GAW Report No. 215

Report of the First Session of the CAS Environmental Pollution and Atmospheric Chemistry Scientific Steering Committee (EPAC SSC)

(Geneva, Switzerland, 10-12 June 2014)

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REPORT of the FIRST SESSION of the CAS ENVIRONMENTAL POLLUTION and ATMOSPHERIC CHEMISTRY SCIENTIFIC STEERING COMMITTEE (EPAC SSC)

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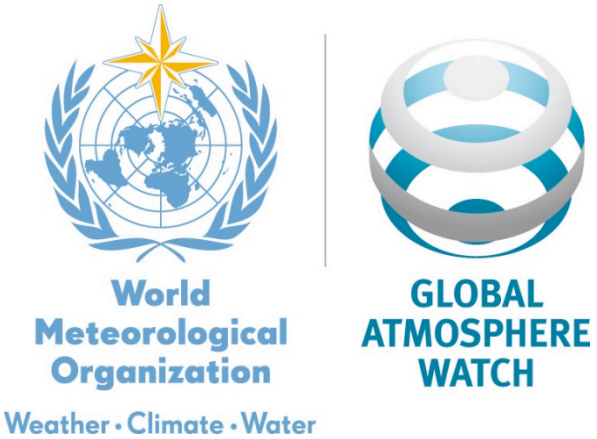

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1. OPENING OF THE MEETING

The first meeting of the CAS Environmental Pollution and Atmospheric Chemistry Scientific Steering Committee (EPAC SSC) was opened at the World Meteorological Organization (WMO) Secretariat at 10 a.m. on the 10th June 2014 by the SSC Chair Greg Carmichael who welcomed the participants to the meeting. The list of participants to the session can be found in Annex B. Xiao-Ye Zhang participated in the session via teleconferencing.

2. ADOPTION OF THE AGENDA

The provisional agenda can be found in Annex A. The main items consisted of establishing a scope of activities for the Committee, review of the current status of the GAW Programme and strategic planning. It was agreed that the meeting would be carried out in a discussion or brain-storming mode rather than in the form of formal presentations. With this note the agenda was adopted.

3. GAW PROGRAMME IN CONTEXT OF WMO AND CAS

Greg Carmichael introduced the terms of reference to the participants. He explained that SSC is a new body that was established at the Sixteenth Session of the Commission of Atmospheric Sciences (CAS-16), held in Antalya, Turkey in November 2013. He outlined the tasks of the group. Currently the group includes only five members. The Committee will be extended with two plus two members in the next two years. The Chair outlined the organization of the session and expected outcomes. He stressed that it is expected that each SSC member will have an assignment for particular tasks.

A *Tour de Table* was carried out so that all the participants became acquainted. SSC members described their areas of expertise and their involvement or relationship to the GAW Programme. The Chair noted that the CAS representative in the Inter-Commission Task Team for WIGOS (WMO Integrated Global Observing System) Sandro Fuzzi would join the meeting via teleconference and would give a presentation on WIGOS and in particular on involvement of CAS and GAW in this initiative.

Liisa Jalkanen gave a presentation on the GAW Programme and its place within WMO. She explained the organizational structure of WMO. She noted that Member countries are represented in WMO by the heads of National Meteorological and Hydrological Services (NMHS). She also noted that this representation of the countries in some cases created biases in representation of the activities outside of NMHSs. She stressed that major decisions are taken by Congress and noted that SSC should be involved in the preparation of documents for Congress.

Liisa Jalkanen further highlighted that SSC as a group was created under the Commission for Atmospheric Sciences and should consider in its work the recommendations of CAS and CAS Management Group that represents CAS during inter-sessional periods.

The participants of the session discussed the important role of Permanent Representatives (PRs) in the implementation of GAW activities. It was stressed that in many countries PRs must be involved in the nomination or approval of experts who support the GAW Programme. It was also noted that GAW country contacts nominated by PRs are also useful focal points in their countries.

Liisa Jalkanen continued with a description of the GAW Programme. She mentioned the involvement of the GAW Programme in WIGOS, Global Climate Observing System (GCOS), collaboration with the Group on Earth Observations (GEO) and GAW's contribution to the Global Framework for Climate Services (GFCS). She further stressed that the mission of GAW is to support long-term systematic observations globally. GAW also works on the delivery of products and improvement of predictive capacity through chemical data assimilation. She noted that persistent organic pollutants (POPs) and heavy metals are not coordinated by WMO but they are under considerations of United Nations Environment Programme (UNEP).

Liisa Jalkanen presented the quality assurance system within GAW and approaches to integrate observations using different platforms (including satellite and aircraft). She noted that the ultimate goal of the quality assurance system is to ensure that data in the data centres are consistent, and of known and adequate quality. She stressed that capacity development plays an important role in ensuring the high quality of observational data.

Greg Carmichael enquired about the impact that capacity development within GAW has on career development. He noted that examples of success stories could be used to advertise GAW leading to further support of the programme. He stressed that communication must be an important aspect of the programme and capacity building can be communicated as an important part of the broader GAW activities.

Liisa Jalkanen gave a short overview of the GAW publications. She stressed that GAW observations constitute the basis for important assessments. Further discussion on this topic is summarized under agenda item on GAW application areas and services.

The group discussed the role of the GURME project within GAW. This project has a large capacity development role and it is built through demonstration projects. Paul Monks stressed that only focussing on megacities can be quite limiting as medium size cities experience similar problems and are larger in number. He proposed to address urban areas rather than only focusing on megacities. Liisa Jalkanen mentioned that many countries need to do operational air quality forecasts and she mentioned India as an example where an implementation plan for megacities was developed. Paul Monks expressed his concerns about spreading the limited capabilities available within the GAW Programme to urban areas. He stressed that focusing too much on urban areas can put under risk the background observations. He recommended keeping a balance between global and regional/local issues. In response, Greg Carmichael stressed that services should be provided in places where people are impacted and this is one of the reasons why Members are pushing for urban services. Xiao-Ye Zhang stressed that local networks should contribute to operational air quality forecasts. Greg Carmichael further elaborated on this topic and stated that the role of GAW in urban measurements should be specified. Kobus Pienaar reminded the group that GAW works on a global scale rather than on an urban scale because there are many different factors that can impact atmospheric composition on a smaller scale.

4. RELATIONSHIP OF GAW WITH OTHER WMO PROGRAMMES AND INITIATIVES

Within this agenda item the following aspects were discussed:

a. WMO Integrated Global Observation System (WIGOS)
   - Technical regulations review
   - Rolling Review of Requirements (RRR)

b. Global Framework for Climate Services (GFCS)

c. Global Climate Observing System (GCOS)
d. World Weather Research Programme (WWRP)

Sandro Fuzzi gave a presentation about WIGOS via teleconference. He stressed the importance of the evolution of the observational part of GAW using the Rolling Review of Requirements (RRR) process. He reminded that the evolution should address user requirements. These user requirements should be identified and clearly documented. Sandro Fuzzi indicated that currently GAW focal areas are not fully addressing potential applications. He stressed that there is a clear need for the development of a list of application areas within current "atmospheric chemistry" WMO application area that are overarching SAG (Scientific Advisory Group) focal groups. He also stressed that to reach success with GAW activities a contact between NMHSs, Research Institutes and Universities should be re-established and re-enforced. Sandro Fuzzi stressed that if the GAW community does not make the requirements, they will be compiled by another community without the involvement of GAW experts. He noted that the starting point should be in the identification of the limited number of application areas that require atmospheric composition observations.

