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Some features of the topography of mean monthly 300-mb surface over India

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(*Received 26 October 1959*)

ABSTRACT. The range of variation of the monthly mean height of 300-mb surface over India suggests a threefold classification of the radiosonde stations in India. Little relation is seen between the highest mean maximum ground temperature and the highest mean height of 300-mb surface. This surface is practically level over whole of India from June to September and later during the year, slopes down from south to north from 70°N onwards, the slope increasing every month upto January and falling thereafter. Over South India there is very little annual variation.

1. Data used

The monthly mean values of the height of 300-mb surface used in the analysis have been extracted from the tables of Normals of Temperatures, Contour heights and Dew-points prepared in 1955 by the India Meteorological Department for departmental use. In cases where published normals appeared doubtful, new normals were computed by taking from the original records. daily values for the period of five years, 1951—55 if available, and for whatever period possible, in case the observations are not available for these five years. Surface temperatures given in Table 1 have been taken from *Climatological Tables of Observatories in India* (1952) published by India Meteorological Department.

2. Analysis

An analysis of the monthly normals of the height of 300-mb surface over India reveals the following interesting features.

2·1. *Classification of the radiosonde stations*—The shapes of the monthly mean heights over the stations suggest a threefold classification of the radiosonde stations in India, partitioned, as it were, by 22° and 17°N latitudes.

Group 1—Stations north of 22°N, *viz.*, Delhi, Jodhpur, Shillong, Allahabad and Calcutta (see Fig. 1), exhibiting bell shaped curve, *i.e.*, large annual variation.

Group 2—Stations between 22° and 17°N, *viz.*, Nagpur, Veraval, Santacruz, Poona and Visakhapatnam (see Fig. 2), exhibiting a dome-shaped curve, *i.e.*, a smaller annual variation.

Group 3—Stations south of 17°N, *viz.*, Madras, Port Blair and Trivandrum (see Fig. 3), exhibiting a small annual variation and even suggesting a double peak.

2·2. *Relationship between mean values of surface temperature and height of 300-mb surface*—From Table 1 it is seen that the highest values of the 300-mb isobaric levels are attained in July at most of the stations of Groups 1 and 2. At Calcutta, although the highest value is in August, it is only 1 m more than the July value. At Veraval, however, the highest value is reached earlier in June but exceeds the July value only by 6 m. It is possible that these exceptions arise on account of the instrumental error and error of averaging. At stations of Group 3 the highest values are reached in April or May and a feeble secondary maximum of value is reached in November.

Theoretically, the thickness of the layer between 1000-mb and 300-mb is proportional to the mean temperature of the layer. If it is granted that the variation of the height of 1000-mb level is negligible in comparison with the variation of 300-mb level, it can

TABLE 1

Highest and lowest values of monthly mean contour heights of 300-mb surface and of the monthly mean maximum surface temperature, and the range of variations of monthly mean heights

Station	Highest		Lowest		Range between highest and lowest value of height of 300-mb surface (metres)
	Geopotential height (metres)	Surface mean max. temperature (°F)	Geopotential height (metres)	Surface mean max. temperature (°F)	
1. Delhi	9729 (Jul)	104·8 (May)	9360 (Jan)	70·5 (Jan)	369
2. Jodhpur	9724 (Jul)	105·4 (May)	9400 (Jan)	76·3 (Jan)	324
3. Shillong	9785 (Jul & Aug)	75·3 (Jul)	9502 (Jan)	60·1 (Jan)	283
4. Allahabad	9722 (Aug)	107·1 (May)	9447 (Jan)	74·8 (Jan)	275
5. Calcutta	9725 (Aug)	96·8 (Apr)	9517 (Jan)	79·4 (Dec)	208
6. Nagpur	9734 (Jul)	108·7 (May)	9574 (Jan)	81·7 (Dec)	160
7. Veraval	9725 (Jun)	89·2 (Nov)	9592 (Jan)	81·8 (Feb)	133
8. Santacruz	9744 (Jul)	91·1 (May) (Colaba)	9634 (Jan)	83·1 (Feb) (Colaba)	110
9. Poona	9731 (Jul)	100·9 (Apr)	9627 (Jan)	81·7 (Aug)	104
10. Visakhapatnam	9710 (Jun)	92·0 (May)	9637 (Feb)	80·6 (Jan)	73
11. Madras	9726 (Jun)	101·3 (May)	9680 (Sep)	84·1 (Dec)	46
	9704 (Nov)		9691 (Jan)		
12. Port Blair	9745 (May & Jun)	89·1 (Apr)	9716 (Sep)	83·1 (Sep)	30
	9721 (Nov)		9715 (Dec & Feb)		
13. Trivandrum	9738 (May)	88·7 (Mar)	9695 (Jul)	82·7 (Jul)	43
	9717 (Nov)		9703 (Jan)		

