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Contribution of the Winter Salinity Barrier Layer to Summer Ocean–Atmosphere Variability in the Bay of Bengal

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This study finds that the winter (December–February) barrier layer (BL) in the Bay of Bengal (BoB) acts as a dynamical thermostat, modulating the subsequent summer BoB SST variability and potentially affecting the Indian summer monsoon (ISM) onset and associated rainfall variability. In the years when the prior winter BL is anomalously thick, anomalous sea surface cooling caused by intensified latent heat flux loss appears in the BoB starting in October and persists into the following year by positive cloud–SST feedback. During January–March, the vertical entrainment of warmer subsurface water induced by the anomalously thick BL acts to damp excessive cooling of the sea surface caused by atmospheric forcing and favors development of deep atmospheric convection over the BoB. During March–May, the thinner mixed layer linked to the anomalously thick BL allows more shortwave radiation to penetrate below the mixed layer. This tends to maintain existing cold SST anomalies, advancing the onset of ISM and enhancing June ISM precipitation through an increase in the land–sea tropospheric thermal contrast. We also find that most CMIP5 models fail to reproduce the observed relationship between June ISM rainfall and the prior winter BL thickness. This may be attributable to their difficulties in realistically simulating the winter BL in the BoB and ISM precipitation. The present results indicate that it is important to realistically capture the winter BL of the BoB in air–sea coupled models for improving the simulation and prediction of ISM.