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

Name – Tim Oakley **GCOS Network Manager**	**Year – 2021** **(Includes statistics from 2011 to 2020)**

Network Station List (2022 update)

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	178 Stations (0)	No Changes
RA-V	153 Stations (+2)	Australia 0-20000-0-94340 (Richmond PO) to 0-20000-0-94341 (Richmond A/P AWS) – **Change request received from BOM. Replacement of manual site with AWS. Parallel period of observations undertaken. BOM working on provision of CLIMAT reports.** 0-20000-0-94689 (Broken Hill) to 0-20000-0-94691 (Broken Hill A/P AWS) – **Change request received from BOM. Replacement of manual site with AWS. Parallel period of observations undertaken. BOM working on provision of CLIMAT reports.** 0-20000-0-94485 (Tibooburra PO) to 0-20000-0-95485 (Tibooburra A/P) – **Change request received from BOM. Replacement of manual site with AWS. Parallel period of observations undertaken. BOM working on provision of CLIMAT reports.** 0-20000-0-94480 (Marree) to 0-20000-0-95480 (Marree A/P) – **Change request received from BOM. Replacement of manual site with AWS. Parallel period of observations undertaken. BOM working on provision of CLIMAT reports.** 0-20000-0-94967 (Cape Bruny Lighthouse) to 0-20000-0-95967 (Cape Bruny) – **Change request received from BOM. Replacement of manual site with AWS. Parallel period of observations undertaken. BOM working on provision of CLIMAT reports.** 0-36-9-94330 (Karuini North) – **Change request received from BOM. New GSN station.** 0-20000-9-95936 (Melbourne – Olympic Park) – **Change request received from BOM. New GSN station.**
RA-VI	139 Stations (0)	No Changes
ANTON	42 Stations (0)	No Changes
TOTAL	**1023 Stations**	

GCOS Upper Air Network (GUAN)

RA-I	23 Stations (0)	No Changes
RA-II	38 Stations (0)	No Changes
RA-III	18 Stations (0)	No Changes
RA-IV	24 Stations (0)	No Changes
RA-V	38 Stations (0)	No Changes
RA-VI	24 Stations (0)	No Changes
ANTON	12 Stations (0)	No Changes
TOTAL	**177 Stations (0)**	

The above changes will be submitted to AOPC (June 2022). The 2022 update will be published in July 2021.

Network Performance

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 2021 percentage of stations that are compliant and those that are partially or non-compliant. In brackets are the statistics for 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	**21%** (20% 2020) (26, 37, 31, 40, 29, 29, 32, 28, 23)	**38%** (37% 2020) (33, 21, 34, 25, 31, 33, 33, 36, 39)	**5%** (4% 2020) (6, 5, 3, 9, 15, 10, 10, 11, 14)	**36%** (39% 2020) (35, 37, 32, 26, 25, 28, 25, 25, 24)
RA-II	258	**76%** (77% 2020) (76, 74, 79, 83, 78, 71, 73, 73, 75)	**16%** (14% 2020) (17, 14, 15, 10, 14, 21, 19, 19, 19)	**0%** (2% 2020) (1, 5, 0, 2, 2, 3, 2, 2, 1)	**8%** (7% 2020) (6, 7, 6, 5, 6, 5, 6, 6, 5)
RA-III	101	**72%** (68% 2020) (72, 52, 63, 65, 61, 76, 89, 84, 69)	**13%** (7% 2020) (5, 24, 15, 29, 35, 20, 6, 13, 28)	**2%** (2% 2020) (9, 1, 6, 0, 0, 1, 0, 0, 0)	**13%** (23% 2020) (14, 23, 16, 6, 4, 3, 5, 3, 3)
RA-IV	178	**86%** (87% 2020) (82, 88, 86, 90, 88, 88, 88, 81, 80)	**12%** (9% 2020) (16, 7, 12, 7, 9, 10, 11, 17, 18)	**1%** (2% 2020) (1, 4, 1, 2, 2, 1, 1, 1, 1)	**1%** (2% 2020) (1, 1, 1, 1, 1, 1, 0, 1, 1)
RA-V	151	**60%** (72% 2020) (66, 62, 61, 67, 66, 70, 63, 58, 52)	**22%** (11% 2020) (15, 21, 21, 15, 16, 17, 16, 23, 34)	**2%** (3% 2020) (4, 1, 3, 3, 4, 1, 7, 7, 1)	**16%** (14% 2020) (15, 16, 15, 15, 14, 13, 14, 12, 11)
RA-VI	138	**77%** (79% 2020) (81, 75, 82, 84, 77, 80, 82, 78, 81)	**11%** (7% 2020) (7, 15, 8, 7, 14, 9, 12, 17, 15)	**1%** (4% 2020) (3, 1, 2, 2, 3, 5, 2, 1, 0)	**11%** (10% 2020) (9, 9, 8, 7, 6, 6, 4, 4, 4)
ANTON	42	**81%** (91% 2019) (88, 84,83, 81, 77, 79, 60, 45, 50)	**17%** (5% 2020) (10, 14, 12, 17, 19, 19, 36, 43, 33)	**2%** (2% 2020) (2, 2, 5, 2, 2, 2, 2, 5, 12)	**0%** (2% 2020) (0, 0, 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%** (17% 2020) (17, 22, 18, 23, 16, 17, 19, 13, 12)	**21%** (20% 2020) (19, 15, 22, 17, 22, 20, 20, 23, 22)	**4%** (4% 2020) (6, 4, 5, 8, 11, 8, 7, 12, 13)	**57%** (60% 2020) (58, 59, 55, 52,51, 55, 54, 52, 53)
RA-II	664	**71%** (73% 2020) (71, 67, 77, 80, 73, 71, 73, 67, 57)	**17%** (15% 2020) (19, 17, 14, 12, 17, 18, 15, 22, 30)	**1%** (3% 2020) (2, 7, 1, 1, 2, 4, 4, 1, 2)	**11%** (9% 2020) (8, 9, 8, 8, 8, 7, 8, 10, 11)
RA-III	298	**68%** (67% 2020) (74, 57, 60, 64, 63, 73, 81, 73, 65)	**12%** (8% 2020) (3, 15, 13, 22, 25, 14, 6, 15, 23)	**1%** (2% 2020) (5, 1, 8, 1, 0, 1, 1, 1, 0)	**19%** (23% 2020) (18, 27, 19, 13, 12, 12, 12, 11, 12)
RA-IV	337	**72%** (70% 2020) (71,75, 77, 80, 78, 78, 72, 67, 66)	**16%** (17% 2020) (18, 10, 10, 8, 10, 11, 18, 18, 18)	**4%** (3% 2020) (3, 4, 2, 2, 3, 3, 2, 2, 3)	**8%** (10% 2020) (8, 11, 11, 10, 9, 8, 8, 13, 13)
RA-V	247	**52%** (60% 2020) (55, 57, 60, 64, 63, 64, 59, 56, 50)	**16%** (9% 2020) (13, 23, 19, 16, 18, 21, 17, 24, 34)	**3%** (3% 2020) (4, 2, 4, 4, 1, 9, 6, 3)	**29%** (28% 2020) (28, 18, 17, 16, 15, 14, 15, 14, 13)
RA-VI	594	**81%** (79% 2020) (84, 79, 85, 85, 79, 81, 77, 77, 74)	**7%** (9% 2020) (5, 10, 5, 5, 12, 8, 13, 15, 18)	**2%** (2% 2020) (3, 1, 1, 1, 1, 3, 3, 1, 1)	**10%** (10% 2020) (8, 10, 9, 9, 7, 7, 7, 7, 7)

