Role of Biennial Rossby waves in the Indian Ocean Dipole Formation

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The Indian Ocean Dipole (IOD) is a climate mode that occurs interannually in the tropical parts of the Indian Ocean. Normally it has been found that the sea surface temperature (SST) is low in the western Indian Ocean and high in the eastern Indian Ocean. But in some years this SST gradient reverses and causes shifting of convective activities over the western equatorial Indian Ocean, which is identified as IOD. A positive IOD is characterized by cool SST anomaly in the southeastern tropical Indian Ocean and warm SST anomaly in the western tropical Indian Ocean. The development of IOD was associated with the propagation of Rossby waves in the tropical Indian Ocean [Gnanaseelan et al., 2005]. Now it has been confirmed that understanding the mechanism of the interannual variability in the Indian Ocean, on which predictability of the climate depends, is not possible without complete understanding of long equatorial waves (especially Rossby waves). In this study role of biennial Rossby waves (BRWs) in the IOD formation has been studied.

The interannual variability of the tropical Indian Ocean is examined using 44 years (1958 – 2001) of Simple Ocean Data Assimilation (SODA) sea surface height anomalies and Hadley Centre Ice sea surface temperature (HADISST) anomalies. A two-dimensional Finite Impulse Response (FIR) filter is used to filter out biennial Rossby wave components from the SODA sea surface height anomalies over the Indian Ocean. The details of FIR filter are given in Polito et al., [2000]. Biennial Rossby wave signals play a significant role in strengthening the surface dipole in both western and eastern region of the tropical Indian Ocean. Downwelling biennial Rossby waves along 1.5^{o}S are seen propagating westward from the eastern boundary, more than one year prior to the formation of positive Indian Ocean Dipole (IOD). These strong downwelling signals reached the western equatorial Indian Ocean during the peak dipole time.

Figure 1 shows BRW propagation along 1.5^{o}S during 1958 - 2001. Downwelling BRWs can be clearly seen propagating westward from the eastern boundary, about one year prior to the formation of the positive IOD events. These strong downwelling signals reach the western equatorial Indian Ocean during the peak phase of positive dipole. In normal years BRW signals do propagate westward but do not reach the western boundary.

Saji et al., [1999] characterized the interannual variability in the Indian Ocean using a simple dipole mode index, which is the difference of SST anomalies between the western equatorial Indian Ocean region (50^{o} – 70^{o}E, 10^{o}S-10^{o}N) and tropical southeastern Indian Ocean (90-110^{o}E, 10^{o}S- Equator). They found that this SST anomaly pattern represents an internal mode of the variability within the Indian Ocean. Figure 2 shows dipole mode index for (a) HADISST anomalies (b) SODA SSHA (c) BRWs. Dipole mode indices for HADISST anomalies and BRWs have been calculated based on Saji et al., [1999], and seem to be well comparable. Thus the present study emphasizes the role

of BRW in the control of the evolution of the surface characteristics during the IOD events.

References

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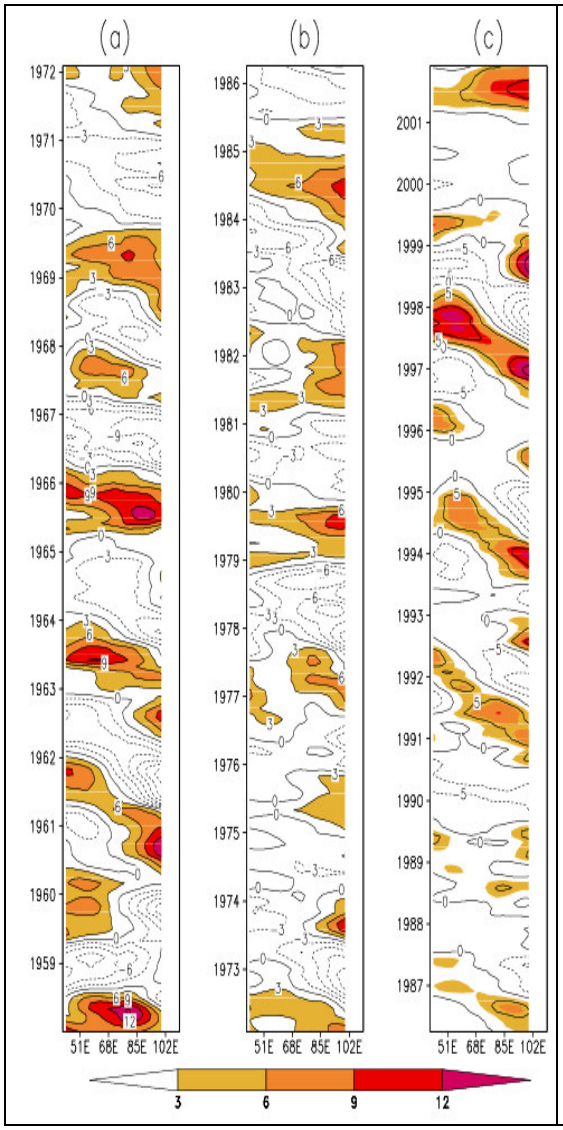

Figure 1: Propagation of BRW (mm) along 1.5°S.

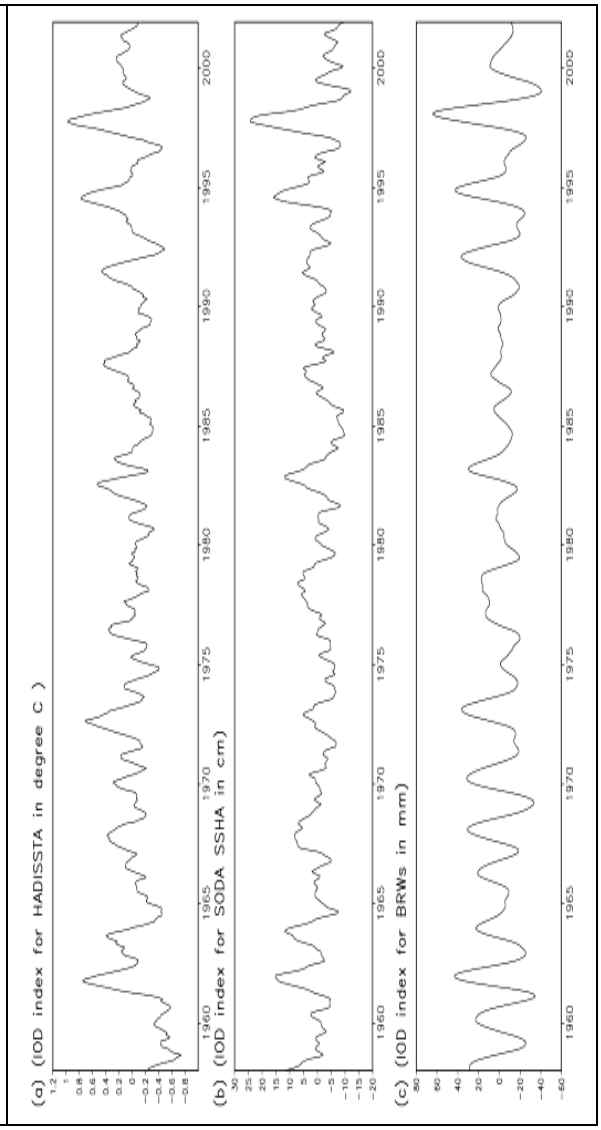

Figure 2: IOD indices (a) HADISSTA [degree C] (b) SODA SSHA [in cm] (c) BRWs [in mm].