

Liquid clouds substantially contribute to Earth's radiation budget but are still poorly represented in global circulation models (GCMs), i.e. due to uncertainties in the description of the cloud-scale microphysical processes such as drizzle production. Drizzle production in pure liquid clouds is the main mechanism of liquid water removal and it affects the dynamics and lifetime of clouds as well as the boundary layer dynamics and thermodynamics. In models, this process is described by the autoconversion parametrization, that characterizes the mass transfer rate from cloud droplets to embryonic drizzle particles. Various parametrizations of autoconversion have been proposed in recent years for numerical models but their evaluation is still controversial because direct observations of drizzle development in the cloud are missing.

In this work, new criteria to detect drizzle development in the cloud is presented. We base the new criteria on the skewness of the Doppler spectra obtained from the Ka-band radars operating at JOYCE (Jülich Observatory for Cloud Evolution) and at the Barbados Cloud Observatory. The skewness is sensitive to early drizzle production and drizzle growth through the cloud: normally, cloud droplets without any significant fall velocity but under the influence of turbulence will lead to a Gaussian Doppler spectrum (i.e. skewness is zero), whereas the onset of drizzle will lead to a deviation from the ideal Gaussian form (if downward velocities are defined positive, positive skewness at first and negative when drizzle starts to dominate the spectrum).

In the presented algorithm, coherent structures in space and time of positive, zero and negative skewness values are identified. They correspond to different stages of drizzle droplet development (classes) such as drizzle seeding, drizzle growth/non-drizzle and mature drizzle, respectively. The separation between the drizzle growth and the non-drizzle class is based on the reflectivity profile, which is assumed to be adiabatic for non-drizzle clouds.

The new algorithm has been tested on a statistical ensemble of liquid cloud case studies collected at JOYCE as well as on a number of shallow cumulus cloud cases observed at the Barbados Cloud Observatory. After algorithm application, the different drizzle classes are characterized in terms of standard Doppler spectra moments reflectivity, mean Doppler velocity, spectral width and microwave-radiometer-derived LWP. These are compared to the different categories identifying drizzle in the common Cloudnet target classification. The goal is to quantitatively estimate the benefits that the new criteria can provide compared to the current Cloudnet target classification, which states a standard application at cloud observatories world-wide and has often being used for model evaluation. The new criteria are currently being implemented as an extension to the Cloudnet target categorization algorithm. We suggest that the new algorithm can provide additional observational constraints for evaluating the autoconversion parametrization in numerical models.