Post-launch Wavelength Registration of OMPS Nadir Sensors

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Prelaunch Calibration

- Ball Aerospace (BATC) designed, built, and calibrated all three OMPS sensor, including –
  - Nadir Mapper (NM), sometimes called Total Column (TC) after its principal product
  - Nadir Profiler (NP)
  - Limb Profiler (LP); not discussed in this report
- For all 3 sensors, BATC provided preflight Channel Band Center (CBC) and Bandpass (BPS) tables based on lab measurements; estimated thermal and atmospheric shifts from ground to orbit were applied to the band passes (slit functions).

NASA Wavelength Registration Algorithm

- A high-res solar spectrum (sampled at 0.01 nm) developed by KNMI for OMI is convolved with the preflight bandpasses centered in turn at each band center to form a synthetic solar spectrum
- For OMPS NP, solar activity corrections are applied to the synthetic spectrum
- A polynomial scaling function (essential for EV) morphs synthetic irradiance into synthetic radiance
- An implementation of the Levenberg-Marquardt nonlinear least squares algorithm used to minimize the difference between synthetic and measured irradiance or radiance
- The final optimizing CBC and the spectral calibration coefficients used to constitute it at each spatial index are the principal products.

Dispersion Relation

- For both nadir sensors, each spatial index has an independent band center solution whose coefficients are applied as follows:

  CBC(iSpat,iSpec) = a0(iSpat) + a1(iSpat)*(iSpec-iSpec0) + a2(iSpat)*(iSpec-iSpec0)^2 + a3(iSpat)*(iSpec-iSpec0)^3

  where iSpat is the spatial pixel index, iSpec the spectral pixel index, and iSpec0 is the spectral pixel index of the fitting window lower bound.

