



An Integrated Global Atmospheric Chemistry Observations Strategy & WMOs Leading Role: GAW & IGACO

Leonard Barrie

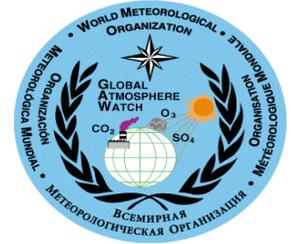
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Search Engine "GAW" →

www.wmo.ch/web/arep/gaw/gaw_home.html

GAW: What is it?



- The Global Atmosphere Watch programme of WMO
- *Established* in 1989 by merging the Global Ozone Observing System (GO₃OS) and Background Monitoring of Air Pollution (BAPMoN) programmes
- *Coordinated* by the Environment Division of WMO's Atmospheric Research and Environment Programme (AREP) department under the Commission for Atmospheric Science (CAS) and its Working Group on Environmental Pollution and Atmospheric Chemistry.



The GAW Mission

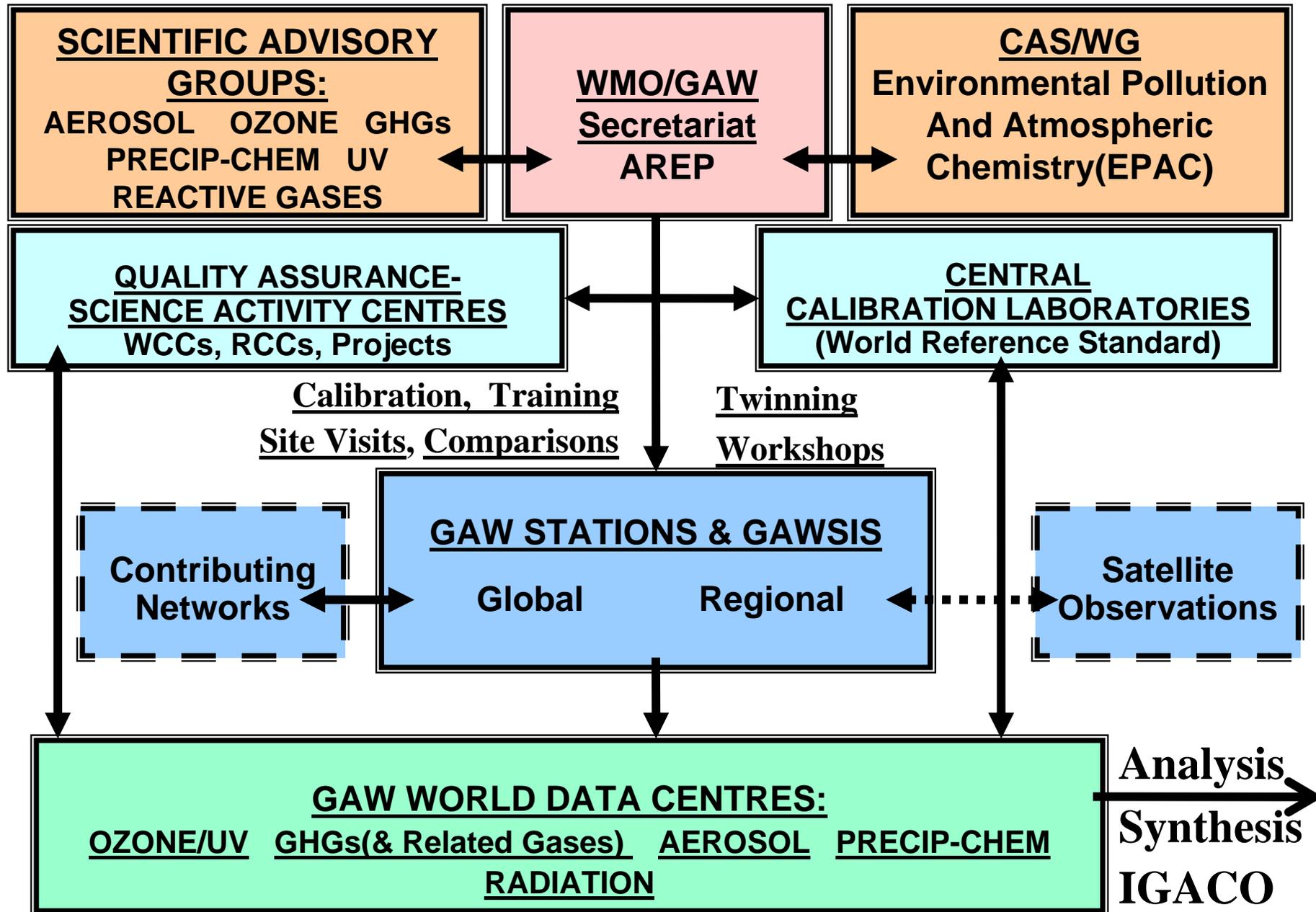
- ***Systematic Global Monitoring Of Chemical Composition of the Atmosphere.***
- ***Analysis and Assessment in Support of International Conventions.***
- ***Development Of Air Pollution and Climate Predictive Capability***

Motivation

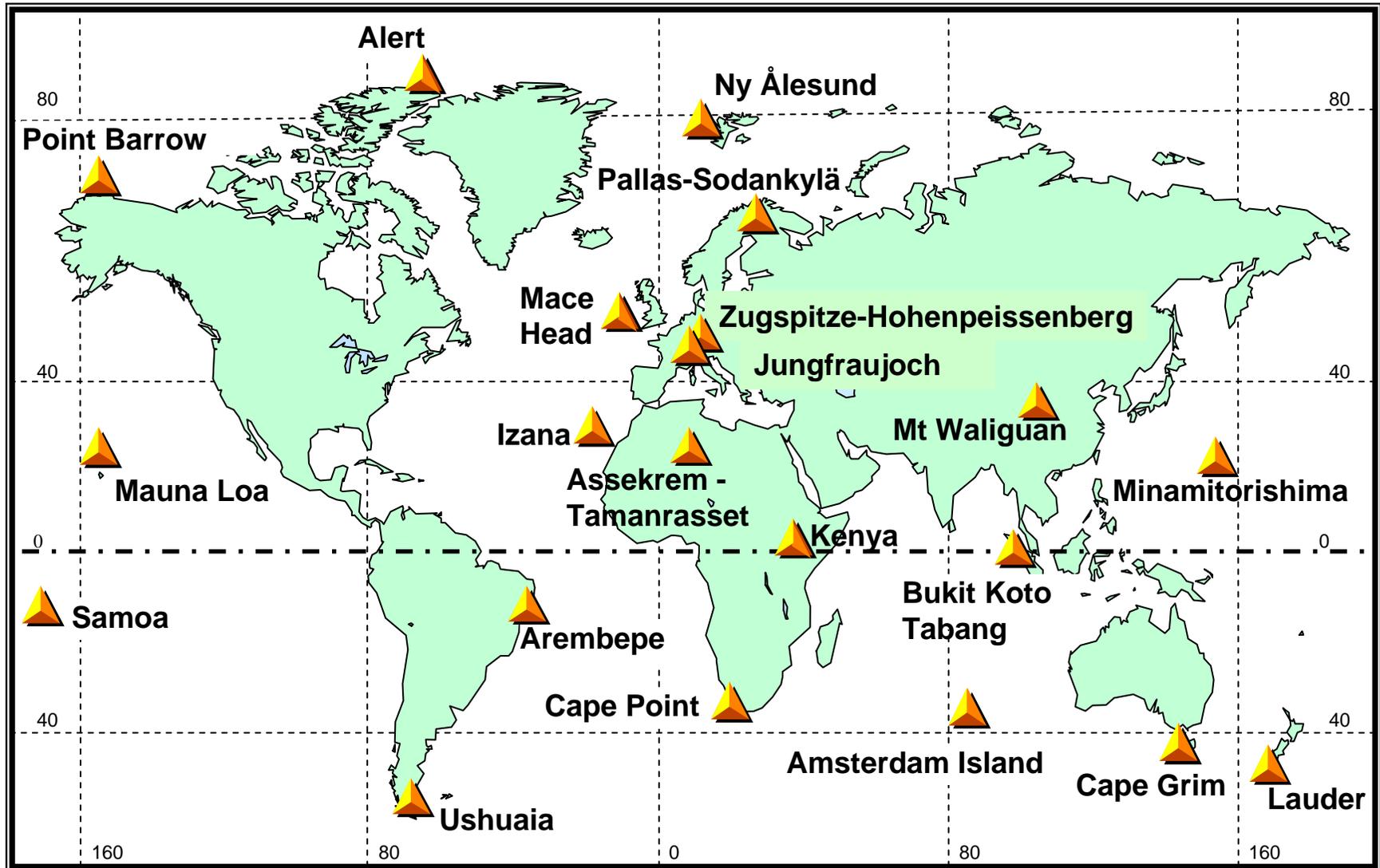


- Improved Weather Forecasting: By Including Aerosols, Ozone and Reactive Gas Observations
- Air Pollution Forecasting, Health Effects, Long Range Transport and Deposition Effects
- Climate, Climate Change and Climate Prediction
- Oxidizing Power: The Atmosphere As A Waste Processor. Key to Global Hg and some POPs
- Stratospheric Ozone Depletion and Surface UV Enhancement: Are Halocarbon controls working? Effects of UV on biosphere?

GAW Monitoring Components



GLOBAL STATIONS IN GAW



Neumayer Station 

 South Pole

March 2005

Central Calibration Laboratories

{Hosts of WMO World Reference Standards}



- **CO₂, CH₄, N₂O, CO** NOAA CMDL USA
- **Total Ozone** NOAA CMDL USA Dobson
MSC, Canada Brewer
MGO, Russia M124
- **Ozone Sondes** FZ-Juelich, Germany
- **In Situ Ozone** NIST USA
- **Aerosol Optical Depth** WORCC, Davos, CH

World or Regional Calibration Centres

{Linking Observations to World Reference Standards and Ensuring Network Comparability}

- | | |
|---|---|
| ▪ Total Ozone | 6 Regional Dobson Centres
1 Regional EU Brewer Centre
1 Brewer travelling standard |
| ▪ Ozone Sondes | FZ-Julich, Germany |
| ▪ <i>In Situ</i> O₃, CO, CH₄ | EMPA, Switzerland |
| ▪ CO₂, CH₄, N₂O | NOAA CMDL USA |
| ▪ N₂O, VOC | IMK-IFU Garmisch Germany |
| ▪ Aerosol Optical Depth | WORCC, Davos, CH |
| ▪ Aerosol physical | IFT, Leipzig, Germany |
| ▪ Precip. Chemistry | SUNY Albany USA |

GAW Station Information System ...

GAW SIS Online - comprehensive information on all GAW stations

- Database
- Search / Update
- Inventory / Audit

(Supported by **Switzerland**)

GAWSIS 2.1 - Microsoft Internet Explorer
Address: http://www.empa.ch/gaw/gawsis/

GAWSIS STATION INFORMATION SYSTEM
by QA/SAC Switzerland

Welcome to GAWSIS!
GAWSIS is being developed and maintained by QA/SAC Switzerland in collaboration with the WMO GAW Secretariat, the GAW World Data Centres and other GAW representatives to improve the management of information about the GAW network of ground-based stations. The goal is to provide the GAW community and other interested people with an up-to-date, searchable data base of

■ site descriptions ■ measurement programs and available data ■ contact people
Please provide **feed-back** that may help us improve this site. Thanks to all who help keep the underlying information current.

