



Supplement of

Improved calibration procedures for the EM27/SUN spectrometers of the Collaborative Carbon Column Observing Network (COCCON)

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Table S1: MEA and PE for both channels for all the available EM27/SUN instruments and for every single calibration measurement carried out at KIT.

SN	Date	MEA _{1Ch}	PE _{1Ch}	MEA _{2Ch}	PE _{2Ch}
29	2017-11-21	0.9878	0.000350	N/A	N/A
29	2018-07-03	0.9878	-0.000224	0.9891	0.000836
32	2014-06-03	0.9811	0.002407	N/A	N/A
32	2014-07-15	0.9864	0.001592	N/A	N/A
32	2015-08-13	0.9833	0.001675	N/A	N/A
32	2016-09-09	0.9870	0.001280	N/A	N/A
32	2021-01-04	0.9827	0.002953	0.9851	0.001077
32	2021-02-16	0.9829	0.002201	0.9879	0.000460
33	2017-08-08	0.9832	-0.003117	0.9853	-0.002626
34	2018-07-17	0.9877	-0.000327	0.9873	-0.001319
37	2014-06-03	0.9782	-0.001389	N/A	N/A
37	2014-07-15	0.9852	-0.002241	N/A	N/A
37	2014-09-25	0.9886	-0.001965	N/A	N/A
37	2015-08-13	0.9843	-0.000683	N/A	N/A
37	2016-09-09	0.9881	0.002557	N/A	N/A
37	2017-03-17	0.9881	0.001853	N/A	N/A
37	2017-05-15	0.9873	0.001759	N/A	N/A
37	2017-07-25	0.9872	0.001826	N/A	N/A
37	2017-09-20	0.9880	0.001771	N/A	N/A
37	2017-10-11	0.9882	0.002000	N/A	N/A
37	2017-11-21	0.9875	0.001770	N/A	N/A
37	2018-01-23	0.9720	0.003249	0.9739	0.000877
37	2018-01-25	0.9837	0.002044	0.9850	0.001199
37	2018-11-12	0.9826	0.001929	0.9842	-0.000920
37	2019-04-23	0.9826	0.003163	0.9853	0.000692
37	2020-12-29	0.9823	0.002088	0.9952	0.000034
37	2021-01-05	0.9813	0.001135	0.9848	-0.000259
37	2021-02-18	0.9805	0.001501	0.9854	-0.000877
38	2014-06-03	0.9715	-0.000823	N/A	N/A
38	2014-07-15	0.9808	-0.000055	N/A	N/A
38	2015-08-13	0.9878	-0.001417	N/A	N/A
38	2020-01-16	0.9813	-0.000139	0.9866	-0.000768
39	2014-06-03	0.9759	-0.002198	N/A	N/A
39	2014-07-15	0.9817	-0.001653	N/A	N/A
39	2015-08-13	0.9782	-0.001052	N/A	N/A
39	2016-09-09	0.9792	-0.002300	N/A	N/A
39	2017-02-10	0.9816	-0.002440	N/A	N/A
39	2020-07-22	0.9792	-0.002988	0.9761	-0.003129
41	2014-06-03	0.9780	-0.001540	N/A	N/A
41	2014-07-15	0.9842	-0.000914	N/A	N/A

