Calibration Adjustments for the MODIS Aqua 2015 Ocean Color Reprocessing

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MODIS/VIIRS Science Team, Calibration Breakout

Silver Springs, MD,

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Background:

- The upcoming MODISA Ocean Color reprocessing (R2014.0) is mainly about a new data format (HDF5) for the L2 files, ancillary data, algorithm updates
- We used new fits for the whole time series (avoids uncertainty from predictions during regular processing)
- MCST provided complete refit of RSB LUT (now V6.1.33.8_OC2)
- OBPG redid xcal analysis (now axc38d) of MODISA to itself
- MODIS Aqua does not show strong changes in polarization sensitivity -> polarization correction still prelaunch, xcal adjustments only for gains

Xcal: MODISA 'true' TOA radiance

air aerosol whitecap glint water gas

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

from MODISA NIR
assumes MCST NIR band characterization

from MODISA $L^w(\lambda)$ 6-day mean
(7 days excluding central day,
only frames 300-1050)

$L(\lambda)$ = radiance at wavelength λ
$t(\lambda)$ = transmission at wavelength λ

Xcal to itself: small impact on temporal trending, potentially large impact on scan angle depencence

Crosscalibration coefficients:

$L_m/M_{11} = L_t$

$M_{11} = a_0 + a_1 * f + a_2 * f^2 + a_3 * f^3 + a_4 * f^4$

L_m: measured TOA radiance (MODISA)

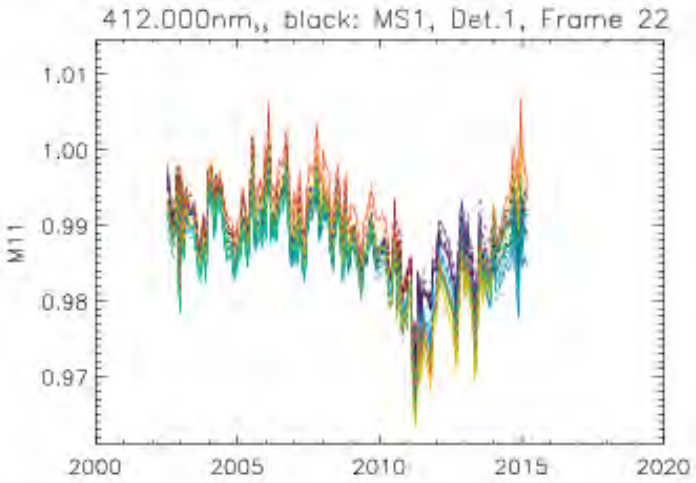
L_t: true TOA radiance (from MODISA L3)

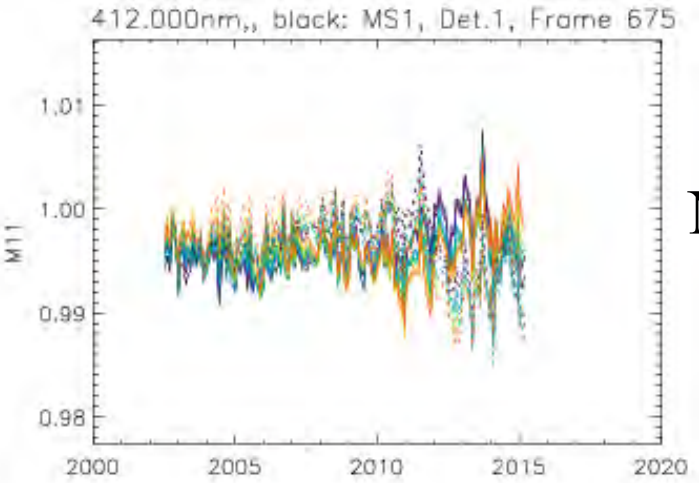
f: frame number (0-1353)

M_{11}: gain correction, depends on band, MS, detector. Total of 2*10*5 = 100 polynomial coefficients ($a_{(i)}$) per band per day. ~2-3 million matchups per day.

M_{11} at 412nm for 4 different scan angles:

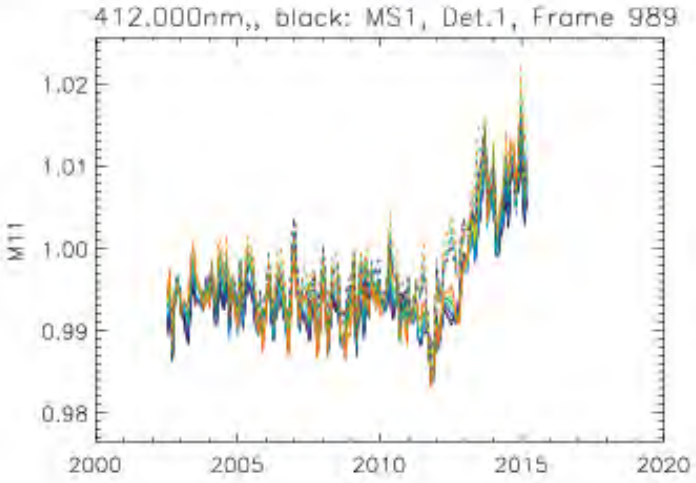
Beg. of scan (lunar)

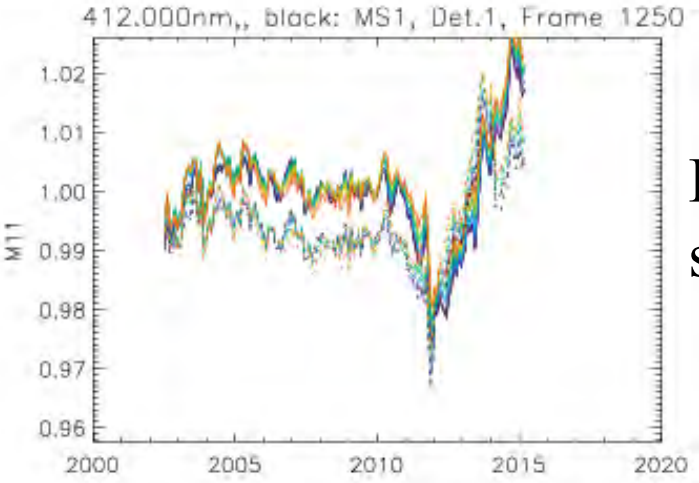




Nadir

Solar Diffuser



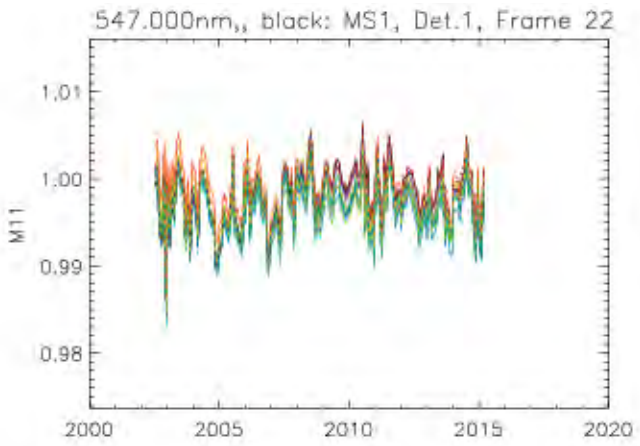


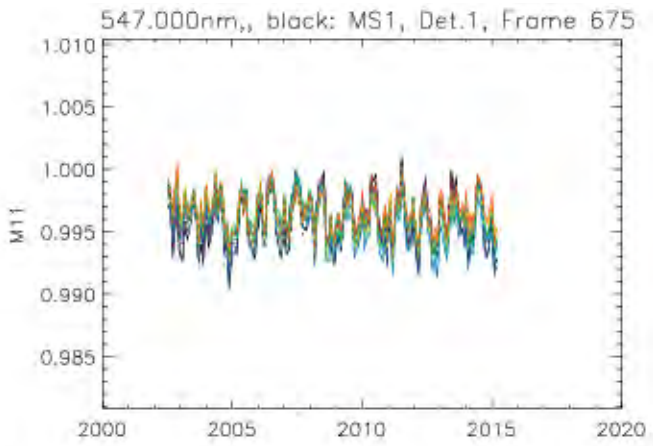
End of scan

- Colors: detectors 1-10
- Solid (dashed) lines: mirror side 1 (2)

M_{11} at 547nm for 4 different scan angles:

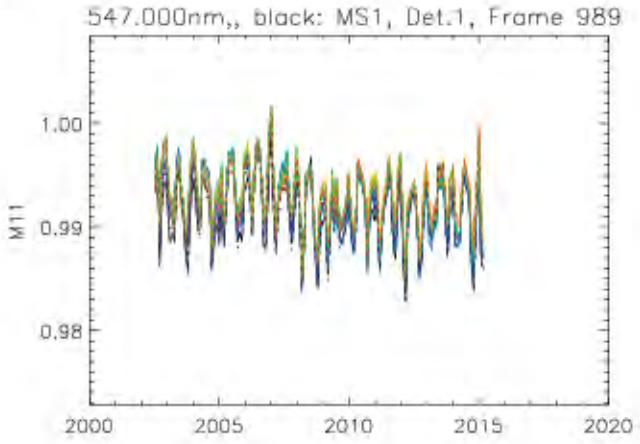
Beg. of scan (lunar)

