ccast and noaa relative fov response

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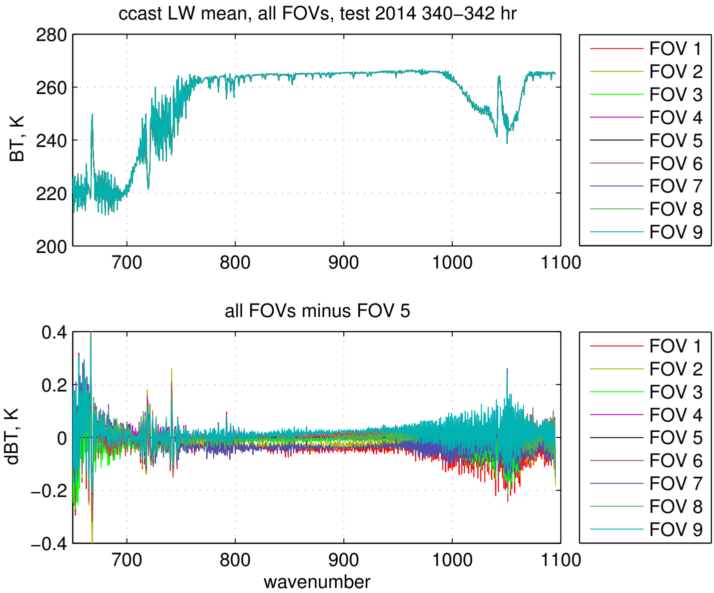
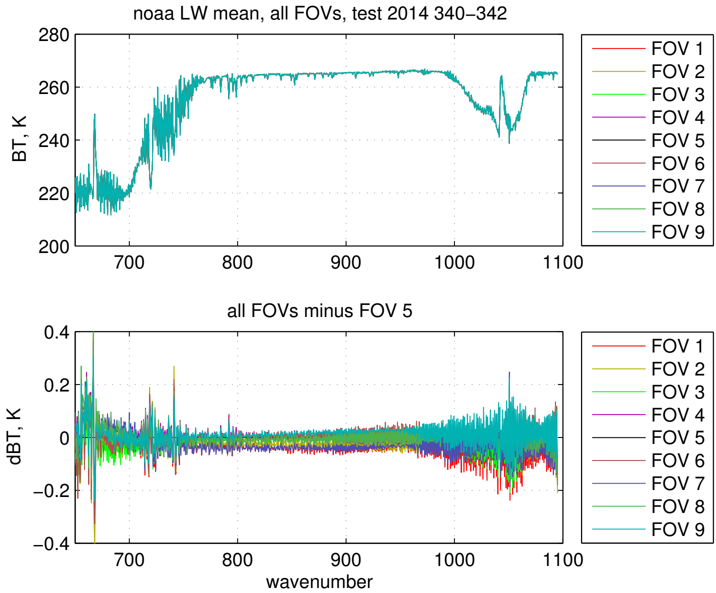
test methods

