A groundwater model as a benchmark for a fully-integrated supra-regional-scale hydrological modeling

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Climate change is an evident environmental issue for the 21th century. Numerous regions, in which water resources were previously abundant but might not be anymore in the near future, need to improve their understanding of the hydrological cycle in their region.

The proposed study takes place within a synthesis project for groundwater management and climate change impact studies of the southern region of Quebec (Canada). From a quantitative point of view, the influence of climate change might result in a reduction of baseflow, and thus a reduction of water availability, during the drier summer months. The optimal management of this groundwater resources problem requires the study of multiple spatial and temporal scales on which the influence of climate change on the hydrological cycle is investigated.

As part of the synthesis project, we aim to examine the influence of climate change on baseflow through a fully-integrated and physically-based hydrological model at a supra-regional-scale (36 800 km2) for which 10 plausible climate change scenarios will be considered. Such an approach is supported by the use of the HydroGeoSphere (HGS) code. Historical observations of groundwater head and of streamflow are available for the past 20 years. These two complementary observation sets will be used for the parameter estimation process. However, due to the computationally expensive execution of such a coupled surface-subsurface hydrological model, the parameter estimation and predictive uncertainty analyses are challenging.

To mitigate this issue, we propose a bottom-up approach, in which a pure groundwater model is first considered and calibrated against groundwater head observations. This pure groundwater model will serve as a benchmark for a fully-integrated hydrological model. It will allow identifying optimal parameter estimation strategies in terms of their computational efficiency, and it will provide a good initial estimate of groundwater flow parameters for the integrated hydrological model.