Geophysical Research Abstracts
Vol. 18, EGU2016-10877, 2016
EGU General Assembly 2016

Using WRF to understand how topographically-driven mesoscale features influence rainfall variability in Tigris-Euphrates System

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The Headwaters of the Tigris-Euphrates System (HWTES) is a critical region for the regional hydropolitics in the Middle East, particularly after the recent growing conflicts that have been partly attributed to water resource scarcity. However, lack of the in-situ data has made it difficult to study the hydrometeorology of the region with full rigor. Regional climate models are a pivotal resource to tackle this issue by providing a complete spatio-temporal coverage for the hydroclimate variables. In this study, we have implemented the Weather Research and Forecasting (WRF) Model, driven by the NCEP/DOE Reanalysis 2 (R2), for a domain spanning 30-55E and 22-45N. Several sensitivity analyses were performed in order to find a set of physics parameters that appropriately captures the interannual variability and annual cycle of rainfall over the HWTES. The simulations were conducted at 27km spatial resolution and for the period 1983-2013. Results showed that the annual cycle of precipitation produced by WRF agrees much more closely with the observations than that of the original R2 product. This was particularly evident during the transition months of April and October, which were further examined to study mechanism. The WRF model significantly outperforms the R2 in simulating the interannual variability of rainfall for these two months over the HWTES. Our diagnostic analysis suggests that the main reason for this is WRF's capability to resolve topographically-driven low-level moisture transport from two directions. These two mesoscale features that are missed or significantly weak in the coarse-resolution R2 data are a southeasterly barrier jet along the Zagros Mountains that originates over the Persian Gulf and a low-level westerly flow along the East Turkey Highlands. The latter, imposed by the synoptic-scale systems that are reasonably well-resolved in the R2 data, carries moist, warm air from the Mediterranean toward the HWTES.