Detector-to-Detector Residuals in MODIS Aqua calibration coefficients

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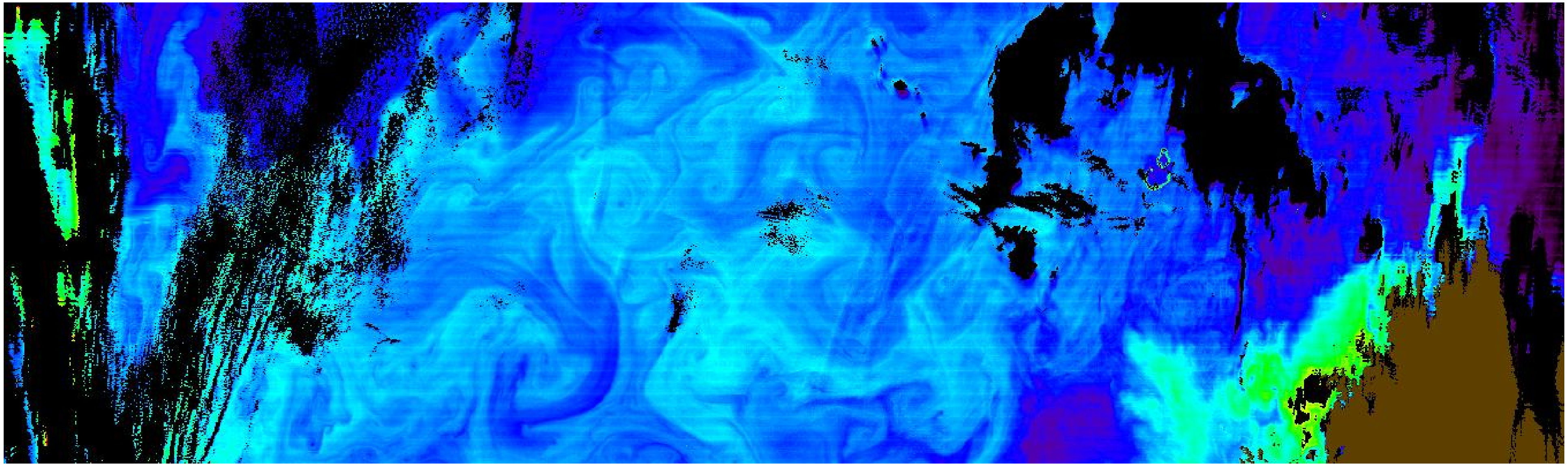
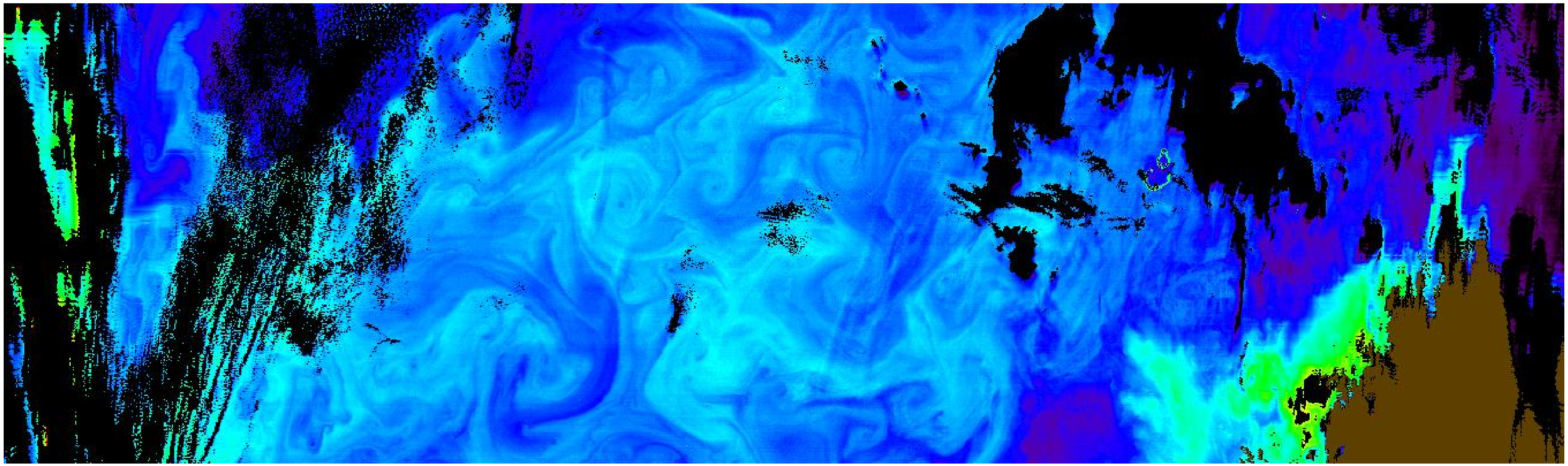
1: Futuretech Corp., 2: SAIC

Acknowledgements: MCST, OBPG

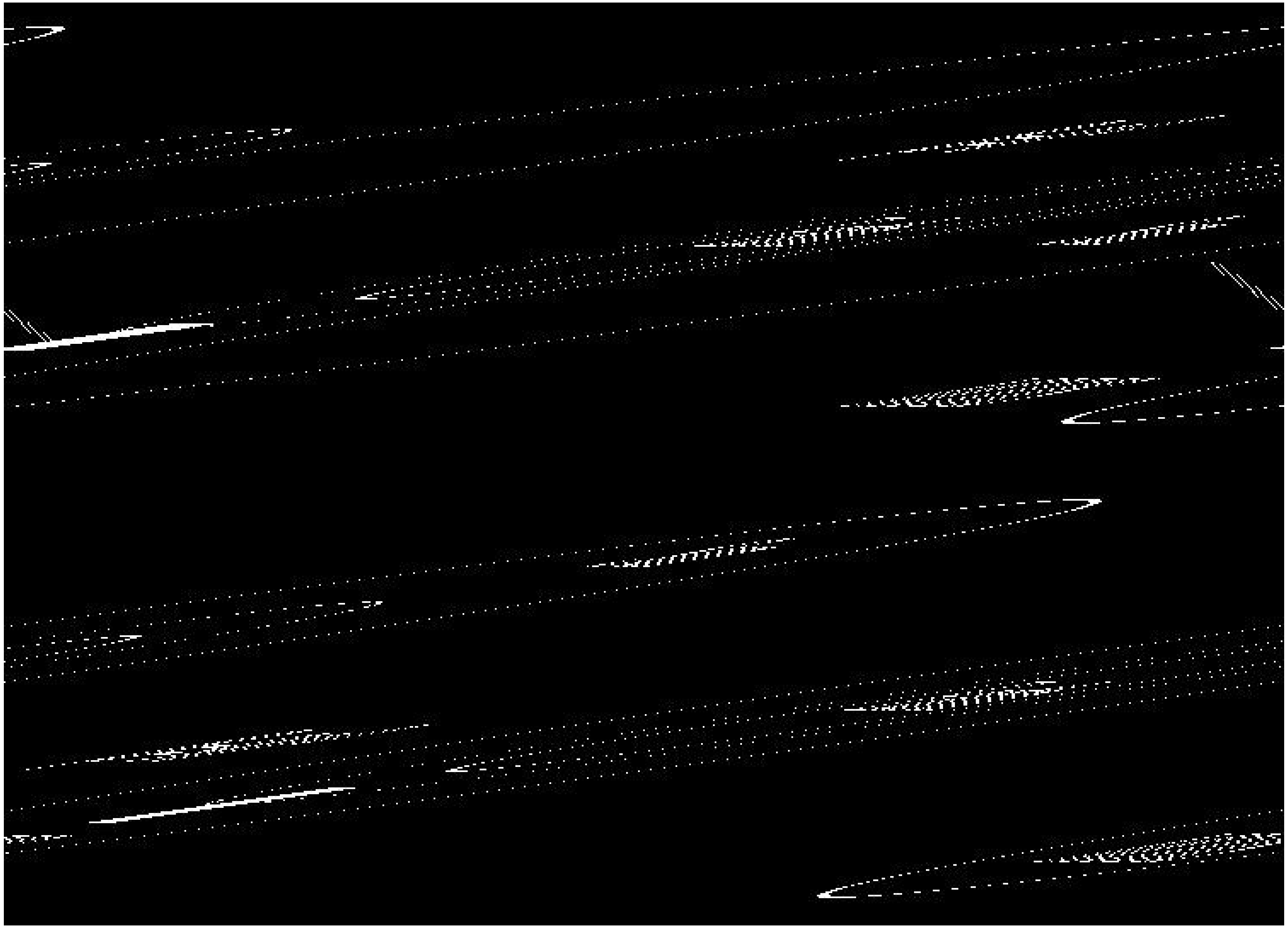
MODIS Aqua nLw 412nm, before correction:



After correction:



‘Sun-yaw’ or beta angle



MODIS SD Measurement Setup (Waluschka et al., 2004)

