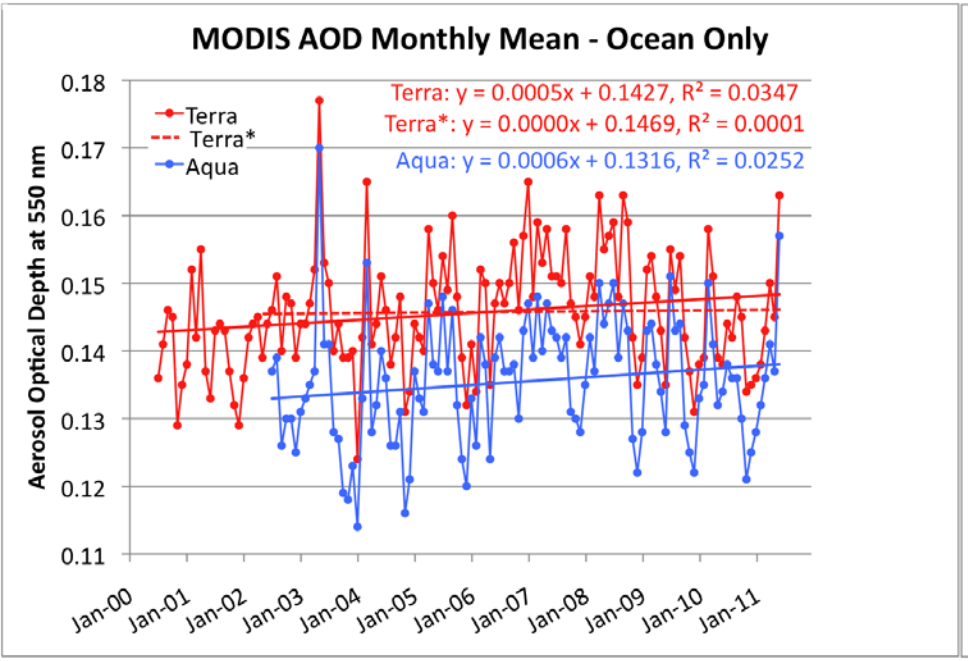
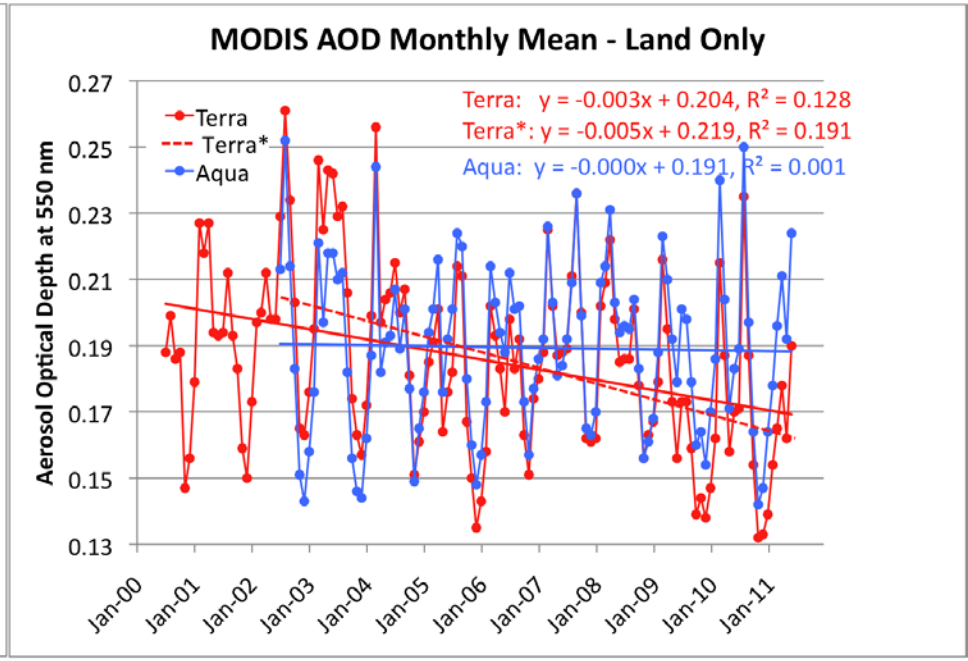
Impact of Approach #2 on MODIS dark-target aerosol products

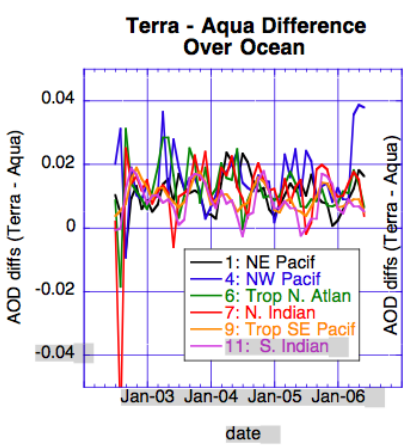
AOD Trends: Terra ≠ Aqua

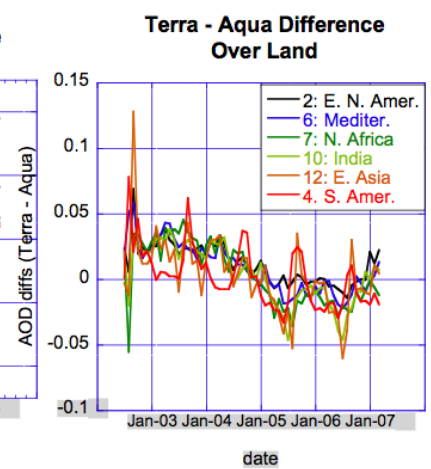




- Ocean Trend: Terra = Aqua = negligible
- Ocean Offset: Terra – Aqua = 0.01

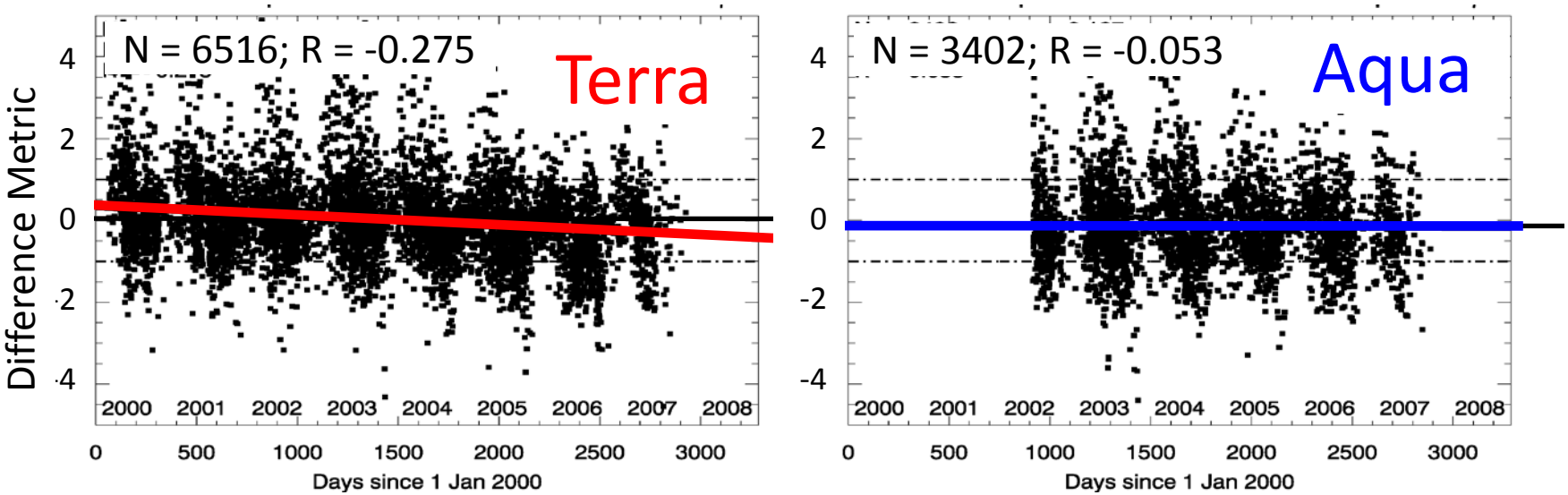
- Land Trend: Terra = -0.03/dec; Aqua = 0.0
- Land Offset: Terra – Aqua = 0.01 - 0.03/dec





