



# Report from the Commission for Atmospheric Sciences

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# Intro



**CAS had its fifteenth session from 18-25 November 2009 in Incheon.**



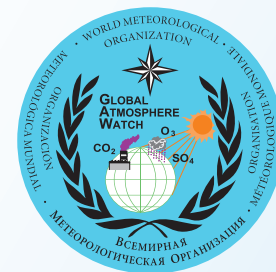
# Update on nomenclature



**CAS-XV recognized the need to simplify a confusing situation with respect to nomenclature and definitions related to the word “programme” and recommended that WMO formally delete AREP as a programme and recognize GAW and WWRP, including THORPEX, as main programmes of CAS delivering on key outcomes of the WMO Strategic Plan. Ensuing discussion clarified that CAS-XV also regarded the GAW programme as a key component of the WMO Integrated Global Observing System.**



# The Global Atmosphere Watch mission

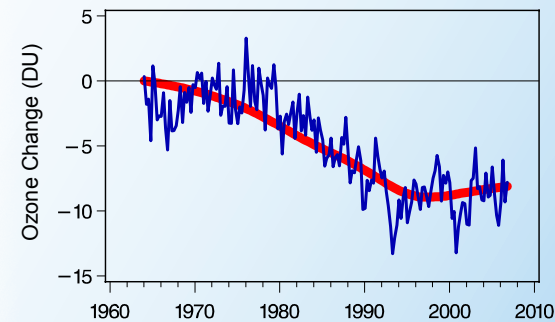
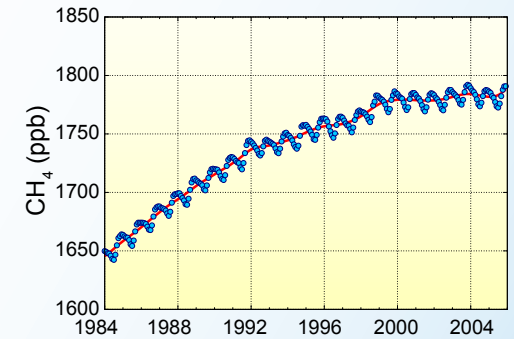


**Systematic Global Monitoring of the Chemical Composition of the Atmosphere**

**Analysis and Assessments in Support of International Conventions**

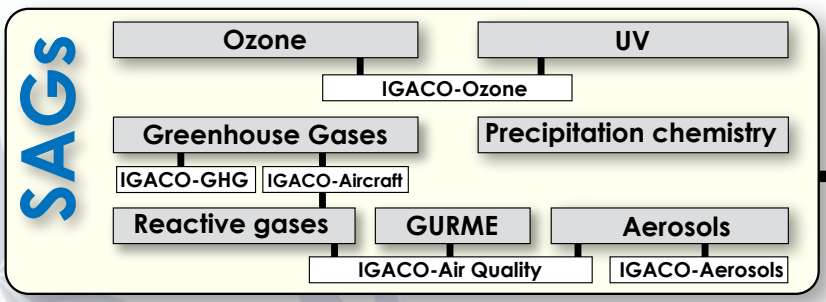
- ✓ **WMO/UNEP Scientific Assessment of Ozone Depletion. Work on the 2010 issue has begun**
- ✓ **IPCC Assessments. Planning of AR5 has started (to appear in June 2013)**

**Development and improvement of our ability to predict Air Pollution and Climate**





# The GAW System



**GAW Secretariat**

CAS Open Programme Area Group  
**EPAC**  
Environmental Pollution & Atmospheric Chemistry  
Joint Steering Committee

**Quality Assurance & Science Activity Centres**  
World & Regional Calibration Centres

<b>GHG</b> NOAA ESRL/GMD (USA)	<b>N<sub>2</sub>O VOC</b> IMK-IFU (DE)	<b>CH<sub>4</sub></b> JMA (JP)	<b>Precip. chem.</b> SUNY Albany (USA)	<b>Physical aerosol properties</b> IFT (DE)	<b>In situ O<sub>3</sub>, CO, CH<sub>4</sub></b> EMPA (CH)	<b>Optical depth</b> WORCC (CH)	<b>Total O<sub>3</sub></b> 3 WCC (US, CA, RU) 6 Dobson RCC (JP, AU, ZA, AR, DE, CZ) 1 Brewer RCC (ES)	<b>O<sub>3</sub> Sondes</b> FZJülich (DE)
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**Central Calibration Laboratories**  
Host GAW World Reference Standards

<b>CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O CO, Dobson O<sub>3</sub></b> NOAA ESRL/GMD (USA)	<b>Brewer total O<sub>3</sub></b> Environment Canada	<b>Ozone-sondes</b> FZJülich (DE)	<b>In situ O<sub>3</sub></b> NIST (USA)
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**Contributing networks**

