The 7th Asia-Pacific GAW Workshop on GHG

WMO/IAEA 6th Round-Robin Comparison & related progress

WMO/IAEA Round Robin Referee: ***Lingxi Zhou**[1]
(zhoulx@cams.cma.gov.cn)
NOAA Coordinating Team: **Pieter Tans**[2], **Duane Kitzis**[2],
Ken Masarie[2] (wmorr@noaa.gov)

1. CAMS, CMA, China
2. GMD, ESRL, NOAA, USA,

22-23 Oct. 2015, Jeju

WMO

GAW

- **The primary goal of the WMO/IAEA RR Comparison Experiment is to assess the level to which participating labs maintain their link to the WMO scales using normal operating procedures.**

- **Maintaining a direct link to the WMO scales and successfully propagating the scales to working laboratory scales are fundamental to the measurement process and to achieving the desired levels of compatibility between laboratories as specified by the GGMT meetings.**

WMO/IAEA Recommended compatibility of

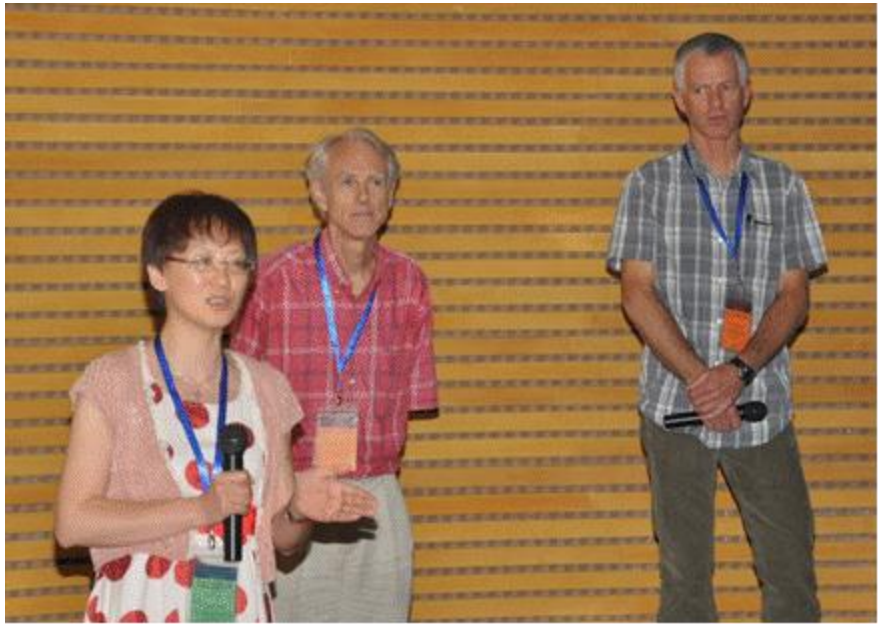
Table 1- Recommended compatibility of measurements within the scope of GGMT

Component	Compatibility goal	Extended compatibility goal	Range in unpolluted troposphere	Range covered by the WMO scale
CO_2	± 0.1 ppm (Northern hemisphere) ± 0.05 ppm (South. hemisphere)	± 0.2 ppm	360 - 450 ppm	250 – 520 ppm
CH_4	± 2 ppb	± 5 ppb	1700 – 2100 ppb	300 – 2600 ppb
CO	± 2 ppb	± 5 ppb	30 – 300 ppb	20 -500 ppb
N_2O	± 0.1 ppb	± 0.3 ppb	320 – 335 ppb	260 – 370 ppb
SF_6	± 0.02 ppt	± 0.05 ppt	6 – 10 ppt	1.1 – 9.8 ppt
H_2	± 2 ppb	± 5 ppb	450 – 600 ppb	140 −1200 ppb
$\delta^{13}C\text{-}CO_2$	± 0.01‰	± 0.1‰	-7.5 to -9‰ vs. VPDB	
$\delta^{18}O\text{-}CO_2$	± 0.05‰	± 0.1‰	-2 to +2‰ vs. VPDB	
$\Delta^{14}C\text{-}CO_2$	± 0.5‰	± 3‰	0-70‰	
$\Delta^{14}C\text{-}CH_4$	± 0.5‰		50-350‰	
$\Delta^{14}C\text{-}CO$	± 2 molecules cm^{-3}		0-25 molecules cm^{-3}	
$\delta^{13}C\text{-}CH_4$	± 0.02‰	± 0.2‰		
$\delta D\text{-}CH_4$	± 1‰	± 5‰		
O_2/N_2	± 2 per meg	± 10 per meg	-250 to -800 per meg (vs. SIO scale)	

GAW Report No. 213, July 2014

- **A dedicated website (http://www.esrl.noaa.gov/gmd/ccgg/wmorr) was developed and works well which covers General Info** (Docs & Guidelines), **Products** (Archived Results & WMO Reports), **Current RR** (Instructions, Participants, Calibration Scales, Cylinders, Time-Table, Status, and Reporting function such as Account Information, Cylinder Arrival, Cylinder Shipping and Measurement Results), **Contact & Feedback**

- **Participants will no longer report results directly to the WMO/IAEA RR referee.**



- **A dedicated RR website**

  Ken Masarie

- **Duane Kitzis, doorway at NWR**

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NOAA Coordinating Team

Pieter Tans (Carbon Cycle Group Chief)
Duane Kitzis (Logistics)
Ken Masarie (Web and Data Management)

WMO/IAEA Round Robin Referee

Lingxi Zhou (Referee)
E-mail: zhoulx@cams.cma.gov.cn

- The 6th RR started in Jan. 2014 and officially close on 7 Sept. 2015
- Labs in each of the 5 circuits (Circuit 1: 13 labs, Circuit 2: 8 labs, Circuit 3: 10 labs, Circuit 4: 11 labs, Circuit 5: 6 labs) received a set of two RR cylinders.

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WMO/IAEA Round Robin Comparison Experiment - Current Status

Round Robin #6 is currently underway [started: January 2014]

State of the current Round Robin experiment. The initial TimeTable, set by the NOAA Team, may be adjusted based on actual cylinder arrival and shipping dates reported by participants.

Please Note: The current Round Robin experiment will close on **2015-09-07**.

✗ - awaiting input information from lab.

The actual departure date as reported by the participant is displayed as

- yyyy-mm-dd if it is on or before the actual arrival date plus the scheduled number of weeks
- yyyy-mm-dd if it is within 2 weeks of the actual arrival date plus the scheduled number of weeks
- yyyy-mm-dd if it is beyond 2 weeks of the actual arrival date plus the scheduled number of weeks.

All Circuits | Circuit 1 | Circuit 2 | Circuit 3 | Circuit 4 | Circuit 5

Round Robin #6: 48 labs total

Circuit 1: 13 labs

24% 0.7K/s 309K/s

Cylinders: CB10006, CB09974

Circuit 1: 13 labs

Cylinders: CB10006, CB09974

Lab	Scheduled Arrival	Scheduled Departure	Scheduled Weeks	Actual Arrival	Actual Departure	Measurements Completed	Results Reported
1. NCAR (United States)	2014-02-27	2014-03-20	3	2014-02-25	2014-03-26	✓	✓
2. NOAA-CSD (United States)	2014-04-10	2014-04-24	2	2014-04-11	2014-05-02	✓	✓
3. NEON (United States)	2014-05-08	2014-05-22	2	2014-05-08	2014-05-28	✓	✓
4. NIST (United States)	2014-05-29	2014-06-19	3	2014-06-03	2014-07-11	✓	✓
5. HU (United States)	2014-07-03	2014-07-24	3	2014-07-15	2014-08-05	✓	✓
6. PSU (United States)	2014-07-31	2014-08-14	2	2014-08-07	2014-08-22	✓	✓
7. CALTECH (United States)	2014-08-21	2014-09-18	4	2014-09-09	2014-10-06	✓	✓
8. BLG (United States)	2014-09-25	2014-10-23	4	2014-10-09	2014-11-05	✓	✓
9. AMERIFLUX (United States)	2014-10-30	2014-11-13	2	2014-11-12	2014-11-24	✓	✓
10. EC (Canada)	2014-11-20	2014-12-18	4	2014-12-04	2014-12-22	✓	✓
11. NOAA (United States)	2015-01-05	2015-02-16	6	2015-01-05	2015-06-15	✓	*N/A*
12. HMS (Hungary)	2015-06-30	2015-07-14	2	2015-06-15	2015-07-10	✓	✓
13. AEMET (Spain)	2015-08-04	2015-09-01	4	2015-07-20	2015-08-17	✓	✓

Circuit 2: 8 labs

Cylinders: CB10295, CB10296

Lab	Scheduled Arrival	Scheduled Departure	Scheduled Weeks	Actual Arrival	Actual Departure	Measurements Completed	Results Reported
1. NCAR (United States)	2014-02-27	2014-03-20	3	2014-02-25	2014-03-26	✓	✓
2. CSIRO (Australia)	2014-04-20	2014-05-18	4	2014-04-21	2014-05-29	✓	✓
3. NIWA (New Zealand)	2014-05-25	2014-06-22	4	2014-06-10	2014-07-08	✓	✓
4. SAWS (South Africa)	2014-06-29	2014-07-27	4	2014-07-29	2014-10-10	✓	✓
5. CMA (Peoples Republic of China)	2014-08-03	2014-08-31	4	2014-10-21	2014-11-21	✓	✓
6. KMA/KGAWC (Republic of Korea)	2014-12-09	2015-01-06	4	2014-12-09	2015-02-03	✓	✓
7. NOAA (United States)	2015-02-06	2015-03-06	4	2015-02-09	2015-07-07	✓	***N/A***
8. MGO (Russia)	2015-07-19	2015-08-02	2	2015-07-27	2015-08-14	✓	✓

Circuit 3: 10 labs

Cylinders: CB09968, CB10288

Lab	Scheduled Arrival	Scheduled Departure	Scheduled Weeks	Actual Arrival	Actual Departure	Measurements Completed	Results Reported
1. NCAR (United States)	2014-02-27	2014-03-20	3	2014-02-25	2014-03-26	✓	✓
2. LSCE (France)	2014-04-30	2014-05-28	4	2014-05-07	2014-06-16	✓	✓
3. WCC-EMPA (Switzerland)	2014-06-04	2014-07-02	4	2014-06-19	2014-07-11	✓	✓
4. EMPA (Switzerland)	2014-07-09	2014-08-06	4	2014-07-21	2014-08-26	✓	✓
5. FMI (Finland)	2014-08-13	2014-09-10	4	2014-09-01	2014-10-01	✓	✓
6. IMAU (Netherlands)	2014-09-17	2014-10-15	4	2014-10-02	2014-11-13	✓	✗
7. RUG (Netherlands)	2014-11-25	2014-12-23	4	2014-11-14	2015-01-15	✓	✓
8. ECN (The Netherlands)	2015-01-15	2015-02-12	4	2015-01-16	2015-02-02	✓	✓
9. UEA (United Kingdom)	2015-02-19	2015-03-19	4	2015-02-15	2015-04-01	✓	✓
10. RHUL (United Kingdom)	2015-03-26	2015-04-23	4	2015-04-01	2015-05-05	✓	✓

Circuit 4: 11 labs

Cylinders: CB10259, CB10281

Lab	Scheduled Arrival	Scheduled Departure	Scheduled Weeks	Actual Arrival	Actual Departure	Measurements Completed	Results Reported
1. NCAR (United States)	2014-02-27	2014-03-20	3	2014-02-25	2014-03-26	✓	✓
2. UHEI-IUP (Germany)	2014-05-20	2014-06-17	4	2014-05-30	2014-07-10	✓	✓
3. UBA/SCH (Germany)	2014-07-29	2014-08-26	4	2014-07-14	2014-07-30	✓	✓
4. KIT/IMK-IFU (Germany)	2014-09-02	2014-09-16	2	2014-08-01	2014-09-24	✓	✓
5. UBA/ZUG (Germany)	2014-09-23	2014-10-21	4	2014-09-25	2014-10-20	✓	✓
6. MPI-BGC (Germany)	2014-10-28	2014-11-25	4	2014-10-27	2014-12-18	✓	✓
7. RSE (Italy)	2015-02-17	2015-03-03	2	2014-12-30	2015-01-27	✓	✓
8. IAFMS (Italy)	2015-03-10	2015-03-24	2	2015-01-27	2015-02-03	✓	✓
9. UNIURB (Italy)	2015-03-31	2015-04-28	4	2015-02-03	2015-04-15	✓	✓
10. ENEA (Italy)	2015-05-05	2015-05-19	2	2015-04-30	2015-06-12	✓	✓
11. ICOS (European Union)	2015-06-17	2015-07-15	4	2015-06-29	2015-07-29	✓	✓

Circuit 5: 6 labs

Cylinders: CB10067, CB09973

Lab	Scheduled Arrival	Scheduled Departure	Scheduled Weeks	Actual Arrival	Actual Departure	Measurements Completed	Results Reported
1. JMA (Japan)	2013-12-12	2014-01-09	4	2013-09-24	2013-11-13	✓	✓
2. MRI (Japan)	2014-01-16	2014-02-06	3	2013-11-14	2013-12-13	✓	✓
3. AIST (Japan)	2014-04-03	2014-05-01	4	2013-12-13	2014-01-24	✓	✓
4. NIES (Japan)	2014-02-27	2014-03-27	4	2014-01-24	2014-02-14	✓	✓
5. TU (Japan)	2014-04-03	2014-05-01	4	2014-02-18	2014-04-14	✓	✓
6. NCAR (United States)	2014-07-01	2014-07-22	3	2014-07-01	2015-06-10	✓	✓

- As in previous RR, air in each cylinder is near ambient range of CO_2, CH_4, CO, H_2, N_2O, SF_6, O_2/N_2, $\delta^{13}C$ & $\delta^{18}O$ of CO_2
- The preliminary results reported by the participants posted to the dedicated RR website on 8 Sept. (the week before GGMT-2015)
- It is not terribly useful to send results once the RR results are made available to all participants because the experiment is no longer a blind.

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WMO/IAEA Round Robin Comparison Experiment - Archived Results

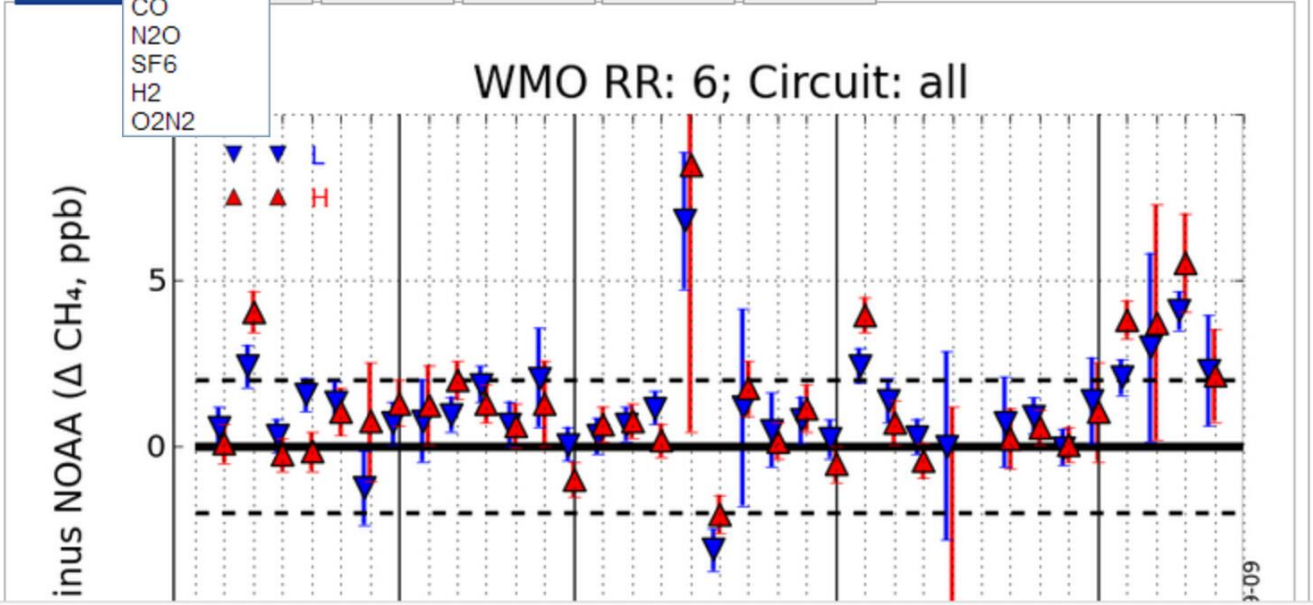
Round Robin 6 (2014-2015)

Parameter: CH4

CH4
CO2
CO2C13
CO2O18
CO
N2O
SF6
H2
O2N2

Results | Scales | Cylinders

All Circu | 1 | Circuit 2 | Circuit 3 | Circuit 4 | Circuit 5



- 6th RR 40 labs reported for CO_2, 36 for CH_4, 28 for N_2O, 18 for SF_6, 27 for CO, 10 for H_2, 15 for CO_2 stable isotopes, and 6 for O_2/N_2
- 5th RR 39 labs reported for CO_2, 26 for CH_4, 21 for N_2O, 17 for SF_6, 23 for CO, 10 for H_2, 10 for CO_2 stable isotopes.
- 4th RR 26 labs reported for CO_2, 12 for CH_4, 6 for N_2O, 6 for SF_6, 8 for CO, 2 for H_2, and 7 for CO_2 stable isotopes.

