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Table S1. WMO/ IAEA Round Robin experiments results (laboratory minus NOAA or INSTAAR) conducted over the time period, that are on the same scale as the data used in the analysis. All RR data is from the WMORR website ([Global Monitoring Laboratory - Carbon Cycle Greenhouse Gases \(noaa.gov\)](https://globalmonitoringlaboratory-carboncyclegreenhousegases.noaa.gov/)) except for ECCC's SF₆ data, which was updated to the SF₆ X2014 scale, and CSIRO's $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ RR#5 data, which was provided to us by CSIRO. INSTARR's $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ data was provided to us by INSTAAR, with updates for scale via JRAS-06 realization, to be consistent with flask data scale realization. All other laboratory isotope differences were updated according to the new INSTAAR data.

Species	RR #	Date	CSIRO	MPI-BGC	UHEI-IUP	LSCE	SIO	ECCC
CO ₂ (ppm)	5	2009-2012	0.00, 0.00, -0.10	-0.02, 0.00, 0.00	-0.04, -0.04, -0.08	0.06, 0.01, 0.12	-0.20, -0.14, -0.11	-0.02, -0.02, -0.03
	6	2014-2015	0.04, 0.00	-0.01, -0.02	-0.03, -0.06	-0.05, 0.00		0.09, 0.06
$\delta^{13}\text{C}$ (‰)	5	2009-2012	-0.055, -0.061, -0.082	-0.056, -0.044, -0.048	-0.053, -0.050, -0.056			0.006, 0.001, -0.006
	6	2014-2015	-0.042, -0.029	-0.033, -0.039	-0.082, -0.086			0.013, 0.003
$\delta^{18}\text{O}$ (‰)	5	2009-2012	0.111, 0.022, -0.024	-0.452, -0.066, -0.656	0.081, 0.112, 0.035			0.187, 0.170, 0.107
	6	2014-2015	0.177, 0.210	0.066, 0.066	0.035, -0.016			0.200, 0.165
CH ₄ (ppb)	6	2014-2015	0.50, 0.60	0.30, -0.40	0.10, -0.70			0.30, 0.40
N ₂ O (ppb)	5	2009-2012	-0.11, -0.05, -0.15					
	6	2014-2015	-0.10, -0.14	0.16, -0.07	0.14, 0.01	0.24, 0.37		-0.45, -0.43
SF ₆ (ppt)	6	2014-2015		0.00, 0.02				0.05, 0.05

Table S2. Time stamps of data sets (mm/dd/yyyy)

ALERT

Laboratory	CO ₂	CH ₄	N ₂ O	SF ₆	$\delta^{13}\text{C-CO}_2$	$\delta^{18}\text{O-CO}_2$
CSIRO	10/09/2018	10/09/2018	10/09/2018		10/09/2018	10/09/2018
MPI-BGC	02/02/2018	02/02/2018	02/02/2018	02/02/2018	02/02/2018	02/02/2018
UHEI-IUP	03/06/2018	03/06/2018	03/06/2018		03/06/2018	03/06/2018
LSCE	03/23/2017	03/20/2017	03/23/2017	03/23/2017	09/25/2017	10/03/2017
SIO	01/17/2019				01/17/2019	01/17/2019
ECCC	11/06/2018	01/24/2018	03/02/2018	01/24/2018	09/04/2018	08/20/2018
NOAA	10/10/2018	11/14/2018	11/14/2018	02/02/2018	01/23/2020	01/23/2020

CGO

Laboratory	CO ₂	CH ₄	N ₂ O	$\delta^{13}\text{C-CO}_2$	$\delta^{18}\text{O-CO}_2$
CSIRO	10/18/2018	07/05/2018	07/05/2018	10/18/2018	10/09/2018
NOAA	10/18/2018	07/03/2018	06/28/2018	01/23/2020	01/23/2020

MLO

Laboratory	CO ₂	CH ₄	N ₂ O	$\delta^{13}\text{C-CO}_2$	$\delta^{18}\text{O-CO}_2$
CSIRO	10/18/2018	07/05/2018	07/05/2018	10/18/2018	10/10/2018
SIO	01/17/2019			01/17/2019	01/17/2019
NOAA	10/18/2018	06/28/2018	06/28/2018	01/23/2020	01/23/2020

Table S3. Compilation of average flask pair differences for CO₂, in ppm, for each laboratory

	AVERAGE FLASK PAIR DIFFERENCE	STD DEV. OF PAIR DIFF	NUMBER OF DATA PTS
CSIRO	0.15	0.21	346
MPI-BGC	0.12	0.25	302
UHEI-IUP	0.12	0.07	546
LSCE	0.11	0.11	239
SIO	0.10	0.08	640
ECCC	0.10	0.12	825
NOAA	0.10	0.17	879

Table S4. Compilation of average flask pair differences for $\delta^{13}\text{C}\text{-CO}_2$ (‰) for each laboratory