**GAW stations & GAW SIS**

**Satellites & Aircraft**

**World Data Centres**

<b>WOUDC</b> Ozone & UV Environment Canada (CA)	<b>WDCGG</b> Greenhouse gases JMA (JP)	<b>WDCA</b> Aerosols NILU (NO)	<b>WRDC</b> Radiation MGO (RU)	<b>WDCPC</b> Precip. chem. SUNY Albany (USA)	<b>WDC-RSAT</b> Satellite data DLR (DE)
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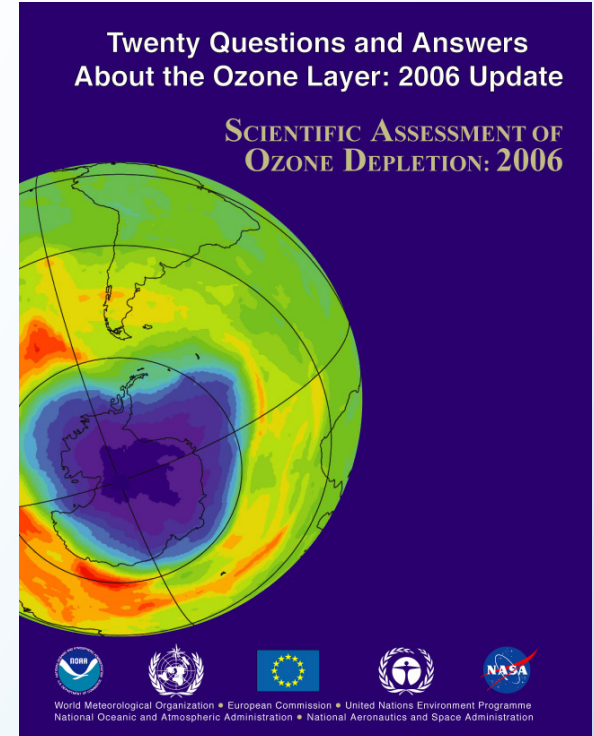
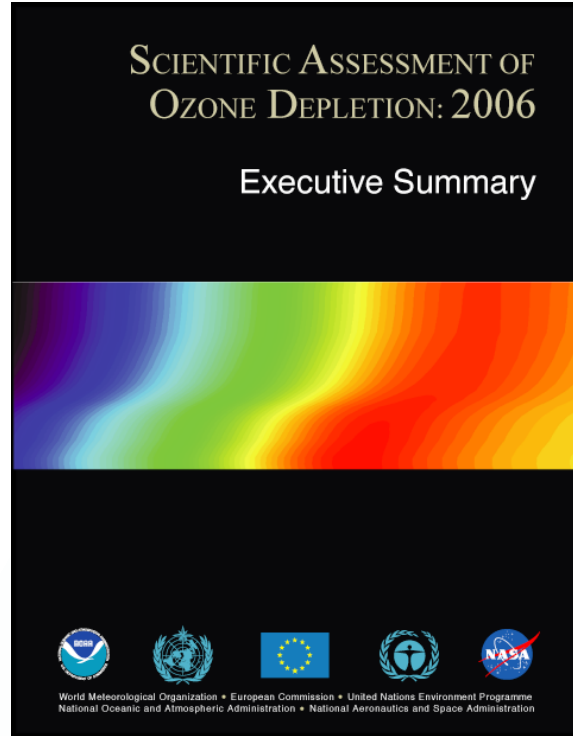
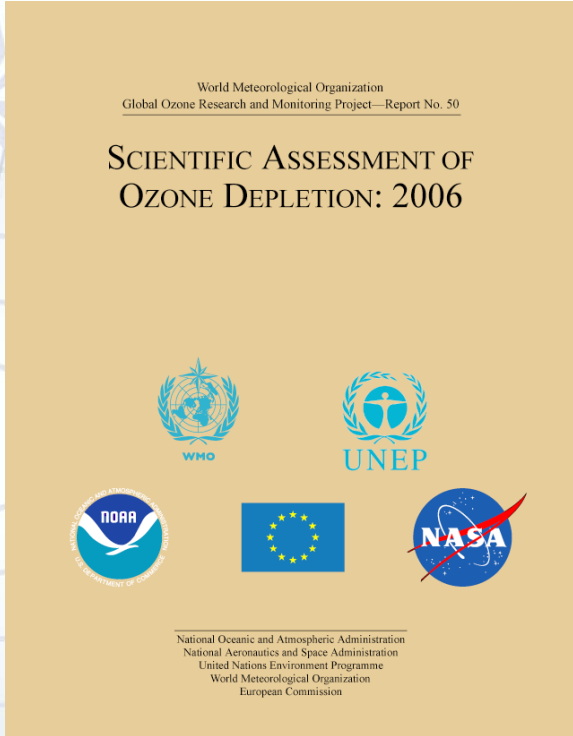
**IGACO products**

GHG Bulletins  
O<sub>3</sub> Bulletins  
Assessments  
Global fields



# Support for the Vienna Convention

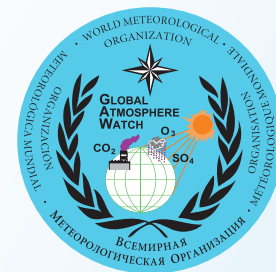
## WMO/UNEP Scientific Assessment of Ozone Depletion



