Snow Particle Orientation Observed by Ground-Based Microwave Radiometry

Falling snow plays an essential role in the hydrological cycle; however, its microphysical characteristics still pose large uncertainties in numerical weather prediction models. An important source of uncertainty for snowfall retrievals is whether snow particle with a certain orientation or not. While it is well-known that small crystals fall with the major axis horizontally-aligned, for larger aggregates, their falling attitude is still not clear.

Oriented snow particles can induce polarized difference (PD) between vertical and horizontal polarizations due to their dichroic effects. In order to investigate potential snowfall PDs, a Dual-Polarized microwave Radiometer (DPR) has been deployed at Zugspitze Mountain (2650m MSL). The DPR provides Brightness Temperature (TB) measurements at three channels, one at 90 GHz and the other two channels (vertical and horizontal polarizations) at 150 GHz.

A statistical analysis has been performed using a dataset containing 458 hours of falling snow during the year 2010. The observed PD at 150 GHz ranged up to -10K during snowfall. The analysis shows that (1) an increase in snow water content corresponds to the increasing TBs and PDs, the latter resulting from oriented snow particles; (2) the occurrence of cloud liquid water also enhances TBs but damps PDs. Radiative Transfer (RT) simulations with horizontally-oriented snow oblates capture well the observed PDs and TBs and confirm the effects of snow and liquid water on PDs and TBs. Thus the use of PD information offers a high potential for an improved retrieval of ice and liquid water phase in precipitation systems.