Feb 2020 CrIS J2 TVAC MN Gas Cell ILS Tests

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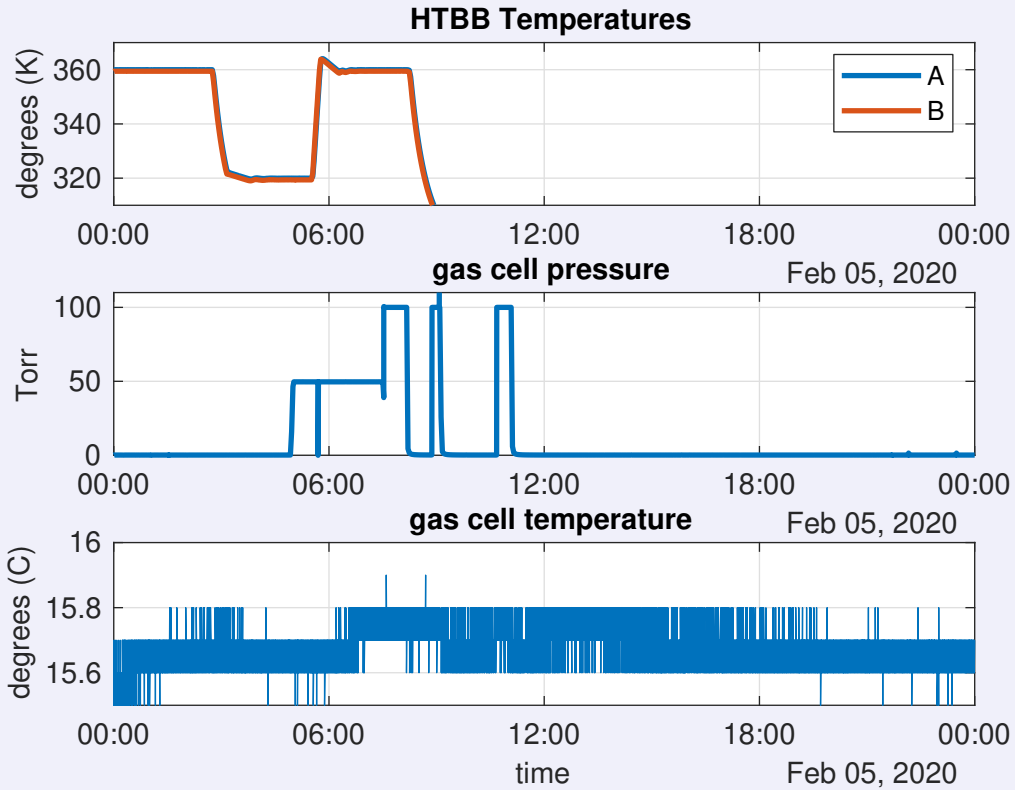
Introduction

- We present an analysis of the CrIS J2 TVAC MN Plateau 22 CO_2, CH_4, and CO gas cell ILS tests, and compare measurements with calculated reference truth from LBLRTM and UMBC-LBL.
- Overall the results look good, with metrology laser residuals consistent across temperature plateaus, sides, and bands.
- 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. We did not have high-level logs for all tests, at the time of this analysis.
- The J2 MN tests were done at the 876/1052/808 point extended resolution, vs. the 866/1052/799 point high resolution used for PFL and PFH.

Methods

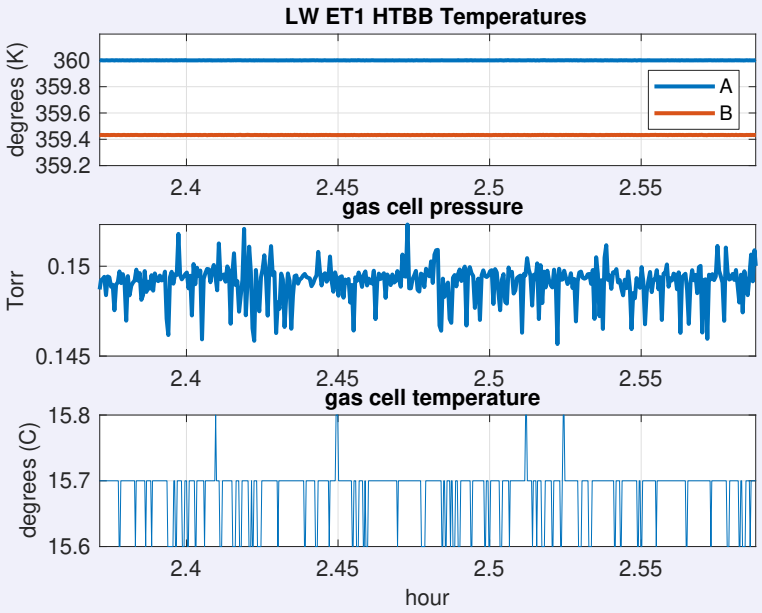
- For each test we partition the data into four legs, FT1, FT2, ET1, and ET2 (cell full, HTBB temperature T1, etc.)
- For each test leg, we take the mean of the associated count spectra, calculate the transmittance as $(FT2 - FT1)/(ET2 - ET1)$, apply our standard processing filters, and do the SA correction, 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.

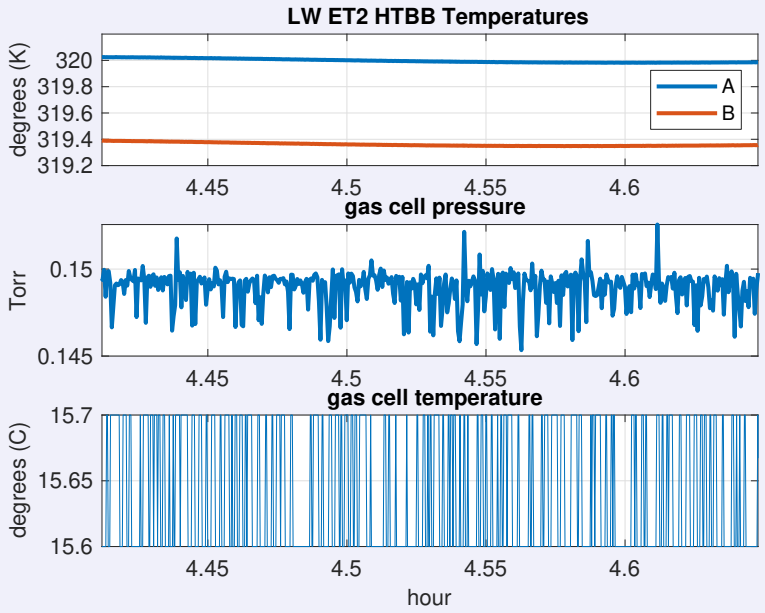
5 Feb 2020 TVAC MN Side 2 Plateau 22

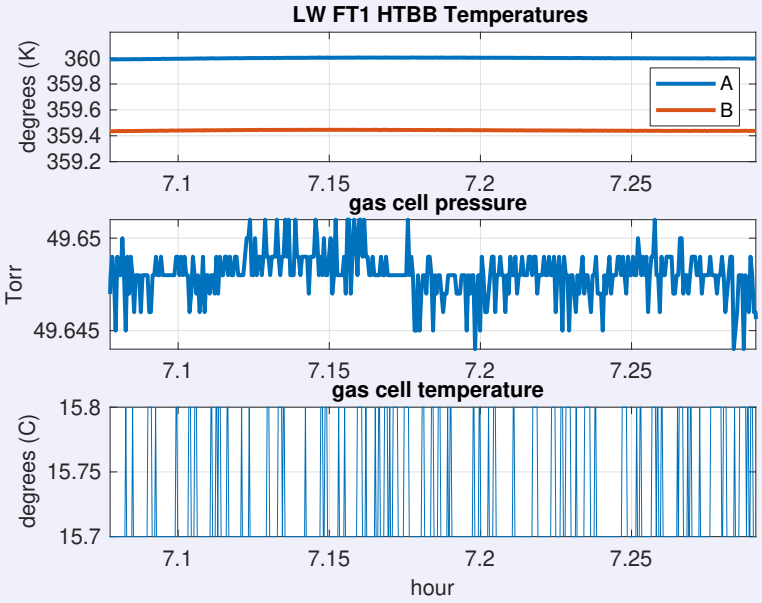


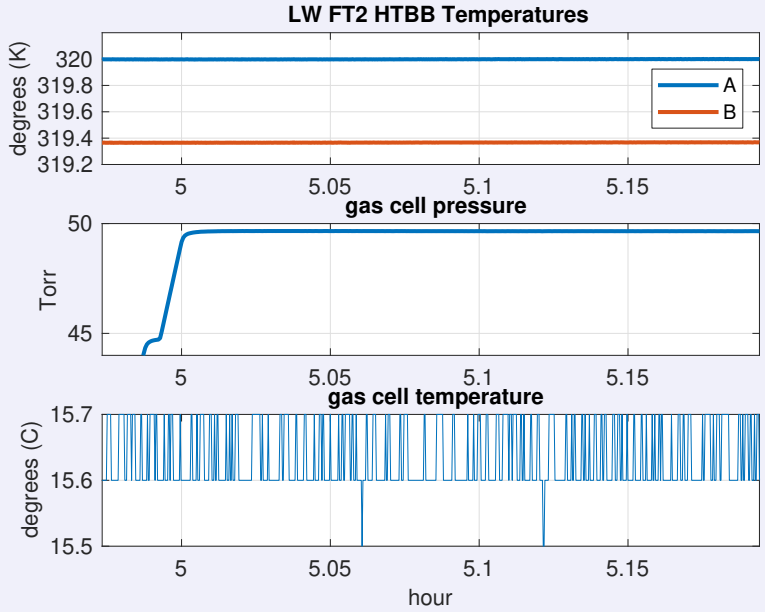
HTBB temperatures, gas cell pressure and gas cell temperature from the CCS files, for 5 Feb 2020. This data is used along with a scan of the CMD and SQL files for an overview and to find the test stages.

