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TOPMELT: a topography-based distribution function approach to snowmelt simulation. Evaluation of model uncertainty in snow covered area and hydrological response simulation.

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This work provides an assessment of uncertainty for a topography-based distribution function approach to snowmelt simulation (TOPMELT). The model integrates a radiation enhanced temperature-index snowmelt within a semi-lumped basin-scale hydrological model (ICHYMOD). The radiation enhanced temperature-index snow melt method is based on using an energy index as an index of snowmelt similarity and accounts for the temporal variation of the radiation distribution over the basin. With the proposed module pixels with similar energy index are identified and grouped together in energy index classes. The snowpack modelling is carried out for each energy index class, hence ensuring significant computational efficiency. Since the energy index is varying along the year, TOPMELT incorporates a routine which accounts for the different distribution of the energy index classes with time and ensures a consistent temporal simulation of the snowmelt. As such, the model permits to produce spatially distributed maps of snow water equivalent by exploiting a semi-lumped hydrological approach.
A sensitivity and uncertainty analysis of the main snow model parameters is performed in order to quantify the effects of different parametrizations in terms of both temporal/spatial snow cover area (SCA) and runoff performances. The case study area is the upstream part of the Adige river basin (2719 km2), placed in the western part of Southern Tyrol (Northern Italy), where quality controlled MODIS data and snow depth observations, collected at about 30 stations distributed over the catchment, are available over 5 years (2012-2016). Uncertainty assessment is carried out by comparing MODIS maps, snow depth surveys and discharge data at different stream-gauge stations available within the test basin.
The results show that model uncertainty is affected in a significant way by the temporal resolution of the energy index spatial distribution. By using a monthly energy index distribution, the model is able to reproduce reasonably well both MODIS-observed SCA and runoff characteristics over different basins. It is shown how MODIS data may be used to update regularly the water equivalent distribution and runoff uncertainty.