Calibration and characterization adjustments to the MODIS ocean color bands by the OBPG

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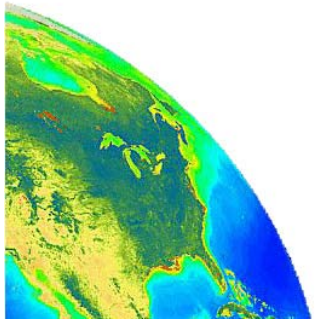
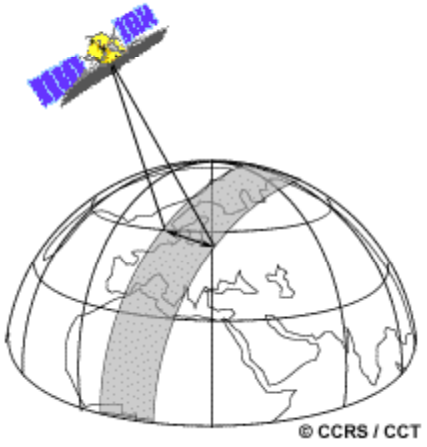
MODIS issues:

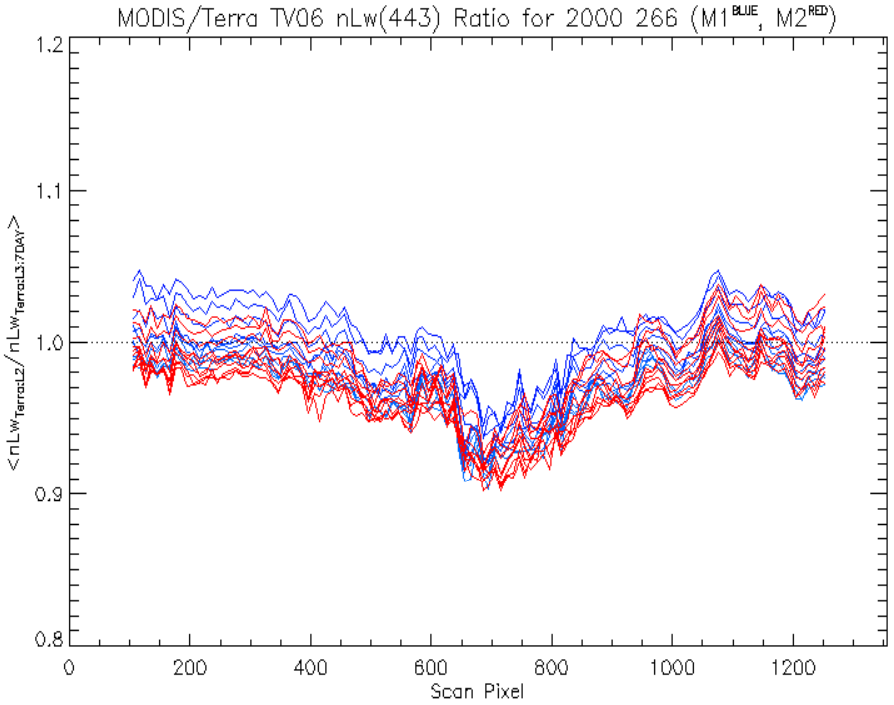
- Small calibration errors (~0.1%) lead to striping/erroneous trending in OC products
- MODIS scan angle radiometric sensitivity changes with time (not for SeaWiFS)
- On-orbit calibration can only be trended for lunar view angle (beginning of scan) and solar diffuser view angle (2nd half of scan, see later slide)
- No on-board capability to trend polarization sensitivity changes on-orbit (not an issue yet for MODIS Aqua but for MODIS Terra)



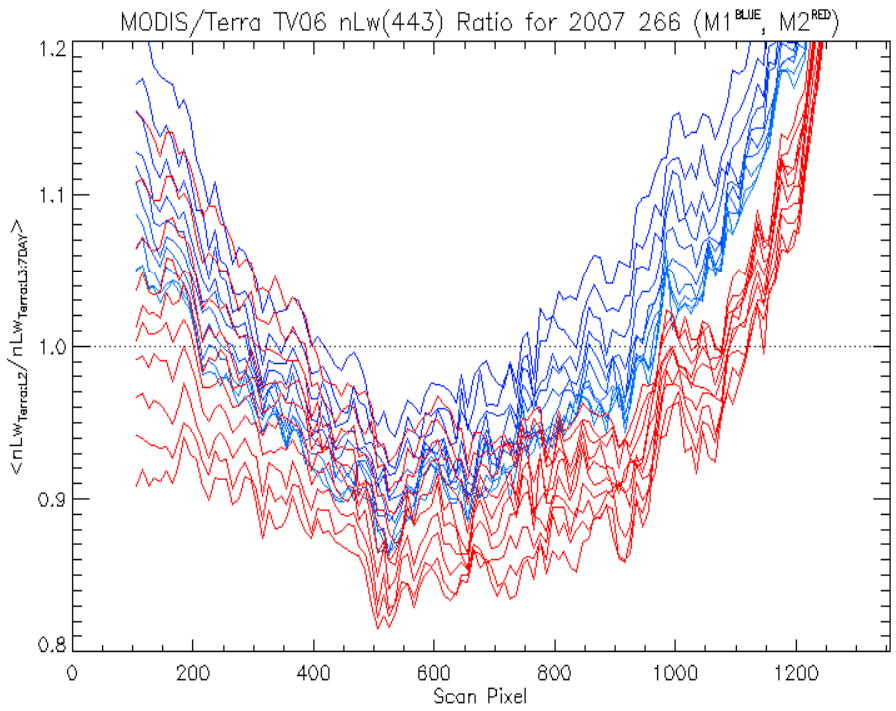


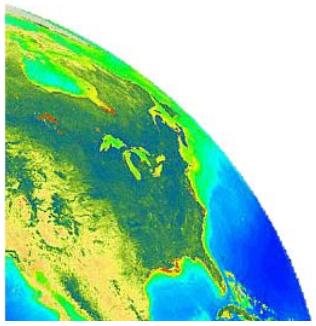
MODIS Terra response-versus-scan (RVS): 443nm

RVS 2000:



RVS 2007:





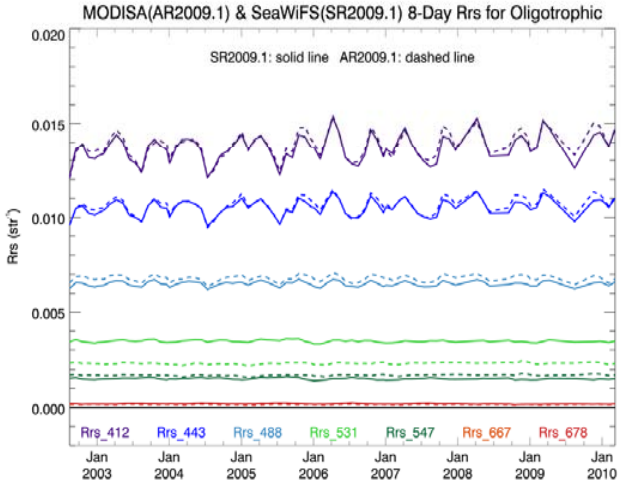
- Some striping and small RVS dependency in 2000
- Strong striping (mirror side and detector) and large RVS dependency in 2007

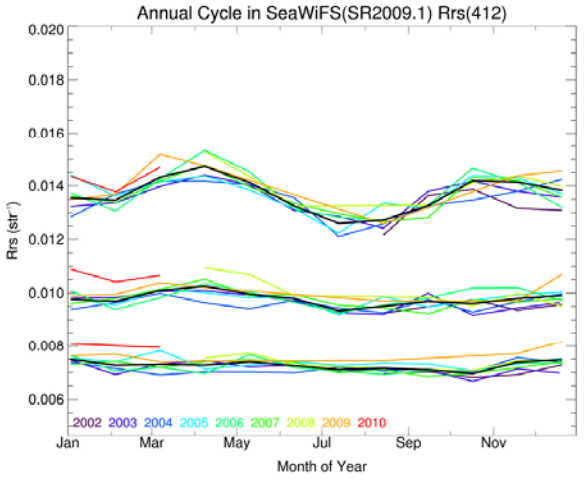
Temporal trend analysis:

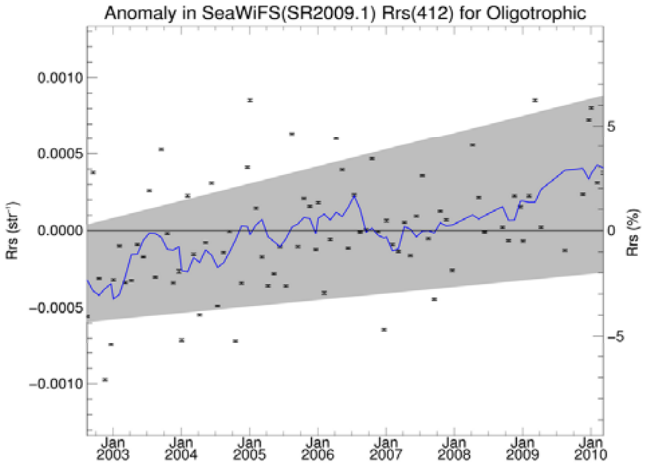
Example: SeaWiFS Rrs 412nm for oligotrophic regions

