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Modulation of Australian Rainfall by Indian Ocean Dipoles

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In a series of atmospheric general circulation model (AGCM) experiments, the potential impact of characteristic Indian Ocean sea surface temperature (SST) patterns in modulating low- to mid-latitude precipitation around the Indian Ocean-rim countries is examined. The imposed SST perturbations closely resemble a leading mode of Indian Ocean variability with features of both tropical and subtropical Indian Ocean dipoles. We investigate precipitation changes over the surrounding landmasses induced by a basin-wide re-organisation of the atmospheric circulation in the AGCM simulations. These include changes in the strength of the Walker circulation, regional changes in baroclinicity, thermal winds and moisture flux. The relative contribution of regional Indian Ocean SST poles, both individually and in combination, are quantified for these precipitation changes.
Of particular importance for Australian precipitation is the sign and magnitude of meridional gradients of East Indian Ocean SST. A reduction (increase) in the meridional SST gradient drives a corresponding response in the atmospheric thickness gradients and results in anomalous dry (wet) conditions over Australia. This is due to easterly (westerly) anomalies in the thermal wind over Australia and anomalous offshore (onshore) moisture advection during the anomalously dry (wet) conditions. The tropical SST pole has a larger impact on the atmospheric circulation and Australian precipitation than the southern subtropical pole. However, there is clear evidence that the southern pole does act to enhance the Australian rainfall response, when it occurs in conjunction with, but with opposite sign to, the eastern tropical pole. Implications of recent non-uniform Indian Ocean warming on Australian precipitation and seasonal forecasting are discussed. We also assess impacts for other Indian Ocean rim countries.