- 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

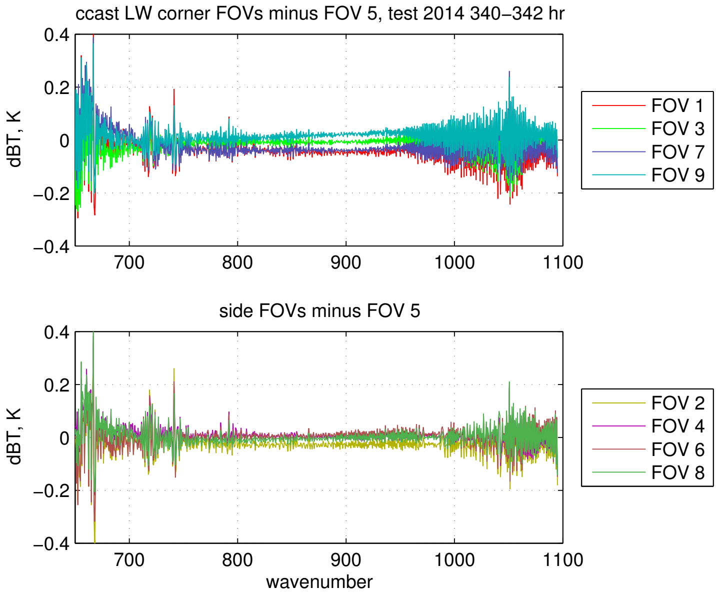
ccast LW mean



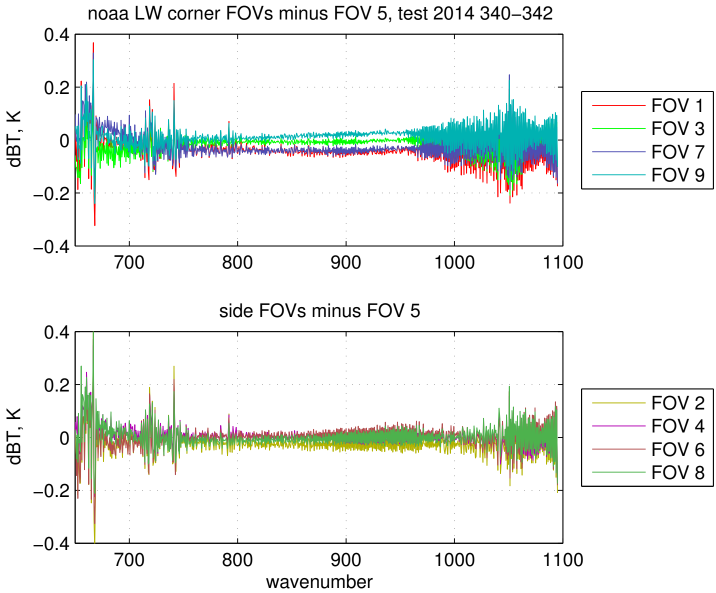
noaa LW mean


noaa LW mean, all FOVs, test 2014 340–342
BT, K
280
260
240
220
200
700
800
900
1000
1100
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
0.4
0.2
0
−0.2
−0.4
700
800
900
1000
1100
wavenumber
FOV 1
FOV 2
FOV 3
FOV 4
FOV 5
FOV 6
FOV 7
FOV 8
FOV 9

