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Cross-equatorial dry intrusions and their impact on Indian summer monsoon-associated water cycle

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Dry intrusion (DI) is the slantwise descent of dry air from the extratropical upper troposphere to the mid/lower troposphere of the lower latitudes. When reaching the tropical regions, DIs substantially change the overall amount of available moisture, ocean surface fluxes into the atmosphere, as well as the atmospheric stability to vertical motion and the 3-dimensional flow and associated dynamics. However, the occurrence of such events has not been quantified systematically. Here, we quantify the climatological occurrence of DIs that extend from the extratropics to tropical regions. Specifically, we focus on events that host subsequent cross-equatorial flow. Using 6-hourly ERA-Interim reanalysis data with a Lagrangian approach, we show that during the summer monsoon season (June to September) DIs enter the tropical region from the southern hemisphere with peaks that exceed 10 % frequency in time. DI arrival into the tropics is associated with dry and cold lower-tropospheric anomalies, and consequently induced ocean evaporation and sensible heat flux into the atmosphere. Although cross-equatorial DIs are rare, a hotspot of such DIs is evident in the Indian Ocean, having a potential role for Indian summer monsoon (ISM) water cycle. The dominance of the ISM for the annual rainfall over India implies that small changes in the evaporation and moisture pathways may influence the ISM precipitation downstream significantly. Indeed, we demonstrate the connection between ISM rainfall and the preceding water-cycle interaction under DI conditions, and further show that DIs entering the Indian subcontinent modify the low-level jets.