Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

AAS01-06 Room:101A Time:May 24 10:15-10:30

Eastern Indian Ocean warming associated with negative Indian Ocean dipole: Case study on the 2005 and 2010 events

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Indian Ocean Dipole (IOD) is a short-term climate variation, the positive (negative) phase of which is characterized by low (high) sea surface temperature (SST) anomalies in the eastern equatorial Indian Ocean and high (low) SST anomalies in the western equatorial Indian Ocean. In 2005 and 2010, warm SST anomalies appeared in the eastern equatorial Indian Ocean and lasted more than three months from August to October, associated with the negative phase of IOD.

In this study, observation data from a long-term moored buoy were used together with satellite, in situ, and atmospheric reanalysis datasets to clarify the processes that produced the anomalous SST variation in 2005 and 2010. We focused on locations (5S, 95E) and (8S, 95E) where in situ measurements by RAMA (Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction) buoys were available. Temporal changes in the mixed layer temperature were obtained from the buoy data. Air-sea heat fluxes and horizontal heat advection were estimated from the buoy data, satellite-based data, and reanalysis products.

Heat balance analysis demonstrated that both air-sea heat fluxes and horizontal heat advection accounted for the temperature variation of the ocean mixed layer. Among surface heat fluxes, the variation of latent heat loss had a major role to produce the warm SST anomalies. The anomalous latent heat flux were associated with the weakening of wind speed in the fall season of 2005 and 2010: there was no strong south-easterly monsoon wind from August to October in these years, and the deceleration of wind speed leads to warm SST anomalies through suppressed evaporation. The positive horizontal heat advection due to the south-eastward surface current warmed the south-eastern tropical Indian Ocean. Compared with the case of the positive phase of IOD, in which the heat advection is the major factor to control SST, our analysis shows that air-sea heat exchanges play a more active role to produce the SST anomalies in the eastern Indian Ocean during the negative IOD.

Keywords: Indian Ocean Dipole, Tropical Indian Ocean, TRITON buoy