Title:	Long-term changes in the Arabian Peninsula rainfall and their relationship with the ENSO signals in the tropical Indo-Pacific
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Abstract:	We investigate long-term changes in winter rainfall patterns across the Arabian Peninsula (AP) through an analysis of the Climate Research Unit (CRU) gridded rainfall dataset, and long-term rainfall measurements collected at 39 stations distributed across the AP over the period 1951–2010. We reveal a long-term increase in winter rainfall of about 25–30% over the eastern AP and a long-term decrease of about 10–20% in the southern and northeastern AP. A partial correlation analysis suggests that canonical El Niños are associated with significant negative winter rainfall anomalies in the southern and southwest AP during the 1951–1980 period. However, the extent of the El Niño-induced rainfall deficit decreased in subsequent decades. In fact, a significant above-average rainfall occurs in recent decades over Ethiopia, southwest Yemen and central AP during canonical El Niños. Furthermore, positive phases of the Indian Ocean basin mode (IOBM), which lags the canonical ENSO signal by 3–4 months, are linked with significant below-average winter rainfall over the central and northern AP, but only until the 1970 s. We investigated the teleconnections between the variability of AP winter rainfall and various atmospheric parameters from the European Centre for Medium Range Weather Forecasting (ECMWF) twentieth century (ERA-20C) reanalysis. Notably, sub-tropical westerly jet (STJ) shifted southward and intensified over the AP during recent decades. This shift of the STJ favoured an increase in the frequent passage of transients, which contributed to increased winter rainfall over AP. These events anomalously strengthen the upper level westerlies during El Niño Modokis, adding to the recently-strengthened STJ over the AP, thereby further intensifying the transient activity. This large-scale background change likely weakened the impact of canonical El Niño and the IOBM events.
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