

Seventh Session of the Research Board Environmental Pollution and Atmospheric Chemistry Scientific Steering Committee

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1. Welcome and Adoption of the Agenda

The seventh session of the Research Board Environmental Pollution and Atmospheric Chemistry Scientific Steering Committee (EPAC-SSC) was held online, hosted by the World Meteorological Organization (WMO) from 8 to 11 February 2021. Professor Greg Carmichael, Chair of the EPAC-SSC chaired the meeting. He welcomed the participants and introduced the agenda of the meeting ([Annex 1](#)). He explained that the objectives of the meeting were to evaluate the progress with the transformation of the Global Atmosphere Watch (GAW) Programme as was decided at the previous EPAC-SSC meeting and the effectiveness of the collaboration mechanisms with the new Technical Commissions of WMO. Considering the online format of the meeting, EPAC-SSC decided to focus on open issues and workplans to guide further evolution of the programme. In the view of above, the reporting on the activities of different groups was requested to be minimal. EPAC-SSC recognizes that the spectrum of the activities of different GAW groups is very broad and EPAC-SSC greatly appreciates these activities. If required EPAC-SSC will follow up on the topics via dedicated meetings. The participants who attended the meeting are listed in [Annex 2](#).

Greg Carmichael thanked all the contributors to the work on the GAW Programme and all members of the EPAC-SSC for their work and commitment. He acknowledged the members of EPAC-SSC who are rotated out (Xiao-Ye Zhang, Paul Monks and Markku Kulmala) and welcomed the new members (Julie Nicely, Admir Targino and Barry Lefer). He reminded everybody that GAW is in the middle of the 2016–2023 GAW Implementation Plan (IP) period and that next GAW IP will be influenced by the guidance of the Research Board (RB). He stressed the importance of early engagement in the development of the next IP. As a reminder, he stated that the GAW Programme has been aligning itself with the new structure at WMO, with its two new commissions (i.e. the Services Commission (SERCOM) and the Infrastructure Commission (INFCOM)). At the heart of GAW are the Scientific Advisory Groups (SAGs), the newly created Expert Teams (ETs) which deal with GAW infrastructure and make important connections with the Infrastructure Commission, and the new science-for-services initiatives, which represent an attempt to translate science into services and which represent GAW's link to the Services Commission.

Greg Carmichael further iterated that EPAC-SSC would like to see an integrated workplan for 2021 and understand major activities for various groups. EPAC-SSC will try to better understand the diverse activities and potential issues and will think strategically to resolve issues and/or advance activities.

2. Guidance from the Research Board

The Chair of the Research Board, Celeste Saulo, presented the main outcomes of the Research Board Session held at the end of January 2021 and summarized the work and roles of different bodies under the Research Board.

She presented the update on the Concept Notes being developed by the RB to:

- Articulate the high-level scientific priorities and key activities to the scientific community and partners, including funding agencies and stakeholders,
- Enable the research programmes to work more effectively on cross-cutting aspects,
- Facilitate interactions between WMO bodies,
- Provide an inclusive framework for partners of WMO including Regional Associations,
- Provide a basis for future activities and potentially attract funding agencies: e.g. an Open Science Conference by 2025.

She described the engagement of the RB representatives in the work of the Technical Commissions.

- The following activities were identified by the RB as priorities of 2021: Finalizing Concept Notes (spring 2021),
- Engagement of RB members in different tasks (ongoing),
- Extension of the Task Team on Exascale computing and Artificial Intelligence (AI) with a new focus (until the Extraordinary session of the World Meteorological Congress (Cg-Ext (2021) in October 2021),
- Continuation of Task Team on SARS-CoV-2/COVID-19/Meteorological and Air Quality Factors (until Cg-Ext (2021) in October 2021),
- RB help to identify synergies and give support to the three programmes (ongoing),
- Hydrology Research Strategy to improve the delivery of hydrologic information and services and build partnerships across WMO, UNESCO and the community (ongoing),
- Collaboration with the Technical Commission on Infrastructure (INFCOM) on Global Data Processing and Forecasting System (GDPFS) pilot projects (Typhoon Forecast and Warning in the Asian Pacific; Seamless Prediction from minutes to hours, etc.) and new WMO data policy (ongoing),
- Collaboration with the Technical Commission on Services (SERCOM) on Science to Services activities for urban, aviation, health and other applications (ongoing),
- Interaction and strengthening collaboration with regions and contribute to the regional association reform (starting in spring),
- Capacity-building and education – Links with programme initiatives – Focus on Early Career Scientists (starting in spring 2021),
- Organizing a training activity to optimize the use of information available through the research expert database (ongoing),
- RB input into calls to shape research priority funding (ongoing),

- Planning for Open Science Conference on the Earth System in close collaboration across WMO, International Science Council (ISC), UNESCO (IOC), Scientific Advisory Panel (SAP) and the private sector (ongoing),
- Collaboration with SAP on complementary topics and using synergies (ongoing).

Deon Terblanche, the Co-Chair of the RB, requested EPAC-SSC to include a discussion on its contribution to the planned Open Science Conference (OSC), including how GAW could also use the time leading up to OSC 2025 through related events optimally to inform its own future plans. He also noted that it would be beneficial for the EPAC-SSC to discuss possible approaches that will enhance joint activities and allow the better synchronization of the next GAW IP with those of the World Weather Research Programme (WWRP) and the World Climate Research Programme (WCRP).

Greg Carmichael emphasized that the Task Team under the Research Board produced a concept note on the future of computing, Exascale computing and AI and SSC is invited to provide comments on this concept note.

3. Scientific Priorities of GAW

3.1 Setting up the science agenda

Greg Carmichael reiterated that the goal of the meeting is to develop an integrated workplan for 2021, to make EPAC-SSC better understand major activities of the various groups and assist them strategically moving forward.

After the meeting EPAC-SSC plans to appoint new members of the groups (SAGs, ETs, science-for-services initiatives). Here the goal is to achieve regional and gender balance in the representation of the groups' membership. WMO has an overarching goal to achieve at least 40% female representations in the different groups. This is something that the SSC will be mindful of going forward. The SSC will also consider the inclusion of early career scientists to the different groups within GAW.

3.2 Issues from Scientific Advisory Groups (SAGs) for SSC consideration and workplans for 2021

3.2.1 SAG on Aerosols

Paolo Laj, Chair of the SAG on Aerosols, gave a presentation summarizing the SAG's work and plans for 2021. He started by summarizing the status of the aerosol assessment to date:

- Five papers have already been published;
- Three papers are in preparation on aerosol global trends with the main conclusion indicating negative global trends in aerosol load.

He followed up with a description of the plans of the SAG on Aerosols to continue this assessment which started two years ago which includes increased efforts in expanding the GAW network to cover under-sampled areas and to produce more aerosol products.

The next priority for SAG Aerosol in 2021 is detecting and understanding the impact of COVID-19. One paper was published in 2020 on the estimation of emission decrease in Europe. As some variables and mechanisms have been altered by the change in sources of aerosols due to COVID-19 policies, the goal for 2021 is to promote work that includes treatment of these issues.

The priorities for SAG on Aerosols in 2021:

- To evaluate how the Global Aerosol Assessment data set contributes to Measurement-Model-Fusion for Global Total Atmospheric Deposition (MMF-GTAD) for dry deposition in collaboration with the Scientific Advisory Group on Total Atmospheric Deposition (SAG-TAD);
- To address the evolution of GAW Aerosol Lidar Network (GALION); Judd Welton and Lucia Mona are invited to the next Aerosols SAG meeting to start the discussion;
- To contribute to the Rolling Review of Requirement (RRR) process on requirements for GAW, hopefully in the form of a scientific paper with the Expert Team on Atmospheric Composition Network Design and Evolution (ET-ACNDE);
- Continue contribution to Global Climate Observing System (GCOS) Essential Climate Variables (ECV) requirements for aerosol products;

- To hire new expertise (memberships), needed according to the updated Terms of Reference of the group;
- To maintain a training and communication activities;
- To publish Aerosol Bulletin #4 and prepare Aerosol Bulletin #5.

Paolo Laj discussed a growing need for cross-SAG problem solving, as many issues that affect one SAG may also affect others. Joint interactions have already been established between SAG Aerosols, SAG on Reactive Gases and SAG-TAD, and this network can be expanded in order to treat issues more efficiently.

Examples given of cross-SAG collaboration:

- Constructing the in situ monitoring system;
- Engagement in promoting sustainability and favouring expansion in sparse data regions;
- Interactions with GCOS and RRR;
- Contributions to the Global Air Quality Forecasting and Information System (GAFIS), Measurement-Model Fusion for Global Total Atmospheric Deposition (MMF-GTAD) and the Integrated Global Greenhouse Gas Information System (IG3IS);
- Collaboration with the World Weather Research Programme (WWRP), World Climate Research Programme (WCRP), and the International Global Atmospheric Chemistry (IGAC) project;
- Provide guidance to the Expert Teams on the use of non-conventional observational technologies;
- Addressing the human health dimension, as with COVID-19.

The SAG works closely with the ATMO-ACCESS joint European programme. The SAG also noted a need to discuss how the cross-SAGs activities are going to be facilitated in GAW and if topics will be treated in an ad-hoc manner.

