High Frequency Variations in Evolution of Indian Ocean Dipole Events in 2003 and 2006

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Outline

- High frequency variations in
  1. evolutions of 2003 and 2006 IOD events.
  2. IOD and El Niño in 2006
  3. IOD and Monsoon in 2006
- Conclusions
Indian Ocean Dipole

Alongshore Winds

Equatorial Zonal Winds

(Saji et al., 1999)
Role of equatorial Zonal winds and along shore winds
Threshold SST for maintenance of large-scale convection

OLR vs SST (40S to 40N, 1985–1989)

Lau et al (1997)
Evolution of 2003 IOD event SSTA

Jul

Aug

Sep

Oct

Nov

Dec
Evolution of 2006 IOD event SSTA

April 2006
Evolution of 2003 IOD event (DMI, SST, SSH and rainfall anomalies in east and equatorial zonal wind anomalies)
Evolution of 2003 IOD event (anomalies of Rainfall, $U_{eq}$, SSH, SST and $U_{along}$-shore)
Evolution of 2006 IOD event (DMI, SST, SSHA and rainfall anomalies in east and equatorial zonal wind anomalies)

[Graph showing time series data for SSHA, SST, East DMI, and rainfall anomalies with highlighted periods and annotations for Eq. Zonal winds and Rain anom.]
Evolution of 2006 IOD event (anomalies of Rainfall, $U_{eq}$, SSH, SST and Ualong-shore)
Differences in SSTA and SSHA between 2003 and 2006 July.

SSTA

SSHA

Net heat flux

SST

March 8th 2007
Filtered (20-60 days) OLR and wind anomalies averaged between 10ºS-10ºN in 2003.
Equatorial Zonal wind (70-90E and 5S-5N) wavelet spectrum (NCEP reanalysis)

(Rao and Yamagata, 2004)

1982 and 1997 - co-occurred with ENSO

Absence of ISD activity
Linear Trend in SST, OLR and Winds
(Under global warming are the properties of IOD changing?)

(Ajaya Mohan, Rao and Yamagata, 2007)
IOD and El Niño
Evolution of East DMI and Niño 3.4 in 2006
Evolution of 2006 El Niño event (anomalies of Rainfall, Ueq/east DMI, SSH, SST)
Equatorial Zonal winds in central Indian and western Pacific Oceans (130°E-180°E) in 2006
Impact of Indian Ocean Sea Surface Temperature on Developing El Niño

(a) SON - Precipitation and 850 hPa wind anomalies (TIP_POST)

(b) SON - Precipitation and 850hPa wind anomalies (POST76 - Obs)

Fig. 6. (a) Anomalous precipitation (mm day⁻¹, shaded) and 850-hPa wind anomalies from the TIP_POST solutions; (b) same as (a) but from observations.

Annamalai et al., (2005)
Filtered (20-60 days) OLR and wind anomalies averaged between 10°S-10°N.
IOD and MONSOON
Indian Summer Monsoon in 2006

(Source: Monsoon Online, IITM)
Correlation of East Central India monsoon rainfall with velocity potential (Shading) and Moisture Divergence

(Ajaya Mohan, Rao and Yamagata, 2007)
Conclusions

- Unusually strong early warming (in July) in central tropical Indian Ocean excited an MJO in the tropical Indian Ocean and ultimately terminated IOD in 2003 due to strong westerlies associated with this strong MJO.

- Eventhough, MJO was excited in Sep. 2006 it was unable to terminate IOD in 2006, due to strong cooling in the eastern Indian Ocean (SSTs well below 28.5°C).

- MJOs generated in the tropical Indian Ocean in 2006 generated westerly wind bursts in western equatorial Pacific and eventually initiated 2006 El Niño event.

- In spite of strong El Niño conditions in the tropical Pacific, Indian Summer Monsoon rainfall was above normal in 2006 due to the strong Indian Ocean Dipole. Even in absence of northward propagating ISOs in July/August 2006 the monsoon rainfall was above normal.