A Tale of Two Sites: Prediction of snow depth distribution at the first-order basin scale in the Colorado Rocky Mountains.

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Abstract. To shed light on the problem of anticipating peak-accumulation snow depth distribution at unmeasured sites, high-resolution LiDAR measurements of snow depth at 2 sites in northern Colorado are considered in a practical way. After simulating sparse, point-sampled snow observations at 30m resolution (over a square kilometer) from the high-resolution data sets and downloading collocated independent variables from the USGS website, several statistical models of snow depth are fit at each site and used to predict the snow distribution at the other. The site not used in fitting the each model is considered "unmeasured" and its data brought in only to validate predictions at the end. As prediction of snow depth values remains unrealistic, the focus of prediction turns to capturing the spatial structure of non-stationarity in mean snow depth over each "unmeasured" site. Predicted spatial patterns are validated via application to sampling design and mean snow depth estimation. Predicted patterns reveal up to 4 regions of different mean snow depth at each site. In one case, sampling to estimate the mean in each of these regions explains nearly 40% of the residuals of a model with a single mean value. While the extra amount of variance explained depends on the amount of variability at the predicted site, results in the prediction context are competitive with typical scores seen in snow depth interpolation even while using predictor variables which were obtained via the internet and less detailed models than are used in interpolation. This indicates that predicted patterns show promise for capturing spatial non-stationarity in snow depth resulting from independent physical controls. Such prediction of spatial distribution of snow depth has applications ranging from remote sensing to data assimilation to hydrologic modeling.

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