Paolo Laj in response to the question mentioned that SAG was not directly involved in the studies related to aerosol transmission of COVID-19, neither was it involved in the WMO Task Team on COVID-19. Concerning engagement with the Sand and Dust Storms Warning Advisory System Steering Committee (SDS-WAS SC), no discussions have taken place since 2020. Perhaps the push towards near real time (NRT) will be a good opportunity to see if this raises interest in SDS-WAS.

Bruce Forgan, a vice-president of INFCOM, noted that there is a need for increased contribution from the aerosol community to the RRR process as well as more information on aerosol measurement practices and uncertainties for the [Guide to Instruments and Methods of Observation](#) (WMO-No. 8 the CIMO Guide). The Secretariat noted that the SAG on Aerosols has produced a very detailed measurement guidelines' document and interacts with Expert Team on Atmospheric Composition Measurement Quality (ET-ACMQ) on quality assurance approaches. Bruce Forgan further proposed that collaboration on the update of the Guide in collaboration with the Standing Committee on Measurements, Instruments and Traceability (SC-MINT) can be an important area of collaboration between INFCOM and GAW.

3.2.2 *SAG on Reactive Gases*

Lucy Carpenter, Chair of the SAG on Reactive Gases (SAG-RG) summarized activities and workplans of the group for 2021. She described the progress on development of the WMO Reactive Gases Bulletin No. 3: Emissions of Reactive Gases from Biomass Burning, the finalization of the VOC measurement guidelines and transition of the NOAA VOC flask data to the World Data Centre on Reactive Gases. In the plans for 2021 she mentioned SAG's engagement in the work on the global burden to disease, work on the next Bulletin, contribution to the RRR process, continued collaboration with the thematic SAGs on Aerosol and Total Atmospheric Deposition, Measurement-Model Fusion initiative, Tropospheric Ozone Assessment Report (TOAR) project, and work on the NO_x measurement guidelines.

She brought up issues requiring SSC attention:

- The need for further efforts to facilitate expansion of reactive gas observations in under-sampled regions (e.g. Africa);
- Additional help required to archive data from monitoring stations in under-reported regions (e.g. China);
- Guidance required on the establishment of working practices with the ETs so SAGs can better contribute to issues with direct feedback into the network and data quality;
- Clarification of SAG membership (role of ex-officio members).

For the future, Lucy Carpenter proposed continued inter-SAG collaboration with the potential of the formation of an overarching "Scientific SAG" which may be better at tackling interdisciplinary issues (drawing on a range of experts) and interacting more straightforwardly with the other GAW groups. She also noted the lack of guidance from SSC on the priority activities.

In the discussion Joerg Klausen noted that other bodies in GAW also require input from SSC and SAGs.

Concerning data transfer to WDCRG, she expressed appreciation to the NILU team and confirmed that global VOC observations from the flask network were stopped in 2020 with unclear potential for continuation.

3.2.3 *SAG on Total Atmospheric Deposition*

Ariel Stein, Chair of the SAG on Total Atmospheric Deposition (SAG-TAD) presented activities of the group and the plans for 2021.

He stressed that SAG started moving towards its extended mandate from wet to total deposition. The SAG also extended its membership to include experts in the area of dry deposition (four new members are proposed). The World Data Centre for Precipitation Chemistry (WDCPC) and the Quality Assurance Science Activity Centre (QA/SAC)–America was moved to the Illinois State Water Survey (USA). Lab intercomparison studies are to remain at Illinois State Water Survey.

SAG-TAD Workplan for 2021:

- To organize first joint meeting of Aerosol SAG, SAG-TAD and SAG-RG;
- Clarify how to consolidate SAG-TAD needs and elevate them to WMO as there is a need for measurement sites in Africa, Latin America and some parts of Asia;

- Develop a science review on dry deposition measurement techniques;
- Create a GAW dry deposition chemistry manual following the example of the wet deposition chemistry manual (*Manual for the GAW Precipitation Chemistry Programme* (WMO/TD 1251, GAW Report 160));
- Continue collaboration with the Steering Committee of MMF-GTAD initiative.

The Chair of the SAG participated in the meeting of the GESAMP on marine microplastics. He concluded that the network for precipitation chemistry is not always appropriate for the microplastic sampling. He expressed the need to look further into this issue and decide how best to integrate it.

Comments on the presentation:

- Greg Carmichael: elevating the importance of atmospheric composition in WMO would be a good way to improve observational network coverage; RB can play a role in this promotion and closer collaboration with TCs could also be helpful;
- Oksana Tarasova: in relation to microplastics, the work was led by GESAMP Working Groups 38 and 40 which organized a dedicated workshop in November 2020; Paolo Laj and Ariel Stein supported the team in connection with observations and deposition analysis;
- Joerg Klausen: despite the importance of microplastics in addressing environmental pollution, this should not be a focus for GAW; GAW can maybe contribute to the atmospheric transport of microplastics;
- Dr Venkatesan: there is a need to develop standards for sampling methodology for microplastics and to encourage in situ FTIR/MiniFTIR field studies to assist the work of GESAMP.

Action: Secretariat to follow up with Dr Venkatesan, Ariel Stein, Paolo Laj and GESAMP's Working Group 38 on the GAW engagement in microplastics.

Greg Carmichael further noted that, in general, there are very few atmospheric composition observations over the ocean. This topic should be further discussed by SSC.

Action: SSC to consider the questions of atmospheric composition over the ocean and appoint the lead person.

3.2.4 SAG on Greenhouse Gases

Alex Vermeulen, Chair of the SAG on Greenhouse Gases (SAG-GHG) updated the meeting on the activities of the SAG and its workplan for 2021, as follows:

- Produce the GAW Greenhouse Gas Bulletin No. 17;
- Update the measurement guidelines for several greenhouse gases as they have not been updated in 20 years;
- Continue progress on the capacity-building centre for isotopic atmospheric composition measurements with the International Atomic Energy Agency (IAEA);
- Develop a concept for a greenhouse gas reference network;
- Enhance cooperation with the metrology community;
- Work with the World Data Centre on Greenhouse Gases (WDCGG) on FAIR data provision and an improved data lifecycle;

- Support organizations (mostly non-NMHSs) that are working on improving the sustainability of observations;
- Support the development of user driven products based on high precision and accurate long-term observations;
- Increase interactions with the Global Carbon Project (GCP), IG3IS, COPERNICUS, and the TRANSCOM initiative.

Alex Vermeulen ended his presentation by opening up some possible topics for discussion. He reiterated the need to improve the sustainability of greenhouse gas observation networks by raising the visibility of the non-National Meteorological Services contributions to atmospheric composition measurements. He added that this could also be helped by having better RRR for GHGs, as currently these pose certain problems for SAG-GHG. By ignoring technological solutions, there is more difficulty in designing a better global network and thereby improving the network in under-sampled regions (e.g. Africa). Lastly, he brought up the issue of how best to support the long tail of science. Current inversion systems still cannot use their data because of model issues with the (vertical) transport, and there followed a discussion on the issues with the model representation of vertical transport. There has been work done on this topic within the IG3IS community and by SAG Applications which see a lot of synergies between the direct and inverse aspects of air quality modelling.

Action: SSC to further evaluate the importance of vertical transport and Planetary Boundary Layer (PBL) and initiate joint activities between GAW groups, and, in collaboration with the other research programmes.

It was noted that there is a lack of connection between SAG-GHG and SAG Ozone-UV (SAG O₃-UV) on the ozone depleting substances (ODSs) which are also greenhouse gases.

Action: SSC to make sure that SAG O₃-UV and GHG get in contact about ODSs.

3.2.5 *SAG on Ozone and UV Radiation (SAG O₃-UV)*

Matt Tully, Chair of the SAG O₃-UV presented the work of the group and its plans for 2021.

The focus will be on the following topics:

- Transition and adaptation to the new GAW structure;
- Update SAG membership to reflects new SAG structure;
- Advance development of the worldwide UV App for smartphones;
- Put substantial efforts on the development of the joint Brewer Central Calibration Laboratory;
- Plan to produce the first Global Ozone Bulletin;
- Contributions to 2022 WMO/UNEP Scientific Assessment of Ozone Depletion;
- Represent the SAG in the work of 2020 WMO/UNEP Ozone Research Managers Meeting which was postponed to 2021;
- Support for Quadrennial Ozone Symposium (to be held online 3–9 October 2021);

- Improve collaboration with SAG-RG on assessment of the COVID-19 impact on the ozone in the free troposphere of the northern hemisphere in support of the publication of [WMO Reactive Gases Bulletin: Highlights from the Global Atmosphere Watch Programme](#).

The SAG would appreciate the guidance of SSC on the way to provide support for network Dobson and Brewer operators and Regional Calibration Centres and on the expectations from collaborating with the other SAGs (e.g. on ODSs and ozone in the free troposphere). Matt Tully expressed concerns that the migration of the quality assurance activities to the dedicated group could degrade the coordination of Regional Calibration Centres. He stressed that the SAG would continue to oversee the overall health of the Dobson and Brewer networks globally.

