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**Summary Report and Recommendations  
from the  
Seventeenth Session of the GCOS/WCRP  
Atmospheric Observation Panel for Climate  
(AOPC-XVII)**

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**AOPC-XVII**  
**30 April - 3 May 2012**

**Summary Report and Recommendations**

**1 Opening of the Meeting**

Prof Adrian Simmons, Chairman of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC) opened the meeting on 30 April 2012, 1.45 pm, at WMO Headquarters in Geneva. The participants (Annex I) were welcomed by Dr Wenjian Zhang, Director of the WMO Observations and Information Systems Department, who stressed that observations of the GCOS Essential Climate Variables (ECVs) are providing the base for the future Global Framework for Climate Services (GFCS). Important milestones on establishing the GFCS are the up-coming meeting of WMO's Executive Council and an Extraordinary Session of the WMO Congress. The WMO Executive Council will also discuss the Implementation Plan for the WMO Integrated Observing System (WIGOS), which identifies the subjects, details and long-term view provided by the Implementation Plan on the Evolution for Global Observing System (EGOS IP; cf. item 8.4 below).

The Chair reviewed the proposed agenda, inviting any changes or additions. The adopted agenda can be found in Annex II.

**2 Report from the AOPC Chair**

The AOPC Chairman reported on his work in support of the Panel during the past year, as well as on the meetings he attended in his capacity as Chairman of the GCOS Steering Committee (SC), representing GCOS as a whole. A major effort was also the publication of an updated version of the 'Systematic Observation Requirements for Satellite-based Data Products for Climate', the so-called 'Satellite Supplement' to the GCOS Implementation Plan (GCOS-154)<sup>1</sup>, in December 2011. Prof Simmons further stressed the need to review and revitalize activities that had been assigned to the Working Group on Observational Datasets for Reanalysis, jointly managed by AOPC and the World Climate Research Programme (WCRP), beginning with discussions at the first meeting of the new WCRP Data Advisory Council. He then briefed AOPC members on the planned sponsors' review of the GCOS programme, which had been initiated by the Secretary General of WMO writing to all sponsors earlier this year. The review panel was expected to be established by the middle of 2012 to work until the middle of 2013. The GCOS SC should submit information in support of the review process and AOPC was invited to contribute its thoughts on achievements, contributions, strength, weaknesses and opportunities regarding the atmospheric domain of the programme.

***Actions and recommendations:***

1. The Chair invited AOPC Members to provide through him input to the GCOS SC concerning the SC's submission to the GCOS review. The AOPC Chair agreed to contact the other Panel Chairs to extend a similar invitation.

**3 Report of the GCOS Director and Secretariat**

After introductory remarks Dr Carolin Richter, Director of the GCOS Secretariat, briefed the Panel on the Secretariat's activities during the intra-sessional period. She introduced Dr J.-L.

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<sup>1</sup> The Supplemental Details to the Satellite-based Component of the Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC (2010Update) are available under: <http://www.wmo.int/pages/prog/gcos/Publications/gcos-154.pdf>

Fellous, who had been assigned the new function of GCOS space rapporteur. In this role, Dr Fellous will attend all Panel meetings, the SC session and relevant expert meetings to improve information exchange with space agencies. Dr Richter outlined the support of the SC and the Panels' work as a core activity for the Secretariat, alongside engagement with the executive bodies of the sponsor organisations, and numerous other programme activities throughout the domains. She explained the Secretariat's staffing situation, and in particular noted the 20th anniversary of the GCOS programme. A brochure entitled 'GCOS 1992-2012 - 20 Years in Service for Climate Observations' had been developed for this occasion and a celebratory event would be held at WMO headquarters on 29 June. A publication describing the history of the GCOS will also be published in the journal 'Weather'.

***Actions and recommendations:***

2. The Panel welcomed Dr Fellous, who has been assigned the new function of a GCOS space rapporteur.

### **3.1 Update on draft GFCS Implementation Plan**

Dr William Westermeyer from the GCOS Secretariat briefed the participants on the Observations and Monitoring Annex of the draft GFCS Implementation Plan, for which the GCOS Secretariat and the WMO Observing and Information Systems Department have taken the lead in preparing. The Observations and Monitoring Component will be one of five annexes to the main GFCS Implementation Plan, the others being the Research, Modelling, and Prediction Component; the Climate Services Information System Component; the User Interface Platform Component; and the Capacity Building Component. The main GFCS Implementation Plan, which is still being finalized, draws on each of these annexes. AOPC Members were specifically invited to review the actions proposed in the atmospheric domain and help to refine or replace them.

***Actions and recommendations:***

3. AOPC discussed and provided a number of comments on the Observations and Monitoring Annex to the draft GFCS Implementation Plan, covering planned initial implementation activities. In particular, it recommended to expand the initial actions in Table 2.5.1 of the draft annex for the Commission for Climatology (CCI)'s climate data rescue efforts and the efforts in developing a Climate Data Management System (CDMS), as well as to explicitly mention the Monitoring Centres for the GCOS Surface Network (GSN) and for the GCOS Upper-Air Network (GUAN). The Chair encouraged all panel members to read the annex and provide any further comments to Dr Westermeyer.

## **4 World Climate Research Programme Perspective**

Dr Michel Rixen from the World Climate Research Programme (WCRP) updated the Panel on recent and upcoming activities of the Programme. He outlined WCRP's contribution to the 'Future Earth' Initiative of the International Council for Science (ICSU) and the envisaged GFCS, and stressed the importance of climate data for WCRP. Main outcome of an extraordinary session of the WCRP Joint Scientific Committee held October 2011 in Boulder, USA, was the formulation of so-called 'Grand Science Challenges' and a new programme structure, which foresees establishment of a WCRP Modeling Advisory Council (WMAC), a WCRP Data Advisory Council (WDAC) and a WCRP Working Group on Regional Climate. The WDAC succeeds the former joint GCOS/WCRP Observations and Assimilation Panel (WOAP). GCOS will be represented in the WDAC by its panel chairs.

***Actions and recommendations:***

4. The Panel thanked Dr Rixen for his briefing on future changes to the Programme. It appreciated being represented on the new WDAC. The Panel looked forward to its continued cooperation and engagement with WCRP as its new structure evolves.
5. The panel noted with concern that it had been more than two years since the former WOAP met for the last time, and that the membership of the WDAC had yet to be agreed. Even if WDAC were to be able to meet in Beijing, China, as originally planned, it would be for only one day.
6. AOPC recognized the need to discuss both with the other GCOS/WCRP Panels and with the WDAC how to address the issues raised in the 'WOAP action plan on WCRP research activities on surface fluxes'. It noted that progress on this subject could not be made until the WDAC was fully established.
7. The Panel encouraged the GCOS and WCRP Secretariats to continue their effort to further develop the concept of ECV inventories. Consideration should be given to inventories covering fluxes as well as the ECVs themselves. The development of future inventories should be undertaken in close collaboration with the Committee on Earth Observation Satellites (CEOS) Working Group on Climate, which was developing a questionnaire related to establishment of data inventories.

## **5 GSN, GUAN and RBCN**

### **5.1 Monitoring of network performance and report from the Analysis and Archive Centre**

Dr Andreas Becker from the German Meteorological Service, Deutscher Wetterdienst (DWD), Mr Nozomu Ohkawara from the Japan Meteorological Agency (JMA) and Dr Matthew Menne of the US National Climatic Data Center (NCDC), reported on performance monitoring of the GSN, the GUAN, and the WMO Regional Basic Climatological Network (RBCN).

#### ***Actions and recommendations:***

8. AOPC acknowledged the excellent reports provided and the comprehensive work done by the Commission for Basic Systems (CBS) Lead and Monitoring Centres at DWD and JMA in synchronizing their results, thus identifying both common problems and data transmission issues specific to one centre or the other.
9. The Panel encouraged the Monitoring Centres to accumulate and publish online statistics of user visits.
10. AOPC requested the GCOS Secretariat to encourage National Meteorological and Hydrological Services (NMHSs) to implement the Commission for Instruments and Methods of Observation (CI-MO) classification guidelines at their sites, especially for GSN stations.
11. AOPC agreed to recommend to CBS in September via the CBS Implementation/Coordination Team on Integrated Observing Systems (ICT-IO) the production of daily CLIMAT messages, and suggested that these be named DAILY CLIMAT or DAILY climate reports. To ensure homogeneity of climate data series these messages should be produced in the same way as countries produce their monthly CLIMATs<sup>2</sup>.
12. AOPC considered a number of issues related to radiosonde reports. All radiosonde sites, especially GUAN sites, should be requested to report their sonde type. Countries that have not registered their sondes can receive a number from WMO. As

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<sup>2</sup> This recommendation states the status at the AOPC meeting. It was followed up and overcome by ICT-IO/CBS policy not to create any new ASCII messages, but to amend BUFR tables. The CBS rapporteur on GCOS matters will now work with the CCI Task Team on National Climate Monitoring Products to create new tables templates.

the full upper-air sounding is useful and assimilated in numerical models, all countries should report significant as well as mandatory levels.

