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## 23rd Session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC-23)

Darmstadt, Germany  
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GCOS-218  
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*Note this report does not describe all the presentations but summarizes the discussions and actions agreed.*

*Presentations are made available at: <https://public.wmo.int/en/programmes/global-climate-observing-system/atmospheric-observation-panel-climate>*

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## 1. OPENING OF THE MEETING

AOPC-23 was held at EUMETSAT, in Darmstadt. The meeting opened with a welcome to all participants from the AOPC Chairman, Ken Holmlund, who also welcomed the new panel members, Imke Durre, Rainer Hollmann and Dale Hurst. All the participants introduced themselves and explained their role within AOPC. The list of participants can be found in Annex 1. The agenda (Annex 2) was adopted.

The goal of the meeting was to present to the panel the progress of the four Task Teams instigated at AOPC-22, to review the progress of the GCOS Implementation Plan (GCOS-200) actions and to agree on the definitions for the ECV products to be then used for both the ECV fact sheets and the OSCAR requirements database.

Ken Holmlund explained general logistics and organization of additional activities.

Alain Ratier, Director General of EUMETSAT welcomed the participants. He underlined the importance of GCOS for EUMETSAT. Since the year 2000, climate monitoring is part of the EUMETSAT programme, with EUMETSAT playing a big role in the Committee on Earth Observation Satellites/Coordination Group for meteorological Satellite (CEOS/CGMS) Working Group on Climate, WGClimate, in the ECV inventory and in work to determine the uncertainty in the Climate Data Records.

## 2. UPDATE FROM GCOS

Stephen Briggs

[Update from GCOS](#) (link to presentation)

Carolin Richter

Stephen Briggs and Carolin Richter presented an update of GCOS activities. Following action G3 and G4 of the GCOS Implementation Plan (GCOS-200), GCOS undertook the task to develop climate indicators, which was specifically noted by Subsidiary Body for Scientific and Technological Advice (SBSTA). GCOS has now identified a set of Climate Indicators; surface temperature, ocean heat, atmospheric CO<sub>2</sub>, sea level, ocean acidification, glacier mass balance and Arctic and Antarctic sea ice extent, that are meant to be used to tell stories about climate change in a way that can be understood by non-experts. A set of subsidiary indicators are under discussion. Discussions on identifying a climate indicator for land surface, as phenology or greenness, and for extremes are still ongoing. Carolin Richter presented on the GCOS contribution to the Global Stocktake. The GCOS Steering Committee at its 25<sup>th</sup> meeting (GCOS SC-25) agreed to create a task force to determine how GCOS could contribute to the United Nations Framework Convention on Climate Change (UNFCCC)'s Paris Agreement. The task force will also develop a plan for adaptation and mitigation that might then lead to the formation of a future GCOS panel on adaptation. The task force has identified several actions in the GCOS IP supporting Article 14 of the Paris agreement. Additionally it has also identified new areas, such as monitoring of the urban areas, which will include the design of other urban based adaptation observations and the monitoring of the impacts of adaptation.

A document presenting GCOS contributions to the UNFCCC's Paris Agreement is under preparation and once ready it will be shared with the UNFCCC and the GCOS Steering Committee. GCOS will also distribute the consolidated document to AOPC members. Carolin Richter presented the draft GCOS strategy plan, the GCOS Communication strategy and the time plan for 2018-2023, which includes a joint panel meeting in 2019 in Morocco, a science conference, the revision of the status report identifying gaps and ultimately leads to recommendations and actions for a revision of the IP to be published in 2023. During the discussion following this presentation, it was noted that as a result of the ongoing dialogue between GCOS and UNFCCC and the success of an Earth Information Day organized by GCOS for the Conferences of the Parties (COP) 21, GCOS had been asked to organize a similar event for COP 22.

Action: GCOS and the Paris Agreement	Responsibility
1) GCOS to distribute to AOPC members the consolidated document about the role of GCOS in Paris Agreement	GCOS Secretariat

## 2.1 Update from AOPC chair

Kenneth Holmlund  
Caterina Tassone

[Overview](#) (link to presentation)

Ken Holmlund presented a status report on AOPC and the key points from the last session of the GCOS Steering Committee (GCOS SC-25) of interest to the AOPC panel, which are:

- Complement ECV products requirements, including identifying product requirements for adaptation needs;
- Develop fact sheets for the ECVs;
- Ensure a stronger involvement in the IPCC review process;
- Establish a working group across the panels on the use of the WIGOS Meta Data standards;
- Noted a lack of adaptation expertise within AOPC;
- Noted problematic gender balance within AOPC;
- Need to review Membership (2<sup>nd</sup> term not automatic).

Ken Holmlund also confirmed that the strategy adopted to raise panel members' participation through the year, which consisted in having full panel webex meetings every three months, was very successful, and he suggested that a similar approach should be used for facilitating the interaction between the three panels. He also explained that in order to work efficiently, each atmospheric related action of IP is assigned to a AOPC member, who is responsible for the coordination and reporting to the panel on the action. Similarly, each ECV is assigned to a AOPC member who is responsible for reviewing and updating the User Requirements in the IP, and responding to questions related to the specific ECV. The list of the ECV stewards can be found in Annex 5. Finally Ken Holmlund expressed concern about the funding of certain types of observations.

In the discussion following the presentation, the need to consider urban observations was raised. It was noted that urban observations are not useful for climate monitoring but rather for adaptation, and thus one set of observations cannot be used for both needs. Cities are currently already adapting to climate change compared to countries and regions, and information on cities can be extremely useful also for the Global Stocktake. However, data sharing is still an issue.

Actions from the panel meeting in 2017 (Annex 3) were reviewed. Action 22/2 and 22/12 are still ongoing, GCOS Secretariat and Peter Thorne will continue working on these actions. Action 22/13, required AOPC to appoint a member for a joint working group with the other panels on metadata standards. Imke Durre volunteered to take up this role.

All other actions are closed, with the exception of action 22/20 on parallel observations collection and analysis effort.

It is suggested that the WMO Integrated Global Observing System (WIGOS) could be the platform to move this action forward. However, even if parallel measurements are shared, there is still no repository to store them. The action was closed as it is expected WIGOS to work on this issue. GCOS Secretariat will follow progress with WIGOS.