QuickFind
Station Report: [dropdown]
Contact Information: [dropdown]
GO! Clear

Select by Station type
 Global Regional Contributing

Select by Parameter: [dropdown]

Refresh Reset

GAWSIS World Data Centres
[WDCGG \(Gases\)](#)
[WRDC \(Radiation\)](#)
[WQJDC \(Ozone/UV\)](#)
[WDCA \(Aerosols/AOD\)](#)
[WDCPC \(Precipitation\)](#)

What's New
29.04.2004 Minor bug fixes and a new feature: Click on 'Find Information' to produce lists of people involved in GAW.
26.12.2004 New Release of GAWSIS. The most obvious improvement is the addition of an inter-active map as an alternative navigation tool and to produce presentation graphics. Also, many of the forms used for editing/adding information have been updated. Please provide **feed-back** and **report errors** you may encounter.
28.10.2002 The tasks of the World Data

QA/SAC Switzerland is hosted by the Swiss Federal Laboratories for Materials Testing and Research (EMPA), Dübendorf, Switzerland. Funding provided by MeteoSwiss is gratefully acknowledged.

GAWSIS 2.1 - Microsoft Internet Explorer
Address: http://www.empa.ch/gaw/gawsis/reports.asp

GAWSIS STATION INFORMATION SYSTEM
by QA/SAC Switzerland

Station Characteristics
06.04.2004 10:04:29/0

GAW ID Jungfrauoch (Switzerland)
Regional fixed station in WMO RA VI - Europe

station status full operation
time zone UTC+1
climate zone xx (High Alpine)
description The high alpine research station Jungfrauoch is situated on a mountain saddle between the two mountains Jungfrau (4158m) and Mönch (4099m). The station is located in the center of Europe and is surrounded by highly industrialized regions. This special geographical situation offers the opportunity to monitor background concentrations but also to investigate the transport of anthropogenic pollutants from the boundary layer to the free troposphere.

Measurement Program

type	parameter	method	start	end	details
Aerosol	Light absorption coefficient	Aethalometer	01.08.1995		[i]
	Light scattering coefficient	Nephelometer	01.08.1995		[i]
	Mass (major inorganic components)	Ion Chromatography (IC) [general]	01.07.1999		[i]
	Mass (total aerosol)	Filter sampling + gravimetry	1973		[i]
	Number concentration	Condensation particle counter (CPC)	01.08.1995		[i]
Greenhouse Gas	Optical depth	Sunphotometry/Filter Radiometry	01.04.1999		[i]
	CFCs	GC-MS	01.01.2000		[i]
	HCFCs	GC-MS	01.01.2000		[i]

Variable

PS

**Primary
Standard**



BIPM/CIPM

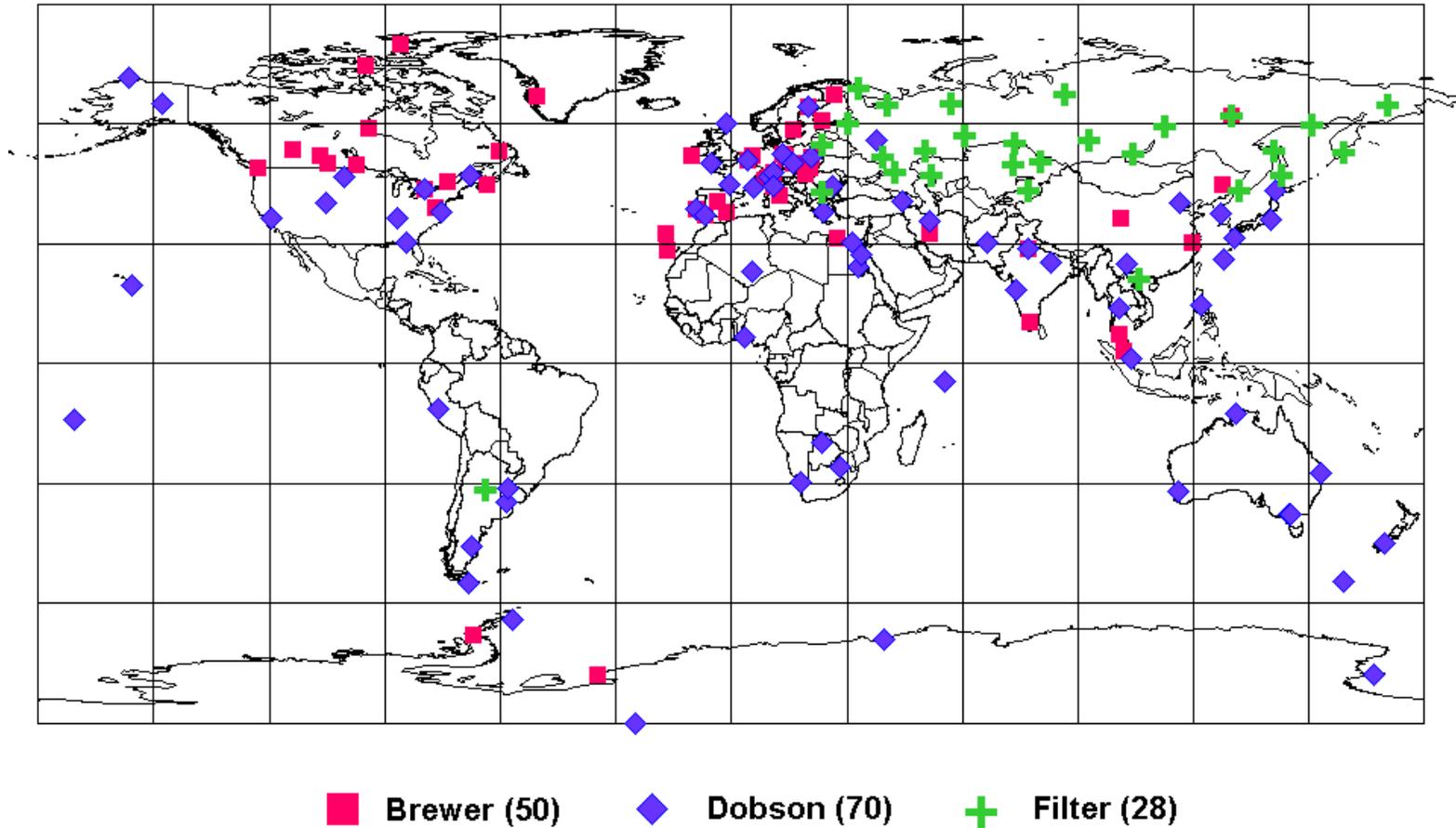
**Quality Assurance Linking
Observations to PS**

**An Observational Network With
Global Coverage**

A World Data Archive/Analysis Centre

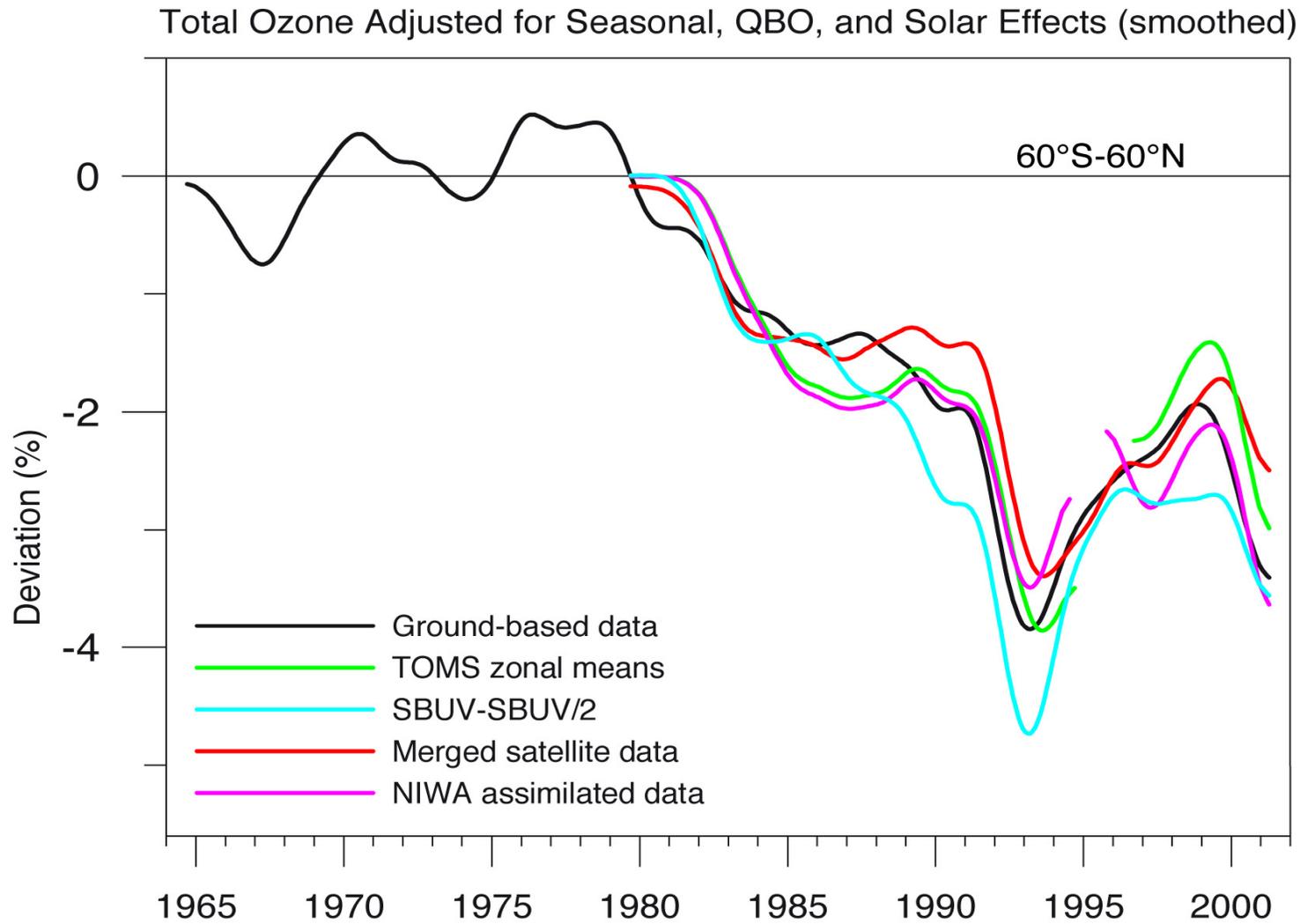
**Oversight Advisory Groups Of Experts For All Aspects
of the Network**

GAW GLOBAL TOTAL COLUMN OZONE NETWORK: 2001- 2004 Stations Submitting Data



The symbols represent different instrument types.

