NOAA's Role in Insuring International Greenhouse Gas Measurement Quality

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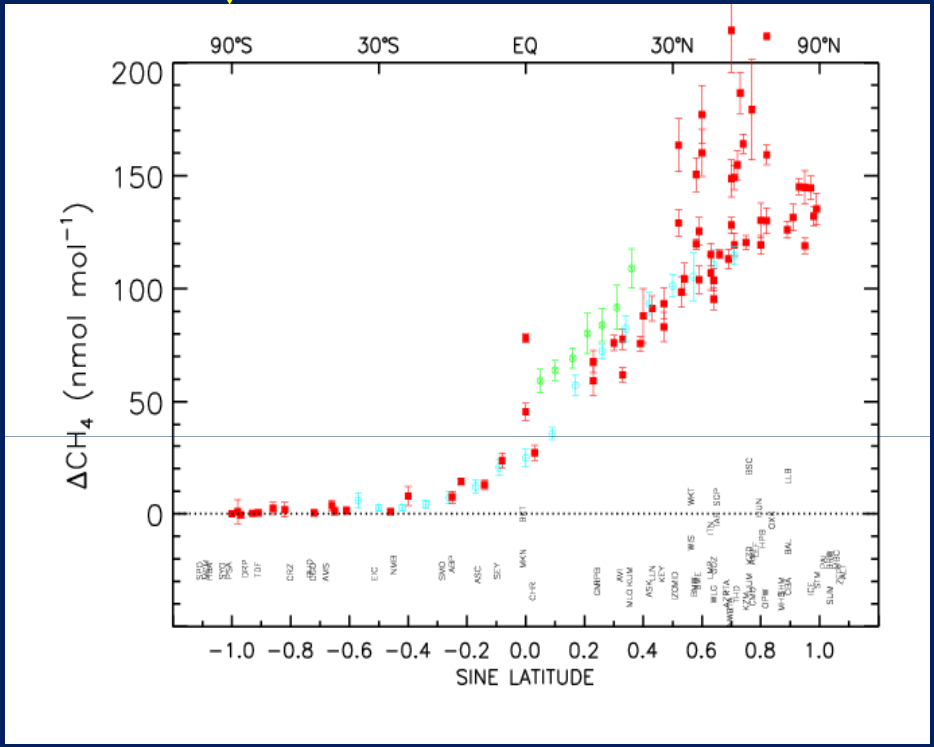
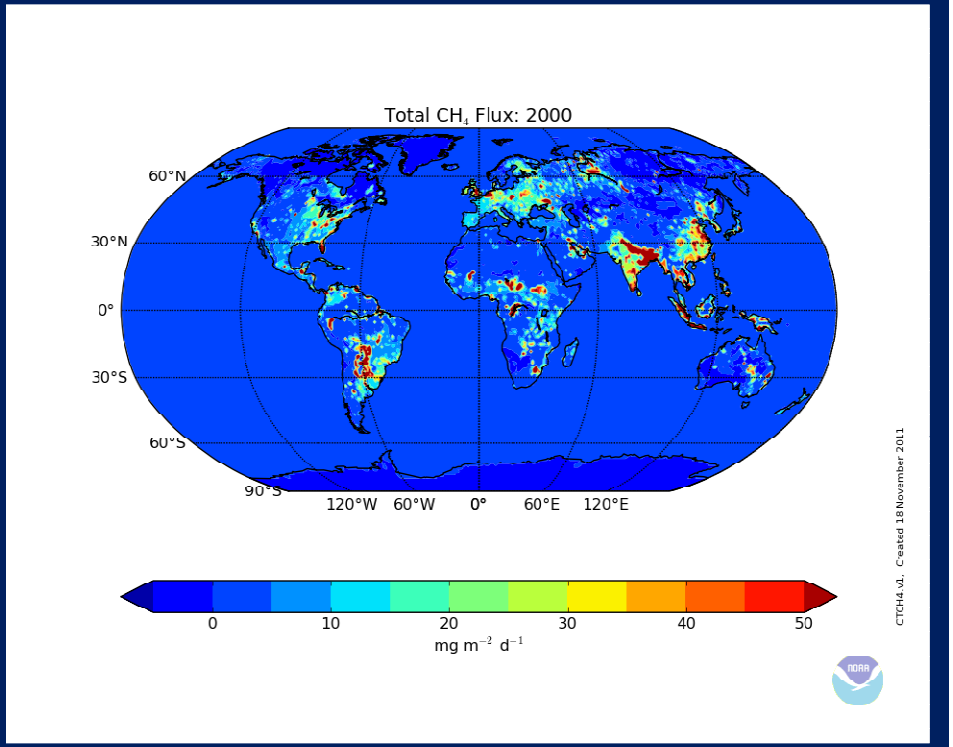
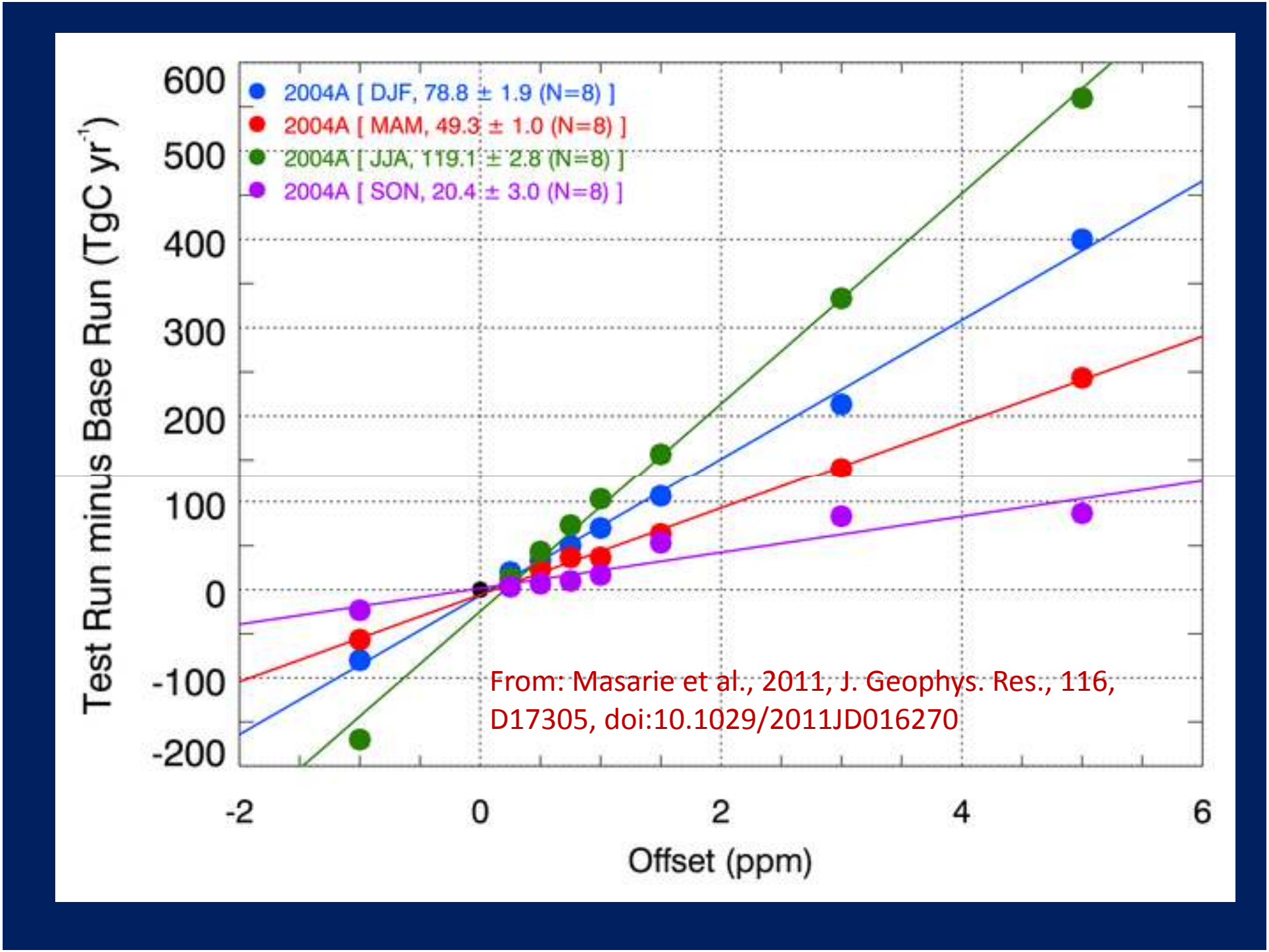
Want to convert spatial patterns in observations…



