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OFFICE NOTE 413

COMPLEX QUALITY CONTROL FOR OBSERVATION ERRORS OF RAWINSONDE TEMPERATURES AND HEIGHTS

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Abstract

The Complex Quality Control of Heights and Temperature (CQCHT) program deals with two classes of rough errors--those that are hydrostatically detectable and those that are not. Those rough errors associated with small hydrostatic residuals are errors in temperature that entered the processing before the calculation of heights. These errors are referred to as observation errors. They may be due to instrument error, any other error preceding the computation of heights, or errors of representativeness. It is often impossible to distinguish between these sources of observation values. This note describes the part of CQCHT used in their diagnosis: the checks and Decision Making Algorithm (DMA). Examples are given illustrating many of the situations in which temperature and height observation errors occur. A comparison is made between the earlier, more modest quality control (qc) and the present version. It is suggested that the effectiveness of the present qc allows the abandonment of the (traditional) rejectlist at NCEP.

1. Introduction

The quality control of operational rawinsonde height and temperature data is performed at NCEP by the Complex Quality Control (CQC) of rawinsonde Heights and Temperatures (CQCHT) program. The CQCHT algorithm was described in detail in the NMC Office Note 390 (and in ON 408). It is assumed that the reader of this text is familiar with ON 390, or at least has it at hand.

As in any CQC, residuals of various CQCHT checks are first calculated, and then the Decision Making Algorithm (DMA) analyzes the pattern of residuals in order to detect, identify and, if possible, correct rough errors in these data. For the mandatory isobaric surfaces, the CQCHT contains the hydrostatic check, the baseline check and three statistical checks: the increment check, the vertical interpolation check and the horizontal interpolation check. As long as the mandatory surface heights are not measured independently but computed at stations from measured temperatures and pressures, the hydrostatic check does not react to measurement errors. The absence of large hydrostatic residuals in combination with the presence of large increments as well as of large horizontal and vertical check residuals is thus an indication that the errors in such report may be of observational origin.

The investigation of rough observational errors began at NCEP several years ago, when the first version of CQCHT was implemented. It has been demonstrated that, unlike communication errors, the temperature observation errors usually persist to one or another extent in the vertical direction over thick layers often involving many mandatory surfaces. The accumulated influence of even small errors of this kind results in large errors in hydrostatically computed heights of these surfaces. As a rule, the absolute values of such height errors increase upwards.

When the CQCHT was first implemented, the NCEP Global and Regional Data Assimilation Systems both used the isobaric height as the mass variable, and it was decided that the CQCHT algorithm should not only detect and, if possible, correct rough errors in processing and communicating data, but also to share with the human specialists its suspicions of the height errors of observational origin. The CQCHT DMA simply provided the NCEP Senior Duty Meteorologist (SDM) with its information about all profiles with suspected large observation errors, and it was up to the SDM to decide which parts of such profiles (if any, including temperatures) to reject from the assimilation.

Along with this practice, there were several attempts to design entirely objective procedures to deal with the temperature observation errors and related errors in height. This task was particularly important in connection with the so-called rejectlisting which was used at NCEP for many years and is still used nowadays at some other weather prediction centers. Inclusion of a rawinsonde station into the rejectlist means that all reports coming from this station during a month or even larger periods of time will have either the mass part or wind part or both completely ignored. The number of such stations for height and temperature in the rejectlist used until recently at NCEP exceeded 100. It was particularly detrimental if stations in a region with sparse network were rejectlisted and/or if the rejectlist enclosed large regions, as was the case with the WMO Blocks 42 and 43 (the Indian Subcontinent).

Various statistics of the CQCHT performance, investigated during several years, led us to the conclusion that, with a properly designed version of the CQCHT DMA, there

would be no need at all for rejectlisting the height or temperature of any rawinsonde reports. This new DMA, which was designed recently at EMC and implemented into the operational NCEP practice on October 25, 1995, is briefly described in this Office Note. It uses the following main principles:

1. Concerning communication and computation errors--the DMA actions don't differ from those of the previously operational DMA. The only differences are in the treatment of suspected observational errors.

2. Much smaller absolute values of increments and statistical check residuals of temperature are used to indicate suspected observational errors than is the case for communication and computation errors. That is necessary because of the above-mentioned vertical persistence of the observation errors. With the detection of errors with smaller absolute magnitude, the CQCHT now takes on the new role of determining values that may more or less accurately give the true atmospheric state at the observation location, but nevertheless are not representative for numerical weather prediction (nwp) purposes. This new role of CQCHT is shared with OIQC and the assimilations themselves.

3. Along with decision Type 4 (exclude from the assimilation), the new CQCHT DMA more extensively uses Type 3 decisions (assimilate with diminished weight).

4. The DMA is automated to the largest possible extent. It does make some Type 5 decisions (request for human help) but these decisions are made very seldom, mostly when a surface pressure measurement error is suspected.

This note describes the checks used to diagnose observation errors in Section 2, show the manner in which the residuals are normalized in Section 3, describe the DMA for observation errors in Section 4, give examples of observation errors in Section 5 and some statistics of the operation of the quality control in Section 6.

2. The checks

As for all CQC (Gandin, 1988), the various check residuals are first calculated, and then the Decision Making Algorithm (DMA) determines whether there are errors or not. The checks used in the determination of observation errors are the increment, horizontal, and vertical checks. Also, for surface pressure observation error determination, the increment and horizontal residual of "mean-sea-level" pressure are used. An explanation of these checks follows.

Increment check

The increment is the difference between an observed value and the guess value (6 hr forecast) interpolated to the observation location. In the data processing on the Cray, the interpolated forecast value is included as an "event" in the upper air PREPBUFR file, meaning that CQCHT does not need to compute it. All that is necessary is to subtract the guess from the observed value. This check has the advantage that it is always available, but the disadvantage that it is sensitive to forecast error.

Horizontal statistical check

This check is described in full in O.N. 390. The increments are horizontally interpolated, using optimal interpolation, to the observation location, excluding the observed increment in the interpolation. The four (at most) surrounding stations used in

the interpolation are chosen to be the closest one from each quadrant, at a distance of no more than 1000 km. The horizontal residual is the difference between the observed increment and the interpolated increment. This check's residuals are less sensitive to the model error than are the increments themselves.

Vertical statistical check

The vertical check is similar to the horizontal check except that the optimal interpolation is performed in the vertical. The vertical residual is the difference between the observed increment and the interpolated increment.

The magnitude of the increment by itself is very useful in determining data quality. However, there is the possibility of some error in the forecast. The use of the horizontal and vertical residuals minimizes this difficulty, but they must be used together: the vertical check can isolate which station has an error, while the horizontal check can isolate which level has an error. The agreement between the checks gives confidence in the result.

Increment check for mean-sea-level pressure

The equations for reduction of pressure are given in O.N. 390. Two height levels near the surface are used to define a near-surface temperature. The temperature profile underground is assumed to have a constant lapse, with a value matching this near-surface value. The hydrostatic equation is used to obtain the pressure at zero height. The increment is the difference between the "observation" obtained in this way and the "guess" obtained by a similar procedure.

Horizontal check for mean-sea-level pressure

The horizontal check for mean-sea-level (msl) pressure is performed in a similar manner to the horizontal check for mandatory level temperatures. The residual is the difference between the msl pressure increment and the interpolated msl pressure increment. As for temperatures and heights, this residual is particularly useful to minimize the effects of possible model error that would affect the increments, but less so their horizontal variation.

3. Use of Statistics of the Residuals

The magnitudes of the residuals are used by CQCHT when finding suggested values for correction, but not for diagnosing observation errors. Rather, the absolute value of the residuals is divided by the long-term average value of the residual standard deviation. To further facilitate analysis, the value is then multiplied by a constant. Thus, if r_i is the increment (residual), r_h is the horizontal residual, and r_v is the vertical residual (all for either T or z); and r_p is the msl pressure increment, and r_q is the msl pressure horizontal residual, then the following quantities are defined:

$$x_i = \frac{2|r_i(x,y,l,v)|}{z_i(l,v)}$$

$$x_h = \frac{2|r_h(x,y,l,v)|}{z_h(l,v)}$$

$$x_v = \frac{2|r_v(x,y,l,v)|}{z_v(l,v)}$$

and

$$x_p = \frac{2|r_p(x,y)|}{P}$$

$$x_q = \frac{2|r_q(x,y)|}{P}$$

where the temperature and height residuals are functions of horizontal position (x,y), level (l), and variable (v). The long-term average standard deviations are assumed to depend only upon the level and variable. The msl pressure residuals depend only upon position. They are normalized by P, which has the value of 5 hPa. The values of z_i, z_h, and z_v are given in Fig. 1 for height and in Fig. 2 for temperature. The values represent 5 standard deviations for the increments, horizontal residuals, and vertical residuals.

4. Decision Making Algorithm for Observation Errors

The Decision Making Algorithm (DMA) uses the quantities defined in the last section and certain limits to diagnose observation errors. These limits can be used to tune the response of the algorithm so that definite errors are most often detected but questionable errors are most often not selected. The values used presently by CQCHT are:

$$s_{T1} = 4.0 \qquad s_{T2} = 6.0$$
$$s_{z1} = 5.5 \qquad s_{z2} = 7.0$$
$$L = 4.0.$$

The manner in which these values are used may be seen in the following description of the DMA using pseudo-code.

The CQCHT makes one of two possible decisions for each observational error. When the datum is determined to be definitely bad, decision 4 is assigned, and when the datum is of questionable quality, decision 3 is assigned. (See O.N. 390.) Normally, when decision 3 is assigned, a datum will be used in the analysis/forecast system with diminished weight.

For temperature:

$SUM = x_i + x_h + \{x_v$ if $x_v^{l+1} < s_{Tl}$ and $x_v^{l-1} < s_{Tl}\}$, where l is the level index
$ICNT = 2$ {or 3 if x_v is in SUM}
$AVG = SUM / ICNT$

$NONZ^j = \{x_i^j \text{ if } x_i^j > L\} + \{x_h^j \text{ if } x_h^j > L\} + \{x_v^j \text{ if } x_v^j > L\}$, $j=l-1,l,l+1$
if $\{(NONZ^l \geq 2 \text{ and } NONZ^{l-1} \geq 2) \text{ or } (NONZ^l \geq 2 \text{ and } NONZ^{l+1} \geq 2)\}$ or
$\{AVG \geq s_{T2}\}$ then set decision to 4
elseif $\{AVG \geq s_{T1} \text{ and } AVG < s_{T2}\}$ then set decision to 3

For height:

$SUM = x_i + x_h + \{x_v \text{ if } x_v^{l+1} < s_{z1} \text{ and } x_v^{l-1} < s_{z1}\}$
$ICNT = 2$ {or 3 if x_v is in SUM}
$AVG = SUM / ICNT$
if $AVG \geq s_{z2}$ set decision to 4
elseif ($AVG \geq s_{z1}$ and $AVG < s_{z2}$) then set decision to 3

For surface pressure:

$SUM = x_p + x_q$
$AVG = SUM / 2$
if $AVG \geq s_{T1}$ then set decision to 4

For temperature, height and surface pressure, *AVG* measures the average residual magnitude, relative to its normal magnitude. The vertical residual is sensitive to errors at adjacent levels, since an error at level *l* may cause the vertical residuals to be large at levels *l-1* and *l+1*, and is therefore not used unless the adjacent level residuals are sufficiently small. This leads to its not being used in some situations where it is not contaminated. For sufficiently large values of *AVG*, the datum is rejected, while for intermediate values, the datum is used with diminished weight.

For temperature, there is an additional factor to consider. When there are observational errors, they tend to persist in the vertical, even though this persistence is not always pronounced for temperature. Therefore, if the layer, and the one above or below, have two or more residuals of size of equal or greater to one standard deviation of the normal, then this is sufficient for the value to be considered to be in error.

5. Examples of observation errors

The number of individual temperature or height observation errors averages about 370 at each main (00 or 12 UTC) observation time. Rough classifications of these errors are made, and a number of examples are shown.

A full explanation of the form of the examples may be found in O.N. 390. They are shown in a form that is standard for CQCHT. It has 5 parts, namely: 1) two header lines with station identification, information and date, 2) information regarding the baseline check, 3) a table of numbers for each pressure level representing the relative size, for height and temperature, of the increment (IINC), vertical residual (IVOI), horizontal residual (IHOI), (temporal residual, ITMP), the hydrostatic error type, if any (IHSC), and the baseline residuals (IBAS, IIPL, IHPL), 4) a table of the variable and residual values by pressure, and 5) the DMA results.

The examples are all taken from 00 UTC October 24, 1995 and are selected to give a good crossection of the errors encountered. Table 1 gives a short description of each example. The examples are grouped in the classes shown in Table 2.

Table 1. Description of observation error examples.

