EMS Annual Meeting Abstracts
Vol. 15, EMS2018-723, 2018

Predicting Thunderstorm Intensities

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A NWP post-processing to predict occurrence and intensities of thunderstorms is developed for the region of the European Eastern Alps. Ground based ALDIS lightning detection data is used to derive a proxy for the strength of thunderstorms on a $18\times18km^2$ grid. The NWP system is the 51-member ensemble the European Centre of Medium-Range Weather Forecasts (ECMWF). Measures for location and spread of approx. 100 direct and derived covariates are considered.

A binomial model is employed for the occurrence of thunderstorms. The intensity is modeled using a hurdle approach, i.e., combining the binomial model and a zero truncated negative binomial for positive counts. This approach is capeable to handle excees zeros and overdisperion. The parameters of the models are described by generalized additive model type additive predictors, i.e., for each covariate a potentially nonlinear function can be expressed. Selection of influential terms is performed by a combination of stability selection and gradient boosting. The final models are estimated using Markov chain Monte Carlo (MCMC) simulation which provides credible inference of effects, scores and predictions.

The selection of terms and MCMC simulation is applied for data of the year 2016. Out-of-sample performance is evaluated for 2017. The occurrence model outperforms a reference climatology—based on seven years of data—up to a forecast horizon of 5 days. The intensity model evaluated using the ranked probability score and log-likelihood also performs superior to the climatology. Furthermore, reasonable calibration of the count data model is visualized using hanging rootograms. A sample case—synoptically a weak baric gradient situation—illustrates various types of potential forecast quantities such as quantiles and exceedance probabilities.