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On predicting 300-mb contour heights and temperatures from 500-mb data

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ABSTRACT. It has been shown in this paper that simple relationships exist, in India, between 1000–500 mb and 500–300 mb thicknesses and also between 500–300 mb thickness and 300 mb temperature. The utility of these relationships in providing a quick and fairly accurate check during analysis is brought out. The possibility of using these relationships for 300 mb prognosis has also been indicated.

1. Introduction

Three dimensional weather map analysis is based on the construction of contour charts from the surface upwards. In drawing these charts, the surface analysis is taken as corresponding to the 1000-mb level which, because of the availability of a large number of observations, is most reliable.

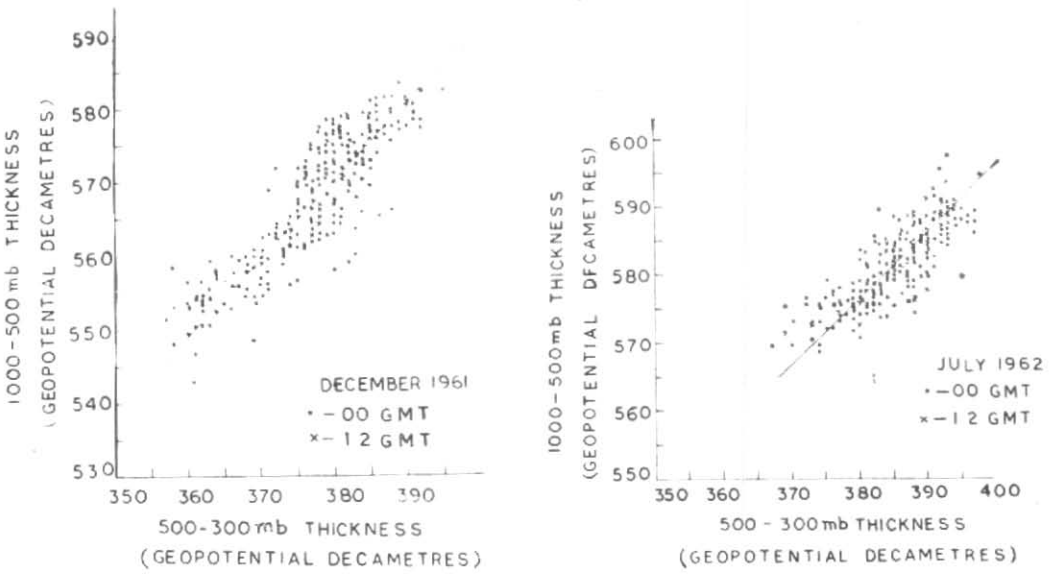
The standard practice after that is to prepare the relative topography of a higher level with the help of thicknesses and shear winds. A graphical addition of the 1000-mb level and the relative topography of the higher level will provide the absolute topography of the higher levels. The process can then be repeated for still higher level. This practice is, however, not in vogue in our country as it is rather time consuming and not practicable within the operational time limits. As such the absolute topographies are directly drawn at the various levels as obtained from the upper air reports.

It is found in actual practice, that this method can be followed easily upto about 500 mb. As the density coverage of wind reports decreases markedly above this level, the analysis becomes extremely difficult in the weak gradients existing in tropical latitudes. This fact, together with the spareness of radiosonde data, makes it more or less subjective. It is also seen that, at higher levels, the quality of data begins to fall off somewhat and in order to maintain the continuity of charts, the analyst has to apply individual checks to a large number of radiosonde values.

At the same time, the present day demands require that charts should be available at least upto 300-mb level. It is, therefore, not only desirable but also essential to have some method by which the relative topographies of 300-mb level can be determined with the help of 1000-500 mb relative topographies. Such a method, if available, will not only result in de-facto increase in the number of values available (on which to base the 300-mb chart) but will also provide a ready check on the accuracy of the radiosonde data.

Many meteorological services are using empirical relationships for computing the 300-mb relative topography and 300-mb temperatures expressed as functions of the parameters at lower levels. These methods have been summarised in *W.M.O. Tech. Note*, No. 35 (Techniques for high-level analysis and forecasting of wind- and temperature-fields—1961).

It is worthy of note that while in countries in middle and higher latitudes, definite relationships governing these parameters are found to exist; the Sudanese Meteorological Service is of the view that 'no correlation between 1000-500 mb and 500-300 mb thicknesses seems to exist in the tropics' (see *W.M.O. Tech. Note*, No. 35, p. 122). Therefore, an effort is made in this paper to check if



Figs. 1 and 2. Relationship between 1000-500 mb and 500-300 mb thicknesses

really no such relationships exist in all areas of tropics and, if they exist, what are the exact relationships for Indian region.

2. Data

For exploring the existence of any possible relationship between 1000-500 mb and 500-300 mb thicknesses and temperature at 300 mb and the 500-300 mb thickness, data for the two representative months, *viz.*, December 1961 and July 1962 at the following stations were taken—

Station	Long. (E)	Lat. (N)
1. Trivandrum	76°57′	08°29′
2. Port Blair	92 43	11 40
3. Nagpur	79 07	21 09
4. New Delhi	77 12	28 35
5. Gauhati	91 43	26 05

Both 00 and 12 GMT observations were made use of. Thickness graphs were plotted and are shown in Figs. 1 and 2.

