



Decadal subsurface cooling and sea level fall in the tropical south Indian Ocean caused by Pacific wind forcing

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Observations and model hindcasts of multi-decadal changes in the Indian Ocean (IO) indicate a zonally-extended band in the southern tropics where sea level has substantially fallen since the 1960s. The sea level drop is consistent with the observed decrease in upper-ocean heat content associated with a shoaling thermocline in this region. Understanding the causes of these regional trends is of crucial importance for improving projections of future changes. Here we use a sequence of global ocean model simulations to investigate the contribution of remote versus local influences on the tropical IO: a hindcast experiment forced by atmospheric reanalysis data for 1958 to 2004 and two perturbation experiments where the interannual variability in the forcing is restricted to the Pacific Ocean and the Indian Ocean, respectively. We identify a significant contribution from the western equatorial Pacific, via wave transmission of thermocline anomalies through the Indonesian Archipelago, and their subsequent westward propagation by baroclinic Rossby waves. Whereas interannual variability in the southwestern tropical thermocline appears mainly governed by IO atmospheric forcing, the simulations suggest that the bulk of the long term cooling trend is due to this oceanic teleconnection, especially in the eastern part of the IO. This “trend” can be understood in terms of multi-decadal changes in the IO, representing a manifestation of the major shifts in Pacific climate in the mid 1970s and late 1990s associated with the Pacific Decadal Oscillation. Closer inspection of the spatio-temporal evolution of IO thermocline anomalies indicates different dynamics in the eastern and western parts of the basin: east of the Ninety East Ridge the Pacific influence governs much of the variability on interannual to multidecadal time scales, west of the ridge the variability is governed by IO forcing. The oceanic teleconnection implies that future trends in the tropical IO will depend on the evolution of the thermocline in the western tropical Pacific in response to changes in the trade winds over the Pacific Ocean.