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Monitoring of GCOS Atmospheric Networks

(Submitted by Mr S. Roesner, CBS/OPAG/IOS Rapporteur on GCOS Matters)

Summary and Purpose of Document

The document contains a summary of activities carried out by GCOS monitoring centres in compiling and analysing the availability of data from GSN and GUAN stations.

ACTION PROPOSED

The meeting is invited to take into consideration the information contained in this document when discussing the means and procedures to further improve availability of climate data on the basis of GCOS monitoring activities.

Appendix: **Monitoring of GCOS Atmospheric Networks**

Monitoring of GCOS Atmospheric Networks

Stefan Rösner[1)], Christiana Lefebvre[1)], Mark McCarthy[2)]
1) Deutscher Wetterdienst, Germany
2) Met Office, Hadley Centre, UK

1. Introduction

At the time being two GCOS atmospheric network have been established: the GCOS Upper Air network (GUAN[1]) and the GCOS Surface Network (GSN[2]). For both GCOS atmospheric networks monitoring centres have been designated. The GUAN performance is monitored by the European Centre for Medium Range Weather Forecast (ECMWF), and the GSN is monitored jointly by the Japan Meteorological Agency (JMA) and the Deutscher Wetterdienst (DWD). The monitoring centres provide reports on the monitoring results on a regular basis

2. Monitoring the GCOS Upper Air Network (GUAN)

2.1 Background

The principal aims of the GUAN are to ensure a relatively homogenous distribution of upper air stations that meet specific record length and homogeneity requirements outlined by GCOS and to develop, and make available, their current and historical data. It is important to establish a network of stations with reliable prior records and which will continue to provide data in the future. The selection process considered the following guidelines, in order of importance, (1) the position of the station in its contribution to a spatially homogenous network, (2) The performance of the site in producing consistently high quality data, and (3) The existence of a historical record of reasonable length.

Logistical and economical reasons have lead to the closures of many global radiosonde sites, particularly in geographically remote or data sparse areas. This has underlined the necessity for a continuous long-term support network. A 150 station network was proposed at the first session of the atmospheric observation panel for climate (AOPC) (GCOS-6, 1994).

The European Centre for Medium Range Weather Forecasting (ECMWF) was requested by CBS-XI to act as lead data monitoring centre, and provide 6-monthly reports on availability and quality of upper air data from GUAN stations. The Met Office Hadley Centre in the UK and National Oceanographic and Atmospheric Administration (NOAA), National Climate Data Centre (NCDC) in the US, are to act as GUAN data analysis centres (GCOS-45, 1998) committed to creating and maintaining datasets and metadata products relating to the GUAN.

Monitoring activities are currently occurring at both ECMWF and the Hadley Centre providing reports on quality and receipt of daily TEMP and PILOT observations, and receipt of monthly CLIMAT TEMP data respectively.

2.2 Details of the monitoring procedure(s)

CLIMAT TEMP reports are received at the Met Office routinely each month via the GTS, email, post, and fax. These pass though in-house decode and hydrostatic quality control procedures and are maintained on the Hadley centre CLIMAT TEMP archive.

The monthly receipt of CLIMAT TEMP messages is monitored. A reference list of the reliability of all GUAN and other CLIMAT TEMP stations based on percentage of reports received in the 1990s is compared against stations received each month and presented graphically on the Met Office GUAN website . Assessments of station reliability over 6 month

[1] GCOS-6, Annex VII
[2] GCOS-26, GCOS-34, GCOS-35, GCOS-53

to annual timescales are produced on request, with work underway to routinely provide these and other statistics via the web interface.
ECMWF provide reports on the quality and availability of daily TEMP and PILOT radiosonde messages received and decoded at ECMWF in time for the appropriate analysis.
Monitoring charts and tables presenting data receipt and gross error counts are being produced on a monthly basis, and work is underway to present these on the ECMWF website.

2.3 Results

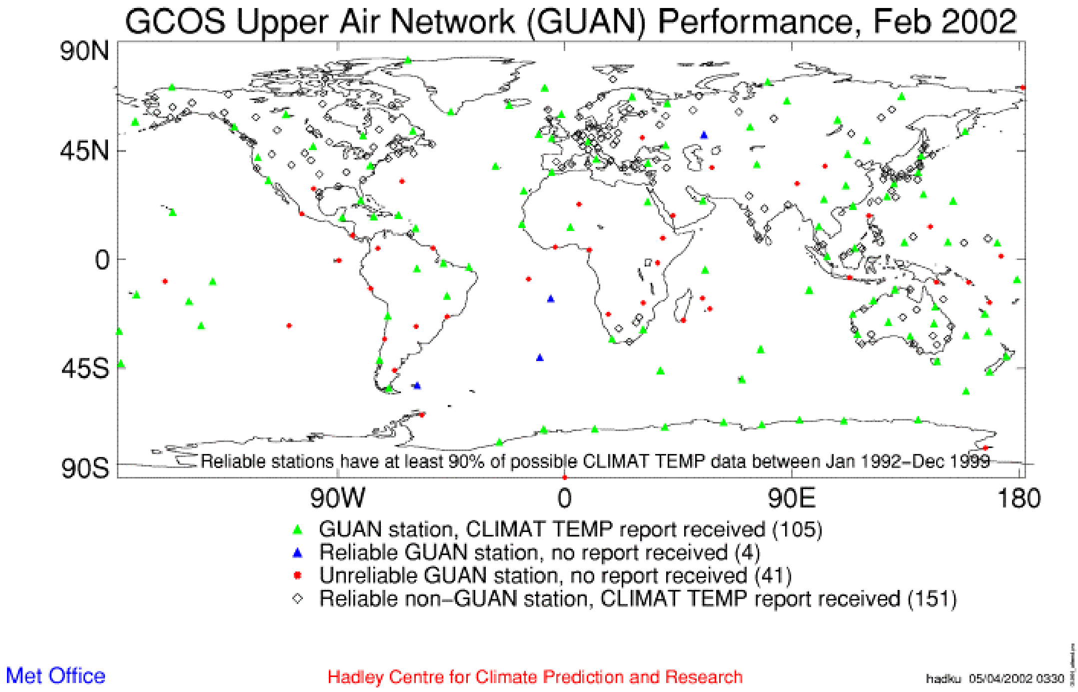

Figure 1: Map of CLIMAT TEMP receipt at Hadley Centre for February 2002

Figure 1 above shows the GUAN performance based on CLIMAT TEMP receipt for February 2002, also shown are non-GUAN reliable stations that have reported a CLIMAT TEMP message. Typical reception tends to be of the order of 100 stations. Approximately 25-30% of the network fails to report consistently. South America, Africa and parts of Asia are regions

WMO REGION	1999 Reporting percentage	2000 Reporting percentage	2001 Reporting percentage
I – Africa	63%	53%	53%
II – Asia	64%	58%	60%
III – S. America	60%	52%	52%
IV – N+Cntrl.America	55%	60%	84%
V – S.W.Pacific	76%	76%	75%
VI – Europe	92%	89%	89%
VII – Antarctica	72%	74%	75%
Globe	69%	66%	69%

Table 1: Reporting percentage of CLIMAT TEMP messages 1999-2001 by WMO RA

where performance is particularly poor.
Table 1 shows the percentage receipt of GUAN data since 1999. 18% of the network is effectively silent (less than 10% of reports received), refer to Annex B which lists station reliability 1999-2001. Over this period the GUAN has maintained its overall performance, but it is clear that the network has further degraded over Africa and South America – regions of great importance for climate monitoring and research. Improvement in reporting has been observed in North and Central America, largely due to improved receipt of data from the Caribbean.

