SNPP OMPS Nadir Calibration Updates

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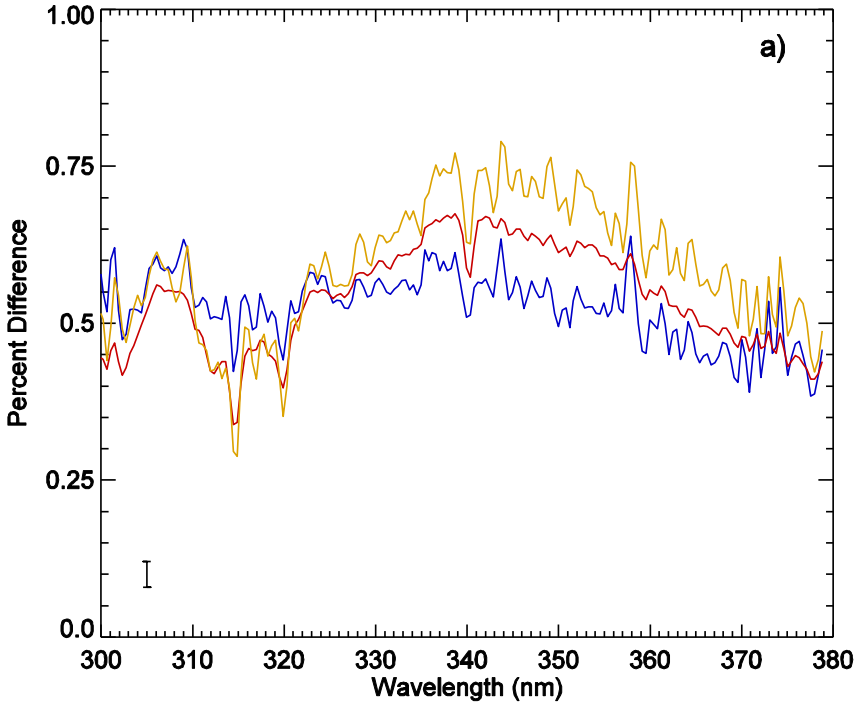
NASA OMPS Science Team / SIPS

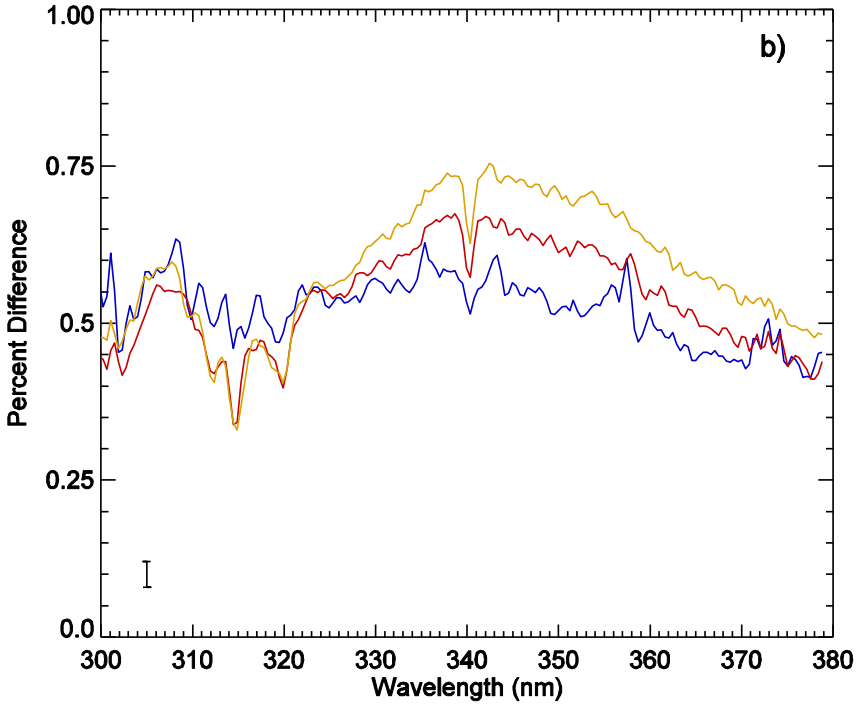
Summary

- We have performed detailed analysis of the OMPS radiances from both the NM and NP sensors to improve the calibration of the instruments
- Results from our analysis will be presented in the following areas:
  - Improved calibration sequence
  - Calibration coefficients
  - Along-orbit and "seasonal" wavelength shifts
  - Dichroic effects on the 290-310 nm radiances
  - Long-term stability

Small (.002 nm) seasonal wavelength shift seen in NM sensor

- Comparisons of reference solar flux measurements on 31 Aug 2012, 4 Apr 2013, and 28 Aug 2013 with 21 Mar 2012
  - Left – No shift in wavelengths
  - Right – 0.002 nm shift for **31 Aug 2012** and **28 Aug 2013**

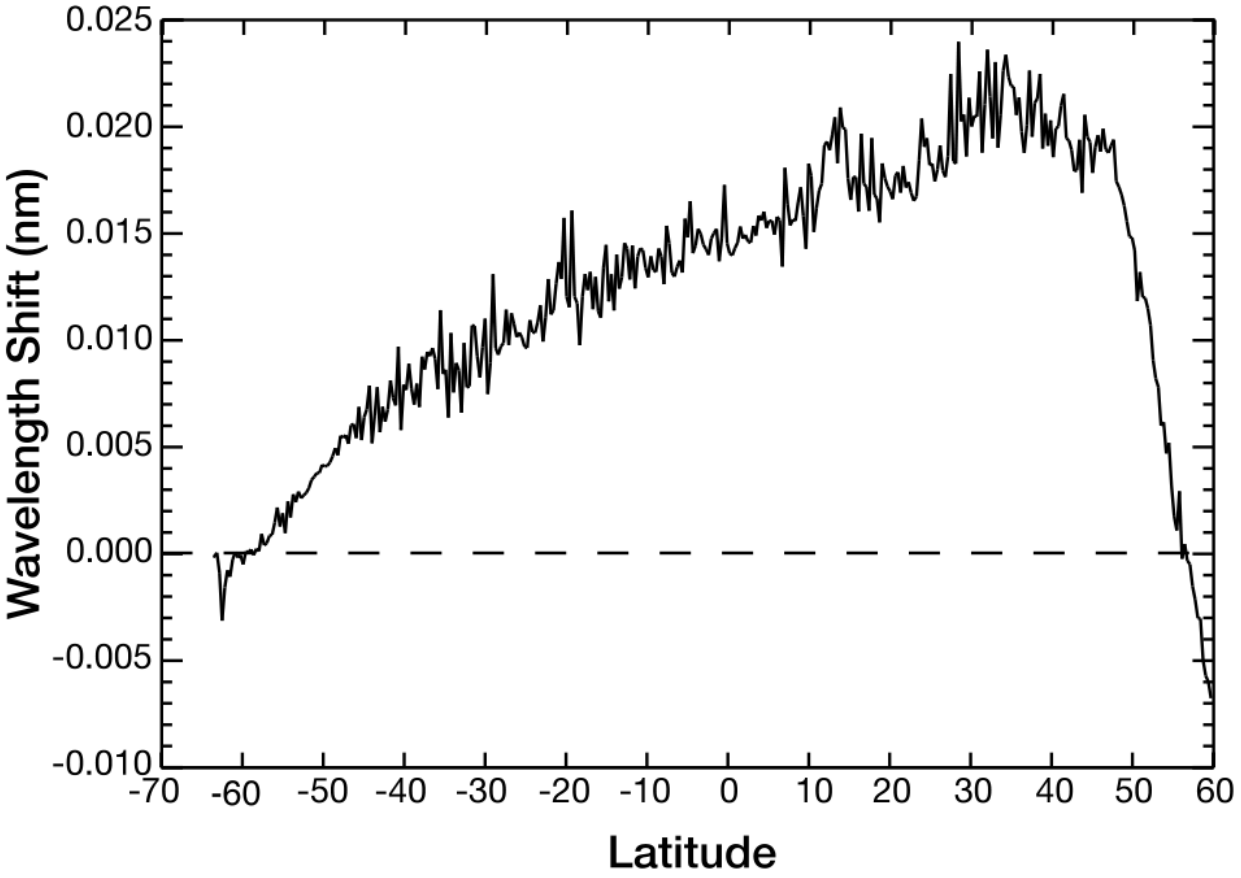




Intra-orbital wavelength shifts are seen in NM sensor

Comparison of Earth measured radiances for non-ozone absorbing wavelengths compared to synthetic solar flux

This shift is now accounted for in our V2 retreivals

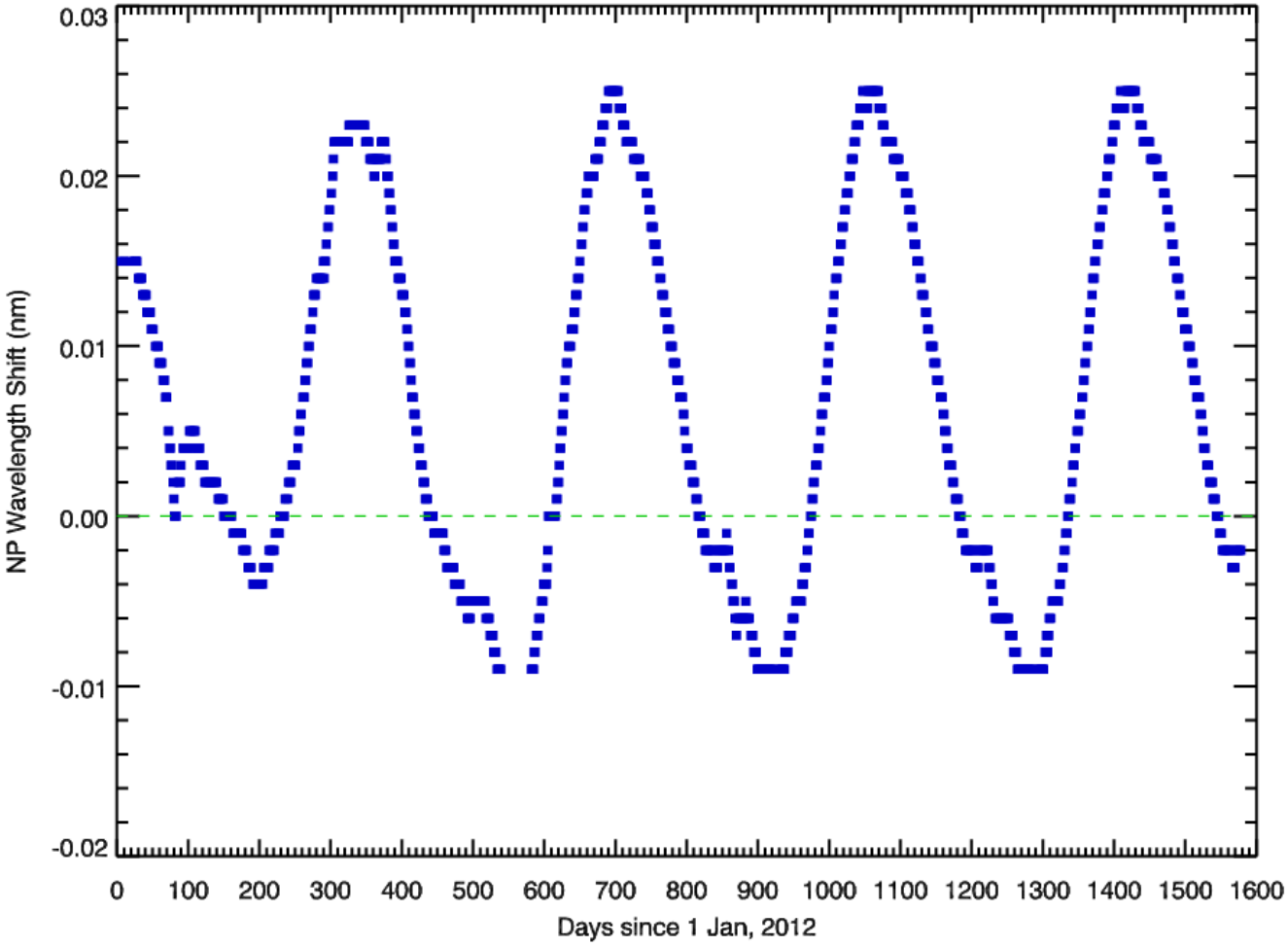


NP Wavelength Shift

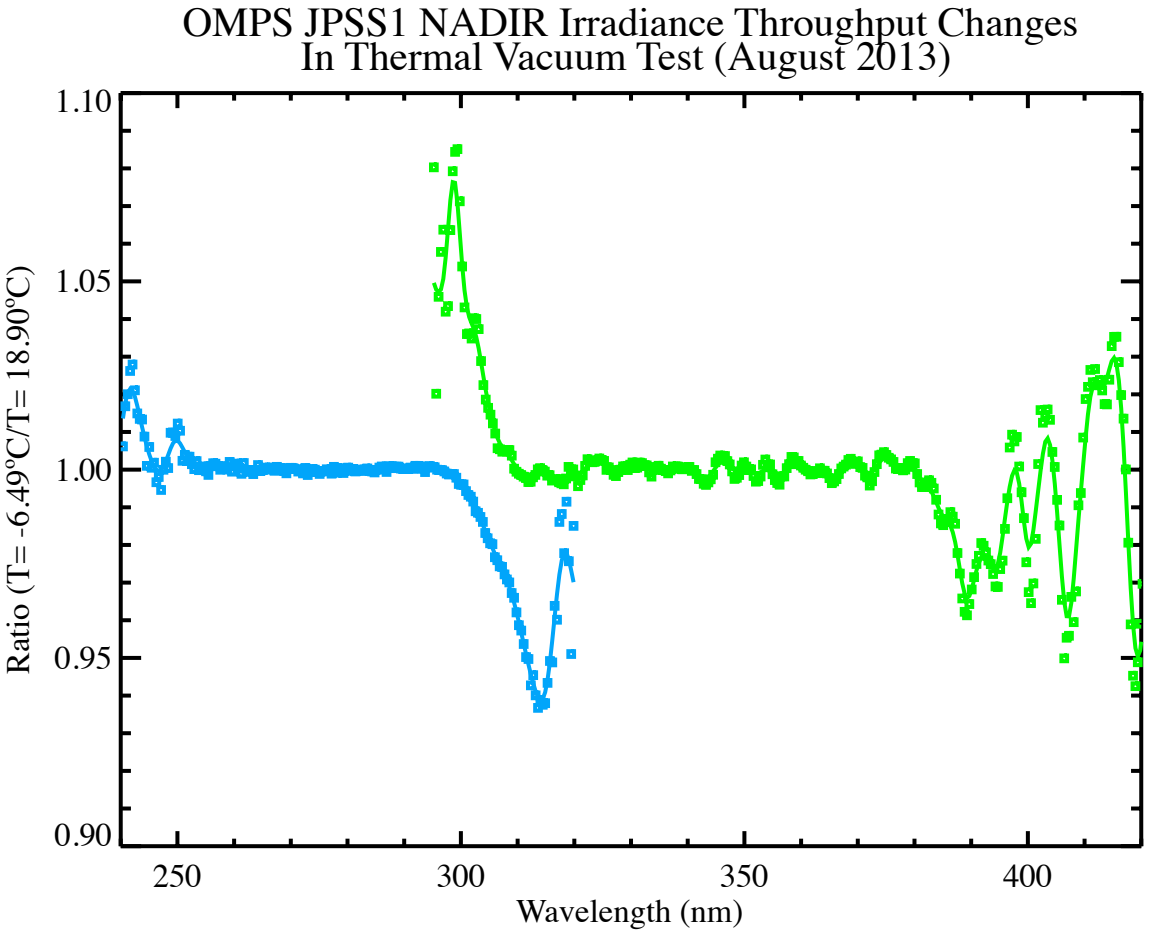
Comparison of solar irradiances with synthetic solar flux shows a seasonal wavelength shift

