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Modeling of Transpiration by natural Vegetation through Maximisation of net Carbon Profit

S. Schymanski (1), M. Sivapalan (1), M. L. Roderick (2)

(1) Centre for Water Research, The University of Western Australia, Crawley, Australia, (2) CRC for Greenhouse Accounting, The Australian National University, Canberra, Australia (schymans@cwr.uwa.edu.au / Fax: +61 8-64881015 / Phone: +61 8-64881683)

Evapotranspiration often represents more than 90% of the annual water balance, yet hydrological models have traditionally focussed on the remaining 5-10% that is the runoff. Especially in ungauged catchments or under a changing climate there is a need for better understanding the controls on evapotranspiration, and incorporating that understanding into hydrological models. One approach to modelling evapotranspiration relies on using estimates of vegetation properties like leaf area index (LAI) and canopy roughness and empirical correlations linking transpiration with vegetation- and climate variables. For many agricultural crops these correlations are well documented and LAI can be estimated using handheld devices. However for natural vegetation the correlations are unknown and it is not even sure if the correlations are constant or vary with time.

The present study suggests that a simple model based on ecological optimality is capable of reproducing vegetation- and water balance dynamics without any prior knowledge about the vegetation on a particular site.

The model is based on a physical water balance model by Reggiani et al. (2000), an ecophysiological gas exchange and photosynthesis model (Cowan and Farquhar 1977; von Caemmerer 2000) and the hypothesis that natural selection leads to a vegetation type that optimally uses available resources to maximise its 'net carbon profit' (the difference between carbon acquired by photosynthesis and carbon spent on maintenance of the organs involved in its uptake). While the site properties such as soil type and depth, topography and climate have to be prescribed, the model creates the 'optimal' dynamically adjusting vegetation for the particular site and calculates the water- and

CO_2- fluxes between soil, watershed boundaries, vegetation and atmosphere.

Comparison of some of the model outputs with observed time series of Normalised Difference Vegetation Index (NDVI, a measure for projected foliage cover) and long-term gas exchange measurements from Eddy flux stations give encouraging results.

Keeping in mind that the model is based on entirely hypothetical vegetation, and that no form of calibration has been applied, we conclude that this approach is very powerful for predicting the water balance in ungauged catchments and/or under changing climate.

Literature

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