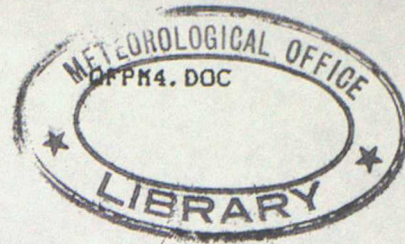


DUPLICATE ALSO



CENTRAL FORECASTING MONITORING NOTE NO. 5
MONITORING STATISTICS FOR SATEM_s AND SATOB_s,
DECEMBER 1989-FEBRUARY 1990 and JUNE-AUGUST 1990

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1. Introduction

Forecasting Products Monitoring Note 3 presented observation minus global model background field (O-B) statistics for SATEMs and SATOBs for September to November 1989. This Note gives similar statistics for the periods December 1989 to February 1990 and June to August 1990. For convenience, these periods will be referred to as P1 and P2 respectively.

Like the earlier Note, results for AIREPs, TEMPs/PILOTs and LASS (Local Area Sounding System) data are shown for comparison. Also, comments in Monitoring Note 3 regarding the purpose of these Notes and the exchange of monitoring data with other centres (which has governed the choice of vertical bands used in the analysis) equally apply to this Note.

When comparing statistics from the different observation types, the representativeness of the observations needs to be borne in mind. The satellite temperatures (and to a lesser extent winds) are in reality areal averages in the horizontal and vertical. However they are presented to the model as values at a point. TEMP observations are also averaged in the vertical to form layer means before they are passed to the model. In contrast, AIREP reports can be considered as 'point' observations and these are not averaged. Since the model values are essentially averages over tens of millibars in the vertical and 100 km or so in the horizontal, the representativeness 'errors' for AIREPs are likely to be larger compared to the other types. The rms differences quoted below implicitly include a contribution due to differences between observation and model representativeness.

The circumstances under which the observations are made also need to be considered. TEMPs report at fixed times regardless of synoptic conditions. However reports from AIREPs are biased towards jets where wind gradients are large, SATEMs away from areas of precipitation where gradients are likely on average to be weaker and SATOBs can only occur where cloud exists - in the Tropics tending to be associated with areas of convection and in mid-latitudes with areas of strong winds where vertical and horizontal gradients are relatively high.

Results are presented in the form of charts of mean and rms O-B differences by observation type, by band and by season. Except where stated, the background field is the 6 hour forecast from the 15 level operational NWP global model. Observations are for all hours combined.

Since the main aim of the Note is to investigate the characteristics of the satellite data, the comments concentrate on this aspect. It is intended to produce a separate Note on perceived model biases (as suggested for example by some of the O-B differences for sondes) in due course.

2. Temperatures

2.1 SATEMs

Strictly the observations used here are compressed code SATEMs i.e. at 240 km resolution, as opposed to the low resolution 500 km SATEMs which are distributed widely over the GTS. Results are for NOAA-10 and NOAA-11 observations combined. The compressed code data are received as virtual temperatures over layers between significant levels. They are presented to the model as actual temperatures at the mid-points of standard levels.

SATEM data over land are not used by the model. This means that over the land the model analyses and background fields are influenced largely by observation types other than SATEMs - above 150 hPa principally by TEMPs. This will be reflected in the O-B statistics. In contrast, over the sea, where SATEMs are used and there are few TEMPs, the impact of SATEMs on the analyses and background fields is much greater.

Figs 1-2 and 3-4 show mean and rms O-B values for P1 and P2 respectively for the band 850-1000 hPa (for which the model is presented with a temperature increment at 922 hPa). Over land, where SATEMs are not used, mean differences are often large. Elsewhere they are generally within ± 1 deg C, except over the west Pacific and west Atlantic, where they exceed 1 deg C, more especially in P1. RMS differences over the sea lie within 1-2 deg C in the Tropics but exceed 3 deg C in mid-latitudes in P1. Temperatures at the 922 hPa level are excluded from the model north of 30 deg south.

Figs 5-6 and 7-8 are equivalent to 1-4 for the band 100-300 hPa. Mean differences over the sea are within ± 1 deg C in both periods. Corresponding rms values vary from 1 deg C over the tropical Atlantic to 3 deg C in northern mid-latitudes in P1.

Figs 9-12 relate to the band 30-50 hPa. For P1, means are close to zero except over the north Atlantic and the western hemisphere south of 60 degrees south, where they are negative. For P2, means are more generally negative. RMS differences range from 1 deg C over the Tropics to over 3 deg C in northern mid-latitudes in P1 and over Antarctica in P2. Temperatures above 100 hPa are not presented to the model south of 60 deg south.

2.2 TEMPs

Figs 13 and 14 show mean and rms differences for TEMPs in the band 800-999 hPa for the period P1. As for all the observation types, data-sets of monthly summary statistics have been used to produce these charts. For TEMPs, statistics are available in 100 hPa bands and for this analysis, values for one month from any single 100 hPa band have been excluded if fewer than 30 observations exist or if more than 5% of the observations have been flagged at the final stage of the quality control. This last criterion should have the effect of excluding the poorest quality TEMPs. Temperature observations from WMO blocks 42 and 43 (India) are permanently rejected due to long-standing poor quality and are not included in these figures.

Mean differences in fig 13 are negative over Australia but positive over much of north America, Europe and Asia. RMS differences vary from 1-2 deg C over the oceans and western Europe to 2-4 deg C elsewhere. Figs 15 to 16 for the bands 100-299 hPa indicate little overall bias and rms values

between 1 and 3 deg C. For 10-99 hPa, figs 17 and 18, means are significantly positive especially in the Tropics and southern hemisphere, and rms differences show considerable fluctuation across the globe - between 1.5 and 5 deg C.

Figs 19-24 correspond to figs 13-18 for period P2. Results are broadly similar to those for P1 with the expected seasonal variation in the magnitude of the rms values outside the Tropics. However this is masked to some extent for the lowest band due to changes in the opposite sense in the absolute magnitude of the mean differences.

The marked differences in the TEMP (and PILOT) values that occasionally occur from grid box to grid box are likely to arise more from variations in the quality of the observations within those boxes rather than abrupt changes in the quality of the background field (except near high topography). This could be due to changes in instrument type, tracking method, observing practice, representativeness etc.

Comparing results for SATEMs and TEMPs, for the lowest band, biases and rms values are significantly greater for the SATEMs north of about 30 deg north whereas south of this latitude values are similar. SATEM values over land are much higher everywhere. At 100-300 hPa, mean O-B differences are not significantly biased for either the TEMPs or SATEMs (discounting the Himalayan region) and for the rms values the SATEMs are slightly less than for TEMPs. Mean differences tend to be of opposite sign for the highest level (negative for SATEMs, positive for TEMPs) and rms values are again lower in general for the SATEMs.

The discrepancy between the mean O-B values for TEMPs and SATEMs at the highest band may be due to an artefact of the interpolation procedures used to estimate temperatures at a single level, where the data in reality represent values over layers. (Reference : Swinbank and Wilson, Short Range Forecasting Research Technical Note no. 48).

2.3 AIREPs

Figs 25 and 26 show mean and rms differences for AIREPs in the band 100 to 299 hPa for P1. Observations more than 10 deg C from the background have been excluded. Note that values for January 1990 are not available.

Overall mean differences are close to zero (as they are for SATEMs) and rms differences range from about 2-3 deg C, somewhat higher than they are for SATEMs.

2.4 LASS

LASS data are presented to the model as temperatures on standard levels from 850 hPa upwards. Values at 1000 hPa are also derived but, like the bottom level SATEMs north of 30 deg south, are not used.

Figs 27 and 28 display mean and rms O-B differences for LASS data for P2 only (results are not available in a suitable form for P1). The band used here is 500-1000 hPa. The background field is a 3 hour fine mesh forecast, in contrast to the 6 hour global forecast used for the other types. Observations

that have been flagged by the LASS processing scheme as likely to be suspect are excluded (i.e. data over surface elevation of more than 500m, those with all HIRS and MSU data missing and those with differences in brightness temperature between background field and sounding greater than a certain threshold).

The average mean difference is seen to be about zero but there is a distinct variation across the fine mesh area - positive values in the north-west and negative in the south-east. The same is true for the bands 850-1000 and 700-850 hPa taken separately and for each of the three months comprising P2 (not shown). The equivalent values for SATEMs in the fine mesh runs (also not shown) do not exhibit this feature. The precise reason for the NW/SE variation is not known but may be related to land/sea biases previously noted in the thickness patterns by the LASS processing group.

RMS O-B differences are nearly everywhere less than 1 deg C, compared to values between 1.5 and 2.0 deg C for SATEMs over the same area and using a 3 hour fine mesh background field. The lower rms values for LASS data are to be expected given that they use the fine mesh background field as a 'first guess'.

3. Winds

3.1 SATOBs

SATOB winds are available from four satellites : METEOSAT, GMS, GOES and INSAT. The area of coverage of these satellites is approximately :

METEOSAT	-	60 deg W to 60 deg E
INSAT	-	70 deg E to 100 deg E
GMS	-	90 deg E to 170 deg E
GOES	-	160 deg W to 70 deg W

Until February 7th 1990 METEOSAT observations above 500 hPa north of 30 deg north were not presented to the model. They were included after monitoring results indicated their quality had improved significantly over the two years or so prior to that date. After March 14th 1990, GMS winds above 500 hPa polewards of 20 deg N/S were excluded from the analysis after monitoring studies showed their quality to be relatively poor, in particular markedly under-estimating winds in jets. INSAT observations have always been excluded from the model - their quality has been consistently poor.

Figs 29 to 32 show for period P1 and band 700-999 hPa, vector mean winds, vector mean differences, mean speed differences and rms vector differences. A feature in fig 30 of interest, apart from the large vector differences in the Indian Ocean from INSAT, are the line of 'convergence' in the biases along 0-10 deg south. Mean speed differences (fig 31) are in general small (less than 1 mps - metres per second). RMS differences are of the order 4-6 mps over all latitudes. INSAT winds compare unfavourably with those from other satellites at all bands and seasons and further reference to them is omitted.

Figs 33 to 36 are equivalent to figs 29 to 32 for period P2, although note that the results are now for 701-1000 hPa. A line of convergence is again evident around 0-10 deg south in the vector wind differences, especially in the east Pacific (observations from GOES). In contrast to the mean speed differences for P1, values for P2 are significantly different from zero for P2, being less than -2 mps in the central Pacific and greater than +2 mps off the west coast of central Africa (observations from METEOSAT). RMS differences are as small as 3 mps in some areas for this period.

Figs 37 to 40 display results for the 100-399 hPa band for P1. A striking feature of fig 38 is the easterly bias in the mid-latitude winds especially in the observations from GMS i.e. over east Asia and Australasia. Also of note is a divergence in the biases around 0-10 deg south where convergence is observed below 700 hPa. Mean speed differences are large negative where easterly biases exist and positive in the Tropics. There is a very wide range of rms difference values - from 5 mps to in excess of 20 mps.

Similar remarks pertain to results for period P2 in figs 41 to 44, once allowance is made for the fact that the strongest winds and greatest under-estimation of speeds are now present in the southern hemisphere. The area of divergence is however further north than in P1, at 10 deg north.

Note that observations at 400 hPa are included in the upper band for P2 but not for P1. This means that GMS upper level winds in the winter hemisphere (polewards of 25 degrees) which are routinely assigned to 400 hPa are included in the upper band in P2 (south of 25 deg south) but not in P1.

3.2 TEMPs/PILOTs

The same criteria for selection is used here for sonde winds as used for temperatures (section 2.2). Figs 45 to 48 show mean speed and rms vector differences for the bands 700-999 and 100-399 hPa for period P1. For the lower band, speed differences tend to be negative, particularly over north America and south-east Asia. RMS differences in general range from 4-7 mps with the lowest values tending to be over inland areas between 50-70 deg north. Where comparison between TEMP and SATOB values is possible, the rms differences are smaller for SATOBs in the north and south Atlantic, where the SATOBs are derived from METEOSAT. Otherwise, the SATOB values are in general larger.

For 100-399 hPa, speed differences are generally positive (particularly over south Asia, although here there are also some large negative values). RMS values vary from 4-5 mps in northern mid-latitudes to greater than 10 mps in some areas. There is no indication of the negative O-B differences for sondes in mid-latitudes which are evident for SATOBs. However there is some suggestion, as observed for SATOBs, that mean differences are positive in the Tropics. RMS differences are generally far smaller compared to SATOBs except over and around Africa where they are similar.

Figs 49 to 52 display mean speed and rms vector differences for the same two bands for P2. For 700-999 hPa, mean differences for P2 are similar to those of P1 but for 100-399 hPa, mean differences in P2 are more positive in the southern mid-latitudes but smaller over and around the Himalayas (i.e. differences are larger in the winter season in both cases). This is also reflected in relative magnitudes of the rms vector differences. Although generally there is an increase of around 1-2 mps in the rms values in mid-latitudes between summer and winter, over Australasia the difference for the 700-999 hPa band is in the opposite sense - winter values are smaller.

3.3 AIREPs

Figs 53 and 54 show mean and rms differences for P1 for the band 100-399 hPa. Observations with an rms vector difference from background greater than 60 mps have been excluded. The O-B means are positive (again no negative biases in mid-latitudes) and as high as about 5 mps in the Tropics. RMS differences lie generally in the range 7-14 mps, and are considerably less than those for SATOBs in the north-west Pacific (where mean differences are very marked). Elsewhere the differences between the types are generally within 2 mps.

4. Implications for the operational suite

Implications of these results for the operational suite are broadly similar to those stated in Monitoring Note 3 for the period September to November 1989. This is not unexpected given that no significant model changes have taken place since Autumn 1989.

We may conclude from results presented here that

- omitting from the model tropospheric SATEM data over land and 850-1000 hPa SATEM data over the sea north of 30 deg south is justified, comparing corresponding SATEM and TEMP results.

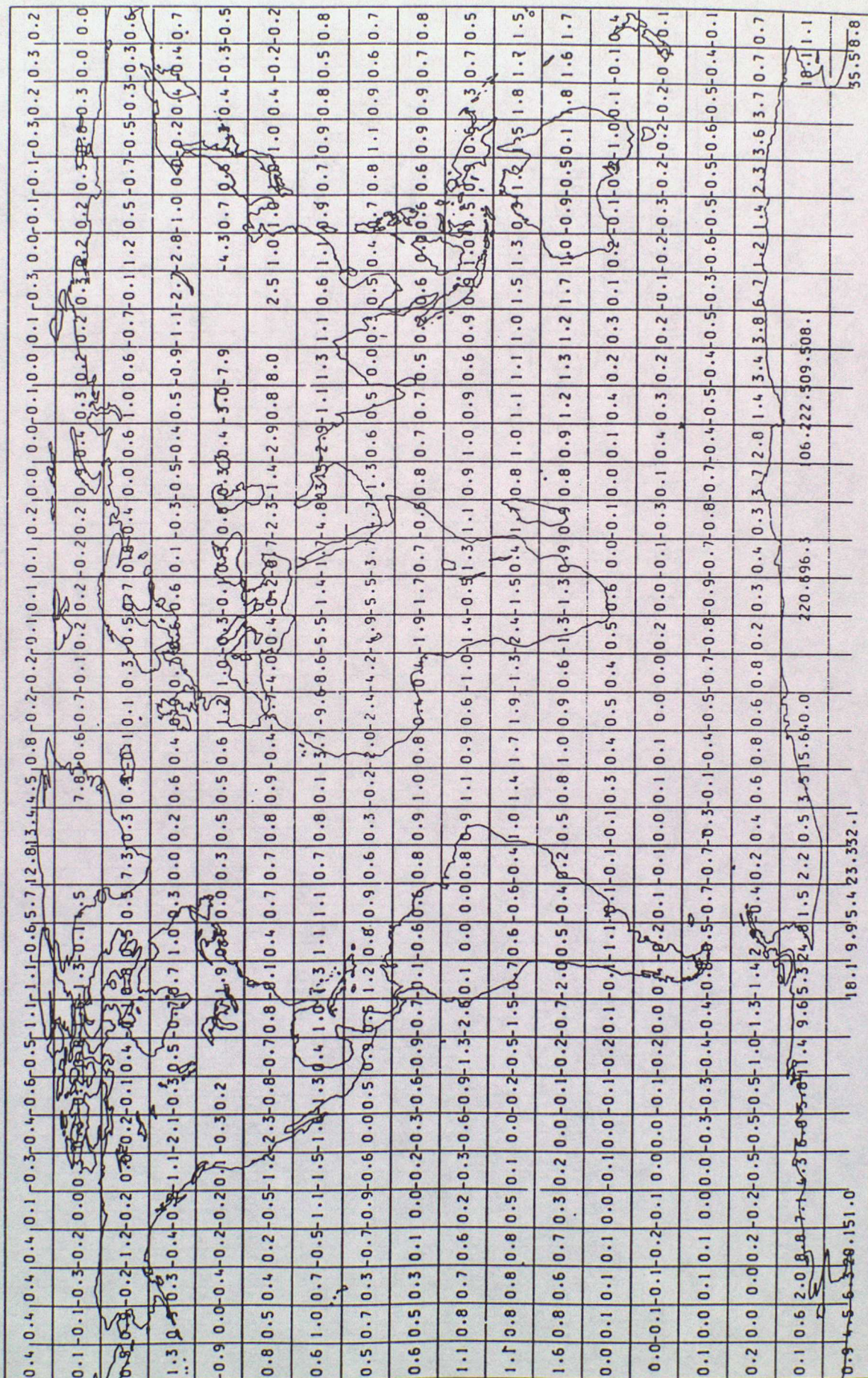
- SATEM data above 100 hPa over all surfaces could be usefully included in the model (not just over the sea and sea ice). This is particularly significant for the unified model, soon to be implemented operationally, which has more levels in the stratosphere and a top level of 7 hPa where TEMP coverage becomes poor.

- the SATOB results for June to August 1990 support the decision made earlier in the year to reinstate high level METEOSAT observations and to reject GMS high level observations polewards of 20 degrees.

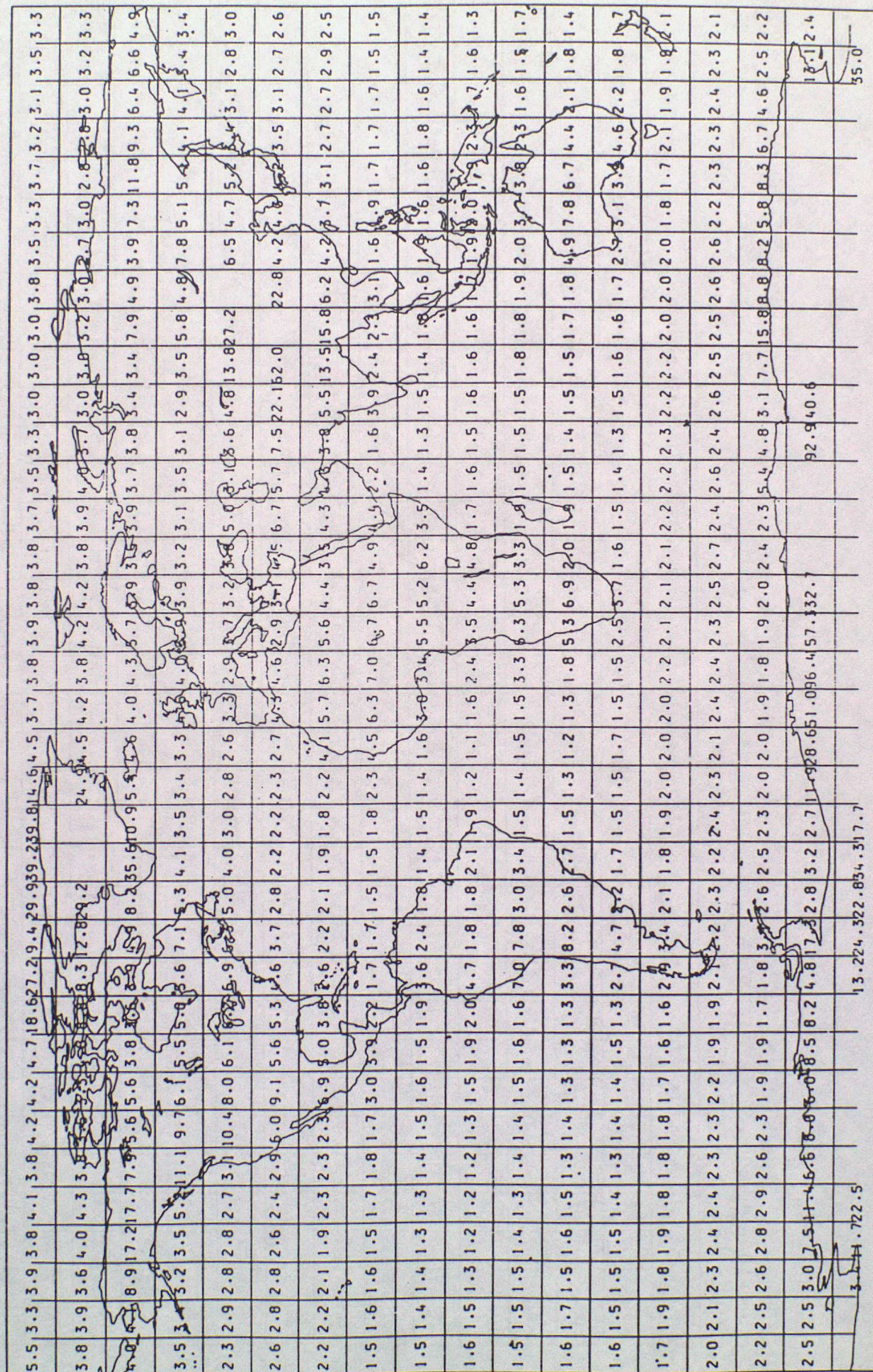
SATEMS : MEAN O-B TEMPERATURE DIFFERENCES (DEG C) BETWEEN 850 AND 1000 HPA
1/12/89 TO 28/02/90
NOAA-10 AND NOAA-11 STATISTICS COMBINED
VALUES ARE PRINTED WHERE > 30 OBS ARE PRESENT

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SATEMS : MEAN O-B TEMPERATURE DIFFERENCES (DEG C) BETWEEN 850 AND 1000 HPA
1/06/90 TO 31/08/90
NOAA-10 AND NOAA-11 STATISTICS COMBINED
VALUES ARE PRINTED WHERE > 30 OBS ARE PRESENT



SATEMS : RMS O-B TEMPERATURE DIFFERENCES (DEC C) BETWEEN 850 AND 1000 HPA
1/12/89 TO 28/02/90
NOAA-10 AND NOAA-11 STATISTICS COMBINED
VALUES ARE PRINTED WHERE > 30 OBS ARE PRESENT



SATEMS : RMS O-B TEMPERATURE DIFFERENCES (DEG C) BETWEEN 850 AND 1000 HPA
1/06/90 TO 31/08/90
NOAA-10 AND NOAA-11 STATISTICS COMBINED
VALUES ARE PRINTED WHERE > 30 OBS ARE PRESENT

