GLOBAL CLIMATE OBSERVING SYSTEM

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**GCOS STEERING COMMITTEE
THIRTY FIRST SESSION**

GCOS SC-31, 2–5 July 2024
WMO, Geneva, Switzerland

Report from GCOS Networks: GSN & GUAN

The following report is the annual report from the GCOS Network Manager, on the performance of the GCOS Networks (GSN & GUAN) for 2023. A summary of this report will be presented under agenda item 7.1, including any significant changes for 2024 (Q1 & Q2).

GCOS Surface Network (GSN)
GCOS Upper Air Network (GUAN)
Network Performance Summary

Name – Tim Oakley
GCOS Network Manager

Year –   2023
(Includes statistics from 2011 to 2022)

1 – GSN/GUAN Metadata

1.1 Network Station List (2024 proposed update, yet to be approved by AOPC)

GCOS Surface Network (GSN)

RA-I	*154 Stations (0)*	*No Changes*
RA-II	*258 Stations (0)*	*No Changes*
RA-III	*101 Stations (0)*	*No Changes*
RA-IV	*177 Stations (0)*	*No Changes*
RA-V	*153 Stations (0)*	*No Changes*
RA-VI	*139 Stations (0)*	*No Changes*
ANTON	*41 Stations (-1)*	Delete: Antarctica Stations 89327 (Mt Siple) is closed
TOTAL	*1023 Stations (-1)*	

GCOS Upper Air Network (GUAN)

RA-I	*23 Stations (0)*	*No Changes*
RA-II	*38 Stations (0)*	*No Changes*
RA-III	*18 Stations (0)*	*Argentina* *Delete station 87576(Ezeiza Aero): Upper-Air station closed* *Replace with 0-2000-0-87582* *(Aeroparque Aero 34.5589S ; 58.4198W ; 6m)*
RA-IV	*24 Stations (0)*	*No Changes*
RA-V	*39 Stations (0)*	*No Changes*
RA-VI	*24 Stations (0)*	*No Changes*
ANTON	*12 Stations (0)*	*No Changes*
TOTAL	*178 Stations (0)*	

The above changes will be submitted to AOPC (Sept 2024). The 2024 update will be published in Oct 2024.

1.2 Comparison of GCOS GSN station list with nominations in WMO OSCAR/Surface.

Region/GCOS/OSCAR:

RA-I/154/152:   Missing OSCAR/Surface station in Libya (62124 – Sebha): Not reporting CLIMAT
               Missing OSCAR/Surface station in Mali (61270 – Kita): Reporting CLIMAT
               Missing OSCAR/Surface station in Mauritania (61415 – Nouadhibou): Reporting CLIMAT
               Additional OSCAR/Surface station in Senegal (61660 – Dakar-diass): Reporting CLIMAT

RA-II/258/247:   Missing OSCAR/Surface station in Kazakhstan (28952 – Kostanay): Not reporting CLIMAT
               Missing OSCAR/Surface station in Kazakhstan (35394 – Karaganda): Not reporting CLIMAT
               Missing OSCAR/Surface station in Russian Fed. (25173 – Mys Shmidta): No CLIMAT since 2013
               Missing OSCAR/Surface station in Russian Fed. (25325 – Ust'oloj): No CLIMAT since 2013
               Missing OSCAR/Surface station in Russian Fed. (25594 – Buhta): No CLIMAT since 2013
               Missing OSCAR/Surface station in Saudi Arabia (40361;40393;40430;40438;41024;41140):
                    Reporting CLIMAT except 40438. Nomination has recently been removed.

RA-III/101/102:   Additional OSCAR/Surface station in Peru (84455 – Tarapoto): Reporting CLIMAT

RA-IV/177/177:   Complete match

RA-V/153/153:   Complete match

RA-VI/139/135:   Missing OSCAR/Surface station in Cyprus (17609 – Larnaca): Reporting CLIMAT
Missing OSCAR/Surface station in Romania (15085 – Bistrita): Reporting CLIMAT
Missing OSCAR/Surface station in Romania (15280 – Vorfu Omu): Reporting CLIMAT
Missing OSCAR/Surface station in Turkey (17170 – Van/Feritmelen): Reporting CLIMAT

Antarctica/41/40: Missing OSCAR/Surface station (89642 – Dumont D'urville): Reporting CLIMAT

GSN/1023/1006 (98.3% consistency)

1.3 Comparison of GCOS GUAN station list with nominations in WMO OSCAR/Surface.

RA-I/23/23:   Complete match

RA-II/38/37:   Missing OSCAR/Surface station in Saudi Arabia (41112). WSI change?

