WMO approach to high quality measurements of atmospheric composition

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WEATHER CLIMATE WATER
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Organisation météorologique mondiale

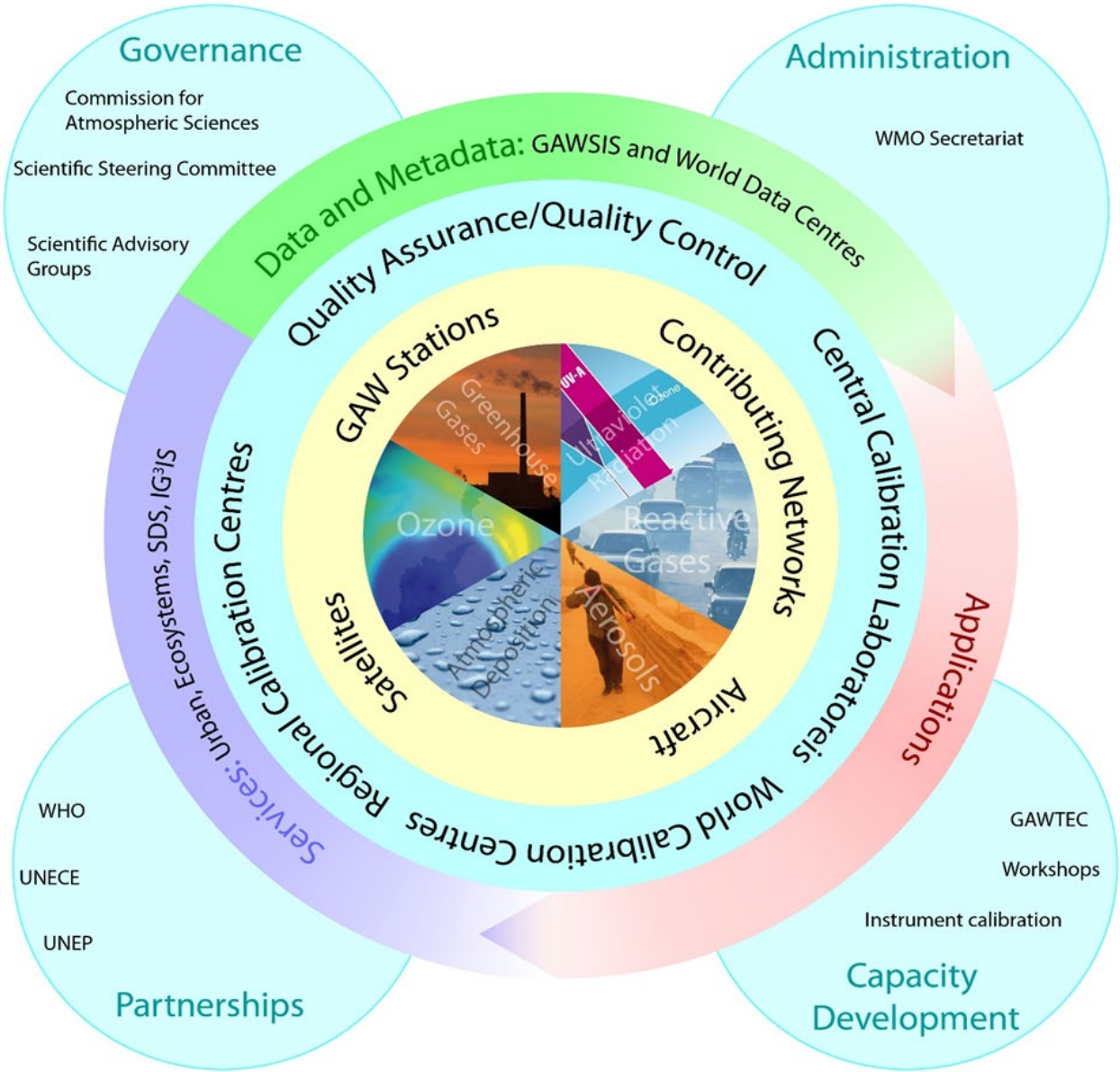
GAW

Global Atmosphere Watch

GAW is a research programme of the WMO that provides international leadership in research and capacity development in atmospheric composition observations and analysis through:

- *maintaining and applying long-term systematic observations of the chemical composition and related physical characteristics of the atmosphere,*
- *emphasizing quality assurance and quality control,*
- *delivering integrated products and services related to atmospheric composition of relevance to users.*

GAW Implementation Plan: “science for services”



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“Health” of the observational network

GAW Station Information System (GAWSIS)

GAW in-situ observational network comprises:

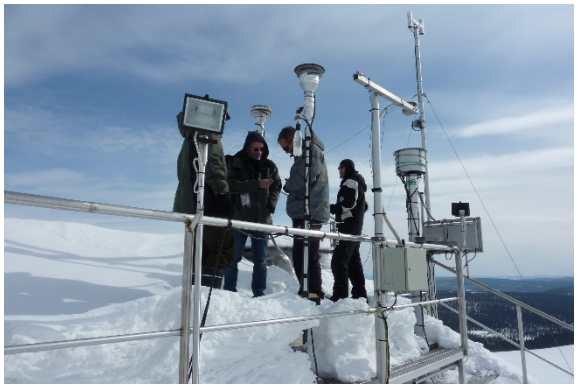
- Global stations (31)
- Regional stations
- Local stations
- Mobile platform
- Contributing networks (11)

There are defined requirements and procedures for the GAW stations

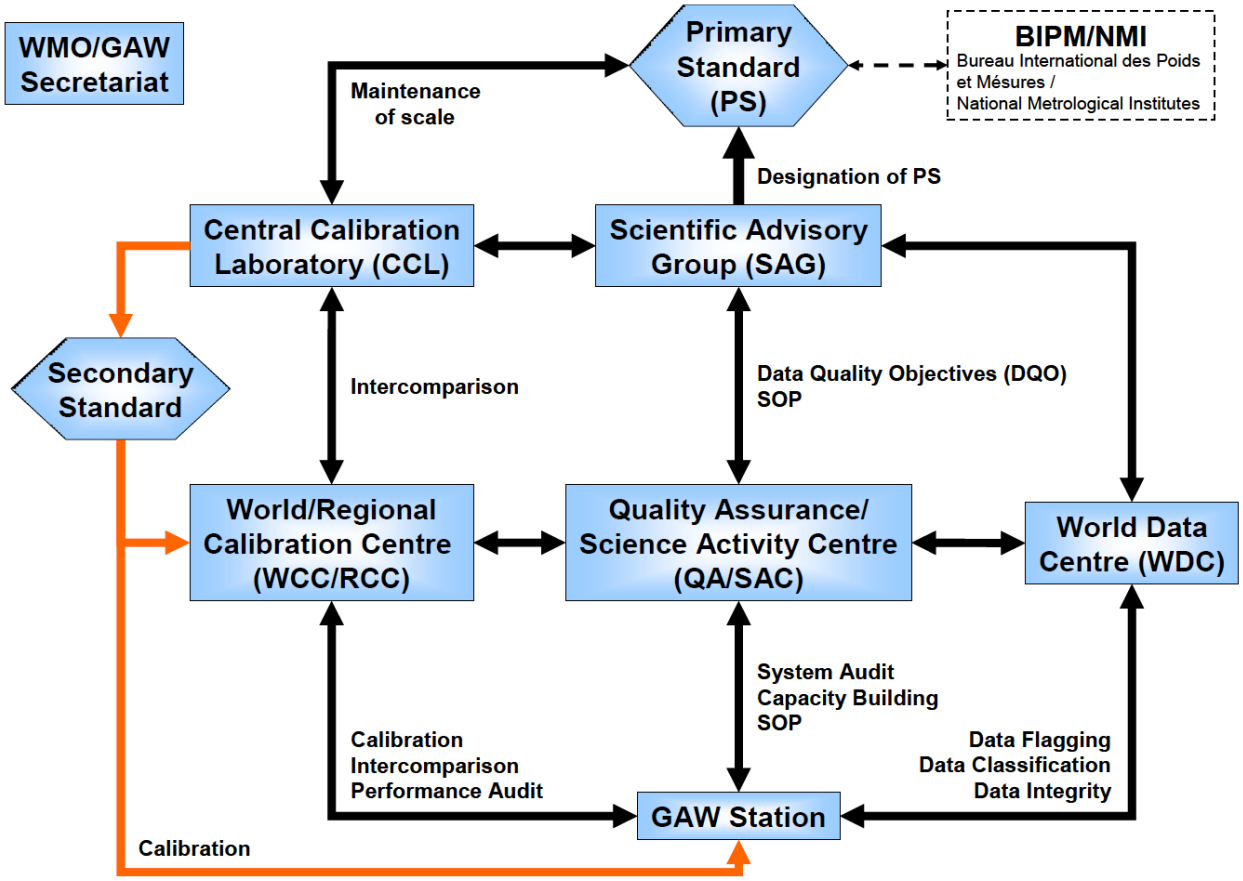
Elements of the GAW Quality Assurance Framework

