new cris calibration algorithm comparisons

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August 5, 2015

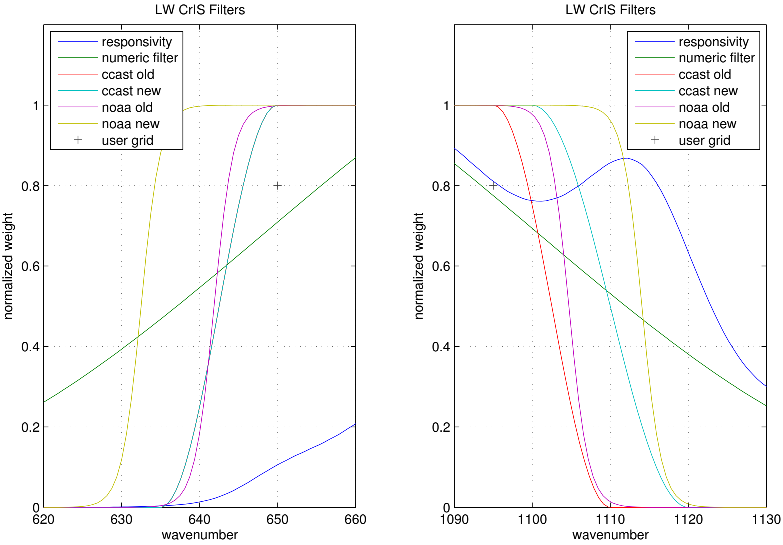
introduction

- we compare an updated version of CCAST with our implementation of NOAA 4. This allows for identical ILS, translation to the user grid, and other processing details, so the only difference is the calibration equation
- we show results for both clear matchups and FOV 5 relative tests, including tests of both algorithms with and without responsivity
- after reviewing the 10 June 2015 calibration algorithm comparisons of Yong Han and Yong Chen, we modified the CCAST processing filters to be closer to the new NOAA filters
- the CCAST filters can not be identical because the ratio-first algorithm needs to roll off the calibration ratio inside instrument responsivity

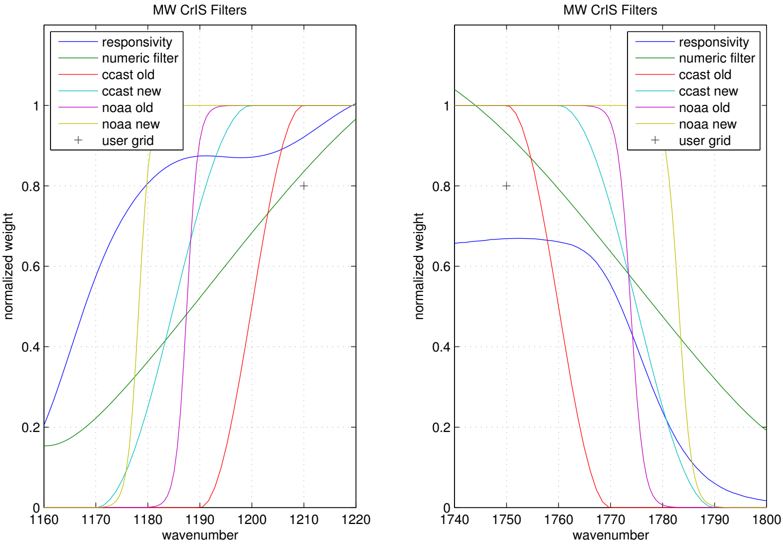
methods

- for tests with calculated radiance we start with 2300 clear matchups from ccast granule SDR_d20150218_t0318115 and calculate upwelling radiances with kcarta at a 0.0025 cm-1 grid
- for the "flat" tests the new ccast processing filters are applied pointwise and the result is convolved to the CrIS user grid
- for the "resp" tests instrument responsivity is applied pointwise to the kcarta radiances, these are convolved to the user grid, and then divided pointwise by inverse responsivity
- relative tests are with data averaged over the three day test period, 17-19 Feb 2015
- all test are done with periodic sinc wrapping at the sensor grid, added guard points, and double Fourier interpolation to the user grid