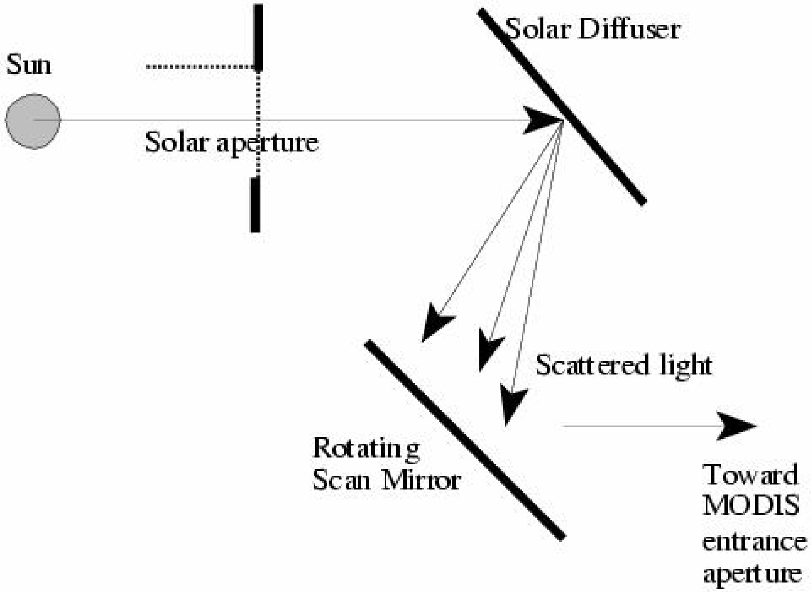


Fig. 4: Light path

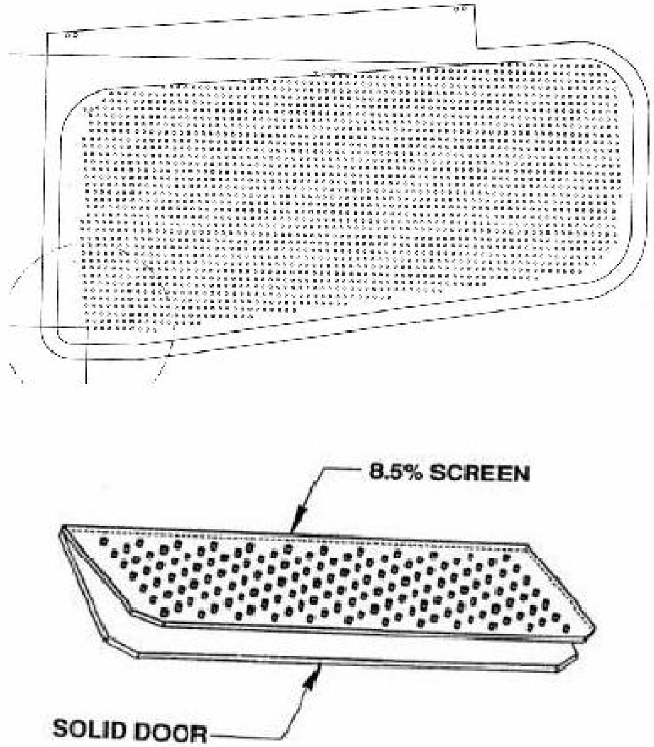


Fig. 5: Attenuation screen

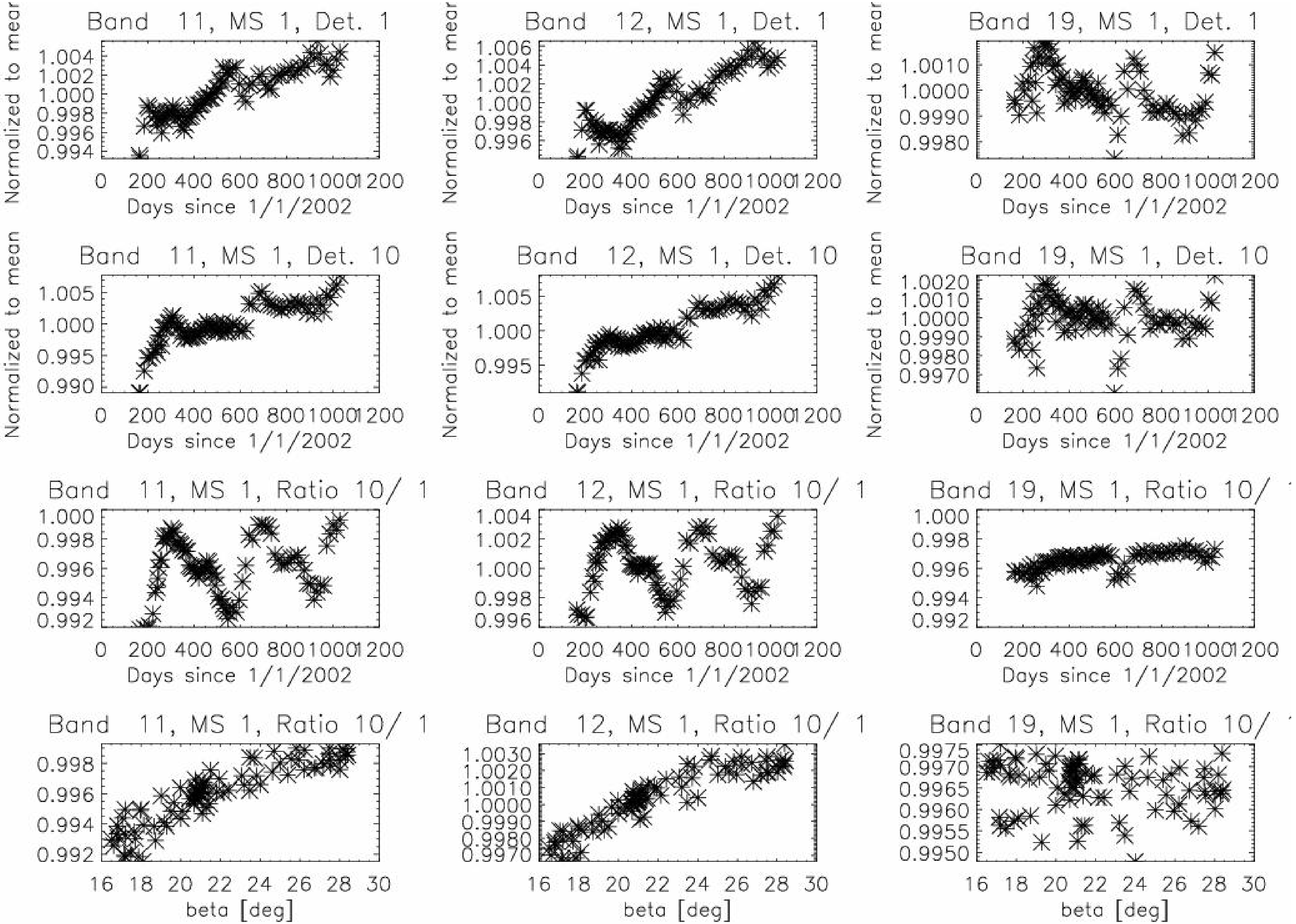
Part 1:
Results from on-orbit SD measurements with ocean bands

Next slide: m1 measurements

- Provided by MCST
- Not used in calibration LUTs
- Calculated with:

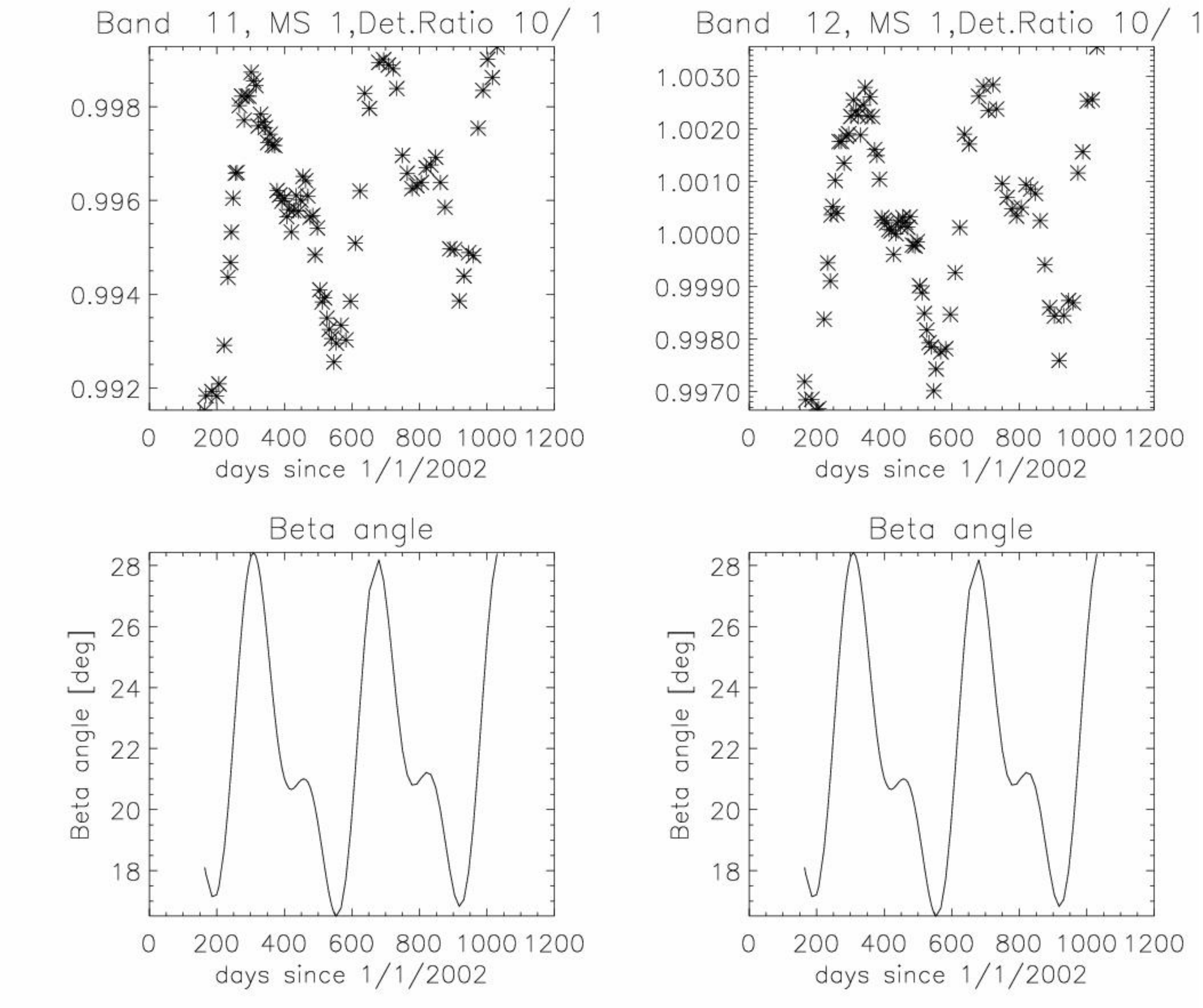
$$m1 = BRF * \cos\theta * \Gamma * \Delta / (dn^* * d^2_{ES})$$