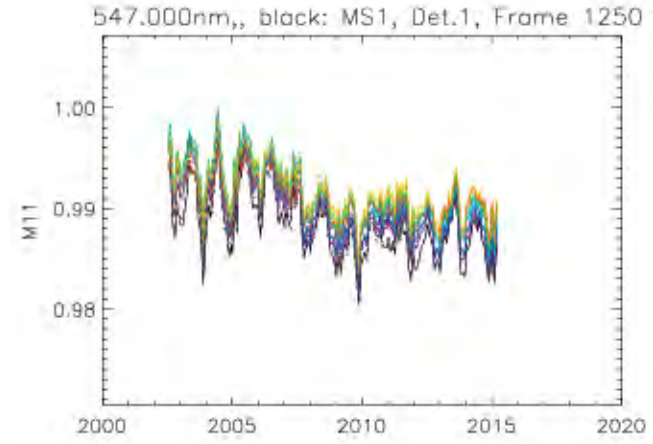




Nadir

Solar Diffuser



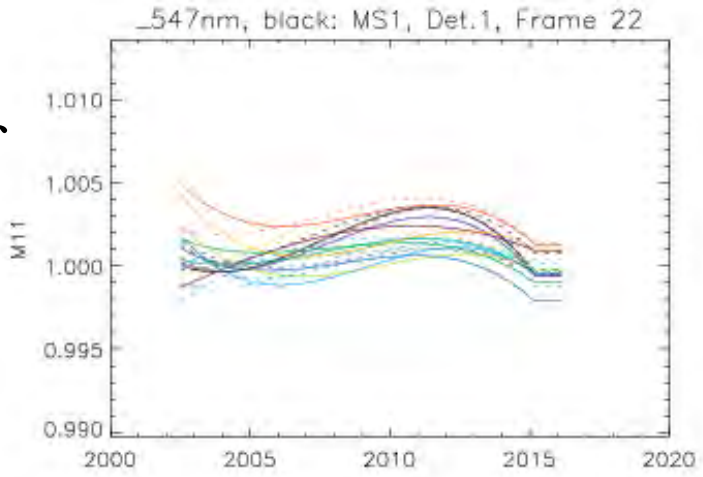


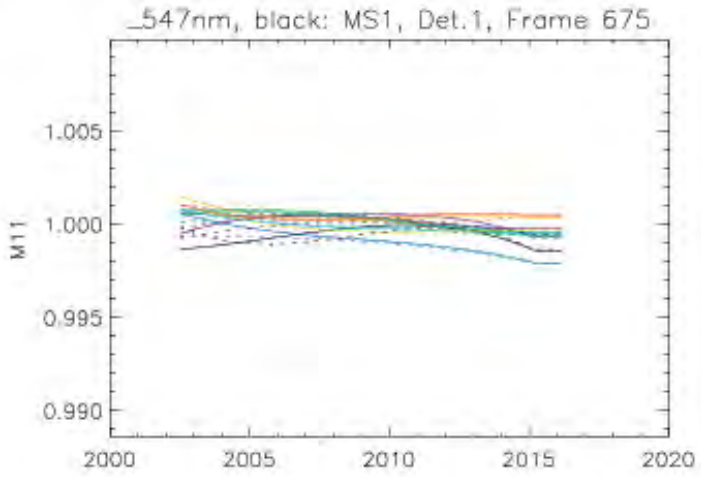
End of scan

- Colors: detectors 1-10
- Solid (dashed) lines: mirror side 1 (2)

M_{11} at 547nm after temporal fit:

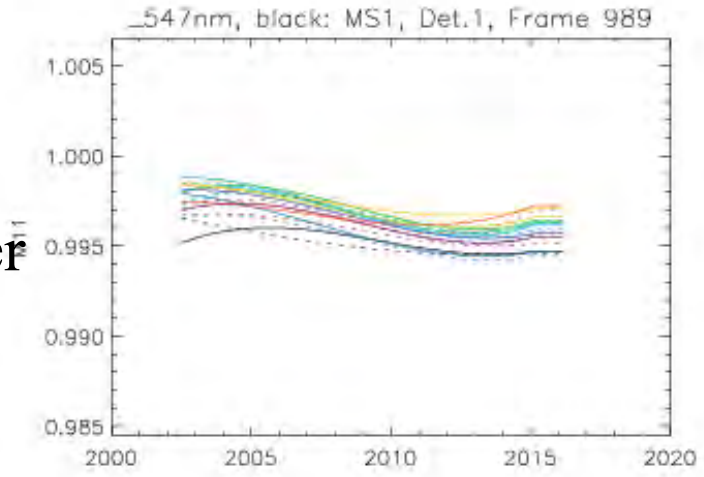
Beg. of scan (lunar)

