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Simulating French hydropower operations in a land surface model

Laure Baratgin[1], Jan Polcher[1], Philippe Quirion[2], and Patrice Dumas[3]
[1]Laboratoire de Météorologie Dynamique, IPSL, CNRS, Ecole Polytechnique, Palaiseau, France
[2]CIRED, CNRS, Nogent-sur-Marne, France
[3]CIRAD, UMR CIRED, Montpellier, France

Climate change and water management are expected to have significant impacts on river flows. Hydropower production is therefore expected to evolve, while low carbon electricity could become more valuable in the context of the transition towards sustainable societies.

Hydrological models have been used to evaluate the potential of hydropower plants based on simulated flows. Some of these studies represent dams and water management. However, dam operation is done independently for each dam or each river basin, without considering the specificities of hydroelectric reservoirs whose operation results from an optimization of the entire power system.

We propose and validate a demand-based method to represent hydropower in the routing module of a land surface model at the scale of a national power grid. First, hydropower infrastructures are placed in coherence with the hydrological network and links are built between reservoir and power plants. Then, coordinated dam operation is simulated by distributing the total electric demand to be satisfied by hydropower over the different power plants.

The method is developed within the routing scheme of the ORCHIDEE land surface model, so that changes in climate or land use can be considered in future studies.

We calibrate and validate the model by simulating hydropower production in France over the period 2012-2018 using SAFRAN climate forcing data and comparing it to available observations of hydropower generation. Several rules for the dispatch of production between the power plants are compared and evaluated.

We show that an operating rule based on climatological inflows, reservoir volumes and hydraulic heads can simulate a dispatch of production that enables the model to replicate hourly hydropower plants output throughout the period.