

CrIS Sep 2013 Gas Cell Test

preliminary analysis and applications

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overview

- ▶ Preliminary analysis of the 23 Sep 2013 CrIS FM2 gas cell bench test shows good agreement with calculated data.
- ▶ We present representative results and consider applications determining the ILS and form of the calibration equation.
- ▶ The test uses a gas cell between the instrument and a black body. Four measurements are made: cell full with BB at T_1 , cell full with BB at T_2 , cell empty with BB at T_1 , and cell empty with BB at T_2 .
- ▶ Let FT_1 , FT_2 , ET_1 and ET_2 be the corresponding on-axis count spectra. Then

$$\tau = (FT_2 - FT_1)/(ET_2 - ET_1)$$

gives a good approximation of the gas cell transmittance.

methods

The main processing steps are

- ▶ read the CCSDS data packets
- ▶ take interferograms to count spectra
- ▶ take the mean of spectra over stable test intervals
- ▶ find $\tau_{\text{obs}} = f \circ SA^{-1} \circ f((FT_2 - FT_1)/(ET_2 - ET_1))$
- ▶ compare observed and calculated spectra

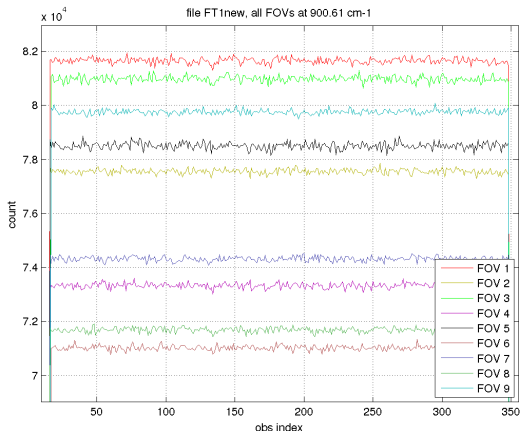
The last step can be embedded in a search where we minimize $\text{RMS}(a \cdot \tau_{\text{obs}} + b - \tau_{\text{calc}})$ as a function of metrology laser wavelength. From this we get both a conventional residual and the difference of wavelength at the minima from the Neon calibration value.

test parameters

- ▶ metrology laser wavelength from Neon cal
- ▶ 4 Oct 2013 Exelis side 1 focal plane values
- ▶ ILS calculation done initially with sinc
- ▶ gas cell pressure nominal 40.128 torr
- ▶ gas cell pressure used 22 torr, from our fit
- ▶ gas cell length nominal 12.59 cm
- ▶ gas cell length used 12.543 cm, from 2008 TVAC
- ▶ test temperatures

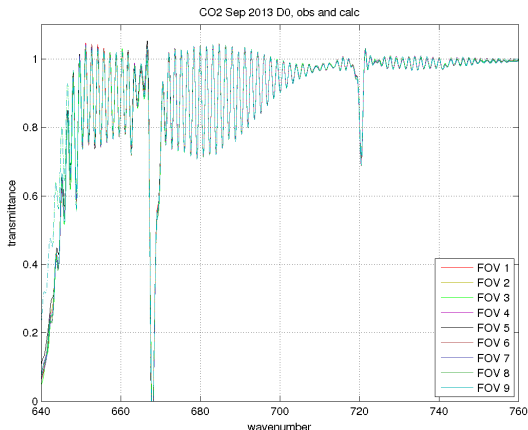
Collection	HTBB Temp K	Temp K
Empty Cold	319.66	304.07
Empty Hot	368.17	304.00
Filled Cold	319.67	303.66
Filled Hot	368.15	303.61

test data



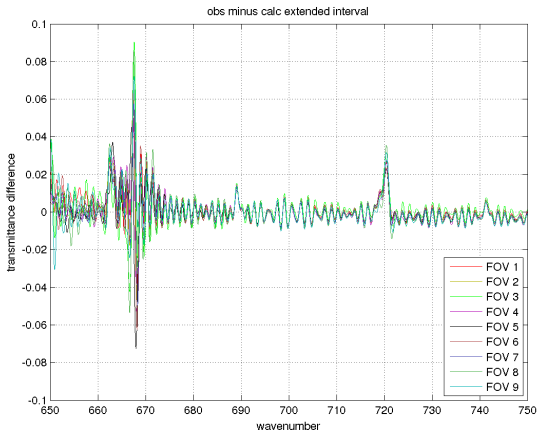
A midband channel from count spectra for one sweep direction over the course of a test segment. std / mean is about 0.0013 for each FOV, for the channel shown here.