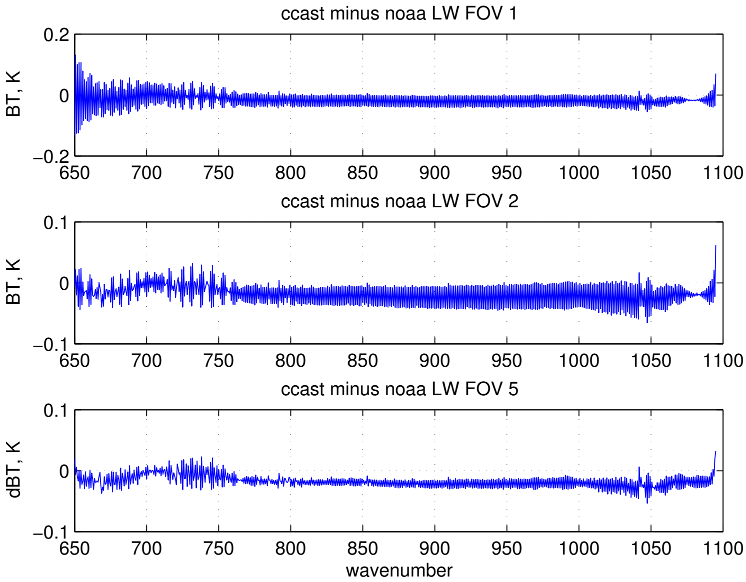
ccast LW breakout



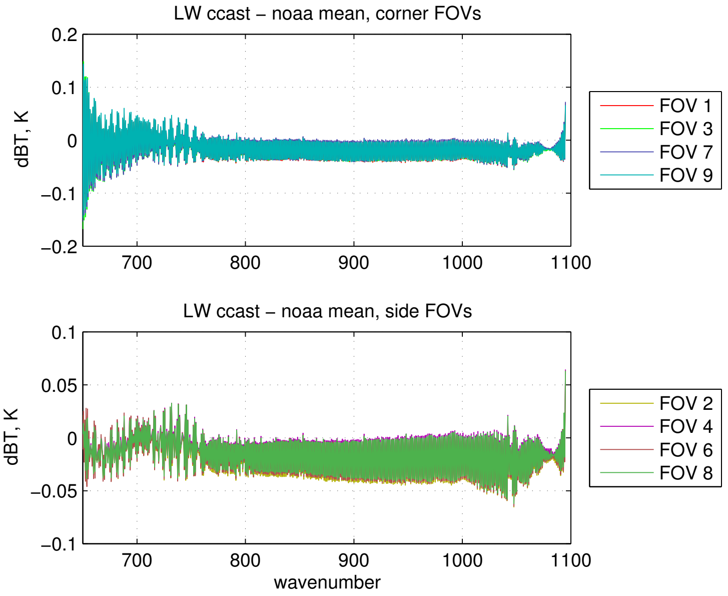
noaa LW breakout



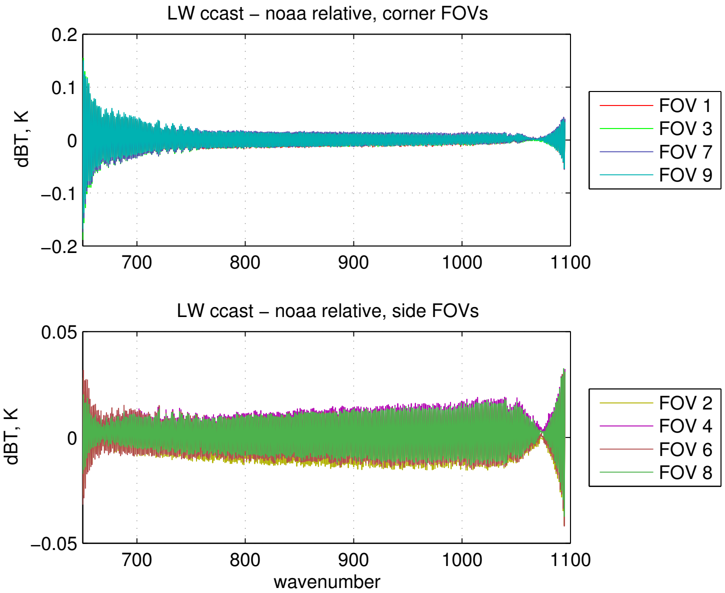
ccast minus noaa fovs 1, 2, and 5



ccast minus noaa all fovs



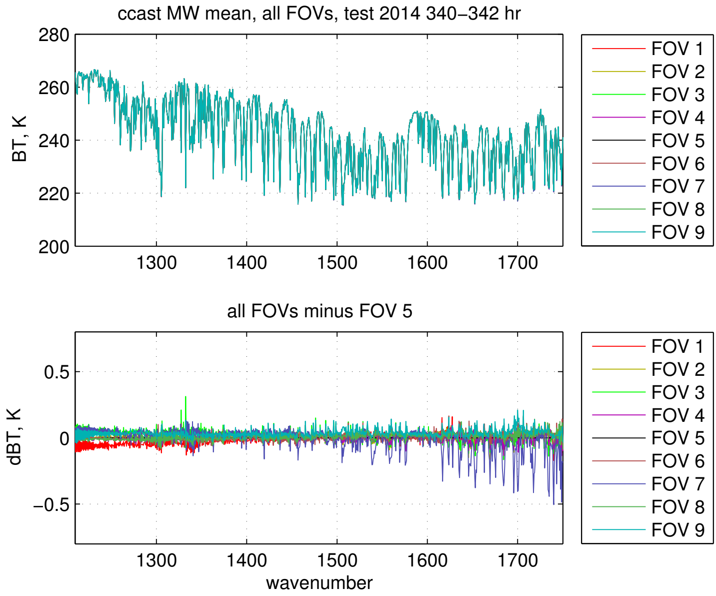
ccast minus noaa relative, all fovs



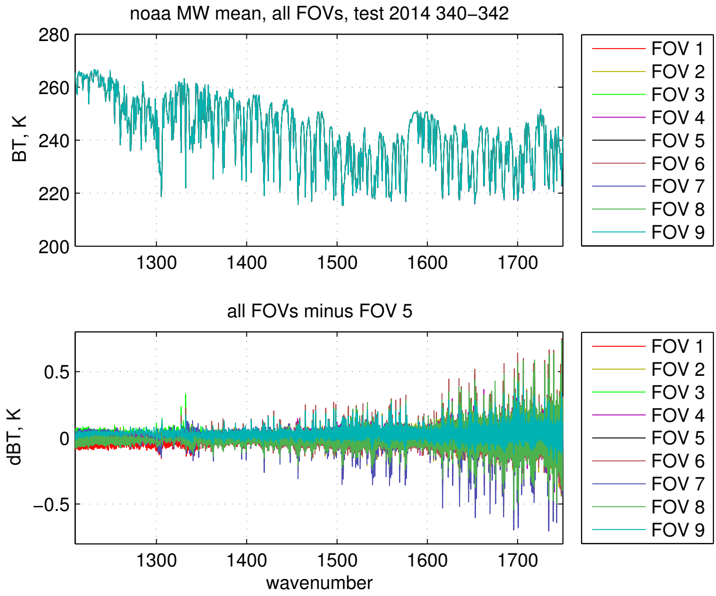
LW discussion

- ccast and noaa are generally in good agreement
- in the LW, ccast is around 0.02K colder than noaa
- in the previous slide, "ccast minus noaa relative" is (ccast all FOVs − FOV 5) − (noaa all FOVs − FOV 5)
- the ccast nonlinearity correction uses the UW a2 values
- the slightly greater difference at 650 cm^{-1} may be due to different processing filters. umbc ccast uses the same raised cosine filters for internal processing and the calculation of reference truth
- the current ccast calibration equations and ILS are shown in the support slides