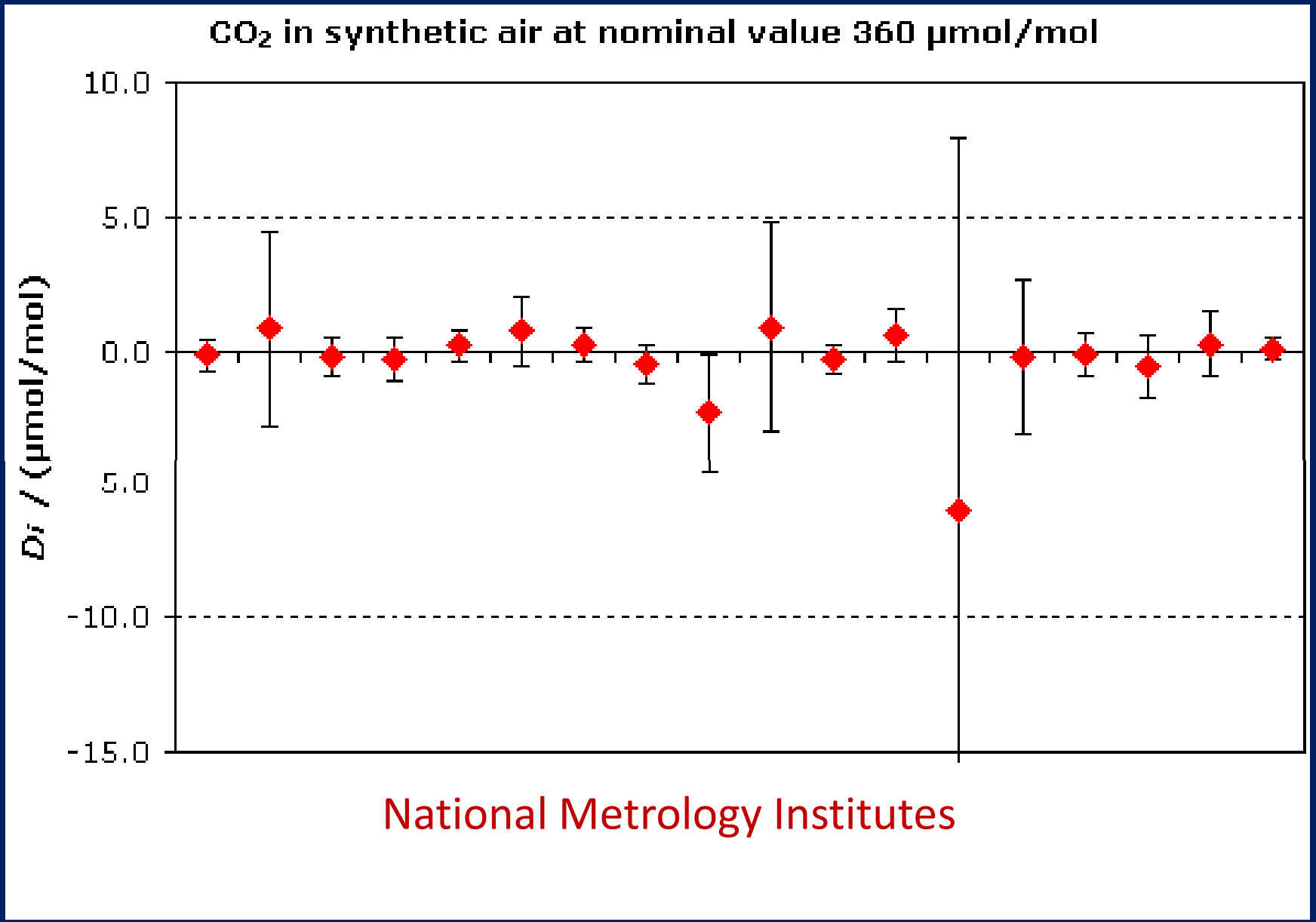


…into emissions

Small biases in observations will bias emissions


2004A [DJF, 78.8 ± 1.9 (N=8)]
2004A [MAM, 49.3 ± 1.0 (N=8)]
2004A [JJA, 119.1 ± 2.8 (N=8)]
2004A [SON, 20.4 ± 3.0 (N=8)]
Test Run minus Base Run (TgC yr-1)
600
500
400
300
200
100
0
-100
-200
-2
0
2
4
6
Offset (ppm)
From: Masarie et al., 2011, J. Geophys. Res., 116, D17305, doi:10.1029/2011JD016270

Data must be comparable



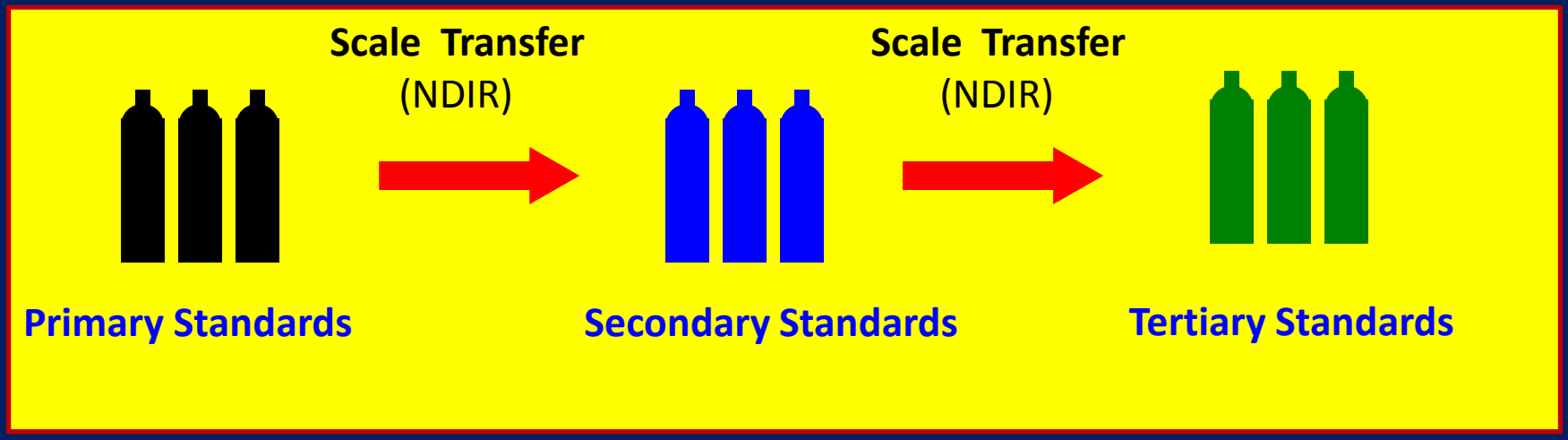
National Metrology Institutes

NOAA Role in Comparability

- CCL for CO_2, CH_4, N_2O, and SF_6 (+CO)
  - Insure standards are “SI-traceable” (i.e., T, P, mass)
  - Develop QS to meet ISO 17025 and ISO 34
  - Participate in “key comparisons” with NMIs
  - Standards equivalent to NMIs
- NOAA acts as WCC for CO_2 (and other gases)
  - Organize international comparisons of standards
- GAW participants obtain standards from CCL
  - Maintain as short a link as possible to CCL

WMO CO_2 mole fraction scale

- Reference scale for CO_2 in dry air, maintained by NOAA/GMD
- Defined by 15 primary standards (~250 to 520 ppm)



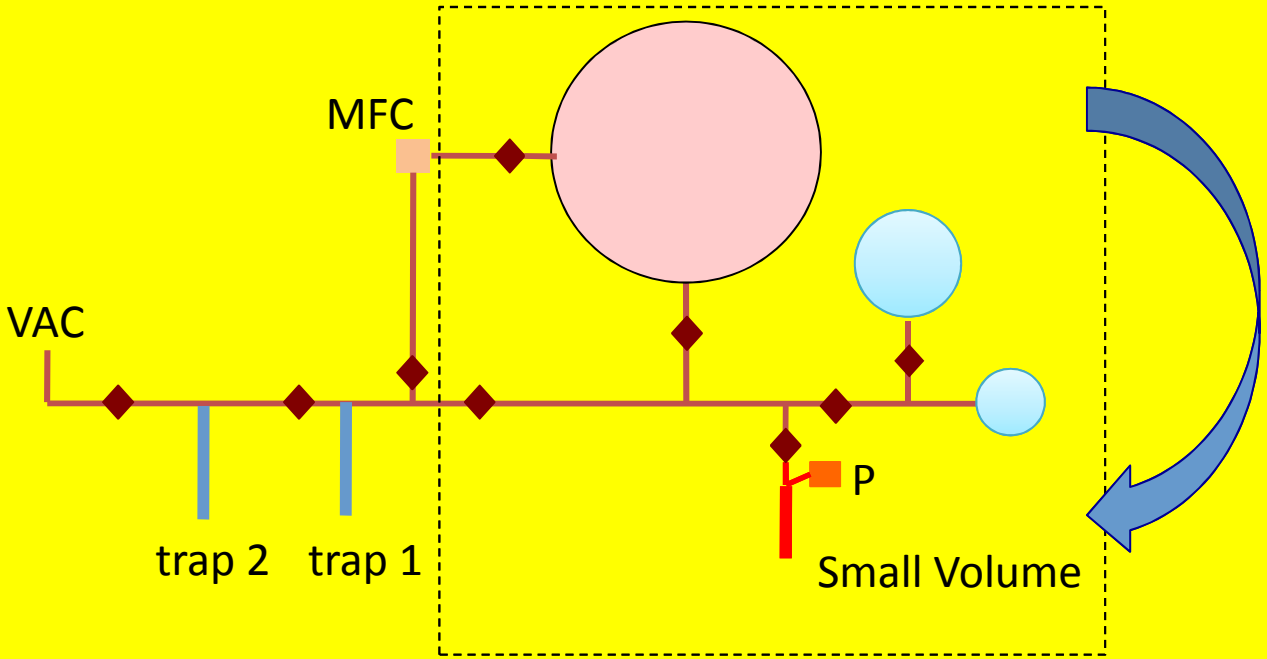
What is the manometer?

-Device used to determine the mole fraction of CO_2 in dry air (absolute).

Zhao et al., *J. Geophys. Res.*, **102**, 5885-5894, 1997.