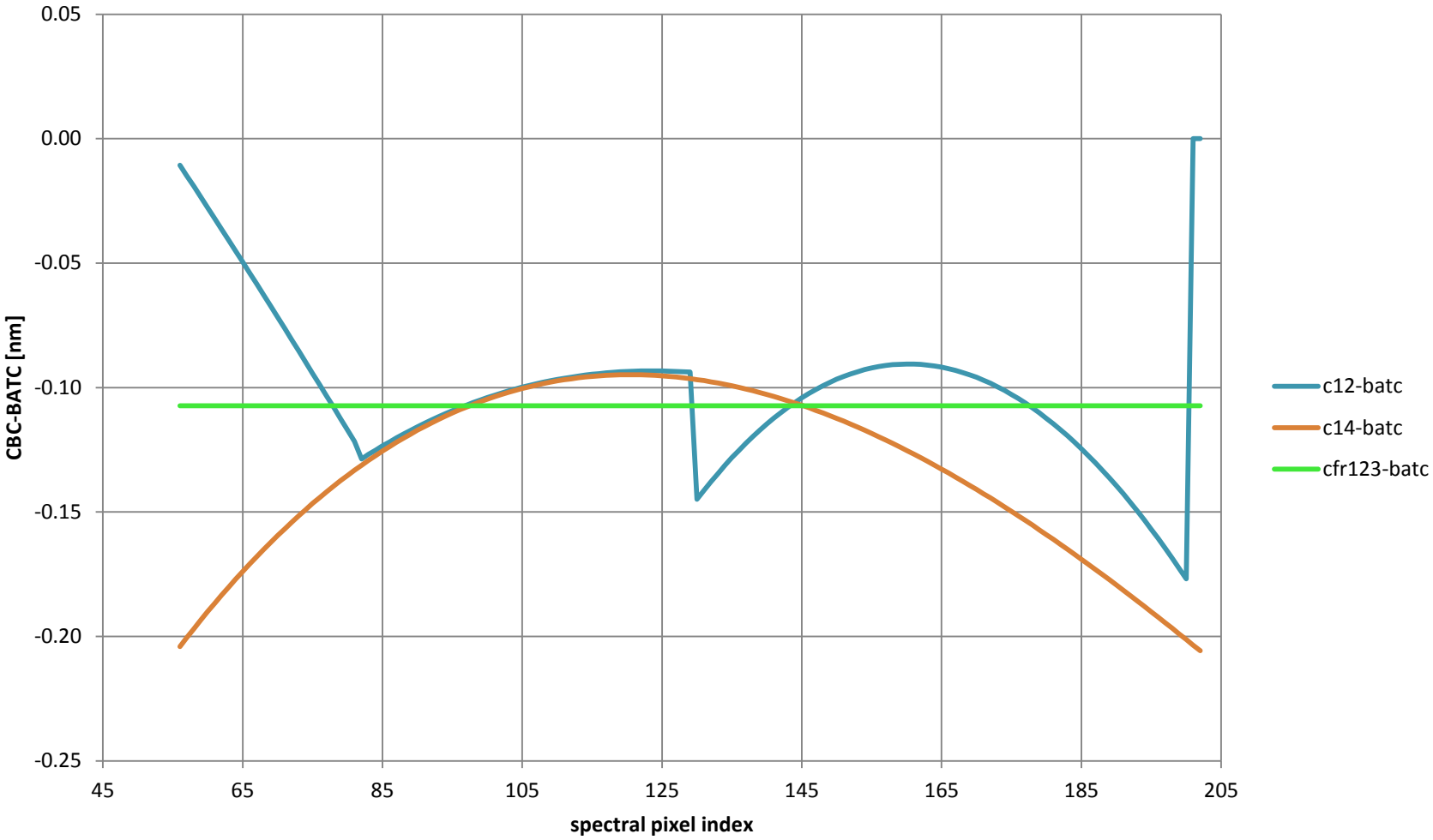
Some Results To Date

- Updated CBC tables for solar calibration for NP and NM
- New mid-EV CBC for NM
- Extended tabulation of NP seasonal/annual shifts vs. nadir telescope temperature

NP Solar CBC Evolution

- In the newest parametrization of the CBC for both NP and NM, only a0 is varied (independently for each spatial index); a1, a2, and a3 are frozen (hence, fr123)
