CrIS Nonlinearity Comparisons

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overview

Small nonlinearities in the CrIS detector response can be corrected in ground-segment processing. We

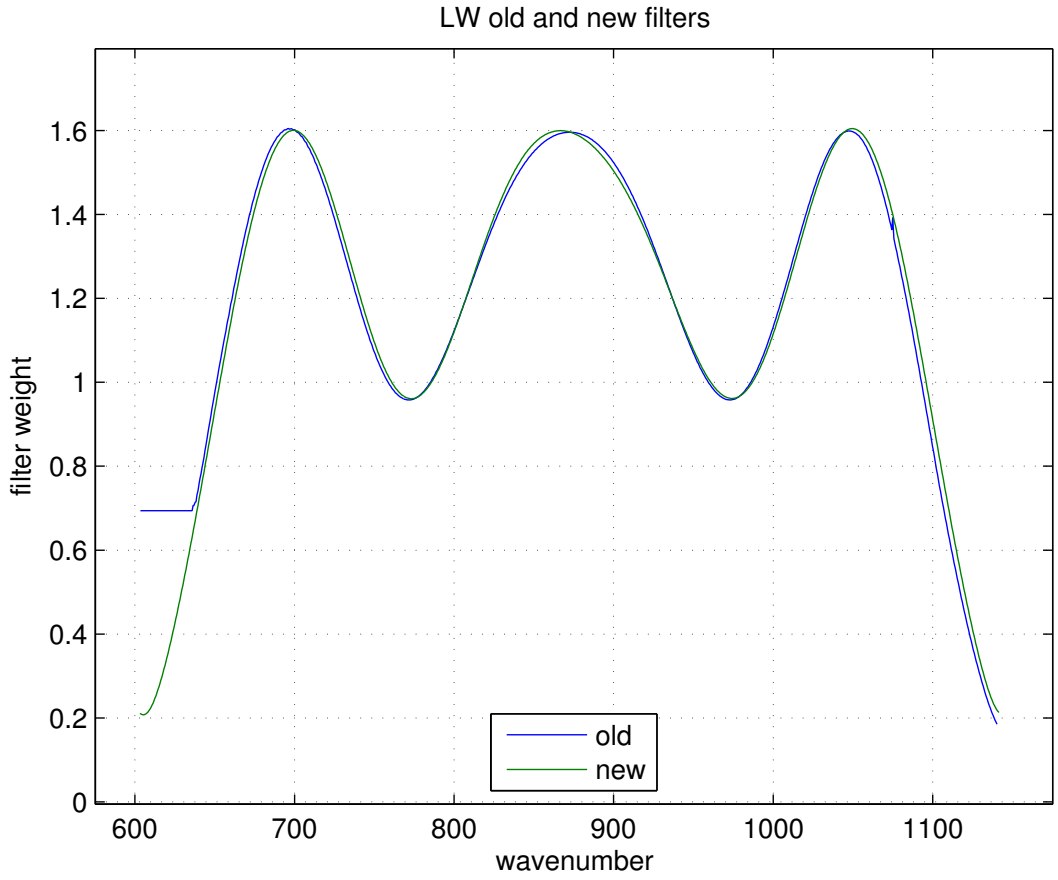
- briefly describe the CCAST nonlinearity correction
- describe our tests for variation of FOV response
- compare CCAST and IDPS FOV response
- look at the effect of adjusting the a_2 weights
- test the nonlinearity correction in high res mode

Our initial motivation for looking into this was to get the nonlinearity correction working for the CrIS high res mode

ccast nonlinearity

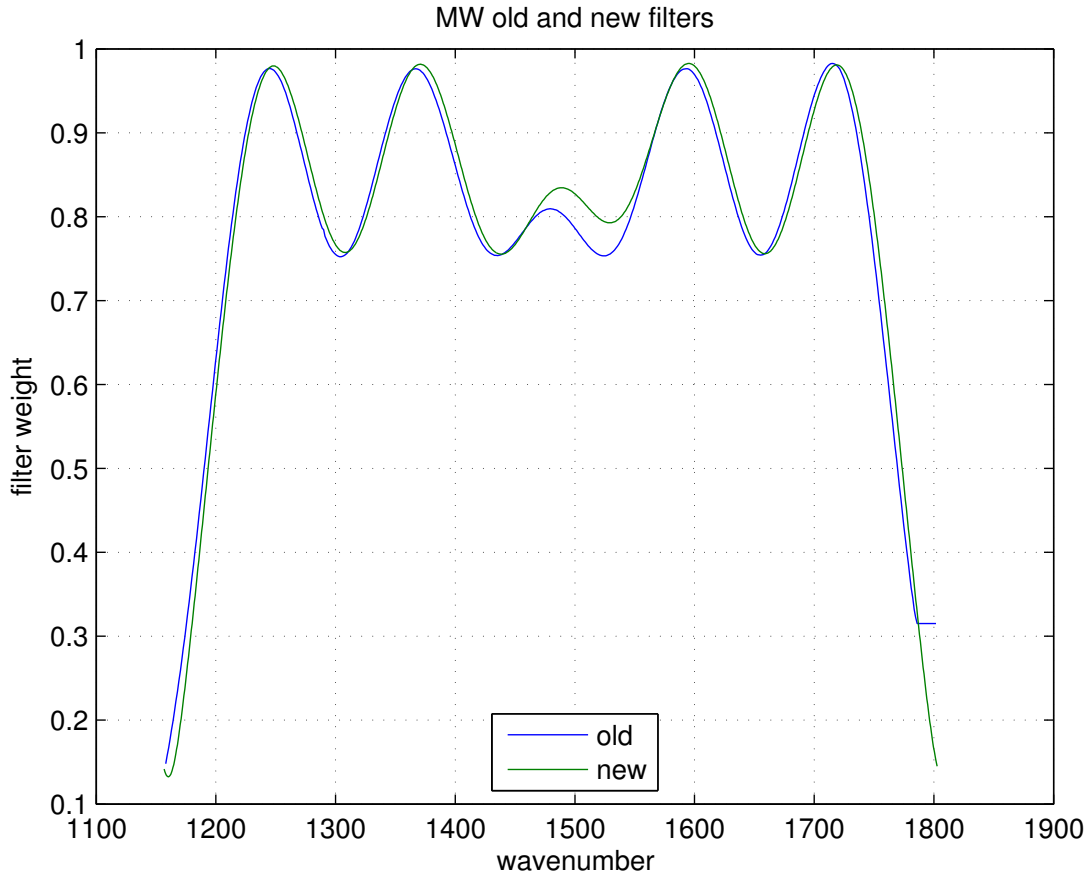
- the ccast nonlinearity correction follows the CrIS ATBD with the UW form of the correction factor, $1 + 2a_2 V_{DC}$
- count spectra are divided by the numeric filter at the sensor grid, in the DC level integral
- the numeric filter is taken from time-domain weights, and the frequency domain representation needs to be normalized to match the filters used for the original a_2 fitting
- our initial problems with the new filters were resolved with this normalization
- the time-domain representation of the filter allows the same code to work for both regular and high resolution modes

