

A first look at the Jan 2020 CrIS TVAC PFH gas cell tests

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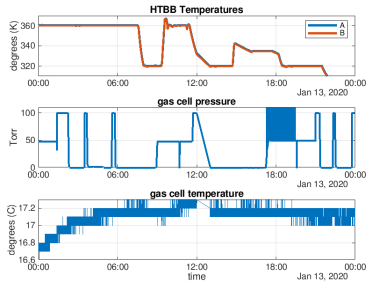
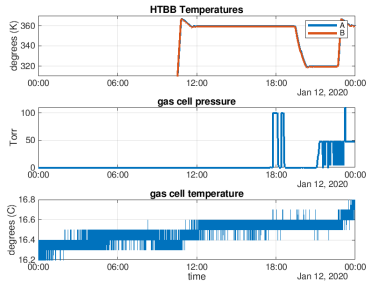
Introduction

- ▶ We present a preliminary analysis of the PFH Plateau 21 CH_4 , CO_2 , and CO gas cell tests, and compare these with calculated reference truth from LBLRTM and UMBC-LBL.
- ▶ We have also done a reanalysis of the PFL Plateau 20 test with more careful harvesting of the individual test legs and more accurate calculated transmittances. The resulting changes to the metrology laser relative residuals were less than 1 ppm.
- ▶ Examples of monitoring test logs (the CSS, CMD, and TCR files) are given in the form of plots of HTBB temperature, gas cell temperature, and gas cell pressure over time.
- ▶ The J2 tests continue to be done at the older 866/1052/799 point resolutions.

Methods

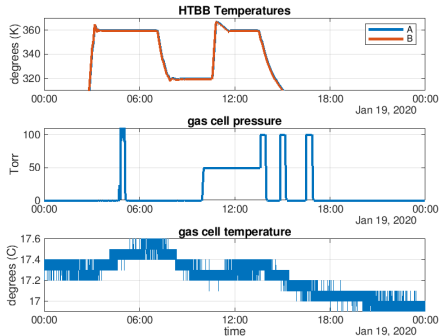
- ▶ For each gas we partition the data stream into four test legs, FT1, FT2, ET1, and ET2 (cell full, HTBB temperature T1, etc.)
- ▶ For test each leg, we take the mean of the associated count spectra, calculate the transmittance as $(FT2 - FT1)/(ET2 - ET1)$, apply our standard processing filters, and do the SA correction, all at the sensor grid. Expected transmittance values are also calculated at the sensor grid.
- ▶ This is similar in some ways to the “ratio first” calibration algorithm used as an option in UMBC CCAST processing, but note that we do not do a full radiance calibration, or any nonlinearity correction, for the analysis here.
- ▶ Measured and calculated transmittances are compared first as is, and then by fitting obs to calcs and examining fitting weights and residuals.
- ▶ This approach, with fitting adjustments, is acceptable for our application because our main task is spectral calibration and our fitting methods are robust in the face of radiometric uncertainty.

12-13 Jan 2020 TVAC PFH Plateau 21



HTBB temperatures, gas cell pressure and gas cell temperature from the CCS files, for 12-13 Jan 2020. This data is used along with a scan of the CMD and SQL files for an overview and to find the test stages.

19 Jan 2020 TVAC PFH Plateau 21

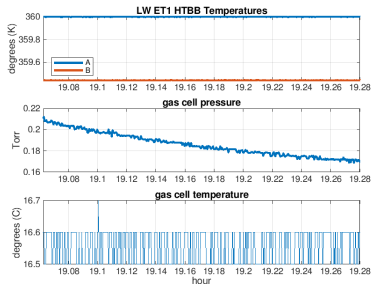


HTBB temperatures, gas cell pressure and gas cell temperature from the CCS files, for 19 Jan 2020. This data is used along with a scan of the CMD and SQL files for an overview and to find the test stages.

