Review of OBPG crosscalibration approach

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Background:

- OBPG derives large corrections to RVS and polarization for MODIST with a crosscalibration approach, using MODISA as truth
- OBPG uses the crosscalibration for MODISA to itself to correct RVS residuals
- In the ratio to MOBY in-situ measurements, significant seasonal oscillations are seen for MODISA, but less strong for MODIST
- Conundrum: how can the adjusted data (MODIST) be better than the source data (MODISA)?

Crosscalibration:
How do we get MODIST ‘true’ TOA radiance L_t?

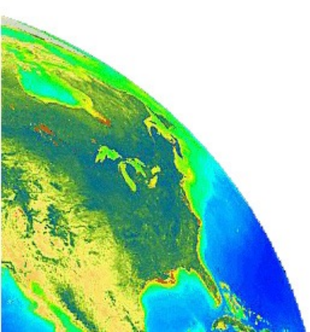
air — aerosol — whitecap — glint — water — gas

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

$L^a(\lambda)$: from MODIST NIR (same pixel); assumes MCST NIR band characterization

$L^w(\lambda)$: from MODISA L3 data (7-day mean)

Note: usually, this equation is used to derive the water leaving radiance $L^w(\lambda)$ from the measured TOA radiance L_t)



Crosscalibration coefficients:

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

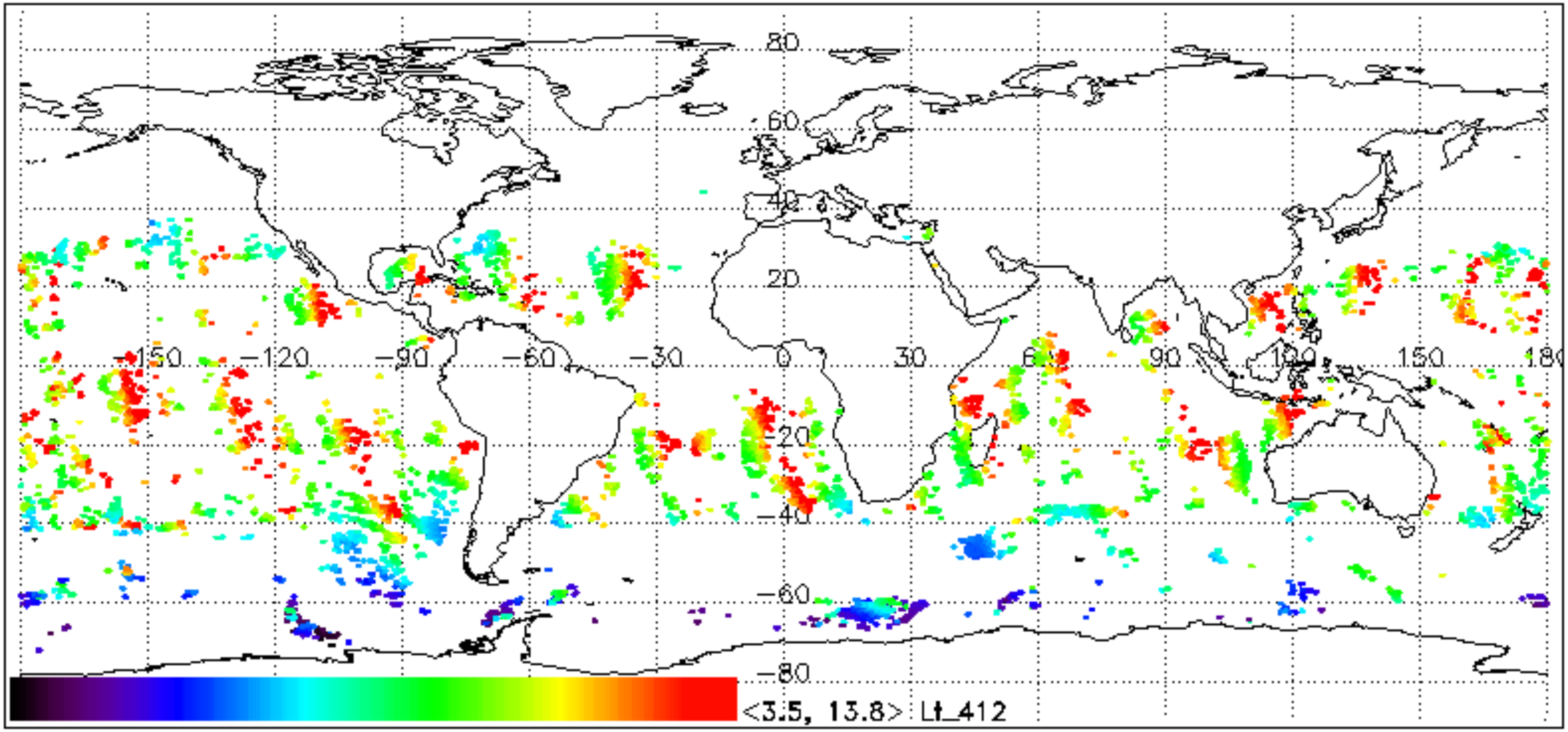
L_m: measured TOA radiance (MODIST)

L_t: true TOA radiance (from MODISA)

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

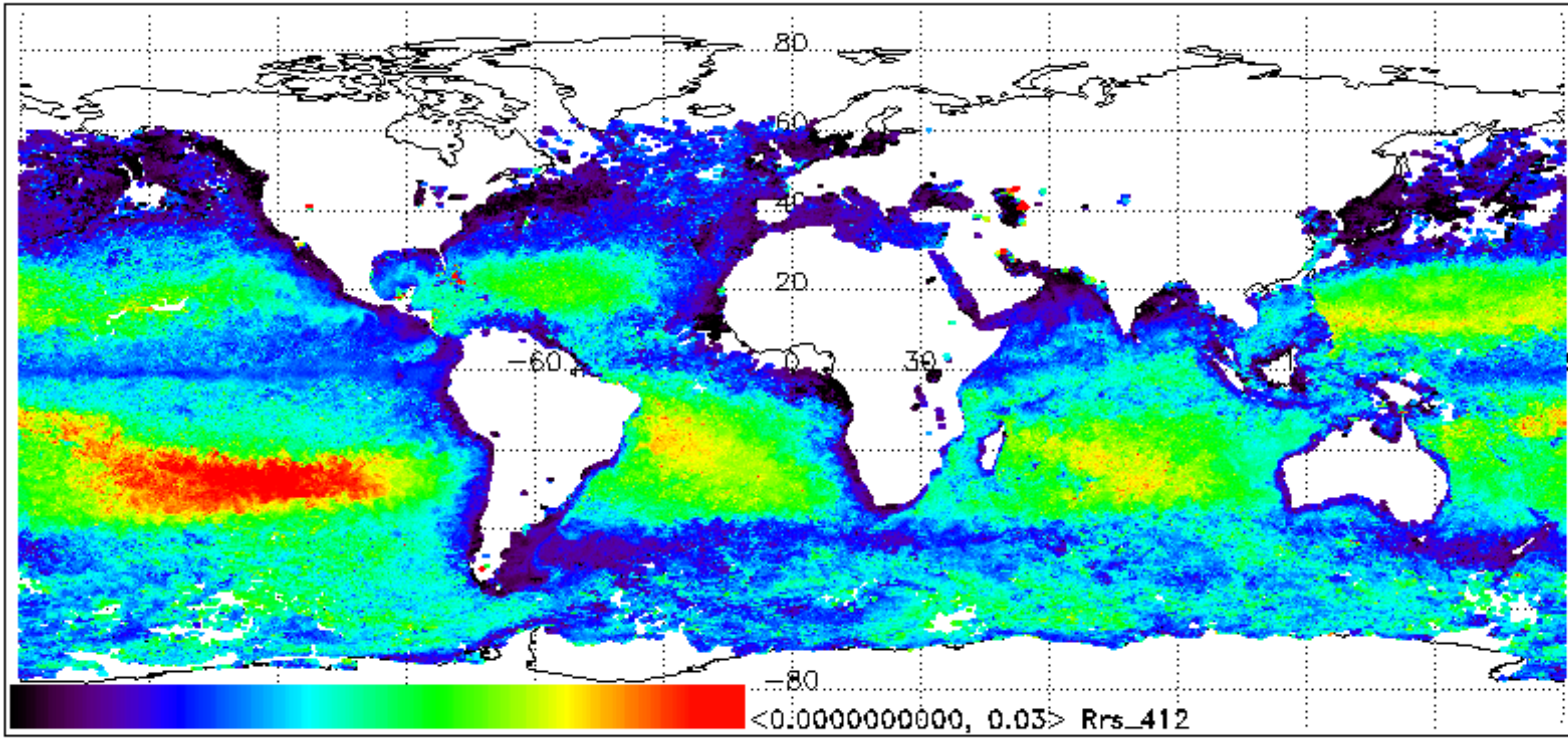
M_{11}, m_{12}, m_{13} : fitted instrument characterization parameters (depends on band, MS, detector; function of scan angle (4^{th} order polynomial for M_{11}, 2^{nd} order for m_{12} and m_{13})