In the discussion it was noted that input from the SAG O₃-UV is critical for the RRR process. The representative of the Infrastructure Commission noted that it would be imperative for GAW to feed into the process revision of the RRR as well as associated application areas conducted by the Joint Expert Team on Earth Observing System Design and Evolution (JET-EOSDE). For future satellite missions, it would not only be important for the SAG to help in defining the requirements, but for them to also provide the necessary in situ/ground-based observations for calibration and validation and synergetic approaches.

Matt Tully further confirmed that the Study Group on Integrated Health Services is aware of the development of the UV App and this work is included in the joint WMO-WHO (World Health Organization) workplan.

The Chair of the RB appreciated the efforts made by the GAW community on production of the Bulletin. She expressed support of the RB towards promotion of these materials to increase their visibility. She advised that materials be compiled in such a way as to be easily comprehended by the broad community. The SAG chairs highlighted that more light-weight publications that build more on real-time data, where CO₂ emissions are tracked at shorter timescales, or react more quickly to events like forest fires, droughts, weather anomalies (stratospheric warming events, etc.) would be more impactful.

Action: SSC to communicate to the RB the availability and delivery timeline of the GAW Bulletins and negotiate their further promotion.

3.2.6 SAG on Applications (SAG App)

Vincent-Henri Peuch, a Co-Chair of the SAG App presented the activities of the SAG and its plans for 2021. The group meets twice a year with the next meeting set for April 2021 to discuss the preliminary outcomes of the Working Group on Numerical Experimentation (WDNE) aerosol exercise. The SAG recognized that they collectively connect many important institutions and international initiatives, functioning mainly as an information exchange mode. Vincent-Henri Peuch mentions that they hope to focus on these linking capabilities and to have many discussions on agenda setting activities with GAW initiatives in mind.

He followed this introduction with an update on how the SAG is dealing with the new streamlined Terms of Reference. The key focus of the SAG is to help with data assimilation and coupled modelling atmospheric composition in the Earth system and to work closely with thematic SAGs within GAW, GAW initiatives and Numerical Weather Prediction (NWP) and Climate Modelling centres with relevant national and international programmes and projects. Additionally, they will continue to promote best practices and applications that use observational data in near real-time on scales larger than urban.

Overview of the 2021 Agenda:

- Set the research agenda on Data Assimilation and Coupled Chemistry Climate/Weather Interactions in Earth System Models through discussions and alignment of the plans of key institutions and initiatives;
- Particular attention to be paid to “big events”: for example, “Godzilla” plume in June 2020 and sand transport to Europe in February 2021, wildfires (e.g. California/Washington fires in September 2020 and their impact on air quality, weather and temperature);
- Liaise with the Infrastructure Commission (Standing Committee on Earth System Modelling Prediction and Projection) and continue collaboration with WGNE on aerosol activities;
- Ensure that GAW greenhouse gas data is well reflected in the sixth Intergovernmental Panel on Climate Change (IPCC) Assessment Report;
- Help with requirements for future satellite missions: NASA/ACCP (Aerosols and Clouds, Convection and Precipitation) and EU-ESA/Copernicus;
- Support Air Quality-Health collaboration with WHO by showing how GAW can feed into the Global Burden of Disease (GBD) process and bring in new aspects such as source-apportioned particulate matter and time resolution;
- Contribute to the coordination of international activities that aim at characterization of effects of COVID-19-related emission changes (in collaboration with the hGAW Urban Research Meteorology and Environment (GURME)) on atmospheric composition;
- Contribute to the work of the TT-COVID-19 under the Research Board, with the first report reviewing meteorology and air quality effects on COVID-19 to appear in the coming weeks;
- Consolidate the interfaces with GAFIS, MMF-GTAD and IG3IS.

Vincent-Henri further confirmed that at present, the body of peer-reviewed evidence regarding the potential of aerosol as a vector of SARS-CoV-2 in outdoor environment (direct and through deposition on fomite/surface) is limited. Correlative studies should be approached with caution as there is increased awareness of confounding factors. Many early manuscripts have not made it to publication for this reason.

3.2.7 SAG on GAW Urban Research Meteorology and Environment (SAG-GURME)

Ranjeet Sokhi, Chair of the SAG-GURME, began by introducing the SAG members and thanking the Secretariat for their support and presented activities of the group and its plans for 2021. He described the diverse hazards that occur in urban regions and a growing need for more integrated approaches to urban research. He articulated the connections that SAG-GURME has to different groups. Ranjeet Sokhi then iterated the ongoing work programme of GURME, as follows:

- Continued support for the demonstration projects, with the Moscow pilot project among the newest ones;
- Continued improvement of the science of air quality and meteorological forecasting on urban scale;
- Support for the second phase of the Air Quality Prediction and Forecasting Improvement for Africa (PREFIA) project, plan a workshop and training session in September/October 2021;
- Complete observational and modelling analysis of Air Quality and COVID-19 and submit the papers;

- Continued collaboration with WWRP on urban weather forecasting e.g. Paris Olympics 2024 project.

New SAG-GURME initiatives:

- Engagement with small-scale modelling studies of the dispersion of pathogens like COVID-19;
- Integrated observations for cities that would include air quality, meteorology and climate;
- Strengthening synergies and interactions with SAG App, SAG Aerosol and other groups;
- Work with WGNE as it is important in the context of the links between aerosol and cloud microphysics;
- Establish collaboration with WWRP Expert Team on Weather Modification, focusing on the role of aerosols from megacities in modifying cloud condensation nuclei and the effect on cloud and precipitation formation downwind of an emission source.

Following this presentation, Estelle De Coning stressed that the urban environment presents as a challenge for the World Weather Research Programme's (WWRP) SSC Implementation Plan (IP) as well. The WWRP looks at urban research from a weather perspective, with flagship projects such as the Paris Olympics (2024).

It was noted that SAG-GURME also contribute to the work of the SERCOM Study Group on Integrated Urban Services which was appreciated by the President of the SERCOM.

In the follow-up discussions several SAGs stressed their engagement in COVID-19 research.

[Action: Secretariat to organize a joint telecon between SAG chairs to take stock of the ongoing work on COVID-19 impacts.](#)

3.3 Open discussion on scientific priorities

Greg Carmichael summarized the discussions and he stressed that many of the ideas should be brought to the next GAW Symposium, which is planned later this year. As GAW is close to the end of its Implementation Plan, there is a need to start formulating some ideas for the next IP.

Greg Carmichael stressed that at this point WCRP is finalizing its next IP and IGAC is doing so as well. He is in conversation with the leadership of these programmes to ensure more effective connections are built in their plans.

[Action: SSC to form the think tank group on conceptual development of the next GAW IP.](#)

The SSC members were invited to provide their reflection on the scientific priorities of GAW as well as on the ways in which these priorities can be better connected to the work of the programmes and initiatives such as the International Global Aerosol Programme (IGAP) plan, the international Commission on Atmospheric Chemistry and Global Pollution (iCACGP), and other scientific activities.

Melita Keywood expressed her deep appreciation for the activities presented by the SAGs, despite the challenges faced in the last ten months. From an iCACGP perspective, the focus is to understand how atmospheric composition and chemistry play a role in meeting the United Nations Sustainable Development Goals (SDGs). While atmospheric

chemistry is important for several goals, it is not directly articulated in SDGs. The iCACGP hopes to better promote the importance of atmospheric chemistry in reaching the goals. Specifically, this can be done through the grant application process where the contribution of the proposed research to SDGs would be explicitly asked. In relation to GAW, it should be made sure that the information that is collected and used by the programme is recognized as playing an important goal in reaching SDGs.

SSC members stressed that the integration of observations from different SAGs should be addressed in some way. There are other common points where SAGs can work together, and SSC will try to define these and advise SAGs. Studies related to the connection between COVID-19 and atmospheric composition may also be useful.

Another way to potentially meet SDGs would be to have more observation facilities in developing parts of the world. Collaboration with the broader community could be built around common needs for observations. Only a joint effort can ensure the expansion and the sustainability of the atmospheric composition infrastructure. Other research programmes of WMO (WWRP and WCRP) should be important partners for several research topics as well. The RB offers a new opportunity as a non-inter-governmental structure to represent the international scientific community and reach a larger audience.

Marcos Andrade and Paolo Laj organized an event at the European Geoscience Union General Assembly on the Sustainability of Atmospheric Observations. The notes on this event and its potential outcomes were published as an article in the WMO Bulletin¹. The focus of the commentary was on the ways in which there could be improvements in observations in different countries and articulated the need to fill in observational gaps. Everyone faces the same issue: too many observations in some regions, and close-to-none in others.

Action: SSC to develop a statement/comment/paper on the needs for atmospheric composition observations.

Ranjeet Sokhi stated that based on his experience from working on air quality with colleagues in Africa and South Asia, many regions are under-represented from an observational standpoint. Observations grow organically, but a decision must be made on what, where and why observations are needed, and this issue highlights areas of science that linked to geographical regions, for example Africa, where observations are needed but which have been neglected historically. Therefore, WMO-GAW and groups must find where and how they can motivate, include, attract or supplement observations. These observations must be scientifically motivated and address multiple aspects of science, i.e. atmospheric composition, air quality, meteorology, etc. It would be useful for GAW to present a plan of where observations are needed the most, where they can be pulled together and how SSC can support this initiative. This is addressed by one of the GAW Expert Teams, ET-ACNDE, that looks at the evolution of the observing system in the context of applications.