RA-III/18/16:   Additional OSCAR/Surface station in Argentina (87582 – Aeroparque): New station request
Missing OSCAR/Surface station in Brazil (82193 Belem): Reporting TEMP
Missing OSCAR/Surface station in Brazil (82397 Fortaleza): Not reporting TEMP
Missing OSCAR/Surface station in Brazil (83779 Marte): Reporting TEMP

RA-IV/24/24:   Complete match

RA-V/39/39:   Complete match

RA-VI/24/24:   Complete match

Antarctica/12/12:   Complete match

GUAN/178/175 (98.3% consistency)

2 – Network Performance

2.1 GSN

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 2023 percentage of stations that are compliant and those that are partially or non-compliant. In brackets are the statistics for 2022, 2021, 2020, 2019, 2018, 2017, 2016, 2015, 2014, 2013, 2012 and 2011 respectively.

GCOS Surface Network (GSN)

Region	No.	12 Monthly CLIMAT	6 - 11 Monthly CLIMAT	1 - 5 Monthly CLIMAT	0 Monthly CLIMAT
RA-I	155	23% (30% 2022) (21, 20, 26, 37, 31, 40, 29, 29, 32, 28, 23)	31% (30% 2022) (38, 37, 33, 21, 34, 25, 31, 33, 33, 36, 39)	8% (5% 2022) (5, 4, 6, 5, 3, 9, 15, 10, 10, 11, 14)	38% (35% 2022) (36, 39, 35, 37, 32, 26, 25, 28, 25, 25, 24)
RA-II	258	82% (81% 2022) (76, 77, 76, 74, 79, 83, 78, 71, 73, 73, 75)	9% (11% 2022) (16, 14, 17, 14, 15, 10, 14, 21, 19, 19, 19)	1% (0% 2022) (0, 2, 1, 5, 0, 2, 2, 3, 2, 2, 1)	8% (8% 2022) (8, 7, 6, 7, 6, 5, 6, 5, 6, 6, 5)
RA-III	101	70% (73% 2022) (72, 68, 72, 52, 63, 65, 61, 76, 89, 84, 69)	4% (11% 2022) (13, 7, 5, 24, 15, 29, 35, 20, 6, 13, 28)	1% (1% 2022) (2, 2, 9, 1, 6, 0, 0, 1, 0, 0, 0)	25% (15% 2022) (13, 23, 14, 23, 16, 6, 4, 5, 3, 3)
RA-IV	178	83% (86% 2022) (86, 87, 82, 88, 86, 90, 88, 88, 88, 81, 80)	14% (11% 2022) (12, 9, 16, 7, 12, 7, 9, 10, 11, 17, 18)	2% (1% 2022) (1, 2, 1, 4, 1, 2, 2, 1, 1, 1, 1)	1% (2% 2022) (1, 2, 1, 1, 1, 1, 1, 1, 0, 1, 1)
RA-V	151	68% (62% 2022) (60, 72, 66, 62, 61, 67, 66, 70, 63, 58, 52)	12% (19% 2022) (22, 11, 15, 21, 21, 15, 16, 17, 16, 23, 34)	6% (5% 2022) (2, 3, 4, 1, 3, 3, 4, 1, 7, 7, 1)	14% (14% 2022) (16, 14, 15, 16, 15, 15, 14, 13, 14, 12, 11)
RA-VI	138	80% (78% 2022) (77, 79, 81, 75, 82, 84, 77, 80, 82, 78, 81)	9% (9% 2022) (11, 7, 7, 15, 8, 7, 14, 9, 12, 17, 15)	2% (3% 2022) (1, 4, 3, 1, 2, 2, 3, 5, 2, 1, 0)	9% (10% 2022) (11, 10, 9, 9, 8, 7, 6, 6, 4, 4, 4)
ANTON	42	76% (79% 2022) (81, 91, 88, 84,83, 81, 77, 79, 60, 45, 50)	17% (19% 2022) (17, 5, 10, 14, 12, 17, 19, 19, 36, 43, 33)	5% (0% 2022) (2, 2, 2, 2, 5, 2, 2, 2, 2, 5, 12)	2% (2% 2022) (0, 2, 0, 0, 0, 0, 2, 0, 2, 7, 5)