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WMO/IAEA Round Robin Comparison Experiment - Current Calibration Scales

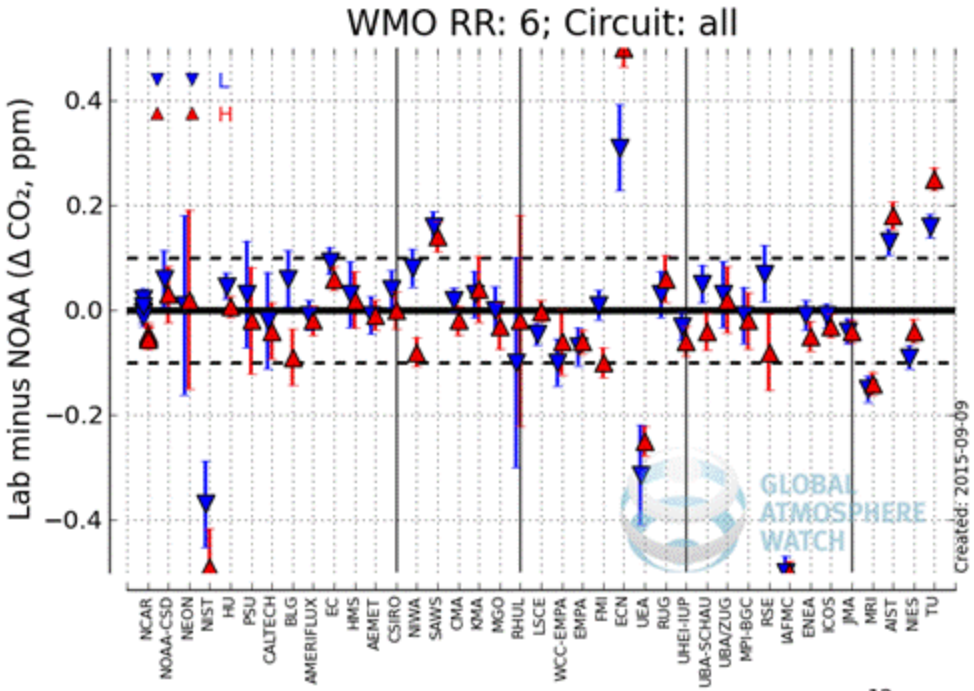
Round Robin #6 is currently underway [started: January 2014]

Calibration scales of the current WMO/IAEA Round Robin Experiment.

A World Meteorological Organization (WMO) Central Calibration Laboratory (CCL) is responsible for maintaining and distributing the WMO Mole Fraction scale for a specified gas in air. NOAA Earth System Research Laboratory (ESRL) Global Monitoring Division (GMD) is the WMO CCL for CO_2, CH_4, N_2O, SF_6, and CO. Max Planck Institute for Biogeochemistry (MPI-BGC) laboratory in Jena, Germany is the CCL for H_2 and for the stable isotopes of CO_2 ($\delta^{13}C$ and $\delta^{18}O$).

The following table summarizes the calibration scales used to assign values to the current WMO Round Robin cylinders. **Please Note:** For these experiments, H_2 values have been assigned to the WMO Round Robin cylinders by NOAA and the stable isotopes of CO_2 values have been assigned by the University of Colorado (CU), Institute of Arctic and Alpine Research (INSTAAR), Stable Isotope Laboratory (SIL).

Parameter(s)	Calibration Scale*	Primary Contact	Lab
CO_2	WMO-CO2-X2007	Pieter Tans	NOAA
CH_4	WMO-CH4-X2004A	Ed Dlugokencky	NOAA
CO	WMO-CO-X2014	Paul Novelli	NOAA
N_2O	WMO-N2O-X2006A	Brad Hall	NOAA
SF_6	WMO-SF6-X2014	Brad Hall	NOAA
H_2	NOAA-H2-X1996	Paul Novelli	NOAA
$\delta^{13}C$ and $\delta^{18}O$ (CO_2)	SIL Lab Scale	Bruce Vaughn	SIL


WMO RR: 6; Circuit: all
Lab minus NOAA (Δ CO₂, ppm)
L
H
0.4
0.2
0.0
−0.2
−0.4
NCAR
NOAA-CSD
NEON
NIST
HU
PSU
CALTECH
BLG
AMERIFLUX
EC
HMS
AEMET
CSIRO
NIWA
SAWS
CMA
KMA
MGO
RHUL
LSCE
WCC-EMPA
EMPA
FMI
ECN
UEA
RUG
UHEI-IUP
UBA-SCHAU
UBA/ZUG
MPI-BGC
RSE
IAFMC
ENEA
ICOS
JMA
MRI
AIST
NIES
TU
GLOBAL ATMOSPHERE WATCH
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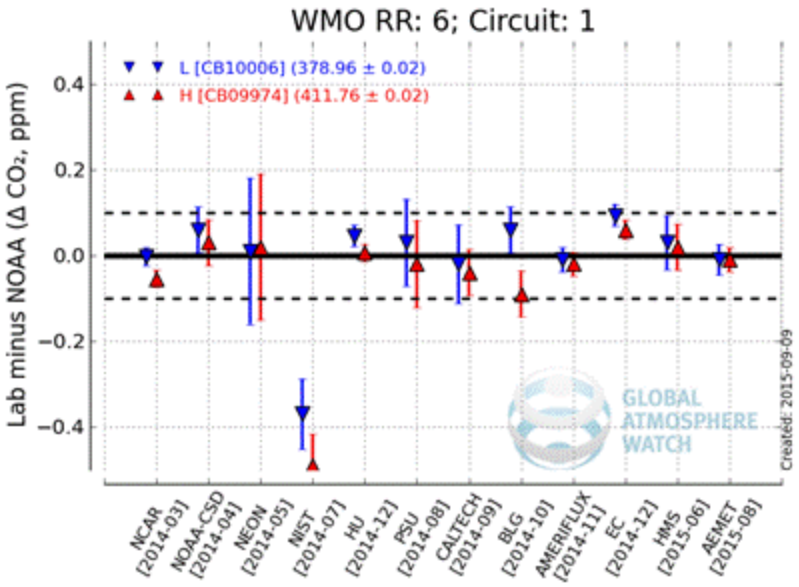
CO_2


WMO RR: 6; Circuit: 1
L [CB10006] (378.96 ± 0.02)
H [CB09974] (411.76 ± 0.02)
Lab minus NOAA (Δ CO₂, ppm)
0.4
0.2
0.0
−0.2
−0.4
NCAR [2014-03]
NOAA-CSD [2014-04]
NEON [2014-05]
NIST [2014-07]
HU [2014-12]
PSU [2014-08]
CALTECH [2014-09]
BLG [2014-10]
AMERIFLUX [2014-11]
EC [2014-12]
HMS [2015-06]
AEMET [2015-08]
GLOBAL ATMOSPHERE WATCH
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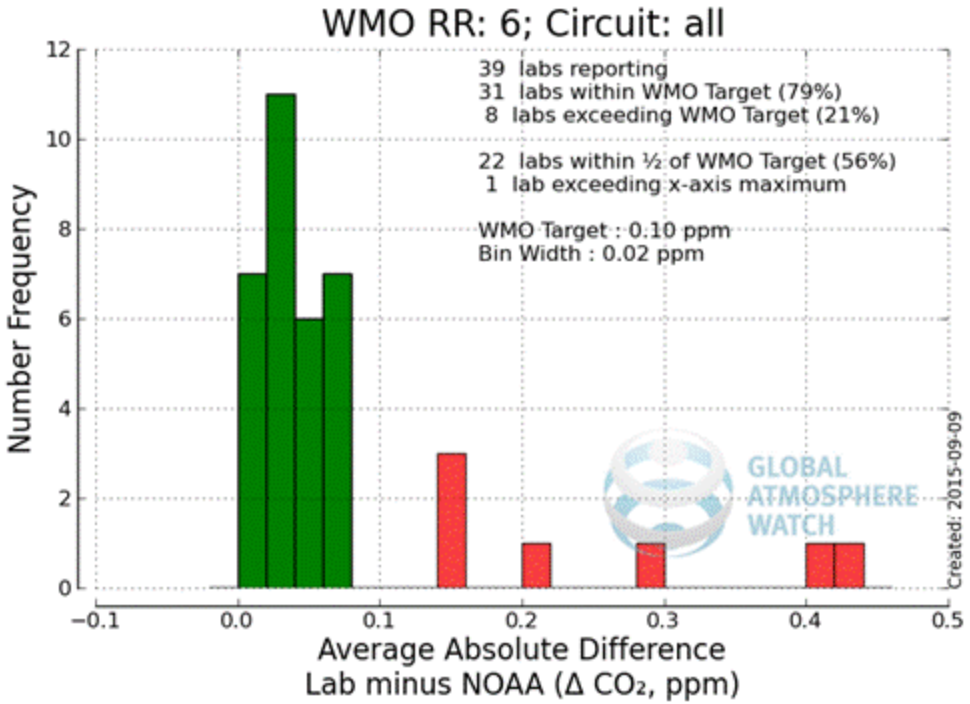
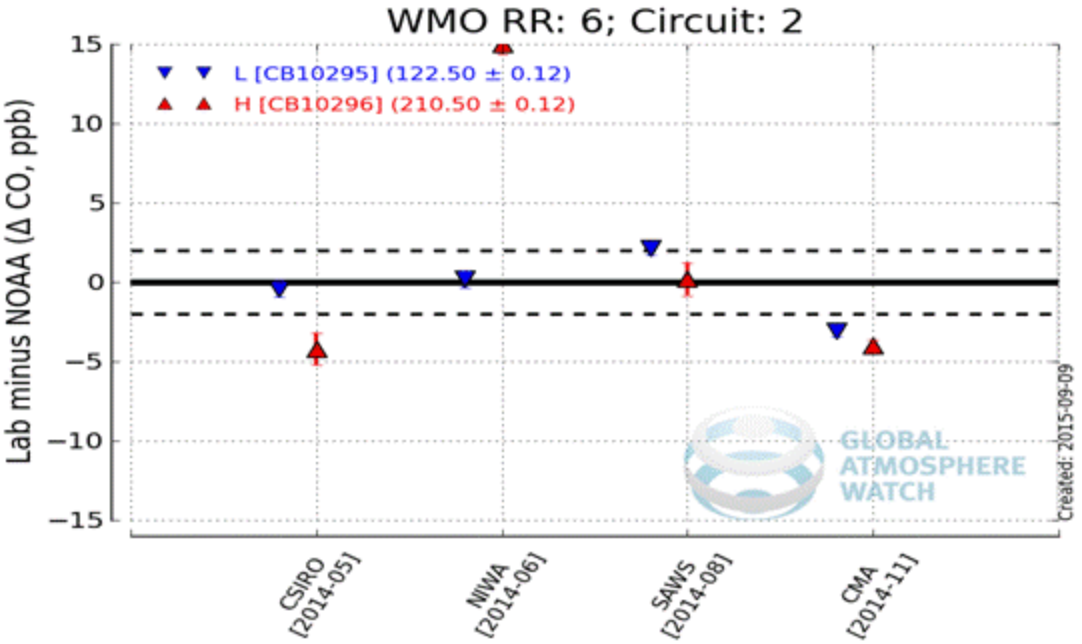
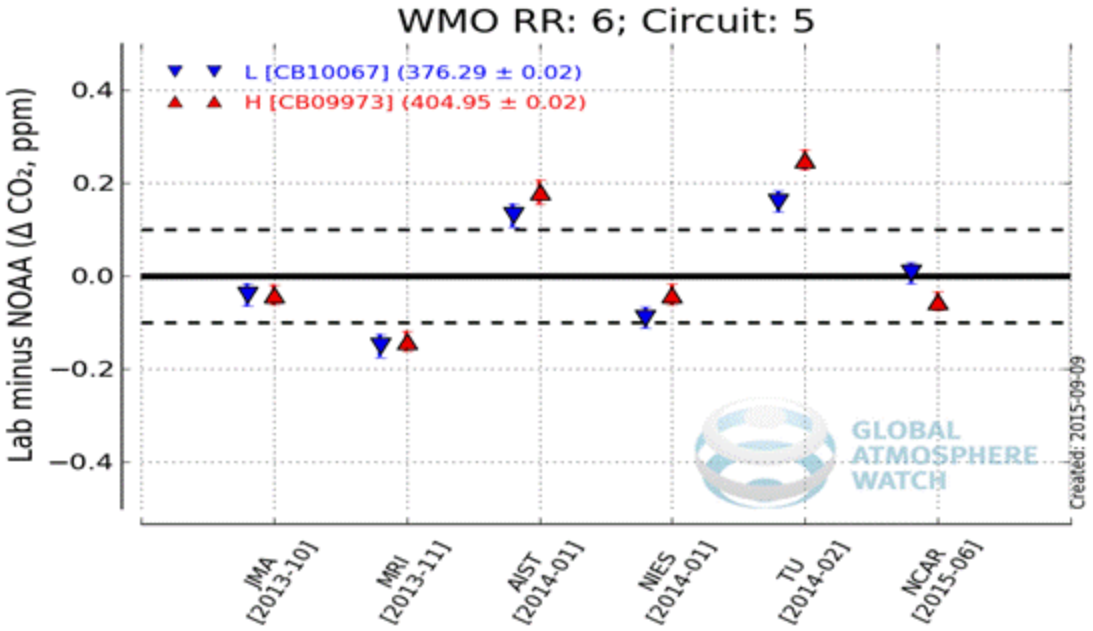
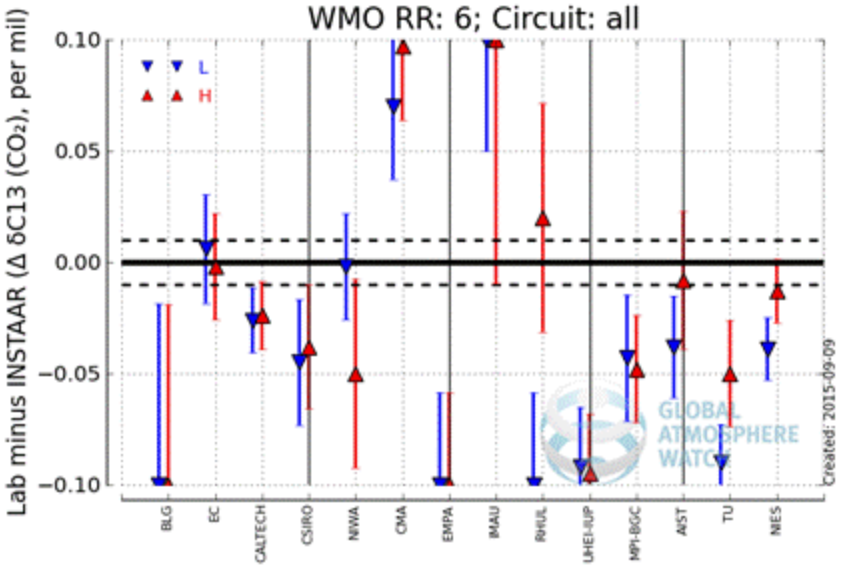
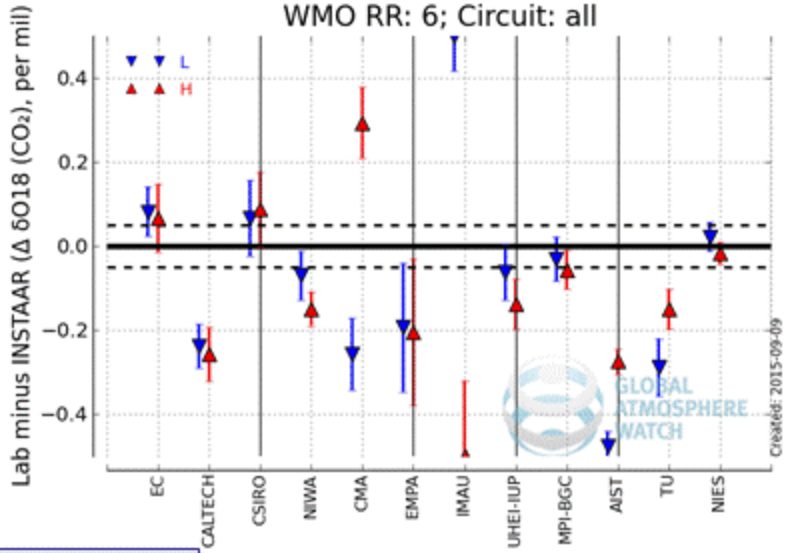

WMO RR: 6; Circuit: all
39 labs reporting
31 labs within WMO Target (79%)
8 labs exceeding WMO Target (21%)
22 labs within ½ of WMO Target (56%)
1 lab exceeding x-axis maximum
WMO Target : 0.10 ppm
Bin Width : 0.02 ppm
Number Frequency
12
10
8
6
4
2
0
−0.1
0.0
0.1
0.2
0.3
0.4
0.5
Average Absolute Difference
Lab minus NOAA (Δ CO₂, ppm)
GLOBAL ATMOSPHERE WATCH
Created: 2015-09-09


WMO RR: 6; Circuit: 2
L [CB10295] (122.50 ± 0.12)
H [CB10296] (210.50 ± 0.12)
Lab minus NOAA (Δ CO, ppb)
15
10
5
0
−5
−10
−15
GLOBAL ATMOSPHERE WATCH
Created: 2015-09-09
CSIRO [2014-05]
NIWA [2014-06]
SAWS [2014-08]
CMA [2014-11]

