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On the relationship between 5-day mean 700-mb Contour Anomalies and 5-day mean surface Temperature Anomalies over the Indian region

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ABSTRACT. In this note, a study has been made of the geographical distribution of the correlation coefficients between 5-day mean 700-mb contour anomalies and 5-day mean surface temperature anomalies over the sub-continent of India during the winter season. It is seen that the two elements are positively correlated all over the above area. The correlation coefficients steadily increase northwestwards, the region with maximum value being located in west Rajasthan, north Gujarat and the neighbourhood. Regression curves have been drawn for the stations Ahmedabad and Jodhpur lying in the above areas and an objective method of forecasting 5-day mean surface temperatures from 5-day mean 700-mb charts has been suggested for these two stations.

1. Introduction

In the U.S.A., Namias and his collaborators have noticed a close and significant relationship between the 5-day (or 30-day) mean circulations and the average weather characteristics during the same 5-day (or 30-day) period and suggested some quantitative and objective methods of translating mean circulation patterns into temperature and precipitation. In this connection they made a detailed study of the mean contour patterns at 700-mb level with reference to the mean surface temperature distributions over the U.S.A. They found that there is a moderately good correlation between the mean contour anomalies and the mean temperature anomalies. Almost everywhere the correlations are positive. In some areas they are uniformly high enough to be of material assistance in translating 700-mb contour anomalies into surface temperature anomalies. In this note, a study has been made on similar lines to see if the mean contour anomalies are closely related to the mean temperature anomalies in the Indian region also and whether the mean contour charts could be used to issue medium range forecasts for temperature for the above region.

2. Preparation of mean charts

For the purpose of this study, 5-day mean 700-mb charts have been prepared for the Indian region and the neighbourhood for the winter months (January and February) of the years 1954—58. For the preparation of these charts, the same 5-day periods have been taken as were used by the Weather Bureau, U.S.A. for the preparation of their 5-day mean northern hemispheric charts. This has been done so that the mean charts prepared by the authors could be later extended on all sides (with the help of the data from the American charts) for the purpose of studying the genesis and progress of the important pressure systems which affect the weather over India. For such a study, charts covering a wide area is very necessary. During the period under study the Weather Bureau was issuing medium range forecasts twice or thrice a week and hence there is an overlapping period of one or more days in their two successive mean charts. The total number of mean 700-mb charts prepared in connection with the present study is about 90. The charts were prepared in the following way—

From the daily working 700-mb charts, constructed by differential method in Weather Central, Poona, contour values at the corner and central points of the various five-degree latitude-longitude squares were determined by interpolations. The 5-day means of the contour values at the above points were then worked out and plotted and the isolines drawn. Thus the 5-day mean 700-mb contour

patterns were obtained. The 5-day normal 700-mb charts were also prepared with the help of the normal data of the Indian radiosonde stations, which were available from the Office of the Deputy Director General of Observatories (Climatology), Poona.

For this study, 35 stations evenly distributed over the country were selected and the list is shown in Table 1. From the above two sets of charts, the 5-day mean contour values and the 5-day normal contour values were determined for each of the above stations for the various 5-day periods by interpolations and the contour anomalies for the station in question were obtained by subtracting the latter from the former.

Five-day mean surface temperature (average of maximum and minimum) was worked out for each of the above stations for the same five-day periods for which the contour charts were prepared. From the mean temperature for a particular 5-day period was subtracted the corresponding 5-day normal temperature. In this way temperature anomalies for the different stations for the various periods were obtained. Thus, two sets of values, namely, (1) 5-day mean 700-mb contour anomalies and (2) 5-day mean surface temperature anomalies were available for the 35 stations under study.

3. Analysis of data

The correlation coefficient between the above two sets of values has been worked for each station (Table 1) and plotted in Fig. 1. It is seen that the correlations are positive everywhere. The coefficients are lowest in the south Peninsula and along the east coast and increase steadily northwestwards, being maximum over west Rajasthan and north Gujarat where a uniform air mass, *viz.*, dry continental air generally prevails during the season under study. The low correlations in south Peninsula and along the east coast might be due to the complex interplay between land and maritime air in the lower levels which apparently disturb the general relationship between the two elements. Namias and his collaborators also noticed similar low correlations along the Pacific and Gulf Coasts.