LW numeric filter



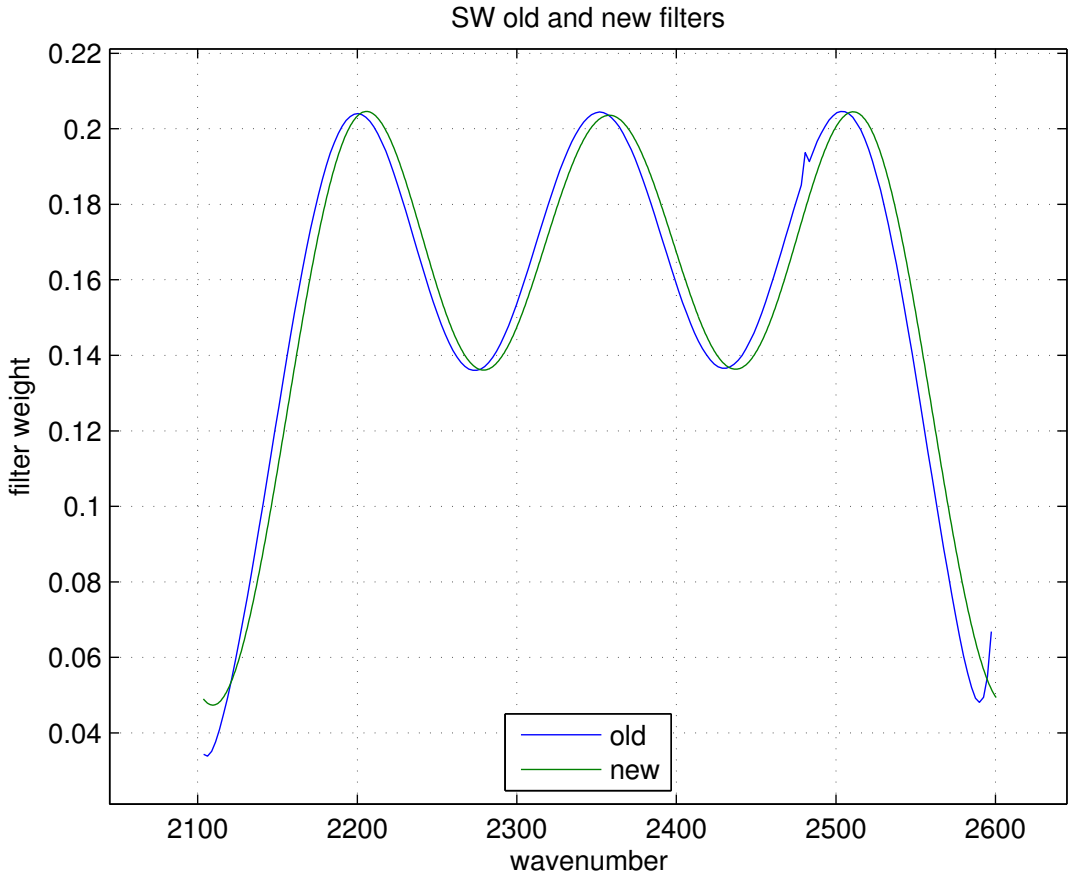
The old (c. 2008) and latest LW numeric filters, with the new filter normalized to match the old

MW numeric filter



The old and latest MW numeric filters, with the new filter normalized to match the old

SW numeric filter



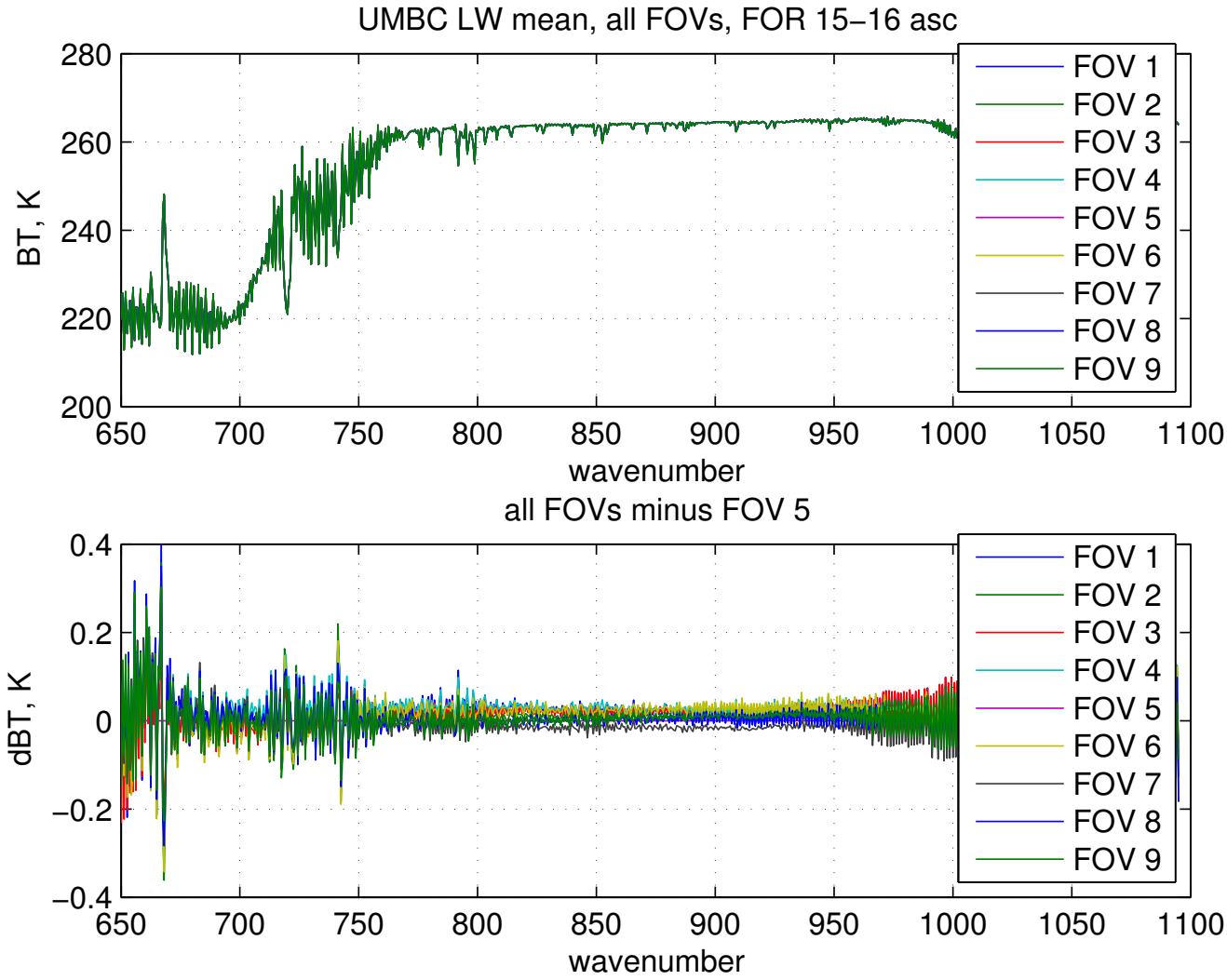
The old and latest SW numeric filters, with the new filter normalized to match the old

test design

- take the average of each FOV over the sample period for FOR 15 and 16 ascending, and compare these with the average for FOV 5
- to the extent that different FOV views dissappear in the averages, this can reveal differences in detector response
- the averages are over approximately 10,000 obs per day
- we look at sample periods 1-3 Mar 2014, 5-18 Mar 2014, and the 27-28 Aug 2013 high resolution test
- for some tests the ccast processing was rerun with modified a_2 values

