GAW Report No. 214

Report of the GAW 2013 Symposium and the Fourth Session of the CAS JSC OPAG-EPAC

(Geneva, Switzerland, 18-20 March 2013)
REPORT OF THE GAW 2013 SYMPOSIUM
and
REPORT of the FOURTH SESSION of the CAS JOINT
SCIENTIFIC COMMITTEE of the OPEN PROGRAMME AREA
GROUP on ENVIRONMENTAL POLLUTION and
ATMOSPHERIC CHEMISTRY
(JSC OPAG-EPAC)

(Geneva, Switzerland, 18-20 March 2013)
Presentations are available on the enclosed CD.
TABLE OF CONTENTS

PART I – Report of the GAW 2013 Symposium

1. OPENING OF THE MEETING ........................................................................................................ 1

2. INTERNATIONAL INITIATIVES ................................................................................................. 2

3. GAW ACTIVITIES...................................................................................................................... 4
   3.1 SAG on Greenhouse Gases .................................................................................................. 4
   3.2 SAG on Ozone .................................................................................................................... 5
   3.3 SAG on Precipitation Chemistry ....................................................................................... 5
   3.4 SAG on Aerosols ................................................................................................................ 6
   3.5 SAG on Reactive Gases ..................................................................................................... 6
   3.6 SAG on UV ........................................................................................................................ 7
   3.7 Expert Team on Near-real-time Chemical Data Transfer .................................................. 8
   3.8 Expert Team on World Data Centres ............................................................................... 9
   3.9 SAG GURME .................................................................................................................... 10

4. REGIONAL AND INTERNATIONAL ACTIVITIES AND APPLICATIONS ............................. 11

5. WAY FORWARD FOR GAW AND BREAK OUT GROUPS .................................................. 15
   5.1 Communication and outreach .......................................................................................... 17
   5.2 QA/QC and Rolling Review of Requirements ................................................................. 17
   5.3 Current socio-economic and policy priorities and sustainability and expansion of networks ........................................................................................................ 18
   5.4 Integrated use of observations.......................................................................................... 19

6. JOINT GAW AND CLRTAP HTAP SESSION ...................................................................... 20

7. NATIONAL AND REGIONAL AIR QUALITY AND ATMOSPHERIC CHEMISTRY ACTIVITIES .................................................................................................................. 21

8. ACTIVITIES AT GAW STATIONS ......................................................................................... 25

9. ACTIVITIES AT GAW CENTRAL FACILITIES .................................................................... 30

10. ANALYSIS OF OBSERVATIONS, PRODUCTS AND SERVICES ........................................ 35

11. CLOSURE OF THE GAW 2013 SYMPOSIUM ................................................................... 37

Annex A – Agenda ..................................................................................................................... 39
Annex B – List of participants .................................................................................................. 42
Annex C – List of posters ......................................................................................................... 50
Participants attending the GAW 2013 Symposium, WMO, Geneva, Switzerland, 18-20 March 2013
PART I

REPORT of the GAW 2013 SYMPOSIUM
1. OPENING OF THE MEETING

The Global Atmosphere Watch (GAW) 2013 Symposium was opened at the World Meteorological Organization (WMO) Secretariat at 9 a.m. on the 18th March 2013 by the Co-Director of the Research Department, Dr Deo Terblanche (on behalf of the WMO Deputy Secretary General). In his welcoming speech he indicated that the GAW Programme is a recognized international programme which is confirmed by the fact that 31 countries are represented at the Symposium. Dr Terblanche mentioned that observations are the backbone of the programme and many stations perform rather complex observations of multiple parameters and using multiple instruments. Dr Terblanche stressed that sustainability of the observational network is very important. It can be achieved by addressing user needs and needs for services, including those provided by the Global Framework for Climate Service (GFCS).

Prof. Øystein Hov, Chair of the Joint Scientific Committee of the Open Programme Area Group on Environmental Pollution and Atmospheric Chemistry (JSC OPAG-EPAC), welcomed the participants to the Symposium. He mentioned that in 2014 the GAW Programme would celebrate its 25th anniversary. In the earlier stages the programme was mostly focused on stratospheric ozone and acid precipitation but within the course of time the focus of the programme has shifted to climate, interaction of atmospheric composition and carbon cycle, impact of the atmospheric composition on marine environment. He stressed that air quality and health are among the upcoming priorities of the programme due to urbanization. The other new direction is the move of climate research from purely research filed into more operational, which opens some new areas where GAW can contribute. Research of Polar Regions is another coming priority where interactions between pollution and climate play an essential role. Dr Hov also stressed the importance of GAW observations, though the concept of the GAW should move towards application of research for provision of services with a substantial cross-cutting component.

The opening was followed by the presentation of the President of the WMO Commission for Atmospheric Sciences (CAS) Dr Michel Béland on recent CAS developments. Dr Béland addressed recent activities and changes within CAS and highlighted the decisions of the 15th CAS session that took place in 2009. The CAS President informed the meeting participants that CAS came up with six new research proposals to WMO Congress XVI that include:

- Carbon Flux Measurement Systems
- Better Sub-seasonal to Seasonal predictions
- Tackling the Grey Zone (Precipitation...)
- Geo-Engineering
- Megacities Integrated Environmental Prediction Initiative
- Improving polar forecast services

Dr Béland stressed that GAW is becoming one of the important players in Atmospheric Sciences, in particular through getting involved in the Polar Prediction Project, through addressing ozone variation in the stratosphere in high latitudes of the southern and northern hemispheres, through research on stratosphere-troposphere interactions, as well as through aerosols, black carbon and greenhouse gas measurements and assessments. All these provide critical information to initiate, calibrate and validate Global Climate Models (GCM). GAW works with the Working Group on Numerical Experimentation (WGNE) on aerosols and with the Global Climate Observing System (GCOS) on essential climate variables. Dr Béland stressed that priorities coming from different initiatives, like GFCS, WIGOS (WMO Integrated Global Observing System), Future Earth and “UNEP Provia” (United Nations Environment Programme/Programme of Research on Climate Change Vulnerability, Impacts and Adaptation) must be aligned to provide a proper guidance to the development of research. He stressed that duplication of coordination and redundancy of strategic priorities should be reduced.

Dr Liisa Jalkanen, Chief of Atmospheric Environment Research Division (AER) presented a general overview of the GAW Programme with the emphasis on the recent developments and priorities. Dr Jalkanen reminded the participants the mission of GAW which is:
• Systematic long-term monitoring of atmospheric chemical and physical parameters globally
• Analysis and assessment
• Development of predictive capability

She highlighted the developments in individual GAW focal areas, extension of the GAW observational network, history and objectives of the current Symposium, collaborating programmes and initiatives. Dr Jalkanen highlighted in her presentations a number of data applications and important services that are provided by the GAW Programme. She also stressed the importance of the activities related to Megacities and large urban complexes.

The GAW Symposium 2013 was organized in a manner that oral presentations focused mainly on the frameworks, concepts and services that are important for future programme development while GAW core activities were presented at the poster sessions. This report is based on the summary of both types of sessions. The Symposium also included four break-out groups that worked on the main challenges for the GAW Programme.

2. INTERNATIONAL INITIATIVES

This session was focused on the international initiatives providing in addition or in collaboration with the GAW Programme the regional and global coordination and guidelines to the research in the area of atmospheric composition.

Gelsomina Pappalardo presented an initiative on Integration of Atmospheric Observing System in Europe. There is a convincing evidence of the need to build a pan-European integrated observing system for geosciences covering the atmospheric, ocean and terrestrial domains. Dr Pappalardo explained that the European Union (EU) strategy is based mainly on developing synergies between Research Infrastructures (RIs) and Joint Programming Initiatives (JPIs). RIs, in particular, are a key instrument in bringing together a wide diversity of stakeholders to look for solutions to many of the problems society is facing today. Moreover, RIs offer unique research services to users from different countries, attract young people to science and help to shape scientific communities. The European Strategy Forum on Research Infrastructures (ESFRI) was set-up following a recommendation of the EU Council to support a coherent and strategy–led approach to policy making on research infrastructures in Europe.

Regarding the atmospheric domain, which is relevant for GAW, the actual goal is the full implementation of the existing RIs assuring long-term observations and the future plan is the establishment of a network of European Infrastructures dedicated to the observation of atmospheric compositions with the long-term goal of establishing a European Integrated Atmospheric Observations component of GEOSS (Global Earth Observation System of Systems). This should combine the existing European Research Infrastructures (ERI) of the atmospheric domain IAGOS (In-service Aircraft for a Global Observing System) and ICOS (Integrated Carbon Observation System), the Integrated Infrastructures Initiative ACTRIS (Aerosols, Clouds, and Trace gases Research Infrastructure network), and the Integrating Activity InGOS (Integrated Non-CO₂ Greenhouse Gas Observing System).

To address the question from the audience concerning the inclusion of satellite data and modelling activities, Dr Pappalardo stressed that those activities are indeed included (e.g. through MACC (Monitoring Atmospheric Composition and Climate) projects). An agreement is in place between the EU and the European Space Agency (ESA) concerning the unitization of satellite observations, though the funding for satellite measurements is coming from different sources and is not within a EU mandate.

The other integrating/coordinating project relevant to the GAW Programme is the International Global Atmospheric Chemistry (IGAC), which was presented by its Co-Chair Prof. Paul Monks. The IGAC project (www.igacproject.org) is a Core Project under the umbrella of the International Geosphere Biosphere Programme (IGBP) and co-sponsored by the international
Commission on Atmospheric Composition and Global Pollution (iCACGP). IGAC’s mission is to coordinate and foster atmospheric chemistry research towards a sustainable world by integrating, synthesizing, guiding, and adding value to research undertaken by individual scientists through initiating new activities, acting as a hub of communication for the international atmospheric chemistry research community, and through building scientific capacity. This mission is well in line with the GAW strategy and ensures tight collaboration between the GAW Programme and IGAC. The need for a multi-disciplinary approach is widely accepted by IGAC. IGAC works towards global sustainability. It takes a challenge of addressing global issues such as climate, human health and ecosystems through integration of IGAC’s core activities focused on emissions, atmospheric processes and atmospheric composition. It takes into consideration individual and societal responses to those core activities. The details of the current activities and collaboration with WMO were given in the presentation.

In response to the criticism from the audience concerning the need for two “parallel” initiatives like IGAC and GAW, Prof. Monks stressed that the programmes have different mandates and IGAC tackles wider environmental issues than GAW does. He also mentioned that IGAC as a part of the IGBP will also be involved in the “Future Earth” initiative.

An experience of integrated programmes and initiatives described above highlights the importance of national activities. A good example of how the national activities can foster international development was given in the presentation by Gabriela Seiz from MeteoSwiss. In recognition of the importance of the issues advocated in the UN Framework Convention on Climate Change (UNFCCC) and the Vienna Convention/Montreal Protocol, the Swiss Federal Council decided to commit to a long-term GAW-CH Programme in order to substantiate the GAW goals on the national level. The details of GAW-CH Office national activates were given in the presentation. To support international capacity building a CATCOS (Capacity building and Twinning for Climate Observing Systems) project is financed by the Swiss Agency for Development and Cooperation (SDC). The coordination is done by MeteoSwiss, while the implementation partners are Paul Scherrer Institute (PSI), the Swiss Federal Laboratories for Materials Science and Technology (Empa), University of Zurich and University of Fribourg. The project runs from September 2011 to February 2014. The project goals are subdivided into an atmospheric domain for aerosol and GHG measurements (stations enhanced in Indonesia and Kenya, newly installed in Chile and Vietnam), a terrestrial domain for glacier monitoring (Kyrgyzstan, Ecuador and Colombia), and a capacity building cross-cutting domain to further the production, management and analysis of climate data. From a GAW perspective, the CATCOS project shows good promise for closing gaps in data sparse areas, most notably in South America, Central Africa, and South East Asia.

Dr Seiz assured that after the official end date of the project the newly established stations would be supported by Switzerland (through inclusion into audit plan of the World Calibration Centre in Empa). Dr Seiz also informed that the studies of the connection between the ozone layer and climate are not the focus of the CATCOS project but they remain a priority for the GAW-CH Programme.

Heather Adair-Rohani from the World Health Organization (WHO) gave an overview on Air Quality and Health. One of the most well studied health-damaging pollutants is fine particulate matter (PM). Fine particulate matter can penetrate deep into the lungs and impact the body systematically. Epidemiological studies have linked various outcomes with both acute and chronic exposure to fine PM, including cardiovascular disease, chronic respiratory diseases, childhood pneumonia, adverse pregnancy outcomes, and cancers. In December 2012, a new set of disease burden estimates published in the Lancet show air pollution as one of the largest risk factors for both morbidity and mortality. This study estimated household air pollution (or indoor air pollution) to be responsible for 3.5 million premature deaths annually and outdoor air pollution to be responsible for 3.3 million premature deaths a year. The epidemiological evidence of air pollution is ever-growing. One important development is a new integrated concentration response function. This new technique derives health risk across various sources of combustion related to air pollution (e.g. outdoor air pollution, household air pollution, active smoking). WHO’s programme of work on air quality focuses on both indoor and outdoor air quality. In terms of indoor or household air quality,
WHO regularly monitors access to household energy to estimate exposure, actively contributes to various global energy initiatives (e.g. UN Secretary General’s Sustainable Energy for All, Global Alliance for Clean Cookstoves) and completes normative work on how to improve health through improved indoor air quality (e.g. later this year, WHO will be releasing the first set of Indoor Air Quality Guidelines for household fuel combustion). Like indoor air quality much of WHO’s work on outdoor air quality involves the monitoring of outdoor air quality and associated disease burden as well as conducting normative work for countries to improve air quality and health. Moving forward, WHO plans to improve its exposure and disease burden estimates from outdoor air pollution using new methods that incorporate satellite based estimates of PM, statistical modelling and ground level measurements.

The participants of the Symposium asked to clarify the concept of “urban health” and to explain how WHO sets up the limitation levels for PM and help to reach the recommended levels. Dr Adair-Rohani explained that public health in urban areas is one of the concerns of WHO. Current limitations were set up to reflect the pollution levels that have confirmed negative effects on human health. It is clear that these limitations are very strict and cannot be reached by main developing countries. Where the absolute limitations are not feasible currently, WHO set up the interim targets. To reach those WHO is working on the preparations of Guidelines on household combustion, as this process is considered as the main contributor to the aerosol pollution in developing world.

3. GAW ACTIVITIES

This session of the Symposium reflected the activities and the progress in GAW focal areas. The presentations were given by the Chairs of GAW Scientific Advisory Groups (SAGs) and Chairs of the Expert Teams (ETs).

The Chairs of the SAGs and Expert Teams are listed below:

- Rick Artz, SAG Precipitation Chemistry
- Ed Dlugokencky, SAG Greenhouse Gases
- John Ogren, SAG Aerosols
- Stuart Penkett, SAG Reactive Gases
- Johannes Stäehelin, SAG Ozone
- Ann Webb, SAG UV
- Greg Carmichael, SAG GURME
- Jörg Klausen, Expert Team World Data Centres (ET-WDC)
- Vincent-Henri Peuch, Expert Team on Near-real-time Chemical Data Transfer (ET-NRT CDT)

3.1 SAG on Greenhouse Gases

Ed Dlugokencky, the Chair of the SAG on Greenhouse Gases (SAG-GHG), reported on recent activities and the progress done by greenhouse gas community within the GAW Programme. He informed that membership of SAG GHG has changed considerably since GAW 2009. A broader range of expertise is covered now by SAG than before. SAG GHG meets every 2 years for one day adjacent to the WMO/IAEA Meeting on Carbon Dioxide, Other Greenhouse Gases, and Related Measurement Techniques (GGMT). The next meeting will be June 9, 2013, just after the International Carbon Dioxide Conference, and just before the next GGMT. SAG GHG writes the annual WMO GAW Greenhouse Gas Bulletin; recent bulletins have focused on the global CO₂ budget in 2012 and the global distribution and trends of N₂O in 2011. Measurement guidelines for CO₂ are behind schedule, but we hope to publish them as a GAW Report in 2013.

GAW GHG Central Calibration Labs (CCL) continue to interact with National Metrology Institutes (NMI). After WMO signed the mutual recognition agreement with the International Bureau of Weights and Measures (BIPM), the NOAA (National Oceanic and Atmospheric Administration) CCL hosted a meeting of the CCQM GAWG (Consultative Committee for Amount of Substance:
combined with model predictions. The data were collected primarily from the major world, the global and regional wet deposition patterns were developed from measurement data some regions of Asia and Australia, focusing on the characterization of acid deposition. SO, NO, Cl, H+, pH, NH4+, Ca2+, Mg2+, Na+, K+, P and organic acids. The global discussion is separated into two sections, base chemistry, temporal trends and, in some regions, dry deposition fluxes. Given the paucity of measurements in many areas of the world, the global and regional wet deposition patterns were developed from measurement data combined with model predictions. The data were collected primarily from the major deposition regions, dry deposition fluxes. Given the paucity of measurements in many areas of the world, the global and regional wet deposition patterns were developed from measurement data combined with model predictions. The data were collected primarily from the major deposition

3.2 SAG on Ozone

Johannes Stähelin, the Chair of the SAG on Ozone, reported on recent activities and the progress done by the ozone community within the GAW Programme. Dr Stähelin in particular informed, that GAW provides the calibration for the global Dobson and Brewer total ozone networks using the Langley plot method. The record of the Langley plot measurements of the world primary Dobson instrument shows excellent long-term stability (maximal deviation in ozone (at 300 DU) since 1972 is within ± 0.5 %) and the Dobson network continues to provide important ground-based measurements with high data quality. However, the number of stations contributing to high quality Dobson measurements was decreasing since the beginning of the century. For the calibration of the Brewer network two triades are operated (at Toronto, Canada, and at Izaña, Tenerife) which are tied to Langley plot measurements. However, SOPs (Standard Operating Procedures) for Brewer instruments and SOPs for Brewer intercomparisons still need to be developed. Level 0 data and complete calibration information should be reported to the World Ozone and Ultraviolet Radiation Data Centre (WODUC) in future. SOPs for ECC (electrochemical concentration cell) ozonesonde measurements are available (GAW Report No. 201), and the efforts to homogenize the ozonesonde measurements available at different archives need to be continued.

The IGACO (Integrated Global Atmospheric Chemistry Observations)-O3/UV Office (funded by the Finnish Meteorological Institute (FMI)) was very successful in starting and pursuing important projects such as (ACSO: Absorption Cross Sections of Ozone) and in contributing to important international activities (Initiative on Past Changes in the Vertical Distribution of Ozone, supported by SPARC (Stratosphere-troposphere Processes And their Role in Climate), IO3C (International Ozone Commission), IGACO-O3/UV and NDACC (Network for Detection of Atmospheric Composition Changes).

The participants of the meeting stressed that currently ozonesonde data are stored in five different data archives in different formats. The Ozone SAG Chair confirmed that SAG is aware of this problem and works towards the harmonization of data submission and centralizations of the data archives.

3.3 SAG on Precipitation Chemistry

Richard Artz, the Chair of the SAG on Precipitation Chemistry, reported on the recent business of the SAG including SAG membership, progress with the Second Global Assessment, updates concerning the Quality Assurance/Science Activity Centre (QA/SAC) Americas and the World Data Centre (WDC) Precipitation Chemistry, and proposed next steps. He informed the participants, that preparation of the Second Global Assessment of Precipitation Chemistry and Deposition is nearing completion. The Assessment is being written for the World Meteorological Organization by scientists from South Africa, Norway, Russia, Australia, Japan, India, Italy, Switzerland, France, England, the USA and Canada. The Assessment covers the period from 2000 to 2007 and describes the global composition of precipitation and patterns of wet deposition of SO2, NO3-, Cl-, H+, pH, NH4+, Ca2+, Mg2+, Na+, K+, P and organic acids. The global discussion is supplemented by detailed regional discussions of Africa, South America, North America, Europe, Asia and Australia, focusing on the characterization of acid-base chemistry, temporal trends and, in some regions, dry deposition fluxes. Given the paucity of measurements in many areas of the world, the global and regional wet deposition patterns were developed from measurement data combined with model predictions. The data were collected primarily from the major deposition...
monitoring networks of the world and screened based on GAW Report No. 160 (Manual for the GAW Precipitation Chemistry Programme). Measured data were augmented using model predictions obtained from the Coordinated Model Studies Activity of the Task Force on Hemispheric Transport of Air Pollution (TF HTAP) under the framework of the United Nations Economic Commission for Europe (UN ECE) Convention on Long-Range Transboundary Air Pollution (CLRTAP). The measurement-model results were combined into maps of sulphur and nitrogen wet deposition and, where possible, dry deposition.

An update of the QA/SAC Americas noted that results from all laboratory intercomparison studies between 1985 and 2012 have been made available on the website and include intercomparison summary data as well as detailed information for each of the approximately 85 participating laboratories. The WDC Precipitation Chemistry website now includes links to all major global networks and information identifying which laboratories analyze data for each of the participating measurement stations. In each case, links are provided to the QA laboratory results from the Laboratory Intercomparison Studies.

The SAG plans to meet in Chicago in May 2013 to discuss membership, to initiate the update of GAW Report No. 160 and to discuss collaboration with emerging measurement networks in South America and Africa.

In response to the question of the CAS President concerning urban observations, SAG-PC Chair clarified, that those observations are removed from analysis due to limited representativeness of urban sites.

3.4 SAG on Aerosols
John Ogren, the Chair of the SAG on Aerosols, reported on recent activities and the progress made by the aerosol community within the GAW Programme. He stressed that the objective of the aerosol component of the WMO Global Atmosphere Watch is to improve climate and air quality assessments and predictions through measurements and analysis of the spatio-temporal distribution of aerosol properties for up to multidecadal time scales. To accomplish this objective, the GAW SAG for Aerosols recommends measurement of a comprehensive suite of aerosol properties at GAW stations. Three networks coordinate these measurements using in-situ methods for chemical composition, number concentrations, size distribution, light scattering and absorption; lidars for vertical profiles of backscattering and extinction; and filter radiometers for aerosol optical depth, respectively. The WDC for Aerosols archives and disseminates data from in-situ measurements and Aerosol Optical Depth (AOD), while the WDC for Remote Sensing of the Atmosphere facilitates combined access to GAW and satellite remote sensing data; data from the participating lidar networks are archived and disseminated by the network-specific data centres. Two World Calibration Centres (Aerosol Physical Properties and Optical Depth) organize training courses, conduct site audits, and calibrate and characterize instruments to ensure that GAW data are of known, high quality; in this context, it is important to note that GAW still lacks a World Calibration Centre for Aerosol Chemistry. Publications written or organized by the SAG include standard operating procedures, Aerosol Bulletins and peer-reviewed scientific papers (e.g., trend analyses). Aerosol SAG Chair stressed that due to complexity of aerosol observations and data products, science is important for quality assurance of both.

The participants of the Symposium requested about the role of Indian network for aerosol (as Skynet) and AERONET (AErosol RObotic NETwork) in the GAW aerosols programme. Aerosol SAG Chair welcomed Skynet to join the GAW Programme, while AERONET decided not to join GAW as a contributing network.

3.5 SAG on Reactive Gases
Martin Schultz, on behalf of Stuart Penkett, the Chair of the SAG on Reactive Gases, on recent activities and the progress done by the reactive gas community within the GAW Programme. He informed the participants that Reactive Gases SAG consists of 15 members from 8 countries and focuses on surface ozone, CO, VOCs, NOx, and SO2. The previous SAG meeting was held in Malta in 2011 and the next meeting is scheduled for November 2013 in Garmisch-
Partenkirchen. Recent GAW reports for the group of Reactive Gases include GAW Report No. 192 (CO Measurement Guidelines), Nos. 199 and 209 (O₃), No. 204 (VOCs), No. 195 (NOx). There is a network in place with reasonable coverage of ozone and CO measurements (although significant gaps remain and time series are not always sufficiently long for trend analysis). Recently, a substantial amount of VOC (volatile organic compounds) data has been added to the WDCGG database. The NOx network is growing but is currently limited mainly to Europe and China. There is growing concern that some measurements will not be continued or stations closed down due to national funding issues (particularly in North America). On the other hand, significant growth of the network is expected in Asia. In Europe, the EU funded ACTRIS (Aerosols, Clouds, and Trace gases Research InfraStructure network) project (2011-2015) is providing active support to GAW and creates opportunities for harmonizing data quality and data access and expanding GAW reactive gases measurements. With respect to CO, recent highlights include a review of the calibration scales by NOAA, and the ongoing assessment of new measurement techniques based on laser spectroscopy by Empa. Major activities concerning surface ozone include a new, comprehensive measurement guideline report and a measurement comparison and network status review in South America. A 4th meeting of VOC experts was held in York in 2012, and much progress was made on VOC calibration scales, measurement quality, and data submission. A CLL for non-methane hydrocarbons (NMHCs) was established in 2010 at the UK National Physical Laboratory (NPL) and a CCL for monoterpenes proposed by NIST was recently accepted. SOPs are being prepared. Network compatibility for NMHCs measurement now mostly meets the data quality objectives. NOx activities include a round-robin and a side-by-side comparison at Hohenpeissenberg. The implementation of a NOx WCC in Jülich has been delayed. Initial planning steps for setting up a SO₂ network have been made. Empa performed 12 site audits between 2009 and 2012 and recently revised the audit strategy to additionally include measurements with a travelling instrument and an independent inlet line over a period of 1 to 2 months following the conventional performance audit. GAW reactive gases data are increasingly used for the evaluation of numerical models. Thirteen stations are delivering near-real-time or delayed mode O₃ and CO data to the European MACC-II (Monitoring Atmospheric Composition and Climate - Interim Implementation) atmospheric service. New opportunities arise from integrating airborne measurements (e.g. IAGOS) and the SAG sees a need to work towards a better integration of GAW with regional networks.