Liisa Jalkanen noted that an ad hoc group is being compiled to review satellite observation of atmospheric compositions. This group will be tasked to have an initial look at the RRR process. Geir Braathen further confirmed that ad hoc group plans to hold its first meeting in autumn 2014. It would discuss general requirements and develop a plan for RRR implementation. He noted that if SSC and an ad hoc group formulate application areas, the requirements for those applications areas could be identified by SAG. Application areas have to be identified and formulated with the help of SAG Chairs.

Greg Carmichael stressed that application areas should be discussed with the SAG Chairs and include current applications within focal areas (e.g. Integrated Global Greenhouse Gas Information System (IG^{3}IS), needs for independent emission verification) and some other IGACO areas. He stressed that application areas must be identified by the end of 2014.

Sandro Fuzzi returned to the network aspects. He mentioned that there is a strong need for recognition and support of GAW stations by NMHSs if we want to sustain the observational network. Communications with PRs are not sufficient to ensure such recognition. Procedures are needed for direct involvement of Institutions other than NMHSs to ensure rationale and positive GAW contribution to WIGOS. He stressed again that inter-SAG operations are required to confront with applications that cut across thematically.

Greg Carmichael informed SSC concerning the involvement of the GAW Programme in WIGOS activities (through representation in several WIGOS task teams). He mentioned that GAW observations are included in the technical regulations related to WIGOS. He informed SSC about the request sent to the CAS President related to the review of GAW's contribution to volume 1 of the Technical Regulations related to WIGOS.

SSC worked on the proposed Section 5 of volume 1 of Technical Regulation. The group introduced several changes and approved the corrected text.

***AI (action item)-1**. WIGOS*

i. Follow-up review of technical regulations (DONE)
ii. Satellite meeting will be held fall 2014 for further discussions of atmospheric composition community needs for satellite observations. The group is expected to provide a contribution to RRR process as well

iii. Need to identify application areas for WIGOS that drives the RRR by the end of this year (in consultation with SAG Chairs)

Liisa Jalkanen gave a presentation on the Global Framework for Climate Services. Greg Carmichael stressed that as GFCS is one of WMO priorities, it should be supported in GAW to ensure better integration in the whole strategy of the WMO. He also mentioned that the GAW community provides an important contribution in climate related activities, e.g. through scientific publications, but the role of GAW in these publications is not pronounced.

In this connection Karla Longo asked about the interface between GAW and policy making. Greg Carmichael responded that internal communication is done through Directors, while communication with the outer world happens through other initiatives. Xiao-Ye Zhang mentioned that climate and air quality are related issues. "Future Earth" initiative pays a lot of attention to this relation. He stressed that SSC should encourage the modelling community to use different factors driving climate change and its connection with air quality and include in the modelling the feedbacks with reactive gases, aerosols, greenhouse gases.

Liisa Jalkanen informed SSC that GFCS board meets in November 2014. It could be an opportunity to highlight GAW at that meeting, including the importance of observations of climate forcers and discussed above connection between air quality and climate.

Liisa Jalkanen gave a short presentation on the involvement of GAW in GCOS activities. SSC took note of this information.

Greg Carmichael presented some joint activities between GAW and WWRP. He stressed that there are several aspects where collaboration between two communities can be improved. SSC discussed a need to work more closely together with WWRP given the WMO/CAS increased interest in aerosols and their impact on weather and climate, and urban services.

***AI-2**. Develop concrete collaborations, starting with the World Weather Open Science Conference (WWOSC) 2014 Conference in Montreal (August 2014) and the white paper developments and HIWeather (high impact weather initiative)*

5. GAW OBSERVATIONS AND DATA

Within this agenda item the following aspects were discussed:

a. Relationship to other networks
b. Relationship to research initiatives (e.g., COST, EU)
c. Filling the gaps
d. Data submission and flow
e. Use of GAW data
f. Satellite measurements
g. Local stations

SSC reviewed the status of the GAW observational network. The major issue discussed by the group was on how to acquire more stations and how to improve the data delivery. Several opportunities were considered. Melita Keywood proposed to check non GAW stations and approach the ones that fit the purpose of the programme. Kobus Pienaar noted that GAW needs a clearer concept of what it means to be a part of GAW. Xiao-Ye recommended to start from encouragement of the national networks to join GAW.

Greg Carmichael stressed that the main obstacle in the network extension is a lack of motivation. Many stations and networks are unclear what GAW can offer or how they can benefit of being a part of the programme. Xiao-Ye Zhang responded that high level recognition of the countries contribution, appreciation at the Congress and Executive Council could be a motivation. Kobus Pienaar further stressed that GAW can provide access to international expertise, recommend harmonized measurement techniques, and ensures a global picture based on compatible observations. Greg Carmichael further noted that motivation should be contained in formulated application areas, so that the use of data becomes attractive. In this respect Kobus Pienaar noted that it should be clear what services the GAW community can deliver.

Karla Longo noted that in the further development of GAW an attempt should be made to improve the sense of community. She indicated the lack of communications within GAW and with the outside community. She noted that SSC and GAW experts should better communicate with regional and local communities, for example with national meteorological societies. Kobus Peinaar further elaborated that GAW should "market" its activities. To ensure better reflection of GAW activities at regional level an attempt should be made to organize side meetings at the regional association meetings. Kobus Pienaar noted that it is important to create an enabling environment for science.

SSC discussed data delivery within GAW. Melita Keywood commented that currently the data submission process is too complicated. To improve the situation of data submission she recommended to simplify and to automate the data submission process.

After further discussions SSC agreed on several action items.

AI-3. *Expand efforts to utilize national/regional networks and to get them to associate/contribute to GAW. Work with the SAGs to develop statement of win/win value proposition for interacting with GAW, and to identify what are the barriers limiting interactions with GAW.*

AI-4. *Ask SAGs & data centres regarding how they see the problems of data flow – missing data and suggested solutions. If we increase the use of the data, the submissions will likely increase.*

SSC considered the recommendation made by the CAS MG to develop requirements and applications for the new category of GAW stations, namely GAW "local" stations.

Greg Carmichael stressed that there is a need for stations that can be used to verify forecasting systems for urban environment. Paul Monks stressed that before developing recommendations for local stations, SSC should identify a set of tasks that can be answered by local stations. Greg Carmichael reminded that these tasks should support operational forecasts and estimates of population exposure and disease.

