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Ocean Science Discussions

Interactive comment on "North Indian Ocean variability during the Indian Ocean dipole" *by* J. Brown et al.

Anonymous Referee #1

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General comments:

Based on the 12-year hindcast experiment of the North Indian Ocean (NIO) from 1993 to 2004 with the assimilation of sea surface height and sea surface temperature anomalies, the authors discuss the surface current variability. In particular, they discuss the variability in relation with the Indian Ocean dipole (IOD). Considering the fact that observations in the NIO are still limited, outputs from an ocean model with assimilation is very useful in such a study. However, many results presented in this manuscript have already been discussed in existing literatures. Therefore, I suggest the authors to review existing studies more carefully and show more clearly what is novel in this paper.

Specific comments:

1) Findlater (1969) should be cited for the Findlater Jet and Wyrtki (1973) should be cited for the Wyrtki Jet. Also, Saji et al. (1999) was the first to introduce the term Indian Ocean Dipole and should be referred in this paper.

Findlater, J., 1969: A major low-level air current near the Indian Ocean during the northern summer. Q. J. R. Meteorol. Soc., 95, 362-380.

Saji, N. H., B. N. Goswami, P. N. Vinayachandran, and T. Yamagata, 1999: A dipole mode in the tropical Indian Ocean. Nature, 401, 360-363.

Wyrtki, K., 1973: An equatorial jet in the Indian Ocean. Science, 181, 262-264.

2) Although observations in the NIO are limited, there are some papers (e.g. Masumoto et al. 2008; Horii et al. 2008) that discuss the impact of the IOD on surface currents.

Horii, T., H. Hase, I. Ueki, and Y. Masumoto, 2008: Oceanic precondition and evolution of the 2006 Indian Ocean dipole. Geophys. Res. Lett., 35, L03607, doi:10.1029/2007GL032464.

Masumoto, Y., T. Horii, I. Ueki, H. Hase, K. Ando, and K. Mizuno, 2008: Short-term upper-ocean variability in the central equatorial Indian Ocean during 2006 Indian Ocean Dipole event. Geophys. Res. Lett., 35, L14S09, doi:10.1029/2008GL033834.

3) In stating the IOD also affects the inhabitants of the region with weather extremes impacting the climate of India, Asia, Africa, and Australia, as well as the rest of the planet (Page 4, Last 3 lines), the authors may refer to relevant papers such as Ashok et al. (2001), Black et al. (2003), Behera et al. (2005), Saji et al. (2003), and Guan and Yamagata (2003).

Ashok, K., Z. Guan, and T. Yamagata, 2001: Impact of the Indian Ocean Dipole on the decadal relationship between the Indian monsoon rainfall and ENSO. Geophys. Res. Lett., 28, 4499-4502.

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Behera, S. K., J. -J. Luo, S. Masson, P. Delecluse, S. Gualdi, A. Navarra, and T. Yamagata, 2005: Paramount impact of the Indian Ocean Dipole on the East African Short Rains: A CGCM Study. J. Climate, 18, 4514-4530.

Black, E., J. Slingo, and K. R. Sperber, 2003: An observational study of the relationship between excessively strong short rains in coastal East Africa and Indian Ocean SST. Mon. Weather Rev., 131, 74-94.

Guan, Z., and T. Yamagata, 2003: The unusual summer of 1994 in East Asia: IOD Teleconnections. Geophys. Res. Lett., 30, doi:10.1029/2002GL016831.

Saji, N.H., and T. Yamagata, 2003: Possible impacts of Indian Ocean dipole events on global climate. Clim. Res., 25, 151-169.

4) EOF analyses have been applied to the SST anomalies (deviations from the mean seasonal cycle) over the tropical Indian Ocean in existing literatures. Saji et al. (1999) found that the 1st EOF mode captures the basin-wide warming/cooling associated with ENSO events (Cadet 1985; Klein et al. 1999; Venzke et al. 2000) and explains about 30% of the total variance whereas the 2nd EOF mode captures the IOD and explains about 12% of the total variance. This is contrasted with the present manuscript, where the first three modes are dominated by the annual cycle and fourth mode resembles the IOD, but no EOF mode captures the basin-wide mode linked with the ENSO. Please explain the discrepancy.

Cadet, D. L., 1985: The Southern Oscillation over the Indian Ocean. J. Climate, 5, 189-212.

Klein, S. A., B. J. Soden, and N.-C. Lau, 1999: Remote sea surface temperature variations during ENSO: Evidence for a tropical atmospheric bridge. J. Climate, 12, 917-932.

Venzke, S., M. Latif, and A. Villwock, 2000: The coupled GCM ECHO-2. Part II: Indian Ocean response to ENSO. J. Climate, 13, 1371-1383.

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5) Are the first three cEOF modes for SST-SWX, SST-SSH, and SST-SCU related with the seasonal cycle? Do Rule N and North's rule of thumb both suggest that the 4th mode is significant?

6) Rossby waves associated with the IOD have already been discussed by Murtugudde et al. (2000), Xie et al. (2002), and Rao et al. (2002). Rao et al. (2002) have applied EOF to TOPEX/POSEIDON SSHA data and complex EOF to simulated upper 300 m heat content anomaly (HCA). The major difference between Fig. 10 of this study and Figs. 2 and 3 of Rao et al. (2002) is that the SSHA is negative over the Arabian Sea in this study while the SSHA and HCA in Rao et al. (2002) is positive. Please explain this discrepancy.

Murtugudde, R. G., J. P. McCreary, and A. J. Busalacchi, 2000: Oceanic processes associated with anomalous events in the Indian Ocean with relevance to 1997-1998. J. Geophys. Res., 105, 3295-3306.

Rao, S. A., S. K. Behera, Y. Masumoto, and T. Yamagata, 2002: Interannual subsurface variability in the tropical Indian Ocean with a special emphasis on the Indian Ocean Dipole. Deep-Sea Res. II, 49, 1549-1572.

Xie, S.-P., H. Annamalai, F. A. Schott, and J. P. McCreary, 2002: Structure and mechanisms of south Indian Ocean climate variability. J. Climate, 15, 864-878.

7) Zonal surface current and SSH variability during IOD years have also been discussed by previous studies. For instance, Vinayachandran et al. (1999) demonstrated the lack of spring Wyrtki Jet in 1994 before the onset of the positive IOD. Han et al. (2006) have presented differences during the decay phase of the 1994 and 1997 positive IOD events.

Han, W., T. Shinoda, L.-L. Fu, and J. P. McCreary, 2006: Impact of atmospheric intraseasonal oscillations on the Indian Ocean Dipole during the 1990s. J. Phys. Oceanogr., 36, 670-690.

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Vinayachandran, P. N., N. H. Saji, and T. Yamagata, 1999: Response of the equatorial Indian Ocean to an unusual wind event during 1994. J. Geophys. Res., 26, 1613-1616.

Technical corrections:

1) Page 5, Line 18: Replace exacting with exact.

2) Page 13, Lines 2-3: Replace Figure 15 with Figure 14 and Fig. 14 with Fig. 15.

3) Page 17, Line 9: Replace affect with effect.

4) Page 19: Line numbers are incorrect.

5) Replace all Vinaychandran with Vinayachandran.

Interactive comment on Ocean Sci. Discuss., 5, 213, 2008.

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Interactive Comment