

GLOBAL CLIMATE OBSERVING SYSTEM (GCOS)

Activity Report to WMO Executive Council (EC-70):

Draft Strategy, Recent activities emerging from the GCOS Implementation Plan and GSN and GUAN Network Performance

Drafting a strategy

The GCOS Steering Committee decided at its 25th session in October 2017 to develop a strategy that will provide additional clarity about the purpose of GCOS. The draft strategy will be endorsed by the executive heads of all sponsoring organizations and provided to the WMO Congress in May 2019.

The draft strategy is promoting three strategic goals:

- I. Identify user needs. In particular, identify observations that more fully meet the needs of adaptation and mitigation to climate change, support sustainable development, the requirements of the UNFCCC and other multilateral environmental agreements (MEA).
- II. In order to meet these needs, GCOS aims to ensure that climate observations are enhanced and continued into the future to provide the empirical evidence needed to understand and predict the evolution of the climate, to guide mitigation and adaptation measures, to assess risks and enable attribution of climatic events to underlying causes, and to underpin climate services. GCOS will need to support integrated observations of the physical, chemical and biological properties and processes across the atmospheric, oceanic and terrestrial domains, in order to fully monitor the Earth's water and carbon cycles and energy.
- III. Advocate for free and open access to relevant data.

GCOS was established in 1992. However, it is now facing new challenges. With the UNFCCC Paris Agreement¹ of 2015, there is a wide consensus that supporting climate policy to address adaptation and mitigation is vital. The science has improved dramatically: the existence of anthropogenic climate change is clear and warming of the climate system is unequivocal².

This consensus on the need to act to mitigate and adapt to climate change together with improving and expanding observational technologies leads to more demands on the global climate observing system.

¹ UNFCCC Decision 1/CP.21, Paris Agreement:
<http://unfccc.int/resource/docs/2015/cop21/eng/10a01.pdf>

² See IPCC (2014) Climate Change 2014 Synthesis Report, IPCC Geneva

GCOS will consider how best to support users beyond its traditional role of supporting the science and understanding of climate change to include the global climate related observation needs of adaptation, mitigation, sustainable development, disasters and emergency response, and in responding overall to the Paris Agreement.

In order for climate observations to support an improved understanding of the climate system, a better attribution of events, and more reliable forecasts and projections, GCOS will need to ask for the whole climate system to be monitored. GCOS will incorporate the Earth's water and carbon cycles and energy balance in their entirety and aim to explain the changing conditions of the biosphere.

Observation technology is evolving. An example has been in the oceans with new autonomous equipment collecting data. New and higher resolution satellite data is becoming available. Other developments that use lower levels of technology but are likely to grow must be considered by GCOS.

A clear trend over the past decades has been a migration of individuals into cities, with over 50% of the world's population now living in urban areas. Observations are needed where people live, especially in the new urban megacities, to support adaptation, sustainable development and disasters as well as emergency response and resilience. GCOS will develop plans to address this.

Finally, to ensure high quality data is available, GCOS will need to improve its monitoring of the performance of ECV observations and implementation of the GCOS plans. This should be a central part of the work of the Science Panels.

Recent activities emerging from the GCOS Implementation Plan

1. Promoting Global Climate Indicators

The GCOS implementation plan asks for the development of an agreed set of global climate indicators that can be used to communicate to the widest community the scope and rate of changes to the climate in a widely accessible manner. The current list of climate indicators is being promoted: Global Surface Temperature, Ocean Heat, Atmosphere Carbon Dioxide, Sea Level, Ocean Acidification, Sea Ice Extent in the Arctic and Antarctic and Glacier Change.

2. Task Team on Paris Agreement

GCOS has created a task force that will identify where existing and future observations for climate can support the ambitions of the Paris Agreement and subsequent UNFCCC COP decisions in relation to the global stocktake. It will also consider where GCOS can provide advice for observations supporting adaptation, mitigation, assessments of losses and damages, as well as methods of implementation. Effective support for these actions will be delivered through climate services which, themselves, require access to extensive, reliable and accurate observational data on the past and current evolution of essential climate variables.

3. Using Radar to compliment precipitation climatology

The GCOS/WMO CCI Radar Task Team (GRAD TT), is responsible for identifying requirements for the use of radar data for climate studies, including specifying adequate metadata and guidance on how to facilitate user access and preservation of data and to handle historical data. The first meeting was held at the Finnish Meteorological Institute in Helsinki in August 2017. A document including the above topics is in preparation.

4. Lightning Observations for Climate Applications

Lightning is a new ECV in the atmospheric domain, and an assigned task team, the joint GCOS/WMO CCI Task Team on Lightning Observations for Climate Applications (TTLOCA), is

working on developing requirements and guidelines on the use of lightning data for climate, including the review and update of current lightning ECV requirements and the definition of standards and requirements for data management and data exchange of lightning monitoring for climate applications.