Γ = vignetting function from SD screen
Δ = SD degradation measured by SDSM
dn^* = measured counts minus dark current (temperature corrected)
d_{ES} = distance Earth-Sun



Band 11, MS 1, Det. 1
Band 12, MS 1, Det. 1
Band 19, MS 1, Det. 1
Band 11, MS 1, Det. 10
Band 12, MS 1, Det. 10
Band 19, MS 1, Det. 10
Band 11, MS 1, Ratio 10/ 1
Band 12, MS 1, Ratio 10/ 1
Band 19, MS 1, Ratio 10/
Band 11, MS 1, Ratio 10/ 1
Band 12, MS 1, Ratio 10/ 1
Band 19, MS 1, Ratio 10/
Normalized to mean
Days since 1/1/2002
beta [deg]

Pattern related to beta angle:



MODIS Focal Planes

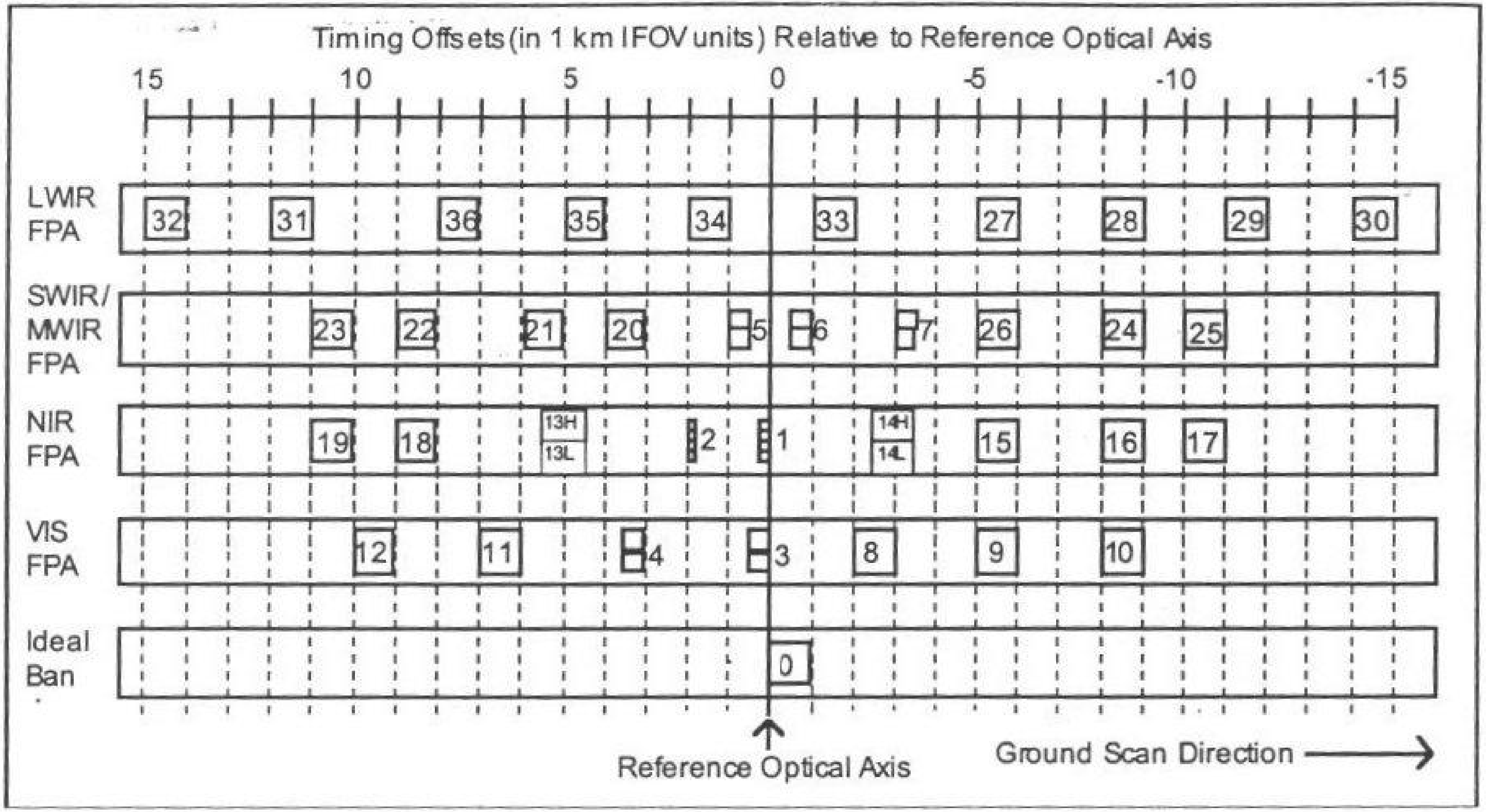
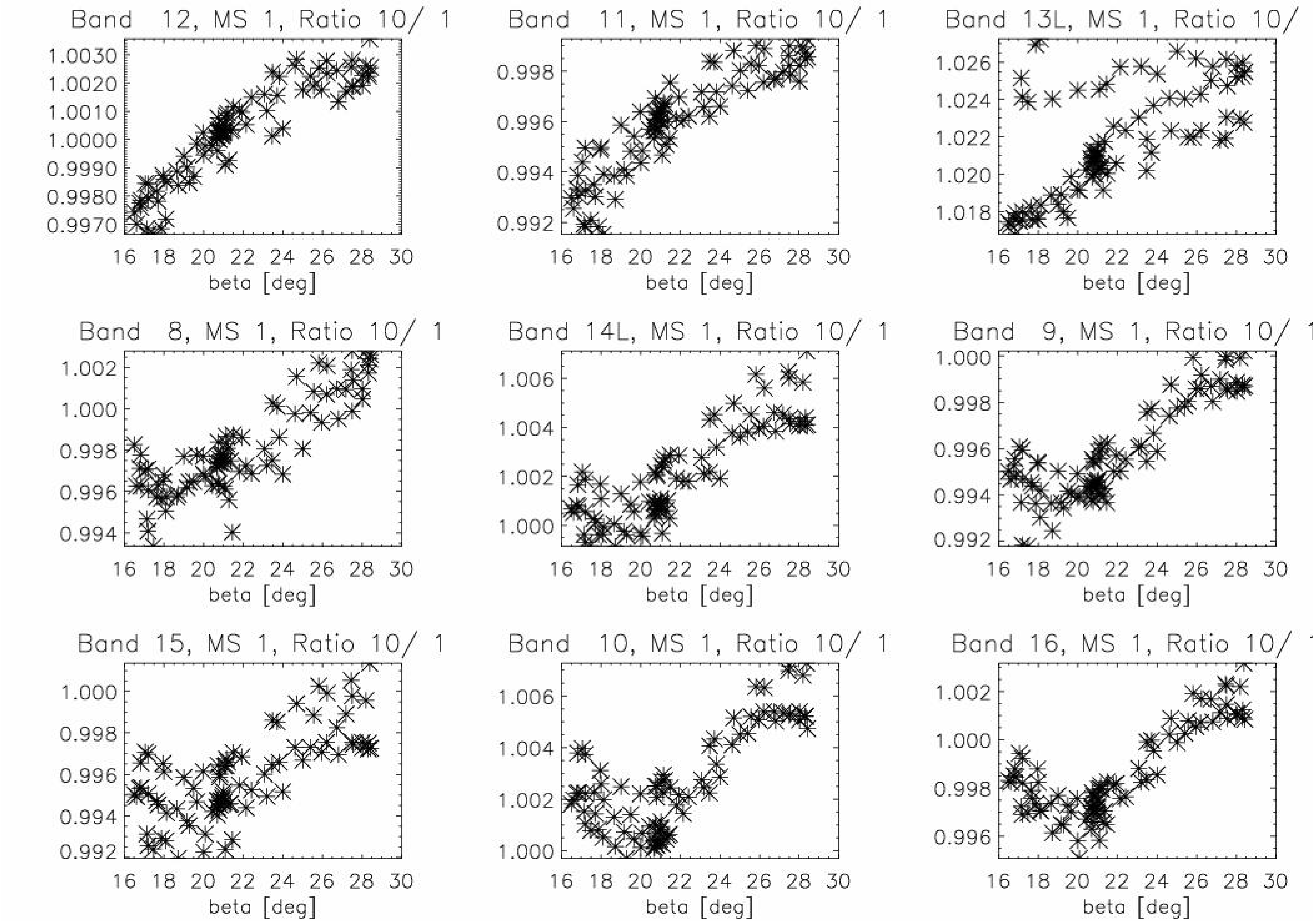


