

Japan's Contributions to GAW

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Japan Meteorological Agency

WMO Global Atmosphere Watch (GAW)

What is GAW?

- **Established in 1989 by merging long-term monitoring programmes dating back to the 1970s or earlier**
- **Focuses on global networks for ozone, greenhouse gases, reactive gases, atmospheric wet deposition, UV radiation, and aerosols**
- **Coordinates activities and data from hundreds of stations, including 24 Global Stations.**

WMO/GAW Strategic Plan: 2008–2015 covers GAW's mission, long-term objectives and implementation principles, etc., consistent with the WMO Strategic Plan.

WMO Global Atmosphere Watch (GAW)

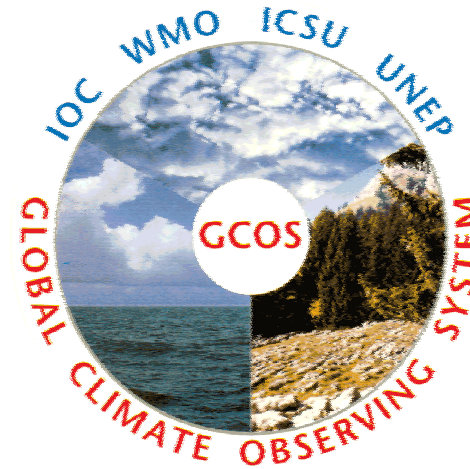
Mission of GAW

- **Reduce environmental risks to society and meet the requirements of environmental conventions.**
- **Strengthen capabilities to predict climate, weather and air quality.**
- **Contribute to scientific assessment in support of environmental policy**

To be achieved through

- **Maintaining and applying global, long-term observations of the chemical composition and selected physical characteristics of the atmosphere.**
- **Emphasizing quality assurance and quality control.**
- **Delivering integrated products and services of relevance to users.**

WMO/GAW & Global Climate Observing System (GCOS)



WMO/GAW Global Atmospheric CO₂ & CH₄ Monitoring Network has been designated as a Comprehensive Network of GCOS (GCOS–GAW Agreement in October 2006), providing vital and continuous support to the United Nations Framework Convention on Climate Change (UNFCCC).

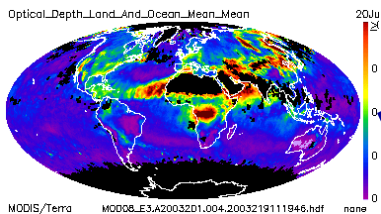
WMO/GAW & Integrated Global Atmospheric Chemistry Observations (IGACO)

The GAW programme builds on the Integrated Global Atmospheric Chemistry Observations (IGACO) strategy.

IGACO System Components

Observations

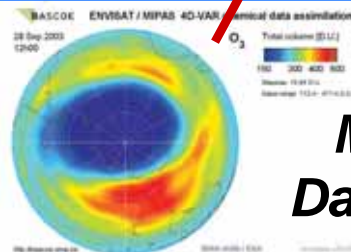
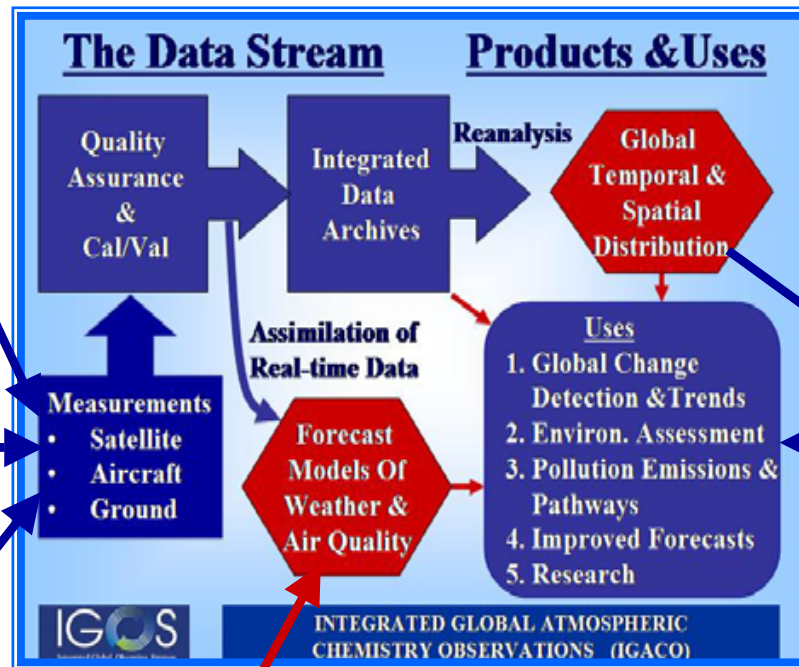
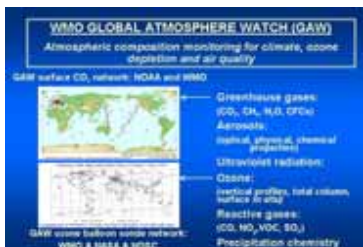
Satellite



