A preliminary comparison of CrIS processing algorithms after the SNPP CrIS MWIR anomaly

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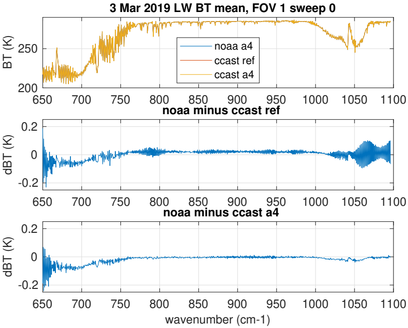
Introduction

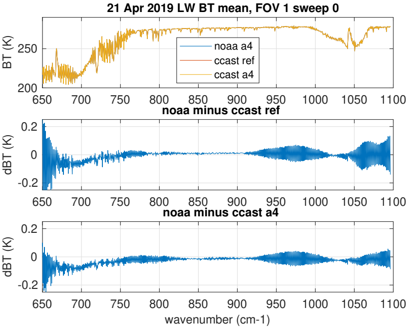
- We present a preliminary comparison of NPP CrIS high res products for the NOAA A4, UMBC CCAST A4, and UMBC CCAST reference calibration algorithms, before and after the NPP MW anomaly.
- Complex residuals for the NOAA product are slightly larger before and significanty larger after the anomaly.
- Differences in the NOAA and UMBC CCAST processing include
  - CCAST uses cosine apodization of the extended point set outside the user-grid OPD, rather than truncation or circular shift
  - CCAST uses "small n" psinc (psinc at the decimated sensor grid) for both the ILS and SA matrix
  - CCAST spectral-space processing filters for the reference algorithm have a slightly narrower passband and more gradual rolloff than the A4 filters. The difference is greatest at the low end of the LW band.
- The CCAST reference and NOAA A4 calibration equations and CCAST apodization are described in an appendix.

Test Data

- NOAA data are GCRSO-SCRIF HDF5 files from NOAA CLASS. CCAST data are from our regular production runs, with the A4 algorithm selectable as an option.
- CCAST uses 45-scan and NOAA 60-scan granules. For these preliminary tests we simply took the intersection of scans for two overlapping granules, one pair before and one pair after the anomaly.
- The pre-anomaly test set consists of 1110 obs from relatively warm granules, midpoint time 03-Mar-2019 04:07:11. The set is divided into even and odd sweeps (even and odd FORs) and broken out by FOV.
- The post-anomaly test set consists of 1260 obs from another pair of warm granules, midpoint time 21-Apr-2019 04:08:29. The set is also divided into even and odd sweeps and broken out by FOV.
- We show representative cases for corner, side, and center FOVs, for both sweep directions.

LW FOV 1 Sweep 0 BT Spectra

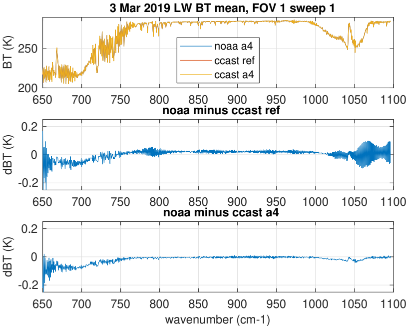




Pre-anomaly mean BT spectra for NOAA A4, CCAST ref, and CCAST A4. The CCAST A4 and NOAA A4 algorithms are in good agreement, aside from the slight dip at the low end of the LW.

Post-anomaly mean BT spectra for NOAA A4, CCAST ref, and CCAST A4. The NOAA and CCAST algorithms are diverging.

LW FOV 1 Sweep 1 BT Spectra



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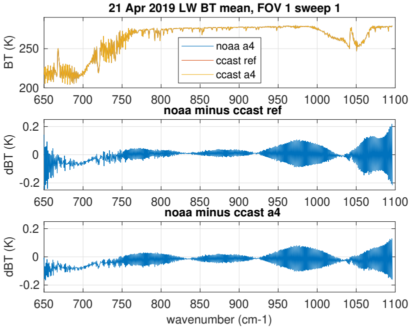
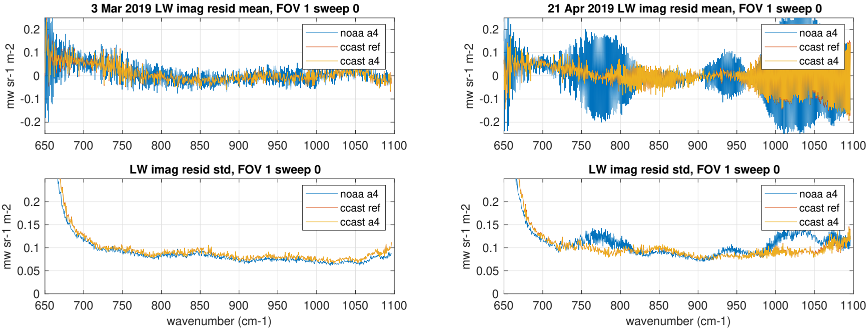


Post-anomaly mean BT spectra for NOAA A4, CCAST ref, and CCAST A4. The divergence is larger for sweep direction 1.