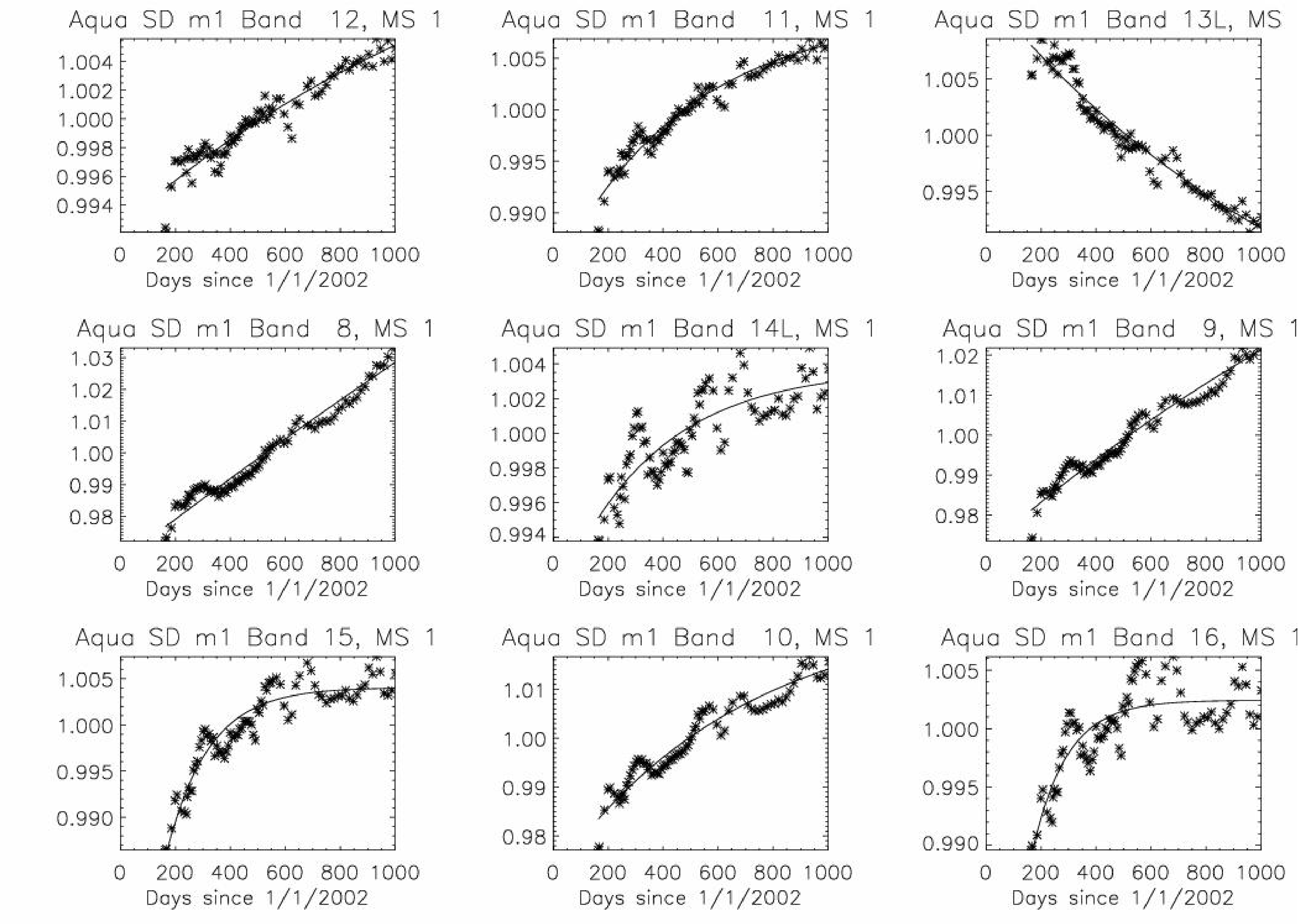
Figure 3-11. Offset of Each Band Relative to the Reference Optical Axis


Band 12, MS 1, Ratio 10/ 1
Band 11, MS 1, Ratio 10/ 1
Band 13L, MS 1, Ratio 10/
Band 8, MS 1, Ratio 10/ 1
Band 14L, MS 1, Ratio 10/ 1
Band 9, MS 1, Ratio 10/ 1
Band 15, MS 1, Ratio 10/ 1
Band 10, MS 1, Ratio 10/ 1
Band 16, MS 1, Ratio 10/
beta [deg]

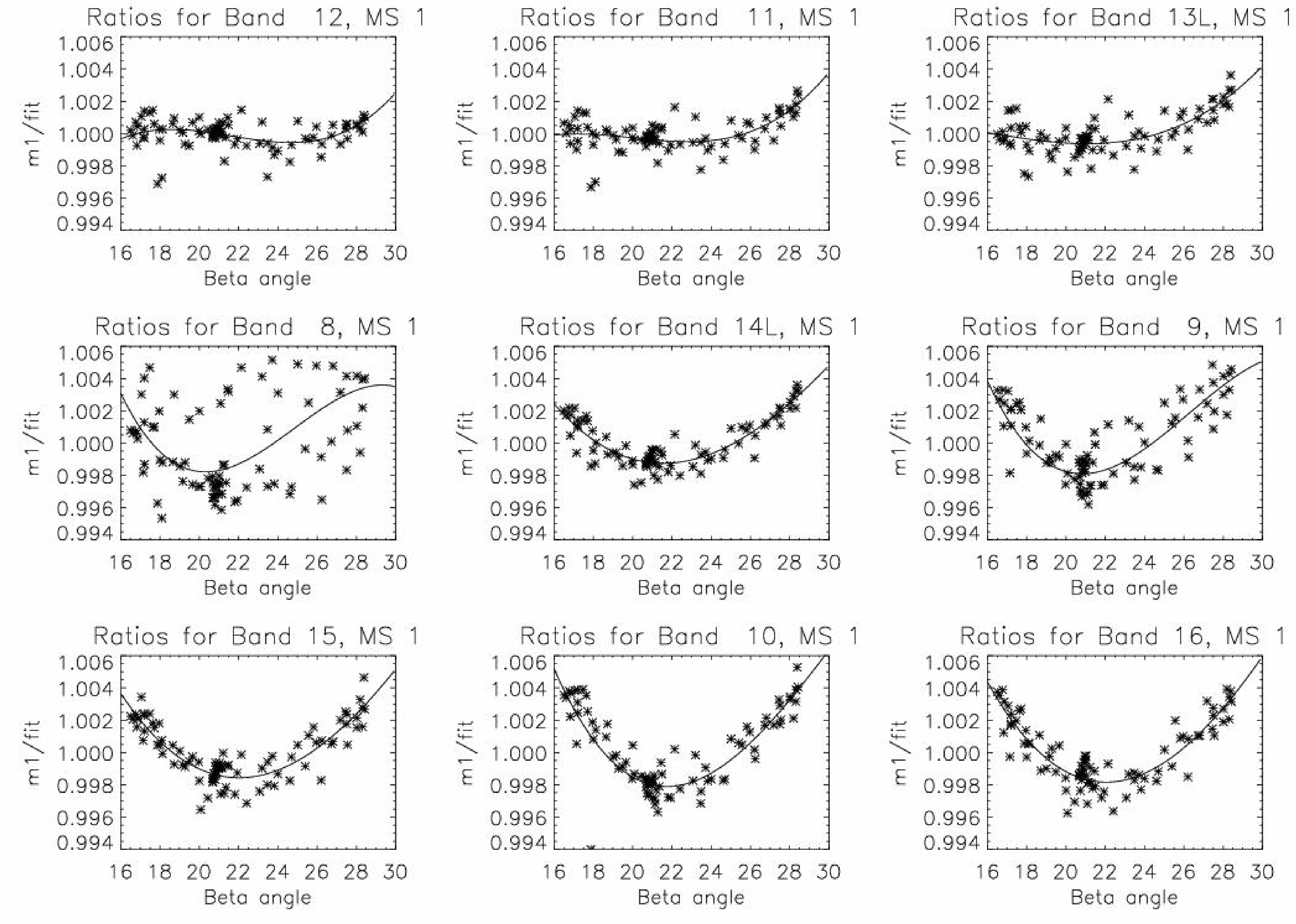
Conclusions:

- True vignetting function is detector dependent (~0.5% effect)
- This detector dependence is probably band dependent (~0.2% effect, determined by position on the focal plane)
- Open question: is the detector-averaged vignetting function also band dependent ?