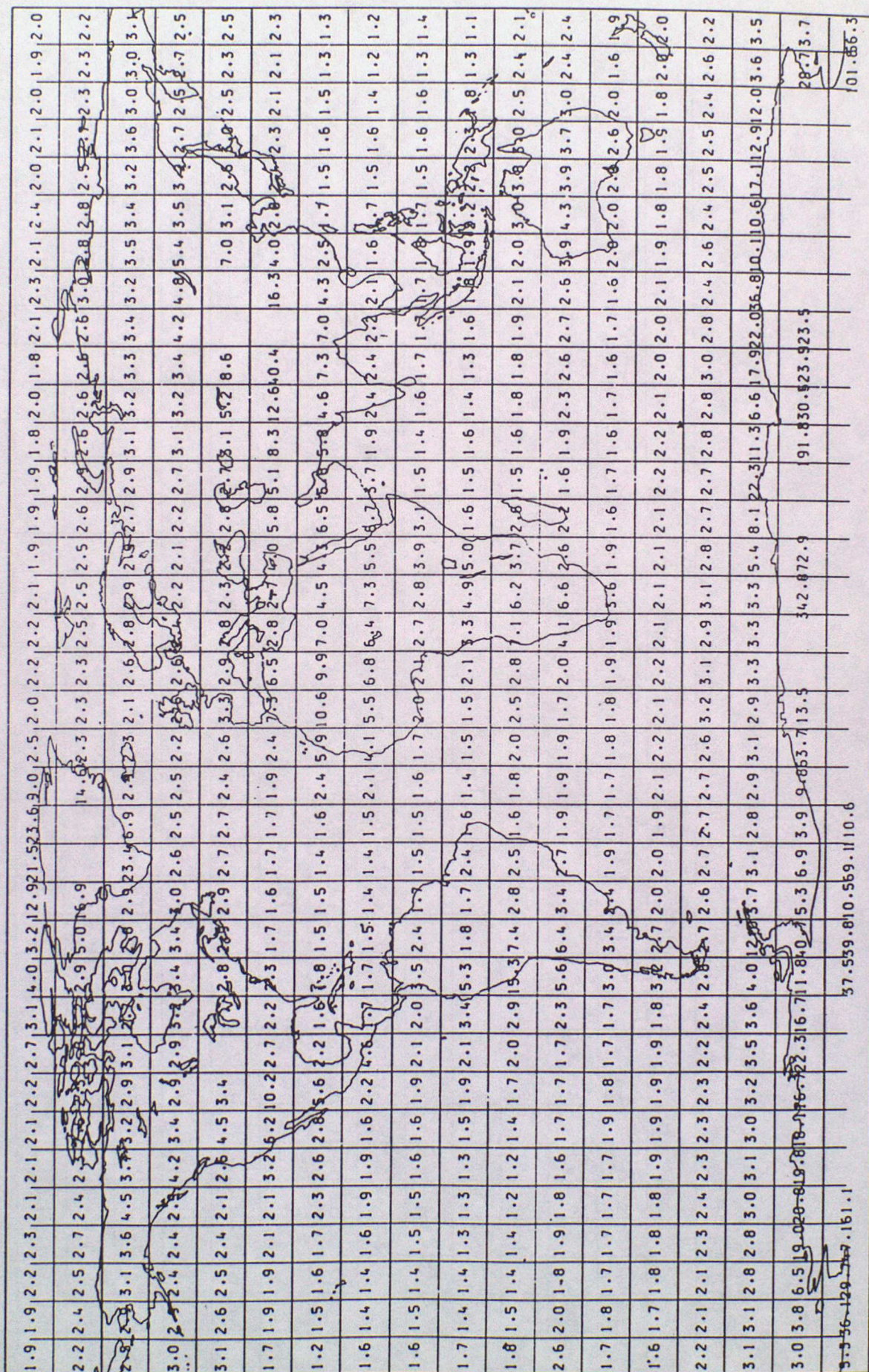


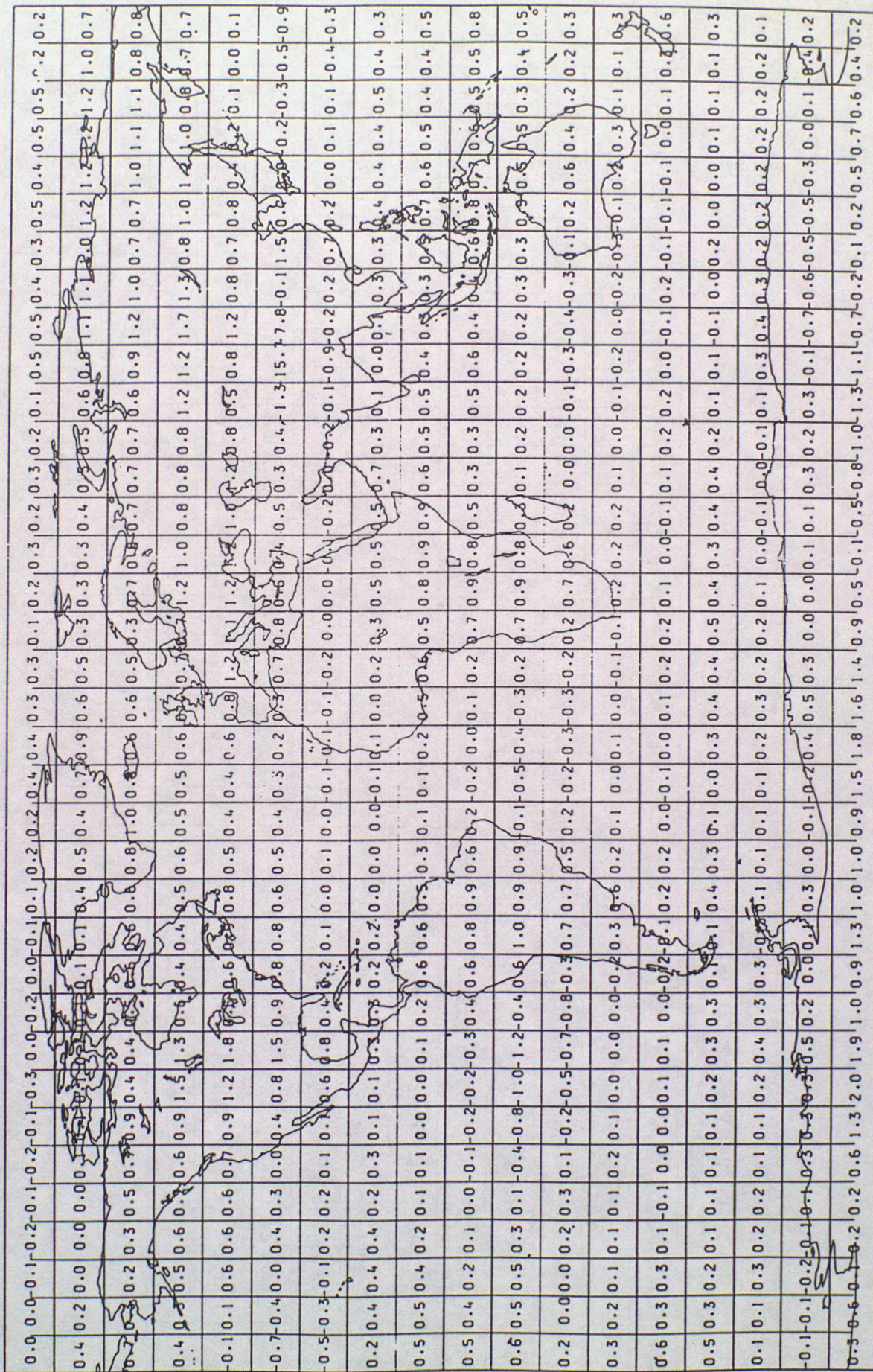
Figure 5

SATEMS : MEAN O-B TEMPERATURE DIFFERENCES (DEG C) BETWEEN 100 AND 300 HPA

1/12/89 TO 28/02/90

NOAA-10 AND NOAA-11 STATISTICS COMBINED

VALUES ARE PRINTED WHERE > 30 OBS ARE PRESENT



SATEMS : MEAN O-B TEMPERATURE DIFFERENCES (DEG C) BETWEEN 100 AND 300 HPA
1/06/90 TO 31/08/90
NOAA-10 AND NOAA-11 STATISTICS COMBINED
VALUES ARE PRINTED WHERE > 30 OBS ARE PRESENT

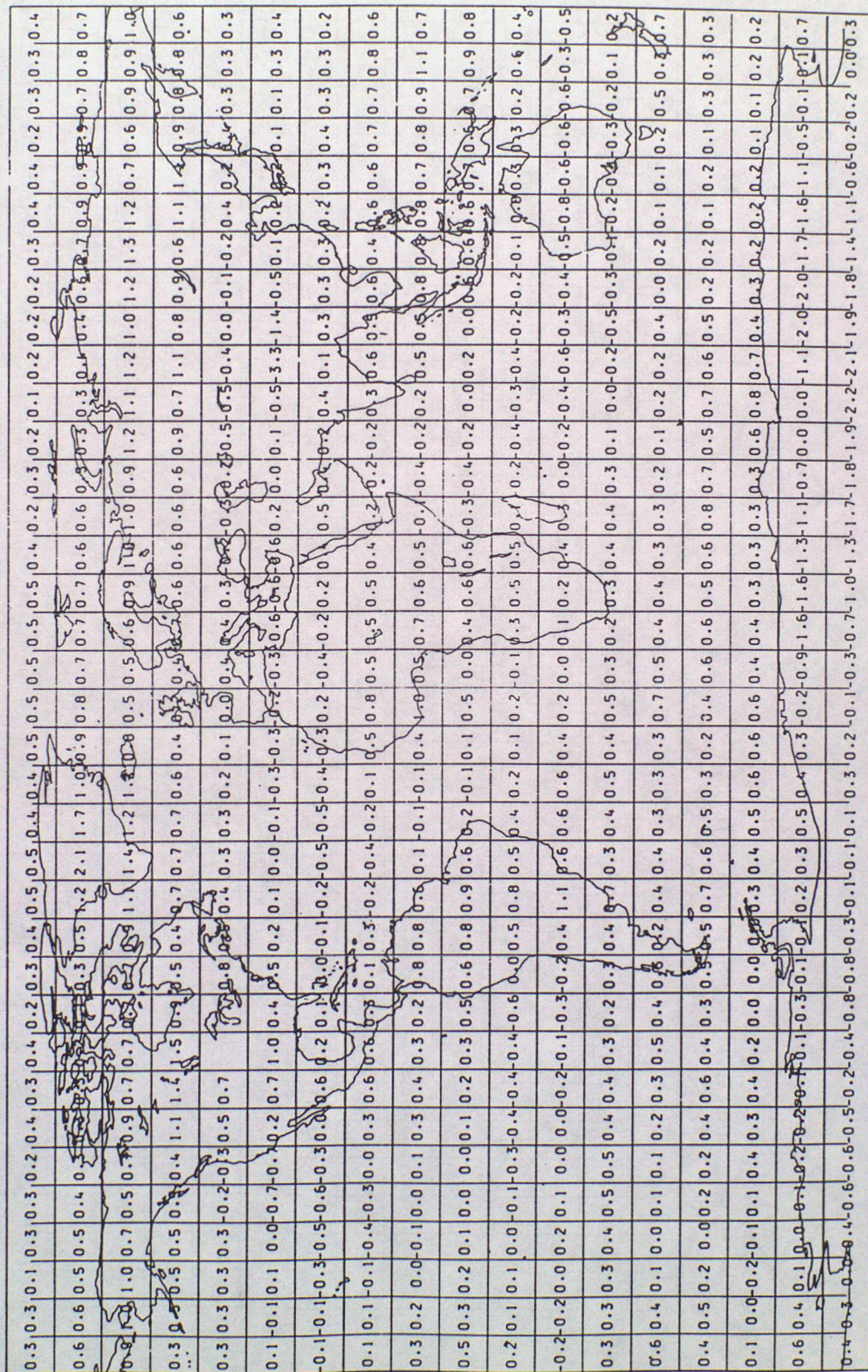


Figure 7

SATEMS : RMS 0-8 TEMPERATURE DIFFERENCES (DEG C) BETWEEN 100 AND 300 HPA
 1/12/89 TO 28/02/90
 NOAA-10 AND NOAA-11 STATISTICS COMBINED
 VALUES ARE PRINTED WHERE > 30 OBS ARE PRESENT

1.5	1.8	1.5	1.4	1.6	1.2	1.4	1.4	2.8	2.3	3.2	1.7	2.4	2.5	2.1	2.3	1.7	1.4	1.7	1.4	1.5	1.5	1.4	1.4	1.3	1.2	3.3	1.8	1.9	1.5	1.9	1.7	3.1	2.6	2.4	2.7
1.8	2.0	1.7	1.7	1.6	1.5	1.9	2.0	2.2	2.2	2.2	2.1	2.2	2.2	2.2	2.2	2.1	1.9	1.9	1.9	1.6	1.6	1.8	1.7	1.6	1.8	1.9	1.8	2.0	2.7	2.0	2.8	2.4	2.2		
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2.6	2.6	2.5	2.2	2.2	2.2	2.1	2.2	2.8	2.3	2.1	1.9	1.9	1.8	1.8	2.0	2.2	1.9	2.2	2.0	2.0	1.7	1.9	2.5	1.5	2.2	1.1	1.9	2.5	2.2	2.2	2.7	2.8	3.0	3.0	
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1.4	1.3	1.3	1.2	1.1	1.1	1.3	1.4	1.6	1.5	1.5	1.6	1.4	1.3	1.2	1.2	1.2	1.1	1.2	1.3	1.3	1.4	1.1	1.2	1.2	1.2	1.2	1.3	1.3	1.4	1.6	1.6	1.5	1.4	1.4	
1.5	1.4	1.4	1.3	1.3	1.2	1.2	1.2	1.3	1.3	1.5	1.6	1.6	1.5	1.3	1.3	1.4	1.3	1.2	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.4	1.4	1.5	1.4	1.6	1.8	1.9	1.6	
1.7	1.6	1.7	1.8	1.6	1.6	1.5	1.6	1.6	1.6	1.8	1.8	1.6	1.6	1.6	1.7	1.7	1.7	1.8	1.7	1.6	1.8	1.7	1.7	1.7	1.8	1.7	1.8	1.7	1.8	1.7	1.7	1.8	1.8		
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2.0	2.0	2.0	2.0	2.1	2.1	2.1	2.0	2.0	2.0	2.1	1.9	2.0	2.0	2.0	1.9	1.8	1.9	1.8	1.8	1.8	1.8	1.8	2.0	1.9	2.0	2.0	1.9	2.0	2.0	2.0	2.0	2.0	2.0	2.0	
1.6	1.9	1.7	1.7	1.8	1.9	1.8	1.8	1.8	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.6	1.5	1.6	1.8	1.8	1.8	1.7	1.7	1.9	2.0	2.2	1.9	1.7	1.6	1.5	1.6	1.6	1.7		
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SATEMS : RMS O-B TEMPERATURE DIFFERENCES (DEG C) BETWEEN 100 AND 300 HPA
1/06/90 TO 31/08/90
NOAA-10 AND NOAA-11 STATISTICS COMBINED
VALUES ARE PRINTED WHERE > 30 OBS ARE PRESENT

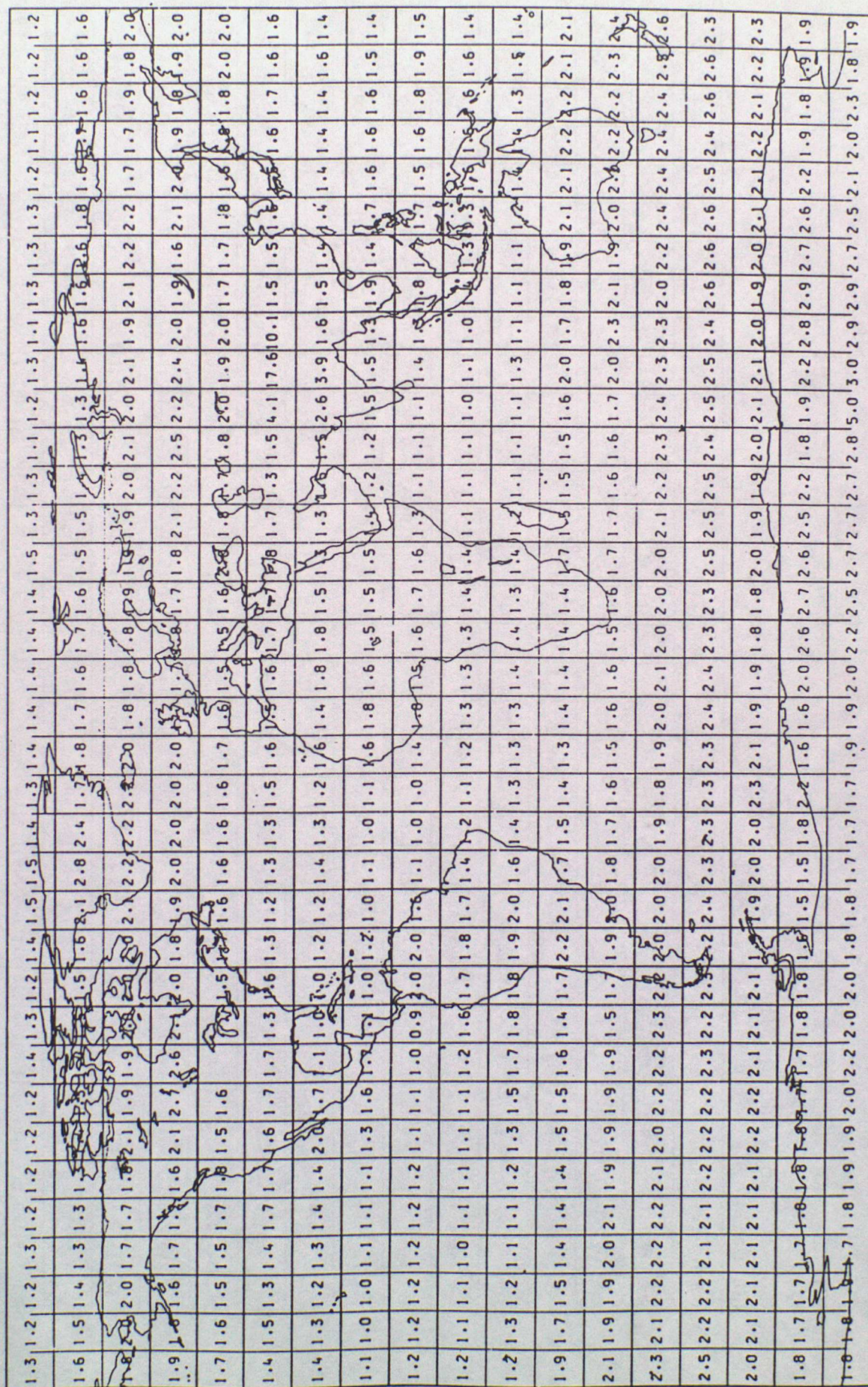


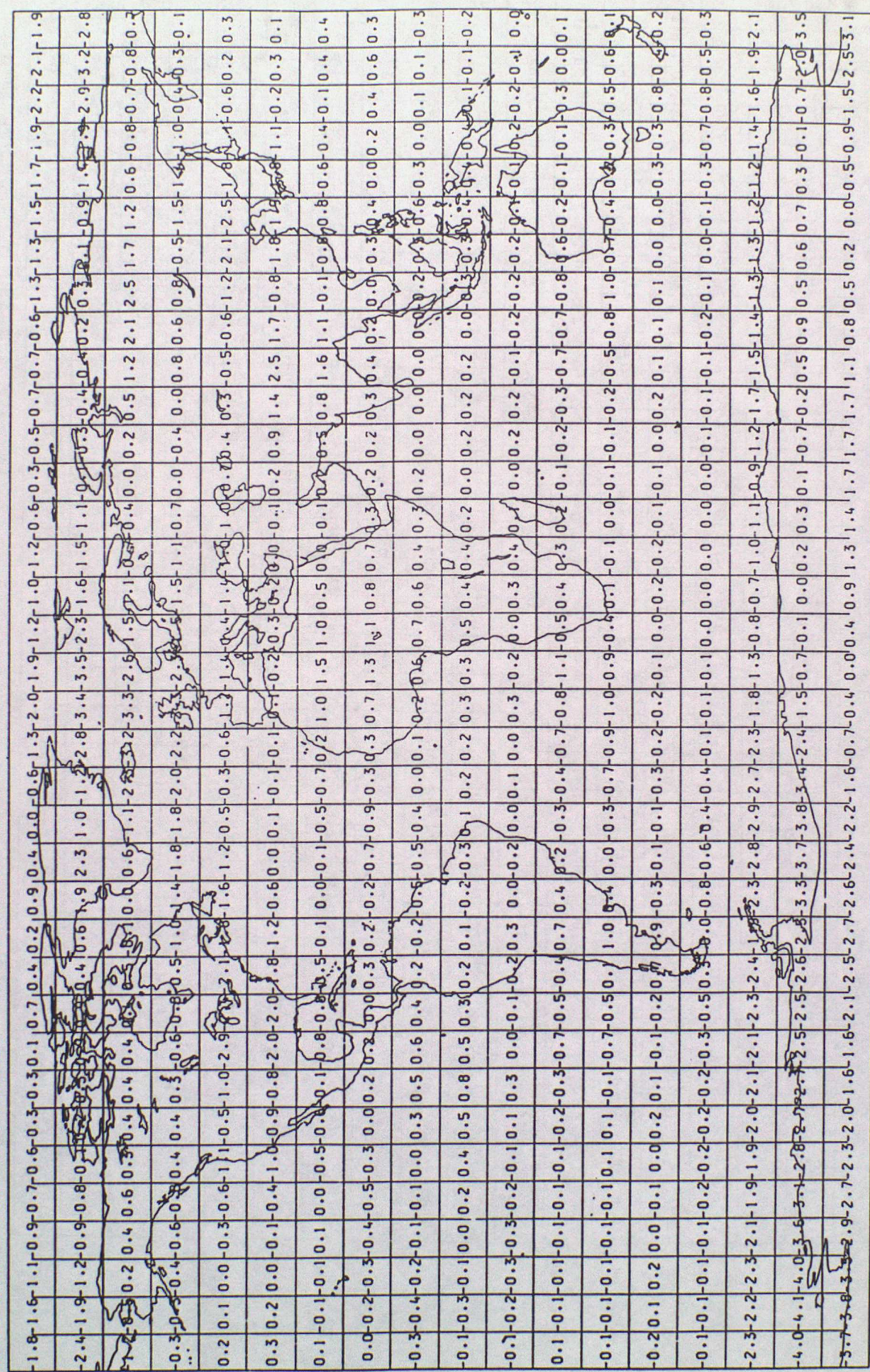
Figure 9

SATEMS : MEAN O-B TEMPERATURE DIFFERENCES (DEG C) BETWEEN 30 AND 50 HPA

1/12/89 TO 28/02/90

NOAA-10 AND NOAA-11 STATISTICS COMBINED

VALUES ARE PRINTED WHERE > 30 OBS ARE PRESENT



SATEMS : MEAN 0-8 TEMPERATURE DIFFERENCES (DEG C) BETWEEN 30 AND 50 HPA
1/06/90 TO 31/08/90
NOAA-10 AND NOAA-11 STATISTICS COMBINED
VALUES ARE PRINTED WHERE > 30 OBS ARE PRESENT