'Deprecated' 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	15% (20% 2022) (18, 17, 17, 22, 18, 23, 16, 17, 19, 13, 12)	18% (19% 2022) (21, 20, 19, 15, 22, 17, 22, 20, 20, 23, 22)	9% (4% 2022) (4, 4, 6, 4, 5, 8, 11, 8, 7, 12, 13)	58% (57% 2022) (57, 60, 58, 59, 55, 52,51, 55, 54, 52, 53)
RA-II	664	78% (62% 2022) (71, 73, 71, 67, 77, 80, 73, 71, 73, 67, 57)	9% (26% 2022) (17, 15, 19, 17, 14, 12, 17, 18, 15, 22, 30)	2% (1% 2022) (1, 3, 2, 7, 1, 1, 2, 4, 4, 1, 2)	11% (11% 2022) (11, 9, 8, 9, 8, 8, 8, 7, 8, 10, 11)
RA-III	298	65% (62% 2022) (68, 67, 74, 57, 60, 64, 63, 73, 81, 73, 65)	5% (16% 2022) (12, 8, 3, 15, 13, 22, 25, 14, 6, 15, 23)	4% (2% 2022) (1, 2, 5, 1, 8, 1, 0, 1, 1, 1, 0)	26% (20% 2022) (19, 23, 18, 27, 19, 13, 12, 12, 12, 11, 12)
RA-IV	337	67% (73% 2022) (72, 70, 71, 75, 77, 80, 78, 78, 72, 67, 66)	21% (16% 2022) (16, 17, 18, 10, 10, 8, 10, 11, 18, 18, 18)	3% (3% 2022) (4, 3, 3, 4, 2, 2, 3, 3, 2, 2, 3)	9% (8% 2022) (8, 10, 8, 11, 11, 10, 9, 8, 8, 13, 13)
RA-V	247	59% (57% 2022) (52, 60, 55, 57, 60, 64, 63, 64, 59, 56, 50)	9% (11% 2022) (16, 9, 13, 23, 19, 16, 18, 21, 17, 24, 34)	17% (3% 2022) (3, 3, 4, 2, 4, 4, 1, 9, 6, 3)	15% (29% 2022) (29, 28, 28, 18, 17, 16, 15, 14, 15, 14, 13)
RA-VI	594	82% (79% 2022) (81, 79, 84, 79, 85, 85, 79, 81, 77, 77, 74)	7% 11% 2022) (7, 9, 5, 10, 5, 5, 12, 8, 13, 15, 18)	2% (1% 2022) (2, 2, 3, 1, 1, 1, 1, 3, 3, 1, 1)	9% (9% 2022) (10, 10, 8, 10, 9, 9, 7, 7, 7, 7, 7)

RA-I is the poorest performing region, with only 23% of stations meeting the minimum requirement, and 38% not providing any CLIMAT messages. For most regions the percentage of compliant stations versus non-compliant stations has remained similar across the 12 years, however for RA-I the trend is more negative with non-reporting GSN stations being 11% higher (37% 2018-2023 v 26% 2011-2017).

According to statistics provided by the DWD GSN Monitoring Centre (GSNMC), the countries where all GSN stations did not report any CLIMAT for 2023 (March 2023 to Feb 2024) are as follows:

RA-1: Angola; Botswana (1 station); Burundi (1 station); D.R.Congo; Eritea (1 station); Ethiopia; Zambia; Zimbabwe; Madagascar (6 Stations); Nigeria; Sudan.
RA-II: Afghanistan (1 Station); Nepal (1 Station); Oman (2 Stations); Qatar (1 Station); Tajikistan; UAE.
RA-III: Bolivia; Suriname; Venezuela (includes coding format issues).
RA-IV: None.
RA-V: Cook Islands; Kiribati; Pitcairn (1 station); Solomon Islands; Tuvalu; Vanuatu.
RA-VI: Albania (1 station); Croatia (1 station); Macedonia (1 station); Syrian Arab Republic.
Antarctica: None, apart from 89327 which is being deleted in 2024 GSN station list update.

For the 'deprecated' RBCN network, which includes the GSN, the situation is even worse in RA-I with only 15% of stations meeting the minimum requirement. All regions, except RA-VI, show an 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, this is particular significant for RA-I. (Note: Although the RBCN network has been deprecated by WMO, its replacement RBON is not able to distinguish those stations with the CLIMAT reporting requirements so the monitoring continues to use the RBCN to identify those stations.)