RA-I is the poorest performing region, with only 21% of stations meeting the minimum requirement, and 36% not providing any CLIMAT messages, this has not significantly changed, neither better or worse, over the last 10 years. Both 2021 and 2020 has the worst performance statistics over the 10 years but this is possibly because of the COVID pandemic, which is known to have impacted manual observing stations.

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. All regions 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.

GCOS Upper Air Network (GUAN)

The following table is the 2021 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 2020. For 2013 to 2018 these are based on availability according to NCEP, and for 2011 to 2012 to NCEI.

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

Fourteen (14) of the GUAN stations (8%) were 'Silent' (zero reported TEMP observations) during 2021, an increase of 2 from 2020, which is the highest since this monitoring was started in 2011. In 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.

The key points for each region are as follows:

In Region I, only 47% of the GUAN stations have met the minimum requirement for 2021, which was a significant improvement on the previous years (30% in 2020 and 22% in 2019 and 2018). However, 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. Six (6) stations were in-active during the period; Vacoas, Mauritius (Radiosonde consumables); Khartoum, Sudan (Hydrogen system); Douala, Cameroon (Unknown); Harare, Zimbabwe (Unknown), Windhoek, Namibia (Unknown) and Marion Island, South Africa (Unknown). A further nine (9) stations had at least 1 month with zero reported TEMP observations; 61052; 61641; 63450; 63741; 63894; 63985; 65578; 68110; and 68592.

The performance in Region II in 2021 (47%) was worse than that for the previous years, with eleven (11) 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 11 years, it is not meeting the GUAN requirements. The drop in performance was primarily due to the Indian stations (5 out of 6) having significant outages due to the COVID pandemic. In addition, the two Thailand station (48327 & 48453) had lengthy periods of inactivity/low activity owing to radiosonde supply issues.

The performance in Region III in 2021 (61%) was the same as the previous year but has deteriorated when compared to the two years before that (72%). Two (2) stations were in-active during the period; 82397 Fortaleza, Brazil (Unknown) and 84008 San Cristobal, Ecuador (Radiosonde supply and Hydrogen system). A further 4 stations did not meet the minimum requirement.

The performance in Region IV in 2021 was the same as in 2020 & 2019, with only 1 station not meeting the minimum requirement (78762 Juan Santamaria, Costa Rica). No stations were completely in-active during the period but three (3) stations, 78583, 78762 and 80001, had at least 1 month with zero reported TEMP observations.

Region V was the same as for the previous 4 years, with 8 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, Kermadec, New Zealand and Brunei, all due to having no radiosonde consumables, except for Kermadec which was due to COVID. Two (2) stations, 91643 and 94995, had at least 1 month with zero reported TEMP observations.

The performance in Region VI in 2021 (87%) was the same as 2020 and 2014-2018, with 3 stations not meeting the minimum requirement. Three (3) stations, 17130, 37789 and 40265, had at least 1 month with zero reported TEMP observations.

The performance in the Antarctica region in 2021 was the same as for 2020 (50%), which was a deterioration to that of the previous 3 years, with 6 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 163 GUAN stations which reported a TEMP message in 2021:

85% (138) reported either a low/high resolution BUFR message. [In 2020 - 72% (118)]
15% (25) not reporting BUFR (i.e. TAC only)   [In 2020 - 16% (26)]
10% (16) only reporting BUFR   [In 2020 -12% (19)]

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 2021 no new projects have been implemented.**