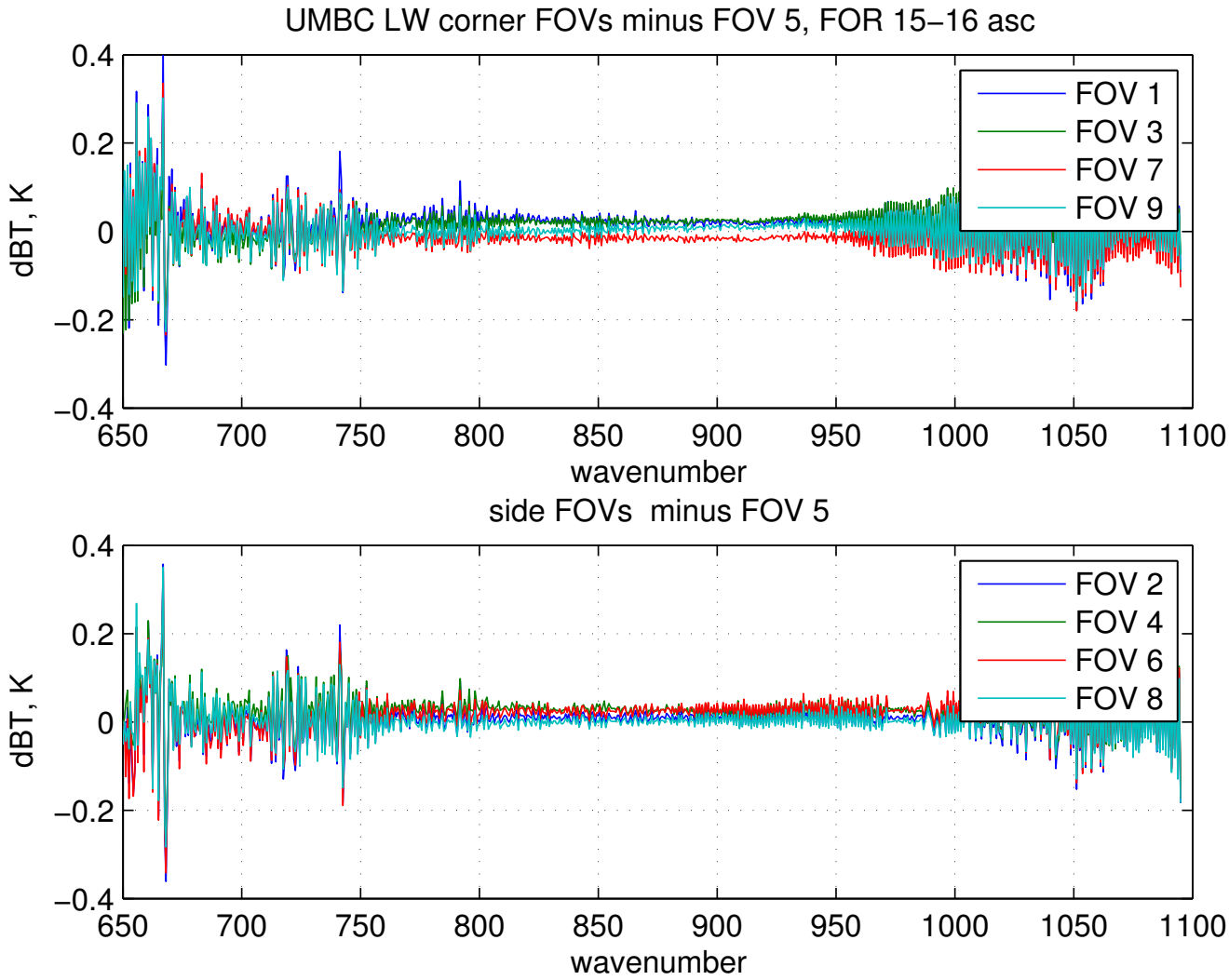
These initial tests are comparisons with FOV 5 rather than the most linear FOV to help sort out geometric or other variations in FOV response from nonlinearity.

ccast LW 2-week test



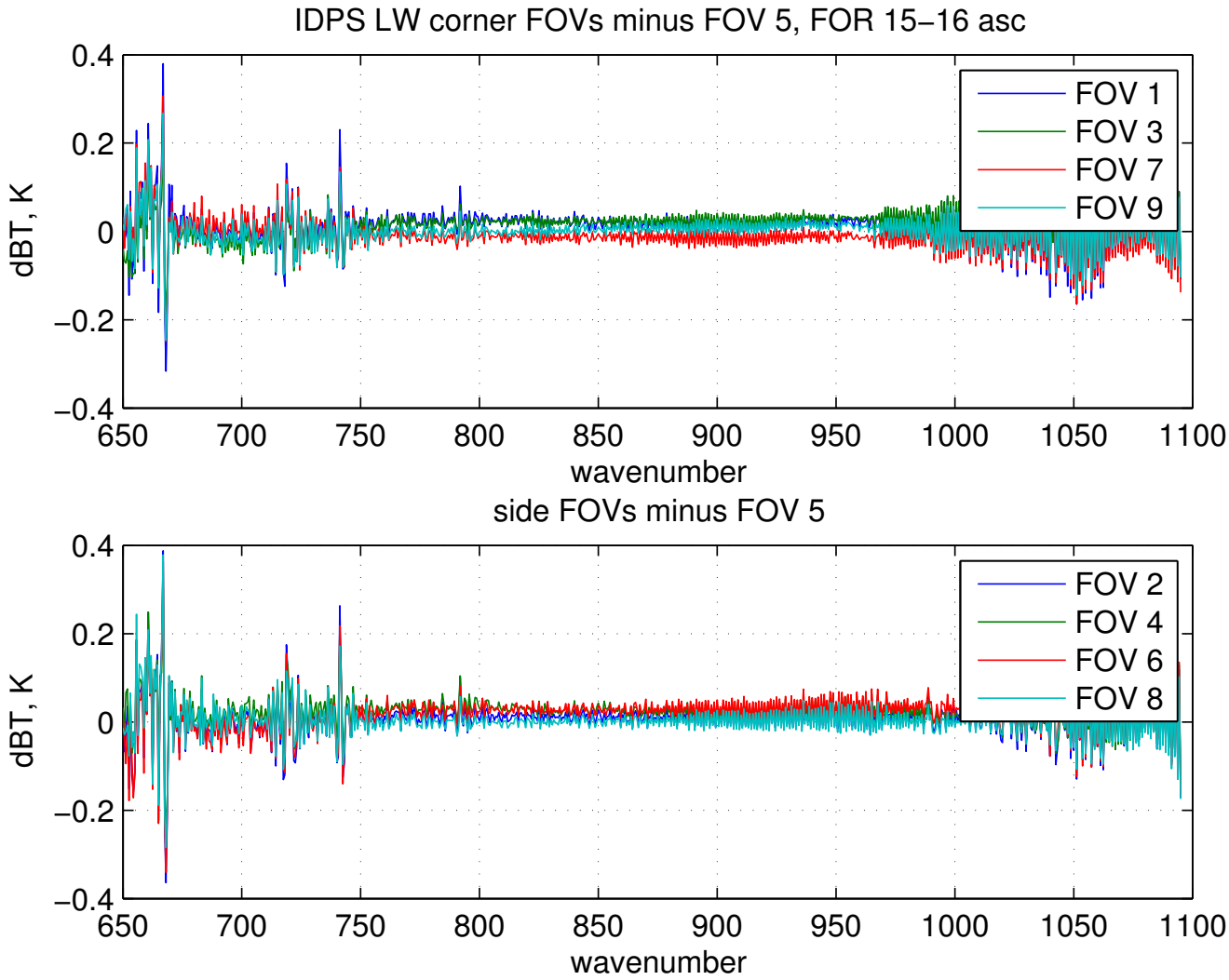
CCAST LW mean for all FOVs, and for all FOVs minus FOV 5