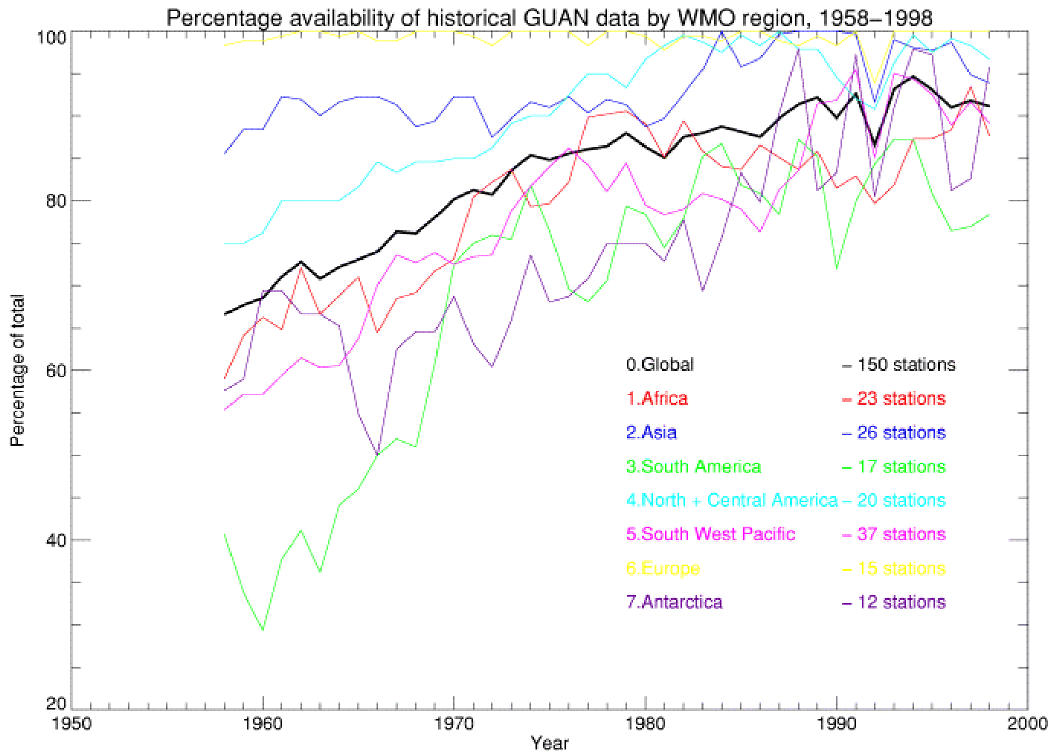

Figure 2: Percentage availability of historical GUAN data by WMO RA. Based on combination of CLIMAT TEMP data from the Hadley Centre, and MONADS from the CARDS project at NCDC.

Figure 2 shows the availability of historical GUAN data for the period 1958-1998. These data are from a combined temperature series from the Hadley Centre CLIMAT TEMP archive and monthly mean statistics from the CARDS dataset kept at NCDC. It is clear that historically it is possible to obtain 80-100% coverage of the GUAN back to the 1970s. South America, Antarctica, SouthWest Pacific, and Africa still require further augmentation if the GUAN historical series is to achieve acceptable spatial homogeneity. Source data from all GUAN stations are desirable for assessing differences between the currently available datasets, and station history data is vital to assess spurious signals and biases in the time-series.

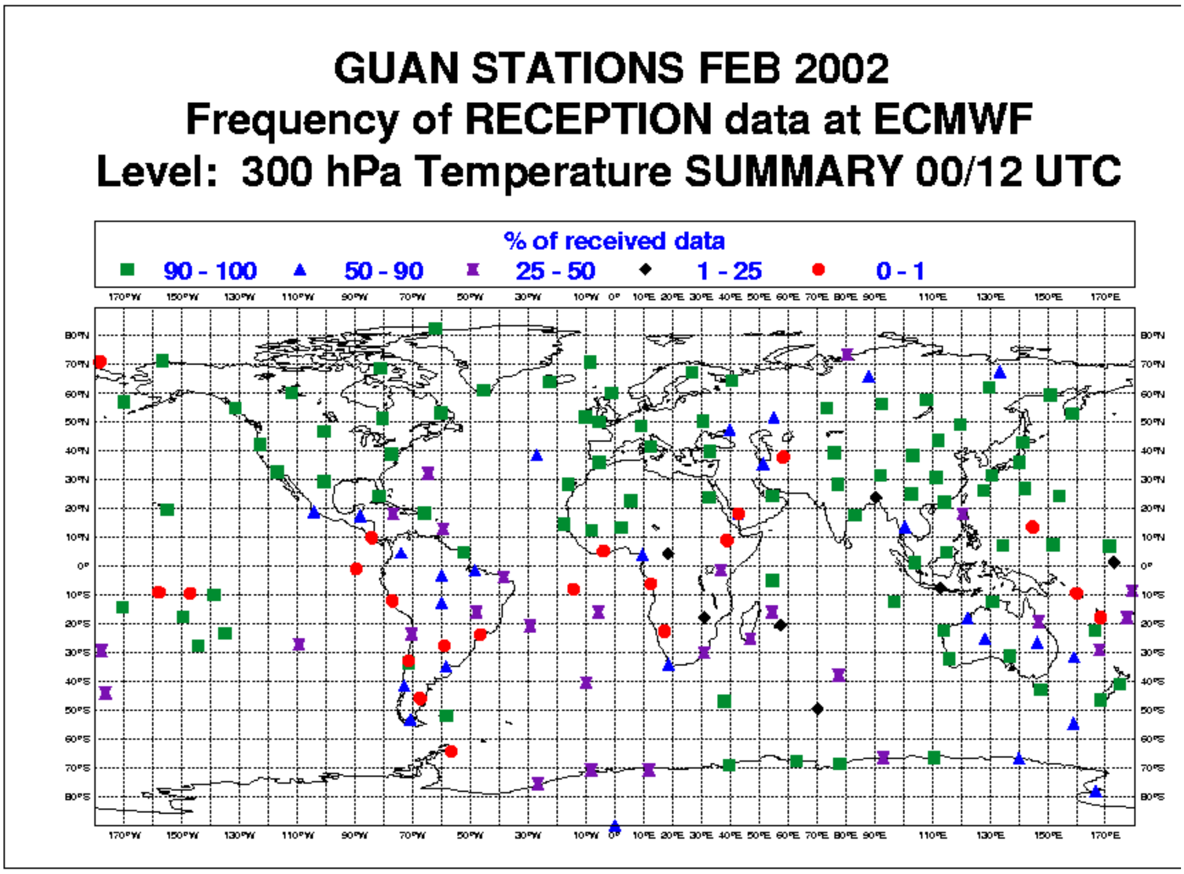

Figure 3: ECMWF monitoring statistics for TEMP reports.