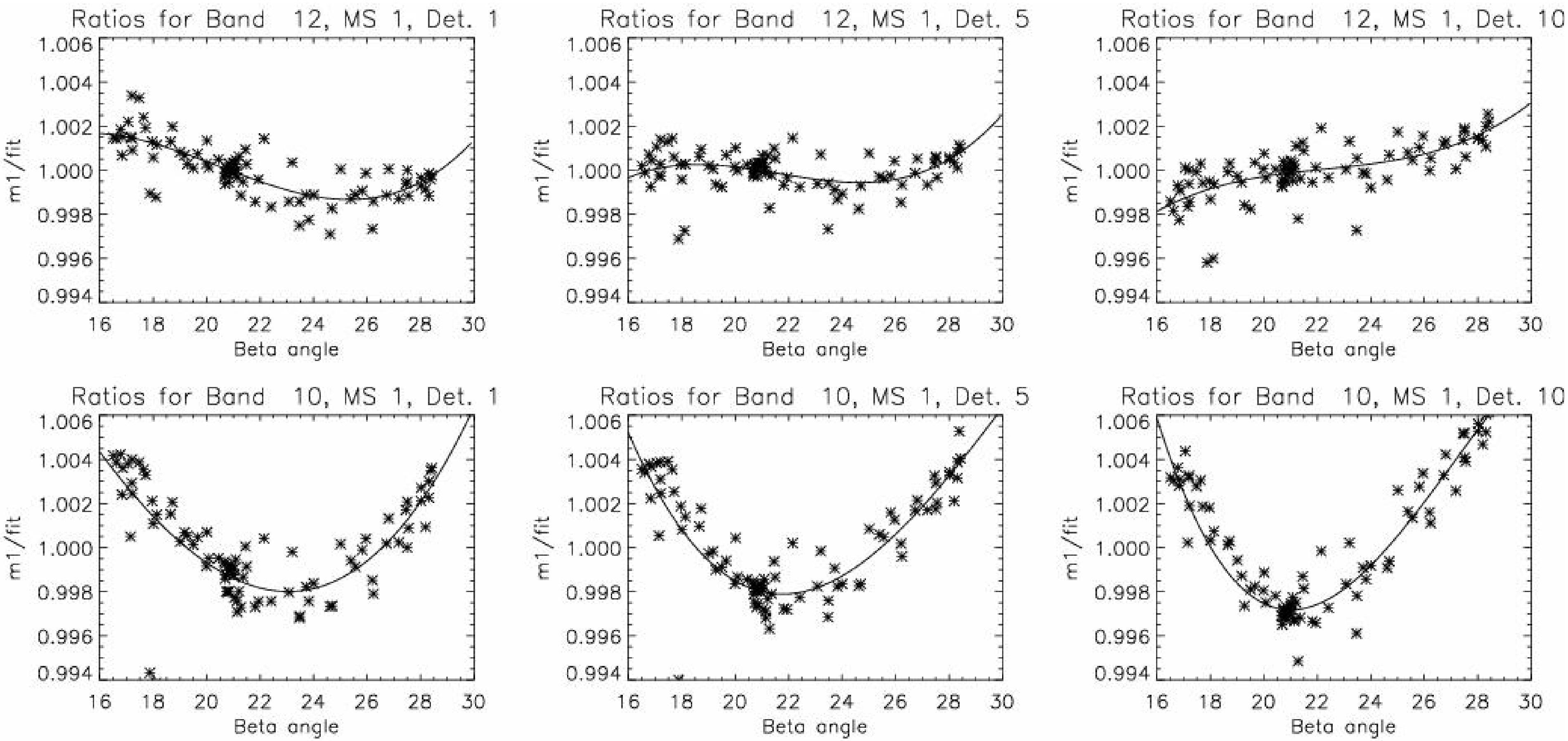
<u>Assumption: exponential degradation of gains (inverse of m1)</u>
(plot shows normalized m1 of detector 5 as a function of time)



Residuals from exponential degradation of m1, detector 5
(residuals fitted with 3rd order polynomial, plotted versus beta angle)

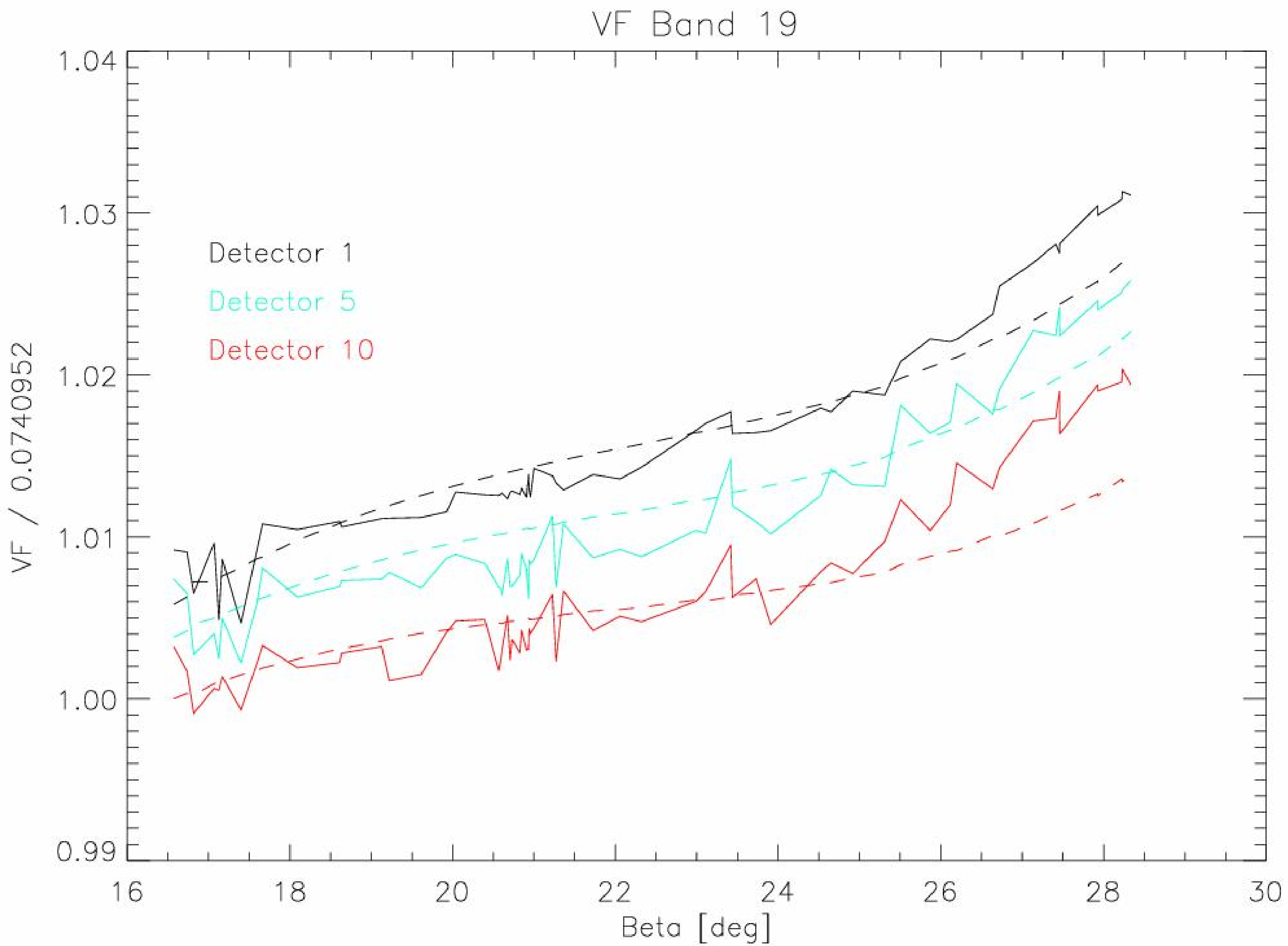


Residuals from exponential degradation of m1, detectors 1,5,10
(residuals fitted with 3rd order polynomial, plotted versus beta angle)

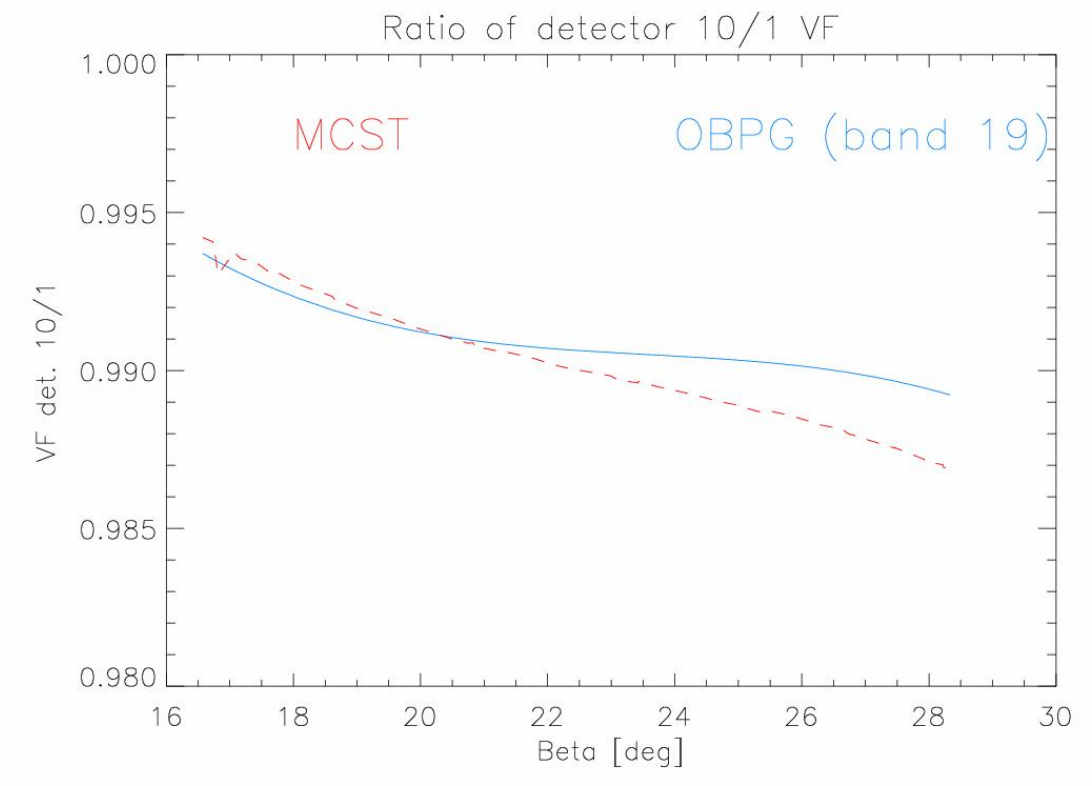


Part 2:
Results from on-orbit SD measurements with non-ocean bands

Vignetting function:
(dashed line: MCST, solid line: OBPG)



Detector 10/1 ratio from detector-dependent VF corrects detector ratio beta angle dependence...



... but makes striping worse !

