Progress Report
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1 CrIS TVAC

The CrIS TVAC gas cell tests showed generally good agreement between observed and calculated spectra. We show representative results from the PFL side 1 CO, CH_4, CO_2, and the MN side 1 NH_3 test, and a representative summary of CO and CO_2 residuals across different test stages. The PFL tests show good agreement with calculated transmittances for CO, CH_4 and CO_2. The CO CH_4, and CO_2 side 1 residuals are reasonably consistent across the MN, PFH, and PFL tests. There was a low-frequency component in the residuals in some tests. In addition, there was a significant difference between nominal and observed gas cell pressure in some tests. When this occured the observed value was used for the calculated spectra.

There is a close parallel between our expression for transmittance

$$\tau_{\text{obs}} = f \cdot \text{SA}^{-1} \cdot f \cdot \frac{\text{FT}_2 - \text{FT}_1}{\text{ET}_2 - \text{ET}_1}$$

and our default CrIS calibration equation

$$r_{\text{obs}} = F \cdot r_{\text{ICT}} \cdot f \cdot \text{SA}^{-1} \cdot f \cdot \frac{\text{ES} - \text{SP}}{\text{IT} - \text{SP}}$$

Here f is a raised-cosine bandpass filter, SA^{-1} the inverse of the ILS matrix, r_{ICT} is expected ICT radiance at the sensor grid, and F is Fourier interpolation from sensor to user grid. The same f is applied to line-by-line transmittances before convolution to the CrIS sensor grid. All tests shown here were done using UMBC LBL for calculated transmittances.

To match observed and calculated transmittance spectra we minimize $\mathrm{RMS}(a \cdot \tau_{\mathrm{obs}} + b - \tau_{\mathrm{calc}})$ over the fitting interval as a function of the metrology laser wavelength. From this we get both a conventional residual and the difference of wavelength at the minima from the neon calibration value. The latter difference is the "metrology laser residual." The CO and CH_4 side 1 residuals are very consistent across the MN, PFH, and PFL tests. For CO_2, the MN and PFH tests were in good agreement, in comparison with the PFL tests. Our NH_3 residuals were generally larger than for CO_2.

Remaining work includes checking and refining measurements of the focal plane geometery and adding a nonlinearity correction to the observed data.

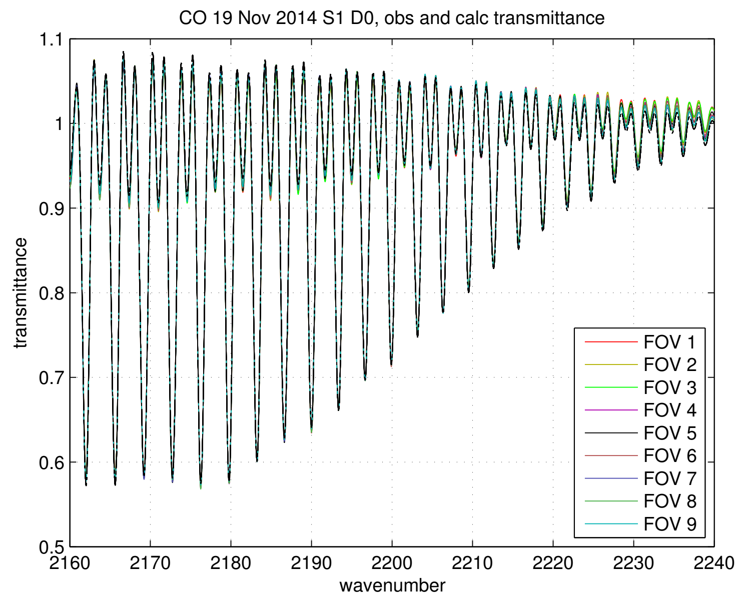

Figure 1: CO observed and calculated transmittance for all FOVs, over the fitting interval. At this level of detail we see all values are very close.