be said that, generally, the highest values of the mean temperature of the above layer are attained in July in the case of stations of Groups 1 and 2 and in April or May in case of stations of Group 3. It may be seen from column 4 of Table 1 that the highest values of monthly mean maximum surface temperatures are reached in the period April to June at stations of Groups 1 and 2 and in the period March to May at stations of Group 3. Comparing, from columns 3 and 4, the months when the highest mean temperatures of the 1000–300-mb layer (as inferred from highest values of 300-mb surface) on the one hand and the highest maximum temperature of the surface on the other occur, it is seen that there is little relation between the two. This lack of correspondence perhaps indicates that the ground heating is far from responsible for the magnitude of the mean temperature or the thickness of the layer.

The lowest levels of the 300-mb surface are reached in February at Visakhapatnam and Port Blair and in January at the other stations. At stations of Group 3 a feeble secondary minimum value also is reached in another month. The lowest values of monthly mean maximum temperatures at most of these stations are reached in December or January (*vide* Table 1). On comparing columns 5 and 6 it is seen that the primary minimum heights are reached in the same period as lowest mean maximum temperature.

3. The behaviour of the mean 300-mb surface

An examination of Figs. 1 to 3 reveals an interesting pattern of variation of the slope of the monthly mean surface. North of 17°N, the height of the normal surface, in any month, generally decreases (*i.e.*, the surface slopes down) with latitude. This south-north slope is a maximum in January falling by 267 gpm from Poona to Delhi. The average gradient is roughly 260 gpm for 10° of latitude, *i.e.*, 1 in 4000. With the advance of summer this slope of the mean surface diminishes. The mean surface becomes practically level in the month of June and remains so till September although the height of this level rises and falls during the period. After September, however, the northward slope of the mean surface increases month after month till the highest value is reached in January.

Figs. 1 and 2 show that the curves are of the shape of an ogive to the left and straight line to the right, indicating that although the rate of fall of the monthly normal surface over the stations from September to January is uniform, the rate of its subsequent rise is, at first, gradual from January to March and then rapid from March to June.

At stations of Group 3 the height of the mean surfaces varies very little from station to station in a given month and from one month to another over given station. The range of variation of heights from one station to another in any month never exceeds 38 m. The range of variation from one month to another over any station is never more than 46 m. The heights of mean monthly surfaces over the stations vary only slightly from month to month. It is also noticed from the figures that the mean surface rises and falls twice in the course of the year.

The range of the heights of the surface over stations during each month shown in Table 2 and Fig. 4 indicates that the surface is almost level over the country in the months of July, August and September. In view of the fact that the height of the surface over all the stations rises or falls in step (see Figs. 1-3), this figure also confirms the conclusion reached above from the shape of the curves that (*i*) the south to north slope of the 300-mb surface increases uniformly from September to January, (*ii*) it decreases at first more gradually from January to March and later more rapidly from March to June, and (*iii*) it remains practically level from July to September.