Action: Urban Observations	Responsibility
2) GCOS Secretariat to contact Copernicus UrbanSIS to explore urban ECV	GCOS Secretariat
Action: Parallel measurements	Responsibility
3) GCOS Secretariat to follow progress with WIGOS on parallel measurements.	GCOS Secretariat

## 2.2 Update from WCRP

Shinya Kobayashi

[WCRP](#) (link to presentation)

Shinya Kobayashi presented an update for WCRP. The two overarching objectives of WCRP are to determine the predictability of climate and the effect of human activities on climate. Observations are critical across the entire WCRP enterprise, from process studies, to model development, initialization and verification, and there is a strong link to GCOS through the WCRP Data Advisory Council (WDAC). He reported also on the 5<sup>th</sup> conference on Reanalysis which was held in November 2017. Key messages from this conference were the importance of supporting the use of observations for reanalysis, including the use of high-quality observations and of datasets extended back in time, and the need to promote quantification and communication of the quality of reanalyses that would broaden their usage in operational services and policy making.

Shinya Kobayashi also explained that major volcanic eruption impacts on decadal and seasonal forecasts. There is the additional need of near-real time observations of SO<sub>2</sub> amount, injection height and dispersion in the stratosphere. It was noted that even though the WCRP has volcanic ash among their requirements in their application area, the requirement for SO<sub>2</sub> is very important for monitoring volcano eruption and should therefore be added to the requirements. Finally, the new WCRP strategy was presented to the panel. There is an explicit reference in the current draft strategic plan to a sustained observing systems and innovation, international coordinated field experiments, open data policies and interoperability, high-end data infrastructures and stronger WCRP-GCOS strategic alignment. The Implementation Plan will address WCRP-GCOS governance.

## 2.3 Upcoming Joint Steering Committee of WCRP

Carolin Richter

Carolin Richter acknowledged that Shinya Kobayashi's presentation had covered the important points regarding WCRP activities. She emphasized the importance of the collaboration between GCOS and WCRP, noting also that the GCOS scientific panels are shared with WCRP. With the WCRP strategy due to be finalized, Carolin Richter asked Shinya Kobayashi to convey to WCRP the message that there is strong alignment between GCOS and WCRP. WCRP should rely on GCOS to formulate their specific requirements, using the same mechanism that was used in the past.

## 3. GENERAL INFORMATION

### 3.1 Anomalous Behaviour of lower stratospheric O<sub>3</sub> and H<sub>2</sub>O

Dale Hurst

[Anomalous Behaviour of Lower Stratospheric O<sub>3</sub> and H<sub>2</sub>O](#)  
(link to presentation)

Dale Hurst presented the trends in stratospheric ozone from 1998 to 2016 based on four merged satellite-based ozone records and on two chemistry-climate models. Verification of downward trends is obtained with the Electrochemical Concentration Cell (ECC) ozone-sondes, underlying the need to continue using radiosondes for O<sub>3</sub>. Dale Hurst also showed the stratospheric water vapour behavior in the stratosphere, where a strong anomalous drop in the tropical areas is seen in 2016.

### 3.2 National Centers for Environmental Information (NCEI) Update

Imke Durre

[NCEI](#) (link to presentation)

Imke Durre presented the ongoing work at NCEI. NCEI is the steward of oceanic, atmospheric and geophysical data and is responsible for preserving, monitoring, assessing and providing public access to these data. She presented different examples of description of historical events using multiple sources, and examples of monitoring data reports, such as for daily precipitation, for daily max, min and average temperature, sub-daily synoptic and sub-monthly  $T_{\min}$  reports. She finally commented that NCEI did not switch to using WIGOS station identifier as those are not yet widely used.

### 3.3 Climate Monitoring SAF: An overview

Rainer Hollmann

[Overview](#) (link to presentation)

Rainer Hollmann, as the head of science satellite earth based radiation, presented the EUMETSAT Satellite Application Facility on Climate Monitoring (CM SAF), whose objective is to generate and archive high-quality satellite-derived products of the energy & water cycle in support to monitor, understand and adapt to climate variability and climate change. One of the objectives for CM SAF is to provide cyclic update of CDRs of variables related to GCOS and the energy & water cycle. As of now, 20% of Climate Data Records (CDR) in the WG Climate ECV inventory are from CM SAF. Plans for the 2017-2022 period include to extend the CDR portfolio with global precipitation CDR and regional evapotranspiration CDR. He presented some examples of products provided by the CM SAF and released in early 2017, e.g. brightness temperature, surface albedo, surface radiation, cloud properties, and showed an example of integrated Multi Source Climate Monitoring for the sunshine duration, where significant improvement is seen when combining the in-situ and satellite data. Finally, he explained that with the CM SAF Interim Climate Data Record (ICDR) it is possible to release products that can be used as support to climate services five days after observations are made.

### 3.4 Air-sea heat fluxes and wind stress Ocean ECV: relation to AOPC.

Elizabeth Kent

[OOPC-fluxes](#) (link to presentation)

Elizabeth Kent gave an overview of the upcoming conference OceanObs'19 (September 16-20 2019), whose main goal is to further develop effective strategies for a sustained, multidisciplinary, and integrated ocean observing system, and to better connect user communities and observers. She then presented the elements of the strategy to achieve observations for air-sea fluxes on a global basis, which include:

- Surface flux reference sites: time series moorings (sustained, high temporal resolution, and representative and critical sites, ~10 per ocean basin);
- Well-instrumented Voluntary Observing Ships (VOS) (supply ships going to polar regions, select upgraded routes for spatial structure and representativeness of flux reference sites);
- Gridded products (reanalysis, satellite, blended) - Tuned/validated against flux reference sites;
- Ongoing, facilitated comparisons;
- Attention to quality, improvement (dedicated in-situ comparisons and sensor and bulk formulae improvements);
- Hybrid products with assimilation and/or constraints.

Heat flux depends on the surface ECV from atmosphere and on clouds. It results from a parameterization, so high resolution ECV measurements are needed in order to use a formula to compute heat stress. In-situ measurements are needed, as surface heat flux cannot be measured with satellite. This topic requires both panels, AOPC and OOPC, to work together, in order to avoid to propose different requirements for the same variables.

Action: Air-sea fluxes	Responsibility
4) Connect with OOPC to explore if they would be supporting of a co-writing team for writing a white paper about requirements for fluxes. Present paper at next AOPC.	Liz Kent

## 4. GCOS IMPLEMENTATION PLAN

### 4.1 Open and ongoing actions

Ken Holmlund [IP actions](#) (link to presentation)

Ken Holmlund presented the AOPC relevant actions of the GCOS Implementation Plan.

