A computer program to process vaisala RS 21-12 C radiosonde data.

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A COMPUTER PROGRAM TO PROCESS
VAISALA RS 21-12 C RADIOSONDE DATA

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A Vaisala RS 21-12 C radiosonde is used for boundary layer research at the Royal Netherlands Meteorological Institute. Pressure, temperature and wind data are stored on paper tape. A Self Reading Theodolite is used to determine the wind profile. A set of computer programs for the processing of the raw data is described. The main functions of the subprograms are:

- Conversion of the raw data to meteorological parameters. A set of algorithms, given by Vaisala is used for that purpose.
- Interpolation of the parameters to successive two-millibar levels, and calculation of some derived parameters.
- Matching of the wind data to the radiosonde data.
- Quality check of the data.
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1. INTRODUCTION

The Royal Netherlands Meteorological Institute (KNMI) carries out theoretical and experimental boundary layer research. During experiments a Vaisala RS 21-12 C radiosonde (403 MHz) is used to measure the temperature, humidity and pressure in and above the boundary layer. Most of the ground equipment used for these radiosoundings is also manufactured by Vaisala: Ground Check Chamber GC 20, UHF Receiver UR 12 and PTU Digitizer COD 11. This radiosonde system measures the parameters mentioned above automatically every eight seconds. After some processing, the data is stored on paper tape by a Facit 4070 Punch.

Elevation and azimuth of the sonde are also measured, to determine the wind profile. For this purpose a Self Reading Theodolite is used (Warren Knight, Philadelphia U.S.A., model 87 AG). At more or less regular time intervals a push-button is used to activate a Theodolite Data Recording System (Part number 801560-0, Northern Precision Laboratories Inc., Fairfield N.J., U.S.A.). This recording system produces a printout of elevation, azimuth and time.

For the processing of these raw data a set of computer programs has been written in BEA (Burroughs Extended Algol) for the Burroughs B6800 computer at KNMI. This set consists of several subprograms. The main functions are:

a. Conversion of the raw radiosonde data to meteorological parameters

The data on paper tape consist of five-digit octal numbers, representing frequencies as transmitted by the radiosonde. A set of algorithms, given by Vaisala, is used to convert these numbers to decimal meteorological parameters.

b. Interpolation of parameters

The radiosonde measures pressure, temperature and humidity every eight seconds, but not simultaneously. Since the time intervals are known, the measured values of temperature and humidity can be interpolated to values that belong to the nearest measured pressure level. Then potential temperature, dew point, specific humidity and height are calculated. Finally the interpolated and calculated values, and the raw data are printed.
c. **Quality check of data**

While reading the paper tape, only punching errors are removed. During the data-processing several checks are made to detect erroneous values and malfunctions of the equipment. The operator can choose whether suspect values are rejected, or printed with some indication. It is also possible to run the program without automatic fault detection. All these quality checks are part of the processing mentioned sub b.

d. **Calculation of wind, temperature and humidity profiles**

The theodolite data (if available) are used to calculate the wind speed and wind direction profiles. The radiosonde data are used to calculate the altitude of the wind levels. The number of wind levels is determined during the flight by the theodolite operator, by pressing the button more or less frequently. These wind levels do in no way correspond to the radiosonde data levels (every eight seconds). Now the complete wind, temperature and humidity profiles are determined. Through interpolation these parameters are calculated for successive two-millibar levels, and a complete printout of the data is made. When no wind data are available, the program functions in the same way, omitting the wind profile.

e. **Plotting of wind, temperature and dew point profiles**

Temperature and dew point profiles and, if available, the wind profile are plotted on an aerological diagram.
2. GENERAL INFORMATION

2.1 Layout of the paper tape

The radiosonde measures temperature $T$, relative humidity RH, pressure $P$, and two reference frequencies $K_1$ and $K_2$. In addition a second pressure signal $P_p$ is transmitted, which must be used above the 100 mbar level. The measurement of this group of parameters is repeated at time intervals of about eight seconds. A clock signal is generated by the COD 11 digitizer (a part of the receiving equipment) for every group of parameters. The output of each measuring cycle is stored on paper tape, so the time interval between the punching cycles is also about eight seconds. For each cycle, the time is measured when the punching starts, so corrections must be made afterwards to determine the exact moment at which a certain parameter actually was measured by the radiosonde. Since the radiosonde measures (and transmits) the various parameters within a group consecutively in time, every parameter within a group has an individual time correction.