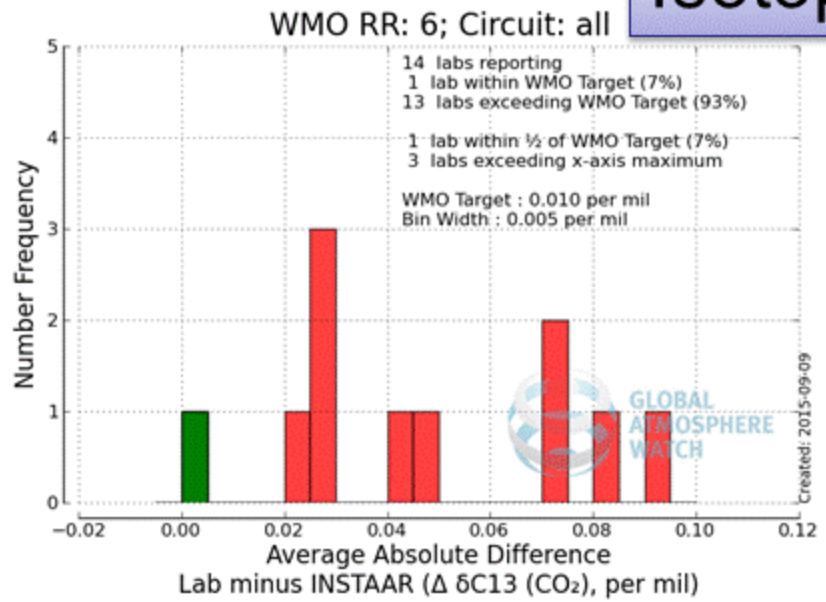
CO_2

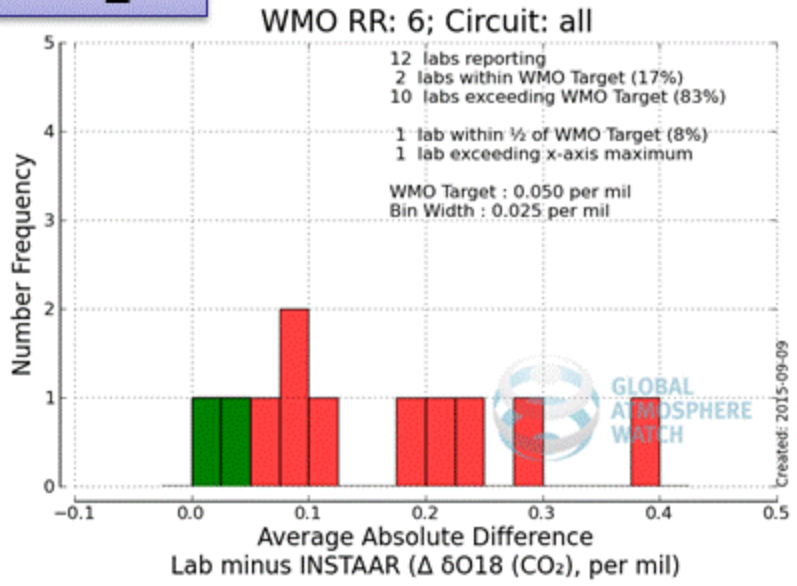

WMO RR: 6; Circuit: 5
L [CB10067] (376.29 ± 0.02)
H [CB09973] (404.95 ± 0.02)
Lab minus NOAA (Δ CO₂, ppm)
0.4
0.2
0.0
−0.2
−0.4
GLOBAL ATMOSPHERE WATCH
Created: 2015-09-09
JMA [2013-10]
MRI [2013-11]
AIST [2014-01]
NIES [2014-01]
TU [2014-02]
NCAR [2015-06]

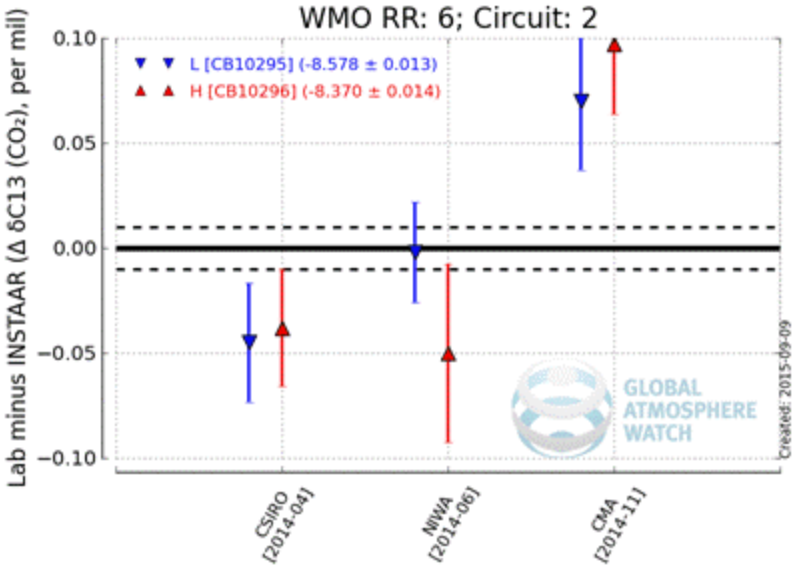

WMO RR: 6; Circuit: all
Lab minus INSTAAR (Δ δC13 (CO₂), per mil)
L
H
BLG
EC
CALTECH
CSIRO
NIWA
CMA
EMPA
IMAU
RHUL
UHEI-IUP
MPI-BGC
AIST
TU
NIES
Created: 2015-09-09

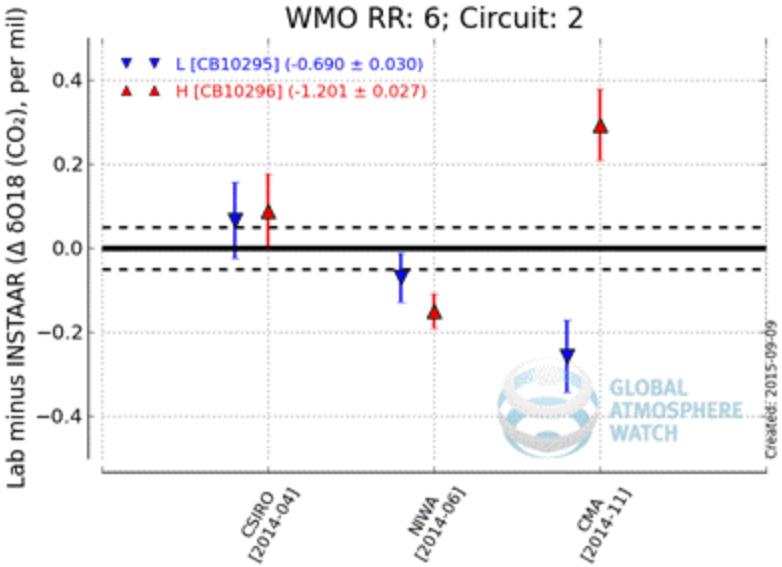

WMO RR: 6; Circuit: all
Lab minus INSTAAR (Δ δO18 (CO₂), per mil)
L
H
EC
CALTECH
CSIRO
NIWA
CMA
EMPA
IMAU
UHEI-IUP
MPI-BGC
AIST
TU
NIES
Created: 2015-09-09

Isotope CO_2

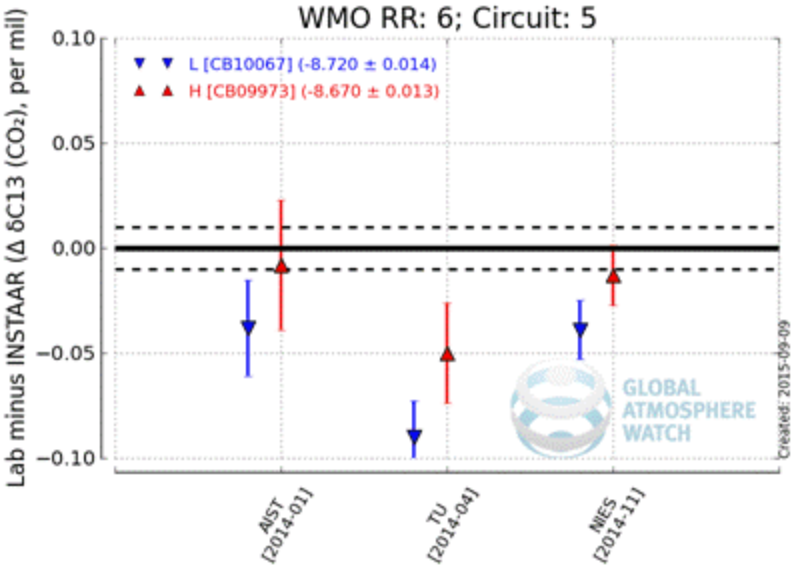

WMO RR: 6; Circuit: all
14 labs reporting
1 lab within WMO Target (7%)
13 labs exceeding WMO Target (93%)
1 lab within ½ of WMO Target (7%)
3 labs exceeding x-axis maximum
WMO Target : 0.010 per mil
Bin Width : 0.005 per mil
Number Frequency
Average Absolute Difference
Lab minus INSTAAR (Δ δC13 (CO₂), per mil)
Created: 2015-09-09

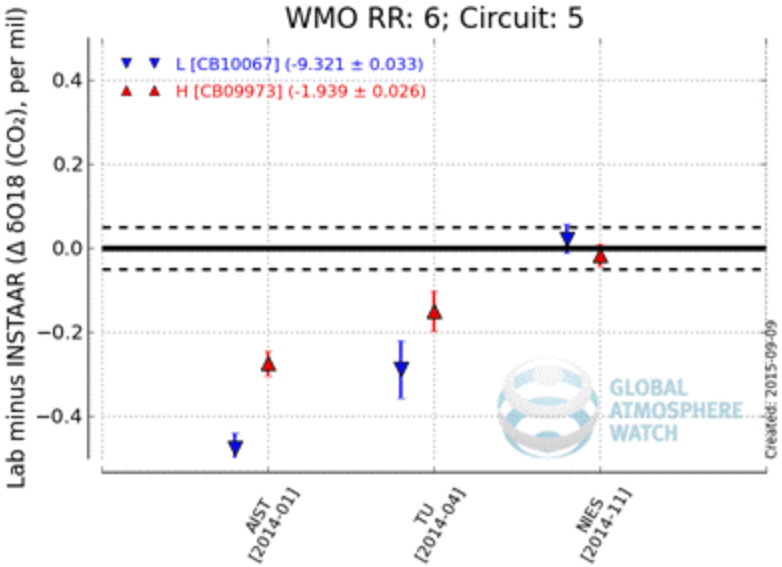

WMO RR: 6; Circuit: all
12 labs reporting
2 labs within WMO Target (17%)
10 labs exceeding WMO Target (83%)
1 lab within ½ of WMO Target (8%)
1 lab exceeding x-axis maximum
WMO Target : 0.050 per mil
Bin Width : 0.025 per mil
Number Frequency
Average Absolute Difference
Lab minus INSTAAR (Δ δO18 (CO₂), per mil)
Created: 2015-09-09

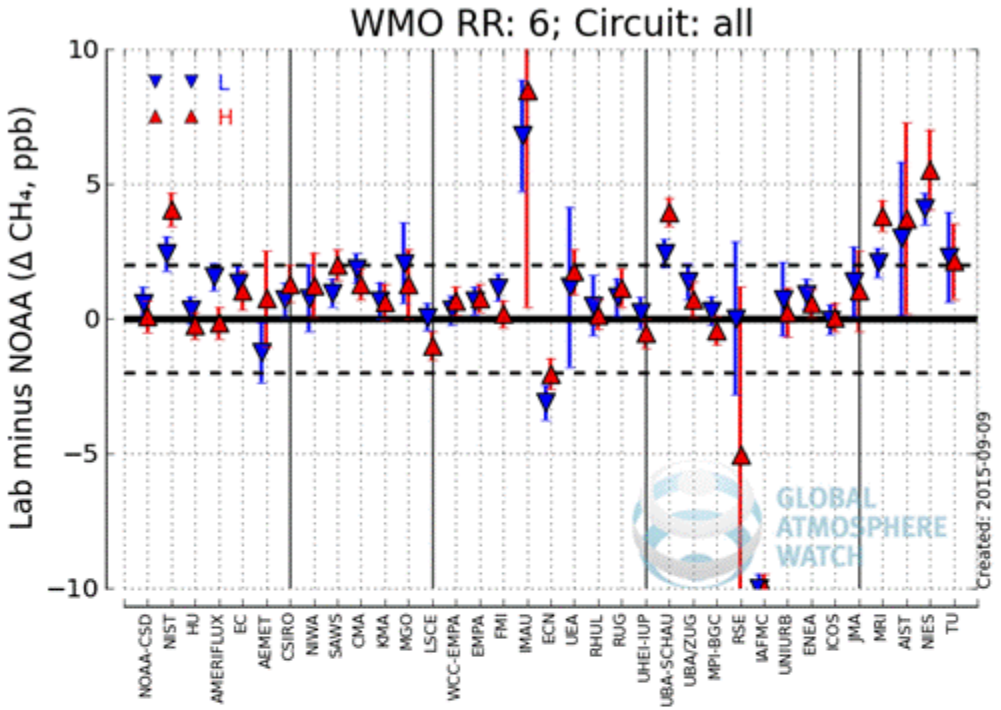

WMO RR: 6; Circuit: 2
L [CB10295] (-8.578 ± 0.013)
H [CB10296] (-8.370 ± 0.014)
Lab minus INSTAAR (Δ δC13 (CO₂), per mil)
0.10
0.05
0.00
−0.05
−0.10
GLOBAL ATMOSPHERE WATCH
Created: 2015-09-09
CSIRO [2014-04]
NIWA [2014-06]
CMA [2014-11]


WMO RR: 6; Circuit: 2
L [CB10295] (-0.690 ± 0.030)
H [CB10296] (-1.201 ± 0.027)
Lab minus INSTAAR (Δ δO18 (CO₂), per mil)
0.4
0.2
0.0
−0.2
−0.4
GLOBAL ATMOSPHERE WATCH
Created: 2015-09-09
CSIRO [2014-04]
NIWA [2014-06]
CMA [2014-11]

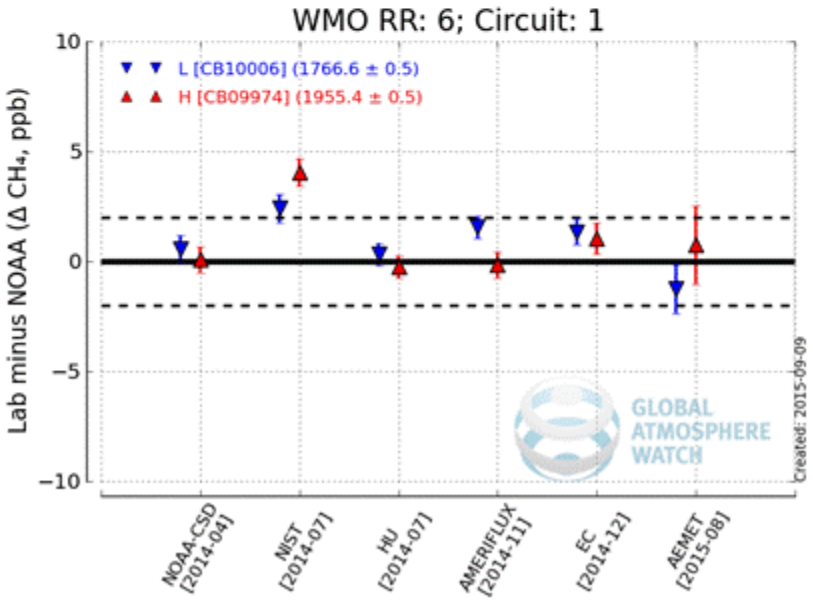
Isotope CO_2

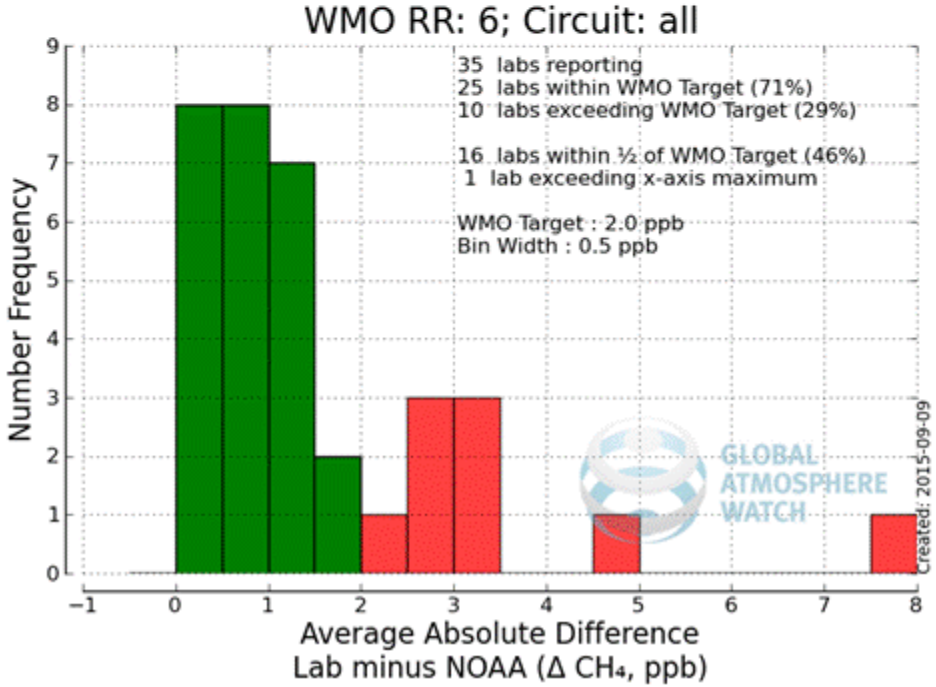

WMO RR: 6; Circuit: 5
L [CB10067] (-8.720 ± 0.014)
H [CB09973] (-8.670 ± 0.013)
Lab minus INSTAAR (Δ δC13 (CO₂), per mil)
0.10
0.05
0.00
−0.05
−0.10
GLOBAL ATMOSPHERE WATCH
Created: 2015-09-09
AIST [2014-01]
TU [2014-04]
NIES [2014-11]