CO_2 MN side 2 gas cell test legs





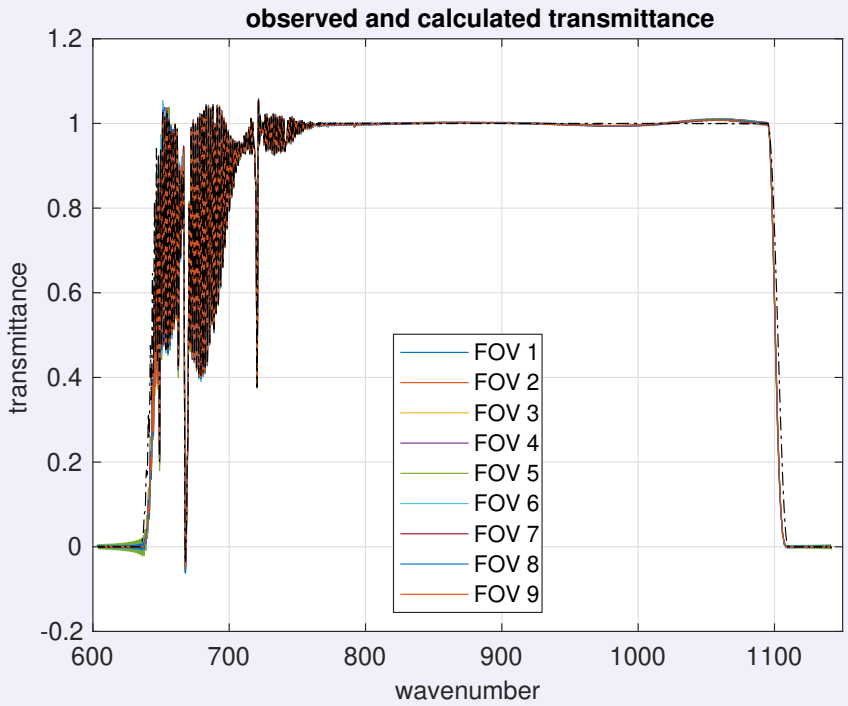




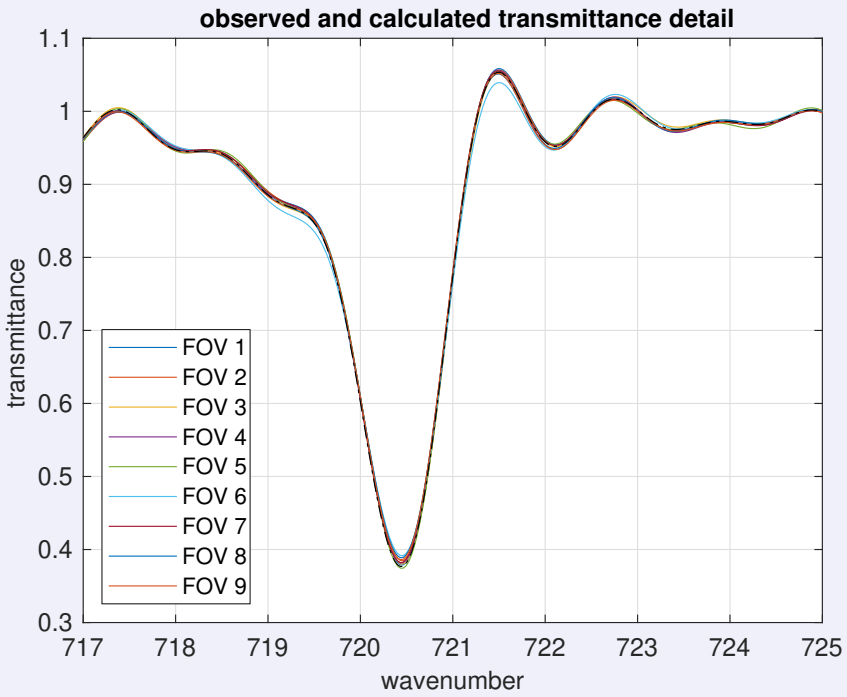
CO_2 LW MN side 2 test parameters

- MN Plateau 22, 5 Feb 2020
- side 2, sweep direction 0
- fitting interval 672 to 712 cm^{-1}
- metrology laser 773.98002 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 49.43 Torr
- gas cell temperature 15.60 C
- gas cell length 12.59 cm

CO_2 side 2 data before fitting

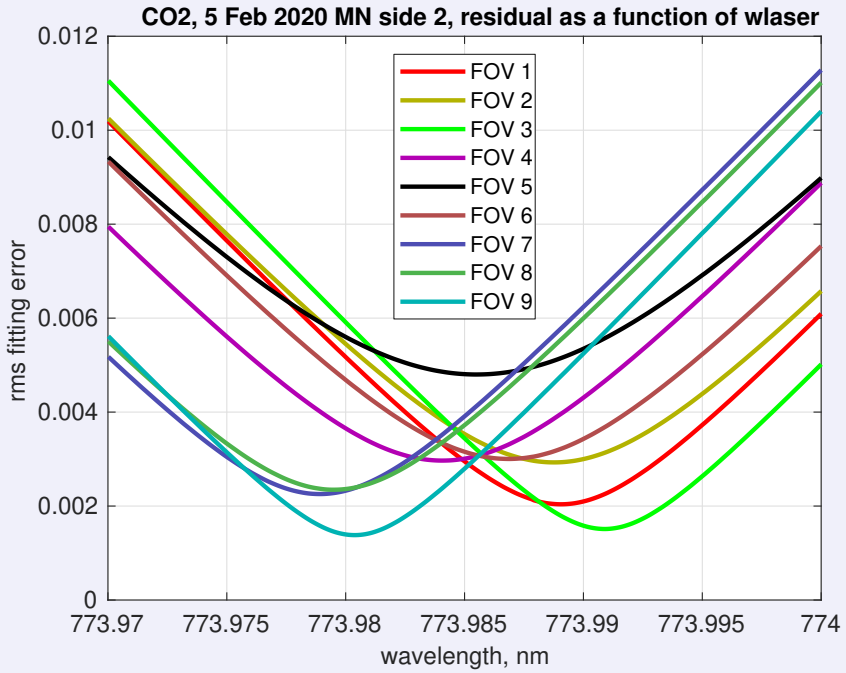


Measured transmittance after the SA correction but before any fitting, together with calculated transmittance.

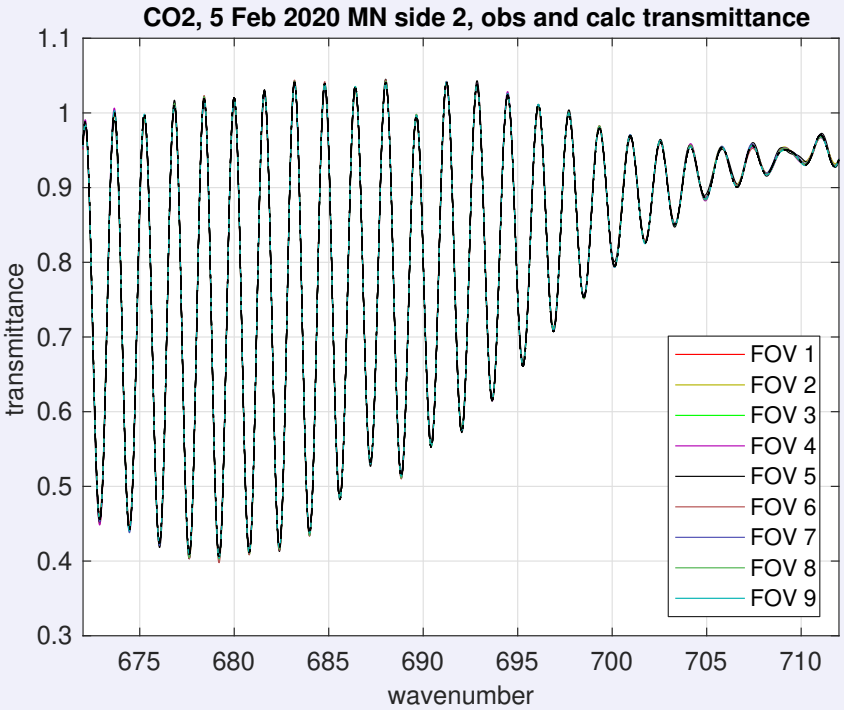


A detail from the previous plot. Measured FOV to FOV consistency and agreement with calculated transmittance is relatively good.

CO_2 side 2 fitting overview

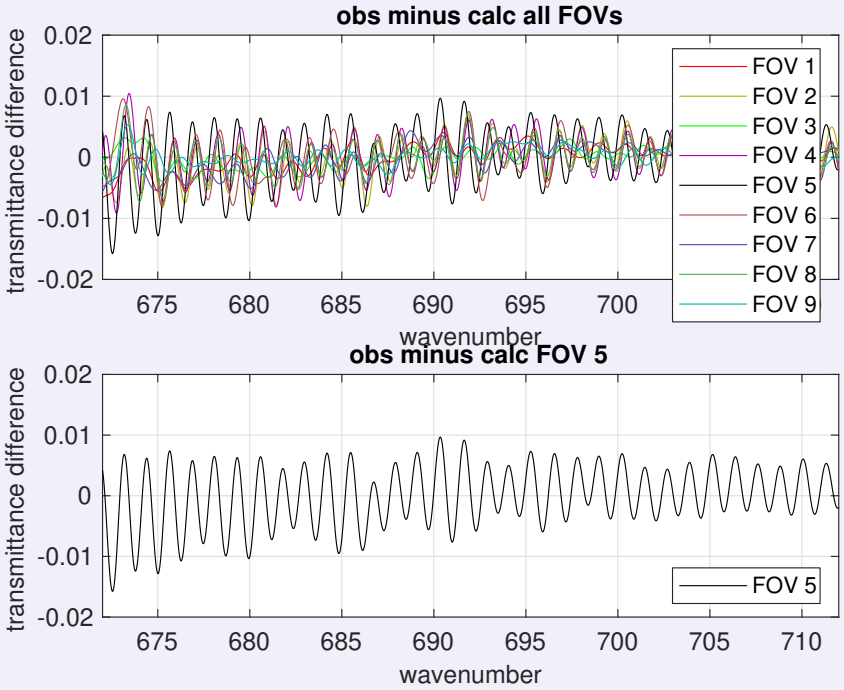


Residuals RMS$(a \cdot \tau_{\text{obs}} + b - \tau_{\text{calc}})$ over the fitting interval as a function of metrology laser wavelength.

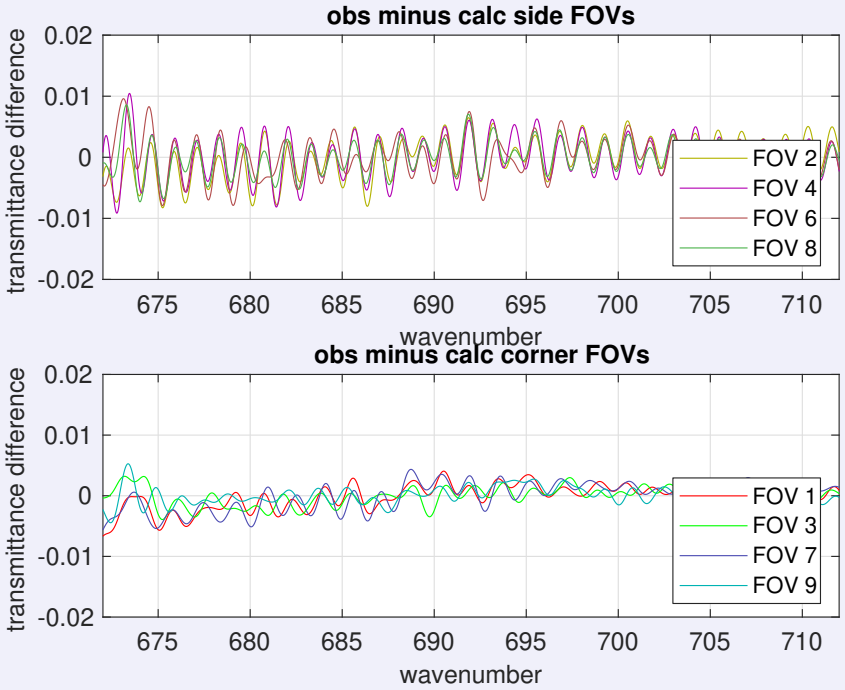


Fitted observed and calculated transmittance, over the fitting interval. At this level of detail we see all values are very close.