Example	Station	Comments
1	51076	T_{925}, decision 3; is the guess bad?
2	10868	T_{925}, T_{10} given decision 3; probable errors
3	72425	either guess or data are bad at and above 10 hPa
4	20891	z, T at upper levels marked, bad
5	20744	z_{50}, decision 3; small errors in T's and z's probable
6	15480	many levels are bad
7	31088	T, z bad at several levels
8	43371	few levels very bad, many levels moderately bad
9	54823	small consistent T errors leading to a few large z errors
10	47185	moderate to large errors at many levels
11	89001	all data are bad, marked
12	51828	small consistent T errors leading to large z errors
14	25400	T_{150}, decision 4; datum is bad
13	44292	T_{150}, decision 3; moderate error likely
15	04018	z_{500}, z_{400} given decision 3; probably no error
16	89009	below ground heights marked

Table 2. Observation errors by classes

Error class description	Example Nos.
error at lowest level	1,2
error at top level	2,3,4,5
z and/or T bad at several levels	3,4,6,7,8,9,10,11,12
T bad at 1 level, not bottom or top	13,14
probably no error	15
coding/decoding problem	13
pressure reduction problem	16

Errors at the lowest level

One of the greatest difficulties in observational error determination is presented when the increment and horizontal residual of temperature are large for the lowest level. It is possible that the measured temperature is not the true air temperature and should be marked as bad. Or it may be that the forecast is suspect, leading to a large increment. In some of the cases that have been investigated, it was found that the forecast was indeed in error, but that the error was caused by a strong gradient in temperature, slightly misplaced or by a nearby surface feature, etc. Diagnosed observation errors often occur when there is a strong surface temperature inversion. Such a diagnosis is questionable in the strictest sense since there is no reason for a particular meteorological situation to cause an instrument error. But the diagnosis is appropriate when the diagnosed errors are not representative for nwp purposes.

An example of likely forecast error is shown in Example 1. The temperature increment at 925 hPa is 7.5 K and the horizontal temperature residual is 5.5 K. The

residuals at 850 hPa are consistent, but smaller. The authors' judgment is that the observations are good. Example 2 is similar, except that it seems more likely in this case that the observation is in error or non-representative, particularly since the residuals change so rapidly in the vertical.

The examination of significant level temperatures helps to understand what often happens. In a large majority of cases, the temperatures that are suspected of observation errors at the lower few levels, are vertically consistent with the significant level temperatures. This means that either the whole lower part of the profile is in error, or that the temperature(s) marked are not representative for nwp use. In either case, it is appropriate to mark the data with decision 3 or 4. Further discussion and statistics will be given in section 6.

Observation errors at the top level(s)

There are two factors competing to make temperature and height observations compare poorly with either the forecast or their horizontal neighbors at high levels. First of all, the temperature sensor is more subject to radiation, ventilation and lag problems. Therefore, the temperature readings are more likely to be in error at very high levels. Secondly, the numerical forecast models have more error at high levels, being very bad by 10 hPa. The combination of these factors leads to a relatively large number of observation error diagnoses at the highest levels, especially at 10 hPa and above.

Example 2 showed a diagnosis of a bad temperature at 10 hPa. The increment and horizontal residual are consistent, lending support to this diagnosis. Example 3 is similar, except that higher levels are also observed, showing increasing error. The temperature error is reflected in the height field, so that 10 hPa and above temperatures are marked, while 7 hPa and above heights are marked. All are decision 4 (bad) except for the 7 hPa height which gets decision 3 (questionable). It is possible that the model temperatures are in error, but the general agreement of the increments and horizontal residuals at 10 and 7 hPa makes this unlikely. And Example 4 shows a similar situation. The 70 and 50 hPa temperatures are likely bad, leading to several upper levels of height that are also bad.

Example 5 is a little different. In this case, there are small but consistently negative temperature increments through much of the atmosphere. They produce steadily increasing height increments, which finally become large at 50 hPa, the top level. This height is marked as questionable.

Observation errors at several levels

Examples 3 and 4 already showed more than one level of observation error, but the emphasis there was on errors at high levels. There are many examples where there are many levels of error, beginning most anywhere in the profile.

A most dramatic case is Example 6. Almost all temperatures and heights above 850 hPa are marked as bad. Surely, the temperature sensor had major problems from the beginning. Other less dramatic cases are represented by Examples 7, 8, 10 and 12.

Example 9 shows only moderate temperature increments, but they are consistent, leading to moderately large height increments at 50 hPa and above. The heights are marked as questionable.

All the data for station 89001 in Example 11 are bad, but remarkably hydrostatically consistent. Therefore, there was no hydrostatic suspicion, but observation

errors are detected for these data and they are appropriately marked. There is generally more difficulty in determining the quality of the lowest reported level temperature, and for that reason, it is never marked a "bad" but only "questionable", regardless of the size of the residuals. In this case, the 1000 hPa temperature is so marked.

Observation error at a single level, not the bottom or top

In a small number of cases, there is a single temperature in a profile that is bad. Example 13 is such a case. The 150 hPa temperature is bad, but no other levels. It is possible that this particular measurement is unrepresentative, or there may be another reason for its disagreement. The temperature is marked as questionable.

Coding or decoding problem

Station 25400 presents an interesting example: Example 14. Data are missing at 150 and 100 hPa. The 150 hPa temperature is marked as bad, as it should be. But it is likely that in this case this temperature was misinterpreted by the decoder. This data is probably some other variable entirely. (An examination of the original message was not performed to verify exactly what happened.)

Probably no error

Example 15 shows a case in which two heights were marked as questionable. The increments attain a moderate value, but do not grow with height. There may be no error, since the heights are internally consistent. However, the residuals are large enough that these values should be considered as suspect. Cases of this sort are not frequent (see section 6).

Pressure reduction problem

Station 89009, the South Pole, presents an interesting puzzle in Example 16. There are no measured below ground temperatures, but heights are obtained at the station by some pressure reduction method. That method is clearly incompatible with the one used by CQCHT, giving height increments that increase to 173 m at 1000 hPa. Furthermore, the layer temperatures and lapse rates implied by the reported below-ground temperatures are inconsistent with the 500 hPa temperature. Fortunately, the global system uses only temperatures, so this puzzle is only of theoretical interest, but should it have happened over North America, it would be important to exclude the use of these heights. They are properly marked as bad (questionable at 700 hPa).

6. Statistics of operation of the observation error diagnosis

The new algorithm described in this note is far more productive in diagnosing observation errors than the previous one. It was implemented for NCEP's global runs on October 25, 1995, but it was monitored in experimental mode, beginning with September, 1995. Fig. 3 shows the average number of diagnosed observation errors per observation time for selected levels and in total for June-December 1995, taken from routine (experimental) monitoring. The jump in the number of diagnosed observation errors is dramatic. The average number has increased by a factor of nearly 8. The variation from month to month, other than the jump from August to September, is just a normal variation and does not represent a trend.

Note also that the number of observation errors does not change much between levels. The levels chosen were ones at a low level (925 hPa), mid level (500 hPa), high level (100 hPa), and very high level (10 hPa). Remarkably, even 10 hPa shows a large number of errors diagnosed, even though the number of sondes reaching this level is diminished. This is due to the factors already discussed which make observations and forecasts difficult at this level and above.

In order to quantify the quality of the determination of observation errors (including instrument errors, representativeness errors, etc.), all the errors diagnosed for one observation time, 00 UT 25 January 1996, were examined in detail. Also, this case was rerun using the old version of observation error determination. A count of the observations errors that were detected by the old method is given in Table 3, showing the number of errors of decision 3 and 4 for each mandatory level for both temperature and height. The temperature errors that are detected are distributed throughout the atmosphere, while the height errors that are detected are found mostly above the tropopause. Comparison with the new CQCHT, shows that all these cases were caught by it also, and with almost always the same decision. Therefore, there is little to be gained by looking further at the old results.

Table 3. Observation errors detected by the old method.

	Temperature		**Height**	
pressure	**decsn=3**	**decsn=4**	**decsn=3**	**decsn=4**
1000		3		1
850		1		
700		1		
500		2		
400	1	3	2	
300		1		1
250		1		1
200				
150		1		1
100				3
70		1		3
50		2		2
30		2		5
20			4	
10			7	
TOTAL	1	18	13	17

The results from the new observation error detection are summarized in Table 4 for temperature and Table 5 for height. They shows not only the CQCHT decision, but also a judgment of what is appropriate, based upon detailed examination of each

diagnosed error. The possible outcomes are:

4 ⇨ ✓ This indicates that an original decision of 4 is believed to be correct.

3 ⇨ ✓ This indicates that an original decision of 3 is believed to be correct.

4 ⇨ C The original decision was 4, but the data are internally consistent. For temperature, internally consistent means that the significant level temperatures support the mandatory level temperature that was suspect. For height, internally consistent means that the height increments at adjacent levels do not differ significantly from the observed increment.

3 ⇨ C The original decision was 3, but the data are internally consistent.

4 ⇨ X The original decision was 4. However, the data are believed to be correct.

3 ⇨ X The original decision was 3. However, the data are believed to be correct.

Table 4. Temperature error counts by pressure and decisions.

Pressure	**4 ⇨ ✓**	**3 ⇨ ✓**	**4 ⇨ C**	**3 ⇨ C**	**4 ⇨ X**	**3 ⇨ X**	**TOTAL**
1000		2		30			32
925		3	7	18			28
850	3	5	10	8	1		27
700	2	3	3	8	3	4	23
500	3	1	4	5	2		15
400	4	3	2	5			14
300	2	3	1	8			14
250	1	1	1	7			10
200		4		3			7
150	4	3		2			9
100	1	3	2	4			10
70	3			6			9
50	2	2	2	5			11
30	1	1	2	7			11
20	2	2	1	5			10
10	2	1	2	2		2	9
7				2			2
5				1			1
3	1						1
TOTAL	31	37	37	126	6	6	243

The overall number of diagnoses of temperature observation error is 243, compared with 19 from the old code. A large number (67 %) are either 4 ⇨ C or 3 ⇨ C decisions, meaning that many temperatures that are marked are internally consistent with the significant level temperatures. About a third of these are diagnosed at 1000 or 925 hPa, usually the first reported level. These temperatures are non-representative and should most likely not be used or used with diminished weight in any analysis. It can also be seen that most of these internally consistent temperatures are given a decision of 3, rather than 4, so that they would generally have some impact on the analysis. The number of bad temperatures diagnosed correctly (37+37) forms most of the remainder, with a few (6+6) bad diagnoses.

Table 5. Height error counts by pressure and decisions.

Pressure	4 ⇨ ✓	3 ⇨ ✓	4 ⇨ C	3 ⇨ C	4 ⇨ X	3 ⇨ X	TOTAL
1000	9	5		1			15
925	8	5		1			14
850	2	3	3	3		3	15
700	3	1	2	2	3	3	14
500	4	1	2	3	2	1	13
400	9	2	1	4		1	17
300	2	2	1			3	8
250	4	4					8
200	4	3					7
150	5	4					9
100	6	4					10
70	8	5					13
50	11	9					20
30	12	7					19
20	5	8					13
10	4	8					12
7							0
5		1					1
3							0
TOTAL	96	72	9	14	5	11	207

The distribution of decisions for height observation errors, as seen in Table 5, is rather different from those for temperature. Most decisions (96+72) are believed to be appropriate. There are a few diagnoses (9+14) where the heights are internally consistent, but they are all in the lower- to mid-troposphere. There are relatively few decisions (5+11) that are bad. The total number of height observation errors for this time was 207. For temperature and height together, there were 450 observation error decisions. In 6 %, the decisions are believed to be erroneous.

The number of observation errors (450) may seem excessive, but compared to the amount of data that was on the rejectlist, it is small. The number of stations on the rejectlist was about 150, with about half reporting at any given time. A sample shows that the average number of levels reported at these stations is approximately 25. Therefore, the average number of pieces that would be rejected from the rejectlist is about 150x0.5x2x25 = 3750 (counting both temperature and height). It would appear that the new CQCHT is effective in chosing those data most likely to need to be rejected without being excessive as was the rejectlist.

In summary, this note has described the method leading to a more sensitive (and intelligent) use of the residuals to diagnose observation errors. This has allowed the removal of (nearly) all upper air stations from the reject list for the mass part of the report. Examples have shown the effectiveness in diagnosing errors at single and multiple levels. The largest remaining problem is to accurately diagnose temperature errors at the lowest level or two. The sensitivity to low-level inversions in the diagnosis and large gradients

near the surface in the forecast tend to compound the problem. Work continues to improve the diagnosis of observation errors, especially at the lowest levels.

References

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Gandin, L.S., 1988: Complex quality control of meteorological observations. *Mon. Wea. Rev.*, **116** (5), 1137-1156.

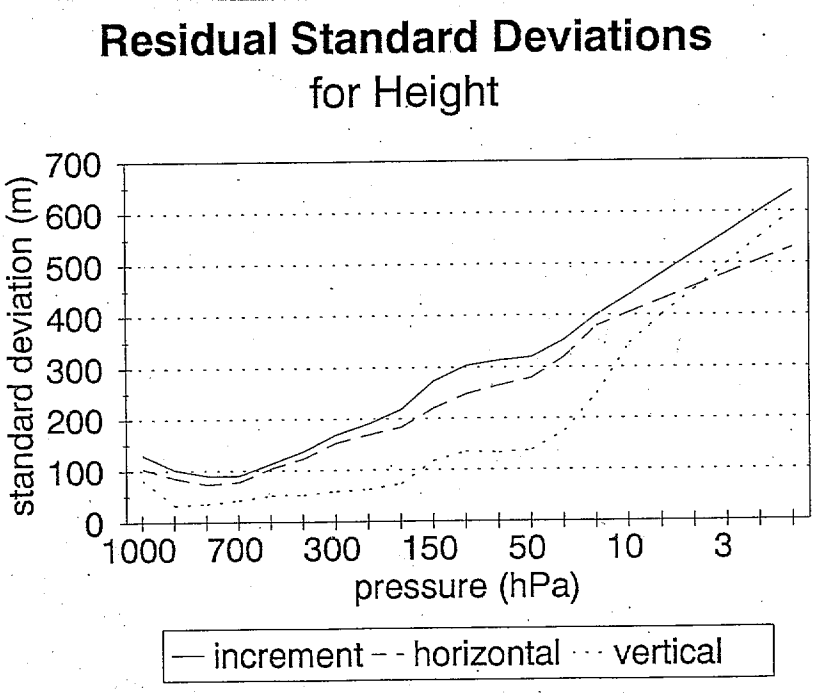

Fig. 1 Long-term average standard deviation of height increment, horizontal residual and vertical residual at each mandatory pressure.