- The next chart shows the difference (near nadir, for example) between various incarnations of the NP CBC and the preflight CBC derived by BATC; note that for the newest version, the plot is constant as a function of wavelength
- [reminder: a0(x,t) plots, residuals]

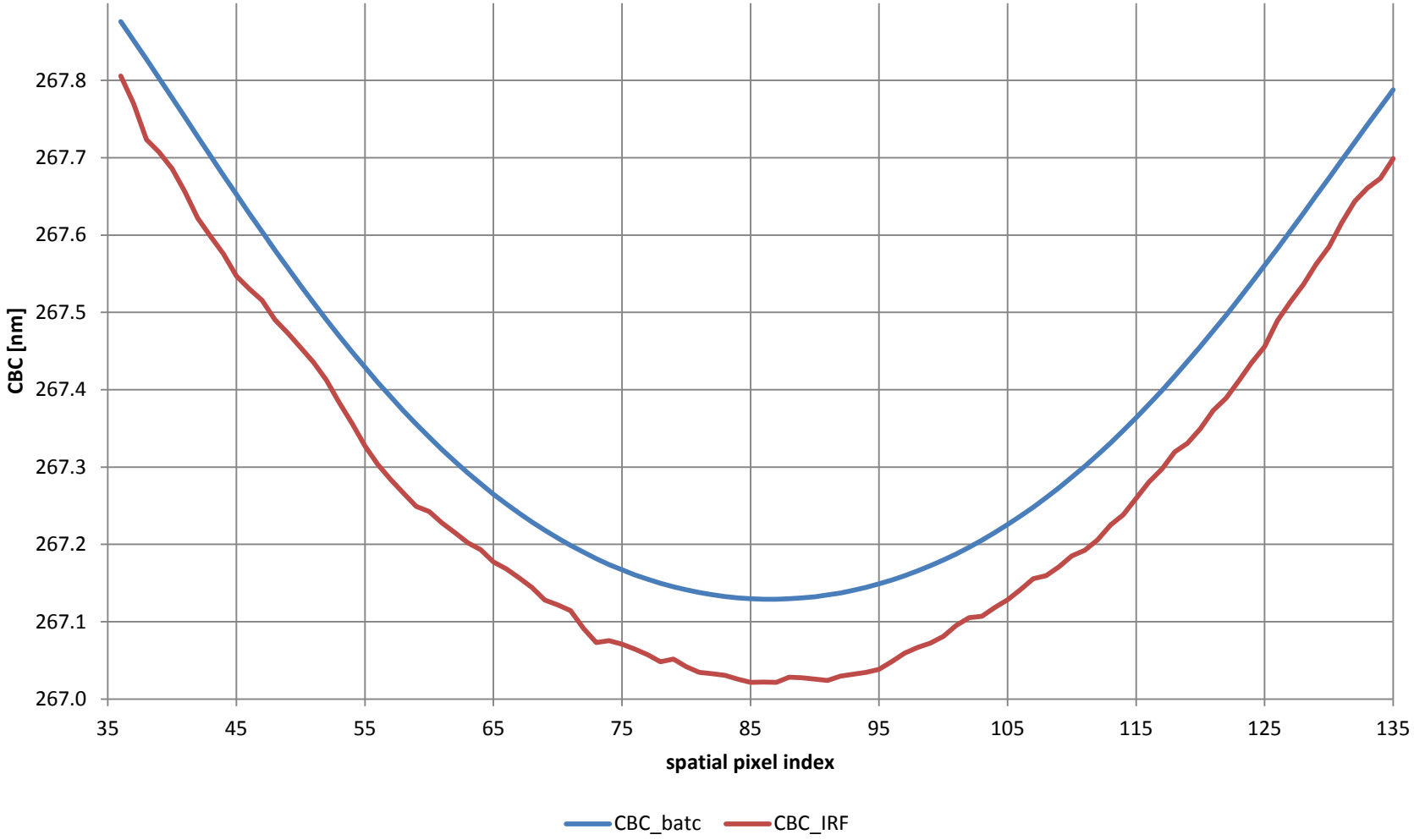
NP postlaunch CBC - preflight BATC CBC near nadir (spatial index 86)