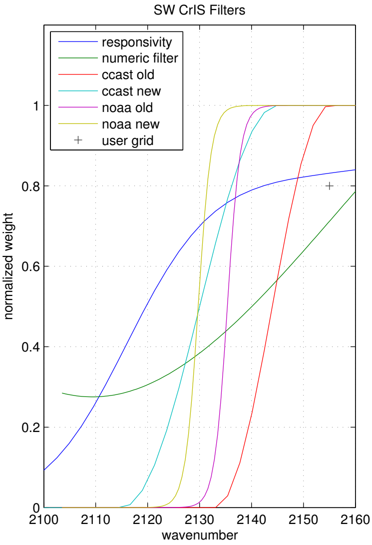
ccast and noaa LW filters



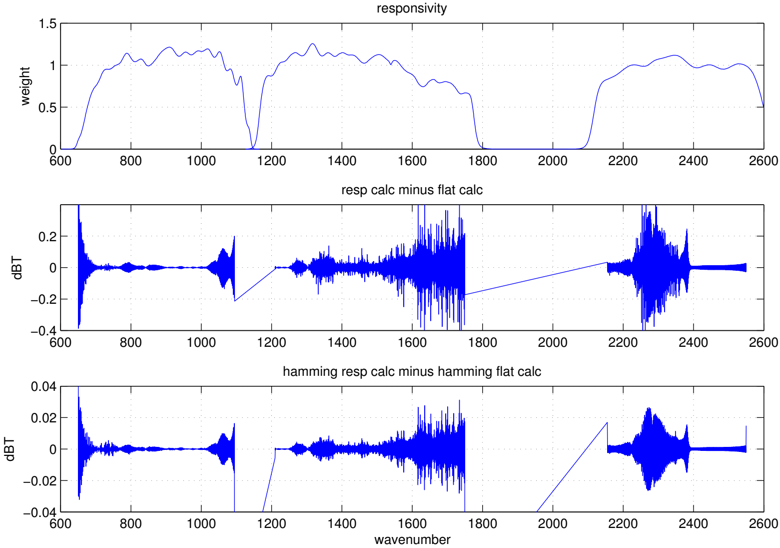
ccast and noaa MW filters



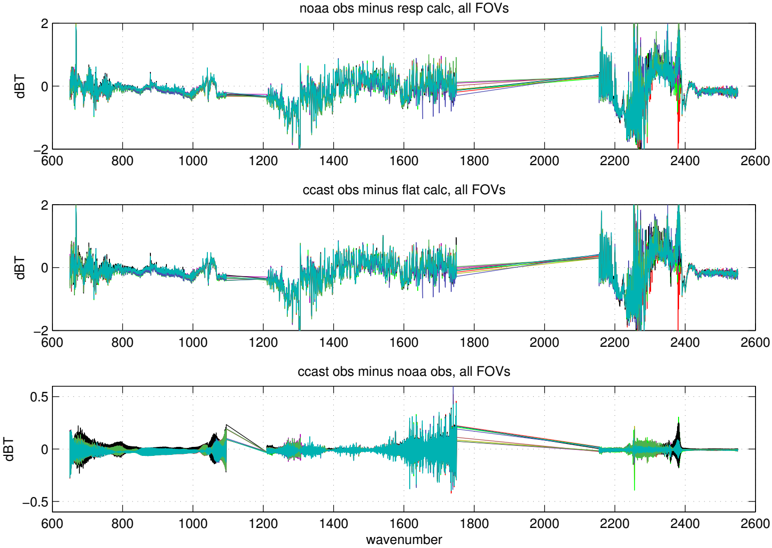
ccast and noaa SW filters



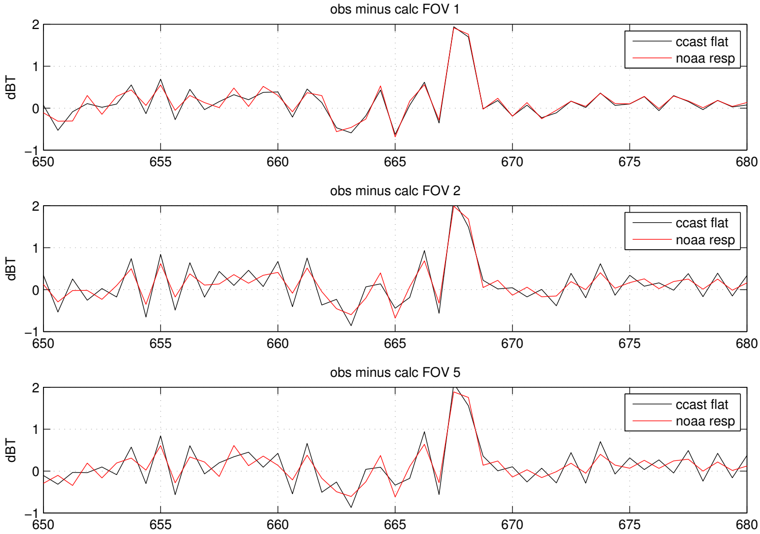
responsivity vs flat reference truth



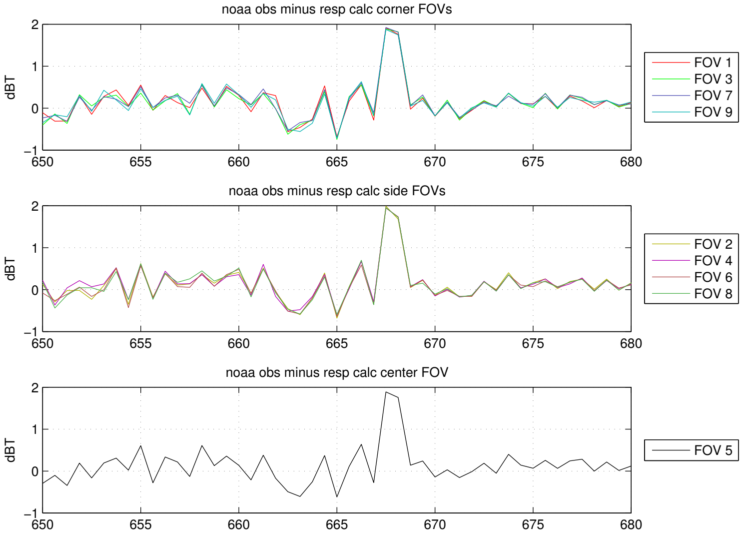
obs minus calc overview



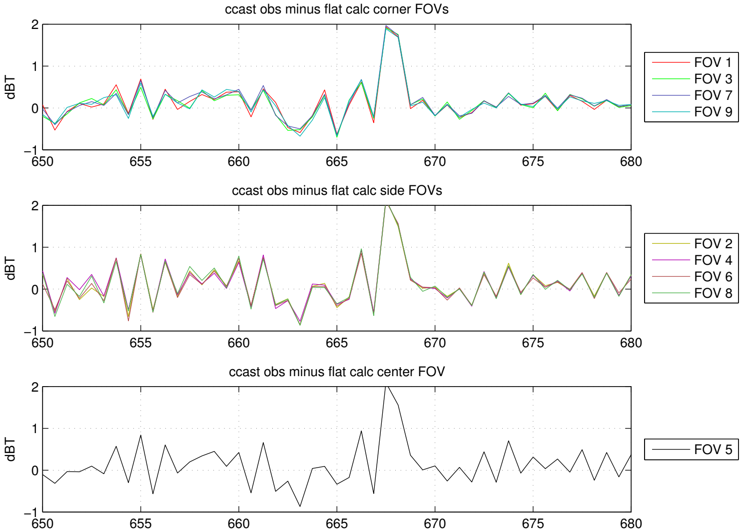
obs minus calc LW detail



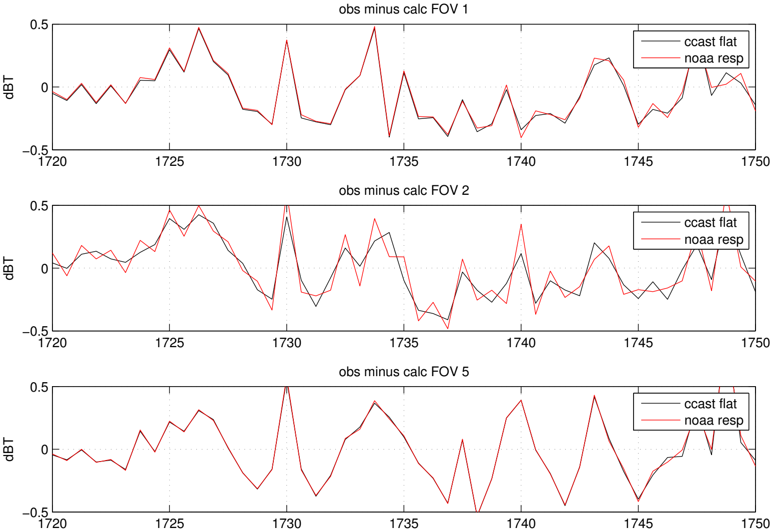
noaa all fovs LW detail



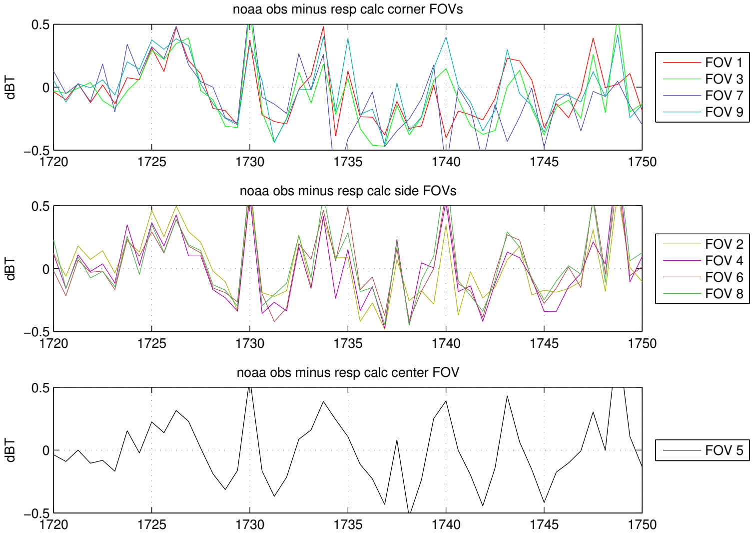
ccast all fovs LW detail