Figure 3 shows the reception of daily TEMP reports at ECMWF as a percentage of the 28 possible days. Again much of the Northern Hemisphere is well observed, but large regions of the Southern Hemisphere are poorly covered, notably South America and East and South Africa.

Figure 4 shows receipt and gross error count for the African region for 300hPa temperatures from TEMP reports in February. For 300hPa temperatures in February 31 Gross errors were identified. This is only a very small fraction of the total number of reports received.

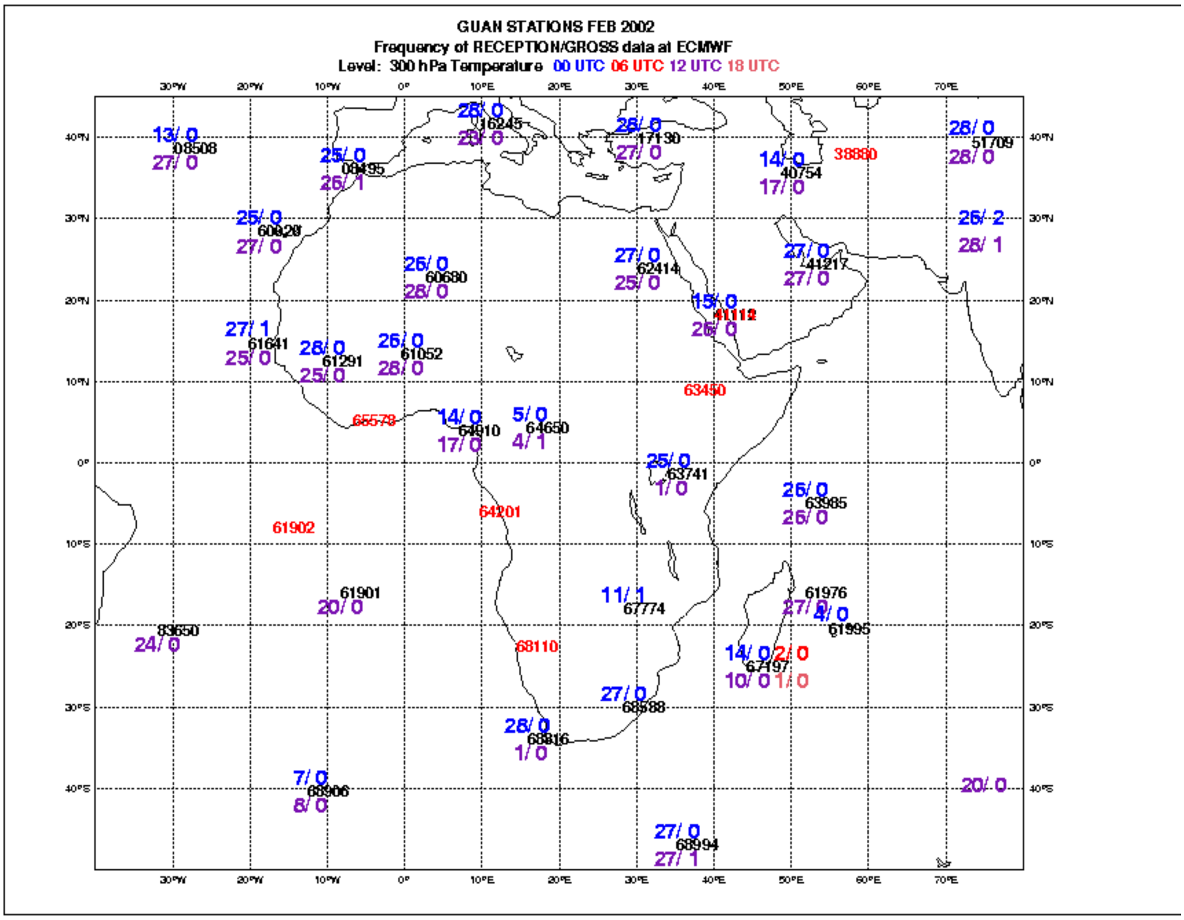

Figure 4: Days received/gross errors for African stations for each reporting hour, February 2002. From ECMWF TEMP receipt.

2.4 Future activities

Further development of the web sites at The Met Office, ECMWF, NCDC, and GCOS will allow easy access to a multitude of monitoring and data products related to GUAN. Information and data appears on the originating centres web-site, and good links between each of these sites allows ease of access to all relevant GUAN information.

Website development is currently underway at the Met Office. Reporting percentages and station reliability lists will become available. It is also intended to place coded and decoded CLIMAT TEMP messages for GUAN stations on the web. Provision of the augmented and improved temperature series (see figure 2) via the web is problematic due to security issues related to external access to the database on which the data are stored. GUAN Data are currently available from the NCDC CARDS project website, and ECMWF monitoring statistics will be available on the web shortly.

Station reliability and data receipt, rather than data quality, are the principal issues to be resolved if it is hoped to achieve the network standards of data availability and homogeneity required to make GUAN worthwhile. This includes real-time reporting, and obtaining further historical data and station history information from particular regions.

3. Monitoring the GCOS Surface Network

3.1 Background

The GSN was based on a proposal of the WMO Commission for Climatology (CCl) Working Group on Climate Change Detection, which had been discussed at the first session of the Atmospheric Observation Panel for Climate (AOPC) (GCOS-6, 1994). In March 1996, participants of a joint CCl and Commission for Basic Systems (CBS) Experts Meeting on the GSN (GCOS-26, 1996) drafted a more detailed concept. Finally, an initial selection of a GSN was published in 1997 (GCOS-34, 1997). Ranking and selecting by use of an objective method led to about 1000 GSN stations to be included in the GSN. As of December 2001 the GSN consists of 987 surface stations.

The need for monitoring the performance of this network was recognised and formulated by the Second Joint CCl/CBS Meeting on GSN (GCOS, 35, 1997). The participants considered it essential that the operational exchange of the GSN temperature and pressure data via CLIMAT messages on the GTS be monitored routinely.

At the third session of the Joint Data and Information Management Panel (JDIMP) (GCOS-39, 1997) the DWD offered to monitor the GSN data flow, data availability, and data quality with special regard to precipitation. In August 1997 the CCl agreed that the availability and quality of CLIMAT messages being distributed over the GTS be globally monitored by monitoring centres, with the assistance of regionally designated focal points (WMO 1997a,b). In the following of this agreement, Germany and Japan officially offered to serve as GSN Monitoring Centres (WMO, 1998).