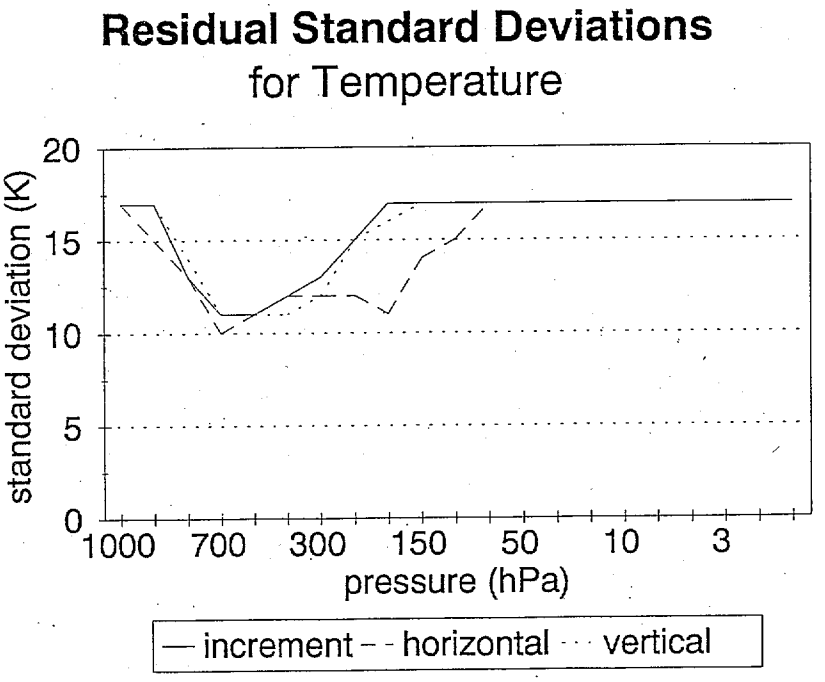

Fig. 2. Long-term average standard deviation of temperature increment, horizontal residual and vertical residual at each mandatory pressure.

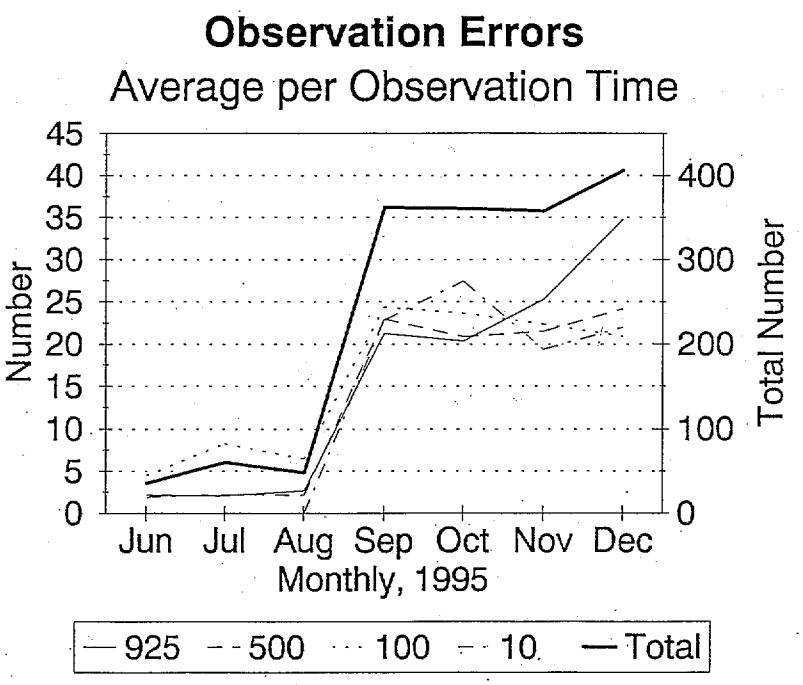

Fig. 3. Average numbers of observation errors per observation time for selected levels (925, 500, 100 and 10 hPa) and for all levels combined (total) for June-December 1995.

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STN ID: 51076   LAT:   47.73  LON:   88.08 EAST   ELEVATION:  735.00
DATE/TIME: 95102400 HOUR:   -1. SCAN: 2
P-MSL: 1030.1  GES P-MSL: 1033.6  DINCPS:   -3.2  HINCPS:   -1.4  BASELINE RESID:   -4.8
        PRESSURE      VALUE  NEW-VALUE CORRECTION
   PS       942.0      942.0      942.6        0.6
   ZS       942.0      735.0      739.8        4.8
   Z1      1000.0      250.0      229.3      -20.7
   Z2       925.0      888.0      881.7       -6.3

      IINC  IVOI  IHOI  ITMP
 PRES  Z  T  Z  T  Z  T  Z  T  IHSC  IBAS  IIPL  IHPL
 1000  2  -  2  -  0  -  -  -     0     1     5     2
  925  2  6  3  4  0  5  -  -     0
  850  0  4  3  1  1  3  -  -     0
  700  2  0  1  2  1  1  -  -     0
  500  2  0  2  0  0  1  -  -     0
  400  2  0  2  0  0  0  -  -     0
  300  2  0  0  0  0  0  -  -     0
  250  2  0  2  0  0  0  -  -     0
  200  2  0  1  0  0  1  -  -     0
  150  1  0  0  0  0  1  -  -     0
  100  1  0  1  0  0  0  -  -     0
   70  1  1  1  1  0  1  -  -     0
   50  0  1  1  0  0  1  -  -     0
   30  1  4  0  3  2  3  -  -     0
   20  2  0  3  0  3  0  -  -     0

    OBSERVATION    INCREMENT     HYRES HYRES    VERTICAL    -----HORIZONTAL------|  --GUESS--
PRESS HEIGHT  TEMP HEIGHT  TEMP HEIGHT  TEMP HEIGHT  TEMP HEIGHT  TEMP ZCMP TCMP HEIGHT  TEMP
 1000   250.****** -22.9999.9 99999.9999.9 -12.9999.9  -5.9999.9  1.1****** 272.****** 99999.9999.9
  925   888.   9.2 -16.   7.5 99999.9999.9  -9.   5.3   0.   5.5  1.1  1.2  904.   1.7 99999.9999.9
  850  1585.   4.6   5.   4.6   4.   3.1   8.   1.6   6.   3.4  1.1  1.1 1580.   0.0 99999.9999.9
  700  3135.  -5.1  13.  -0.7  -1.  -0.3   3.  -2.0   8.  -1.4  1.0  1.0 3122.  -4.4 99999.9999.9
  500  5730. -17.7  23.  -0.2  17.   3.5   8.  -0.1   1.  -0.9  1.0  1.0 5707. -17.5 99999.9999.9
  400  7370. -27.9  26.   0.0   5.   1.5   8.   0.0   1.  -0.6  1.1  1.1 7344. -27.9 99999.9999.9
  300  9370. -43.1  25.   0.5  -1.  -0.3   1.   0.4   2.  -0.1  1.1  1.1 9345. -43.6 99999.9999.9
  250 10580. -52.1  35.   0.4   6.   2.4  12.   0.4  10.   0.4  1.1  1.1 10545. -52.5 99999.9999.9
  200 11990. -62.3  35.  -0.8  -1.  -0.2   9.  -1.0   8.  -1.3  1.1  1.1 11955. -61.5 99999.9999.9
  150 13740. -65.5  34.   0.6 -12.  -2.9   6.   0.9  -6.  -1.0  1.1  1.1 13706. -66.1 99999.9999.9
  100 16230. -61.9  43.  -0.7   4.   0.7  18.  -0.4   4.   0.5  1.1  1.1 16187. -61.2 99999.9999.9
   70 18450. -61.1  36.  -2.0  10.   2.0  14.  -1.5   3.  -1.5  1.1  1.1 18414. -59.1 99999.9999.9
   50 20550. -57.9  17.  -2.0  -4.  -0.9  11.  -1.0 -10.  -1.5  1.1  1.1 20533. -55.9 99999.9999.9
   30 23780. -57.1 -27.  -4.9   6.   0.7  -5.  -4.6 -60.  -4.2  1.1  1.1 23807. -52.2 99999.9999.9
   20 26370. -51.7 -72.  -0.1  -6.  -1.0 -59.   0.8 -99.   0.0  1.1  1.1 26442. -51.6 99999.9999.9

DMA RESULTS
  SCAN PRESSURE  VARIABLE  IHSC DECISION  OLD VALUE  CORRECTION  NEW VALUE
     2      925         T     0        3        9.2         0.0        9.2
```

Example 1. Decision 3 for T_{925}. The guess may be in error.

```
STN ID: 10868   LAT:   48.25  LON:   11.58 EAST   ELEVATION:  484.00
DATE/TIME: 95102400 HOUR:   -1. SCAN: 2
P-MSL: 1026.2  GES P-MSL: 1026.6  DINCPS:   -0.4  HINCPS:    0.1  BASELINE RESID:   -5.0
        PRESSURE      VALUE  NEW-VALUE CORRECTION
   PS       968.0      968.0      968.6        0.6
   ZS       968.0      484.0      489.0        5.0
   Z1      1000.0      220.0      211.4       -8.6
   Z2       925.0      862.0      850.1      -11.9

      IINC  IVOI  IHOI  ITMP
 PRES  Z  T  Z  T  Z  T  Z  T  IHSC  IBAS  IIPL  IHPL
 1000  2  -  1  -  0  -  -  -     0     1     0     0
  925  2  6  1  6  1  6  -  -     0
  850  1  0  1  3  0  0  -  -     0
  700  0  1  0  0  0  0  -  -     0
  500  1  0  1  0  0  0  -  -     0
  400  0  0  0  0  0  0  -  -     0
  300  0  1  0  0  0  0  -  -     0
  250  1  1  1  0  0  0  -  -     0
  200  1  0  1  0  1  0  -  -     0
  150  1  0  0  0  0  0  -  -     0
  100  1  0  1  0  0  0  -  -     0
   70  1  0  1  0  0  1  -  -     0
   50  1  0  0  0  0  0  -  -     0
   30  2  0  2  0  0  0  -  -     0
   20  1  1  0  2  0  0  -  -     0
   10  2  7  1  8  0  2  -  -     0

    OBSERVATION    INCREMENT     HYRES HYRES    VERTICAL    -----HORIZONTAL------|  --GUESS--
PRESS HEIGHT  TEMP HEIGHT  TEMP HEIGHT  TEMP HEIGHT  TEMP HEIGHT  TEMP ZCMP TCMP HEIGHT  TEMP
 1000   220.******  -19.9999.9 99999.9999.9  -9.9999.9  -7.9999.9  0.8****** 239.****** 99999.9999.9
  925   862.  12.8  -16.   7.9 99999.9999.9  -4.   7.9  -8.   7.1  0.8  0.8  878.   4.9 99999.9999.9
  850  1567.  10.0  -11.  -0.1   1.   0.6  -3.  -3.6  -5.  -0.9  0.8  0.8 1578.  10.1 99999.9999.9
  700  3164.   3.6   -2.   0.8   6.   2.1   0.   0.7  -1.   0.7  0.8  0.8 3166.   2.8 99999.9999.9
  500  5810. -14.5    9.   0.6   9.   1.9   7.   0.4   7.   0.4  0.8  0.8 5801. -15.1 99999.9999.9
  400  7450. -28.9    7.   0.1   -2.  -0.7  -1.  -0.3   2.   0.0  0.8  0.8 7443. -29.0 99999.9999.9
  300  9440. -44.7   11.   1.0   0.  -0.1  -1.   0.6   8.   0.6  0.8  0.8 9429. -45.7 99999.9999.9
  250 10640. -53.9   23.   1.2   5.   2.0   7.   0.7  12.   0.7  0.8  0.8 10617. -55.1 99999.9999.9
  200 12040. -63.7   31.   0.8   0.   0.0  10.   0.4  16.   0.3  0.8  0.8 12009. -64.5 99999.9999.9
  150 13780. -65.1   33.   0.5  -18.  -4.2   7.   0.3   7.  -0.8  0.8  0.8 13747. -65.6 99999.9999.9
  100 16280. -60.7   40.   0.2   5.   0.8  13.  -0.1  14.   1.0  0.8  0.8 16240. -60.9 99999.9999.9
   70 18490. -62.1   41.   1.0  -1.  -0.1  11.   1.1  17.   1.4  0.8  0.8 18449. -63.1 99999.9999.9
   50 20560. -62.3   41.  -0.7  -8.  -1.5   7.  -0.8  12.  -1.1  0.8  0.8 20519. -61.6 99999.9999.9
   30 23770. -57.9   58.  -0.6  24.   3.3  26.  -0.9  19.  -0.4  0.8  0.8 23712. -57.3 99999.9999.9
   20 26330. -55.9   49.   2.1  -7.  -1.1   8.   3.1  20.   0.6  0.8  0.8 26281. -58.0 99999.9999.9
   10 30760. -55.1   64.  -9.6  14.   1.4  45.  -9.8  22.  -3.0  0.8  0.8 30696. -45.5 99999.9999.9

DMA RESULTS
  SCAN PRESSURE  VARIABLE  IHSC DECISION  OLD VALUE  CORRECTION  NEW VALUE
     2      925         T     0        3       12.7         0.0       12.7
     2       10         T     0        3      -55.1         0.0      -55.1
```

Example 2. Decision 3 for T_{925} and T_{10}. There are probable errors at both levels.