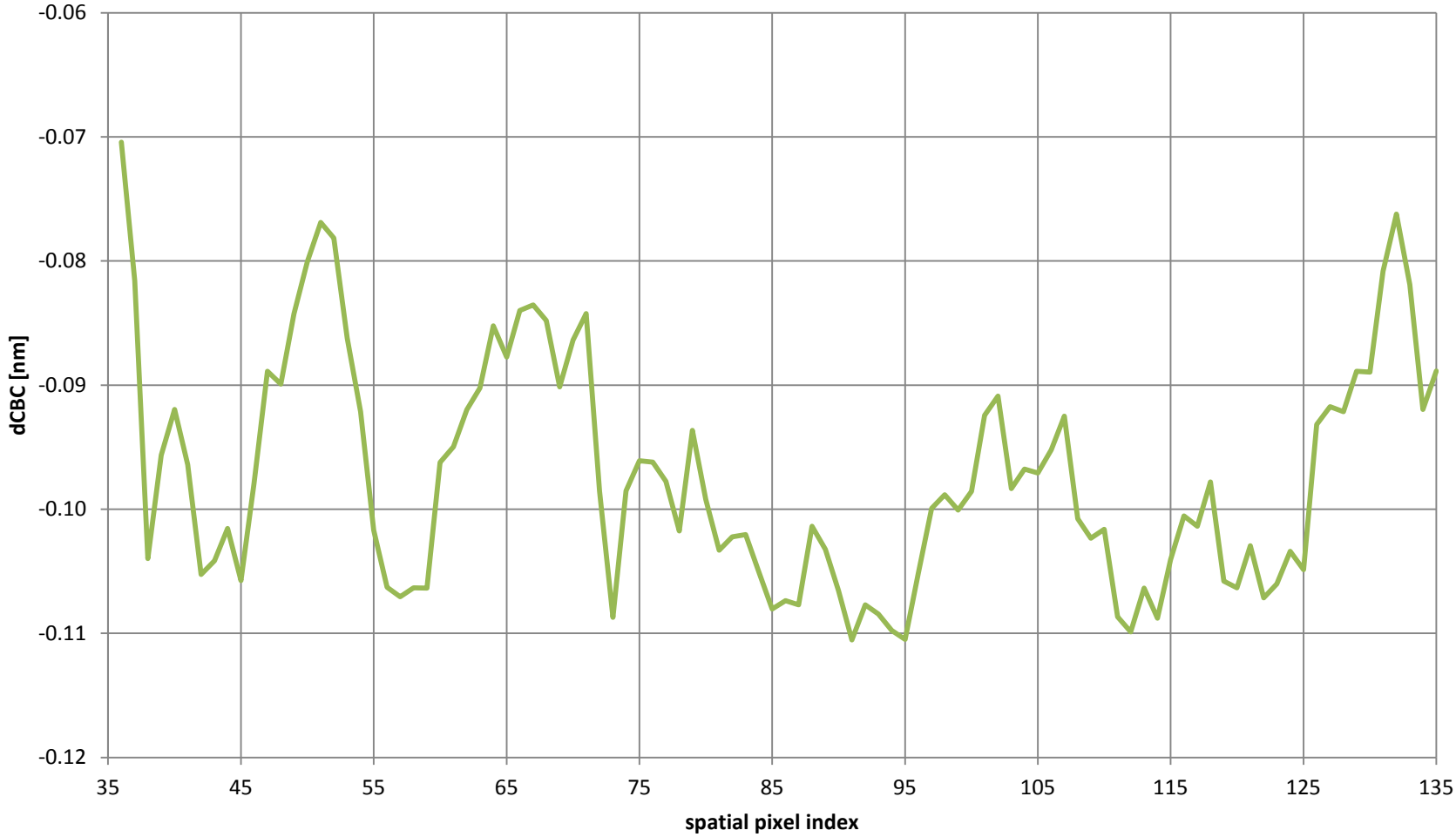
NP Slit Edge Features

- The next 2 slides show slit edge irregularities that appear in post-launch analysis that were smoothed in the preflight BATC CBC

NP Spectral Smile at spectral index 100 for preflight (BATC) and IRF CBCs



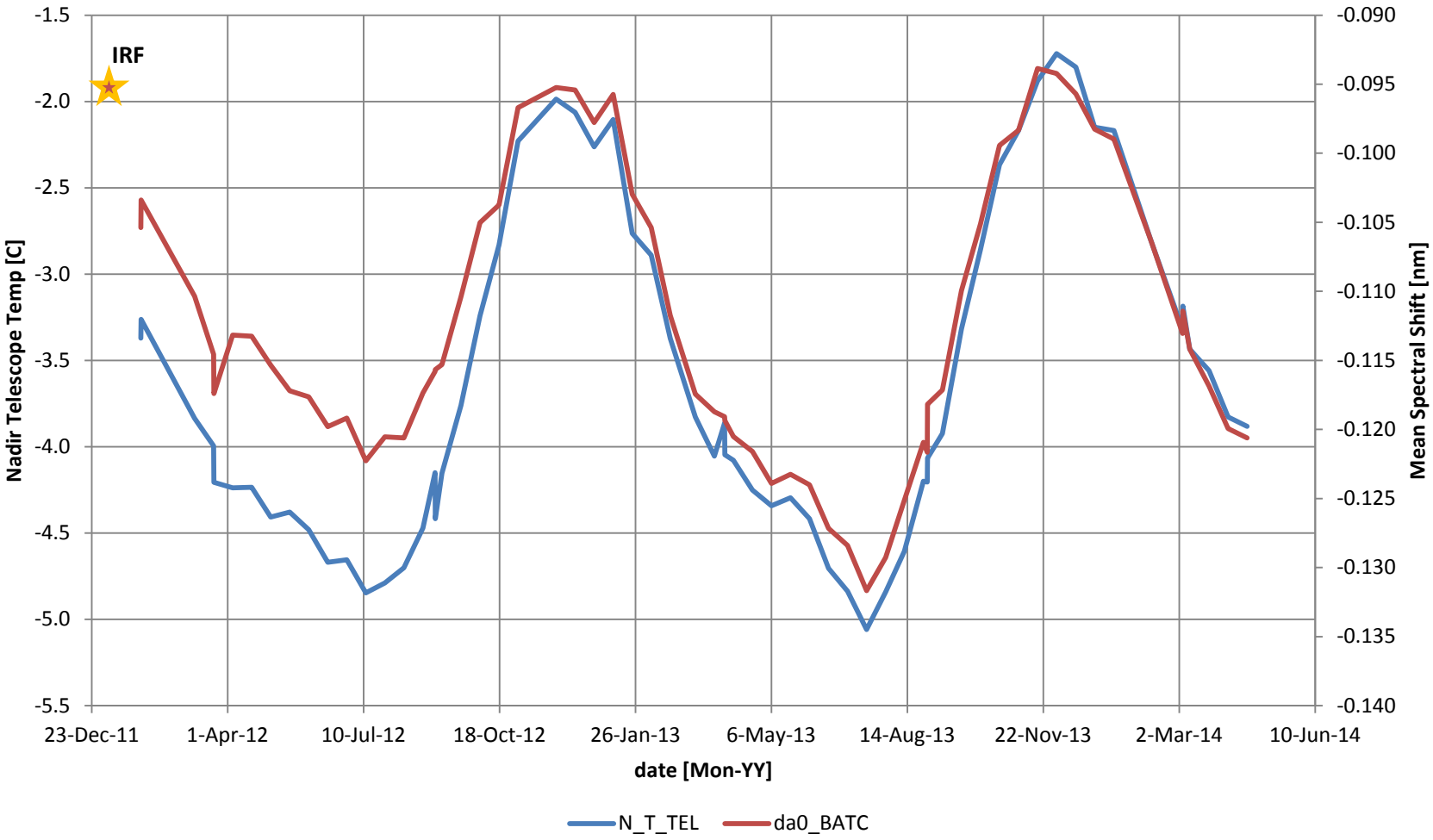
NP CBC for IRF - preflight CBC (BATC) at spatial index 100