41	2015-08-13	0.9846	-0.000856	N/A	N/A
41	2017-05-15	0.9840	-0.002494	1.0530	-0.022330
42	2016-07-28	0.9770	0.001905	N/A	N/A
42	2019-04-02	0.9836	0.002447	0.9712	-0.000393
44	2017-02-28	0.9728	-0.005602	0.9807	-0.005904
45	2017-07-25	0.9847	0.001866	0.9854	0.000401
46	2017-07-25	0.9859	0.000993	0.9843	0.000075
50	2017-03-17	0.9858	0.001239	N/A	N/A
50	2020-02-19	0.9904	0.001564	0.9899	0.001157
50	2021-02-16	0.9881	0.001292	0.9892	0.000060
50	2021-02-18	0.9880	0.001203	0.9842	0.003910
51	2014-12-04	0.9810	0.000607	N/A	N/A
51	2016-01-19	0.9800	0.001218	N/A	N/A
51	2019-01-22	0.9877	0.000823	0.9900	0.000456
51	2021-08-02	0.9901	-0.002350	0.9894	-0.001304
52	2017-03-17	0.9874	0.003725	N/A	N/A
52	2018-11-13	0.9865	0.004455	0.9862	0.003067
53	2017-03-17	0.9851	0.001416	N/A	N/A
53	2018-11-12	0.9891	0.000584	0.9982	0.001968
53	2021-02-16	0.9875	0.000989	0.9832	0.001001
59	2017-06-30	0.9899	0.001515	0.9892	0.000986
59	2021-01-25	0.9851	0.001716	0.9862	0.000164
61	2015-08-05	0.9892	-0.001082	N/A	N/A
62	2016-01-21	0.9799	0.004075	N/A	N/A
63	2016-01-21	0.9827	0.000105	N/A	N/A
63	2017-12-19	0.9885	0.001434	0.9854	0.001132
65	2016-05-10	0.9872	0.001057	N/A	N/A
69	2016-08-25	0.9873	0.002111	N/A	N/A
69	2019-10-15	0.9876	0.002075	0.9866	0.000242
70	2016-08-02	0.9789	0.004659	N/A	N/A
72	2017-02-08	0.9975	0.001792	N/A	N/A
75	2017-05-15	0.9969	0.002442	0.9834	0.003803
76	2017-06-08	1.0210	-0.000313	1.0050	-0.000892
77	2017-09-26	0.9871	0.000233	0.9876	-0.000525
80	2018-04-17	0.9865	-0.002753	0.9875	-0.001511
80	2020-06-04	0.9861	-0.012950	0.9893	-0.011090
80	2021-11-17	0.9886	-0.011440	0.9885	-0.008102
81	2018-11-12	0.9918	0.001715	0.9911	0.000585
81	2020-06-04	0.9898	0.003007	0.9919	0.000924
81	2021-02-26	0.9928	0.003160	0.9952	0.001903
82	2018-07-16	0.9841	0.002818	0.9843	0.001056
83	2018-05-02	0.9881	0.005742	0.9863	0.003796
83	2019-08-08	0.9883	0.006970	0.9863	0.004094
83	2021-10-28	0.9870	0.006456	0.9867	0.003943

