CrIS a2 adjustments from extended resolution data

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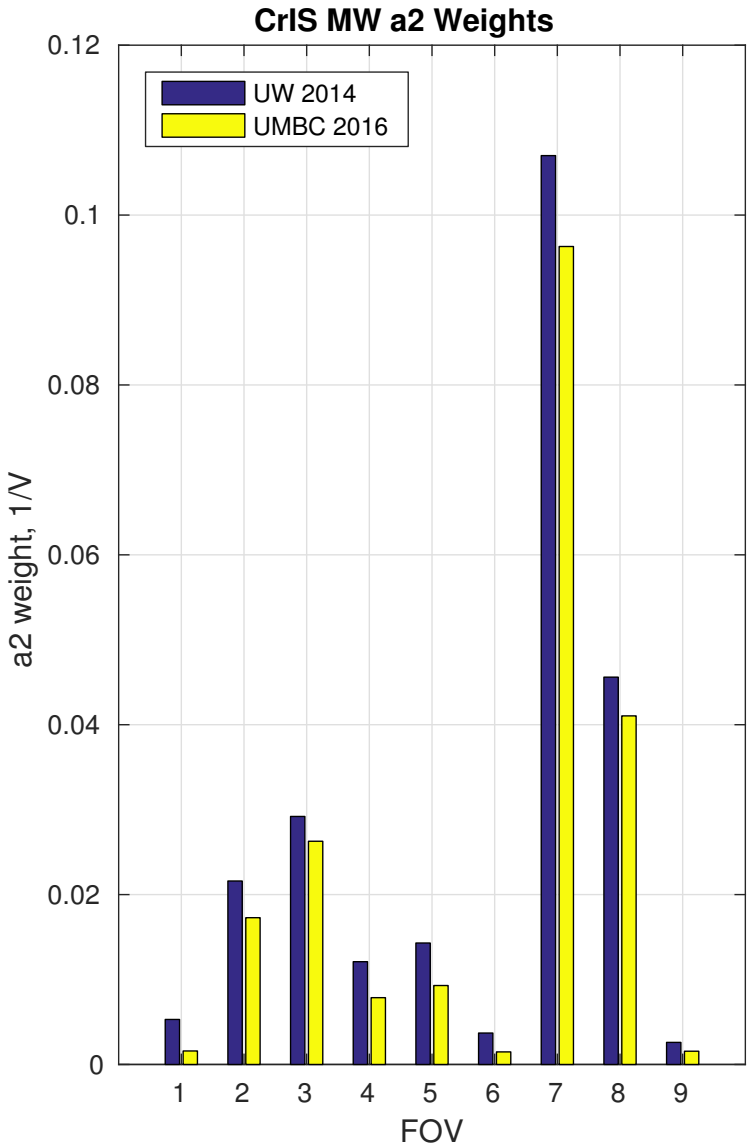
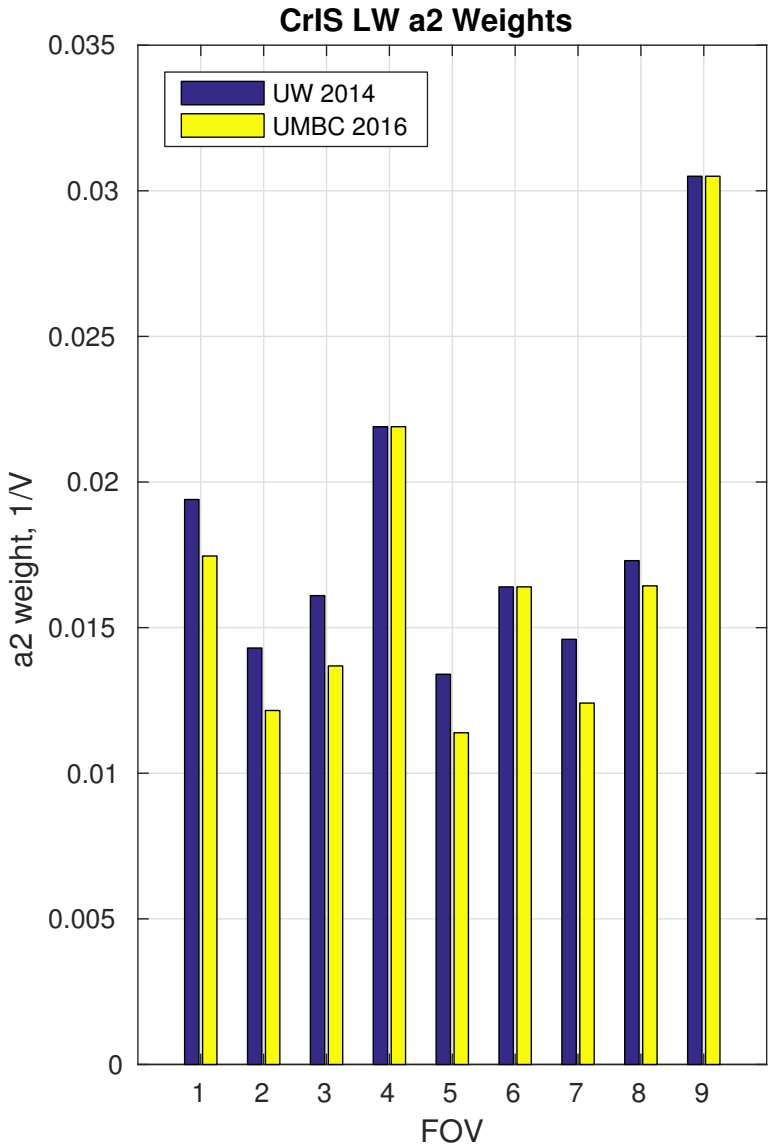
introduction

- detector response for the CrIS LW and MW bands has significant FOV-dependent nonlinearity
- the resulting variation is considerably reduced by the UW nonlinearity correction algorithm and associated “a2” parameters
- however in validation tests and calibration algorithm comparisons MW FOV 7 nonlinearity dominates other residuals
- adjustments to the UW 2014 a2 values are proposed based on extended resolution observations over a three day test period, 4–6 Dec 2015

MW and LW a2 values





UW 2014 current and UMBC 2016 proposed a2 values

methods

- calibrated radiances are from the UMBC CCAST reference algorithm, with cosine apodization of extended interferograms, periodic sinc wrapping at the sensor grid, and double Fourier interpolation to the high res user grid
- tests are done with FOR 15 and 16 averaged over 4–6 Dec 2015
- the fitting intervals are 660 to 1060 cm^{-1} for the LW and 1250 to 1700 cm^{-1} for the MW
- UW used smaller intervals, 672 to 682 cm^{-1} for LW and 1585 to 1600 cm^{-1} for MW, and averaged low res data over four days