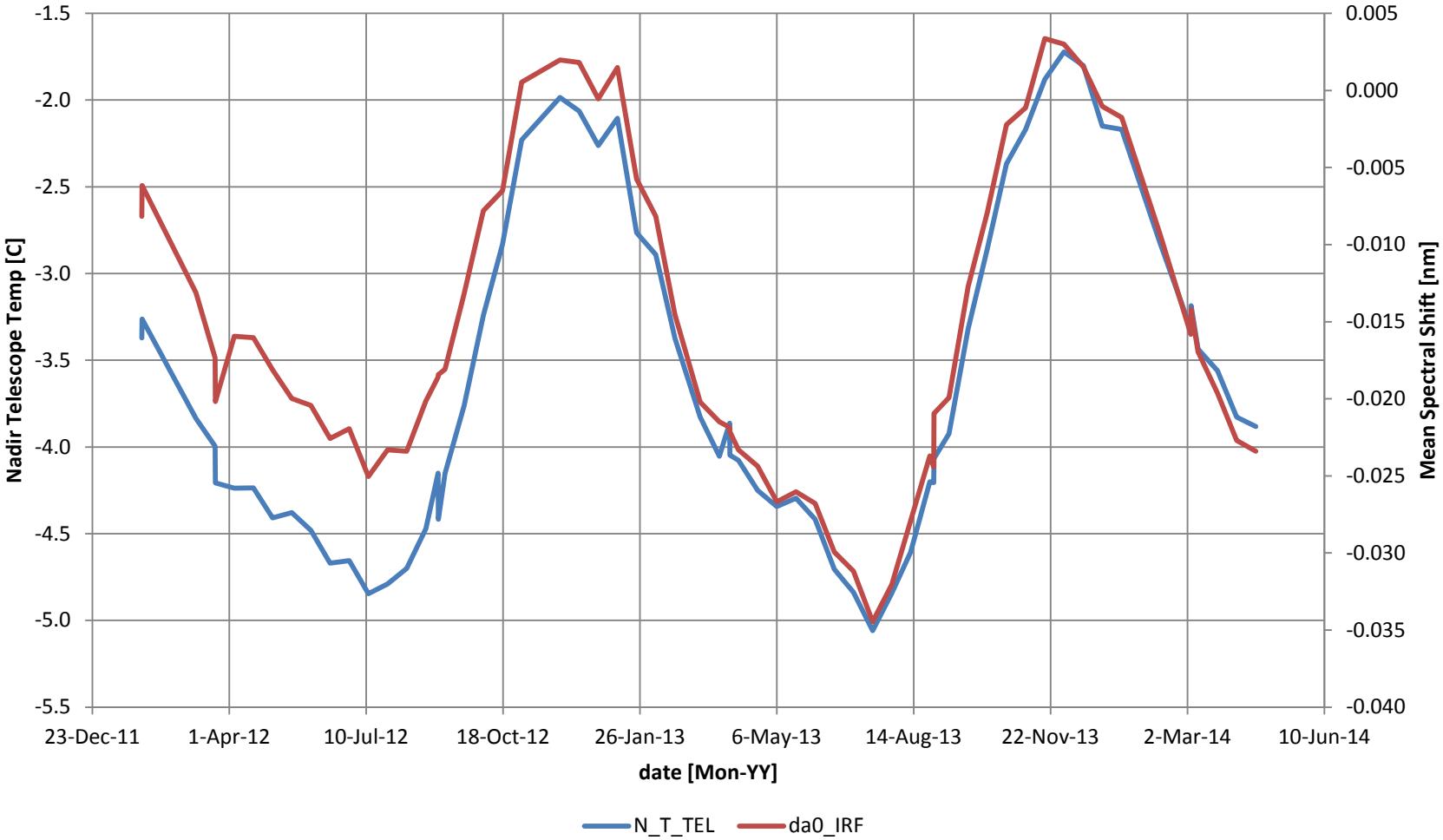
NP “Seasonal” Spectral Shift

- The following charts illustrate the correlation between annual (“seasonal”) variation cycles of Nadir Telescope Temperature (during solar calibration) and wavelength (a0 in the current model)
- A star toward the upper left of the first chart indicates the approximate date and wavelength of the initial reference solar flux (IRF), the measurement baseline for the second chart.

