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

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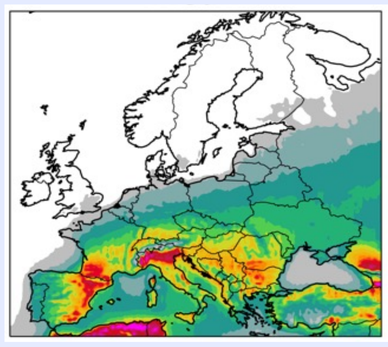
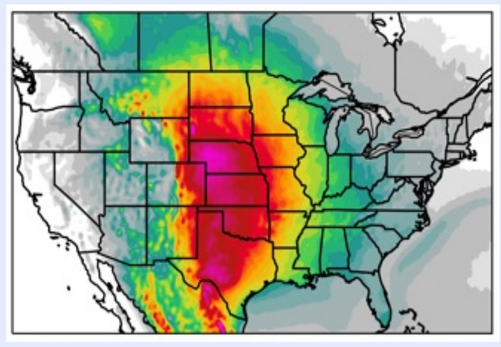
Introduction

We have developed an Additive Logistic Regression model for large hail occurrence (AR_{hail}) using:

- Convective parameters from the ERA5 **reanalysis**.
- **Hail reports** from the European Severe Weather Database (ESWD) and the Storm Prediction Centre (SPC).
- **Lightning observations** from the Met Office Arrival Time Difference network (ATDnet) and the National Lightning Detection Network (NLDN).

The model accurately reproduces the climatological distribution of observed hail events in Europe and the United States:





Methodology

The large hail model was developed taking convective initiation explicitly into account as done by Rädler et al. (2019).

$$P_{hail} = P_{lightning} \cdot P_{hail|lightning}$$

ERA5 original

Lightning model predictors
1. *MU Lifted Index*
2. *RH between 500-850 hPa*
3. *Convective Precipitation*
4. *MU Mixing Ratio*
5. *Land Sea Mask*

Hail model predictors
1. *MU CAPE above -10°C*
2. *MU Effective Bulk Shear*
3. *ML Mixing Ratio*
4. *Height 0° isotherm*

Reforecasts

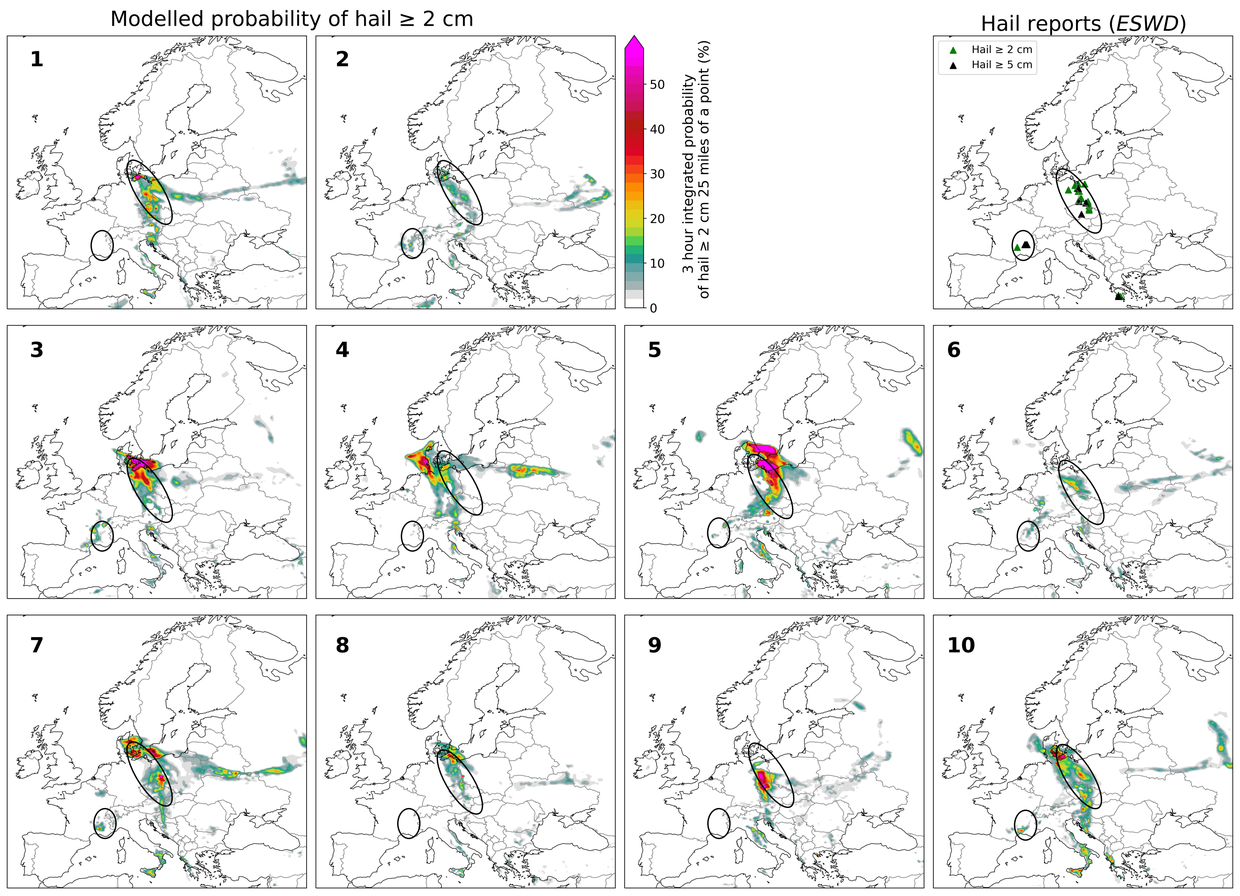
Lightning model predictors
1. *MU Lifted Index*
2. *RH between 500-850 hPa*
3. *Convective Precipitation*

