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RADIATION ERROR OF DIFFERENT RADIOSONDES AT PAYERNE, 1956

by

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Abstract

The radiation errors of radiosondes, compared with each other at Payerne, 1956, are determined as differences of day and night soundings.

Since the radiation error of several radiosondes which were compared with one another at Payerne in May—June, 1956, is only partly known, I decided to make use of the data then obtained to study this aspect of the radiosondes. I have used the same method as in the case of the Finnish (Väisälä) radiosonde, namely a comparison of day and night soundings [1,5]. By this method, the difference between the radiation error by day and by night (negative) is obtained. On applying this correction to the day soundings, we obtain the values which should be observed during the night (without sunshine) under the same temperature conditions. ROSSI [2] has carried out an analogous investigation using the data obtained during the first international comparison of radiosondes at Payerne in May, 1950.

The radiation error of the Finnish radiosonde was determined by means of observations made in 1938—41 and 1945 [1,5]. The following formula was obtained [1]:

$$\triangle T = S(h) \cdot I(h,p) \sqrt{\frac{300}{v_{0.1}}} \left(\frac{100}{p}\right)^{0.852} \tag{1}$$

where h = true elevation angle of the sun,
p = pressure at the radiosonde, mb,

$r_{0,1}$ = reduced rate of ascent (gpm/min.) as derived from the formula

$$r_{0,1} = -17220 \frac{d\sqrt[6]{p}}{dt},$$

t = time of ascent (min.),
$\triangle T$ = radiation error (°C) to be subtracted from the measured value [5],
$S(h)$ = radiation error function (°C) [1],
$I(h, p)$ = relative radiation intensity at the radiosonde [6].

As the data from Payerne are rather limited for our purpose, we shall use as the basis for our computations the 5-minute means of temperatures as given in Forms 2 of the Payerne results [8]. The following height groups are used:

Group	Approx. Pressure
5	100 mb
6	70 »
7	50 »
8	30 »

As the number of night soundings at 30 mb is small, the results of this group are not very reliable. Group 4 with 200 mb pressure cannot be used because of the great temperature fluctuations in this layer.

For each night sounding and for each height group we have computed the mean value of all the radiosondes in the train. In this way we obtain the means based on different numbers of sondes, from 3 to 14. When two soundings were made during the same night, the mean of these has been used. All night soundings are considered to refer to midnight (24 hours).

These night temperatures were then plotted against time and, by joining the successive points with straight lines, four temperature curves were obtained[1]). The temperatures at the time of each day sounding were then read from these night temperature curves. Assuming a linear change of air temperature with time, it is with these interpolated »night» temperatures that the observed day temperatures have to be compared in order to obtain the radiation error. Table 1 contains these interpolated temperatures

[1]) The value for the night temperature between May 29—30 at 30 mb, which was measured by only one radiosonde and which differs strikingly from the surrounding values, has been discarded. For the night June 7—8, the temperature —52° at 50 mb is an interpolated value based on the change in temperature shown by the day soundings.

for each day sounding. The »Hour» in the table means the time when the radiosondes were at a height of about 70 mb.

Now, the differences between each day sounding temperature and the temperatures in Table 1 were calculated for each radiosonde. Table 2 contains the type numbers of the radiosondes and Table 3 the mean values of the day-night differences for every radiosonde and every height group. These are the radiation errors of the radiosondes in our view. In the last rows, 5* is the mean value of the radiation error according to Formula (1) which has been used in correcting the temperature values of the Finnish

Table 1. Temperatures for day soundings interpolated from night temperature curves

Asc. No.	Day	Hour	Height Group 5	6	7	8
26	27	10	—	—	—	—
23	»	16	—	—	—	—
1	28	10	—59.3	—58.2	—55.7	—52.8
2	»	16	—59.3	—58.2	—55.7	—52.8
3	29	10	—59.0	—58.1	—56.1	—53.0
4	»	16	—58.7	—58.0	—56.5	—53.0
5	30	10	—56.5	—56.9	—56.0	—53.3
6	»	16	—55.3	—56.4	—55.7	—53.4
7	31	10	—53.8	—56.4	—55.5	—53.0
8	»	16	—53.9	—56.8	—55.6	—52.7
9	1	10	—54.1	—56.7	—55.4	—52.1
10	»	16	—54.2	—56.6	—55.3	—51.9
2 bis	2	16	—54.6	—55.6	—54.3	—50.8
11	4	10	—56.3	—55.2	—53.2	—50.4
12	»	16	—57.0	—55.6	—53.4	—50.6
13	5	10	—57.4	—55.8	—53.7	—51.2
14	»	16	—57.3	—55.7	—53.7	—51.2
15	6	10	—56.5	—55.3	—53.4	—52.3
16	»	16	—56.3	—55.1	—53.3	—52.4
17	7	10	—55.0	—54.6	—52.7	—51.6
5 bis	»	16	—54.6	—54.3	—52.4	—51.7
19	8	10	—53.2	—53.7	—52.0	—51.8
20	»	16	—52.8	—53.6	—52.1	—51.9
16—18	9	10	—51.7	—53.3	—52.3	—52.1
17—22	11	10	—53.0	—54.7	—53.2	—52.2
A	»	17	—53.4	—55.0	—53.3	—52.2
B	12	17	—54.3	—55.2	—54.8	—52.2
C	13	12	—54.3	—55.4	—55.6	—52.2
D	»	17	—54.3	—55.4	—55.6	—52.2
E	14	13	—54.2	—55.7	—54.4	—

