DUPLICATE

MET O.8 MONITORING NOTE NO. 2 (FORECASTING PRODUCTS MONITORING NOTE)

OPD STATISTICS FOR 1988

By

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CONTENTS

1. Introduction

This report presents statistics derived from the OPD for 1988 in a similar fashion to that for 1987 (see Met O.8 Monitoring Note number 1). The statistics are presented for combined TEMP and PILOT reports, satellite cloud track winds, satellite temperatures and aircraft reports. Statistics are presented by latitude band and season in the form of vertical profiles of the observation minus background (o-b) and observation minus analysis (o-a) increments. Please note that the horizontal scales of these plots have changed since last year and that the number of observations and number flagged are given on the right vertical axis of each plot. The geographical variation of OPD statistics is available this year, in the form of statistics for 10 degree by 10 degree latitude, longitude boxes. In all cases all observations, regardless of flagging , are used in the calculation of the statistics.

2. Results

2.1. TEMP and PILOT reports

TEMP and PILOT reports were grouped into 30 degree latitude bands for the months of June and December 1988. The vertical profiles of these statistics are presented in figures 2.1.1 to 2.1.9.

The results for the Antarctic region (60 to 90 S) are given in figures 2.1.1 (June) and 2.1.2 (December). There is a marked seasonal variation in the mean and standard deviation of temperature, wind speed and direction statistics in the boundary layer. In the winter from 750 to 250 hPa the background temperature field is warmer than the observations (mean o-b negative) but this has disappeared by the summer. The most noticeable change from June to December occurred because of the introduction of the AC scheme. In December the standard deviation of o-a increments has approached the values of the standard deviation of o-b increments. A comparison with the statistics for 1987 shows that the standard deviation of o-b temperature increments for the month of December has been reduced by approximately 0.5 k in the troposphere. This may be due to the introduction of the AC scheme.

The statistics for the o-b increments for the latitude band 30 to 60 S show a small seasonal change in the statistics in the boundary layer and little change in the troposphere apart from those for relative humidity. In this latitude band and in the latitude band 60 to 90 S the background humidity is lower than the observed values in the mid and upper troposphere, but this is much more pronounced in winter than in summer (see figs. 2.1.3 and 2.1.4). A small reduction in the standard deviation of o-b temperature differences was found when the December 1988 statistics where compared with those for 1987.

In the latitude band from 30 S to 30 N little seasonal variation in the statistics was apparent (apart from the changes as a result of the introduction of the AC scheme) so the statistics for the latitude band 0 to 30 S are presented as typical for the tropics.

A comparison of the statistics for June and December for the latitude band 30 to 60 N (figs. 2.1.6 and 2.1.7) reveals little seasonal variation, even in the boundary layer. In this latitude band the bias of the background field agaist observations is very small (apart from relative humidity). The large peaks in the standard deviation of temperature around 950 hPa and wind speed at 150 hPa are considered to be due to the presence of erroneous observations.

Figures 2.1.8 and 2.1.9 present the results for the latitude band from 60 to 90 N. In the winter the background field near surface temperatures are too cold, a feature that was noted in the report on the 1987 statistics. In the summer this bias is not present. There are only small differences in the bias and standard deviation of o-b increments above the boundary layer between summer and winter. The introduction of the AC scheme does not appear to have improved the fit of the background field to the observations but the fit of observations to the analysis field is poorer than before.

2.2 Satellite Cloud Track Winds in the CM

2.2.1 Introduction

During 1988 satellite cloud track wind observations (SATOBs) originated from five satellites :

Name	Coverage
METEOSAT	60 W - 60 E , 60 S - 60 N
GMS	70 E - 160 W, 60 S - 60 N
GOES E & W	170 E - 20 W , 50 S - 50 N
INSAT	30 E - 100 E, 20 S - 30 N

The satellite coverage shown in the table was determined from observations present in the OPD for July and December 1988 in 10 degree latitude/longitude boxes.

Observations from METEOSAT, GOES and GMS were produced at times valid for three or four different hours of the day whereas those for INSAT were valid at only one hour (06 GMT). It is known that on some occasions INSAT observations were received after the data cut-off time for the 06 GMT CM run (1130 GMT) and these would then be missing from the OPD.

All SATOB data except those from INSAT and those from METEOSAT north of 30 degrees north above 500 hPa were used in the model.

The statistics presented are for all observations regardless of flagging. The background field is a six-hour CM forecast.

2.2.2 Results

Figure 2.2.1 shows the mean vector wind for July based on SATOBs below 700 hPa, with observations grouped by 10 degree boxes. An arrow is plotted only where the number of observations in that category is greater than 50 ;

the centre of the arrow shafts corresponds to the position of the winds plotted. Figure 2.2.2 shows the mean vector difference between observations and the CM background field for the same variable. (Note the change of scale of the shaft length).

Both the July and December charts indicate relatively large differences over Indonesia and the equatorial Pacific, where there is a marked zone of convergence implied by the SATOB increments (discussed further below). The four arrows plotted in grid boxes close to India in both months are derived from INSAT observations alone. For the two higher bands of wind categories mentioned later, there are insufficient numbers of observations from INSAT to permit the plotting of any grid box values.

Figures 2.2.5 to 2.2.8 display mean vector winds and differences for July and December for the 700-400 hPa band. There are fewer observations for this band, a result of the types of clouds used to derive winds and the schemes used to assign cloud heights to levels. The largest vector differences (figures 2.2.6 and 2.2.8) occur where the observations under-estimate speeds in jets e.g over the south Atlantic in July and the north-west Pacific in December.

Mean winds and differences for observations above 400 hPa are shown for July and December in figures 2.2.9 to 2.2.12. Again the systematic under-estimation of wind speeds in jets is evident from the difference charts. The largest differences occur in the north-west Pacific in December (fig 2.2.12) where the winds have been derived from GMS ; however assumptions cannot be made from these results alone about the relative quality of data from different satellites because the characteristics of the model background field vary across the globe.

The figures for the high level winds also suggest a degree of divergence for the SATOB increments at the equator. This corresponds to the zone of convergence observed at lower levels. Thus the SATOB increments have led to a model enhancement of the Hadley circulation at the equator. It is possible that this feature is caused by persistent and systematic observation or model errors but an alternative and perhaps more likely explanation is that the SATOBs ,being derived from motions of cloud, tend to be produced in the Tropics in areas of convection associated with lines of low-level convergence.

2.3 Satellite temperature observations

2.3.1 Introduction

Compressed code SATEMs (CCS) at 250 km resolution are present in the OPD from four satellites for the following periods in 1988 :

NOAA-10 - complete year

DMSP-2 - from May

DMSP-3 - from August

NOAA-11 - from December

Although the NOAA series also produce SATEMs at 500 km resolution they provide essentially the same information as the CCS and are therefore not included in the statistics which follow. The DMSP series are U.S. military satellites that produce observations at 175 km resolution. Comparison of observations against model background fields carried out at the Met. Office has indicated that the statistical characteristics of the DMSP-2 and DMSP-3 data are similar and likewise the NOAA-10 and NOAA-11 data.

Locally retrieved satellite temperatures (LASS) are also present in the OPD, from May 1988 and for the FM only. They are derived from NOAA-10 and use a short period FM forecast as a 'first-guess'. The data as presented to the model and available in the OPD are averaged to a resolution of 240 km.

Results for June and December 1988 are presented in the following sections. To assist intepretation we note :

1) DMSP are not used in the model

2) NOAA data are not used over model land and the lowest level temperature, 922 hPa (derived from the 1000-850 hPa thickness), is excluded from the model north of 30 degrees. Also excluded are NOAA temperatures above 100 hPa south of 60 degrees.

3) LASS data are not used over model land.

4) The retrieval technique for the NOAA data changed in September from a 'statistical' to a 'physical' scheme which results in less dependence on collocated sonde observations.

5) The Met. Office's assimilation scheme changed from an Optimum Interpolation (OI) based scheme to the 'Analysis Correction' scheme at the end of November. The latter assimilates observations at their proper validity time rather than assuming they are valid at the model analysis hour.

6) The statistics are based on all observations regardless of flagging.

2.3.2 <u>NOAA-10 CCS observations in the CM model</u>

Figures 2.3.1 to 2.3.6 show vertical profiles of means and standard deviations of observation minus CM background field differences for June in 30 degree latitude bands. Figures 2.3.7 to 2.3.12 display the same products for December. Data over all model surface types have been included.

Some features of the charts are :

1) A large seasonal difference for the 60-90 S results but less so for the other bands, particularly, as one would expect, for 0-30 S and 0-30 N.

2) Significant biases generally at the lowest level, 922 hPa, of either sign.

3) Large, usually negative biases above 150 hPa, i.e. observations colder than background fields.

4) Relatively large standard deviations at 922 hPa and at the tropopause compared to other levels.

5) For the two southern hemisphere bands, a much closer fit for the analysis to the observations than the background field to the observations in June compared to December. This is a consequence of the introduction of the analysis correction scheme in November which is known to fit observations less closely than the OI scheme.

6) No apparent significant differences in the statistical characteristics of the SATEM minus background increments from those presented for 1987 in OPD Monitoring Note number 1. However direct comparison of results for 1988 presented here with results for 1987 is not in fact possible because a mixture of latitude bands have been used and for 1987 results were grouped by model surface type.

2.3.3 Satellite temperatures in the FM model

Figures 2.3.13 to 2.3.15 present statistics in a similar format to those of the previous section for LASS, for CCS from NOAA-10 and for CCS from DMSP-2 for December. For all three types only observations over model sea or sea ice are included in the analysis. The background field is a three-hour FM forecast.

Figure 2.3.13 shows that the biases and standard deviations for the LASS data are small compared to those for the other types. This is to be expected given that the LASS data are derived using a short period FM forecast as first-guess. However even for LASS the values are large above 70 hPa. As found for observations in the CM model, relatively large standard deviations are evident at the tropopause and, in the case of the CCS data, significant biases at the 922 hPa level. There are larger biases for the DMSP-2 data below 400 hPa compared to NOAA-10 although for the statndard deviations the DMSP-2 values are somewhat less overall and substantially less at the bottom level.

Figures 2.3.16 and 2.3.17 show for December 1988 the geographical variation across the FM area of the mean differences between observations and FM background field for LASS and CCS respectively. The levels are 850 hPa for LASS and 922 hPa for CCS, in both cases the lowest levels for which data are stored in the OPD. The contours are based on 10 x 10 degree grid box values, derived from observations over the sea for LASS but land and sea for CCS. Although the CCS are derived from NOAA-10 and NOAA-11 and LASS only from NOAA-10, the characteristics of the NOAA-10 and NOAA-11 CCS are not significantly different.

Figure 2.3.16 for LASS shows the increments at 850 hPa to vary from -1.0 deg C in the south-west of the region to over +1.0 in the far north-west - a pattern that is repeated in other months at that level. For CCS, figure 2.3.17, the increments range from +4.5 in the south-west to -2.5 in the north-east, again a pattern which occurs in other months. These significantly large gradients reflect to some degree persistent model biases but also, it is believed, differences in the characteristics of the observations across the region.

2.4 AIREP observations

Wind and temperature observations from aircraft (AIREPS) were grouped into 100 hPa pressure bands and 10 degree latitude bands. Only three pressure bands were used, viz., 399 to 300 hPa, 299 to 200 hPa and 199 to 100 hPa. The majority of the observations are concentrated in the pressure band from 299 to 200 hPa and consequently o-b statistics are presented for this band in table 2.4.1 and table 2.4.2.

Table 2.4.1. AIREP temperature and wind statistics by latitude and season: pressure band 299 to 200 hPa, Jun 1988

Latitude band	Temp(k) mean	Temp(k) s.d	Speed(kts) mean	Speed(kts) s.d.	Dir(deg) mean	Dir(deg) s.d.
30-40 S	0.5	4.3	4.4	18.5	-1.8	21.2
10-0 S	0.9	3.0	4.2	12.7	1.1	53.6
50-60 N	-0.3	3.2	3.9	14.2	2.0	24.7

Table 2.4.2 AIREP temperature and wind statistics by latitude and season: pressure band 299 to 200 hPa, Dec 1988

Latitude band	Temp(k) mean	Temp(k) s.d.	Speed(kts) mean	Speed(kts) s.d.	Dir(deg) mean	Dir(deg) s.d.
30-40 S	0.5	3.5	4.5	26.2	-1.2	25.7
0-10 S	1.2	3.1	4.1	11.1	-1.7	39.0
50-60 N	0.2	3.4	3.6	16.3	0.1	18.1

The statistics for the latitude band 30 to 40 S show, as in previous years, a small positive bias of temperature and wind speed observations against the background field in this pressure band . This bias varies very little from winter to summer. A small reduction, around 0.5 K, was noticed in the standard deviation of o-b increments when the December 1988 statistics were compared with the 1987 statistics. A similar reduction was noted for TEMP observations. An examination of all the statistics showed that the standard deviation of analysis increments was very close to that for the background increments in December 1988.

Since there was found to be negligible latitudinal or seasonal variation in the Tropics, only the statistics for the latitude band from 0 to 10 S are given in the table. These statistics show again the bias of temperature and wind speed observations against the background field but a reduction in the standard deviation of temperature and wind speed increments, when compared to more southerly latitudes.

In the latitude band 50 to 60 N the bias of AIREP temperature observations against the background field is very small, but the wind speed bias remains. There is a small seasonal variation in the standard deviation of background increments, as one might expect. A study of the 1987 statistics revealed that the introduction of the AC scheme did not appear to have had any impact on the fit of the observations to the background field at these latitudes.

3. Conclusions

These results suggest that there has been little change in the observation minus background statistics from 1987 to 1988. The most noticeable changes have been as a result of the introduction of the new analysis scheme which has led to an increase in the standard deviation of observation minus analysis increments for all data types at all latitudes. There has been a small improvement in the fit of the background temperature field to AIREP and TEMP observations in the southern hemisphere. This may be due to the introduction of the AC scheme. In the tropics and northern hemisphere there has been no noticeable change in the fit of the background field to the observations.

MET. O8. MONITORING NOTE NO. 2.   FIGURES:

FIG 2.1.1.   TEMP + PILOTS.

DATA DERI[illegible] FROM CM OPD FROM 1 JUN 1988 TO 30 JUN 1988 STATISTICS GENERATED ON SIGMA LEVELS. DATA USED: NO EXCLUSIONS
STATISTICS [illegible]ERATED FOR MODEL DATA TYPE(S): 00-08 N. OBS USED IN STATISTICS: 548

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MEAN OF DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS

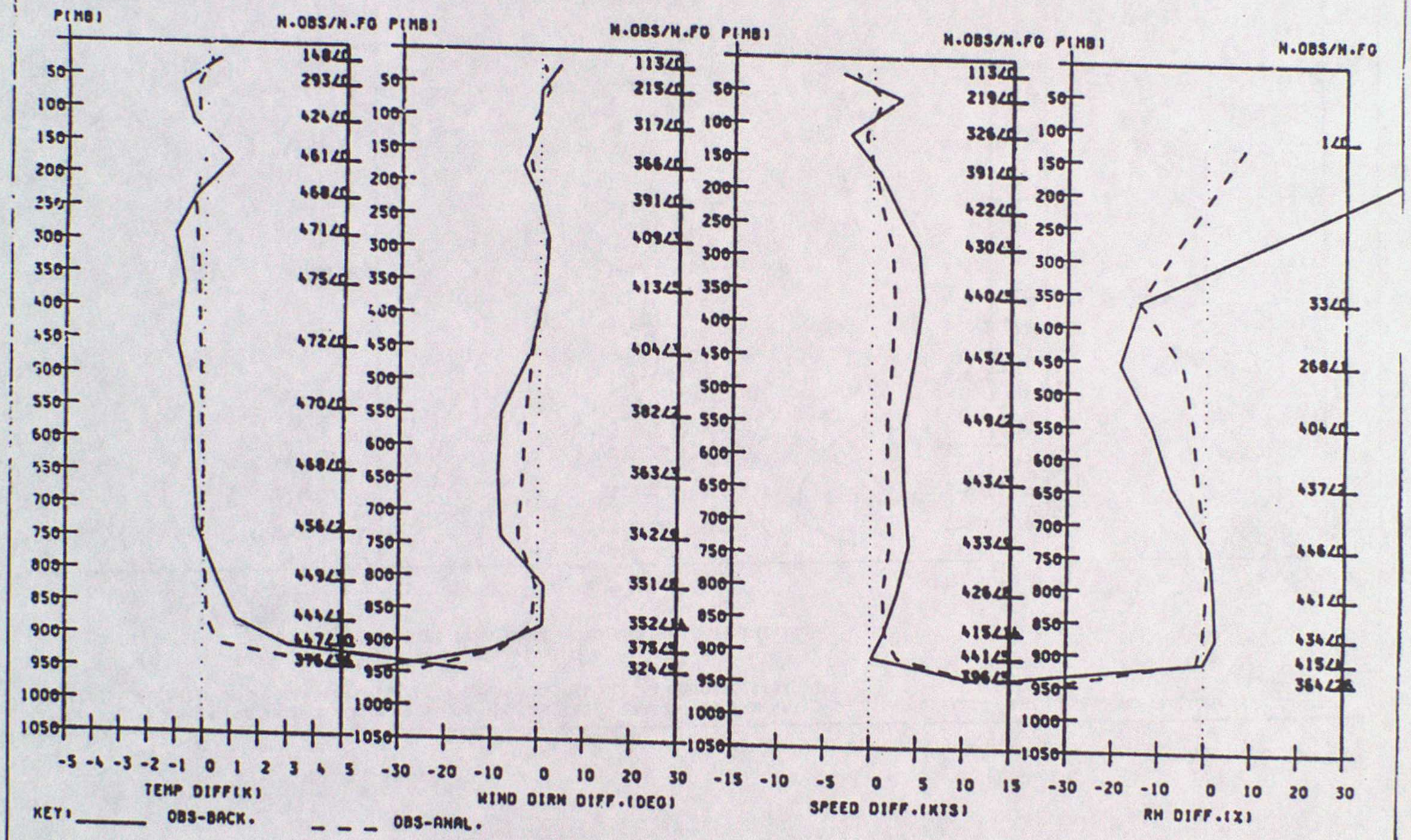

FIG 2.1.1. CONT.

DATA DERIVED FROM CM OPD FROM 1 JUN 1988 TO 30 JUN 1988 STATISTICS GENERATED ON SIGMA LEVELS. DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR MODEL DATA TYPE(S): 00-08 N. OBS USED IN STATISTICS: 548

LAT1: -90.00 LAT2: -60.00 LONG1: -180.00 LONG2: 180.00
SD OF DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS

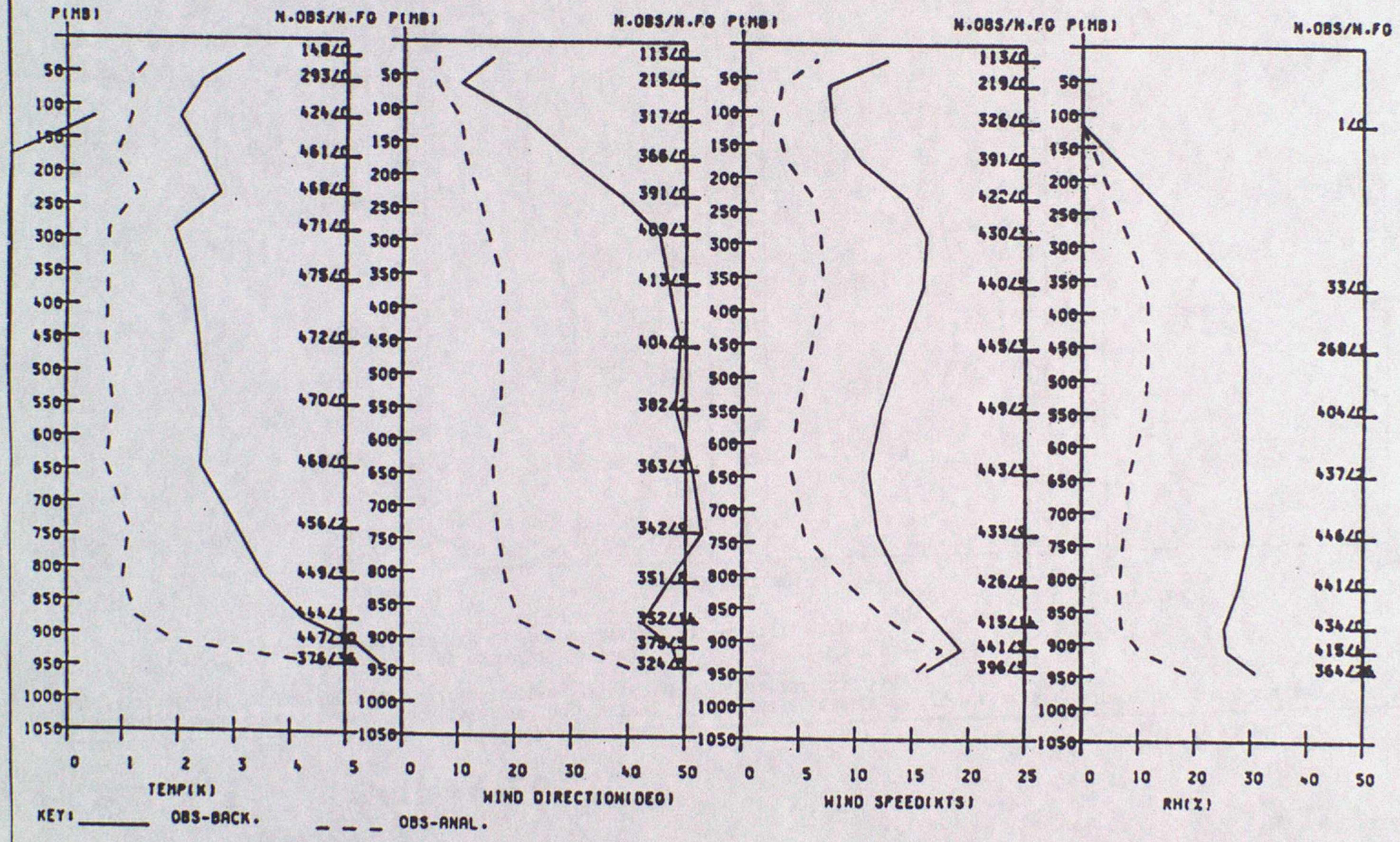

FIG. 2.1.2. TEMPS + PILOTS.

DATA DERIVED FROM CM OPD FROM 1 DEC 1988 TO 31 DEC 1988 STATISTICS GENERATED ON SIGMA LEVELS.
STATISTICS GENERATED FOR MODEL DATA TYPE(S): 00-08 N. OBS USED IN STATISTICS: 659 DATA USED: NO EXCLUSIONS

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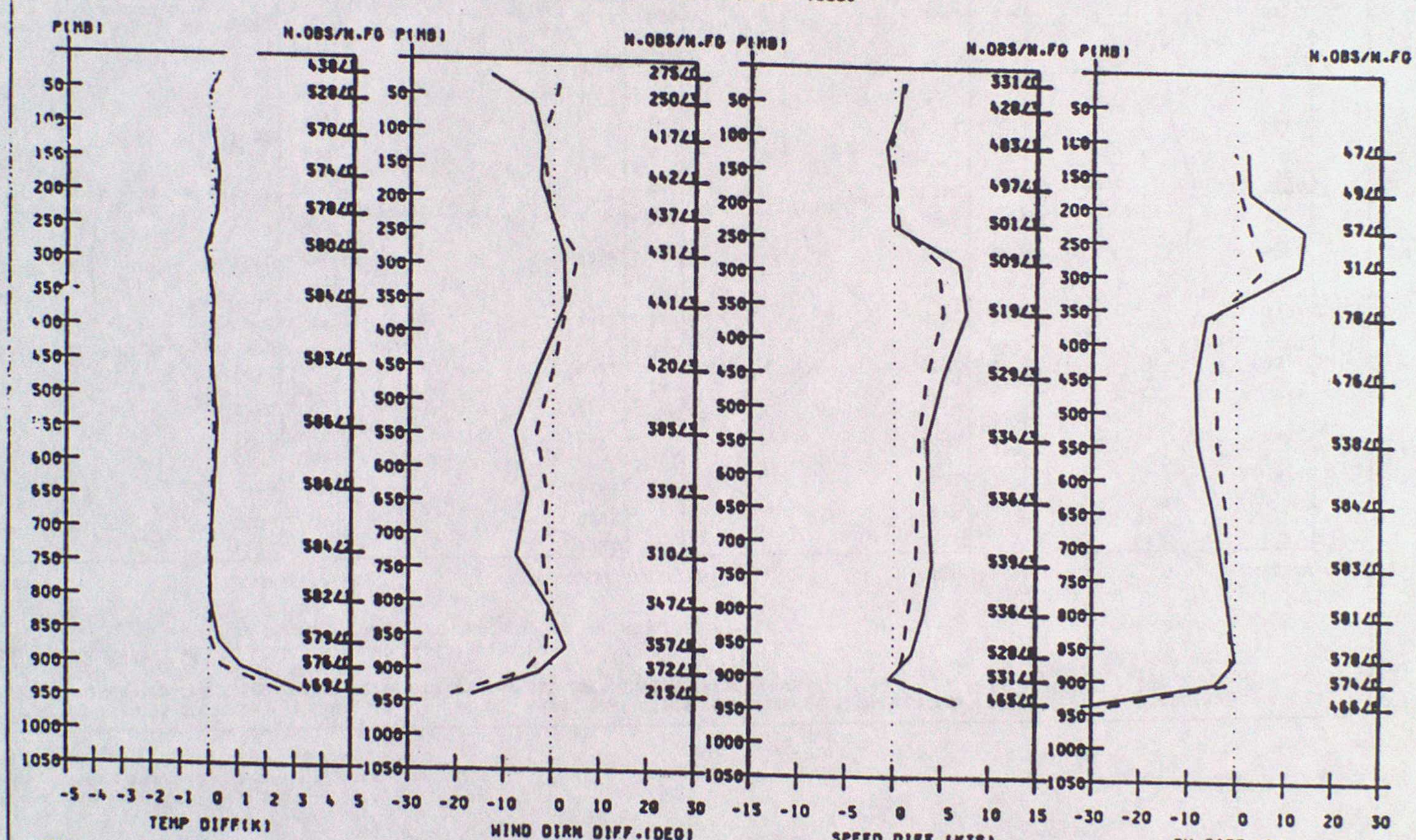
MEAN OF DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS



KEY: ______ OBS-BACK. — — — OBS-ANAL.

FIG. 2.1.2. CONT.

