WMO/GAW observation system and greenhouse gases

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The rationale for Global Atmosphere Watch (GAW) is driven by the need :

- to understand the complex mechanisms with respect to natural and anthropogenic atmospheric change;
- improve the understanding of interactions between the atmosphere, ocean and biosphere;
- provide **reliable** scientific data and information for national and international policy makers.

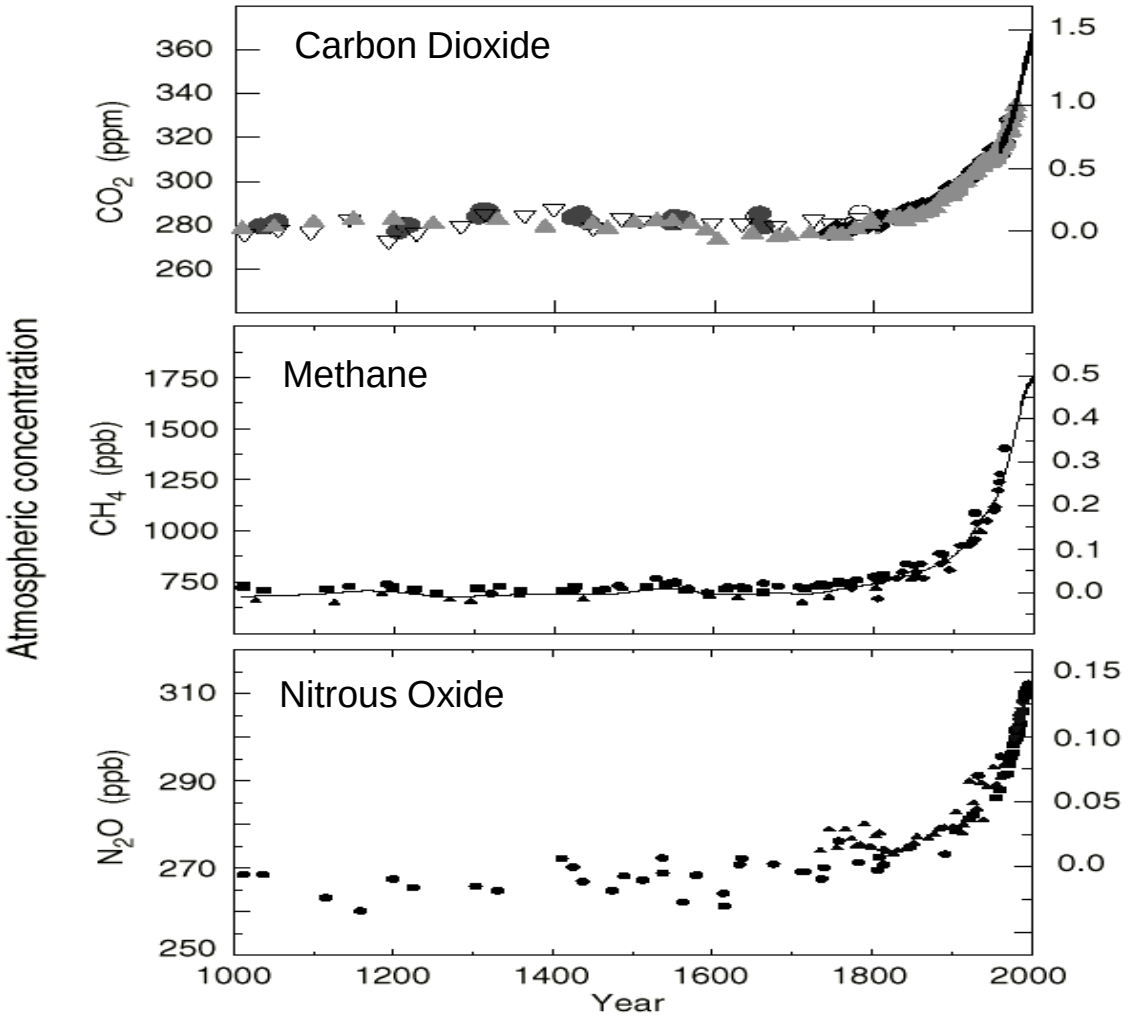
GAW Strategy in achieving the goals is presented in the GAW Strategic Plan : 2008-2015

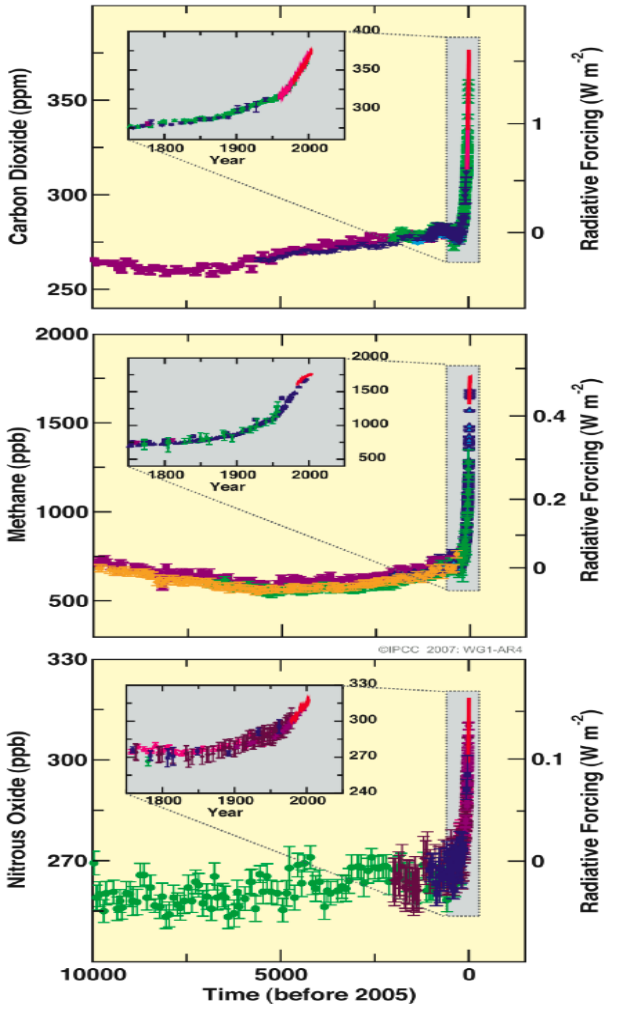
What is GAW?

