KONINKLIJK NEDERLANDS METEOROLOGISCH INSTITUUT

VERSLAGEN

V-329

G.J. Cats en J. Reiff

A vertically detailed analysis of some air mass properties

De Bilt, 1979

Publikatienummer; K.N.M.I. V-329 (MO)

Koninklijk Nederlands Meteorologisch Instituut,
Meteorologisch Onderzoek,
Postbus 201,
3730 AE De Bilt,
Nederland.

U.D.C.: 551.511.2 :
551.509.323/324

ABSTRACT

For the study of properties of air masses which are expected to arrive some time later above a certain point, one can make use of an isentropic trajectory model, which predicts source areas. In order to apply this information as a forecasting tool, it is essential to dispose of a detailed analysis of such air mass properties as temperature and humidity. This report describes a method to obtain such an analysis.

The temperature and humidity of the advected air mass had been analysed as linear combinations of observed temperatures (respectively humidities) at nearby stations. The weights are taken proportional to the inverse of the square of the distance between air mass source and observation point. Since only at some levels the air mass source is known (namely at the trajectory levels), the weights are linearly interpolated between those levels. Some analysis examples and an algol program description are given.

1. INTRODUCTION

The trajectory model described by Reiff, Saraber and Cannemeijer (1979) is at present run operationally at the Royal Netherlands Meteorological Institute. The output of this model is an estimate of the present position of the air which is expected to arrive above a certain point, say, 12 or 24 hours later. For this, winds from the institute's forecast model are used. Due to vertical wind shear the present position is not the same for the air masses arriving at different heights.

One of the purposes of the model is to predict the vertical temperature and humidity profile of the air arriving at De Bilt. For this purpose, analysed temperature and humidity profiles in the source area are required. Since the institute's forecast model uses only four levels, a vertically detailed analysis can be obtained only by using the rawinsonde observations in and near the source area. Of cource, it must be investigated whether such a detailed analysis is necessary. As a first step, a simple analysis scheme has been developed and programmed. This report is a description of that scheme.

At different heights the trajectory model yields source areas in general at different geographical positions. The temperature and humidity analysis scheme must take this into account. Therefore the scheme results in temperature and humidity profiles which are not really vertical. They will hereafter be denoted by "skew temperature profiles" and "skew humidity profiles".

A survey of the main analysis equations are given in Chapter 2. Some sample analyses are given in Chapter 3. In Appendix A the algol program is described in detail and the text is given, an output example is shown in Appendix B. The appendices may be obtained seperately from the library of the Royal Meteorological Institute, De Bilt, The Netherlands.

2. ANALYSIS PROGRAM

The main characteristics of the analysis program are:

1) In the program σ-coordinates are used, because it may be assumed that the meteorological properties that we analyse (such as temperature inversions) follow the orography of the terrain.
2) Every significant level of every rawinsonde observation is interpreted as a significant level in the analysed "skew temperature and humidity profiles".
3) At each significant level σ of the skew profiles the meteorological quantity $\phi^a(\sigma)$ has to be analysed. Its value is obtained from the observed profiles as:

$$\phi^a(\sigma) = \sum_{i=1}^{N} w_i(\sigma)\phi_i^o(\sigma), \tag{1}$$

where $\phi_i^o(\sigma)$ is the observed value at station i, and $w_i(\sigma)$ is the weighting factor for station i at level σ.

4) The observed value $\phi_i^o(\sigma)$ is approximately obtained by a vertical linear interpolation from the nearest significant levels of rawinsonde i.
5) The weights $w_i(\sigma)$ are determined as follows:
At σ_o, the level of one of the trajectory starting points (which do not necessarily coincide with the σ-levels of the end points, because of vertical motions and of varying surface pressure) the weights $w_i(\sigma_o)$ are given by:

$$w_i(\sigma_o) = \frac{1/d_1^2(\sigma_o)}{\sum_{j=1}^{N} 1/d^2(\sigma_o)} \tag{2}$$

where $d_i(\sigma_o)$ is the distance between the i-th rawinsonde station and the trajectory starting point at level σ_o.

The weights, given by (2) are a very simple first guess, For our purposes, this guess suffices, because the average distance between the rawinsonde stations in Western Europe (about 250 km) is much smaller than the correlation length in temperature fields (about 1200 km, Lorenc et al., 1977) and in humidity fields (about 700 km, Van Maanen, 1979).

At σ-levels that are intermediate between two trajectory starting point levels, the weights $w_i(\sigma)$ are obtained by linear interpolation, and at levels below the lowest trajectory level by linear extrapolation from the $w_i(\sigma_o)$. If σ corresponds to a level that exceeds all trajectory levels, the weights are taken as

$$w_i(\sigma) = w_i(\sigma_o), \qquad (\sigma<\sigma_o^*)$$

where σ_o^* is the highest trajectory-level. (i.e. σ_o^* is the lowest σ_o value, because σ is decreasing with height).

6) The number of significant levels in the skew profiles, being the sum of numbers of significant levels in the rawinsonde used, is high. This number is reduced in two steps. Firstly, if at two significant levels σ, temperature and humidity differ less than certain specified limits, the two significant levels are replaced by one. The second step consists of the following procedure: at each significant level the temperature is linearly interpolated between the temperatures analysed at the lowest and the highest significant level. The level with the largest deviation between interpolated and analysed temperature is kept as a significant level, if the deviation exceeds a certain tolerance. This procedure is repeated both below the now defined characteric point and above it, until all deviations are less than the tolerance.(See figure 10). Then the procedure is repeated with mixing ratio replacing temperature.

7) The analysis procedure may lead to superadiabatic profiles. In general, two significant levels will not be at the same geographical position, and therefore a superadiabatic profile is not always unphysical. The analysis scheme therefore has no convective adjustment procedure.

3. EXAMPLES

The analysis program was run on four situations:

1) 0000 GMT, 30 May, 1978.
2) 0000 GMT, 1 June, 1978.
3) 0000 GMT, 12 October, 1978.
4) 0000 GMT, 13 October, 1978.

In fig. 1 the starting positions are given of the trajectories of the air masses which are expected to arrive 12 hours later above De Bilt (06260). By hand 3 or 4 nearby rawinsonde stations were selected. The observed potential temperature and relative humidity profiles are plotted in figs. 2 - 9, together with the analysed skew profiles. In the analysis only the significant points that are left after the reduction of section 2, point 6 are indicated. The limits for considering two consecutive significant levels as one, were chosen as follows:

The σ-level difference of the two points should be less than 3 times 10^{-3}, the temperature difference less than 0.2 K and the dewpoint depression difference less than 0.3 K. Further, the permitted tolerance in the second part of the procedure for reduction of the number of significant levels, was taken to be 0.3 K in temperature and 0.3 g/kg in mixing ratio. The remaining number of significant points is much lower than the sum of the numbers of observed significant levels, which shows that the reduction procedure is effective.

Some properties of the analysis scheme are reflected in the analysis of the skew temps:

a) A great vertical detailing is achieved. At 30 May, and 1 June 1978 (figure 2 and 4) for example, the nocturnal inversion would not have been detected if only surface and 850 mbar temperatures had been available. This indicates that at least in a number of cases the vertical detailing is physically significant.
b) The observed temps often show qualitatively the same meteorological features. For instance, the nocturnal temperature inversions in figure 2 and 4 occur for the different temps at nearly the same σ-level. However, differences of several degrees centigrade exist at the same σ-level between the different temps: In figure 2, the surface temperature between the temps differs 3 degrees, while in

figures 6 and 8 the surface temperature of the temps nearest to the analysis point, differs 4 degrees. Because we want to end up with an analysis error smaller or equal than one degree centigrade, this illustrates that it is not allowed to take the nearest observed temp as representative for the source area: An interpolation scheme between different temps is required.

c) Sometimes large wind shears occur, which lead to very skew analysed profiles (see fig. 1). On 12 October 1978, for instance, this leads to a large weight for the station 06476 in the upper levels, and for the stations 10739 and 09548 in the lower ones. This is reflected in the analyzed profiles (figs. 6 and 7), which are almost identical to the observations of 06476 above $\sigma = 0.6$, and to the average of 10739 and 09548 below $\sigma = 0.9$. It is therefore essential that the weights in the interpolation scheme depend on height.

d) All four examples show, that the mixing ratio at the surface for the different rawinsondes does not spread more than 1 g/kg over typically 200 kilometers, while the mixing ratio's above the surfaces often spread more than 3 g/kg. This is possible due to the method of observation: The gold meter skin-method or humicap-method used in radiosondes is less accurate than the wet bulb method used to calibrate the sonde measurement at the surface. The upper air humidity measurements still show a correlation length of 700 km (Van Maanen, 1979). For our analysis this means that an interpolation scheme with different weights in the vertical still is worthwhile for the humidity measurements.

4. FINAL REMARKS.

The presented analysis scheme meets the following requirements:

1. Vertical details of the observed profiles still show up in the analysis. Undesired smoothing is in this way avoided.
2. The reduction technique results in the desired amount of significant points.

The value of the presented analysis scheme can only be assessed by using it in an advective model. Only then it may be investigated how important it is to know in detail the structure of for instance the nocturnal inversion, in order to forecast height and temperature of the mixed layer twelve hours later.

REFERENCES

Lorenc, A., I. Rutherford and G. Larsen, 1977: The ECMWF Analysis and data assimilation scheme. Analysis of mass and wind fields. European Centre for Medium Range Weather Forecasts, Technical Report no. 6.

Reiff, J., M.J.M. Saraber and F. Cannemeijer, 1979: Een drie-dimensionaal trajectoriënmodel. K.N.M.I. Scientific Report WR 79-... pp .... (to be published).

Van Maanen, J., 1979: Objective Analysis of Humidity by the optimum interpolation method. (to be published).

Figure captions

Fig. 1. Starting positions at 0000 GMT of the trajectories ending in De Bilt (06260) at 1200 GMT for the four examples, including the positions of the stations used in the analysis.

Fig. 2. Observations and analysis of potential temperature (θ), plotted as a function of σ, in the first example (30 May 1978).

Fig. 3. As fig. 2, however with observations and analysis of mixing ratio (r).

Fig. 4. As fig. 2, however for the second example (1 June 1978).

Fig. 5. As fig. 3, for 1 June 1978.

