The Global Observing System for Climate

GCOS Upper Air Network (GUAN) Radiosonde Observations Past, Present and Future

CIMO-TECO-2018

Amsterdam, The Netherlands

GCOS Secretariat, WMO

Tim Oakley, GCOS Network Manager

WMO UNESCO IOC ICSU International Council for Science UNEP

UNEP

ICSU International Council for Science

IOC

UNESCO

WMO

GCOS GLOBAL CLIMATE OBSERVING SYSTEM

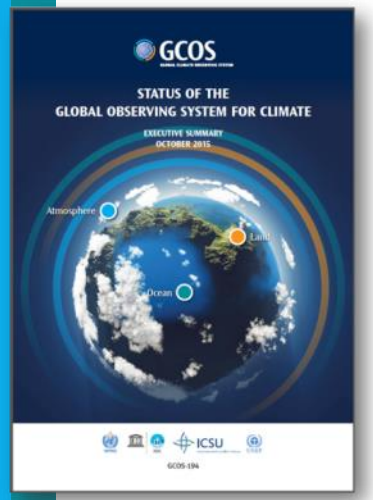
GCOS established April 1992

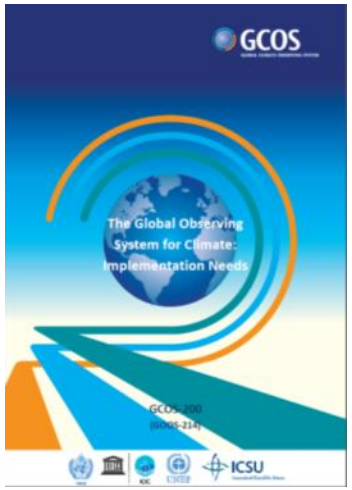
The vision of GCOS is that all users have access to the climate observations, data records and information which they require to address pressing climate-related concerns. GCOS users include individuals, national and international organizations, institutions and agencies.

The role of GCOS is to work with partners to ensure the sustained provision of reliable physical, chemical and biological observations and data records for the total climate system – across the atmospheric, oceanic and terrestrial domains, including hydrological and carbon cycles and the cryosphere.

GCOS Progress: Improving global climate observations

United nations conference on climate change
COP21/CMP11





- Support Adaptation & Mitigation
- Water, Energy and Carbon cycles
- Additional Essential Climate Variables
- More help for networks in developing countries
- Climate Indicators

