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Detailed simulation of storage hydropower systems in a large Alpine watershed

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The Italian Alpine region holds the largest share of hydropower production in Italy, accounting for more than 75% of the national hydropower installed capacity, and satisfying about 20% of the daily electricity demand in Italy. Furthermore, storage hydropower plays a major role, accounting for about 60% of installed capacity and mean annual hydropower production in the region.
From a modeling perspective, simulation of storage hydropower systems represents an open challenge in hydrology due to the difficulties in acquiring technical information of each system. Therefore most of the work done so far focuses on run-of-the-river systems, adopt indirect proxies of regional storage hydropower production (e.g. gross potential estimates, selected quantiles of the streamflow flow duration curves), or limit the analysis to a particular system.
In this study, we present an application of HYPERstreamHS model in the Adige river basin, located in the south-eastern part of the Alps. HYPERstreamHS is a distributed hydrological model specifically designed to simulate in detail the interactions between anthropogenic infrastructures (such as reservoirs and diversion channels) and the natural hydrologic system. The conceptual model of the Adige river basin (drainage area of about 10500 square kilometers closed at Trento gauging station) includes the presence of 30 storage reservoirs and 27 large hydropower plants (i.e. with average nominal capacity larger than 3 MW).
A multi-site calibration procedure has been performed by comparing observed and simulated streamflow time series during the period 2000-2013, achieving an overall Nash-Sutcliffe efficiency of 0.82. Afterwards, the hydropower production module has been successfully validated against historical hydropower production time series in the Noce river basin, a large tributary of the Adige river with a drainage area of about 1300 square kilometers that hosts 12% of the installed capacity of the entire Adige basin. The resulting modelled hydropower production differed from the observed data by 6%. The implementation and validation of the remaining hydropower systems in the Adige watershed is currently ongoing.