### 4.2 CEOS-CGMS JWGC and status of actions to the IP

Jörg Schulz [CEOS/CGMS-WG](#) (link to presentation)

After a brief introduction of the WGClimate, whose main task is to coordinate and encourage collaborative activities between the world’s major space agencies in the area of climate monitoring, Jörg Schulz presented the Space Agencies response to the GCOS IP that addresses those GCOS IP actions with space relevance. A technical supplement that includes more detailed responses to the GCOS IP has been drafted, and will be shared with the AOPC panel members. The work of the WGClimate is focusing on two main topics, the Space Agency Response to the GCOS IP and the Implementation of the Climate Architecture via the population of the ECV inventory followed by the Gap Analysis and the Action Plan. The ECV inventory has 913 records and covers 30 out of the 37 possible ECVs, providing detailed view for each data record. WGClimate plans to deliver the first gap analysis report and action plan for endorsement at the 33rd Meeting of the CEOS Strategic Implementation Team (SIT-33, 23-25 April 2018) and at CGMS Plenary (CGMS-46, 3-8 June 2018) and the second gap analysis and action plan for endorsement by 2019 CEOS and CGMS Plenaries.

Action: Response of Space Agencies to GCOS IP	Responsibility
5) A technical supplement for the Space Agency Response to the GCOS IP is ready. GCOS Secretariat to send this supplement to the AOPC panel members.	GCOS Secretariat

Action: GCOS and Space agencies	Responsibility
6) Provide standing invitation with standing agenda item to a space rapporteur	GCOS Secretariat

### 4.3 Harmonization of global radiosoundings and Global Navigation Satellite Systems (GNSS) data in the frame of Copernicus Climate Change Service (C3S)

Fabio Madonna

[GNSS](#) (link to presentation)

Fabio Madonna presented the objectives of the C3S\_311a\_LOT3: rationalize, harmonize and improve access to open and free observational records. This will lead to the development of consistent quality control algorithms for in situ climate data arising from Baseline and Reference networks at various time scales (hourly, daily, monthly, annually), the development of methods to detect and adjust for inhomogeneity due to instrumentation changes, calibration drifts and observing station relocations, and will provide and quantify uncertainty in a consistent and metrologically rigorous manner. According to the Service Contract 1, Lot3 must facilitate access to data from the following networks:

- Surface Temperature: USCRN, RBSN, GSN, RBCN;
- Temperature/humidity/wind (profiles): GRUAN, GUAN, RAOB;
- Ozone (concentration, columns and profiles): NDACC, SHADOZ, GAW Networks;
- CO, CO<sub>2</sub>, CH<sub>4</sub> (concentration, columns and profiles): TCCON, GAW networks;
- Integrated water vapour (from GNSS zenith tropospheric delay only): International GNSS Service (IGS), EUREF, all international GNSS networks.

The first part of the project focusses on access to in-situ sounding temperature and humidity from reference and baseline radiosoundings network and time series harmonization. All the data and metadata will be provided to C3S users using a Common Data Model. The second step will include the estimation of uncertainties, identification of breaks and adjustment for historical data back to 1979 (only for station having metadata since 2000). Acknowledging the importance to provide the C3S users with the best ensemble of the available harmonization datasets of radiosounding temperature and humidity profiles, C3S 311a Lot3 will also make available a few already existing harmonized radiosonde datasets provided by several institutions over the last decade. In 2020 the focus will be on facilitating access to the data from international GNSS networks and to harmonize the retrieval of integrated water vapour using the GRUAN GNSS data processing, which is the only one that has a complete analysis of total uncertainty of the GNSS Integrated Precipitable Water (GNSS-IPW).

### 4.4 Breakout groups

Actions from the IP were divided into three areas; composition, radiation and other actions

- Breakout group on Radiation IP Actions (A11 and A12)

The breakout group discussed actions A11 and A12 of the Implementation Plan.

For A11 it was recognized that additional support from GCOS to the operations of the Baseline Surface Radiation Network (BSRN) would be of benefit, although given that most of the resources available to the BSRN community was voluntary, the extent to expansion of the network/more data in the archive would be limited. It was agreed that:

- (1) AOPC would continue to invite BSRN to report to the meeting on a biennial basis;
- (2) GCOS would continue to support the biennial BSRN workshop;
- (3) GCOS Secretariat would assist, as requested, the BSRN archive manager for the communication and management with WMO Members, both in terms of inactive stations and the integration of new stations.

For A12 it was noted that there was no communication between the BSRN management and that of the World Radiation Data Centre (WRDC) in Russia. It was agreed that:

(1) The GCOS Secretariat would contact the WRDC for a status report on the archive and any issues. Plus request that the WRDC provide an annual report to AOPC.

(2) Phil Jones agreed to contact the World Energy and meteorological Council (WEMC) about the available of radiation data from the private sector and whether this is made available to the WRDC.

- Break out group on Composition:

For A32 Olga Kalashnikova will communicate with the Copernicus group working on this and with WGClimate.

For A33 the Global Atmosphere Watch (GAW) will report on progress and GCOS and GAW will work together to establish a quantitative framework.

There is modest progress on A35. Greg Carmichael will check on the report by WGClimate in October 2018.

- Break out group on other actions:

For A1: C3S lot 3 should provide access to historical GSN, lot 2 to near-real data. AOPC needs to monitor progress. Peter Thorne will report at AOPC-24 and pending on progress, AOPC is to consider transition this action to a routine activity. Imke Durre will report on progress of daily Climate to AOPC-24.

For A2 The meeting confirmed nominal progress with anticipated testing of the beta release. Peter Thorne and Elizabeth Kent to report at AOPC-24.

For A3 it is decided to refocus activity on the actual action and to report on progress at next teleconference.

For A4 it is required that GCOS Secretariat re-discuss how to proceed with this action.

For A5, regarding the transition to BUFR, more information from the NMHSs regarding their plans for the transitions including the time if known, needs to be obtained. GCOS Secretariat should prepare the request to be sent to GCOS Focal Points.

For A6 could also benefit on direct interaction with the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM).

For A10 it is decided to concentrate on the availability of sunshine data records at the NMHSs and whether those are mostly for climate. It was highlighted that many European NHMSs are now sharing radiation measurements. The GCOS Secretariat will ask Rainer Hollmann to follow up on this action.

For A20 it is decided that GCOS needs to get an update on aircraft observation by asking the Expert Team on Aircraft-Based Observing Systems (ET-EBO) for an update and possibly to provide a report, if available. Caterina Tassone will contact Dean Lockett.

For A28 Zhanqing Li reports that there is a lot of interest at NASA and it will be beneficial to have an endorsement from GCOS. For now, he is going to look in how to better implement this action.

The list of actions updated from AOPC-23 will be provided to AOPC by GCOS Secretariat.

#### 4.5 Presentations from breakout groups

During the presentations from the breakout groups it was decided that AOPC needs to find experts to address the actions that have not been started yet, in particular with radiation expertise. Stephen Briggs suggested that for each actions there should be more background information and more detailed information on progress.

