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Analysis of the distribution of the isotopic composition of evapotranspiration flux in a semi-arid savanna.

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The cycling of water in semi-arid regions is critical for the ecohydrologic processes of savanna systems. Stable isotopes of water serve as important tracers of water movement, and studies of how the isotopic distribution of rainfall is transformed through geomorphic basin characteristics into an isotopic distribution of runoff have yielded insight into watershed dynamics. However, in many drylands, the majority of return flux of water out of ecosystems is in the form of evapotranspiration. Through a combination of field measurements and modeling, we present a study of the factors that influence the transformation of the isotopic distribution of precipitation into an isotopic distribution of evapotranspiration. Field observations were collected at a micrometerological tower located in a mixed-savanna in Laikipa, Kenya. The tower is equipped with an off-axis integrated cavity output spectroscopy system (ICOS), and the isotopic composition of atmospheric water vapor has been sampled at 1 Hz from 2010 through 2012. Evapotranspiration isotopic composition is estimated based on Keeling plots for each 30 minute time period, with seasonal dynamics evident throughout this multi-year study. Isotopic analysis of collected rainfall and cryogenic vacuum distillation of soil and plant samples at the site aid in the interpretation of water cycling. A decrease in the variance of evapotranspiration flux composition relative to precipitation is indicative of soil water mixing as well as runoff and recharge effects. Stochastic modeling of the isotopic inputs and outputs of the semi-arid systems demonstrates the strength of the influence that rainfall climatology, plant rooting depth, and evapotranspiration characteristics have on the ratio of the variances of input and output isotopic composition.