ccast LW 2-week test



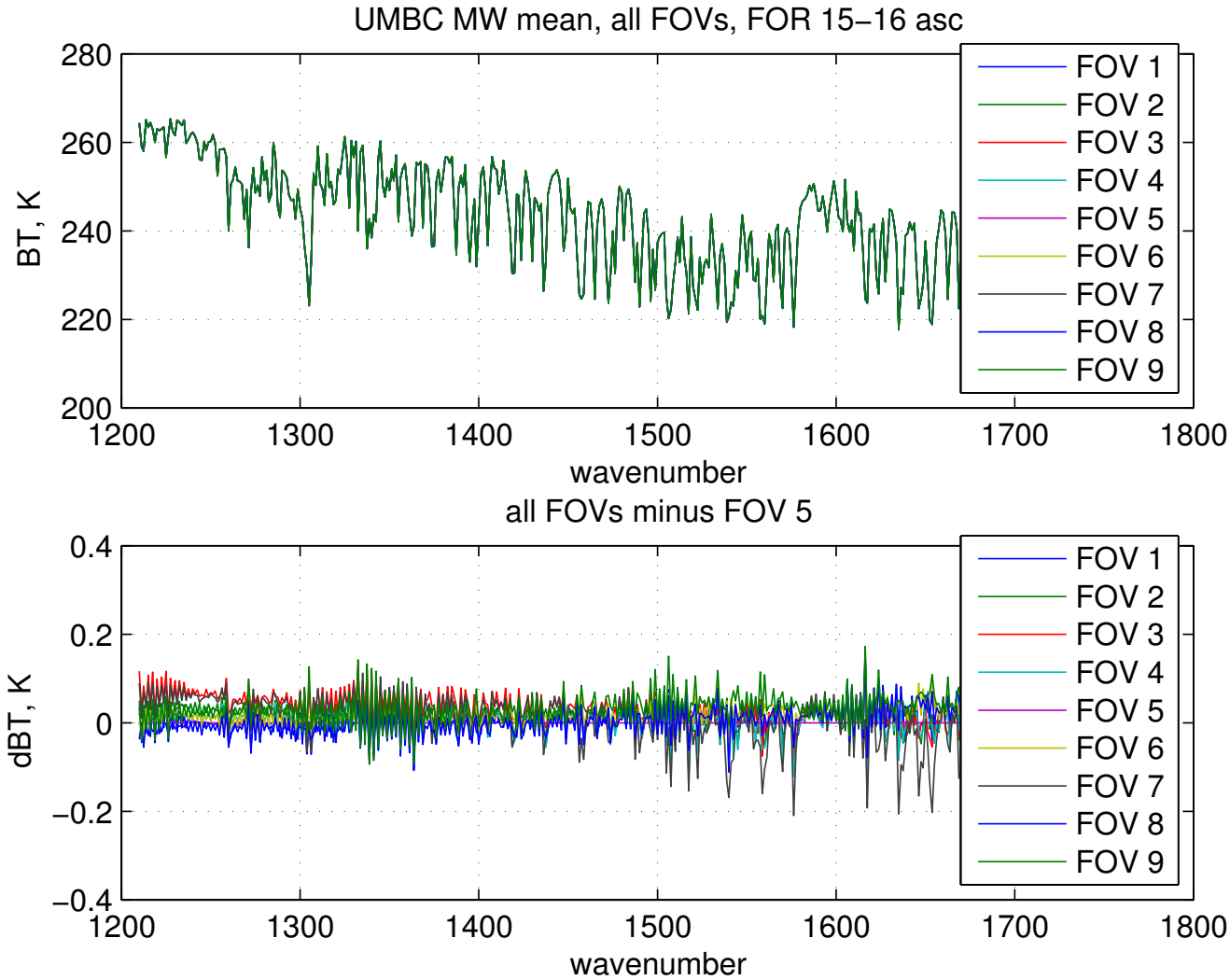
CCAST LW corner and side FOVs broken out separately

IDPS LW 2-week test



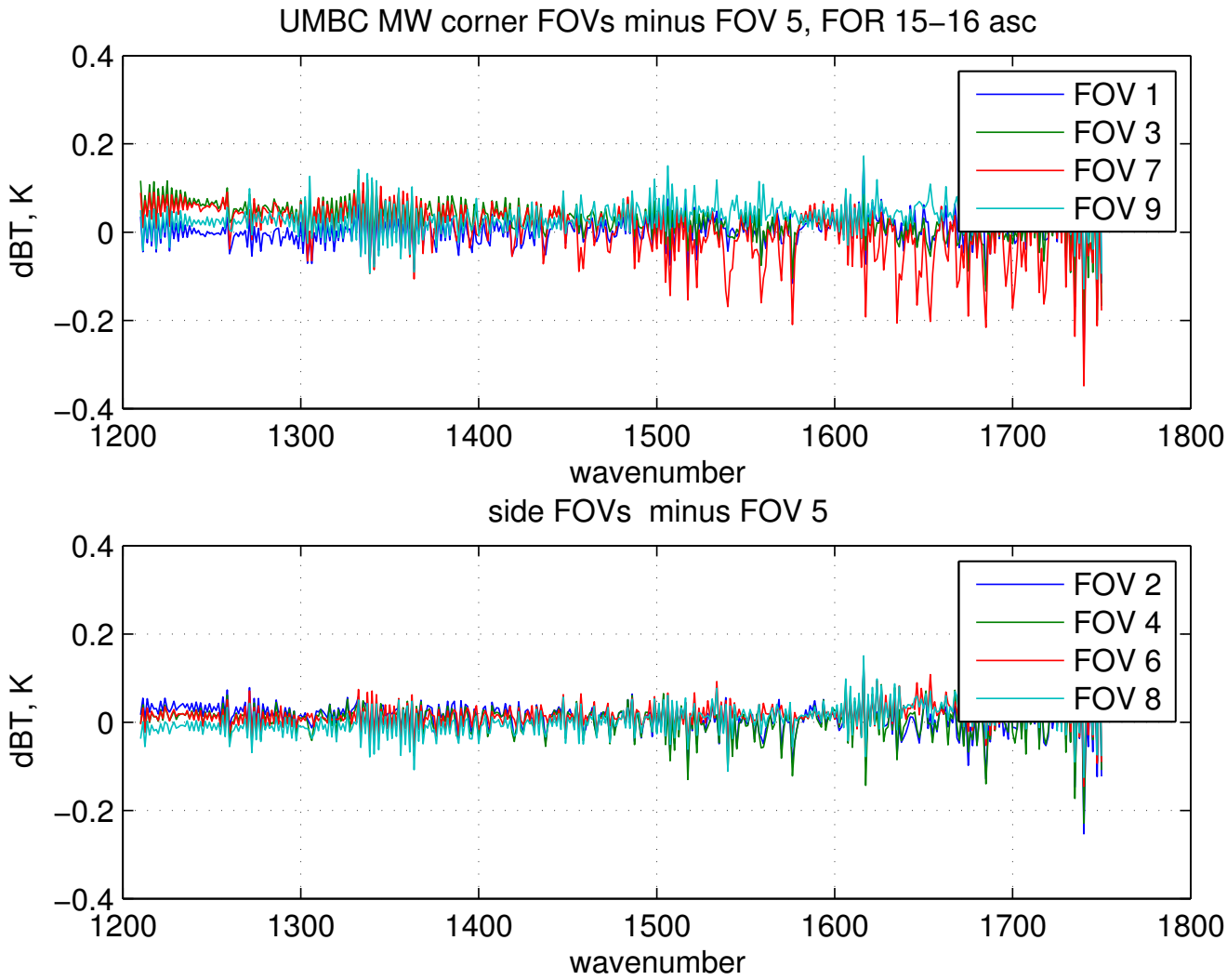
IDPS LW corner and side FOVs broken out separately