Figure 10

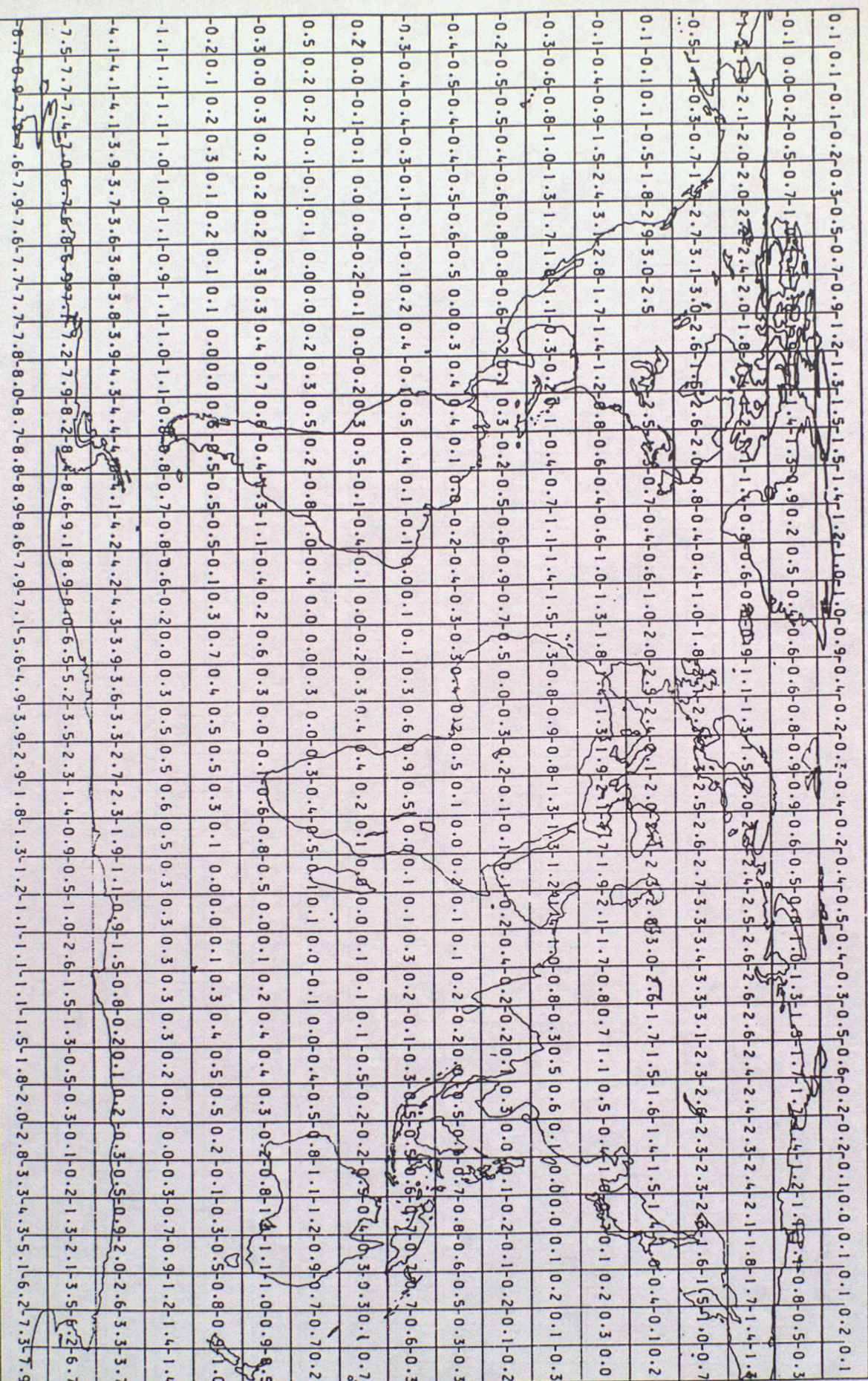


Figure 11

SATEMS : RMS 0-B TEMPERATURE DIFFERENCES (DEG C) BETWEEN 30 AND 50 HPA

1/12/89 TO 28/02/90

NOAA-10 AND NOAA-11 STATISTICS COMBINED

VALUES ARE PRINTED WHERE > 30 OBS ARE PRESENT

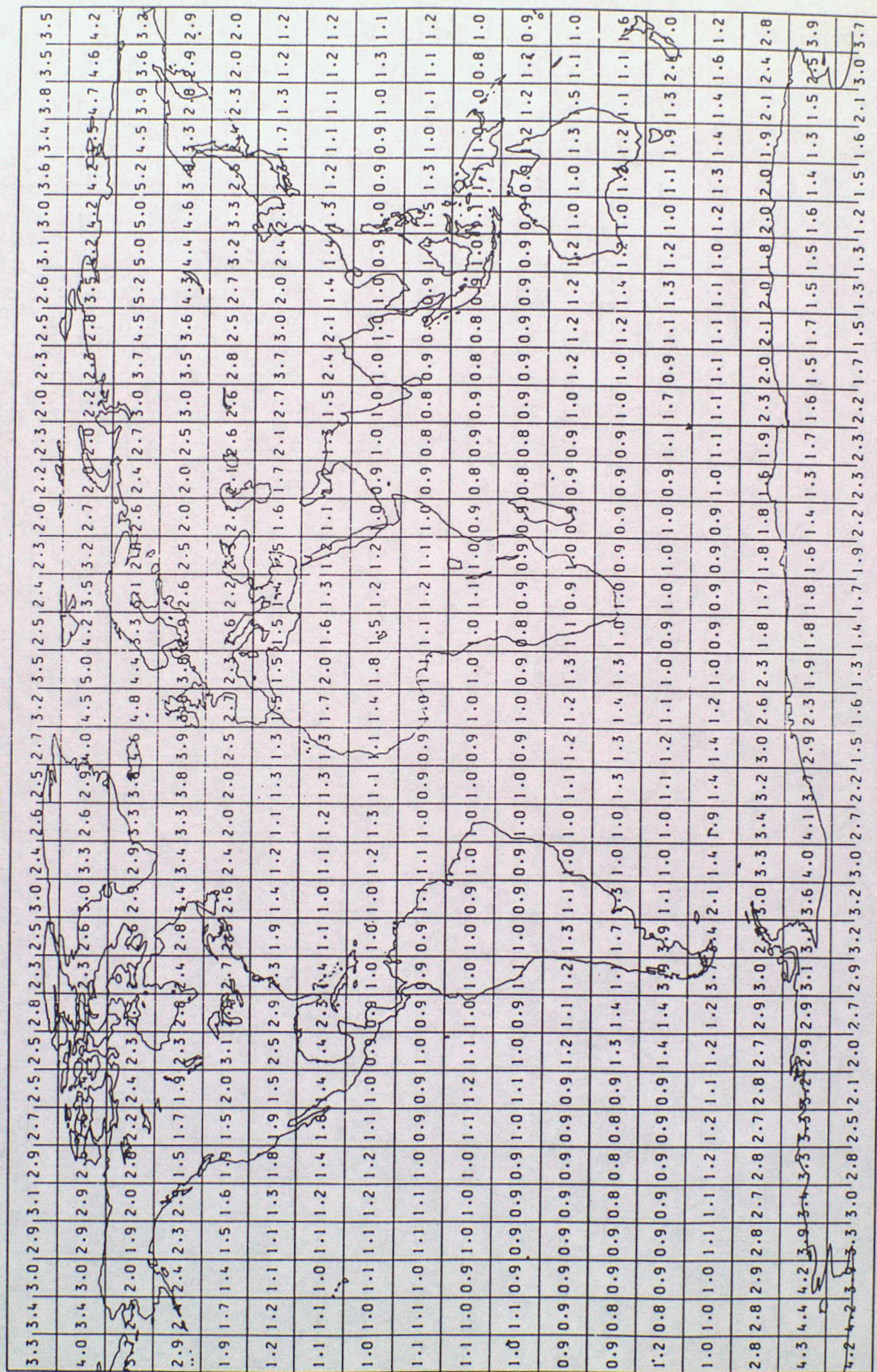


Figure 12

SATEMS : RMS 0-8 TEMPERATURE DIFFERENCES (DEG C) BETWEEN 30 AND 50 HPA

1/06/90 TO 31/08/90

NOAA-10 AND NOAA-11 STATISTICS COMBINED

VALUES ARE PRINTED WHERE > 30 OBS ARE PRESENT

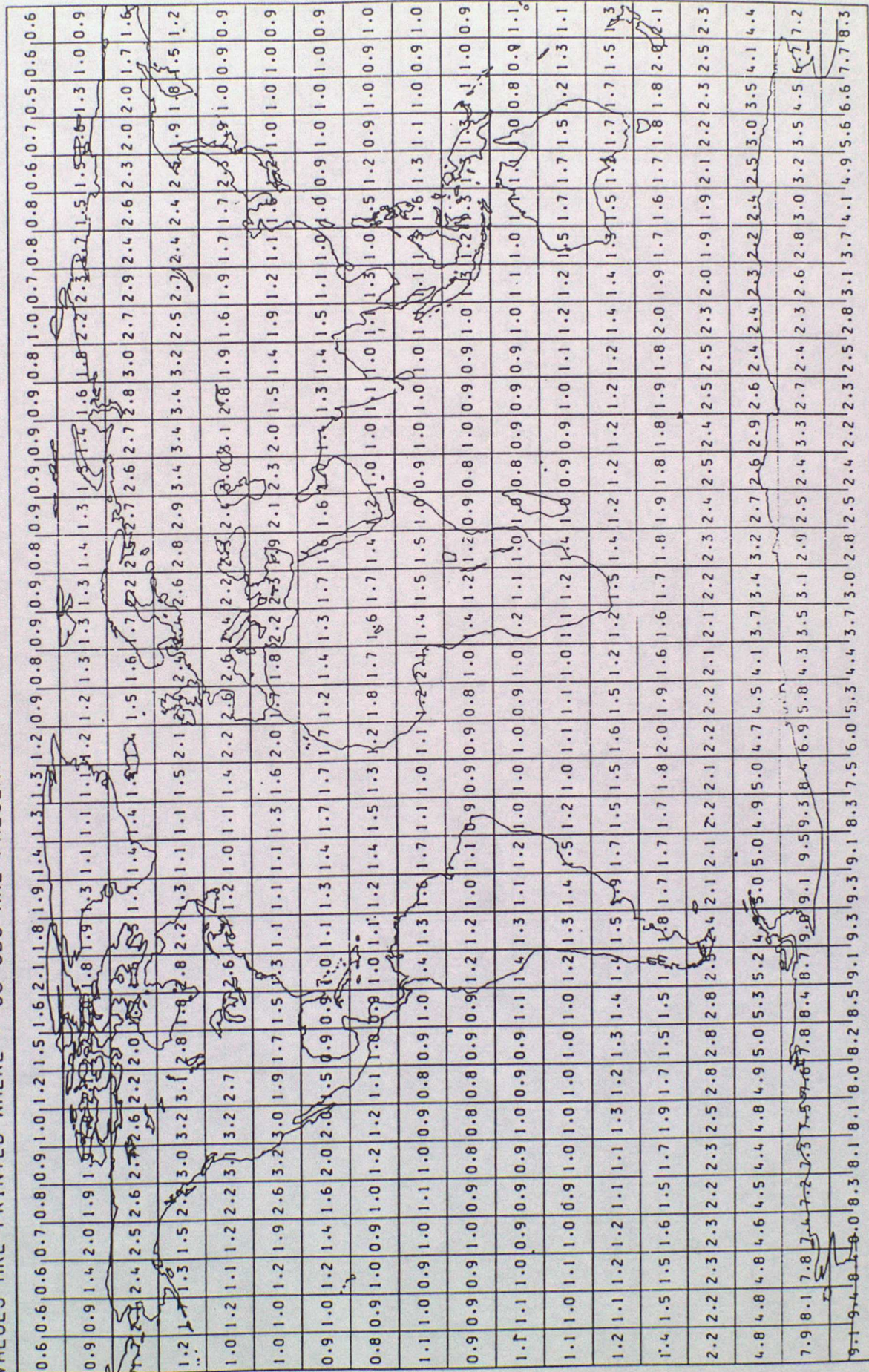


Figure 13

SONDES : 0-B TEMPERATURE DIFFERENCES (DEG C) 800 TO 999 HPA
 1/12/89 TO 28/02/90
 QUALITY CONTROL APPLIED
 VALUES ARE PRINTED WHERE > 100 OBS ARE PRESENT

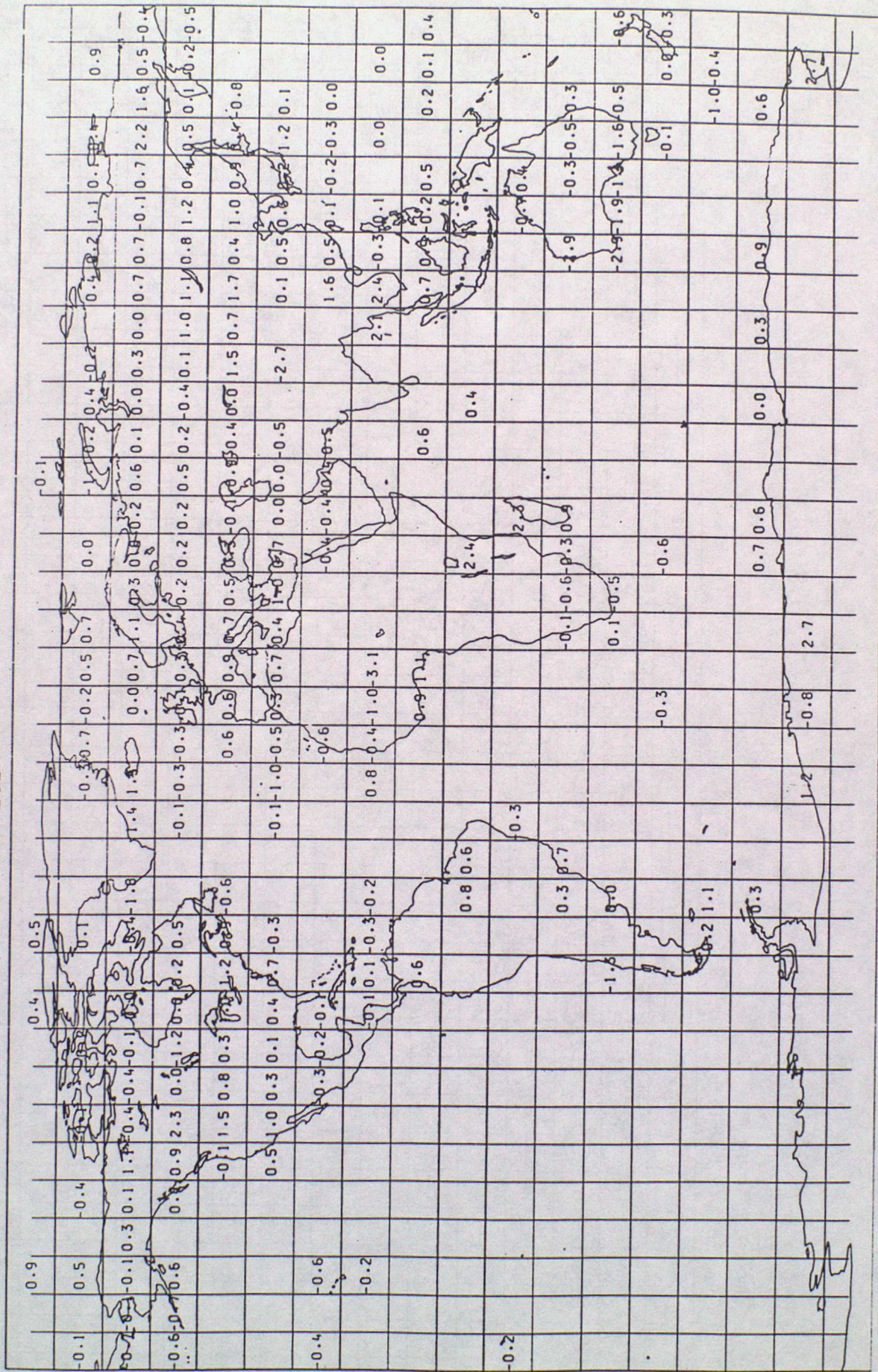
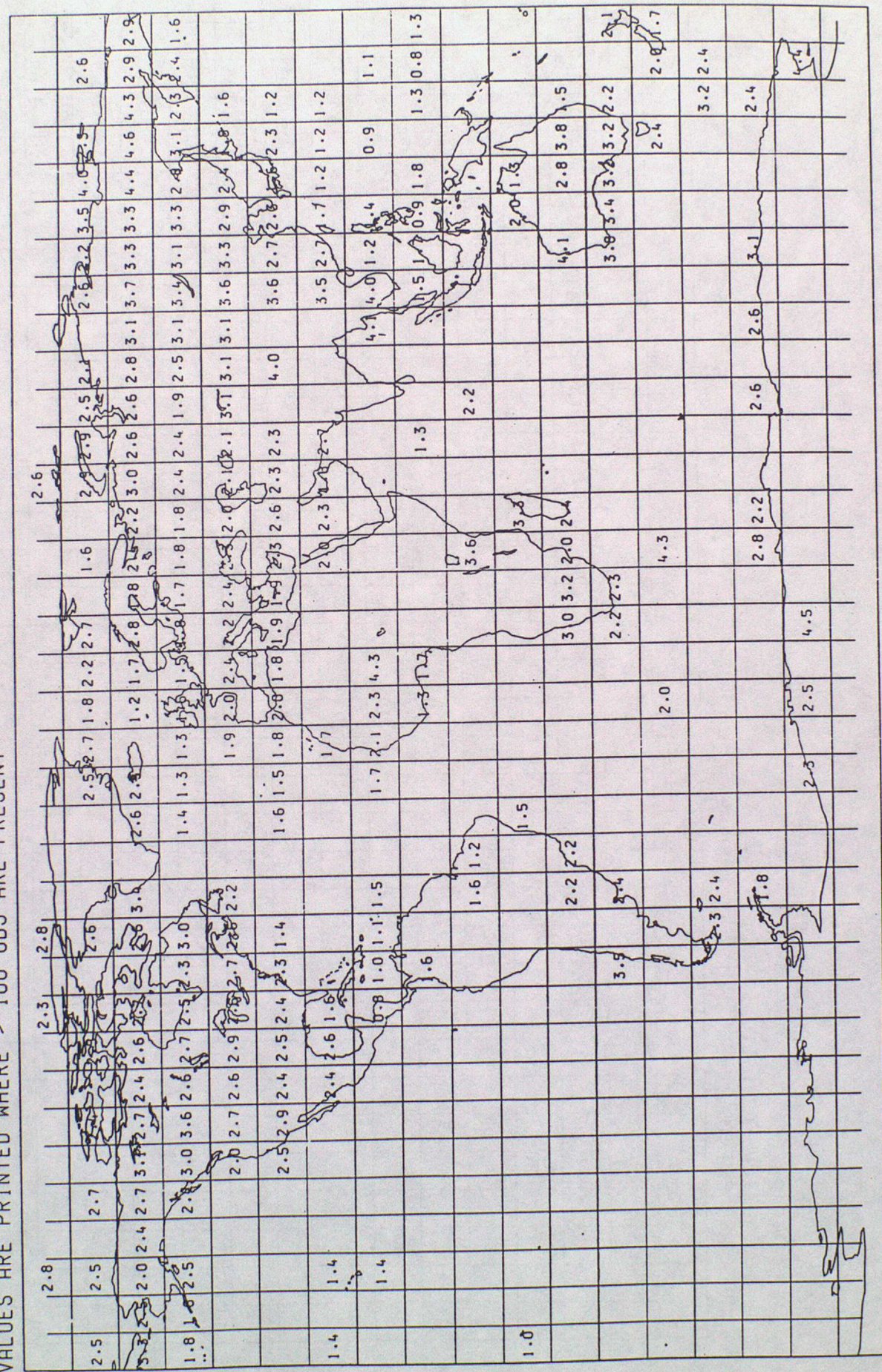


Figure 14

SONDES : RMS 0-B TEMPERATURE DIFFERENCES (DEG C) 800 TO 999 HPA
 1/12/89 TO 28/02/90
 QUALITY CONTROL APPLIED
 VALUES ARE PRINTED WHERE > 100 OBS ARE PRESENT

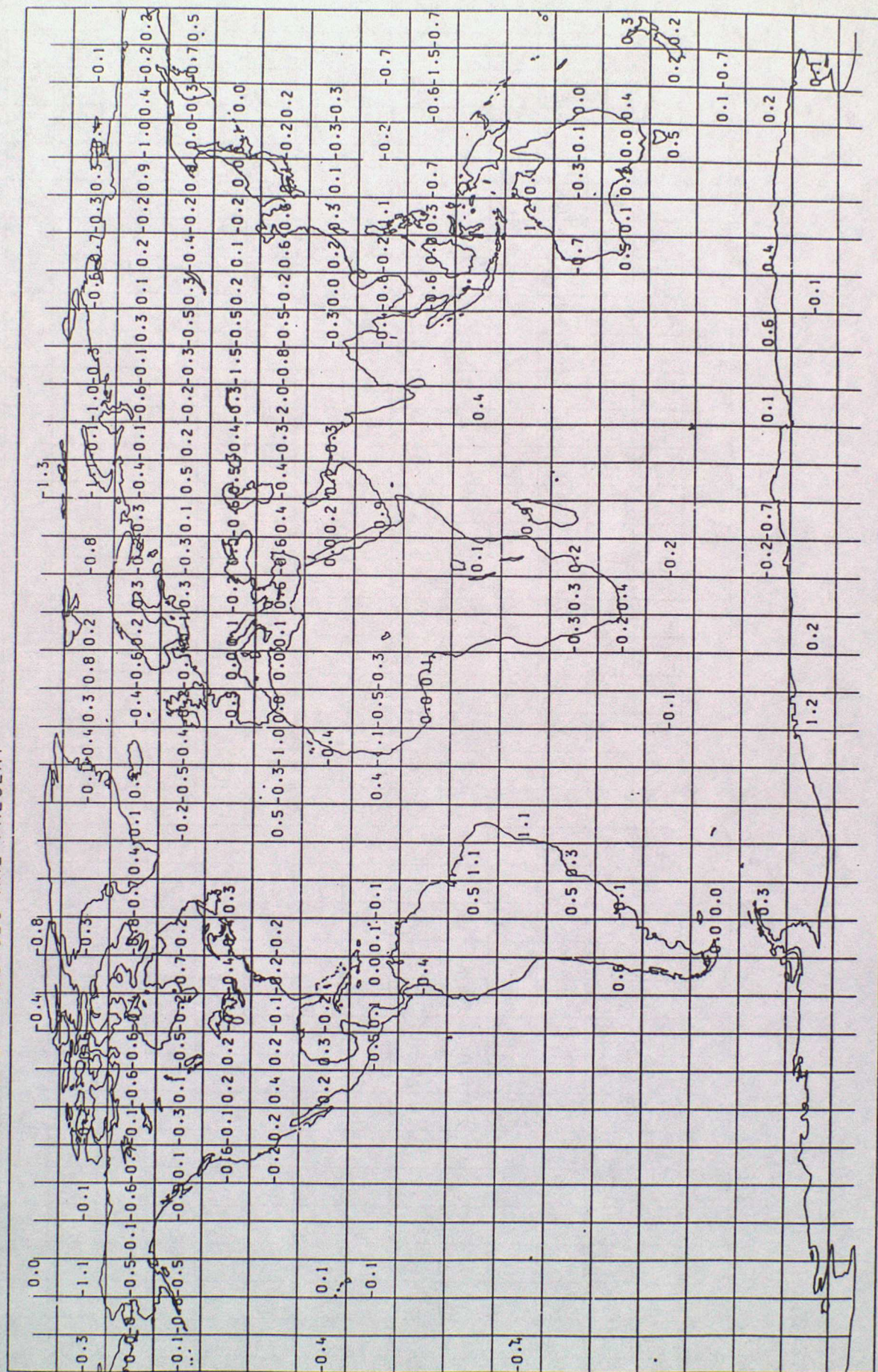


SONDES : O-B TEMPERATURE DIFFERENCES (DEG C) 100 TO 299 HPA

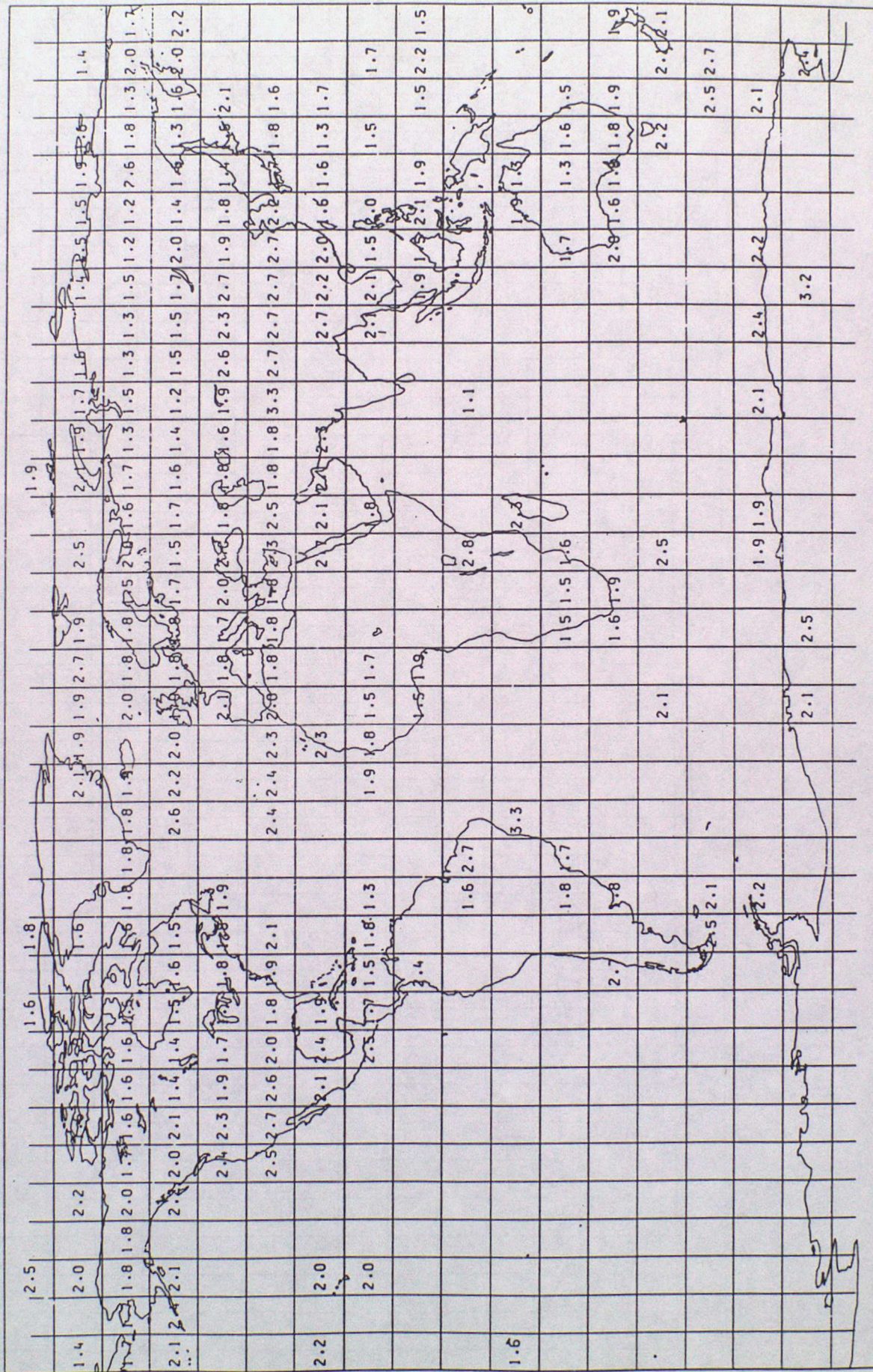
1/12/89 TO 28/02/90

QUALITY CONTROL APPLIED

VALUES ARE PRINTED WHERE > 100 OBS ARE PRESENT



SONDES : RMS O-B TEMPERATURE DIFFERENCES (DEG C) 100 TO 299 HPA
1/12/89 TO 28/02/90
QUALITY CONTROL APPLIED
VALUES ARE PRINTED WHERE > 100 OBS ARE PRESENT