Action: IP actions	Responsibility
7) Develop a better formulation of the IP actions that includes also specifying the sub-actions within the action, the responsible partie(s), and updating a detailed description of the status of the action itself.	GCOS Secretariat together with AOPC member responsible of action

## 5. NETWORKS UPDATE

### 5.1 Update on the BSRN and the WRMC

Amelie Driemel

[BSRN](#) (link to presentation)

The Baseline Surface Radiation Network (BSRN, <http://bsrn.awi.de/>) is a global observatory network that provides observations of the best possible quality for short and long-wave surface radiation fluxes in 1 min resolution. All data from the BSRN are archived in the World Radiation Monitoring Center (WRMC), at the Alfred-Wegener Institut in Bremerhaven. Amelie Driemel, in her function of director of the WRMC, presented the main issues:

- As of March 2018, the network comprises more than 10 000 monthly datasets;
- New data paper on BSRN in the Journal ESSD (<https://doi.org/10.5194/essd-2018-8>);
- Some stations closed or no longer maintained or exhibit financial problems;
- Inactive status will be introduced for stations that lag behind with submission for more than 2 years;
- Some quality issues e.g. in remote areas difficult to manage;
- Lots of retirements in 2017 (concerns stations: CAM/LER, GVN, LIN, TAM, SURFRAD stations, Australian stations).

Discussion that followed pointed out that as part of an action of the GCOS IP, the BSRN should expand, however, there is no support for having more stations. There was also a question whether there are adequate change management procedures. There are guidelines on changes to the metadata, but not for a change of a station scientist. There are generally no parallel measurements (e.g. when changing instruments) and there is also the issue of changing surroundings for some stations, for example when buildings are built around a station (prominent case: XIA, which had to be excluded from the BSRN network). GCOS monitoring principles are good guidelines for accompanying changes. Since the BSRN is designated as the global baseline network for surface radiation for GCOS, GCOS has a responsibility of getting more involved with the BSRN. Therefore, GCOS should strengthen the relation with BSRN. If possible, there should be GCOS presence at the 15th BSRN Workshop held at CIRES, Boulder CO, 16-20 July 2018. To facilitate possible funding of the BSRN it is however important to emphasize the importance of this network for different applications, such as solar energy, satellite validation and closing the energy and hydrological cycles.

### 5.2 GSN, GUAN and GCM

Tim Oakley

[GSN, GUAN and GCM](#) (link to presentation)

Tim Oakley presented his 2017 monitoring report on the GCOS Surface Network (GSN) and the GCOS Upper-Air Network (GUAN) performance to the meeting. Whilst both networks in all WMO Regions were far from optimum, there were indications of even further deterioration of the networks in RA-I (Africa) and to a lesser extent RA-III (South America). The primary reasons for these networks poor performance continues to be the lack of resources, and skills, in the operations and maintenance of the instrumentation, and for the GUAN the provision of consumables.

The projects undertaken by the GCOS Cooperation Mechanism (GCM) were also presented but due to the lack of new funds into the trust fund this has been limited to only ongoing projects or those directly targeted by the sponsoring country.

Tim Oakley as the GCOS network manager was requested to make contact again with the Ecuador Met Service for an update on the status of the Galapagos station, to see if GCM support would be beneficial to restart the measurements in this unique and beneficial location.

One of the suggestions from the panel was to consider whether there is another station in the proximity of a non-working GUAN station with better performance. If this is the case, support to the GUAN station should end. It was also proposed that funding should go preferably to stations having long records.

Action: GUAN	Responsibility
8) Contact the Met service of Ecuador and ask for an update for the state of the upper air station. Offer help if necessary	Tim Oakley

### 5.3 Update on GRUAN activities

Ruud Dirksen

[GRUAN](#) (link to presentation)

Ruud Dirksen presented an update on the GCOS Reference Upper-Air Network (GRUAN) activities. GRUAN has currently 26 sites, with the aim to expand to 30-40 sites worldwide. Priority for GRUAN in terms of measurements are temperature, water vapour, pressure and wind, as well as ozone. A Lead Centre provides for day-to-day management of the network, the coordination among stations and archival and dissemination of GRUAN data. There are more than 30000 GRUAN-processed radiosounding profiles in the archive. Measurements for GRUAN include also stratospheric water vapour soundings, which are done with RS92 up to the Upper Troposphere-Lower Stratosphere (UTLS) and with a reference instrument, e.g. Frost Point Hygrometer (FPH) or the Cryogenic Frost Point Hygrometer (CFH), above the UTLS. There are 9 GRUAN sites with these kind of soundings. There is a lot of work ongoing for the change from RS92 to RS41, including calibration and intercomparisons studies.

According to Ruud Dirksen, the more urgent issues that need attention are:

- Need for GRUAN sites in Africa, S. America, Central Asia: it is suggested for the panel members to identify people they know and might be interested and put them in contact with the Lead Centre. There is also a recent interest from Senegal, and Bob Holzworth will provide a contact in Brazil. There is evidence of growing interest from China as they are sending five people to next Implementation Coordination Meeting ICM-10;
- Impending ban on R23 cryogen (essential for CFH): This will be discussed at next ICM10. The report of this meeting will be provided to AOPC that will follow up in order to make sure that there will be no impact on climate monitoring;
- Vacant co-chair: The situation of selecting a new co-chair is problematic, as the document defining a new Terms Of Reference for the co-chair has not been approved yet. GCOS Secretariat will organize a teleconference where the major players (GCOS, Deutscher Wetterdienst (DWD), Lead Centre, the WG chair, WMO/CLW and WMO/OBS) will agree on a way forward;
- Lead Centre: Limited resources and time divided between DWD and GRUAN; many tasks items reside with the Lead Centre and lead to delays and backlog. Therefore 3 people are not enough and 3 more people would be needed to run the Lead Centre successfully;
- More support from GCOS Secretariat: GCOS already agreed that it will write the report of the annual ICM meetings. As more help is requested, Ruud Dirksen agreed to prepare a list on possible duties for the Lead Centre that could be taken up by GCOS Secretariat. The list will then be reviewed by AOPC and a decision on how best for GCOS to support the Lead Centre will be taken.

Action: GRUAN	Responsibility
9) Given the lack of GRUAN in some area of the world, AOPC panel members are asked to reach out to their contacts in these countries and to let Ruud Dirksen know of these contacts.	AOPC

Action: GRUAN	Responsibility
10) Provide GCOS Secretariat with a list of possible duties of Lead Centre to be taken up by GCOS. List will then be forwarded to AOPC and discussed at next teleconference	Ruud Dirksen

## 6. TASK TEAMS

### 6.1 GCOS Surface Reference Network Task Team (GSRN TT)

Peter Thorne

[GSRN](#) (link to presentation)

Peter Thorne presented the report of the 1st meeting of the GSRN Task Team. He summarized the key issues and the work plan.