Again, this shift is now accounted for in our V2 retreivals

No significant intra-orbital shift is indicated

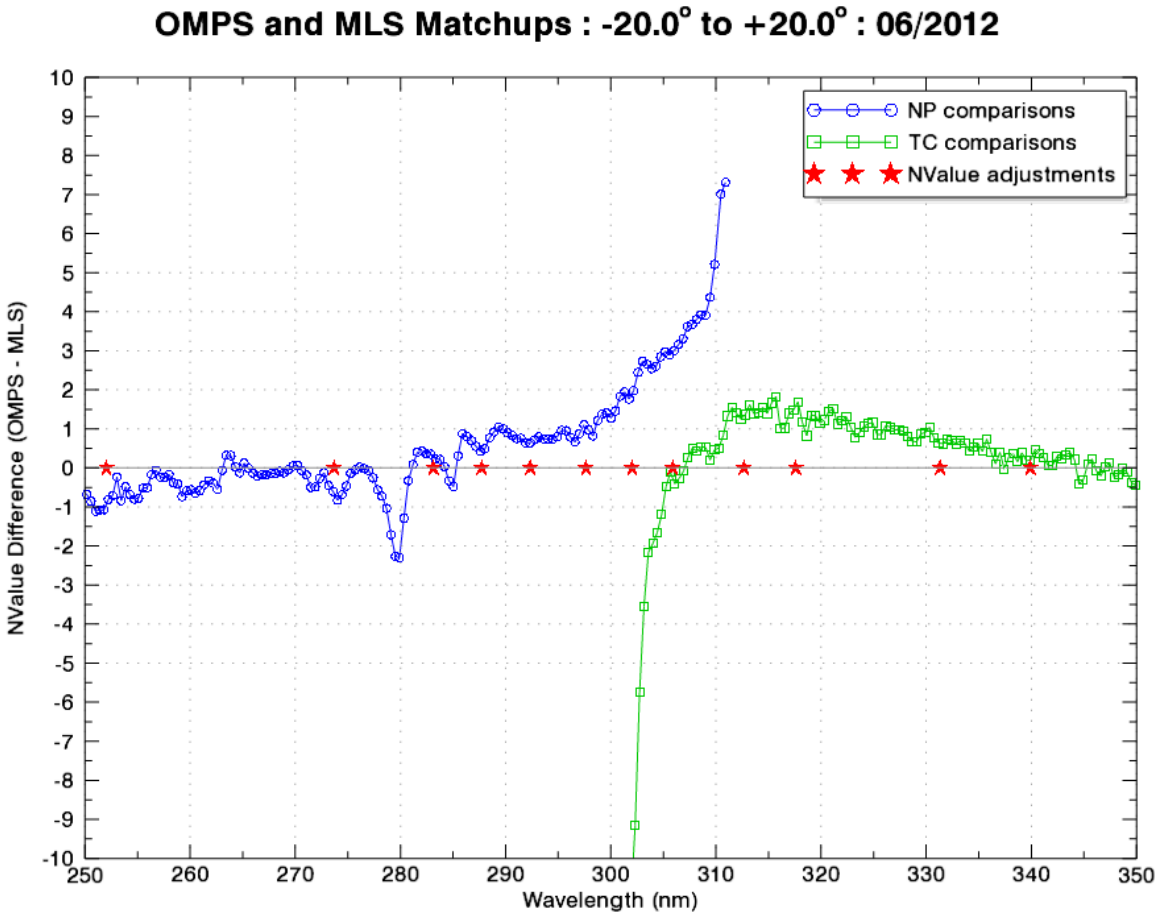


Adjustments needed to account for changes in throughput, particularly in dichroic region

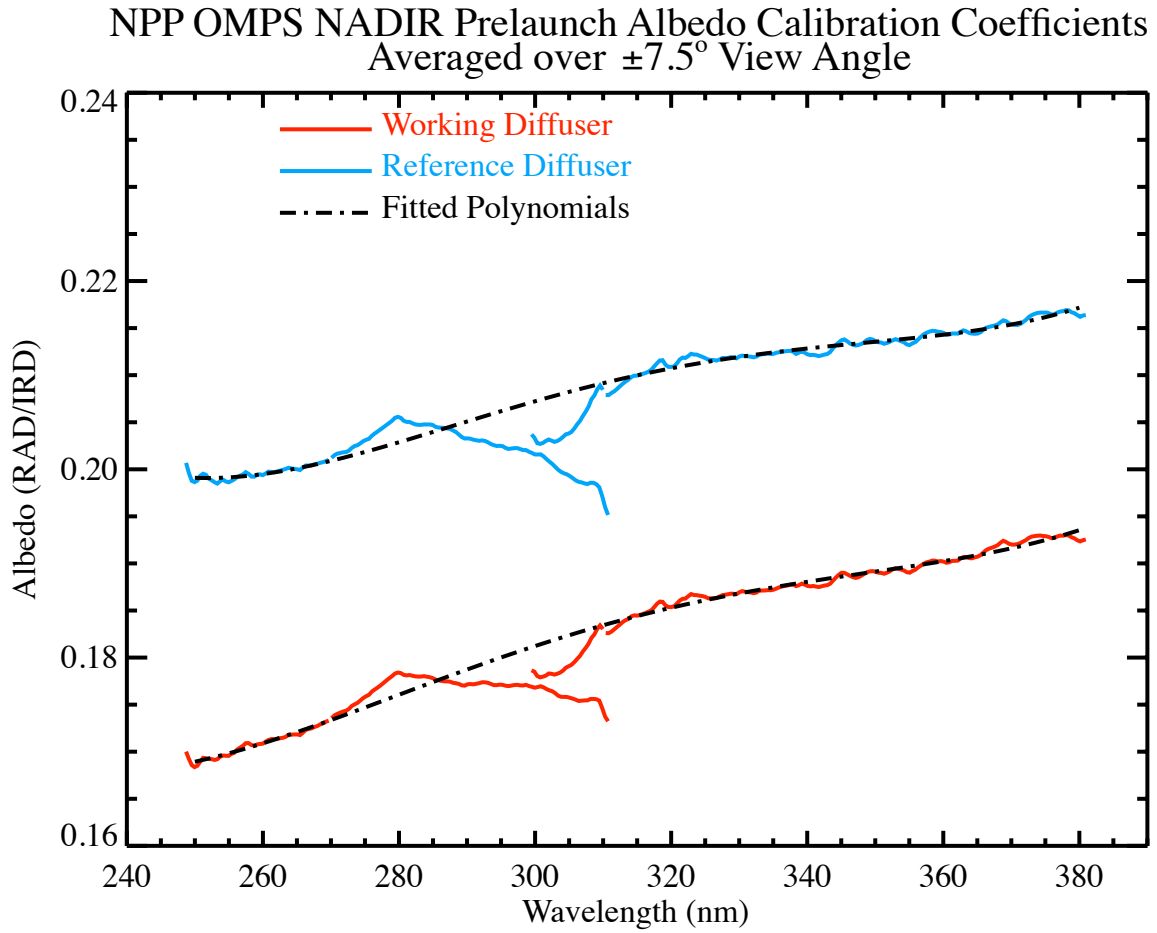


V1 OMPS/MLS matchup comparisons showed problems unrelated to dichroic adjustment

- MLS ozone/temp profiles from matched up dataset used in radiative transfer calculations of normalized radiances
- Calculated NR compared to OMPS measured NR
- N values difference compared
  - $N = -100\log_{10}(NR)$
  - ΔN = -2.3% radiance difference

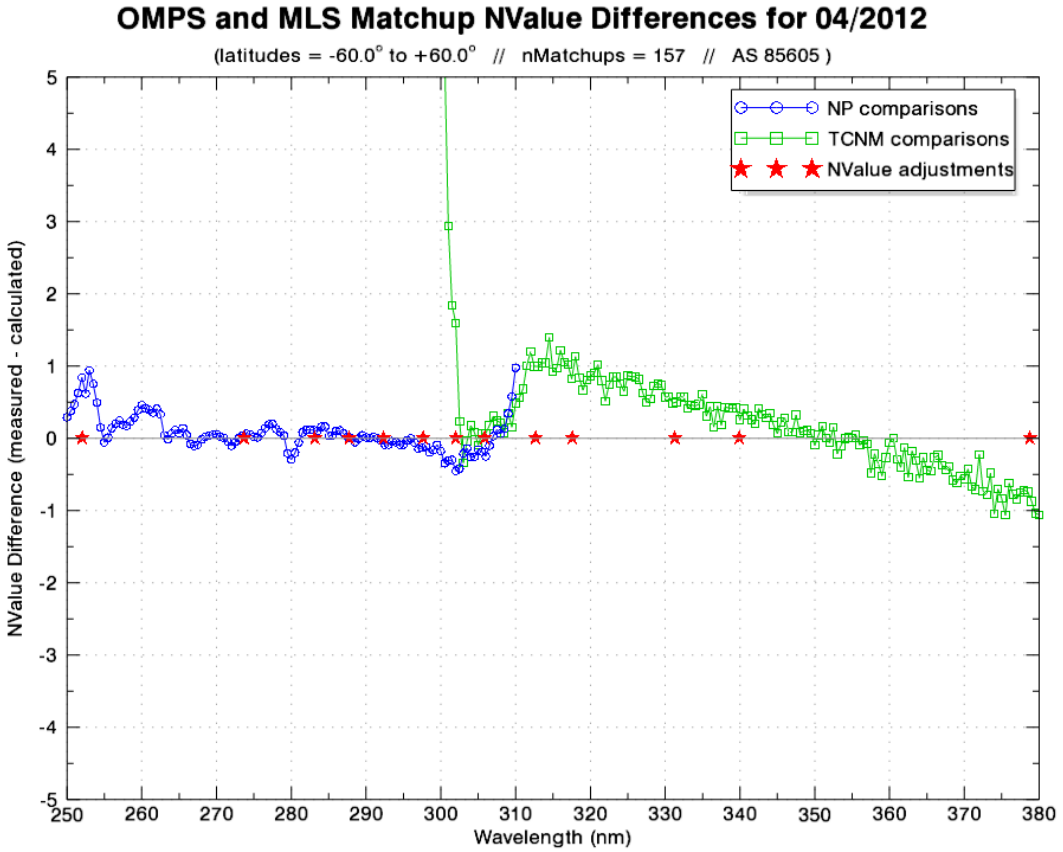


Adjustments needed to account for "unphysical" behavior of cal coefficients

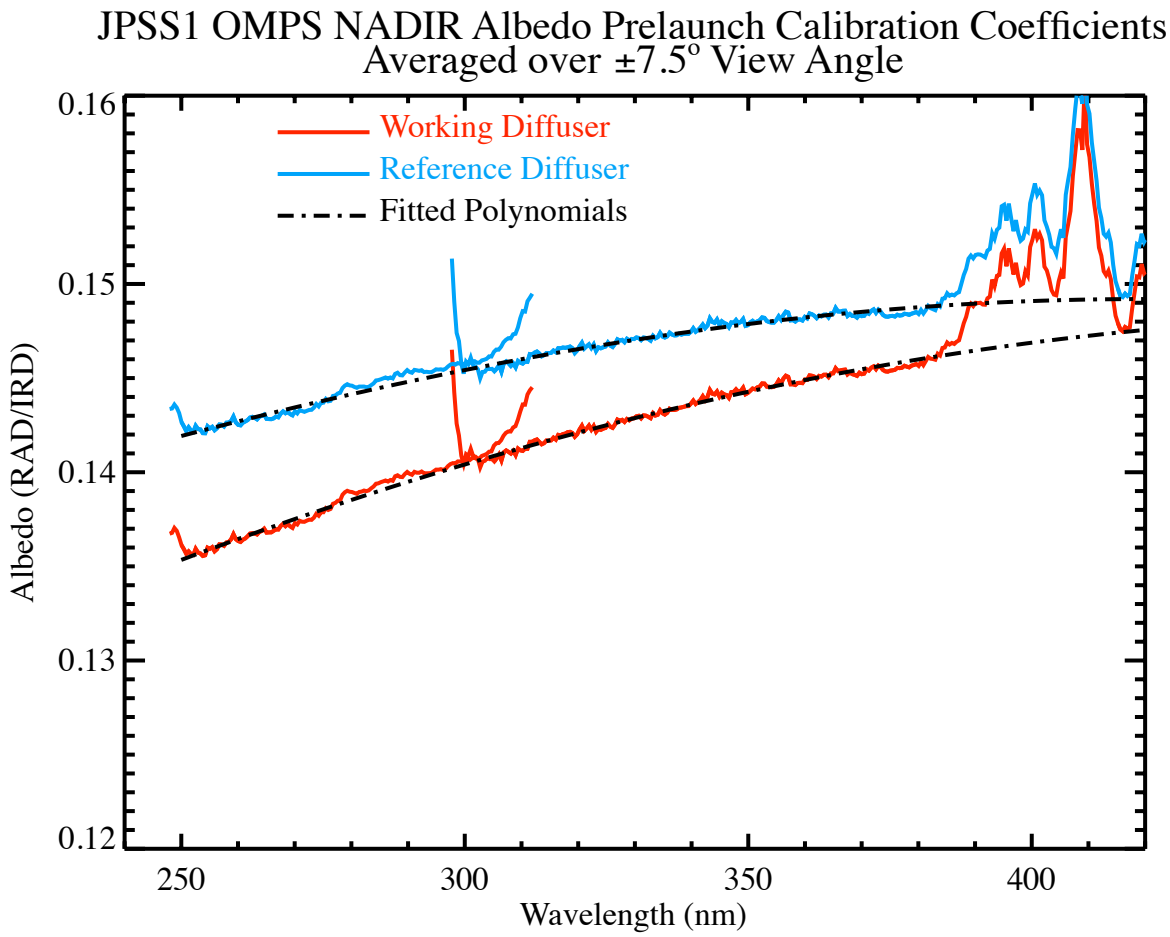


V2 OMPS/MLS Matchup Comparisons showed better performance with new coefficients

- Includes corrections for dichroic region
- Includes corrections for stray light

