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Large scale high resolution modelling of the West African rivers and aquifers

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West Africa has been classified as one of the most vulnerable regions in the world for water resources to face global changes, both climatic and demographic. The population is expected to double by 2050 leading to increased pressure on the use of water resources. In this context, it is necessary to understand the dynamics of major African hydrosystems as large rivers (Niger river, Senegal river...) and transboundary aquifers in order to predict the fate of water resources for the next decades. The ParFlow-CLM physical-based model was chosen for its ability to simulate surface water and groundwater dynamics in a coupled manner. This type of modelling makes it possible to represent the main hydrological processes observed over the whole West Africa region. It operates at a relatively fine spatial resolution (1 km²). The main challenge is to determine the hydrodynamic parameters of the soil for the entire region and on a 100 m thickness (i.e. 3.5 million pixels times 11 layers).

As a first step, the model was implemented on two catchments monitored by the AMMA-CATCH observatory. These two watersheds are representative of the major and contrasted processes found in WA : being respectively representative of Sudanian and Sahelian climates. In order to assess the relevance of the regional databases (SoilGrids and GLHYMPS), simulations were carried out with original and adjusted (based on observations) soil parameters and results were evaluated with local measurements. It appears that the deep weathered lithology is not considered in databases for most of hard-rock areas in intertropical areas with no tectonic uplift. Aquifer thicknesses, permeabilities and porosities have to be significantly enhanced for the model to represent the correct flow paths. Furthermore, in the Sahel where most of the annual precipitation falls during a dozen events only, a crust layer (consistent with observations) has been added to represent the large runoff coefficients which lead to the early season floods.

In a second step, the model was implemented at the West Africa scale using the adjusted soil parameters. These parameters were obtained using a simple linear law that have been applied uniformly over the entire domain and a mask over a part of the Sahel representative of the crusting zones. Results will be compared with both remotely sensed and in situ data : GRACE provides water stock variations at a very large scale, MERRA and ERA reanalysis provide evapotranspiration data. Altimeters and in situ measurements provide river flow data. In the near

future the launch of the SWOT satellite will bring new observations to complete the current one. The evaluation of the different compartments of the hydrological cycle should reveal spatial discrepancies in the model's ability to represent processes, highlighting the points on which further work should focus.