**Need for long term validated and homogenous time series with global coverage: GOME/GOME-2, TOMS/OMI**

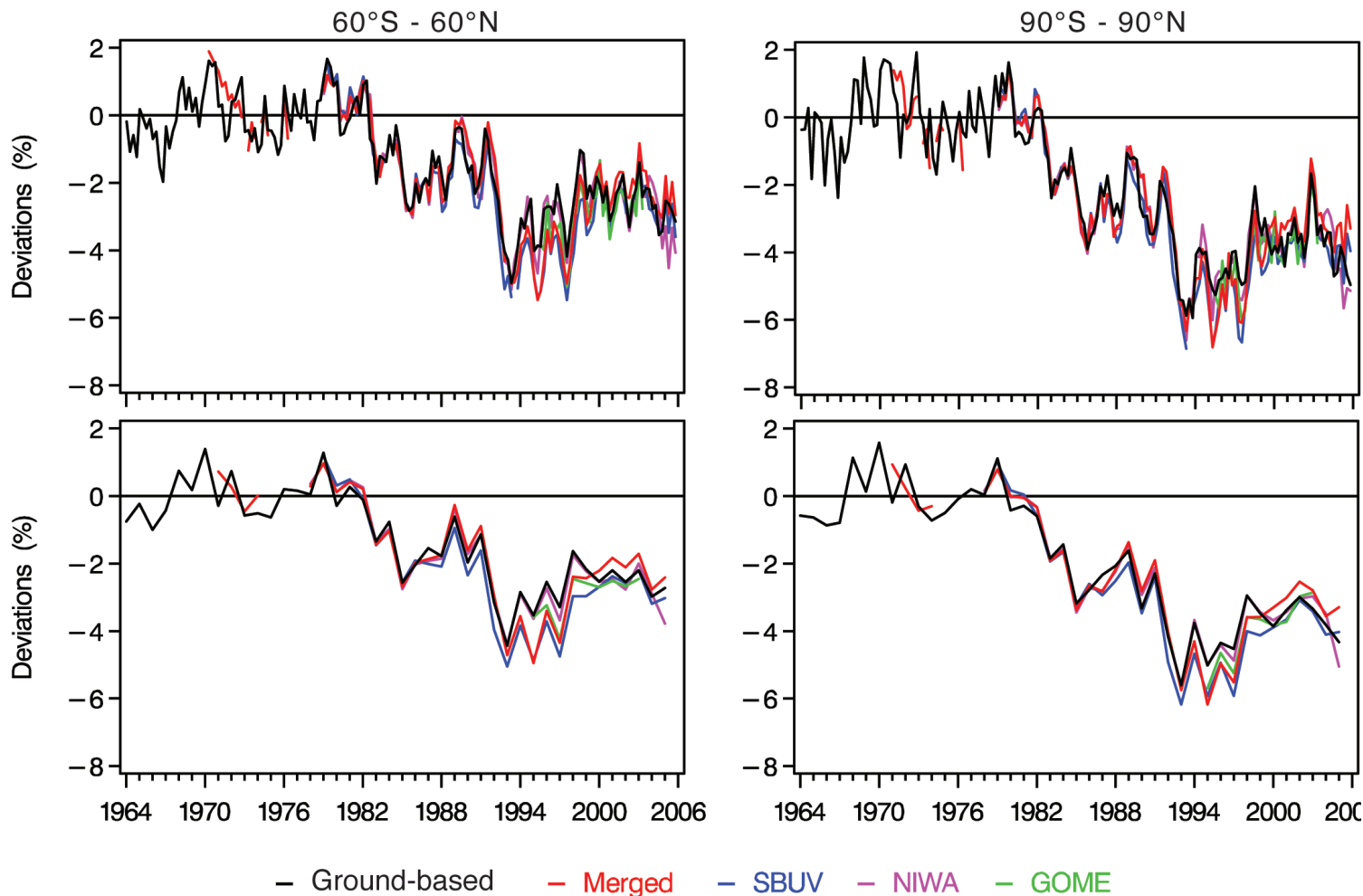


# Support for the Vienna Convention



## WMO/UNEP Scientific Assessment of Ozone Depletion: Needs both ground based and satellite data

From Ch. 3 of the Ozone Assessment

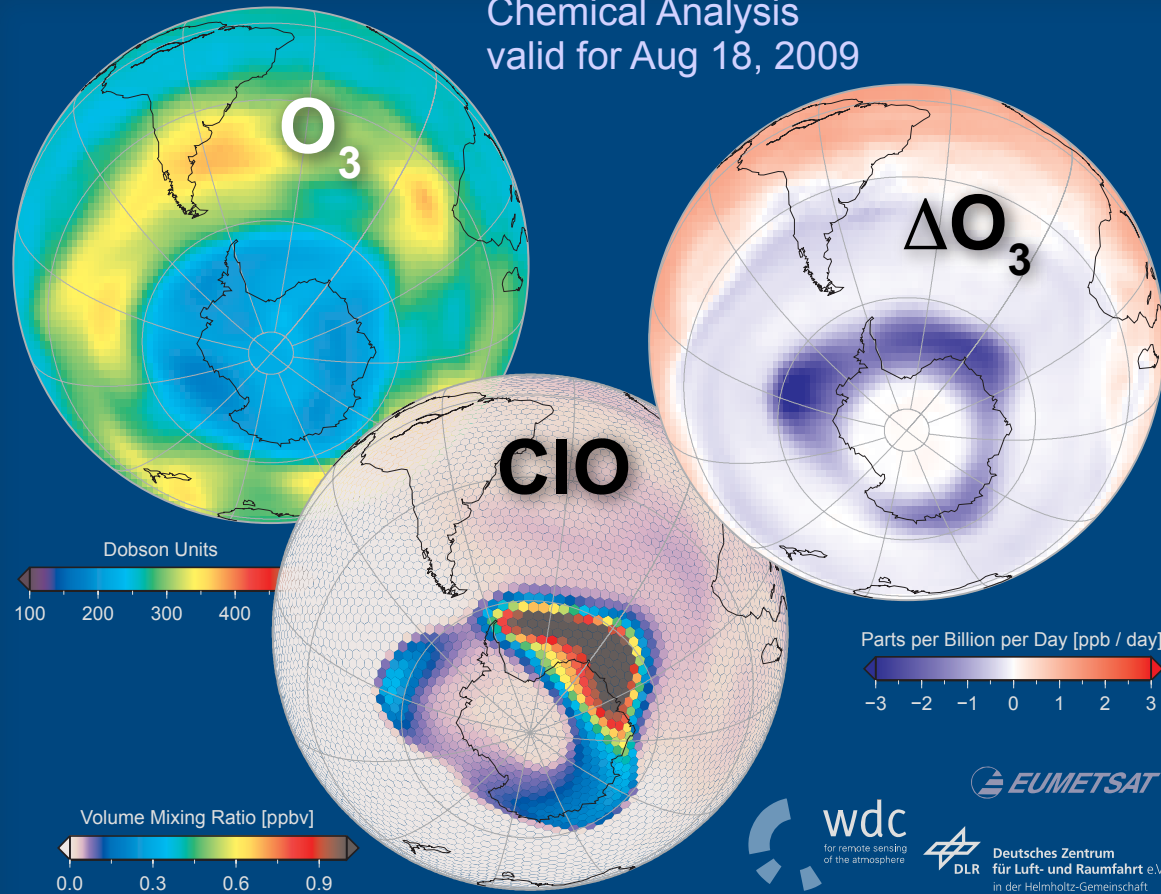




# Antarctic Ozone Bulletin

No 1/2009

Chemical Analysis  
valid for Aug 18, 2009



Latest information on the current Antarctic ozone hole as monitored by GOME-2 on Metop: a chemistry-transport model driven by GOME-2 observations shows the current extent of this year's ozone hole (left picture),  $\text{ClO}_x$  activation (center) related to stratospheric clouds and sun light, and chemical ozone depletion (right). Source: ICSU/WMO-GAW World Data Center for Remote Sensing of the Atmosphere (WDC-RSAT), <http://wdc.dlr.de> WDC-RSAT is a WMO-GAW World Data Centre since July 2009.



