GAW Report No. 197

Addendum for the Period 2012 – 2015 to the WMO Global Atmosphere Watch (GAW) Strategic Plan 2008 – 2015

For more information, please contact:

World Meteorological Organization

Research Department

Atmospheric Research and Environment Branch

7 bis, avenue de la Paix – P.O. Box 2300 – CH 1211 Geneva 2 – Switzerland

Tel.: +41 (0) 22 730 81 11 – Fax: +41 (0) 22 730 81 81

E-mail: AREP-MAIL@wmo.int

Website: http://www.wmo.int/pages/prog/arep/gaw/gaw_home_en.html

World Meteorological Organization

Weather • Climate • Water

© World Meteorological Organization, 2011

The right of publication in print, electronic and any other form and in any language is reserved by WMO. Short extracts from WMO publications may be reproduced without authorization, provided that the complete source is clearly indicated. Editorial correspondence and requests to publish, reproduce or translate these publication in part or in whole should be addressed to:

Chairperson, Publications Board
World Meteorological Organization (WMO)
7 bis, avenue de la Paix
P.O. Box 2300
CH-1211 Geneva 2, Switzerland

Tel.: +41 (0) 22 730 84 03
Fax: +41 (0) 22 730 80 40
E-mail: Publications@wmo.int

NOTE

The designations employed in WMO publications and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of WMO concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Opinions expressed in WMO publications are those of the authors and do not necessarily reflect those of WMO. The mention of specific companies or products does not imply that they are endorsed or recommended by WMO in preference to others of a similar nature which are not mentioned or advertised.

This document (or report) is not an official publication of WMO and has not been subjected to its standard editorial procedures. The views expressed herein do not necessarily have the endorsement of the Organization.

WORLD METEOROLOGICAL ORGANIZATION
GLOBAL ATMOSPHERE WATCH

Addendum for the Period 2012 - 2015

to the WMO Global Atmosphere Watch (GAW) Strategic Plan 2008 - 2015

Main Contributors

Gerhard Müller (Chair)
Rick Artz and SAG Precipitation Chemistry
Greg Carmichael and SAG GURME
Ed Dlugokencky and SAG Greenhouse Gases
John Ogren and SAG Aerosols
Stuart Penkett and SAG Reactive Gases
Johannes Stähelin and SAG Ozone
Ann Webb and SAG UV
Jörg Klausen and Expert Team on World Data Centres (ET-WDC)
Øystein Hov and JSC OPAG EPAC

WMO Secretariat

Liisa Jalkanen, Oksana Tarasova, Geir Braathen, Slobodan Nickovic and Pauline Mooney-Corelli

Editor

Jörg Klausen

May 2011

Table of Contents

1. **INTRODUCTION** **1**
   1.1 Purpose and Structure of Document 1
   1.2 Framework of GAW 1
   1.3 Achievements during 2008-2011 3
      1.3.1 Organizational Components 3
      1.3.2 Observing Systems 6
      1.3.3 Quality Assurance 7
      1.3.4 Data Management 8
      1.3.5 Integration and Application of Observations 8
      1.3.6 GAW Focal Areas 9
      1.3.7 Outreach 14
   1.4 Acceptance of Stations and Designation of Central Facilities 14

2. ORGANIZATIONAL COMPONENTS **15**
   2.1 National Meteorological and Hydrological Services (NMHSs) 15
   2.2 Expert Groups 15
   2.3 Central Facilities 15
   2.4 Secretariat 16
   2.5 GAW Partners 16

3. OBSERVING SYSTEMS **17**
   3.1 Surface-Based Observations 17
      3.1.1 Land-based Observations 17
      3.1.2 Ship-based Observations 17
   3.2 Aircraft Observations 17
   3.3 Satellite-based Observations 17
   3.4 Integrated Observing System 18

4. QUALITY ASSURANCE **19**
   4.1 Products and Services 19

5. DATA MANAGEMENT **20**
   5.1 Products and Services 20

6. INTEGRATION AND APPLICATION OF OBSERVATIONS **22**
   6.1 Reanalysis and Forecasts including Assimilation 22
   6.2 Assessments 22
   6.3 Products and Services 22

7. GAW FOCAL AREAS **23**
   7.1 Ozone 23
      7.1.1 Column (Total) Ozone 23
      7.1.2 Ozone Profile Measurements 23
      7.1.3 Products and Services 24

7.2 Greenhouse Gases 25
7.2.1 Carbon Dioxide (CO_2) (incl. $\Delta^{14}C$, $\delta^{13}C$ and $\delta^{18}O$ in CO_2, and O_2/N_2 Ratios) 25
7.2.2 Methane (CH_4) 26
7.2.3 Nitrous Oxide (N_2O) 27
7.2.4 Halocarbons and SF_6 27
7.2.5 Molecular Hydrogen (H_2) 27
7.2.6 Products and Services 27
7.3 Reactive Gases 28
7.3.1 Surface Ozone 28
7.3.2 Carbon Monoxide (CO) 28
7.3.3 Volatile Organic Compounds (VOCs) 29
7.3.4 Nitrogen Oxides (NO_x) 29
7.3.5 Sulphur Dioxide (SO_2) 30
7.3.6 Products and Services 30
7.4 Atmospheric Wet Deposition 30
7.4.1 Products and Services 31
7.5 UV Radiation 31
7.5.1 Products and Services 32
7.6 Aerosols 32
7.6.1 Products and Services 34

8. ANCILLARY VARIABLES 35
8.1 Solar Radiation 35
8.2 Meteorological Observations 35
8.3 Natural Radioactivity 35

9. GAW URBAN RESEARCH METEOROLOGY AND ENVIRONMENT (GURME) PROJECT 36
9.1 Implementation Strategy 36
9.2 Modelling Needs 36
9.3 Observational Needs 36
9.4 Air Quality 36
9.5 Capacity Building 37
9.6 User Community 37
9.7 Products and Services 37

10. OUTREACH 39
10.1 Communications 39
10.2 Capacity Building 39
10.3 Products and Services 39

11. RESOURCES 41

References 42
List of Figures, Tables and Boxes 44
Annex 1 - Overview of Responsible Bodies and Assigned Tasks 45
Annex 2 - Procedure for Acceptance of New Stations/Networks in Gaw 48
Annex 3 - Procedure for Designation of GAW Central Facilities 50
Acronyms and Abbreviations 51
Global Atmosphere Watch Report Series 57

1. INTRODUCTION

1.1 Purpose and Structure of Document

The Global Atmosphere Watch (GAW) Programme celebrated its 20th anniversary in 2009. During this time GAW has gained broad acceptance as the global long-term measurement, analysis and assessment programme for atmospheric composition.

The GAW Strategic Plan serves to guide the development of the Programme during an eight year period. The present 'WMO Global Atmosphere Watch (GAW) Strategic Plan: 2008-2015', published as GAW Report No. 172, specified implementation tasks for the period 2008-2011 [*WMO*, 2007c]. The purpose of this document, the 'Addendum to the GAW Strategic Plan: 2008-2015', is to guide the work of all GAW contributors for the period 2012-2015. The general strategy for the development of the Programme, the long-term objectives, the implementation principles, and the various goals spelled out in sub-chapters of the original document remain unchanged.

The structure of this document follows by and large the structure of the original document. To keep it as concise as possible, several sections are not re-produced herein, and the reader is advised to consult the original document. *Chapter 1.2* describes the framework within which GAW operates and develops. *Chapter 1.3* presents updates of the current structure of GAW, and highlights some of the achievements during 2008 – 2011. *Chapters 2 – 11* list ongoing and new tasks for the remainder of the implementation period. For each task, the responsible body (underlined) and contributors (normal print) are specified, and the period of activity is indicated. For tasks carried over from the GAW Strategic Plan either verbatim or in spirit, the original task number is given in square brackets. The appendices formulate requirements and procedures for acceptance of new stations and Central Facilities. They illustrate the importance these components have for GAW. Finally, a table lists all bodies responsible for the implementation of GAW and the tasks assigned to them.

1.2 Framework of GAW

The GAW Strategic Plan is in line with the WMO Strategic Plan 2008-2011 [*WMO*, 2008a] and the follow-up WMO Strategic Plan 2012-2015 [*WMO*, 2011c], and it contributes to the identified Global Societal Needs: protection of life and property; poverty alleviation, sustained livelihoods and economic growth; and sustainable use of natural resources and improved environmental quality. The GAW Programme fully aligns with the five strategic thrusts of WMO[1], with results of GAW naturally centering more in the areas of air quality, long-range transport of air pollutants, and climate [*WMO*, 2011c].

Specific challenges addressed by GAW are rooted in the diversity and the comparatively strong research orientation of atmospheric monitoring networks contributing to the Programme. The challenges have to do with global network design and implementation on the one hand, and integrated application of observations in 4D space on the other hand. Rational network design calls for

- Increased coordination among regions and within each type of network
- Extension of the Programme in under-sampled regions
- A focus on quality-control
- Further harmonization and operationalization of data management; while the integration of observations requires some of the above plus
- Enhanced interaction of the data generation and assimilation/modelling communities
- Development of re-analysis products for combining different types of measurements

The International Council for Science (ICSU) has conducted an open 'Visioning Process' to shape the future of Earth System Science, out of which five 'Grand Challenges' emerged that

[1] *The strategic thrusts enumerated in the WMO Strategic Plan are i) Improving service quality and service delivery, ii) Advancing scientific research and application as well as development and implementation of technology, iii) Strengthening capacity building, iv) Building and enhancing partnerships and cooperation, v) Strenghtening good governance.*

represent barriers to sustainable development [*Reid et al.*, 2010]. GAW supports the first two of these through reliable provision and application of atmospheric observations:

- Improve the usefulness of forecasts of future environmental conditions and their consequences for people
- Develop, enhance, and integrate observation systems to manage global and regional environmental change

The WMO Commission for Atmospheric Sciences at their fifteenth session (CAS-XV) in Incheon in 2009 [*WMO*, 2010a] "noted the successful completion of strategic plans of implementation for the Global Atmosphere Watch Programme […] and agreed that there was now a sound basis for managing, coordinating and evaluating activities […]". It further emphasized several areas, in which WMO, and specifically GAW as one of the implementing programmes need to be active:

- Coupling and integration, when appropriate, of numerical weather prediction systems with modelling systems for air quality, hydrology, oceanography and sea ice; developing enhanced prediction chains where tailored products from numerical weather prediction models are applied to benefit areas such as disaster risk reduction, food security, health and ecosystems (CAS-XV 8.2.3).
- A common approach developed with the help of WMO and its partners nationally and internationally, including: the WMO co-sponsored Intergovernmental Panel on Climate Change (IPCC), the United Nations Framework Convention on Climate Change (UNFCCC), the WMO-UNEP supported Vienna Convention on the Protection of the Ozone Layer, the Reactive Nitrogen Initiative, the Global Earth Observation System of Systems (GEOSS), Global Monitoring for Environment and Security (GMES), the Convention on Long-range Transboundary Air Pollution (CLRTAP), the Malé declaration, and the International Maritime Organization (IMO) MARPOL (CAS-XV 8.3.2);
- Work towards an Integrated Global Carbon Observation Prediction and Assessment System, acknowledging that monitoring requirements may be forthcoming to support global emission reduction and mitigation policy (CAS-XV 8.3.3).
- […] Lead a global partnership to link globally the technical work on the regional/continental long range transport of air pollution; […] support the analysis of the global reactive nitrogen cycle […]; take the lead in the technical analysis on the interaction of climate variability and change and air pollution on a regional basis, and in combination on a global basis […] (CAS-XV 8.3.4).
- Extension of capacity-building programmes to the developing countries showing real evidence of progress and achievement (CAS-XV 13.1).
- Implementation of a comprehensive initiative in air quality involving all programme areas of the Commission and including regional aspects (CAS-XV 13.1).

These recommendations are further corroborated by the outcomes of the World Climate Conference-3[2] (WCC-3) that formally introduced the Global Framework for Climate Services, concluding that "present capabilities to provide effective climate services fall far short of meeting present and future needs, [and that a] most urgent need is for much closer partnership between the providers and users of climate services" [*WCC-3*, 2009].

GAW has broadened its scope to address environmental risk reduction; improved prediction of climate, weather and air quality; as well as contributions to scientific assessments [*WMO*, 2007c]. For example, a renewed awareness of the effects of volcanic eruptions primarily on air traffic safety has underlined the usefulness of GAW. The WMO Executive Council (EC-XLII) [*WMO*, 2010b] has passed a number of statements of direct relevance to the implementation of GAW. These include:

[2] *http://www.wmo.int/wcc3/page_en.php*

- A request to WMO Members to identify potential regional [UV] calibration centres in under-represented areas as well as the identification of a world calibration centre [for UV] (EC-XLII 3.4.13); and revisiting the definition and delivery of the UV Index (UVI) (EC-XLII 4.2.52).
- The high priority for a sustainable volcanic ash observational capability (EC-XLII 3.4.16); and the creation of an inter-Commission Scientific Advisory Group on volcanic ash (EC-XLII 4.2.40).
- Coordination between air quality forecasting and heat health warning systems based on the notion of a large number of excess deaths due to air pollution during heatwaves (EC-XLII 4.2.53); and for WMO to partner with WHO and other relevant organizations in pursuit of solutions related to climate change and to air pollution in the area of human health impacts (EC-XLII 4.2.56).
- To increase the density of GAW stations in the tropical region and to take the lead with regional networks in analyzing the interaction of climate change and air pollution on regional and global levels (EC-XLII 4.2.55).
- To establish new Global Atmosphere Watch (GAW) Urban Research Meteorology and Environment (GURME) pilot projects, such as the one in support of the Commonwealth Games in India (EC-XLII 4.2.54).

Lending support to the Global Climate Observing System (GCOS), observations are openly available in the GAW World Data Centres and aid in our understanding of changes in stratospheric ozone, greenhouse warming, and air quality on both regional and global scales. GCOS recognizes the importance of GAW as the backbone of the global in-situ[3] atmospheric observing system for atmospheric composition [*GCOS*, 2010]. Several GAW networks (ozone, CO_2/CH_4, N_2O) have already been explicitly accepted by GCOS as baseline or comprehensive networks, and GAW with its contributing networks is the basis for the observation of other Essential Climate Variables (ozone precursors, additional greenhouse gases, aerosols, surface radiation).

1.3 Achievements during 2008-2011

1.3.1 Organizational Components

The basic organizational elements of GAW remain as described in the current GAW Strategic Plan (see Figure 1 in [*WMO*, 2007c]).

During the period 2008-2011, the GAW Programme has made significant progress in extending its base of Central Facilities by designating:

- The Central Calibration Laboratory for 8 hydrocarbons at the National Physical Laboratory in Teddington, UK
- The Central Calibration Laboratory for stable isotopes in CO_2 at the Max-Planck Institute for Biogeochemistry in Jena, Germany
- The Central Calibration Laboratory for molecular hydrogen (H_2) at the Max-Planck Institute (MPI) for Biogeochemistry in Jena, Germany
- The Central Calibration Laboratory for SF_6 at NOAA/ESRL in Boulder, U.S.A.
- The World Calibration Centre for CO_2 (audits) at Empa, Switzerland
- The World Calibration Centre for NO_x at IEK-8, Jülich, Germany
- The World Data Centre for Aerosols at NILU, Norway (taking over the work by JRC Ispra, Italy)
- The World Data Center for Remote Sensing of the Atmosphere at DLR, Germany

The complete list of Central Facilities supported by WMO Members and serving the GAW Programme is given in Table 1.