WGClimate

CEOS

CGMS

ECV Inventory: The Architecture for Climate Monitoring from Space in Action

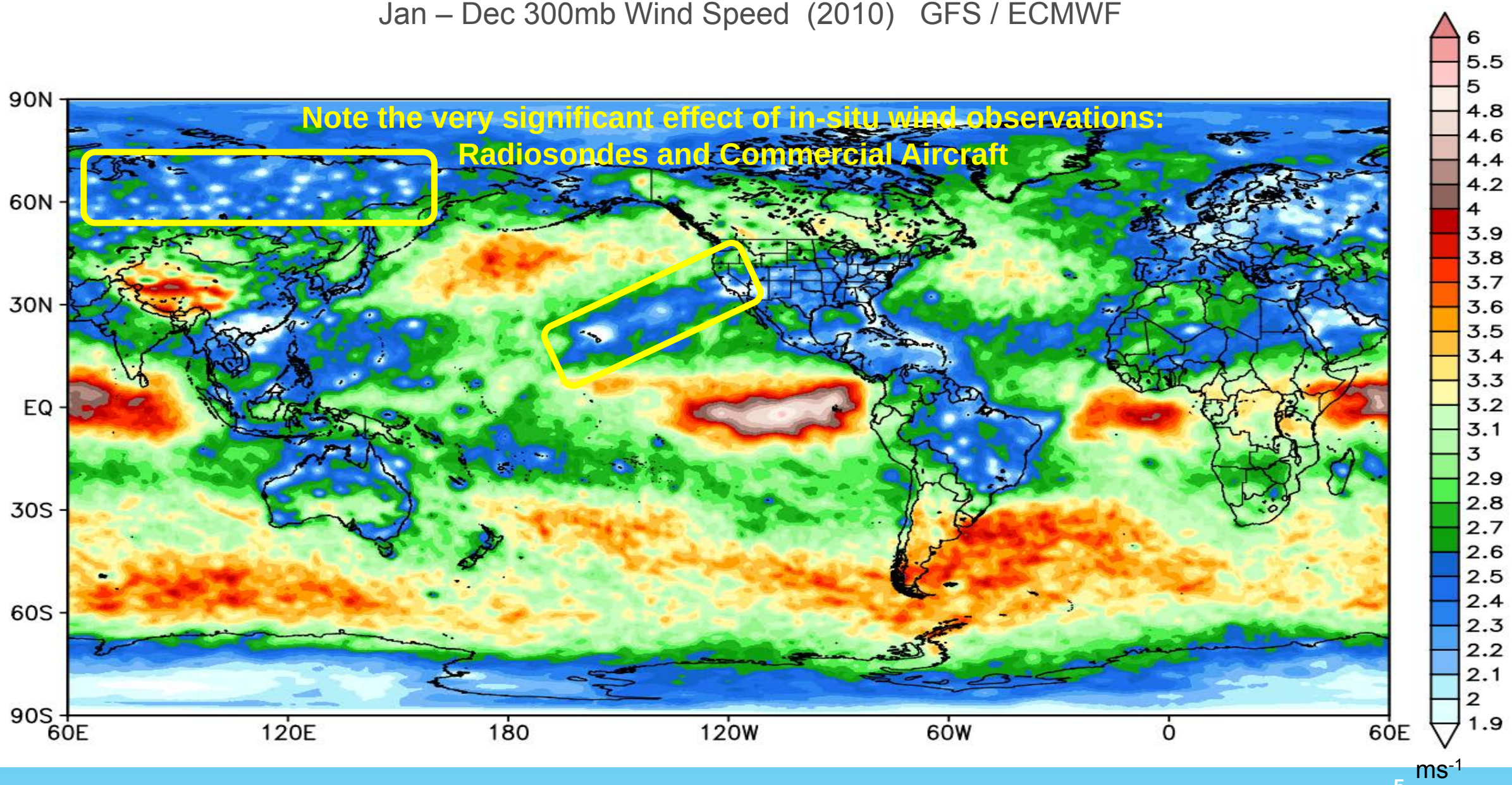
2015 **2016** **2017**

The value of radiosonde measurements

- Most data providers and users still understand and value the radiosonde measurements.
- 800 + stations globally providing between 1 – 4 soundings per day.
  (NCEP monitoring: 1250 daily soundings; 460,000 per year; 60 million $usd consumables)
- GCOS Status Report 2015 – "To date, no new system has proved to be competitive with the radiosonde system with regards to accuracy, vertical resolution/range and consistency. They also provide main meteorological variables (temperature, wind and humidity) all together."
- *Global NWP - "Isolated radiosondes are individually much more valuable and bring much more benefit to forecast quality than observations in a dense network (benefit per station that is!)"*
- *Global Basic Observing Network (GBON) meeting (2018) documented the significant value of radiosonde observations for both Global NWP and Climate monitoring, and proposed text for WMO Congress 2019 reinforces the need for* radiosonde measurements: - 500 km, 12-hourly
  - vertical resolution - 100 m or better
  - top - 30 hPa or better

Root-Mean Square of Analysis Differences: 300mb Wind Speed

Jan – Dec 300mb Wind Speed (2010) GFS / ECMWF



SOURCE: Langland et al.; from 5th WMO Impact Workshop, Sedona 2012

Scope and Purpose of GUAN

GCOS Upper-Air Network was designed and implemented more than 20 years ago.

The scope of the GUAN is a global network with the spacing set at 5 to 10 degrees latitude, sufficient to resolve synoptic-scale waves. The desired parameters are temperature, pressure (geopotential height), wind, and humidity (at least in the troposphere). The inclusion criteria are:

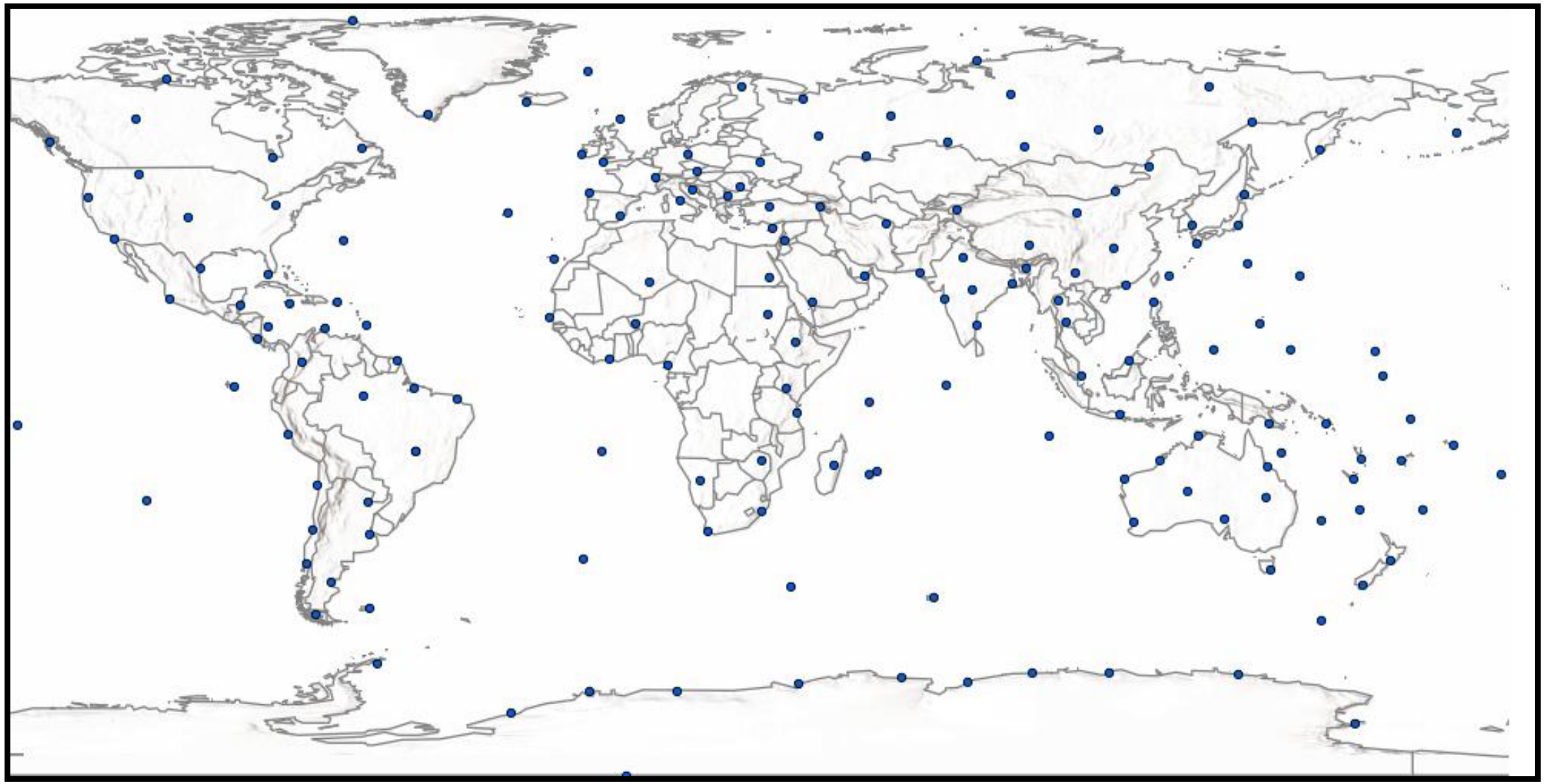
- Commitment by NMHSs with regard to continuity;
- Length and quality of historical time series;
- Current measurement quality.

The purposes of the GUAN are the following:

- To establish national commitments for the preservation of a minimum set of upper-air stations for the foreseeable future;
- To build a collection of validated data from these stations in standardized formats;
- To provide this information to the global climate community with no formal restrictions.

GCOS Upper Air Network (GUAN)

GCOS Upper-Air Network (GUAN) - 177



Network Monitoring - GUAN

Performance Report of the 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, four (4) in 2012 and five (5) in 2011.

GUAN STATIONS Sep 2018
Frequency of Reception data at ECMWF
Level: 100 hPa Temperature SUMMARY 00/12 UTC