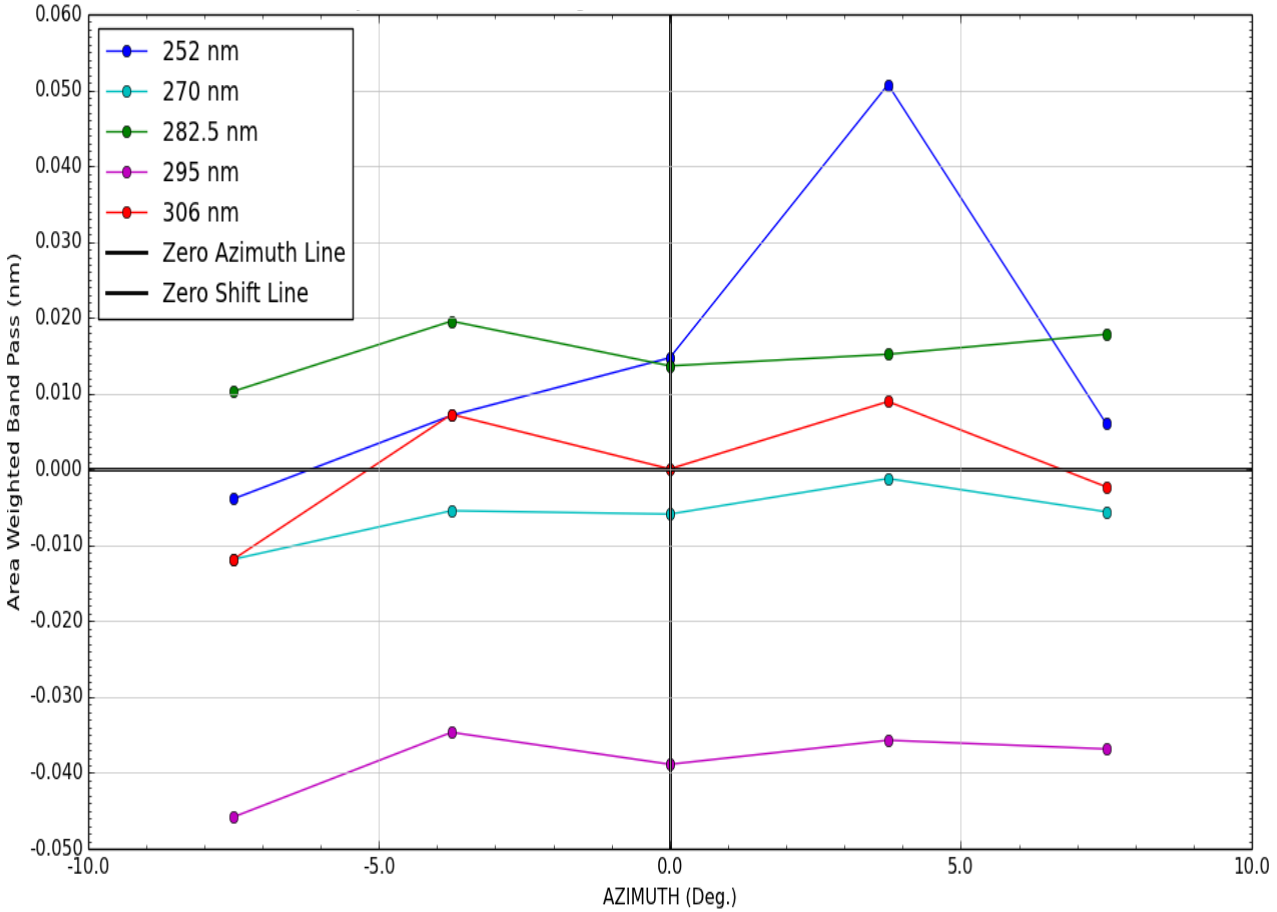


J1 calibration coefficients show the same type of unphysical behavior



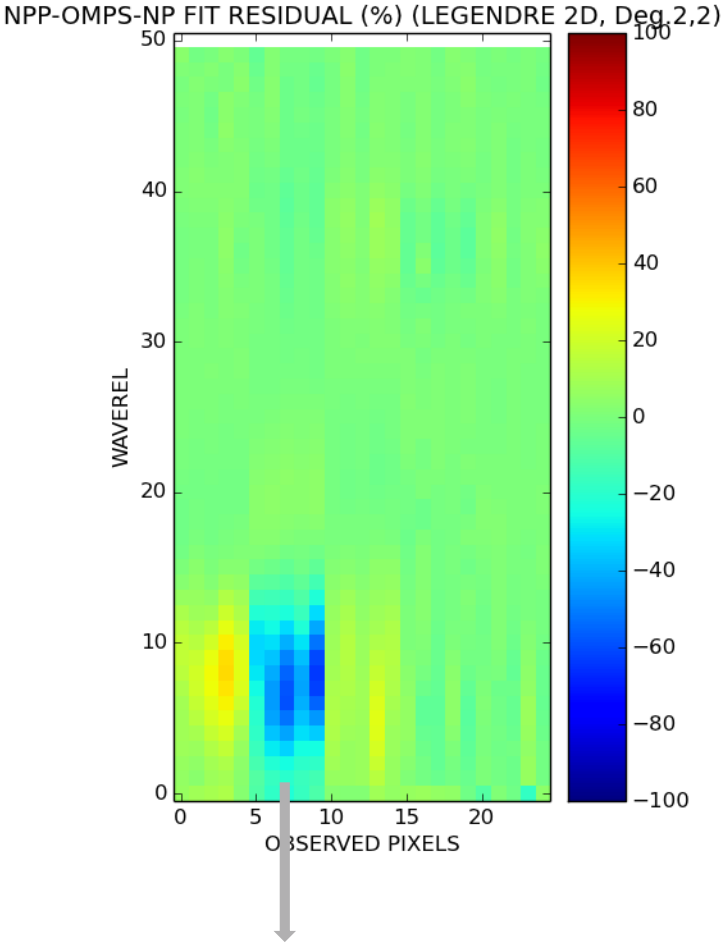
NP Bandpass Issue Near 295 NM

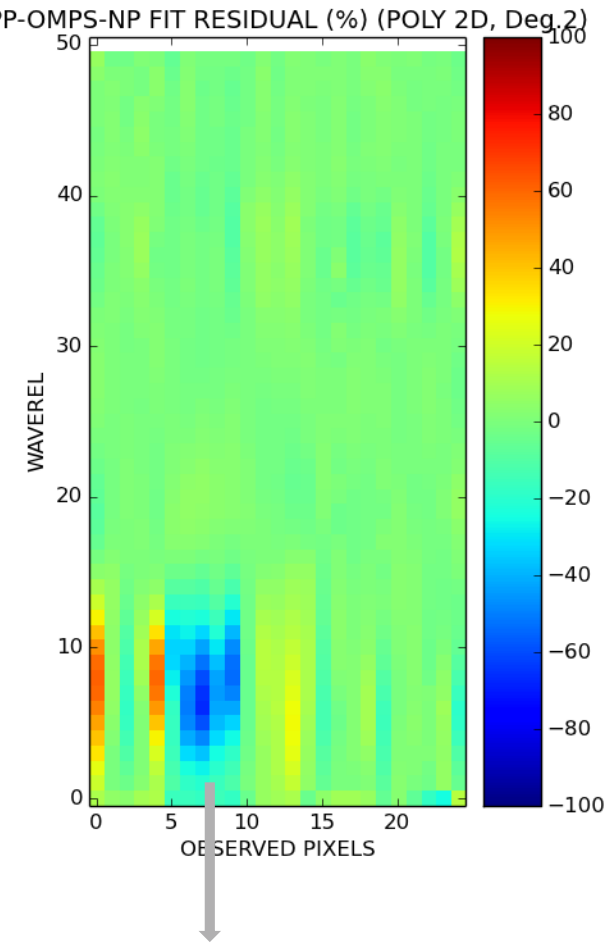
Weighted-average central wavelength does not match Ball's Channel Band Center (CBC) wavelength



NP Bandpass Issue Near 295 NM

Our own fitting analysis indicates that there is something wrong with the 295 nm Data





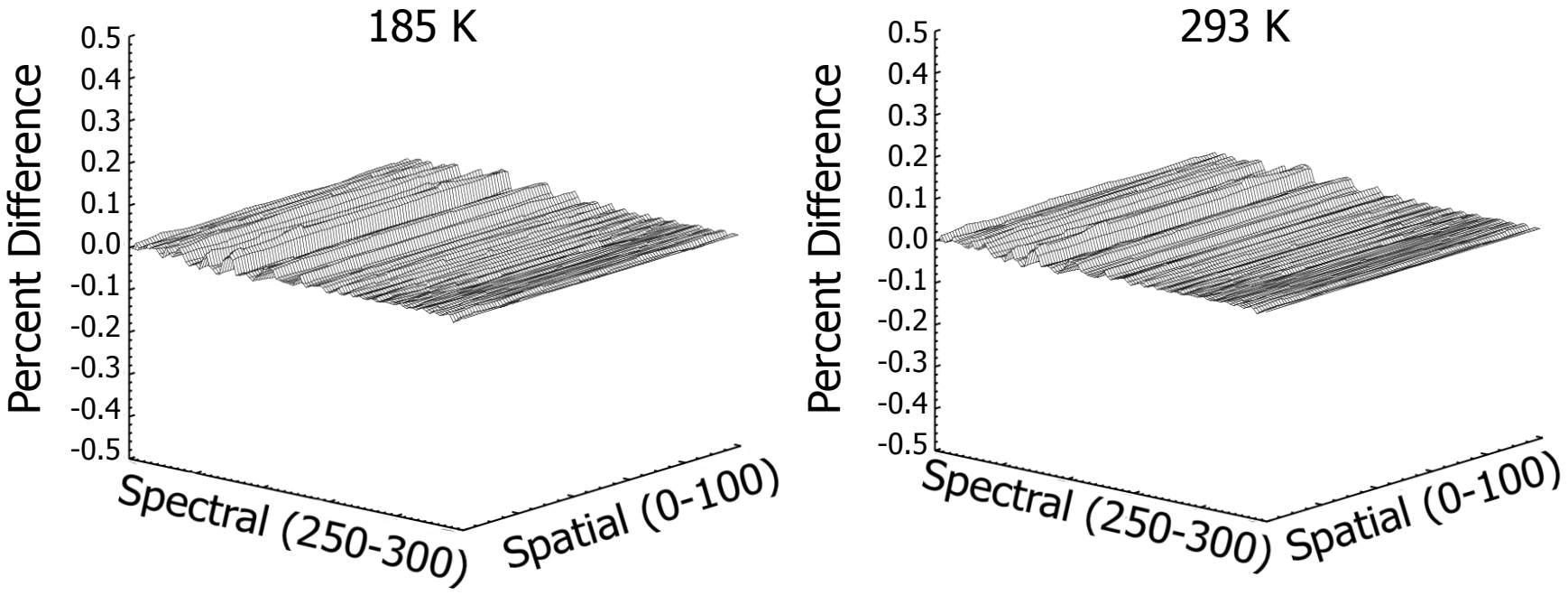
Relatively large fit residuals for pixels corresponding to 295 nm (pixel index 5 - 9). These are happening at the tails. The degree of polynomials used for fitting is 2.