The following activities are included in the GAW Quality Management Framework:

- assessment of infrastructures, operations and the quality of observations at the sites,
- development of documentation in support of the quality assurance system,
- establishment and support of infrastructure for network wide implementation of quality assurance and quality control (QA/QC) actions,
- documentation of data submitted to the World Data Centres (WDCs),
- training of station personnel, and
- improvement of the quality and documentation of legacy data at the WDCs.



Quality Assurance/Quality Control Concept



- One reference standard or scale
- The definition of data quality objectives (DQOs)
- Establishment of guidelines on how to meet these quality targets (MGs and SOPs)
- Timely submission of data and associated metadata to the responsible World Data Centre
- Support GCOS Climate Monitoring principles

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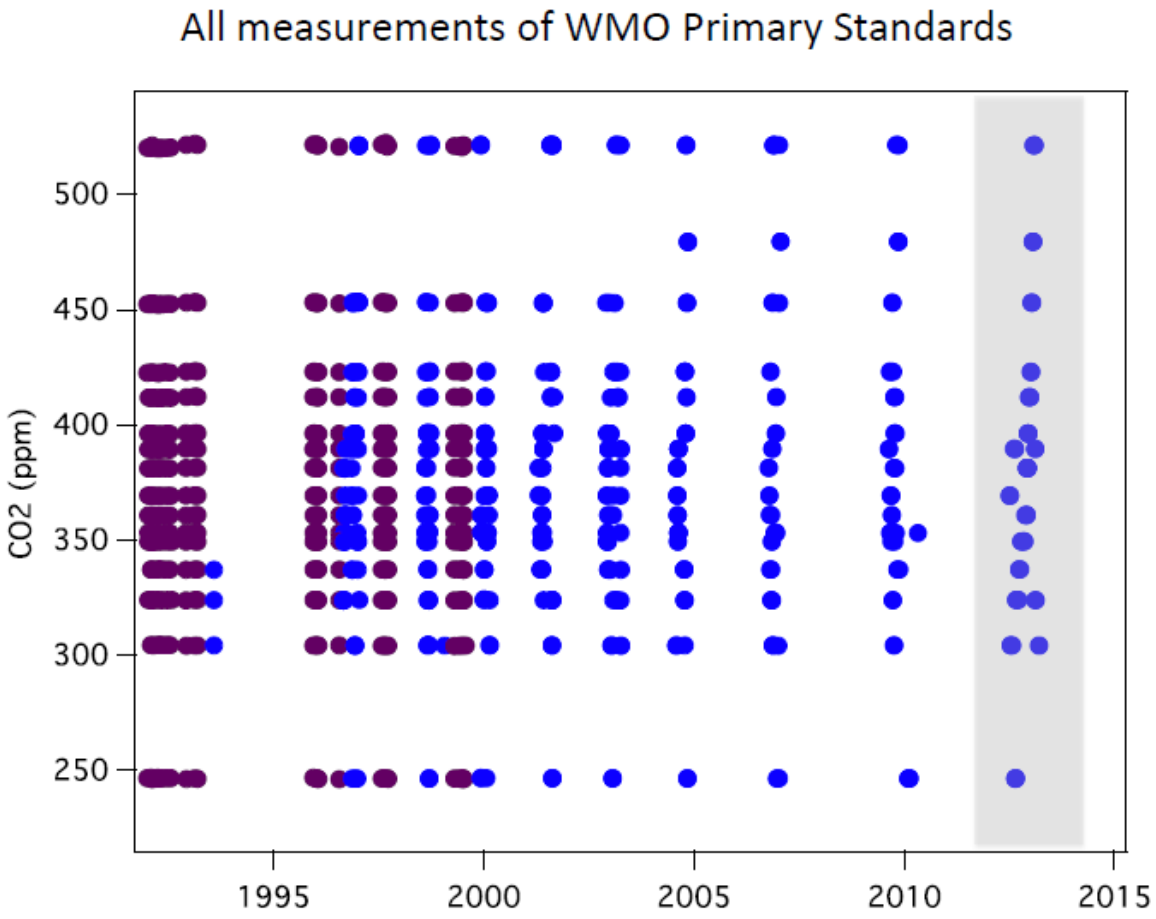
Complexity of GAW QA implementation