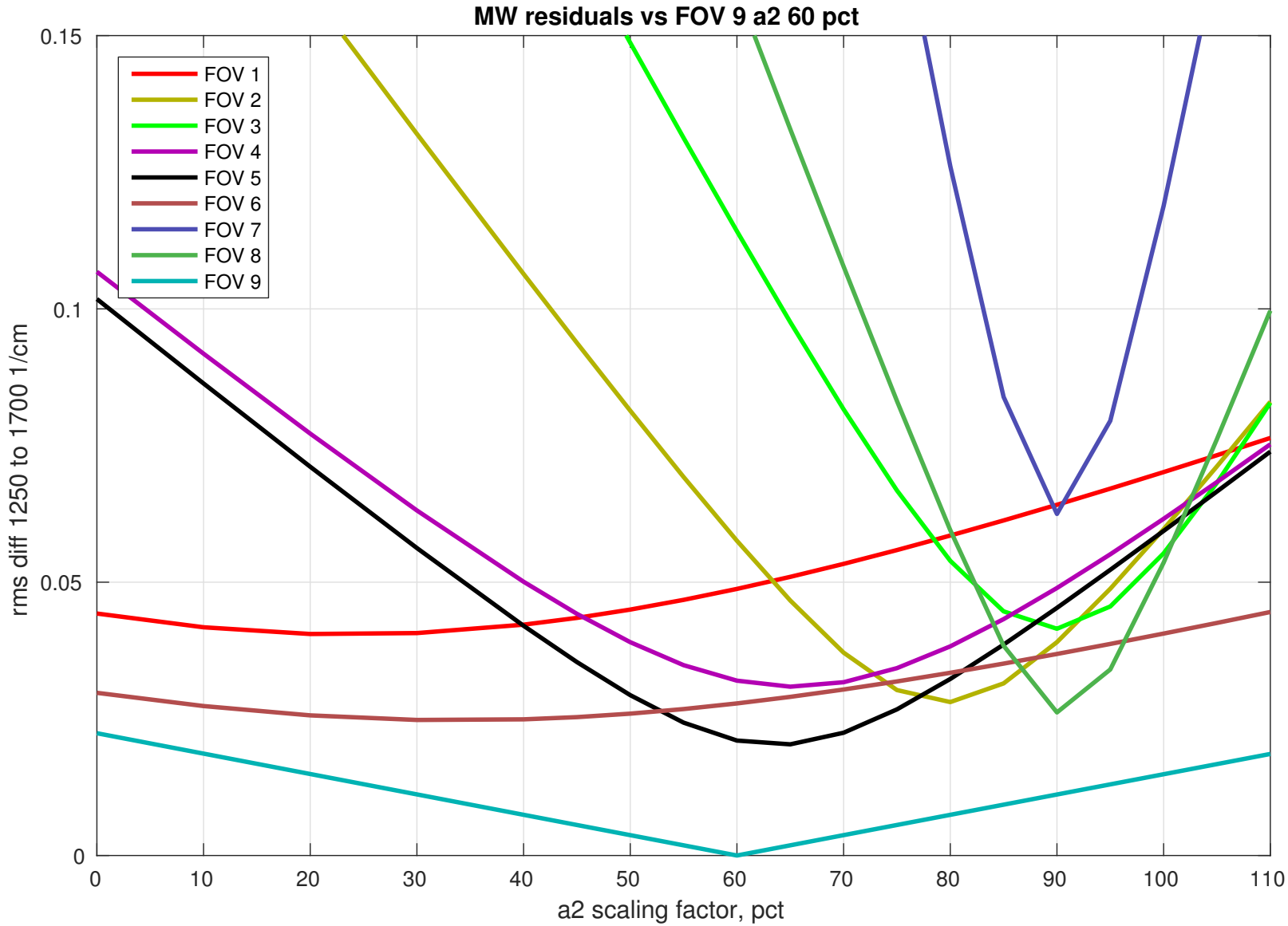
methods

- the a2 values shown here are expressed as percentages (scaling factors) of the 2014 UW a2 values.
- brightness temperature averages are taken for separate ccast runs with a2 scaling factors ranging from 0 to 1.2 in steps of 0.05.
- these are used to build a 3-D table of mean brightness temp spectra by FOV by a2 scaling factor
- residuals are the RMS average of the difference of brightness temperature spectra over the fitting intervals
- for a particular FOV, a2 value, and fitting interval we can then find a2 values to minimize the residual over the fitting interval for all other FOVs

a2 fitting algorithm

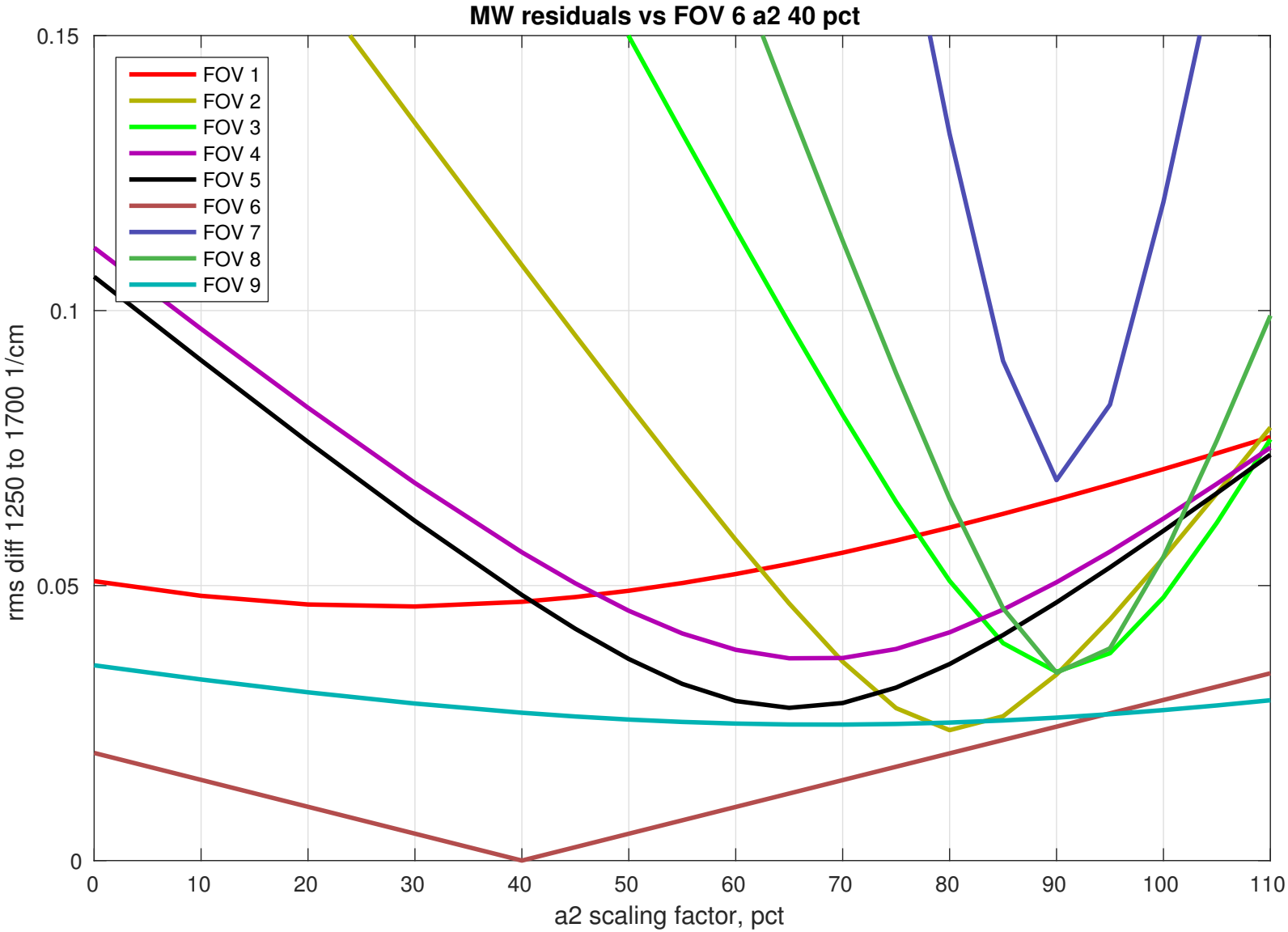
- select the two most linear FOVs, and for each choose an a2 scaling factor to minimize the sum of all residuals. For the MW this gives a scaling factor of 0.6 for FOV 9 and 0.4 for FOV 6
- get the a2 scaling factors for the remaining FOVs at the minima of residuals as a function of a2 factors
- check that the a2 factors we get from the two most linear FOVs agree
- check spectral differences of the most and least linear FOVs to verify that the a2 selections look sensible
- the following slides show these steps for the CrIS MW band, after first finding a2 scaling factors for FOVs 9 and 6 as noted above

MW FOV 9 residuals



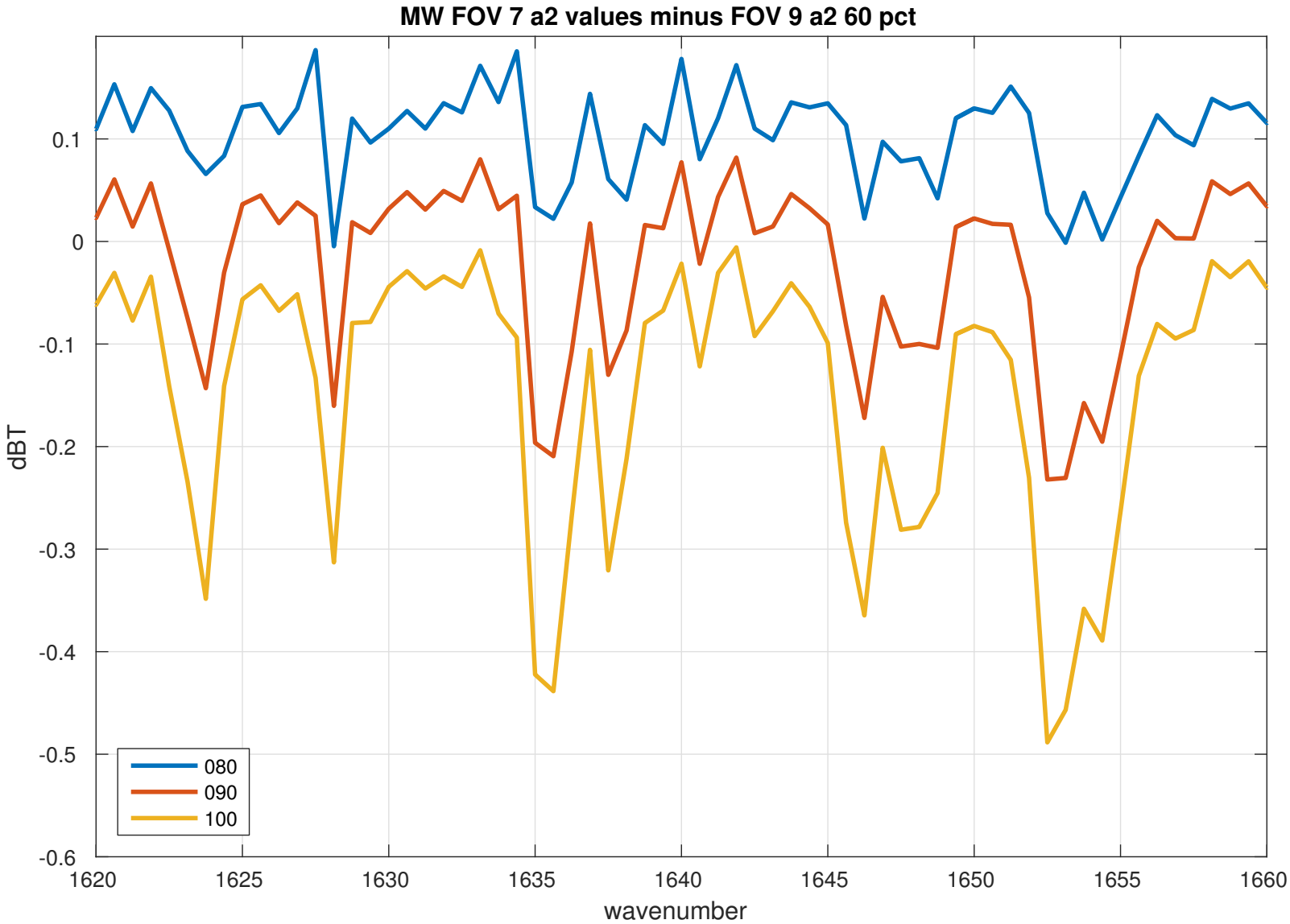
MW fitting residuals for FOV 9 with an a2 scaling factor of 60 pct

