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On the spatial distribution of the transpiration and soil moisture of a Mediterranean heterogeneous ecosystem in water-limited conditions.

Matteo Curreli (1), Roberto Corona (1), Nicola Montaldo (1), John D. Albertson (2), and Ram Oren (2)

(1) Department of Civil Engineering, Environmental and Architecture, University of Cagliari, Italy. , (2) Department of Civil and Environmental Engineering, Pratt School of Engineering, Duke University

Mediterranean ecosystems are characterized by a strong heterogeneity, and often by water-limited conditions. In these conditions contrasting plant functional types (PFT, e.g. grass and woody vegetation) compete for the water use. Both the vegetation cover spatial distribution and the soil properties impact the soil moisture (SM) spatial distribution. Indeed, vegetation cover density and type affects evapotranspiration (ET), which is the main lack of the soil water balance in these ecosystems. With the objective to carefully estimate SM and ET spatial distribution in a Mediterranean water-limited ecosystem and understanding SM and ET relationships, an extended field campaign is carried out. The study was performed in a heterogeneous ecosystem in Orroli, Sardinia (Italy). The experimental site is a typical Mediterranean ecosystem where the vegetation is distributed in patches of woody vegetation (wild olives mainly) and grass. Soil depth is low and spatially varies between 10 cm and 40 cm, without any correlation with the vegetation spatial distribution. ET, land-surface fluxes and CO_2 fluxes are estimated by an eddy covariance technique based micrometeorological tower. But in heterogeneous ecosystems a key assumption of the eddy covariance theory, the homogeneity of the surface, is not preserved and the ET estimate may be not correct. Hence, we estimate ET of the woody vegetation using the thermal dissipation method (i.e. sap flow technique) for comparing the two methodologies. Due the high heterogeneity of the vegetation and soil properties of the field a total of 54 sap flux sensors were installed. 14 clumps of wild olives within the eddy covariance footprint were identified as the most representative source of flux and they were instrumented with the thermal dissipation probes. Measurements of diameter at the height of sensor installation (height of 0.4 m above ground) were recorded in all the clumps. Bark thickness and sapwood depth were measured on several trees to obtain a generalized estimates of sapwood depth. The known of allometric relationships between sapwood area, diameter and canopy cover area within the eddy covariance footprint helped for the application of a reliable scaling procedure of the local sap flow estimates which are in a good agreement with the estimates of ET eddy covariance based. Soil moisture were also extensively monitored through 25 probes installed in the eddy covariance footprint. Results show that comparing eddy covariance and sap flow ET estimates eddy covariance technique is still accurate in this heterogeneous field, whereas the key assumption, surface homogeneity, is not preserved. Furthermore, interestingly wild olives still transpire at higher rates for the driest soil moisture conditions, confirming the hydraulic redistribution from soil below the roots, and from roots penetrating deep cracks in the underlying basalt parent rock.