Dr Schultz stressed that there are several critical needs to be addressed by the GAW Programme, including the need for better integration of aircraft data and use by the aircraft platform of Quality Assurance system similar to the one within GAW and the lack of regional involvement. He brought to the attention of the participants the concerns expressed by the SAG on GAW Data Quality Objective (DQO) (achievable against useful) and lack of visibility of GAW reports.

3.6 SAG on UV

Susana Diaz reported on behalf of Ann Webb, the Chair of the SAG on UV, on recent activities and the progress done by the UV community within the GAW Programme. Since 2010 several documents have been produced by the SAG UV related to quality assurance (GAW Report No. 190 (2010), Report No. 191 (2010), Report No. 198, which is an Addendum to GAW Report No. 146 (2011)). In the last years, substantial improvements have been reached in the accuracy of measurements; unfortunately the network of the measurement stations continues declining both in developed and developing countries. Nevertheless, research is going on in the health and environment sector as there is a need to enhance the understanding of UV Radiation effects. Related to UV effects on humans, the focus is moving from negative effects (skin cancer and cataract) toward positive effects (vitamin D and immune system). A document was produced rationalizing units in UV erythema and vitamin D weighted irradiance, the document is ready for voting at CIE (International Commission on Illumination). It is also available through SAG. WHO lead a discussion on UV Index and two members of SAG UV were part of the process (Sinclair C, and Webb A), a paper with the conclusions was published in Health Physics (103(3):301-306. DOI: 10.1097/HP0b013e31825b581e). A public site in Environment Canada where people can check UVI anywhere at any time has been established
Recently, Davos (RCC) became a WCC for UV Radiation. The WOUDC archive large numbers of accumulated datasets (~550,000 files) received from 506 stations, from 166 agencies, in 82 countries. WOUDC has a project underway to automate the mirroring of data sent to NDACC and is planning to begin a similar project for the European Ultraviolet Database (EUVDB). UV reconstruction from satellite information is still a challenge, snow, aerosols and clouds are factors difficult to manage, nevertheless, satellite data is very useful for climatology, seasonal variations and ocean coverage analysis. Since 1991, UV has been part of the UNEP/WMO Scientific Assessment on Ozone Depletion with a summary chapter as part of UNEP Environmental Effects of Ozone Depletion. Nevertheless, in 2014, UV will not be part of the UNEP/WMO Scientific Assessment on Ozone Depletion but will keep the chapter in UNEP Environmental Effects of Ozone Depletion. Future activities of the SAG UV include:

- Harmonisation of data from Total Ozone Mapping Spectrophotometer (TOMS) and OMI (Ozone Monitoring Instrument) UV
- Coordination with the Instrument Working Group responsible for the update of the Spectral Instruments document
- Exploration of the use of pyranometer data (GAW resource with a much longer and higher resolution record) to estimate UV Radiation levels
- To carry out a survey of countries and organizations making UVI forecasts, and establishment of the basis of those forecasts.

### 3.7 Expert Team on near real-time Chemical Data Transfer

Vincent-Henri Peuch, the Chair of the Expert Team on Near-real-time Chemical Data Transfer (ET-NRT CDT), reported on recent activities and the progress in the implementation of the near-real-time delivery of GAW data. In the period from 2009 to present, the use of atmospheric composition data in near-real-time has become a reality, both for Numerical Weather Prediction (NWP) and for specific applications such as air quality forecasts. Experimental tests including aerosol effects in meteorological models and forecasts, illustrated with an example in the European Centre for Medium-Range Weather Forecasts (ECMWF) Integrated Forecasting System, are in particular promising. Observational data is generally used for assimilation or for routine monitoring of performance of forecasts. The ET has met four times since its first meeting in February 2010. It has discussed and clarified the understanding of “near-real-time”, a concept that is otherwise rather loosely defined or defined differently in different contexts: real-time is less than 3h (making it possible to enter operational applications); near-real-time is between 3h and some days (useful for follow-up of events and for on-line/quick-look verification of models/services); delayed mode is from some days to some months (useful for validation and re-analyses). A number of examples of usage of NRT atmospheric composition data were presented, some in connection with the GURME (GAW Urban Research Meteorology and Environment) project (the System of Air Quality Weather Forecasting and Research “SAFAR” for Delhi in India; the pilot project for air quality forecasts for Shanghai in China). Benefits from the usage of data from the ICOS and IAGOS European research infrastructures in the context of the validation of products of the MACC-II project was also demonstrated. Maps comparing NRT aerosol information available in 2009 and 2012, provided by the SAG Aerosol Chair, further indicated positive developments ongoing with a growing number of sites making observations available. Some worldwide examples of air quality data available in real-time or near-real-time completed the picture. A last example was on the use of ozonesonde data in near-real-time to assess and characterise rapidly the impact of assimilation of a new satellite data stream in the MACC-II system running daily at ECMWF. Overall, the presentation demonstrated that a wealth of composition data is available today within hours and up to a few days delivery of observational data, and that there is a growing number of services that use this data in a timely fashion at the global, regional and local scales. The ET-NRT CDT plans to publicise this new state-of-play by preparing and publishing a reference paper later this year. The chair of the ET indicated a number of remaining challenges, starting from re-enforcing the dialogue with data providers and showing how usage of the data (e.g. screening/monitoring in assimilation…) can bring useful information and be a benefit to them. Working with the WIS (WMO
Information System) and on metadata characterization and interoperability requires significant effort in the near future. To finish, Vincent-Henri Peuch mentioned two activities over which the ET could work: one is to see how “data harvesting” activities could be set up in order to take advantage of a large number of data available on the internet in very disparate forms; the second is to discuss potential of crowd-sourcing (cheap instruments, subjective observations...) in the context of getting near-real-time information on some on-going or developing events.

John Ogren reminded the lessons learned from BAPMoN (Background Air Pollution Monitoring Network), when different kinds of instruments, in particular cheap instruments, were used for atmospheric composition observations. The GAW Programme grew from that phase and requires certain quality of observations, which can not be achieved with the approach, proposed by ET-NRT. Chair of ET-NRT responded to this call that, indeed, there is a crucial need for a backbone of reliable and quality-assured stream of data and that crowd-sourced information cannot replace this; the question is really on the additional value of it, and the debate is entirely open.

Carl Brenninkmeijer stressed that in the modern world filled with the available data, emission assessments and reasonable modelling tool it is difficult to justify the call for further model developments. Chair of ET-NRT replied that there is a very large scope for progress in atmospheric composition models: in particular, assimilation of observational data shows clearly shortcomings in many aspects of the models.

### 3.8 Expert Team on World Data Centres

Jörg Klausen, the Chair of Expert Team on GAW World Data Centres, reported on the progress made in the archiving and dissemination of the GAW measurement data. The team includes the managers of the GAW World Data Centres: Hiroshi Koide (WDCGG), Tony Colavecchia (WOUDC), Markus Fiebig (WDCA), Van Bowersox (WDCPC), Anatoly Tsvetkov (WDCR), Julian Meyer-Arnek (WDC-SAT). The motivation for ET-WDC is three-fold: management of integrated observation in the GAW context, management of integrated observations in the WMO context (WIGOS), and making information discoverable for NHMSs, academia, and other interested parties through WIS. During the reporting period ET-WDC met three times (in Geneva and Toronto) and held four teleconferences. Topics of concern were related to operational aspects of the WDCs and the GAW Station Information System (GAWSIS) along with the work on data acquisition and data flow (at the Centres), data documentation, and data dissemination (to users). The team further considered the tasks assigned in the Addendum to the GAW Strategic Plan (GAW Report No. 197). ET documented some progress on most of the tasks. A major achievement was the development of a GAW metadata profile in line with the WMO core metadata profile that will facilitate the integration of the WDCs and GAWSIS in the WIS. Some WDCs have made provisions to accept uncertainty information, but many aspects of harmonizing metadata information on data quality and traceability remain open. While GAWSIS serves as a central node for metadata across all GAW focal areas, harmonized access to data across WDCs has only been identified as an important strategic goal of the ET but its full potential has not been realized yet. Overall, the WDCs have further improved their services as long-term archives for GAW and continue to be important partners for scientific assessments and for the generation of value-added products.

The presentation of the Chair of ET-WDC caused active discussion among the Symposium participants. In particular, it was mentioned that there are at least 15 other (non-GAW) world data archives for the GAW variables. The Chair of ET-WDC stressed that national or project archives are often funded by national agencies or project money. They are struggling for visibility and reluctant to accept existing data centres. GAW is a comprehensive global programme, but it relies on funding from other sources and voluntary contributions of member countries. CAS President M. Béland stressed in this respect the bad experience during the International Polar Year, where merging of data centres did not work and datasets were just unnecessarily multiplied (“community is killing itself by doing it”). Rather, improved interoperability of existing archives and common access should be advanced. The approach of connecting (fragmented) data centres via portals also reflects GAW’s co-ordinating role.
As one of the promising steps on harmonization Jörg Klausen mentioned the inclusion of WIGOS metadata standard into WMO Executive Council document, which will make this standard mandatory for execution.

3.9 SAG GURME

Greg Carmichael, Chair of the SAG on GURME, reported on the recent activities and progress made by this project. GURME activities since 2009 were reported in terms of highlights. A major activity of GURME is the promotion of pilot projects. The pilot project on Latin America cities began in 2003. Several workshops for this project were recently held and they were listed in the presentation with the most recent being a workshop on short-lived climate forcers (SLCFs) for Latin America, held in September 2011, in Mexico City; and a workshop on Air Quality (AQ) forecasting held in Costa Rica in October 2011. A new air quality forecasting system at the Chilean Meteorological Office was established to run operationally forecasting of winter PM levels. The GURME Pilot Project on air quality forecasting for EXPO 2010 was a part of the overall multi-hazard early warning system developed for the Shanghai EXPO (MHEWS (Multi-Hazard Early Warning Systems) Shanghai). This project was led by the Shanghai Meteorological Administration. The project had several elements, including enhancements to the observing system; expansion of quality & weather forecasting products (e.g., AQ, heat waves, and pollen); a field experiment (joint with the National Center for Atmospheric Research (NCAR)); and workshop activities. Phase II of this project is now underway with a focus on further developing joint Health-Meteorology Services. A new pilot project in India was developed in 2011. The System of Air Quality Forecasting and Research (SAFAR) grew out of an earlier AQ forecasting workshop held in India. The goals of the project include: development of (a) state of the art System of Air Quality Forecasting & Research (SAFAR) and (2) Weather-Now, -Tomorrow and Now-casting services for Indian Metropolitan cities. These services are dedicated for dissemination of information on weather and air quality directly related to human health and agriculture to the general public. This project is led by the India Institute for Tropical Meteorology and was launched in support of the Commonwealth Games held in Delhi in October 2012. The system encompasses establishment of a new AQ monitoring network and a forecast distribution system that includes displays around the city. The Delhi system in now operational at the India Meteorological Service. The system has now been installed in Pune and plans are to install it in other cities around India over the next 5-10 years. Near-real-time Data Application to Air Quality Forecasts is the newest pilot project. This project at CMA has the objectives to: develop and establish a NRT chemical data transfer system to collect and process both ground-based and satellite observations, based on the WMO data transfer protocols for conventional weather data; develop an AQ forecasting system and integrate it with the NRT system to illustrate the capacity of NRT data to enhance the accuracy of AQ forecasts in China; develop an emission estimating system using the NRT data and inverse modelling methodology; and exchange and transfer research results with other national and international agencies.

GURME activities within the last several years also addressed expanding collaborations with other organizations (e.g., EU, COST (European Cooperation in Science and Technology), IGAC, GEO (Group on Earth Observations)). Examples include GURME joint activities with MEGAPOLI (Megacities: Emissions, urban, regional and Global Atmospheric POLLution and climate effects, and Integrated tools for assessment and mitigation) project, with MACC (GEMS (Global and regional Earth-system (Atmosphere) Monitoring using Satellite and in-situ data)) project; with COST Actions (728 Enhancing meso-scale meteorological modelling capabilities for air pollution and dispersion applications; ES0602 Chemical weather; ES0603 Allergenic pollen; and ES1004 European framework for online integrated air quality and meteorology modelling (EuMetChem), with IGAC (Megacity Report, biomass burning, and regional networks (China, America’s, S. Asia)), with WHO activities on AQ links to health effects; and with GEO through the Global Urban Observation and Info Task. GURME reports were produced from some of these activities and are available from the GAW website. GURME also co-organized several meetings and sessions at conferences. For example GURME co-organized and hosted the 4th international Workshop on Air Quality Forecasting Research in Geneva in December 2012. Finally the GURME website was updated and further information can be found at mce2.org/wmogurme.org/.
A meeting participant requested the details for the model and emission data special resolution, used in the Santiago case study. GURME SAG Chair responded that model special resolution was 4x4 km and emissions were provided on the same spatial scale.

4. REGIONAL AND INTERNATIONAL ACTIVITIES AND APPLICATIONS

Observations at the GAW stations and those done by contributing networks supported by coordination activities at the national level constitute the core of the GAW Programme. These observations need to be integrated/complemented with the aircraft observations and satellite retrievals by means of models. Integrated observations and derived data products are important for provision of services required by society (from ordinary people to policy makers). This session addressed GAW relevant observations performed from different platforms, including GAW observations at mountain stations, at different aircraft measurement platform and from satellite and application/unitizations of GAW data in support of WIGOS, Global Framework for Climate Services (GFCS), societal beneficial areas in GEO, volcanic ash monitoring, chemical weather forecast and the IPCC (Intergovernmental Panel on Climate Change) process.

Carl Brenninkmeijer gave a presentation on the use of aircrafts as a measurement platform for atmospheric composition observations. There is a proven 15-20 years track record of three atmospheric observing systems based on passenger aircraft: Comprehensive Observation Network for Trace gases by Airliner (CONTRAIL), Measurements of OZone, water vapour, carbon monoxide and nitrogen oxides by in-service Airbus airCraft (MOZAIC) and Civil Aircraft for the Regular Investigation of the Atmosphere Based on an Instrument Container (CARIBIC). CONTRAIL and MOZAIC use instrument packages aboard several aircrafts in continuous deployment. CARIBIC uses a modified air freight container with a large set of equipment that is deployed monthly.

The passenger aircraft systems have provided detailed consistent data over large parts of the globe, including vertical profiles. The number of vertical profiles for CO₂, CO and O₃ probably surpasses that of any other system. CARIBIC has provided the first ever systematic dataset on aerosol elemental composition in the upper troposphere – lower stratosphere (UTLS). These aircraft projects can be operated over many decades, which is important from the GAW perspective. Aircraft data are been used more often for atmospheric studies. The thinned satellite based capacity for trace gas measurements over the next years render the passenger aircraft systems of immediate additional relevance. IAGOS that merges MOZAIC and CARIBIC into IAGOS-CORE and IAGOS-CARIBIC does not merely combine the 2 different systems as an observational infrastructure but provides real time data and furthermore renders the resulting observing system truly global by operating from different continents.

Participants of the Symposium asked about the possibility for NRT data delivery from the aircraft platforms and on the harmonization of observations between three aircraft projects. Dr Brenninkmeijer replied that in the IAGOS project data delivery will be possible after aircraft landing. He also stressed that the projects try to deliver the best possible quality of data and harmonization of the measurement techniques between the projects is not of the highest priority.

Dr Barbara Ryan, Director of the GEO Programme gave an overview of the Group on Earth Observations. Following three Earth Observation Summits, GEO was created in 2005 in order to develop a coordinated and sustained Global Earth Observation System of Systems (GEOSS) to enhance decision making in nine Societal Benefit Areas (SBAs). Today GEO counts 89 member states and 67 participating organizations from all over the world, although with lower participation amongst developing countries. The development of GEOSS is achieved by improving and coordinating observation systems, advancing broad and open data policies and practices, fostering increased use of Earth observation data and information, and building capacity. Coordination of space-based observation is ensured by the Committee on Earth Observation Satellites (CEOS), widely recognized as the Space arm of GEO, and by the Coordination Group on Meteorological Satellites (CGMS). For the global coordination of in-situ networks the situation is more difficult.
despite the excellent efforts of WMO for meteo-related networks. The European Environment Agency (EEA) is charged by the European Commission to ensure such coordination at the European level in the context of the Copernicus programme. EEA is trying to extend the approach and best practices also outside Europe. Other gaps that are being targeted by activities of the GEO Work Plan include the uncertainty over continuity of observations, large spatial and temporal gaps in specific datasets, limited access to data and associated benefits in developing world, inadequate data integration and interoperability, lack of relevant processing systems to transform data into useful information, inadequate user involvement, and eroding or little technical infrastructure in many parts of the world.

Dr Ryan showed several examples of use of Earth Observation data, including pollutants tracking, tools for health decision-making, climate-change detection and adaptation, and carbon assessments and budgets. In its strong advocacy for broad and open data policies GEO has established its Data Sharing Principles which its member states and participating organizations adhere to: full and open exchange of data, provision of data and products at minimum time delay and minimum cost (i.e. free of charge or cost of reproduction for research and development use). An infrastructure, the GEOSS Common Infrastructure (GCI), has been put in place to facilitate the sharing of observation data and information products. Thanks to a brokering approach more than 14 million data records are now discoverable. The WIS is one of the community portals linked to the GCI, ensuring the WIS data are available from the GEO Portal, and that the GEOSS resources are available for WIS users. GEO is convinced that the value of data are not in the data itself but in their use. The US change to free and open data policy for Landsat in 2009 illustrates this nicely: The number of daily delivered data increased by more than 100 times; new ways of using the data were adopted, e.g. requiring time series over the same location; and a significant number of new jobs were created.

The CAS President stressed that coordination initiatives put too much emphasis on the data dissemination while basic observations get less and less attention. He wondered if GEO supports basic observations. Dr Ryan responded that GEO budget is built on in-kind contribution by countries and can be used for capacity building (e.g. organization of workshops).

Dr Sue L Barrell, Chair of Inter-Commission Coordination Group on WIGOS (ICG-WIGOS) gave a presentation “WMO Integrated Global Observing System (WIGOS) – What does it mean for GAW?” She brought to the attention of participants that WIGOS is a future observing framework for the coordination and evolution of WMO observing systems and WMO contributions to co-sponsored observing systems, with a focus on integration, interoperability, optimised system design and best-practice operations. The component observing systems of WIGOS are the Global Observing System (GOS) of the WMO World Weather Watch (WWW), the WMO Hydrological Observing System (WHOS), and the observing components of the GAW and Global Cryosphere Watch (GCW), including both the space-based and surface-based components. WIGOS will provide the essential building blocks to support coordinated, comprehensive, reliable and trusted observations for all users and will support members in the delivery of their weather, climate, water and related environmental services. Dr Barrell stressed that GAW will benefit from WIGOS in many ways, such as through a more rigorous, well-documented and monitored approach to the application of standards and metadata in observations, greater visibility of procedures, requirements and measurement capabilities through the WIGOS Operational Information Resource, optimised network design to meet diverse operational and user needs, and increased operational efficiency of GAW and associated observing networks at global and national levels.

Several meeting participants expressed their concerns that WIGOS needs to provide a practical example of its work. Metadata change will take a long time to implement and to prove usefulness there should be other areas where highlighted benefits of WIGOS can be demonstrated.

Dr Deon Terblanche, Co-Director of WMO Research Department, gave a presentation on “Global Framework for Climate Services (GFCS)”. He highlighted that GFCS has been established in response to the need for science-based climate information and prediction for planning, policy and practice on the global, regional and national scales. The GAW Programme provides critical
data, information and scientific understanding of long-term trends and changes in atmospheric composition that are at the foundation of global change and of relevance to the GFCS. The GFCS is designed to address the full value chain from observations, research, and product development to service delivery involving various actors. Initially the GFCS will focus on four priority areas, namely, water, disaster risk reduction, health and agriculture/food security. The GFCS is designed around five pillars, i.e. the User Interface Platform, Observations and Monitoring, Research, Modelling and Prediction, the Climate Service Information System and Capacity Development. The GAW Programme is highly relevant to especially the Observation and Monitoring pillar of the GFCS and to most of its current focus areas. GAW should actively engage, take advantage of the opportunities to strengthen the global observation system relevant to Essential Climate Variables (ECVs) and support the implementation of the framework.

Dr Terblanche's presentation was followed by discussions of GFSC concept, liability of the parties/service providers, connection with health issues and possible involvement of GAW community in this initiative. Dr Terblanche underlined that liability could be best addressed through addressing a quality of the delivered services, in particular through reporting of the uncertainty related to provided forecasts. These uncertainties should be taken in consideration in the decision making process. The CAS President M. Béland confirmed that statement refereeing to the work of a number of research centres for climate adaptation. Users work together with the service providers at those centres. Users set up the requirements and understand very well the uncertainty concept (users factor for this uncertainty in the decision making process).

Dr Terblanche further referred to the established collaboration with WHO concerning the provision of air quality forecast as one of the GFCS services. He also stressed that air quality forecasting is not a part of GFCS as such, but it is rather provided as a service in connection with climate. The best way for the GAW community to be involved in the GFCS is to take into consideration the GFCS Implementation Plan, which highlights the importance of improved observations and analysis of greenhouse gases as well as urban activities.

Dr Werner Thomas from the German Weather Service presented his work on the assessment of the global observational network capacity for volcanic ash detection. In his presentation Dr Thomas clarified that a number of different measurement systems ranging from in-situ to remote sensing techniques from space and from the ground were used to gather information about ash cloud of the Icelandic volcano, and this clearly showed the potential and the need for an integrated atmospheric observing system. A recent survey of ceilometer and lidar stations encountered about 1070 stations (as of March 2013) world-wide, including the international networks, like the European Aerosol Research Lidar Network (EARLINET) in Europe, MicroPulse Lidar NETwork (MPLnet) in the US, NDACC, Asian Dust and Aerosol Lidar Observation Network (AD-NET) operated by Japan, and several more. About 180 of these stations offer either station information and/or quick looks of raw data in near-real-time (within 3 hours after data acquisition) and may deliver important data for aviation in case of emergency due to volcanic eruptions. A website hosted by DWD (www.dwd.de/ceilomap) gathers information on the global scale and can be freely accessed by the general public. Quick looks can be opened by mouse clicks and forward trajectories of several major volcanoes in Europe may be overlaid, in order to identify regions potentially affected by ash clouds.

The recent volcanic ash events showed that a combination of WMO's GAW Aerosol Lidar Observation Network (GALION) and national ceilometer networks could be a powerful super-network, solving the known problem of too sparse profile measurements in space and time. The survey showed however that many different instrument types (~15 different ceilometers) are operated, hampering consistent aerosol retrievals across national borders. Consequently, first steps towards data harmonization (data format issues) and data exchange were discussed within COST action ES0702 European Ground-Based Observations of Essential Variables for Climate and Operational Meteorology (EG-CLIMET) and led to a proposal to the Network of European Meteorological Services (EUMETNET) (called E-PROFILE, accepted) to further integrate national ceilometer networks especially in Europe. The EARLINET consortium as part of the EU FP7 project ACTRIS is scientifically supporting these activities. Main recommendations are expected
from EARLINET related to retrieval algorithm development, ceilometer calibration and quality assurance.

Following the request from a Symposium participant a special training session was organized to help the GAW community to get themselves familiar with the web based application developed by Dr Thomas.

Dr Sandro Fuzzi from National Research Council in Bologna brought back the attention of the participant to the value of the ground-based measurements using the example of two GAW Global stations, supported by Italy. He stressed that mountain areas are highly sensitive to global change. At the same time, mountains provide unique opportunities to detect and analyse global change processes and phenomena. At high mountain stations under atmospheric background conditions, global change processes can be studied by means of continuous monitoring activities. The presentation highlighted the activities performed at two of the 28 GAW Global stations: Monte Cimone (CMN) in the northern Apennines, Italy, and the Nepal Climate Observatory Pyramid (NCO-P) located in the Himalayan range. Both stations are equipped with a full set of instrumentation recording, beside meteorological and radiation measurements, the atmospheric concentration of major pollutants, greenhouse and halogenated gases and physical and chemical aerosol properties. Most of these data are also available in near-real-time. CMN maintains the longest European record of CO$_2$ atmospheric concentration in background conditions. NCO-P is located at 5079 m a.s.l. in the Sagarmatha National Park, in the eastern Nepalese Himalaya, and is the highest GAW Global station. Besides being part of GAW, NCO-P is central for the observing network of the Atmospheric Brown Cloud (ABC) programme sponsored by UNEP. A linkage between GAW and ABC is not only in terms of monitoring stations, but also in the exploitation of the data, would certainly benefit both programmes.

Renate Christ from the IPCC Secretariat, described the IPCC process and progress in the preparation of next IPCC assessment. The details can be found on the IPCC home page at www.ipcc.ch.