Xcal approach (step 1): select MODIST L_m from 1 day



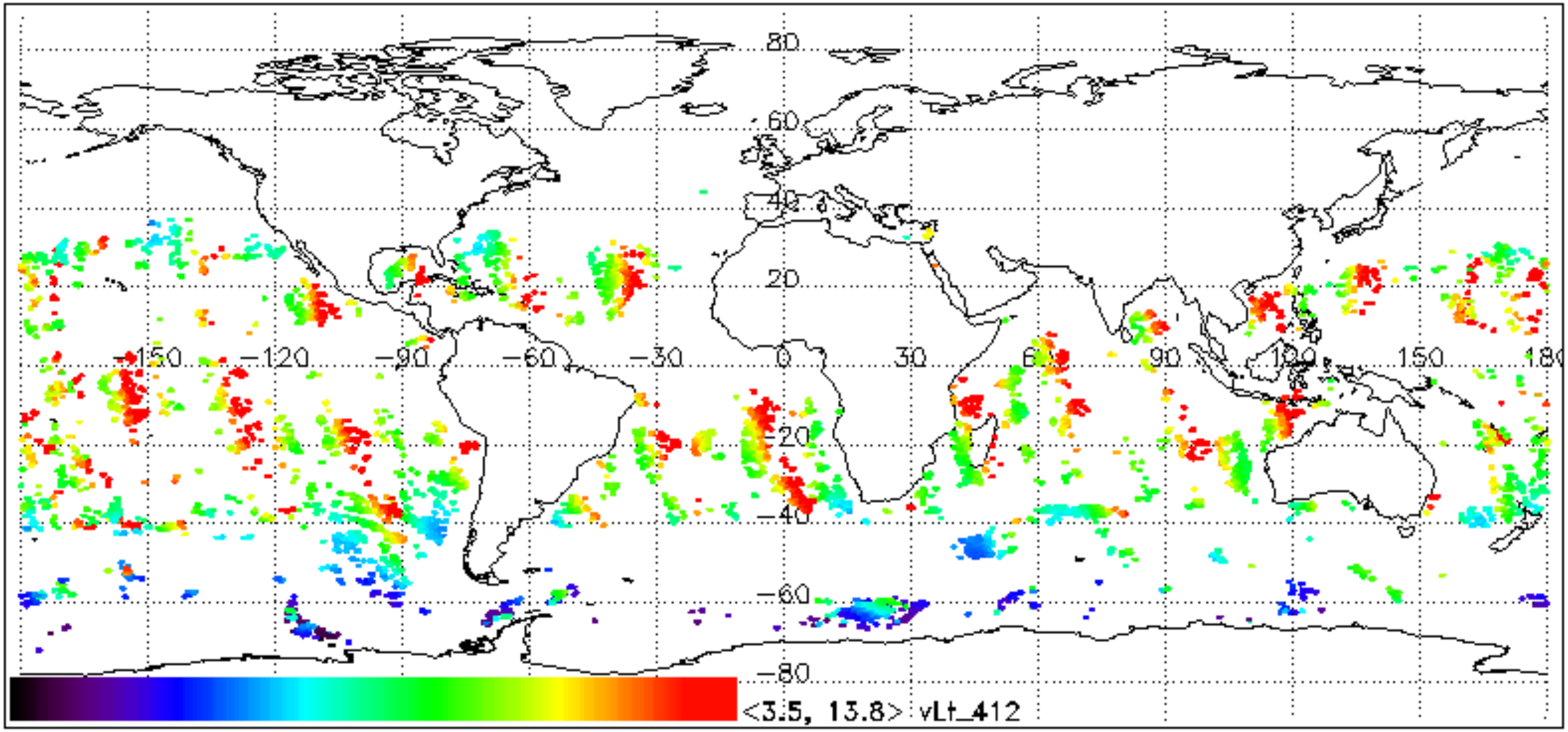
Strict selection criteria (deep water, low chlorophyl, low AOT, low glint)

Xcal approach (step 2): use MODISA L3 (7 days) Rrs



Rrs: remote sensing reflectance (BOA, water-leaving reflectance)

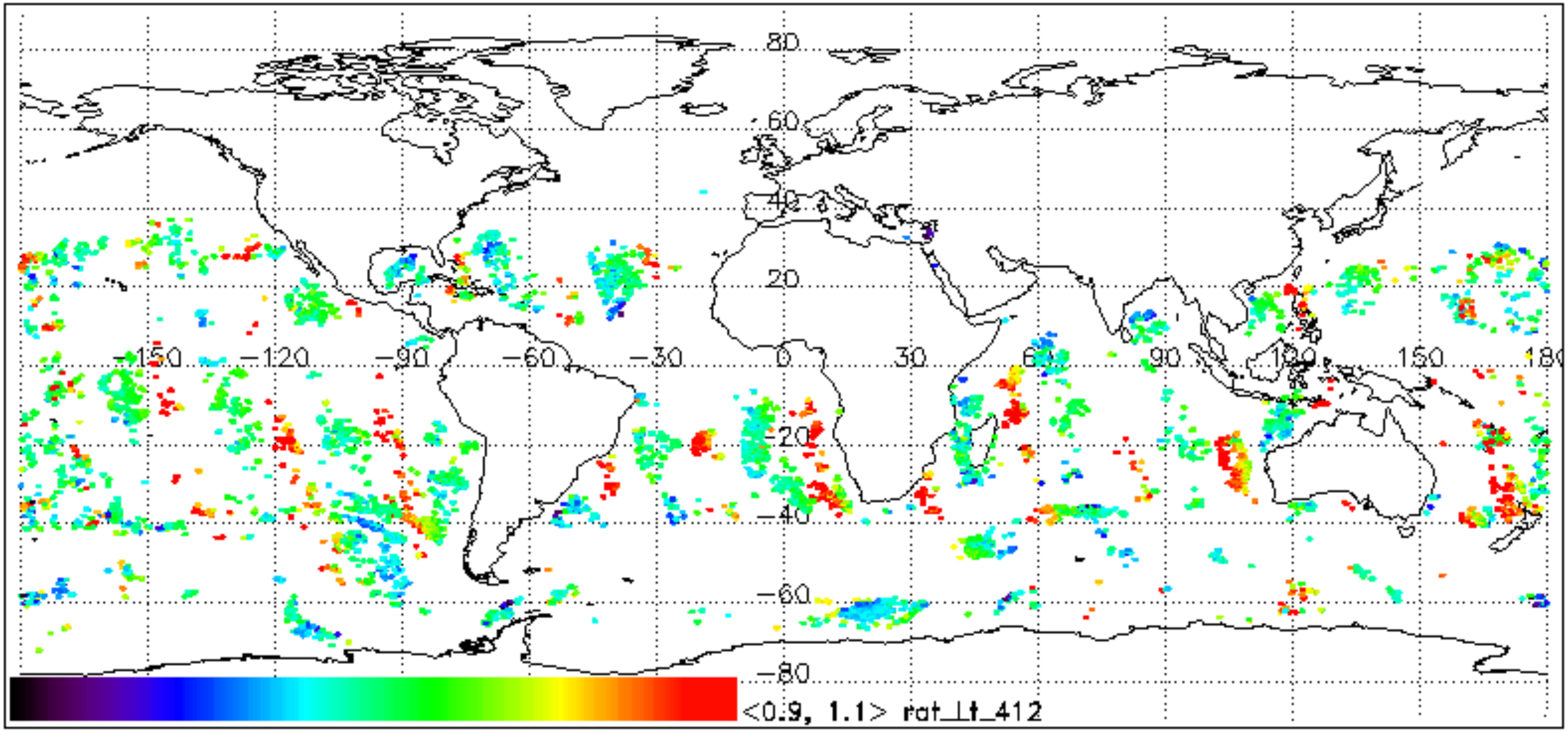
Xcal approach (step 3): Lt (vicarious Lt from L3)



Lt calculated with (see slide 3, L^w, from Rrs):

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

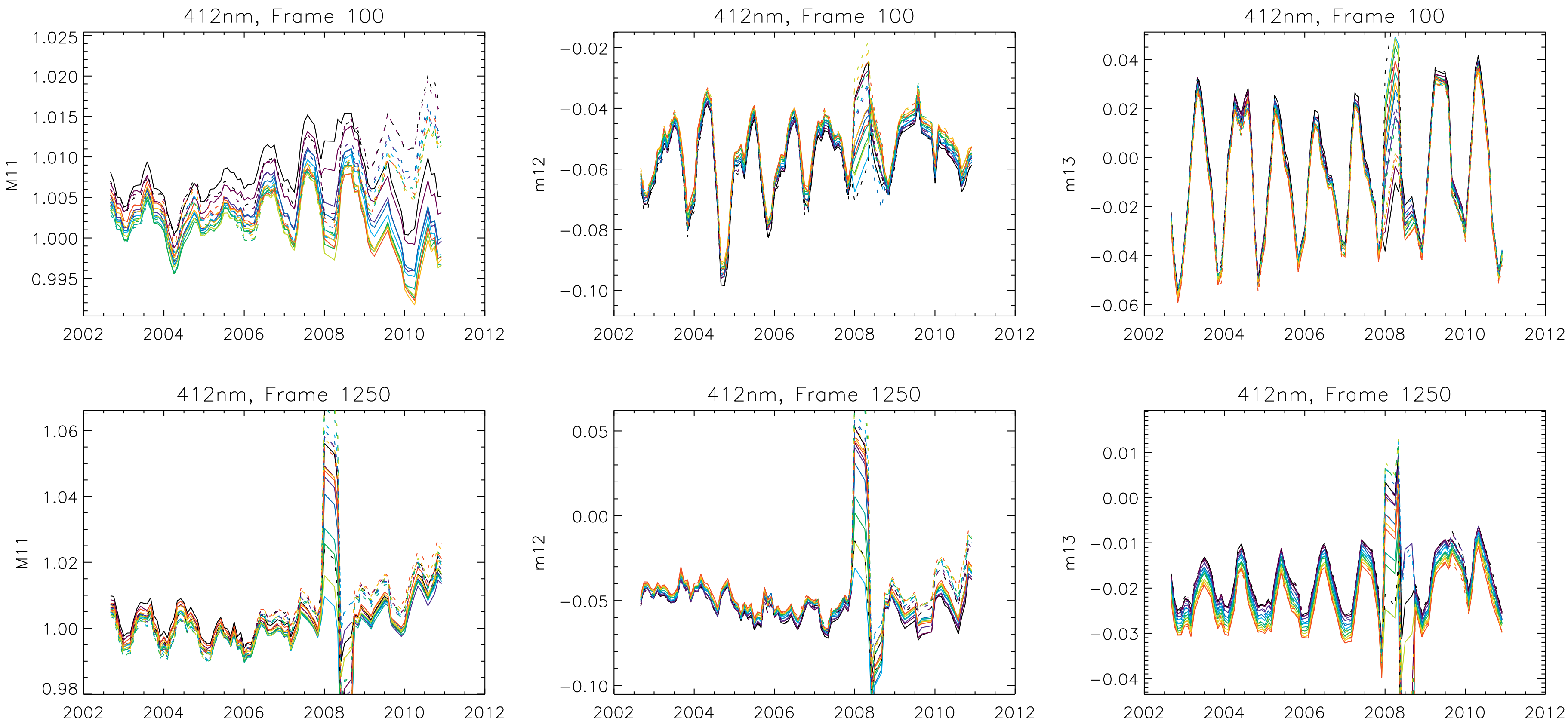
Xcal approach (step 4): Derive M_{11}, m_{12}, m_{13}