ccast MW mean

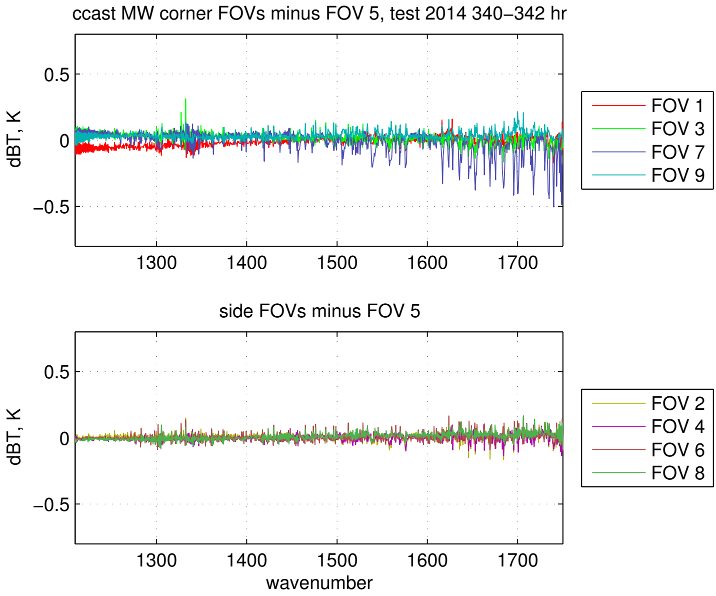


noaa MW mean

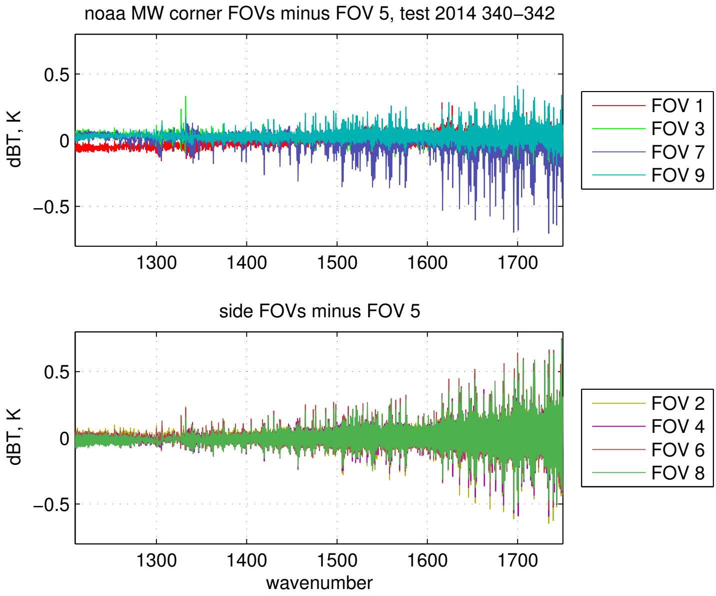


noaa MW mean, all FOVs, test 2014 340–342
BT, K
280
260
240
220
200
1300
1400
1500
1600
1700
FOV 1
FOV 2
FOV 3
FOV 4
FOV 5
FOV 6
FOV 7
FOV 8
FOV 9
all FOVs minus FOV 5
dBT, K
0.5
0
–0.5
1300
1400
1500
1600
1700
wavenumber
FOV 1
FOV 2
FOV 3
FOV 4
FOV 5
FOV 6
FOV 7
FOV 8
FOV 9