Global average minus **annual cycle** equals **anomaly**

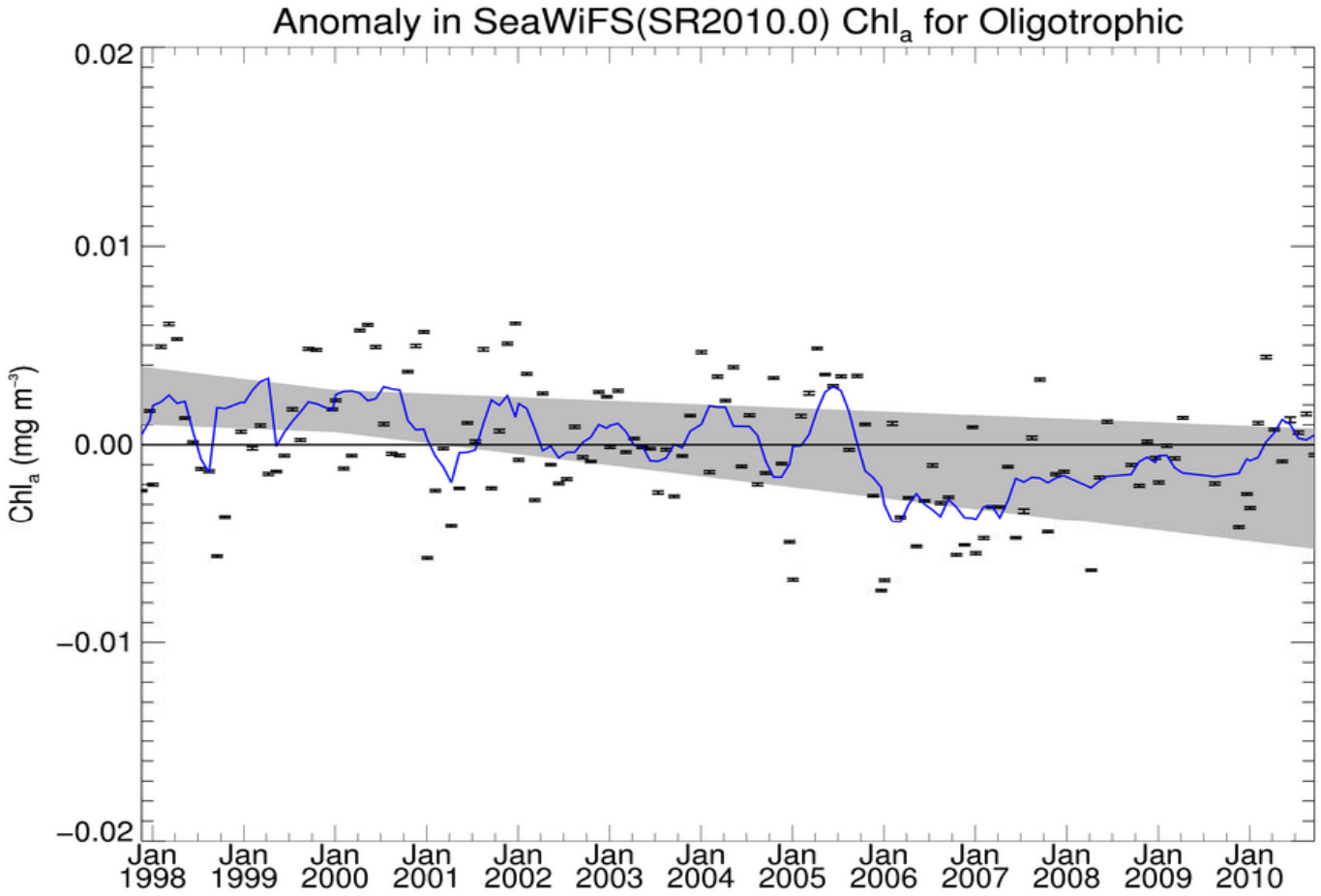
(solid purple line) (mean of top lines) (dots:value with error bar, blue line:same data smoothed gray area:linear trend range)