Dr Vincent-Henri Peuch from ECMWF presented the MACC-II European project, which he is coordinating. MACC-II is the third in a series of European projects that have been developing and delivering a range of data and information services on atmospheric composition since 2005, under the umbrella of the European programme Copernicus, formerly called GMES (Global Monitoring for Environment and Security). MACC-II is a large project involving 36 partners from 13 European countries and it will run until July 2014, when the operational phase of Copernicus is expected to start. The scope of the services is wide-ranging, covering long-range pollutant transport, European air quality, dust outbreaks, solar energy, UV radiation, wildfire and anthropogenic emissions, climate forcing by gases and aerosols, surface fluxes of CH$_4$ and CO$_2$ and some other services. The development of these services have benefited from the collaboration between weather services, environment agencies and the academic sector. The systems developed in MACC-II and its precursor projects (a global system run at ECMWF and an ensemble seven individual regional models over Europe) assimilate a large number of atmospheric composition observations, on top of observations assimilated for meteorology and they have yet little equivalent worldwide. MACC-II benefits from near-real-time observational data provided by GAW as well as by other programmes (the European Environment Agency/ European Environment Information and Observation Network (EEA/EIONET), ICOS, IAGOS, ACTRIS, AERONET…) for assimilation or verification purposes. The range of real-time and retrospective (delayed-mode) products of MACC-II is freely available at www.copernicus-atmosphere.eu. Some recent examples of these products were provided, as an illustration of the capabilities of MACC-II: a plume of biomass burning aerosol transported from Asia to the Seattle area, which has been responsible for a thick haze experienced in July 2012; results from evaluating the local vs. exported contributions to PM$_{10}$ pollution in Paris and Oslo for a 5-day period in October 2012; experimental birch pollen forecasts done in collaboration with the EAN (European Aeroallergen Network), which performs Europe-wide monitoring of aeroallergens in the atmosphere; or experimental near-real-time high-resolution (16km) global CO$_2$ forecasts based on MACC-II optimised fluxes. Overall, it was
demonstrated that MACC-II is already in readiness for the operational phase of Copernicus and that the environmental services delivered benefit to a wide and growing basis of users.

Prof. John Burrows from the University of Bremen made a presentation on GAW relevant remote sensing from space and its evolution. Originally European atmospheric measurements with Meteosat were focused on meteorological parameters. Atmospheric composition observations began with the SCIAMACHY (SCanning Imaging Absorption spectroMeter for Atmospheric CHartographY) project which was selected as a nationally funded atmospheric observations instrument for phase A of the ESA (European Space Agency) Polar orbiting satellite in 1989. SCIA-mini was also proposed in late 1988 in response to the ESA call for idea for atmospheric composition measurements from ERS-2 (European Remote-Sensing Satellite-2). SCIA-mini was selected but descoped to become GOME (Global Ozone Monitoring Experiment). GOME was launched in 1995 aboard ERS-2 into a sun synchronous orbit having a descending node and an equator crossing time of 10:30 a.m. It made 16 years of measurements until ESA decommissioned ERS-2 in 2011. These missions provided data on many atmospheric constituents. Following the success of GOME, a slightly improved version GOME-2 was selected as the first solar backscattered instrument for trace gas measurements from operational meteorological platform MetOp (Meteorological Operational satellite programme). GOME-2 began its operation in late 2006 and the second GOME-2 began in late 2012. The third will begin 2016. MetOp will be succeeded by MetOp second generation with a Sentinel 5 instrument. This is somewhat closer in its capability to SCIAMACHY nadir observations. The results from the SCIAMACHY project represent a milestone in remote sensing of atmospheric composition. Sadly the sudden and unexpected loss of Envisat coupled with the lack of follow on other than GOME-2 has resulted in the lack of vertical profiling of the atmosphere by European space born instruments and lack of measurements of greenhouse gases in the boundary layer. New missions are urgently needed to fill these gaps. One possibility is the CarbonSat, which is selected as one of two missions for the ESA Explorer 8 mission in competition with FLEX (FLuorescence EXplorer). A new concept called SCIA-ISS has been developed for rapid implementation on International Space Station (ISS).

5. WAY FORWARD FOR GAW AND BREAK OUT GROUPS

Prof. Øystein Hov in his presentation summarized the main issues highlighted at the GAW-2013 Symposium and provided a view on the future priorities that will shape the GAW Programme further. In his presentation he reminded the mandate of WMO and the mission of the GAW Programme as it is formulated in the GAW Strategic plan for 2008-2015. Prof. Hov further evaluated the status of the GAW Programme by the five «strategic thrusts» as defined in the WMO Strategic Plan 2012-2015. Those include:

1. Improving service quality and service delivery
2. Advancing scientific research and applications development and implementation of technologies
3. Strengthen capacity building
4. Build and enhance partnerships and cooperation
5. Strengthen good governance

In respect to call for advancing research and improving services Prof. Hov brought several examples of success stories including the formation and activities of the GURME project, long-term observations and trend analysis of key pollutants (e.g. surface ozone, \(\text{SO}_2\)), participation of GAW stations in the validation of MACC-II forecasts for several reactive gases, success of the network in detection and tracing volcanic ash, provision of the observational truth in support of stratospheric ozone recovery.

Development and harmonization of the GAW stations network itself may serve as an example of a successful story in respect to technical implementation. In the area of service delivery, a number of GAW publications can be considered as an example of the service to community,
including greenhouse gas and ozone bulletins. Sand-and-Dust storm warning system is an example of community relevant service as well.

The capacity building is one of the important components of the GAW Programme. Several countries are supporting this activity including Switzerland and Germany. The GAW Programme management should be re-evaluated and possible ways for optimization should be considered in a view of the fifth WMO strategic trusts area.

The way forward for GAW should be seen against current and new priorities in WMO Strategic Plan 2016-2019, which can be summarized as «Science for service» and include:

1. Disaster risk reduction focus
2. Global integrated polar prediction system (GIPPS)
3. Megacities
4. Global Framework for Climate Services (GFCS)
5. WMO Integrated Global Observing System (WIGOS) and WMO Information System (WIS)

In addressing those priorities, GAW can contribute for example:

• Through observations, analysis and prediction of pollution episodes due to extreme weather events, like heat waves, or forest fires
• Through information on short-lived climate forcers in polar regions (including aerosol)
• Through megacities activities addressed by GAW in GURME
• Through global observations of long-lived greenhouse gases and aerosols, that can be used as a tool for climate mitigation, which goes together with adaptation
• Through integration of different spatial and temporal scales that can be considered as a contribution to WIGOS

In view of the WMO priorities, a GAW strategy for 2016-2019 should cover the following aspects:

• User driven products: on Air Quality, deposition, UV, dust including volcanic ash, climate, NWP including seasonal weather forecasts, atmospheric chemical input to marine environment
• Towards "one chain": Research driven and operational observations, model development and application, and services
• Core GAW activity: Doing good observations and not only collecting others’ observations
• Policy facilitation: through Air Quality regulations, environmental conventions (e.g. CLRTAP), GFCS, IPCC, new global/regional alliances, and fewer parallel processes in the technical activities underpinning policies
• Data stewardship: through WIS (WIGOS) and user-data provider interaction
• Foster country contributions to research, infrastructure, education, institutional building
• Management structure should be through community of practice.

The priorities for the GAW Programme development were discussed by the participants. In response to the question of “THE priority”, Prof. Hov stressed that background observations is a unique feature of the GAW Programme and it must be preserved as well as an attempt should be made to consider where those observations can be moved to services. He also stressed that regional networks (that a capable of detecting pollution episodes) should be encouraged to join GAW and implement its Quality Assurance principles.

The participants also requested if the principle «Science for service» refers to scientific or commercial services. Prof. Hov explained that WMO works to address user needs, so the services are user driven. Redundancy of activities should be avoided. The general evolution of the system should be aligned with the changing user requirements. For example, meteorological data is a public good, but funding is needed to provide it, hence specific information should be priced.
Four breakout groups were organized to stimulate discussions about the current state of the GAW Programme, future priorities, sustainability and services.

5.1 Communication and outreach
The break-out session on Communication and Outreach was led by Michel Williams and Greg Carmichael.

The discussion topics covered the way to communicate GAW and tools and channels for it. Session participants discussed strategy and opportunities to make GAW more recognized. It was concluded in particular, that making GAW better known can help to attract funding, to use its outputs and to create a feeling of engagement. Target audiences for such communication can be GAW community, policy makers, experts, general public. Similar messages can be propagated through different channels depending on the target audience.

Development of a GAW communications plan was identified as a key need in communication. It should engage GAW SAGs, ET and other relevant GAW groups. WMO will provide support for development of such a plan.

The following tools and channels can be used for communicating GAW:

- Branding – GAW as an international resource of great value for science and human well-being
- Guidance document for authors of peer reviewed papers
- Press stories – success with GHG Bulletin and ozone issue. Press releases can cover the compelling stories and be prepared on opportunity basis
- Social and digital media – Twitter, Facebook, Webinars, Youtube, website
- Internal – A sustainable mechanism

There are several opportunities to make GAW better known. For example, in 2014 GAW will celebrate its 25th anniversary. This date can be used as a hook for mobilizing a broader communications plan. The other opportunity could be use of strategic partners such as WHO and UNEP. GAW can be communicated at the audiences such as the UNEP Governing Council.

Carl Brenninkmeijer proposed to issue an annual bulletin “Health of the atmosphere”, which will cover different topics and reflect the most interesting or critical events related to atmospheric composition. This idea was supported by the meeting participants.

5.2 QA/QC and Rolling Review of Requirements
The break-out session on QA/QC and Rolling Review of Requirements was led by Rainer Steinbrecher and Maznorizan Mohamad.

This break-out group addressed the following topics:

- Definition of Data Quality Objectives: Where to go?
- What are the connections between DQOs and user requirements?
- How to formulate platform independent user requirements?
- What is the observational capacity and where are the gaps?
- How efficient is the current GAW QA/QC system?

Known data quality is essential for users. Therefore, a rigorous Quality Assurance and Quality Control system (QA/QC) system has been implemented in WMO/GAW. DQOs to be achieved need implementation of QA/QC measures in the GAW network. The DQOs will be used *inter alia* as a basis to support decision makers as well as to support assessments as observational evidence (e.g. inventories, model output, and satellite retrievals). In order to enhance DQOs, the user-field requirements should be known. As defined by GAW, the user requirements are not system dependent; they are intended to be technology free. The Rolling Review of Requirements (RRR) process considers this. The “goal” is a maximum requirement. The
“threshold” is the minimum requirement that has to be met to ensure that data are useful. The “breakthrough” is an intermediate level between “threshold” and “goal” which, if achieved, would result in a significant improvement for the targeted application.

As a summary of user cases, requirements should be defined for the scientific community (e.g. modelling, satellite, agricultural, environmental, and air quality communities), politics, and the public. The requirements should be discussed in detail within corresponding SAGs and then defined. The SAGs should “translate” user requirements into technical requirements to the observing system.

The GAW Programme currently focuses on seven areas: Aerosols, Greenhouse Gases, Reactive Gases, Ozone, UV Radiation, Precipitation Chemistry, and GURME. No obvious gaps in the focal areas were identified but it was noted that the role of oceans in the GAW Programme activities should be better represented, perhaps in a new focal area. The observational capacity within the focal areas should be reviewed by the specific SAGs. This review should then form a basis for a user oriented gap analysis resulting in recommendations for optimizing the observational network.

At present, the performance of the GAW QA/QC system is very good compared to other WMO programmes. The development of documents for measurement guidelines or standard operating procedures for GAW target parameters is on track as documented by the latest GAW reports (see GAW web page). The activities to link the GAW scales to international accepted reference materials have been launched and will be continued by the specific expert groups of WMO/GAW and the BIPM. The efforts to transfer the scale to regional calibration centres need to be fostered.

5.3 Current socio-economical and policy priorities and sustainability and expansion of networks

The break-out session on Socio-economical and Policy Priorities and Sustainability and Expansion of Networks was led by Sonja Vidic and Shiv Dev Attri.

The following aspects were discussed at the break-out session:

- GAW and international conventions
- Sustainability of station funding
- Health of the network
- How to address socio-economic priorities through GAW activities?
- How to use these priorities to secure funding for activities?
- Is policy making addressed appropriately with the GAW activities?
- Are we providing the services and products that are required?

It was confirmed that through its existence, the GAW Programme has substantially contributed to international conventions, including UNFCCC and the Vienna Convention/Montreal Protocol on ozone depleting substances. The GAW Programme provides observational evidence on whether measures have been taken or not to regulate the substances under question. In spite of significant support to those agreements the GAW visibility is lost as soon as it is formally adopted. Hence, support of Conventions should be lower priority than directly addressing user/stakeholder requirements.

To address socio-economic priorities GAW built monitoring networks and internationally supported infrastructures [SAGs, Calibration Facilities, Data Centres] in order to provide reliable long-term data to underpin scientific knowledge for sound environmental policies. So far this is known and accepted in the scientific community. The other problem is a weak recognition of GAW at a regional level. The regional component of GAW is neglected, therefore national authorities do not have a link to GAW activities and do not understand the value of GAW. Partly this is also due to the uneven distribution of quality of information across GAW regions. There is a need to have
uniformity of observations and quality in different regions. On the other hand, the relevance of GAW is far away from daily life and short-term pressures that policies worry about.

To secure funding for activities the community involved in GAW should:

- Be more visible
- Be more innovative in showing the value of GAW – both globally and regionally
- Carry out relevant research and development activities
- Initiate monitoring of atmospheric species which are meeting global and national/institutional requirements

Sustainability of station funding in general could be ensured through the following:

- Generation of products and information relevant to national and global socio-economic services and policies
- Better awareness of environmental policy makers of the GAW products available for sound environmental programmes and information
- Better support of NMSs in implementing the GAW Programme

5.4 Integrated use of observations

The break-out session on Integrated Use of Observations was led by Emilio Cuevas and Zhang Xiaoye.

The following questions were addressed at the session:

- Assimilation of data in environmental models
- GAW contribution to global assessments
- Data validation
- Use of GAW data, e.g., by modellers to a satisfactory extent
- Recognition of the GAW data usage
- Are modellers also providing products to those offering them data?

The group confirmed that GAW is a scientific network with high quality, long-term core data, while the NRT data is in another category within GAW. GAW data accessibility needs improvement. It is unclear if GAW data centres can establish and implement standardized NRT GAW data flow through GTS (Global Telecommunication System), and if WIGOS-defined data dissemination strategy and format can be implemented in the future. The group proposed to evaluate the AERONET concept for GAW core and NRT data.

GAW contributions to global assessments are highly recognized, but increased visibility of GAW by international assessments is always needed.

Combination of the in-situ and column measurements can be done through:

- Promotion of selected GAW sites with combined in-situ and column (Max-DOAS (Multi Axis Differential Optical Absorption Spectroscopy), FTIR (Fourier Transform Infrared Spectroscopy)) measurements, utilizing the potential of the GAW contributing networks.
- Integration of GAW and satellite information: methodologies for integration, consistent and consolidated data
- Combination of long-term airplane programme observations and GAW core observations (including and evolving IAGOS, CARIBIC and CONTRAIL)

The group recommended that GAW carry out special measurements in critical sites as megacities besides background data.

Concerning data Policy the group recommended acknowledgments through reference to journals, doi (digital object identifier) publications, negotiated with GAW data centres etc.
During discussions it was stressed that to increase the value of the GAW Programme more diverse conditions (not only background) can be represented. That will help in particular the satellite and modelling community in validation of their products.

During the discussions that followed presentations of the break-out groups outcome, the participants noted that the GAW Programme is rather weak in communication. The GAW website is designed by scientists and for scientists; it is not attractive to the general public. GAW data and products must be communicated outside of the scientific community.

Communication problems in GAW are partly due to historical reasons:

- Meteorological agencies in many countries are not the most competent in GAW activities (in cases instead of reaching out within the country those activities are understated)
- GAW is a voluntary programme of WMO, which is not the “highest priority” activity to be supported by all NMHSs (National Meteorological and Hydrological Services)

6. JOINT GAW AND CLRTAP HTAP SESSION

The joint session of the GAW 2013 Symposium and annual meeting of the Task Force on Hemispheric Transport of Air Pollution (TF HTAP) under the Convention on Long-Range Transboundary Air Pollution (CLRTAP) was opened at 9 a.m. on 20 March 2013 by Prof. Øystein Hov and Co-Chairs of the Task Force Dr Terry Keating and Dr Frank Dentener. Prof. Hov gave an overview of the GAW 2013 Symposium and stressed the importance of collaboration in particular with the modelling community, which is well represented in HTAP. Dr Keating gave an overview of HTAP, highlighted its mandate, model experiments, cooperative activities. He stressed that TF HTAP is an integrator and user of global atmospheric observations and developer and user of interoperable data systems. Though integration and interoperability are not goals of TF HTAP itself, but useful or necessary to answer policy-relevant science questions. TF HTAP provides a good user case to demonstrate the application of an integrated global observing system and GAW can play an important role in the provision of data infrastructure and necessary tools for systems harmonization. In HTAP Phase 1, the analysis of observations and models was largely decoupled, while in Phase 2, HTAP is positioned to do much more in terms of model-observation evaluation.

Three presentations were made on data infrastructures.

Dr Rudolf B. Husar in his presentation “The Co-Evolution of the HTAP Data Network and the GEO Air Quality & Atmospheric Composition Community of Practice” highlighted the collaboration between HTAP and GEO. He presented a number of tools and infrastructures that were used by the HTAP and GEO community.

The participants of the session expressed their criticism due to the lack of connections between HTAP activities and GAW activities, unnecessary duplication of the data infrastructures and lack of “branding” of GAW observations in HTAP. In response, the Co-Chairs of HTAP stressed that this joint session is an attempt to address the indicated issues.

Kjetil Tørseth in his presentation “Surface Observations Database for HTAP” introduced the observational database for HTAP activities hosted at EBAS. He described the convention on station codes, instrument names and data formats. It was stressed that EMEP HTAP is NOT the place to access primary datasets from contributing networks. It is only a “snapshot” collection of data, and the main objective is to generate one “harmonized” dataset, and to facilitate data retrieval for modellers. Use of the data should be restricted to the HTAP assessment efforts and limited according to the data policy.

In response to the previous presentations Dr Jörg Klausen presented a concept of “GAW Data”. The presentation introduced the GAW Programme as taking responsibility for coordinating long-term observations of ozone, greenhouse gas, reactive gas, aerosol, precipitation chemistry,
and UV globally. One of the main assets of GAW is an emphasis on data quality. Hence, the GAW QA system emphasizes a traceability chain from the observations at the stations all the way to GAW World References, in certain instances to SI (International System of Units) (represented by BIPM/NMIs). In terms of metadata, GAW has played a pioneering role and continues to do so by contributing to the Task Team on WIGOS Metadata (TT-WMD) and the definition of a WIGOS core metadata standard.

The data are made available through six dedicated GAW World Data Centres. Additionally, a fairly large number of other archives co-exist that were established to serve other (international) programmes. All of them serve objectives that are in line with the GAW Programme and with some of them, there are formal collaborations. GAWSIS provides partial integration of these archives and a station-centric view to facilitate discovery of data. The harmonized metadata representation within GAWSIS also facilitates analyses of the availability of data. The presentation introduced two geographically resolved indicators to characterize ‘health-of-networks’ for each observed variable, namely ‘period covered’ and ‘latency’. These indicators permit to quickly evaluate the global distribution, overall length and recent availability of observations that are accessible through archives or at least claimed to be made. In future, such indicators will be refined and made available for the purpose of evaluation, evolution and design of observing networks.

7. NATIONAL AND REGIONAL AIR QUALITY AND ATMOSPHERIC CHEMISTRY ACTIVITIES

This poster session presents an overview of the GAW related activities at national and regional levels.

Dr S. D. Attri from the India Meteorological Department (IMD), India, presented an “Overview of Environmental Monitoring Activities in India”. In his poster Dr Attri stressed that IMD has a long tradition of monitoring weather and climate for over 135 years. It has been maintaining ozone, radiation and precipitation chemistry networks for the last 4-6 decades. IMD is currently upgrading its monitoring networks under the project entitled “Environment Monitoring and Research”, which includes:

- Monitoring of aerosol optical properties using Skyradiometer through a network of 12 stations
- Total columnar ozone measurement using Brewer and Dobson spectrometer at five locations
- Surface ozone monitoring through a network of ten stations
- Measurement of vertical distribution of ozone using IMD ozonesonde at four stations
- Monitoring of precipitation chemistry through a network of eleven stations
- System for Air quality Forecasting And Research (SAFAR) is in operation since 2010 in New Delhi and is being augmented for other megacities in India
- Establishment of two (2) online and four (4) grab sample greenhouse gases monitoring systems

Black carbon measurements and nephelometer networks in the country are under process. The network aims at providing systematic, reliable and comprehensive observations of the chemical composition and physical characteristics of the atmosphere in India. This will help better environmental assessments related to climate change, air quality and the long-range transport of pollution between regions.

Michael Bittner from the German Aerospace Center (DLR), Oberpfaffenhofen, Germany, presented a poster on “The Network for the Detection of Mesopause Change (NDMC)". NDMC is a global programme with the mission to promote international cooperation among research groups investigating the mesosphere region (50-100km) with the goal of early identification of changing climate signals. This programme involves the coordinated study of atmospheric variability at all time scales, the exchange of know-how, and the coordinated development of improved
observation, analysis techniques and modelling. The initial emphasis is on the mesopause region airglow techniques using the existing ground-based and satellite measurement capabilities. Participation or association of researchers using other techniques in the same altitude region will be actively developed. NDMC is concerned with coupling processes and will interface with related activities throughout the atmosphere. It is affiliated with the GAW Programme of WMO and with NDACC.

Gerardo Benitez Carbajal from the National Meteorological Service (SMN), Argentina presented a poster on "Regional GAW in Argentina: Activities, Results and Projects". The goal of this work is to show several GAW Regional stations in Argentina, demonstrate their status, activities, projects and results. The SMN contributes with five stations, while the CITEDEF Institute (Ministry of Defense) contributes with only one. La Quiaca Observatory (operated by SMN) is a high altitude station (3459 m a.s.l.) The following parameters are measured daily: surface ozone concentration (reported to WDCGG), UVB radiation measurements with broadband instruments (soon to be submitted to WOUDC), global and diffuse radiation measurements. The Dobson spectrophotometer will be installed at the station as well as carbon monoxide gas analyzer (CO) TEI 48 (the two instruments are planned to be installed in August 2013). The Pilar Observatory (operated by SMN) is located in the centre of the country. The following parameters are measured daily: surface ozone concentration (reported to WDCGG), UVB radiation with broadband instruments, global and diffuse radiation. The Microtops system will be installed at the station soon. Therefore there will be measurements of total ozone column, aerosols AOD, and direct UV radiation. The Comodoro Rivadavia Station (operated by SMN) performs measurements of total ozone column (reported to WOUDC), and UVB radiation measurements with broadband instruments (soon to be submitted to WOUDC). A global radiation and LIDAR system has been implemented at this station in collaboration with CITEDEF Institute, the new instrument is still under testing. The San Julián Observatory (operated by SMN) performs the measurements of the following parameters on a daily basis: surface ozone concentration (reported to WDCGG), UVB radiation measurements with broadband instruments (soon to be submitted to WOUDC), global and diffuse radiation measurements. The Microtops system may be installed at the station depending on the evaluation results. The San Julián Observatory, stopped activities in mid-2011 due to repairs at the airport but will restart its activities in April 2013. The Rio Gallegos Station (operated by CITEDEF) is a contributing station with total ozone column and nitrogen dioxide (NO$_2$) measurements. The CITEDEF managers are concerned that this station is considered regional for the GAWSIS. The Buenos Aires Observatory (operated by SMN) measures on a daily basis the following parameters: UVB radiation with broadband instruments (soon to be submitted to WOUDC), global and diffuse radiation and total ozone column measurements. It also serves as a Regional Calibration Centre for surface ozone, total ozone Dobson instrument and broadband UBV in the GAW Programme, and National Calibration Centre for Solar Radiation.

Hiroshi Koide from the Japan Meteorological Agency (JMA), Japan, presented a poster on “Recent Progress and Vision in the Japanese GAW Activities”. Recent topics of Japanese GAW activities supported mainly by JMA were presented: (1) JMA and other domestic research laboratories started a series of cooperative measurements of H$_2$, Rn, O$_3$/N$_2$, halocarbon and CO$_2$ isotopic ratio at Minamitorishima (GAW Global station) since 2011, in addition to the operational major GHGs monitoring at the site; (2) The Regional Dobson Calibration Centre (RDCC) for Asia operated by the JMA, held the latest Dobson regional intercomparison in 2011 at the JMA Aerological Observatory in Tsukuba Science City; (3) For the monitoring of solar and downward long-wave radiation, JMA started enhanced radiation observations at five stations in Japan, which joined the Baseline Surface Radiation Network (BSRN) in March 2010. The observation data are reported to the World Radiation Data Centre (WRDC) regularly; (4) In January 2010, JMA started near-real-time data transmission of aerosol optical depth at Ryori, one of the GAW Precision Filter Radiometer (PFR) stations, to the World Optical Depth Research and Calibration Centre (WORCC) as a contribution to the GOS-GAW Pilot Project through the WMO Information System; (5) In the coming issue of the annual WDCGG Data Summary, SAG for reactive gases and WDCGG cooperatively provided a new chapter on global VOCs characteristics and variability; (6) In harmony with the BIPM/WMO MoU in the international sector, JMA and other major observation laboratories in Japan have established a domestic alliance with the National Metrology Institute of
Japan (NMIJ). Series of intercomparison activities named iceGGO (InterComparison Experiments for Greenhouse Gases Observations) are planned and conducted since 2012 onward, partly in combination with the operational activities of the GAW WCC for methane in Asia and the South-West Pacific supported by JMA. Recent efforts and future perspectives on JMA’s model and data assimilation products are also briefly presented.

