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Assessment of nominal data requirements for robust estimation of fractional snow cover in alpine-forested terrain

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The presented research examines what minimum combination of input variables are required to obtain state-of-the-art fractional snow cover (FSC) estimates for heterogeneous alpine-forested terrains. Currently, one of the most accurate FSC estimators for alpine regions is based on training an Artificial Neural Network (ANN) that can deconvolve the relationships among numerous compounded and possibly non-linear bio-geophysical relations encountered in alpine terrain. Under the assumption that the ANN optimally extracts available information from its input data, we can exploit the ANN as a tool to assess the contributions toward FSC estimation of each of the data sources, and combinations thereof. By assessing the quality of the modeled FSC estimates versus ground equivalent data, suitable combinations of input variables can be identified. High spatial resolution IKONOS images are used to estimate snow cover for ANN training and validation, and also for error assessment of the ANN FSC results. Input variables are initially chosen representing information already incorporated into leading snow cover estimators (ex. two multispectral bands for NDSI, etc.). Additional variables such as topographic slope, aspect, and shadow distribution are evaluated to observe the ANN as it accounts for illumination incidence and directional reflectance of surfaces affecting the viewed radiance in complex terrain. Snow usually covers vegetation and underlying geology partially, therefore the ANN also has to resolve spectral mixtures of unobscured surfaces surrounded by snow. Multispectral imagery if therefore acquired in the fall prior to the first snow of the season and are included in the ANN analyses for assessing the baseline reflectance values of the environment that later become modified by the snow. In this study, nine representative scenarios of input data are selected to analyze the FSC performance. Numerous selections of input data combinations produced good results attesting to the powerful ability of ANNs to extract information and utilize redundancy. The best ANN FSC model performance was achieved when all 15 pre-selected inputs were used. The need for non-linear modeling to estimate FSC was verified by forcing the ANN to behave linearly. The linear ANN model exhibited profoundly decreased FSC performance, indicating that non-linear processing more optimally estimates FSC in alpine-forested environments.