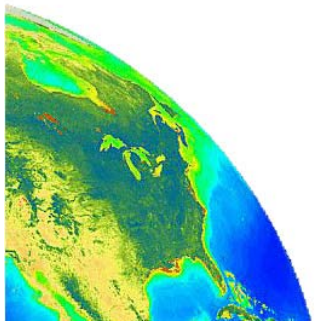




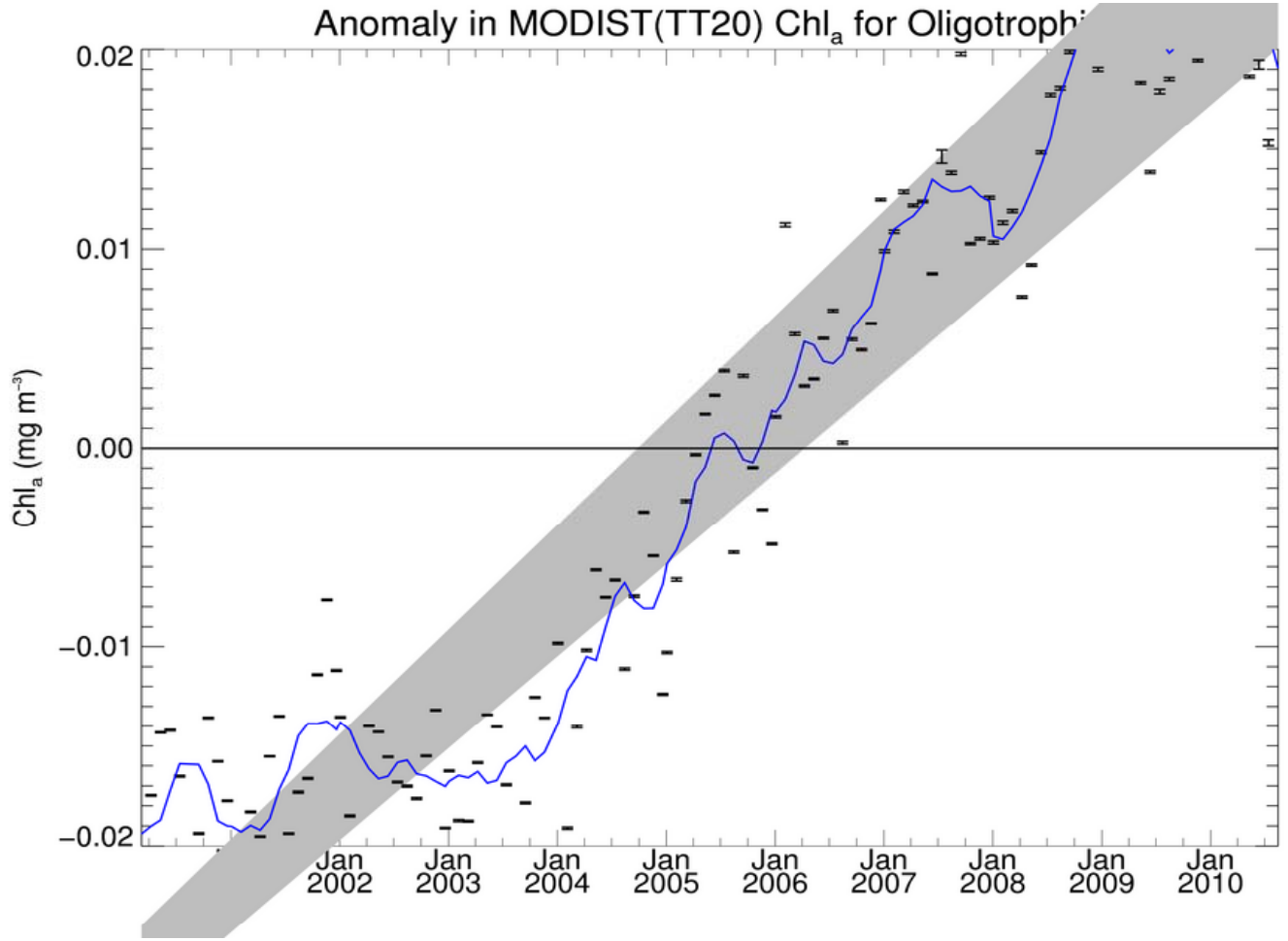


Temporal trend: chl-a SeaWiFS

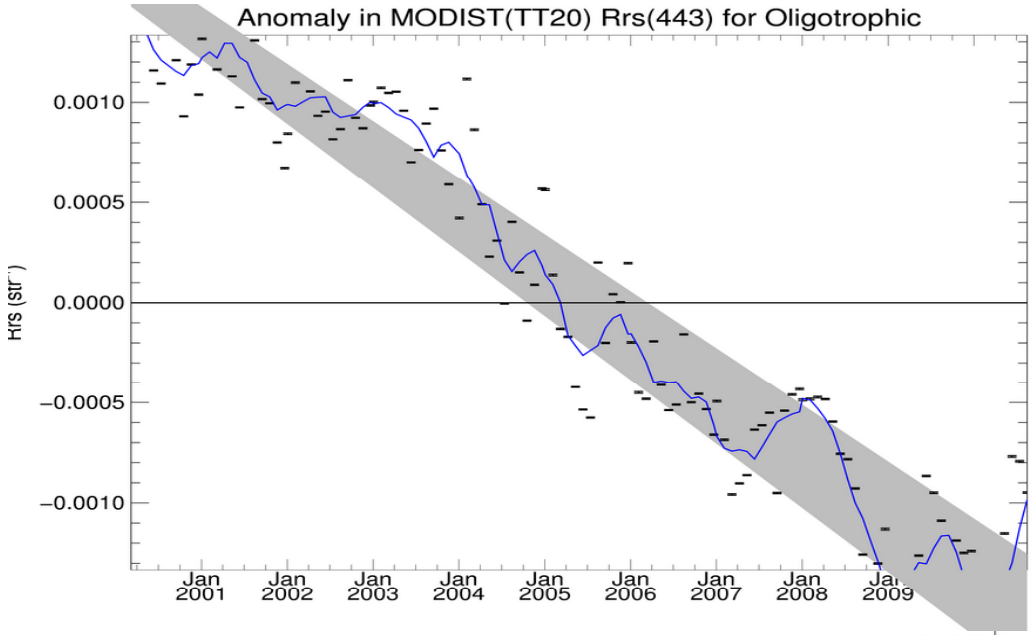


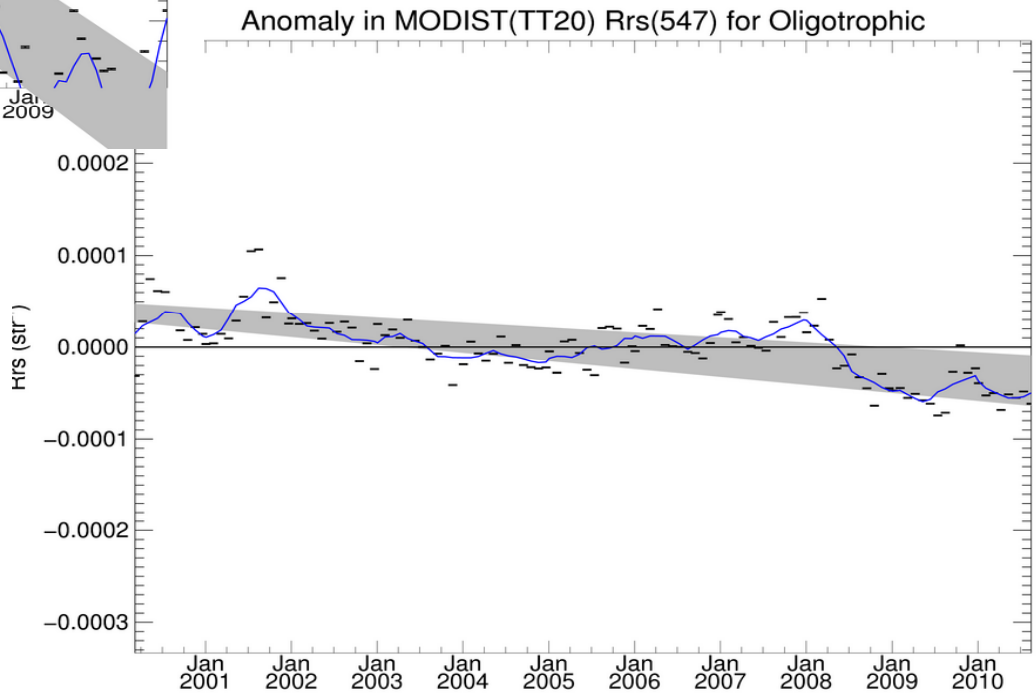


chl-a trend in MODIS Terra w/o calibration adjustment



443nm and 547nm trend in MODIS Terra w/o cal. adj.





Approach summarized:

- Baseline: MCST lunar and SD trending (not official Collection 6 LUT)
- MCST lunar analysis: time dependent NIR RVS
- MODIS Terra bands 8-12 (& 3-4) crosscalibrated to SeaWiFS (as for Terra in Kwiatkowska et al., Applied Optics, 2008)
- Approach: Use SeaWiFS L3 nLw, bring to TOA, adjust MODIS calibration for every month of the mission (15-day L3)
- Verify with analysis using only MODIS Terra data: temporal trends (seasonal cycle removed) and ratio of L2/L3 versus scan angle

Modeling of TOA Stokes vector over oceans

air aerosol whitecap glint water gas

$$\begin{bmatrix} L_t \\ Q_t \\ U_t \\ 0 \end{bmatrix}$$

$$L_t(\lambda) = [\, L_r(\lambda) + L^a(\lambda) + tL_f(\lambda) + TL_g(\lambda) + t_d(\lambda)L^w(\lambda) \,] \cdot t_g(\lambda)$$

from MODIS NIR
assumes MCST NIR band characterization

$\lambda' \rightarrow \lambda$
fit based on bio-optical models

$L^{wn}(\lambda')$

SeaWiFS
15-day mean

Crosscalibration approach:

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

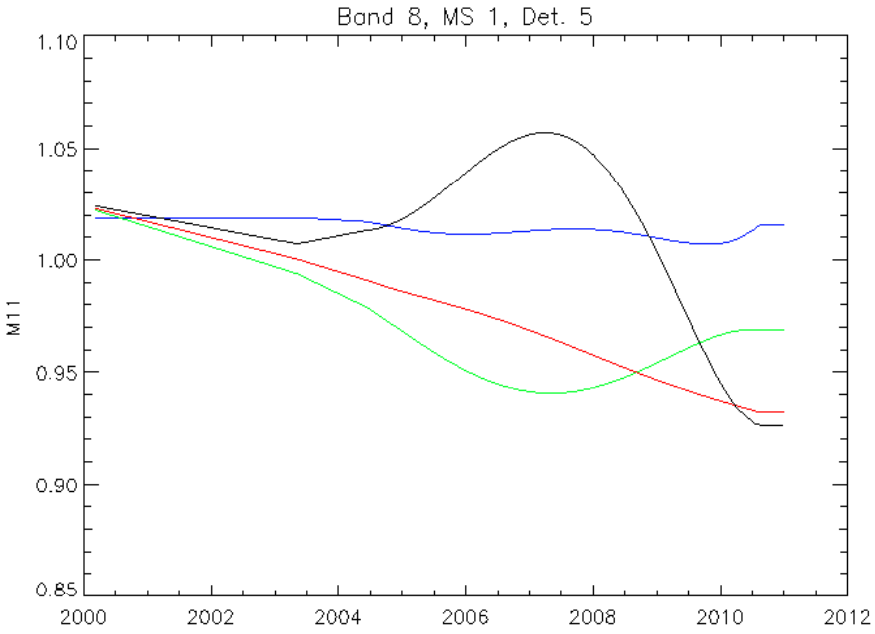
L_m: measured TOA radiance (MODIS)

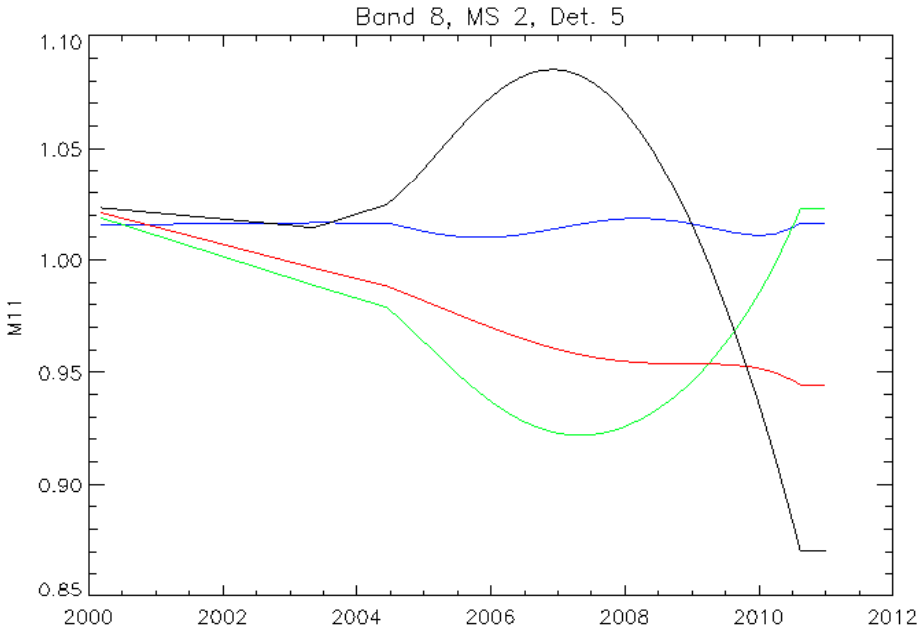
L_t: true TOA radiance (from SeaWiFS)

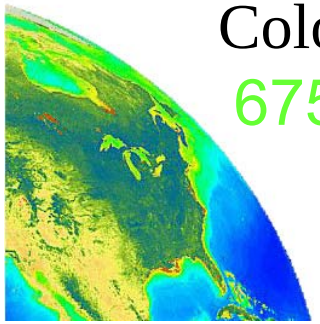
Q, U : linear Stokes vector components, modeled from Rayleigh and glint

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

MODIS Terra gain corrections as a function of time at different view angles at 412nm:

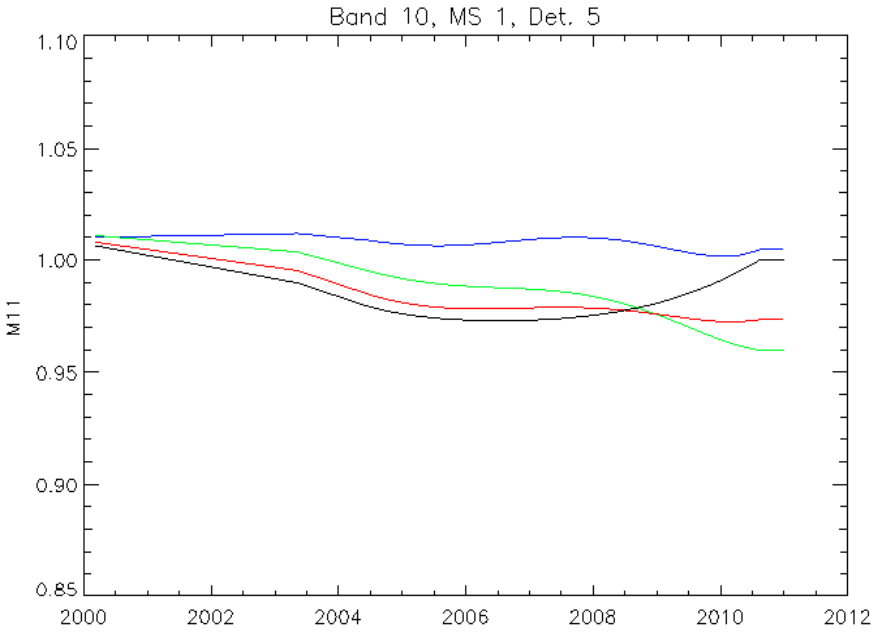


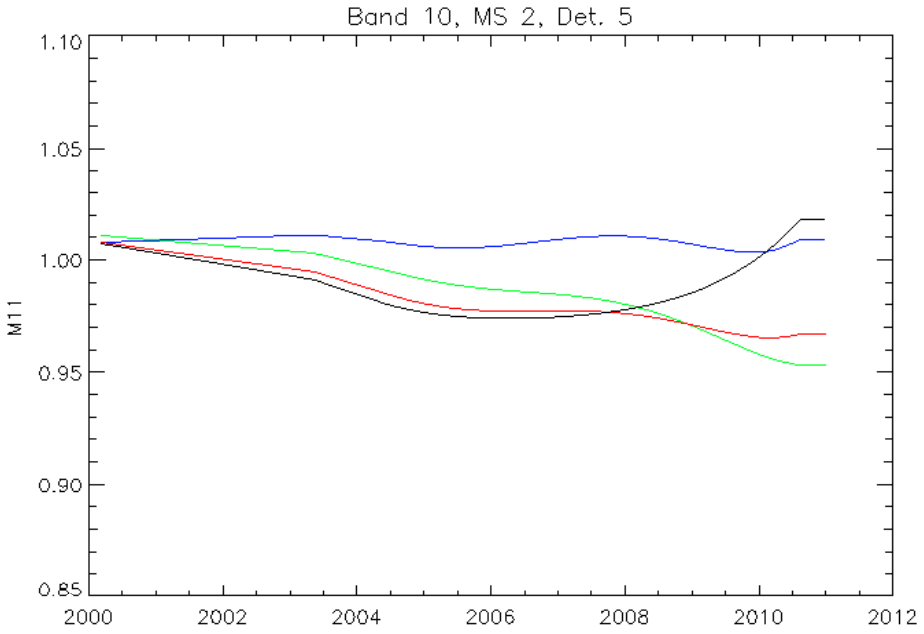


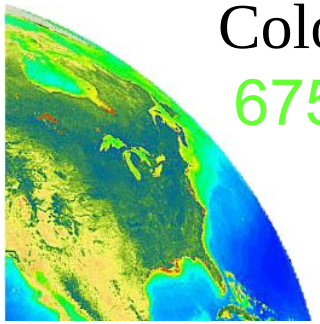


Color coding: Frame/pixel 22 (beginning of scan, lunar), 675 (nadir), 989 (solar diffuser), 1250 (end of scan)

MODIS Terra gain corrections as a function of time at different view angles at 488nm:

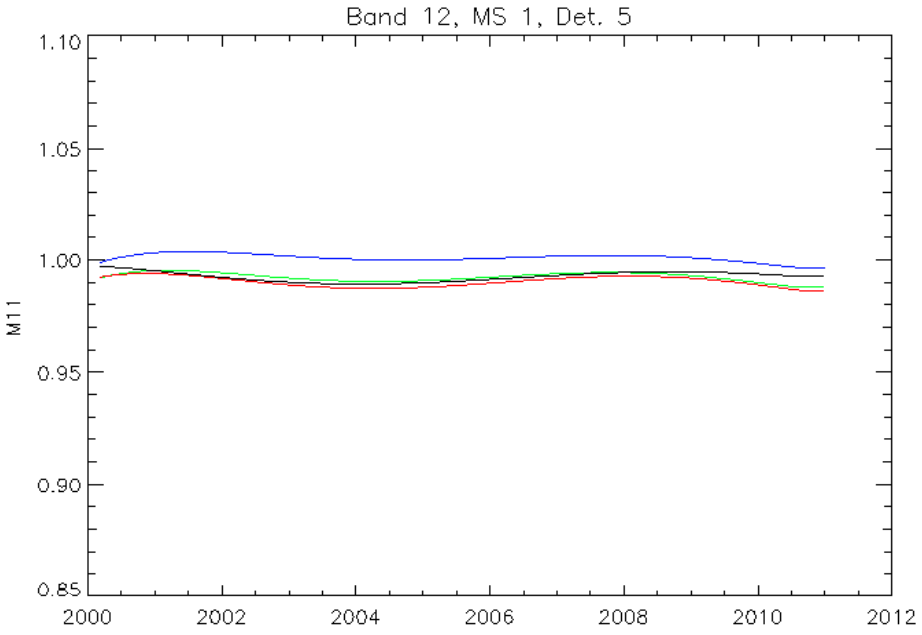


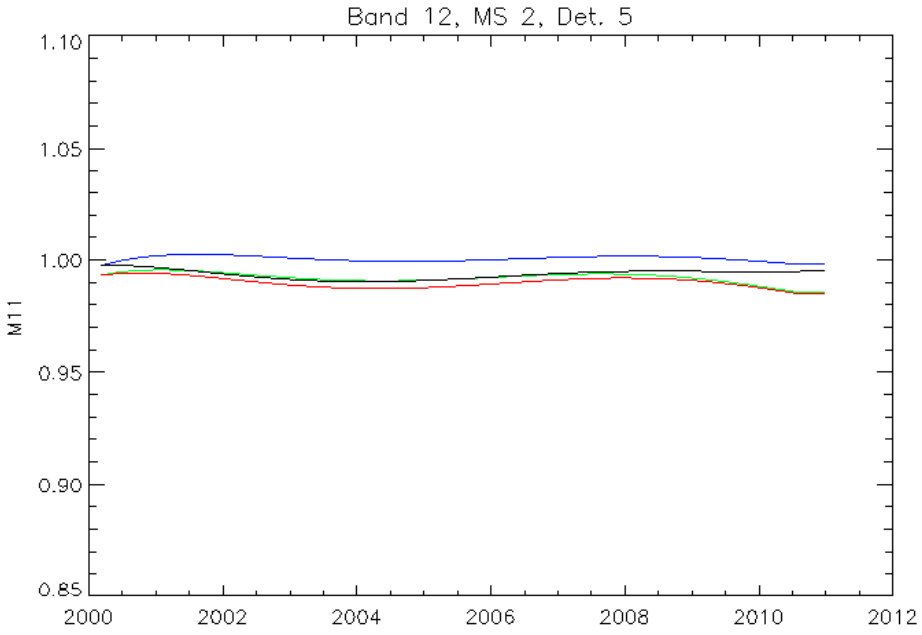


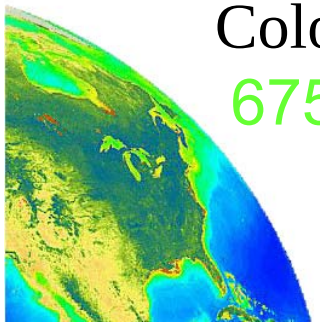


Color coding: Frame/pixel 22 (beginning of scan, lunar), 675 (nadir), 989 (solar diffuser), 1250 (end of scan)

MODIS Terra gain corrections as a function of time at different view angles at 547nm:

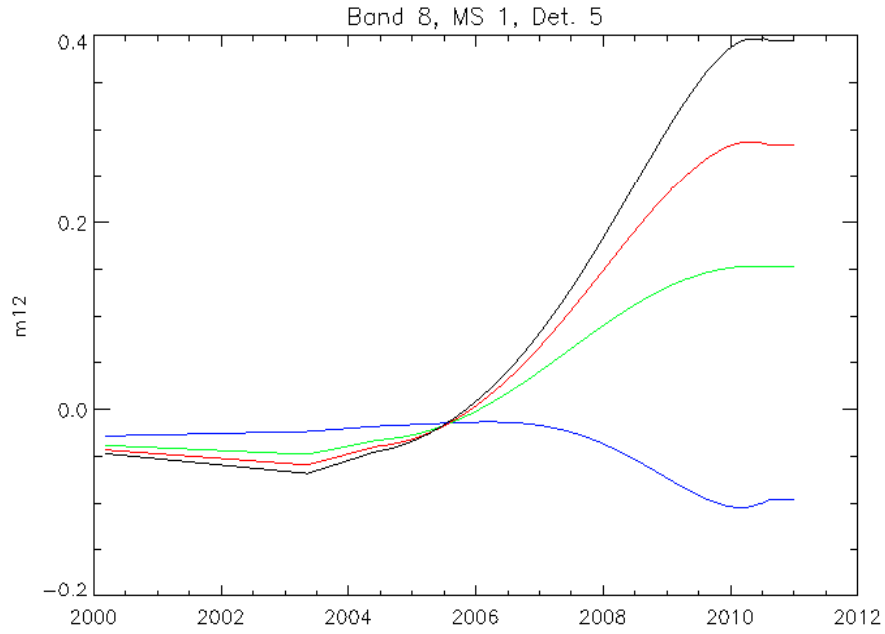


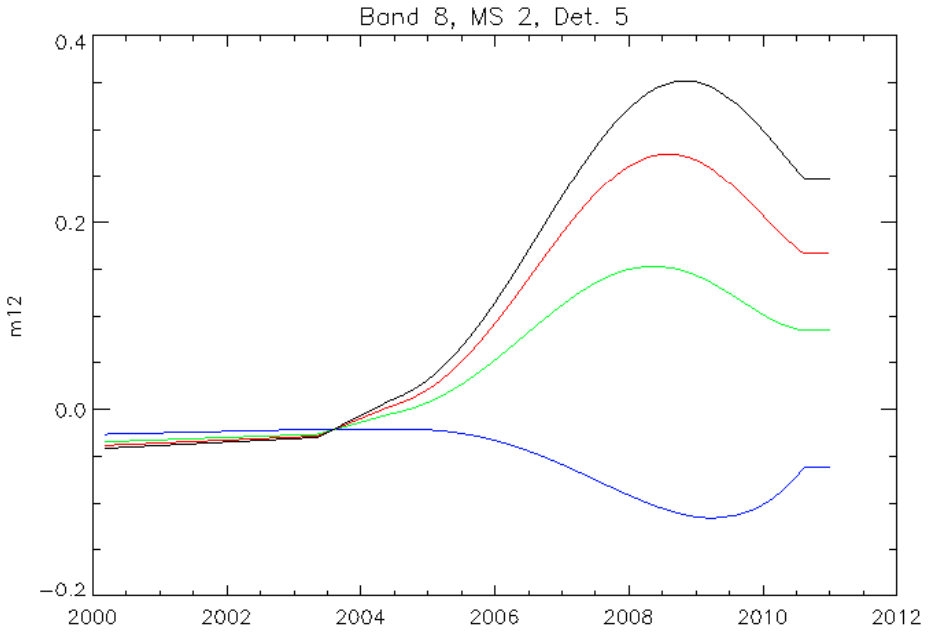


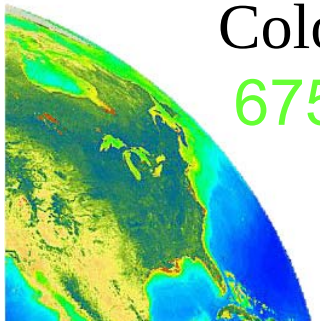


Color coding: Frame/pixel 22 (beginning of scan, lunar), 675 (nadir), 989 (solar diffuser), 1250 (end of scan)

MODIS Terra polarization corrections as a function of time at different view angles at 412nm:







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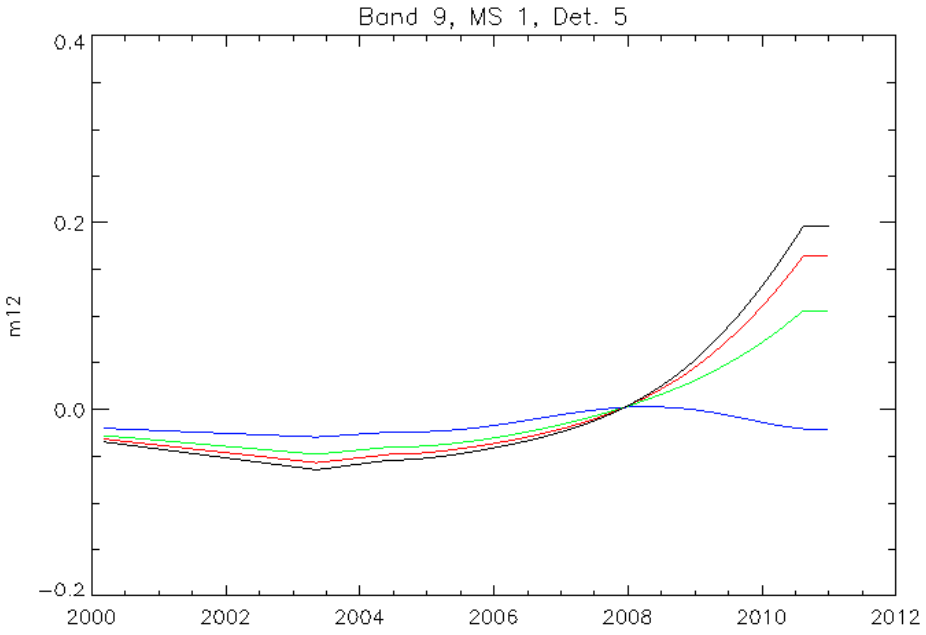
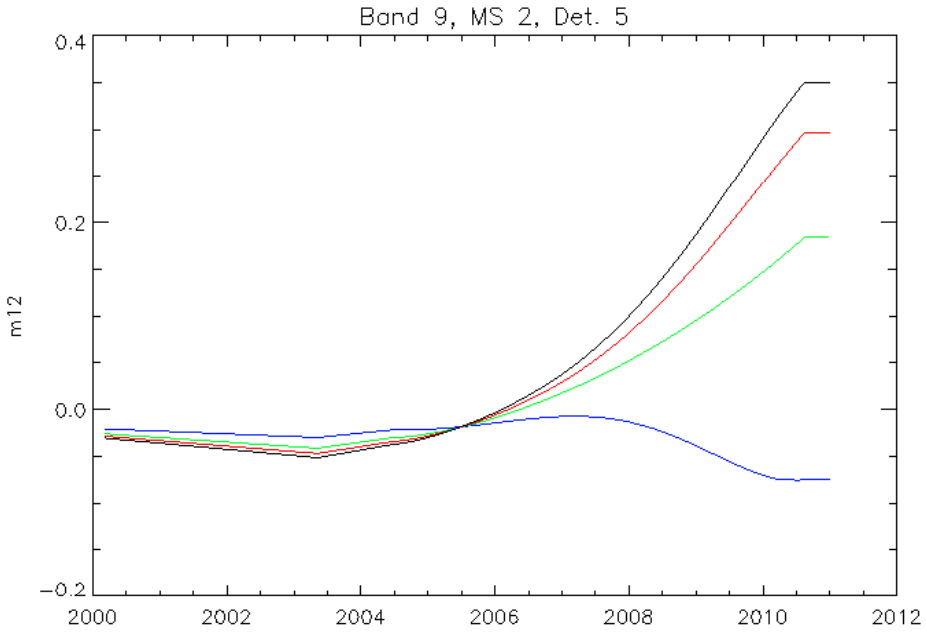
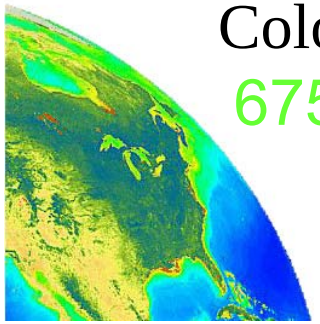
MODIS Terra polarization corrections as a function of time at different view angles at 443nm:







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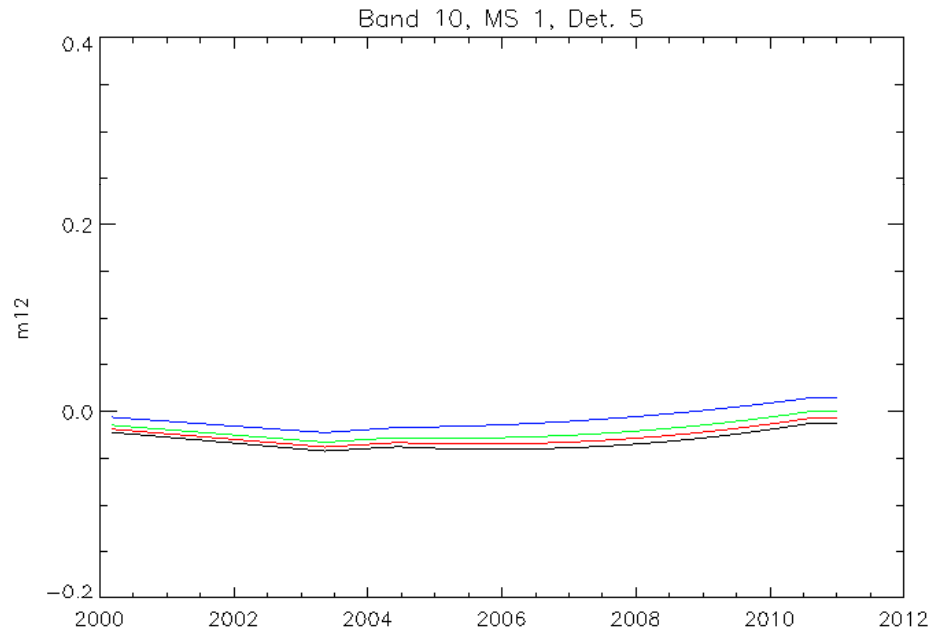
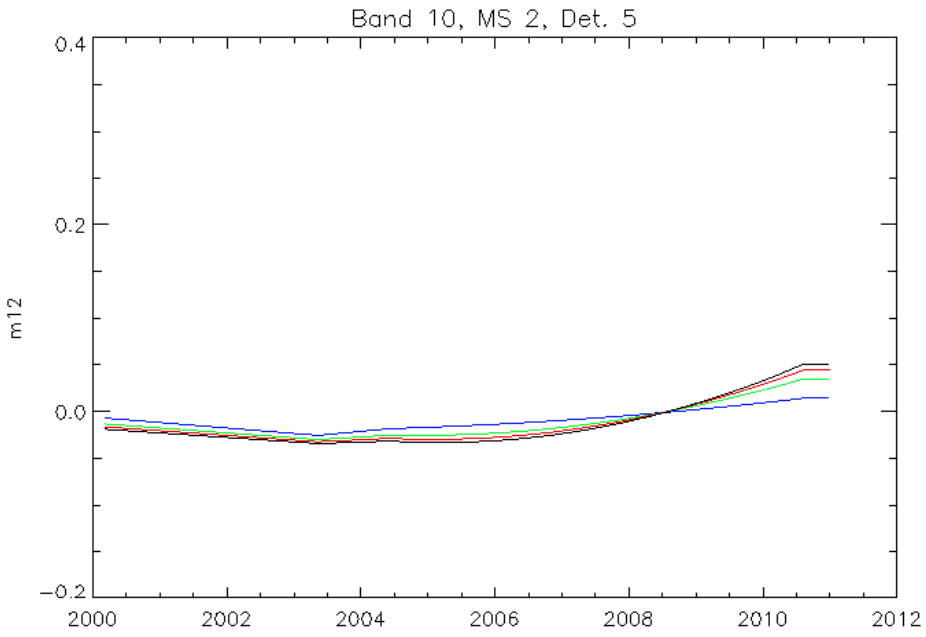
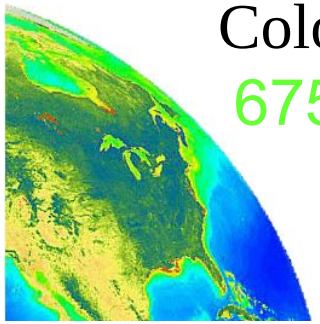
MODIS Terra polarization corrections as a function of time at different view angles at 488nm:

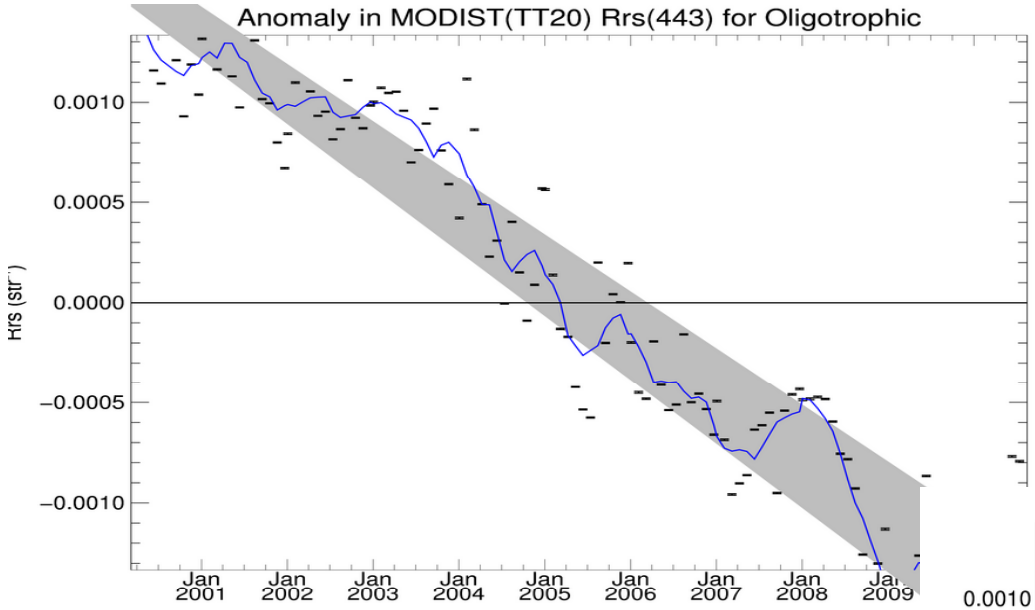


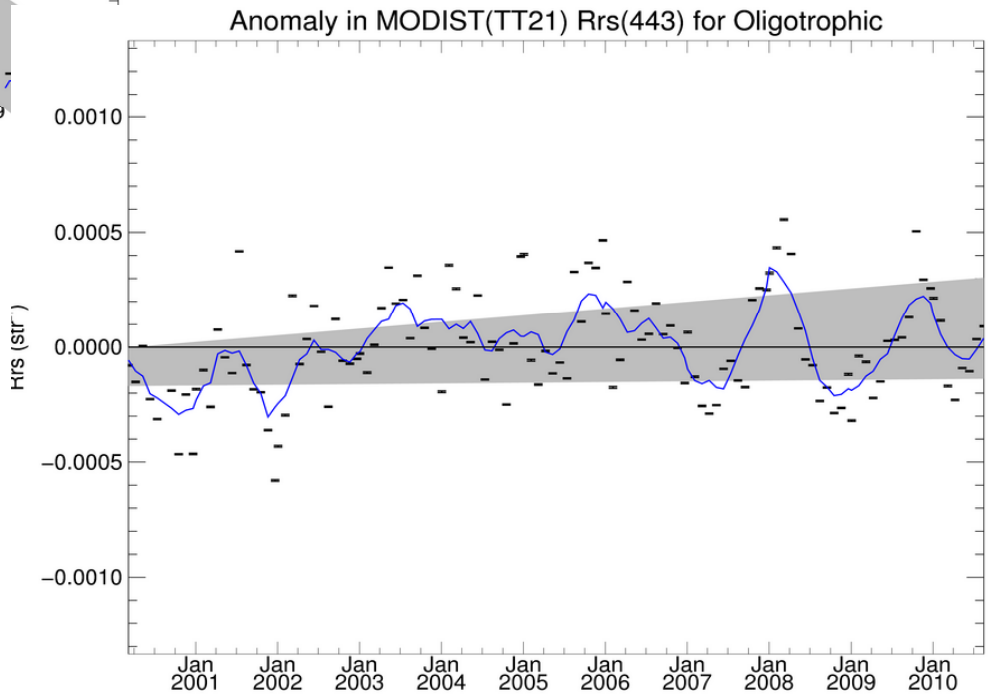




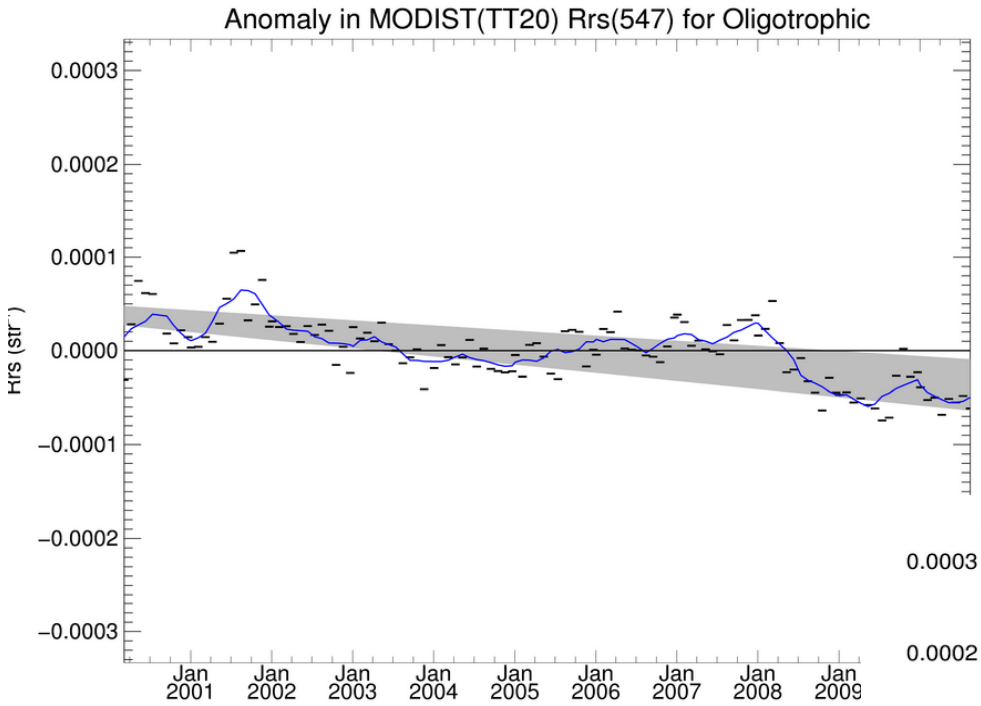
Color coding: Frame/pixel 22 (beginning of scan, lunar), 675 (nadir), 989 (solar diffuser), 1250 (end of scan)

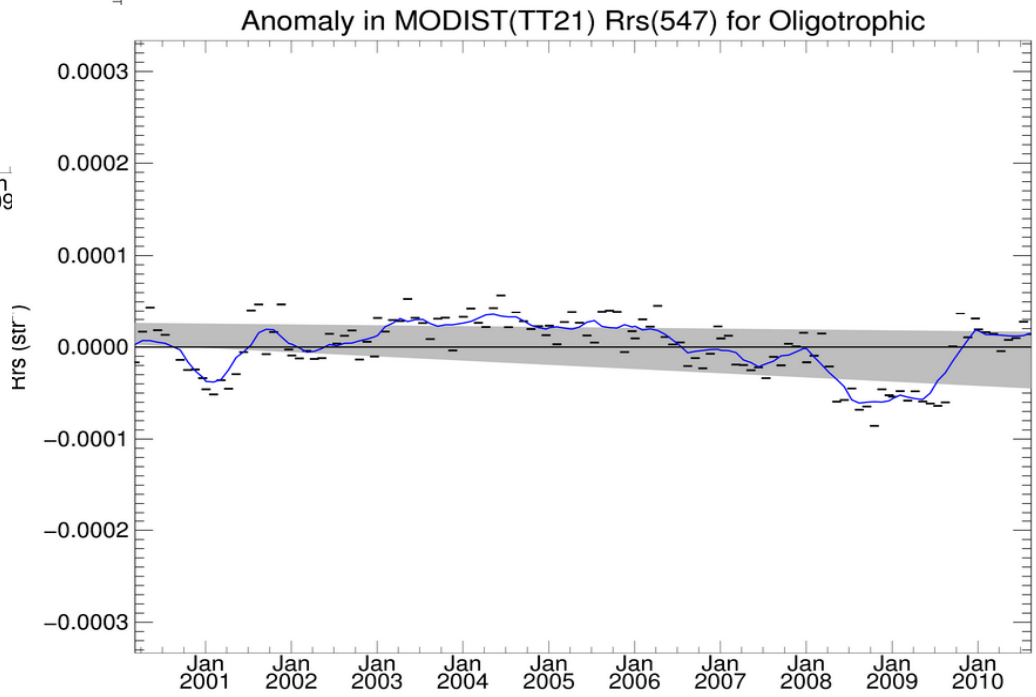
443nm trend in MODIS Terra with & w/o xcal



