Improvements to reference gas cylinder production and calibration at Scripps.

Tim Lueker, Ralph Keeling.

Scripps Institution of Oceanography

SCHMIDT FAMILY FOUNDATION

Scripps standard gas program

1) The improved performance of our RIX air compressor (post rebuild).

2) The expansion of our filling station to include 4 more cylinder filling ports.

3) The performance of our new MEECO ™ H_2O analyzer.

4) Improved methodology for minor adjustments to concentrations.

5) Computerized database for cylinder records.

6) Cylinder inventory including calibration standard gas histories, analysis results and historical gas cylinder collection, with tagged cylinders for improved tracking and monitoring.

7) Our abilities to provide gases, including preparation and calibration of standard cylinders for field projects. Examples “LA megacities” and Barrow Alaska O_2/N_2 field instrument.

Where are my Precious gases???


NOTICE

Fill 4 cylinders (each 141 cu ft. or 4000 liter) per hour

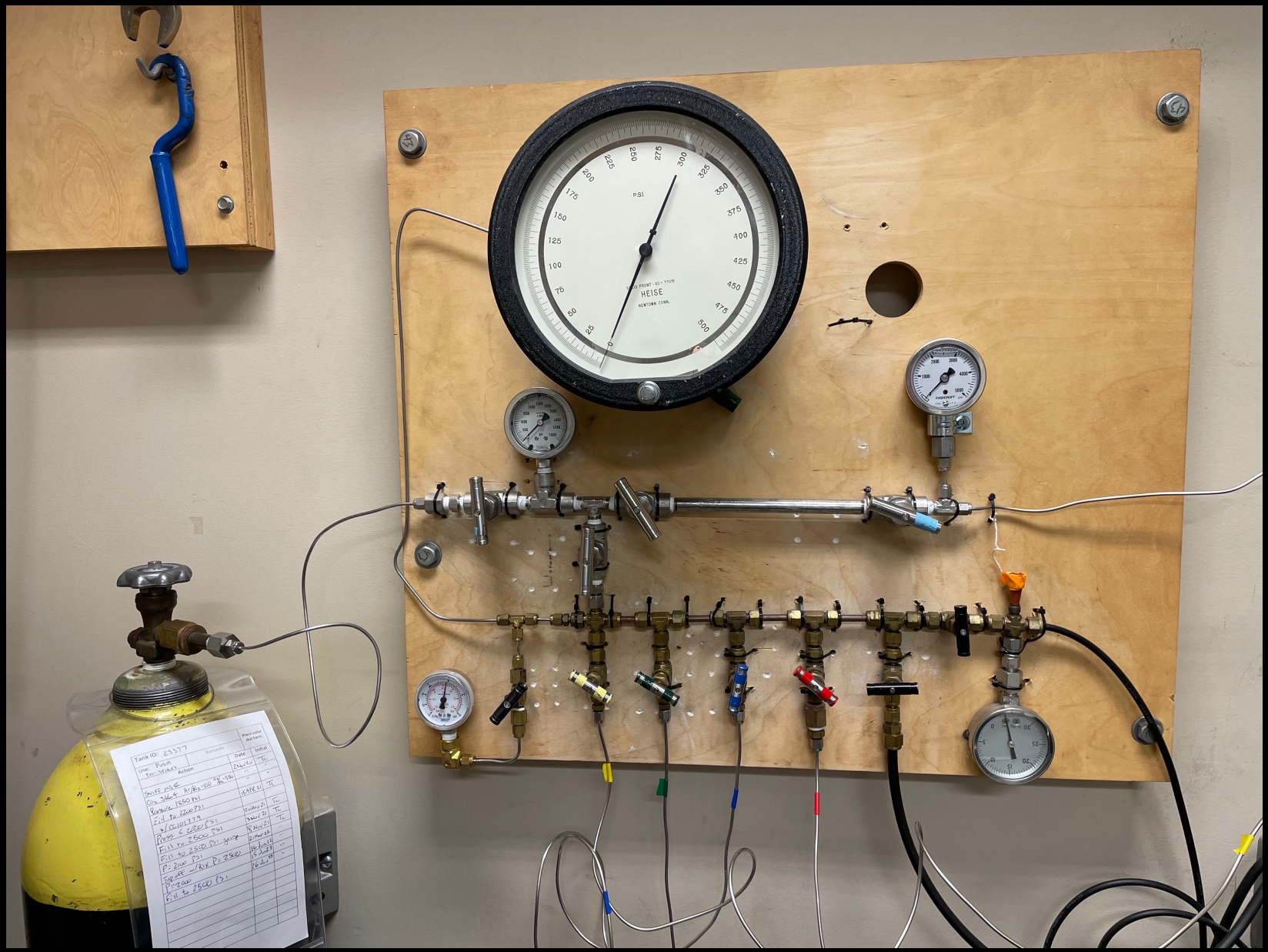
(N150 internal vol = 1.04 cu ft. or 29.5 liter)

Fill 6 N265 (N265 = 243 cu ft.) ~2.5 hours.

Drying and mol sieve columns and Corblin (transfer) pump .

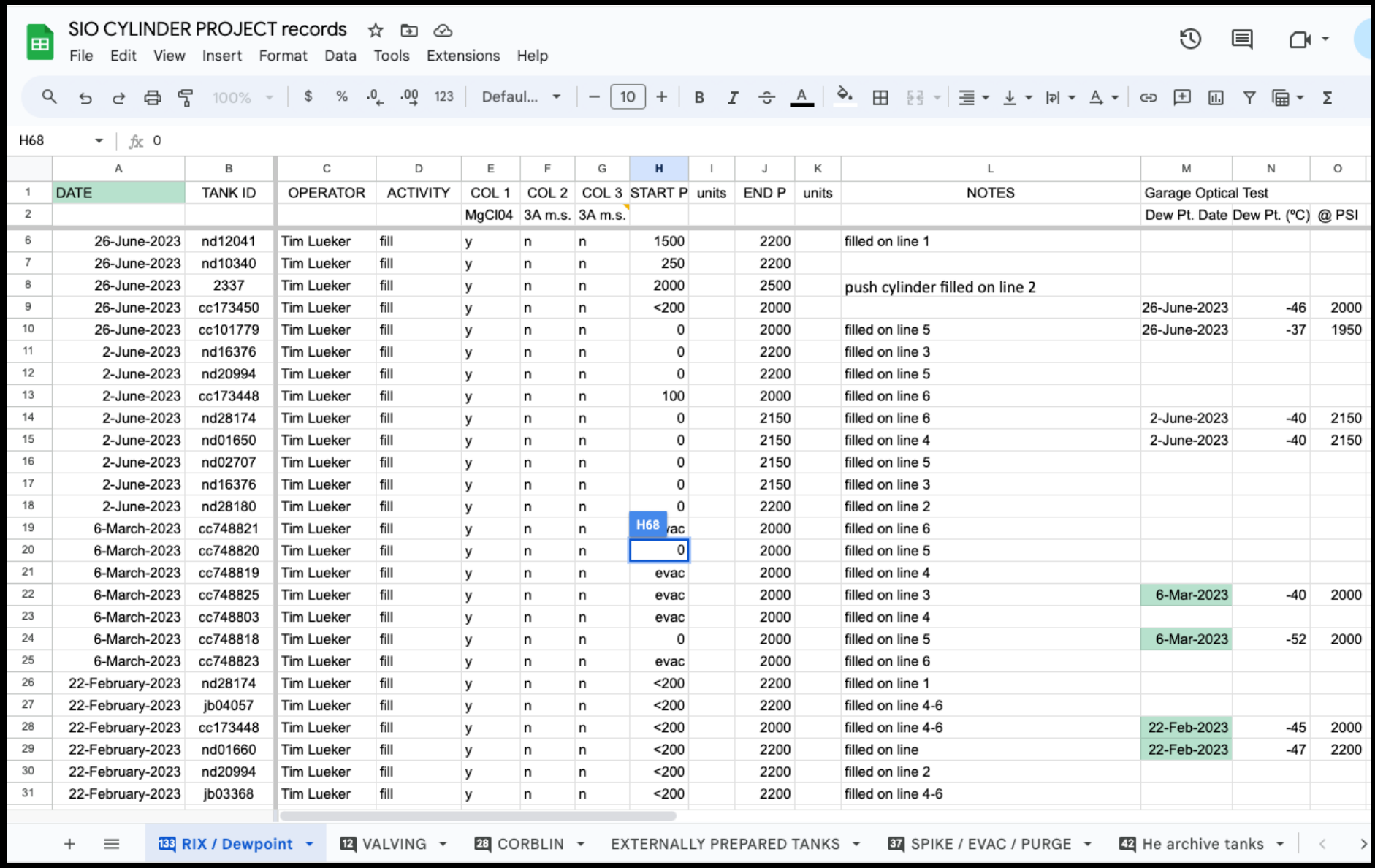
MEECO H_2O analyzer – precise to 0.1 ppm H_2O?.

Spiker volume (11.7cc) and gauge for addition of gases to cylinders.



Precise gauge allows differential mixing to give precise adjustments of gases .

Cylinder filling, valving, mixing and preparation database.



