A few values of $K$ which do not fit in may be due to the absence of favourable conditions of instability in the atmosphere at that time.

Examination of Table 3 shows the relationship between the millibaric height difference of convective condensation level (CCL) and freezing level (FL) to the frequency of occurrence of thunderstorms. This method was developed by Legg (1948) and Tillotson (1951). The present study corroborates their findings that when the difference between CCL and FL is greater, the chances of occurrence of thunderstorms are more.

The values of the compound probabilities have been shown in Table 4 after computing them by taking the values of S, I, and $K$ simultaneously. The values of these two parameters have been plotted in the base and five times the compound-probability percentage depicted in three dimensional diagram in Fig. 2.

5. It is very clear from the Tables 1, 2 and 3 that the occurrence of thunderstorms mostly takes place in the afternoon or in the early part of night at Srinagar and its neighbourhood.

6. The authors wish to express their sincere thanks to Shri Ranjit Singh for his valuable guidance. They are also very much thankful to the staff of Meteorological Centre, Srinagar for their valuable help in preparing the diagrams and going through the manuscript.

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13 May 1975

REFERENCES


A COMPARATIVE STUDY OF THERMISTOR RESPONSE BETWEEN GROUND AND 80 KM

1. While investigating the suitability of an indigenous microbead thermistor as a temperature sensor for meteorological rocket payload, comparative study of the time constants of the micro-

bead thermistor*, a bead thermistor used in laboratory tests and a rod thermistor used in the IMD radiosonde, was conducted.

2. The time constant of the thermistor can be defined as the time taken by the thermistor to come to an equilibrium with 63.2 per cent of the change in the ambient temperature.

*Developed by M/S Tempo Industrial Corporation, Bombay
The time constant $T$ is given by

$$T = \frac{M_t C_t}{S} \tag{1}$$

where, $M_t$ is the weight of the thermistor, $C_t$ is the specific heat at constant temperature and $S$ is the dissipation factor of the thermistor. $M_t C_t$ is called the heat capacity of the thermistor.

From Eq. (1) it is seen that by keeping the heat capacity of the thermistor constant, one can increase $S$ and achieve a smaller time constant. $S$ is expressed as:

$$S = 4 \sigma A_t T_e^3 + \frac{2K\beta}{X} + h_t A_t \tag{2}$$

where, $\sigma$—Stefan Boltzmann constant ($= 1.38 \times 10^{-12} \text{cal cm}^{-2} \text{sec}^{-1} \text{K}^{-4}$), $A_t$—surface area of thermistor, $K$—thermal conductivity of lead wires ($= 0.074 \text{cal cm}^{-1} \text{sec}^{-1} \text{K}^{-1}$), $\beta$—cross sectional area of lead wires ($= 1 \times 10^{-4} \text{cm}^2$ for bead thermistor), $X$—length of lead wires, $h_t$—convective heat transfer coefficient and $T_e$—environmental temperature.

The first term of R.H.S. in Eq. (2) gives the rate of energy transfer per degree Kelvin by long wave radiation. It depends upon the area of the thermistor and the environmental temperature. The second term gives the heat transfer rate per degree Kelvin due to conduction along the thermistor leads. This term will contribute more if $X$, the lead length, is decreased, but minimum length of lead has to be allowed so as to connect the thermistor to binding posts. Thermal conductivity remaining constant, $\beta$ the cross-section of the wire, can be made thinner. But again this is limited by the fact that it has to withstand the vibration of the rocket to the order of 100 to 2000 c/s. Third term gives the rate of heat transfer per degree Kelvin by forced convection.

3. All calculations are carried out assuming atmosphere as continuum upto 80 km, instead of dividing it into three regions, namely, continuous region, slip region and molecular region. By such an assumption, a maximum difference of only 10 per cent on the positive side, is likely in the value of the time constants. Hence, for a simplified calculation, atmosphere is considered as a continuum.

In Eq. (2) all quantities except $h_t$ are known. They are either physical constant of thermistor or atmosphere. Thus, $h_t$ is computed for various levels and dissipation factor is calculated. All atmospheric constants are taken from 1962 ARDC model of U.S.A.

$$R_e = \frac{\rho d v}{\mu}$$

where, $d$—diameter of thermistor; $v$—fall velocity of thermistor, i.e., of parachute which the thermistor along with payload descends; $\mu$—viscosity and $\rho$—atmospheric density.