13. AOPC also noted with regret the slow take up of BUFR code for radiosondes to enable weather forecasting and monitoring centres to exploit the full potential of this type of observation.
14. AOPC requested the GCOS Secretariat to liaise with WIGOS to promote action on the radiosonde issues noted above.
15. AOPC thanked NCDC for continued outstanding execution of its tasks as Archive and Analysis Centre for GSN and GUAN. The Panel encouraged bi-lateral and wider international agreements for large national contributions of data to the centre. This includes optional use of an automated mechanism for updates and periodic refreshment.
16. The Panel was pleased to see that NCDC was establishing an inventory and photographic record of the non-US climate data held in paper form in some 1500 boxes. The Panel recognized that digitization of this record would be a substantial task. It further noted that digitization of records was a problem faced by very many NMHSs. The Panel welcomed the information that new sources of upper-air data would be included in a new version of the Integrated Global Radiosonde Archive (IGRA) data base, IGRA-2, that would soon become available.

## **5.2 CBS Lead Centres Activities**

Meeting participants were briefed by the GCOS Implementation Manager Mr Richard Thigpen on the outcomes from the third bi-annual coordination workshop of the CBS Lead Centres for GCOS. This workshop was hosted by DWD in Hamburg, Germany, from 11-13 October 2011.

### ***Actions and recommendations:***

17. AOPC asked the GCOS Secretariat to arrange for support letters from WMO to be sent to the Lead Centres to help them secure the internal support needed to carry on their work. GCOS currently does not have funding for regular CBS Lead Centres meetings; such meetings in future could be funded via the GFCS mechanism.

## **5.3 Report from AGG**

The Advisory Group on GSN and GUAN (AGG) met prior to the AOPC-XVII meeting in the morning of Monday 30 April 2012. The report is attached as Annex III.

### ***Actions and recommendations:***

18. The Panel endorsed the proposals for station changes from the AGG [cf. the AGG report in Annex III]

## **5.4 Status of updating Vol. A to higher resolution coordinates**

Mr Mohan Abayasekara reported on the status of submissions made by WMO Members towards the revised version of Vol. A with higher geographic resolution.

## **5.5 GSN and GUAN System Improvement Activities**

Mr Richard Thigpen delivered an overview and status report on recent initiatives to revitalize upper-air and surface networks and to improve the overall network performance. These initiatives include direct renovation projects, Technical Support Projects, and various training activities. In particular, the new contacts from the Lead Centres in Mozambique and Morocco spent a week of training at WMO with the Implementation Manager and a member of the US Lead Centre's team earlier in 2012.

***Actions and recommendations:***

19. The Panel thanked the Implementation Manager for his continuing system improvement efforts. It noted with pleasure the ongoing success of the GCOS Cooperation Mechanism (GCM), especially the support to GUAN stations at Dar-es-Salaam, Vacoas, Harare, Rarotonga, and Khartoum. AOPC also appreciated the efforts to renovate stations in Madagascar and Angola.

## **6 CCI Issues**

Dr William Wright, co-chair of the Open Panel of CCI Experts on Climate Data Management (OPACE 1), informed the meeting on issues related to CCI, such as redefining standard climate normals, updating of World Weather Records (WWRs), and climate metadata and interoperability within a forthcoming Climate Data Management System (CDMS). Furthermore, the CCI management group has established a group on climate services, which should take up some of those issues.

***Actions and recommendations:***

20. AOPC thanked the CCI representative for his very informative briefing on matters of substantial relevance to GCOS, and AOPC in particular. The Panel considered it important to receive regular updates on CCI activities to avoid duplication of efforts.
21. AOPC noted that widespread adoption of CDMSs should solve some of the network issues discussed under agenda item 5.
22. AOPC fully supported the work being undertaken by CCI aimed at extension of WMO resolution 40 to make the exchange of historical climate data mandatory. Panel members were urged to provide any support that might be required by CCI.
23. The panel recognized the need for dual climate normals, one representing the most recent period, and one fixed to provide the basis for trend display. It nevertheless considered that 1981 to 2010 was a better period for the latter, notwithstanding the fact that much trend information is currently presented relative to the 1961 to 1990 normal.

## **7. Atmospheric composition**

### **7.1 Contribution by GAW**

The meeting was briefed by Dr Oksana Tarasova from the WMO Global Atmosphere Watch (GAW) Programme on activities related to the development of the atmospheric composition ECVs for ozone profiles, greenhouse gases and aerosols. Dr Tarasova in particular reported on progress of the GCOS baseline and comprehensive networks for Ozone, CO<sub>2</sub>-CH<sub>4</sub> and N<sub>2</sub>O. Following this, Dr James Butler reported on private sector engagement in Greenhouse Gas (GHG) observation.

***Actions and recommendations:***

24. The Panel thanked the representative of the WMO Global Atmosphere Watch (GAW) for her briefing and welcomed the further development of the links established with the Bureau International des Poids et Mesures (BIPM).
25. The Panel recommended to the GCOS Steering Committee that developments be monitored and discussions continued on private sector involvement in GHG observation.
26. Although ESA's Environmental Satellite (ENVISAT) had exceeded its nominal live time by 5 years, AOPC nevertheless regretted the apparent loss of the satellite in view of the invaluable data it had continued to supply. The Panel urged for minimal delays in launch of the operational Global Monitoring for Environment and Security

27. In the view of expected closures of crucially important observing stations, e.g. from the GAW network, the AOPC Chair will express concern over station closures at the upcoming meeting of the UN Framework Convention on Climate Change (UNFCCC) Subsidiary Body for Scientific and Technological Advice (SBSTA) and highlight that many observations should be regarded as global public goods.
28. The Panel appreciated that for national managers it is essential to demonstrate the usefulness of their observations and that good feedback from data users to data providers was important in this regard.

## **7.2 WCRP SPARC Perspectives (including Data Initiative)**

Dr Greg Bodeker, co-chair of the Stratospheric Processes and their Role in Climate (SPARC) initiative, presented recent developments within this WCRP core-programme. The SPARC Data Initiative will assess the state of data availability with a primary focus on satellite observations, targeted at 25 trace gas species and aerosols.

### ***Actions and recommendations:***

29. AOPC encouraged the linking of appropriate SPARC activities with those of the CEOS Working Group on Climate.
30. In view of clear evidence, the Panel decided to propose an additional footnote to the ECV table covering the importance of spectrally resolved solar radiance measurements in the next revision of the GCOS IP. In the meantime clarifying notes on the ECVs could be communicated, e.g. on the GCOS and GOSIC websites.

## **8. Other Atmospheric Networks and Issues**

### **8.1 GRUAN**

Dr Greg Bodeker, in his second capacity as co-chair of the GCOS Reference Upper-air Network (GRUAN) Working Group on Atmospheric Reference Observations (WG-ARO), which has since been renamed the Working Group on GRUAN (see item 42 below), provided an overview on progress in the establishment of GRUAN.

### ***Actions and recommendations:***

31. AOPC expressed its gratitude to the National Oceanic and Atmospheric Administration (NOAA) for support of the co-chairs of the AOPC Working Group on Atmospheric Reference Observations (WG-ARO) and of the regular Implementation and Coordination Meetings (ICMs).
32. AOPC was very pleased with the progress to date, but concerned about the sustainability of funding for WG-ARO activities and ICM sessions. The Panel encouraged GCOS Secretariat or AOPC representative attendance at ICMs.
33. AOPC agreed to recommend to the Secretary General of WMO that the offer of DWD to continue to host the Lead Centre for GRUAN be accepted, and to review performance in five years time.
34. AOPC intends to conduct a scientific review of GRUAN's performance at its 2015 session. The Panel expected that GRUAN would be fully established by then and would look for first scientific results from GRUAN.
35. AOPC agreed that the GRUAN Manual and Guide could be published as GCOS publications. It supported the recommendation from the WIGOS/CIMO/CBS/GCOS expert meeting that specific details of and information on GRUAN from the GRUAN Manual and Guide and as identified in the meeting report (cf. GCOS-155, Annex IV

36. AOPC revised the membership and Terms of Reference of the WG-ARO as given in Annex IV to include representatives from the four relevant WMO Technical Commissions (CIMO, CBS, CAS, CCI) as ex-officio members as recommended by the GCOS/CBS/CIMO/WIGOS Expert Meeting, and decided to make a small amendment to the GRUAN organigram viz. arrow from commissions to AOPC changed from red to blue and wording changed from "Guidance" to "Guidance on specific issues". That has been reflected in both the Manual and Guide.
37. AOPC expressed concern over the growing size of WG-ARO. It approved the requested additional members to the WG-ARO for the coming year, but in case of further requests, the size of the WG should be robustly justified. Establishment of an 'executive council' consisting of the co-chairs and head of the Lead Centre might be considered as a future solution.
38. The Panel decided to make explicit reference to the Space-based Inter-Calibration System (GSICS) in the in the advocacy and outreach section of the GRUAN Manual and Guide.
39. AOPC was please to be informed that there would be GCOS representation at the GRUAN network expansion workshop and encouraged attendance by representatives of the WMO Technical Commissions.
40. AOPC considered the proposal from WG-ARO to establish a GRUAN trust fund. This was thought to be a good idea in principle, but practicalities need to be investigated. AOPC was of the opinion that a GRUAN trust fund would best be administered by the GRUAN Lead Centre.
41. AOPC recommended that GRUAN sites should endeavour to launch soundings at times that match the overpass-times of the hyperspectral instruments IASI, AIRS and CrIS at least 4 times a month.
42. Acknowledging that the WG-ARO is not expected to take on responsibility for potential reference networks other than the GRUAN, the Panel decided to rename WG-ARO as the Working Group on the GCOS Reference Upper-air Network (WG-GRUAN).