```
STN ID: 72425   LAT:   38.37  LON:   82.55 WEST   ELEVATION:  246.00
DATE/TIME: 95102400 HOUR:    0. SCAN: 2
P-MSL: 1017.4  GES P-MSL: 1019.9  OINCPS:   -2.4  HINCPS:   -2.4  BASELINE RESID:   -5.8
        PRESSURE       VALUE   NEW-VALUE CORRECTION
   PS       989.0       989.0       989.7        0.7
   ZS       989.0       246.0       251.8        5.8
   Z1      1000.0       156.0       149.2       -6.8
   Z2       925.0       827.0       786.3      -40.7

      IINC  IVOI  IHOI  ITMP
 PRES  Z  T  Z  T  Z  T  Z  T  IHSC  IBAS  IIPL  IHPL
 1000  2  -  2  -  2  -  -  -     0     2     4     4
  925  1  1  0  1  2  1  -  -     0
  850  0  1  0  0  1  0  -  -     0
  700  0  0  0  0  1  0  -  -     0
  500  0  0  1  0  0  0  -  -     0
  400  0  1  0  1  0  0  -  -     0
  300  0  0  0  0  0  1  -  -     0
  250  0  1  0  1  0  1  -  -     0
  200  0  0  0  0  1  1  -  -     0
  150  0  0  0  0  1  0  -  -     0
  100  1  0  2  0  1  1  -  -     0
   70  0  1  0  1  1  1  -  -     0
   50  0  0  1  0  1  0  -  -     0
   30  0  3  1  3  2  3  -  -     0
   20  2  2  1  1  3  2  -  -     0
   10  4  7  0  4  7  6  -  -     0
    7  7 12  1  7  9  9  -  -     0
    5 11 18  2 12  -  -  -  -     0
    3 20 20 18 20  -  -  -  -     0

     OBSERVATION    INCREMENT     HYRES HYRES    VERTICAL     -----HORIZONTAL------    --GUESS--
PRESS HEIGHT   TEMP HEIGHT  TEMP HEIGHT  TEMP HEIGHT  TEMP HEIGHT  TEMP ZCMP TCMP HEIGHT   TEMP
 1000    156.****** -19.9999.9 99999.9999.9 -12.9999.9  -17.9999.9  0.9*****   175.****** 99999.9999.9
  925    827.  19.4  -11.   2.1 99999.9999.9   -2.   1.6  -13.   1.8  0.9  0.9   838.  17.3 99999.9999.9
  850   1547.  15.0   -4.   1.0      1.   1.1    2.   0.1  -10.  -0.4  0.9  0.9  1551.  14.0 99999.9999.9
  700   3165.   7.0   -2.   0.0      3.   1.1   -2.  -0.4   -8.   0.1  0.9  0.9  3167.   7.0 99999.9999.9
  500   5840. -12.1    5.   0.4     10.   2.0    4.   0.7    3.   0.7  0.9  0.9  5835. -12.5 99999.9999.9
  400   7500. -25.3    3.  -1.1     -2.  -0.6    0.  -1.4    3.  -0.2  0.9  0.9  7497. -24.2 99999.9999.9
  300   9540. -37.3    2.   0.8      3.   0.8   -1.   0.6    5.   1.0  0.9  0.9  9538. -38.1 99999.9999.9
  250  10770. -47.3    4.   1.3     -2.  -0.7    0.   1.1   10.   1.5  0.9  0.9 10766. -48.6 99999.9999.9
  200  12210. -57.9    9.  -0.3     -1.  -0.2    3.  -0.6   19.   1.0  0.9  0.9 12201. -57.6 99999.9999.9
  150  13990. -65.1   13.  -0.1     -2.  -0.5    0.   0.0   28.  -0.4  0.9  0.9 13977. -65.0 99999.9999.9
  100  16450. -68.1   30.  -0.3      9.   1.4   22.   0.1   27.  -1.3  0.9  0.9 16420. -67.8 99999.9999.9
   70  18590. -65.3    8.  -2.3    -15.  -2.9    3.  -2.1  -20.  -1.9  0.9  0.9 18582. -63.0 99999.9999.9
   50  20660. -59.9  -15.  -0.6     -4.  -0.7  -12.   0.4  -36.  -0.8  0.9  0.9 20675. -59.3 99999.9999.9
   30  23870. -60.3  -19.  -4.4     24.   3.3   14.  -3.8  -56.  -3.9  0.9  0.9 23889. -55.9 99999.9999.9
   20  26400. -58.5  -75.  -3.0     -7.  -1.2  -30.  -1.3  -98.  -3.3  0.9  0.9 26475. -55.5 99999.9999.9
   10  30800. -56.9 -139.  -9.2     29.   2.8  -16.  -5.9 -208.  -7.7  0.9  0.9 30939. -47.7 99999.9999.9
    7  33070. -56.5 -244. -15.5     10.   2.0  -34.  -9.6 -305. -11.6  1.0  1.0 33314. -41.0 99999.9999.9
    5  35200. -56.9 -428. -22.1     -2.  -0.4  -69. -14.9 99999.9999.9********** 35628. -34.8 99999.9999.9
    3  38430. -57.1 -854. -31.8     -2.  -0.3 -663. -28.6 99999.9999.9********** 39284. -25.3 99999.9999.9

DMA RESULTS
  SCAN PRESSURE  VARIABLE  IHSC DECISION  OLD VALUE  CORRECTION  NEW VALUE
     2       10         T     0        4      -56.9         0.0      -56.9
     2        7         T     0        4      -56.4         0.0      -56.4
     2        7         Z     0        3   33070.0          0.0   33070.0
     2        5         T     0        4      -56.9         0.0      -56.9
     2        5         Z     0        4   35200.0          0.0   35200.0
     2        3         T     0        4      -57.1         0.0      -57.1
     2        3         Z     0        4   38430.0          0.0   38430.0
```

Example 3. Possibly bad guess or bad data at and above 10 hPa.

```
STN ID: 20891   LAT:   71.98  LON:  102.47 EAST   ELEVATION:   32.00
DATE/TIME: 95102400 HOUR:    0. SCAN: 2
P-MSL: 1001.1  GES P-MSL: 1000.2  OINCPS:    1.0  HINCPS:    0.9  BASELINE RESID:    8.7
        PRESSURE       VALUE   NEW-VALUE CORRECTION
   PS       997.0       997.0       995.9       -1.1
   ZS       997.0        32.0        23.3       -8.7
   Z1      1000.0         0.0         9.1        9.1
   Z2       925.0       600.0       824.4      224.4

      IINC  IVOI  IHOI  ITMP
 PRES  Z  T  Z  T  Z  T  Z  T  IHSC  IBAS  IIPL  IHPL
 1000  2  -  2  -  1  -  -  -     0     3     1     1
  925  1  1  1  1  0  0  -  -     0
  850  1  0  1  0  0  0  -  -     0
  700  0  0  0  0  1  0  -  -     0
  500  0  0  0  0  0  0  -  -     0
  400  0  1  0  1  1  1  -  -     0
  300  0  1  0  2  0  1  -  -     0
  250  0  1  0  1  0  1  -  -     0
  200  0  0  0  0  1  0  -  -     0
  150  1  0  2  0  2  0  -  -     0
  100  0  0  1  0  0  0  -  -     0
   70  1  4  1  3  2  4  -  -     0
   50  5  5  4  4  5  4  -  -     0
   30  7  2  5  2  7  2  -  -     0
   20  7  0  6  1  -  -  -  -     0

     OBSERVATION    INCREMENT     HYRES HYRES    VERTICAL     -----HORIZONTAL------    --GUESS--
PRESS HEIGHT   TEMP HEIGHT  TEMP HEIGHT  TEMP HEIGHT  TEMP HEIGHT  TEMP ZCMP TCMP HEIGHT   TEMP
 1000      0.******  -23.9999.9 99999.9999.9  -17.9999.9  -10.9999.9  1.1*****     23.****** 99999.9999.9
  925    600. -12.7   -9.   1.3 99999.9999.9     3.   1.3   -4.   1.0  1.1  1.2   609. -14.0 99999.9999.9
  850   1250. -10.3   -8.   0.1      2.   1.9   -3.  -0.5   -4.  -0.9  1.1  1.1  1258. -10.4 99999.9999.9
  700   2730. -16.3   -4.   0.4      3.   1.1    1.   0.4   -6.  -0.2  1.1  1.1  2734. -16.7 99999.9999.9
  500   5180. -32.7   -6.  -0.3      1.   0.2   -2.  -0.1   -7.  -0.3  1.2  1.2  5186. -32.4 99999.9999.9
  400   6720. -44.3   -7.  -0.9      7.   2.3   -3.  -1.1   -9.  -1.0  1.2  1.2  6727. -43.4 99999.9999.9
  300   8590. -56.9   -4.   1.5     -4.  -1.0    1.   2.0   -7.   1.6  1.2  1.2  8594. -58.4 99999.9999.9
  250   9720. -62.3   -7.  -1.2    -10.  -3.6   -2.  -1.6  -10.  -0.9  1.2  1.2  9727. -61.1 99999.9999.9
  200  11110. -57.3  -10.  -0.3     -4.  -1.1    4.   0.0  -16.  -0.4  1.1  1.1 11120. -57.0 99999.9999.9
  150  12920. -56.3  -31.  -0.1    -12.  -2.8  -25.   0.1  -44.  -0.8  1.1  1.1 12951. -56.2 99999.9999.9
  100  15510. -57.7   -6.  -0.9     25.   4.2   18.   0.2  -14.  -1.0  1.2  1.2 15515. -56.8 99999.9999.9
   70  17750. -60.7  -36.  -6.0      6.   1.2   11.  -4.5  -44.  -5.4  1.2  1.2 17786. -54.7 99999.9999.9
   50  19820. -63.1 -119.  -7.2    -11.  -2.1  -47.  -5.6 -114.  -5.6  1.2  1.2 19939. -55.9 99999.9999.9
   30  22960. -65.9 -189.  -3.5     20.   2.7  -72.  -2.7 -167.  -2.5  1.2  1.2 23149. -62.4 99999.9999.9
   20  25410. -67.7 -208.   0.9      1.   0.2 -116.   1.5 99999.9999.9********** 25618. -68.6 99999.9999.9

DMA RESULTS
  SCAN PRESSURE  VARIABLE  IHSC DECISION  OLD VALUE  CORRECTION  NEW VALUE
     1      150         Z     1        1   12290.0        630.0   12920.0
     2       70         T     0        3      -60.6         0.0      -60.6
     2       50         T     0        3      -63.1         0.0      -63.1
     2       30         Z     0        4   22960.0          0.0   22960.0
     2       20         Z     0        3   25410.0          0.0   25410.0
```

Example 4. Several bad temperatures and heights at 70 hPa and above.