M_{11}, m_{12}, m_{13} calculated with (see slide 4):

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

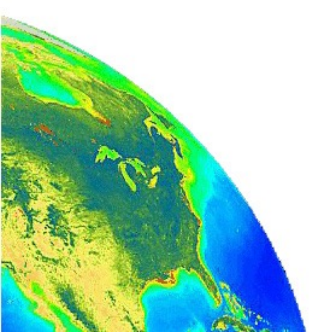
Xcal results: MODISA to SeaWiFS, 412nm



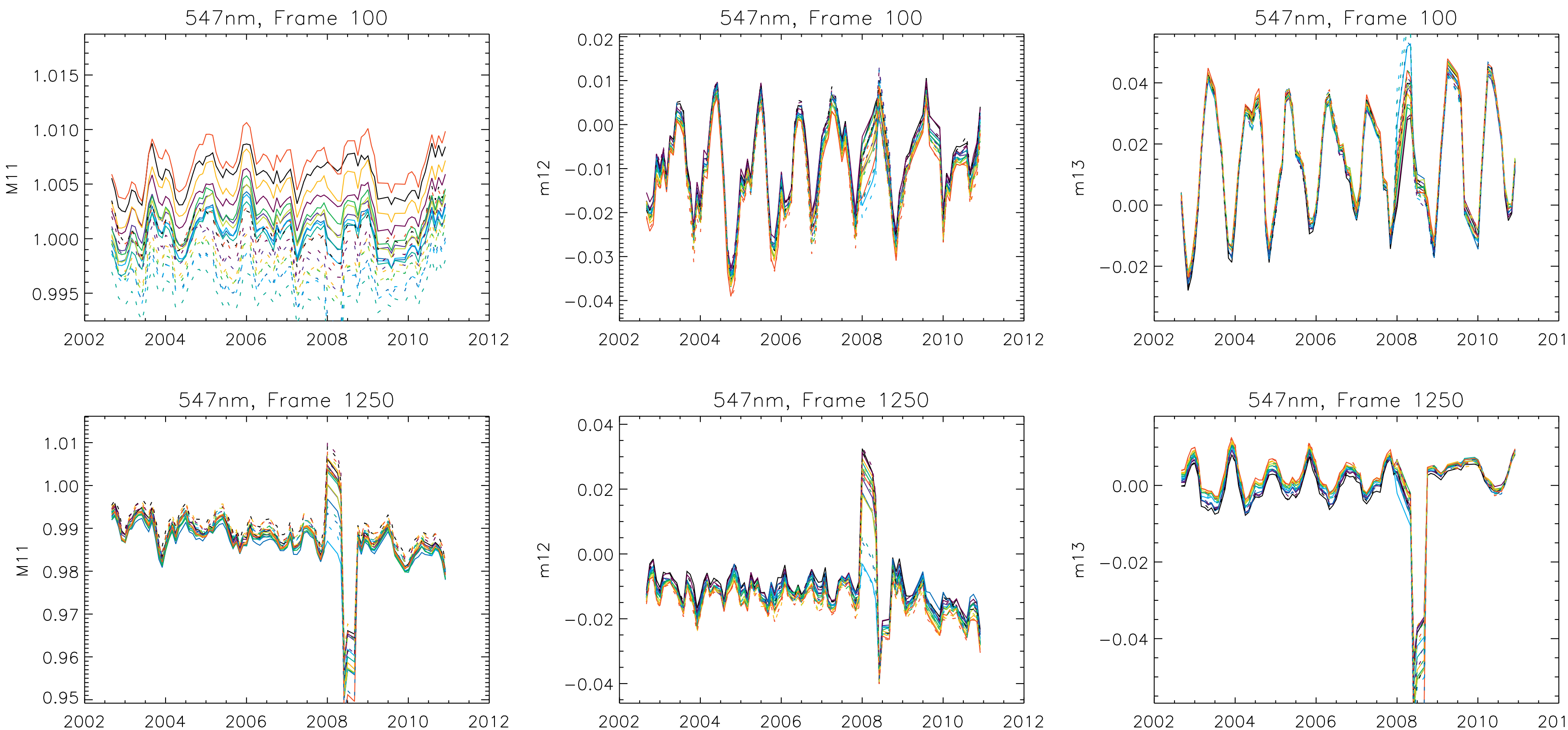
Solid/dashed: mirror side 1/2; colors: detectors 1-10

Eval version 61b, 3-month smoothing

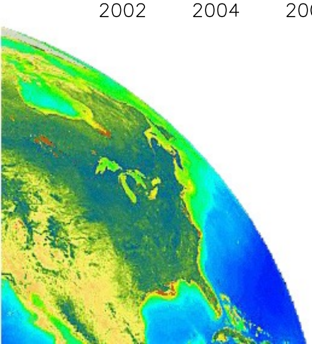
Seasonal oscillations in all 3 parameters (6% for m_{13}, BOS) , but no trend



Xcal results: MODISA to SeaWiFS, 547nm

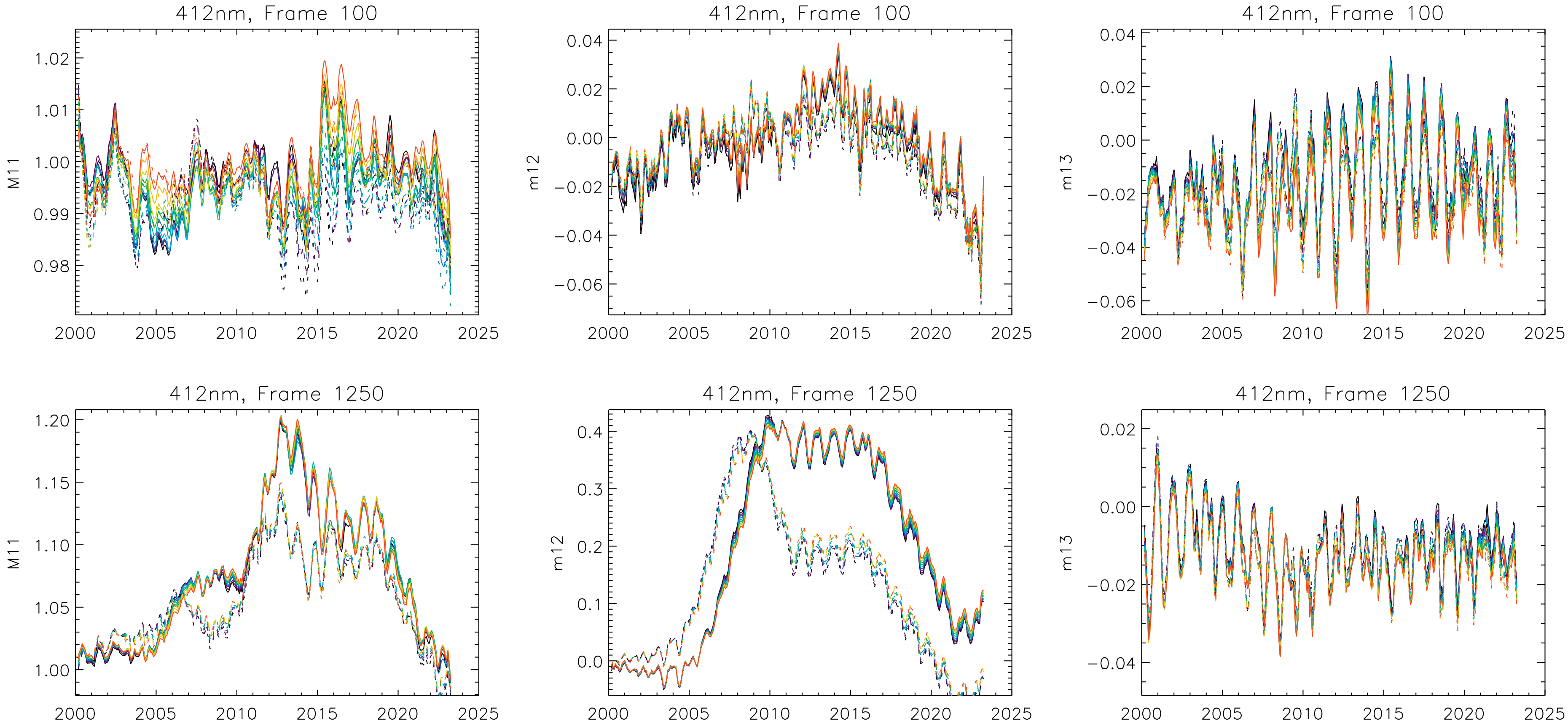


Eval version 61b, 3-month smoothing



Seasonal oscillations in all 3 parameters, but no trend.
MODISA uses prelaunch for operational processing.

