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Weak sensitivity of the terrestrial water budget to soil texture maps in the ORCHIDEE land surface model

Salma Tafasca (1), Agnès Ducharne (1), and Christian Valentin (2)

(1) METIS (Milieux Environnementaux, Transferts et Interactions dans les Hydrosystèmes et les Sols), Institut Pierre Simon Laplace (IPSL), Sorbonne Université, CNRS, EPHE, Paris, France (salma.tafasca@upmc.fr), (2) iEES-Paris (Institut d'Ecologie et des Sciences de l'Environnement de Paris), Sorbonne Université, CNRS, INRA, IRD, Paris, France

Soil physical properties play an important role for estimating soil water and energy fluxes. Since field measurement of these properties is difficult and costly, many hydrology and land surface models (LSMs) use soil texture maps to infer soil hydraulic parameters. The impact of soil texture on soil water processes has been extensively assessed, however, to our knowledge, it has never been studied at global or subcontinental scales. In the present study, we investigated the impact of soil texture on global soil water fluxes and storage using the ORCHIDEE LSM, which offers a process-based description of soil hydrology, combining a 1D-vertical Richards equation and the Van Genuchten-Mualem model for unsaturated hydraulic parameters. This model was run off-line at the 0.5° resolution, and we prescribed multiple input soil texture maps from the literature to this model to examine its response to each texture, and to each map. Among all water fluxes, surface runoff and infiltration exhibited the highest sensitivity to soil texture change, and medium textured soils showed the highest evapotranspiration rates and the lowest total runoff. Yet, the partitioning of precipitation between evapotranspiration and total runoff is shown to be primarily dependent on climatic conditions and less dependent on soil texture. In particular, the different soil texture maps resulted in globally similar water budgets, although high local differences were observed. Compared to several observation-based products, we also found that ORCHIDEE satisfactorily simulated the global patterns and mean of evapotranspiration whichever the soil texture map, including with a uniform loamy soil. In line with few other results, this study suggests that soil texture, although used as the only soil descriptor in many hydrology and land surface models, may not be a relevant control of soil hydrology, at least at the 0.5° resolution explored here.