apodization of CrIS extended interferograms

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introduction

- we show that applying a cosine apodization at the edges of the new extended interferograms reduces sweep direction and FOV 5 relative residuals, in comparison to processing without such apodization
- results are from a three day test period, 8-10 Nov 2015
- all test are done with the CCAST reference calibration algorithm, processing filters as presented in our 5 May 2015 telecon talk, periodic sinc wrapping at the sensor grid, and double Fourier interpolation to the user grid
- tests with the NOAA reference calibration algorithm would be significant, but were not done in time for this presentation

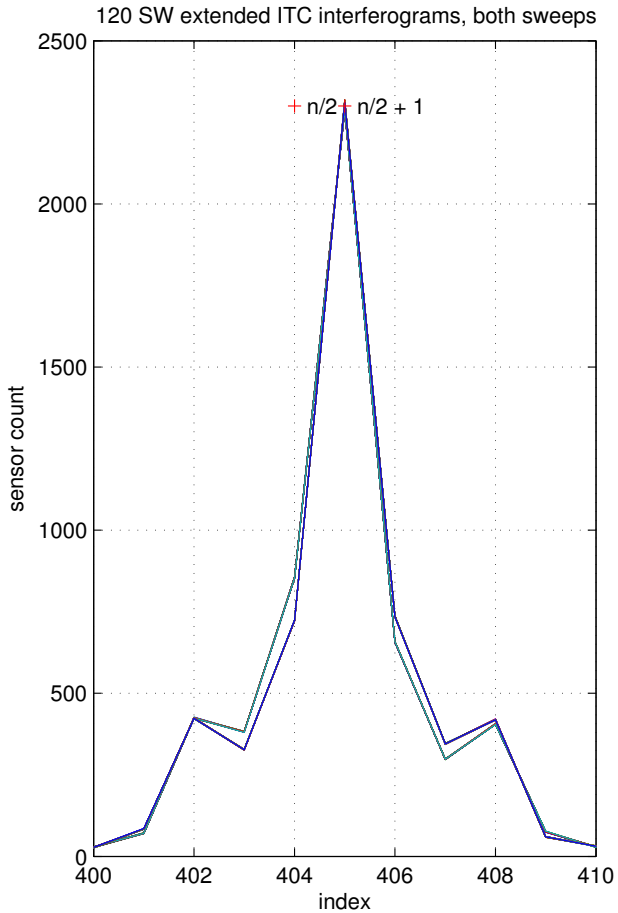
CrIS resolution modes

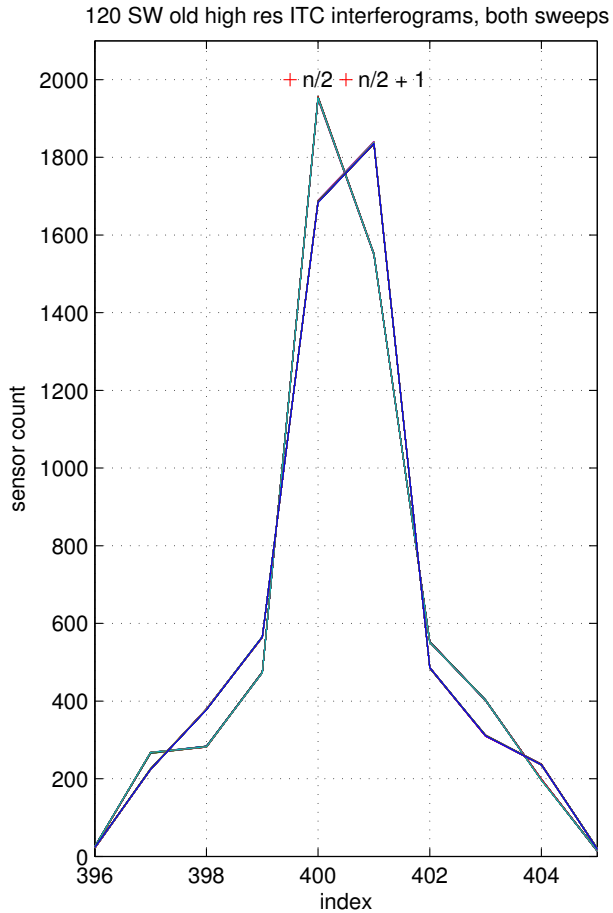
- UMBC CCAST sensor-grid resolution modes include

mode	LW	MW	SW	comment
lowres	866	530	202	low res
hires1	866	1039	799	old high res
hires2	866	1052	799	2014 high res
hi3to2	866	1052	800	truncation test
hires3	874	1052	808	new extended res

