P8A.1 THE DECOMPOSITION OF HETEROGENEOUS RAIN INTO HOMOGENEOUS COMPONENTS: RESULTS FROM A STATISTICAL INVERSION OF COUNT DATA

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1. OVERVIEW

The objective of this summary is to look at raindrop counts from a perspective entirely removed from past approaches as described in detail in Jameson (2007). In that work a statistical inversion technique is developed that is based upon the work of Tarantola (1987) founded upon the Bayesian approach. That method is applied here in the analyses of both impact and video disdrometer rain count measurements. Namely, it is assumed that each observation is drawn from a single Poisson distribution associated with a mean value from the set of mean values, ***C***. Writing the summation over the set of observations at diameter *D* and letting m_i be the number of times n_i occurs during *M* observations of *D* it follows that

$$P(\boldsymbol{C} \mid D) = \frac{\sum_{i=1}^{M} \frac{\boldsymbol{C}^{\mu_i}}{\mu_i !} e^{-C}}{\sum_{j=1}^{C_{\max}} \sum_{i=1}^{M} \frac{C_j^{\ \mu_i}}{\mu_i !} e^{-C_j}} \qquad (1)$$

where μ_i are the number of drops found during the i^{th} observation, and the summation is now over the *M* observations of *D* in the time series and | denotes conditioning on the observations of *D*. The entire joint probability density function (pdf) of all the mean values of counts, *P(**C**,D)*, is then simply given by

$$P(\boldsymbol{C}, D) = P(\boldsymbol{C} \mid D) P(D) \qquad (2)$$

where *P(D)* is the observed distribution of the drop diameters over the entire data set. In a real sense, this joint pdf may be considered the *complete drop size distribution* given the set of observations. The classical single realization of a drop size distribution is, then, just one of many potential trajectories through this complete drop size distribution.

Meteorologically, two sets of raindrop count data were analyzed in Jameson (2007). Only one is briefly touched upon here. Namely, consider a 16 hours long even observed at one minute resolution using a Joss-Waldvogel impact disdrometer. The data were found to be statistically heterogeneous (Fig.1).

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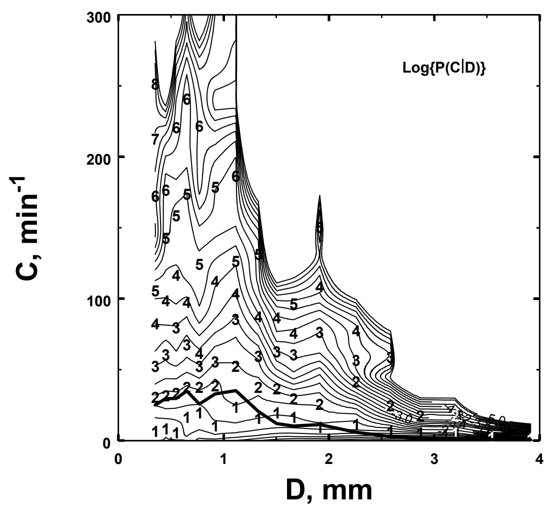

*FIG.1: Contours of the logarithm (base 10) of P(**C**|D) calculated using (1) for the one-minute disdrometer data. There are now several $\hat{C}$ at most diameters indicative of statistical heterogeneity. The solid line denotes the arithmetic average $\overline{C}$.*

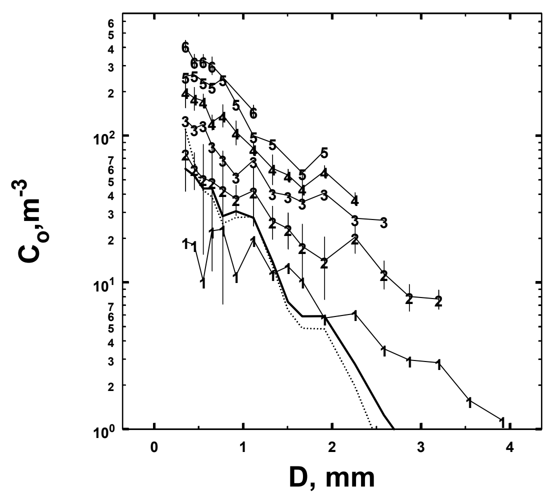

FIG.2: Peak drop concentrations corresponding to the peak counts in Fig.1. Vertical lines of the standard deviation error about each peak are shown on alternate curves connecting successively smaller likelihood peaks at each drop size, with each curve representing a statistically homogeneous components of the statistically heterogeneous rain. The bold, solid line denotes the mean concentration curve, while the dotted line represents the mean concentrations estimated directly from the average drop counts.

The analyses reveal an exponential-like component likely associated with back-ground, light steady rain along with six statistically homogeneous components having drop size distributions which can be used to characterize all of the information (except for correlations, which remain very important) contained in each set of data (Fig.2).

As explained in Jameson (2007), these drop size distributions can be related to the structures in the time series of the rainfall rate (Fig.3). That is, because the components are statistically homogeneous, the drop size distributions can be interpreted physically. In these data, large numbers of smaller drops (‘stratiform rain’) are found in the regions of light rainfall sandwiched between those of more intense rainfall (‘convective rain’) where coalescence has apparently produced larger drops at the expense of smaller ones. Moreover, this discovery allows statistical heterogeneity to be explicitly and analytically incorporated into various research areas such as radar theory, for example (see Jameson, 2008).

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2. REFERENCES

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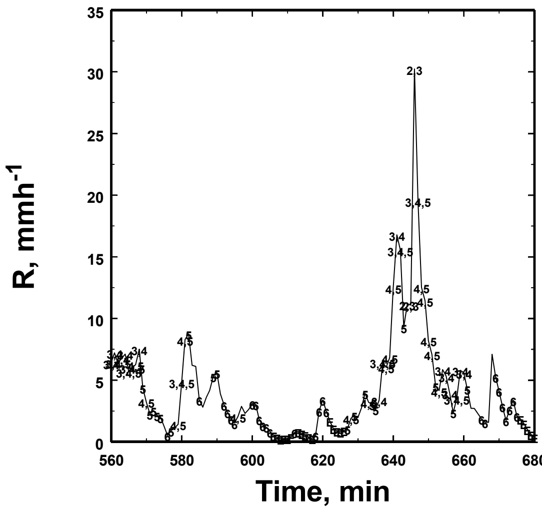

FIG.3: A representative section of the major contributors from the statistically homogeneous components in Fig.2 to the time series of the rainfall rate. The commas between two numbers mean that more than one component contributed significantly to the observed R, likely because the one minute observation interval allows the combination of different components. The association of components with different features of the time series is apparent.