Daily Forecasts of Mountain Snowpack using a Snowdrift-Permitting Model

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ABSTRACT

Ongoing work to simulate the substantial spatial and temporal variability in energy and mass associated with cold regions hydrology has resulted in the Canadian Hydrological Model (CHM), a distributed model development framework. It is capable of a multi-scale basin discretization to permit greater spatial resolution where it is warranted. CHM includes most snow wind redistribution, interception, sublimation, accumulation, and ablation processes as well as sophisticated wind and energetics calculations for complex terrain and forest canopies.

Recent work evaluated the capacities of the above-treeline snow redistribution routines in CHM against lidar snow depth observations for a ~1000 km^2 mountain domain in the Canadian Rockies. These simulations were conducted at a 'snowdrift-permitting' scale (200 m or finer) using a pre-processing step to pre-compute wind fields. This approach allowed for efficient downscaling of the meteorological forecasts of the High-Resolution Deterministic Prediction System (HRDPS) forecasts from Environment and Climate Change Canada.

Large-extent estimates of snow mass are of significant value for water resource estimates in complex mountain terrain. An example of implementing CHM for daily forecasting purposes as the core of the Snowcast snow prediction system in the Canadian Rockies is shown. Specifically, the above-described work is extended to cover an area of almost 190,000 km^2 at a snowdrift-permitting scale. A set of observations at multiple scales are used to diagnose the model. These range from point observations, snow surveys, and lidar observations at a catchment scale, and indices derived from remotely sensed imagery at the mountain range scale. The inclusion of wind-induced and gravitational snow redistribution processes for mountain snowpack forecasts are required to accurately predict the snow mass heterogeneity and the evolution of snow mass and persistence with elevation. Without redistribution, snowpacks are overestimated at high elevations and the transport of snow from high elevation to low elevation is missed. These late-lying, low elevation snowpacks are important for estimating spring runoff. Lastly, the technical challenges of running snowdrift-permitting models over large extents are discussed.

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