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SMALL SCALE VARIABILITY OF MEDITERRANEAN PRECIPITATION DURING HIRE'98

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1 INTRODUCTION

Variability of rainfall at small scale is a key point for various scientific questions (e.g. identification of microphysical mechanisms involved in precipitation generation, hydrological applications or rainfall measurement network design). Since the early days of weather radar, its measurements have been used to study the structure of rainfall (e.g. Marshall, 1953; Zawadzki, 1973). More recently, the variability of the Drop Size Distribution (DSD) has been studied (e.g. Sauvageot and Koffi, 2000; Jameson and Kostinski, 2001). But the link between the structure of rainfall and the corresponding DSD observed has not been thoroughly investigated (Sempere Torres et al., 2000). In this paper, we present a quantitative analysis of the small scale structure of Mediterranean rainfall, as a first step towards the study of the relation between structure and DSD.

2 HIRE'98

The HYDROMET Integrated Radar Experiment (Uijlenhoet, 1999) took place in Marseille, French Mediterranean coast, during the autumn of 1998. Different rain sensors were deployed to study intense Mediterranean precipitation and its impact on a large urban area. Our analysis is based on measurements from (i) a network of 25 rain gauges (6 min. time step), (ii) an S-band PPI radar (located at Nîmes, 90 km north-west of Marseille; resolution of 5 min. and 1×1 km^2), (iii) an X-band RHI radar (resolution of 1 min. and 250×125 m^2), (iv) an X-band vertically pointing radar (resolution of 4 s and 7.5 m), and (v) an optical spectro-pluviometer. We have selected the three most intense events in terms of rain intensity and total amount: 07/09, 11/09 and 05/10. To illustrate the variability of these events, fig. 1 shows the total rain amount (in about 5 h) for the 07/09 event.

3 GEOSTATISTICAL ANALYSIS OF THE RADAR MEASUREMENTS

The different radar data at hand allow an analysis of the variability of the rain intensity at different scales and resolutions in the horizontal and vertical planes. We adopt a geostatistical approach to quantify the variability and to estimate the organization of the rain field. To restrict the analysis to significant rainfall, we threshold the radar reflectivity data at 35 dBZ (about 5 mm$\cdot$h^{-1}). The variability is then separated in two components (Barancourt et al., 1992). First, intermittency corresponds to the organization of zones above and below the threshold. It is studied using indicator geostatistics (Journel, 1983). Second, the inner variability corresponds to the fluctuations within zones above the threshold. Analyses of the variogram maps of the indicator and thresholded data (see fig. 2 for examples) provides qualitative and quantitative characteristics of the spatial structure of precipitation: anisotropy, maximum altitude of rain and length scales. The resulting mean shape of the intense rain cells is consistent with the rain generating cell model proposed by Marshall (1953).

4 DROP SIZE DISTRIBUTION MEASUREMENTS

The spectro-pluviometer provides raindrop size and fall speed measurements for the three rain events considered (fig. 3 presents the DSDs for the 07/09 event). It was located at the same place as the vertically pointing radar. As explained above, we have estimated the organization of rainfall in the vertical plane over this instrument. Such a configuration offers the opportunity to investigate the link between the space-time structure of rainfall and the temporal evolution of DSDs at the ground.

5 CONCLUSIONS AND PERSPECTIVES

The spatial structure of three typical intense Mediterranean rain events has been quantitatively assessed applying geostatistical tools to rain gauge and radar measurements. Additionally, DSDs have been measured with an optical spectro-pluviometer. The next step of this work will be to quantify the relation between these two components of the variability of rainfall.

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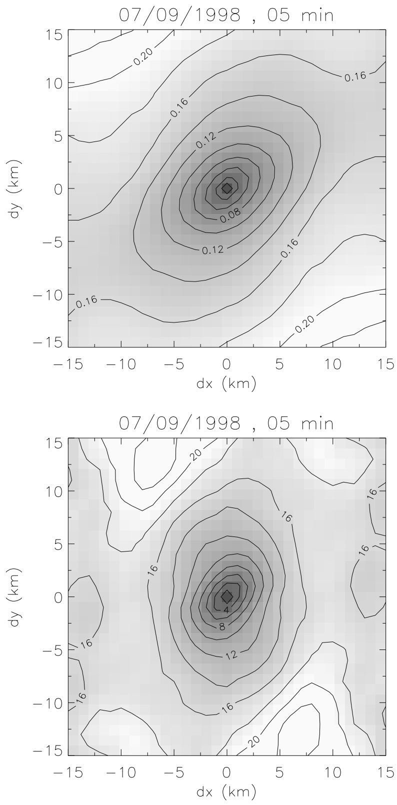

Figure 2: Variogram maps of the indicator (top) and thresholded measurements (bottom) for the 07/09 rain event, obtained from the PPI radar images.

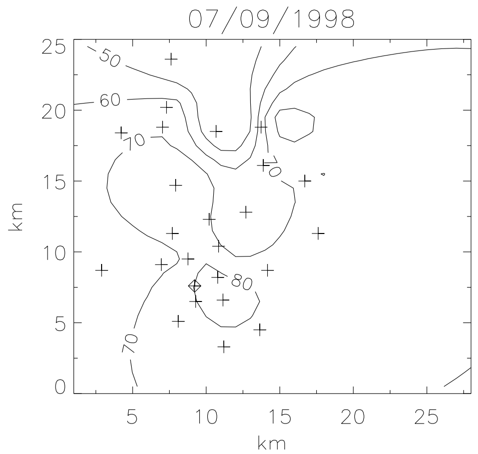

Figure 1: Total rain amount (in mm) for the 07/09 rain event. Signs "+" represent the 25 rain gauges over the area.

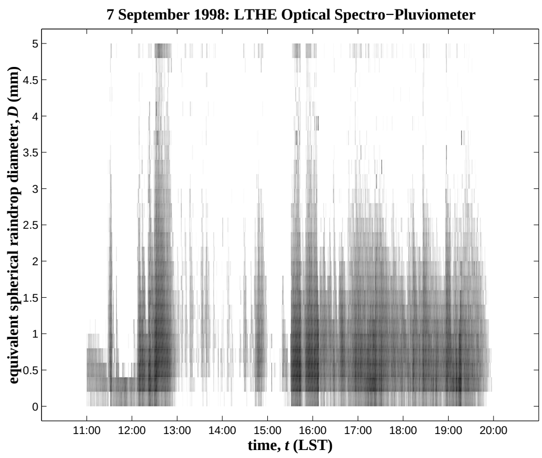

Figure 3: Drop size distributions for the 07/09 rain event (1 min. time step).