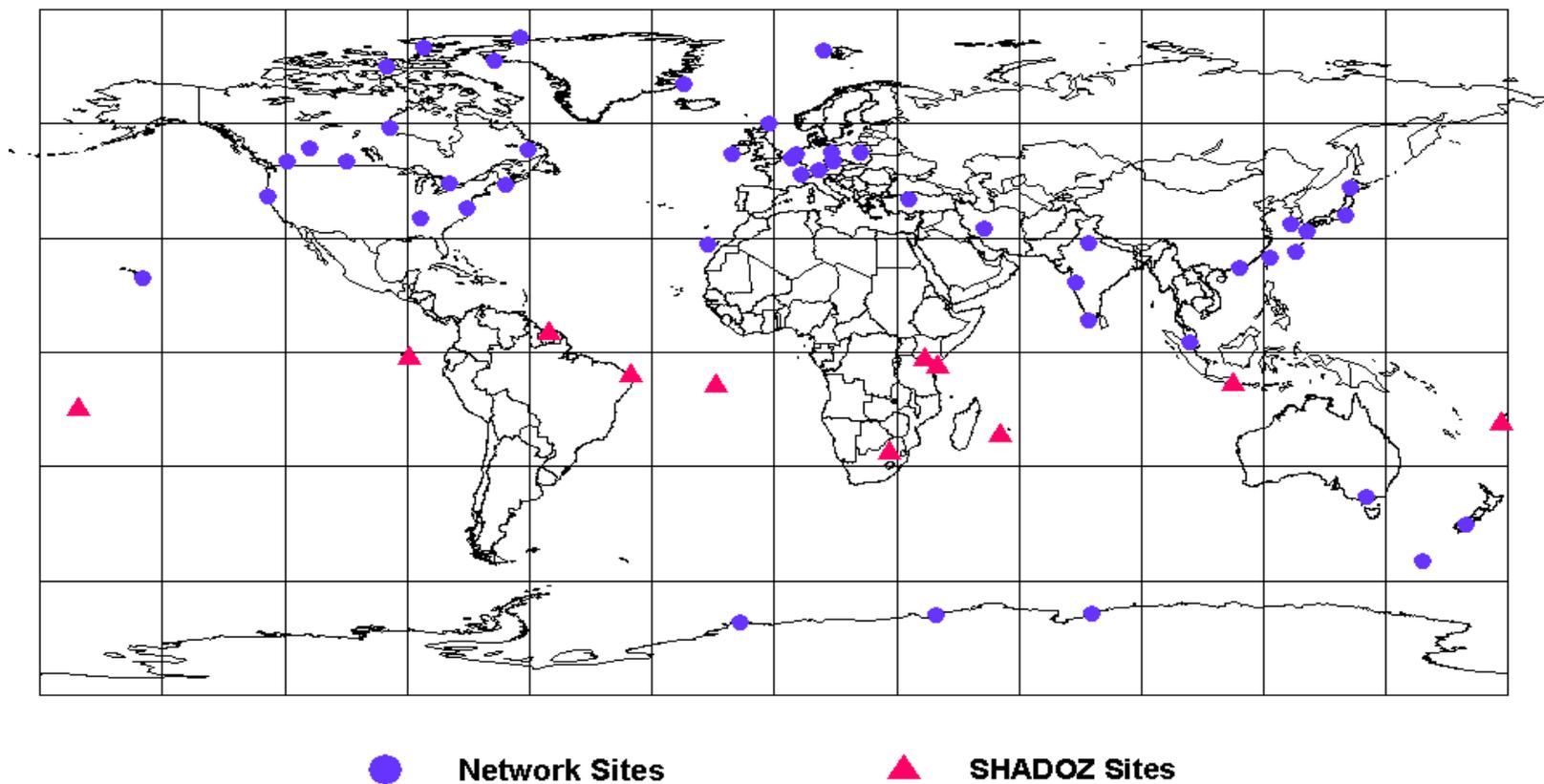
Compliments of WOUDC, MSC, Toronto {Ed Hare Manager}.



**Ozone Assessment 2002 Chapter 4 Figure 4-4
(adapted from Fioletov)**

WMO/GAW Global Ozone Research and Monitoring Report # 47

GAW GLOBAL OZONE SONDE NETWORK: 2001- 2004 Stations Submitting Data To WOUDC



The red triangles represent sites of GAW Contributing partner
NASA/SHADOZ.

Compliments of WOUDC, MSC, Toronto {Ed Hare Manager}.

WMO Ozone Bulletins

Every Two Weeks Aug to Nov

Antarctic Ozone Bulletin

No 2/2005

Ozone Hole Area (Mkm²)

Updated through Aug 30, 2005

2005 2004 2003 95-04 Mean 95-04 Max 95-04 Min

The size of the ozone hole (area where total ozone is less than 220 DU) as calculated by the US National Weather Service's Climate Prediction Center. This figure is based on the NOAA SBUW2 instrument. The red curve shows the development in 2005 in comparison to 2003 (green), 2004 (blue) and the mean and range over the 1996-2004 time period (gray and black curves).

Executive summary

Since the last WMO Antarctic Ozone Bulletin, which was published on 23 August, temperatures have remained cold inside the south polar vortex, and at 20 km altitude ECMWF data show a cooling of a few Kelvin during the last week. Minimum total ozone columns are around 130-140 DU, which is only slightly less than 10 days ago. However, the area where the total ozone column is less than 220 DU has increased from 12 to 22 million km² during the 10-day period since the previous Bulletin. A forecast for the next 7 days indicates a further increase to about 26 million km². Although the development of the ozone hole of 2005 is similar to what was observed in 2003, it is still too early to make a statement about the maximum size of this year's ozone hole.

World
Meteorological
Organization
Member of United Nations

1 Sep 2005

Global Atmosphere Watch

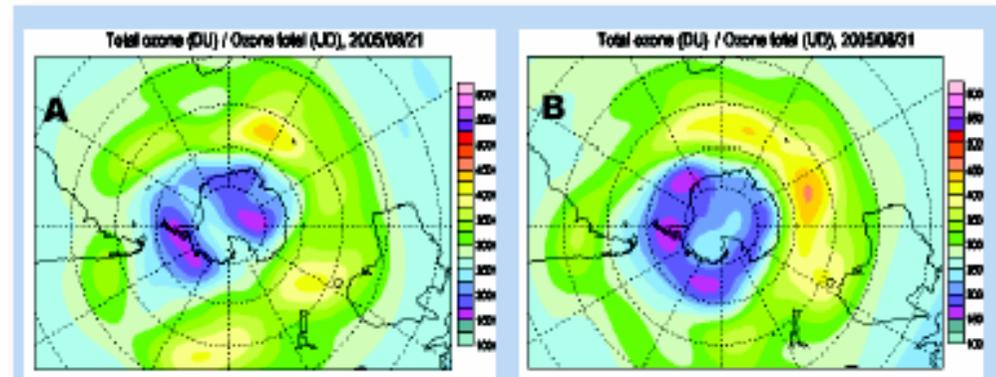


Figure 4. Total ozone maps synthesised by the World Ozone and UV Data Centre at Environment Canada. Panel A shows the situation on 21 August 2005 and panel B shows the situation on 31 August 2005. It is clearly visible that the area with a total ozone column inferior to 200 DU (dark blue and violet) has increased significantly during this 10-day period.

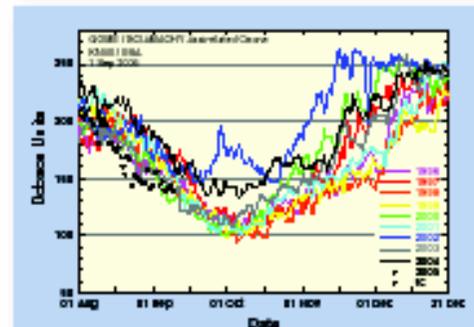


Figure 5. Daily minimum total ozone columns in the Southern Hemisphere as observed by GOME and SCIAMACHY from 1996 to now. The black dots show the observations for 2005. During most of August, minimum ozone columns have been lower than at the same time of the year for the 1996-2004 period. The forecast indicates that the first week of September will be similar to 2003.

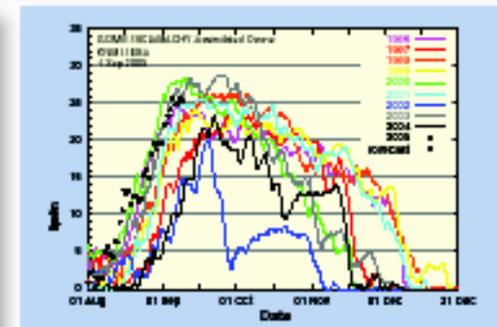


Figure 6. Area (millions of km²) where the total ozone column is less than 220 Dobson units. All the years from 1996 to 2005 (black dots) are shown. The open circles are forecasts for the next 8 days. This figure shows that the size of the ozone hole has increased from 12 to 22 Mkm² during the last 10 days. The forecasts indicate a further increase to about 26 Mkm² during the next week.

Contact: Geir Braathen Gbraathen @wmo.int

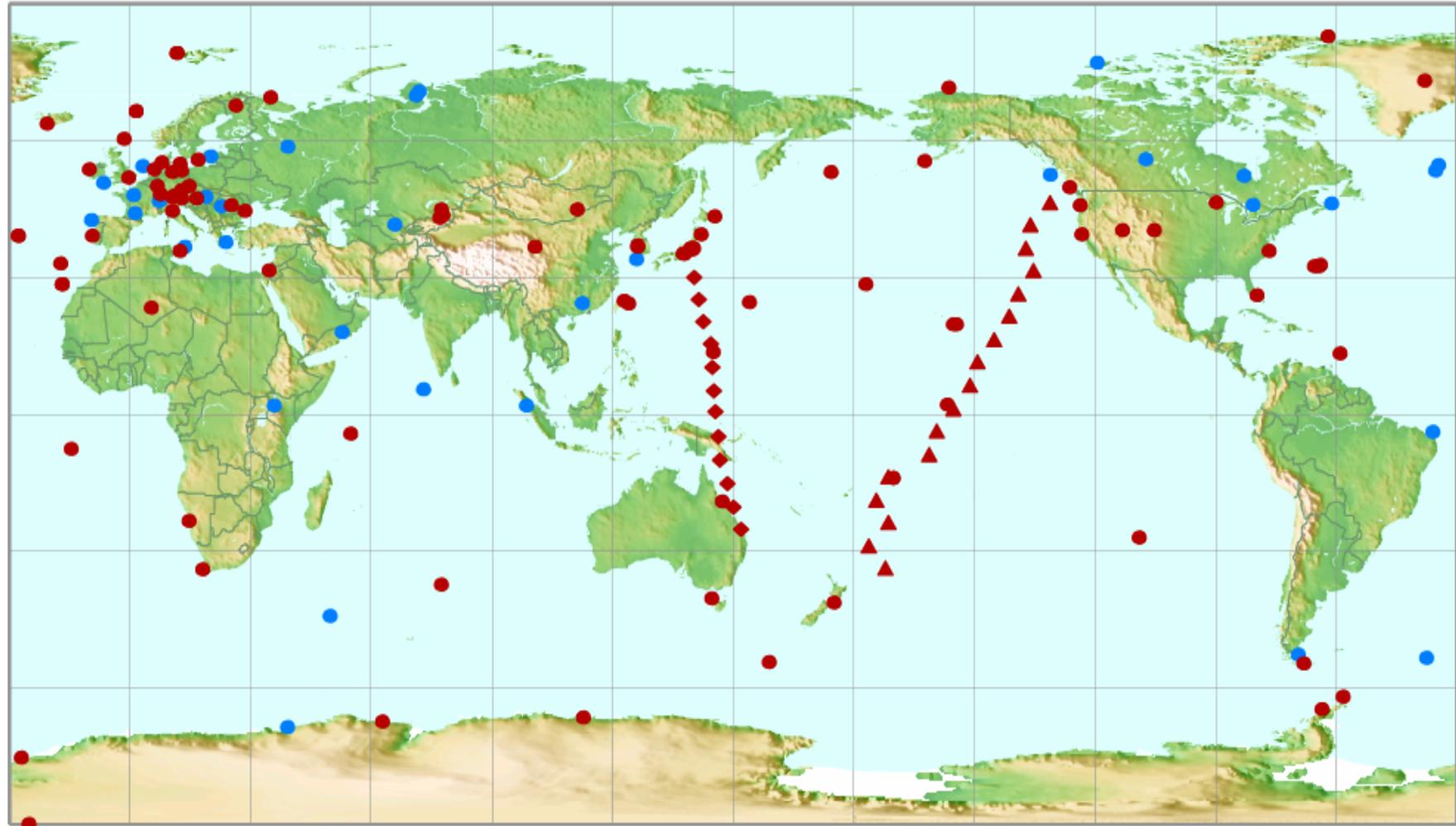
The WMO/GAW Global Atmospheric CO₂ & CH₄ Monitoring Network:



- Started as BAPMoN in the 1970s which became part of GAW in 1989
- Biennial WMO/IAEA CO₂ and Isotopes Measurements Experts Workshops (13th in Boulder 19-22 Sept 2005)
- Quadrennial International Carbon Dioxide Conference (7th in Boulder 26-30 Sept 2005)
- October 2005 GCOS Steering Committee endorses it as a Comprehensive network of GCOS.

GAW Global Carbon Dioxide Network

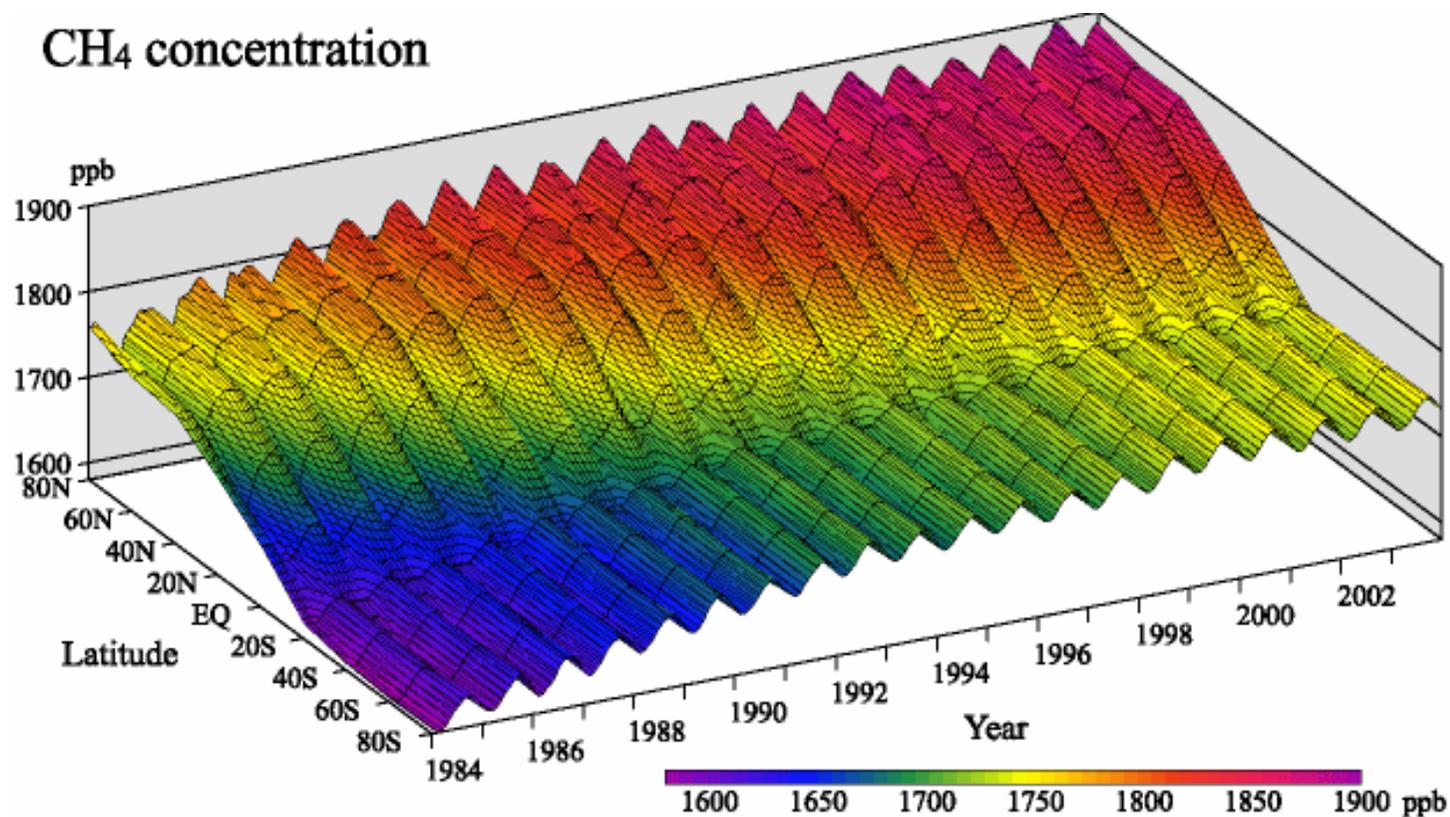
{Major Partner NOAA/CMDL}



WMO World Data Centre for Greenhouse Gases
As of 30 September 2004

● Operational ▲ Operational (ship) ◆ Operational (aircraft) ● Report Expected

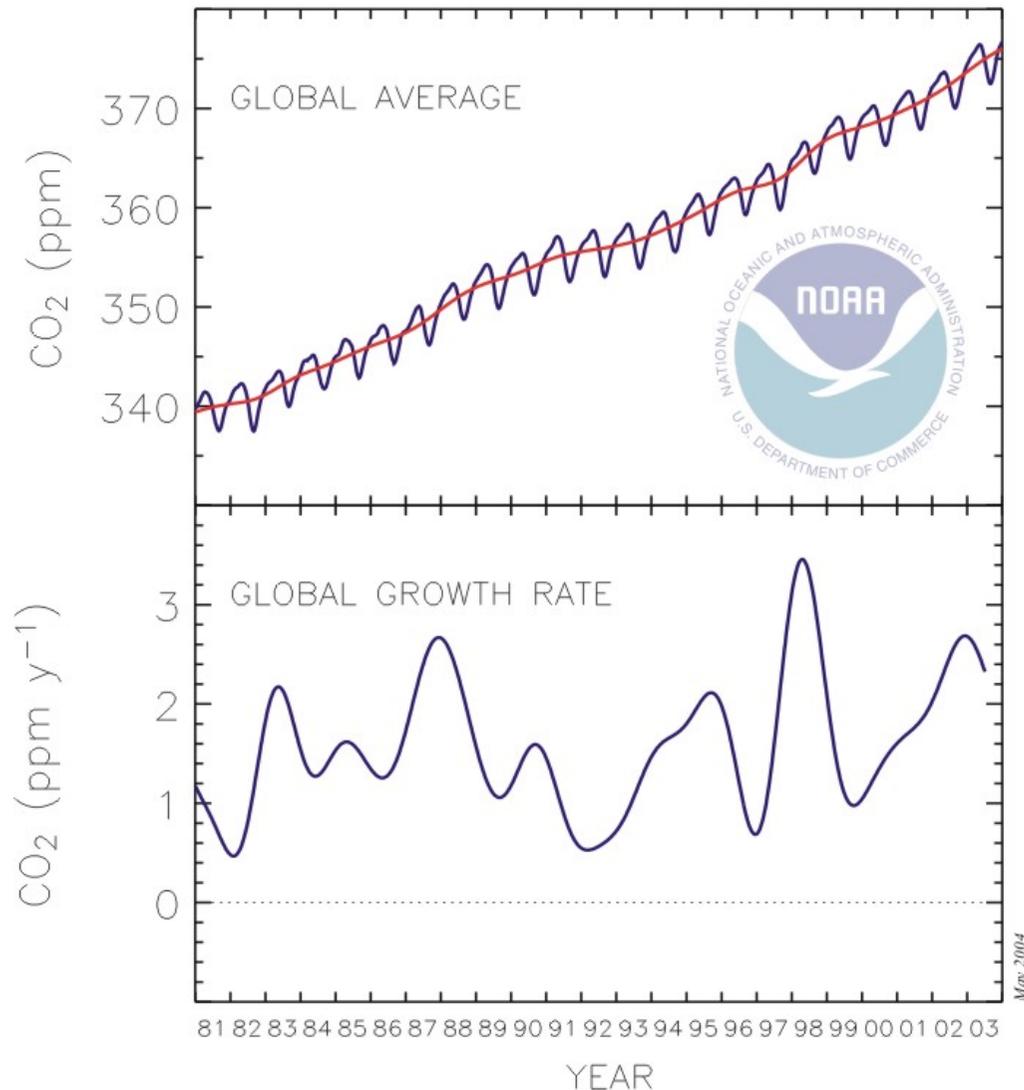
All Data Available From GAW World Data Centre For Greenhouse Gases



<http://gaw.kishou.go.jp/wdcgg.html>

Carbon Dioxide Measurements

NOAA CMDL Carbon Cycle Greenhouse Gases



Top: Global average atmospheric carbon dioxide mixing ratios (blue line) determined using measurements from the NOAA CMDL cooperative air sampling network. The red line represents the long-term trend. Bottom: Global average growth rate for carbon dioxide. Principal investigator: Dr. Pieter Tans, NOAA CMDL Carbon Cycle Greenhouse Gases, Boulder, Colorado, (303) 497-6278 (pieter.tans@noaa.gov, <http://www.cmdl.noaa.gov/ccgg>).