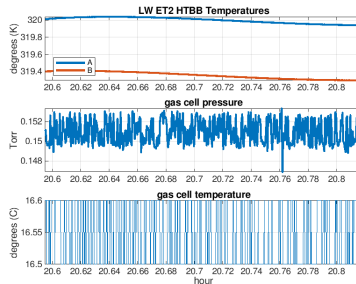
CO₂ LW PFH side 1 test parameters

- ▶ PFH Plateau 21, 12 Jan 2019
- ▶ side 1, sweep direction 0
- ▶ fitting interval 672 to 712 cm⁻¹
- ▶ metrology laser 774.22556 nm, from neon 703.44765 nm
- ▶ ATBD default focal plane
- ▶ SA correction from ILS with periodic sinc at the sensor grid
- ▶ HTBB nominal T1 360 K, T2 320 K
- ▶ gas cell pressure 48.36 Torr
- ▶ gas cell temperature 16.65 C
- ▶ gas cell length 12.59 cm

CO₂ PFH side 1 cell empty test legs

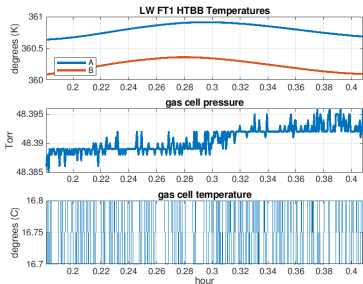


ET1 “empty high” leg of the the 12 Jan CO₂ transmittance test. The x-axis here is hour of the day. The HTBB temps are stable but we see a vestigial pressure drift.

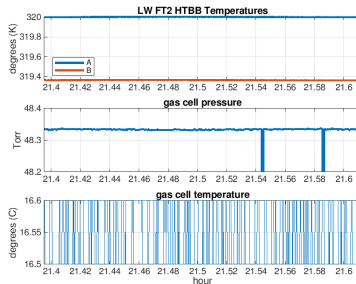


ET2 “empty low” leg of the the 13 Jan CO₂ transmittance test. We see some HTBB drift.

CO₂ PFH side 1 cell full test legs

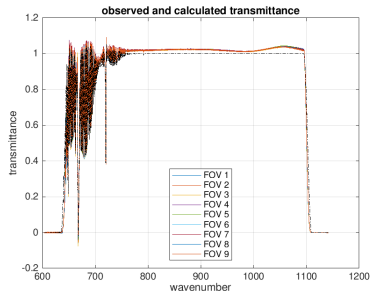


FT1 “full high” leg of the the 12 Jan CO₂ transmittance test. The x-axis is hour of the day. As in the empty low leg we see some HTBB drift.

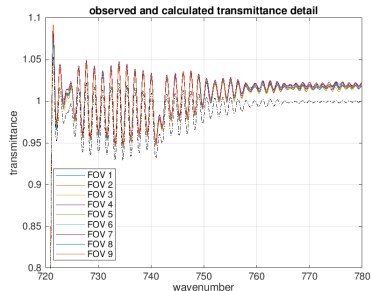


FT2 “full low” leg of the the 12 Jan CO₂ transmittance test. This looks good.

CO₂ side 1 data before fitting

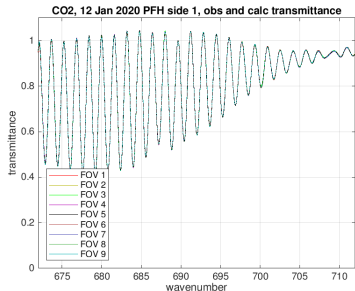


Observed and calculated transmittance after the SA correction but before any fitting. We see a significant bias, possibly due to the HTBB drifts.

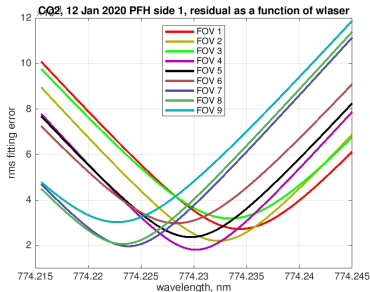


A detail from the previous plot. The FOV to FOV consistency is relatively good.

CO₂ side 1 fitting overview

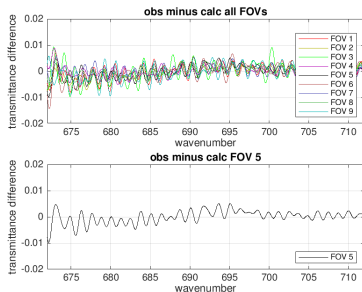


Observed and calculated transmittance for all FOVs, over the fitting interval. At this level of detail we see all values are very close.

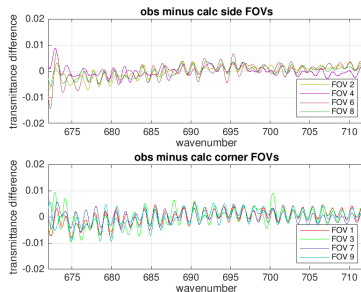


Residuals $\text{RMS}(a \cdot \tau_{\text{obs}} + b - \tau_{\text{calc}})$ over the fitting interval as a function of metrology laser wavelength, for each FOV.