Extract CO_2 (and N_2O)

P = 20-90 kPa
T = 37 °C



for ideal gases ….

$$\text{mole fraction } \{CO_2 + N_2O\} = \frac{P_{CO2}/T_{CO2}}{P_{air}/T_{air}} \frac{1}{VR}$$

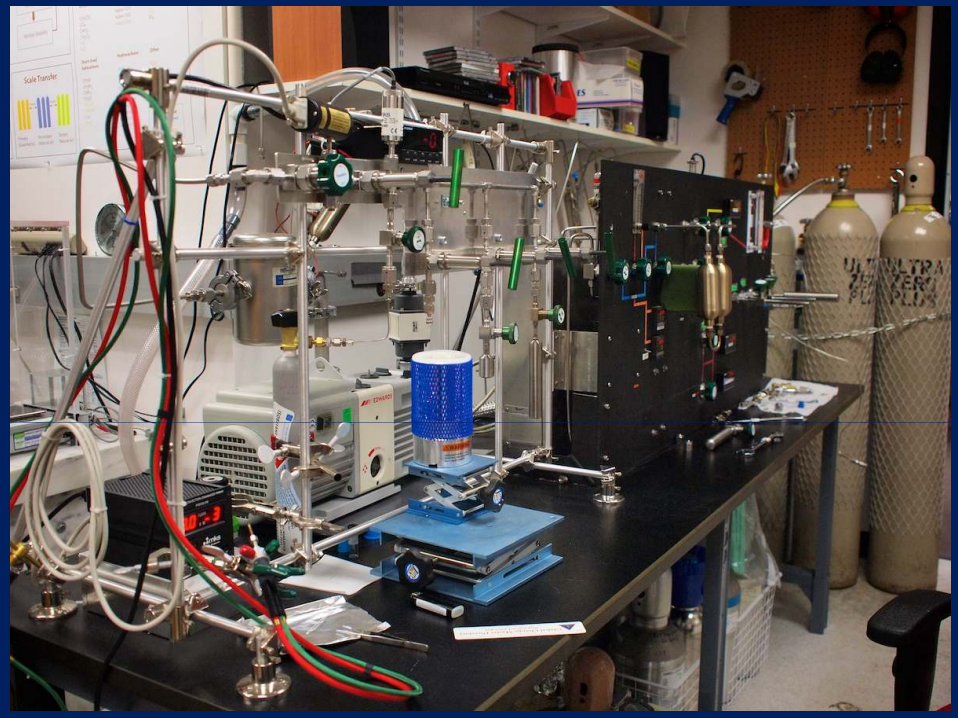
Traceable to SI quantities T and P

VR = Volume Ratio

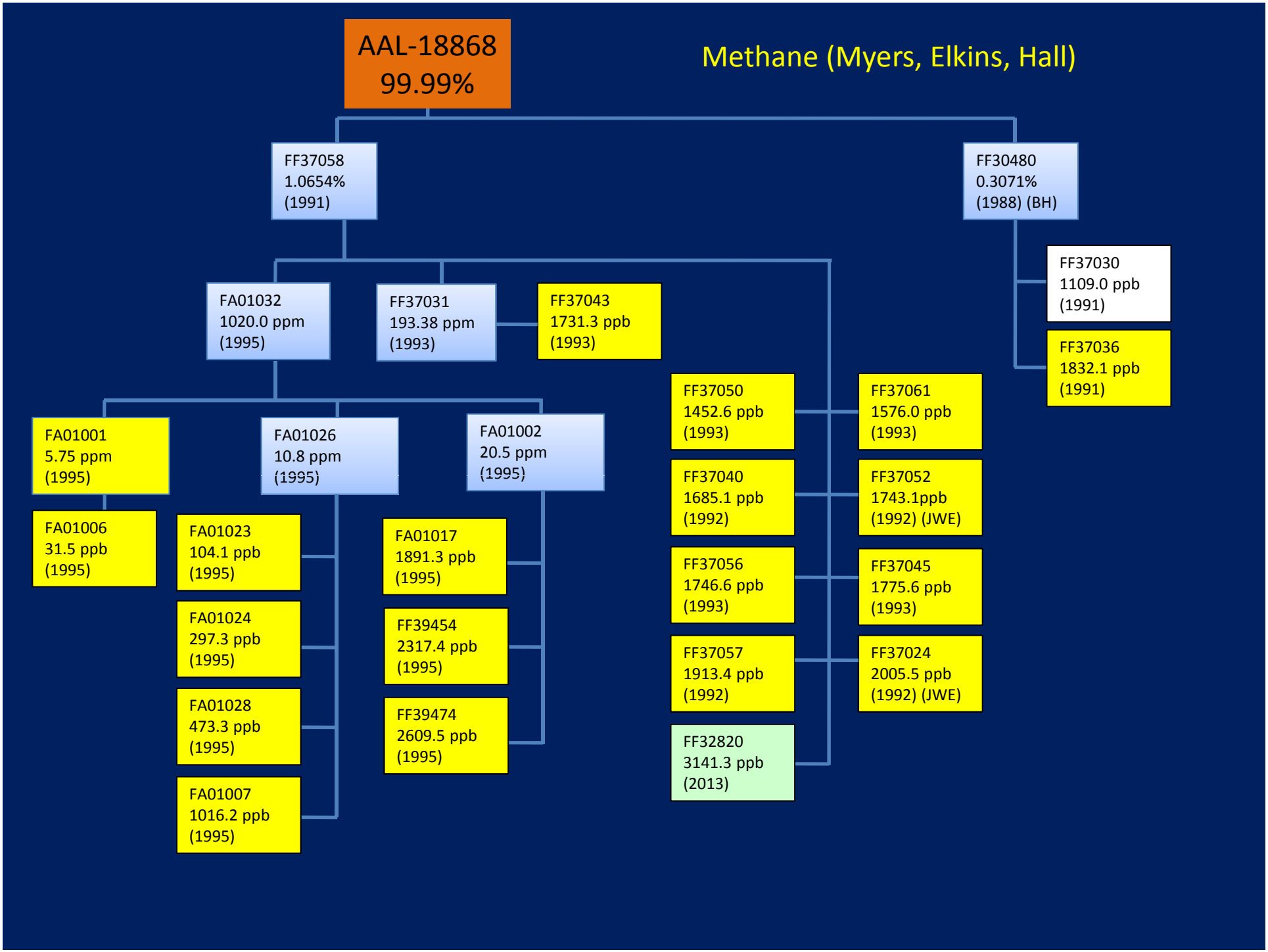
Uncertainty: ±0.07 ppm (~1 part in 5000, 1-σ)

Zhao and Tans, J. Geophys. Res. 111. doi: 10.1029/2005JD006003. issn: 0148-0227, 2006

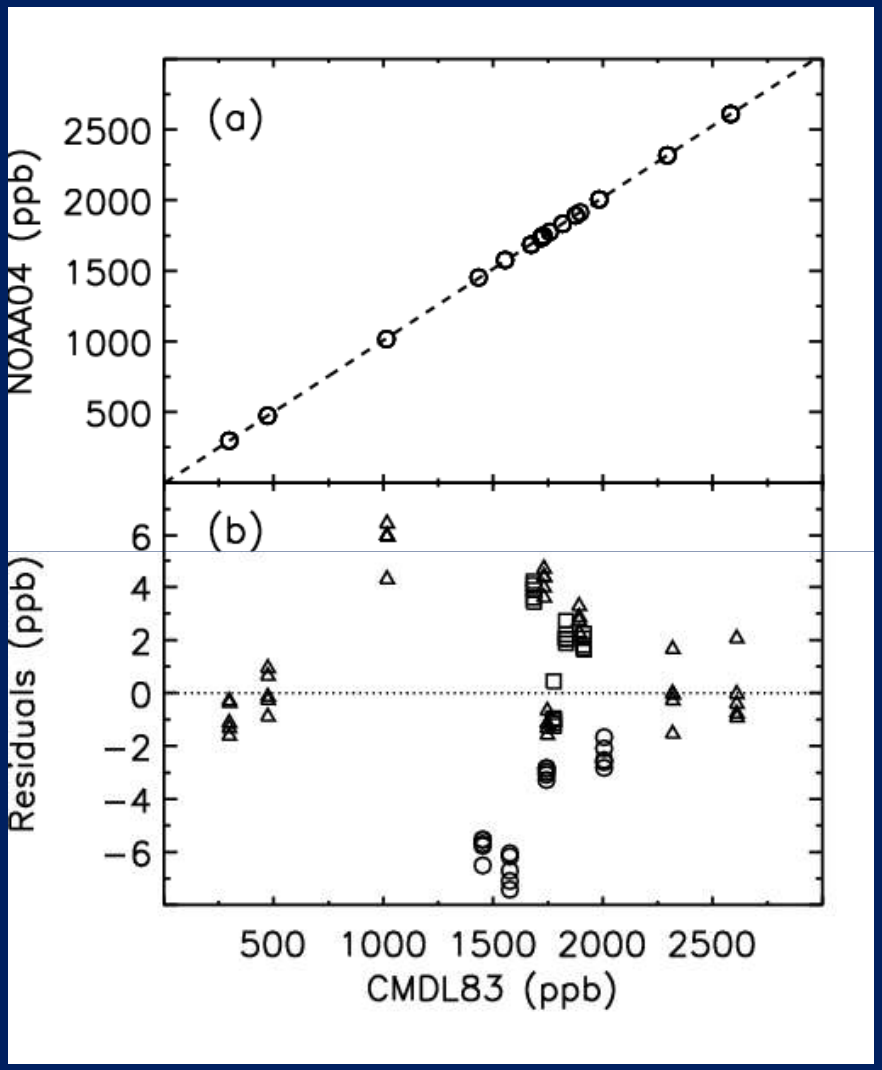
Gravimetric Standards Capability

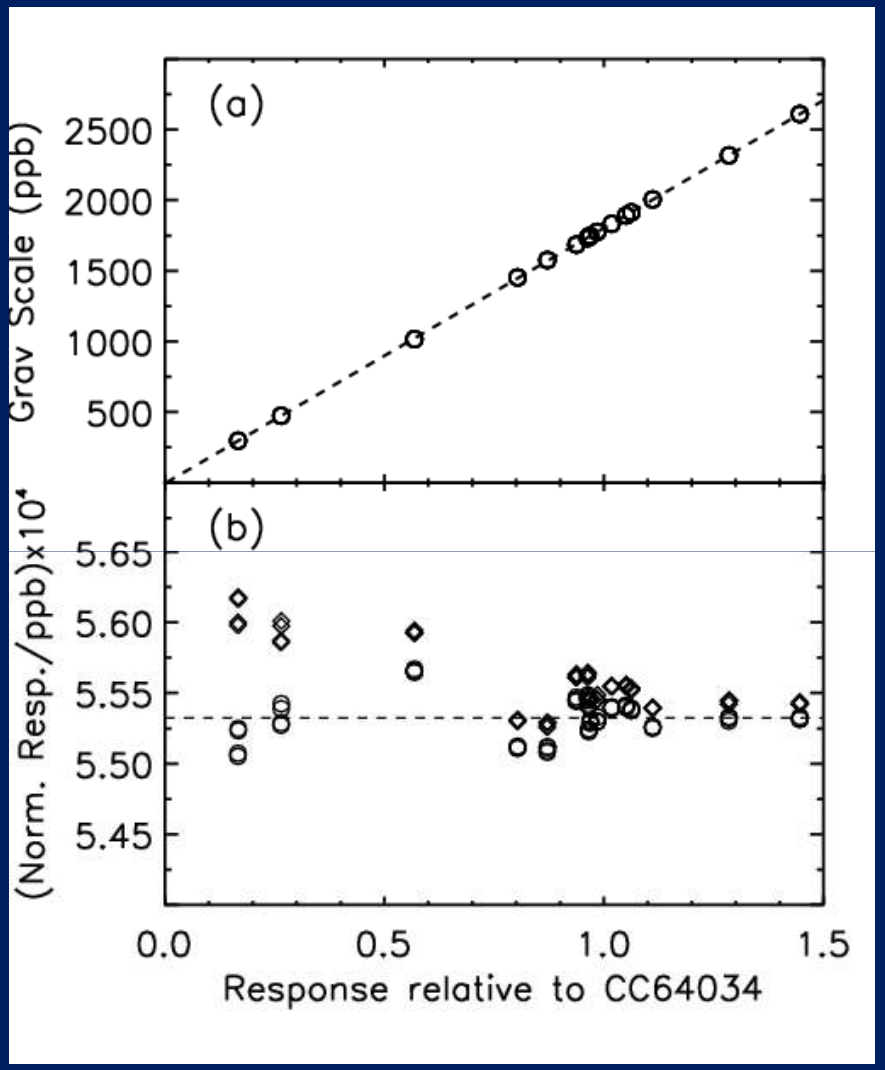


Used for CH_4, N_2O, SF_6, (and CO)


