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# Lightning patterns and their relation to the radar-derived hail kinetic energy

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The main purpose of the investigation is to establish a valuable relationship between cloud-to-ground (CG) lightning, the radar-derived hail kinetic energy and an estimate of the extent and amount of hail damage on ground. If a good relationship exists, lightning information from a Lightning Positioning and Tracking System (LPATS) alone can be used to determine the expected amount of damage within a given region of interest (e.g. densely populated areas in Central Europe).

During the Swiss National Research Programme "Climate changes and natural disasters" (NRP31, 1992-98) more than 200 thunderstorm cells have been measured in a 3D-mode with the ETH research Doppler radar. The radar parameters are compared with LPATS-data from Switzerland and South-Germany, available for the years 1992-96. In addition, hail damage information on agriculture for each storm is provided by the Swiss Hail Insurance Company on a yes/no basis for individual communities. For special cases, more detailed spatial damage information is available for damage to agriculture (resolution of single fields) and buildings, provided by Swiss buildings insurers.

For this study, CAPPIS are generated at two levels (close to the ground at 1.5 km MSL and at 2 km above the melting level where intense hailstone growth occurs) with a spatial resolution of 0.5 x 0.5 km every 5 minutes.

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The extent of the cell is individually approximated for each time step by a circle, including all reflectivity values above 30 dBZ. From reflectivity values higher than 55 dBZ, the hail kinetic energy is calculated, according to the relationship obtained from the international hail suppression experiment "Grossversuch IV". Within the defined circles, the location of individual CG-lightning (positive and negative) is determined from both LPATS in order to compare the systems' lightning detection efficiencies.

At present, 30 hail cells of different intensities have been analysed and some preliminary results from the sample are discussed in the paper. Some are given below:

The number of negative CG-lightning per hour correlates well with the global hail kinetic energy per hour. Weak cells reveal 10 to 50 negative CG-lightning and 50 to 500 MJ, whereas severe storms can show up to 1500 lightning and a global hail kinetic energy up to 200 GJ. The time lag between the maximum in negative CG-lightning intensity and the energy peak increases with storm severity (weak 5, moderate 15 and severe storms up to 50 minutes), while positive CG-lightning intensity seems to increase after the maximum energy value has been reached. Further analyses will involve spatial correlation between the lightning and energy pattern at ground level, which in turn can be correlated with the damage extent on ground.