CO₂ side 1 obs minus calc breakouts



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



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

CO₂ side 1 tabulated residuals

metrology laser absolute residuals, ppm

-2.20	5.94	11.37	7	4	1
-2.97	5.42	8.65	8	5	2
-3.62	3.62	10.20	9	6	3

metrology laser relative residuals, ppm

-7.62	0.52	5.94	7	4	1
-8.40	0.00	3.23	8	5	2
-9.04	-1.81	4.78	9	6	3

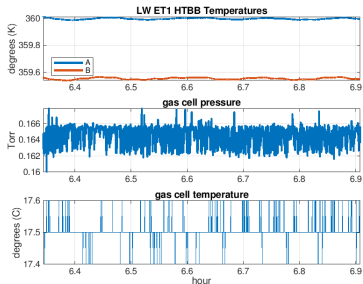
regression fitting weights and residuals

FOV	"a"	"b"	dmin	wmin	wfov
1	0.975	0.0032	0.0027	11.37	774.2344
2	0.975	0.0058	0.0022	8.65	774.2323
3	0.976	0.0060	0.0032	10.20	774.2335
4	0.968	0.0068	0.0018	5.94	774.2302
5	0.964	0.0144	0.0024	5.42	774.2298
6	0.982	-0.0013	0.0030	3.62	774.2284
7	0.976	-0.0037	0.0020	-2.20	774.2239
8	0.975	0.0052	0.0021	-2.97	774.2233
9	0.982	-0.0017	0.0030	-3.62	774.2228

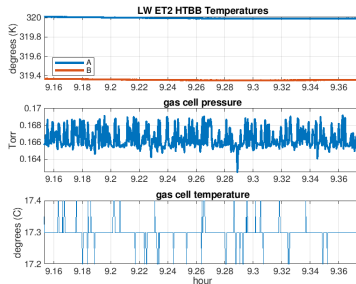
CO₂ LW PFH side 2 test parameters

- ▶ PFH Plateau 21, 19 Jan 2019
- ▶ side 2, sweep direction 0
- ▶ fitting interval 672 to 712 cm⁻¹
- ▶ metrology laser 775.20773 nm, from neon 703.44765 nm
- ▶ ATBD default focal plane
- ▶ SA correction from ILS with periodic sinc at the sensor grid
- ▶ HTBB nominal T1 360 K, T2 320 K
- ▶ gas cell pressure 49.75 Torr
- ▶ gas cell temperature 17.27 C
- ▶ gas cell length 12.59 cm

CO₂ PFH side 2 cell empty test legs

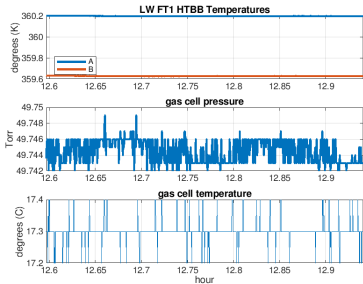


ET1 “empty high” leg of the the 19 Jan side 2 CO₂ transmittance test. The x-axis is hour of the day. We see a small HTBB temperature wobble.

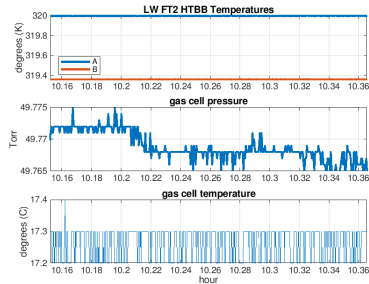


ET2 “empty low” leg of the the 13 Jan CO₂ transmittance test. This looks good.

CO₂ PFH side 2 cell full test legs

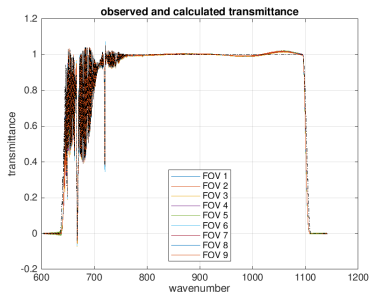


FT1 “full high” leg of the the 19 Jan CO₂ transmittance test. The x-axis is hour of the day. This looks good

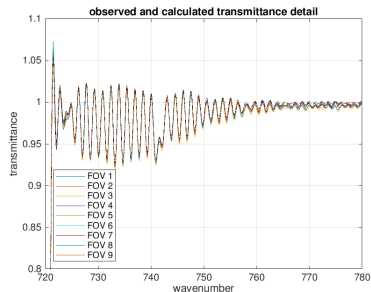


FT2 “full low” leg of the the 19 Jan CO₂ transmittance test. This looks good, the pressure drift is very small.