CO_2 side 2 obs minus calc breakouts



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



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

CO_2 side 2 tabulated residuals

metrology laser absolute residuals, ppm

-1.42	5.17	11.63	7	4	1
-0.78	7.11	11.24	8	5	2
0.52	8.91	14.08	9	6	3

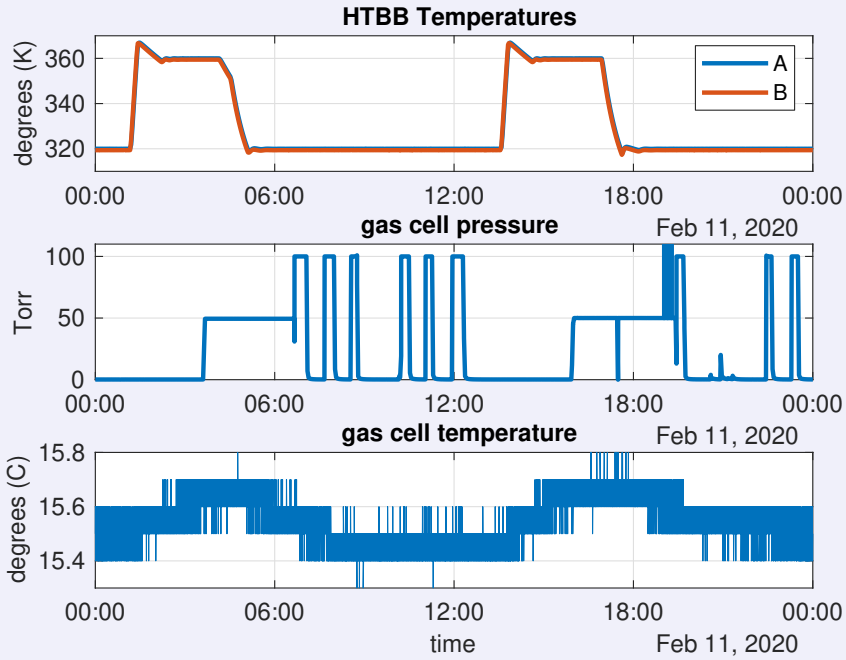
metrology laser relative residuals, ppm

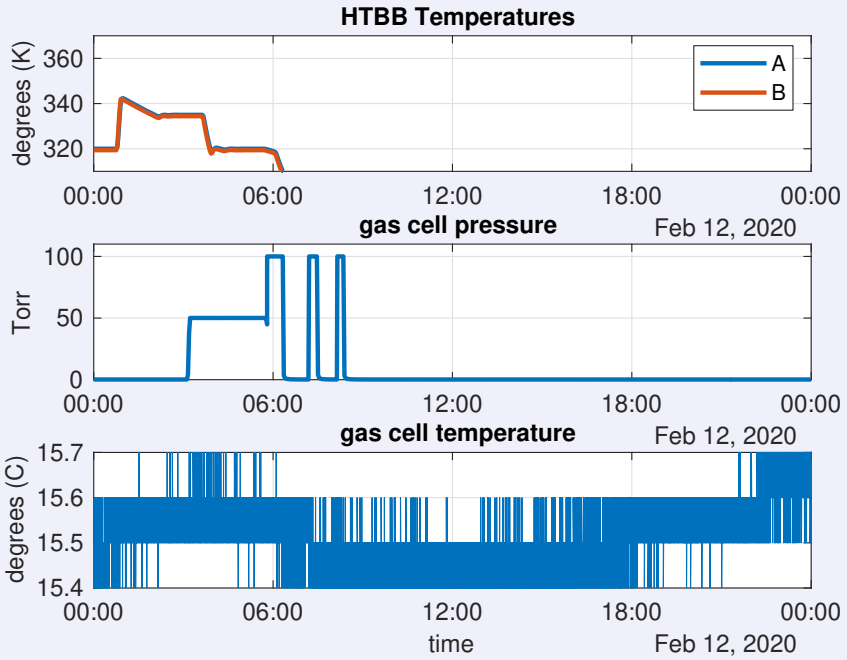
-8.53	-1.94	4.52	7	4	1
-7.88	0.00	4.13	8	5	2
-6.59	1.81	6.98	9	6	3

regression fitting weights and residuals

FOV	"a"	"b"	dmin	wmin	wfov
1	0.993	0.0059	0.0020	11.63	773.9890
2	0.993	0.0070	0.0029	11.24	773.9887
3	0.991	0.0079	0.0015	14.08	773.9909
4	0.984	0.0140	0.0030	5.17	773.9840
5	0.994	0.0065	0.0048	7.11	773.9855
6	0.987	0.0123	0.0030	8.91	773.9869
7	1.002	-0.0010	0.0023	-1.42	773.9789
8	0.988	0.0105	0.0023	-0.78	773.9794
9	0.988	0.0102	0.0014	0.52	773.9804

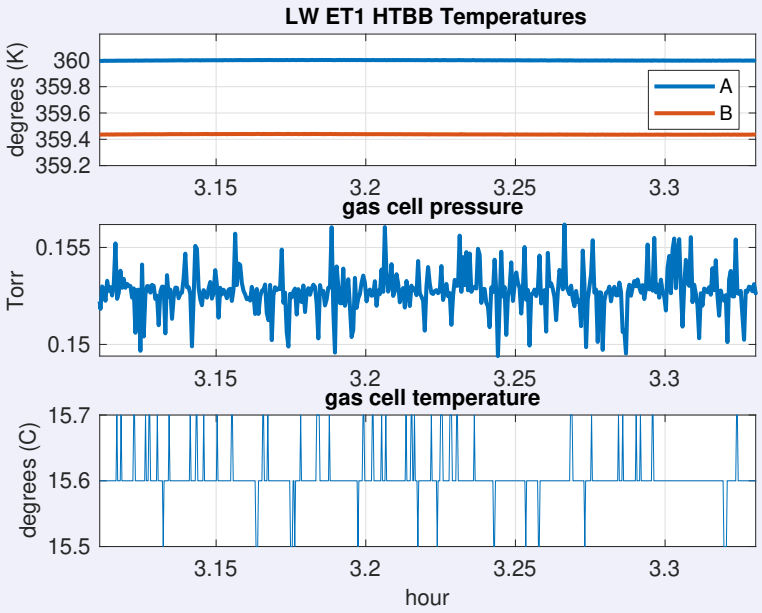
11-12 Feb 2020 TVAC MN Side 1 Plateau 22

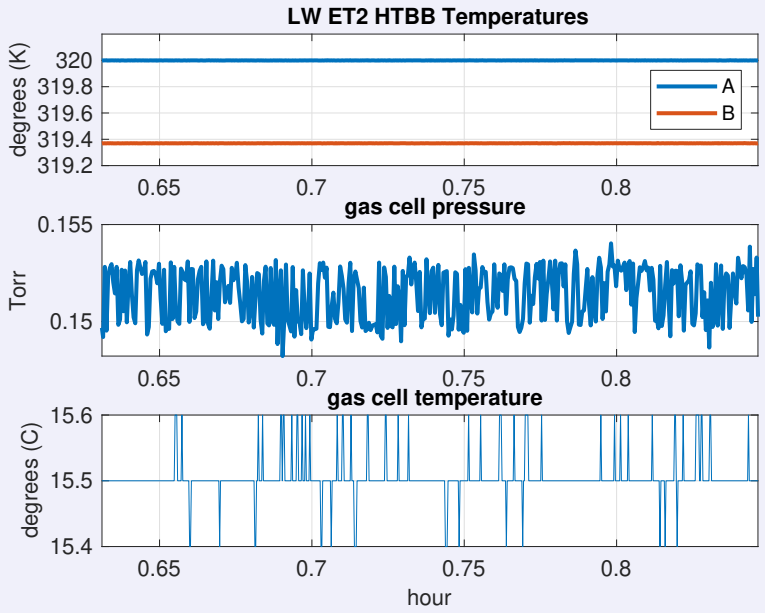


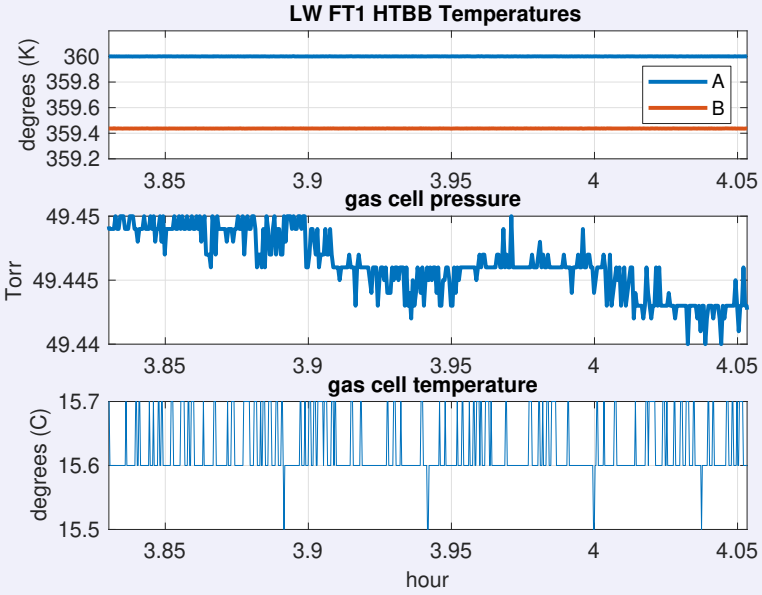


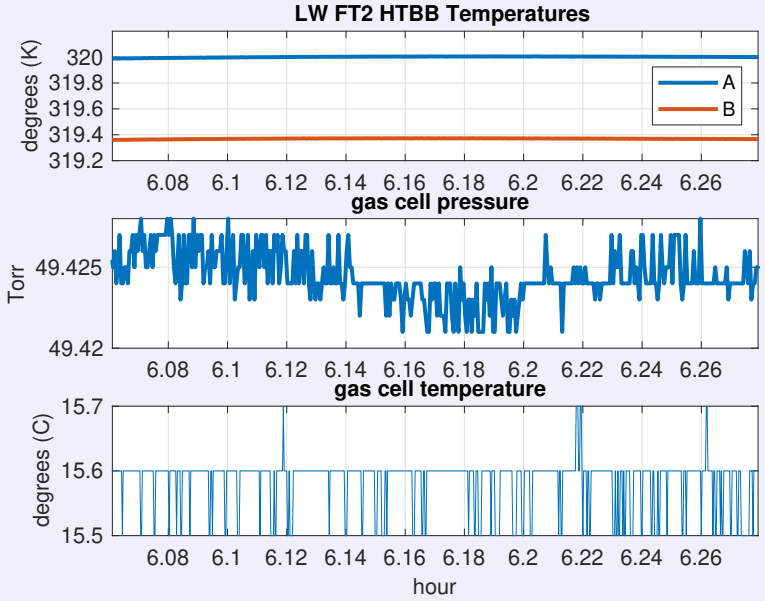
HTBB temperatures, gas cell pressure and gas cell temperature from the CCS files, for 11-12 Feb 2020. This data is used along with a scan of the CMD and SQL files for an overview and to find the test stages.