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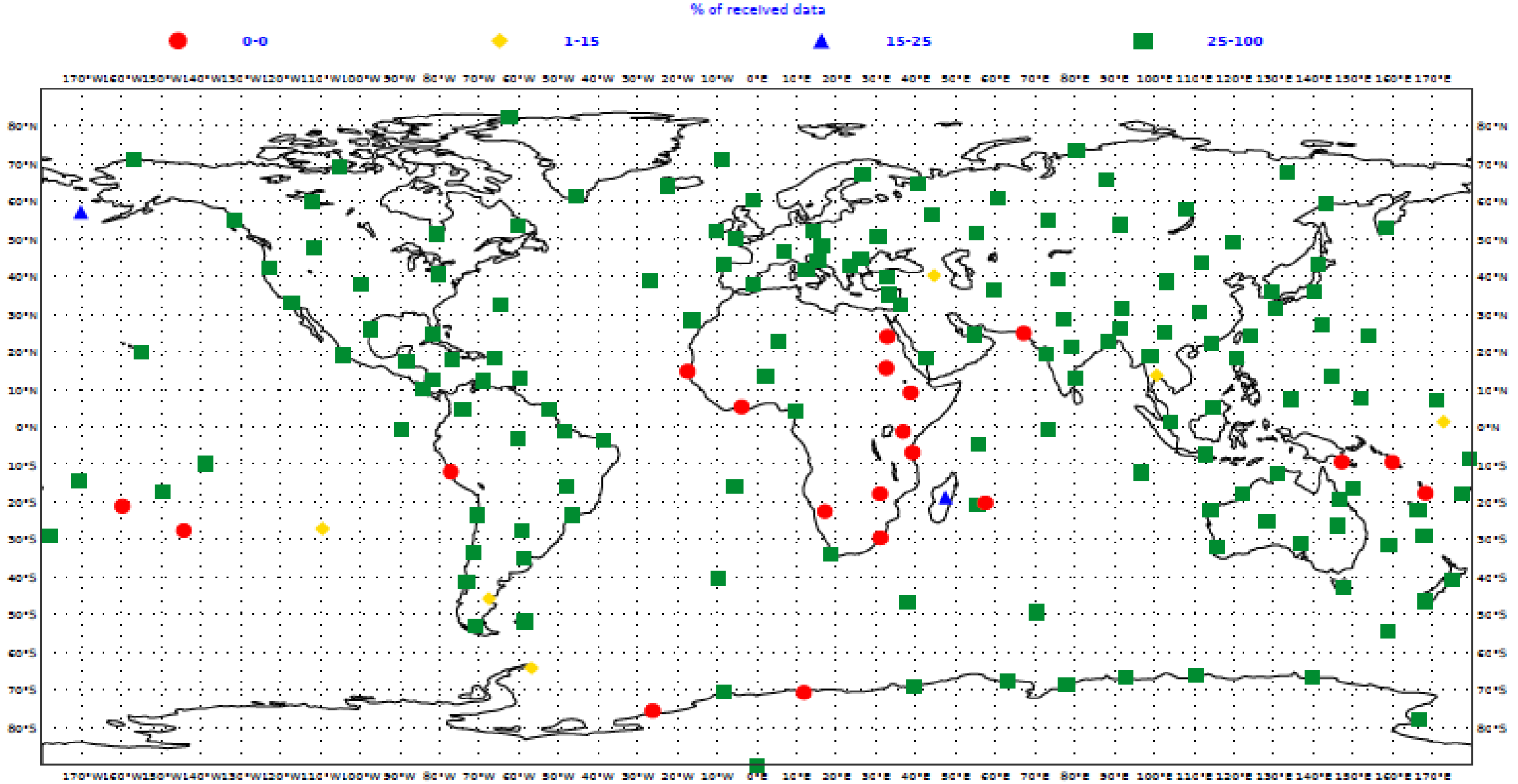
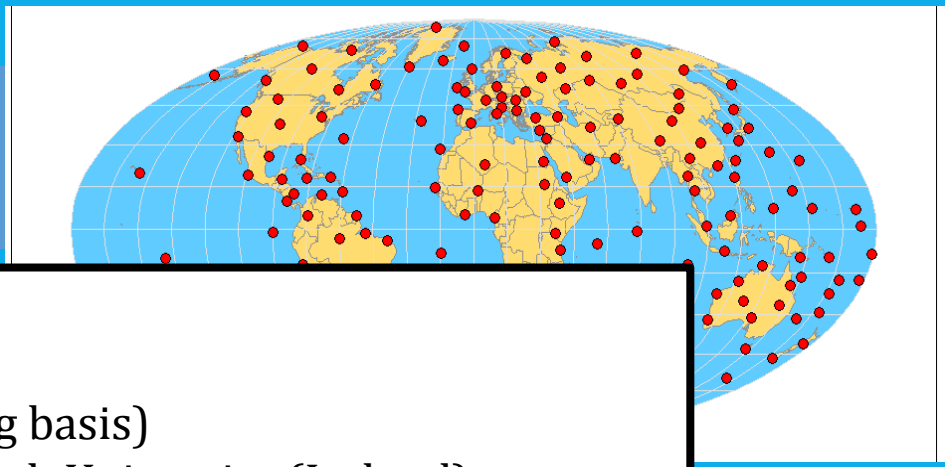


Why do we need to review the GUAN?