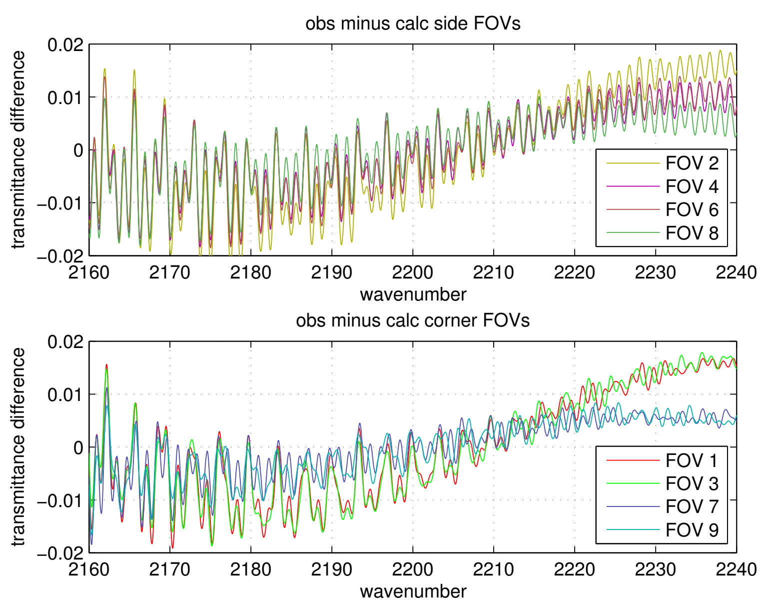

Figure 2: CO observed minus calculated transmittance for side and corner FOVs, over the fitting interval.

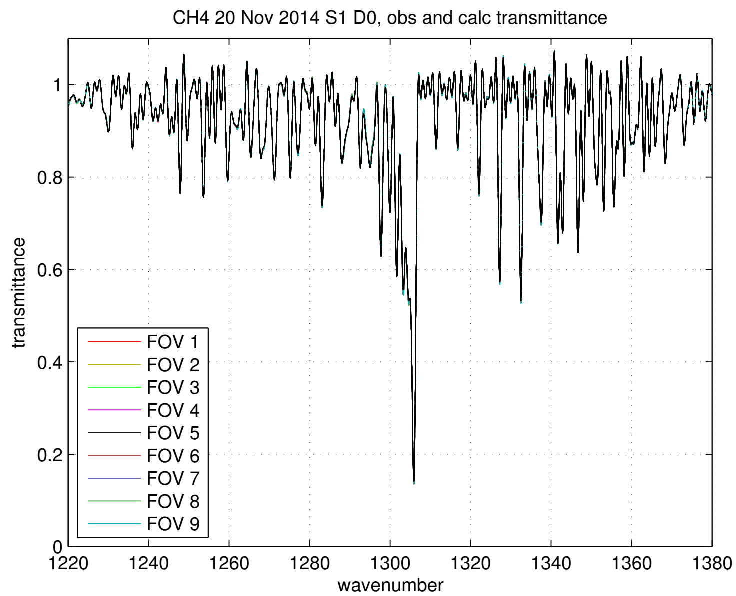

Figure 3: CH_4 observed and calculated transmittance for all FOVs, over the fitting interval. At this level of detail we see all values are very close.