obs and calc



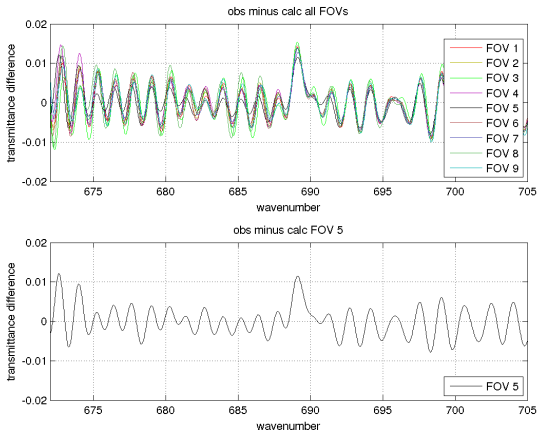
Observed and calculated transmittance spectra for all FOVs, for side 1, sweep direction 0. At this level of detail we see all values are very close.

obs minus calc



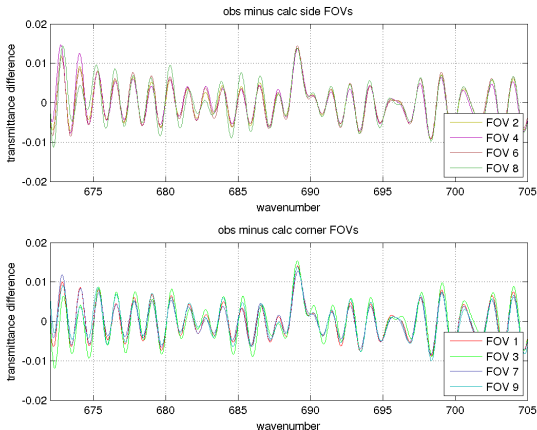
Observed minus calculated transmittance spectra for all FOVs, over an extended interval.

obs minus calc



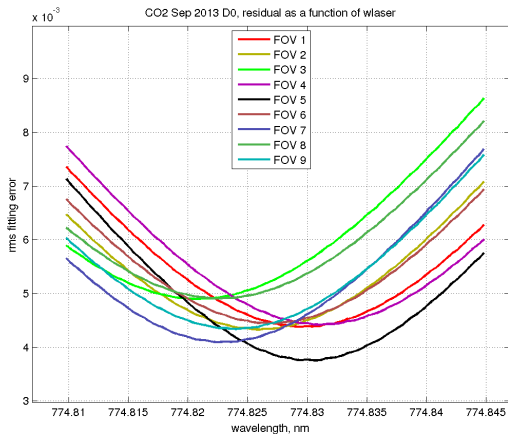
Observed minus calculated transmittance spectra for all FOVs, and for just FOV 5, over the fitting interval.

obs minus calc



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

fitting residuals



Fitting residuals $\text{RMS}(a \cdot \tau_{\text{obs}} + b - \tau_{\text{calc}})$ as a function of metrology laser wavelength, for each FOV.

tabulated residuals

metrology laser residuals

PPM	-9.55	1.55	-0.52
FOV	7	4	1
PPM	-9.55	1.03	-5.16
FOV	8	5	2
PPM	-7.49	-3.36	-11.87
FOV	9	6	3

regression fitting weights

FOV	<i>a</i> wt	<i>b</i> wt	residual	met laser
1	1.001	-0.0052	0.0044	774.8294
2	0.990	0.0053	0.0043	774.8258
3	1.015	-0.0168	0.0049	774.8206
4	0.984	0.0099	0.0044	774.8310
5	0.957	0.0365	0.0038	774.8306
6	1.001	-0.0042	0.0044	774.8272
7	1.000	-0.0043	0.0041	774.8224
8	0.987	0.0075	0.0049	774.8224
9	0.986	0.0083	0.0043	774.8240

conclusions

- ▶ data collection looks very stable
- ▶ the metrology laser residuals look good for a bench test
- ▶ the a and b weights are very close to 1 and 0 respectively, suggesting our estimate of 22 torr cell pressure is not too far off. But earlier tests assuming a 10 cm cell and 25 torr also gave a good fit.
- ▶ the difference between the nominal and fitted cell pressures might be due to the CO_2 being a partial pressure
- ▶ results were similar for sweep direction 1

applications

- ▶ gas cell tests may help resolve questions about the best form of the ILS and calibration equations.
- ▶ we have both good calculated data and observations averaged over many looks. But the spectral signal is small relative to the BB as seen thru the filters, and not always larger than the obs to obs variance.
- ▶ our initial tests found no significant difference in periodic vs regular sinc in comparing obs minus calc or sweep directions.
- ▶ we did see a 1 or 2 PPM improvement in the metrology laser residuals with a calibration equation of the form

$$\tau_{\text{obs}} = f(\text{SA}^{-1}f(\text{FT}_2 - \text{FT}_1)/\text{SA}^{-1}f(\text{ET}_2 - \text{ET}_1))$$