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Investigating the terrestrial-atmospheric water balance for the Tana River basin, East Africa

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The fully coupled atmospheric-hydrological WRF-Hydro modeling system is applied to the Tana River basin (TRB) in East Africa for the period 2011-2014 in order to analyze the terrestrial-atmospheric water balance components and their feedback mechanisms. The outputs from the fully coupled modeling system are compared to those of the WRF stand-alone model. The study area encompasses the Mathioya-Sagana subcatchment (3279 km^2) in the upper TRB. Our model set up consists of two domains at 25 km and 5 km horizontal resolution covering East Africa and the study area, respectively. The WRF-Hydro inner domain is enhanced with hydrological routing at a 500 m horizontal grid resolution.
The simulated monthly precipitation over the subcatchment compared with the Tropical Rainfall Measuring Mission (TRMM) satellite data gives an overall correlation coefficient of 0.8/0.7 for fully coupled/stand-alone model and a mean absolute error (MAE) of 1.5 mm/day for both models for the entire simulation period. Overall the models yield more annual total precipitation compared to TRMM. The two models are drier during the March, April, May (MAM) season and wetter during the October, November, December (OND) season. Compared to observation stations, both modeling systems provide a correlation coefficient of 0.6 for precipitation. The simulated and observed discharges at the Tana Rukanga gauge, located in the subcatchment, exhibit a correlation coefficient of 0.5 at daily resolution. The WRF-Hydro also overestimates the cumulated discharge (2011-2014) by about 50 %. The analysis of the atmospheric water balance in both WRF and WRF-Hydro simulation reveals a positive moisture divergence during the MAM and OND rainy seasons. Precipitation recycling and efficiency measures derived from the atmospheric water budget are also investigated.