CO₂ side 2 data before fitting

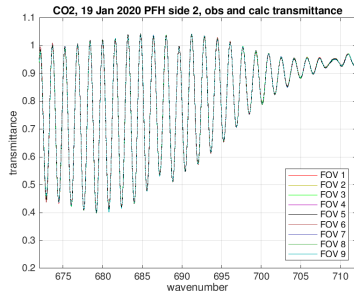


Observed and calculated transmittance after the SA correction but before any fitting. This looks much better than the CO₂ side 1 case.

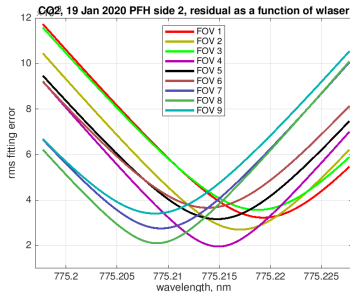


A detail from the previous plot. FOV to FOV consistency and agreement with calculated transmittance is relatively good.

CO₂ side 2 fitting overview

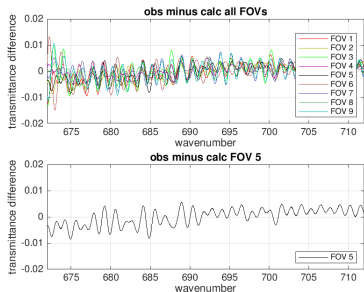


Observed and calculated transmittance for all FOVs, over the fitting interval. At this level of detail we see all values are very close.

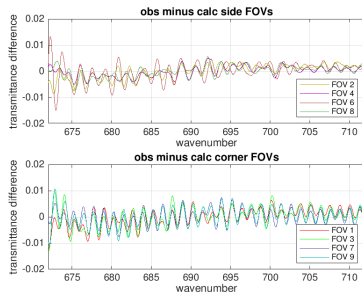


Residuals $\text{RMS}(a \cdot \tau_{\text{obs}} + b - \tau_{\text{calc}})$ over the fitting interval as a function of metrology laser wavelength, for each FOV.

CO₂ side 2 obs minus calc breakouts



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



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

CO₂ side 2 tabulated residuals

metrology laser absolute residuals, ppm

2.06	9.29	14.96	7	4	1
1.55	9.16	12.00	8	5	2
1.16	8.00	14.32	9	6	3

metrology laser relative residuals, ppm

-7.09	0.13	5.80	7	4	1
-7.61	0.00	2.84	8	5	2
-8.00	-1.16	5.16	9	6	3

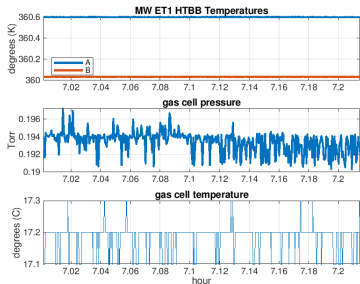
regression fitting weights and residuals

F0V	"a"	"b"	dmin	wmin	wfov
1	0.996	0.0071	0.0032	14.96	775.2193
2	0.995	0.0095	0.0027	12.00	775.2170
3	0.997	0.0084	0.0036	14.32	775.2188
4	0.989	0.0105	0.0020	9.29	775.2149
5	0.997	0.0045	0.0032	9.16	775.2148
6	0.996	0.0062	0.0037	8.00	775.2139
7	0.994	0.0059	0.0028	2.06	775.2093
8	0.994	0.0052	0.0021	1.55	775.2089
9	0.995	0.0041	0.0034	1.16	775.2086