5. Regional Workshops in light of importance of climate adaptation

As called for in the implementation plan, GCOS will hold regional workshops, particularly in light of the importance of adaptation, to identify needs and potential regional cooperation. The regional work programme envisaged would be an ideal forum to discuss adaptation needs, promote guidance and best practice and design projects to improve observational networks.

These workshops will result in regional plans that will highlight the greatest needs and benefits of the proposed observational improvements. Donors would be encouraged to address these needs, either through the GCOS Coordination Mechanism, other actors or directly.

The workshops could be held jointly with other interested stakeholders. One potential preparation would be to cooperate with WMO Regional Climate Centres to design and run specific regional small projects to assess existent capabilities needs in each country, identify potential opportunities of south-south cooperation, ongoing cooperation programmes and possible involvement of governments and the private sector.

These regional workshops will include representatives of countries in the region, potential donors and technical experts.

As a first step, GCOS, jointly with WIGOS, has organized a workshop in Nadi, in Fiji, on from 9 to 12 October 2017, which developed an outline for a *Pacific region observing network plan in support of the GCOS Implementation Plan and the Implementation Plan for the Evolution of Global Observing Systems (EGOS IP)* to:

- o Strengthen regional and national meteorological networks to support adaptation actions and avert loss and damage;
- o Identify capacity building needs to ensure the sustainability of the networks;
- o Support requests for finance from the operating entities of the financial mechanism under the Convention, the GCOS Cooperation Mechanism and other relevant funding sources.

The draft plan is being developed by GCOS and WIGOS in collaboration with the Secretariat of the Pacific Regional Environmental Programme (SPREP), the Pacific Islands Communication and Infrastructure Panel (PICI), and Pacific Meteorological Council, until December 2018.

GCOS jointly with WIGOS and the Data Management Applications Division is currently planning for a second workshop in a sub-Saharan, tropical African region, in 2018.

6. Observations for Adaptation

The Terrestrial Observation Panel for Climate (TOPC) has decided to establish a Task team to look at observations to monitor or support adaptation. Adaption planning requires observations of the current state and assessment of risks of impacts and information on how these are changing. Some of this information comes from global observational systems and so GCOS is including these global monitoring needs in future observational requirements. In addition, some adaptation actions can be remotely sensed, and TOPC will consider how to the observations needed to do this to support reporting to the UNFCCC Global Stocktake.

7. Progress in providing access to ECVs

The GCOS science panels have started the process of reviewing progress on the new implementation plan and ensuring mechanisms are in place to monitor the observation, maintenance and free and open accessibility of all the ECVs.

In this context, the work of the Joint CEOS-CGMS Working Group on Climate needs to be highlighted which is tasked with responding on the monitoring of climate from space. This working group has built an inventory for ECVs³, which is accessible through a website. The ECV inventory is the backbone of the architecture for climate monitoring from space and provides a comprehensive view as to what Climate Data Records are currently planned or available.

8. Continued commitment of space agencies

The Working Group on Climate has coordinated and compiled [the space agencies' response to the GCOS Implementation Plan](#). This document reiterates the commitment of space agencies worldwide to address actions required for implementation of the Global Climate Observing system and its specific contribution to climate change adaptation efforts around the world.

9. GCOS Network Management

Many actions in the Implementation Plan are related to the operation and monitoring of the GCOS Upper-Air Network (GUAN). A Task Team was created to review the network requirements, assess and document the benefits of meeting stated requirements and to review how it contributes as a baseline network in the tiered network framework with GRUAN and the comprehensive network. A first meeting of the Task Team took place at the DWD Meteorological Observatory in Lindenberg, Germany from 5 to 6 December 2017. The key message from this meeting was a need to refocus the requirements of the GUAN in provided 'guaranteed' high-quality observations and the benefits of its designation as a baseline network. It was also decided that the original data should be retained and archived, and a common format for the raw data should be defined.

The GCOS Secretariat is reporting regularly on the GUAN, the GCOS Surface Network (GSN), and the GCOS Cooperation Mechanism, including the station list update, monitoring statistics for past and current years and current and recent observations projects undertaken by the GCOS network management.

A key component to report, update and encourage the work and responsibilities of the Lead Centres is the biannual meeting between the Lead Centre Representatives, WMO and GCOS. The last meeting was held in Cambridge, UK in September 2016 and tentatively the next meeting is to take place in Asheville, USA (September 2018).

Since January 2016 additional monitoring of the GSN stations has been provided through the EUMETNET Quality Monitoring Portal (<https://eucos.dwd.de/ravi/>), QMP.

This enhanced QMP not only provides real-time availability and timeliness statistics for surface and upper-air messages received at DWD (Offenbach) but also measurement quality as compared with NWP background fields (ECMWF). Members are encouraged to monitor the performance of their GSN stations through this portal, and report any issues with the appropriate WMO/GCOS Secretariat.