SONDES : 0-B TEMPERATURE DIFFERENCES (DEG C) 10 TO 99 HPA
1/12/89 TO 28/02/90
QUALITY CONTROL APPLIED
VALUES ARE PRINTED WHERE > 100 OBS ARE PRESENT

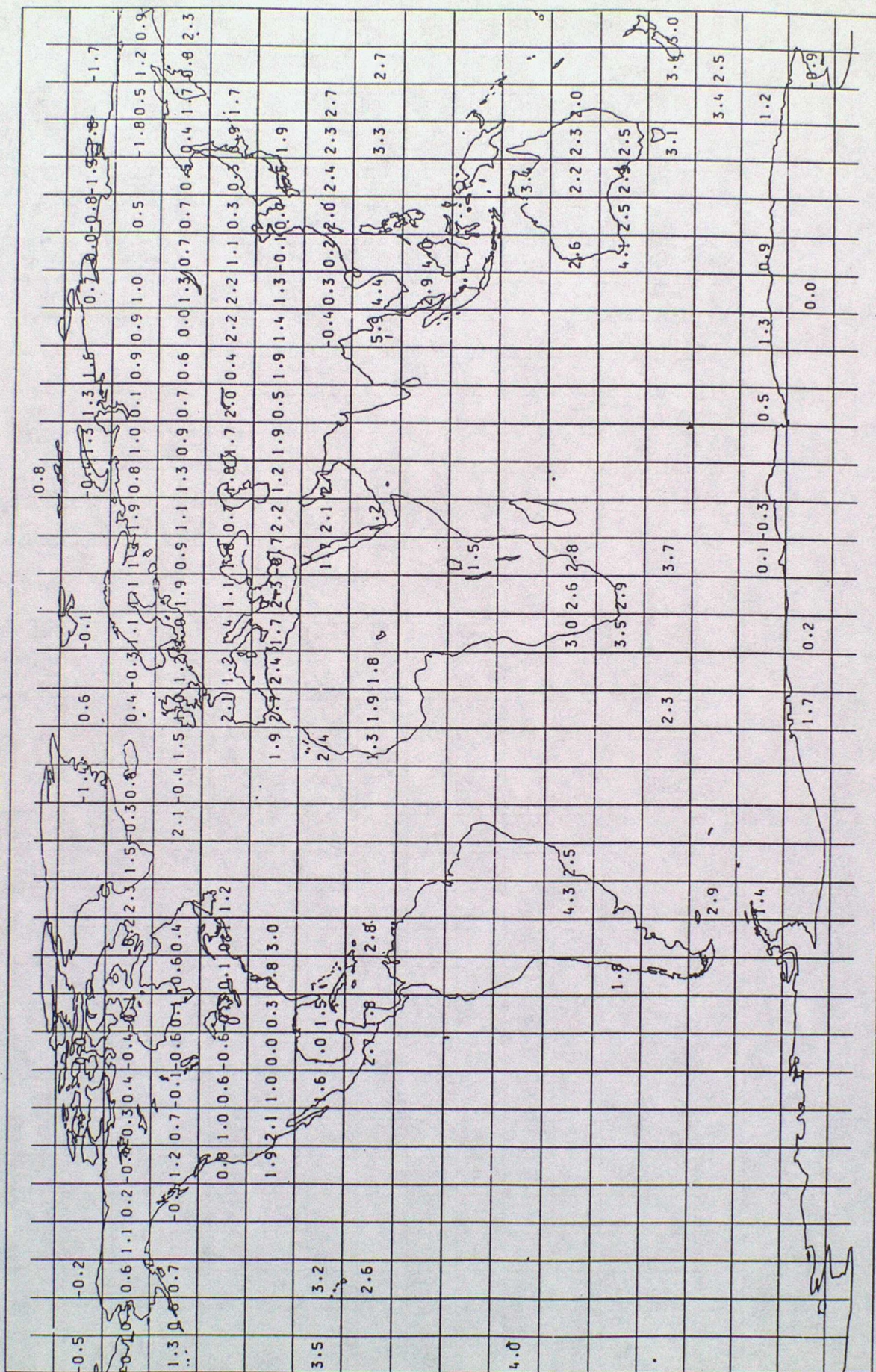


Figure 18

SONDES : RMS 0-8 TEMPERATURE DIFFERENCES (DEG C) 10 TO 99 HPA
 1/12/89 TO 28/02/90
 QUALITY CONTROL APPLIED
 VALUES ARE PRINTED WHERE > 100 OBS ARE PRESENT

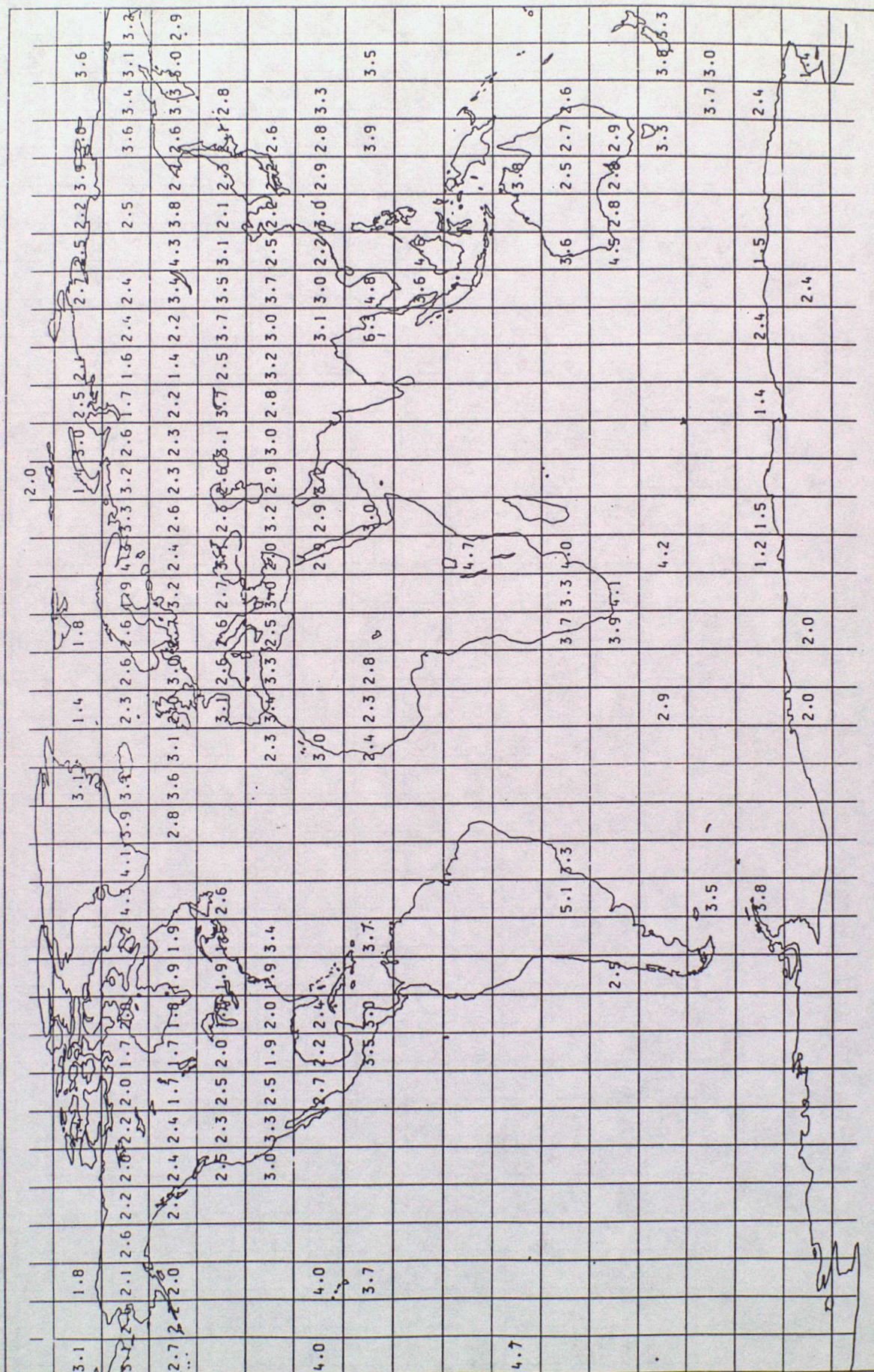
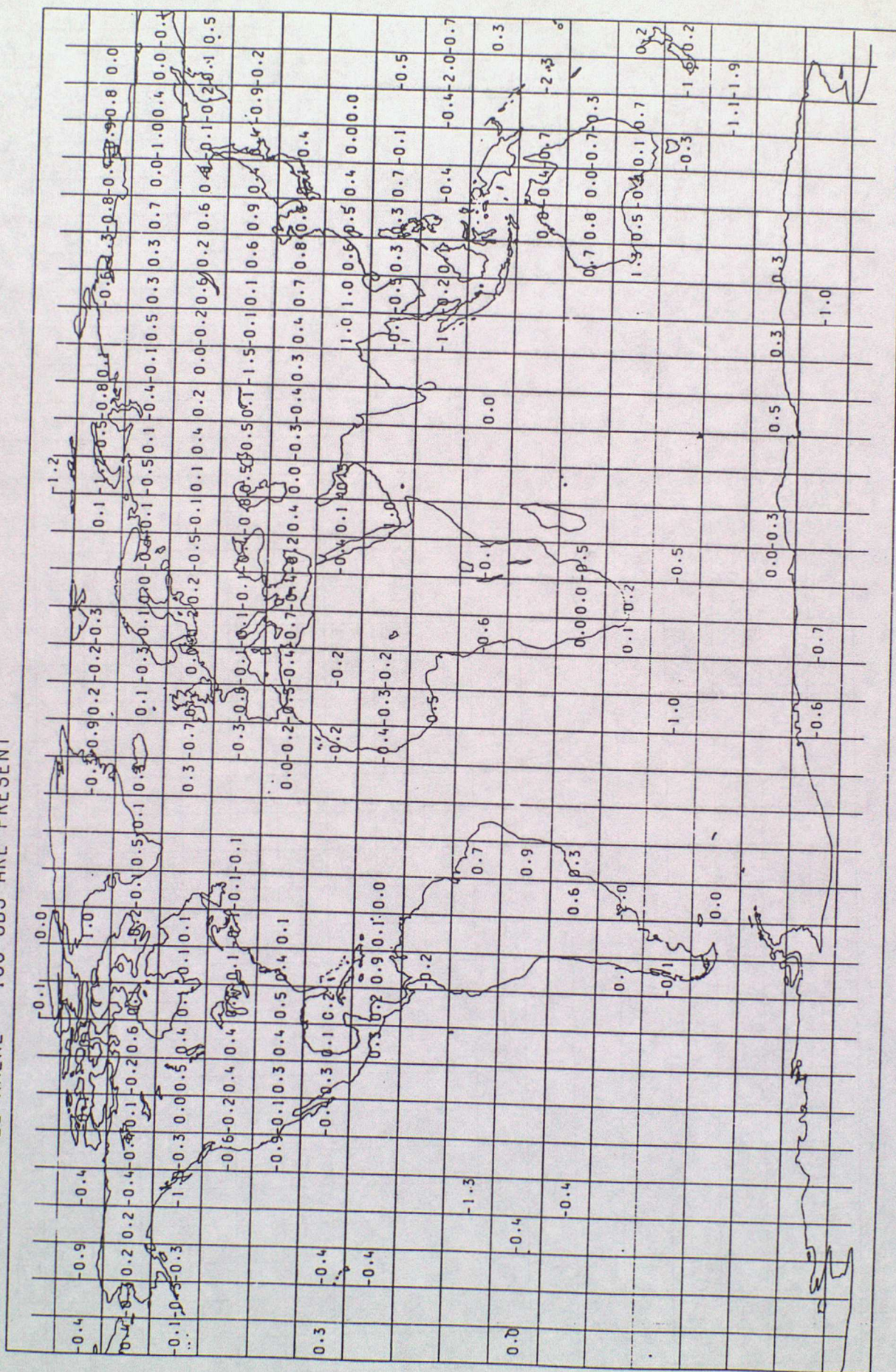
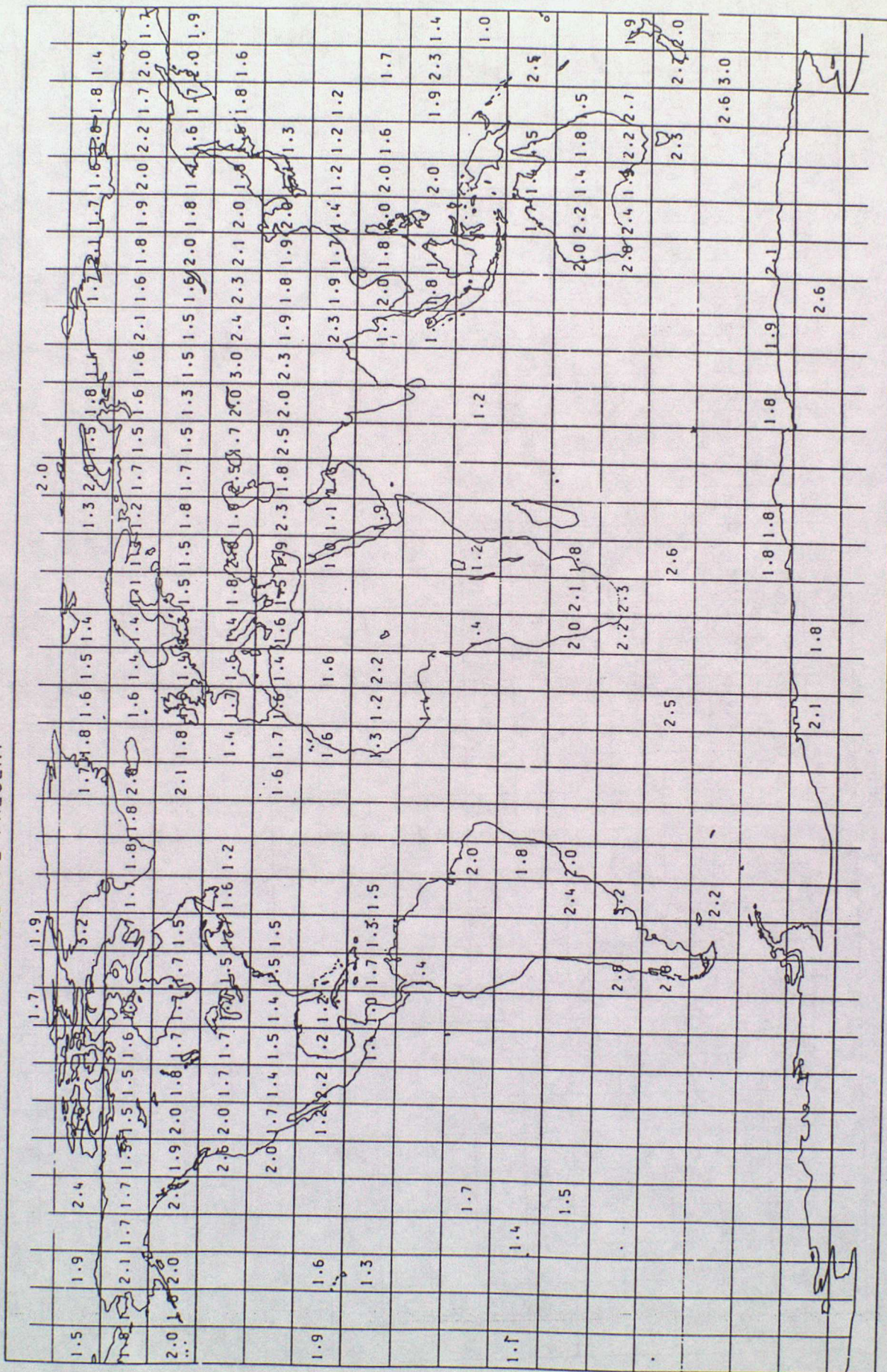


Figure 21



SONDES : RMS 0-8 TEMPERATURE DIFFERENCES (DEG C) 100 TO 299 HPA
 1/06/90 TO 31/08/90
 QUALITY CONTROL APPLIED
 VALUES ARE PRINTED WHERE > 100 OBS ARE PRESENT

Figure 22



SONDES : RMS 0-B TEMPERATURE DIFFERENCES (DEG C) 10 TO 99 HPA
 1/06/90 TO 31/08/90
 QUALITY CONTROL APPLIED
 VALUES ARE PRINTED WHERE > 100 OBS ARE PRESENT

Figure 24

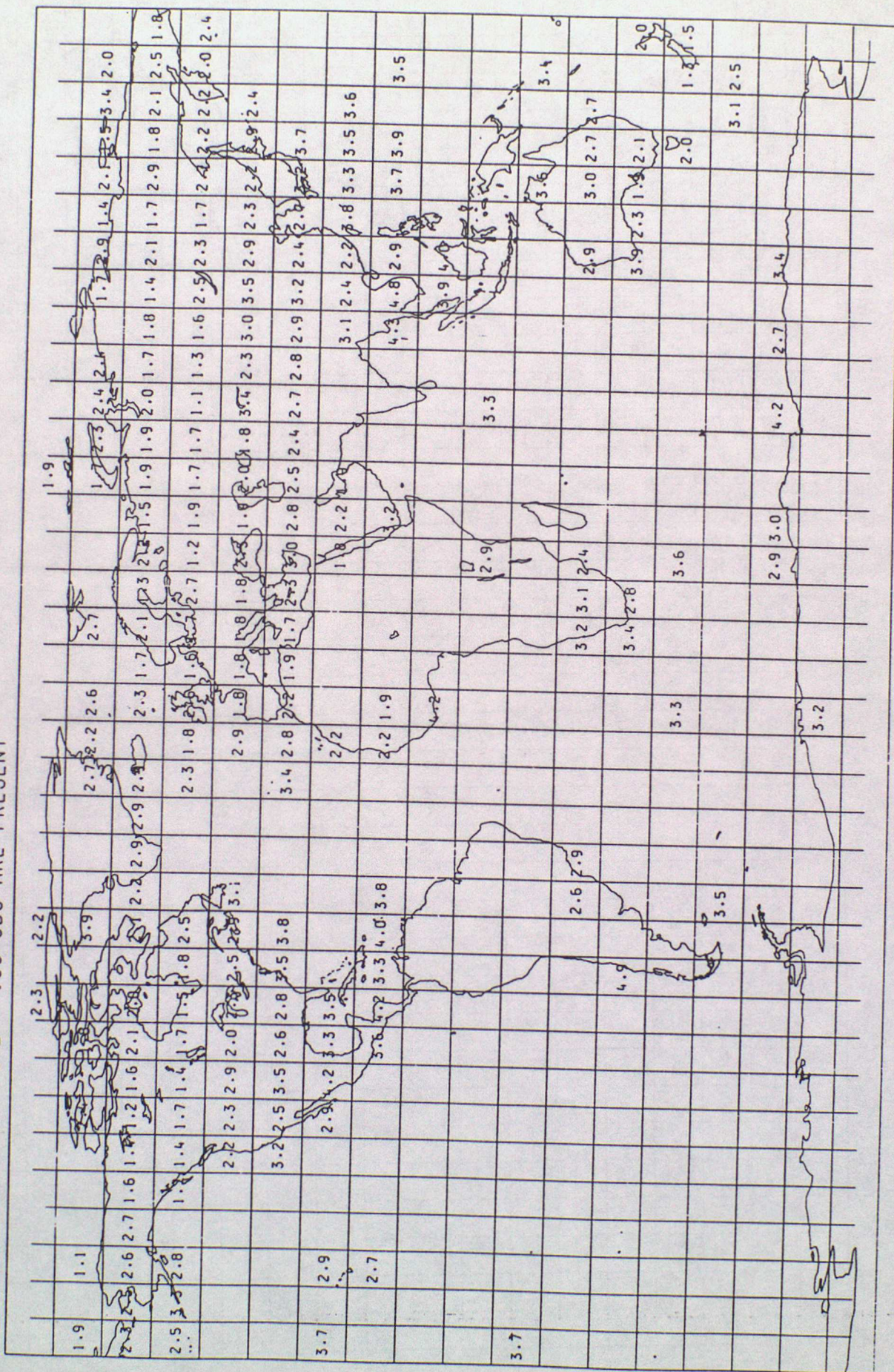


Figure 25

AIREPS : MEAN 0-8 TEMPERATURES (DEG C) BETWEEN 100 AND 299 HPA
 DEC 89 & FEB 90
 GROSS ERROR CHECK APPLIED
 VALUES ARE PRINTED WHERE > 100 OBS ARE PRESENT