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21 Aug. 2009

Global Atmosphere Watch



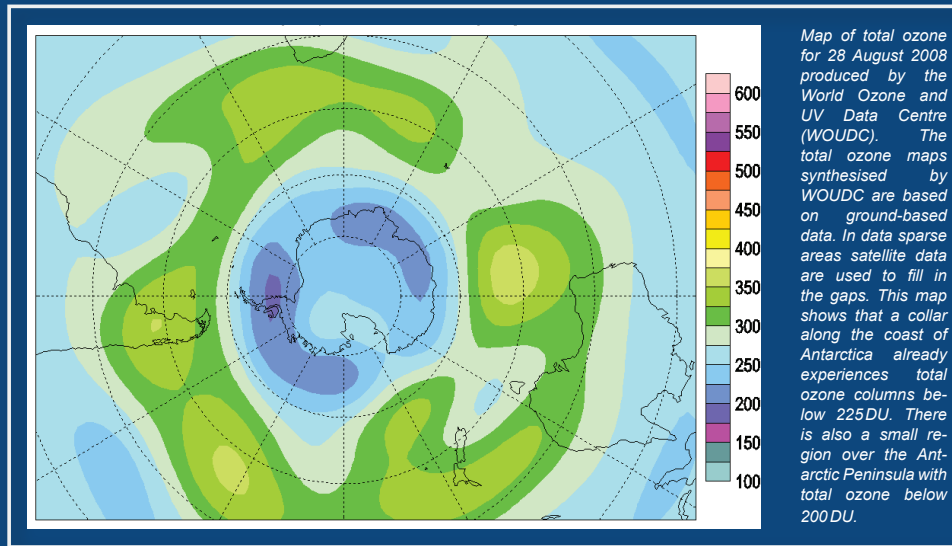
# Support for the Vienna Convention



## WMO Antarctic Ozone Bulletins

### Antarctic Ozone Bulletin

No 1/2008



**A end product that needs data in NRT, but also quality assured data.**

**Ground based and balloon data for the detailed picture and satellite data for the “big picture”.**



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28 Aug. 2008

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# Support for the Vienna Convention

## WMO Antarctic Ozone Bulletins



Several web services with satellite data:

### TEMIS

✓ <http://www.temis.nl>

### NASA GSFC Ozone Watch web site

✓ <http://ozonewatch.gsfc.nasa.gov>

### WDC-RSAT

✓ <http://wdc.dlr.de/>

### JPL site on Aura-MLS

✓ [http://mls.jpl.nasa.gov/plots/mls/mls\\_plot\\_locator.php](http://mls.jpl.nasa.gov/plots/mls/mls_plot_locator.php)

### WMO World Ozone and UV Data Centre

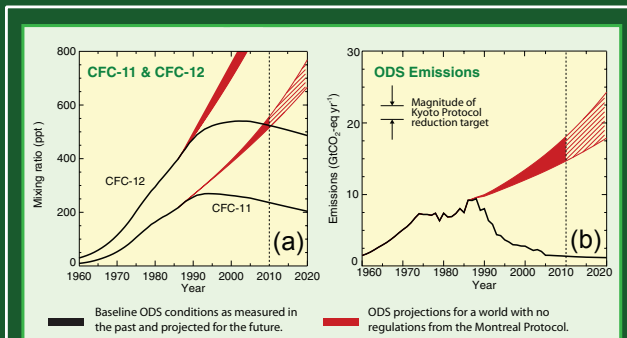
✓ <http://www.woudc.org>

# Support for the UNFCCC



## WMO Greenhouse Gas Bulletin

The State of Greenhouse Gases in the Atmosphere Using Global Observations through 2007



The Montreal Protocol (1987), resulted in reduced production and consumption of ozone depleting substances (ODS). By 2010 this will have caused a reduction of greenhouse gas warming that is a factor of five greater than the reduction target of the first commitment period (2008-2012) of the Kyoto Protocol.

The Montreal Protocol controls the production and consumption of ODS, the substances that cause stratospheric ozone depletion. Panel (a) shows how measured atmospheric abundances (black curves) of CFC-11 and CFC-12 declined starting in the early 1990s as a result of the protocol. For comparison the projected increases (red curves) in the absence of a Montreal Protocol is shown. The abundances in 2010 will be one half or less of what they would have been without the protocol. Panel (b) shows the sum over all ODS emissions expressed as an equivalent emission of CO<sub>2</sub>. Starting in the late 1980s, ODS emissions fell sharply (black curve) compared to those expected without the protocol (red curve). By 2010, the Montreal Protocol will have reduced emissions from ODSs by an amount equivalent to ~11 Gton CO<sub>2</sub> per year (including offsets); this is 5 to 6 times the reduction target of the first commitment period (2008-2012) of the Kyoto Protocol (2 Gton CO<sub>2</sub> eq/yr). Based on Velders et al., Proc. Natl. Acad. Sci., 104, 4814-4819, 2007. Figure prepared by E. Dlugokencky, D. Dailey-Fisher, and D. Fahey, NOAA ESRL.

### Executive summary

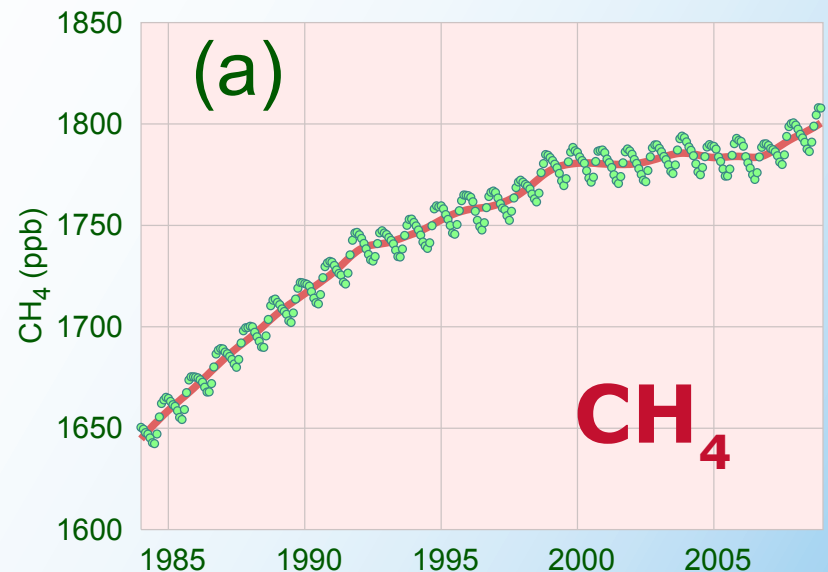
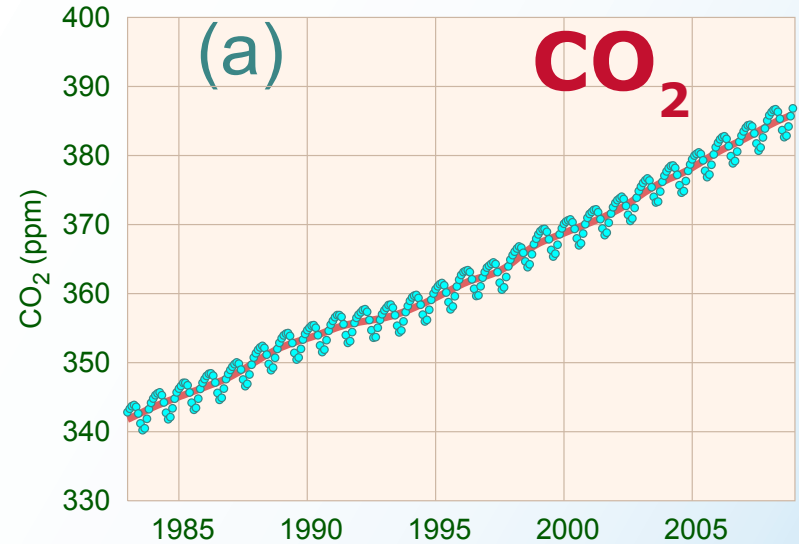
The latest analysis of data from the WMO-GAW Global Greenhouse Gas Monitoring Network, a comprehensive network of the Global Climate Observing System (GCOS), shows that the globally averaged mixing ratios of carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) have reached new highs in 2007 with CO<sub>2</sub> at 383.1 ppm, CH<sub>4</sub> at 1789 ppb and N<sub>2</sub>O at 320.9 ppb. These values are higher than those in pre-industrial times (before 1750) by 37%, 156% and 19%, respectively. Atmospheric growth rates in 2007 of CO<sub>2</sub> and N<sub>2</sub>O are consistent with recent years. The mixing ratio of CH<sub>4</sub> shows the largest increase since 1998. The NOAA Annual Greenhouse Gas Index (AGGI) shows that from 1990 to 2007 the atmospheric radiative forcing by all long-lived greenhouse gases has increased by 24.2%. The combined radiative forcing by the most abundant ozone depleting substances, CFC-11 and CFC-12, exceeds that of N<sub>2</sub>O. They are decreasing very slowly as a result of emission reductions under the Montreal Protocol on Substances That Deplete the Ozone Layer.



