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Identification and Climatology of Extreme Precipitation Events in the Middle East

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Extreme precipitation events in the Middle East can cause flooding with dramatic societal and economic impacts. Previous studies of extreme precipitation have elucidated the larger-scale meteorological circulation patterns in which heavy convective storms develop. These events are associated with tropical-extratropical interactions whereby a midlatitude upper-level trough intrudes into the subtropics and triggers a poleward incursion of tropical moisture over the Middle East. We present a new algorithm that can identify extreme precipitation events based on tropospheric circulation characteristics. The algorithm detects (i) stratospheric potential vorticity (PV) streamers and cutoff-lows on isentropic surfaces, and (ii) structures of high vertically integrated water vapor fluxes (IVF). The algorithm is applied to ERA-Interim reanalysis data (1979-2015) and detects over 90% (80%) of the 99th (97.5th) percentile of extreme precipitation days in the region of interest. The detected PV intrusions and IVF structures follow the seasonality of extreme precipitation days, with a dry season from June to September and a wet season from October to May with peaks in late autumn and early spring. The extreme precipitation days and incursion of IVF structures over the region remain roughly constant over the years whereas the PV intrusions are subject to an increasing trend. Further, we investigate the relationship between the southward extent of PV intrusions, the maximum of IVF structures and the extreme precipitation days. Finally, we examine the performance of the algorithm using a rain gauge data set of stations in Saudi Arabia. This study demonstrates potential for application of our algorithm in weather forecasting, early warning systems and climate change analyses.