- WMO/GAW was established 1989 by merging GO_3OS and BAPMoN.
- GAW focuses on global networks for **GHGs, ozone, UV, aerosols, selected reactive gases, and precipitation chemistry**.
- GAW is a partnership involving contributors from 80 countries.
- GAW is coordinated by the Environment Division of WMO/AREP under the purview of WMO Commission for Atmospheric Science (CAS)
- Currently GAW coordinates activities and data from 27 Global stations, 413 Regional stations, and 164 Contributing stations (http://gaw.empa.ch/gawsis/)

Global GAW stations

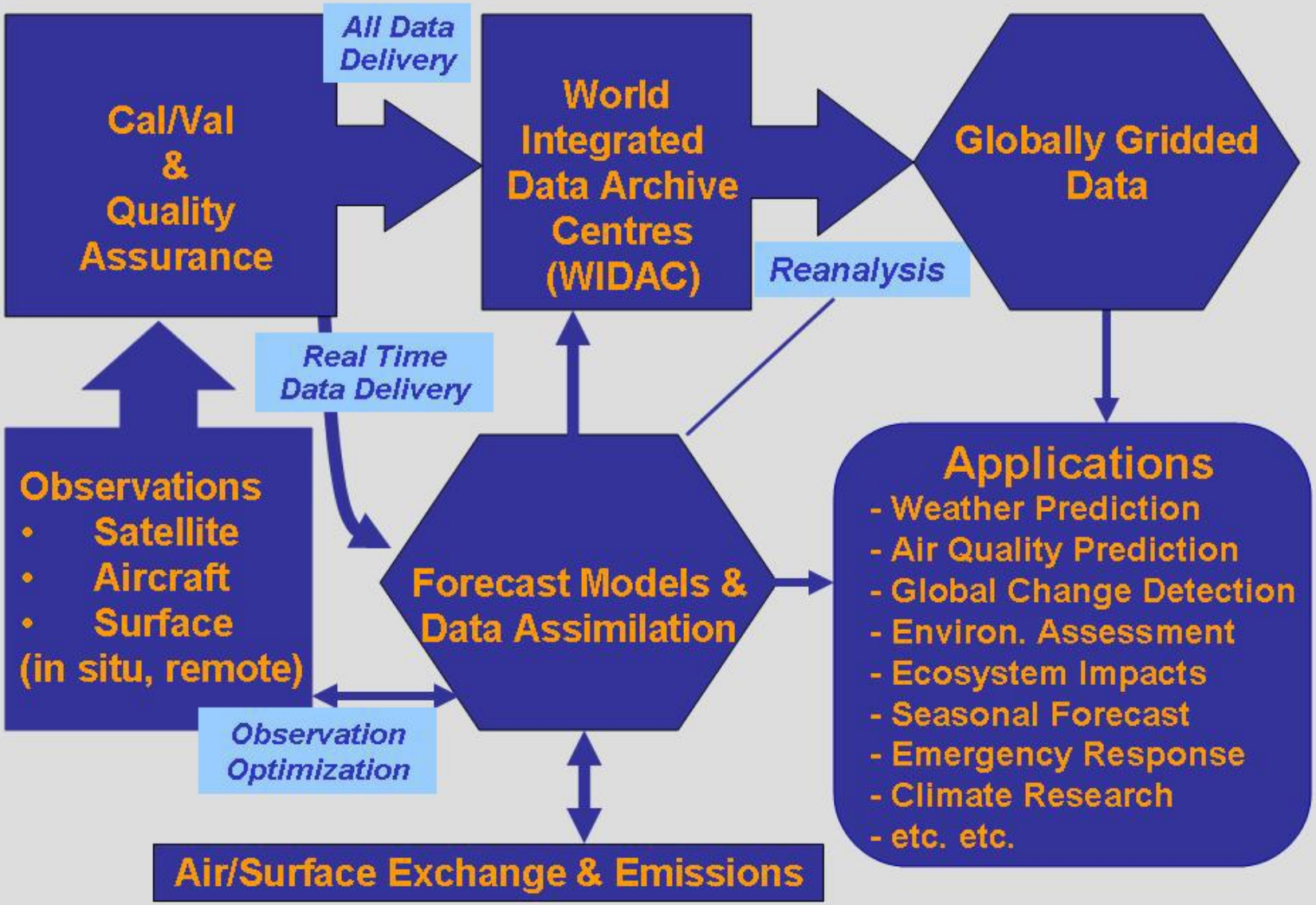
Long records of Carbon Dioxide (CO_2), Methane (CH_4), and Nitrous Oxide (N_2O) concentrations all show sharp increases