CO_2 MN side 1 gas cell test legs









CO_2 LW MN side 1 test parameters

- MN Plateau 22, 11 Feb 2020
- side 1, sweep direction 0
- fitting interval 672 to 712 cm^{-1}
- metrology laser 773.11974 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
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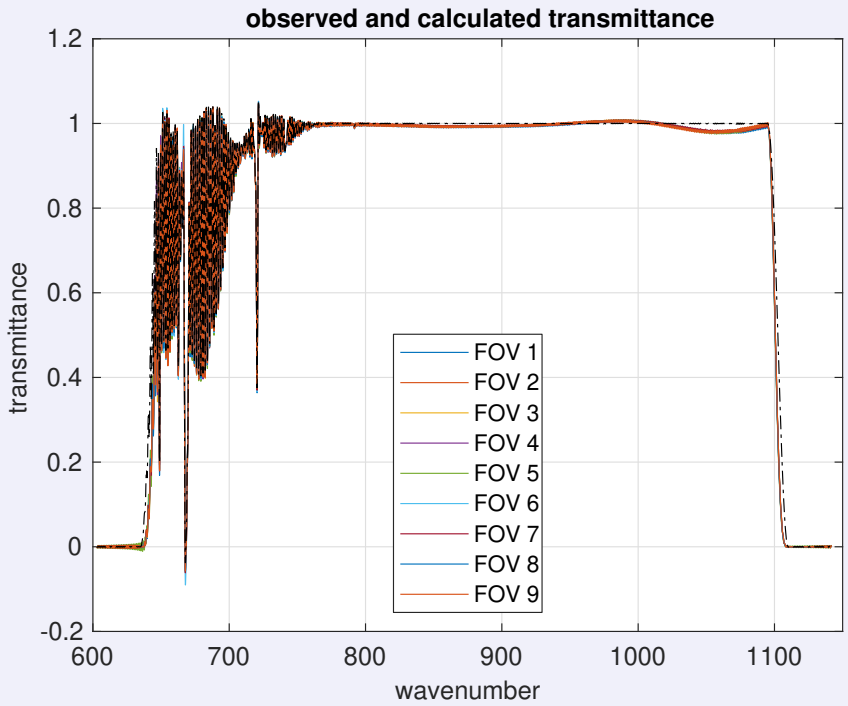
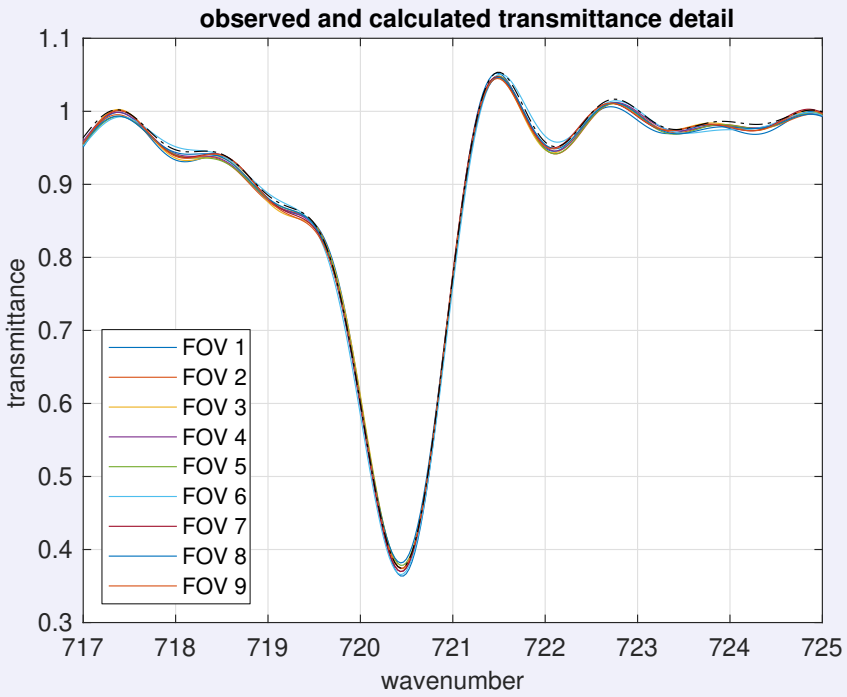
- gas cell temperature 15.70 C
- gas cell length 12.59 cm

CO_2 side 1 data before fitting

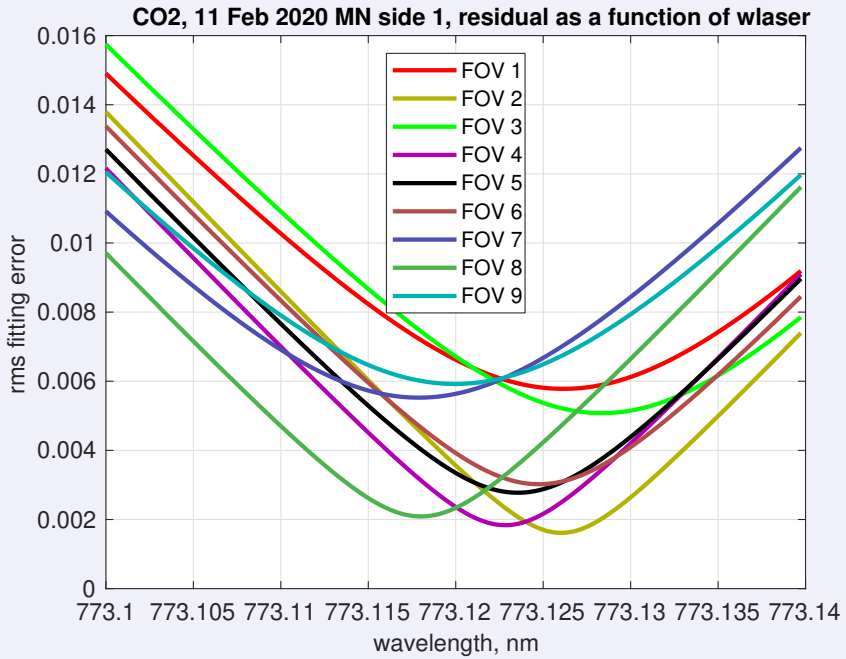


Measured transmittance after the SA correction but before any fitting, together with calculated transmittance.



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

CO_2 side 1 fitting overview



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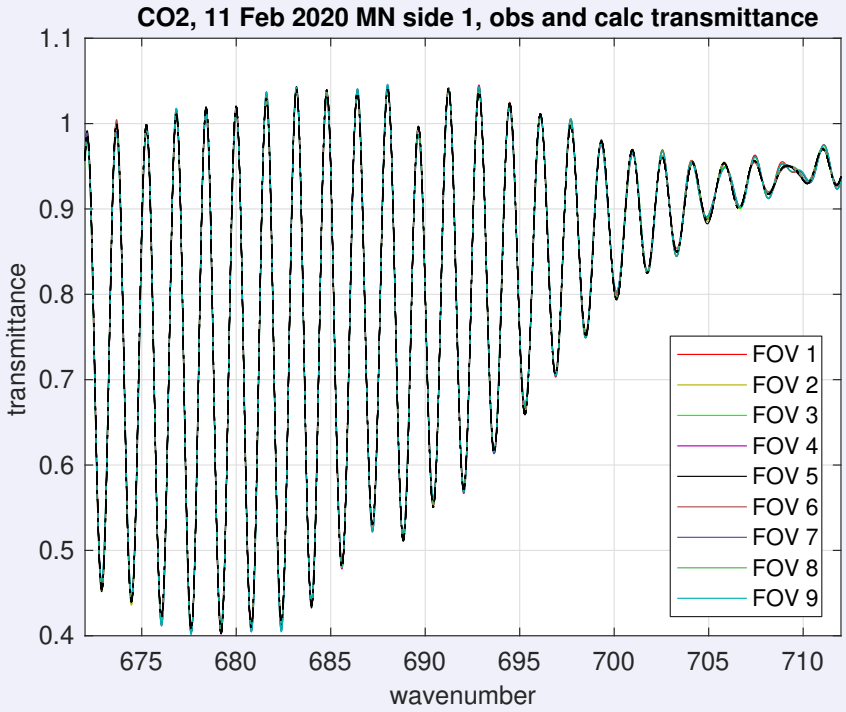
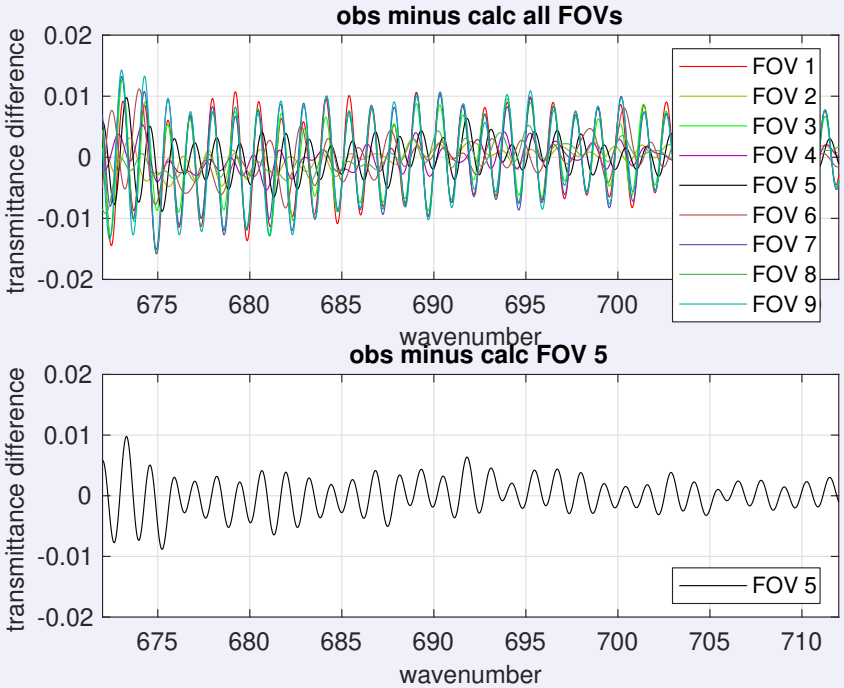
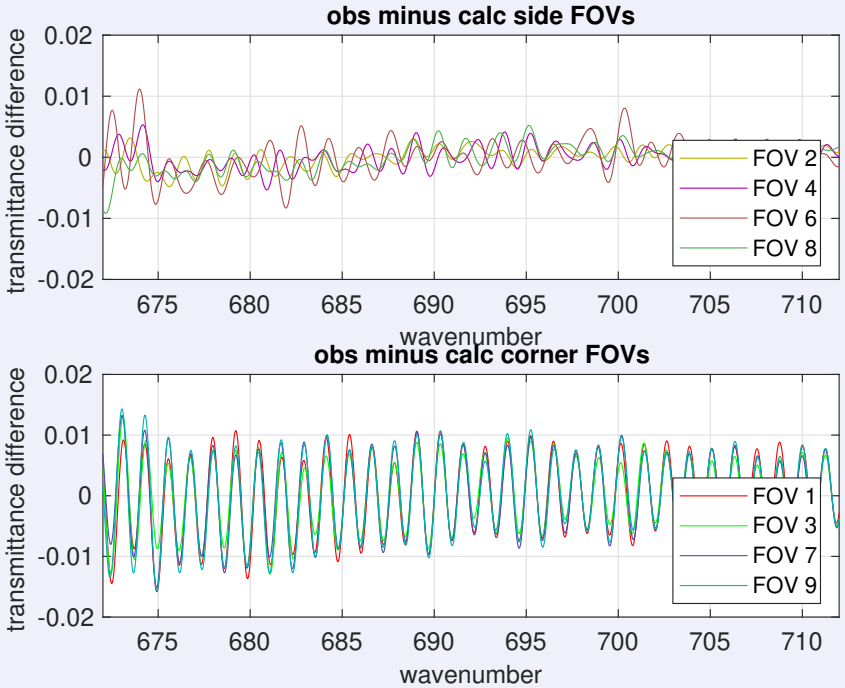


