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SOME CHARACTERISTICS OF A RADIO THEODOLITE ASCENT THROUGH CUMULONIMBUS CLOUDS

Nagpur Airport experienced intense thunderstorm activity towards the evening of 3 September 1970. The present note describes the behaviour of a radiosonde balloon released at 1920 IST for the routine radiosonde ascent and which was presumably caught up in the thunderstorm updrafts at about 5 km. The velocity of the updraft, the vertical extent of the *Cb* cell etc, have been calculated from the variations in the rate of ascent of the balloon.

2. The rate of ascent of the radiosonde balloon on 3 September 1970 is shown in Fig. 1. During the first 3 km of the ascent, the balloon rose with approximately the normal rate of ascent for this layer, *viz.*, 20-24 kmph. From 3 to 5·3 km the rate of ascent decreased to 10 kmph, but above 5·3 km shot up to 48 kmph at 7·4 km. Except for a slight fall at a height of 8·6 km the rate of ascent remained practically constant around 50 kmph upto 9 km. After 9 km the rate of ascent decreased abruptly and above 12 km, it attained once again the usual value of 10-15 kmph for those levels.

3. According to Petterssen *et al.* (1945), vertical velocities in convective currents are unlikely to exceed 10-15 m/sec. Allowing for the normal rate of ascent, the updraft velocity between 5·3 to 9 km works out to 8-10 m/sec. It is, therefore, likely that the balloon entered *Cb* cell at an altitude of 5·3 km and was caught up in its updraft and carried aloft with an accelerated speed upto a height of 9 km, wherefrom it was subsequently released from the influence of the updraft.

4. The temperature profiles recorded during the radiosonde ascent is shown in Fig. 2 and indicates a shallow layer of cold air at the surface and moist-adiabatic lapse rate upto 730 mb. From 730 mb to 605 mb, an isothermal layer was present above which till 500 mb, the lapse rate was again moist-adiabatic. At 500 mb (5·3 km) when the balloon entered the cell, the lapse rate became super-adiabatic till 430 mb where the temperature was —20°C. The existence of superadiabatic lapse rate in *Cb* cells has also been reported by Venkiteshwaran and Tilakan (1952). Below —20°C, no further growth in solid state occurs according to Knight and Knight (1970), since most of the supercooled water freezes by —20°C. Only in extraordinarily strong updrafts of the value of 33 m/second, is the super cooled liquid

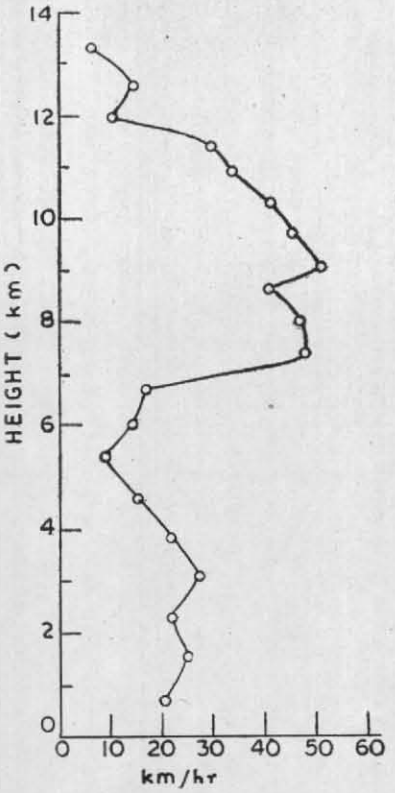

Fig. 1. Rate of ascent of the balloon

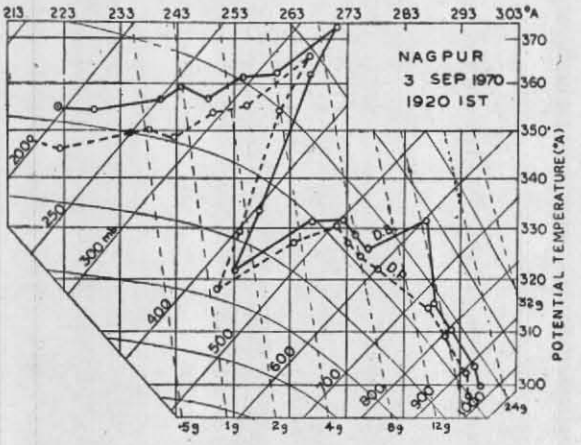

Fig. 2. Temperature profile of the sounding

water carried well above the freezing level (Byers 1949). In the present case, the height of the —20°C isotherm above the freezing level was 2·8 km. In agreement with the updraft velocity encountered in this case, it is unlikely that any supercooled water droplets remained unfrozen below —20°C. The latent heat thus liberated can account for the steep rise in temperature till 330 mb, where it reached 0°C. The top of the *Cb* cell, was shown by the weather radar to extend to approximately 9 km, it is assumed that the

balloon left the cell at its top, *i.e.*, at 330 mb (10 km). Deshpande (1963), has, in one case, also reported temperatures above freezing point at the top of a *Cb* cell.

After the balloon left the cell, it again encountered a steep temperature lapse upto 315 mb. A similar fall in the lapse rate, when the balloon probably has left the cell, was noticed by Barnes (1970). As has been pointed out earlier, the balloon ascended normally above 330 mb.

From the characteristic features of the sounding mentioned above, it would appear that the radiosonde balloon entered a thunderstorm cell and was caught up in its updraft at 5·3 km. The updraft velocity is estimated as 8-10 m/sec. The region of updraft in the *Cb* cell seems to have been extended to 9 km nearing the top layers of the cell. The existence of superadiabatic lapse rates in the first part of the updraft region and the occurrence of considerably high temperature at the top of the cell are also interesting.

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