Mean Nadir Telescope Temperature vs Spectral Shift [rel. to BATC]



Mean Nadir Telescope Temperature vs Spectral Shift [rel. to IRF]



NM (TC) Solar CBC Evolution

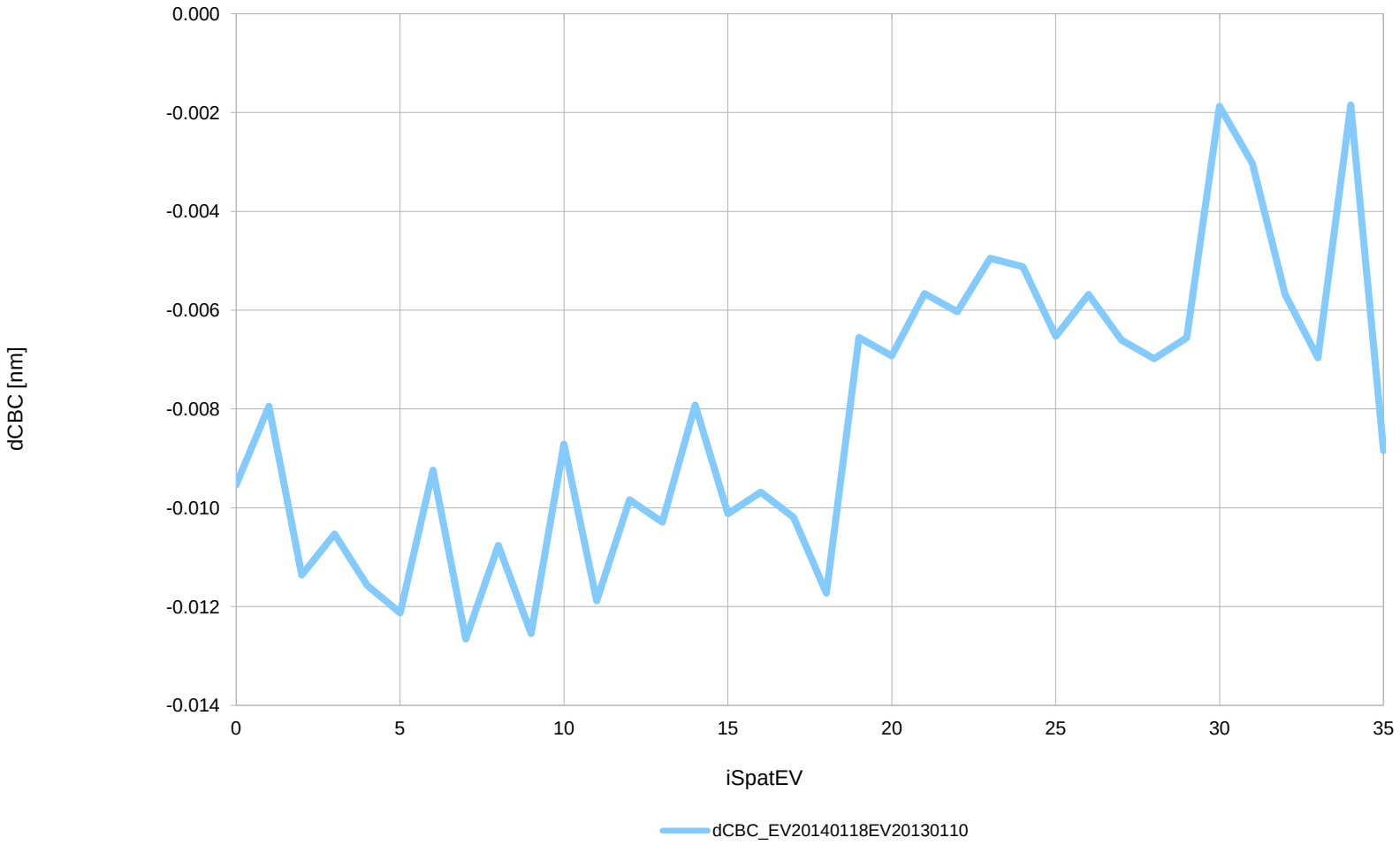
- CBC, dCBC, a0(x,t) plots, residuals

NM mid-EarthView CBC

- Cross-track differences between solar and mid-EV CBCs
- EV intraorbital spectral shifts