```
STN ID: 20744   LAT:    72.38  LON:    52.73 EAST   ELEVATION:    19.00
DATE/TIME: 95102400 HOUR:     0. SCAN: 2
P-MSL:   987.4  GES P-MSL:   988.9  OINCPS:    -1.5  HINCPS:    -1.2  BASELINE RESID:     0.0
         PRESSURE       VALUE   NEW-VALUE CORRECTION
    PS       985.0       985.0       985.0         0.0
    ZS       985.0        19.0        19.0         0.0
    Z1      1000.0      -100.0      -100.0         0.0
    Z2       925.0       510.0       510.2         0.2

        IINC  IVOI  IHOI  ITMP
   PRES  Z  T  Z  T  Z  T  Z  T  IHSC  IBAS  IIPL  IHPL
   1000  0  -  0  -  0  -  -  -     0     0     2     2
    925  1  0  3  0  2  0  -  -     0
    850  1  1  0  1  1  1  -  -     0
    700  0  0  1  0  1  0  -  -     0
    500  1  2  0  1  1  2  -  -     0
    400  2  1  3  0  3  1  -  -     0
    300  2  1  0  0  3  1  -  -     0
    250  2  2  2  1  3  2  -  -     0
    200  2  1  0  0  3  1  -  -     0
    150  3  1  2  1  4  1  -  -     0
    100  3  0  1  0  4  0  -  -     0
     70  4  3  2  2  5  2  -  -     0
     50  6  2  8  2  6  2  -  -     0

      OBSERVATION    INCREMENT     HYRES HYRES    VERTICAL    -----HORIZONTAL------    --GUESS--
 PRESS HEIGHT  TEMP HEIGHT  TEMP HEIGHT  TEMP HEIGHT  TEMP HEIGHT  TEMP ZCMP TCMP HEIGHT  TEMP
  1000 -100.****** -9.9999.9 99999.9999.9     0.9999.9    -6.9999.9 1.1****** -91.****** 99999.9999.9
   925  510.  -5.5  -14.   0.7 99999.9999.9    -7.   0.0   -13.   0.5 1.1  1.1  524.  -6.2 99999.9999.9
   850 1170. -10.3   -8.   1.4     3.   2.8     0.   1.3    -9.   1.1 1.1  1.1 1178. -11.7 99999.9999.9
   700 2630. -23.1   -4.  -0.7     3.   0.9     3.  -0.8    -8.  -0.4 1.1  1.1 2634. -22.4 99999.9999.9
   500 5000. -42.5  -11.  -1.9     3.   0.6     2.  -1.5   -10.  -2.3 1.1  1.1 5011. -40.6 99999.9999.9
   400 6470. -51.1  -27.  -1.2    -8.  -2.6   -13.  -0.4   -33.  -1.7 1.1  1.1 6497. -49.9 99999.9999.9
   300 8320. -56.3  -26.  -1.3     2.   0.5    -1.  -0.4   -37.  -1.2 1.1  1.1 8346. -55.0 99999.9999.9
   250 9480. -53.5  -36.  -2.2    -5.  -1.8   -10.  -1.4   -45.  -2.0 1.1  1.1 9516. -51.3 99999.9999.9
   200 10930. -51.7  -41.  -1.7     9.   2.9    -3.  -0.8   -48.  -1.1 1.1  1.1 10971. -50.0 99999.9999.9
   150 12780. -54.3  -66.  -1.9    -4.  -0.9   -24.  -1.4   -69.  -2.0 1.1  1.1 12846. -52.4 99999.9999.9
   100 15360. -56.7  -77.  -0.9    -3.  -0.5   -15.   0.2   -81.  -0.7 1.1  1.1 15437. -55.8 99999.9999.9
    70 17610. -59.5 -103.  -4.1     5.   0.9   -23.  -3.3   -97.  -2.7 1.1  1.1 17713. -55.4 99999.9999.9
    50 19700. -62.5 -139.  -3.5     1.   0.1   -86.  -2.6  -129.  -3.0 1.1  1.1 19839. -59.0 99999.9999.9

DMA RESULTS
  SCAN PRESSURE  VARIABLE  IHSC DECISION  OLD VALUE  CORRECTION  NEW VALUE
     2       50         Z     0        3    19700.0         0.0    19700.0
```

Example 5. Small consistent temperature errors leading to a moderately large height increment.

```
STN ID: 15480   LAT:   44.22  LON:   28.63 EAST   ELEVATION:   17.00
DATE/TIME: 95102400 HOUR:    0. SCAN: 2
P-MSL: 1036.1  GES P-MSL: 1034.5  OINCPS:    1.6  HINCPS:    0.9  BASELINE RESID:   12.6
        PRESSURE       VALUE  NEW-VALUE CORRECTION
    PS     1034.0      1034.0     1032.5       -1.5
    ZS     1034.0        17.0        4.4      -12.6
    Z1     1000.0       284.0      292.8        8.8
    Z2      925.0       929.0      900.0      -29.0

       IINC  IVOI  IHOI  ITMP
  PRES  Z  T  Z  T  Z  T  Z  T  IHSC  IBAS  IIPL  IHPL
  1000  0  0  0  3  0  1  -  -     0     4     2     1
   925  2  6  1  4  0  7  -  -     0
   850  6  9  0  5  4  9  -  -     0
   700 14  0  4  5 13  1  -  -     2
   500 20 11 15  8 20 10  -  -     0
   400 20 10 14  6 20 10  -  -     0
   300 20 12 19  7 20 14  -  -     0
   250 20 12 18  6 20 15  -  -     0
   200 20  9 20  5 20 13  -  -     0
   150 20  8 19  5 20 10  -  -     0
   100 20  9 20  6 20 11  -  -     0
    70 20  8 20  5 20  8  -  -     0
    50 20  8 20  6 20  8  -  -     0
    30 20  1 20  0 20  4  -  -     0
    20 20  4 20  4 20  3  -  -     0

     OBSERVATION    INCREMENT     HYRES HYRES    VERTICAL     -----HORIZONTAL------     --GUESS--
 PRESS HEIGHT   TEMP HEIGHT   TEMP HEIGHT   TEMP HEIGHT   TEMP HEIGHT   TEMP ZCMP TCMP HEIGHT   TEMP
  1000    284.    6.8      5.  -0.6 99999.9999.9     -5.  -4.6    -3.  -1.8  0.9  0.9    279.    7.4 99999.9999.9
   925    929.   10.6     15.   8.2     2.   1.6     -3.   5.3     5.   8.1  0.9  0.9    914.    2.4 99999.9999.9
   850   1629.    7.2     40.   9.0     2.   1.5      2.   5.7    26.   8.5  0.9  0.9   1589.   -1.8 99999.9999.9
   700   3218.   -5.8     94.  -0.6    33.  11.5     13.  -4.7    77.  -0.8  0.9  0.9   3124.   -5.2 99999.9999.9
   500   5890. -11.5    196.   8.8    67.  13.6     58.   6.4   171.   8.3  0.9  0.9   5694.  -20.3 99999.9999.9
   400   7560. -23.9    254.   9.4     1.   0.5     55.   4.8   229.   9.3  0.9  0.9   7306.  -33.3 99999.9999.9
   300   9600. -36.5    339.  11.8    -6.  -1.4     82.   6.1   312.  12.6  0.9  0.9   9261.  -48.3 99999.9999.9
   250  10840. -42.7    401.  13.0    -6.  -2.4     82.   6.9   376.  12.9  0.9  0.9  10439.  -55.7 99999.9999.9
   200  12330. -48.3    495.  11.7     3.   0.9    121.   6.2   463.  10.7  0.9  0.9  11835.  -60.0 99999.9999.9
   150  14230. -46.7    597.  10.6     0.   0.0    161.   6.2   546.  10.2  0.9  0.9  13633.  -57.3 99999.9999.9
   100  16910. -48.1    716.  11.7     1.   0.1    193.   8.0   674.  11.9  0.9  0.9  16194.  -59.8 99999.9999.9
    70  19250. -49.3    840.  10.8    -3.  -0.6    233.   6.7   788.  10.9  0.9  0.9  18410.  -60.1 99999.9999.9
    50  21450. -49.9    935.  10.2    -2.  -0.3    267.   7.8   872.  10.0  0.9  0.9  20515.  -60.1 99999.9999.9
    30  24800. -49.3   1070.   1.7     7.   1.0    356.  -0.7   995.   5.1  0.9  0.9  23730.  -51.0 99999.9999.9
    20  27460. -48.3   1095.   6.0    -3.  -0.4    575.   5.7  1041.   4.7  0.9  1.1  26365.  -54.3 99999.9999.9

DMA RESULTS
  SCAN PRESSURE  VARIABLE  IHSC DECISION  OLD VALUE  CORRECTION  NEW VALUE
     1      700         T     2        3       -5.8         0.0       -5.8
     2      925         T     0        4       10.6         0.0       10.6
     2      850         T     0        4        7.2         0.0        7.2
     2      700         T     2        3       -5.8         0.0       -5.8
     2      700         Z     2        4     3218.0         0.0     3218.0
     2      500         T     0        4      -11.4         0.0      -11.4
     2      500         Z     0        4     5890.0         0.0     5890.0
     2      400         T     0        4      -23.8         0.0      -23.8
     2      400         Z     0        4     7560.0         0.0     7560.0
     2      300         T     0        4      -36.4         0.0      -36.4
     2      300         Z     0        4     9600.0         0.0     9600.0
     2      250         T     0        4      -42.6         0.0      -42.6
     2      250         Z     0        4    10840.0         0.0    10840.0
     2      200         T     0        4      -48.2         0.0      -48.2
     2      200         Z     0        4    12330.0         0.0    12330.0
     2      150         T     0        4      -46.6         0.0      -46.6
     2      150         Z     0        4    14230.0         0.0    14230.0
     2      100         T     0        4      -48.1         0.0      -48.1
     2      100         Z     0        4    16910.0         0.0    16910.0

     2       70         T     0        4      -49.2         0.0      -49.2
     2       70         Z     0        4    19250.0         0.0    19250.0
     2       50         T     0        4      -49.9         0.0      -49.9
     2       50         Z     0        4    21450.0         0.0    21450.0
     2       30         Z     0        4    24800.0         0.0    24800.0
     2       20         Z     0        4    27460.0         0.0    27460.0
```

Example 6. Most temperature and height data are bad.

```
STN ID: 31088   LAT:    59.37  LON:  143.20 EAST   ELEVATION:     8.00
DATE/TIME: 95102400 HOUR:     0. SCAN: 2
P-MSL: 1009.0  GES P-MSL: 1011.4  OINCPS:   -2.4  HINCPS:   -1.6  BASELINE RESID:    1.9
        PRESSURE      VALUE  NEW-VALUE CORRECTION
   PS     1008.0     1008.0     1007.8       -0.2
   ZS     1008.0        8.0        6.1       -1.9
   Z1     1000.0       70.0       71.7        1.7
   Z2      925.0      690.0      671.7      -18.3

      IINC  IVOI  IHOI  ITMP
 PRES  Z  T  Z  T  Z  T  Z  T  IHSC  IBAS  IIPL  IHPL
 1000  2  2  1  3  0  3  -  -     0     0     4     2
  925  1  1  2  2  2  1  -  -     0
  850  0  2  0  0  0  1  -  -     0
  700  0  2  0  0  0  2  -  -     0
  500  2  4  0  2  0  3  -  -     0
  400  4  5  2  2  2  4  -  -     0
  300  7  6  4  4  4  4  -  -     0
  250  9  3  8  0  6  3  -  -     0
  200  9  4  5  2  6  5  -  -     0
  150  9  5  5  3  7  4  -  -     0
  100 12  3 17  2 10  4  -  -     0

    OBSERVATION    INCREMENT     HYRES HYRES    VERTICAL     -----HORIZONTAL------   --GUESS--
PRESS HEIGHT   TEMP HEIGHT   TEMP HEIGHT  TEMP HEIGHT  TEMP HEIGHT  TEMP ZCMP TCMP HEIGHT  TEMP
 1000     70.  -4.5   -20.  -2.9 99999.9999.9   -11.  -4.0    -7.  -4.4  1.0  1.1    90.  -1.6 99999.9999.9
  925    690.  -3.5   -14.   2.2     6.   5.1    -5.   2.5   -14.   1.5  1.0  1.0   704.  -5.7 99999.9999.9
  850   1360.  -5.3    -3.   2.1     5.   3.9     1.   0.8    -5.   1.1  1.0  1.0  1363.  -7.4 99999.9999.9
  700   2860. -12.9     6.   1.9    -1.  -0.2     1.   0.7     3.   1.5  1.0  1.0  2854. -14.8 99999.9999.9
  500   5350. -26.9    21.   3.4    -4.  -0.9    -1.   1.9     6.   2.6  1.0  1.0  5329. -30.3 99999.9999.9
  400   6920. -39.1    48.   4.3     1.   0.4     8.   2.3    26.   3.6  1.0  1.0  6872. -43.4 99999.9999.9
  300   8840. -48.5    90.   5.8   -11.  -2.7    20.   3.8    54.   4.2  1.0  1.0  8750. -54.3 99999.9999.9
  250  10040. -50.3   126.   4.0     6.   2.2    36.   1.0    77.   2.9  1.0  1.0  9914. -54.3 99999.9999.9
  200  11490. -48.3   146.   5.6   -12.  -3.7    27.   3.3    87.   4.6  1.0  1.0 11344. -53.9 99999.9999.9
  150  13380. -48.7   192.   6.2    -2.  -0.4    46.   4.4   121.   4.9  1.0  1.0 13188. -54.9 99999.9999.9
  100  16030. -52.9   266.   3.7    11.   1.9   173.   2.6   181.   4.4  1.0  1.0 15764. -56.6 99999.9999.9

DHA RESULTS
  SCAN PRESSURE  VARIABLE  IHSC DECISION  OLD VALUE  CORRECTION  NEW VALUE
     2      400         T     0        3     -39.1         0.0      -39.1
     2      300         T     0        3     -48.4         0.0      -48.4
     2      300         Z     0        3    8840.0         0.0     8840.0
     2      250         Z     0        4   10040.0         0.0    10040.0
     2      200         Z     0        4   11490.0         0.0    11490.0
     2      150         Z     0        4   13380.0         0.0    13380.0
     2      100         Z     0        4   16030.0         0.0    16030.0
```

Example 7. Several bad temperatures and heights at 400 hPa and above.