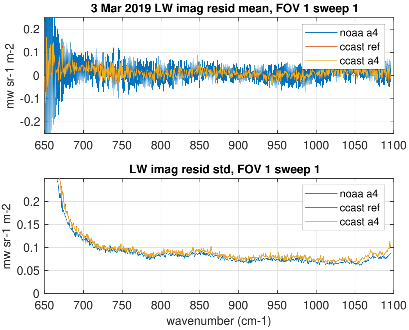
LW FOV 1 Sweep 0 Complex Residuals



Pre-anomaly complex residual mean and standard deviation. The NOAA complex residual is a little larger.

Post-anomaly complex residual mean and standard deviation. The NOAA complex residual is significantly larger and the standard deviations have diverged.

LW FOV 1 Sweep 1 Complex Residuals



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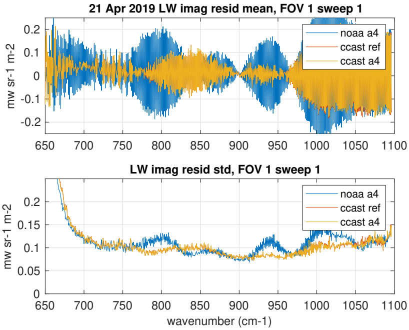
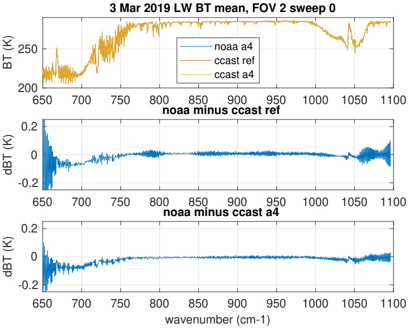
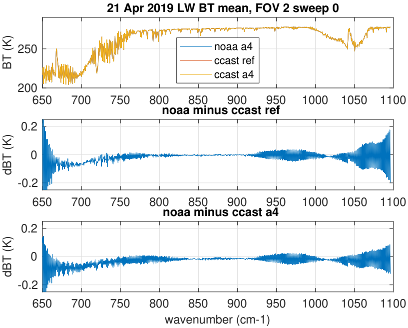


Post-anomaly complex residual mean and standard deviation. The NOAA complex residual is significantly larger and the standard deviations have diverged.

LW FOV 2 Sweep 0 BT Spectra

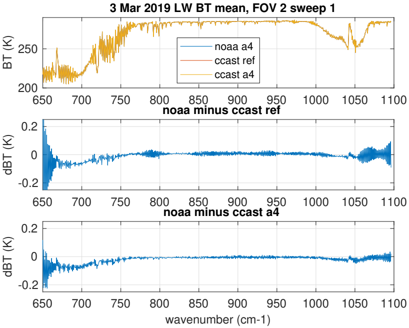




Pre-anomaly mean BT spectra. The CCAST A4 and NOAA A4 algorithms are in good agreement.

Post-anomaly mean BT spectra. The NOAA and CCAST algorithms are diverging.

LW FOV 2 Sweep 1 BT Spectra



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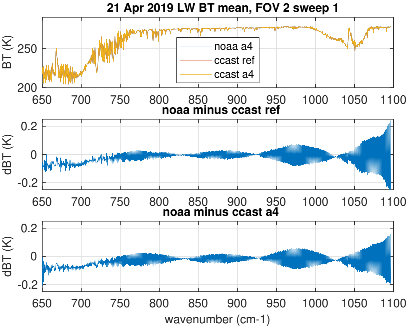
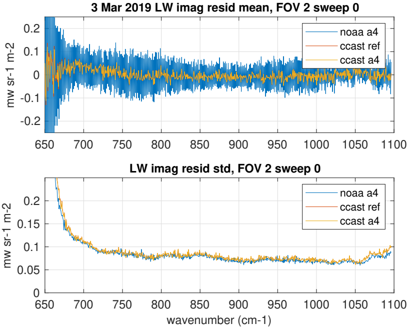
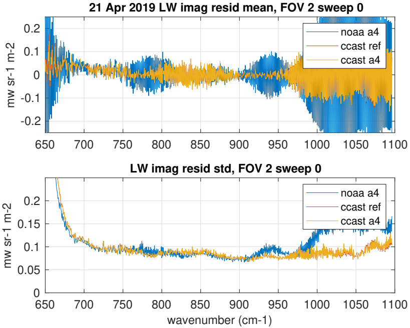


Post-anomaly mean BT spectra. The NOAA and CCAST algorithms are diverging.