[3] *The term in-situ is ambiguous. As used by GCOS, it can include ground-based remote-sensing as well as point observations. In GAW, in-situ refers to point observations only, both on the ground as well as aloft (e.g., by sondes, aircraft).*

Table 1 - List of GAW Central Facilities and host institutions as of January 2011

Variable	QA/SAC	Central Calibration Laboratory (CCL) (Host of Primary Standard)	World Calibration Centre (WCC)	Regional Calibration Centre (RCC)	World Data Centre (WDC)
CO_2	JMA (A/O)	ESRL	ESRL (round robin) Empa (audits)		JMA
carbon isotopes		MPI-BGC			JMA
CH_4	Empa (Am, E/A) JMA (A/O)	ESRL	Empa (Am, E/A) JMA (A/O)		JMA
N_2O	UBA	ESRL	IMK-IFU		JMA
CFCs, HCFCs, HFCs					JMA
SF_6		ESRL			JMA
H_2		MPI-BGC			JMA
Total Ozone	JMA (A/O)	ESRL[1], EC[2]	ESRL[1], EC[2]	BoM[1], ESRL[1], IZO[2] JMA[1], MOHp[1], MGO[3], OCBA[1], SAWS[1], SOO-HK[1]	EC[5], DLR[6]
Ozone Sondes	IEK-8	IEK-8	IEK-8		EC
Surface Ozone	Empa	NIST	Empa	OCBA	JMA
Precipitation Chemistry	NOAA-ARL	ISWS	ISWS		NOAA-ARL
CO	Empa	ESRL	Empa		JMA
VOC	UBA	NPL	IMK-IFU		JMA
SO_2					JMA
NO_x	UBA		IEK-8 (NO)		JMA
Aerosol	UBA (physical properties)		IfT (physical properties)		NILU[5], DLR[6]
Optical Depth		PMOD/WRC[4]	PMOD/WRC		NILU
UV Radiation				ESRL (Am), EUVC/PMOD (E)	EC
Solar Radiation		PMOD/WRC	PMOD/WRC		MGO

[1]Dobson, [2]Brewer, [3]Filter instruments, [4]Precision Filter Radiometers (PFR), [5]ground-based, [6]satellite-based

Host Institutions

BoM	Bureau of Meteorology, Melbourne, Australia (Regional Dobson Calibration Centre, RDCC for Australia)
BSRN	Baseline Surface Radiation Network, Federal Institute of Technology (ETH), Zürich, Switzerland
DLR	German Aerospace Centre, Oberpfaffenhofen, Wessling, Germany (Word Data Centre for Remote Sensing of the Atmosphere, WDC-RSAT)
EC	Environment Canada, Toronto, Canada (World Ozone and UV Data Centre, WOUDC)
ESRL	Global Monitoring Division, Earth System Research Laboratory (ESRL), National Oceanic and Atmospheric Administration (NOAA), Boulder CO, USA
Empa	Swiss Federal Laboratories for Materials Testing and Research, Dübendorf, Switzerland (QA/SAC Switzerland and WCC-Empa)
EUVC	European Ultraviolet Calibration Center, cf. PMOD/WRC
IEK-8	Institute for Energy and Climate Research: Troposphere (IEK-8), Research Center Juelich GmbH, Juelich, Germany
IfT	Institute for Tropospheric Research, Leipzig, Germany
IMK-IFU	Karlsruhe Institute of Technology (KIT), Institute for Meteorology and Climate Research, IMK-IFU, Garmisch-Partenkirchen, Germany
ISWS	Illinois State Water Survey, Champaign IL, USA
IZO	Izaña Observatory, Tenerife, Spain (Regional Brewer Calibration Centre, RBCC)
JMA	Japan Meteorological Agency, Tokyo, Japan (World Data Centre for Greenhouse Gases, WDCGG; QA/SAC Japan, Regional Dobson Calibration Centre, RDCC for Asia)
MGO	A.I. Voeikov Main Geophysical Observatory, Russian Federal Service for Hydrometeorology and Environmental, St. Petersburg, Russia (World Radiation Data Centre, WRDC; RCC for Filter Instruments)
MPI-BGC	Max-Planck Institute (MPI) for Biogeochemistry in Jena, Germany
MOHp	Meteorologisches Observatorium Hohenpeissenberg (Regional Dobson Calibration Centre, RDCC for Europe)
NOAA-ARL	U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Air Resources Laboratory, Silver Spring MD, USA (World Data Centre for Precipitation Chemistry, WDCPC)
NILU	Norwegian Institute for Air Research (World Data Centre for Aerosols, WDCA)
NIST	National Institute for Standards and Technology, Gaithersburg MD, USA
NPL	National Physical Laboratory, Teddington, Middlesex, United Kingdom
OCBA	Observatorio Central Buenos Aires, Argentina (Regional Dobson Calibration Centre, RDCC for South America)
PMOD/WRC	Physikalisch-Meteorologisches Observatorium Davos/World Radiation Centre, Davos, Switzerland
SAWS	South African Weather Service, Pretoria, South Africa (Regional Dobson Calibration Centre, RDCC for Africa)
SOO-HK	Solar and Ozone Observatory, Hradec Kralove, Czech Republic (RCC)
UBA	German Environmental Protection Agency, Berlin, Germany

1.3.2 Observing Systems

The designation of several GAW Global stations during 2008-2011 pays tribute to the support of the GAW Programme by WMO Members. These stations are:

- Cape Verde Atmospheric Observatory (CVO, Cape Verde)
- Pyramid Climate Observatory (PYR, Nepal)
- Trinidad Head (THD, USA)
- Monte Cimone (CMN, Italy)

The current ground-based network as reflected in GAWSIS[4] consists of 28 Global stations (consisting of 33 distinct platforms) and some 800 Regional and Contributing stations (Figure 1), and the number of stations registered with GAWSIS has been steadily growing.

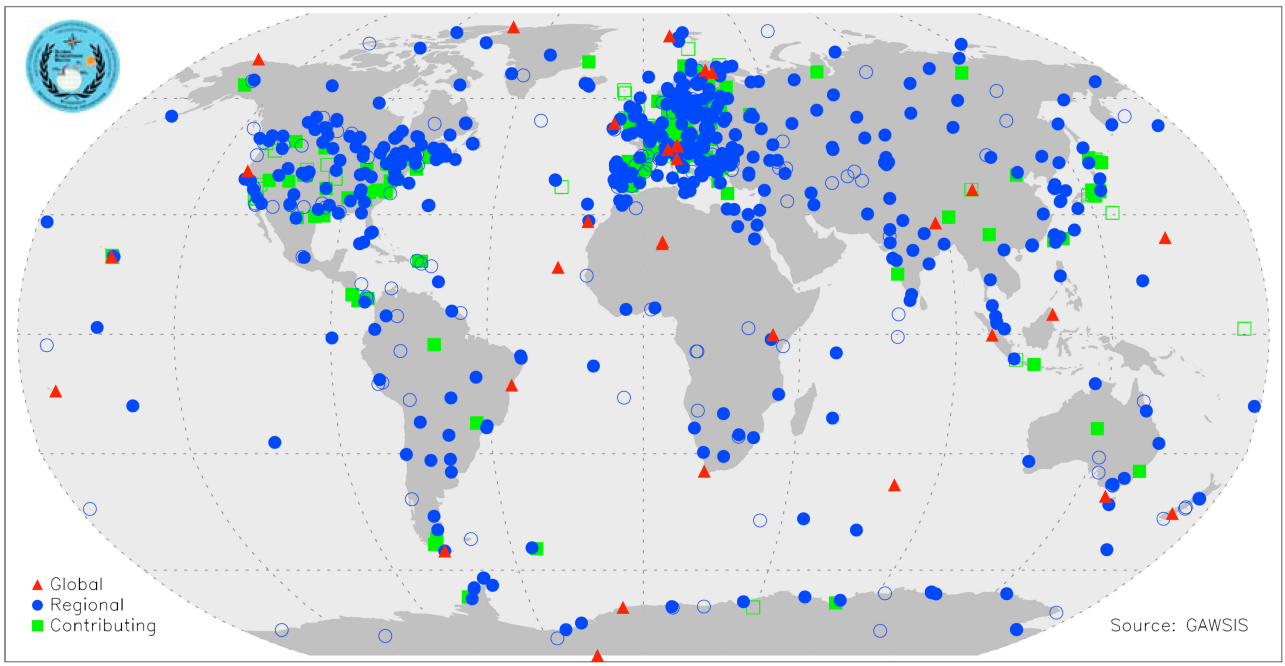

Figure 1 - Location of stations in GAW as of May 2011. Closed or inactive stations for which data are available at a GAW World Data Centre or an affiliated data centre are denoted with open symbols

The SAG UV has invited known monitoring stations (non-GAW) to become contributing stations, thereby increasing submissions to WOUDC. The SAG GG has convened a break-out group at the GAW2009 Symposium to assess the spatial distribution of greenhouse gas monitoring. The SAG PC has been working on an assessment [*Vet et al.*, in preparation] that is very relevant for the global precipitation chemistry network. Under-sampled regions of the world still remain, though, and continuous efforts are needed to narrow these gaps. Data from ship-based observations have increased somewhat over recent years, primarily as regards flask sampling from ships, but also AOD. With TCCON[5] (for total column CO_2) joining GAW as a contributing network and GALION[6] (for aerosol Lidar observations) being established, remote-sensing from the ground has been improved significantly. Both networks have been registered with GAWSIS. By using passenger aircraft, high-frequency and wide-ranging CO_2 data have been obtained by continuous measuring equipment in the CONTRAIL[7] project. Their CO_2 data collected by air sampling equipment between Australia and Japan since 1993 are available at the WDCGG.

[4] *http://gaw.empa.ch/gawsis/*

[5] *http://www.tccon.caltech.edu/*

[6] *http://alg.umbc.edu/galion/*

[7] *http://www.jal-foundation.or.jp/shintaikikansokue/Contrail_index(E).htm*

Furthermore, the European Union's ESFRI road map[8] has benefited the development of a sustainable infrastructure (IAGOS-ERI[9]) for atmospheric observations based on instrumented commercial passenger aircraft. IAGOS-ERI continues the MOZAIC[10] programme and deploys newly developed high-tech instruments for regular in-situ measurements of atmospheric chemical species (O_3, CO, CO_2, CH_4, NO_x, NO_y, H_2O), aerosols and cloud particles. CARIBIC will continue to do detailed measurements as part of the IAGOS consortium that is expected to become a European Infrastructure by ~2015. Lastly, the successful launch of GOSAT[11] and the promise of new instruments scheduled for launch in the coming years, such as OCO-2[12] and precursor Sentinel 5, will dramatically improve our ability to characterize the distribution of CO_2, CH_4 and related atmospheric constituents. The European Space Agency ESA has started the Climate Change Initiative (CCI)[13] to exploit robust long-term global records of essential climate variables. In addition, the families of Sentinel satellites as part of the ESA GMES[14] programme will expand significantly the list of spaceborne observations of climate variables.

Integration of observations is a primary objective of the IGACO strategy. As part of the implementation of IGACO through GAW an IGACO-O3/UV office was established in Finland[15]. Integration of observations for other thematic foci (greenhouse gases, aerosols, reactive gases, air quality / long-range transport) is targeted by various groups and programmes within and outside GAW. Progress has been achieved with respect to integrated observations, in particular regarding the carbon cycle. For example, NOAA has been pioneering the integration of in-situ tall tower observations with targeted aircraft observations.

1.3.3 Quality Assurance

The implementation of the GAW quality assurance system progressed in several areas. A number of Central Facilities were designated to extend the range of parameters covered (see Chapter 1.3.1).

Regular standards circulation, calibrations and station audits were performed by CCLs and WCCs/RCCs already designated in GAW. This includes in particular round-robin campaigns for CO_2 and methane; a Dobson instrument intercomparison; several Brewer instrument intercomparisons; and a surface ozone intercomparison for South America in 2010.

Several new or updated measurement guidelines were published for N_2O and CH_4 [*WMO*, 2009d], CO in situ measurements [*WMO*, 2010d], UV measurements [*WMO*, 2010e; f], and the Dobson Handbook was revised [*WMO*, 2009a]. Updated data submission guidelines include the WDCGG Data Submission and Dissemination Guide [*WMO*, 2009b] and guidelines for NRT ozone data submission [*WMO*, 2009c].

An agreement was signed between WMO and BIPM to nominate laboratories for participation in key comparisons of standards organized by BIPM that led to specific daughter agreements with

- World Radiation Centre (PMOD/WRC, Davos, Switzerland) for solar irradiance
- Empa for surface ozone
- NOAA/ESRL for carbon dioxide, methane, nitrous oxide and carbon monoxide

[8] *http://ec.europa.eu/research/infrastructures/index_en.cfm?pg=esfri*

[9] *http://www.iagos.org/*

[10] *http://mozaic.aero.obs-mip.fr/web/*

[11] *http://www.jaxa.jp/projects/sat/gosat/index_e.html*

[12] *http://oco.jpl.nasa.gov/*

[13] *http://earth.eo.esa.int/workshops/esa_cci/*

[14] *http://www.esa.int/esaLP/*

[15] *http://www.igaco-o3.fi/introduction/index.html*

Training of station operators constitutes an important part of the QA system. Within 2008-2010, about 60 persons operating GAW stations were trained at the GAW Training and Education Centre (GAWTEC) supported by Germany in six two week courses. Intercomparison campaigns are also usually accompanied by personnel training. The International Pyrheliometer Intercomparison (IPC-XI) in 2010 was attended by a record number of participants.

Data Quality Objectives (DQOs) for several thematic areas were reviewed at the expert meetings, namely for

- Key greenhouse gases at the 15th meeting of experts on carbon dioxide, other greenhouse gases and related tracers measurement techniques in 2009
- Ozone cross sections at the respective workshop in 2010
- Total ozone measurements at the Brewer workshop in 2010
- VOCs at the third VOC workshop in 2010
- NO and NO_2 (DQOs established) at the NO_{xy} expert meeting in 2009
- Aerosol parameters at the GALION workshop in 2010

1.3.4 Data Management

All WDCs continue to provide important archiving and data dissemination services as evidenced by the continuous use of the data sets. Some have made significant progress in further developing user-oriented products such as mapping capabilities and global overviews. WDCPC is currently being re-established as a portal for its regional tributaries. WDCA is now operated as part of the NILU/EBAS data services architecture. CAS-XV [*WMO*, 2010a] recommended that GAWSIS be established as a permanent World Data Centre for Metadata within GAW. At present, WDC-RSAT and WDCGG are DCPC[16] candidates, and GAWSIS is listed as a pilot project within the WMO Information System (WIS). Two pilot projects in the context of WIGOS/WIS have improved interoperability of the GAW World Data Centres by becoming components of the WMO Information System (WIS), and by achieving near-real-time submission and exchange of ozone and AOD data for a number of stations. Interoperability of most WDCs as well as NDACC through exchange of metadata with GAWSIS is operational, albeit limited in scope. Metadata exchange with a number of regional or topical data centres is being established or negotiated. Within the ET-WDC WIGOS/WIS pilot project, the WIS-compliant representation of GAWSIS metadata has been achieved. WDC-RSAT and WDCGG have established or are in the process of establishing similar capabilities. A meeting was held in 2010 that brought together the GAW WDC managers and experts from several contributing networks such as NOAA/ESRL, NDACC, NASA-AVDC, NASA-SHADOZ and BSRN to discuss various data management issues.

1.3.5 Integration and Application of Observations

To fully exploit the potential of observations of atmospheric composition and change, the GAW Programme places an emphasis on their integration and application. Achievements in this area are very diverse and range from fundamental data management issues all the way to global assessments. During the period 2008-2011, the WIGOS/WIS pilot project on near-real-time (NRT) exchange of GAW data of ozone and aerosol parameters was successfully completed. In support of NRT data delivery, GAW established the Expert Team on Near-Real-Time Chemical Data Transfer (ET NRT-CDT). As a result, graphical representations of AOD data are now available with very short delay[17], and a guidance document on the reporting of total ozone data in near real time is available [*WMO*, 2011b]. Further, GAW supported the development of chemical weather modelling systems (participating in scientific boards of projects such as MACC, and of TF-HTAP and TFMM). During the Icelandic volcano eruption in 2010, the GALION network strongly supported validation of models for volcanic ash transport, providing NRT delivery of Lidar observed vertical profiles of aerosol properties, advancing basic understanding and helping air traffic control.

[16] *Data Collection and Production Centre*

[17] *http://www.pmodwrc.ch/worcc/pmod.php?topic=aod_graphs_recent_data; data available for registered users through EBAS at http://ebas.nilu.no/*

To demonstrate the role of GAW in this area, the SAG Aerosol is represented in the WMO inter-Commission Scientific Advisory Group on volcanic ash. In the forthcoming GAW global assessment of precipitation chemistry and deposition [*Vet et al.*, in preparation], a huge effort went into integrating observed and model-simulated data. In a joint activity of GAW and GESAMP, observed and model-simulated data were integrated in a global assessment of atmospheric chemical input to the oceans [*GESAMP*, in preparation]. The WMO Sand Dust Storm Warning Advisory and Assessment System dust modelling partners achieved to use MODIS dust aerosol data in NRT for data assimilation and model validation. The urban focus of GAW, GURME, has been promoting the use of and using MACC data sets as boundary conditions in GURME air quality forecasting projects, and plays an active role in important international assessments, including HTAP of EMEP, and the Black Carbon and Tropospheric Ozone Assessment prepared jointly with UNEP. GURME is also publishing jointly with IGAC the Megacity Assessment [*WMO/IGAC*, in preparation].

1.3.6 GAW Focal Areas

Ozone. A major outcome from the stratospheric ozone component of GAW was the 2010 edition of the quadrennial WMO/UNEP Scientific Assessment of Ozone Depletion [*WMO*, 2010c].

Dobson intercomparisons were conducted for RA I in Irene, South Africa in October 2009 by the South African Weather Service, and in Buenos Aires in November/December 2010 by the Servicio Meteorológico Nacional of Argentina.

Several Brewer spectrophotometers in Brazil, Chile, Egypt, Indonesia, Iran, Morocco and Russia have been repaired and calibrated by the International Ozone Services with financial support from the Environment Canada-WMO Brewer Trust Fund (extended until 2015). A Brewer workshop was arranged in Aosta, Italy, in September 2009. Calibration and maintenance of the Dobson and Brewer spectrophotometers are of prime importance for the quality of the long-term ozone time series, which feed into the quadrennial WMO/UNEP Scientific Assessment of Ozone Depletion.

Two meetings of the Ozone Research Managers of the Parties to the Vienna Convention for the Protection of the Ozone Layer have been held at the WMO Secretariat in Geneva in May 2008 and in May 2011, respectively. A meeting between the WMO and NDACC ozonesonde community in February 2009 discussed enhancements to the reporting of additional data fields and metadata within the respective data file formats.

An ad-hoc Expert Team on Absorption Cross Sections of Ozone (ACSO) has been established jointly by WMO and the International Ozone Commission with the mandate to assess the need for changing and harmonizing the ozone cross sections used by the ground-based and satellite communities.

Four “ozone theme meetings” were held at the WMO Secretariat in Geneva where challenges related to ozone measurements and stratospheric ozone science were discussed. These meetings were held collaboratively by the GAW Ozone SAG, the IGACO-Ozone/UV office[18] at the Finnish Meteorological Institute and the Network for the Detection of Atmospheric Composition Change (NDACC) in accordance with the IGACO-Ozone/UV Implementation plan [*WMO*, 2008b]. Two of these meetings (2009 and 2010) dealt with the question of introducing new absorption cross sections for ozone in the global ozone observing system[19]. In collaboration with the SPARC programme a workshop on past changes in the vertical distribution of ozone was held in January 2011. The results from this workshop and the ensuing analysis will feed into the 2014 WMO/UNEP Ozone Assessment.