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STATISTICS GENERATED FOR MODEL DATA TYPE(S): 00-08 N. OBS USED IN STATISTICS: 659

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SD OF DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS

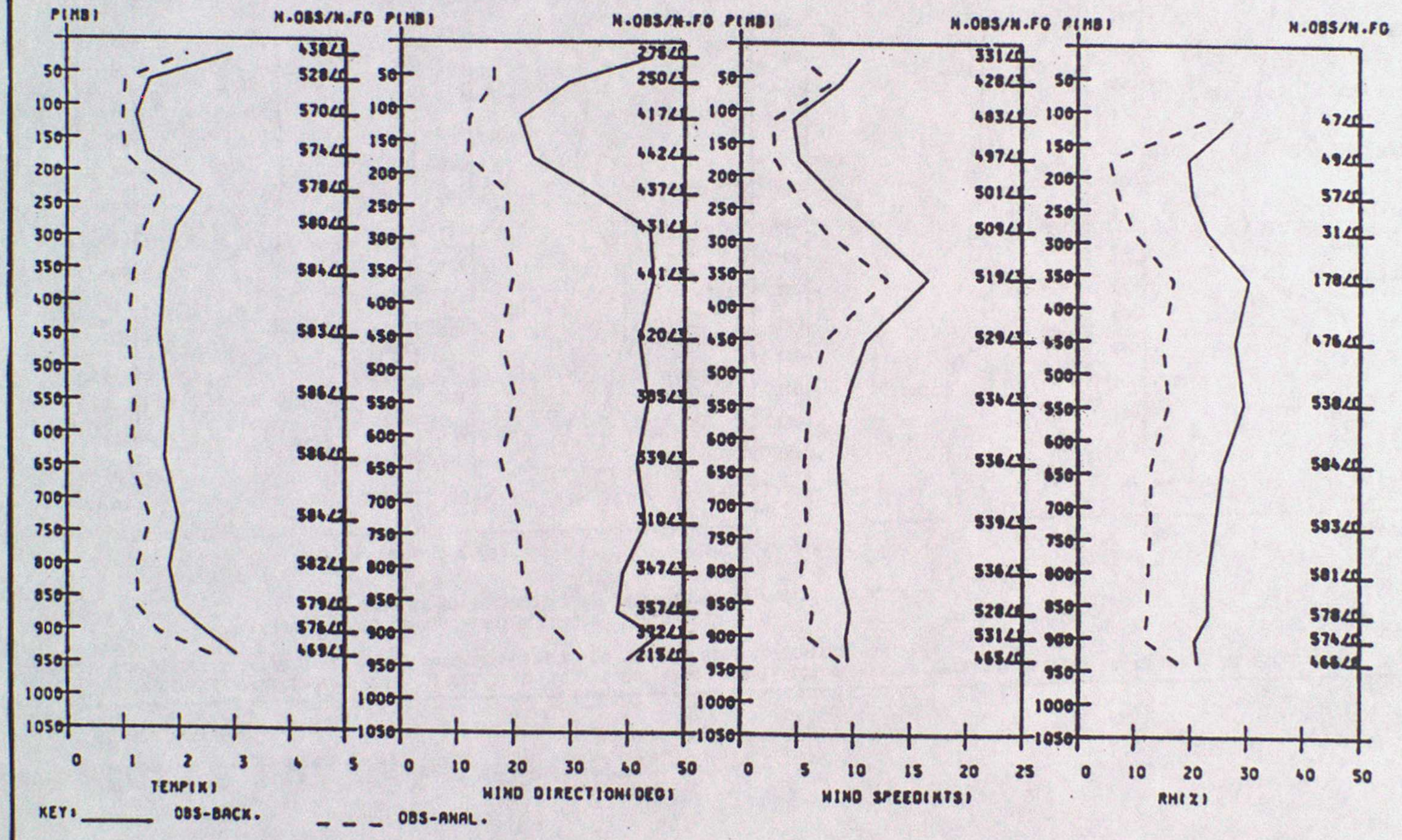

FIG 2.1.3. TEMPS + PILOTS.

DATA DERIVED FROM CM OPD FROM 1 JUN 1988 TO 30 JUN 1988 STATISTICS GENERATED ON SIGMA LEVELS. DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR MODEL DATA TYPE(S): 00-08 N. OBS USED IN STATISTICS: 3951
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MEAN OF DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS

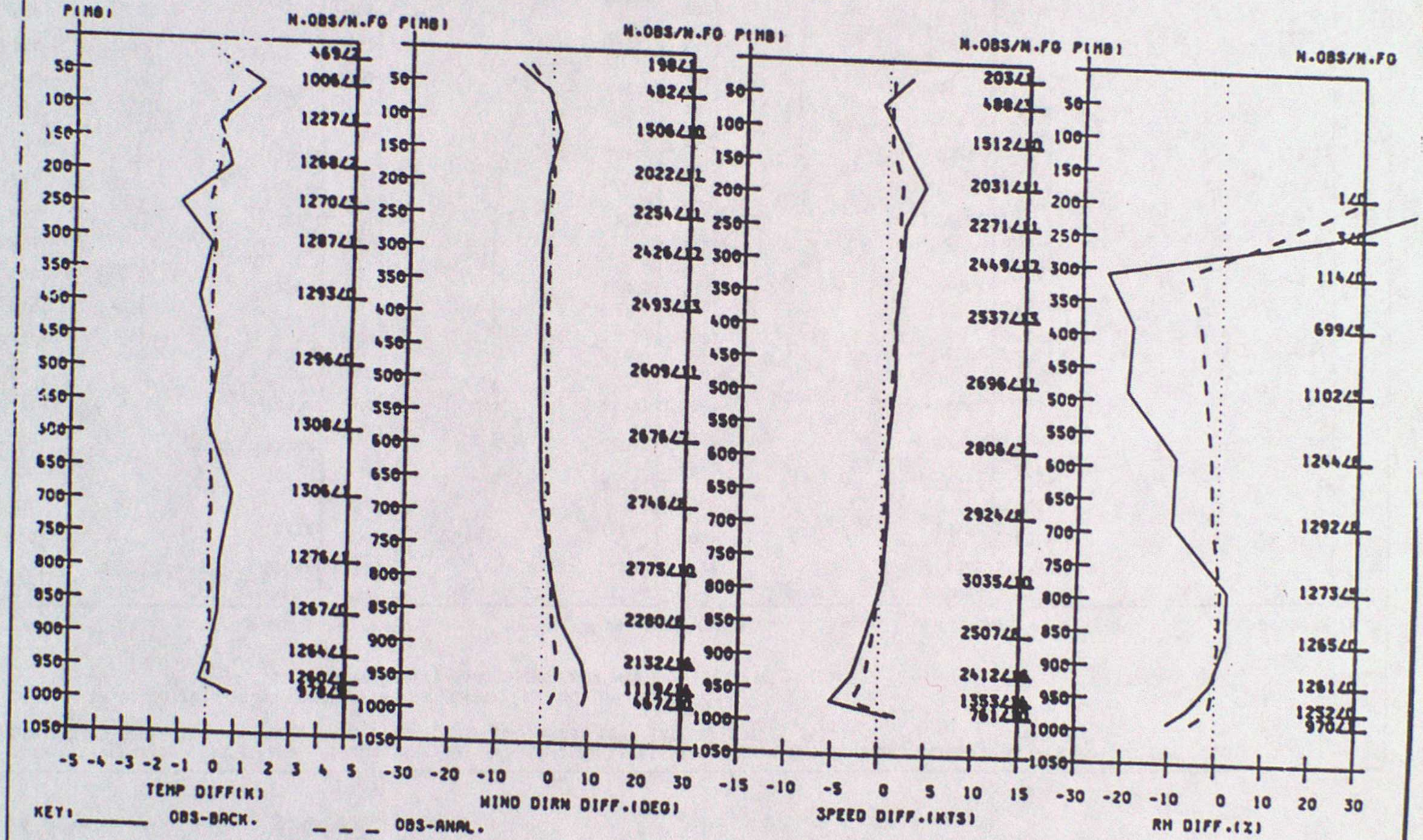

FIG 2.1.3. CONT.

DATA DERIVED FROM CM OPD FROM 1 JUN 1988 TO 30 JUN 1988 STATISTICS GENERATED ON SIGMA LEVELS. DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR MODEL DATA TYPE(S): 00-08 N. OBS USED IN STATISTICS: 3951

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SD OF DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS

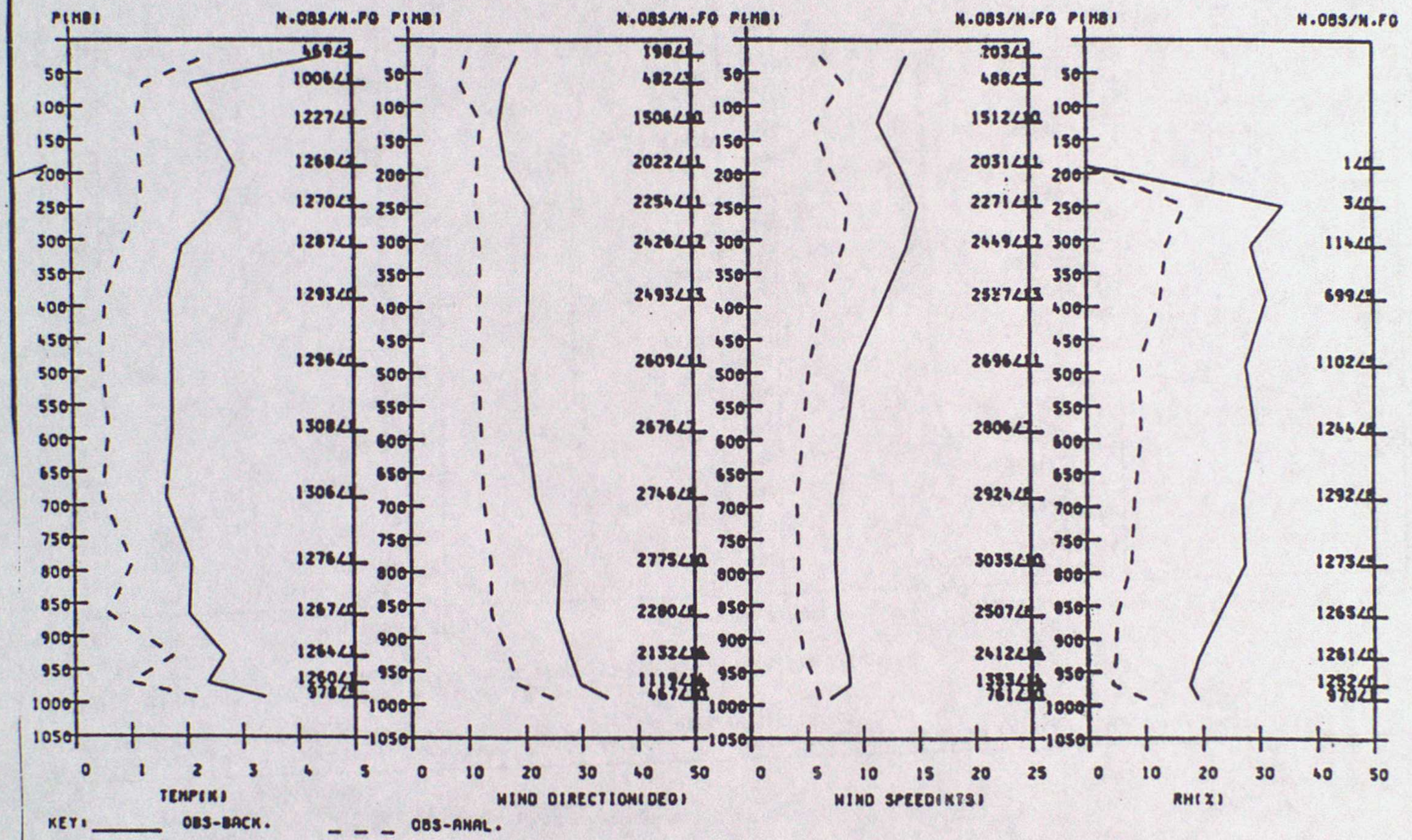

FIG 2.1.4. TEMPS + PILOTS

DATA DERIVED FROM CM OPD FROM 1 DEC 1988 TO 31 DEC 1988 STATISTICS GENERATED ON SIGMA LEVELS. DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR MODEL DATA TYPE(S): 00-08 N. OBS USED IN STATISTICS: 4266

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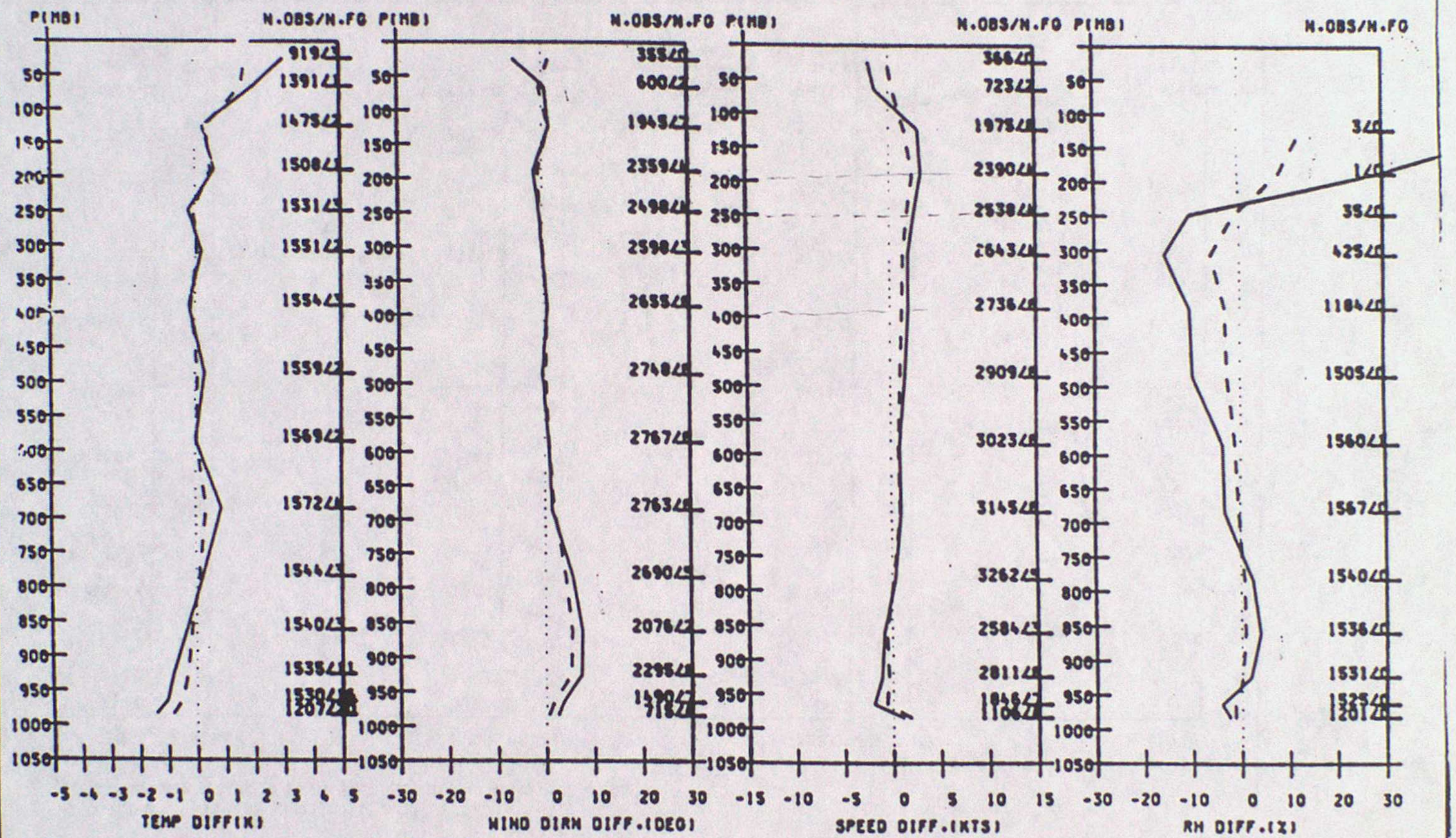
MEAN OF DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS



KEY: ______ OBS-BACK. _ _ _ OBS-ANAL.

FIG. 2.1.4 CONT.

DATA DERIVED FROM CM OPD FROM 1 DEC 1988 TO 31 DEC 1988 STATISTICS GENERATED ON SIGMA LEVELS. DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR MODEL DATA TYPE(S): 00-08 N. OBS USED IN STATISTICS: 4266

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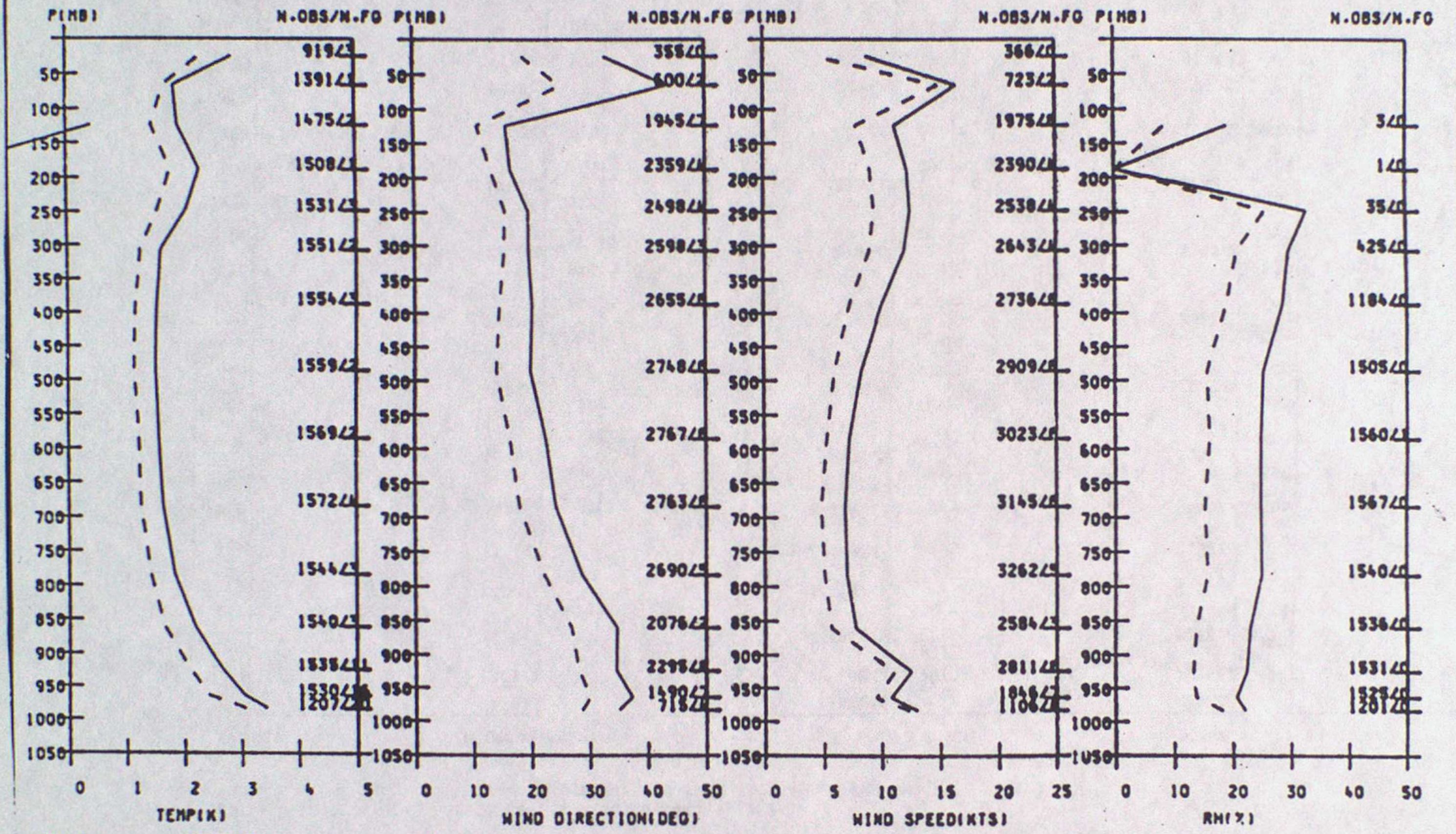
SD OF DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS



KEY: ——— OBS-BACK. — — — OBS-ANAL.

FIG 2.1.5. TEMPS + PILOTS

DATA DERIVED FROM CM OPD FROM 1 DEC 1988 TO 31 DEC 1988 STATISTICS GENERATED ON SIGMA LEVELS. DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR MODEL DATA TYPE(S): 00-08

LAT1: -30.00 LAT2: 0.00 LONG1: -180.00 LONG2: 180.00
MEAN OF DIFFERENCES FROM BACKGROUND AND ANALYS,S FIELDS

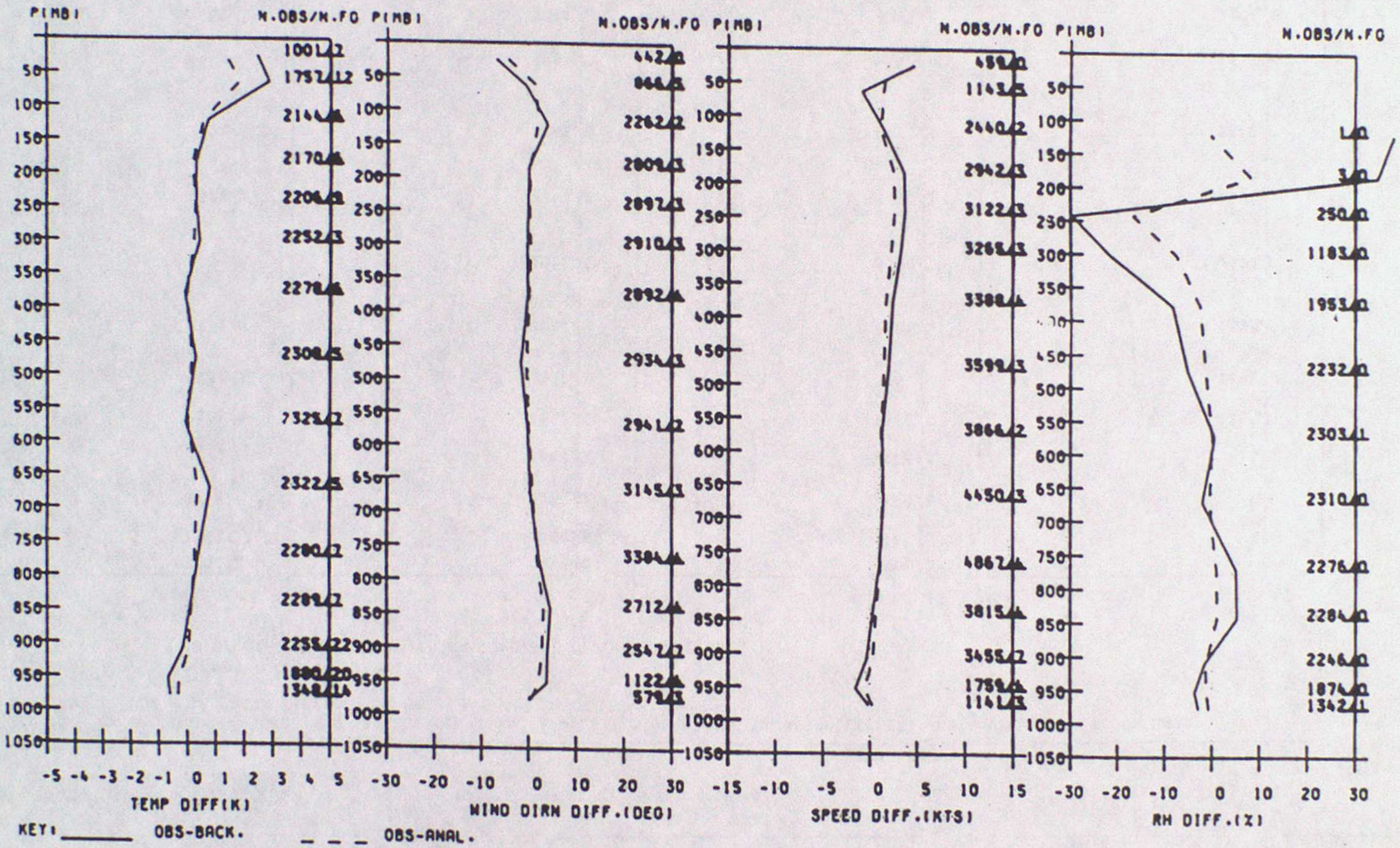
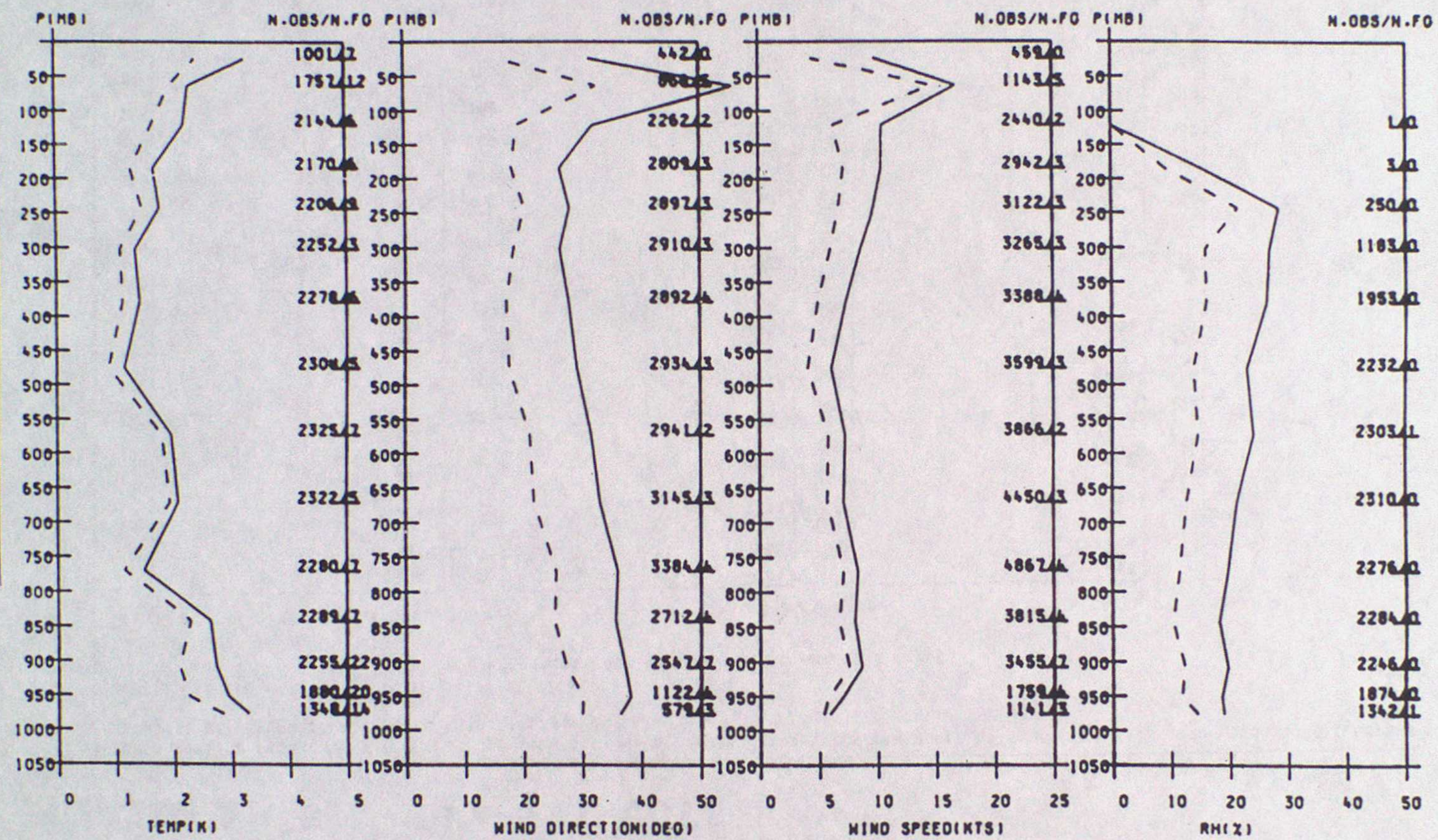


FIG 2.1.5 CONT.