ccast MW 2-week test



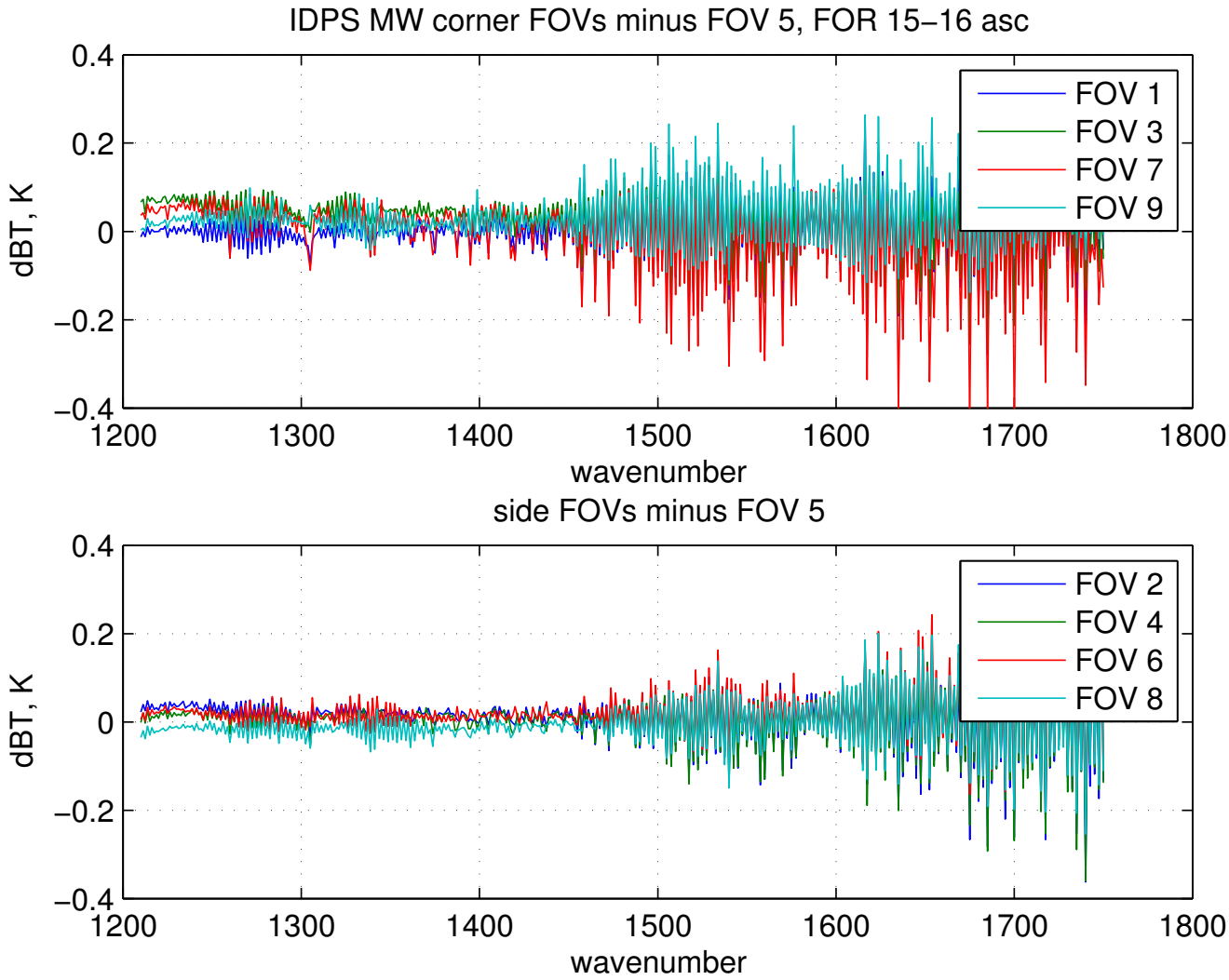
CCAST MW mean for all FOVs, and for all FOVs minus FOV 5

ccast MW 2-week test



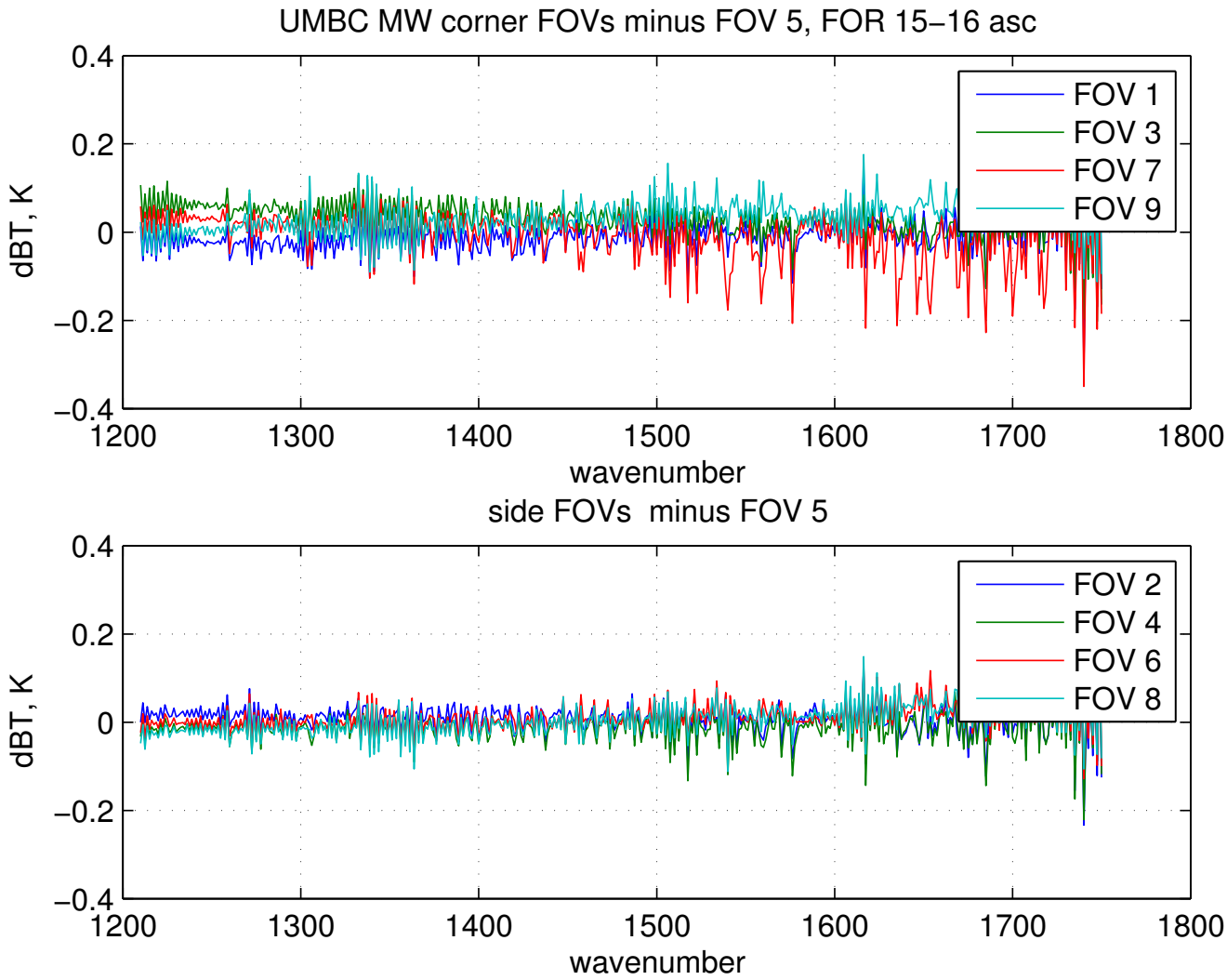
CCAST MW corner and side FOVs broken out separately