In January 1999 the GSNMC have formally been implemented (GCOS-53, 1999).

3.2 Details of the monitoring procedure(s)

In order to start from identical information, the GSNMC at JMA and DWD agreed on using an identical software to analyse CLIMAT bulletins received via GTS. Details about this software are given in EMCGG-1/Doc.7.

Monitoring CLIMAT messages at JMA and DWD is a multiple step procedure

1. Bulletins with CLIMAT messages are collected until a cut off date (21st day 00 UTC of the following month).
2. Received bulletins are analysed and decoded with the GSNMC monitoring software 'FORMCHECK', and
3. statistical information about the received bulletins and the therein included CLIMAT messages are generated at each centre separately.
4. The files with statistical information generated by 'FORMCHECK' are exchanged between the centres, and information included (see below) is stored into the GSNMC RDBMS operated by DWD.
5. Missing CLIMATs at JMA and DWD are identified and exchanged, so that, at the end, both centres have an identical list of GSN stations received.
6. DWD and JMA apply their quality check procedures for monthly precipitation amount and monthly mean temperature respectively. The quality of air pressure is not monitored.
7. At the end a GSN data set is generated which consists of a) a block with station meta data, b) the CLIMAT messages (if available), c) information on the format errors detected, d) the bulletin header by which the CLIMAT messages was received, and e) a block with the quality information.

As from many stations CLIMATs are received several times for a certain month, criteria have been formulated, to select the most 'correct' message. To identify the message with the highest priority the following scheme as applied:

1. If the month-year-group detected is as expected, the priority-ID is set to 1 (PID=1), if not PID=2.
2. Is the content of the message ‘NIL’ PID=PID+2. If not PID=PID+0.
3. Was any exchange mode ‘ii’ identified in the bulletin header? In this case PID=PID+0. If not PID=PID+4.

Finally, the message with the lowest PID is selected. If several messages from one station have the same PID, the one received latest is selected. But in some cases there is even no difference in the reception time. Examples which information about the received CLIMAT messages is available from ‘FORMCHECK’ is given in Annex A. Further information is available from each of the GSNMC Monitoring Reports. Fig. 5 gives an overview on the flow of monitoring information in the GSNMC.

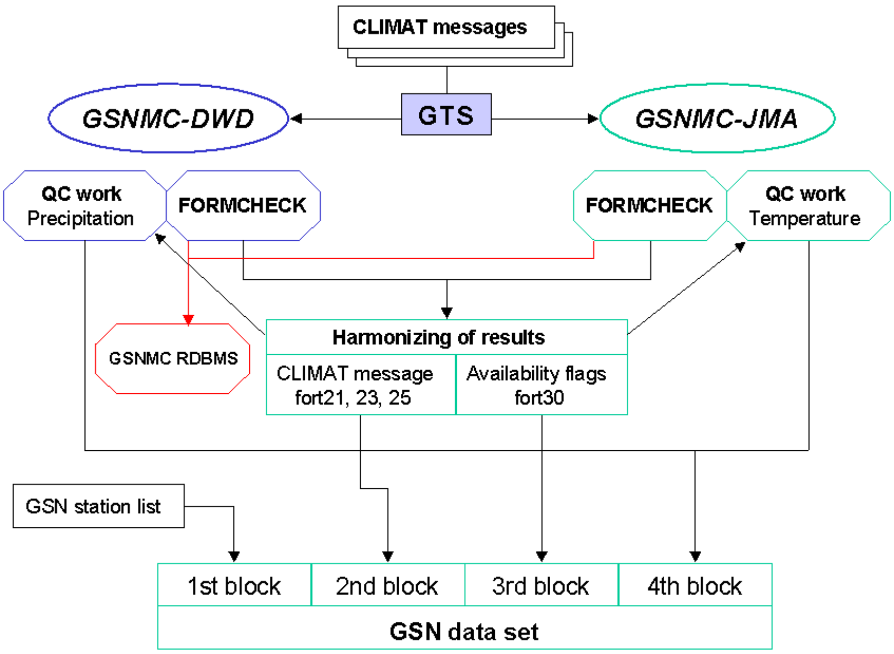

Fig. 5: Illustration of the data flow between the two joint GSNMCs at JMA and DWD.

3.3. Results/Findings

The basic GSN monitoring results are published in biannual monitoring reports which are available on the GSNMC homepage[3] for download. The GSN data set, which consists of the GSN CLIMATs, the format quality information from ‘FORMCHECK’ and quality information on precipitation and temperature data is sent regularly to the Word Data Centre A for Meteorology (WDC-A) and is made available as a rolling 12-months archive on the GSNMC homepage as well.
Comparison of received CLIMATs between JMA and DWD show, that there are differences which neither could be explained nor have they been expected.

[3] http://www.gsnmc.dwd.de

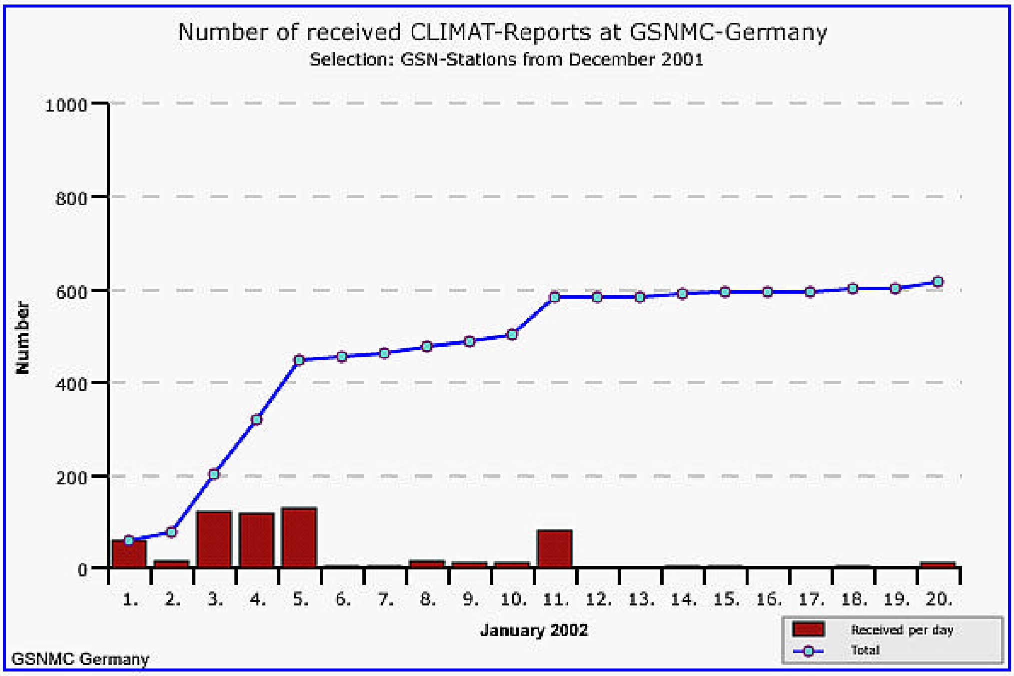

Fig. 6: Reception of GSN-CLIMATs at DWD in January 2002.

