A possible mechanism for the weakening of El Niño-monsoon relationship during the recent decade

D. S. Pai

1. Introduction

Summer heating of Asiatic land mass relative to the surrounding oceanic water mass, which results in the land-sea thermal contrast is regarded as the principal cause of the Asian summer monsoon circulation. Indian summer monsoon, an important part of the Asian summer monsoon, is considered to be an active component of the global climate. It is well accepted that total rainfall received during the monsoon season (June–September) over Indian region is an indicator of the strength of Indian summer monsoon circulation. However, the Indian summer monsoon rainfall shows significant year to year variation. This is depicted in Fig. 1, which is the time series of All India Summer Monsoon Rainfall (ISMR) for the period 1901–1998 expressed as the percent departure of area weighted seasonal monsoon rainfall from the long period normal (Pai et al, 1998).

The year to year variation of ISMR is linked to number of forcings both local as well as remote. The sea surface temperatures (SSTs) over central and east Pacific Ocean are one of the important remote forcings, which influence the ISMR. In general, warm (cold) SSTs over central and east Pacific Ocean favor a deficient (excess) ISMR.
Flohn and Fleer (1975) made a preliminary survey of climatic anomalies in various tropical regions and found that several El Niño events (warm SSTs over the Pacific) were followed by drought conditions over India during the subsequent monsoon season. The association between El Niño and deficient monsoon rainfall was also later studied by number of other researchers (Sikka, 1980; Angell, 1981; Rasmusson and Carpenter, 1982; Thapliyal et al, 1998, etc.).

It is noticed that in the recent years the robust El Niño-monsoon relationship was weak. For example during the year 1997, which is the strongest El Niño event of the century, the ISMR was in the positive side of the normal. Krishna Kumar et al (1999) attributed the increased winter surface temperatures over Eurasia associated with the global warming trend as one of the reasons for the observed weakening of El Niño-monsoon relationship. They presumed the continuation of this Eurasian warming during the monsoon season and thereby increase the land-sea contrast, which may negate the effect of the El Niño. If this theory is true then the ISMR may never be deficient again as the 1995 IPCC report (Nicholls et al, 1996) predict the persistence of global warming trend for many more years. Incidentally the year 2002 was a deficient monsoon year (ISMR = −19%). Further, the examination of El Niño-monsoon rainfall relationship in past years shows that during the period 1921–40 also the El Niño-deficient monsoon rainfall association was weak (discussed in Sect. 3). This observation contradicts the argument of global warming trend over the Eurasia during winter induced by green house gas forcing as the real cause of the observed weakening of El Niño-monsoon relationship in the recent years (1901–98). Further it is not clearly understood how the temperature anomalies during winter act as an extended memory to influence the monsoon almost six months later.

Rajeevan et al (1998) have highlighted the significant precursory signals in the surface air temperatures over northwest Europe and Eurasia for the subsequent ISMR. They observed that during deficient (excess) monsoon years the meridional gradient in the surface air temperature anomalies over Eurasia during January is directed towards pole (equator). This temperature gradient acts as a precursor for the subsequent mid latitude blocking activity, which ultimately influences the Indian monsoon. In this study, it is shown that even after the global warming trends are removed from the surface air temperature data, such significant signals from Eurasia for the subsequent ISMR exist.

This study also examines the factors behind this precursory signal and attempts to explain the probable mechanism for the weakening of