## **8.2 International Surface Temperature Initiative**

Dr Matt Menne updated AOPC Members on progress of the International Surface Temperature Initiative (ISTI) on behalf of the initiative's leads Dr Peter Thorne and Dr Kate Willett.

### ***Actions and recommendations:***

43. The meeting was pleased to learn of the progress of the ISTI and expressed the wish to be kept informed of further development. It encouraged all with relevant data to support this initiative. The committee was interested to learn that homogenization methods are able to cope with siting effects, for example urban heat island changes, after about 1930 for the contiguous US.

## **8.3 Climate Reference Network**

Dr Matt Menne also gave an overview on NOAA's Benchmark Climate Observing Network for the US.

### ***Actions and recommendations:***

44. The Panel thanked Dr Menne for presenting the concept of the US Climate Reference network (USCRN), which has been running for nearly 10 years now and looked forward to it being described in a peer-reviewed article published by the American Meteorological Society.

45. AOPC recognized that a number of interesting lessons were likely to be learnt from the USCRN. The Panel would be interested in information on the annual costs associated with running the US reference network, as well as information on which other countries were running reference surface networks and how the latter differed from the US network. Notwithstanding the usefulness of high-quality observations for surface meteorological variables, the Panel was not in a position to judge the value of establishing a global reference network, and stressed the importance of maintaining the GSN in the first place.

#### **8.4 Update on the development of the EGOS-IP**

Dr John Eyre, Chairman of the CBS Expert Team on the Evolution of the Global Observing System (ET-EGOS), presented the latest version of the EGOS IP.

##### ***Actions and recommendations:***

46. The Panel thanked the Chairman of the ET-EGOS for presenting the draft EGOS IP. It congratulated the ET-EGOS on this document, which now is in much better shape than the draft provided for comment a year ago. The Panel looked forward to seeing the comments provided by GCOS reflected in the next version. AOPC noted that surface-based measurements of surface radiation were the most important gap to fill in the current draft for the EGOS IP. Furthermore, it encouraged ET-EGOS to report progress against this Plan in future.

#### **8.5 Review of AOPC Requirements in WMO/CEOS RRR Database**

The Rolling Review of Requirements (RRR) Database<sup>3</sup> is managed by the WMO Space Programme in cooperation with CEOS. It details user requirements for space-based observations and shall be supplemented by a 'space-based capabilities' database by August 2012. Dr Jérôme Lafeuille from the WMO Space Programme explained the scope and functionality of these databases and asked for feedback from the Panel experts.

##### ***Actions and recommendations:***

47. AOPC encouraged all its members to consult the section of the RRR Database, and send proposed changes for requirements that fell within their area of expertise to the GCOS Secretariat. The Chair was invited to review proposals and submit a consolidated list of changes to the WMO Space Programme.

### **9 Marine Issues**

Dr D.E. Harrison reported on recent activities in the oceanic domain on behalf of Dr Eric Lindstrom, Chair of the Ocean Observations Panel for Climate (OOPC) and delivered a scientific lecture on air-sea anomalies. He specifically outlined the plan for a Framework for Ocean Observing, and the future of the Global Ocean Observations System (GOOS).

##### ***Actions and recommendations:***

48. AOPC expressed its concern over the difficult situation regarding funding for the International Comprehensive Ocean-Atmosphere Data Set (ICOADS). ICOADS is the most extensive collection of surface marine data spanning the past three centuries and widely used by the international community. The Panel urged all in a position to help to work together to find an effective way of ensuring continued operation and development of the ICOADS.
49. The Panel noted that Ocean constellations constitute the largest part of the CEOS virtual constellation and that new measurements, e.g. of ocean salinity, are becoming

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<sup>3</sup> The RRR database is accessible online: <http://www.wmo-sat.info/db/>

available from space. It noted that the failure of ESA's ENVISAT satellite had impacted ocean as well as atmospheric observation.

50. Subject to OOPC agreement, AOPC decided to terminate the joint AOPC/OOPC Working on Group Sea-Surface Temperature (SST) and Sea-Ice, with the understanding that alternative arrangements to cover the two ECVs concerned would be considered by OOPC.
51. The Panel congratulated the AOPC/OOPC Sea-Surface Pressure Working Group for the success of its work that had inter-alia enabled the production of the 20<sup>th</sup> Century Reanalysis Project dataset. The Panel stressed the continuing need for data rescue activities and shared the concern of the Working Group over the continuation of the International Surface Pressure Databank (ISPD) after the end of NOAA's Climate Database Modernization Program (CDMP). It urged that this useful initiative be continued in some form.
52. The Panel thanked Dr Harrison for his comprehensive briefing on the latest status of air-sea anomalies, as well as for highlighting the most pressing issues in implementing the ocean observing system for climate.

## **10 Terrestrial issues**

Dr Michel Vestraete, who is a member of AOPC as well as the Terrestrial Observation Panel for Climate (TOPC), provided a summary presentation on terrestrial domain issues on behalf of TOPC Chairman Prof. Han Dolman.

### ***Actions and recommendations:***

53. The Panel noted the lack of space-based sensors for measuring vegetation height or emission rates that would be essential to verify the Reducing Emissions from Deforestation and Forest Degradation (REDD+)/emission trading process.
54. The Panel was pleased to learn that a proposal for establishing a reference network for ecosystems monitoring will be presented to the European Space Agency (ESA) scientific advisory committee (ESAC) by the chairman of the Global Terrestrial Observing System (GTOS). The Panel stressed the importance of maintaining a close connection between this initiative and GCOS through its terrestrial and atmospheric panels.

## **11 ECV data in international data centres**

Dr Gabriela Seiz, Swiss National Coordinator and Head of the Swiss GCOS office, presented the recent initiative on documenting the availability of Swiss ECV data in international data centres. This initiative highlights the problem that such dedicated international data centres do not exist for all ECVs, including some in the atmospheric domain.

### ***Actions and recommendations:***

55. AOPC thanked the Swiss National Coordinator for her excellent report on the availability of Swiss ECV data in international data centres. It asked the GCOS Secretariat to raise awareness of the Swiss data report by announcing it in the upcoming issue of the GCOS newsletter. It also recognized the importance of a 'push mechanism', currently provided in form of a monthly email from the GCOS Secretariat to CBS focal points for GCOS and related climatological data. It would be useful to expand this message to include performance statistics on other ECVs, if regular monitoring was performed for them.
56. The Panel recommended that online performance monitoring and use statistics be provided by all data centres. If legal restrictions prohibit data centres from making such information publically available, it should be accessible for registered users. The

World Glacier Monitoring Centre (WGMS) was encouraged to function as a role model in taking on performance monitoring.

57. AOPC stressed the need for acknowledgement of data producers, e.g. by publication of data sets in specialised peer-review journals such as 'Earth Systems Science Data'.

58. The panel was informed on the planned move of the International Satellite Cloud Climatology Project (ISCCP) data centre from NASA to NCDC.

## **12 Satellite Issues, Data and Products**

### **12.1 Report from the GCOS Space Rapporteur**

Dr Jean-Louis Fellous informed the Panel on relevant activities of space agencies and space coordination groups such as the CEOS Working Group on Climate. He provided an overview on ECV satellite products for the three domains and presented details on satellites missions of interest.

#### ***Actions and recommendations:***

59. AOPC thanked the GCOS Space Rapporteur for his very informative report on key issues related to satellite observations, in particular, building a climate monitoring architecture, developing consensus on a maturity matrix, in-depth ECV analysis and the 'Research to Operation Paradigm'.

### **12.2 Update on progress of the ESA CCI**

An update on Progress of the ESA Climate Change Initiative (CCI) was given by Dr Roger Saunders.

#### ***Actions and recommendations:***

60. The Panel welcomed the update on progress of the ESA CCI, and looked forward to seeing data sets becoming available by the end of the year, to be assessed by the Climate Modelling User Group. Space agencies should continue to support integrated science teams that encompass product assessment and reprocessing.

### **12.3 Report from CGMS-39**

Dr Johannes Schmetz reported on climate activities of the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) and on the 39th meeting of the Coordination Group for Meteorological Satellites (CGMS), held in St. Petersburg, Russia, from 3 – 7 November 2011.

#### ***Actions and recommendations:***

61. The Panel was pleased to hear a comprehensive report on the ongoing work and plans within CGMS related to climate monitoring from space, the plans towards a global architecture for Climate Monitoring, as well as the additional update on relevant outcome from recently held International Science Working Groups

62. The Panel noted that the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organization (UNESCO) had reported on the status of 'sea surface temperature for numerical weather prediction' and for the next CGMS session, IOC will prepare a paper on guidance to CGMS members on ocean wind measurements.