SIO CYLINDER PROJECT records

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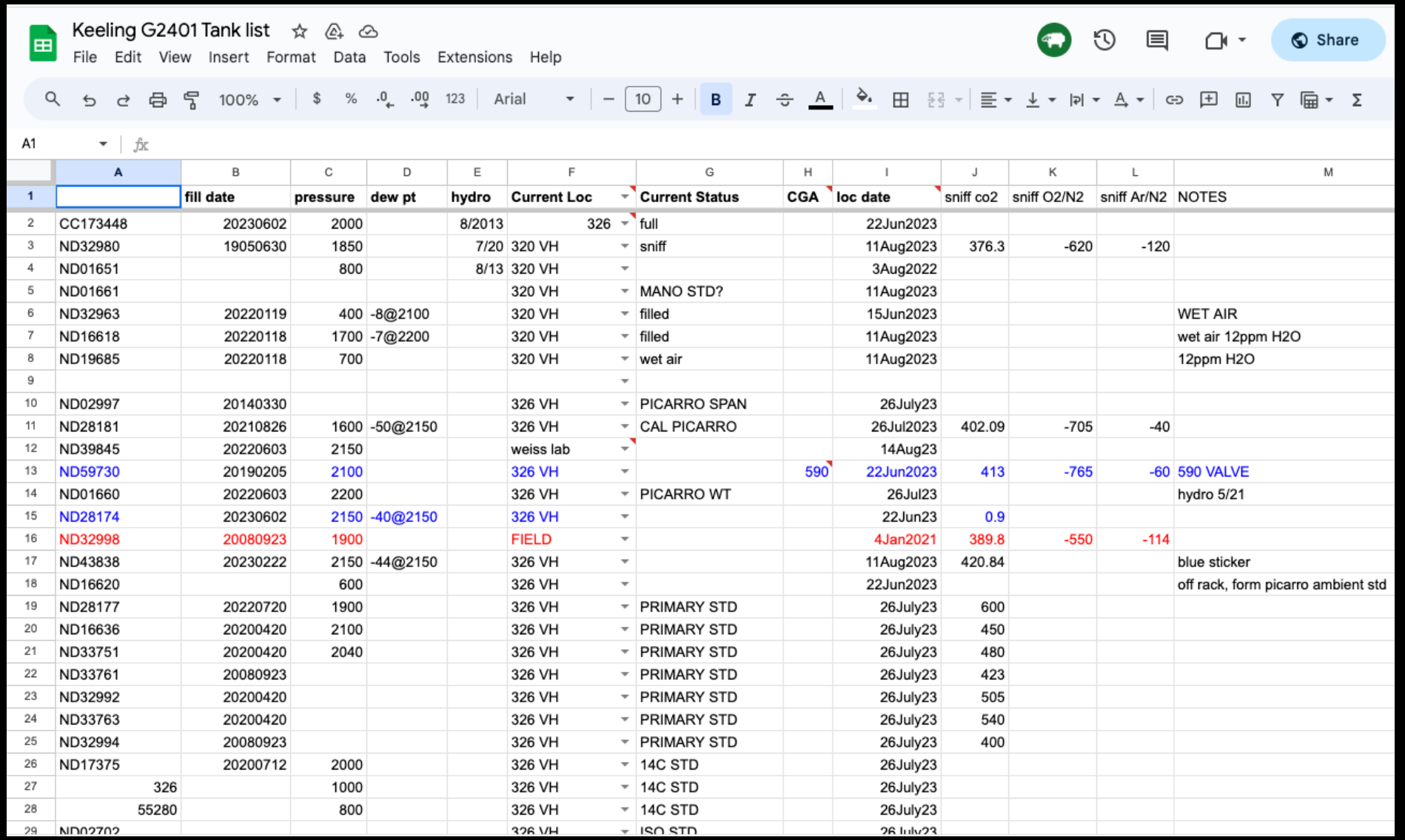
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	DATE	TANK ID	OPERATOR	ACTIVITY	COL 1	COL 2	COL 3	START P	units	END P	units	NOTES	Garage Optical Test		
2					MgCl04	3A m.s.	3A m.s.						Dew Pt. Date	Dew Pt. (°C)	@ PSI
6	26-June-2023	nd12041	Tim Lueker	fill	y	n	n	1500		2200		filled on line 1			
7	26-June-2023	nd10340	Tim Lueker	fill	y	n	n	250		2200					
8	26-June-2023	2337	Tim Lueker	fill	y	n	n	2000		2500		push cylinder filled on line 2			
9	26-June-2023	cc173450	Tim Lueker	fill	y	n	n	<200		2000			26-June-2023	-46	2000
10	26-June-2023	cc101779	Tim Lueker	fill	y	n	n	0		2000		filled on line 5	26-June-2023	-37	1950
11	2-June-2023	nd16376	Tim Lueker	fill	y	n	n	0		2200		filled on line 3			
12	2-June-2023	nd20994	Tim Lueker	fill	y	n	n	0		2200		filled on line 5			
13	2-June-2023	cc173448	Tim Lueker	fill	y	n	n	100		2000		filled on line 6			
14	2-June-2023	nd28174	Tim Lueker	fill	y	n	n	0		2150		filled on line 6	2-June-2023	-40	2150
15	2-June-2023	nd01650	Tim Lueker	fill	y	n	n	0		2150		filled on line 4	2-June-2023	-40	2150
16	2-June-2023	nd02707	Tim Lueker	fill	y	n	n	0		2150		filled on line 5			
17	2-June-2023	nd16376	Tim Lueker	fill	y	n	n	0		2150		filled on line 3			
18	2-June-2023	nd28180	Tim Lueker	fill	y	n	n	0		2200		filled on line 2			
19	6-March-2023	cc748821	Tim Lueker	fill	y	n	n	H68 vac		2000		filled on line 6			
20	6-March-2023	cc748820	Tim Lueker	fill	y	n	n	0		2000		filled on line 5			
21	6-March-2023	cc748819	Tim Lueker	fill	y	n	n	evac		2000		filled on line 4			
22	6-March-2023	cc748825	Tim Lueker	fill	y	n	n	evac		2000		filled on line 3	6-Mar-2023	-40	2000
23	6-March-2023	cc748803	Tim Lueker	fill	y	n	n	evac		2000		filled on line 4			
24	6-March-2023	cc748818	Tim Lueker	fill	y	n	n	0		2000		filled on line 5	6-Mar-2023	-52	2000
25	6-March-2023	cc748823	Tim Lueker	fill	y	n	n	evac		2000		filled on line 6			
26	22-February-2023	nd28174	Tim Lueker	fill	y	n	n	<200		2200		filled on line 1			
27	22-February-2023	jb04057	Tim Lueker	fill	y	n	n	<200		2200		filled on line 4-6			
28	22-February-2023	cc173448	Tim Lueker	fill	y	n	n	<200		2000		filled on line 4-6	22-Feb-2023	-45	2000
29	22-February-2023	nd01660	Tim Lueker	fill	y	n	n	<200		2200		filled on line	22-Feb-2023	-47	2200
30	22-February-2023	nd20994	Tim Lueker	fill	y	n	n	<200		2200		filled on line 2			
31	22-February-2023	jb03368	Tim Lueker	fill	y	n	n	<200		2200		filled on line 4-6			

RIX / Dewpoint | VALVING | CORBLIN | EXTERNALLY PREPARED TANKS | SPIKE / EVAC / PURGE | He archive tanks

Over 250 cylinders in our inventory (N150 and N265 and steel).



Keeling G2401 Tank list

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Share

	A	B	C	D	E	F	G	H	I	J	K	L	M
1		fill date	pressure	dew pt	hydro	Current Loc	Current Status	CGA	loc date	sniff co2	sniff O2/N2	sniff Ar/N2	NOTES
2	CC173448	20230602	2000		8/2013	326	full		22Jun2023				
3	ND32980	19050630	1850		7/20	320 VH	sniff		11Aug2023	376.3	-620	-120	
4	ND01651		800		8/13	320 VH			3Aug2022				
5	ND01661					320 VH	MANO STD?		11Aug2023				
6	ND32963	20220119	400	-8@2100		320 VH	filled		15Jun2023				WET AIR
7	ND16618	20220118	1700	-7@2200		320 VH	filled		11Aug2023				wet air 12ppm H2O
8	ND19685	20220118	700			320 VH	wet air		11Aug2023				12ppm H2O
9													
10	ND02997	20140330				326 VH	PICARRO SPAN		26July23				
11	ND28181	20210826	1600	-50@2150		326 VH	CAL PICARRO		26Jul2023	402.09	-705	-40	
12	ND39845	20220603	2150			weiss lab			14Aug23				
13	ND59730	20190205	2100			326 VH		590	22Jun2023	413	-765	-60	590 VALVE
14	ND01660	20220603	2200			326 VH	PICARRO WT		26Jul23				hydro 5/21
15	ND28174	20230602	2150	-40@2150		326 VH			22Jun23	0.9			
16	ND32998	20080923	1900			FIELD			4Jan2021	389.8	-550	-114	
17	ND43838	20230222	2150	-44@2150		326 VH			11Aug2023	420.84			blue sticker
18	ND16620		600			326 VH			22Jun2023				off rack, form picarro ambient std
19	ND28177	20220720	1900			326 VH	PRIMARY STD		26July23	600			
20	ND16636	20200420	2100			326 VH	PRIMARY STD		26July23	450			
21	ND33751	20200420	2040			326 VH	PRIMARY STD		26July23	480			
22	ND33761	20080923				326 VH	PRIMARY STD		26July23	423			
23	ND32992	20200420				326 VH	PRIMARY STD		26July23	505			
24	ND33763	20200420				326 VH	PRIMARY STD		26July23	540			
25	ND32994	20080923				326 VH	PRIMARY STD		26July23	400			
26	ND17375	20200712	2000			326 VH	14C STD		26July23				
27	326		1000			326 VH	14C STD		26July23				
28	55280		800			326 VH	14C STD		26July23				
29	ND02702					326 VH	ISO STD		26 July23				