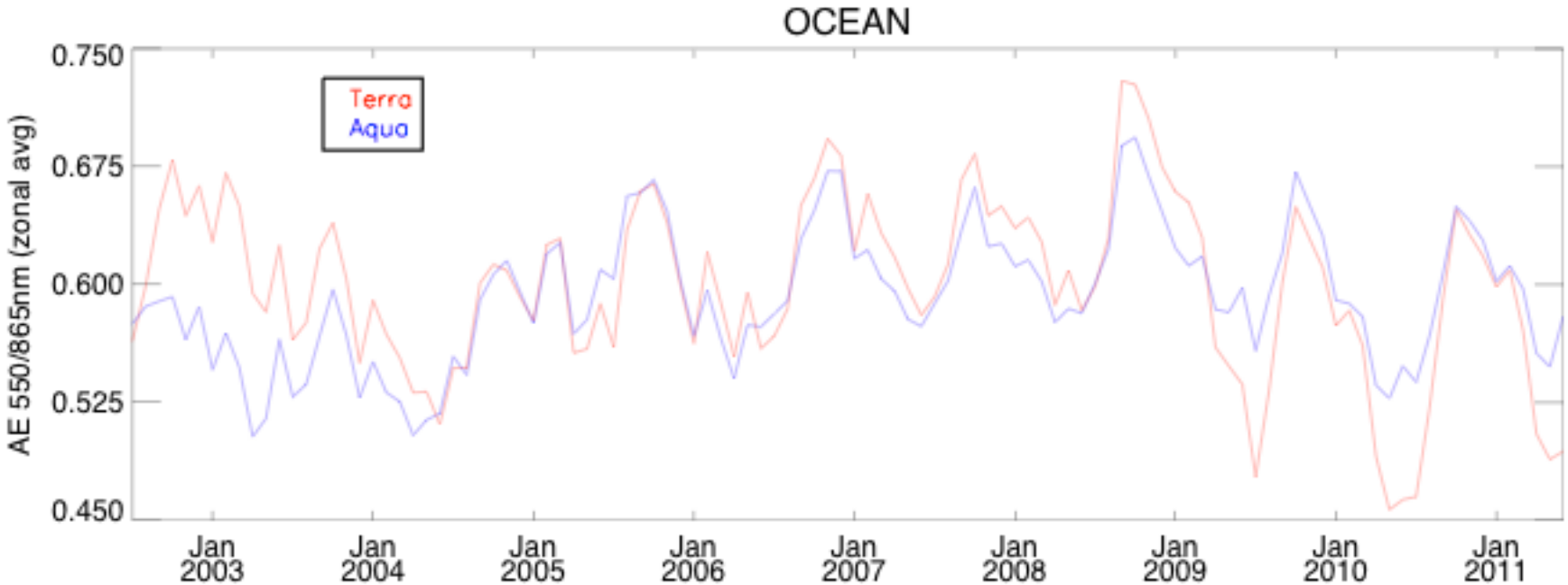
Performance of MODIS instruments may be changing…

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



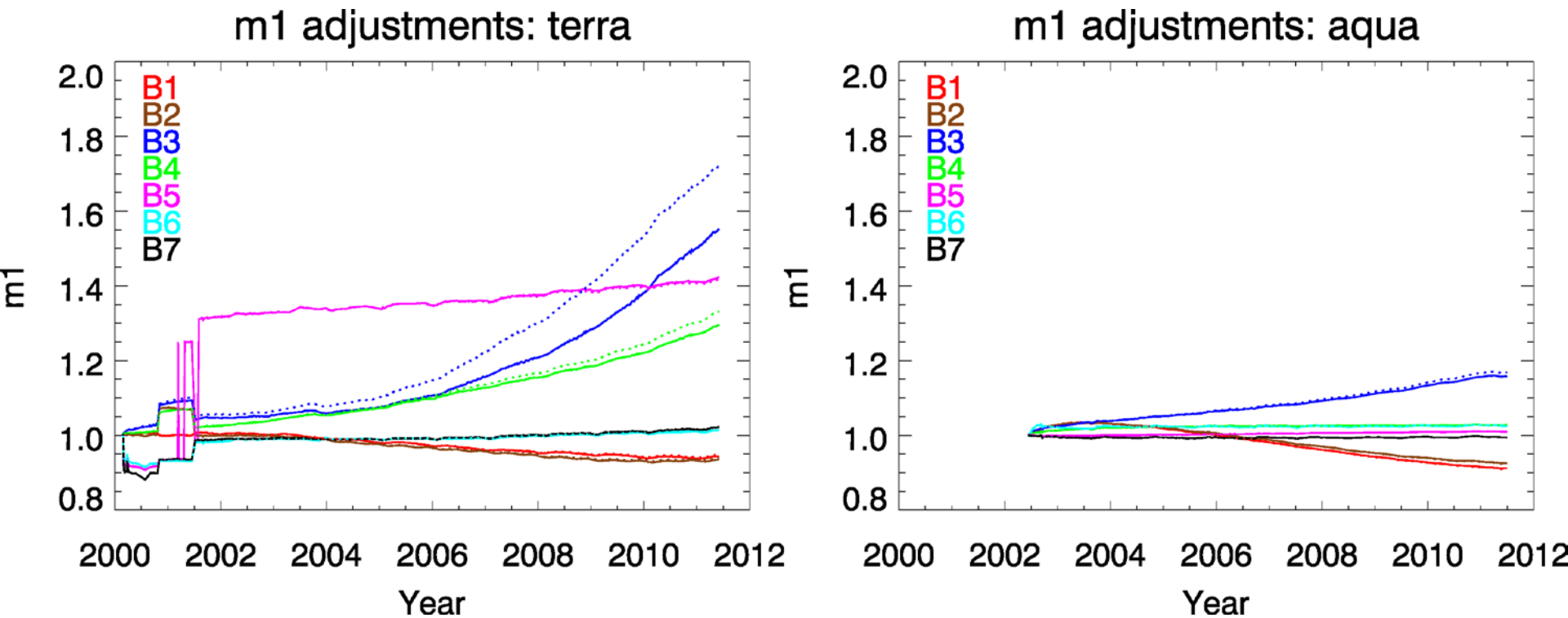
- Over land: 14 AERONET sites with >7 years of data
- Terra: Pre-2004, MODIS>AERONET; Post-2004 MODIS<AERONET
- No trend for Aqua.
- Δ(Terra – Aqua) similar to Δ(Terra – AERONET)

