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Improving land surface hydrological simulations over France using a high resolution river network and a description of anthropocentric pressures

Lucia Rinchiuso[1,2], Agnès Ducharne[1,2], Jan Polcher[3,2], Philippe Peylin[4,2], Pedro Arboleda Obando[1,2], Anthony Schrapffer[5,6,7], and Eric Sauquet[8]

[1]METIS (Milieux Environnementaux, Transferts et Interactions dans les Hydrosystèmes et les Sols), Sorbonne Université, CNRS, EPHE, Paris, France
[2]Institut Pierre Simon Laplace (IPSL), France
[3]LMD - Laboratoire de Météorologie Dynamique, France
[4]LSCE - Laboratoire des Sciences du Climat et de l'Environnement, Gif-sur-Yvette, France
[5]Centro de Investigaciones del Mar y de la Atmósfera (CIMA-UBA/CONICET), Buenos Aires, Argentina
[6]Atmospheric and Oceanographic Science Department, FCEyN, University of Buenos Aires, Argentina
[7]French-Argentinean Institute for the Study of Climate and its Impacts (UMI-IFAECI/CNRS-CONICET-UBA), Buenos Aires, Argentina
[8]INRAE, UR RiverLy, Villeurbanne, France

The evolution and possible limitation of water resources under climate change will become a crucial problem over the next decades and accurate hydrological projections are fundamental tools to assess the problem. The goal of this study is to improve the simulation of both river discharges and evaporation with the ORCHIDEE (Organising Carbon and Hydrology in Dynamic Ecosystems) land surface model by accounting for a high-resolution river network and water management influence.

This work will allow us to produce long-term projections of river discharge in France under different regional-scale climate change scenarios for the national project Explore2 and the French climate services.

To this end, we present here the evaluation and calibration of an improved version of ORCHIDEE, run off-line over France with atmospheric forcing from the SAFRAN reanalysis at an 8-km resolution and 1-hourly time step. First, we implement a high-resolution river routing scheme recently developed to better reproduce the water flow through the river network from the source to the outlet. It relies on topographical and hydrological information from the MERIT Hydro (Multi-Error-Removed Improved-Terrain) digital elevation model scaled at a 2km resolution, which allows us to define sub-basins at a higher resolution than the atmospheric forcing and to correctly position a majority of French gauging stations along the reconstructed rivers.

By comparing the discharge simulations to observations from the French hydrometric database (http://hydro.eaufrance.fr/) on about 800 stations with variable upstream areas, selected for their

long and good-quality record, and medium-to-low human pressures, we find a very general overestimation of river discharge by the model, except in mountainous areas where earlier studies showed that the SAFRAN reanalysis was underestimating precipitation. The comparison of the simulated evapotranspiration to the data-driven FLUXCOM gridded product, over the upstream area of each selected station, shows a systematic underestimation, which can be explained by the underestimation of precipitation over mountains, and is elsewhere consistent with the overestimation of river discharge.

Further comparison to water withdrawals and consumption data from the national database BNPE (http://bnpe.eaufrance.fr/) suggests that both river discharge overestimate and evapotranspiration underestimate can be partly attributed to the neglect of water management in ORCHIDEE, although the studied stations have been selected for their weak human influence. We will thus incorporate water management information in ORCHIDEE in two ways: by activating an irrigation parametrization to consistently describe the impact of this human pressure on both river discharge and evapotranspiration, and by reducing river discharge from the other abstraction sources. The related parameters will finally be calibrated such as to best reproduce the observed discharge, evapotranspiration, and irrigation withdrawals.