AAL-18868
99.99%
Methane (Myers, Elkins, Hall)
FF37058
1.0654%
(1991)
FF30480
0.3071%
(1988) (BH)
FF37030
1109.0 ppb
(1991)
FF37036
1832.1 ppb
(1991)
FA01032
1020.0 ppm
(1995)
FF37031
193.38 ppm
(1993)
FF37043
1731.3 ppb
(1993)
FA01001
5.75 ppm
(1995)
FA01026
10.8 ppm
(1995)
FA01002
20.5 ppm
(1995)
FA01006
31.5 ppb
(1995)
FA01023
104.1 ppb
(1995)
FA01024
297.3 ppb
(1995)
FA01028
473.3 ppb
(1995)
FA01007
1016.2 ppb
(1995)
FA01017
1891.3 ppb
(1995)
FF39454
2317.4 ppb
(1995)
FF39474
2609.5 ppb
(1995)
FF37050
1452.6 ppb
(1993)
FF37040
1685.1 ppb
(1992)
FF37056
1746.6 ppb
(1993)
FF37057
1913.4 ppb
(1992)
FF32820
3141.3 ppb
(2013)
FF37061
1576.0 ppb
(1993)
FF37052
1743.1ppb
(1992) (JWE)
FF37045
1775.6 ppb
(1993)
FF37024
2005.5 ppb
(1992) (JWE)

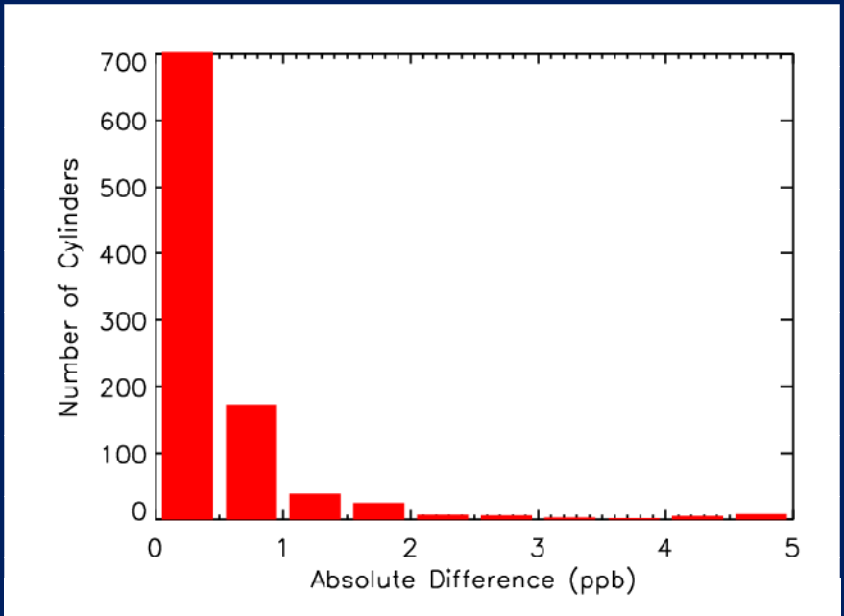
NOAA CH_4 1° Standards

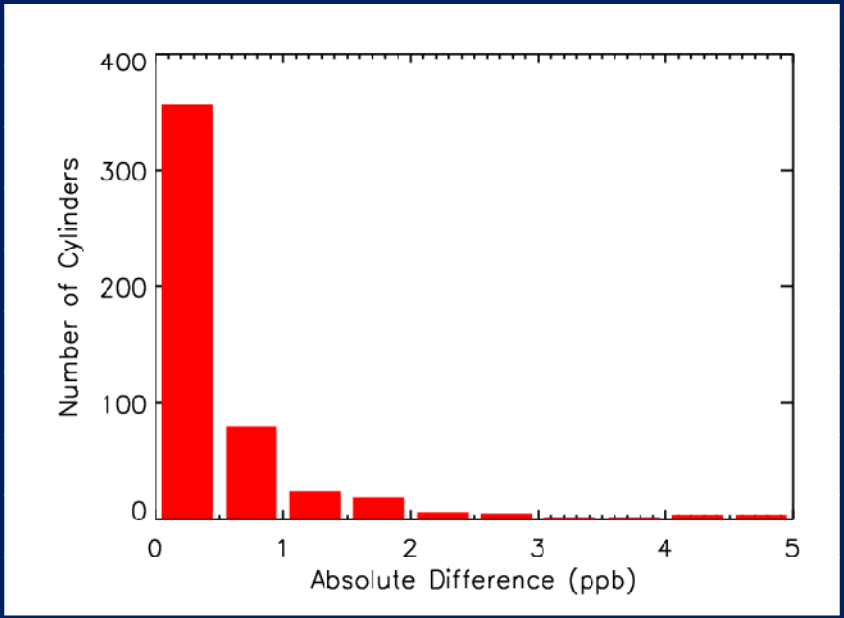




Source: Dlugokencky et al., JGR, doi:10.1029/2005JD006035, 2005

All standards



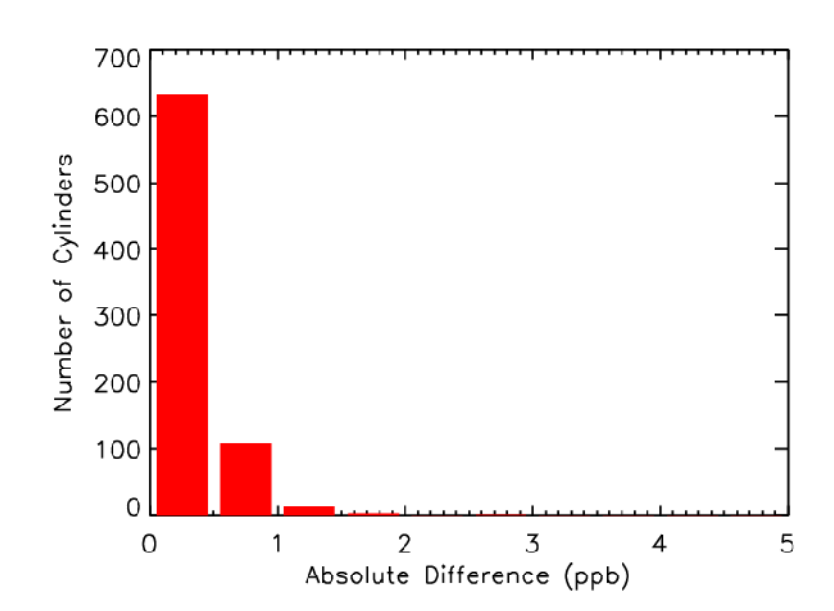


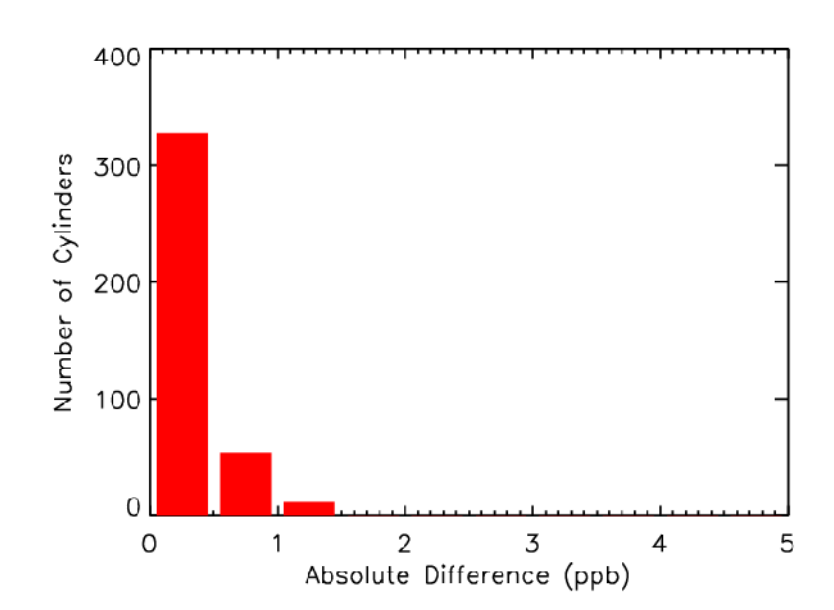
CH_4 CCL Goal:
Transfer scale to <±1 ppb

Recalibration: 6 mo or greater
Mean = 0.7 ppb
n = 963
91% are 0 to 1.0 ppb

Recalibration: 3 yr or greater
Mean = 0.6 ppb
n = 499
88% are 0 to 1.0 ppb

Ambient (1600-1900 ppb)