CO_2 standard cylinders
White Stripes (1980s)
I.R. Manos (1990s)
High CO_2 (2020).
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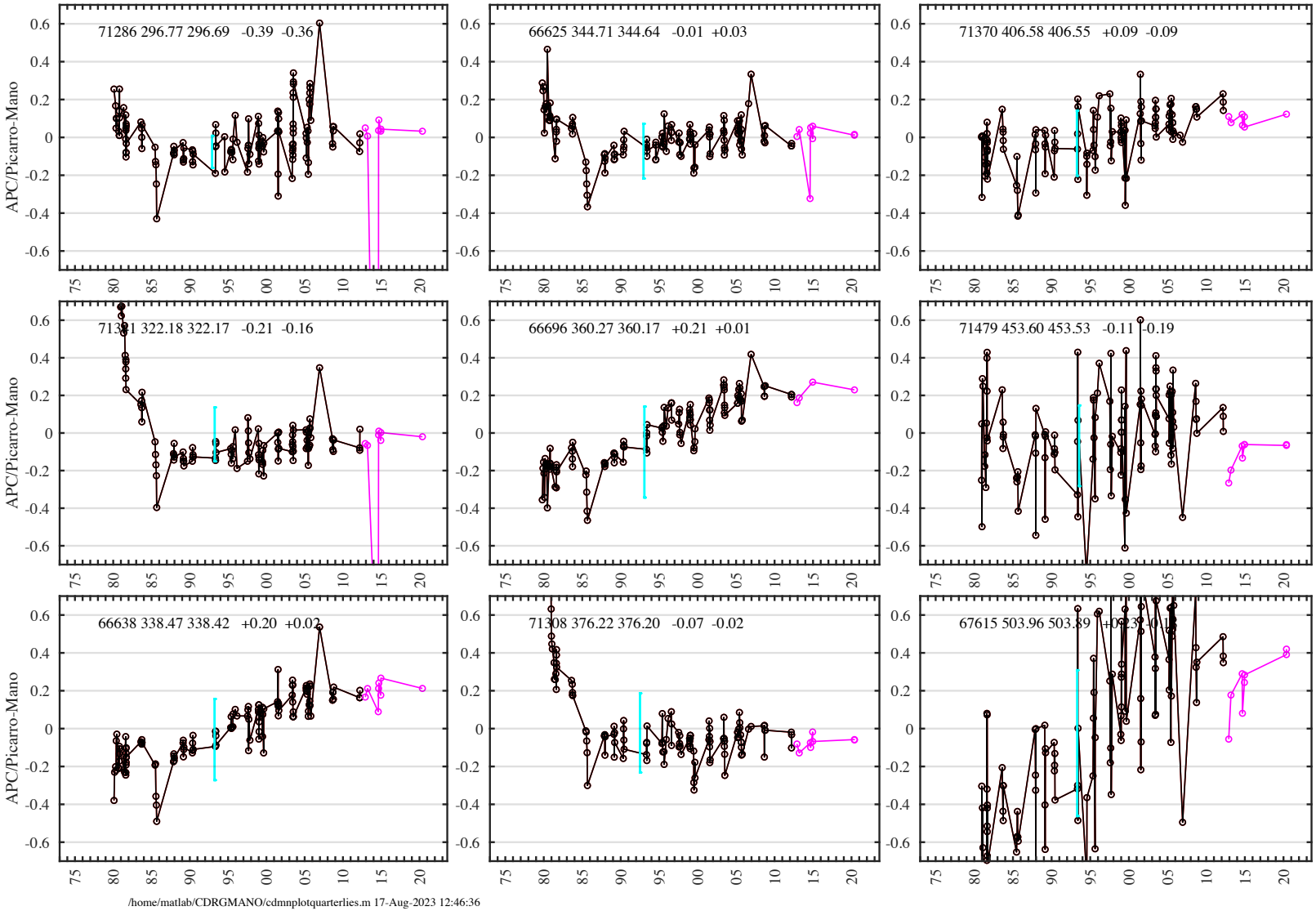
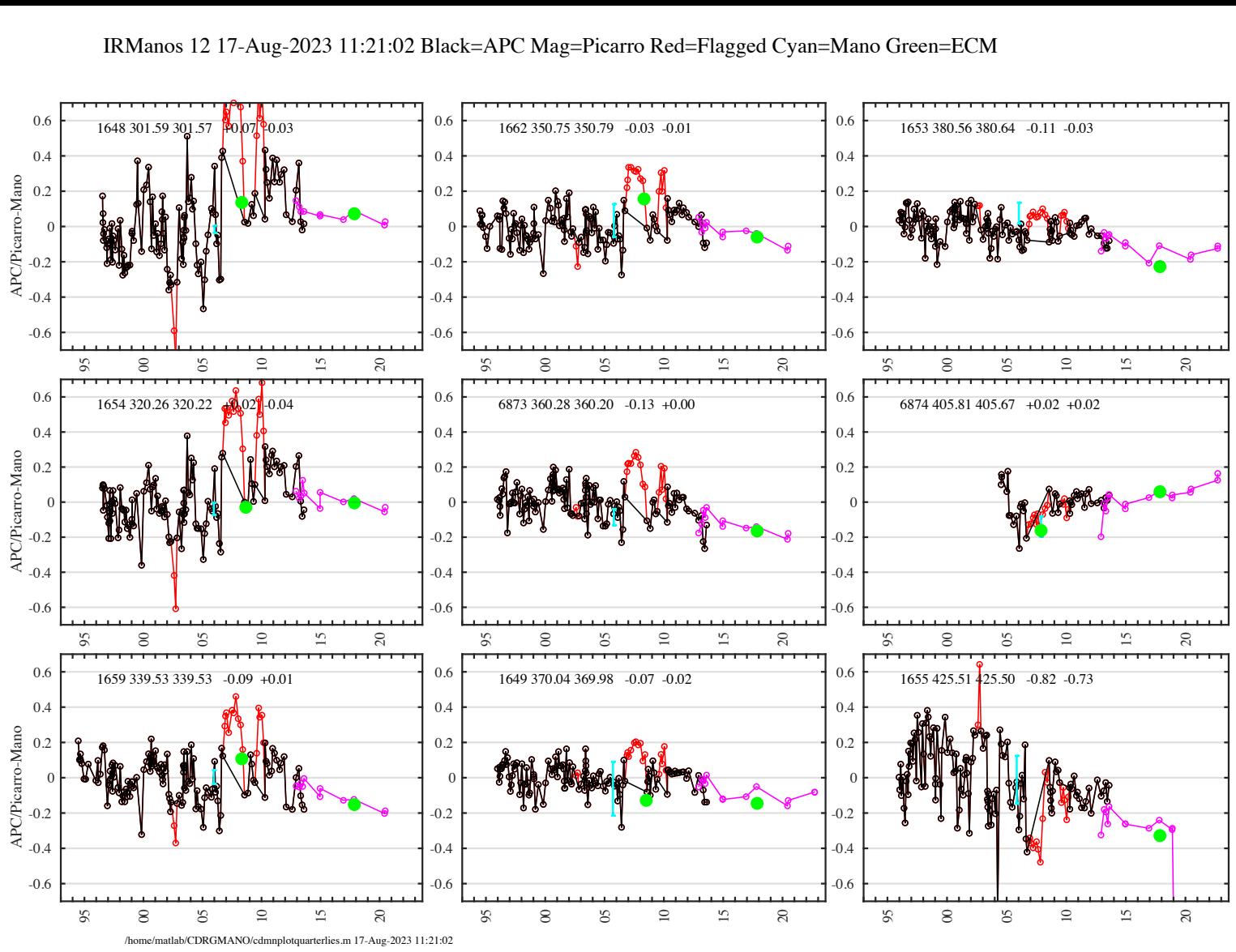
WhiteStripes 12 17-Aug-2023 12:46:36 Black=APC Mag=Picarro Red=Flagged Cyan=Mano Green=ECM