```
STN ID: 43371   LAT:     8.48  LON:   76.95 EAST   ELEVATION:    64.00
DATE/TIME: 95102400 HOUR:    -1. SCAN: 2
P-MSL: 1009.3  GES P-MSL: 1007.0  OINCPS:    2.3  HINCPS:    2.0  BASELINE RESID:   -2.4
        PRESSURE      VALUE  NEW-VALUE CORRECTION
   PS     1002.0     1002.0     1002.3        0.3
   ZS     1002.0       64.0       66.4        2.4
   Z1     1000.0       84.0       81.6       -2.4
   Z2      925.0      764.0      858.5       94.5

      IINC  IVOI  IHOI  ITMP
 PRES  Z  T  Z  T  Z  T  Z  T  IHSC  IBAS  IIPL  IHPL
 1000  2  4  1  4  2  2  -  -     0     0     4     3
  925  2  1  1  1  4  0  -  -     0
  850  3  2  2  1  4  1  -  -     0
  700  2  3  1  2  3  2  -  -     0
  500  0  3  1  2  2  3  -  -     0
  400  1  2  0  0  1  0  -  -     0
  300  3  4  1  2  0  1  -  -     0
  250  4  4  1  2  0  2  -  -     0
  200  6  5  2  3  4  6  -  -     0
  150  8  7  7  5  7  8  -  -     0
  100 10  3  7  1  9  4  -  -     0
   70 10  1  6  0  -  -  -  -     0
   50 12  1  8  0  -  -  -  -     0
   30 11  3  6  3  -  -  -  -     0
   20 12  2 11  1  -  -  -  -     0

    OBSERVATION    INCREMENT     HYRES HYRES    VERTICAL     -----HORIZONTAL------   --GUESS--
PRESS HEIGHT   TEMP HEIGHT   TEMP HEIGHT  TEMP HEIGHT  TEMP HEIGHT  TEMP ZCMP TCMP HEIGHT  TEMP
 1000     84.  22.8    22.  -5.7 99999.9999.9     9.  -5.0    21.  -3.2  1.1  1.1    62.  28.5 99999.9999.9
  925    764.  21.8    20.  -1.5     6.   5.1     3.   1.4    26.   0.5  1.1  1.1   744.  23.3 99999.9999.9
  850   1494.  17.2    21.  -2.4     6.   4.6     7.  -1.2    24.  -1.1  1.1  1.1  1473.  19.6 99999.9999.9
  700   3125.   8.0    14.  -2.9     7.   2.5     4.  -1.7    20.  -1.7  1.1  1.1  3111.  10.9 99999.9999.9
  500   5830.  -7.3     2.  -3.0    11.   2.3     4.  -2.0    16.  -2.7  1.1  1.1  5828.  -4.3 99999.9999.9
  400   7540. -16.9   -16.  -2.0     5.   1.5    -3.  -0.4    12.   0.1  1.1  1.1  7556. -14.9 99999.9999.9
  300   9630. -32.5   -39.  -4.0    -2.  -0.5    -8.  -2.1     6.  -1.0  1.1  1.1  9669. -28.5 99999.9999.9
  250  10890. -44.1   -59.  -5.1     7.   2.5    -6.  -2.4     0.  -2.5  1.1  1.1 10949. -39.0 99999.9999.9
  200  12340. -57.7  -100.  -6.7    -2.  -0.5   -14.  -3.5   -54.  -5.4  1.1  1.1 12440. -51.0 99999.9999.9
  150  14070. -75.9  -175.  -9.3    -8.  -1.8   -59.  -7.2  -115.  -8.4  1.1  1.1 14245. -66.6 99999.9999.9
  100  16360. -85.7  -229.  -4.2     7.   1.2   -77.  -2.4  -163.  -4.5  1.1  1.2 16589. -81.5 99999.9999.9
   70  18360. -76.3  -244.  -1.7    -6.  -1.2   -58.  -0.6 99999.9999.9********** 18604. -74.6 99999.9999.9
   50  20330. -67.3  -277.  -1.6   -13.  -2.7   -87.  -0.7 99999.9999.9********** 20607. -65.7 99999.9999.9
   30  23480. -60.7  -297.  -4.4    23.   3.0   -76.  -3.7 99999.9999.9********** 23777. -56.3 99999.9999.9
   20  26030. -54.7  -350.  -2.9    -7.  -1.2  -206.  -2.1 99999.9999.9********** 26380. -51.8 99999.9999.9

DHA RESULTS
  SCAN PRESSURE  VARIABLE  IHSC DECISION  OLD VALUE  CORRECTION  NEW VALUE
     2      200         T     0        4     -57.6         0.0      -57.6
     2      150         T     0        4     -75.8         0.0      -75.8
     2      150         Z     0        4   14070.0         0.0    14070.0
     2      100         Z     0        4   16360.0         0.0    16360.0
     2       70         Z     0        4   18360.0         0.0    18360.0
     2       50         Z     0        4   20330.0         0.0    20330.0
     2       30         Z     0        4   23480.0         0.0    23480.0
     2       20         Z     0        4   26030.0         0.0    26030.0
```

Example 8. Many levels of small to moderate temperature errors, leading to many large height increments. The larger temperature errors and several height errors are marked.

```
STN ID: 54823   LAT:    36.68  LON:  116.98 EAST   ELEVATION:    58.00
DATE/TIME: 95102400 HOUR:    -1. SCAN: 2
P-MSL: 1028.0  GES P-MSL: 1030.1  OINCPS:    -2.0  HINCPS:     0.2  BASELINE RESID:     5.2
        PRESSURE       VALUE  NEW-VALUE CORRECTION
   PS     1021.0      1021.0     1020.4       -0.6
   ZS     1021.0        58.0       52.8       -5.2
   Z1     1000.0       228.0      232.1        4.1
   Z2      925.0       879.0      859.8      -19.2

      IINC  IVOI  IHOI  ITMP
 PRES  Z  T  Z  T  Z  T  Z  T  IHSC  IBAS  IIPL  IHPL
 1000  1  4  2  3  0  1  -  -     0     1     3     0
  925  0  1  0  0  1  1  -  -     0
  850  0  1  0  0  1  1  -  -     0
  700  0  0  0  0  1  2  0  -  -  0
  500  2  3  0  3  2  2  -  -  -  0
  400  2  0  1  1  1  3  0  -  -  0
  300  4  2  3  1  3  2  -  -  -  0
  250  4  2  2  1  4  2  -  -  -  0
  200  5  1  5  0  5  0  -  -  -  0
  150  5  0  2  0  4  0  -  -  -  0
  100  6  3  3  3  4  2  -  -  -  0
   70  7  1  4  0  4  0  -  -  -  0
   50  8  1  5  0  5  1  -  -  -  0
   30  8  2  5  1  5  3  -  -  -  0
   20  8  1  8  0  5  1  -  -  -  0

    OBSERVATION    INCREMENT     HYRES HYRES    VERTICAL     -----HORIZONTAL------    --GUESS--
PRESS HEIGHT  TEMP HEIGHT  TEMP HEIGHT  TEMP HEIGHT  TEMP HEIGHT  TEMP ZCMP TCMP HEIGHT  TEMP
 1000   228.  11.6   -17.   5.2 99999.9999.9   -14.   4.2     3.   1.3  0.9  0.9   245.   6.4 99999.9999.9
  925   879.   8.0    -4.   2.0      5.   4.6     2.  -0.2     8.   1.2  0.9  0.9   883.   6.0 99999.9999.9
  850  1572.   4.0     2.   1.0      2.   1.7     2.   0.2     9.   1.2  0.9  0.9  1570.   3.0 99999.9999.9
  700  3134.  -0.9     6.  -0.1      1.   0.3     0.  -0.8    11.   0.2  0.9  0.9  3128.  -0.8 99999.9999.9
  500  5740. -15.5    17.   2.7     -3.  -0.7     3.   2.7    17.   1.8  0.9  0.9  5723. -18.2 99999.9999.9
  400  7390. -27.1    29.   0.1      5.   1.5     4.  -1.0    33.   0.5  0.9  0.9  7361. -27.2 99999.9999.9
  300  9440. -34.7    51.   1.9     10.   2.4    14.   1.0    40.   2.0  0.9  0.9  9389. -36.6 99999.9999.9
  250 10700. -39.3    63.   3.0      0.  -0.1    10.   2.1    55.   2.5  0.9  0.9 10637. -42.3 99999.9999.9
  200 12210. -47.7    87.   1.5     10.   3.1    27.   0.5    70.  -0.5  0.9  0.9 12123. -49.2 99999.9999.9
  150 14070. -58.3    98.   1.1      6.   1.5    19.   0.1    65.  -0.2  0.9  0.9 13972. -59.4 99999.9999.9
  100 16570. -63.3   133.   4.5    -20.  -3.4    38.   4.0    79.   2.6  0.9  0.9 16437. -67.8 99999.9999.9
   70 18760. -61.5   162.   1.5    -10.  -2.0    45.   0.4    93.   1.1  0.9  0.9 18598. -63.0 99999.9999.9
   50 20870. -57.3   186.   1.7      5.   1.0    52.   1.0   112.   1.7  0.9  0.9 20684. -59.0 99999.9999.9
   30 24150. -50.5   223.   2.9      2.   0.2    69.   2.4   130.   4.1  0.9  0.9 23927. -53.4 99999.9999.9
   20 26790. -51.5   250.   1.7      3.   0.6   142.   1.2   136.  -1.5  1.0  1.0 26540. -53.2 99999.9999.9

DMA RESULTS
  SCAN PRESSURE  VARIABLE  IHSC DECISION  OLD VALUE  CORRECTION  NEW VALUE
     2       50         Z     0        3    20870.0         0.0    20870.0
     2       30         Z     0        3    24150.0         0.0    24150.0
     2       20         Z     0        3    26790.0         0.0    26790.0
```

Example 9. Many levels of small temperature errors, leading to a few large height increments. Only height levels are marked.

```
STN ID: 47185   LAT:    33.28  LON:  126.17 EAST   ELEVATION:    72.00
DATE/TIME: 95102400 HOUR:     0. SCAN: 2
P-MSL: 1020.6  GES P-MSL: 1020.2  OINCPS:     0.4  HINCPS:     0.3  BASELINE RESID:     4.2
        PRESSURE       VALUE  NEW-VALUE CORRECTION
   PS     1012.0      1012.0     1011.5       -0.5
   ZS     1012.0        72.0       67.8       -4.2
   Z1     1000.0       169.0      172.7        3.7
   Z2      925.0       825.0      797.6      -27.4

      IINC  IVOI  IHOI  ITMP
 PRES  Z  T  Z  T  Z  T  Z  T  IHSC  IBAS  IIPL  IHPL
 1000  0  4  0  3  0  1  -  -     0     1     0     0
  925  1  1  1  0  0  0  -  -     0
  850  1  1  2  0  1  0  -  -     0
  700  0  0  1  0  0  0  -  -     0
  500  1  5  1  3  1  4  -  -     0
  400  3  6  1  4  2  4  -  -     0
  300  5  4  5  1  5  4  -  -     0
  250  6  4  3  2  6  5  -  -     0
  200  7  4  4  2  8  7  -  -     0
  150  8  3  6  2  9  4  -  -     0
  100  8  0  7  0  9  0  -  -     0
   70  6  2  5  1  7  1  -  -     0
   50  3  5  2  4  4  4  -  -     0
   30  0  5  0  3  1  5  -  -     0
   20  3  7  5  6  2  7  -  -     0

    OBSERVATION    INCREMENT     HYRES HYRES    VERTICAL     -----HORIZONTAL------    --GUESS--
PRESS HEIGHT  TEMP HEIGHT  TEMP HEIGHT  TEMP HEIGHT  TEMP HEIGHT  TEMP ZCMP TCMP HEIGHT  TEMP
 1000   169.  14.4    -3.  -5.9 99999.9999.9     3.  -4.7    -4.  -1.7  0.9  0.9   172.  20.3 99999.9999.9
  925   825.  12.0   -10.  -2.4      3.   2.2    -4.   0.2    -6.  -0.4  0.9  0.9   835.  14.4 99999.9999.9
  850  1528.   8.2   -12.  -1.2      2.   1.6    -6.  -0.1    -9.  -0.1  0.9  0.9  1540.   9.4 99999.9999.9
  700  3119.   2.4    -4.  -0.3      9.   3.0     4.   0.7    -2.   0.4  0.9  0.9  3123.   2.7 99999.9999.9
  500  5780. -12.5   -10.  -4.1     21.   4.2     6.  -2.7    -8.  -3.2  0.9  0.9  5790.  -8.4 99999.9999.9
  400  7450. -23.5   -35.  -5.2      3.   1.1    -6.  -3.4   -23.  -3.8  0.9  0.9  7485. -18.3 99999.9999.9
  300  9500. -36.9   -72.  -3.8      4.   1.0   -21.  -1.3   -58.  -3.9  0.9  0.9  9572. -33.1 99999.9999.9
  250 10740. -46.7   -91.  -5.2      5.   2.0   -17.  -2.9   -80.  -5.0  0.9  0.9 10831. -41.5 99999.9999.9
  200 12190. -56.9  -122.  -5.3      4.   1.3   -26.  -3.1  -108.  -5.5  0.9  0.9 12312. -51.6 99999.9999.9
  150 13960. -68.1  -168.  -4.1     -4.  -0.9   -58.  -2.8  -149.  -4.0  0.9  0.9 14128. -64.0 99999.9999.9
  100 16360. -71.7  -184.  -0.9    -12.  -2.1   -72.  -0.8  -172.   0.5  0.9  0.9 16544. -70.8 99999.9999.9
   70 18520. -64.1  -143.   2.9     17.   3.3   -49.   1.8  -145.   1.4  0.9  0.9 18663. -67.0 99999.9999.9
   50 20640. -55.5   -75.   6.8     19.   3.8   -21.   5.4   -92.   5.0  0.9  0.9 20715. -62.3 99999.9999.9
   30 23930. -47.5    13.   6.6    -24.  -3.2    -1.   4.2   -28.   6.3  0.9  0.9 23917. -54.1 99999.9999.9
   20 26640. -41.7   101.   8.9     -3.  -0.4    95.   7.7    63.   9.4  0.9  0.9 26539. -50.6 99999.9999.9

DMA RESULTS
  SCAN PRESSURE  VARIABLE  IHSC DECISION  OLD VALUE  CORRECTION  NEW VALUE
     2      500         T     0        3    -12.4         0.0    -12.4
     2      400         T     0        3    -23.4         0.0    -23.4
     2      300         T     0        3    -36.9         0.0    -36.9
     2      200         T     0        3    -56.9         0.0    -56.9
     2      200         Z     0        4 12190.0         0.0  12190.0
     2      150         Z     0        4 13960.0         0.0  13960.0
     2      100         Z     0        4 16360.0         0.0  16360.0
     2       70         Z     0        3 18520.0         0.0  18520.0
     2       50         T     0        3    -55.4         0.0    -55.4
     2       30         T     0        4    -47.4         0.0    -47.4
     2       20         T     0        4    -41.6         0.0    -41.6
```

Example 10. Several moderate to large temperature and height errors.