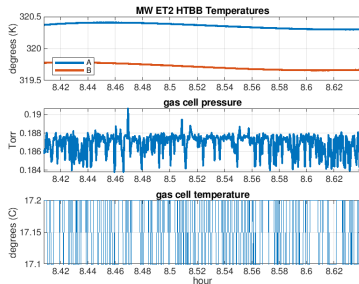
CH₄ MW PFH side 1 test parameters

- ▶ PFH Plateau 21, 13 Jan 2019
- ▶ side 1, sweep direction 0
- ▶ fitting interval 1220 to 1380 cm⁻¹
- ▶ metrology laser 774.22465 nm, from neon 703.44765 nm
- ▶ ATBD default focal plane
- ▶ SA correction from ILS with periodic sinc at the sensor grid
- ▶ HTBB nominal T1 360 K, T2 320 K
- ▶ gas cell pressure 48.70 Torr
- ▶ gas cell temperature 17.17 C
- ▶ gas cell length 12.59 cm

CH₄ PFH side 1 cell empty test legs

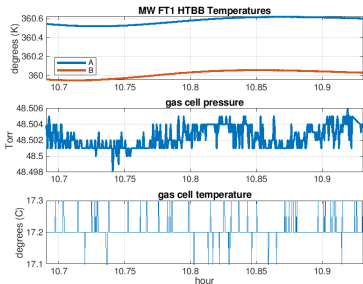


ET1 “empty high” leg of the the 13 Jan CH₄ transmittance test. The x-axis is hour of the day. This looks good.

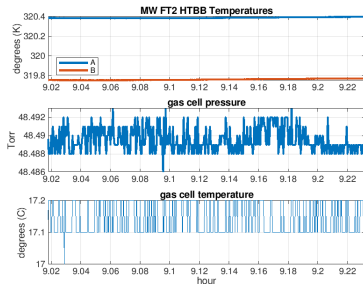


ET2 “empty low” leg of the the 13 Jan CH₄ transmittance test. We see some HTBB drift.

CH₄ PFH side 1 cell full test legs

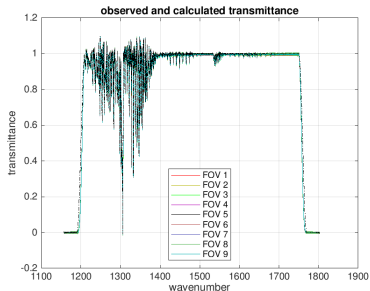


FT1 “full high” leg of the the 13 Jan CH₄ transmittance test. The x-axis is hour of the day. As in the empty low leg we see some HTBB drift.

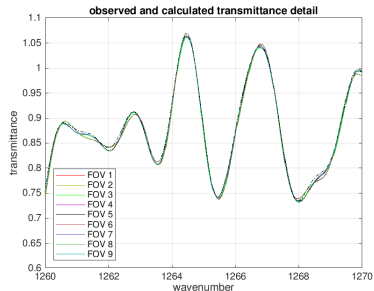


FT2 “full low” leg of the the 13 Jan CH₄ transmittance test. This looks good.

CH₄ side 1 data before fitting

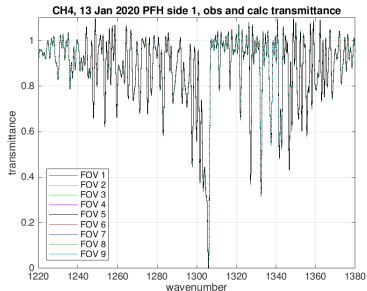


Observed and calculated transmittance after the SA correction but before fitting. This looks relatively good

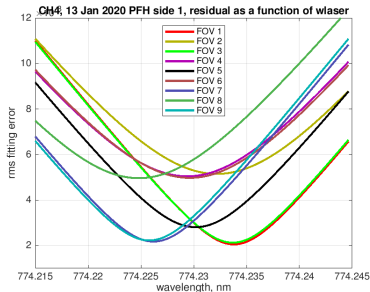


A detail from the previous plot. The FOV to FOV consistency and bias are of a similar, relatively small magnitude.

CH₄ side 1 fitting overview

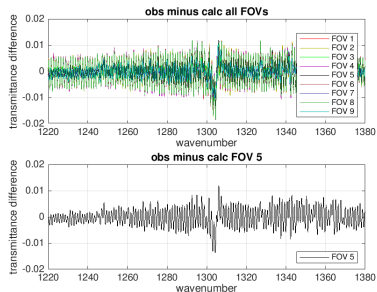


Observed and calculated transmittance for all FOVs, over the fitting interval. At this level of detail we see all values are very close.