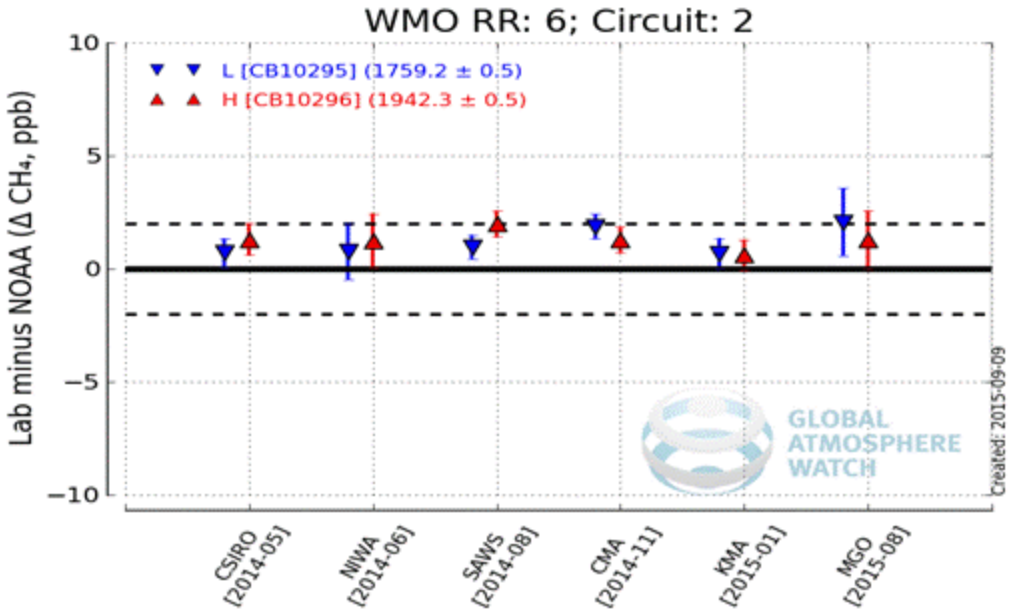

WMO RR: 6; Circuit: 5
L [CB10067] (-9.321 ± 0.033)
H [CB09973] (-1.939 ± 0.026)
Lab minus INSTAAR (Δ δO18 (CO₂), per mil)
0.4
0.2
0.0
−0.2
−0.4
GLOBAL ATMOSPHERE WATCH
Created: 2015-09-09
AIST [2014-01]
TU [2014-04]
NIES [2014-11]


WMO RR: 6; Circuit: all
Lab minus NOAA (Δ CH₄, ppb)
L
H
Created: 2015-09-09
GLOBAL ATMOSPHERE WATCH
NOAA-CSD
NIST
HU
AMERIFLUX
EC
AEMET
CSIRO
NIWA
SAWS
CMA
KMA
MGO
LSCE
WCC-EMPA
EMPA
FMI
IMAU
ECN
UEA
RHUL
RUG
UHEI-IUP
UBA-SCHAU
UBA/ZUG
MPI-BGC
RSE
IAFMC
UNIURB
ENEA
ICOS
JMA
MRI
AIST
NIES
TU

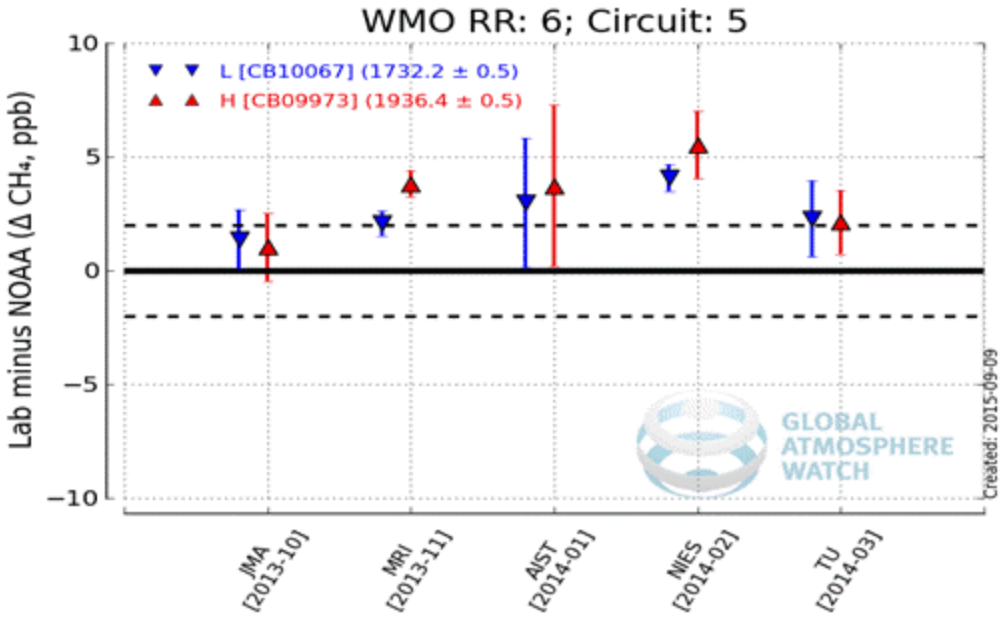
CH_4

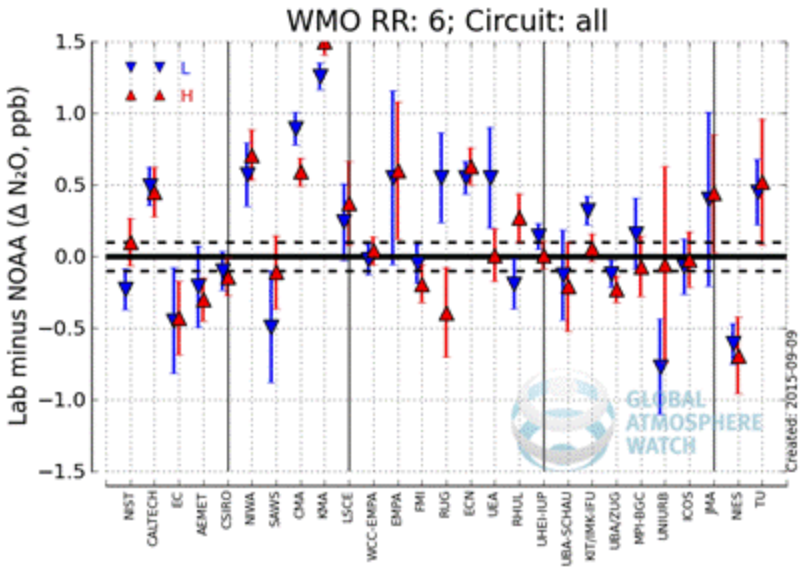

WMO RR: 6; Circuit: 1
Lab minus NOAA (Δ CH₄, ppb)
L [CB10006] (1766.6 ± 0.5)
H [CB09974] (1955.4 ± 0.5)
Created: 2015-09-09
GLOBAL ATMOSPHERE WATCH
NOAA-CSD [2014-04]
NIST [2014-07]
HU [2014-07]
AMERIFLUX [2014-11]
EC [2014-12]
AEMET [2015-08]

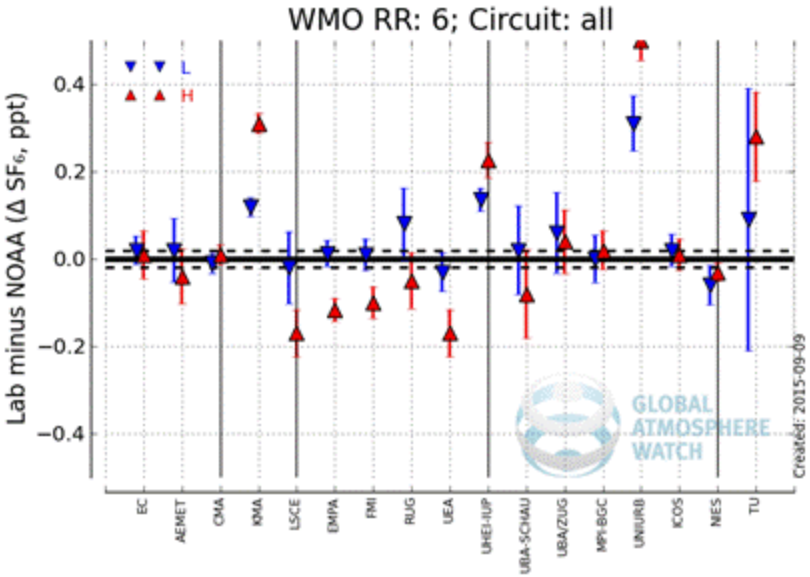

WMO RR: 6; Circuit: all
35 labs reporting
25 labs within WMO Target (71%)
10 labs exceeding WMO Target (29%)
16 labs within ½ of WMO Target (46%)
1 lab exceeding x-axis maximum
WMO Target : 2.0 ppb
Bin Width : 0.5 ppb
Number Frequency
Average Absolute Difference
Lab minus NOAA (Δ CH₄, ppb)
Created: 2015-09-09
GLOBAL ATMOSPHERE WATCH


WMO RR: 6; Circuit: 2
L [CB10295] (1759.2 ± 0.5)
H [CB10296] (1942.3 ± 0.5)
Lab minus NOAA (Δ CH4, ppb)
10
5
0
−5
−10
GLOBAL ATMOSPHERE WATCH
Created: 2015-09-09
CSIRO [2014-05]
NIWA [2014-06]
SAWS [2014-08]
CMA [2014-11]
KMA [2015-01]
MGO [2015-08]

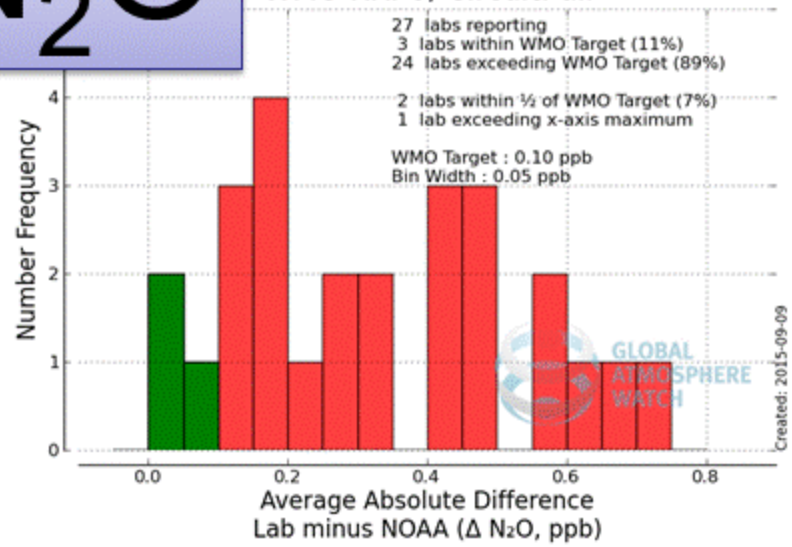
CH_4


WMO RR: 6; Circuit: 5
L [CB10067] (1732.2 ± 0.5)
H [CB09973] (1936.4 ± 0.5)
Lab minus NOAA (Δ CH4, ppb)
10
5
0
−5
−10
GLOBAL ATMOSPHERE WATCH
Created: 2015-09-09
JMA [2013-10]
MRI [2013-11]
AIST [2014-01]
NIES [2014-02]
TU [2014-03]

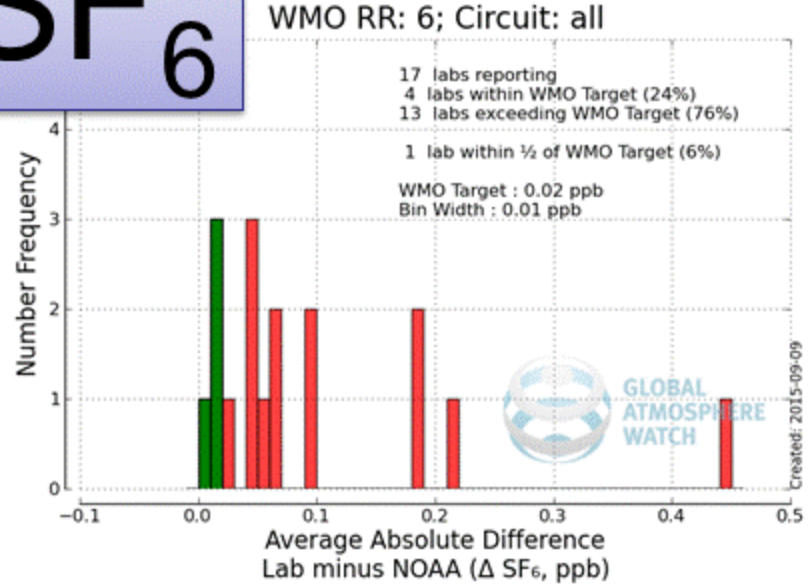

WMO RR: 6; Circuit: all
Lab minus NOAA (Δ N2O, ppb)
L
H
Created: 2015-09-09
GLOBAL ATMOSPHERE WATCH
NIST
CALTECH
EC
AEMET
CSIRO
NIWA
SAWS
CMA
KMA
LSCE
WCC-EMPA
EMPA
FMI
RUG
ECN
UEA
RHUL
UHEI-IUP
UBA-SCHAU
KIT/IMK-IFU
UBA/ZUG
MPI-BGC
UNIURB
ICOS
JMA
NIES
TU

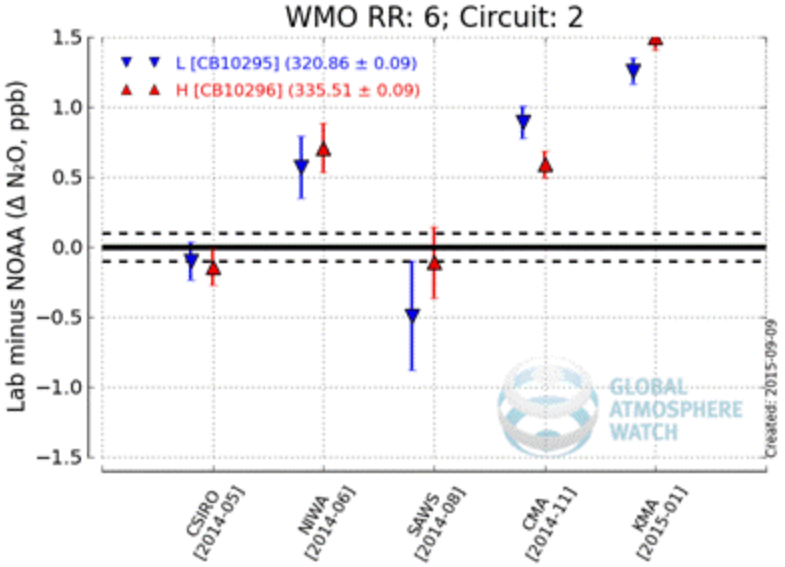

WMO RR: 6; Circuit: all
Lab minus NOAA (Δ SF6, ppt)
L
H
Created: 2015-09-09
GLOBAL ATMOSPHERE WATCH
EC
AEMET
CMA
KMA
LSCE
EMPA
FMI
RUG
UEA
UHEI-IUP
UBA-SCHAU
UBA/ZUG
MPI-BGC
UNIURB
ICOS
NIES
TU

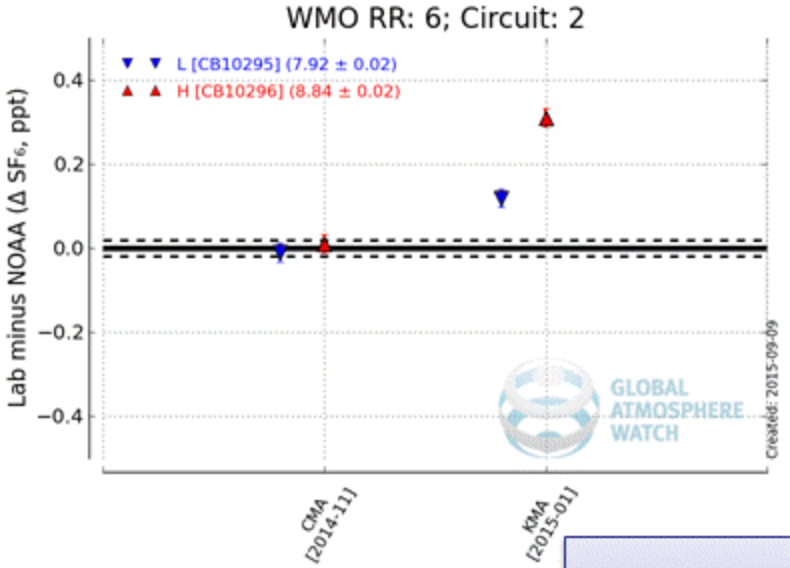
N_2O


WMO RR: 6; Circuit: all
27 labs reporting
3 labs within WMO Target (11%)
24 labs exceeding WMO Target (89%)
2 labs within ½ of WMO Target (7%)
1 lab exceeding x-axis maximum
WMO Target : 0.10 ppb
Bin Width : 0.05 ppb
Number Frequency
Average Absolute Difference
Lab minus NOAA (Δ N2O, ppb)
Created: 2015-09-09
GLOBAL ATMOSPHERE WATCH