MW FOV 6 residuals



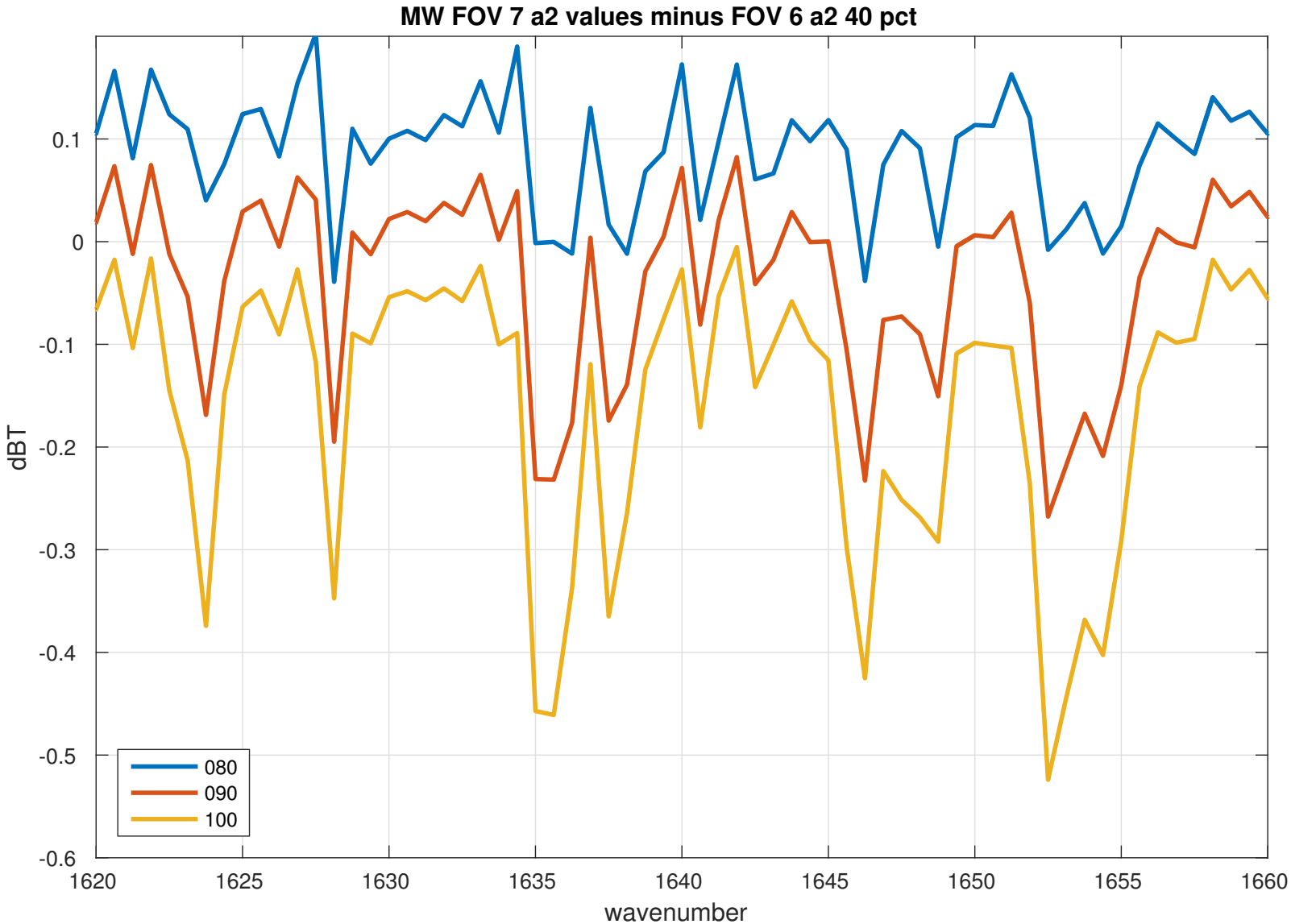
MW fitting residuals for FOV 6 with an a2 scaling factor of 40 pct