³ See: <http://climatemonitoring.info/ecvinventory>

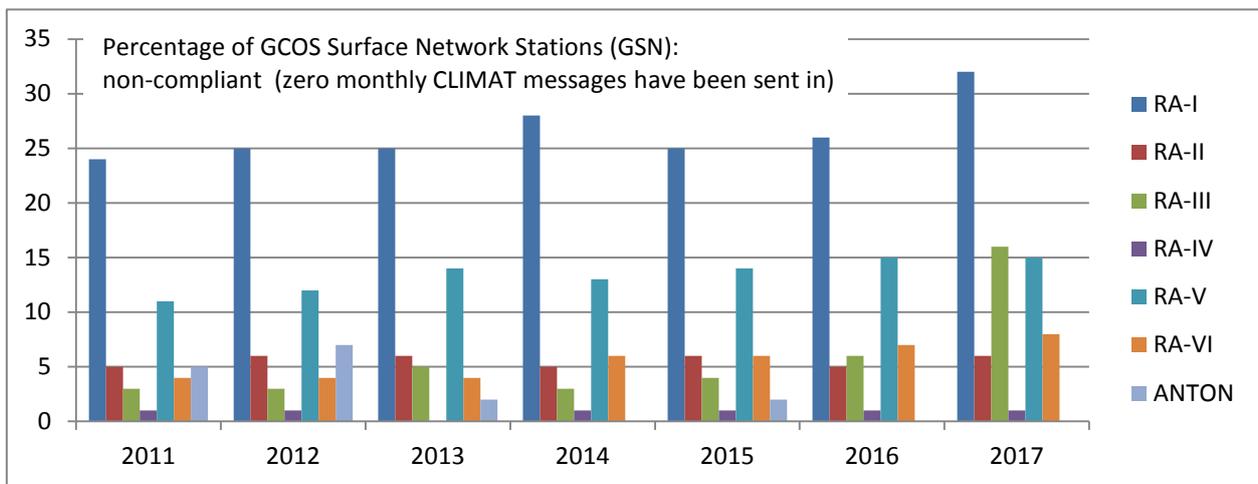
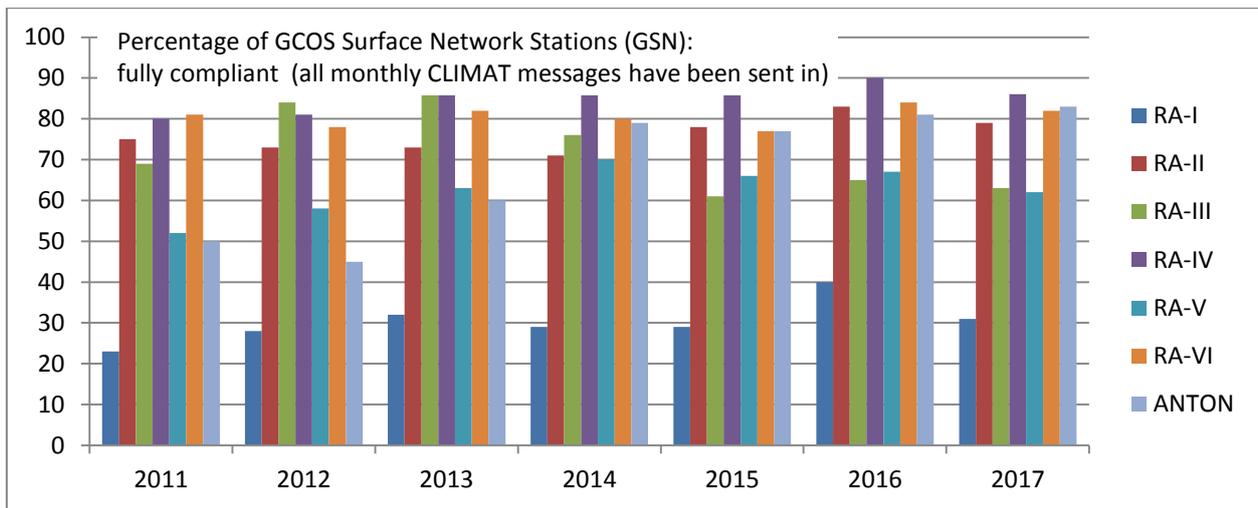
Several actions in the Implementation Plan are related to the operation of the GCOS Reference Upper-Air Network (GRUAN). GRUAN is an international reference observing network of sites measuring ECVs above the Earth's surface. It is the response to the need of WMO and GCOS for the highest accuracy data possible and is also part of WIGOS. GRUAN measurements provide long-term, high-quality climate data records from the surface, through the troposphere, and into the stratosphere that are being used to determine trends, constrain and calibrate data from more spatially-comprehensive observing systems (including satellites and current radiosonde networks), as well as providing appropriate data for studying atmospheric processes. GRUAN has currently 26 sites, with the aim to expand to 30 to 40 sites.