SF_6

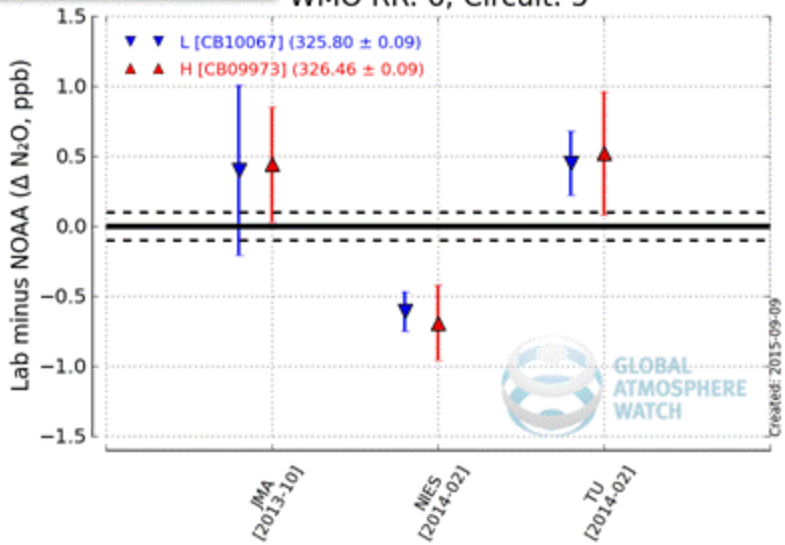

WMO RR: 6; Circuit: all
17 labs reporting
4 labs within WMO Target (24%)
13 labs exceeding WMO Target (76%)
1 lab within ½ of WMO Target (6%)
WMO Target : 0.02 ppb
Bin Width : 0.01 ppb
Number Frequency
Average Absolute Difference
Lab minus NOAA (Δ SF6, ppb)
Created: 2015-09-09
GLOBAL ATMOSPHERE WATCH

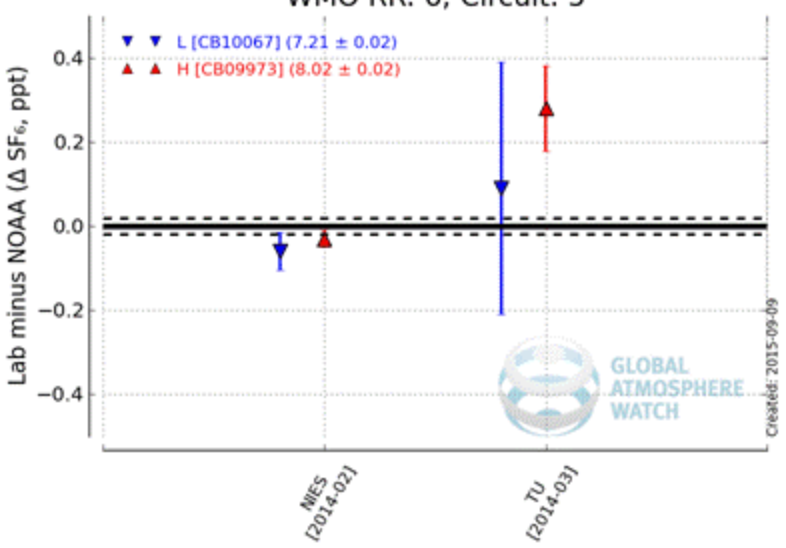

WMO RR: 6; Circuit: 2
L [CB10295] (320.86 ± 0.09)
H [CB10296] (335.51 ± 0.09)
Lab minus NOAA (Δ N2O, ppb)
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
GLOBAL ATMOSPHERE WATCH
Created: 2015-09-09
CSIRO [2014-05]
NIWA [2014-06]
SAWS [2014-08]
CMA [2014-11]
KMA [2015-01]

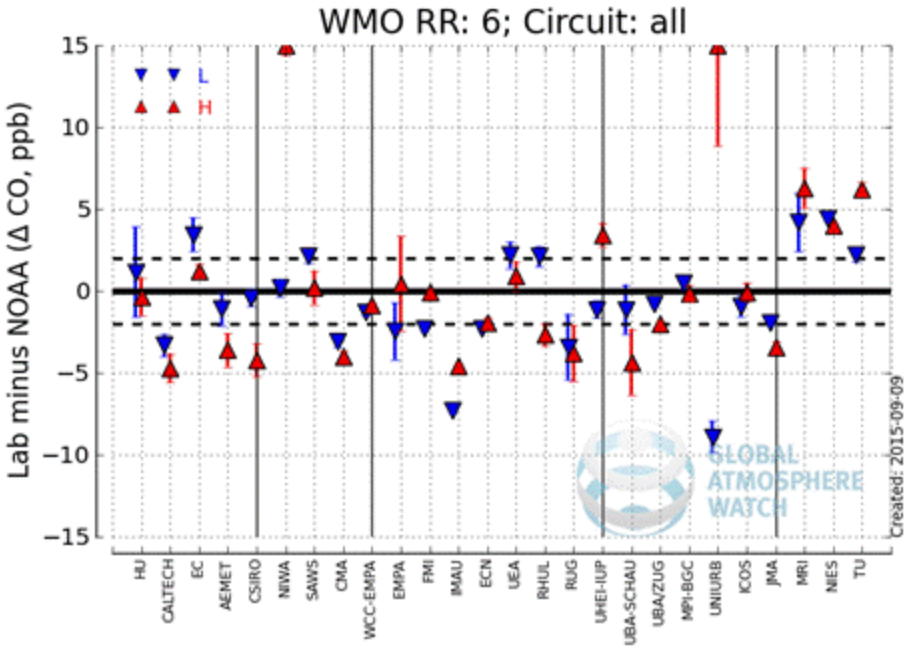

WMO RR: 6; Circuit: 2
L [CB10295] (7.92 ± 0.02)
H [CB10296] (8.84 ± 0.02)
Lab minus NOAA (Δ SF6, ppt)
0.4
0.2
0.0
−0.2
−0.4
GLOBAL ATMOSPHERE WATCH
Created: 2015-09-09
CMA [2014-11]
KMA [2015-01]

N_2O

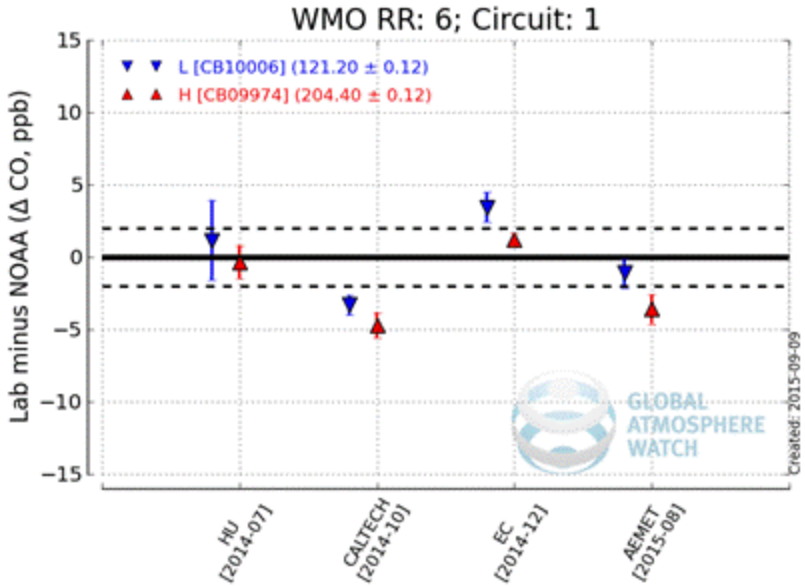
SF_6

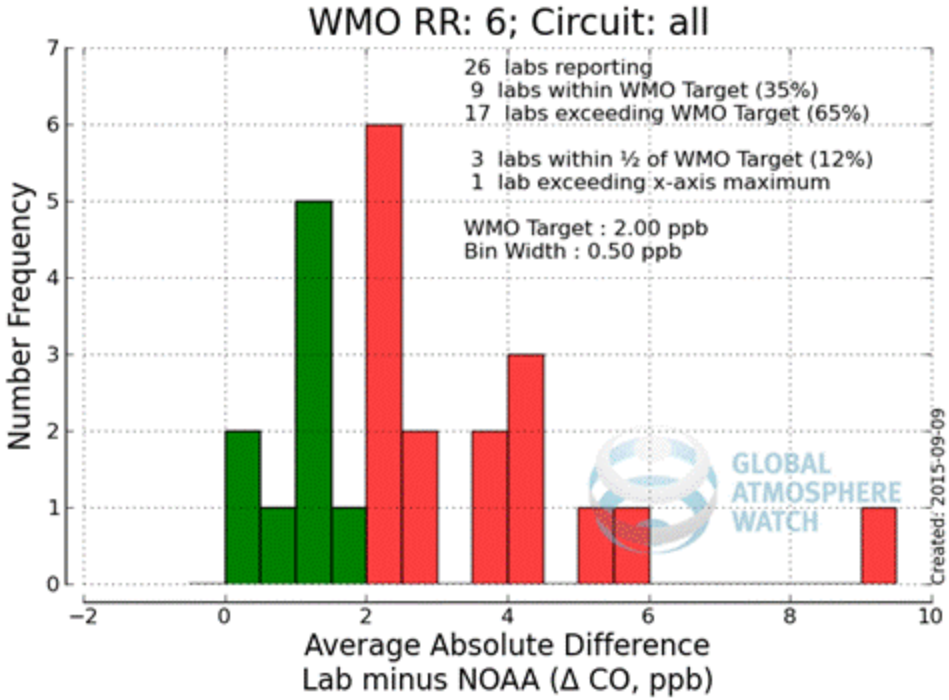

WMO RR: 6; Circuit: 5
L [CB10067] (325.80 ± 0.09)
H [CB09973] (326.46 ± 0.09)
Lab minus NOAA (Δ N2O, ppb)
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
GLOBAL ATMOSPHERE WATCH
Created: 2015-09-09
JMA [2013-10]
NIES [2014-02]
TU [2014-02]

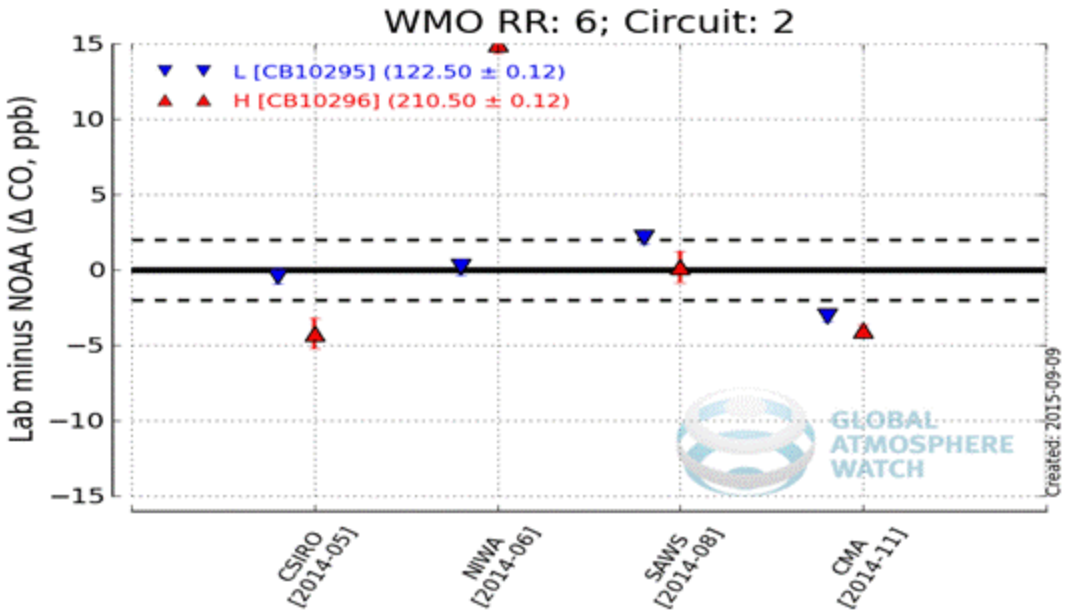

WMO RR: 6; Circuit: 5
L [CB10067] (7.21 ± 0.02)
H [CB09973] (8.02 ± 0.02)
Lab minus NOAA (Δ SF6, ppt)
0.4
0.2
0.0
−0.2
−0.4
GLOBAL ATMOSPHERE WATCH
Created: 2015-09-09
NIES [2014-02]
TU [2014-03]


WMO RR: 6; Circuit: all
Lab minus NOAA (Δ CO, ppb)
L
H
HU
CALTECH
EC
AEMET
CSIRO
NIWA
SAWS
CMA
WCC-EMPA
EMPA
FMI
IMAU
ECN
UEA
RHUL
RUG
UHEI-IUP
UBA-SCHAU
UBA/ZUG
MPI-BGC
UNIURB
ICOS
JMA
MRI
NIES
TU
GLOBAL ATMOSPHERE WATCH
Created: 2015-09-09

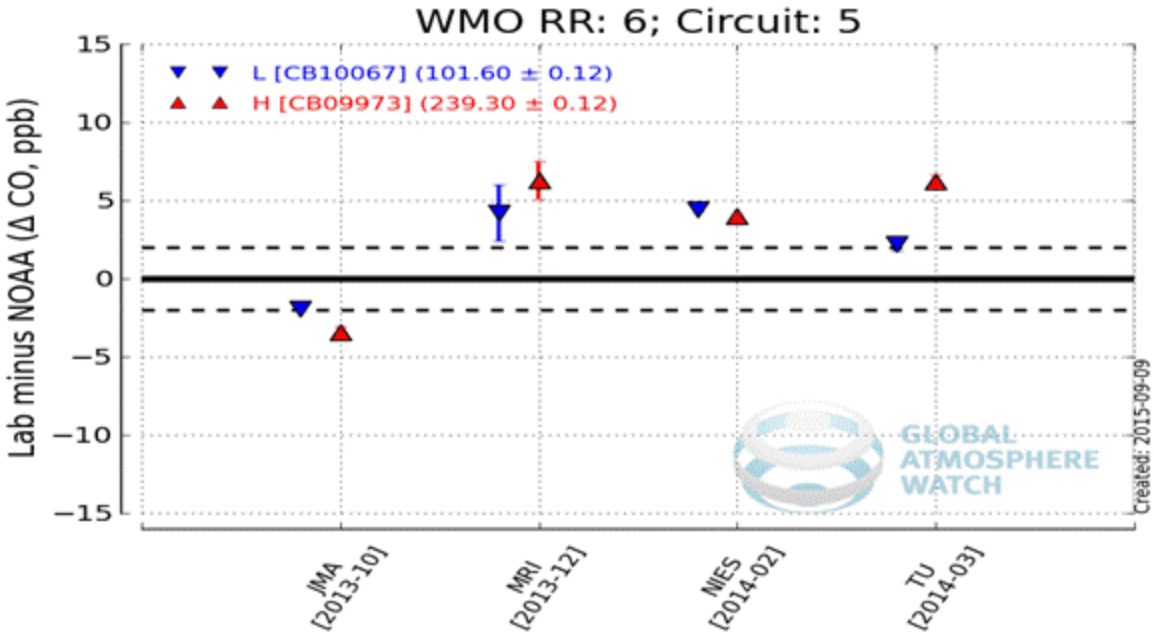
CO


WMO RR: 6; Circuit: 1
L [CB10006] (121.20 ± 0.12)
H [CB09974] (204.40 ± 0.12)
Lab minus NOAA (Δ CO, ppb)
HU [2014-07]
CALTECH [2014-10]
EC [2014-12]
AEMET [2015-08]
GLOBAL ATMOSPHERE WATCH
Created: 2015-09-09


WMO RR: 6; Circuit: all
26 labs reporting
9 labs within WMO Target (35%)
17 labs exceeding WMO Target (65%)
3 labs within ½ of WMO Target (12%)
1 lab exceeding x-axis maximum
WMO Target : 2.00 ppb
Bin Width : 0.50 ppb
Number Frequency
Average Absolute Difference
Lab minus NOAA (Δ CO, ppb)
GLOBAL ATMOSPHERE WATCH
Created: 2015-09-09


WMO RR: 6; Circuit: 2
L [CB10295] (122.50 ± 0.12)
H [CB10296] (210.50 ± 0.12)
Lab minus NOAA (Δ CO, ppb)
15
10
5
0
−5
−10
−15
GLOBAL ATMOSPHERE WATCH
Created: 2015-09-09
CSIRO [2014-05]
NIWA [2014-06]
SAWS [2014-08]
CMA [2014-11]