LW FOV 2 Sweep 0 Complex Residuals

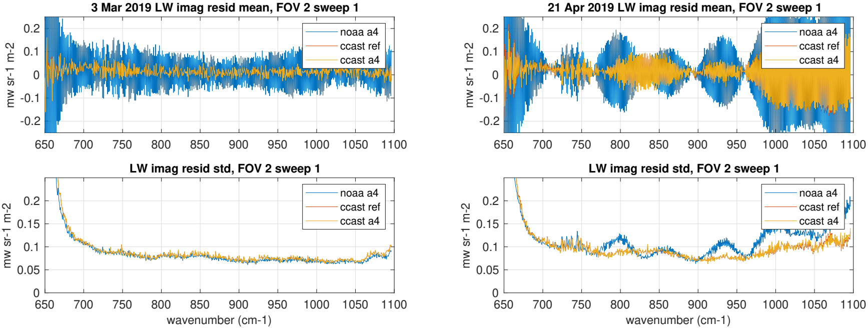




Pre-anomaly complex residual mean and standard deviation. The NOAA complex residual is significantly larger even before the anomaly.

Post-anomaly complex residual mean and standard deviation. The NOAA complex residual is significantly larger and the standard deviations have diverged.

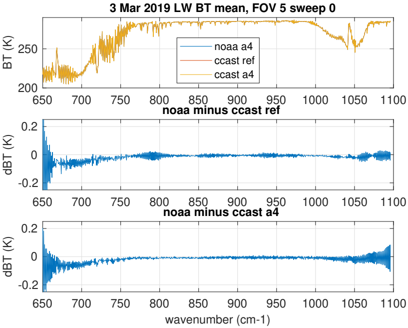
LW FOV 2 Sweep 1 Complex Residuals



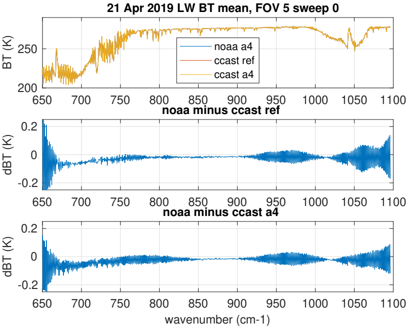
Pre-anomaly complex residual mean and standard deviation. The NOAA complex residual is significantly larger even before the anomaly.

Post-anomaly complex residual mean and standard deviation. The NOAA complex residual is significantly larger and the standard deviations have diverged.

LW FOV 5 Sweep 0 BT Spectra

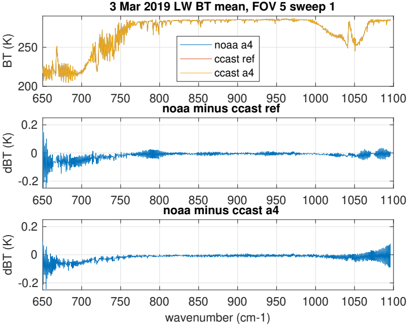


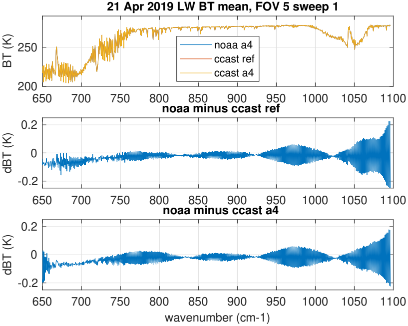
Pre-anomaly mean BT spectra. The CCAST and NOAA algorithms are in moderately good agreement.



Post-anomaly mean BT spectra. The NOAA and CCAST algorithms are beginning to diverge.