84	2018-03-27	0.9900	-0.000094	2.4840	-0.018970
84	2020-06-04	0.9871	0.000828	0.9873	-0.000291
85	2018-10-25	0.9894	0.000950	0.9874	0.000656
86	2018-01-10	0.9845	0.001965	0.9810	0.001271
88	2018-03-05	0.9850	-0.001101	1.0080	-0.001195
88	2019-11-29	0.9869	-0.001827	0.9850	-0.001932
88	2021-11-17	0.9847	-0.000219	0.9890	-0.000592
91	2018-02-26	0.9859	0.001310	0.9802	0.000646
92	2018-05-15	0.9845	0.002905	N/A	N/A
92	2019-12-17	0.9838	0.004053	0.9844	0.002009
94	2018-06-18	0.9808	0.000974	0.9830	-0.002992
95	2018-06-19	0.9820	-0.000238	0.9826	-0.000241
96	2019-09-17	0.9840	0.001917	0.9862	-0.000265
97	2019-02-20	0.9889	0.000029	0.9841	0.000038
97	2020-06-04	0.9858	0.001895	0.9855	0.000198
98	2019-02-20	0.9894	0.004378	0.9920	0.000953
98	2021-02-26	0.9873	0.000968	0.9912	0.000308
99	2018-11-06	0.9807	0.004082	0.9840	0.002695
103	2019-02-04	0.9851	0.002262	0.9873	0.001320
103	2021-10-19	0.9836	0.002190	0.9903	0.001211
104	2019-02-04	0.9847	0.002773	0.9857	0.001908
106	2019-03-25	0.9819	-0.000163	0.9873	-0.001472
109	2019-03-25	0.9852	0.001953	0.9860	0.000450
110	2019-03-26	0.9878	0.005564	0.9633	0.000883
111	2019-02-11	0.9880	-0.000586	0.9856	-0.003916
112	2019-07-09	0.9881	-0.002138	0.9887	-0.002514
113	2019-07-15	0.9860	0.002527	0.9841	0.000328
114	2019-07-24	0.9865	0.002282	0.9882	-0.000072
115	2019-07-24	0.9862	0.000944	0.9839	-0.000467
116	2019-09-30	0.9862	0.002884	0.9819	0.000889
117	2019-10-22	0.9777	0.002248	0.9819	0.001116
118	2019-11-11	0.9847	0.005822	0.9879	0.005157
119	2019-11-01	0.9809	-0.002006	0.9831	-0.001204
120	2019-11-07	0.9845	0.002689	0.9892	0.000866
120	2020-12-29	0.9738	0.002641	0.9829	-0.000287
120	2021-02-18	0.9859	0.002210	0.9868	0.001430
120	2021-02-19	0.9844	0.002942	0.9889	0.001367
121	2019-11-19	0.9816	0.007284	0.9845	0.004085
122	2019-11-19	0.9888	-0.000258	0.9856	-0.000914
126	2019-12-13	0.9861	0.000598	0.9892	0.000199
127	2019-12-11	0.9805	0.002659	0.9850	0.001382
128	2019-12-11	0.9860	-0.000554	0.9862	-0.001052
130	2019-12-17	0.9839	0.002367	0.9855	0.001113
131	2020-01-20	0.9869	-0.000480	0.9840	-0.001214

132	2020-01-16	0.9839	-0.001991	0.9872	-0.003004
134	2020-03-17	0.9888	0.003688	0.9877	0.001704
136	2020-07-02	0.9879	0.004427	0.9911	0.002265
136	2021-02-16	0.9881	0.004911	0.9898	0.003329
136	2021-02-18	0.9890	0.005411	0.9905	0.003368
136	2021-02-19	0.9881	0.005162	0.9886	0.003246
136	2021-03-03	0.9901	0.005367	0.9891	0.003531
138	2020-03-11	0.9883	0.002182	0.9837	0.000559
138	2020-07-02	0.9875	0.003924	0.9851	0.002787
139	2021-01-25	0.9845	0.000714	0.9860	-0.000588
140	2021-02-05	0.9852	0.002233	0.9821	0.000512
141	2021-02-12	0.9841	0.003084	0.9853	0.001731
142	2020-08-14	0.9939	0.002832	0.9930	0.002315
142	2021-04-23	0.9890	0.000884	0.9866	0.000388
143	2020-11-10	0.9870	0.000795	0.9863	0.004561
144	2020-11-13	0.9859	-0.001597	0.9849	-0.002115
145	2021-01-04	0.9852	0.000635	0.9855	-0.000230
146	2021-01-04	0.9875	0.002578	0.9882	0.001299
147	2021-03-06	0.9867	0.002605	0.9874	0.001681
148	2021-04-23	0.9884	-0.002023	0.9858	-0.001938
149	2021-03-05	0.9867	-0.001832	0.9895	-0.001389
150	2021-03-22	0.9850	-0.005994	0.9867	-0.004125
150	2021-04-01	0.9862	-0.006687	0.9872	-0.005458
155	2021-05-06	0.9887	0.001532	0.9923	0.000897
155	2021-05-19	0.9914	0.000865	0.9864	0.000689
156	2021-09-05	0.9867	0.007324	0.9936	0.004239

