MONITORING OF RADIOSONDE DATA

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1. INTRODUCTION

ECMWF undertakes regular monitoring of the availability and quality of data from the Global Observing System (GOS) and has in particular devoted much effort to the development of tools and procedures for the monitoring of radiosonde data in non real-time. The aim of this activity is to complete the real-time quality control achieved by data pre-processing and assimilation, i.e. to detect the stations which do have a quality problem but are still used occasionally in the analysis. It has now been widely recognized that the average quality of a 6-hour forecast (first-guess field) is in most cases of the same order as the average quality of observational data coming in on the GTS; therefore, deficiencies in data quality can be revealed by systematic discrepancies from the first-guess (Hollingsworth et al, 1986). This paper describes some of the different tools that ECMWF has at its disposal for the detection of such deficiencies.

This paper also presents some current aspects of two activities recommended by CBS-IX in this area, namely that ECMWF should act as a lead centre for radiosonde monitoring and that it should undertake a Pilot study to assess the value of exchange of information between users and producers of radiosonde data.

2. THE TOOLS FOR OPERATIONAL MONITORING

The basic information for data monitoring is provided by the statistics files produced for each analysis cycle (four times per day). These files contain all the data given as input to the operational analysis, together with the quality

control flags and the flags set during the optimum interpolation. They also contain the values of the departures of the observation from the first-guess fields, the unitialised analysis and the initialised analysis; these departures are computed for each observed data, by interpolating the fields from the model levels to the observed levels.

Then monthly statistics files are produced at the beginning of each month from the daily files produced during the previous month. The content of the monthly files is indicated in table 1; they are scanned to detect the stations with any significant change either in availability or quality. Apart from their use for the daily monitoring of the analysis, the daily files are used when a detailed investigation of a problem is required, or when some particular event occurs during the month.

Based on those two types of files, several application softwares have been developed to produce results in graphical or tabular form. Some examples are given hereafter, for both availability and quality monitoring; most of them have been developed recently, but additional information can be found in papers by Böttger et al (1987a and b) and Radford (1987).

2.1. Availability

The selected example (table 2) is a list of land-based radiosonde stations showing a change in reporting frequency of 500 hPa geopotential of at least 10 observations compared with the average over the previous three months; such a list is produced every month and included in the ECMWF global data monitoring report.

2.2. Quality

The basic graphical information for one particular station (figures 1 and 2) gives the mean monthly differences between observations and field, either for all standard levels for one month (fig 1) or for 3 standard levels for 13 months (fig 2). The example shown is Bermuda, where steps to correct the observed problem were taken by the station operators in April 1988.

Table 3 is a list of so-called suspect stations for geopotential height, established according to criteria agreed by CBS-ext 1985: at least 10 observations received in the month, and RMS departure from first-guess of the

worst level larger than a certain threshold (100 m in this case). Similar lists are produced for wind, and they are studied every month, together with all the other material, to try to find out whether the problem is due to the model or to the observations.

Finally, figure 3 is an example of the charts produced to compare the monthly performances of all the stations in a given area; these charts are particularly useful as cross-reference which is required for delivering a sound judgement on the performance of individual stations.

3. COORDINATION OF RADIOSONDE MONITORING; PILOT STUDY

3.1. Coordination of radiosonde monitoring

Following the recommendation of CBS-IX, ECMWF, as a lead centre for radiosonde monitoring, will establish every 6 months from June 1989 onwards consolidated lists of suspect stations (for height and for wind measurements), to be distributed to all the interested NWP centres by the WMO secretariat. This list will contain the stations for which there is convincing evidence that their observations are wrong and corrective action is required. Ideally, such evidence will be obtained from a cross-comparison of the monitoring results of various centres, to be sent to the lead centre for this type of data.