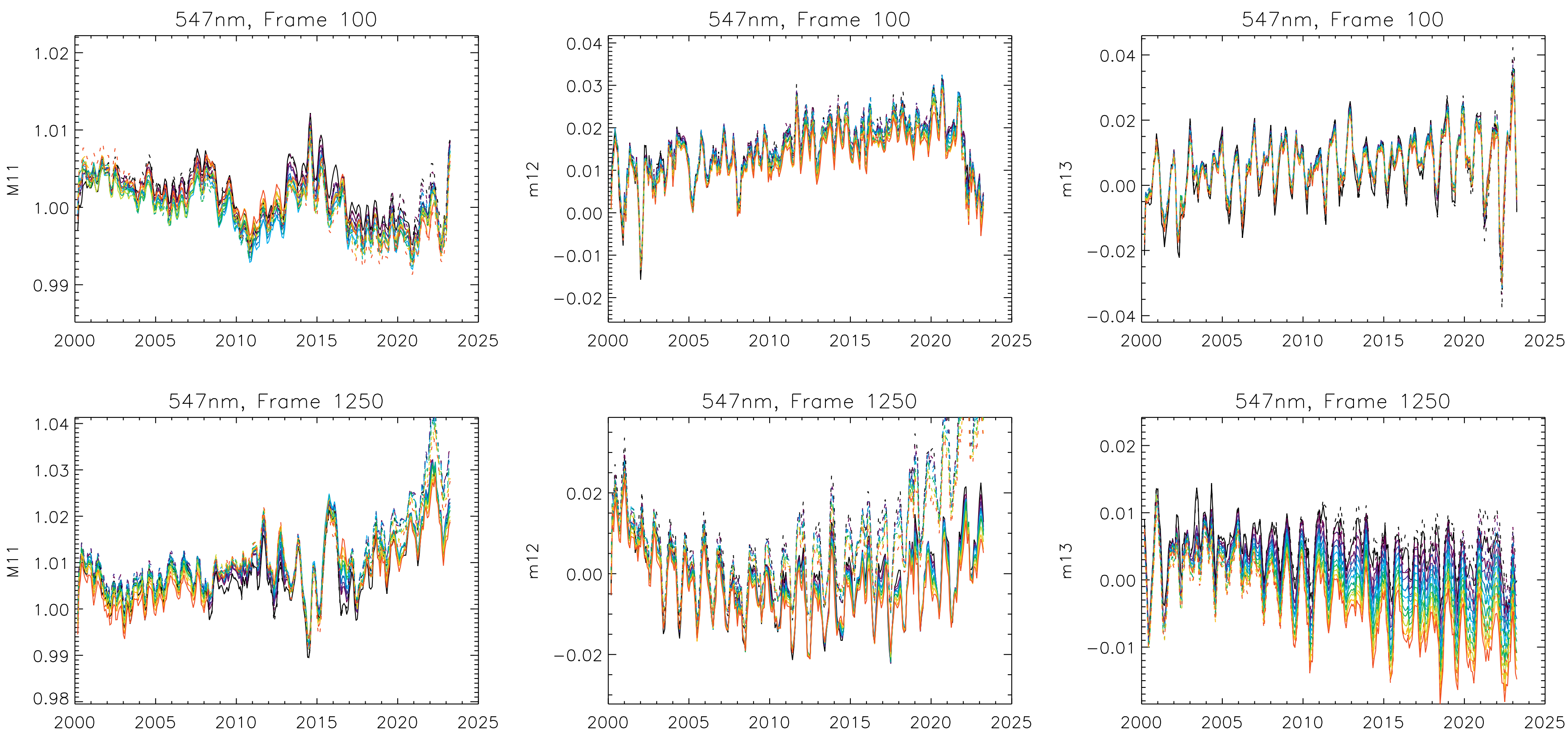
Xcal results: MODIST to MODISA, 412nm



Operational v2.4b, 3-month smoothing

Seasonal oscillations in all 3 parameters, strong trend in m_{12}

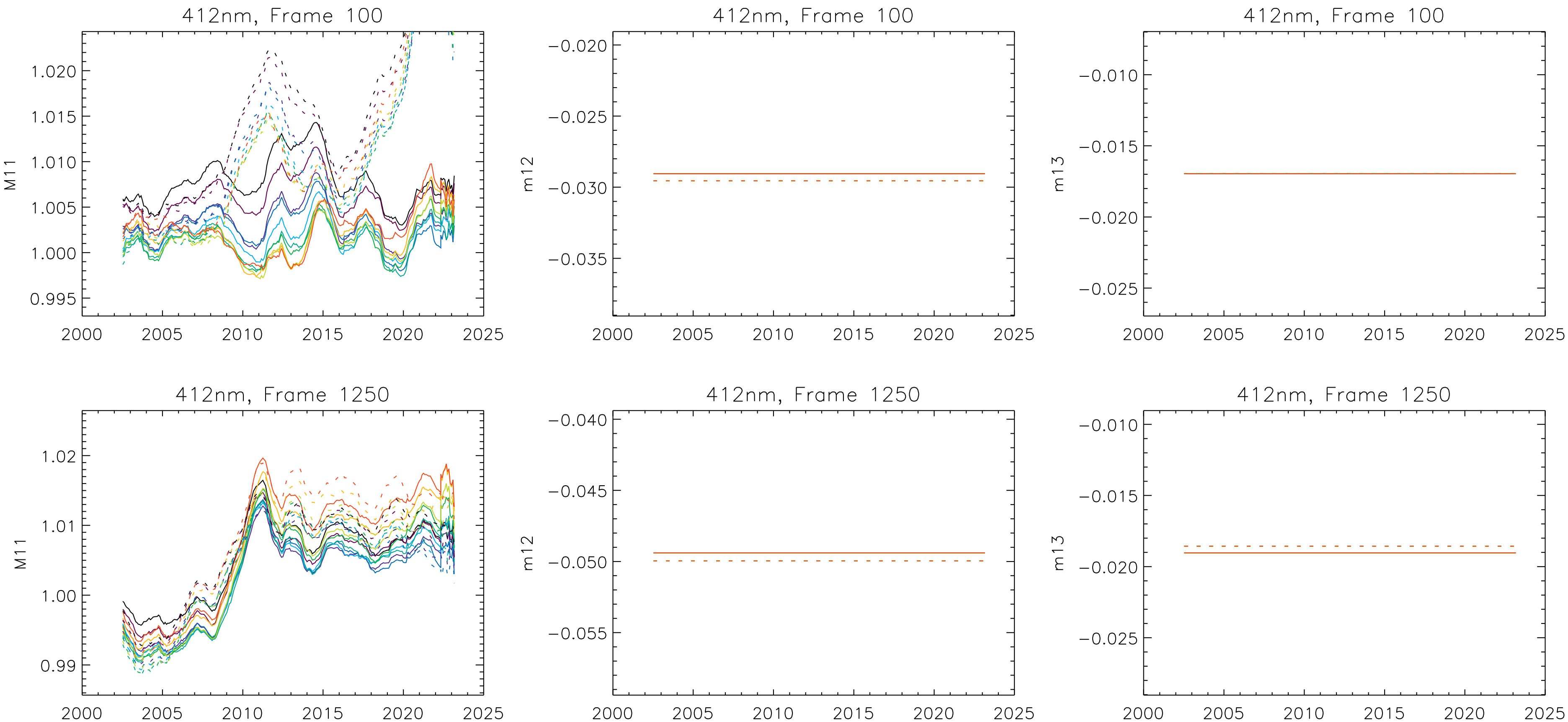
Xcal results: MODIST to MODISA, 547nm



Operational v2.4b, 3-month smoothing

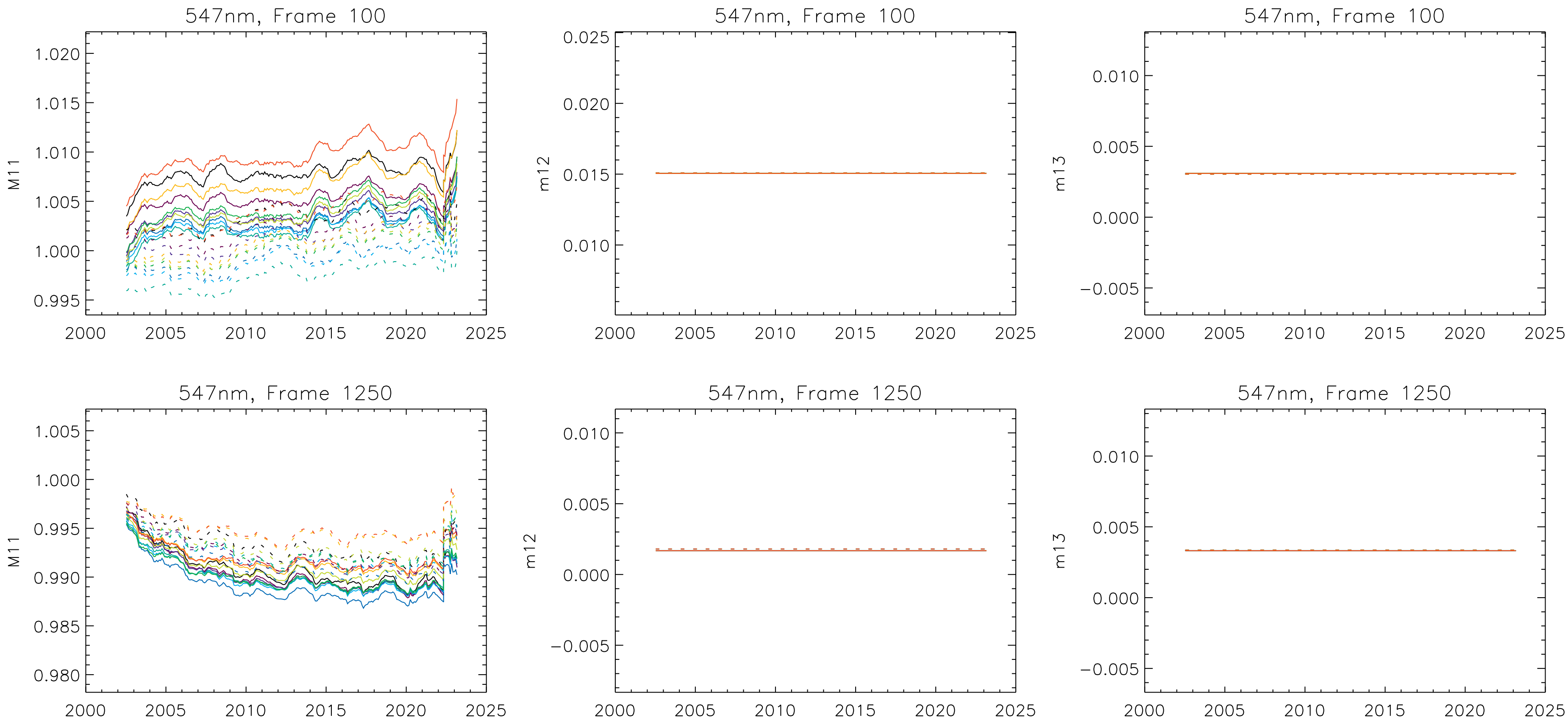
Seasonal oscillations in all 3 parameters, obvious trends, but not large.