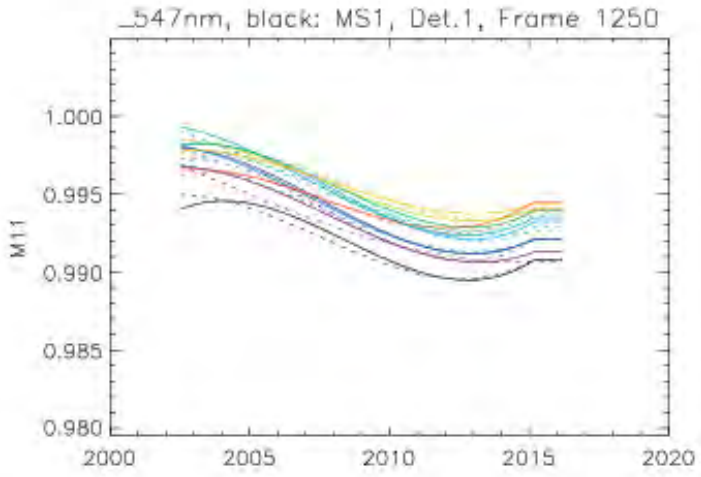




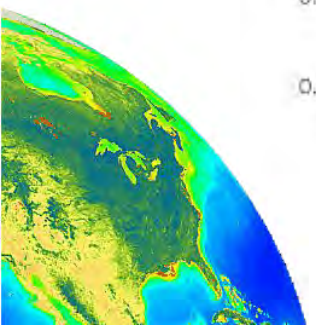
Nadir

Solar Diffuser



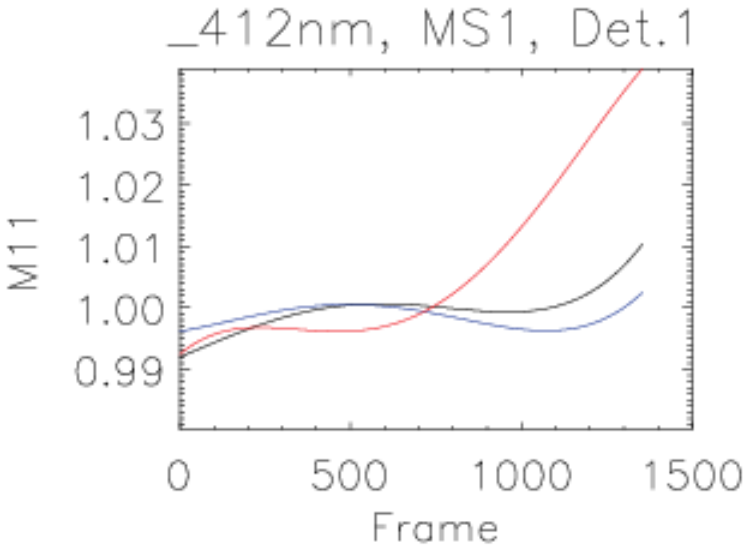


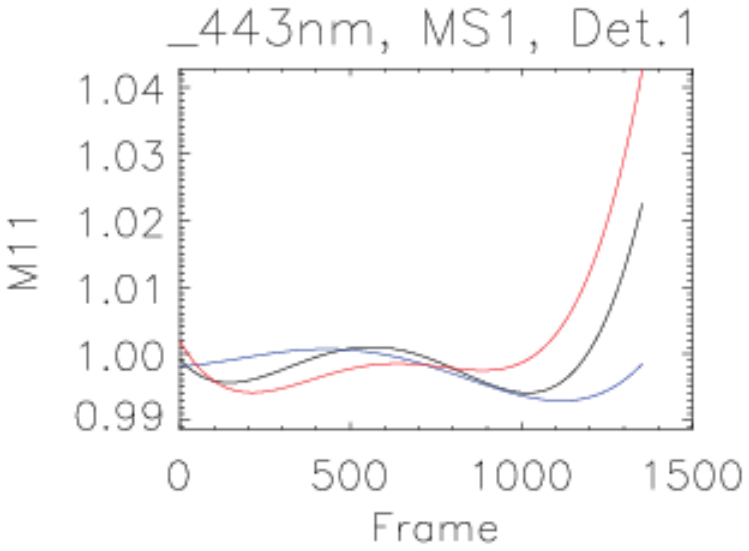
End of scan

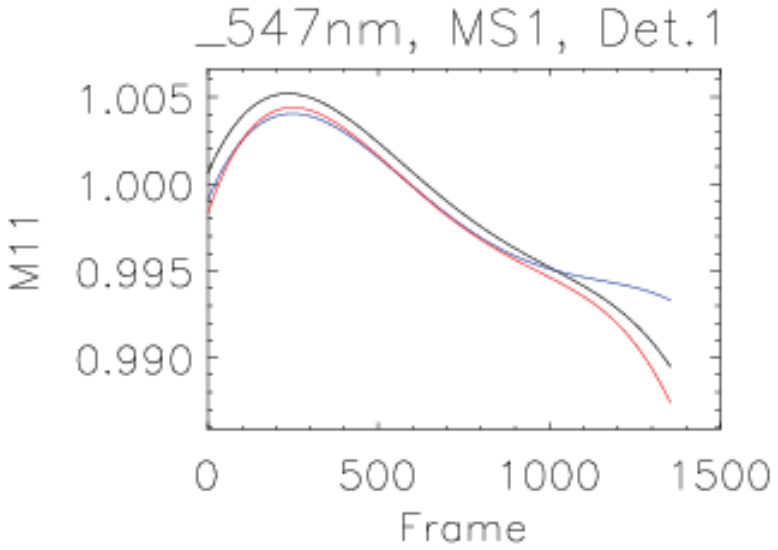


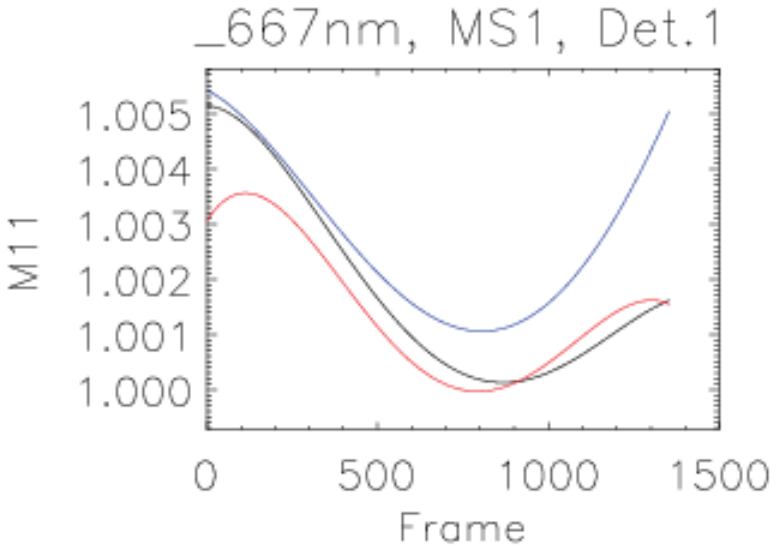
- Colors: detectors 1-10
- Solid (dashed) lines: mirror side 1 (2)

M11 scan angle dependence: Average (black), BOM (blue), EOM (red)





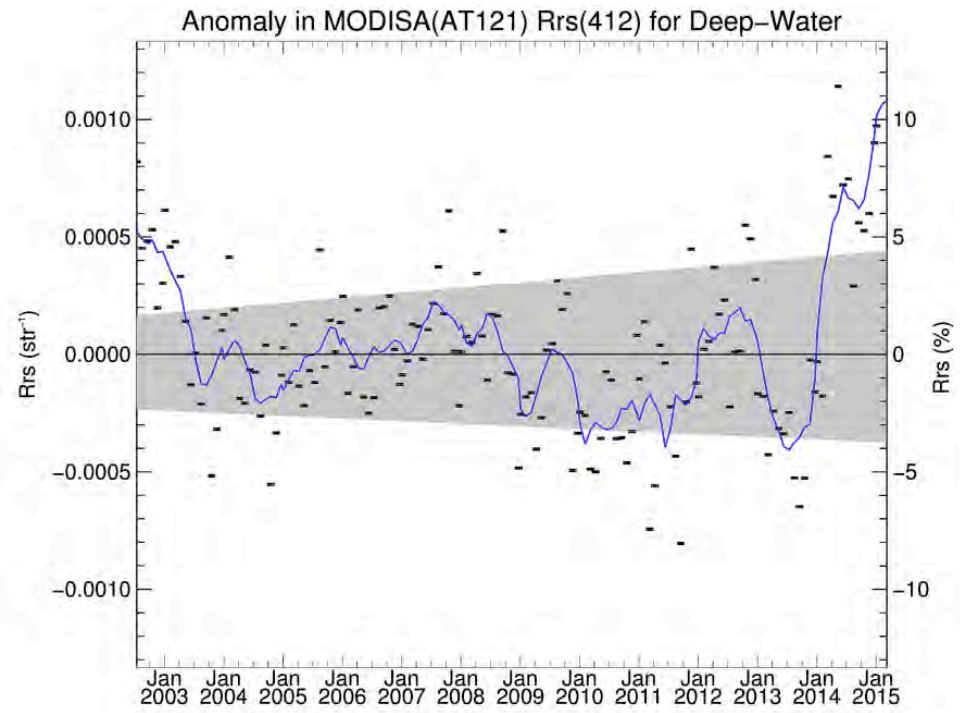




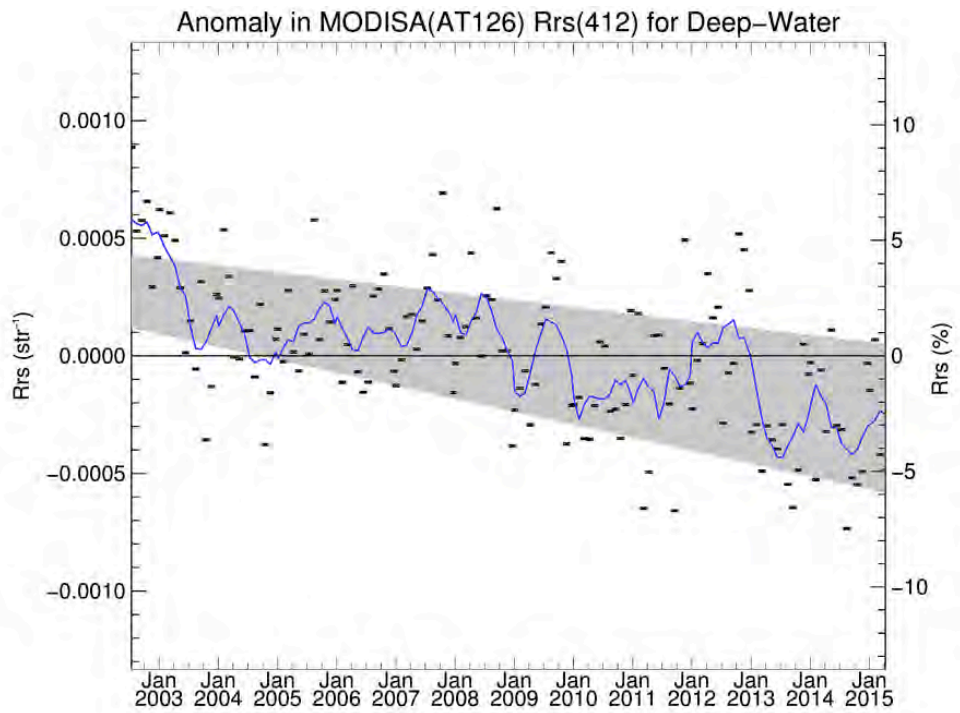
Temporal anomaly: 412nm Rrs

- ~5% downward trend in reproc. over 13 years
- Operational end of mission artifacts due to not updating neither MCST LUT nor xcal

Operational:



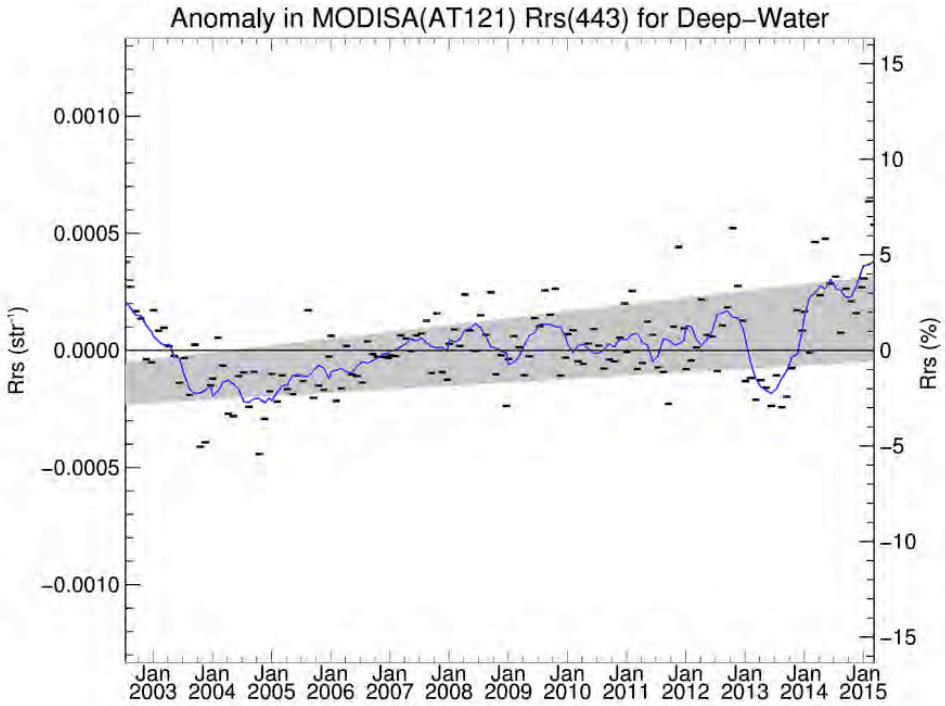
Reprocessing:



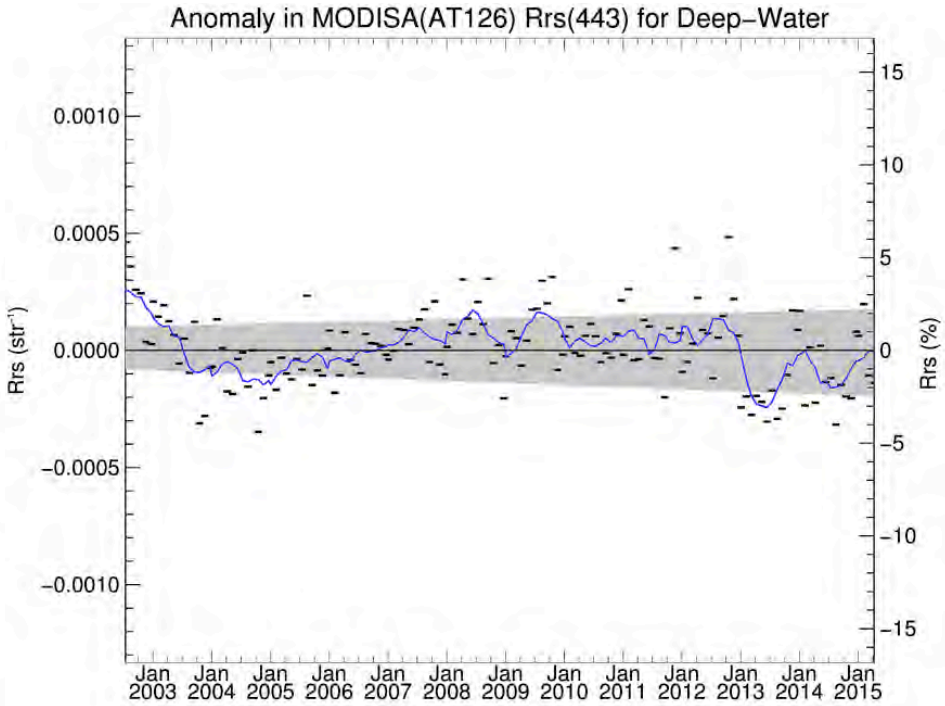
Temporal anomaly: 443nm Rrs

- No apparent trend in reproc. over 13 years, higher variability at end and beginning
- Operational end of mission artifacts due to not updating neither MCST LUT nor xcal