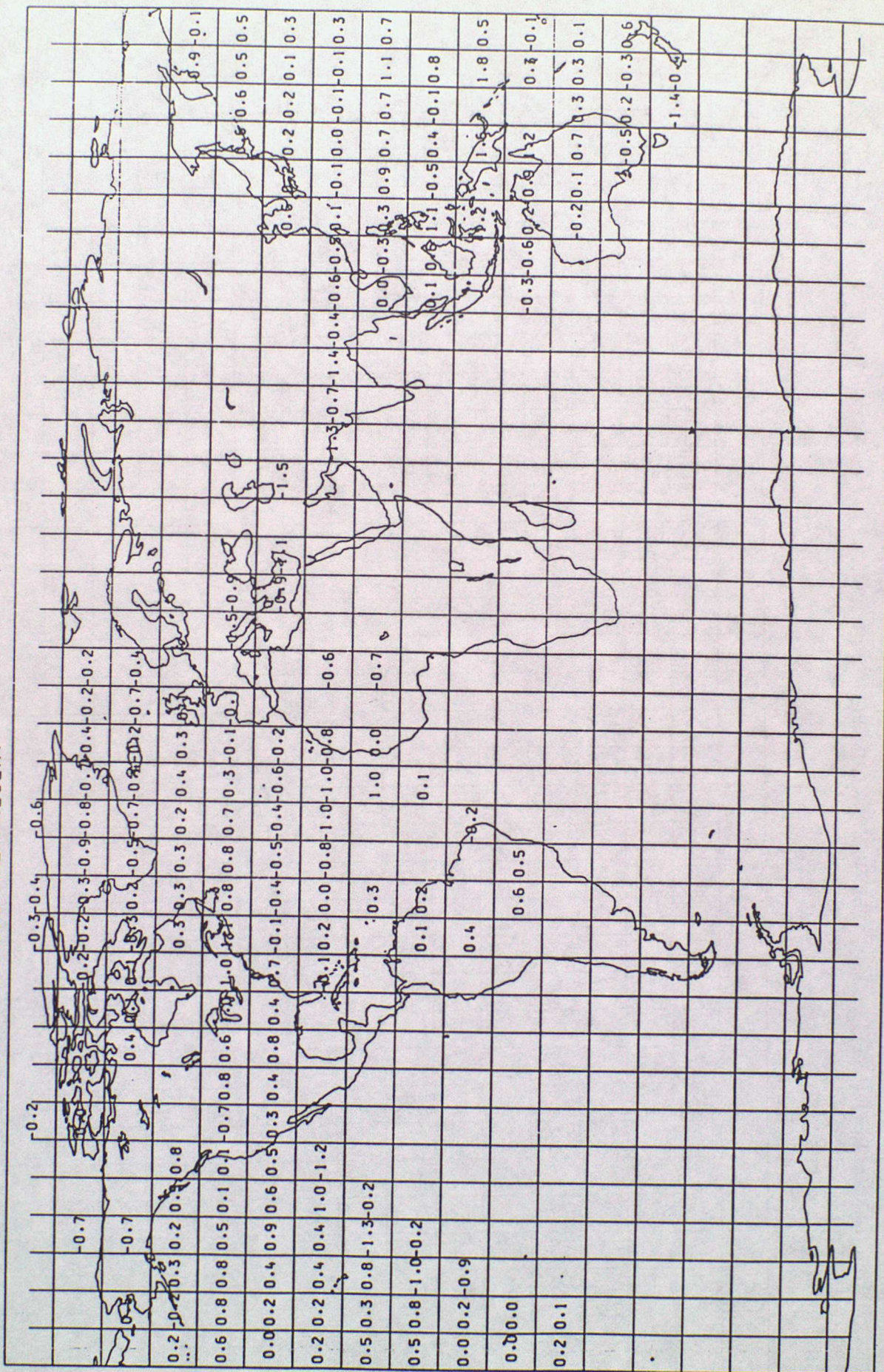
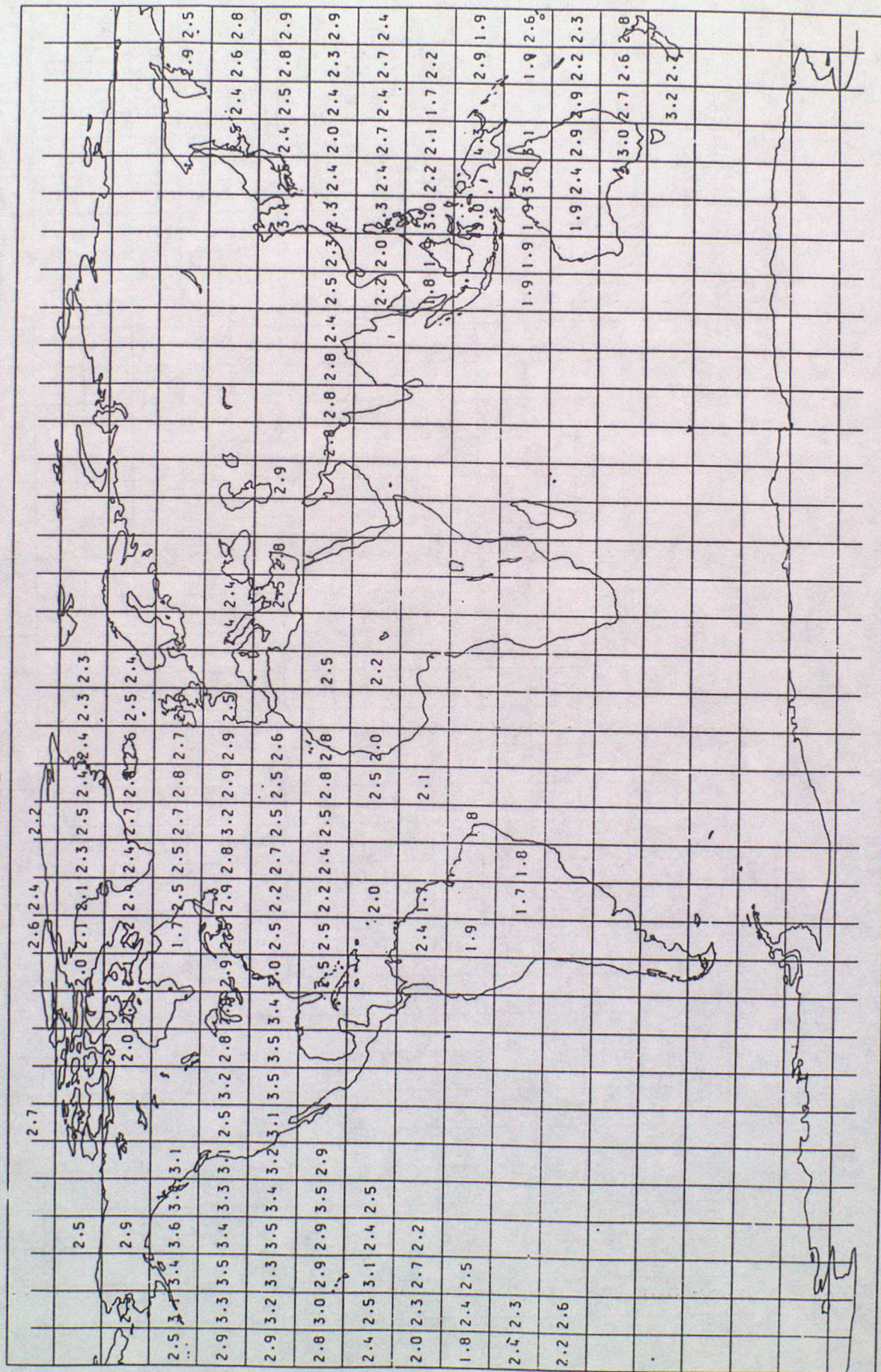


Figure 26

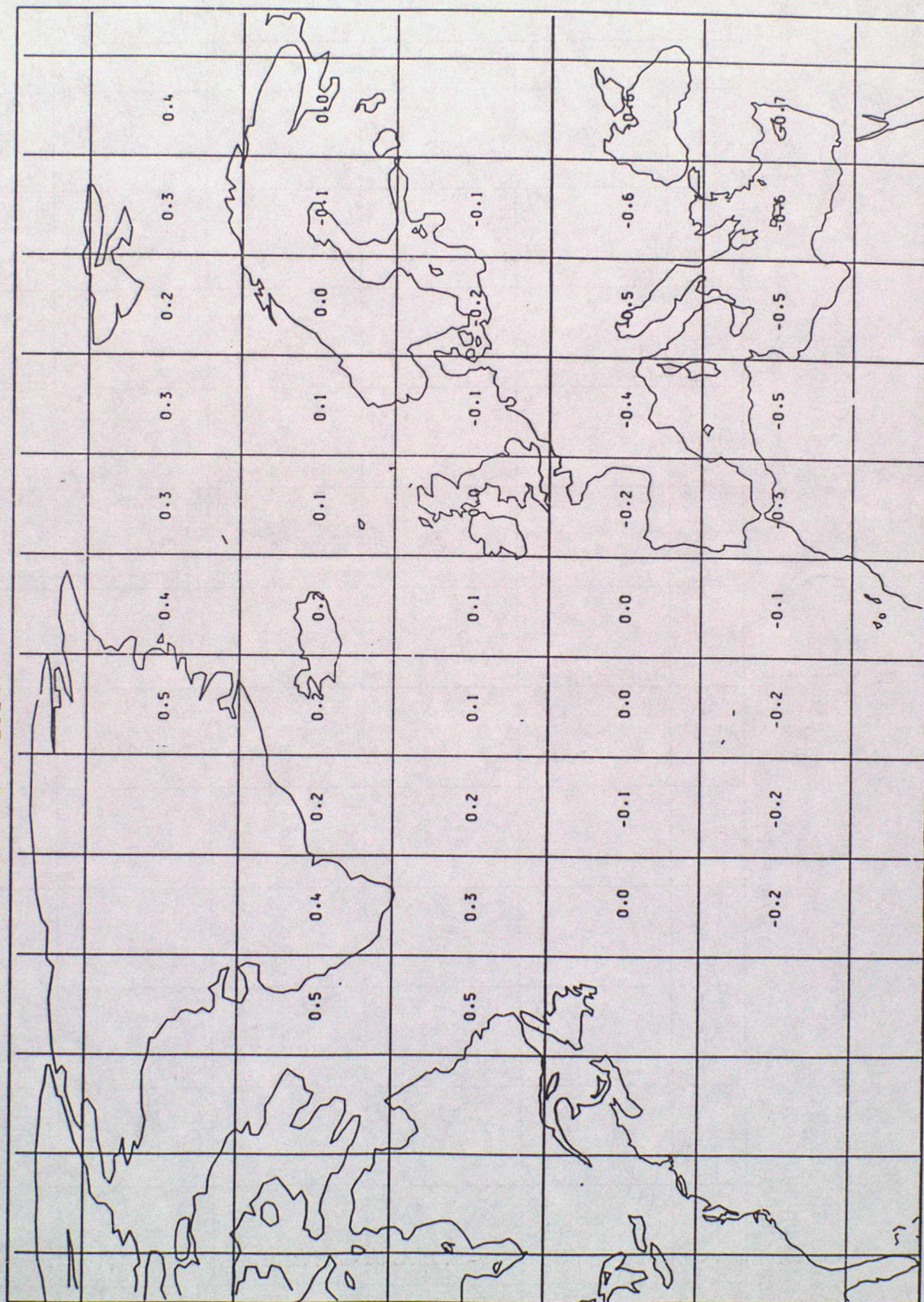


LASS : MEAN O-B TEMPERATURE DIFFERENCES (DEG C) BETWEEN 500 AND 1000 HPA

1/06/90 TO 30/08/90

DATA FROM NOAA-10

VALUES ARE PRINTED WHERE > 30 OBS ARE PRESENT



CLASS : RMS 0-B TEMPERATURE DIFFERENCES (DEG C) BETWEEN 500 AND 1000 HPA

1/06/90 TO 30/08/90

DATA FROM NOAA-10

VALUES ARE USED WHERE > 30 OBS ARE PRESENT

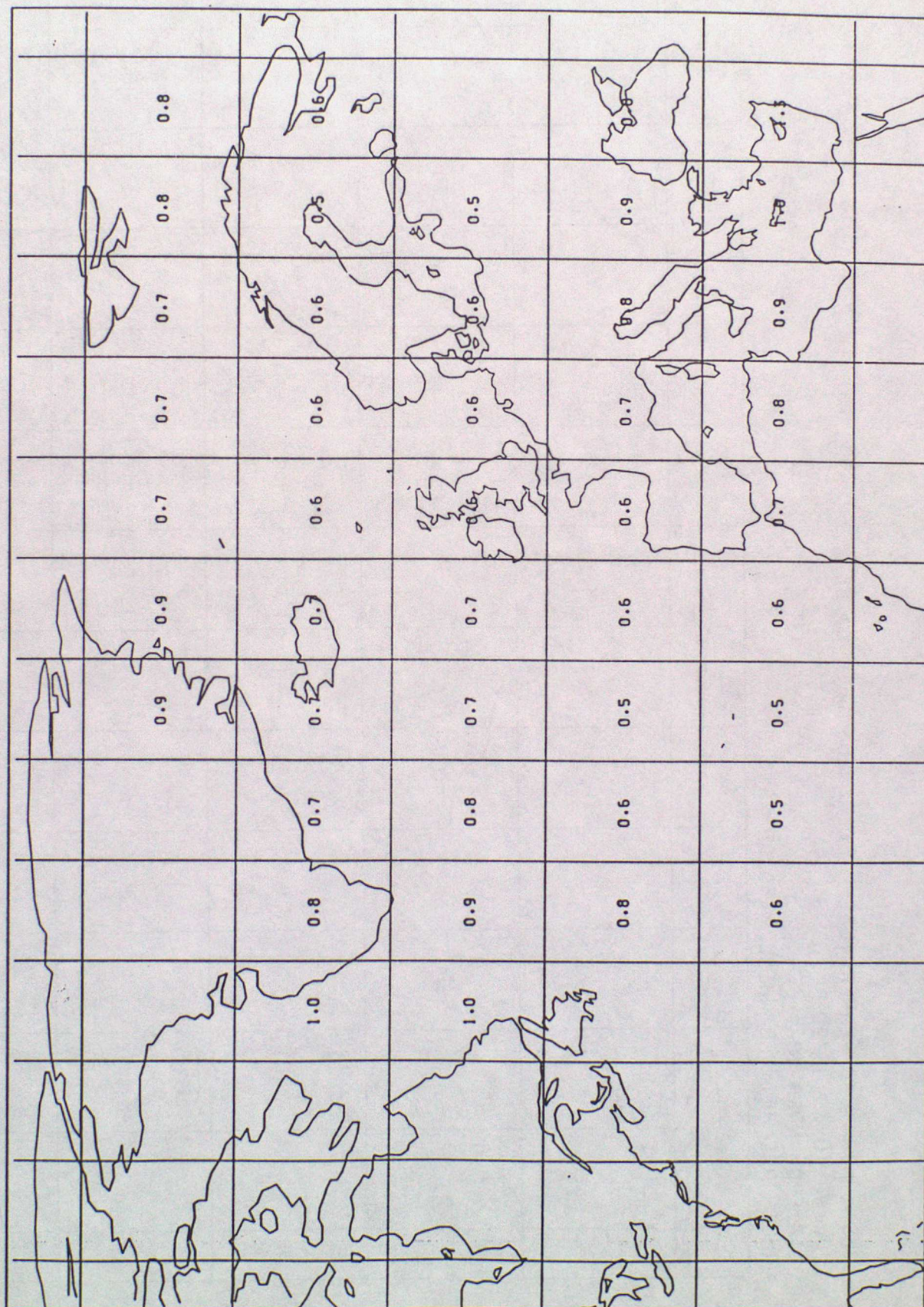


Figure 29

SAT08 VECTOR MEAN WINDS BETWEEN 700-999 HPA
1/12/89 TO 28/02/90
ALL OBSERVATIONS
VALUES PLOTTED WHERE > 10 OBS ARE PRESENT

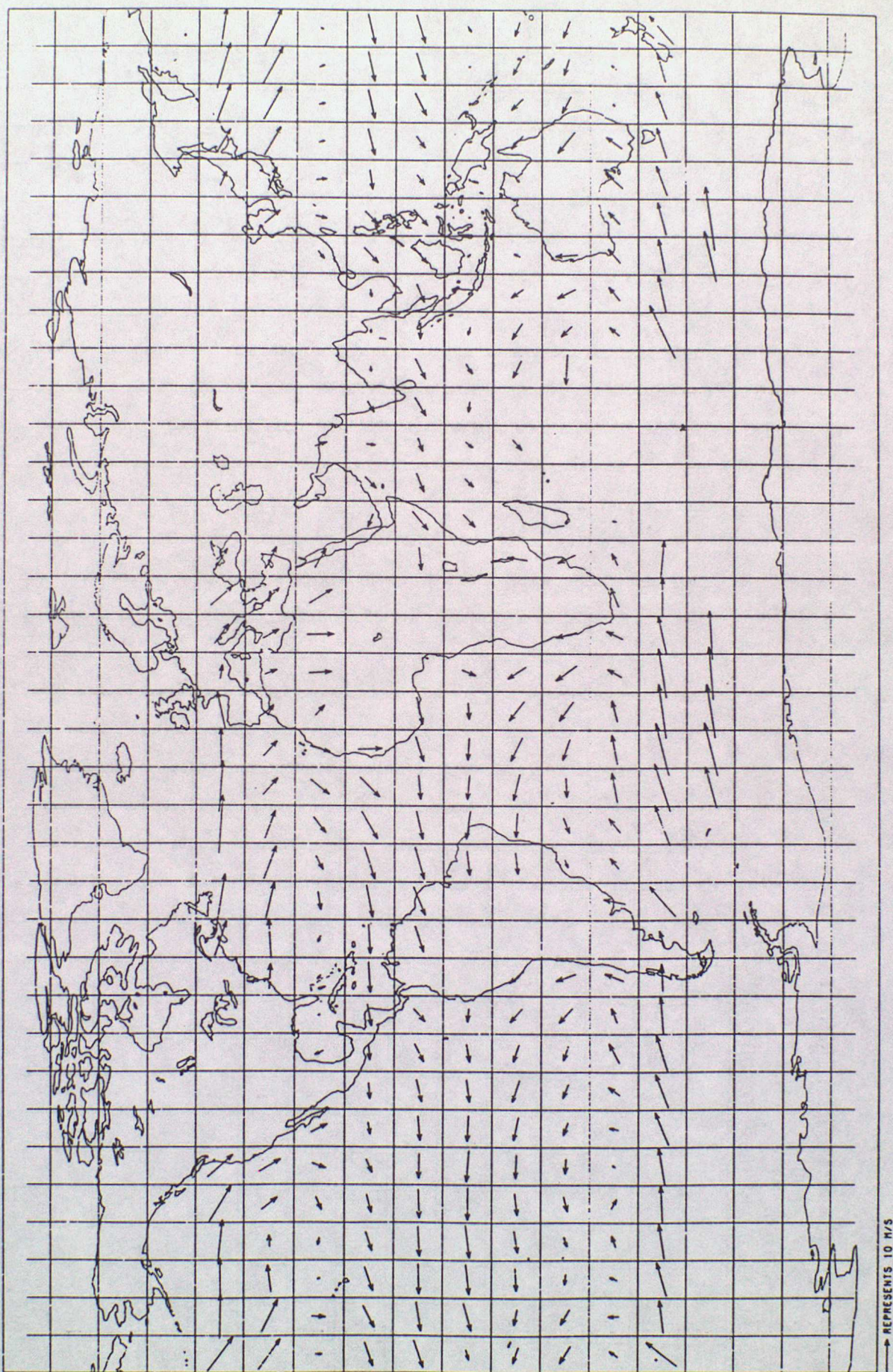


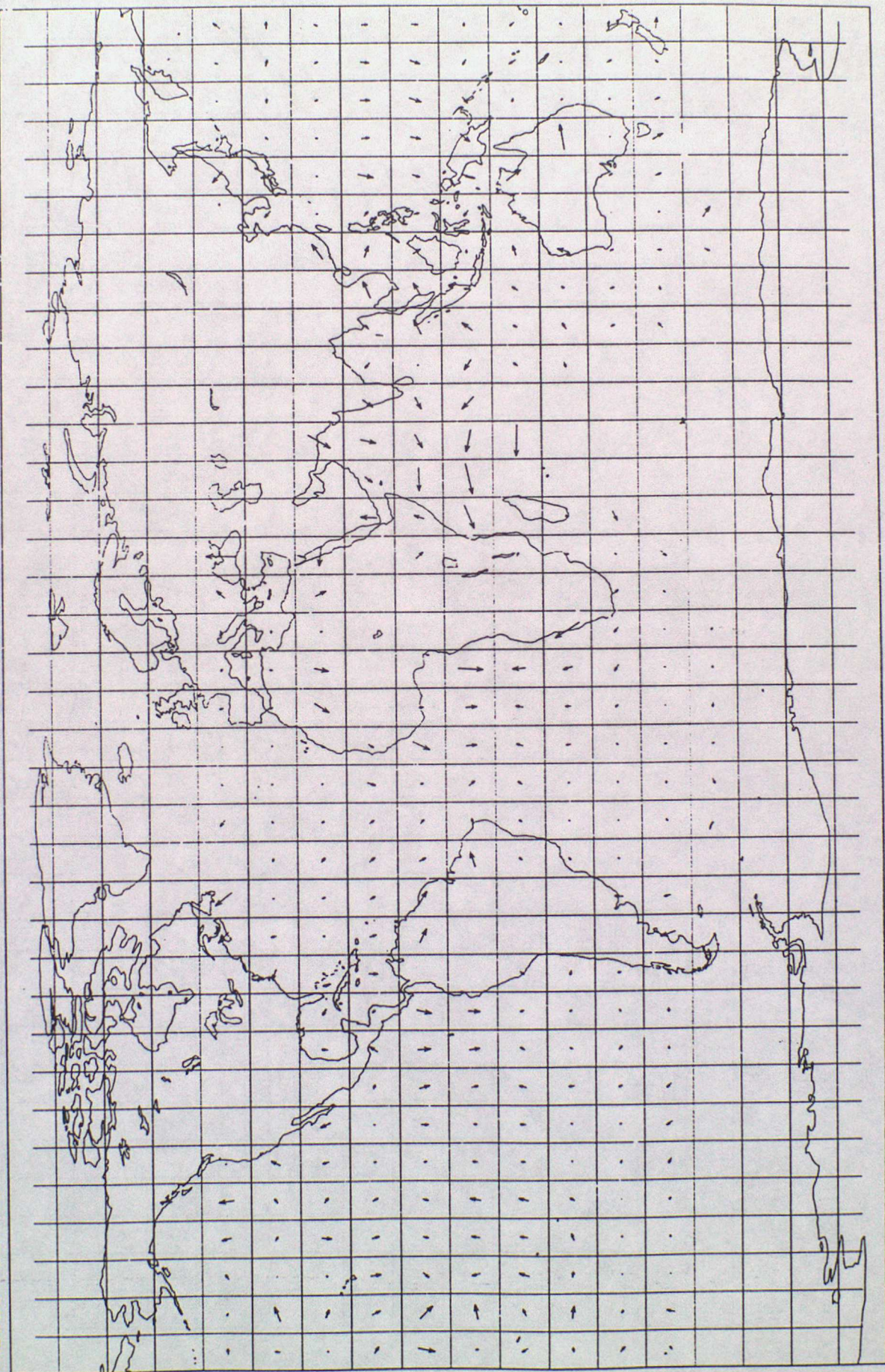
Figure 30

SATOB O-B VECTOR WIND DIFFERENCES BETWEEN 700-999 HPA

1/12/89 TO 28/02/90

ALL OBSERVATIONS

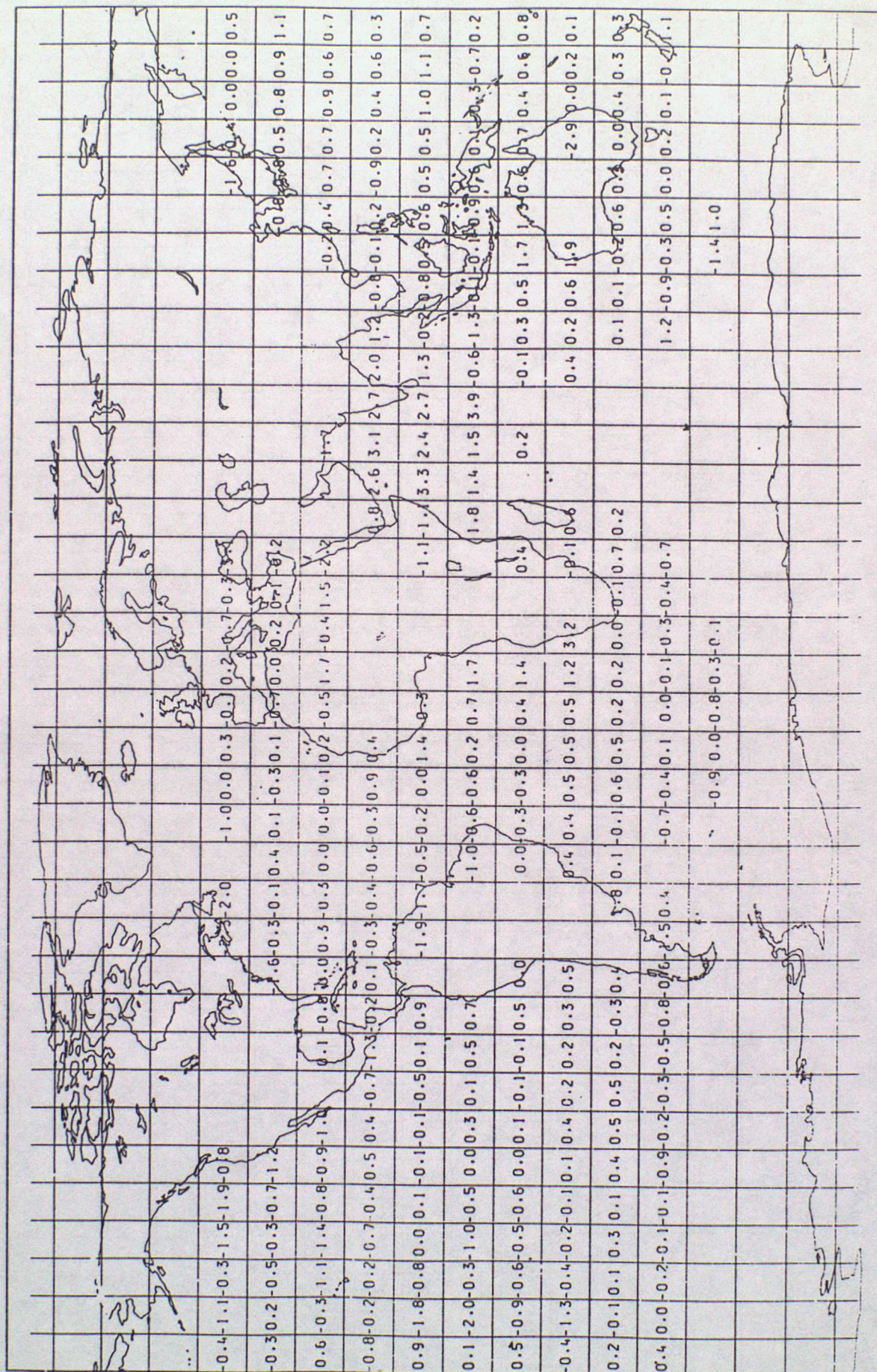
VALUES PLOTTED WHERE > 10 OBS ARE PRESENT



→ REPRESENTS 5 M/S

Figure 31

SATOB5 : MEAN O-B SPEED DIFFERENCES (M/S) BETWEEN 700 AND 999 HPA
 1/12/89 TO 28/02/90
 ALL OBSERVATIONS
 VALUES ARE PRINTED WHERE > 10 OBS ARE PRESENT