63. The panel strongly supported the CGMS action on its satellite operators to provide regular information on satellite/instruments events affecting calibration and establish corresponding websites. It noted that this is also pursued within GSICS.

64. With regard to the recent successful launch of the Suomi-NPP satellite, the Panel noted with interest the CGMS action on NASA and NOAA to report on cal/val results from the Suomi-NPP instruments, including comparisons of Suomi-NPP sensors with Earth Observing System (EOS) sensors and with airborne instruments at the next CGMS. In that context discussions iterated on the usefulness of having integrated science teams for the satellite instruments, a point that had been elevated by NASA at CGMS-39.
65. The Panel again restated the need for all Atmospheric Motion Vector (AMV) and Clear-sky radiance products to be subject to reprocessing. It was noted that this is an established activity at EUMETSAT and JMA; other agencies are strongly encouraged to pursue such activities as well.
66. The panel was very interested to learn that recent impact studies of use of AMVs in Numerical Weather prediction (NWP) showed very coherent positive impacts for all the participating NWP centres (reported at the 11th International Winds Workshop). This corroborates the request and requirement for a reprocessing of AMVs with state-of-the-art algorithms by all satellite operators.
67. It was reported that the launch of Metop-B would bring global full resolution AVHRR data from two spacecraft (Metop-A and Metop-B) in the same orbit plane for the first time ever. Overlap of half a swath or more in the Advanced Very High Resolution Radiometer (AVHRR) data from these two satellites will allow for the generation of AMVs over the entire globe. The panel welcomed this potential additional source of data on winds fields.
68. The Panel was supportive of utilising the available AMVs from the NASA MISR instrument in reanalyses as suggested at the 11th International Winds Workshop.
69. In the area of Radio-Occultation (RO) measurements from satellites the Panel applauded the ongoing work by CGMS agencies toward an increased coverage by RO sensors by enabling near-real-time access to RO instruments on satellite research missions. This should be complemented by a high-quality processing of the RO data such that the observations are adequate for NWP. Noting the inherently high certainty of RO measurements and the potential of RO measurements to serve as anchors in the climate observing system, the Panel strongly supported and encouraged the activities.
70. AOPC supported the notion that hyperspectral infrared (IR) measurements provide ample opportunities for studying the influences of cloud, moisture and lapse rate changes on the radiation budget and thus climate change. It consequently supported CGMS in its deliberations on a coordinated orbit phasing of satellites to ensure adequate sampling of the diurnal cycle. This should ideally include coverage with hyperspectral IR observations in the early morning, mid morning, and afternoon orbits.
71. AOPC strongly supported the view formulated by the Television Infrared Observation Satellite (TIROS) Operational Vertical Sounder (TOVS) International Working Group (and others) that the postponement of the Climate Absolute Radiance and Refractivity Observatory (CLARREO) absolute calibration mission is unfortunate because of its outstanding potential role as absolute reference instrument in space. Furthermore, the Panel iterated the fact that future IR interferometers (such IASI-NG) are also very much needed as a reference for other instruments in the coming decades.
72. The panel encouraged the GCOS and WCRP Secretariats to send a follow-up letter to the recipients of the first joint GCOS/WCRP letter calling for strengthening collaboration on climate data records with a more explicit formulation of their request.
73. The Panel was pleased with the significant progress of the EUMETSAT activities in support of climate monitoring, specifically the completed and ongoing reprocessing activities of climate data records from Meteosat imagers of the first and second generation and various instruments on the polar orbiting Metop satellite. The Panel also expressed support and encouragement to pursue the planned activities on

climate data record generation at the European level, e.g. within GMES. It noted that the ongoing work has a strong relationship with planning work towards an architecture for climate monitoring from space.

#### **12.4 Report from SCOPE-CM Initiative, including Maturity Index**

##### ***Actions and recommendations:***

74. AOPC was pleased to see that the Sustained Coordinated Processing of Environmental Satellite Data for Climate Monitoring (SCOPE-CM) initiative will provide an independent assessment of climate data records, following the recommendation from the WOAP Frascati Workshop. AOPC encourages participation in these projects and would like to see additional projects started in order to get more ECV datasets assessed, especially from the oceanic and terrestrial domains. The Panel noted that the five projects of the SCOPE-CM initiative have evolved beyond the pilot stage into an established activity where the participants have taken a firm ownership. The Panel thanked EUMETSAT for playing a substantial role in this effort.

#### **12.5 Progress in the CEOS Response to the updated Satellite Supplement**

Dr Mitchell Goldberg, who joint the session form remote, informed the Panel on progress in the CEOS' Response to the updated GCOS 'Satellite Supplement'.

##### ***Actions and recommendations:***

75. The Panel expressed its appreciation for the report by the Coordinator of the CEOS Climate Societal Benefit Area on progress in the CEOS' Response to the GCOS Implementation Plan and Satellite Supplement, and looked forward to the CEOS Response being published later this year, in time for SBSTA 37 / COP 18.

76. AOPC recognized the CEOS effort in establishing an inventory of ECV data records; It considered that a merged or parallel effort to create an inventory *in-situ* data records would be highly useful.

#### **13 Cryospheric issues**

The meeting was updated on the progressing in establishing a Global Cryosphere Watch (GCW), including a Cryosphere Observing System (CryOS) by Dr Barry Goodison from the WMO Observations and Observing Systems Department. Dr Goodison also reported on the upcoming CIMO Solid Precipitation Intercomparison Experiment (SPICE), which will start in November 2012 as a multiple-site experiment running until 2014.

##### ***Actions and recommendations:***

77. The Panel appreciated the briefing on the status of the GCW and was pleased with the progress made, in particular in setting up the GCW data portal

78. AOPC welcomed the update on SPICE and urged appropriate participation by cryospheric and climate communities. It supported the suggestion to make SPICE a Demonstration Project for GCW.

##### **Next session**

79. The Panel agreed provisionally to hold its next session in Geneva, for four days (including the half-day AGG session), on 2-5 April 2013.

## Annex I

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## Annex II

### MEETING AGENDA

| Item   | Doc. No. | Presenter(s) (time slots include discussion) |
|--|----------|--|
| <b>Monday 30 April</b>   |          |  |
| <b>13.45 – 18.00</b>   |          |  |
| <b>1. Opening of the Meeting (30')</b>                         |          |  |
| 1.1 Welcome and introductions                                  |          | Simmons, WMO                                 |
| 1.2 Adoption of Agenda   | 1        | Simmons                                      |
| 1.3 Conduct of the Meeting                                     |          | Secretariat                                  |
| <b>2. Report from the AOPC Chair</b>                           |          |  |
| - Issues and objectives for the meeting                        | 2.1      | Simmons (20')                                |
| - Review of activities since AOPC-XVI,                         | 2.2      | Simmons, GCOS Sec (10')                      |
| - AOPC input to the GCOS review                                |          |  |
| <b>3. Report of GCOS Director and Secretariat</b>              |          |  |
| - Overview of Secretariat activities                           | 3        | Richter (10')                                |
| 3.1 Update on draft GFCS Implementation Plan                   | 3.1      | Westermeyer (20')                            |
| <b>4. World Climate Research Programme Perspective</b>         |          |  |
| - WOAP Frascati Workshop: outcome and follow up,               | 4        | Asrar / Rixen (30')                          |
| - Implications of change from WOAP to new WCRP Data Council    |          |  |
| <b>5. GSN, GUAN and RBCN</b>                                   |          |  |
| 5.1a GSN Monitoring Centres Report (DWD and JMA)               | 5.1a     | Becker / Ohkawara (30'+10')                  |
| 5.1b Report from NCDC Analysis/Archive Centre                  | 5.1b     | Menne (15'+5')                               |
| 5.2 CBS Lead Centres Activities                                | 5.2      | Menne / Thigpen (20'+5')                     |
| <b>18.00 End of day 1</b>                                      |          |  |
| <b>Tuesday 1 May</b>   |          |  |
| <b>09.00 – 12.30</b>   |          |  |
| 5.3 Report from AGG  | 5.3      | Jones (20'+5')                               |
| 5.4 Status of updating Vol. A to higher resolution coordinates | 5.4      | Abayasekara (5')                             |
| 5.5 GSN and GUAN System Improvement Activities                 | 5.5      | Thigpen (20'+5')                             |
| 5.6 Annual submission of WWRs                                  | 5.6      | Menne (10'+5')                               |
| <b>6. WMO CCI Issues</b>                                       |          |  |

