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Forecasting Large Hail using Logistic Models and the ECMWF Ensemble Prediction System

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An Additive logistic Regression model for large hail was developed based on convective parameters from ERA5 reanalysis, severe weather reports from the European Severe Weather Database (ESWD), and lightning observations from the Met Office Arrival Time Difference network (ATDnet). This model was shown to accurately reproduce the spatial distribution and the seasonal cycle of observed hail events in Europe.
To explore the value of this approach to medium-range forecasting, a similar statistical model was developed using four predictor parameters retrieved from the ECMWF Ensemble Prediction System (EPS) reforecasts: Mixed Layer CAPE, Deep Layer Shear, Mixed Layer Mixing Ratio, and the Wet Bulb Zero Height. Probabilistic large hail predictions were created for all available 11-member ensemble forecasts (2008 to 2019), for lead times from 12 to 228 hours.
First, we evaluated the model's predictive skill depending on the forecast lead time using the Area Under the ROC Curve (AUC) as a validation score. For forecasts up to two to three days, the model highlights a very high predictive skill (AUC ≥ 0.95). However, it remains skillful even for extended forecasts (AUC=0.86 at 180 hours lead time) showing that it can identify regions with hail potential well in advance. Second, we compared the forecast spatial probabilities at various lead times with observed hail occurrence focusing on a few recent hail outbreaks. Finally, the skill of our four-dimensional model was compared with that of composite parameters such as the Significant Hail Parameter (SHP) and the product of CAPE and Deep Layer Shear (CAPESHEAR). The logistic model outperformed CAPESHEAR at all lead times. Compared to SHP, the model exhibited a higher skill especially at short lead times (up to 36 h). These results show that our approach can improve hail forecasting metrics especially when compared to those based on CAPE-SHEAR approaches only.

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