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Role of anomalous states of upper tropospheric circulation on extremely dry and wet summer monsoon events

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Seasonal changes in wind pattern, monsoon, sometimes result in severe droughts and intense flooding in many parts of the world including South Asian countries like Pakistan. The livelihood of a vast population in Pakistan depends on agriculture and land use is strongly influenced by water-based ecosystems that depend on the monsoon rains. Furthermore, climate change studies undertaken so far reveal that action is essential in order to prevent long term damage to water cycle and thus of great concern to the community and stakeholders. Pakistan Summer Monsoon (PSM) is affected by both the disturbances from the tropical and the extratropical regions; however there is lack of understanding of physical mechanisms of PSM compared to other regional studies i.e. Indian Summer Monsoon (ISM) and South-East Asian Monsoon (SEAM). In our study, we applied heat and vorticity budgets and wave train analysis to reveal the mechanisms of the extremely dry and wet PSM events associated with the anomalous upper tropospheric circulation. We found that the extremely dry(wet) PSM events were closely related with the anomalous cyclonic(anticyclonic) upper-tropospheric circulation around central Asia. We also found that in addition to Rossby-wave (Matsuno-Gill) type atmospheric response, the Rossby wave train along the Asian Jet originating from northwestern Europe or North Atlantic Ocean induced the anomalous cyclonic(anticyclonic) upper-tropospheric circulation around central Asia. Therefore, devastating drought(flood) events over the PSM region resulting from weak(strong) convection anomalies, are induced by both the tropical and extratropical processes. Key Words: Monsoon, Extremes Climate Events, Physical Mechanism, Heat Budget, Vorticity, Wave Train