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Nowcasting Foehn Wind Events Using the AdaBoost Machine Learning Algorithm

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The south foehn is a characteristic downslope windstorm in the valleys of the northern Alps in Europe that demands reliable forecasts because of its substantial economic and societal impacts. Traditionally, a foehn is predicted based on pressure differences and tendencies across the Alpine ridge. Here, a new objective method for foehn prediction is proposed based on a machine learning algorithm (called AdaBoost, short for adaptive boosting). Three years (2000–02) of hourly simulations of the Consortium for Small-Scale Modeling's (COSMO) numerical weather prediction (NWP) model and corresponding foehn wind observations are used to train the algorithm to distinguish between foehn and nonfoehn events. The predictors (133 in total) are subjectively extracted from the 7-km COSMO reanalysis dataset based on the main characteristics of foehn flows. The performance of the algorithm is then assessed with a validation dataset based on a contingency table that concisely summarizes the cooccurrence of observed and predicted (non)foehn events. The main performance measures are probability of detection (88.2%), probability of false detection (2.9%), missing rate (11.8%), correct alarm ratio (66.2%), false alarm ratio (33.8%), and missed alarm ratio (0.8%). To gain insight into the prediction model, the relevance of the single predictors is determined, resulting in a predominance of pressure differences across the Alpine ridge (i.e. similar to the traditional methods) and wind speeds at the foehn stations. The predominance of pressure-related predictors is further established in a sensitivity experiment where ∼2500 predictors are objectively incorporated into the prediction model using the AdaBoost algorithm. The performance is very similar to the run with the subjectively determined predictors. Finally, some practical aspects of the new foehn index are discussed (e.g., the predictability of foehn events during the four seasons). The correct alarm rate is highest in winter (86.5%), followed by spring (79.6%), and then autumn (69.2%). The lowest rates are found in summer (51.2%).