Effect is negligible

We re-fit without the 295 nm Ball data

We calculated effective absorption coefficients for low and high temperatures and compared to coefficients calculated using a fit that included 295 nm data

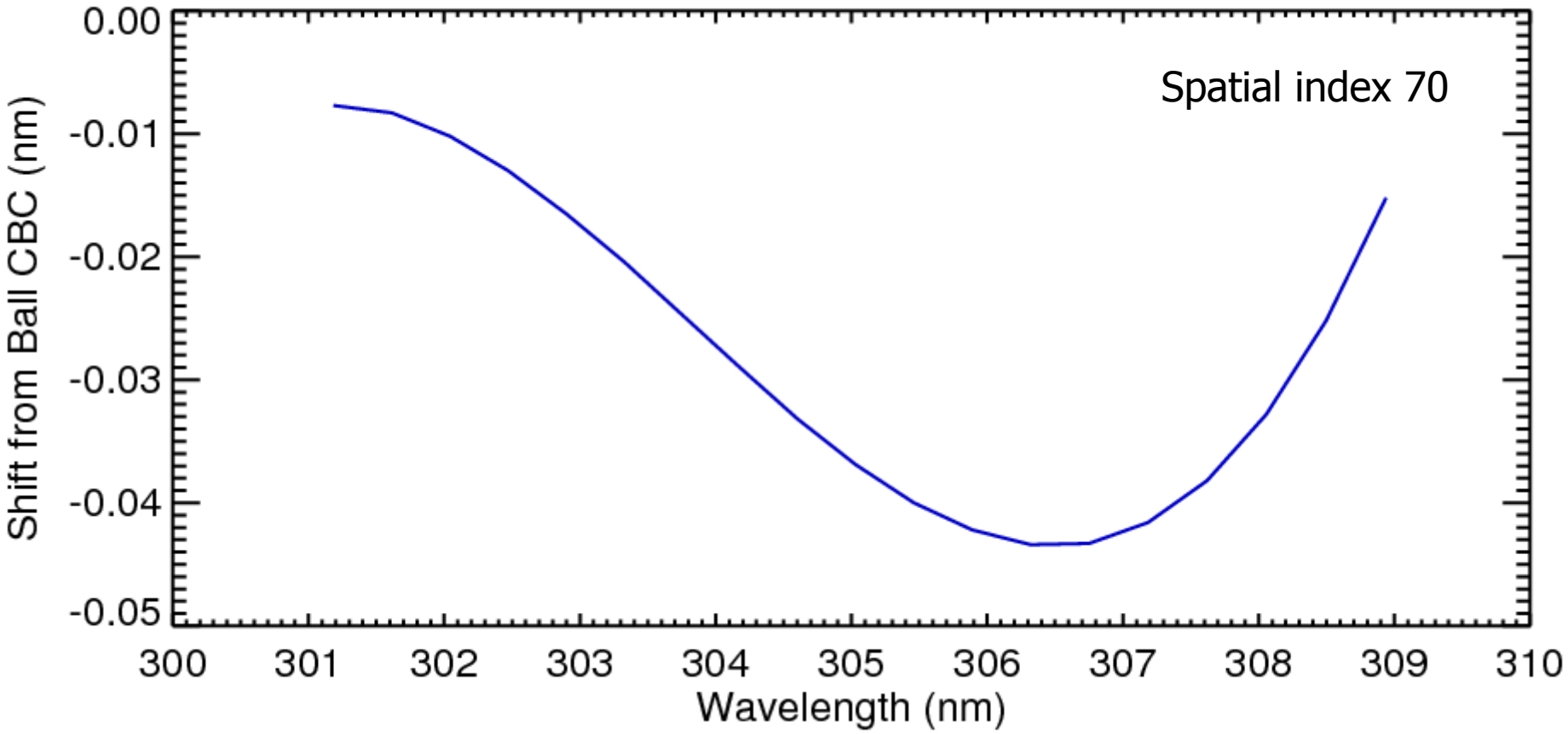
Results show negligible effect (< 0.1%)



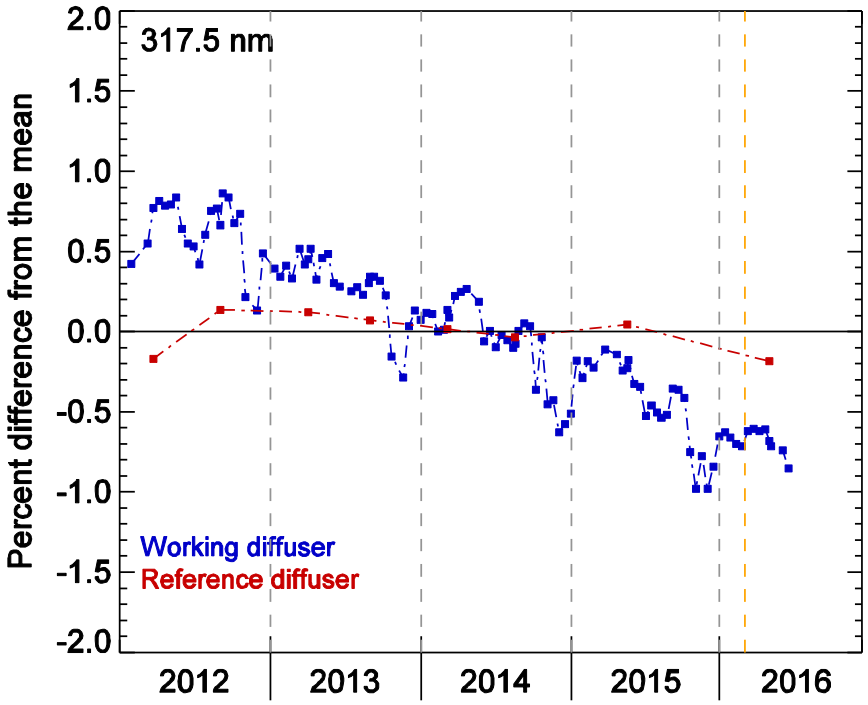
Bandpass Issues in Dichroic Region

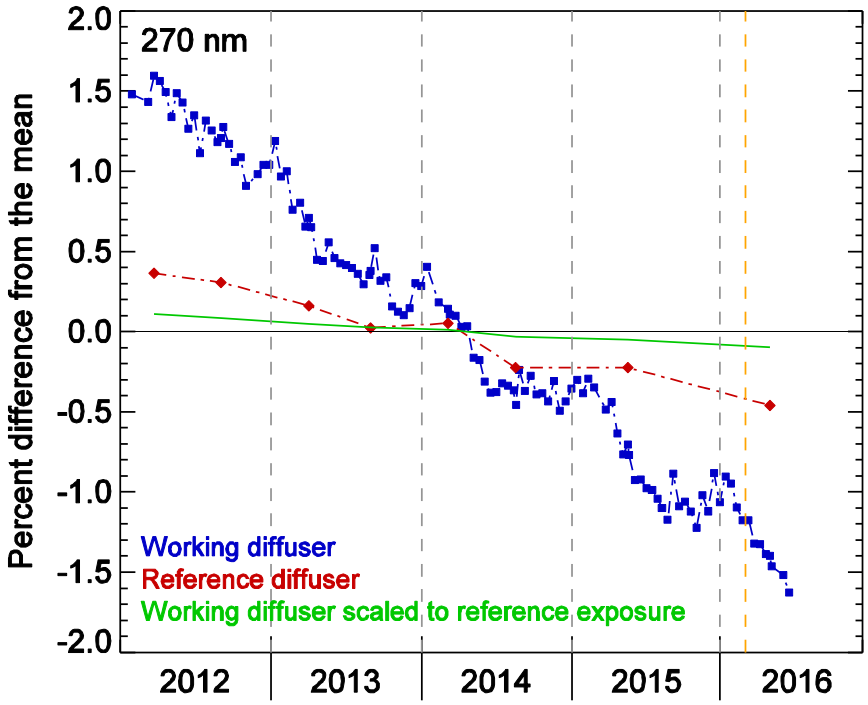
- Bandpass measurements taken by Ball in dichroic region are OK
  - However, Ball's analysis using those measurements did not include the dichroic's sensitivity factor
  - Their analysis led to incorrect wavelength assignments within dichroic region
- We did our own analysis to account for this sensitivity
  - We did no implement any change to the NM because predicted shift made the irradiance residuals worse
  - Resulted in noticeable wavelength shift for NP, irradiance residuals did not get worse
    - We implemented this change

NP Shifts Become Sizeable

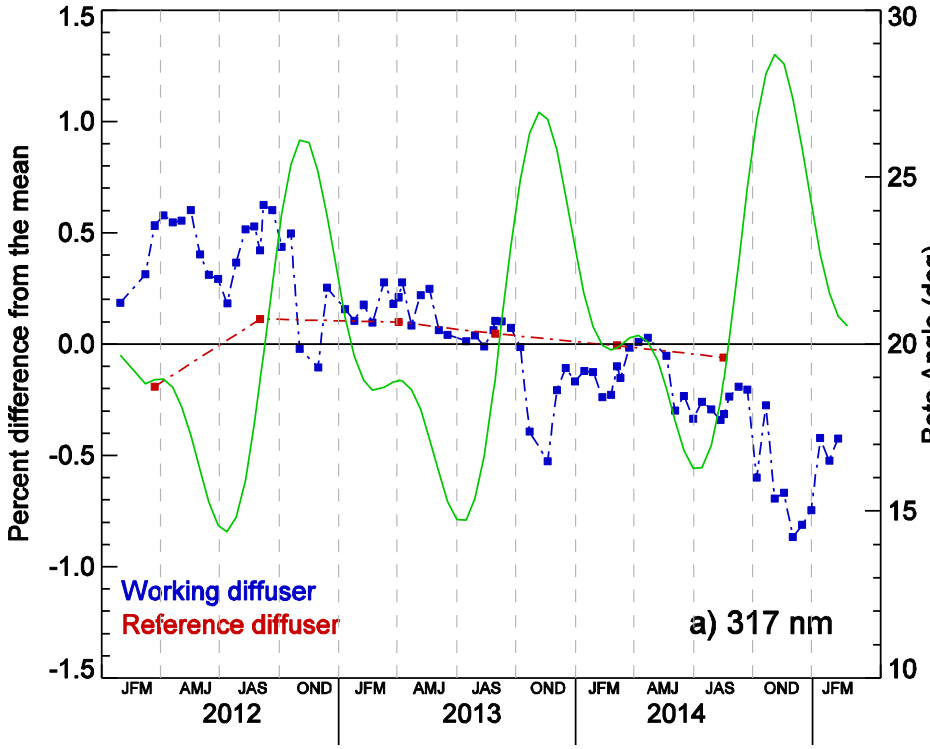


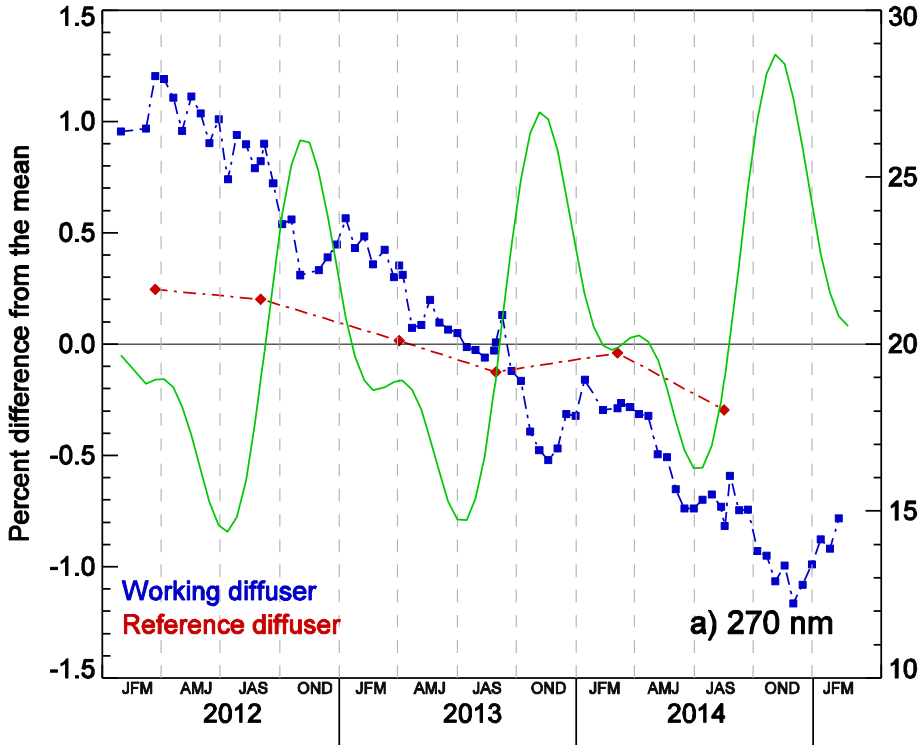
Working and Reference Diffuser (Solar Flux) Measurements