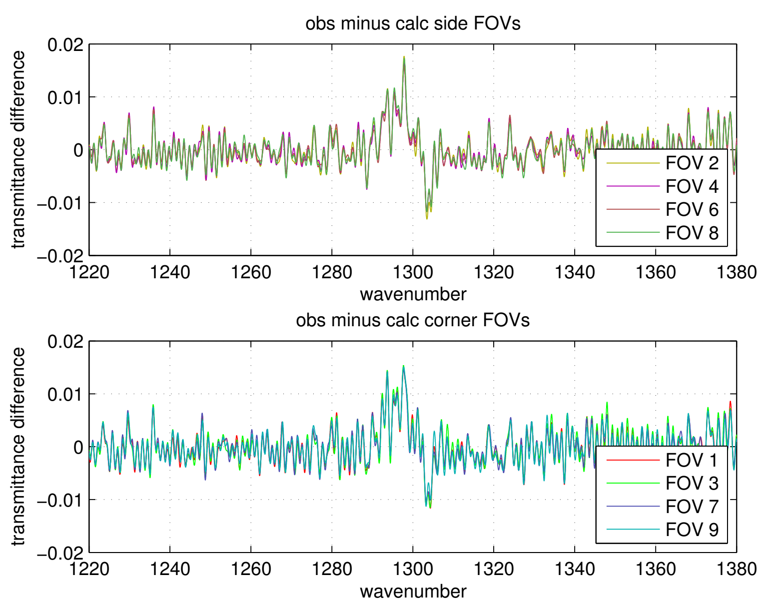

Figure 4: CH_4 observed minus calculated transmittance for side and corner FOVs, over the fitting interval.

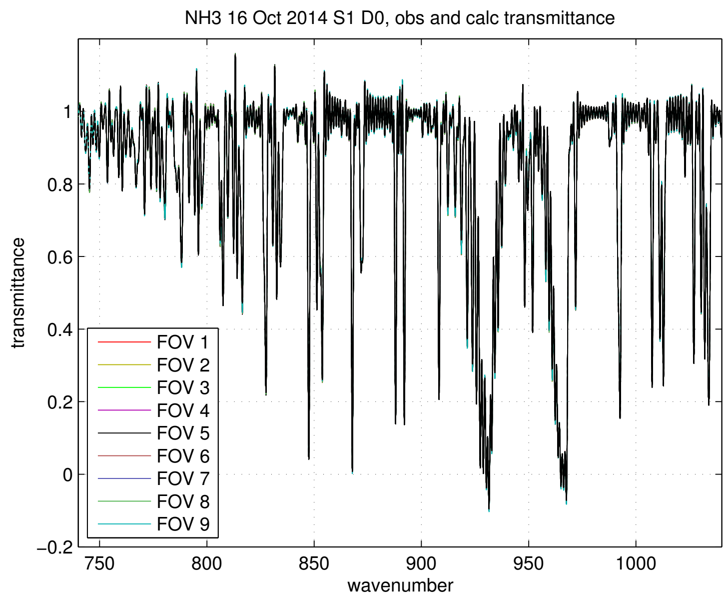

Figure 5: NH_3 observed and calculated transmittance for all FOVs, over the fitting interval. At this level of detail we see all values are close.

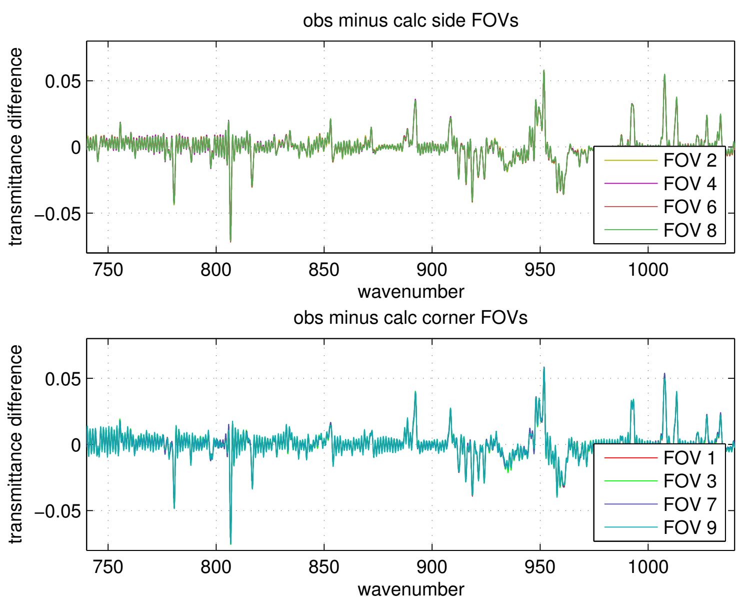

Figure 6: NH_3 observed minus calculated transmittance for side and corner FOVs, over the fitting interval.

