Progress Report
Oct–Dec 2014

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January 11, 2015

cris tvac

- we show representative results from the CrIS TVAC tests, the PFL side 1 CO, CH_4, and CO_2 tests, and the MN side 1 NH_3 test
- the PFL tests show good agreement with calculated transmittances for CO, CH_4 and CO_2
- we also show and representative residuals across the test stages
- the CO and CH_4 side 1 residuals are consistent across the MN, PFH, and PFL tests
- there was a low-frequency component in residuals in some tests
- there was a significant difference between nominal and observed gas cell pressure in some tests

test methods

- there is a close parallel between our expression for transmittance

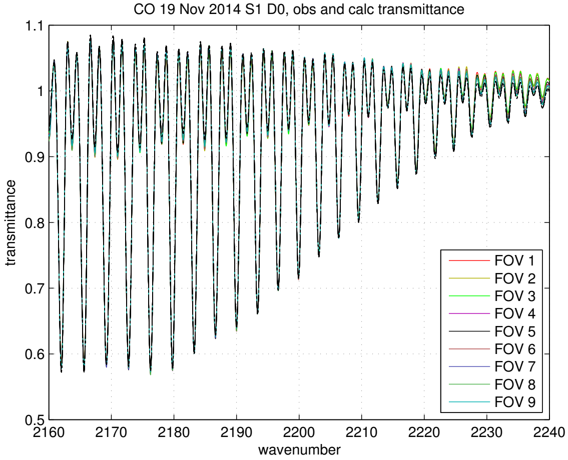
$$\tau_{\text{obs}} = f \cdot \text{SA}^{-1} \cdot f \cdot \frac{\text{FT}_2 - \text{FT}_1}{\text{ET}_2 - \text{ET}_1}$$

and our default CrIS calibration equation

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

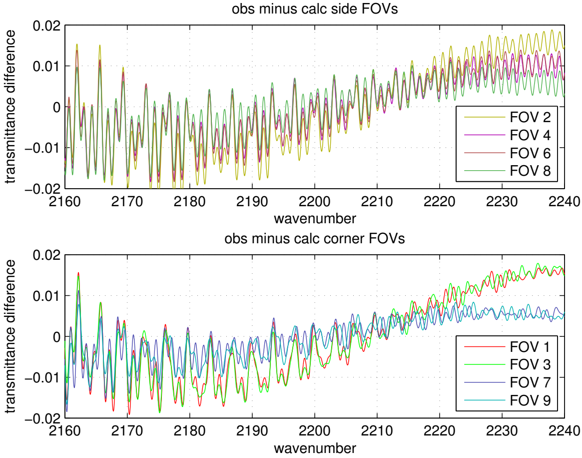
- here f is a raised-cosine bandpass filter, SA^{-1} the inverse of the ILS matrix, r_{ICT} is expected ICT radiance at the sensor grid, and F is Fourier interpolation from sensor to user grid.
- the same f is applied to the line-by-line transmittances before convolution to the CrIS sensor grid

CO obs and calc



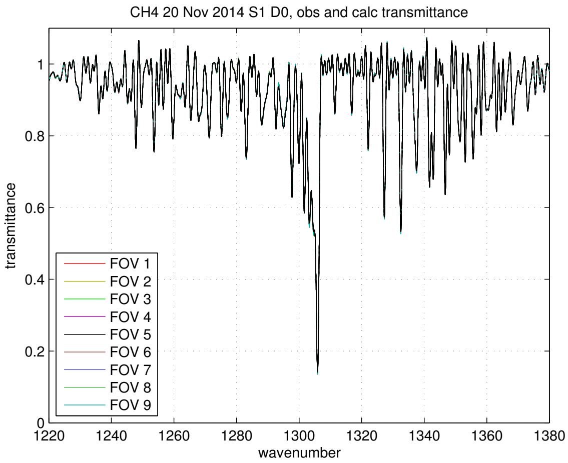
Observed and calculated transmittance for all FOVs, over the fitting interval. At this level of detail we see all values are very close.