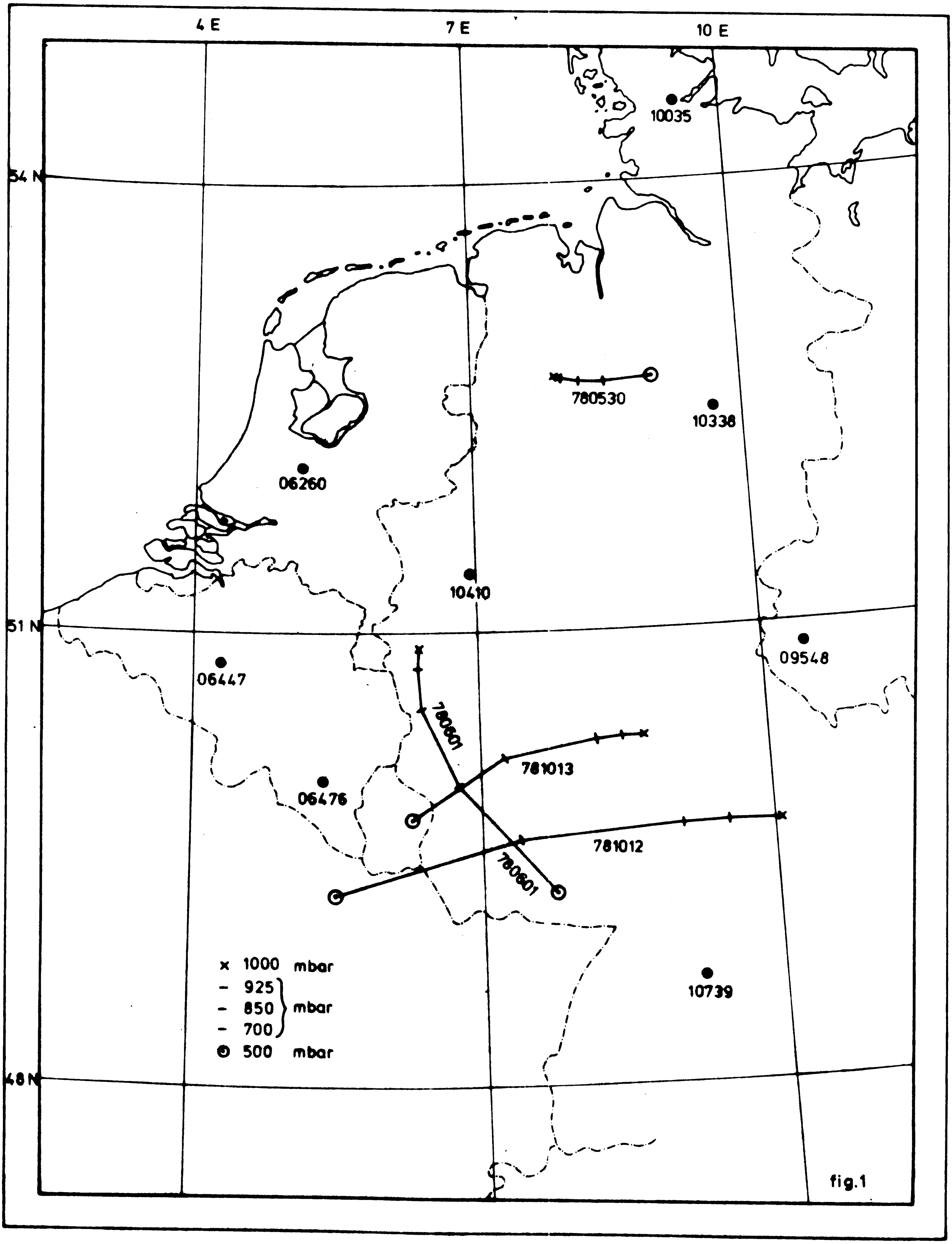
Fig. 6. As fig. 2, however for the third example (12 October 1978).

Fig. 7. As fig. 3, for 12 October 1978.

Fig. 8. As fig. 2, however for the fourth example (13 October 1978).

Fig. 9. As fig. 3, for 13 October 1978.

Fig. 10. Different stages of the significant points reduction technique. In the original analysis there are 7 significant points, after reduction in stage d there are 5 significant points left.



4 E
7 E
10 E
54 N
51 N
48 N
10035
780530
10338
06260
10410
06447
09548
780601
781013
06476
781012
780601
10739
x 1000 mbar
- 925
- 850 mbar
- 700
⊙ 500 mbar

fig.1

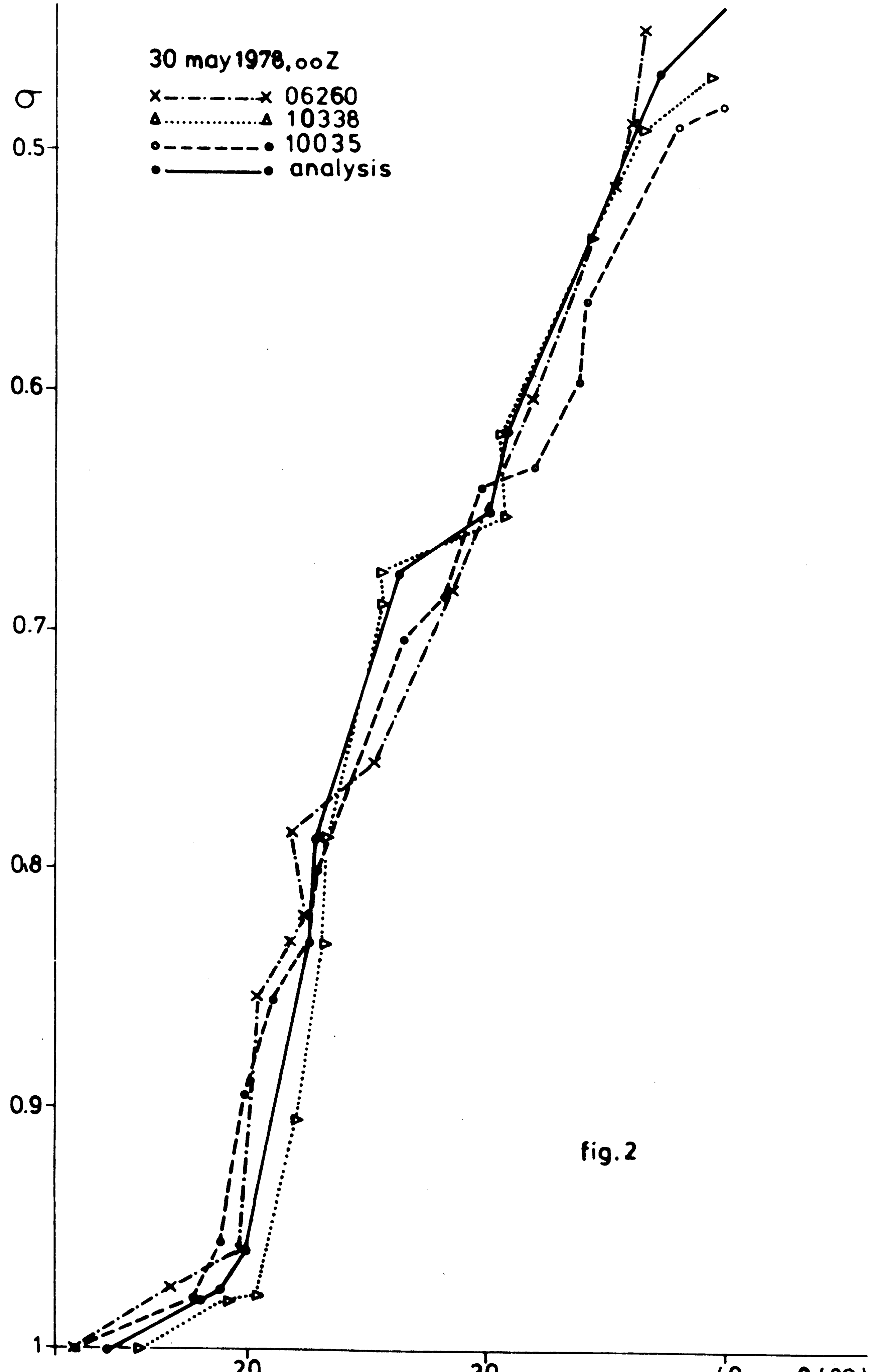

30 may 1978, ooZ
06260
10338
10035
analysis
σ
0.5
0.6
0.7
0.8
0.9
1
20
30
40
θ (°C)

fig. 2

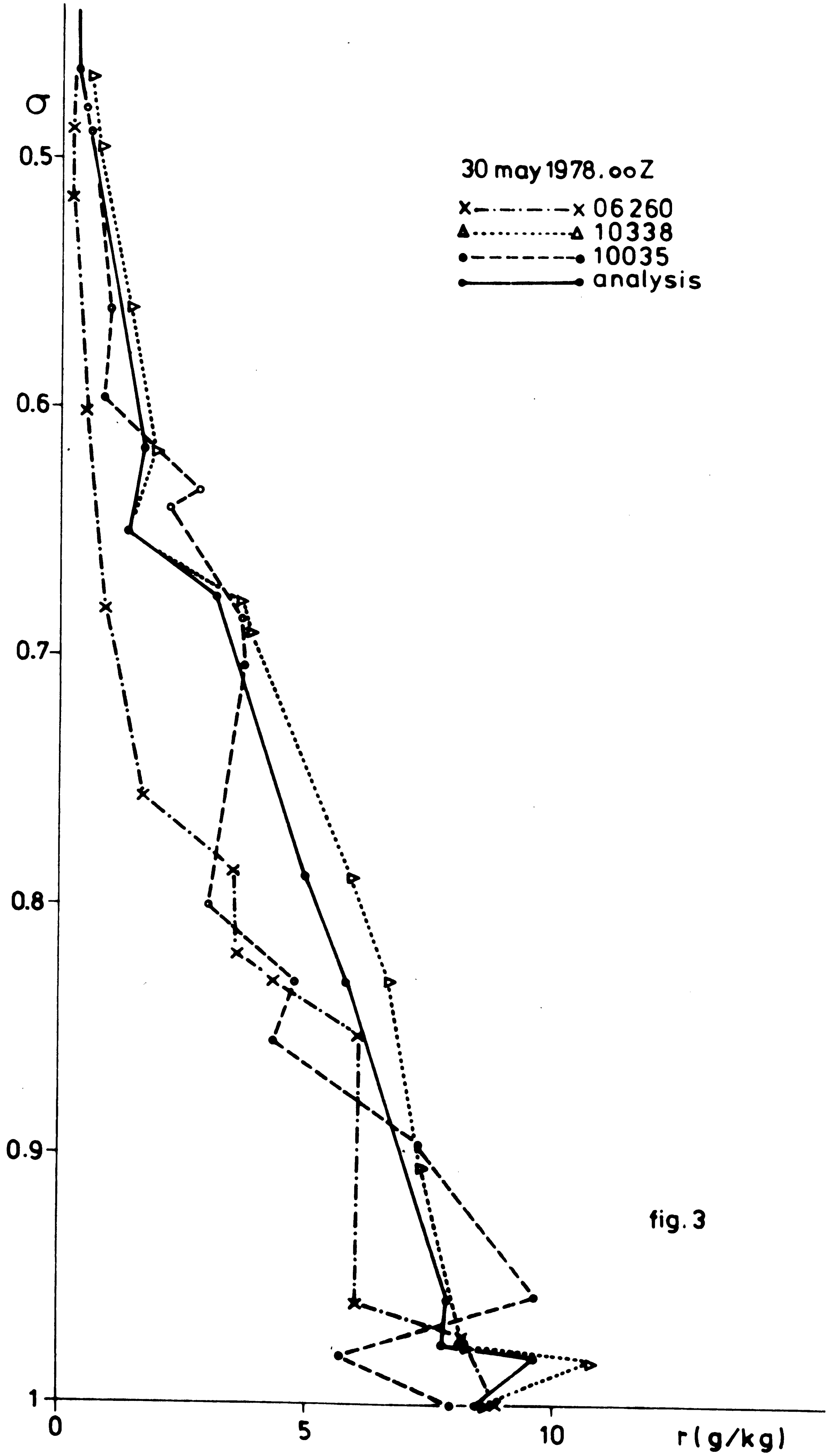

σ
0.5
0.6
0.7
0.8
0.9
1
0
5
10
r (g/kg)
30 may 1978. 00Z
06260
10338
10035
analysis

