Global temperature and monsoon activity

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In this paper an attempt has been made to search a new parameter for the prediction of the Indian summer monsoon rainfall. For this purpose the relationship of the global surface-air temperature of four standard seasons viz., Winter (December-January-February), Spring (March-April-May), Summer (June-July-August), Autumn (September-October-November) with the Indian summer monsoon rainfall has been carried out. The same analysis is also carried out with surface-air temperature anomalies within the tropical belt (30°S to 30°N) and Indian summer monsoon rainfall. For the present study data for 30 years period from 1958 to 1988 have been used. The analysis reveals that there is a strong inverse relationship between the monsoon activity and the tropical belt temperature.

1. Introduction

In order to improve the empirical forecast of the all India summer monsoon rainfall it is necessary to update the old parameters and to search for new parameters in the light of advanced scientific knowledge. Monsoon is basically a thermally driven large-scale circulation which can not be isolated from the planetary scale circulation. Therefore, it is expected that any global-scale thermal anomaly may have its influence on the monsoon. The present study deals with interannual variability of Indian summer monsoon rainfall and its possible relationship with global surface air temperature anomalies. For this purpose, Indian summer monsoon rainfall has been taken as an index of the large-scale performance of monsoon. Verma *et al* (1985) have shown that there is a remarkable correspondence between winter northern-hemisphere temperature and Indian summer monsoon rainfall. Recently Dugam *et al* (1993) have shown that the January temperature anomaly over De-Bilt is one of the new parameters for the seasonal forecasting of the Indian summer monsoon rainfall.

Recently, a dynamic stochastic transfer model has been developed by Thapliyal (1982) with some improvements in forecast accuracy. Gowariker *et al* (1989) made an attempt to develop parametric and power regression models which use signals from a large number of parameters that appear to be physically linked with monsoon circulation. These models are very useful for issuing the forecast for Indian summer monsoon rainfall. The search for a new parameter for these models will improve model performance in future.

2. Data details and analysis

The updated data of subdivisional and all India summer monsoon rainfall are obtained from Mooley and Parthasarthy (1984). The monsoon rainfall series for Peninsular and north-west India have been prepared by area weighted average of the corresponding subdivisions.

The monthly global and tropical belt (30°S to 30°N) surface air temperature data for the 30 year period from 1958 to 1988 have been taken from a compendium of data on global change (Thomas *et al* 1990). From these data the temperature anomaly data series for four standard seasons viz., Winter (December-January-February), Spring (March-April-May), Summer (June-July-August), Autumn (September-October-November) have been prepared and used for further analysis.

In this paper, we have analysed the global as well as tropical belt temperature for four standard seasons

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mentioned above. The correlation analysis is carried out between the global/tropical belt temperature anomaly and the Indian summer monsoon rainfall indices over three homogeneous regions. The lag and lead correlation analysis is also carried out between seasonal/annual tropical belt temperature anomaly and the Indian summer monsoon rainfall indices for three homogeneous regions of India.

3. Discussion

In order to understand the lag and lead relationship between the tropical belt temperature anomaly and monsoon rainfall, we have computed the correlation coefficients between the monsoon rainfall over the three homogeneous regions of India and tropical belt temperature anomaly of the (1) preceding year, (2) concurrent year and (3) succeeding year.

Table 1 gives the lag and lead correlation coefficients between the tropical belt temperature and the

Table 1. *Lag and lead relationship between seasonal, annual tropical temperature anomaly and rainfall departure for all India, peninsular India, northwest India (1959–1988).*

		All India	Penin. India	Northwest India
	−1	0.34	0.33	0.10
Winter	0	0.16	0.18	−0.08
(DJF)	1	−0.52*	−0.38#	−0.59*
	−1	0.29	0.30	0.06
Spring	0	−0.06	−0.03	−0.31
(MAM)	1	−0.22	−0.16	−0.34
	−1	0.26	0.19	0.08
Summer	0	−0.25	−0.16	−0.39#
(JJA)	1	−0.36#	−0.35	−0.33
	−1	0.29	0.25	0.07
Autumn	0	−0.17	−0.12	−0.31
(SON)	1	−0.22	−0.20	−0.18
	−1	0.29	0.23	0.06
Annual	0	−0.02	0.02	−0.23
(J-D)	1	−0.42#	−0.35	−0.43#

5% level of significance.
* 1% level of significance.