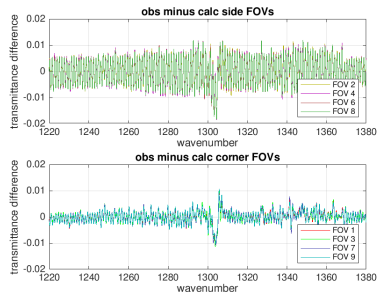


Residuals $\text{RMS}(a \cdot \tau_{\text{obs}} + b - \tau_{\text{calc}})$ over the fitting interval as a function of metrology laser wavelength, for each FOV.

CH₄ side 1 obs minus calc breakouts



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



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

CH₄ side 1 tabulated residuals

metrology laser absolute residuals, ppm

1.94	6.07	11.75	7	4	1
0.26	7.23	9.69	8	5	2
1.42	6.46	11.62	9	6	3

metrology laser relative residuals, ppm

-5.30	-1.16	4.52	7	4	1
-6.97	0.00	2.45	8	5	2
-5.81	-0.77	4.39	9	6	3

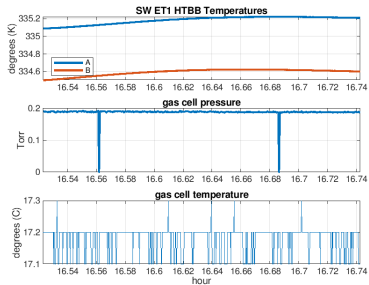
regression fitting weights and residuals

F0V	"a"	"b"	dmin	wmin	wfov
1	0.991	0.0122	0.0020	11.75	774.2338
2	0.994	0.0087	0.0051	9.69	774.2322
3	0.992	0.0108	0.0021	11.62	774.2337
4	0.994	0.0080	0.0050	6.07	774.2294
5	0.992	0.0101	0.0028	7.23	774.2303
6	0.995	0.0073	0.0050	6.46	774.2297
7	0.992	0.0096	0.0022	1.94	774.2262
8	0.995	0.0071	0.0050	0.26	774.2249
9	0.992	0.0103	0.0022	1.42	774.2258

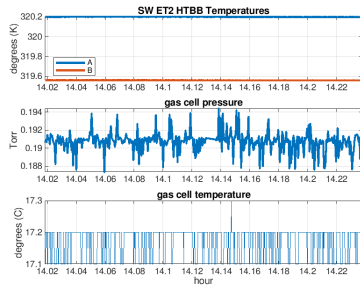
CO SW PFH side 1 test parameters

- ▶ PFH Plateau 21, 13 Jan 2019
- ▶ side 1, sweep direction 0
- ▶ fitting interval 2160 to 2240 cm^{-1}
- ▶ metrology laser 774.22453 nm, from neon 703.44765 nm
- ▶ ATBD default focal plane
- ▶ SA correction from ILS with periodic sinc at the sensor grid
- ▶ HTBB nominal T1 335 K, T2 320 K
- ▶ gas cell pressure 49.58 Torr
- ▶ gas cell temperature 17.15 C
- ▶ gas cell length 12.59 cm

CO PFH side 1 cell empty test legs

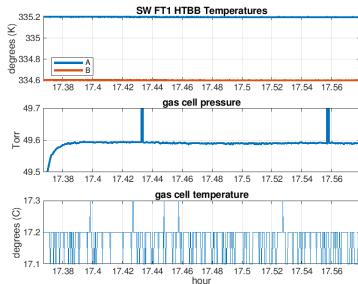


ET1 “empty high” leg of the the 13 Jan CO transmittance test. The x-axis here is hour of the day. We see some HTBB drift.

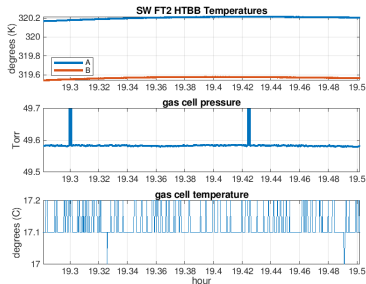


ET2 “empty low” leg of the the 13 Jan CO transmittance test. This looks good.

CO PFH side 1 cell full test legs

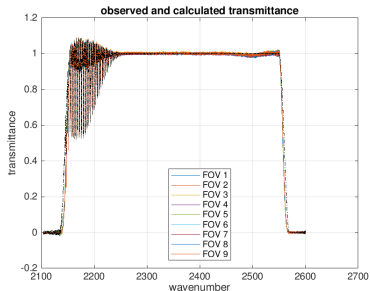


FT1 “full high” leg of the the 13 Jan CO transmittance test. HTBB temps look good but we have a small droop in pressure at the start.