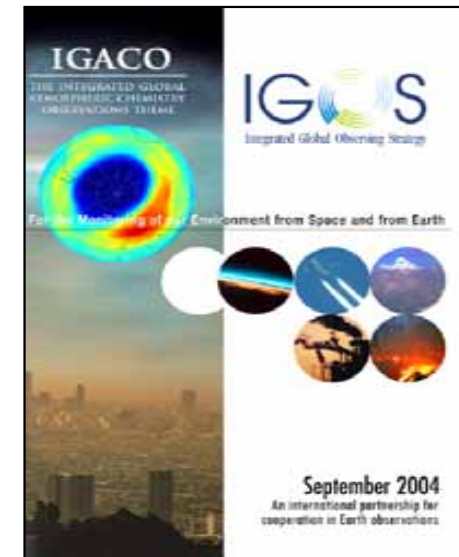
Aircraft



Ground-based



Modelling and Data Assimilation

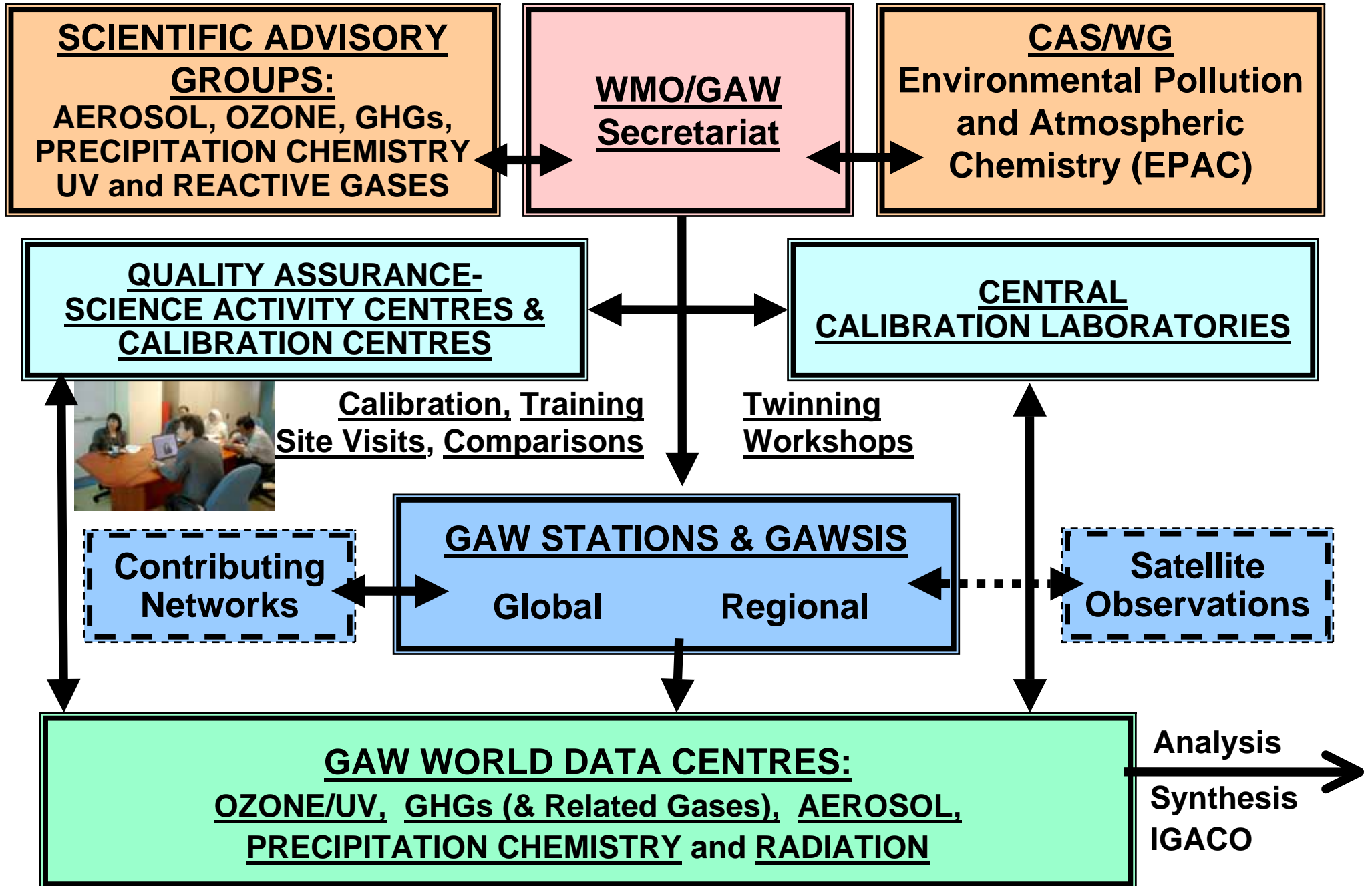


Global Products

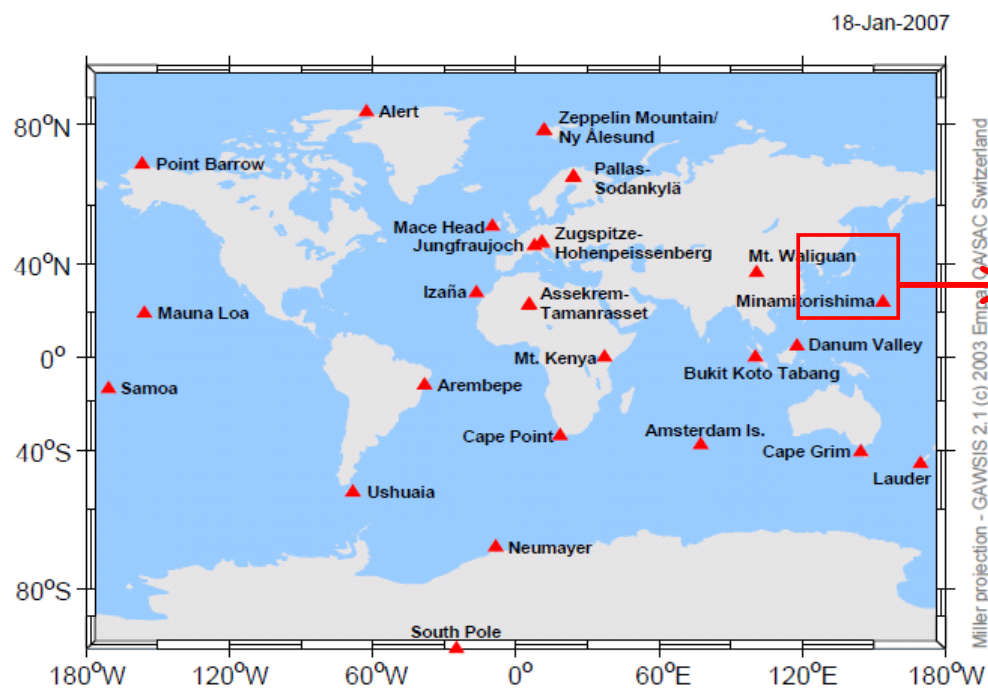


- Ozone Depletion
- Air Quality
- Climate

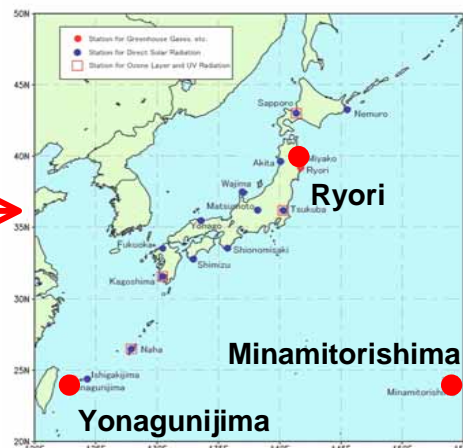
GAW Components



GAW Monitoring Network



GAW Global surface-based *in situ* and remote sensing stations



Observation Sites of JMA



Near-surface concentrations of greenhouse gases are measured at three stations of JMA: Ryori, Minamitorishima and Yonagunijima.