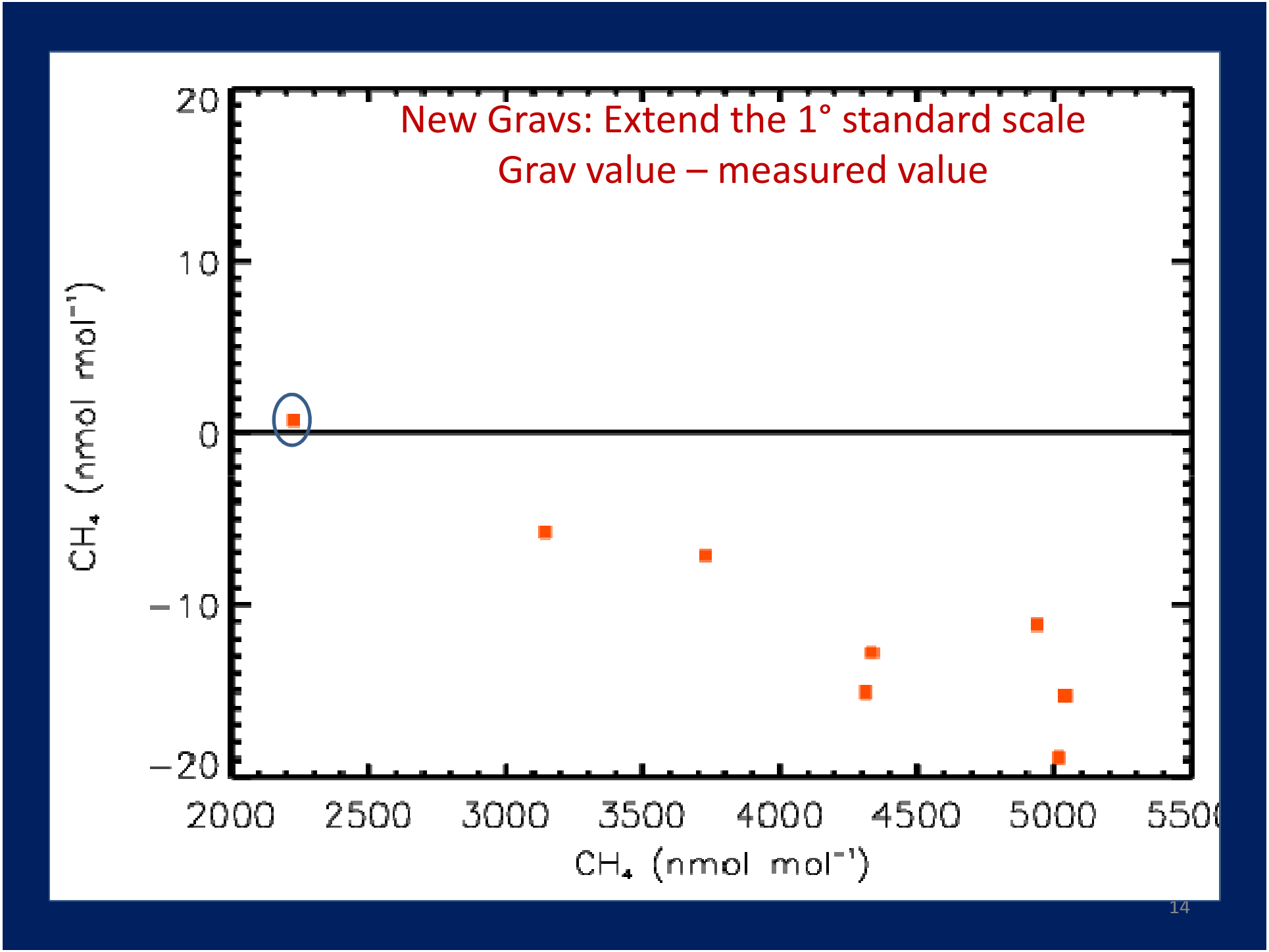


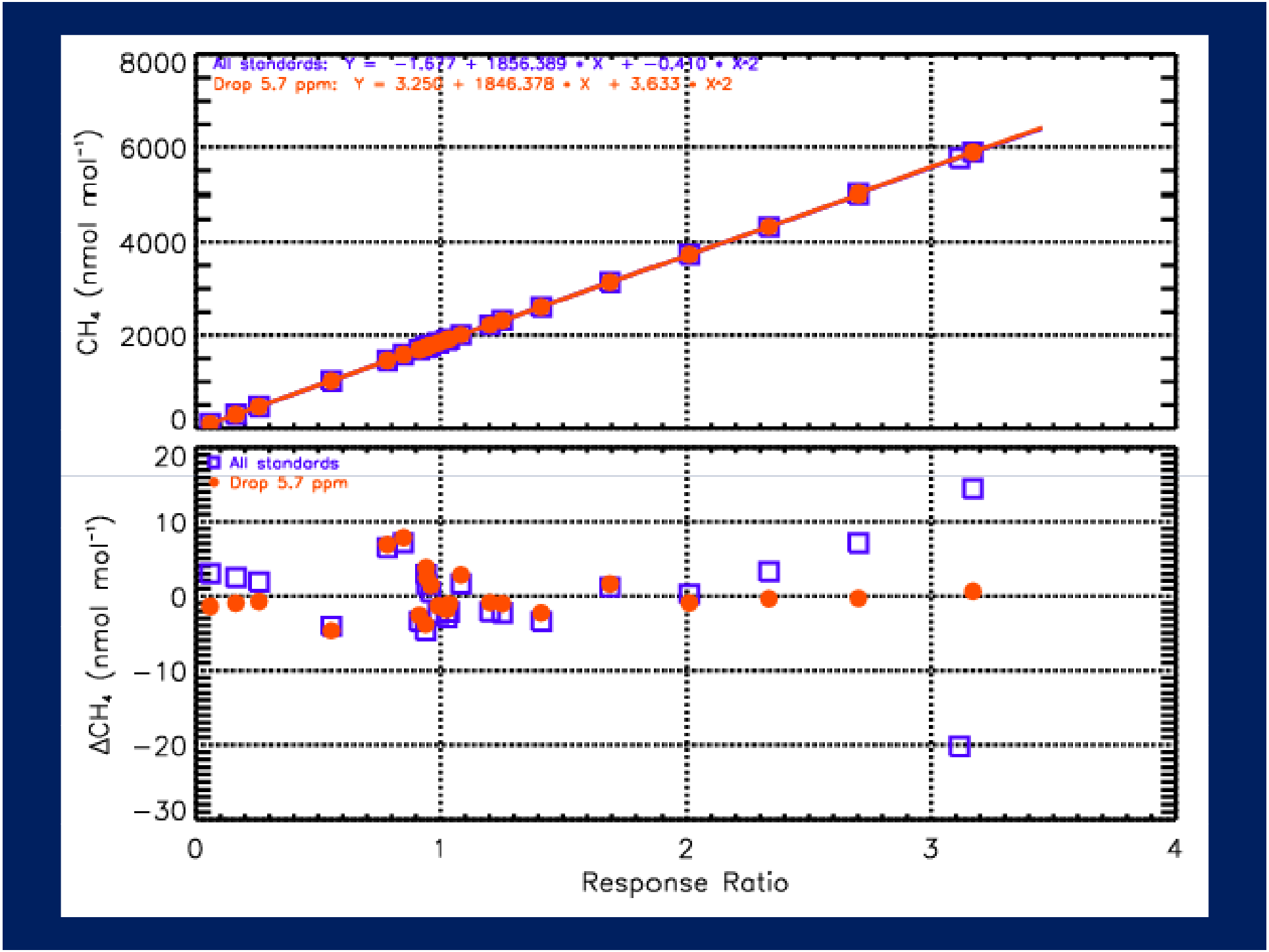


CH_4 CCL Goal:
Transfer scale to <±1 ppb

Recalibration: 6 mo or greater
Mean = 0.3 ppb
n = 757
98% are 0 to 1.0 ppb

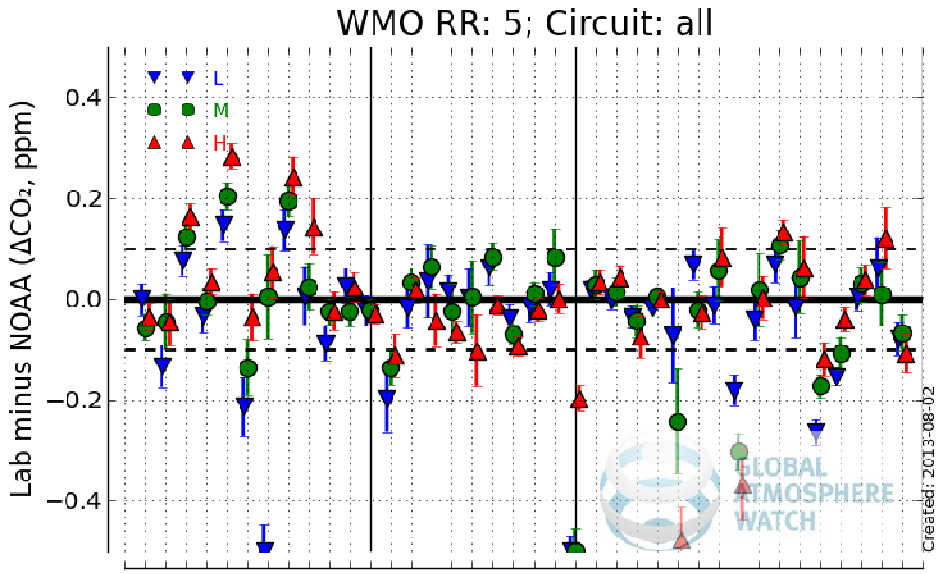
Recalibration: 3 yr or greater
Mean = 0.3 ppb
n = 392
97% are 0 to 1.0 ppb