fig. 3

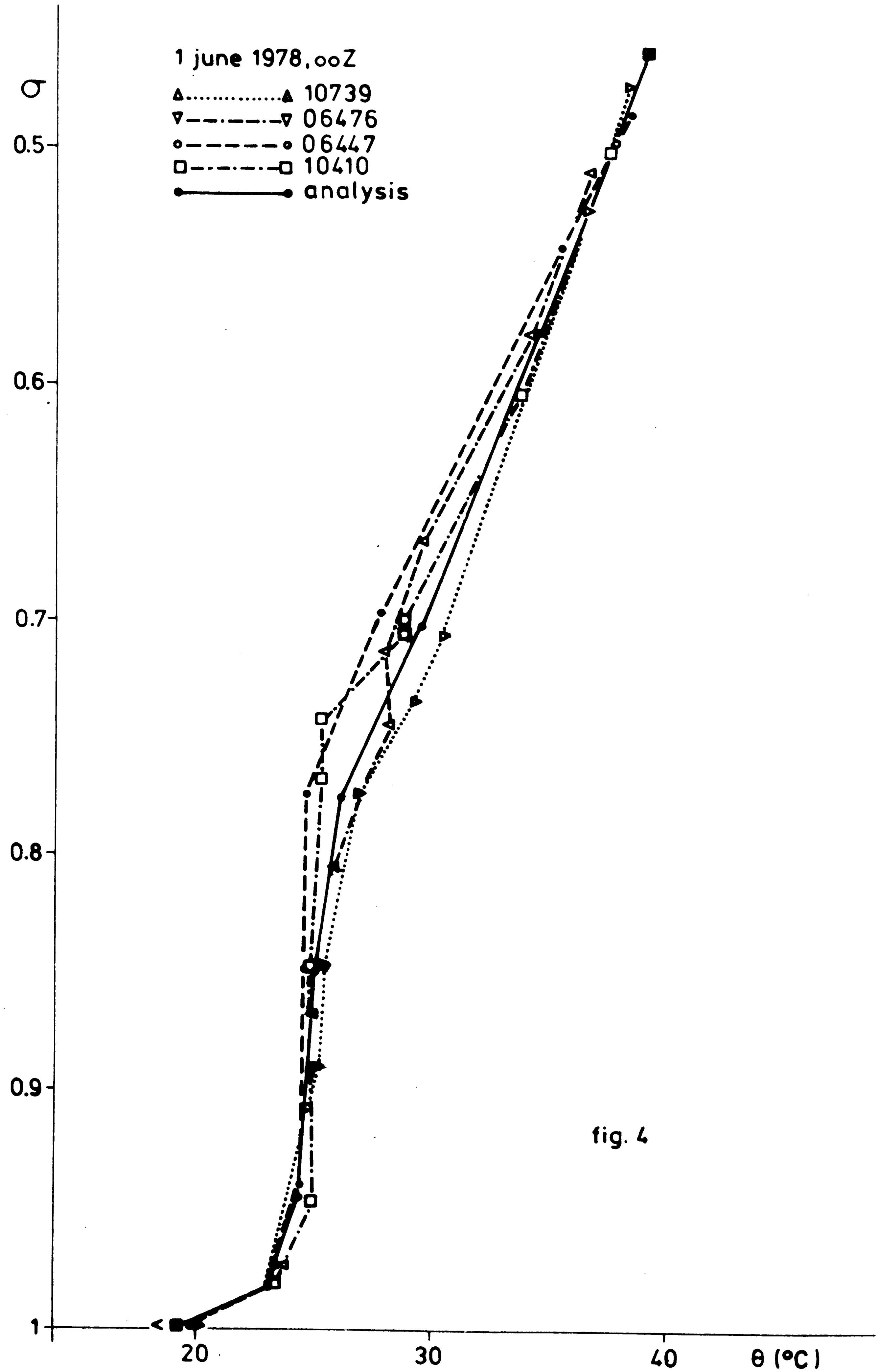
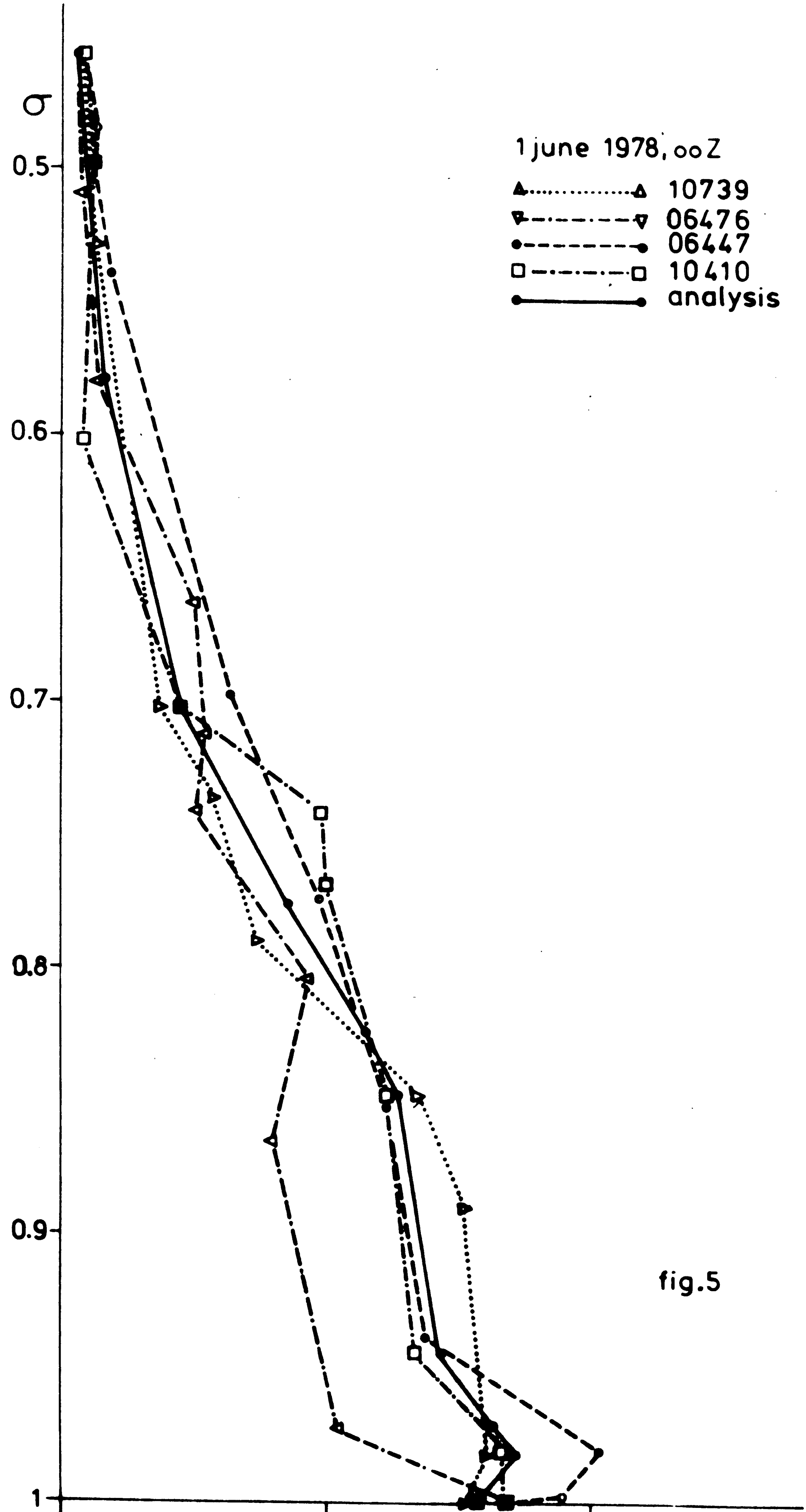
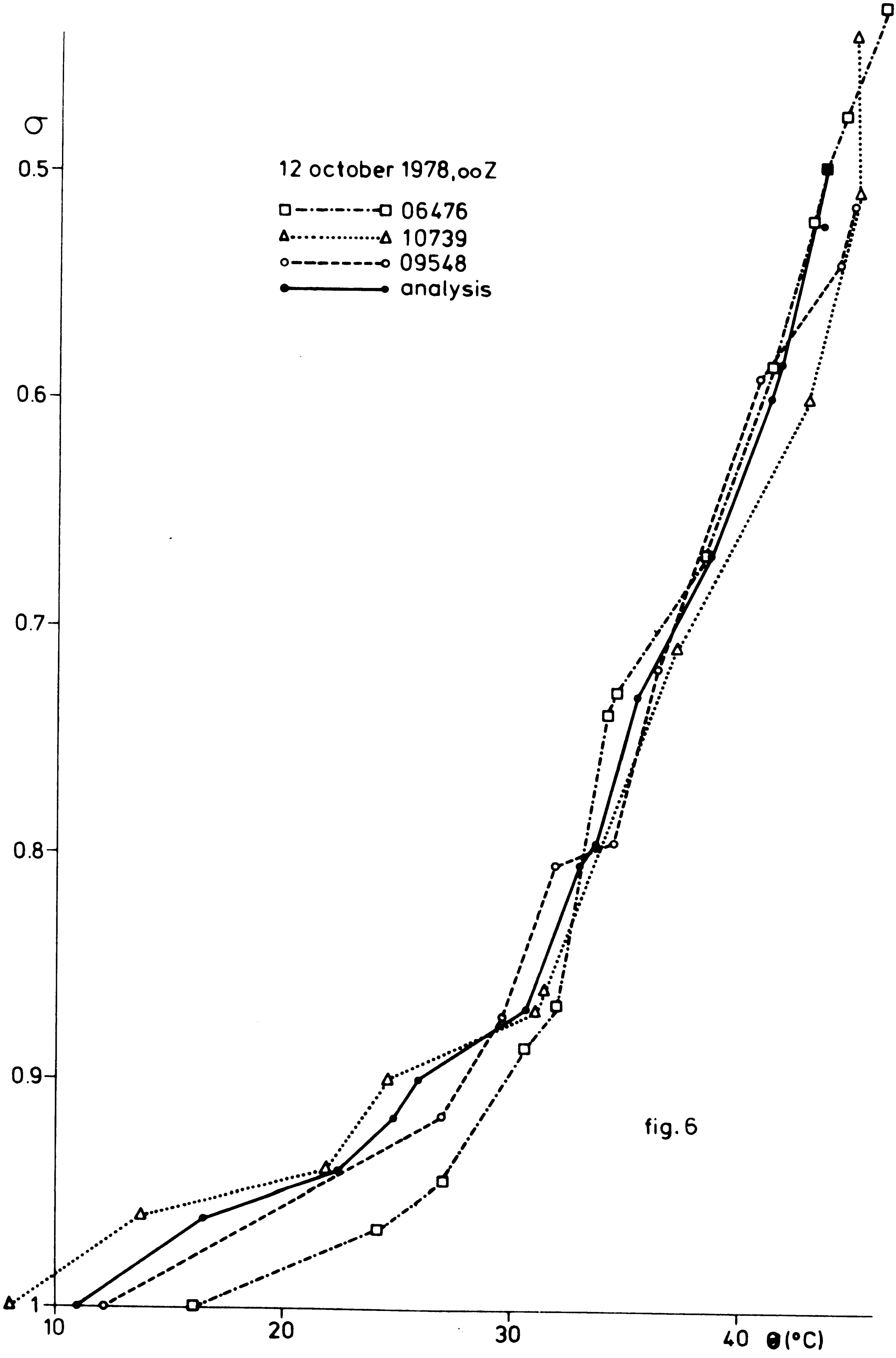