[18] *http://www.igaco-o3.fi/programme/index.html*

[19] *http://igaco-o3.fmi.fi/ACSO/index.html*

Greenhouse Gases. The greenhouse gas observation and analysis system evolved during 2008-2011. The number of observational stations has increased. New Central Facilities were designated to improve QA/QC of greenhouse gas observations (the CCL for SF_6 was assigned to NOAA/ESRL; the CCL for stable carbon and oxygen isotopes of CO_2 and the CCL for H_2 were assigned to the MPI-Biogeochemistry; the WCC for CO_2 Audits was assigned to Empa). New robust optical measurement techniques that use off-axis integrated cavity output spectroscopy or cavity ring-down spectroscopy are increasingly being used by GAW partners to measure greenhouse gases such as CO_2, CH_4 and N_2O. CO_2 standards prepared by NOAA now specify $\delta^{13}C$ (CO_2) upon request. Molecular hydrogen – albeit not a greenhouse gas itself – is now under the auspices of the SAG for Greenhouse Gases. The 15th WMO/IAEA Meeting of Experts on Carbon Dioxide, Other Greenhouse Gases and Related Tracer Measurement Techniques took place at the MPI-Biogeochemistry in Jena in 2009, where the DQOs for key greenhouse gas and isotope measurements were evaluated, results of scale comparisons and round robin comparison exercises were shown, and new terms for QA/QC based on the International Vocabulary of Metrology were introduced to the community and recommended for use (http://gaw.empa.ch/glossary.html). The scale for molecular hydrogen developed at the MPI in Jena was designated as the WMO calibration scale, and MPI Jena accepted a role as Central Calibration Laboratory (CCL) for molecular hydrogen for GAW.

A major step towards integrating total column measurements of greenhouse gases with in situ measurements was achieved when the Total Column Carbon Observing Network (TCCON) joined the GAW Programme as a contributing network and its representatives were invited to the GHG SAG. Measurement guidelines for CH_4 and N_2O were prepared and published [*WMO*, 2009d], and a Data Submission and Dissemination Guide prepared by the WDCGG was reviewed and released thereafter [*WMO*, 2009b].

Data stored at the WDCGG were widely used by the modelling community for model validation and greenhouse gas flux estimates (particularly in the TransCom project).

The WMO Greenhouse Gas Bulletin has gained international recognition by the UNFCCC as a source of information on greenhouse gases (referred under UNFCCC reference list http://unfccc.int/ghg_data/ghg_data_non_unfccc/items/3170.php both for COP-15 and COP-16).

Reactive Gases. Substantial progress has been made towards the attainment of GAW goals in various areas. The database for both CO and surface ozone measurements is substantial and a base for many scientific studies. Spatial and seasonal variability as well as trends can be determined for both these molecules. Audits by WCC-Empa at GAW stations and regional calibration facilities were continued (totally 63 audits for surface ozone or 16 audits since 2008, and 46 audits for CO or 14 audits since 2008). Audit reports are available through GAWSIS (http://gaw.empa.ch/gawsis/). Measurement guidelines were published for CO measurements [*WMO*, 2010d].

A global network for a defined set of VOCs that uses discrete air samples from the NOAA/ESRL/GMD cooperative air sampling network is now affiliated with GAW-VOC. The global stations Jungfraujoch, Cape Verde and Hohenpeissenberg continue to measure a larger range of these compounds. The data show for the first time the global distribution, highlighting the strong hemispheric and seasonal differences for VOC in the atmosphere [*Helmig et al.*, 2009]. The WCC-VOC has audited several stations and laboratories. Several workshops on VOC measurements within GAW aligned the work of individual contributors to the network and laid the foundation for the formal establishment of CCLs for individual molecules. NPL was assigned as CCL for 8 hydrocarbons prepared in collaboration of the Gas Analysis Working Group of the Consultative Committee of Weight and Measures (GAWG-CCQM) of BIPM and WCC-VOC. The database for VOCs in the WDCGG has been substantially enlarged and the continuous records of VOC from several stations provide the basis for trend calculations. Still the number of stations contributing to the WDCGG is rather small. Better visibility of European VOC data within GAW has been achieved by establishing web-links to the EBAS data base from within GAWSIS. In the near future available DQOs and SOPs will be revised in the course of a joint effort of the SAG RG subgroup on

VOCs and the EU-funded project ACTRIS (Aerosol, Clouds and Trace Gases Infrastructure Network; INFRA-2010-1.1.16).

A workshop in October 2009 at the Hohenpeissenberg Observatory defined goals and an implementation strategy of the measurement of nitrogen compounds (NO_x and NO_y) within GAW. A GAW report describing the outcome of this workshop is expected in 2011. Up to now only few data of nitrogen oxides are available at WDCGG, and some of them are of questionable quality. A global network for NO and NO_2 measurements within GAW has been proposed, whereas the expansion towards additional oxidised nitrogen species and towards mobile platforms and remote sensing techniques will be tackled at a later stage. Measurement methods for NO and NO_2 detection were recommended. The Institute of Energy and Climate Research, Troposphere of the Research Centre Jülich, Germany, (FZJ, IEK-8) was assigned WCC for NO_x. The Central Calibration Laboratory (CCL) for NO_x will be established in collaboration with and using the experience of the metrological community, similar to the one for VOC.

The GAW Training and Education Centre (GAWTEC) hosted at Zugspitze/Schneefernerhaus in Germany and jointly driven by the State of Bavaria, the German Environmental Agency (UBA-D), the German Meteorological Service (DWD), Empa and WMO offers training to enable station personnel archiving the required DQOs of NO_x measurement.

Atmospheric Wet Deposition. The major focus of the Precipitation Chemistry SAG in recent years was the development of a global assessment for major ions in precipitation. The regional contributions, the database, and the maps for the assessment were completed in 2010. The assessment is expected to be submitted for publication as a journal article in the peer reviewed literature during late spring of 2011. The SAG is working closely with the International Nitrogen Initiative community and has also been approached by the Intergovernmental Panel on Climate Change to provide nitrogen data for the fifth IPCC assessment.

In addition to the preparation of the global assessment, the twice-annual laboratory intercomparison studies continued as normal and the QA/SAC web page was continually upgraded. We have established a precipitation chemistry station in Argentina to enhance the coverage in South America and expect data collection to commence in 2011. The SAG is communicating with regional experts to explore the development of a South American precipitation chemistry network. In light of the global assessment work on the measurement of phosphorus in precipitation, several national networks considered including the routine measurement of total phosphorus along with the usual suite of ions. Collaboration with numerous international groups including EMEP, NADP, HTAP, and EANET continued, during science meetings and elsewhere.

UV Radiation. The SAG UV met in August 2008 in Brazil in connection with the Radiation Symposium IRS2009, which included a session on the SAG UV activities, and in February 2010 in Bangkok. The SAG Instrument group has finalized the GAW reports in the series “Instruments to Measure Solar Ultraviolet Radiation”, the latest ones being on Multi-channel filter instruments (GAW Rep 190) [*WMO*, 2010e] and on array spectroradiometers (GAW Rep 191) [*WMO*, 2010f]. A major step occurred in 2008 when the PMOD UV Calibration Center was formally recognized by WMO as the GAW Regional Calibration Center for Europe (see Table 1). The DQOs for scanning spectroradiometers and broadband instruments are in preparation [*WMO*, 2011a]. A UV intercomparison for broadband instruments was organized for South America in 2010.

Aerosols. Standard operating procedures (SOPs) for the observation of aerosol mass concentration, light absorption and scattering are near completion. The implementation plan for the GAW Aerosol Lidar Observation Network (GALION) has been published [*WMO*, 2007b], supporting the international coordination of the observation of vertical aerosol profiles, as well as the validation of satellite observations using long-term ground-based measurements. The collaboration between GAW and EMEP, with support from the EU FP6 projects ACCENT, EUSAAR and GEOmon, has helped identify and address gaps in coordination of global observations of aerosols and other atmospheric constituents [*Laj et al.*, 2009; *Myhre and Baltensperger*, 2011]. This cooperation is still

ongoing within the EU FP7 ACTRIS project (2011-2015). WDCA and GAWSIS collaborate on establishing a global overview.

WDCA moved from JRC Ispra to NILU, and has since expanded its data holdings on aerosol composition and optical properties. Australia has agreed to submit their BSRN AOD data to WDCA. AOD data from the PFR network are now available in near-real time through the WORCC from 21 instruments. China has announced plans to establish an RCC for AOD. A third international Filter Radiometer Comparison (FRC-III) was held at WORCC in 2010. The WMO Sand and Dust Storm Warning Advisory and Assessment System[20] (SDS-WAS), jointly implemented under the WWRP and the GAW Programmes is up and running. Between 2007 and 2011, some 34 site audits have been conducted by WCC-AP, and this ongoing task proceeds according to schedule. At WDC-RSAT a first version of the one stop shop for satellite aerosol products was implemented, which allows harmonized access to metadata and links to available satellite datasets.

Considering the scientific needs, the increasing maturity of aerosol programmes at a number of stations as well as the advancements of in-situ aerosol measurement equipment, the list of comprehensive aerosol variables recommended for long-term measurement in the global network has been updated (Table). Further, the SAG-Aerosol recommends a change in timetable for submission of final, quality-assured data to the World Data Centers: With the exception of variables where instruments must be returned to a central calibration facility for post-measurement calibration (e.g., AOD), final data should be submitted no later than six months after conclusion of the calendar year in which the data were collected.

Table 2 - Comprehensive aerosol variables recommended for long-term measurement in the global network

Variable	Frequency of observation
Multiwavelength aerosol optical depth	Continuous
Mass concentration in two size fractions (fine, coarse)	
Mass concentration of major chemical components in two size fractions	
Light absorption coefficient at various wavelengths	
Light scattering and hemispheric backscattering coefficient at various wavelengths	
Aerosol number concentration	
Aerosol number size distribution	
Cloud condensation nuclei number concentration at various super-saturations	
Vertical distribution of aerosol backscattering and extinction	
Detailed size fractionated chemical composition	Intermittent
Dependence of aerosol variables on relative humidity, especially aerosol number size distribution and light scattering coefficient.	

Ancillary Variables. The International Pyrheliometer Comparison (IPC-XI) in 2010 had record participation of more than 80 participants from around 40 countries. Since 2007, a number of absolute radiometers were launched on satellites to measure the total solar irradiance. These instruments are traceable to the World Radiometric Reference at PMOD/WRC in Davos, Switzerland.

[20] *http://www.wmo.int/pages/prog/arep/wwrp/new/Sand_and_Dust_Storm.html*

GAW continues to take advantage of the meteorological observations made world-wide and coordinated by the WMO Secretariat's Observing and Information Systems Department (OBS). A number of GAW stations are collocated with GCOS surface or upper-air observations.

The "IAEA/WMO Technical Meeting on Sources and Measurements of Radon and Radon Progeny Applied to Climate and Air Quality Studies" was held in Vienna in June 2009[21]. The meeting brought together scientists and engineers involved in measurements and modeling of radon fluxes from the Earth's surface, measurement of atmospheric radon and radon progeny concentrations, and development and use of atmospheric transport models. A major focus of the meeting was on moving towards agreed approaches to estimating radon fluxes, and to improving their quality assurance and that of concentrations of radon and radon progeny in the atmosphere.

GURME. GURME has contributed to improving the capabilities of NMHSs to handle meteorological and related features of air pollution by addressing end-to-end aspects of air quality, linking the observational capabilities of GAW with the needs of chemical weather prediction, with the goal of providing high quality air quality services. GURME has established itself as an international cross-cutting platform for connecting scientists, experts, and operational personnel between and within NMHSs, environmental agencies, municipal governments, international organizations and others involved in air quality issues.

A training event on Air Quality Forecasting for South Asia was held in December 2008, in Pune, India, and a Latin American Cities Air Quality Modelling Project Workshop in August 2009, in Mexico City. These training activities focused on air quality modelling to support various research and application, including forecasting, activities, and included hands-on training using contemporary meteorological and air pollution models. The training workshop held in Niigata, Japan, in January 2011, in collaboration with the Acid Deposition Monitoring Network in East Asia (EANET), focused on providing training in air quality modeling to support the monitoring network activities and associated applications.

Several pilot projects were successfully advanced during this period. The Shanghai Pilot Project, part of the WMO Shanghai MHEWS project, was initiated in 2007, and was successfully implemented/demonstrated during the 2010 Expo. Activities included enhancing the observing system; enhancing air quality & weather forecasting (& heat waves); a field experiment (joint with NCAR) to provide data to evaluate air quality models; and a variety of workshops and training activities. In this project an important step has been taken towards providing health related forecasts. The SAFAR (System for Air Quality Forecasting And Research) pilot project, focusing on air quality forecasting in support of the Commonwealth Games (CWG) held in New Delhi India in October 2010, was established as a follow-up activity from the training workshop held in 2008, demonstrating the importance of the facilitator and catalyst role of GURME. This is the first air quality forecasting (AQF) system demonstrated broadly to the public in India and successfully operated during the CWG. A new pilot project, led by the China Meteorological Administration (CMA), was initiated in 2010 that is focused on NRT Application to Air Quality Forecasts.

GURME has had extensive and diverse collaboration on a variety of activities, including co-sponsoring sessions at international conferences, such as the biannual Urban Air Pollution Conference and the International Workshop on Air Quality Forecasting Research (IWAQFR). GURME continues its active collaboration with COST Actions, especially 728, with several joint publications, and ES 0602 on Chemical Weather. GURME is actively participating in large scale research projects such as the EU MEGAPOLI and MACC projects by giving them a global dimension and by promoting the use of and using MACC data sets as boundary conditions in GURME air quality forecasting projects. GURME plays an active role in important international assessments, including HTAP of EMEP (CLRTAP) and the Black Carbon and Tropospheric ozone Assessment prepared jointly with UNEP. GURME is publishing jointly with IGAC the Megacity Assessment.

[21] http://www-pub.iaea.org/mtcd/meetings/Announcements.asp?ConfID=37743

1.3.7 Outreach

The GAW website was improved in 2009-2010. The first webcast of a national GAW conference in January 2011 enabled remote participation for those interested in GAW. GAWSIS continued to highlight the ground-based observation network of GAW and to interlink GAW and related observational data. WMO Antarctic and Greenhouse Gas Bulletins were distributed regularly and articles on GAW activities were included frequently in WMO publications.

In GAWTEC over 240 GAW station personnel from about 56 countries have been trained. Establishing twinning partnerships between several WMO Members with developed GAW Programmes and ones under development, and the support for participation of developing country and young scientists at major conferences continues to be an important part of GAW capacity building. The GAW Symposium in 2009 was an excellent opportunity to strengthen or establish collaboration between various WMO Members.

1.4 Acceptance of Stations and Designation of Central Facilities

The GAW network of ground-based stations and observation platforms has matured enough to warrant a formal procedure for acceptance of additional stations in the Programme. This procedure for becoming a GAW Contributing or Regional station, or for existing stations to be promoted to a GAW Global station, is explained in Annex 2.

2. ORGANIZATIONAL COMPONENTS

2.1 National Meteorological and Hydrological Services (NMHSs)

Task 2.1 Designate country contacts for GAW national activity and maintain cooperation and information sharing with them.
(NMHSs, Secretariat, GAWSIS | 2012 ~ 2015)

Task 2.2 [2.2] Identify and approach WMO Member countries willing to support of GAW tasks of high priority.
(Secretariat, GAW experts | 2012 ~ 2015)

Task 2.3 [2.3] Strengthen co-operation between various agencies within countries.
(Secretariat, NMHSs, Environmental agencies, Research organizations | 2012 ~ 2015)

Task 2.4 [2.4] Cooperate in cross-programme and inter-commission activities that promote the near real time delivery of observations and their utilization.
(Secretariat, ET-NRT-CDT | 2012 ~ 2015)

Task 2.5 Coordinate and cooperate with National Meteorological and Hydrological Services (NMHSs) for the implementation and use of WMO Information System (WIS).
(NMHSs, Secretariat | 2012 ~ 2015)

Task 2.6 [2.5] Improve the traceability of observations to recognized WMO-GAW standards through establishment of Central Facilities and implementation of GAW observational guidelines and procedures.
(SAGs, NMHSs | 2012 ~ 2015)

Task 2.7 [2.7] Support implementation of the IGACO strategy leading to integration of atmospheric composition observations with meteorological observations using numerical modelling and assimilation techniques and to the production of new effective environmental prediction products.
(Secretariat, SAGs, modelling community, NMHSs, GMES | 2012 ~ 2015)

2.2 Expert Groups

Task 2.8 Review progress in implementation of the GAW Programme.
(JSC OPAG EPAC, Secretariat | 2012 ~ 2015)

Task 2.9 Share information on outcomes from SAGs with the GAW community in a timely manner.
(SAGs, Secretariat | 2012 ~ 2015)

2.3 Central Facilities

Task 2.10 Improve three-way communication among GAW Central Facilities, observational stations and Secretariat in particular by annually reporting to the Secretariat using the template provided.
(Secretariat, Central Facilities | 2012 ~ 2015)

Task 2.11 [2.12] Promote the establishment of GAW Central Facilities to fill gaps in the programme.
(JSC OPAG EPAC, Secretariat, SAGs | 2012 ~ 2015)

Task 2.12 Ensure traceability and compatibility of the WMO scales to the internationally recognized standards via identification of and participation in key-comparisons, as appropriate.
(CCLs, SAGs, NMIs, BIPM, CCQM | 2012 ~ 2015)

2.4 Secretariat

Task 2.13 [2.20] Establish priorities for funding arrangements and prepare plans for the use of available funds (budgets).
(Secretariat | 2012 ~ 2015)