DATA DERIVED FROM CM OPD FROM 1 DEC 1988 TO 31 DEC 1988 STATISTICS GENERATED ON SIGMA LEVELS. DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR MODEL DATA TYPE(S): 00-08

LAT1: -30.00 LAT2: 0.00 LON01: -180.00 LON02: 180.00
SD OF DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS



KEY: ______ OBS-BACK. - - - OBS-ANAL.

FIG 2.1.6. TEMPS + PILOTS

DATA DERIVED FROM CM OPD FROM 1 JUN 1988 TO 30 JUN 1988 STATISTICS GENERATED ON SIGMA LEVELS. DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR MODEL DATA TYPE(S): 00-08 N. OBS USED IN STATISTICS:32344

LAT1: 30.00 LAT2: 60.00 LONG1: -180.00 LONG2: 180.00
MEAN OF DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS

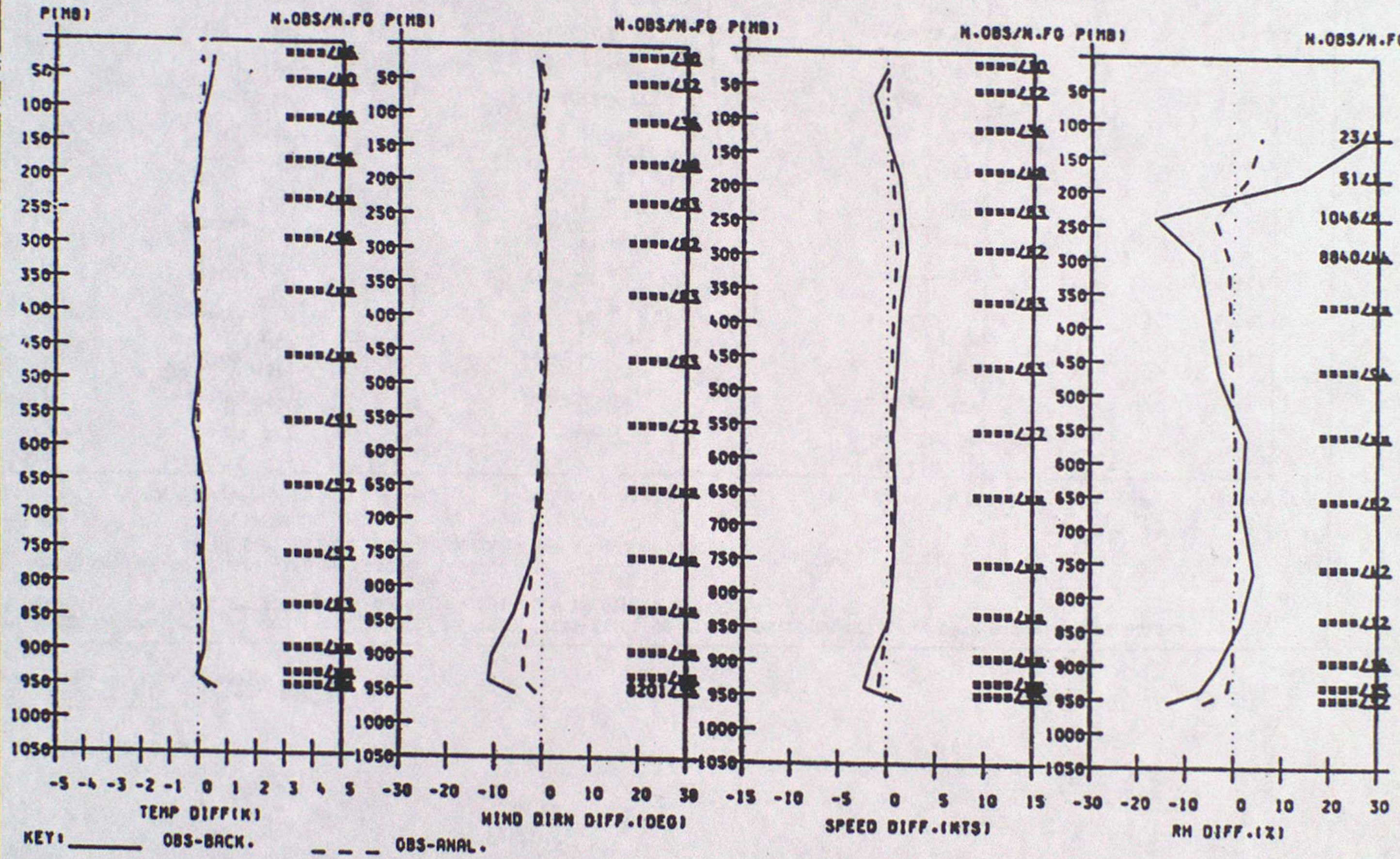


FIG. 2.1.6. CONT.

DATA DERIVED FROM CM OPD FROM 1 JUN 1988 TO 30 JUN 1988 STATISTICS GENERATED ON SIGMA LEVELS. DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR MODEL DATA TYPE(S): 00-08 N. OBS USED IN STATISTICS:32344

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SD OF DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS

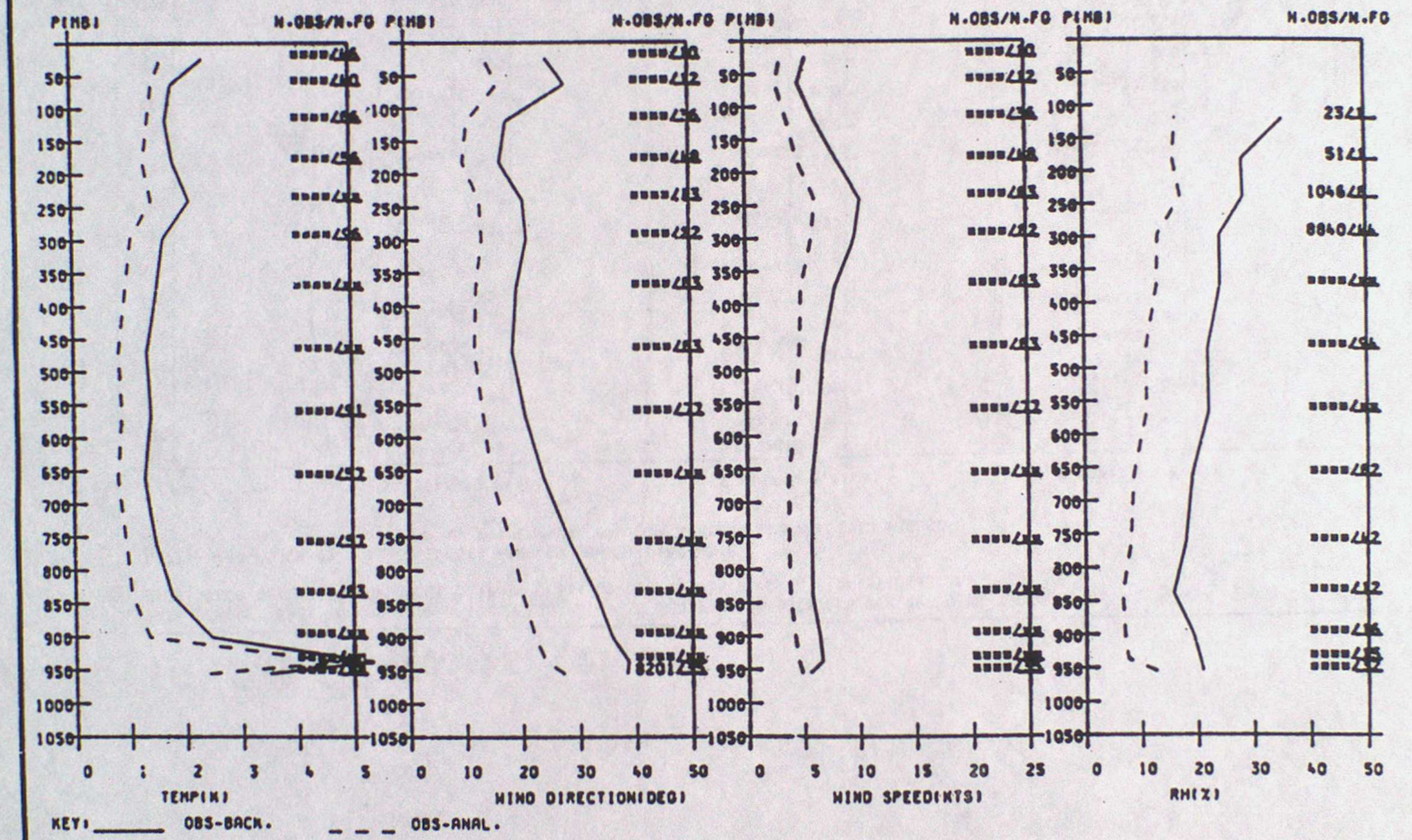

FIG. 2.1.7. TEMPS + PILOTS

DATA DERIVED FROM CM OPD FROM 1 DEC 1988 TO 31 DEC 1988 STATISTICS GENERATED ON SIGMA LEVELS. DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR MODEL DATA TYPE(S): 00-08 N. OBS USED IN STATISTICS:34880

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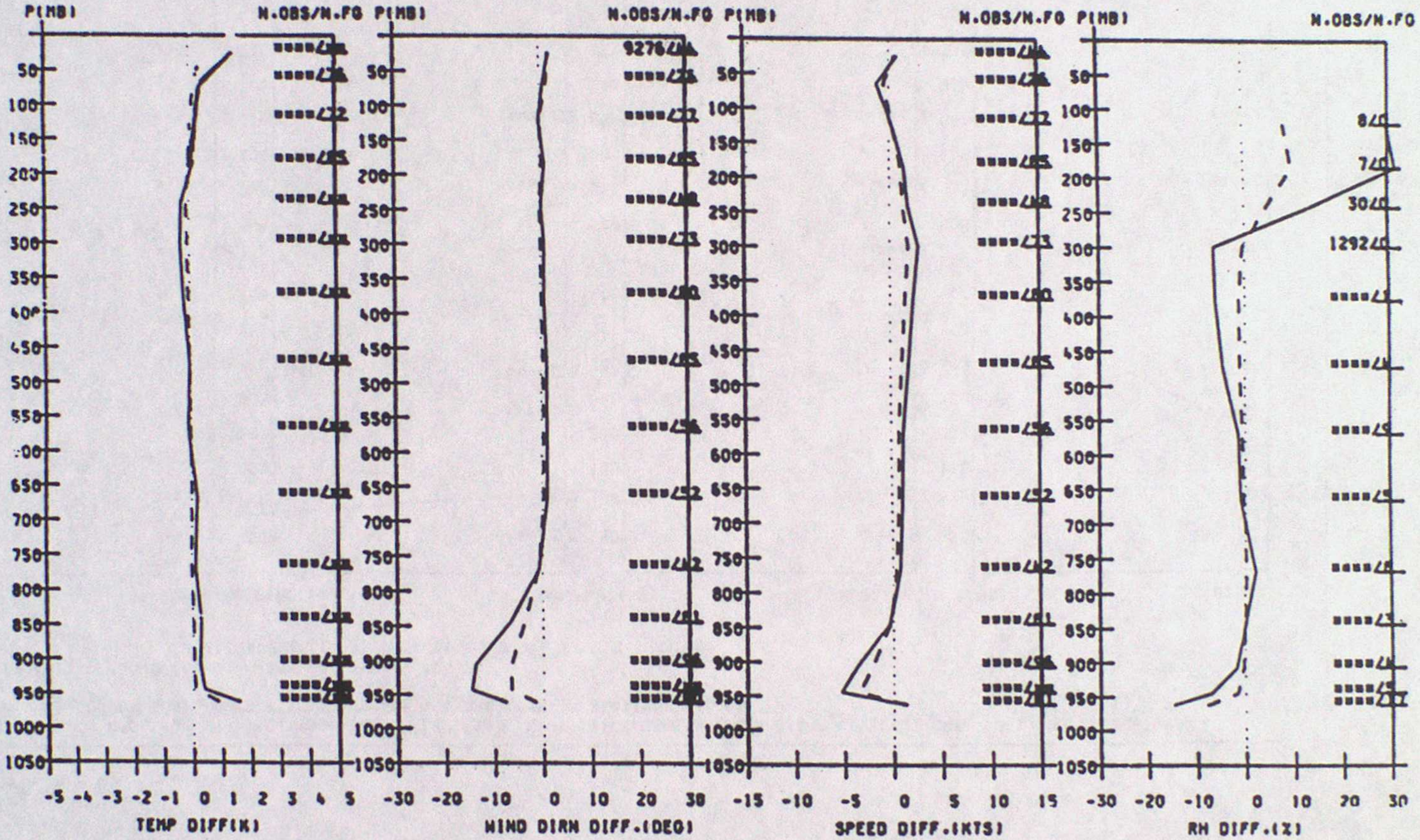
MEAN OF DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS



KEY: ______ OBS-BACK. _ _ _ OBS-ANAL.

FIG 2.1.7. CONT.

DATA DERIVED FROM CM OPD FROM 1 DEC 1988 TO 31 DEC 1988 STATISTICS GENERATED ON SIGMA LEVELS. DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR MODEL DATA TYPE(S): 00-08 N. OBS USED IN STATISTICS:34680

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SD OF DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS

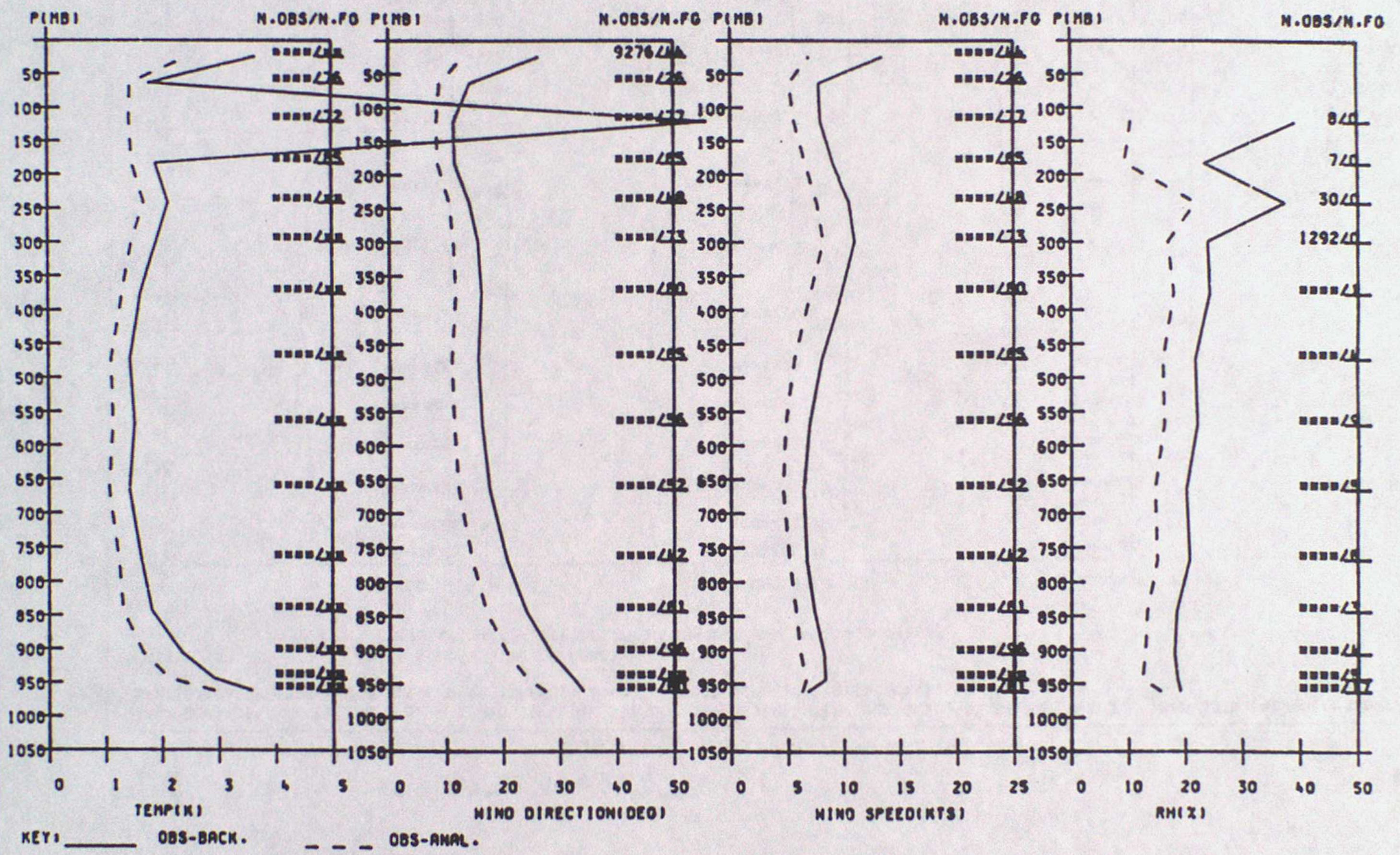

FIG. 2.1.8. TEMPS + PILOTS.

DATA DERIVED FROM CM OPD FROM 1 JUN 1988 TO 30 JUN 1988 STATISTICS GENERATED ON SIGMA LEVELS. DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR MODEL DATA TYPE(S): 00-08 N. OBS USED IN STATISTICS: 7607

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MEAN OF DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS

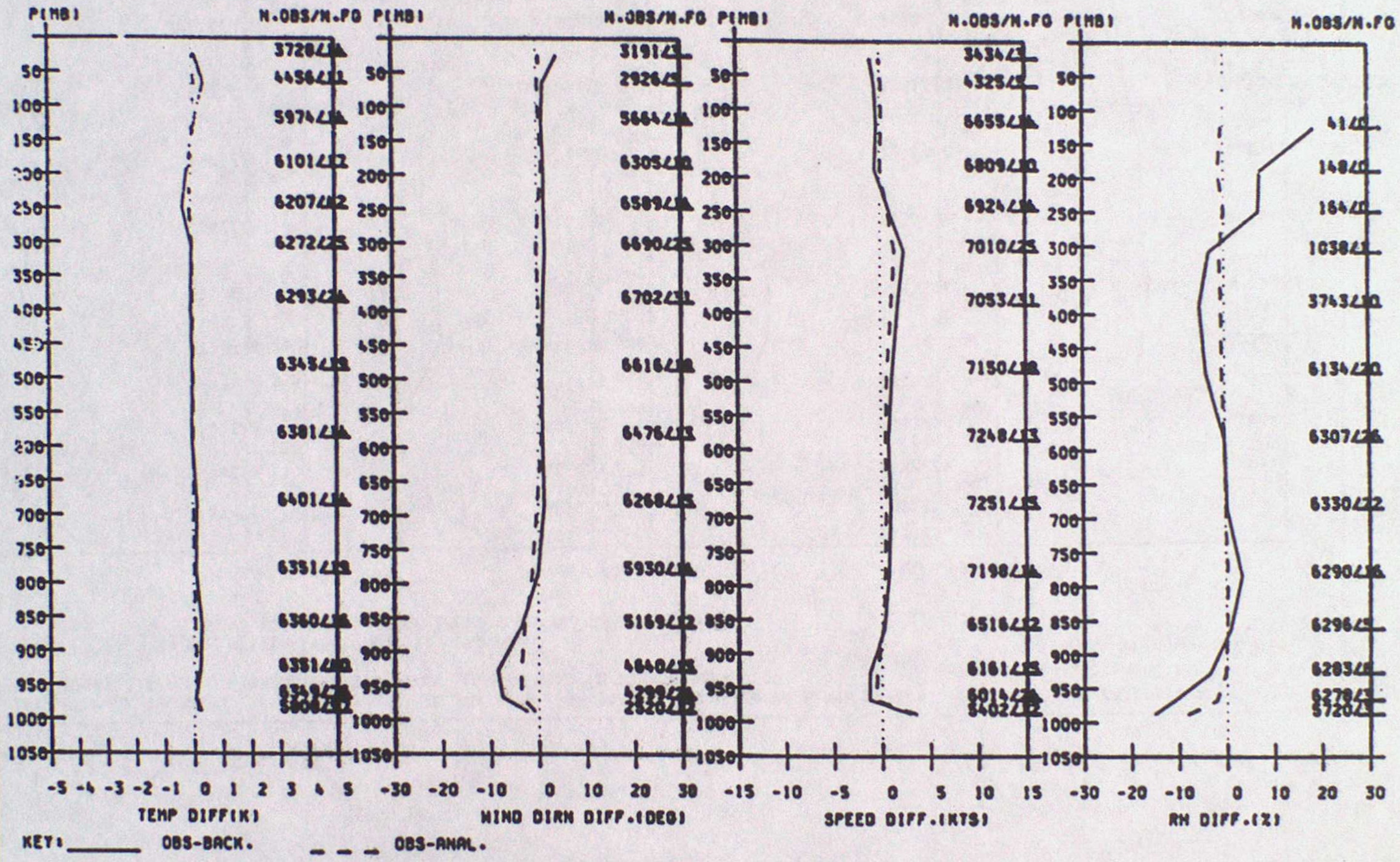

FIG. 2.1.8. CONT.

DATA DERIVED FROM CM O*O FROM 1 JUN 1988 TO 30 JUN 1988 STATISTICS GENERATED ON SIGMA LEVELS. DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR MODEL DATA TYPE(S): 00-08 N. OBS USED IN STATISTICS: 7607

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SD OF DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS

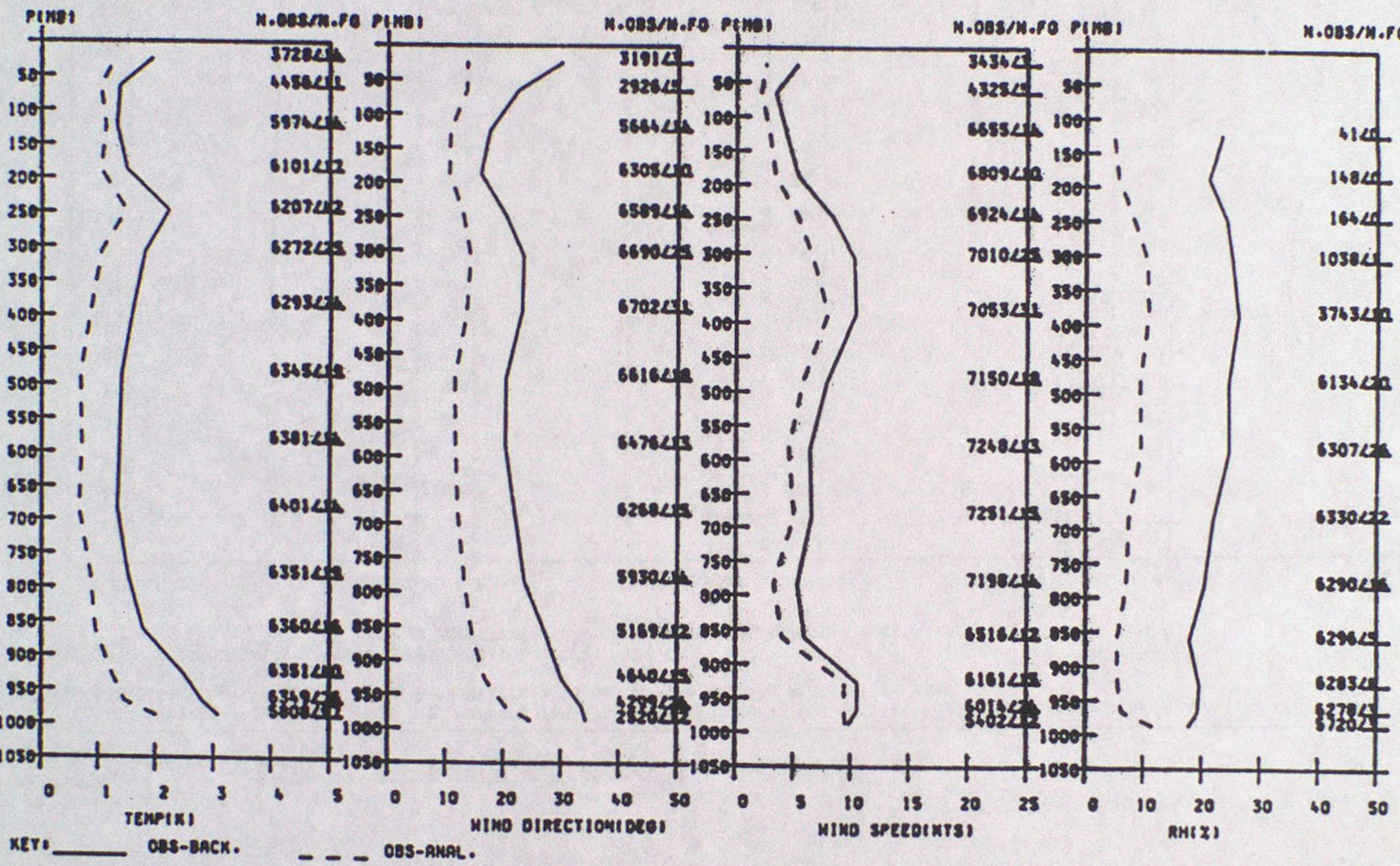

FIG. 2.1.9. TEMPS + PILOTS

DATA DERIVED FROM CM OPD FROM 1 DEC 1988 TO 31 DEC 1988 STATISTICS GENERATED ON SIGMA LEVELS. DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR MODEL DATA TYPE(S): 00-08 N. OBS USED IN STATISTICS: 8459

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MEAN OF DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS

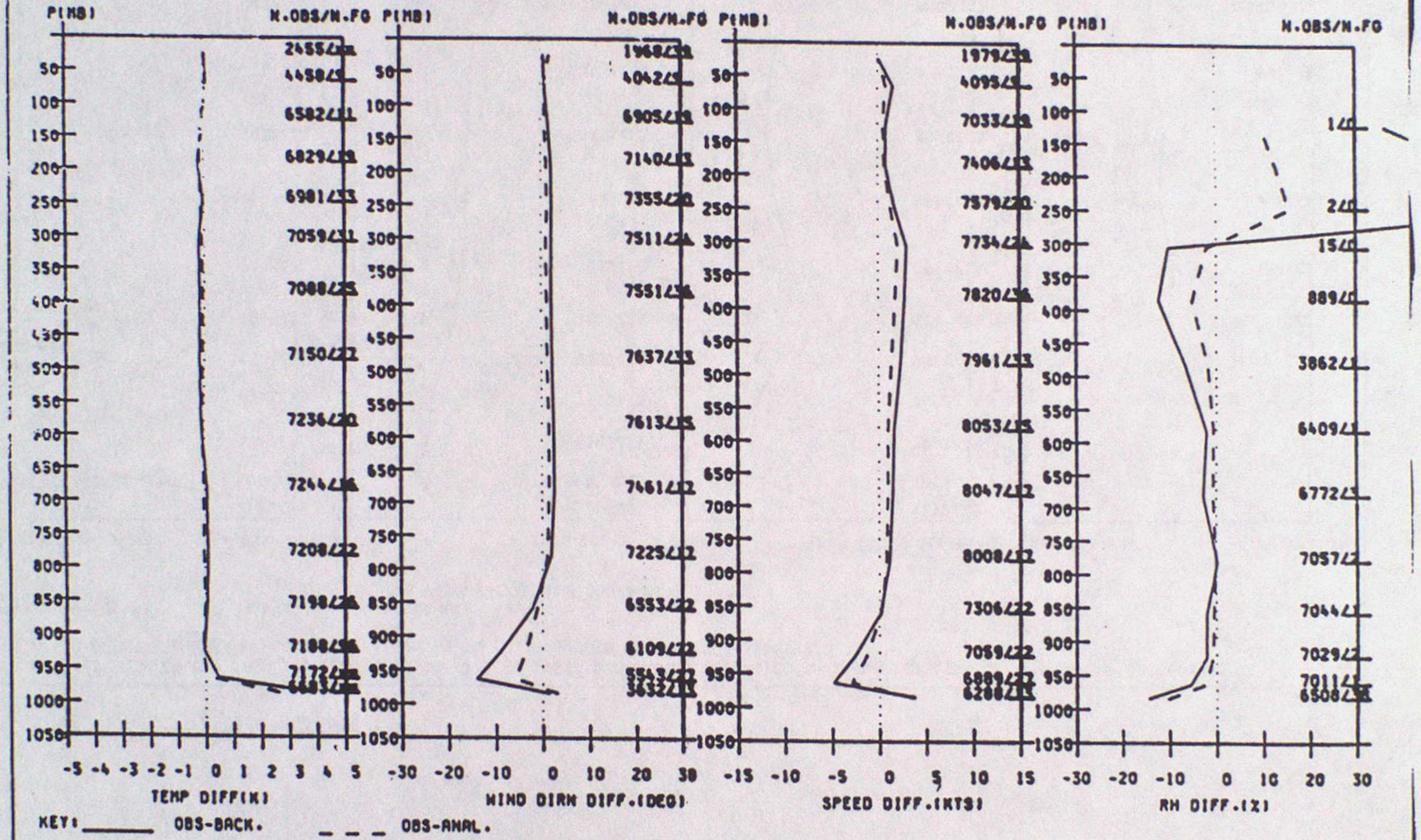
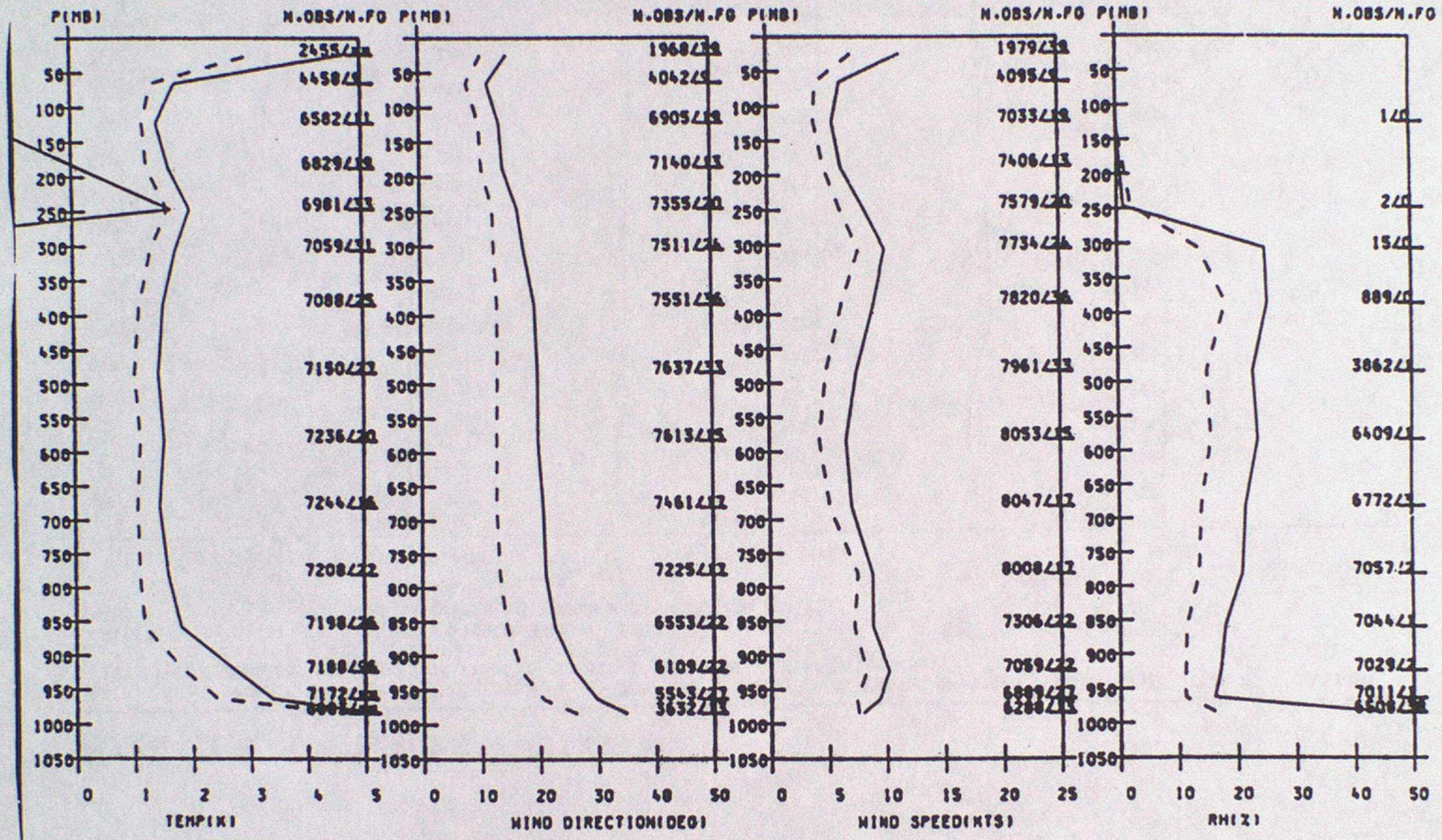


FIG. 2.1.9. CONT.

DATA DERIVED FROM CM OPD FROM 1 DEC 1988 TO 31 DEC 1988 STATISTICS GENERATED ON SIGMA LEVELS. DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR MODEL DATA TYPE(S): 00-08 N. OBS USED IN STATISTICS: 8459

LAT1: 60.00 LAT2: 90.00 LONG1: -180.00 LONG2: 180.00
SD OF DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS



KEY: ______ OBS-BACK. _ _ _ OBS-ANAL.