- Network now 20+ years old
- Significant changes in both technology and data users
- GUAN often cited as being of little difference from the comprehensive network
- Requirements more explicit on the needs and benefit of high quality data, demanding a stronger governance on data availability, timeliness, accuracy
- Operators (Mainly WMO Members) have forgotten their commitment
- Increasing pressure on resources
- 2014 GCOS network review meeting recommended an updated, more proactively managed network
- Operational monitoring, Tiered networks and programmes such as GAIA-CLIM have highlighted the weaknesses in the current system

Task-Team GUAN



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Membership

Chair (If no suitable candidate, agreed on a meeting by meeting basis)
AOPC Expert – Peter Thorne (peter.thorne@nuim.ie) – Maynooth University (Ireland)
GRUAN Expert – Richard Querel (Richard.Querel@niwa.co.nz) – NIWA (New Zealand)
NWP Expert – Bruce Ingleby (bruce.ingleby@ecmwf.int) – ECMWF (UK)
CBS/National Expert – Hiram Escabi (hiram.escabi@noaa.gov) – NWS (USA)
Satellite Expert – Marc Schroeder (Marc.Schroeder@dwd.de) – DWD (Germany)
National Expert – (Large GUAN contribution – China, Japan, Russia?)
GCOS Network Manager (Secretariat support) – Tim Oakley (toakley@wmo.int) (UK)
GCOS AOPC SO (Secretariat support) – Caterina Tassone (ctassone@wmo.int) (Switzerland)
CIMO expert team on upper air systems representative – Later meeting, if required
HMEI Observer – Later meeting, if required

Action A13	
Action	
Benefit	
Who	
Time frame	
Performance indicator	
Annual cost	

	10 hPa, twice-daily
	making

Action A5:	Transition to BUFR
Action	Encourage dual transmission of TAC and BUFR for at least 6 months and longer if inconsistencies are seen (to compare the two data streams for accuracy).
Benefit	Transition to BUFR does not introduce discontinuities in the datasets. BUFR allows metadata to be stored with data.
Who	Parties operating GSN stations for implementation
Time frame	Ongoing for implementation; review by 2018
Performance indicator	Proven capability to store BUFR messages giving same quality or better as TAC data
Annual cost	US$ 100 000–1 million

Action	For radiosonde data and any other data that require substantive processing from the original measurement (e.g. digital counts) to the final estimate of the measurand (e.g. T and q profiles through the lower stratosphere); the original measured values should be retained to allow subsequent reprocessing.
Benefit	Possibility to reprocess data as required, improved data provenance
Who	HMEI (manufacturers), NMHSs, archival centres.
Time frame	Ongoing.
Performance indicator	Original measurement raw data and metadata available at recognized repositories
Annual cost	US$ 100 000–1million

ANNEX 4: SWOT ANALYSIS FOR GUAN (SUMMARY FROM MEETING)