Task 2.14 [2.16] Maintain the GAW web site as an interactive tool for the GAW system so that all GAW components have appropriate web pages.
(Secretariat, SAGs, WDCs, WCCs, RCCs, QA/SACs | 2012 ~ 2015)

Task 2.15 [2.17] Initiate meetings and sessions dedicated to critical issues of the GAW system.
(Secretariat, SAGs, ETs, GAW partners | 2012 ~ 2015)

Task 2.16 Publish reports of JSC OPAG EPAC sessions as GAW report in a timely manner.
(Secretariat, JSC OPAG EPAC | 2012 ~ 2015)

Task 2.17 Cooperate with GCOS at national and international levels to promote GAW activities as a contribution to the GCOS network.
(Secretariat, NMHSs, SAGs | 2012 ~ 2015)

Task 2.18 [2.21] Designate GAW advisors to assist with strategic and operational matters and outreach.
(Secretariat, SAGs, ETs | 2012 ~ 2015)

2.5 GAW Partners

Task 2.19 [2.25] Distribute relevant GAW information and publications originating from the Secretariat, the GAW Central Facilities, and GAW bodies to other international programmes interested in GAW.
(Secretariat, JSC OPAG EPAC, SAGs, Central Facilities | 2012 ~ 2015)

Task 2.20 [2.24] Cooperate with other international research and measurement programmes and networks such as GCOS, IGBP, IGAC, SPARC, BSRN, NDACC, NDMC and regional networks such as EMEP, EANET – by mutual participation in appropriate meetings and activities.
(JSC OPAG EPAC, Secretariat, SAGs, International programmes | 2012 ~ 2015)

3. OBSERVING SYSTEMS

3.1 Surface-Based Observations

3.1.1 Land-based Observations

Task 3.1 [3.1] Pursue opportunities to maintain and improve the GAW network of stations.
(Secretariat, NMHSs, Research organizations, JSC OPAG EPAC | 2012 ~ 2015)

Task 3.2 [3.2] Encourage the establishment of new GAW stations in data-sparse regions identified by SAGs and expert groups, by inviting applications and evaluating them according to the established acceptance procedures.
(Secretariat, SAGs, WMO Members, GAW partners | 2012 ~ 2015)

Task 3.3 [3.5] Promote the augmentation of surface-based observations by remote sensing observations (total column, LIDAR profiling, balloon sondes).
(SAGs, Secretariat, JSC OPAG EPAC | 2012 ~ 2015)

Task 3.4 [3.6] Encourage and organize joint activities (including the quadrennial GAW symposium) of station personnel to increase communication and co-ordination between GAW stations.
(Secretariat, SAGs, WMO Members | 2012 ~ 2015)

3.1.2 Ship-based Observations

Task 3.5 Develop a strategy to include more ship-based observations in the GAW Programme.
(JSC OPAG EPAC | 2012 ~ 2012)

Task 3.6 Define and describe atmospheric observations from ships as mobile platform and encourage submission of data from ships to WDCs in cooperation with GCOS, GOOS and other related international programmes.
(SAGs, Secretariat | 2012 ~ 2015)

3.2 Aircraft Observations

Task 3.7 [3.8] Promote the establishment and support the continuation of routine aircraft air chemistry monitoring programmes.
(Secretariat, SAGs, WMO Members, GAW partners | 2012 ~ 2015)

Task 3.8 [3.9] As a step toward integration of aircraft observations with other observations, assist aircraft programmes in delivering data in near real time through the Aircraft Meteorological Data Relay (AMDAR) system.
(Secretariat, Aeronautical Met Division of the WMO Secretariat,
GAW partners | 2012 ~ 2015)

Task 3.9 [3.10] Encourage archiving atmospheric composition data from aircraft monitoring programmes in appropriate WDCs.
(SAGs, WDCs, ET-WDC, Secretariat, GAW partners | 2012 ~ 2015)

Task 3.10 [3.11] Encourage traceability of aircraft observations of GAW variables to the WMO GAW standards.
(SAGs, Secretariat, GAW partners | 2012 ~ 2015)

3.3 Satellite-based Observations

Task 3.11 Review the status and requirements for satellite observations of atmospheric chemistry variables on a regular basis.
(WDC-RSAT, SAGs, TT-GSR | 2012 ~ 2015)

Task 3.12 [3.16] Specify the requirements for new generation air chemistry satellite observations and surface-based measurements associated with calibration and validation of existing satellites.
(TT-GSR, WMO Space Programme, CBS ET-Sat, CEOS, WDC-RSAT, GAW partners | 2012 ~ 2012)

Task 3.13 [3.13] Encourage space agencies to realize satellite missions covering the needs of the GAW Strategic Plan.
(Secretariat, CBS ET-Sat, TT-GSR, SAGs, Space agencies | 2012 ~ 2015)

3.4 Integrated Observing System

No tasks are proposed here, since various tasks in Chapters 5 (Data Management), 6 (Integration and Application of Observations) and 7 (GAW Focal Areas) address this issue.

4. QUALITY ASSURANCE

Task 4.1 [4.3] Establish DQOs for GAW variables where they are still missing, and review existing DQOs regularly.
(SAGs, QA/SACs | 2012 ~ 2015)

Task 4.2 Cooperate with metrology institutes both at international and national levels regarding the maintenance of measurement standards to ensure traceability to the International System of Units (SI) of observational data acquired in and provided from the GAW network.
(SAGs, WDCs, QA/SACs | 2012 ~ 2015)

Task 4.3 Organize comparison and training sessions to ensure quality assured and traceable data at laboratories and stations.
(SAGs, WCCs, QA/SACs | 2012 ~ 2015)

Task 4.4 [4.4] Identify and, where feasible, establish SAG sub-groups and Central Facilities for the variables not currently covered.
(SAGs, QA/SACs, Secretariat | 2012 ~ 2015)

Task 4.5 [4.5] Develop measurement guidelines and, when appropriate, SOPs for a prioritized list of variables.
(SAGs, QA/SACs, WCCs | 2012 ~ 2015)

Task 4.6 [4.7] Provide training and workshops for GAW measurement personnel with emphasis on building capacity and partnerships for developing countries while simultaneously improving the quality of data provided by all GAW stations.
(Secretariat, SAGs, CCLs, QA/SACs, WCCs, RCCs | 2012 ~ 2015)

Task 4.7 [4.8] Approach WMO Members to report traceability chains and internal quality control measures relevant to the measurement programmes of all stations in their country and document this in GAWSIS and the respective WDCs.
(SAGs, QA/SACs, WDCs | 2012 ~ 2015)

Task 4.8 [4.9] Assess the quality of data residing at the WDCs, and identify and reject questionable data.
(WDCs, QA/SACs, WCCs, RCCs, SAGs | 2012 ~ 2015)

Task 4.9 [4.11] Establish guidance documents detailing the methods for ensuring traceability of remote-sensing equipment to the GAW primary standards.
(SAGs, CBS ET-Sat, QA/SACs | 2012 ~ 2015)

Task 4.10 [4.12] Generalize the guidelines for GAW system audits to include all GAW variables.
(QA/SACs, SAGs | 2012 ~ 2015)

4.1 Products and Services

Current Products and services

- Guidance documents detailing data quality objectives (DQOs), operation and maintenance of instruments, uncertainty estimation, etc.
- Traceability of GAW reference scales to international standards wherever feasible.
- Training material and workshops for operators.
- Documents by World Data Centres addressing quality of data archived.
- Guidelines for system and performance audits.

Future Products and Services (in addition to above)

- More guidance documents covering more variables.
- More comprehensive documentation on data quality of data residing at the WDCs.

5. DATA MANAGEMENT

Task 5.1 [5.1] Secure proper resources, maintain comprehensive up-to-date storage devices and back-up strategies, and implement appropriate data access, dissemination, and security policies.

(WDCs, ET-WDC | 2012 ~ 2015)

Task 5.2 [5.3] Continue cooperative relationships with contributing networks to increase submission of data to the WDCs.

(WDCs, SAGs, ET-WDC | 2012 ~ 2015)

Task 5.3 [5.2] Harmonize metadata information among WDCs and GAWSIS, in particular with respect to data quality and traceability information.

(ET-WDC, WDCs, GAWSIS, SAGs, QA/SACs | 2012 ~ 2015)

Task 5.4 [5.4] Operate in each WDC a comprehensive set of data plausibility checks and provide timely feedback on data problems to data providers before acceptance of data; identify questionable data in the archives and request data submitters to explain the data or re-submit revised data.

(WDCs, ET-WDC, SAGs, QA/SACs | 2012 ~ 2015)

Task 5.5 [5.5] Identify gaps in the metadata record for legacy data, and approach data submitters with requests for repletion, update and clarification.

(WDCs, SAGs, ET-WDC | 2012 ~ 2015)

Task 5.6 [5.8] Further develop and maintain Internet sites for GAWSIS and each WDC that provide user friendly access to measurement data, metadata, quality assurance information, relevant meteorological information, and value-added products such as maps, reports on measurement guidelines, quality assurance and technical issues.

(WDCs, GAWSIS, ET-WDC, SAGs | 2012 ~ 2015)

Task 5.7 [5.9] Support scientific assessments and produce value-added data analysis/statistics products.

(WDCs, SAGs, ET-WDC | 2012 ~ 2015)

Task 5.8 [5.12] Give guidance for making tools available for format conversion to simplify the submission procedure using internet technologies as much as possible.

(ET-WDC, WDCs | 2012 ~ 2015)

Task 5.9 [5.13] Provide support and feed-back to SAGs (on a system level) and individual sites/scientists (on a data set level) regarding possible improvements in their measurements based on problems discovered during the data management and analysis process.

(WDCs, SAGs | 2012 ~ 2015)

Task 5.10 [5.15] For appropriate variables, develop cooperative systems for global data discovery and access by establishing links to major networks.

(WDCs, SAGs, ET-WDC, GAWSIS, Secretariat | 2012 ~ 2015)

5.1 Products and Services

Current Products and services

- Up-to-date archiving capability for atmospheric observations at the World Data Centres (WDCs).
- Up-to-date data and metadata discovery capabilities through GAWSIS and the WDCs.
- Internet sites providing easy access to data and metadata through GAWSIS and the WDCs.
- Links to contributing networks, enabling global overviews on atmospheric observation capabilities and available data.
- Global data sets in support of scientific assessments and other applications.

- Maps of global distributions of atmospheric constituents and physical properties of the atmosphere for selected variables

Future Products and Services (in addition to above)

- Expanded global coverage of atmospheric observational data and comprehensive metadata.
- More integrated data discovery and access tools through the WMO Information System (WIS) and its contributaries.
- Data format conversion tools for improved useability of GAW data.
- Fully harmonized metadata following international standards.

6. INTEGRATION AND APPLICATION OF OBSERVATIONS

6.1 Reanalysis and Forecasts including Assimilation

Task 6.1 [6.2] Cooperate with centres that lead developments in chemical weather/climate modelling and strengthen collaboration between data producers, modellers and end users.
(SAGs, ET-NRT-CDT | 2012 ~ 2015)

Task 6.2 Continue to promote cooperation with TransCom and other modeling initiatives in the integration and use of observational data for greenhouse gases.
(SAG GG | 2012 ~ 2015)

Task 6.3 [6.5] Coordinate activities of centres currently executing experimental sand and dust storm models to provide user-tailored products.
(SDS-WAS Steering Committee | 2012 ~ 2015)

6.2 Assessments

Task 6.4 [6.9] Organize scientific assessments of the relevant GAW components.
(Secretariat, SAGs, WMO Members, GAW partners, International programmes | 2012 ~ 2015)

Task 6.5 [6.10] Consolidate and assess data and information regularly for the preparation of the Antarctic and Arctic Ozone Bulletins.
(Secretariat, GAW partners, Space agencies, Ozone experts | 2012 ~ 2015)

Task 6.6 [6.11] Consolidate and assess data and information for the preparation of the annual Greenhouse Gas Bulletin.
(Secretariat, SAG GG, WDCGG, NOAA/ESRL | 2012 ~ 2015)

Task 6.7 [6.12] Consolidate and assess data and information and establish an Aerosol Bulletin.
(SAG Aerosols, Secretariat | 2012 ~ 2015)

Task 6.8 [10.8] Consolidate and assess data and information and establish a WMO Bulletin on reactive gases, such as surface ozone, Nox, CO and VOCs.
(SAG RG, Secretariat | 2012 ~ 2015)

6.3 Products and Services

Current Products and Services

Research and operational centres are developing next-generation atmospheric/climate models, including atmospheric chemistry modules that interact with atmospheric transport models. Several research projects are already established to integrate chemical and meteorological data with models and are moving to operational mode: WRF-CHEM (USA), MACC (EU), CHRONOS (Canada); among others. Several research projects are also established to provide experimental routine mineral dust forecasts.

Future Products and Services (in addition to above)

- Weather forecasts improved by consideration of atmospheric composition.
- Chemical composition forecasts.
- Climate models with built-in interaction between atmospheric composition and thermodynamics.
- Near-real-time delivery of short- to medium-range chemical weather forecasts.
- Mineral dust model reanalysis for assessing the dust impacts on health, economy, environment and climate.

7. GAW FOCAL AREAS

7.1 Ozone

Task 7.1 Begin to establish the rolling review of requirements (RRR) 4-stage process for each GAW focal area, starting with a review of scientifically defendable users' requirements, with the objective of updating the statement of guidance, considering both satellite and non-satellite observations.

(SAG Ozone, Secretariat | 2012 ~ 2015)

7.1.1 Column (Total) Ozone

Task 7.2 [7.1] Continue high quality measurements and calibrations of the Dobson network and update SOPs for Dobson instruments.

(SAG Ozone | 2012 ~ 2015)

Task 7.3 Maintain regional standards at RCCs and organize comparison with national standard instruments in the region for the Dobson spectrophotometer network.

(RCCs | 2012 ~ 2015)

Task 7.4 [7.2] Finalize the station calibration procedure and SOPs of Brewer instruments.

(SAG Ozone | 2012 ~ 2015)

Task 7.5 [7.3] Ensure that the calibrations of the station Brewer instruments are performed in a proper way.

(SAG Ozone | 2012 ~ 2015)

Task 7.6 [7.4] Document the calibration histories of the individual station instruments so that the Brewer network obtains a long-term perspective.

(SAG Ozone, WOUDC | 2012 ~ 2015)

Task 7.7 Establish a mechanism of systematic calibration at regional level for the Brewer spectrophotometer network.

(SAG Ozone | 2012 ~ 2015)

Task 7.8 Agree on and implement new ozone absorption cross sections for retrieval of atmospheric ozone measurements.

(SAG Ozone, IGACO-O3/UV Office | 2012 ~ 2014)

Task 7.9 Promote near-real-time transmission of total column ozone data in CREX format via GTS/WIS.

(SAG Ozone | 2012 ~ 2015)

Task 7.10 [7.6] Submit Level 0 data and associated calibration information to the WOUDC to accurately trace the performance of the individual instruments;

(SAG Ozone, WOUDC | 2012 ~ 2015)

Task 7.11 [7.5] Create a virtual database for available satellite data.

(WDC-RSAT | 2012 ~ 2015)

Task 7.12 Implement 'one-stop' access to satellite-derived ozone total column data and products.

(WDC-RSAT | 2012 ~ 2015)

7.1.2 Ozone Profile Measurements

Task 7.13 [7.9] Continue the operation of a long-term data quality control programme for ozone sondes including regular tests of delivered ozone sondes by chamber measurements possibly supported by inter-comparison flights.

(WCC-IEK-8, NMHSs | 2012 ~ 2015)

Task 7.14 [7.10] Enhance the reporting of ozone sonde data to – and the documentation of data at – the WOUDC in order to document all important quantities and to characterize the data quality of the individual series.

(WOUDC | 2012 ~ 2015)

Task 7.15 [7.12] Foster close cooperation of the networks of GAW and SHADOZ, NILU, NDACC to make best use of synergies.

(SAG Ozone | 2012 ~ 2015)

Task 7.16 Promote near-real-time transmission of ozone sounding data in CREX format via GTS/WIS.

(SAG Ozone | 2012 ~ 2015)

Task 7.17 Implement 'one-stop' access to satellite-derived ozone vertical profile data and products.

(WDC-RSAT | 2012 ~ 2015)

7.1.3 Products and Services

Current Products and Services

The following six entities handle data and information on stratospheric ozone under the auspices of WMO-GAW:

1. The World Ozone and UV Data Centre (WOUDC), hosted by Environment Canada, Toronto (http://www.woudc.org).
2. The Stratospheric Ozone web pages hosted by the WMO Secretariat provide links to important web sites, services and archives that hold data and information on ozone depletion.
3. GAWSIS, hosted by MeteoSwiss, provides information on measurement programmes and links to archived data (see WOUDC above) for all GAW stations that carry out stratospheric ozone measurements.
4. The WMO Northern Hemisphere Ozone Mapping Centre, hosted by the Laboratory of Atmospheric Physics at the Aristotle University of Thessaloniki, Greece (http://lap.physics.auth.gr/ozonemaps2/).
5. The IGACO-Ozone/UV Office hosted by the Finnish Meteorological Institute, Helsinki (http://www.igaco-o3.fi).
6. The World Data Centre for Remote Sensing of the Atmosphere, hosted by the German Aerospace Centre (http://wdc.dlr.de/).

The WOUDC has a sophisticated system for retrieval of data from individual stations and from the entire network. It is also possible to get plots of ozone time series from individual stations, based on total ozone observations and ozone sonde profiles. The WOUDC produces global and hemispheric maps of total ozone based on a combination of ground-based and satellite data. These maps, which are updated daily, are very useful for the WMO Antarctic and Arctic Ozone Bulletins.