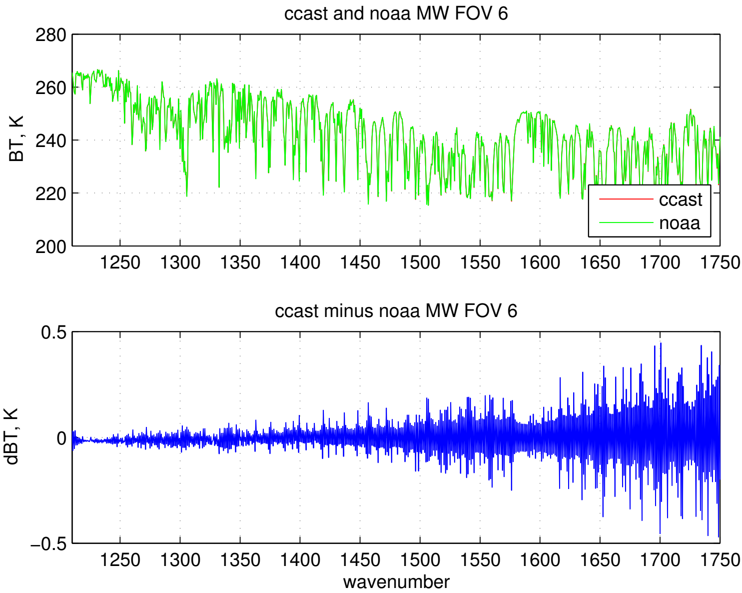
ccast MW breakout



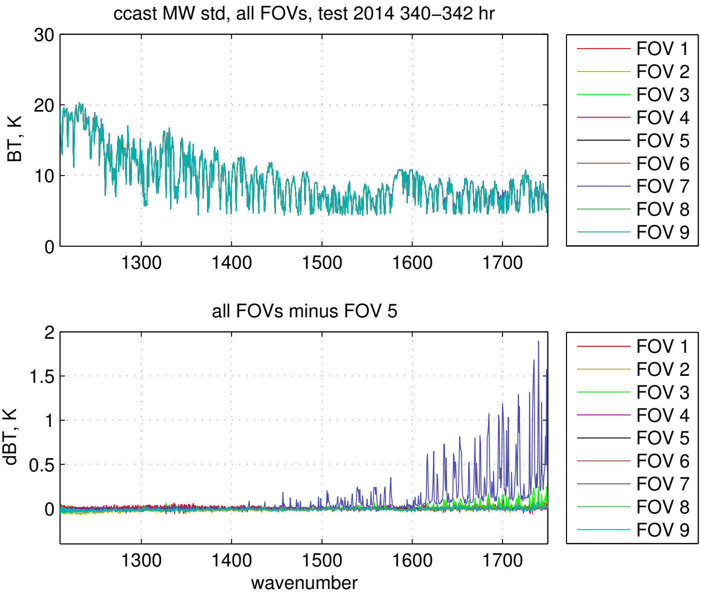
noaa MW breakout



ccast minus noaa FOV 6



ccast MW std

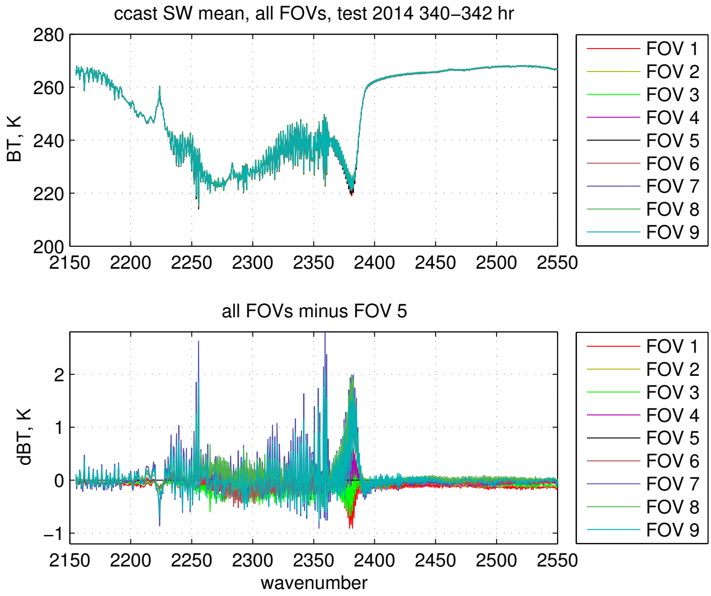


ccast MW std, all FOVs, test 2014 340–342 hr
BT, K
30
20
10
0
1300
1400
1500
1600
1700
FOV 1
FOV 2
FOV 3
FOV 4
FOV 5
FOV 6
FOV 7
FOV 8
FOV 9
all FOVs minus FOV 5
dBT, K
2
1.5
1
0.5
0
1300
1400
1500
1600
1700
wavenumber
FOV 1
FOV 2
FOV 3
FOV 4
FOV 5
FOV 6
FOV 7
FOV 8
FOV 9

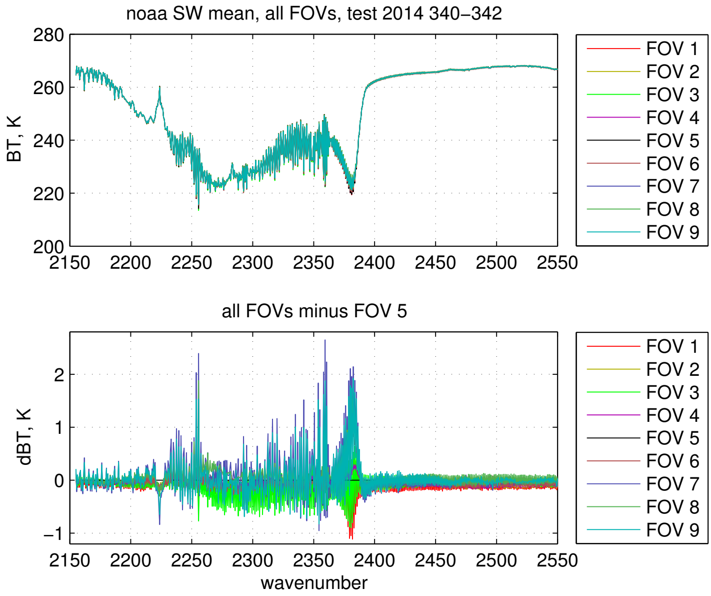
MW discussion

- the noaa MW FOV response is too variable
- this may be due to problems with the nonlinearity correction
- the ccast MW nonlinearity correction uses the UW a2 values
- FOV 7 is the most nonlinear, and only partially corrected with the ccast first order adjustment
- 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

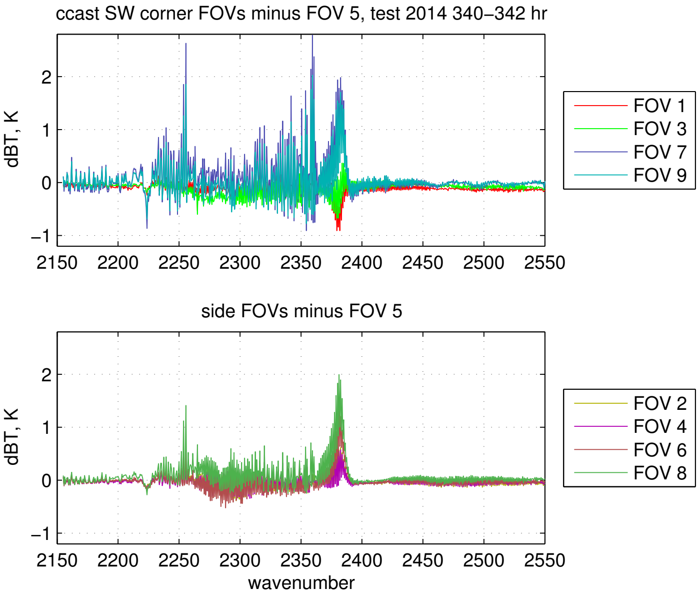
ccast SW mean



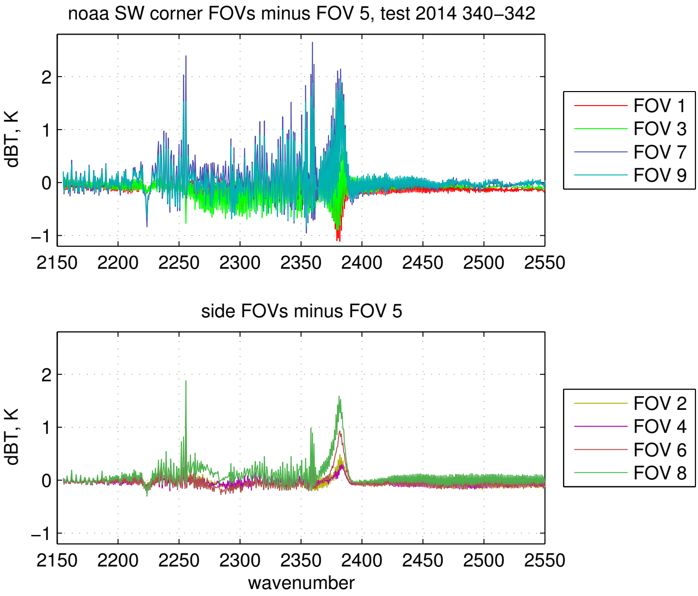
noaa SW mean


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
2150
2200
2250
2300
2350
2400
2450
2500
2550
wavenumber
FOV 1
FOV 2
FOV 3
FOV 4
FOV 5
FOV 6
FOV 7
FOV 8
FOV 9

