A CGCM Study on the Interaction between IOD and ENSO

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(Manuscript received 19 July 2005, in final form 29 November 2005)

DOI: 10.1175/JCLI3797.1

ABSTRACT

An atmosphere–ocean coupled general circulation model known as the Scale Interaction Experiment Frontier version 1 (SINTEX-F1) model is used to understand the intrinsic variability of the Indian Ocean dipole (IOD). In addition to a globally coupled control experiment, a Pacific decoupled noENSO experiment has been conducted. In the latter, the El Niño–Southern Oscillation (ENSO) variability is suppressed by decoupling the tropical Pacific Ocean from the atmosphere. The ocean–atmosphere conditions related to the IOD are realistically simulated by both experiments including the characteristic east–west dipole in SST anomalies. This demonstrates that the dipole mode in the Indian Ocean is mainly determined by intrinsic processes within the basin. In the EOF analysis of SST anomalies from the noENSO experiment, the IOD takes the dominant seat instead of the basinwide monopole mode. Even the coupled feedback among anomalies of upper-ocean heat content, SST, wind, and Walker circulation over the Indian Ocean is reproduced.

As in the observation, IOD peaks in boreal fall for both model experiments. In the absence of ENSO variability the interannual IOD variability is dominantly biennial. The ENSO variability is found to affect the periodicity, strength, and formation processes of the IOD in years of co-occurrences. The amplitudes of SST anomalies in the western pole of co-occurring IODs are aided by dynamical and thermodynamical modifications related to the ENSO-induced wind variability. Anomalous latent heat flux and vertical heat convergence associated with the modified Walker circulation contribute to the alteration of western anomalies. It is found that 42% of IOD events affected by changes in the Walker circulation are related to the tropical Pacific variabilities including ENSO. The formation is delayed until boreal summer for those IODs, which otherwise form in boreal spring as in the noENSO experiment.