SATOB VECTOR MEAN WINDS BELOW 700 MB
JULY 1988
VALUES PLOTTED ONLY WHERE > 50 OBS ARE PRESENT

Fig 2.2.1

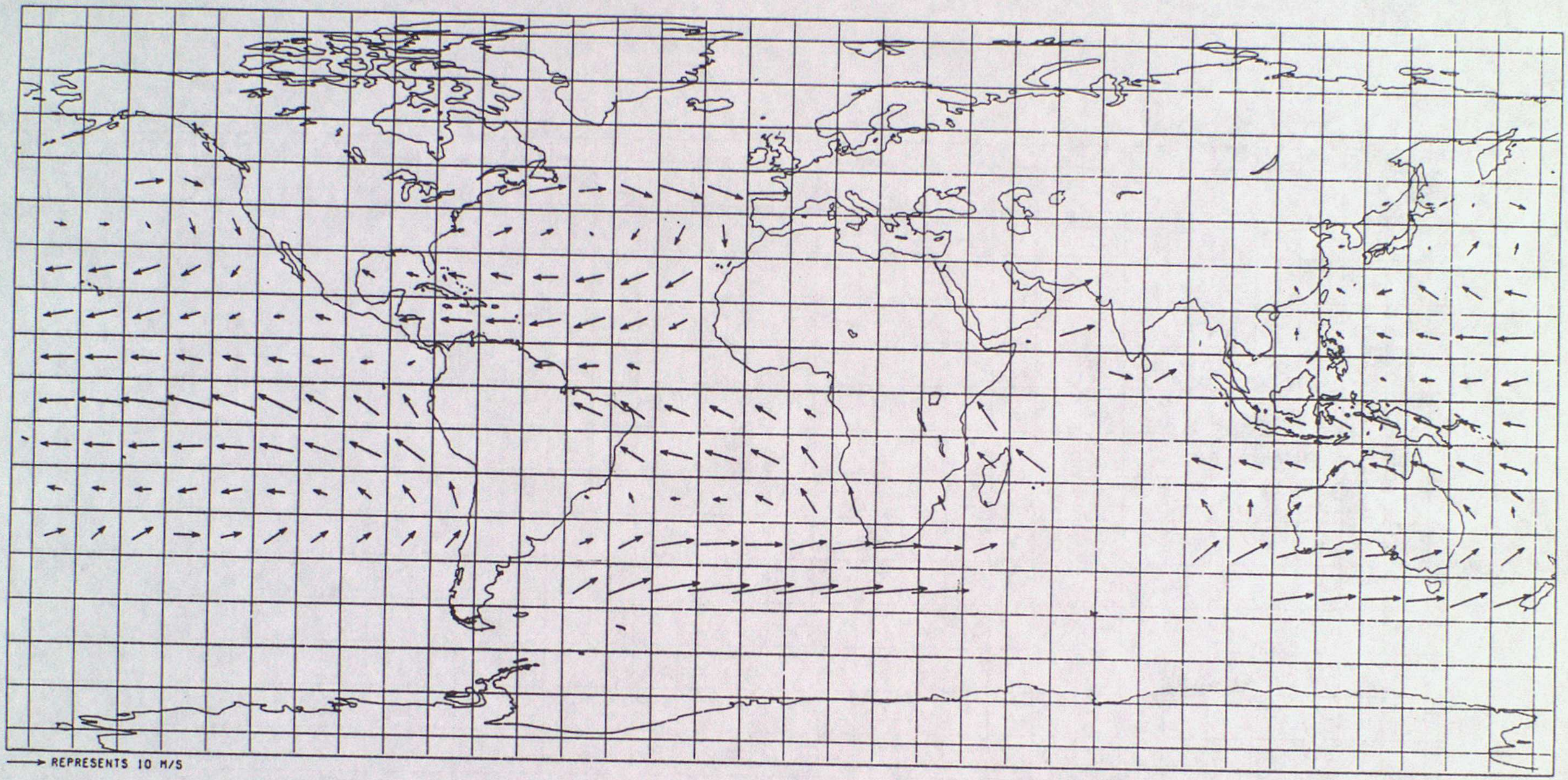


Fig 2.2.2

SATOB-BACKGROUND VECTOR WIND BIASES BELOW 700 MB
JULY 1988
VALUES PLOTTED ONLY WHERE > 50 OBS ARE PRESENT

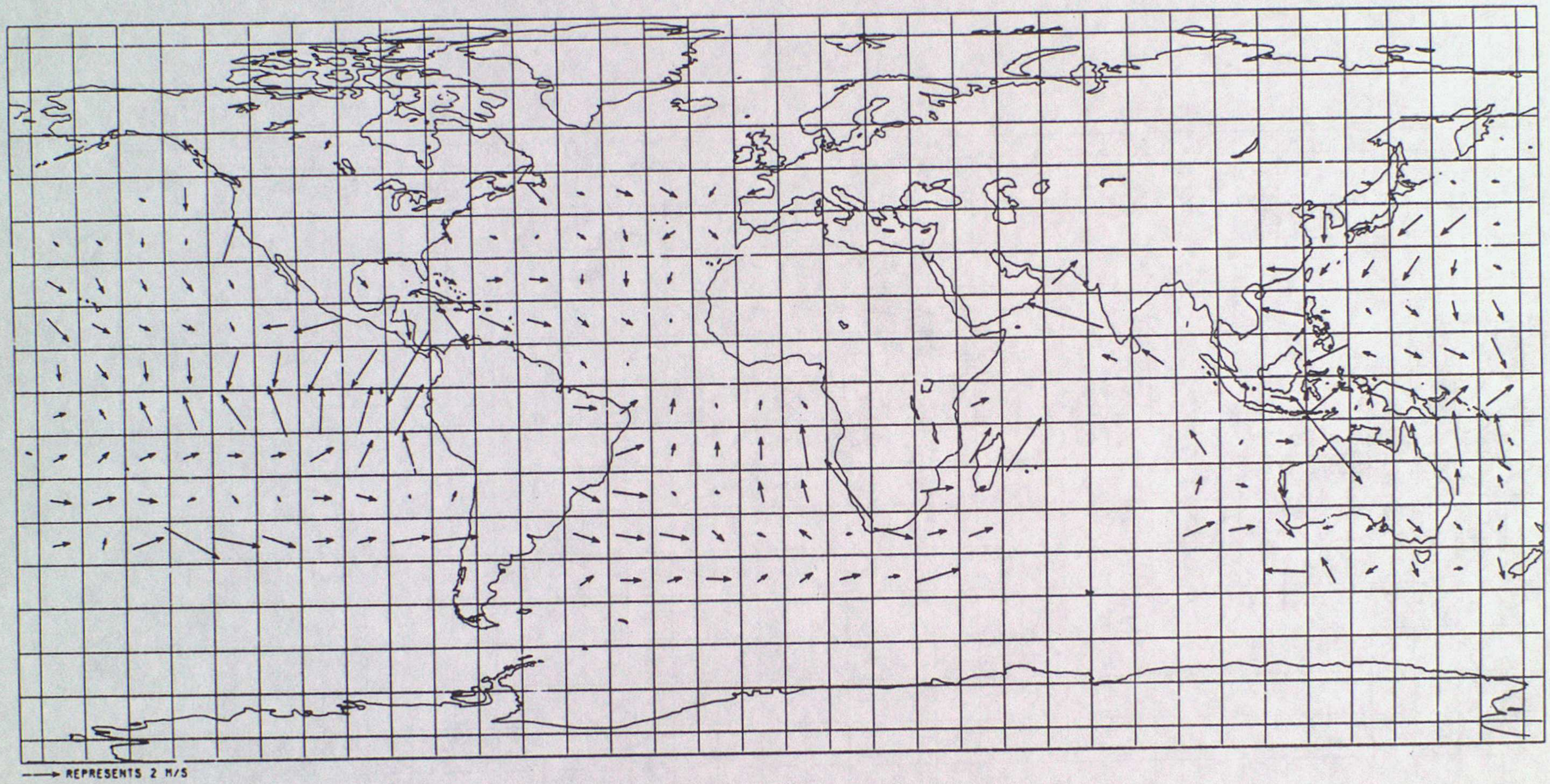


Fig 2.2.3

SATOB VECTOR MEAN WINDS BELOW 700 MB
DECEMBER 1988
VALUES PLOTTED ONLY WHERE > 50 OBS ARE PRESENT

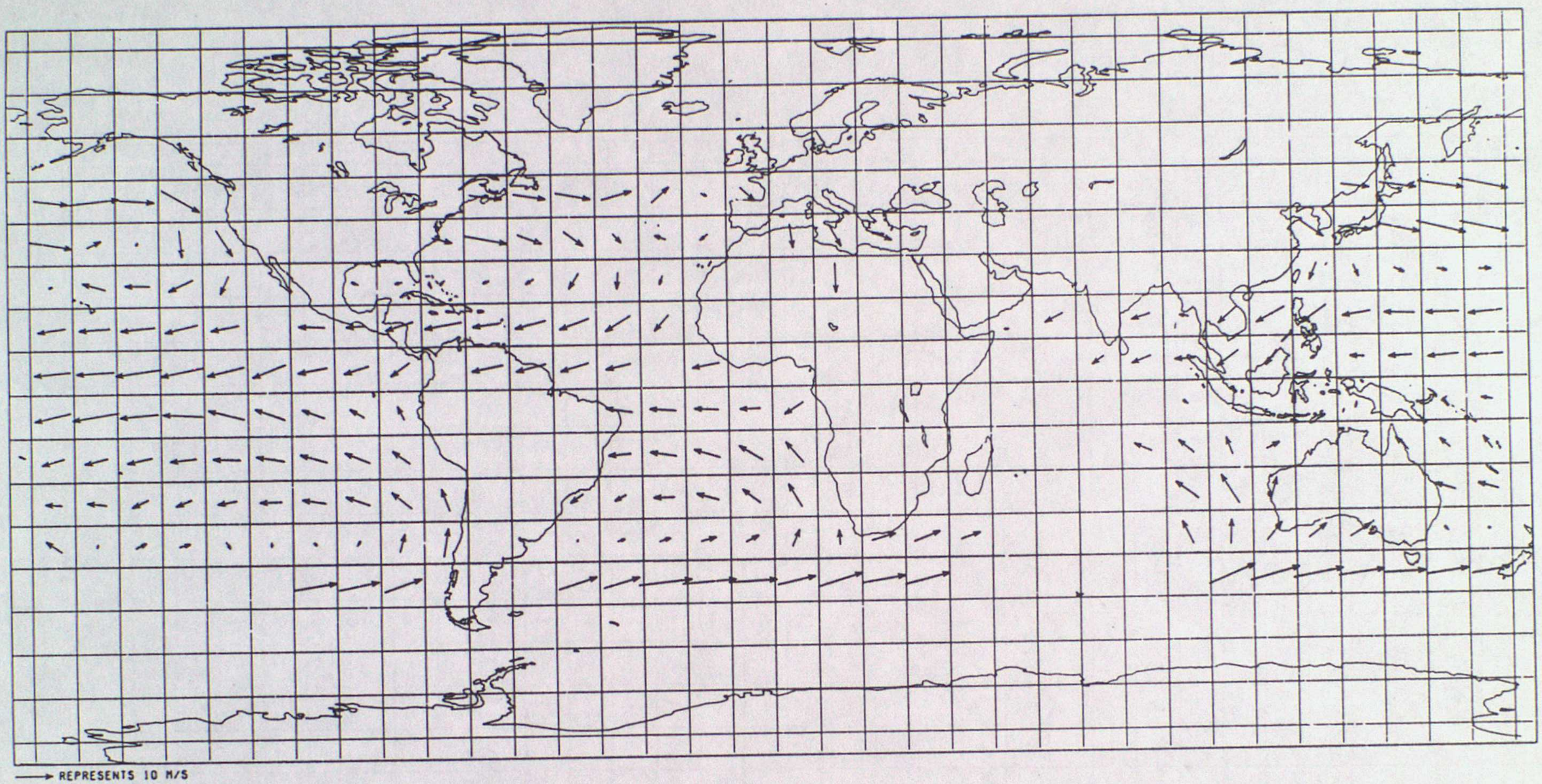


Fig 2.2.4

SATOB-BACKGROUND VECTOR WIND BIASES BELOW 700 MB
DECEMBER 1988
VALUES PLOTTED ONLY WHERE > 50 OBS ARE PRESENT

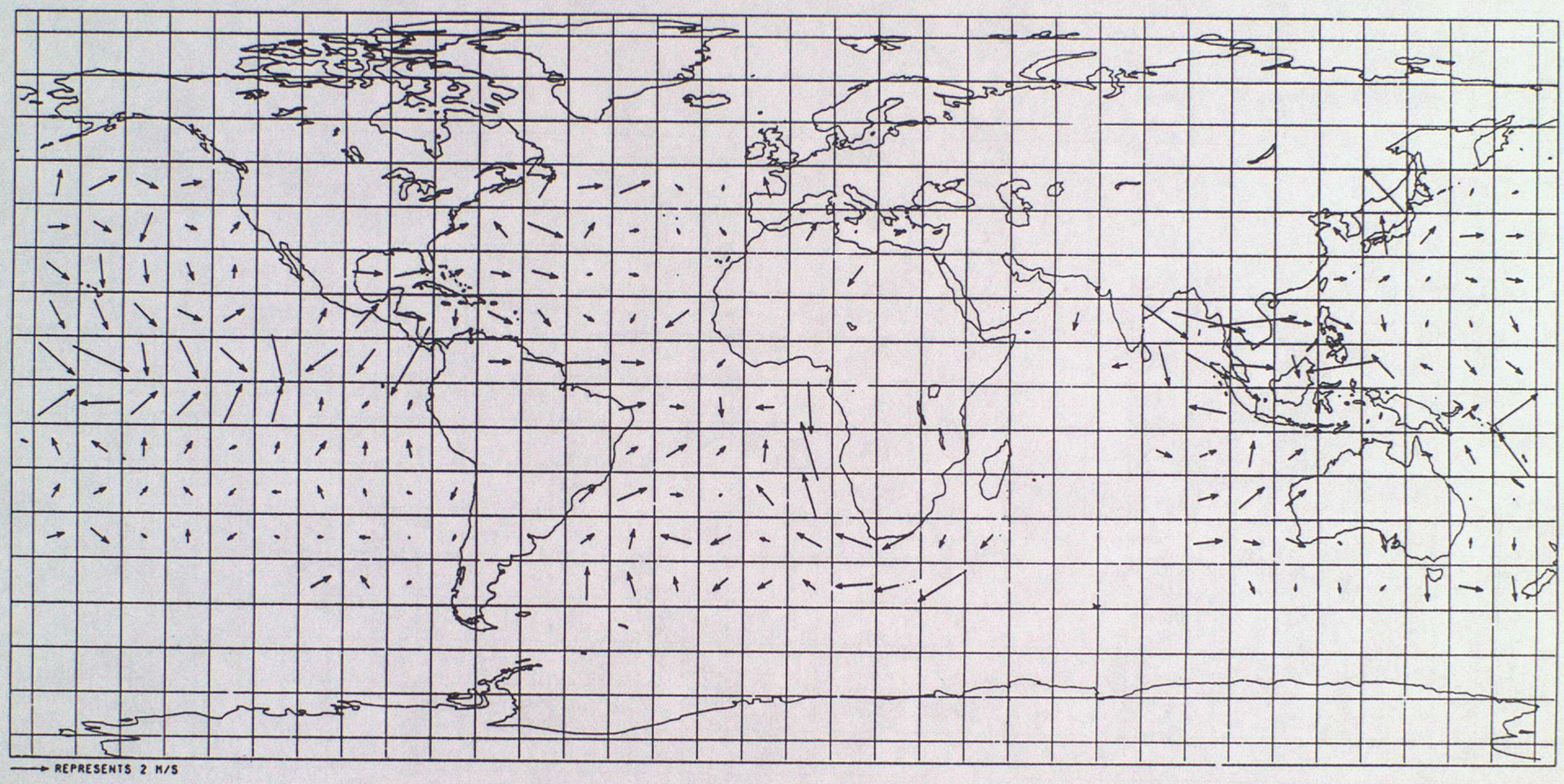


Fig 2.2.5

SATOB VECTOR MEAN WINDS 700-400 MB
JULY 1988
VALUES PLOTTED ONLY WHERE > 50 OBS ARE PRESENT

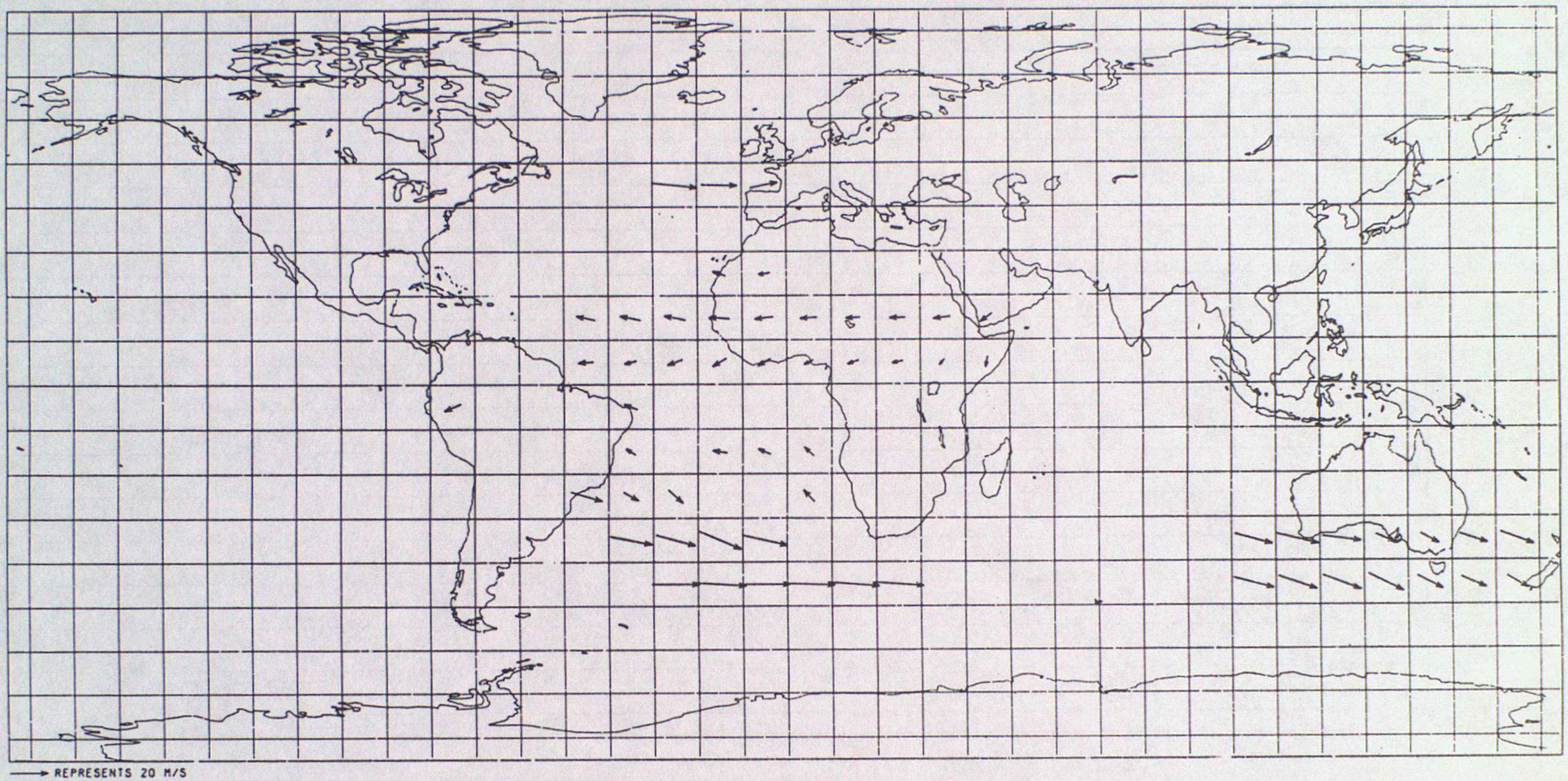


Fig 2.2.6

SATOB-BACKGROUND VECTOR WIND BIASES 700-400 MB
JULY 1988
VALUES PLOTTED ONLY WHERE > 50 OBS ARE PRESENT

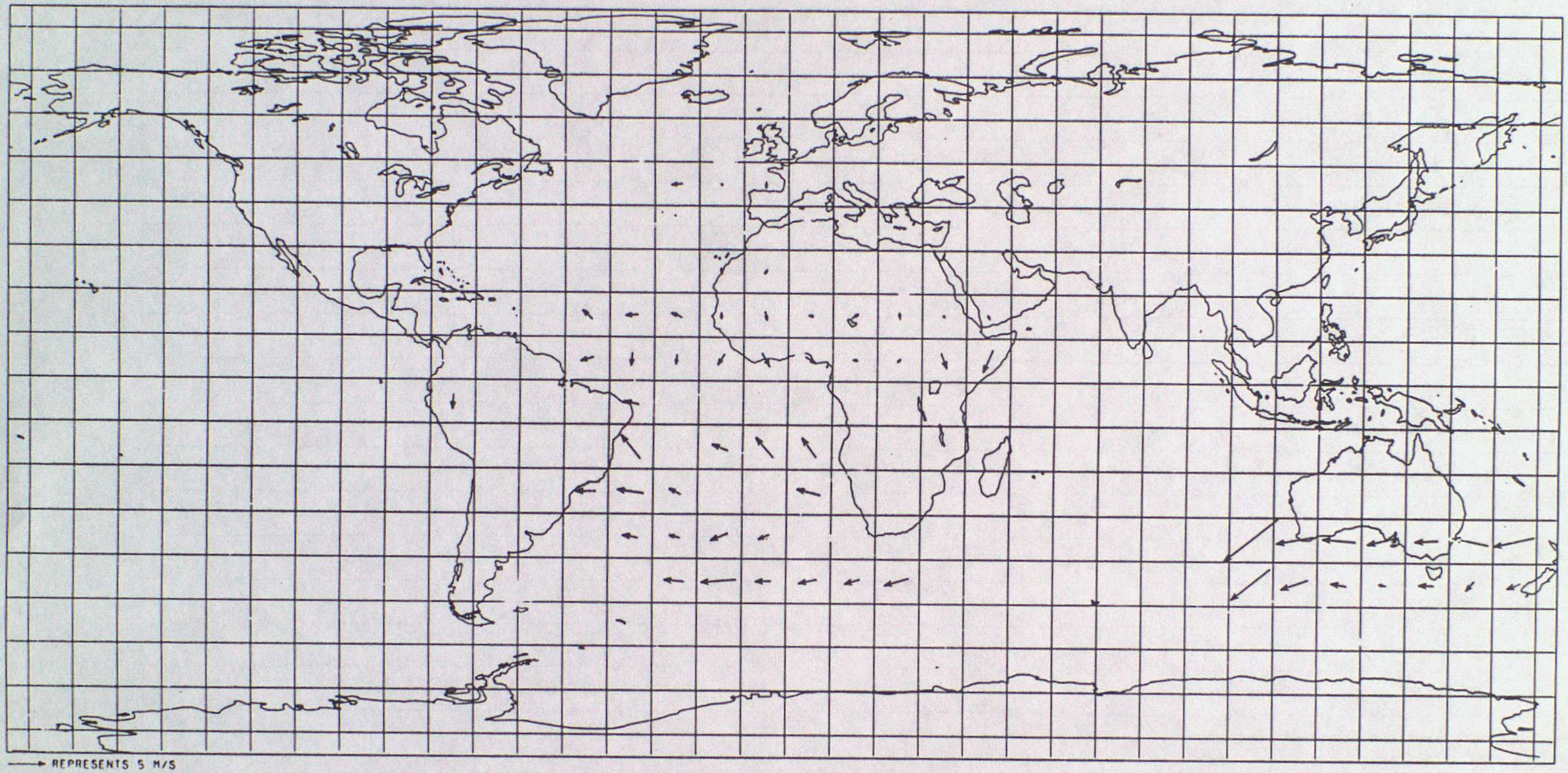


Fig 2.2.7

SATOB VECTOR MEAN WINDS 700-400 MB
DECEMBER 1988
VALUES PLOTTED ONLY WHERE > 50 OBS ARE PRESENT

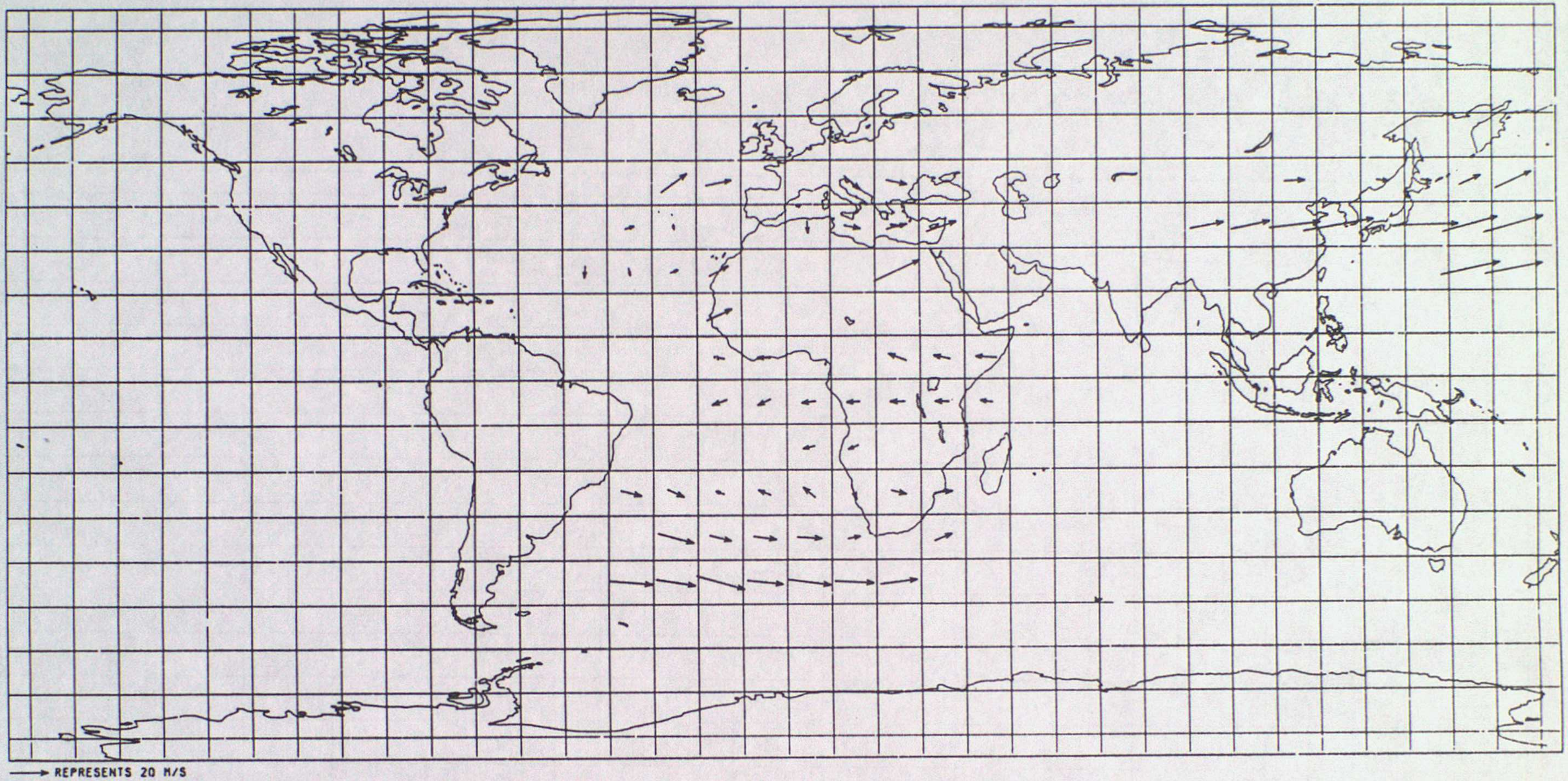
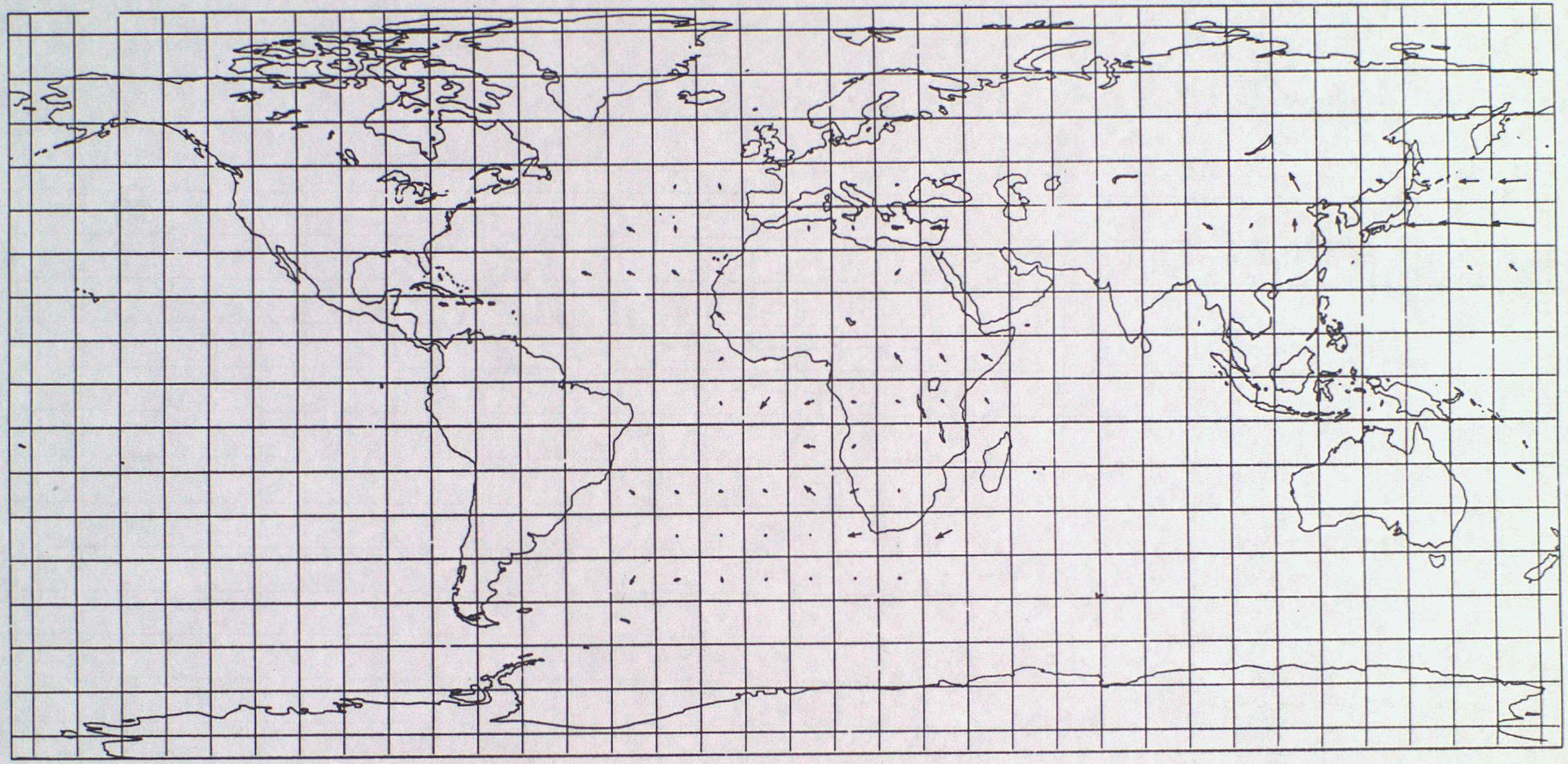


Fig 2.2.8

SATOB-BACKGROUND VECTOR WIND BIASES 700-400 MB
DECEMBER 1988
VALUES PLOTTED ONLY WHERE > 50 OBS ARE PRESENT



REPRESENTS 10 M/S

Fig 2.2.9

SATOB VECTOR MEAN WINDS ABOVE 400 MB
JULY 1988
VALUES PLOTTED ONLY WHERE > 50 OBS ARE PRESENT

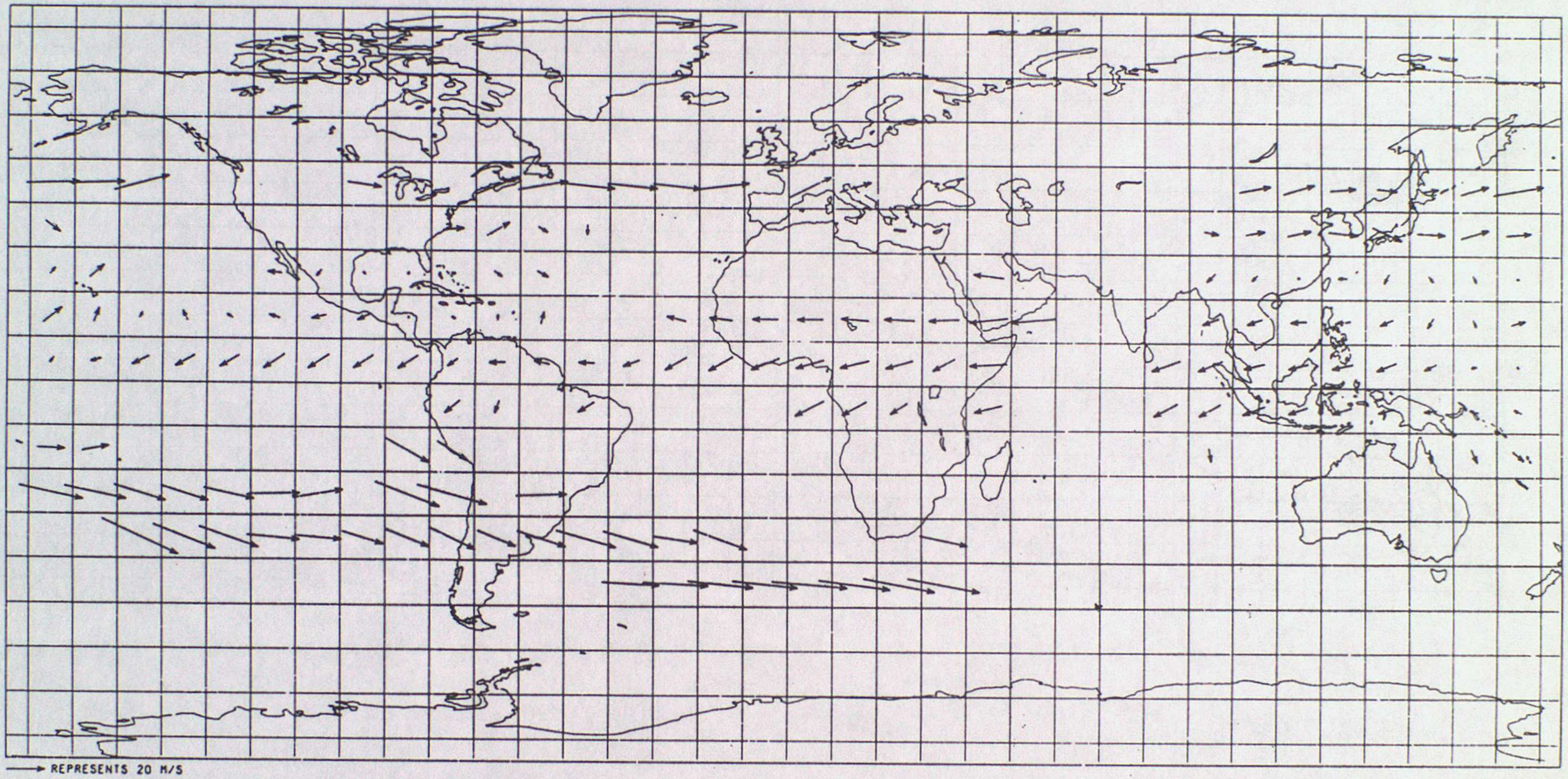


Fig 2.2.10

SATOB-BACKGROUND VECTOR WIND BIASES ABOVE 400 MB
JULY 1988
VALUES PLOTTED ONLY WHERE > 50 OBS ARE PRESENT

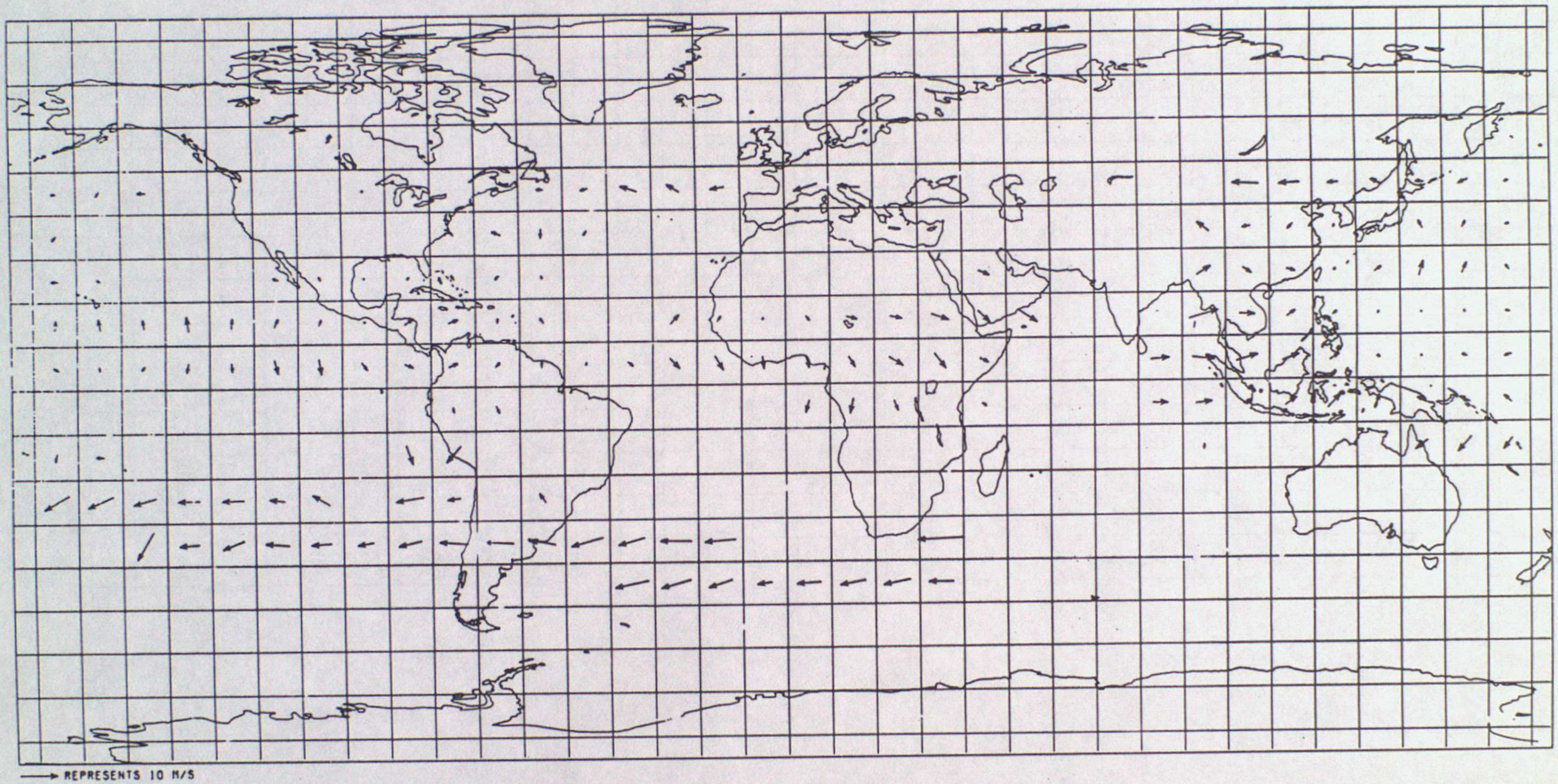
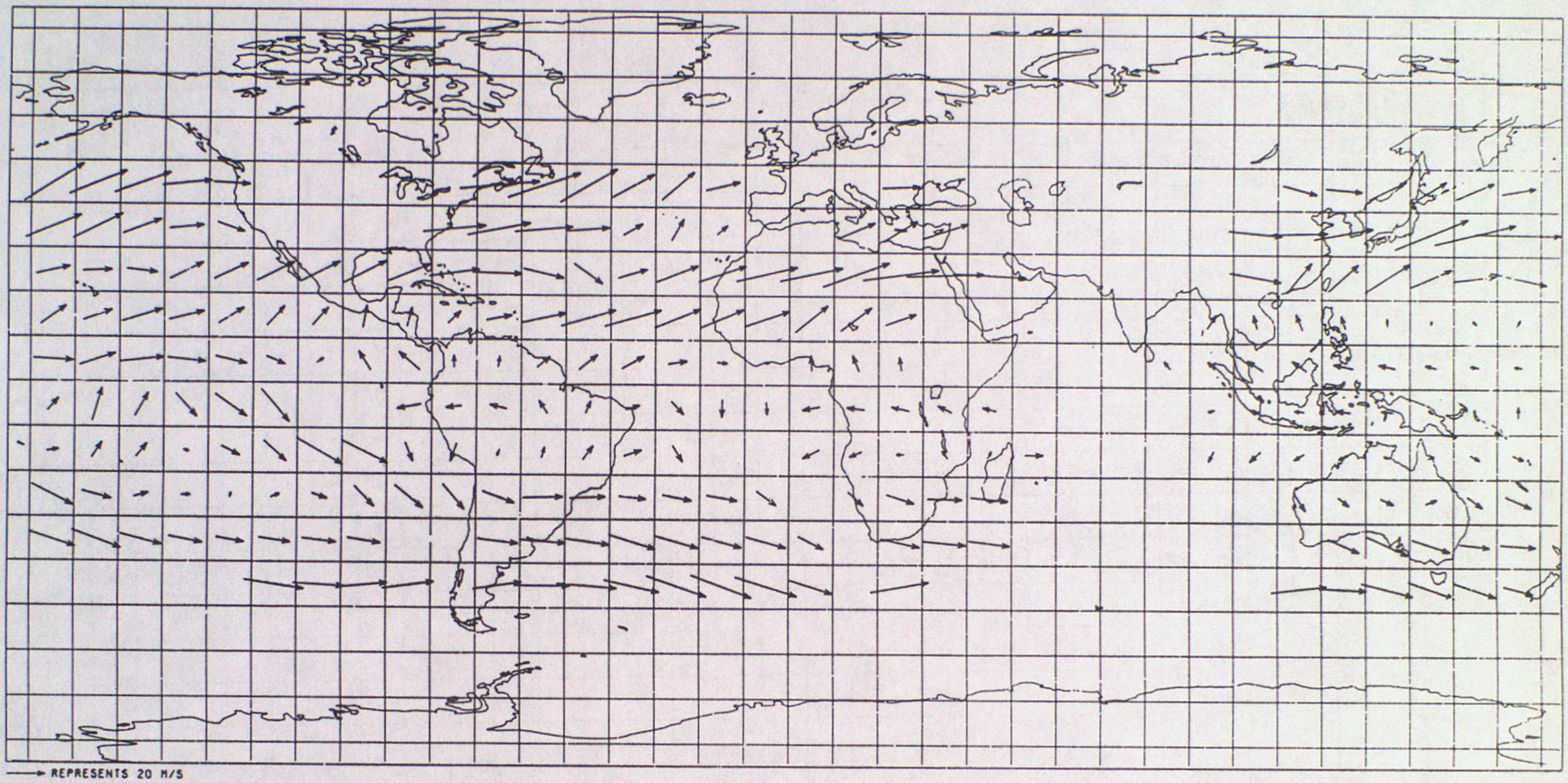