IDPS MW 2-week test



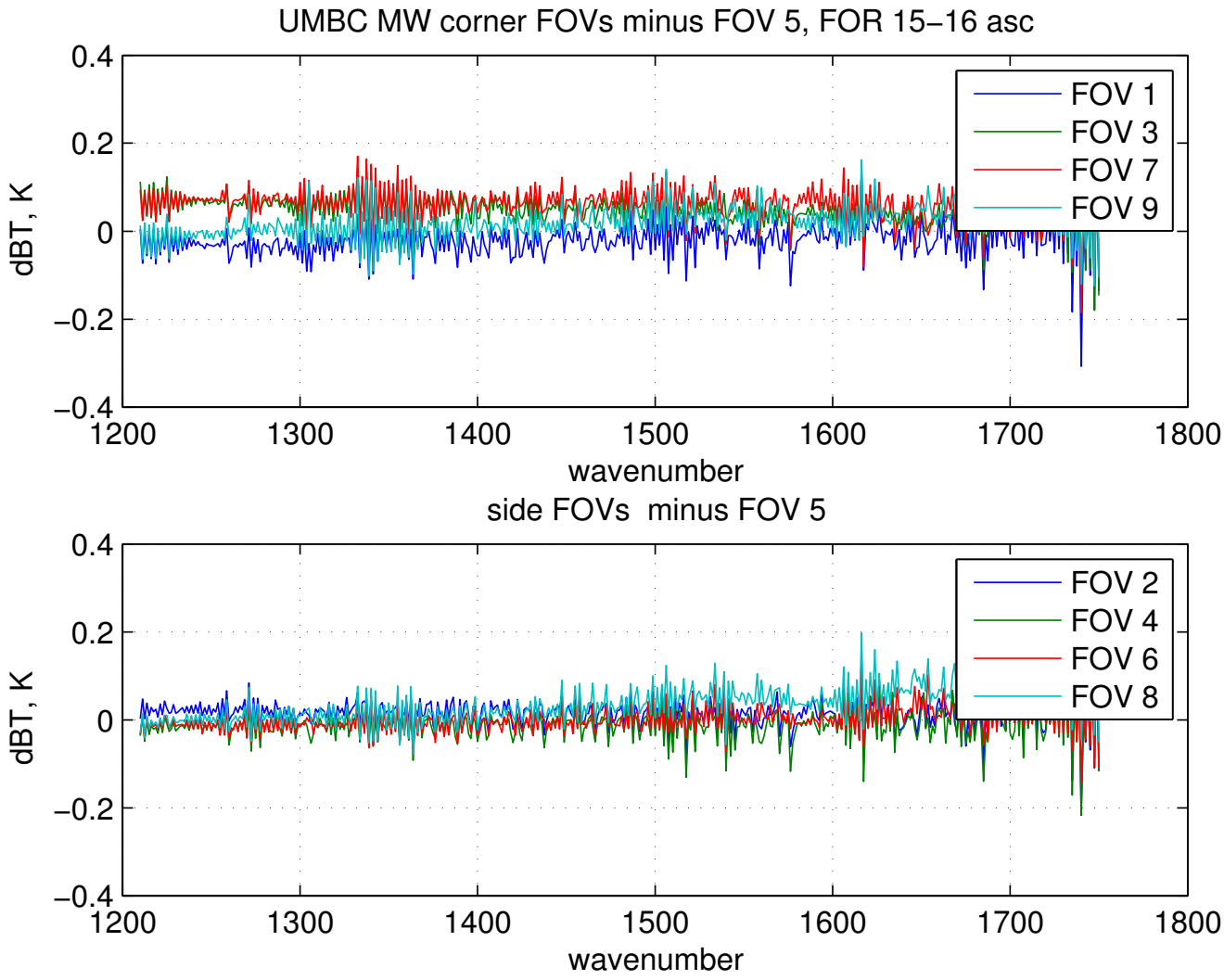
IDPS LW corner and side FOVs broken out separately

ccast MW 3-day a_2 test



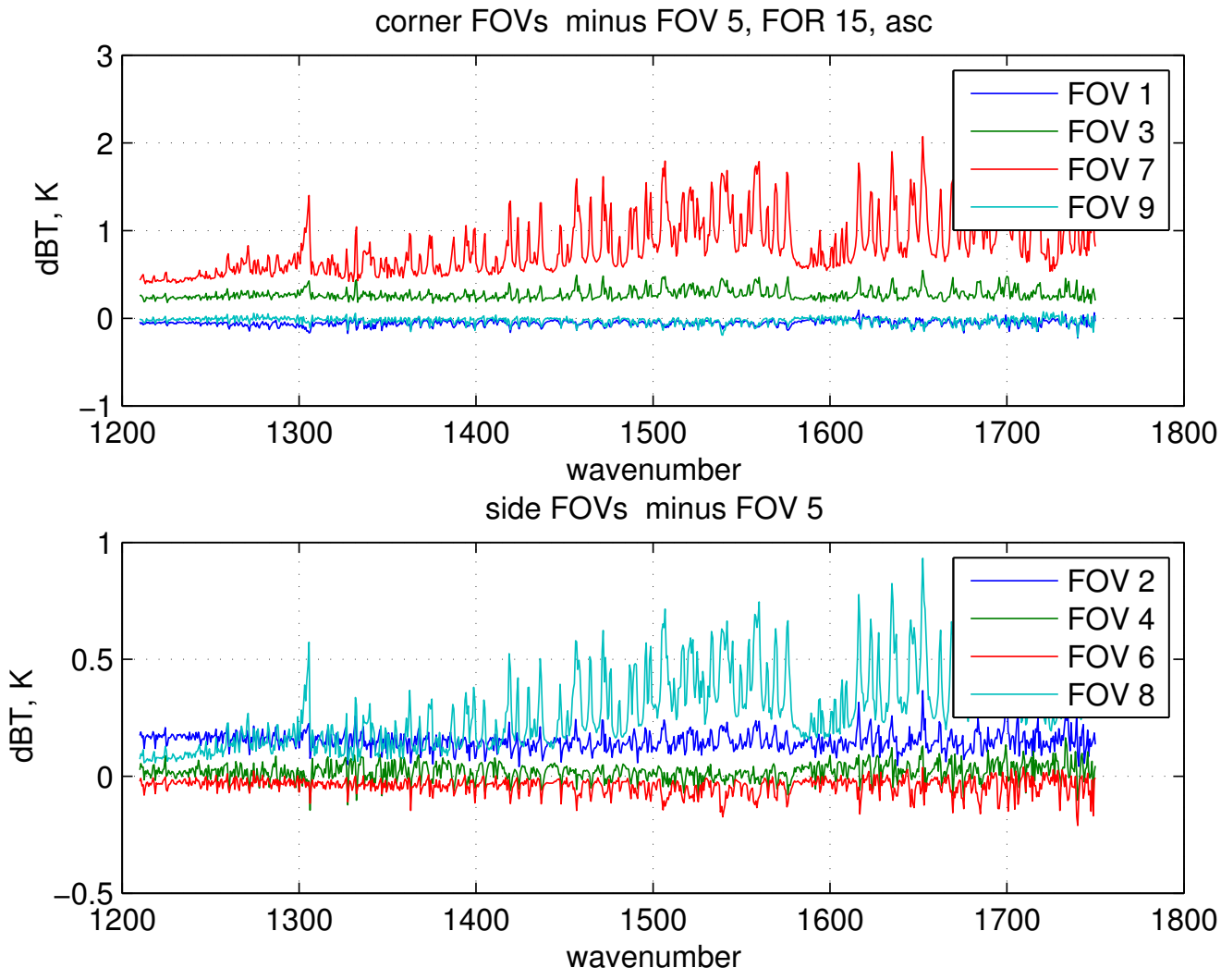
CCAST MW 3-day test with regular a_2 weights