SATOB5 : RMS 0-B VECTOR DIFFERENCES (M/S) BETWEEN 700 AND 999 HPA
1/12/89 TO 28/02/90
ALL OBSERVATIONS
VALUES ARE PRINTED WHERE > 10 OBS ARE PRESENT

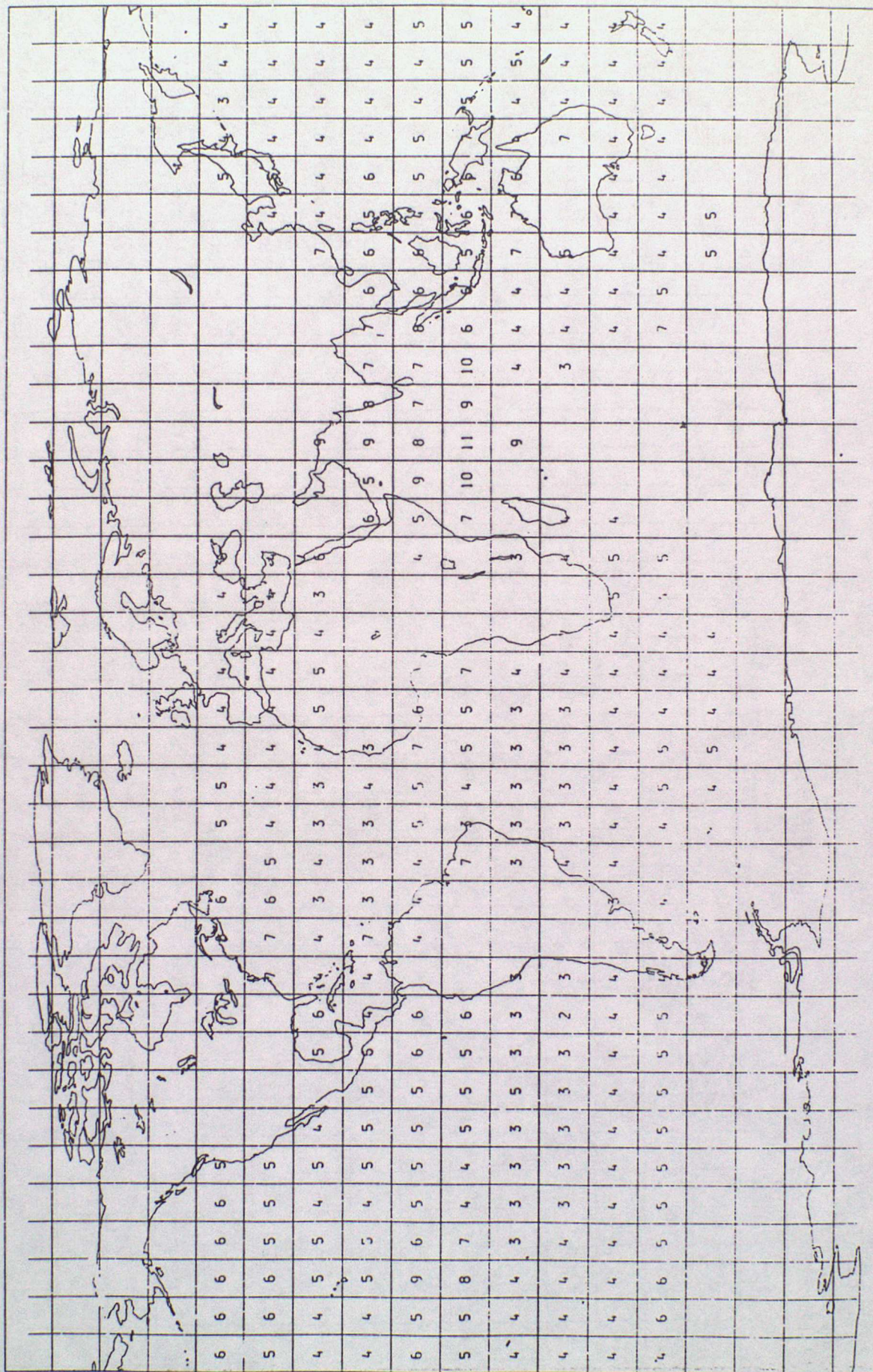
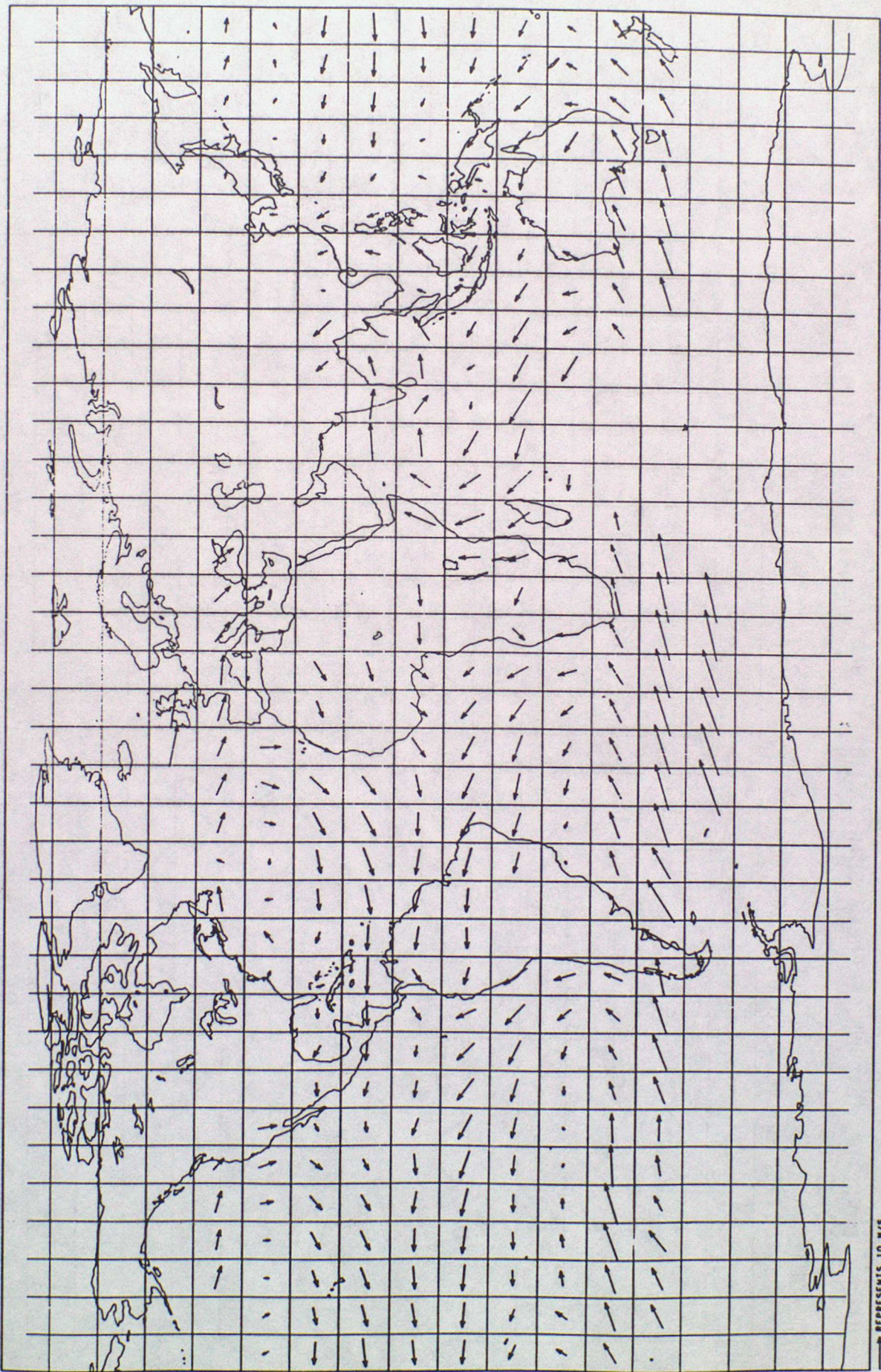


Figure 33

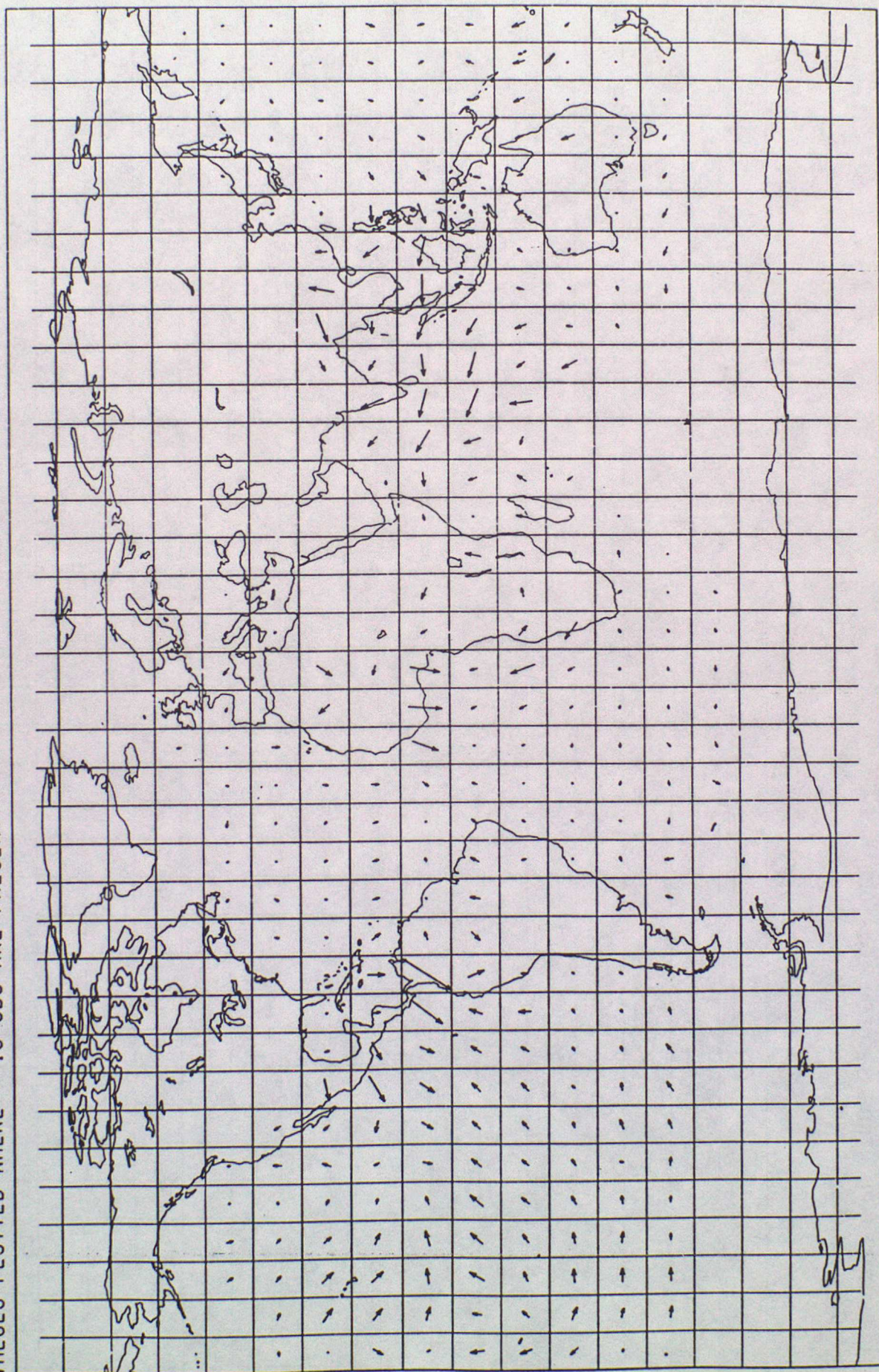
SATOB VECTOR MEAN WINDS BETWEEN 701-1000 HPA
1/06/90 TO 31/08/90
ALL OBSERVATIONS
VALUES PLOTTED WHERE > 10 OBS ARE PRESENT



→ REPRESENTS 10 M/S

Figure 34

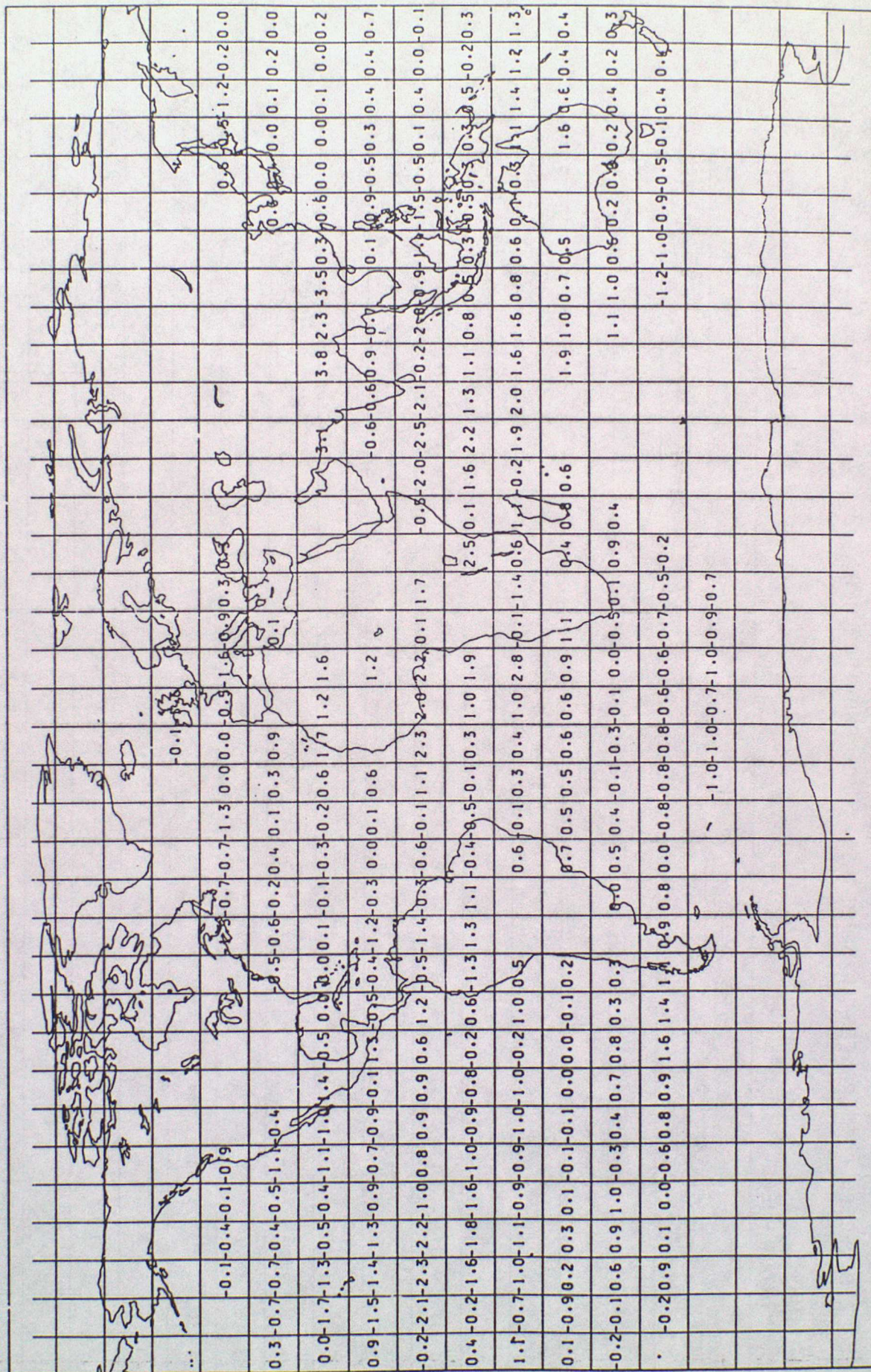
SATOB 0-8 VECTOR WIND DIFFERENCES BETWEEN 701-1000 HPA
1/06/90 TO 31/08/90
ALL OBSERVATIONS
VALUES PLOTTED WHERE > 10 OBS ARE PRESENT



→ REPRESENTS 5 M/S

Figure 35

SATOB5 : MEAN O-B SPEED DIFFERENCES (M/S) BETWEEN 701 AND 1000 HPA
 1/06/90 TO 31/08/90
 ALL OBSERVATIONS
 VALUES ARE PRINTED WHERE > 10 OBS ARE PRESENT



SAT0BS : RMS 0-B VECTOR DIFFERENCES (M/S) BETWEEN 701 AND 1000 HPA
11/06/90 TO 31/08/90

ALL OBSERVATIONS
VALUES ARE PRINTED WHERE > 10 OBS ARE PRESENT

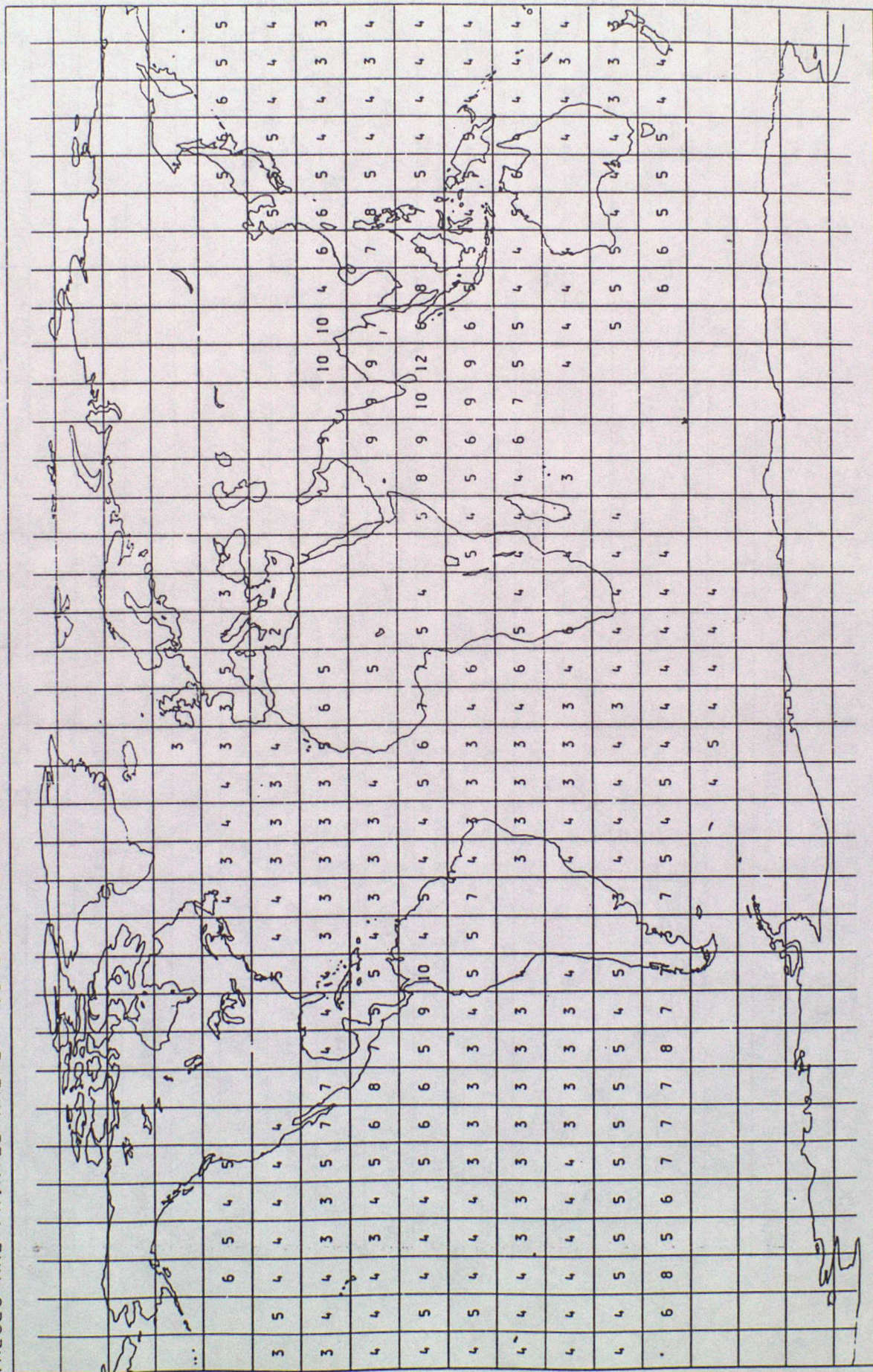


Figure 37

SATOB VECTOR MEAN WINDS BETWEEN 100-399 HPA

1/12/89 TO 28/02/90

ALL OBSERVATIONS

VALUES PLOTTED WHERE > 10 OBS ARE PRESENT

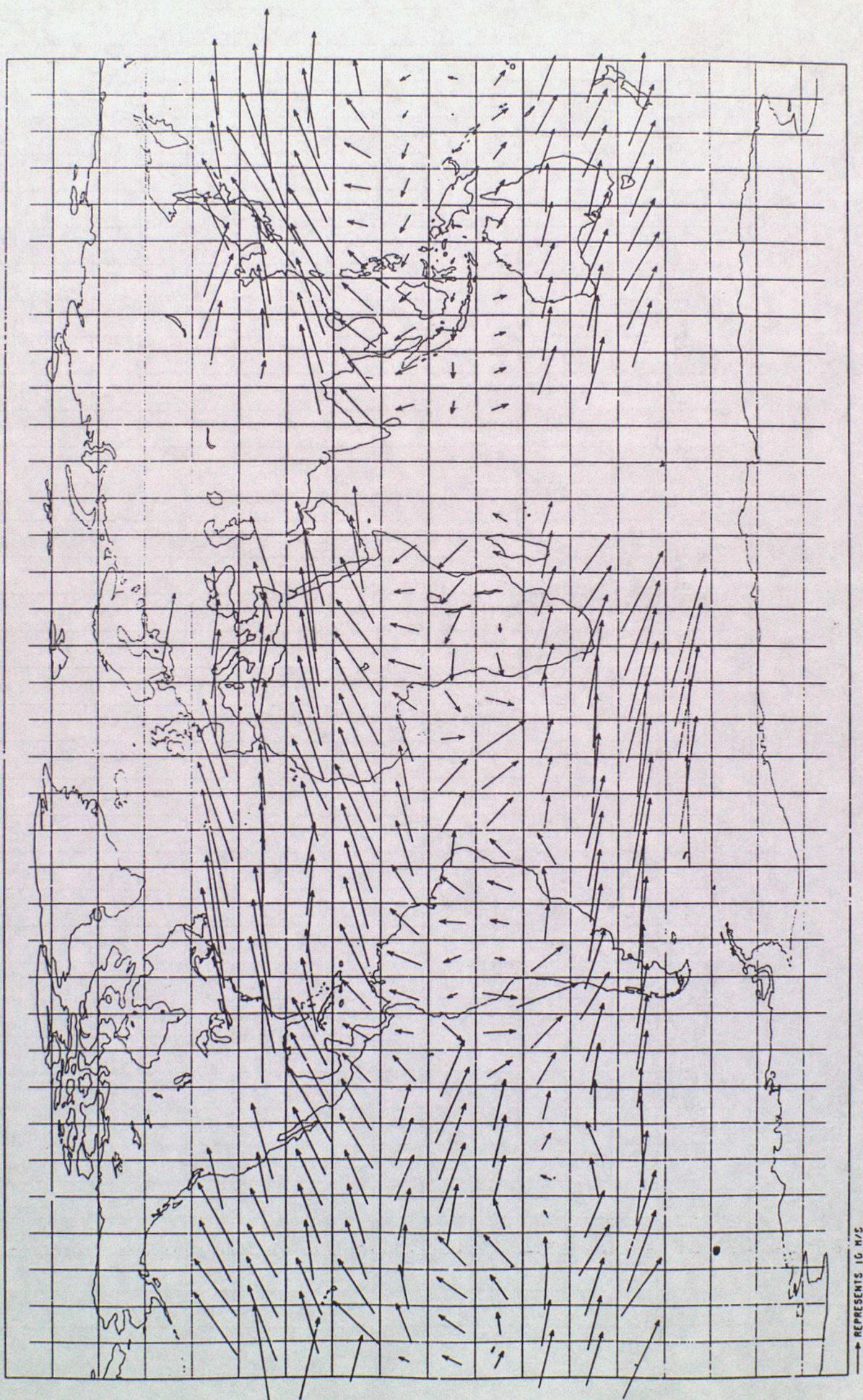
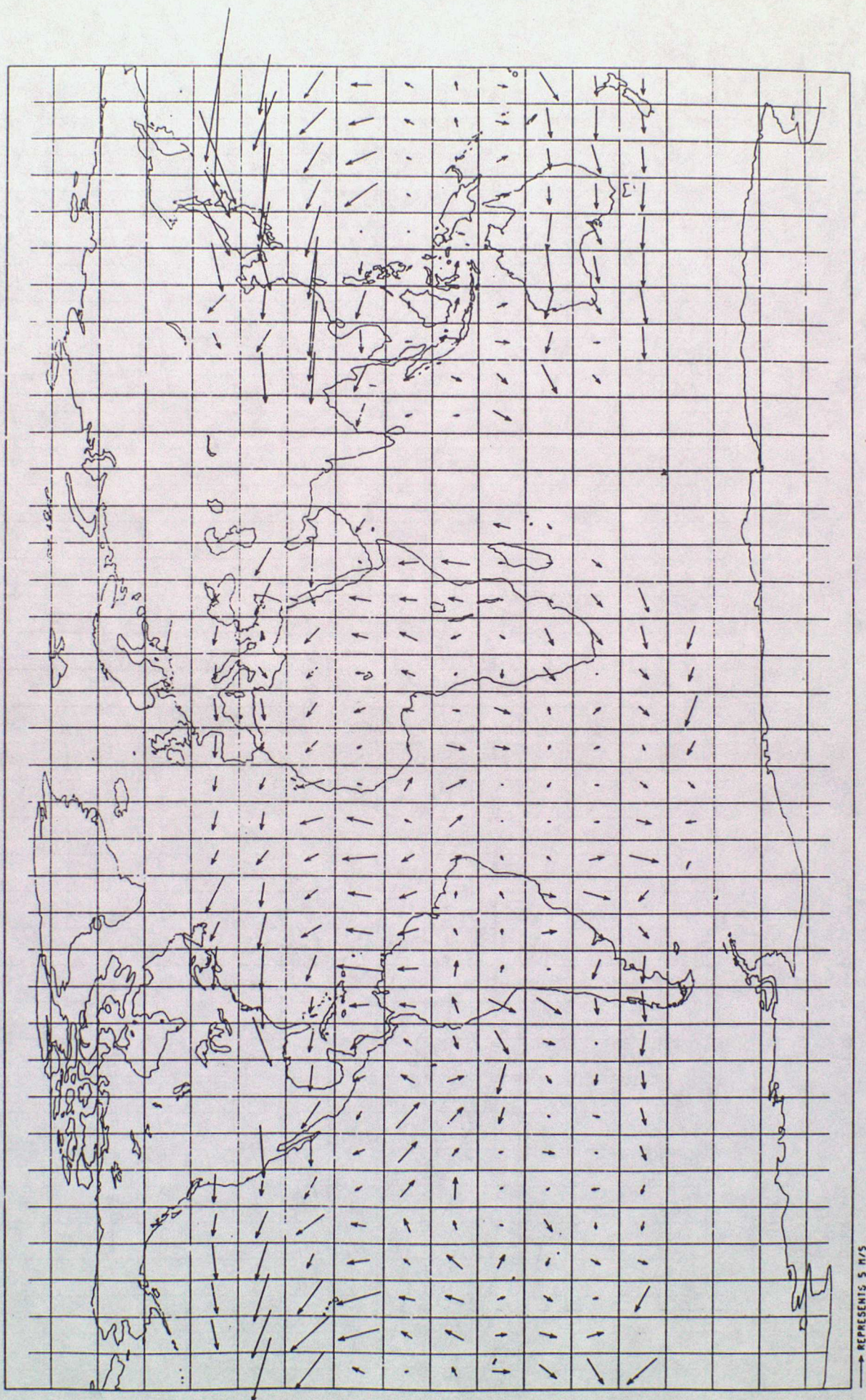