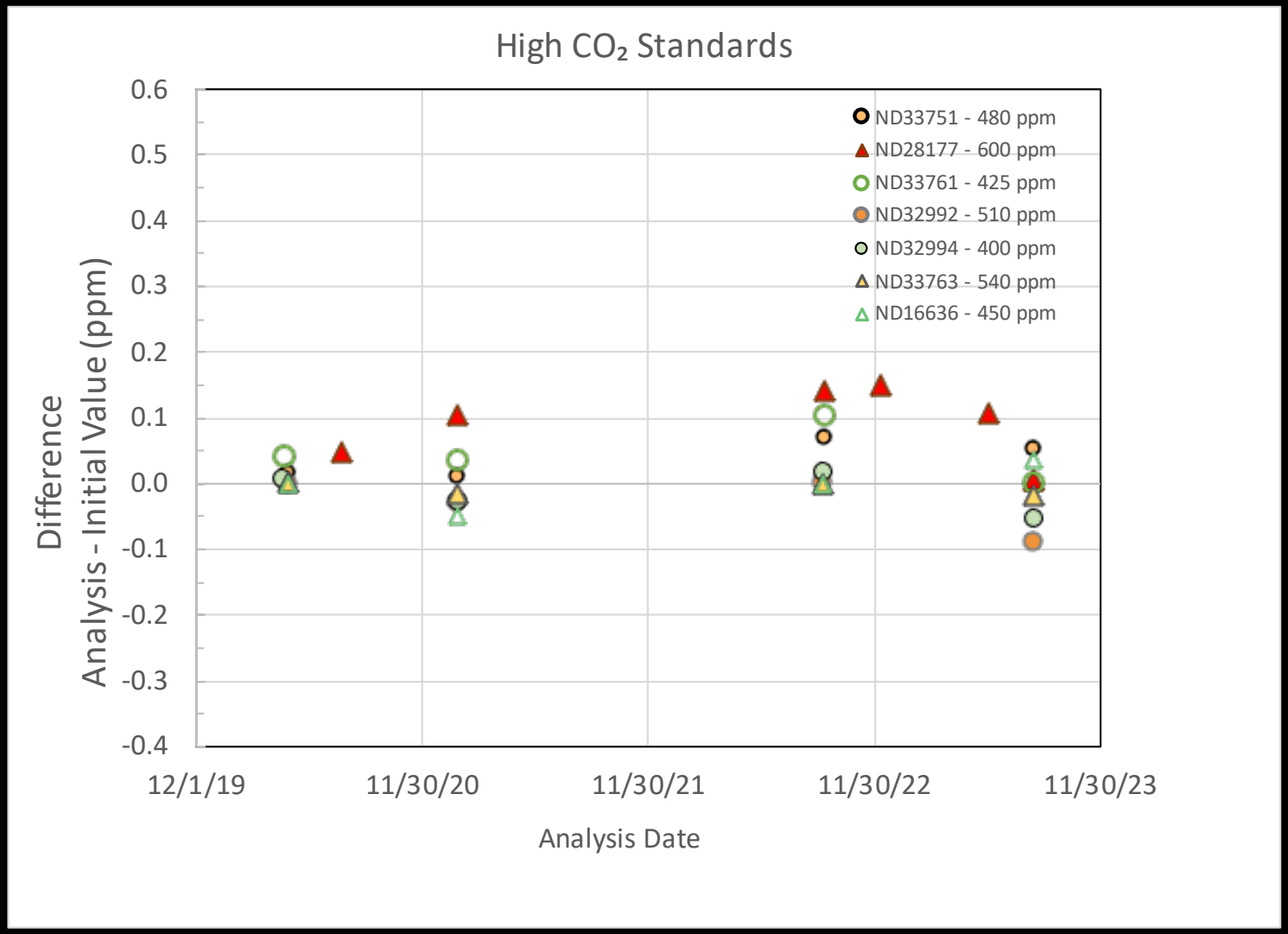


/home/matlab/CDRGMANO/cdmnplotquarterlies.m 17-Aug-2023 12:46:36

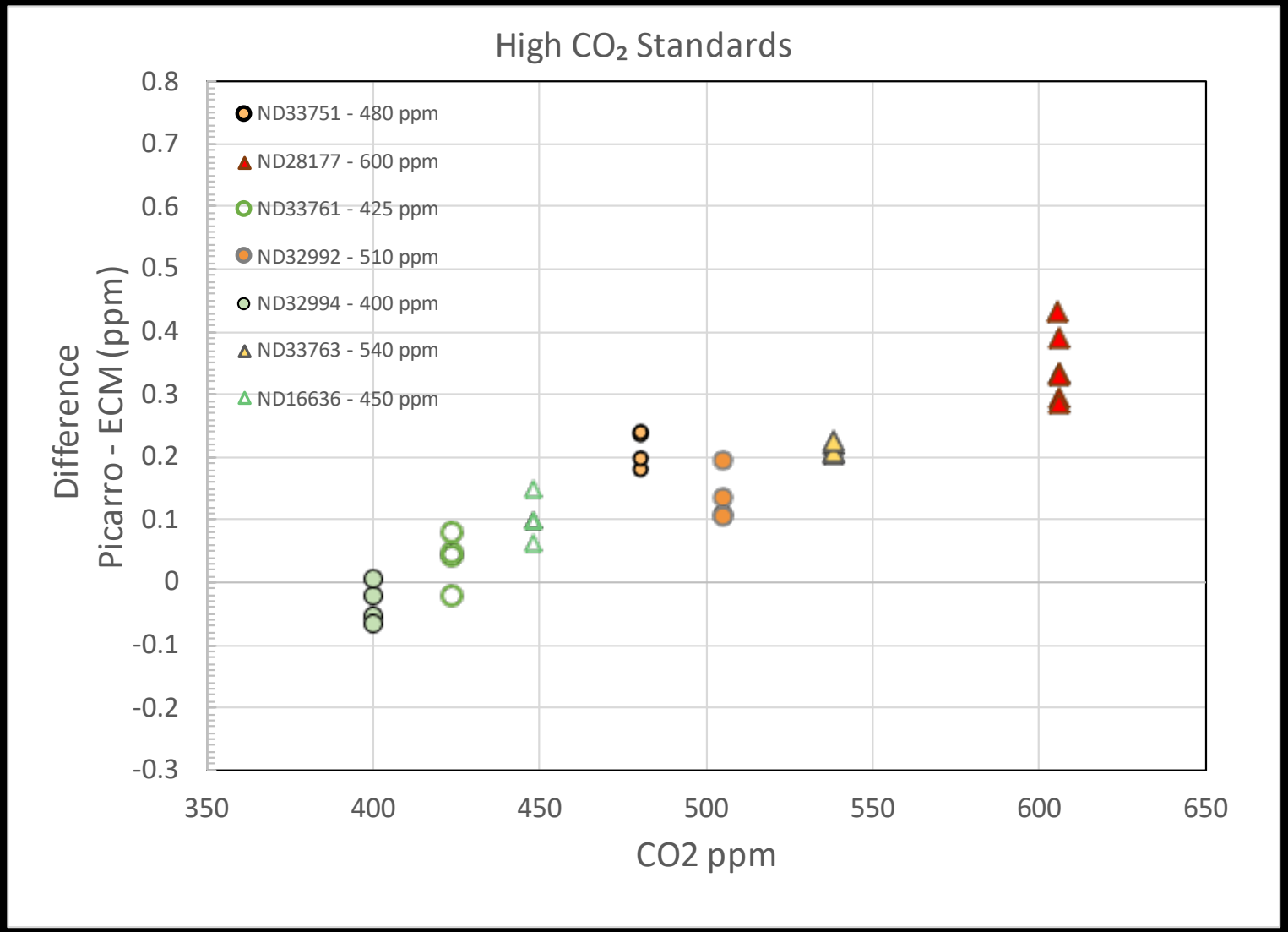
Stability of IR mano CO_2 cylinders.



Stability of High CO_2 cylinders.



High CO_2 cylinder Manometric Analyses.



High CO_2 cylinder Manometric Analyses.

Precision Statistics from 2023 High CO2 standard tank analyses.