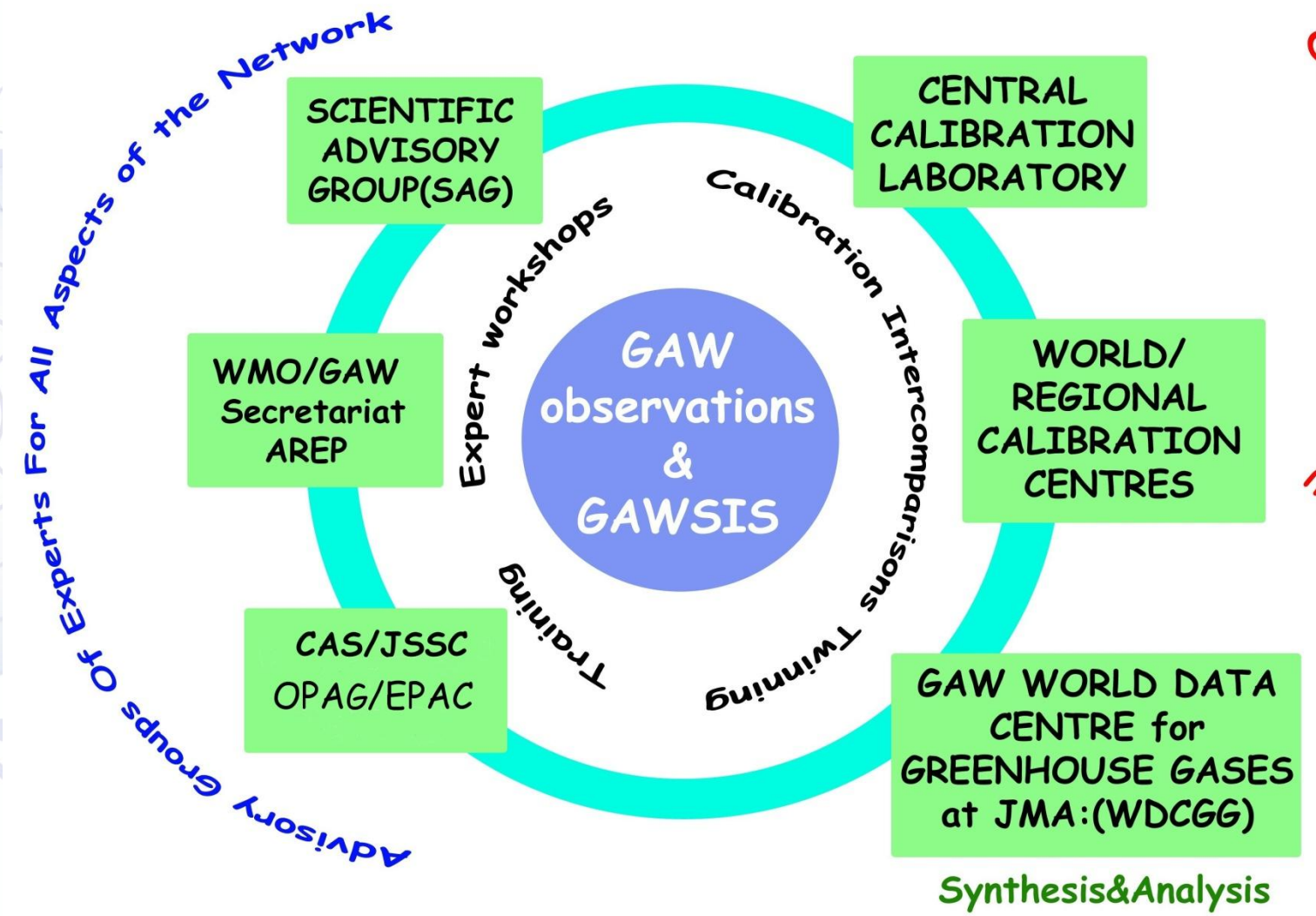


Measurements before about 1960 are mostly from bubbles trapped in glacial ice. After that, WMO- coordinated instrumental observations abound.

Components: Integrated Atmospheric Observations System



GAW Global CO_2 & CH_4 Monitoring Network Components

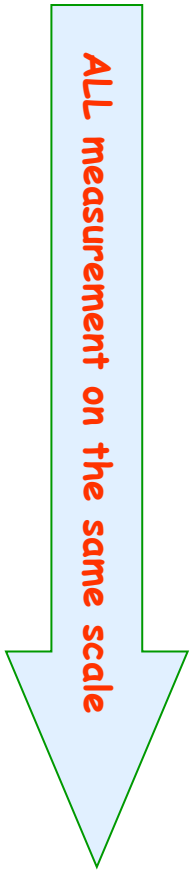


An Observational Network with Global Coverage

GAW Surface-Based In Situ (continuous and flask) and Routine Commercial Aircraft Observations