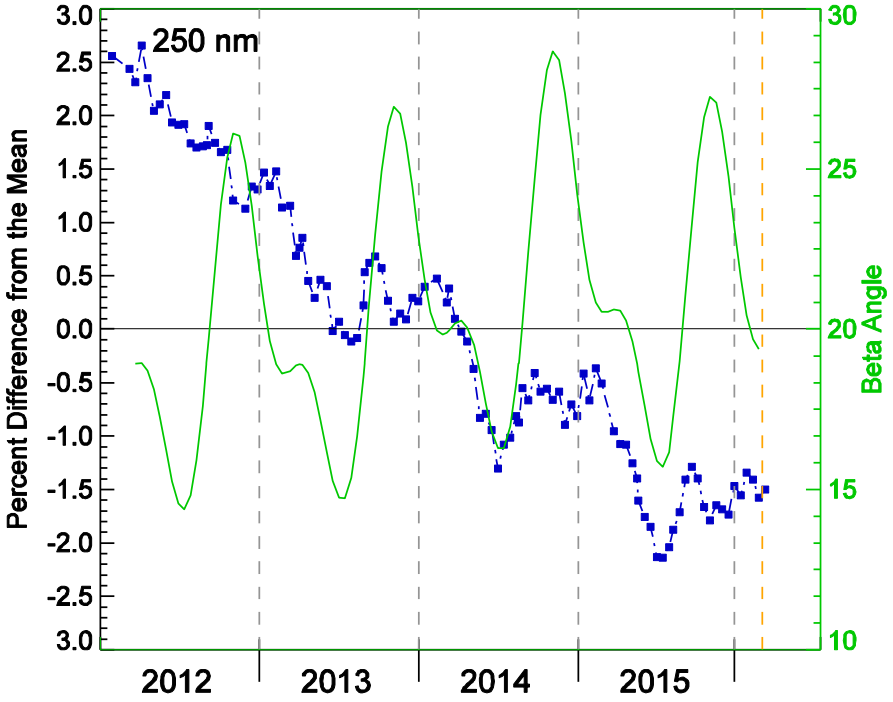


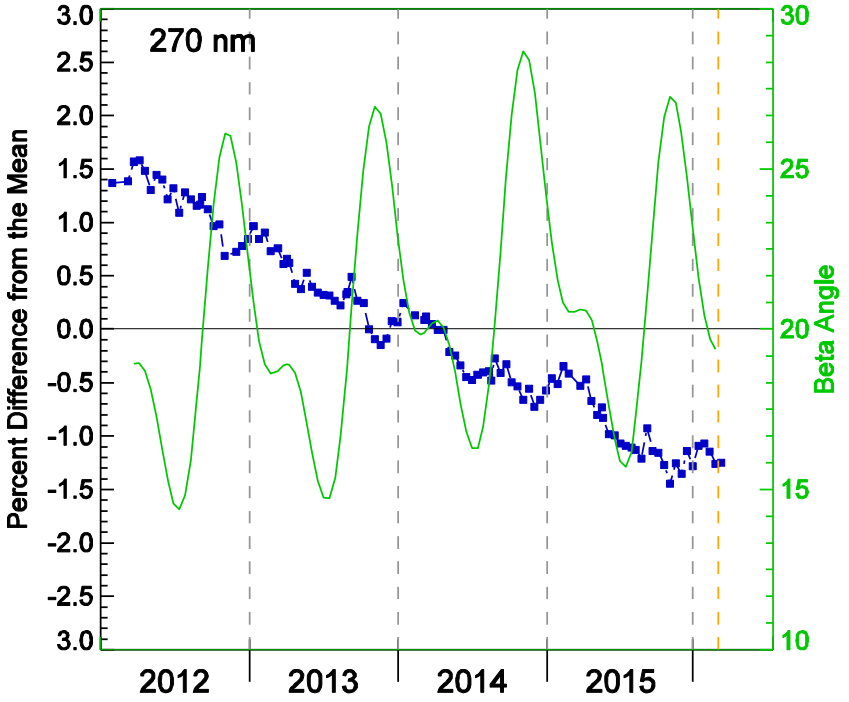
Compared to Beta Angle



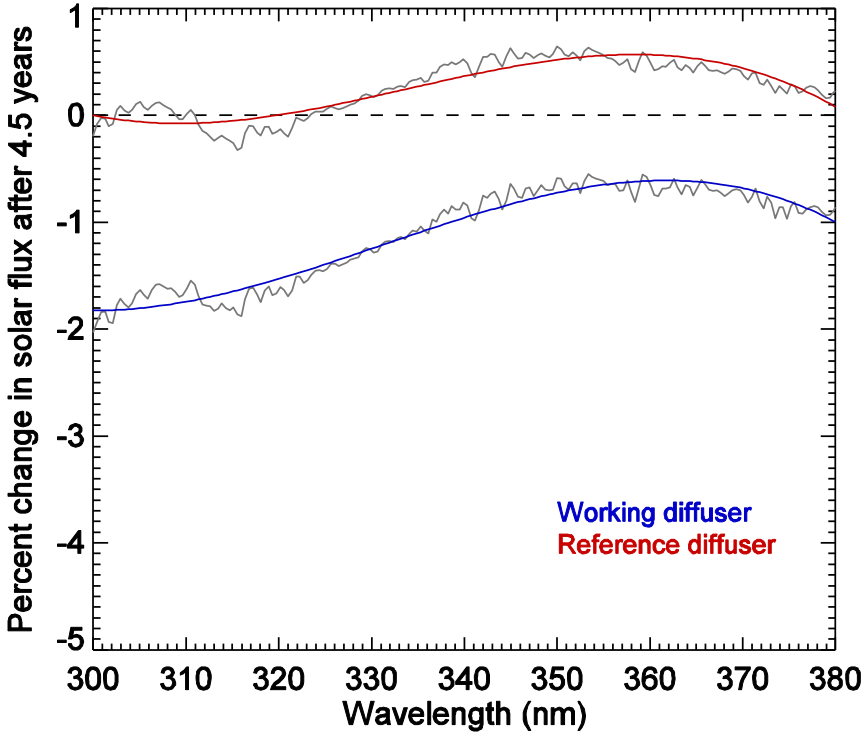


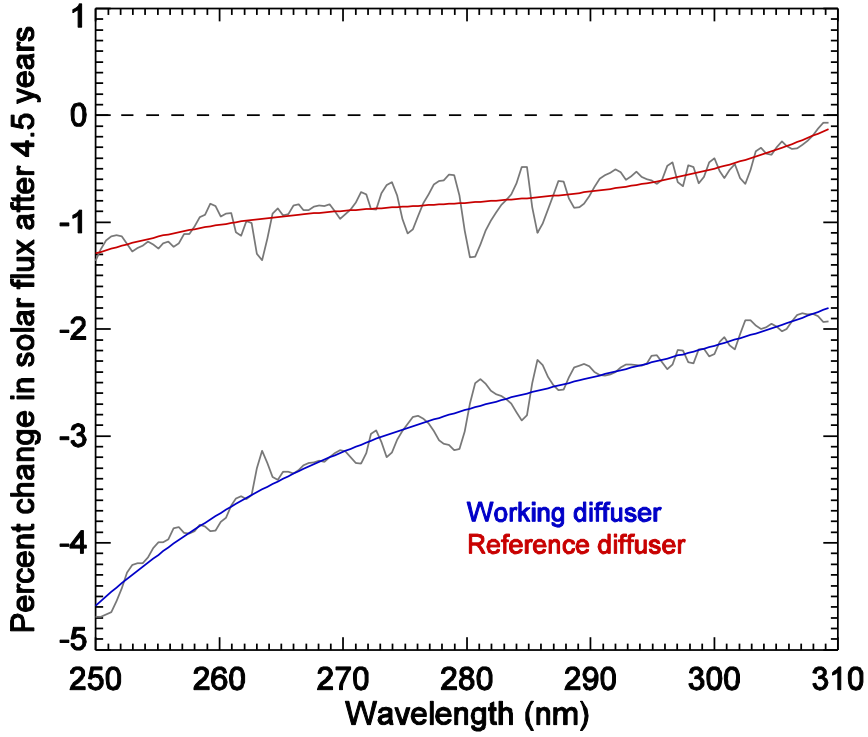
Compared to Beta Angle



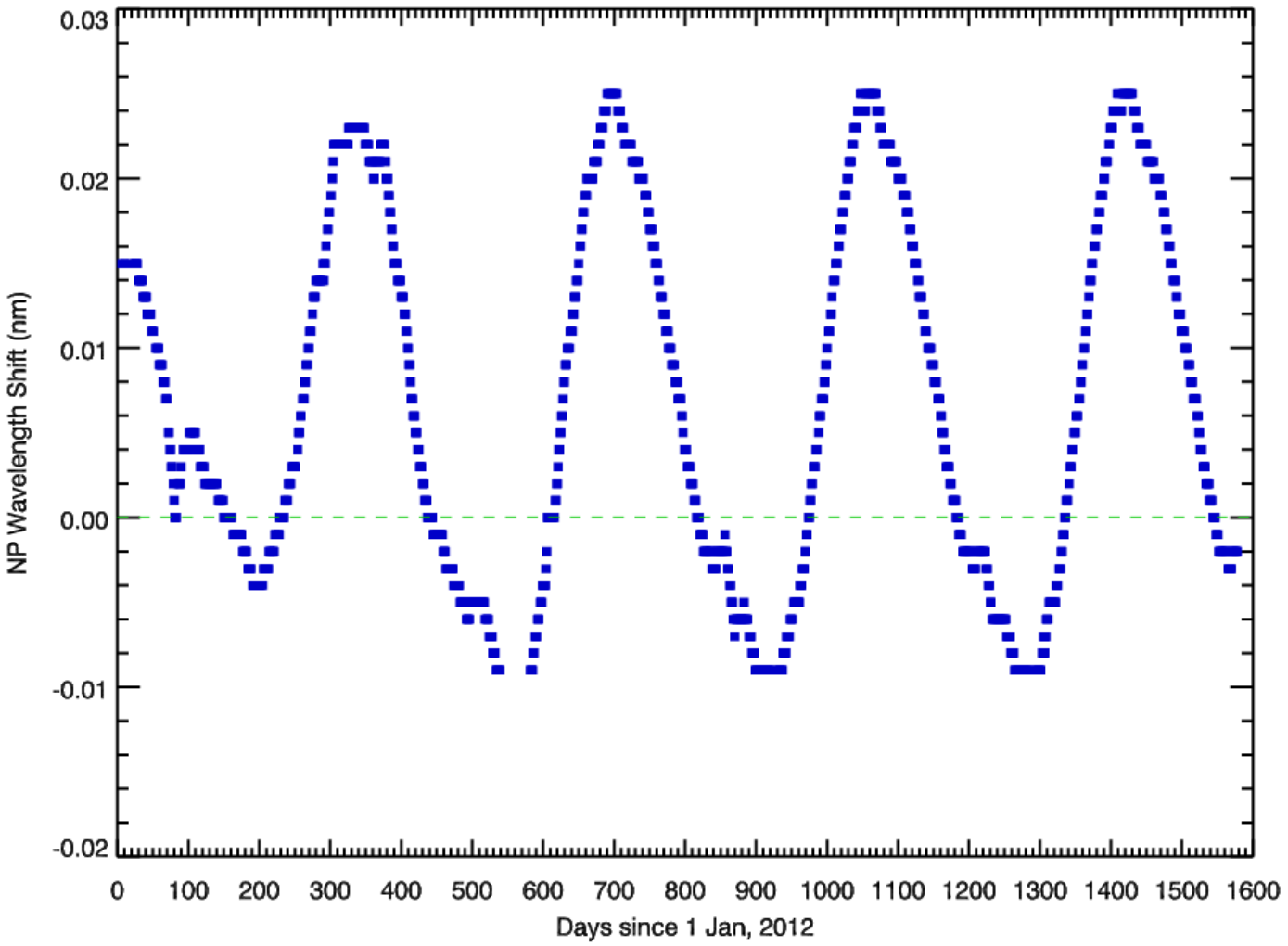


Change After 4.5 Years

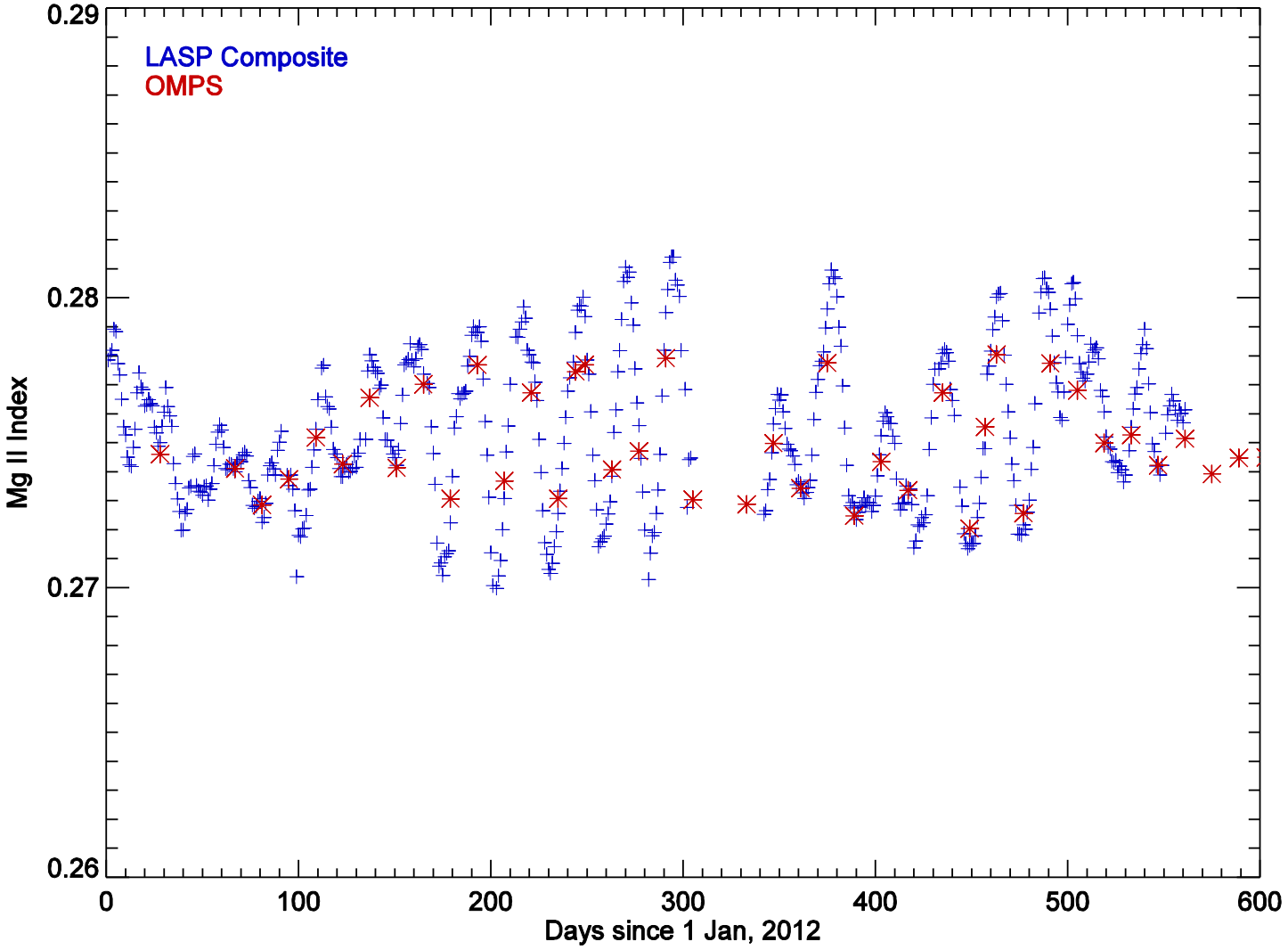




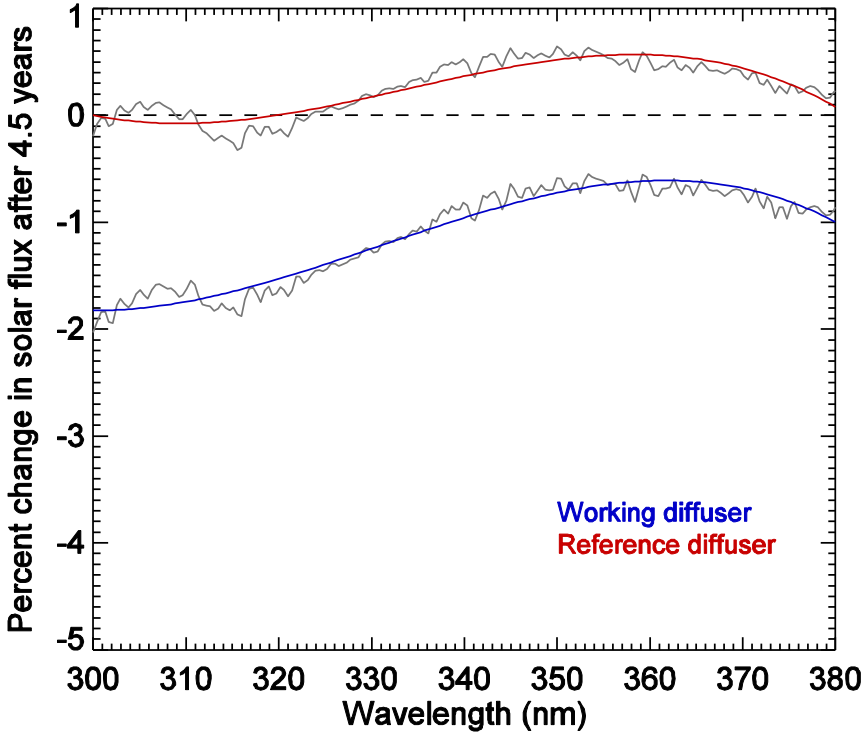
NP Wavelength Shift