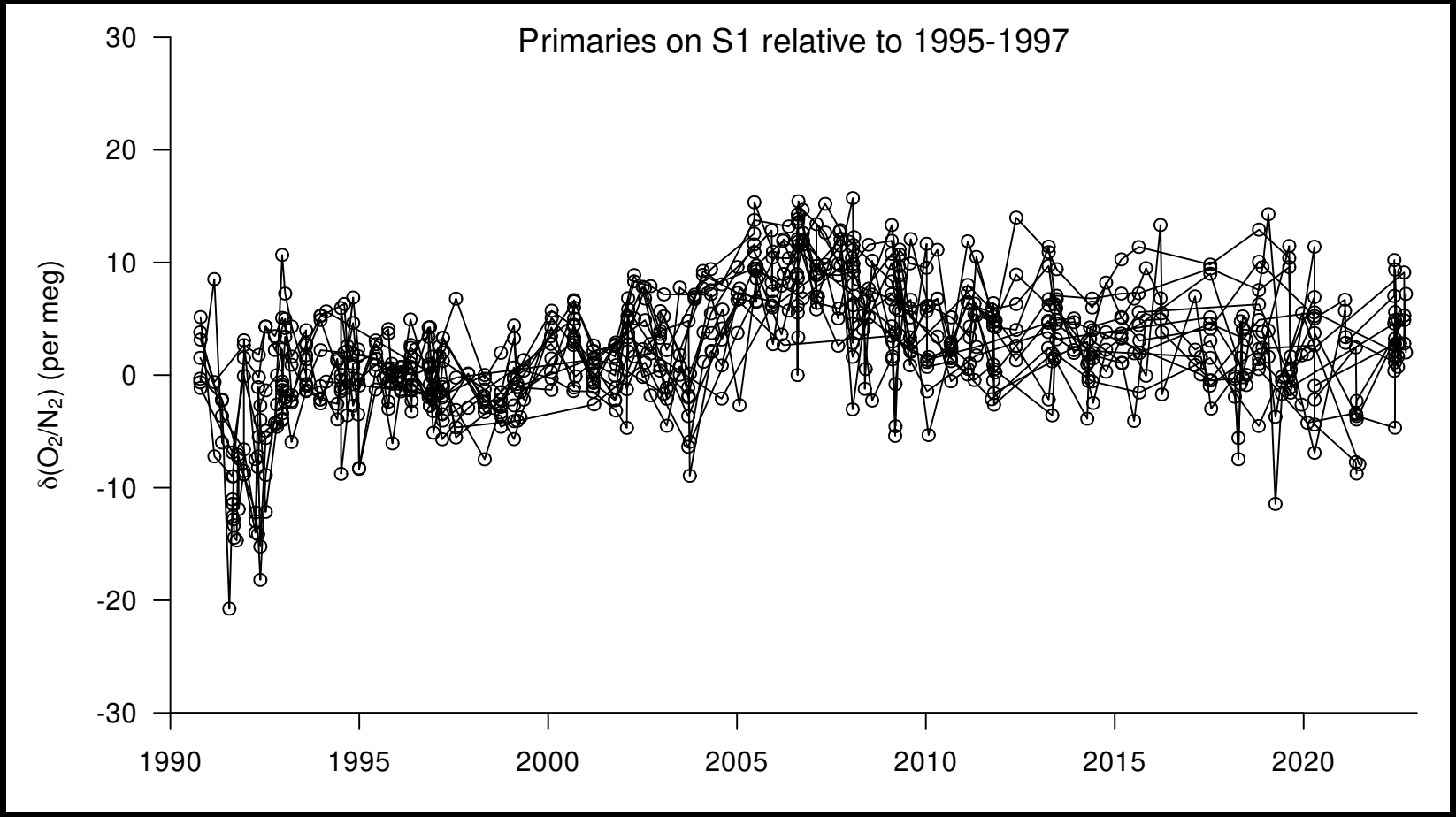
20-Jul-23

G.Emanuele

Fill Date	Tank	Fill	Uncorr ppm CO2	Avg ppm CO2	Stdev ppm CO2	N	Deviation	Pair Difference
29-Jun-23	<32994>	1A	400.646	400.718	0.102	2	-0.072	-0.144
29-Jun-23	<32994>	1B	400.790				0.072	
26-Jun-23	<33761>	1A	423.755	423.808	0.057	3	-0.053	
12-Jul-23	<33761>	2A	423.801				-0.007	-0.068
12-Jul-23	<33761>	2B	423.868				0.060	
22-Jun-23	<16636>	1A	448.700	448.678	0.031	2	0.022	0.044
22-Jun-23	<16636>	1B	448.656				-0.022	
21-Jun-23	<33751>	1B	480.823	480.828	0.012	3	-0.005	
13-Jul-23	<33751>	2A	480.819				-0.009	-0.022
13-Jul-23	<33751>	2B	480.841				0.014	
20-Jun-23	<32992>	1A	505.665	505.711	0.066	2	-0.047	-0.094
20-Jun-23	<32992>	1B	505.758				0.047	
27-Jun-23	<33763>	1A	538.453	538.451	0.003	2	0.002	0.004
27-Jun-23	<33763>	1B	538.449				-0.002	
5-Jul-23	<28177>	1B	606.267	606.330	0.054	3	-0.063	
10-Jul-23	<28177>	2A	606.360				0.030	-0.002
10-Jul-23	<28177>	2B	606.362				0.032	
16-Jun-23	<1661>	7A	380.538	380.575	0.041	3	-0.037	
3-Jul-23	<1661>	8A	380.568				-0.007	-0.051
3-Jul-23	<1661>	8B	380.619				0.044	

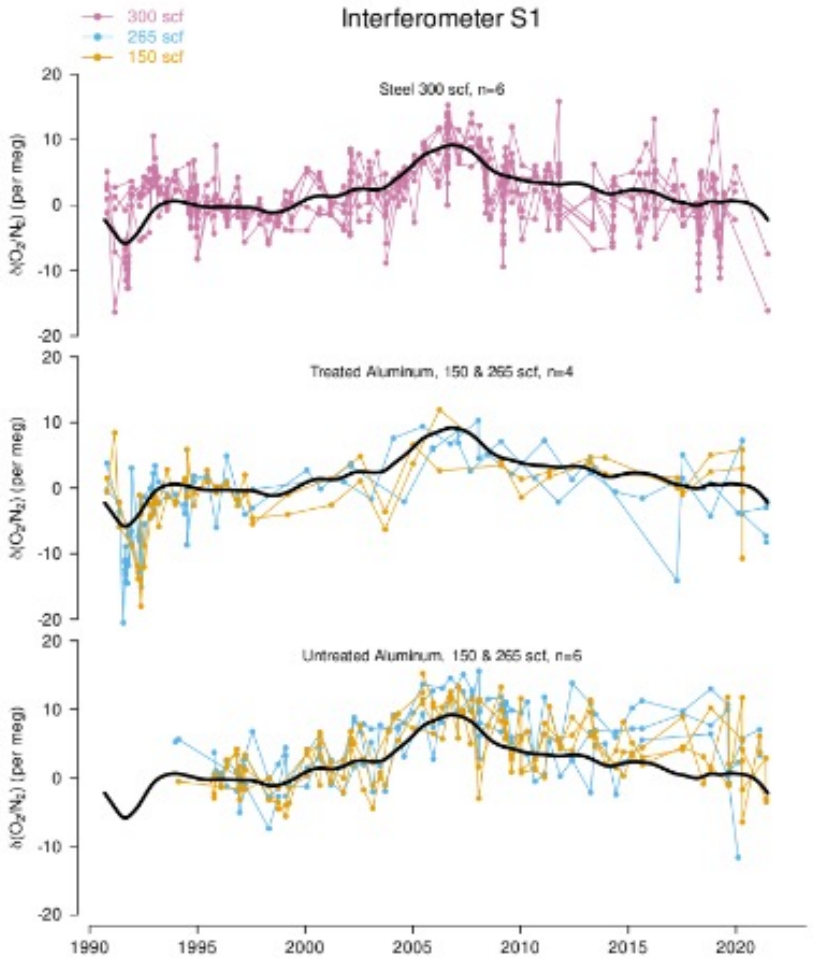
High CO2 tanks only		
	All	Pairs Only
Pooled Stdev:	0.053	0.051
Pt In:	9188	9578
With <1661>		
	All	Pairs Only
Pooled Stdev:	0.051	0.049
Pt In:	9202	9562

Stability of O2 standard cylinders.



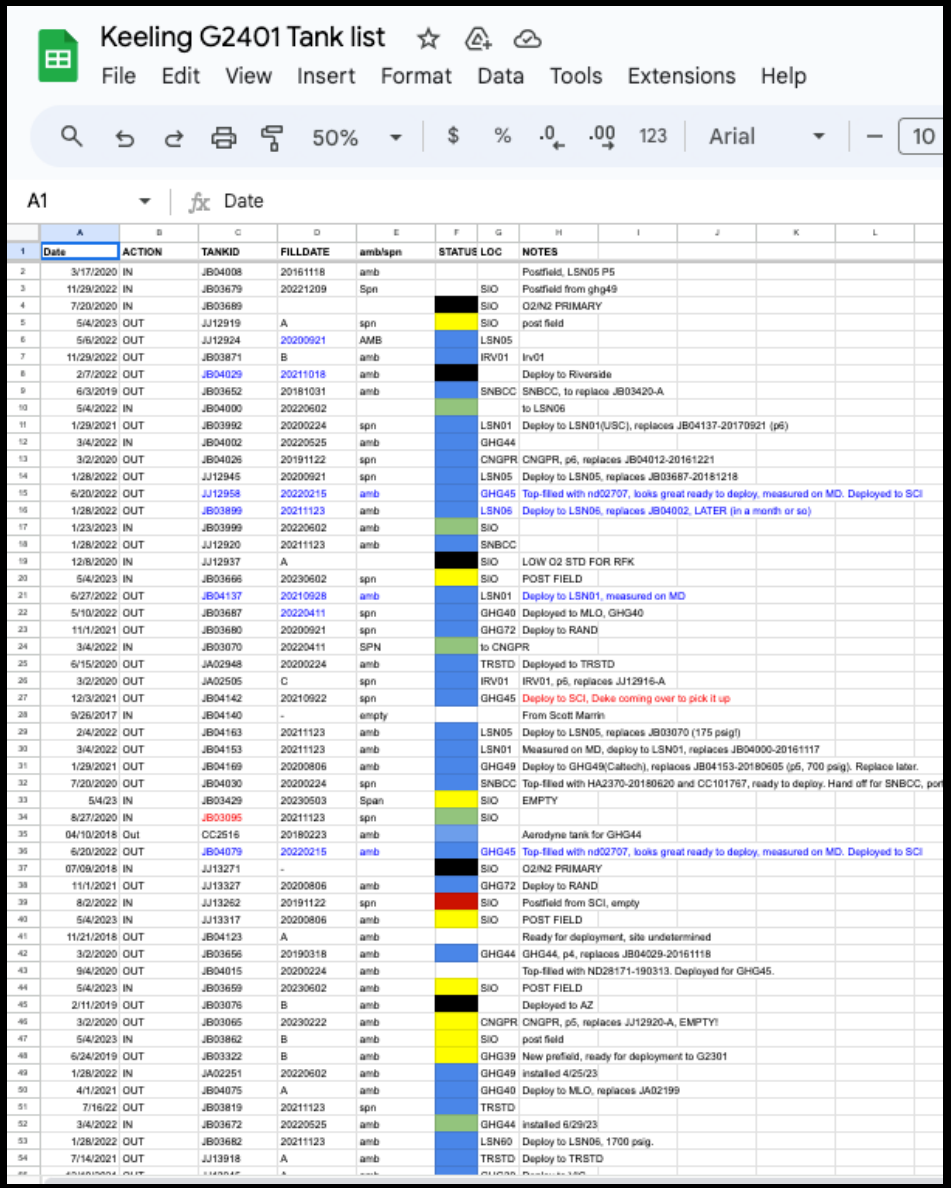
Stability of O2 standard cylinders by type.

