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The linkages between Antarctic sea ice extent and Indian summer monsoon rainfall

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ABSTRACT

Teleconnection between the Antarctic sea ice and the tropical climate has been extensively investigated. This study examines the interannual relationship between the variability of sea ice extent in the Indian Ocean sector (20–90°E) and Indian summer monsoon rainfall under the influence of the Mascarene High. Sea ice extent during April-May-June (AMJ) appears to have a significant correlation with the summer monsoon rainfall over Peninsular India region during June-July-August-September from 1979 to 2013. Composites of mean sea level pressure (MSLP), 500 hPa geopotential height, and 850 hPa wind anomalies during high and low ice phases show a positive relation between the sea ice extent and the Mascarene High, revealing that high (low) ice phase corresponds respectively to the strengthening (weakening) of the Mascarene High as well as an increase (decrease) in Indian summer monsoon rainfall. During the respective high (low) ice phase years, positive (negative) MSLP anomalies were found, particularly over the Mascarene High region, associated with the eastwards (westwards) shifts of its climatology locations. Similar features were observed at 500 hPa geopotential height anomalies. In addition, strong anticyclonic (cyclonic) anomalies in the Mascarene High region were found in 850 hPa winds, which led to corresponding strong (weak) south westerlies and thus respective positive (negative) Indian summer monsoon rainfall anomalies.

1. Introduction

Antarctic sea ice extent is an extremely important feature in southern polar regions (Wadhams, 2009). It is also known as an essential factor in the climate system. Its variability influences global systems, regionally and remotely (Yuan and Martinson, 2000; Zhang, 2007; Liu et al., 2002; Oza et al., 2017), including both the physical and biological systems (Massom and Stammerjohn, 2010). Over the past decade, the interaction between Antarctic sea ice extent and tropical climate had been studied extensively by various researchers. Many previous studies have confirmed the relationship between sea ice variability and atmospheric circulation in the Southern Hemisphere (Simmonds and Budd, 1991; Simmonds and Wu, 1993; Simmonds and Jacka, 1995; Godfred-Spenning and Simmonds, 1996; Simmonds, 2003; Pezza et al., 2008), particularly under the influence of El Niño Southern Oscillation or ENSO (White and Peterson, 1996; Turner, 2004; Schneider et al., 2012). In addition, Antarctic sea ice extent has also been strongly linked to other climate variability indices related to the tropical Indian Ocean Sea Surface Temperature (SST) (Yuan and Martinson, 2000; Rai and Pandey, 2006; Rai et al., 2008) and tropical Pacific precipitation (Yuan and Martinson, 2000) on different timescales. For example, Rai and Pandey (2006) identified that SST over the southeast Indian Ocean has a strong relationship with sea ice variability. In a different study, Liu et al. (2011) revealed that southwestern Indian Ocean SST (50°– 70°E, 10°–25°S) has a possible impact on the interannual sea ice concentration anomalies from 1979 to 2009. Their results demonstrate that sea ice concentration in the Antarctic Peninsula, Ross Sea shelf, and the Indian Ocean sector is mostly affected by changes in the western Indian Ocean SST.

Indian summer monsoon is known as one of the most significant phenomena in the global climate framework. The event usually commences in June and ends in September. The intensities of the rainfall

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