SSC agreed that there is a need for "local" stations. These stations will complement the current GAW observational network and a way to establish such a connection should be identified. The expected/potential uses of such stations could be better source quantification; estimates of local-regional-global gradients; CO_2 flux estimates; support health impact assessments; and improvements of air quality forecasts.

SSC expressed its concerns related to the implementation of such stations, including the stations requirements (observational methods, link to standards, etc.) and the relation of these stations to other activities (such as activities of Environmental Protections Agencies). SSC

discussed how best to respond to SAGs/CAS MG requests on this matter. There is a need to develop an action plan, perhaps a white paper on how to connect regional, local and global activities (e.g. on observations and calibrations). It should be clear that local stations should not duplicate the municipal air quality networks. Furthermore, it is important to keep in mind that GAW is a research programme, rather than monitoring for regulatory purposes.

Following the discussion several action points were formulated:

AI-5. *Develop recommendations and action plan for "local" station designation in consultation with SAGs/CAS MG.*

AI-6. *Discussed and later approved request for new NAPD as a GAW contributing network, and Puy de Dome station, as a new GAW Global station.*

AI-8*. Develop a plan for the role of satellites within GAW (to be discussed at the upcoming ad hoc group meeting fall 2014)*

6. OVERVIEW OF COMMISSION ON ATMOSPHERIC SCIENCES (CAS) ATIVITIES AND RECOMMENDATIONS

SSC discussed the recommendations for activities of the recent CAS-16 session that was held in November 2013 and of the CAS Management Group that was held in April 2014.

Greg Carmichael reminded that CAS-16 session identified six priority areas in a ten-year plan. There priorities include:

- High Impact Weather and its socio-economic effects in the context of global change
- Water: Modelling and predicting the water cycle for improved DRR and resource management
- Integrated Global Greenhouse Gas Information System: Serving society and supporting policy
- Aerosols: Impacts on air quality, weather and climate
- Urbanization: Research and services for megacities and large urban complexes (GURME with new WMO office)
- Evolving Technologies: Their impact on science and its use

Two of those six priorities are directly linked to GAW and the others can include GAW in collaboration with the other divisions or organizations.

Greg Carmichael stressed that the implementation of IG^{3}IS will require the development of an implementation plan. This activity must be initiated before the next WMO Congress. He noted that addressing urbanization would require much closer collaboration with WWRP. The way of involvement and collaboration will be discussed at the WWOSC in Montreal.

SSC went through the relevant CAS MG action items and formulated the response.

List of relevant CAS action items

CAS MG-9 Action Item 2: *EPAC SSC should develop an implementation plan for IG^{3}IS with a long-term strategy and short-term goals, in a 10 years' time horizon following the procedure selected for the development of the PPP and S2S plans by WWRP. CAS MG advised that this process should start with a 2-3 day meeting to discuss ideas and opportunities and that this should*

be an inclusive process. CAS MG agreed that it is a CAS responsibility to support research that underpins emission estimates of GHGs, PM (and other biogeochemical substances). CAS MG felt that concrete steps are now necessary to move this initiative forward, integrating current developments into a global plan, that GAW is entrusted with the task of initiating the implementation plan development, and that EC-66 in June 2014 should be asked to support the first step.

AI-9. *Set up a meeting of experts from carbon community to move this forward. A lot is done within GEO Carbon.*

CAS MG-9 Action Item 5: *The Environmental Pollution and Atmospheric Chemistry Scientific Steering Committee (EPAC SSC) to review the GAW structure as to its usefulness and relevance to for instance the demands from services and different application areas.*

SSC discussed the current GAW structure. Current structure works well but there is a need to develop more cross cutting (across the SAGs) activities. These will be associated with the main application areas to be identified in the updated GAW Implementation Plan. Some of the identified needs such as enhancing the modelling and analysis within GAW and the role of satellite observations should at least be addressed through adding additional capabilities to the SAGs as needed. The use of data in the context of future services was discussed and further adjustments to data centre activities in this context were recommended.

AI-10*. Set up a task team or extend the current ET-WDC with independent members and organize a meeting to review the data centres and their role in GAW moving forward*

CAS MG-9 Action Item 6: *The EPAC SSC to consider and act upon the items proposed by Sandro Fuzzi as member of the ICG-WIGOS while the Secretariat is requested to establish a mechanism for routine interaction between Sandro Fuzzi, EPAC SSC, SAG Chairs and the CAS MG.*

See AI-1

CAS MG-9 Action Item 7: *EPAC SSC to address the local station category issue in their next meeting.*

See AI-5

CAS MG-9 Action Item 8: *CAS and WMO in general should work with Members to raise its profile in research funding circles (IGFA, Belmont Forum) in order to maintain and build momentum in atmospheric research and model development across timescales.*

See AI-7

CAS MG-9 Action Item 9: *The emerging priorities in the WMO Strategic Plan for 2016-2019 need to be addressed and responded to by EPAC SSC and WWRP SSC.*

AI-11. *Identify application areas – reduce into overarching themes in the GAW Implementation Plan. For WIGOS keep in mind current GAW key words, CAS future direction and IGACO strategy, etc. This item is tightly coupled to GAW Implementation Plan development and contribution to WIGOS. SSC will develop a draft set to be shared with SAGs.*

SSC brainstormed ideas summarized in Figure 1 (draft consolidation by Greg Carmichael to stimulate discussion)

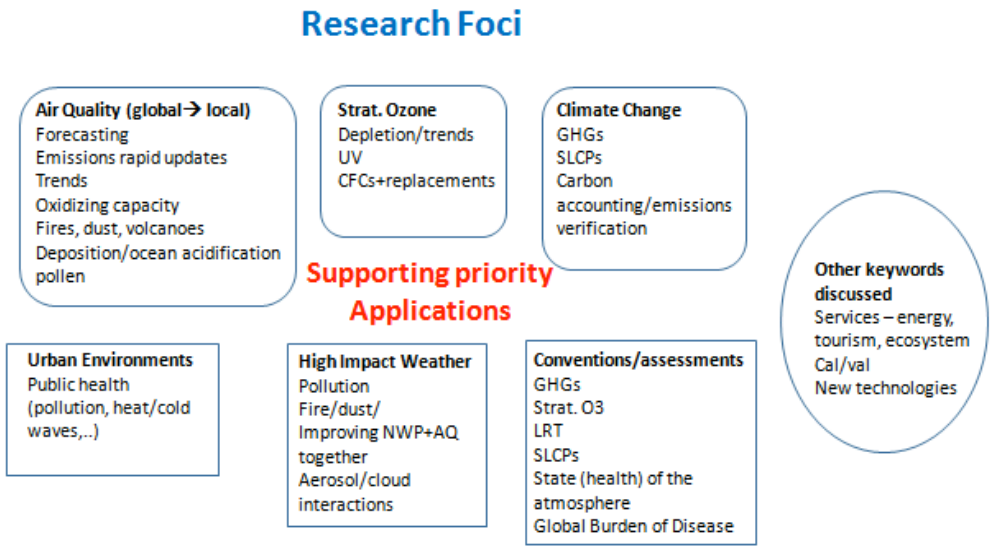

Figure 1. Schematic summary of the application areas

CAS MG-9 Action Item 10: *The review of the WIGOS Manual Volume I and the General standards and recommended practices-documents are left with EPAC SSC to respond to CAS President in order to meet 10 July deadline on behalf of GAW.*

