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Relative contributions of Pacific and Indian SST anomalies to regional climate variability

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The relative effect of the tropical Indian and Pacific sea surface temperature (SST) on climate of the Pacific and Indian Ocean rim countries is investigated using a multidecadal ensemble generated with the National Center for Atmospheric Research (NCAR) Community Atmospheric Model (CAM3). Observed monthly SST from the Hadley Centre for the period 1949-2006 has been prescribed in the global oceans to generate five sets of numerical experiments: using (1) climatological SST around the globe (control), (2) monthly varying SST across/around the globe, (3) varying SST only in the Indian Ocean north of 30S, (4) varying SST in the tropical Pacific between 30S and 30N and (5) the Pacific and Indian Ocean SST together. The atmospheric response to Indian Ocean SST for interannual-to-decadal variability is assessed. Predictability in these experiments is analysed with an index based on the signal-to-noise ratio.

The largest differences between the control run and the Indian Ocean experiment occur over the tropics during austral wintertime (JJA). Trends in simulated rainfall suggest that the Indian Ocean warming has driven changes in the tropical atmospheric circulation, with a southward displacement of the Hadley Cell and consequent shift of the Inter-Tropical Convergence Zone (ITCZ) during JJA. The first mode of SST variability exhibits a basinwide uniform signal over the Indian Ocean, with its positive phase associated with an anomalous cyclonic circulation at low levels of the atmosphere east of Madagascar. This induces an upward motion throughout the troposphere, causing enhanced precipitation over the western Indian Ocean and east Africa. The second mode of variability in the Indian Ocean experiment is characterized by a zonal SST dipole that, in turn, induces an east-west pressure gradient at the surface and generates an anomalous cyclonic circulation at low- and mid- levels of the atmosphere. The anomalous circulation shifts the ITCZ northward and advects moisture to the Madagascar warm pool, enhancing local precipitation.

These interannual modes of variability show different patterns for the Pacific experiment. The rainfall response over southern and eastern Africa is stronger in the experiment forced with SST varying in both Indian and Pacific Oceans, but can also be seen to a smaller degree in the Pacific SST experiment . This suggests that the Pacific SST anomalies also play an important role for rainfall predictability over southern and eastern Africa. The linearity in the simulations is also investigated over other regions, particularly Australia.