MW FOV 7 minus FOV 9



detail of FOV 7 minus FOV 9 spectral difference

MW FOV 7 minus FOV 6

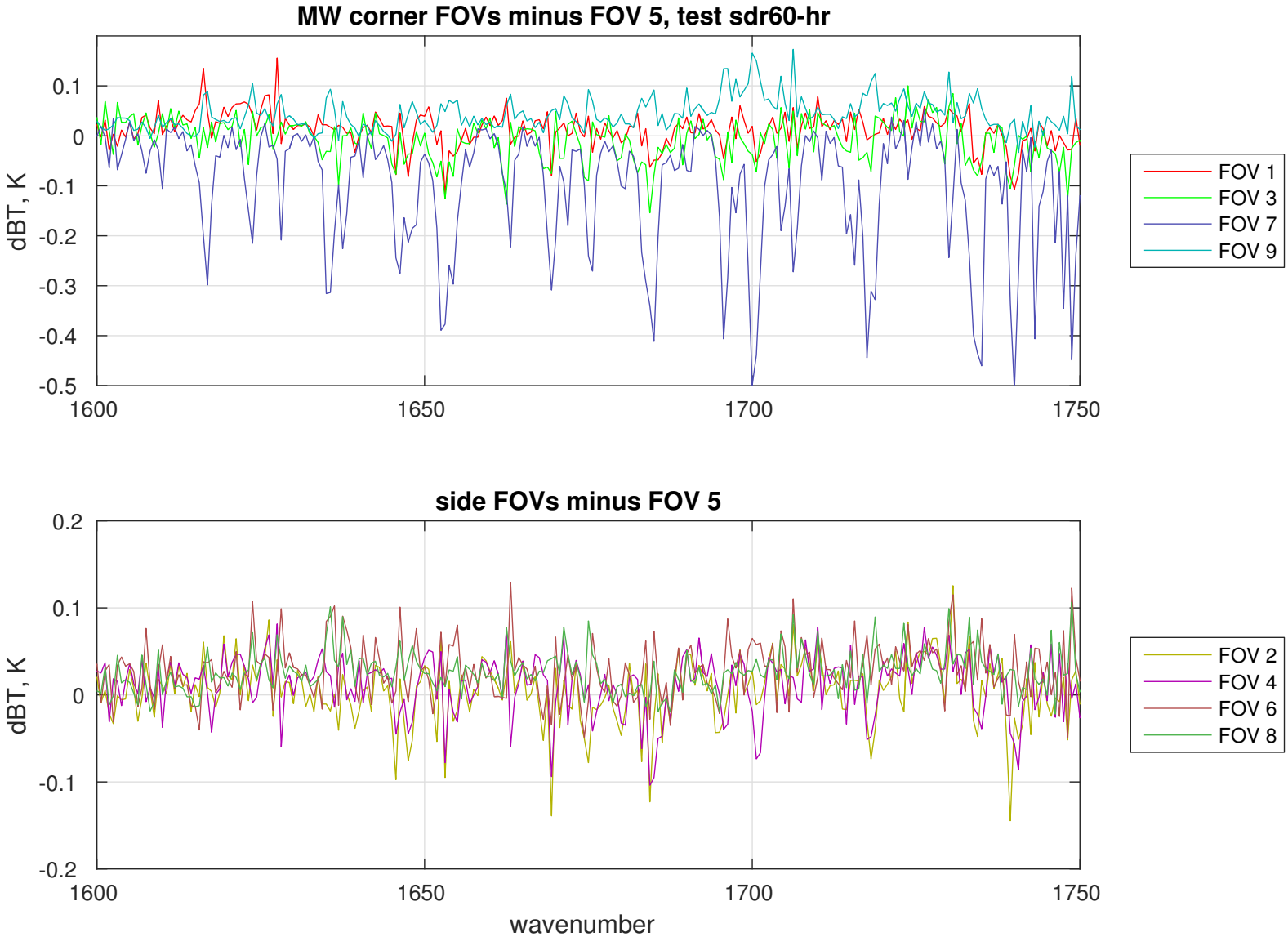


detail of FOV 7 minus FOV 6 spectral difference

MW FOV 5 relative tests

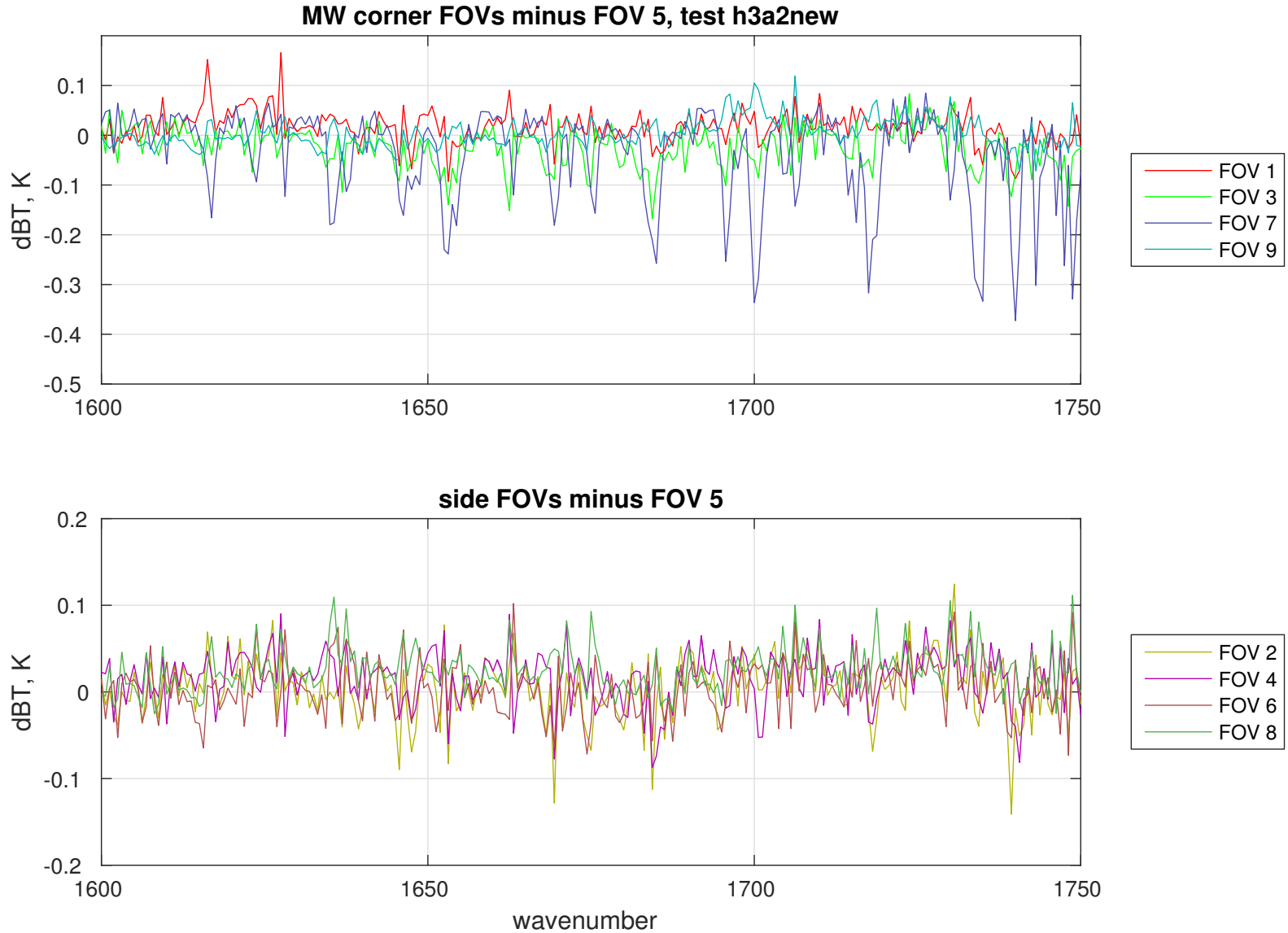
- to check these results we did CCAST runs with the old and new a2 values
- the following slides show MW FOV 5 relative differences for the same 3–day period, using the CCAST reference algorithm for both the UW 2014 and UMBC 2016 a2 values
- we see significant improvements for FOV 7, the least linear, and FOVs 9 and 6, the most linear MW FOVs
- FOV 2 is slightly improved, FOV 1 slightly worse, and in general any changes for the remaining FOVs are small and ambiguous

MW FOV 5 relative tests



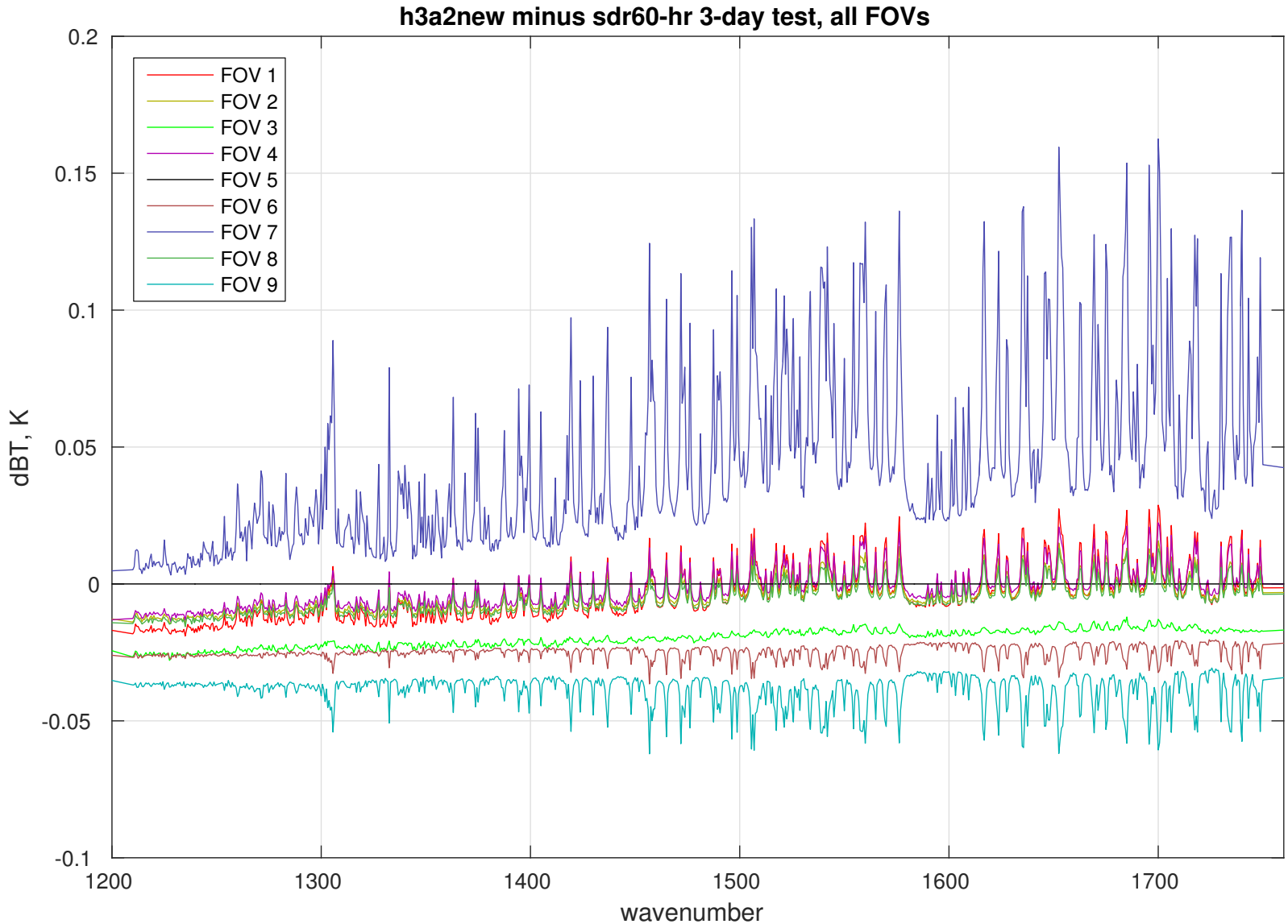
MW FOV 5 relative differences for the UW 2014 a2 values

