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Application of machine learning to large hail prediction - the importance of radar reflectivity, lightning occurrence and convective parameters derived from ERA5

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This study presents a concept for coupling remote sensing data and environmental variables with machine learning techniques for the prediction of large hail events. In particular, we want to address the following question: How would one improve the performance of large hail warnings / forecasts if thermodynamic and kinematic parameters derived from a numerical weather prediction model are combined with real-time remote sensing data? For this purpose, POLRAD radar reflectivity, EUCLID lightning detection data, and convective indices calculated from the ERA5 reanalysis are combined and then compared with large hail reports from Poland (2008-2017). The data fusion of multiple sources, coupled with the machine learning approach, makes it possible to greatly improve the robustness of large hail prediction compared to any single product commonly used in operational forecasting. This is especially noticeable with the reduced number of false alarms. Although the created machine learning models are mainly driven by radar reflectivity, composite thermodynamic and kinematic indices such as Hail Size Index (HSI), Significant Hail Parameter (SHIP), Large Hail Parameter (LGHAIL), and WMAXSHEAR provide an added value to a model's performance. The accuracy achieved by a random forest model brings with it encouraging prospects for future research with respect to operational forecasters (who may fill in the gaps within NWP-derived data with remotely sensed measurement) and climatological studies that aim to investigate past and future changes in severe weather occurrences.