Xcal results: MODISA to itself, 412nm



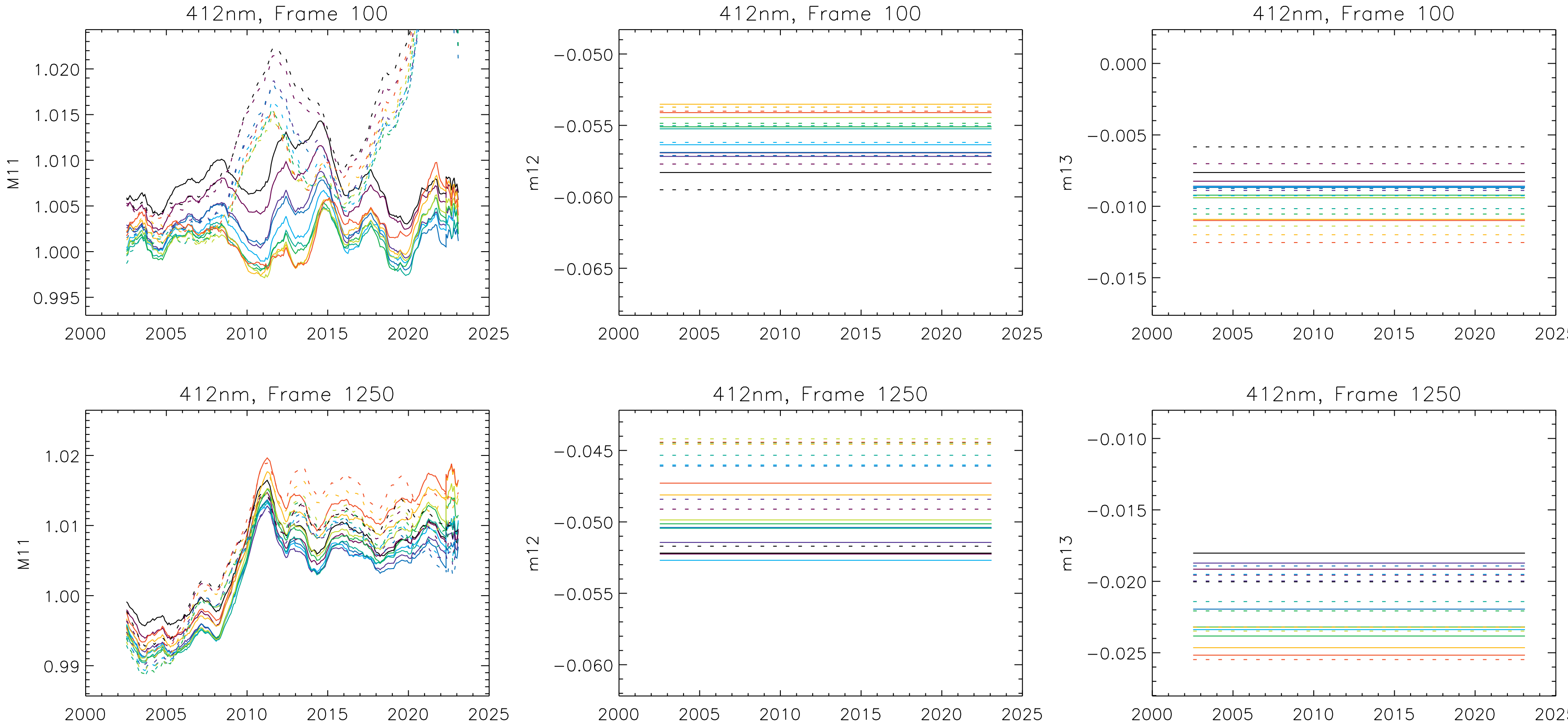
Operational v2.8d, 1-year smoothing

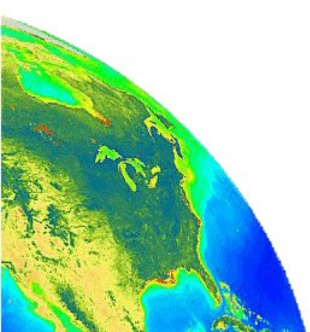
Xcal results: MODISA to itself, 547nm



Operational v2.8d, 1-year smoothing

Xcal: MODISA to itself, 412nm, no detrending

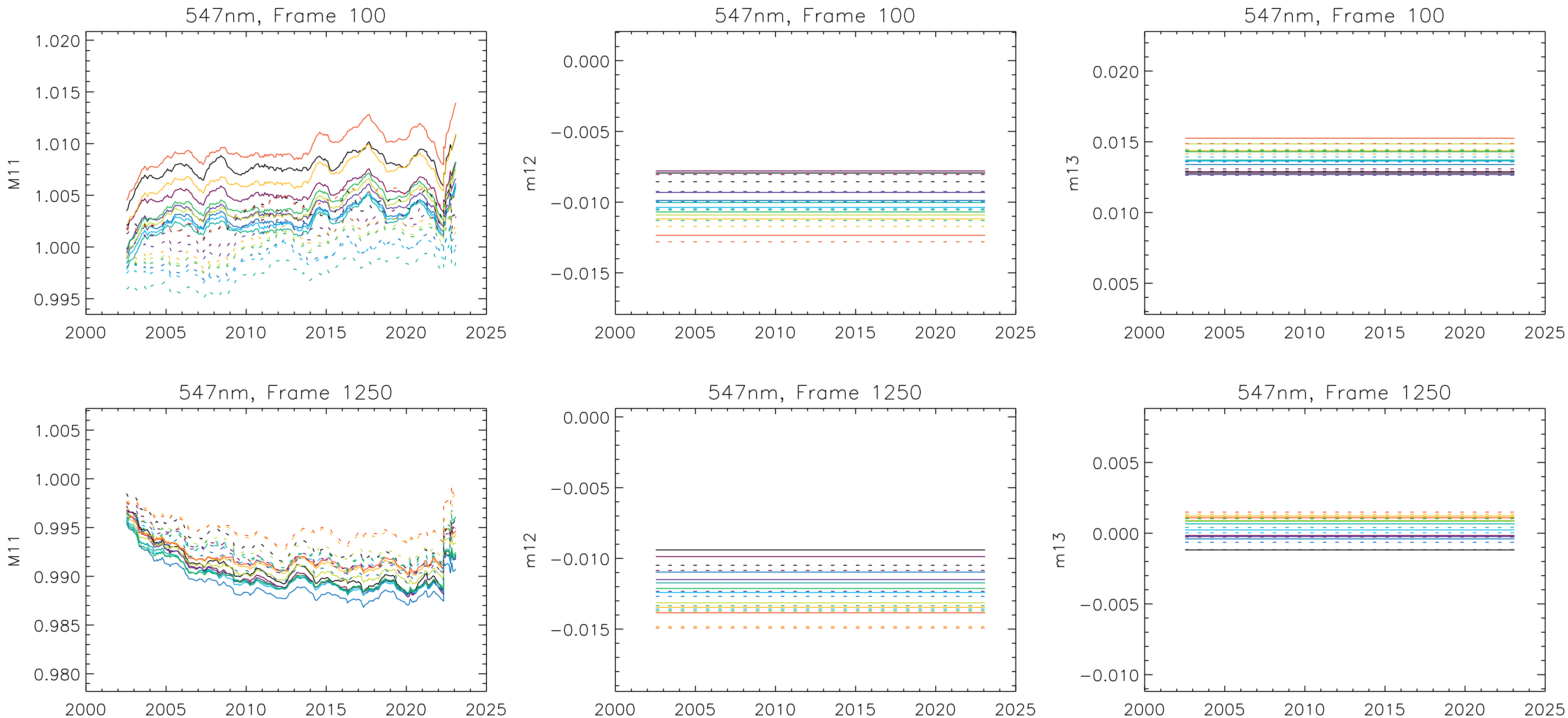




Eval v2.7e, M_{11} with 1-year smoothing; m_{12} and m_{13} from xcal to SeaWiFS, mission average