1 june 1978, ooZ
10739
06476
06447
10410
analysis
σ
0.5
0.6
0.7
0.8
0.9
1
20
30
40
θ (°C)

fig. 4



σ
1 june 1978, 00Z
10739
06476
06447
10410
analysis
0.5
0.6
0.7
0.8
0.9
1
0
5
10
r (g/kg)

fig.5



σ
0.5
0.6
0.7
0.8
0.9
1
10
20
30
40
θ(°C)
12 october 1978, 00Z
06476
10739
09548
analysis

fig. 6

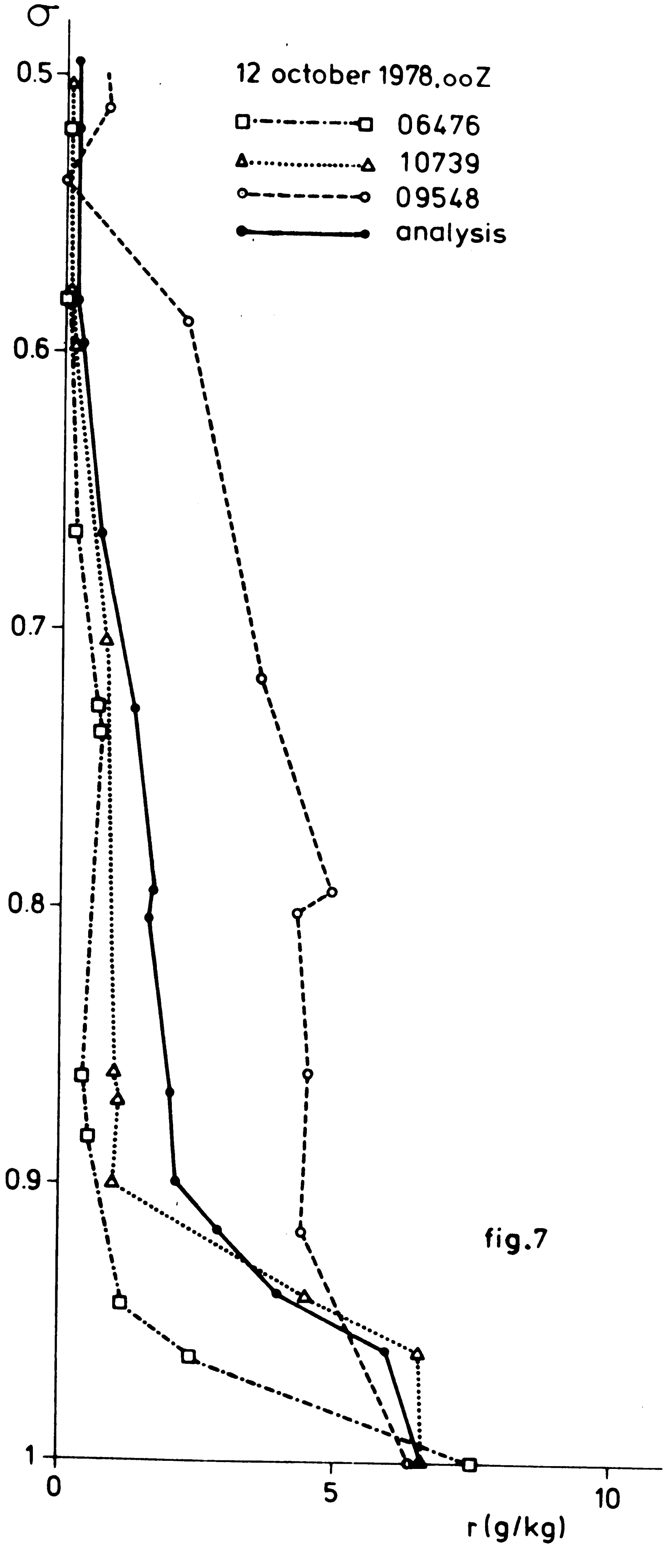
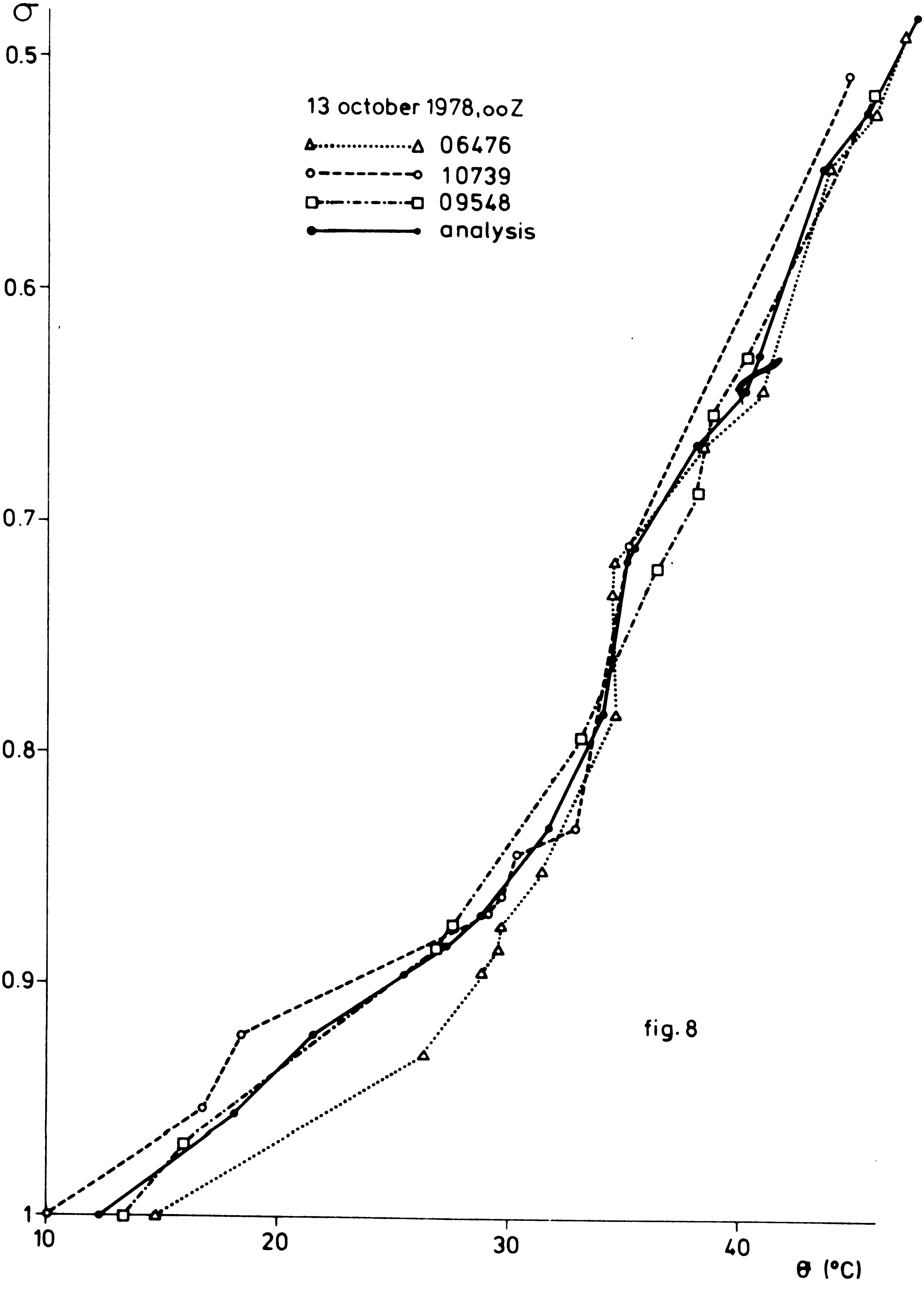

σ
0.5
0.6
0.7
0.8
0.9
1
0
5
10
r (g/kg)
12 october 1978.00Z
06476
10739
09548
analysis

fig.7



σ
0.5
0.6
0.7
0.8
0.9
1
10
20
30
40
θ (°C)
13 october 1978, ooZ
06476
10739
09548
analysis

fig. 8

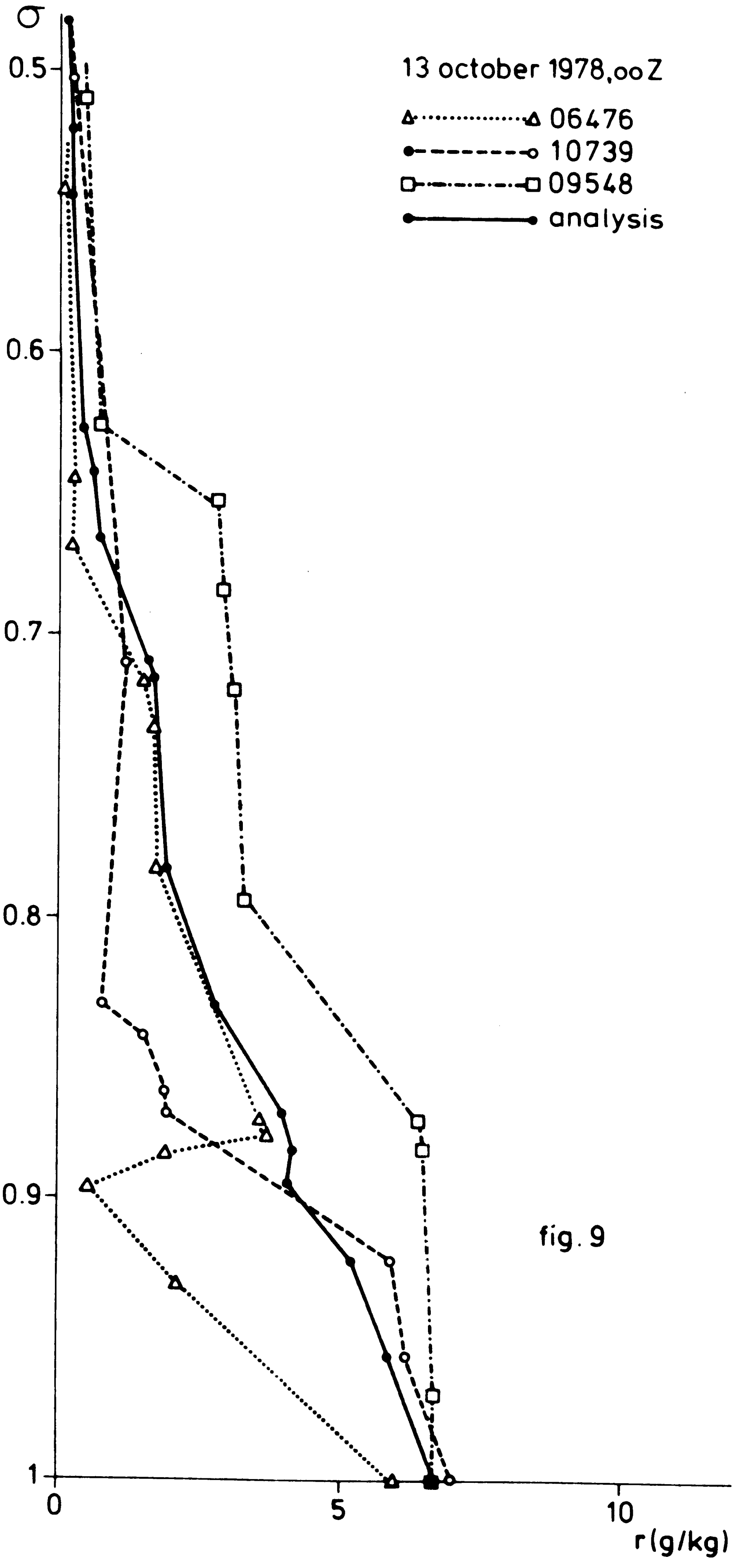

σ
0.5
0.6
0.7
0.8
0.9
1
0
5
10
r(g/kg)
13 october 1978,oo Z
06476
10739
09548
analysis