Table S2: Correction factors for XCO_2 , XCH_4 , XCO , XH_2O and $XAir$ for all the available EM27/SUN instruments with respect to the COCCON reference spectrometer SN37 for every single side-by-side measurement carried out at KIT, Karlsruhe

SN	Date	No. co.	K_{XCO_2}	K_{XCH_4}	K_{XCO}	K_{XH_2O}	K_{XAir}
29	140718	195	1.000393	0.998811	N/A	0.999108	1.002586
32	150414	195	0.999965	1.001230	N/A	1.000010	0.997850
32	150422	178	1.000041	1.001340	N/A	0.999811	0.997732
33	170807	71	0.999746	0.999675	N/A	0.999161	1.001214
33	170815	69	0.999477	0.999933	N/A	0.998651	1.000470
34	180718	106	0.999767	0.999861	1.015124	0.999827	1.000653
34	180719	151	0.999837	0.999919	1.011808	1.000296	1.000481
38	150410	127	1.000129	0.999599	N/A	0.998667	1.000585
38	150421	199	1.000153	0.999690	N/A	0.998187	1.000895
39	140717	185	0.999764	0.999566	N/A	0.999360	1.000129
39	150414	210	0.999563	1.001041	N/A	0.999456	0.997887
39	150415	236	0.999676	1.001010	N/A	0.999348	0.997814
41	140717	185	0.999901	1.000076	N/A	0.999920	0.999264
41	150414	210	1.000038	1.000979	N/A	0.999814	0.998241
41	150422	183	1.000021	1.001489	N/A	0.998330	0.997775
42	160730	47	0.999478	1.001646	N/A	0.999510	0.996344
42	160801	145	0.999557	1.001682	N/A	1.000332	0.996166
44	170227	147	0.999670	1.000566	N/A	0.999120	0.998021
45	170807	124	0.999679	0.999697	N/A	0.999066	1.000287
45	170815	38	0.999670	0.999363	N/A	0.999037	1.000234
46	170807	155	0.999952	0.999597	N/A	0.999024	1.000433
46	170815	73	0.999851	0.999655	N/A	0.998959	1.000159
50	150421	127	0.999944	1.000085	N/A	1.000199	0.999952
50	150422	201	1.000168	1.000284	N/A	0.999603	0.999791
51	160126	78	0.999271	1.001036	N/A	1.000373	0.997073
51	160129	71	0.999378	1.000892	N/A	0.999818	0.997135
52	150421	146	0.998802	1.000043	N/A	1.000256	1.000067
52	150422	201	0.999482	1.000825	N/A	0.999631	0.999161
52	180221	116	0.999824	0.999966	1.000158	1.000693	1.000233
52	181018	134	1.000163	0.999949	0.998452	0.999970	1.000717
52	181114	153	0.999757	0.999736	1.002854	1.000029	1.000912
52	181116	156	0.999881	0.999793	0.992038	1.000095	1.000971
53	150421	145	0.999143	1.001005	N/A	0.999915	0.998366
53	150422	196	0.998935	1.000776	N/A	1.000286	0.998694
59	160318	131	0.999843	0.999683	N/A	0.998759	1.000538
61	151002	158	0.999861	0.999479	N/A	0.998404	1.001489
62	160121	29	0.999328	1.000425	N/A	0.999680	0.997768
63	160121	29	1.000445	1.001458	N/A	1.001036	0.997381

