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The role of Vegetation Dynamics on the Soil Water Balance of a Water-limited Mediterranean Ecosystem on Sardinia

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Mediterranean ecosystems are commonly heterogeneous savanna-like ecosystems, with contrasting plant functional types (PFTs, e.g., grass and woody vegetation) competing for the water use. At the same time the structure and function of the vegetation regulates the exchange of mass, energy and momentum across the biosphere-atmosphere interface, influencing strongly the soil water budget.

The objective is to investigate the role of the PFT vegetation dynamics on the soil water budget of a water-limited ecosystem, a typical Mediterranean ecosystem in Sardinia, Italy.

The case study is in Orroli, situated in the mid-west of Sardegna within the Flumendosa river watershed. The site landscape is a mixture of Mediterranean patchy vegetation types: trees, including wild olives and cork oaks, different shrubs and herbaceous species. An extensive field campaign started in May 2003. Nearly five years of data are available now. Interestingly, hydrometeorological conditions of the monitored years strongly differ, with dry and wet years in turn. Land-surface fluxes and CO_2 fluxes are estimated by an eddy correlation technique based micrometeorological tower. Soil moisture profiles were also continuously estimated using water content reflectometers and gravimetric method, and periodically leaf area index (LAI) estimates of PFTs are made using the Accupar LP-80 by Decagon Devices Inc.

A parsimonious ecohydrologic model is applied to the case study. It couples a vege-

tation dynamic model (VDM), which computes the change in biomass over time for two PFTs using basic rules regarding competition for a limiting resource, and a 3-component (bare soil, grass and woody vegetation) land surface model (LSM). The VDM provides the green biomass and the LAI evolution through time, and the LSM uses this information in the computation of the land surface fluxes and updating the soil water content in the root-zone.

The coupled VDM-LSM model is successfully tested for the case study, demonstrating model high performance for the wide range of eco-hydrologic conditions included in the observation period.

Hydro-meteorological scenarios are then generated using a weather generator that allows simulation of hydrometeorological variables from historical time series (available from 1922 for this basin). The use of the calibrated VDM-LSM allow to predict soil water balance and vegetation dynamics for the generated hydrometeorological scenarios.

Results demonstrate that vegetation dynamics are strongly influenced by the inter-annual variability of atmospheric forcing, with vegetation density changing significantly according to seasonal rainfall amount. At the same time the vegetation dynamics affect the soil water balance. The inclusion of the VDM in the LSM is demonstrated to be essential when studying the climate-soil-vegetation interactions of these water-limited ecosystems.