MW FOV 5 relative tests



MW FOV 5 relative differences for the UMBC 2016 a2 values

MW UMBC minus UW a2

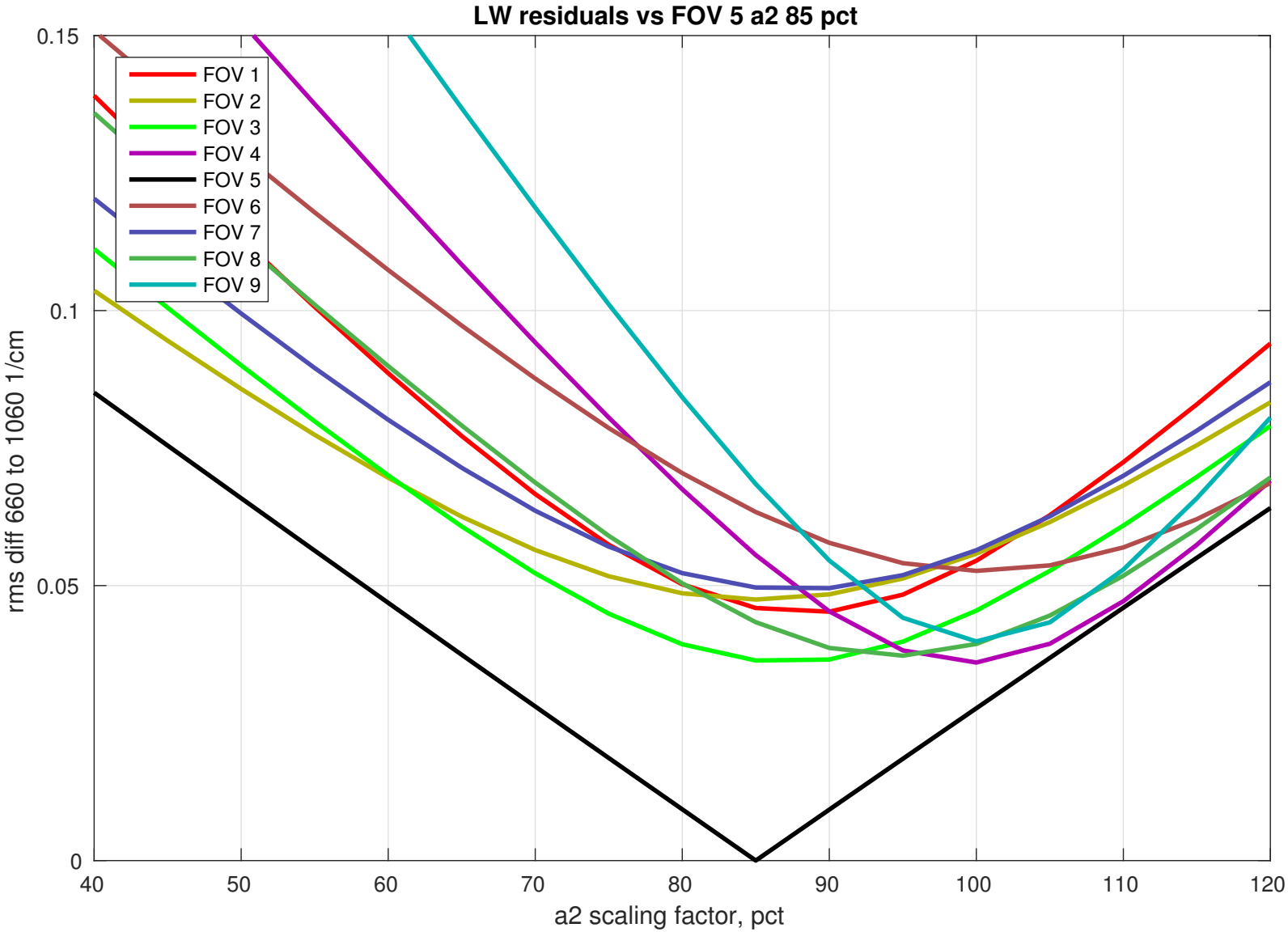


MW spectral difference for UMBC 2016 and UW 2014 a2 values

LW a2 fitting

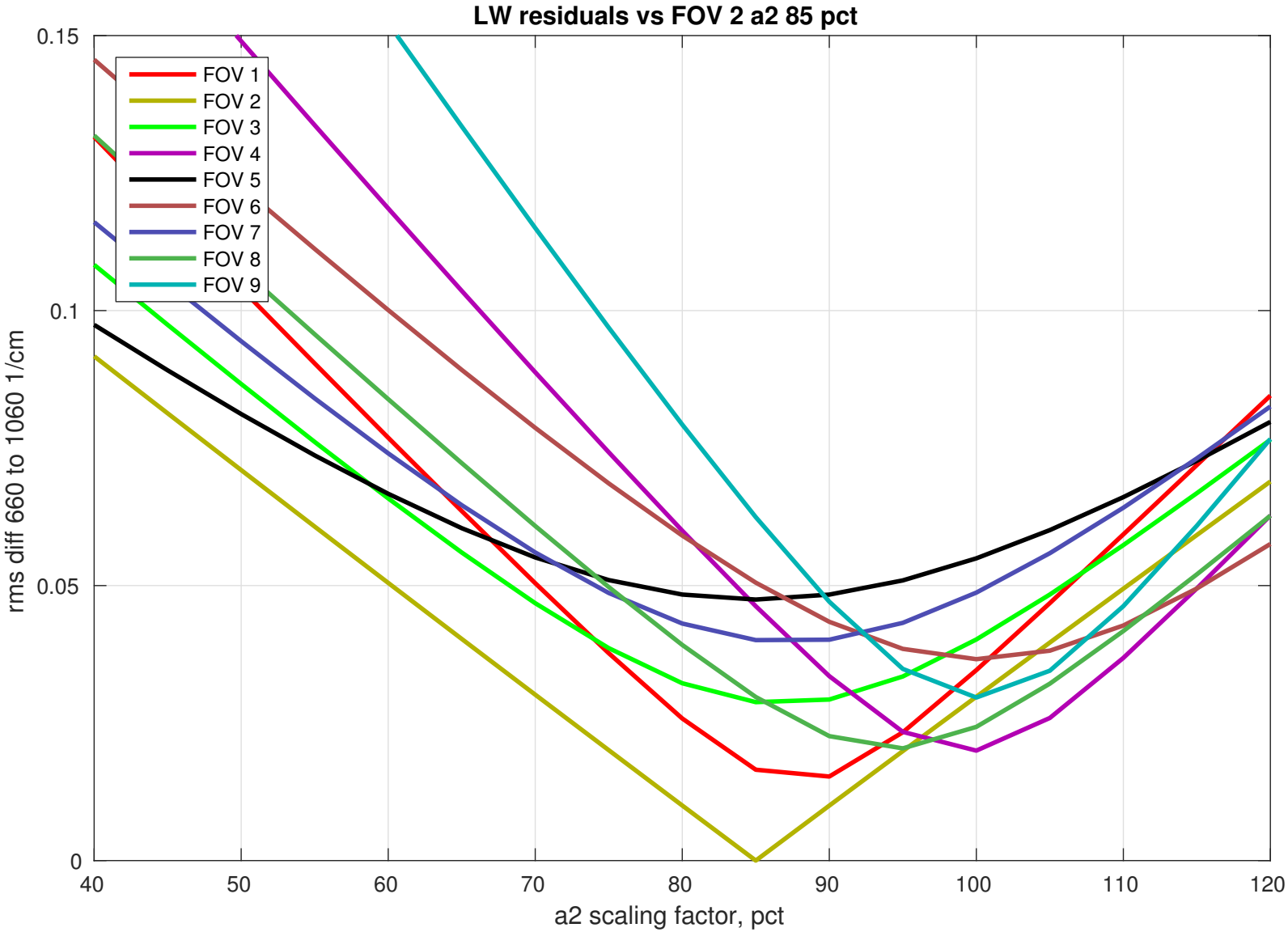
- the steps above were repeated for the LW band
- we start with the two most linear FOVs and find a2 scaling factors to minimize the sum of all residuals. For the LW this was 85 pct for FOVs 5 and 2.
- residual minima are more closely grouped and the a2 scaling factors are closer to 100 pct (the UW values) for the LW, in contrast with the MW band
- the spectral differences of the most and least linear FOVs support the updated a2 selections
- however the validation tests show no significant improvement

LW FOV 5 residuals



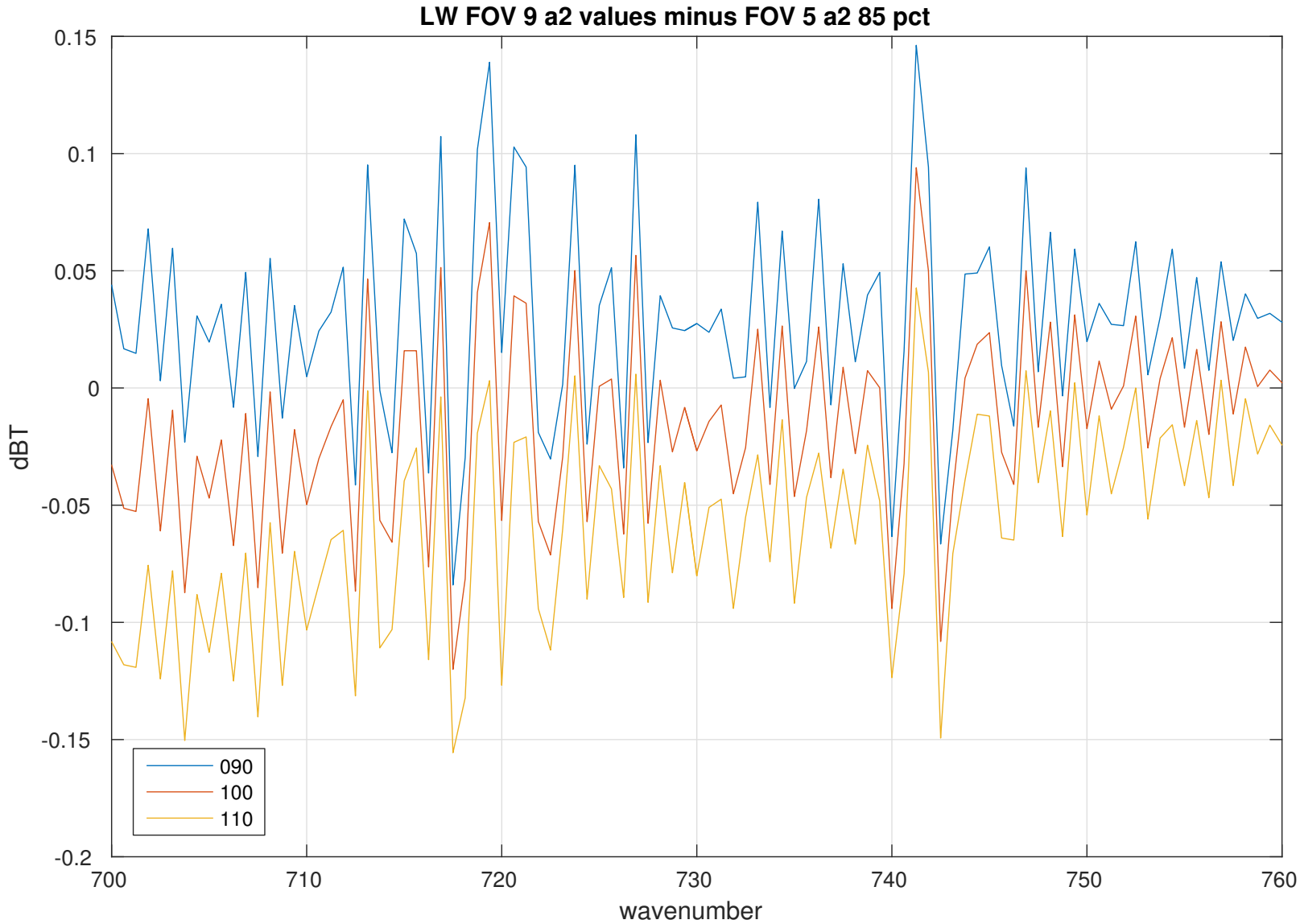
LW fitting residuals for FOV 5 with an a2 scaling factor of 85 pct