The Ozone Mapping Centre at the University of Thessaloniki produces maps of total ozone over the Northern Hemisphere where one blends satellite and ground-based data.

The IGACO-Ozone/UV web site at FMI, Helsinki (http://www.igaco-o3.fi/en/index.html), contains information on the progress of the implementation of IGACO-Ozone/UV and will also contain a portal with links to ozone relevant sites.

The WDC-RSAT web site gives access to satellite data on atmospheric trace gases, aerosols, clouds, solar radiation, surface parameters and dynamics. Some data are stored at the centre itself and other data will be accessible through links to the relevant satellite data centres. This centre also provides information on the development of the ozone hole during the August-

December period and has model results for ozone loss and other parameters relevant to ozone depletion.

An important product concerning stratospheric ozone is the WMO Antarctic Ozone Bulletin, which is published approximately bi-weekly during the Antarctic ozone hole season from late August until December. This publication combines data from ground-based instrument, balloons and satellites with meteorological data from NOAA and ECMWF in order to interpret the development of the Antarctic ozone hole from one year to the next.

Future Products and Services (in addition to above)

- A one-stop shop (i.e., portal) for all resources related to stratospheric ozone to be developed by WDC-RSAT.
- Delivery of stratospheric ozone data in near real time using the WIS infrastructure. A handbook on how to submit data has been developed by CHMI and is being published as a GAW report.

7.2 Greenhouse Gases

Task 7.18 Begin to establish the rolling review of requirements (RRR) 4-stage process for each GAW focal area, starting with a review of scientifically defendable users' requirements, with the objective of updating the statement of guidance, considering both satellite and non-satellite observations.

(SAG GG, Secretariat | 2012 ~ 2015)

Task 7.19 Encourage submission of data from mobile platforms (e.g. aircraft) and remote sensing (satellite and ground-based) to archive and develop integrated three dimensional datasets.

(WDCGG | 2012 ~ 2015)

Task 7.20 Maintain a catalogue on the relationships between different measurement scales and the WMO scale, based on comparisons of standard gases maintained by different laboratories.

(SAG GG, QA/SACs, WCCs, WDCGG | 2012 ~ 2015)

7.2.1 Carbon Dioxide (CO_2) (incl. $\Delta^{14}C$, $\delta^{13}C$ and $\delta^{18}O$ in CO_2, and O_2/N_2 Ratios)

Task 7.21 [7.15] Continually review DQOs for CO_2 (and its isotopes) and O_2 measurements to ensure that they meet the scientific needs to reduce uncertainties in our knowledge of the carbon cycle.

(CO_2 Experts | 2009 ~ 2015)

Task 7.22 Consider the potential role of analyzers that can continuously monitor CO_2 isotopes at GAW stations for improving our understanding of the carbon cycle.

(SAG GG | 2012 ~ 2015)

Task 7.23 Consider isotope issues when preparing CO_2 standards

(CCL, SAG GG, WCCs | 2012 ~ 2015)

Task 7.24 [7.16] Develop procedures and comparison strategies to ensure that GAW stations measure CO_2 relative to the WMO CO_2 mole fraction scale.

(SAG GG, CCL, QA/SACs, CO_2 Experts, WCCs | 2009 ~ 2015)

Task 7.25 [7.18] Make recommendations for expansion of the CO_2 measurement network that will improve attribution of fluxes in inverse model studies.

(SAG GG, CO2 Experts | 2012 ~ 2015)

Task 7.26 [7.19] Promote the validation of remotely-sensed CO_2 measurements with in situ measurements.

(SAG GG | 2012 ~ 2015)

Task 7.27 [7.20] Encourage CO2 flux measurement networks to rigorously calibrate to the WMO CO_2 mole fraction scale and submit data to the WDCGG.

(SAG GG | 2012 ~ 2015)

Task 7.28 [7.21] Review the internal consistency of CO_2 observations archived at the WDCGG. Data should be available in "versions" (similar to NOAA's GLOBALVIEW-CO_2 product) with consistent quality control flags. Develop methods to archive quality-assured retrievals of CO2 column abundance.

(QA/SAC Japan, WDCGG, SAG GG | 2012 ~ 2015)

Task 7.29 [7.22] Develop methods to archive new quality-assured data streams needed for assimilation models. For example, these include analyzed meteorological fields that conserve mass and are available at high temporal and spatial resolution. These fields should be available within one month of data collection for long-term carbon cycle studies, but shorter time scales will be needed for applications such as the impacts of drought on carbon sinks.

(SAG GG, WDCGG | 2012 ~ 2015)

Task 7.30 [7.24] Develop the capability to accept and archive CO_2 column data retrieved from satellite and ground-based observations.

(WDCGG, SAG GG, Space agencies | 2012 ~ 2015)

Task 7.31 [7.25] Archive and develop integrated data sets using satellite, aircraft and surface-based measurements of CO_2.

(WDCGG, SAG GG | 2012 ~ 2015)

7.2.2 Methane (CH_4)

Task 7.32 Update the Guidelines for CH_4 measurements with regard to novel commercially available instrumentation based on spectroscopic techniques.

(SAG GG, QA/SACs, CCL, WCCs | 2012 ~ 2015)

Task 7.33 [7.29] Encourage WMO Members to increase the number of sampling sites, particularly those making high-frequency measurements, in the tropics, in the Arctic, and on continents.

(SAG GG, Secretariat, NMHSs, GAW partners | 2012 ~ 2015)

Task 7.34 [7.27] Enhance cooperation among GAW laboratories on CH_4 measurement techniques and quality assurance.

(SAG GG, QA/SACs | 2012 ~ 2015)

Task 7.35 [7.26] Develop procedures to ensure that CH_4 data archived with the WDCGG are reported on the current WMO CH_4 mole fraction scale, with version number. These procedures will include audits and inter-comparisons of standard scales and atmospheric measurements.

(SAG GG, CCL-NOAA, QA/SACs | 2012 ~ 2015)

Task 7.36 [7.19] Promote the validation of remotely-sensed CH_4 measurements with in situ measurements.

(SAG GG | 2012 ~ 2015)

Task 7.37 [7.24] Develop the capability to accept and archive CH_4 column data retrieved from satellite and ground-based observations.

(WDCGG, SAG GG, Space agencies | 2012 ~ 2015)

Task 7.38 [7.25] Archive and develop integrated data sets using satellite, aircraft and surface-based measurements of CH_4.

(WDCGG, SAG GG | 2012 ~ 2015)

7.2.3 Nitrous Oxide (N_2O)

Task 7.39 [7.32] Identify laboratories with the appropriate expertise to participate in expansion of the GAW N_2O measurement network.
(SAG GG | 2012 ~ 2015)

Task 7.40 [7.33] Increase the number of sampling sites.
(SAG GG, NMHSs | 2012 ~ 2015)

Task 7.41 [7.31] Enhance cooperation among GAW laboratories on N_2O measurement techniques and quality assurance.
(SAG GG, WCC-N_2O, QA/SAC Germany | 2012 ~ 2015)

Task 7.42 [7.30] Develop procedures to ensure that N_2O data archived in the WDCGG are reported on the WMO N_2O mole fraction scale. These procedures will include audits and inter-comparisons of standard scales and atmospheric measurements.
(SAG GG, CCL-NOAA, WCC-N_2O, QA/SAC Germany | 2012 ~ 2015)

7.2.4 Halocarbons and SF_6

Task 7.43 Designate the Central Calibration Laboratory for CFCs, HFCs, HCFCs, and PFCs, develop systematic mechanisms for comparing CFC measurements in different programmes, and then produce time series of globally averaged mole fractions concentrations to be published in the WMO Greenhouse Gas Bulletin.
(SAG GG, WDCGG | 2012 ~ 2015)

Task 7.44 [7.35] Support establishment of a quality assurance system for measurements of halogenated compounds.
(SAG GG, Secretariat | 2012 ~ 2015)

7.2.5 Molecular Hydrogen (H_2)

Task 7.45 [7.56] Develop and seek approval from JSC OPAG EPAC for a hydrogen measurement programme under the auspices of GAW.
(SAG GG, Secretariat | 2012 ~ 2015)

Task 7.46 [7.58] Develop DQOs and measurement guidelines in cooperation with current measurement groups (NOAA, CSIRO, AGAGE, EUROHYDROS).
(SAG GG, CCL-H_2 | 2012 ~ 2015)

Task 7.47 [7.57] Initiate the establishment of a World Calibration Centre for H_2.
(SAG GG, CCL-H_2, Secretariat | 2012 ~ 2015)

Task 7.48 [7.60] Coordinate comparison excercises.
(CCL-H_2, SAG GG | 2012 ~ 2015)

Task 7.49 Encourage monitoring networks to implement the new WMO H_2 calibration scale.
(CCL-H_2, SAG GG | 2012 ~ 2015)

Task 7.50 [7.61] Promote scientific collaboration between the various measurement and modelling groups to develop predictive modelling capabilities for present and future H_2 scenarios.
(SAG GG | 2012 ~ 2015)

7.2.6 Products and Services

- Calibrated gas mixtures (standards) for selected greenhouse and reactive gases for use at observatories throughout the world.
- Greenhouse gas data and time-series plots from GAW stations and contributing laboratories are available through WDCGG.
- Annual Greenhouse Gas Bulletin, prepared by SAG GG, that provides background information for non-specialists on CO_2, CH_4, and N_2O, the three gases with the largest contribution to radiative forcing by long-lived greenhouse gases, and their current globally averaged abundances in the atmosphere.

- Annual Data Summary and data archive on CD/DVDs, produced and distributed by WDCGG.
- Annual Greenhouse Gas Index produced by NOAA/ESRL that describes the relative changes in radiative forcing due to CO_2, CH_4, N_2O, and a suite of 15 minor gases since 1990, the reference year of the Kyoto Protocol.
- Interactive Data Visualization (IADV) tool operated by NOAA/ESRL to view up-to-date plots of NOAA's measurements of greenhouse gases and other tracers. NOAA ESRL's "Trends in Atmospheric CO_2" web page that shows current trends in CO_2 at Mauna Loa and globally.
- CarbonTracker, a data assimilation technique developed at NOAA/ESRL, but with versions now in Europe and Asia, utilizes GAW CO_2 observations to estimate CO_2 uptake and release.
- The NOAA/ESRL GLOBALVIEW products for CH_4 and CO_2 that are based on observational data from GAW and particularly serve the needs of carbon cycle modelers. These products come in versions that provide a convenient starting point for comparisons of different models.
- Column averaged mole fractions for several of the greenhouse gases, notably CO_2 and CH_4, which are validated by comparison with TCCON observations, and are important in advancing the understanding of trace gas cycling on regional scales.

7.3 Reactive Gases

Task 7.51 Begin to establish the rolling review of requirements (RRR) 4-stage process for each GAW focal area, starting with a review of scientifically defendable users' requirements, with the objective of updating the statement of guidance, considering both satellite and non-satellite observations.

(SAG RG, Secretariat | 2012 ~ 2015)

Task 7.52 Encourage submission of data from mobile platforms (e.g. aircraft) and remote sensing (e.g. satellite) to archive and develop integrated three dimensional datasets.

(WDCGG | 2012 ~ 2015)

7.3.1 Surface Ozone

Task 7.53 [7.37] Issue a SAG Guidance Document on surface ozone measurements containing updated DQOs and SOPs for continuous measurements including calibration and quality assurance.

(SAG RG | 2012 ~ 2015)

Task 7.54 Promote near-real-time transmission of data for surface ozone for modeling purposes.

(SAG RG | 2012 ~ 2015)

Task 7.55 [7.40] Compile existing audit information on surface ozone measurements at GAW Global and Regional stations and provide summaries of what is available.

(WCC-Empa, QA/SAC Switzerland, WDCGG | 2012 ~ 2015)

Task 7.56 [7.38] Continue biennial calibrations by the RCC for the South American stations.

(RCC-SMN (OCBA) | 2009 ~ 2015)

7.3.2 Carbon Monoxide (CO)

Task 7.57 [7.43] Provide a harmonized CO scale using improved instrumental techniques and inter-comparisons.

(SAG RG, CCL-NOAA, QA/SAC Switzerland, WCC-Empa | 2012 ~ 2015)

Task 7.58 A new CO scale should be provided based on a new set of gravimetric standards (WMO-20XX scale). After consolidation, the CCL is expected to re-assign values for all cylinders including best estimates of the uncertainty.

(CCL-NOAA, QA/SAC Switzerland, WCC-Empa | 2012 ~ 2013)

Task 7.59 [7.47] Support surface sites interested in vertical profiling, with some flights coincident in time/space with satellite overpasses.
(Secretariat, SAG RG | 2012 ~ 2015)

Task 7.60 [7.46] Support civil aircraft based regular observations for the free troposphere.
(Secretariat, SAG RG | 2012 ~ 2015)

Task 7.61 Promote near-real-time transmission of data for carbon monoxide for modeling purposes.
(SAG RG | 2012 ~ 2015)

Task 7.62 [7.44] Develop an SOP detailing the necessary steps for the harmonization of CO time series currently archived at WDCGG, correct data accordingly, and request approval by the data submitters.
(SAG RG, QA/SAC Switzerland, WCC-Empa, WDCGG | 2012 ~ 2013)

Task 7.63 [7.48] Define requirements for combining satellite, aircraft and surface-based measurements.
(SAG RG | 2012 ~ 2015)

Task 7.64 Develop the methodology to accept and archive CO column data from satellite and ground based observations.
(WDCGG, ET-WDC | 2012 ~ 2015)

Task 7.65 Archive and develop integrated data sets using satellite, aircraft and surface-based measurements of CO.
(WDCGG, SAG RG | 2012 ~ 2015)

7.3.3 Volatile Organic Compounds (VOCs)

Task 7.66 Develop comprehensive DQOs and SOPs for in-situ measurements.
(SAG RG, Secretariat | 2012 ~ 2014)

Task 7.67 [7.51] Set up further Central Calibration Laboratories (CCLs) for core VOCs
(SAG RG, Secretariat | 2012 ~ 2015)

Task 7.68 [7.49] Foster a global flask network for weekly measurements of core VOCs using air samples already collected for other purposes by NOAA, EMEP and other networks.
(SAG RG, Secretariat, NMHSs | 2012 ~ 2015)

Task 7.69 [7.50] Encourage a programme of more frequent measurements of a wider range of VOCs at a small number of well-maintained sites.
(SAG RG, Secretariat, NMHSs | 2012 ~ 2015)

Task 7.70 [7.52] Enhance the VOCs data archived at the WDCGG to include ground-based data, aircraft data, and to consider how to link to satellite data suitable for IGACO purposes.
(SAG RG, WDCGG, Secretariat, WMO Members | 2012 ~ 2015)

7.3.4 Nitrogen Oxides (NO_x)

Task 7.71 Establish the DQOs and SOPs for NO and NO_2 observations.
(SAG RG, SAG RG Subgroup on NO_x, Secretariat | 2012 ~ 2015)

Task 7.72 Establish Central Facilities (CCL and WCC/RCC) for NO and NO_2 measurements.
(SAG RG, Secretariat, GAW partners | 2012 ~ 2015)

Task 7.73 Ensure that in-situ measurements made by different laboratories are compatible within the data quality objectives.
(WCC-IEK-8, SAG RG, WMO Members | 2012 ~ 2015)

Task 7.74 Extend an observational network for NO_x observations initially focusing on in-situ NO and NO_2 measurements at surface sites.
(SAG RG, Secretariat, NMHSs | 2012 ~ 2015)

Task 7.75 Expand the GAW activities towards specific NO_y components but not total NO_y measurements.

(SAG RG | 2012 ~ 2015)

Task 7.76 Provide in-situ measurement data to validate satellite and ground-based NO_2 column and profile measurements

(SAG RG | 2012 ~ 2015)

Task 7.77 Work towards an integrated approach, which will include NO_x measurements from different platforms, starting with surface in-situ and air-borne measurements with subsequent extension to satellite and ground-based remote sensing.

(SAG RG, SAG RG Subgroup on NO_x, GAW partners | 2012 ~ 2015)

7.3.5 Sulphur Dioxide (SO_2)

Task 7.78 Set up a workshop to discuss all aspects of SO_2 measurements in global and regional atmospheres pertinent to GAW.

(SAG RG, Secretariat | 2012 ~ 2012)

Task 7.79 [7.54] Encourage agencies with the capability to make measurements of SO_2 in the remote atmosphere, including ground-based and aircraft measurements, to engage in the GAW Programme.

(SAG RG, Secretariat | 2012 ~ 2015)

7.3.6 Products and Services

Current Products and Services

- Reactive gas data from GAW stations and contributing laboratories as well as plots are available through the WDCGG (http://gaw.kishou.go.jp/wdcgg).
- Annually the WDCGG publishes a Data Summary and distributes the data archive on CD/DVDs to WMO Members.
- A strategy for long-term measurements of VOCs [*WMO*, 2007a].
- Stations audit reports.
- Scientific publications by the GAW partners based on the observations at GAW stations.

Future Products and Services (in addition to above)

- Extension of the observational database.
- Near-real-time data access through the GTS/WIS (following establishment of NRT data delivery).
- Reports of comparison campaigns.
- Provision of validation data for modelling products (e.g., chemical weather forecast by MACC).
- Extended documentation such as bulletins, measurement guidelines and assessments for reactive gases.
- Report on recommendations for Nox measurement techniques.

7.4 Atmospheric Wet Deposition

Task 7.80 Begin to establish the rolling review of requirements (RRR) 4-stage process for each GAW focal area, starting with a review of scientifically defendable users' requirements, with the objective of updating the statement of guidance, considering both satellite and non-satellite observations.

