Representation of the canopy conductance in modelling the surface energy budget

Rationale

The canopy conductance has a direct impact on the surface energy budget and consequently on the sensible heat flux density and the boundary layer over vegetative surfaces. Since a large percentage of surfaces in the world is vegetated, Land Surface Models (LSMs) of weather forecasting and climate models should represent canopy processes well.

Traditionally, processes controlling the conductance are separated and assumed to affect this conductance independently, a Jarvis-Stewart (henceforth JS-)model. An alternative approach is to relate the canopy conductance to the net flow of carbon dioxide. The net flow of carbon dioxide is a function of the primary production and the photorespiration which are both functions of the environmental variables.
Various studies appeared where both models have been compared locally. The objective of this study is to see whether useful estimates of the canopy conductance can be obtain if the model parameters are derived from global vegetation maps.

Results

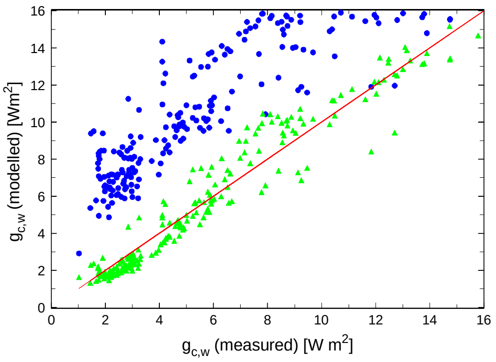

Figure 1: Scatter plot of modelled against measured canopy conductance for FIFE-KANSAS: simulated with physiology based model (green) and with JS-model (blue).

From Figure 1 it appears that the JS-model with 'a priori' chosen parameters (taken from the ECMWF ERA40 classification) overestimates the canopy conductance, whereas the physiologically based model (values for C4 plants have been adopted together with a LAI of 2) gives better estimates.

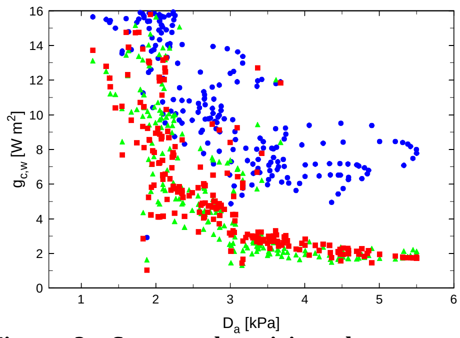

Figure 2: Scatter plot giving the canopy conductance as function of D_a; measurements (red), physiologically based model (green) and JS-model (blue).

The JS-model underestimates the response of the canopy conditions to dry conditions (Figure 2). The physiologically based model with a priori chosen parameters represents the effect of increasing D_a better.

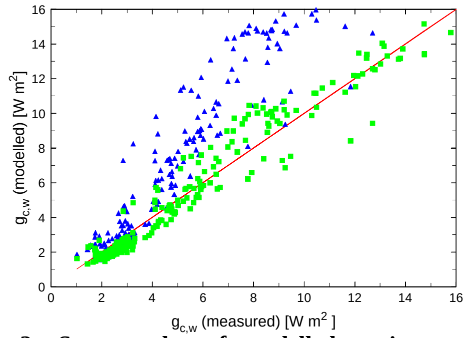

Figure 3: Scatter plot of modelled against meaured canopy conductance for FIFE-KANSAS: simulated with standard (green) and 'big leaf' physiology based model (blue)

We also explored whether a 'big leaf' model for the absorption of PAR was sufficient. Assuming that the PAR is uniformly absorbed by the vegetation leads to overestimations of the canopy conductance and of the latent heat flux density (Figure 3). Describing absorption of LAI as an exponential function of LAI lead to good results and fortunately, an analytic expression, avoiding numerical integration, was feasible.

Conclusion

For a C4 prairie grass in Kansas it appeared that a physiological based model which parameters are taken a priori from global vegetation maps, leads to better estimates of the canopy conductance than a JS-model with a priori chosen parameter values. Assuming that the PAR is absorbed exponentially as function of LAI appeared correct and an analytical expression for scaling up the conductance from leaf to canopy was feasible.

WAGENINGEN UR

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