Hail model predictors
1. *MU CAPE*
2. *Deep Layer Shear*
3. *Specific humidity 925 hPa*
4. *Height 0° isotherm*

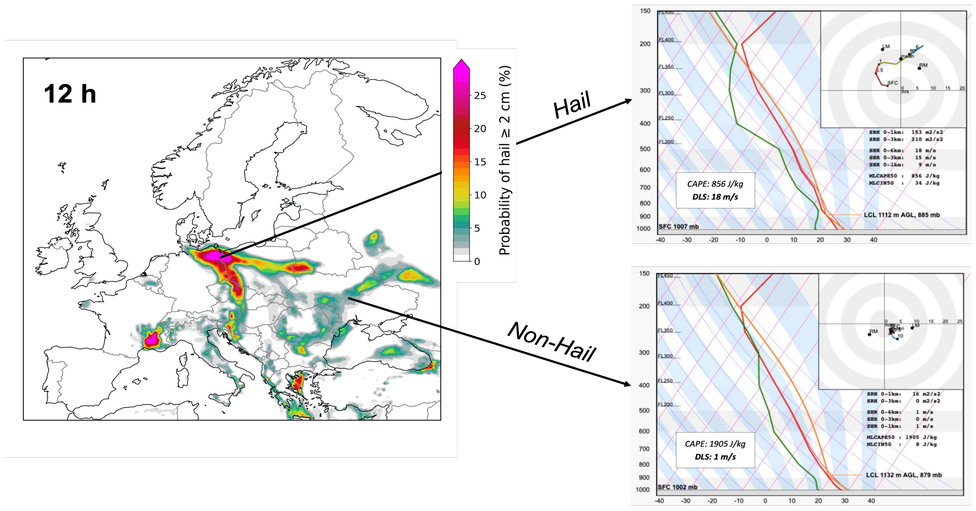
The models were applied to the ECMWF Ensemble Prediction System (EPS) yielding **probabilistic forecasts between 2008 and 2019, for 11 members and lead times from 12 to 228 hours.**

Applications to a case study - 15th June 2019

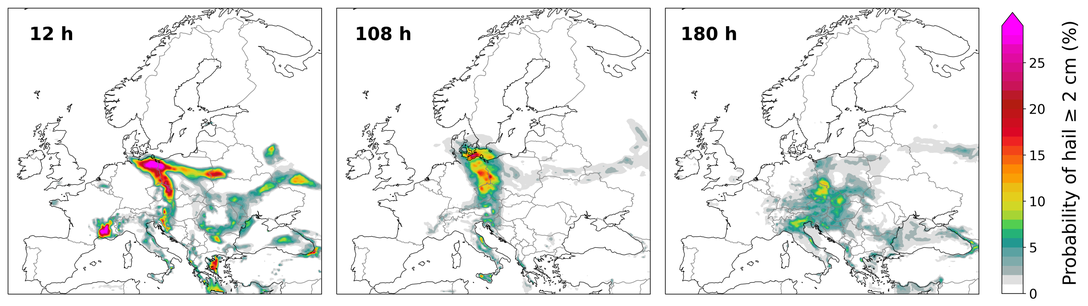
T-108 hours Hail Forecast per Ensemble members