Ahmad Mizani from the Indonesian Agency for Meteorology, Climatology and Geophysics, (BMKG), Indonesia, presented a poster on “the Indonesia Global Atmosphere Watch Programme”. BMKG runs one out of the 28 Global stations in the WMO GAW Programme at one platform, Bukit Kototabang. Bukit Kototabang (0.20 S, 100.32 E) is a remote equatorial site in Sumatera, 7 km from the nearest city (Bukittinggi). The site is surrounded by tropical rain forests with some agricultural activities taking place in the vicinity of the station. The first GAW measurement programme at Bukit Kototabang started at the end of 1995, and included: basic meteorology, solar radiation, ozone, wet and aerosol sampling. Nowadays in cooperation with international agencies, such as NOAA, EMPA and CSIRO (Commonwealth Scientific and Industrial Research Organisation), BMKG have widen the spectrum of measurements at Bukit Kototabang to follow the WMO guidelines for GAW Global stations.

Constance Colnex Okuku from the Kenya Meteorological Department (KMD), Kenya, presented an overview of “Global Atmosphere Watch Activities in Kenya”. The Mt. Kenya GAW Global station is located in the Mt. Kenya wildlife reserve, 20 km from the inhabited area. It is situated at latitude 0°3’S, longitude 37°18’E and mean elevation of 3897 m above sea level. The station provides a unique site for both measurements of chemical composition and physical properties of the earth atmosphere since it is located in the tropics in Africa, a data sparse area. The complete programme focuses on surface ozone (O₃), carbon monoxide (CO), radiation measurements, precipitation sampling, aerosols, carbon dioxide (CO₂), methane (CH₄), water vapour (H₂O) and meteorological parameters. EMPA Switzerland, WMO and GAWTEC, Germany, provide technical support and training to station managers and operators. The data collected is transmitted to various WDCs for archiving. The main objective of the poster was to highlight the characteristics of some measured gas species at MKN GAW Global station and the role of the KMD towards the fulfilment of the GAW objectives and mandate. Total column and surface ozone, ozonesonde and CO data are analyzed using graphical plots for trends analysis and calculation of hourly, daily, seasonal means for diurnal, seasonal and annual cycles. In addition to MKN GAW station, KMD have established two more observation sites for CO, surface ozone, particulate matter (PM₁₀) and sulphur dioxide (SO₂) at Chiromo Campus, University of Nairobi and Jomo Kenyatta International Airport (JKIA) through funding by the Kenyan government. This network is supposed to give sufficient data for air quality forecasting in the country and the region. The current challenge of power fails at MKN GAW is being addressed and a new power line to the station is almost complete.

Juan Carlos Pelaez from the Instituto de Meteorologia, Cuba, presented a poster on “Havana Total Ozone Measurements and UV Solar Radiation Monitoring as contribution to GAW”. The main direction of work of the Ozone Havana Station since the mid 1980s is on total ozone measurements. These measurements started with utilizations of the Russian-made filters ozonometers M83 and M124. Since 2003, the Dobson spectrophotometer No. 67 is used for total ozone measurements. The results of measurements are sent daily to the http://exp-studies.tor.ec.gc.ca/e/ozone/Curr_allmap_g.htm and on a monthly basis to the WOUDC http://es-ee.tor.ec.gc.ca/cgi-bin/totalozone. The other aspect reflected in the poster is the activities of monitoring of solar UVB and UVA radiation over the territory of Cuba. This work demonstrated in particular a remarkable difference of regime in solar ultraviolet radiation UVB measured from the ground and estimated by the OMI (Ozone Monitoring Instrument) corrected for aerosol optical thickness at two tropical stations (Mexico City and Havana) where the atmospheric aerosol has different origins and behaviour.

Ramón Juan Moreta from the State Meteorological Agency of Spain (AEMET), presented a poster on “AEMET’s Contribution to the WMO/GAW Programme”. The AEMET contribution to the WMO/GAW Programme is based on the active participation from both the Izaña Atmospheric
Research Centre (Santa Cruz de Tenerife, Canary Islands) and the Special Radiation Network and Atmosphere Watch Service (AEMET headquarters in Madrid). The former is a GAW Central Facility operating the Regional Brewer Calibration Centre for Europe (a detailed presentation about their activities is summarized in a separate poster). The latter is responsible for operating the GAW Regional stations registered for Spain. This Service provides a wide range of measurements within the framework of the WMO/GAW which comprises monitoring data from the Broadband Radiation Network (solar radiation), EMEP/VAG/CAMP Network (background pollution), Brewer spectrophotometer network (total ozone column) and the ozonesonde observation programme (vertical ozone profiles). Furthermore, two additional networks operate within this Service: the National Radiometric Laboratory (calibration of UVER (Ultraviolet Erythermal Radiation) Broadband Radiometers) and the Cimel sun-photometer network (aerosols remote sensing). Finally, in order to ensure quality control of data provided from this Service, quality assurance requirements established for all networks are accredited with a Quality Management System (QMS) certification in accordance with the standard UNE-EN ISO 9001 since 2006.

Patel Khageshwar Singh from the Pt. Ravishankar Shukla University, India, presented a poster on “Black Carbon Pollution in Central India”. The ambient PM samples were collected from February 2007 to January 2008 at the residential area, Kota. The road dust and pond sediment samples were collected in summer 2008. The particle size less than 0.1 mm was used for the analysis. The thermal method was used for the analysis of the black carbon (BC), organic carbon (OC) and carbonate carbon (CC). The highest concentration of polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) in the air was observed in December and January, mainly due to the lowest wind speed and temperature inversion. The concentration of OC and CC was decreased remarkably in the dust and sediment samples. The highest concentration of monochloro PCBs in the air, dust and sediment was seen, mainly due to coal combustion. The concentration of BC, PAHs and PCBs in the air, dust and sediment was found to be much higher than the allowed limits.

Shinya Takatsuji from the Japan Meteorological Agency (JMA), Japan, presented a poster on “JMA Aircraft Observations of Atmospheric CO2, CH4, CO and N2O in the Mid-troposphere over the western North Pacific”. The JMA started C-130H aircraft measurements in 2011, and observed seasonal variations of carbon dioxide (CO2), methane (CH4), carbon monoxide (CO) and nitrous oxide (N2O) in the mid-troposphere over the western North Pacific region. The aircraft flies regularly from Atsugi Base to Minamitorishima, collecting approx. 24 flasks of air samples along the way once a month. The observed mole fractions suggest the influence from anthropogenic or biospheric sources and sinks in East and South Asia. In the past, several intensive observation campaigns in the mid-troposphere using a research aircraft were conducted for only a short time period. Recently, for example, a major aircraft measurement project named Comprehensive Observation Network for Trace gases by Airliner (CONTRAIL) has provided a large amount of CO2 mole fraction observations in the upper troposphere. But there was a significant lack of a long-term monitoring (spatially and temporally) in the mid-troposphere over the western Pacific region. Continuation of this aircraft measurement programme for many years would promote our understanding of the spatial variations of the greenhouse gas fluxes in Asia and of those long-term variations induced by the rapidly growing human activities and climate change. The data is available from WMO/GAW and the WDCGG.

Yuri Tsaturov from the Russian Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet), Russian Federation, presented a poster on “GAW Related Activities in Russian Federation”. The GAW network in the Russian Federation in 2012 was represented by 10 sites for precipitation chemistry measurements, 28 sites for total ozone measurements and 2 sites for greenhouse gases measurements. Some of those stations were presented in more detail. Comparison of methane observations at Tiksi with the dataset from Barrows is shown, highlighting good agreement between these two northern locations. Analysis of total ozone deviation from average annual data (1973 - 2002) for five regions of the Russian Federation is presented on the poster. Future plans include the update of the equipment at some of the existing stations (e.g. use of Ultraviolet ozone spectrometer UVOS, ICS-1000 DIONEX - Ion Chromatography System with Auto-sampler for Chemistry Precipitation measurements, use of PICCARO instrument
(CO/CO₂/CH₄/H₂O) and FTS (Fourier Transform Spectroscopy) instrument in the near-infrared, solar absorption spectrum to retrieve column-average mixing ratios of CO₂, CH₄, N₂O and several other gases with high precision and accuracy).

Lingxi Zhou from the Chinese Academy of Meteorological Sciences (CAMS), China Meteorological Administration (CMA), China, presented a poster on “Chinese GAW Activities and the Greenhouse Gases Application”. Since the 1980s, CMA has put in place seven atmospheric background stations - Waliguan in Qinghai (WLG), Shangdianzi in Beijing (SDZ), Lin'nan in Zhejiang (LAN), Longfengshan in Heilongjiang (LFS), Shangri-La in Yunnan (XGL), Jinsha in Hubei (JSA) and Akedala in Xinjiang (AKD), which represent a number of typical climatic, ecological and economic zones in China. Greenhouse gases and related tracers have been observed by network stations in a standard and consistent routine in response to the Kyoto Protocol and the Montreal Protocols. In particular, the Waliguan Global Atmosphere Watch Baseline Observatory has engaged in flask air sampling analysis since 1990 and in-situ observations since 1994. The 20-year history in observation rewards the longest time series in atmospheric CO₂ records in China. The flask air sampling analysis and the in-situ observations were launched in other background stations in 2006. Comparison of the Chinese greenhouse gases observations with the global trends was presented in the first Chinese Greenhouse Gases Bulletin.

8. ACTIVITIES AT GAW STATIONS

Ekaterina Batchvarova from the National Institute of Meteorology and Hydrology (NIMH), Bulgaria, presented a poster on “Turbulence, Ozone and Wind Profiles under Sea Breeze Situations at a Bulgarian Black Sea Site”. She presented an experimental meteorological site of NIMH, which is situated near the small village of Ahtopol at the southern Bulgarian Black Sea coast. A Scintec MFAS sodar is in operation there since summer 2008 allowing climatological records of the wind profile up to 400 – 600 m height. Turbulence observations using ultrasonic anemometers add to the creation of been unique for Bulgaria data basis for coastal boundary layer studies. Ozone measurements have been performed with DASIBI Model 1003 AH during summer periods since 2008. The poster presents examples of classical sea breeze cells which fall within the range of the sodar in spring and fall months and the related typical surface energy exchange parameters. The measured ozone levels are high and often exceed long-term objectives for the protection of human health. As working hypothesis these levels are explained by the atmospheric circulation above the semi-closed basin of the Black Sea, similarly to the reported high ozone levels over the Mediterranean. The site is suitable for atmospheric composition studies and could be further developed to a background atmospheric composition observatory and meteorological experimental site through collaboration within international or bilateral projects.

Gerardo Benitez Carbajal from the National Meteorological Service (SMN), Argentina, presented a poster on “Ushuaia GAW: Activities, Results and Projects”. Meteorological equipment and radiation sensors are mounted on a platform near the main building. The air inlet is placed on a small tower at the top of the roof. Power supply is reliable and all the equipment is connected to a UPS (uninterruptible power supply) system. The station has no air conditioning, but electrical heating is available. Ushuaia has a subantarctic climate. Temperature average is 2 °C (35 °F) in the coldest month and 9 °C (48°F) in the warmest month. The lowest record is −25 °C (−13 °F) (July), and the highest record is 29 °C (84°F) (December). The low temperature ever recorded in summer is −6 °C (21 °F) (February). Prevailing wind direction is southwestern (80% of the time). Strong winds whip the station all year. Tree growth in Ushuaia reflects the direction of prevailing winds and has given them the name "flag-trees" because of the way they are bent by the wind. The programme of Ushuaia GAW continues normal operations. Future goals include the plans for acquisition of instruments to measure carbon dioxide (CO₂) and methane (CH₄) and continuation with the ozone sounding project. The plan is also to install an aethalometer to measure black carbon or elemental carbon (EC) particles in air and continuous ambient particulate TEOM Monitor, Series 1400ab, for the determination of aerosol particle mass (PM10).
Gerardo Benitez Carbajal from SMN, Argentina, presented a poster on the activities of the “GAW Regional Stations in Antarctica”. The goal of this poster was to show the status, activities, some projects and results from the GAW Regional stations in Antarctica operated by Argentina. SMN contributes with only one station, while the Dirección Nacional Antartica (DNA) contributes to GAW with three stations. At Marambio station, operated by SMN an extended set of observations includes total ozone column measurements (data are reported to WOUDC), UVB broadband measurements (data soon to be reported to WOUDC), multiwave length optical depth and PFR (Precision Filter Radiometers) aerosol measurements. Two new projects are on-going and aim at extending the aerosol measurement programme with nephelometer, Differential Mobility Particle Sizer (DMPS), Multi-angle absorption photometer (MAAP) and TSI Optical Particle Sizer. The gas concentration measurement programme will be extended with Picarro System for Carbon Dioxide (CO₂), Methane (CH₄) and water vapour measurements. Installation of a gas analyzer for surface ozone (O₃) TEI49C is also planned. Station Carlini (Jubany) operated by DNA and Consiglio Nazionale delle Ricerche perform only greenhouse gases measurements. The San Martín Station operated by DNA performs total ozone column (Brewer) measurements and reports the data to WOUDC. Belgrano II Station operated by DNA and Consiglio Nazionale delle Ricerche also performs only total ozone column measurements which are reported to WOUDC.

Paolo Cristofanelli from the Institute of Atmospheric Sciences and Climate of the Italian National Research Council (ISAC-CNR), Italy, presented a poster on “Atmospheric Composition Studies in the Mediterranean Basin at the GAW/WMO Global station “O. Vittori” – Mt. Cimone (2165 m a.s.l.”). The Italian Climate Observatory “O. Vittori” is part of the Mt. Cimone GAW Global station (44°12’ N, 10°42’ E, 2165 m a.s.l.) which represents the only high mountain station continuously running in the Mediterranean basin, a hot-spot region both in terms of climate change and atmospheric pollution. The Italian Climate Observatory “O. Vittori” (http://www.isac.cnr.it/cimone/) is composed of laboratories for measurements of trace and greenhouse gases and physical proprieties of aerosol. Aerosol samplers for PM10 and PM1 are accommodated in a specific designed shelter and a small chemistry laboratory permits a clean treatment of collected samplings even during experimental filed campaigns. External experimental activity can be hosted on the equipped terrace. The laboratories run by electric energy only. Remote internet connection allows the near-real-time data delivery and QA/QC. At Mt. Cimone, continuous measurements of surface ozone started in 1996, halogenated gas mixing ratios were continuously determined since 2002, while more recently (since 2007) carbon monoxide, methane and nitrous oxide (since 2008) measurements were activated. Aerosol properties are extensively investigated in terms of particle size distribution in the accumulation - coarse ranges (since 2002) and in the submicron range (since 2005), aerosol absorption and equivalent black carbon (since 2005) and aerosol scattering (since 2007). Aerosol chemistry is also determined during field campaigns as well as by a systematic long-term sampling programme.

Paolo Cristofanelli from ISAC-CNR, Italy, presented a poster on “Atmospheric Brown Cloud Studies in the high Himalayas at the GAW/WMO Global station Nepal Climate Observatory - Pyramid (5079 m a.s.l.”). The Nepal Climate Observatory – Pyramid (NCO-P), (27.95N, 86.82E, 5079 m asl) is located in the eastern Nepal Himalaya, not far from Mt. Everest. NCO-P is located away from large direct anthropogenic pollution sources. The closest major urban area is Katmandu (200 km south-west from the measurement site). Located along the Khumbu valley, the observations are representative of synoptic-scale and mountain thermal circulations. This GAW Global station was promoted by the EvK2CNR committee and the Nepal Academy of Science and Technology (NAST) and was built at the beginning of 2006 when the observation programme was launched. The station was enlarged in spring 2012 to increase the experimental capacity, also considering that the power required to carry out activities is supplied by photovoltaic panels with electric storage cells. A dedicated satellite connection permits the near-real-time data download (http://evk2.isac.cnr.it/realtime.html) and continuous QA/QC. In the framework of the GAW Programme and UNEP-ABC, SHARE (Stations at High Altitude for Research on the Environment) and NextData (a national system for the retrieval, storage, access and dissemination of environmental and climate data from mountain and marine areas) projects, the following continuous measurement programmes are carried out: surface ozone, aerosol size distribution (from 10 nm to 25 µm), total particle number, aerosol scattering and absorption coefficients,
equivalent BC, PM1-PM10, AOD by sun-photometry, global solar radiation (SW and LW), meteorology. Continuous determination of atmospheric Hg is carried out in the framework of the Global Mercury Observing System (GMOS) project of the European Union since spring 2012. Long-term sampling programmes for the off-line determination of halogenated gases and aerosol chemistry are also active (since 2006) together with precipitation chemistry measurements (summer 2012). During the last few years, a special emphasis has been made on studying the influence of the Atmospheric Brown Cloud (e.g. http://www.atmos-chem-phys.net/special_issue162.html) and open biomass burning to the atmospheric composition variability in the Himalayas, providing for the first time reliable information about the occurrence of acute pollution events in this sensitive mountain region.

Emilio Cuevas from the Meteorological State Agency of Spain (AEMET), Spain, presented a poster on the “Izaña Atmospheric Research Centre: GAW Activities”. The Izaña Atmospheric Research Center (IARC) is part of the Meteorological State Agency of Spain (AEMET). The IARC is a Joint Research Unit of the National Research Council (CSIC). The main objective of IARC’s GAW Programme is to provide data and scientific added-value on the chemical composition and related physical characteristics of the atmosphere and their trends. The IARC manages the Global GAW Izaña Observatory (IZO), (28°18’N, 16°29’W, 2373 m a.s.l.), the urban air quality research Observatory at Santa Cruz (SCO), (52 m a.s.l.), the Botanic ozonesonde Observatory (BTO), (30 m a.s.l.), and the high mountain Pico Teide Observatory (PTO), (3555 m a.s.l.). Long-term monitoring of in-situ greenhouse gases (CO₂, CH₄, N₂O and SF₆) and in-situ reactive gases (O₃, CO, NO(NO₂, SO₂) have been carried out since 1984. The ozone layer is monitored with both Brewer spectrophotometers and ECC sondes since 1992 providing unique information on the subtropical upper troposphere-lower stratosphere (UTLS) region. IZO hosts the Regional Brewer Calibration Centre for Europe (RBCC-E). A comprehensive programme of in-situ (ACTRIS station) and column aerosols (AERONET, GAW-PFR, MPLNet) is carried out for air quality and climate studies. IZO is an absolute calibration site of AERONET-Europe. A FTIR programme has been implemented for long-term monitoring of atmospheric gas composition in the framework of the international networks NDACC (Network for the Detection of Atmospheric Composition Change) since 1999 and TCCON (Total Carbon Column Observing Network) since 2007. IZO is a part of the Baseline Surface Radiation Network (BSRN) located in a strategic site to conduct studies of dust radiative forcing. GAW twining is currently held with global stations of Ushuaia, Argentina (ozonesonde programme) and Tamanrasset, Algeria (Brewer and Cimel-AERONET), as well as cooperation with other institutions working in Antarctica. IARC develops activities within the WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS WAS). More information is available at http://izana.aemet.es.

Wolfgang Fricke from Deutscher Wetterdienst (DWD), Germany, presented a poster on “Hohenpeissenberg Meteorological Observatory - GAW Global Site”. The Hohenpeissenberg Observatory – together with Zugspitze – is a GAW Global station since 1994. The GAW measurement programme was set on top of meteorological observations that had started in 1781 and on an ozone monitoring programme in place since 1967. The poster shows selected examples of temperature, ozone, VOC, aerosol, greenhouse gases, reactive gases, pH in precipitation, and OH radical measurements and time series. To further improve data quality and the understanding of chemical processes in the atmosphere, the observatory is a partner in different international research projects. Within the EU-FP7 project "ACTRIS", VOC and NOₓ round robins comparisons, data workshops and closure experiments were accomplished. Within ICOS (Integrated Carbon Observation System) Hohenpeissenberg will set up the German Atmospheric Climate Gas Observation Network at tall towers during 2013-2016. Within EUMETSATs Ozone Satellite Application Facility (O₃-SAF), DWD at Hohenpeissenberg validates the satellite ozone profiles processed by the SAF partner the Netherlands Royal Meteorological Institute (KNMI). As a contribution to the MIKLIP-MOSQUITO project funded by the German Federal Ministry of Education and Research, Hohenpeissenberg homogenizes radiosonde records for use in climate model validation. Following the Eyjafjallajökull volcanic eruption in 2010, efforts were made at Hohenpeissenberg in cooperation with WMO to survey and map the existing lidar and ceilometer networks and their relation to GALION (Global Aerosol Lidar Observation Network). In addition and
following recommendations from Hohenpeissenberg observatory, the DWD ceilometer network was upgraded to online capabilities.

Hamzah Herizal from BMKG, Indonesia, presented a poster on the “Analysis of Aerosol Data at Bukit Kototabang Global GAW Station”. He analyzed PM10 measurements at the station for the period 2004-2012. Significant diurnal variations were detected on all working days except Monday. They are characterized by pronounced daily increases with two peaks during morning and evening hours. For the periods of smog haze the diurnal cycle was over-ruled by a general high aerosol load from biomass burning. Trend analysis shows slight positive trends of PM10 concentration at the station. Seasonal cycle of PM10 concentration is largely controlled by precipitation pattern.

Maznorizan Mohamad from the Malaysian Meteorological Department (MMD), Malaysia, presented a poster on “the Monitoring Activities at GAW Stations in Malaysia”. The air quality monitoring network in Malaysia presently comprises of 23 stations, of which 17 are located in Peninsular Malaysia, 4 in Sabah and 2 in Sarawak. MMD operates a GAW Global station in the Danum Valley, Sabah since November 2003. The MMD operates two GAW Regional stations, one at Tanah Rata, Cameron Highlands and the other at Petaling Jaya. The GAW monitoring system in Malaysia focuses on five classes of variables such as precipitation chemistry measurements, aerosols measurements, greenhouse gases, reactive gases measurements and ozone measurements. A number of long-term research projects were carried out in collaboration with local as well as international scientific communities. Among the ongoing activities, collaboration with international scientific communities are listed below:

- Twinning programme with World Calibration Centre for Physical Aerosol Properties (WCCPAP) - Institute for Tropospheric Research, Germany
- Collaboration with National Institute of Environmental Studies (NIES), Japan on flask sampling
- Collaboration with Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia on LoFlo Mark II CO₂ observations
- Collaboration with the Environment Canada on the Global Atmosphere Passive Sampling (GAPS) programme - Persistent Organic Pollutants (POPs)
- Collaboration with Acid Deposition Monitoring Network in East Asia (EANET) for acid deposition analysis
- Collaboration with World Radiation Centre, Davos, Switzerland on Aerosol Optical Depth monitoring using Precision Filter Radiometer (PFR)
- Collaboration with Southern Hemisphere Additional Ozonesondes (SHADOZ) Programme on ozonesonde measurements

Mohamed Mimouni from the Algerian Meteorological Service (ONM), Algeria, presented a poster with “Results of 18 years of Measurements at the GAW station Tamanrasset/Assekrem”. The ONM has established in collaboration with WMO, a GAW station at the couple site of Tamanrasset/Assekrem since 1994 in a desert region of Hoggar mountains at altitudes 1377 m a.s.l. and 2710 m a.s.l. respectively. The Assekrem station is located in a free troposphere and is not impacted by direct anthropogenic pollution. The urban site of Tamanrasset includes the measurements of total ozone, solar radiation and AOD. At the more remote site of Assekrem, which is situated 50 km to the north of Tamanrasset at high altitude, the measurement programme includes gas flasks sampling on a weekly basis, continuous surface ozone, carbon monoxide and UV radiation measurements. Since 2006, measurements of AOD (photometer Cirrus) along with total ozone measurements with Brewer (since 2011) were initiated in collaboration with the Izaña Atmospheric Research Centre. The continuous measurements of surface ozone and carbon monoxide are done in twining with the EMPA since 2003 and 2006 respectively. The measurements of radiation at Tamanrasset are included in the BSRN network since year 2000 with the support of NOAA/ESRL (Boulder). The results of measurements are regularly submitted to GAW World Data Centres (WDC). The analysis of observations shows no trends for most parameters except for CO₂ where the curve shows a regular increase of about 2 ppm/year since 1995. The maximum values of year 2012 was 397 ppm against 365 ppm in 1996.
Ludwig Ries from the Federal Environment Agency, Germany, presented a poster on “Trends of Climate Forcing Gases at Selected Sites in Europe and Worldwide”. Time series with atmospheric concentrations of four relevant climate forcing gases: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O) and sulphur hexafluoride (SF₆) are shown for a number of selected sites in Europe and worldwide. Regional differences between the sites are described in the poster in detail. However, as seen with the time series of the German emission data it is not possible to detect emission changes of a source area like Germany in measured time series at GAW stations in Germany. The reduction of the emissions of the presented climate forcing gases as being reported for Germany does not cause a measurable decline of the atmospheric concentrations of these gases. It only causes a slower increase. This can be shown for example with annual growth rates of CO₂ mole fractions. German CO₂ measurements are taken since 1972 at Schausinsland and since 1994 at Zugspitze and at Neuglobsow station north of Berlin. This comparison shows that the relationship between trends of emissions and determined changes of atmospheric concentrations are not well understood. This raises the question whether a solution can be found by the combination of a set of consecutive measurement stations in a larger area in Europe including the area of Germany and by the continuous determination of the source strength of this set of stations for the related area. It is questionable whether such a continuous monitoring and analysis service can help environmental politics for a more sensitive and sincere detection of the effects of changing emissions. This kind of operative service can give an essential tool for the justification of political efforts to reduce emissions of climate forcing gases.