LW FOV 2 residuals



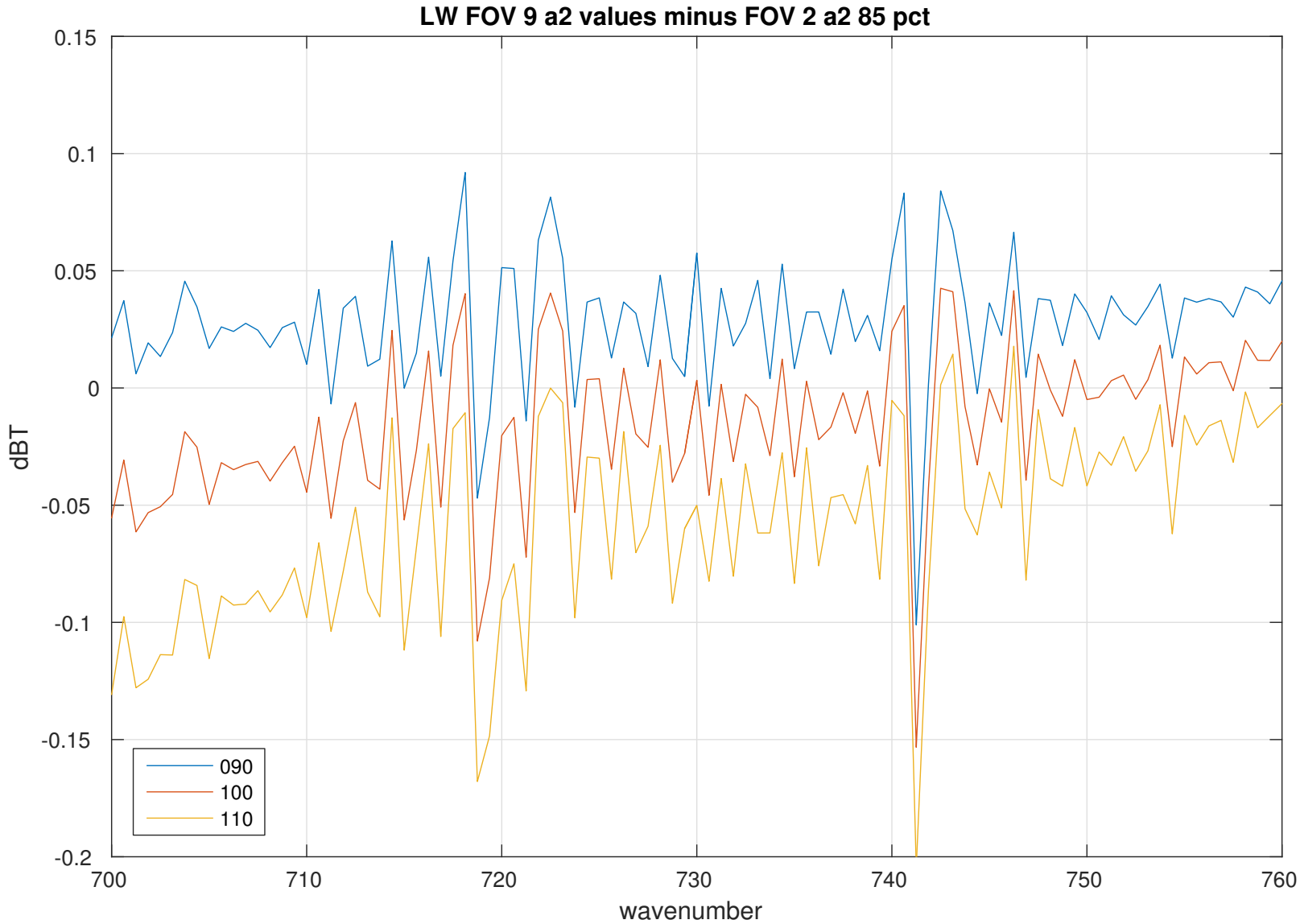
LW fitting residuals for FOV 2 with an a2 scaling factor of 85 pct

LW FOV 9 minus FOV 5



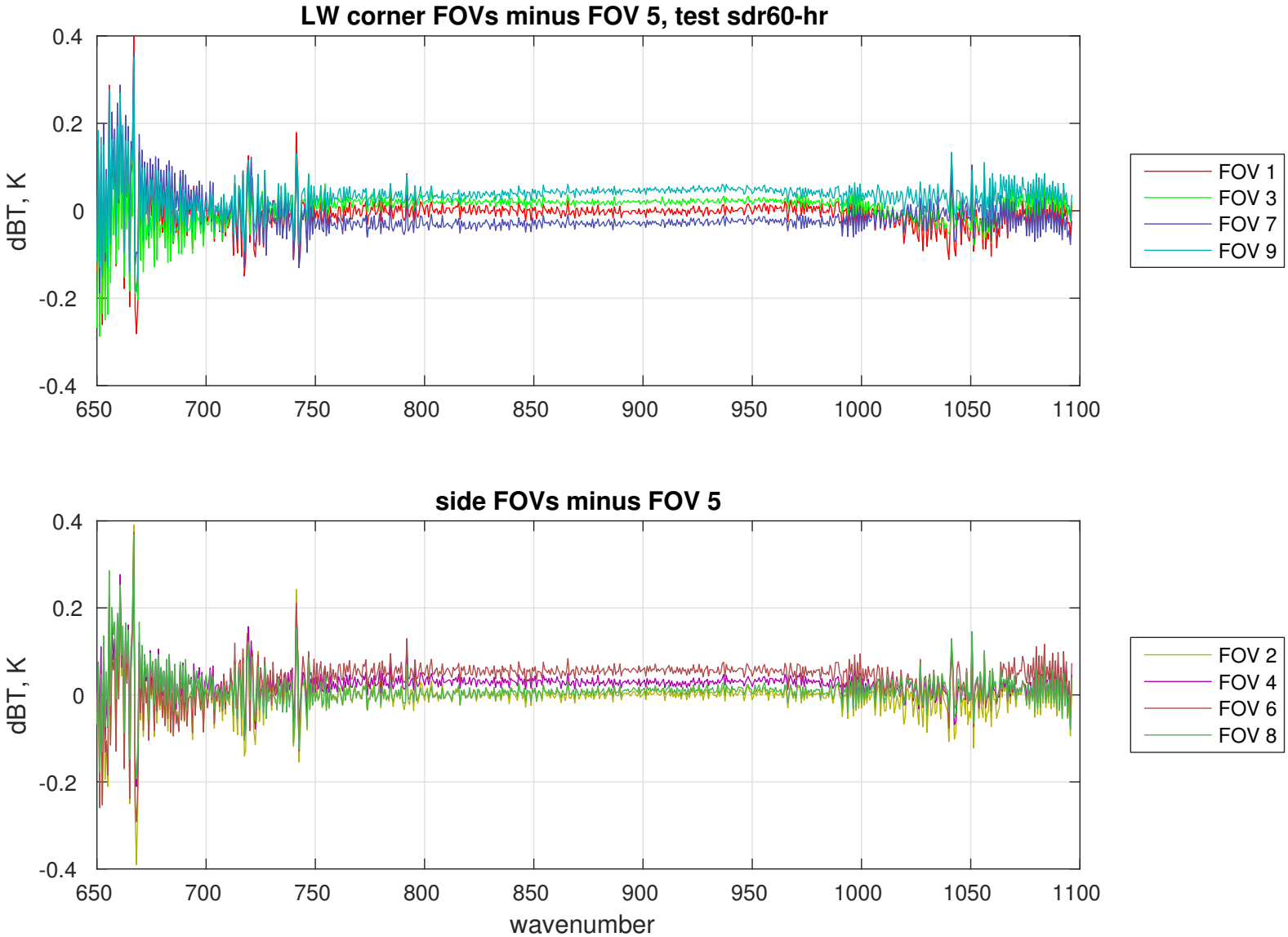
detail of FOV 9 minus FOV 5 spectral difference