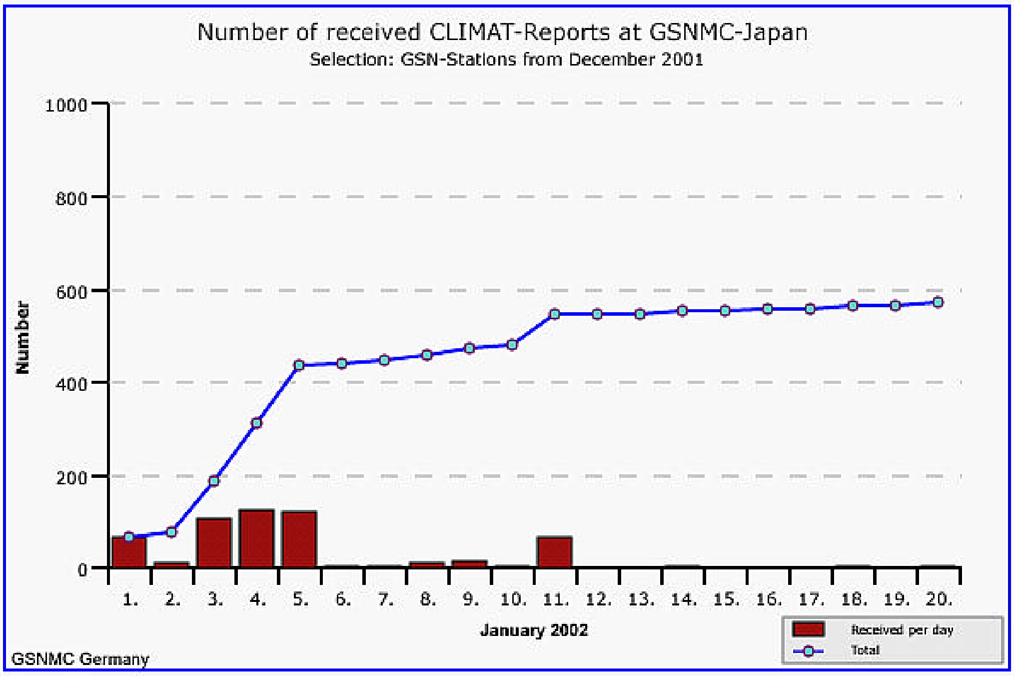

Fig. 7. Same as in Fig. 6 but for JMA.

Fig. 6 shows the typical reception rates of December CLIMATs at DWD for different days in January 2002. In principle the figure for JMA looks similar, as expected. But there are little differences which lead at the end to the fact that JMA systematically receives less GSN CLIMAT messages than DWD does (Fig. 7).

A look at Fig. 8 shows that there are big differences between the WMO RAs as far as availability of GSN CLIMATS at the GSNMC's real time monitoring is concerned. For some areas an improvement is clearly visible such as for WMO RA V, based on immediate reactions taken when the results of the first GSNMC monitoring reports have been communicated to colleagues at the Bureau of Meteorology, as these contacts already existed.

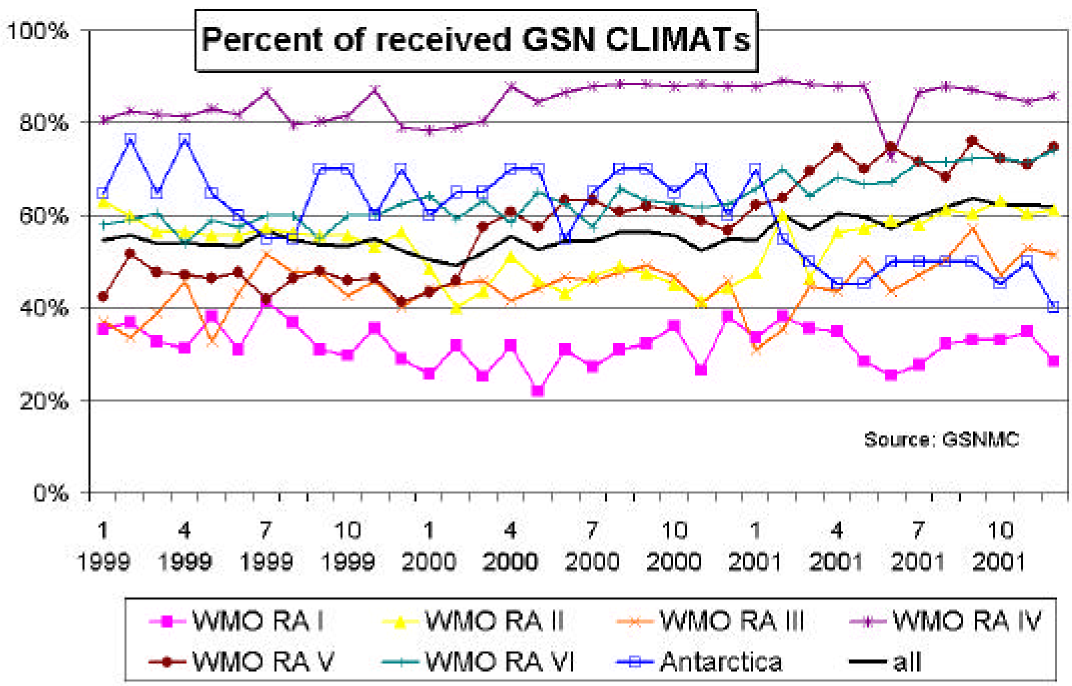

Fig. 8: Received GSN CLIMATs from different WMO RAs.

On the other hand it must be pointed to a serious decline in CLIMATs received from the Antarctica since January 2001 (blue line).
Positive developments can also be seen for WMO RA III, and VI whereas WMO RA II has now reached the same level as at the beginning of the monitoring in January 1999.