Helfried Scheifinger from the Central Institute for Meteorology and Geodynamics (ZAMG), Austria, presented a poster on “Trends of Ozone and Meteorological Parameters at High Alpine Sites”. Datasets from GAW stations are most appropriate to study background air pollution and meteorological trends. For the alpine sites Sonnblick, Jungfraujoch and Hohenpeissenberg the group found increasing ozone concentrations until 2003 especially in winter, whereas in summer there was a small decrease (period 1993-2011). The ozone increase in winter is favoured by changes in the air flow regimes and – to some degree – increasing sunshine duration, whereas in summer there are no trends in those meteorological parameters that are relevant to ozone.

Martin Steinbacher from Empa, Switzerland, presented a poster on the “Global GAW Station Jungfraujoch - Measurement Programme & Selected Results”. The GAW Global station Jungfraujoch (JFJ) is a high-altitude research infrastructure (3580m a.s.l., 46° 33’ N, 7° 59’ E) in the Swiss Alps. It represents a pristine background site that is well suited for long-term ground-based monitoring of atmospheric composition trends in the free troposphere in Central Europe. Predominantly low background levels of air pollutants facilitate the investigation of horizontal (e.g. inter-continental) and vertical transport processes (from the boundary layer to JFJ). Due to its proximity to highly industrialized regions at much lower altitudes and consequently occasional occurrence of pollution events, it is also an appropriate study site for European regional source allocations during pollution events. In addition, JFJ offers ideal conditions to determine aerosol properties related to climate forcing and air quality. With an average cloud occurrence of 37% at JFJ, it is also possible to efficiently investigate the interaction of aerosols with clouds. Today, a comprehensive measurement programme in full compliance with the GCOS Essential Climate Variables is run at JFJ by a multi-institutional consortium. The set of continuously measured parameters comprises reactive gases (O₃, SO₂, CO, NO, NO₂, NOₓ, VOCs, H₂), greenhouse gases (CO₂, CH₄, N₂O, SF₆), about 50 halogenated ozone-depleting substances and greenhouse gases (CFCs, HCFCs, HFCs), CO₂ isotopes (continuous d¹³C, d¹⁸O; integrated ¹⁴CO₂ samples), radon, ⁸⁵Kr, mass concentration in two size fractions (PM1, PM10), major chemical components in two size fractions, light absorption, light scattering and backscattering coefficients at various wavelengths, aerosol number concentration, aerosol size distribution, cloud condensation nuclei (CCN) concentrations at various supersaturations, multiwavelength optical depth, and comprehensive meteorological observations. In addition to the continuous observations, regular dedicated field campaigns are organized for full physical, chemical and optical characterization of the JFJ aerosol and a more in-depth investigation of the interaction of aerosols with clouds. The value of long-term high-quality time series was exemplarily illustrated by the presentation of perennial surface ozone and scattering coefficient data.
Roeland Van Malderen from the Royal Meteorological Institute (RMI), Belgium, presented a poster on “Ozone and UV Observations in Uccle (Belgium) and Utsteinen (Antarctica)”. The RMI has a long record of observations of ozone in the atmosphere. Combined time-series of total ozone, observed with Dobson and Brewer spectrophotometers since 1971 at the mid-latitude station Uccle (Belgium, 50°48’N, 4°21’E, 100 m asl) were reported. At the same location ozone profiles have been measured with balloon soundings since 1969. An analysis of the total ozone column data was presented, using the multiple linear regression technique in order to assess the contributors for the changes in total ozone. Spectral UV observations at Uccle are also available since 1989, and solar radiation data since 1964. At the same site, the regional authorities dispose of time series of surface trace gas measurements. In 2011 a Brewer instrument was installed at the new Belgian station Princess Elisabeth in Utsteinen (Antarctica, 71°57’S, 23°20’E, 1390 m asl). First observations from the summer seasons illustrate the high intensities of UV radiation (UV-index larger than 9) related to the station height, the high albedo and the low ozone content. Also global solar radiation observations are continuously available. However, the focus of this GAW station lies on the characterization of the aerosol properties: optical properties (with a CIME, only during the summer seasons), mass of absorbing aerosols & absorption coefficient (with aethalometer, automated), total aerosol mass (with TEOM-FDMS (Tapered Element Oscillating Microbalance-Filter Dynamics Measurement Systems), automated), aerosol size distribution (with a laser aerosol spectrometer, automated), aerosol scattering coefficient (with nephelometer, automated), and aerosol number concentration (with a condensation particle counter, automated).

Yrjö Viisanen from the Finnish Meteorological Institute (FMI), Finland, presented a poster on “Monitoring of Short-lived Climate Forcers at Pallas-Sodankylä GAW Station”. The Pallas-Sodankylä GAW station is located in Europe north of the Arctic Circle representing the northern boreal zone. It consists of two nodes. Most of the in-situ trace gas and aerosol observations are made at Pallas in the western part of Lapland. At Pallas, the main GHGs are measured by in-situ monitoring and weekly flask samples are analyzed as part of the NOAA co-operative flask sampling programme. Aerosol measurements include equivalent Black Carbon by measuring absorption by aethalometer and scattering by nephelometer, size distribution and total number of aerosols. Cloud properties are measured during campaigns which are organized annually. At Sodankylä, located 125 km to the east, there is the Arctic Research Centre of FMI. There the measurements of ozone profiles (with soundings), total ozone, UV-radiation and AOD, in addition to routine meteorological and sounding observations are conducted. Column CO$_2$ and CH$_4$ are observed at Sodankylä by FTIR spectroscopy as part of Total Carbon Column Observing Network (TCCON). At both sites, CO$_2$ and CH$_4$ fluxes between representative ecosystems and the atmosphere are measured by micrometeorological methods. Pallas and Sodankylä contribute to the Integrated Carbon Observing System (ICOS) atmospheric and ecosystem networks.

9. ACTIVITIES AT GAW CENTRAL FACILITIES

This poster session presents activities of the GAW Central Facilities and related activities on standards development. The detailed report of the GAW Central Facilities was compiled before the meeting, distributed to the meeting participants and made available on the official web page of the GAW Programme. Not all GAW Central Facilities were presented at the GAW 2013 Symposium, hence the readers are recommended to familiarize themselves with a more comprehensive report.

Michael Bittner from the German Aerospace Centre (DLR), Oberpfaffenhofen, Germany, presented a poster on the activities of “World Data Centre for Remote Sensing of the Atmosphere (WDC-RSAT)”. The WDC-RSAT offers scientists and the general public open and simplified access to a continuously growing collection of atmosphere-related satellite-based datasets, data products, and services. It covers atmospheric parameters such as trace gas concentrations (both in the troposphere and the stratosphere), trace gas columns, aerosols, atmospheric dynamics related parameters, radiation, mesopause temperatures, sea and land surface temperatures and

---

1 These instruments are owned by the Belgian Institute for Space Aeronomy, also located at Uccle, Brussels
solar radiation. WDC-RSAT concentrates on Level 3 (composites) and Level 4 (value added) products, although some datasets are available as Level 0 (raw data), Level 1 or Level 2 (georeferenced information). Product specific ISO metadata are provided. WDC-RSAT acts as a publication agent for Digital Object Identifiers (DOI). DOIs facilitate the identification of data (raw data as well as value added products) being cited in publications. Since 2003 the DLR hosts and operates the WDC-RSAT under the nongovernmental auspices of the International Council for Science (ICSU). Since 2009 WDC-RSAT is being implemented to support the WMO/GAW Programme. WDC-RSAT acts as a “one-stop shop”, providing access to space-based observations of the chemical composition of the atmosphere focusing on ozone and aerosols.

Moreover WDC-RSAT actively contributes to the WMO Expert Team on World Data Centres (ET-WDC), which aims at developing a ‘GAW Metadata Profile’ in order to satisfy the requirements of WIS and to extend them to future WIGOS requirements. WDC-RSAT establishes collaboration based on scientific expertise and on the application of up-to-date information exchange technologies (e.g. service-oriented metadata and data access via OGC-compliant interfaces) with a multitude of partners (research infrastructures as well as research projects such as FP7 ARISE).

Markus Fiebig from the Norwegian Institute for Air Research (NILU), Norway, presented a poster on activities of “The World Data Centre for Aerosols: Recent Developments”. The GAW World Data Centre for Aerosol (WDCA) moved to the Norwegian Institute for Air Research (NILU) in 2009. It currently supports data collection, documentation, archiving and access to 8 different types of aerosol parameter sets defined as core variables of the GAW aerosol programme, with further 5 types to be added. The WDCA uses a dual solution of homepage (www.gaw-wdca.org) and database server and web-interface (ebas.nilu.no). This setup allows sharing infrastructure with other programmes such as the UNECE (United Nations Economic Commission for Europe) Convention on Long-Range Transport of Air Pollution (CLRTAP), leading to improved services for both programmes through efficient use of resources. WDCA not only supports documentation of instrumental uncertainty and atmospheric variability, but also traceable (back to the time of measurement) reporting schemes for 5 of its parameter sets, allowing for reprocessing of archived data. Since 2007, the number of stations reporting data to WDCA annually has increased by a factor of 3.9, the number of individual instruments with annually reported data increased by a factor of 5.4. WDCA offers a near-real-time data collection and dissemination service with now 45 participating stations around the globe, reporting data of 72 individual instruments within 3 hours of measurement. User-access events to WDCA data have been doubled since 2007. Not least, these service improvements contributed to 2 publications on global trends in aerosol parameters feeding into the upcoming IPCC report.

Franklin Guenther from NIST, USA, presented a poster on “Advances in Ozone Traceability”. NIST is a Central Calibration Laboratory (CCL) for the surface ozone measurements in the GAW Programme. NIST provides a primary standard for ozone measurement through a Standard Reference Photometer (SRP). The NIST Standard Reference Photometer (SRP) was originally developed by NIST and the United States Environmental Protection Agency (US EPA) to provide traceability of ozone measurements within the United States to NIST. A series of NIST SRPs was built and disseminated throughout the country in US EPA regional laboratories to provide a reliable reference standard for US ambient ozone measurements under US EPA regulations. Interest from around the world prompted NIST to provide the NIST SRP to an increasing number of laboratories worldwide. NIST provides ozone traceability for US industry, academia, and other government agencies. NIST collaborates with BIPM to establish the International Ozone Traceability System.

Deullae Min from the Korea Meteorological Administration (KMA), Republic of Korea, presented a poster on “Current Status and Future Plan of WCC-SF₆”. To support GAW stations in assessing sulphur hexafluoride (SF₆) observations, WMO and the KMA have signed a Memorandum of Understanding (MoU) related to the provision of a WCC for SF₆ in October 2012. KMA has, in its Korea GAW Centre (KGAWC) at Anmyeon-do, Republic of Korea, considerable experience in the field of quality assurance and quality control for the analysis of SF₆ in air samples.
WCC-SF₆ has established several systems for SF₆ laboratory standards, including an evacuation system, a dry air sampling system, a gas chromatograph with electron capture detector, and SF₆ standard gas mixtures traceable to WMO GAW reference scale hosted by the Central Calibration Laboratory (CCL) in National Oceanic and Atmospheric Administration (NOAA, USA). To meet the challenges of WCC-SF₆, KMA/KGAWC will implement the plans: to develop SOPs for SF₆ observations; to provide the technical training course for GAW stations; to conduct comparison campaign and system/performance audits regularly. WCC-SF₆ is designing a programme and contents for extending and enhancing the capability for SF₆ observation supported by several funding sources, such as organizing a SF₆ observation network including the in-situ and/or flask sampling analysis.

Paul Novelli from the Global Monitoring Division/ESRL/NOAA, USA, presented a poster on the activities of "WMO Central Calibration Laboratory for Carbon Monoxide". The WMO Central Calibration Laboratory (CCL) for carbon monoxide (CO) is located at the Global Monitoring Division of the Earth Systems Research Laboratory (ESRL), US National Oceanic and Atmospheric Administration (NOAA), Boulder Colorado. The CO scale, designed for measurements in the remote near-surface troposphere (CO ~40 to 500 nmol mol⁻¹) is based on multiple sets of primary reference gases prepared by a gravimetric method. Secondary standards assigned CO by comparison to the different sets of primary standards are used to define the scale over time. Differences among these calibrations define the long-term uncertainty of the scale. Application of a common reference scale among laboratories is a major step towards the WMO/GAW objective for better comparability of measurements. A serious difficulty for long-term measurements of CO is the fact that when contained in cylinders CO may change with time. The WMO scale has undergone several revisions to account for drift. The CCL works closely with the WMO World Calibration Centre (WCC) for CO at Empa to maintain a reliable set of reference gases. As part of their respective QA/QC procedures, the CCL and WCC frequently compare measurements to evaluate the scale. Gas standards with assigned CO values by the CCL prior to 2004 are referenced to the WMO X2000 scale, while gas mixtures calibrated after 2004 are referenced to X2004. The difference between the two is largely in their uncertainties; X2004 is more precise than X2000. In the past decade many GAW sites have adopted the X2004 scale resulting in greater comparability among laboratories. However, other measurement issues, such as different instrument types and drift in standards complicate achieving the WMO/GAW goals for inter-laboratory compatibility.

Alberto Redondas from the Izaña Atmospheric Research Center, AEMET, Santa Cruz de Tenerife, Spain, presented a poster on activities of "Regional Brewer Calibration Centre-Europe (RBCC-E)". In November 2003, the WMO/GAW Regional Brewer Calibration Centre for RA-VI region (RBCC-E) was established at the Izaña Observatory (IZO) in the Canary Islands by the Meteorological State Agency from Spain (AEMET). IZO is located in the subtropical region (28ºN) on top of the Izaña Mountain (2370 m.a.s.l.) with clear skies and small ozone variability. This allows routine absolute calibrations of the reference radiation instruments similar to Mauna Loa site on Hawaii. A triad of Brewer MK-III double monochromators maintains the ozone reference. The IZO triad is linked to the Environment Canada (EC) triad by yearly calibrations towards the travelling reference BR 017. Recently, and because some uncertainties regarding the support of the world triad by EC, the WMO SAG Ozone agreed in the 2011 meeting, that the RBCC-E will transfer its own calibration based on Langley technique at IZO. A summary of the comparison of Langley calibration against the calibration transferred by the travelling instrument showed a difference in ozone lower than 0.5%. The RBCC-E triad is carefully maintained achieving a long-term agreement between the instruments of the triad with a precision of at least 0.25% in ozone.

Seven (7) Brewer calibration campaigns and 65 calibrations were performed since 2009 involving 40 instruments, which were supported by the CEOS (Committee on Earth Observation Satellites) Cal/Val project. The Arosa campaign results confirm the current status of the Brewer network of the previous campaigns; all of the operational instruments are within ±2% uncertainty range, 80% of them are within 1% range, and 66% the Brewers have a perfect agreement within 0.5% after two years calibration period. The absolute Langley calibration of Dobson and Brewer spectrophotometers at IZO, together with the analysis of different absorption coefficients derived
from the ACSO (Absorption Cross Sections of Ozone) initiative, provided encouraging results since they solve the Brewer-Dobson discrepancies when the Bremen University ozone cross sections are used. Technical developments, as well as the evaluation of the NO$_2$ measurements with the Diemoz’s Brewer MKIV (Aosta, Italy), the testing of new electronic board of the Brewer spectrophotometer with Kipp & Zonen, and the stray light model suitable for ozone corrections developed in collaboration with Karppinen et al. (Finnish Meteorological Institute) are briefly presented in the poster together with the training and capacity building activities carried out with Tamanrasset Station (Algeria), Casablanca and Dakhla (Morocco), King George station (Antarctic Uruguay) and the Korea Meteorological office.

Martin Steinbacher from Empa, Switzerland, presented a poster on “QA/SAC Switzerland - Activities and Achievements”. The GAW Quality Assurance/Scientific Activity Centre (QA/SAC Switzerland), funded by MeteoSwiss and Empa, was established at Empa in 2000. Being closely linked to the World Calibration Centre also hosted by Empa, the QA/SAC mainly focuses on surface ozone, carbon monoxide, methane and carbon dioxide measurements but it is also broader in scope and provides technical and scientific support in general. The main tasks of QA/SAC Switzerland are (a) science activities fostering steady analytical progress, (b) training, twinning, and capacity building, (c) contribution to GAW outreach, e.g. by actively participating in writing GAW reports, and (d) networking / cooperation with other programmes / projects in line with the GAW strategy. Science activities cover the evaluation of novel measurement techniques and their performance improvement, the assessment of their applicability for long-term monitoring purposes, and the dissemination of know-how to the GAW community. Twinning is one of the core tasks of QA/SAC Switzerland since the early beginning because it was recognized that a continuous support of monitoring activities in developing countries is key to maintaining high-precision observations in line with the GAW requirements. QA/SAC Switzerland has also been a partner of the GAW Training and Education Centre (GAWTEC) for a long time. GAWTEC, a German contribution to GAW, provides technical guidance through twice yearly training courses, where the Swiss QA/SAC is regularly involved in teaching. An early achievement by QA/SAC was the development of the GAW Station Information System (GAWSIS; http://gaw.empa.ch/gawsis), which became the official catalogue of GAW stations world-wide. It collects and disseminates metadata from GAW stations and many other ground-based measurement networks. GAWSIS was recently transferred to MeteoSwiss and is now operated by MeteoSwiss. QA/SAC recently contributed to various GAW reports dealing with carbon monoxide (No. 192), nitrogen oxides (No. 195) and, surface ozone (No. 209). QA/SAC’s cooperation with other programmes, e.g. by sharing expert knowledge, aims at fostering the synergies between GAW and those programmes. Examples are the Integrated Carbon Observation System (ICOS), the Integrated non-CO$_2$ Greenhouse gas Observation System (InGOS) and the Aerosol, Clouds, and Trace Gases Research Network (ACTRIS). QA/SAC Switzerland, along with WCC-Empa, aims at improving data availability and data quality by fostering joint efforts of many GAW facilities and partners.

Rainer Steinbrecher from KIT/IMK-IFU, Germany, presented a poster on “KIT World Calibration Centres within the WMO/GAW Programme”. The high data quality with a known traceability is achieved and maintained through rigorous QA/QC procedures. The system and performance audits conducted over the past 10 years for N$_2$O and volatile organic compounds (VOCs) observations within the GAW network revealed considerable progress over the years regarding compatibility of the measurements performed. Sufficient separation of the target compounds from other substances present in air samples (e.g. unknown compounds, CO$_2$, SF$_6$) remains an analytical challenge with the currently applied measurement techniques. A careful determination of the detector response curve of the analytical systems is of importance, in particular for N$_2$O measurements. At present, most laboratories meet the DQOs for VOCs analysis. For N$_2$O, the analytical quality is close to the DQOs when comparing target values close to ambient air concentrations, but may show significant deviations at the lower or upper end of the GAW-recommended observational concentration range.
Joëlle Viallon from the International Bureau of Weights and Measures (BIPM), France, presented a poster on “Comparisons for NO₂, O₃, CH₂O, CH₄ Gas Standards: Supporting Current and Potential CCLs and WCCs”. Compounds regularly measured in the GAW Programme constitute an important part of the strategy developed by the Consultative Committee for Amount of Substance (CCQM), Gas Analysis working group, which envisions the regular execution of comparisons to underpin National Measurement Capabilities. These comparisons require dedicated facilities, a number of which are maintained within the laboratories of the BIPM. BIPM currently maintains four facilities to insure the international equivalence of gas standards for air quality and climate change monitoring:

- The Ozone Reference Standard comparison facility constituted with three Standard Reference Photometers of which one is the common reference of the on-going comparison BIPM.QM-K1. Both the CCL and the WCC for surface ozone, namely NIST and EMPA, take part regularly in this comparison, demonstrating the agreement of GAW standards with other internationally recognised standards for the same quality.
- The greenhouse gas comparison facility constituted with a set of analytical instruments run under repeatability conditions is being used to coordinate the comparison CCQM-K82 of methane in air standards, including standards from the CCL for methane, NOAA-ESRL. The same facility will be used to coordinate a comparison of carbon dioxide in air standards.
- Two dynamic Gas Standards facilities dedicated to the generation of reactive gases for which no primary standards in cylinders are available, and for which the GAW QA/QC system is currently under development. One facility was already used to coordinate the comparison CCQM-K74 of nitrogen dioxide in nitrogen standards at a nominal mole fraction of 10 µmol mol⁻¹. The other will be used to coordinate the comparison CCQM-K90 of formaldehyde in nitrogen standards. Both are regularly discussed during corresponding GAW experts workshops (on NOxy and VOCs) in which laboratory experts from the BIPM and several NMIs take part to facilitate the establishment of WMO/GAW Central Calibration Laboratories for the global monitoring of these species.

Christoph Zellweger from Empa, Switzerland, presented a poster on “New Approach of Performance Audits by WCC-Empa using a Travelling Analyzer”. Empa operates the World Calibration Centre for surface ozone, carbon monoxide, methane and carbon dioxide (WCC-Empa) since 1996 as a Swiss contribution to GAW. To date 63 audits were made mainly at Global GAW stations. The aim of these audits is to ensure traceability to a common reference. These audits provide valuable information on the instrument performance at the time of the comparison. However, the performance audits have the disadvantages that they are limited in temporal coverage (snapshot), are subject to potential biases due to presence of operators (more careful calibration, instrument tuning, dedicated data processing), and that they do not cover the whole measurement system (e.g. inlet design and drying units). In order to overcome these disadvantages, it was suggested by WCC-Empa and QA/SAC Switzerland to run parallel on-site comparisons during performance audits over a period of 1-2 months. First results were presented at the 16th WMO/IAEA Meeting on Carbon Dioxide, Other Greenhouse Gases, and Related Measurement Techniques (GGMT-2011) in Wellington, which resulted in the following recommendation:

“WCC-Empa has demonstrated the benefits of using a travelling instrument for GAW station audits. It is very desirable that the air intake is included in the testing process. This practice is encouraged whenever possible.”

The new performance audit approach includes 1) comparison with travelling standards, 2) side-by-side comparison of CO, CH₄ and CO₂ with an independently calibrated travelling instrument, and 3) an independent air inlet system. In the ideal case, identical results are observed with both the comparisons of the travelling standards and the travelling instrument. In addition, the new performance audit approach opens possibilities to study the whole measurement set-up of a station. For example, problems in the sample drying or in the inlet system can be detected, which
has been shown with case studies carried out during WCC-EmPa audits in 2012. Due to the demonstrated added value, it is planned to continue with the new performance audit approach during future WCC-EmPa audits whenever feasible.

10. ANALYSIS OF OBSERVATIONS, PRODUCTS AND SERVICES

Liisa Jalkanen from WMO, Switzerland, presented a poster on “Climate Services for Megacities and Large Urban Complexes”. The poster highlights the problem of urbanization. It describes the challenges related to the description and characterization of urban areas and assessing their impact on environment. It also stresses that according to the report of the World Bank, “cities, which produce nearly 80 percent of the world’s greenhouse gas emissions, must take a leading role in preventing climate change catastrophe. Now is the time for cities to implement innovative policy measures and enhance their resilience.” WMO/GAW is working on the problem of megacities through its GURME project. An important publication WMO/IGAC Publication “Impacts of Megacities on Air Pollution and Climate” is also presented on the poster.

Liisa Jalkanen from WMO, Switzerland, presented a poster on “WMO GAW Programme Addressing Air Pollution and Climate Change”. The poster gives a general overview of the GAW Programme, highlights observational networks, QA system in GAW and important products in support of policy making for climate and air quality (e.g. UNEP/WMO Integrated Assessment of Tropospheric Ozone and Black Carbon).

Sarah Lawson from CSIRO Marine and Atmospheric Research, Aspendale, Australia, presented a poster on "Biomass Burning Emissions at Robbins Island, Cape Grim, Australia, 41ºS". Biomass Burning emissions were opportunistically measured at Cape Grim during the 2006 Precursors to Particles campaign, when a fire burned through coastal vegetation on Robbins Island for two weeks. An easterly wind advected the plume over the station on two occasions, giving an opportunity to measure the composition of the fresh (~20 minute old) plumes. Subsequently when the wind direction changed from easterly to westerly, the plumes were diluted and recirculated over the ocean and mainland Australia, allowing the changing composition of the plumes to be observed. Emission factors have been calculated for a range of gas and aerosol species in the fresh plume. Enhanced concentrations of ozone and oxygenated volatile organic compounds (OVOCs) were observed in the diluted plume, suggesting photochemical processing was occurring as the plume aged. The ability of particles to act as CCN was investigated both in fresh and aged plumes, by comparing the ratio of $\Delta$CCN number to $\Delta$CN number, for particles > 80nm (CN80). Because all CN particles > 80nm are at a size capable of acting as CCN, the observed difference in the CCN/CN80 ratio may be attributed to different chemical composition of fresh and aged particles. The ratio of $\Delta$CCN/$\Delta$CN80 in aged plumes with ozone production was almost twice as high as the ratio in the fresh plumes.

