EGU2020-257
https://doi.org/10.5194/egusphere-egu2020-257
EGU General Assembly 2020

Spatio-Temporal Dynamics of East Asia Atmospheric Rivers and their Atmospheric Steering and Climatic Regulation

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The identification, climatic modulation and hydrological impact of Atmospheric Rivers (ARs) is an emergent scientific topic in recent years. ARs are important and yet understudied for East Asia (EA). We use our new AR identification algorithm (Pan & Lu, 2019), to build up a comprehensive AR catalog for this region for the first time. Interesting patterns are found: (1) there is a dominant AR route, originating from the Arabian Sea, crossing over the Bay of Bengal and Indochina, South China Sea (SCS) and Southeast China (SEC), and terminating in the western North Pacific; and (2) a nine-stage annual pattern in the climatological frequency is revealed. Stage 1: mid-Mar to mid-May, the formation of Western North Pacific Subtropical Height (WNPSH) near the SCS steers and confines AR in its northwest flank over SEC. Stages 2-5: during the monsoon season from mid-May to late-Aug, the evolution of AR follow the intra-seasonal progression of Asia-Pacific monsoon (including South Asian monsoon, East Asian monsoon and western North Pacific monsoon. Stages 6-9: late-Aug to mid-Mar, ARs leave EA and only occur over the North Pacific. Over all stages, we find the contribution of AR grows significantly with more extreme rainfall (i.e., from the annual rainfall, heavy rainfall, persistent heavy rainfall to large spatial extent persistent heavy rainfall), especially in spring and early-monsoon season. This emphasizes ARs' significant role in extreme or catastrophic rainfall events. Intriguingly, divergence of AR trajectories (also in their characteristics) occurs along the extratropical direction, and such divergent features have spatially heterogenous dependence on the leading modes of a collection of steering atmospheric and regulating climatic signals. Large divergence indicates high sensitivity of AR to transient steering; while small divergence promises high predictability of ARs, thus their associated hydrological impacts.