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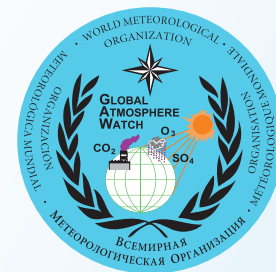
No. 4: 14 November 2008

Global Atmosphere Watch





# Areas where WIS interact with GAW and WWRP



## Sand and Dust Storms

- ✓ No WIS/WIGOS project, but CAS recommendations

## NRT delivery of atmospheric chemistry data (trop. ozone, strat. ozone, aerosols)

- ✓ GAW-IDOA: Improvement of Dissemination of Ozone (total column, profiles and surface) and Aerosol observations through WIS

## Harmonisation of GAW World Data Centres

- ✓ GAW-WDC: Improvement of Interoperability of GAW World Data Centres with WIS and Establishment of Prototype Services to Facilitate User Access to GAW Data

# General recommendations



## CAS-XV Recommendation 6.1.1:

The Commission foresaw that the expansion of the GTS into WIS would lead to easier data discovery and data access. Through WIS, data will be accessible to a much wider community than the National Meteorological and Hydrological Services (NMHSs). The Commission agreed that chemical data delivered in NRT and

assimilated using numerical weather and chemical prediction models are useful for improvement and validation of such models as well as in detecting problems with data quality. Moreover, it will enhance the delivery and quality of products such as the WMO Antarctic Ozone Bulletin.



# General recommendations



**CAS-XV Recommendation 6.1.3:** The Commission recognized that for the success of WIS, it was important to consider the access to WIS of institutes outside of NMHSs. There are several agencies and institutes working with GAW that are not part of or affiliated with NMHSs and who are requested to submit data to the system. Vice versa, being able to acquire data for their use is very relevant for these institutes. Therefore, the Commission strongly recommended that WIS was accessible to a large community of NMHSs, partners and users. For instance, in the IDOA project (paragraph 6.1.2), the World Optical Depth Research Calibration Centre at PMOD Davos Switzerland and the Norwegian Institute for Air Research are data providers external to NMHSs and will be contacted with requests to implement or develop software for transmitting aerosol data over WIS in BUFR/CREX format. The Commission agreed that gateways that permit access for external providers and users to the GTS network need to be identified.

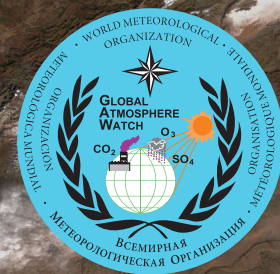
# General recommendations



**CAS-XV Recommendation 6.1.6:** The Commission recognized that effective implementation, sustainment and maintenance of information and observation systems require an effective and regular review of requirements, capabilities and future planning. It noted that the Rolling Review of Requirements (RRR) process was the basis for doing this for both WIS and WIGOS. It also noted the existing documentation within the RRR database and the Statement of Guidance (SoG) for Atmospheric Chemistry was last updated in 2004 even though requirements development has continued outside the RRR process. The Commission decided to work with CBS, in particular its ET on the Evolution of the GOS, to update the RRR documentation and to develop procedures and processes to keep the RRR documentation current.



# *Sand and Dust Storms*



**CAS Recommendation 6.3.5:** The Commission recommended that SDS-WAS regional Nodes adopt common standards for data exchange formats, graphical presentation of forecasts and data exchange. The proposed adoption of the GRIB and netcdf formats of WIS by the North African, Middle East and Europe node was welcomed. The Commission endorsed the principle that both research and operational partners are able to participate in data exchange through WIS. The Commission also recommended that formal invitation letters be sent to observational and modeling partners by the Secretary-General of WMO encouraging participation in exchange of observations and forecasts in support of SDS-WAS.



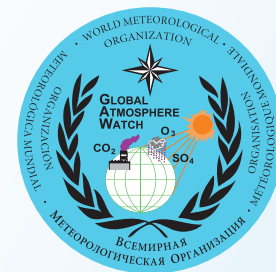


# Sand and Dust Storms

**CAS-XV Recommendation 6.3.6:** The Commission urged SDS-WAS to cooperate with GAW, GOS and other components of WIGOS to generate appropriate observations of sand and dust and to deliver them through WIS in a timely manner to be used for data assimilation and validation of dust forecasts and reanalyses. The Commission encouraged Members to implement core aerosol measurements as recommended by the GAW Aerosol Scientific Advisory Group (WMO/TD-No. 1178) and to assist GAW in implementing an integrated global aerosol observing system serving the needs of SDSWAS users. CAS-XV agreed with CBS-XIV (paragraph 10.18) and recommended that research demonstration projects are used in SDS-WAS to promote the exchange of surface-based in situ and remote sensing aerosol observations (PM<sub>10</sub>, PM<sub>2.5</sub>, AOD and LIDAR).