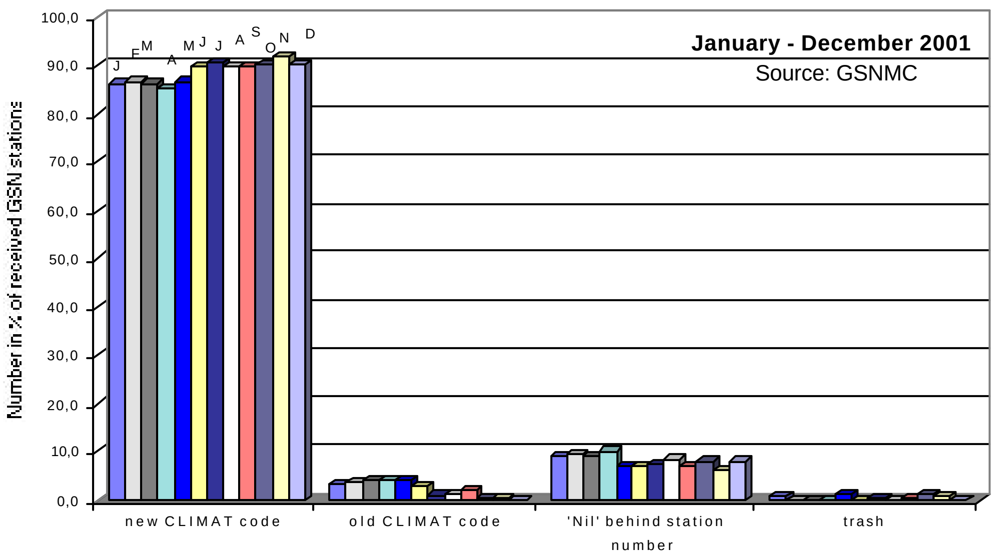

Fig. 9: Number of CLIMATs reporting in new and old FM71 code in percent of all received GSN stations

About 90% of the received GSN stations reporting is using the actual CLIMAT code (FM 71-XI). But there is a considerable amount of 7-10%, having 'NIL' behind the station number. During the last year the number of GSN stations still reporting in old CLIMAT format (FM 71-VI) decreased, because at least two countries switched to use the actual CLIMAT format (Fig. 9).

Up to 1.5% of the reporting GSN stations have several errors in their messages, so that these messages are not decodable ('trash').

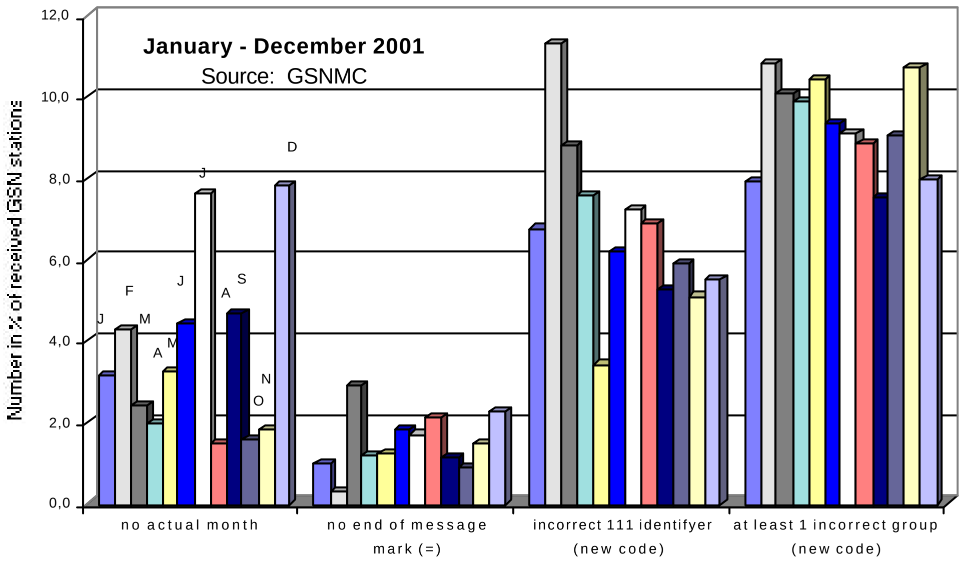

Fig. 10: Frequently detected format errors.

Due to the software FORMCHECK is possible to provide statistics about special errors detected in the monthly messages. Fig. 10 shows, that some of these errors do occur rather frequently. Every month between 40 and 70 GSN stations contain at least one incorrect group, which means one group, that is either too long, too short or not separated by a blank from the following one.

With regard to monitoring the quality of monthly precipitation amount and monthly mean temperature the following results have been found:

1. For many stations these variables are not available (35-40%).
2. More than 50% of the GSN stations report these two variables correctly.
3. 3-5% of the precipitation or temperature data flagged during the automatic QC procedure pass manual control without change.
4. About 2% of the precipitation data, and less than 0,5% of the temperature data reported which have been flagged during the automatic QC procedure need to be manually corrected.
5. Only in a few cases even manual correction was impossible, and data had to be deleted.

At DWD CLIMAT messages from several countries are received regularly via email. This are Bosnia and Herzegovina, Colombia, Kyrgyz Republic, Macedonia (will start soon), Peru, Philippines, and St. Helena. If these CLIMATS are received before the GSNMC's cut off date they are put on the GTS with the appropriate header.

3.4 Future activities

In order to facilitate access to and use of the monitoring results generated at the two GSNMCs are aiming at setting up a web site with access to GSNMC monitoring products. Users will than be able to select the information needed with respect to time, area, and type of station (e.g. GSN or not).
Principally the GSNMC software may be applied to CLIMAT bulletins received at other NMHSs, too, if input files with the CLIMAT bulletins are provided in a the format needed by "FORMCHECK".

Contacts with other NMHSs have already started on the working level. At DWD missing CLIMAT messages (not only from GSN) are actively requested by telecommunication means also before the GSNMC's cut-off-date. An active approach with regard to overcome the format errors is under consideration, and may be implemented as far as additional resources needed will be available. JMA and DWD have already agreed on 'areas of responsibility' at the Implementation Meeting (GCOS-53).

4. Conclusions and recommendations from monitoring the GSN and GUAN

- Due to cuts in the resources at DWD available for GSNMC, the frequency of the GSNMC Monitoring Report needs to be reduced to once a year.
- An Internet system for presenting and investigating the monitoring results should be developed, which eventually replaces the today's GSNMC Monitoring Report.
- The monitoring centres need to be informed which type of changes have been made, and when these changes should become valid.
- Observations made in the Antarctica need to be supported in order to overcome the decline observed.
- Radiosonde observations in South America and Africa need to be supported to reverse the decline in data availability in these important regions.
- Working level contacts for GUAN stations, such that data not received due to GTS or other communication problems can be requested by alternative means.

5. References

GCOS-6 (WMO/TD-No. 640), 1994: Report of the GCOS Atmospheric Observation Panel, first session (Hamburg, Germany, April 25-28, 1994).

GCOS-26 (WMO/TD-No. 766), 1996: Report of the Joint CCl/CBS Expert Meeting on the GCOS Surface Network (Norwich, UK, March 25-27, 1996).

GCOS-34 (WMO/TD-No. 799**), 1997:** Initial Selection of a GCOS Surface Network (February 1997).

GCOS-35 (WMO/TD-No. 839): Report of the Second Joint CCl/CBS Expert Meeting on the GCOS Surface Network (De Bilt, The Netherlands, 25-27 June, 1997).