- GAW has six groups of variables with completely different properties: (long-lived gases, short-lived gases, total column, physical properties of aerosols, chemical properties of aerosols, chemical composition of aerosols and rain water)
- Different variables allow for different traceability chain
- Different groups express requirements in a different way

Central Calibration Laboratories are responsible to support the network reference (standard or scale)

Stability of WMO Mole Fraction Scale for CO_2



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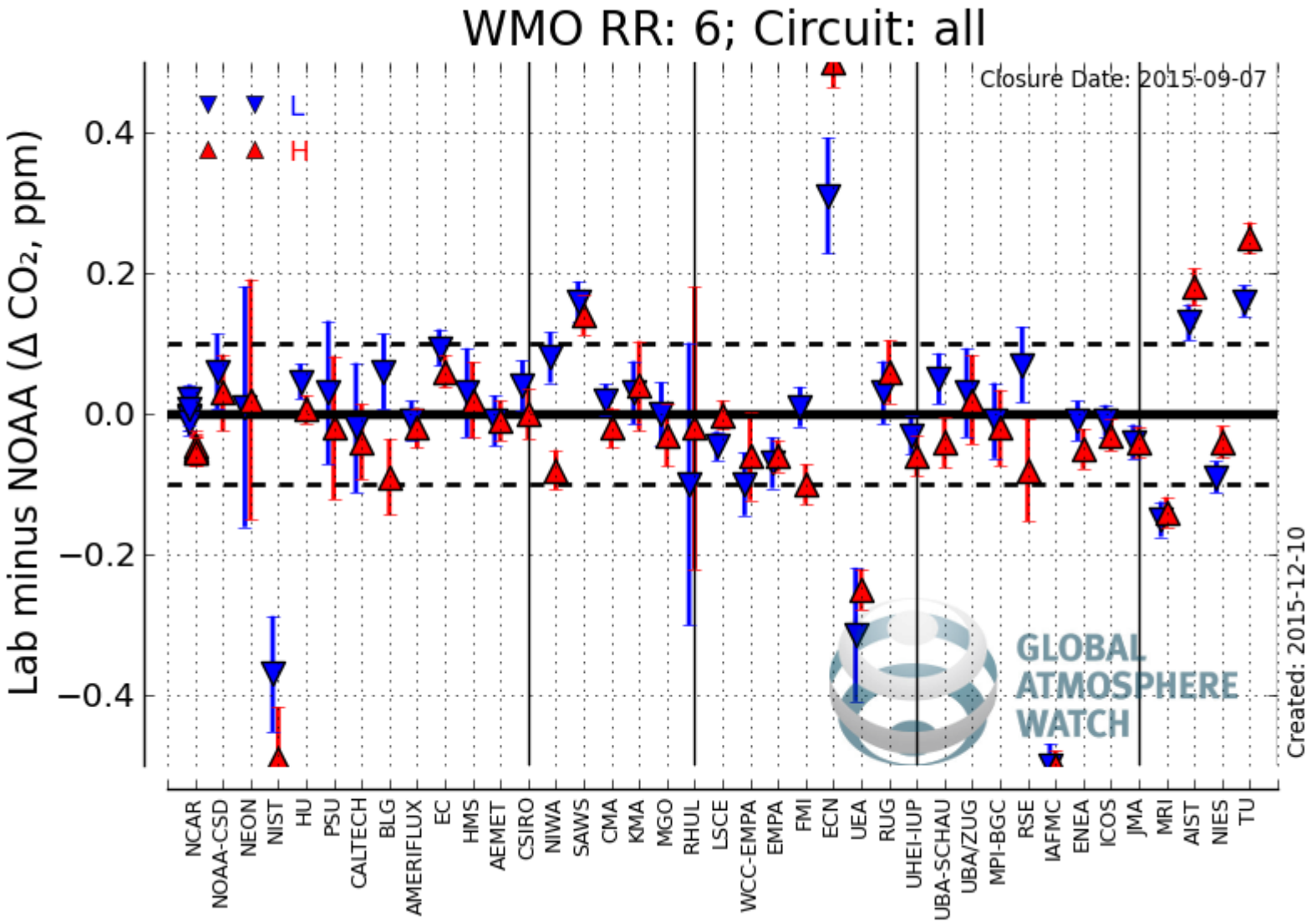
Courtesy of B.Hall