(SAG PC, Secretariat | 2012 ~ 2015)

Task 7.81 Publish the Second Global Assessment for Precipitation Chemistry

(SAG PC | 2012 ~ 2012)

Task 7.82 Develop and outreach programme to present findings from the global assessment.
(SAG PC | 2012 ~ 2015)

Task 7.83 Update GAW Report 160 (Manual for the GAW Precipitation Chemistry Programme)
(SAG PC, WDCPC, QA/SAC Americas | 2012 ~ 2014)

Task 7.84 Develop a strategy for the routine estimation of dry deposition globally to complement the current wet deposition network.
(SAG PC | 2012 ~ 2015)

7.4.1 Products and Services

Current Products and Services

- Biannual laboratory inter-comparisons (through the support of ISWS working jointly with QA/SAC Americas).
- Global assessment for major ions in precipitation combining data from GAW and cooperative regional networks as well as input from simulation models.
- Global assessment on atmospheric input of chemicals into the ocean (in cooperation with GESAMP).

Future Products and Services (in addition to above)

- Comprehensive collection of global precipitation chemistry observations, easily accessible, with comprehensive documentation.
- Basic global data analysis of major ions presented in graphical analysis and made easily accessible.
- Assistance with site establishment and laboratory operations as necessary for developing programmes.
- In cooperation with the International Nitrogen Initiative community and the Intergovernmental Panel on Climate Change, providing nitrogen data for the fifth IPCC assessment.
- Update of the Manual for the GAW Precipitation Chemistry Programme [*WMO*, 2004].

7.5 UV Radiation

Task 7.85 Update the early instrument document (GAW Report 125) by providing an addendum
(SAG UV | 2012 ~ 2014)

Task 7.86 [7.71] Increase the number of GAW associated monitoring sites. Invite selected UV stations, known from the SAG inventory, to become GAW stations.
(SAG UV, Secretariat | 2012 ~ 2015)

Task 7.87 [7.72] Work with the satellite community to improve validation of satellite data. Improve accessibility of satellite data for any specified site. The satellite community is represented on the SAG to help move this goal forward.
(SAG UV, Satellite UV community | 2012 ~ 2015)

Task 7.88 [7.73] Increase the amount of UV data held at WOUDC. Encourage sites from the SAG inventory to submit their data.
(SAG UV, WOUDC | 2012 ~ 2015)

Task 7.89 [7.74] Improve access to UV data through integration of contributing networks and databases (e.g., EUVDB, NSF Polar Network, NDACC). This follows the IGACO goal of “one stop shopping”.
(SAG UV, WOUDC | 2012 ~ 2015)

Task 7.90 [7.75] Work with the satellite community to incorporate satellite derived UV data into GAW.
(SAG UV, IGACO O3/UV Office, Secretariat, WOUDC | 2012 ~ 2015)

Task 7.91 [7.76] Complete SOPs for multifilter and diode array instruments.
(SAG UV | 2012 ~ 2015)

Task 7.92 [7.77] Establish a WCC for UV.
(SAG UV, Secretariat | 2012 ~ 2015)

Task 7.93 [7.78] Collaborate with WHO in updating the Guide to UV Index.
(SAG UV, Secretariat | 2012 ~ 2015)

Task 7.94 [7.79] Explore the provision of a product based on the UV index at WOUDC. Establish a pilot project to test the feasibility, and uptake, of such a product.
(SAG UV, WOUDC | 2012 ~ 2015)

7.5.1 Products and Services

Current Products and Services

- Guideline documents for different types of UV instruments and for QA/QC of measurements.
- Data sets provided through WOUDC.
- Provision of erythemally effective UV, *i.e.*, the UV Index.
- Provision of UV Index forecasts for the public by NMHSs.
- Calibration services for North America and Europe.
- Instrument inter-comparisons for the quality and harmonization of measurements.

Future Products and Services (in addition to above)

- Improved data availability to users especially due to more available broadband data sets.
- Improved accessibility of satellite data for any specified site.
- Global calibration services.
- SOPs for all instrument types.
- Information to the public on UV as related to vitamin D.

7.6 Aerosols

Task 7.95 Begin to establish the rolling review of requirements (RRR) 4-stage process for each GAW focal area, starting with a review of scientifically defendable users' requirements, with the objective of updating the statement of guidance, considering both satellite and non-satellite observations.
(SAG Aerosols, Secretariat | 2012 ~ 2015)

Task 7.96 [7.85] Identify and address gaps in global coordination of aerosol chemistry observations.
(SAG Aerosols | 2012 ~ 2015)

Task 7.97 Coordinate and cooperate with BSRN in aerosol observations.
(Secretariat | 2012 ~ 2015)

Task 7.98 Coordinate and cooperate with IAGOS on aerosol observations.
(Secretariat | 2012 ~ 2015)

Task 7.99 Continuously maintain and update the "one-stop" access to satellite-derived data
(WDC-RSAT, SAG Aerosols | 2012 ~ 2015)

Task 7.100 Prepare new standard operating procedures (SOP) documents for additional instruments, in particular for mobility size spectrometers (such as DMPS or SMPS) and single-particle soot photometer for black carbon mass concentration (BC).
(SAG Aerosols | 2012 ~ 2015)

Task 7.101 [7.81] Conduct on-site audits, calibrations, comparisons and training activities related to in-situ aerosol variables.
(WCC-AP, SAG Aerosols | 2012 ~ 2015)

Task 7.102 Document protocols and recommendations concerning sampling and analytical techniques for aerosol chemistry in general, and specifically for organic compounds.
(SAG Aerosols | 2012 ~ 2015)

Task 7.103 [7.82] Develop procedures for quality assurance, integration, delivery, and application of data from AOD networks.
(SAG Aerosols, SAG Aerosols subgroup on AOD | 2012 ~ 2015)

Task 7.104 [7.83] Assist the development of the GAW Regional Calibration Centres for Aerosol Optical Depth, especially in China.
(SAG Aerosols, SAG Aerosols subgroup on AOD | 2012 ~ 2015)

Task 7.105 Update status of global AOD network based on 2004 AOD workshop report (GAW Report #162)
(SAG Aerosols | 2012 ~ 2015)

Task 7.106 Prepare a proposal for the global AOD network to be considered a GCOS comprehensive surface network
(SAG Aerosols, SAG Aerosols subgroup on AOD, Secretariat | 2012 ~ 2015)

Task 7.107 Actively promote carbonaceous aerosol measurements and research in GAW, according to guidance from the SAG Aerosol.
(Secretariat, SAG Aerosols | 2012 ~ 2015)

Task 7.108 [7.84] Participate in the establishment and coordination of long-term, high-quality lidar networks worldwide for obtaining aerosol profiles.
(SAG Aerosols, SAG Aerosols subgroup on GALION, Secretariat | 2012 ~ 2015)

Task 7.109 [7.89] Contribute to validation of satellite-derived aerosol products with long-term measurements by initially publishing a climatology of aerosol properties observed at GAW stations.
(SAG Aerosols | 2012 ~ 2015)

Task 7.110 [7.86] Enhance aerosol measurements and continue capacity building in developing countries, e.g. by twinning activities.
(SAG Aerosols, WCC-AP, Secretariat | 2012 ~ 2015)

Task 7.111 [7.90] Coordinate the international sand and dust storm warning system in cooperation with WWRP.
(Secretariat, SDS-WAS Steering Committee, SAG Aerosols | 2012 ~ 2015)

Task 7.112 [7.88] Promote the WDCA to user communities.
(Secretariat, WDCA, WCC-AP, SAG Aerosols | 2012 ~ 2015)

Task 7.113 [7.87] Improve the timeliness of submission of data to the World Data Centre for Aerosols.
(WDCA, Secretariat, SAG Aerosols | 2012 ~ 2015)

Task 7.114 Promote near-real-time transmission of data for aerosols, in particular AOD measurements from the PFR (precision filter radiometer) network.
(SAG Aerosols, WDCA, WCC-AP | 2012 ~ 2015)

Task 7.115 Develop and implement procedures for quantitative assessment of quality of data at WDCA.
(SAG Aerosols, WDCA | 2012 ~ 2015)

Task 7.116 Develop a portal at WDCA for access to aerosol data at distributed data centers, exploiting synergies and in collaboration with GAWSIS.
(SAG Aerosols, WDCA, GAWSIS | 2012 ~ 2015)

7.6.1 Products and Services

Current Products and Services

- Easily accessible data, traceable to international standards.
- Near-real-time data of selected aerosol variables for assimilation and verification of numerical weather and air quality forecast models.
- Climatologies of GAW aerosol variables.
- Outreach products (e.g., brochures, technical reports, bulletins).
- Calibration and comparison of aerosol instruments (in situ, lidar, and AOD) for the GAW community and beyond.
- Standard operating procedures for aerosol instruments used in GAW.
- Global coordination of aerosol optical depth and aerosol profiling networks.

Future Products and Services (in addition to above)

- Near-real-time data of vertical profiles of aerosol backscattering for hazard warning systems and for assimilation and verification of numerical weather and air quality forecast models.

8. ANCILLARY VARIABLES

8.1 Solar Radiation

Task 8.1 [8.3] Work with the other WDCs, GAWSIS, BSRN and the satellite community to define and implement user-friendly interfaces for the presentation of radiation data and results of analysis from WRDC.

(WRDC | 2012 ~ 2015)

Task 8.2 [8.5] Ensure that all data submitted to the WRDC from the Global Surface Radiation Network (GSRN) is accompanied by meta-data on traceability to the primary standard and that WRDC clearly flags data in WRDC as to whether or not this meta-data has been provided.

(WRDC | 2012 ~ 2015)

Task 8.3 [8.6] Analyze the WRDC data submitted from the Global Surface Radiation Network (GSRN) including the Baseline Surface Radiation Network (BSRN) to address the needs of users.

(WRDC | 2012 ~ 2015)

Task 8.4 [8.7] Update QA/QC procedures at the WRDC, based on the historical data archive and using satellite information for particular site areas and especially during clear sky conditions.

(WRDC | 2012 ~ 2015)

Task 8.5 [8.9] Review periodically and publish as a WMO technical document WRDC data management procedures/practices.

(WRDC | 2012 ~ 2015)

8.2 Meteorological Observations

Task 8.6 [8.10] Promote data exchange and scientific cooperation between the atmospheric chemistry and meteorological community

(Secretariat, WDCs | 2012 ~ 2015)

Task 8.7 [8.13] Improve discovery of and access to meteorological information from WDCGG and WRDC.

(WDCGG, WRDC | 2012 ~ 2015)

8.3 Natural Radioactivity

Task 8.8 Cooperate in developing mechanisms to exchange data for natural radionuclides with the CTBTO Preparatory Commission.

(Secretariat, WDCGG | 2012 ~ 2015)

Task 8.9 Review the status of measurements and encourage the submission of data for natural radioactivity, in particular ^{222}Rn, to WDCGG.

(WDCGG | 2012 ~ 2015)

9. GAW URBAN RESEARCH METEOROLOGY AND ENVIRONMENT (GURME) PROJECT

9.1 Implementation Strategy

Task 9.1 Evaluate the benefit of the inclusion of chemical variables in NWP and climate models to improve predictions.
(SAG GURME, GAW partners, NMHSs | 2012 ~ 2015)

Task 9.2 Disseminate the results of the 2011 survey of air quality forecasting services of WMO Members and advise CAS and CBS accordingly.
(SAG GURME, Secretariat, C/PWS, JSC OPAG EPAC | 2012 ~ 2012)

Task 9.3 Provide guidelines for establishing an air quality forecasting system.
(SAG GURME | 2012 ~ 2015)

9.2 Modelling Needs

Task 9.4 [9.4] Help improve air quality forecasts by documenting various performance metrics in use for evaluating air quality forecasts, and explore new methods and metrics.
(SAG GURME, Secretariat | 2012 ~ 2015)

Task 9.5 Conduct an assessment of ongoing intercomparison studies of regional and global air quality models building upon ongoing studies such as HTAP, MACC, MICS and AQMEII.
(SAG GURME | 2012 ~ 2013)

9.3 Observational Needs

Task 9.6 [9.6] Continue to document and provide guidance on the use of passive samplers by expanding the passive sampler content of GURME, giving examples of their use, conducting a workshop on regular and precision passive samplers, stimulating performance assess
(SAG GURME, Secretariat | 2012 ~ 2015)

Task 9.7 [9.7] Document and articulate ways in which satellite data can be applied to meet GURME objectives and organize workshops on this issue.
(SAG GURME, Secretariat | 2012 ~ 2015)

Task 9.8 [9.8] Provide advice and guidance to NMHSs on measurements in support of GURME activities, by providing basic requirements and linking to relevant materials from various national Environmental Agencies' guidelines.
(SAG GURME, Secretariat | 2012 ~ 2015)

Task 9.9 [9.9] Stimulate the advancement of chemical data assimilation as a means of increasing capabilities of air quality predictions. This will include activities focused both on research and operational elements, and will be accomplished through expert meetin
(SAG GURME, Secretariat | 2012 ~ 2015)

9.4 Air Quality

Task 9.10 [9.10] Extend the existing GURME web site with information from the pilot projects, results from recent workshops, and training materials, and to better serve its role as a resource centre for countries involved in GURME.
(SAG GURME, Secretariat | 2012 ~ 2015)

Task 9.11 [9.11] Develop new and promote established GURME pilot projects to illustrate the spectrum of NMHSs urban-related activities and opportunities for co-operation with environmental and other agencies.

(SAG GURME, Secretariat | 2012 ~ 2015)

Task 9.12 [9.12] Link wherever appropriate into related/complementary activities within WMO by collaborating on a common topic and/or by collocating a project. Examples are issues related to aerosols, heat islands, fine scale meteorological forecasting (including that in support of emerging needs such as wind power forecasting), and urban climate monitoring within IPCC, CIMO, WWRP programmes.

(SAG GURME, Secretariat | 2012 ~ 2015)

Task 9.13 [9.13] Continue to promote GURME activities and accomplishments by organising GURME sessions and presentations in international conferences.

(SAG GURME, Secretariat | 2012 ~ 2015)

9.5 Capacity Building

Task 9.14 [9.15] Conduct additional regional workshops focused on "Advanced air quality modelling" and "Capacity building on basic aspects of air quality forecasting".

(SAG GURME, Secretariat | 2012 ~ 2015)

9.6 User Community

Task 9.15 [9.16] Foster and continue close co-operation with the health and ecosystem impacts community. This will include efforts to coordinate sessions at relevant conferences.

(SAG GURME, Secretariat | 2012 ~ 2015)

Task 9.16 [9.17] Assist providers of air quality forecasting services in outreach and public information aspects of air quality by sharing best-practices and experiences, and by working more closely with forecast users.

(SAG GURME, Secretariat | 2012 ~ 2015)

Task 9.17 [9.18] Expand the scope of activities and help NMHSs improve their urban air quality products. Promote these activities to user groups in all related socioeconomic sectors including human-health and agriculture, placing special emphasis on pollen bulletins and pollen forecasts to mitigate detrimental health effects like asthma.

(SAG GURME, Secretariat | 2012 ~ 2015)

Task 9.18 [9.19] Contribute air quality forecasting techniques as an important element of multi-hazard early warning systems for integrated disaster risk management.

(SAG GURME, Secretariat | 2012 ~ 2015)

9.7 Products and Services

Current Products and Services

- An international cross-cutting platform for connecting scientists, experts, and operational personnel between and within NMHSs, environmental agencies, municipal governments, international organizations and others involved in air quality issues.
- Contribution of air quality forecasting techniques as an important element of multi-hazard early warning systems for disaster risk management.
- Communication of air quality information to the public.
- Survey of NMHSs' needs and capabilities in urban air quality activities.
- GURME website as a resource for NMHSs and others involved in urban air quality issues.
- Provision of information on use of air quality forecasting models.
- Facilitation or initiation and expansion of urban meteorological and air quality activities through pilot projects.

- Support for developing country participants to relevant international conferences.
- GURME training courses on air quality modelling, forecasting and use of satellite data in air quality.

Future Products and Services

- Updated survey of WMO Members' air quality services.
- Guidelines for establishing air quality forecasting systems.
- Evaluation of the benefit of the inclusion of chemical variables in NWP and climate models to improve predictions.
- Assessment of ongoing intercomparison studies of regional and global air quality models.
- Documentation of the impact of the use of NRT chemical data and assimilation on air quality forecasting.
- Definition of meteorological and air quality measurements needed for chemical weather forecasting.
- Continued development of guides of best practices.
- Expert guidelines on the use of precision passive samplers.

10. OUTREACH

10.1 Communications

Task 10.1 Disseminate the WMO Ozone and Greenhouse Gas Bulletins at major conferences to increase visibility of WMO and especially the GAW Programme.
(Secretariat | 2012 ~ 2015)

Task 10.2 [10.3] Maintain and update the GAW web site. This includes more links to web sites hosted by various GAW partners. Encourage partners to add links to GAW on their web sites and/or establish GAW web pages on their own web sites.
(Secretariat, GAW partners | 2012 ~ 2015)

Task 10.3 [2.22] Improve the information flow to the GAW community by regular distribution of information on GAW activities at least once per year.
(Secretariat | 2012 ~ 2015)

Task 10.4 [10.10] Establish and maintain a library/gallery of photographs, graphs and cartoons pertaining to the GAW network. Cooperate with GAWSIS on making this available to the GAW community
(Secretariat, GAWSIS, GAW stations, SAGs, Central Facilities | 2012 ~ 2015)

Task 10.5 [10.11] Continue organization of GAW and GURME-oriented sessions at international scientific meetings, including the General Assembly of the European Geosciences Union and American Geophysical Union.
(Secretariat | 2012 ~ 2015)

10.2 Capacity Building

Task 10.6 [10.12] Organize and support training and education workshops related to the GAW core measurement parameters at the GAW Training and Education Centre (GAWTEC) and elsewhere.
(Secretariat, QA/SACs, SAGs | 2012 ~ 2015)

Task 10.7 [10.13] Enhance training by supporting participation of appropriate GAW affiliated persons in international scientific meetings and workshops.
(Secretariat, All GAW bodies | 2012 ~ 2015)

Task 10.8 [10.15] Encourage twinning partnerships of developing GAW measurement programmes with established GAW Central Facilities, laboratories and stations, to develop the capacity for sustained quality-assured measurements.
(Secretariat, SAGs, Central Facilities, GAW stations | 2012 ~ 2015)

Task 10.9 [10.16] Build capacity for urban air quality forecasting and management by organizing expert and training workshops and through pilot projects in selected urban regions.
(SAG GURME, Secretariat | 2012 ~ 2015)

Task 10.10 [6.7] Support the education of the public in applying chemical weather forecast products.
(SAG GURME, Secretariat, SDS-WAS Steering Committee | 2012 ~ 2015)

10.3 Products and Services

Current Products and Services

- GAWSIS, hosted by MeteoSwiss, providing information on stations, measurement programmes and contacts, and linking to archived data for all GAW stations.
- A number of web sites providing and cross-linking GAW-related information.
- GAW-related bulletins (Ozone, GHG).
- Regular training sessions at the GAW Training and Education Center (GAWTEC).

