



## **On associations between the 11-year solar cycle and the Indian Summer Monsoon system**

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In this observational study, the associations between the characteristics of the Indian Summer Monsoon (ISM) and the 11-year solar cycle have been investigated using a statistical analysis. A rather complex picture, with considerable spatial variation, has been observed. The most striking features appear in August and to some extent in July, where for higher solar activity, precipitation is reduced over the equatorial Indian Ocean and increased over the western Pacific Ocean and to a lesser extent over part of the Indian subcontinent. In terms of mechanisms, it is suggested that these associations result from a combination of effects: on one side, an effect which maximizes in July-August with warmer temperatures in the lower stratosphere for maximum solar activity, and is consistent with a reduction of the convective activity in the equatorial region and an enhancement in off-equatorial regions; on the other side, a modulation of the mean sea level pressure fields, with a more southerly position of the monsoon trough in June, and a northwestward shift of the Mascarene High in July-August consistent with a stronger monsoon circulation. High solar activity could also cool the February-March SST in the southern Indian Ocean, which weakens the subsequent monsoon. Observations over the period 1871-2001 confirm these associations. As a result of the reported mechanisms, the 11-year solar cycle has poor skill for foreshadowing the ISM as a whole. However, the associations, occurring on the time scale of months, provide a new insight and would be of considerable interest for further modeling studies.