# Ozone and aerosols



**CAS-XV Recommendation 6.1.2:** The Commission is pleased that a WIS-WIGOS Pilot Project entitled “Improvement of Dissemination of Ozone and Aerosol observations through the WIS” (GAW-IDOA) has been approved by the EC-WG on WIGOS and WIS. IDOA aims at improving the availability of ozone (total column, profiles and surface) and aerosol (Aerosol Optical Depth (AOD) and surface Particulate Matter (PM)) observations to the user community through WIS (noting that WIS includes the GTS) and at preparing documentation to help other communities to make their observing practices compatible. The pilot project combines activities already proposed by the CAS SAGs for Ozone and Aerosols, the CAS ET-NRT CDT, and the CBS ET-EGOS. Considering Resolution 15 (Cg-XV), the Commission urged all Members who carry out regular ozone (total and profile) and aerosol observations to support this project and to submit their data for easy access by users in near-real-time via the WMO Global Telecommunications System of the WMO Information System (GTS/WIS).

# Interoperability of GAW World Data Centres with WIS



**CAS-XV Recommendation 5.3.1.5:** The Commission agreed on the usefulness of the GAW Station Information System (GAWSIS, <http://gaw.empa.ch/gawsis/>), a system for tracking and providing information on monitoring efforts in GAW and recommended the establishment of GAWSIS as a permanent World Data Centre for Metadata within GAW with a view of becoming a DCPC for WIS. Information includes lists of stations and contacts and station reports, these include site characterization, measurement programme (including metadata and hyperlinks to data archives), contacts and bibliographic references. The Commission urged the Members that operate stations in relevant networks to make observational data available through GAW WDCs in a timely fashion and agreed with the OPAG EPAC JSC recommendation that station information for interested networks contributing to GAW should be included in GAWSIS even if the data are not available through GAW WDCs.



# Interoperability of GAW World Data Centres with WIS



**CAS-XV Recommendation 6.1.4:** The Commission noted that a WIS-WIGOS Pilot Project entitled “Improvement of Interoperability of GAW World Data Centres with WIS and Establishment of Prototype Services to Facilitate User Access to GAW Data” (ET-WDC PP) had been approved by the EC WG on WIGOS-WIS. The aims of this project are to:

- (a) Improve the possibilities to discover data archived at individual GAW World Data Centres (WDCs);
- (b) Improve dissemination of data archived at the WDCs beyond their designated communities;
- (c) Establish tailored services for the GAW global stations allowing them comfortable access to data and information products;

while retaining the visibility of the individual data centres.

A progress report was submitted for the WIGOS steering group meeting which took place in October 2009. The Commission recommends to the data centres to continue to progress in implementing the project plan including developing the necessary functionality needed for compliance with WIS. Recognizing that several data centres are struggling to meet existing requirements, WMO Members supporting them are encouraged to continue and, where possible, expand support for these data centres.

# 6 GAW WDCs hosted in 6 countries



## WOUDC

- ✓ Total/Profile Ozone, UV

## WRDC

- ✓ (Broadband) Solar Radiation

## WDCGG

- ✓ Greenhouse Gases and some reactive gases (incl. surface O<sub>3</sub>)