Angstrom Exponent (AE) Trends over ocean



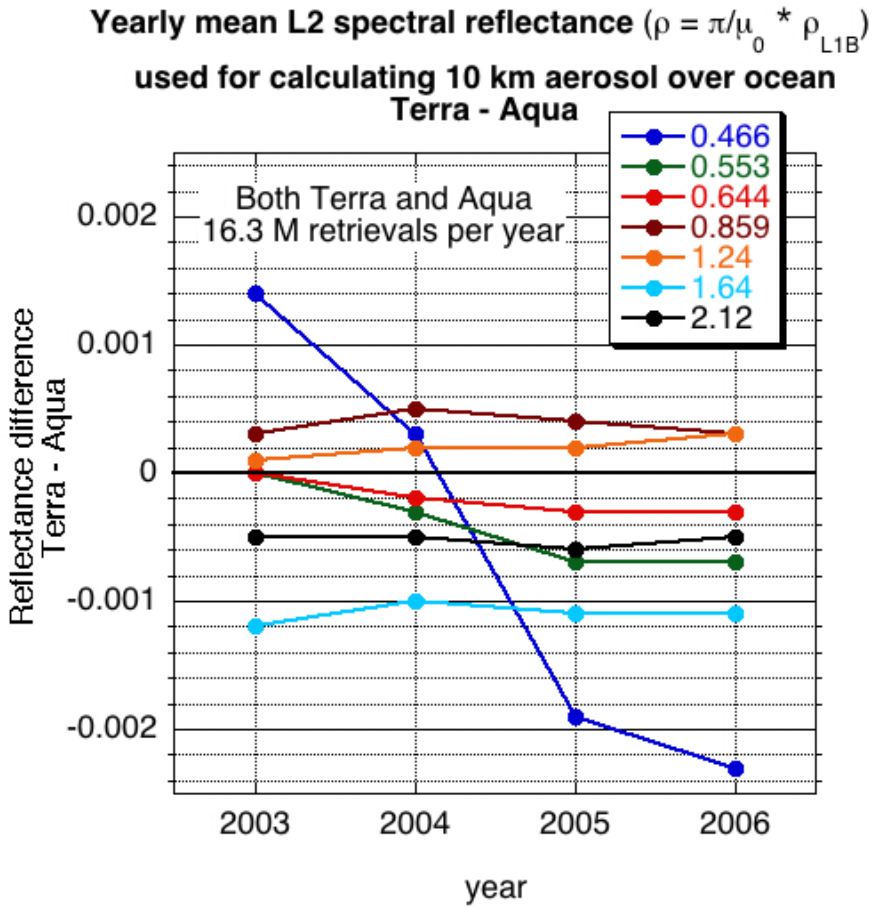
- Pre-2005: Terra > Aqua
- 2005-2008: Terra ~ Aqua
- Post-2008: Terra < Aqua

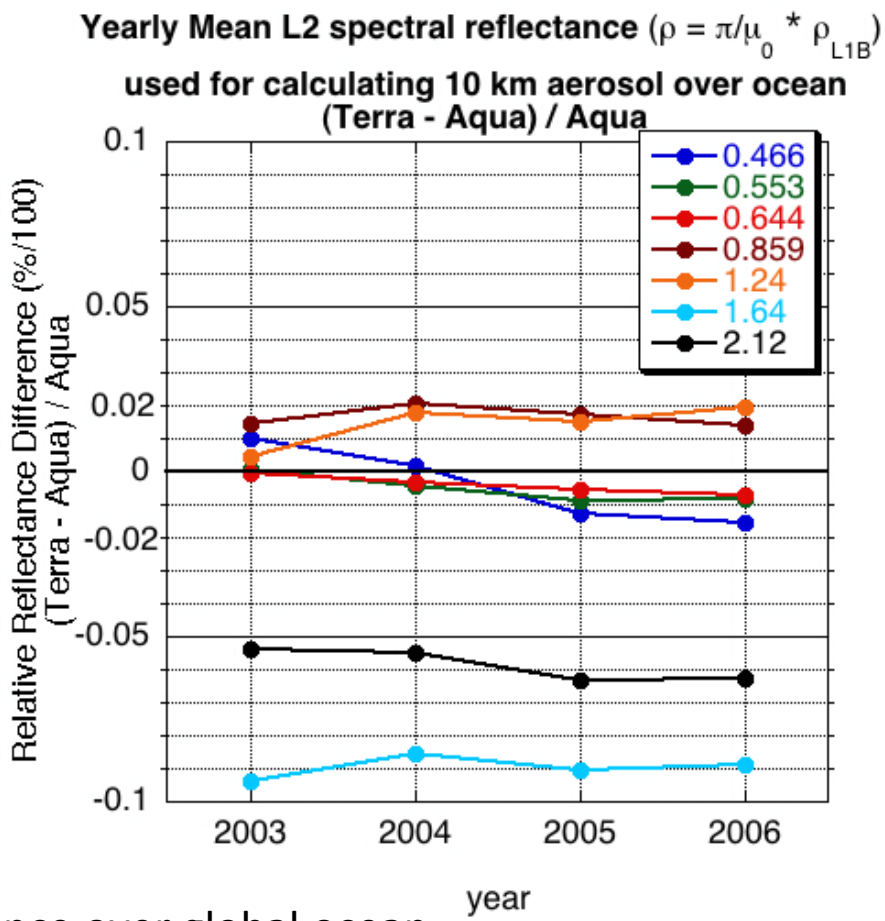
Terra has degraded much more than Aqua



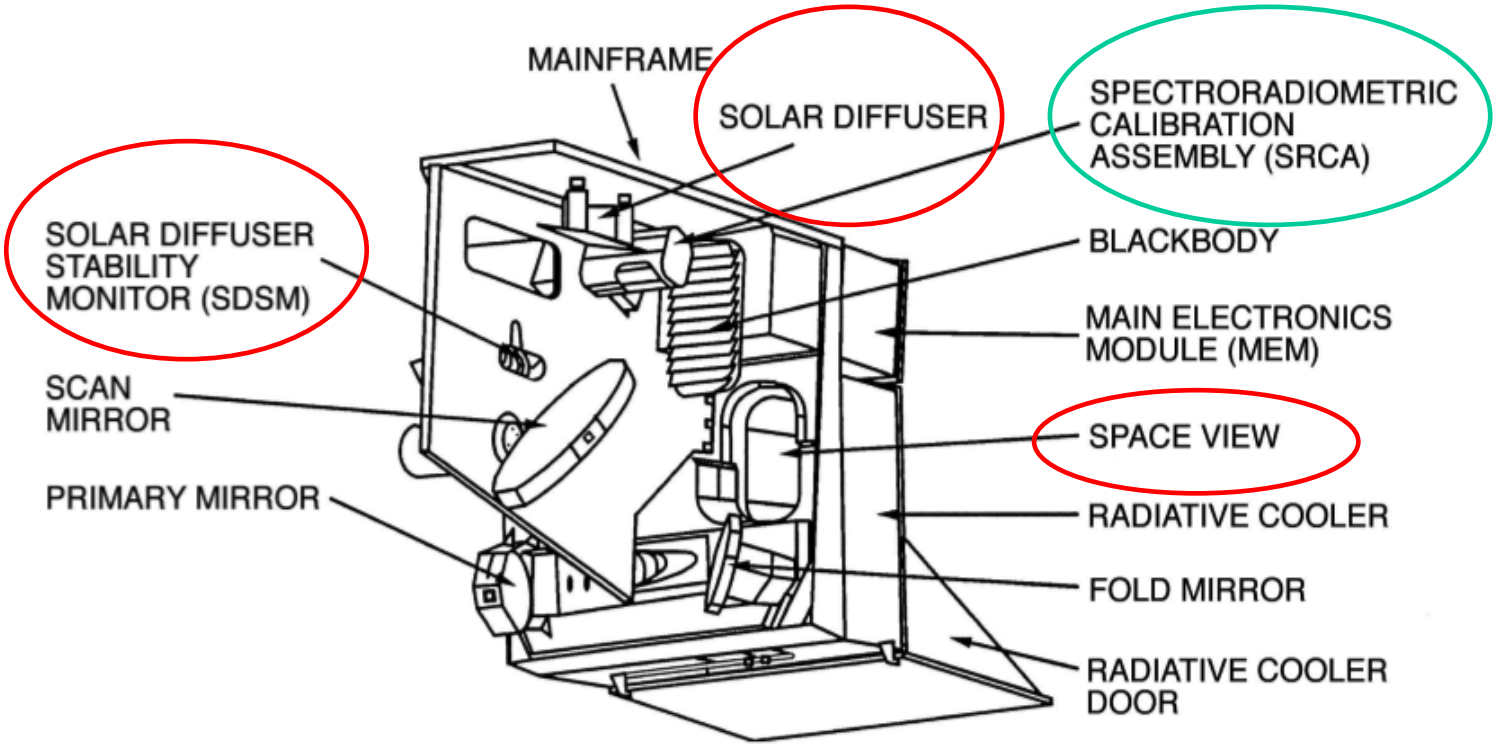
- Band 3 (Blue, 466 nm) has changed the most