2.2 GUAN

GCOS Upper Air Network (GUAN)

The following table is the 2023 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 ECMWF. In brackets are the same statistics for 2011 to 2022. For 2013 to 2018 these are based on availability according to NCEP, and for 2011 to 2012 to NCEI.

Region	Number of GUAN stations (2023)	% meeting minimum GCOS requirements in 2023 (% for 2022, 2021, 2020, 2019, 2018, 2017, 2016, 2015, 2014, 2013, 2012 and 2011)
RA-I	23	**43%** (47%, 47%, 30%, 22%, 22%, 30%, 39%, 35%, 39%, 46%, 48%, 57%)
RA-II	38	**84%** (84%, 71%, 84%, 87%, 87%, 89%, 87%, 87%, 87%, 87%, 87%, 87%)
RA-III	18	**56%** (61%, 61%, 61%, 72%, 72%, 61%, 61%, 67%, 72%, 67%, 89%, 78%)
RA-IV	24	**79%** (92%, 96%, 96%, 96%, 92%, 92%, 87%, 79%, 83%, 75%, 83%, 87%)
RA-V	38	**82%** (82%' 79%, 79%, 79%, 79%, 79%, 84%, 79%, 76%, 74%, 84%, 87%)
RA-VI	24	**75%** (83%, 87%, 87%, 92%, 87%, 87%, 87%, 87%, 87%, 83%, 92%, 87%)
Antarctica	12	**67%** (67%, 50%, 50%, 67%, 67%, 67%, 58%, 67%, 58%, 58%, 83%, 83%)

Twenty (20) of the GUAN stations (11%) were 'Silent' (zero reported TEMP observations) during 2023, a further increase of 4 from 2022, which is again the highest since this monitoring was started in 2011. In 2022 it was 16, in 2021 it was 14, 2020 and 2019 it was 12, 2018 and 2017 it was eleven (11), 2016 and 2015 it was seven (7), 2014 and 2013 it was three (3), four (4) in 2012 and five (5) in 2011. Graph below shows this trend.

Number of GUAN Stations In-active for whole year
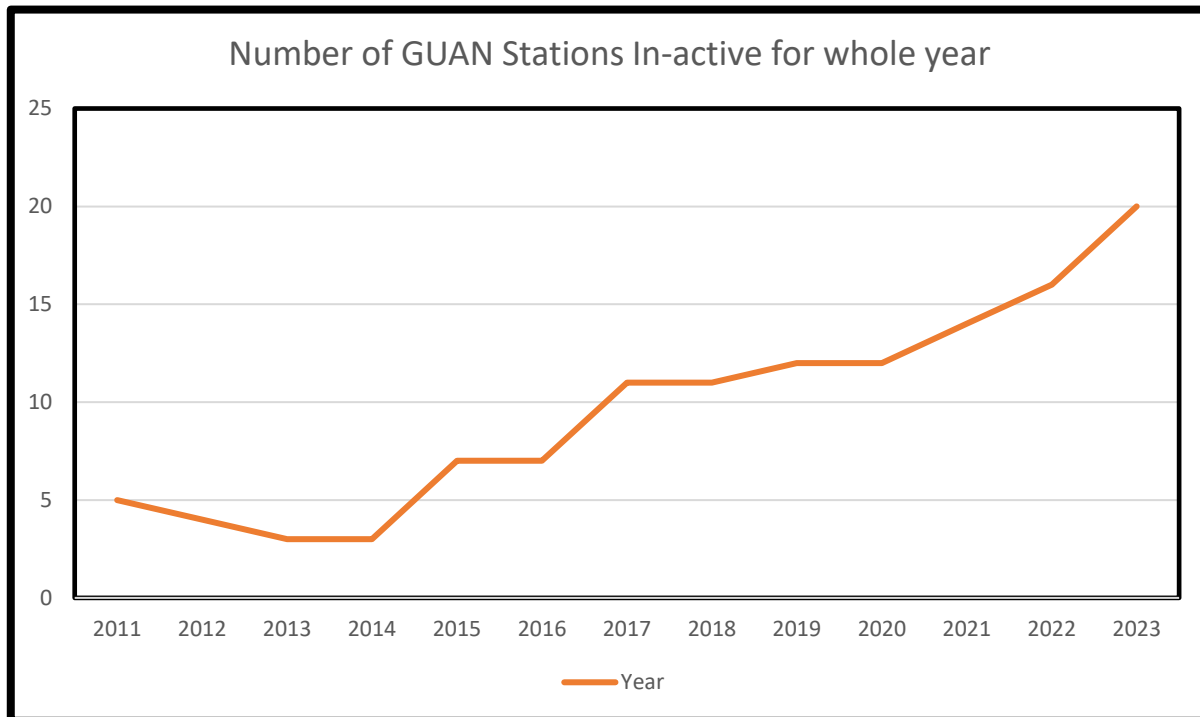
It is very evident that the number of long-term in-active GUAN stations has increased significantly over the last 4 years, and many of the regions are showing a decreasing performance of stations meeting the minimum requirements. This is most likely due to the increasing resources needed to operate and maintain an upper-air station, and the challenges that many of the NMHS are facing on funding. GCOS has also received very limited support funds into its cooperation mechanism for several years, which in the past has supported the operations of 2-3 GUAN stations each year.