**Major Partner
NOAA/CMDL
Hosts “Global View”
and has many
products**

&

**works closely with
WDCGG**



Core Aerosol Variables

- optical depth
- light scattering coefficient
- light absorption coefficient
- mass (preferably in two size fractions)
- major chemical components in two size fractions

GAW Report # 153. WMO/GAW Aerosol Measurement Procedures Guidelines and Recommendations (September 2003) produced by GAW Aerosol SAG

Building A Global AOD Network Monitoring

A WMO/GAW Experts Workshop

*A Global Surface-Based Network for Long Term
Observations of Column Aerosol Optical Properties*

hosted by C. Wehrli, WORCC PMOD

March 2004 in Davos

A Blueprint For Moving Forward:

GAW Report # 162. WMO/GAW Expert Workshop on a Global Surface-based Network for Long Term Observations of Column Aerosol Optical Properties (Davos, Switzerland, 8-10 March 2004)

The Ground-based Global AOD Network

“is currently un-coordinated”

Global AOD Network Long-term Sites

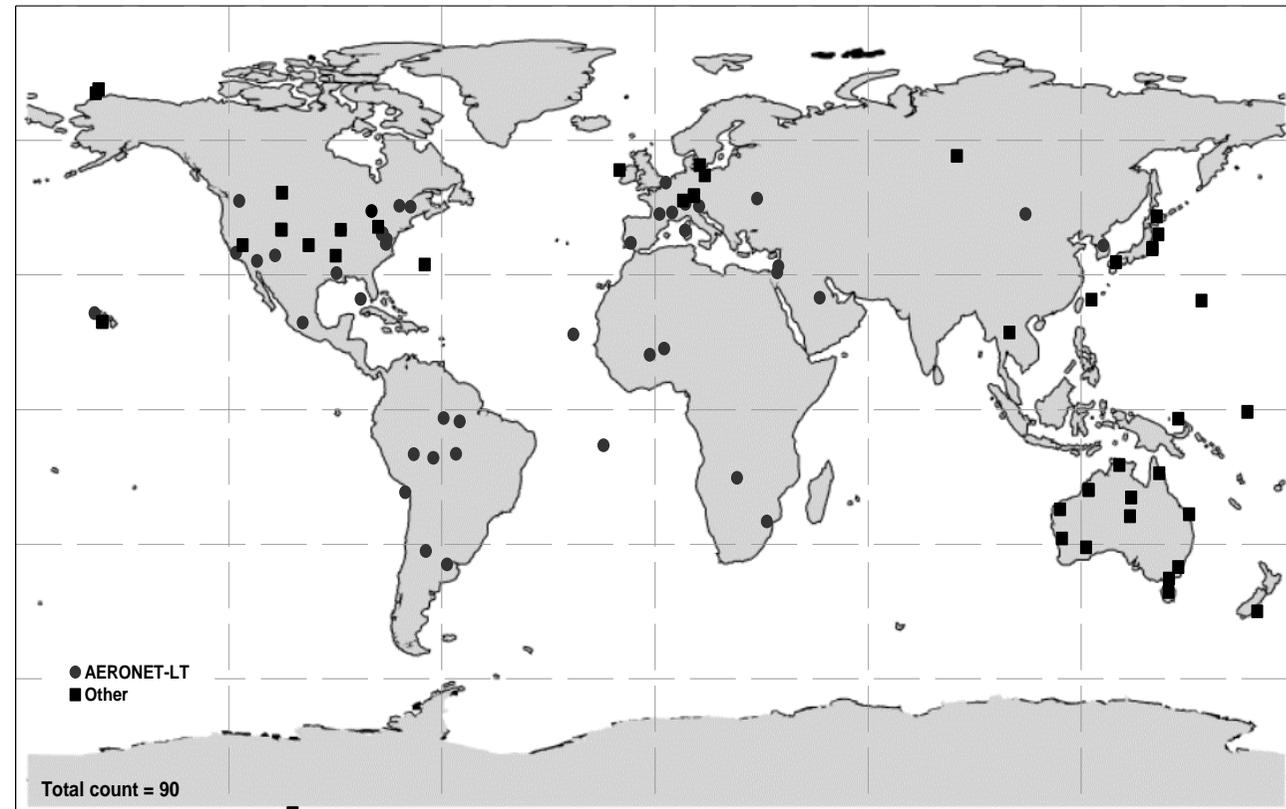
4+ years in operation, >50% coverage, as of March 2004

Latitudinal distribution

Polar regions:	4
Midlatitude North:	50
Tropics:	26
Midlatitude South:	10
Total	90

Major data gaps

Africa, Asia, India, Polar region and Oceans

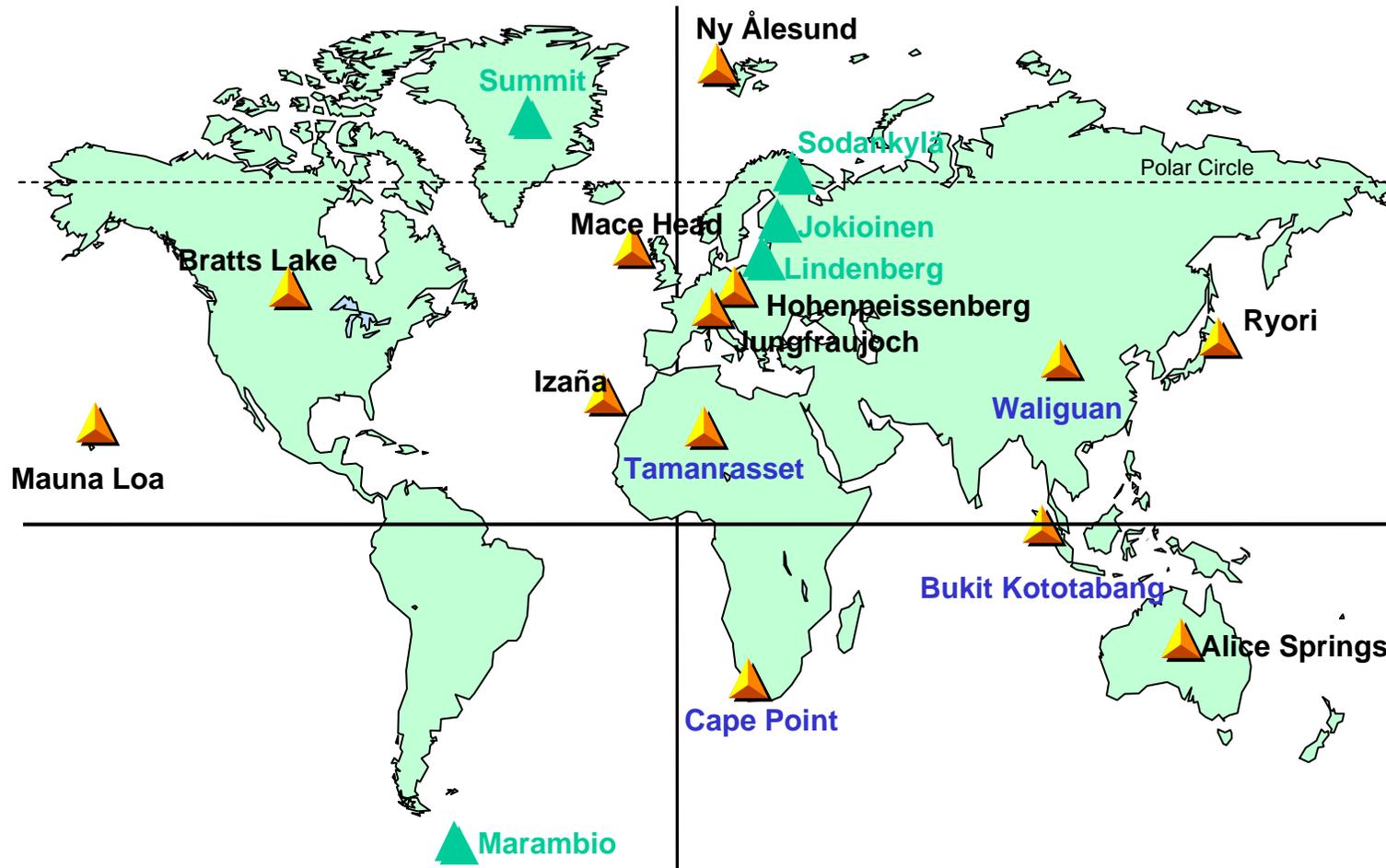


International: AERONET, BSRN, GAWPFR, SKYNET

Courtesy of Chris Wehrli Davos AOD Calibration centre

National: Australia, China, Finland, Germany, Japan, Netherlands, Russia, USA(4)

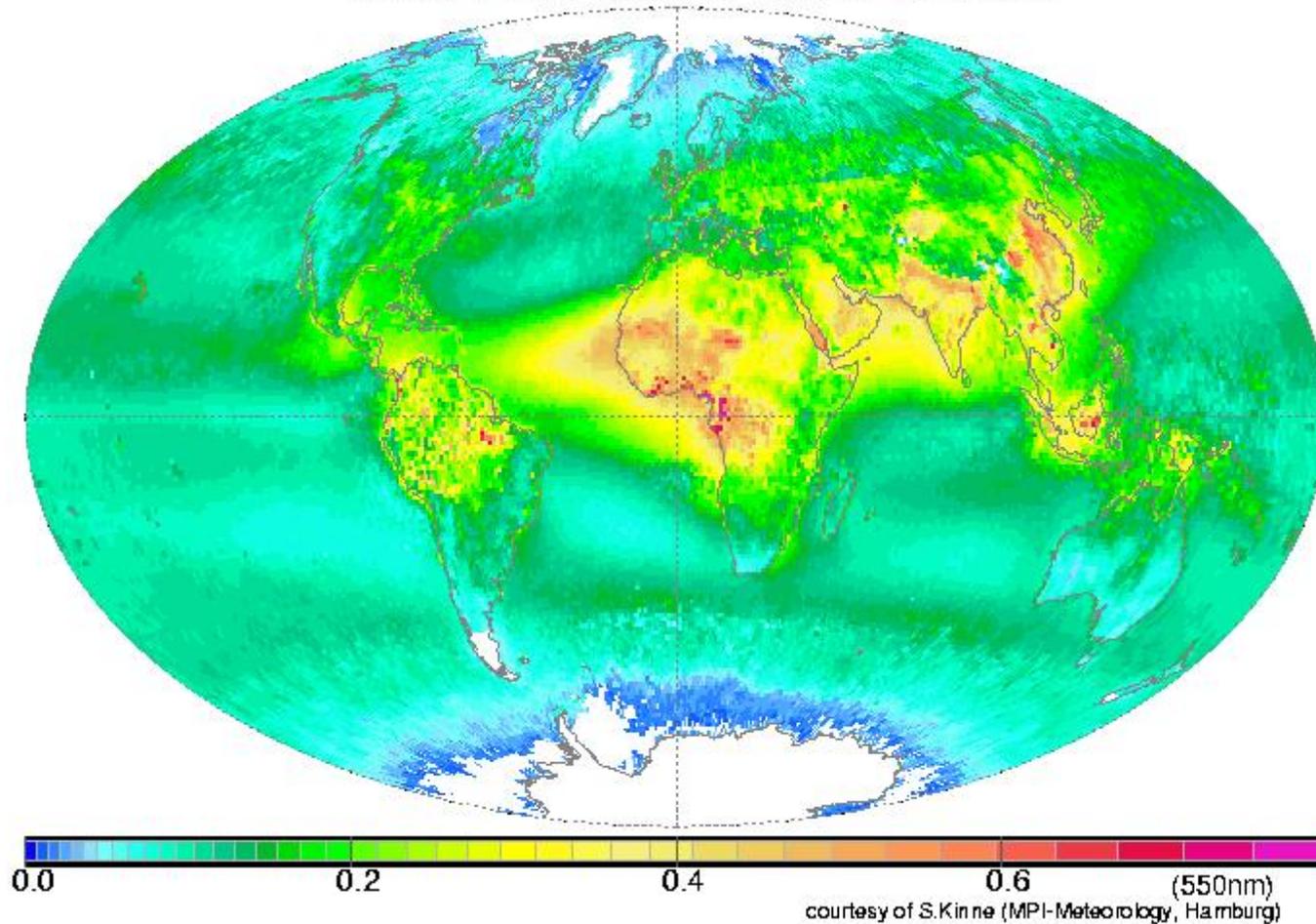
GAWPFR and WORCC/Davos The Core of Quality Assurance



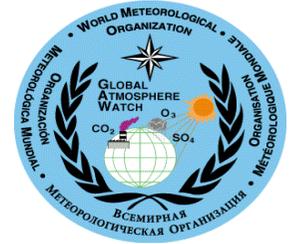
2004: 9 GAW stations operational, 4 stations pending deployment &
5 additional PFRs operated by FMI, DWD, ETHZ

Operational Aerosol Satellites Are Coming: So Far Only Demonstration Missions

SATELLITE COMPOSITE of AOD



A best estimate of the global distribution of annual average tropospheric aerosol optical depth (AOD) compiled by combining data from six satellites (operating for limited periods between 1979 and 2004). Observations for a region were selected using ground-based AOD observations as guidance (courtesy of S. Kinne MPI, Hamburg, Germany).