Reflectance difference: Terra - Aqua





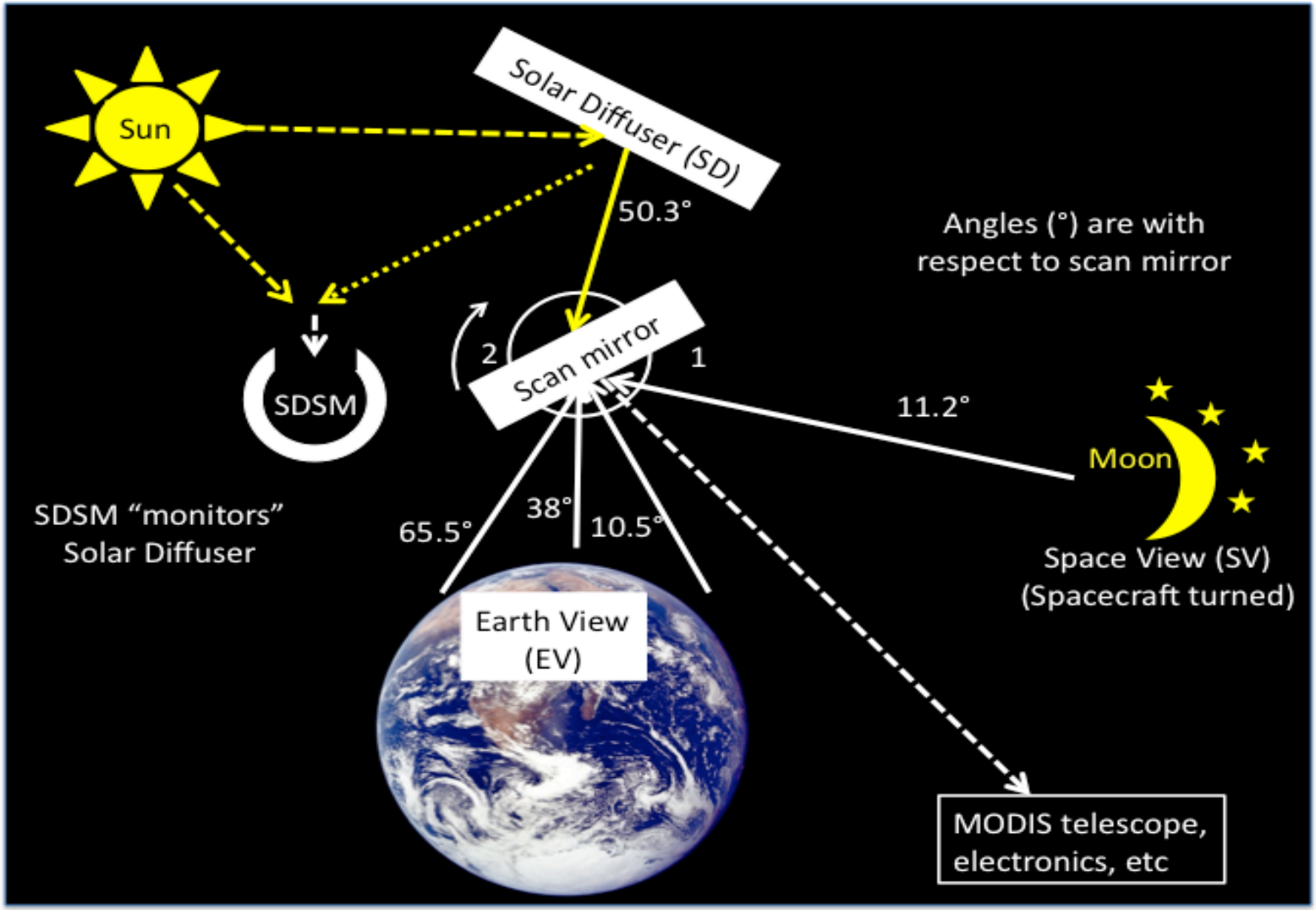
- Calculated "Level 2" aerosol reflectance over global ocean
- B3 (Blue, 466 nm) trended from +1% in 2003 to -1% in 2006
- Other bands did not trend, but were "offset" (e.g. B2 for Terra high by 2%)



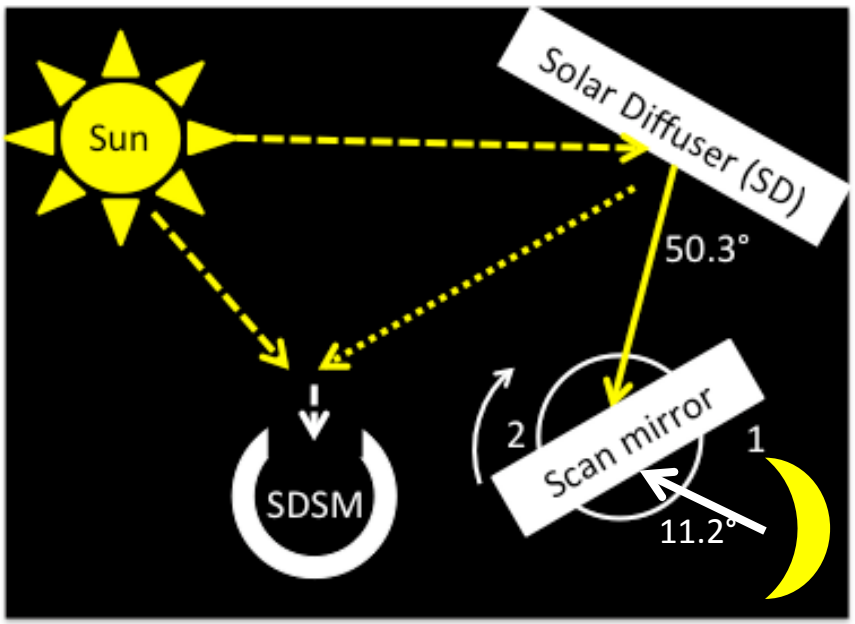
MODIS has many “redundancies” to monitor reflective band calibration

Why are Terra’s products changing?

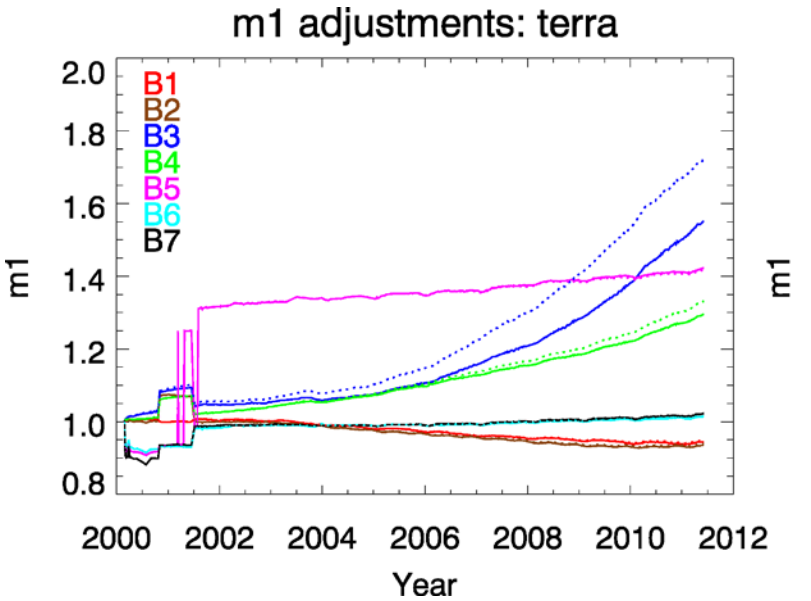
Intro to Reflective Band calibration (Geometry): Acronym "soup"