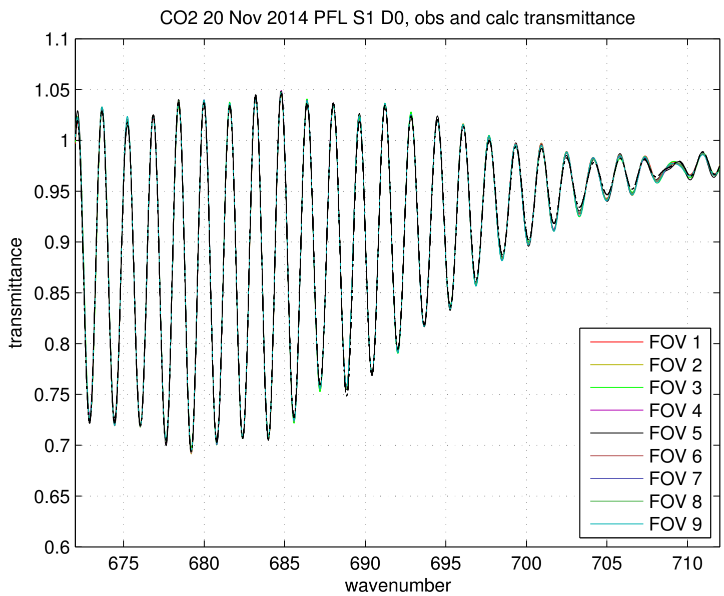

Figure 7: CO_2 observed and calculated transmittance for all FOVs, over the fitting interval. At this level of detail we see all values are close.

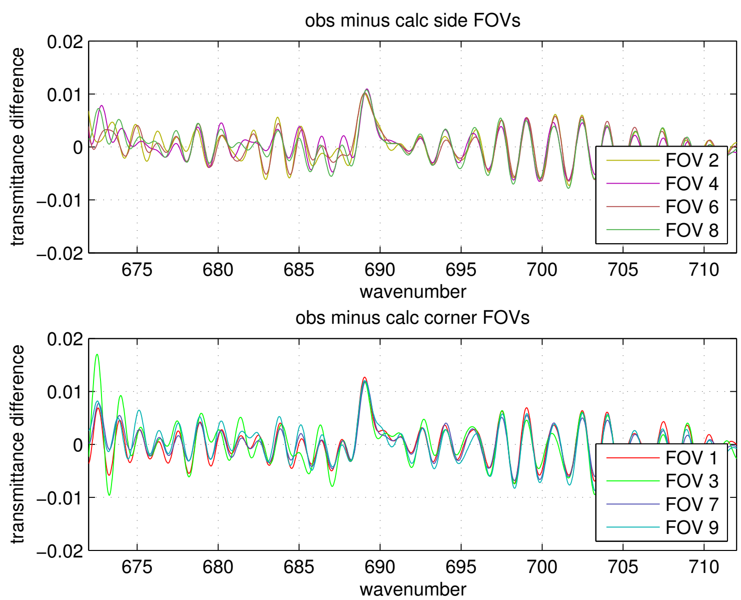

Figure 8: CO_2 observed minus calculated transmittance for side and corner FOVs, over the fitting interval.