GCOS has established a task team to work on the development of a GCOS Surface Reference Network (GSRN TT). A position paper, developed by members of the community "Towards a global land surface climate fiducial reference measurements network" and published in the International Journal of Climatology in 2018 (DOI: 10.1002/joc.5458), includes the rationale of the existence of a global surface reference network. Basing their work on this paper, the GSRN Task Team is asked to move forward the concept of a global surface reference network towards the practical implementation of such a network and to provide a concrete roadmap for consideration of the key stakeholders. During the meeting, held at Maynooth University in Ireland, from 1 to 3 November 2017, it was decided to produce a document that will include benefits, requirements, network design, governance and management proposals. This document will be part of the material used to assess the interest in the GSRN from stakeholders and to investigate about possible resources.

(a) Performance Report of the GCOS Surface Network (GSN)

The following statistics are an annual summary of the monthly CLIMAT messages in the GCOS Climate Archive (National Climate Environmental Information, NCEI, US). According to the GCOS requirements, a fully compliant GSN/RBCN shall have 12 CLIMAT reports. The values represent the 2017 percentage of stations that are compliant and those that are partially or non-compliant. In brackets are the statistics for 2016, 2015, 2014, 2013, 2012 and 2011 respectively.

Region	No.	12 Monthly CLIMAT	6 - 11 Monthly CLIMAT	1 - 5 Monthly CLIMAT	0 Monthly CLIMAT
RA I	155	31% (40,29,29,32,28,23)	34% (25,31,33,33,36,39)	3% (9,15,10,10,11,14)	32% (26,25,28,25,25,24)
RA II	258	79% (83,78,71,73,73,75)	15% (10,14,21,19,19,19)	0% (2, 2, 3, 2, 2, 1)	6% (5, 6, 5, 6, 6, 5)
RA III	101	63% (65,61,76,89,84,69)	15% (29,35,20,6,13,28)	6% (0, 0, 1, 0, 0, 0)	16% (6, 4, 3, 5, 3, 3)
RA IV	178	86% (90,88,88,88,81,80)	12% (7, 9,10,11,17,18)	1% (2, 2, 1, 1, 1, 1)	1% (1, 1, 1, 0, 1, 1)
RA V	151	61% (67,66,70,63,58,52)	21% (15,16,17,16,23,34)	3% (3, 4, 1, 7, 7, 1)	15% (15,14,13,14,12,11)
RA VI	138	82% (84,77,80,82,78,81)	8% (7,14, 9,12,17,15)	2% (2, 3, 5, 2, 1, 0)	8% (7, 6, 6, 4, 4, 4)
ANTON	42	83% (81,77,79,60,45,50)	12% (17,19,19,36,43,33)	5% (2, 2, 2, 2, 5, 12)	0% (0, 2, 0, 2, 7, 5)



Regional Basic Climatological Network (RBCN, includes the GSN above)

Region	No.	12 Monthly CLIMAT	6 - 11 Monthly CLIMAT	1 - 5 Monthly CLIMAT	0 Monthly CLIMAT
RA I	723	18% (23,16,17,19,13,12)	22% (17,22,20,20,23,22)	5% (8,11,8,7,12,13)	55% (52,51,55,54,52,53)
RA II	664	77% (80,73,71,73,67,57)	14% (12,17,18,15,22,30)	1% (1, 2, 4, 4, 1, 2)	8% (8, 8, 7, 8, 10, 11)
RA III	298	60% (64,63,73,81,73,65)	13% (22,25,14, 6,15,23)	8% (1, 0, 1, 1, 1, 0)	19% (13,12,12,12,11,12)
RA IV	337	77% (80,78,78,72,67,66)	10% (8, 10, 11, 18, 18, 18)	2% (2, 3, 3, 2, 2, 3)	11% (10, 9, 8, 8, 13, 13)
RA V	247	60% (64,63,64,59,56,50)	19% (16,18,21,17,24,34)	4% (4, 4, 1, 9, 6, 3)	17% (16,15,14,15,14,13)
RA VI	594	85% (85,79,81,77,77,74)	5% (5, 12, 8, 13, 15, 18)	1% (1, 1, 3, 3, 1, 1)	9% (9, 7, 7, 7, 7, 7)

RA I is the poorest performing region, with only 31% of stations meeting the minimum requirement, and 32% not providing any CLIMAT messages, this has not significantly changed,