	AVERAGE FLASK PAIR DIFFERENCE	STD DEV. OF PAIR DIFF	NUMBER OF DATA PTS
CSIRO	0.015	0.015	309
MPI-BGC	0.039	0.093	286
UHEI-IUP	0.013	0.009	409
LSCE	0.057	0.102	189
SIO	0.028	0.018	11
ECCC	0.013	0.018	439
NOAA	0.018	0.021	795

Table S5. Compilation of average flask pair differences for $\delta^{18}\text{O}\text{-CO}_2$ (‰) for each laboratory

	AVERAGE FLASK PAIR DIFFERENCE	STD DEV. OF PAIR DIFF	NUMBER OF DATA PTS
CSIRO	0.119	0.132	307
MPI-BGC	0.104	0.179	286
UHEI-IUP	0.029	0.018	280
LSCE	0.215	0.396	189
SIO	0.080	0.089	11
ECCC	0.060	0.050	391
NOAA	0.064	0.103	635

Table S6. Compilation of average flask pair differences for CH₄, in ppb, for each laboratory

	AVERAGE FLASK PAIR DIFFERENCE	STD DEV. OF PAIR DIFF	NUMBER OF DATA PTS
CSIRO	1.86	1.74	346
MPI-BGC	1.42	1.44	303
UHEI-IUP	1.61	2.34	504
LSCE	1.23	1.22	247
ECCC	0.74	0.76	841
NOAA	1.24	1.23	886

Table S7. Compilation of average flask pair differences for N₂O, in ppb, for each laboratory

	AVERAGE FLASK PAIR DIFFERENCE	STD DEV. OF PAIR DIFF	NUMBER OF DATA PTS
CSIRO	0.29	0.22	338
MPI-BCG	0.16	0.13	302
UHEI-IUP	0.13	0.08	532
LSCE	0.16	0.13	245
ECCC	0.19	0.14	690
NOAA	0.30	0.26	861

Table S8. Compilation of average flask pair differences for SF₆, in ppt, for each laboratory

	AVERAGE FLASK PAIR DIFFERENCE	STD DEV. OF PAIR DIFF	NUMBER OF DATA PTS
MPI-BGC	0.03	0.04	299
LSCE	0.04	0.04	257
ECCC	0.03	0.03	691
NOAA	0.04	0.04	864

Table S9. Summary of same-flask annual median CO₂ values, in ppm, for each of the five laboratory difference distributions (laboratory minus ECCC). The 95 % confidence limits of the computed annual median value are shown in parentheses followed by the number of individual measurement differences included in the computation.

Year	CSIRO	MPI-BGC	UHEI-IUP	LSCE	NOAA
1999					-0.17 (-0.20,-0.12) 13
2000					-0.02 (-0.03,0.01) 60
2001					0.02 (-0.01,0.04) 46
2002	0.25 (0.18,0.33) 32				0.02 (0.00,0.03) 89
2003	0.21 (0.15,0.26) 40				0.00 (-0.01,0.03) 88
2004	0.20 (0.16,0.27) 34				-0.02 (-0.03,0.00) 73
2005	0.10 (0.05,0.15) 37	0.00 (-0.05,0.05) 34	0.13 (0.10,0.15) 46		-0.03 (-0.05,0.00) 76
2006	0.10 (0.06,0.14) 32	0.01 (-0.05,0.14) 18	0.16 (0.10,0.22) 33		0.03 (0.01,0.05) 95
2007	0.10 (0.04,0.20) 23	0.06 (0.01,0.10) 20	0.10 (0.05,0.17) 31	0.49 (0.44,0.56) 23	0.04 (0.02,0.05) 92
2008	0.05 (0.02,0.09) 35	-0.10 (-0.21,0.04) 18	-0.13 (-0.15,0.00) 14	0.16 (0.12,0.24) 32	-0.16 (-0.20,-0.09) 69
2009	0.10 (0.08,0.14) 57	-0.08 (-0.16,0.16) 17	0.00 (-0.04,0.08) 30	0.17 (0.15,0.23) 37	-0.04 (-0.07,-0.01) 88
2010	0.02 (0.00,0.06) 74	-0.03 (-0.10,0.03) 21	-0.05 (-0.05,-0.01) 40	0.07 (0.04,0.10) 37	-0.08 (-0.09,-0.06) 92
2011	-0.01 (-0.06,0.03) 62	0.00 (-0.04,0.05) 19	-0.04 (-0.06,0.00) 33	0.06 (-0.02,0.14) 37	-0.04 (-0.06,0.00) 46
2012	-0.01 (-0.03,0.03) 67	-0.04 (-0.10,0.00) 22	-0.03 (-0.06,0.01) 41	0.11 (0.08,0.13) 43	-0.06 (-0.08,-0.04) 49
2013	0.01 (-0.02,0.04) 66	-0.09 (-0.12,0.29) 17	-0.07 (-0.09,-0.04) 32	0.07 (0.02,0.20) 13	-0.09 (-0.10,-0.06) 48
1999-2013	0.06 (0.05,0.07) 559	-0.02 (-0.04,0.00) 186	0.00 (-0.01,0.02) 300	0.12 (0.11,0.15) 222	-0.02 (-0.03,-0.01) 1024