The data is punched in 8-channel ASCII code. The values are given in five-digit octal numbers. The time is in seconds; direct interpretation of the other values is impossible. An example of a punching cycle is given in figure 1. A complete tape consists of 12 ground check cycles, followed by the flight measurements. There is no tape feed between any of the cycles. The 12 ground check cycles consist of calibration values, as described hereafter.

2.2 Calibration of the radiosonde and ground level measurements

Every radiosonde is calibrated by the operator shortly before launch. The Ground Check Chamber GC 20 and a well-calibrated barometer are used for that purpose. To carry out the calibration, the radiosonde sensors are exposed to known values of temperature, pressure and humidity in the GC 20. The values, measured by the radiosonde, are punched in the same way as during the flight. The procedure consists of three phases:

a. Exposure to known temperature and pressure

Four cycles are punched, of which $T$, $P$, $K_1$ and $K_2$ are used. The operator writes down the temperature and pressure in the GC 20.
b. Exposure to a known humidity; low value, usually RH = 2%

Four cycles are punched, of which RH, k₁ and k₂ are used. The operator writes down the humidity in the GC 20.

c. Exposure to a known humidity; high value, usually RH = 75%

Four cycles are punched, of which RH, k₁ and k₂ are used. The operator writes down the humidity in the GC 20.

This completes the calibration.

The sensors for T, P₀ and P of the radiosonde have also been calibrated in the factory. Three groups of three numbers will be used in the calculations. These numbers are specific for every radiosonde.

The ground level values of the parameters, measured by the sonde, and some synoptical observations are written down at the start of the flight. These are used for calculations, or just for the final printout of the sounding.

All these ground check values are noted down on a standard form (in Dutch) and must be fed into the computer by hand. In this way a file is created which can be recognized by the project code (5 positions) and the radiosonde number (7 positions). The file is called GRCHK (short for groundcheck). Its layout is shown in figure 2; an example is given in figure 3.

2.3 Theodolite data input

An example of the printout of the Theodolite Data Recording System is given in figure 4. Here C denotes clock, A azimuth and E elevation; the time of the start is always 0 s. Time is given in hours, minutes and seconds, while azimuth and elevation are in degrees.

A theodolite data file is created (manually), called THEO/project code/sonde number. An example corresponding to the printout in figure 4, is given in figure 5. On every line we see elevation, azimuth and time. Only the first line is different; here we see a code number (always 1), followed by wind direction (degrees) and wind speed (knots) of a ground measurement, followed by the station height (m). This first line must be added to the theodolite data, when file THEO is created.
2.4 Project code file

A project code (5 positions) is used to simplify the identification of data files. During processing, a project number (1 to 9) refers to the project code. The project codes are listed in a file called PROJECT. The project number is the corresponding line number in this file. An example of this file is given in figure 6. So project number 2 corresponds to project code PUK 81.
3. DESCRIPTION OF THE PROGRAMS

A flow chart of the set of programs is given in figure 7. The programs SONDE, WIND, TEMP and PLOTROOS are described hereafter.

3.1 Program SONDE

3.1.1 Input
- Radiosonde data and Groundcheck data from paper tape (input code number 6) or diskfile SONDE (input code number 10). One of these code numbers must be used in the start procedure. When the data input comes from paper tape, the data are stored on diskfile SONDE automatically. Therefore paper tape input is necessary only for the first run, and should not be used more often than necessary.
- Calibration data and groundlevel measurements from diskfile GRCBK.
- Project code from diskfile PROJECT. The appropriate project number must be used in the start procedure.

3.1.2 Output
- Printout of radiosonde data after interpolation to pressure levels and calculation of derived parameters.
- Printout of raw data, i.e. paper tape data converted to meteorological parameters without any interpolation.
- Printout of calibration data and resulting corrections.
- Diskfile OUTSONDE. This file contains the radiosonde data after interpolation to pressure levels and calculation of derived parameters, including the groundlevel measurements. This file will be removed automatically when program TEMP is executed.

An example of the printout is given in figure 8.

3.1.3 Special features
Automatic quality check of the data, and automatic deletion or labeling of erroneous values is possible. Moreover parts of the output can be suppressed. A choice must be made out of the options given in figure 9; the corresponding quality check code number must be used in the start
procedure. The code number for 2 mbar values is only to be used in the start procedure for program WIND.

