Evaluation of the Coupled Hydrology Land-Surface Model (MESH) for High-Mountain Snow and Glacier Process Simulation

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ABSTRACT

The objectives of this study are (1) to examine the performance of the snow and glacier routines in the coupled hydrology land-surface model (MESH), that incorporates the Canadian Land Surface Scheme (CLASS); and (2) to quantify the influence of physical parameterization and meteorological forcing on snowpack and glacier simulations in high mountains. Of particular interest in MESH is its ability to simulate blowing snow, snow interception by canopy, and glacier ice energetics. Here, a physically-based parameterization approach was used with parameters selected based on the understanding of the physical system with no calibration. The model was configured in single column mode and forced with multiple years (163 years in total) of hourly *in situ* meteorological observations and run at eight alpine research sites in the Canadian Rockies that are part of the Canadian Rockies Hydrological Observatory (CRHO) and five alpine sites from the Earth System Model-Snow Model Intercomparison Project (ESM-SnowMIP). The ensemble of these sites represent alpine ridges, alpine forests and clearings, alpine tundra, grassland meadows, a barren moraine, and a glacier. Observations of shortwave and longwave irradiance were adjusted for elevation to the single column model site. A process-based approach was used to evaluate how realistically the model simulates snowpack evolution and changes in snow and ice energetics. The model represented snow accumulation, snowmelt onset, and ablation rates quite well at all sites. The modelled snow interception and sub-canopy snow routines were able to accurately simulate snowpack under forest canopy. At the wind-blown alpine ridges, an adequate representation of the snowpack evolution was possible when using MESH blowing snow algorithms. The glacier routines of the model were able to simulate ice ablation on a glacier reasonably well. Falsification of the forcing meteorology by not accounting for terrain impacts on radiative forcing and for elevational influences on precipitation and temperature resulted in large difference in simulations of snowpack evolution and melt contribution from glacier ice and so show the importance of including slope, aspect, and elevation in hydrological land surface schemes applied for mountain snow and ice simulation.

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