The corss-equatorical gradient variability: The role of heat, momentum, and freshwater flux

*Takahito Kataoka[1]

1. JAMSTEC Japan Agency for Marine-Earth Science and Technology

The ocean-atmosphere feedback associated with the thermodynamic coupling among wind speed, evaporation, and sea surface temperature (SST), called the wind-evaporation-SST (WES) feedback, contributes to the cross-equatorial SST gradient over the tropical oceans. By conducting an eigenanalyses of simple linear air-sea coupled models, it is shown that three additional feedback processes are present when the variable oceanic mixed layer depth (MLD) is considered. The horizontal structures of the leading modes are similar to the WES mode, which shows a meridional dipole in the SST anomalies straddling the equator with cross-equatorial wind anomalies that represent the weakening/strengthening of the trade winds over the warm/cool SST anomalies.
In the presence of the damping term, the WES mode exists as a least damped mode consistent with previous studies. When the buoyancy flux anomaly associated with the latent heat flux anomaly is considered, a similar dipole mode in obtained, but the decaying time scale is about 40 % smaller. The freshwater flux coupling also gives a cross-equatorial gradient mode, but its stability is even smaller (decaying time scale is about 30 % of that of the WES). On the other hand, the momentum coupling allows a strongest meridional dipole variability, which is weakly unstable, indicating the importance of the wind mixing effect on the tropical meridional modes.

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