The work of the Task Team builds on an initial whitepaper, [Thorne et al. \(2018\)](#) that provides a firm underlying scientific foundation. During the 1st meeting the task team agreed on a list of benefits, requirements, design principles, diversity of areas observed and ECVs to be observed. The output of this meeting is summarized in GCOS-214.

At the meeting it was agreed that many ECVs should be measured at the same site, though not necessary at all sites, and the sites should be chosen to be representative of the different climate zones. It is suggested to start from existing stations and then to expand the network. The next step is to draft a document as done for GRUAN (GCOS-112) to give the GSRN a firm technical foundation. The job of this Task Team is to provide the documentation and work necessary to WMO members to decide if this is something that the global climate community wants to take on. The Task Team will also consider the necessity of another meeting, where a broader community should be invited to participate.

In the discussion that followed the presentation one of the main points was the need to determine the fundamental questions a GSRN should be able to answer. It was also noted the importance of identifying the existing stations and how many of them already satisfy the requirements of a surface reference network. It was also suggested that the GSRN would benefit greatly from the creation of a Lead Centre.

The panel members are asked to review the GCOS-214 and in particular to suggest benefits of such a network related to their expertise.

Action: GSRN TT	Responsibility
11) AOPC to provide input on Annex 4 of GCOS-214 and in particular to suggest benefits of such a network related to their expertise.	AOPC

### 6.2 Lightning Task Team

Robert Holzworth

[TTLOCA](#) (link to presentation)

In the GCOS IP (GCOS-200), lightning was recognized as a new ECV. A task team on lightning (TTLOCA) was established with the main task to define standards and requirements for data management and data exchange of lightning monitoring for climate applications; propose a strategy for open data access for lightning climate applications given the dominance of the private sector and encourage space agencies and operators of ground-based systems to provide global coverage and reprocessing of existing datasets. Robert Holzworth presented the work of the task team and the future workplan. So far, most data sources have been identified. In the next year, the TTLOCA will identify space and time resolution needed for Climate studies, work with government and private sources to settle on a reasonable Climate data set for

Lightning data, identify the metadata needed for such data sets to be useful (e.g. detection efficiencies) and write a white paper with the recommendations for Lightning data for climate applications.

### 6.3 Radar Task Team

Rainer Hollmann [Radar TT \(link to presentation\)](#)

Rainer Hollmann presented the progress of the radar task team. The radar task team is tasked with defining radar data requirements for climate monitoring, relevant metadata and best practices, identifying procedures for quality control of radar data for climate applications. In order to support future evolving climate applications, the recommendation of the task team is to save radar parameters, i.e. reflectivity in dBz and not accumulated rainfall in mm, 3-dimensional volume scans in the highest possible resolution and log of changes of important metadata.

The team has also defined minimum recommendations and a goal for metadata needed to use the radar data for climate studies and recommends a glossary of radar matters to be jointly defined with IPET-OWR. The team is also working with delivering an inventory of existing archives, guidance on how to facilitate user access and preservation of data and recommendation on how to handle historical data. All this information will be produced in a report that will be published as a GCOS report, to be then endorsed at AOPC-24. In order to raise awareness, a manuscript for BAMS will also be submitted.

AOPC agreed on the presented way forward. There was a consensus to include a recommendation that manufacturers should provide and store information on how the level 2 data product is being generated. It was also noted, that as radar will become increasingly important for reanalysis, the guidelines on data storage should reflect that. AOPC also asked that the Radar Task Team continues to link with the other task team within WMO. Future plans should include to make the data in existing archives available.

### 6.4 GUAN Task Team

Tim Oakley [GUAN TT \(link to presentation\)](#)

Tim Oakley presented the report of the 1st meeting of the GUAN Task Team (Lindenberg, Dec 2017). He summarized the key outputs from the meeting and the proposed work-plan. The primary decision from the Task Team experts was that the GUAN should not continue in its current form and should be reworked along the recommendations from the GCOS Ispra meeting, the details of which were included in the report submitted to the meeting.

AOPC agreed that the GUAN Task Team should continue with its current work-plan but regular updates should be provided to the quarterly teleconference of AOPC members.

Tim Oakley asked the AOPC panel to help identifying experts in radiosondes for the task team, as there is much work to be done by the task team but very few volunteers. As for GRUAN, it was suggested that GUAN would also benefit from the creations of a Lead Centre. AOPC also identified the need to better clarify the different network roles in terms of the tiered approach.

Action: GUAN TT	Responsibility
12) Propose to discuss the concept of a tiered network approach at GCOS joint panel meeting in 2019.	GCOS Secretariat

AOPC decided that the four Task Teams should proceed as planned and the outcome will be reviewed at next AOPC.

## 7. ECV SESSION

### 7.1 ECV requirements in OSCAR

John Eyre

[WIGOS RRR](#) (link to presentation)

John Eyre presented the WIGOS Rolling Review of Requirements (RRR) process, including the 14 Application Areas (AAs) and the statements of guidance (SoGs), which are gap analyses. Climate Monitoring is one of the AAs and, within the RRR process, GCOS is the recognized authority for it. The AA Climate Monitoring should now also include the GFCS requirements. Within the RRR process, Climate Monitoring is treated as an exception because of the work done by GCOS; the two GCOS reports, “Status of the Global Observing System for Climate GCOS-195” and The Global Observing System for Climate: Implementation Needs - GCOS 200” are considered as the SoG. The AA “Climate Science (WCRP)” should share requirements with the GCOS AA “Climate Monitoring” to the extent that requirements of the AA Climate Science are the same as those of GCOS. For other requirements of the AA Climate Science, such as those for observations for process studies, WCRP will propose separate requirements. It was also noted the GCOS requirements for atmospheric composition variables rely on advice from GAW, and therefore high level coordination is needed to further streamline those matters across the AAs. He explained also the OSCAR/Requirements and gave a detailed explanation of the three values for each of the variable within an application area: the "threshold" (minimum requirement to be met to ensure that data are useful), the "goal" (ideal requirement above which further improvements are not necessary) and the "breakthrough" (intermediate level between "threshold" and "goal" which, if achieved, would result in a significant improvement for the targeted application). GCOS will use these definitions when reviewing the requirements in the IP Annex A, where currently only one value is defined.

