

Letters To The Editor

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SOME OBSERVATIONS OF TURBULENCE IN THE UPPER TROPOSPHERE OVER POONA

Venkiteshwaran and Jayarajan (1952) have shown how regions of turbulence can be located in the upper air from the records of the F-type radiosondes by observing the rate of rotation of the paper fan, indicated by the length of the paper tape record for a complete Olland cycle. Observations of clear air turbulence recorded by aircraft pilots reveal that the optimum level for its occurrence is about 10 km, roughly the height of the tropopause in the middle latitudes (Bannon 1951, Jones 1949). Cases have, however, been also reported at much higher and lower levels. Arnold (1954) has described instances of severe turbulence in the stratosphere in the region between 24 to 32 km when the radiosonde even separated from the balloon. Sinha (1954) has examined the Dines meteorograph ascents at Agra, and shown that regions of blur occurring in the records can be attributed to turbulence. He has also analysed the regions where they occur in different months. He has shown from these records, that the distinct regions in the upper troposphere and stratosphere where turbulence can exist are between 150-200mb and 50-100 mb. The present note describes the features of turbulence observed from the F-type radiosonde ascents at Poona in 1954, at levels above 10 km, when the balloons reached a height not less than 18 km. The lowest temperature in the tropopause is attained at Poona between 17 and 19 km.

In 1954, about 32 F-type radiosonde flights reached the tropopause and above. The maximum height reached by the balloon was 21 km. Seven out of these flights showed only small or no turbulence above 10 km. Only on two occasions, the sky was overcast or drizzling at the time of ascent. However, since the region under examination is 10 km

and above the weather at the time of release of the balloon is not of importance unless thundery conditions were prevailing.

The following figures are some examples showing the variation of temperature with height and the corresponding variation of the rate of rotation of the fan as indicated by the length of the paper tape per complete cycle.

It is observed from most of the flights, that the regions of turbulence lie between 12-15 km and between 15-17 km. They are generally below the level of lowest temperature in the tropopause. When turbulence is observed in both the regions, they are generally separated by a distance of 2-3 km. The general depth of the regions of turbulence is only about one kilometre or less, though occasionally it has been 2 km. Their intensity is such as to cause rotation of the fan in the 12-17 km region to correspond to the normal rotation of the fan in the 6-7.5 km region.

In the regions of the tropopause above the level of lowest temperature, at about 17km no appreciable turbulence has been observed. In a large number of cases, there has been a sharp and rapid decrease in the rate of rotation of the fan above 17 km. Scrase (1954) has shown how a marked drag coefficient occurs on a balloon at high altitudes, *viz.*, approximately 18 km for 2 kgm balloons. The drag coefficient increase is associated with the decrease in Reynolds number as the balloon ascends. When a critical Reynolds number of drag conditions occurs there is a change from the turbulent to laminar boundary layer flow around the balloon. Since the laminar boundary layer has a greater thickness than the turbulent boundary layer the balloon drags more air with it and therefore rises less rapidly, when it has reached a certain critical level in the upper atmosphere. It is also feasible

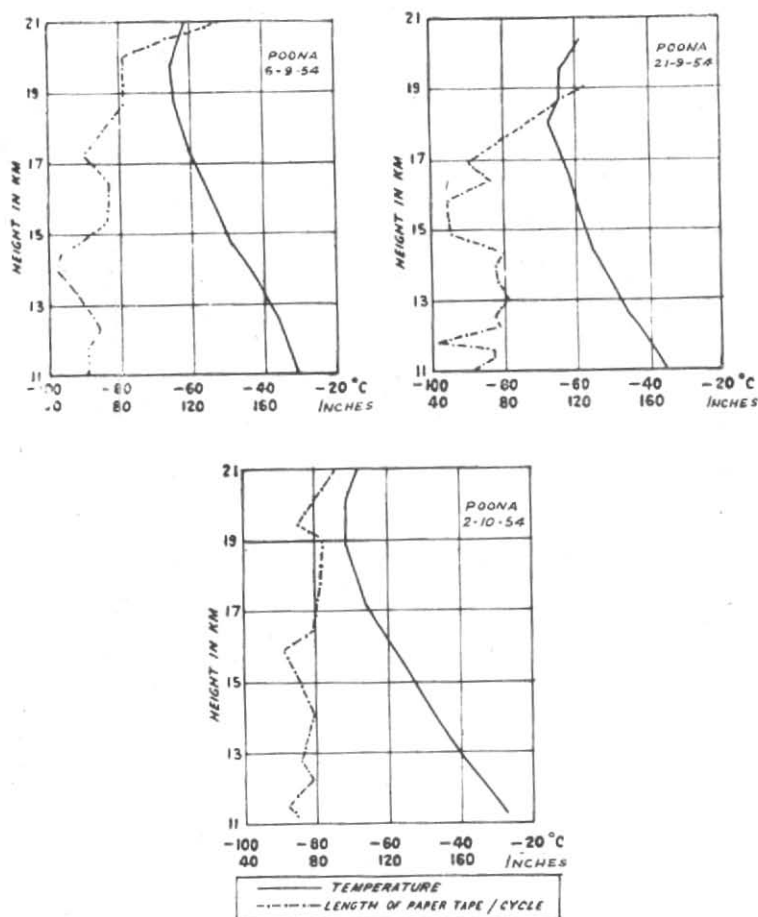


Fig. 1

that the decrease in the rate of ascent of the balloon, as indicated by the rate of rotation of the fan, is closely related to the change in lapse rate and its effect on the difference in temperature between the

gas in the balloon and the air outside.

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REFERENCES

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| Arnold, A. | 1954 | <i>Bull. Amer. met. Soc.</i> , 35 , 8, pp. 377-378. |
| Bannon, J. K. | 1951 | <i>Prof. Notes</i> , Met. Office, London, 7 , 104. |
| Jones, R. F. | 1949 | <i>Met. Res. Papers</i> , London, 484. |
| Scrase, F. J. | 1954 | <i>Quart. J. R. met. Soc.</i> , 80 , 345, pp. 369-376. |
| Sinha, K. L. | 1954 | <i>Weather</i> , 9 , 1. |
| Venkiteshwaran, S. P. and Jayarajan, A. P. | 1952 | <i>Indian J. Met. Geophys.</i> , 3 , 3, pp. 203-211. |