20th WMO/IAEA Meeting on Carbon Dioxide, Other Greenhouse Gases, and Related Measurement Techniques (GGMT-2019)

Component	Network compatibility goal[1]	Extended network compatibility goal[2]	Range in unpolluted troposphere (approx. range for 2017)	Range covered by the WMO scale
CO_2	0.1 ppm (NH) 0.05 ppm (SH)	0.2 ppm	380 - 450 ppm	250 – 520 ppm
CH_4	2 ppb	5 ppb	1750 – 2100 ppb	300 – 5900 ppb
CO	2 ppb	5 ppb	30 – 300 ppb	30 - 500 ppb
N_2O	0.1 ppb	0.3 ppb	325 – 335 ppb	260 – 370 ppb
SF_6	0.02 ppt	0.05 ppt	8 – 10 ppt	2.0 – 20 ppt
H_2	2 ppb	5 ppb	400 – 600 ppb	140 −1200 ppb
$\delta^{13}C\text{-}CO_2$	0.01‰	0.1‰	-9.5 to -7.5‰ (VPDB)	
$\delta\ ^{18}O\text{-}CO_2$	0.05‰	0.1‰	-2 to +2‰ (VPDB-CO_2)	
$\delta\ ^{13}C\text{-}CH_4$	0.02‰	0.2‰	-51 to -46‰ (VPDB)	
$\delta\ ^{2}H\text{-}CH_4$	1‰	5‰	-120 to -63‰ (VSMOW)	
$\Delta^{14}C\text{-}CO_2$	0.5‰	3‰	-50 to 50‰	
$\Delta\ ^{14}C\text{-}CH_4$	0.5‰		50-350‰	
$\Delta\ ^{14}C\text{-}CO$	2 molecules cm^{-3}		0-25 molecules cm^{-3}	
O_2/N_2	2 per meg	10 per meg	-900 to -400 per meg (vs. SIO scale)	

