Hail hazard in Germany related to orographic and atmospheric characteristics

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The temporal and spatial variability of hail events in Germany is investigated based on the detection of hail signals in three-dimensional radar data from German weather service (DWD) using an adjusted version of the Waldvogel criterion (distance between melting layer and echotop height). Additional filtering with lightning detections and tracking of the signals improves the reliability of the detected hail streaks. The results of the analyses show a high spatial variability in the frequency of hail events, which is caused by the superposition of large-scale climatology and local-scale flow dynamics. A surprising finding is that most of the hot spots in hail frequency are located downstream of the low-mountain ranges. Additional simulations with the numerical weather prediction model COSMO confirm that flow convergence at lower levels emerging downstream of the mountains play a major role for the specific distribution of the hail events. These convergence zones tend to occur especially for low Froude number flows, where the flow is expected to go partly around the mountains.
Using ERA-Interim and CFS reanalyses, the ambient conditions prevailing on the detected hail events are investigated. The analyses show that most of the hail events occur during pre-frontal conditions, where an upper-level trough approaches from the west. During those situations, convective instability, e.g. in terms of vertical gradient of equivalent potential temperature, reaches a maximum. Mid-level temperature lapse rate is highest, producing high CAPE values, especially over the southern parts of Germany.