3.2. The pilot study on radiosonde monitoring

The potential value of regular exchange of technical information between data producers and data users has often been pointed out. In the case of radiosonde observations, CBS-IX (1988) agreed to a proposal that ECMWF would set up a one-year "Pilot study to establish the value of information exchange between ECMWF and national focal points for radiosonde systems". Since the beginning of the study in October 1988, 45 WMO members have agreed to participate and have designated a national focal point. They provide ECMWF with information on the equipment and ground procedures in use at their stations, and they receive monitoring results every month, mainly in the form of vertical profiles as shown in fig 1. A report on the Pilot study will be presented to CBS-X in 1990.

REFERENCES

Böttger, H., Radford, A., and Söderman, D., (1987a): ECMWF monitoring tools and their application to North American radiosonde data, ECMWF Technical Memorandum No. 133 (available from ECMWF)

Böttger, H., Radford, A., and Söderman, D., (1987b): ECMWF radiosonde monitoring results for OWSE-NA evaluation July 1986 to July 1987, ECMWF Technical Memorandum No. 140 (available from ECMWF)

Hollingsworth, A., Shaw, D.B., Lönnberg, P., Illari, L., Arpe, K., and Simmons, A.J., (1986): Monitoring of observation and analysis quality by a data assimilation system. Mon. Wea. Rev. (114) 861-879

Radford, A.M., (1987): ECMWF radiosonde monitoring results. ECMWF/WMO Workshop on Radiosonde Data Quality and Monitoring

WMO (1985): Commission for Basic Systems, abridged final report of the extraordinary session, Hamburg 1985.

WMO (1988): Commission for Basic Systems, abridged final report of the ninth session, Geneva 1988.

TABLE 1: Monthly Monitoring Statistics Files

Data for each station: identifier, latitude/longitude/altitude,
mean solar angle at 00 and 12 utc

for each standard level, at 00 and 12 utc:

number of TEMP heights reported
used to calculate statistics
number of TEMP winds reported
used to calculate statistics
number of PILOT winds reported
used to calculate statistics

number of heights rejected by analysis
number of winds rejected by analysis

Mean U-component departure
Mean V-vomponent departure
Mean geopotential departure

Standard deviation U-component departure
Standard deviation V-component departure
Standard deviation geopotential departure

RMS vector wind departure

All departure data are given from first-guess
uninitialised analysis
initialised analysis

Stations with decreased reporting frequency				Stations with increased reporting frequency			
Ident	Time	Feb	Mar	Ident	Time	Feb	Mar
17220	(00)	10	0	+ 72435	(00)	0	30
71701	(12)	18	0				
83612	(00)	15	0				
83612	(12)	14	0				
89009	(12)	12	0				
89664	(12)	15	0				
04202	(00)	23	11	13275	(00)	13	29
04202	(12)	25	13	24817	(00)	5	31
07761	(00)	19	9	24817	(12)	6	29
22113	(00)	27	15	26702	(00)	6	31
22113	(12)	28	17	26702	(12)	6	31
25594	(00)	20	1	48900	(00)	2	22
25594	(12)	22	4	71603	(00)	5	30
36870	(00)	28	6	71603	(12)	6	29
36870	(12)	28	6	+ 72435	(12)	1	31
38836	(00)	28	8	76151	(00)	3	30
38836	(12)	27	7	76151	(12)	4	31
38954	(12)	28	18	89571	(12)	10	27
42779	(00)	25	4	91701	(00)	3	20
42779	(12)	23	3				
61415	(12)	22	7				
63741	(00)	27	2				
68240	(12)	21	2				
* 72353	(00)	27	15				
* 72353	(12)	28	14				
85201	(12)	22	3				
89009	(00)	22	7				

* - Notified in monthly WWW/MMS letter October 1988.
\+ - Notified in monthly WWW/MMS letter November 1988.

