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The effect of plant water stress approach on the modelled energy-, water and carbon balance for Mediterranean vegetation; implications for (agro)meteorological applications.

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Current land surface schemes in many crop, weather and climate models make use of the coupled photosynthesis–stomatal conductance (A–gs) models of plant function to determine the transpiration flux and gross primary productivity. Vegetation exchange is controlled by many environmental factors, and soil moisture control on root water uptake and stomatal function is a primary pathway for feedbacks in sub-tropical to temperate ecosystems. Representations of the above process of soil moisture control on plant function (often referred to as a 'beta' factor) vary among models. This matters because the simulated energy, water and carbon balances are very sensitive to the representation of water stress in these models.

Building on Egea et al. (2011) and Verhoef and Egea (2014), we tested a range of 'beta' approaches in a leaf-level A-gs model (compatible with models such as JULES, CHTESSEL, ISBA, CLM), as well as some beta-approaches borrowed from the agronomic, and plant physiological communities (a combined soil-plant hydraulic approach, see Verhoef and Egea, 2014). Root zone soil moisture was allowed to limit plant function via individual routes (via CO_2 assimilation, stomatal conductance, or mesophyll conductance) as well as combinations of that.

The simulations were conducted for a typical Mediterranean field site (Avignon, France; Garrigues et al., 2015) which provides 14 years of near-continuous measurements of soil moisture and atmospheric driving data. Daytime (8-16 hrs local time) data between April-September were used. This allowed a broad range of atmospheric and soil moisture/vegetation states to be explored. A number of crops and tree types were investigated in this way.

We evaluated the effect of choice of beta-function for Mediterranean climates in relation to stomatal conductance, transpiration, photosynthesis, and leaf surface temperature. We also studied the implications for a range of widely used agro-/micro-meteorological indicators such as Bowen ratio and the omega decoupling coefficient (which quantifies the degree of the aerodynamic coupling between a vegetated surface and the atmospheric boundary layer; Jacobs and de Bruin, 1992); and applications (e.g. the use of surface temperature based water stress indices).

Results showed that choice of 'beta' function has far-reaching consequences. For certain widely used 'beta'-models the predicted key fluxes and state variables, predominantly compared using kernel density functions, showed considerable 'clumping' around narrow data ranges. This will have implications for the strength of land-surface feedback predicted by these models, and for any agrometeorological applications they are used for. Recommendations as to the most suitable 'beta'-functions, and related parameter sets, for Mediterranean climates were made.

References

Garrigues, S. et al. (2015) Evaluation of land surface model simulations of evapotranspiration over a 12-year crop succession: impact of soil hydraulic and vegetation properties, Hydrol. Earth Syst. Sci., 19, 3109–3131; Jacobs, C. M. J. and de Bruin, H. A. R. (1992) The sensitivity of regional transpiration to land-surface characteristics: Significance of feedback, J. Climate, 5(7), 683–698; Verhoef, A. and Egea, G. (2014) Agriculture and Forest Meteorology, 191, 22–32; Egea, G., Verhoef, A., and Vidale, P. L. (2011) Agricultural and Forest Meteorology, 151, 1370-1384