Operational:



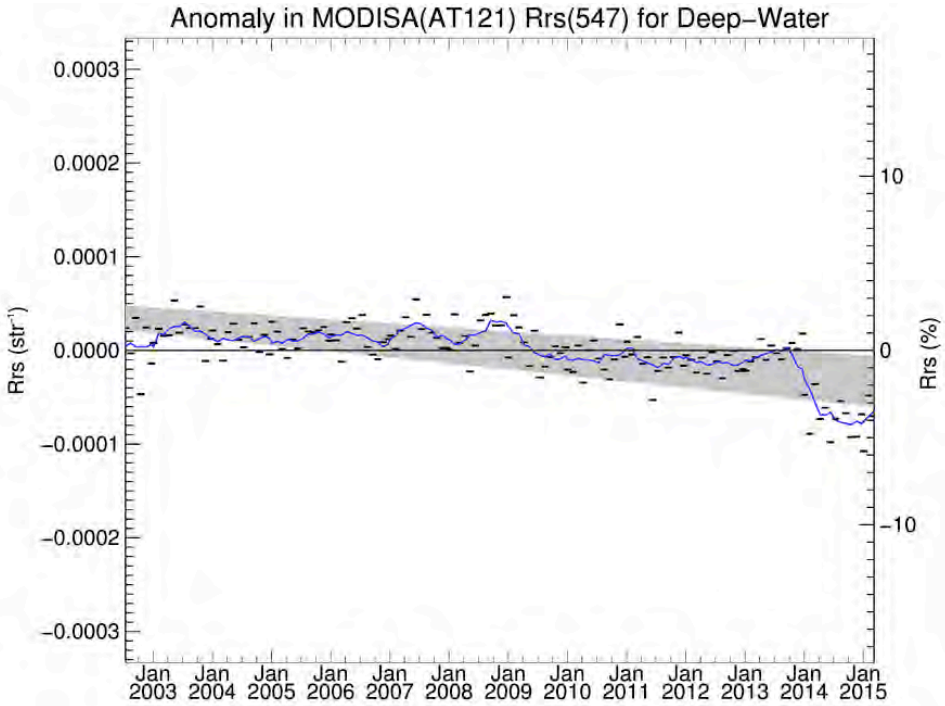
Reprocessing:



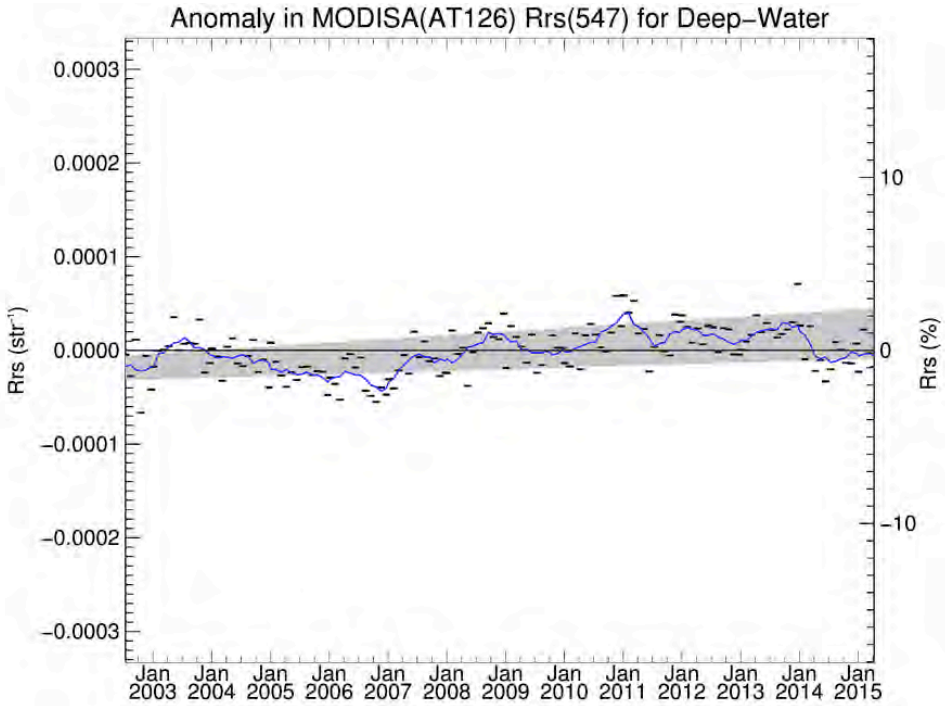
Temporal anomaly: 547nm Rrs

- Slight upward trend in reproc., stronger in olig., less in meso. and eutr.
- Operational end of mission artifacts due to not updating neither MCST LUT nor xcal

Operational:



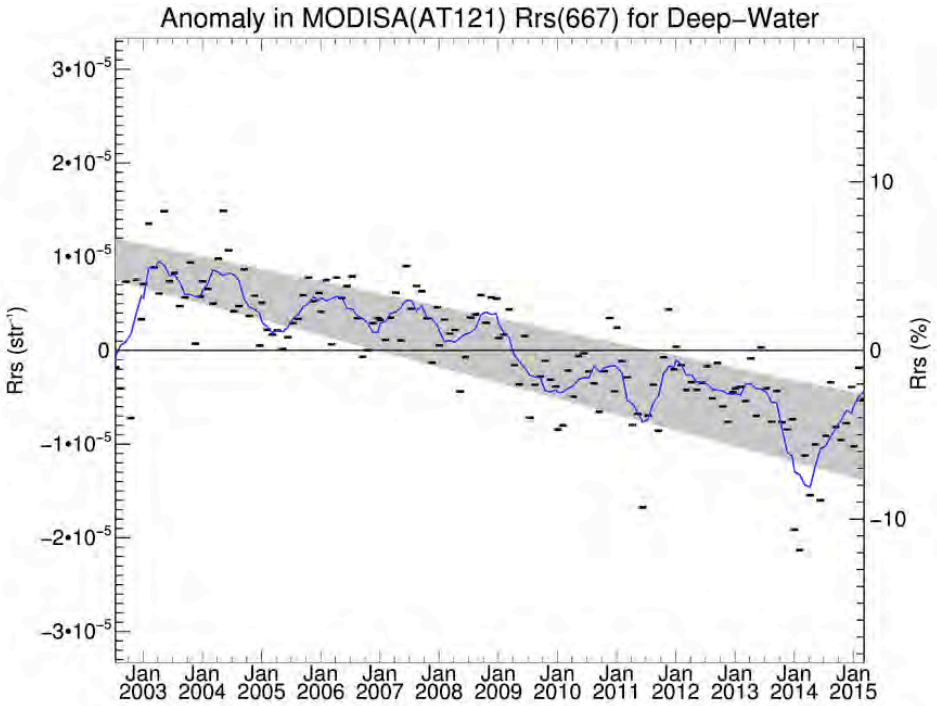
Reprocessing:



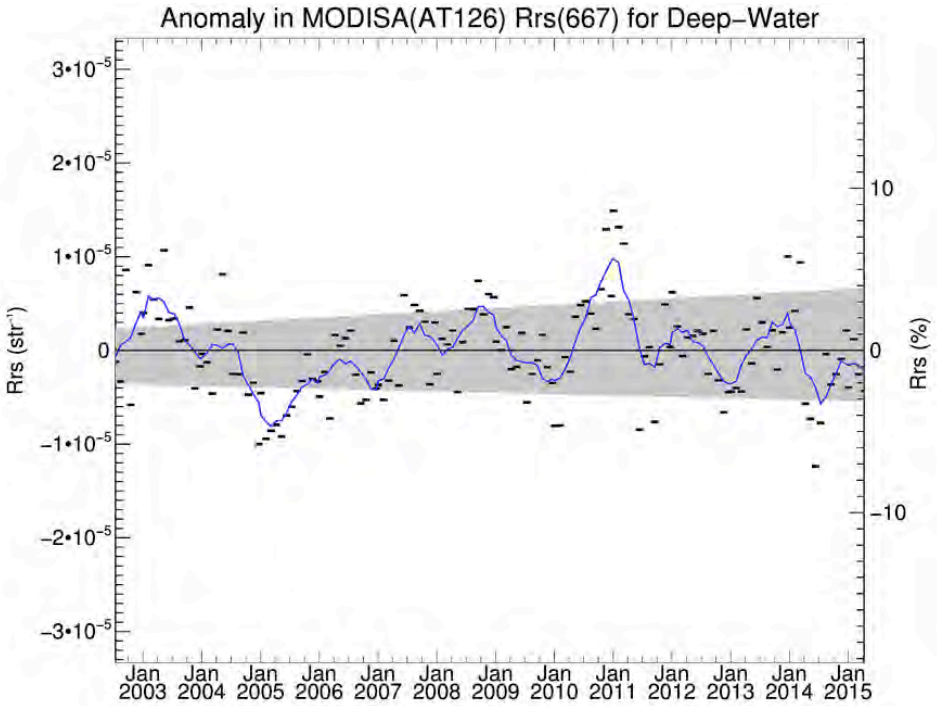
Temporal anomaly: 667nm Rrs

- No apparent trend in reproc., same for 678nm
- Operational had a clear downward trend (about 10%), same for 678nm