In the view of COVID-19 and the associated economic crisis there is a risk that the funds for international activities outside of Europe will be restricted. This is a good time for WMO to speak loudly and inform countries that sustainability of the observations is an effort that they need to continue to make.

The GAW community should also keep in mind that the lack of observations in some countries is related to the lack of local expertise. For example, companies in several South American countries have invested money and effort in building the observational

¹ <https://public.wmo.int/en/resources/bulletin/sustainability-of-atmospheric-observations-developing-countries>

infrastructure for air quality. After a while, observing stations stop working due to a lack of expertise and resources. This then sets the countries years back, and it is therefore important to act on this in order to maintain network operations and ensure data quality.

Despite atmospheric composition being highly relevant, the efforts of WMO related to the sustainability and coverage of observations remain largely focused on basic meteorological variables including temperature and humidity (Global Basic Observing Network (GBON), Systematic Observations Financing Facility (SOFF)). There seems to be an unwillingness to take on atmospheric composition in those programmes, as it is seen as "a bridge too far".

There are a lot of pieces working together, and many challenges to be overcome, but finding ways to improve may help to achieve some of the issues discussed. From the point of view of ozone research, the community is rather limited and there are only a handful of scientists on the ground. At the same time coordination has been quite challenging and there is a lot of unnecessary bureaucracy. It can be challenging to use the synergies and make sure things run more smoothly. The multitude of organizations should promote cooperation instead of duplication in order to make the process more effective.

4. Science-for-Services in GAW

4.1. Setting up the agenda for services

Greg Carmichael introduced the session by stressing that one of the overarching objectives of the GAW Programme is to improve the predictability of composition, weather and climate. The GAW Programme focuses on the science that supports the Earth system viewpoint related to atmospheric composition and builds the understanding that allows for predictions in how atmosphere composition will change and how it impacts weather and climate. The need for such systems is driven by societal impacts, and supports various services such as climate, environmental, weather and atmospheric composition services. There are several examples of new and ongoing science-for-services initiatives in GAW that will be discussed throughout the presentations. The development of these new services is driven by the clear needs of the user community. In the context of the emerging environmental services, a collaboration must be built with the Technical Commission on Services that address a broad range of WMO provided services and applications.

4.2 Guidance from the Technical Commission on Services

Ian Lisk, President of the Services Commission (SERCOM) reiterated that the remit of SERCOM is being all about weather, water, climate, and related environmental services. SERCOM is in line with WMO Long-Term Goal 1: better serving the needs of society. SERCOM serves as the pipeline that guides science through infrastructure and into services and applications, including the WMO's considerate network of external partnerships.

More precisely, the role of SERCOM is to:

- Develop and maintain WMO normative material related to the delivery of services, as specified in the WMO Technical Regulations;
- Develop and promote the principles of globally consistent service delivery and the compilation of "best practices";
- Coordinate assistance to Members in order to enhance these capabilities and enable effective implementation and compliance;
- Establish cooperation and partnership mechanisms.

Ian Lisk proceeded to discuss the progress that SERCOM has made, despite the hindrance of pandemic conditions and mentioned the establishment of six Standing Committees under SERCOM. Additionally, three study groups on integrated health services (a joint effort with WHO), integrated energy services and integrated urban services were established. Efforts are being made to ensure balanced grouping in terms of gender and geographical representation, but there is still work to be done on this front.

Ian Lisk continued with the SERCOM priorities of 2021, as follows:

- SERCOM Intergovernmental session, February 22–26, 2021;
- A review of SERCOM workplans and priorities;
- Sorting out the SERCOM website(s) post-Reform;
- Several ongoing discussions, including WMO data policy sector requirements, multi-hazard frameworks and collaboration with RB;

- Assessing the impacts of COVID-19 on the delivery of member services (e.g. aviation).

Greg Carmichael thanked Ian Lisk, and highlighted the importance of making better connections, particularly to the regions. It is necessary to be mindful and strategic in terms of reaching out to regions and getting input and assistance from the regions as SSC work plans and applications are compiled.

4.3 Integrated Global Greenhouse Gas Information System

Phil DeCola, Co-Chair of the Integrated Global Greenhouse Gas Information System, presented on IG3IS plans and inputs for the future of GAW. This initiative is primarily focused on translating observations and modelling science into mitigation services, but the measurements and developed analysis approaches have applications that would co-benefit studies on shorter-lived climate forcing compounds, including chemically active specimens that have impacts on air quality and human health.

IG3IS is a common framework for the provision of systematic services for stakeholder communities working to reduce their greenhouse gas emissions. This initiative is focused on stakeholder “entrainment” on the use of atmospheric concentration data to target mitigation opportunities, improve inventories and track progress effectively. It also works to establish a consensus on a coherent set of “best practices” through active efforts by quality control “benchmarking” the methods across a wide range of scales and applications. This initiative has been very successful in obtaining high exposure through the UN framework convention Subsidiary Body for Scientific and Technological Advice.

Phil DeCola continued the presentation by listing some IG3IS accomplishments for 2020, as follows:

- The launch of the new IG3IS Steering Committee (SC) and six subsequent meetings of SC;
- Participation in the third Annual European Geoscience Union (EGU) Session: Science-based Greenhouse Gas Emission Estimates in Support of National and Sub-National Climate Change Mitigation (May 2020);
- An IG3IS Good Practice Guidelines Community Workshop: Towards an International Standard for Urban GHG Monitoring and Assessment in June 2020 and production of the first draft of the good practice guidelines in December 2020;
- The launch of new IG3IS projects such as the Vienna Urban Carbon Laboratory (October 2020);
- Two Stakeholder Consultations in lieu of the second biannual IG3IS User Summit (November 2020);
- Participation in UNFCCC Climate Dialogues Earth Information Day, Mitigation Panel and Posters.

During the last SC meeting, there was a review of the IG3IS comprehensive plan for 2021. A few of the highlights from this plan, as follows:

- The next round of Stakeholder Consultations to be organized;
- The fourth Annual EGU IG3IS Session: Science-based Greenhouse Gas Emission Estimates in Support of National and Sub-National Climate Change Mitigation would be considered as a forum for scientific discussions;

- Potential organization of IG3IS Good Practice Guidelines for National scale Community Workshop;
- Responding to the community-wide review of the Urban GHG Monitoring Good Practice Guidelines draft, goal to publish – autumn 2021;
- Fulfilment of the great potential of collaborating with key GAW SAGs, SCs and ETs;
- Initiating new IG3IS projects across sub-national, national, industrial methane and global objectives.

Phil DeCola proceeded to discuss the future of GAW (“The GAW Revolution”) and the next Implementation Plan. If WMO is to fully engage in the climate arena, it cannot do so without embracing its role in promoting atmospheric composition. To do so, WMO and partners must engage broadly across commissions, Members and international partners and promote the investment, deployment, application and use of atmospheric composition measurements. IG3IS can help in this goal by taking the time to engage and entrain stakeholders and users to whom it has access to in various communities.

4.4 Global Air Quality Forecasting and Information System

Johannes Flemming, European Centre for Medium-Range Weather Forecasts (ECMWF), Chair of the Global Air Quality Forecasting and Information System (GAFIS) initiative introduced the activities of the group. He began by introducing the steering committee, formed in spring 2020. The high-level objective of GAFIS is “to enable and provide air quality forecasting and information services in a globally harmonized and standardized way tailored to the needs of society”. GAFIS offers a transition of science to services by focusing on operational air quality forecasting, later adding retrospective analysis. GAFIS hopes to engage within WMO-GAW and externally with the Air Quality scientific community and users, taking care that results may be used for operational Air Quality Forecasting (AQF).

GAFIS thematic topics were outlined, as follows:

1. Capacity-building for AQF and information systems: GAFIS held an AQ system survey which yielded one of the first concrete results of this effort. More than 50 organizations from all continents participated, and with these details, GAFIS was able to better understand how AQF is carried out. The results of this survey were made public on the [GAFIS website](#).
2. Best practices and challenges of operational AQF: GAFIS hopes to follow the best practices of NWP which mostly stem from coordinated intercomparison efforts. The example of Environment Canada was given, where forecasts were coordinated consistently and yielded near real-time data.
3. Air quality observations required for AQF: Johannes Flemming supported the discussion on observation gaps and data availability by pointing out the need for accessible data in places where it is lacking and suggested that this could be countered by making sure that the data is accessible from an operational point of view. GAFIS is striving to find ways in which quality observations hosted at different sites and originating at different sources can be subjected to quality control procedures.
4. Operational and scientific synergies between AQF and numerical weather prediction: from a scientific point of view, GAFIS wants to make sure that it is acknowledged that using atmospheric composition in NWP can help to reduce bias and improve scores. It remains a challenging topic.

