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**IMPLEMENTATION-COORDINATION TEAM
ON INTEGRATED OBSERVING SYSTEM
(ICT-IOS)**
Eighth Session

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**REVIEW OF THE STATUS OF THE SURFACE-BASED COMPONENTS OF THE GCOS
STATUS OF THE GCOS SURFACE (GSN), UPPER AIR (GUAN) , AND REFERENCE
UPPER AIR (GRUAN) NETWORKS**

(Submitted by the GCOS Secretariat)

SUMMARY AND PURPOSE OF DOCUMENT

The document provides information on the status of implementation of the WMO-IOC-UNEP-ICSU Global Climate Observing System (GCOS) Surface Network (GSN), the GCOS Upper Air Network (GUAN), and the GCOS Reference Upper Air Network (GRUAN).

ACTION PROPOSED

The Meeting is invited to note the information contained in this document when discussing how it organises its work and formulates its recommendations.

Appendices: **A.** Results of GSN Monitoring
B. Results of GUAN Monitoring
C. Annex to paragraph 2.3

DISCUSSION

1. AOPC network meeting

1.1 Preceding the upcoming Nineteenth Session of the Atmospheric Observation Panel for Climate (AOPC-XIX), GCOS will organize a review meeting on the dedicated GCOS Surface and Upper-Air Networks, GSN and GUAN (7-8 April 2014, Ispra, Italy). This GCOS network review meeting will focus on the design, scientific principles, performance and data use of the GSN and GUAN. It is recognized that these networks were initiated some 20 years ago, when observing systems were very different and GCOS is taking the opportunity to review the requirements, in light of changes in both technology and data needs. The two-day meeting is about scoping the need for change and presenting this to AOPC, and as such, experts for specific, operational networks, monitoring and archive centres, and data users have been invited.

1.2 If given a mandate from AOPC, it is expected that further meetings will be required to design the future GCOS networks, in collaboration with the WMO Integrated Observing System (WIGOS), and it is at this stage, that experts from all the Regions shall be consulted and asked to contribute.

1.3 The primary topics of the network meeting are as follows:

- Are the GSN/GUAN networks still fit for purpose, given current requirements; action on silent stations; priority within the network?
- Atmospheric ECVs and products (requiring in-situ observation) where are the gaps, both in observing capability and data availability/quality from current networks?
- Monitoring – availability versus content of report (i.e., Quality requirement, vertical coverage for radiosonde reports, TEMP versus BUFR)?
- Other networks (i.e., GPS Water Vapour, Aircraft, Radar's)
- Overlap with other domains (Ocean Observations Panel for Climate and Terrestrial Observation Panel for Climate)

2. CBS-LC-GCOS

2.1 The CBS Lead Centres for GCOS (CBS-LC-GCOS) Coordination Meeting was hosted by Meteorologica de Chile in Santiago, Chile, from 8 to 10 October 2013. The Coordination Meeting considered reports from individual Lead Centres' activities, GCOS Monitoring Centres and of the GCOS Archive Centre; it reviewed their activities, results of monitoring performance reports and their Terms of Reference. The current status of the WIGOS Implementation Plan and the associated Task Teams was presented to the meeting, including areas for future collaboration and contribution.

2.2 The Coordination Meeting agreed on a number of recommendations that will be provided to various WMO and GCOS bodies through the WMO and GCOS Secretariats¹. Issues with relevance to ICT-IOS are the following:

¹ The full meeting report is available under:
http://www.wmo.int/pages/prog/gcos/Publications/CBS-LC-GCOS-4_Final-Report_2.0.pdf

- It was shown in Region V that there are a significant number of GSN stations which are reporting a SYNOP but not the CLIMAT message. This was mainly due to a lack of training and availability of suitable software. The CBS-LC-GCOS for Region V agreed to investigate the possibility for a CLIMAT workshop in Australia.
- The GSN Monitoring Centre (GSNMC) will expand their monthly monitoring to all CLIMAT messages of the Regional Basic Climatological Network (RBCN) and the CBS-LC-GCOS for RA VI will distribute these results to all Lead Centres via e-mail. It was recognized that this would increase the work load for the Lead Centre but they were requested to attempt to address as the RBCN issues as time permits, noting that the GSN remains the priority.
- The meeting agreed, subject to funding, that the 5th CBS Lead Centre for GCOS Meeting should be arranged for October 2015; the venue to be decided.