Fitted observed and calculated transmittance, over the fitting interval. At this level of detail we see all values are very close.

CO_2 side 1 obs minus calc breakouts



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



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

CO_2 side 1 tabulated residuals

metrology laser absolute residuals, ppm

-2.33	4.01	8.15	7	4	1
-2.20	4.92	8.15	8	5	2
0.39	6.47	11.12	9	6	3

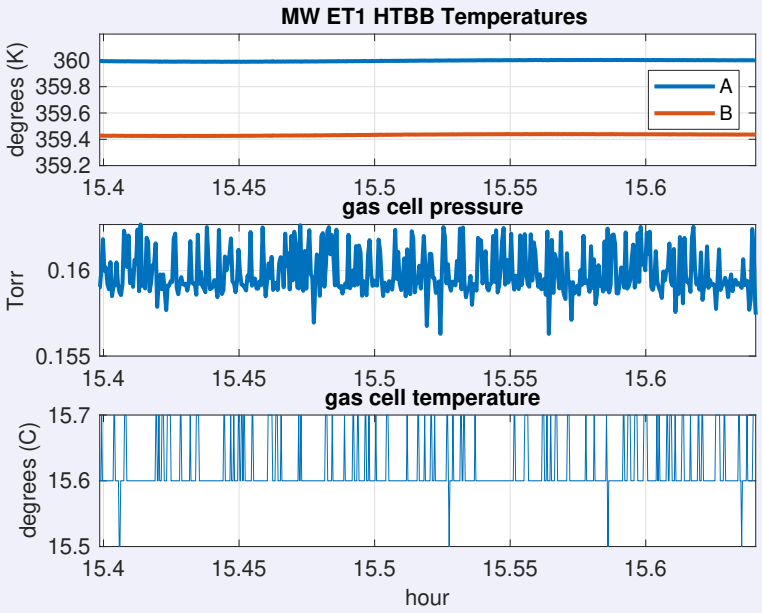
metrology laser relative residuals, ppm

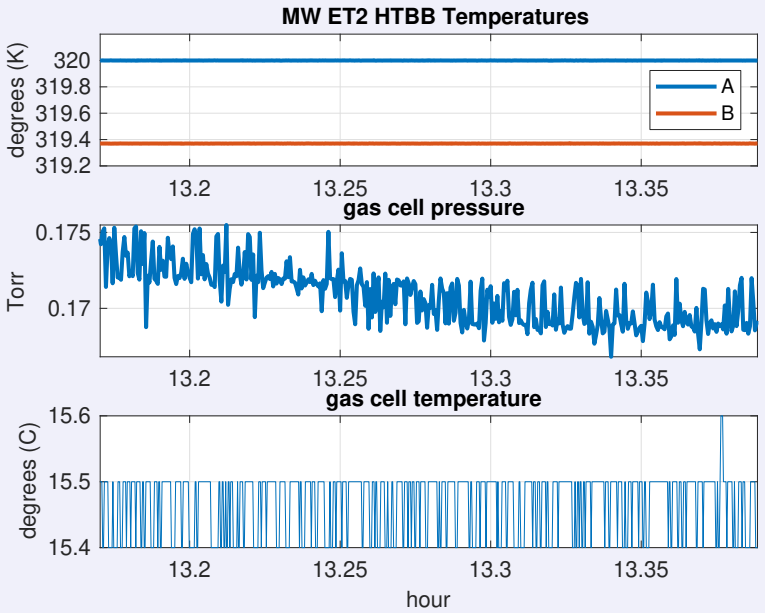
-7.24	-0.91	3.23	7	4	1
-7.11	0.00	3.23	8	5	2
-4.53	1.55	6.21	9	6	3

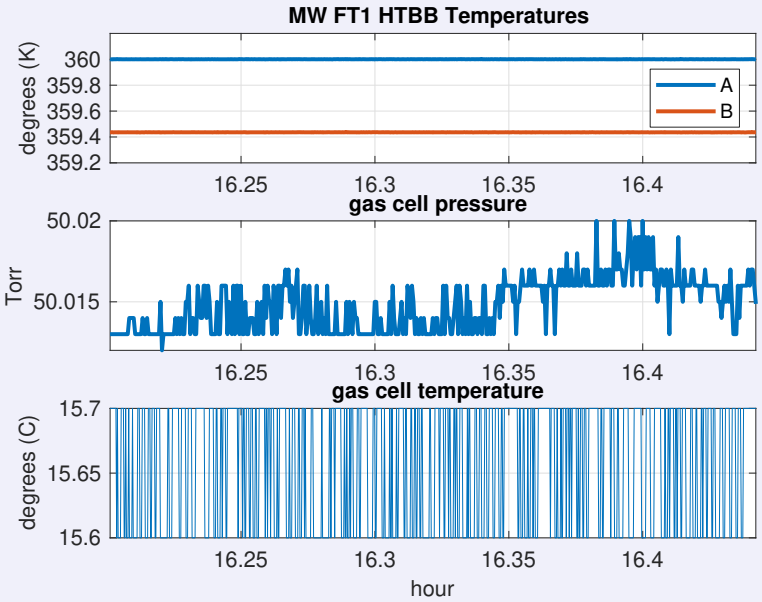
regression fitting weights and residuals

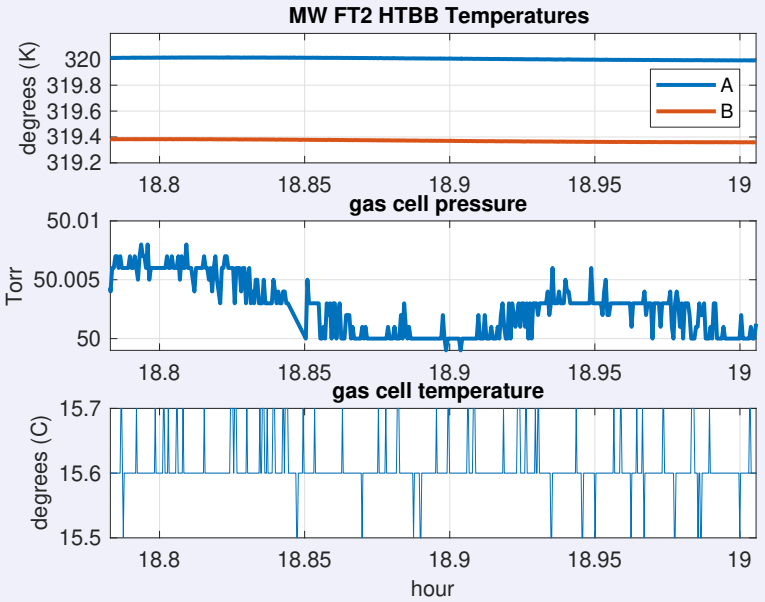
FOV	"a"	"b"	dmin	wmin	wfov
1	1.003	0.0061	0.0058	8.15	773.1260
2	0.997	0.0109	0.0016	8.15	773.1260
3	0.996	0.0105	0.0051	11.12	773.1283
4	0.999	0.0094	0.0018	4.01	773.1228
5	0.992	0.0150	0.0028	4.92	773.1235
6	1.001	0.0063	0.0030	6.47	773.1247
7	1.003	0.0041	0.0055	-2.33	773.1179
8	1.005	0.0029	0.0021	-2.20	773.1180
9	1.005	0.0028	0.0059	0.39	773.1200

