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INTERESTING FEATURES SHOWN BY A RADIO SONDE ASCENT AT POONA ON 26 APRIL 1950, DURING A THUNDERSTORM

A thunderstorm occurred over Poona on the evening of 26 April 1950. At one stage there was a considerable fall of hail stones, some of the stones being approximately one inch in diameter. About 1 inch of rain fell mostly during the hours from 1845 to 1930 IST.

An F-type[1] radiosonde balloon was released at 1947 IST when it was raining lightly. From the records of this ascent it was observed that the balloon was forced down in the atmosphere more than once. The details of these and the associated temperature distribution in the region of the atmosphere through which the balloon traversed are described here.

Fig. 1 gives the variation of pressure and temperature with time experienced by the radiosonde. Fig. 2 gives the rate of rotation of the fan operating the radio-meteorograph. This rate of rotation is measured by the length of paper tape per complete Olland cycle and is given by the distance between two consecutive signals from the fixed reference contacts in the instrument. Fig. 3 gives the tephigram obtained from the ascent giving the distribution of dry bulb and wet bulb temperatures.

The corresponding characteristic points in the three Figures 1 to 3 are numbered serially, beginning from the layers near the ground. The history of flight of the balloon has also been divided into 7 phases in Fig. 1.

1. *Movement of the balloon in the thunderstorm*

It is observed from Fig. 1, that in phase I, the balloon was rising uniformly for about 6 minutes till it reached the 827 mb level when its rate of ascent was reduced for about 6 minutes. Later, it again rose uniformly for about another 6 minutes till it reached the 671 mb level after which the balloon descended to the 750 mb level in about 8 minutes. It again rose for about 10 minutes till it reached the 593 mb level. After this, as the fan ceased to rotate, no signals were received. However, the radiosonde receiver on the ground was kept tuned to the signaller ; and after a break of 24 minutes, the signals were again received continuously for another 28 minutes till it reached 320 mb.

The approximate rates of ascent or descent of the balloon in the different phases is given in the following table—

Phase	Characteristic points	Approximate rate of ascent (kmph)	Remarks
I	up to 2	13	
II	2 to 4	3	
III	4 to 5	15	
IV	5 to 8	-7	Balloon descending ; rate of descent about 11 kmph between the points 6 and 7
V	8 to 11	11	
VI	11 to 12	—	
VII	12 to 17	13	

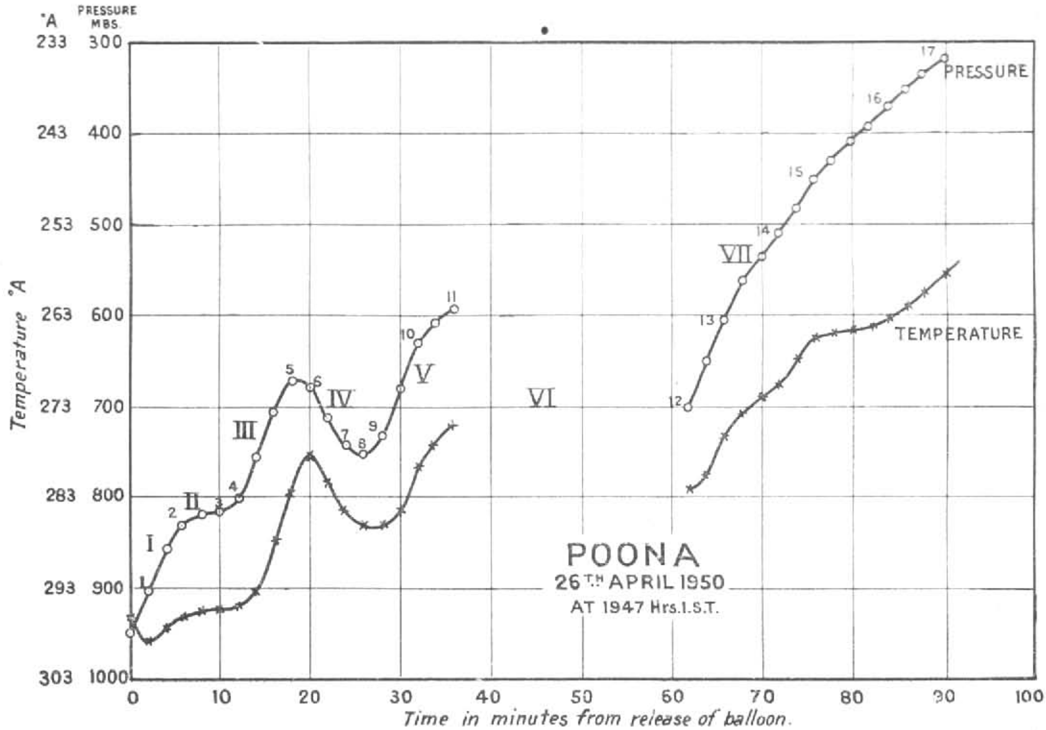
°A
PRESSURE MBS.
Temperature °A
PRESSURE
TEMPERATURE
POONA
26TH APRIL 1950
AT 1947 Hrs.I.S.T.
Time in minutes from release of balloon.