Part 3:
Detector-to-Detector Residuals from Earth-View Data

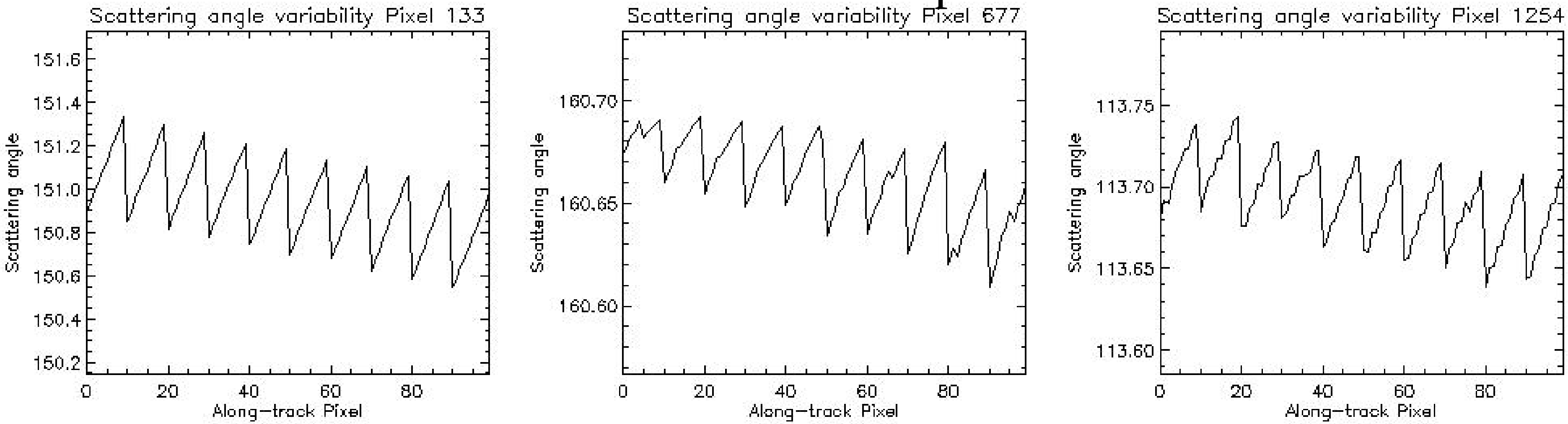
Aqua detector/mirror-side dependency

- Goal: quantify Aqua detector dependency for all ocean bands including the NIR bands for earthview TOA radiances (Lt's)
- How:
  - find runs of 20 pixels along the track which meet strict flag and low chlorophyll/AOT requirements
  - for each run calculate percent differences between the Lt at mirror side 1 detector 1 and the Lt's at the other pixels in the run
  - average percent differences for all the runs found

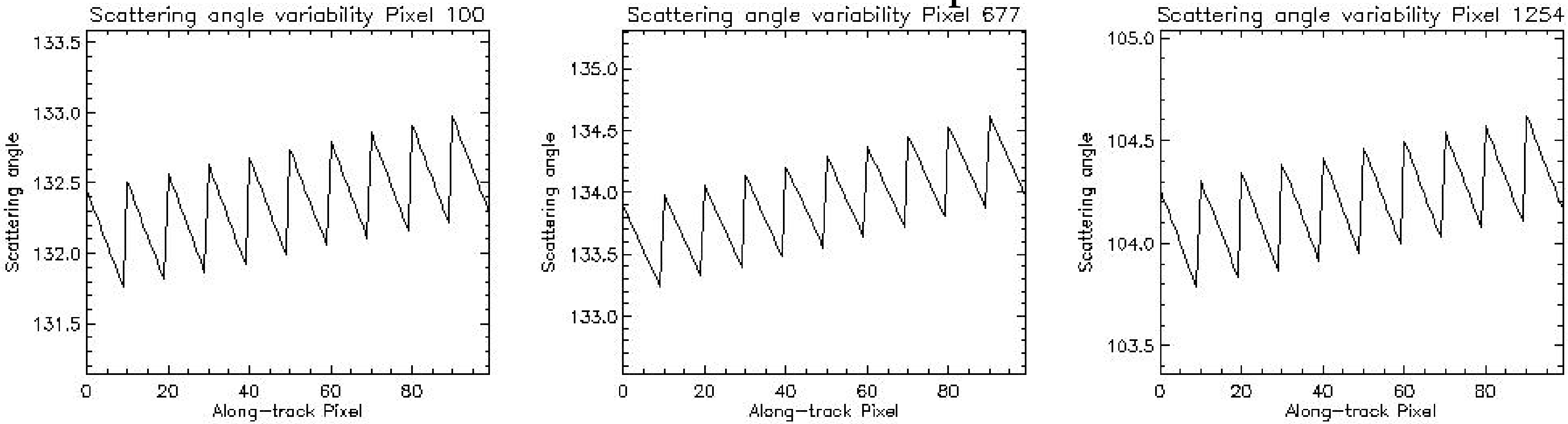
Aqua detector/mirror-side dependency – scattering angle