	--- rms fit ----			--- met laser --		
FOV	MN	PH	PL	MN	PH	PL
1	4.4	1.5	9.9	13.2	15.0	10.3
2	2.8	3.5	10.6	3.4	5.2	2.3
3	4.9	2.4	10.0	4.1	2.8	2.6
4	2.7	3.4	7.7	4.4	6.7	3.9
5	1.7	2.8	7.9	3.1	3.1	2.6
6	2.4	3.3	8.1	3.1	2.6	3.6
7	3.9	1.6	5.3	-0.5	-0.5	-0.8
8	2.4	3.3	6.5	-6.7	-6.7	-5.7
9	4.7	2.6	5.2	7.2	4.9	7.5

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log torr: MN 40.5 PH 39.9 PL 45.0
obs torr: MN 41.0 PH 26.0 PL 45.0
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Figure 9: CO side 1 test comparison. “rms fit” is $1000 \cdot \mathrm{RMS}(a \cdot \tau_{\mathrm{obs}} + b - \tau_{\mathrm{calc}})$ and “met laser” is the metrology laser residual.

	--- rms fit ----			--- met laser --		
FOV	MN	PH	PL	MN	PH	PL
1	1.6	1.4	3.3	8.3	11.3	0.3
2	1.6	1.2	3.2	2.1	2.6	-6.2
3	2.8	1.9	4.0	1.3	-0.3	-4.1
4	1.8	1.8	3.0	3.6	5.4	-3.1
5	2.5	2.1	3.4	3.6	4.9	-1.8
6	2.5	1.6	3.0	2.1	1.8	-3.9
7	1.7	1.2	3.1	-6.2	-3.9	-13.4
8	1.8	2.4	3.1	-6.5	-4.9	-11.1
9	1.7	1.9	3.6	0.8	0.8	-6.2

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log torr: MN 40.2 PH 40.0 PL 40.7
obs torr: MN 40.2 PH 40.0 PL 22.0
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Figure 10: CO_2 side 1 test comparison. “rms fit” is $1000 \cdot \mathrm{RMS}(a \cdot \tau_{\mathrm{obs}} + b - \tau_{\mathrm{calc}})$ and “met laser” is the metrology laser residual

2 CrIS full resolution processing

After several earlier tests, on 4 Dec 2014 the CrIS instrument changed over to full resolution processing, with a nominal 0.8 cm OPD for all three bands. We show a representative comparison of results from the UMBC CCAST and NOAA/STAR full resolution processing. The tests shown here were done with CCAST and NOAA high res data from 6–8 Dec 2014. We take the average and standard deviation of FOR 15 and 16 independently for each FOV, and compare these values with the values for FOV 5. Results are for 32,186 CCAST and 32,120 NOAA descending FORs. The intent is to show variation among FOVs, as might arise from varying nonlinearity or artifacts of the self-apodization correction. Due to some initial problems with the impulse mask, as a precaution FORs where any LW channel was greater than 320K were discarded.

For the MW band FOV 7 is the least linear, and only partially corrected with the CCAST first-order adjustment. The NOAA variation in FOV response is much greater than what we see with CCAST. This may be due to problems with the NOAA nonlinearity correction. A normalized frequency domain representation of the numeric filter needs a scaling factor to match the original nonlinearity measurements. We used 1.6047 for LW, 0.9826 for MW, and 0.2046 for SW for these values.

For the SW band CCAST and NOAA are generally in good agreement. Residuals for both are significantly larger than for the LW band, and NOAA vs CCAST differences are generally greatest for the coldest lines and regions. FOV 7 minus FOV 5 is significantly greater than for other FOVs at 2255 and 2359 cm^{-1}, for both CCAST and NOAA.

There is significant convergence in the CCAST and NOAA processing. We are working with Yong Han's group on the MW differences. Variation due to nonlinearity, especially for the MW band, is significantly greater than some of the more subtle effects we have been considering recently. Note again that these results are relative to FOV 5 and are not comparisons with with expected observed radiance from model data or radiance from other sounders.