The annual range of the monthly mean values of heights is highest at Delhi, in the

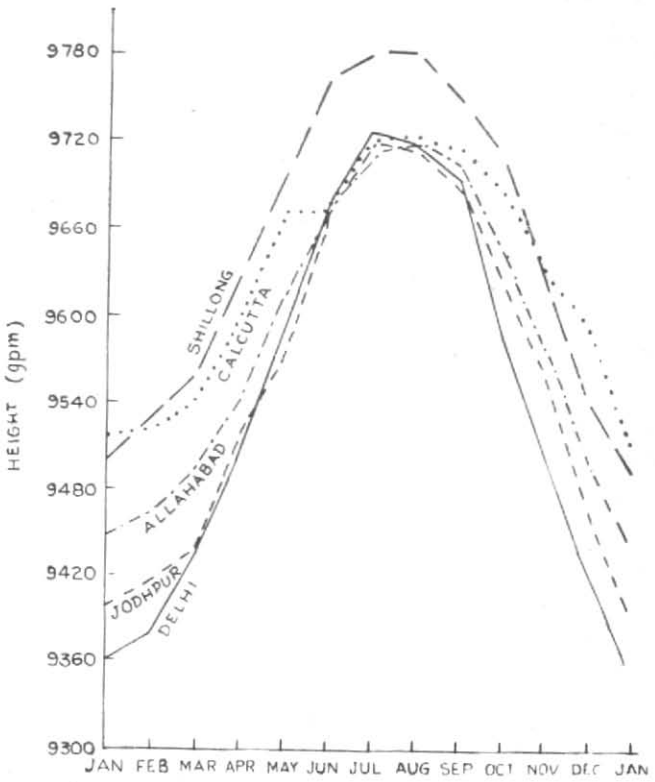

FIG. 1. MONTHLY NORMALS OF STATIONS NORTH OF 22°N

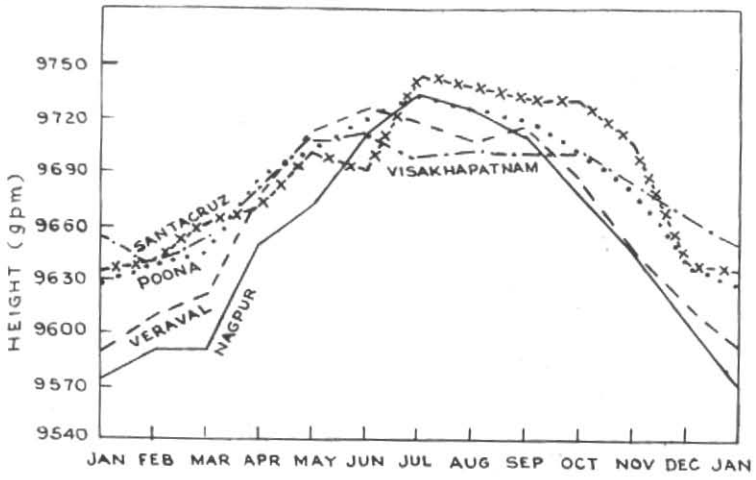

FIG. 2. MONTHLY NORMALS OF STATIONS BETWEEN 17°N AND 22°N

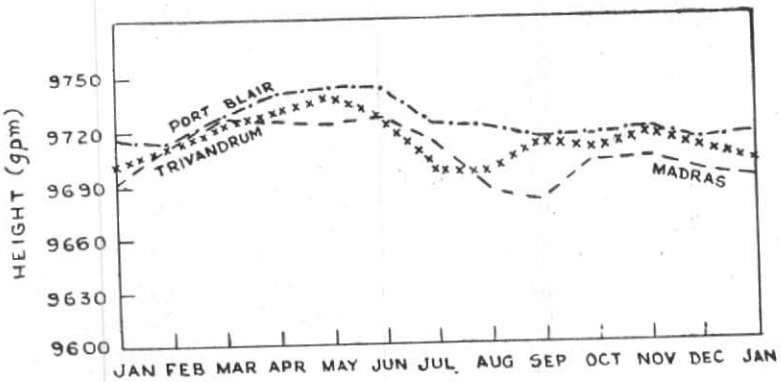

FIG. 3. MONTHLY NORMALS OF STATIONS SOUTH OF 17°N

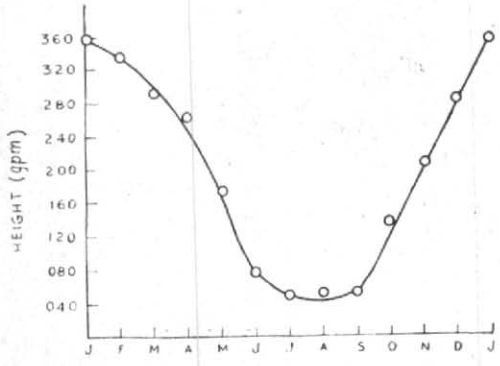

FIG. 4. MONTHLY RANGE OF NORMALS OVER INDIA

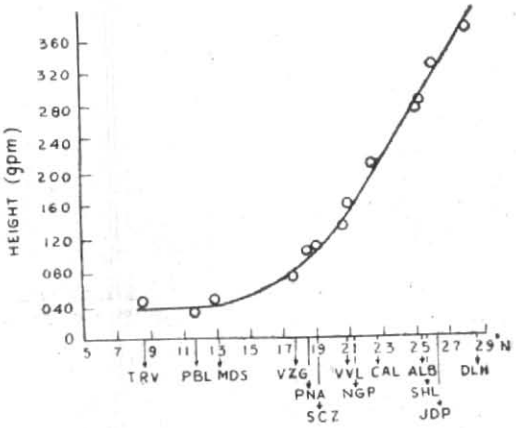

FIG 5. ANNUAL RANGE OF NORMALS SHOWN LATITUDE-WISE

TABLE 2

The range of variation of the normal values over the station during each month

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Range	357	336	292	262	174	75	49	54	51	139	209	284

NOTE—The values of normals for July, August and September over Shillong have not been taken into account as they appeared abnormal in comparison with other stations and hence unreliable

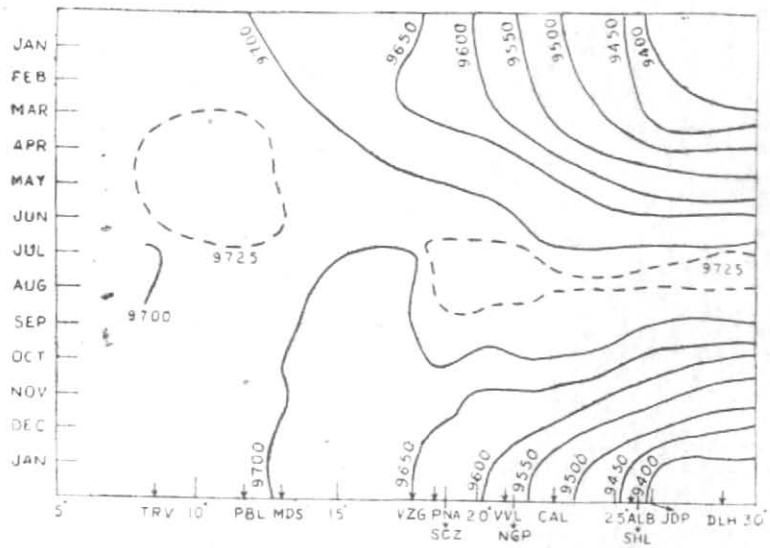

FIG. 6. CONTOURS OF MEAN 300-MB SURFACE LATITUDE VS TIME IN MONTHS

farthest north, and lowest at Port Blair in the south. In Fig. 5 the range at each station is plotted against its latitude. It is seen that these points are aligned along a smooth curve rising up rapidly. This indicates that the annual range not only increases from south to north but also increases at a *faster rate* northwards from Visakhapatnam.

With a view to obtaining a synoptic picture of the normals under study, these values were charted at points corresponding to the latitudes of the stations on one axis and months on the other. Isopleths representing equal values of contour heights were drawn at intervals of 50 m, *vide* Fig. 6. In their own language these isopleths corroborate the conclusions drawn above. As the language of the curvature and gradient of the isopleths is obvious no explanation is offered.

4. Acknowledgements

I wish to acknowledge, with thanks, the guidance given by Dr. P. R. Pisharoty in preparing this note and the help rendered by my colleague, Mr. R. Chellappa in making some of the computations required for verification.