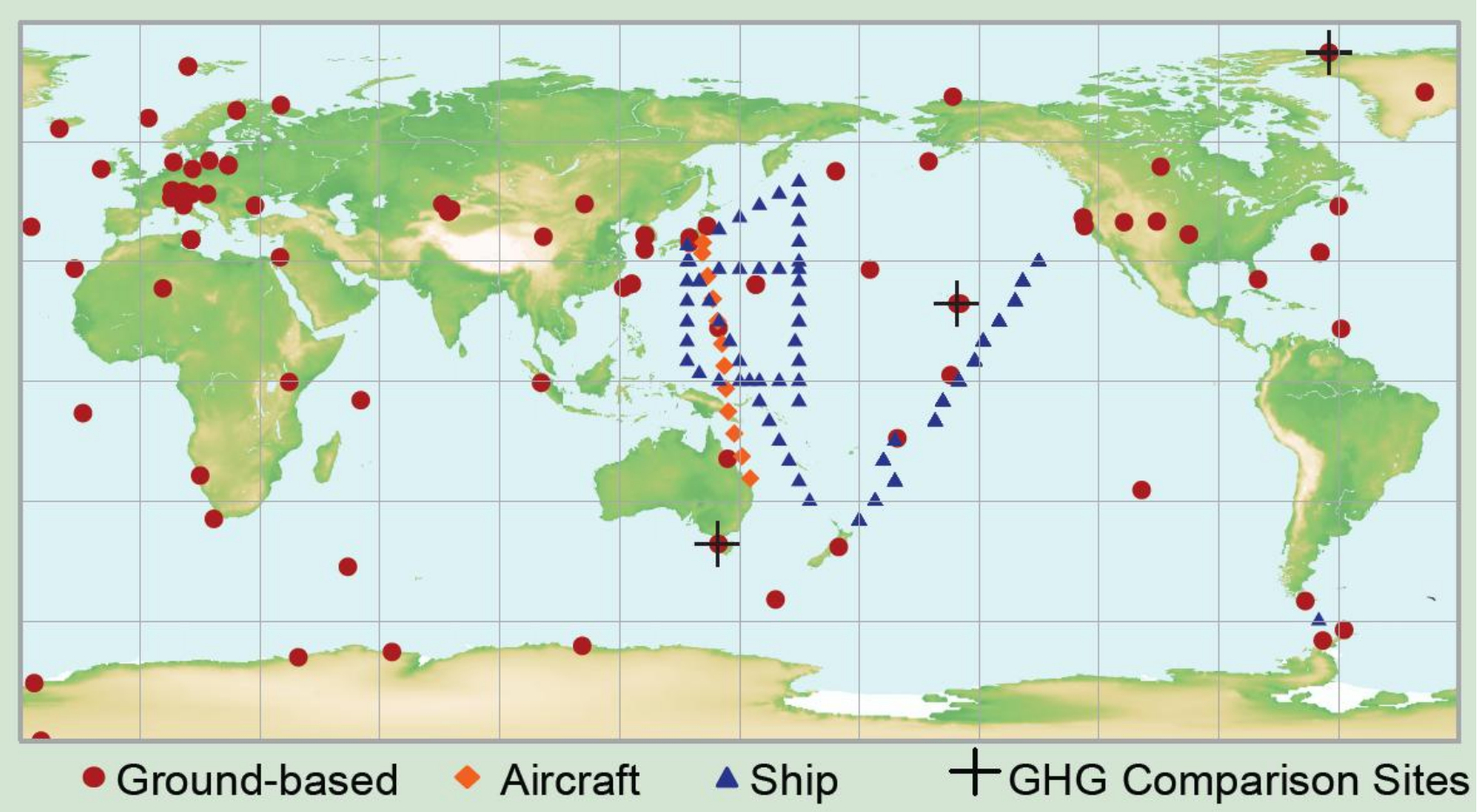
Contributing surface based networks (AGAGE, TCCON)

Contributing Aircraft and Satellite measurements



Integrated observations by means of models
Data products and assessments

The WMO-GAW global network for carbon dioxide



The network for methane is similar to this.