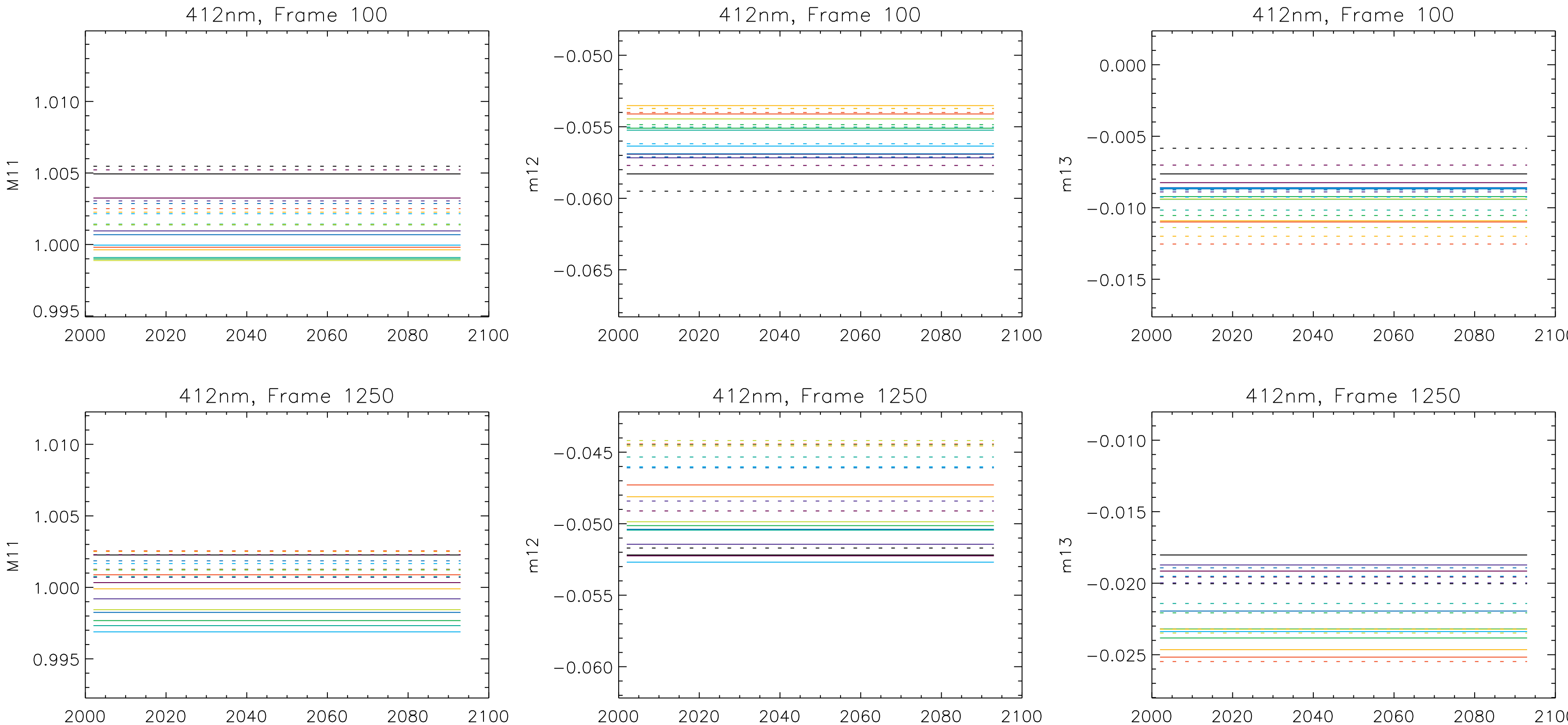
Similar polarization sensitivity (m_{12}) at beginning and end of scan. Prelaunch: increase with HAM AOI

Xcal: MODISA to itself, 547nm, no detrending



Eval v2.7e, M_{11} with 1-year smoothing; m_{12} and m_{13} from xcal to SeaWiFS, mission average

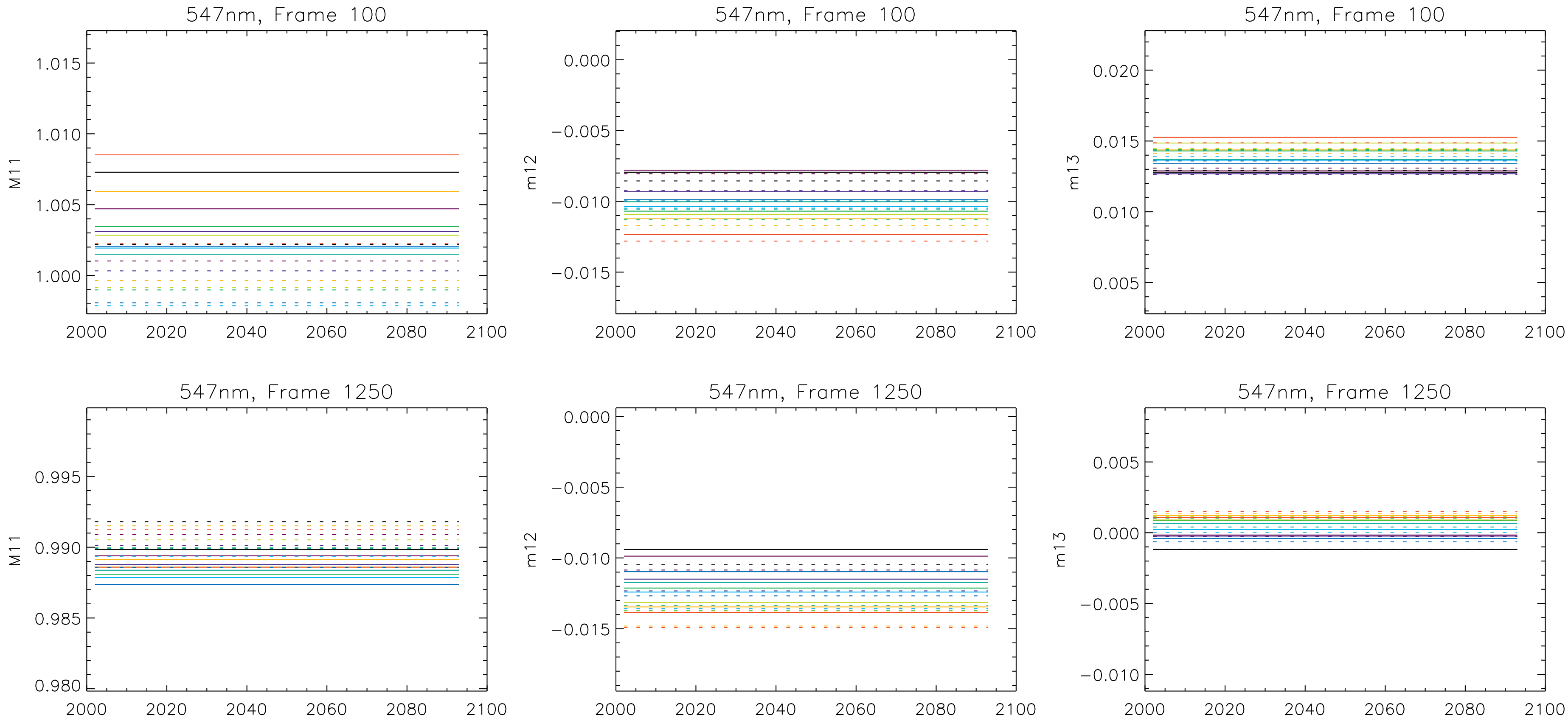
Xcal results: MODISA to SeaWiFS, 412nm



Eval version 61e: mission average M_{11}, m_{12} and m_{13}

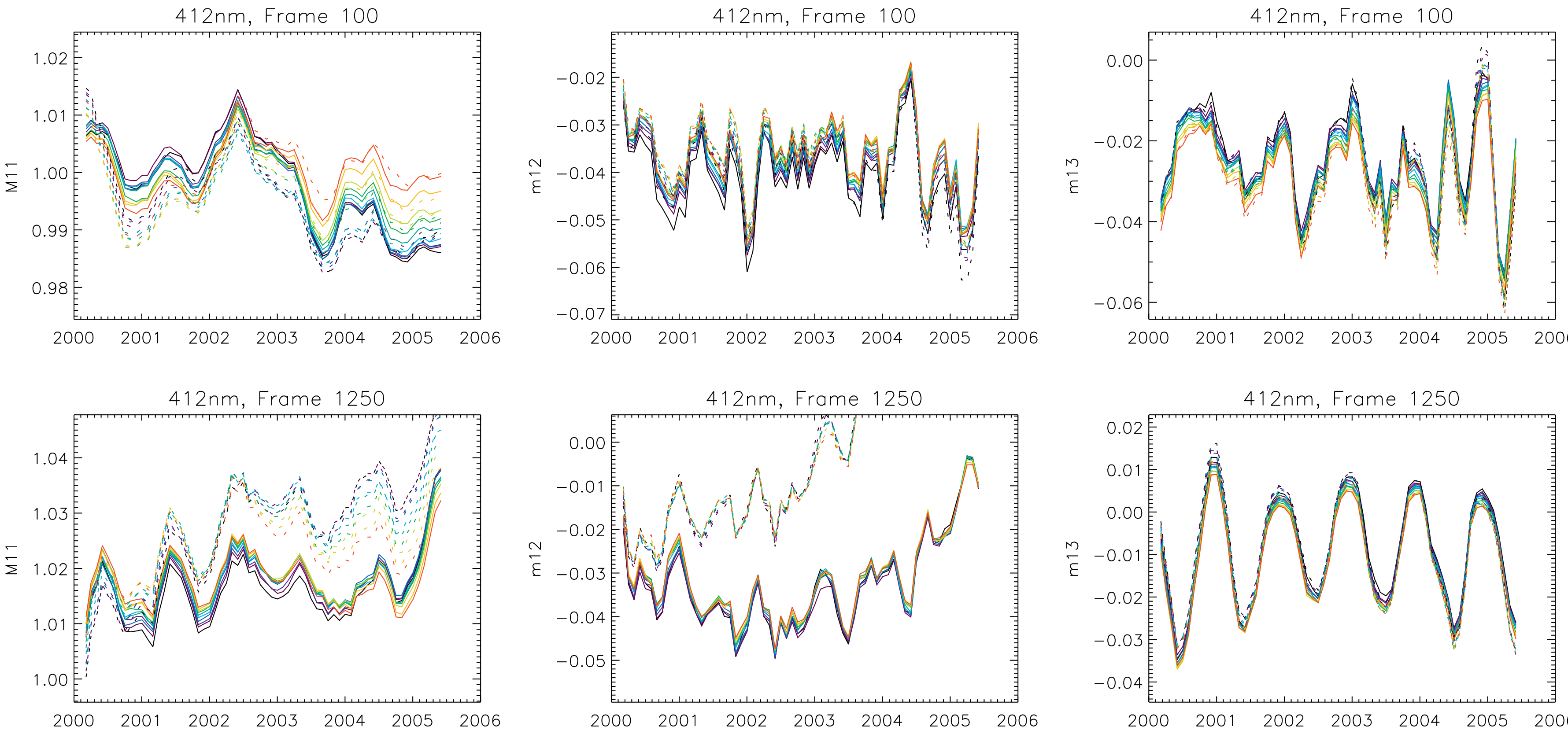
Similar polarization sensitivity (m_{12}) at beginning and end of scan. Prelaunch: increase with HAM AOI