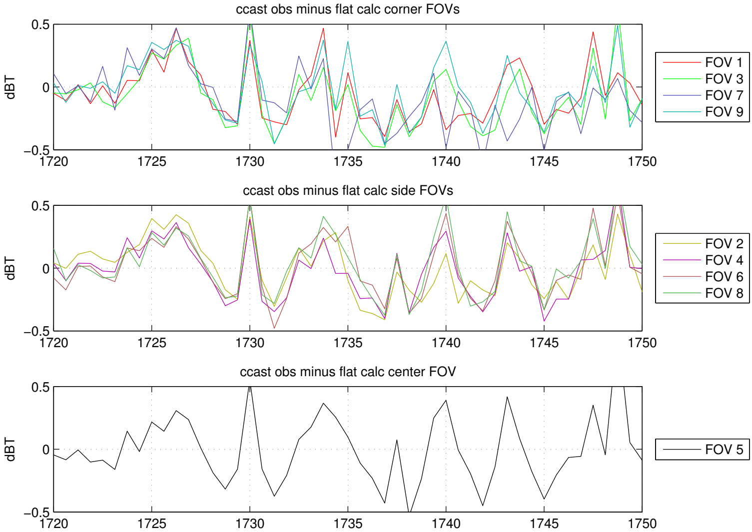
obs minus calc MW detail



noaa all fovs MW detail



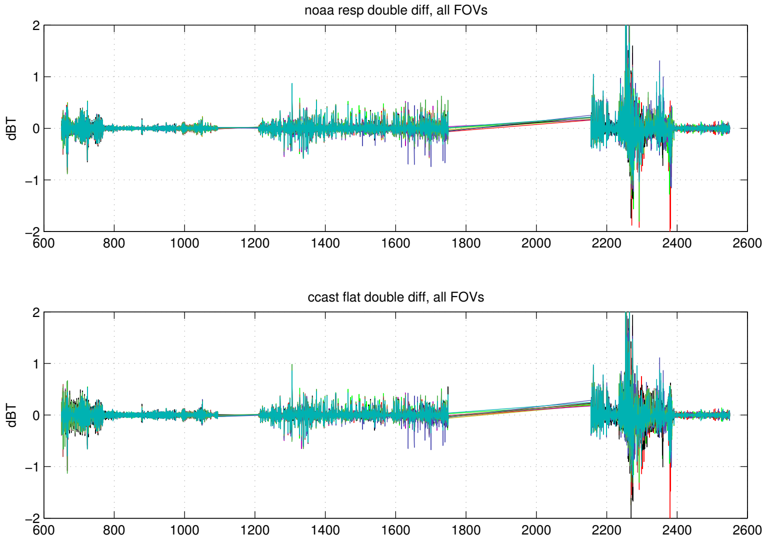
ccast all fovs MW detail



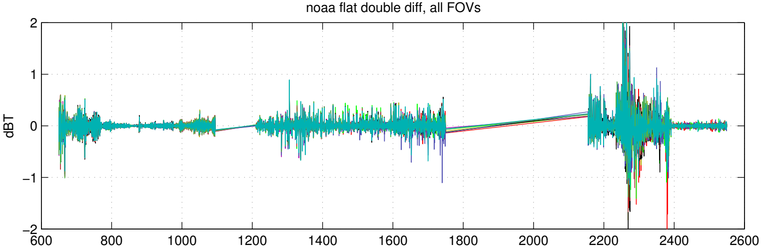
obs minus calc summary

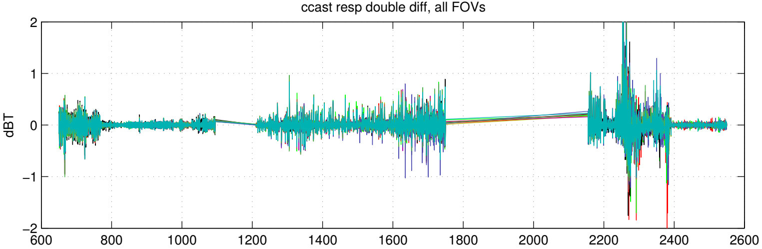
- at the level of detail in the overview, CCAST minus flat and NOAA minus resp are relatively close
- the main differences are below 700 cm-1 in the LW, where CCAST is slightly worse, and above 1600 cm-1 in the MW, where it is slightly better
- in the LW detail we see FOV 1 in good agreement above around 665 cm-1 but NOAA better for FOV 2 and 5