CO obs minus calc



Observed minus calculated transmittance for side and corner FOVs, over the fitting interval.

CH_4 obs and calc



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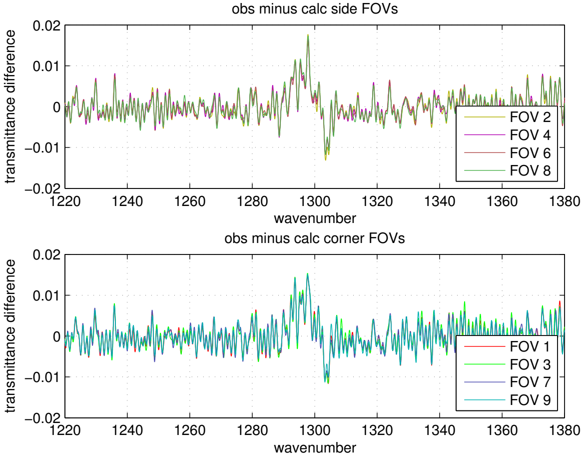
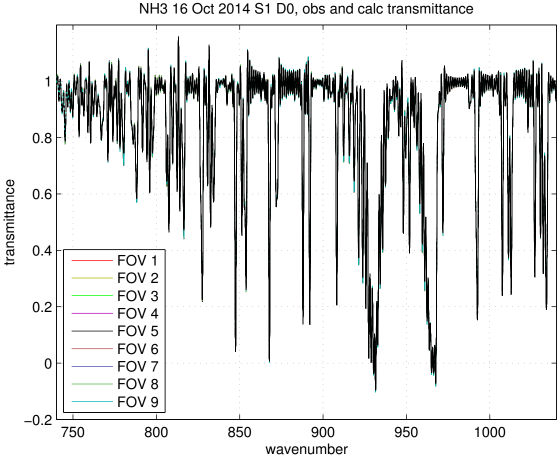
CH_4 obs minus calc



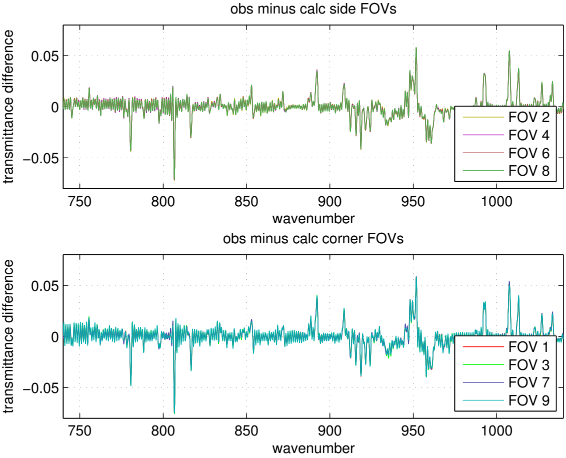
Observed minus calculated transmittance for side and corner FOVs, over the fitting interval.

NH_3 obs and calc



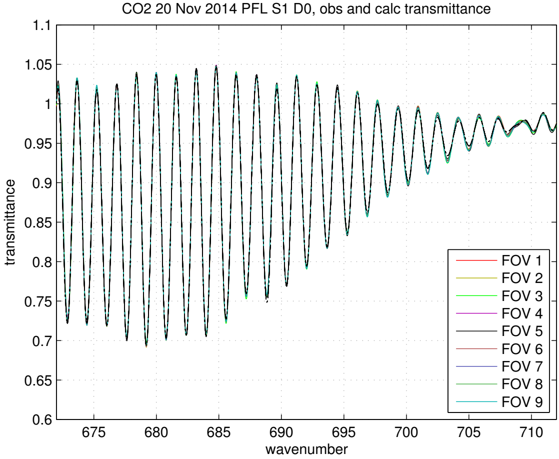
Observed and calculated transmittance for all FOVs, over the fitting interval. At this level of detail we see all values are close.