2.3 The Coordination Meeting reviewed the TOR and the areas of responsibilities of the CBS-LC-GOS, see Appendix C.

3. BUFR coding

It is proposed that the communication of the BUFR message, according to WMO regulations, becomes a mandatory requirement for the GUAN and GSN stations, allowing the global access to the improved metadata and higher resolution data. However, it is accepted, and a concern, that many of the global monitoring centers, are not as yet able to handle the BUFR message. Thus GCOS needs to work with WMO, in particular CBS and CIMO, to ensure that this transition is well understood and is completed with minimal risk to the networks.

4. Issues at GUAN stations

4.1 It is increasingly more evident that technical issues, failures in hydrogen generators and re-supply of consumables are resulting in significant downtimes for many of the GUAN stations. These issues are primarily due to lack of finance and often the long lead-times needed to get spend approval even for relatively small amounts of money. This is of particular relevance to a number of the Pacific Islands stations. GCOS is supporting where it can, both with funding from the GCOS Cooperation Mechanism (GCM) and working with industry for a speedy resolution, but immediate contact with the GCOS Secretariat when the issue is identified could help to lessen the downtime of the system. It is important that Members formally report to WMO and GCOS at the earliest opportunity on station closures or changes in practices which have an impact on the GSN and GUAN.

4.2 In 2010, GCOS updated the minimum requirements for a GUAN station, to report temperature and wind to 30hPa and humidity to the tropopause, on at least 25 days each month. Members should note that the balloon size and how it is handled, has a significant impact on the burst heights achieved and thus every effort should be made to ensure the minimum requirement is reached for all GUAN stations.

5. GRUAN Implementation

5.1 The most recent sixth Implementation - Coordination Meeting (ICM-6) was held from 10 - 14 March 2014 near the GRUAN site of Howard University at Beltsville, USA. The annual GRUAN meetings afford an opportunity for the Working Group on GRUAN (WG GRUAN), the GRUAN Lead Centre, Task Teams, and representatives from initial and prospective GRUAN sites and other stakeholders to review progress, highlight issues and exchange views. The meeting's main goals were to update participants on GRUAN progress and to discuss new developments, with a focus on:

- Maximizing the utility of GRUAN activities and measurements to benefit the Global Observing System. In this regard the presence of representatives from WIGOS, NOAA and NASA was noted with appreciation by attendees.
- Progress on site certification,
- Progress on network expansion,
- Establishing links with the scientific and meteorological communities,
- Review and progress of the work plans for the GRUAN Lead Centre, the WG-GRUAN, and GRUAN task teams,
- Consideration of new data streams to include in coming years as called for in the current GRUAN Implementation Plan.

5.2 The aspect how to shape the interface between GRUAN, GUAN and the wider upper-air network of the Global Observing System (GOS), hence how the wider network can benefit from GRUAN practices and expertise, will also be subject of the upcoming network review meeting (see above). A number of operating procedures being implemented at GRUAN sites cannot be feasibly implemented in the wider GUAN network; however, the lessons learned at GRUAN sites should be transferred to GUAN sites with the support of the appropriate mechanisms. The lessons from change management procedures, which are required at GRUAN sites, may be applied at GUAN sites without requiring the same rigor of change management. This is meant to reach out to GUAN and to offer the lessons that GRUAN may be able to provide. Besides this, the cooperation between CIMO and GRUAN during the last radiosonde intercomparison campaign was seen as highly beneficial for both sides and ICM-6 recommended maintaining this cooperation in upcoming radiosonde intercomparisons.

5.3 Concerning the current shape of the network with stations predominately located in northern hemispheric mid and high latitudes, it is hoped that concerted effort can be made to expand GRUAN, especially in the tropics and in Africa and South America (WMO region III). WIGOS and GRUAN should actively pursue this issue collaboratively.

5.4 GRUAN data is flowing through NOAA's National Climatic Data Centre (NCDC) to data users and the GRUAN metadata database has been operational for the past 5 years. This database contains information about the sites, the measurement systems, instrument and sensor level information. One important aspect is that the database also contains information to handle change management, which requires some level of traceability over time. To make sure that metadata can be used interoperably between data centers, the climate and forecast convention has been chosen. With the use of these metadata, GRUAN data can be accessed through the WMO Information System

(WIS) via Global Information System Centers (GISCs). Arnoud Apituley from KMNI serves as the GRUAN liaison to the WIGOS metadata task team.