The quality check is in no way foolproof. Not all types of suspect values are rejected. On the other hand correct values are sometimes rejected when the preceding value was found to be suspect. A careful inspection of the output, if necessary followed by corrections in the data files, is important if reliable radiosonde data are to be obtained.

3.1.4 Links to other programs and files
- The start procedure for SONDE also starts TEMP when the quality check code number ≠ 0.
- Diskfile OUTSONDE provides for data input to WIND and TEMP.

3.1.5 Identification of files
Most of the files are identified by extra numbers and codes:
- GRCHEK:
  GRCHEK/project code/radiosonde number.
- SONDE:
  SONDE/project code/radiosonde number.
- PROJECT:
  no extra identification.
- OUTSONDE:
  OUTSONDE/project code/radiosonde number.
  project code : 5 positions, characters and numbers.
  radiosonde number: 7 positions, numbers only.

3.1.6 Start procedures
The program SONDE can be started by two startjobs:
1. START JOB/SONDE (A, B, C, D,)
2. START JOB/PROFILE (A, B, C)
where:
A = project number
B = radiosonde number
C = quality check code number
D = input code number; 6 for paper tape, 10 for diskfile

A listing of these startjobs is given in Figures 10 and 11.
When paper tape input for the radiosonde data is used, only JOB/SONDE can be used.

3.1.7 Computations

Conversion of paper tape data to meteorological values

The octal numbers are first converted to decimal values and stored in diskfile SONDE. This yields the time in seconds, but additional conversion is necessary for the other parameters. The decimal samples (S) are converted to the corresponding frequencies (f) in MHz, using:

\[ f = (S + 231424) \times 10^{-4} \]  \hspace{1cm} (1)

So \( T_S \), \( RH_S \), \( P_{ps} \), \( K_1 \), \( K_2 \) and \( P_S \), measured by the sonde, are now represented by frequencies. No further conversion is necessary for \( K_1 \) and \( K_2 \). In order to calculate the meteorological values from these frequencies, the following procedure is used for \( T \), \( P_p \) and \( P \):

Compute \( y \):

\[ y = \frac{f_2^{-2} - f^{-2}}{f_2^{-2} - f_1^{-2}} \]  \hspace{1cm} (2)

where \( f_1 \) and \( f_2 \) are the frequencies corresponding to \( K_1 \) and \( K_2 \); \( f_E \) is the frequency corresponding to \( T \), \( P_p \), or \( P \).

Compute \( v \):

\[ v = \frac{1}{2.375 - y} \]  \hspace{1cm} (3)

Compute the meteorological value \( M \):

\[ M = (c_0 + c_1 v + c_2 v^2) \times 0.1 \]  \hspace{1cm} (4)

Here the \( c_i \) are the factory calibration values for \( T \), \( P_p \) and \( P \), stored on lines 8, 9 and 10 in diskfile GRCK. In this way meteorological values for \( T_S \), \( P_{ps} \) and \( P_S \) are found. The units are °C, mbar and mbar. Finally a correction as a result of the preflight calibration is necessary for \( T_S \) and \( P_S \).
During the calibration procedure the sonde is placed in the Ground Check Chamber, and \( T_{sc} \) and \( P_{sc} \) are measured. Four cycles are punched, and the mean values are used to compute \( T_{sc} \) and \( P_{sc} \), following the procedure already described. If any value differs more than the standard deviation from the mean value, this value is rejected. In case that more than one value differ more than the standard deviation from the mean value, no values are rejected. The reference values \( T_r \) and \( P_r \) are measured by the operator. In this way the corrections \( \Delta T \) and \( \Delta P \) are found:

\[
\Delta T = T_r - T_{sc} \\
\Delta P = P_r - P_{sc}
\]

(5)  (6)

Subsequently every \( T_s \) and \( P_s \) value measured by the sonde must be corrected to find its final value:

\[
T = T_s + \Delta T \\
P = P_s + \Delta P
\]

(7)  (8)

There is no calibration procedure for \( P_p \), so that \( P_p = P_{ps} \).