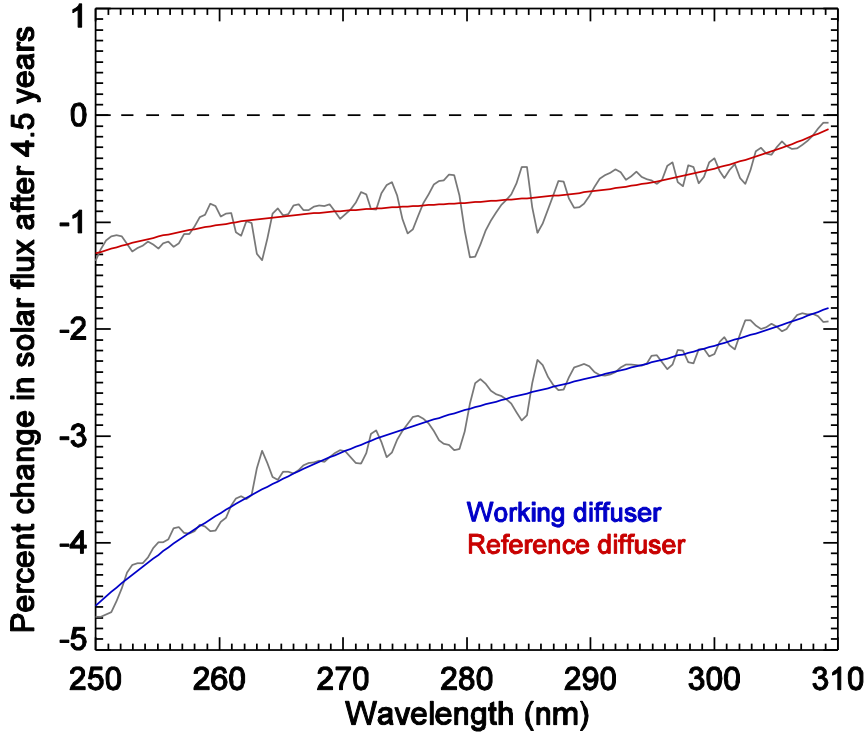


Mg II Index

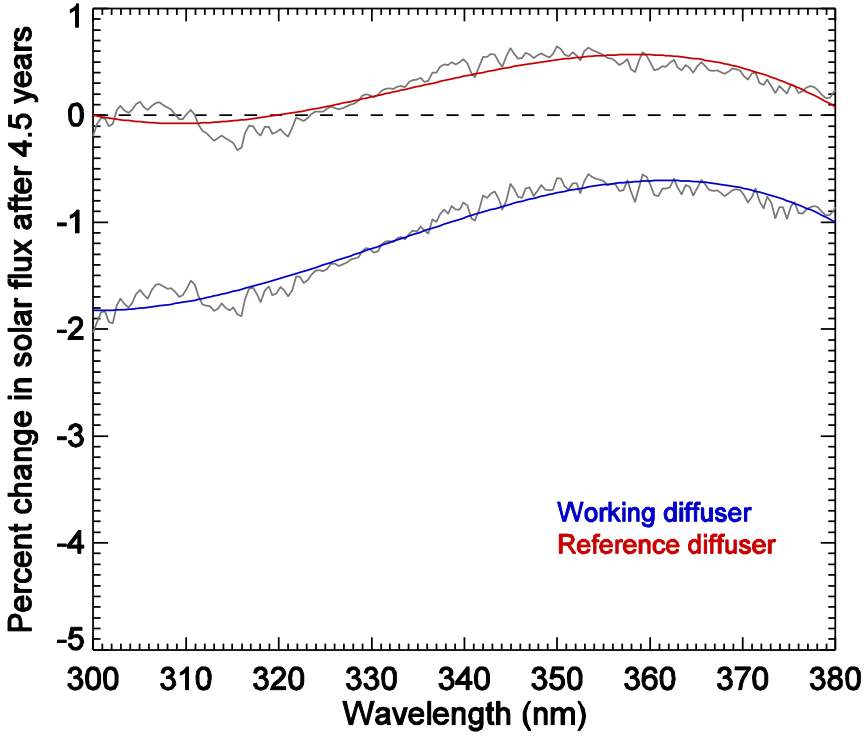

LASP Composite
OMPS
Mg II Index
0.29
0.28
0.27
0.26
0
100
200
300
400
500
600
Days since 1 Jan, 2012

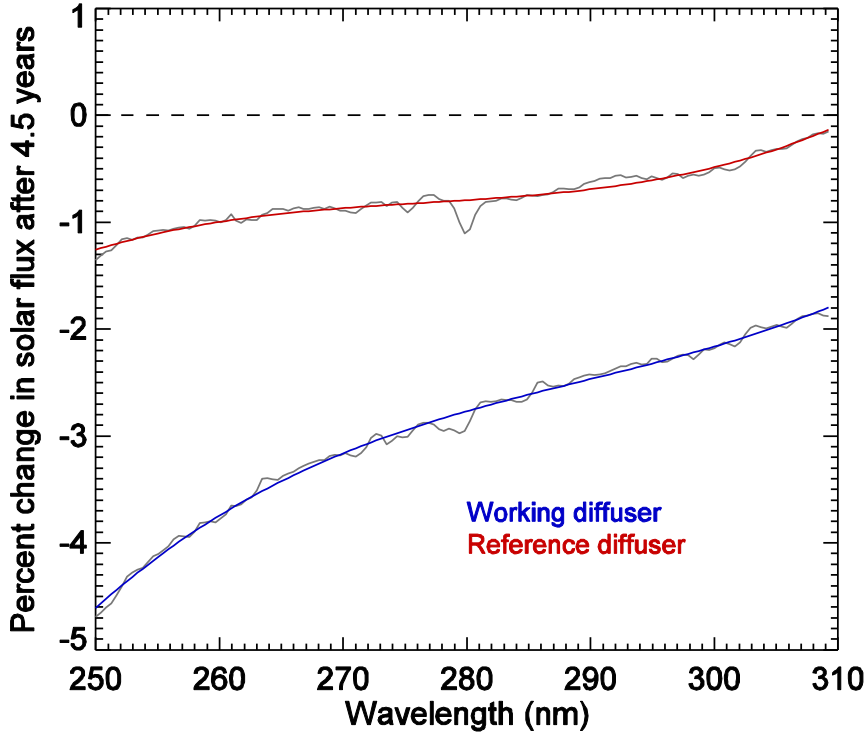
Change After 4.5 Years



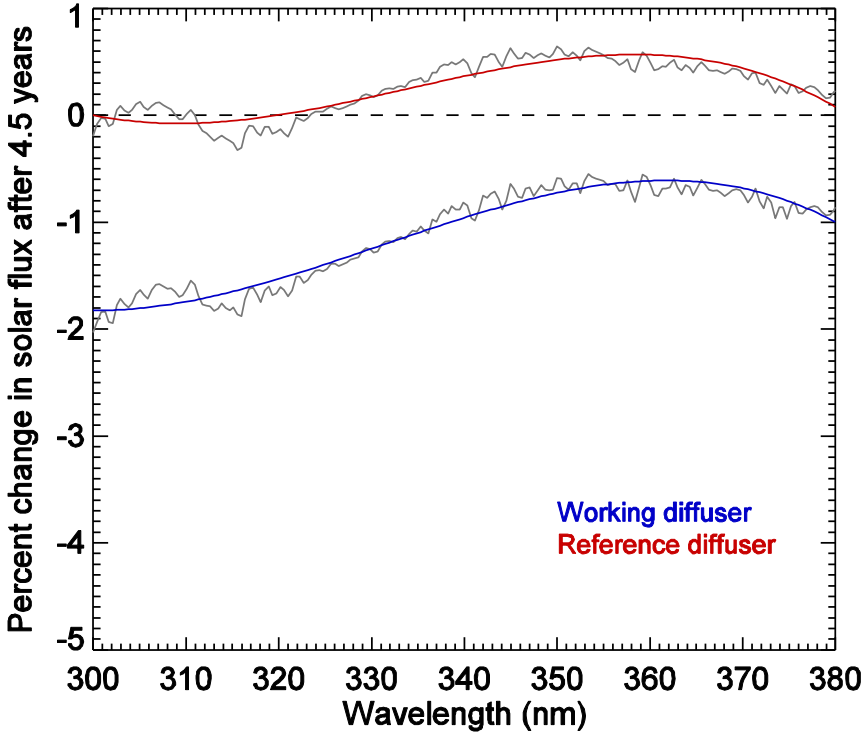


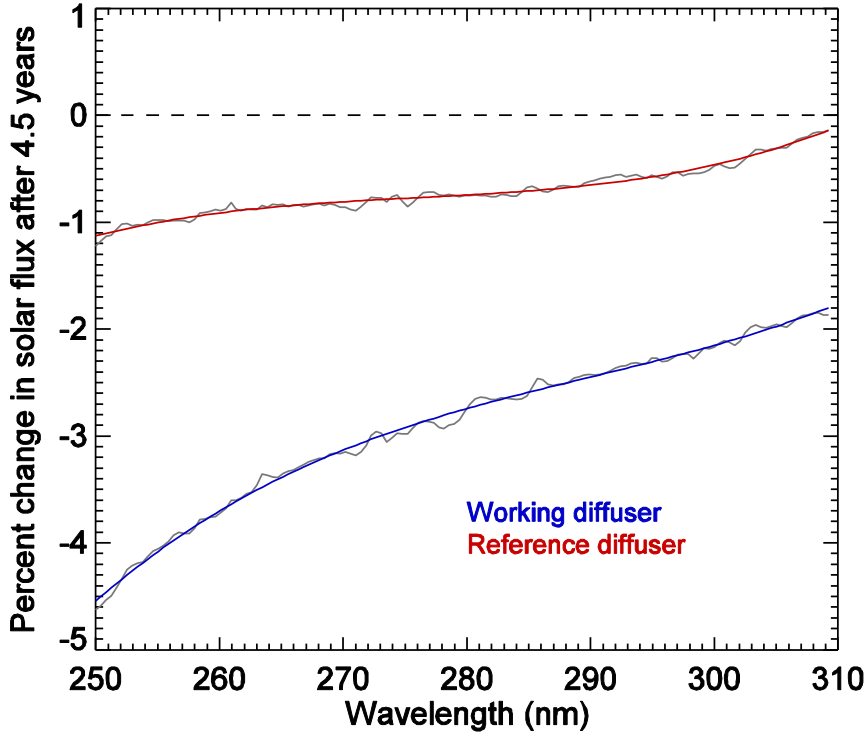
Change after taking into account wavelength shift