65	160511	107	1.000415	1.000424	N/A	1.000599	1.000217
69	160908	158	0.999514	0.999849	N/A	0.999494	0.999521
70	160831	200	0.999807	1.001654	N/A	1.000982	0.996414
70	160906	56	0.999753	1.001580	N/A	1.001328	0.996621
72	170215	96	0.998327	0.999388	N/A	1.000643	1.000088
72	170216	178	0.998520	0.998420	N/A	1.000130	1.002024
75	170516	171	0.998061	0.998648	N/A	0.999866	1.001418
75	170517	202	0.998058	0.998647	N/A	0.999914	1.001408
76	170608	160	0.996716	0.997441	N/A	1.000363	1.003012
77	170927	193	1.000023	0.999936	N/A	0.999972	1.000232
80	180418	161	0.999968	1.000296	1.010162	0.999863	0.999910
80	180419	243	0.999834	1.000320	1.003831	1.000316	0.999709
80	201031	110	0.999622	0.999549	0.980766	1.000120	0.999822
81	180718	107	1.000385	0.998933	1.012114	0.999529	1.002041
81	180719	177	1.000330	0.998963	1.015495	0.999772	1.001819
81	180725	147	1.000369	0.999011	1.008416	0.999927	1.001970
81	181018	174	0.999877	0.999522	0.999741	0.999651	1.001829
81	190418	231	0.999621	1.000084	1.010366	0.999742	1.000031
81	190425	38	0.999600	1.000334	0.978844	0.999368	0.999276
81	190430	116	0.999638	1.000145	1.000728	0.999457	1.000023
81	190619	157	0.999659	1.000517	0.999353	1.000165	0.999543
82	180717	66	0.999994	1.000890	1.025654	1.001119	0.998441
82	180718	142	0.999987	1.000862	1.019237	1.000951	0.998487
82	180719	176	0.999967	1.000796	1.024719	1.000955	0.998533
83	180507	207	0.999568	0.999711	1.011595	1.000029	1.000359
84	180406	184	0.999846	0.999436	1.004520	0.999695	1.001346
84	180411	223	1.000073	0.999727	1.004404	0.999575	1.000966
84	180418	176	0.999850	0.999515	1.005300	0.999677	1.001431
84	180419	249	1.000135	0.999554	1.009196	0.999947	1.001129
85	180124	87	0.999910	0.999527	0.924988	0.999105	0.999992
85	180208	94	0.999620	0.999265	1.010130	0.999763	1.001262
85	180213	149	0.999680	0.999267	1.004048	1.000352	1.001152
85	180214	125	1.000033	0.999290	0.996659	0.999899	1.001568
86	180124	91	0.999639	0.999768	0.940946	0.999775	0.998909
86	180208	91	0.999742	0.999628	1.004275	1.000140	0.999545
86	180213	160	0.999719	0.999646	1.002725	1.000866	0.999481
86	180214	155	0.999785	0.999703	1.003655	0.999993	0.999137
88	180314	86	0.999881	1.000228	1.006994	1.000591	0.999989
91	180228	150	0.999420	0.999986	0.995523	1.000346	1.000309
92	180515	13	0.999990	0.999915	1.012568	1.001652	0.999707
96	190213	93	0.999311	1.000066	0.985728	1.000659	0.999069
96	190619	146	0.999822	1.000423	0.996482	1.000140	0.999326
96	210901	110	1.000209	1.000480	0.963405	0.999462	1.000311
96	210902	137	0.999890	0.998614	1.047150	1.000947	0.998414