- CCAST user-grid resolution modes include the original $0.8/0.4/0.2$ cm^{-1} OPD low res mode and the 0.8 cm^{-1} OPD high res mode
- double Fourier interpolation from the sensor to user grid allows for any combination of sensor and user resolutions
- interferogram centers are at decimated points $n/2+1$ for even point sets. The center is at $n/2+1$ for the 799 point set as well, but in that case is not an integer

interferogram centers



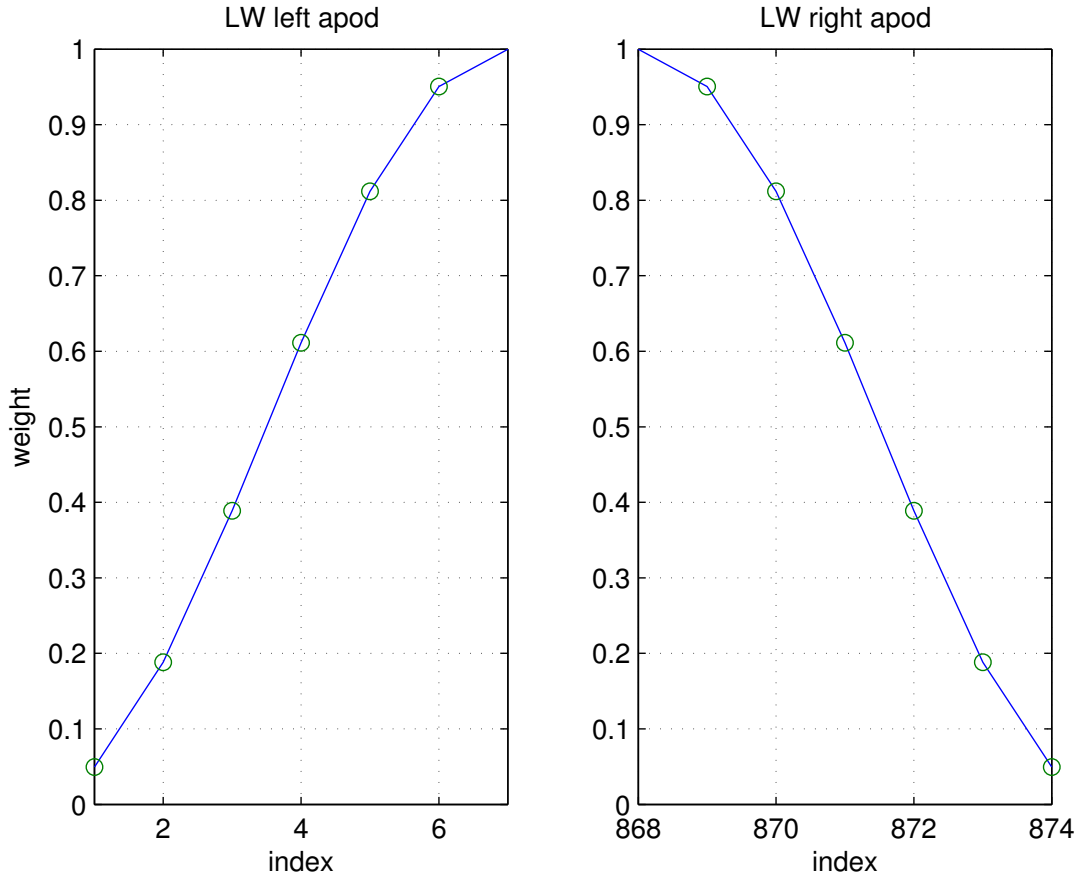


center detail of phase-corrected interferograms for 120 SW ICT looks (one 60-scan granule), including both sweep directions

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.