The key points for each region are as follows:

In Region I, only 43% of the GUAN stations have met the minimum requirement for 2023, which was slightly down on 2022 but slightly above the 13-average (39%). This region continues, by some margin, to be the worst performing region, with this very poor performance 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. Five (5) stations were in-active during the period; Dakar/Yoff, Senegal (unknown); Vacoas, Mauritius (Radiosonde consumables); Khartoum, Sudan (Equipment and consumables); Addis Ababa, Ethiopia (Unknown); and Harare, Zimbabwe (Unknown). A further seven (7) stations had at least 1 month with zero reported TEMP observations; 63741; 63894; 64910; 68110; 68592; 68906 and 68994.

The performance in Region II in 2023 (84%) was the same as for the previous year and similar to the 13-year average (85%). Two stations (2) were in-active during the period; Karachi Airport, Pakistan (No consumables, pilot messages only); and Gan, Maldives (No consumables). In addition, three (3) stations had long periods of inactivity; 40745, 48327 and 48453.

The performance in Region III in 2023 (56%) was slightly worse than the previous year same and is below the 13-year average (68%). Four (4) stations were in-active during the period; 78762 Juan Santamaria, Costa Rica (Unknown); 82397 Fortaleza, Brazil (Unknown); 84008 San Cristobal, Ecuador (Radiosonde supply and Hydrogen system) and 84628 Lima, Peru (Unknown). One (1) station was in-active for much of the year (85469 Isla de Paccua, Chile) and a further 3 stations did not meet the minimum requirement.

The performance in Region IV in 2023 (79%) was significantly worse than previous years, with 5 stations not meeting the minimum requirement. One (1) station was completely in-active during the period, 78762 Juan Santamaria, Costa Rica (unknown); and two (2) stations had significant periods of in-activity, 71836 Moosonee, Canada and 78988 Hato, Curacao.

Region V performance (82%) was the same as for 2022 and slight improvement on the previous 4 years, with 7 stations not meeting the minimum requirement. Five (5) stations were completely in-active during the period, Honiara, Solomon Islands; Vanuatu, Bauerfield; Rarotonga, Cook Islands; Port Moresby, PNG and Kermadec, New Zealand, all due to having no radiosonde consumables, except for Kermadec which stopped operations due to COVID and as yet this has not restarted.

The performance in Region VI in 2023 (75%) was much worse than previous years, and was the lowest percentage of stations meeting minimum requirement since the start of this monitoring report (2011). Three (3) stations were completely in-active during the period, Ankara, Turkey (Signal Interference); Kyiv, Ukraine (Conflict) and Yerevan; Armenia (Equipment and consumables). In addition, one (1) station, 40265, had at least 1 month with zero reported TEMP observations.

The performance in the Antarctica region in 2023 (67%) was the same as for previous year, with 4 stations not meeting the minimum requirement. No stations were completely in-active during the period. Halley Bay (89022) continues to have extensive period of inactivity owing to the station needing relocating for safety reasons. Base Marambio (89055) continue to have very few observations each month.

GUAN TEMP message reporting

Of the 158 GUAN stations which reported a TEMP message in 2023:

89% (141) reported either a low/high resolution BUFR message	85% (2022); 85% (2021)
11% (17) did not report in BUFR (i.e. TAC only)	15% (2022); 15% 2021)
12% (19) only reporting BUFR	9% (2022); 10% (2021)

3 – GCOS Cooperation Mechanism

The GCM 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 3.5 million USD was raised to accomplish projects dedicated to improving climate observation systems.

- **Due to no available funding in the GCM in 2023 no new projects have been implemented.**