See AI-I (DONE)

Enhanced aerosol observations*. CAS MG* ***recommended*** *for CAS, through GAW, to push the observational capability on a global scale of aerosols and aerosol properties and ensure that the downstream requirements (atmospheric composition/health, NWP, climate) dictate the specification of observed properties, also through the Rolling Review of Requirements (RRR) process. CAS (GAW) has the responsibility to coordinate networks, ensure compatibility of data, perform QA and calibration/standardization, managing the observational data, etc. Furthermore, CAS through WWRP and GAW, encouraged to carry out research and development activities to pave the way for applications and use of aerosol information (services).*

AI-12. *Work with the SAGs addresses this CAS action item. This will be a topic of priority for discussion at the next SSC joint meeting with the SAG Chairs in February 2015*

The CAS MG ***recommended*** *the establishment of an* ***urban sustainability project****, based on integrated weather, climate, water and related environmental services, as a main issue for WMO and cross-cutting for CAS, CBS, GFCS, and services delivery, with CAS to carry the project forward initially. In this initiative it would be desirable for WMO to put the science and service components together. WWRP and GAW are to together bring the urban sustainability issue forward: expand GURME, involve analysis of urban sustainability, modelling capability, how to best interact with the weather community: nowcasting, mesoscale modelling, HiWeather, and S2S.*

See AI-2

*Strategies to **increase the data flows and collaborations** are needed. A collected effort, that includes CAS MG members, is required to help work with WMO Members to help get data flowing.*

See AI-3 and AI-4

*In terms of metadata, the establishment of a **truly global group** (ECMWF, GEO CoP, WMO/GAW, others) who could administer a controlled vocabulary database for atmospheric composition may be a positive option.*

This request was discussed under agenda item 14 (with a respective recommendation made).

7. RELATIONSHIP WITH OTHER ORGANIZATIONS AND INITIATIVES

SSC took a note of the joint activities with a number of international organizations, projects and initiatives. The following collaborations were in particular acknowledged:

1) Joint publication work with the World Health Organization
2) Involvement in the EMEP Programme
3) Joint activities, projects and publications with International Global Atmospheric Chemistry (IGAC) project
4) Involvement of WMO in UNEP lead Climate and Clean Air Coalition (CCAC)

8. GAW APPLICATION AREAS AND SERVICES

SSC discussed the use of GAW data for products and services. It was mentioned in particular that some peer-reviewed publications based on GAW observations are reflected in the IPCC process. This example can be used as a lesson to establish best practises.

Paul Monks proposed to develop a publication on the state of the atmosphere (to be published every five years), which will be an integrated report covering all focal areas. Greg Carmichael supported this idea. He suggested aiming to produce the first publication in 18 months time. The report must be based on GAW observational data, integrating where possible with model results. Simultaneous use of observations and models can help us to learn about processes that control atmospheric composition changes. Melita Keywood noted that this report would motivate Members to submit data. Greg Carmichael further proposed to highlight application areas in the state of the atmosphere report. The following action item was formulated in respect to publications:

***AI-7**. Develop outreach strategy for GAW, communications plan, (SSC+SAGs+Secretariat – draft by time of the next SSC+SAG meeting February 2015) including:*

- *Develop communication strategy with respect to GAW for the PRs and funding sources to highlight the importance of GAW activities and who are participating (outside of the met. Services….)*
- *Common wording to acknowledge the use of GAW data in publications*

SSC had a broad discussion of the possible application areas, along with a review of the application areas identified in other documents. While discussing application areas, the following points were considered:

1) In WMO “atmospheric chemistry” is used as an application area (which serves as a place holder), in addition to the other ten application areas; the proposals were made to include energy and transport sectors, ecosystem and health in the list of application areas.
2) The discussion of application areas should start from the point why we take GAW observations and where atmospheric composition observations are used.

The following ideas were listed as potential specific applications for GAW observations (more systematically depicted in Fig.1): health; trend analysis (documentation of the changing state of the atmosphere); input to improve models; air quality forecasting; emissions verifications; climate impact assessment; eutrification (deposition fluxes estimate); biomass burning and sand and dust storms (multi-hazard warning); Numerical Weather Prediction; analysis of hemispheric transport of pollutants; assessment of ocean acidification; validation of the satellite observations; study of stratospheric ozone depletion; study of oxidative capacity; analysis of land use changes; food security and agricultural impact; environmental sustainability; aerosol, cloud and water; fracking; support of polar activities; monitoring related to urban areas; ecosystem services; tourism; geoengineering; UV Index review; forestry; infrastructure, transport and mobility; urban areas management; recreation and sports; source attribution; emissions and treaties verification, carbon tracking; processes studies; visibility… This list should converge into limited number of overarching application areas.

9. GAW STRATEGY AND IMPLEMENTATION PLAN FROM 2016 ONWARDS

SSC discussed the needs for the GAW Implementation Plan in the context of WMO strategic planning process. Focus will be on the development of a short, high-level plan with the specific tasks in an annex. Discussion focused on the high-level theme “GAW research enabling services”, with services including, climate, high impact weather, urban (air quality/health), ecosystems, support of conventions.

Liisa Jalkanen suggested that the GAW Implementation Plan should only consist of several pages and for the SAGs to develop the tasks. This plan should be synchronized with the WMO Strategic Plan. Greg Carmichael noted that new GAW Implementation Plan should build around the application areas. Paul Monks noticed that a new strategy would motivate the SAGs restructuring. Greg Carmichael suggested having a high level vision with some general guidance of where the SAGs have to head by the end of summer. This document will be shared with the SAGs and ETs, who will provide feedback to SSC. The SSC will continue working on the implementation plan. The draft will be presented to the WMO Congress and then further harmonized with approved WMO priorities. Contribution from SAGs and ETs will be further solicited. SAGs during spring and summer of 2015 should work on the tasks. CAG MG is expected to review the plan in autumn 2015 and approved it after necessary corrections by the end of 2015.

AI-14. *Draft implementation plan should be developed for presentation at Congress 2015, then more detailed implementation plan with tasks should be develop and finalized by December 2015.*

10. GAW 25TH ANNIVERSARY

SSC discussed the plans for the celebration of GAW 25th anniversary at the IGAC conference in September 2014. A publication entitled “25 years of Global Coordinated Atmospheric Composition Observations and Analyses” will be prepared. The GAW community was invited to advertise GAW in presentations and posters. An overview talk by Greg Carmichael is planned to

reflect on the opportunities and total impact that GAW is having on people/capacity support and training.