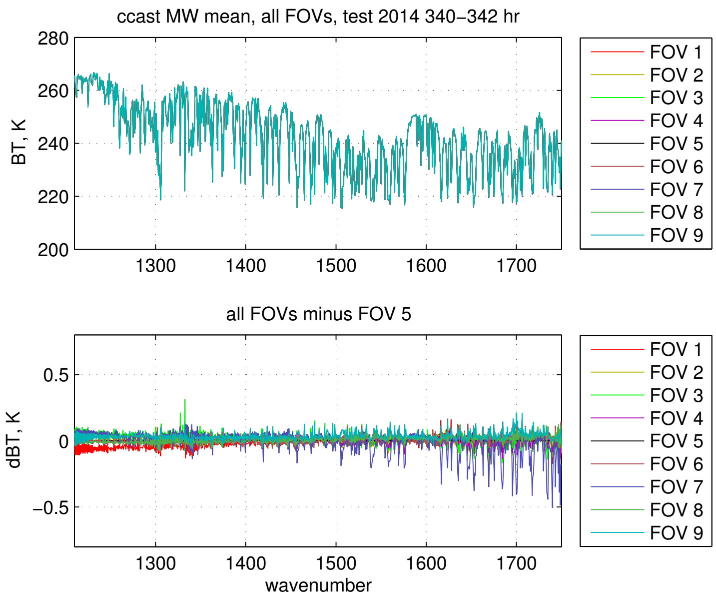

Figure 11: CCAST MW mean

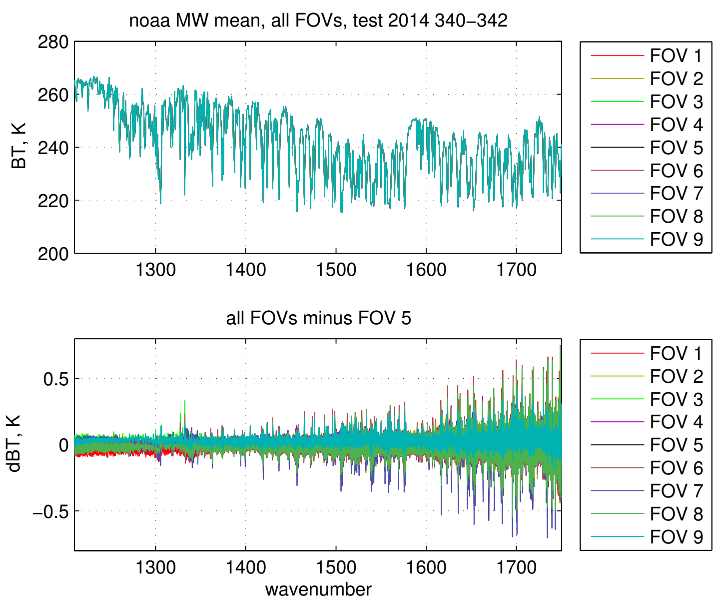

Figure 12: NOAA MW mean

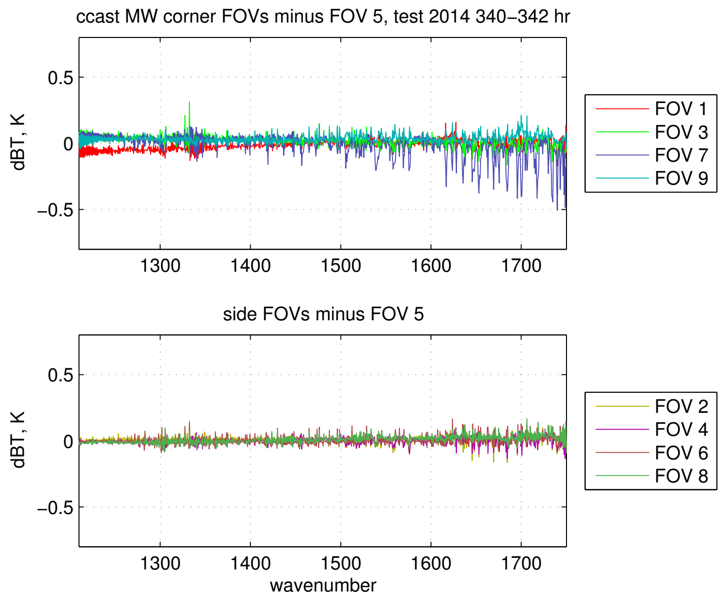