A systematic approach to observations is needed

What Is The Integrated Global Observing Strategy (IGOS) Partnership?

A Consortium of 13 Partners Formed in 1999 with a secretariat that rotates lead every 2 years. They meet regularly with CEOS

- Food and Agriculture Organization (FAO)

The IGOS Partners include the:

Global observing systems

- Global Climate Observing System (GCOS)
- Global Ocean Observing System (GOOS)
- Global Observing System (GOS) of the WMO
- **Global Atmospheric Watch(GAW) of the WMO**
- Global Terrestrial Observing System (GTOS)

Sponsors of the global observing systems

- World Meteorological Organization (WMO)
- U.N. Educational, Scientific, and Cultural Organization (UNESCO)
- U.N. Environment Programme (UNEP)
- Intergovernmental Oceanographic Organization (IOC)
- International Council for Science (ICSU)

Committee on Earth Observation Satellites(CEOS)

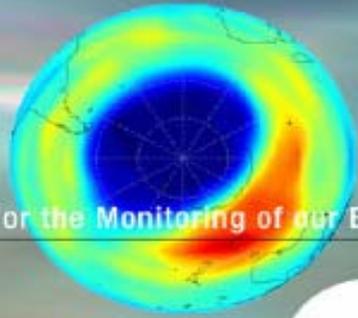
includes all national and regional government agencies with an Earth observing satellite system

Global change research programs

- International Geosphere-Biosphere Programme (IGBP)
- World Climate Research Programme (WCRP)
- International Group of Funding Agencies for Global Change Research (IGFA)

IGACO

THE INTEGRATED GLOBAL
ATMOSPHERIC CHEMISTRY
OBSERVATIONS THEME



For the Monitoring of our Environment from Space and from Earth

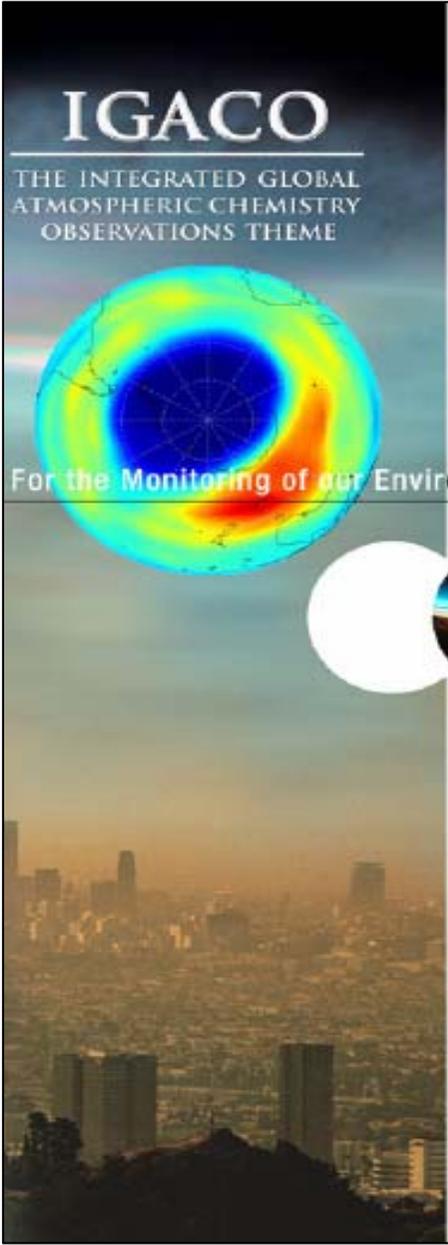


IGOS

Integrated Global Observing Strategy

September 2004

An international partnership for
cooperation in Earth observations



IGACO TARGET VARIABLE LIST

Chemical species	Air Quality	Oxidation Capacity	Climate	Stratospheric Ozone Depletion
O ₃	✓	✓	✓	✓
H ₂ O (water vapour)	✓	✓	✓	✓
CO	✓	✓		
CO ₂			✓	
CH ₄		✓	✓	✓
HCHO	✓	✓		
VOCs	✓	✓		
N ₂ O			✓	✓
NO _x = NO+NO ₂	✓	✓	✓	✓
HNO ₃	✓	✓		✓
SO ₂	✓	✓	✓	✓
BrO, ClO, OClO HCl, ClONO ₂ CH ₃ Br, CF ₃ Br, CFC-11, CFC-12, HCFC-22				✓ ✓ ✓ ✓
aerosol optical properties	✓		✓	✓
actinic flux	✓	✓		

Example of a timeline diagram

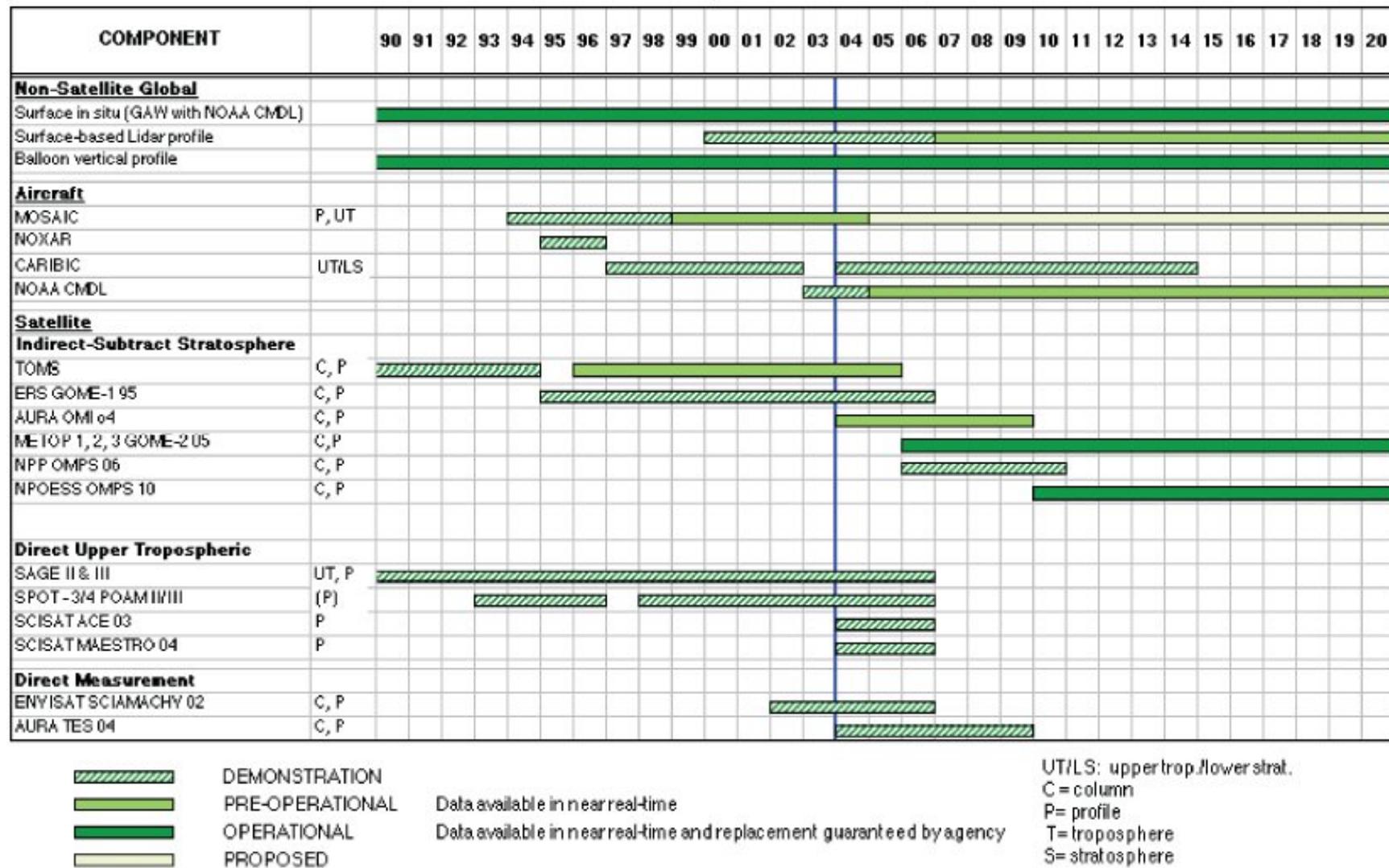
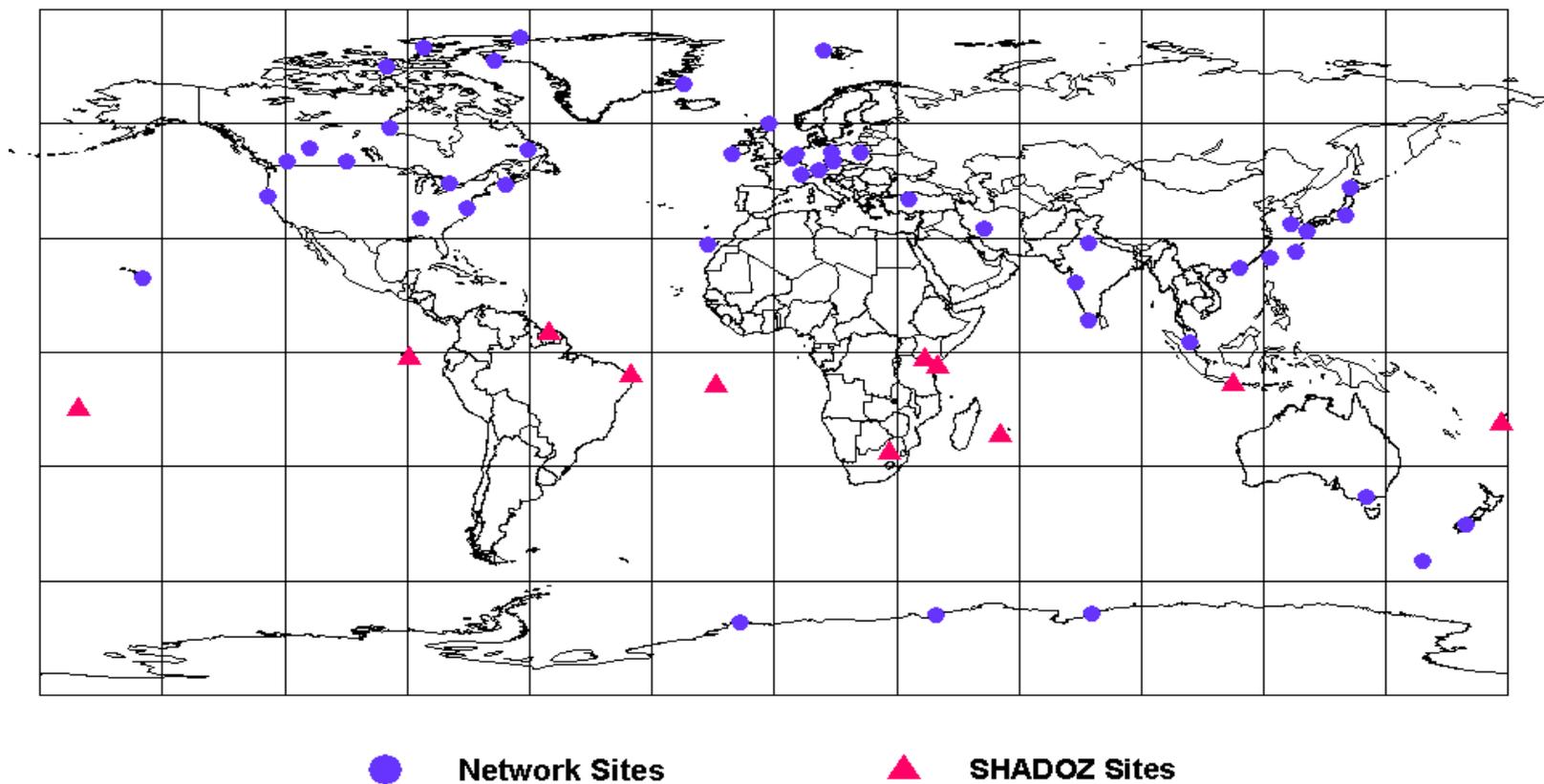