Environmental influences on modelled hail probability

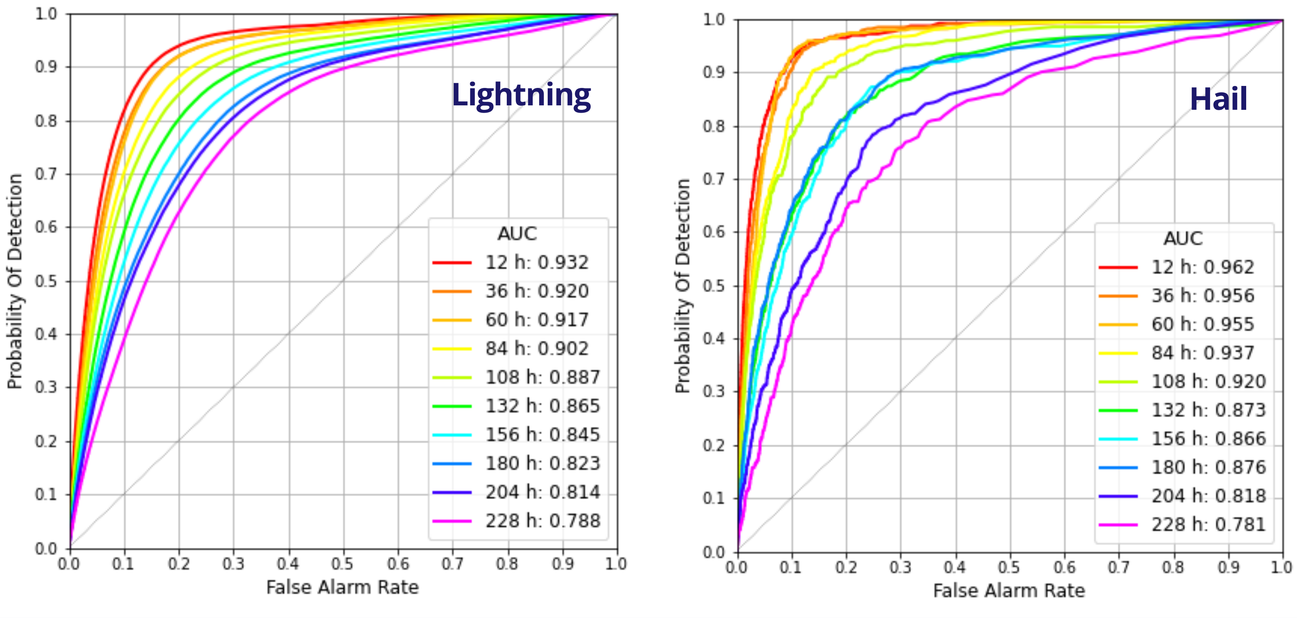


Hail Ensemble Mean Forecasts per lead times

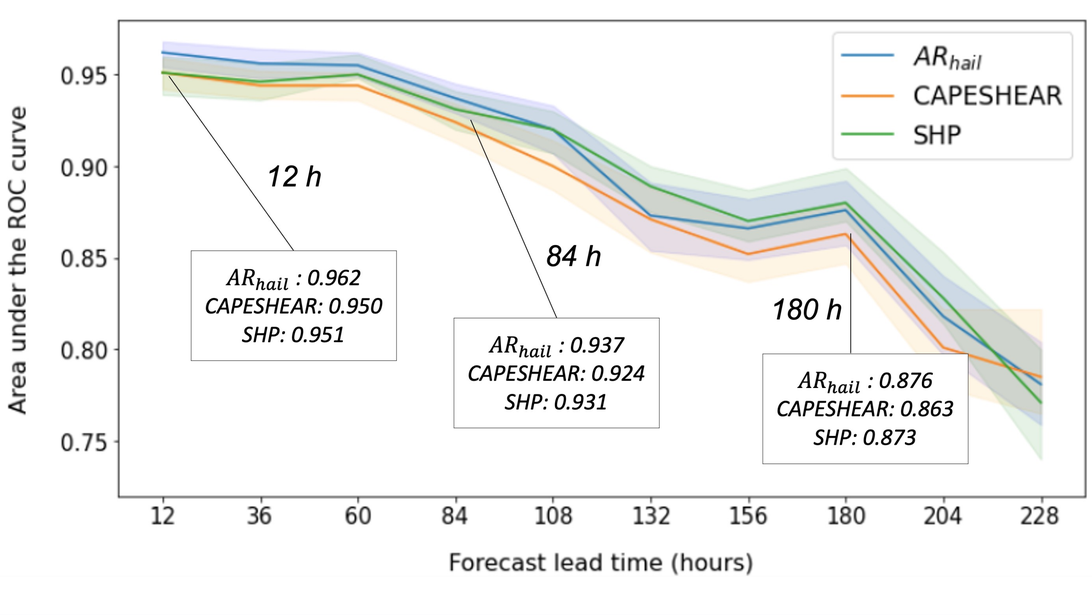


Model evaluation

ROC curves depending on the lead time



Lead-time dependent performance



Future work

- Evaluate the performance of the **full ERA5 derived models** for large hail and lightning.
- Make use of the EPS to **develop probabilistic ensemble hail (and lightning) forecasts** for Europe.
- Develop **very large hail** and **severe wind gusts** models.

See **Poster P41** to know more about experimental hail & lightning forecasts