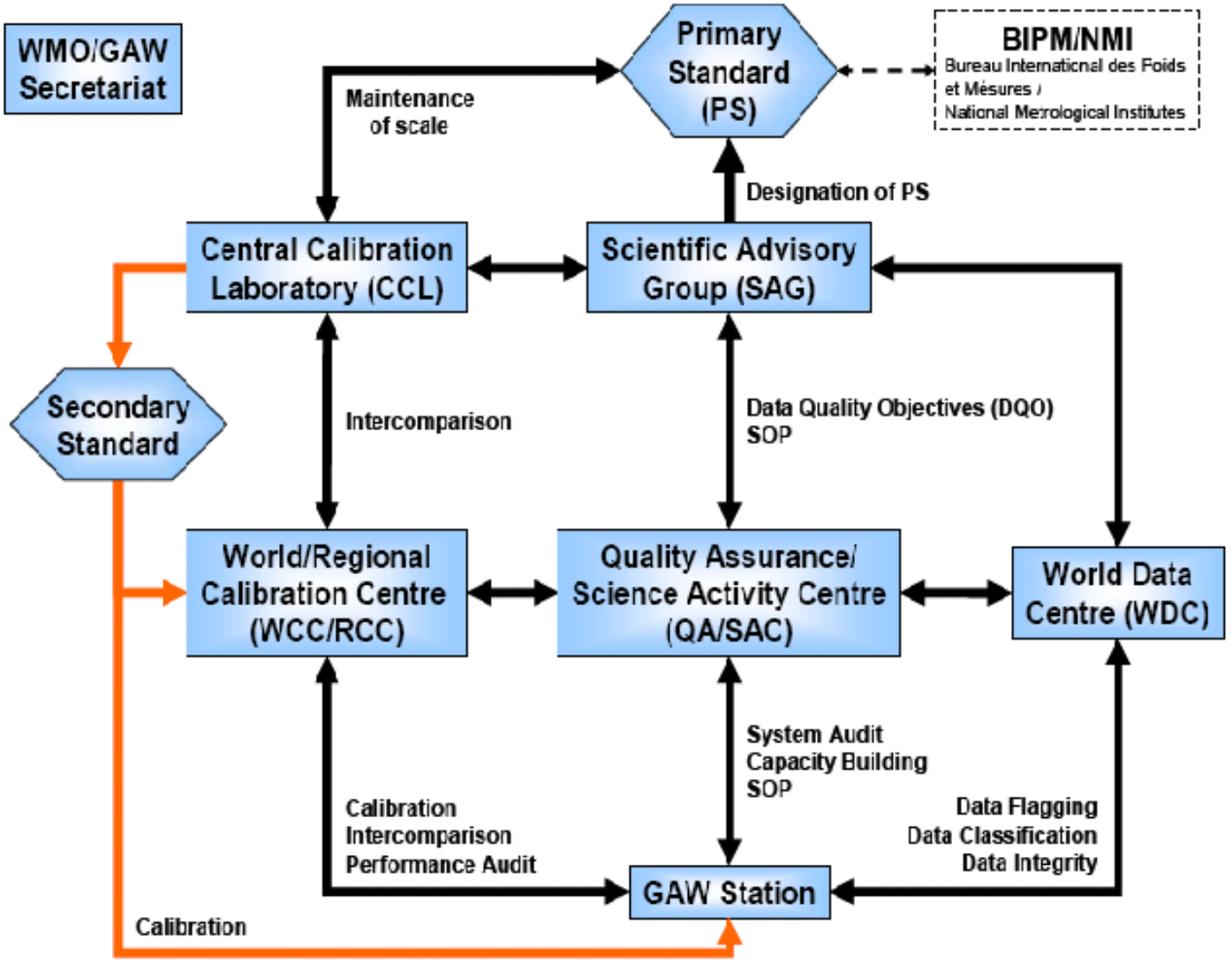
Forty-four countries contributed CO_2 data to the GAW WDCGG. Approximately 50% of the measurement records are obtained at sites in the NOAA ESRL cooperative air sampling network.

Need for quality control

- Detect small trends (through DQO)
- Detect small spatial gradients
- Ensure long-term stability of observations
- Data comparability (on the same scale)

comparability: comparability of measurement results that are metrologically traceable to the same reference
compatibility: difference of any pair of values from different measurement results (should be) smaller than some chosen uncertainty of that difference

Conceptual framework of the GAW quality system



Central Facilities

Five types of central facilities:

- Central Calibration Laboratories (CCLs)
- Quality Assurance/Science Activity Centres (QA/SACs)
- World Calibration Centres (WCCs)
- Regional Calibration Centres (RCCs)
- World Data Centres (WDCs)

Recommended compatibility of GHG measurements in the GAW programme (DQOs)

Component	Compatibility goal	range in the unpolluted troposphere
CO_2	± 0.1 ppm (± 0.05 ppm in the southern hemisphere)	360 … 420 ppm
$\delta^{13}C\text{-}CO_2$	± 0.01 ‰	-7.5 … -9 ‰ vs. VPDB
$\delta^{18}O\text{-}CO_2$	± 0.05 ‰	-2 … +2‰ vs. VPDB
$\Delta^{14}C\text{-}CO_2$	± 1 ‰	0 … 70‰
O_2/N_2	± 2 per meg	-250 … -550 per meg
CH_4	± 2 ppb	1700 … 2000 ppb
CO	± 2 ppb	30 … 300 ppb
N_2O	± 0.1 ppb	320 … 335 ppb
H_2	± 2 ppb	450 … 600 ppb
SF_6	± 0.02 ppt	5 … 9 ppt

Primary Standards

Central Calibration Laboratories

Hosts of WMO World Reference Standards for long-lived GHG

- CO_2, CH_4, N_2O, SF_6 -NOAA ESRL, USA
- CO_2 isotopes – MPI-Biogeochemistry, Jena
- CH_4 isotopes – not assigned
- CFCs, HCFCs, HFCs - not assigned

Quality Assurance I

World or Regional Calibration Centres

Linking Observations to World Reference Standards and Ensuring Network Comparability through intercomparison campaigns and regular audits

- CO_2 - NOAA ESRL USA
  - EMPA, Switzerland
- CH_4 - EMPA, Switzerland (Am, E/A)
  - JMA, Japan (A/O)
- N_2O - IMK-IFU Garmisch, Germany
- CFCs, HCFCs, HFCs - WCC is not assigned

Quality Assurance II

Standard measurements procedures and measurements guidelines

- CH_4 and N_2O - updated GAW report 185
- CO_2 - GAW report 134 (evolving through biennial meetings)
- CFCs, HCFCs, HFCs - MG are not established

The Guide for Data submission and dissemination (by WDCGG) is updated (GAW report 188)