ccast MW 3-day a_2 test



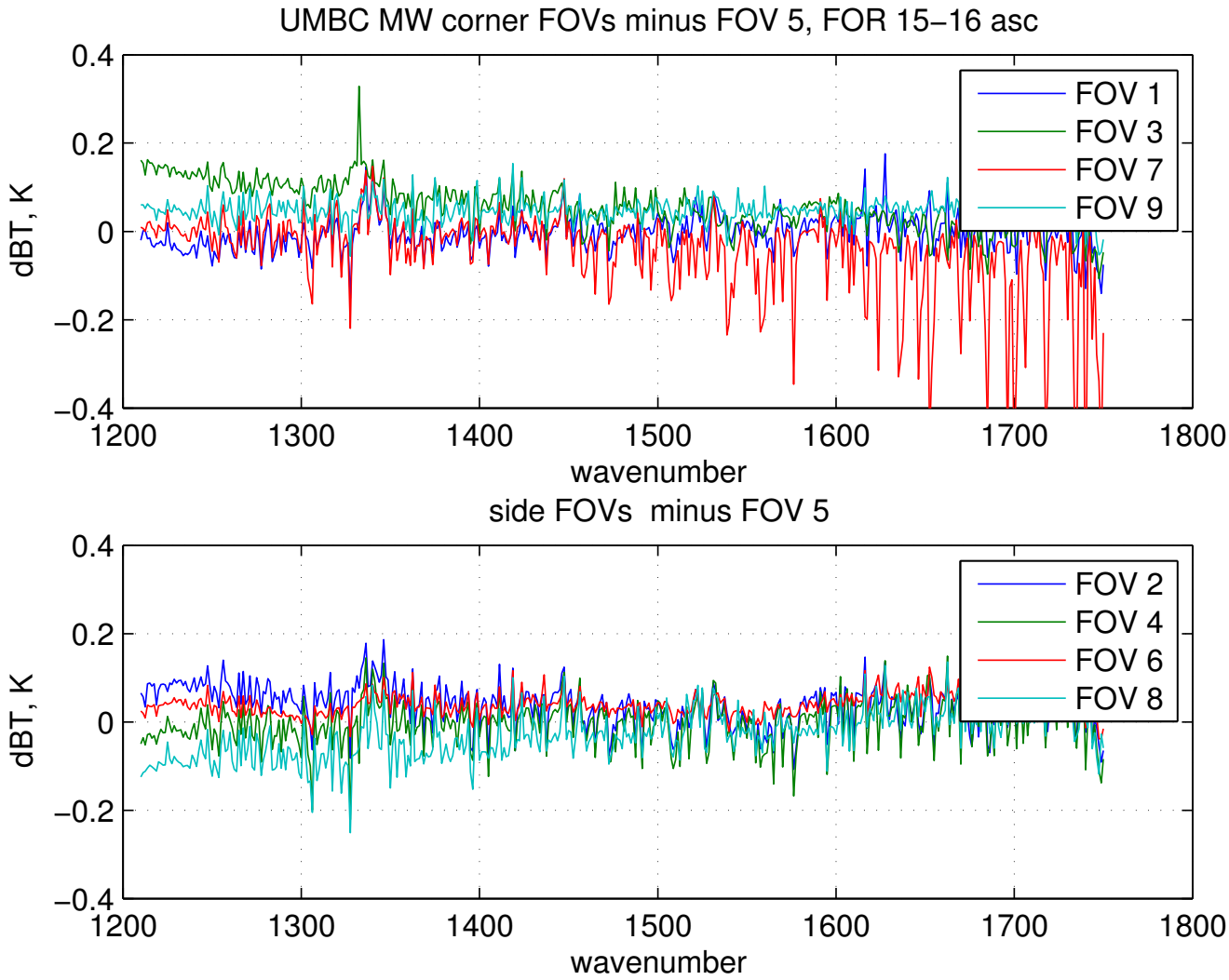
CCAST MW test with $0.9 \cdot a_2$ weights. FOVs 7 and 9 are improved, especially FOV 7, while FOV 8 is a little worse

ccast high res test



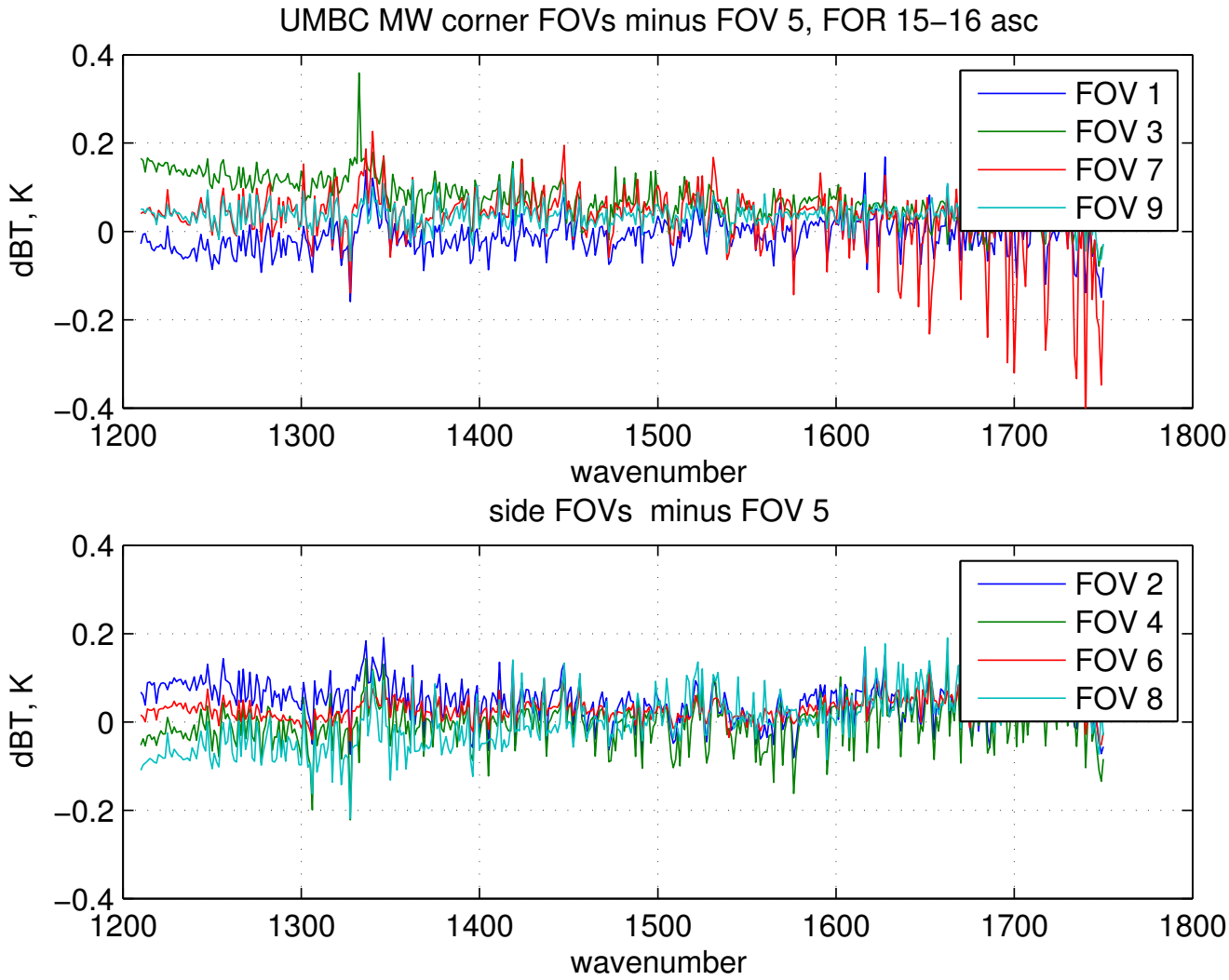
CCAST 27-28 Aug 2013 high res test with no nonlinearity correction. FOVs 7 and 8 are significantly out of group.

