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Role of the Somalia-Oman upwelling and ENSO on Indian monsoon rainfall variability

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The Indian summer monsoon rainfall has complex, regionally heterogeneous, interannual variations with huge socioeconomic impacts, but the underlying mechanisms remain uncertain. The upwelling along the Somalia and Oman coasts starts in late spring, peaks during the summer monsoon, and strongly cools the sea surface temperature (SST) in the western Arabian Sea. They restrict the westward extent of the Indian Ocean warm pool, which is the main moisture source for the monsoon rainfall. Thus, variations of the Somalia–Oman upwelling can have significant impacts on the moisture transport toward India. Here the authors use both observations and an advanced coupled atmosphere–ocean general circulation model to show that a decrease in upwelling strengthens monsoon rainfall along the west coast of India by increasing the SST along the Somalia–Oman coasts, and thus local evaporation and water vapor transport toward the Indian Western Ghats (mountains). Further observational analysis reveals that such decreases in upwelling are caused by anomalously weak southwesterly winds in late spring over the Arabian Sea that are due to warm SST/increased precipitation anomalies over the Seychelles–Chagos thermocline ridge of the south-western Indian Ocean (and vice versa for years with strong upwelling and weak west Indian summer monsoon rainfall). The latter SST/precipitation anomalies are often related to El Niño Southern Oscillation (ENSO) conditions of the previous winter. This mechanism can hence explain why an El Niño event tends to strengthen following summer's Indian monsoon.