Over west Rajasthan and Gujarat the correlations appear to be high enough to be of material assistance in determininig one element from the other, *i.e.*, in translating 700-mb height anomalies into surface temperature anomalies. The regression equation of of temperature anomalies y on contour anomalies x have been determined in respect of Ahmedabad and Jodhpur which are situated in the above areas. The equations are—

$$y = 0{\cdot}0488\,x - 1{\cdot}4642 \text{ for Ahmedabad (1)}$$

and $$y = 0{\cdot}0536x + 0{\cdot}4015 \text{ for Jodhpur (2)}$$

The regression lines are shown in Figs. 2 and 3 respectively. The x-arrays and y-arrays of data in respect of the above two stations are shown in Tables 2 and 3. The mean values have been plotted in Figs. 2 and 3 and it is seen that the points generally lie fairly close to the regression lines. These lines will enable one to make a fair estimate of the mean surface temperatures at the above two stations from the mean 700-mb contour values for these places.

4. Acknowledgement

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REFERENCES

Namias, J.	—	*Met. Monogr.*. **2**, 6.
	1947	*Extended Forecasting by Mean Circulation Methods*, U.S. Weath. Bur.
	1943	*Methods of extended forecasting—practised by five-day Forecast Section*, U.S. Weath. Bur.
Rai Sircar, N. C. and Lal, S. S.	1960	*Indian J. Met. Geophys.*, **11**, 3. p. 239.

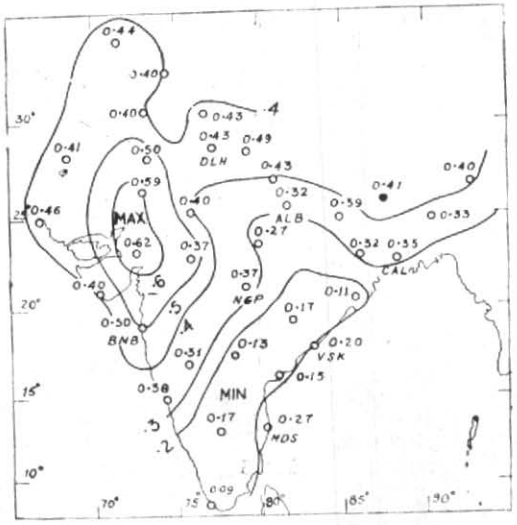

Fig. 1. Correlation coefficients between 700-mb contour anomalies and surface temperature anomalies over the sub-continent of India during winter season

