Estimation of Soil Moisture, Peak Leaf Area Index and Evapotranspiration Partitioning at Two Semi-Arid Grassland Sites using the Statistical-Dynamical Ecohydrology Model

John P. Kochendorfer, Jorge A. Ramírez
Department of Civil and Environmental Engineering, Colorado State University

Abstract. The soil-water balance and plant water use are investigated at two semi-arid grassland sites in the US Great Plains using the Statistical-Dynamical Ecohydrology Model (SDEM). A key feature of the SDEM is that it partitions evapotranspiration into transpiration, evaporation from canopy interception, and evaporation from the soil surface. That partitioning is significant for the soil-water balance because the dynamics of the three processes are very different. Evapotranspiration partitioning is validated based on other studies, as well as through the calculation of water-use efficiencies with modeled transpiration and estimates of net primary productivity. Sensitivity of models results to variations in the peak in green leaf area index (LAI) suggests that the peak is determined by some minimum in root zone soil moisture during the growing season. That minimum appears to be close to the soil matric potential at which the dominant grass species begins to experience water stress and well above the wilting point, thereby suggesting an ecological optimality hypothesis in which the need to avoid water-stress-induced leaf abscission is balanced by the maximization of carbon assimilation and associated water use. Finally, analysis of the sensitivity of model-determined peak green LAI to soil texture shows that use of the optimality hypothesis reproduces the so-called "inverse texture effect", which consists of the observation that natural vegetation in dry climates tends to be most productive in sandier soils despite their lower water holding capacity.