```
STN ID: 89001   LAT:  -70.32  LON:    2.37 WEST   ELEVATION:   52.00
DATE/TIME: 95102400 HOUR:    0. SCAN: 2
P-MSL:99999.0  GES P-MSL:*******  OINCPS:99999.0  HINCPS:99999.0  BASELINE RESID:99999.0
        PRESSURE       VALUE  NEW-VALUE CORRECTION
    PS************************    99999.0    99999.0
    ZS************          52.0    99999.0    99999.0
    Z1     99999.0     99999.0    99999.0    99999.0
    Z2     99999.0     99999.0    99999.0    99999.0

       IINC  IVOI  IHOI  ITMP
  PRES  Z  T  Z  T  Z  T  Z  T  IHSC  IBAS  IIPL  IHPL
  1000 20  4 17  1  -  -  -  -     0     -     -     -
   925  -  -  -  -  -  -  -  -     0
   850 20 13 20  7  -  -  -  -     0
   700 20 16 20  7  -  -  -  -     0
   500  - 20  - 12  -  -  -  -     0
   400 20 20 20 16  -  -  -  -     0

     OBSERVATION    INCREMENT     HYRES HYRES    VERTICAL     -----HORIZONTAL------|  --GUESS--
 PRESS HEIGHT   TEMP HEIGHT   TEMP HEIGHT   TEMP HEIGHT   TEMP HEIGHT   TEMP ZCMP TCMP HEIGHT   TEMP
  1000    207.    2.2    336.    6.0 99999.9999.9    101.    1.5 99999.9999.9********** -129.   -3.8 99999.9999.9
   925************ 99999.9999.9 99999.9999.9 99999.9999.9 99999.9999.9********************** 99999.9999.9
   850  1530.    0.8    396.   12.8    16.    6.9    86.    7.8 99999.9999.9**********  1134.  -12.0 99999.9999.9
   700  3062.   -6.9    467.   12.6    -3.   -1.1    92.    6.0 99999.9999.9**********  2595.  -19.5 99999.9999.9
   500******* -17.7 99999.   17.0 99999.9999.9 99999.   10.1 99999.9999.9********************** -34.7 99999.9999.9
   400  7280.  -28.7    735.   17.7    35.    4.3   534.   12.8 99999.9999.9**********  6545.  -46.4 99999.9999.9

DMA RESULTS
  SCAN PRESSURE  VARIABLE  IHSC DECISION  OLD VALUE  CORRECTION  NEW VALUE
     2     1000         T     0        3        2.1         0.0        2.1
     2     1000         Z     0        4      207.0         0.0      207.0
     2      850         T     0        4        0.7         0.0        0.7
     2      850         Z     0        4     1530.0         0.0     1530.0
     2      700         T     0        4       -6.8         0.0       -6.8
     2      700         Z     0        4     3062.0         0.0     3062.0
     2      500         T     0        4      -17.7         0.0      -17.7
     2      400         T     0        4      -28.7         0.0      -28.7
     2      400         Z     0        4     7280.0         0.0     7280.0
```

Example 11. All data are bad and are marked.

```
STN ID: 51828   LAT:   37.13  LON:   79.93 EAST   ELEVATION: 1375.00
DATE/TIME: 95102400 HOUR:   -1. SCAN: 2
P-MSL: 1036.5  GES P-MSL: 1036.0  OINCPS:    0.5  HINCPS:   -0.4  BASELINE RESID:    1.8
        PRESSURE       VALUE  NEW-VALUE CORRECTION
    PS      875.0      875.0      874.8       -0.2
    ZS      875.0     1375.0     1373.2       -1.8
    Z1     1000.0      293.0      290.4       -2.6
    Z2      925.0      927.0      928.1        1.1

       IINC  IVOI  IHOI  ITMP
  PRES  Z  T  Z  T  Z  T  Z  T  IHSC  IBAS  IIPL  IHPL
  1000  1  -  0  -  3  -  -  -     0     0     0     0
   925  4  -  4  -  5  -  -  -     0
   850  4  5  7  3  6  3  -  -     0
   700  0  5  0  3  1  7  -  -     0
   500  5  4  4  2  4  4  -  -     0
   400  6  2  4  1  6  2  -  -     0
   300  6  1  4  1  6  2  -  -     0
   250  6  1  4  0  7  2  -  -     0
   200  6  2  3  1  7  3  -  -     0
   150  7  3  4  2  8  3  -  -     0
   100  8  2  6  1  9  2  -  -     0
    70  9  2  5  1 10  2  -  -     0
    50 10  1  7  0 11  2  -  -     0
    30 10  2  5  1 12  1  -  -     0
    20 11  3 11  3 11  2  -  -     0

     OBSERVATION    INCREMENT     HYRES HYRES    VERTICAL     -----HORIZONTAL------|  --GUESS--
 PRESS HEIGHT   TEMP HEIGHT   TEMP HEIGHT   TEMP HEIGHT   TEMP HEIGHT   TEMP ZCMP TCMP HEIGHT   TEMP
  1000   293.******   -14.9999.9 99999.9999.9      4.9999.9   -29.9999.9  1.0******   307.****** 99999.9999.9
   925   927.******   -29.9999.9 99999.9999.9 -11.9999.9   -33.9999.9  1.0******   956.****** 99999.9999.9
   850  1617.    9.8    -32.    5.1 99999.9999.9    -19.    3.6    -33.    3.4  1.0  1.0  1649.    4.7 99999.9999.9
   700  3209.    2.4      1.    4.7      5.    1.8      1.    2.7     -8.    5.4  1.0  1.0  3208.   -2.3 99999.9999.9
   500  5850. -12.5     43.    3.2      1.    0.1     17.    1.8     36.    3.7  1.0  1.0  5807. -15.7 99999.9999.9
   400  7520. -22.9     60.    2.1      1.    0.5     15.    0.9     54.    2.4  1.0  1.0  7460. -25.0 99999.9999.9
   300  9570. -37.1     78.    1.8      2.    0.6     19.    1.0     74.    2.3  1.0  1.0  9492. -38.9 99999.9999.9
   250 10810. -46.1     90.    1.2      4.    1.6     21.    0.1     88.    2.1  1.0  1.0 10720. -47.3 99999.9999.9
   200 12270. -52.5    102.    2.5     -2.   -0.6     16.    1.4    103.    2.6  1.0  1.0 12168. -55.0 99999.9999.9
   150 14110. -57.5    139.    3.9      3.    0.7     37.    2.9    129.    3.5  1.0  1.0 13971. -61.4 99999.9999.9
   100 16650. -60.1    184.    2.9     -4.   -0.7     58.    1.8    165.    3.1  1.0  1.0 16466. -63.0 99999.9999.9
    70 18870. -58.7    207.    2.7    -12.   -2.2     52.    1.8    191.    3.1  1.0  1.0 18663. -61.4 99999.9999.9
    50 21000. -55.1    238.    1.9      0.    0.0     71.    1.0    226.    2.5  1.0  1.0 20762. -57.0 99999.9999.9
    30 24310. -50.1    273.    2.8     12.    1.6     72.    1.8    287.    2.0  1.1  1.1 24037. -52.9 99999.9999.9
    20 26980. -47.3    329.    4.4      6.    1.0    196.    3.9    324.    2.7  1.1  1.1 26651. -51.7 99999.9999.9

DMA RESULTS
  SCAN PRESSURE  VARIABLE  IHSC DECISION  OLD VALUE  CORRECTION  NEW VALUE
     1      400         T     2        1      -12.9       -10.0      -22.9
     2      850         Z     0        3     1617.0         0.0     1617.0
     2      700         T     0        3        2.4         0.0        2.4
     2      250         Z     0        3    10810.0         0.0    10810.0
     2      150         Z     0        4    14110.0         0.0    14110.0
     2      100         Z     0        4    16650.0         0.0    16650.0
     2       70         Z     0        4    18870.0         0.0    18870.0
     2       50         Z     0        4    21000.0         0.0    21000.0
     2       30         Z     0        4    24310.0         0.0    24310.0
     2       20         Z     0        4    26980.0         0.0    26980.0
```

Example 12. Small to moderate consistent temperature errors lead to large height errors.

```
STN ID: 44292   LAT:    47.93  LON:   106.98 EAST   ELEVATION: 1313.00
DATE/TIME: 95102400 HOUR:     0. SCAN: 2
P-MSL: 1031.7  GES P-MSL: 1023.1  OINCPS:     7.3  HINCPS:     6.2  BASELINE RESID:    -0.7
        PRESSURE      VALUE  NEW-VALUE CORRECTION
    PS      874.0      874.0      874.1        0.1
    ZS      874.0     1313.0     1313.7        0.7
    Z1     1000.0      251.0      247.0       -4.0
    Z2      850.0     1530.0     1529.2       -0.8

       IINC  IVOI  IHOI  ITMP
  PRES  Z  T  Z  T  Z  T  Z  T  IHSC  IBAS  IIPL  IHPL
  1000  1  -  2  -  2  -  -  -     0     0    12    10
   925  -  -  -  -  -  -  -  -     0
   850  0  3  2  3  0  1  -  -     0
   700  1  0  0  0  1  1  -  -     0
   500  2  0  2  0  3  0  -  -     0
   400  1  0  0  0  1  1  -  -     0
   300  1  0  0  0  2  0  -  -     0
   250  2  0  1  0  2  2  -  -     0
   200  2  0  1  0  2  0  -  -     0
   150  3  5  3  5  4  4  -  -     0
   100  4  0  3  1  3  2  -  -     0
    70  4  0  2  0  4  0  -  -     0
    50  4  1  4  0  4  1  -  -     0
    30  1  0  0  0  1  0  -  -     0
    20  1  0  1  0  1  0  -  -     0

     OBSERVATION    INCREMENT     HYRES HYRES    VERTICAL     -----HORIZONTAL------    --GUESS--
PRESS HEIGHT   TEMP HEIGHT   TEMP HEIGHT   TEMP HEIGHT   TEMP HEIGHT   TEMP ZCMP TCMP HEIGHT   TEMP
 1000   251.****** 16.9999.9 99999.9999.9 14.9999.9 21.9999.9  0.9*****  235.****** 99999.9999.9
 925************ 99999.9999.9 99999.9999.9 99999.9999.9 99999.9999.9************************ 99999.9999.9
 850   1530.  -2.3    3.  3.3 99999.9999.9   -7.  3.2   -4.  1.5  1.0  1.0  1527.  -5.6 99999.9999.9
 700   3080.  -1.7   10.  0.2    9.  3.2    2. -0.7    7.  0.8  0.9  0.9  3070.  -1.9 99999.9999.9
 500   5700. -17.3   22. -0.1   23.  4.7   11. -0.3   25. -0.2  0.9  0.9  5678. -17.2 99999.9999.9
 400   7330. -28.5   19.  0.7   -5. -1.4    2.  0.6   14.  1.4  0.9  0.9  7311. -29.2 99999.9999.9
 300   9320. -44.3   22.  0.5   -4. -0.9    3.  0.3   24. -0.6  0.9  0.9  9298. -44.8 99999.9999.9
 250  10520. -54.3   29.  0.1    5.  2.0    8. -0.2   30.  2.2  0.9  0.9 10491. -54.4 99999.9999.9
 200  11920. -62.5   32.  0.7   -3. -0.8   -6. -0.6   35.  0.0  0.9  0.9 11888. -63.2 99999.9999.9
 150  13700. -59.3   74.  6.4   -7. -1.7   31.  6.4   69.  4.0  1.0  1.0 13626. -65.7 99999.9999.9
 100  16220. -60.9   92. -1.1   -9. -1.4   30. -2.0   63. -2.6  1.0  1.0 16128. -59.8 99999.9999.9
  70  18460. -57.7   97. -0.9    7.  1.4   27. -0.4   85. -0.8  1.1  1.1 18363. -56.8 99999.9999.9
  50  20600. -57.7   98. -1.5   18.  3.7   48. -1.2   92. -1.3  1.2  1.2 20502. -56.2 99999.9999.9
  30  23800. -55.5   35. -0.9  -38. -5.1  -11. -0.8   31. -0.9  1.2  1.2 23765. -54.6 99999.9999.9
  20  26390. -53.3   39.  0.5   -6. -1.0   22.  0.7   38.  0.9  1.2  1.2 26351. -53.8 99999.9999.9

DHA RESULTS
  SCAN PRESSURE  VARIABLE  IHSC DECISION  OLD VALUE  CORRECTION  NEW VALUE
     2      150         T     0        3      -59.3         0.0      -59.3
```

Example 13. Single moderate temperature error at 150 hPa. It is marked to be used with reduced weight.

