Atmospheric Drivers of Rainfall Events in the Republic of Djibouti

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The Republic of Djibouti is a small country (23 200 km\textsuperscript{2}) in East Africa, characterised by an arid context coupled with a high variability of rainfall that generates flash floods causing severe damage to the population and infrastructure. The mechanisms controlling climate dynamics in Djibouti and the Eastern Africa region remain poorly understood. In this study, we document the atmospheric mechanisms associated with extreme rainfall events in the Republic of Djibouti. To that end, we use at the daily timescale rain-gauge data (a network of 36 stations on the period 2013-2020), satellite-based rainfall estimates (CHIRPS, IMERG, MSWEP and RFE) and atmospheric reanalyses (ERA5), selected over their common period 2001-2020.

A multivariate Hierarchical Ascendant Classification of rainy days in Djibouti (≥ 10% of grid-points exceeding 1 mm.day\textsuperscript{-1}, according to all four satellite products) reveal 4 clusters (intense rainfall, moderate rainfall, rainy in the southwest, rainy in the east) which differentiate from each other by the intensity and spatial extent of rainfall. These clusters show a non-homogeneous seasonal distribution, occurring mainly in the March-April-May (MAM) and July-August-September (JAS) seasons, and more rarely in October-November-December (OND). The atmospheric circulation anomaly patterns associated with the clusters are quite similar and highly season-dependent. In MAM most clusters display an anomalous trough over the Red Sea from 700 hPa to 200 hPa. In JAS, an anomalous low over the southern Red Sea drives a thicker than normal monsoon flow at 700 hPa (especially for the southwest cluster), while upper northerlies prevail at 200 hPa. In OND, most rainy events result from moisture advection from the Western Indian Ocean favoured by positive phases of the Indian Ocean Dipole. Some highly unusual atmospheric circulation patterns, which are not depicted by the above classification (e.g., associated with tropical cyclones), also result in intense rainfall events in the Republic of Djibouti.