Impact of groundwater on present-day climate and climate sensitivity in the CNRM-ESM2 Earth System Model

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The continental hydrology is an active component of the climate system. It is likely to influence the water and energy exchanges at the land surface, as well as the ocean salinity and temperature at the mouth of the largest rivers. It is therefore necessary to accurately represent the continental hydrological processes in Earth System Models (ESM). Recently, groundwater schemes have been integrated to ESMs. Indeed, through their interactions with rivers and soil water contents, aquifers are part of the surface hydrology. Thus, their representation in ESM can be expected to have an impact on the simulated climate.

In CNRM-ESM2 – developed by Météo-France for the next Coupled Climate Intercomparison Project (CMIP6) – the land surface is represented by the SURFEX modeling system in which the hydrology is simulated with the ISBA Land Surface Model (LSM), coupled to the CTRIP River Routing Model (RRM). ISBA solves the temperature and soil moisture equations with a 14-layer discretization while the snowpack is simulated with an explicit 12-layer scheme. CTRIP, the CNRM version of the TRIP model, simulates river discharges at a 0.5° resolution. It also includes a parameterization of unconfined aquifers and a floodplain scheme.

This new hydrological system has been validated in offline mode in previous studies. Here, we evaluate the impact of the simulated aquifers in present-day global climate simulations, as well as in climate change scenarios. More specifically, we assess the impact of groundwater on the climate sensitivity in abrupt CO\(_2\) experiments – where the concentration of CO\(_2\) is quadrupled – and in transient experiments – with a 1% per year increase in the CO\(_2\) concentration.