John Eyre presented also the vision for WIGOS 2040, the WIGOS Implementation plan and the requests from WMO/CBS and WIGOS to GCOS, which have been translated in the following actions:

Action: GCOS and CBS	Responsibility
13) Review of Vision for WIGOS in 2040	AOPC

Action: GCOS and CBS	Responsibility
14) Provide input for requirements for the atmospheric ECV for the Climate Monitoring Application area in OSCAR.	GCOS Secretariat and John Eyre

John Eyre agreed to help with providing input for requirements for the atmospheric ECV for the Climate Monitoring Application area in OSCAR.

### 7.2 Mapping of ECV products with OSCAR variables

Caterina Tassone

[ECV mapping](#) (link to presentation)

Caterina Tassone briefly presented the process needed to update the content of the OSCAR/Requirements for the Climate Monitoring Application Area. Initially, the GCOS requirements as specified in the GCOS IP (GCOS-200) Annex A for the different ECV products will be used. This requires a mapping of the ECV products with the OSCAR variables defined in the RRR, and therefore a clear definition of the ECV products, and also noting that OSCAR/Requirements contains requirements for observations. The work of providing definition for all the ECV products has already started and was led by the ECV stewards. While undertaken this work, it has been noted that some ECV products need to be redefined or in some cases new products need to be added to the list of existing one. Once this first step of mapping the ECV products with OSCAR

variables is completed, GCOS will provide a list of requirements for observations for Climate Monitoring to be reviewed by IPET-OSDE. It is already agreed that variables needed for fully describe an ECV but not yet included in OSCAR, will be added to OSCAR. When possible, the ECV products requirements from the IP will be used. Requirements for new ECV products or clearly out-of-date will be provided by the ECV steward and reviewed by the science community before being added to the OSCAR/requirement tables.

### 7.3 Fact sheets

Valentin Aich

[Fact sheets](#) (link to presentation)

Valentin Aich presented the drafts of the fact sheets. Fact sheets were requested by the GCOS Steering Committee as a tool to easily present the main characteristics of an ECV, including a rationale about the importance of the variable for climate monitoring, the definition and requirements of the ECV products, a list of data sources where these products can be found and a plot showing the trend of the ECV. The panel is asked to review the fact sheets and add missing information.

### 7.4 Breakout Groups

In order to move forward with defining and reviewing the ECV products and reviewing the fact sheets, the panel's member were divided into 3 groups (surface, upper-air and composition ECVs). The revised tables, although not completed yet, will be edited by GCOS Secretariat, reviewed by the ECV steward when necessary, and finally sent to IPET-OSDE chair for comments and suggestions.

There was no time to review the fact sheets and it was decided that this will be done offline. Each steward is to finalize the factsheets related to their ECV and GCOS Secretariat will circulate the ECV fact sheets to the full panel for final revision. Final approval of the fact sheets will take place during the quarterly teleconference.

Action: Fact Sheets	Responsibility
15) Review of the ECV fact sheets	AOPC

## 8. GENERAL INFORMATION

### 8.1 EUMETSAT reprocessing activities

Jörg Schulz

[EUMETSAT-Climate](#) (link to presentation)

Jorg Schulz summarized the work done by EUMETSAT in terms of contribution to climate monitoring, which includes long term, multi-satellite programmes, with service continuity; continuous improvement and expansion of portfolio of observations; unique patrimonial archive with decades of observations; data rescue; recalibration and production of climate records; data access; cooperation with users in validation, research and applications; training and support to climate-related capacity building initiatives. Efforts are made in terms of the estimation of uncertainties for Fundamental Climate Records, as decision making requires appreciation of uncertainties. Science and reference data are needed to document and trace uncertainties in observations and climate records. Recalibration of older data prior to 1982 is a huge opportunity even if difficult. Use of long climate data records for global reanalysis enables the analysis of high impact weather attributable to climate change.

## 8.2 GAIA-CLIM /IP Action 31

Peter Thorne

[GAIA-CLIM](#) (link to presentation)

Jörg Schulz

Peter Thorne presented the Gap Analysis for Integrated Atmospheric ECV CLimate Monitoring (GAIA-CLIM) key objectives:

- Improve the utility of non-space component to characterize the satellite component of EO;
- Develop tools and techniques;
- Provide advice on what next steps are required.

GAIA-CLIM is the direct response to Action 31 from the GCOS IP. Work leads to better understanding of where missing non-satellite observations are limiting, improved understanding of co-location effects and better quantification of the role of data assimilation. Jörg Schulz explained the GAIA-CLIM Virtual observatory, which makes co-located non satellite reference and satellite data available via the internet and supports the exploitation of ground-based reference data for satellite product validation at Level 1 and 2. There has been a substantive and sustained effort at identifying and documenting all relevant gaps, including gap characteristics, gap impacts and gap potential remedies. Eleven broad thematic recommendations have been formulated and now the challenge is how to use these recommendations. AOPC was asked for suggestion on how the recommendations can best gain visibility. The following action was decided:

Action: GAIA-CLIM	Responsibility
16) Panel to distribute the final report of GAIA-CLIM to relevant parties in their community to inform and get feedback.	AOPC

## 9. MISCELLANEOUS

### 9.1 Climate Extreme Indicators

Valentin Aich

[Climate Extreme Indicators](#) (link to presentation)

Valentin Aich presented extreme events indicators for heavy precipitation, droughts and heatwaves. AOPC proposed to add to this list an indicator for cold spells.

### 9.2 Regional Workshops

Tim Oakley

[Fiji GCOS/WIGOS Workshop](#) (link to presentation)

Valentin Aich

There was no time at the meeting to present the report on the Fiji GCOS/WIGOS workshop (October 2017) and the plans for further GCOS Regional workshops. The AOPC members were asked to review the document provided before the meeting, and if they have any comments or suggestions for future workshops to contact the GCOS Secretariat.

## 9.3 WMO Resolution 40 Annex 2 Discussion

Tim Oakley

Tim Oakley updated the meeting on the current for WMO Resolution 40, which is the primary data policy for all WMO Members sending meteorological and related data through the WMO Information System (WIS). There is a draft document to be approved by the Commission for Basic Systems (CBS), and then forwarded to WMO Executive Council, requesting an amendment to Annex to Resolution 40 and GCOS has been asked to contribute to this document.

The meeting agreed that the GCOS text should focus on the observations that contribute to the Essential Climate Variables and the gaps in historical data which can arise from reports not being transmitted.

## 10. CLOSURE

### 10.1 AOPC Workplan

Caterina Tassone

Actions for AOPC-23, see Annex 4 were discussed and agreed by the panel. It was agreed that the regular teleconference every three months for the panel members should be continued as this is a very effective tool to monitor and facilitate progress throughout the year.

### 10.2 AOB

The panel was presented with the suggestion of a Joint GCOS meeting that will include the three GCOS Science panels, AOPC, TOPC and OOPC, and were favourable to this idea.