Figure 13: CCAST MW FOV groups

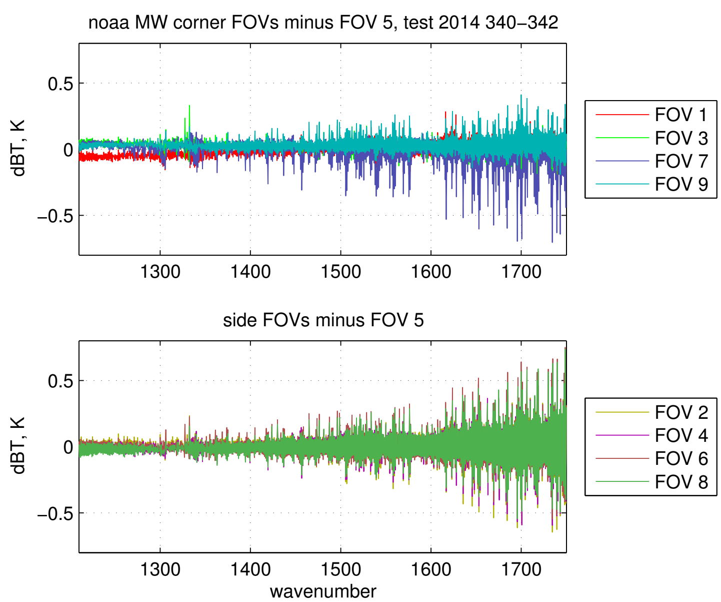

Figure 14: NOAA MW FOV groups

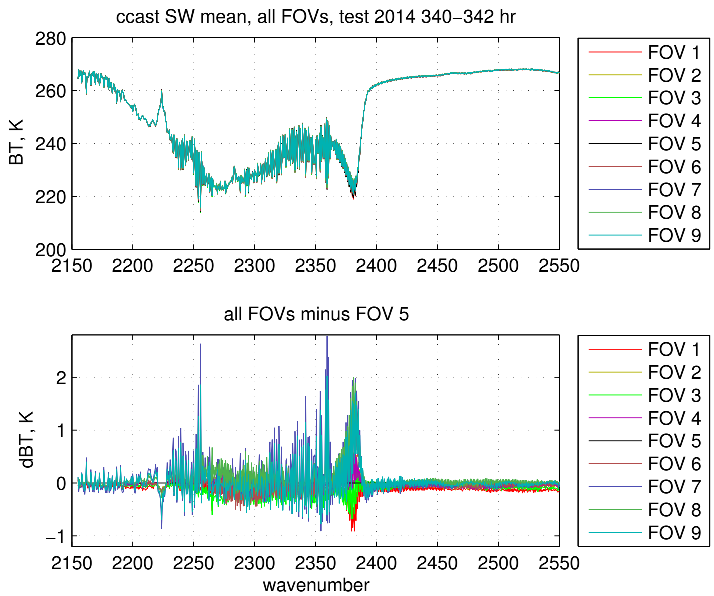

Figure 15: CCAST SW mean

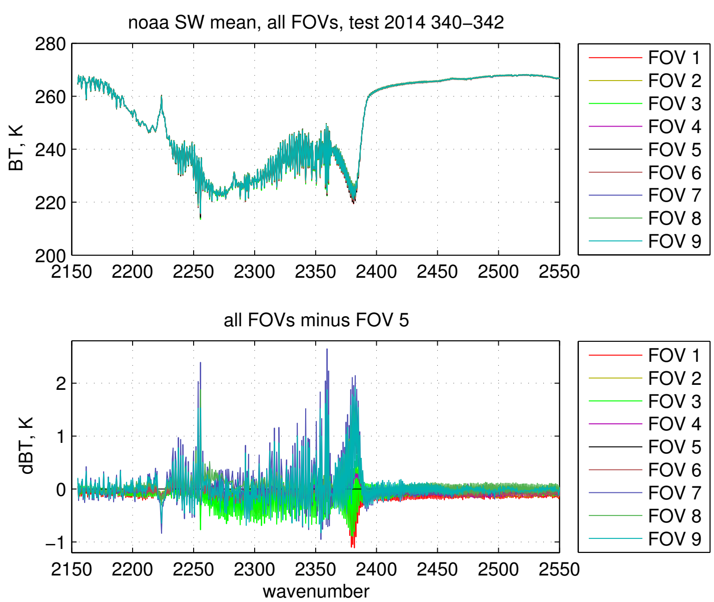