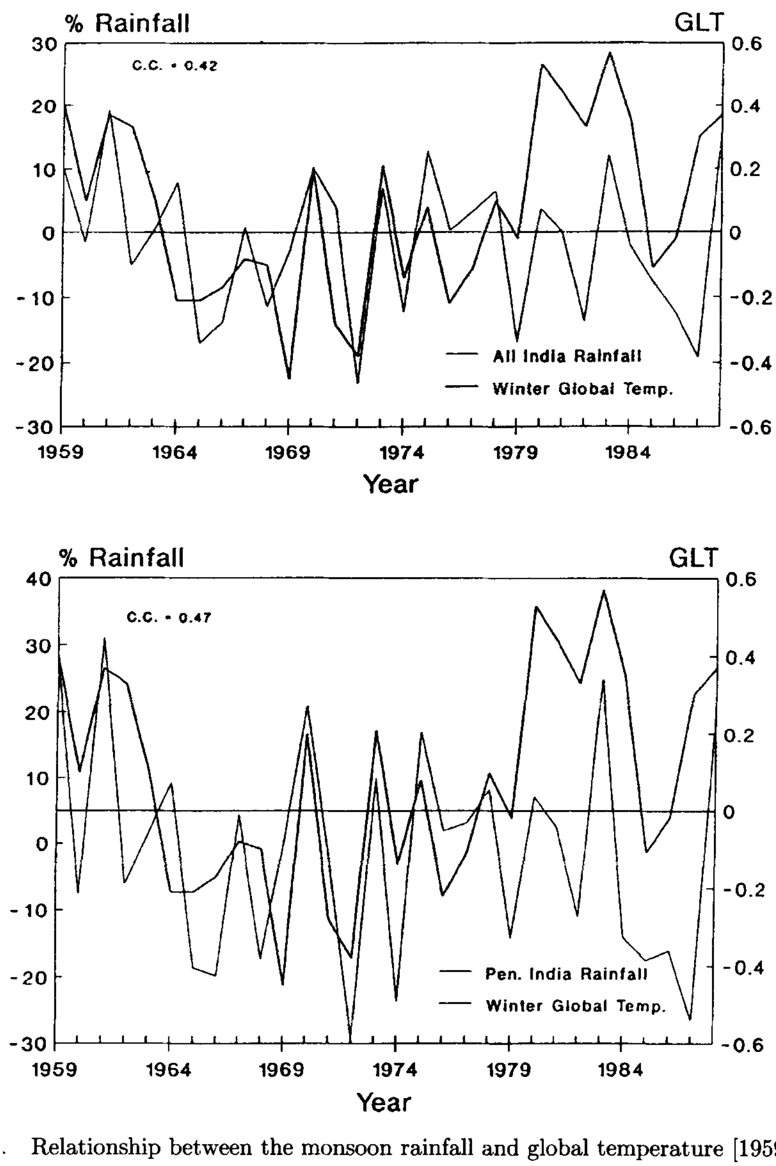

Figure 1. Relationship between the monsoon rainfall and global temperature [1959–1988].

monsoon rainfall over the above mentioned three regions of India. It seems that the succeeding year tropical belt temperature has an inverse relationship with monsoon rainfall. This relationship is statistically significant at 1% level. It suggests some negative feed back mechanism between the monsoon activity and the tropical belt temperature.

Similar analysis is carried out with seasonal global surface air temperature anomaly. Monsoon rainfall over all India and peninsular India show significant relationship with global surface air temperature anomalies in the winter season. The correlation coefficients are significant at 5% and 1% level. This relationship has a special importance that this parameter (global surface air temperature anomaly in winter) can be used for the long-range forecast of Indian summer monsoon rainfall.

4. Conclusion

- This study examined the relationship between the winter global surface air temperature anomaly and the Indian summer monsoon rainfall. The relationship is direct and is found to be statistically significant. This relationship assumes a special importance because of its predictive potential.
- There is a strong inverse relationship between the monsoon activity and the tropical belt temperature.

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