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Atmospheric Rivers in Association with Summer Heavy Rainfall over the Yangtze Plain on Sub-seasonal Time Scale

Ping Liang, Guangtao Dong, Huqiang Zhang, Mei Zhao, and Yue Ma
Shanghai Regional Climate Centre, China (liangping1107@163.com)

Atmospheric Rivers (ARs), referring to long and narrow bands of enhanced water vapor transport, mainly from the tropics into the mid-latitudes in the low atmosphere. They often contribute to heavy rainfall generations outside the tropics. However, there is a lack of such AR studies in East Asia and it is still unclear how ARs act on different time scales during the boreal summer when frequent heavy precipitation events take place over the region. In this study, climatological ARs and their evolutions on both synoptic and sub-seasonal time scales associated with heavy rainfall events over the Yangtze Plain in China are investigated. Furthermore, its predictability is assessed by examining hindcast skills from an operational coupled seasonal forecast model. Results show that ARs embedded within the South Asian monsoon and Somali cross-equatorial flow provide a favorable background for steady moisture supply of summer rainfall into East Asia. We can call this favorable background as a climatological East Asian AR which has close connections with seasonal cycle and climatological intra-seasonal oscillation (CISO) of rainfall in the Yangtze Plain during its Meiyu season. The East Asian AR is also influenced by anomalous anti-cyclonic circulations over the tropical West Pacific when heavy rainfall events occur over the Yangtze Plain. Different from orography-induced precipitation, ARs leading to heavy rainfall over the Yangtze Plain are linked with the intrusions of cold air from its north. The major source of ARs responsible for heavy precipitation events over the Yangtze Plain appears to originate from tropical West Pacific on both synoptic and sub-seasonal time scales. By analyzing 23-yr hindcasts for May-June-July with start date of 1 May, we show that the current operational coupled seasonal forecast system of the Australian Bureau of Meteorology (named as ACCESS-S1) has skillful rainfall forecasts at lead-time of 0 month (i.e. forecasting May monthly mean with initial conditions on 1 May), but the skill degrades significantly at longer lead time. Nevertheless, the model shows skills in predicting the variations of low-level moisture transport affecting the Yangtze River at longer lead time, suggesting that the ARs influencing summer monsoon rainfall in the East Asian region are likely to be more predictable than rainfall itself. This provides a potential of utilizing the skill from the coupled forecast system in predicting ARs to guide its rainfall forecasts in the East Asian summer season at longer lead time.