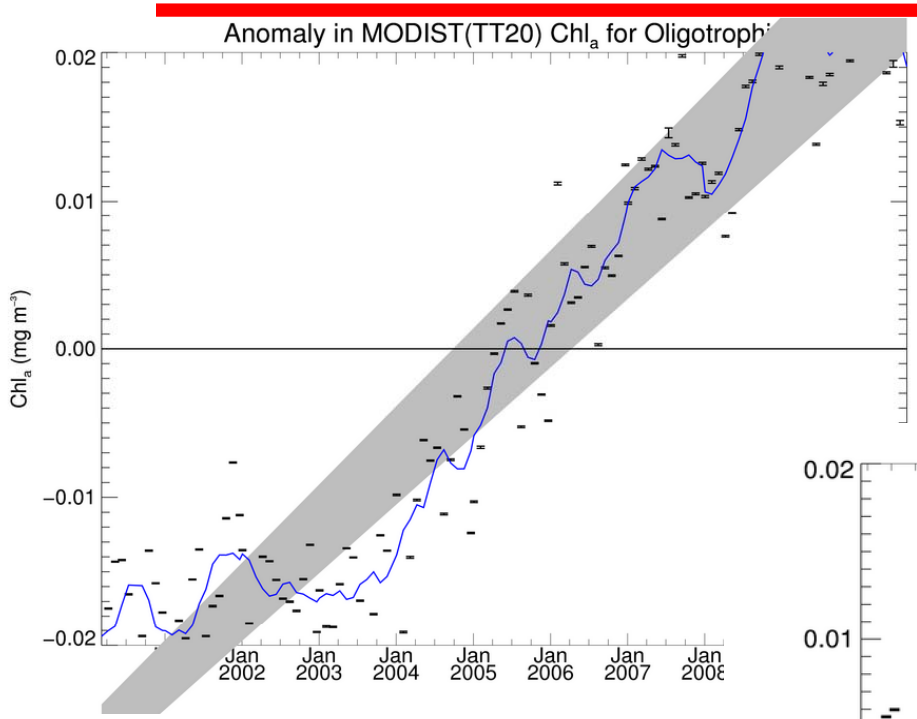


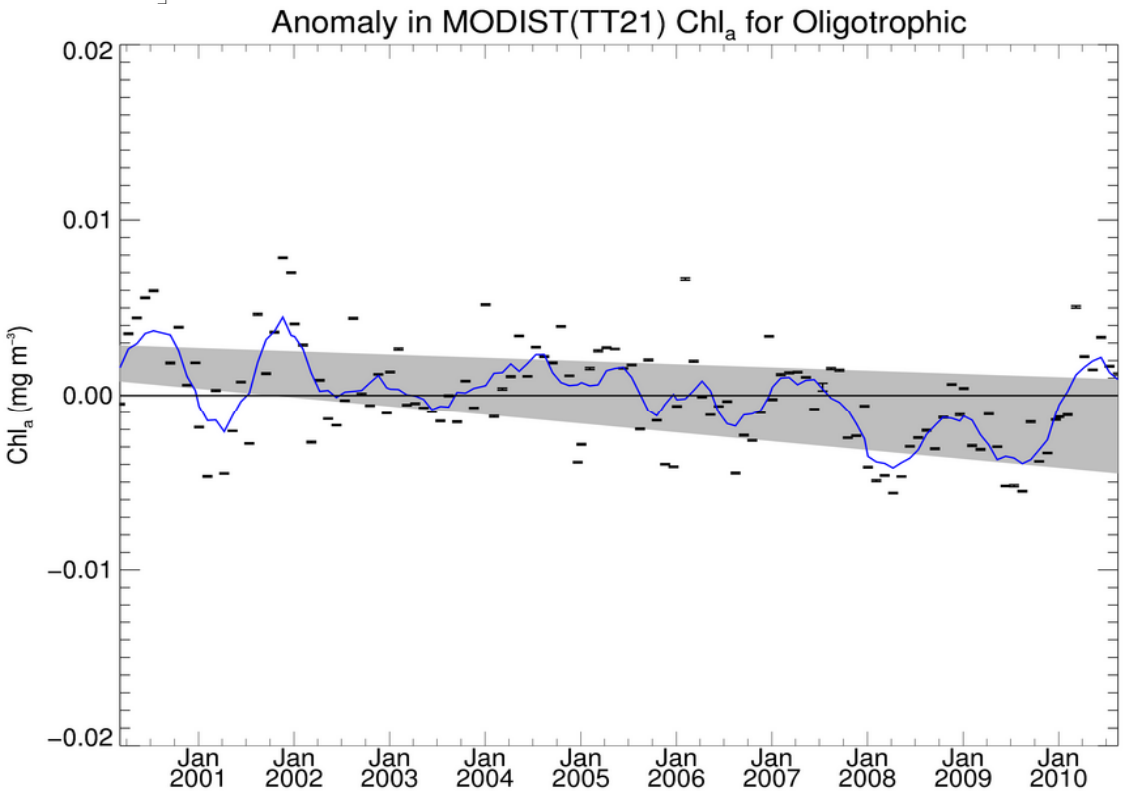
547nm trend in MODIS Terra with & w/o xcal





