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A dynamical combination of rainfall-runoff models by mutually correcting their internal state variables

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The aim of this presentation is to investigate the possibility to dynamically combine two models to take advantage of the strengths of the two models. The combination was done using a multi-model method called Super Model (SUMO, van den Berge et al., 2011), which was created by climatologists. The novelty of the SUMO method is to modify the internal variables (the store levels) of one model taking into account the values of the internal variables of the other model. This modification is made multilaterally between the different models. The ensemble of the different models constitutes a Super Model in which all the models exchange information on their internal variables with each other at each time step. A parallel can be done with data assimilation, considering that, here, the internal variables of another model would be assimilated.

The approach was tested using two lumped hydrological models, HYMOD and GR4J, which are parcimonious bucket-type rainfall-runoff models with respectively five and four parameters. They are robust and perform well on a wide range of catchments. However, their conceptualizations of hydrological processes differ. For example, the GR4J model considers an intercatchment groundwater exchange that is not considered by HYMOD. In contrast, HYMOD takes a variability in the rainfall-runoff response shape into account by using a parameter, which is not the case for GR4J.

The Super Model made up of HYMOD and GR4J was tested on 650 French catchments. Flow simulation improvements were observed when compared to the original simulation of the individuals models on more than 30% of the tested catchments. Interesting behaviours were observed: indeed, the Super Model simulated flow can go out of the range of the original simulations of GR4J and HYMOD. Depending on the season, the Super Model simulated flows can present values close to a model and then close to another one. This results are interesting because they are impossible to obtain with traditional multi-model approaches like weighted average of the two model flows.

References

van den Berge, L. A., F. M. Selten, W. Wiegerinck, and G. S. Duane, 2011. A multi-model ensemble method that combines imperfect models through learning. Earth System Dynamics, 2(1): 161–177.