Geophysical Research Abstracts
Vol. 14, EGU2012-10170, 2012
EGU General Assembly 2012

Constraining key hydraulic parameters of Scots Pine through sapflow data assimilation along a climatic gradient

O. Sus (1), J. Martínez-Vilalta (1), R. Poyatos (1), and M. Williams (2)
(1) CREAF, UA Barcelona, Spain (o.sus@creaf.uab.es), (2) School of GeoSciences, The University of Edinburgh, UK

In order to model the water balance of a forest ecosystem and predict its response to environmental changes, the response of tree transpiration to environmental conditions needs to be simulated. The plant hydraulic system can be conceptualised as a series of hydraulic resistances. The flow of water between any two locations of this system is proportional to the hydraulic conductivity and the water potential gradient linking them. The different components of the plant hydraulic system can change during drought as a result of varying stomatal conductance, xylem hydraulics and the regulation of leaf and root area.

However, within this soil-plant-atmosphere continuum (SPAC), physical processes of water flow are better understood than plant hydraulics. For example, the effects of leaf microclimate on stomatal regulation of transpiration are not well understood. Moreover, little is known about how key hydraulic traits vary seasonally or as a function of environmental conditions. Within corresponding models, empirical parameters are introduced as surrogates for a range of complex and/or unknown mechanisms.

Data assimilation (DA) methodology has shown to be a useful technique for model parameter estimation in various disciplines of the geosciences. However, few studies have applied DA to constrain parameter values within the SPAC in forest transpiration models. DA could prove to be particularly useful in quantifying these parameters, which are often not directly measurable. Sapflow data are highly appropriate for this purpose, as they are the measurable end-product of water transport through the SPAC in response to environmental conditions. Accordingly, these data provide temporally highly resolved, direct constraints on associated key parameters within models.

In this study, we assimilated sapflow data from three different Scots Pine sites – following a climatic gradient from the southern dry limit of its distribution (southern Catalunya, Spain) up to the northern temperate zone (Scotland) – into a process-based ecosystem model (SPA). Within SPA, photosynthesis and transpiration are linked by a stomatal conductance module that maximises daily carbon gain per unit leaf nitrogen within the limitations of canopy water storage and soil to canopy water transport. At each site, sap flow was measured using the Granier method for a representative period, covering from several months in the growing season up to a whole year. Applying a sequential DA technique (EnKF), we constrained key hydraulic and structural parameters (root and aboveground plant resistance to water transport, minimum leaf water potential, root to leaf mass ratio) and further analysed apparent patterns of seasonal and latitudinal variability. We conducted the assimilation experiments with both synthetic (i.e. model generated) and real sapflow data in order to estimate the applicability of the DA methodology. Our results are complementary to field site experiments by providing independent insights into stand-scale plant hydraulics, which bear further implications on water use efficiency and hydraulic limitations on carbon assimilation.