Quality Assurance III

Stations twinning/ Training/Expert workshops

Twinning

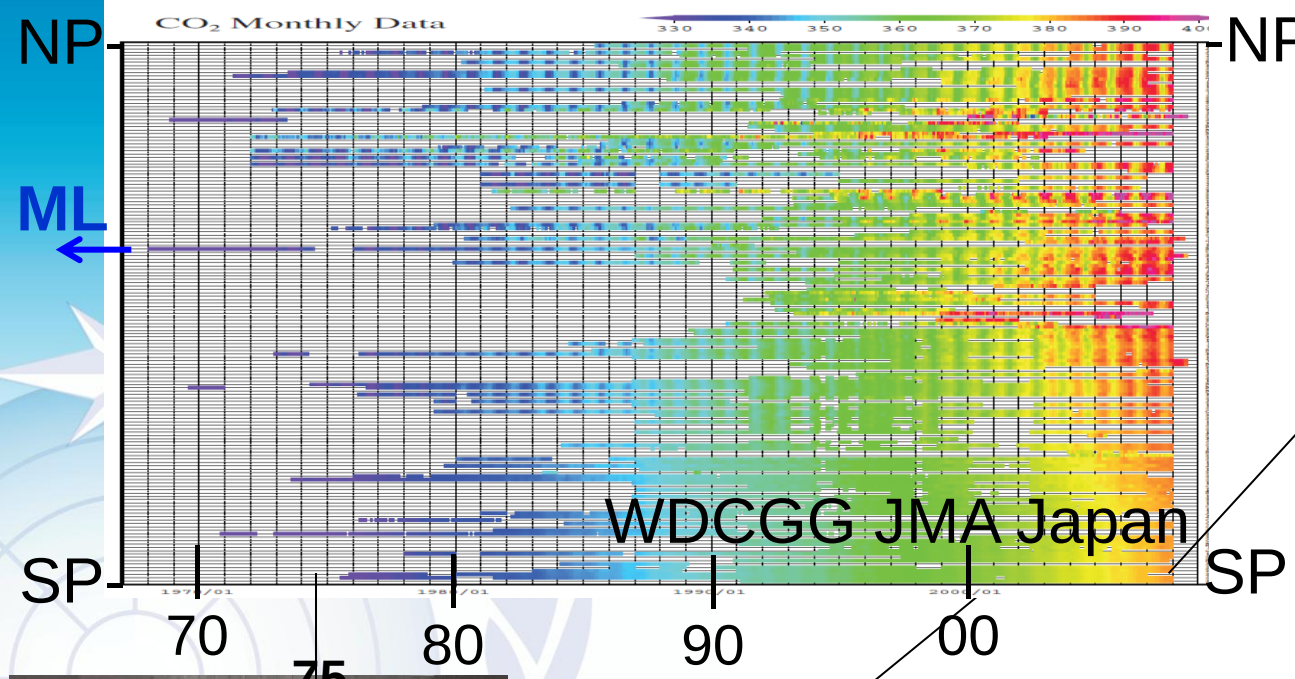
- Empa - Assekrem (Algeria), Bukit Koto Tabang (Indonesia) and Mt. Kenya (Kenya)
- The Institute for Meteorology and Climate Research, (IMK-IFU) - Cape Point (South Africa).
- NOAA (ESRL) - Ushuaia (HATS group), Tiksi (Russia) and a number of others

Training

- The GAW Training and Education Centre (GAWTEC)

Expert meetings

- Biennial WMO/IAEA Meeting of Experts on Carbon Dioxide, Other Greenhouse Gases, and Related Tracer Measurement Techniques (since 1975)