Tentatively the Joint GCOS meeting will be held in Morocco, during the week 18<sup>th</sup> to 22<sup>nd</sup> March 2019.

The GCOS Secretariat and the panel participants expressed their sincere gratitude to the host of the meeting, Ken Holmlund. The AOPC benefited greatly from the provision of excellent meeting facilities and enjoyed thoroughly the generous hospitality of EUMETSAT.

The meeting closed on 9 March 2018 at 12:00 hrs.

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**ANNEX 2: Agenda**

## Agenda

Day 1: Tuesday, 6 <sup>th</sup> March 2018 (Opening, Updates and IP)					
Time		ITEM	N°	Presenter	Targeted outcome
09:00-9:15	Opening	Opening of the Meeting	1.		
		Welcome and introductions	1.1	Ratier	
		Adoption of Agenda	1.2	Holmlund	
		Introduction of participants	1.3	All	
		Conduct of the Meeting	1.4	Holmlund	
		Aims and expectations	1.5	Holmlund	
09:15-10:45	Opening	Update from the Secretariat	2.		
		Update from GCOS	2.1	Richter	Information
		Update from AOPC Chair. Presentation of actions from AOPC-22 and discussion	2.2	Holmlund/ Tassone	Closure of AOPC-22 actions and update of open actions for AOPC-23
10:45-11:00		Coffee Break			
11:00-12:30	Opening	General information	3.		
		Presentation	3.1	Hurst	Information
		Presentation (included NCEI update)	3.2	Durre	Information
		Presentation (included SAF)	3.3	Holmann	Information
		OOPC-fluxes	3.4	Kent	Information
12:30-14:00		Lunch			
14:00-15:30	Implementation Plan	Implementation Plan	4.		
		Open and ongoing actions	4.1	Holmlund/Tassone	IP
		Response to IP - satellite	4.2	Schultz	IP
		GNSS-C3S	4.3	Madonna	IP
15:30-15:50		Coffee Break			
15:50-17:30		Break out groups - IP actions	4.4		
17:30		End of day 1			

Day 2: Wednesday, 7 <sup>th</sup> March 2018 (Networks and Task Teams)					
Time		ITEM	N°	Presenter	Targeted outcome
09:00-10:15		Continuation of Implementation Plan	4		
		Presentation of break-out groups	4.4		Workplan for AOPC
10:15-10:30		Coffee Break			
10:30-11:15	Networks	Networks update	5.		
		BSRN	5.1	Driemel	
		GSN, GUAN and GCM	5.2	Oakley	
11:15-12:15		GRUAN	5.3	Dirksen	
12:15-13:30		Lunch			
13:30-17:30	Task Teams	Task Teams	6.		
		GCOPS Surface Reference Network TT	6.1	Thorne	
		Lightning Task Team	6.2	Holzworth	
		Coffee break			
		GUAN Task Team	6.3	Oakley/Thorne	
		Radar Task Team	6.4	Hollmann	
17:30		End of day 2			
19:30		Dinner			

Day 3: Thursday, 8 <sup>th</sup> March 2018 (ECV)					
Time		ITEM	N°	Presenter	Targeted outcome
		ECV session			
9:00-10:30		ECV requirements and the RRR	7.1	Eyre	
		Mapping of ECV products with OSCAR variables	7.2	Tassone	
		Fact sheets	7.3	Aich	
10:30-10:45		Coffee Break			
10:45-12:15		Break out groups on 7.	7.4		
12:15-13:00		Lunch			
13:00-14:00		Tour of EUMETSAT			
14:00-15:15		General information/or satellite(EUMETSAT)	8.		
		EUMETSAT reprocessing activities	8.1	Schulz	
		GAIA-CLIM/IP action 31	8.2	Schulz/Thorne	
15:15-15:30		Coffee Break			
15:30-16:30		Break out groups on 7.(continued)			
16:30-17:30		Discussion and approval of definition et al.			
17:30		End of day 3			

Day 4: Friday, 9 <sup>th</sup> March 2018 (Closure)					
Time		ITEM	N°	Presenter	Targeted outcome
09:00-10:00		Miscellaneous	9.		
		Climate Extreme indicators	9.1	Aich	
		Regional Workshops: a) Fiji GCOS WIGOS workshop b) Discussion on upcoming workshop	9.2	Oakley	
		WMO Resolution 40-Annex 2 Discussion	9.3	Oakley	
10:00-12:00	Closure	Closing	10.		
		Actions from AOPC-23	10.1	Tassone	New AOPC-23 actions
		AOB.	10.2	Holmlund	
12:00		End of Meeting			

**ANNEX 3: List of Actions from AOPC-22**

N°	Action	Responsibility	Status
22/1	<b>GCOS and WCRP cooperation:</b> GCOS and WCRP Secretariats to develop a formal process for collecting observational requirements for Climate Monitoring from the research community	GCOS Secretariat	Closed
22/2	<b>Open data policy:</b> Copernicus to request support from GCOS on national data availability and associated metadata. Involve WIGOS.	Peter Thorne	Ongoing
22/3	<b>Access to high quality networks:</b> Consider to invite Fabio Madonna to next AOPC as the service lead for lot 3 of Copernicus C3S_311a about access to high quality networks (baseline and reference network). The objective for this lot is to rationalize, harmonize and generally improve access to measurements provided by the large variety of existing networks, to facilitate climate monitoring, estimation of ECVs and uncertainty assessments.	GCOS Secretariat	Closed
22/4	<b>IP actions:</b> Identify experts on the way forward for IP actions postponed for future	AOPC	Closed
22/5	<b>ECV requirements :</b> Write a complete description of the Application Area (Climate monitoring) to be submitted to the other two panels, to be used for the OSCAR/requirements DB	GCOS Secretariat	Closed
22/6	<b>OSCAR/requirements:</b> Secretariat to discuss with the other panels the use of 3 values for the OSCAR requirements table	GCOS Secretariat	Closed
22/7	<b>Requirements for RS launches:</b> Put together the terms of reference for a task team to study the relationship between GUAN and the broader GOS radiosondes networks, including studying impacts on obtaining higher altitude for radiosondes, flexible launch time and keeping the original data from radiosondes	GCOS Secretariat, Phil Jones, Peter Thorne, Ken Holmlund	Closed
22/8	<b>Cloud and water vapour:</b> Ken Holmlund to discuss with Carolin Richter and Stephen Briggs how to best bring up to the space agencies the requirement for lidar type of mission. Possibly produce an AOPC position paper.	Ken Holmlund	Closed
22/9	<b>Cloud and water vapour:</b> Include discussion and notes sent from Helene Chepfer in report of AOPC22	GCOS Secretariat	Closed
22/10	<b>Cloud and water vapour:</b> bring up the requirement for lidar type of mission at CEOS and CGMS	Carolin Richter, Ken Holmlund	Closed
22/11	<b>IP requirements for GHG:</b> Unify the IP requirements for GHG. Jim Butler to start working at the GGMT in August.	James Butler, Greg Carmichael	Closed
22/12	<b>Metadata standards:</b> Facilitate contact with regard to the potential for the Copernicus service to use OSCAR (WIGOS). OSCAR only uses pub 9 as id, but Copernicus needs a larger set of station ids.	GCOS Secretariat and Peter Thorne	Ongoing
22/13	<b>Metadata standards:</b> AOPC to communicate to the other panels the decision to use WIGOS metadata standards and follow up. Set up a joint group to consider an extension for climate records standards that can build up on work already done by the climate CEOS CGMS JWG.	GCOS Secretariat	Open