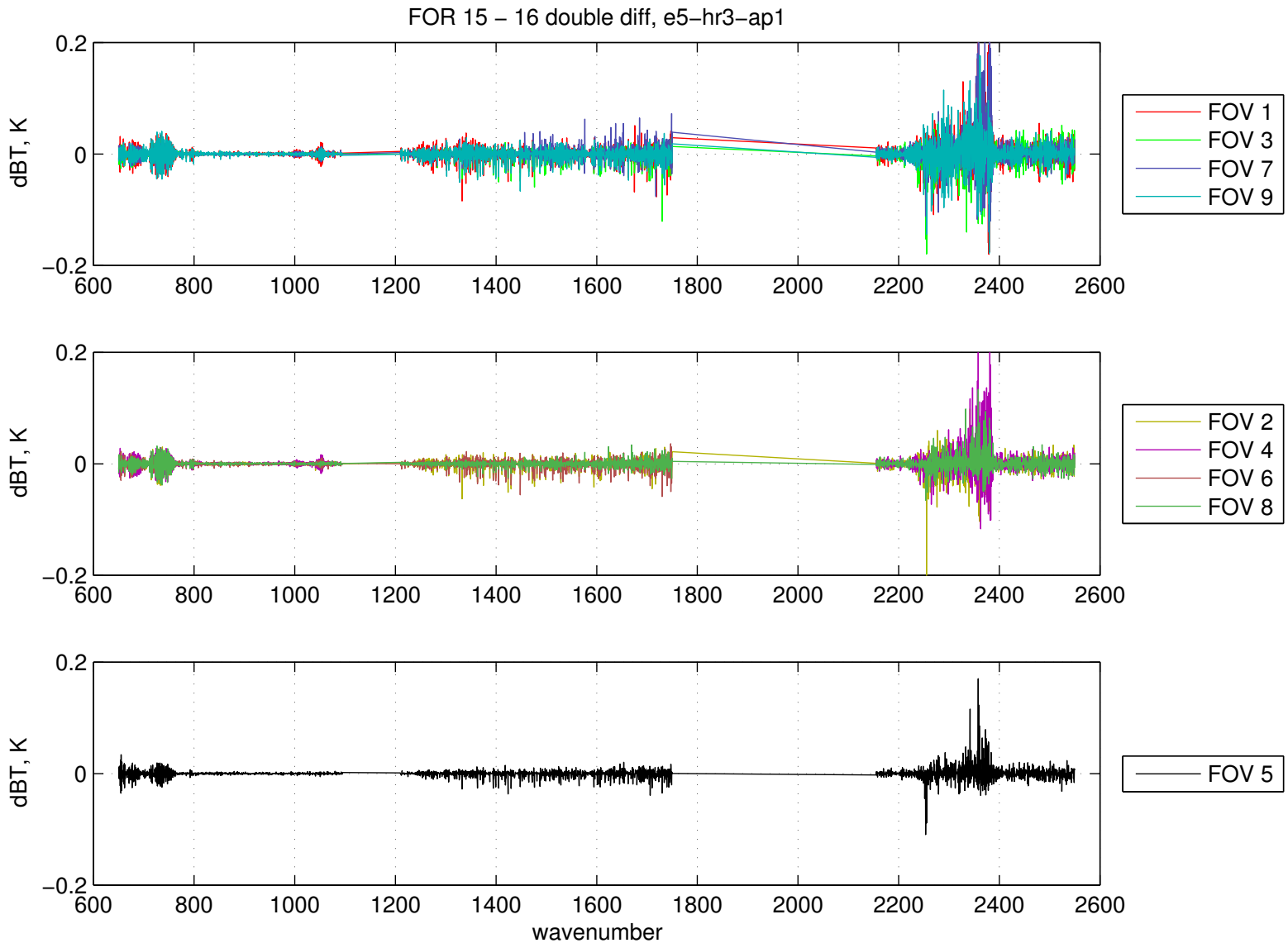
sweep direction differences

- as a proxy for sweep direction differences we compare 3-day means of FOR 15 and 16 for 8-10 Nov 2015
- for comparison purposes we include sweep direction differences for the CCAST and NOAA algorithms from the 17-19 Feb 2015 tests
- the double differences shown here are