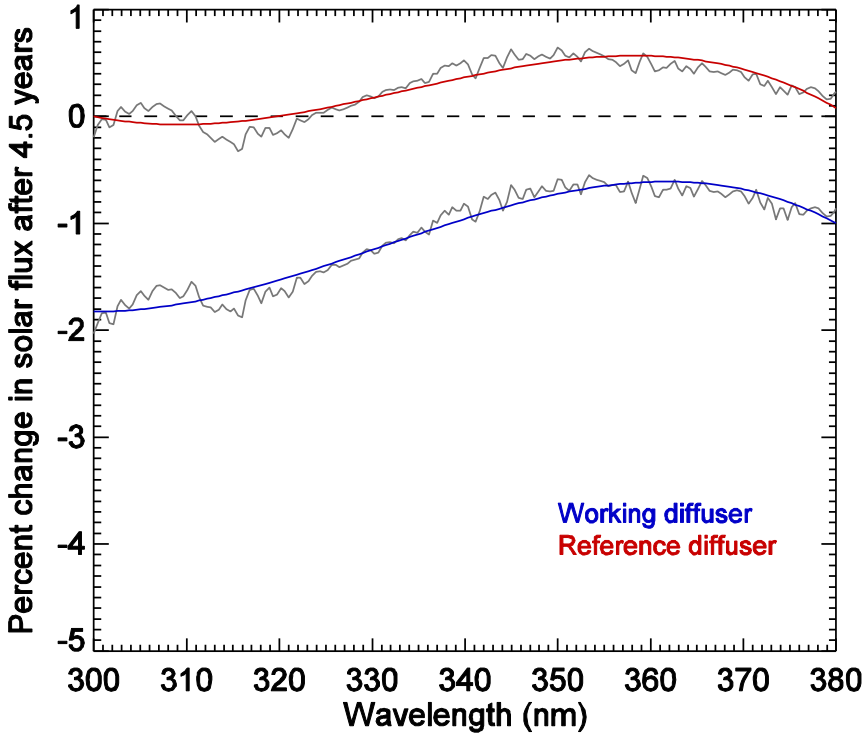


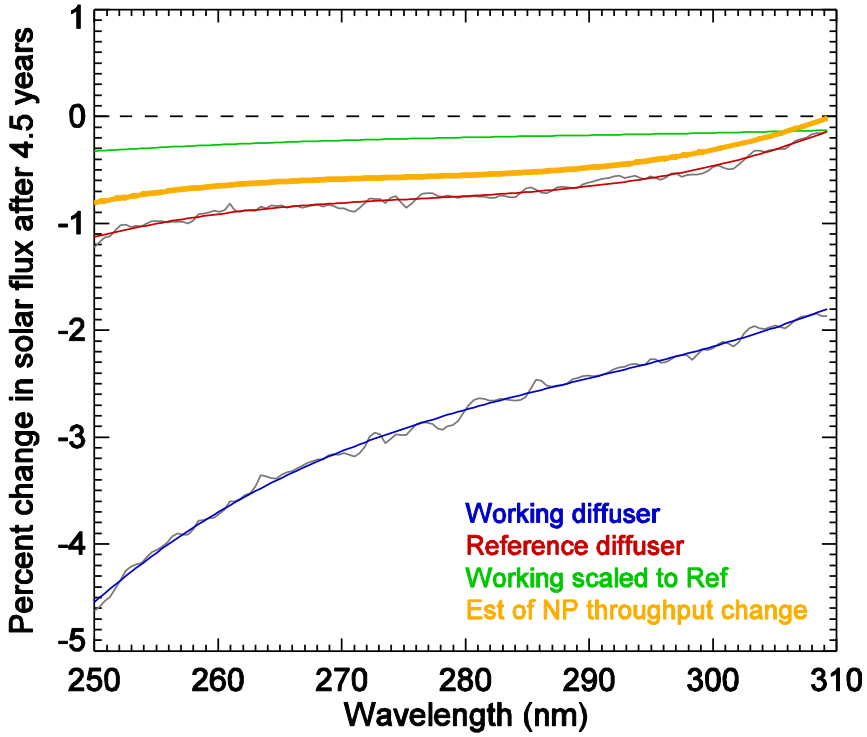
Change after taking into account wavelength shift, solar activity





How much of the change is due to actual sensor degradation?

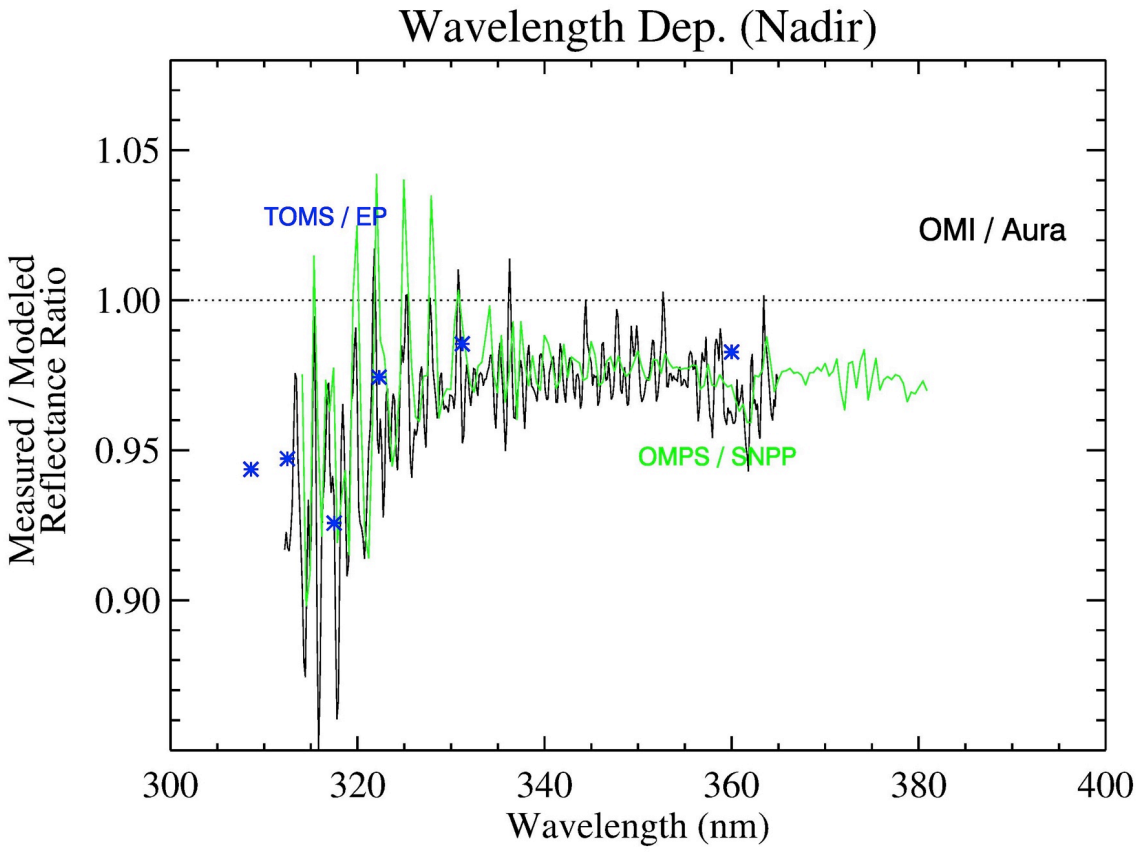




"Soft" Calibration

- Soft Calibration Designed to Account for Any Remaining Issues
  - Ice Radiance Used to Determine Absolute Adjustment for 331 nm at nadir
  - Mimimum sea surface reflectivity used to adjust absolute across the track
  - Comparisons of calculated to measured normalized radiances used to determine 317 nm adjustment
  - Residuals used to determine adjustments at other wavelengths

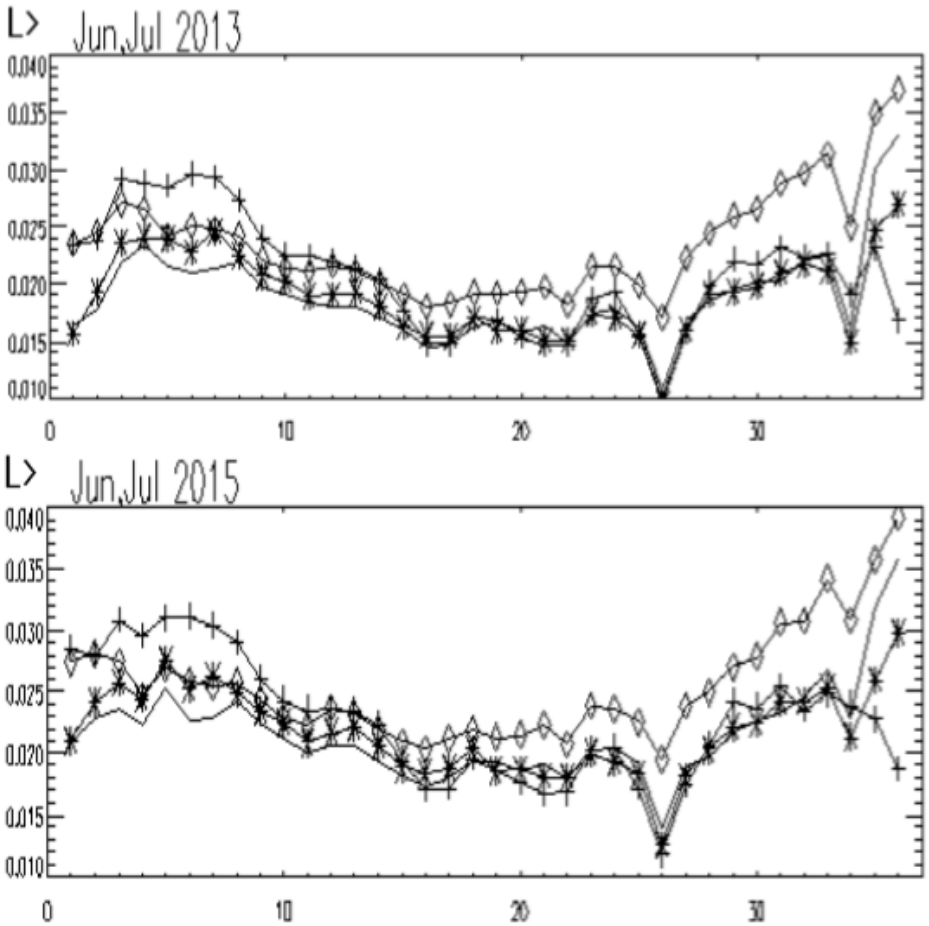
Ice Radiance Analysis



Minimum Reflectivity Analysis

Overview of Land Minimum Reflectivity for NMBUV OMPS 60004 non-absorbing channels

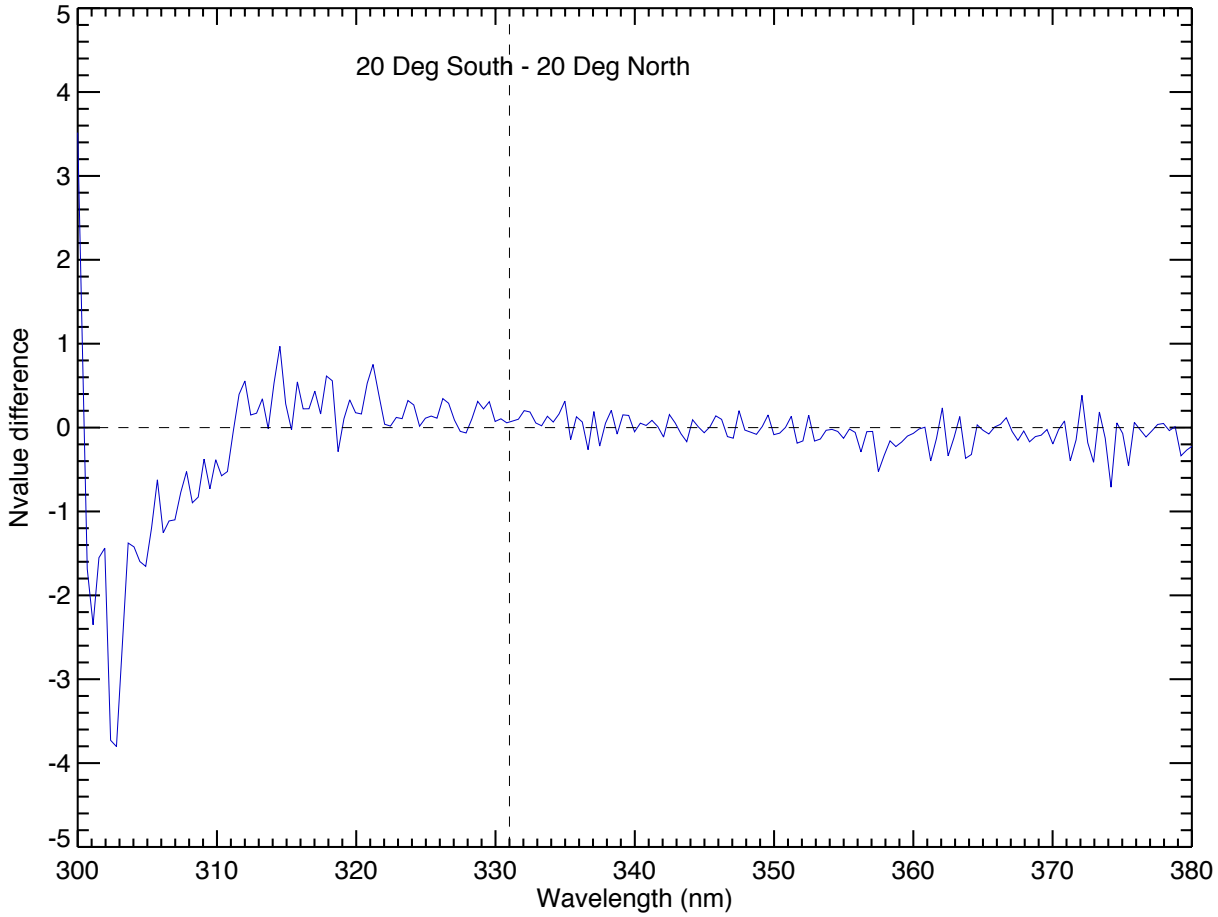
(+, *, -, <>) 313, 345, 360, 372



>> Overall relatively consistent pattern with time. Suggestion of a very slight upward drift