fig. 9

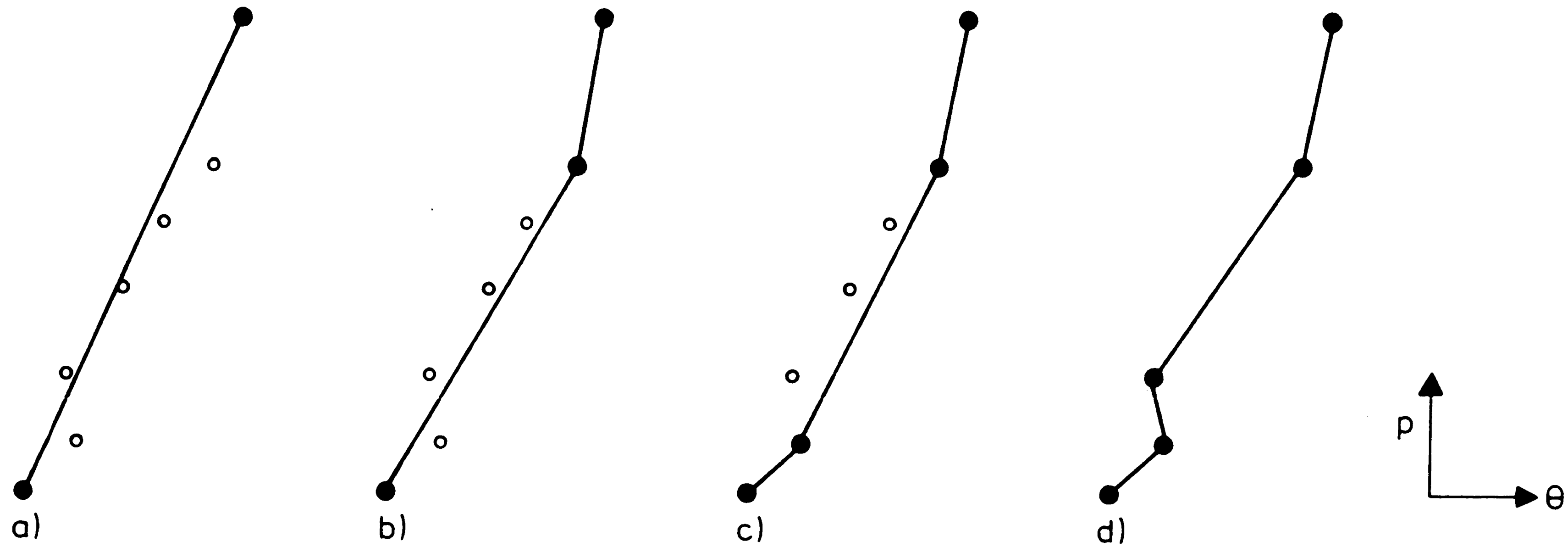


figure 10

○ significant points in θ before reduction technique

● significant points left after reduction technique

KONINKLIJK NEDERLANDS METEOROLOGISCH INSTITUUT

VERSLAGEN

V-329

(appendix)

G.J. Cats en J. Reiff

A vertically detailed analysis of some air mass properties

De Bilt, 1979

Publikatienummer: K. N. M. I. V-329 (appendix) (MO)

Koninklijk Nederlands Meteorologisch Instituut,
Meteorologisch Onderzoek,
Postbus 201,
3730 AE De Bilt,
Nederland.

U. D. C.: 551. 511. 2 :
551. 509. 323/324

APPENDIX A: DESCRIPTION OF THE ANALYSIS PROGRAM

The analysis program is divided into an input and an analysis/ output section. The procedures used in these sections are described in detail.

I. INPUT SECTION

From the input section the following data arrays are obtained:

(1) The starting points of the trajectories at some levels.

(2) The significant levels of some rawinsonde ascents in the surroundings of the trajectory starting points. These significant levels are given by their pressure and the values of the meteorological quantities that have to be analyzed (e.g. potential temperature, mixing ratio, dewpoint depression).

The input section of the Algol program consists of two procedures. The procedure READDATA contains the statements to fill the data arrays from a file (title = CRDD) and the procedure INPUTPRINT prints out the input data.

a) Procedure READDATA(M,DATE,TRAJ,N,TEMPS,CHAR);
(the text of this procedure is found in Appendix A, lines 6000 to 42000).
The input is read from the card file CRDD.(see line 26000).
The first record of this file should contain M (the number of trajectory levels) and DATE (the date) in the format <I4,X4,I8> (X4 = 4 blancs) (see line 29000).
Then M records follow, each containing an identification (for instance the endpoint pressure of the trajectory) and the coordinates (pressure (mbar), longitude (degrees east), latitude (degrees north)) of the starting points of the trajectories.

The M records each have format <4F8.2> (see lines 30000-31000). The contents of the M records are stored in the two-dimensional array TRAJ[1:M,0:3].

Then, for each rawinsonde ascent that is used in the analysis the following set of records should follow:

(1) Station identification and location.

The location is given by longitude (degrees east) and latitude (degrees north). The format should be <I8,X8,2F8.2> (line 33000) and the data are stored in the two-dimensional array TEMPS[1:N,0:2], where N is the number of rawinsonde stations used (N is inferred from the number of sets of rawinsonde records).

(2) A number of records which contain the observations at significant levels. Each record should contain the pressure (mbar), the height (m) and the values of the quantities to be analyzed at one significant level in the format <10F8.2> (line 36000). Missing observations should be coded 99999, but missing height may also be coded 0. If the pressure is missing, the significant level will be skipped. The first significant level must correspond to the surface level. The number of significant levels must not exceed 31. The data are stored in the three-dimensional array CHAR[1:N,0:30,1:K] where K is the number of quantities to be analyzed (including pressure and height).

(3) The last record of each rawinsonde set must contain a non-digit symbol to indicate the end of the array of the significant levels (for instance an "end of 6467 on 78101200" card, where only the first "e" is read). If the number l of significant levels at the rawinsonde station k ($1 \leqslant k \leqslant N$) is less than 31, the element CHAR[k,l,1] is not filled and contains its starting value: zero. The number l is inferred by

the remaining program from the fact that CHAR[k,1,1]=0. By virtue of this construction the analysis program determines the number of significant levels at each station automatically, so this number is not required as an independent input parameter.

b) Procedure INPUTPRINT(M,DATE,TRAJ,N,TEMPS,CHAR); (lines 43000 through 74000). The data read by READDATA are printed on the file LP, which must be declared in an outer block. An output example is given in Appendix B.

II. ANALYSIS AND OUTPUT SECTION

a) Real procedure LINEAR(X,A,FA,B,FB) (lines 75000 through 78000). The value attributed to LINEAR will be the linearly interpolated or extrapolated value of the function f from its values FA in point A and FB in point B to the point X. If FA or FB is missing, LINEAR will return the value 99999.

b) Real procedure DISTANCE(LON1,LAT1,LON2,LAT2); (lines 79000 through 85000). DISTANCE returns the distance between the points given by their longitude (LON1 and LON2 resp.) and latitude (LAT1 and LAT2 resp.). The coordinates are expressed in degrees east and north resp. The distance is expressed in km.

c) Procedure MAKEDSTNCS(M,TRAJ,N,TEMPS,DSTNCS,WGTS); lines 86000 through 91000). The array DSTNCS[1:M,1:N] is filled with the distances between the M trajectory starting points and the N rawinsonde station locations. The array WGTS[1:M,1:N] is filled with the corresponding weights. The parameters M,N,TRAJ and TEMPS are obtained from the input section.

d) Procedure WEIGHTS(P,W,M,TRAJ,N,WGTS);
(lines 92000 through 125000).
The array W[1:N] is filled with the weighting factors $W_i(P)$ (i=1...N) (see Eq. 2).
The parameters P and TRAJ[I,1] (I=1...M) should be expressed in the same units, e.g. mbar or σ-coordinates.

e) Procedure PRINTWEIGHTS(M,TRAJ,N,TEMPS,DSTNCS,WGTS);
(lines 126000 through 149000).
This procedure may be invoked to obtain a listing of the array DSTNCS and of the weights W at the levels which are listed in line 143000 (these levels are in mbar, if the trajectory and rawinsonde data are in mbar; if, however, the latter are in 1000 σ, then the listed levels are also in 1000 σ).

f) Integer procedure MAXIMUM(H,N,K);
(lines 150000 through 158000).
MAXIMUM will be equal to the lowest index I($K \leqslant I \leqslant N$) for which holds $H[I] \geqslant H[J]$ for all J.

g) Real procedure SFCPRESS(P,M,TRAJ,N,WGTS,CHAR);
(lines 159000 through 168000).
The weights $W_i(P)$ are determined (see d). These are used to interpolate the observed surface pressures (CHAR[I,0,1]). SFCPRESS then obtains the value of the surface pressure below the starting point of the trajectory at level P. This surface pressure is needed to determine the value of σ, corresponding to P. The way to obtain the surface pressure, however, might be replaced by more sophisticated methods (e.g. from an analysis of the 1000 mbar level).

h) Procedure PTOSIGMA(M,TRAJ,N,CHAR,WGTS);
(lines 169000 through 179000).
The pressure as given by TRAJ[I,1] (I=1...M) and CHAR[I,J,1] (I=1...N,J=1....30) is transformed to σ. The surface pressure needed for the transformation of TRAJ is obtained from SFCPRESS, and the surface pressure for the transformation of CHAR is

found in CHAR[I,0,1]. The calculated σ-coordinates are multiplied by 1000.

i) Procedure FILLSFCDATA(M,TRAJ,N,CHAR,WGTS,L,SFCDATA); (lines 180000 through 197000).
This procedure has been incorporated into the analysis program to obtain a guess of the surface parameters of the analyzed temperature and humidity profiles. This guess may be obtained from an interpolation of observed surface values with weights corresponding to the lowest trajectory level, or, alternatively, may be read from a data file (title = SURFACEDATA).
The surface parameters are stored in the array SFCDATA[1:L], where SFCDATA[I] is the value of the same meteorological quantity as given by CHAR[J,0,I] (J=1...N).

j) Real procedure INTERP(L,I,N,CHAR,SIGMA,NR); (lines 198000 through 231000).
INTERP returns the value of the meteorological quantity L at station I at σ-level SIGMA. This value is obtained from a linear interpolation of CHAR[I,K,L] (K=0...30).
The procedure searches the integer K, such that CHAR[I,K,1]$\leqslant$SIGMA$\leqslant$CHAR[I,K+1,1]. If NR does not equal 0, the program starts the searching procedure at K=NR. It therefore saves computation time if the right value of K is given in NR. If, however, NR=0, the interpolation is performed between CHAR[I,0,L] and CHAR[I,1,L], whether or not SIGMA is between CHAR[I,0,1] and CHAR[I,1,1]. This exception has been implemented, because CHAR[I,0,1] contains the surface pressure, and not σ=1000.