11. WORLD WEATHER OPEN SCIENCE CONFERENCE IN MONTREAL, CANADA, AUGUST 2014

SSC discussed the World Weather Open Science Conference and the opportunities to work closer with WWRP. GURME plans to hold a SAG meeting during this conference. Integration of weather and atmospheric composition research will be further highlighted at the meeting. A number of white papers are expected to be drafted.

12. RECOMMENDATIONS AND ACTION ITEMS FROM JSC OPAG EPAC 2013

SSC reviewed the recommendations of the JSC OPAG EPAC made at the last meeting of that group in March 2013. A list of action items is provided in Annex D. SSC concluded that no further actions were needed.

13. MEMBERSHIP IN GAW EXPERT GROUPS

Liisa Jalkanen gave some background information on expert and steering groups within GAW. She explained that the composition of SAG's should serve several purposes:

1) Should address the new vision for GAW
2) Should suffice the CAS requirements
3) Should fulfil their function

Paul Monks noted that if application areas are introduced more prominently in the GAW structure, SAGs composition should be reconsidered in this context.

SSC proposed that SAGs and ETs meet in person every year and a half. SSC meets every year and every second year with the SAG and ET Chairs. There is also a pool of experts in OPAG-EPAC which was established by CAS-16 Session. Members were requested to provide expert names for this pool.

SSC discussed the current SAG memberships and the need to develop a plan to bring into compliance with the new CAS guidelines.

CAS Guidelines:

- Eight years total service with attention to gender and region balance.
- SSC appoints and reviews (in practice reviews will be annually with respect to membership changes, and Chairs will be reviewed in year four).
- Any exception is to be suggested by the SSC (EPAC or WWRP) Chair to the CAS President, who then consults with the CAS MG. The CAS President will keep a file of exceptions and report to the CAS Session on these.
- CAS discussed the size of committees but did not finalize a number (nor did the CAS MG), though the recommendation was put to limit the size to 10 full members based on practicalities approach.

SSC proposed to change SAG Chairs violating CAS recommendations within at least the next two years. Within the next year the SAGs should have a Chair-elect, before next SSC meeting. At the next meeting there should be either leaving SAG Chairs, Chairs-elect or both. New Chairs have to be named before next meeting.

SSC reviewed all SAGs one by one. All community members should be reviewed at different times. Some are more sustainable and others are not due to the fact that the expert community is rather small (e.g. UV).

Currently the size and strategy of SAGs vary greatly (see table below) in the use of ex officio members and roles of network and data centres representatives.

SAGs	***Chair (appt. date)***	***Current # on SAG***	***Actions*** ***(# leaving based on 8y rule: # replaced)***
GHG	2003	11	(1:)
RG	2011	15	(2: request is for 2+IAGOS)
UV	2002/2013	6	(3:)
Aer	1999	13	(5:)
Ozone	2013	8	(3:)
Gurme	2014	5	(0:)
Precip	1996	8	(6-counting Kobus:)

After the discussion the SSC formulated the following action item:

AI-15*. Implement the SSC proposal for the SAGs. Main points are:*

- *In addition to complying with CAS (eight-year rule) the normal term as SAG Chair is four years. Regardless of leadership role the eight-year max term will hold for SAG members.*
- *SAG membership size is typically (6-10), with maximum size not to exceed ten, with size determined by SSC in consultation with SAG Chair and Secretariat. Adding new members done by SSC should address the new strategic vision and should help fulfill the GAW and CAS programme needs.*
- *Make wider use of ex officio members, with data centre representatives and network contacts typically ex officio.*
- *Make wider use of experts and perhaps ad hoc sub groups to do specific short-term tasks.*
- *Ex officio and experts may be invited to SAG meetings as needed (in consultation with Secretariat with respect to any budget consideration)*
- *Implementation will proceed immediately with transitions taking place at the next joint SSC-SAG Chairs meeting in February 2015; exceptions being GHG because of convention needs, and UV because of recently named Chairperson and number of SAG members needing to leave because of eight-year rule.*

14. MATTERS ARISING

SSC reviewed a proposal received from Martin Schultz to establish a task team on Atmospheric Chemistry metadata vocabulary.

SSC members agreed that there is a need for such a group. SSC discussed how to link this group to current GAW activities. Practically SSC will be responsible for membership and financial obligation of the group, though the activities must be linked to WIGOS and WIS. Greg Carmichael

noted that the group can start from small and practical things, e.g. as a task team. Melita Keywood noted that the group can address cross-cutting activities. SSC can review the performance and achievements and decide how useful it would be to convert this activity into long-term phase.

> ***AI-13.*** *SSC considered Vocabulary Atmospheric Composition (VAC) task team establishment as a positive initiative, though the work of this task team will be reviewed in one year. The group should be aware that any updates would be appreciated at the February 15, 2015 joint meeting. Inform CAS through the minutes of the SSC and informally let Oystein Hov know. Communicate that membership may be appended over time as needs arise from SSC/Secretariat.*

SSC further discussed its operations and means of communications and formulated several further action items.

> ***AI-16*** *Set up next SSC meeting with SAG and ET Chairs (16-20 February 2015).*
> ***AI-17*** *Meet with SSC members at IGAC meeting (September 2014).*
> ***AI-18*** *Determine SSC assignments, communications, and set up regular conference calls.*
> ***AI-19*** *Develop plan to produce state (health) of the atmosphere assessments/statements using GAW data and SAGs. Target first product for 2015.*
> ***AI-20*** *Develop closer connections between Air Quality and Climate Change throughout GAW.*

15. CLOSURE OF THE MEETING

The Chair closed the meeting at 5.00 p.m. on the 12th June 2014.

ANNEX A

First Session of the CAS EPAC SSC

10 – 12 June 2014, Geneva, Switzerland

Agenda

1. Opening of the meeting
2. Approval of the agenda
3. Introductions
4. Context of the meeting
5. GAW Programme, its relationship within WMO and with other organizations and initiatives
6. GAW observations and data
7. GAW application areas and services
8. Important upcoming meetings
9. Future for GAW
10. GAW groups
11. Action items and recommendations
12. Assignments for SSC members
13. Place and date of next meeting
14. Closure of the meeting

ANNEX B

First Session of the CAS EPAC SSC

10 - 12 June 2014, Geneva, Switzerland

List of Participants

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ANNEX C

Proposal for Atmospheric Composition Vocabulary Task Team

Proposers

Martin G. Schultz, IEK-8, Forschungszentrum Jülich, Germany (Chair of GAW RG SAG)

Jörg Klausen, Meteo Swiss, Zürich, Switzerland (Chair of ET-WDC)

Summary

We propose to establish a WMO expert team to collect, examine, reconcile, and enhance existing vocabularies and code lists relevant to atmospheric composition and air quality observations and modelling. This group shall consist of experts from various organizations that are involved in building interoperable systems related to atmospheric chemistry, including air quality, atmospheric monitoring, and chemistry climate interactions. The primary objectives of the group shall be the definition of terms and relations which shall be published on the WMO controlled vocabulary server and the publication of best practices and guidelines for the use of such vocabularies and code lists for metadata encoding in support of interoperability and improved data documentation. The group shall maintain close contact with other relevant WMO teams (in particular ET-WDC, IPET-MDRD, TT-WMD and IPET-DRMM) and other relevant groupings outside WMO in order to ensure broad consensus and avoid diversification and duplication of efforts. The group shall consist of approximately 15 core members who will regularly review and add atmospheric composition and air quality vocabulary terms and their relations and it shall seek to involve a wider community through an open discussion forum (e.g. a wiki or email list). Annual reports to EPAC SSC and ICG-WIGOS will be prepared.