Fig. 1

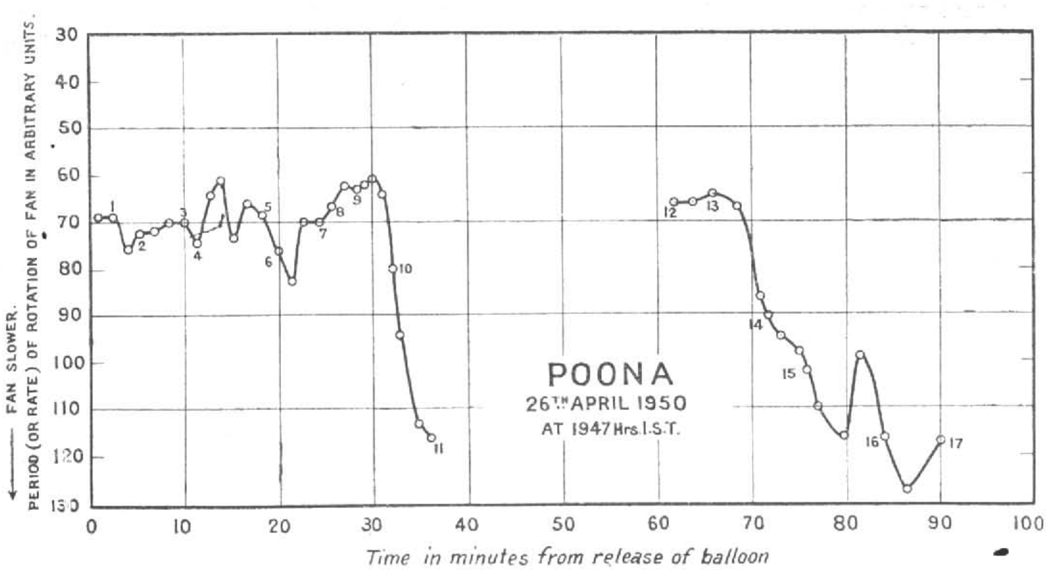
FAN SLOWER.
PERIOD (OR RATE) OF ROTATION OF FAN IN ARBITRARY UNITS.
POONA
26TH APRIL 1950
AT 1947 Hrs.I.S.T.
Time in minutes from release of balloon