- in the MW detail we see NOAA and CCAST in generally good agreement for FOV 5, CCAST slightly better for FOV 1, and significantly better for FOV 2
- the breakouts by FOV show both NOAA and CCAST with distinct side and corner FOV groups, and results generally as noted above

noaa resp and ccast flat double diffs



noaa flat and ccast resp double diffs





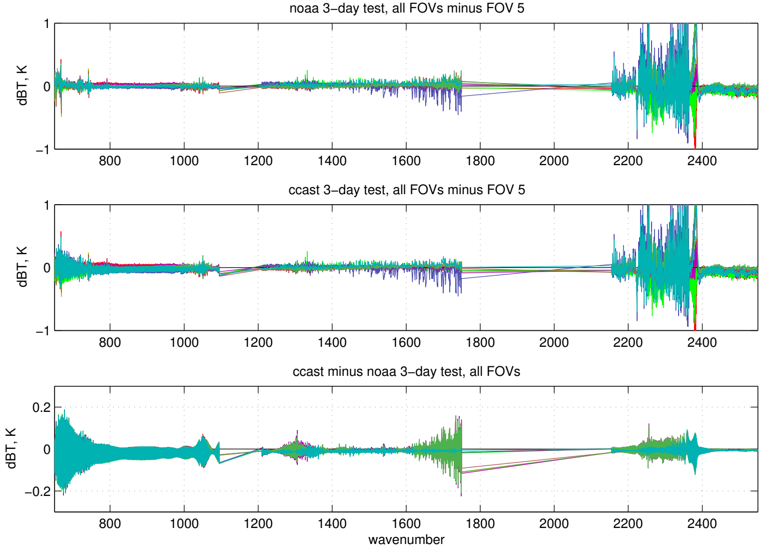
double difference summary

- the NOAA double difference is

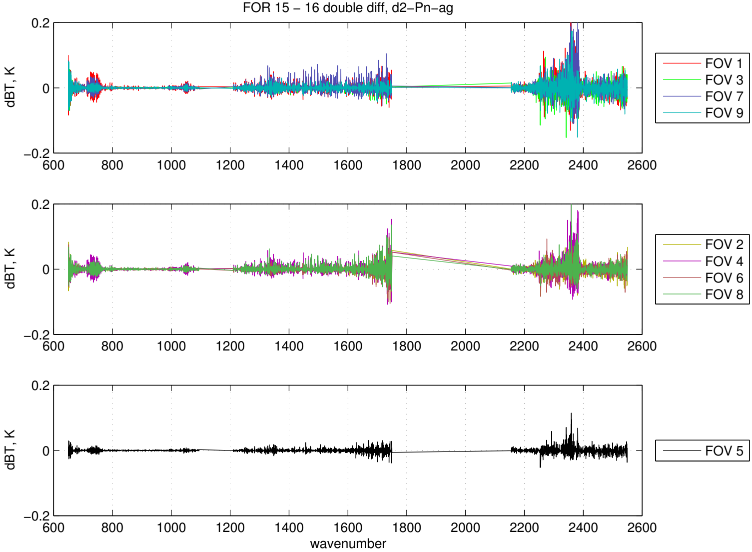
  $$(\text{noaa obs} - \text{noaa resp}) - (\text{noaa apodized obs} - \text{noaa apodized resp})$$

  other double differences are analogous
- NOAA with responsivity and ccast with flat reference truth are generally similar, with CCAST slightly worse at the low end of the LW and slightly better in MW above around 1600 cm-1
- adding responsivity improves CCAST slightly at the low end of the LW and possibly in the SW, but makes it significantly worse above 1600 cm-1 in the MW
- removing responsivity generally makes NOAA slightly worse in the LW and SW, and possibly also in the MW