To convert the frequency representing RH to a meteorological value (percent), a different procedure is followed, in which the calibration is directly incorporated. Using (2) we compute \( y \). Then we compute \( z \):

\[
z = \frac{y - z_2}{z_1 - z_2} \times \left( x_1 - x_2 \right) + x_2
\]

(9)

To calculate \( x_1, x_2, z_1 \) and \( z_2 \) we need the preflight calibration values, found for a low and a high humidity (2% and 75%). These two calibrations consist of four measurements each, and again one can be rejected by calculation of the standard deviation. The formulas to calculate \( x_1 \) and \( z_1 (i = 1, 2) \) are:

\[
x_1 = \frac{-9.1366 + \sqrt{83.4775 + 133.734 \times (123.431 - A_i)}}{133.734}
\]

(10)

where \( A_1 = 2\% \).

\( A_2 = 75\% \).
\[ z_i = \frac{f_{E1}^{-2} - f_i^{-2}}{f_{E2}^{-2} - f_i^{-2}} \]  

where \( f_{E1} \) = radiosonde frequency corresponding to 2% RH.
\( f_{E2} \) = radiosonde frequency corresponding to 75% RH.
\( f_{E1} \) is calculated using (1).
Finally the value found for \( z \) (9) is converted to a relative humidity value (percent):

\[ \text{RH} = 123.431 - 18.2712 \times z - 133.734 \times z^2 \]  

This completes the conversion of paper tape data to meteorological values. Formulas (1) to (12) have been provided by Vaisala.

**Interpolation to pressure levels: calculation of derived parameters**

For each group of measurements the time is measured only once; the clock is read when the measurements are punched. However, the data are sampled before the punching, so a time difference is introduced. Moreover the parameters are not measured simultaneously, so a time correction is necessary for each parameter within a group. If \( t_{g,i} \) is the time given for group \( i \), we calculate for every group \( i \) a time interval \( \tau_i \) (usually about 8 s):

\[ \tau_i = t_{g,i} - t_{g,i-1} \]  

Then we calculate the individual measuring times \( t_{X,i} \) for each parameter \( X \) within group \( i \).

**Individual measuring time:**

\[ t_{T,i} = t_{g,i} - 1.25 \times \tau_i \]
\[ t_{RH,i} = t_{g,i} - 1.10 \times \tau_i \]
\[ t_{PP,i} = t_{g,i} - 0.90 \times \tau_i \]
\[ t_{P,i} = t_{g,i} - 0.40 \times \tau_i \]

No correction is necessary for \( K_1 \) and \( K_2 \), since these parameters are
nearly constant. Since the clock starts when the sonde is launched, but 
the start of a measuring cycle is arbitrary, it is possible that some 
values are measured just before the start. Therefore groups with 
t_{g,i} \leq 10 are rejected.

Since the parameters within a group are not measured simultaneously, the 
parameters are not measured at the same height. By linear interpolation 
the individual measurements are now converted to the values that belong 
to the pressure level of the relevant group. The calculated individual 
measuring times are used for that purpose.

If index p,i denotes the value of a parameter at the pressure level of 
group i, we have

\[
R_{H,pi} = R_{H,i} + \frac{t_{p,i} - t_{RH,i}}{t_{RH,i+1} - t_{RH,i}} \times (R_{H,i+1} - R_{H,i})
\]

(14)

\[
T_{pi} = T_i + \frac{t_{p,i} - t_{T,i}}{t_{T,i+1} - t_{T,i}} \times (T_{i+1} - T_i)
\]

(15)

From now on we shall use the parameters at pressure levels without any 
indication.

We can now calculate the potential temperature $\Theta$ (°C), the dew point TD 
(°C) and the specific humidity SH (g/kg):

\[
\Theta = (T + 273.15) \times (1000 / p)^{0.286} - 273.15
\]

(16)

\[
TD = 241.83 \times \left\{ \frac{\log (RH \times 0.01)}{7.63} + \frac{T}{T + 241.83} \right\}^{-1} - 1
\]

(17)

\[
SH = 1000 \times \left\{ \frac{100 \times 2}{0.622 \times RH \times 6.107 \times 10^{7.53T/(241.83+T)}} - \frac{0.378}{0.622} \right\}^{-1}
\]

(18)

Finally we calculate the height of every (pressure) level. For that we 
must first find the mean virtual temperature $\overline{T}_{v,i,i+1}$ (K) of the layer 
between level i and i+1 through (19) and (20):

\[
\overline{T}_{v,i,i+1} = 0.5 \times (T_{v,i} + T_{v,i+1})
\]

(19)
\[ T_{v,i} = (T_{i} + 273,15) \times (1 + 0.00061 \times SH_{i}) \]  

Then we calculate the height \( z_n \) of level \( n \) (in geopotential meters) as addition of all underlying layers:

\[ z_n = h + \sum_{i=0}^{n-1} \frac{1}{9.8} \times 287 \times T_{v,i,i+1} \times \ln \frac{P_i}{P_{i+1}} \quad (n \geq 1) \]

where \( h \) is the height of the station in meters, and \( P_0 \) \((i = 0)\) the pressure at the radiosonde station, measured with a station barometer (not corrected to sea level). For \( n = 0 \), we take \( z_0 = h \).