Operational:



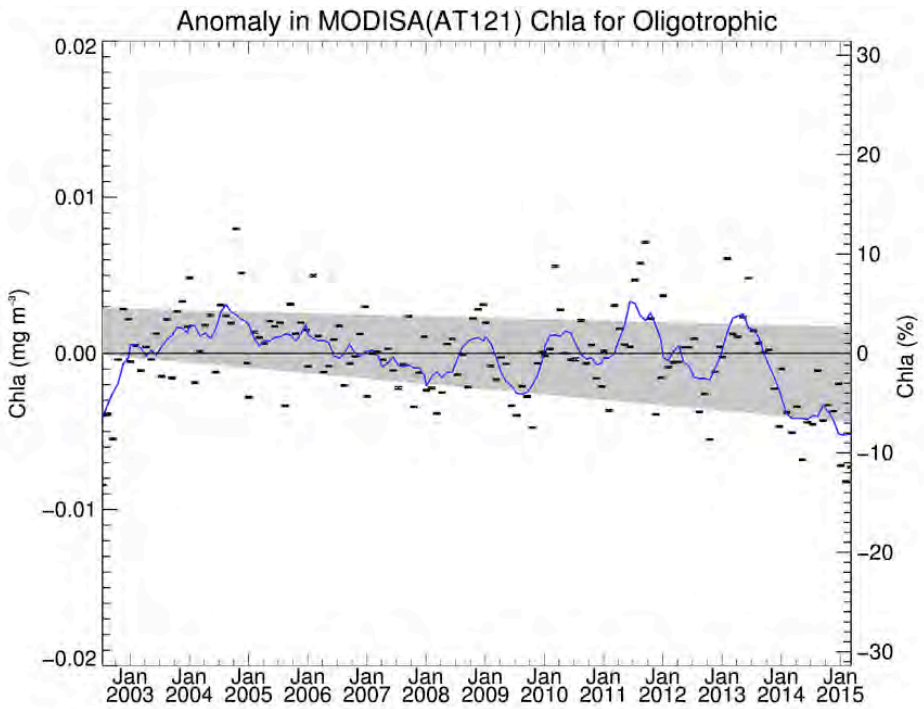
Reprocessing:



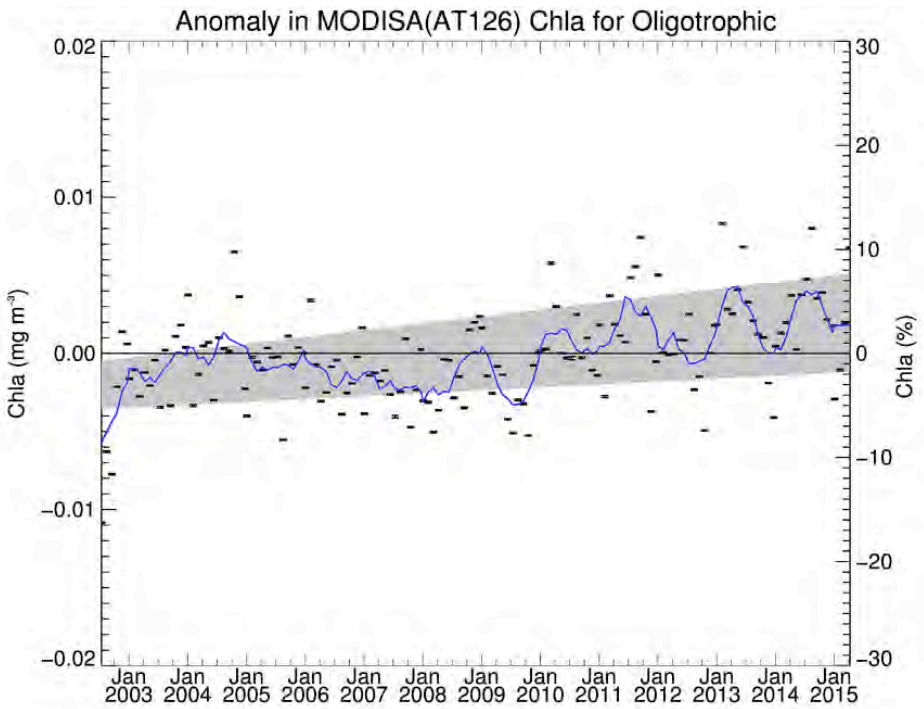
Temporal anomaly: Chl-a, oligotrpohic

- Chlorophyll-a in oligotrophic water is ~10% higher in 2014 for reprocessing

Operational:



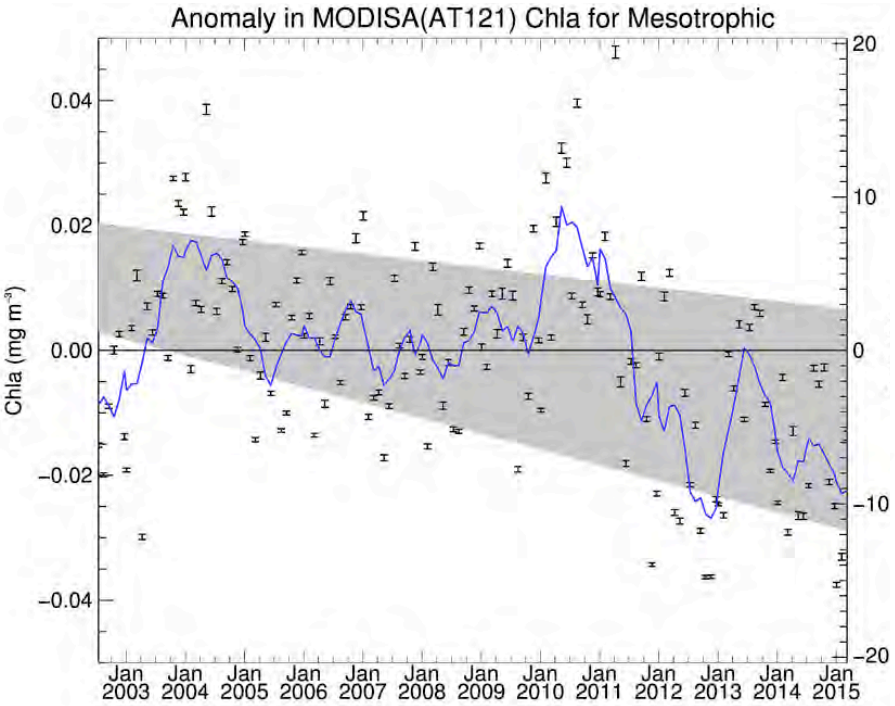
Reprocessing:



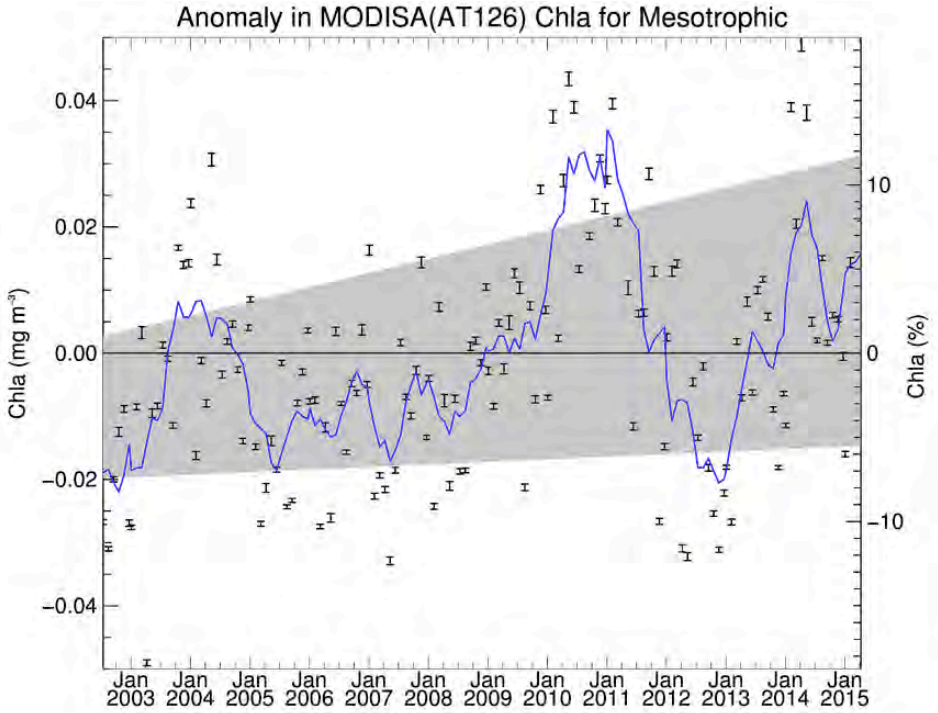
Temporal anomaly: Chl-a, mesotrpohic

- Chlorophyll-a in mesotrophic water is ~15% higher in 2014 for reprocessing

Operational:



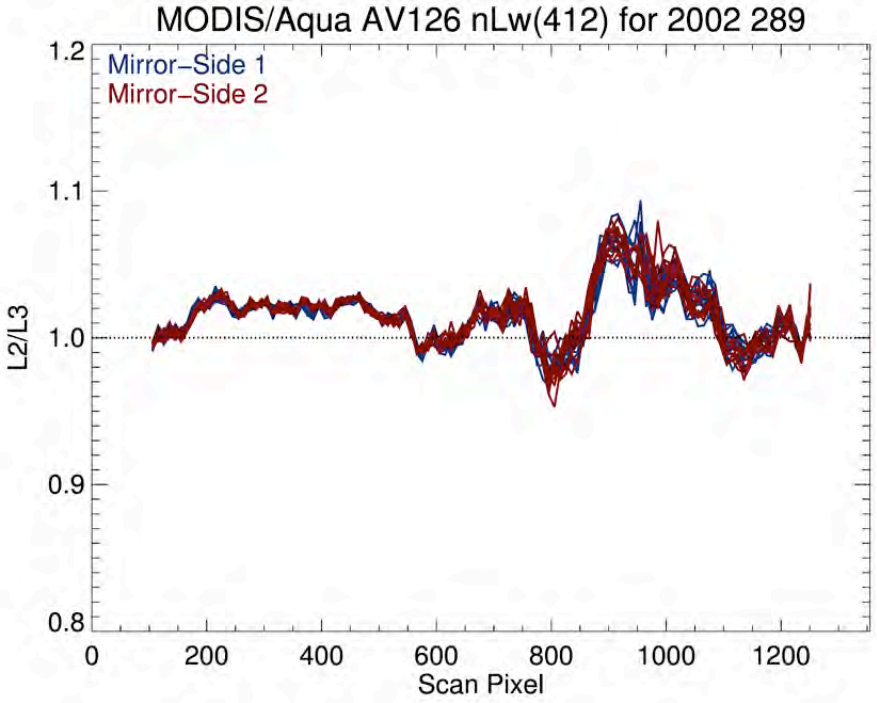
Reprocessing:



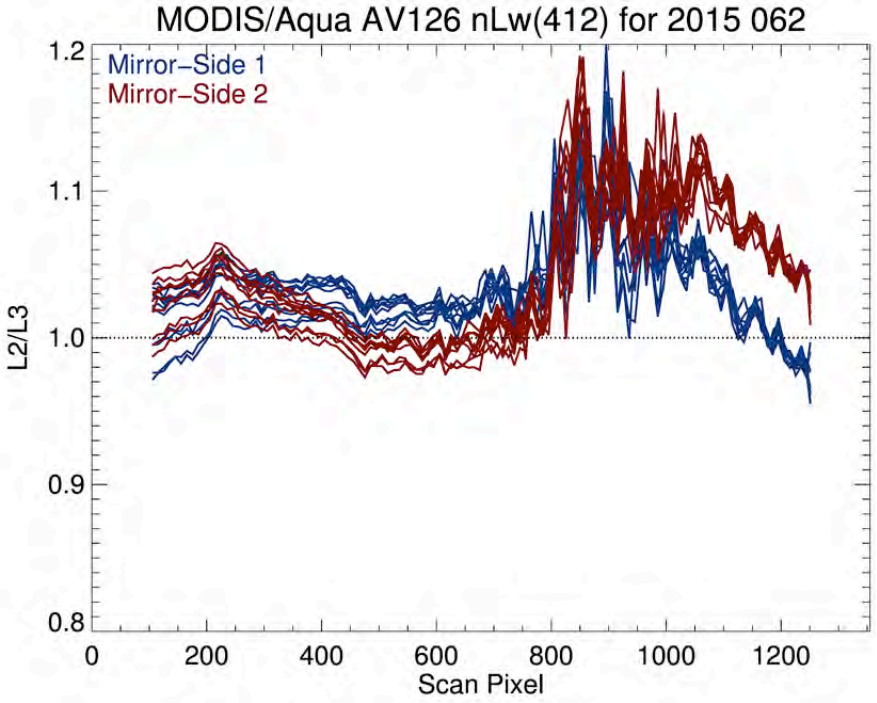
Scan angle dependence of 412nm nLw (reproc.):

- Increased variation around frame 900 (glint region)
- Increased striping and overall variability towards end of mission

Early mission:



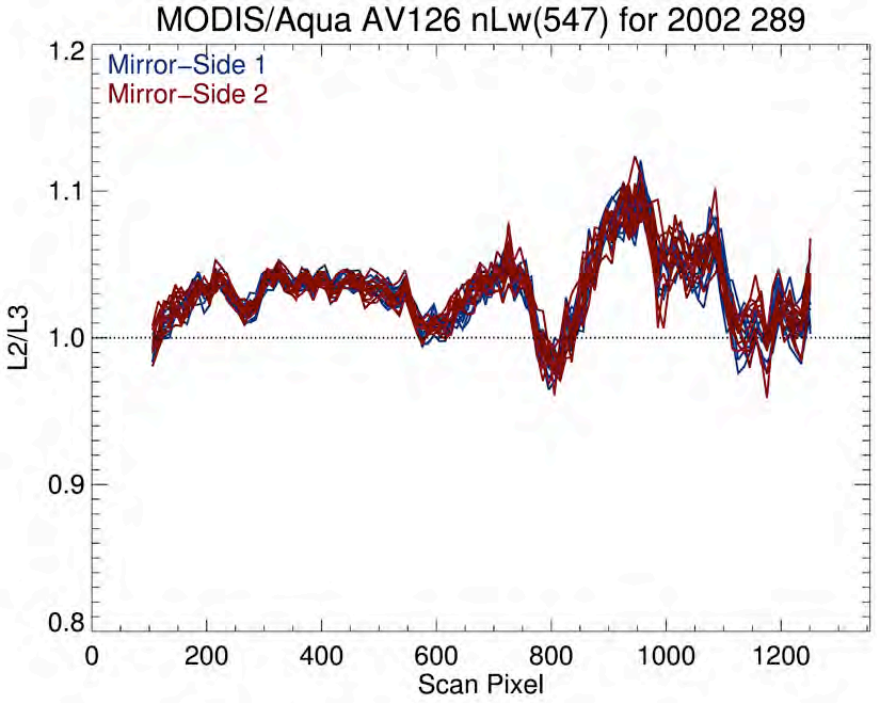
Late mission:



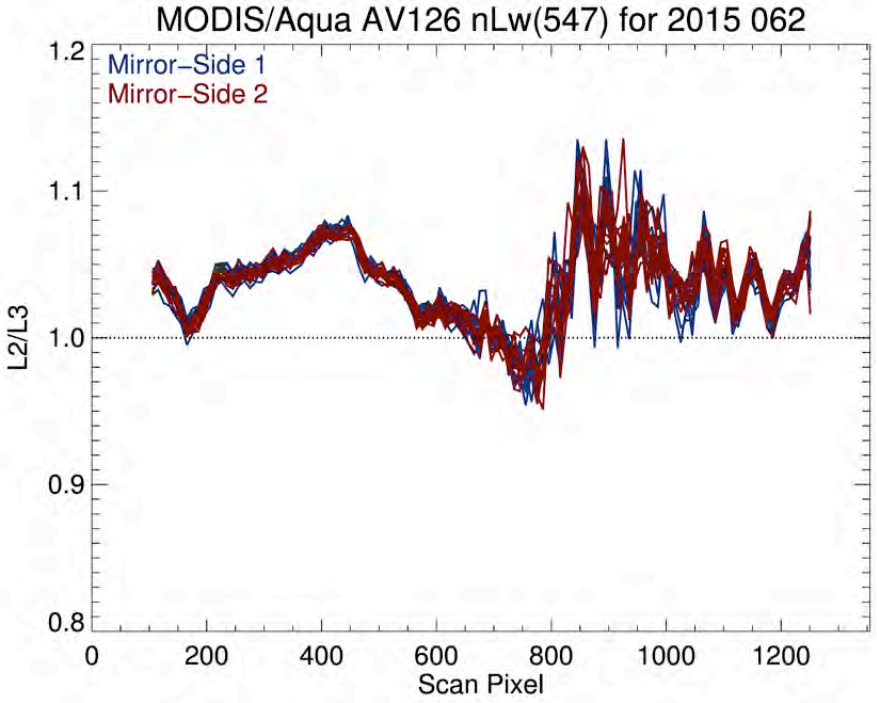
Scan angle dependence of 547nm nLw (reproc.):

- Increased variation around frame 900 (glint region)
- No (global average) striping, not much degradation with time

Early mission:



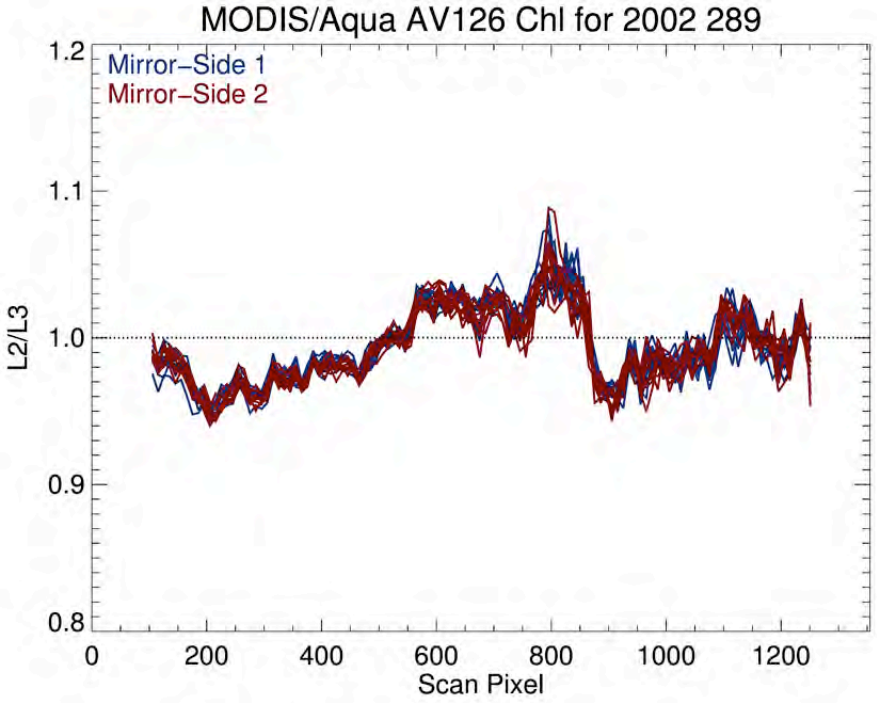
Late mission:



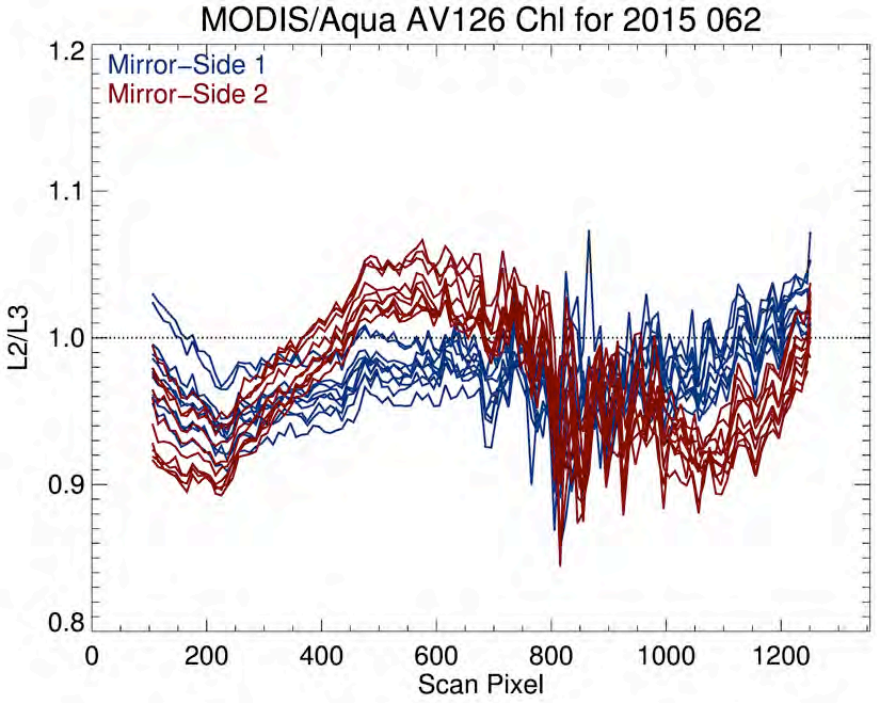
Scan angle dependence of chl-a (reproc.):

- Increased variation around frame 900 (glint region)
- Striping and scan angle dependence increase towards end of mission

Early mission:

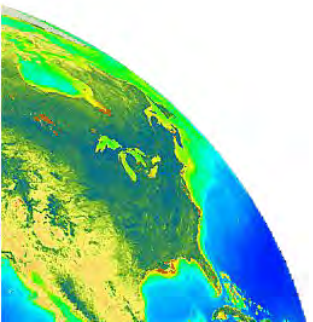


Late mission:

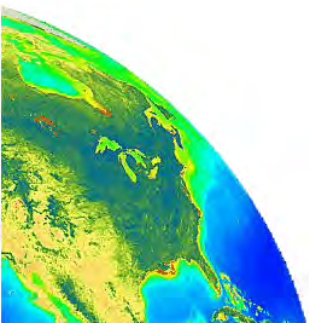


Summary:

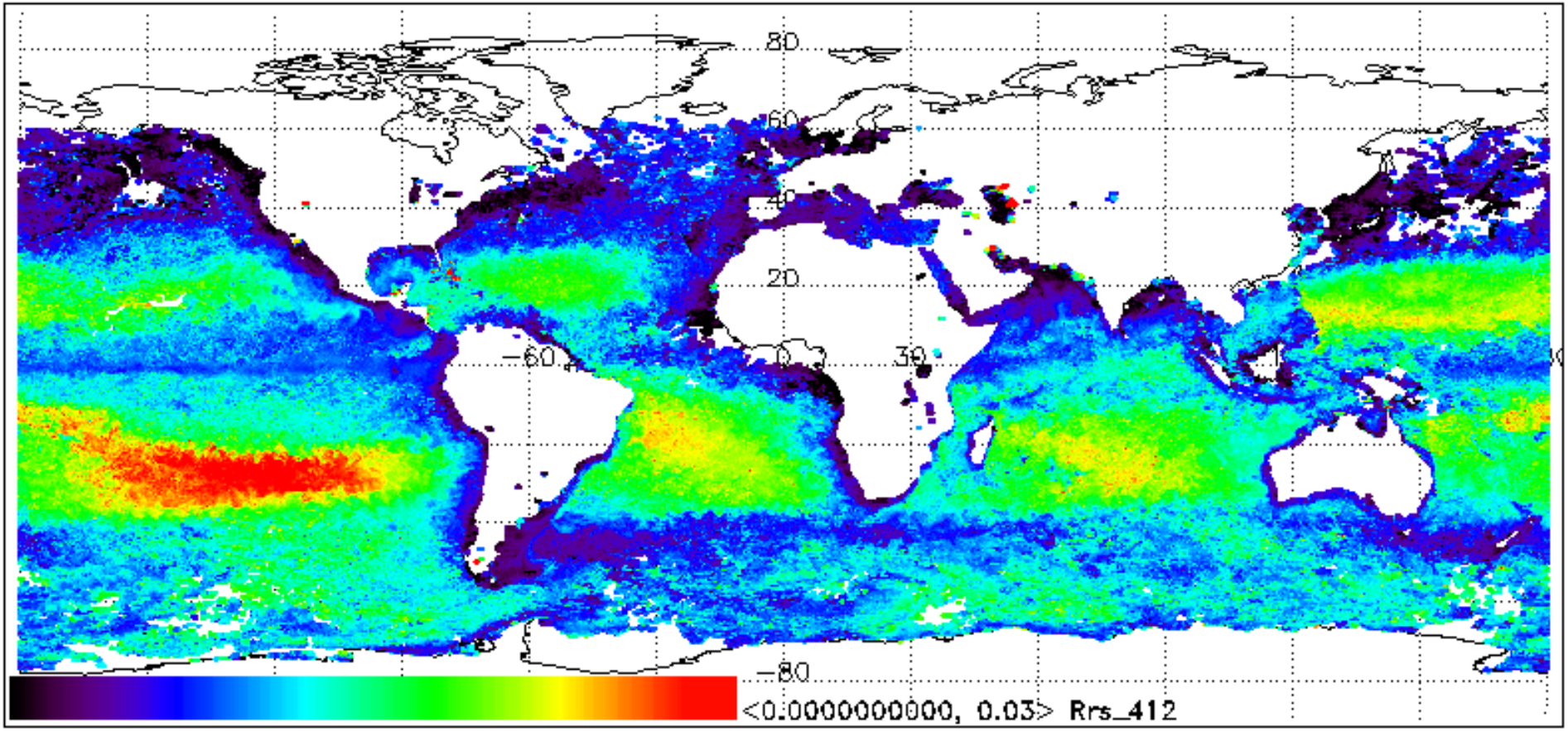
- Reprocessing improves the most recent time period, but variability in blue bands remains
- Overall improvement for long term trend of red bands, but 412nm long term trend still questionable
- Chlorophyll-a ~10-15% higher in 2014 after reprocessing
- Using MODIS Aqua results, MODIS Terra will be crosscalibrated in the next few months (SeaWiFS and MERIS first). Switch to new data format will be made soon without recalibration. Time series may be discontinuous e.g. due to new ancillary data until new crosscalibration is applied.



Backup slides:

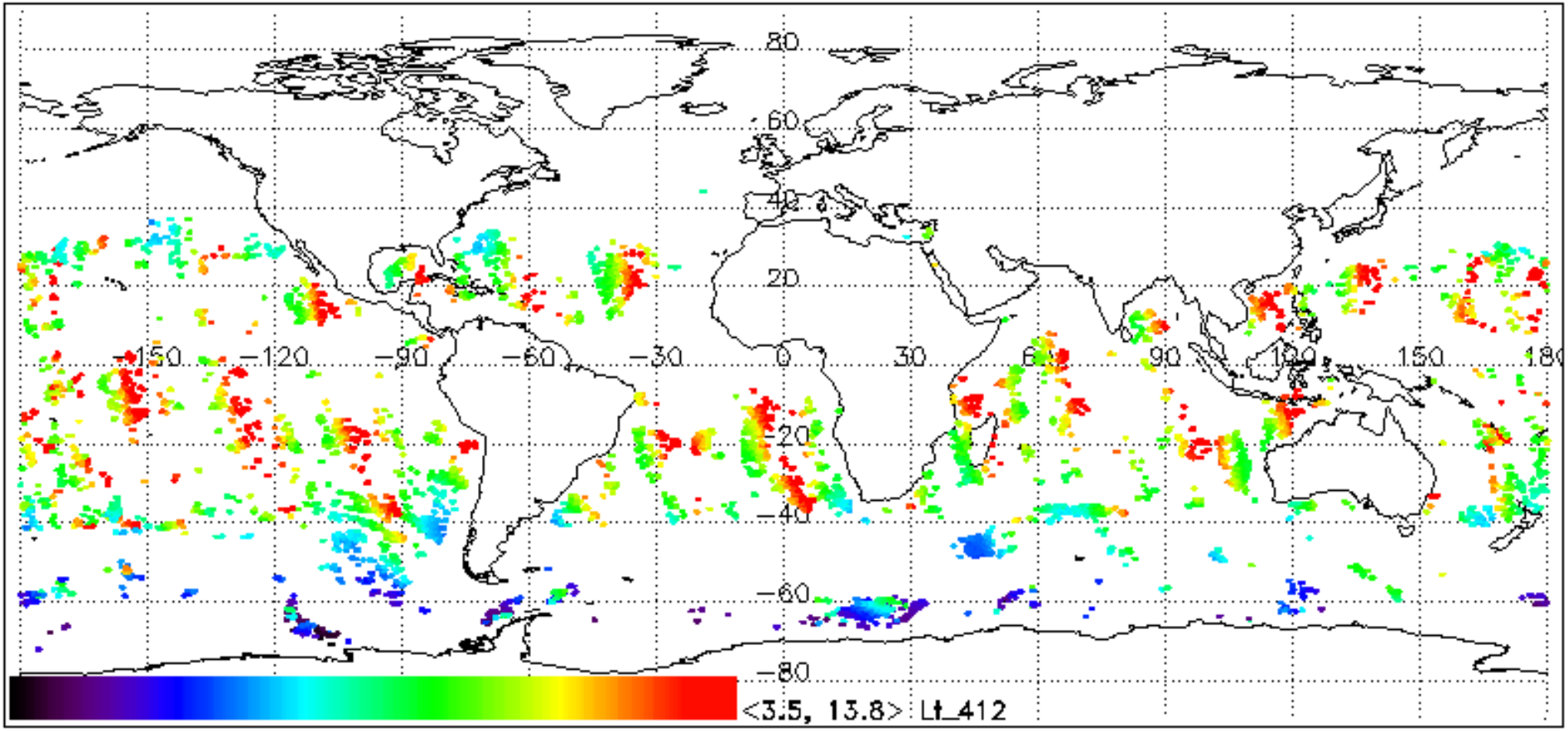


Xcal approach (Step 1): input ‘true’ L3 (15 days) Rrs



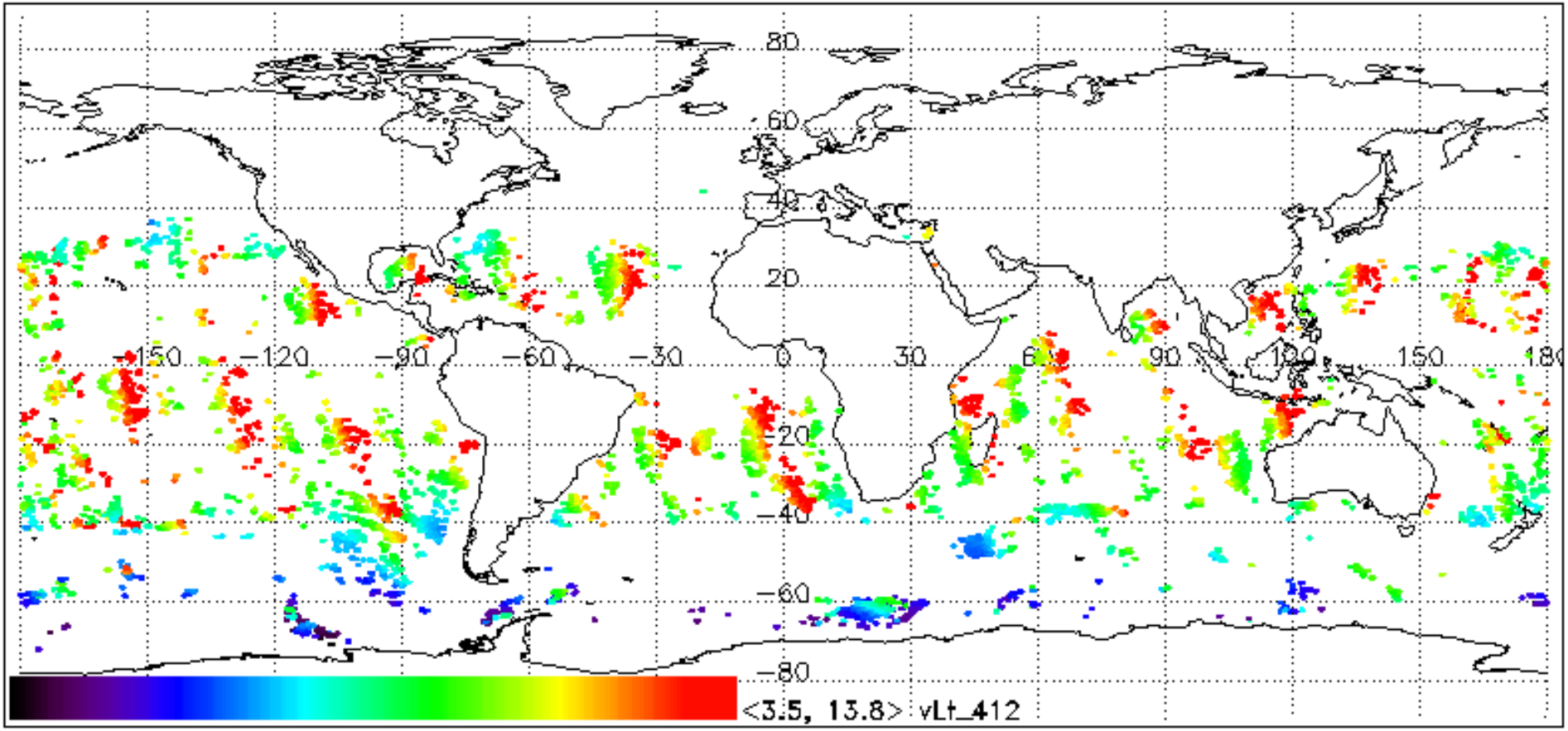
MODIS Aqua: 412nm Rrs (remote sensing reflectance)

Xcal approach (Step 2): input MODIS Lm



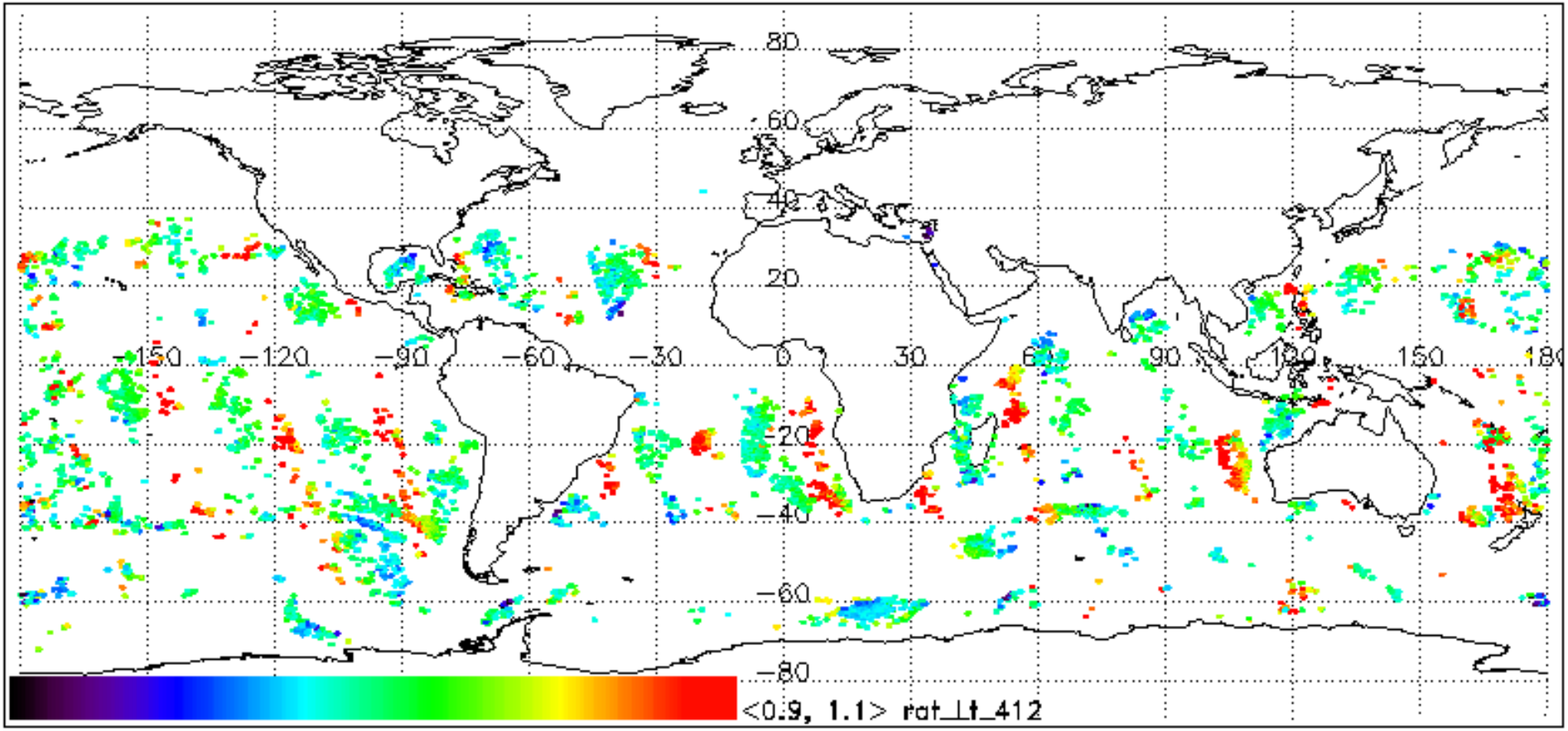
MODIS Terra TOA radiance from one day, screened for chlorophyll, AOT, straylight, etc.

Xcal approach (Step 3): vicarious Lt (from 'true' L3)



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

Xcal approach (Step 4): Ratio Lm/vLt



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