It is reasonable to think that there will not be much difference between the thickness at 00 and 12 GMT of the same date because any possible diurnal variation in the absolute topography will produce a corresponding change in the absolute topography of the higher level. So composite graphs were drawn for December 1961 and July 1962 by combining the 00 and 12 GMT values. These are shown in Fig. 3.

The 300 mb temperature and 500-300 mb thickness relationships are shown in Figs. 4 and 5.

3. Analysis

As will be revealed by Figs. 1 to 5, there exist straight line relationships between 1000-500 mb and 500-300 mb thicknesses and also between the 300 mb temperature and 500-300 mb thickness. The following simple equations are found to hold for these parameters in the two months representative of extreme seasons in India.

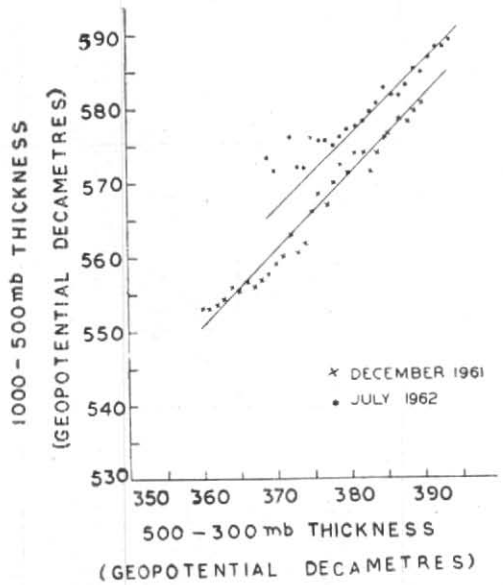


Fig. 3. Relationship between 1000-500 mb and 500-300 mb thicknesses

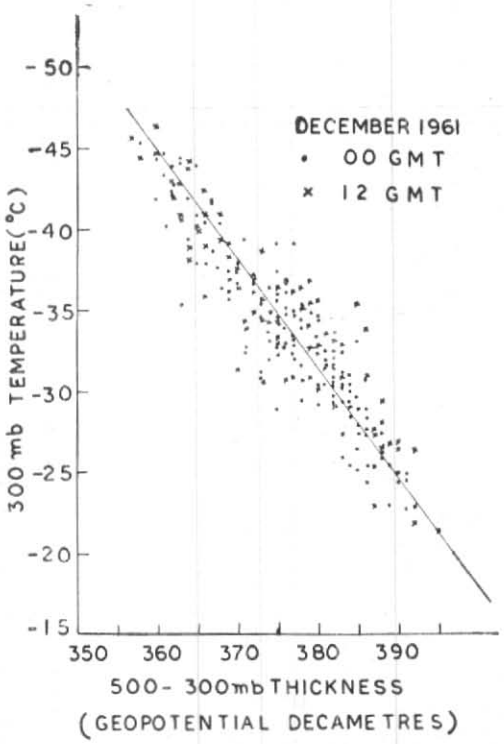


Fig. 4

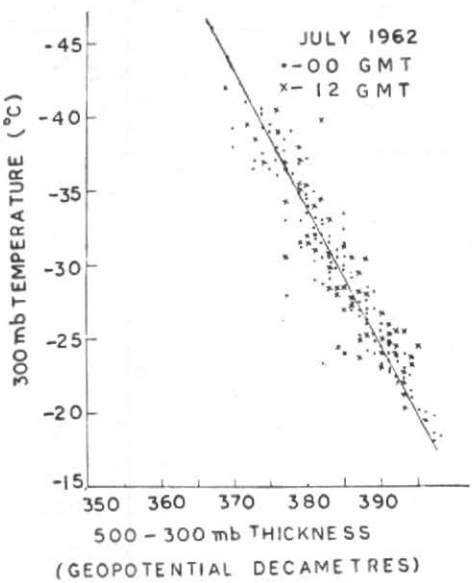


Fig. 5

Figs. 4 and 5. Relationship between 300-mb temperature and 500-300 mb thickness

December

Thickness $Z_{300-500}=Z_{500-1000}-190$

Temperature $t_{300}=0{\cdot}675\,Z_{300-500}-288$

July

Thickness $Z_{300-500}=Z_{500-1000}-196$

Temperature $t_{300}=0{\cdot}95\,Z_{300-500}-395$

where Z denotes the thickness (in geopotential decametres) between the isobaric surfaces denoted by the subscripts, and t gives the temperature in degrees centigrade at the isobaric surface denoted by the subscript.

4. Discussion

The relationships were tested at random for other months and years at different stations and were found to hold good within limits of ± 20 geopotential metres and $\pm 2°C$.

As will be seen, different relationships exist for the representative winter and summer months. As a working practice, the July relationship may be used for the period April—September and the December relationship between October—March. If, however, greater accuracy is aimed at, similar relationships may have to be worked out for every month and every station. The labour involved in working out such detailed relationships may not be commensurate with the gain in accuracy. This aspect is being looked into.

It will be appreciated that these relationships are quite simple to use and provide, in the first instance, a means of ready check available to the analyst for 300 mb analysis. To meet the exacting demands of modern aviation, the need and importance of 300 mb prognosis require no emphasis. But the preparation of prognostic charts for *each* level by the various conventional methods will be very cumbersome and time-consuming to the extent of being operationally not feasible. An easier and equally reliable technique will therefore be to prepare the 1000 and 500 mb prognostic charts by the conventional methods and then to make use of the relationships given in this paper to prepare the 300 mb prognostic chart.

5. Acknowledgement

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REFERENCE

W. M. O. 1961 *W.M.O. Tech. Note*, 35.