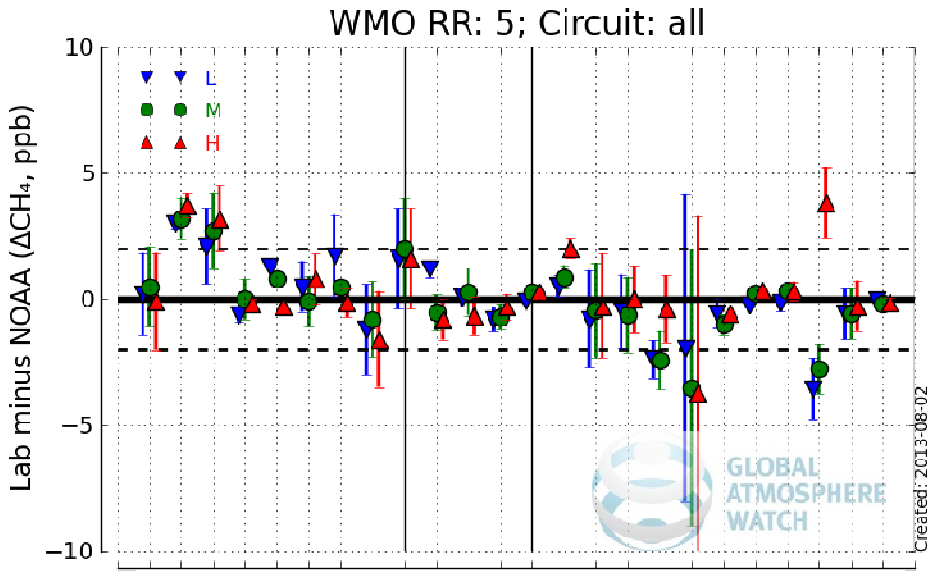

New Gravs: Extend the 1° standard scale
Grav value – measured value
20
10
0
−10
−20
2000
2500
3000
3500
4000
4500
5000
CH₄ (nmol mol⁻¹)
CH₄ (nmol mol⁻¹)


All standards: Y = −1.627 + 1856.389 • X + −0.430 • X^2
Drop 5.7 ppm: Y = 3.250 + 1846.378 • X + 3.633 • X^2
8000
6000
4000
2000
0
CH4 (nmol mol-1)
All standards
Drop 5.7 ppm
20
10
0
−10
−20
−30
ΔCH4 (nmol mol-1)
0
1
2
3
4
Response Ratio

Assessing Comparability

Organizing international comparisons of standards



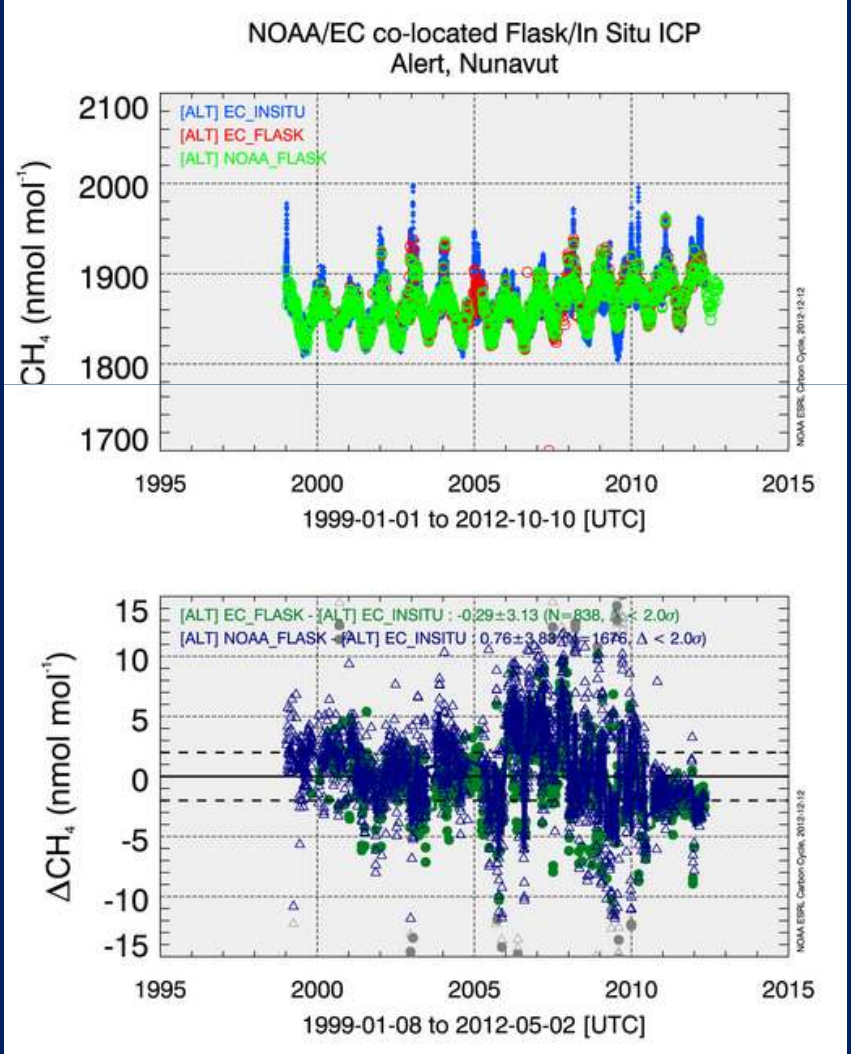


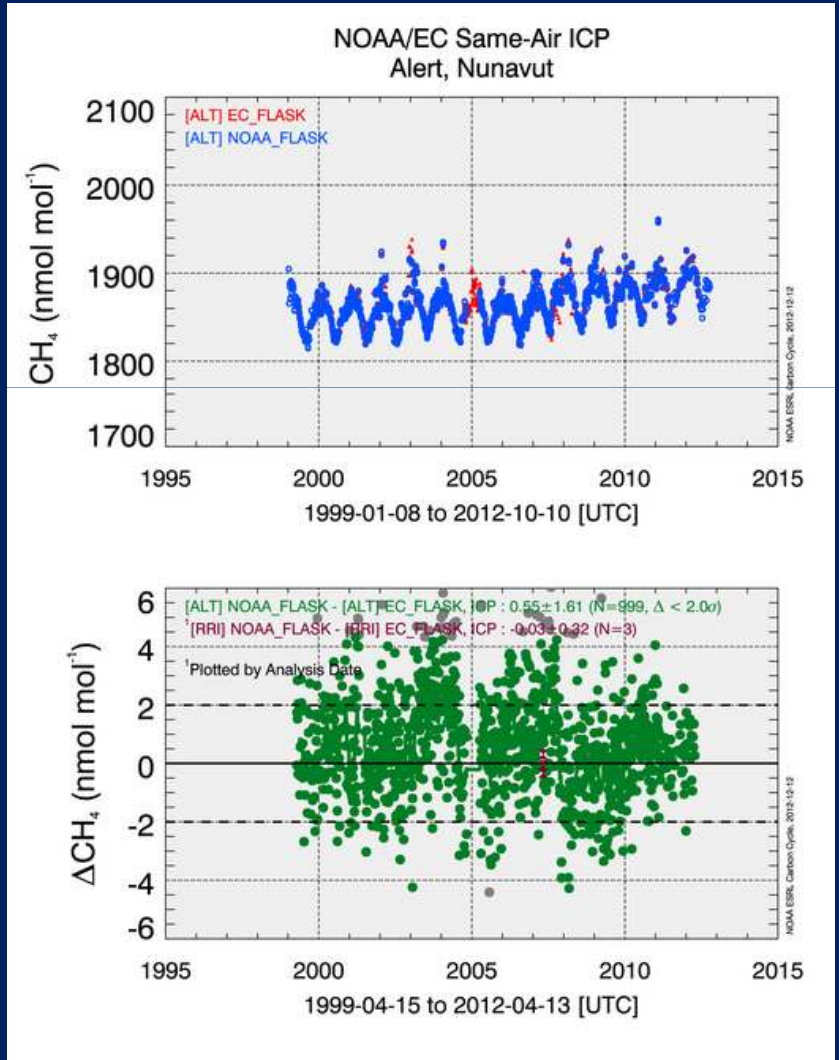
NOAA's role in Compatibility

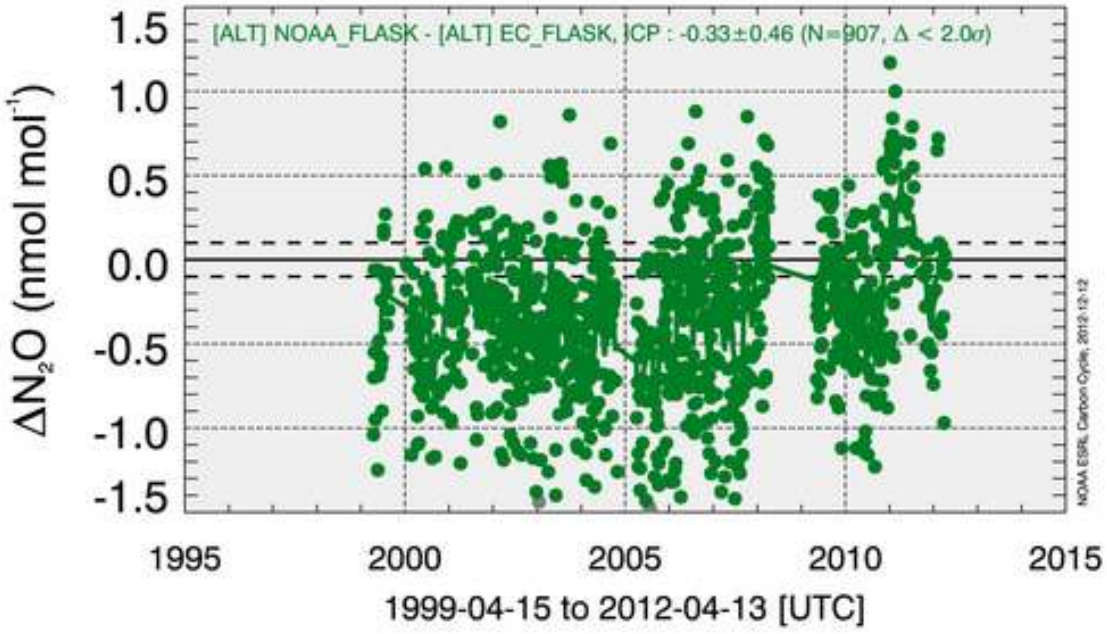
- GAW recommends we participate in comparisons
  - Us them as a source of quality control
  - NEVER use them to correct measurements
- Organize ongoing comparisons of samples (ICP)
  - Same air – each lab analyzes same sample
  - Co-located sampling – e.g., comparison of discrete sample with in situ measurement
  - Maintain DB – summarize results