```
STN ID: 25400   LAT:    65.73  LON:   150.90 EAST   ELEVATION:    43.00
DATE/TIME: 95102400 HOUR:     0. SCAN: 2
P-MSL: 1015.6  GES P-MSL: 1012.8  OINCPS:     2.8  HINCPS:     1.3  BASELINE RESID:    10.2
        PRESSURE      VALUE  NEW-VALUE CORRECTION
    PS     1010.0     1010.0     1008.7       -1.3
    ZS     1010.0       43.0       32.8      -10.2
    Z1     1000.0      110.0      119.1        9.1
    Z2      925.0      710.0      630.6      -79.4

       IINC  IVOI  IHOI  ITMP
  PRES  Z  T  Z  T  Z  T  Z  T  IHSC  IBAS  IIPL  IHPL
  1000  1  2  0  2  1  2  -  -     0     3     4     2
   925  1  1  0  0  1  0  -  -     0
   850  1  1  1  0  2  0  -  -     0
   700  0  1  0  0  0  2  -  -     0
   500  0  1  0  0  2  2  -  -     0
   400  1  1  2  0  3  1  -  -     0
   300  1  0  0  0  3  0  -  -     0
   250  1  1  1  1  4  2  -  -     0
   200  1  0  1  6  4  0  -  -     0
   150  - 20  - 20  - 20  -  -     0
   100  -  -  -  -  -  -  -  -     0
    70  0  2  0  4  4  0  -  -    13
    50  2  2  0  1  4  1  -  -     0
    30  4  5  2  4  4  3  -  -     0
    20  5  1  6  0  4  1  -  -     0

     OBSERVATION    INCREMENT     HYRES HYRES    VERTICAL     -----HORIZONTAL------    --GUESS--
PRESS HEIGHT   TEMP HEIGHT   TEMP HEIGHT   TEMP HEIGHT   TEMP HEIGHT   TEMP ZCMP TCMP HEIGHT   TEMP
 1000    110. -11.5   11.  -3.6 99999.9999.9    5.  -2.8   10.  -3.5  1.0  1.1    99.  -7.9 99999.9999.9
  925    710. -12.3    9.  -1.6    4.  3.4    1.  0.1    7.  -0.3  1.0  1.0   701. -10.7 99999.9999.9
  850   1360. -12.7   10.  -1.1    5.  3.9    5. -0.2   13.  -0.7  1.0  1.0  1350. -11.6 99999.9999.9
  700   2820. -19.9    4.  -1.2    0.  0.1    1. -0.7    5.  -1.7  1.0  1.0  2816. -18.7 99999.9999.9
  500   5260. -31.7   -5.  -1.1    4.  0.8    0. -0.7  -19.  -1.6  1.0  1.0  5265. -30.6 99999.9999.9
  400   6800. -42.5  -16.  -0.9   -2. -0.5   -8. -0.7  -31.  -1.1  1.0  1.0  6816. -41.6 99999.9999.9
  300   8690. -54.5  -16.   0.2   -2. -0.4   -2.  0.8  -37.  -0.8  1.0  1.0  8706. -54.7 99999.9999.9
  250   9840. -59.5  -19.  -1.3   -4. -1.3   -5. -1.5  -49.  -1.7  1.0  1.0  9859. -58.2 99999.9999.9
  200  11240. -57.3  -20.   0.4   -3. -0.8   -9. -7.5  -57.  -0.4  1.0  1.0 11260. -57.7 99999.9999.9
  150******* -15.3 99999.  41.1 99999.9999.9 99999.  41.2 99999.  39.6*****  1.0******* -56.4 99999.9999.9
  100************ 99999.9999.9 99999.9999.9 99999.9999.9 99999.9999.9************************ 99999.9999.9
   70  17880. -59.7  -18.  -2.6   44.  2.9    7.  -5.4  -76.  -0.5  1.0  1.0 17898. -57.1 99999.9999.9
   50  19980. -62.1  -49.  -3.4   10.  1.9   -8.  -2.1  -86.  -1.9  1.0  1.0 20029. -58.7 99999.9999.9
   30  23100. -64.9 -111.  -6.4  -15. -2.0  -34.  -5.6  -94.  -4.8  1.2  1.2 23211. -58.5 99999.9999.9
   20  25590. -64.1 -161.  -1.9   14.  2.3 -107.  -0.7 -134.  -1.3  1.2  1.2 25751. -62.2 99999.9999.9

DHA RESULTS
  SCAN PRESSURE  VARIABLE  IHSC DECISION  OLD VALUE  CORRECTION  NEW VALUE
     2      150         T     0        4      -15.2         0.0      -15.2
```

Example 14. The temperature at 150 hPa is bad and is marked.

```
STN ID: 04018   LAT:    63.97  LON:    22.60 WEST   ELEVATION:    37.00
DATE/TIME: 95102400 HOUR:     0. SCAN: 2
P-MSL: 1002.6  GES P-MSL:   999.3  OINCPS:     3.3  HINCPS:     3.6  BASELINE RESID:    -3.1
        PRESSURE       VALUE  NEW-VALUE CORRECTION
   PS       998.0       998.0       998.4        0.4
   ZS       998.0        37.0        40.1        3.1
   Z1      1000.0        24.0        20.8       -3.2
   Z2       925.0       647.0       526.6     -120.4

       IINC  IVOI  IHOI  ITMP
 PRES  Z  T  Z  T  Z  T  Z  T  IHSC  IBAS  IIPL  IHPL
 1000  3  -  2  -  3  -  -  -     0     1     5     6
  925  4  0  1  1  4  0  -  -     0
  850  5  3  2  2  6  3  -  -     0
  700  6  0  2  1  6  0  -  -     0
  500  7  0  5  0  7  0  -  -     0
  400  6  1  4  1  7  1  -  -     0
  300  5  3  4  3  6  3  -  -     0
  250  4  1  3  0  4  1  -  -     0
  200  2  0  0  0  2  1  -  -     0
  150  1  0  1  0  1  0  -  -     0
  100  1  0  1  0  1  0  -  -     0
   70  1  0  2  0  1  0  -  -     0
   50  0  1  0  1  0  0  -  -     0
   30  0  -  0  -  0  -  -  -     0

     OBSERVATION    INCREMENT     HYRES HYRES    VERTICAL     -----HORIZONTAL------    --GUESS--
PRESS HEIGHT  TEMP HEIGHT  TEMP HEIGHT  TEMP HEIGHT  TEMP HEIGHT  TEMP ZCMP TCMP HEIGHT  TEMP
 1000    24.****** 32.9999.9 99999.9999.9  12.9999.9  29.9999.9 1.2*****   -8.****** 99999.9999.9
  925   647.  -2.3  31.   0.0 99999.9999.9   4.  -1.3  29.   0.5 1.2  1.2   616.  -2.3 99999.9999.9
  850  1315.  -4.3  35.   2.8     0.   0.1   7.   2.9  34.   3.2 1.2  1.2  1280.  -7.1 99999.9999.9
  700  2814. -14.9  42.  -0.5     1.   0.4   6.  -1.4  38.  -0.5 1.2  1.2  2772. -14.4 99999.9999.9
  500  5310. -29.7  63.   0.6    25.   5.2  21.   0.4  58.   0.7 1.2  1.2  5247. -30.3 99999.9999.9
  400  6860. -41.7  66.   1.0    -1.  -0.3  16.   1.5  63.   1.3 1.2  1.2  6794. -42.7 99999.9999.9
  300  8740. -58.5  68.  -3.2     2.   0.4  21.  -3.1  66.  -2.8 1.2  1.2  8672. -55.3 99999.9999.9
  250  9890. -54.9  58.  -1.1    -5.  -1.9  16.   0.1  55.  -1.7 1.2  1.2  9832. -53.8 99999.9999.9
  200 11310. -53.7  40.  -1.1    -9.  -2.9   3.  -0.8  34.  -1.3 1.2  1.2 11270. -52.6 99999.9999.9
  150 13160. -54.5  38.  -0.3     5.   1.3   9.  -0.1  27.  -1.0 1.2  1.2 13122. -54.2 99999.9999.9
  100 15750. -55.3  40.   0.0     0.   0.0  12.   0.2  24.   0.3 1.2  1.2 15710. -55.3 99999.9999.9
   70 18020. -56.7  39.  -0.8     3.   0.6  20.  -0.5  30.   0.2 1.2  1.2 17981. -55.9 99999.9999.9
   50 20130. -58.5  12.  -1.8   -13.  -2.6  -2.  -1.6  12.  -1.2 1.2  1.2 20118. -56.7 99999.9999.9
   30 23340.******  -6.9999.9 99999.9999.9 -11.9999.9   7.9999.9 1.2***** 23346.****** 99999.9999.9

DMA RESULTS
  SCAN PRESSURE  VARIABLE  IHSC DECISION  OLD VALUE  CORRECTION  NEW VALUE
     2      500         Z     0        3     5310.0         0.0     5310.0
     2      400         Z     0        3     6860.0         0.0     6860.0
```

Example 15. Heights at 500 and 400 hPa are suspect and marked questionable. There is likely no error.

```
STN ID: 89009   LAT:   -90.00  LON:     0.00 EAST   ELEVATION: 2854.00
DATE/TIME: 95102400 HOUR:     0. SCAN: 2
P-MSL:99999.0  GES P-MSL:   986.8  OINCPS:99999.0  HINCPS:99999.0  BASELINE RESID:99999.0
        PRESSURE       VALUE  NEW-VALUE CORRECTION
   PS       676.0       676.0     99999.0     99999.0
   ZS       676.0      2854.0     99999.0     99999.0
   Z1      1000.0       215.0     99999.0     99999.0
   Z2       925.0       749.0     99999.0     99999.0

       IINC  IVOI  IHOI  ITMP
 PRES  Z  T  Z  T  Z  T  Z  T  IHSC  IBAS  IIPL  IHPL
 1000 18  - 14  -  -  -  -  -     0     -     -     -
  925 19  - 11  -  -  -  -  -     0
  850 16  - 11  -  -  -  -  -     0
  700  5  -  6  -  -  -  -  -     0
  500  4  1  2  1  -  -  -  -     0
  400  3  1  1  1  -  -  -  -     0
  300  2  0  1  0  -  -  -  -     0
  250  2  0  1  0  -  -  -  -     0
  200  1  1  0  0  -  -  -  -     0
  150  2  1  2  1  -  -  -  -     0
  100  2  0  3  1  -  -  -  -     0

     OBSERVATION    INCREMENT     HYRES HYRES    VERTICAL     -----HORIZONTAL------    --GUESS--
PRESS HEIGHT  TEMP HEIGHT  TEMP HEIGHT  TEMP HEIGHT  TEMP HEIGHT  TEMP ZCMP TCMP HEIGHT  TEMP
 1000   215.****** 173.9999.9 99999.9999.9  86.9999.9 99999.9999.9********** 42.****** 99999.9999.9
  925   749.****** 138.9999.9 99999.9999.9  28.9999.9 99999.9999.9********** 611.****** 99999.9999.9
  850  1321.****** 104.9999.9 99999.9999.9  30.9999.9 99999.9999.9********** 1217.****** 99999.9999.9
  700  2603.****** 36.9999.9 99999.9999.9 -20.9999.9 99999.9999.9********** 2567.****** 99999.9999.9
  500  4890. -44.5  33.   1.0 99999.9999.9   8.   1.3 99999.9999.9********** 4857. -45.5 99999.9999.9
  400  6350. -53.9  31.  -1.0    -3.  -0.8   7.  -1.1 99999.9999.9********** 6319. -52.9 99999.9999.9
  300  8160. -63.1  29.  -0.6     2.   0.6   7.  -0.4 99999.9999.9********** 8131. -62.5 99999.9999.9
  250  9270. -67.3  28.   0.1     0.   0.1   6.   0.0 99999.9999.9********** 9242. -67.4 99999.9999.9
  200 10600. -70.3  29.   1.3    -5.  -1.5  -1.   0.9 99999.9999.9********** 10571. -71.6 99999.9999.9
  150 12300. -73.7  53.   1.9     6.   1.5  22.   1.8 99999.9999.9********** 12247. -75.6 99999.9999.9
  100 14630. -78.3  58.  -0.9   -10.  -1.7  32.  -1.2 99999.9999.9********** 14572. -77.4 99999.9999.9

DMA RESULTS
  SCAN PRESSURE  VARIABLE  IHSC DECISION  OLD VALUE  CORRECTION  NEW VALUE
     2     1000         Z     0        4      215.0         0.0      215.0
     2      925         Z     0        4      749.0         0.0      749.0
     2      850         Z     0        4     1321.0         0.0     1321.0
     2      700         Z     0        3     2603.0         0.0     2603.0
```

The below-ground hts. are consistent with $b \simeq -5.6\times10^{-3}$ and $T_S \simeq 245.1\ (-28.1C)$, while the layer temperatures are $\bar{T}_{1000\text{-}925} = -39.1$, $\bar{T}_{925\text{-}850} = -42.0$ and $\bar{T}_{850\text{-}700} = -47.5$ $\left(\text{from } \bar{T} = -\frac{g\Delta z}{R\Delta p}\right)$. It's hard to determine how the pressure reduction was performed.

Example 16. The underground heights at this North Pole station are suspect. They do not seem to be consistent with any reasonable reduction method.