Rationale

The development of the WMO information system (WIS) and of other interoperable web services in the context of atmospheric composition and air quality requires wide agreement on chemical and meteorological terms and definitions so that they can be used in controlled vocabulary databases and semantic web services that allow for flexible and meaningful data discovery in the form of faceted searches. WMO has set-up various expert and task teams in relation to metadata and their application. In particular these are the inter-programme expert team on metadata and data representation development (IPET-MDRD; http://www.wmo.int/pages/prog/www/WIS/metadata_en.html), the task team on WIGOS metadata (TT-WMD; https://www.wmo.int/pages/prog/www/wigos/icg-wigos-task-teams.html), and the inter-programme expert team on data representation and monitoring (IPET-DRMM; http://www.wmo.int/pages/prog/www/ISS/Meetings/IPET-DRMM_Tokyo2013/IPET-DRMM_DocPlan.html). In the field of atmospheric composition, the WMO Global Atmosphere Watch Station information System (GAWSIS) and the expert team on world data centres (ET-WDC) have undertaken activities towards interoperability. Outside WMO, there are a number of other initiatives with similar objectives and activities. Among the actors involved are space agencies, environmental protection agencies, UNEP bodies such as the task force on hemispheric transport of air pollution, the group on global earth observations, and various research initiatives including for example the climate and forecasting conventions group and observation networks such as the international carbon observing system (ICOS) or the in-service aircraft for a global observing system (IAGOS) infrastructure among others. Yet, there remains a gap concerning the coherent definition of controlled vocabularies and semantic ontologies in the field of atmospheric composition and air quality, and as of yet it has not been possible to achieve a broad community consensus on such vocabulary. This situation arises largely because of three factors:

1. The field of atmospheric composition and air quality is broad and interdisciplinary and it involves many different stakeholders and actors with overlapping but not necessarily congruent terminologies and interests. For example, while a chemical compound such as ozone is relevant for almost all actors, a concept such as Br_y (i.e. the total amount of inorganic bromine in the atmosphere) is relevant for stratospheric ozone chemistry and chemistry-climate interaction, but irrelevant for air quality. Conversely, the concept of particulate matter size classes such as PM1, PM2.5, or PM10 is primarily relevant for air quality and less meaningful for chemistry climate studies. Furthermore, there are concepts, such as daily maximum 8-hour average threshold exceedances which are legally binding, but differ among regions and nations.
2. The topic of atmospheric composition has considerable overlap with other domains, including meteorology, oceanography, land ecosystems, and others. For example, atmospheric composition scientists use the types of numerical models as meteorologists and should therefore employ the same concepts with respect to grid definitions, characterization of model features, etc. Many substances are transported across compartment boundaries, for example through emission, deposition, or re-suspension. It is thus necessary for the definition of atmospheric composition vocabularies to learn about existing standards in these fields in order to enable interoperability across disciplines, and the complexity of the problem grows quickly.
3. Until now, there has been a lack of a suitable governance structure which would involve sufficiently many stakeholders and actors to reach a broad consensus on central elements of the vocabulary in the field. Too many programmes, initiatives and projects have worked independently of each other with little or no communication, and previous attempts to establish standards have reached only parts of the community, which has led to several incomplete and incompatible vocabulary collections and thesauri.

We consider the development of widely accepted terms and definitions for atmospheric composition and air quality a central element for reaching the strategic objectives of the Environmental Pollution and Atmospheric Chemistry programme of WMO and therefore propose to establish a WMO expert team to collect, examine, reconcile, and enhance existing vocabularies and code lists relevant to atmospheric composition and air quality observations and modelling. There is an immediate need for such a group in order to ensure a smooth start of the WMO integrated global observing system (WIGOS) and in support of operational or quasi-operational activities that undertake monitoring and forecasting of the atmospheric composition.

Terms of Reference

- To collect, examine, reconcile, and enhance existing vocabularies and code lists relevant to atmospheric composition and air quality observations and modelling
- To submit such vocabularies and code lists to the WMO executive committee (EC) for endorsement and subsequent publication on the WMO code list server (http://codes.wmo.int/).
- To make recommendations on best practices for the use of such vocabularies and code lists for metadata encoding in support of interoperability and improved data documentation and to communicate these recommendations to stakeholders and the wider scientific community.
- To keep abreast of related developments by and engage with relevant stakeholders outside WMO in achieving the above objectives.
- To liaise with other relevant WMO expert teams and task teams (specifically ET-WDC, IPET-MDRD, TT-WMD and IPET-DRMM).

In order to ensure coordination, the group shall prepare annual reports to EPAC SSC and ICG-WIGOS.

Modus operandi

The group shall convene regularly (i.e. every 2 months) by web or teleconference. Physical meetings may be planned if necessary. In addition to this intra-group communication, an unrestricted web platform (wiki, email list, or other) shall be maintained in order to allow discussions in the wider community.

Composition

The proposed expert team shall include approximately 15 members from the wider atmospheric chemistry and air quality communities. These core members shall be supported by an unrestricted number of associated members who participate in the open email or wiki discussions. The initial composition of the core members reflects a large range of stakeholders, experiences and environmental programme involvement related to the topics of atmospheric composition and air quality. In the proposed list below an attempt was made to also achieve balance between genders and world regions.

Name	Institution	Country	Background/Legitimation	Status
Martin Schultz	Forschungszentrum Jülich	Germany	Chair GAW SAG on reactive gases, Co-Chair GEO atmospheric composition and air quality community of practice, member ET-WDC, member of WCRP/SPARC SSC	confirmed
Jörg Klausen	Meteo Swiss	Switzerland	Chair ET-WDC, member TT-WMD, lead GAWSIS/OSCAR	confirmed
Stefan Jensen	European Environmental Agency	Denmark	Head of group MDI1 - SEIS and reference data, GEMET thesaurus	confirmed
Stefan Falke	Northrop Grumman	USA	NASA…	confirmed
Gao Chen	NASA Langley	USA	NASA GTE data archive, TSAD	confirmed
Mark Hedley	Met Office	UK	- member IPET-MDRD; - involved in WMO registry implementation and metadata management; - managing metadata interoperability projects in the Met Office; - involved in CF-NetCDF community	confirmed
Kate Roberts	Bureau of Meteorology	Australia		contacted
Sandy Starkweather	NOAA	USA		contacted(?)
Erin Robinson, ESIP	Earth Science Information Platform (ESIP)	USA	ESIP Information and Virtual Community Director	?
David Gay, US NADP or Bob Larson, CapMon ??				?
Markus Fiebig	Norwegian Institute for Air Research (NILU)	Norway	EMEP/EBAS member of GAW SAG aerosol	contacted
Frédéric Chabaux	Meteo France	France	MACC/Copernicus	confirmed