NH_3 obs minus calc



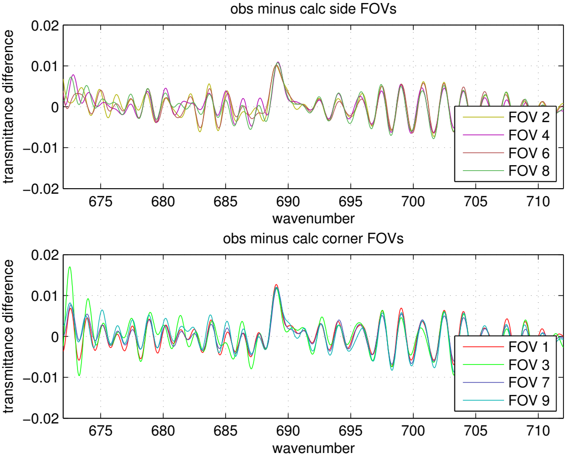
Observed minus calculated transmittance for side and corner FOVs, over the fitting interval.

CO_2 obs and calc



Observed and calculated transmittance for all FOVs, over the fitting interval. At this level of detail we see all values are close.

CO_2 obs minus calc



Observed minus calculated transmittance for side and corner FOVs, over the fitting interval.

CO side 1 test comparison

"rms fit" is $1000 \cdot \mathrm{RMS}(a \cdot \tau_{\mathrm{obs}} + b - \tau_{\mathrm{calc}})$
"met laser" is the metrology laser residual

	--- 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

log torr: MN 40.5 PH 39.9 PL 45.0
obs torr: MN 41.0 PH 26.0 PL 45.0

CO_2 side 1 test comparison

"rms fit" is $1000 \cdot \mathrm{RMS}(a \cdot \tau_{\mathrm{obs}} + b - \tau_{\mathrm{calc}})$
"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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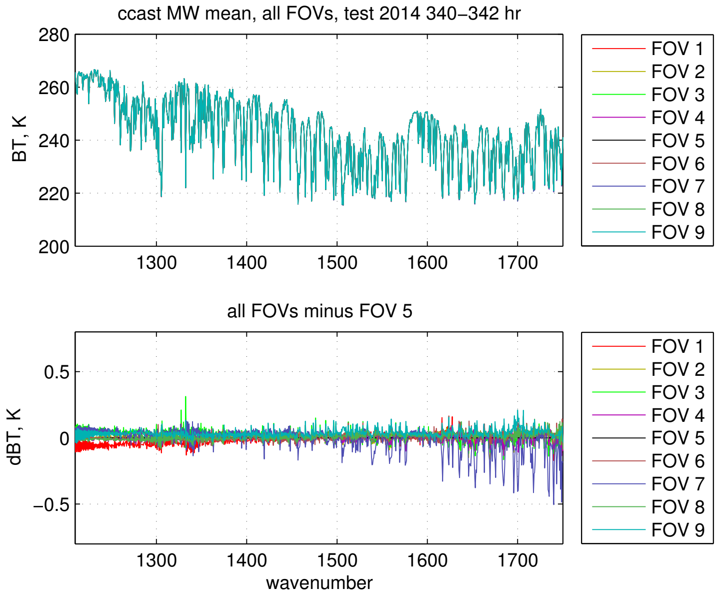
notes and comments

- 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 value is the "metrology laser residual"
- the CO and CH_4 side 1 residuals are consistent across the MN, PFH, and PFL tests
- comparing CO_2 tests, the MN and PFH tests were in reasonable agreement in comparison with the PFL tests
- our NH_3 residuals were generally larger than for CO_2
- all tests shown here were done using UMBC LBL for calculated transmittances
- to do: derive final focal plane geometery

