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PRECIPITATION CLASSIFICATION AT SOUTHERN BRAZIL IN TERMS OF RAINDROP SIZE DISTRIBUTION PARAMETERS DURING CHUVA-SUL

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ABSTRACT

Data obtained from raindrop size distribution (DSD) by Joss–Waldvogel (JW) disdrometer installed in Santa Maria (Brazil) were used to classified rainfall rate in six classes proposed by Tokay and Short (1996). The analysis allowed characterizing the microphysics of precipitation that occurred in southern Brazil during the campaign CHUVA-Sul.

RESUMO

Dados obtidos através da distribuição do tamanho de gotas de chuva (DSD) por um disdrômetro Joss-Waldvogel (JW) instalado em Santa Maria (Brasil), foram utilizados para classificar a intensidade de precipitação em seis classes (Tokay e Short, 1996). A análise permitiu caracterizar a microfísica da precipitação que ocorreu no sul do Brasil durante a campanha CHUVA-Sul.

INTRODUCTION

The spatial variability of the DSD is an important issue for a better understanding of precipitation dynamics and microphysics at small scales, as well as for improved radar rain-rate retrieval. This variability is not well documented and understood. One of the most complete descriptions of rain is given by its DSD. The spatial and temporal variability of DSD reflects variations in the relative importance of the microphysical processes inside clouds, which may be related to differences in the observed ground rainfall integral variables and DSD parameters. According Krajewski et al. (2006) the problem of estimating precipitation dimensional parameters has attracted renewed interest over recent years for two main reasons: a) more complete information on the precipitation characteristics (than the simple instantaneous rainfall rate) is needed for radar calibration or satellite sensor; b) based on a wide variety of physical principles new instruments have been proposed for more accurate measurements and disdrometer comparisons have been performed during experimental campaigns. Classically, DSD is measured by an electromechanical impact disdrometer (Joss and Waldvogel, 1969).

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DATA AND METHODOLOGY

The data of raindrop size distribution were collected during November 5 to December17, 2012, during CHUVA Project, by the model RD-80. In the CHUVA-Sul campaign was held in Santa Maria, southern Brazil, the JW disdrometer was installed at site Conteiner (29°43′37.87″S; 53°43′17.30″W, 84m) with sampling time of one minute. The JW data consist of number of raindrops n_i of average diameter of drops in class *i* (D*i*) in 20 size categories from 0.359 mm to 5.373 mm. The computation of the DSD ($mm^{-1}m^{-3}$) and of the rainfall rate R (mm h^{-1}) from these data involves a simple summation over drop size classes. The rain rate can be derived from the DSD data obtained from the disdrometer using the expression:

$$R = \frac{\pi}{6}\int_0^\infty N_{(D)} D_i^3 v_{(D)} dD$$

where R is the rain rate, $N_{(D)}$ is the number of drops per cubic metre per mm interval, D is the diameter of the drops and $v_{(D)}$ is the terminal velocity of the rain drops (Distromet Ltd., 2010). The disdrometer data are first used to detect (threshold in rainfall rate > 0.2 mm/h with at least 10 min of continuous rain) the rain episodes. A global microphysical analysis is successively performed by analyzing the average DSDs and DSD parameters from the 1-min spectra, classified into six categories of different rainfall rate intensities for database. Among several classifications of rain rate, in this work we use the one proposed by Tokay and Short (1996), taken as representative for the JW disdrometer, averaged for six rainfall rate $(\mathrm{mm\,h^{-1}})$ categories: very light $(R < 1)$, light $(1 \le R < 2)$, moderate $(2 \le \mathrm{R} < 5)$, heavy $(5 \le \mathrm{R} < 10)$, very heavy $(10 \le \mathrm{R} < 20)$, extreme $(\mathrm{R} \ge 20)$.

RESULTS

Figure 1 shows the observed DSDs for the database, taken as representative, averaged for six rainfall rate categories: very light, light, moderate, heavy, very heavy and extreme, with sampling time of one minute of 3,386, 414, 815, 307, 90 and 149, respectively. Looking at Figure 1, the DSDs are always concave downward. This behavior is partly derived from the lack of small drops due to the JW disdrometer dead time problem, highlighted by the sharp decrease in the number of raindrops for diameters lower than 0.6 mm. In addition, for heavy rainfall-rates, the cone water coating may play a role. As the rainfall rate threshold increases, the DSD shifts toward large diameters and is very flat. In the light precipitation categories, the DSDs have an almost exponential shape.

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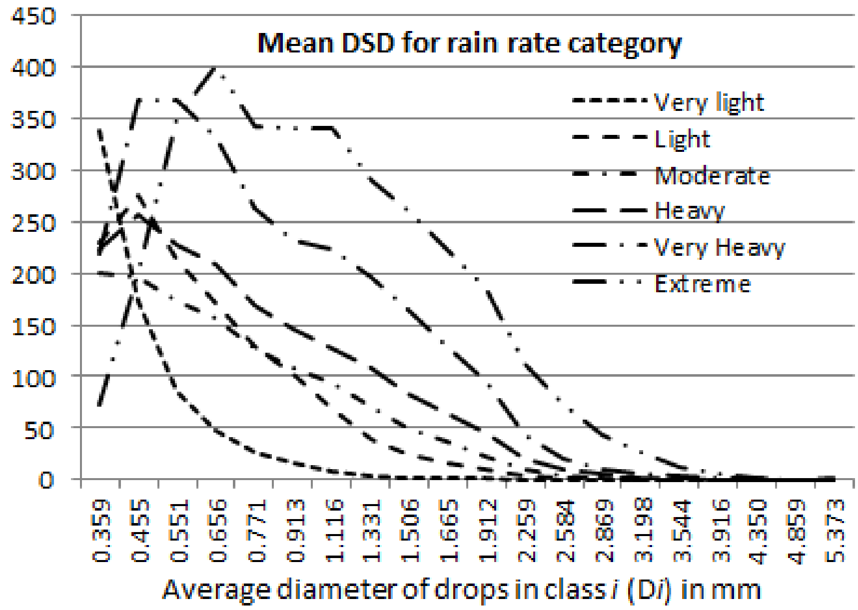

Figure 1. Average observed DSDs for the database for six rainfall rate categories

Otherwise, the heavy rain events are better parameterized by a gamma DSD. The heavy rain events are, therefore, characterized by large values, caused by the strong downward concavity, while N_0 values generally have small. Furthermore, as the rain threshold increases, the exponential N_0 parameters generally tend to decrease.

CONCLUSIONS AND FUTURE WORK

The analysis that was performed has allowed the microphysical characterization of precipitation occurring in southern Brazil and the discrimination between six rainfall rate $(mm\,h^{-1})$: very light (65,61%), light (8,02%), moderate (15,79%), heavy (5,95%), very heavy (1,74%) and extreme (2,89%). These results are of interest for the atmospheric modeling community, and could contribute to improve the description of the microstructure of rainfall in numerical models.

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