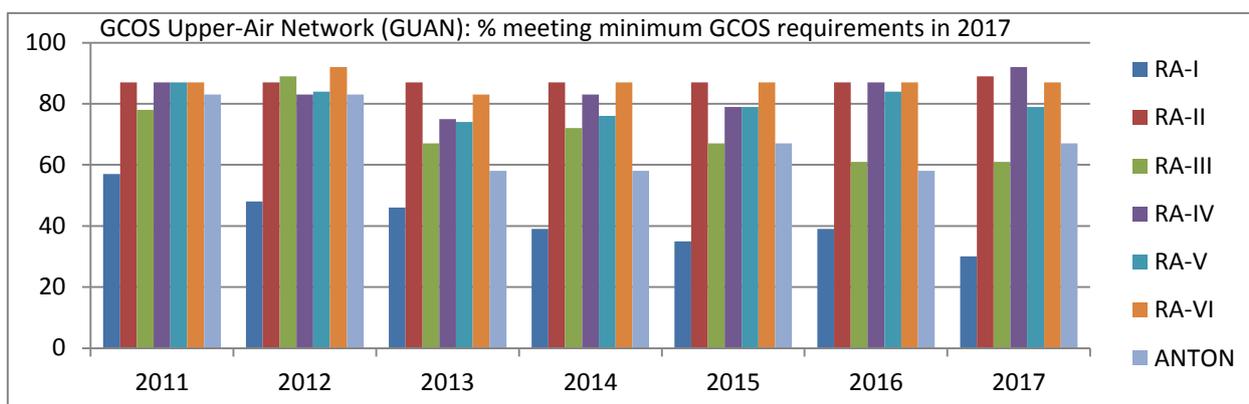
neither better or worse, over the last 7 years. Thus whilst this continues to reinforce the need for GCOS to focus its support in this region, it also highlights that recent efforts to improve these statistics have had little impact. The drop in RA III statistics of fully compliant stations was due to CLIMAT messages from Peru not being received at NCEI.

For the RBCN network, which includes the GSN, the situation is even worse in RA I with only 18% of stations meeting the minimum requirement. Regions I and IV show a significant increase in the percentage of stations with zero reports (RBCN versus GSN), suggesting that not all countries are sending CLIMAT messages for their RBCN stations, in addition to the GSN stations.

(b) Performance Report of the GCOS Upper-Air Network (GUAN)

The following table is the 2017 summary for the GCOS Upper-Air Network (GUAN) monitoring against the GCOS minimum requirements (25 daily soundings to 30hPa per month) for each region, according to the monthly statistics provided by NCEP. In brackets are the same statistics for 2016, 2015, 2014, 2013, 2012 and 2011. For 2012 and 2011 these are based on availability according to NCEI.

Region	Number of GUAN stations	% meeting minimum GCOS requirements in 2017 (% for 2016, 2015, 2014, 2013, 2012 and 2011)
RA I	23	30% (39%, 35%, 39%, 46%, 48%, 57%)
RA II	38	89% (87%, 87%, 87%, 87%, 87%, 87%)
RA III	18	61% (61%, 67%, 72%, 67%, 89%, 78%)
RA IV	24	92% (87%, 79%, 83%, 75%, 83%, 87%)
RA V	38	79% (84%, 79%, 76%, 74%, 84%, 87%)
RA VI	24	87% (87%, 87%, 87%, 83%, 92%, 87%)
ANTON	12	67% (58%, 67%, 58%, 58%, 83%, 83%)



Eleven (11) of the GUAN stations (6%) were 'Silent' (zero reported TEMP observations) during 2017, which is the highest since this monitoring was started in 2011. In 2016 and 2015 it was seven (7), 2014 and 2013 it was three (3), four (4) in 2012 and five (5) in 2011.

(c) The key points for each region are as follows:

China and Fiji, as the hosts of a GCOS meeting, received a 2017 certificate of recognition for their significant contributions to the climate observing system, through their stations nominated to the GCOS Surface Network (GSN) and GCOS Upper Air Network (GUAN).

However, 2017 monitoring of the GSN and GUAN has continued to show that significant areas of the networks are not meeting the minimum requirements, as many countries are lacking the necessary resources and technical skills to operate and maintain their stations.

In **Region I**, only 30% of the GUAN stations have met the minimum requirement for 2017, compared with 39% for 2016, which continues, by some margin, to be the worst performing region. This poor, and worsening, performance is mainly associated with the necessary funding required to operate and maintain an upper-air station. Communication with the station at a technical level to establish the cause of the poor performance continues to be a challenge and often means that relatively simple issues can go unaddressed for long periods of time. In addition there are an increasing number of stations that have problems and failures with their hydrogen generator systems which has resulted in a period of long-term inactivity. Three (3) stations were in-active during the period; Vacoas, Mauritius (Radiosonde consumables); Khartoum, Sudan (Hydrogen system); and Dar es Salaam, Tanzania (Hydrogen system). Eight (8) stations had at least 1 month with zero reported TEMP observations; 61641; 62414; 63985; 64910; 67774; 68110; 68592 and 68816.