Johannes Flemming proceeded to outline the GAFIS plan for 2021–2022, as follows:

- Plan to utilize *Training Materials and Best Practices for Chemical Weather/Air Quality Forecasting (ETR-26)* as a resource for best practices and capacity-building;
- Plan an inventory of data repository for Air Quality data;
- Engage with NWP and operational centres on their AQF efforts to aid in starting intercomparison projects on regional scales;
- Outreach is important and ongoing (participation in GAW Symposium, updated website, etc.).

Greg Carmichael thanked Johannes Flemming and recognized the importance of chemical weather re-analysis, and its impact on applications and emerging technologies.

4.5 Measurement-Model Fusion for Global Total Atmospheric Deposition (MMF-GTAD)

Amanda Cole, MMF-GTAD Steering Committee Chair, presented on GAW's Measurement-Model Fusion for Global Total Atmospheric Deposition. This initiative is focused on deposition as a key component of the Earth system, specifically on nitrogen, sulfur and ozone deposition for now. MMF-GTAD is linked to the UN SDGs due to impacts on crop yields, leaching, acidification and air quality.

This science-for-services initiative aims at giving stakeholders access to high-resolution, high-quality global scale maps of total atmospheric deposition. The anticipated operational system involves gathering, quality controlling and preparing data in a format that is conducive to the applications for operations and for tailored map production.

The activities and progress of MMF-GTAD in 2020 are as follows:

- Preparation of a research methodological paper in journal article (J. Fu);
- The publication of 2019 Expert Meeting Report (R. Vet);
- Published an article in WMO Bulletin;
- Presentations to meetings of the Task Force on Hemispheric Air Pollution (HTAP), Task Force on Measurement and Modelling (TFMM) and International Nitrogen Initiative (INI);
- Participation in SAG meetings to enlist SAG expertise;
- Funding secured to initiate a pilot project on a single year set of deposition maps (J. Gaddis);
- Delivery of the Implementation Plan (January 2021).

The MMF-GTAD Implementation Plan outlines the following objectives:

- Engage stakeholders in product development;
- Review the methodologies for fusing observations and modelling;
- The technical implementation of the initiative;
- Designing and testing operational products;
- Capacity-building and communication.

Amanda Cole then listed the planned activities for 2021, as follows:

- Publication of the journal article (J. Fu);
- Progress on global maps pilot projects, completion in 2022;
- Initiation of data collection activity;
- Organize workshop to explore more Measurement-Model Fusion methodologies and engage experts outside SC to advance the science.

For SSC consideration, Amanda Cole mentioned a need for substantial product funding in order to advance the MMF-GTAD initiative. Continued WMO advocacy to potential users/clients/donors would be greatly appreciated. As the products combine measurements and modelling, they would benefit from expansion of the observation network in under-sampled regions and in deposition and Earth system modelling.

4.6 Other services related initiatives in GAW

There are several other service-related activities that are supported by GAW outside of the three science-for-services initiatives. These include the Air Quality Prediction and Forecasting Improvement for Africa (PREFIA) initiative oriented to AQF using multi-scale approach, development of the UV App for health applications and some others.

Greg Carmichael identified the theme of expanded observations and support and, outreach as a theme that goes across multiple GAW groups and activities. He hopes for increased cross-communication between the commissions and the RB and brought the discussion about to services in a broad sense. Oksana Tarasova offered possibilities for some more brief updates.

Ranjeet Sokhi briefly spoke on the PREFIA initiative which held two successful workshops for local scientists in Nairobi and resulted in the development of a set of protocols. Simultaneously, they established links with other groups that could together be running models under a semi-consistent, common framework in order to identify benchmark model performances and improvements and transfer those skills to local scientists. This has allowed for an active work programme in Africa and, as an open initiative, there is a possibility for anyone with an interest in understanding the atmospheric composition and even the longer-term climate impacts on Africa to engage in activities.

Oksana Tarasova updated the SSC on the progress of the Study Group on Integrated Urban Services. There were four teleconferences in the past year, the last of which was on 3 November 2020. The work is proceeding along three key activities, as follows:

- User mapping (progressing slowly due to hold up with stakeholders);
- Development of the Implementation Plan (setback by a group member being withdrawn by their country);
- Development of the Guidance on high-resolution modelling (progressing well, the outline document was discussed by the group and focal points were contacted to provide names of relevant experts in their respective cities with 13 responses as of yet).

The next telecon plans to bring other groups working on urban agenda in WMO up to speed and cross-reference between groups. Greg Carmichael stated that, at this moment, many different programmes are engaged in the same space, and SSC should take advantage of the private sector and non-profits that are looking to provide services by connecting available low-cost sensor observations to the global air quality forecasts and reflect on how best to provide overarching guidance and practices.

Johannes Flemming added that at GAFIS, the adaptation to low-quality observations has helped to keep an open mind; this allows to assess the data more critically. This has opened opportunities for promoting quality control procedures as well.

Paulo Laj reflected that providing a service implies long-term engagement, the identification of people requiring such a service and an economic model upon which to base the provision of these services. He asked SSC if they had a strategy for ensuring interest in a particular service on a regional scale, and if not, what are the ways in which interest can be insured? He felt that the research component is well satisfied, but the delivery of the service needs adjustments.

Greg Carmichael responded that SSC and leadership should dwell on this important question. SSC have invested in globally important services but have lacked strategic alignment with initiatives with completed cost models. He expressed hope for the future with new RB and integrated fundraising initiatives being established.

Vincent-Henri Peuch added that one way to unearth interest would be to create the need for better quality observations by creating the need for observations themselves. He stated that these initiatives would also help researchers to combine models and attempt to produce a machine learning algorithm for quality control. Yes, observations are important, and they may be at the core of the needs, but models can also offer alternative services. He confirmed the necessity for raising the profile of atmospheric composition within WMO.

Ian Lisk offered his perspective on service needs, stating that times of crisis often offer the best funding opportunities. Once populations are affected, government funding is readily available and offered. But measurements will remain irrelevant in places where they are not needed. Therefore, to ensure a service will be endorsed and provided, it must be usable. SERCOM has a part to play in this by clearly articulating how requirements and user priorities are changing – to not simply be and listen and collaborate, but to become the advocates of the community needs.

Phil DeCola commented that it is necessary to invest in the bedrock foundation of guided solutions and services for climate change and other environmental resource management issues. Observations without a model framework within which to comprehend them are not as useful.

Oksana Tarasova responded by saying that there exists a substantial gap between user wants and the services delivered. The language used when addressing the community needs to be adjusted and can be done through user consultations. This way, stakeholders obtain a better understanding of our utility in providing cost benefit analyses.

Greg Carmichael agreed that the science-for-services initiative is the interface where activities converge. SSC's gaze is opened to the road ahead, and willing to present a compelling case for the utility of atmospheric composition.

Ian Lisk was asked how he envisions future work between WMO-GAW groups and SERCOM. He stated that through SERCOM advocacy, issues can become a part of the "business-as-usual" conversation. He looks forward to seeing the progress of the study groups, as they could become a model for other specific areas in the future.

Lastly, Ranjeet Sokhi asked if it would perhaps be possible to organize yearly conversations between groups, commissions and governments, to find out how science is feeding into services. Communication could prove useful in closing the loop and finding out what works on a more active level.

4.7 Wrap-up on Science-for-Services

Greg Carmichael stated a need to continue supporting science-for-services initiatives. The continuous communication is required within the GAW Programme and with SERCOM to advance the initiatives.

Melita Keywood spoke about potential benefits of COVID-19 on productivity of remote meetings and on reducing greenhouse gas emissions from travel. Remote meetings should continue to be embraced post-pandemic as the range of participants tends to be larger than in the past. She stated that by proceeding with caution, high engagement can be prolonged and increased. Melita Keywood supported the creation of a COVID-19 group to define good protocols for adopting an effective remote work ethic.

Oksana Tarasova touched upon promoting GAW in a saturated virtual work environment. There has been an increase in online news and webinars on topics far and wide. It becomes critical for the programme to continue being “heard” and “seen” when people’s attention span becomes shorter and shorter.

SSC agreed that the small size of the atmospheric composition community could hinder promotion within the larger scientific spheres, but GAW is a foundational component within the community. Vincent-Henri Peuch suggested using “WMO communications team” to get people’s attention, simultaneously elevating GAW and atmospheric composition within the WMO. SSC agreed that with good communication, better service is provided.

The president of SERCOM reminded that while creating a new application, care should be taken to avoid conflict between the services provided by the programme and the services on the national scale. SSC confirmed that this is taken into consideration and for example the Global UV App uses the data from an authoritative source (Copernicus) that does assimilate multiple streams of information from national sources. The App allows for further adaptation if additional sources of data exist.

5. Research Infrastructure in GAW

5.1 Setting up the agenda for Research Infrastructure

The GAW observational and data infrastructure form the foundation for the programme. The objective is to continuously improve these systems using RRR and creating a productive and efficient connection with the WMO Integrated Global Observing System (WIGOS).

Such an elaborate network as GAW is inevitably challenging to manage, but through the partnerships, the atmospheric composition observing system continues to progress. Capabilities are increasing and new instrumentation is being evaluated and brought online. Greg Carmichael stated that SSC is working on extending collaborations with contributing networks.