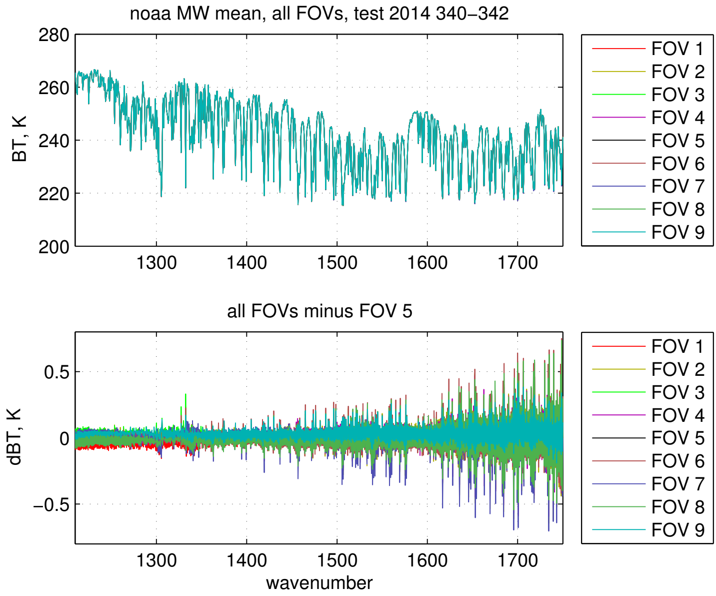
ccast high res

- start with CCAST and NOAA high res data from 6–8 Dec 2014
- 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 shown here are for 32,186 CCAST and 32,120 NOAA descending FORs
- as a precaution, FORs where any LW channel was greater than 320K were discarded
- the intent is to show variation among FOVs, as might arise from varying nonlinearity or artifacts of the self-apodization correction