Diana Claric	Meteorological and hydrological service of Croatia	Croatia	INSPIRE, DCPC-AMMC	contacted
Africa: ?? (maz@met.gov.my?)				contacted
CMA: contact Wenjian Zang, director obs. Dept. CMA				contacted(?)
Ian Galbally	CSIRO	Australia	SAG RG member	confirmed
Hiroshi Koide	Japan Meteorological Agency	Japan	lead WDCGG , member GAW SAG GHG, member GAW SAG RG, member ET-WDC	confirmed
Eiji Toyoda (associate member)	Japan Meteorological Agency	Japan	Chair CBS IPET-MDRD and TT-ApMD, Co-Chair CBS IPET-MDRD, Associate member CBS IPET-DRMM	confirmed

Other agencies which should perhaps be contacted/involved: US EPA, ESA, EUMETSAT (Simon Elliott?), CNR Italy (Sabina di Franco)

ANNEX D

Actions from the JSC OPAG-EPAC Session 2013
(Recurring and New Recommendations)
http://www.wmo.int/pages/prog/arep/gaw/documents/GAW_214_web.pdf

#	Recommendation text	Status	Implementation body
1	GAW stations are requested to publish traceability of their measurements	Recurring	SAGs
2	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.	Recurring	WDCs
3	ET-WDC should discuss the question of DOIs and make a recommendation to be discussed at the next JSC OPAG-EPAC meeting.	New	Chair ET-WDC
4	Yuri Tsaturov gathers information about the plans and progress on the VAAC in Moscow and informs the JSC.	Carried over	Yuri Tsaturov
5	All SAGs should regularly provide feedbacks to GAWTEC about needs for training and guidance in focus areas.	Carried over	SAG Chairs
6	The SAGs are asked to propose new members that represent end users	Recurring	SAG Chairs
7	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.	Recurring	Secretariat
8	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.	Recurring	Secretariat, SAG aerosols
9	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.	Carried over	Secretariat
10	GAW should ensure full participation in WIS for distribution of GAW metadata and physical data.	Recurring	WDCs
11	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.	Recurring	JSC members
12	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.	Recurring	SAGs, ETs
13	The Secretariat will report back to DLR that GAW is not an appropriate affiliation for NDMC.	New, but a follow-up on Recommendation 21 from the previous meeting	Secretariat
14	All the SAGs should define some “Use Cases” and report these back to the JSC.	New	SAGs
15	The next GAW Implementation Plan should contain examples of suitable “Use Cases”.	New	JSC
16	The Secretariat and the JSC work together to provide input from GAW to the WMO Strategic Plan.	New	JSC, Secretariat
17	Provide input to the organization of the Technical Conference (TECO) that takes place before the CAS session	New	JSC members
18	The JSC members should propose approaches for the development of the next GAW Implementation Plan	New	JSC members
19	ET-WDC should make recommendations on the categorization of mobile platforms	New	Chair ET-WDC

ANNEX E

Summary of Action Items

AI-1. WIGOS –

i. Follow-up review of technical regulations. (DONE)

ii. Satellite meeting will be held fall 2014 for further discussions of atmospheric composition community needs for satellite observations. The group is expected to provide a contribution to RRR process as well

iii. Need to identify application areas for WIGOS that drives the RRR by the end of this year (in consultation with SAG Chairs).

AI-2. Develop concrete collaborations, starting with the World Weather Open Science Conference (WWOSC) 2014 Conference in Montreal (August 2014) and the white paper developments and HIWeather (high impact weather initiative).

AI-3. Expand efforts to utilize national/regional networks and to get them to associate/contribute to GAW. Work with the SAGs to develop statement of win/win value proposition for interacting with GAW, and to identify what are the barriers limiting interactions with GAW.

AI-4. Ask SAGs & data centres regarding how they see the problems of data flow – missing data and suggested solutions. If we increase the use of the data, the submissions will likely increase.

AI-5. Develop recommendations and action plan for "local" station designation in consultation with SAGs/CAS MG.

AI-6. Discussed and later approved request for new NAPD as a GAW contributing network, and Puy de Dome station, as a new GAW Global station.

AI-7. Develop outreach strategy for GAW, communications plan, (SSC+SAGs+Secretariat – draft by time of the next SSC+SAG meeting February 2015) including:

- Develop communication strategy with respect to GAW for the PRs and funding sources to highlight the importance of GAW activities and who are participating (outside of the met. Services….)
- Common wording to acknowledge the use of GAW data in publications.

AI-8. Develop a plan for the role of satellites within GAW (to be discussed at the upcoming ad hoc group meeting fall 2014)

AI-9. Set up a meeting of experts from carbon community to move this forward. A lot is done within GEO Carbon.

AI-10. Set up a task team or extend the current ET-WDC with independent members and organize a meeting to review the data centres and their role in GAW moving forward.

AI-11. Identify application areas – reduce into overarching themes in the GAW Implementation Plan. For WIGOS keep in mind current GAW key words, CAS future direction and IGACO strategy, etc. This item is tightly coupled to GAW Implementation Plan development and contribution to WIGOS. SSC will develop a draft set to be shared with SAGs.

AI-12. Work with the SAGs addresses this CAS action item. This will be a topic of priority for discussion at the next SSC joint meeting with the SAG Chairs in February 2015.

AI-13. SSC considered Vocabulary Atmospheric Composition (VAC) task team establishment as a positive initiative, though the work of this task team will be reviewed in one year. The group should be aware that any updates would be appreciated at the February 15, 2015 joint meeting. Inform CAS through the minutes of the SSC and informally let Oystein Hov know. Communicate that membership may be appended over time as needs arise from SSC/Secretariat.

AI-14. Draft implementation plan should be developed for presentation at Congress 2015, then more detailed implementation plan with tasks should be develop and finalized by December 2015.

AI-15. Implement the SSC proposal for the SAGs. Main points are:

- In addition to complying with CAS (eight-year rule) the normal term as SAG Chair is four years. Regardless of leadership role the eight-year max term will hold for SAG members.
- SAG membership size is typically (6-10), with maximum size not to exceed ten, with size determined by SSC in consultation with SAG Chair and Secretariat. Adding new members done by SSC should address the new strategic vision and should help fulfill the GAW and CAS programme needs.
- Make wider use of ex officio members, with data centre representatives and network contacts typically ex officio.
- Make wider use of experts and perhaps ad hoc sub groups to do specific short-term tasks.
- Ex officio and experts may be invited to SAG meetings as needed (in consultation with Secretariat with respect to any budget consideration)
- Implementation will proceed immediately with transitions taking place at the next joint SSC-SAG Chairs meeting in February 2015; exceptions being GHG because of convention needs, and UV because of recently named Chairperson and number of SAG members needing to leave because of eight-year rule.