TC cross-track offset -- mid-EV - IRF at EV resolution, EV orbits 6238, 11531

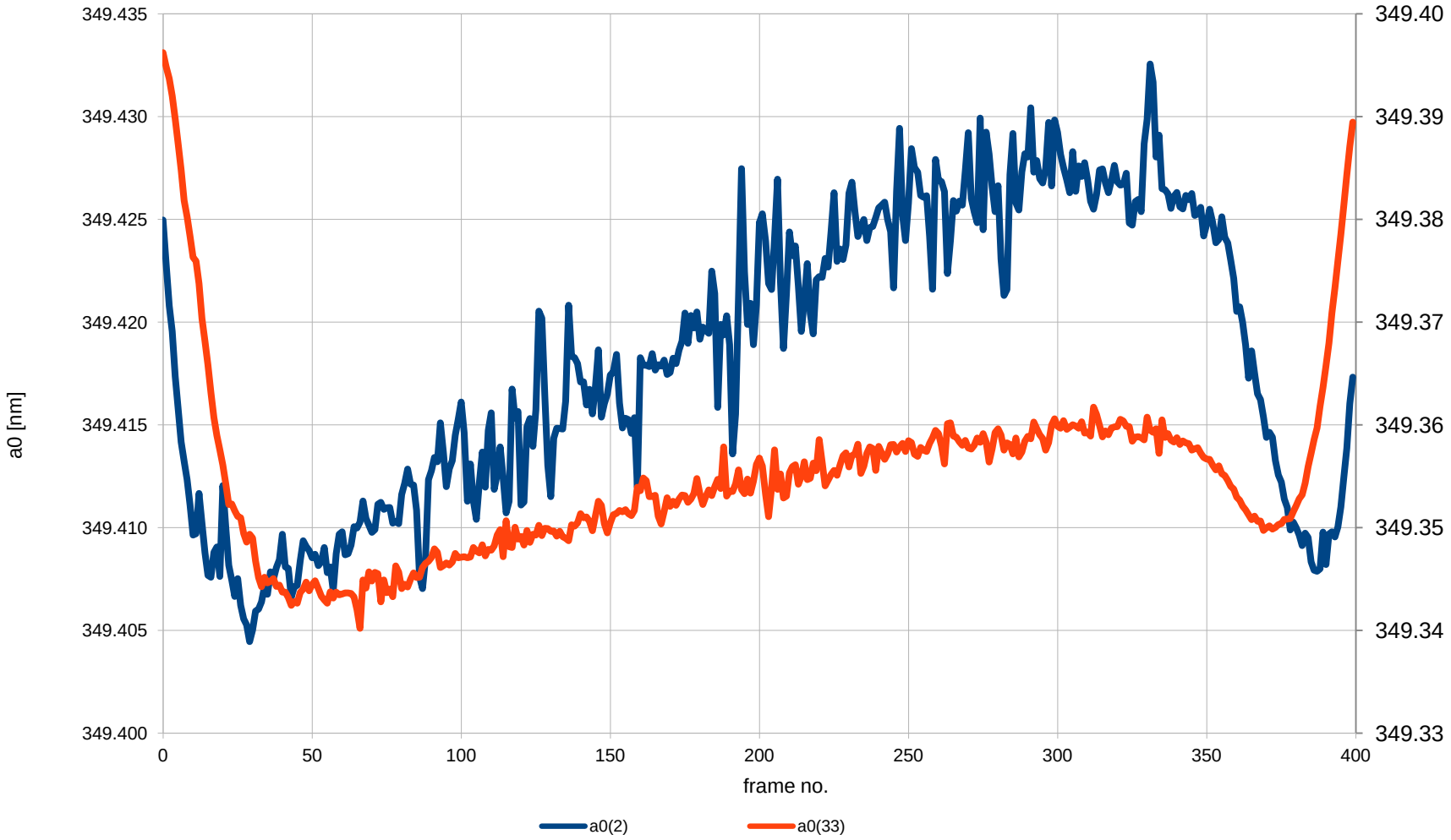
dCBC for TC: mid-EV, 1/14 - 1/13 orbits 6238,11531