LW FOV 9 minus FOV 2



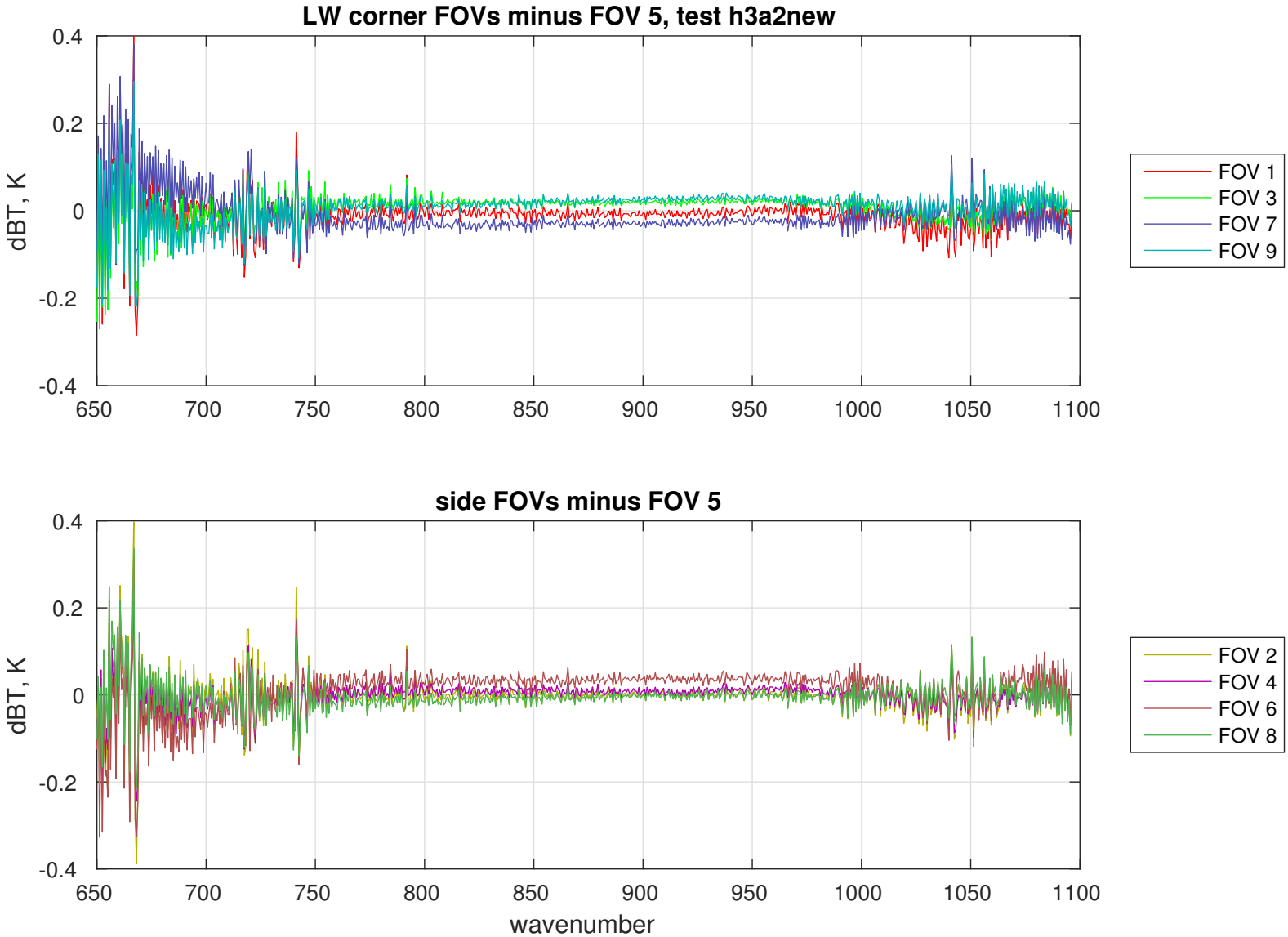
detail of FOV 9 minus FOV 2 spectral difference

LW FOV 5 relative tests



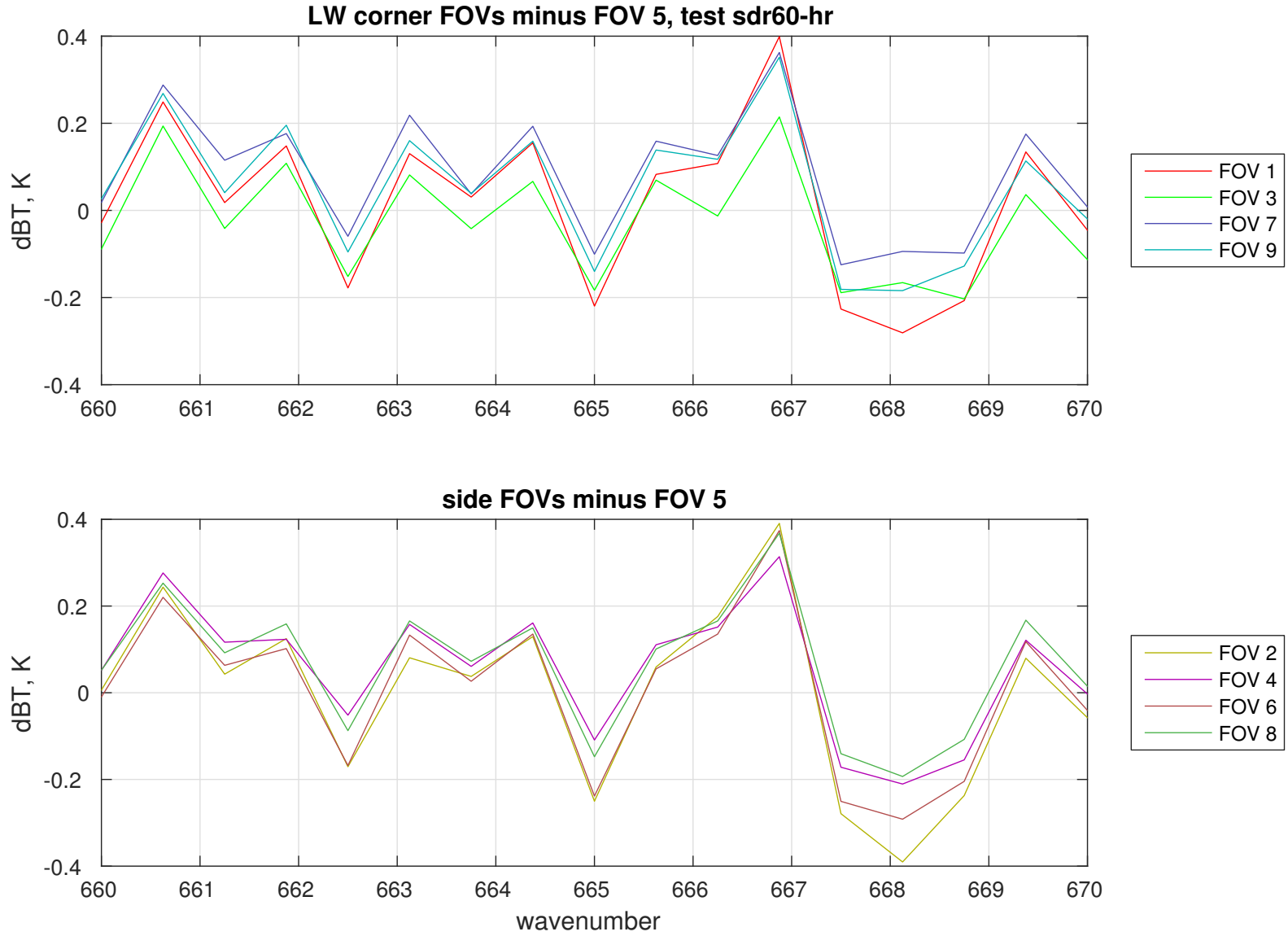
LW FOV 5 relative differences for the UW 2014 a2 values

LW FOV 5 relative tests



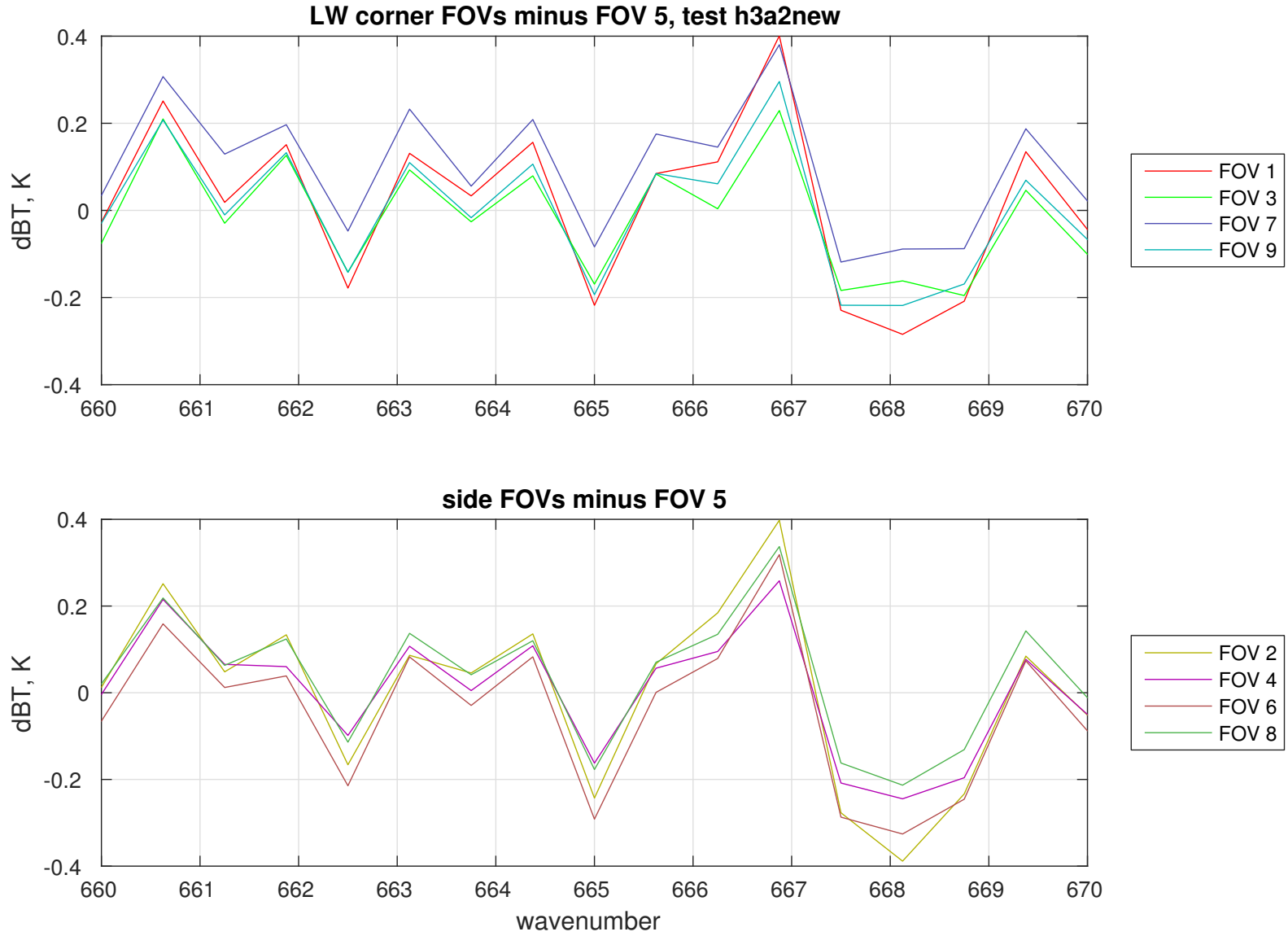
LW FOV 5 relative differences for the UMBC 2016 a2 values