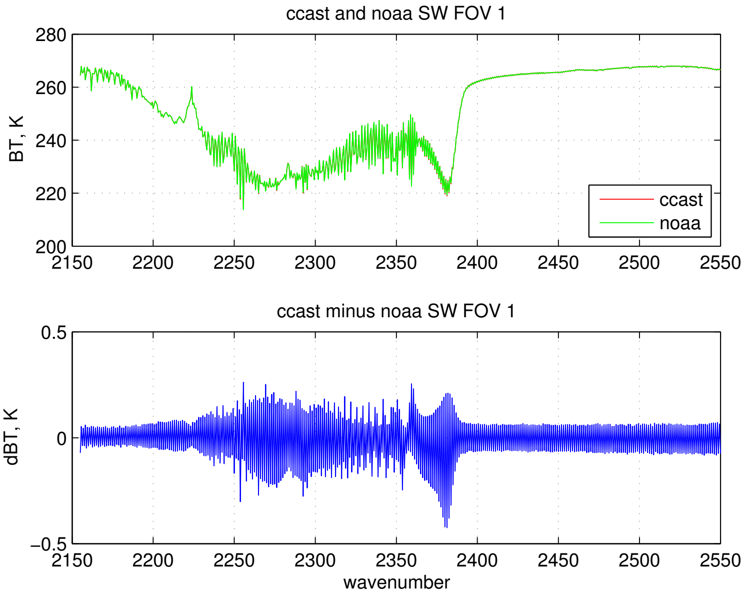
ccast SW breakout



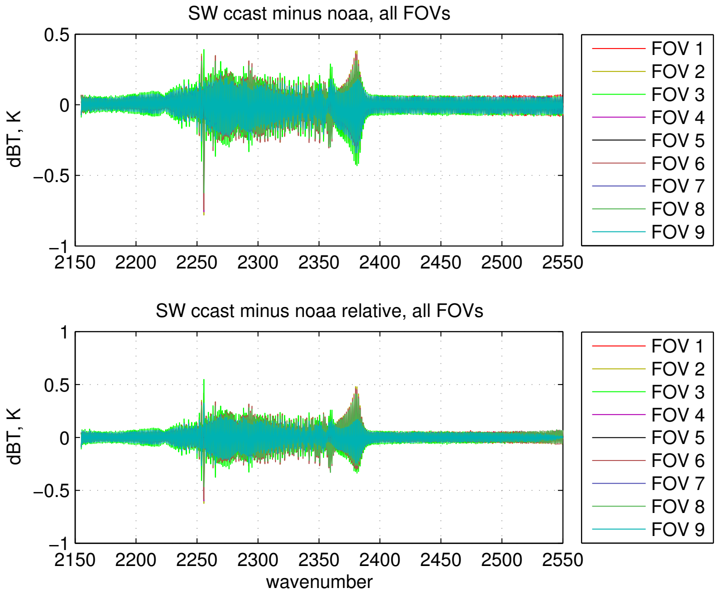
noaa SW breakout



ccast minus noaa FOV 1



ccast minus noaa all FOVs



SW discussion

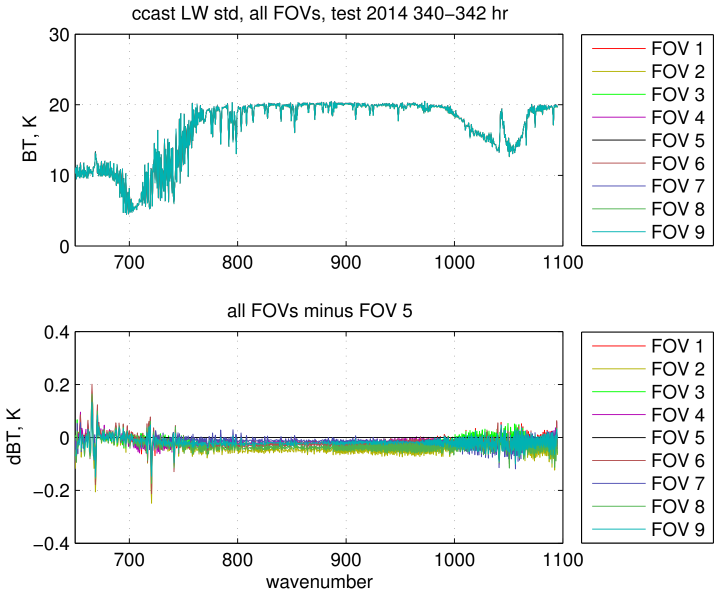
- ccast and noaa are generally in good agreement
- residuals are significantly larger than for the LW band
- residuals and noaa vs ccast differences are generally greatest at the coldest lines and regions
- FOV 7 minus FOV 5 is significantly greater than for other FOVs at 2255 and 2359 cm^{-1}

conclusions

- we are seeing a significant convergence in ccast and noaa processing
- note that these results are relative to FOV 5 or are direct comparisons, and are not comparisons with with expected observed radiance from model data or other sources