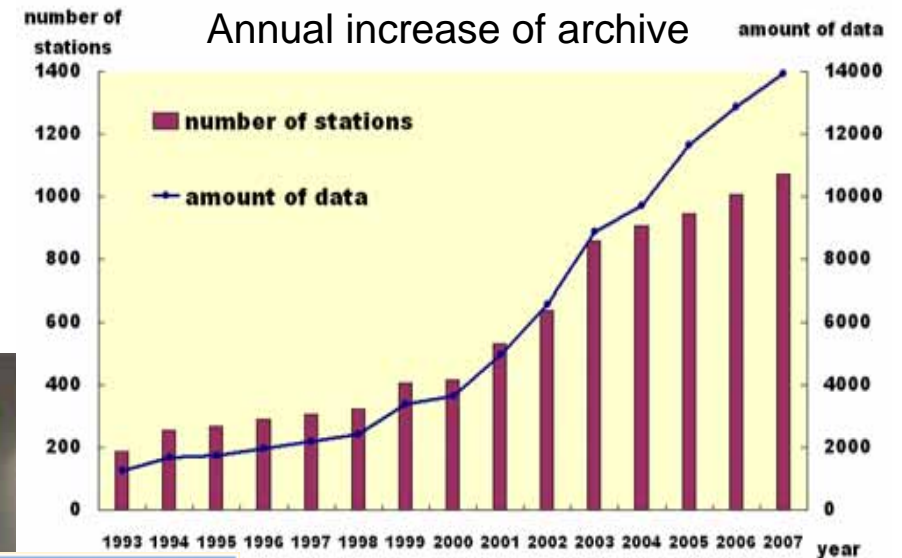
	Ryori	Minamitorishima	Yonagunijima
CO ₂	1987	1993	1997
CH ₄	1991	1994	1998
CO	1991	1994	1998
Surface O ₃	1990	1994	1997
N ₂ O	1990	n/a	n/a
CFC-11,CFC-12,CFC-113	1990	n/a	n/a
CCl ₄ , CH ₃ CCl ₃	1991	n/a	n/a

Monitoring parameters and start year for each station

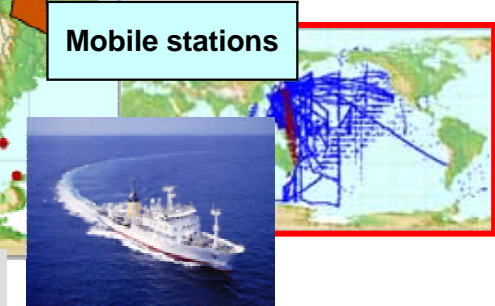
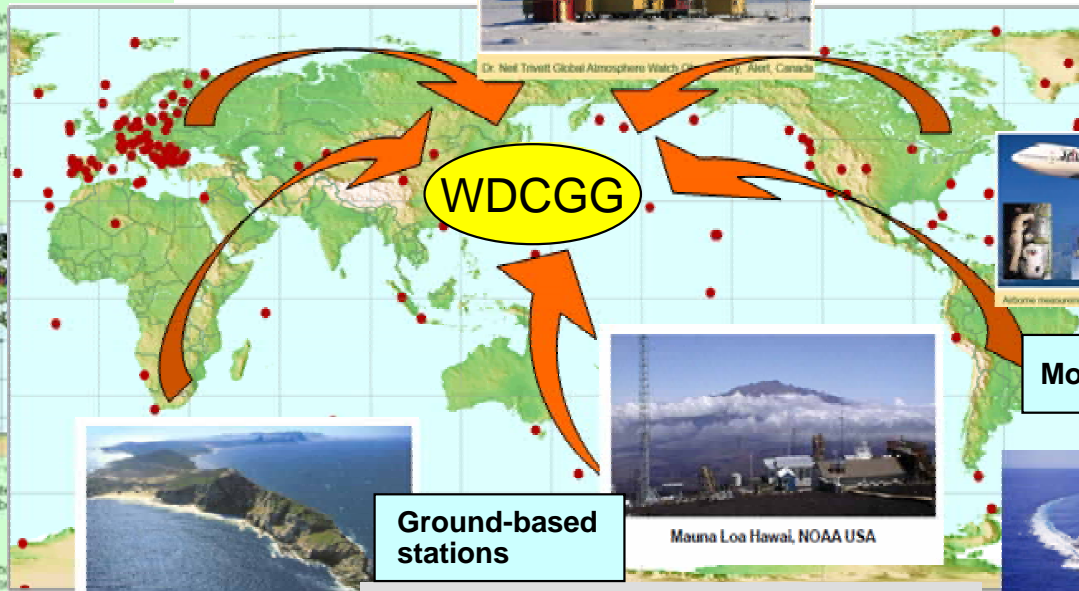
WMO World Data Centre for Greenhouse Gases (WDCGG)