Fall rate of the parachute was observed in the field. The parachute was taken 200 metres up by a balloon and detached to have a free fall along with a dummy payload. Fall rate was found out knowing the height accurately with the help of theodolites. This fall rate was extrapolated upto 80 km. The fall rate is compared (Fig. 1) to that of Wagner (1961).

The parachute has the following parameters: Radius = 200 cm; area = $1.46 \times 10^4 \text{ cm}^2$; $C_d$ (drag coefficient) = 1.5 and weight = 600 gm.

In the calculation of rod thermistor the ascent rate of a balloon was considered with free lift of 2.5 kg.
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Then, using Reynold's number, Prandtl number is calculated by

\[ P_r = \frac{C_p \mu}{\nu} \]

This in turn, is used in the calculation of the Nusselt number given by

\[ N_u = 2 + 0.37 (R_e)^{0.8} (P_r)^{1/3} \]

Finally the convective heat transfer coefficient is given by

\[ h_u = \frac{N_u K}{d} \]

where \( d \) = diameter of thermistor and \( K \) = thermal conductivity of air.

It is logical to assume that there does not exist any temperature gradient in the thermistor itself. Knowing the convective heat transfer coefficient \( h_u \) and the dissipation factor, the time constants are calculated from Eq. (1).

\[ \text{Indian Institute of Tropical Meteorology, Poona} \]
\[ 14 \text{ April 1975} \]

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J. Met., 18, pp. 606-614.

UNUSUAL RAINFALL DURING OCTOBER 1974

1. The spells of rain that occurred in the month of October 1974 were unusual in some respects and were more like the situation normally expected in any September month. The low pressure areas on 6th and 14th which intensified into depressions crossed the Andhra coast and moved inland west-northwestwards and under their influence rainfall activity was carried to the central as well as western parts of the country and thereby the monsoon activity was thus kept up longer there than normal.

2. The rainfall distribution during the month was fairly widespread in almost all parts of the country. The States of Uttar Pradesh, east Rajasthan, west Madhya Pradesh, Maharashtra, Gujarat, Andhra Pradesh and Karnataka had spells of above normal rainfall since the beginning of second week of October, in particular, Rajasthan and Marathwada, had rainfall amount 5 to 8 times more than its normal (Table 1). On comparison with the rainfall of September it was noted that the rainfall of October 1974 was 2 to 4 times more in many places of east Rajasthan, Madhya Pradesh, coastal Andhra Pradesh and Maharashtra.

3. A low pressure area intensified into a depression at 1800 GMT of 6th around 15°N, 87°E and moving northwesterly it was very close to the coast at 00 GMT of 8th (Fig. 1). The depression crossed Andhra coast north of Visakhapatnam around 12 GMT of 8th with the upper air circulation ahead of the surface circulation. But the depression at 12 GMT of 9th weakened into small low pressure areas with the main low pressure system near Chandrapur with the upper air cyclonic circulation extending upto 300 mb. The low pressure area remained active on 10th (00 GMT) with 4 mb drop and moved northwestwards with upper air circulation extending upto 500 mb and with a trough at 300-mb level. It moved further WNW, recurved on 11th at 00 GMT and on 13th it became less marked with an upper air circulation up to 700 mb which also later got completely dissociated by 00 GMT of 14th.

Physical parameters of the thermistors are as follows:

<table>
<thead>
<tr>
<th>Type</th>
<th>Weight</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microbead</td>
<td>3 milligram</td>
<td>2.8 \times 10^{-3} cm²</td>
</tr>
<tr>
<td>Bead</td>
<td>2.2 milligram</td>
<td>1.5 \times 10^{-2} cm²</td>
</tr>
<tr>
<td>Rod</td>
<td>196 milligram</td>
<td>1.367 cm²</td>
</tr>
</tbody>
</table>

Fig. 2 gives time constants in the form of a graph. A slight decrease in the value of time constants between 40 and 60 km is due to the sudden increase in the thermal conductivity values. Thus the microbead thermistor is far superior to the bead thermistor. The time constant of the thermistor can be still reduced by mounting the thermistor on a mylar film, thus increasing its heat capacity. This way, the time constant can be reduced to 50 per cent. Knowing time constant, other atmospheric corrections can be easily calculated.

5. Thanks are due to Mr. H. Mitra who encouraged this work and under whose guidance payload work is being carried out.

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