Figure 4.2.1. An overview of satellite, ground-based and aircraft measurements for tropospheric O₃

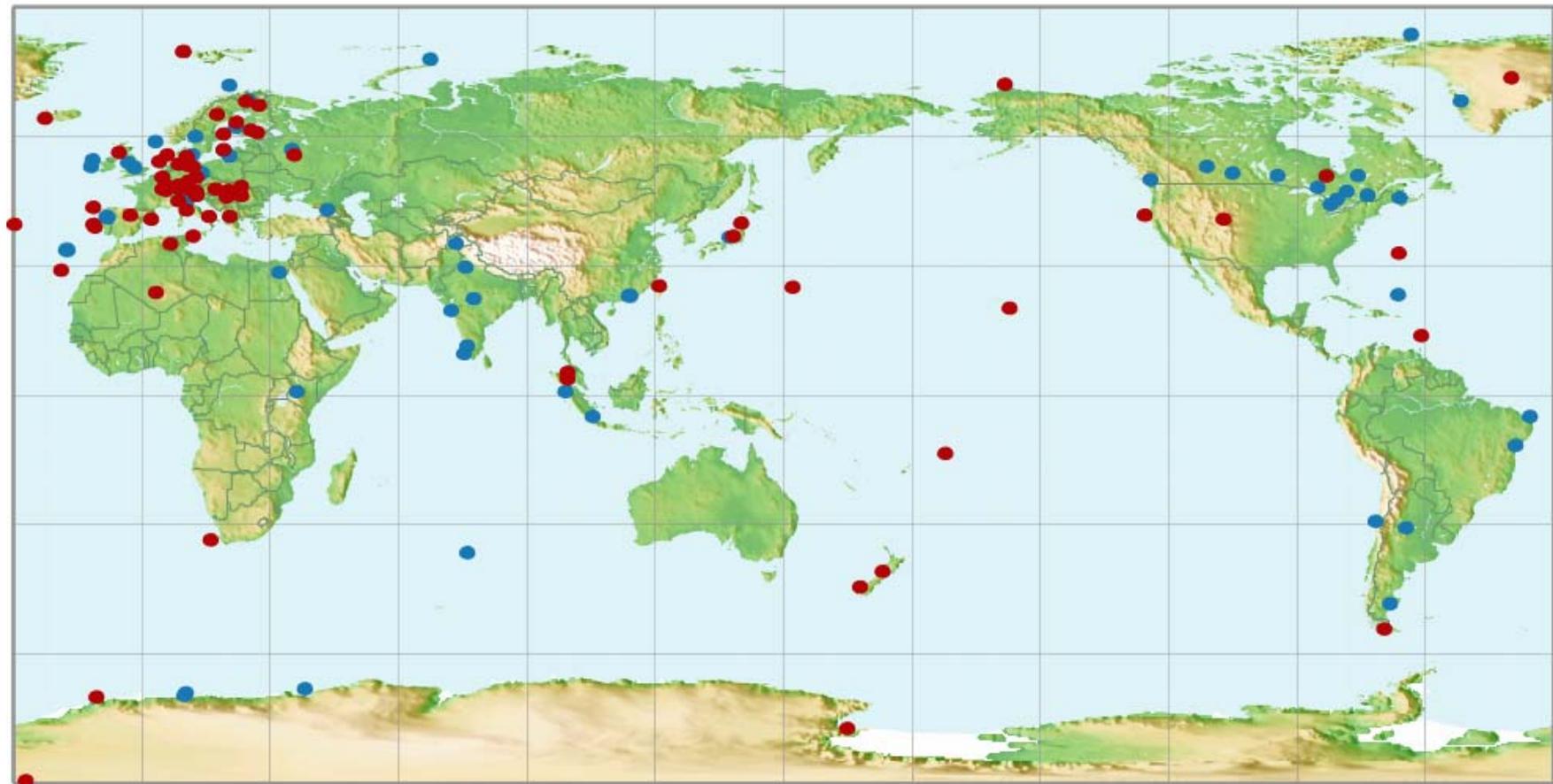
GAW GLOBAL OZONE SONDE NETWORK: 2001- 2004 Stations Submitting Data To WOUDC



**The red triangles represent sites of GAW Contributing partner
NASA/SHADOZ.**

Compliments of WOUDC, MSC, Toronto {Ed Hare Manager}.