k) Procedure MAKESGFCTPTS(M,TRAJ,N,WGTS,L,CHAR,SGNFCNTPNT); (lines 232000 through 279000).
This procedure arranges in decreasing order the σ-coordinates of all observed significant levels of the N rawinsondes. To each of the thus found σ-values a significant level of the analyzed temperature and humidity profile is attributed. The values of the meteorological quantities that are given in CHAR[I,J,K] (I=1...N, J=0...30) are analyzed for each K

($2 \leqslant K \leqslant L$) and stored in SGNFCNTPNT[NR,K] where NR is the consecutive index of the significant level in the analysis result. SGNFCNTPNT[NR,1] contains the corresponding σ-level. If the value of the meteorological quantity K is missing at a station, the corresponding value in SGNFCNTPNT will be 99999.

l) Procedure REDUCENBR(SG,N,TOL,LOBS);
(lines 280000 through 335000).
If two consecutive significant points as given by the array SGNFCNTPNT (here named SG) differ less than by certain prescribed amounts in pressure, dewpoint, etc., they are replaced by one significant point, which coincides with the lower point. The prescribed amounts are given in the lines 308000-310000.
The number of significant levels is further reduced by the procedure AGAIN(L,U,OBS). This procedure selects the significant points which are needed for reproducing the temperature (OBS=3) or mixing ratio (OBS=4) within the tolerance (TOL). The procedure is called in line 323000 for temperature, and then invokes itself for humidity (line 304000). Selected significant points are marked by the boolean array INTAKE. The analyzed significant points are found in, and the selected significant points are stored in the array SG. If n points are selected, σ of the point (n+1) is put equal to zero: SG[n,1]=0.

m) Procedure ANALCRUDE(M,TRAJ,N,WGTS,L,CHAR,SFCDATA,SGNFCNTPNT);
(lines 336000 through 343000).
This procedure has been written to invoke the above-described procedures in a fixed order. This order has been chosen such, that surface parameters are analyzed before, and the parameter at higher levels after the transition of p to σ-coordinates. Since the weights are calculated in slightly different ways before and after the transition, the surface analysis results may slightly deviate from the σ=1 analysis. It is advised to use the σ=1 results. For transformation from σ to p coordinates, however, the required surface pressure is available from the surface analysis.

n) Procedure PRINTCRUDE(DATA,SFCDATA,SGNFCNTPNT,CRUDE);
(lines 344000 through 369000).
This procedure prints the analysis results. First the surface level results are given and then the array of significant points. The last significant point printed is the one that precedes the first point with σ-coordinate equal to 0.
The parameter CRUDE effects the printing of the warning that super-adiabatic profiles may occur.
All results are printed on a file LP, which must be declared in an outer block. An output example is given in Appendix B.

-o-o-o-

APPENDIX B : OUTPUT EXAMPLE OF THE ANALYSIS PROGRAM

Page B1 : Printout of input data (procedure INPUTPRINT).

Page B2 : Output of procedure PRINTWEIGHTS.

Page B3 : Output of procedure PRINTCRUDE, before reduction of number of significant points.

Page B4 : Output of procedure PRINTCRUDE, after reduction of number of significant points.

The input data contain the trajectory data and the observations at three stations. The observations are respectively: pressure, height (missing=99999), potential temperature (centigrade), mixing ratio (g/kg) and dewpoint depression (centigrade) at the significant levels. These observations are analyzed and printed in the same order (pages B3 and B4); however, the pressure has been replaced by 1000 σ, except in the surface level results.

-o-o-o-

DATA ON 78101200

TRAJECTORIES:

START:PRESSURE	LONGIT.	LATIT.	END:PRESSURE
1000.00	10.05	49.67	1000.00
926.25	9.54	49.69	925.00
852.88	9.03	49.70	850.00
705.48	7.37	49.63	700.00
510.73	5.44	49.30	500.00

TEMPS USED:

STATION 6476.LONGITUDE 5.40 LATITUDE 50.03

961.00	0.00	16.10	7.50	3.90
927.00	99999.00	24.20	2.40	25.00
906.00	99999.00	27.00	1.10	37.00
850.00	1601.00	30.60	0.50	43.00
831.00	99999.00	31.90	0.40	46.00
709.00	99999.00	34.20	0.70	31.00
700.00	3216.00	34.60	0.60	31.00
640.00	99999.00	38.50	0.20	38.00
560.00	99999.00	41.50	0.10	39.00
500.00	5870.00	43.40	0.10	31.00
476.00	99999.00	43.70	0.20	27.00
455.00	99999.00	44.80	0.10	27.00
408.00	99999.00	46.50	0.50	9.00
400.00	7520.00	46.50	0.30	11.00

END OF 6476 ON 78101200

STATION 10739.LONGITUDE 9.20 LATITUDE 48.83

990.00	0.00	9.20	6.60	0.80
950.00	99999.00	13.80	6.60	2.70
930.00	99999.00	21.90	3.50	18.00
890.00	99999.00	24.60	1.00	25.00
858.00	99999.00	31.00	1.10	36.00
850.00	1596.00	31.40	1.00	36.00
700.00	3220.00	37.10	0.80	31.00
592.00	99999.00	42.90	0.20	37.00
500.00	5890.00	45.10	0.10	32.00
433.00	99999.00	45.00	0.10	30.00
400.00	7550.00	48.60	0.10	29.00

END OF 10739 ON 78101200

STATION 9548.LONGITUDE 10.37 LATITUDE 50.55

976.00	0.00	12.20	6.50	3.10
893.00	99999.00	27.00	4.40	18.00
850.00	1619.00	29.70	4.50	16.00
784.00	99999.00	32.00	4.30	14.00
774.00	99999.00	34.50	4.90	13.00
700.00	3242.00	36.40	3.60	12.00
575.00	99999.00	40.80	2.20	9.00
525.00	99999.00	44.50	0.00	16.00
500.00	5900.00	45.10	0.80	15.00
400.00	7560.00	48.60	0.50	10.00

END OF 9548 ON 78101200

TABLE OF DISTANCES (KM):

	6476	10739	9548
1000	3.74E+02	1.11E+02	9.57E+01
925	3.33E+02	9.40E+01	1.12E+02
850	2.93E+02	9.21E+01	1.40E+02
700	1.63E+02	1.68E+02	2.59E+02
500	7.65E+01	3.01E+02	4.16E+02

WEIGHTS AT SOME LEVELS:

	6476	10739	9548
1025.00	3.33E-02	3.61E-01	6.06E-01
1000.00	3.61E-02	4.12E-01	5.52E-01
925.00	4.50E-02	5.62E-01	3.93E-01
850.00	7.17E-02	6.47E-01	2.81E-01
800.00	1.95E-01	5.63E-01	2.42E-01
700.00	4.41E-01	3.95E-01	1.65E-01
600.00	6.89E-01	2.17E-01	9.40E-02
500.00	9.11E-01	5.87E-02	3.08E-02
400.00	9.11E-01	5.87E-02	3.08E-02

SURFACE LEVEL (FIRST IS PRESSURE) ON 78101200:

981.22	0.00	11.11	6.58	2.18

ANALYSIS RESULTS, GIVEN BY SIGNIFICANT POINTS:
NOTE: SUPERADIABATIC PROFILE MAY OCCUR....

1000.00	0.00	11.00	6.58	2.10
964.62	99999.00	15.95	5.99	6.43
959.60	99999.00	16.61	5.94	6.99
942.77	99999.00	21.47	4.31	15.49
939.39	99999.00	22.47	3.98	17.20
914.96	99999.00	25.03	2.78	21.65
898.99	99999.00	26.00	2.12	23.37
884.50	99999.00	28.09	2.07	26.59
870.90	99999.00	30.11	2.03	29.85
866.67	99999.00	30.72	2.02	30.92
864.72	99999.00	30.82	1.99	31.00
858.59	99999.00	31.10	1.91	31.15
803.28	99999.00	33.03	1.63	30.51
793.03	99999.00	33.84	1.72	30.09
737.77	99999.00	35.25	1.35	28.06
728.41	99999.00	35.56	1.25	28.04
717.21	99999.00	36.04	1.15	28.57
707.07	99999.00	36.50	1.06	29.10
665.97	99999.00	38.69	0.68	33.10
597.98	99999.00	41.27	0.31	36.15
589.14	99999.00	41.54	0.27	36.35
582.73	99999.00	41.75	0.24	36.58
537.91	99999.00	43.03	0.10	32.67
520.29	99999.00	43.53	0.11	30.62
512.30	99999.00	43.63	0.15	29.42
505.05	99999.00	43.73	0.18	28.33
495.32	99999.00	43.84	0.21	26.88
473.47	99999.00	44.86	0.12	26.81
437.37	99999.00	46.04	0.38	14.60
424.56	99999.00	46.54	0.48	10.26
416.23	99999.00	46.60	0.30	12.06
409.84	99999.00	46.00	0.29	11.88
404.04	7319.12	45.43	0.29	11.73

END OF ARRAY OF SIGNIFICANT POINTS ON 78101200

SURFACE LEVEL (FIRST IS PRESSURE) ON 78101200:

981.22	0.00	11.11	6.58	2.18

ANALYSIS RESULTS, GIVEN BY SIGNIFICANT POINTS:
NOTE: SUPERADIABATIC PROFILE MAY OCCUR....

1000.00	0.00	11.00	6.58	2.10
959.60	99999.00	16.61	5.94	6.99
939.39	99999.00	22.47	3.98	17.20
914.96	99999.00	25.03	2.78	21.65
898.99	99999.00	26.00	2.12	23.37
866.67	99999.00	30.72	2.02	30.92
803.28	99999.00	33.03	1.63	30.51
793.03	99999.00	33.84	1.72	30.09
728.41	99999.00	35.56	1.25	28.04
665.97	99999.00	38.69	0.68	33.10
597.98	99999.00	41.27	0.31	36.15
582.73	99999.00	41.75	0.24	36.58
520.29	99999.00	43.53	0.11	30.62
495.32	99999.00	43.84	0.21	26.88
416.23	99999.00	46.60	0.30	12.06
404.04	7319.12	45.43	0.29	11.73