Function of WDCGG

- Collection of data through quality check
- Archive of observation data
- Creation of value added products
- Dissemination of data and products

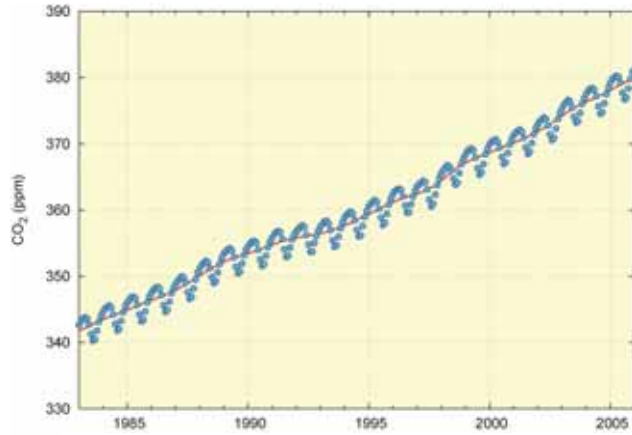


WDCGG website

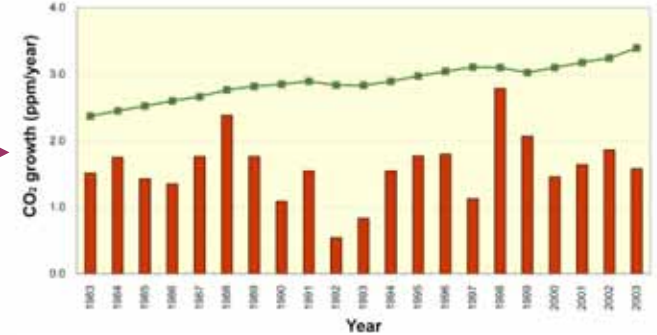
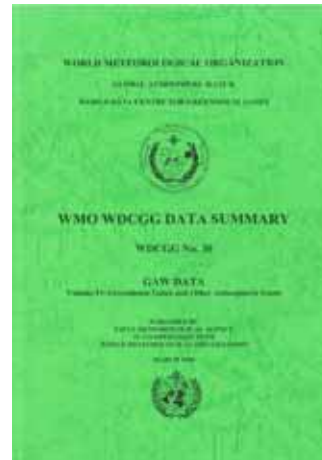


