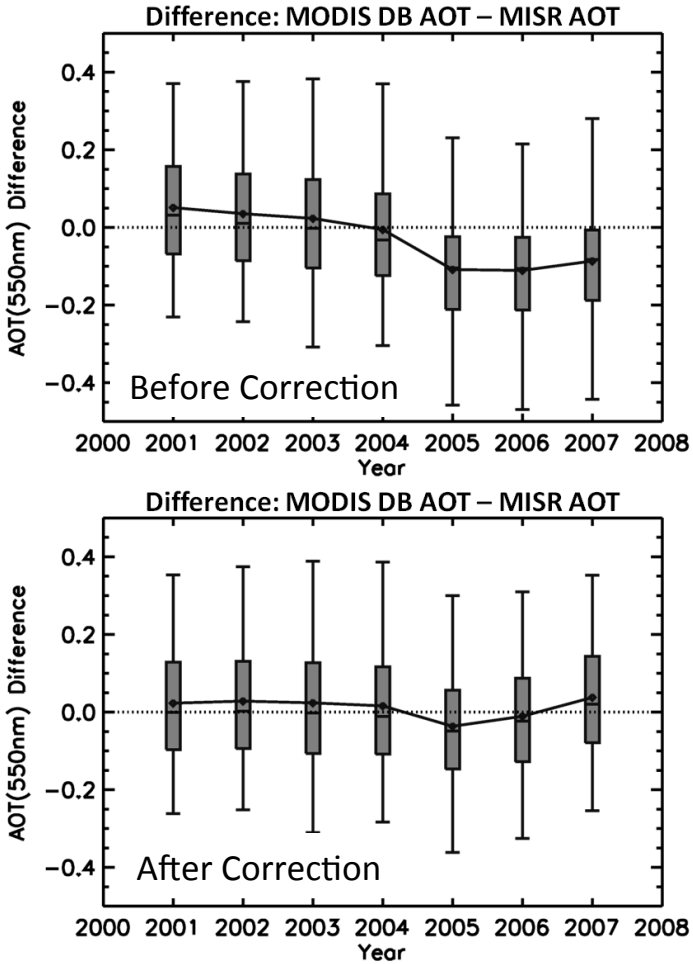
Scan angles (frame): lunar (22), nadir (675), Solar diffuser (989), end-of-scan (1250)

Impacts of Terra RVS and PC corrections on daily AOT values are significant

The Bias in multiyear AOT trends between MODIS/Terra DB and MISR is substantially reduced after applying Terra correction