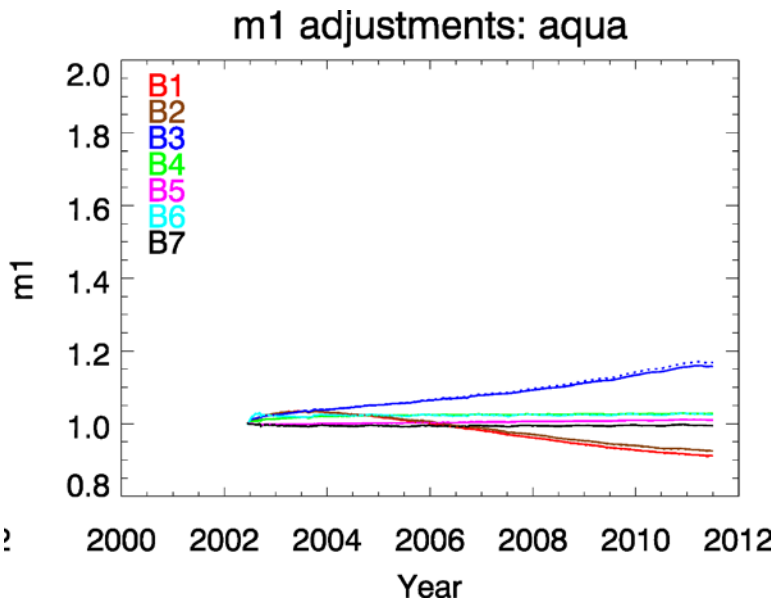


Instrument calibration tied to Solar Diffuser



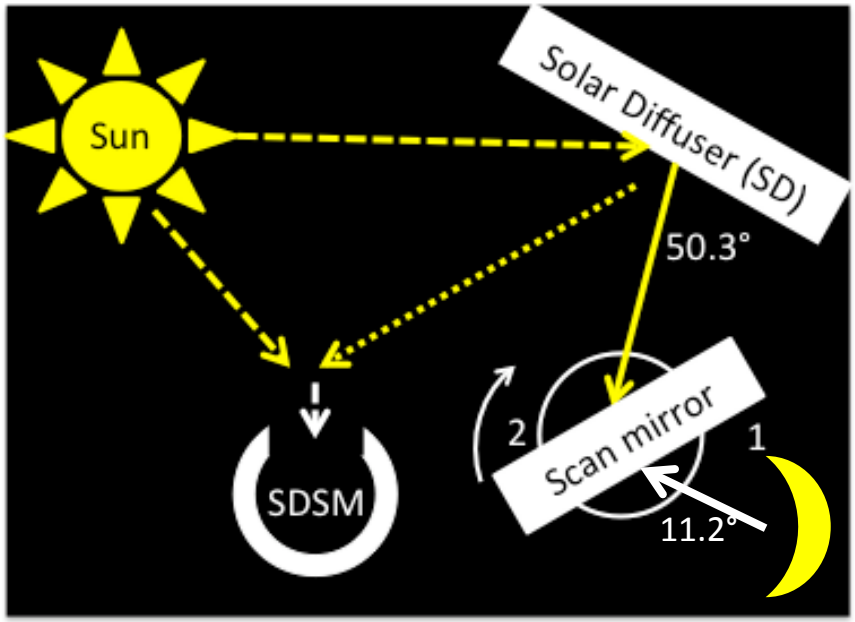
m_1 = inverse of instrument gain



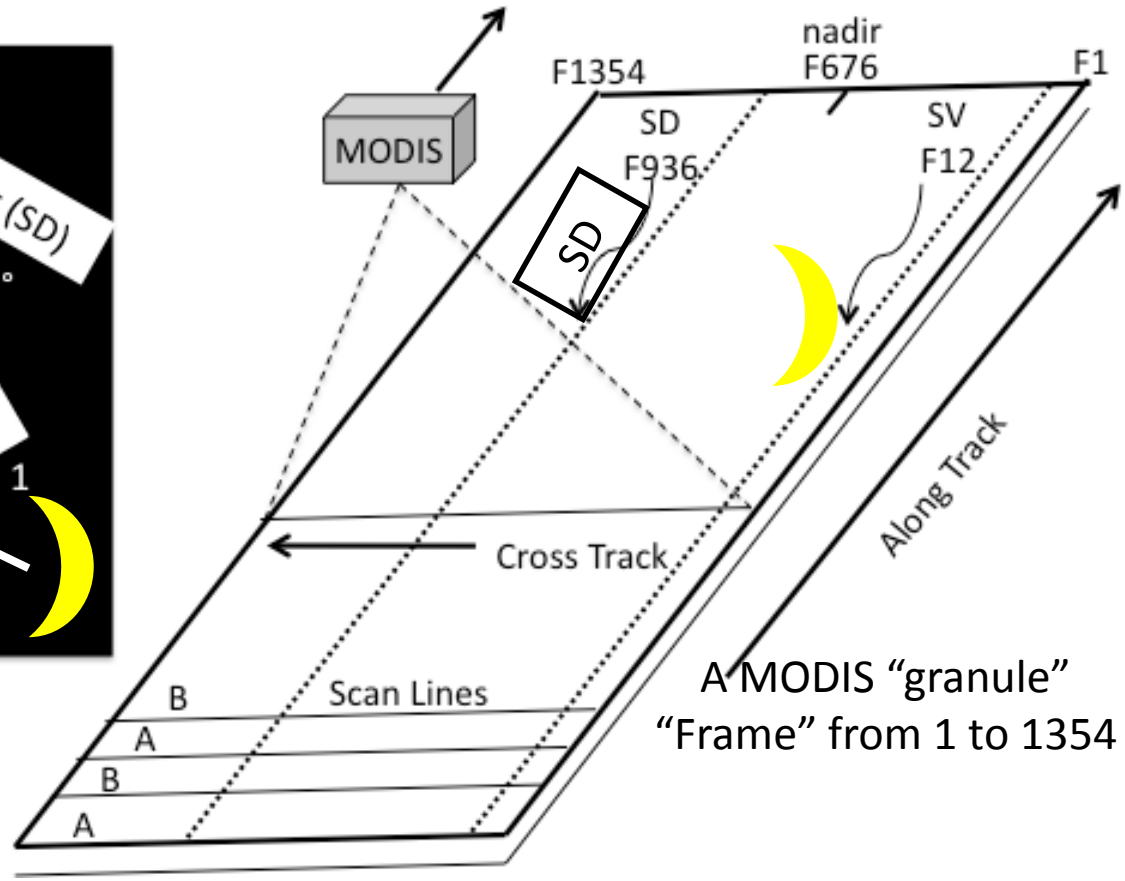


- Terra has “degraded” more than Aqua
- B3: Terra change by 70%, Aqua by 15%

What if Solar Diffuser is changing?



