12C.3

Influence of ENSO on the Indian Ocean dipole

Toshiaki Shinoda* Mike Alexander
NOAA-Climate Diagnostics Center, Boulder, Colorado

Harry Hendon
Bureau of Meteorology Research Centre, Melbourne, Australia

1.Introduction

Atmospheric general circulation model (AGCM) and coupled model experiments are used to investigate the Indian Ocean dipole associated with ENSO via an "atmospheric bridge". The Indian Ocean can be remotely forced by SST variability in the Pacific through changes of the Walker circulation. An ensemble of 16 atmospheric general circulation model (AGCM) simulations are performed in which observed SSTs are specified in the central and eastern tropical Pacific Ocean. The remainder of the global oceans are simulated using a grid of 1-dimensional mixed layer models.

Ocean general circulation model (OGCM) experiments are also used to examine the subsurface variability associated with the SST dipole and its relation to ENSO. The OGCM is forced with the surface fluxes from the NCEP reanalysis. The model was integrated over the period of 1957-97.

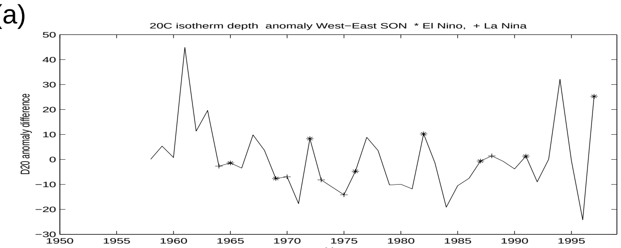
2. Results

Composites of SST and surface fluxes for warm and cold ENSO events for the period 1950-1999 are formed. The coupled model simulates the observed cooling in the eastern Indian Ocean during boreal autumn associated with ENSO. Surface flux anomalies associated with ENSO in the eastern tropical Indian Ocean agree with NCEP reanalysis fluxes reasonably well. AGCM and coupled model experiments suggest that a large portion of surface flux anomalies in the eastern tropical Indian Ocean associated with ENSO is remotely forced by the SST variation in the eastern tropical Pacific. The remotely forced SST in the eastern tropical Indian Ocean significantly contributes to the dipole variation.

Temperatures during SON from the OGCM experiments are analyzed in order to examine the subsurface variation associated with the surface dipole. Fig. 1a shows the time series of the subsurface dipole mode index (DMID20) defined by the difference of the average 20C isotherm depth between the western box (50E-70E, 10N-10S) and the eastern box (90E-110E, 0-10S). The large subsurface dipole occurred during 1961 and 1994. These are non-ENSO years and are associated with the large SST dipole. EOF analysis of the temperature field in the longitude-depth plane is also performed. The first EOF represents the subsurface dipole structure and the time series of the PC-1 shows the similar variation to the DMID20. The DMID20 is weakly correlated with NINO3 SST (correlation coefficient 0.29).

Fig.1b shows the time series of the SST dipole index (DMISST). The relation between the SST dipole and the ENSO is clearly seen. The correlation coefficient between the DMISST and the NINO3 SST is 0.66. However the subsurface dipole is also well correlated with the SST dipole (correlation coefficient between DMISST and DMID20 is 0.75). These results indicate that the ENSO influence on the dipole variation is more prominent in the SST than at depth.

(a)



(b)

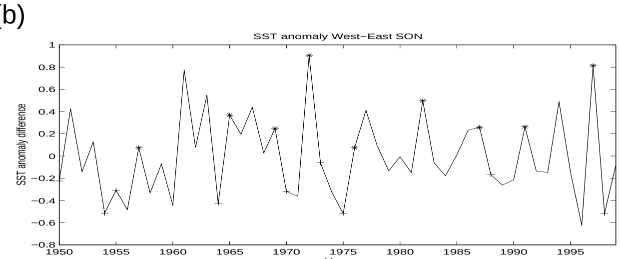


Fig. 1: (a) Time series of the area average 20C isotherm depth between the western box (50E-70E, 10N-10S) and the eastern box (90E-110E,10S-0). (b) Same as (a) except the area average of SST. * indicates the El Nino year and + indicates the La Nina year.

*Corresponding Author Address: Toshiaki Shinoda, NOAA Climate Diagnostics Center, 325 Broadway, Boulder, CO 80303; e-mail <ts@cdc.noaa.gov>