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Drought effects investigation of a forested site at different spatial scales with eddy covariance technique, cosmic ray sensors, electrical resistivity tomography and 2 meters deep soil moisture and matric potential profile

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The forested area is growing in Italy. The eco-hydrological monitoring of such an ecosystem is not trivial, because of canopy height, deep root system and soil heterogeneity. Hence, it is important to merge multiple measurement approaches to quantify the ecohydrological dynamics at the sites. In addition, it is also important to consider multiple temporal and spatial scales from point measurements to areal measurements of the soil-atmosphere interactions. At the Bussoleno - Grangia dell'Alpe forest site (Piedmont, Northwest Italy), we monitored two years, and in particular, two growing seasons (2021 and 2022, with a severe drought in Italy) with areal measures in the atmosphere of actual evapotranspiration (ETa) estimated via eddy covariance technique overcanopy (25 m mast) and areal estimates of soil water content measured continuously with cosmic ray sensors. Moreover, the soil resistivity was measured at the plot scale with Electrical Resistivity Tomography (ERT) technique with several campaigns in which two measurement transects were explored. The point scale with continuous measurements was monitored via soil water content and matric potential probes installed at several depths between 0.1 m and 2 m. In addition, during the ERT campaigns, the soil water content of the first 30 cm profile was also measured via TDR probes in different locations of the experimental site. All this effort allows the reconstruction of a forest volume from about 3 m of soil depth to 23 m of height (height of the eddy covariance setup), including the whole canopy effect. Results highlight the consistency of the soil water content estimation with different approaches (cosmic ray sensors, ERT technique, TDR and capacitive probes). Moreover, using different soil moisture measurements, the ETa regimes can be correctly and well identified. Furthermore, the drought effects are explored also using eddy covariance technique, highlighting that, despite a very low water content above 2 m of soil depth, the vegetation is not severely stressed, likely because of its resilience (the site is characterized by low precipitation, usually below 600 mm/year).

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