Jena 09

Helsinki 07

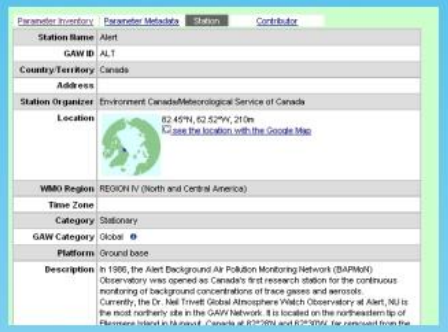
Boulder 05

Toronto 03

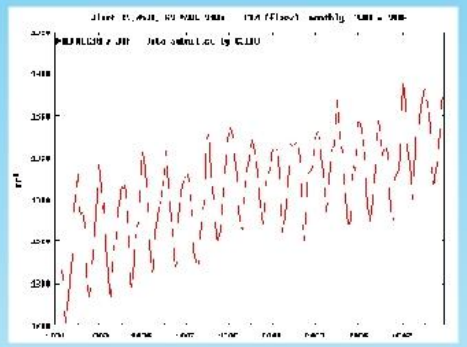
Tokyo 01

World Data Centre for Greenhouse Gases

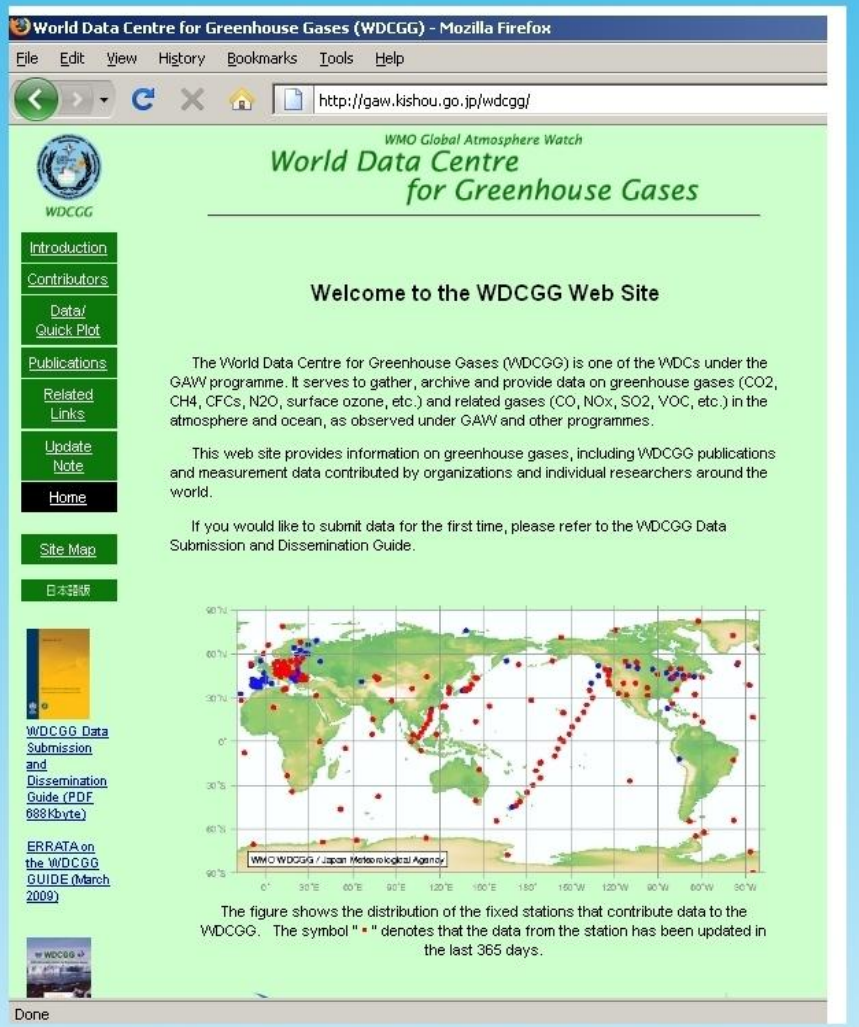
Searchable Station Directory & Metadata



Online data Plot and download



Downloadable Publications



http://gaw.kishou.go.jp/wdcgg/

World Data Centre for Greenhouse Gases

WDCGG

WMO Global Atmosphere Watch

World Data Centre for Greenhouse Gases

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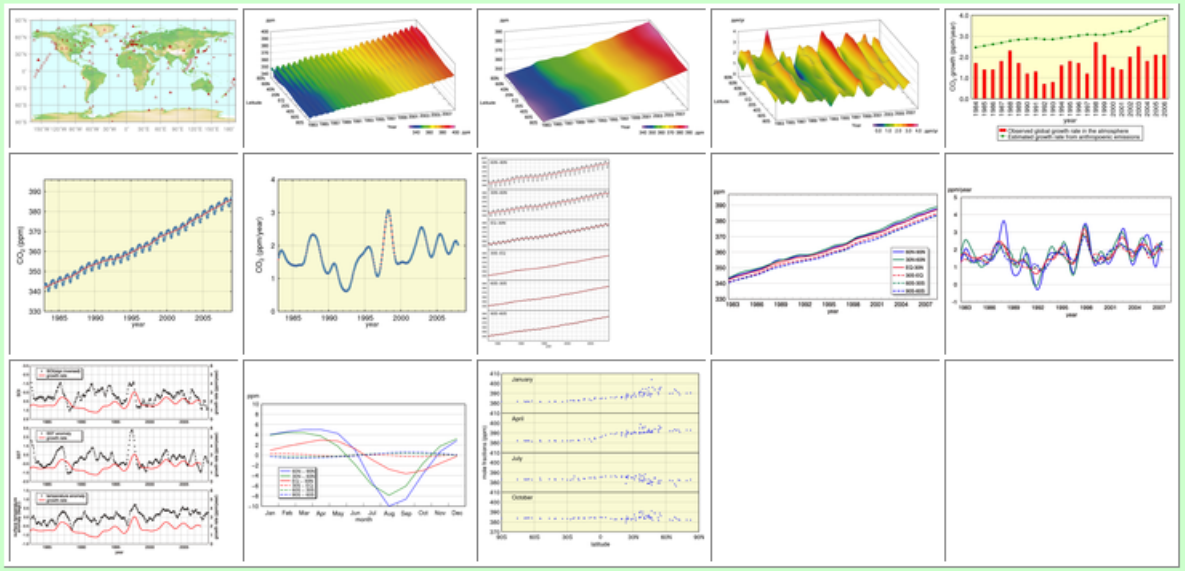
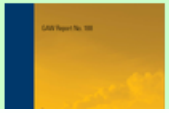
Images based on the data upto 2009
WDCGG DATA SUMMARY No.34 should be referred to for explanation