Greg introduced the three Expert Teams that cover the infrastructure aspect in GAW. The ETs are forward facing, towards the Infrastructure Commission. As applications continue to evolve, some of the research infrastructure will inevitably become embedded in the operational infrastructure thereby making interactions with INFCOM is extremely important.

5.2 Guidance from the Technical Commission on Infrastructure

Bruce Forgan, vice-president of INFCOM, presented on the Infrastructure Commission (INFCOM). INFCOM and SERCOM were established by the Eighteenth session of World Meteorological Congress (Cg-18) through Resolution 7 Establishment of WMO Technical Commissions for the Eighteenth Financial Period. INFCOM is an amalgamation of numerous infrastructure domains (weather, hydrology, oceanography, etc.) and is comprised of four Standing Committees, 28 Expert Teams, five Joint Teams, 11 Task Teams and five Study Groups.

The vice-president proceeded to outline the ways in which GAW and INFCOM can work together to ensure the timeliness of data and information, as follows:

- Assess which well-established GAW infrastructure activities could be melded with INFCOM while keeping the agreed outcomes of sustainability;
- Add to regulatory material (for example, WIGOS manuals, Global Data and Processing Forecasting Systems (GDPFS)) in support of the Unified Data Policy;
- Update the Rolling Review of Requirements regarding atmospheric composition, GAW can provide better input on user needs and how to address requirements in gaps;
- Contribute together to the assessment of observational user requirements for high-resolution modelling activities in support of urban services;
- Joint contributions to the updated chapter on urban observations in the [Guide to Instruments and Methods of Observation](#) (WMO-No. 8 the CIMO Guide);
- Collaborate on training materials and activities to avoid duplication;
- Recognize the emerging domains outside the control of NMHSs so that GAW and INFCOM may coordinate engagement at the global, national and regional levels using GAW's extensive expertise;

- Promote measurement traceability as a design tool to elucidate datum uncertainty as it is beneficial, vital information about the quality of measurement.

Bruce Forgan proceeded to go over the current and future linkages between INFCOM and GAW. From a governance perspective, GAW is represented in INFCOM by experts. He believed that this presence could be improved, and that GAW should have more influence on a strategic level. By fortifying the connections between GAW and INFCOM, duplication of work may also be avoided.

Action: Investigate mechanisms in place for coordination of activities between GAW and INFCOM and make sure the back-and-forth reporting is kept to a minimum.

As GAW is at the forefront of broader “emerging” services, collaboration is important. An alignment of strategies between INFCOM-SERCOM-RB is required to strengthen WIS, WIGOS and GDPFS.

5.3 Expert Team on Atmospheric Composition Data Management

Jörg Klausen, Chair of the Expert Team on Atmospheric Composition Data Management (ET-ACDM) presented the scope and activities of the group and stressed that it focuses on formats and standards. The lack of experts in information technology and data management has affected the progress of the team.

He outlined the ET’s achievements of 2020, which consisted mostly of maintaining and updating the operation of World Data Centres. Six telecons were held, contributions were made to joint SAG/ET sessions and the WMO Data Conference in November 2020.

Jörg Klausen demonstrated the links between data centres and GAWSIS-OSCAR/Surface, stressing the importance of data exchange and harmonization becoming operationally implemented in the OSCAR system so that availability of observations is better documented. He elaborated on the status of persistent identifiers (PIDs)/digital object identifiers (DOIs) implementation in data centres, and asked SSC to provide clear requirements for data identifiers. He summarized the outputs from the WMO Data Conference, stating that the discussion surrounded the potential for a common format for data submissions and retrieval.

The outline of the 2021 Work Plan was presented, as follow:

- Continue operations of data centres and ensure their further evolution in consultation with ET-ACDM;
- Support users through World Data Centres and share user feedback with the ET and SAGs;
- Link World Data Centres operationally to GAWSIS-OSCAR/Surface;
- Link at least some data centres of contributing networks operationally to GAWSIS-OSCAR/Surface;
- Produce a report on the data quality control procedures at the data centres;
- Respond to SAGs’ requests regarding data archiving and dissemination requirements and inform SSC on related proposals;
- Develop a common set of Key Performance Indicators for the data centres supporting GAW;

- Explore netCDF/CF as a common data format, accompanied with WIGOS metadata as a common metadata format for all of GAW and assess the possibility/challenges of writing converters to current formats in use;
- Propose to include DOI/PID in the WIGOS metadata standard for both observing facilities and observations/deployments.

The Expert Team expects the guidance from SSC concerning:

- Recommendation on adopting a single data/metadata format for GAW with cost/benefit considerations (netCDF/CF);
- Recommendation on use of DOIs/PIDs for GAW data and their inclusion in WIGOS metadata standard;
- Formulate clear application-driven requirements on need for real-time/near real-time data management and outline expectations for existing data centres;
- Guidance from SAGs on how to organize variables and vocabularies.

He further elaborated on the need for better integration of the GAW IP and its data management strategy with existing regulatory material and WMO data policy. In the future, ET would appreciate clearer guidance on the use of GAWSIS-OSCAR/Surface for station registration and applications for becoming a GAW station.

Action: SSC requested the ET-ACDM to come up with a proposal for unified metadata for all data centres.

5.4 Expert Team Atmospheric Composition Measurement Quality

Herman G. J. Smit, Chair of the Expert Team on Atmospheric Composition Measurement Quality (ET-ACMQ) presented the activities of the team. He emphasized that the main objective of the group is to bridge the efforts on Quality Assurance and Quality Control (QA/QC) in observation network through:

- The standardization and harmonization of common QA/QC components;
- The monitoring and evaluation of QA/QC of measurements from observation network for each variable;
- Interactions with other QA/QC bodies in GAW, INFCOM, metrology and other non-GAW observational networks.

He added that, as a potential idea, a common QA/QC evaluation framework could be developed and established. He introduced the new member candidates, noting that approval from GAW-SSC is pending. So far, the ETs experience with INFCOM and WMO Secretariat has been positive, with the realization that time is needed to establish proper connection between atmospheric composition observational community and INFCOM. Herman Smit listed the ETs achievements in 2020, and outlined their work plan for 2021, as follows:

- Review the current state of Central Facilities and give recommendations and guidance;
- Summarize the experience and activities of Central Facilities in overarching publication, GAW Report: "GAW Central Facilities 2021 (2016–2020) and role of ET-ACMQ";
- Establish a workplan for 2021–24 including the drafting team for the new GAW report, and develop first vision for next GAW IP.

Some general questions were addressed to the SSC concerning contribution to the GAW Symposium, next GAW IP and the role of the ex-officio members in the ET which were addressed later during the meeting and through written correspondence.

5.5 Expert Team Atmospheric Composition Network Design and Evolution

Richard Eckman, Chair of the Expert Team on the Atmospheric Composition Network Design and Evolution (ET-ACNDE) described that the scope of the group is to review user requirements for the observations related to the three atmospheric composition application areas in support of RRR activity. Good connections have been developed with thematic parameter SAGs, with many SAG members contributing to the work of the Expert Team.

A joint GCOS/GAW evaluation of requirements for climate monitoring ECVs was conducted in autumn 2019, as well as a number of telecons to assess ET's progress and consider its next steps. An ET meeting in October 2020 expressed the need for speeding up the population of the OSCAR requirements database. The ET is on the path to completing its first iteration of recommendations, and Richard Eckman presented a detail plan of its completion.

He touched on ET-ACNDE's interactions with INFCOM and his being a member of the Standing Committee on Earth Observing Systems and Monitoring Networks (SC-ON), and that this provides a useful interface in addressing OSCAR issues and providing input for RRR evolution.

5.6 Other infrastructure related activities

The links between GAW and GCOS, presented by Paulo Laj (and Caterina Tassone), described the process of synthesizing two very separate monitoring systems. Nevertheless, an updated list of ECVs was created. GCOS is reviewing the status of the global observing system for the Earth's climate, to be published in September 2021 in time for the UNFCCC Climate Change Conference in November 2021 in Glasgow. Improvements are difficult to rank, and this is complicated by the two entities originating from very different places. Currently, atmospheric composition has a score of three as in situ observing systems lack measurements in large parts of the world due to volume, variety and policies of the participants. Paulo Laj outlined the future plans of GCOS that would require input from the thematic SAGs.

Markku Kulmala, a member of the Science Advisory Panel, agreed for the need for long-term and comprehensive, high-quality data. He asked SSC how to raise enough resources and stated that the large number of separate groups make building connection difficult in the long run. He suggested promoting an establishment of very high-level research institute with observations and modelling. Such an initiative would require good connections to climate science, atmospheric composition science, and environmental issues such as air quality and hydrology.

The Working Group on Global Basic Observing Network (GBON), introduced by Angela Benedetti discussed the possibility of accepting atmospheric composition variables into the list of GBON variables. However, at the time of discussion, the scope for such inclusion was not considered sufficient, in general the idea was taken positively about such acceptance in the future, and that she would take suggestions on essential atmospheric composition variables for GBON.