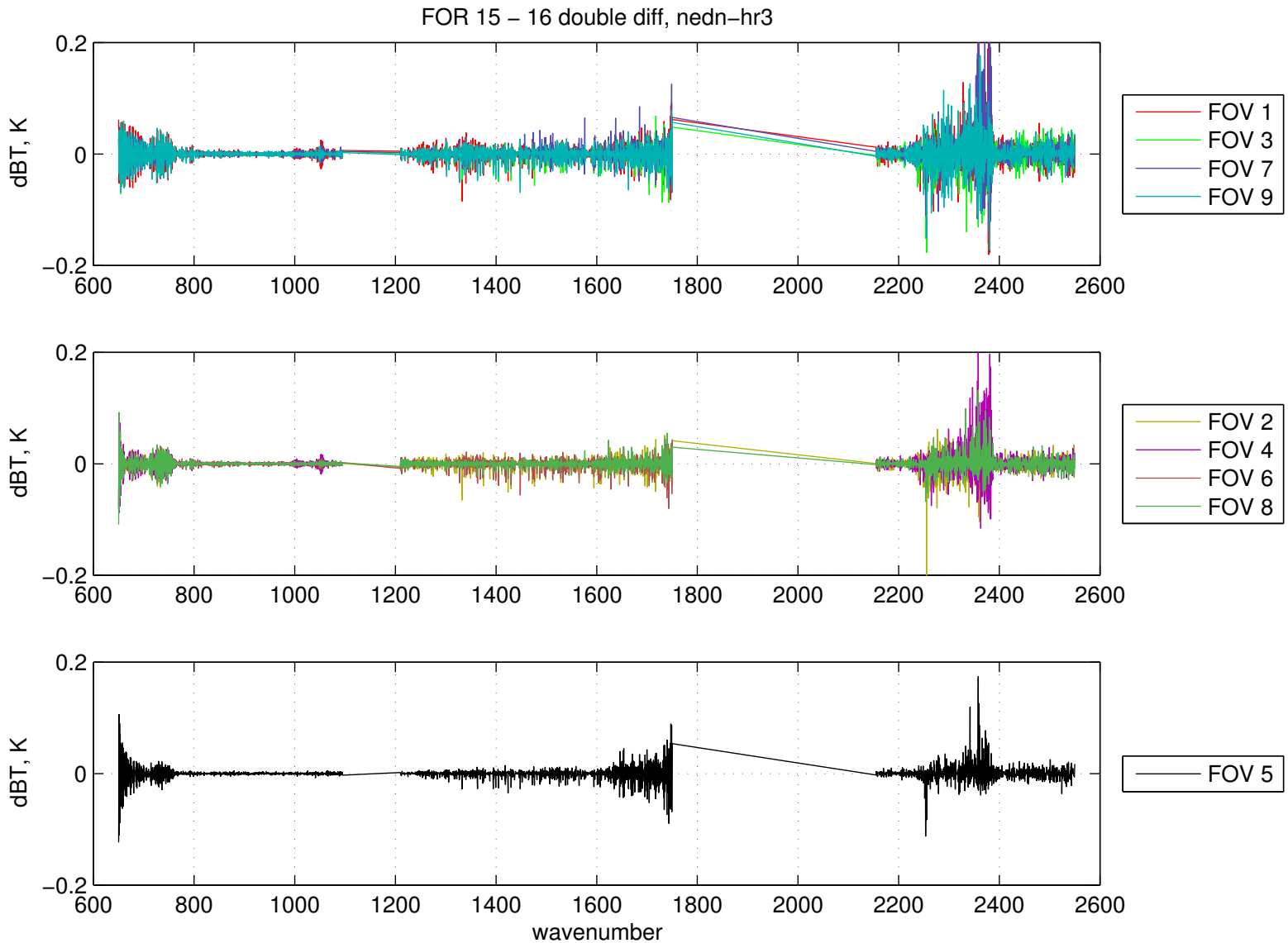
$$(\text{FOR 15} - \text{FOR 16}) - (\text{Hamming FOR 15} - \text{Hamming FOR 16})$$

- the Hamming apodization is applied to radiances before conversion to brightness temperatures, which in turn is done before taking means