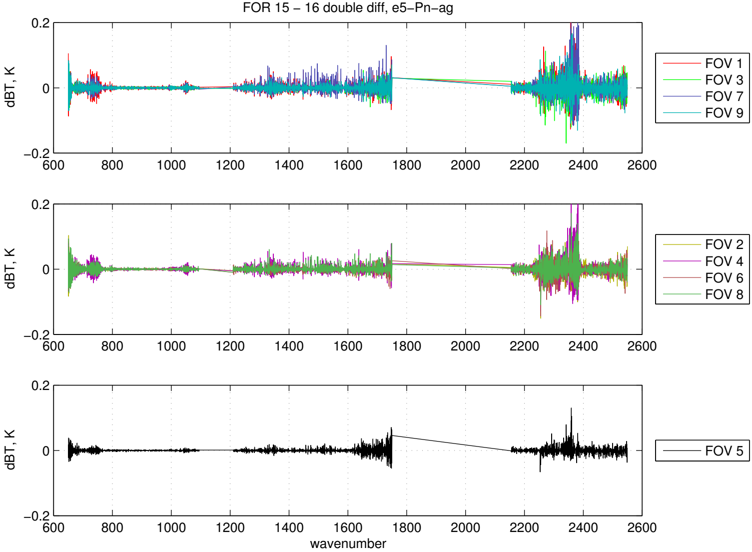
relative test overview



noaa relative double diffs



ccast relative double diffs



relative test summary

- the overview is the difference from FOV 5 of the means of FOR 15 and 16 taken together
- the double differences here are

$$(\text{FOR 15} - \text{FOR 16}) - (\text{apodized FOR 15} - \text{apodized FOR 16})$$

- relative test results are generally consistent with the obs minus calc tests shown earlier
- CCAST is worse in the LW and slightly better in the MW above around 1600 cm-1. Some of the LW difference may be due to the FOV 5 differences we saw in the obs minus calc tests
- the relative double differences are small in comparison with other residuals shown here, with NOAA a little better overall but CCAST significantly better for side FOVs in the MW

conclusions

- we have seen a significant convergence in calibration algorithm results and performance
- overall the NOAA algorithm works slightly better with responsivity and CCAST better without
- remaining differences between the CCAST and NOAA calibration equations are small
- CCAST flat is slightly worse at the LW end of the LW band, and slightly better in the MW above around 1600 cm-1
- differences after Hamming apodization are very small
- although the NOAA algorithm has a few more steps, this has no significant effect on runtime

context for SDR reference truth choices

- CCAST flat output close to true sinc ILS
- CCAST flat RTA simulation requires 3 bandpass filters (12 parameters)
- NOAA resp RTA simulation requires full responsivity curves (roughly 1700 parameters)
- NOAA resp radiance climate record may be affected if responsivity varies from instrument to instrument or changes for a particular instrument
- CrIS flat radiances insensitive to filter characteristic
- LLS believe is will be hard to get international community to use responsivity in the long time frame! Debatable
- Impact of cal eqn and reference truth choices: Later Talk

ccast calibration equation

$$r_{\mathrm{ES}} = F \cdot r_{\mathrm{ICT}} \cdot f \cdot \mathsf{SA}^{-1} \cdot f \cdot \frac{\mathsf{ES} - \langle \mathsf{SP} \rangle}{\langle \mathsf{IT} \rangle - \langle \mathsf{SP} \rangle}$$

- r_{ES} is calibrated earth-scene radiance at the user grid
- F is Fourier interpolation from sensor to user grid
- r_{ICT} is expected ICT radiance at the sensor grid
- f is a raised-cosine bandpass filter with wings at or just inside instrument responsivity
- SA is from a periodic sinc ILS wrapping at the sensor grid
- ES, $\langle \mathsf{IT} \rangle$ and $\langle \mathsf{SP} \rangle$ are corrected for nonlinearity
- $\langle \mathsf{IT} \rangle$ and $\langle \mathsf{SP} \rangle$ are averages over 9 scans