- Organization of meetings providing platforms for scientific/technical and personal exchange
- Representation/participation of WMO/GAW in international science projects.
- Regular participation in international science/technical meetings, providing a platform for the presentation of GAW-related research.
- Publication of proceedings of symposia, conferences, workshops.
- Lobbying at the management level of organizations, promoting GAW-relevant issues
- Hands-on training and sharing of technical expertise.

Future Products and Services (in addition to above)

- Improved web sites, increasing the visibility of the GAW Programme and GAW partners.
- More frequent publication of newsletters.
- A more comprehensive set of guidelines and training material.

11. RESOURCES

Task 11.1 [11.2] Continually review the funding needs of the programme, identify the resources needed to achieve specific GAW goals and how WMO Members and international partners can help meet these needs.

(Secretariat, NMHSs | 2012 ~ 2015)

REFERENCES

GCOS (2010), *Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC (2010 Update),* GCOS-138 (GOOS-184, GTOS-76, WMO TD No. 1523), 180 pp., World Meteorological Organization, Intergovernmental Oceanographic Commission, United Nations Environment Programme, International Council for Science, Geneva, Switzerland.

GESAMP (in preparation), *The Atmospheric Input of Chemicals to the Ocean. Final Report*.

Helmig, D., J. Bottenheim, I. E. Galbally, A. Lewis, M. J. T. Milton, S. Penkett, C. Plass-Duelmer, S. Reimann, P. Tans, and S. Theil (2009), *Volatile Organic Compounds in the Global Atmosphere*, EOS Transactions, 90(52), Feature.

Laj, P., et al. (2009*), Measuring atmospheric composition change,* Atmospheric Environment, 43(33), 5351-5414.

Myhre, C. L., and U. Baltensperger (Eds.) (2011), *Towards a Federated Surface-Based Aerosol Network, A White Paper based on the ENAN Workshop in Emmetten, Switzerland, 28-29 April 2009, in preparation*, 64 pp., World Meteorological Organization, Geneva, Switzerland.

Reid, W. V., et al. (2010), *Earth System Science for Global Sustainability: Grand Challenges,* Science, 330(6006), 916-917.

Vet, R., et al. (in preparation), *A Global Assessment of Precipitation Chemistry and Atmospheric Deposition*, Atmospheric Chemistry and Physics.

WCC-3 (2009), *Conference Statement. Summary of the Expert Segment,* paper presented at World Climate Conferenc-3, Geneva, 31 August – 4 September 2009, World Meteorological Organization, Geneva, Switzerland.

WMO (2004), *Manual for the GAW Precipitation Chemistry Programme - Guidelines, Data Quality Objectives and Standard Operating Procedures* (GAW Report No. 160; WMO TD No. 1251), 186 pp., World Meteorological Organization, Geneva, Switzerland.

WMO (2007a), *A WMO/GAW Expert Workshop on Global Long-Term Measurements of Volatile Organic Compounds (VOCs)* (Geneva, Switzerland, 30 January to 1 February 2006) (GAW Report No. 171, WMO TD No. 1410), World Meteorological Organization, Geneva, Switzerland.

WMO (2007b), *Plan for the implementation of the GAW Aerosol Lidar Observation Network GALION* (GAW Report No. 178, WMO TD No. 1443), 52 pp., World Meteorological Organization, Geneva, Switzerland.

WMO (2007c), *WMO Global Atmosphere Watch (GAW) Strategic Plan (2008 - 2015)* (GAW Report No. 172, WMO TD No. 1384), 104 pp., World Meteorological Organization, Geneva, Switzerland.

WMO (2008a), *WMO Strategic Plan, Geneva May 2007* (WMO TD No. 1028), World Meteorological Organization, Geneva, Switzerland.

WMO (2008b), *IGACO-Ozone and UV Radiation Implementation Plan* (GAW Report No. 182, WMO TD No. 1465), 49 pp., World Meteorological Organization, Geneva, Switzerland.

WMO (2009a), *Operations Handbook - Ozone Observations with a Dobson Spectrophotometer* (GAW Report No. 183, WMO TD No. 1469), 91 pp., World Meteorological Organization, Geneva, Switzerland.

WMO (2009b), *Revision of the World Data Centre for Greenhouse Gases Data Submission and Dissemination Guide* (GAW Report No. 188, WMO TD No. 1507), 55 pp., World Meteorological Organization, Geneva, Switzerland.

WMO (2009c), *Report of the MACC/GAW Session on Near-Real-Time Delivery of the GAW Observations of Reactive Gases,* Garmisch-Partenkirchen, Germany, 6-8 October 2009 (GAW Report No. 189, WMO TD No. 1527), World Meteorological Organization, Garmisch-Partenkirchen, Germany, 6-8 October 2009.

WMO (2009d), *Guidelines for the Measurement of Methane and Nitrous Oxide and their Quality Assurance* (GAW Report No. 185, WMO TD No. 1478), 49 pp., World Meteorological Organization, Geneva, Switzerland.

WMO (2010a), *Commission for Atmospheric Sciences - Fifteenth Session, Incheon, 18-25 November 2009*, 80 pp., World Meteorological Organization, Geneva, Switzerland.

WMO (2010b), *Executive Council Sixty-second session, Geneva, 8–18 June 2010*, 204 pp., World Meteorological Organization, Geneva, Switzerland.

WMO (2010c), *Scientific Assessment of Ozone Depletion: 2010, Global Ozone Research and Monitoring Project* - Report No. 52, National Oceanic and Atmospheric Administration, National Aeronautics and Space Administration, United Nations Environment Programme, World Meteorological Organization, European Commission, Geneva, Switzerland.

WMO (2010d), *Guidelines for the Measurement of Carbon Monoxide* (GAW Report No. 192, WMO TD No. 1551), World Meteorological Organization, Scientific Advisory Group Reactive Gases, Geneva, Switzerland.

WMO (2010e), *Instruments to Measure Solar Ultraviolet Radiation Part 3: Multi-channel filter instruments* (lead author: G. Seckmeyer) (GAW Report No. 190, WMO TD No. 1537), 55 pp., World Meteorological Organization, Geneva, Switzerland.

WMO (2010f), *Instruments to Measure Solar Ultraviolet Radiation Part 4: Array Spectroradiometers* (GAW Report No. 191, WMO TD No. 1538), 39 pp., World Meteorological Organization, Geneva, Switzerland.

WMO (2011a), *Addendum to WMO/GAW 146 Quality Assurance in Monitoring Solar Ultraviolet radiation: State of the Art; Data Quality Objectives (DQO) for Solar Ultraviolet Radiation Measurements. (Part I)*

WMO/GAW Reports 125, Scanning Spectral Instruments, and 164, Broadband Instruments, should be read in conjunction with the above DQOs., Geneva, Switzerland.

WMO (2011b), *Guidelines for Reporting Total Ozone Data in Near Real Time* (GAW Report No. 193, WMO TD 1552), World Meteorological Organization, Geneva, Switzerland.

WMO (2011c), *Addendum for the Period 2012-2015 to the WMO Strategic Plan 2008-2015,* (GAW Report No. 197), World Meteorological Organization, Geneva, Switzerland.

WMO/IGAC (in preparation), *WMO/IGAC Megacity Report*.

———

LIST OF FIGURES, TABLES AND BOXES

Figure 1. Location of stations in GAW as of December 2010.....6

Table 1. List of GAW Central Facilities and host institutions as of January 2011 4

Table 2. Comprehensive aerosol variables recommended for long-term measurement in the global network 12

Box 1. Procedure for acceptance of new stations / networks in GAW. 48

Box 2. Requirements of GAW Central Facilities.....50

ANNEX 1

OVERVIEW OF RESPONSIBLE BODIES AND ASSIGNED TASKS

Body involved	Tasks Assigned (bold: lead responsibility)
Aeronautical Met Division WMO	3.8
All GAW bodies	10.7
BIPM	2.12
C/PWS	9.2
CBS ET-Sat	3.12, 3.13, 4.9
CCL-H_2	**2.12**, 4.6, 7.46, 7.47, **7.48**, **7.49**
CCL-NOAA	**2.12**, 4.6, **7.23**, 7.24, 7.32, 7.35, 7.42, 7.57, **7.58**,
CCQM	2.12
Central Facilities	2.10, 2.19, 10.4, 10.8
CEOS	3.12
CO_2 Experts	**7.21**, 7.24, 7.25
Environmental Agencies	2.3
ET-NRT-CDT	2.4, 2.15, 2.18, 6.1
ET-WDC	2.15, 2.18, 3.9, 5.1, 5.2, **5.3**, 5.4, 5.5, 5.6, 5.7, **5.8**, 5.10, 7.64
GAW experts	2.2
GAW partners	2.15, 3.2, 3.7, 3.8, 3.9, 3.10, 3.12, 6.4, 6.5, 7.33, 7.72, 7.77, 9.1, 10.2
GAW stations	10.4, 10.8
GAWSIS	2.1, 5.3, **5.6**, 5.10, 7.116, 10.4
GMES	2.7
IGACO-O3/UV Office	7.8
International programmes	2.20, 6.4
JSC OPAG EPAC	**2.8**, **2.11**, 2.16, 2.19, **2.20**, 3.1, 3.3, **3.5**, 9.2
Modelling community	2.7
NMHSs	**2.1**, 2.3, **2.5**, 2.6, 2.7, 2.17, 3.1, 7.13, 7.33, 7.40, 7.68, 7.69, 7.74, 9.1, 11.1
NMIs	2.12

Body involved	Tasks Assigned (bold: lead responsibility)
NOAA/ESRL	6.6
Ozone experts	6.5
QA/SACs	2.14, 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, **4.10**, 5.3, 5.4, 7.20, 7.24, 7.32, 7.34, 7.35, 10.6
QA/SAC Americas	7.83
QA/SAC Germany	7.41, 7.42
QA/SAC Japan	**7.28**
QA/SAC Switzerland	7.55, 7.57, 7.58, 7.62
RCCs	2.14, 4.6, 4.8, **7.3**
RCC-SMN (OCBA)	**7.56**
Research organizations	2.3, 3.1
SAGs	**2.6**, 2.7, **2.9**, 2.11, 2.12, 2.14, 2.15, 2.17, 2.18, 2.19, 2.20, 3.2, **3.3**, 3.4, **3.6**, 3.7, **3.9**, **3.10**, 3.11, 3.13, **4.1**, **4.2**, **4.3**, **4.4**, **4.5**, 4.6, **4.7**, 4.8, **4.9**, 4.10, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.9, 5.10, **6.1**, 6.4, 10.4, 10.6, 10.8
SAG Aerosols	**6.7**, **7.95**, **7.96**, 7.99, **7.100**, 7.101, **7.102**, **7.103**, **7.104**, **7.105**, **7.106**, 7.107, **7.108**, **7.109**, **7.110**, 7.111, 7.112, 7.113, **7.114**, **7.115**, **7.116**
SAG Aerosols Subgroup on AOD	7.103, 7.104, 7.106
SAG Aerosols Subgroup on GALION	7.108
SAG GG	**6.2**, 6.6, **7.18**, **7.20**, 7.22, 7.23, **7.24**, **7.25**, **7.26**, **7.27**, 7.28, **7.29**, 7.30, 7.31, **7.32**, **7.33**, **7.34**, **7.35**, **7.36**, 7.37, 7.38, **7.39**, **7.40**, **7.41**, **7.42**, **7.43**, **7.44**, **7.45**, **7.46**, **7.47**, 7.48, 7.49, **7.50**
SAG GURME	**9.1**, **9.2**, **9.3**, **9.4**, **9.5**, **9.6**, **9.7**, **9.8**, **9.9**, **9.10**, **9.11**, **9.12**, **9.13**, **9.14**, **9.15**, **9.16**, **9.17**, **9.18**, **10.9**, **10.10**
SAG Ozone	**7.1**, **7.2**, **7.4**, **7.5**, **7.6**, **7.7**, **7.8**, **7.9**, **7.10**, **7.15**, **7.16**
SAG PC	**7.80**, **7.81**, **7.82**, **7.83**, **7.84**
SAG RG	**6.8**, **7.51**, **7.53**, **7.54**, **7.57**, 7.59, 7.60, **7.61**, **7.62**, **7.63**, 7.65, **7.66**, **7.67**, **7.68**, **7.69**, **7.70**, **7.71**, **7.72**, 7.73, **7.74**, **7.75**, **7.76**, **7.77**, **7.78**, **7.79**
SAG RG Subgroup on NO_x	7.71, 7.77
SAG UV	**7.85**, **7.86**, **7.87**, **7.88**, **7.89**, **7.90**, **7.91**, **7.92**, **7.93**, **7.94**
Satellite UV community	7.87
SDS-WAS Steering Committee	**6.3**, 7.111, 10.10

Body involved	Tasks Assigned (bold: lead responsibility)
Secretariat	2.1, **2.2**, **2.3**, **2.4**, 2.5, **2.7**, 2.8, 2.9, **2.10**, 2.11, **2.13**, **2.14**, **2.15**, **2.16**, **2.17**, **2.18**, **2.19**, 2.20, **3.1**, **3.2**, 3.3, **3.4**, 3.6, **3.7**, **3.8**, 3.9, 3.10, **3.13**, 4.4, **4.6**, 5.10, **6.4**, **6.5**, **6.6**, 6.7, 6.8, 7.33, 7.44, 7.45, 7.47, 7.51, **7.59**, **7.60**, 7.66, 7.67, 7.68, 7.69, 7.70, 7.71, 7.72, 7.74, 7.78, 7.79, 7.80, 7.86, 7.90, 7.92, 7.93, 7.95, **7.97**, **7.98**, 7.106, **7.107**, 7.108, 7.110, **7.111**, **7.112**, 7.113, **8.6**, **8.8**, 9.2, 9.4, 9.6, 9.7, 9.8, 9.9, 9.10, 9.11, 9.12, 9.13, 9.14, 9.15, 9.16, 9.17, 9.18, **10.1**, **10.2**, **10.3**, **10.4**, **10.5**, **10.6**, **10.7**, **10.8**, 10.9, 10.10, **11.1**
Space agencies	3.13, 6.5, 7.30, 7.37
TT-GSR	3.11, **3.12**, 3.13
WCCs	2.14, 4.3, 4.5, 4.6, 4.8, 7.20, 7.23, 7.24, 7.32
WCC-N_2O	7.41, 7.42
WCC-AP	**7.101**, 7.110, 7.112, 7.114
WCC-Empa	**7.55**, 7.57, 7.58, 7.62
WCC-IEK-8	**7.13**, **7.73**
WDCs	2.14, 3.9, 4.2, 4.7, **4.8**, **5.1**, **5.2**, 5.3, **5.4**, **5.5**, **5.6**, **5.7**, 5.8, **5.9**, **5.10**, 8.6
WDCA	7.112, **7.113**, 7.114, 7.115, 7.116
WDCGG	6.6, **7.19**, 7.20, 7.28, 7.29, **7.30**, **7.31**, **7.37**, **7.38**, 7.43, **7.52**, 7.55, 7.62, **7.64**, **7.65**, 7.70, **8.7**, 8.8, **8.9**
WDCPC	7.83
WDC-RSAT	**3.11**, 3.12, **7.11**, **7.12**, **7.17**, **7.99**
WMO Members	3.2, 3.4, 3.7, 6.4, 7.70, 7.73
WMO Space Programme	3.12
WOUDC	7.6, 7.10, **7.14**, 7.88, 7.89, 7.90, 7.94
WRDC	**8.1**, **8.2**, **8.3**, **8.4**, **8.5**, 8.7

ANNEX 2

PROCEDURE FOR ACCEPTANCE OF NEW STATIONS/NETWORKS IN GAW

The backbone of GAW observations is the surface-based in situ and remote sensing network of stations and sampling sites. These are classified as Global, Regional, or Contributing stations. All stations and networks supporting GAW are expected to contribute data of known quality to one of the GAW World Data Centres and to document tracability of observations for a particular variable to the GAW Primary Standard. The requirements for each category are specified in the GAW Strategic Plan [*WMO*, 2007c].