6th WMO Round Robin comparison



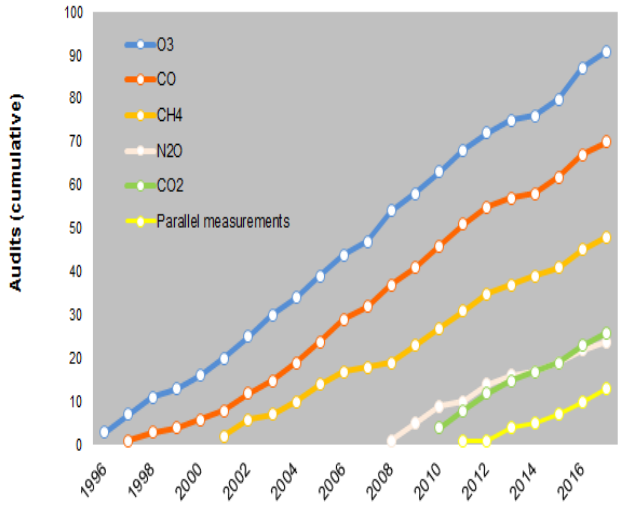
7th Round Robin comparison

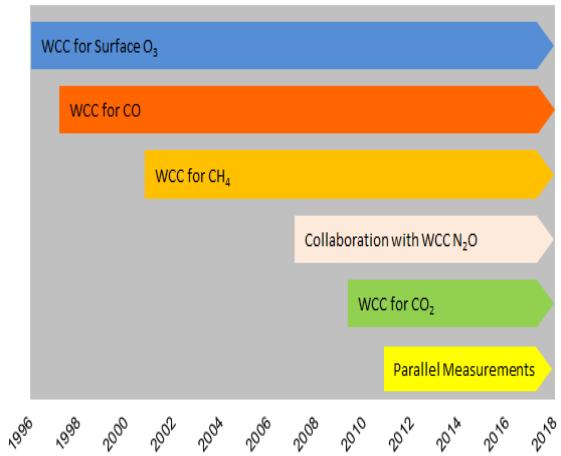
- The 7th WMO/GAW Round Robin Comparison Experiment for greenhouse gases will commence in 2019
- The WMO Round Robin involves a series of aluminum cylinders containing natural air, circulated among a number of laboratories. NOAA serves as the coordinator and analyzes all cylinders
- While the primary focus of the Round Robin experiment is CO_2, many laboratories also report CH_4, CO, N_2O, and SF_6, and some report O_2/N_2, and $\delta^{13}C$ and $\delta^{18}O$ of CO_2.

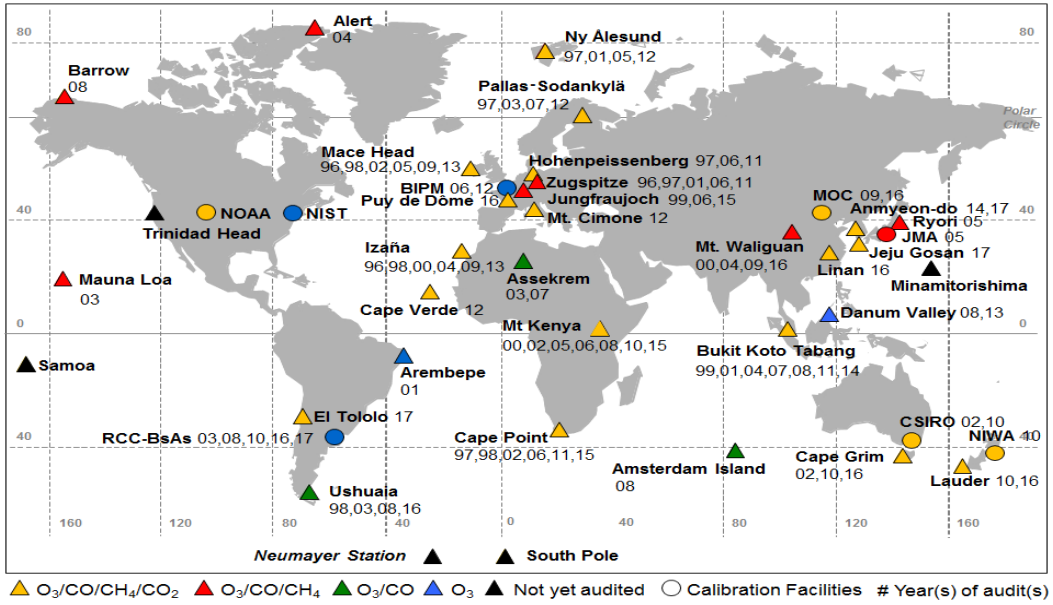
For RR #7, O_2/N_2, and $\delta^{13}C$ and $\delta^{18}O$ of CO_2 will be handled separately (via separate cylinders or designated circuits).