WMO/GAW

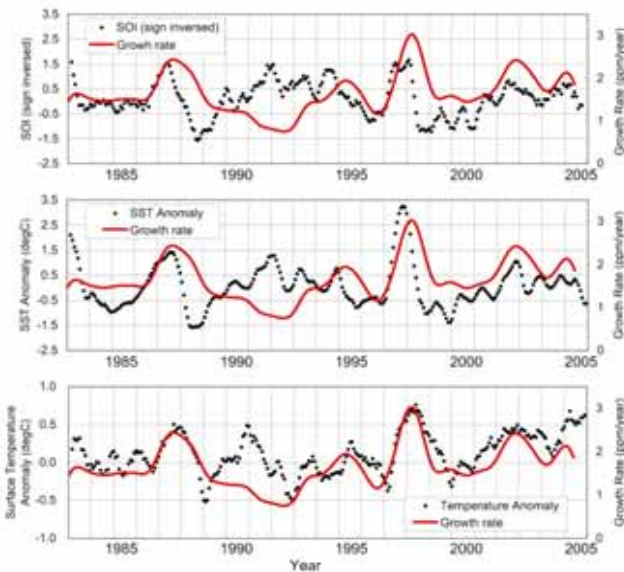
WDCGG Data Summary



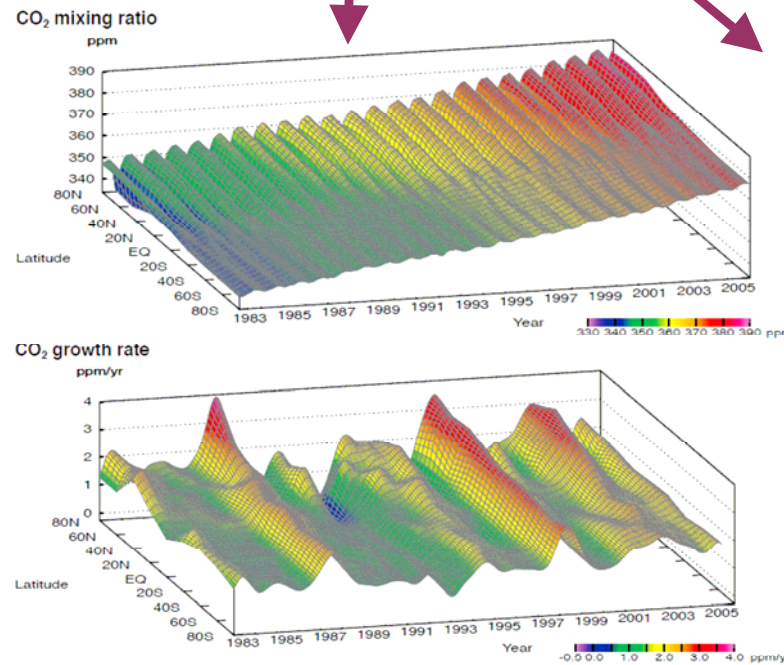
Global mean CO₂ concentrations



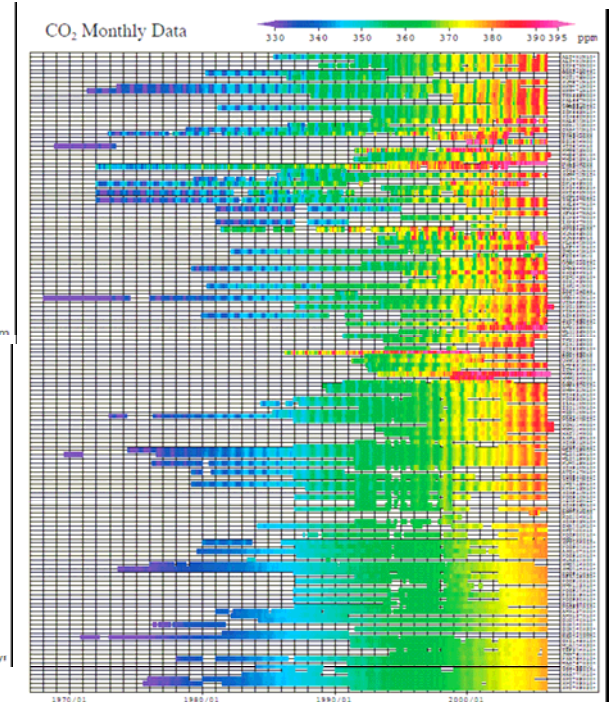
Annual mean atmospheric CO₂ growth rates as observed (red) and estimated from anthropogenic emissions (green).



CO₂ growth rates in the Tropics in comparison with related oceanographical and atmospheric indices.



3D representation of latitudinal – temporal distributions of CO₂ concentrations and their growth rates



Data history for all stations with CO₂ concentrations in color

WMO Greenhouse Gas Bulletin

State of greenhouse gases in the atmosphere

WMO Greenhouse Gas Bulletin
The State of Greenhouse Gases in the Atmosphere Using Global Observations through 2006

Carbon Tracker 2007 release
NOAA Earth System Research Laboratory

Column averaged CO₂ mixing ratio (ppm) for 1 February 2006 calculated from NOAA's CarbonTracker model (see: <http://www.esrl.noaa.gov/gmd/ccgg/carbontracker/>) and measurements from a number of sites in the WMO-GAW Global CO₂ network described in this Bulletin. Blue regions have relatively low CO₂ and red regions have relatively high CO₂. High CO₂ values, mostly from fossil fuel combustion, are observed over North America, Europe and East Asia. The passage of a frontal system is seen between eastern Europe and Asia. CO₂ from a biomass burning plume is being transported from Equatorial Africa towards the Atlantic Ocean.

Executive summary

The latest analysis of data from the WMO-GAW Global Greenhouse Gas Monitoring Network shows that the globally averaged mixing ratios of carbon dioxide (CO₂) and nitrous oxide (N₂O) have reached new highs in 2006 with CO₂ at 381.2 ppm and N₂O at 320.1 ppb. Atmospheric growth rates in 2006 of these gases are consistent with recent years. The mixing ratio of methane (CH₄) remains almost unchanged at 1782 ppb. These values are higher than those in pre-industrial times by 36%, 19% and 155%, respectively. Methane growth has slowed during the past decade. The NOAA Annual Greenhouse Gas Index (AGGI) shows that from 1990 to 2006 the atmospheric radiative forcing by all long-lived greenhouse gases has increased by 22.7%. The combined radiative forcing by CFC-11 and CFC-12 exceeds that of N₂O. They are decreasing very slowly as a result of emission reductions under the Montreal Protocol on Substances That Deplete the Ozone Layer.

