

CORRESPONDENCE

Comments on "An Apparent Relationship between Eurasian Spring Snow Cover and the Advance Period of the Indian Summer Monsoon"

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Dey and Bhanu Kumar (1982) find a relationship between Eurasian spring snow cover and the "advance period" of the Indian summer monsoon. A re-analysis of the data, however, does not support the conclusions of that study.

The first problem is that the snow cover data which are used have periods of missing data in the Himalayan region during the first part of the record (1966–74). This has been pointed out by Matson and Wiesnet (1981) and Dewey and Heim (1981, 1982). The values presented in Dey and Bhanu Kumar (1982) are virtually identical to those obtained from these data. A recent paper by Dickson (1983) illustrates the impact of the missing data upon the results of a snow cover–monsoon rainfall study. Any error introduced by missing data will become relatively greater as the spring season progresses.

One possible way to deal with this problem (Robock and Ahnert, 1983) is to exclude the Himalayan region from the analysis. Dey and Bhanu Kumar, however, hypothesize that the Himalayan snow cover has a radiative feedback on the circulation, so to exclude this area in order to produce a homogeneous time series would defeat their purpose.

Another way to investigate the relationships between snow and the Indian monsoon is to divide the period of data into two parts, the first one corresponding to the period with incomplete data, and the second containing the more recent complete analysis. We chose the periods 1966–72 and 1973–78 (Table 1). With deviations calculated for each period with respect to the means for each period, the correlation between the recomputed spring season Eurasian snow cover deviations and monsoon advance period ($r = 0.40$) falls substantially below the 95% significance level ($r = 0.58$). When we also recomputed the Eurasian spring snow-melt deviations with respect to the separate means for

each period and compare to the monsoon advance period, we find virtually the same correlation coefficient as Dey and Bhanu Kumar. This correlation coefficient also fails the significance test. Note also that the hypothesized negative correlation fails in 4 of the 6 years in the period 1973–78, the one with good snow data (Table 2).

The second problem is with the theoretical explanation for a relationship between Eurasian snow cover and the advance period of the monsoon. The hypothesis concerning the relationship between snow cover, mid-to-upper tropospheric heating, and monsoon strength is not convincing. In general, snow cover has a shallow surface cooling effect which enhances stability and inhibits vertical propagation of an anomaly. The only place in the Eurasian region where the surface is

TABLE 1. Eurasian snow cover deviations (10^6 km^{-2}) in the spring season (March–May) after Dey and Bhanu Kumar (1982).

Year	Deviations
1967–72 base period	
1967	–1.4
1968	–0.7
1969	0.9
1970	–1.2
1971	1.7
1972	0.9
1973–78 base period	
1973	0.1
1974	0.1
1975	–1.3
1976	1.3
1977	–0.5
1978	0.0

TABLE 2. Eurasian spring snowmelt (March snow cover minus May snow cover) deviations (10^6 km^2) of Dey and Bhanu Kumar (1982).

Year	Deviations
1967-72 base period	
1967	0.3
1968	3.1
1969	-2.9
1970	-1.4
1971	0.8
1972	-0.7
1973-78 base period	
1973	0.2*
1974	1.3*
1975	1.2
1976	-0.4
1977	-2.2*
1978	-0.1*

* Hypothesized correlation fails.

high enough to have a direct heating effect is over the Himalayas and the Tibetan plateau, precisely the region where the snow cover data are unreliable. We also question the choice of the "advance period" as the monsoon parameter to which to compare snow cover. Why should this parameter be related to snow cover, and not some other one such as total precipitation or the date of the onset of the monsoon?

To summarize, the study is open to question because it used snow cover data with missing observations over the Himalayan region during the first part of the study. This is precisely the area where good data are needed to test the theoretical justification for the data study. When we test their relationships for the period of the record with good data, neither of the hypothesized relationships between snow cover and the monsoon is statistically significant. There may indeed be a relationship between snow cover and the Indian monsoon, but better observational and theoretical studies are necessary to demonstrate it.

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