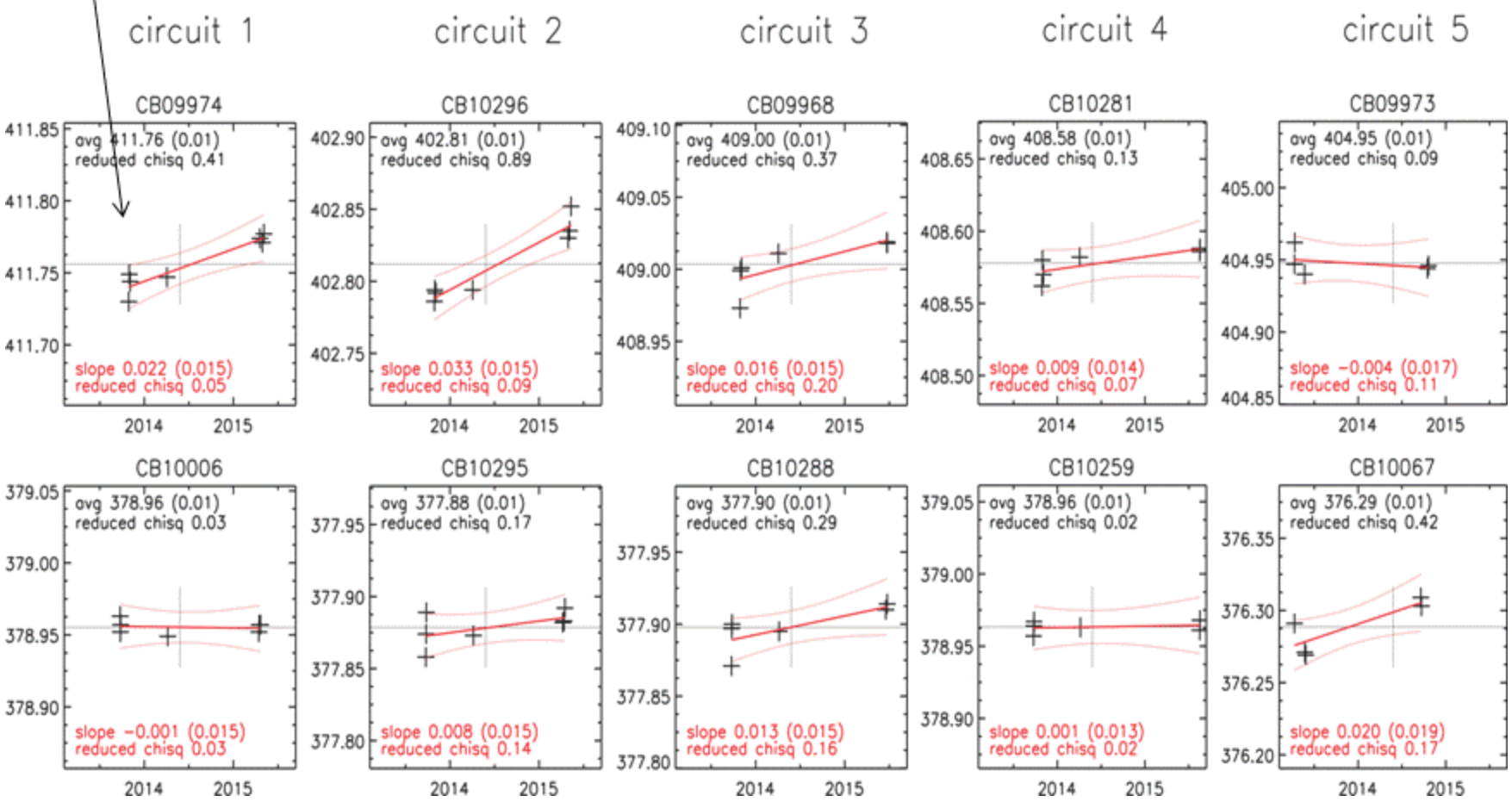
CO


WMO RR: 6; Circuit: 5
L [CB10067] (101.60 ± 0.12)
H [CB09973] (239.30 ± 0.12)
Lab minus NOAA (Δ CO, ppb)
15
10
5
0
−5
−10
−15
GLOBAL ATMOSPHERE WATCH
Created: 2015-09-09
JMA [2013-10]
MRI [2013-12]
NIES [2014-02]
TU [2014-03]

- **Stability of cylinders in the period of 6th RR for CO_2, CH_4, N_2O, SF_6 and CO**
- **Most participants reported uncertainty as one std about the mean of N measurements, the reference labs (e.g., NOAA, INSTAAR, NCAR) report the one std estimate of the reproducibility.**
- **This is an easy way to ensure that uncertainties are reported in a consistent and meaningful way across all parameters.**

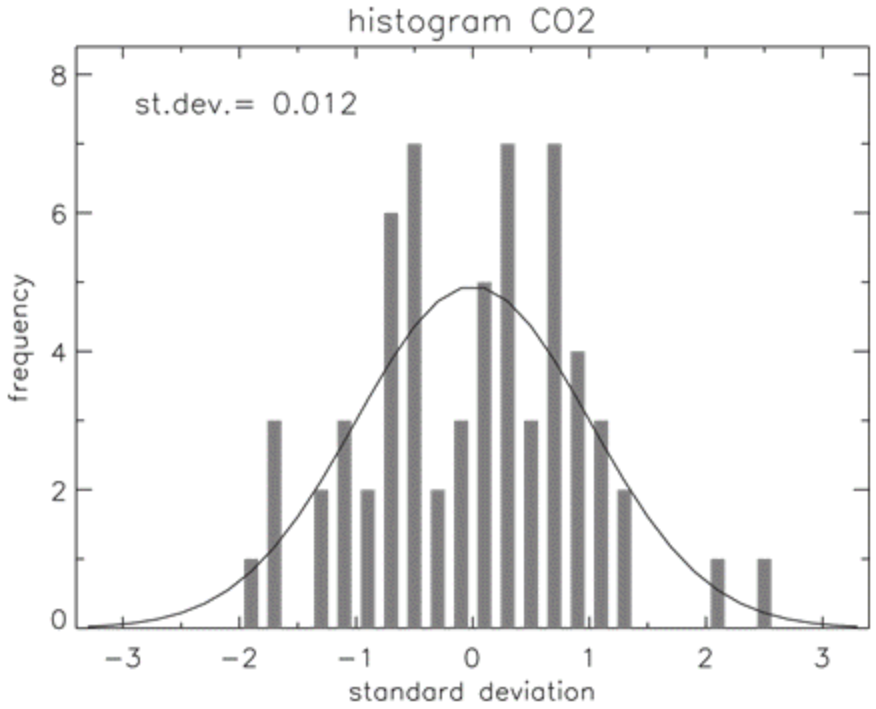
Long-term reproducibility 0.028 ppm (1-σ)

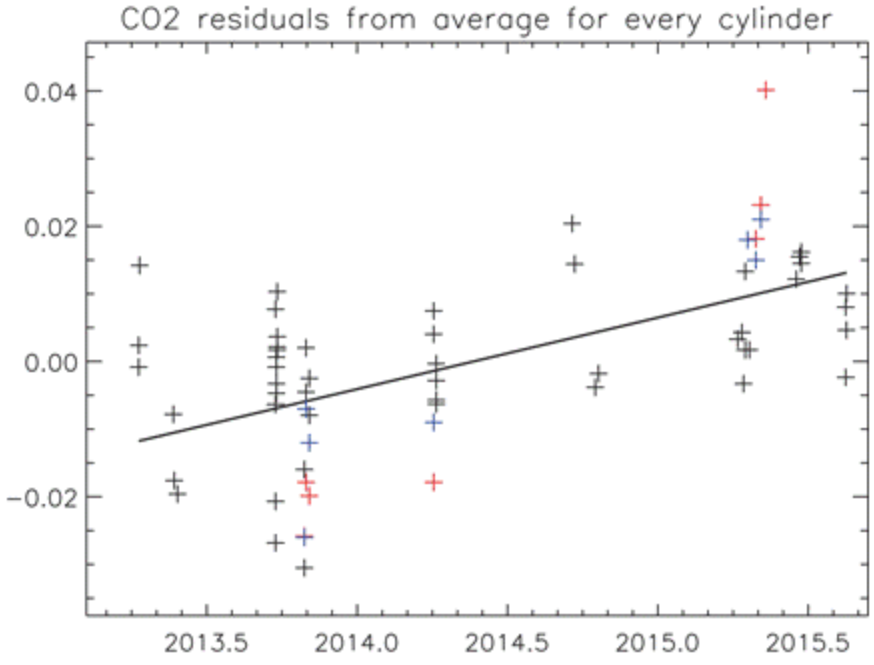
Stability of cylinders in 6th RR - CO_2



Stability of cylinders in 6th RR - CO_2

red "+" corresponds to
CB10296 0.033 ppm/yr
blue "+" to CB09974
0.024 ppm/yr

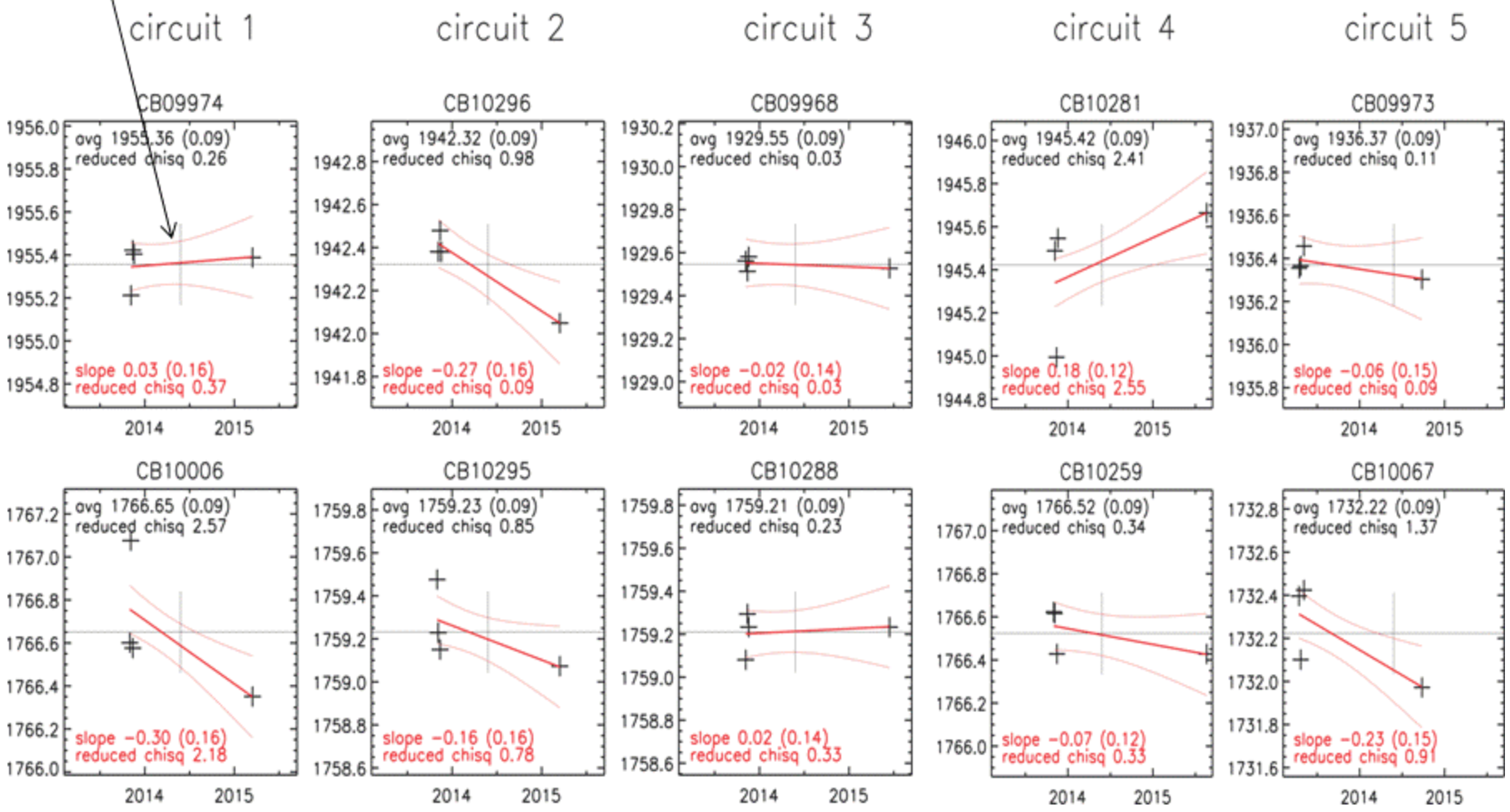




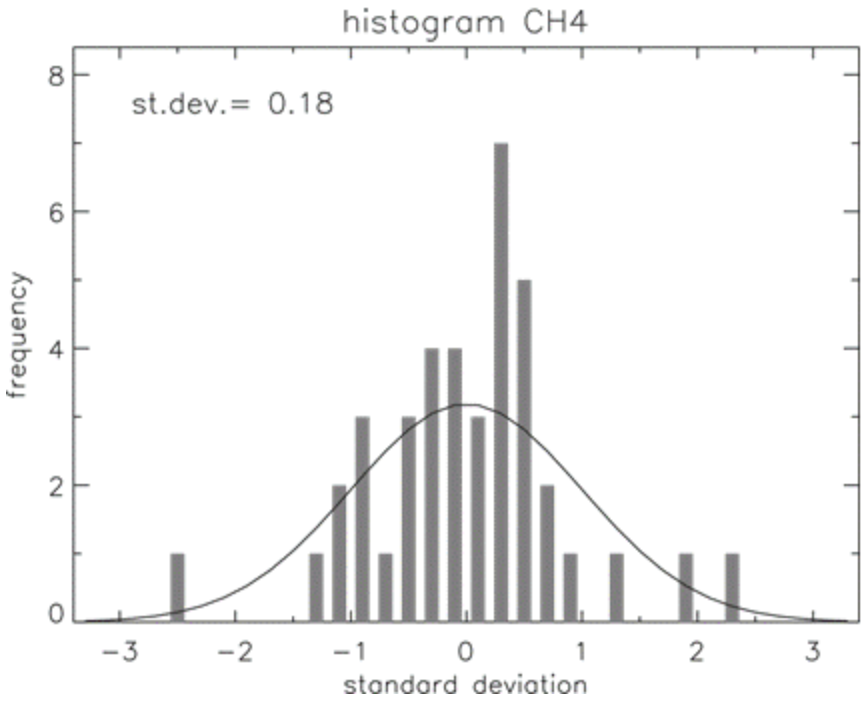
(st. dev. is smaller than long-term reproducibility) (Average slope for all cylinders 0.011 ppm/yr)

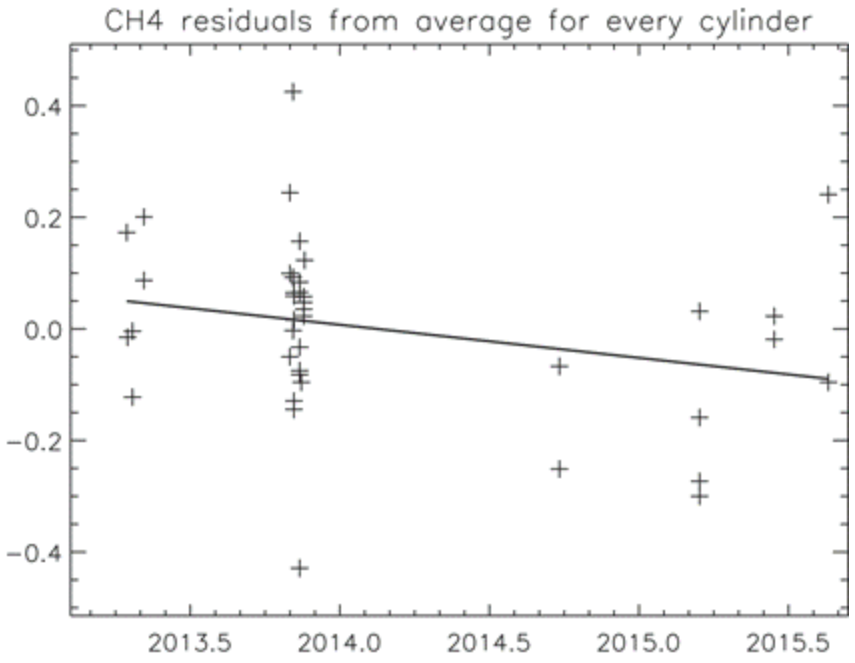
Long-term reproducibility 0.19 ppb (1-σ)