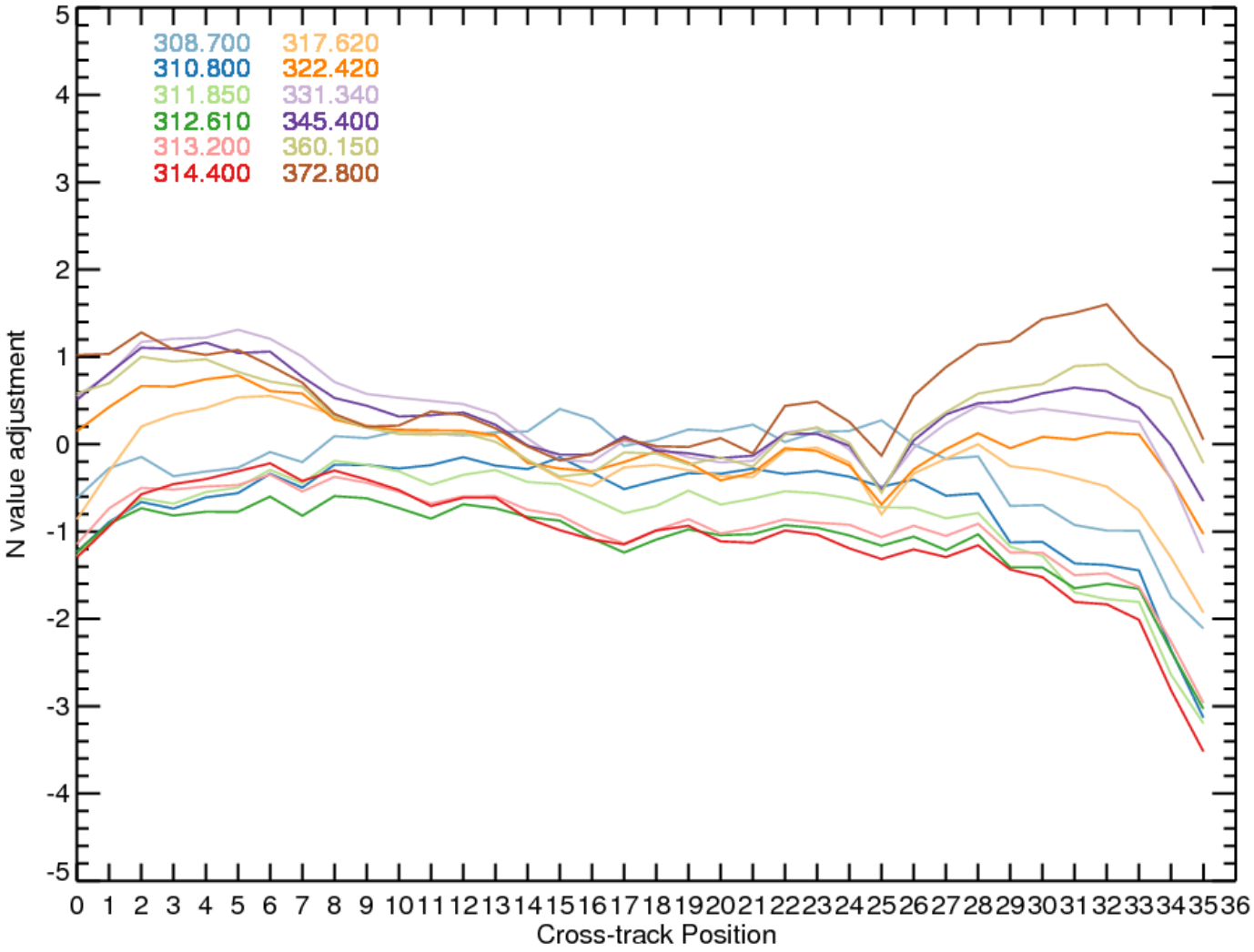
Comparison of Calculated to Measured Normalized Radiances

- NR calculated using:
  - Ozone climatology*
  - Temp climatology
  - Meas viewing cond
  - 331 nm reflectivity



*McPeters, R. D., G. J. Labow, and J. A. Logan (2007), Ozone climatological profiles for satellite retrieval algorithms, J. Geophys. Res., 112, D05308, doi: 10.1029/2005JD006823.

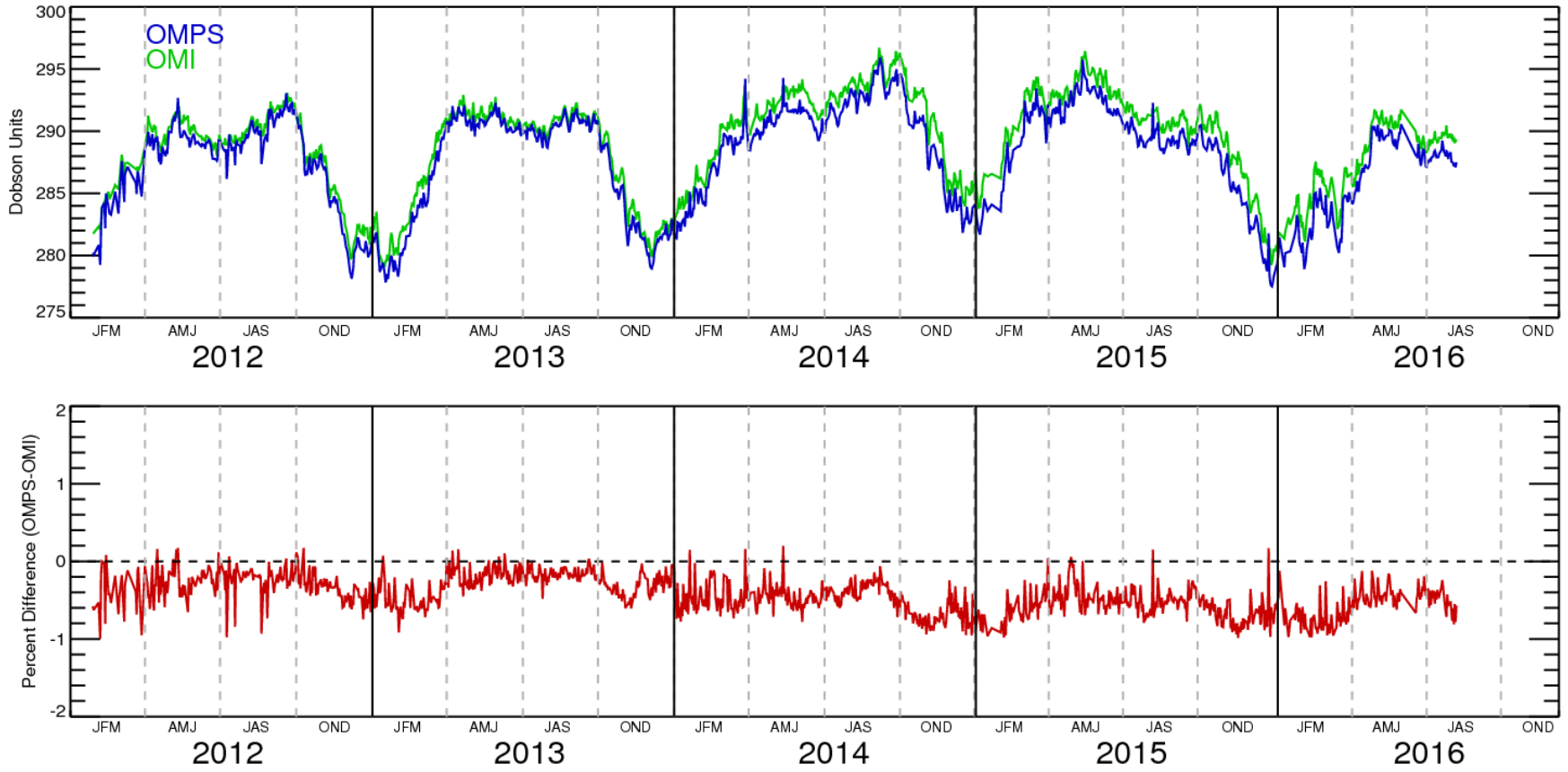
Residual Analysis



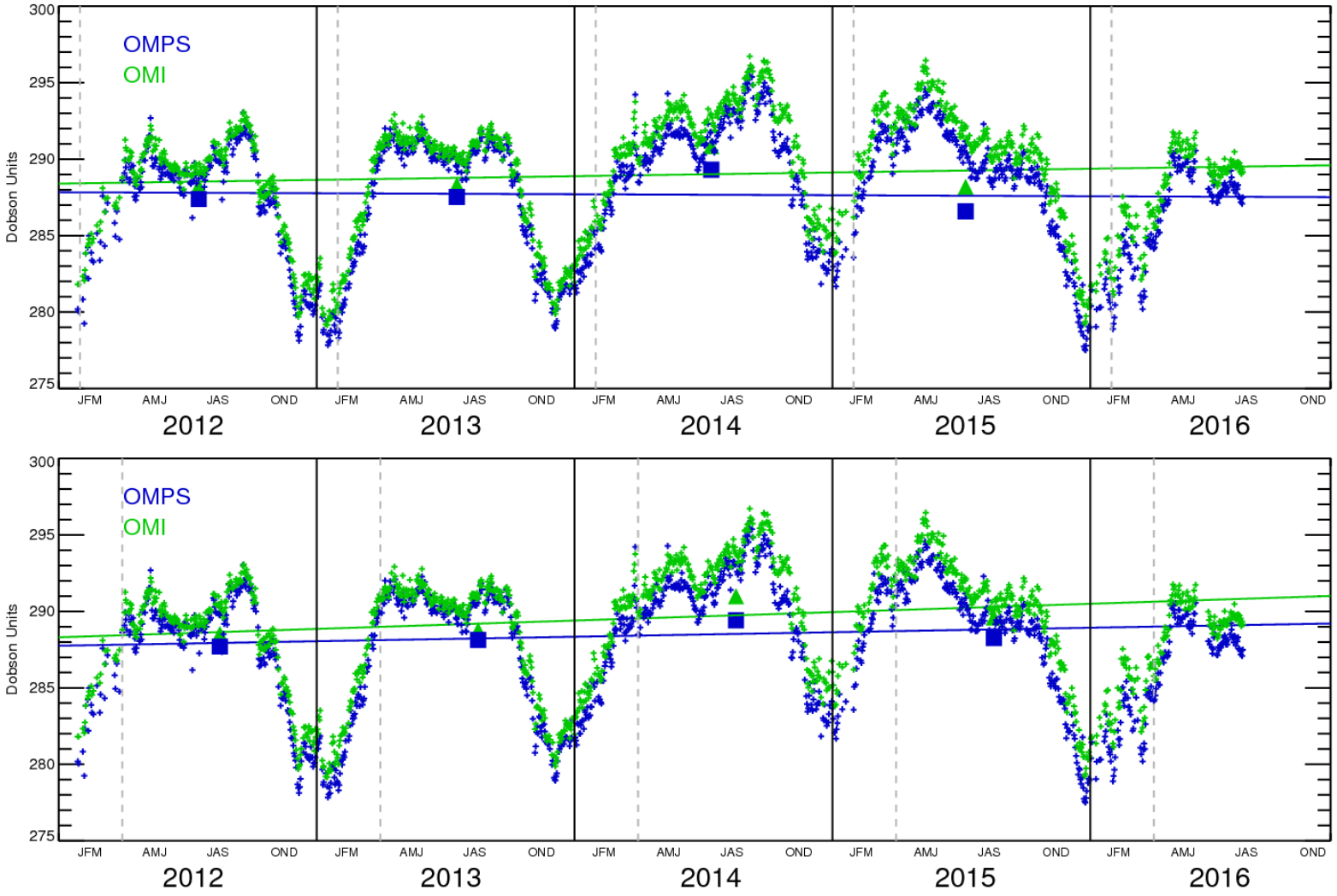
Comparison of OMPS to OMI total ozone

OMI / OMPS / Difference

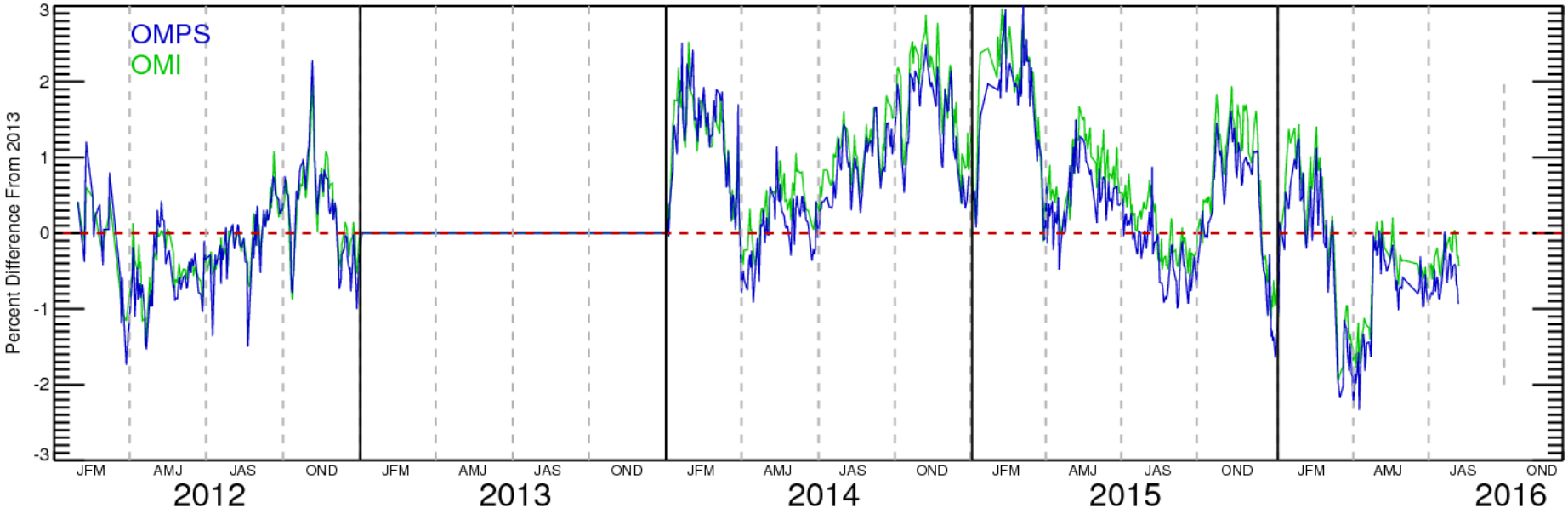
(Average total ozone from -60 to 60 degrees latitude)



Comparisons of OMPS/OMI total ozone



Comparisons of OMPS/OMI total ozone to 2013



Summary

- OMPS nadir sensors met pre-launch specifications (for the most part)
  - NM outside spec for the shortest wavelengths (< 310 nm)
  - Correction for stray light now applied for both NM and NP sensors
- OMPS nadir sensors performing well post-launch
  - Wavelengths shifts understood, now corrected for
  - Sensor performance is linear over the entire signal range
  - Issues in dichroic "transition region" due to "unphysical" behavior of calibration coefficients, now minimized using coefficients corrected by assuming smooth behavior with wavelength
  - Dark current is changing as expected
    - Correction currently applied weekly, will move to daily correction
- Both NM and NP sensors stable, with little to no long-term change