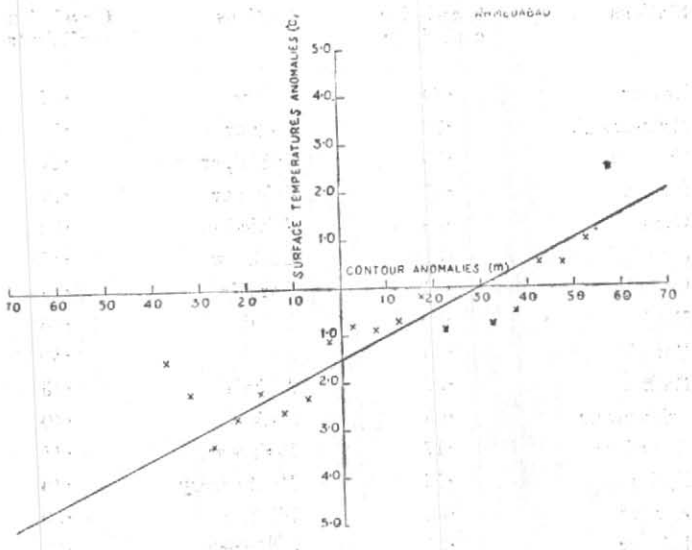

Fig. 2

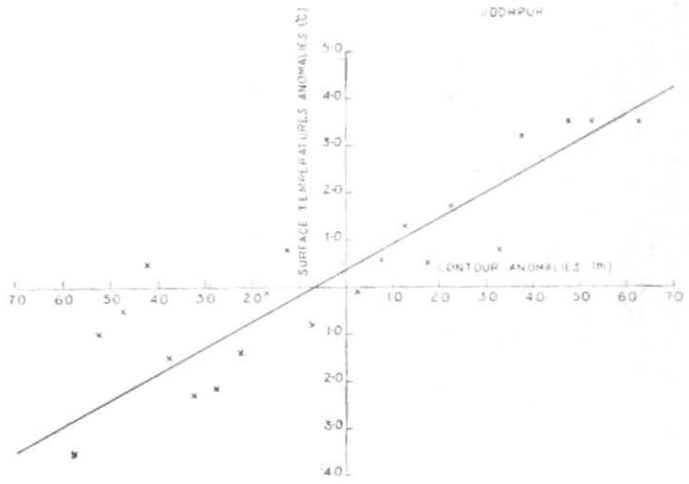

Fig. 3

TABLE 1

List of stations for which correlation coefficients have been calculated

Stations	Correlation coefficients	Stations	Correlation coefficients
Tezpur	·40	Indore	·57
Mymensingh	·33	Nagpur	·37
Calcutta	·35	Jagdalpur	·17
Purnea	·41	Jabalpur	·27
Gaya	·39	Allahabad	·32
Jamshedpur	·32	Lucknow	·43
Cuttack	·11	Bareilly	·49
Visakhapatnam	·20	Delhi	·43
Masulipatam	·15	Kotah	·40
Madras	·27	Ambala	·43
Trivandrum	·09	Sialkot	·40
Bangalore	·17	Peshawar	·44
Hyderabad	·13	Montgomery	·40
Karwar	·38	Bikaner	·50
Bijapur	·31	Jodhpur	·59
Bombay	·50	Jacobabad	·41
Veraval	·40	Karachi	·46
Ahmedabad	·62		

TABLE 2

Ahmedabad

Contour anomalies (x) (metres)	Surface temperature anomalies (y) in °C													Total	Observed means (°C)
	6·0 to 5·1	5·0 to 4·1	4·0 to 3·1	3·0 to 2·1	2·0 to 1·1	1·0 to 0·1	0·0 to —0·9	—1·0 to —1·9	—2·0 to —2·9	—3·0 to —3·9	—4·0 to —4·9	—5·0 to —5·9	—6·0 to —6·9		
—59 to —55															
—54 to —50															
—49 to —45															
—44 to —40															
—39 to —35							1		1					2	—1·5
—34 to —30								1	2					3	—2·2
—29 to —25								1	1	1		1		4	—3·3
—24 to —20								1	3		1			5	—2·7
—19 to —15							1	2	2		1			6	—2·2
—14 to —10							1		1	1	2			5	—3·1
—9 to —5							4	1	2	3			1	11	—2·3
—4 to 0						1	1	2	1					5	—1·1
1 to 5						1	1		1					3	—0·8
6 to 10					1		4	4	1					10	—0·9
11 to 15						2	1			1				4	—0·7
16 to 20						2		1						3	—0·2
21 to 25						2	1	3	1					7	—0·9
26 to 30				1		1	4	2	2					10	0·3
31 to 35						2				1				3	—0·8
36 to 40							1							1	—0·5
41 to 45						1								1	0·5
46 to 50					1			1						2	0·5
51 to 55					1	1								2	1·0
56 to 60					1									1	2·5
61 to 65															
Total				1	2	3	16	18	19	16	7	4	1	1	88	

TABLE 3

Jodhpur

Contour anomalies (x) (metres)	Surface temperature anomalies (y) in °C												Total	Observed means (°C)
	6·0 to 5·1	5·0 to 4·1	4·0 to 3·1	3·0 to 2·1	2·0 to 1·1	1·0 to 0·1	0·0 to —0·9	—1·0 to —1·9	—2·0 to —2·9	—3·0 to —3·9	—4·0 to —4·9	—5·0 to —5·9	—6·0 to —6·9		
—59 to —55										1				1	—3·5
—54 to —50						1			1					2	—1·0
—49 to —45							1							1	—0·5
—44 to —40						1								1	0·5
—39 to —35								1						1	—1·5
—34 to —30						1		1		1	1			4	—2·3
—29 to —25							1	1			1			3	—2·2
—24 to —20						1	3	1	2	1				8	—1·4
—19 to —15					1	1	2	1						5	—0·1
—14 to —10			1	1	3	1	1	2						9	—0·8
—9 to —5				1	1	1	1			1		1		6	0·8
—4 to 0		1	1			1	1							4	2·3
1 to 5				1	2	1		2		1				7	—0·1
6 to 10				1	3	1		2						7	0·6
11 to 15			1	1	1	2	1							6	1·3
16 to 20				1	2			2						6	0·5
21 to 25		1		1	1	3								6	1·7
26 to 30				1										1	2·5
31 to 35				1	1			1						3	0·8
36 to 40		1		2										3	3·2
41 to 45	1													1	5·5
46 to 50			1											1	3·5
51 to 55			1											1	3·5
56 to 60														0	0
61 to 65			1											1	3·5
Total	1	3	6	11	15	16	11	14	3	5	2	1		88	