3.2 Program WIND

3.2.1 Input
- Radiosonde data from diskfile OUTSONDE.
- Groundlevel measurements from diskfile GRCHK.
- Theodolite data from diskfile THEO.
- Project code from diskfile PROJECT.

3.2.2 Output
- Printout of radiosonde data, including parameters derived by SONDE and wind data, after interpolation to pressure levels in 2 mbar steps.
- Diskfile OUTPROFILE. This file is identical to the printout; it will be removed automatically when program TEMP is executed.

An example of the printout is given in figure 12.

3.2.3 Special features
See description of program SONDE.
If no file THEO is available, wind data are given as 9999.

3.2.4 Links to other programs and files
- Diskfile OUTPROFILE provides for data input to TEMP and PLOTROOS.

3.2.5 Identification of files
- OUTSONDE:
  OUTSONDE/project code/radiosonde number.
3.2.6 **Start procedures**

The program WIND can be started by a startjob:

START JOB/PROFILE (A, B, C)

where:

A = project code number
B = radiosonde number
C = quality check code number

A listing of this startjob is given in figure 11.

This procedure starts program SONDE first. The programs TEMP and PLOTROOS are started by this startjob when program WIND is ready.

3.2.7 **Computations**

First linear interpolation is used to convert the radiosonde measurements and derived parameters (program SONDE) from arbitrary pressure levels (as measured by the sonde) to successive pressure levels in 2 mbar intervals. Then the theodolite measurements must be matched to these 2 mbar steps.

The radiosonde and theodolite measurements have the same time scale. So for every theodolite measurement the corresponding height can be found from the sonde data. Now the position of the sonde in a rectangular coordinate system is computed, relative to the start position: using elevation and height of the sonde, the distance along the earth surface is computed, and transformed into rectangular coordinates using the azimuth of the sonde. For low angles of elevation a correction must be applied for refraction in the atmosphere. To that end a fictitious earth radius is used. The correction depends on the height of the sonde. The main formulas are:

\[ d = R_f \ast \phi \]  \hspace{1cm} (22)

where \( d \) = distance along earth surface (m)   
\( R_f \) = fictitious earth radius (m)   
\( \phi \) = angle corresponding to \( d \), seen from earth centre (rad)

\[ \phi = \arccos \left( \frac{R_f}{R_f + z \ast \cos \varepsilon} \right) - \varepsilon \]  \hspace{1cm} (23)
where \[ z = \text{height of sonde (m)} \]
\[ \varepsilon = \text{elevation of sonde (rad)} \]

\[ R_f = R \times (1 + 0.22 \times \exp (-z / 48000)) \]  \hspace{1cm} (24)

where \( R = \text{earth radius} = 6371229 \text{ m} \).

To compute wind speed and direction at height \( z \) (corresponding to a 2 mbar level), the position of the sonde at heights \( z + 25 \) and \( z - 25 \) (m) is computed by interpolation. Along the two horizontal axes of the coordinate system two wind speeds are determined from the displacement in a known time interval. In this way a mean wind speed and wind direction at height \( z \) for a height interval of 50 m are found.

3.3 Program TEMP

This program is a modified version of the operational program TEMPS, in use at KNMI to process synoptical radiosonde data. The improvement of the vertical resolution is one of the modifications.

3.3.1 Input
- Radiosonde data, including wind, from diskfile OUTPROFILE.
- Radiosonde data, excluding wind, from diskfile OUTSONDE.
- Groundlevel measurements from diskfile GRCHK.
- Project code from diskfile PROJECT.

OUTPROFILE can only be used if WIND has been run, otherwise the output will not contain wind data.