CH_4 MN side 1 gas cell test legs





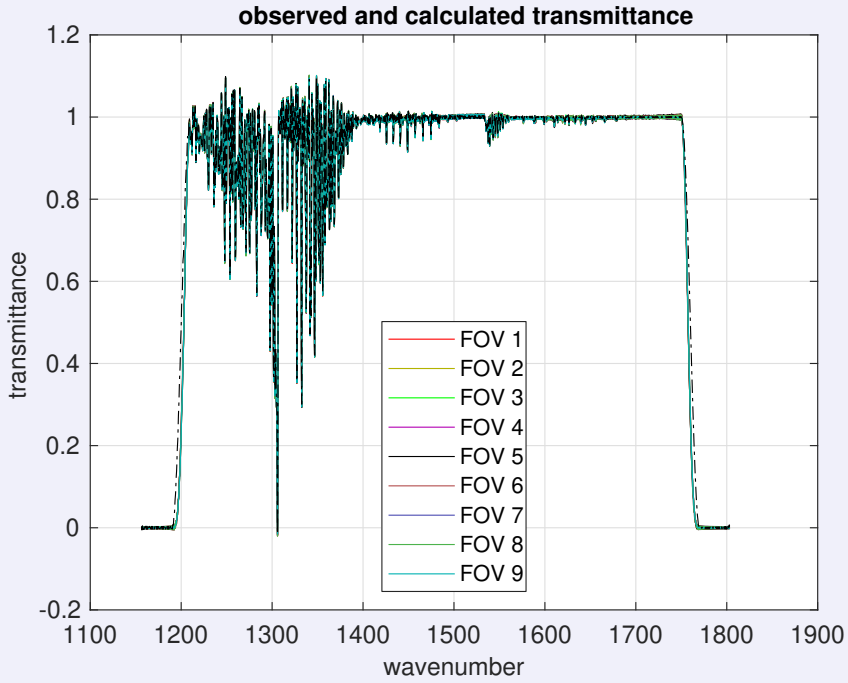




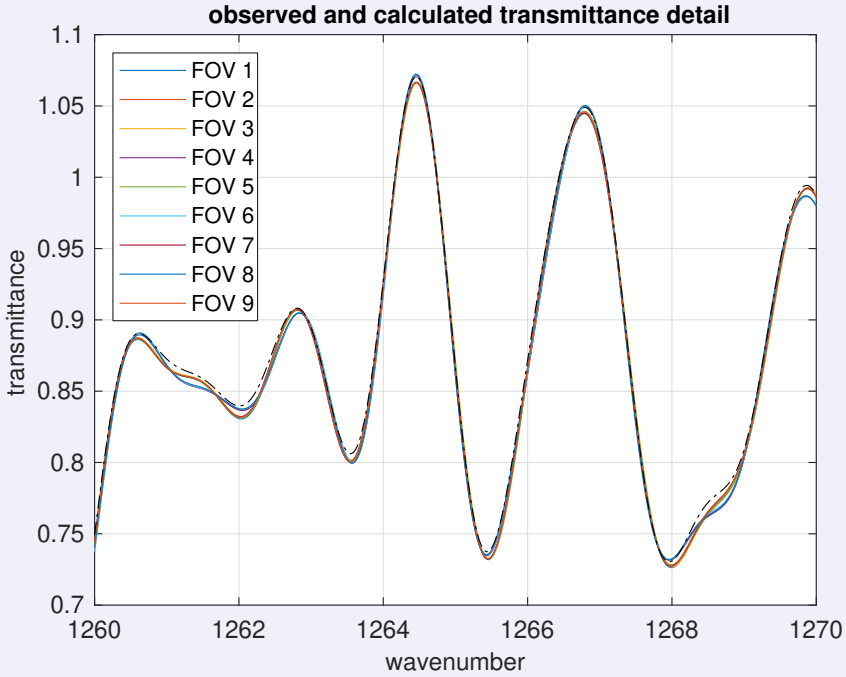
CH_4 MW MN side 1 test parameters

- MN Plateau 22, 11 Feb 2020
- side 1, sweep direction 0
- fitting interval 1220 to 1380 cm^{-1}
- metrology laser 773.11984 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 50.00 Torr
- gas cell temperature 15.63 C
- gas cell length 12.59 cm

CH_4 side 1 data before fitting

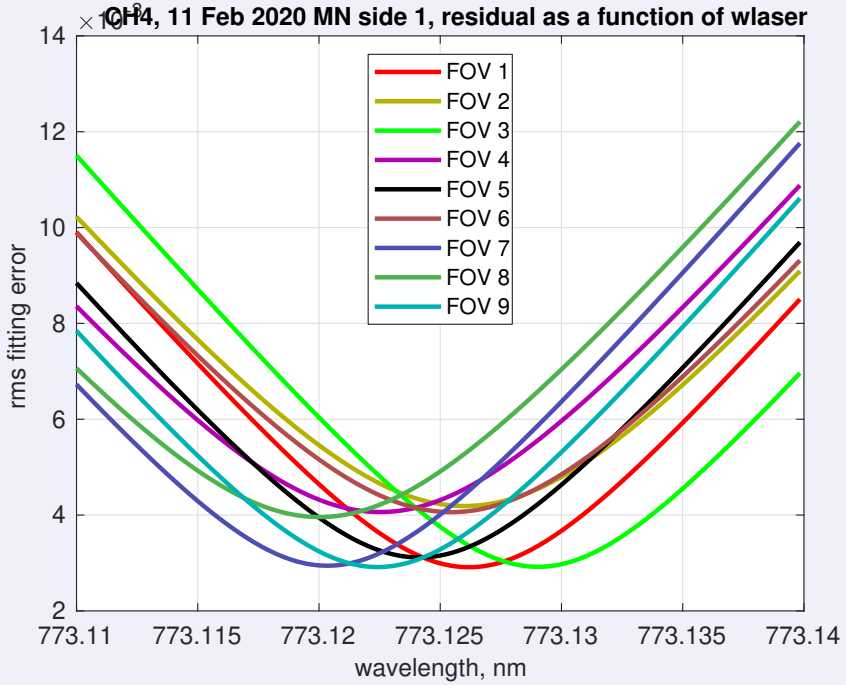


Measured transmittance after the SA correction but before any fitting, together with calculated transmittance.

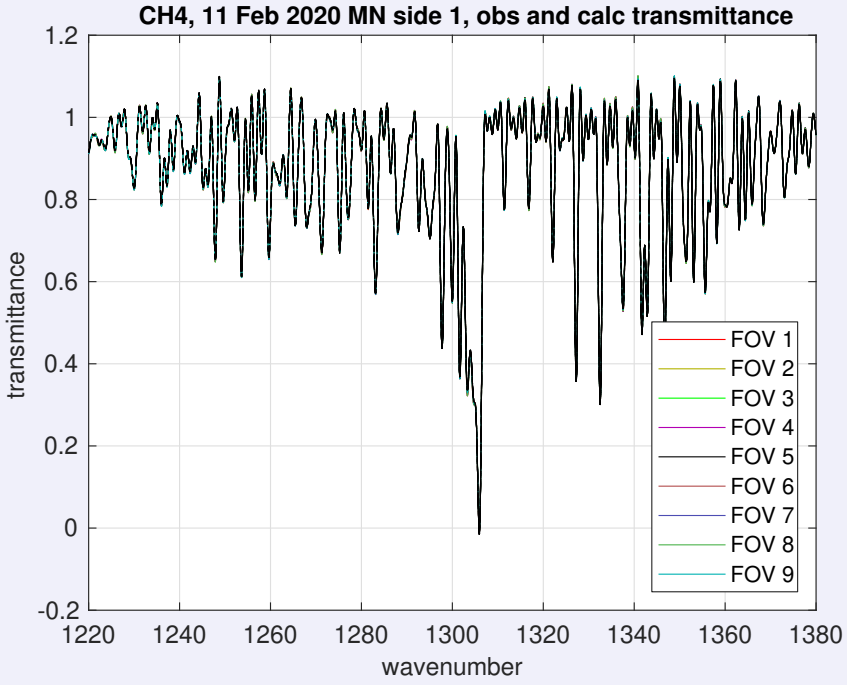


A detail from the previous plot. Measured FOV to FOV consistency and agreement with calculated transmittance is relatively good.

CH_4 side 1 fitting overview

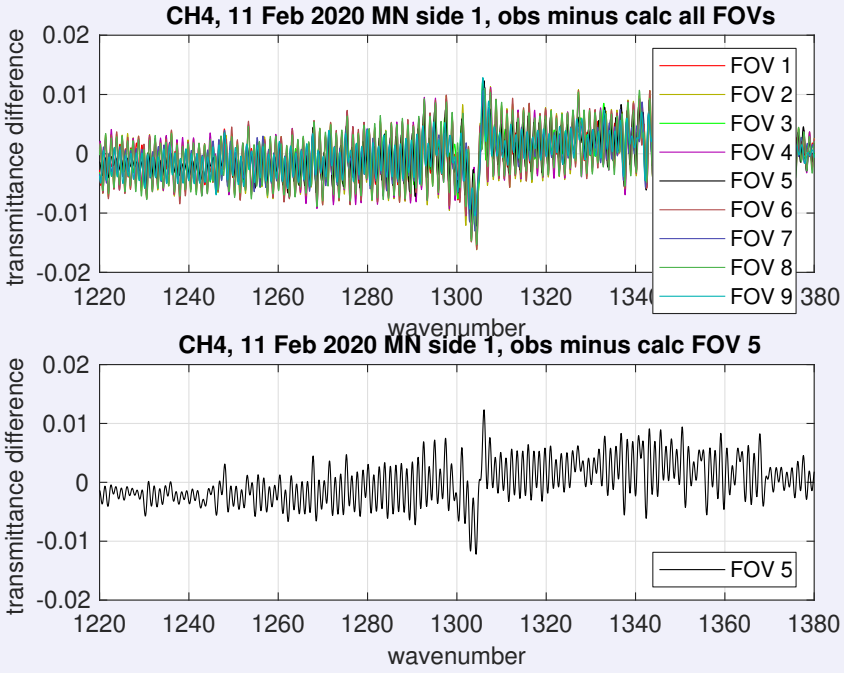


Residuals RMS($a \cdot \tau_{\text{obs}} + b - \tau_{\text{calc}}$) over the fitting interval as a function of metrology laser wavelength.

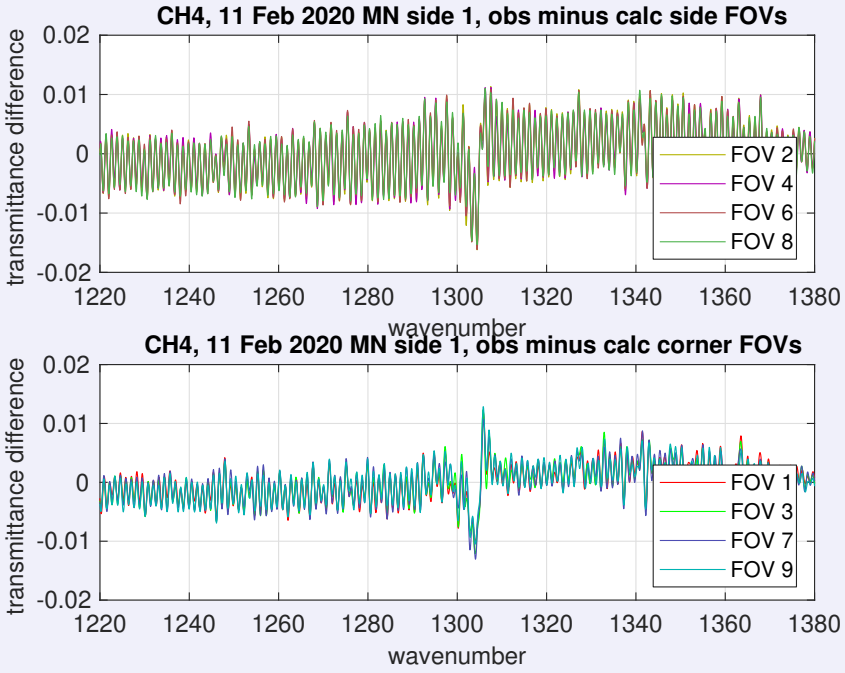


Fitted observed and calculated transmittance, over the fitting interval. At this level of detail we see all values are very close.