Terra Deep Blue AOT on March 10, 2006



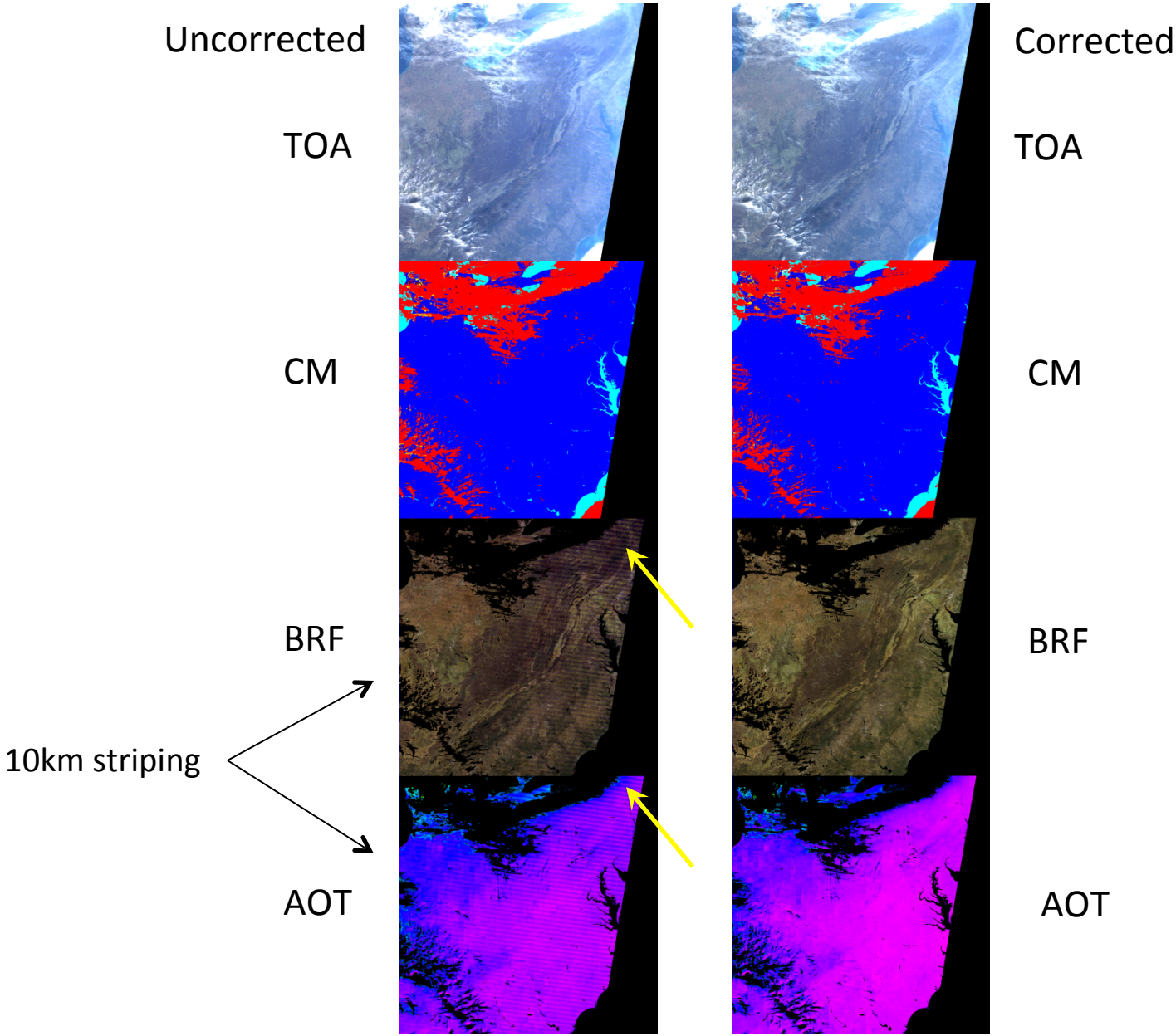


Reference:

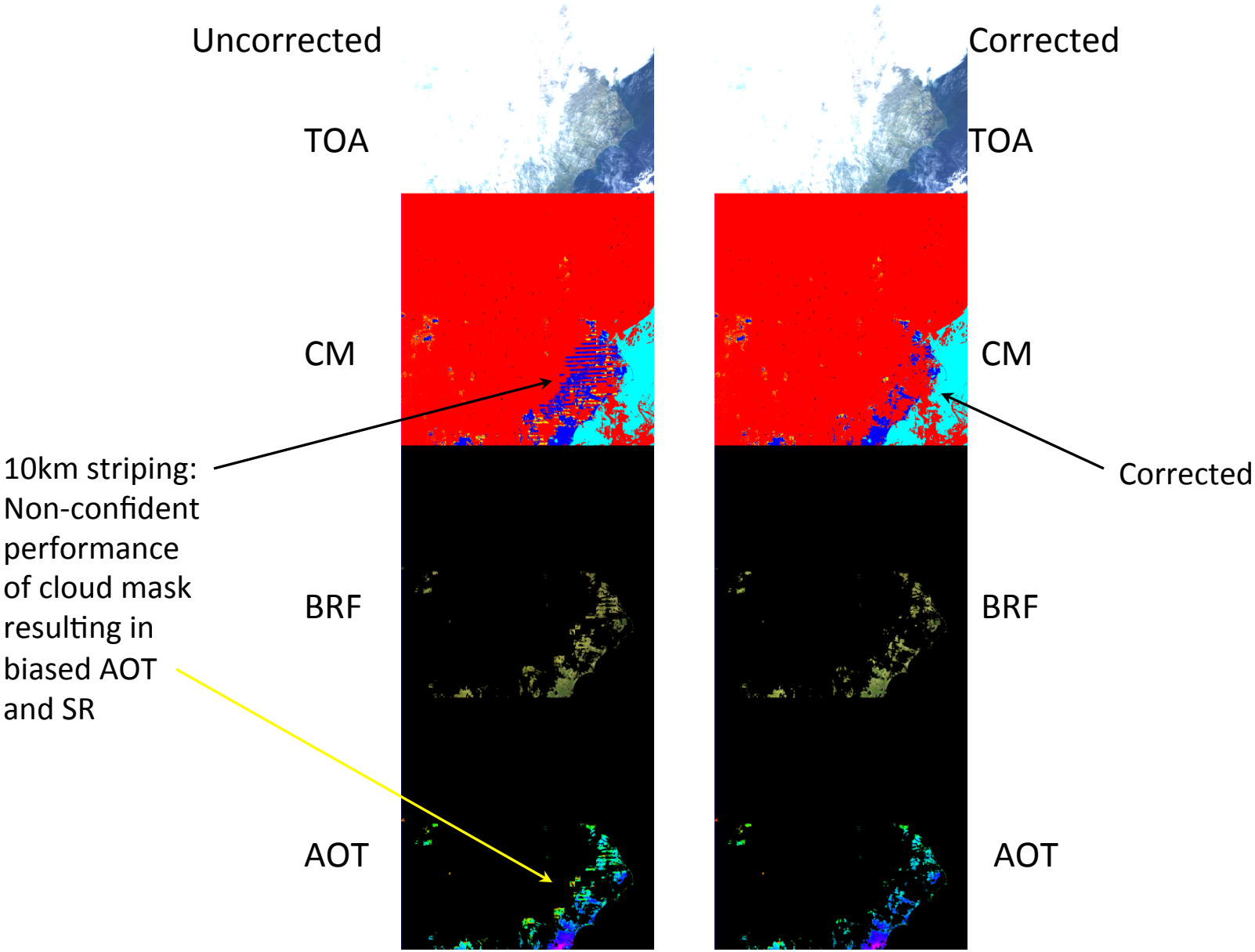
Jeong, M.-J., N. **C. Hsu**, E. J. Kwiatkowska, B. A. Franz, G. Meister, Impacts of cross-platform vicarious calibration on the Deep Blue aerosol retrievals for MODIS aboard Terra, *IEEE Trans. Geosci. Remote Sens*, doi: 10.1109/TGRS.2011.2153205, 2011.

