Effects of Topography on Vegetation-Hydrology Interactions in a Semiarid Grass Ecosystem

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Abstract. It is commonly observed that topography strongly affects the state and distribution of vegetation. This topographic effect is normally considered to operate through the regulation of the incoming solar radiation and lateral redistribution of water and elements. Nevertheless, largely unexplored questions are how plants adjust to terrain effects relative to their location in a landscape, what the implications are for the spatial distribution of the water balance, and whether catchment vegetation-hydrology dynamics can be generalized in the form of terrain indices. In this study, we address vegetation-water-energy dynamics in a semiarid area characteristic of central New Mexico by constructing a dynamic coupled model based on physical, biochemical, or mechanistic representation of individual processes. The modeling system, tRIBS+VEGGIE, considers essential water and energy feedbacks over the river basin and links them to the basic plant life regulatory processes. In a set of numerical experiments, we examine linkages between terrain attributes, patterns of C_4 productivity, and water balance components. For different imposed regimes of lateral water transfer, we identify regions of relative vegetation "favorability". We address their principal controlling mechanisms, as mediated by topographic features of the landscape, and discuss sensitivity. We argue that the influences of site-specific and non-local terrain characteristics are superimposed and the key features of the superposition appear to be of the same form, irrespective of the soil hydraulic type or the actual water transport mechanism involved.