Effects of Vegetation on Shallow Soil Moisture at a Semiarid Montane Catchment

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Abstract. Soil moisture plays an integral role in ecologic processes, particularly in semiarid environments. Because such ecosystems suffer longer periods of water deficit, the availability of water in the soil can limit plant growth and affect the type and distribution of vegetation in an area. While interactions between vegetation and soil moisture at greater depths are relatively well understood, less is known about soil moisture at depths of 5 cm or less. Distinct behaviors may exist between the two cases because root water uptake is expected to be more important deeper in the soil where roots are located, while interception and shading are likely to have greater impacts at shallower depths. Understanding the differences in the behavior of soil moisture at different depths is important because microwave remote-sensing methods can measure shallow soil moisture at large scales, while deeper soil moisture is usually of more interest for ecology and other hydrologic applications. In this study, we investigate the impact of shrub and tree cover on the dynamics and patterns of shallow soil moisture in a semiarid, montane catchment. Instrumentation was installed on two hillslopes: a north-facing hillslope that is vegetated primarily by ponderosa pine with shrubs interspersed, and a south-facing hillslope that is vegetated mainly by shrubs with scattered ponderosa pine. Four types of locations were instrumented on each slope: open or intercanopy, under ponderosa pine (*Pinus ponderosa*), under mountain mahogany (*Cercocarpus montanus*) shrubs, and antelope bitterbrush (*Purshia tridentate*) shrubs. Rain gauges and pyranometers were installed to assess the impact of interception and shading, while time-domain reflectometry (TDR) probes were inserted into the top 5 cm of the soil to monitor hourly soil moisture. Litter depth, canopy cover, and soil moisture were also measured for selected dates on a 15 m grid throughout the catchment. The observations suggest that throughfall rates are lower with less temporal variance under vegetation than in the open, while potential evapotranspiration rates are lower with higher temporal variance. On the south-facing slope, soil moisture under vegetation is higher on average with lower temporal variance than in the open, while soil moisture on the north-facing slope is lower with less temporal variance under vegetation than at intercanopy locations. On both slopes, the frequency of very high and very low values of soil moisture is lower under vegetation than in the open. Gridded data reveal a linear relationship between soil moisture and percent canopy cover (or litter depth) that has a larger positive slope for drier conditions. These data also suggest that the rate of drying and temporal variance of soil moisture decreases with increasing canopy cover and litter depth. While previous literature has shown that soil moisture at greater depths is lower under vegetation than in the open due to root water uptake, these results suggest that shading and interception play a more critical role at shallow depths.