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Dynamics of small-scale precipitation enhancement in mountainous terrain

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In mountainous terrain precipitation patterns are strongly influenced by the topography. At larger scales the complex topography induces orographic cloud formation, while at smaller scales the local flow field leads to the preferred deposition of precipitation in leeward slopes. In this study, we focus on the small-scale precipitation enhancement close to the ridge controlled by the topographically induced local flow field.
A mobile polarimetric X-band radar was deployed in the area of Davos (Switzerland) to determine the spatial variability of snow fall at a high spatial resolution of 75 m. In order to relate measured precipitation fields to flow dynamics, we modelled flow fields with the atmospheric prediction model Advanced Regional Prediction System (ARPS). Additionally, comparison of precipitation fields at a height of hundreds of meters above the surface with snow accumulation at the surface was facilitated by modelling/measuring snow accumulation fields with Alpine3D and Airborne Laser Scans respectively. Based on this dataset we investigated the small-scale precipitation dynamics for one heavy snow fall event in March 2011.
The results showed a clear precipitation enhancement close to the ridge at the transition between the updraft and downdraft zone. The precipitation concentration increased in the presence of flow acceleration at windward slopes and decreased in the presence of flow deceleration at the leeward slopes. Measurements show that the temporal variation of the location of maximum concentration is strongly dependent on the magnitude of the horizontal wind velocity. For situations with strong horizontal winds, the concentration maximum is shifted from the ridge crest towards the leeward slopes. Results further suggest that the small-scale precipitation enhancement at the ridge crest can be temporally and locally increased by the seeder-feeder mechanism. Although precipitation concentration at the height seen by the radar is different to the snow accumulation measured at the ground, these results strongly support the concept of preferential deposition of precipitation.