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Diurnal and seasonal cycles of transpiration of Mediterranean forests explained by adaptation to climate and soil conditions

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The aim of this study is to predict a-priori values for vegetation characteristics from adaptation to climate and soil in water-limited conditions. The vegetation characteristics are in turn used to predict diurnal and seasonal cycles of photosynthesis and transpiration. We combine models for hydraulic architecture and photosynthesis, and derive expressions for photosynthetic capacity, intrinsic water use efficiency and plant hydraulic conductivity as functions of soil water availability, duration of drought, humidity and temperature. The model explained several phenomena reported in literature: positive relations between humidity and leaf nitrogen content and the increase of water use efficiency with stand age. We tested the model using field data of four experimental forest plots in Mediterranean Slovenia that were selected for their topography induced differences in climate and contrasting vegetation characteristics. Data were collected during a regular and an exceptionally dry year. The model performed well in explaining variations in leaf nitrogen content, 13C isotope discrimination and the sensitivity to drought. Predicted diurnal cycles of transpiration agreed well with sap-flux based estimates of transpiration with $r^2 = 0.9$. Adaptation of vegetation to climate and soil explained differences in both diurnal and seasonal cycles of transpiration among the four forest plots.