Figure 38

SATOB 0-B VECTOR WIND DIFFERENCES BETWEEN 100-399 HPA
1/12/89 TO 28/02/90
ALL OBSERVATIONS
VALUES PLOTTED WHERE > 10 OBS ARE PRESENT



SATOB5 : MEAN 0-8 SPEED DIFFERENCES (M/S) BETWEEN 100 AND 399 HPA
 1/12/89 TO 28/02/90
 ALL OBSERVATIONS
 VALUES ARE PRINTED WHERE > 10 OBS ARE PRESENT

Figure 39

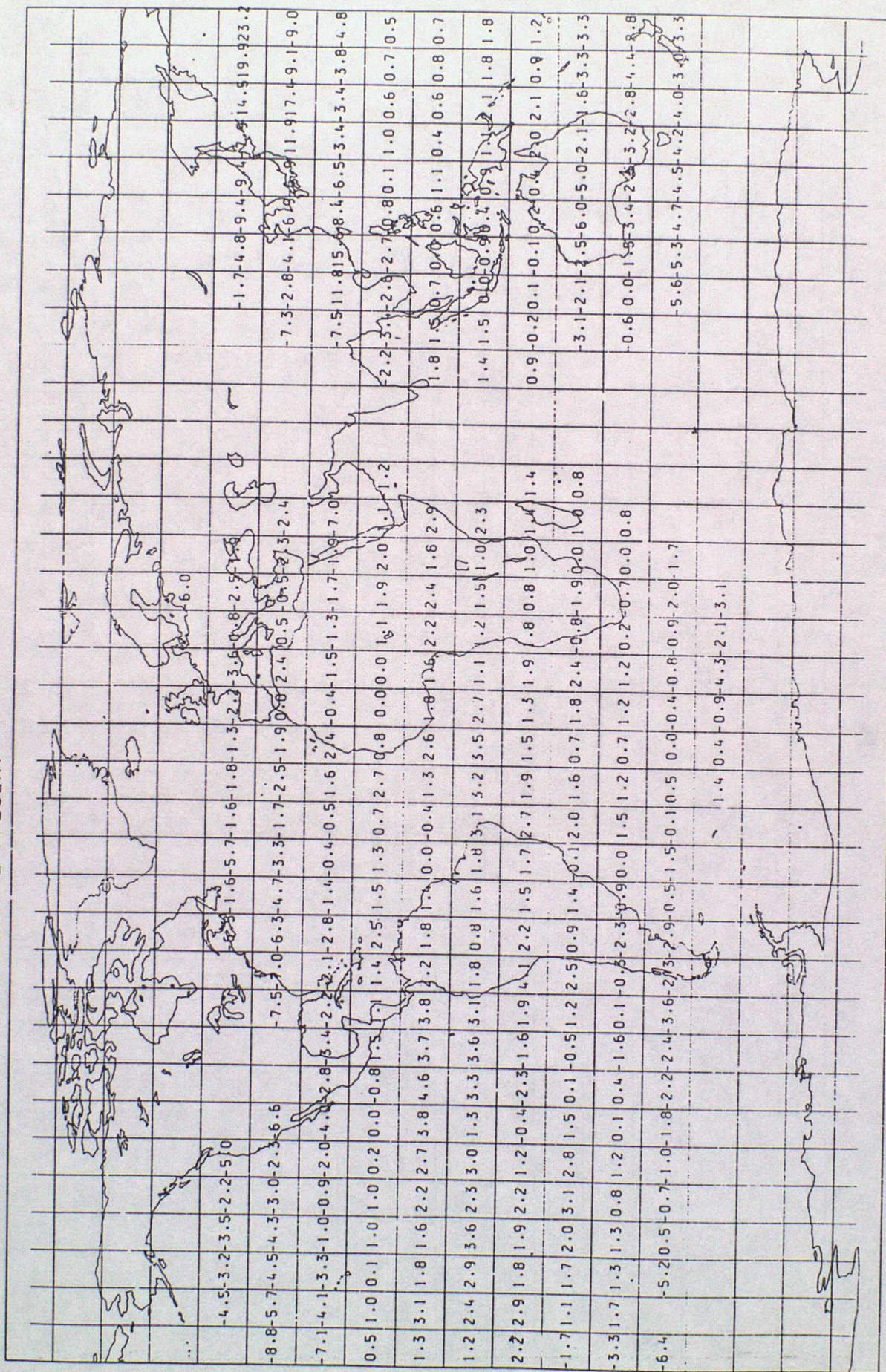


Figure 41

SATOB VECTOR MEAN WINDS BETWEEN 101-400 HPA
1/06/90 TO 31/08/90
ALL OBSERVATIONS
VALUES PLOTTED WHERE > 10 OBS ARE PRESENT

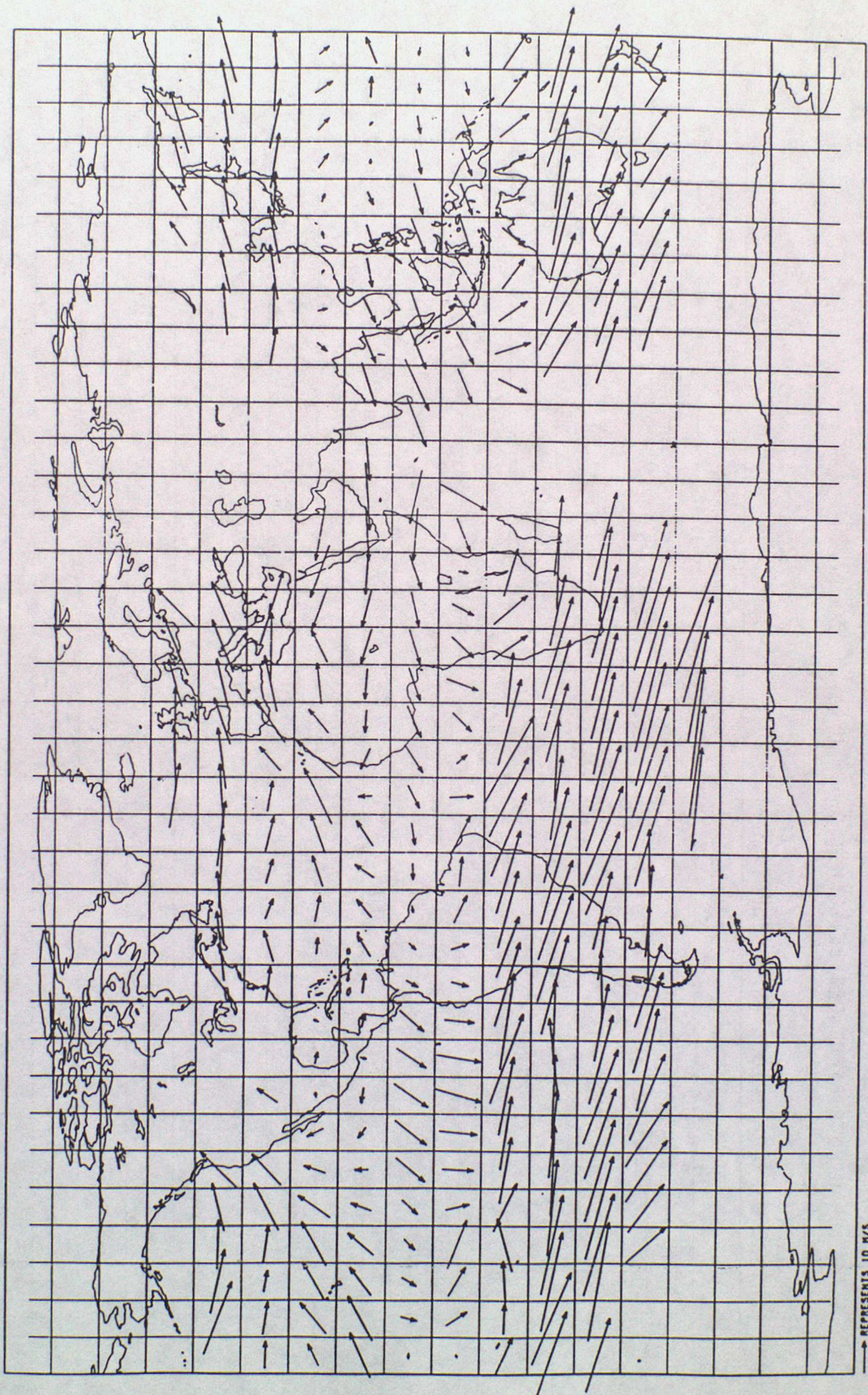


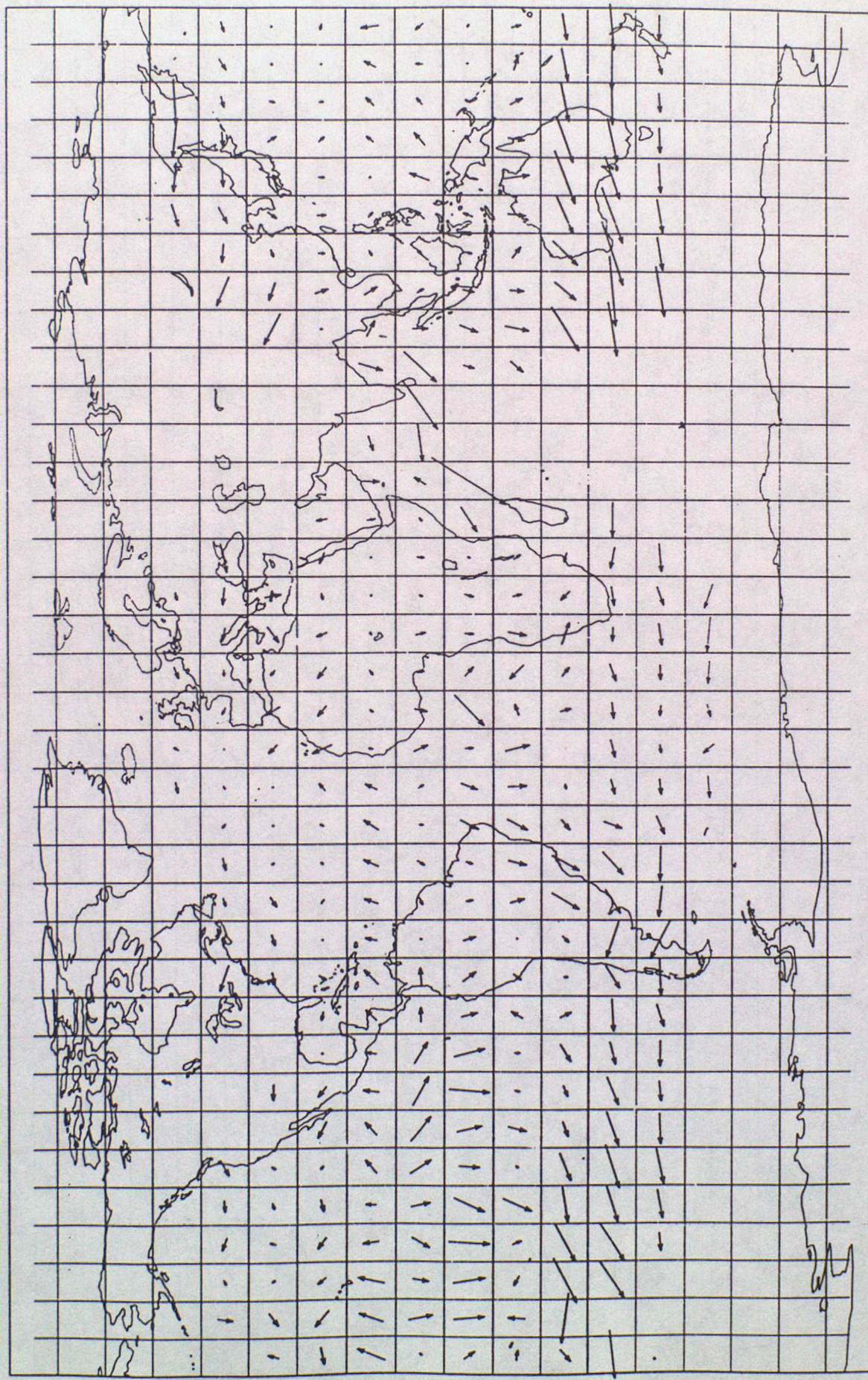
Figure 42

SATOB 0-B VECTOR WIND DIFFERENCES BETWEEN 101-400 HPA

1/06/90 TO 31/08/90

ALL OBSERVATIONS

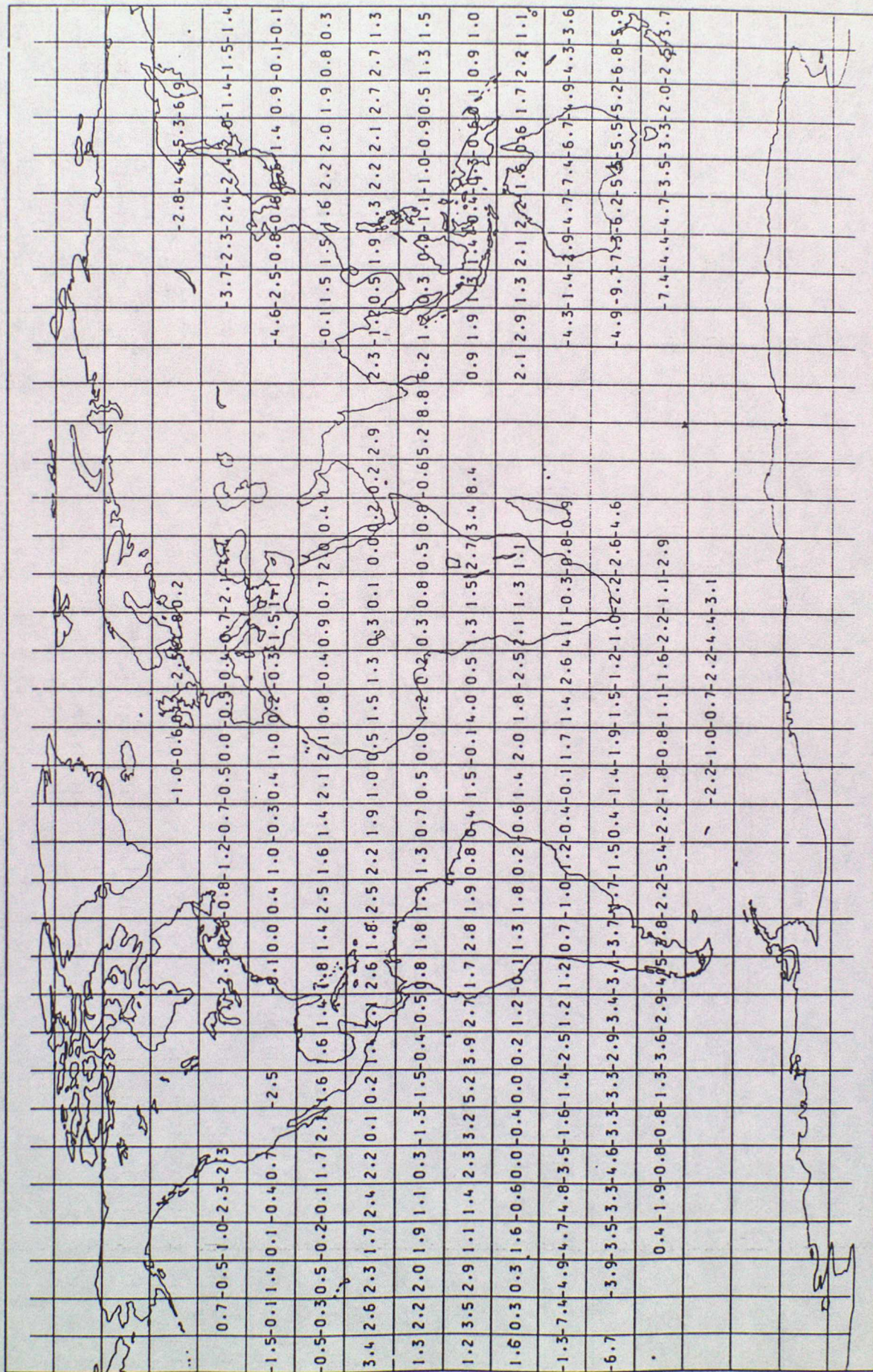
VALUES PLOTTED WHERE > 10 OBS ARE PRESENT



→ REPRESENTS 5 M/S

Figure 43

SATOB5 : MEAN 0-8 SPEED DIFFERENCES (M/S) BETWEEN 101 AND 400 HPA
1/06/90 TO 31/08/90
ALL OBSERVATIONS
VALUES ARE PRINTED WHERE > 10 OBS ARE PRESENT

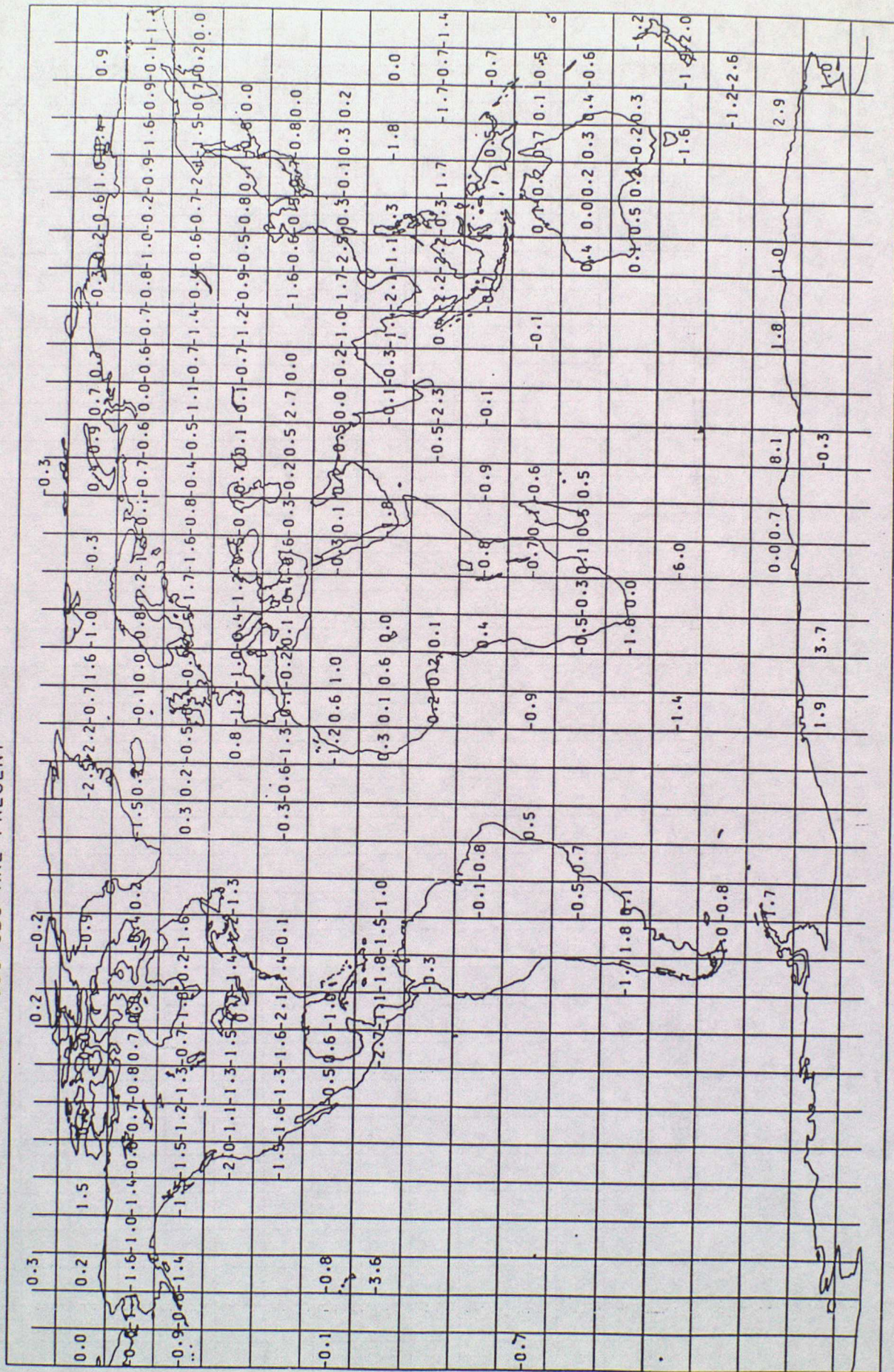


SATOB5 : RMS O-B VECTOR DIFFERENCES (M/S) BETWEEN 101 AND 400 HPA

ALL OBSERVATIONS

SONDES : 0-B SPEED DIFFERENCES (M/S) BETWEEN 700 AND 999 HPA
 1/12/89 TO 28/02/90
 QUALITY CONTROL APPLIED
 VALUES ARE PRINTED WHERE > 100 OBS ARE PRESENT

Figure 45



SONDES : RMS 0-B VECTOR WIND DIFFERENCES (M/S) BETWEEN 700 AND 999 HPA
1/12/89 TO 28/02/90
QUALITY CONTROL APPLIED
VALUES ARE PRINTED WHERE > 100 OBS ARE PRESENT

