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A Simple Model of the Climatology of Intermittent Snowpacks: Failures and Lessons

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We begin by presenting results from a very simple point-scale seasonal description of snow processes, expressed using dimensionless variables. The model is climatological in nature, and is not intended for detailed temporal or spatial simulation of snow conditions. It is, however, potentially suitable as a screening tool for identifying dominant processes, and for investigation of broader-scale questions such as the effect of climate change and climate variability on snow and water resources.

Three dimensionless variables were identified as being useful in summarizing the hydro-climatology of snow/ice-dominated regions. The variables are a scaled mean temperature; a measure of the seasonality of precipitation; and a measure of the magnitude of snowfall relative to snowmelt. These three are shown to provide surprisingly accurate uncalibrated predictions of snowpack climatology across a variety of cool climates in the western USA at which there is a continuous seasonal snowpack.

However, application of the purely seasonal model to warmer locations with intermittent snowpacks produces poor results. We explore the sensitivity of the model by relaxing assumptions, to assess the relative significance of diurnal temperature cycles, temperature variability due to synoptic weather systems and interannual variability, the assumed independence of fluctuations in temperature and rainfall, and the assumed constant value of degree-day factor. The purpose of the sensitivity analysis is to assess whether the simplicity of using similarity variables can be retained while extending the applicability of the model beyond continuous seasonal snowpacks where it performs well.