CH_4 side 1 obs minus calc breakouts



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



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

CH_4 side 1 tabulated residuals

metrology laser absolute residuals, ppm

0.65	3.49	8.15	7	4	1
0.26	5.56	8.02	8	5	2
3.36	7.24	11.90	9	6	3

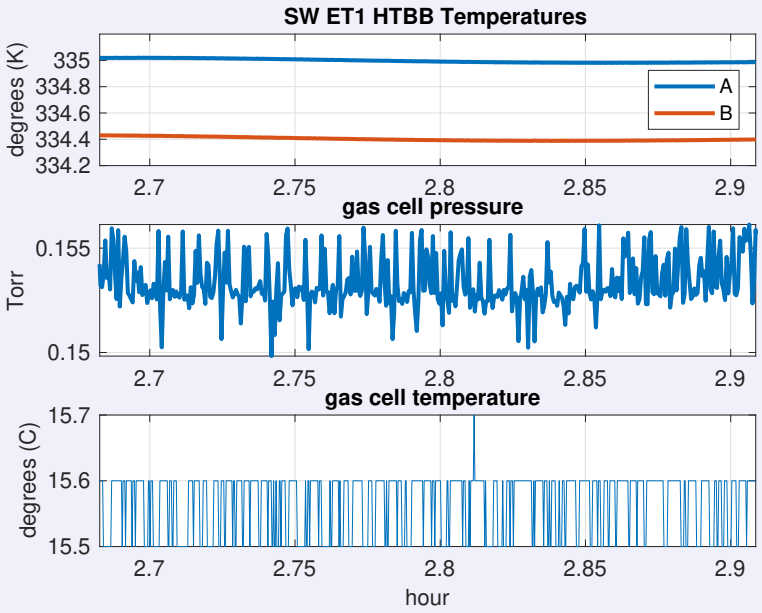
metrology laser relative residuals, ppm

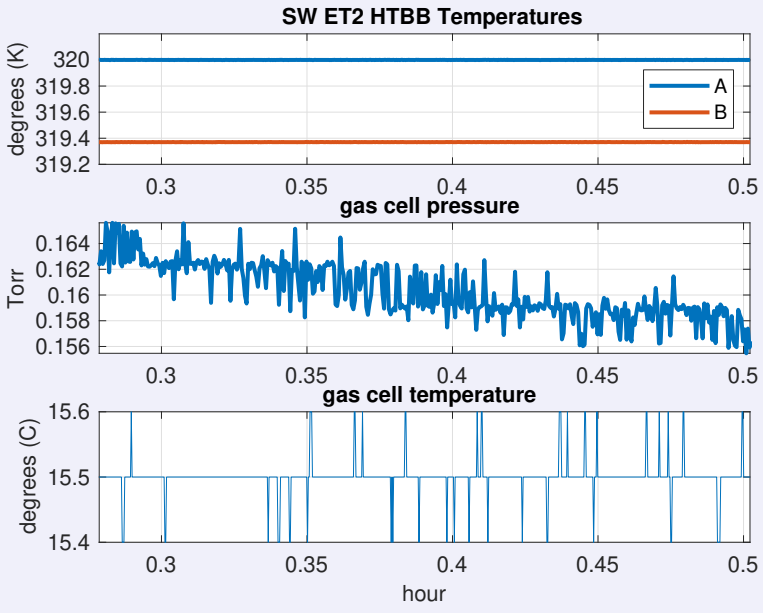
-4.92	-2.07	2.59	7	4	1
-5.30	0.00	2.46	8	5	2
-2.20	1.68	6.34	9	6	3

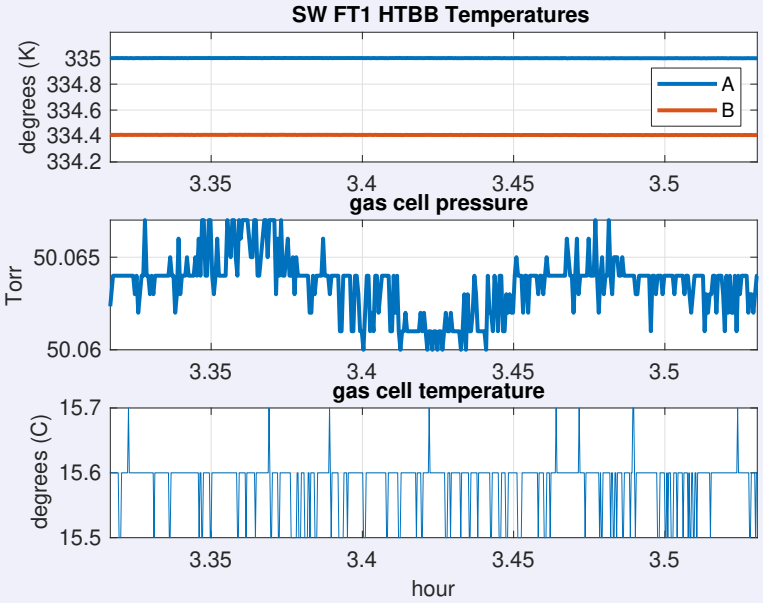
regression fitting weights and residuals

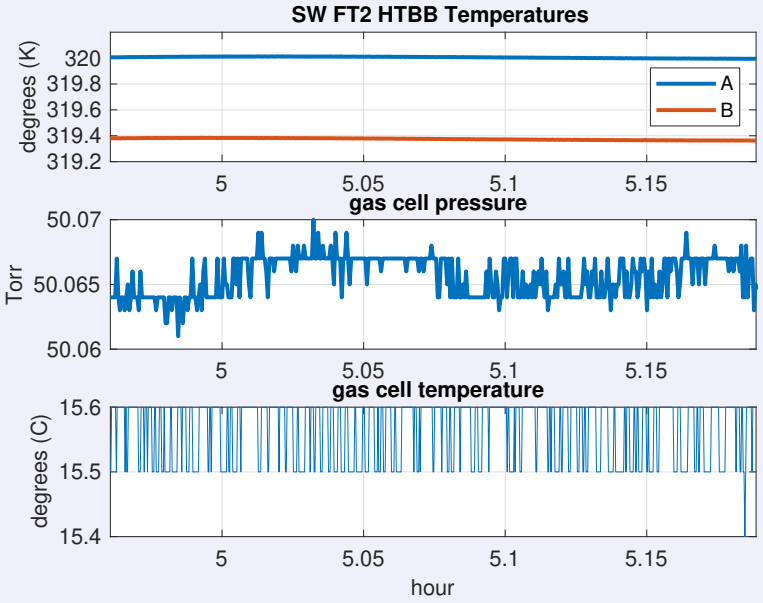
FOV	"a"	"b"	dmin	wmin	wfov
1	0.986	0.0143	0.0029	8.15	773.1261
2	0.990	0.0109	0.0042	8.02	773.1260
3	0.986	0.0136	0.0029	11.90	773.1290
4	0.991	0.0099	0.0041	3.49	773.1225
5	0.988	0.0121	0.0031	5.56	773.1241
6	0.991	0.0094	0.0041	7.24	773.1254
7	0.989	0.0114	0.0029	0.65	773.1203
8	0.990	0.0108	0.0040	0.26	773.1200
9	0.989	0.0113	0.0029	3.36	773.1224

CO MN side gas cell test legs





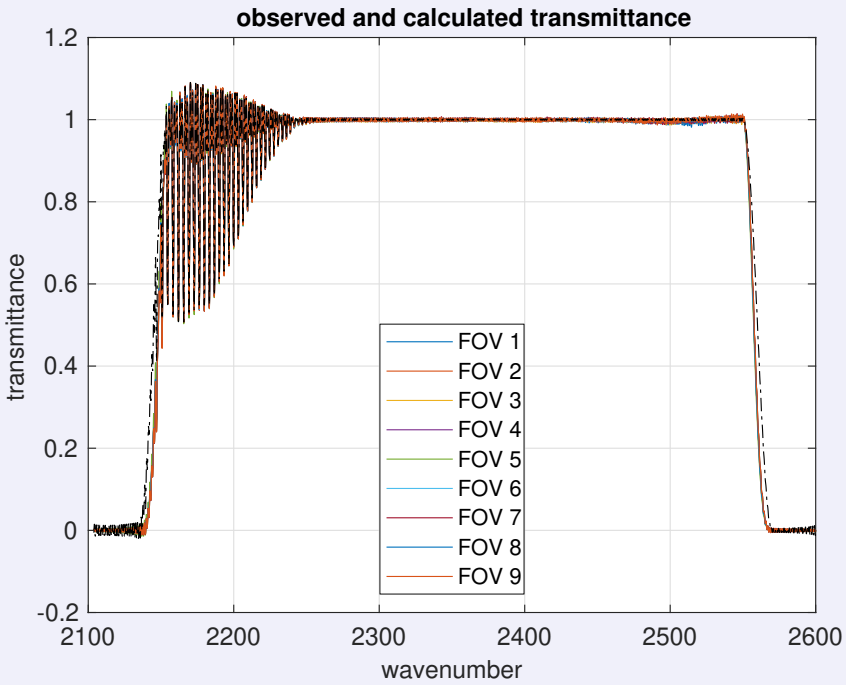




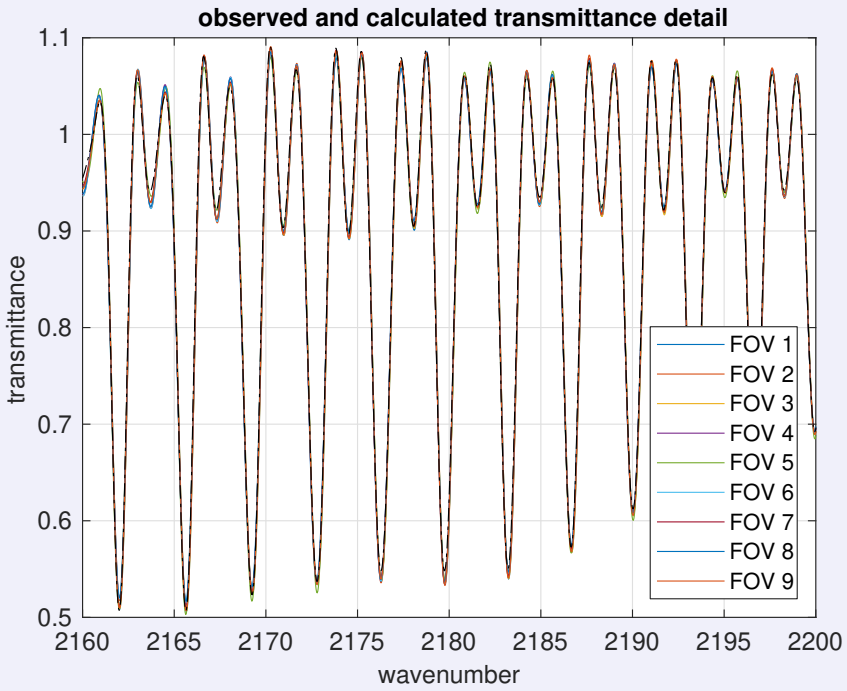
CO SW MN side 1 test parameters

- MN Plateau 22, 12 Feb 2020
- side 1, sweep direction 0
- fitting interval 2160 to 2240 cm^{-1}
- metrology laser 773.11979 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 50.06 Torr
- gas cell temperature 15.57 C
- gas cell length 12.59 cm