Suzie Molloy from CSIRO Marine and Atmospheric Research, Aspendale, Australia, presented a poster on “Identification of a Suitable Baseline Definition of Tropospheric Ozone at Cape Grim, Tasmania”. A fundamental component of the concentration of a given atmospheric species is the baseline or background concentration. This can be considered the underlying concentration of the species in the absence of all other local and regional effects; the starting point upon which the sources and sinks then act on to produce the final concentration which is observed. This baseline concentration is not static, as there are many factors that affect it depending on the atmospheric species. To separate baseline from non-baseline data, a variety of variables can be used depending on the atmospheric species. For tropospheric ozone, selection of baseline data depends on the particular circumstances under which the concentrations are measured and the data that is available. In this study, we build on previous work and trial a set of baseline definitions for use with ozone concentrations measured in the marine boundary layer at the Cape Grim Baseline Air Pollution Station (CGBAPS). These baseline definitions are based on wind speed and direction, radon concentrations and condensation nuclei counts and applied to a 10 year ozone data set from 1992 to 2001. The resulting baseline datasets are analysed for long-term trends and the differences between the trends are examined.
Tatsuya Nagashima from the Center for Regional Environmental Research, National Institute for Environmental Studies, Tsukuba, Japan, presented a poster on “Global Model Validation of Surface Ozone by the WMO/GAW WDCGG”. Seasonal variations of surface ozone concentration calculated by global chemical transport models (CTMs) participated in TFHTAP model intercomparison were compared with those observed at many WMO/GAW sites widely spread on the globe. The aim of this comparison was to evaluate the ability of global CTMs to simulate the observed seasonal transition of surface ozone. The results show that CTMs tend to exhibit similar seasonal variation of surface $O_3$ in many regions on the globe; modelled seasonal variation were consistent with the observation in several regions including East Asia, North Atlantic- Scandinavia, and western US, but did not capture well observations in the other regions. In those regions, e.g. in the Antarctica, most of CTMs underestimate the surface $O_3$ in autumn to winter (May – September), which cause weaker seasonal cycle in the CTMs than in the observations. There are several sites in Central to Eastern Europe where the observations apparently show its peak in the spring but the most of CTMs have their peak in the summer.

John Ogren from the NOAA Earth System Research Laboratory, USA, presented a poster with the SAG Aerosols “Recommendations for the Interpretation of "Black Carbon" Measurements”. Although black carbon (BC) is one of the key atmospheric particulate components driving climate change and air quality, there is no agreement on the terminology that considers all aspects of specific properties, definitions, measurement methods, and related uncertainties. As a result, there is much ambiguity in the scientific literature of measurements and numerical models that refer to BC with different names and based on different properties of the particles, with no clear definition of the terms. A recommended terminology is presented to clarify the terms used for BC in atmospheric research, with the goal of establishing unambiguous links between terms, targeted material properties and associated measurement techniques. Briefly, the recommendations are:

- Black carbon (BC) is a useful qualitative description when referring to light-absorbing carbonaceous substances in atmospheric aerosol; however, for quantitative applications the term requires clarification of the underlying determination.
- Equivalent black carbon (EBC) should be used instead of black carbon for data derived from optical absorption methods, together with a suitable mass absorption coefficient for the conversion of light absorption coefficient into mass concentration.
- Elemental carbon (EC) should be used instead of black carbon for data derived from methods that are specific to the carbon content of carbonaceous matter.
- Refractory black carbon (rBC) should be used instead of black carbon for measurements derived from incandescence methods.
- Soot is a useful qualitative description when referring to carbonaceous particles formed from incomplete combustion.

Andrea Rossa from MeteoSwiss, Switzerland, presented a poster on “CATCOS - Capacity Building and Twinning for Climate Observing Systems”. This poster provided more details on the CATCOS project that has been presented at the oral session by Gabriela Seiz.

Oksana Tarasova from WMO, Switzerland, presented a poster on “An Integrated Global Greenhouse Gas Information System (IGIS)”. An enhancement of the observational capacity is required in particular for implementations of the Integrated Global Greenhouse Gas Information System (IGIS). Such a system would combine ground-based and space-based assets, self-reporting, carbon-cycle modelling, fossil-fuel use data, land-use data, meta-analysis, and an extensive distribution system to provide information about sources and sinks of greenhouse gases at policy-relevant temporal and spatial scales. An IGIS would in particular require improved and denser ground, sea, and air-based measurements (ten times more stations or even more, close to the source areas), sustained space-based observations, and measurements of isotopes and non-$CO_2$ short-lived gases for fossil-fuel combustion attribution.
Enric Terradellas from AEMET, Spain, presented a poster on “WMO Sand and Dust Storm Warning Advisory and Assessment System, Regional Centre for Northern Africa, Middle East and Europe”. The Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS) has a mission to enhance the ability of countries to deliver timely and quality sand and dust storm forecasts, observations, information and knowledge to end users. The Regional Centre for Northern Africa, Middle East and Europe, hosted by the Spanish State Meteorological Agency (AEMET) and the Barcelona Supercomputing Center (BSC-CNS), supports a node of research and operational partners implementing the objectives of the SDS-WAS programme in the region. The Regional Centre web portal (http://sds-was.aemet.es) was designed to allow user access to observational and forecast products, as well as to sources of basic information. The main data sources are in-situ aerosol measurements performed on air quality monitoring stations, indirect observations (visibility and present weather) from meteorological stations, sun photometric measurements (e.g. AERONET network), lidar and ceilometers and satellite products. In 2008, AEMET launched the project SDS-Africa aimed to reinforce the observational capacity for mineral dust in Northern Africa. The main goal of the project, financed by the Spanish Agency for International Development Cooperation (AECID), was to establish a ground-based network of sun photometers in selected locations of Northern Africa for detecting and monitoring dust storms.

The exchange of forecast model products is a core part of the WMO SDS-WAS programme and the basis for the joint visualization and evaluation initiative. The web portal offers side-by-side dust forecasts (dust surface concentration and dust optical depth at 550 nm) issued by seven (7) modelling systems as well as the multi-model median. The dust optical depth (DOD) at 550 nm forecast by the models and multi-model median is first drawn together with the AERONET observations of AOD in monthly plots for 40 selected dust-prone stations. In addition to this NRT evaluation, a system to quantitatively assess the performance of the different models has been set. It yields evaluation scores computed from the comparison of the simulated DOD with the AERONET retrievals of AOD. Finally, the regional centre coordinates with partners and National Meteorological and Hydrological Services in the region different actions aimed to strengthen the capacity of countries to use the observational and forecast products distributed in the framework of the WMO SDS-WAS programme.

Lingxi Zhou from the Chinese Academy of Meteorological Sciences (CAMS), China Meteorological Administration (CMA), China, presented a poster on the preparations to the 17th WMO/IAEA Meeting on Carbon Dioxide, Other Greenhouse Gases, and Related Tracer Measurement Techniques (GGMT-2013), which will be held on 10-14 June 2013, Beijing, China (GGMT 2013 promotion). Details of the meeting can be found on respective web page.

11. CLOSURE OF THE GAW 2013 SYMPOSIUM

Øystein Hov closed the GAW 2013 Symposium at 11.50 a.m. on Wednesday 20th March 2013.
AGENDA

Monday, 18 March

8:00  Registration

Opening and overview Session *(Chair: Deon Terblanche)*

9:00  Opening  DSG or representative, Øystein Hov

9:20  Recent CAS developments  Michel Bélant

9:40  Overview of GAW  Liisa Jalkanen

10:00  Coffee break and group photo

International Initiatives *(Chairs: Lucky Ntsangwane, Hiroshi Koide)*

10:30  Integrated Atmospheric Observing System in Europe  Gelsomina Pappalardo

10:50  IGAC  Paul Monks

11:10  From national GAW activities to supporting international development  Gabriela Seiz

11:30  Air Quality and Health  Heather Adair-Rohani

11:50  Discussion

12:00  Lunch

GAW Activities *(Chairs: Brigitte Buchmann, Constance Okuku)*

13:30  Report of the SAG GHG  Ed Dlugokencky

13:50  Report of the SAG Ozone  Johannes Stähelin

14:10  Report of the SAG Precipitation Chemistry  Richard Artz

14:30  Report of the SAG Aerosols  John Ogren

14:50  Report of the SAG Reactive Gases  Martin Schultz for Stuart Penkett

15:10  Report of the SAG UV  Susana Diaz for Ann Webb

15:30  Coffee break

---

Coffee breaks: hosted by MeteoSuisse
<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td>16:00</td>
<td>Report of the Expert Team on near-real-time Chemical Data Transfer</td>
<td>Vincent-Henri Peuch</td>
</tr>
<tr>
<td>16:20</td>
<td>Report of the Expert Team World Data Centres (ET WDC)</td>
<td>Jörg Klausen</td>
</tr>
<tr>
<td>16:40</td>
<td><strong>Regional and International Activities and Applications</strong> <em>(Chairs: Katie Read, Deullae Min)</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Filling the data gap between surface based measurements and space based observations using passenger aircraft: CONTRAIL, IAGOS-CORE and IAGOS-CARIBIC</td>
<td>Carl Brenninkmeijer</td>
</tr>
<tr>
<td>17:00</td>
<td>GEO overview</td>
<td>Barbara Ryan</td>
</tr>
<tr>
<td>17:20</td>
<td>Break-out group information</td>
<td></td>
</tr>
<tr>
<td>17:35</td>
<td>Adjourn for the Day</td>
<td></td>
</tr>
</tbody>
</table>

**Tuesday, 19 March**

**Regional and International Activities and Applications (cont) *(Chairs: Katie Read, Deullae Min)***

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00</td>
<td>WMO Integrated Global Observing System (WIGOS)</td>
<td>Sue Barrell</td>
</tr>
<tr>
<td>9:20</td>
<td>Global Framework for Climate Services (GFCS)</td>
<td>Deon Terblanche</td>
</tr>
<tr>
<td>9:40</td>
<td>Networks for Volcanic Ash Detection</td>
<td>Thomas Werner</td>
</tr>
<tr>
<td>10:00</td>
<td>Monte Cimone and Pyramid Stations; Links to ABC Asia</td>
<td>Sandro Fuzzi</td>
</tr>
<tr>
<td>10:20</td>
<td>Discussion</td>
<td></td>
</tr>
<tr>
<td>10:30</td>
<td><strong>Coffee break</strong></td>
<td></td>
</tr>
<tr>
<td>11:00</td>
<td>IPCC</td>
<td>Renate Christ</td>
</tr>
<tr>
<td>11:20</td>
<td>MACC-II</td>
<td>V-H Peuch</td>
</tr>
<tr>
<td>11:40</td>
<td>SAG GURME</td>
<td>Greg Carmichael</td>
</tr>
</tbody>
</table>

**Regional and International Activities and Applications (cont) *(Chairs: Yrjo Viisanen, Gerardo Carbajal)***

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:00</td>
<td>Lunch</td>
<td></td>
</tr>
<tr>
<td>13:30</td>
<td>Satellite Activities</td>
<td>John Burrows</td>
</tr>
<tr>
<td>13:50</td>
<td>Way Forward for GAW</td>
<td>Øystein Hov</td>
</tr>
<tr>
<td>14:10</td>
<td><strong>Break-out Sessions</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Communication and outreach <em>(Chair/rapporteur: Michela Maione, Michael Bittner)</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>o QA/QC and Rolling Review of Requirements <em>(Chair/rapporteur: Rainer Steinbrecher, Maznorizan Mohamad)</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Socio-economical and policy priorities and sustainability and expansion of networks <em>(Chair/rapporteur: Sonja Vidi, Shiv Dev Attri)</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Integrated use of observations <em>(Chair/rapporteur: Emilio Cuevas, Zhang Xiaoye)</em></td>
<td></td>
</tr>
<tr>
<td>15:15</td>
<td><strong>Coffee break</strong></td>
<td></td>
</tr>
<tr>
<td>15:45</td>
<td><strong>Break-out Session (cont)</strong></td>
<td></td>
</tr>
<tr>
<td>16:45</td>
<td>Transition</td>
<td></td>
</tr>
<tr>
<td>17:00</td>
<td><strong>Poster Session with</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reception hosted by the Norwegian Meteorological Institute</td>
<td></td>
</tr>
</tbody>
</table>
**Poster sessions:**
- National and regional Air Quality and Atmospheric Chemistry activities
- Activities at GAW stations
- Activities at GAW Central Facilities
- Analysis of observations, products and services

19:00 Adjourn for the Day

**Wednesday, 20 March**

**Joint GAW and CLRTAP HTAP session**

8:00 Registration

**Opening of HTAP and feedback from GAW 2013** *(Chair: Øystein Hov)*

9:00 Opening of HTAP

Terry Keating

Frank Dentener

9:20 Reports of Breakout Groups, summary and discussion

10:30 Coffee break

**Status of data infrastructure**

11:00 HTAP Network & the GEO AQ CoP

Rudy Husar

11:25 EBAS, GAW and other surface network data

Kjetil Torseth & Jörg Klausen

11:50 Closure of GAW 2013

Øystein Hov

End of GAW 2013

12:00 Lunch
LIST OF PARTICIPANTS

Heather Adair-Rohani
World Health Organization
Avenue Appia, 20
CH-1211 GENEVA 27
Switzerland
Tel.: +41-(0)22 791 29 98
Fax: +41-(0)22 791 41 23
Email: adairrohanih@who.int

Mizani Ahmad
BMKG
Jl. Angkasa I No. 2
Kemayoran
JAKARTA 10720
Indonesia
Tel.: +62-21 65 86 62 36
Fax: +62-21 65 86 62 36
Email: mizani.ahmad@gmail.com

Richard Artz
NOAA Air Resources Laboratory
R/ARL - NCWCP - Room 4215
5830 University Research Court
COLLEGE PARK, MD 20740
United States of America
Tel.: +1-301 683 13 67
Fax: +1-301 683 13 70
Email: richard.artz@noaa.gov

Shiv Dev Attri
India Meteorological Department
DDMG (O)
Lodi Road
NEW DELHI-110003
India
Tel.: +91-11 24 64 07 01
Fax: +91-11 24 62 32 20
Email: sdattri@gmail.com

Dr Sue Barrell
Commission of Basic System (CBS)
Bureau of Meteorology
MELBOURNE
Australia
Email: s.barrell@bom.gov.au

Ekaterina Batchvarova
National Institute of Meteorology and Hydrology
66, Blvd Tzarigradsko chaussee
1784 SOFIA
Bulgaria
Tel.: +35- 9 24 62 45 78
Fax: +35-9 29 88 03 80
Email: Ekaterina.Batchvarova@meteo.bg

Michel Bélard
WMO CAS President
Atmospheric and Climate Science
Environment Canada
2121 Trans-Canada Highway
DORVAL, QUEBEC H9P 1J3
Canada
Tel: +15144 214771
Fax: +15144 212106
Email: michel.beland@ec.gc.ca

Michael Bittner
German Aerospace Center Oberpfaffenhofen DFD-DLR
Atmosphere - WDC-RSAT-NDMC
Abt. DFD-ATM
Muenchner Strasse 20
D-82234 WESSLING
Germany
Tel.: +49-81 53 28 13 79
Fax: +49-81 53 28 13 63
Email: michael.bittner@dlr.de

Carl A.M. Brenninkmeijer
Max Planck Institute for Chemistry
Hahn-Meitner-Weg 1
55128 MAINZ
Germany
Tel.: +49-613 13 05 41 00
Fax: carl.brenninkmeijer@mpic.de

Paul Brewer
National Physical Laboratory
CCL for VOCs
Hampton Road
TEDDINGTON, TW11 0LW
United Kingdom
Tel.: +44-(0)20 89 43 60 07
Email: paul.brewer@npl.co.uk
Markus Fiebig
Norwegian Institute for Air Research
WDCA
Instituttveien 18
2007 KJELLER
Norway
Tel.: +47-63 89 82 35
Fax: +47-63 89 80 50
Email: Markus.Fiebig@nilu.no

Wolfgang Fricke
Deutscher Wetterdienst
Hohenpeissenberg Observatory
Albin-Schwaiger-Weg 10
D-82383 HOHENPEISSENBERG
Germany
Tel.: +49-69 80 62 97 10
Fax: +49 69 80 62 97 06
Email: Wolfgang.Fricke@dwd.de

Sandro Fuzzi
Istituto di Scienze dell’Atmosfera e del Clima
Consiglio Nazionale delle Ricerche
Via Gobetti 101
I-40129 BOLOGNA
Italy
Tel.: +39-051 639 95 59
Fax: +39-051 639 96 47
Email: s.fuzzi@isac.cnr.it

Sarantuya Ganjuur
Institute of Meteorology and Hydrology
National Agency for Meteorology and Environment monitoring of Mongolia
Juulchny street-5
Chingelteu district
ULAANBAATAR 210646
Mongolia
Tel.: +976-51 26 49 53
Fax: +976-32 66 14 / 32 65 92
Email: sar_od@yahoo.com

Sachin Ghude
Indian Institute of tropical MeteorologyPhysical Meteorology and Aerology Division
Pashan Rd
PUNE-411 008
India
Tel.: +91-20 25 90 43 50
Email: sachinghude@tropmet.res.in

Sunling Gong
Environment Canada
4905 Dufferin Street ,
M3H 5T4 TORONTO
Canada
Fax: +1 416 739 42 81
Email: Sunling.Gong@ec.gc.ca

Ramon Guardans
Ministry of Agriculture Food and Environment MAGRAMA
Az. Varez de Castro 12
SP-28010 MADRID
Spain
Tel.: +34-6 39 13 77 61
Fax: +34-9 14 45 64 58
Email: ramon.guardans@soundplots.com

Franklin Guenther
NIST
CCL Surface Ozone
100 Bureau Drive
GAITHERSBURG, MD 20899-8393
United States of America
Tel.: +1-301 975 39 39
Fax: +1-301 977 83 92
Email: fguenther@nist.gov

Hamzah Herizal
BMKG
Bukit Kototabang Global GAW Station
Jalan Bukittingji-Medan KM 17
PO BOX 11
BUKITRINGGI #26100
Sumatera Barat
Indonesia
Tel.: +62-752 744 60 89
Fax: +62-752 744 64 49
Email: herizal@bmkg.go.id

Øystein Hov
Norwegian Meteorological Institute
Research
P.O. Box 43 Blindern
NO-0313 OSLO
Norway
Tel.: +47-22 96 33 60
Fax: +47-22 96 30 50
Email: oystein.hov@met.no

Nitin Kumar Jaiswal
Department of Chemistry
Institute of Engineering and Technology
ITM University
Upanwara New Raipur
RAIPUR, Chhattisgarh 493661
India
Tel.: +91-930 068 63 30
Email: nitinkjaiswal@hotmail.com

Terry Keating
US EPA
1200 Pennsylvania Ave NW (MC 6103A)
WASHINGTON, DC 20460
United States of America
Tel.: +1-202 564 11 74
Fax: +1-202 564 15 54
Email: keating.terry@epa.gov
Deog-Su Kim  
Korea Meteorological Administration  
393-17 Haewangwang-ro, Anmyeon-eup  
Taean-gun  
CHUNGCHONAM-DO 357-963  
Republic of Korea  
Tel.: +82-41 674 64 20  
Fax: +82-41 674 64 22  
Email: ducksu@korea.kr

Sang-Woo Kim  
Seoul National University  
School of Earth and Environmental Sciences  
1 Gwanak-ro, Gwanak-gu  
SEOUL 151-747  
Republic of Korea  
Tel.: +82-2 880 67 16  
Fax: +82-2 883 49 72  
Email: sangwookim@snu.ac.kr

Jörg Klausen  
MeteoSwiss  
Federal Office Of Meteorology and Climatology  
Krähbühlstrasse 58  
CH-8044 ZURICH  
Switzerland  
Tel.: +41-(0)44 256 92 23  
Email: joerg.klausen@meteoswiss.ch

Hiroshi Koide  
Japan Meteorological Agency  
WDCGG, WCC, QA/SAC, RDCC  
1-3-4 Otemachi, Chiyoda-ku  
TOKYO 100-8122  
Japan  
Tel.: +81-3 32 87 34 39  
Fax: +81-3 32 11 46 40  
Email: hkoide@met.kishou.go.jp

Joerg Langen  
ESA-ESTEC  
Keplerlaan 1  
2201AZ NOORDWIJK  
The Netherlands  
Tel.: +31-71 565 57 26  
Fax: +31-71 565 57 75  
Email: Joerg.Langen@esa.int

Han Cheol Lim  
Korea Global Atmosphere Watch Center (KGAWC)  
Korea Meteorological Administration  
1764-6, Seungen-2Ri, Anmyeon-Eup  
Taean-Gun  
CHUNGNAM 357-961  
Republic of Korea  
Tel.: +82-41 674 64 20  
Fax: +82-41 674 64 22  
Email: hclim09@korea.kr

Julian Meyer-Arnk  
German Aerospace Center (DLR), DFD-ATM  
WDC-RSAT

Mohamed Mimouni  
Algerian meteorology service  
B.P. 31  
TAMANRASSET 11000  
Algeria  
Tel.: +213 29 34 46 73  
Fax: +213 29 34 46 73  
Email: m_mimouni_dz@yahoo.fr

Maznornizan Mohamad  
Malaysian Meteorological Department  
Jalan Sultan  
46667 PETALING JAYA  
Malaysia  
Tel.: +603 79 67 80 67  
Fax: +603 79 55 09 64  
Email: maz@met.gov.my

Deullae Min  
Korea Meteorological Administration  
WCC-SF6  
393-17 Haewangwang-ro, Anmyeon-eup  
Taean-gun  
CHUNGCHONAM-DO 357-963  
Republic of Korea  
Tel.: +82-41 674 64 20  
Fax: +82-41 674 64 22  
Email: mindl@korea.kr

Paul Monks  
IGAC  
University of Leicester  
Department of Chemistry  
George Porter Building  
LEICESTER, LE1 7RH  
United Kingdom  
Tel.: +441162141
Juan Ramón Moreta  
AEMET  
State Meteorological Agency of Spain  
Special Radiation Network and Atmospheric Monitoring  
C/Leonardo Prieto Castro 8  
28071 MADRID  
Spain  
Tel.: +34-9 15 81 97 73  
Fax: +34-9 15 81 97 67  
Email: jmoretag@aemet.es

Tatsuya Nagashima  
National Institute for Environmental Studies  
16-2 Onogawa  
TSUKUBA, Ibaraki  
Japan  
Tel.: +81-29 850 28 98  
Email: Nagashima.tatsuya@nies.go.jp

Lucky Ntsangwane  
South African Weather Service  
Research  
442 Rigel Avenue South  
Erasmusrand  
PRETORIA  
Tel.: +27-12 367 62 39  
Fax: +27-12 367 61 89  
Email: lucky.ntswgane@weathersa.co.za

John Ogren  
NOAA Earth System Research Laboratory  
325 Broadway  
BOULDER, CO 80305  
United States of America  
Tel.: +1-303 497 62 10  
Fax: +1-303 497 55 90  
Email: John.A.Ogren@noaa.gov

Gelsomina Pappalardo  
National Research Council (CNR-IMAA)  
Contrada S. Loja  
I-85050 TITO (Potenza)  
Italy  
Tel.: +39-09 71 42 72 65  
Fax: +39-09 71 42 72 71  
Email: gelsomina.pappalardo@imaa.cnr.it

Constance Colnex Okuku  
Kenya Meteorological Department  
MKN GAW Station  
P O Box 30259-00100  
Ngong road  
NAIROBI GPO  
Kenya  
Tel.: +254-20 386 78 80  
Fax: +254-20 387 69 55  
Email: colnex2004@yahoo.co.uk

Khageshwar Singh Patel  
Pt. Ravishankar Shukla University  
School of Studies in Chemistry  
Amanaka  
RAIPUR 492010 CG  
Tel.: +91-771 226 28 43  
Fax: +91-771 226 28 18  
Email: patels_k55@hotmail.com

Juan Carlos Pelaez  
Instituto de Meteorología  
Centro de Física de la Atmósfera  
Carretera del Asilo S/N  
Municipio Regla  
Apartado Postal 17032  
CP 11700  
HABANA 17  
Cuba  
Tel.: +537 888 66 41  
Fax: +537 881 34 11  
Email: juan.pelaez@jnsmet.cu

Vincent-Henri Peuch  
ECMWF  
Shinfield Park  
READING, RG2 9AX  
United Kingdom  
Tel.: +44 118 949 91 02  
Fax: +44 118 986 9450  
Email: Vincent-Henri.Peuch@ecmwf.int

Katie Read  
NCAS  
University of York  
HESLINGTON, York YO10 5DD  
United Kingdom  
Tel.: +44- 322565  
Email: katie.read@york.ac.uk

Ludwig Ries  
Federal Environment Agency"Umweltbundesamt  
Plattform Zugspitze  
GAW Global Observatorium  
Zugspitze/Hohenpeissenberg  
Zugspitze 5  
82475 ZUGSPITZE  
Germany  
Tel.: +49-88 21 92 41 10  
Fax: +49-88 21 92 42 09  
Email: ludwig.ries@uba.de

Andrea Rossa  
MeteoSwiss  
Federal Office for Meteorology and Climatology  
Kraehbuehlstrasse 58  
CH-8044 ZURICH  
Switzerland  
Tel.: +41-(0)44 256 93 97  
Fax: +41-(0)44 256 92 78  
Email: andrea.rossa@meteoswiss.ch
LIST OF POSTERS

P1: NATIONAL AND REGIONAL AIR QUALITY AND ATMOSPHERIC CHEMISTRY ACTIVITIES

Attri Shiv Dev, India Meteorological Department, India
Augmentation of GAW activities in India

Bittner Michael, German Aerospace Center Oberpfaffenhofen (DLR), Germany
The Network for the Detection of Mesopause Change (NDMC)

Carbajal Benitez Gerardo, Servicio Meteorologico Nacional (National Meteorological Service), Argentina
Regional GAW in Argentina: activities, results and projects

Koide Hiroshi, Japan Meteorological Agency, Japan
Recent Progress and Vision in the Japanese GAW Activities

Ahmad Mizani, BMKG, Indonesia
The Indonesia Global Atmosphere Watch Programme

Okuku Constance Colnex, Kenya Meteorological Department, Kenya
GAW activities in Kenya

Pelaez Juan Carlos, Instituto de Meteorologia, Cuba
Havana Total Ozone Measurements and UV Solar Radiation Monitoring as contribution to GAW

Ramón Moreta Juan, AEMET (State Meteorological Agency Of Spain), Spain
The AEMET’s contribution to the WMO/GAW Programme

Singh Patel Khageshwar, Pt. Ravishankar Shukla University, India
Black carbon pollution in Central India

Takatsuji Shinya, Japan Meteorological Agency, Japan
JMA aircraft observations of atmospheric CO₂, CH₄, CO and N₂O in the mid-troposphere over the western North Pacific

Tsatsurov Yuri, Roshydromet, Russian Federation
GAW related activities in Russian Federation

Zhou Lingxi, Chinese Academy of Meteorological Sciences (CAMS), China Meteorological Administration (CMA), China
Chinese GAW and the GHGs application

P2: ACTIVITIES AT GAW STATIONS

Batchvarova Ekaterina, National Institute of Meteorology and Hydrology, Bulgaria
Turbulence, ozone and wind profiles under sea breeze situations at a Bulgarian Black Sea site

Carbajal Benitez Gerardo, Servicio Meteorologico Nacional (National Meteorological Service), Argentina
Ushuaia GAW: Activities, results and projects.