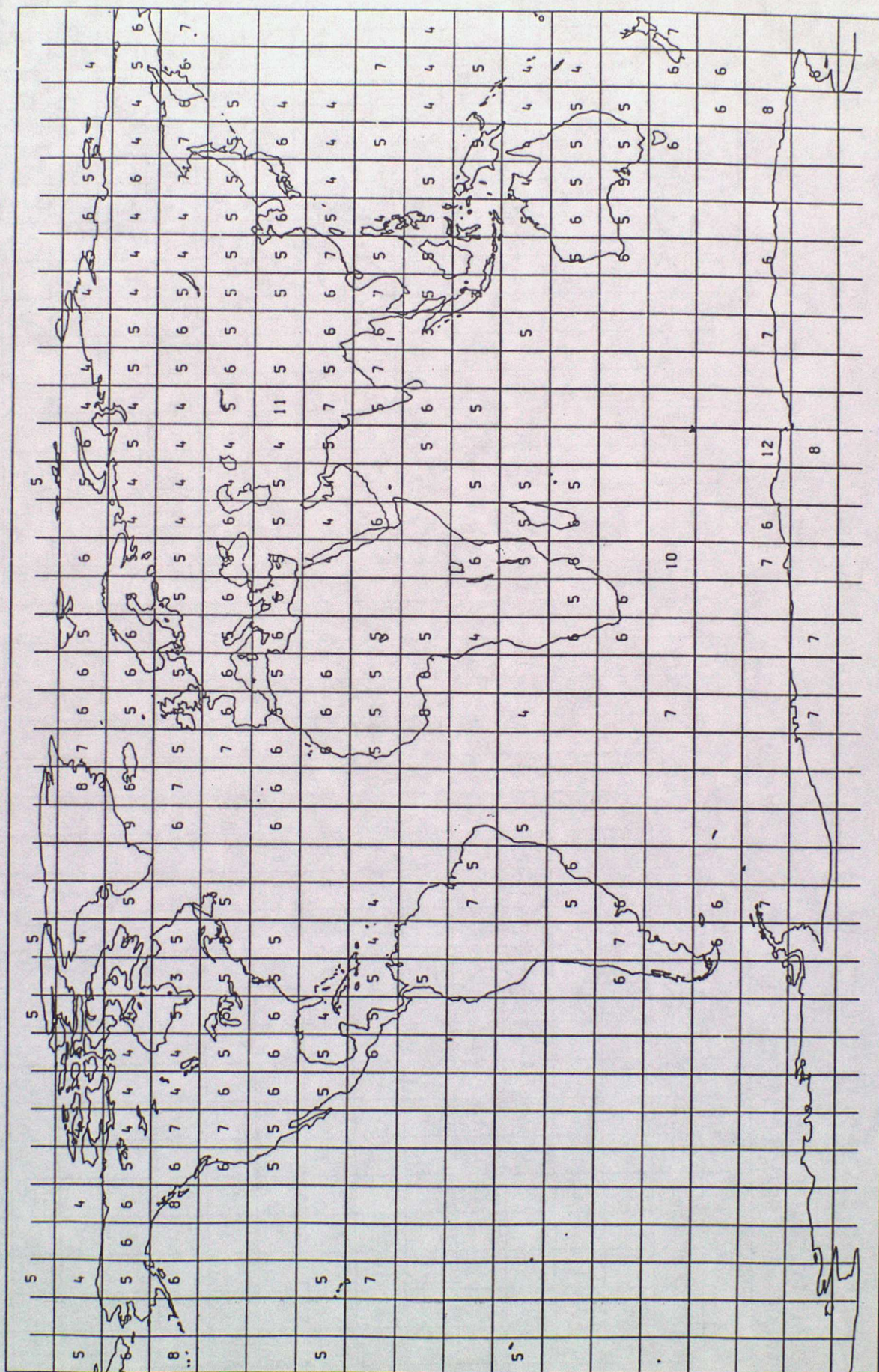


Figure 47

SONDES : 0-B SPEED DIFFERENCES (M/S) BETWEEN 100 AND 399 HPA
 1/12/89 TO 28/02/90
 QUALITY CONTROL APPLIED
 VALUES ARE PRINTED WHERE > 100 OBS ARE PRESENT

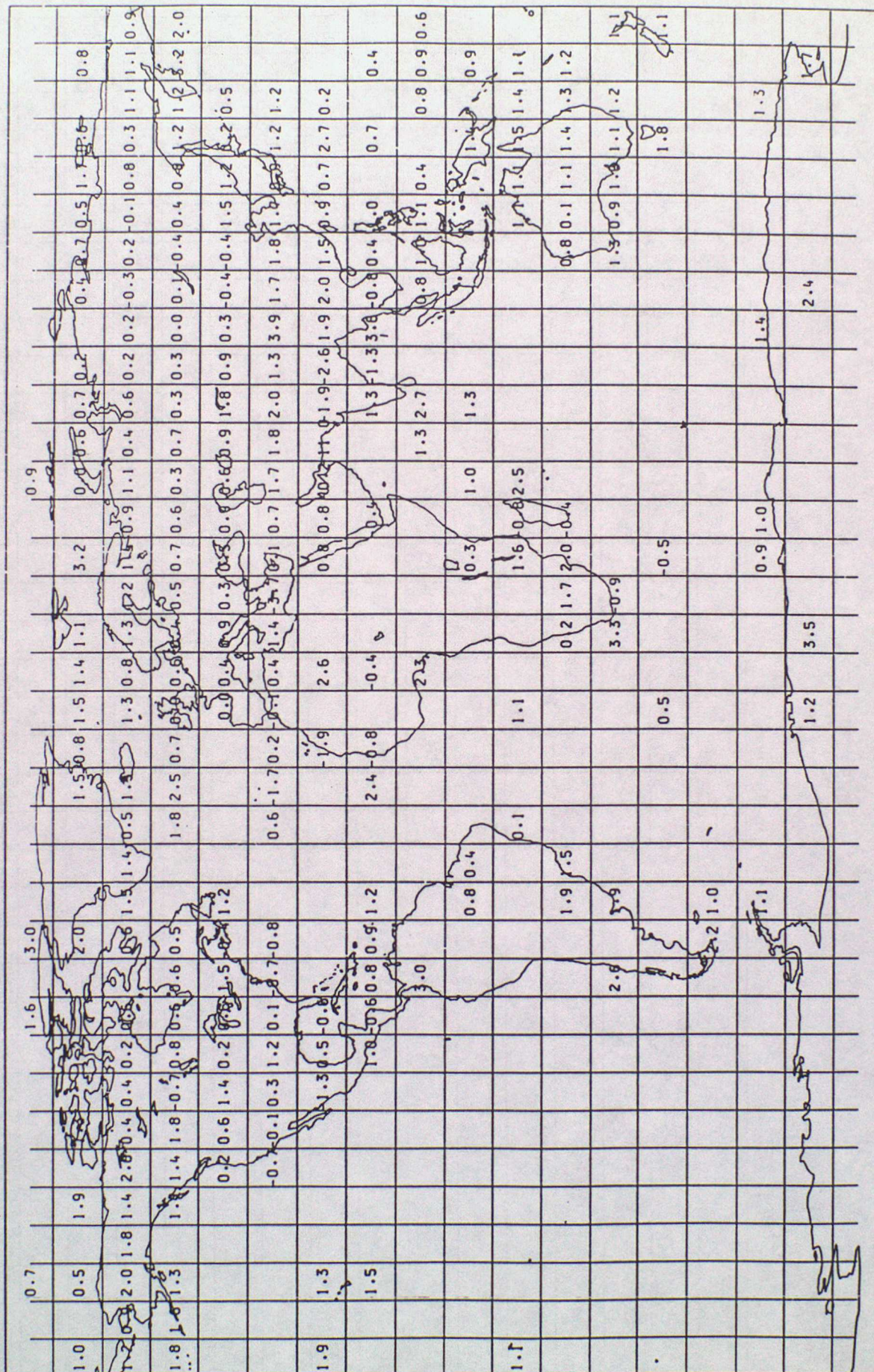


Figure 48

SONDES : RMS O-B VECTOR WIND DIFFERENCES (M/S) BETWEEN 100 AND 399 HPA

1/12/89 TO 28/02/90

QUALITY CONTROL APPLIED

VALUES ARE PRINTED WHERE > 100 OBS ARE PRESENT

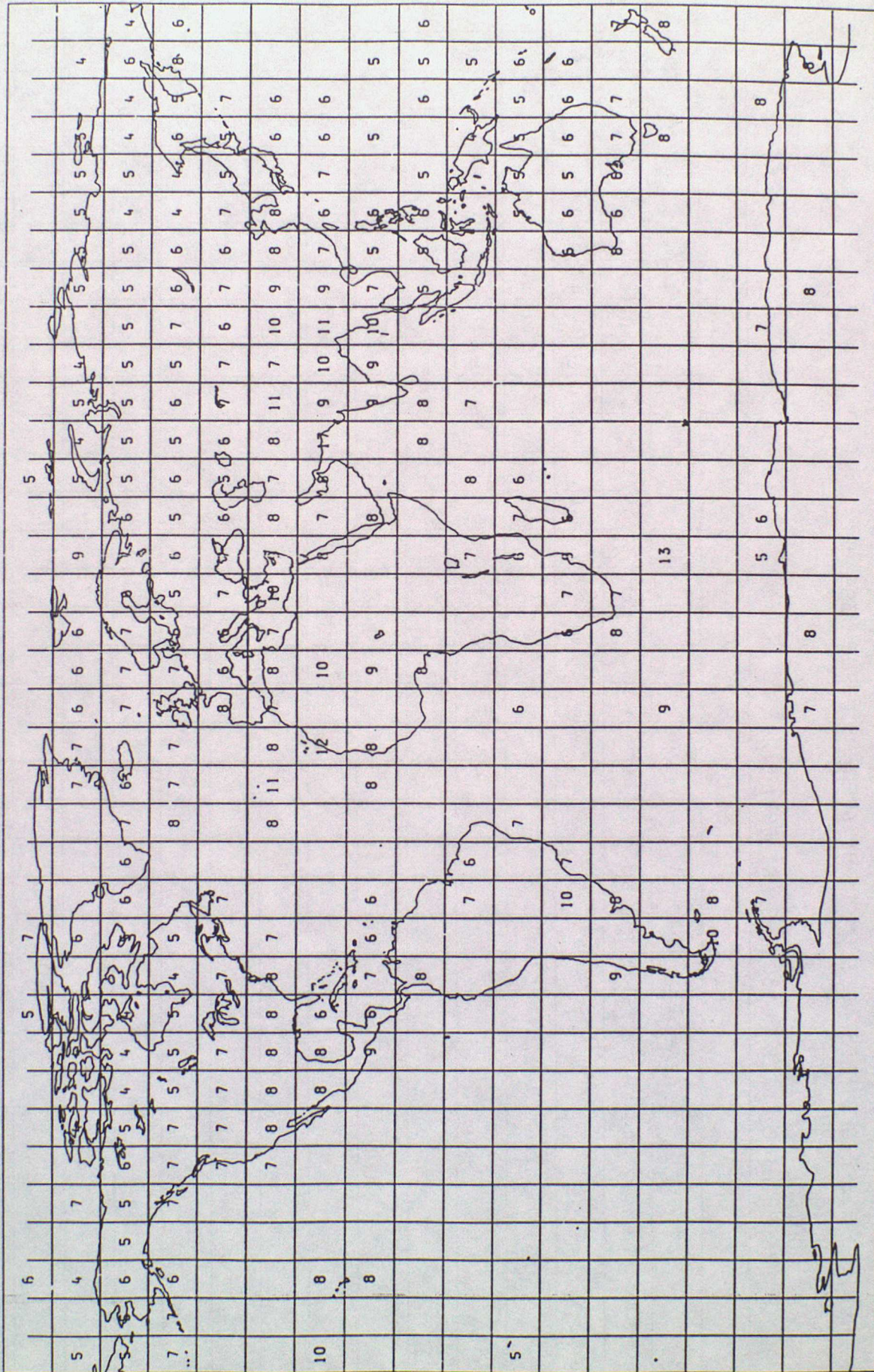
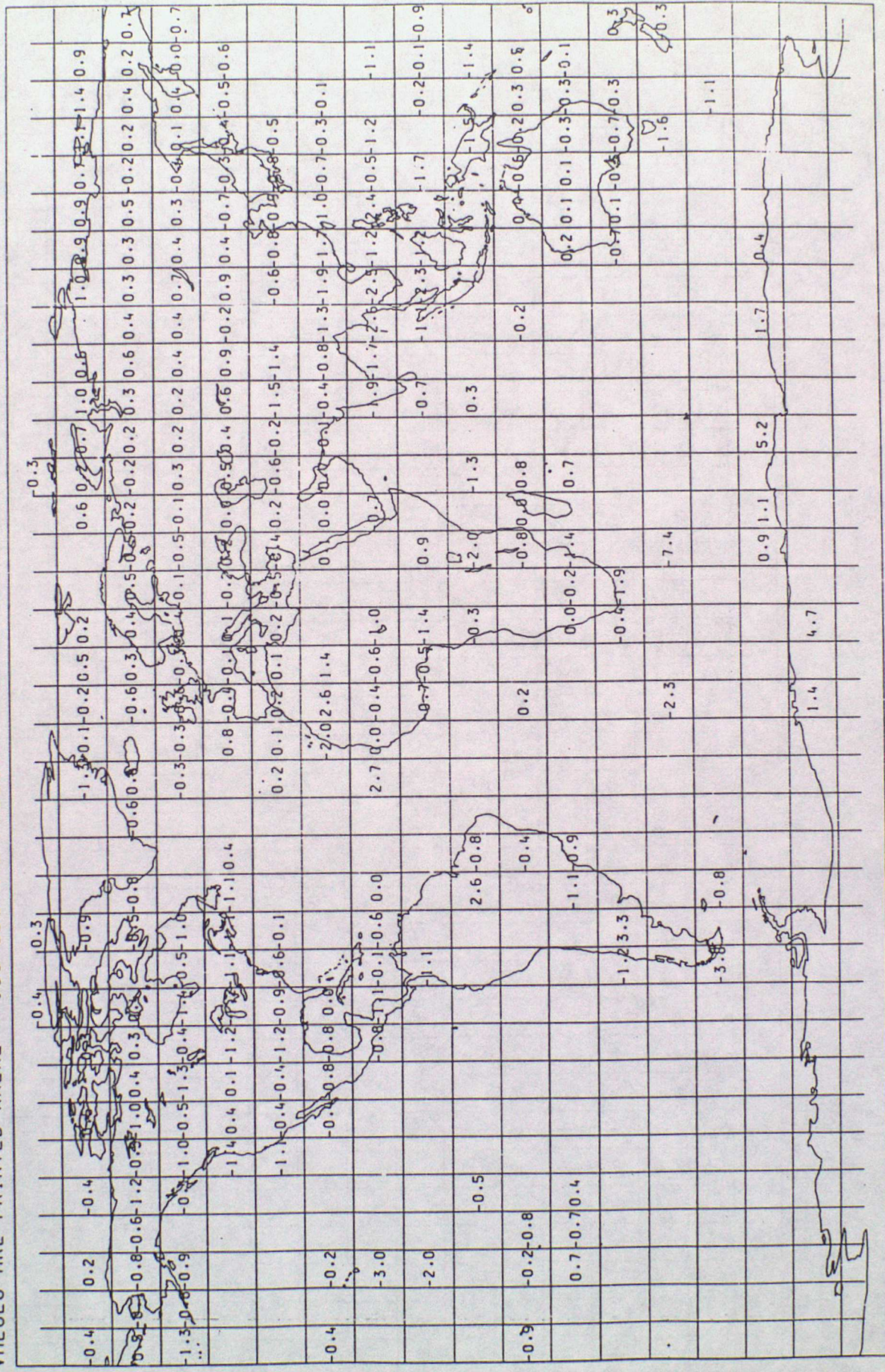


Figure 49

SONDES : 0-8 SPEED DIFFERENCES (M/S) BETWEEN 700 AND 999 HPA
1/06/90 TO 31/08/90
QUALITY CONTROL APPLIED
VALUES ARE PRINTED WHERE > 100 OBS ARE PRESENT



SONDES : RMS 0-B VECTOR WIND DIFFERENCES (M/S) BETWEEN 700 AND 999 HPA
1/06/90 TO 31/08/90
QUALITY CONTROL APPLIED
VALUES ARE PRINTED WHERE > 100 OBS ARE PRESENT

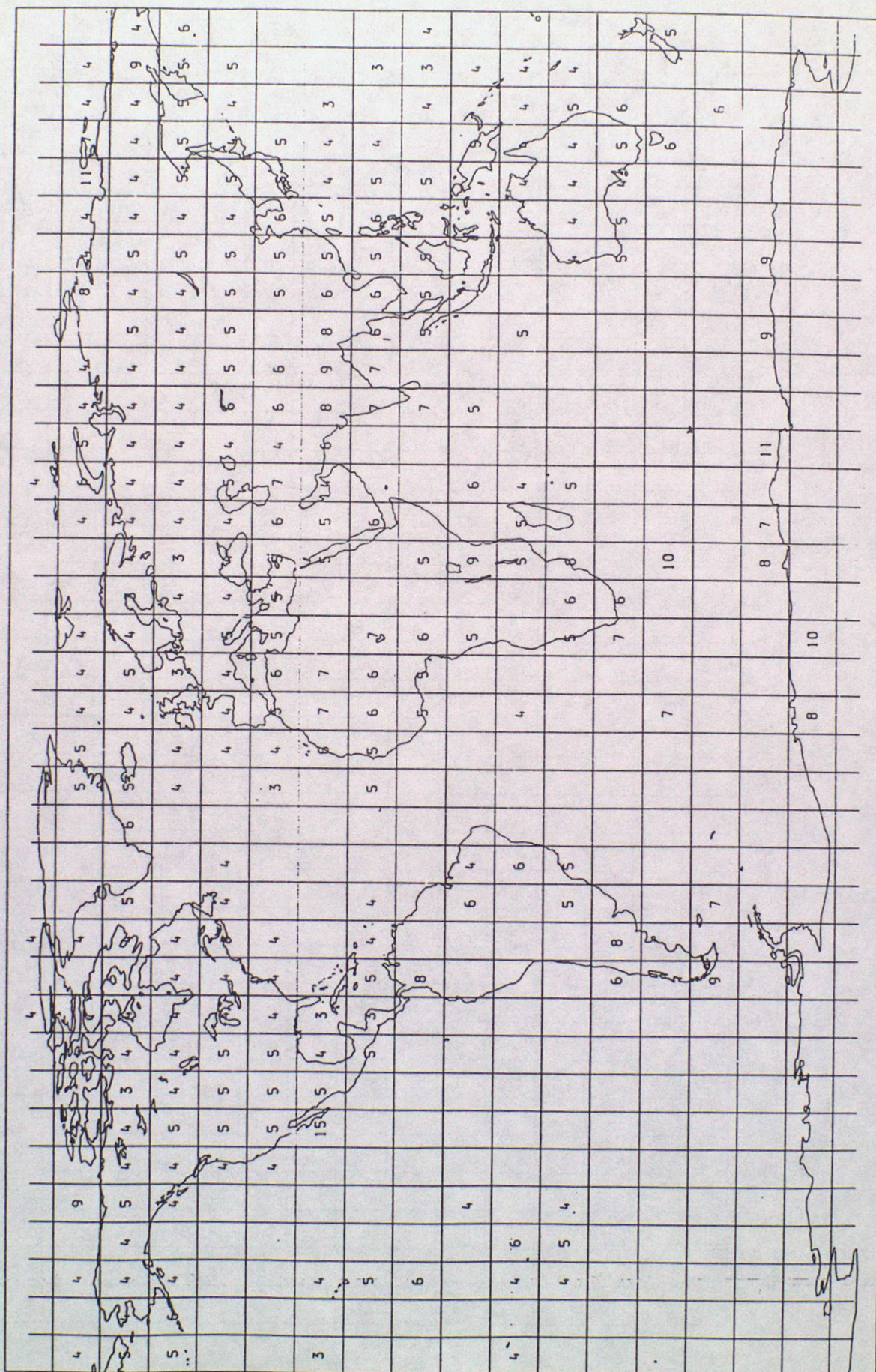


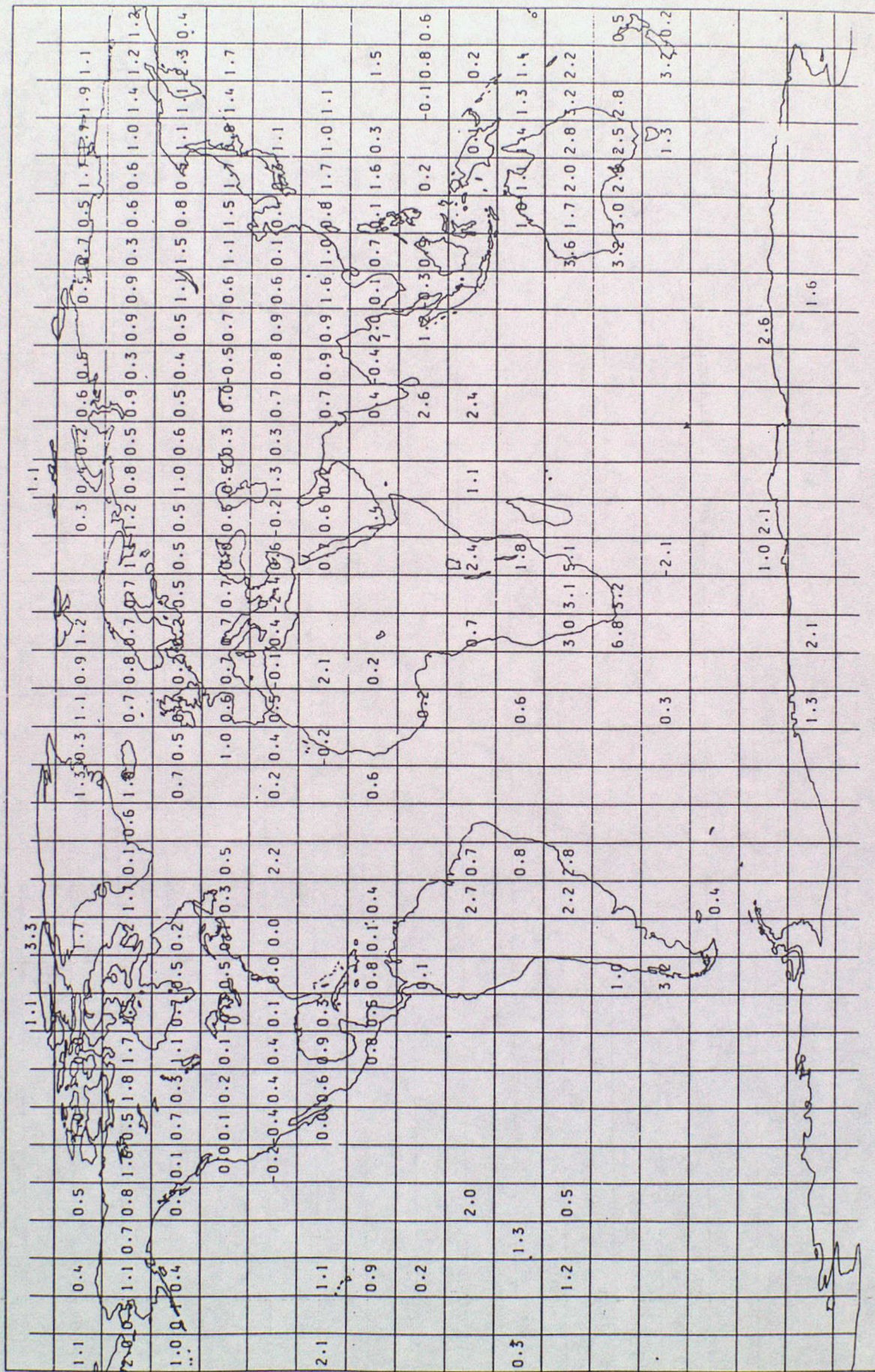
Figure 51

SONDES : 0-8 SPEED DIFFERENCES (M/S) BETWEEN 100 AND 399 HPA

1/06/90 TO 31/08/90

QUALITY CONTROL APPLIED

VALUES ARE PRINTED WHERE > 100 OBS ARE PRESENT



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Figure 54

RAIREPS : RMS O-B SPEED DIFFERENCES (M/S) BETWEEN 100 AND 399 HPA

DEC 1989 & FEB 1990

GROSS ERROR CHECK APPLIED

VALUES ARE PRINTED WHERE > 100 OBS ARE PRESENT

