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Sub-grid Representation of Snow in Land Surface Models

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Abstract

Snow depth and fraction in high-latitude landscapes play a key role in defining surface energy and moisture relationships. In light of the role that snow plays in influencing various processes, it is important that the land surface schemes used in weather and climate models accurately represent the spatial variation of snow depth and cover. In this paper, a new sub-grid snow parameterization is proposed for the Canadian Land Surface Scheme (CLASS), which is used in the Canadian regional and global climate models. The sub-grid scheme takes into account elevation, slope and aspect variations within a grid cell and uses a clustering approach to classify sub-grid cells based on elevation, slope and aspect values into groups. The impact of these modifications on the regional hydrology is assessed by comparing two offline simulations, performed with the original and modified versions of CLASS, driven by atmospheric forcing data from the European Centre for Medium-Range Weather Forecasts (ECMWF) reanalysis (ERA-Interim), for the 1970–2013 period, over a northwest Canadian domain. Results suggest higher Snow Water Equivalent (SWE) in the simulation with modified CLASS compared to the original version. Also, the simulated SWE using the modified CLASS is in better agreement to SNODAS. Furthermore, the results show that the magnitude of streamflows is improved in the modified model. This study thus demonstrates the added value of sub-grid snow parameterization, as reflected in the realistic simulation of surface hydrologic variables.