SD is monitored by SDSM

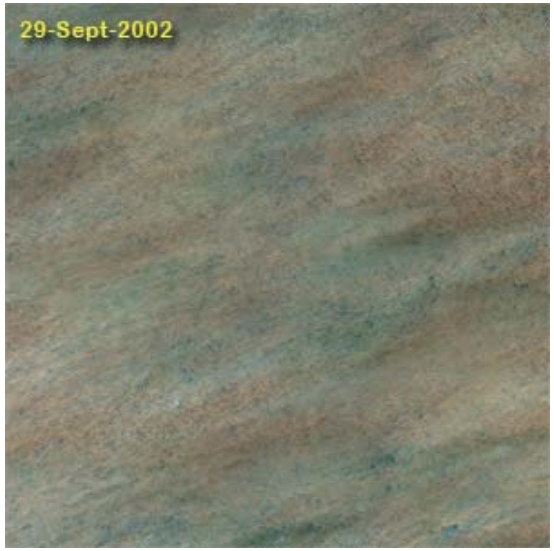


A MODIS "granule"
"Frame" from 1 to 1354

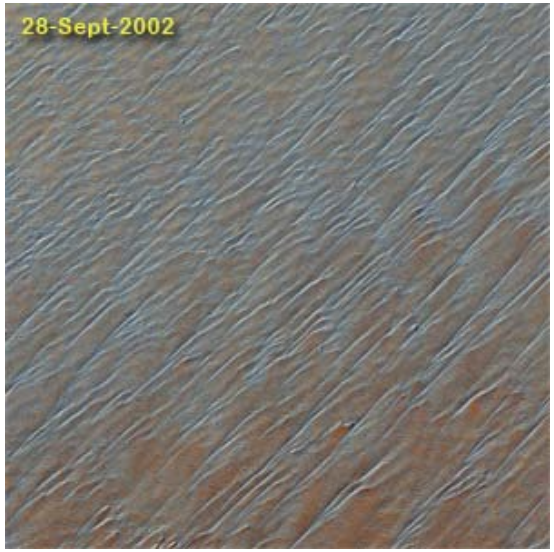
- AOI of "calibrators" (Solar Diffuser and Space View) correspond to Earth View angles
- Different angles of SD as viewed by SDSM and Scan mirror

What if… in addition to gain changes,
The BRF of the SD has changed? And cannot be sufficiently monitored by SDSM?
How could this impact calibration? How could this impact data?

MODIS reflectance trends over desert sites

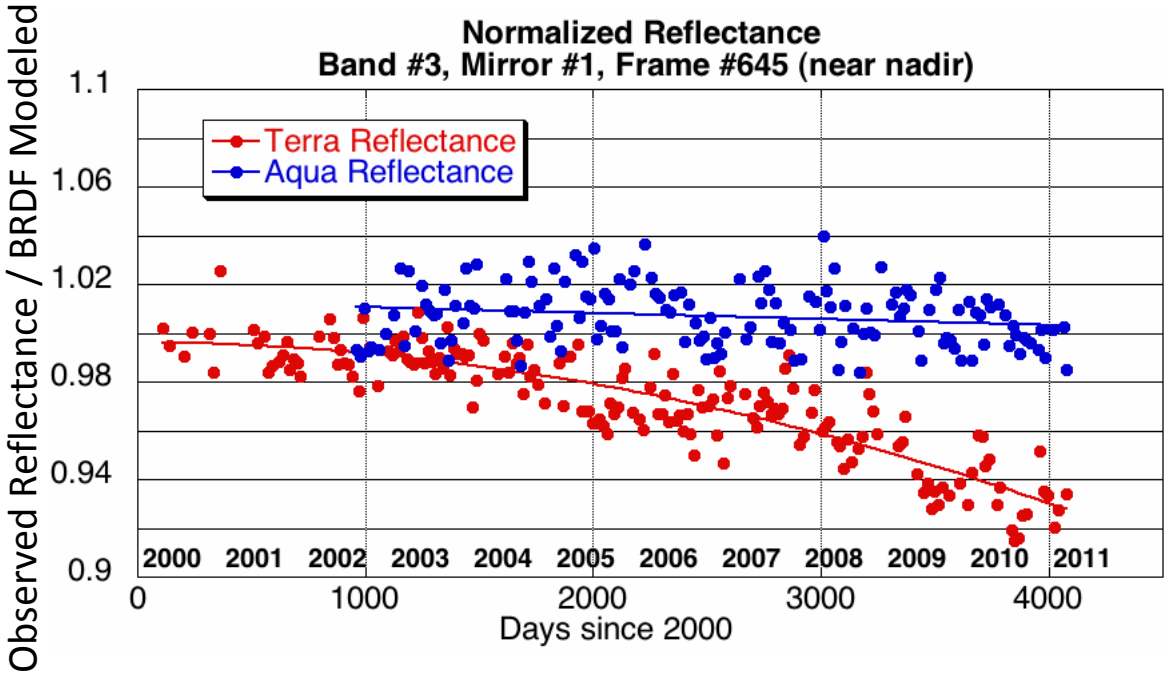


desert test sites



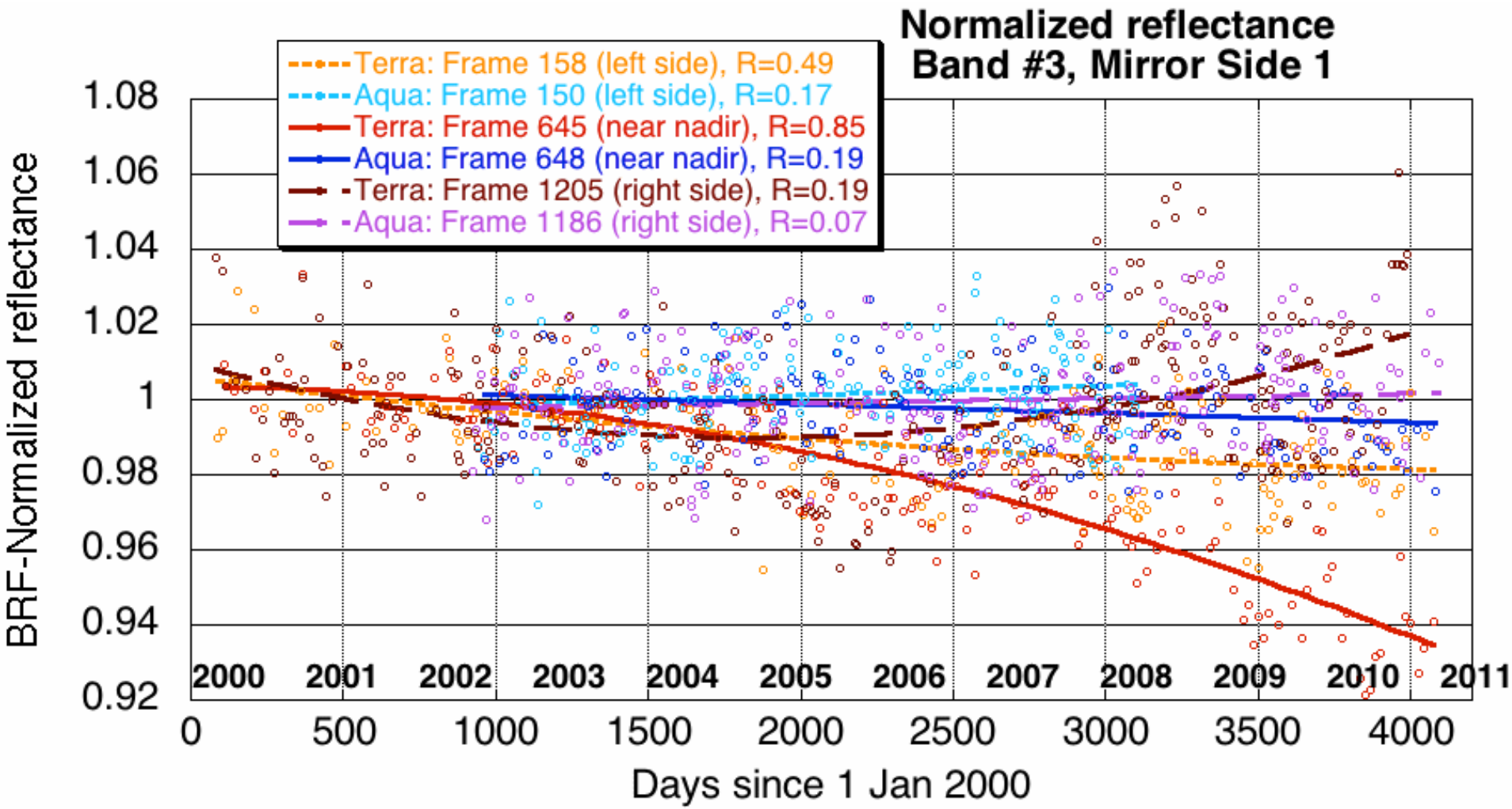
(1) Collect clear-sky MODIS data over desert sites
(2) Develop site-specific BRDF from first 3 years of mission
(3) Over time, compare "observed" reflectance with BRDF modeled reflectance, for different view angles