beginning of the scan | middle of the scan | end of the scan

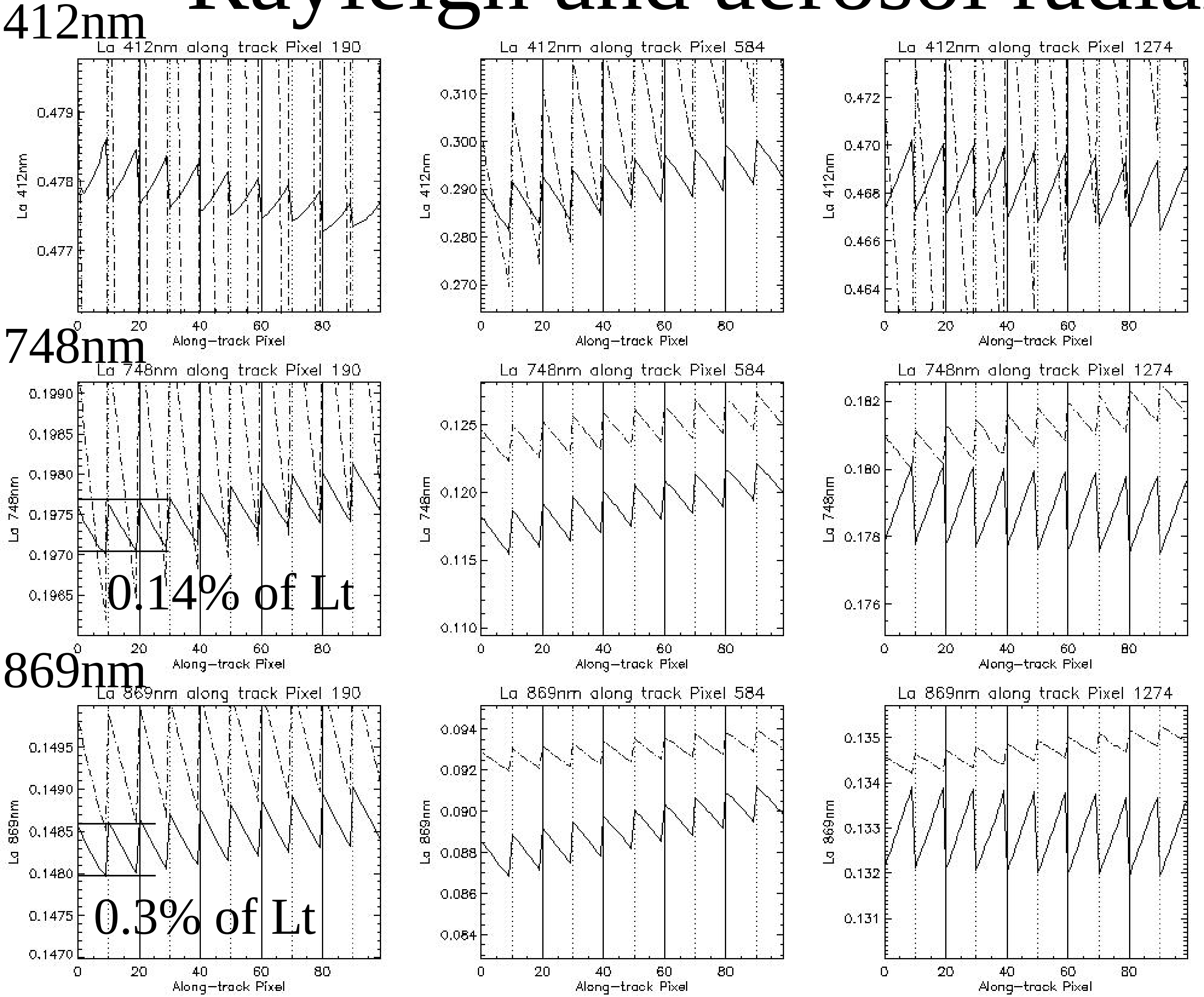
Northern Hemisphere



Southern Hemisphere



Aqua detector/mirror-side dependency Rayleigh and aerosol radiances

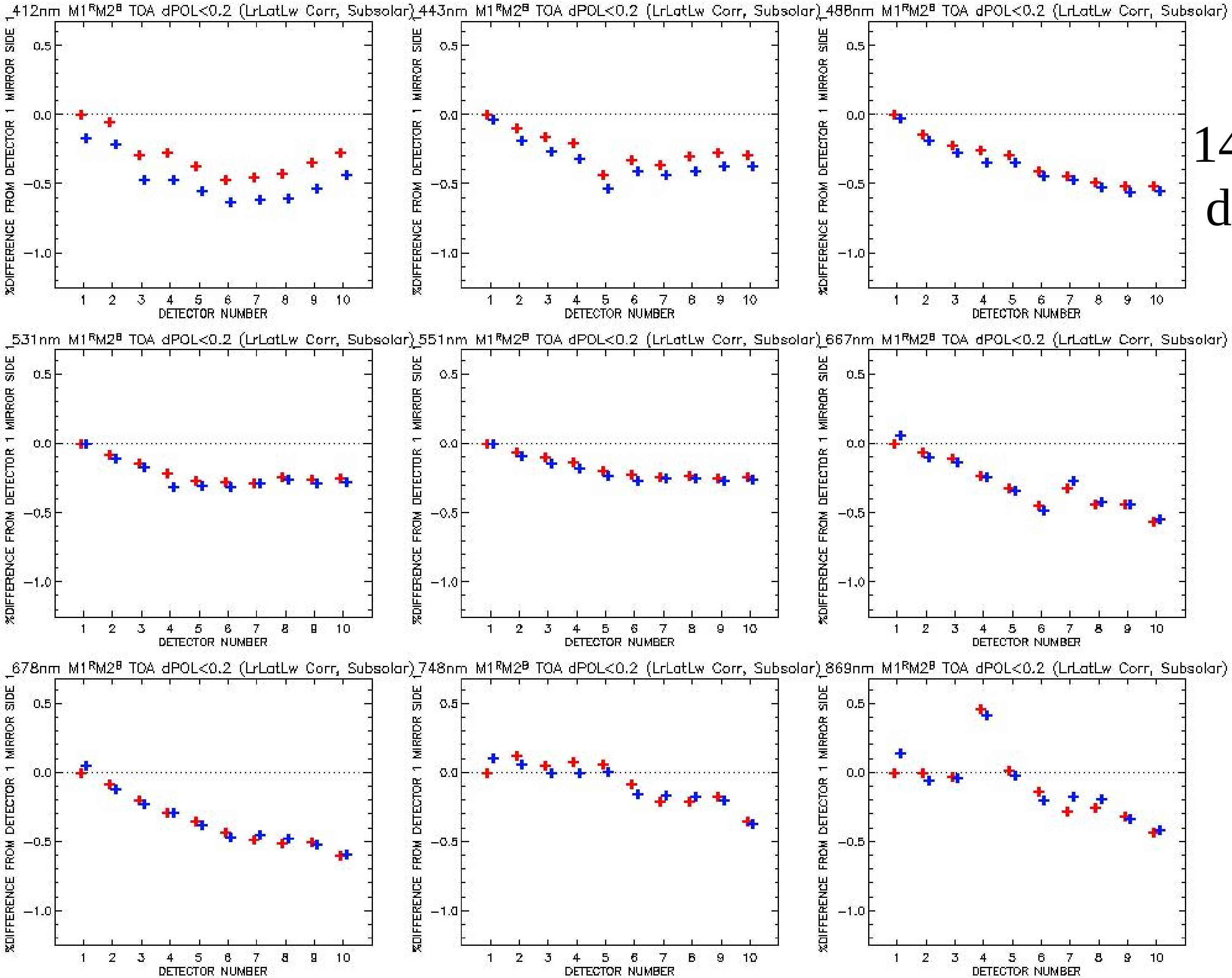


Southern Hemisphere

La - solid lines (aerosols)

Rayleigh - broken lines shifted down from original radiance (can correct for Rayleigh easily)

Aqua detector/mirror-side dependency – with Rayleigh, La and tLw correction

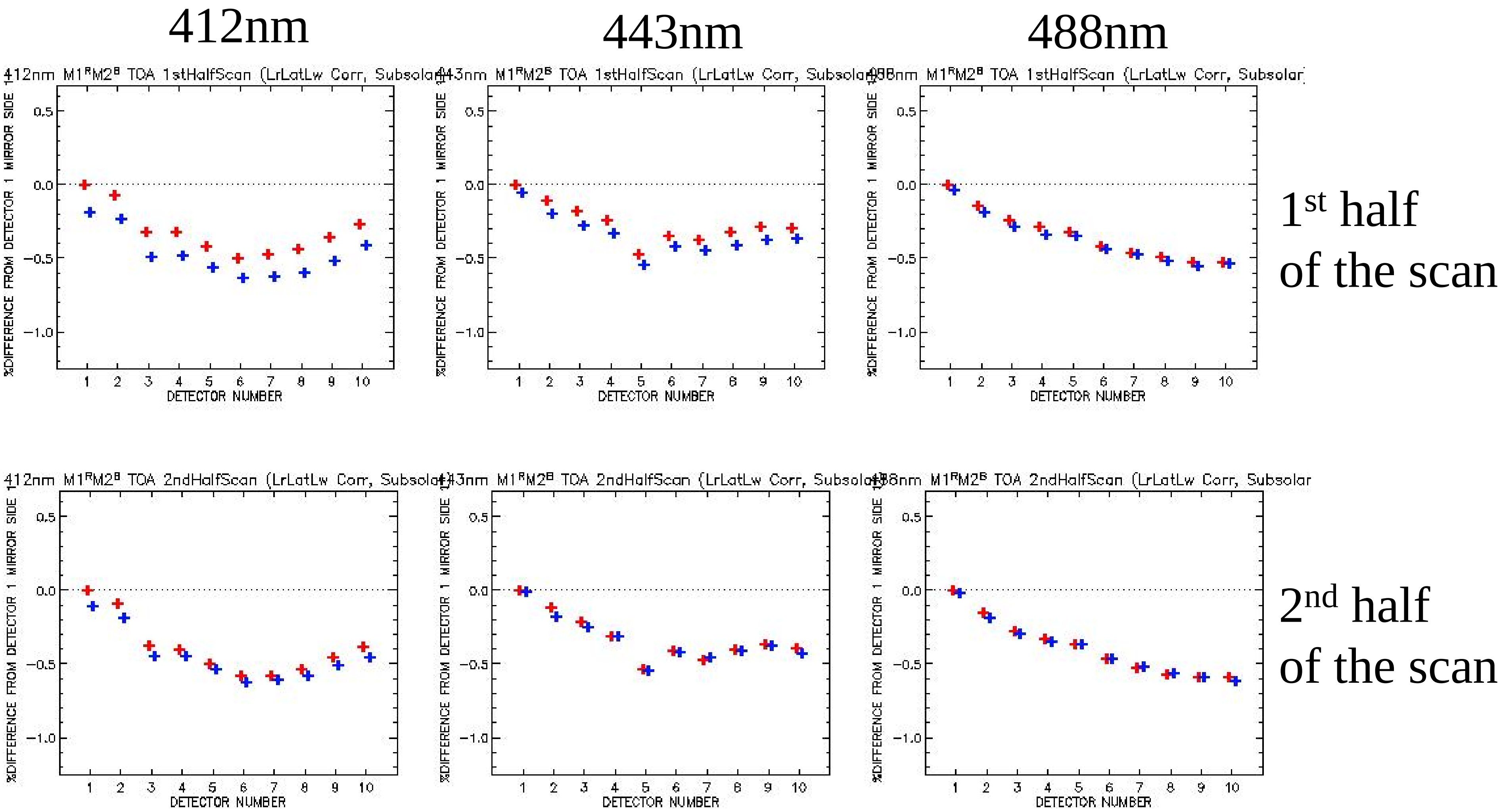


14 Aug 2002
dPOL < 0.2

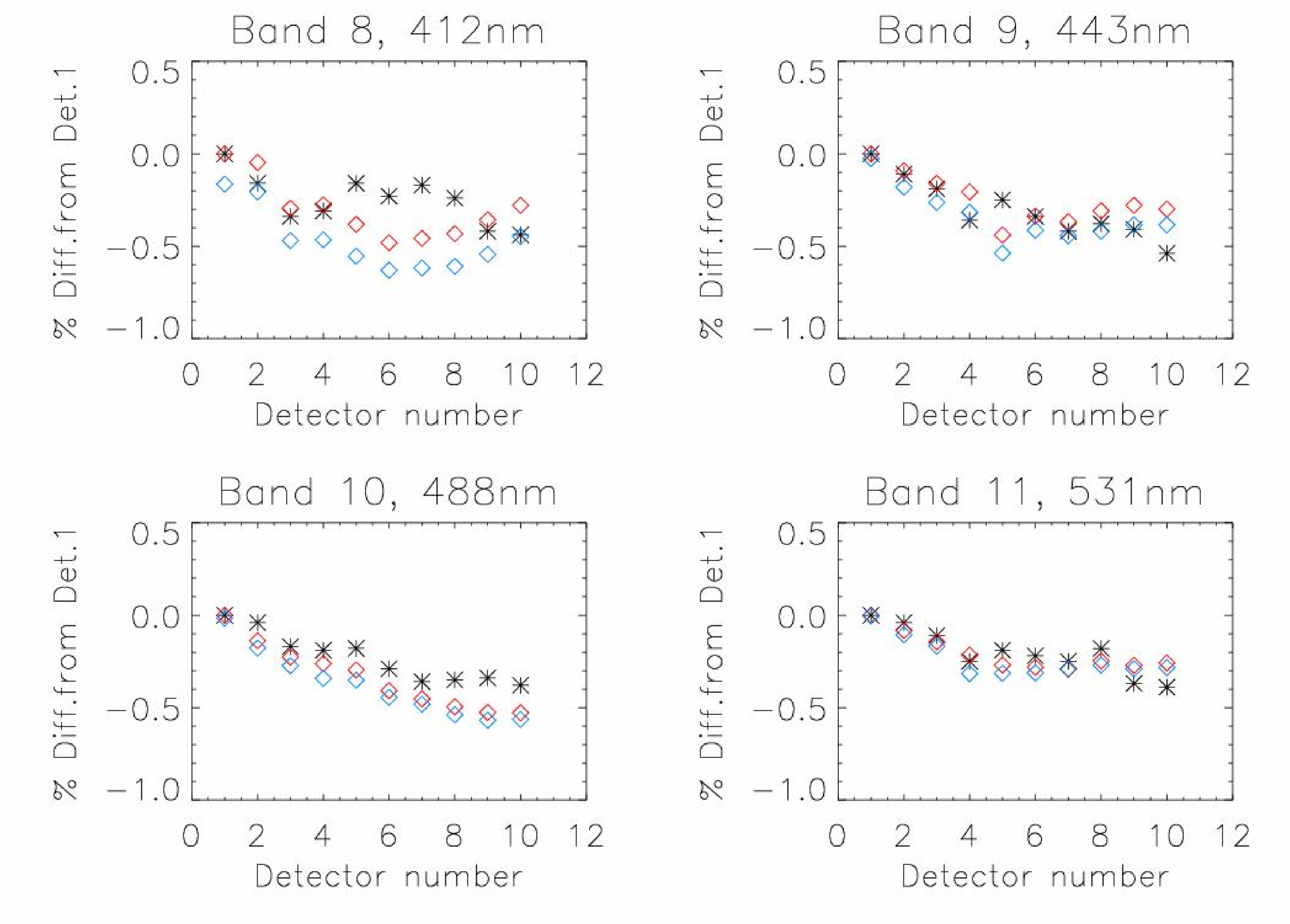
Aqua detector/mirror-side dependency – with Rayleigh, La and tLw correction