Table 2: stations showing a significant change in reporting frequency in March 1989

LIST OF SUSPECT STATIONS : TEMPS/PILOTS - WIND

MAR 1989

Table 3

MONITORING CENTRE : ECMWF
STANDARD OF COMPARISON : FIRST-GUESS FIELD
STANDARD LEVEL (1000-100 HPA) WITH HIGHEST RMS IS SHOWN
SELECTION CRITERIA : AT LEAST 10 OBS AND 15 M/S RMS VECTOR WIND

WMO IDENT	OBS TIME	ELEMENT	LEVEL	OBS RECD	% REJ	RMS	UBIAS	VBIAS
08594	12	V	300	28	4	16.6	10.1	-0.4
15120	12	V	100	28	21	15.0	4.8	-6.6
41256	12	V	250	26	0	15.2	1.4	-1.4
41530	00	V	200	15	100	17.2	11.4	0.2
41661	00	V	250	19	100	29.3	-17.9	1.0
41780	12	V	150	17	100	15.4	-9.2	6.2
42027	12	V	250	17	100	22.2	-0.4	1.0
42339	12	V	250	18	100	15.7	-6.8	1.2
42369	00	V	250	16	6	16.8	-7.0	-2.1
42369	12	V	200	11	9	16.6	-11.5	-6.3
42492	00	V	250	11	100	17.5	12.1	-3.1
42492	12	V	250	12	100	15.5	7.2	-6.6
42971	00	V	300	15	13	20.0	-4.9	-4.1
43014	00	V	300	17	100	25.4	13.3	2.8
43014	12	V	150	11	100	21.1	8.4	8.4
43041	00	V	300	15	13	15.8	-1.9	-2.1
43150	00	V	150	10	0	18.4	-3.5	-4.5
43185	00	V	200	16	6	15.4	-2.8	-6.2
44288	00	V	150	30	100	15.2	2.0	-1.6
44288	12	V	100	25	100	15.1	1.1	3.5
47058	12	V	300	15	13	16.1	-6.7	0.9
54497	00	V	250	26	100	16.9	8.0	-0.4
54497	12	V	150	27	100	16.1	11.9	-1.2
60566	12	V	150	11	100	18.8	-13.3	-4.2
60590	12	V	300	15	13	21.0	-8.5	-8.4
60630	00	V	200	20	100	20.8	-11.6	-1.9
60630	12	V	150	17	100	21.8	-8.7	0.2
60680	00	V	400	14	14	17.9	11.3	-2.0
60680	12	V	400	15	20	18.9	9.1	-6.7
68442	00	V	200	27	11	16.3	-5.9	1.5
68994	00	V	250	30	100	21.2	-8.7	-1.4
68994	12	V	200	31	100	17.6	-7.8	0.0
71603	00	V	300	27	7	15.8	4.2	2.6
76679	00	V	150	22	5	15.4	-2.9	-1.2
76692	00	V	200	24	0	17.3	-4.7	12.1
76692	12	V	200	22	0	17.0	-6.6	12.1
76723	12	V	250	11	9	15.3	-4.0	-6.1
78988	00	V	250	27	4	16.0	-0.3	6.6
83971	12	V	200	26	12	17.5	-3.3	5.9
85934	12	V	300	28	11	15.3	2.8	0.5
87344	12	V	150	24	17	18.2	-3.8	0.2
87418	12	V	200	26	100	16.3	-7.7	1.8
87576	12	V	250	28	7	16.5	-3.0	1.8
96035	00	V	100	15	100	16.0	-1.8	-1.0

