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Ecohydrological Controls over ET Partitioning at a Semi-Arid Forest

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Partitioning ecosystem evapotranspiration (ET) to its components, plant transpiration (T) and soil evaporation (E), is critical for understanding water availability for carbon assimilation, soil respiration, and water use efficiency, as well as for ecosystem management. This is becoming increasingly important in light of persisting predictions of warming and drying trends in the entire Mediterranean region. Respectively, the objective of this research was to partition ET in a semi-arid pine forest (mean annual precipitation 280 mm; LAI ˜1.5) to assess water use patterns and adaptation to water-limited environment.

We used a modified soil respiration chamber (LI-6400-09, LI-COR Inc., USA) to measure soil evaporation (after validating chamber performance using lysimeters). Measurements on 16 permanent collars covering the forest spatial variability were carried out every 10-14 days during the three year (2003-2007) study period, and included diurnal, seasonal, and inter-annual trends. Mean E was compared to measured T (stem heat pulse measurements) and ET (eddy covariance flux-tower) and a suit of environmental measurements (precipitation, soil water content at different depth, soil and air temperatures and net radiation).

Our results showed large spatial variability in E (between collars SD during a measurement day was 47% on average). There was a 30% difference between E in sun-exposed collars (high) and shaded collars (low). Peak E (up to 0.80 mm d-1) were measured during early and late winter, following first rains and early spring warming. During mid-winter and summer, fluxes were relatively constant and small (˜0.10 mm d-1). In

contrast to E, T increased gradually, starting early winter and peaking during spring. Accordingly, the contribution of E to ET (E/ET) varied between 0.40 and 0.70, with complementing changes in T/ET. Inter-annual variability of E was relatively small, in-spite of large variability in precipitation. Variations in E reflected variations in soil water in the superficial layers (top 10 cm), while variations in T reflected those at deeper layers (below 15 cm). The semi-arid climate, characterized by sporadic rain pulses, resulted with repeated wetting of the soil surface layer, but rarely enabled deep infiltration. However, wet deep soil layers dry out over more than one hydrological year, buffering the effects of more rapid changes at the surface. The semi-arid forest is therefore well suited to face the predicted increase in storm intensities, in spite of possible decrease in overall amounts, as often predicted for this region (i.e. more effective infiltration). Soil evaporation in the semi-arid forest seemed most sensitive to tree density (LAI) that affect sunny/shaded areas, and therefore to management practices.