chl-a trend in MODIS Terra with & w/o xcal

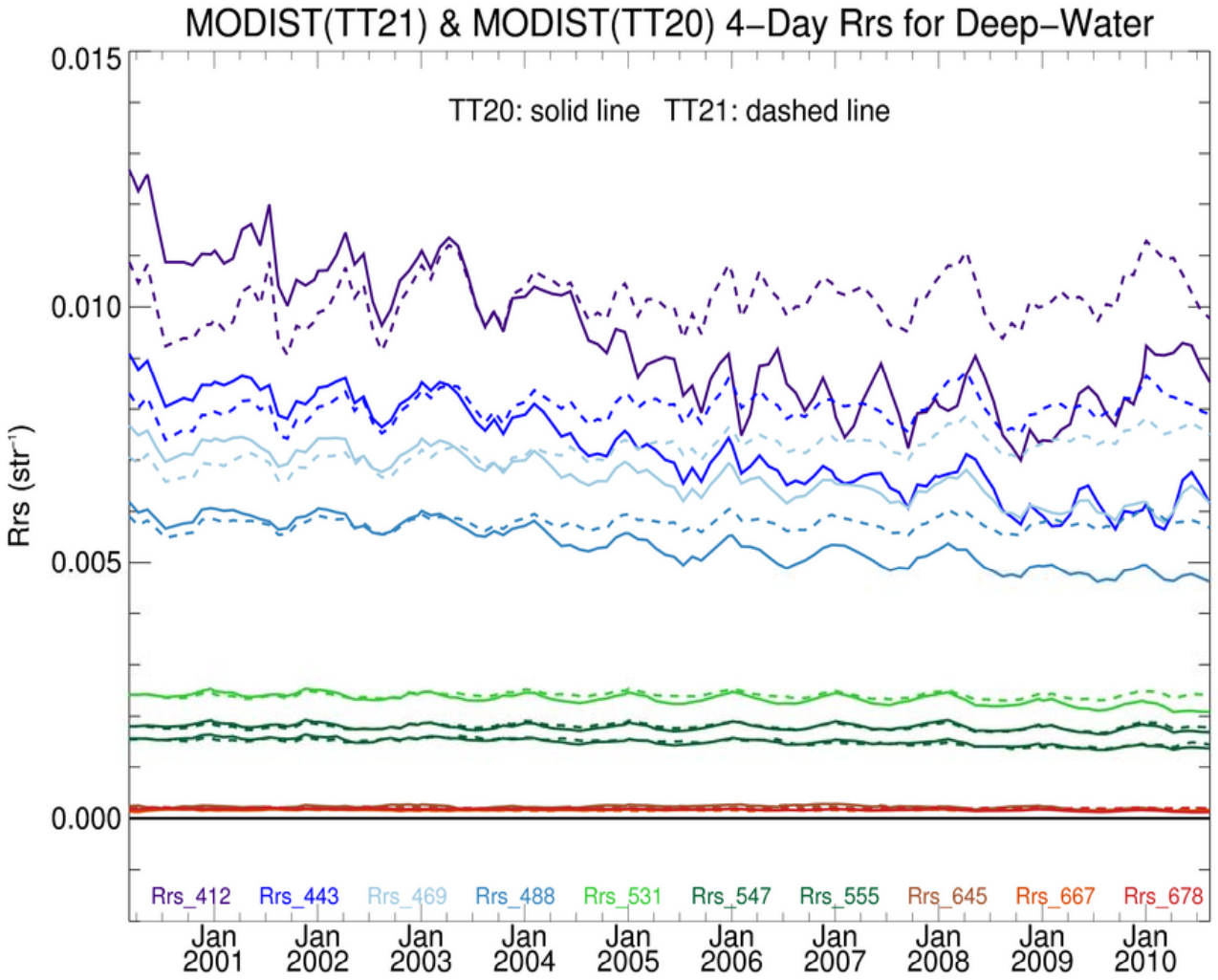




MODIS Terra with & w/o xcal

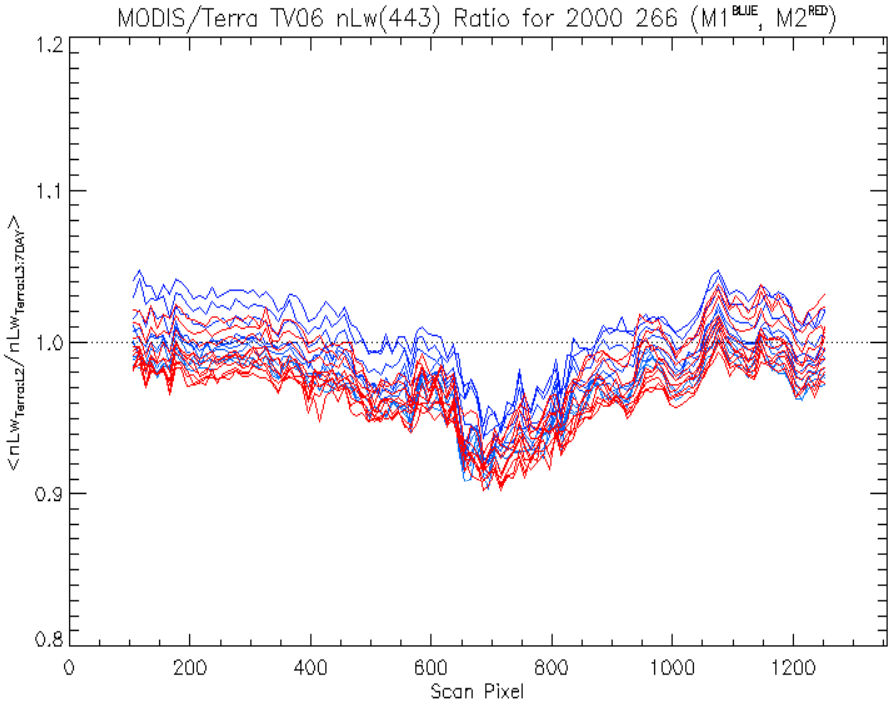
Terra R2010.0 includes land bands, (under evaluation)

Red bands (667nm and 678nm) have been adjusted using MODIS Aqua

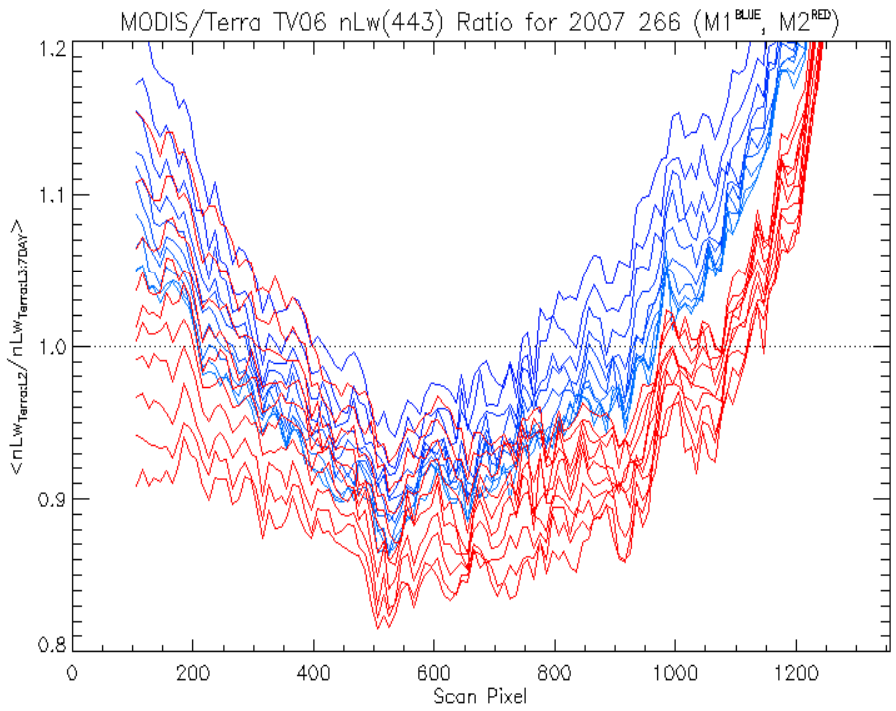


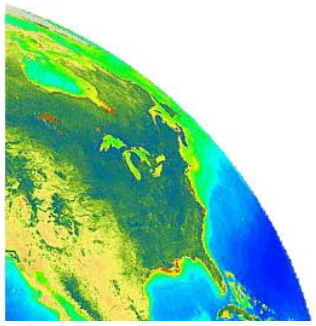
MODIS Terra RVS w/o xcal: 443nm

RVS 2000:



RVS 2007:

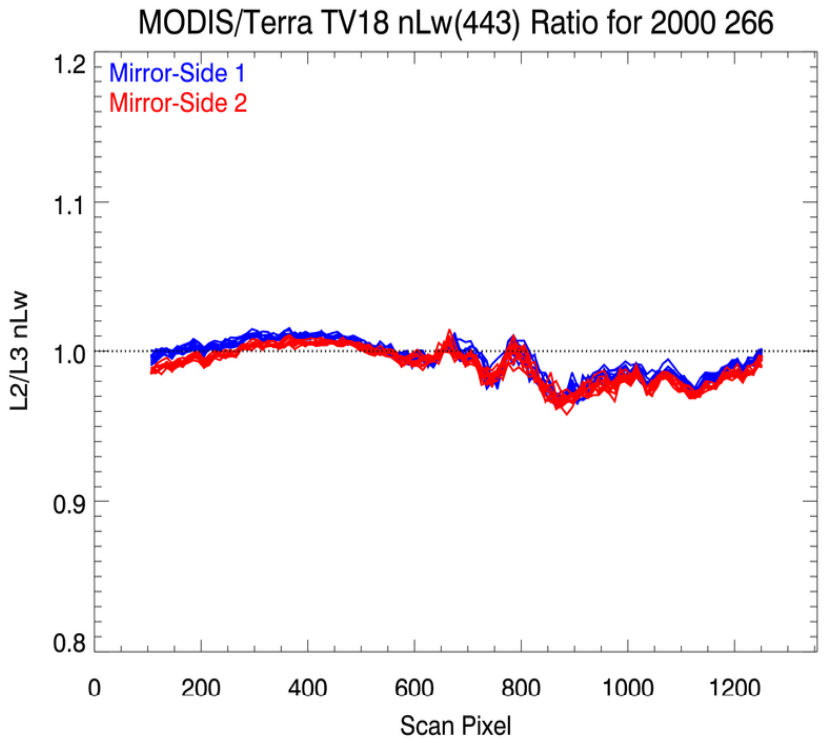




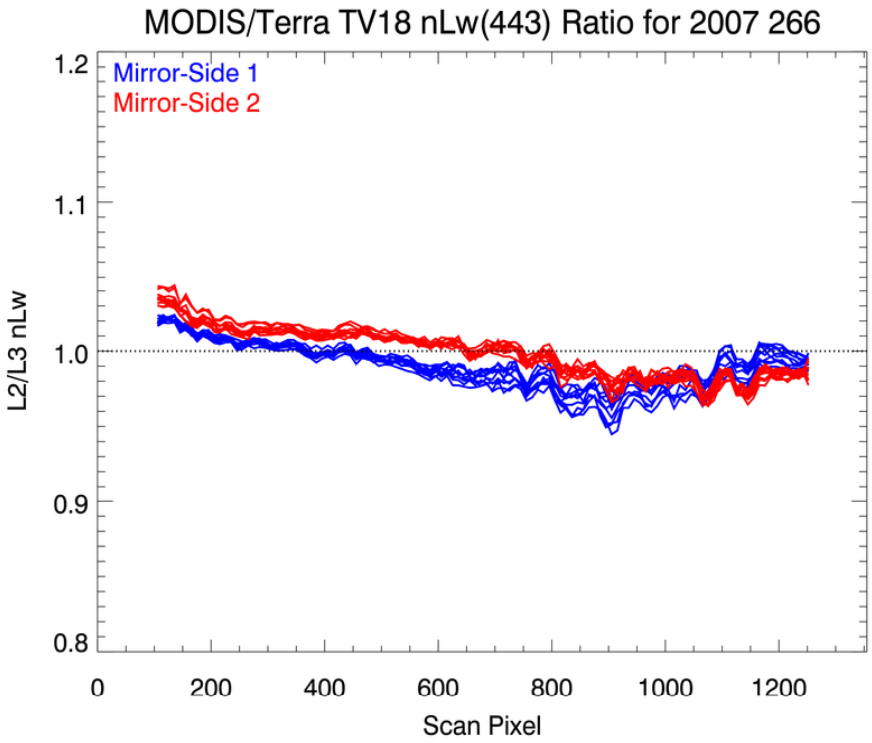
- Some striping and small RVS dependency in 2000
- Strong striping (mirror side and detector) and large RVS dependency in 2007

MODIS Terra RVS with xcal: 443nm

RVS 2000:



RVS 2007:



- Significant improvement for striping and RVS, residual mirror side striping in 2007
- Analysis shown not from final configuration

Summary:

- MODIS Terra reprocessing finished Jan. 2011
  - Good agreement with SeaWiFS and Aqua for long term global averages (temporal trending and scan angle dependence)
  - Sensor degradation in blue (gain and polarization) will impact quality, especially for L2
  - Relative to LUT V6.1.6.2, not the official LUT
  - Lunar trends almost unchanged, SD trends adjusted by ~8% for 412nm, small changes for green and red bands

- MODIS Aqua partial reprocessing R2010.0 to start soon
  - Same approach as before (bands 8 and 9 temporal gain adjustments, no pol. Correction)
  - Only data from 2009 onward
  - Approach without SeaWiFS under development