5.5 A GRUAN-side event is planned for WMO congress in 2015, which will focus on the importance of reference observations for climate science, services, monitoring, and possibly on network expansion.

6. Recommendations

GCOS is inviting ICT-IOS to make the following recommendations through CBS Ext. (2014):

- Members to formally report to WMO and GCOS at the earliest opportunity on station closures or changes in practices which have an impact on the GSN and GUAN;
- Members to ensure the minimum requirement, i.e., to report temperature and wind to 30hPa and humidity to the tropopause, on at least 25 days each month, is reached for all soundings at GUAN stations;
- CIMO and GRUAN to maintain close cooperation in upcoming radiosonde intercomparison exercises; and
- WIGOS and GRUAN to actively pursue GRUAN expansion in the tropics and in Africa and South America.

APPENDIX A**RESULTS OF GSN MONITORING**

The following table is the 2013 summary of the monthly CLIMAT messages received (CR) and coded correctly (CC) at the GSN monitoring centre (hosted by the German Meteorological Service, DWD) by day 21 of the following month (as detailed in the minimum requirement for a GSN station). The quality information is generated by the DWD monitoring centre and only represents seven months of the 2013 period owing to five months being required to undertake the quality checks. The percentage given is based on the number of reports received.

| Region | No. | CR | + CC | Quality (T) | Quality (R) |
|--------|-----|-----|------|-------------|-------------|
| RA-I | 156 | 53% | 43% | 56% | 54% |
| RA-II | 259 | 88% | 82% | 89% | 86% |
| RA-III | 94 | 94% | 88% | 91% | 91% |
| RA-IV | 178 | 96% | 95% | 96% | 91% |
| RA-V | 151 | 83% | 75% | 81% | 72% |
| RA-VI | 138 | 90% | 87% | 91% | 89% |
| RA-VII | 42 | 84% | 82% | 90% | n/a |

Region I is clearly the poorest performing network, in all aspects of the requirements, which reinforces the need for GCOS to focus its support in this region. It is evident from these statistics that the challenges and issues are present across the observing systems, emphasizing the need to support different areas of the observational cycle (i.e. instrumentation, communication, quality management and capacity development).

In several of the regions there are still a significant number of CLIMAT messages that are not being coded correctly, despite the introduction of more automated and standardized software for the encoding. For the worst performing regions consideration should be given for support training in the production of the monthly CLIMAT message.

Whilst the majority of WMO Members are providing the monthly CLIMAT message, there are still a few that are not. It is important to remind Members on their commitment in providing the monthly CLIMAT message both for their GSN and RBCN stations. In support of this, a recommendation from the Lead Centre meeting in Chile, was to organize regional CLIMAT workshops and to start the Australian Lead Center was requested to investigate the feasibility of this.

APPENDIX B**RESULTS OF GUAN MONITORING**

The following table is the 2013 summary for the GUAN monitoring against the GCOS minimum requirements (25 daily soundings to 30hPa per month) for each region.

| | | |
|--------|---------|---------------------------------------|
| RA-I | 24 GUAN | 46% meeting minimum GCOS requirements |
| RA-II | 32 GUAN | 88% meeting minimum GCOS requirements |
| RA-III | 18 GUAN | 67% meeting minimum GCOS requirements |
| RA-IV | 24 GUAN | 75% meeting minimum GCOS requirements |
| RA-V | 38 GUAN | 74% meeting minimum GCOS requirements |
| RA-VI | 24 GUAN | 83% meeting minimum GCOS requirements |
| RA-VII | 12 GUAN | 58% meeting minimum GCOS requirements |

The key points for 2013 were as follows:

Region I:

Only 46% of the GUAN stations in Region 1 have met the minimum requirement in 2013, mainly associated with the 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.

Region II:

Several of the Russian Federation stations have poor quality statistics when compared with the UK Met Office model, possible due to the equipment being used on-site. This needs further investigation.

Region III:

There are a number of stations just below the minimum requirement and in most cases this is due to the soundings not reaching the 30hPa level.