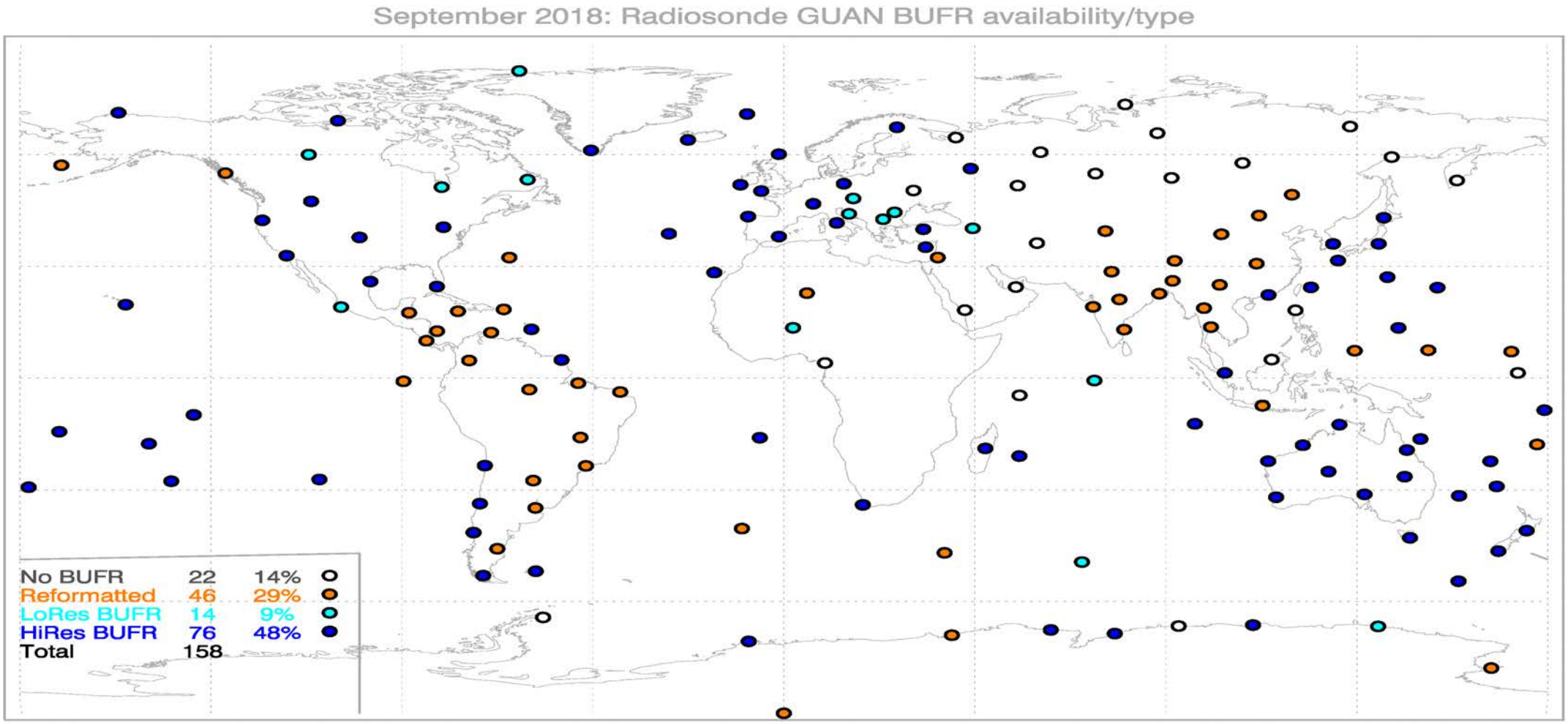
Strengths	Weaknesses
GUAN is a well known brand. It is regarded as high-quality Radiosonde observations. (even if this is only a perception) Common practices and an underpinning standard. Has documented governance through WMO technical regulations and GCOS documents.	The aims, requirements and user needs of GUAN are not known and/or have just been forgotten. No NMHS 'buy-in'. Passive not Active management (i.e. poor performance is not addressed) Little difference between GUAN and the Comprehensive network No auditing of GUAN and little outreach between GUAN operators Requirements and guidance has not been updated to reflect the change in technology and user needs
Opportunities	**Threats**
GUAN best practices and outreach can support the comprehensive network Utilised improved tools for Quality Management & Visualisation Healthy competition in industry for the prestige of suppling GUAN stations Better alignment of GRAUN and GUAN, for example GRUAN products from GUAN stations.	Budget cuts and resource priorities are often targeted at radiosonde system consumables The pollution aspect of radiosondes Lack of clarity on the difference between GRUAN and GUAN might cause competition for resources

Vision for GUAN

Continuing under its current requirements is not the best option

- New focus on a guaranteed quality of observational data, according to updated requirements
- A subset of the comprehensive network based on quality assurance rather than a fixed network of stations. Adopting a tiered-network approach (Comprehensive-GUAN-GRUAN), as described by GAIA-CLIM
- Actively managed through a lead-centre, with a certification process, real-time monitoring and validated station list for the user community
- Process to identify gaps in global/regional networks, both in data sparse areas and least develop countries, to allow targeted support projects, using relevant cooperation and funding mechanisms (i.e. GCM, GCF, national bi-lateral programmes).

ECMWF monitoring of GUAN (coding)



Key points

- Radiosonde measurements still have a significant, and ‘cost effective’, benefit for most WMO applications, notably NWP and Climate Monitoring.
- The Radiosonde technology has continued to be updated/improved in-line with user requirements, also minimising costs and impact on the environment.
- Whilst GUAN is more a CBS governed process, there are several important links to the work of CIMO; (1) Instrument and Methods uncertainty; (2) Specification and procurement; (3) role of a Baseline network in a Tiered network.
- The WMO/CIMO radiosonde intercomparison is a significant contributor to much of that above and with China 2010 being the most recent, the community is looking for the next intercomparison. (will be discussed at the CIMO session)

The Global Observing System for Climate

Thank you

gcos.wmo.int

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