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Modelled Multidecadal Trends in (Very) Large Hail in Europe, the United States and Globally

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Large hail events worldwide result in extensive damage, with individual events occasionally exceeding USD 1 billion in losses. Addressing the lack of comprehensive global observational networks, we developed Additive Logistic Regression Models for mapping the frequency of large and very large hail. These models were trained with data from lightning observations, hail reports, and convective parameters from the ERA5 reanalysis. Applying these models to ERA5 data spanning from 1950 to 2021, we reconstructed the probability of large and very large hail events across Europe and the United States. In the United States, hail trends during this period were generally weak and statistically non-significant. In Europe, trends were predominantly positive and significant with northern Italy standing out as a hotspot. Here, the convective activity has seen an abrupt increase with very large hail being 3 times more likely in recent years (2012-2021) than it was in the 1950s. This trend was corroborated by recent observations in the region, including the establishment of a new European hail record with hailstones measuring 19 cm in north-eastern Italy in July 2023. To create a globally applicable hail model, we used a training dataset of hail reports from Europe, the United States, and Australia combined. This effort resulted in the development of a comprehensive global climatology for very large hail. Additionally, we compared the modelled changes in hail frequency to observed changes in insured losses to better understand the complex relationship between hail frequency and hail risk across different regions worldwide.