Stability of cylinders in 6th RR – CH_4



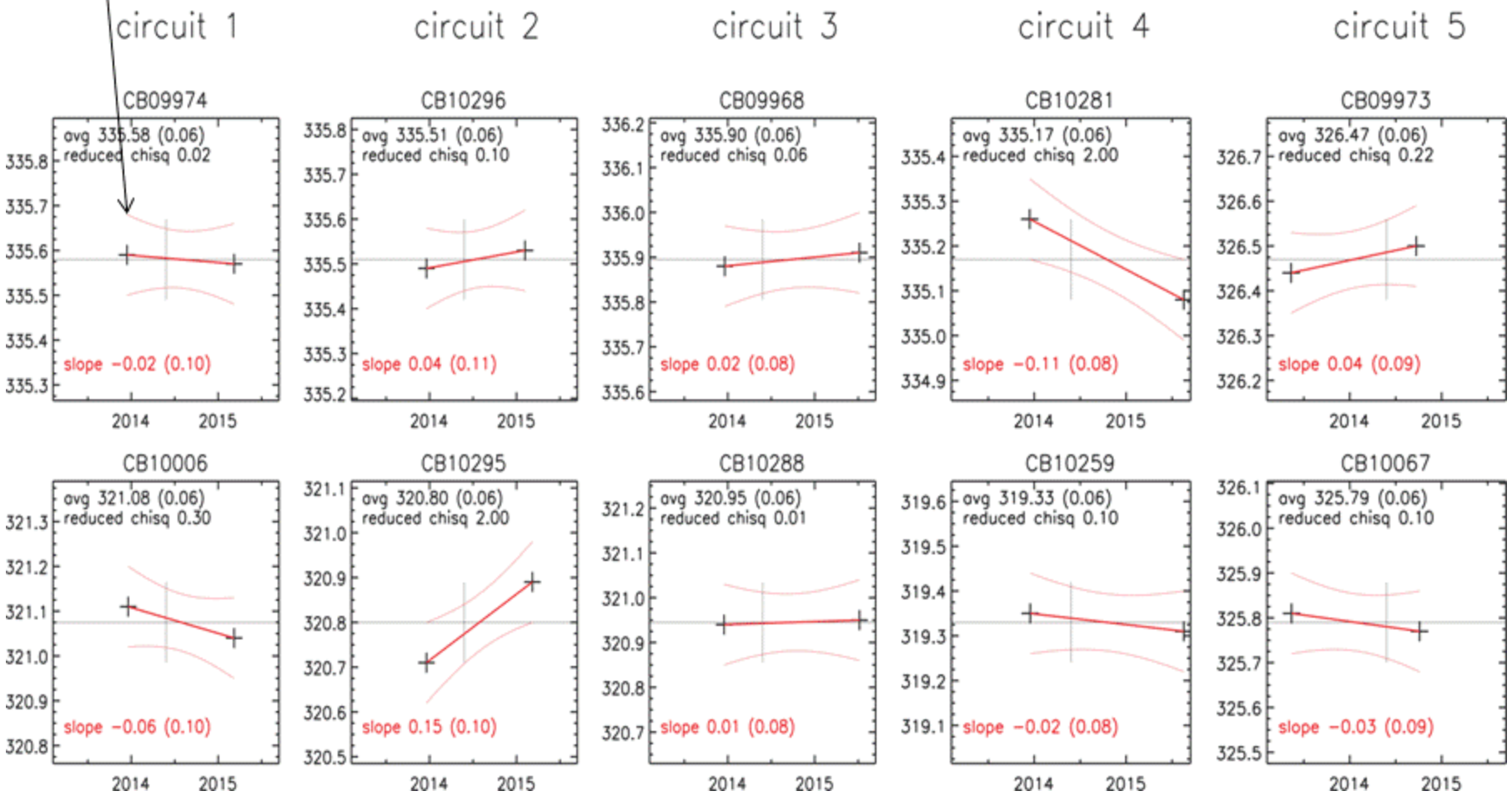
Stability of cylinders in 6th RR – CH_4



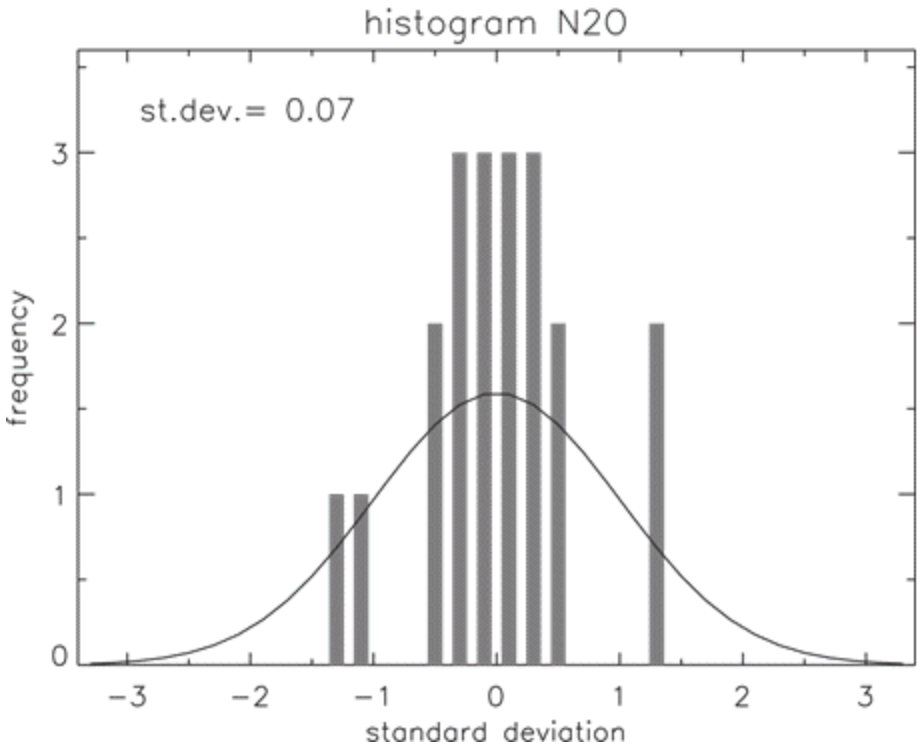


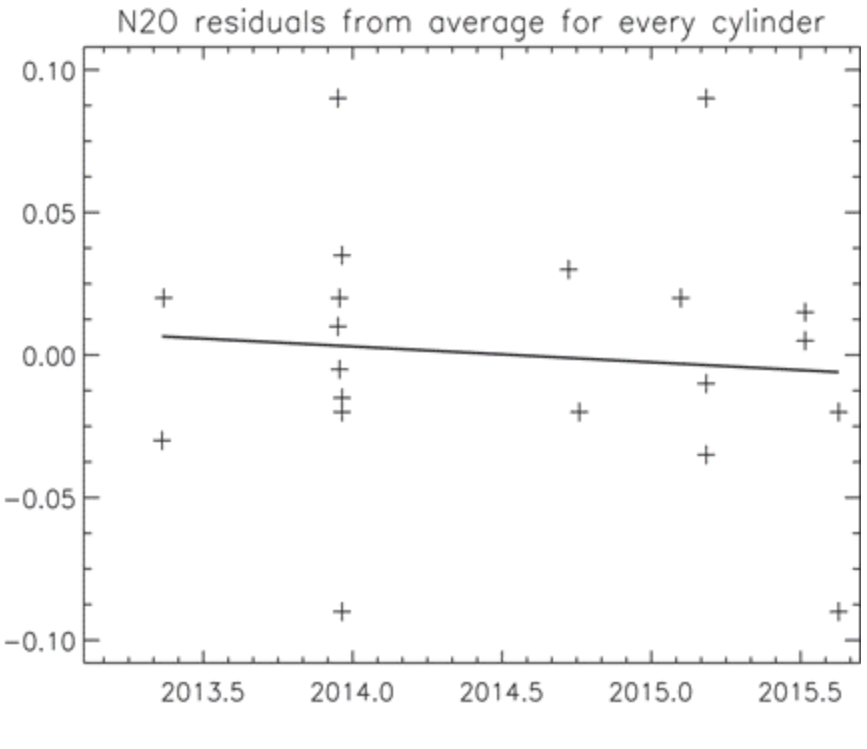
Long-term reproducibility 0.09 ppb (1-σ)

Stability of cylinders in 6th round-robin – N_2O



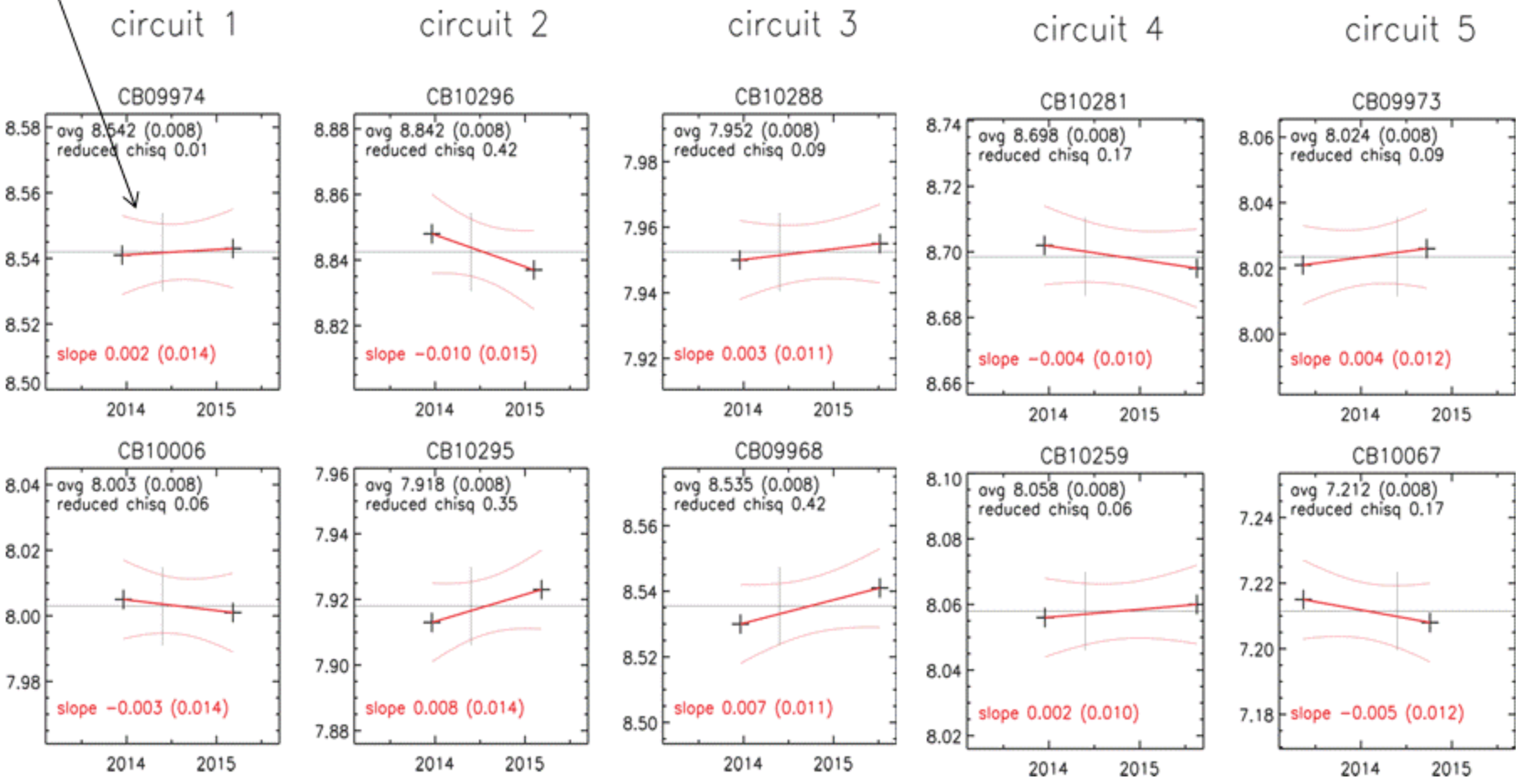
Stability of cylinders in 6th RR – N_2O



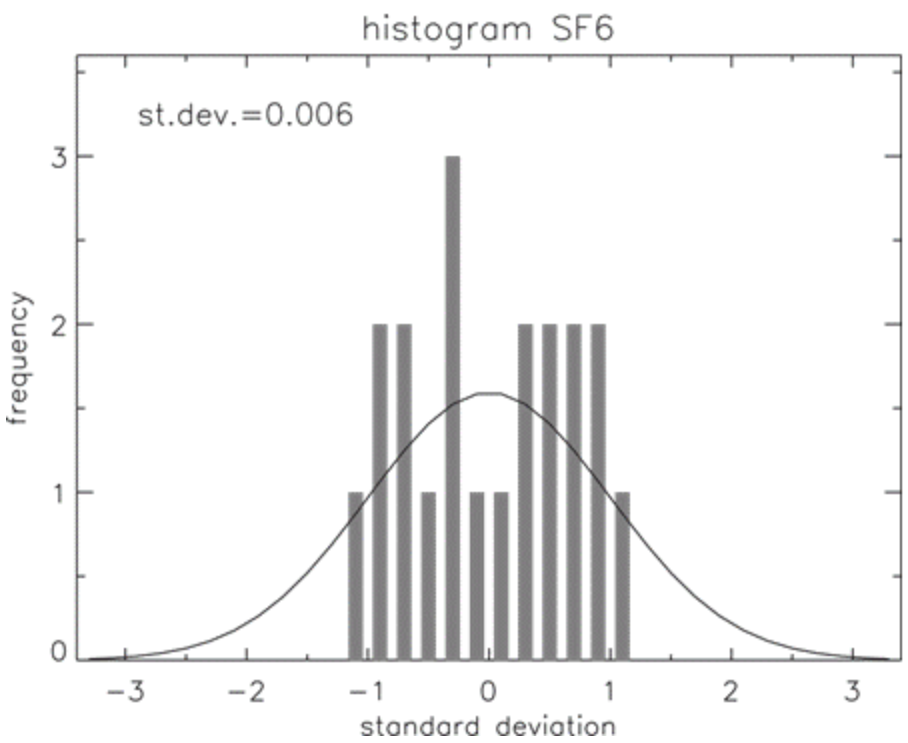


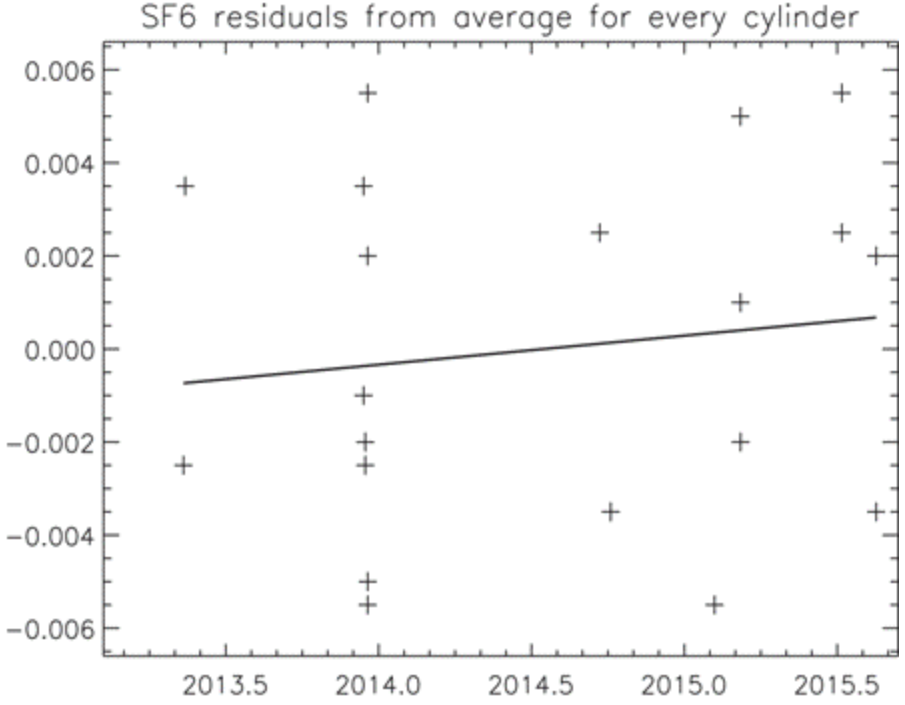
Long-term reproducibility 0.012 ppt (1-σ)