|  |                      |                               |
|--|----------------------|-------------------------------|
| 6.1 WMO CCI issues   | 6.1                  | Wright (30'+10')              |
| <b>7. Atmospheric forcing</b>  |                      |                               |
| 7.1 Contribution by GAW<br>- Progress of Ozone, CO2-CH4 and N2O Baseline Networks<br>- Status of Aerosol Networks<br>- Private sector engagement in GHG observation<br>- Status of data exchange in GAW and non-GAW atmospheric composition networks | 7.1                  | Tarasova / Butler (25'+25')   |
| 7.2 WCRP SPARC Perspectives (including Data Initiative)  | 7.2                  | Bodeker (20)                  |
| <b>12.30 – 14.00 LUNCH</b>   |                      |                               |
| <b>14.00 – 17.30</b>   |                      |                               |
| <b>13. Cryospheric Issues</b>  |                      |                               |
| 13.1 Global Cryosphere Watch:  | 13.1                 | Goodison (20')                |
| 13.2 Update on Solid Precipitation Intercomparison Experiment (SPICE)  | 13.2                 | Goodison (20')                |
| <b>8. Other Atmospheric Networks and Issues</b>  |                      |                               |
| 8.1 Report on GRUAN<br>- Report from WG-ARO<br>- Report from GCOS/CBS/CIMO/WIGOS expert meeting on GRUAN<br>- Lead Centre evaluation   | 8.1a<br>8.1b<br>8.1c | Bodeker / Simmons (45'+15')   |
| 8.2 Global Surface Temperature Dataset Initiative  | 8.2                  | Menne (for Thorne) (10'+5')   |
| 8.3 US surface reference network + discussion  | 8.3                  | Menne (15'+15')               |
| 8.4 Discussion on station closures   | 8.4                  | All (10)                      |
| <b>9. Marine Issues</b>  |                      |                               |
| 9.1 Report from OOPC   | 9.1                  | Fischer (30')                 |
| 9.2 Report from Surface Pressure Working Group   | 9.2                  | Simmons (for Allan) (15')     |
| 9.3 Air-sea anomalies  | 9.3                  | Harrison (30')                |
| <b>17.30 End of day 2</b>  |                      |                               |
| <b>19.30 Group Dinner at Café du Soleil</b>  |                      |                               |
| <b>Wednesday 2 May</b>   |                      |                               |
| <b>9.00 – 12.30</b>  |                      |                               |
| <b>10. Terrestrial Issues</b>  |                      |                               |
| 10.1 Report from TOPC  | 10.1                 | Verstraete (for Dolman) (30') |
| 10.2 Development of a Terrestrial Reference Network  | 10.2                 | Verstraete (15')              |
| <b>11. ECV Data in International Data Centres</b>  |                      |                               |
| 11.1 Report from GCOS Swiss; Discussion on Data Centres  | 11.1                 | Seiz (20'+20')                |
| 11.2 Report from the Global Precipitation Climatology Centre (GPCC)  | 11.2                 | Becker (15')                  |
| 11.3 Report from the World Data Centre for Greenhouse  | 11.3                 | Ohkawara (15')                |

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|--|------|--------------------------------|
| Gases (WDCGG)  |      |                                |
| <b>12. Satellite issues, data and products</b>   |      |                                |
| 12.1 Report from the GCOS Space Rapporteur   | 12.1 | Jean-Louis Fellous (30')       |
| <b>12.30 – 14.00 LUNCH</b>   |      |                                |
| <b>14.00 – 18.00</b>   |      |                                |
| 12.2 Update on progress of the ESA CCI   | 12.2 | Saunders (5'+5')               |
| 12.3 Report from CGMS-XXXIX  | 12.3 | Schmetz (20'+10')              |
| 12.4 Report from SCOPE-CM Initiative, including Maturity Index                           | 12.4 | Schmetz (for Ryan) (15')       |
| 12.5 Progress in the CEOS Response to the updated Satellite Supplement                   | 12.5 | Goldberg (from remote) (20')   |
| 12.6 Report on EUMETSAT Climate Activities   | 12.6 | Schmetz (10'+5')               |
| <b>17.30 End of day 3</b>  |      |                                |
| <b>Thursday 3 May</b>  |      |                                |
| <b>9.00 – 12.30</b>  |      |                                |
| 8.4 Update on the development of the EGOS-IP   | 8.4  | Eyre (15'+10')                 |
| 8.5 Review of AOPC Requirements in WMO/CEOS RRR database                                 | 8.5  | Lafeuille / all (30')          |
| <b>14. Climate Information for Regional Adaptation, Integrated products, Data rescue</b> |      |                                |
| 14.1 European Regional Reanalyses  | 14.1 | Simmons (for Klein-Tank) (15') |
| 14.2 CRUTEM4 and HadSST3   | 14.2 | Jones (15'+15')                |
| 14.3 Update from the World Climate Data and Monitoring Programme (WCDMP)                 | 14.3 | Badour (20')                   |
| 14.4 Update on ClimDev Africa and Regional Workshop in South America                     | 14.4 | Westermeyer (20'+20')          |
| <b>12.30 – 14.00 LUNCH</b>   |      |                                |
| <b>14.00 – 17.30</b>   |      |                                |
| <b>15. GCOS Essential Climate Variables</b>  |      |                                |
| 15.1 General Review of ECV status; Discussion on potential future ECVs                   |      |                                |
| 15.2 Plans for future Adequacy Report  |      |                                |
| <b>16. Upcoming meetings relevant to AOPC</b>  |      |                                |
| <b>17. Summary of decisions and actions</b>  |      |                                |
| <b>17.30</b>   |      |                                |
| <b>18. Closure (10')</b>   |      |                                |
| 18.1 AOB, Next session   |      |                                |
| 18.2 Adjourn   |      |                                |

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## Report from the Advisory Group on GSN and GUAN (AGG) Meeting 30 April 2012

**AGG Members attending:** Phil Jones (Chair), Andreas Becker, Matthew Menne, Steve Colwell (via video conference), Richard Thigpen, and Mohan Abayasekara

**Also attending:** Adrian Simmons, Carolin Richter, Anna Mikalsen, and Greg Bodeker

**Discussion points** (30/04/12 – modified after presentation to AOPC on 01/05/12):

1. AGG notes the new CIMO Classification Guides for surface stations. As this is likely to take some time, it would be useful if GCOS keeps a watching brief, checking when a few countries have implemented the CIMO initiative to see how the GSN sites in those countries perform. Until we have information from a few countries it is premature to say whether a GSN site should have a minimum score on the CIMO scale. CIMO plan to reassess each site every 5 years, so in time this should give useful information about station site representativeness. AOPC should encourage all members to place priority on implementing the CIMO guidance for their GSN sites.
2. AGG notes the findings of the latest CIMO Radiosonde Comparison. At first site this seems like a clear recommendation that some sonde manufacturers are better than others. The aim of the comparison is to encourage sonde suppliers to improve sonde quality, so should be viewed in this light. Users (particularly the analysis and reanalysis centres) already assess the data from sondes regularly. These assessments will be improved if all GUAN sites included in the TEMP message in the available field the sonde type launched with each ascent. It might be necessary for some sonde manufacturers to register their models with WMO. An AOPC recommendation to this effect would be useful. The GCOS Implementation Project Manager needs to keep a watching brief on any CIMO recommendations arising from the Sonde Comparison as it could affect the types of sondes bought and supplied by GCOS to a few sites in the GUAN. Financial considerations and the ground equipment need to be borne in mind as well.
3. Most Chinese upper-air measurements only report the mandatory levels and don't submit their significant level data. An AOPC recommendation could request China to include these additional level data. It is possible that this might just be a switch change somewhere as a few sites in the country do report this information. Before a letter is sent a number of AGG members will contact people they know in China to see if there is a simple solution to the problem. The GCOS Implementation Project Manager reported that some Chinese sites launch different sondes from some of their sites, but without the necessary codes (see previous point) being inserted it is impossible to know how many variants there are.
4. The nested network discussion (national Climate Reference Networks, CRNs) was deferred to the later discussion by Matt Menne with respect to the US experience (item 8.3 on the AOPC agenda). The initial feeling is that GSN sites within a country ought to be part of any national CRN.
5. There is much interest in gaining access to more daily data from GSN sites in real time. The SYNOP network provides the required timeliness, but for most GSN variables this provides data that are not compatible with long historic series supplied by NMSs. Apart from any necessary QC, SYNOP data are generally not reported at the same times of day as nationally produced datasets. In order to solve this incompatibility (a discussion of which is documented for Europe by van den Besselaar et al. 2012), an AOPC recommendation would be for GSN sites to report a daily surface station value using the same observing

schedules as they currently use for the monthly CLIMAT message. This can be considered as a daily CLIMAT message. Phil Jones and William Wright to draft a justification for the need.

6. The GCOS Implementation Project Manager outlined the projects currently in hand around the world and his hopes for the coming 12 months. The details of this are given in section 5.5 of the AOPC agenda.
7. AGG discussed gaps in both the GUAN and GSN networks. The GCOS Implementation Project Manager will look into the following: GUAN additions – Ndjamena, Chad; Entebbe, Uganda and Vilhina, Brazil (83028); GUAN deletions - as observations have stopped at Honiara, Solomons and Bauerfield in Vanuatu; GSN additions – sites in southern Peru and also in Kalimantan (the southern part of Borneo). With the Indonesian case it may be worth contacting KNMI (Albert Klein Tank) who have recently set up a web site (similar to ECA&D for SE Asia and N. Australia). They ought to know where the long and more complete sites are in the region. The GCOS Implementation Project Manager to investigate the addition of sites in Brazil as the network has degraded there in recent years.