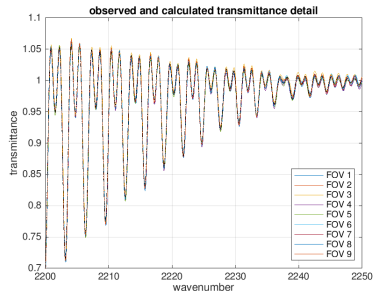


FT2 “full low” leg of the the 13 Jan CO transmittance test. There is a small HTBB drift.

CO side 1 data before fitting

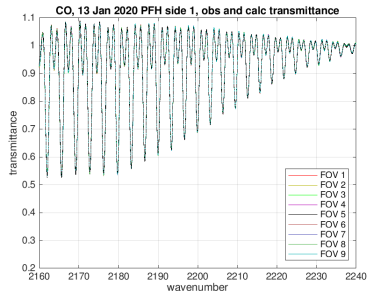


Observed and calculated transmittance after the SA correction but before fitting. This looks relatively good.

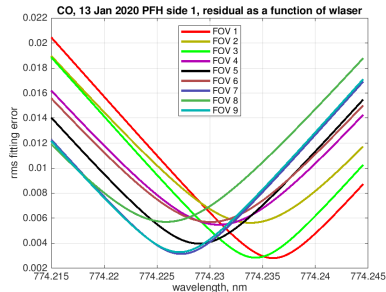


A detail from the previous plot. This looks good.

CO side 1 fitting overview

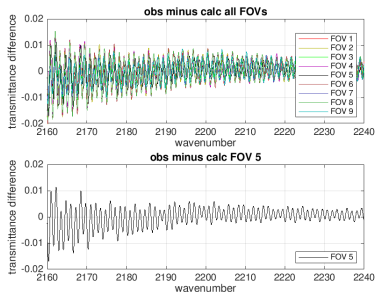


Observed and calculated transmittance for all FOVs, over the fitting interval. At this level of detail we see all values are very close.

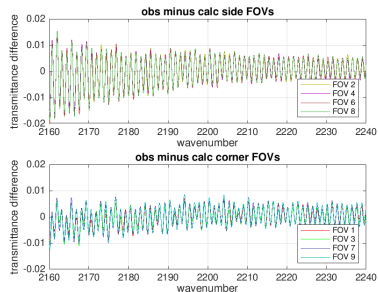


Residuals $\text{RMS}(a \cdot \tau_{\text{obs}} + b - \tau_{\text{calc}})$ over the fitting interval as a function of metrology laser wavelength, for each FOV.

CO side 1 obs minus calc breakouts



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



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

CO side 1 tabulated residuals

metrology laser absolute residuals, ppm

3.62	8.14	14.85	7	4	1
1.68	5.81	12.01	8	5	2
3.49	7.23	12.66	9	6	3

metrology laser relative residuals, ppm

-2.20	2.32	9.04	7	4	1
-4.13	0.00	6.20	8	5	2
-2.32	1.42	6.85	9	6	3

regression fitting weights and residuals

F0V	"a"	"b"	dmin	wmin	wfov
1	0.989	0.0143	0.0028	14.85	774.2360
2	0.990	0.0105	0.0056	12.01	774.2338
3	0.984	0.0136	0.0029	12.66	774.2343
4	0.992	0.0109	0.0055	8.14	774.2308
5	0.991	0.0120	0.0040	5.81	774.2290
6	0.993	0.0069	0.0057	7.23	774.2301
7	0.994	0.0077	0.0031	3.62	774.2273
8	0.998	0.0038	0.0057	1.68	774.2258
9	0.990	0.0104	0.0033	3.49	774.2272

Conclusions

- ▶ We have done a preliminary analysis of the PFH Plateau 21 CH_4 , CO_2 , and CO gas cell tests, and compared these with calculated reference truth. Overall, the results look quite good.
- ▶ The HTBB drift seen in many of the test legs is significant but manageable with our approach to regression fitting. The effect of the drifts could be reduced with more careful subsetting, if needed.
- ▶ Metrology laser relative residuals are in reasonable agreement, and can be reduced further with focal plane adjustments. Metrology laser absolute residuals could be reduced with a more judicious choice of neon wavelength, or possibly by simply using the eng neon value.