22/14	<b>Review of ECV Observation Networks:</b> Contact Dick Dee in September to ask who was awarded the EQC contract and initiate a discussion, which includes details on how the work will move forward	GCOS Secretariat	Closed
22/15	<b>RRR and OSCAR:</b> Confirmation of ownership of RRR Application area Climate monitoring	GCOS Secretariat	Closed
22/16	<b>RRR and OSCAR:</b> Assistance in updating content of OSCAR/requirements for AA Climate Monitoring.	GCOS Secretariat	Ongoing
22/17	<b>RRR and OSCAR:</b> Update of references to GCOS documents that act as RRR s Statement of Guidance (gap analysis) for Climate Monitoring	GCOS Secretariat	Closed
22/18	<b>RRR and OSCAR:</b> Review of contents of OSCAR/Requirements, Space, Surface.	GCOS Secretariat	recommendation
22/19	<b>Lightning:</b> AOPC to engage a Task Team to work on lightning. John Eyre and Bruce Ingleby to give us names of possible experts. Task team to write a position paper on lightning that should then be peer reviewed.	AOPC	Closed
22/20	<b>Parallel observations collection and analysis effort:</b> GCOS sec to discuss with the other panels requests 1. and 2. from text above (Section 11.5 of AOPC-22 report)	GCOS Secretariat	Closed
22/21	<b>GSRN (GCOS Surface Reference Network):</b> Set up a task team to work on the way forward for establishing a GSRN. This includes writing a term of reference and selecting the composition and leader of the task team.	Peter Thorne, Ken Holmlund, Phil Jones, Caterina Tassone	September 2017 (GCOS Secretariat)
22/22	<b>Weather radar:</b> Write a proposal on how best to proceed on the use of radar data for climate studies. Submit the proposal to the panel, to Carolin and after approval to the GCOS Steering Committee	Andreas Becker, Ken Holmlund Philip Jones, Elena Saltikoff	September 2017GCOS Steering Committee
22/23	<b>CATCOS:</b> Report back to AOPC on performance of 5 CATCOS stations and use of support funds.	GCOS Network manager	Ongoing

**ANNEX 4: List of Actions from AOPC-23**

N°	Action	Responsibility	Topic
23/1	GCOS to distribute to AOPC members consolidated document about role of GCOS in Paris Agreement	GCOS Secretariat	Paris Agreement
23/2	GCOS Secretariat to contact Copernicus UrbanSIS in order to explore urban ECV	GCOS Secretariat	Urban Observations
23/3	GCOS Secretariat to follow progress with WIGOS on parallel measurements.	GCOS Secretariat	Parallel measurements
23/4	Connect with OOPC to explore if they would be supporting of a co-writing team for writing a white paper about requirements for fluxes.	Liz Kent	Air-sea fluxes
23/5	A technical supplement for the Space Agency Response to the GCOS IP is ready. GCOS Secretariat to send this supplement to the AOPC panel members.	GCOS Secretariat	Response of Space Agencies to GCOS IP
23/6	Provide standing invitation with standing agenda item to a space rapporteur	GCOS Secretariat	Space agencies
23/7	Develop a better formulation of the IP actions that includes also specifying the sub-actions within the action, the responsible, and updating a detailed description of the status of the action itself.	GCOS Secretariat together with AOPC member responsible of action	IP actions
23/8	Contact the Met service of Ecuador and ask for an update for the state of the upper air station. Offer help if necessary	Tim Oakley	GUAN
23/9	Given the lack of GRUAN in some area of the world, AOPC panel members are asked to reach out to their contacts in these countries and to let Ruud know of these contacts.	AOPC	GRUAN
23/10	Provide GCOS Sec with a list on possible duties of the LC to be taken up by GCOS. List will then be forwarded to AOPC and it will be discussed at next teleconference.	Ruud Dirksen	GRUAN
23/11	AOPC to provide input on Annex 4 of GCOS 214 and in particular to suggest benefits of such a network related to their expertise.	AOPC	GSRN TT
23/12	Propose to discuss the concept of a tiered network approach at GCOS joint panel meeting in 2019.	GCOS Secretariat	GUAN TT
23/13	Review of the Vision for WIGOS 2040	AOPC	CBS/WIGOS
23/14	Provide input for requirements for the atmospheric ECV for the 'Climate Monitoring AA in OSCAR	GCOS Secretariat, John Eyre	
23/15	Review of the ECV fact sheets	AOPC	Fact sheets
23/16	Panel to distribute the final report of GAIA Clim to relevant parties in their community to inform and get feedback.	AOPC	GAIA-CLIM

## ANNEX 5: List of ECV Stewards

(responsible for the ECV adequacy review )

ECV	Steward(s)
Surface wind speed and direction	Elizabeth Kent, Philip Jones
Precipitation	Rainer Hollmann
Temperature (surface)	Phil Jones, Elizabeth Kent
Pressure (surface)	Elizabeth Kent, Philip Jones
Water vapour (surface)	Philip Jones, Elizabeth Kent
Surface Radiation Budget	Rainer Hollmann, Zhanqing Li
Temperature (upper air)	Peter Thorne, Imke Durre
Wind speed and direction (upper air)	Shinya Kobayashi
Earth radiation budget	Peng Zhang
Water Vapour	Dale Hurst, Imke Durre
Cloud properties	Zhanqing Li, Rainer Hollmann
Lightning	Robert Holzworth
Carbon dioxide, Methane and other greenhouse gases	Greg Carmichael, Dale Hurst
Aerosol properties	Olga Kalashnikova, Greg Carmichael, Peng Zhang
Precursors (supporting the aerosol and ozone ECVs)	Greg Carmichael, Olga Kalashnikova, Dale Hurst
Ozone	Dale Hurst, Greg Carmichael

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