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From the clouds to the ground – snow precipitation patterns vs. snow accumulation patterns

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Knowledge about snow distribution and snow accumulation patterns is important and valuable for different applications such as the prediction of seasonal water resources or avalanche forecasting. Furthermore, accumulated snow on the ground is an important ground truth for validating meteorological and climatological model predictions of precipitation in high mountains and polar regions. Snow accumulation patterns are determined by many different processes from ice crystal nucleation in clouds to snow redistribution by wind and avalanches. In between, snow precipitation undergoes different dynamical and microphysical processes, such as ice crystal growth, aggregation and riming, which determine the growth of individual particles and thereby influence the intensity and structure of the snowfall event. In alpine terrain the interaction of different processes and the topography (e.g. lifting condensation and low level cloud formation, which may result in a seeder-feeder effect) may lead to orographic enhancement of precipitation. Furthermore, the redistribution of snow particles in the air by wind results in preferential deposition of precipitation. Even though orographic enhancement is addressed in numerous studies, the relative importance of micro-physical and dynamically induced mechanisms on local snowfall amounts and especially snow accumulation patterns is hardly known.

To better understand the relative importance of different processes on snow precipitation and accumulation we analyze snowfall and snow accumulation between January and March 2016 in Davos (Switzerland). We compare MeteoSwiss operational weather radar measurements on Weissfluhgipfel to a spatially continuous snow accumulation map derived from airborne digital sensing (ADS) snow height for the area of Dischma valley in the vicinity of the weather radar. Additionally, we include snow height measurements from automatic snow stations close to the weather radar. Large-scale radar snow accumulation patterns show a snowfall gradient consistent with the prevailing wind direction. Deriving snow accumulation based on radar data is challenging as the close-ground precipitation patters cannot be resolved by the radar due to shielding and ground clutter in highly complex terrain. Nonetheless, radar measurements show distinct patterns of snowfall and accumulation, which may be the result of orographic enhancement. Station-based snow accumulation measurements are in reasonable agreement with the estimated large-scale radar snow accumulation. The ADS-based snow accumulation maps feature much smaller scale snow accumulation patterns likely due to close-ground wind effects and snow redistribution on top of an altitudinal gradient. To evaluate microphysical processes and patterns influenced by the topography we run a hydrometeor classification on the radar data. The relative importance of topographically induced effects on snow accumulation patterns is investigated based on vertical cross sections of hydrometeor data and corresponding snow accumulation.