## WDCA

- ✓ Aerosols

## WDCPC

- ✓ Precipitation Chemistry

## WDC-RSAT

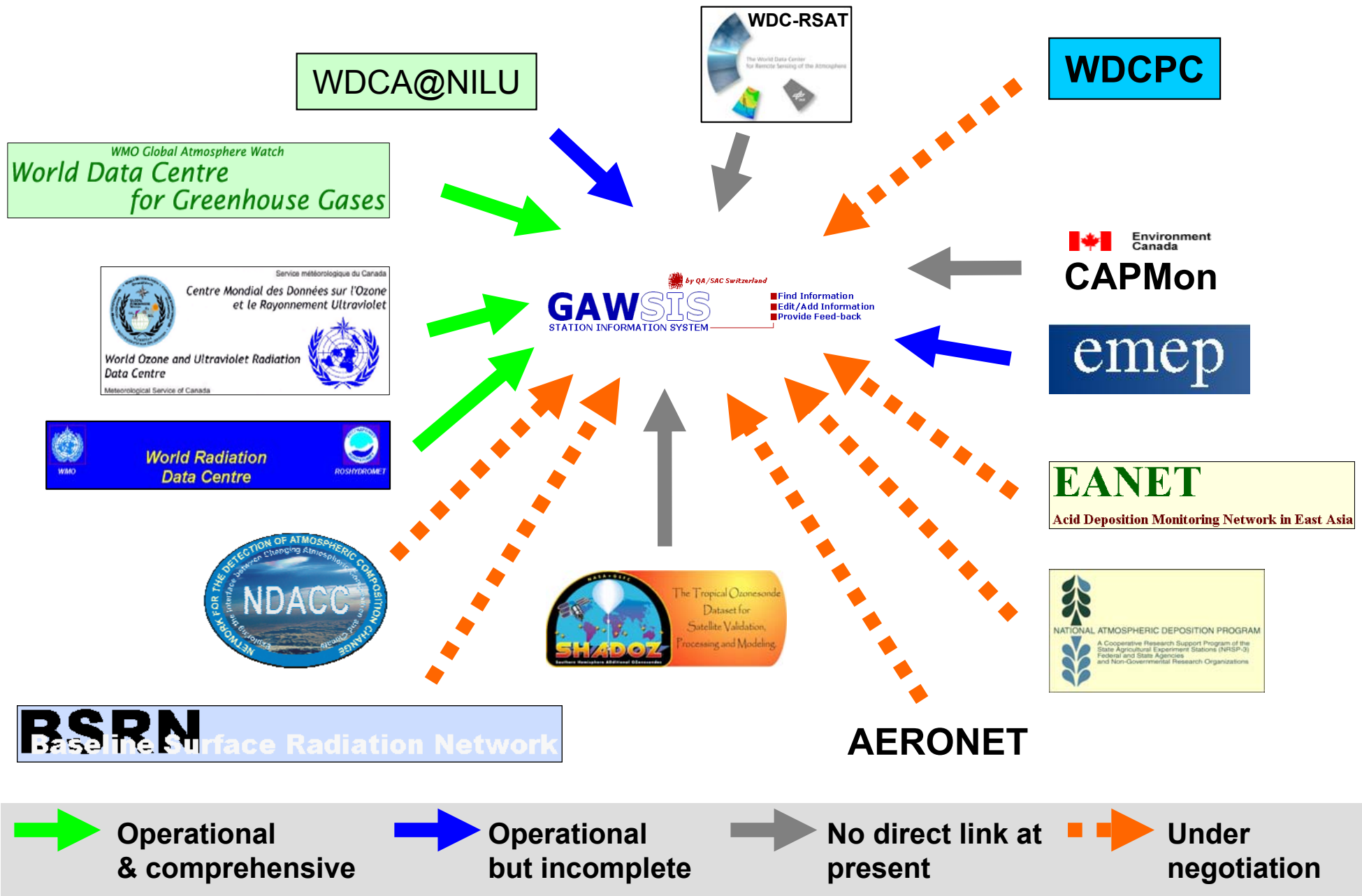
- ✓ Satellite Remote Sensing

## Metadata centre

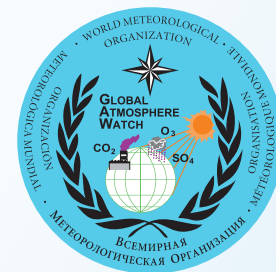
- ✓ GAWSIS
- ✓ Bridges the information on the ground-based observation system across variables
- ✓ Comprehensive metadata



# Integration – Present status



# Goals



 **Improve interoperability of GAW WDCs within GAW and with WIS**

 **Improve the possibility for machines to discover data archived at the individual WDCs**

 **Improve the dissemination of data archived at the WDCs**

 **Establish tailored services for the GAW global stations allowing them comfortable access to data and information products available from WDCs**



# Part 1: Metadata



## Objective

- ✓ **Implementation of ISO/WIS-compliant representations of metadata for the data archived in the WDCs**



## Present Status

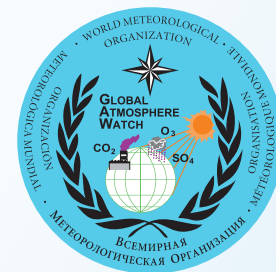
- ✓ **Automatic metadata exchange between GAWSIS and a number of WDCs (WOUDC, WDCGG, WDCA/EBAS, WRDC)**
- ✓ **ISO/WIS-compliant XML representations of GAWSIS metadata available**
- ✓ **Issues remaining pertain to lack of definitions of vocabularies, concrete implementation requirements by WIS**



## Outlook

- ✓ **Include more data centres (WDCPC and others, e.g., NDACC)**

# Part 2: Facilitate access to ground-based data



## Objective

- ✓ Develop a prototype client tool to facilitate extraction of GAW data across multiple WDCs

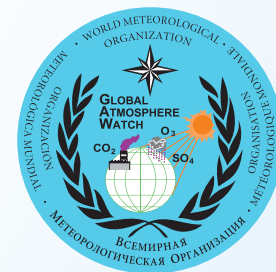
## Present Status

- ✓ Draft implementation under development
- ✓ Present prototype allows synchronous access and handling of WDCGG data only

## Outlook

- ✓ Inclusion of at least one more WDC is pertinent
- ✓ Review of concepts used and prototype by ET-WDC





# Part 3: Tailored/advanced services

## Objective

- ✓ Establish tailored services for the GAW global stations allowing them comfortable access to data and information products available from WDCs

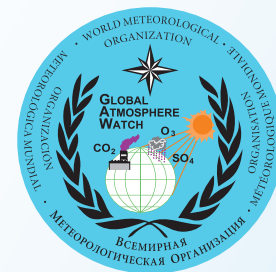
## Present Status

- ✓ Sub-project just started by WDC-RSAT (DLR, Germany)

## Outlook

- ✓ Need to wait for first results first

# Help/assistance needed from CIMO / CBS



 **Choice of vocabularies for WIS-compliant metadata representations. Specifically, guidance is needed for**

- ✓ **naming chemical compounds**
- ✓ **analytical methods used in atmospheric composition monitoring**
- ✓ **physical principles used in atmospheric composition monitoring**