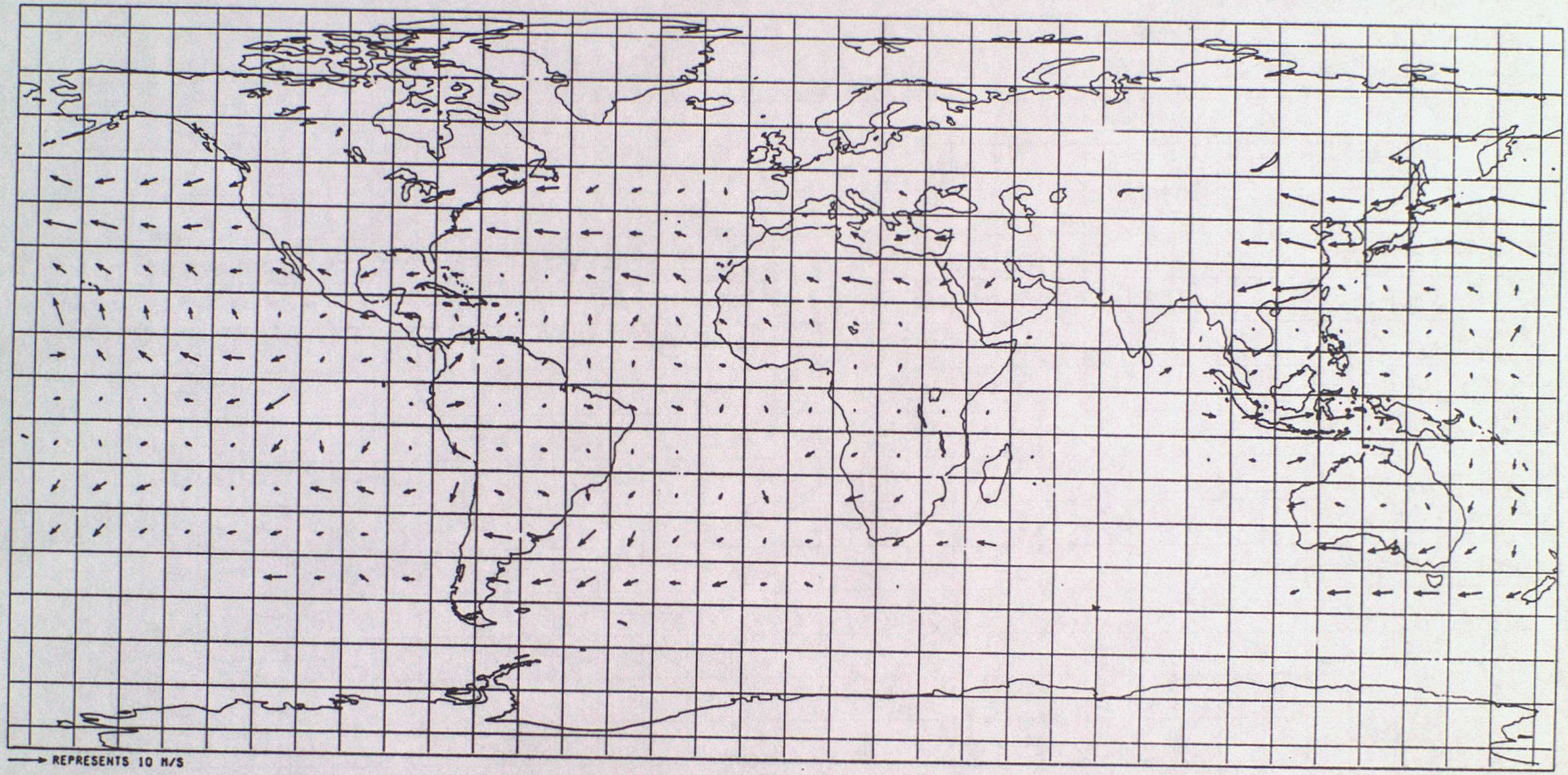
Fig 2.2.11

SATOB VECTOR MEAN WINDS ABOVE 400 MB
DECEMBER 1988
VALUES PLOTTED ONLY WHERE > 50 OBS ARE PRESENT



SATOB-BACKGROUND VECTOR WIND BIASES ABOVE 400 MB
DECEMBER 1988
VALUES PLOTTED ONLY WHERE > 50 OBS ARE PRESENT

Fig 2.2.12



DATA DERIVED FROM CM OPD FROM 1 JUN 1988 TO 30 JUN 1988 STATISTICS GENERATED ON PRESSURE LEVELS DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR IDENTIFIER: 0 0 0 8
DATA FOR ALL ANALYSIS HOURS MODEL TYPE C.C. SATEMS N. OBS USED IN STATISTICS: 15085
LAT1: -90.00 LAT2: -60.00 LONG1: -180.00 LONG2: 180.00 BOX N. 1

DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS

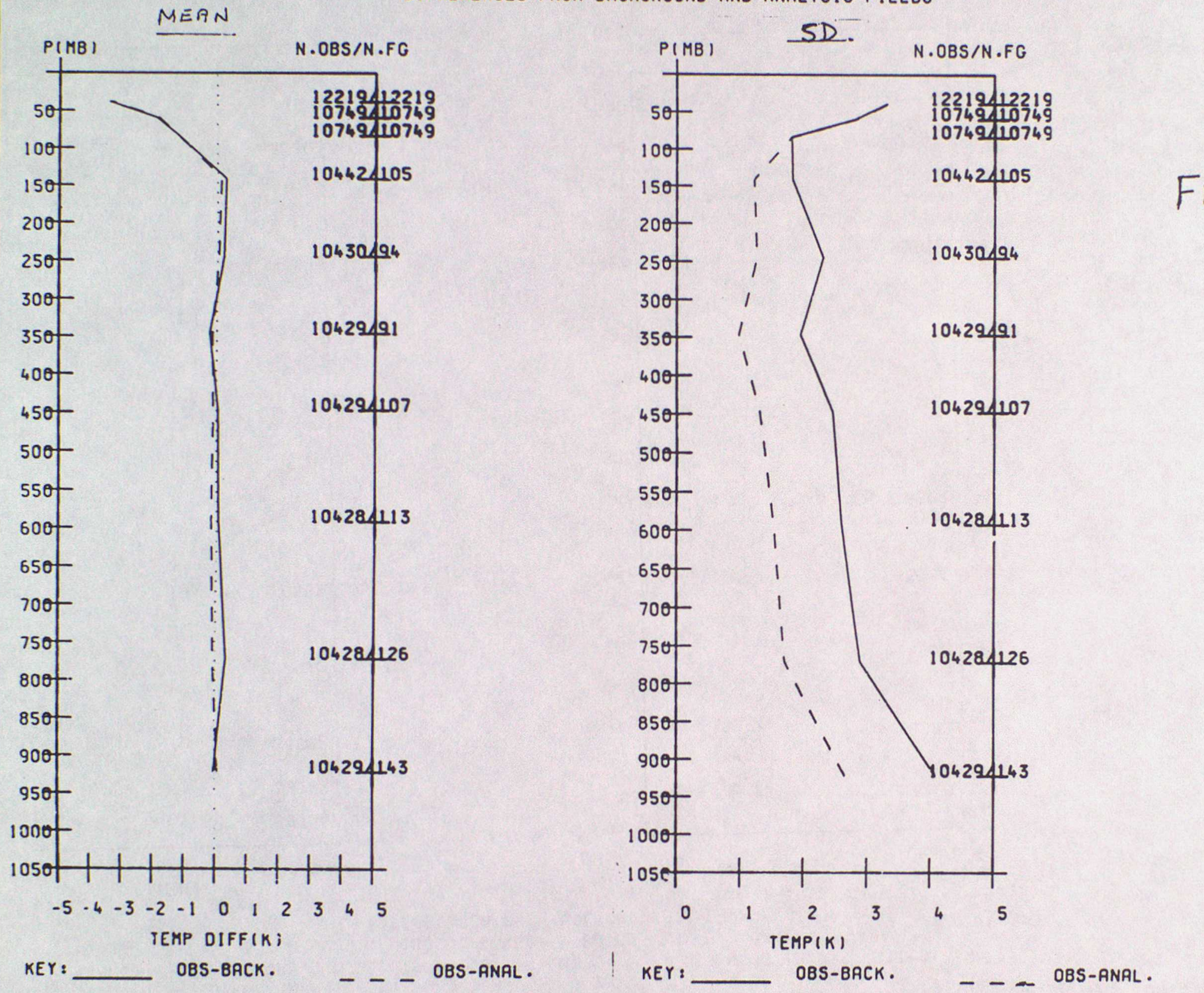


Fig 2.3.1

DATA DERIVED FROM CM OPD FROM 1 JUN 1988 TO 30 JUN 1988 STATISTICS GENERATED ON PRESSURE LEVELS DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR IDENTIFIER: 0 0 0 8
DATA FOR ALL ANALYSIS HOURS MODEL TYPE C.C. SATEMS N. OBS USED IN STATISTICS: 46716
LAT1: -60.00 LAT2: -30.00 LONG1: -180.00 LONG2: 180.00 BOX N. 2

DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS

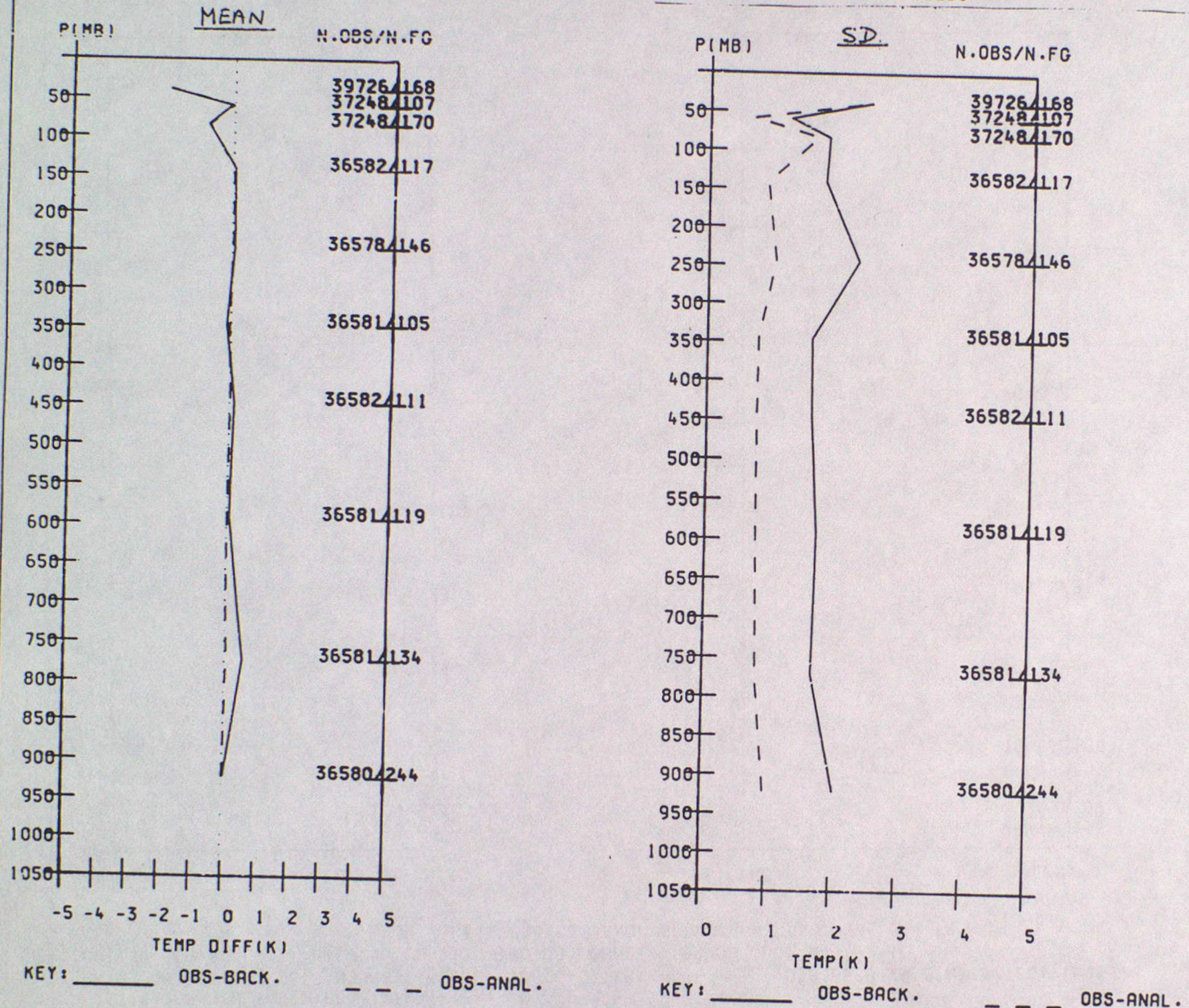
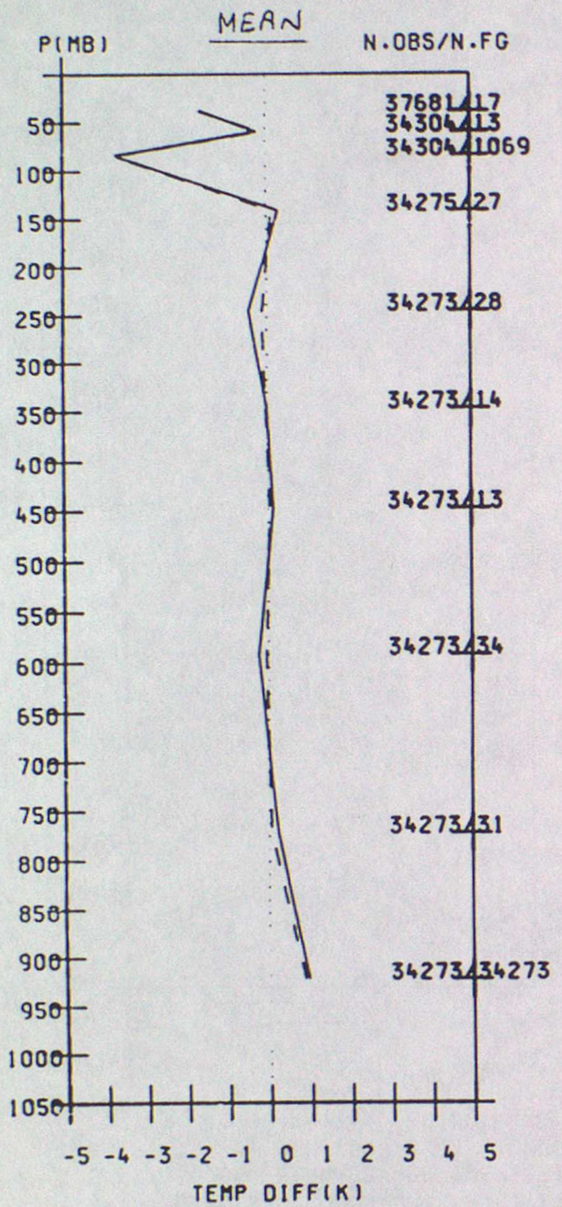


Fig 2.3.2

DATA DERIVED FROM CM OPD FROM 1 JUN 1988 TO 30 JUN 1988 STATISTICS GENERATED ON PRESSURE LEVELS DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR IDENTIFIER: 0 0 0 8
DATA FOR ALL ANALYSIS HOURS MODEL TYPE C.C. SATEMS N. OBS USED IN STATISTICS: 43568
LAT1: -30.00 LAT2: 0.00 LONG1: -180.00 LONG2: 180.00 BOX N. 3

DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS



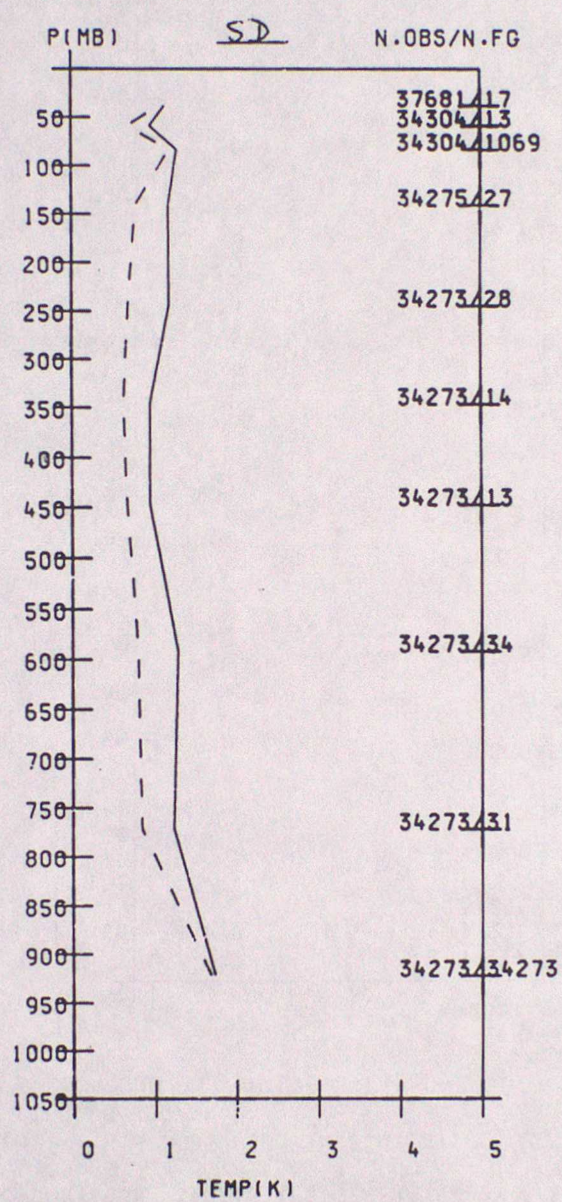
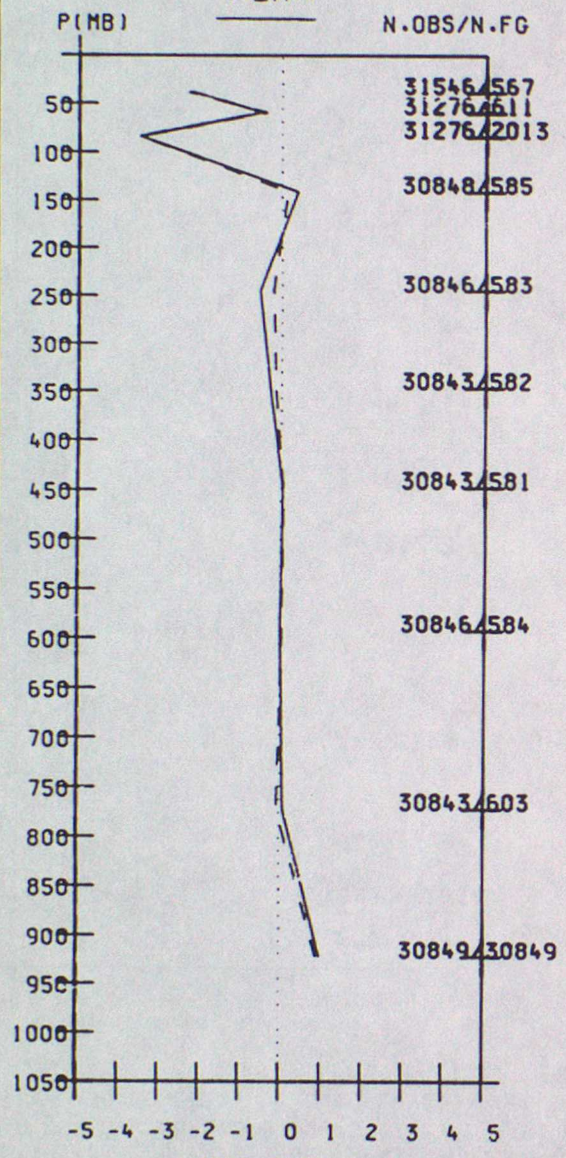


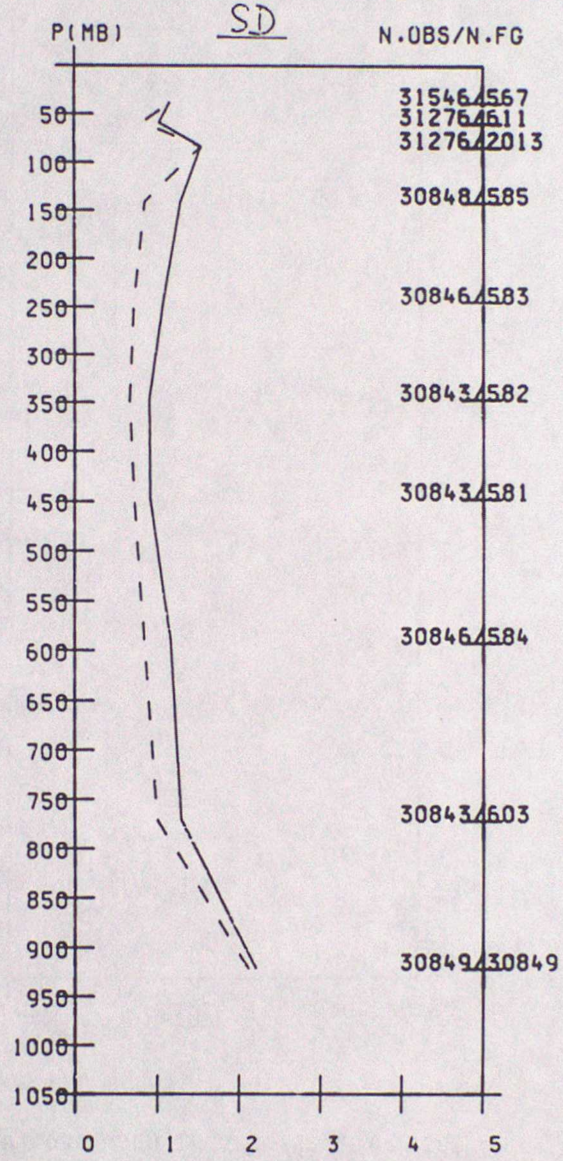
Fig 2.3.3

DATA DERIVED FROM CM OPD FROM 1 JUN 1988 TO 30 JUN 1988 STATISTICS GENERATED ON PRESSURE LEVELS DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR IDENTIFIER: 0 0 0 8
DATA FOR ALL ANALYSIS HOURS MODEL TYPE C.C. SATEMS N. OBS USED IN STATISTICS: 39725
LAT1: 0.00 LAT2: 30.00 LONG1: -180.00 LONG2: 180.00 BOX N. 4

DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS



KEY: ______ OBS-BACK. _ _ _ OBS-ANAL.



KEY: ______ OBS-BACK. _ _ _ OBS-ANAL.

Fig 2.3.4

DATA DERIVED FROM CM OPD FROM 1 JUN 1988 TO 30 JUN 1988 STATISTICS GENERATED ON PRESSURE LEVELS DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR IDENTIFIER: 0 0 0 8
DATA FOR ALL ANALYSIS HOURS MODEL TYPE C.C. SATEMS N. OBS USED IN STATISTICS: 34831
LAT1: 30.00 LAT2: 60.00 LONG1: -180.00 LONG2: 180.00 BOX N. 5

DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS

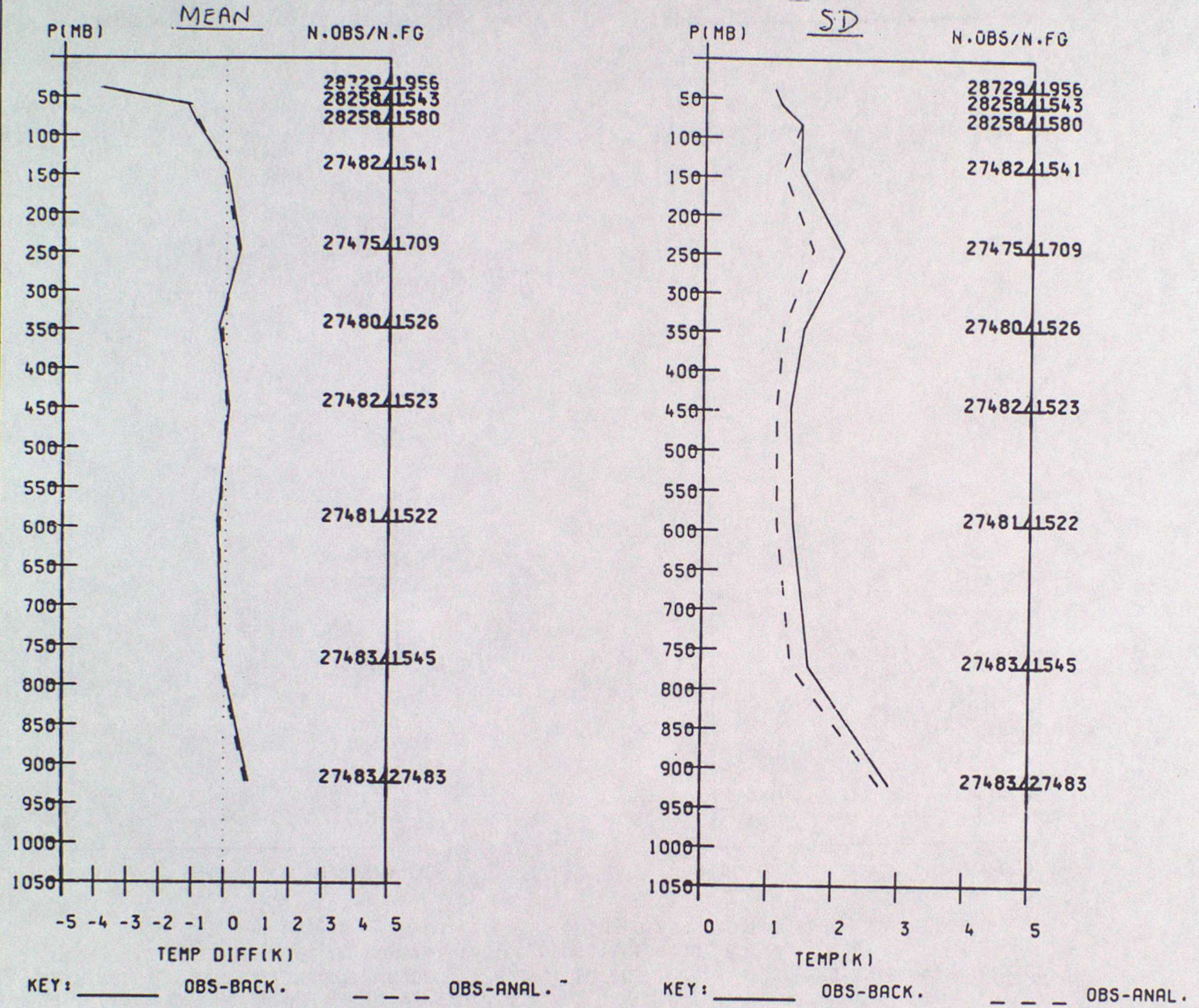
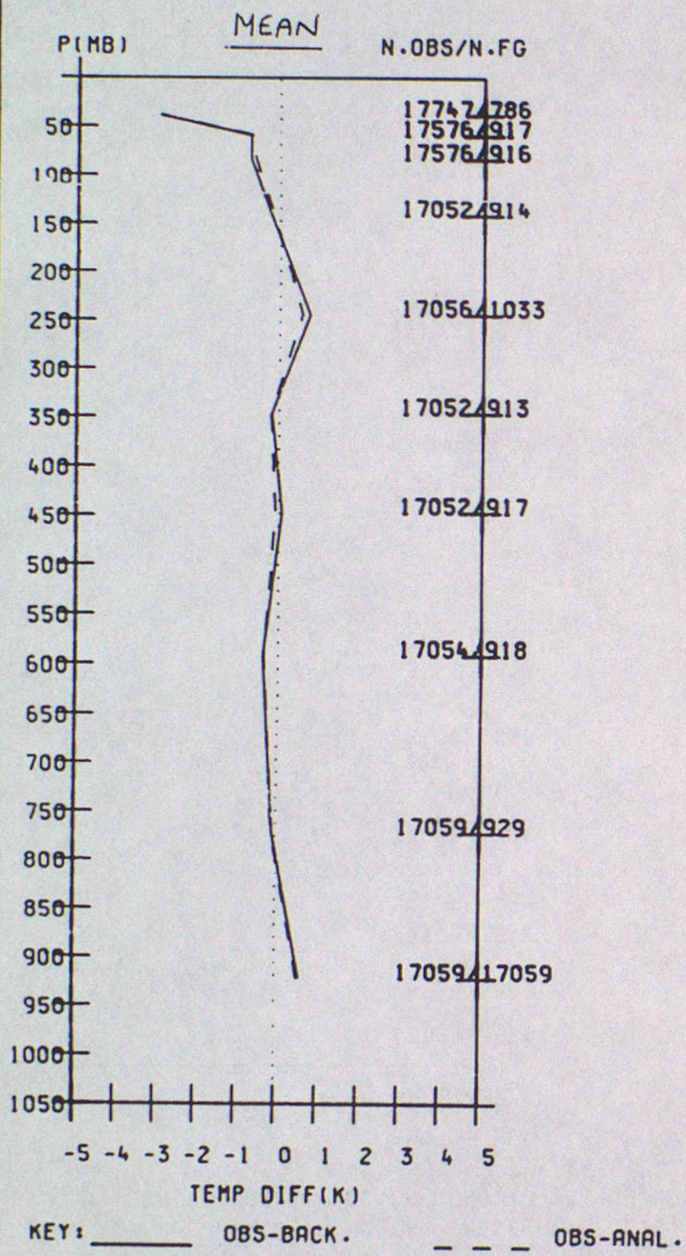