Vincent-Henri Peuch briefly described his engagement in the Standing Committee on Data Processing for Applied Earth System Prediction and Projection under INFCOM. There is an imbalance in that weather aspects are covered while many other components of the Earth system are not. The purpose of this Standing Committee is to enable access to, and use of, numerical analysis and Earth system prediction and projection projects,

at all temporal and spatial scales for WMO Global Data Processing and Forecasting System (GDPFS). The priorities of the group lie in the roadmap of the implementation of GDPFS, and the pilot projects that support this implementation, with atmospheric composition very much in the scope of both. He considers engagement with the GDPFS as an important mechanism to raise awareness of atmospheric composition modelling within WMO.

6. Communication, Capacity-Development and Training during COVID-19

Claudia Volosciuk presented the challenges arising from COVID-19 for communication and capacity-development. Since the onset of the pandemic, there has been a general adaptation to carrying out the activities online. A few online events that occurred in 2020, are as follows:

- Webinars targeting the engagement of urban stakeholders;
- Big scientific meetings, including this year's European Geoscience Union (EGU) General Assembly;
- Launch of the GAWTEC webinar series, co-organized with early career scientists from YESS.

Claudia Volosciuk brought the webinars specifically to the attention of SSC, asking whether they see this activity as a useful addition to the hands-on training courses. When prompted on feedback from participants, she stated that the attendance was good and feedback was generally positive with requests to sharing the recordings.

COVID-19 commanded much of the discourse of this year, with many questions arising on its impact on CO₂ emissions and air pollutants. These concerns were addressed in different formats including:

- Publication of the article in WMO Bulletin Vol. 69 (2);
- Participation of experts and Secretariat in Question and Answer interviews;
- Publication of the WMO Greenhouse Gas Bulletin with a focus on COVID-19 related emissions.

One challenge presented itself in relation to one of the action items in the GAW IP, namely "Facilitate GAW presence at key scientific conferences, including via the co-sponsoring of specialized sessions". This was challenging to deliver on this action item, as activities were held mostly online, and therefore meeting different people from the community was restrained. The question of keeping visibility of GAW in the overloaded electronic environment was raised again.

7. The Planning of the GAW Symposium 2021

2021 is a year of the GAW Quadrennial Symposium that has its objective to bring the community together to review the implementation of the GAW IP and discuss the way forward for the programme. The proposed format for the Symposium would be a series of online events, including a combination of panels, workshops and side events. These efforts would be led by a planning committee, with representatives from SSC and GAW leadership. Main topics will cover common areas of interest such as atmospheric composition science, advancing composition infrastructure and COVID-19. The steps for the organization of the Symposium were outlined.

Deon Terblanche, Co-Chair of the Research Board commented on the relevance of GAW to society in terms of high-quality science and service delivery and policy advice. The RB has decided to embark on the ambitious undertaking of Open Science Conference (OSC) in 2025. This could help with relationships between commissions, GAW, RB and all groups. He stated that bringing the GAW Symposium under the umbrella of the bigger OSC could largely benefit both GAW and RB.

Greg Carmichael added a few action items from the SSC perspective:

Action: SSC meeting to draft action items derived from this week's discussions, share them for comments and approval.

Action: Set up call to inform/coordinate COVID-19 related works.

8. Way forward

SSC was tremendously impressed by the activities/accomplishments of the groups and by the initiative taken to foster new and deeper interactions between the groups.

The SSC reflected on the outcomes of the three day meetings. It revised the action items from the current meeting ([Annex 3](#)) and the status of the action items from the previous meeting ([Annex 4](#)). SSC will be consulting on the action items with the groups that requested specific actions. In particular the requests on the new memberships will be considered offline.

As the high priority actions, the call will be set up to have an initial mapping of the COVID-19 related work in different groups in GAW and the organizing committee will be set up for the Symposium.

SSC noted that it is important to continue interactions and build interfaces with the Technical Commissions and with the other programmes under the Research Board. SSC is also very grateful to Greg and to the community for the efforts during 2020 leading the alignment of GAW with the new organization of WMO.

Greg Carmichael closed the meeting on 11 February at 0700 UTC.

ANNEX 1

WORLD METEOROLOGICAL ORGANIZATION
RESEARCH BOARD

**7th Scientific Steering Committee (SSC)
on the Environmental Pollution and
Atmospheric Chemistry (EPAC)**

WMO

Online 8–11 February 2021

RB/GAW/SSC7/DOC1.0

5 February 2021

Item: 1.0

AGENDA

Date/Time: Monday to Thursday, 8, 9 and 11 February 2021.

Location: online (links to the individual sessions are on the top of the daily agenda, the meeting is in Teams)

Who: extended SSC (SSC members and SAG/ET/SC Chairs)

SCHEDULE

Monday, 8 February 2021

Time UTC		
1900 – 1910	Introduction of SSC	Greg Carmichael
1910 – 1920	Outcomes of the Research Board meeting	RB co-chairs
1920 – 1925	Setting up the scientific priorities in GAW	Greg Carmichael
	Issues from Scientific Advisory Groups for SSC consideration, workplans for 2021 and vision for the next IP	
1925 – 1935	SAG Aerosol	Paolo Laj
1935 – 1945	SAG-RG	Lucy Carpenter
1945 – 1955	SAG-TAD	Ariel Stein
1955 – 2005	SAG-GHG	Alex Vermeulen
2005 – 2015	SAG Ozone and UV	Matt Tully
2015 – 2125	SAG App	V-H Peuch, Frank Dentener
2025 – 2035	SAG-GURME	Ranjeet Sokhi

Time UTC		
2035 – 2115	Discussion on the scientific priorities in the programme and the way forward with the future GAW plans. Potential interaction with the other research programmes, IGAC, iCACGP etc.	Greg Carmichael
2115 – 2200	RESERVED for the SSC members only	Greg Carmichael

Tuesday, 9 February 2021

Time UTC		
1900 – 1910	Science-for-Services: setting up the agenda	Greg Carmichael
1910 – 1920	Service Commission and expectations from GAW	SERCOM (Ian Lisk)
	Issues from Steering Committees for SSC consideration, workplans for 2021 and vision for the next IP	Greg Carmichael
1920 – 1930	IG3IS	Phil DeCola
1930 – 1940	GAFIS	Johannes Flemming
1940 – 1950	MMF – GTAD	Amanda Cole
1950 – 2030	Other services related initiatives (PREFIA, MAP-AQ, UV App) How does GAW engage in the work of the SERCOM groups How to engage user/stakeholders and take regional priorities on board	Greg Carmichael, Ian Lisk, O. Tarasova
2030 – 2050	Communication and capacity-development/training during COVID-19	Claudia Volosciuk
2050 – 2100	Wrap-up on science-for-services	Greg Carmichael

Thursday, 11 February 2021

Time UTC		
0500 – 0510	Research Infrastructure: setting up the agenda	Greg Carmichael
0510 – 0520	Infrastructure Commission and expectations from GAW	Bruce Forgan INFCOM
	Issues from Expert Teams for SSC consideration, workplans for 2021 and vision for the next IP	Greg Carmichael
0520 – 0530	ET Data Management	Joerg Klausen
0530 – 0540	ET Quality Assurance	Herman Smit
0540 – 0550	ET Network Evolution	Richard Eckman
0550 – 0630	Involvement of GAW Groups in the work of the Infrastructure Commissions (Study Groups on GBON, GDPFS, network design, QA-QC, Data Management, GCOS)	V-H Peuch, H.Smit, R.Eckman, J.Kalusen, Paolo Laj, Angela Benedetti
0630 – 0650	Planning of the GAW Symposium	Greg Carmichael
0650 – 0700	Assigning actions and conclusions	Greg Carmichael

LIST OF PARTICIPANTS

Online meeting

Greg Carmichael	United States
Celeste Saulo	Argentina
Deon Terblanche	South Africa
Melita Keywood	Australia
Karla Longo	Brazil
Jacobus Johannes Pienaar	South Africa
Markku Kulmala	Finland
Marcos F. Andrade	Plurinational State of Bolivia
Tong Zhu	China
Julie Nicely	United States
Admir Targino	Brazil
Barry Lefer	United States
Paolo Laj	France
Ranjeet Sokhi	United Kingdom
Alex Vermuelen	Sweden
Ariel Stein	United States
Richard Eckman	United States
Lucy Carpenter	United Kingdom
Matt Tully	Australia
Herman Smith	Germany
Vincent-Henri Peuch	ECMWF
Jörg Klausen	Switzerland
Frank Dentener	JRC of European Commission
Phil DeCola	United States
Jocelyn Turnbull	New Zealand
Johannes Flemming	ECMWF
Amanda Cole	Canada
Angela Benedetti	ECMWF
Ian Lisk	United Kingdom
Bruce Forgan	Australia
Dr R. Venkatesan	India
Paula Etala	Argentina
Roger Stone	Australia

WMO Secretariat:

Jürg Luterbacher,

Oksana Tarasova,

Alexander Baklanov,

Lorenzo Labrador,

Stoyka Natcheva,

Claudia Volosciuk,

Mario Peiro Espi,

Lu Ren,

Kenneth Holmlund,

Mike Sparrow,

Estelle De Coning

**LIST OF DECISIONS, ONGOING ACTIVITIES
AND TIME-LIMITED ACTION ITEMS TAKEN BY THE SEVENTH EPAC-SSC SESSION**

1. Decisions

- D-1.7 Conduct consultation with the substructures of the SERCOM (Standing Committee on Agriculture and on Climate Services) concerning connection with the GAW science-for-services initiatives
- D-2.7 Conduct consultation with the substructures of the INFCOM concerning engagement in GDPFS and actively develop the common activities with INFCOM groups that are doing atmospheric chemical composition and GCOS
- D-3.7 Develop a communication paper on the need for atmospheric composition observations and supplementary materials on costing
- D-4.7 Organize GAW Symposium as a series of online events led by GAW groups

2. Short terms action items

Action Item Number	Content	Responsible	Deadline	Relation to the action item of the pervious SSC meeting (AI-XX.1, AI-XX.2 and AI-XX.3)	Open/closed
AI-1.7	Get formal approval of three new SSC members from the Research Board and solicit more nominations from Asia and Africa	Greg Carmichael, SSC members and Secretariat	1Q 2021	Follow up on AI-17.4, AI-1.5, AI-1.6	
AI-2.7	Establish Capacity-Development group (contact GAW bodies for nominations), in collaboration with WMO Capacity-Development Panel and Training Department	Julie Nicely, GAW substructures, Secretariat	3Q 2021	AI-3.6	
AI-3.7	Facilitate joint work of SAGs O3-UV and GHG on ozone depleting substances	Matt Tully and Alex Vermeulen	1Q 2021		

Action Item Number	Content	Responsible	Deadline	Relation to the action item of the pervious SSC meeting (AI-XX.1, AI-XX.2 and AI-XX.3)	Open/ closed
AI-4.7	Secretariat to facilitate the consultations with the SERCOM in relation to joint activities	Secretariat, Greg, chairs of science-for-services initiatives	2Q 2021		
AI-5.7	Secretariat to facilitate the consultations with the INFCOM on GDPFS, atmospheric composition and GCOS	Secretariat, Greg, chairs of infrastructure groups, GCOS representative	2Q 2021		
AI-6.7	Communicate through the GAW community the importance of exchange of the atmospheric composition data (Unified Data Policy through national focal points)	SSC to prepare the respective letter	1Q 2021		
AI-7.7	Organize a drafting team to produce a high-profile publication related to the needs for atmospheric composition observations	Marcos Andrade to lead (Melita to bring iCACGP)	1Q 2021		
AI-8.7	Develop a community document on the cost of the atmospheric composition measurements to be used for communications with the PRs	ET-ACMO in collaboration with SAGs and Admir to lead from SSC	3Q 2021		Outdated GAW Report can be used as an initial guidance
AI-9.7	SSC to amend the current Implementation Plan	Greg Carmichael, SSC members, Secretariat	1Q 2021	AI-13.6	
AI-10.7	Organize a support mechanism for SAG chairs exchange on the COVID-19 work in GAW	Secretariat	1Q 2021		initiated
AI-11.7	To form a think tank group on conceptual development of the next GAW IP	Greg Carmichael, SSC	2Q 2021		Initial composition to be considered at the interim SSC meeting Q3 2021

Action Item Number	Content	Responsible	Deadline	Relation to the action item of the pervious SSC meeting (AI-XX.1, AI-XX.2 and AI-XX.3)	Open/ closed
AI-12.7	Form a health thematic group to take stock and coordinate inputs to the WHO joint workplan, SG-Health	Tong Zhu, nominations from GAW groups	Q2 2021		
AI-13.7	Evaluate status of atmospheric composition observations over the ocean (connecting with IMO)	Kobus Pienaar to lead	Q3 2021		
AI-14.7	To evaluate needs and opportunity of creating a Task Team on vertical transport/PBL	Greg Carmichael, SAG App, WWRP	Q1 2021		
AI-15.7	Communicate to the RB the availability and delivery timeline of the GAW Bulletin and other outreach materials and ask the RB for promotion	Secretariat	Ongoing		
AI-16.7	Establish a focal group on the biomass burning in GAW	Under scope of SAG App	2Q 2021	AI-6.6	
AI-17.7	Review the content of the migrated website content	SSC members and SAGs	Ongoing	AI-11.6	
AI-18.7	Solicit experts in GAW to provide input to the RB paper on AI	Julie Nicely to lead	2Q 2021		
AI-19.7	SSC requests the ET-ACDM to come up with a proposal for unified metadata for all data centres	Joerg Klausen	4Q 2021		
AI-20.7	ET-ACMQ in collaboration with the other GAW group to develop a guidance document for the GAW community of the automatic QA tools and organize a library of such tools for NRT data delivery	Herman Smit	4Q 2021		
AI-21.7	Update SSC on the strategy for the future GALION	Paolo Laj	2Q 2021		

Action Item Number	Content	Responsible	Deadline	Relation to the action item of the previous SSC meeting (AI-XX.1, AI-XX.2 and AI-XX.3)	Open/closed
AI-22.7	Further facilitate progress of RRR implementation	Greg Carmichael	1Q 2021		
AI-23.7	Organize discussions with SPARC concerning coordination of stratospheric ozone activities	Greg Carmichael, Matt Tully, WCRP	2Q 2021		
AI-24.7	Organize discussion concerning joint activities with IGAC	Greg Carmichael, Melita Keywood	Ongoing		
AI-25.7	Evaluate the need for the new Expert Team on innovative measurement technologies	SSC to think further	Ongoing		

3. Ongoing activities that require attention/support of SSC and long-term actions

The following ongoing activities are considered as requiring the attention of the SSC:

- Development of a concrete plan for resource mobilization by engaging with the relevant activities/members of the Research Board;
 - Working with the science-for-services initiative development and implement data sharing policy for the data originating from those initiatives;
 - Contribute to the work of the Research Board on the organization of the open science meeting on 2025 and development of the next phase of the Implementation Plan;
 - Ongoing improvement of the guidance to GAW groups (on expectations and deliverables);
 - Continue efforts to engage with the other research programmes on common topics.
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ACTION ITEMS OF THE PREVIOUS EPAC-SSC SESSION

Action Item Number	Content	Responsible	Deadline	Relation to the action item of the pervious SSC meeting (AI-XX.1, AI-XX.2 and AI-XX.3)	Open/ closed
AI-1.6	Propose new SSC members and revise SAG memberships	Greg Carmichael, SSC members and Secretariat	1Q 2020	Follow up on AI-17.4, AI-1.5	Added three new members, a representative from RA 1 is needed
AI-2.6	Revise ToRs of subsidiary bodies and approve by correspondence	SSC, SAG/ET/SC Chairs	2Q 2020		Closed: ToRs are approved by the Research Board
AI-3.6	Establish Capacity-Development group	Greg Carmichael, SSC members	3Q 2020		Open: Will be followed up in 2021
AI-4.6	Facilitated the update of the low-cost sensors (LCS) report and follow up	Secretariat	End 2020		Closed: Updated statement to be was launched in February 2021
AI-5.6	GAW SAG-O3 present report on new instruments	Matt Tully	Q2 2021		Open: Work in progress (follow up on the comp campaign at Izana)
AI-6.6	SAG App to report to SSC on collaboration with the Interdisciplinary Biomass Burning Initiative (IBBI)	Vincent-Henri Peuch	3Q 2020		Closed: two new centres established, former members of IBBI contribute to GAW groups
AI-7.6	SAG-GURME to present the work on Urban Heat Island Guidance to SSC	Ranjeet Sokhi	3Q 2021		Open: In progress, webinar in summer to launch
AI-8.6	Secretariat to keep SSC abreast with the development of the Study Group on integrated urban services	Secretariat	4Q 2020		Ongoing
AI-9.6	Secretariat working with international offices populate expert database	Secretariat	4Q 2020		Closed

Action Item Number	Content	Responsible	Deadline	Relation to the action item of the pervious SSC meeting (AI-XX.1, AI-XX.2 and AI-XX.3)	Open/closed
AI-10.6	Follow up with the SAG O3-UV on the progress with development of the UV App	Matt Tully	4Q 2020		Closed: the App was launched in 2021
AI-11.6	Review the content of the migrated website content	SSC members and SAGs	3Q 2020		Ongoing
AI-12.6	SAG-TAD to connect with GESAMP on ocean management workshop in South Africa	Ariel Stein, Bob Duce	2Q 2020		Open: Workshop was postponed by 1 year due to COVID-19
AI-13.6	SSC to amend the current Implementation Plan	Greg Carmichael, SSC members, Secretariat	4Q 2020		Closed: SSC will focus on the development of new IP
AI-14.6	SSC to initiate the process for the drafting of the GAW IP for after 2023	Greg Carmichael, SSC members, Secretariat	1Q 2021		Open: additional SSC meeting on IP after GAW Symposium
AI-15.6	Keep track on the engagement of the GAW experts in the substructures of the new technical commission	Secretariat	3Q 2020		Closed
AI-16.6	ET-ACDM to revise and present to SSC the updated federated data management strategy	Joerg Klausen	4Q 2020		Open: need further discussions by SSC
AI-17.6	Request groups to nominate members to group on capacity-development	Greg Carmichael	2Q 2020		Closed: was followed up in 2021

For more information, please contact:

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