SPATIO-TEMPORAL PREDICTION OF SNOW WATER EQUIVALENT USING THE KALMAN FILTER

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ABSTRACT

Consider a spatio-temporal stochastic process $\{Z(\boldsymbol{s};t) : \boldsymbol{s} \in D;\ t = 1, 2, \cdots\}$ and suppose it is of interest to predict $\{Z(\boldsymbol{s};t_0) : \boldsymbol{s} \in D\}$ at some fixed time point t_0. Purely spatial methods use data $Z(\boldsymbol{s}_1;t_0), \cdots, Z(\boldsymbol{s}_n;t_0)$ to construct a spatial predictor (e.g., kriging). But, when data $\{Z(\boldsymbol{s}_i;t) : i = 1, \cdots, n;\ t = 1, 2, \cdots, t_0\}$ are available, it is advantageous to treat the problem as one of spatio-temporal prediction. The U.S. National Weather Service now use current snow water equivalent (SWE) data and a purely spatial model to predict SWE at sites where no observations are available. To improve SWE predictions, we introduce a spatio-temporal model that incorporates the SWE data from the past, resulting in a Kalman-filter prediction algorithm. A simple procedure for estimating the parameters in the model is developed and an example is presented for the Animas River basin in southwest Colorado.

Key words: cross-validation, kriging, second-order stationary, spatio-temporal model.