Fig 2.3.5

DATA DERIVED FROM CM OPD FROM 1 JUN 1988 TO 30 JUN 1988 STATISTICS GENERATED ON PRESSURE LEVELS DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR IDENTIFIER: 0 0 0 8
DATA FOR ALL ANALYSIS HOURS MODEL TYPE C.C. SATEMS N. OBS USED IN STATISTICS: 22294
LAT1: 60.00 LAT2: 90.00 LONG1: -180.00 LONG2: 180.00 BOX N. 6

DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS



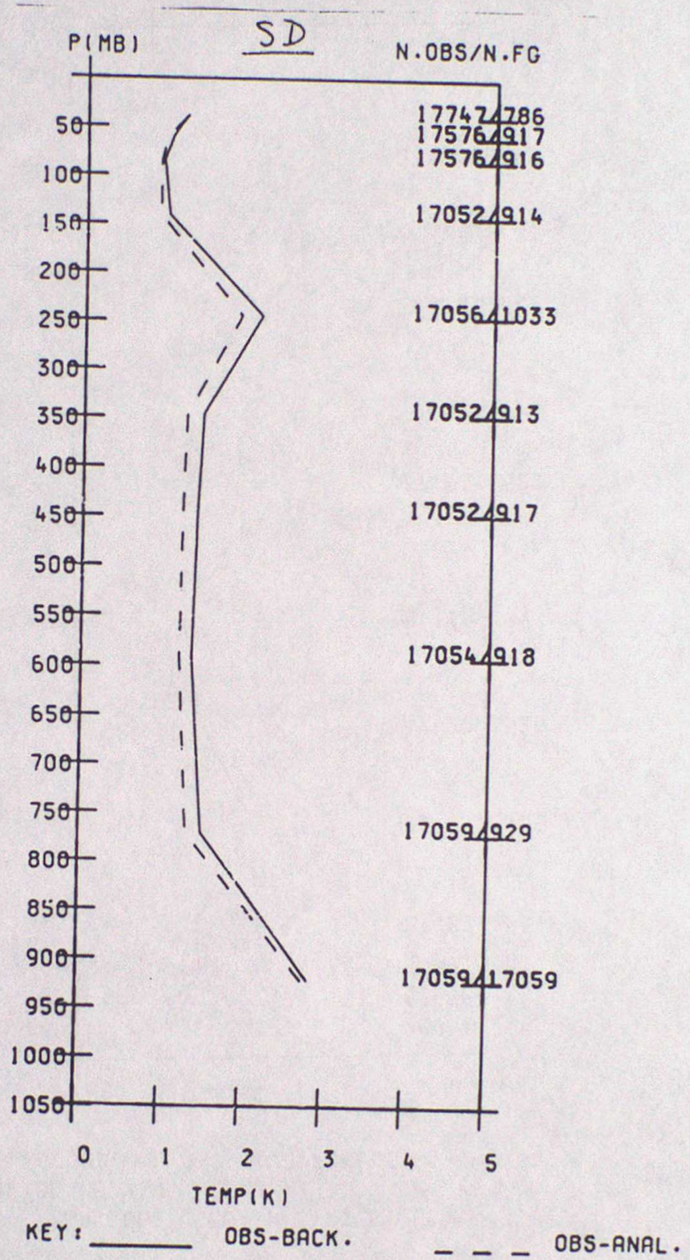


Fig 2.3.6

DATA DERIVED FROM CM OPD FROM 1 DEC 1988 TO 30 DEC 1988 STATISTICS GENERATED ON PRESSURE LEVELS DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR IDENTIFIER: 0 0 0 8
DATA FOR ALL ANALYSIS HOURS MODEL TYPE C.C. SATEMS N. OBS USED IN STATISTICS: 15255
LAT1: -90.00 LAT2: -60.00 LONG1: -180.00 LONG2: 180.00 BOX N. 1

DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS

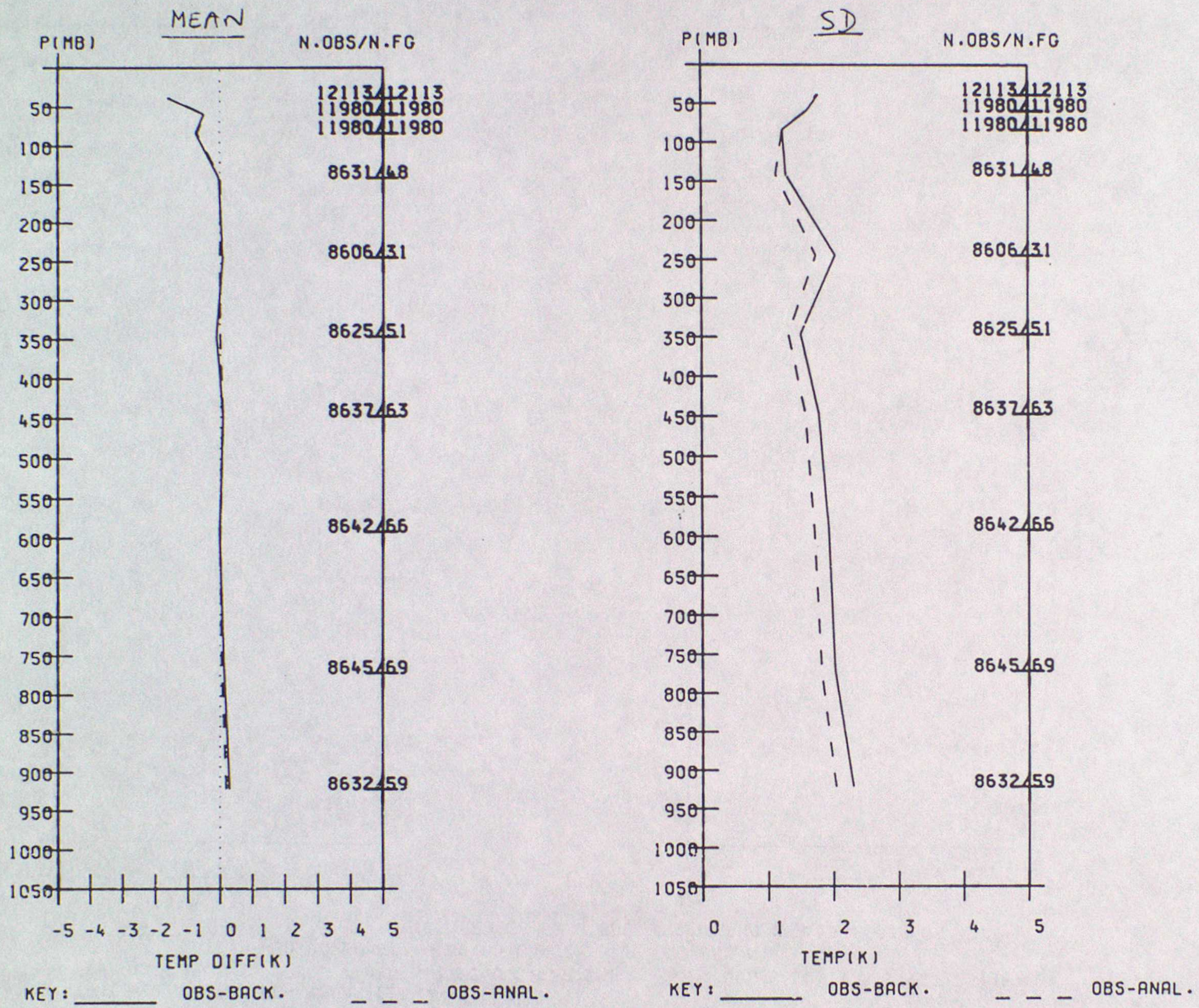


Fig 2.3.7

DATA DERIVED FROM CM OPD FROM 1 DEC 1988 TO 30 DEC 1988 STATISTICS GENERATED ON PRESSURE LEVELS DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR IDENTIFIER: 0 0 0 8
DATA FOR ALL ANALYSIS HOURS MODEL TYPE C.C. SATEMS N. OBS USED IN STATISTICS: 47401
LAT1: -60.00 LAT2: -30.00 LONG1: -180.00 LONG2: 180.00 BOX N. 2

DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS

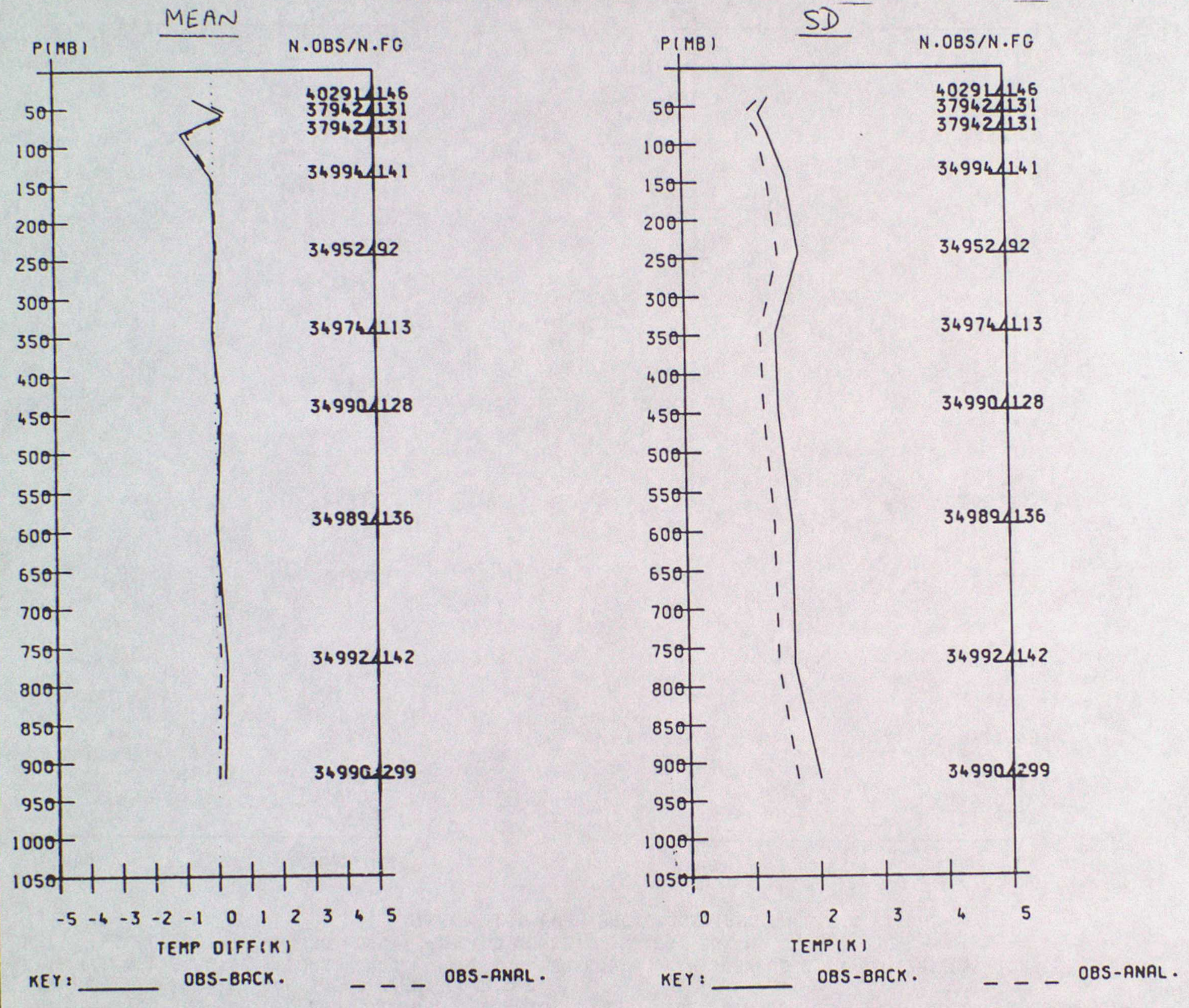
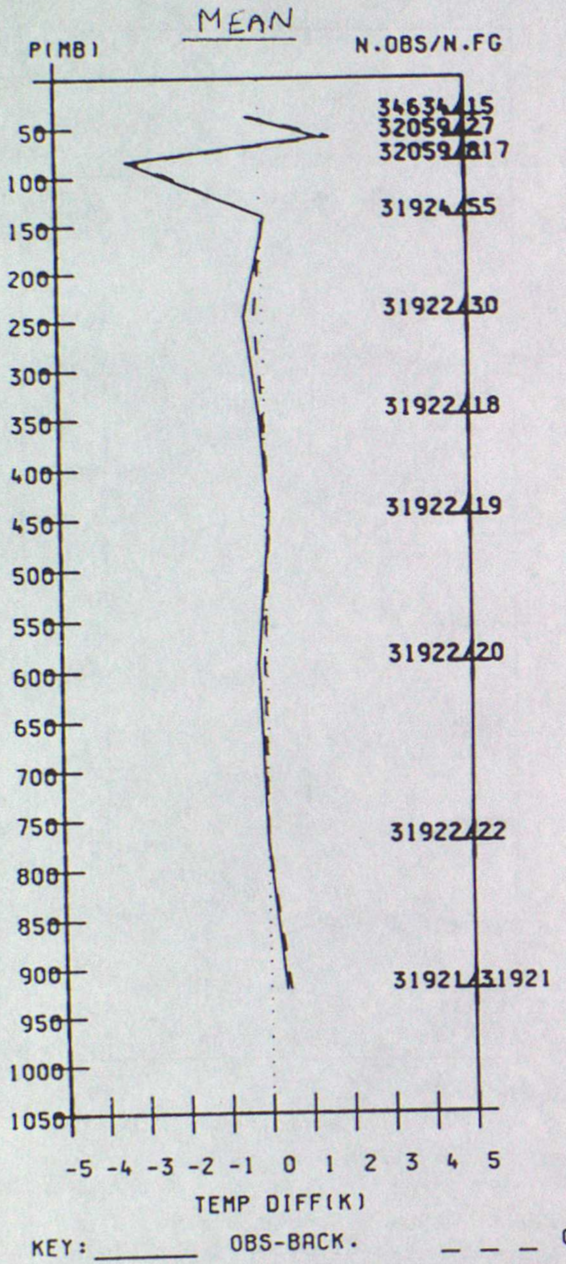


Fig 2.3.8

DATA DERIVED FROM CM OPD FROM 1 DEC 1988 TO 30 DEC 1988 STATISTICS GENERATED ON PRESSURE LEVELS DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR IDENTIFIER: 0 0 0 8
DATA FOR ALL ANALYSIS HOURS MODEL TYPE C.C. SATEMS N. OBS USED IN STATISTICS: 39446
LAT1: -30.00 LAT2: 0.00 LONG1: -180.00 LONG2: 180.00 BOX N. 3

DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS



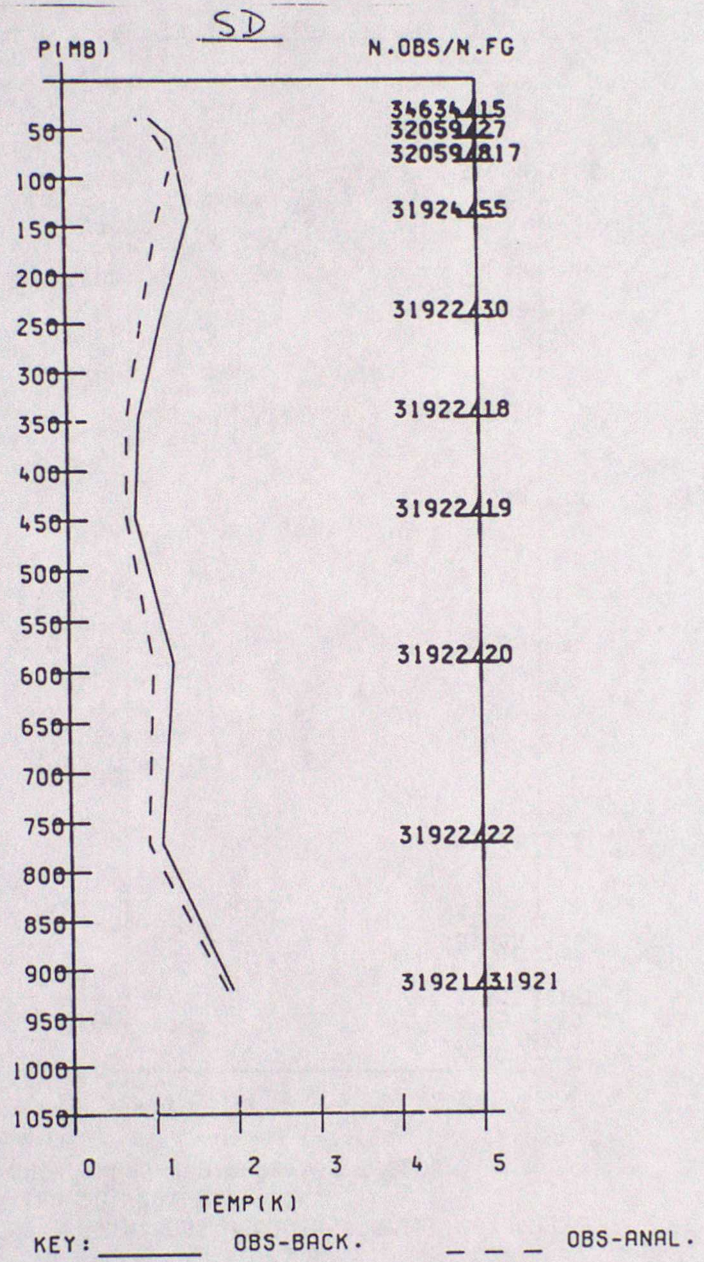
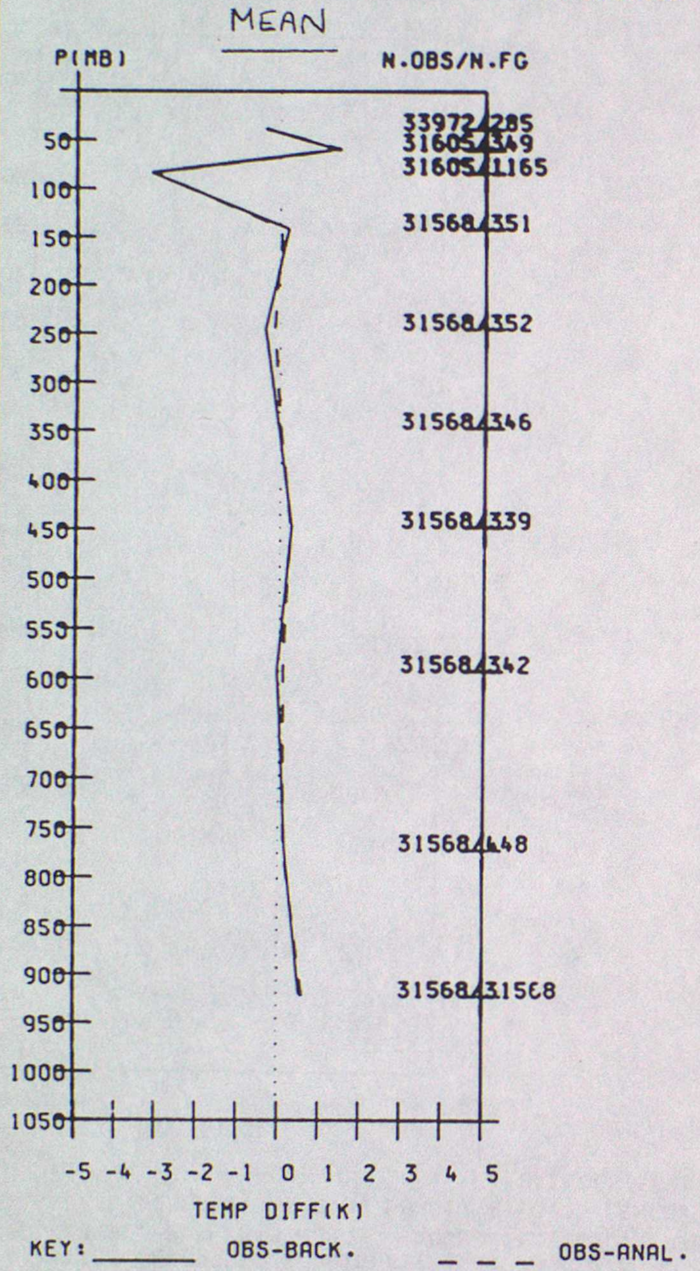


Fig 2.3.9

DATA DERIVED FROM CM OPD FROM 1 DEC 1988 TO 30 DEC 1988 STATISTICS GENERATED ON PRESSURE LEVELS DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR IDENTIFIER: 0 0 0 8
DATA FOR ALL ANALYSIS HOURS MODEL TYPE C.C. SATEMS N. OBS USED IN STATISTICS: 40930
LAT1: 0.00 LAT2: 30.00 LONG1: -180.00 LONG2: 180.00 BOX N. 4

DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS



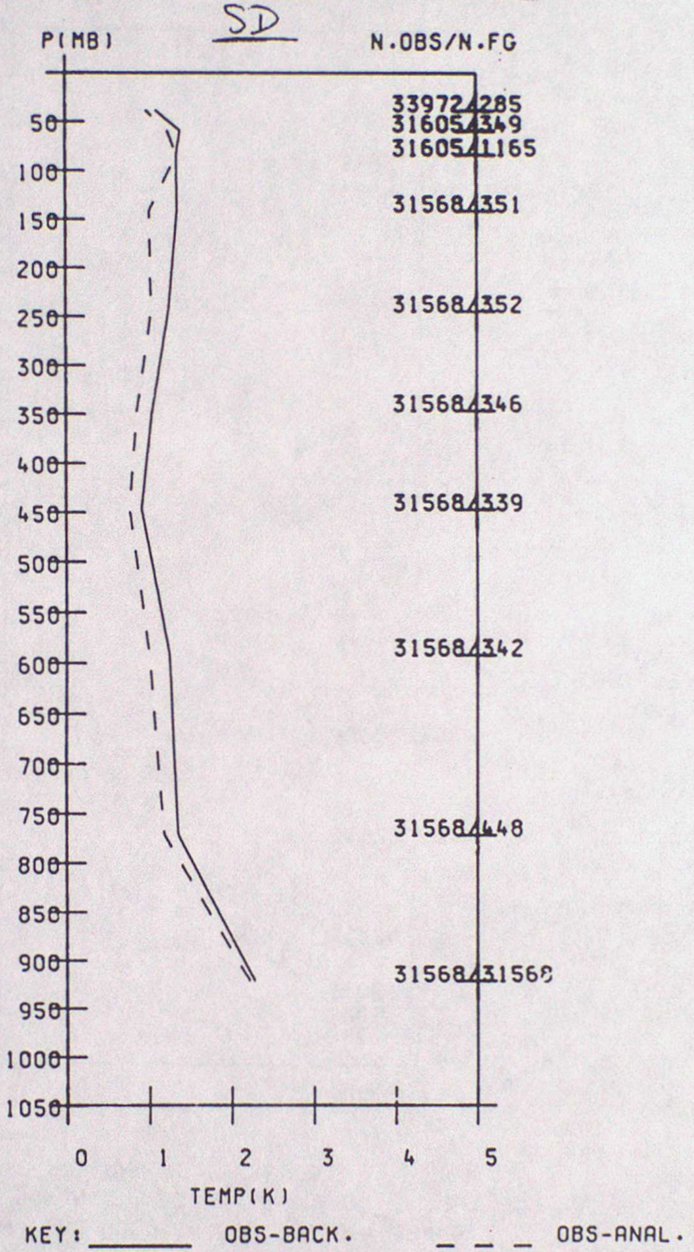
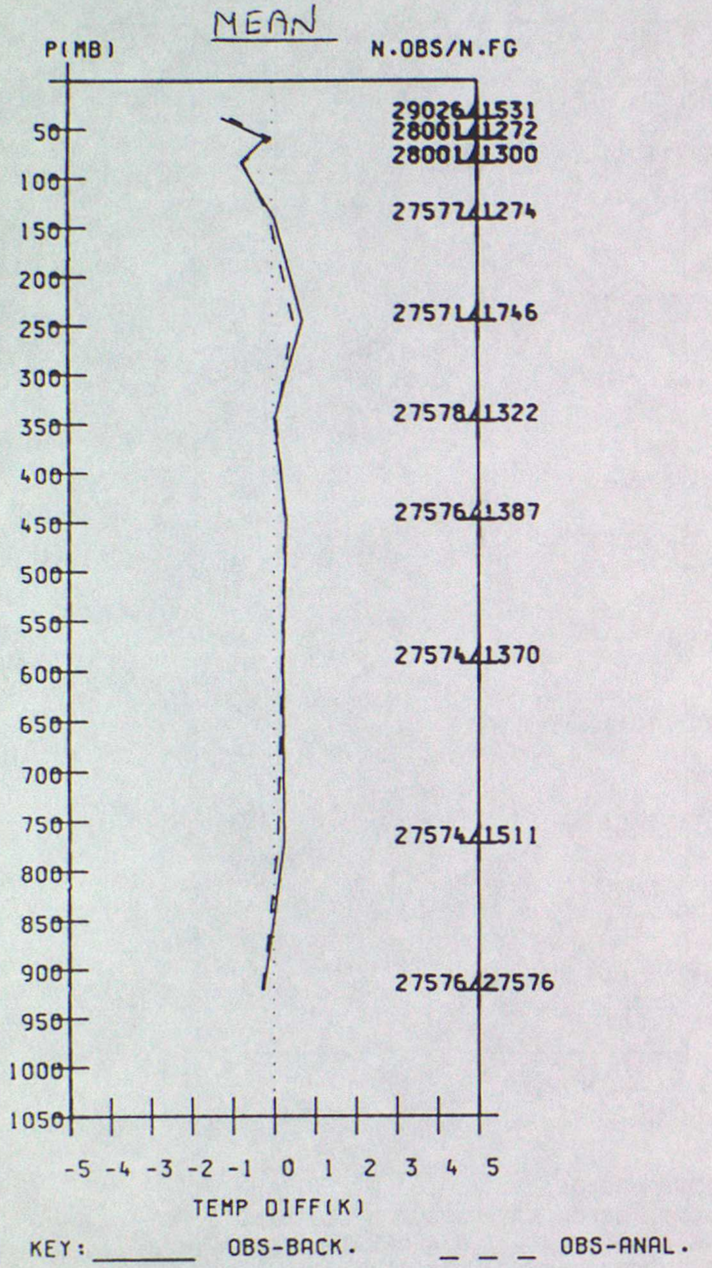