Polarization Correction: MAIAC Analysis

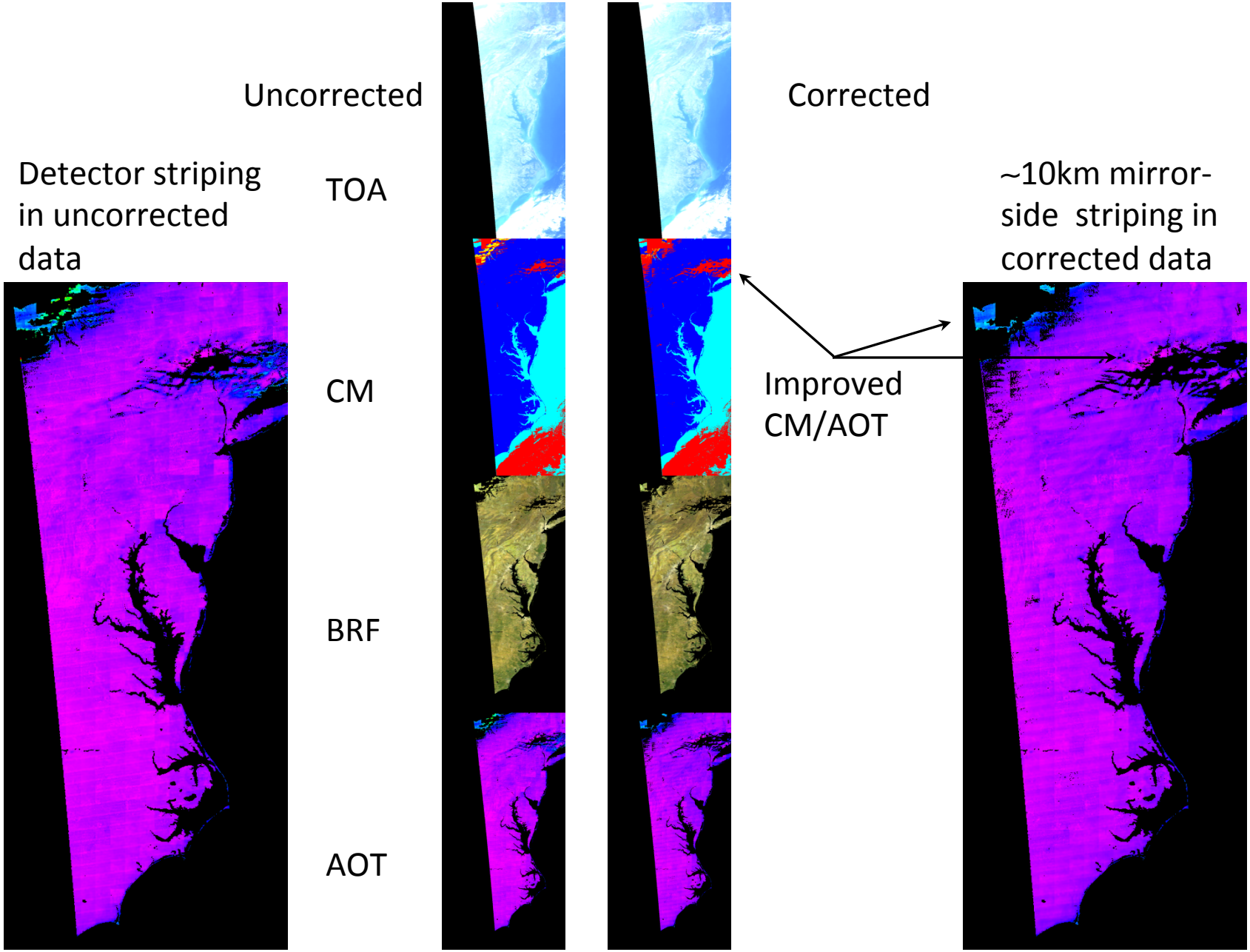
Right side of scan : improved AOT and SR (2012, DOY 349)



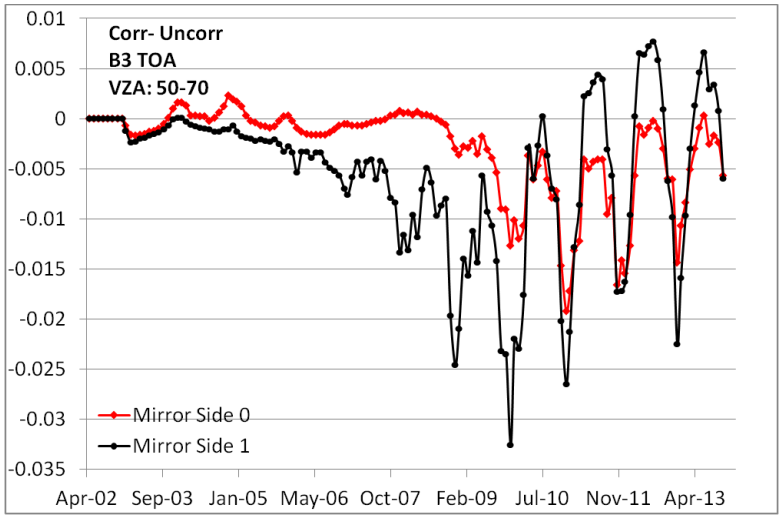
Left side of scan: improved CM/AOT (2003, day 094)