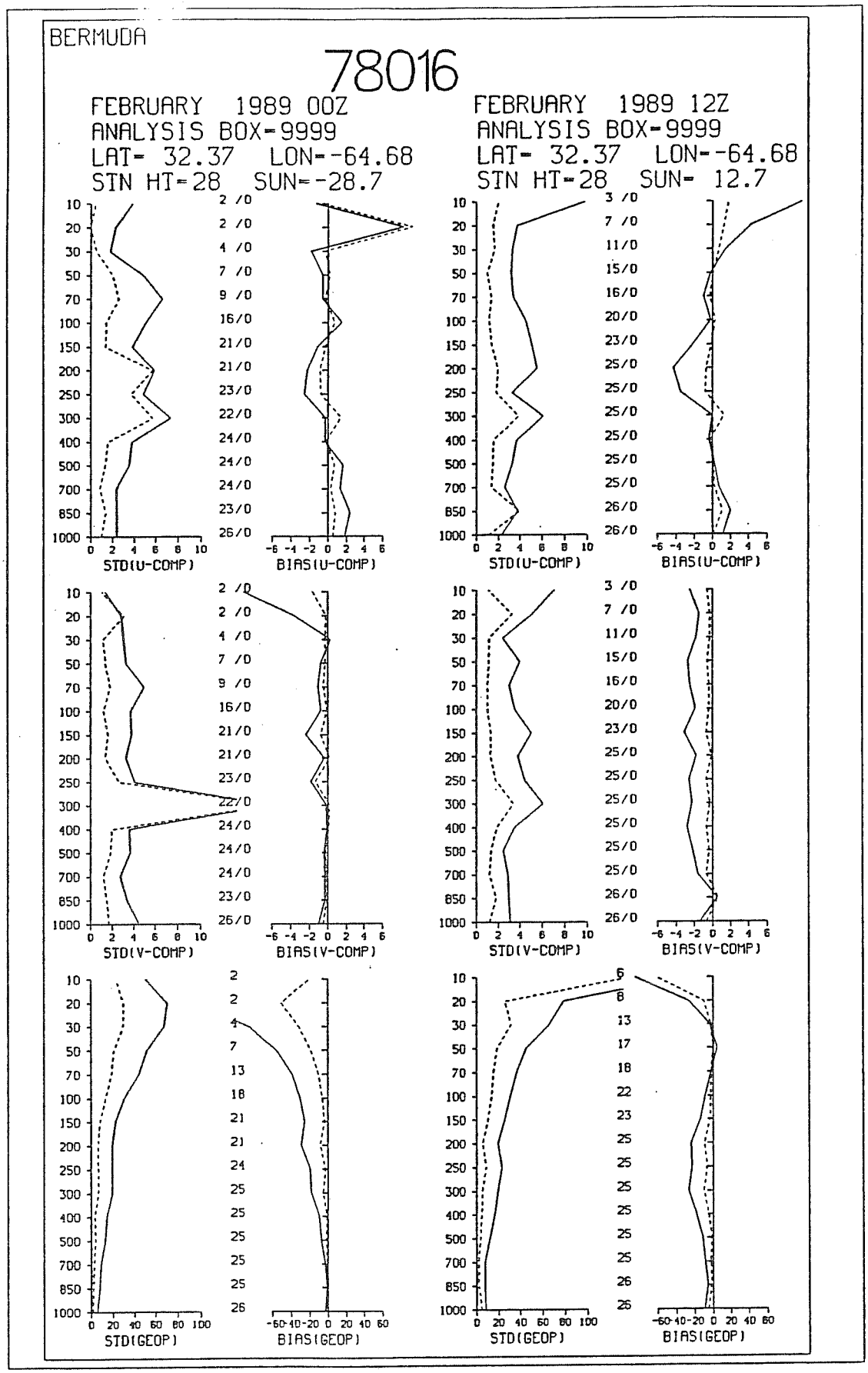

Figure 1: Vertical profiles of observed minus first-guess (solid lines) and observed minus analysis (dashed lines) differences at station 78016 for February 1989