3.3.2 Output
- Plotfile MONW/TEMP.

This file contains temperature and dewpoint temperature as a function of height, and wind data - if available - in 50 mbar level intervals. A plot can be made on a standard (KNMI) \( \theta_s \), \( p \) diagram. An example is shown in figure 13.
3.3.3 **Special features**
- TEMP removes diskfile OUTSONDE after use.
- To plot the temperature and dewpoint temperature profiles, all available data are used.

3.3.4 **Identification of files**
- MONW/TEMP:
  (PLT) MONW/TEMP/radiosonde number.

3.3.5 **Start procedures**
The program TEMP can be started by the startjobs SONDE and PROFILE, as described before.

3.4 **Program PLOTROOS**

3.4.1 **Input**
- Wind data from diskfile OUTPROFILE.
- Groundlevel measurements from diskfile GRCHK.
- Project code from diskfile PROJECT.

3.4.2 **Output**
- Plotfile MONW/WIND:
  This file contains wind data as a function of height. An example of plotted wind data is shown in figure 14. Height marks are given at 500 m intervals.

3.4.3 **Identification of files**
- Plotfile MONW/WIND:
  MONW/WIND/radiosonde number.

3.4.4 **Start procedure**
The program PLOTROOS can be started by the startjob PROFILE.
4. ACKNOWLEDGEMENTS

The formulas to compute a wind profile from the theodolite data, taking into account the curvature of the earth surface and the refraction in the atmosphere were provided by H.R.A. Wessels and Dr. A.G.M. Driedonks. The program PLOTROOS was written by A. Snijders. Discussions with J.G. van der Vliet contributed to the final form of this set of programs.
GRCHK / project code / radiosonde number

100  date (DDMMYY)
200  time of start (HHMM in UTC)
300  radiosonde number (xxxxxx.x)
400  ground check temperature (°C)
500  ground check pressure (mbar)
600  ground check humidity low (% RH)
700  ground check humidity high (% RH)
800  factory calibration for T ($c_0, c_1, c_2$)
900  factory calibrations for $P_p$ ($c_0, c_1, c_2$)
1000 factory calibration for $P$ ($c_0, c_1, c_2$)
1100 station name
1200 station height (m)
1300 ground level temperature (°C)
1400 ground level pressure (mbar)
1500 ground level humidity (% RH)
1600 ground level dewpoint temperature (°C)
1700 clouds in code form $N_h C_1 h C_m C_h$
1800 indication of cloudiness (N/8, text)
1900 remarks
2000 remarks

Fig. 1. layout of the paper tape

station observations
at the start
of the flight

Fig. 2. layout of file GRCHK
GRCHK/CAB  8.6158013
100  270581
200  0831
300  615801.3
400  23.1
500  0006.1
600  002
700  075
800  --2525,4313,-742
900  --885,1458,1910
1000  -10608,22857,8741
1100  CABAUW
1200  0
1300  15.3
1400  1006.1
1500  72
1600  10.2
1700  12532
1800  4/8, CU AC CI
1900  TEST FLIGHT
2000

Fig. 3. Example of file GRCHK
Fig. 4. output of Theodolite Data Recording System

THEO/PUK81/6455381
100  1,245,12,4
200  35.35,123.87,00.06
300  45.33,114.89,00.15
400  46.73,109.69,00.25
500  46.07,110.50,00.45

Fig. 5. example of file THEO

PROJECT
100  CAB81
200  PUK81
300  TEST1
400  CAB82

Fig. 6. example of file PROJECT
Fig. 7. Flow chart of the set of programs
### Radiosounding

**DATE:** 1-6-1993 15:18 GMT  
**RADIOSONDENR.:** 481138.3  
**NAME OF STATION:** ZWEEFVV  
**HEIGHT OF STATION:** 4 M  
**CLOUDS:** 32631 5/8, CU, AC, CI

<table>
<thead>
<tr>
<th>PRESS MBAR</th>
<th>HEIGHT GPM</th>
<th>TIME SEC</th>
<th>TEMP C</th>
<th>P-TEMP C</th>
<th>DEW-P C</th>
<th>RH %</th>
<th>SH G/KG</th>
</tr>
</thead>
<tbody>
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<td>0</td>
<td>22.0</td>
<td>21.2</td>
<td>14.2</td>
<td>61</td>
<td>10.0</td>
<td>GROUNDLEVEL</td>
</tr>
<tr>
<td>1010.0</td>
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<td></td>
<td></td>
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**Fig. 8.** Example of printout of program SONDE
**Fig. 8.** example of print-out of program SONDE; raw data

