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Modelling hail probability over Italy using a machine learning approach

Riccardo Hénin[1], Veronica Torralba[1], Antonio Cantelli[2], Enrico Scoccimarro[1], Stefano Materia[1], and Silvio Gualdi[1]

[1]Fondazione Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC), Bologna, Italy
[2]Generali Italia S.p.A, Mogliano Veneto (TV), Italy

Hail is a meteorological phenomenon with adverse impacts affecting multiple socio-economic sectors such as agriculture, renewable energy and insurance (e.g. Púčik *et al.,* 2019; Martius *et al.,* 2018; Macdonald *et al.,* 2016). The mitigation of the hail-related risk in particularly sensitive regions such as Italy has fostered hail research, aiming at a deeper understanding of the favorable environmental conditions for hail formation and the improvement of hail forecasting skills (Mohr and Kunz, 2013). Nevertheless, one of the major limitations for the study of long-term hail variability is the inherent difficulty in measuring all the hail occurrences and the consequent scarce temporal and spatial coverage of hail observations (Mohr *et al.,* 2015). Therefore, in this study, the Probability Density Functions (PDFs) of several large-scale meteorological variables and convective indices from the ERA5 reanalysis are considered instead, with the aim of describing a conditioned hail probability, following the statistical method by Prein and Holland (2018). Then, the best set of variables to be used as predictors in the hail model are selected with a machine learning approach, based on a genetic algorithm. The model output is an estimation of the hail probability over Italy in the 1979-2020 period, on a 30x30 km grid. The model is validated over the Friuli-Venezia-Giulia region through an independent dataset based on hail pads. The estimated hail probability has been used to characterize the seasonality, long-term variability and trends of the hail frequency and to investigate the potential large-scale drivers of hailstorms over Italy.

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