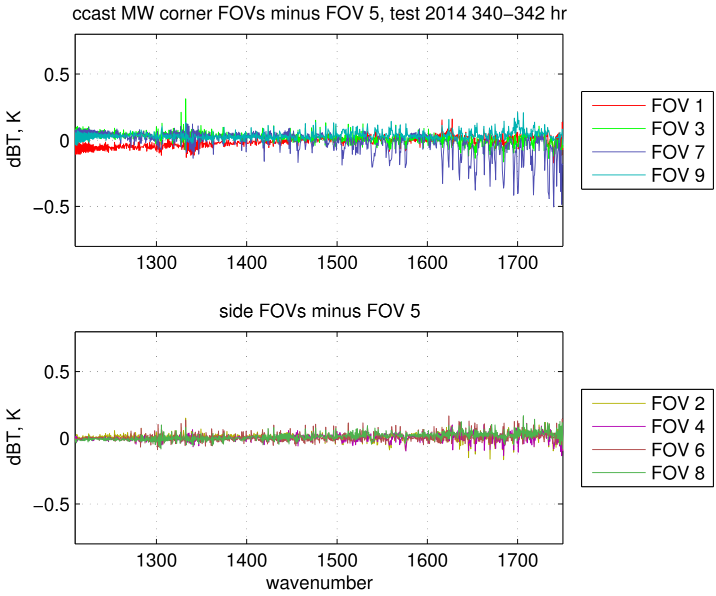
ccast MW mean



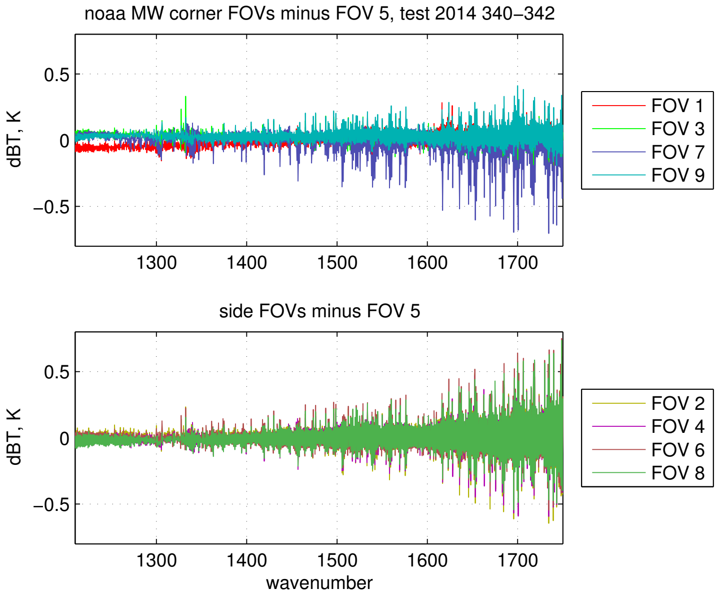
noaa MW mean


noaa MW mean, all FOVs, test 2014 340–342
BT, K
280
260
240
220
200
1300
1400
1500
1600
1700
FOV 1
FOV 2
FOV 3
FOV 4
FOV 5
FOV 6
FOV 7
FOV 8
FOV 9
all FOVs minus FOV 5
dBT, K
0.5
0
–0.5
1300
1400
1500
1600
1700
wavenumber
FOV 1
FOV 2
FOV 3
FOV 4
FOV 5
FOV 6
FOV 7
FOV 8
FOV 9

ccast MW fov groups



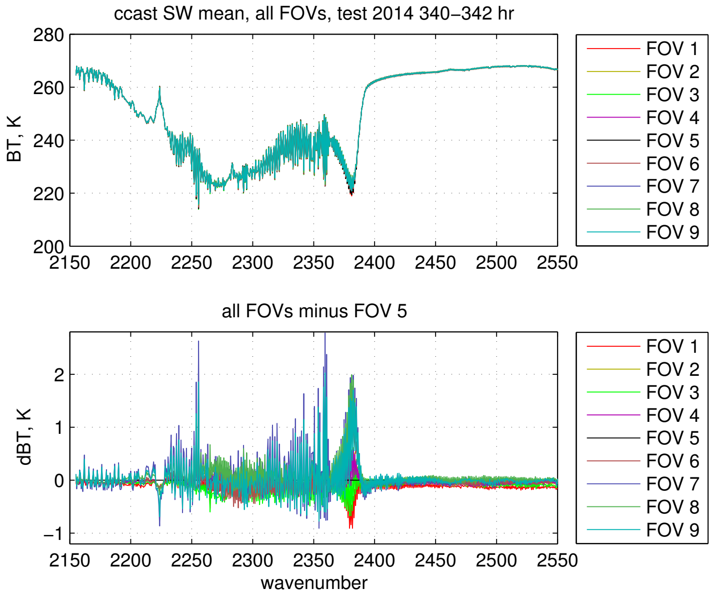
noaa MW fov groups



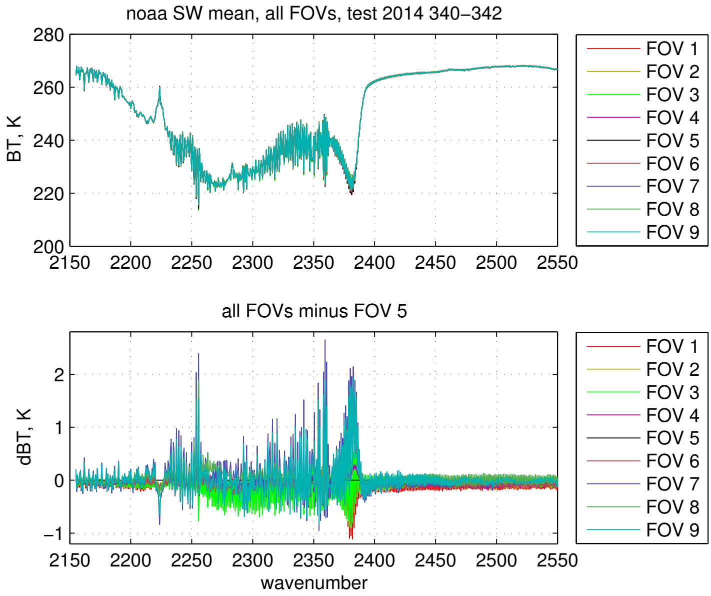
MW discussion

- FOV 7 is the least linear, and only partially corrected for with the CCAST first order adjustment
- the NOAA variation in FOV response is much greater than CCAST
- this may be due to problems with the 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