Stability of cylinders in 6th RR – SF_6



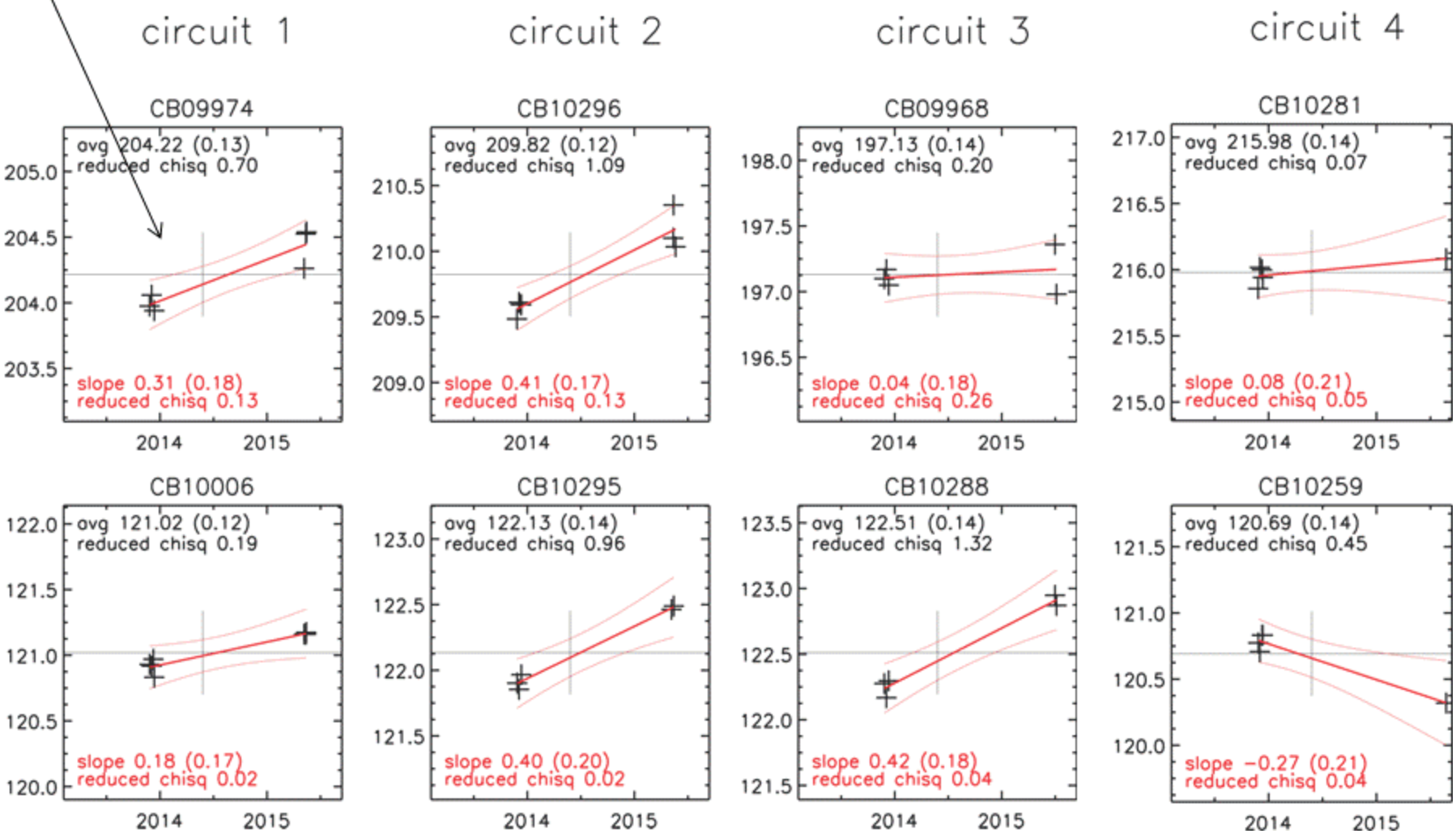
Stability of cylinders in 6th RR – SF_6



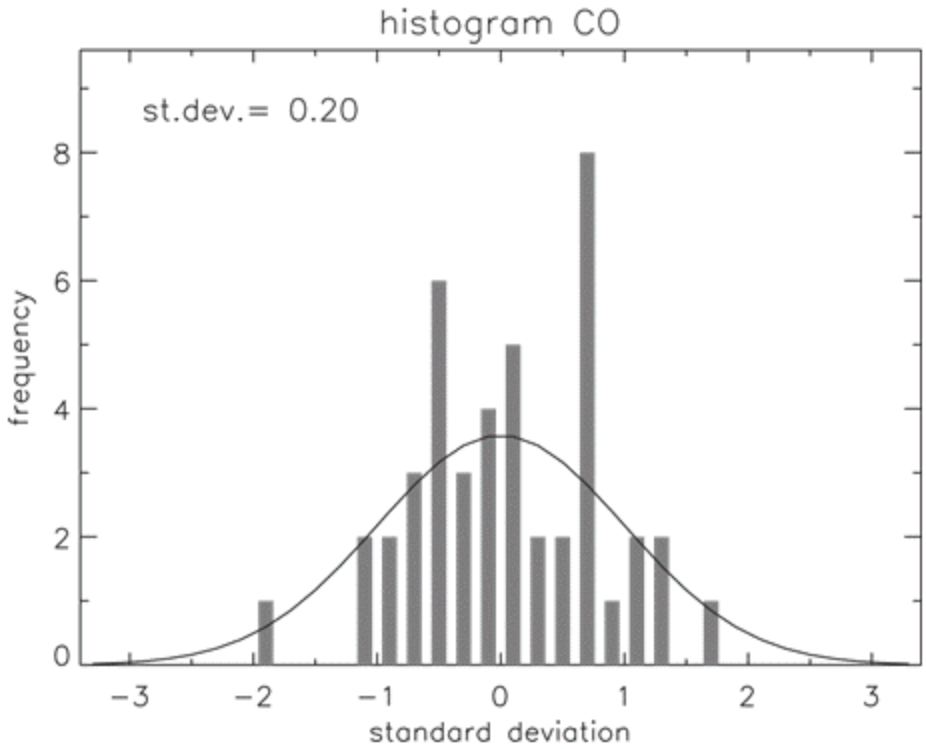


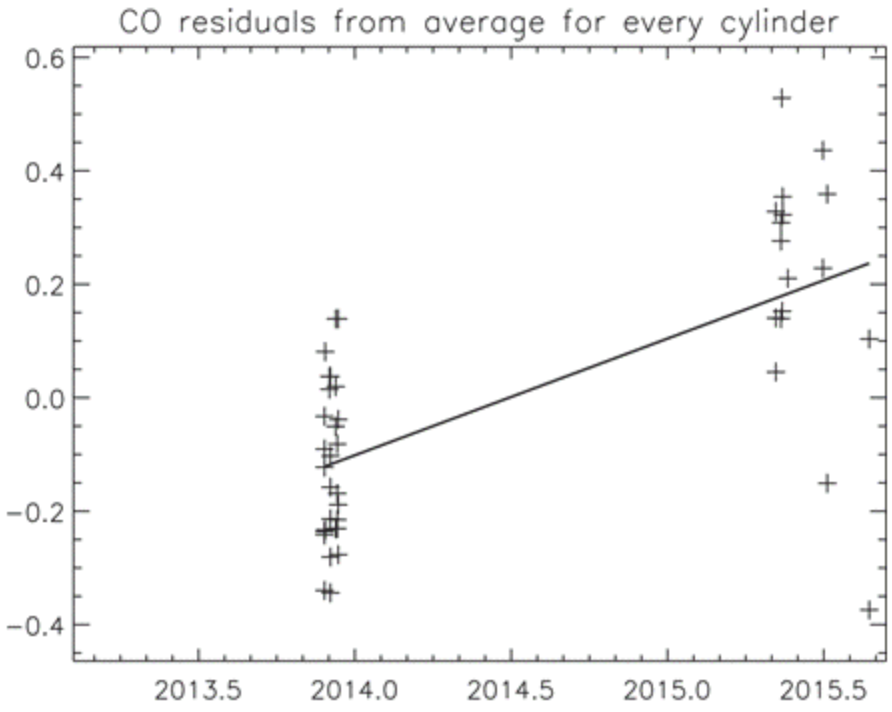
Long-term reproducibility 0.32 ppb (1-σ)

Stability of cylinders in 6th RR - CO



Stability of cylinders in 6th RR - CO





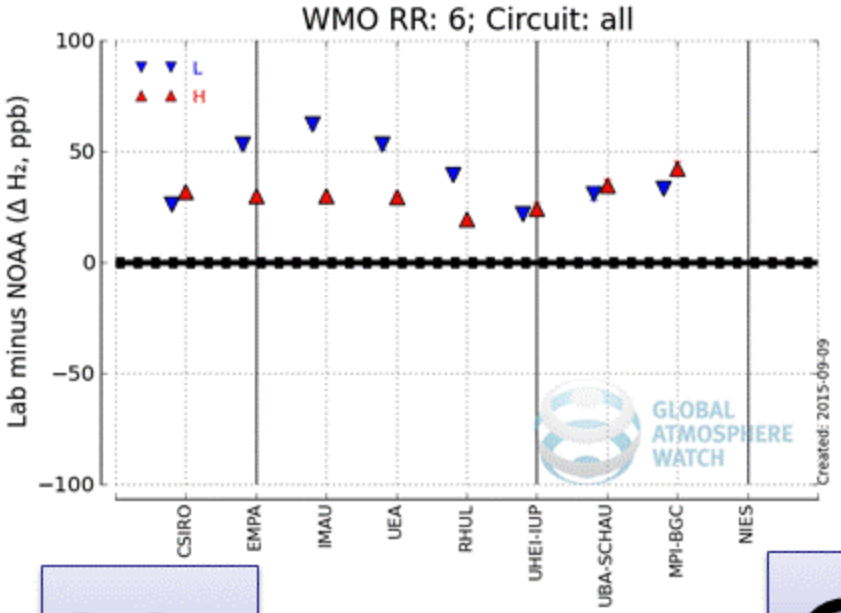
(st. dev. is smaller than long-term reproducibility)

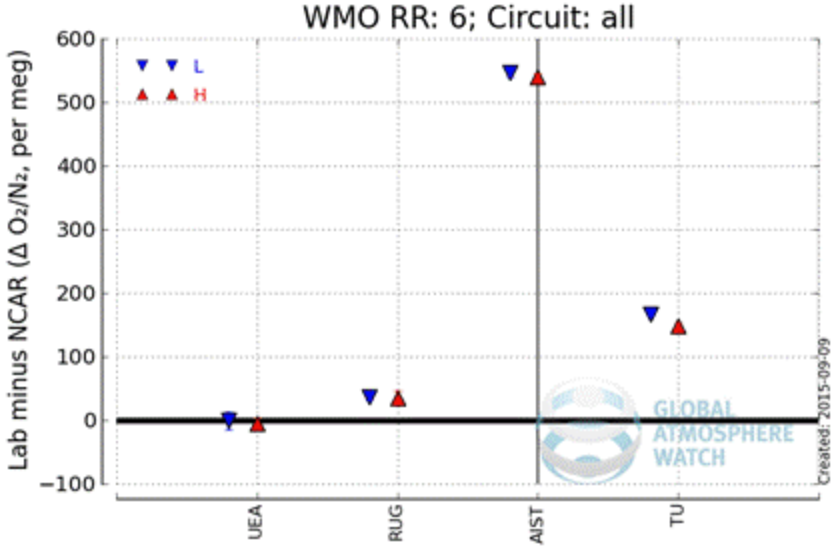
(Average slope for all cylinders 0.21 ppb/yr)

A long way to go

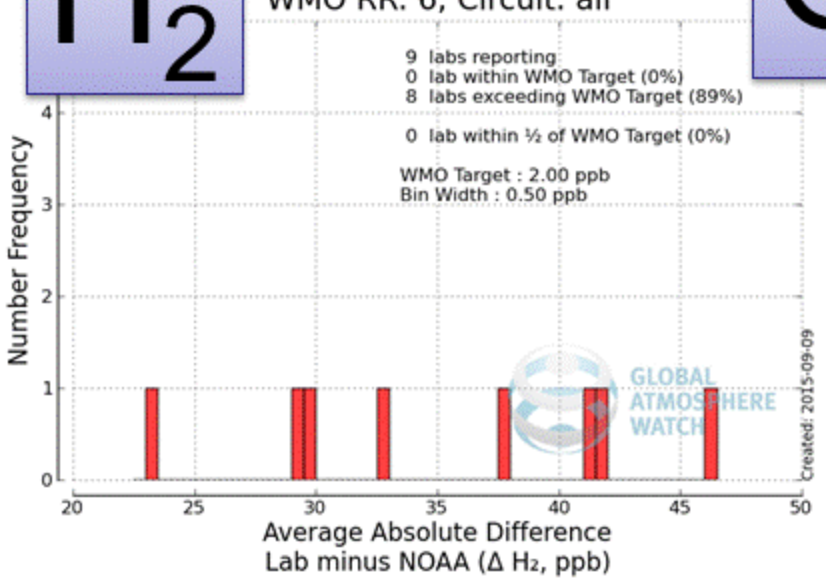
Feedback are expected and appreciated……

Thanks

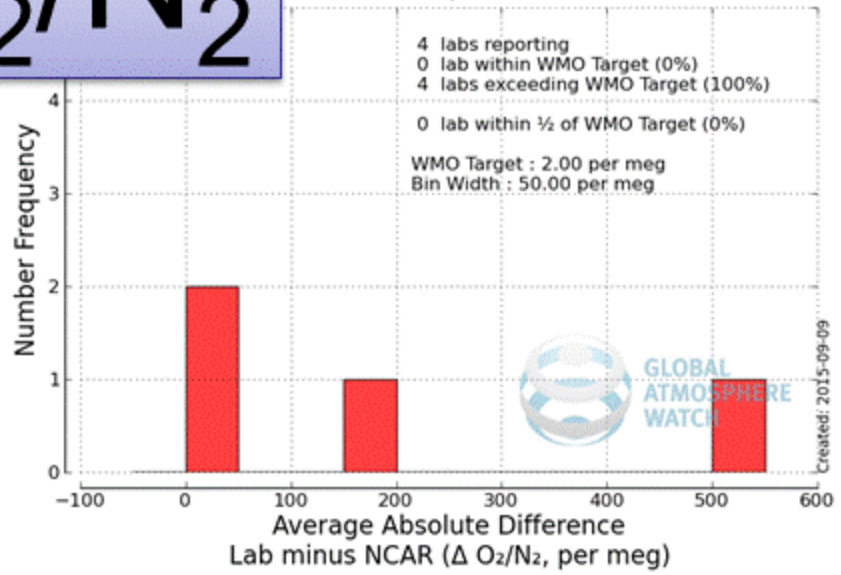

WMO RR: 6; Circuit: all
Lab minus NOAA (Δ H₂, ppb)
100
50
0
−50
−100
L
H
CSIRO
EMPA
IMAU
UEA
RHUL
UHEI-IUP
UBA-SCHAU
MPI-BGC
NIES
GLOBAL ATMOSPHERE WATCH
Created: 2015-09-09

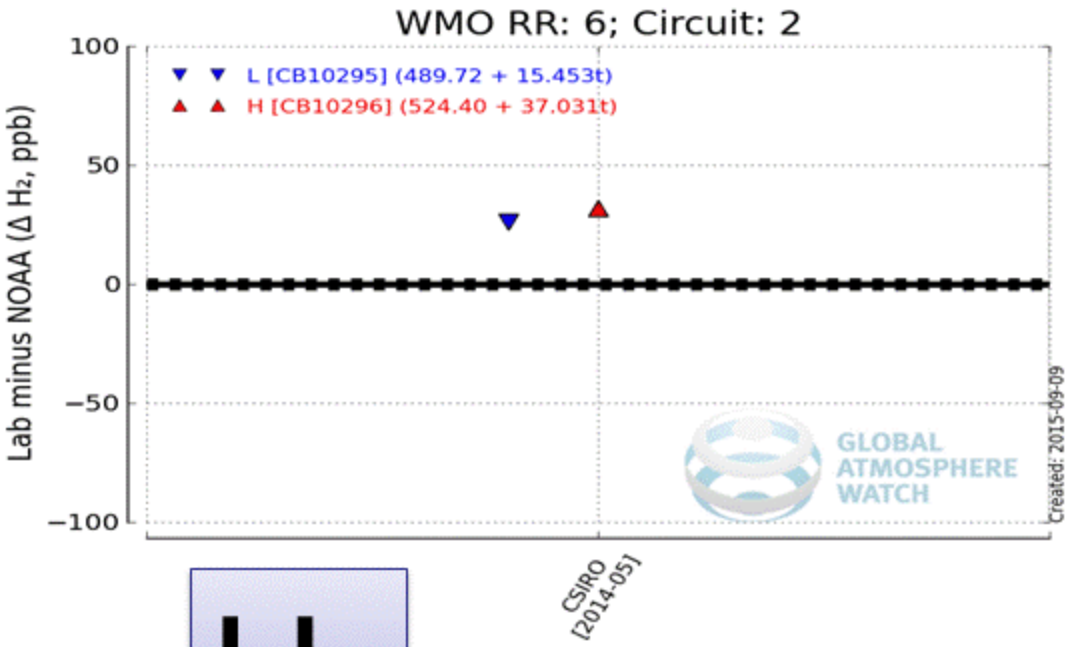

WMO RR: 6; Circuit: all
Lab minus NCAR (Δ O₂/N₂, per meg)
600
500
400
300
200
100
0
−100
L
H
UEA
RUG
AIST
TU
GLOBAL ATMOSPHERE WATCH
Created: 2015-09-09

H_2


WMO RR: 6; Circuit: all
9 labs reporting
0 lab within WMO Target (0%)
8 labs exceeding WMO Target (89%)
0 lab within ½ of WMO Target (0%)
WMO Target : 2.00 ppb
Bin Width : 0.50 ppb
Number Frequency
4
3
2
1
0
20
25
30
35
40
45
50
Average Absolute Difference
Lab minus NOAA (Δ H₂, ppb)
GLOBAL ATMOSPHERE WATCH
Created: 2015-09-09

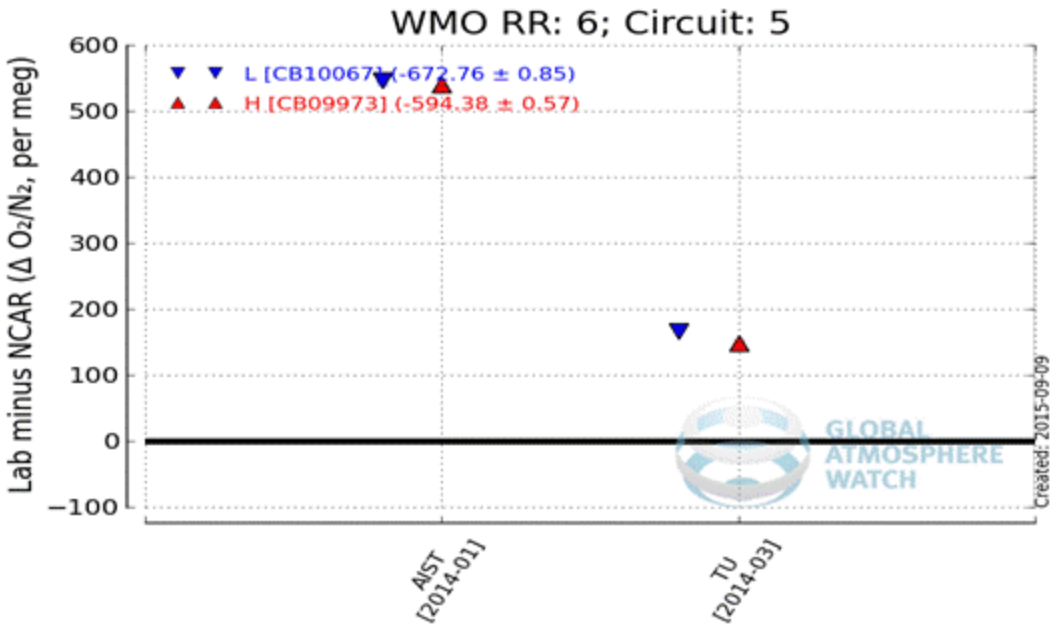
O_2/N_2


WMO RR: 6; Circuit: all
4 labs reporting
0 lab within WMO Target (0%)
4 labs exceeding WMO Target (100%)
0 lab within ½ of WMO Target (0%)
WMO Target : 2.00 per meg
Bin Width : 50.00 per meg
Number Frequency
4
3
2
1
0
−100
0
100
200
300
400
500
600
Average Absolute Difference
Lab minus NCAR (Δ O₂/N₂, per meg)
GLOBAL ATMOSPHERE WATCH
Created: 2015-09-09


WMO RR: 6; Circuit: 2
L [CB10295] (489.72 + 15.453t)
H [CB10296] (524.40 + 37.031t)
Lab minus NOAA (Δ H₂, ppb)
100
50
0
−50
−100
GLOBAL ATMOSPHERE WATCH
Created: 2015-09-09
CSIRO [2014-05]

H_2

O_2/N_2


WMO RR: 6; Circuit: 5
L [CB10067] (-672.76 ± 0.85)
H [CB09973] (-594.38 ± 0.57)
Lab minus NCAR (Δ O₂/N₂, per meg)
600
500
400
300
200
100
0
−100
GLOBAL ATMOSPHERE WATCH
Created: 2015-09-09
AIST [2014-01]
TU [2014-03]

Stability of cylinders in 6th RR – H_2