- Trends in Terra Band #3 (0.47 μm). No trend for Aqua
- Trend varies with Scan Angle (or Frame #)



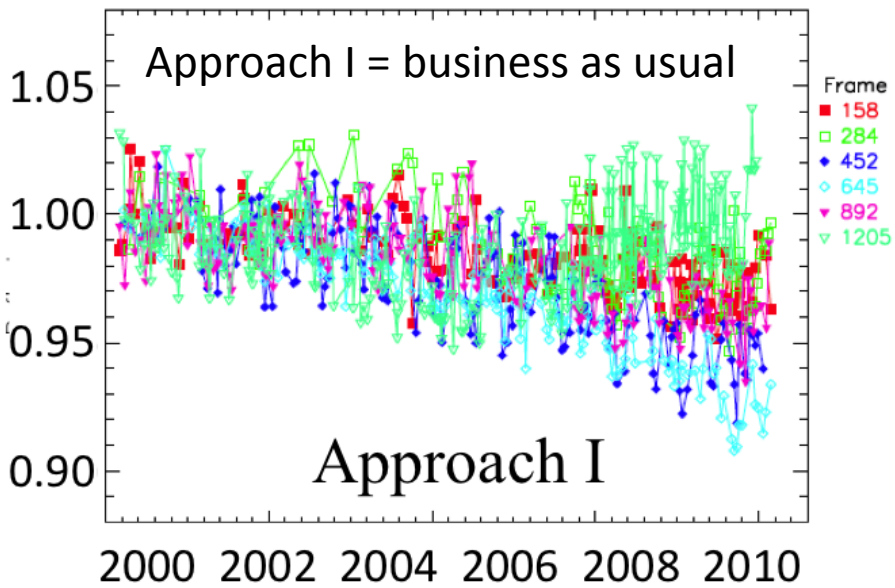
MCST (Sun, Xiong et al)

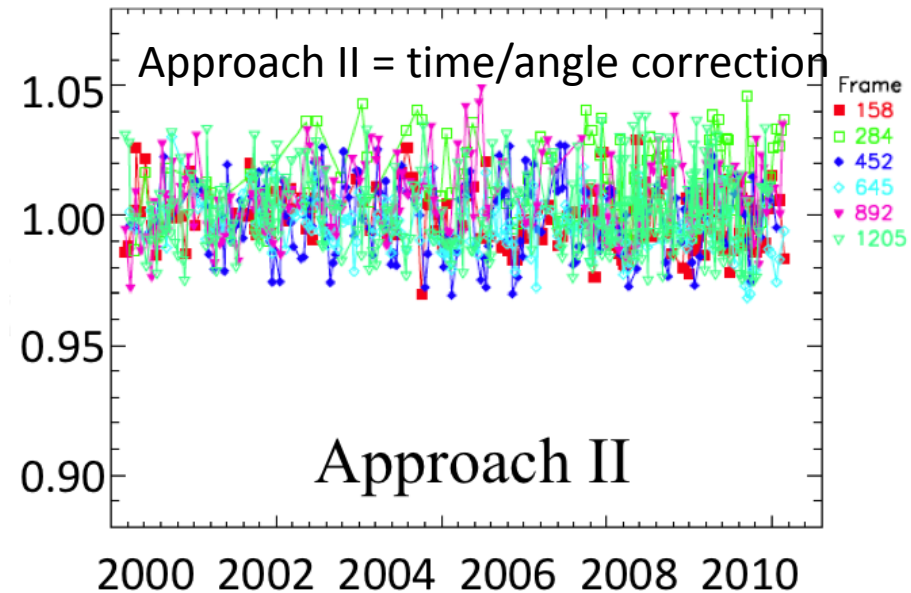
Reflectance trending across the swath



Approach II:
Removes the temporal/angular reflectance trends

Normalized Reflectance Terra Band # 3, Mirror Side #1 Normalized Reflectance





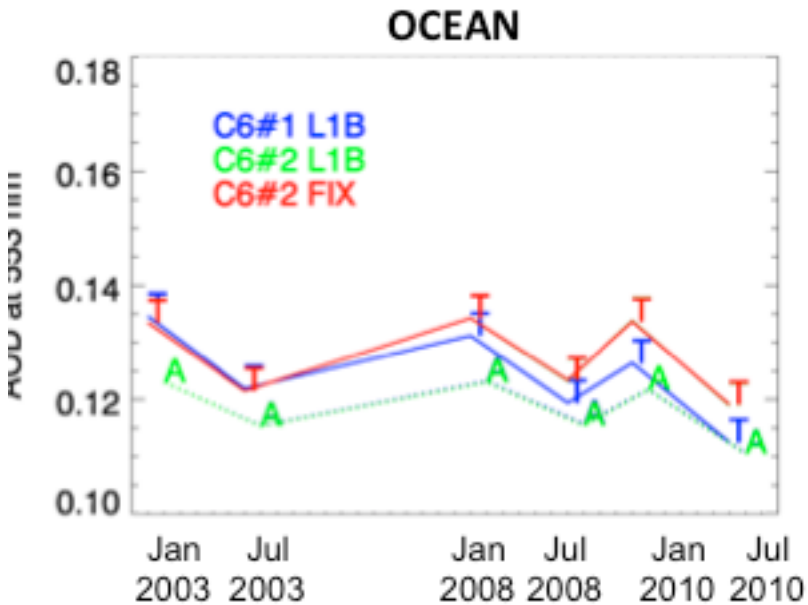
- B3 (466 nm)
  - 7% *decrease* near nadir
  - 0% change on right (near Moon)
  - 3% *increase* on left

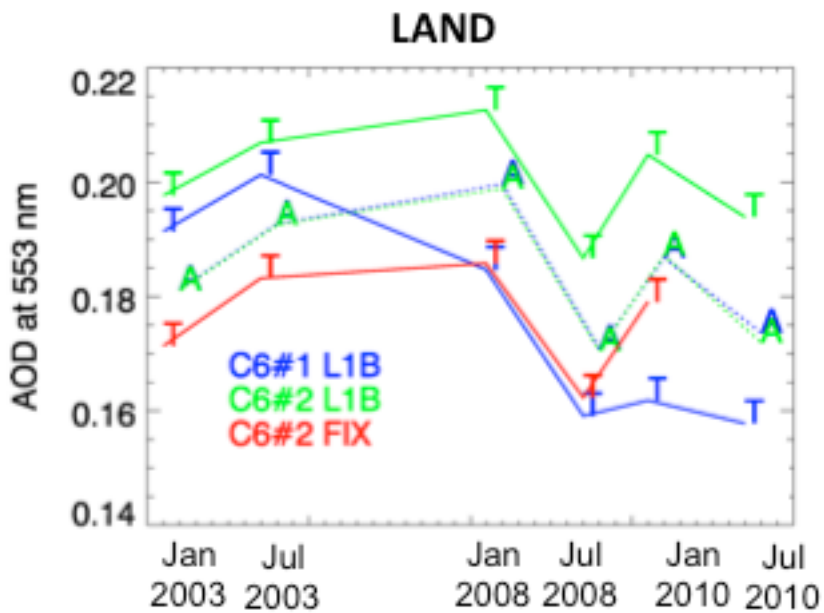
- B1 & B2 (not shown)
  - 3% *decrease* for all angles