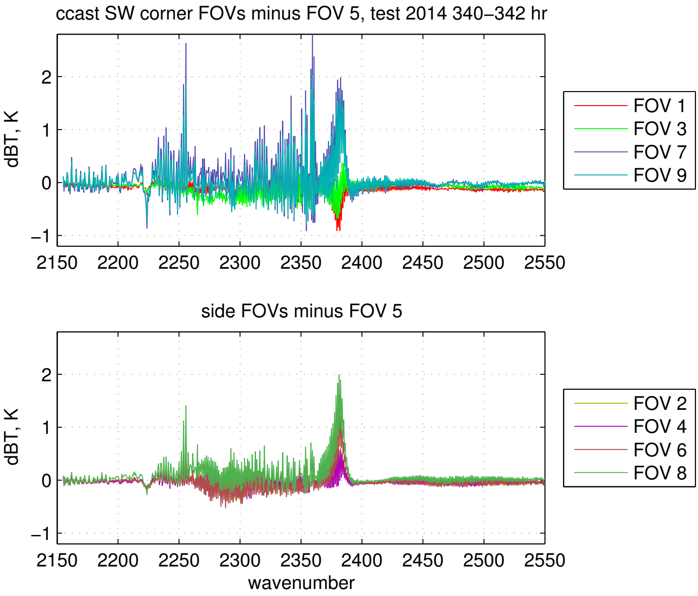
ccast SW mean



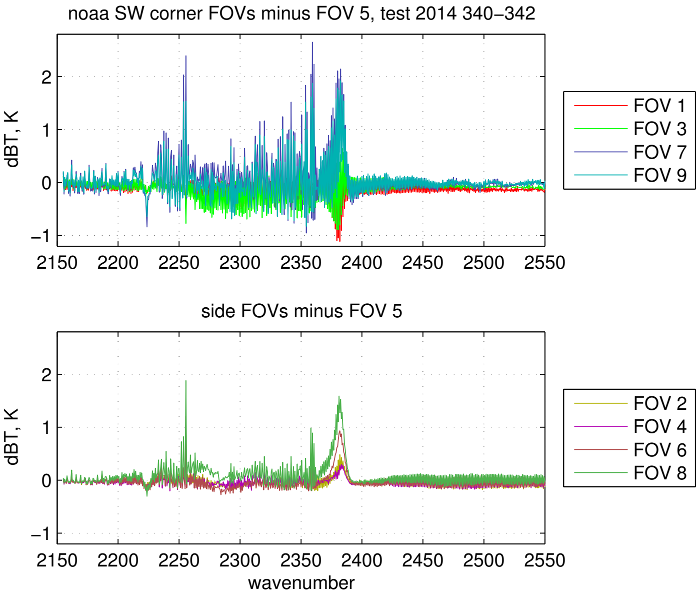
noaa SW mean


noaa SW mean, all FOVs, test 2014 340–342
BT, K
280
260
240
220
200
2150
2200
2250
2300
2350
2400
2450
2500
2550
FOV 1
FOV 2
FOV 3
FOV 4
FOV 5
FOV 6
FOV 7
FOV 8
FOV 9
all FOVs minus FOV 5
dBT, K
2
1
0
–1
wavenumber

ccast SW fov groups



noaa SW fov groups



SW discussion

- CCAST and NOAA are generally in good agreement.
- residuals are significantly larger than for the LW band
- residuals 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

conclusions

- 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