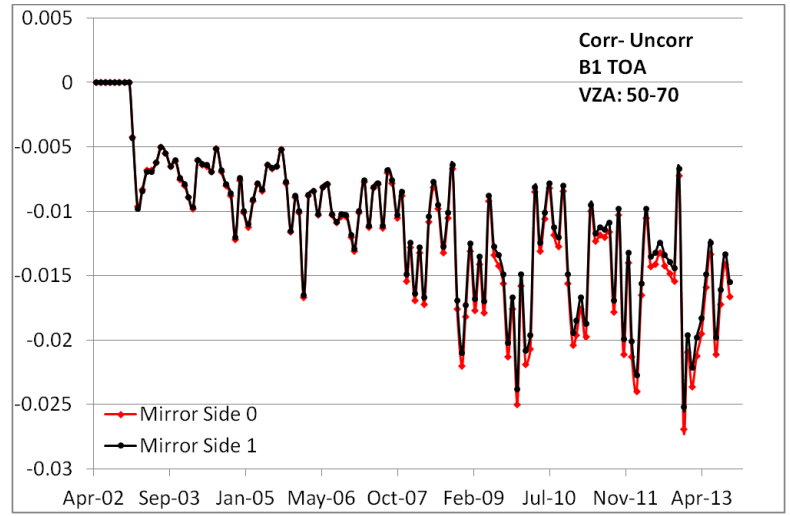


Left side of scan: Small Overcorrection (2012, day 349)

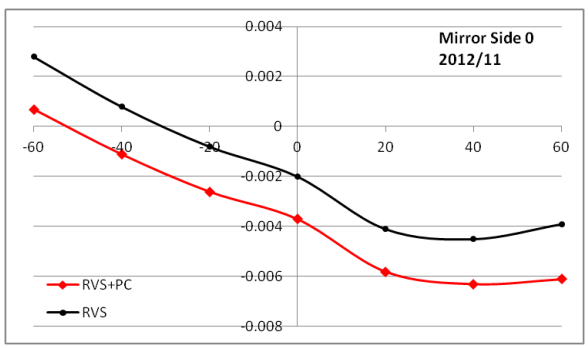


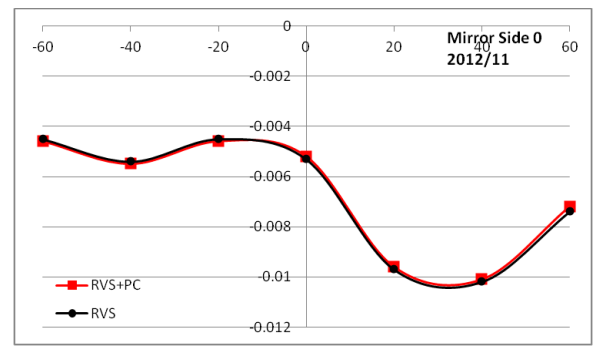
Polarization Correction: Detailed MAIAC Analysis (clear-sky pixels, monthly averages)