The performance in **Region II** in 2017 was similar to that for the previous years, with 4 stations not meeting the minimum requirement. No stations were completely in-active during the period, although the station in Pakistan (41780) is only launching PILOT balloons and with no TEMP soundings for 7 years, it is not meeting the GUAN requirements. The two stations in Thailand (48327 Chiang Mai and 48453 Bangna) both had lengthy periods of inactivity owing to radiosonde supply issues, similar to 2016.

The performance in **Region III** in 2017 was the same as 2016 but slightly worse than for the period 2013-2015, and a marked decrease from 2011-12, with 7 stations not meeting the minimum requirement. Three (3) stations were completely inactive, Manus 82332 and Fortaleza 82397, Brazil (Equipment and Hydrogen system) and San Cristobal 84008, Ecuador (Equipment and staffing issues).

The performance in **Region IV** in 2017 was again an improvement on the previous year, with 2 stations not meeting the minimum requirement. No stations were completely in-active during the period but two (2) stations, 76654 and 78762, had at least 1 month with zero reported TEMP observations.

Region V was slightly worse in 2017 compared to 2016, with 8 stations not meeting the minimum requirement. Four (4) stations were completely in-active during the period, Honiara, Solomon Islands; Vanuatu, Bauerfield; Rarotonga, Cook Islands and Port Moresby, PNG, all due to having no radiosonde consumables. Three (3) stations, 91610, 94302 and 96315, had at least 1 month with zero reported TEMP observations.

The performance in **Region VI** in 2017 was the same as for the previous 3 years, with 3 stations not meeting the minimum requirement. Only Yerevan, Armenia, had a period of inactivity owing to a fault with the hydrogen system, which was resolved at the end of March 2017.

The performance in the **Antarctica** region in 2017 was a small improvement than for 2016, with 4 stations not meeting the minimum requirement. No stations were completely in-active during the period. Halley Bay (89022) had an extensive period of inactivity owing to the station needing to be relocated for safety reasons.

10. News with regard to soil moisture and the programme on forest and land cover dynamics

Support for some of the networks remains uncertain. The future of the International Soil Moisture Network (ISMN) is still unclear but funding is now secured for GOFC-GOLD which supports forest and wildfire observations.

11. Confirmed commitment to continue coordination of the Global Terrestrial Network –Hydrology

EC-69 requested to facilitate the identification of a suitable institution amongst Members to take over the coordination of the Global Terrestrial Network –Hydrology to ensure the continued provision of services provided by GTN-H. The IHP/HWRP secretariat, hosted by the German Federal Institute of hydrology in Koblenz, Germany, has firmly committed to take over the coordination.

12. Setting requirements for ocean Essential Climate Variables

The GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC) is responsible for overseeing requirements for ocean Essential Climate Variables. The panel is also responsible for setting requirements for physical Essential Ocean Variables (EOVs) for GOOS (for climate, real time services, and ocean health). Hence, for climate applications, OOPC works with the Global Ocean Observing System (GOOS) biogeochemistry and biology panels to deliver requirements for ocean ECVs into GCOS. For real time services, OOPC works with the JCOMM services programme area. The panel runs observing system evaluations to ensure the observing system is designed to meet requirements. OOPC then works with the JCOMM observations programme area on observing system targets, implementation and performance.

In order to meet consultation and reporting needs with GCOS, GOOS, WCRP and JCOMM, OOPC has developed a set of EOVS specification sheets in order to ensure the requirements are developed reviewed and reported consistently (www.goosocean.org/eov). These EOVS specifications were the basis of the ECV based actions in the GCOS implementation plan; in addition, network specifications have been developed with the JCOMM observations programme area (JCOMMOPS) to improve the articulation of missions, targets, and key performance indicators for the observing system, to be tracked by JCOMMOPS (from deployment through to data delivery). These network specifications were drawn on for the observing networks section of the ocean chapter of the GCOS implementation plan, and the progress against GCOS actions are therefore automatically monitored by JCOMMOPS.

The requirements developed through the EOVS specification process will feed into the RRR, ensuring consistency in how OOPC develops, reviews and communicates requirements.

Noting that we are seeing significant developments both in forecasting systems and in the observing system, the OOPC agreed to review the Statements of Guidance from the ocean observations perspective, and are providing feedback to the nominated representatives.

13. Developing the ocean observing system for climate

OOPC coordinates focussed reviews and evaluations to develop and improve the ocean observing system for climate. In recent years, 2 have spun off into finite lifetime projects (TPOS 2020 and the Deep Ocean Observing System). The current work plan is focussed on:

Ocean Heat and Freshwater storage

OOPC has initiated a review of the observing system for tracking changes in Ocean Heat and Freshwater Storage, and a workshop is anticipated in late 2018. This review will be an important contribution to improved tracking of changes ocean heat and freshwater content. The review framework has been proposed as an OceanObs'19 Community Whitepaper.

