Abstract

For an improved understanding of the hydrometeorological conditions of the Tana River basin of Kenya, East Africa, its joint atmospheric-terrestrial water balances are investigated. This is achieved through the application of the Weather Research and Forecasting (WRF) and the fully coupled WRF-Hydro modeling system over the Mathioya-Sagana subcatchment (3279 km^2) and its surroundings in the upper Tana River basin for 4 years (2011–2014). The model setup consists of an outer domain at 25 km (East Africa) and an inner one at 5-km (Mathioya-Sagana subcatchment) horizontal resolution. The WRF-Hydro inner domain is enhanced with hydrological routing at 500-m horizontal resolution. The results from the fully coupled modeling system are compared to those of the WRF-only model. The coupled WRF-Hydro slightly reduces precipitation, evapotranspiration, and the soil water storage but increases runoff. The total precipitation from March to May and October to December for WRF-only (974 mm/year) and coupled WRF-Hydro (940 mm/year) is closer to that derived from the Climate Hazards Group Infrared Precipitation with Stations (CHIRPS) data (989 mm/year) than from the TRMM (795 mm/year) precipitation product. The coupled WRF-Hydro-accumulated discharge (323 mm/year) is close to that observed (333 mm/year). However, the coupled WRF-Hydro underestimates the observed peak flows registering low but acceptable NSE (0.02) and RSR (0.99) at daily time step. The precipitation recycling and efficiency measures between WRF-only and coupled WRF-Hydro are very close and small. This suggests that most of precipitation in the region comes from moisture advection from the outside of the analysis domain, indicating a minor impact of potential land-precipitation feedback mechanisms in this case. The coupled WRF-Hydro nonetheless serves as a tool in quantifying the atmospheric-terrestrial water balance in this region.