Region IV:

Several stations have similar issues with hardware failures in the tracking part of the system. These faults are taking longer to resolve than normal owing to financial constraints. However, no request for support via the GCOS Cooperation Mechanism has been received.

Region V:

This is another challenging region with 30% of the stations not reaching the minimum requirements. Several of the Australian GUAN stations have dropped below the minimum requirements owing to a change in practices (smaller balloons) resulting in lower burst heights. This has been reported to Bureau of Meteorology and they agreed to reverse this change at their GUAN stations.

Region VI:

No specific issues occurred.

Region VII

Most of the stations not meeting the minimum requirement are as a result of the burst height of the balloons. Antarctica is a challenging environment for the handling and performance of the balloons, however GCOS will consult with the stations themselves, through the lead-centre, on the cause and any possible solutions.

APPENDIX C

ANNEX TO PARAGRAPH 2.3

1. Terms of Reference of the CBS Lead Centres for GCOS for submission to CBS Ext. (2014)

In support of the Global Framework for Climate Services, especially by improving quality and sustainability of climate data, the Lead Centres for GCOS will:

1. Diagnose problems in the Regional Basic Climatological Networks (RBCNs) and the Antarctic Observing Network (AntON), with the emphasis on the GSN and GUAN, by using the available monitoring reports, such as those produced by the GCOS Monitoring and Analysis CENTRES and major WMO NWP Centres;
2. Liaise with nominated National Focal Points for GCOS and related Climatological Data, and other responsible officials, to rectify identified problems so as to improve data and meta data availability and quality;
3. Coordinate activities with other GCOS CENTRES and/or other WMO CENTRES as appropriate;
4. Report to CBS and GCOS on actions taken, progress achieved, concerns and recommendations on a yearly basis in a time frame that corresponds to planned AOPC and CBS meetings;
5. Assist AOPC in the design of GSN and GUAN and Regions in the design of RBCNs/AntON;
6. Assist the WMO Secretariat in maintaining the list of National Focal Points for GCOS and related Climatological Data.

2. Area of responsibilities of the CBS Lead Centres for GCOS

- **Morocco (RA I)** is responsible for stations in: Algeria, Benin, Burkina Faso, Cameroon, Cape Verde, Central African Republic, Chad, Congo, Comoros Island Côte d'Ivoire, Egypt, Gabon, Ghana, Gambia, Guinea, Guinea Bissau, Guinea Equatorial, Liberia, Libyan Arab Jamahiriya, Madagascar, Mali, Niger, Nigeria, Mauritania, Morocco, Senegal, Sierra Leone, Sao Tome and Principe, Sudan, Togo, Tunisia.
- **Mozambique (RA I)** is responsible for stations in: Angola, Botswana, Burundi, Canary Island, Comoros Island, Democratic Republic of the Congo, Djibouti, Eritrea, Ethiopia, Kenya, Lesotho, Malawi, Mauritius, Mozambique, Namibia, the Ocean Islands (St. Helena Island, Ascension Island, Martin de Vivies, Iles Crozet, Iles Kerguelen), Rwanda, Seychelles, Somalia, South Africa, Swaziland, Uganda, United Republic of Tanzania, Zambia, Zimbabwe.
- **Iran (RA II and part of RA VI)** is responsible for stations in: Afghanistan, Armenia, Azerbaijan, Bahrain, India, Iran, Jordan, Kazakhstan, Kyrgyzstan,

Maldives, Nepal, Oman, Pakistan, Qatar, Russian Federation, Saudi Arabia, Sri Lanka, Syria, Tajikistan, Turkey, United Arab Emirates, Yemen.

- **Japan (RA II)** is responsible for stations in: Brunei, Cambodia, China, Hong Kong China, Japan, Laos, Malaysia, Mongolia, Myanmar, Philippines, Republic of Korea, Singapore, Thailand, Vietnam.
 - **Chile (RA III)** is responsible for all stations in RA III.
 - **USA (RA IV)** is responsible for most stations in RA IV plus Hawaii.
 - **Australia (RA V)** is responsible for most stations in RA V, except those countries noted for Japan and Hawaii (USA).
 - **Germany (RA VI)** is responsible for most stations in RA VI, except those countries noted for Iran.
 - **UK (British Antarctic Survey)** is responsible for stations in Antarctica.
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