Network wide quality control

- World Calibration Centre for Surface O_3, CO, CH_4, and CO_2 (WCC-Empa)







- established in 1996, more than 90 audits since then
- ensures traceability to the GAW reference and determines compatibility
- assists stations with regards to instruments and measurement issues (WCC-Empa & QA/SAC-CH)
- improves technical know-how at stations through on-site training (WCC-Empa & QA/SAC-CH)

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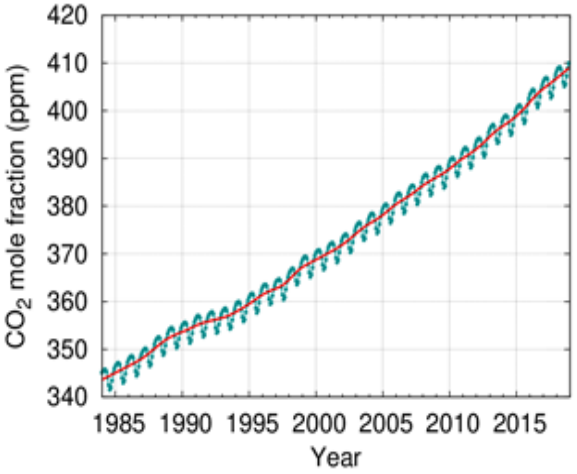
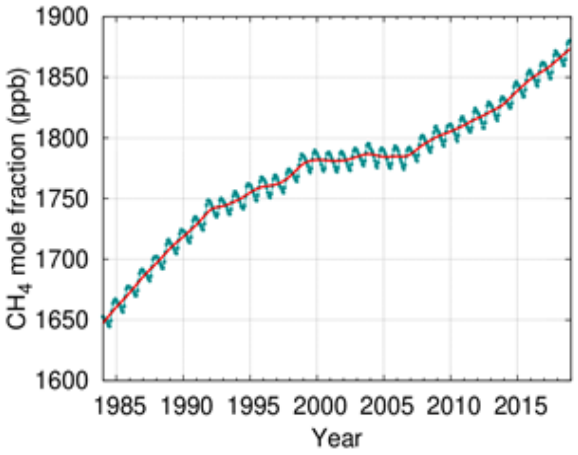
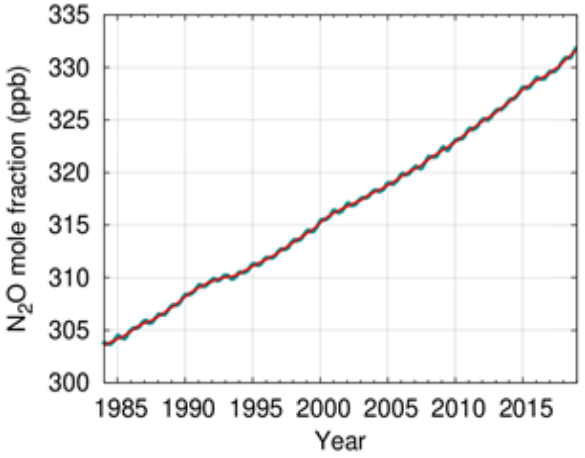
Levels of the main greenhouse gases







	CO_2	CH_4	N_2O
2018 global mean abundance	**407.8 ± 0.1 ppm**	**1869 ± 2 ppb**	**331.1 ± 0.1 ppb**
2018 abundance relative to year 1750[a]	**147%**	**259%**	**123%**
2017-18 absolute increase	**2.3 ppm**	**10 ppb**	**1.2 ppb**
Mean annual absolute increase of last 10 years	**2.26 ppm yr^{-1}**	**7.1 ppb yr^{-1}**	**0.95 ppb yr^{-1}**

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Low Cost Sensors Statement

- Based on peer-reviewed publications through 2017
- Applications of sensors, definitions, sensor performance, evaluation exercises and facilities, quality assurance , conclusions and recommendations
- Covers on-line sensors for:
  - Reactive gases or other air pollutants including NO, NO_2, O_3, CO, SO_2, and total VOCs.
  - Long-lived greenhouse gases: CO_2 and CH_4
  - Airborne particulate matter (PM)

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To share your experience, publications and related meetings please use the LCS forum **https://wmoairsensor.discussion.community/**

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Observations in GAW

- Can be used directly as observational evidences for environmental policy
- Can be used to study the processes that drive atmospheric composition changes
- Can be combined with inverse modelling tools to understand fluxes/emissions
- Can be used for initiation of the forecasts and verification

Many of the GAW observations are supported by the Research Infrastructures
(ACTRIS, ICOS, IAGOS)

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Thank you
Merci

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