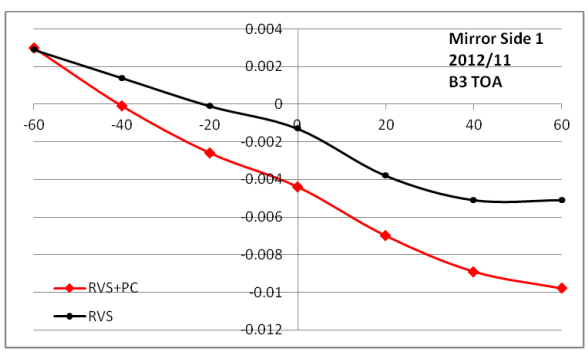


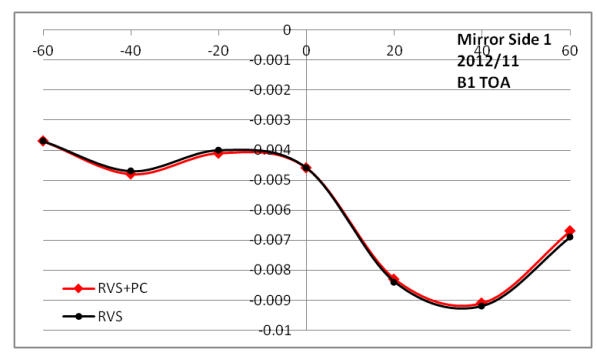


Partitioning between RVS and PC

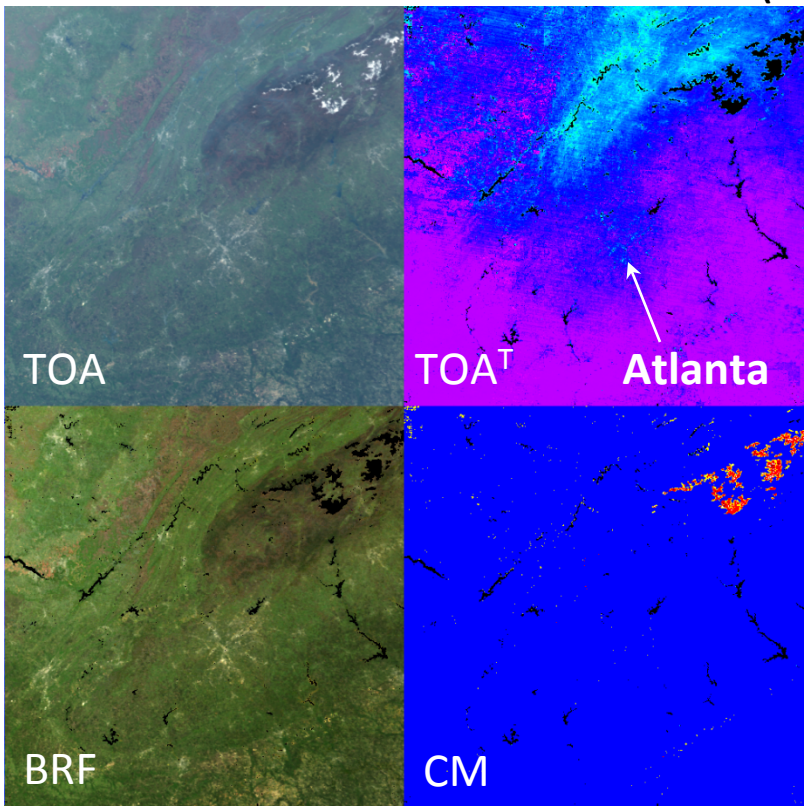
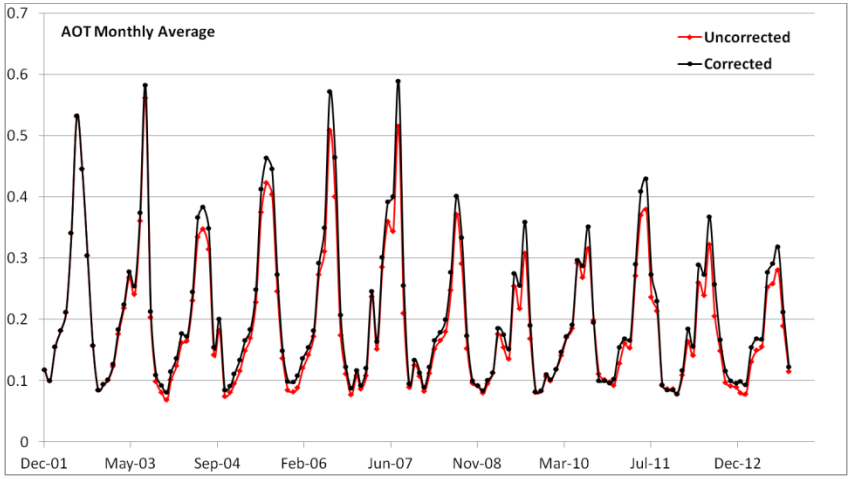