Fig. 2

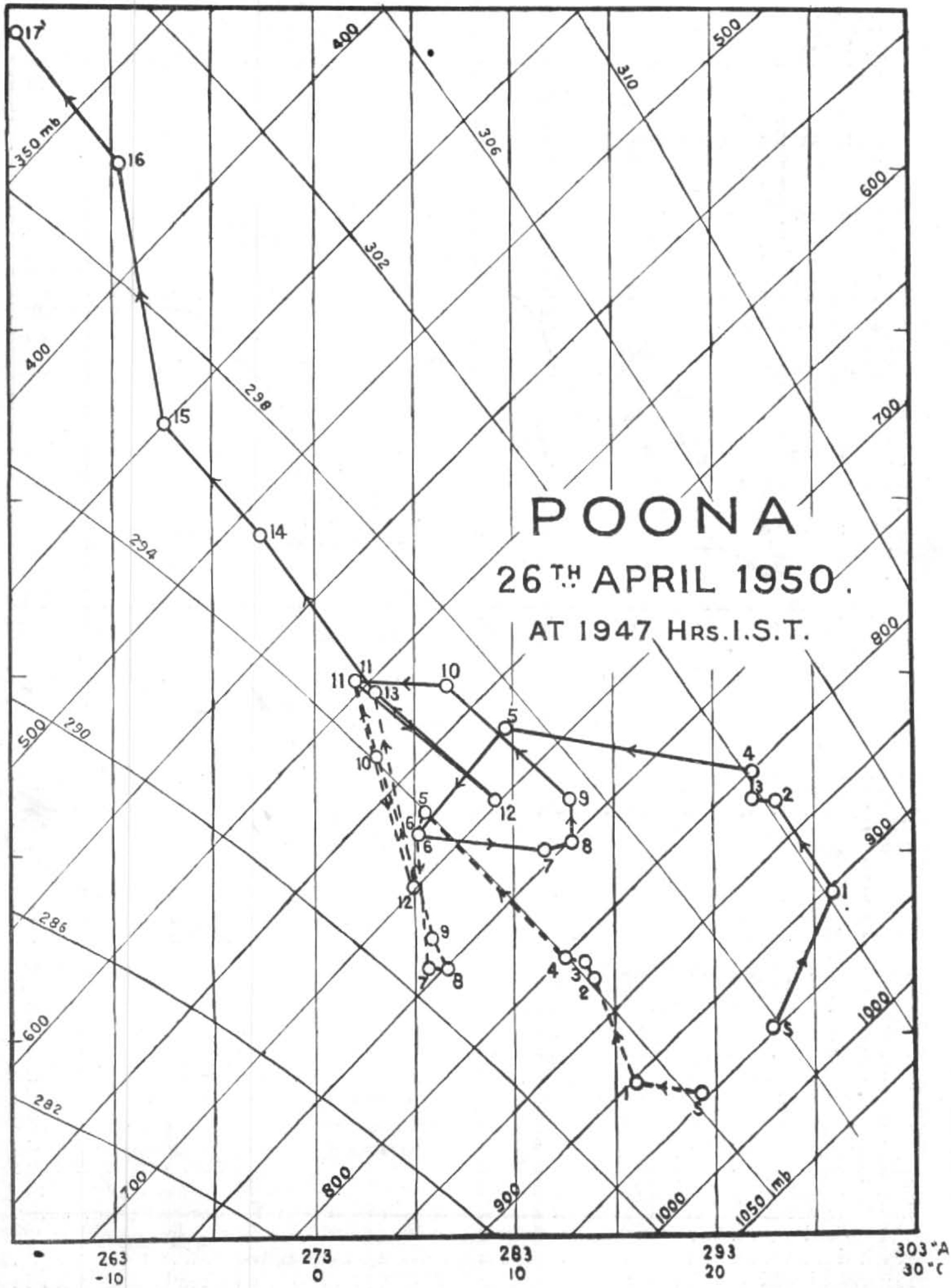
POONA
26TH APRIL 1950.
AT 1947 HRS. I.S.T.
350 mb
400
500
600
700
800
900
1000
1050 mb
282
286
290
294
298
302
306
310
263
-10
273
0
283
10
293
20
303°A
30°C

Fig. 3

When we examine the ascent curves in Figs. 1 and 2, it is observed that during the the phases II and IV, though the balloon was rising at an appreciably lower rate in phase II, and even descending in phase IV, the fan in the meteorograph was rotating almost at the same rate as, or even at a faster rate than in phase I during the ascent immediately after release. As the fan design is such that it can rotate only when there is an opposing wind along its axis of rotation, the balloon must have experienced in these two phases II and IV strong downward currents of air. The balloon had a free lift of 2500 gm before release, and as it was raining lightly at the time of release, there must have been a small decrease in this due to the weight of water on it. Comparing the rate of ascent, in the region corresponding to phase I with that at phase II, it is observed that the rate of ascent had decreased from about 13 kmph to about 3 kmph ; this corresponds to a downward current of approximately 10 kmph in phase II.

