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Global off-line evaluation of the ISBA-TRIP continental hydrological system used in the CNRM-CM6 climate model for the next CMIP6 exercise

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The land surface hydrology represents an active component of the climate system. It is likely to influence the water and energy exchanges at the land surface, the ocean salinity and temperature at the mouth of the largest rivers, and the climate at least at the regional scale. In climate models, the continental hydrology is simulated via Land Surface Models (LSM), which compute water and energy budgets at the surface, coupled to River Routing Model (RRM), which convert the runoff simulated by the LSMs into river discharge in order to transfer the continental fresh water into the oceans and then to close the global hydrological cycle. Validating these Continental Hydrological Systems (CHS) at the global scale is therefore a crucial task, which requires off-line simulations driven by realistic atmospheric fluxes to avoid the systematic biases commonly found in the atmospheric models.

In the CNRM-CM6 climate model of Météo-France, that will be used for the next Coupled Climate Intercomparison Project phase 6 (CMIP6) exercise, the land surface hydrology is simulated using the ISBA-TRIP CHS coupled via the OASIS-MCT coupler. The ISBA LSM solves explicitly the one dimensional Fourier law for soil temperature and the mixed form of the Richards equation for soil moisture using a 14-layers discretization over 12m depths. For the snowpack, a discretization using 12 layers allows the explicit representation of some snow key processes as its viscosity, its compaction due to wind, its age and its albedo on the visible and near infrared spectra. The TRIP RRM uses a global river channel network at 0.5° resolution. It is based on a three prognostic equations for the surface stream water, the seasonal floodplains, and the groundwater. The streamflow velocity is computed using the Maning's formula. The floodplain reservoir fills when the river height exceeds the river bankfull height and vice-versa. The flood interacts with the ISBA soil hydrology through infiltration and with the overlying atmosphere through precipitation interception and free water surface evaporation. Finally, the groundwater scheme is based on the two-dimensional groundwater flow equation for the piezometric head. Its coupling with ISBA permits to account for the presence of a water table under the soil moisture column allowing upward capillarity fluxes into the soil.

In this study, we will present the off-line evaluation at the global scale of the ISBA-TRIP CHS over a recent period (1979-2010). The system will be compared to observations such as GRACE (Gravity Recovery and Climate Experiment) terrestrial water storage data, snow and permafrost extents from NSIDC (National Snow and Ice Data Center), or in-situ river discharge measurements from several sources. In addition we will also explore the impacts on the simulated water budget to account for some processes such as upward capillarity fluxes from groundwaters or seasonal floodplains. At last, it is envisaged to discuss some results about land/atmosphere interactions induced by these processes in the CNRM-CM6 climate model.