Origins of biases in the Arabian-Sea climatological state for the CMIP5 models

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In this study, we investigate biases of a suite of 32 coupled ocean-atmosphere models in representing the climatological mean state of the Arabian Sea, as measured by differences between climatologies of the model fields and observations. The suite consists of 31 models from the Coupled Model Intercomparison Project Phase 5 (CMIP5) and the Coupled model For the Earth Simulator (CFES) developed at the Japan Agency for Marine-Earth Science and Technology (JAMSTEC). In the multi-model-mean fields, errors in the depth of the 20˚C isotherm (D20) are largest in the northwestern corner of the Arabian Sea basin (Fig. 1a), suggesting they are linked to errors in the models' simulation of Arabian Sea High Salinity Water (ASHSW), which is a watermass generated along the northern boundary of the Arabian Sea. In addition, the mixed-layer thickness (MLT) increases to unrealistically large values near the northern boundary of the basin during the winter (Fig. 1b). Another prominent bias occurs for sea-surface salinity (SSS) along the west coast of India, which is linked to SSS errors in the Bay of Bengal that are advected into the northern Arabian Sea by the West Indian Coastal Current (WICC). Our analyses suggest the following conclusions. The MLT bias leads to the generation of too much ASHSW and its spread into the interior of the northern Arabian Sea, resulting in the excess volume of upper water and thus the D20 bias. The wintertime MLT bias is most strongly linked to the density stratification (jump) across the bottom of the mixed layer, rather than to errors in the surface buoyancy flux. In turn, the density jump is determined largely by SSS advected by WICC along the west coast of India. Ultimately, then, the stratification errors in the northern Arabian Sea are linked to errors in the freshwater input (rain and river outflow) into the Bay of Bengal.

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