CO_2	CH_4	N_2O	Halocarbons	O_3	CO	NOx	SO_2





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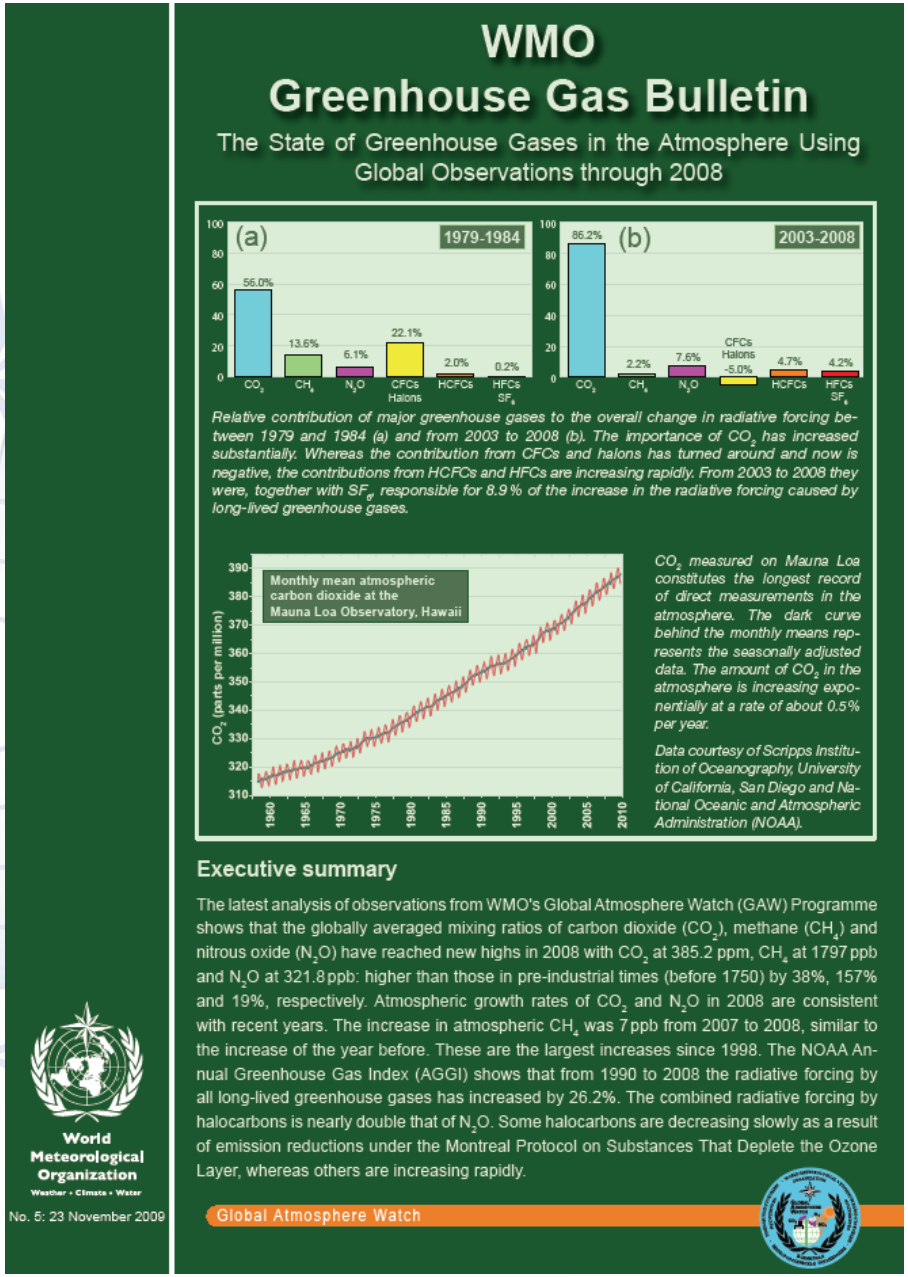

WMO

Greenhouse Gas Bulletin

The State of Greenhouse Gases in the Atmosphere Using Global Observations through 2008

Relative contribution of major greenhouse gases to the overall change in radiative forcing between 1979 and 1984 (a) and from 2003 to 2008 (b). The importance of CO_2 has increased substantially. Whereas the contribution from CFCs and halons has turned around and now is negative, the contributions from HCFCs and HFCs are increasing rapidly. From 2003 to 2008 they were, together with SF_6 responsible for 8.9 % of the increase in the radiative forcing caused by long-lived greenhouse gases.

CO_2 measured on Mauna Loa constitutes the longest record of direct measurements in the atmosphere. The dark curve behind the monthly means represents the seasonally adjusted data. The amount of CO_2 in the atmosphere is increasing exponentially at a rate of about 0.5% per year.

Data courtesy of Scripps Institution of Oceanography, University of California, San Diego and National Oceanic and Atmospheric Administration (NOAA).

Executive summary

The latest analysis of observations from WMO's Global Atmosphere Watch (GAW) Programme shows that the globally averaged mixing ratios of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) have reached new highs in 2008 with CO_2 at 385.2 ppm, CH_4 at 1797 ppb and N_2O at 321.8 ppb: higher than those in pre-industrial times (before 1750) by 38%, 157% and 19%, respectively. Atmospheric growth rates of CO_2 and N_2O in 2008 are consistent with recent years. The increase in atmospheric CH_4 was 7 ppb from 2007 to 2008, similar to the increase of the year before. These are the largest increases since 1998. The NOAA Annual Greenhouse Gas Index (AGGI) shows that from 1990 to 2008 the radiative forcing by all long-lived greenhouse gases has increased by 26.2%. The combined radiative forcing by halocarbons is nearly double that of N_2O. Some halocarbons are decreasing slowly as a result of emission reductions under the Montreal Protocol on Substances That Deplete the Ozone Layer, whereas others are increasing rapidly.

World Meteorological Organization
Weather • Climate • Water

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Global Atmosphere Watch

Annual Greenhouse Gas Bulletins

Bulletin 1 (March 2006) CO_2 global distribution

Bulletin 2 (November 2006) CH_4 global distribution

Bulletin 3 (November 2007) *NOAA's Carbon Tracker model*

Bulletin 4 (November 2008) Montreal Protocol

Bulletin 5 (November 2009) Importance of CO_2

WMO

THANK YOU