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Impacts of energy balance modelling on the uncertainties in simulated evapotranspiration: Evaluation and sensitivity analysis for the JULES land surface model.

Sebastien Garrigues (1,2), Emma Robinson (1), Douglas B. Clark (1), Eleanor Blyth (1), Simon Dadson (1,3), Martin Best (4), John Edwards (4), Hiroshi Kusabiraki (5), Gilles Boulet (2), Lionel Jarlan (2), and Aaron Boone (6)

(1) Centre for Ecology and Hydrology (CEH), Wallingford, UK, (2) CESBIO, Toulouse, France, (3) School of Geography and the Environment, University of Oxford, Oxford, UK, (4) Met Office, Exeter, UK, (5) Japan Meteorological Agency, Tokyo, Japan, (6) CNRM, Meteo France/CNRS, Toulouse, France

Enhanced modelling of evapotranspiration (ET) is required to address important research questions such as the impacts of changes in land-cover and land-use on the hydrological response of catchments to rainfall. ET has been recognized as one of the most uncertain terms in the surface water balance simulated by land surface models. Uncertainties in simulated ET can be attributed to (i) model structure and parameters and (ii) errors in the forcing variables used to drive the model and to integrate it spatially. A single-source surface energy balance does not account for radiative and turbulent interactions between the canopy air space and the substrate below the canopy. This can be a strong source of structural uncertainties in surface fluxes simulated over heterogeneous surfaces (e.g. forest canopy partially buried by snow, sparse vegetation with large fraction of bare ground) for which the substrate has a significant impact on the total energy balance. However, while separate representation of the energy exchanges for the substrate and the canopy should provide more realistic modelling framework, the larger number of parameters may increase the total uncertainties for large-scale simulations. This goal of this work is to assess the uncertainties in the modelling of the energy balance in a land surface model and its impact on the simulation of evapotranspiration and the partitioning between soil evaporation, plant transpiration and canopy interception. This study was achieved within the Hydro-JULES project which aims at developing an integrated land surface-hydrological modelling platform in conjunction with the Joint UK Land Environment Simulator (JULES) land surface model. We evaluated the dual-source scheme that has been recently implemented in the JULES land surface model. This work has two objectives:

- assess the performances of the JULES dual-source against in situ observations at various contrasted sites: BERMS (Saskatchewan) forest site; Avignon (France) Mediterranean crop site and semi-arid olive orchard sites in Morocco and Tunisia.
- conduct a sensitivity and uncertainty analysis to identify the most influential parameters of the dual-source scheme on the simulation of evapotranspiration and its partitioning.

The outcomes of this work will help to identify in which environmental conditions (soil, climate, surface heterogeneity) a dual-source scheme provides more accurate estimation of total evapotranspiration than a single-source model. The partitioning of ET into soil evaporation and plant transpiration will also be evaluated for sites for which sap flow or isotopic measurements were available. This study will bring key insights on the compromise to reach between enhanced modelling complexity and increased uncertainties generated by a larger number of parameters.