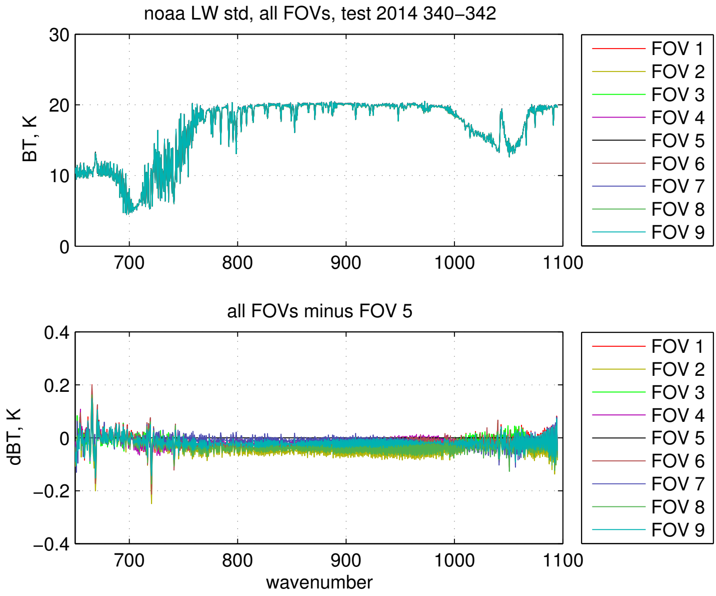
- supplementary slides include
  - a comparison of standard deviations
  - ccast ILS and calibration equations

ccast LW std



ccast LW std, all FOVs, test 2014 340–342 hr
BT, K
30
20
10
0
700
800
900
1000
1100
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
0.4
0.2
0
−0.2
−0.4
700
800
900
1000
1100
wavenumber
FOV 1
FOV 2
FOV 3
FOV 4
FOV 5
FOV 6
FOV 7
FOV 8
FOV 9

noaa LW std



noaa LW std, all FOVs, test 2014 340–342
BT, K
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FOV 1
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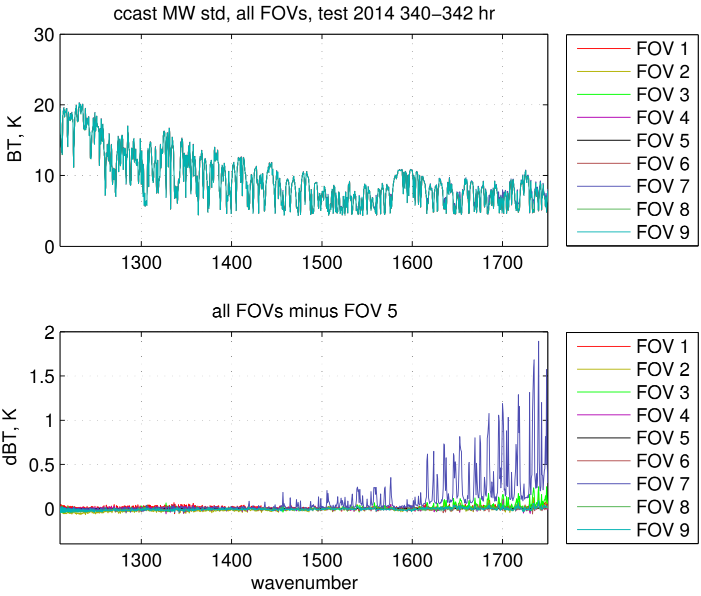
FOV 5
FOV 6
FOV 7
FOV 8
FOV 9
all FOVs minus FOV 5
dBT, K
0.4
0.2
0
–0.2
–0.4
wavenumber

ccast MW std



ccast MW std, all FOVs, test 2014 340–342 hr
BT, K
30
20
10
0
1300
1400
1500
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1700
FOV 1
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FOV 3
FOV 4
FOV 5
FOV 6
FOV 7
FOV 8
FOV 9
all FOVs minus FOV 5
dBT, K
2
1.5
1
0.5
0
1300
1400
1500
1600
1700
wavenumber
FOV 1
FOV 2
FOV 3
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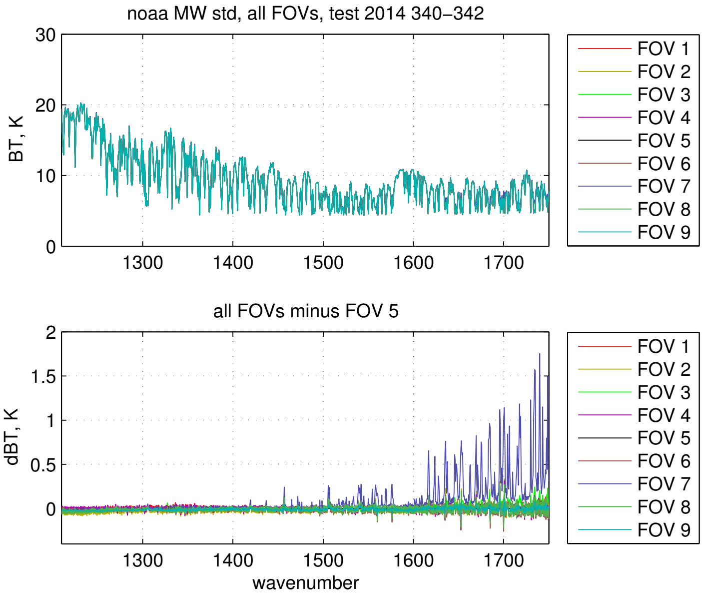
FOV 7
FOV 8
FOV 9