Xcal results: MODISA to SeaWiFS, 547nm



Eval version 61e: mission average M_{11}, m_{12} and m_{13}

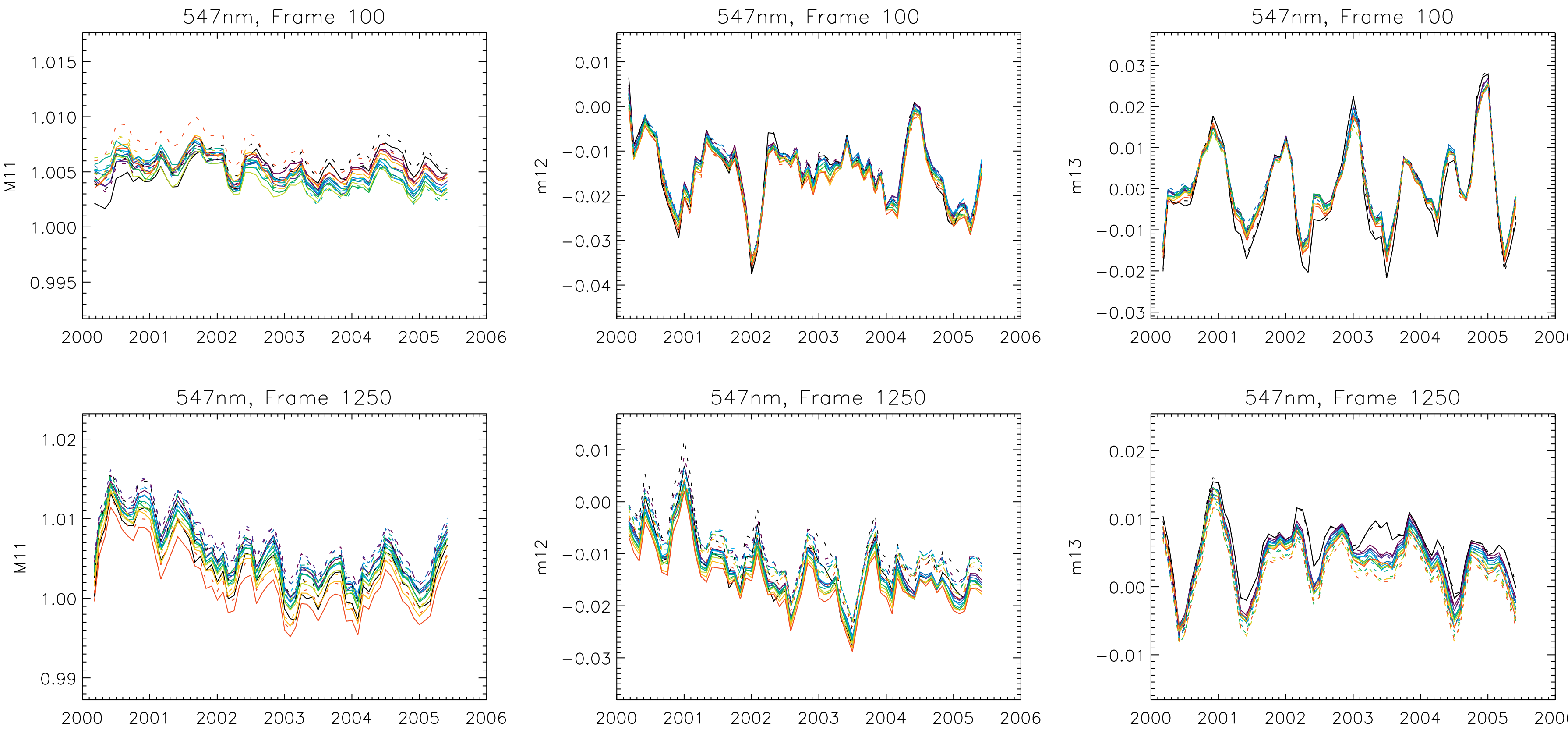
Xcal results: MODIST to SeaWiFS, 412nm

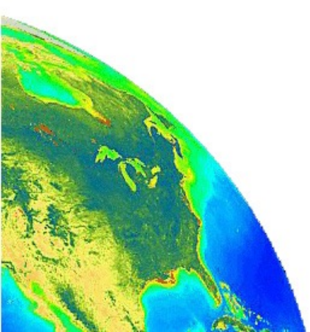


Eval version 26b, 3-month smoothing

Seasonal oscillations in all 3 parameters

Xcal results: MODIST to SeaWiFS, 547nm

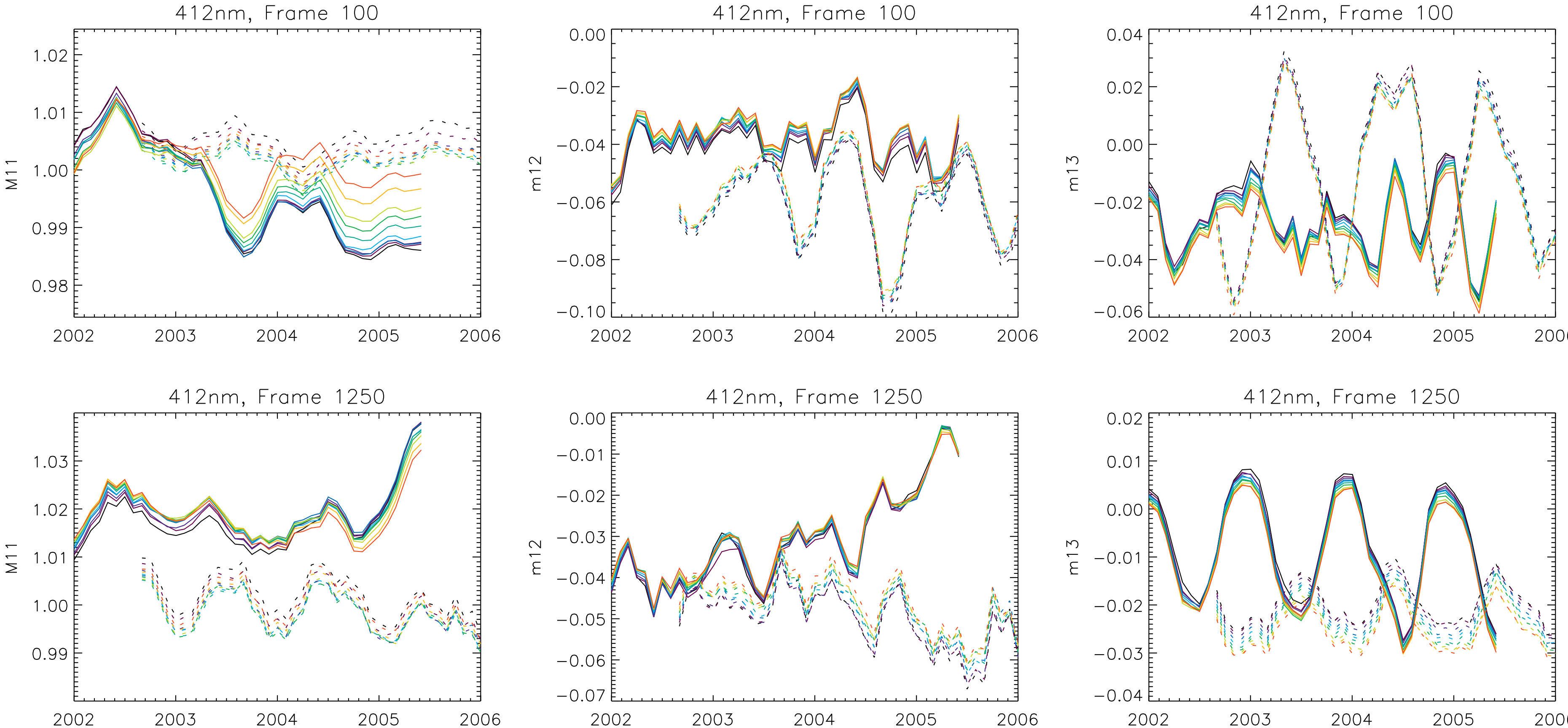




Eval version 26b, 3-month smoothing

Seasonal oscillations in all 3 parameters

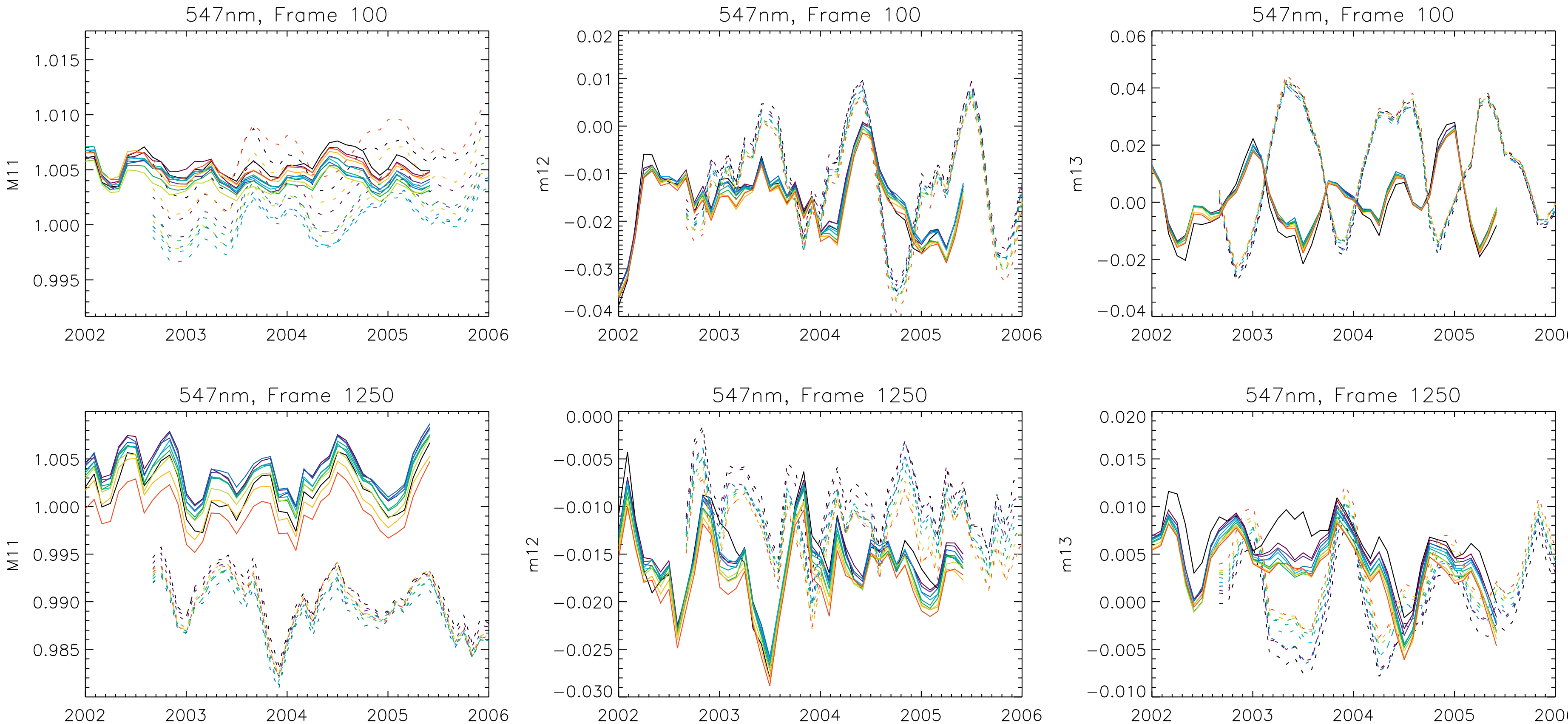
MODIST and MODISA to SeaWiFS, 412nm



Seasonal oscillation opposite in phase for m_{13}, end of scan;
Larger variation in MODISA, BOS, m_{12} and m_{13}, than MODIST.
MODISA M_{11} oscillation EOS should improve MOBY ratio.

Solid line: MODIST; dashed line: MODISA; only mirror side 1

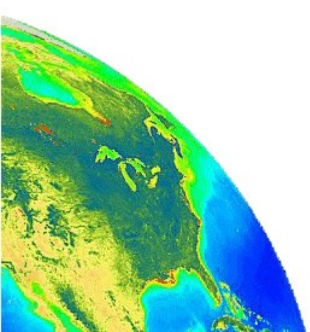
MODIST and MODISA to SeaWiFS, 547nm



Similar variation for m_{13}, end of scan (not opposite in phase).

Larger variation in MODISA, BOS, m_{12} and m_{13}, than MODIST.

MODISA M_{11} oscillation EOS should improve MOBY ratio.



Solid line: MODIST; dashed line: MODISA; only mirror side 1

Summary:

Good!