END OF ARRAY OF SIGNIFICANT POINTS ON 78101200

PROGRAMMA ANALYSIS/TRAJECTORYMODEL. BLAD 1

```
BEGIN
ARRAY DSTNCS,WGTS[1:5,1:4],SFCDATA[1:5],SGNFCNTPNT[0:120,1:5];
ARRAY TRAJ[1:5,0:3],TEMPS[1:4,0:2],CHAR[1:4,0:30,1:5];
INTEGER M,N,DATE;
FILE LP(KIND=PRINTER);
PROCEDURE READDATA(M,DATE,TRAJ,N,TEMPS,CHAR);
INTEGER M, %NUMBER OF TRAJECTORY LEVELS.READ FROM CARD
     DATE, %DATE                          .READ FROM CARD
        N; %NUMBER OF TEMPS USED          .DERIVED FROM CARD
ARRAY  TRAJ,            % [N,0]:ENDPOINT PRESSURE OF TRAJECTORY LEVEL N
                        % [N,1]:STARTPOINT PRESSURE
                        % [N,2]:STARTPOINT LONGITUDE IN DECREES EAST
                        % [N,3]:STARTPOINT LATITUDE  IN DEGREES NORTH
                        % TRAJ[1:M,0:3]  .READ FROM CARD
      TEMPS[*,*],       % (I,0]:IDENTIFICATION OF TEMPS I
                        % [I,1]:LONGITUDE IN DEGREES EAST
                        % [I,2]:LATITUDE IN DEGREES NORTH
                        % TEMPS[1:N,0:2] .READ FROM CARD
       CHAR[*,*,*];     % [I,J,K]: CHARACTERISTIC LEVEL J(LEQ 30) OF
                        % TEMPS I CONTAINING OBSERVATION K(LEQ 10)
                               % J=0 FOR SURFACE LEVEL
                        % CHAR[1:N,0:30,1:K] WITH K=NR OF RELEVANT OBSERVS
                        %                     .READ FROM CARD
BEGIN
   INTEGER I,J;
   FILE CARD(KIND=READER,TITLE="CRDD.");
   LABEL EOC,MOR;
   N:=0;
   READ(CARD,<I4,X4,I8>,M,DATE)[EOC];  % M AND DATE
   FOR I:=1 STEP 1 UNTIL M DO
   READ(CARD,<4F8.2>,TRAJ[I,*])[EOC];  % M CARDS WITH WITH TRAJECTORIES
MOR:N:=*+1;
   READ(CARD,<I8,X8,2F8.2>,TEMPS[N,*])[EOC];% N*(1TEMPS,NR OF CHAR)
   FOR I:=0 STEP 1 UNTIL 30 DO
   BEGIN                                     %EACH TEMP.DATA-SET ENDS
                                             %IN FORMAT.ERROR (MOR)
      READ(CARD,<10F8.2>,CHAR[N,I,*])[EOC:MOR];%MISSING=99999.MISSING
      IF I>0 AND CHAR[N,I,2]=0 THEN CHAR[N,I,2]:=99999;%HEIGHT MAY BE 0
      IF CHAR[N,I,1]=99999 THEN I:=*-1; %FIRST DATA MUST BE PRESENT,
   END;                                 %ELSE SKIP RECORD
EOC:
N:=*-1
END OF READDATA;
PROCEDURE INPUTPRINT(M,DATE,TRAJ,N,TEMPS,CHAR); VALUE M,N,DATE;
INTEGER M,N,DATE; ARRAY TRAJ,TEMPS[*,*],CHAR[*,*,*];
BEGIN INTEGER I,J;
   LABEL NEXT,AF;
   EBCDIC ARRAY A[0:79];
   WRITE(LP [SKIP 1]);
   WRITE(LP[SPACE 5]);
   WRITE(LP,<"DATA ON",I9>,DATE);
```