#### **Decisions:**

1. Changes to the GUAN, GSN. Add Khartoum to the GUAN as it has recently been upgraded and is working well. Remove Guantanamo from the GSN – GCOS Implementation Project Manager to inform the USA. The Cuban GSN sites are working OK. Ascension Island is currently not working, but should be kept on the list as there are initiatives between the UK and USA to restart upper-air observations.
2. The GUAN station at Gibraltar will likely close. AOPC to send a letter to Steve Palmer of the UK Met Office. If it does close, the suggested replacement is Murcia in SE Spain. GCOS Implementation Project Manager to make the necessary change and inform the parties should the observations cease.

#### **References:**

The CIMO site classification is published in the report of CIMO-XV (WMO-No. 1046), available from: [http://www.wmo.int/pages/governance/tc/tc\\_reports\\_en.html](http://www.wmo.int/pages/governance/tc/tc_reports_en.html)  
Part 1 Annex 4 beginning on Page 47

Report from the 2010 CIMO Radiosonde-Intercomparison:  
[http://www.wmo.int/pages/prog/www/IMOP/publications/IOM-107\\_Yangjiang.pdf](http://www.wmo.int/pages/prog/www/IMOP/publications/IOM-107_Yangjiang.pdf)

van den Besselaar, E.J.M. et al 2012: Synoptic messages to extend climate data records. *Journal of Geophysical Research*, **117**, D07101, doi:10.1029/2011JD16887.

## Annex IV

# Revised Terms of Reference for AOPC Working Group on GRUAN (formerly named Working Group on Atmospheric Reference Observations, WG-ARO)

## Terms of Reference (July 2012)

### *Background*

The GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC) Working Group on GRUAN (WG-GRUAN) was established in 2006 in recognition of the importance of initiating reference-quality observations of vertical profiles of essential climate variables, starting with temperature and water vapour, from the surface into the stratosphere to enhance monitoring and understanding of climate variability and change.

The 2004 GCOS Implementation Plan identified the establishment of a reference-quality network as 'a very high priority' for implementation by 2009. While this very ambitious timeline was not achieved, significant progress has been made. The 2010 Update of the GCOS Implementation Plan (GCOS-138) reiterated the call for the establishment of the GCOS Reference Upper Air Network (GRUAN) for reference upper-air measurements and a complementary system for reference measurements from satellites, and support of reanalysis and reprocessing activities as a key need. Since 2008 DWD (Deutscher Wetterdienst) have hosted the GRUAN Lead Centre consisting of scientific and secretarial support at their Lindenberg Observatory to oversee day-to-day operations of the network. In early 2012 more formal involvement of WMO and its technical commissions was endorsed at a meeting held under the auspices of the WMO Integrated Global Observing System (WIGOS). This enhanced involvement of WMO in GRUAN operations will be achieved by incorporating representatives from relevant WMO Technical Commissions.

A GRUAN Implementation Plan was published in July 2009 (GCOS-134) covering the period until 2013. An amendment to this implementation plan, covering the period through 2016, will be published in September/October 2012.

It is the Working Group's responsibility to facilitate this implementation, liaising with other groups and national and international bodies to ensure that an eventual GRUAN network is fit for purpose, robust and has the required long-term commitment and management structures. The WG-GRUAN also provides guidance to the GRUAN Lead Centre. The WG-GRUAN membership consists of a broad range of scientific and technical experts who contribute expert oversight and support to GRUAN development and operations.

The AOPC, supported by the GCOS Secretariat and guided by the GCOS Steering Committee, provides ultimate direction and oversight of GRUAN. The WG-GRUAN provides direct guidance on the operation of GRUAN and is supported by specific GRUAN Task Teams and the GRUAN Analysis Team for Network Design and Operations Research (GATNDOR). The day-to-day management and coordination of the network, including training and ensuring the archival and dissemination of GRUAN data, is the responsibility of the GRUAN Lead Centre. An organizational structure for GRUAN as a whole is given in Figure 1.

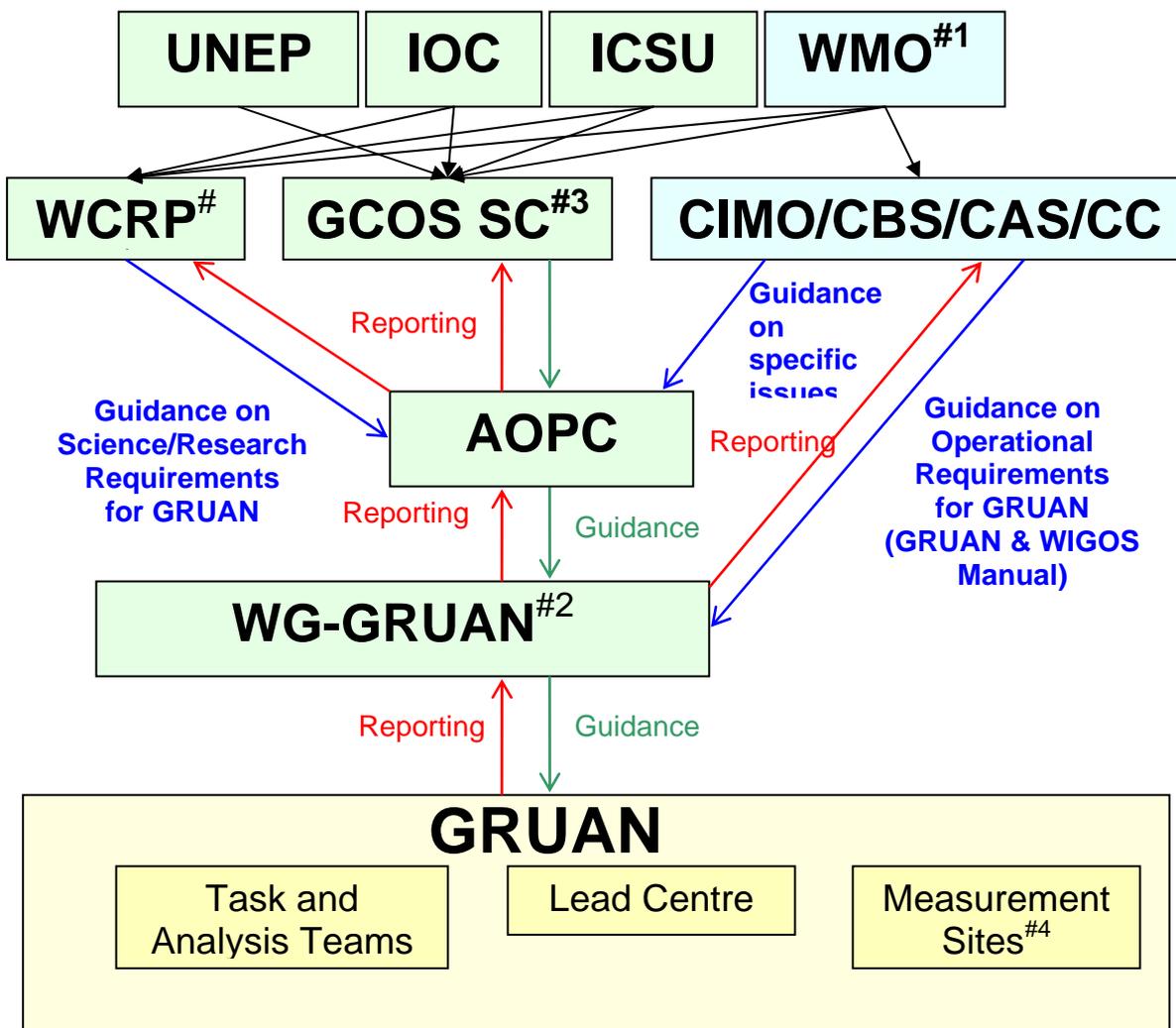


Figure 1: Organizational diagram for GRUAN management and oversight.

**Notes**

1. WCRP identifies scientific and research requirements for GRUAN, while WMO identifies operational requirements.
2. Composition of WG-GRUAN to be determined by the AOPC in consultation with WMO and should include one representative from each of CIMO, CBS, CAS and CCI; these representatives will be responsible for reporting back to their respective Technical Commission;
3. GCOS Steering Committee.
4. GRUAN Measurement Sites are contributed by Members of WMO.

**Working group roles and responsibilities**

The working group has a range of roles and responsibilities that reflect the GCOS and WMO expectations of its outputs. Here, these have been arranged under broad categories that reflect the core facets of the expected work.