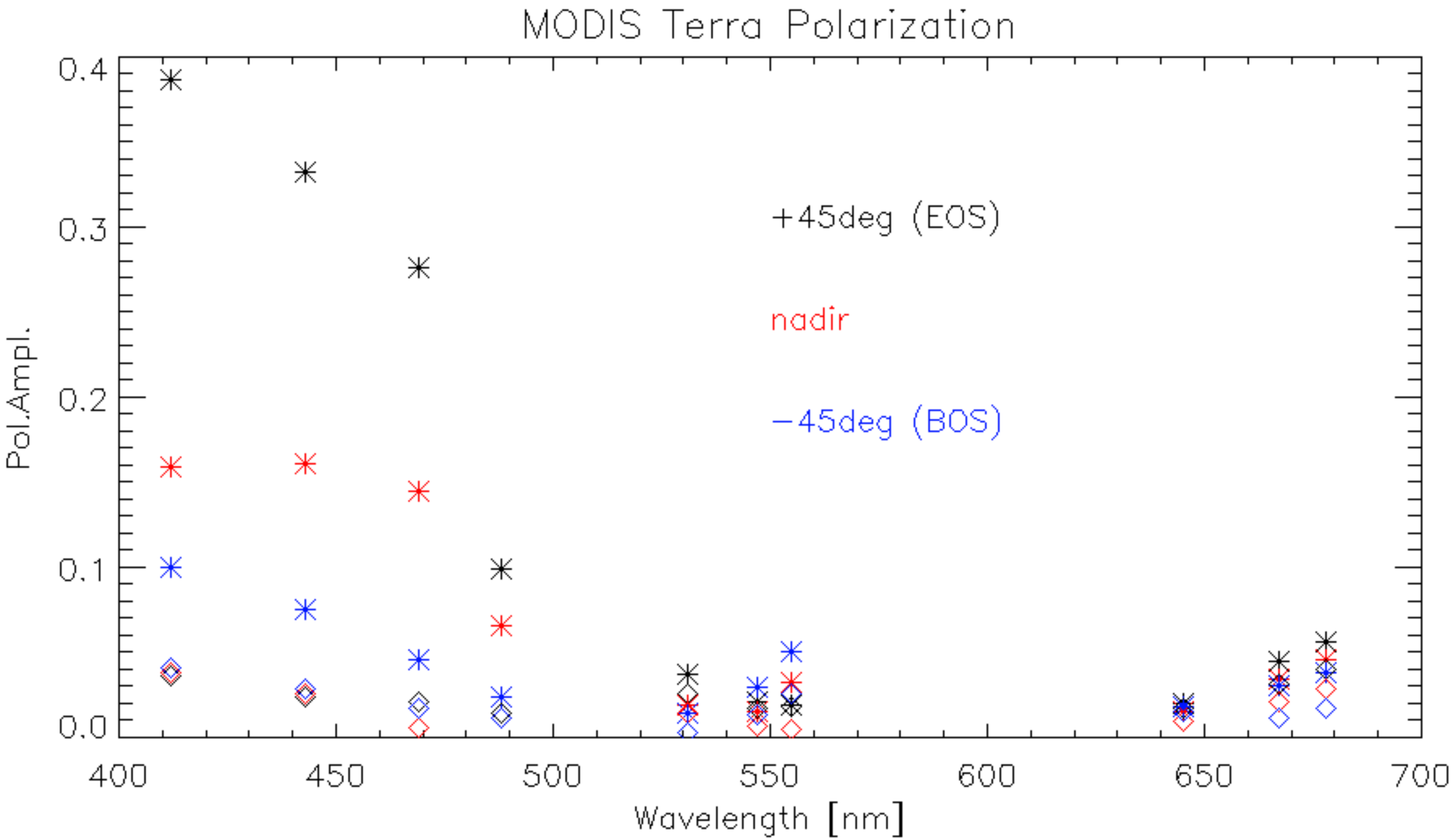
- Xcal of MODISA to SeaWiFS shows no large polarization sensitivity trend over time (until 2011).
- Xcal of MODIST to MODISA shows very large polarization sensitivity trends over time for MODIST in the blue bands. Correcting for these changes improves the agreement of MODIST ocean color products with MODISA and SeaWiFS, so these long term trends are likely real changes of the MODIST instrument polarization sensitivity.

???

- Both xcals (and xcal of MODIST to SeaWiFS) show large seasonal oscillations in polarization sensitivity (with opposite phase for 412nm end of scan) that are very unlikely to be actual changes of the instrument polarization sensitivity.
- Xcal of MODISA to SeaWiFS shows seasonal oscillations in M_{11}, on the order of 1% at 412nm. Although there are potential mechanisms for such an oscillation (e.g. temperature sensitivity, linearity), these are unlikely to be the reasons for the oscillation.
- Xcal of MODIST to SeaWiFS has smaller oscillations than MODISA to SeaWiFS (until 2005).

Backup

Xcal results: Max. Polarization Amplitude



Stars: mission max. (as of 2014)
Diamonds: beginning of mission