 **Choice of mechanism for harvesting metadata at WDCs and GAWSYS by WIS and assistance with implementation.**

 **Detailed review of the current implementation of this Project would be helpful.**



# GAW IDOA Pilot Project

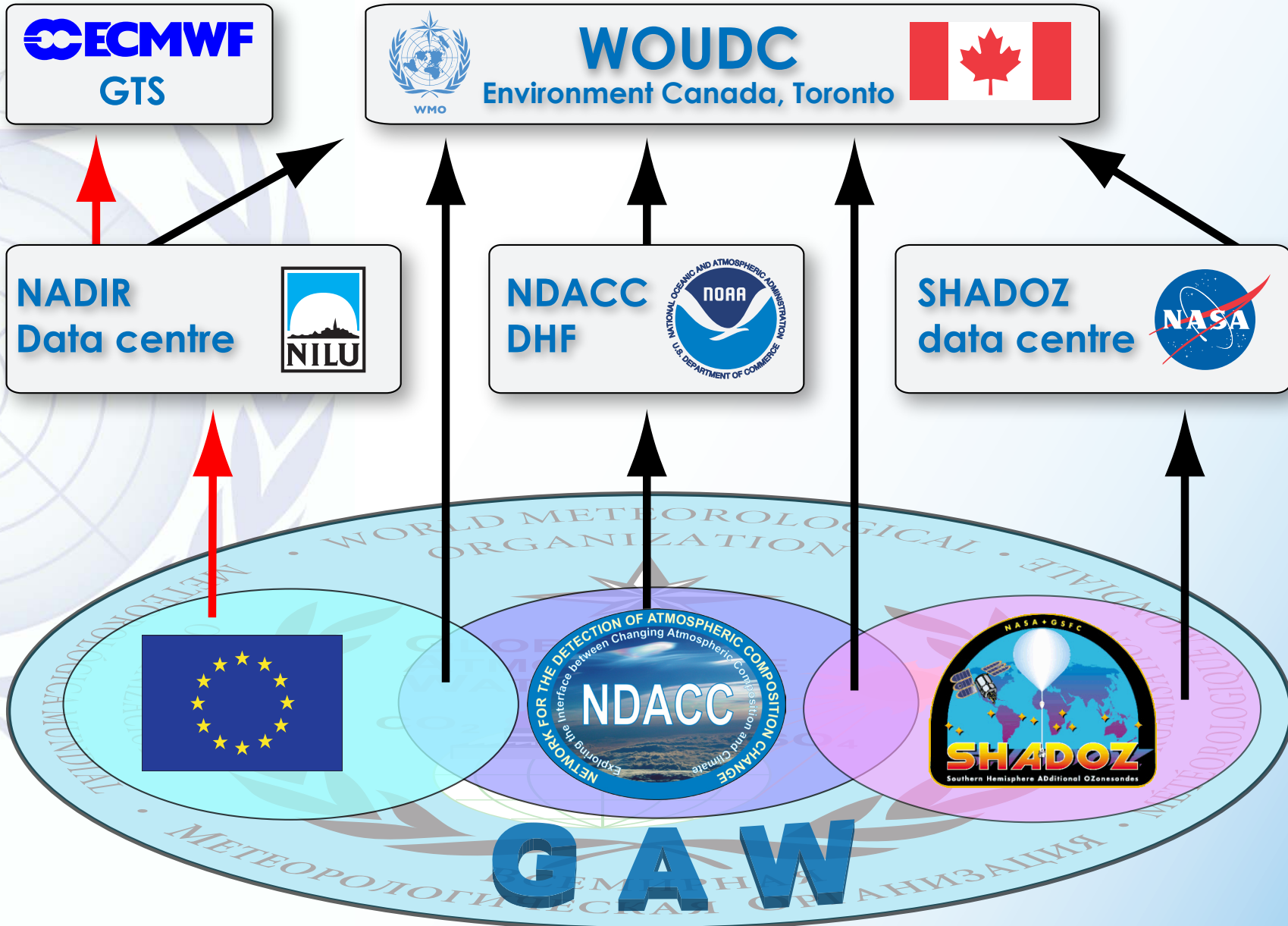


## Near-real time delivery of ozone and aerosol data

- ✓ Useful for quality control
- ✓ Needed for satellite validation
- ✓ Useful for model validation (e.g. for the MACC project)
- ✓ Needed for the WMO ozone bulletins
- ✓ Some stations already submit total ozone to the GTS (Canada, Czech Republic, Japan)
- ✓ CHMI (Vanicek, Cervena, Stanek) have developed software for coding of total ozone data to CREX.
- ✓ As a first step one should make this software available to stations that belong NHMSs.
- ✓ Next step will be to include non-NHMS stations. An ftp server will be needed for this.

# GAW IDOA Pilot Project

## Ozonesonde data flow





# GAW IDOA Pilot Project

## Aerosol Optical Depth



### Implementation progress

- ✓ Sun photometry data measured by PFR instruments is collected in NRT (hours) or daily basis from about 20 GAW stations by WRC-WORCC at Davos and processed into quick-look AOD results that are presented on a web page.

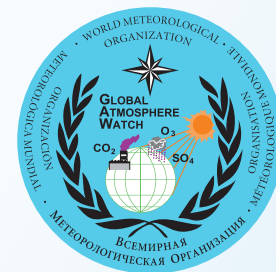


### Implementation Constraints

- ✓ WORCC is hosted at a research institute without access to GTS network; public internet (VPN, FTP protocols) is used instead.
- ✓ There was great reluctance from some NMI to allow for direct access to their internal network in order to collect raw data via TCP/IP.
- ✓ Potential data users remained obscure. WORCC got no requests for NRT data so far, apart from some participating GAW stations themselves.

# **GAW IDOA Pilot Project**

## **Aerosol Optical Depth**



### **Action Plan**

- ✓ **Software scripts for daily data transfer via ftp-push were developed and provided to those GAW stations where IT security rules would not allow direct access to instrumentation.**
- ✓ **AOD data may now be fed in NRT to the new WDCA located at NILU since January 2010.**

### **Lessons Learned**

- ✓ **GAW Aerosol Optical Depth global network is operated by WORCC with data residing at WDCA and meta-data being maintained at GAWSIS. All 3 players are external to NMHI and the GTS network. This constellation makes NRT integration of AOD in WIGOS potentially more difficult than for parameters entirely managed by individual NMHI's.**

# GAW IDOA Pilot Project

## Aerosol Optical Depth



### Challenges

- ✓ Definition of ISO 19115 meta data for AOD in collaboration with GAWSIS and WDCA.
- ✓ Establishment of data format and protocols for NRT transmission to WDCA in collaboration with WDCA at NILU.
- ✓ NRT delivery at hourly lag would need major additional development effort.

### Implementation Priorities for the next period

- ✓ Establishment of data format and protocols for NRT transmission to WDCA in collaboration with NILU.

### Resources Status

- ✓ PFR instrumentation at several GAW stations was upgraded for TCP/IP access using funding provided by WORCC.
- ✓ Software development and hardware facilities were provided and can be sustained through WORCC operational budget supported by Meteo Swiss.



# Reactive gases (surface ozone etc.)



**The EU funded GEMS and MACC projects are users of rapid- delivery data**



**Meeting in Garmisch in Oct 2009**



**Stations participating in NRT delivery for GEMS**

- ✓ **Zugspitze/Hohenpeissenberg (Germany)**
- ✓ **Mt. Cimone (Italy)**
- ✓ **Izaña and Santa Cruz (Spain)**
- ✓ **Cape Point (South Africa)**
- ✓ **Tamanrasset/Assekrem (Algeria)**
- ✓ **Neumayer (Antarctica)**
- ✓ **Moussala (Bulgaria)**



**Letters of agreement between WMO, MACC and stations are in the process of being signed.**

# Reactive gases (surface ozone etc.)



## Species of interest as a first step

- ✓ Ozone
- ✓ CO

## Next step (near to mid-term future)

- ✓ NO<sub>x</sub>
- ✓ SO<sub>2</sub>
- ✓ VOCs

## MACC is coordinated by ECMWF (Adrian Simmons)

- ✓ This will facilitate the contact between MACC and GTS/WIS



# More info

[\*http://www.wmo.int/gaw\*](http://www.wmo.int/gaw)

[\*http://www.igaco-o3.fi\*](http://www.igaco-o3.fi)

[\*http://gaw.empa.ch/gawsis\*](http://gaw.empa.ch/gawsis)





Changdeokgung

Kamsahamnida  
Thank you