World Meteorological Organization
No. 1 - 19 November 2007

Overview

This is the third in a series of WMO-GAW Annual Greenhouse Gas Bulletins. Each year, these bulletins report the latest trends and atmospheric burdens of the most influential, long-lived greenhouse gases: carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O), as well as a summary of the contributions of the lesser gases. These three major gases alone contribute about 88% of the increase in radiative forcing of the atmosphere by changes in long-lived greenhouse gases occurring since the beginning of the industrial age (~1750).

The Global Atmosphere Watch (GAW) programme of the World Meteorological Organization (WMO) promotes systematic and reliable observations of the global atmospheric environment, including measurements of CO₂, CH₄, N₂O, and other atmospheric gases. Sites where some or all of these gases are monitored are shown in Figure 1. The measurement data are reported by participating countries and archived and distributed by the World Data Centre for Greenhouse Gases (WDCGG) at the Japan Meteorological Agency (JMA).

Statistics on the present global atmospheric abundances are given in Table 1. They are obtained from a global analysis method using a data set which is available to the WMO World Reference Standard (<http://gaw.kishou.go.jp/wdcgg/>).

The values in Table 1 are slightly different from those in the Fourth Assessment Report of IPCC, mainly due to the different selection of stations employed.

The three major greenhouse gases have been increasing in the atmosphere since the beginning of the industrial age. Water vapour is a natural component of the climate and weather system that is indirectly affected by human activities through changes in temperature, land surface characteristics and aerosol effects on clouds. This Bulletin focuses on those greenhouse gases that are directly influenced by human activities and that are generally much longer lived in the atmosphere than water vapour.

According to the NOAA Annual Greenhouse Gas Index (AGGI), the total radiative forcing by all long-lived greenhouse gases has increased by 22.7% since 1990 and by 103% from 2005 to 2006 (see Figure 2 and <http://www.esrl.noaa.gov/gmd/aggi/>).

Carbon Dioxide (CO₂)

CO₂ is the single most important infrared absorbing, anthropogenic gas in the atmosphere and is responsible for 63% of the total radiative forcing of Earth by long-lived greenhouse gases. Its contribution to the increase in radiative forcing is 87% for the past decade and 91% for the last five years. For about 10,000 years before the industrial revolution, the atmospheric abundance of CO₂ was nearly constant at ~280 ppm (=number of molecules of the greenhouse gas per million molecules of dry air). This abundance represented a balance among large seasonal fluxes (on the order of 100 Gt/annum (Gt of carbon per year)) between the atmosphere and biosphere (photosynthesis and respiration) and the atmosphere and the ocean (physical exchange of CO₂). Since the late 1700s, atmospheric CO₂ has increased by 36%, primarily because of emissions from combustion of fossil fuels (currently about 0.4 Gt carbon per year) and, to a lesser extent, deforestation (~1.6 Gt

Figure 1. The WMO-GAW global greenhouse gas network for carbon dioxide. The network for methane is similar to this.

Table 1. Global abundances of key greenhouse gases as averaged over the twelve months of 2006 as well as trends from the WMO-GAW global greenhouse gas monitoring network.

	CO ₂ (ppm)	CH ₄ (ppb)	N ₂ O (ppb)
Global abundance in 2006	381.2	1782	320.1
2006 abundance relative to year 1750?	136%	205%	119%
2005-06 absolute increase	2.0	-1	0.8
2005-06 relative increase	0.52%	-0.05%	0.25%
Mean annual absolute increase during last 10 years	1.93	2.4	0.76

* Assuming a pre-industrial mixing ratio of 280 ppm for CO₂, 1750 ppb for CH₄, and 270 ppb for N₂O.

Figure 3. Globally averaged CO₂ (a) and its growth rate (b) from 1982 to 2006.

Figure 4. Globally averaged CH₄ (a) and its growth rate (b) from 1984 to 2006.

Nitrous Oxide (N₂O)

Nitrous oxide (N₂O) contributes 6.2% of the total radiative forcing from long-lived greenhouse gases. Its atmospheric abundance prior to industrialization was 270 ppb. N₂O is emitted into the atmosphere from natural and anthropogenic sources, including the oceans, soil, combustion of fuels, biomass burning, fertiliser use, and various industrial processes. One-third of its total emissions is from anthropogenic sources. It is removed from the atmosphere by photochemical processes in the stratosphere. Globally averaged N₂O during 2006 was 320.1 ppb, up 0.8 ppb from the year before (Figure 5). The mean growth rate has been 0.76 ppb per year over the past 10 years.