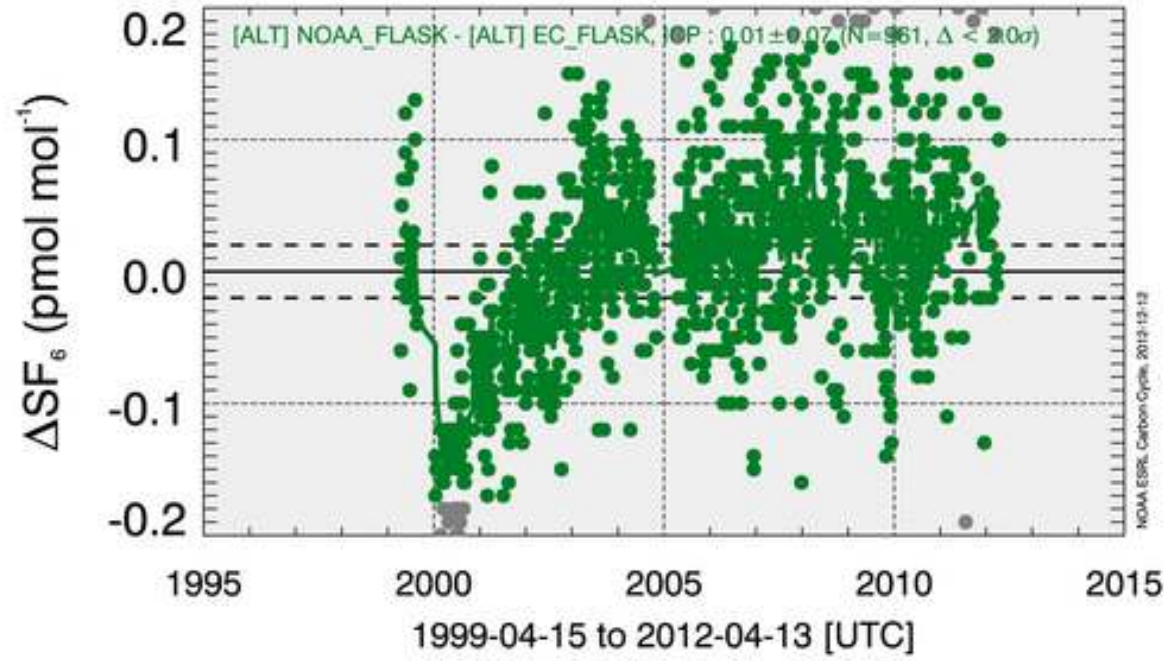
Assessing Compatibility

Participate in ongoing comparisons of air samples



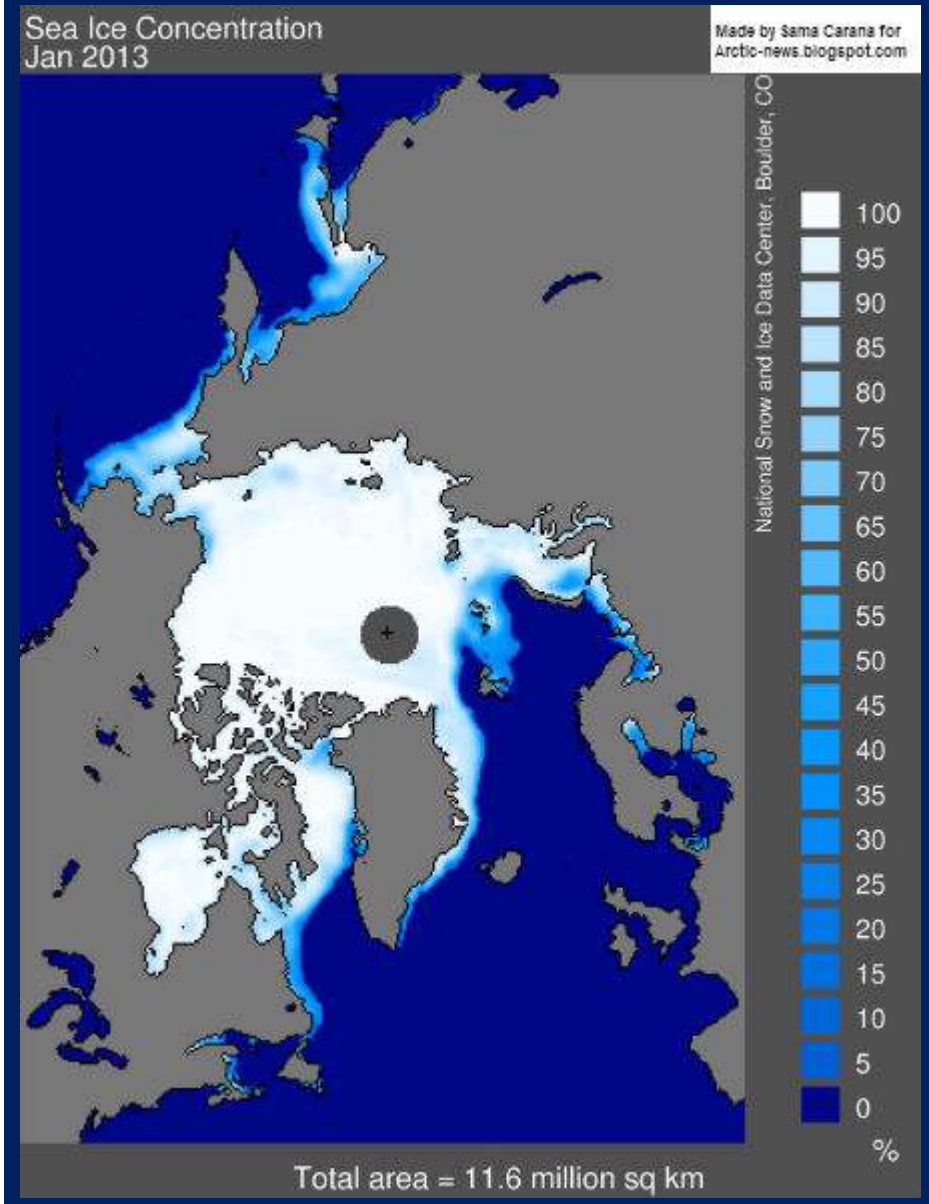


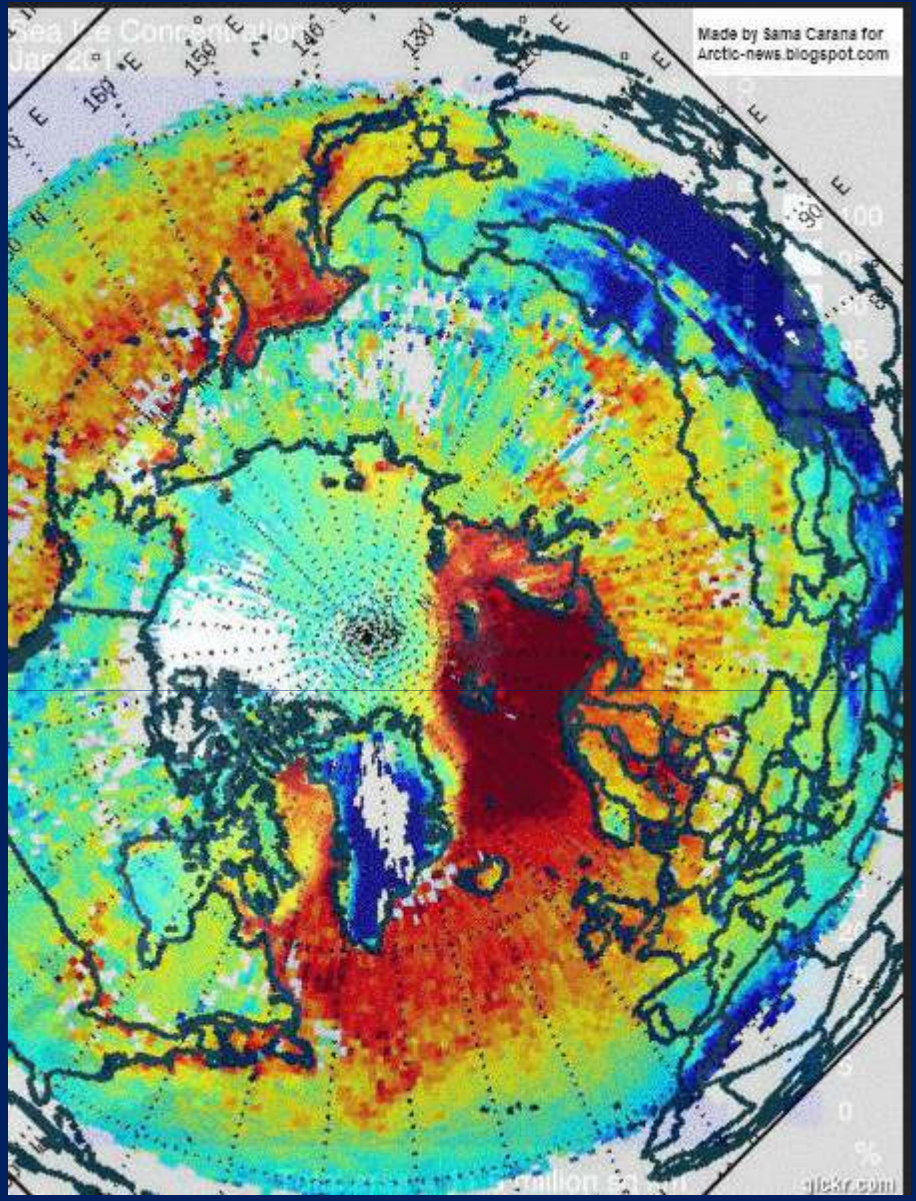

[ALT] NOAA_FLASK - [ALT] EC_FLASK, CP : -0.33±0.46 (N=907, Δ < 2.0σ)
ΔN2O (nmol mol-1)
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
1995
2000
2005
2010
2015
1999-04-15 to 2012-04-13 [UTC]
NOAA ESRL Carbon Cycle, 2012-12-12