96	210903	263	0.999989	0.999923	1.011451	0.999773	1.000101
97	190225	172	1.000353	0.998278	1.010598	0.999270	1.003794
97	190226	234	1.000552	0.998408	1.008618	0.999612	1.003212
97	190227	221	1.000549	0.998437	1.009864	0.999684	1.003111
97	190228	188	1.000477	0.998520	1.009467	0.999429	1.002925
98	190225	172	1.000211	0.997951	1.009182	0.999236	1.004401
98	190226	232	1.000420	0.998104	1.009917	0.999758	1.003737
98	190227	221	1.000353	0.998109	1.009045	0.999743	1.003701
98	190228	188	1.000372	0.998108	1.009468	0.999284	1.003537
99	181109	95	0.999119	0.999757	0.983937	1.000142	0.999207
103	190205	166	0.999678	0.999405	0.981226	1.000054	1.000286
103	190206	107	0.999550	0.999055	0.994940	1.000072	1.001232
104	190204	95	0.999549	0.999579	0.949667	1.000264	0.999971
104	190205	187	0.999671	0.999767	0.981718	0.999940	0.999393
104	190206	102	0.999602	0.999601	1.000725	0.999925	1.000204
106	190328	109	1.000083	0.998764	1.007227	0.999716	1.001900
109	190328	97	1.000462	0.999022	1.008688	1.000239	1.001705
110	190328	112	1.000425	0.998077	1.002886	0.999744	1.003435
111	190213	171	0.999927	0.999788	0.997346	0.999476	1.000482
112	190710	216	0.999755	1.000262	1.027484	0.999507	1.000915
113	190716	162	1.000015	1.000491	0.991814	1.000814	0.999787
113	190717	202	1.000010	1.000585	0.989887	1.000514	0.999602
114	190724	82	0.999847	1.000141	1.018357	1.000521	1.001245
115	190725	224	0.999852	1.000209	1.028141	0.999798	1.000790
116	191014	198	0.999927	0.999285	1.005141	0.999180	1.001041
117	191031	164	0.999949	1.000036	1.003073	1.000302	0.999963
118	191122	29	1.000127	0.999448	0.966857	0.999973	1.001340
119	191122	31	0.999571	0.999652	0.988616	0.999770	1.000080
121	191130	125	0.999762	0.999766	0.982319	1.000585	0.998644
122	191130	95	0.998602	0.999058	0.987770	0.999427	1.001091
126	191216	91	0.999880	0.999885	0.951584	0.999559	0.999524
127	191210	146	1.000403	1.000175	0.990600	1.000476	0.998972
128	191210	139	1.000360	1.000269	0.997030	0.999765	0.998933
130	191229	99	0.998820	0.999881	1.003674	1.000924	0.998229
131	200121	173	1.000187	0.999339	0.994538	1.000197	1.001422
132	200115	155	0.999889	1.000284	0.987270	1.000286	1.000357
134	200318	158	1.000155	0.999901	1.005764	1.000866	1.000000
136	210719	25	1.000053	0.999560	0.933800	1.000187	1.000210
138	200707	132	1.000129	0.999899	1.012863	1.000262	1.000409
139	210211	133	1.000248	0.999163	0.988336	1.000002	1.001686
139	210213	178	0.999930	0.999349	0.997897	0.999757	1.001555
139	210214	205	1.000005	0.999178	0.991988	0.999713	1.001240
140	210211	68	1.000002	0.998894	0.993187	1.000321	1.003456
140	210213	191	0.999857	0.999419	0.994007	0.999889	1.001826

140	210214	199	0.999976	0.999442	0.988563	0.999740	1.001240
141	210213	144	1.000184	0.999231	0.993377	0.999961	1.001949
141	210214	203	1.000182	0.999236	0.985607	1.000285	1.001513
142	200820	94	1.000304	0.998414	0.970518	0.999025	1.003127
142	210424	195	1.000191	0.999697	1.000878	1.000788	1.001057
143	201118	123	1.001476	1.000205	1.004962	0.999849	0.998218
144	201118	121	0.999126	1.000294	1.008717	1.000789	0.997622
145	210115	146	1.000155	1.000442	0.970292	1.000792	0.998361
146	210111	190	1.000257	0.999662	0.985213	1.000079	1.000107
147	210306	184	1.000351	0.999847	1.000995	1.000174	1.001006
148	210424	178	1.000251	0.999800	1.013563	1.000735	1.000963
148	210426	243	1.000284	0.999691	1.010905	1.000080	1.001191
149	210306	184	1.000254	0.999808	1.004445	0.999816	1.000705
150	210330	241	1.000080	1.000077	1.005934	0.999812	0.999982
150	210331	224	1.000078	1.000165	1.006747	0.999822	0.999691
155	210531	220	1.000245	0.999332	1.019804	0.999927	1.001786
156	210908	90	1.000723	0.999926	1.002241	0.999931	1.000104