CO side 1 data before fitting

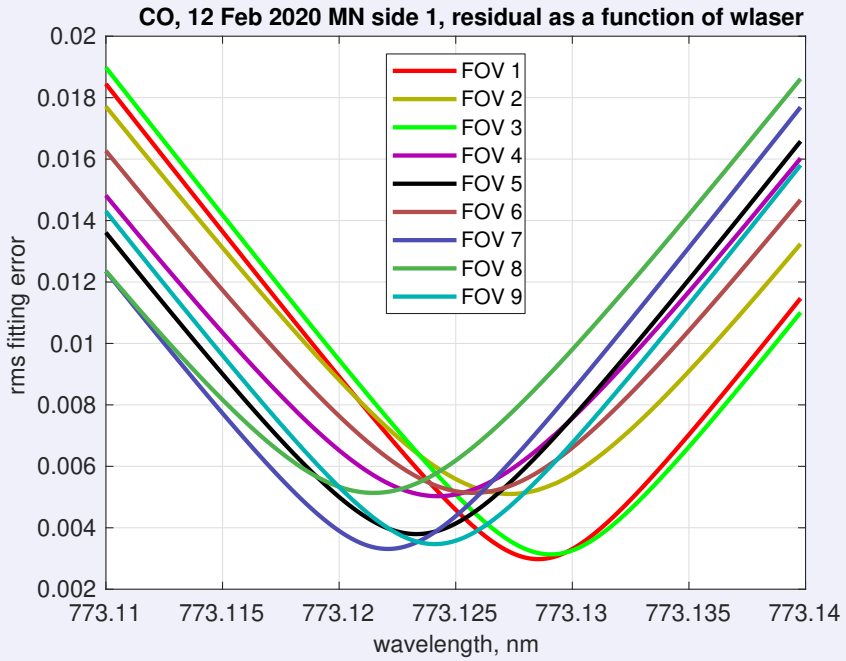


Measured transmittance after the SA correction but before any fitting, together with calculated transmittance.

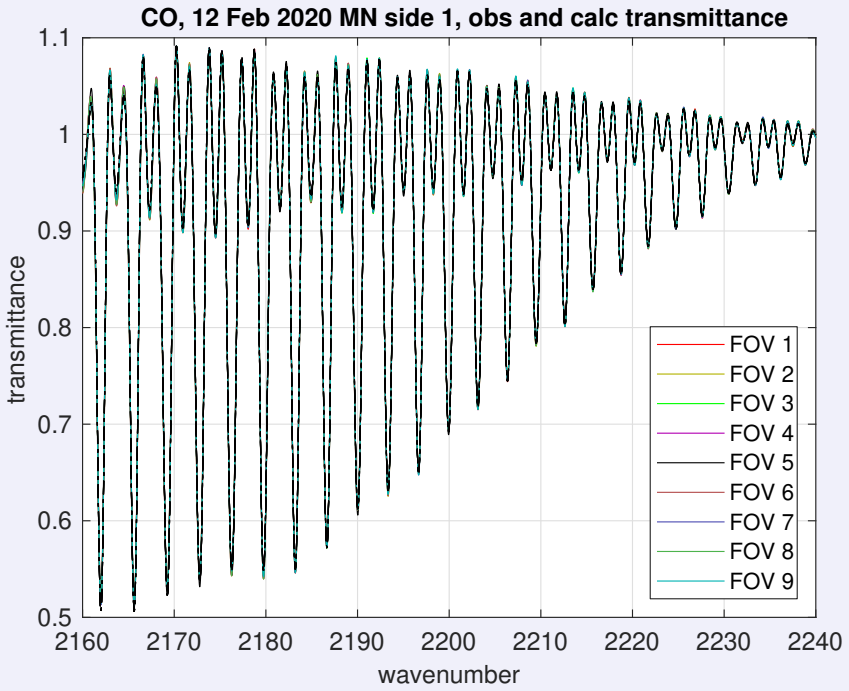


A detail from the previous plot. Measured FOV to FOV consistency and agreement with calculated transmittance is relatively good.

CO side 1 fitting overview

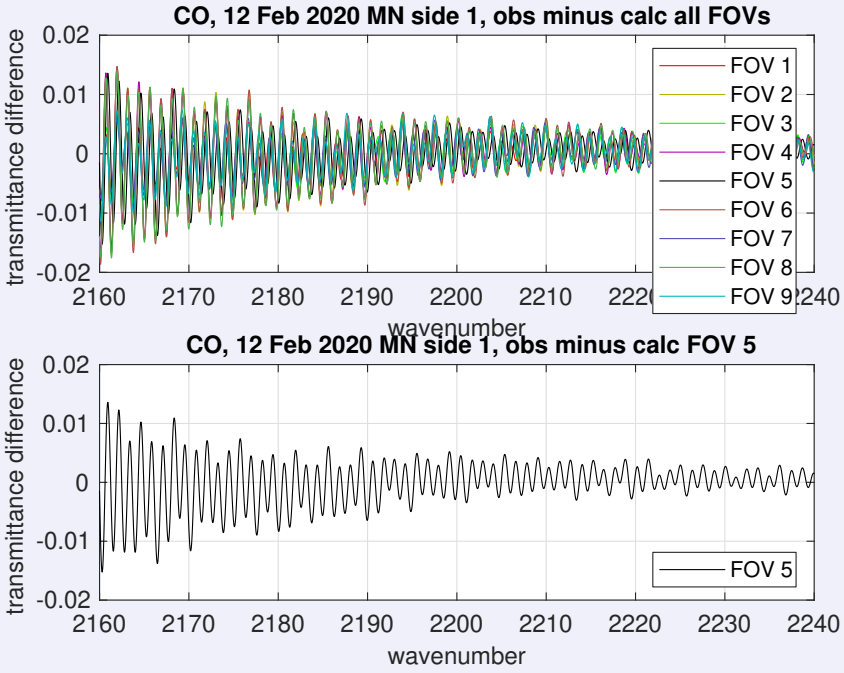


Residuals RMS$(a \cdot \tau_{\text{obs}} + b - \tau_{\text{calc}})$ over the fitting interval as a function of metrology laser wavelength.

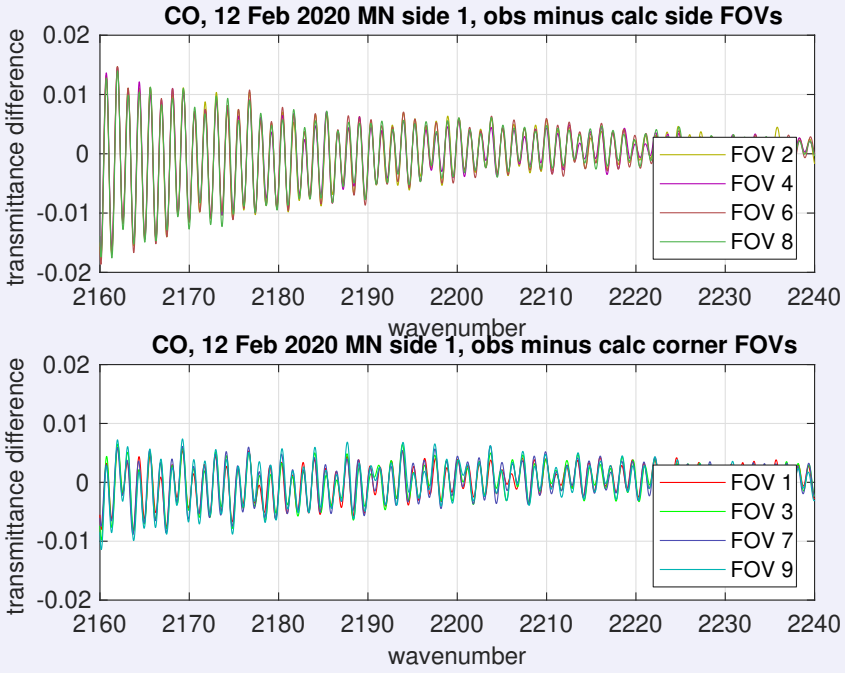


Fitted observed and calculated transmittance, over the fitting interval. At this level of detail we see all values are very close.

CO side 1 obs minus calc breakouts



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



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

CO side 1 tabulated residuals

metrology laser absolute residuals, ppm

2.97	5.82	11.25	7	4	1
2.20	4.53	9.70	8	5	2
5.56	7.76	12.03	9	6	3

metrology laser relative residuals, ppm

-1.55	1.29	6.73	7	4	1
-2.33	0.00	5.17	8	5	2
1.03	3.23	7.50	9	6	3

regression fitting weights and residuals

FOV	"a"	"b"	dmin	wmin	wfov
1	0.989	0.0126	0.0030	11.25	773.1285
2	0.991	0.0104	0.0051	9.70	773.1273
3	0.989	0.0126	0.0031	12.03	773.1291
4	0.993	0.0082	0.0050	5.82	773.1243
5	0.989	0.0122	0.0038	4.53	773.1233
6	0.994	0.0070	0.0051	7.76	773.1258
7	0.992	0.0092	0.0033	2.97	773.1221
8	0.997	0.0042	0.0051	2.20	773.1215
9	0.987	0.0136	0.0035	5.56	773.1241

TVAC ILS residual summary

metrology laser residuals, ppm

	FOV								
Test	1	2	3	4	5	6	7	8	9
01-07_pl_s1_CH4	7.90	8.42	13.60	2.72	5.05	8.94	-0.52	0.78	5.05
01-07_pl_s1_CO2	7.51	9.46	11.40	2.85	5.70	7.90	-2.59	-2.85	1.42
01-08_pl_s1_CO	10.36	8.81	12.18	4.40	4.40	7.77	1.94	1.68	6.22
01-12_ph_s1_CO2	11.37	8.65	10.20	5.94	5.42	3.62	-2.20	-2.97	-3.62
01-13_ph_s1_CH4	11.75	9.69	11.62	6.07	7.23	6.46	1.94	0.26	1.42
01-13_ph_s1_CO	14.85	12.01	12.66	8.14	5.81	7.23	3.62	1.68	3.49
01-19_ph_s2_CO2	14.96	12.00	14.32	9.29	9.16	8.00	2.06	1.55	1.16
02-05_mn_s2_CO2	11.63	11.24	14.08	5.17	7.11	8.91	-1.42	-0.78	0.52
02-11_mn_s1_CH4	8.15	8.02	11.90	3.49	5.56	7.24	0.65	0.26	3.36
02-11_mn_s1_CO2	8.15	8.15	11.12	4.01	4.92	6.47	-2.33	-2.20	0.39
02-12_mn_s1_CO	11.25	9.70	12.03	5.82	4.53	7.76	2.97	2.20	5.56

Conclusions

- We have done a preliminary analysis of the MN Plateau 22 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 managable 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 wavelengh, or possibly by simply using the eng neon value.