LW FOV 5 Sweep 1 BT Spectra

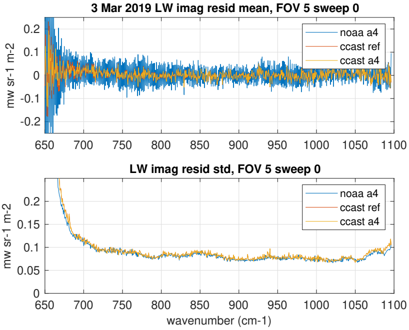


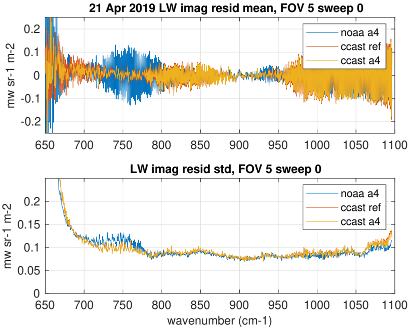


Pre-anomaly mean BT spectra. The CCAST and NOAA algorithms are in moderately good agreement.

Post-anomaly mean BT spectra. The NOAA and CCAST algorithms are diverging.

LW FOV 5 Sweep 0 Complex Residuals

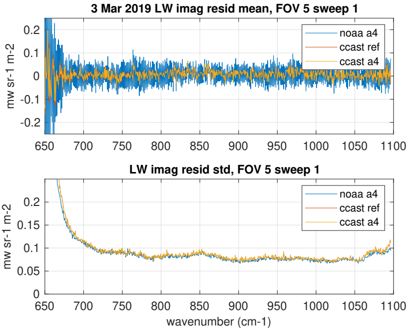


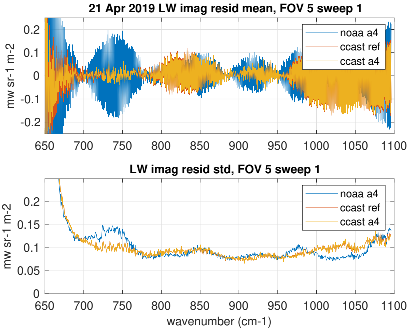


Pre-anomaly complex residual mean and standard deviation. The NOAA complex residual is a little larger.

Post-anomaly complex residual mean and standard deviation. Both residuals are larger.

LW FOV 5 Sweep 1 Complex Residuals

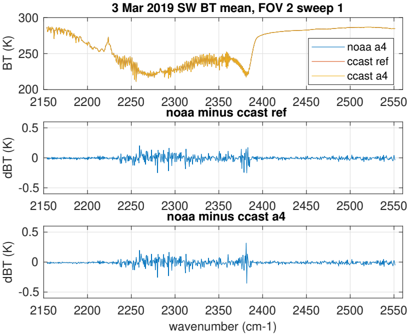


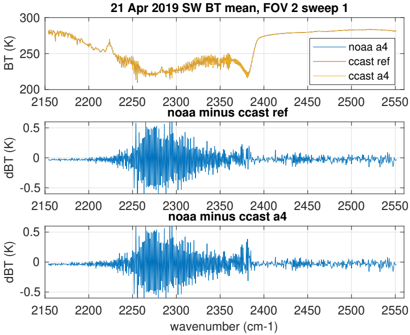


Pre-anomaly complex residual mean and standard deviation. The NOAA complex residual is a little larger.

Post-anomaly complex residual mean and standard deviation. The NOAA residual is larger and the standard deviations have diverged.

SW FOV 2 Sweep 1 BT Spectra

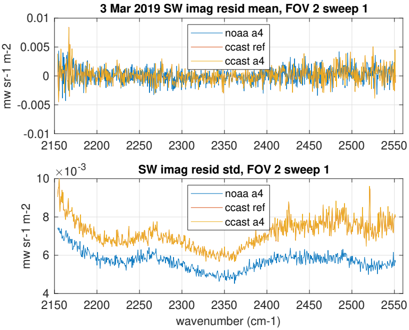




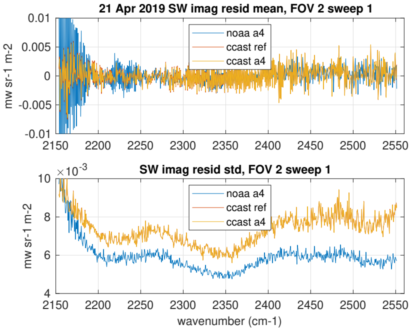
Pre-anomaly mean BT spectra. The CCAST and NOAA algorithms are in relatively good agreement (but note the extended x axis vs the LW plots).

Post-anomaly mean BT spectra. The NOAA and CCAST algorithms are diverging.

