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Evapotranspiration in water limited environments: Up-scaling from the crown canopy to the eddy flux footprint

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Evapotranspiration in Water Limited Environments (WLE) plays a central role in explaining ecohydrological dynamics and the mass-energy interactions between the land surface and the atmosphere. To gain more in-depth knowledge on these interactions and dynamics demands that evapotranspiration components be quantified and the role of each of each evaporative flux be known at finer temporal and spatial scales ( ).

In this research we integrate eddy covariance, energy flux, biometric and sapflow measurements together with remote sensing. The aims of the research are to assess (1) the role of transpiration fluxes in dry areas, (2) the energy balance and (3) the applicability of eddy footprints in tree transpiration up-scaling and mapping using remote sensing.

Field measurements were done in the Sardon catchment close to Salamanca, Spain (DOY 249 -269, 2009).Where the tree species Quercus Ilex and Quercus Pyrenaica are the dominant vegetation and thus were the focus of this study. Sap-flow was measured and up-scaled using Quick-Bird imagery combined with species-specific biometric up-scaling functions. Post-processing eddy data was done to determine evapotranspiration from sensible and latent heat fluxes. Furthermore, 2-D flux footprints were determined using 30-min energy flux data, and discretized over the land surface. Finally, the transpiration contribution to evapotranspiration was determined by up-scaling sap-flow from the tree canopies inside the eddy footprint.

It was found that Quercus ilex and Quercus pyrenaica transpire an average of 0.17 mm/day, while average dry season evapotranspiration was ∼0.4 mm/day. The sources of the measured evapotranspiration varied with wind direction and thermal stratification. The cross wind integrated footprint varies 20m to 600m during daytime and reaches up to 1800m at night. The cumulative crosswind footprint shows that about 80% of the flux is from a distance of 300-500m. We were able to achieve an energy balance closure of 86% and found that ground heat flux played a key role in energy flux partitioning as it reaches up to 50% of net radiation. The trees enclosed in the studied footprint covered 11% of the footprint surface area, and contributed 35% of the evapotranspiration measured by eddy covariance, thereby highlighting the importance of their contribution in the total evapotranspiration of the catchment.