Relative drift



- 16 primaries (excluding 2 leakers)
- Start of service ranges from 1986–1995
- 3 materials: steel, untreated aluminum, treated aluminum
- 3 volumes: 300 scf, 265 scf, 150 scf
- If some of the primaries are drifting, that means there is an artifact in the S2 scale.
- There appears to be some fanning out of the ensemble

LA Megacities 16 field stations, 93 cylinders (and counting)



Keeling G2401 Tank list

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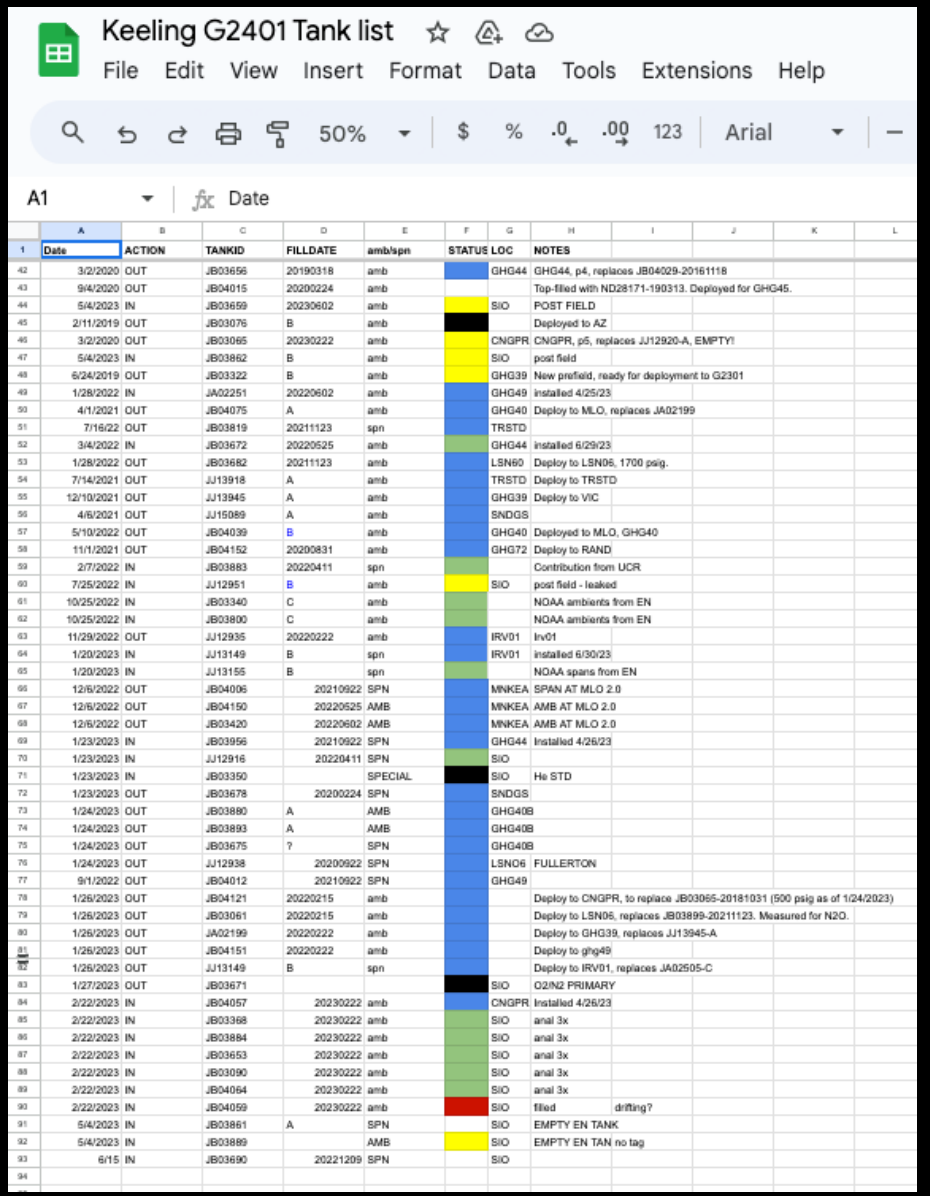
A1 Date

	Date	ACTION	TANKID	FILLDATE	amb/spn	STATUS	LOC	NOTES
2	3/17/2020	IN	JB04008	20161118	amb			Postfield, LSN05 P5
3	11/29/2022	IN	JB03679	20221209	Spn		SIO	Postfield from ghg49
4	7/20/2020	IN	JB03689				SIO	O2/N2 PRIMARY
5	5/4/2023	OUT	JJ12919	A	spn		SIO	post field
6	5/6/2022	OUT	JJ12924	20200921	AMB		LSN05	
7	11/29/2022	OUT	JB03871	B	amb		IRV01	Irv01
8	2/7/2022	OUT	JB04029	20211018	amb			Deploy to Riverside
9	6/3/2019	OUT	JB03652	20181031	amb		SNBCC	SNBCC, to replace JB03420-A
10	5/4/2022	IN	JB04000	20220602				to LSN06
11	1/29/2021	OUT	JB03992	20200224	spn		LSN01	Deploy to LSN01(USC), replaces JB04137-20170921 (p6)
12	3/4/2022	IN	JB04002	20220525	amb		GHG44	
13	3/2/2020	OUT	JB04026	20191122	spn		CNGPR	CNGPR, p6, replaces JB04012-20161221
14	1/28/2022	OUT	JJ12945	20200921	spn		LSN05	Deploy to LSN05, replaces JB03687-20181218
15	6/20/2022	OUT	JJ12958	20220215	amb		GHG45	Top-filled with nd02707, looks great ready to deploy, measured on MD. Deployed to SCI
16	1/28/2022	OUT	JB03899	20211123	amb		LSN06	Deploy to LSN06, replaces JB04002, LATER (in a month or so)
17	1/23/2023	IN	JB03999	20220602	amb		SIO	
18	1/28/2022	OUT	JJ12920	20211123	amb		SNBCC	
19	12/8/2020	IN	JJ12937	A			SIO	LOW O2 STD FOR RFK
20	5/4/2023	IN	JB03666	20230602	spn		SIO	POST FIELD
21	6/27/2022	OUT	JB04137	20210928	amb		LSN01	Deploy to LSN01, measured on MD
22	5/10/2022	OUT	JB03687	20220411	spn		GHG40	Deployed to MLO, GHG40
23	11/1/2021	OUT	JB03680	20200921	spn		GHG72	Deploy to RAND
24	3/4/2022	IN	JB03070	20220411	SPN			to CNGPR
25	6/15/2020	OUT	JA02948	20200224	amb		TRSTD	Deployed to TRSTD
26	3/2/2020	OUT	JA02505	C	spn		IRV01	IRV01, p5, replaces JJ12916-A
27	12/3/2021	OUT	JB04142	20210922	spn		GHG45	Deploy to SCI, Deke coming over to pick it up
28	9/26/2017	IN	JB04140	-	empty			From Scott Marrin
29	2/4/2022	OUT	JB04163	20211123	amb		LSN05	Deploy to LSN05, replaces JB03070 (175 psig!)
30	3/4/2022	OUT	JB04153	20211123	amb		LSN01	Measured on MD, deploy to LSN01, replaces JB04000-20161117
31	1/29/2021	OUT	JB04169	20200806	amb		GHG49	Deploy to GHG49(Caltech), replaces JB04153-20180605 (p5, 700 psig). Replace later.
32	7/20/2020	OUT	JB04030	20200224	spn		SNBCC	Top-filled with HA2370-20180620 and CC101767, ready to deploy. Hand off for SNBCC, por
33	5/4/23	IN	JB03429	20230503	Span		SIO	EMPTY
34	8/27/2020	IN	JB03095	20211123	spn		SIO	
35	04/10/2018	Out	CC2516	20180223	amb			Aerodyne tank for GHG44
36	6/20/2022	OUT	JB04079	20220215	amb		GHG45	Top-filled with nd02707, looks great ready to deploy, measured on MD. Deployed to SCI
37	07/09/2018	IN	JJ13271	-			SIO	O2/N2 PRIMARY
38	11/1/2021	OUT	JJ13327	20200806	amb		GHG72	Deploy to RAND
39	8/2/2022	IN	JJ13262	20191122	spn		SIO	Postfield from SCI, empty
40	5/4/2023	IN	JJ13317	20200806	amb		SIO	POST FIELD
41	11/21/2018	OUT	JB04123	A	amb			Ready for deployment, site undetermined
42	3/2/2020	OUT	JB03656	20190318	amb		GHG44	GHG44, p4, replaces JB04029-20161118
43	9/4/2020	OUT	JB04015	20200224	amb			Top-filled with ND28171-190313. Deployed for GHG45.
44	5/4/2023	IN	JB03659	20230602	amb		SIO	POST FIELD
45	2/11/2019	OUT	JB03076	B	amb			Deployed to AZ
46	3/2/2020	OUT	JB03065	20230222	amb		CNGPR	CNGPR, p5, replaces JJ12920-A, EMPTY!
47	5/4/2023	IN	JB03862	B	amb		SIO	post field
48	6/24/2019	OUT	JB03322	B	amb		GHG39	New prefield, ready for deployment to G2301
49	1/28/2022	IN	JA02251	20220602	amb		GHG49	installed 4/25/23
50	4/1/2021	OUT	JB04075	A	amb		GHG40	Deploy to MLO, replaces JA02199
51	7/16/22	OUT	JB03819	20211123	spn		TRSTD	
52	3/4/2022	IN	JB03672	20220525	amb		GHG44	installed 6/29/23
53	1/28/2022	OUT	JB03682	20211123	amb		LSN60	Deploy to LSN06, 1700 psig.
54	7/14/2021	OUT	JJ13918	A	amb		TRSTD	Deploy to TRSTD