Air-Sea Fluxes and Wind Stress

A task team has been established to oversee the development of a strategy for observations of Air Sea Fluxes, and an ambitious forward strategy has been proposed as a Community Whitepaper in OceanObs'19. Improvements in Air Sea Fluxes and the diurnal cycle are essential in underpinning seamless prediction systems, and coupled forecasts down to shorter timescales. Improvements in air sea fluxes are critically dependant on ocean surface stress observations, and so OOPC has a focussed effort to improve ocean surface stress products also.

Boundary Currents and their interactions with the shelf.

An international task team is being formed to develop requirements sustained observations of Boundary Currents and their interaction with the shelf. Boundary currents are dynamic features in the ocean, focus the regional distribution of heat and properties, and are regions of strong air-sea interaction, and the source of large errors in climate models. In addition, how boundary currents interact with the continental shelf can moderate the cross shelf exchange of properties, particularly carbon, and nutrients, and can therefore impact on ocean productivity and the carbon cycle. The dynamic nature of boundary currents makes them a challenge to measure, and a portfolio of observing platforms are needed. The group aims to develop best practices for boundary current observations, and a development strategy for key boundary current regimes.

14. Regional Ocean Observing System reviews and development projects

OOPC monitors progress of regional projects and reviews. In particular, OOPC identifies synergies and issues or advances which need to be raised to the global level, or can be used to advance the global observing effort.

The TPOS 2020 project was formed out of a review supported by OOPC, and is tasked with redesigning and re-energising the Tropical Pacific Observing System. The project noted in particular the need for further work on refining requirements, observing system design for Ocean Surface Stress and Air Sea Fluxes. As these issues are broader than the Tropical Pacific, TPOS 2020 will collaborate closely with OOPC. The First report was published in 2016, following external review.

Following the approval of the TPOS 2020 First Report by the sponsors, the tropical Pacific was recognised as a WIGOS Pre-Operational Pilot at EC-69, acknowledging the recommendations of the first report, with the implementation and governance transition coordinated through a JCOMM Transition and Implementation Task Team.

Re-energising the western tropical Pacific observing system is the priority, and pilot project has been established to oversee regional implementation. The project is now working towards a second Report which will be available for review and published ahead of the WMO Congress. The report will have greater focus particularly on shorter (weather and extreme events) timescale requirements, and on the status of subseasonal to interannual forecast systems.

Similar regional efforts to evolve, integrate and enhance regional, basin scale observing systems, such as the European funded AtlantOS project and follow up Blueprint for an Atlantic Ocean Observing System, the Southern Ocean Observing System (SOOS) programme, and the Deep Ocean Observing Strategy to extend sustained observations into the full depth of the ocean. Regional reviews are also underway in the Tropical Atlantic and Indian Ocean. The need for ongoing regional, basin scale coordination is expected to be discussed at the OceanObs'19 conference.

15. Observing System implementation and performance tracking.

OOPC works closely with the JCOMM Observations Coordination Group, the membership of which comprises globally coordinated sustained oceanographic and marine meteorological

observing networks, to set targets for the observing networks which in combination meet ECV requirements. Improved targets and Key Performance Indicators have been identified to improve tracking of the observing system performance for level of effort, coverage, and data delivery. OOPC ensured that these reflect targets identified as actions in the GCOS Implementation Plan (GCOS-200). The JCOMMOPS technical Coordination platform routinely tracks the performance of the observing networks, against targets, so the status of the observing system for climate can now be summarized on demand.

16. *OceanObs'19 Decadal Conference.*

OceanObs'19 represents the culmination of a major planning effort to set agenda for the next decade of sustained ocean observing, with a focus on 'connecting observations to users'. It is hoped that operational services delivery will therefore be strongly represented. As with previous conferences, OOPC is playing a lead organising role. Further information can be found at www.oceanobs19.net.

OceanObs'19 builds on two previous OceanObs conferences. OceanObs'99 set the basis for what we know now as the sustained ocean observing system for climate, building on the major international experiments conducted in the 1980s and 1990s; and OceanObs'09 set the framework for expanding and evolving the ocean observing system to meet a broader range of requirements, through the Framework for Ocean Observing which has been heavily leaning on the framework of the Global Climate Observing System, as systems of climate observing systems.

17. *GCOS Cooperation Mechanism*

The GCOS Cooperation Mechanism is the system improvement and resource mobilization activity of the GCOS programme. It has been established following a decision by the UNFCCC SBSTA in 2004 (UNFCCC Decision 5/CP.5) in order "to enable developing countries to collect, exchange, and utilize data on a continuing basis in pursuance of the UNFCCC". Since then, more than 3 million USD have been raised over the years to accomplish projects dedicated to improve climate observation systems.

New funds to the GCOS Cooperation Mechanism have reduced significantly. Currently, the GCOS Cooperation Mechanism is only able to offer low cost emergency support or projects with an explicit request from the donor (i.e. Kenya and Swiss funding).

