



MASiN: Toward a calibrationless snow cover model for hydrological studies

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Most hydrological models simulate snowmelt using a degree day or simplified energy balance method which usually requires a calibration of the model parameters using discharge data. This method is recognized as promoting equifinalities in models having a high number of parameters to be calibrated as this is the case in distributed models. In addition, calibrating parameters that control snow pack evolution by the mean of discharge data leads to empirical relations which are not proven to remain valid in a changing climate. We here introduce an original physically based snow pack model suitable for hydrological modeling and whose simulation process does not require calibration. The snowpack is modeled using a multi-layer approach. The model called MASiN computes the energy and mass balance of each layer using hourly meteorological data: air temperature, relative humidity, wind velocity and precipitation. Initial parameterization is performed based on published values and a sensitivity analysis. The MASiN simulated snow depth is compared against measurements and simulation from three other models calibrated at each study sites: the snow module of the hydrological model Hydrotel and two empirical snow model at different locations where available data range from nine to twenty one years. MASiN showed good ability to simulate snow depth evolution at every location with Nash Sutcliffe coefficients ranging from 0.684 to 0.873. It gives better results than the calibrated Hydrotel snow module at most location with a mean improvement of the Nash Sutcliffe coefficient by 7 % and is slightly less good than the two calibrated empirical models with a mean Nash Sutcliffe coefficient difference of 6.5 % between MASiN and the best model. MASiN is also the model which shows the smallest mean offset between the simulated and real disappearance of the snow pack. Those results proved the model to be a promising tool for hydrological studies especially where calibration data are lacking.