GCOS-39 (WMO/TD-No. 847) (UNEP/DEIA/MR.97-8) (GOOS-11) (GTOS-11), 1997: Report of the GCOS/GOOS/GTOS Joint Data and Information Management Panel, third session (Tokyo, Japan, July 15-18, 1997).

GCOS-45 (WMO/TD-No. 922), 1998: Report of the joint meeting of the GCOS/WCRP Atmospheric Observation Panel for climate and the GCOS/GOOS/GTOS

GCOS-53 (WMO/TD-No. 958), 1999: GCOS Surface Network (GSN) Monitoring Centre Implementation Meeting (Offenbach, Germany, 19-20 January, 1999).

World Meteorological Organization**, WMO-No. 870, 1997a:** Commission for Climatology, Twelfth Session, Geneva, 4-14 August 1997. Abridged Final Report with Resolutions and Recommendations.

World Meteorological Organization**, WMO-No 306, 1997b:** Manual on Codes, International Codes, Volume I.1, 1995 edition, Suppl. No. 1 (VI, 1997), Rec. 7 (CBS-XI), WMO, Genf, 1997.

Annex A

Examples for monitoring data created with ‘FORMCHECK’

Information from 10147 for the April 2001 CLIMAT as received at DWD (gfort30_200104.dat):

```
00149 10147 2001050107471110909001000001010000808000000000000000 0222222222200000000002222222222222222222000000000000000000000  000000000000000000CSDL_DWHF_010000_COR
03375 10147 2001050507001110909001000001006000808000000000000000 0222222222200000000000222020222222222222000000000000000000000  000000000000000000CSDL01_EDZW_050000_RRA
03454 10147 2001050507001110909001000001006000808000000000000000 0222222222200000000000222020222222222222000000000000000000000  000000000000000000CSDL98_EDZW_050000
```

Station 10147 has been received three times at DWD. The information included in the same file created at JMA are:

```
02419 10147 2001050506581110909001000001006000808000000000000000 0222222222200000000000222020222222222222000000000000000000000  000000000000000000CSDL01_EDZW_040600_RRA
02447 10147 2001050507011110909001000001006000808000000000000000 0222222222200000000000222020222222222222000000000000000000000  000000000000000000CSDL01_EDZW_050000_RRA
```

At JMA this station has been received only two times. But JMA received a bulletin CSDL01 EDZW 040600 which has not been received at DWD.

According to the selection criteria the message in line 3375 is selected and listed in a file named g/jLASTCLIMAT_200104.dat created at DWD/JMA:

```
DWD: 10147 20010505 0700 1  1  1  090900 100000 100600 080800 CSDL01_EDZW_050000_RRA
JMA: 10147 20010505 0701 1  1  1  090900 100000 100600 080800 CSDL01_EDZW_050000_RRA
```

In the GSN data set the following information for 10147 is included (mGSN_200104.dat):

```
10147 HAMBURG FUHLSBUETTEL       5338    959 10094 20112 30076003 401180037 5081 60069515 7117073 8000000 9000000
20400 31505 40200       60101       8030000 9000002 0014902 1001714 2020602 3103114 4013225 5122312 60100 722121 2001050507011110909001000001006000808000000000000000
0222222222200000000000222020222222222222000000000000000000000   0000000000000000CSDL01_EDZW_050000    7.6 2    7.6     69 2     69
```

ANNEX B

Reliability of GUAN stations 1999-2001

Number of stations	WMO REGION	Number of reliable stations	Number of less reliable stations	Number of poor stations	Number of silent stations
23	I – Africa	7	6	7	3
26	II – Asia	13	3	3	7
17	III – S. America	2	9	2	4
20	IV – N+Cntrl.America	11	1	7	1
37	V – S.W.Pacific	25	4	0	8
15	VI – Europe	11	3	0	1
12	VII – Antarctica	8	1	0	3
150	Globe	77	27	19	27

A reliable station has reported at least 90% of months, 1999-2001.
A less reliable station has reported between 50% and 89% of months, 1999-2001.
A poor station has reported between 10% and 49% of months, 1999-2001.
A silent station has reported less than 10% of months, 1999-2001.

< 10% reception:

21982 OSTROV VRANGELJA	RUSSIAN FED ASIA	0
33345 KYIV	UKRAINE	0
38880 ASHGABAT	TURKMENISTAN	0
51709 KASHI	CHINA	8
52681 MINQIN	CHINA	0
53068 ERENHOT	CHINA	8
55299 NAGQU	CHINA	0
57461 YICHANG	CHINA	6
61902 WIDE AWAKE FIELD	ASCENSION ISLAND	0
67197 FORT-DAUPHIN	MADAGASCAR	8
68110 WINDHOEK	NAMIBIA	0
78016 BERMUDA NAVAL AIR STATION	BERMUDA	0
81405 CAYENNE/ ROCHAMBEAU	FRENCH GUIANA	3
84008 SAN CRISTOBAL (GALAPAGOS)	ECUADOR	0
84628 LIMA-CALLAO/AEROP. INTL CHAVEZ	PERU	8
85469 ISLA DE PASCUA	CHILE	0
89009 AMUNDSEN-SCOTT	ANTARCTICA	8
89055 BASE MARAMBIO (MET. ANTARTICO)	ANTARCTICA	0
89664 MCMURDO	ANTARCTICA	0
91217 WSMO AGANA, GUAM MARIANA IS.	GUAM	0
91517 HONIARA	SOLOMON ISLANDS	0
91557 BAUERFIELD (EFATE)	VANUATU	0
91610 TARAWA	KIRIBATI	0
91801 PENRHYN	COOK ISLANDS	0
92035 PORT MORESBY W.O.	PAPUA NEW GUINEA	0
96935 SURABAYA/JUANDA	INDONESIA	3
98223 LAOAG	PHILIPPINES	6

Between 10% and 49% reception:

41114 KHAMIS MUSHAIT	SAUDI ARABIA	17
50527 HAILAR	CHINA	33
56778 KUNMING	CHINA	47
61995 VACOAS (MAURITIUS)	MAURITIUS	22
61996 MARTIN DE VIVIES (ILE AMSTERDAM)	AMSTERDAM ISLAND	33
63450 ADDIS ABABA-BOLE	ETHIOPIA	22
63741 NAIROBI/DAGORETTI	KENYA	11
64910 DOUALA R.S.	CAMEROON	47
65578 ABIDJAN	COTE D'IVOIRE	25
67774 HARARE (BELVEDERE)	ZIMBABWE	14
70026 BARROW/W. POST W. ROGERS	USA (ALASKA)	31
72201 KEY WEST/INT., FL.	USA	31
72261 DEL RIO/INT., TX.	USA	31
76654 MANZANILLO, COL.	MEXICO	22

78397 KINGSTON/NORMAN MANLEY	JAMAICA	31
78583 BELIZE/PHILLIP GOLDSTON INTL.	BELIZE	39
78954 GRANTLEY ADAMS	BARBADOS	31
85543 QUINTERO	CHILE	17
87860 COMODORO RIVADAVIA AERO	ARGENTINA	47