SW FOV 2 Sweep 1 Complex Residuals

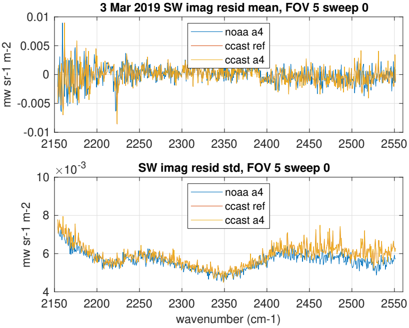


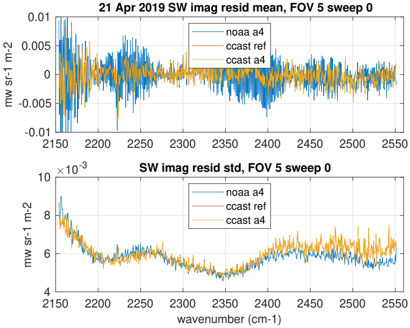
Pre-anomaly complex residual mean and standard deviation. The complex residuals are similar, but the ccast standard deviation is significantly larger.



Post-anomaly complex residual mean and standard deviation. The NOAA complex residual is significantly larger at the low end of the band.

SW FOV 5 Sweep 0 Complex Residuals





Pre-anomaly complex residual mean and standard deviation. The complex residuals and standard deviations are similar.

Post-anomaly complex residual mean and standard deviation. The NOAA complex residual is significantly larger.

Conclusions

- Complex residuals for the NOAA product are slightly larger before and significanty larger after the anomaly.
- This may be due to the mild cosine apodization working better for the case of a significant ZPD shift.
- Because the complex residuals are smaller, we suspect the CCAST BT spectra are closer to reference truth after the anomaly. But this needs to be verified.
- The slightly larger NOAA complex residuals before the anomaly are puzzling, we do not recall seeing this in earlier tests.
- The CCAST complex residual standard deviation is larger than NOAA for the SW side and corner FOVs. This may be due to the different forms of the SA matrix.
- The next step is comparison with calculated reference truth, from clear matchups.

CCAST Calibration Equations

CCAST reference equation

$$r_{\mathrm{ES}}^{\mathsf{user}} = F \cdot r_{\mathrm{ICT}}^{\mathsf{sensor}} \cdot f_{\mathsf{cos}} \cdot \mathsf{SA}^{-1} \cdot f_{\mathsf{cos}} \cdot \frac{\Delta\mathsf{ES}}{\Delta\mathsf{IT}}$$

NOAA algorithm A4

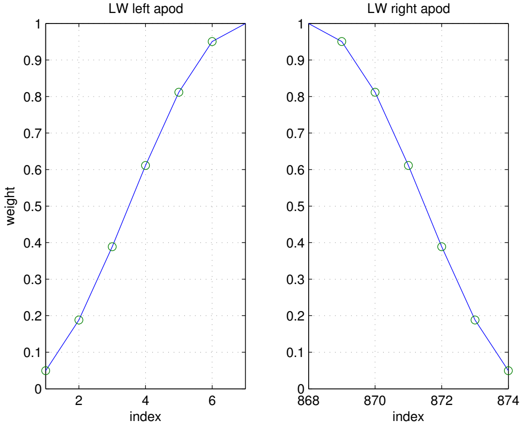
$$r_{\mathrm{ES}}^{\mathsf{user}} = r_{\mathrm{ICT}}^{\mathsf{user}} \cdot \frac{F \cdot f_{\mathrm{ATBD}} \cdot \mathsf{SA}^{-1} \cdot f_{\mathrm{ATBD}} \cdot (\frac{\Delta\mathsf{ES}}{\Delta\mathsf{IT}}) \cdot |\Delta\mathsf{IT}|}{F \cdot f_{\mathrm{ATBD}} \cdot \mathsf{SA}^{-1} \cdot f_{\mathrm{ATBD}} \cdot |\Delta\mathsf{IT}|}$$

$$\Delta\mathsf{ES} = \mathsf{ES} - \langle\mathsf{SP}\rangle, \quad \Delta\mathsf{IT} = \langle\mathsf{IT}\rangle - \langle\mathsf{SP}\rangle$$

Extended Interferogram Apodization

- we can drop 6 points on each side of the extended resolution interferograms and stay very close to the OPD spec
- $(n - 12) \cdot dx = 1.5995$ for the LW, 1.6081 for the MW, and 1.6001 for the SW bands, for typical metrology laser values
- this includes the MW band, even though that was not extended in the recent update
- apodizing (rather than dropping) these points leaves effective resolution within specs
- note that the apodized extension discussed here is distinct from any downstream apodization (such as Hamming) that is applied to user-grid radiances

Extended Interferogram Apodization



edge of band details for the LW extended resolution apodization. The apodization is symmetrical and all the weights are non-zero.