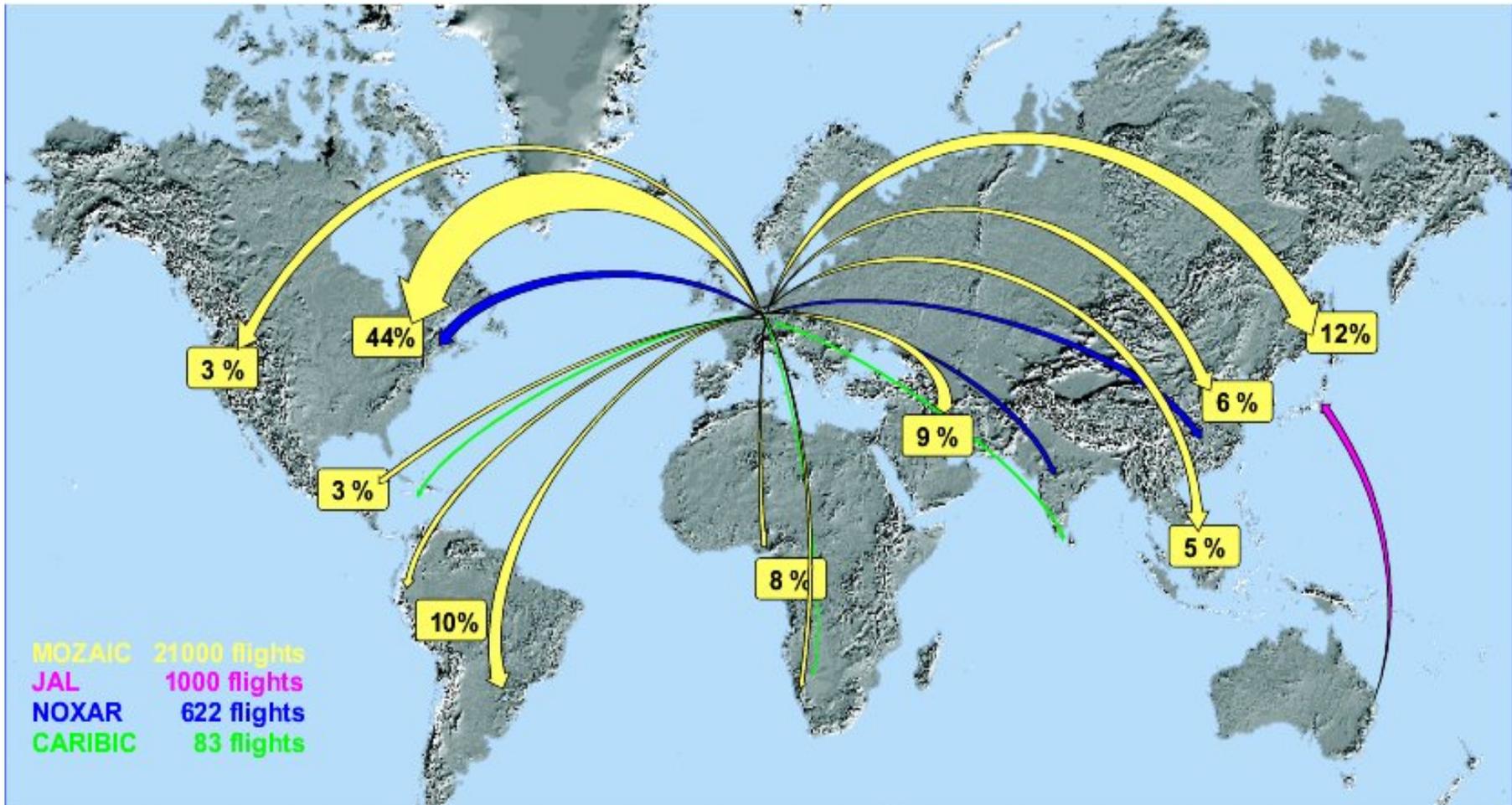
GAW Global In Situ Surface O₃ Network



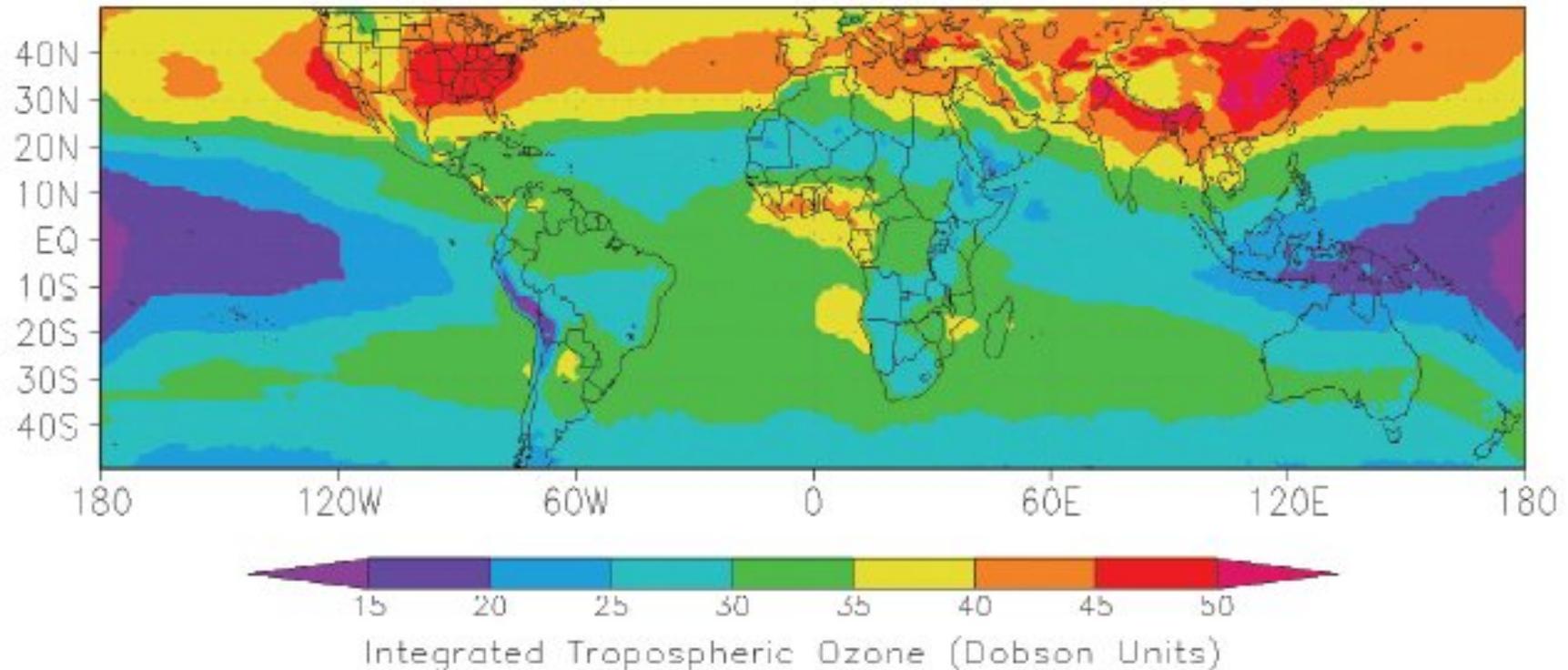
● Operational ● Report Expected

WMO World Data Centre for Greenhouse Gases
As of 30 September 2004

Flight routes with regular observations



Satellite Column Observations From Low Earth Polar Orbiting Satellites



Tropospheric ozone from combined TOMS and SBUV data, showing major source regions and large-scale transport in the Northern hemisphere. [Courtesy J. Fishman, NASA]

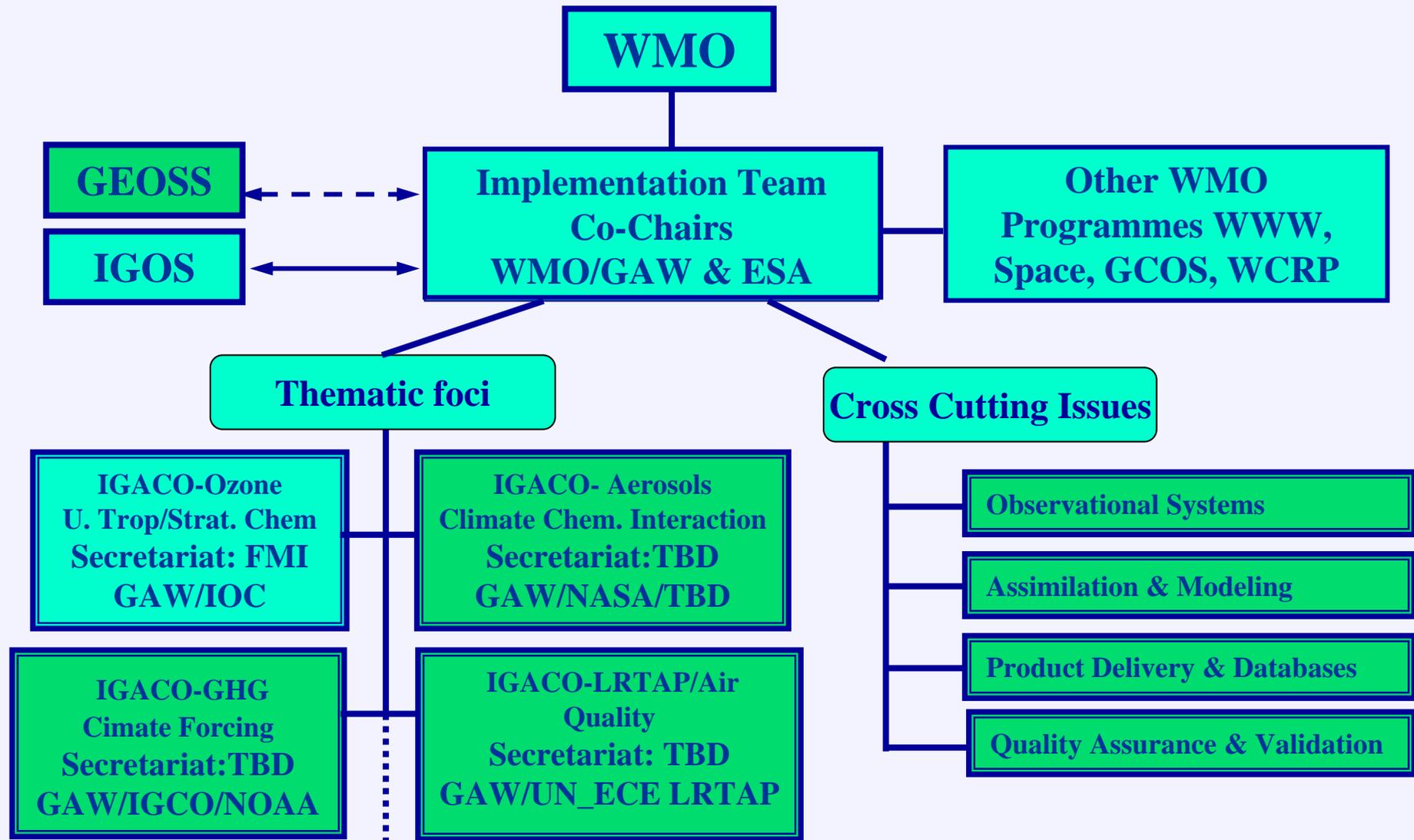
The IGACO System Components

The Data Stream

Products & Uses



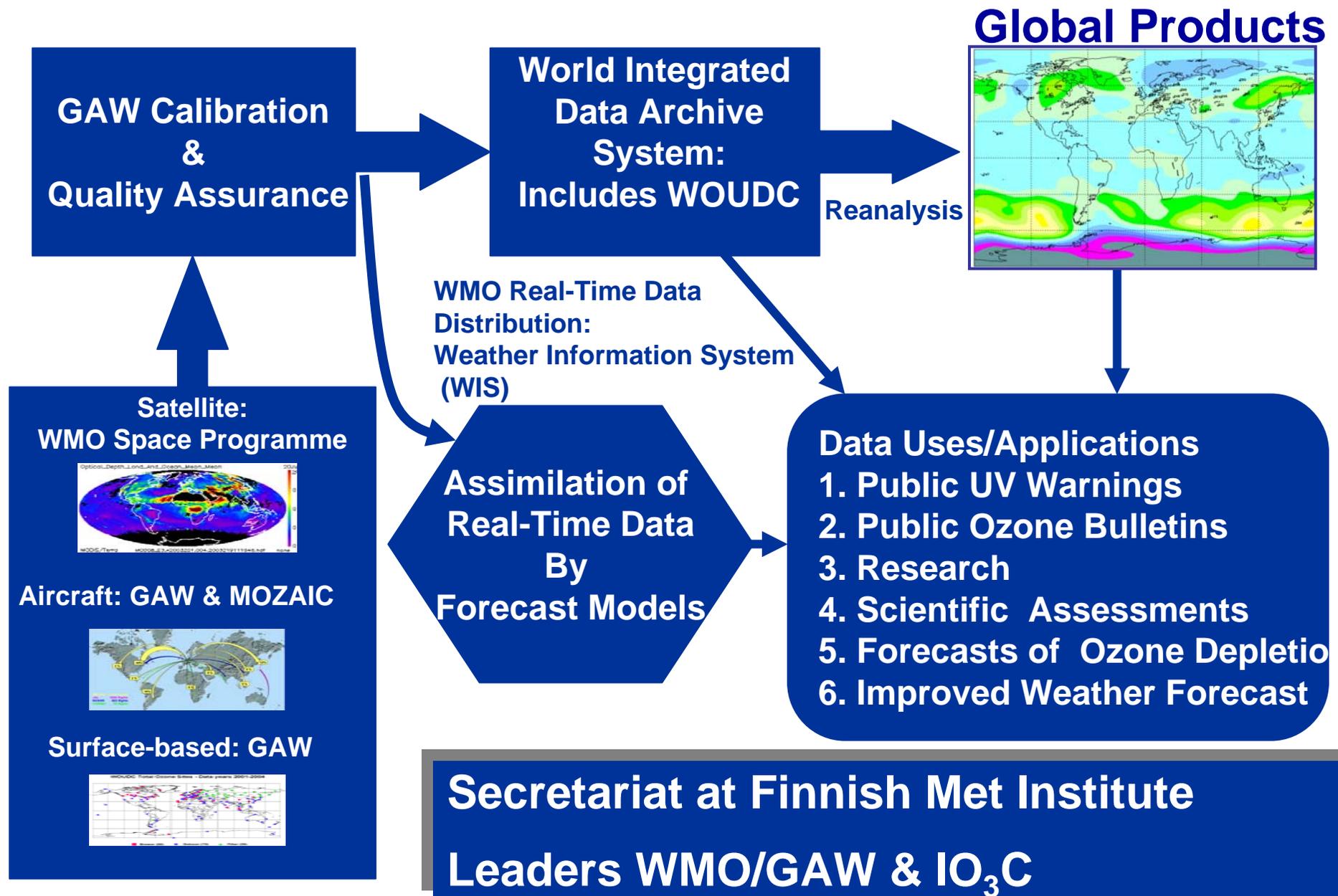
IGACO Implementation: Top-Down Meets Bottom-up



Examples of IGACO-relevant national, regional, international activities:

GEMS	ACCENT	AERONET	EMEP	EANET	WMO/GAW	NDSC
Satellite-Programmes		NATCHEM	BSRN	IMPROVE	IAGOS/MOZAIC	

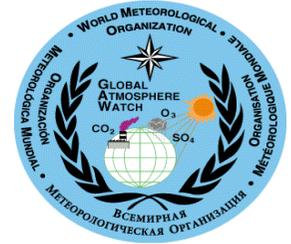
IGACO-Ozone





Upcoming Cross- Cutting Events

- **24-26 Oct., 2005 Joint WMO/GAW-ACCENT Workshop on the Global Tropospheric Carbon Monoxide Observations System, Quality Assurance and Applications, Zurich hosted by EMPA contact Jorg Klausen, L. Barrie, G. Braathen**
- **24-26 April 2006 WMO Geneva “Chemical Data Assimilation in Atmospheric Forecast and Re-analysis Models An ACCENT/WMO Expert Workshop in support of IGACO”, contacts are P. Borrell and L. Barrie**



WMO



THANK YOU