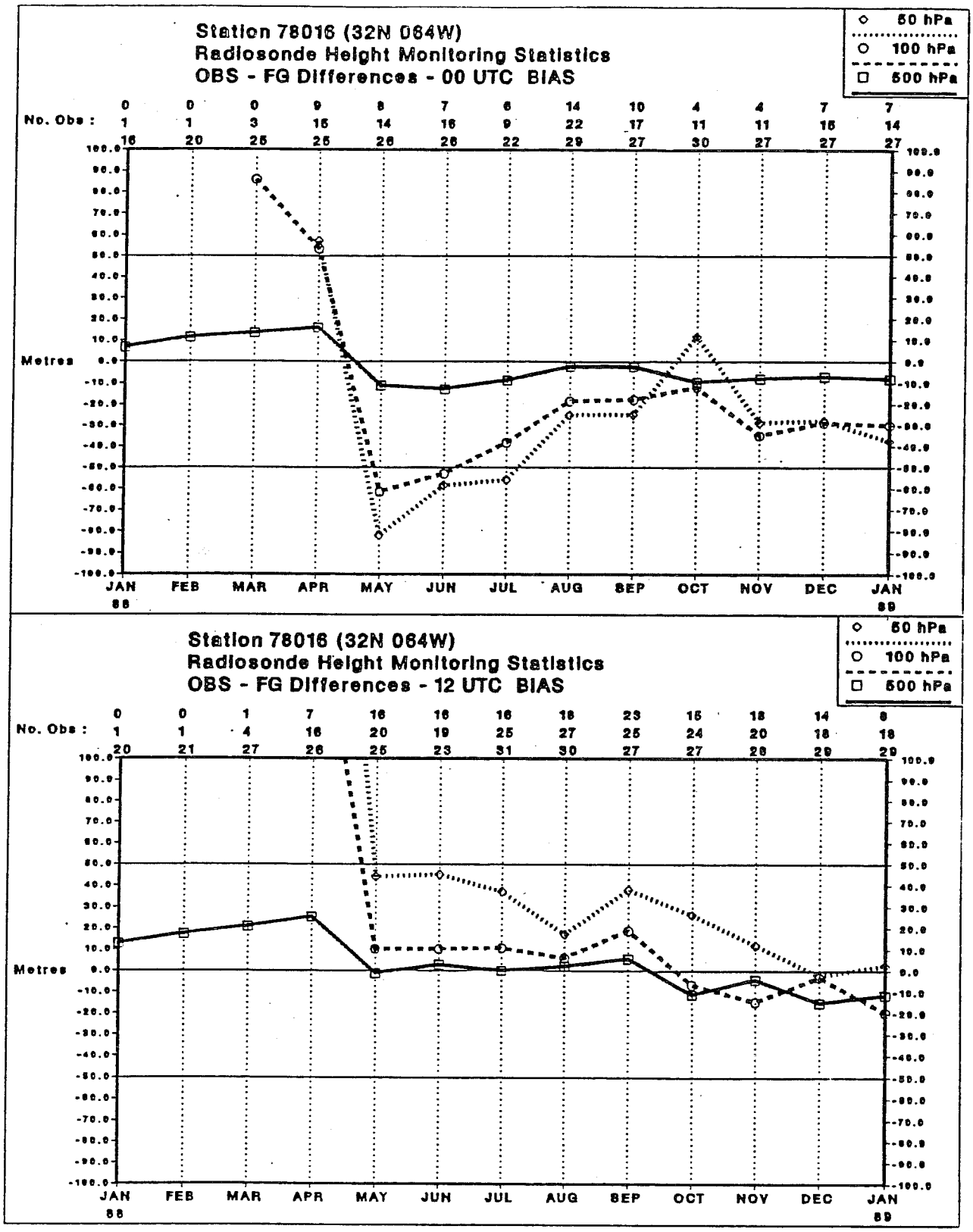

Figure 2: Time graphs of mean monthly differences between observations and first-guess of geopotential height at station 78016, 00 UTC data (above) and 12 UTC (below)