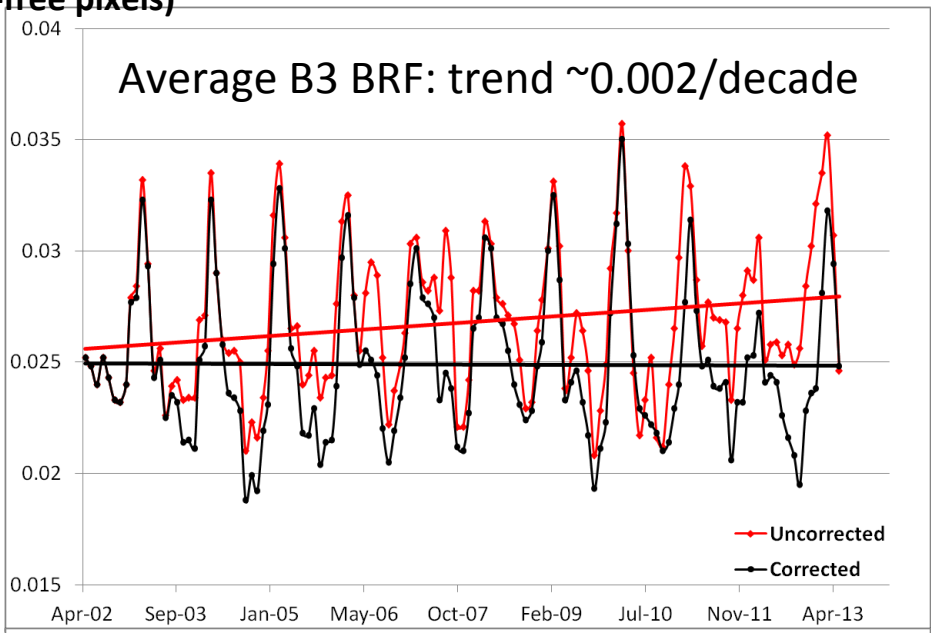
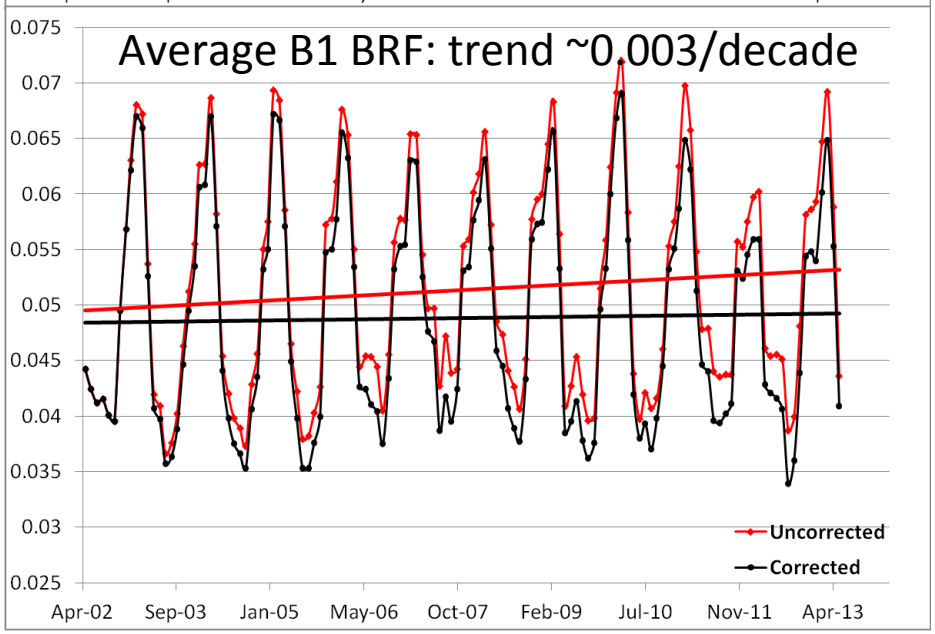








Bias Partitioning Between AOT and BRF

(cloud-free pixels)

April 12, 2003 (Georgia, 500km Tile)