Other Greenhouse Gases

The ozone depleting chlorofluorocarbons (CFCs) also contribute to the radiative forcing of the atmosphere. Their overall contribution to the global radiative forcing is significant (12% of the total). <http://www.esrl.noaa.gov/gmd/aggi/>.

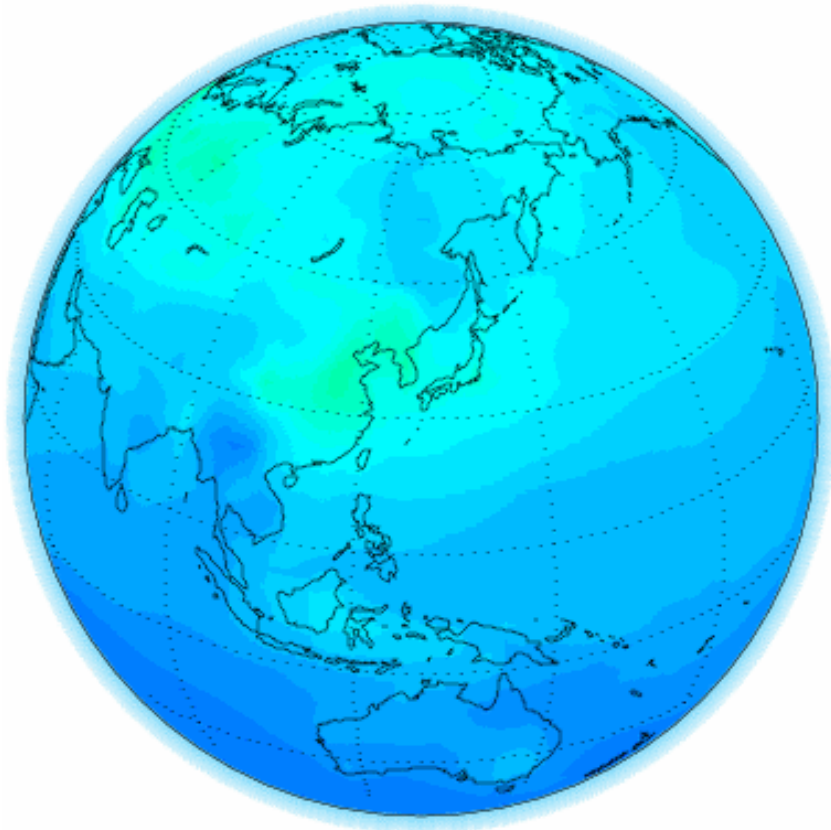
Methane (CH₄)

Methane contributes 16.6% of the direct radiative forcing due to long-lived greenhouse gases affected by human activities. Its chemistry also indirectly affects climate by influencing tropospheric ozone and stratospheric water vapour. Methane is emitted to the atmosphere by natural processes (~40%, e.g., wetlands and termites) and anthropogenic sources (~60%, e.g., fossil fuel exploitation, rice agriculture, ruminant animals, biomass burning, and landfills); it is removed from the atmosphere by reaction with the hydroxyl radical (OH) and has an atmospheric lifetime of ~9 years. Before the industrial era, atmospheric methane was at ~700 ppb (ppb=number of molecules of the greenhouse gas per billion (10⁹) molecules of dry air). Increasing emissions from anthropogenic sources are responsible for the factor of 2.5 increase in CH₄. The cycling of methane, however, is complex and managing its atmospheric burden requires an understanding of its emissions and its budget of sources and sinks. Globally averaged CH₄ in

Figure 5. Time series of monthly mean mixing ratio of N₂O from 1981 to 2006.

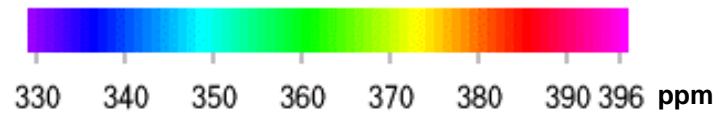
The WDCGG makes substantial contributions to the annual Bulletin.

JMA's Analysis on Global CO₂ Distributions and Fluxes



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Global distributions of CO₂, simulated from estimated fluxes and atmospheric transport



1985 - 01
(Year - Month)