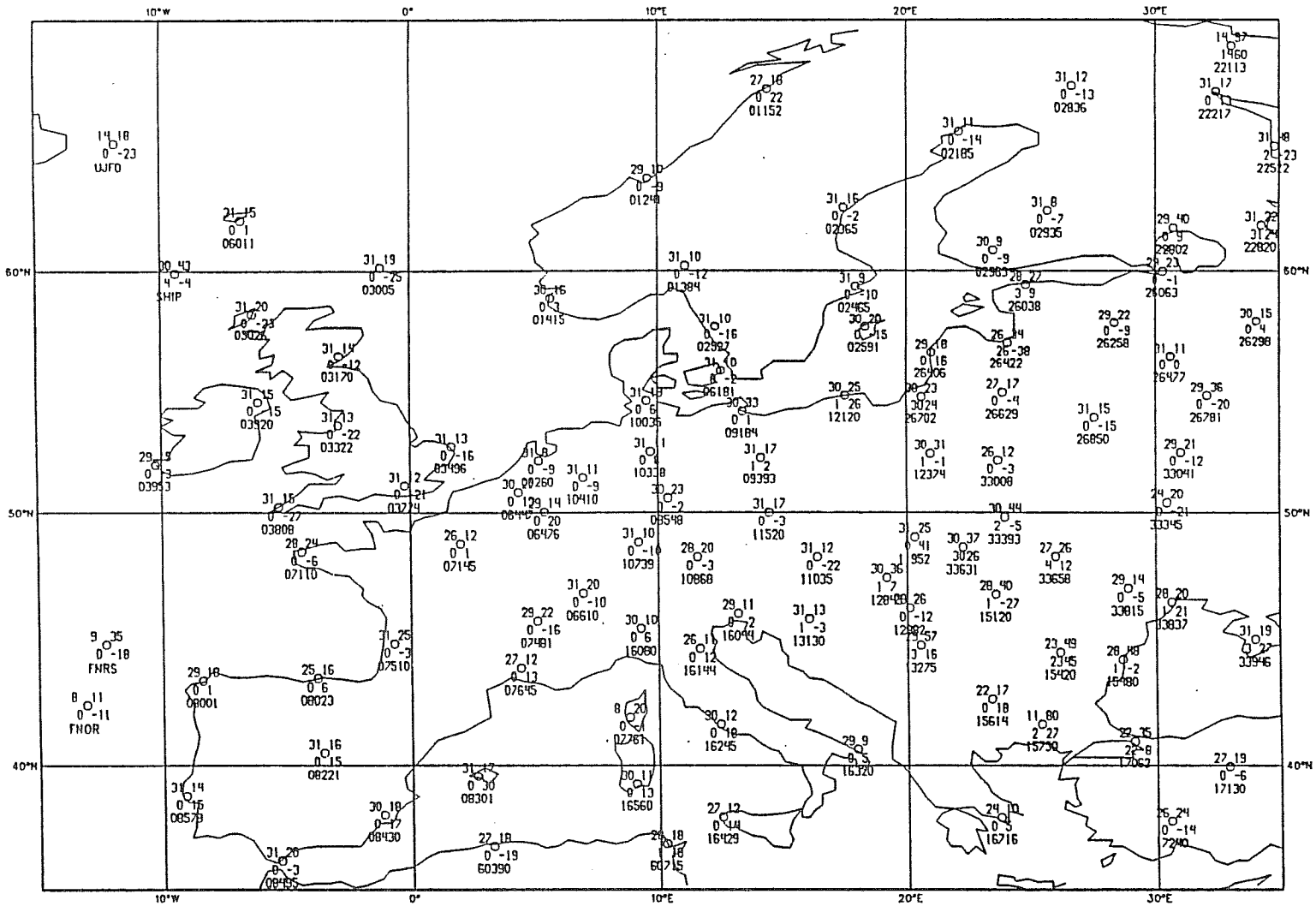

Figure 3: chart of monitoring statistics for March 1989, 00 UTC, 200 hPa geopotential; for each radiosonde station, the 4 values are the number of observations received (top left), number of observations rejected (bottom left), mean departure from first-guess (bottom right) and standard deviation departure from first-guess (top right)