Table 2. Radiosondes

Type No.	Origin	Radiation effect [7, inform. 18 (rév.)]
1	Belgium	Rather weak
2	Deutsche Bundesrepublik	No effect below 30 mb
3	Model Lang	No effect below 100 mb
4	U.S.A.	Very weak
5	Finland	Corrections applied from 500 mb
6	France	Exists, corrections known
7	Japan	Corrections applied from 400 mb
8	India I (fan)	Exists
9	United Kingdom	Corrections applied from ground level
10	Holland	Exists
11	Switzerland	Up to 100 mb no influence, higher not known
12	U.S.S.R.	Very weak up to 50 mb, not known above
13	India II (chronom.)	Exists
14	Poland	Weak up to 100 mb

Table 3. Mean Differences Day-Night (°C) and their Ratio (%) to the Radiation Error calculated according to Formula (1)

Type No.	Day-Night (°C) Height Group				As percentage of 5* according to Formula (1)				Weighed Mean
	5	6	7	8	5	6	7	8	
1	0.0	0.2	2.5	4.2	0	4	32	33	21
2	1.3	1.5	2.4	3.9	34	28	31	31	31
3	2.1	2.8	4.0	5.6	55	52	52	44	50
4	1.0	1.0	1.8	3.2	26	19	23	25	23
5	0.8	1.1	1.5	2.2	21	20	20	17	19
6	3.5	5.7	8.1	10.6	92	106	106	84	97
7	0.9	1.7	3.1	4.7	24	31	40	37	35
8	2.7	3.6	7.4	11.5	71	67	96	91	84
9	2.4	3.5	5.7	6.9	63	65	74	55	65
10	2.7	2.9	4.0	6.3	71	54	52	50	55
11	0.4	1.2	3.7	5.7	11	22	48	44	35
12	3.9	5.7	7.3	10.0	103	106	95	80	94
13	2.0	2.2	3.1	6.3	53	41	40	50	45
14	4.8	7.6	9.8	—	126	140	127	—	132
5*	3.8	5.4	7.7	12.6	—	—	—	—	
9*	2.9	4.0	5.7	9.2	77	74	74	73	

radiosonde, and 9* the mean radiation error of the English radiosonde according to Scrase [4]. When computing the values 9* the mean ascensional rate of the radiosonde trains has been taken into account.

When studying the values given in Table 3, we must bear in mind that they are referred to the mean night values of *all* the radiosondes. Therefore any individual corrections for these radiosondes have been eliminated from these mean values to a great extent but not from the individual day values. Actually, the reference should have been made to the night values of the same radiosonde whose radiation error is to be determined, but for this purpose the Payerne data are wholly inadequate.

The temperature values used have been uncorrected for radiation apart from the values of the Finnish radiosonde, for which the observations are always corrected. Table 3 shows that about 20% of the radiation error of the Finnish radiosonde has not been corrected, i.e. the radiation error of the instruments used is 20% greater than the value in Formula (1). This must be due to the fact that the outer construction of the radiosonde has been changed a little since Formula (1) was determined.

The main feature seen from Table 3 is that all radiosondes are affected by an error due to solar radiation. The amount of the error varies considerably. The error of radiosonde types 1 and 11 is, according to Table 3, relatively small at 100 and 70 mb. Since the individual difference of these sondes from the mean of all sondes during the night is about —0.7 and —0.6°C respectively, this means that the error values of types 1 and 11 would have been slightly greater than in Table 3 if the day soundings had been referred to the night soundings of the same radiosonde type.

The other part of Table 3 shows the error of each sonde relative to the error 5* of the Finnish radiosonde according to Formula (1). The main feature here is that the error of most radiosondes bears an almost constant ratio to 5*. This is especially the case with types 2, 3, 4, 6, 9, 12, 13, 14. The measured errors of type 9 are a little smaller than the values 9*. It should be noted that the values of the height group 8 are less reliable than the others.

More soundings have been made with the radiosonde type 2, which (with type 4) was attached to the train as reference sonde, than with the other sondes. We therefore made a special study of type 2, using only soundings made with it, in order to check the results in Table 3. The result of seven day soundings was as follows:

Height Group	5	6	7	8
Day-Night	1.0	1.6	2.9	3.8 °C
Mean error	±0.2	0.3	0.4	0.5 °C

Unfortunately during the week June 2—8 no night soundings with the sonde type 2 were made. Therefore six day soundings were unusable for our calculation. The result obtained is in very good agreement with the values in Table 3. The mean errors give an idea of the accuracy.

Because the data are rather scant for our purpose, it is not possible to go into detail. Especially, it is not possible to study the dependence of the radiation error on the elevation angle of the sun. The results above belong to a mean elevation angle of about 45°. This investigation shows, nevertheless, that the method of day-night differences gives reliable results. Had all the radiosondes been investigated in this way, the radiation corrections obtained would allow soundings to be corrected in daily work by a uniform method. Such an investigation of radiosondes can be made by means of sounding results of daily synoptic work.

In conclusion, it may be pointed out that the method of day-night differences disregards the daily variation of temperature. ROSSI has carried out a series of observations on this variation [3] and he has established that the daily amplitude in the height layers investigated by us is only of the order of 0.5°C. We have established that the same is true concerning the daily variation of temperature in Spitzbergen [5, p. 61]. This statement justifies the use of our method.

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Corrigendum

In the table 2 of my paper »Radiation Error of Different Radiosondes at Payerne, 1956» (Geophysica 6:1) the type characteristics of the two Indian radiosondes have been changed with one another. The RS type No 8 is to be corrected to India I (Chronometric) and No 13 to India II (Fan).

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