LW FOV 5 relative tests



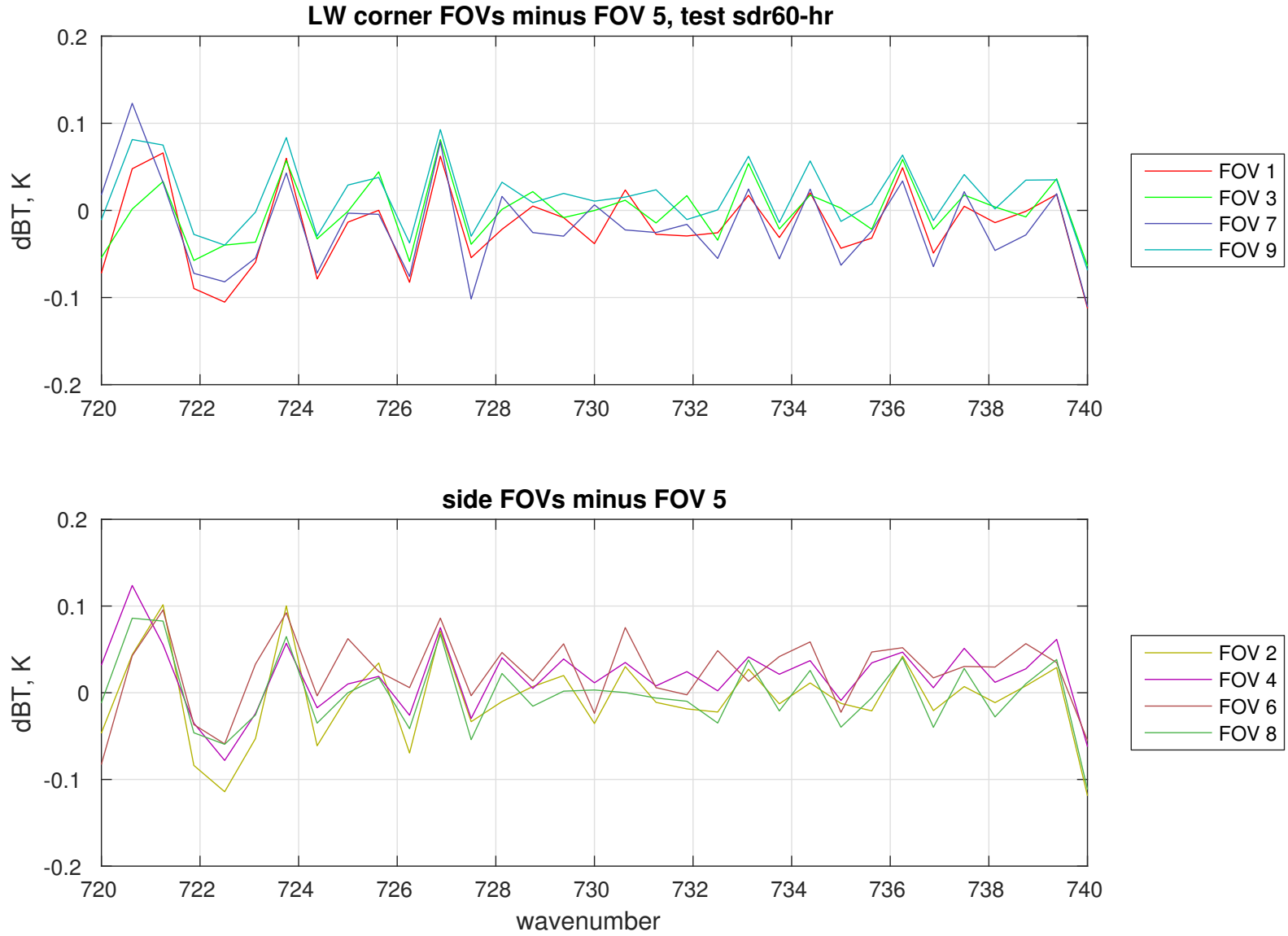
LW FOV 5 relative differences for the UW 2014 a2 values, detail

LW FOV 5 relative tests



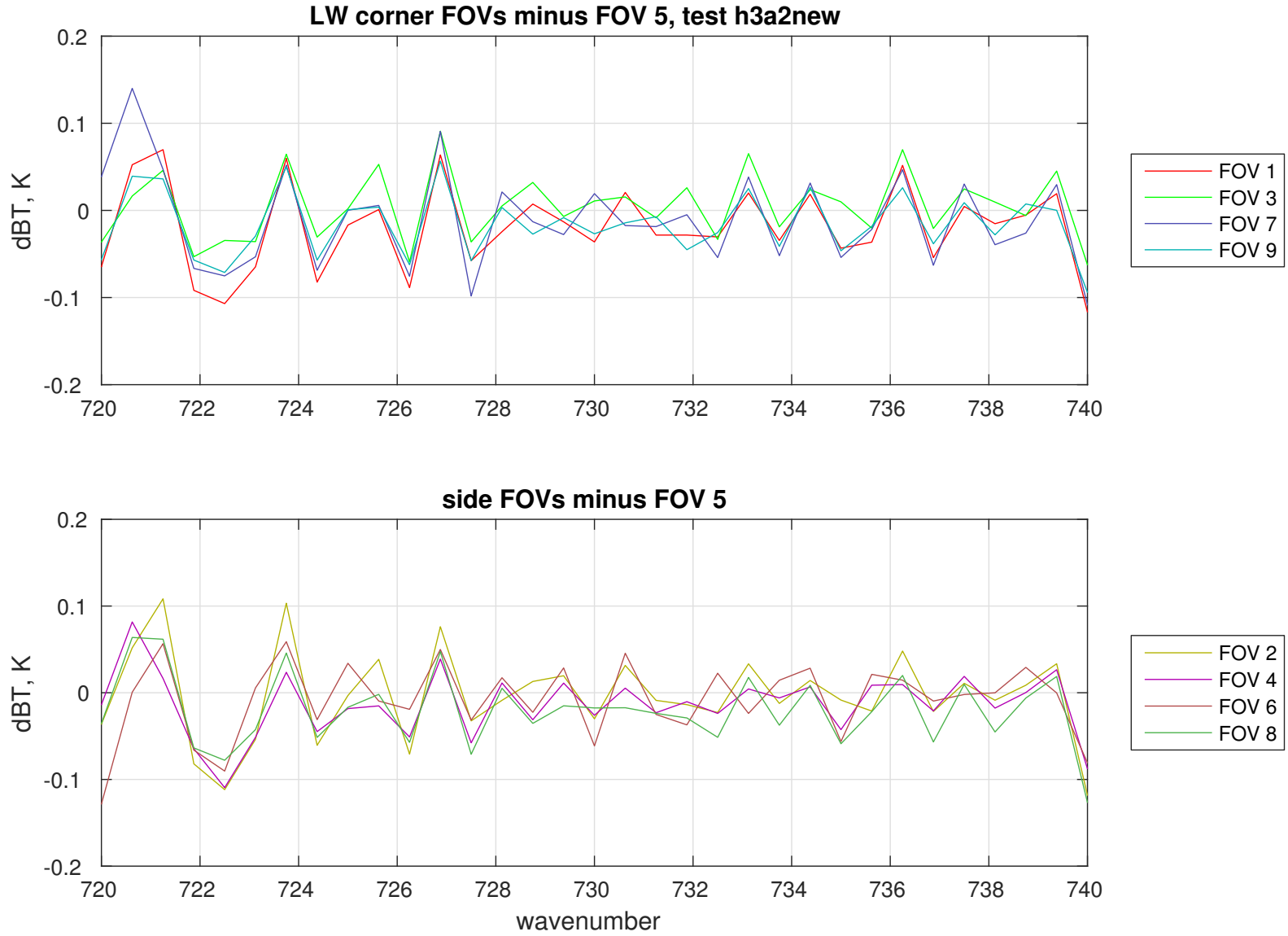
LW FOV 5 relative differences for the UMBC 2016 a2 values, detail

LW FOV 5 relative tests



LW FOV 5 relative differences for the UW 2014 a2 values, detail

LW FOV 5 relative tests



LW FOV 5 relative differences for the UMBC 2016 a2 values, detail

conclusions

- the MW improvement is significant
- the resolution of the FOV 5 relative tests may not be sufficient to validate the smaller LW a2 changes
- the differences in UW and UMBC a2 values are not due just to the different fitting intervals—the UMBC algorithm with the UW interval gives results that are closer to the UMBC than the UW values
- if we start the LW fitting with FOVs 5 and 2 at 100 pct rather than 85 pct (that is, with the UW a2 values) the other scaling factors also increase by 10 or 15 pct and the fitting residuals become slightly larger