AI-16 Set up next SSC meeting with SAG and ET Chairs (16-20 February 2015).

AI-17 Meet with SSC members at IGAC meeting (September 2014).

AI-18 Determine SSC assignments, communications, and set up regular conference calls.

AI-19 Develop plan to produce state (health) of the atmosphere assessments/statements using GAW data and SAGs. Target first product for 2015.

AI-20 Develop closer connections between Air Quality and Climate Change throughout GAW.

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LIST OF RECENT GLOBAL ATMOSPHERE WATCH REPORTS*

100. Report of the Workshop on UV-B for the Americas, Buenos Aires, Argentina, 22-26 August 1994.

101. Report of the WMO Workshop on the Measurement of Atmospheric Optical Depth and Turbidity, Silver Spring, USA, 6-10 December 1993, (edited by Bruce Hicks) (WMO TD No. 659).

102. Report of the Workshop on Precipitation Chemistry Laboratory Techniques, Hradec Kralove, Czech Republic, 17-21 October 1994 (WMO TD No. 658).

103. Report of the Meeting of Experts on the WMO World Data Centres, Toronto, Canada, 17 - 18 February 1995, (prepared by Edward Hare) (WMO TD No. 679).

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).

105. Report of the Fourth Session of the EC Panel of Experts/CAS Working Group on Environmental Pollution and Atmospheric Chemistry (Garmisch, Germany, 6-11 March 1995) (WMO TD No. 718).

106. Report of the Global Acid Deposition Assessment (edited by D.M. Whelpdale and M-S. Kaiser) (WMO TD No. 777).

107. Extended Abstracts of Papers Presented at the WMO-IGAC Conference on the Measurement and Assessment of Atmospheric Composition Change (Beijing, China, 9-14 October 1995) (WMO TD No. 710).

108. Report of the Tenth WMO International Comparison of Dobson Spectrophotometers (Arosa, Switzerland, 24 July - 4 August 1995).

109. Report of an Expert Consultation on 85Kr and 222Rn: Measurements, Effects and Applications (Freiburg, Germany, 28-31 March 1995) (WMO TD No. 733).

110. Report of the WMO-NOAA Expert Meeting on GAW Data Acquisition and Archiving (Asheville, NC, USA, 4-8 November 1995) (WMO TD No. 755).

111. Report of the WMO-BMBF Workshop on VOC Establishment of a "World Calibration/Instrument Intercomparison Facility for VOC" to Serve the WMO Global Atmosphere Watch (GAW) Programme (Garmisch-Partenkirchen, Germany, 17-21 December 1995) (WMO TD No. 756).

112. Report of the WMO/STUK Intercomparison of Erythemally-Weighted Solar UV Radiometers, Spring/Summer 1995, Helsinki, Finland (WMO TD No. 781).

112A. Report of the WMO/STUK '95 Intercomparison of broadband UV radiometers: a small-scale follow-up study in 1999, Helsinki, 2001, Addendum to GAW Report No. 112.

113. The Strategic Plan of the Global Atmosphere Watch (GAW) (WMO TD No. 802).

114. Report of the Fifth WMO Meeting of Experts on the Quality Assurance/Science Activity Centres (QA/SACs) of the Global Atmosphere Watch, jointly held with the Second Meeting of the Coordinating Committees of IGAC-GLONET and IGAC-ACE^{Ed}, Garmisch-Partenkirchen, Germany, 15-19 July 1996 (WMO TD No. 787).

115. Report of the Meeting of Experts on Atmospheric Urban Pollution and the Role of NMSs (Geneva, 7-11 October 1996) (WMO TD No. 801).

116. Expert Meeting on Chemistry of Aerosols, Clouds and Atmospheric Precipitation in the Former USSR (Saint Petersburg, Russian Federation, 13-15 November 1995).

117. Report and Proceedings of the Workshop on the Assessment of EMEP Activities Concerning Heavy Metals and Persistent Organic Pollutants and their Further Development (Moscow, Russian Federation, 24-26 September 1996) (Volumes I and II) (WMO TD No. 806).

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

118. Report of the International Workshops on Ozone Observation in Asia and the Pacific Region (IWOAP, IWOAP-II), (IWOAP, 27 February-26 March 1996 and IWOAP-II, 20 August-18 September 1996) (WMO TD No. 827).

119. Report on BoM/NOAA/WMO International Comparison of the Dobson Spectrophotometers (Perth Airport, Perth, Australia, 3-14 February 1997), (prepared by Robert Evans and James Easson) (WMO TD No. 828).

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

121. Report of the Eighth WMO Meeting of Experts on Carbon Dioxide Concentration and Isotopic Measurement Techniques (prepared by Thomas Conway) (Boulder, CO, 6-11 July 1995) (WMO TD No. 821).

122. Report of Passive Samplers for Atmospheric Chemistry Measurements and their Role in GAW (prepared by Greg Carmichael) (WMO TD No. 829).

123. Report of WMO Meeting of Experts on GAW Regional Network in RA VI, Budapest, Hungary, 5 to 9 May 1997.

124. Fifth Session of the EC Panel of Experts/CAS Working Group on Environmental Pollution and Atmospheric Chemistry, (Geneva, Switzerland, 7-10 April 1997) (WMO TD No. 898).

125. Instruments to Measure Solar Ultraviolet Radiation, Part 1: Spectral Instruments (lead author G. Seckmeyer) (WMO TD No. 1066), 2001.

126. Guidelines for Site Quality Control of UV Monitoring (lead author A.R. Webb) (WMO TD No. 884), 1998.

127. Report of the WMO-WHO Meeting of Experts on Standardization of UV Indices and their Dissemination to the Public (Les Diablerets, Switzerland, 21-25 July 1997) (WMO TD No. 921).

128. The Fourth Biennial WMO Consultation on Brewer Ozone and UV Spectrophotometer Operation, Calibration and Data Reporting, (Rome, Italy, 22-25 September 1996) (WMO TD No. 918).

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

130. Jülich Ozone Sonde Intercomparison Experiment (JOSIE, 5 February to 8 March 1996), (H.G.J. Smit and D. Kley) (WMO TD No. 926).

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

132. Report of the Ninth WMO Meeting of Experts on Carbon Dioxide Concentration and Related Tracer Measurement Techniques (Edited by Roger Francey), (Aspendale, Vic., Australia).

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

134. Guide on Sampling and Analysis Techniques for Chemical Constituents and Physical Properties in Air and Precipitation as Applied at Stations of the Global Atmosphere Watch. Carbon Dioxide (WMO TD No. 980).

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).

136. WMO/EMEP/UNEP Workshop on Modelling of Atmospheric Transport and Deposition of Persistent Organic Pollutants and Heavy Metals (Geneva, Switzerland, 16-19 November 1999) (Volumes I and II) (WMO TD No. 1008).

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