High-resolution snow depth prediction using Random Forest algorithm with topographic parameters and an ecosystem map: a case study in the Greiner Watershed, Nunavut

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Abstract

Increased surface temperatures (0.7 per decade) in the Arctic affects polar ecosystems by reducing the extent and duration of annual snow cover. Monitoring of these important ecosystems needs detailed information on snow cover properties (depth and density) at resolutions (< 100 m) that influence ecological habitats and permafrost thaw. As arctic snow is strongly influenced by vegetation, an ecotype map at 10 m resolution was added to a method with the Random Forest (RF) algorithm previously developed for alpine environments and applied here over an arctic landscape for the first time. The topographic parameters used in the RF algorithm were Topographic Position Index (TPI) and up-wind slope index (Sx), which were estimated from the freely available Arctic DEM at 2 m resolution. Ecotypes with taller vegetation with moister soils were found to have deeper snow because of the trapping effect. Using feature importance with RF, snow depth distributions were predicted from topographic and ecosystem parameters with a root mean square error = 8 cm (23%) ($R^2 = 0.79$) at 10 m resolution for an arctic watershed (1 500 km^2) in western Nunavut, Canada.

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