PROGRAMMA ANALYSIS/TRAJECTORYMODEL. BLAD 2

```
   WRITE(LP[SPACE 2]);
   WRITE(LP,<"TRAJECTORIES:",/,
"START:PRESSURE LONGIT. LATIT.    END:PRESSURE">);
   FOR I:=1 STEP 1 UNTIL M DO
   WRITE(LP,<X6,3F8.2,X7,F8.2>,
         FOR J:=1,2,3 DO TRAJ[I,J],TRAJ[I,0]);
   WRITE(LP[SPACE 2]);
   WRITE(LP,<"TEMPS USED:">);
   I:=0;
NEXT: I:=*+1; IF I>N THEN GO TO AF;
   WRITE(LP,<"STATION",I6,".LONGITUDE",F8.2," LATITUDE",F8.2>,TEMPS[I,*]
        );
   FOR J:=0 STEP 1 UNTIL 30 DO
   BEGIN IF CHAR[I,J,1]=0 THEN
      BEGIN WRITE(LP,<"END OF",I6," ON",I9>,TEMPS[I,0],DATE);
            IF I<N THEN GO TO NEXT ELSE GO TO AF
      END ELSE
      BEGIN REPLACE A BY " " FOR 80;
            WRITE(A,<10F8.2>,CHAR[I,J,*]);
            WRITE(LP,<A80>,A)
      END
   END;
AF:
END OF INPUTPRINT;
REAL PROCEDURE LINEAR(X,A,FA,B,FB); REAL X,A,B,FA,FB;
BEGIN IF FA=99999 OR FB=99999 THEN LINEAR:=99999 ELSE
   LINEAR:=(FB*(X-A)-FA*(X-B))/(B-A)
END;
REAL PROCEDURE DISTANCE(LON1,LAT1,LON2,LAT2);
VALUE LON1,LON2,LAT1,LAT2; REAL LON1,LON2,LAT1,LAT2;
BEGIN REAL D;
   D:=2*(1-COS((LON1-LON2)/57.3)*SIN(LAT1/57.3)*SIN(LAT2/57.3)-
                              COS(LAT1/57.3)*COS(LAT2/57.3));
   DISTANCE:=SQRT(ABS(D))*6000
END OF DISTANCE;
PROCEDURE MAKEDSTNCS(M,TRAJ,N,TEMPS,DSTNCS,WGTS);%DSTNCS IS FILLED WITH
INTEGER M,N;ARRAY TRAJ,TEMPS,DSTNCS,WGTS[*,*];%DISTANCES OF THE TRAJ.END
 BEGIN INTEGER I,J;REAL S,D;                    %POINTS TO THE TEMPS USED.
   FOR I:=1 STEP 1 UNTIL M DO FOR J:=1 STEP 1 UNTIL N DO
   DSTNCS[I,J]:=DISTANCE(TRAJ[I,2],TRAJ[I,3],TEMPS[J,1],TEMPS[J,2]);
   FOR I:=1 STEP 1 UNTIL M DO
   BEGIN
      S:=0;
      FOR J:=1 STEP 1 UNTIL N DO
      BEGIN
         D:=DSTNCS[I,J];
         IF D<10 THEN D:=10; %MINIMUM DISTANCE IS 10 KM
         WGTS[I,J]:=1/D/D;
         S:=*+WGTS[I,J]
      END;
```

```
      FOR J:=1 STEP 1 UNTIL N DO
      WGTS[I,J]:=*/S
   END
END OF MAKEDSTNCS;
PROCEDURE WEIGHTS(P,W,M,TRAJ,N,WGTS); VALUE P,M,N;
REAL P; INTEGER M,N; ARRAY W[*],TRAJ,WGTS[*,*];
BEGIN INTEGER I,J;
   ARRAY WU,WL[1:N];
   REAL D,SL,SU,PL,PU;
   I:=M; SL:=SU:=0;
   WHILE TRAJ[I,1]<P AND I>1 DO I:=*-1; %I:=HIGHEST TRAJ.LEVEL BELOW P
   FOR J:=1 STEP 1 UNTIL N DO
   BEGIN
      WL[J]:=WGTS[I,J];
      IF I<M THEN WU[J]:=WGTS[I+1,J];
   END;
   PL:=TRAJ[I,1];
   IF I<M THEN PU:=TRAJ[I+1,1];
   FOR J:=1 STEP 1 UNTIL N DO
      IF I<M THEN
         W[J]:=LINEAR(P,PL,WL[J],PU,WU[J]) %LINEAR INTERPOLATION IN VER-
      ELSE W[J]:=WL[J]                    %TICAL. LINEAR EXTRAPOLATION
END OF WEIGHTS;                              %ABOVE P. CONSTANT ABOVE
                                             %HIGHEST TRAJ.LEVEL
PROCEDURE PRINTWEIGHTS(M,TRAJ,N,TEMPS,DSTNCS,WGTS);
INTEGER M,N; ARRAY TRAJ,TEMPS,DSTNCS,WGTS[*,*];
BEGIN INTEGER I,J;
   REAL P;
   ARRAY W[1:N];
   WRITE(LP [SKIP 1]);
   WRITE(LP[SPACE 5]);
   WRITE(LP,<"TABLE OF DISTANCES (KM):">);
   WRITE(LP,<X9,7I9>,FOR J:=1 STEP 1 UNTIL N DO TEMPS[J,0]);
   FOR I:=1 STEP 1 UNTIL M DO
   BEGIN
      WRITE(LP,<I8>,TRAJ[I,0]);
      WRITE(LP,<X9,7E9.2>,FOR J:=1 STEP  1 UNTIL N DO DSTNCS[I, J])
   END;
   WRITE(LP [SPACE 2]);
   WRITE(LP,<"WEIGHTS AT SOME LEVELS:">);
   WRITE(LP,<X9,7I9>,FOR J:=1 STEP 1 UNTIL N DO TEMPS[J,0]);
   FOR P:=1025,1000,925,850,800,700,600,500,400  DO
   BEGIN
      WRITE(LP,<F8.2>,P);
      WEIGHTS(P,W,M,TRAJ,N,WGTS);
      WRITE(LP,<X9,7E9.2>,W[*])
   END
END OF PRINTWEIGHTS;
INTEGER PROCEDURE MAXIMUM(H,N,K); ARRAY H[*]; INTEGER N,K;
BEGIN INTEGER I,J;
```



```
  REAL MAX;                               %MAXIMUM BECOMES THR INDEX I (KSISN)
   MAX:=H[K]; J:=K;                       %WITH H[I] THE MAXIMUM OF ALL
   FOR I:=K+1 STEP 1 UNTIL N DO           %H[J].(KSJSN).IF MORE H[I] ARE
   IF H[I]>MAX THEN                       %EQUAL TO THE MAXIMUM, I WILL BE THE
   BEGIN  MAX:=H[I];J:=I END;             %LOWEST INDEX
   MAXIMUM:=J
END OF MAXIMUM;
REAL PROCEDURE SFCPRESS(P,M,TRAJ,N,WGTS,CHAR); VALUE P,M,N;
REAL P; INTEGER M,N; ARRAY TRAJ,WGTS[*,*],CHAR[*,*,*];
BEGIN INTEGER I,J;
   ARRAY W[1:N];
   REAL SP;                               %SURFACE PRESSURE BELOW START POINT
   WEIGHTS(P,W,M,TRAJ,N,WGTS);            %OF TRAJECTORY AT LEVEL P IS INTER-
   FOR I:=1 STEP 1 UNTIL N DO            %POLATED FROM TEMPS SURFACE PRESSURE
   SP:=*+W[I]*CHAR[I,0,1];                %WITH WEIGHTS OBTAINED FROM "WEIGHTS
   SFCPRESS:=SP
END OF SFCPRESS;
PROCEDURE PTOSIGMA(M,TRAJ,N,CHAR,WGTS);
INTEGER M,N; ARRAY TRAJ[*,*],CHAR[*,*,*], WGTS[*,*];
BEGIN INTEGER I,J; ARRAY H[1:M];
   FOR I:=1 STEP 1 UNTIL N DO             %TRAJ AND CHAR ARE TRANSFORMED TO
   FOR J:=1 STEP 1 UNTIL 30 DO            %SIGMA. CHAR[I,0,1] REMAINS OBSERVED
   CHAR[I,J,1]:=*/CHAR[I,0,1]*1000;  %SURFACE PRESSURE AT TEMPS[I]
   FOR I:=1 STEP 1 UNTIL M DO             %SIGMA IS MULTIPLIED BY 1000
   H[I]:=TRAJ[I,1]/SFCPRESS(TRAJ[I,1],M,TRAJ,N,WGTS,CHAR);
   FOR I:=1  STEP 1 UNTIL M DO
   TRAJ[I,1]:=H[I]*1000
END OF PTOSIGMA;
PROCEDURE FILLSFCDATA(M,TRAJ,N,CHAR,WGTS,L,SFCDATA);% SFCDATA[1:L]
INTEGER L,M,N;ARRAY CHAR[*,*,*],TRAJ,WGTS[*,*],SFCDATA[*];
BEGIN INTEGER I,J;         %SFCDATA IS FILLED WITH CRDSF(TITLE=SURFACEDATA
   REAL SF;                 %IF NO CARDFILE IS GIVEN, THEN SFCDATA IS FILL-
   ARRAY W[1:N];            %ED WITH INTERPOLATED CHAR[I,0,J] 1LEQ J LEQ L
   FILE CRDSF(KIND=READER,TITLE="SURFACEDATA.");
   IF CRDSF.RESIDENT THEN READ(CRDSF,<10F8.2>,SFCDATA) ELSE
   BEGIN
      WEIGHTS(TRAJ[1,1],W,M,TRAJ,N,WGTS);
      FOR I:=1 STEP 1 UNTIL L DO
      BEGIN
         SF:=0;
         FOR J:=1 STEP 1 UNTIL N DO
         SF:=*+W[J]*CHAR[J,0,I];
         SFCDATA[I]:=SF
      END
   END
END OF FILLSFCDATA;
REAL PROCEDURE INTERP(L,I,N,CHAR,SIGMA,NR); VALUE NR;
INTEGER L,I,N,NR; REAL SIGMA; ARRAY CHAR[*,*,*];
% INTERP BECOMES THE VALUE OF THE L-TH OBSERVATION AT HEIGHT SIGMA AT
% STATION I. TO SAVE COMUTATION TIME, NR MAY BE USED TO DENOTE THE
```

```
% HIGHEST LEVEL OF THE CHARACTERISTIC POINTS NOT ABOVE SIGMA. IF,
% HOWEVER, NR=0 INTERP RETURNS THE VALUE THAT OBTAINS FROM THE
% INTER/EXTRA-POLATION BETWEEN CHAR[I,0,L] AND CHAR[I,1,L] AT HEIGHT
% SIGMA.
BEGIN
   REAL H,H1;
   LABEL OF,OK;
   IF SIGMA=1000 THEN BEGIN H:=CHAR[I,0,L]; GO TO OF END;%SURFACE LEVEL
OK:H1:=IF NR=0 THEN 1000 ELSE CHAR[I,NR,1];
   IF H1=SIGMA THEN
   BEGIN H:=CHAR[I,NR,L]; GO TO OF END;%COINCIDENCE WITH CHARACT. LEVEL
   IF H1>SIGMA THEN IF NR<30 THEN
   BEGIN IF CHAR[I,NR+1,1] LEQ SIGMA THEN
      BEGIN H:=LINEAR(SIGMA,H1,CHAR[I,NR,L],
                           CHAR[I,NR+1,1],CHAR[I,NR+1,L]);GO TO OF
      END
   END ELSE
   BEGIN
      H:=CHAR[I,NR,L]; GO TO OF END;
   IF H1>SIGMA THEN
   BEGIN
      WHILE H1 GEQ SIGMA AND NR<30 DO NR:=*+1;
      NR:=*-1; GO TO OK
   END ELSE
   BEGIN
      WHILE H1 <  SIGMA AND NR>0  DO NR:=*-1;
      GO TO OK
   END;
OF:INTERP:=H
END OF INTERP;
PROCEDURE MAKESGFCTPTS(M,TRAJ,N,WGTS,L,CHAR,SGNFCNTPNT);
INTEGER M,N,L; ARRAY TRAJ,WGTS,SGNFCNTPNT[*,*],CHAR[*,*,*];
BEGIN
   ARRAY NR,W,HN[1:N],HL[1:L];
   INTEGER I,K,R,S,T,MAX;
   REAL H,H2;
   LABEL MOR1,MOR2,OF;
   DEFINE F(@,@U,@UU)=FOR @:=@U STEP 1 UNTIL @UU  DO#,
          SUM(SIG,NZ)=
          BEGIN LABEL MSS; SGNFCNTPNT[NZ,1]:=SIG;
             WEIGHTS(SIG,W,M,TRAJ,N,WGTS);
             F(I,2,L)
             BEGIN
                H:=0;
                F(K,1,N)
               BEGIN H2:=INTERP(I,K,N,CHAR,SIG,NR[K]);
                   IF H2=99999 THEN BEGIN H:=H2;GO TO MSS END;
                   H:=*+W[K]*H2
                END;
MSS:            SGNFCNTPNT[NZ,I]:=H
```



```
             END
          END#;
   SUM(1000,0);  %SURFACE LEVEL IN SGNFCNTPNT[0,*]
   MAX:=30*N;
   THRU MAX DO
   BEGIN
      F(K,1,N)
      BEGIN
         R:=NR[K];
         IF R<30 THEN BEGIN R:=*+1;HN[K]:=CHAR[K,R,1] END
         ELSE HN[K]:=0
      END;
      F(K,1,N) IF HN[K] NEQ 0 THEN GO TO MOR1;
      GO TO OF;
MOR1: F(K, 1,N)  IF NR[K]<30 THEN GO TO MOR2;
      GO TO OF;
MOR2: S:=MAXIMUM(HN,N,1);
      T:=*+1;
      NR[S]:=*+1;
      R:=NR[S];
      IF R>30 THEN R:=30;
      F(K,S+1,N)
      IF CHAR[K,NR[K],1]=CHAR[S,R,1] AND NR[K]<30 THEN
      NR[K]:=*+1;     %COINCIDING CHARACTERISTIC LEVELS
      SUM(CHAR[S,R,1],T)
   END;
OF:
END OF MAKESGFCTPTS;
PROCEDURE REDUCENBR(SG,N,TOL,LOBS); ARRAY SG[*,*];%SGNFCNT POINTS
INTEGER N, LOBS;%UPPERBOUNDS: SG[0:30*N,1:LOBS]
REAL TOL;%NUMBER OF SGPNTS ID REDUCED BY ASSUMING COINCIDENCE IF
   %PRESSURE,TEMPERATURE AND DEWPOINT COINCIDE TO WITHIN GIVEN
   %LIMITS(SEE PROCEDURE), AND BY DELETING POINTS THAT DESCRIBE
   %TEMPERATURE AND DEWPOINT MORE ACCURATE THAN TOL
BEGIN ARRAY A[0:30*N];
   BOOLEAN ARRAY INTAKE[0:30*N];
   INTEGER I,J,K,L,L1,M,MAX,NBR,U,U1;
   PROCEDURE AGAIN(L,U,OBS); VALUE L,U,OBS; INTEGER L,U,OBS;
   BEGIN INTEGER I;
      U1:=U-1; L1:=L+1;
      IF U1 GEQ L1 THEN
      BEGIN
         FOR I:=L1 STEP 1 UNTIL U1 DO
         A[I]:=ABS(SG[I,OBS]-LINEAR(SG[I,1],SG[L,1],SG[L,OBS],
                         SG[U,1],SG[U,OBS]));
         K:=MAXIMUM(A,U1,L1);
         IF A[K]>TOL THEN
         BEGIN
            INTAKE[K]:=TRUE;
            AGAIN(L,K,OBS);
```

```
            AGAIN(K,U,OBS)
         END
         ELSE IF OBS=3 THEN AGAIN(L,U,4)%AFTER CHECK ON TEMPERATURE A
      END                  %CHECK ON MIXING RATIO IS PERFORMED.
   END OF AGAIN;
   NBR:=30*N;
   WHILE SG[MAX,1] NEQ 0  AND MAX<NBR DO MAX:=*+1;
%CHECK ON COINCIDENCE WITH SPECIFIED TOLERANCES:
   FOR I:=1 STEP 1 UNTIL MAX DO
   IF  ABS(SG[I-1,1]-SG[I,1])<3   %PRESSURE TOLERANCE
   AND ABS(SG[I-1,3]-SG[I,3])<0.2 %TEMPERATURE TOLERANCE
   AND ABS(SG[I-1,5]-SG[I,5])<0.3 %DEWPOINT DEPRESSION TOLERANCE
   THEN
   BEGIN
      FOR J:=I+1 STEP 1 UNTIL MAX DO
      FOR M:=1 STEP 1 UNTIL LOBS DO
      SG[J-1,M]:=SG[J,M];
      MAX:=*-1;
      I:=*-1
   END;
   FOR I:=1 STEP 1 UNTIL MAX DO INTAKE[I]:=FALSE;
   AGAIN(0,MAX,3);
   INTAKE[0]:=INTAKE[MAX]:=TRUE;
   NBR:=0;
   FOR I:=0 STEP 1 UNTIL MAX DO
   IF INTAKE[I] THEN
   BEGIN
      FOR J:=1 STEP 1 UNTIL LOBS DO
      SG[NBR,J]:=SG[I,J];
      NBR:=*+1
   END;
   IF NBR<MAX THEN MAX:=NBR;
   IF MAX<30*N THEN SG[MAX+1,1]:=0
END OF REDUCENBR;
PROCEDURE ANALCRUDE(M,TRAJ,N,WGTS,L,CHAR,SFCDATA,SGNFCNTPNT);
INTEGER M,N,L;
ARRAY TRAJ,WGTS,SGNFCNTPNT[*,*],CHAR[*,*,*],SFCDATA[*];
BEGIN
   FILLSFCDATA(M,TRAJ,N,CHAR,WGTS,L,SFCDATA);
   PTOSIGMA(M,TRAJ,N,CHAR,WGTS);
   MAKESGFCTPTS(M,TRAJ,N,WGTS,L,CHAR,SGNFCNTPNT)
END OF ANALCRUDE;
PROCEDURE PRINTCRUDE(DATE,SFCDATA,SGNFCNTPNT,CRUDE);BOOLEAN CRUDE;
ARRAY SFCDATA[*],SGNFCNTPNT[*,*]; INTEGER DATE;
BEGIN
   INTEGER I,P,MAX; LABEL  OF;
   MAX:=30*N+1;
   WRITE(LP [SKIP  1]);
   WRITE(LP [SPACE 5]);
   WRITE(LP,<"SURFACE LEVEL (FIRST IS PRESSURE) ON",I9,":">,DATE);
```



```
   WRITE(LP,<10F9.2>,SFCDATA);
   WRITE(LP [SPACE 2]);
   P:=4;
   WRITE(LP,<"ANALYSIS RESULTS, GIVEN BY SIGNIFICANT POINTS:">);
   IF CRUDE THEN
   WRITE(LP,<"NOTE: SUPERADIABATIC PROFILE MAY OCCUR....">);
   THRU MAX DO
   BEGIN
      IF SGNFCNTPNT[I,1]=0 THEN GO TO OF;
      WRITE(LP,<10F9.2>,SGNFCNTPNT[I,*]);
      I:=*+1;
      P:=*+1;
      IF P=50 THEN
      BEGIN P:=0; WRITE(LP [SKIP 1]); WRITE(LP[SPACE 5]) END
   END;
OF:
   WRITE(LP,<"END OF ARRAY OF SIGNIFICANT POINTS ON",I9>,DATE)
END OF PRINTCRUDE;
READDATA(M,DATE,TRAJ,N,TEMPS,CHAR);
INPUTPRINT(M,DATE,TRAJ,N,TEMPS,CHAR);
MAKEDSTNCS(M,TRAJ,N,TEMPS,DSTNCS,WGTS);
PRINTWEIGHTS(M,TRAJ,N,TEMPS,DSTNCS,WGTS);
ANALCRUDE(M,TRAJ,N,WGTS,5,CHAR,SFCDATA,SGNFCNTPNT);
PRINTCRUDE(DATE,SFCDATA,SGNFCNTPNT,TRUE);
REDUCENBR(SGNFCNTPNT,N,0.3,5);
PRINTCRUDE(DATE,SFCDATA,SGNFCNTPNT,TRUE);
END.
```