noaa MW std



noaa MW std, all FOVs, test 2014 340–342
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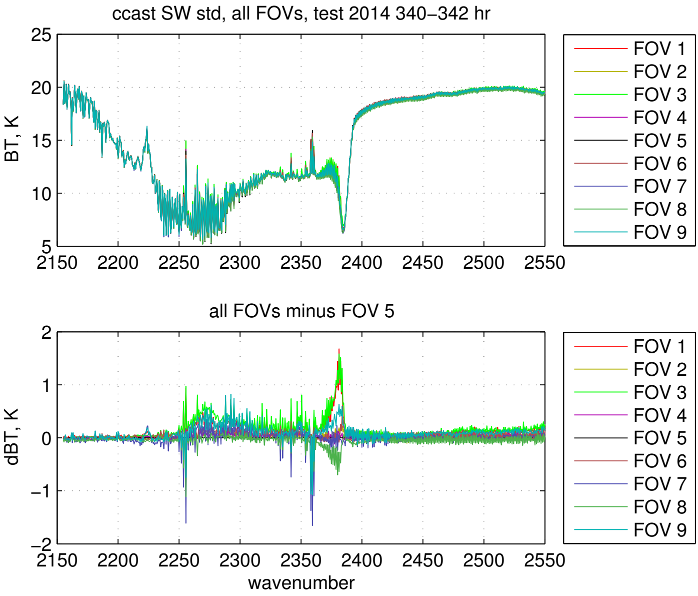
FOV 9

ccast SW std



ccast SW std, all FOVs, test 2014 340–342 hr
BT, K
25
20
15
10
5
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
−2
2150
2200
2250
2300
2350
2400
2450
2500
2550
wavenumber
FOV 1
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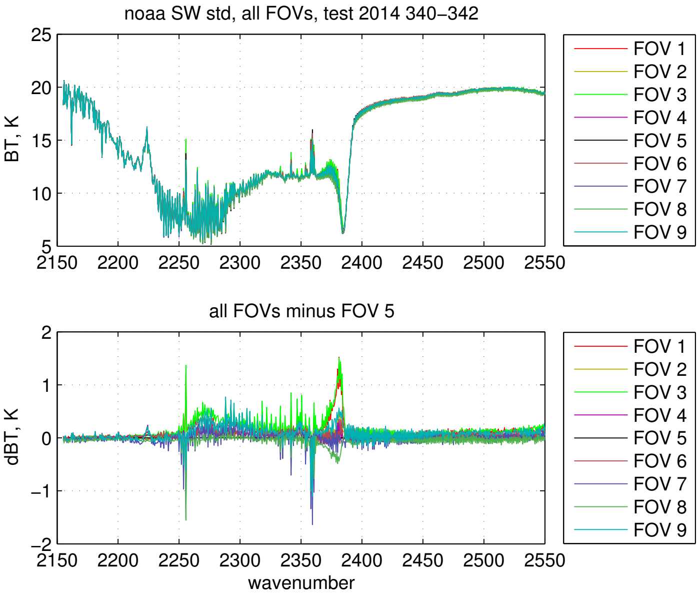
FOV 7
FOV 8
FOV 9

noaa SW std



noaa SW std, all FOVs, test 2014 340–342
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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
−2
wavenumber

calibration equation

The CCAST reference calibration equation is

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

- r_{OBS} is calibrated radiance at the user grid
- F is Fourier interpolation from sensor to user grid
- f is a raised-cosine bandpass filter
- r_{ICT} is expected ICT radiance at the sensor grid
- SA^{-1} is the inverse of the ILS matrix
- ES is earth-scene count spectra
- IT is calibration target count spectra
- SP is space-look count spectra

calibration notes

- the IT and SP looks are averaged over several scans
- we divide the count spectra by the numeric filter at the sensor grid, but this cancels out in the ratio $(\mathrm{ES}-\mathrm{SP})/(\mathrm{IT}-\mathrm{SP})$
- F is a zero-filled double Fourier interpolation
- $f \cdot \mathrm{SA}^{-1} \cdot f$ can be considered as a physically-based smoothing of the rows and columns of SA^{-1}

CCAST ILS

the CrIS ILS for FOV_i can be represented as

$$\int_{\mathrm{FOV}_i} w_i(\theta)\,\mathrm{sinc}(2\pi d(v - v_0 \cos\theta))\,d\theta$$

- d is max OPD
- v is frequency
- v_0 is reference or channel frequency
- $\mathrm{sinc}(x) = sin(x)/x$ for $x \neq 0$, 1 for $x = 0$.
- $\mathrm{sinc}(2\pi d(v - v_0 \cos\theta))$ gives the ILS for a single ray at off-axis angle θ
- integration is over the intersection of on-axis arcs with FOV_i, with $w_i(\theta)$ the length of an intersecting arc at off-axis angle θ