Carbajal Benitez Gerardo, Servicio Meteorologico Nacional (National Meteorological Service), Argentina
GAW – Regional (Antarctic) Stations – Argentina
Cristofanelli Paolo, ISAC-CNR, Italy
Atmospheric composition studies in the Mediterranean basin at the GAW/WMO global station “O. Vittori” - Monte Cimone (2165 m a.s.l.)

Cristofanelli Paolo, ISAC-CNR, Italy
Atmospheric Brown Cloud studies in the high Himalayas at the GAW/WMO global station Nepal Climate Observatory - Pyramid (5079 m a.s.l.)

Cuevas Emilio, Meteorological State Agency of Spain (AEMET), Spain
The Izaña Atmospheric Research Center: GAW activities

Eleftheriadis Konstantinos, N.C.S.R Demokritos, Greece
Long-term observations of aerosol properties at the GAW DEM suburban background station

Fricke Wolfgang, Deutscher Wetterdienst, Germany
Hohenpeissenberg Meteorological Observatory - GAW Global Site

Herizal Hamzah, BMKG, Indonesia
Progress and Challenge of Bukit Kototabang Global GAW Station

Kim Sang-Woo, Seoul National University, Republic of Korea
Recent developments and future plans at Gosan Climate Observatory, Korea within the framework of ABC and WMO-GAW

Maione Michela, University of Urbino, Italy
Ten years of continuous observations of stratospheric ozone depleting gases at Monte Cimone (Italy); analysis of the effectiveness of the Montreal Protocol from a regional perspective.

Maznorizan Mohamad, Malaysian Meteorological Department, Malaysia
The Monitoring Activities at GAW Station in Malaysia

Mimouni Mohamed, Algerian meteorology service, Algeria
Results of 18 years of measurements at the GAW station Tamanrasset/Assekrem

Ries Ludwig, Federal Environment Agency, Germany
Trends of climate forcing gases at German GAW Stations in comparison to national emission trends

Scheifinger Helfried, ZAMG, Austria
Ozone trends at high alpine GAW stations

Steinbacher Martin, Empa, Switzerland
The Global GAW Station Jungfraujoch

Van Malderen Roeland, Royal Meteorological Institute, Belgium
Ozone and UV observations in Uccle (Belgium) and Utsteinen (Antarctica)

Viisanen Yrjö, Finnish Meteorological Institute, Finland
Pallas-Sodankylä GAW-station

P3: ACTIVITIES AT GAW CENTRAL FACILITIES

Bittner Michael, German Aerospace Center Oberpfaffenhofen (DLR), Germany
World Data Centre for Remote Sensing of the Atmosphere (WDC-RSAT)

Fiebig Markus, Norwegian Institute for Air Research, Norway
The World Data Centre for Aerosols: Recent Developments

Guenther Franklin, NIST, USA
Advances in Ozone Traceability
Min Deullae, Korea Meteorological Administration, Republic of Korea
Current Status and Future Plan of WCC-SF6

Novelli Paul, Global Monitoring Division/ESRL/NOAA, USA
WMO Central Calibration Laboratory for Carbon Monoxide

Steinbacher Martin, Empa, Switzerland
QA/SAC Switzerland - activities and achievements

Steinbrecher Rainer, KIT/IMK-IFU, Germany
KIT World Calibration Centres within the „Global Atmosphere Watch“ (GAW) Programme of the World Meteorological Organization (WMO)

Viallon Joële, BIPM, France
Comparisons for NO\textsubscript{2}, O\textsubscript{3}, CH\textsubscript{2}O, CH\textsubscript{4} gas standards: Supporting current and potential CCLs and WCCs

Zellweger Christoph, Empa, Switzerland
Improved performance audits by WCC-Empa through on-site comparisons with a travelling analyser

**P4: ANALYSIS OF OBSERVATIONS, PRODUCTS AND SERVICES**

Dixit Satish Kumar, ICFAI University Raipur, India
Particulate matter in aerosol and their multivariate analysis

Jalkanen Liisa, WMO, Switzerland
Climate Services for Megacities and Large Urban Complexes

Jalkanen Liisa, WMO, Switzerland
WMO GAW Programme addressing air pollution and climate change

Lawson Sarah, CSIRO Marine and Atmospheric Research, Aspendale, Australia
Biomass Burning Emissions - Robbins Island, Cape Grim, Australia, 41°S

Molloy Suzie, CSIRO Marine and Atmospheric Research, Aspendale, Australia
Identification of a Suitable Baseline Definition of Tropospheric Ozone at Cape Grim, Tasmania

Ogren John, NOAA Earth System Research Laboratory, USA
Recommendations for the interpretation of "black carbon" measurements

Rossa Andrea, MeteoSwiss, Switzerland
CATCOS - Capacity Building and Twinning for Climate Observing Systems

Tarasova Oksana, WMO, Switzerland
An integrated Global Greenhouse Gas Information System (IGIS)

Zhou Lingxi, Chinese Academy of Meteorological Sciences (CAMS), China Meteorological Administration (CMA), China
GGMT 2013 promotion
PART II

REPORT of the FOURTH SESSION of the
CAS JOINT SCIENTIFIC COMMITTEE of the
OPEN PROGRAMME AREA GROUP on
ENVIRONMENTAL POLLUTION AND ATMOSPHERIC CHEMISTRY
(JSC OPAG-EPAC)
TABLE OF CONTENTS

1. OPENING OF THE MEETING .................................................................................................................. 57
2. ADOPTION OF THE AGENDA ........................................................................................................... 57
3. APPROVAL OF THE REPORT FROM THE PREVIOUS JSC OPAG-EPAC MEETING .......................... 57
4. FEEDBACK FROM GAW 2013 ......................................................................................................... 58
5. GAW STRATEGIC PLAN FROM 2016 ONWARDS ........................................................................ 60
6. COMMISSION ON ATMOSPHERIC SCIENCES (CAS) SESSION PREPARATIONS .......................... 61
7. SATELLITE ACTIVITIES ..................................................................................................................... 61
8. WIGOS, WIS AND DATA QUESTIONS ............................................................................................... 62
9. MATTERS ARISING .............................................................................................................................. 63
10. CLOSURE OF THE MEETING .......................................................................................................... 63

Annex A – Summary of Recommendations from the Previous JSC Meeting ........................................ 64
Annex B – Recurring and New Recommendations .................................................................................. 66
Annex C – Recommendation letter ........................................................................................................ 67
Annex D – Agenda ................................................................................................................................... 68
Annex E – List of participants .................................................................................................................. 69
1. OPENING OF THE MEETING

The meeting of the CAS Joint Scientific Committee of the Open Programme Area Group on Environmental Pollution and Atmospheric Chemistry (JSC OPAG-EPAC) was opened at the World Meteorological Organization (WMO) Secretariat at 2 p.m. on the 20th March by the Co-Director of the Research Department, Dr Deon Terblanche, and the JSC Chair, Prof. Øystein Hov who welcomed the participants to the meeting. The list of participants to the session can be found in Annex E. A Tour de Table was carried out so that all the participants became acquainted. Apologies had been received from Ann Webb who was unable to attend this meeting. Invited experts taking part in the meeting were Andrea Rossa, Meteoswiss and Shinya Takatsuji, Japanese Meteorological Agency (JMA). This meeting followed the GAW 2013 Symposium that was held on 18-20 March at the WMO Secretariat.

2. ADOPTION OF THE AGENDA

The provisional agenda can be found in Annex D. The main items were preparation of the 16th Session of the Commission on Atmospheric Sciences (CAS), strategic planning for the Global Atmosphere Watch (GAW) Programme for the period starting 2016 and consideration in this respect the outcome of the GAW 2013 Symposium. Considerations of satellite observations in support of GAW and activities in support of the WMO Integrated Global Observing System (WIGOS) and the WMO Information System (WIS), and issues related to GAW data were also included in the meeting agenda. Discussions on GAW data accommodate requests from John Ogren and Jörg Klausen communicated to Øystein Hov prior to the meeting.

John Ogren informed that he would like to discuss the formation of an outreach team for putting together press material. Øystein Hov suggested that this topic could fit in under “matters arising” together with a discussion on the Bulletin on the Health of the Atmosphere, which had been suggested during the discussion sessions at the GAW 2013 Symposium.

Liisa Jalkanen reminded the JSC that GAW will celebrate its 25th anniversary in 2014. Some discussion of possible related activities could be addressed under “matters arising”. Discussion on the update of GAW Report No. 143 (GAW Measurements Guide) requested by John Ogren was proposed to be included under agenda item “GAW Strategic Plan for period starting 2016”.

Michel Béland informed that he would like to raise topics that were discussed during the GAW 2013 Symposium. This request has been noted and included in agenda item “Feedback from GAW 2013”

The agenda was adopted with the additions described above.

3. APPROVAL OF THE REPORT FROM THE PREVIOUS JSC OPAG-EPAC MEETING (APRIL 2011)

The meeting discussed all the recommendations made at the previous meeting. Some recommendations had been completed and some were carried forward as recurring. The overview of the progress on the recommendations is given in Annex A. Recommendations that were carried forward and new recommendations defined during the present session are given in Annex B.

There was a discussion concerning Recommendation 4. There was agreement that the first half of the recommendation, which deals with meta-data, data versions and data storage is an ongoing and continuous activity. The second half deals with the question of Digital Object Identifiers (DOIs). The JSC decided that this question should be discussed by the ET-WDC, and the ET-WDC is asked to make a recommendation that will be handled at the next Steering Committee meeting in 2014. The first half of Recommendation 4 is hence considered to be
recurring and constitutes Recommendation 2 in the updated list (Annex B). The second half, concerning the DOIs constitutes Recommendation 3 in the updated list.

The Task Team that was proposed in Recommendation 17 (Annex A) has not been established yet due to the lack of personnel and resources. The recommendation letter (Annex C) discussed in Recommendation 15 (Annex A) should be discussed once the Task Team has completed its work. Satellite activities were discussed in more detail under agenda item n°7.

There was a short discussion concerning the request from the German Aerospace Center (DLR) about accepting the Network for Detection of Mesospheric Change (NDMC) as contributing to GAW. There was an agreement that temperature measurements are not within the scope of GAW, so it was decided that GAW is not an appropriate affiliation for NDMC. The Secretariat will respond to DLR that GAW is not an appropriate affiliation for NDMC (Recommendation n°13, Annex B).

Øystein Hov concluded that the members have to give their comments on the 2011 report by the end of March. After that the report will be approved and finalized.

4. FEEDBACK FROM GAW 2013

Relevant items from the breakout sessions and from the meeting itself were discussed.

Øystein Hov proposed to make a tour de table so that all the members would get a chance to express their views.

Jörg Klausen stated that outreach was highlighted as very important during GAW 2013. Outreach activities and communication need more attention. There were also several speakers who talked about interoperability and usability of data as well as data access. Those issues are of high relevance for GAW in communication and outreach aspects as well.

Vincent-Henri Peuch highlighted a problem of “sustainability of observations” as one of the themes discussed at the break-out sessions. He said that we ought to be more resistant to changes in funding. There is no easy solution to this but if we don’t ask the question it will never be addressed.

Deon Terblanche was of the opinion that GAW has much to give and he feels positive about the future. He thinks we should work to reach an agreement among the 191 members to support the skeleton of GAW. This could help to sustain GAW activities.

Michel Béland pointed out that one needs to model atmospheric chemistry correctly in order to model climate and weather correctly. Every year 2 million people die from air pollution and 30,000 from extreme weather. This shows the importance of abating air pollution. The challenge is how we can bring the world of atmospheric chemistry into the traditional operational world. There is no mentioning of GAW. Not all is done via meteorological services. There is often a lack of collaboration between meteorology and atmospheric chemistry. This problem should be brought forward to the WMO Members. We should define a GAW baseline and present it to the members. We should define the sentinels for the health of the atmosphere. We have the tools to mitigate and adapt and to save lives. This should be presented and explained in a clear and concise way at Congress and EC (Executive Council). So far, the potential of GAW has only been explained piecewise.

Øystein Hov pointed out that we must find a core of essential data and that we should also consider the local scale.
Johannes Staehelin pointed out the fact that there are many measurement sites in Europe. We need 10 times less measurements over Europe. 90% of the measurements in Europe ought to be carried out in Asia and Africa.

Øystein Hov concurred with that viewpoint and mentioned that the European stations are pretty much co-located when one looks globally at it.

Greg Carmichael expressed the need to redefine some measurements. We have to meet the needs of the society.

John Ogren raised the issue of the GAW requirement for a measurement site to be free of influence of significant local pollution sources. This means that we may need to define other categories of stations.

Jörg Klausen proposed to create a group that can identify a few so-called “Use Cases”. He mentioned that trend analysis is important and good to perform, but such analysis is not of particular interest for normal citizens. We need products that address the interests of the general public. One example of a product aimed at the ordinary citizen could be advice on air quality and whether it is advisable to stay outdoors or not. Another example that might be of interest to policy makers and scientists, but not to the general public, is the CO₂ trend in the atmosphere. GAW global products are too general, without addressing specific requirements of the user community. Many of those communities are not identified by GAW.

Øystein Hov added that we should articulate the value of GAW activities. This could be done via WMO Congress. It is necessary to demonstrate that GAW makes a difference for mitigation. The “Use Cases” is a valuable approach that should be addressed by SAGs.

This discussion led to the formulation of the following two recommendations:

- All the SAGs should define some “Use Cases” and report these back to the JSC. (Recommendation 14, Annex B)
- The next GAW Implementation Plan should contain examples of suitable “Use Cases”. (Recommendation 15, Annex B)

Michel Béland suggested that GAW can start from the most obvious cases, e.g. GAW can develop useful products and services in conjunction with the Olympic Games. The WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS) activity is a good example of user driven service. The SDS-WAS could be expanded to deal with forest and bush fires. This could be branded as a product from GAW. This would give a lot of visibility to the Programme. The same arguments are also valid for the GAW Urban Research Meteorology and Environment (GURME) project.

Assessments where GAW is involved can only provide visibility to GAW if there is a communication plan developed in the programme. The World Climate Research Programme (WCRP) brings the modelling community together and there are a number of projects and initiatives that GAW can be better linked to such as the International Global Atmospheric Chemistry (IGAC) project, the Task Force on Hemispheric Transport of Air Pollutants (TF HTAP) etc. An attempt should be made to map the players in the area of the atmospheric composition research and to link to them. The current situation is more a competition rather than collaboration.

Øystein Hov stressed that there are not many observations in the background areas, although measurements of urban pollution are less critical as many measurements are already done. He stressed that there is a certain value in GAW observations. There were also several applications of GAW observations reported at the GAW 2013 Symposium, including use of the GAW data by the European Centre for Medium-Range Weather Forecasts (ECMWF), both on a global and regional scale. Such use requires NRT delivery of observations of atmospheric chemistry parameters. Vincent-Henri Peuch added that this work started 10 years ago and is now
starting to give results. Applications of the atmospheric composition observations are getting more critical for weather and climate research community, for example for the Working Group on Numerical Experimentation (WGNE).

While there is clear interest and benefits for the weather and climate community if atmospheric composition data is used but there is no clear benefits for the GAW community to deliver data in near real-time, as has been stressed by John Ogren. In response to this comment Vincent-Henri Peuch replied that forecasts from the MACC (Monitoring Atmospheric Composition and Climate) models are made available on the web and can be used by station operators. The MACC scientists can make individual time series available. This model datasets can be used for verification of observations and analysis of interesting episodes as well.

5. GAW STRATEGIC PLAN FROM 2016 ONWARDS

After some discussion it was agreed that global issues and priorities addressed by the GAW Programme ought to be communicated to WMO strategic planning office and be reflected to the degree possible in the WMO Strategic Plan for the period 2016-2023. This matter will be discussed at the CAS Management Group meeting in May and then at the 16th CAS Session in November 2013. The Presidents of the WMO technical commissions might also have useful viewpoints on the GAW items to be included in the WMO Strategic Plan. The discussion led to the following recommendation:

_The Secretariat and the JSC work together to provide input from GAW to the WMO Strategic Plan._ (Recommendation 16, Annex B)

It was made clear that WMO will have only one strategic plan, hence the GAW Programme has to reflect WMO priorities in the GAW Implementation Plan.

One of the activities in a view of the new WMO Strategic Plan is an update of the WMO Technical Regulations. Several inconsistencies exist between different versions of the technical regulations. Initiation of WIGOS and GFCS should also be reflected in the updated technical regulations. It is critical for GAW to determine which parts of the programme should be reflected in the technical regulations and respective chapters should be reviewed respectively. GAW contributes to WIGOS and respective contribution to the technical regulations is provided by Ann Webb, who is a member of the WIGOS Task Team on Regulatory Materials.

There was some discussion concerning the number of SAGs, and if some could be combined or if there is a need for additional ones. There was agreement that many things work well and should not be changed. It was agreed that the number of thematic SAGs remain without change.

Participants further discussed the process of the GAW Implementation Plan preparation. Øystein Hov proposed that the approach used for the development of the GAW Strategic Plan for the period 2008-2015 should be followed with the development of the new GAW Implementation Plan. MeteoSwiss provided strong support during the process leading up to the 2008-2015 GAW Strategic Plan publication. It is very likely that outside help will be also needed for the next GAW Implementation Plan. There was some discussion on how the activities of the SAGs can be mapped on the five Strategic Thrusts of WMO. It might also be an idea to contact outside entities, such as IGAC and GEOSS (Global Earth Observation System of Systems) in the development of the new GAW Implementation Plan.

Collaboration with the Commission for Instruments and Methods of Observations (CIMO) is an important aspect of current and future GAW activities. Recommendations on GAW observations are included in the CIMO Guide and need regular updating. Oksana Tarasova informed that there is an agreement with the Observations Department that the current CIMO guide will be simplified and that it will make reference to GAW measurement guidelines and standard operating
procedures rather than including its own material on GAW relevant measurement techniques. The GAW technical guides should go through a peer review process and get ISBN numbers.

6. CAS SESSION PREPARATIONS

Deon Terblanche opened this agenda item by explaining how CAS members are appointed. He also pointed out that the CAS session is an opportunity to show achievements and the value of the GAW Programme to the members. He also stressed that GAW should establish closer collaboration with the World Weather Research Programme in a number of cross-cutting areas.

Dr Terblanche reminded that the following two tasks have to be carried out by JSC in preparation to the 16th CAS Session:

- Provide input to the organization of the Technical Conference (TECO) that takes place before the CAS session (Recommendation 17, Annex B)
- The JSC members should propose approaches for the development of the next GAW Implementation Plan (Recommendation 18, Annex B)

WMO Secretariat is currently working on the agenda for the CAS Session. The CAS Session is more formal than the technical conference. TECO is more of an informative nature and aims at providing background information for the formal discussion during the session. Planning of the TECO is done by Secretariat. JSC was invited to provide an input to the TECO planning process. It was also suggested that the members can be approached and requested to come up with contributions in the form of sending young scientists and not only have high-level speakers.

"Use Cases" discussed earlier at the GAW 2013 Symposium and brought up for discussion by Jörg Klausen can be considered at the TECO. Such a discussion in a cross cutting forum could lead to valuable input to the GAW Implementation Plan and also create some common spirit among meteorological and atmospheric composition communities.

7. SATELLITE ACTIVITIES

Jérôme Lafeuille and Stephan Bojinski from WMO’s Space Programme joined the meeting at 4:05 p.m.

Liisa Jalkanen highlighted that the 16th WMO Congress made a recommendation to establish a Task Team for satellite requirements and requested respective letter to be sent to space agencies. She also mentioned Jörg Langen’s critical comments related to original request discussed at the previous JSC meeting in April 2011. Dr Langen commented that coordination of the satellite observations are addressed by CEOS (Committee on Earth Observation Satellite). The point nevertheless was taken further for discussion at the 16th WMO Congress in May 2011. The recommendations from Congress assigned to the Task Team different tasks than was originally planned by JSC. There is interest from the satellite experts to take part in the Task Team. One possibility would be to establish the Task Team under the umbrella of WIGOS.

Jérôme Lafeuille explained that within CEOS and Coordination Group on Meteorological Satellites (CGMS) there is a need for guidance on what are the needs of the atmospheric chemistry community in term of satellite observations. The problem is to identify these requirements from different user communities. There should be no attempt to make new requirements, but rather to consolidate existing requirements. He informed that the Expert Team on Evolution of the Global Observing System (ET-EGOS) attempts to consolidate what comes from the SAGs, though SAGs are not the only groups that formulate requirements. ET-EGOS can gather information from various groups. The Expert Team on Satellite Systems (ET-SAT) could respond on behalf of the space agencies on the formulated requirements.
During the debate that followed there was a discussion as to whether the whole IGACO report should be updated or if one should focus just on the satellite data requirements. Several participants expressed the need for an update of the IGACO Report, but it was finally agreed that it would complicate matters if one aims at updating the whole strategy, as this would be a long and complicated process. Congress has asked for satellite requirements, so the Task Team should focus on that. It was further stressed that requirements are formulated on a platform and technology independent way, with the scientific needs as a basis. The requirements should also be made independently of programmatic. Hence “satellite requirements” as is do not exist. There are needs for satellite observations, rather than platform driven requirements. Jörg Langen further advised, on behalf of the space agencies, that the requirements must be general and define the specification to the complete observing system for a particular application or scientific issue. If one requires satellites to carry out observations at a specified horizontal resolution, for example, as the only observing system, then it becomes difficult. It was suggested that one way forward would be to review the current satellite instrument proposals and make a summary of those. It was also pointed out that this issue touches on the visibility of the GAW Programme. GAW should take part in decisions related to satellite missions planning.

It was decided that it is the task of the Secretariat to establish the Task Team and organize its work. The Task Team should have representatives from the GAW community (e.g. SAGs) as well as the satellite community (e.g. CEOS, CGMS).

The following recommendation was adopted.

•  *A task team for requirements for atmospheric composition data from satellites should be established before the end of 2013* (Recommendation 9, Annex B)

Øystein Hov rounded off the discussion on this point and pointed out that the establishment of this Task Team constitutes Task 3.12 in the Addendum to the GAW Strategic Plan: 2008-2015.

### 8. WIGOS, WIS AND DATA QUESTIONS

Jörg Klausen introduced this agenda item. He stated that WIGOS should be regarded like a strategy. The Metadata core was agreed upon the preceding week at the meeting of the respective WIGOS Task Team. He suggested that it would be beneficial for the GAW partners to have closer collaboration with the WIS experts. Station categorisation is an important part of the metadata. Currently three categories of stations are considered in GAW: Global, Regional and Contributing. These station categories include mainly stationary platforms. Mobile platforms such as ships and aircraft do not fit into the current GAW stations categorization. It is difficult for the partners like IAGOS be linked to GAW, though GAW promotes integration of different observational platforms.

Øystein Hov thanked Dr Klausen for explaining these issues. He commented that JSC is not the right forum for such technical issues. Instead of discussing the issue itself, one should identify the right forum. Jörg Klausen proposed that the ET-WDC (Expert Team World Data Centres) could make recommendations on stations categorization, which was agreed by JSC members. As soon as the ET-WDC has made its recommendations, the JSC chair will consider the proposal and consult JSC members if needed.

The following recommendation was adopted:

•  *ET-WDC should make recommendations on the categorization of mobile platforms.* (Recommendation 19, Annex B)
9. MATTERS ARISING

The following two topics had already been identified for this agenda item.

1. Annual GAW Bulletin on the Health of the Atmosphere
2. GAW celebrates its 25th anniversary in 2014

There was some discussion on how to raise the profile and visibility of GAW in relation to the 25th anniversary of the programme. In this context it was discussed if GAW can provide input to the World Meteorological Day, but this was not possible. Oksana Tarasova informed that in 2013 the theme is “World Weather Watch” and that in 2014 the theme is “Youth”. In the context of GAW visibility Michel Béland proposed to consider the Weather Open Science Conference, which will take place in August 2014 in Montreal and could be used for the GAW promotion as well.

Jörg Klausen informed about problems at the Physikalisch-Meteorologisches Observatorium Davos (PMOD) to keep Precision Filter Radiometers (PFR) network running. This is one of the core networks of GAW for AOD. This network does not provide the same information as AERONET due to the limited number of stations, but it is considered of great use and importance within the GAW aerosol programme. PMOD originally did not mean to run a global network but rather provide calibration services, hence PRF is rather a reference network. There was some discussion around this theme and it was concluded that PMOD should send a request for endorsement to the Secretariat and that it will then be discussed in the Aerosol SAG.