**Radiosounding**

**Date:** 1-9-1983 15.10 GMT

**Raw Data**

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| Clouds | 32631 5/8, CU, AC, CI |

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<th>Hum (%)</th>
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GROUNDCHECK VALUES:
TEMPERATURE  30.2 °C
PRESSURE      1009.8 MBAR
HUMIDITY LOW  2 %
HUMIDITY HIGH 75 %

TEMP. CORRECTION = 0.5832
PRESS. CORRECTION = 0.0743

RADIOSONDENR. : 481138.3
CALIBRATION VALUES :
T:   -2350  3853  -437
PP:  -1930  4805  -812
P:    -9331  20412 9810

GROUNDCHECK LISTING:

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Fig. 8. example of printout of program SONDE; calibration data

quality check code number

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<tr>
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<td>* * * * * *</td>
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<td>* * * *</td>
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<td>file OUTSONDE</td>
<td>* * * * * *</td>
</tr>
<tr>
<td>2 mbar values</td>
<td>* * * *</td>
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Fig. 9. quality check code number
JOB/SONDE (11/23/83)

1000 ?BEGIN JOB SONDE(INTEGER PROJ,INTEGER PSNR,INTEGER SIGN,INTEGER CLS);
1100 USERCODE=MONW/PO;
1200 CHARGE=AFMALG;
1300 CLASS=CLS;
1400 MAXPROCTIME=1100-(CLS*CLS*CLS);
1500 MAXIOTIME=1100-(CLS*CLS*CLS);
1600 MAXLINES=2800-(CLS*CLS*CLS);
1700 REAL DT;
1710 TASK TSK;
1800 IF SIGN EQL 1 OR SIGN EQL 6 OR SIGN EQL 8 THEN
1900 DISPLAY(STRING(RSNR,""=") & " WITH AUTOMATIC DELETE")
2000 ELSE DISPLAY(STRING(RSNR,""=") & " WITHOUT AUTOMATIC DELETE");
2100 DT:=RSNR*1000+PROJ*10+SIGN;
2200 RUN SONDE(CLS DIV 10)[TSK];VALUE=DT;
2250 DT:=RSNR*1000+PROJ;
2300 IF SIGN NEQ 0 AND TSK IS COMPLETED THEN
2400 RUN TEMP;VALUE=DT;
2500 END JOB;

Fig. 10. job/sonde

JOB/PROFILE (11/23/83)

1000 ?BEGIN JOB PROFILE(INTEGER PROJ,INTEGER RSNR,INTEGER SGN);
1100 USERCODE=MONW/PO;
1200 CLASS=10;
1300 CHARGE=AFMALG;
1400 STRING STR;
1500 REAL DT;
1600 DT:=RSNR*1000+PROJ*17+SGN;
1700 RUN SONDE(1);VALUE=DT;
1800 RUN WIND;VALUE=DT;
1850 DISPLAY("OPSTARTVALUE = " & STRING(DT,""="));
1900 RUN PLOTOOS;VALUE=DT;
2000 STR="MONW/WIND/"&STRING(RSNR,7);
2100 RUN(OBER)INSERTPLOT ON OPER(STR);
2200 DT:=RSNR*1000+PROJ;
2300 RUN TEMP;VALUE=DT;
2400 END JOB;

Fig. 11. job/profile
### Radiosounding

**Calculated 2 mbar levels**

**Date:** 1-6-1983 15.18 GMT

**RadioSonDe No.:** 481138.3  
**Name of Station:** TWEF NY  
**Height of Station:** 4 M  
**Clouds:** Sc 5/8, Cu, Ac, Ci

