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Modelling the snowmelt and the snow water equivalent by creating a simplified energy balance conceptual snow model

Philippe Riboust (1,2), Guillaume Thirel (2), Nicolas Le Moine (1), and Pierre Ribstein (1)

(1) Sorbonne Universités, UPMC Univ Paris 06, CNRS, EPHE, UMR 7619 Metis, 4 place Jussieu, 75005 PARIS, FRANCE , (2) Hydrosystems and Bioprocesses Research Unit (HBAN), Irstea, 1, rue Pierre-Gilles de Gennes, CS 10030, 92761 Antony Cedex, France

A better knowledge of the accumulated snow on the watersheds will help flood forecasting centres and hydro-power companies to predict the amount of water released during spring snowmelt. Since precipitations gauges are sparse at high elevations and integrative measurements of the snow accumulated on watershed surface are hard to obtain, using snow models is an adequate way to estimate snow water equivalent (SWE) on watersheds. In addition to short term prediction, simulating accurately SWE with snow models should have many advantages. Validating the snow module on both SWE and snowmelt should give a more reliable model for climate change studies or regionalization for ungauged watersheds. The aim of this study is to create a new snow module, which has a structure that allows the use of measured snow data for calibration or assimilation.

Energy balance modelling seems to be the logical choice for designing a model in which internal variables, such as SWE, could be compared to observations. Physical models are complex, needing high computational resources and many different types of inputs that are not widely measured at meteorological stations. At the opposite, simple conceptual degree-day models offer to simulate snowmelt using only temperature and precipitation as inputs with fast computing. Its major drawback is to be empirical, i.e. not taking into account all of the processes of the energy balance, which makes this kind of model more difficult to use when willing to compare SWE to observed measurements.

In order to reach our objectives, we created a snow model structured by a simplified energy balance where each of the processes is empirically parameterized in order to be calculated using only temperature, precipitation and cloud cover variables. This model's structure is similar to the one created by M.T. Walter (2005), where parameterizations from the literature were used to compute all of the processes of the energy balance. The conductive fluxes into the snowpack were modelled by using analytical solutions to the heat equation taking phase change into account. This approach has the advantage to use few forcing variables and to take into account all the processes of the energy balance. Indeed, the simulations should be quick enough to allow, for example, ensemble prediction or simulation of numerous basins, more easily than physical snow models.

The snow module formulation has been completed and is in its validation phase using data from the experimental station of Col de Porte, Alpes, France. Data from the US SNOTEL product will be used in order to test the model structure on a larger scale and to test diverse calibration procedures, since the aim is to use it on a basin scale for discharge modelling purposes.