Table S10. 11-12 year increases of CO₂ (ppm) calculated from individual datasets from six laboratories (2005-2016), using the de-seasoned data from Nakazawa's curve-fitting routine. (Nakazawa et al., 1997)

12 yr trend	2016	2005	2005-2016	11 yr trend	2015	2005	2005-2015	11 yr trend	2016	2006	2006-2016
CSIRO	404.22	380.64	23.59		401.63	380.64	20.99		404.22	383.52	20.70
MPI-BGC	404.25	380.82	23.43		401.88	380.82	21.06		404.25	383.45	20.81
UHEI-IUP	404.15	380.68	23.47		401.69	380.68	21.01		404.15	383.32	20.83
SIO	404.44	380.46	23.98		401.95	380.46	21.50		404.44	383.52	20.92
ECCC	404.17	380.57	23.60		401.61	380.57	21.04		404.17	383.17	21.01
NOAA	404.32	380.68	23.64		401.72	380.68	21.04		404.32	383.38	20.94
Mean	404.26	380.64	23.62	Mean	401.75	380.64	21.11	Mean	404.26	383.39	20.87
s.d.	0.11	0.12	0.20	s.d.	0.14	0.12	0.19	s.d.	0.11	0.13	0.11
(Max - min)	0.29	0.36	0.55	(Max - min)	0.35	0.36	0.50	(Max - min)	0.29	0.35	0.30
Rel. Diff %			2.33	Rel. Diff %			2.39	Rel. Diff %			1.45

Ref. Nakazawa, T., Ishizawa, M., Higuchi, K. and Trivett, N.B.: Two curve fitting methods applied to CO₂ flask data, Environmetrics, Vol 8, 197-218, 1997.

Table S11. Summary of same-flask annual median N₂O values, in ppb, for each of the five laboratory difference distributions (laboratory minus ECCC). The 95 % confidence limits of the computed annual median value are shown in parentheses followed by the number of individual measurement differences included in the computation.

Year	CSIRO	MPI-BGC	UHEI-IUP	LSCE	NOAA
2001					0.08 (-0.04,0.20) 73
2002	-0.27 (-0.36,-0.15) 30				-0.06 (-0.14,0.07) 97
2003	-0.22 (-0.34,0.02) 39				-0.10 (-0.21,-0.03) 89
2004	-0.23 (-0.28,-0.04) 31				-0.10 (-0.17,0.00) 77
2005	-0.14 (-0.28,-0.01) 36	-0.08 (-0.19,0.08) 32	-0.01 (-0.04,0.18) 46		-0.40 (-0.52,-0.17) 73
2006	-0.08 (-0.37,0.13) 33	-0.01 (-0.30,0.42) 17	-0.03 (-0.20,0.12) 34		-0.29 (-0.43,-0.12) 99
2007	-0.27 (-0.60,0.04) 23	0.17 (-0.17,0.45) 21	-0.05 (-0.31,0.14) 32	1.04 (0.84,1.26) 26	-0.24 (-0.53,-0.09) 94
2008	0.13 (-0.13,0.40) 36	0.02 (-0.06,0.16) 19	0.16 (-0.06,1.85) 14	0.98 (0.90,1.29) 30	0.05 (-0.09,0.23) 68
2009	0.08 (-0.07,0.25) 55	0.12 (-0.42,0.91) 16	0.33 (0.26,0.49) 29	0.37 (0.27,0.62) 38	-0.08 (-0.18,0.05) 85
2010	-0.04 (-0.22,0.04) 73	-0.16 (-0.26,0.29) 21	0.01 (-0.11,0.18) 38	0.45 (0.37,0.51) 37	-0.17 (-0.30,-0.08) 89
2011	-0.02 (-0.18,0.14) 62	0.28 (0.04,0.63) 18	0.23 (0.18,0.38) 32	0.44 (0.13,0.69) 35	0.16 (0.00,0.52) 47
2012	0.10 (-0.02,0.30) 37	-0.04 (-0.21,0.65) 15	0.20 (0.02,0.49) 21	0.46 (0.30,0.89) 27	0.08 (-0.20,0.41) 31
2013	-0.27 (-0.42,-0.08) 33		0.04 (-0.10,0.45) 14		-0.06 (-0.20,0.11) 21
2001-2013	-0.11 (-0.17,-0.05) 488	0.03 (-0.06,0.09) 163	0.09 (0.03,0.14) 260	0.55 (0.48,0.66) 201	-0.10 (-0.14,-0.08) 943