Between 50% and 89% reception:

02836 SODANKYLA	FINLAND	89
04270 NARSARSUAQ	GREENLAND	86
08508 LAJES/SANTA RITA (ACORES)	PORTUGAL	86
24266 VERHOJANSK	RUSSIAN FED ASIA	83
35121 ORENBURG	RUSSIAN FED ASIA	58
47991 MINAMITORISHIMA	JAPAN	78
60680 TAMANRASSET	ALGERIA	61
61052 NIAMEY-AERO	NIGER	78
61641 DAKAR/YOFF	SENEGAL	89
61901 ST. HELENA IS.	ST. HELENA	69
61976 SERGE-FROLOW (ILE TROMELIN)	TROMELIN ISLAND	64
63985 SEYCHELLES INTER. AIRPORT	SEYCHELLES	81
78762 JUAN SANTAMARIA	COSTA RICA	61
80222 BOGOTA/ELDORADO	COLOMBIA	78
82397 FORTALEZA	BRAZIL	89
83378 BRASILIA (AEROPORTO)	BRAZIL	72
83780 SAO PAULO (AEROPORTO)	BRAZIL	58
85442 ANTOFAGASTA	CHILE	67
85799 PUERTO MONTT	CHILE	75
85934 PUNTA ARENAS	CHILE	81
87155 RESISTENCIA AERO.	ARGENTINA	53
88889 MOUNT PLEASANT AIRPORT	FALKLAND ISLANDS	89
89642 DUMONT D'URVILLE	ANTARCTICA	81
91643 FUNAFUTI	TUVALU	64
91765 PAGO PAGO/INT.AIRP.	SAMOA	81
91925 ATUONA	FRENCH POLYNESIA	86
96315 BRUNEI AIRPORT	BRUNEI	86

GOOD STATIONS > 90% reception:

01001 JAN MAYEN	NORWAY	100
03005 LERWICK	UK	97
03808 CAMBORNE	UK	100
03953 VALENTIA OBSERVATORY	IRELAND	100
04018 KEFLAVIKURFLUGVOLLUR	ICELAND	97
08495 GIBRALTAR	GIBRALTAR	100
10739 STUTTGART/SCHNARRENBERG	GERMANY	100
16245 PRATICA DI MARE	ITALY	100
17130 ANKARA/CENTRAL	TURKEY	97
20674 OSTROV DIKSON	RUSSIAN FED ASIA	100
22550 ARHANGEL'SK	RUSSIAN FED EUROPE	100
23472 TURUHANSK	RUSSIAN FED ASIA	92
28698 OMSK	RUSSIAN FED ASIA	100
30230 KIRENSK	RUSSIAN FED ASIA	94
32540 PETROPAVLOVSK-KAMCHATSKIJ	RUSSIAN FED ASIA	97
34731 ROSTOV-NA-DONU	RUSSIAN FED EUROPE	100
41217 ABU DHABI INTER. AIRPORT	UNITED ARAB EMIRATES	100
45004 KING'S PARK	HONG KONG	100
47412 SAPPORO	JAPAN	100
47646 TATENO	JAPAN	100
47827 KAGOSHIMA	JAPAN	97
47936 NAHA	JAPAN	100
47971 CHICHIJIMA	JAPAN	97
48455 BANGKOK	THAILAND	100
48698 SINGAPORE/CHANGI AIRPORT	SINGAPORE	100
60020 SANTA CRUZ DE TENERIFE, CMZ	SPAIN (CANARY ISLES)	94
61998 PORT-AUX-FRANCAIS	KERGUELEN ISLAND	92
62414 ASSWAN	EGYPT	92
68588 DURBAN INTNL. AIRPORT	SOUTH AFRICA	100
68816 CAPE TOWN INTNL. AIRPORT	SOUTH AFRICA	100
68906 GOUGH ISLAND	SOUTH AFRICA	92
68994 MARION ISLAND	SOUTH AFRICA	94
70308 ST. PAUL	USA (ALASKA)	100
70398 ANNETTE ISLAND	USA (ALASKA)	100
71082 ALERT UA, N.W.T.	CANADA	94
71816 GOOSE UA, NFLD.	CANADA	94
71836 MOOSONEE, ONT	CANADA	92
71934 FORT SMITH UA, N.W.T.	CANADA	94

72293 SAN DIEGO/MIRAMAR, NAS, CA.	USA	100
72403 STERLING, VA.	USA	92
72597 MEDFORD/MEDFORD	USA	100
72764 BISMARCK/MUN., ND.	USA	100
78526 SAN JUAN/INT., PUERTO RICO	PUERTO RICO	97
82193 BELEM (AEROPORTO)	BRAZIL	92
82332 MANAUS (AEROPORTO)	BRAZIL	92
89002 NEUMAYER	ANTARCTICA	97
89022 HALLEY	ANTARCTICA	92
89512 NOVOLAZAREVSKAJA	ANTARCTICA	100
89532 SYOWA	ANTARCTICA	100
89564 MAWSON	ANTARCTICA	100
89571 DAVIS	ANTARCTICA	100
89592 MIRNYJ	ANTARCTICA	100
89611 CASEY	ANTARCTICA	97
91285 HILO/GEN. LYMAN, HAWAII, HAWAII	HAWAII	100
91334 TRUK, CAROLINE IS.	TRUK ISLAND	100
91376 MAJURO/MARSHALL IS. INTNL.	MAJURO	94
91408 KOROR, PALAU IS.	PALAU ISLAND	97
91592 NOUMEA (NLLE-CALEDONIE)	NEW CALEDONIA	97
91938 TAHITI- FAAA	FRENCH POLYNESIA	100
91958 RAPA	FRENCH POLYNESIA	100
93417 PARAPARAUMU AERODROME	NEW ZEALAND	94
93844 INVERCARGILL AERODROME	NEW ZEALAND	94
93986 CHATHAM ISLAND	NEW ZEALAND	94
93997 RAOUL ISLAND, KERMADEC IS.	NEW ZEALAND	94
94120 DARWIN AIRPORT	AUSTRALIA	100
94203 BROOME AIRPORT	AUSTRALIA	100
94294 TOWNSVILLE AMO	AUSTRALIA	100
94302 LEARMONTH AIRPORT	AUSTRALIA	100
94461 GILES	AUSTRALIA	100
94510 CHARLEVILLE AMO	AUSTRALIA	100
94610 PERTH AIRPORT	AUSTRALIA	100
94659 WOOMERA AERODROME MO	AUSTRALIA	100
94975 HOBART AIRPORT	AUSTRALIA	100
94995 LORD HOWE ISLAND AERO	AUSTRALIA (ISLANDS)	100
94996 NORFOLK ISLAND AERO	AUSTRALIA (ISLANDS)	100
94998 MACQUARIE ISLAND	AUSTRALIA (ISLANDS)	100
96996 COCOS ISLAND AERO	COCOS ISLAND	97