

Differential reflectivity columns and hail-linking C-band radar-based estimated column characteristics to a uniquely large dataset of crowdsourced surface observations in Switzerland

Martin Aregger¹, Olivia Martius¹, Alessandro Hering², Urs Germann²

¹University of Bern, Switzerland

²Federal Office of Climatology and Meteorology MeteoSwiss, Switzerland

It has been shown that differential reflectivity columns (ZDRC) are a radar signature that can be used to characterize the updrafts of severe convective storms. Consequently, various studies have attempted to link ZDRC characteristics to severe weather development, such as tornado formation, intense precipitation, and hail. Much of this work, specifically on hail, has been done on case studies with limited ground truth hail data and using S-band radar data. Here, we investigate the characteristics of ZDRC automatically detected on an operational C-band radar network and relate them to hail on the ground using 173'000 crowdsourced hail reports collected over a period of 3.5 years in Switzerland.

The automated detection of ZDRC in the alpine region provides challenges regarding visibility and data quality due to effects such as ground clutter and the shielding of the radar beam by topography. Further, ZDR measurements are affected by the effects of differential attenuation and artefacts such as three-body scattering. To counteract these effects, we derive a 3D composite of ZDR using all five Swiss weather radars, two of which are located at an altitude of close to 3000 m above sea level. This composite is then used to identify ZDRC by an adapted version of an established detection algorithm.

The detected ZDRC areas and heights, as well as maximum measured ZDR values, are linked to reported hail size categories, and we attempt to determine thresholds to differentiate between storms producing hail of different sizes and non-hail-producing storms. Further, we investigate the potential of ZDRC to nowcast hail for possible warning applications. Switzerland is a unique location for this work due to the high frequency of hail, the good overlap of the radars, the scanning strategy with an exceptionally high spatial and temporal resolution and the large number of hail reports from the population.