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USing the probability density function of radar reflectivity to identify precipitation in thunderstorms

C.A. DIOP (1,,)

(1) (dioca@aero.obs-mip.fr), () Laboratoire d'Aérologie UMR 5560 CNRS/UPS - OMP - Toulouse - France

Using the probability density function of radar reflectivity to identify precipitation in thunderstorms

Cheikh Abdoulahat DIOP*, Frédéric MESNARD*, Henri SAUVAGEOT* and Olivier PUJOL**

Abstract

In many studies discussing the statistical characterization of the rain rate, most of the authors have found that the probability density function (PDF) of the rain rate follows a lognormal law. However, a more careful analysis of the PDF of the radar reflectivity Z suggests that it is a question of a mixture of distributions. The purpose of this work is to identify precipitation types that can coexist in a continental thunderstorm from the PDF of the radar reflectivity. The data used come from the NEXRAD S-band radar network, notably the level II database. From reflectivity ranging from -10 dBZ to 70 dBZ, we compute the PDF. We find that the total distribution is a mixture of several populations adjusted by several gaussian distributions with known parameters : mean, standard deviation and proportion of each one in the mixture. Since it is known that the rainfall is a sum of its parts and is composed of hydrometeors of various sizes, these statistical findings are in accordance with the physical properties of the precipitation. Then each component of the mixed distribution is tentatively attributed to a physical character of the precipitation. The first distribution with low reflectivities is assumed to represent the background of the small sized particles. The second component centred around medium Z corresponds to stratiform rain, the third population located at larger Z is due to heavy rain. Eventually a fourth population is present for hail.

*Observatoire Midi-Pyrénées, Laboratoire d'Aérologie, CNRS/Université Paul Sabatier, Toulouse , France
**Université des Sciences et Technologies de Lille, UFR de Physique Fondamentale, Laboratoire d'Optique Atmosphérique, Lille, France