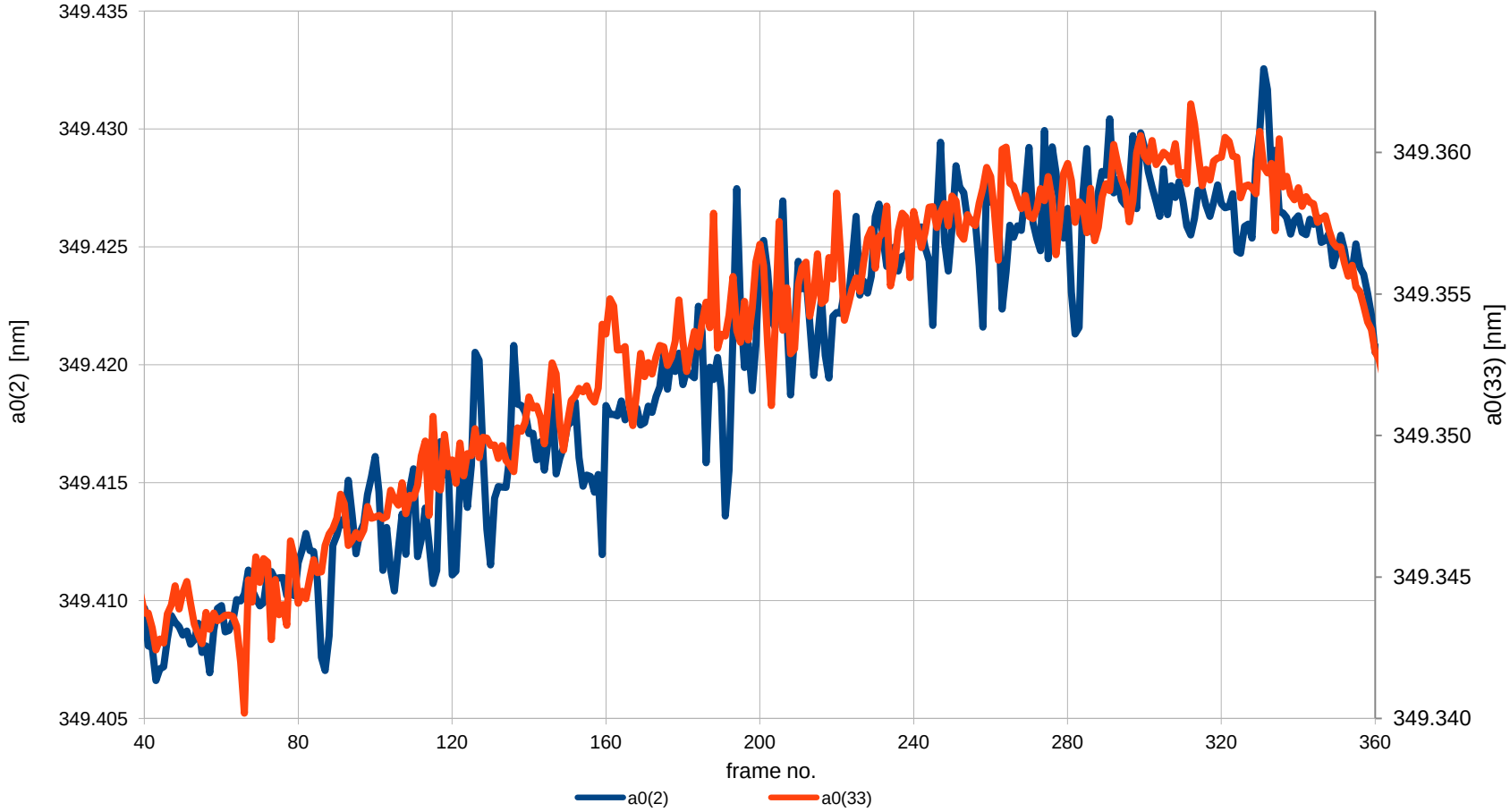
TC Intraorbital Wavelength Shift

- First slide includes distorted wavelength registration in the earliest and latest frames; on the right, in particular, mainly because of very high SZA (exceeding 90 degrees near the beginning and toward the end of EV), and weak radiance (~1% of baseline at mid-EV), long optical path, etc.
- Second slide clips the first and last 40 frames (about 5 minutes each) – note the similarity of the shifts for far left and far right macropixels (the 3rd and 34th, respectively, of 36).

TC intraorbital shift (full EV)



TC intraorbital shift (clipped)



What's Next?

- NASA Operationalization & Testing
- Ring Effect correction for EV analysis