Keeling G2401 Tank list

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A1 Date

	Date	ACTION	TANKID	FILLDATE	amb/spn	STATUS	LOC	NOTES
42	3/2/2020	OUT	JB03656	20190318	amb		GHG44	GHG44, p4, replaces JB04029-20161118
43	9/4/2020	OUT	JB04015	20200224	amb			Top-filled with ND28171-190313. Deployed for GHG45.
44	5/4/2023	IN	JB03659	20230602	amb		SIO	POST FIELD
45	2/11/2019	OUT	JB03076	B	amb			Deployed to AZ
46	3/2/2020	OUT	JB03065	20230222	amb		CNGPR	CNGPR, p5, replaces JJ12920-A, EMPTY!
47	5/4/2023	IN	JB03862	B	amb		SIO	post field
48	6/24/2019	OUT	JB03322	B	amb		GHG39	New prefield, ready for deployment to G2301
49	1/28/2022	IN	JA02251	20220602	amb		GHG49	installed 4/25/23
50	4/1/2021	OUT	JB04075	A	amb		GHG40	Deploy to MLO, replaces JA02199
51	7/16/22	OUT	JB03819	20211123	spn		TRSTD	
52	3/4/2022	IN	JB03672	20220525	amb		GHG44	installed 6/29/23
53	1/28/2022	OUT	JB03682	20211123	amb		LSN60	Deploy to LSN06, 1700 psig.
54	7/14/2021	OUT	JJ13918	A	amb		TRSTD	Deploy to TRSTD
55	12/10/2021	OUT	JJ13945	A	amb		GHG39	Deploy to VIC
56	4/6/2021	OUT	JJ15089	A	amb		SNDGS	
57	5/10/2022	OUT	JB04039	B	amb		GHG40	Deployed to MLO, GHG40
58	11/1/2021	OUT	JB04152	20200831	amb		GHG72	Deploy to RAND
59	2/7/2022	IN	JB03883	20220411	spn			Contribution from UCR
60	7/25/2022	IN	JJ12951	B	amb		SIO	post field - leaked
61	10/25/2022	IN	JB03340	C	amb			NOAA ambients from EN
62	10/25/2022	IN	JB03800	C	amb			NOAA ambients from EN
63	11/29/2022	OUT	JJ12935	20220222	amb		IRV01	Irv01
64	1/20/2023	IN	JJ13149	B	spn		IRV01	installed 6/30/23
65	1/20/2023	IN	JJ13155	B	spn			NOAA spans from EN
66	12/6/2022	OUT	JB04096	20210922	SPN		MNKEA	SPAN AT MLO 2.0
67	12/6/2022	OUT	JB04150	20220525	AMB		MNKEA	AMB AT MLO 2.0
68	12/6/2022	OUT	JB03420	20220602	AMB		MNKEA	AMB AT MLO 2.0
69	1/23/2023	IN	JB03956	20210922	SPN		GHG44	Installed 4/26/23
70	1/23/2023	IN	JJ12916	20220411	SPN		SIO	
71	1/23/2023	IN	JB03350		SPECIAL		SIO	He STD
72	1/23/2023	OUT	JB03678	20200224	SPN		SNDGS	
73	1/24/2023	OUT	JB03880	A	AMB		GHG40B	
74	1/24/2023	OUT	JB03893	A	AMB		GHG40B	
75	1/24/2023	OUT	JB03675	?	SPN		GHG40B	
76	1/24/2023	OUT	JJ12938	20200922	SPN		LSN06	FULLERTON
77	9/1/2022	OUT	JB04012	20210922	SPN		GHG49	
78	1/26/2023	OUT	JB04121	20220215	amb			Deploy to CNGPR, to replace JB03065-20181031 (500 psig as of 1/24/2023)
79	1/26/2023	OUT	JB03061	20220215	amb			Deploy to LSN06, replaces JB03899-20211123. Measured for N2O.
80	1/26/2023	OUT	JA02199	20220222	amb			Deploy to GHG39, replaces JJ13945-A
81	1/26/2023	OUT	JB04151	20220222	amb			Deploy to ghg49
82	1/26/2023	OUT	JJ13149	B	spn			Deploy to IRV01, replaces JA02505-C
83	1/27/2023	OUT	JB03671				SIO	O2/N2 PRIMARY
84	2/22/2023	IN	JB04057	20230222	amb		CNGPR	Installed 4/26/23
85	2/22/2023	IN	JB03368	20230222	amb		SIO	anal 3x
86	2/22/2023	IN	JB03884	20230222	amb		SIO	anal 3x
87	2/22/2023	IN	JB03653	20230222	amb		SIO	anal 3x
88	2/22/2023	IN	JB03090	20230222	amb		SIO	anal 3x
89	2/22/2023	IN	JB04064	20230222	amb		SIO	anal 3x
90	2/22/2023	IN	JB04059	20230222	amb		SIO	filled drifting?
91	5/4/2023	IN	JB03861	A	SPN		SIO	EMPTY EN TANK
92	5/4/2023	IN	JB03889		AMB		SIO	EMPTY EN TAN no tag
93	6/15	IN	JB03690	20221209	SPN		SIO	

BRW O2/N2 field instrument
20, N150 cylinders / year

A	B	C	D	E	F	G	H	I	J	
Request #	Project	Brief Description	Date Needed (mm/dd/yyyy)	Requestor	Preparer	Tank ID	Date Filled (yyyymmdd)	Date Completed (yyyymmdd)		Requ
181	O2	Junk	11/07/22	Shane	Tim	nd01650		20220411	in use	Ambient
182	O2	Junk	12/15/2022	Shane	Tim	nd02707	11/07/2022	11/07/2022	344B	Ambient
183	O2	Scan	2/15/2023	Shane	Tim	ha2370	11/07/2022	11/07/2022	344C	nd size, no constraints
184	BRW	low O2 span	4/15/2023	Eric	Tim	cc101774	3/27/23		344C	BRW span: O2= -800 to -850, C
	BRW	low O2 span	4/15/2023	Eric	Tim	cc113293	3/27/23		344C	BRW span: O2= -800 to -850, C
	BRW	high O2 span	4/15/2023	Eric	Tim	cc748819	3/27/23		344C	BRW span: O2= -550 to -625, C
	BRW	high O2 span	4/15/2023	Eric	Tim	cc748825	3/27/23		344C	BRW span: O2= -550 to -625, C
185	BRW	wt	4/15/2023	Eric	Tim	cc748821	4/13/2023	4/13/2023	344B	working tank ambient air
	BRW	wt	4/15/2023	Eric	Tim	cc748820	4/13/2023	4/13/2023	344B	working tank ambient air
	BRW	wt	4/15/2023	Eric	Tim	cc748803	4/13/2023	4/13/2023	344B	working tank ambient air
	BRW	wt	4/15/2023	Eric	Tim	cc748818	4/13/2023	4/13/2023	344B	working tank ambient air
	BRW	wt	4/15/2023	Eric	Tim	cc748823	4/13/2023	4/13/2023	344B	working tank ambient air
	BRW	wt	4/15/2023	Eric	Tim	cc101776	4/13/2023	4/13/2023	344B	working tank ambient air
	BRW	wt	4/15/2023	Eric	Tim	cc101782	4/13/2023	4/13/2023	344B	working tank ambient air
	BRW	wt	4/15/2023	Eric	Tim	cc113309	4/13/2023	4/13/2023	344B	working tank ambient air
	BRW	wt	4/15/2023	Eric	Tim	cc113308	4/13/2023	4/13/2023	344B	working tank ambient air
	BRW	wt	4/15/2023	Eric	Tim	cc748814	4/13/2023	4/13/2023	344B	working tank ambient air
	BRW	wt	4/15/2023	Eric	Tim	cc748817	4/13/2023	4/13/2023	344B	working tank ambient air
	BRW	wt	4/15/2023	Eric	Tim	cc748810	4/13/2023	4/13/2023	344B	working tank ambient air
	BRW	wt	4/15/2023	Eric	Tim	cc113300	4/13/2023	4/13/2023	344B	working tank ambient air
	BRW	wt	4/15/2023	Eric	Tim	cc173467	4/13/2023	4/13/2023	344B	working tank ambient air
	BRW	wt	4/15/2023	Eric	Tim	cc173444	4/13/2023	4/13/2023	344B	working tank ambient air
	BRW	wt	4/15/2023	Eric	Tim	cc101767	4/13/2023	4/13/2023	344B	working tank ambient air
186	O2	HWT	6/5/2023	Shane	Tim	HA2353-20220603	6/1/23	6/1/23	344	CO2 420ppm, O2 -780permeg,
187	O2	LWT	6/19/2023	Shane	Tim	ND59726-20230615	6/1/23	6/16/23	344B	CO2 410ppm, O2 -735permeg,
188	O2	PWT	7/1/2023	Shane	Tim	ND44520-20220215	6/1/23	6/1/23	343	baseline with argon spike