The GCOS Secretariat drafted an explanatory note for a proposal to the Green Climate Fund, which is asking for support to 10 countries, focusing on their GSN and GUAN stations. This was an attempt to link the fundamental need for local observations to understand the current state of local climate and how this underpins NWP models and national adaptation. The feedback from WMO Programme Office (GCF) was that this would not be successful in attracting funding support but positive suggestions were given on how we might adapt this as a component of 'larger' proposal.

18. *Activate national coordinators*

Coordination among observation systems at different scales from subnational to global to inform adaptation should be promoted through relevant focal points and national coordinators, as well as Regional Climate Coordinators and alliances.

Austria, Germany and Switzerland conduct regular reporting meetings at which national experts describe and assess progress made in national coordination of climate observing systems. All three Members have established and published national climate observations inventories, which can be found on the WMO web site, on the GCOS page (gcos.wmo.int).

19. Rolling review of requirements and applications area incl. Statements of guidance, Climate Monitoring (GCOS)

(a) Application Areas

GCOS/WCRP was previously listed as the owner of nine application areas in OSCAR/requirements, some of which contained variable lists and actual information that were severely out of date. GCOS has been asked to revise the list of applications areas, and to revise and update the actual values of the requirements for the variables. At the last Atmospheric Observation panel for Climate, AOPC, meeting in 2017 (AOPC-22), it was decided that it would be preferable to start with a single application area, Climate Monitoring, that will include also the needs of WCRP. This was supported by the sixth session of the WCRP Data Advisory Council (WDAC), which recommended to fold the WCRP requirements into the climate monitoring ones envisaged by GCOS by default. However, WCRP has decided that the application area defined by GCOS is not adequate to capture the WCRP requirements for process studies and has therefore defined its own application area, Climate Science.

Following discussions at the three science panels, GCOS has consolidated the previously defined Application Areas in a single one called 'Climate Monitoring', which also includes the GFCS requirements.

GCOS has confirmed ownership of the climate monitoring application area and has delivered a final description of the application areas as: "The WMO-IOC-UNEP-ICSU Global Climate Observing System (GCOS) is an internationally coordinated network of global observing systems for climate, is designed to meet the requirements for climate observations, which are essential to climate monitoring. Climate observations are fundamental to detect, model and assess climate change, support adaptation to climate change, monitor the effectiveness of policies for mitigating climate change, develop climate information services, promote sustainable national economic development and meet other requirements of the UNFCCC and other convention and agreements."

(b) Statement of Guidance

Within the Rolling Review of Requirement process, 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 Statement of Guidance for the GCOS Application Area 'Climate Monitoring'.

(c) Requirements defined for Climate Monitoring

GCOS has specified requirements for ECV. The requirements reflect current needs and capabilities and are the basis for long-term, systematic observations of the climate as discussed in the GCOS Implementation Plan. The requirements, that were produced by the three GCOS science panels supported by a range of experts and subject to a public review as part of the development of the Implementation Plan, are listed in the GCOS Implementation Plan, Annex A, and are going to be used as a first entry for the OSCAR/requirements database. At the moment, this implies that rather than the three values for the requirements (threshold, break-through and goal) specified in OSCAR, for each variable only one value of requirement will be specified, that corresponds to the goal. During the last science panel meetings, it was decided that in the next update to the requirements, three values will be specified.

The panels have now started the process of mapping the ECV products into the OSCAR variables. This task requires identifying all the ECV products and their definition, and assuring that each of them can be matched to one of the variables in OSCAR. When no match can be found or when changes in the definitions are required, GCOS will ask for the necessary amendments in OSCAR. Another question being currently discussed at the panel level, is whether the OSCAR/requirements for the Climate monitoring Application area should reflect the requirement for long-term series for climate observations, either as an additional entry in the table or as a more general statement in narrative form. It is anticipated that the full

process required to update the requirements of the Application Area 'Climate Monitoring' will be concluded in year 2018.

Action G10 in the Implementation Plan calls for the panel to routinely maintain, review and revise the list of ECV product requirement. A formal process for reviewing the requirements to be then included in the update of the Implementation Plan in five years was presented to the three panels and agreed upon. As part of this process, GCOS has launched an open invitation to ask anyone interested and with relevant expertise to comment on the existing requirements. Comments can cover the existing ECV and ECV products or propose new ones. In addition to comments on the existing list of ECV and their requirement, GCOS is also asking for comments on the overall targets for the monitoring on the climate cycles (Water, Carbon and Energy). Furthermore, as GCOS is now looking to support climate adaptation, the GCOS ECV requirements should also cover these needs. As part of the review, experts are also asked to provide threshold and goal requirements, and, when needed, an intermediate value. The responses to this invitation will then be considered by the GCOS science panels, who will produce a first version of the revision that will be subject to a further public, open review.
