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Indian Ocean Warming during 1958-2004 Simulated by A Climate System Model and Its Possible Mechanisms

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The structure and evolution characteristics of Indian Ocean sea surface temperature (SST) during the second half of the twentieth century are detected, using observation, reanalysis and a Climate System Model named FGOALS-gl developed by LASG/IAP. The basinwide warming trend is the dominant mode in Indian Ocean SST variability during the second half of the twentieth century. The basin averaged SSTA transition from negative to positive takes place during the late-1970s. And the warming is limited in the upper 100m. The coupled climate system model FGOALS-gl can reasonably reproduce the Indian Ocean sea temperature warming pattern. The external forcing dominates the linear warming trend. Furthermore, the contribution of anthropogenic forcing is approximately as three times as that of natural forcing based on the results of FGOALS-gl. The model FGOALS-gl is used to analyze the equation of the mixed layer temperature and identify mechanisms responsible for the warming. A diagnostic method based on the ocean mixed layer heat budget is developed here. Among the atmospheric forcing, the latent heat flux makes the greatest contributions to the basinwide warming, and surface longwave radiation ranks second due to the increasing greenhouse gases. The easterly wind anomalies over the equatorial Indian Ocean reduce the wind speed in equatorial western Indian Ocean, leading to less evaporation and warmer SST on the basis of WES adjustment. In addition, the easterly wind anomalies drive westward anomalous currents near the equator, and the resultant warm advection also makes for the maximum warming appearing in equatorial western Indian Ocean.