Los Angeles Times Magazine
MAY 21, 1989

Weathermen of the Apocalypse

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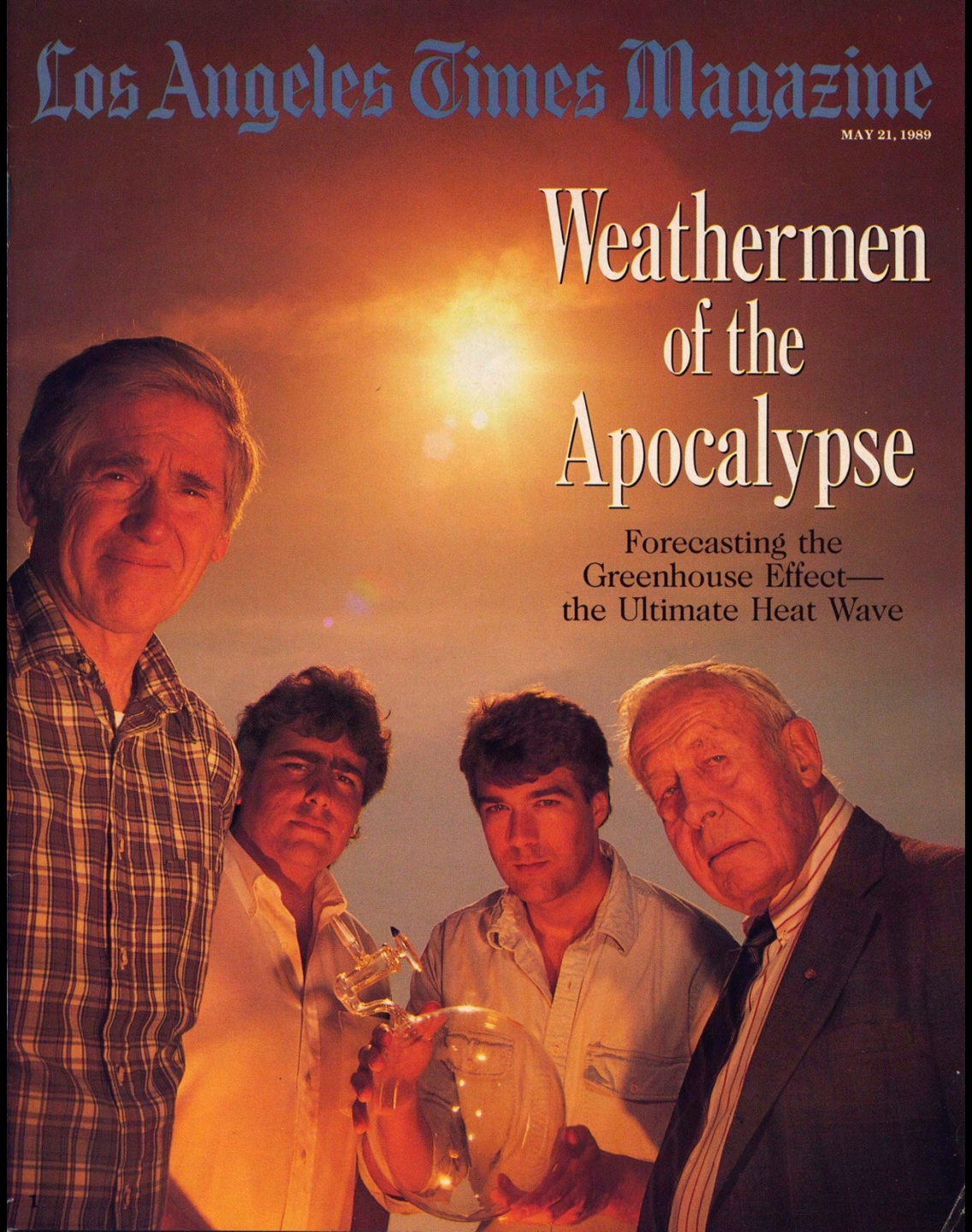

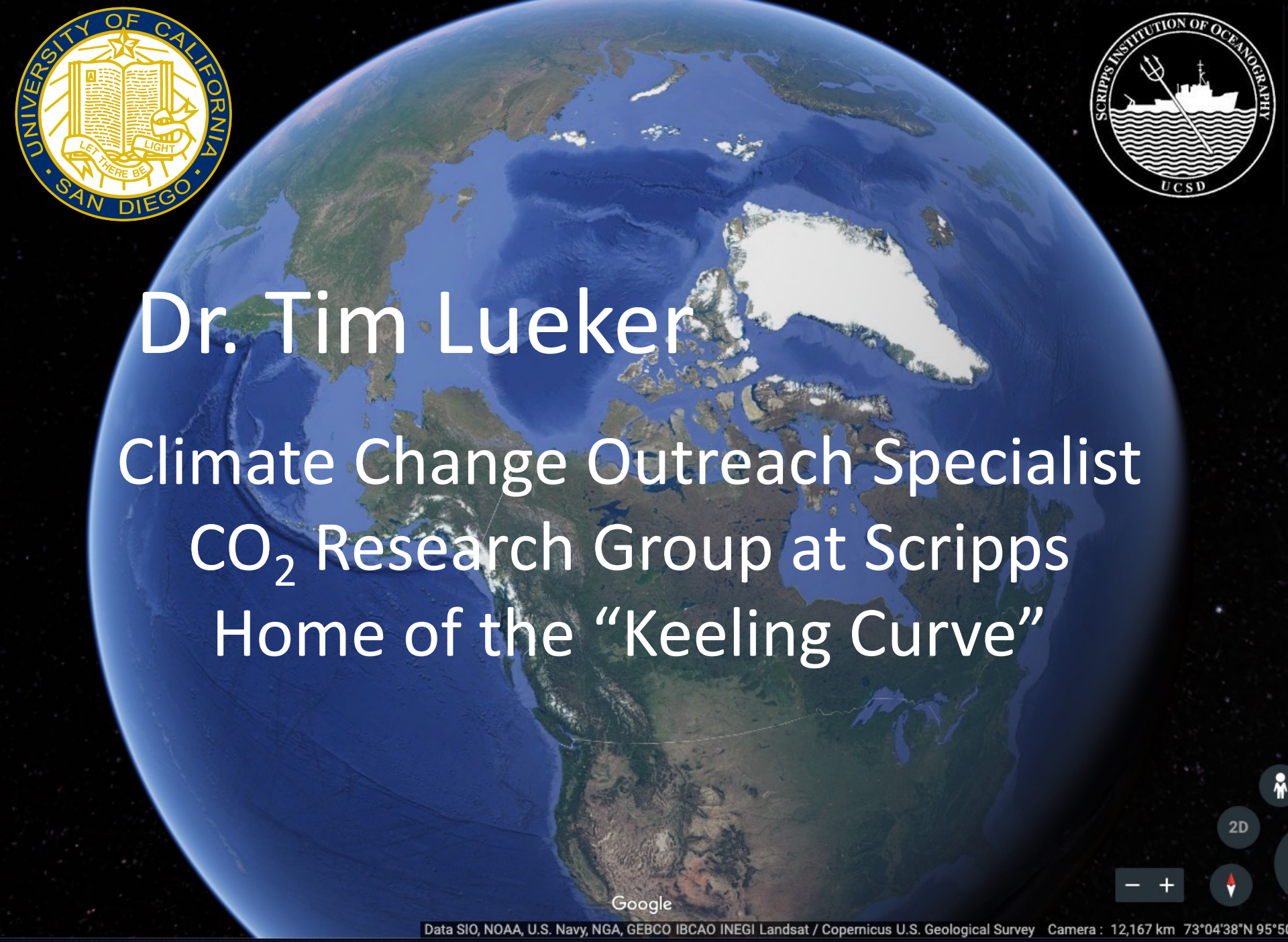

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