No discussion has taken place related to the proposed Health of the Atmosphere Bulletin, neither recommendations were made.

10. CLOSURE OF THE MEETING

The Chair closed the meeting at 5.15 p.m. on the 20th March 2013.
### SUMMARY OF RECOMMENDATIONS FROM THE PREVIOUS JSC MEETING

<table>
<thead>
<tr>
<th>#</th>
<th>Recommendation text</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GAW stations are requested to publish traceability of their measurements.</td>
<td>Recurring. It was agreed that a link to the WIGOS metadata standard should be made.</td>
</tr>
<tr>
<td>2</td>
<td>The GAW Secretariat should encourage the initiation of a process aiming at the establishment of an SF₆ calibration centre.</td>
<td>This Recommendation has been accomplished through the establishment of such a calibration centre at the Korea Meteorological Administration.</td>
</tr>
<tr>
<td>3</td>
<td>The GURME SAG should look into the pollen problem and make a recommendation on how to put more emphasis on this in the next GAW Strategic Plan (2016 onwards).</td>
<td>Included as a Task in the Addendum to the GAW Strategic Plan. Complete.</td>
</tr>
<tr>
<td>4</td>
<td>We should be more conscientious about meta-data, data versions, and data storage. We should raise the level of awareness and take advantage of the technical development. One needs a system for recognition of data providers in publications. ET-WDC should follow up the development in the area of data publications. There are journals that allow for peer-reviewed publication of data. This would give data originators credit and there would be more stringent quality control and version control. This could be promoted in GAW.</td>
<td>Agreement that first half of this is Recommendation is an ongoing activity. The second half of the recommendation is about Digital Object Identifier (DOI) numbers. This issue has been raised several times at various meetings, also in the ET-WDC. There is no consensus in the community, so this remains an unresolved issue. It was pointed out that DOIs is also a commercial issue. If one pushes for DOIs this will constitute a change in policy, which currently amounts to store data in the WDCs. It was agreed that the ET-WDC should look into the DOI question and recommend the best way forward. This recommendation should be split in two, with the first half carried forward as an ongoing task and the other half as a concrete action item for the ET-WDC.</td>
</tr>
<tr>
<td>5</td>
<td>Any agreement with contributing networks should contain a list of stations and their characteristics.</td>
<td>Complete.</td>
</tr>
<tr>
<td>6</td>
<td>GAW should begin to build up a capacity to contribute to the Rolling Review of Requirements. This should go as tasks in the Addendum to the GAW Strategic Plan for each SAG.</td>
<td>Complete.</td>
</tr>
<tr>
<td>7</td>
<td>The OPAG-EPAC JSC supports the establishment of the VAAC in Moscow.</td>
<td>Yuri Tsaturov informed that the VAAC is not yet established, but there is work under way. He will ask for details and inform the JSC.</td>
</tr>
<tr>
<td>8</td>
<td>SAGs should provide feedback to GAWTEC about needs for training and guidance on focus areas</td>
<td>The Aerosol, PC and RG SAG has done this, but not the other SAGs.</td>
</tr>
<tr>
<td>9</td>
<td>The SAGs are asked to propose new members that represent end users.</td>
<td>Recurring.</td>
</tr>
<tr>
<td>10</td>
<td>SAG aerosol is requested to discuss and review the observations of what is called BC in order to contribute to the classification of their quality and their value in model validation. SAG Precipitation Chemistry is asked to discuss what it can contribute to the observational evidence of deposition of BC in precipitation, particularly in snow. The determination of the magnitude and trend of ozone as a Short-Lived Climate Forcer (SLCF) is dependent on good measurements of ozone in the upper troposphere and around the tropopause. Limb-scanning instruments on satellite platforms are important in this context to establish the observational basis for UT ozone distribution and change.</td>
<td>Complete.</td>
</tr>
<tr>
<td>11</td>
<td>SAG Greenhouse Gases is asked to discuss the issue of observing the global distribution and trend in halocarbon replacement gases, in order to assess their contribution to the greenhouse effect and to quantify their role as SLCFs.</td>
<td>Ed Dlugokencky informed that this is done through AGAGE and affiliated networks. Complete.</td>
</tr>
<tr>
<td>12</td>
<td>More emphasis should be put on the quantification of the life cycle of water vapour in the atmosphere. Supporting interaction between GAW and the GCOS Reference Upper Atmosphere Network (GRUAN) is encouraged.</td>
<td>Lisa Jalkanen informed that there is contact between GAW and GRUAN and Jörg Klausen added that there is also contact through CIMO. Recurring.</td>
</tr>
<tr>
<td>Recommendation</td>
<td>Text</td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>The JSC recommends that when SDS-WAS enters a permanent operational phase, it should be made sure that there is interoperability of observations of atmospheric aerosols, including exchange of data, between GAW and SDS-WAS. In this way the information value in all observations for model validation and process understanding is maximised, and a good return from investments in observations is ensured.</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>GAW should be prepared to contribute further to the on-going work in the framework of WMO and the GAW Aerosol Lidar Observation Network (GALION) to improve the predictive capability of volcanic ash, including validation of model forecasts.</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Spain presented its nomination in CBS-15 (Sept. 2012) to act as a Regional Specialised Meteorological Centre with the activity specialisation in Atmospheric Dust Storm Forecasts (RSMC-ASDF). Spain proposed to act as an RSMC-ASDF for Northern Africa (north of Equator), Middle East and Europe. This recommendation can be considered complete.</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Spain presented its nomination in CBS-15 (Sept. 2012) to act as a Regional Specialised Meteorological Centre with the activity specialisation in Atmospheric Dust Storm Forecasts (RSMC-ASDF). Spain proposed to act as an RSMC-ASDF for Northern Africa (north of Equator), Middle East and Europe. This recommendation can be considered complete.</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>This will be discussed in the Task Team on satellite data requirements once it has completed its work. Carried forward.</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>New missions for limb scanning are urgently needed in order to continue the analysis of the evolution in time and space of the distribution with height of trace species that influence climate, in particular ozone and water vapour.</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>A task team should be established to review the requirements for satellite observations and concurrent surface observations (remote sensing and in-situ), to support the advancement of the main issues in GAW. Each SAG and Expert Team are asked to suggest 1-2 members of the task team, and sound out with the people they propose if they are willing to contribute. It should be made sure to include the operational needs of volcanic ash and sand and dust storm (experimental) services, and also of other (experimental) operational expertise related to GAW. The Secretariat together with the SAG and ET chairs and the JSC chair will propose a task team and its term of reference, with the help of the nominations from the SAGs etc. The task team needs to have a reasonable number of members (ca. 10) covering the appropriate areas of expertise while ensuring a reasonable geographical as well as gender representation. WMO should provide secretarial support. The task team ought to have its first meeting in 2011 to be put in motion. An 18-24 month activity period is foreseen, followed by a peer review process to ensure that the team’s report has high credibility.</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>The Task Team has not been established yet due to lack of personnel and resources. The recommendation letter discussed in Recommendation 15 should be discussed once the Task Team has completed its work. Carried forward.</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>The JSC asks the Secretariat to evaluate whether GAW is the most appropriate affiliation for NDMC in WMO, as the focus of NDMC is on observing mesopause temperatures. The Secretariat is asked to recommend for the JSC how to proceed in this matter.</td>
<td></td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>Spain presented its nomination in CBS-15 (Sept. 2012) to act as a Regional Specialised Meteorological Centre with the activity specialisation in Atmospheric Dust Storm Forecasts (RSMC-ASDF). Spain proposed to act as an RSMC-ASDF for Northern Africa (north of Equator), Middle East and Europe. This recommendation can be considered complete.</td>
</tr>
<tr>
<td>14</td>
<td>There was agreement that this has happened to a good extent. This is ongoing work, so it is carried forward.</td>
</tr>
<tr>
<td>15</td>
<td>This will be discussed in the Task Team on satellite data requirements once it has completed its work. Carried forward.</td>
</tr>
<tr>
<td>16</td>
<td>Same as 15.</td>
</tr>
<tr>
<td>17</td>
<td>The Task Team has not been established yet due to lack of personnel and resources. The recommendation letter discussed in Recommendation 15 should be discussed once the Task Team has completed its work. Carried forward.</td>
</tr>
<tr>
<td>18</td>
<td>Jörg Klausen informed that there is good contact between the ET-WDC and the WIS project office. GAW is regarded as a role model in WIS. Recurring.</td>
</tr>
<tr>
<td>19</td>
<td>Recurring.</td>
</tr>
<tr>
<td>20</td>
<td>Recurring.</td>
</tr>
<tr>
<td>21</td>
<td>There was agreement that temperature measurements are not within the scope of GAW, so it was decided that GAW is not an appropriate affiliation for NDMC. Complete.</td>
</tr>
</tbody>
</table>
## RECURRING AND NEW RECOMMENDATIONS

<table>
<thead>
<tr>
<th>#</th>
<th>Recommendation text</th>
<th>Status</th>
<th>Implementation body</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GAW stations are requested to publish traceability of their measurements</td>
<td>Recurring</td>
<td>SAGs</td>
</tr>
<tr>
<td>2</td>
<td>We should be more conscientious about meta-data, data versions, and data storage. We should raise the level of awareness and take advantage of the technical development.</td>
<td>Recurring</td>
<td>WDCs</td>
</tr>
<tr>
<td>3</td>
<td>ET-WDC should discuss the question of DOIs and make a recommendation to be discussed at the next JSC OPAG-EPAC meeting.</td>
<td>New</td>
<td>Chair ET-WDC</td>
</tr>
<tr>
<td>4</td>
<td>Yuri Tsaturov gathers information about the plans and progress on the VAAC in Moscow and informs the JSC.</td>
<td>Carried over</td>
<td>Yuri Tsaturov</td>
</tr>
<tr>
<td>5</td>
<td>All SAGs should regularly provide feedbacks to GAWTEC about needs for training and guidance in focus areas.</td>
<td>Carried over</td>
<td>SAG Chairs</td>
</tr>
<tr>
<td>6</td>
<td>The SAGs are asked to propose new members that represent end users</td>
<td>Recurring</td>
<td>SAG Chairs</td>
</tr>
<tr>
<td>7</td>
<td>More emphasis should be put on the quantification of the life cycle of water vapour in the atmosphere. Supporting interaction between GAW and the GCOS Reference Upper Atmosphere Network (GRUAN) is encouraged.</td>
<td>Recurring</td>
<td>Secretariat</td>
</tr>
<tr>
<td>8</td>
<td>GAW should be prepared to contribute further to the on-going work in the framework of WMO and the GAW Aerosol Lidar Observation Network (GALION) to improve the predictive capability of volcanic ash, including validation of model forecasts.</td>
<td>Recurring</td>
<td>Secretariat, SAG aerosols</td>
</tr>
<tr>
<td>9</td>
<td>A task team should be established to review the requirements for satellite observations and concurrent surface observations (remote sensing and in-situ), to support the advancement of the main issues in GAW. The team should be established before the end of 2013.</td>
<td>Carried over</td>
<td>Secretariat</td>
</tr>
<tr>
<td>10</td>
<td>GAW should ensure full participation in WIS for distribution of GAW metadata and physical data.</td>
<td>Recurring</td>
<td>WDCs</td>
</tr>
<tr>
<td>11</td>
<td>The OPAG-EPAC JSC should put high priority on well targeted and high quality contributions to relevant international conventions and assessments. This forms an important part of the justification of the GAW Programme.</td>
<td>Recurring</td>
<td>JSC members</td>
</tr>
<tr>
<td>12</td>
<td>Efforts should be made by the entities of GAW (SAGs, ETs etc.) to make sure that GAW activities with high relevance also for other programmes are communicated with these in order to maximise the scientific return from investments.</td>
<td>Recurring</td>
<td>SAGs, ETs</td>
</tr>
<tr>
<td>13</td>
<td>The Secretariat will report back to DLR that GAW is not an appropriate affiliation for NDMC.</td>
<td>New, but a follow-up on Recommendation 21 from the previous meeting</td>
<td>Secretariat</td>
</tr>
<tr>
<td>14</td>
<td>All the SAGs should define some “Use Cases” and report these back to the JSC.</td>
<td>New</td>
<td>SAGs</td>
</tr>
<tr>
<td>15</td>
<td>The next GAW Implementation Plan should contain examples of suitable “Use Cases”.</td>
<td>New</td>
<td>JSC</td>
</tr>
<tr>
<td>16</td>
<td>The Secretariat and the JSC work together to provide input from GAW to the WMO Strategic Plan.</td>
<td>New</td>
<td>JSC, Secretariat</td>
</tr>
<tr>
<td>17</td>
<td>Provide input to the organization of the Technical Conference (TECO) that takes place before the CAS session.</td>
<td>New</td>
<td>JSC members</td>
</tr>
<tr>
<td>18</td>
<td>The JSC members should propose approaches for the development of the next GAW Implementation Plan.</td>
<td>New</td>
<td>JSC members</td>
</tr>
<tr>
<td>19</td>
<td>ET-WDC should make recommendations on the categorization of mobile platforms.</td>
<td>New</td>
<td>Chair ET-WDC</td>
</tr>
</tbody>
</table>
Statement by WMO GAW SSG, 29\textsuperscript{th} April 2011 concerning the continuation of the existing limb and occultation and GHG measurements from space

\textbf{Introduction}

In order to assess accurately the climate and chemistry interactions in a changing atmosphere and climate, long-term knowledge of atmospheric composition is required in the UT/LS, stratosphere and mesosphere (e.g. ozone, ozone depleting species, water vapour, aerosol, polar stratospheric clouds, polar mesospheric clouds, greenhouse gases). As reported and foreseen by WMO Report 140 and IGOS-IGACO, measurements of atmospheric composition from space are an essential component of the Global Earth Observation System of Systems (GEOSS).

The space agencies are to be commended on their development over the past 25 years of nadir sounding of the vertical columns of trace gas composition and noting the successes of

\begin{itemize}
  \item[a)] The SCIAMACHY project and its spin off GOME and GOME-2, by the European national space agencies, ESA and EUMETSAT in the early morning orbit
  \item[b)] The development of instruments by NASA and European national agencies in the early afternoon orbit
\end{itemize}

and the plans for geostationary measurements of air quality parameters by ESA/EUMETSAT, the South Korean Space Agency, JAXA and NASA. Similarly the Ozone Mapping and Profiler Suite (OMPS) will ensure continuity of the nearly 40-year NASA record of total column and profile ozone created by previous BUV sensors.

However, since the selection of the instrumentation for NASA AURA, ESA ENVISAT, and the CSA SCISAT-1, no new limb or occultation vertical profile sounding measurements of atmospheric composition, which are key for reporting, monitoring, and verification of the Montreal Protocol and any post Kyoto agreement, are firmly planned and committed.

Based on the demonstrations by SCIAMACHY and GOSAT, there is now a recognised need for measurements, having high spatial resolution and temporal sampling, of carbon dioxide and methane from space to complement and enhance the ground based measurements of these gases.

\textbf{GAW Recommendation}

In order

\begin{itemize}
  \item[a)] To avoid significant data gaps in the long-term measurement of the composition of key atmospheric species and essential climate variables (ozone and key ozone depleting species, aerosols, water vapour, polar stratospheric clouds), in the upper troposphere, the stratosphere, and the mesosphere
  \item[b)] To provide the maximum time for the preparation of new and improved measurements to continue and consolidate the long-term data record
  \item[c)] To maximise the scientific return from ENVISAT, AURA and SCISAT-1
\end{itemize}

it is therefore essential to maintain the atmospheric limb sounding and occultation instruments aboard ESA ENVISAT (SCIAMACHY, MIPAS and GOMOS), NASA AURA (MLS) and the CSA SCISAT-1 delivering data for the maximum possible period. In particular GAW recommends the prolongation of ENVISAT limb and occultation measurements significantly beyond the current planned termination of measurements in 2014, foreseen by ESA.
4th Session of the CAS JSC OPAG-EPAC

Geneva, Switzerland, 20 March 2013

AGENDA

Wednesday, 20 March: start at 14.00 and end at 17.30

1. Opening of the session
2. Adoption of agenda
3. Approval of the report of previous JSC OPAG-EPAC meeting
4. Feedback from GAW 2013
5. GAW Strategic Plan for period starting 2016
6. Commission on Atmospheric Sciences (CAS) session preparations
7. Satellite activities
8. WIGOS, WIS and data questions
9. Matters arising
10. Closure of meeting
List of Participants

Richard Artz  
NOAA Air Resources Laboratory  
1315 East West Highway R/ARL  
SILVER SPRING, MD 20910  
USA  
Tel.: +1-301 713 09 72  
Fax: +1-301 713 01 19  
Email: richard.artz@noaa.gov

Michel Béland  
Atmospheric and Climate Science  
Environment Canada  
2121 Trans-Canada Highway  
DORVAL, QUEBEC H9P 1J3  
Canada  
Tel.: +15144 214771  
Fax: +15144 212106  
Email: michel.beland@ec.gc.ca

Greg Carmichael  
University of Iowa  
3100 SC College of Engineering  
IOWA CITY, IA 52240  
United States of America  
Tel.: +1-319 335 33 33  
Fax: +1-319 335 33 37  
Email: gcarmich@engineering.uiowa.edu

Edward Dlugokencky  
NOAA Earth System Research Laboratory  
325 Broadway  
BOULDER, CO 80305  
USA  
Tel.: +1 303-497-6228  
Email: ed.dlugokencky@noaa.gov

Øystein Hov  
Norwegian Meteorological Institute  
PO Box 43 Blindern  
OSLO N-03133  
Norway  
Tel.: +47 22963360  
Fax: +47 22963350  
Email: oystein.hov@met.no

Jörg Klausen  
International Affairs Division, GAW-CH Office  
Federal Department of Home Affairs FDHA  
Federal Office of Meteorology and Climatology MeteoSwiss  
Kraehbuehlstrasse 58,  
CH-8044 ZURICH  
Switzerland  
Tel: +41 44 256 92 23  
Fax: +41 44 256 92 78  
Email: Joerg.klausen@meteoswiss.ch

Hiroshi Koide  
Japan Meteorological Agency  
Atmospheric Environment Division  
Global Environment and Marine Department  
Japan Meteorological Agency (JMA)  
1-3-4, Otemachi, Chiyoda-ku,  
TOKYO 100-8122  
Japan  
Tel.: +81 3 3287 xxxx  
Fax: +81 3 3211 xxxx  
Email: hkoide@met.kishou.go.jp

Joerg Langen  
ESA-ESTEC  
Keplerlaan 1  
2201AZ NOORDWIJK  
The Netherlands  
Tel.: +31-71 565 57 26  
Fax: +31-71 565 56 75  
Email: Joerg.Langen@esa.int

John Ogren  
NOAA Earth System Research Laboratory  
325 Broadway  
R/GMD1  
BOULDER, CO 80305  
USA  
Tel.: +1(303)497-6210  
Fax: +1(303)497-5590  
Email: John.A.Ogren@noaa.gov

Vincent-Henri Peuch  
ECMWF  
Shinfield Park  
READING, RG2 9AX  
United Kingdom  
Tel.: +44 118 949 91 02  
Fax: +44 118 986 9450  
Email: Vincent-Henri.Peuch@ecmwf.int
Andrea Rossa  
Federal Office of Meteorology and Climatology  
MeteoSwiss  
Krähbühlstrasse 58  
CH-8044 ZURICH  
Switzerland  
Tel. +41 44 256 93 97  
Fax: +41 44 256 92 78  
Email: andrea.rossa@meteoswiss.ch

Johannes Staehelin  
Institute for Atmospheric and Climate Science  
Swiss Federal Institute of Technology Zürich  
ETHZ  
Universitätstrasse 16  
CH-8092 ZURICH  
Switzerland  
Tel.: +41 44 633 27 48  
Fax: +41 44 633 10 58  
Email: Johannes.Staehelin@env.ethz.ch

Shinya Takatsuji  
Japan Meteorological Agency  
WCC  
1-3-4 Otemachi, Chiyoda-ku  
TOKYO 100-8122  
Japan  
Tel.: +81-3 32 87 34 39  
Fax: +81-3 32 11 46 40  
Email: takatsuji@met.kishou.go.jp

Yuri Tsaturov  
Special Assistant to the Head  
Roshydromet  
12, Novovagankovsky per.  
MOSCOW  
Russian Federation  
Tel.: +7 499 252 24 29  
Fax: +7 499 252 24 29  
Email: tsaturov@mecom.ru

Yrjö Viisanen  
Finnish Meteorological Institute  
P.O. Box 503  
00101 HELSINKI  
Finland  
Tel.: +358-9-19295490  
Fax: +358-9-19295403  
Email: yrjo.viisanen@fmi.fi

Xiaoye Zhang  
China Meteorological Administration  
Chinese Academy of Meteorological Sciences (CAMS)  
46 Zhong-Guan-Cun S. Ave.  
BEIJING 100081  
China  
Tel.: +86-10-6840-8943(O)  
Fax: +86-10-6217-5931  
Email: xiaoye@cams.cma.gov.cn

WMO Secretariat  
7 bis, avenue de la Paix  
GENEVA 2 CH-1211  
Switzerland  
Geir Braathen  
Atmospheric Environment Research Division (AER)  
Research Department (RES)  
Tel.: +41 22 730 82 35  
Fax: +41 22 730 80 49  
Email: gbraathen@wmo.int

Liisa Jalkanen  
RES/AER  
Tel.: +41 22 730 85 87  
Fax: +41 22 730 80 49  
Email: ljalkanen@wmo.int

Slobodan Nickovic  
RES/AER  
Tel.: +41 22 730 80 95  
Fax: +41 22 730 80 49  
Email: snickovic@wmo.int

Oksana Tarasova  
RES/AER  
Tel.: +41 22 730 81 69  
Fax: +41 22 730 80 49  
Email: otarasova@wmo.int

Deon Terblanche  
RES/ARE  
Tel.: +41 22 730 82 40  
Fax: +41 22 730 80 49  
Email: dterblanche@wmo.int
LIST OF RECENT GLOBAL ATMOSPHERE WATCH REPORTS*

104. Report of the Fourth WMO Meeting of Experts on the Quality Assurance/Science Activity Centres (QA/SACs) of the Global Atmosphere Watch, jointly held with the First Meeting of the Coordinating Committees of IGAC-GLONET and IGAC-ACE, Garmisch-Partenkirchen, Germany, 13 to 17 March 1995 (WMO TD No. 689).
113. The Strategic Plan of the Global Atmosphere Watch (GAW) (WMO TD No. 802).

* (A full list is available at http://www.wmo.int/pages/prog/arep/gaw/gaw-reports.html)


120. WMO-UMAP Workshop on Broad-Band UV Radiometers (Garmisch-Partenkirchen, Germany, 22 to 23 April 1996) (WMO TD No. 894).


129. Guidelines for Atmospheric Trace Gas Data Management (Ken Masarie and Pieter Tans), 1998 (WMO TD No. 907).


131. WMO Workshop on Regional Transboundary Smoke and Haze in Southeast Asia (Singapore, 2 to 5 June 1998) (Gregory R. Carmichael). Two volumes.


133. Workshop on Advanced Statistical Methods and their Application to Air Quality Data Sets (Helsinki, 14-18 September 1998) (WMO TD No. 956).


135. Sixth Session of the EC Panel of Experts/CAS Working Group on Environmental Pollution and Atmospheric Chemistry (Zurich, Switzerland, 8-11 March 1999) (WMO TD No.1002).


139. The Fifth Biennial WMO Consultation on Brewer Ozone and UV Spectrophotometer Operation, Calibration and Data Reporting (Halkidiki, Greece, September 1998) (WMO TD No. 1019).


149. Comparison of Total Ozone Measurements of Dobson and Brewer Spectrophotometers and Recommended Transfer Functions (prepared by J. Staehelin, J. Kerr, R. Evans and K. Vanicek) (WMO TD No. 1147).

150. Updated Guidelines for Atmospheric Trace Gas Data Management (Prepared by Ken Maserie and Pieter Tans (WMO TD No. 1149).


154. WMO/IMEP-15 Trace Elements in Water Laboratory Intercomparison. (WMO TD No. 1195).


170. WMO/GAW Expert Workshop on the Quality and Applications of European GAW Measurements (Tutzing, Germany, 2-5 November 2004) (WMO TD No. 1367).


176. The Tenth Biennial WMO Consultation on Brewer Ozone and UV Spectrophotometer Operation, Calibration and Data Reporting (Northwich, United Kingdom, 4-8 June 2007) (WMO TD No. 1420), 61 pp, March 2008.


182. IGACO-Ozone and UV Radiation Implementation Plan (WMO TD No. 1465), 49 pp, April 2009.
193. Guidelines for Reporting Total Ozone Data in Near Real Time (WMO TD No. 1552), 19 pp, April 2011 (electronic version only).
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), 330 pp, April 2011.
201. Quality Assurance and Quality Control for Ozonesonde Measurements in GAW (Prepared by Herman Smit and ASOPOS Panel), 95 pp. October 2014


208. WMO GURME Workshop on Urban Meteorological Observation Design, (Shanghai, China, 11-14 December 2011)


210. Report of the Third Session of the CAS Joint Scientific Committee of the Open Programme Area Group on Environmental Pollution and Atmospheric Chemistry (JSC OPAG-EPAC), (Geneva, Switzerland, 27-29 April 2011) (electronic version only)


213. 17th WMO/IAEA Meeting on Carbon Dioxide, Other Greenhouse Gases and Related Tracers Measurement Techniques (GGMT-2013), (Beijing, China, 10 - 13 June 2013), 168 pp. July 2014