*Governance*

- To provide scientific, technical and management oversight of the operations of the GRUAN Lead Centre, which will manage the overall work and evolution of the network, and which shall report to the WG-GRUAN at least twice a year;

- To define roles and responsibilities of the GRUAN Lead Centre and, as deemed appropriate, other centres, for data management, quality monitoring, analysis and capacity development purposes;
- To initiate, approve, manage and dissolve, as appropriate, task teams established to undertake specific activities in support of GRUAN;
- To encourage and support the activities of GATNDOR and provide feedback and input as requested by that team;
- To ensure that GRUAN operations are well aligned with the goals and directions of GCOS through liaison with the AOPC;
- To ensure that GRUAN operations are well aligned with WMO goals and directions through the representatives of WMO Technical Commissions;

#### *Site selection, assessment, and certification*

- To define essential and desirable requirements of a GRUAN site in terms of operational principles, the collection of metadata, assessment of measurement uncertainties, data management, variables addressed, and instrumentation. Develop these requirements in consultation with other relevant observing programmes, make them publically available, and periodically reassess their validity;
- To certify sites based on (i) information submitted by the site, (ii) an assessment made by the Lead Centre, and (iii) potentially on-site assessment by WG and/or Lead Centre members, against the set of requirements. Periodically reassess/audit sites against these same requirements;
- To decide on the composition of GRUAN, including the selection of sites. This should be done in consultation with AOPC and other advisory bodies as appropriate;

#### *Coordination*

- Together with relevant stakeholders, to plan and realize annual Implementation and Coordination Meetings (ICMs) to be hosted at, or associated with, a GRUAN site and to include a site visit;
- To report at least annually to AOPC on its activities, including the progress towards a reference network, the performance of the network once established, the uses and value of the data collected, and the implications for the global observing system;
- To ensure that the GRUAN Implementation Plan and individual work plans from ICM meetings are carried out, including but not limited to undertaking those activities mandated to the WG-GRUAN;
- To evaluate 6-monthly progress reports from the Lead Centre and GRUAN Task Teams and provide feedback in a timely manner;

#### *Advocacy and outreach*

- To work with relevant agencies and programmes to define and promote GRUAN for long-term atmospheric reference observations of a range of specific variables, and to make optimal use of existing and planned infrastructure within the WMO Global Observing System. This includes inter alia, working with the WIGOS planning office as a WIGOS pilot project; the WMO Space Programme, Commission on Basic Systems (CBS) and CIMO on satellite and radiosonde calibration and validation issues, including reference instrumentation and metadata;
- To provide for appropriate communication and outreach activities (through such activities as conferences, making connections with other programmes, organizing special conference sessions on GRUAN etc.).
- To work with strategic partner organizations and projects as specified from time to time inter-alia by AOPC, in annual Implementation and Coordination Meetings or in the GRUAN Implementation Plan.

### *Mode of operation*

- The Chair or Co-chairs will be appointed by the AOPC.
- Working Group members will be approved by the AOPC.
  - Co-chairs from each Task Team and from GATNDOR are expected to be members.
  - At least one member will explicitly represent each of the four WMO Technical Commissions associated with GRUAN (Figure 1).
  - At least one expert in the following fields shall be present to ensure a plurality of views:
    - Climate science
    - In-situ atmospheric observations
    - Satellite observations
    - NWP / reanalyses
    - Statistics
    - Metrology
  - Members may fulfil multiple roles, but AOPC needs to be mindful of any potential conflicts of interest that may arise as a result.
  - The AOPC decides at its annual meetings on additional experts and observers to join the WG-GRUAN as ex-officio or full members.
- Members will be expected to serve for at least two years or until the membership is reviewed.
- During the GRUAN implementation phase it is envisaged that annual WG-GRUAN meetings will be convened together with ICMs (see above), which group members will be expected to attend. Funding to support in part or in full WG-GRUAN meetings should be sought from sponsors.
- The WG-GRUAN will generally correspond by e-mail and teleconferences (to be undertaken every other month), and take advantage of relevant workshops and conferences to hold meetings (in addition to meeting at the time of ICMs). Additional meetings will be convened by the Chair(s) upon demand, in consultation with the GCOS Secretariat and GRUAN partner institutions.
- These Terms of Reference will be subject to periodic review by AOPC in liaison with the Co-chairs of the Working Group and the Lead Centre.

## WG-GRUAN Membership

| Name                                       | Country               | Affiliation                  | Relevant areas of expertise  | Roles  |
|--|-----------------------|------------------------------|--|--|
| <b>Chairmen</b>                            |                       |                              |  |  |
| Peter Thorne<br>peter.thorne@noaa.gov      | USA                   | CICS-NC /<br>NOAA<br>NCDC    | Climate data records   | Co-chair, CCI representative                         |
| Greg Bodeker<br>greg@bodekerscientific.com | New Zealand           | Bodeker Scientific           | Documentation, governance, instrumentation and observing practices | Co-chair   |
| <b>Members</b>                             |                       |                              |  |  |
| Arnoud Apituley                            | Netherlands           | KNMI                         | Ground-based remote sensing instrumentation, research              | Member   |
| Franz Berger                               | Austria /Germany      | DWD                          | Surface based remote sensing, site management                      | Member, Director of Lindenberg Observatory           |
| Stephan Bojinski                           | Switzerland / Germany | WMO                          | satellite observations   | Member, WMO Secretariat                              |
| Geir Braathen                              | Switzerland / Norway  | WMO                          | NDACC co-chair   | Member, WMO Secretariat                              |
| Belay Demoz                                | USA                   | Howard University            | Observational research, site operation                             | Member, Co-chair site representatives task team      |
| John Dykema                                | USA                   | Harvard University           | GPS-RO and metrology   | Member   |
| Alessandro Fasso                           | Italy                 | University of Bergamo        | Environmental statistics   | Member, member of TIES                               |
| Masatomo Fujiwara                          | Japan                 | Hokkaido University          | Radiosonde and ground-based remote sensing instrumentation         | Member, Co-chair task team on radisondes             |
| Rolf Philipona                             | Switzerland           | MeteoSwiss                   | Radiosonde and ground-based remote sensing instrumentation.        | Member, Co-chair task team on radisondes             |
| Tom Gardiner                               | UK                    | National Physical Laboratory | Metrology  | Member, co-chair Task Team on scheduling             |
| Dale Hurst                                 | USA                   | NOAA                         | In situ and remote sounding  | Member, co-chair Task Team on sites                  |
| Thierry Leblanc                            | USA                   | JPL-Table Mountain Facility  | Ground-based remote sensing instrumentation                        | Member, co-chair Task Team on ancillary measurements |
| Fabio Madonna                              | Italy                 | Potenza                      | In situ and remote sounding  | Member, Chair GATNDOR                                |

|                            |                       |                                  |  |  |
|----------------------------|-----------------------|----------------------------------|--|--|
| Andrea Merlone             | Italy                 | INRIM                            | Metrology  | Member, chair of Meteomet initiative                               |
| Kalev Rannat               | Estonia               | Tallinn University of Technology | GNSS-PW  | Member, co-chair Task Team on GNSS precipitable water measurements |
| Tony Reale                 | USA                   | NOAA NESDIS                      | Satellite program validation (NPROVS)                      | Member, co-chair task team on ancillary measures                   |
| Dian Seidel                | USA                   | NOAA Air Resources Laboratory    | Historical climate change, radiosonde data records         | Member   |
| Masato Shiotani            | Japan                 | Kyoto University                 | Satellite data, SPARC                                      | Member   |
| Doug Sisterson             | USA                   | ARM program                      | Observing networks programme management expertise          | Member   |
| David Tan                  | UK                    | ECMWF                            | Reanalyses and NWP expertise                               | Member   |
| Russell Vose               | USA                   | NOAA NCDC                        | Historical climate change, data management, network design | Member   |
| Jimmy Voyles               | USA                   | ARM program                      | Instrumentation  | Member   |
| Junhong Wang               | USA                   | NCAR                             | Radiosonde and GNSS technologies and climate datasets      | Member, co-chair task team on GNSS precipitable water measurements |
| David Whiteman             | USA                   | NASA/GSFC                        | Climate change research                                    | Member, co-chair Task Team on scheduling                           |
| Steve Williams             | USA                   | NCAR                             | In-situ and remote-sensing Instrumentation                 | Member   |
| <b>Ex-officio Members</b>  |                       |                                  |  |  |
| <b>GCOS representative</b> |                       |                                  |  |  |
| Carolin Richter            | Switzerland / Germany | WMO                              | GCOS representative  | Ex-officio, Director GCOS Secretariat                              |
| <b>WMO representative</b>  |                       |                                  |  |  |
| Miroslav Ondras            | Slovenia              | WMO OBS                          | CIMO   | Ex-officio; WMO  |

|   |              |              |  |   |
|---|--------------|--------------|--|---|
|   | /Switzerland | Department   | perspective,<br>WMO guiding<br>literature                  | Secretariat   |
| <b>CIMO representative</b>                  |              |              |  |   |
| Bertrand Calpini                            | Switzerland  | Meteoswiss   | Observation<br>programme and<br>site management;<br>LIDARs | Ex-officio, CIMO<br>President   |
| <b>CBS representative</b>                   |              |              |  |   |
| N.N.  |              |              |  | Ex-officio,   |
| <b>CAS representative</b>                   |              |              |  |   |
| N.N.  |              |              |  | Ex-officio,   |
| <b>CCI representative</b>                   |              |              |  |   |
| Peter Thorne                                |              |              |  | Ex-officio, also<br>co-chair  |
| <b>GRUAN Lead Centre<br/>representative</b> |              |              |  |   |
| Holger Vomel                                | Germany      | DWD          | Upper-air water<br>vapour                                  | Ex-officio, Head<br>of Lead Centre  |
| Howard Diamond                              | USA          | NOAA<br>NCDC | US GCOS Office   | Ex-officio; Head<br>of US GCOS<br>Office  |
| Christopher D Miller                        | USA          | NOAA         | Climate<br>Programme<br>management                         | Ex-officio, Chief<br>of the Research<br>and Monitoring<br>Division for<br>NOAA's Climate<br>Program<br>Office |

Please note:

'Members' serve in their personal capacity as experts, whereas 'ex-officios' serve in their respective role, representing organizations or programmes.