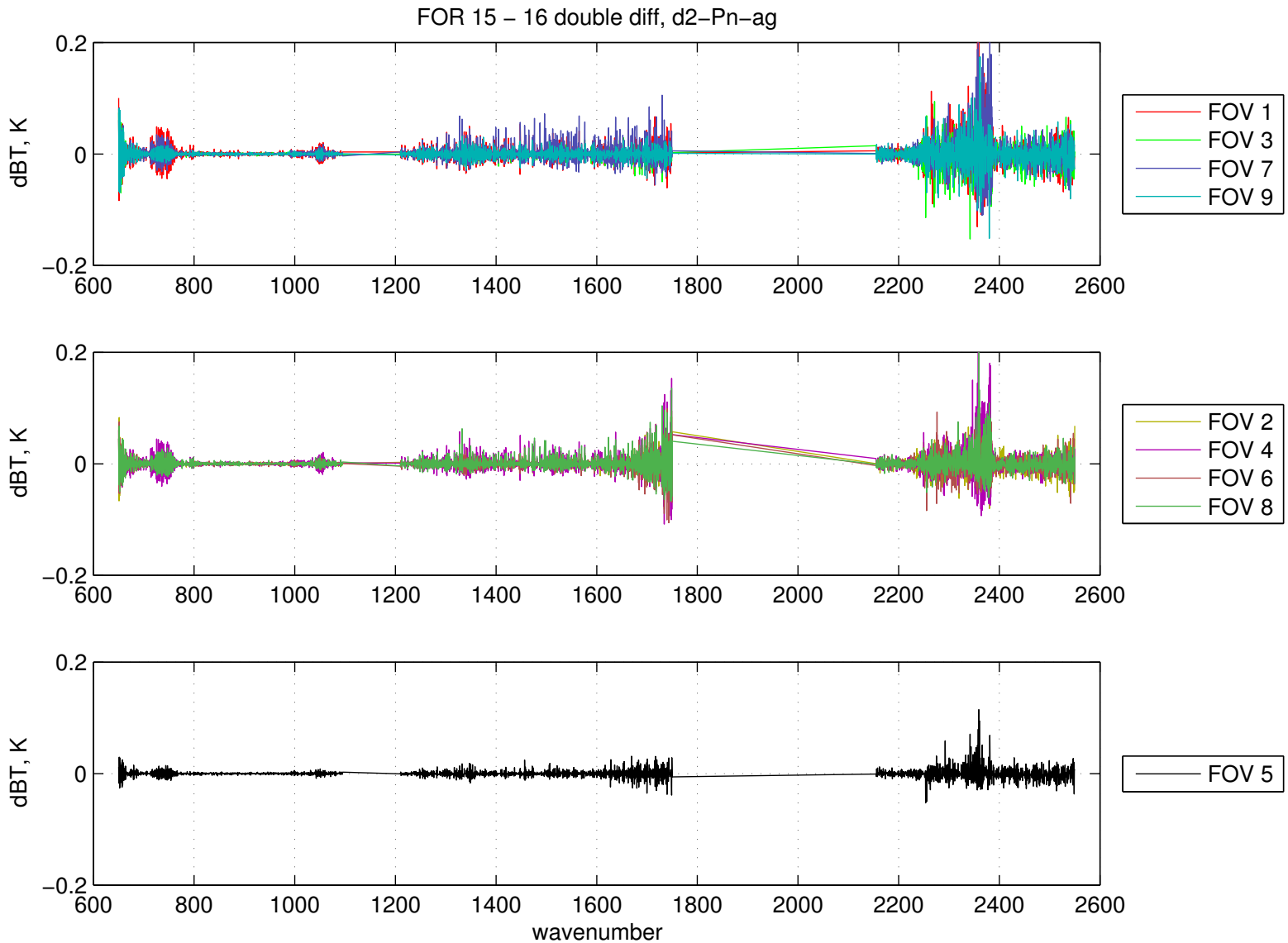
ccast apodized extended resolution



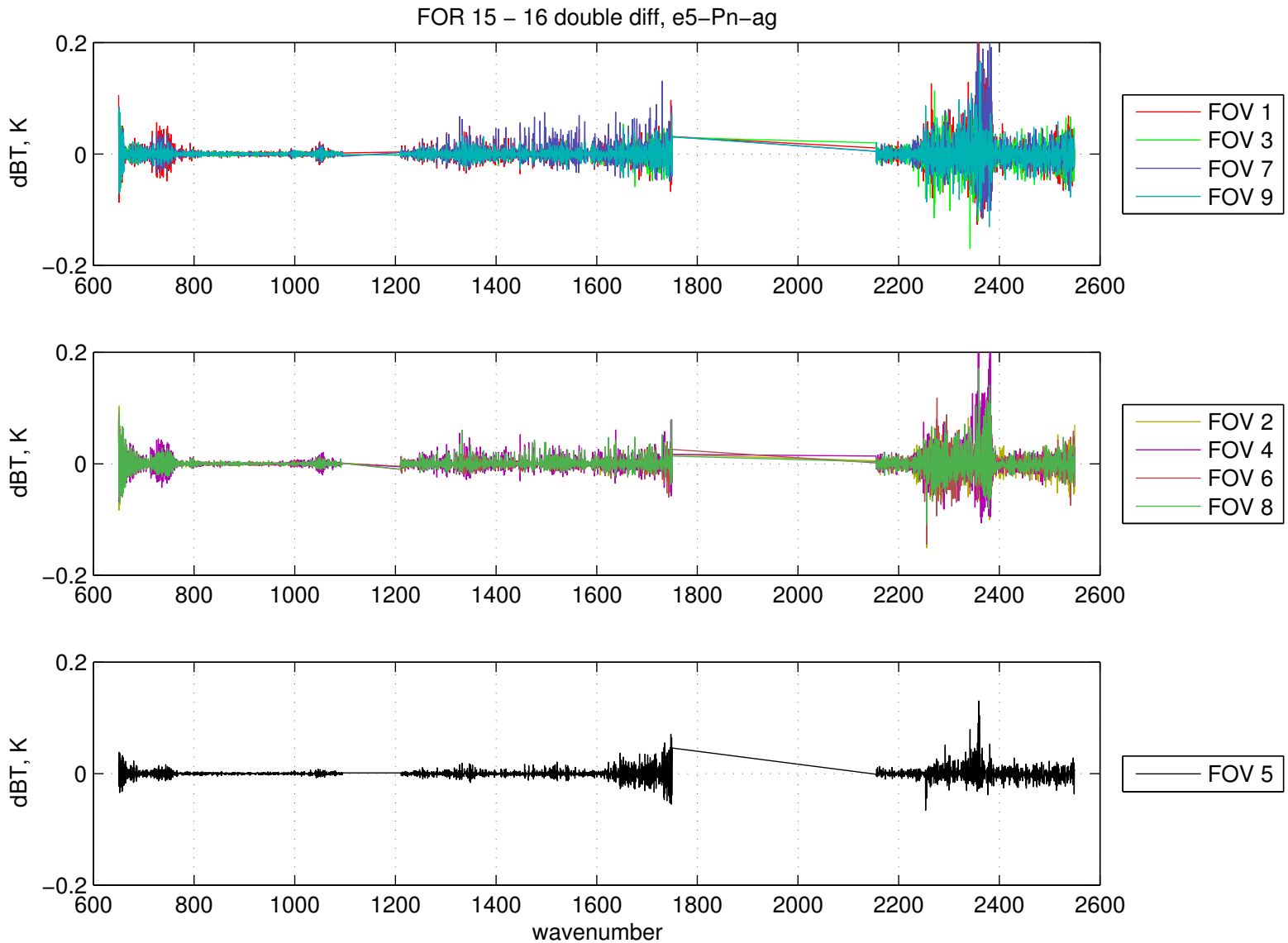
ccast unapodized extended resolution



noaa 17-19 feb 2015 high res tests



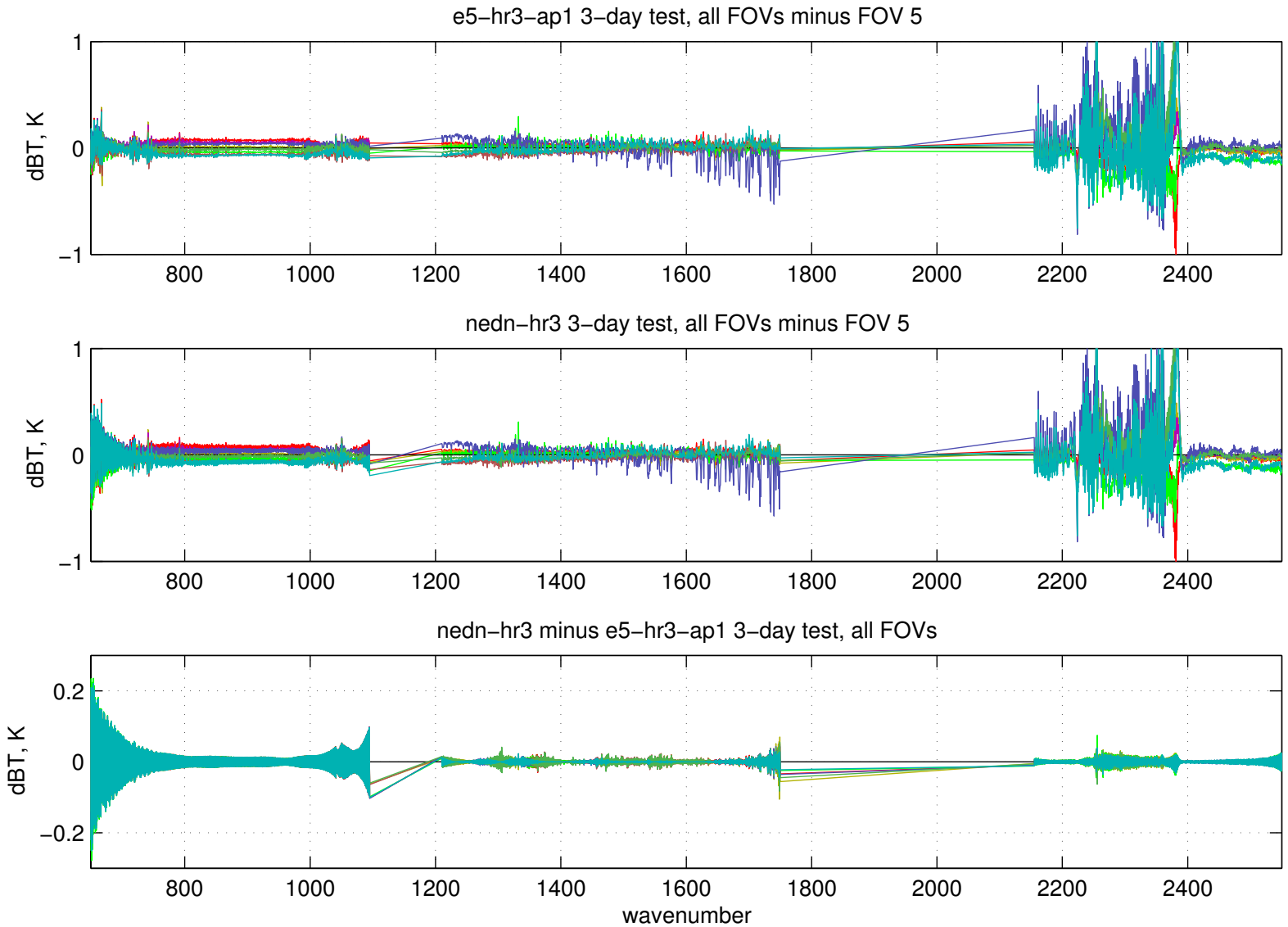
ccast 17-19 feb 2015 high res tests



comments

- sweep direction differences are less with apodized extended resolution with the CCAST reference algorithm, in comparison with both CCAST without apodization and the best NOAA and CCAST results from the Feb 2015 tests
- these results would be more significant if we had included tests of apodized extended resolution using the NOAA reference algorithm. (That should be easy but we forgot to update the point-dependent specs for the NOAA processing filters.)
- the following slide shows FOV 5 relative differences for the CCAST reference algorithm, with and without the extended apodization. The apodization gives a significant improvement in the LW

fov 5 relative differences



conclusions

- applying a cosine apodization at the edges of the new extended interferograms reduces sweep direction and FOV 5 relative residuals, in comparison to processing without such apodization
- further potential improvements such as circular shift should be compared with such an apodization rather than with standard processing
- with the apodization the FOV 7 nonlinearity dominates the FOV 5 relative residuals in the LW and MW
- several variations of the apodization shown here, including a 4-point symmetric function, a 7/6 point asymmetric function, and shifting all transforms to odd $(n-1)$ point sets with the 6 point function all gave similar or slightly worse results