Global or Regional GAW stations are operated by WMO members. A Contributing station is one that is operated by a WMO partner network or organization that contributes data of known quality to one of the GAW World Data Centres and that is linked to the GAW Primary Standard for a particular variable [*WMO*, 2007c]. A contributing network is one that has signed a letter of agreement (LoA) with WMO. Any such agreement should contain a list and the characteristics of the stations that will be included in the GAW network as Contributing stations. Some of the stations within these networks are also classified as Global or Regional GAW stations. Examples of GAW contributing networks are TCCON, NDACC, BSRN or EMEP. Contributing stations can apply individually for designation as Regional or Global station. The procedure for acceptance of individual stations or networks is as follows:

Box 1 - Procedure for acceptance of new stations / networks in GAW

1. Prior to the application of an individual station to be accepted as a Contributing, or Regional or Global station, or a network as a Contributing network, the essential characteristics as given in Boxes 9 and 10 of the GAW Strategic Plan: 2008-2015 [*WMO*, 2007c] should be consulted to make sure the station / network qualifies.
2. An application letter should be sent by email and by regular mail to the Chief of the Atmospheric Environment Research Division at the WMO Secretariat. To upgrade the status of already registered stations, a similar letter is required. A template for an application letter is available from the GAW web site[22]. Concurrent with the application letter to the WMO Secretariat, the station should be registered in the GAW Station Information System (GAWSIS)[23].
3. A contributing network is one that has signed a letter of agreement (LoA) with WMO. Any such agreement should contain a list and the characteristics of the stations that will be included in the GAW network as Contributing stations. The applications for Regional station status are evaluated by the relevant SAG(s), depending on the measurement programme. JSC OPAG EPAC is responsible for evaluating applications for Global station status. As soon as a letter of acceptance is sent by the WMO Secretariat, the station is recognized as such in the GAW Programme and will be displayed in GAWSIS.
4. If measurements at a station were started more than a year prior to the application and satisfy the requirements of the GAW Programme, submission of the data and metadata to the responsible World Data Centre[24] is expected as part of the application. Data and metadata submission is required in due time after acceptance of a station in the GAW Programme as specified in Box 9 of the GAW Strategic Plan: 2008-2015 [*WMO*, 2007c].

To reflect the activities of a station registered in GAWSIS as adequately as possible, station managers are required to check and update the information in GAWSIS concerning measurement programme and station status at least annually (or more often, e.g. always after changes of the

[22] *http://www.wmo.int/pages/prog/arep/gaw/documents/Application_template_Aug10.doc*

[23] *http://gaw.empa.ch/gawsis/codes.asp*

[24] *see www.wmo.int/gaw/wdc or http://gaw.empa.ch/gawsis/ for more information*

measurement programme). The status of stations registered in GAWSIS will be classified as follows:

- 'Active': Station is submitting data to the World Data Centres in due time for at least one variable registered in GAWSIS.
- 'Inactive': Station has not submitted data for any variable registered in GAWSIS for the past 27 months.
- 'Intermittent operation': Stations operating long-term but on a campaign or opportunity basis can request this operating status.
- Effective January 2012, information on stations registered in GAWSIS that have no measurement programme listed in GAWSIS and no record of any data submission to one of the recognized data centres will be archived but no longer be displayed in GAWSIS, after consultation with the GAW Country Contact.

ANNEX 3

PROCEDURE FOR DESIGNATION OF GAW CENTRAL FACILITIES

Five types of Central Facilities dedicated to six groups of measurement variables form the basis of quality assurance and data archiving for the GAW global monitoring networks. These Central Facilities include:

- Central Calibration Laboratories, CCLs (Terms of Reference are given in Box 5 of the GAW Strategic Plan [*WMO*, 2007c])
- Quality Assurance/Science Activity Centres, QA/SACs (Box 6, ibid.)
- World Calibration Centres, WCCs (Box 7, ibid.)
- Regional Calibration Centres, RCCs (Box 7, ibid.)
- World Data Centres, WDCs (Box 8, ibid.)

Table 1 in Chapter 1.3.1 lists the facilities and organizations responsible for each measurement variable as of January 2011. There are still a number of variables that do not have a complete set of Central Facilities assigned to them in the GAW Programme, and GAW welcomes applications from interested organizations. Institutions offering to establish a Central Facility for the GAW Programme are requested to submit an application to the GAW Secretariat, addressing in particular the following requirements:

Box 2 - Requirements of GAW Central Facilities

- A confirmed capacity to run a Central Facility in accordance with the respective Terms of Reference;
- Long term experience in performing the activities assigned to the particular type of Central Facility;
- Availability of high level laboratory and equipment, and trained personnel dedicated to performing the required work and to running the facility;
- Annual reporting to the Secretariat using a template provided. The reporting depends on the kind of Central Facility as specifically described in the Terms of Reference and the respective agreement;
- If relevant to the task, a willingness to participate in BIPM key comparisons;
- Other relevant information (e.g., connection with GAW stations, support of exchange/ twinning programmes in GAW etc.);

The organization operating the Central Facility shall bear all costs arising in the course of the implementation and its operation, and shall strive to perform to the best of their knowledge, taking into account the current state of the art.

Applications submitted to the GAW Secretariat are evaluated by the respective expert group (e.g. SAG) that will make a recommendation for decision by JSC OPAG EPAC. Designations of Central Facilities in general have no time limitation.

Central Calibration Laboratories, and World and Regional Calibration Centres designated within the GAW Programme are not necessarily operated by National Metrological Institutes and may thus not be eligible automatically for key comparisons organized by BIPM. If an institution operating a Central Facility (e.g., a CCL or a WCC) is not yet eligible for key comparisons as organized by BIPM, a nomination should be sought. One of the mechanisms is the establishment of a side agreement with BIPM through the already existing agreement between BIPM and WMO. An agreement is signed with institutions responsible for each individual Central Facility, which specifies the mutual rights and obligations of the Parties.

ACRONYMS AND ABBREVIATIONS

ACCENT	Atmospheric Composition Change European Network of Excellence
ACSO	Absorption Cross Sections of Ozone
ACTRIS	Aerosol, Clouds and Trace Gases Infrastructure Network
AGAGE	Advanced Global Atmospheric Gases Experiment
AMDAR	Aircraft Meteorological Data Relay Programme
AOD	Aerosol Optical Depth
AQF	Air Quality Forecasting
AQMEII	Air Quality Model Evaluation International Initiative
AREP	Atmospheric Research and Environment Programme
ASRC-SUNY	Atmospheric Sciences Research Centre, State University of New York (SUNY), Albany NY, USA
BIPM	Bureau of International Weights and Measures
BoM	Bureau of Meteorology, Melbourne, Australia
BSRN	Baseline Surface Radiation Network
CARIBIC	Civil Aircraft for the Regular Investigation of the atmosphere Based on an Instrument Container
CAS	Commission for Atmospheric Sciences
CBS	Commission for Basic Systems
CCL	Central Calibration Laboratory, host of GAW reference scale
CCQM	Comité Consultatif pour la Quantité de Matière/Consultative Committee for Amount of Substance
CDT	Chemical Data Transfer
CEOS	Committee on Earth Observation Satellites
CFC	Chlorofluorocarbon
CG	Congress
CHRONOS	Canadian Regional and Hemispheric Ozone and NO_x System
CLRTAP	Convention on Long-Range Transboundary Air Pollution
COST	European Cooperation in the field of Scientific and Technical Research
CSIRO	Commonwealth Scientific and Industrial Research Organization
CTBTO	Comprehensive Nuclear-Test-Ban Treaty Organization (Preparatory Commission), Vienna
CWG	Common Wealth Games
DCPC	Data Collection and Production Centres
DLR	German Aerospace Centre, Oberpfaffenhofen, Wessling, Germany
DQO	Data Quality Objective
DWD	Deutscher Wetterdienst/German Meteorological Service
EANET	Acid Deposition Monitoring Network in East Asia
EBAS	NILU database of atmospheric chemical composition data and physical properties of the atmosphere
EC	Executive Council
EC	European Commission
EC	Environment Canada
ECMWF	European Centre of Medium Range Weather Forecast
EMEP	Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe
EML	Environmental Measurements Laboratory, New York, USA

Empa	Swiss Federal Laboratories for Materials Testing and Research, Dübendorf, Switzerland
ENAN	European Network of Aerosol Networks (a GEOmon initiative)
EPAC	Environmental Pollution and Atmospheric Chemistry
ERI	European Research Infrastructure
ESFRI	European Strategy Forum on Research Infrastructures
ESRL	Earth System Research Laboratory, NOAA
ET	Expert Team
ETH	Federal Institute of Technology, Zurich
ET-NRT CDT	Expert Team on Near-real-time Chemical Data Transfer
ET-SAT	Expert Team on Satellite systems
ET-WDC	Expert Team World Data Centre
EU	European Union
EU-FP6	European Union Framework Programme 6
EUROHYDROS	European Network for Atmospheric Hydrogen Observations and Studies
EUVDB	European UV Data Base
FMI	Finnish Meteorological Institute
FZ-Jülich	Forschungszentrum Jülich, Germany
FZJ, IEK-8	Institute of Energy and Climate Research, Troposphere of the Research Centre, Jülich
GALION	GAW Aerosol Lidar Observation Network
GAW	Global Atmosphere Watch
GAWG-CCQM	Gas Analysis Working Group of the Consultative Committee of Weight and Measures
GAWSIS	GAW Station Information System
GAWTEC	GAW Training and Education Centre
GCOS	Global Climate Observing System
GEMS	Global and regional Earth-system Monitoring using Satellite and *in situ* data
GEOMON	Global Earth Observation and monitoring
GEOSS	Global Earth Observation System of Systems
GG	Greenhouse Gases
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
GHG	Greenhouse Gas
GMD	Global Monitoring Division (as part of NOAA ESRL)
GOOS	Global Ocean Observing System
GOSAT	Global Greenhouse Gas Observation by Satellite
GMES	Global Monitoring for Environment and Security
GSP	GAW Strategic Plan
GSRN	Global Surface Radiation Network
GTS	Global Telecommunication System
GURME	GAW Urban Research Meteorology and Environment project
HCFC	Hydrochlorofluorocarbons
HFCs	Hydrofluorocompounds
HTAP	Hemispheric Transport of Air Pollution
IADV	Interactive Data Visualization
IAEA	International Atomic Energy Agency
IAGOS-ERI	In-service Aircraft for a Global Observing System-European Research Infrastructures
ICSU	International Council for Science
IFT	Institute for Tropospheric Research, Leipzig, Germany

IGAC	International Global Atmospheric Chemistry Project
IGACO	Integrated Global Atmospheric Chemistry Observations
IGBP	International Geosphere-Biosphere Programme
IMK-IFU	Forschungszentrum Karlsruhe, Institute for Meteorology and Climate Research, Garmisch-Partenkirchen, Germany
IMO	International Maritime Organization
IPC	International Pyrheliometer Comparison
IPCC	Intergovernmental Panel on Climate Change
ISWS	Illinois State Water Survey, USA
IWAQFR	International Workshop on Air Quality Forecasting Research
IZO	Izaña Observatory, Tenerife, Spain
JMA	Japan Meteorological Agency
JRC	Joint Research Centre of the European Commission, Ispra, Italy
JSC	Joint Scientific Committee
JSC OPAG EPAC	Joint Scientific Committee of the Open Area Programme Group on Environmental Pollution and Atmospheric Chemistry
LIDAR	Light Detection And Ranging
LRTAP	Long-Range Transport of Air Pollutants
MACC	Monitoring of Atmospheric Composition and Climate
MARPOL	International Convention for the Prevention of Pollution from Ships
MEGAPOLI	Megacities: Emissions, urban, regional and Global Atmospheric POLIution
MGO	Main Geophysical Observatory, St Petersburg, Russian Federation
MHEWS	Multi-Hazard Early Warning Systems
MICS	Model InterComparison Study
MODIS	Moderate Resolution Imaging Spectroradiometer
MOHp	Meteorologisches Observatorium Hohenpeissenberg, Germany
MOZAIC	Measurement of Ozone by Airbus In-service aircraft
MPI	Max-Planck Institute
MPI-BGC	Max-Planck Institute Biogeochemistry, Jena
NADP	National Atmospheric Deposition Programme (in the United States of America)
NCAR	National Centre for Atmospheric Research
NDACC	Network for the Detection of Atmospheric Composition Change
NDMC	National Drought Mitigation Centre
NILU	Norwegian Institute for Air Research
NIST	National Institute of Standards and Technology, Gaithersburg MD, USA
NMHS	National Meteorological and Hydrological Service
NMIs	National Metrological Institutes
NPL	National Physical Laboratory
NOAA	National Oceanic and Atmospheric Administration
NSF	National Science Foundation
NRT	Near-real-time, specifying observations 'not older than 1-2 hours that can be incorporated into the data assimilation schemes of weather or air quality forecast models'
NWP	Numerical Weather Prediction
OCBA	Observatorio Central Buenos Aires, Argentina
OPAG	Open Programme Area Group
PC	Precipitation Chemistry
PFR	Precision Filter Radiometer

PMOD/WRC	Physikalisch-Meteorologisches Observatorium Davos/World Radiation Centre, Davos
PWS	Public Weather Service
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QA/SAC	Quality Assurance/Science Activity Centre
RA	Regional Association
RCC	Regional Calibration Centre
RDCC	Regional Dobson Calibration Centre
RG	Reactive Gas
SAFAR	System for Air Quality Forecasting And Research
SAG	Scientific Advisory Group
SAWS	South African Weather Service, Pretoria, South Africa
SDS	Sand and Dust Storm
SDS-WAS	Sand and Dust Storm Warning Advisory and Assessment System
Secretariat	Atmospheric Research and Environment Division at WMO responsible for GAW
SHADOZ	Southern Hemisphere Additional Ozonesondes programme
SI	International System of Units
SMN	Servicio Meteorologico Nacional, Argentina
SOO-HK	Solar and Ozone Observatory, Czech Hydrometeorological Institute, Hradec Kralove
SOPs	Standard Operating Procedures
SPARC	Stratospheric Processes and Their Role in Climate
SUNY	State University of New York
TCCON	Total Column Carbon Observing Network
TF-HTAP	Task Force on Hemispheric Transport of Air Pollution
TFMM	Task Force on Measurements and Modelling
TT-GSR	Task Team on GAW Satellite Requirements
UBA	German Environmental Protection Agency, Berlin
UNEP	United Nations Environment Programme
UNFCC	United Nations Framework Convention on Climate Change
UV	Ultraviolet Radiation
VOCs	Volatile Organic Compounds
WCC	World Calibration Centre
WCC-3	World Climate Conference
WCC-AP	World Calibration Centre for Aerosol Physics, Leipzig
WCC-IEK-8	World Calibration Centre Forschungszentrum, Jülich
WDC	World Data Centre
WDCA	World Data Centre for Aerosols
WDCGG	World Data Centre for Greenhouse Gases
WDCPC	World Data Centre for Precipitation Chemistry
WDC-RSAT	World Data Centre for Remote Sensing of the Atmosphere
WHO	World Health Organization
WIGOS	WMO Integrated Global Observing System
WIS	WMO Information System
WMO	World Meteorological Organization
WORCC	World Optical Depth Research and Calibration Centre
WOUDC	World Ozone and UV Data Centre

WRC	World Radiation Centre
WRDC	World Radiation Data Centre, St Petersburg, Russia
WRF-CHEM	Weather Research and Forecast with Chemistry, USA
WWRP	World Weather Research Programme

GLOBAL ATMOSPHERE WATCH REPORT SERIES

Most of the recent GAW Reports are available for download as PDF files at http://www.wmo.int/pages/prog/arep/gaw/gaw-reports.html. The very latest reports that have appeared are listed here.

195. A WMO/GAW Expert Workshop on Global Long-term Measurements of Nitrogen Oxides (WMO TD No. 1570), 45 pp, February 2011.

194. 15th WMO/IAEA Meeting of Experts on Carbon Dioxide, Other Greenhouse Gases and Related Tracers Measurement Techniques (Jena, Germany, 7-10 September 2009) (WMO TD No. 1553), 318 pp, April 2011.

193. Guidelines for Reporting Total Ozone Data in Near Real Time (WMO TD No. 1552).

192. Guidelines for the Measurement of Atmospheric Carbon Monoxide (WMO TD No. 1551), 44 pp, July 2010.

191. Instruments to Measure Solar Ultraviolet Radiation Part 4: Array Spectroradiometers (lead author: G. Seckmeyer) (WMO TD No. 1538), 43 pp. November 2010.

190. Instruments to Measure Solar Ultraviolet Radiation Part 3: Multi-channel filter instruments (lead author: G. Seckmeyer) (WMO TD No. 1537), 55 pp. November 2010.

189. Report of the MACC/GAW Session on the Near-Real-Time Delivery of the GAW Observations of Reactive Gases, Garmisch-Partenkirchen, Germany, 6-8 October 2009, (WMO TD No. 1527), 31 pp. August 2010.

188. Revision of the World Data Centre for Greenhouse Gases Data Submission and Dissemination Guide (WMO TD No.1507), 55 pp, November 2009.

187. Joint Report of COST Action 728 and GURME – Review of the Capabilities of Meteorological and Chemistry-Transport Models for Describing and Predicting Air Pollution Episodes (ISBN 978-1-905313-77-8) (WMO TD No. 1502), 69 pp, December 2009, electronic version -July 2009.

186. 14th WMO/IAEA Meeting of Experts on Carbon Dioxide Concentration and Related Tracers Measurement Techniques (Helsinki, Finland, 10-13 September 2007) (WMO TD No. 1487), 31 pp, April 2009.

185. Guidelines for the Measurement of Methane and Nitrous Oxide and their Quality Assurance (WMO TD No. 1478), 49 pp, September 2009.

184. Technical Report of Global Analysis Method for Major Greenhouse Gases by the World Data Center for Greenhouse Gases (WMO TD No. 1473), 29 pp, June 2009.

183. Operations Handbook – Ozone Observations with a Dobson Spectrophotometer (WMO TD No. 1469), 91 pp, March 2009.