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## Annex V

### List of Acronyms

|                |   |
|----------------|---|
| AOPC           | ATMOSPHERE OBSERVATION PANEL FOR CLIMATE                                      |
| AGG            | AOPC ADVISORY GROUP ON GSN AND GUAN   |
| AIRS           | ATMOSPHERIC INFRARED SOUNDER (NASA)   |
| AMV            | ATMOSPHERIC MOTION VECTOR   |
| AREP           | ATMOSPHERIC RESEARCH AND ENVIRONMENT PROGRAMME (WMO)                          |
| AVHRR          | ADVANCED VERY HIGH RESOLUTION RADIOMETER                                      |
| AWS            | AUTOMATIC WEATHER STATION   |
| BIPM           | BUREAU INTERNATIONAL DES POIDS ET MEASURES                                    |
| BUFR           | BINARY UNIVERSAL FORM FOR THE REPRESENTATION OF METEOROLOGICAL DATA (code)    |
| CBS            | COMMISSION FOR BASIC SYSTEMS (WMO)  |
| CCI            | CLIMATE CHANGE INITIATIVE (ESA)   |
| CCL            | COMMISSION FOR CLIMATOLOGY (WMO)  |
| CDMS           | CLIMATE DATA MANAGEMENT SYSTEMS   |
| CEOS           | COMMITTEE ON EARTH OBSERVATION SATELLITES                                     |
| CGMS           | COORDINATION GROUP FOR METEOROLOGICAL SATELLITES                              |
| CIMO           | COMMISSION FOR INSTRUMENTS AND METHODS OF OBSERVATION (WMO)                   |
| CLARREO        | CLIMATE ABSOLUTE RADIANCE AND REFRACTIVITY OBSERVATORY                        |
| CLARIS         | EUROPE-SOUTH AMERICA NETWORK FOR CLIMATE CHANGE ASSESSMENT AND IMPACT STUDIES |
| CDMP           | CLIMATE DATABASE MODERNIZATION PROGRAM (NOAA)                                 |
| CLIMDEV AFRICA | CLIMATE FOR DEVELOPMENT IN AFRICA   |
| COP            | CONFERENCE OF THE PARTIES   |
| DWD            | DEUTSCHER WETTERDIENST (GERMANY)  |
| ECMWF          | EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS                            |
| ECV            | ESSENTIAL CLIMATE VARIABLE  |
| ENVISAT        | ENVIRONMENTAL SATELLITE (ESA)   |
| EOS            | EARTH OBSERVING SYSTEM (NASA polar orbiting satellites)                       |
| ESA            | EUROPEAN SPACE AGENCY   |
| ESAC           | ESA SCIENTIFIC ADVISORY COMMITTEE   |
| ET-EGOS        | EXPERT TEAM ON EVOLUTION OF THE OBSERVING SYSTEM (WMO)                        |
| EUMETSAT       | EUROPEAN ORGANISATION FOR THE EXPLOITATION OF METEOROLOGICAL SATELLITES (WMO) |
| GAW            | GLOBAL ATMOSPHERE WATCH (WMO)   |
| GCM            | GCOS COOPERATION MECHANISM  |
| GCW            | GLOBAL CRYOSPHERE WATCH   |
| GFCS           | GLOBAL FRAMEWORK FOR CLIMATE SERVICES   |
| GEO            | GROUP ON EARTH OBSERVATIONS   |
| GEOSS          | OBSERVING EARTH OBSERVATION SYSTEM OF SYSTEMS                                 |
| GHG            | GREENHOUSE GAS  |
| GMES           | GLOBAL MONITORING FOR ENVIRONMENT AND SECURITY                                |
| GOOS           | GLOBAL OCEAN OBSERVING SYSTEM   |
| GPCC           | GLOBAL PRECIPITATION CLIMATOLOGY CENTRE                                       |
| GPS            | GLOBAL POSITIONING SYSTEM   |
| GRUAN          | GCOS REFERENCE UPPER-AIR NETWORK  |
| GSICS          | GLOBAL SPACE-BASED INTERCALIBRATION SYSTEM                                    |
| GSN            | GCOS SURFACE NETWORK  |

|          |  |
|----------|--|
| GTOS     | GLOBAL TERRESTRIAL OBSERVING SYSTEM  |
| GUAN     | GCOS UPPER-AIR NETWORK   |
| IASI     | INFRARED ATMOSPHERIC SOUNDING INTERFEROMETER   |
| ICM      | IMPLEMENTATION AND COORDINATION MEETING (GRUAN)  |
| ICODS    | INTERNATIONAL COMPREHENSIVE OCEAN- ATMOSPHERE DATA SET   |
| ICT-IOS  | IMPLEMENTATION/COORDINATION TEAM ON INTEGRATED OBSERVING SYSTEMS (CBS)                         |
| IGRA     | INTEGRATED GLOBAL RADIOSONDE ARCHIVE   |
| IOC      | INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION (UNESCO)  |
| IP       | IMPLEMENTATION PLAN  |
| IPCC     | INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE  |
| ISPD     | INTERNATIONAL SURFACE PRESSURE DATA BANK   |
| ISTI     | INTERNATIONAL SURFACE TEMPERATURE INITIATIVE   |
| JMA      | JAPAN METEOROLOGICAL AGENCY  |
| MIPAS    | MICHELSON INTERFEROMETER FOR PASSIVE ATMOSPHERIC SOUNDING (ON ENVISAT)                         |
| MSU      | MICROWAVE SOUNDING UNIT  |
| NASA     | NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (USA)  |
| NMHSS    | NATIONAL METEOROLOGICAL AND HYDROLOGICAL SERVICES  |
| NCDC     | NATIONAL CLIMATIC DATA CENTER (USA)  |
| NMS      | NATIONAL METEOROLOGICAL SERVICE  |
| NPP      | NET PRIMARY PRODUCTION   |
| NWP      | NUMERICAL WEATHER PREDICTION   |
| NASA     | NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (USA)  |
| NOAA     | NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (USA)  |
| OOPC     | OCEAN OBSERVATIONS PANEL FOR CLIMATE   |
| OPAG     | OPEN PROGRAMME AREA GROUP  |
| OPACE    | OPEN PANEL OF CCI EXPERTS  |
| RBCN     | REGIONAL BASIC CLIMATOLOGICAL NETWORKS (WMO)   |
| REDD+    | REDUCING EMISSIONS FROM DEFORESTATION AND FOREST DEGRADATION IN DEVELOPING COUNTRIES (UNFCCC ) |
| RO       | RADIO OCCULTATION  |
| RRR      | ROLLING REQUIREMENTS REVIEW (WMO)  |
| SBSTA    | SUBSIDIARY BODY FOR SCIENTIFIC AND TECHNOLOGICAL ADVICE (UNFCCC)                               |
| SCOPE-CM | SUSTAINED COORDINATED PROCESSING OF ENVIRONMENTAL SATELLITE DATA FOR CLIMATE MONITORING        |
| SPARC    | STRATOSPHERIC PROCESSES AND THEIR ROLE IN CLIMATE (WCRP)                                       |
| SPICE    | SOLID PRECIPITATION INTERCOMPARISON EXPERIMENT (WMO CIMO)                                      |
| SST      | SEA-SURFACE TEMPERATURE  |
| TOPC     | TERRESTRIAL OBSERVATION PANEL FOR CLIMATE  |
| TIROS    | TELEVISION INFRARED OBSERVATION SATELLITE  |
| TOVS     | TIROS OPERATIONAL VERTICAL SOUNDER   |
| UNESCO   | UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION                               |
| UNFCCC   | UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE  |
| USCRN    | US CLIMATE REFERENCE NETWORK   |
| WCDMP    | WORLD CLIMATE DATA AND MONITORING PROGRAMME (WMO)  |
| WCRP     | WORLD CLIMATE RESEARCH PROGRAMME   |
| WDCGG    | WORLD DATA CENTRE FOR GREENHOUSE GASES   |
| WG-ARO   | AOPC WORKING GROUP ON ATMOSPHERIC REFERENCE OBSERVATIONS (AOPC)                                |
| WIGOS    | WMO INTEGRATED GLOBAL OBSERVING SYSTEM   |
| WMAC     | WCRP MODELLING ADVISORY COUNCIL  |
| WDAC     | WCRP DATA ADVISORY COUNCIL   |

WMO  
WOAP  
WWR

WORLD METEOROLOGICAL ORGANIZATION  
WCRP OBSERVATIONS AND ASSIMILATION PANEL  
WORLD WEATHER RECORD

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