Similarly, a rate of ascent of about 15 kmph in phase III became a rate of descent of about 7 kmph in phase IV. The maximum downward current experienced by the balloon must have been not less than 22 kmph.

After about 30 minutes, the rate of ascent of the balloon decreased slightly, but the rate of rotation of the fan decreased very rapidly; the pressure in this region was about 675 mb and the temperature about 285°A. Later, after about 36 minutes from release, when the temperature of the air was approximately 2°C, and the pressure 600 mb, the fan rotation stopped. When the fan restarted rotation after about 60 minutes from release, the balloon was at about the 700 mb level. It, therefore, appears from the above, that the balloon was experiencing heavy rain or snow after 30 minutes and the accumulation of snow and the freezing of the rain stopped the rotation of the fan at about 36 minutes. It is probable that the balloon rose slightly higher after this, but later the accumulation was so great that it was forced down. It is probable that it reached a level lower than 700 mb, but the ice melted and the fan was free to rotate only at about 700 mb after 62 minutes. It is observed that during the last phase, the balloon rose only at the rate of about 8 kmph. This is probably because it started rising before all the snow collected on it had melted and again reached the freezing level when further melting would not have been possible.

2. *The tephigram*

The tephigram for the ascent is shown in Fig. 3. It shows the characteristics of the air at the different places where the balloon found itself during the ascent or descent. However, the following observations can be made from the tephigram.

(*a*) *Phases* I *to* IV—There was a ground inversion due to the rain cooled air. Up to the level corresponding to the characteristic point 5, the air was not saturated, and was even drier than what one would expect it to be. However, when the balloon reached the 671 mb level, the dry bulb temperature fell suddenly to that of wet bulb indicating a very high super-adiabatic lapse rate. Simultaneously, the balloon was caught in the downward current which brought it down from the 671 mb level to the 750 mb level. During this descent, the rise of temperature was almost along the dry adiabatic.

It is interesting to observe in this connection, that till the balloon reached the 671 mb level after its release, the wet bulb temperature of the air was changing along the saturation adiabatic. However, during the descent of the balloon, though the dry bulb temperature changed along the dry adiabatic, the wet bulb temperature remained almost the same. The reduction in the wet bulb potential temperature is presumably due to the descending column entraining air from outside the cloud.[2]

(*b*) *Phases* V *and* VI—After coming down to a level of 750 mb the balloon rose again till it reached the 593 mb level where the temperature was 2°C. In this region of the thundercloud, one should expect a large amount of wet ice which can easily stick to the balloon and the meteorograph cover. The accumulation was so profuse that the balloon was forced down due to its weight. This aspect has been already dealt with in previous paragraphs.

(*c*) *Phase* VII—The accumulated ice on the balloon described above, melted during the descent ; it is quite possible that during this stage, the balloon reached a much lower level than that corresponding to 698 mb ; ice must have been melting at this lower level at a gradual rate, with the result that the balloon rose so slowly that the fan was not rotating. However, at the stage when it reached the 698 mb level, some pieces of ice might have slipped down suddenly and the balloon started rising more rapidly and the signals began to be received again.

The region of the atmosphere through which the balloon rose during the phase VII had a lapse rate nearly equal to that of the saturation adiabatic till it reached the 450 mb above which it decreased to about 1°C/km till 372 mb, above which level, the lapse rate again increased. Probably the envil of the thunderstorm was in the region between 450 and 372 mb, *i.e.*, between 6·8 and 8·3 km above sea level.

From the above analysis, one can also observe that the up and down currents are mainly near the boundary of the warm air mass below and the cold air mass above. The currents extend from about 750 mb to 650 mb.

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