MCST: Junqiang Sun

Approach II:
Impact on AOD time series

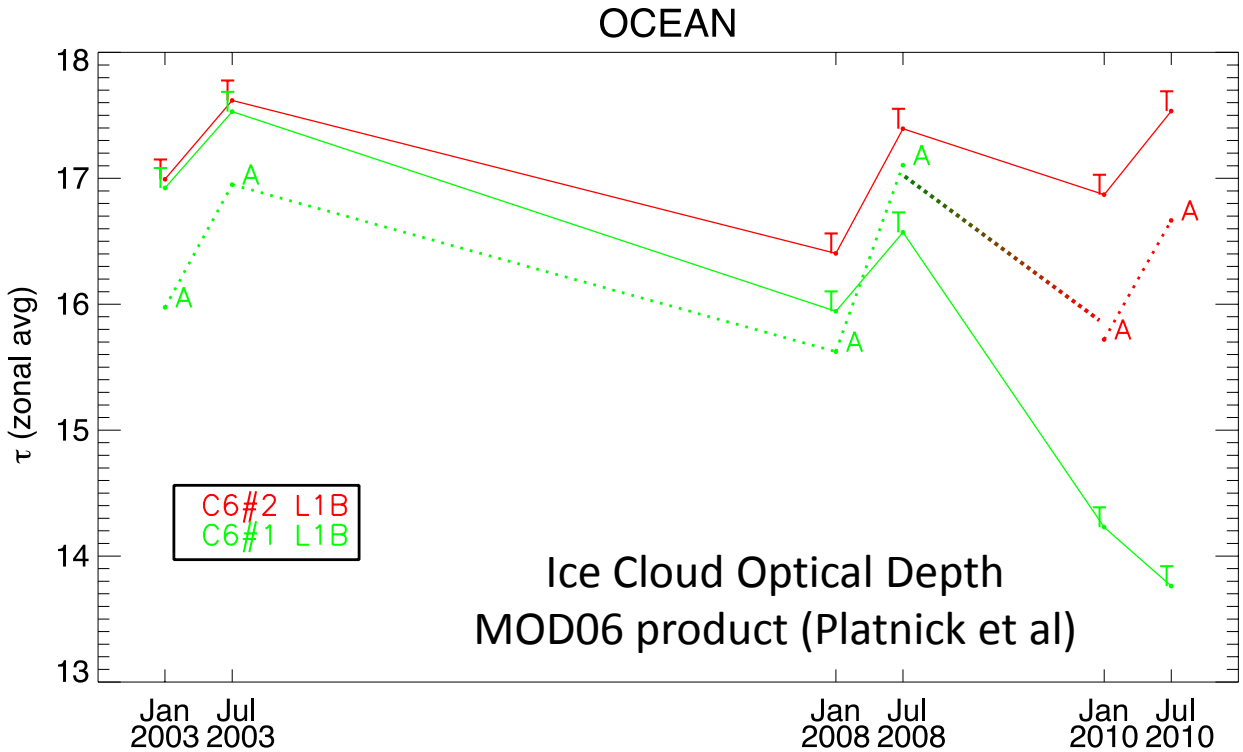
Two calibration Approaches: One AOD algorithm





- Take advantage of MODAPS' testing capabilities
- 6 months processed with same dark-target aerosol algorithms
- Terra (T) Approach II now "in sync" with Aqua (A) time series
- Note that Approach II is calibrated using bright targets
- (Terra-Aqua) offset remains 0.01 (ocean) and 0.015 (land)
- "Fix" means multiplying B3 for Terra by 0.98 (Moon normalization)

Two calibration Approaches: One COD algorithm



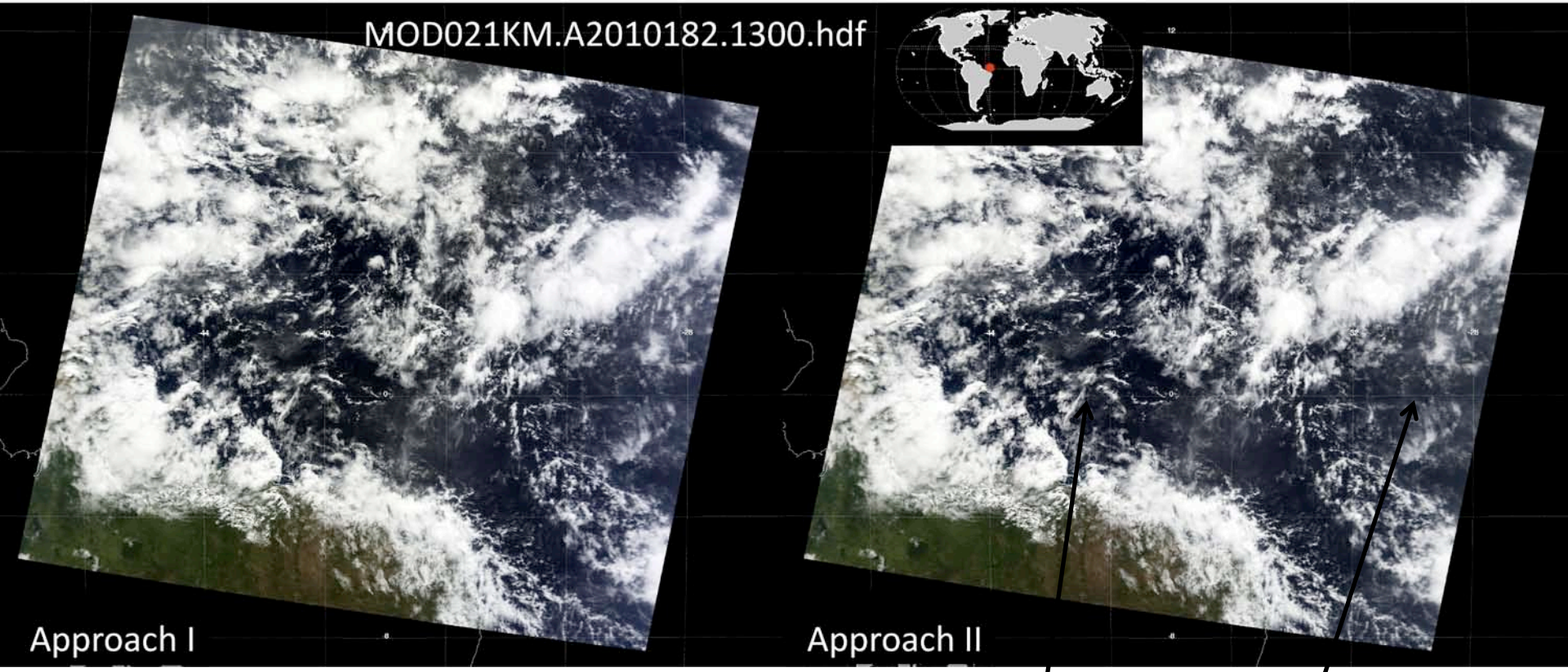
- Approach II may also help to remove Terra-Aqua divergence for cloud optical properties; cloud algorithms use Band 1 and Band 2.
- Seems to work for liquid clouds over land and water clouds over ocean, but not for liquid over ocean or ice over land.

Conclusion

- MODIS Dark target algorithms and products are validated and identical for Terra and Aqua
- For C5, we found trend in Terra AOD
- AOD trend over land consistent with trends in Band #3
- If standard calibration (e.g. Approach I) is used for C6 calibration, then trend will remain for C6.
- If alternative calibration (e.g. Approach II) is used for C6 calibration, then Terra trend might be removed.
- Cloud optical property retrieval may also be improved with Approach II.
- With Approach II, Terra is biased high compared to Aqua.
- More testing is necessary.

- C6 delay: All product teams need to be happy: dark target aerosol, deep blue, Platnick's cloud product, Eric Vermote's land product, etc, etc..

… and removes “bluing” of RGB visible images



More “bluing”

Less “bluing”

Thank you