ccast high res test



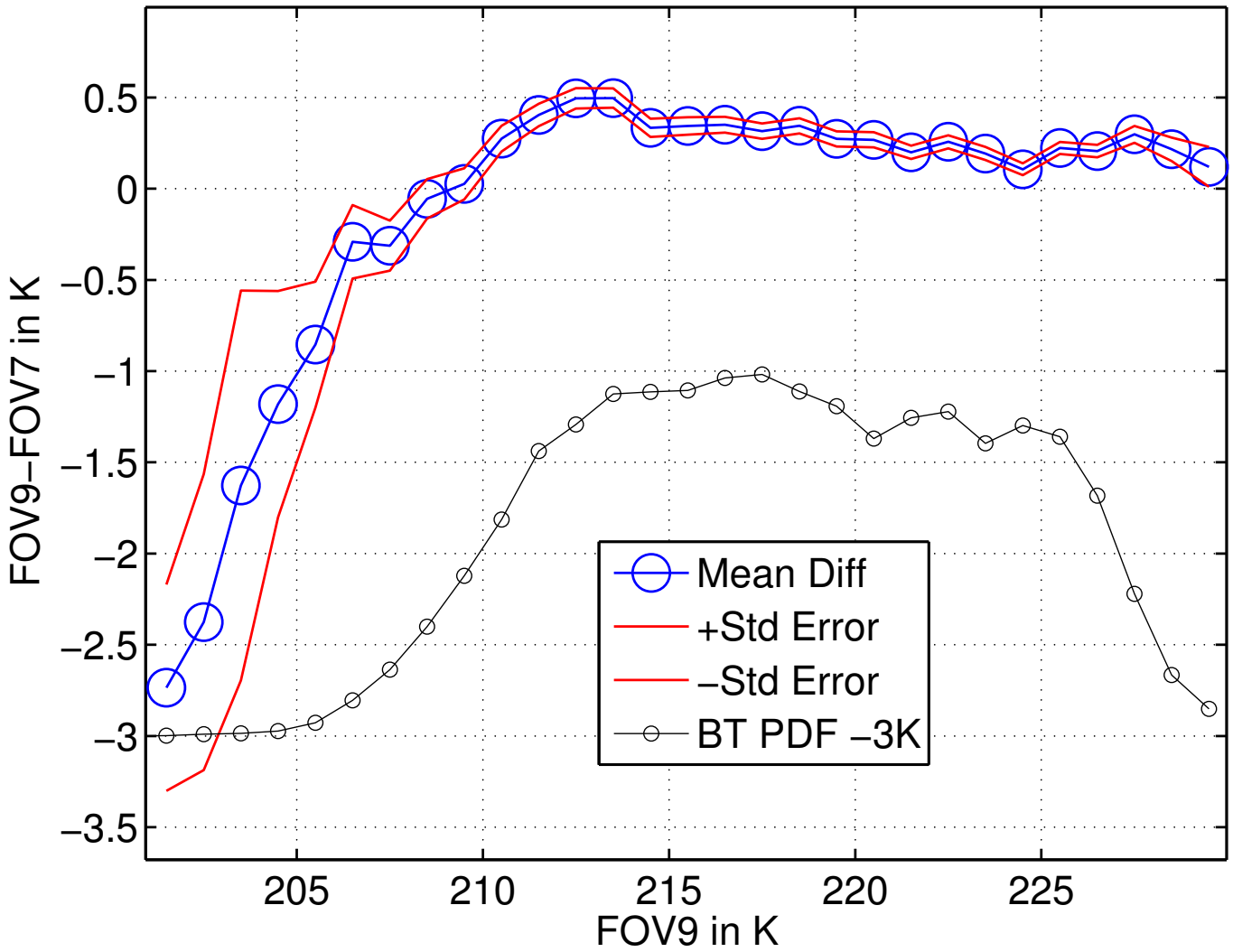
CCAST 27-28 Aug 2013 high res test with regular a_2 weights

ccast high res test



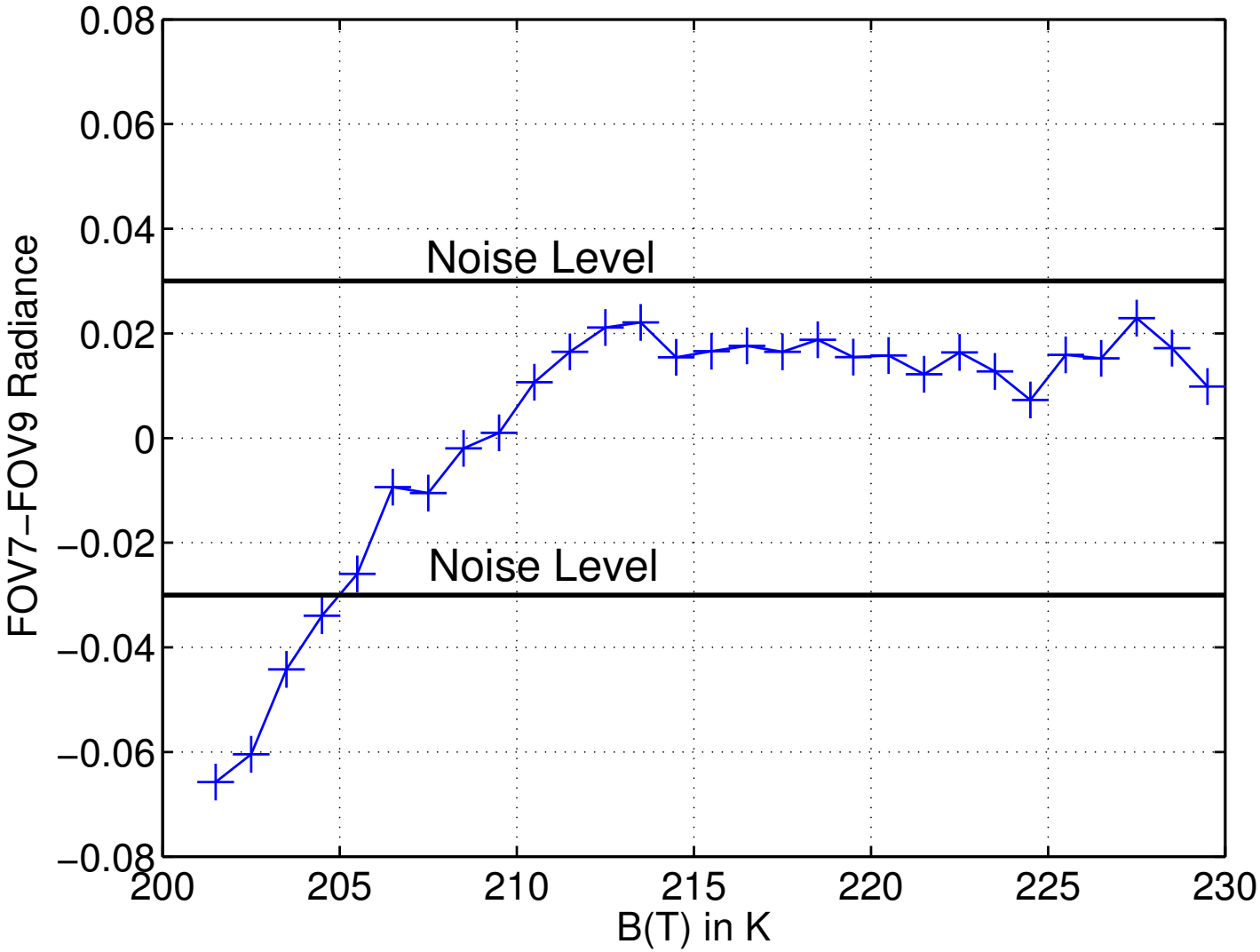
CCAST 27-28 Aug 2013 high res test with $0.9 \cdot a_2$ weights

1635 cm^{-1} cold diffs



1635 cm^{-1} cold FOV 9 minus FOV 7 brightness temp diffs

1635 cm^{-1} cold diffs



1635 cm^{-1} cold FOV 7 minus FOV 9 radiance diffs

conclusions

- all tests were done without any added apodization
- our test for variation of FOV response, averaging and then comparing individual FOVs over relatively long time spans, seems to be valid
- these initial tests are comparisons with FOV 5 rather than the most linear FOV to help sort out geometric or other variations in FOV response from nonlinearity
- MW FOVs 7 and 9 may need adjustment of the a_2 weights
- the large difference for MW FOV 7 may be due to problems with cold scenes, or may require a second-order correction term
- the ccast nonlinearity correction works in high res mode