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<tr>
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<th>Height (GPM)</th>
<th>Time (SEC)</th>
<th>Temp (°C)</th>
<th>Temp (°F)</th>
<th>Dew-P (°C)</th>
<th>RH %</th>
<th>SH (mm)</th>
<th>DD (mil)</th>
<th>FF (m/sec)</th>
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</thead>
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1006.0  38.4  7.3  21.9  22.4  13.0  60  9.3  247.9  5.7
1004.0  55.7  11.0  21.4  21.1  12.4  60  8.9  247.9  5.7
1002.0  72.9  14.5  21.1  19.2  11.9  59  8.7  253.7  5.7
1000.0  80.1  17.9  19.3  17.8  11.5  59  8.5  254.3  6.0
998.0   107.4 21.3  19.7  17.3  11.1  59  8.5  246.3  6.0
996.0   124.7 24.9  19.7  20.0  11.4  59  8.4  244.9  6.3
994.0   142.0 28.5  19.7  21.2  11.3  59  8.4  243.1  6.5
992.0   159.4 32.5  20.0  21.7  11.3  57  8.4  234.2  6.1
990.0   176.8 36.7  20.4  21.2  11.3  56  8.5  232.7  5.9
988.0   194.3 40.1  20.4  21.4  11.2  56  8.4  218.0  6.4
986.0   211.9 43.5  20.3  21.5  11.2  56  8.4  221.4  7.0
984.0   229.3 46.8  20.7  21.6  11.1  56  8.4  211.0  9.3
982.0   246.7 50.0  21.1  21.4  11.1  55  8.3  204.7  9.2
980.0   264.5 53.7  21.0  21.7  11.0  55  8.3  199.4  9.2
978.0   282.1 57.0  21.1  21.2  10.9  54  8.3  202.7  7.6
976.0   299.8 60.8  21.1  21.2  10.8  55  8.3  201.4  7.7
974.0   317.5 64.5  21.1  21.4  10.6  54  8.2  198.1  8.1
972.0   335.2 68.2  21.1  21.5  10.5  54  8.1  196.5  8.3
970.0   353.0 71.9  21.0  21.6  10.4  54  8.1  197.1  8.2
968.0   370.7 74.4  21.0  21.6  10.4  54  8.2  198.5  7.3
966.0   388.4 77.0  20.9  21.6  10.4  54  8.2  198.5  7.3
964.0   406.1 80.1  20.8  21.6  10.4  55  8.1  198.9  7.9
962.0   423.8 83.5  20.6  21.6  10.4  55  8.1  198.9  8.2
960.0   441.5 87.0  20.5  21.6  10.4  55  8.1  198.3  8.7
958.0   459.2 90.5  20.4  21.6  10.4  55  8.1  197.5  8.9
956.0   476.9 93.9  20.3  21.7  10.3  55  8.1  196.2  9.0
954.0   494.6 97.4  20.2  21.7  10.3  55  8.1  195.4  8.9
952.0   512.3 100.8 20.1  21.7  10.2  55  8.1  195.1  9.1
950.0   529.9 104.3 20.0  21.7  10.2  55  8.1  195.0  9.1
948.0   547.6 107.8 19.9  21.7  9.9  57  8.0  195.6  9.3
946.0   565.3 111.3 19.8  21.7  9.8  57  8.0  193.0  7.7
944.0   583.0 114.8 19.7  21.7  9.7  58  8.0  188.7  7.3
942.0   600.7 118.3 19.6  21.6  9.6  58  8.0  194.4  7.4
940.0   618.4 121.8 19.5  21.6  9.6  58  8.0  194.4  7.4
938.0   636.1 125.3 19.4  21.6  9.5  58  8.0  191.7  7.3
936.0   653.8 128.8 19.3  21.5  9.4  58  8.0  193.0  7.7
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932.0   689.2 135.8 19.1  21.4  9.2  59  7.9  192.9  7.6
930.0   706.9 139.3 19.1  21.4  9.2  59  7.9  192.5  7.9
928.0   724.6 142.8 19.0  21.3  9.1  60  7.9  192.8  8.5
926.0   742.3 146.3 19.0  21.3  9.1  61  7.9  194.2  9.1
924.0   760.0 149.8 18.9  21.2  9.0  62  7.8  194.4  9.1

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Fig. 12. Example of printout of program WIND
Fig. 13. Example of plotout of program TEMP

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PUKK K6

- ii: 6272746
- Datum: 250981
- GG: 1112
- NC: 20832

FZL

- Tgold

Graph showing depth and temperature measurements with specific values and units.
VALUES AT 500 M INTERVALS:

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<th>DIRECTION (DEGREES)</th>
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<tr>
<td>3704</td>
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</tr>
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</table>

GROUND LEVEL:

PP : 1009.6
TT : 13.5
ll : 9.9
CLOUDS: 78701
7/8, CU, SC, CI

+: EACH 500M INTERVAL
\(\Delta\): START
\(\nabla\): END

Fig. 14. Example of plotout of program PLOTROOS