DERIVING MICROPHYSICAL CHARACTERISTICS OF SNOW AND ICE PARTICLES FROM A DUAL POL WEATHER RADAR

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This paper aims at investigating the potential of dual pol weather radar to probe ice particles in clouds and precipitation. Typically, solid precipitation (dry snow, ice crystals) related moments such as melted equivalent snowfall rate (S) or ice water content (IWC) are retrieved from radar reflectivity Z using a simple power law, e.g. $S = cZ^d$. Such a relationship results from a retrieval practice widely used for rain and, as in rain, may differ from case to case due to the great variability of the particle size distribution (PSD).

Z, S and IWC being extensive parameters, the concept of "Normalized Distribution" developed by Testud et al. (2000) and extended to ice particle spectrum by Delanoe et al. (2005) has to be applied, resulting in considering a universal power-law like $S/N_0^*=m[Z/N_0^*]^d$ instead of a variable $S=cZ^d$ one. Here, N_0^* denotes the "generalized intercept parameter" of the PSD defined in this last paper [$N_0^*=4^4$ $IWC/(\pi r_w.D_m^4)$, D_m: mean volume melted diameter]. So, at the end, estimating S or IWC from Z involves estimating this parameter too.

Ice particles respond differently from raindrops with respect to polarimetric radar probing. The larger is a raindrop, the more oblate is its shape. Hence in rain, the differential phase shift builds up essentially from large drops. The situation for snow and ice particles is somewhat inverse: pristine ice particles present a larger axis ratio than big snowflakes, thus large variation of the differential phase shift PHI_{DP} may be observed even when crossing light precipitation of ice. Such large PHI_{DP} variations are not associated with along path attenuation, since attenuation by ice particles is negligible. The inverse model is based on power laws as particle density vs. diameter and axis ratio vs. diameter that should be carefully documented.

On the other hand, in the conventional formulation of ZPHI, the estimated N_0^* is assumed constant along the processed ray segment. While this assumption is reasonably realistic in rain, it is not through an ice/snow layer, where microphysical processes induce vertical variations of the PSD. For instance, aggregation is responsible of both particle size increase and depletion of particle population. The latter consequence shows that the vertical profile of N_0^* decreases drastically downward. Since the radar antenna usually operates at a tilt angle position, such vertical profile impacts as an along-beam profile of N_0^*.
For taking this along-path variation into account, a new version of ZPHI for snow/ice layer has been developed in which the along-range profile of N_0^* itself is retrieved through a minimization procedure. Application of this new algorithm on simulated data shows the good consistency between the simulated profiles and the retrieved one. Results from real radar data will be shown also, both from X-band and C-band radars.

Keywords: dual polarimetry, ice/snow microphysics, normalized particle size distribution, vertical profile