Figure 16: NOAA SW mean

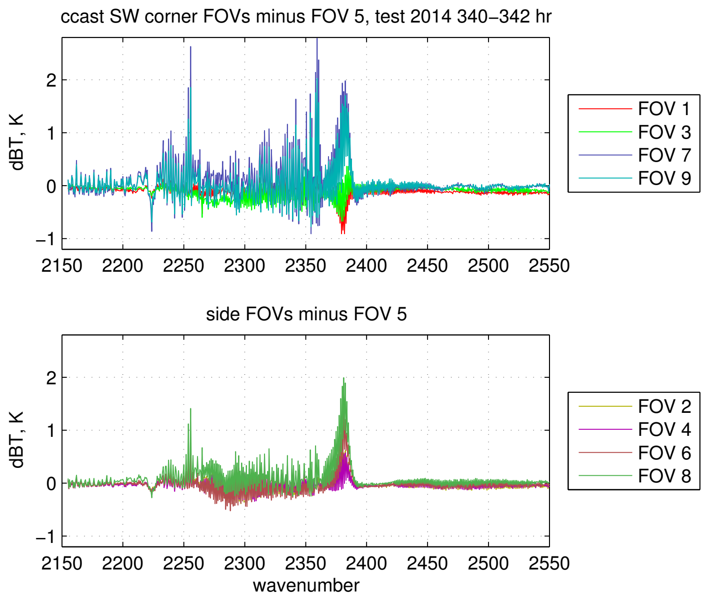

Figure 17: CCAST SW FOV groups

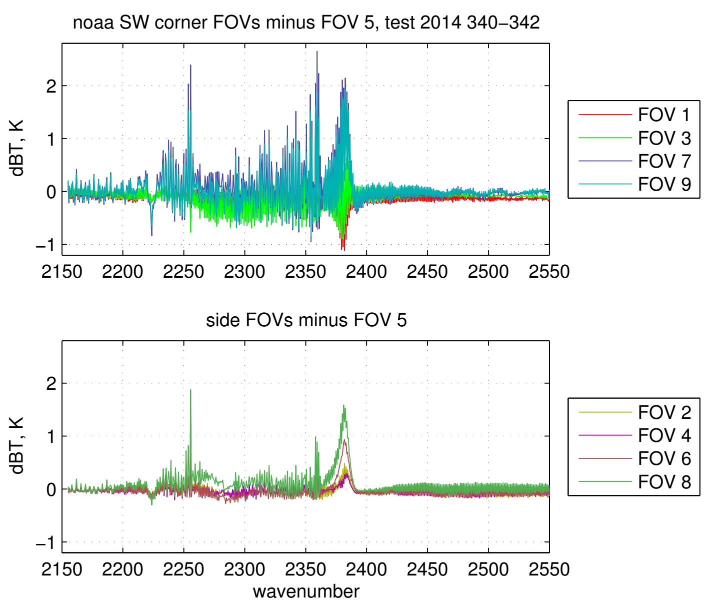

Figure 18: NOAA SW FOV groups