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Identification and Climatology of Rainfall Types over Southern West Africa

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Different rainfall types over southern West Africa (SWA) are identified using three-dimensional rainfall reflectivity data from the Tropical Rainfall Measuring Mission Precipitation Radar (TRMM-PR) during its active period 1998–2013 and are analyzed with respect to their contribution to total rainfall, their preferred environmental conditions and their association with infrared (IR) satellite data. The contribution of highly organized convective systems to total rainfall decreases southward, from around 71% percent in the Sudan region to 56% in the coastal strip, while it increases for less-intense convective elements. Irrespective of type, rainfall occurs in conjunction with midlevel anomalies of relative vorticity which alter the vertical structure of horizontal wind and thus, low-level windshear. The preferred location for organized convection is a highly sheared environment, i.e. the region of midlevel northeasterlies, while intense rainfall types are suppressed in a deep westerly regime with weaker windshear. The magnitude of the thermodynamical factors convective available potential energy (CAPE), convective inhibition (CIN) and downdraft CAPE (DCAPE) play an inferior role in the organisation of convective systems. Combining TRMM-PR rainfall elements with IR-based cloud tracking reveals that organized convection is almost always long-lived (>9h) but varies significantly with respect to propagation speed (5–15 m/s). Less intense rainfall types tend to be short-lived, diurnal phenomena.

The novel approach of a merged radar-IR analysis for the understudied SWA stresses the importance of midlevel (wave) disturbances on type and lifetime of convective systems and thus, the rainfall amount in this region. This study suggests that further investigations on the character of the disturbances and their implications on the development of both rainfall type and environmental controls are necessary to improve future operational forecasting of quantitative rainfall over SWA.