

Why is initialization of heat content anomalies in the tropical Indian Ocean difficult in a CGCM with SST-nudging?

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We have evaluated oceanic initial conditions in the tropical Indian and Pacific Oceans prepared by a coupled general circulation model (CGCM) with a sea surface temperature (SST)-nudging scheme. It is shown that the heat content anomalies in the upper 150 m are generated extremely well in the Pacific even though only the SST data is incorporated. In contrast, the upper ocean heat content anomalies produced by the model have negative correlation coefficients over vast areas of the tropical Indian Ocean. We propose that this is due to a difference in the SST-outgoing longwave radiation (OLR) relationship between the Indian and Pacific Oceans; the use of SST-nudging generally assumes that correlation coefficients between SST and OLR are negative, but this is not necessarily true. The correlation coefficients between SST and OLR anomalies are negative in the central to eastern equatorial Pacific, and this feature is well reproduced in the model. As a result, equatorial zonal wind anomalies are well captured by the model, and forced equatorial Kelvin and Rossby waves are accurately reproduced. On the other hand, the model cannot capture the observed positive correlation coefficients in the eastern equatorial Indian Ocean, particularly from January to April. As a result, equatorial zonal wind anomalies tend to have an opposite sign and induce equatorial Kelvin and Rossby waves with a wrong sign. The positive correlation between SST and OLR is an outcome of remote influence, but this is more difficult to simulate in an atmospheric general circulation model (AGCM) and a CGCM with strong SST nudging, in which local air-sea interaction is not explicitly allowed. Since the results presented in this study is based on a single model, it will be interesting to check skills of other models in initializing the upper ocean heat content with an SST-nudging scheme.

Keywords: Tropical Indian Ocean, Ocean-atmosphere coupled model, SST-OLR relationship, Upper ocean heat content, SST-nudging