[ALT] NOAA_FLASK - [ALT] EC_FLASK, CP : 0.01±0.07 (N=961, Δ < 2.0σ)
ΔSF6 (pmol mol-1)
0.2
0.1
0.0
-0.1
-0.2
1995
2000
2005
2010
2015
1999-04-15 to 2012-04-13 [UTC]
NOAA ESRL Carbon Cycle, 2012-12-12

Conclusions

- Climate change is a global problem
- We must work with a cooperative spirit to produce globally-consistent high-quality LLGHG data that will be useful in advancing climate change science





NSIDC: Sea Ice Loss (%)

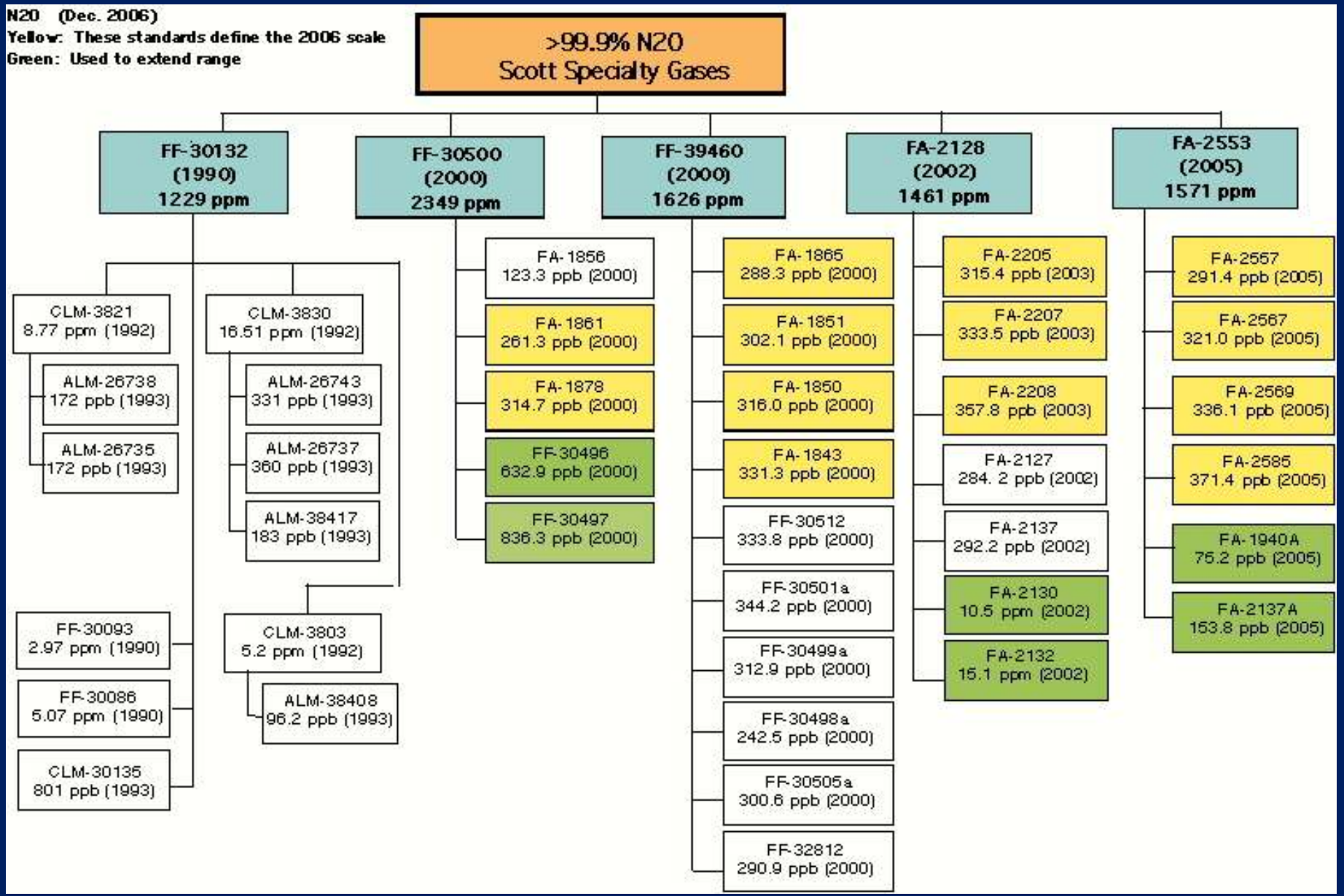
1780

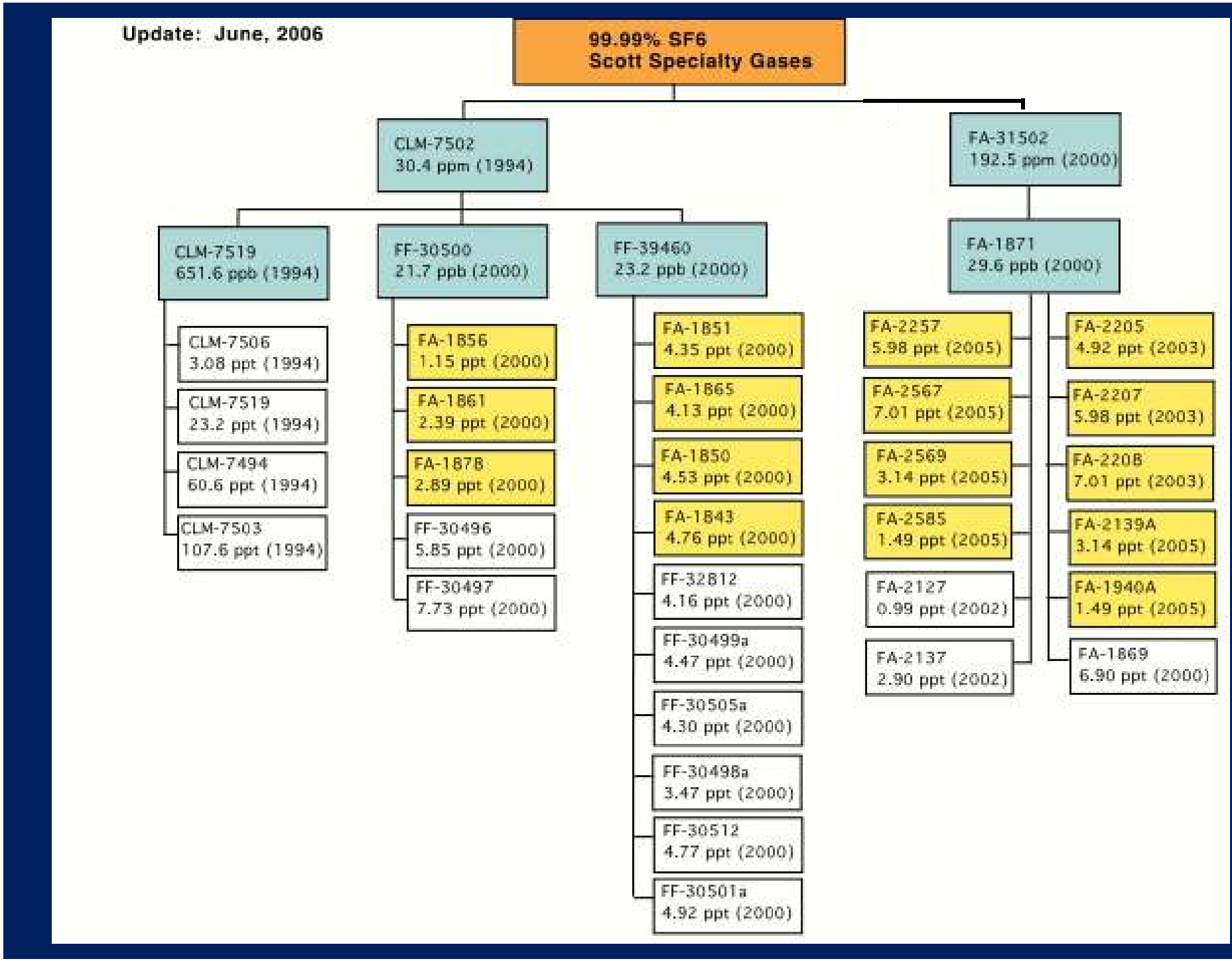
1920

AIRS CH_4: ppb

http://arctic-news.blogspot.co.uk/2013/02/...

http://www.esrl.noaa.gov/gmd/ccl/index.html




Update: June, 2006
99.99% SF6
Scott Specialty Gases
CLM-7502
30.4 ppm (1994)
FA-31502
192.5 ppm (2000)
CLM-7519
651.6 ppb (1994)
FF-30500
21.7 ppb (2000)
FF-39460
23.2 ppb (2000)
FA-1871
29.6 ppb (2000)
CLM-7506
3.08 ppt (1994)
CLM-7519
23.2 ppt (1994)
CLM-7494
60.6 ppt (1994)
CLM-7503
107.6 ppt (1994)
FA-1856
1.15 ppt (2000)
FA-1861
2.39 ppt (2000)
FA-1878
2.89 ppt (2000)
FF-30496
5.85 ppt (2000)
FF-30497
7.73 ppt (2000)
FA-1851
4.35 ppt (2000)
FA-1865
4.13 ppt (2000)
FA-1850
4.53 ppt (2000)
FA-1843
4.76 ppt (2000)
FF-32812
4.16 ppt (2000)
FF-30499a
4.47 ppt (2000)
FF-30505a
4.30 ppt (2000)
FF-30498a
3.47 ppt (2000)
FF-30512
4.77 ppt (2000)
FF-30501a
4.92 ppt (2000)
FA-2257
5.98 ppt (2005)
FA-2567
7.01 ppt (2005)
FA-2569
3.14 ppt (2005)
FA-2585
1.49 ppt (2005)
FA-2127
0.99 ppt (2002)
FA-2137
2.90 ppt (2002)
FA-2205
4.92 ppt (2003)
FA-2207
5.98 ppt (2003)
FA-2208
7.01 ppt (2003)
FA-2139A
3.14 ppt (2005)
FA-1940A
1.49 ppt (2005)
FA-1869
6.90 ppt (2000)