Fig 2.3.10

DATA DERIVED FROM CM OPD FROM 1 DEC 1988 TO 30 DEC 1988 STATISTICS GENERATED ON PRESSURE LEVELS DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR IDENTIFIER: 0 0 0 8
DATA FOR ALL ANALYSIS HOURS MODEL TYPE C.C. SATEMS N. OBS USED IN STATISTICS: 33277
LAT1: 30.00 LAT2: 60.00 LONG1: -180.00 LONG2: 180.00 BOX N. 5

DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS



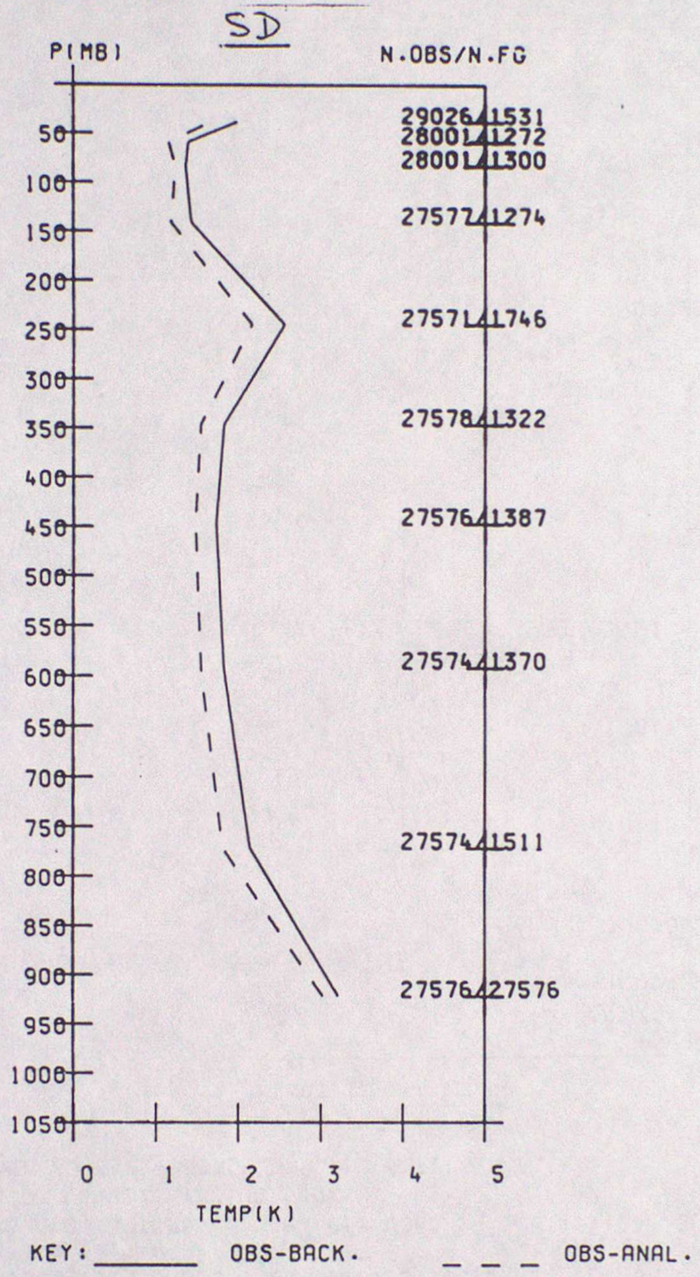


Fig 2.3.11

DATA DERIVED FROM CM OPD FROM 1 DEC 1988 TO 30 DEC 1988 STATISTICS GENERATED ON PRESSURE LEVELS DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR IDENTIFIER: 0 0 0 8
DATA FOR ALL ANALYSIS HOURS MODEL TYPE C.C. SATEMS N. OBS USED IN STATISTICS: 20582
LAT1: 60.00 LAT2: 90.00 LONG1: -180.00 LONG2: 180.00 BOX N. 6
DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS

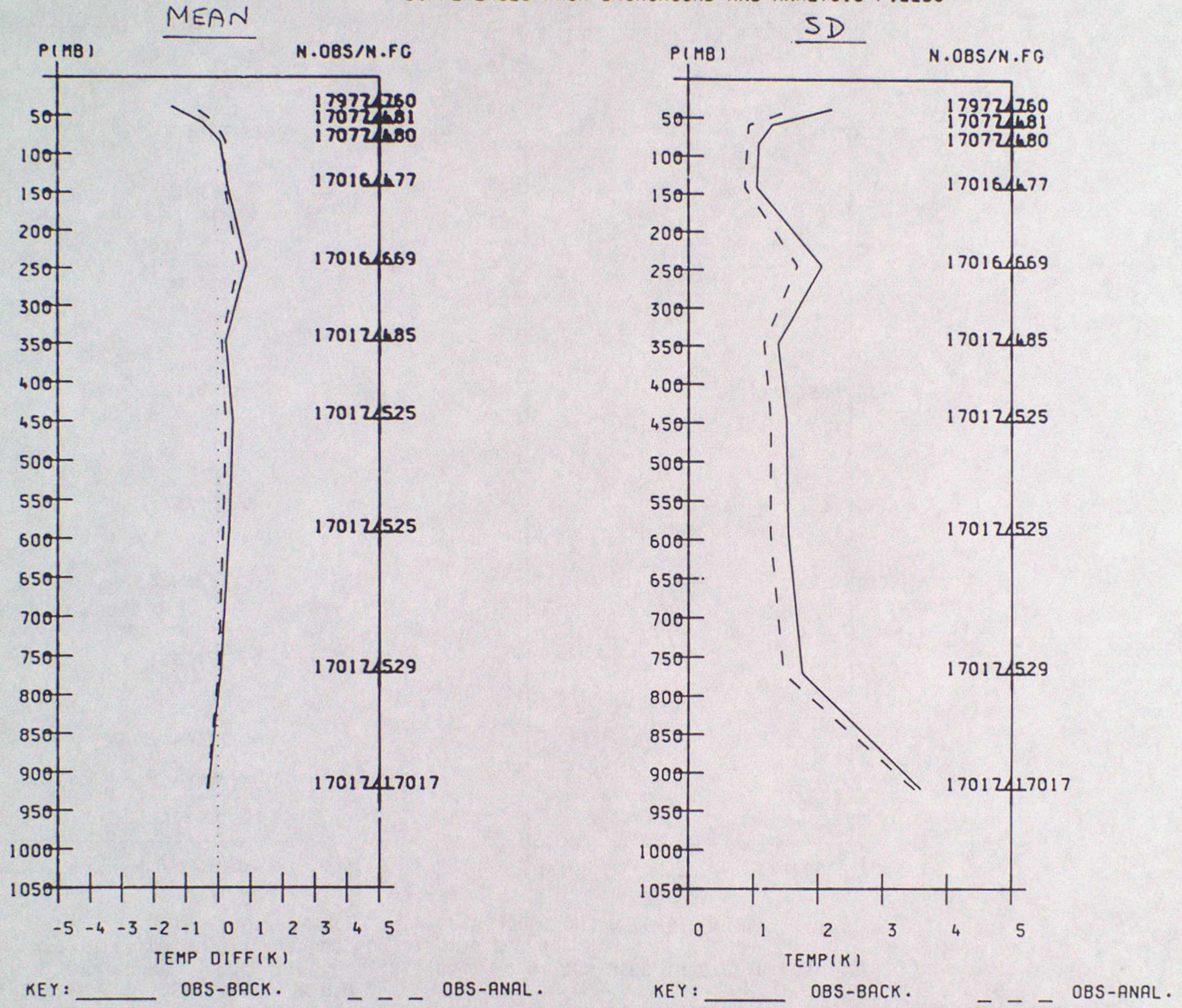


Fig 2.3.12

DATA DERIVED FROM FM OPD FROM 1 DEC 1988 TO 31 DEC 1988 STATISTICS GENERATED ON PRESSURE LEVELS DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR IDENTIFIER: LASS N. OBS USED IN STATISTICS:12371
DATA FOR ALL ANALYSIS HOURS MODEL TYPE HERMES
LAT1: 30.00 LAT2: 80.00 LONG1: -80.00 LONG2: 40.00 BOX N. 1
DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS

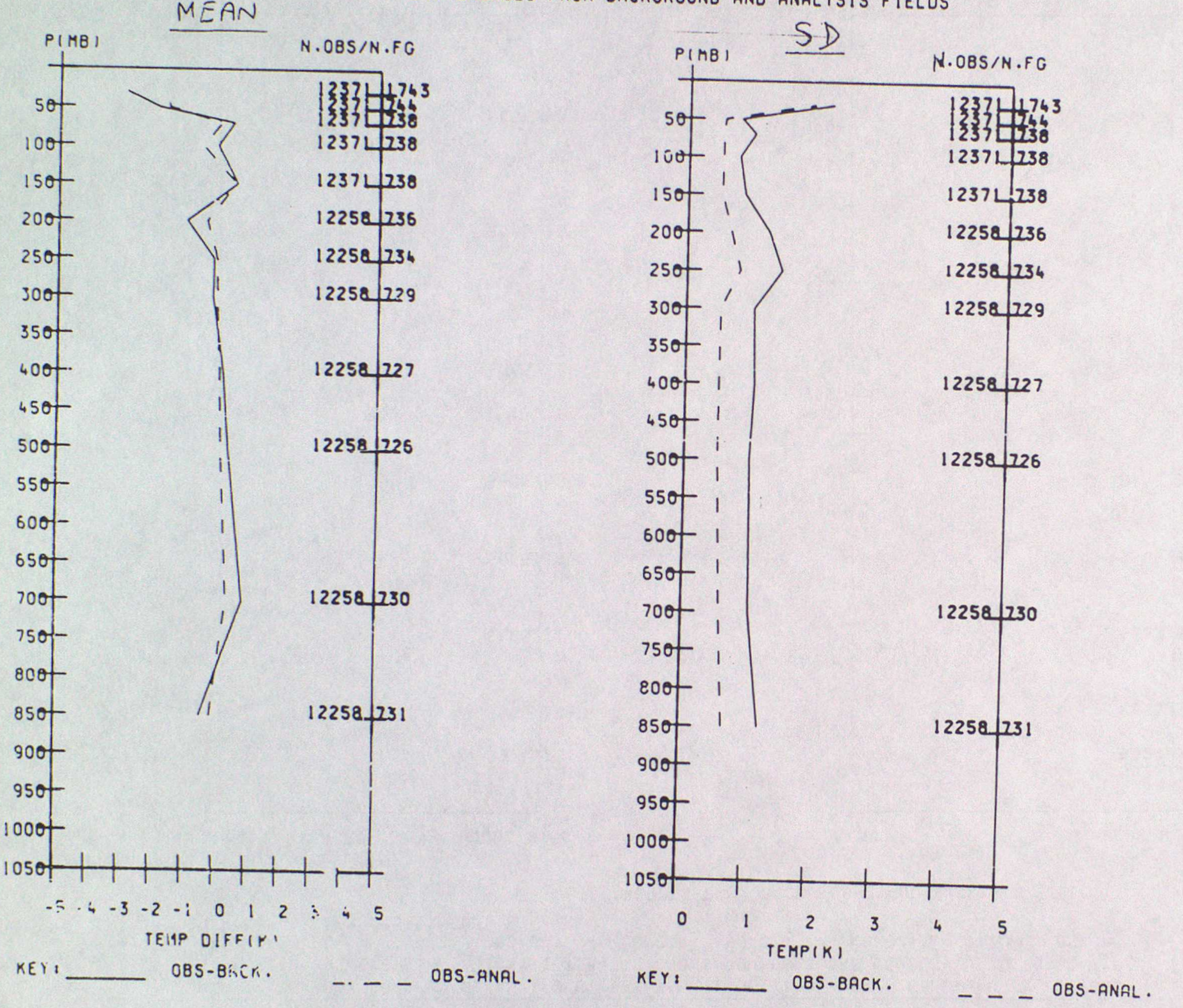


Fig 2.3 13

DATA TAKEN FROM FM OPD FROM 1 DEC 1988 TO 31 DEC 1986 DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR IDENTIFIER: 0 0 0 8 ON PRESSURE LEVELS MODEL DATA TYPE=C.C. SATEMS
LAT1: 30.00 LAT2: 80.00 LONG1: -80.00 LONG2: 40.00 BOX N. 1 N. REPORTS: 7515 N. OBS USED: 7515
DATA FOR ALL ANALYSIS HOURS

DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS

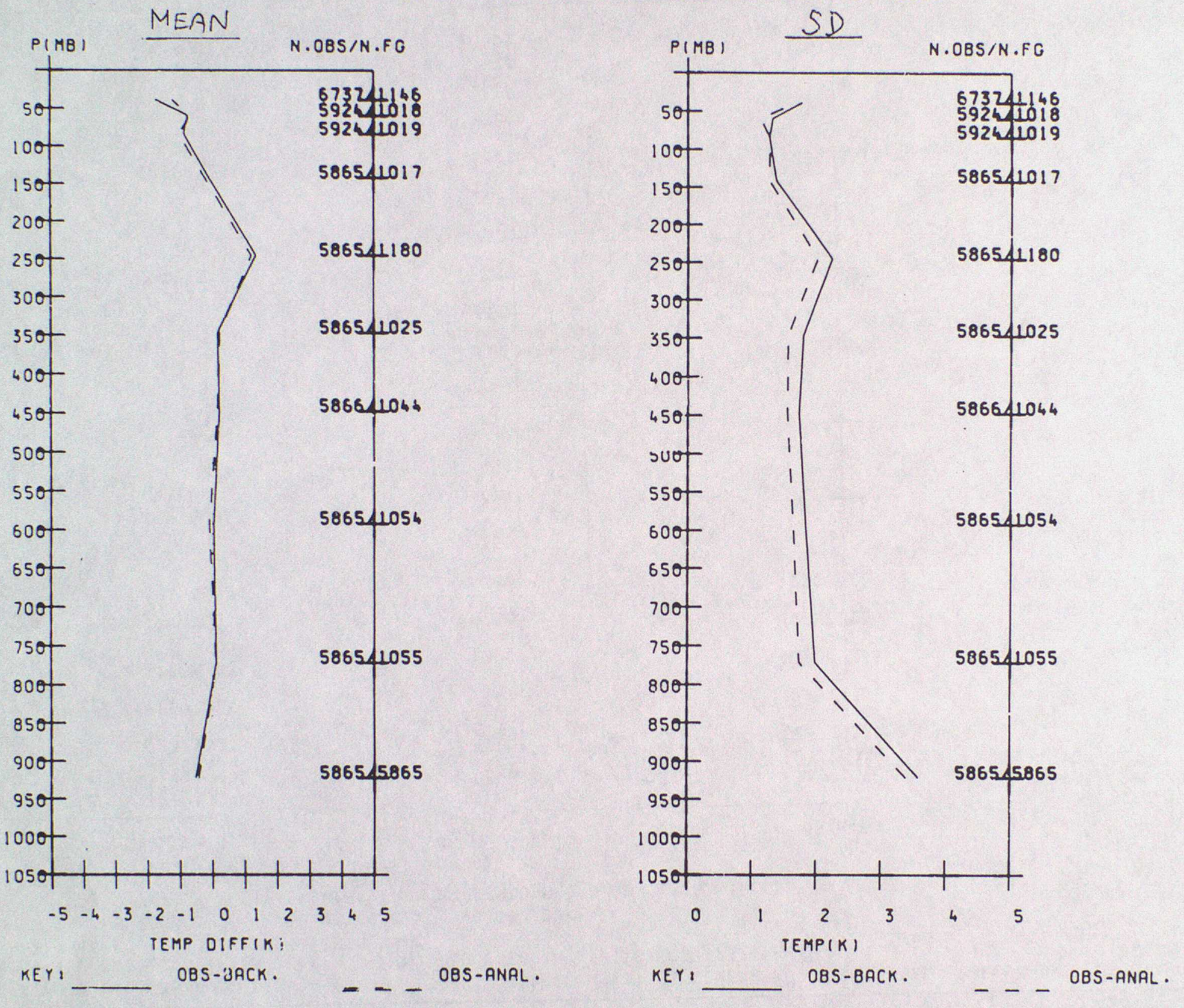
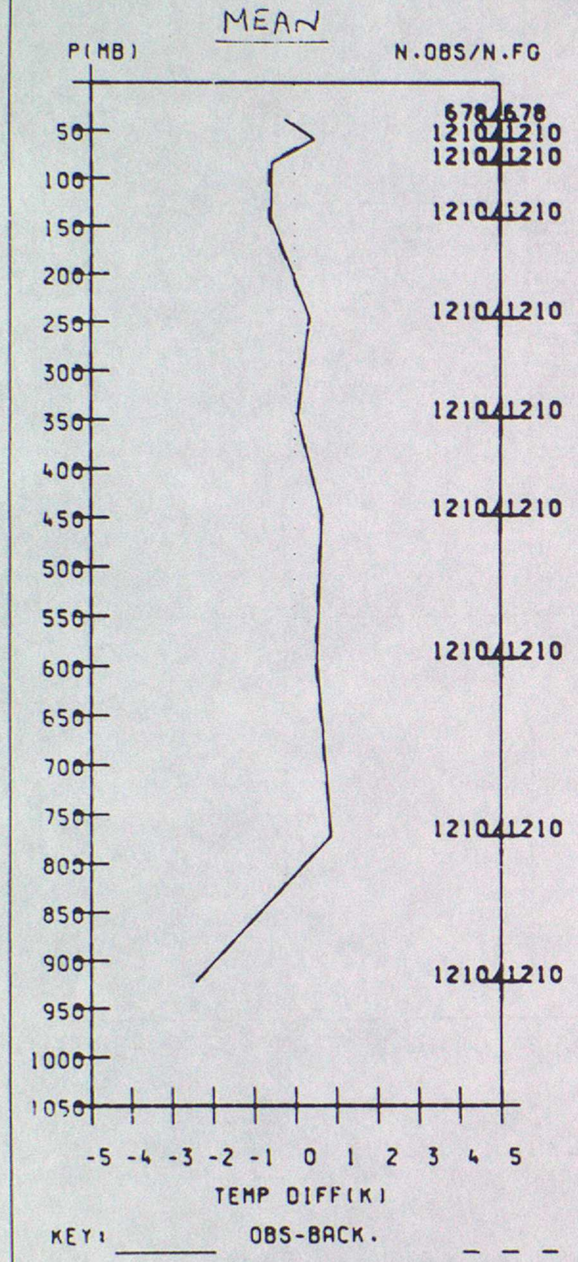


Fig 2.3.14

DATA TAKEN FROM FM OPD FROM 1 DEC 1988 TO 31 DEC 1988 DATA USED: NO EXCLUSIONS
STATISTICS GENERATED FOR IDENTIFIER: 0 0 0 2 ON PRESSURE LEVELS MODEL DATA TYPE=C.C. SATEMS
LAT1: 30.00 LAT2: 80.00 LONG1: -80.00 LONG?: 40.00 BOX N. 1 N. REPORTS: 1377 N. OBS USED: 1377
DATA FOR ALL ANALYSIS HOURS

DIFFERENCES FROM BACKGROUND AND ANALYSIS FIELDS



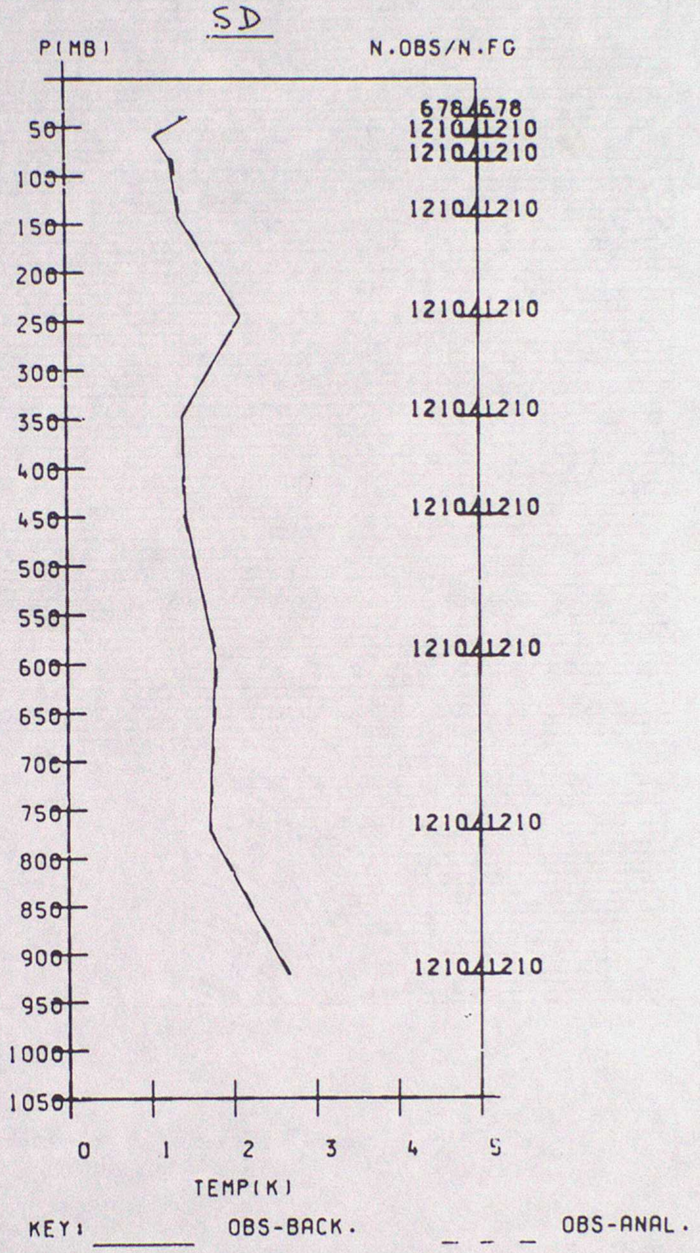


Fig 2.3.15

Fig 2.3.16

LASS-BACKGRD TEMPERATURE DIFFERENCES AT 850 HPA
DECEMBER 1988
DATA FROM NOAA-10
VALUES USED ONLY WHERE NO. OBS > 70

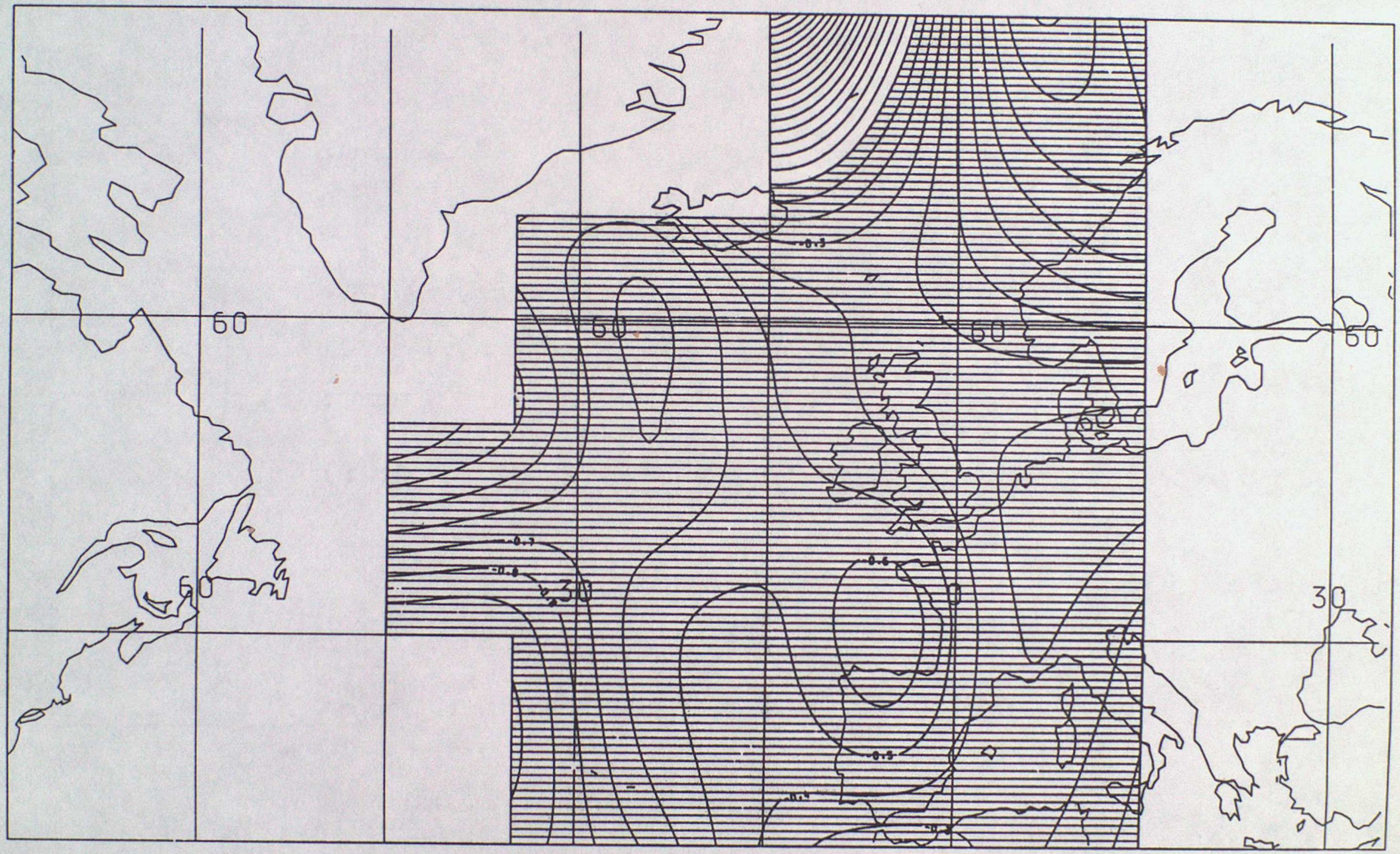


Fig 2.3.17

CCS-BACKGRD TEMPERATURE DIFFERENCES AT 922 HPA
DECEMBER 1988
DATA FROM NOAA-10 & NOAA-11
VALUES USED ONLY WHERE NO. OBS > 70