14 Aug 2002

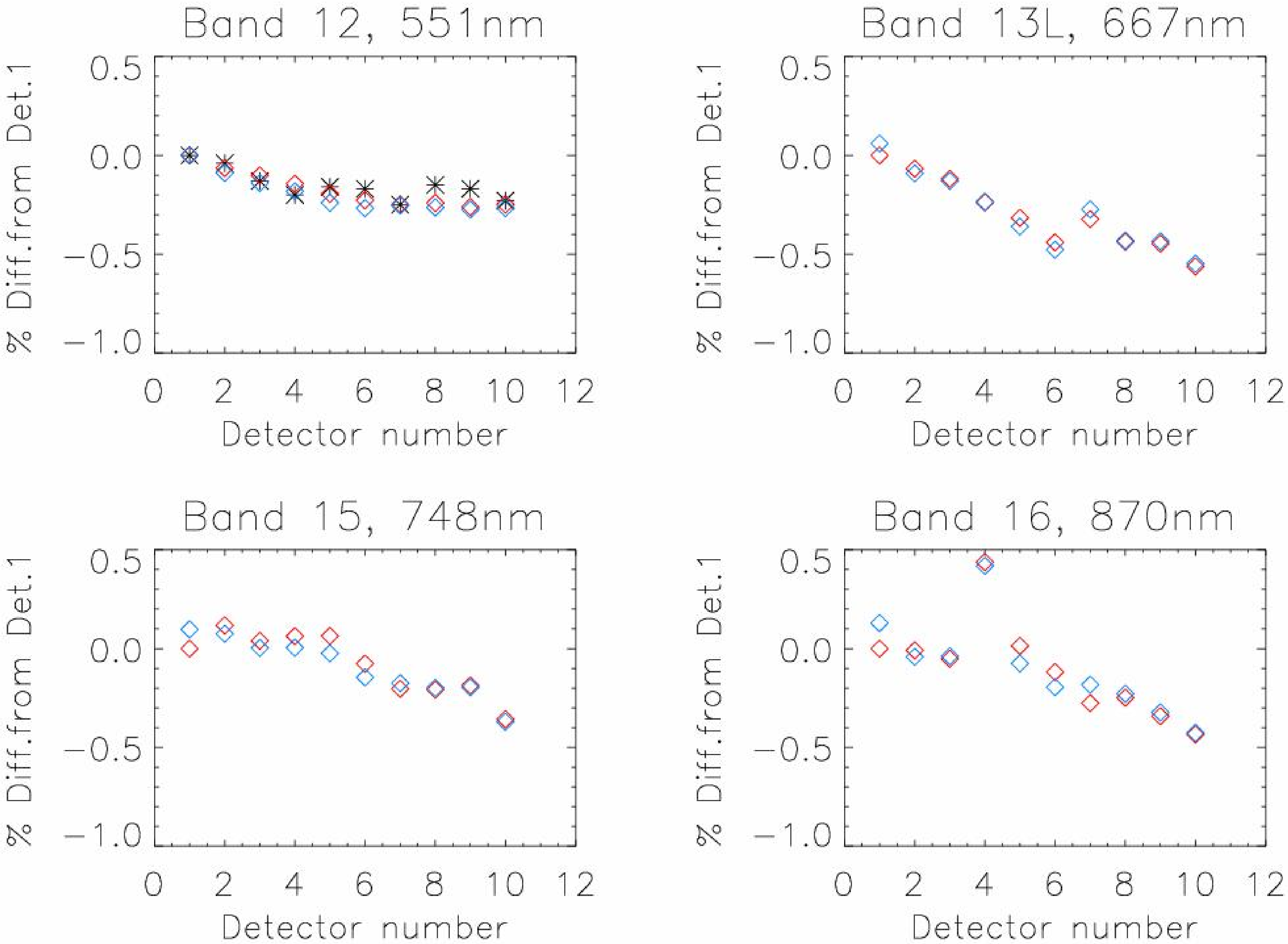
no limit on dPOL



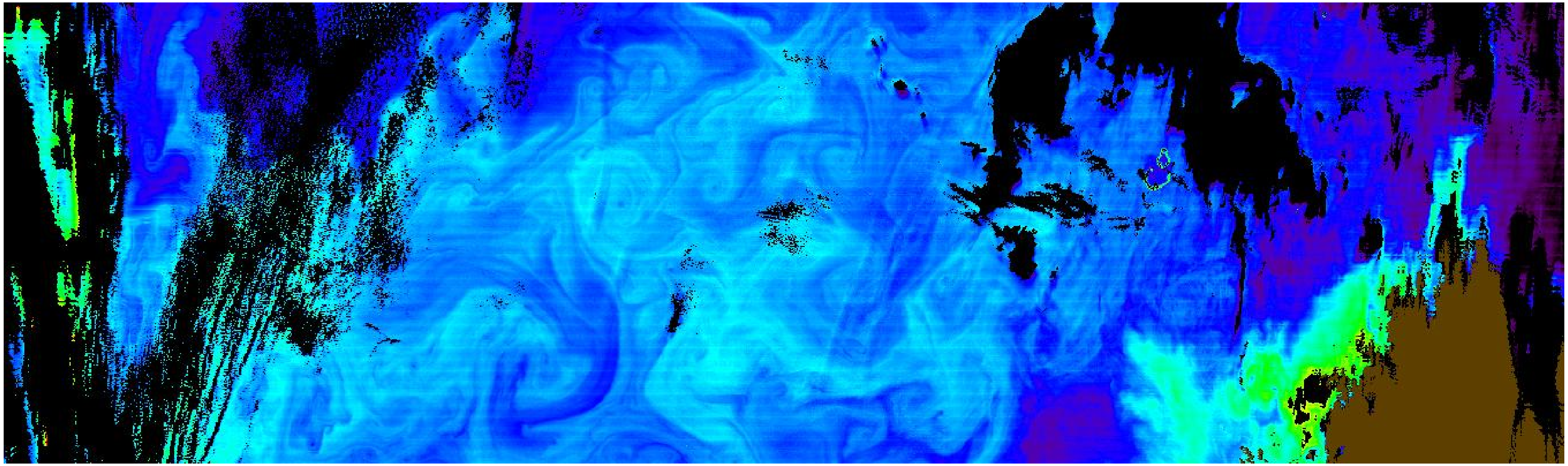
Comparison to lunar analysis of MCST (*):



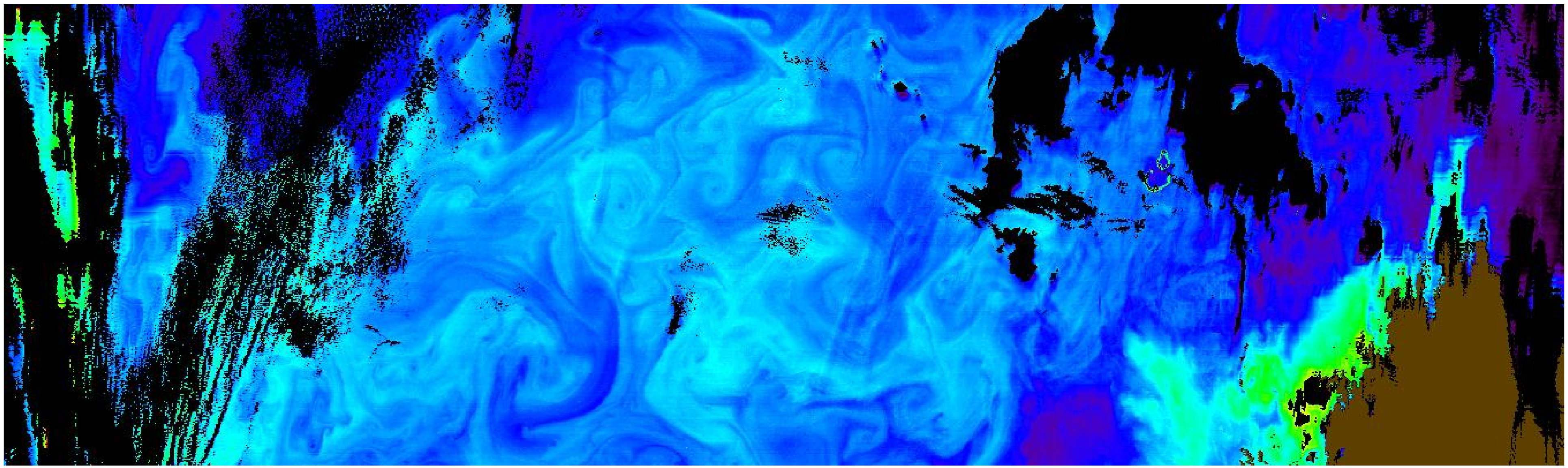
Comparison to lunar analysis of MCST (*):



MODIS Aqua nLw 412nm, before correction:



After correction:



Conclusions:

- **Corrections from TOA analysis significantly reduce striping**
- Corrections confirmed by lunar analysis
- Detector dependent vignetting function removes beta angle dependence in detector ratio, but increases striping
- Open question: what causes SD to introduce offsets between detectors ?