Analysis of Raindrop Size Distributions Over Varying Spatiotemporal Scales

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(Dated: 23 April 2015)

Using an array of 21 Thies Clima Laser Precipitation Monitors and a 2-Dimensional-Video-Disdrometer, the Raindrop Size Distribution will be investigated using a variety of statistical techniques. Temporal and spatial variability will constitute the main focus of the study. Techniques such as Bayesian Decomposition and statistical correlation will be used to bring new insight to Raindrop Size Distribution variability analysis.

I. INTRODUCTION AND CONTEXT

Rainfall has been recently been observed to vary over spatial scales of less than a kilometer and temporal scales less than five minutes, both of which are less than the typical period between radar measurements [1]. Observations of varying properties include rain rate [2], accumulation [3] and the relative abundance of raindrop sizes (called a raindrop size distribution, hereafter RSD,)[4]. Understanding the nature of the RSD has been the subject of several works, such as [5], but the atmospheric microphysics community has not fully deciphered RSD behavior. Understanding RSD behavior leads us to an understanding of erosion (due to the impact of drops on the ground,) flood hazard assessment, and storm evolution (see, e.g., [6] [7] [8] [9].)

In order to understand RSD variability, an array of optical rain measurement equipment was installed at Dixie Plantation in South Carolina over summer and fall 2013. Within the array are 21 instruments with a temporal resolution of one minute and one two-dimensional instrument that takes several pictures of raindrops as they pass through, with a temporal resolution better than one millisecond. The student and advisor have both worked on constructing the array and maintaining it, and conducted several studies using the data obtained. This proposal aims at taking steps forward in analyzing the RSD behavior in an effort to better characterize rainfall properties and rain impacts on our planet, using data from the Dixie Plantation instrument array.

II. OUTLINE AND GOALS

The main thrust of the project will be an investigation into the temporal and spatial variability of the RSD. However, in order to proceed in a methodical and organized fashion, several tasks must be undertaken.

The first task will be to revamp the existing data processing code. The current version's mechanics are poorly constructed, and need to be rewritten more coherently and functionally. A refined pipeline will be written to facilitate future projects by making the code more maintainable, and operable by a person of average computer knowledge. This will ensure continued progress on the project after the author has graduated, and enable more efficient data processing. The refined pipeline will also allow for the next layer of the foundation: an organized and comprehensive data library.

The current archive of data is split into "intervals," where the lab has a raw file for each detector that contains the data since the last retrieval. This format has frequently been a source of hindrances and frustration to the lab, and needs to be restructured. The refined pipeline will divide the archived files into a series of directories and files organized by date and instrument. This library will reorganize the data for the project.

With the project infrastructure more firmly constructed, work on the main project can proceed. The first line of inquiry will be the correlation of RSDs over varying spatial scales. The correlations will be compared at distances between 1 meter and 100 meters for a variety of storm types. The second line of inquiry will be the correlation between the RSD at one point in time to the RSD some time later at the same position. By combining the findings of both lines of inquiry, a deeper understanding of RSD variability will be achieved. The project's outlined goals will be completed according to the schedule in Table I. Results will be disseminated as seen on Table II.

Goal	Target Date
Automated Processing Code Completed	1 September 2015
Processing Code Technical Document	15 September 2015
Raw Data Processed	1 November 2015
Complete Spatial Study	15 December 2015
Complete Temporal Study	1 April 2015

TABLE I. A schedule for the completion of various goals for the duration of the study. This schedule is intended as a guideline and may be adjusted as needed.

Dissemination Type	Date(s) of Dissemination
Manuscript submitted to the Journal of the Atmospheric Sciences	29 February 2016
Presentation at the Palmetto American Meteorological Society Annual Mini-Conference*	March 2016
Presentation at the College of Charleston School of Sciences and Mathematics Annual Poster Session 2016*	April 2016
Presentation at the 17th International Conference on Clouds and Precipitation	25-29 July 2016

TABLE II. Dissemination types marked with * indicate the minimum expected dissemination.

III. METHODS

A variety of techniques must be utilized to accomplish each step of the project. For the development of the refined pipeline, Python programming will be used to write the code. In addition, a technical document describing the mechanisms and implementation of the pipeline will be prepared. This will assist in future development and the construction of the library, constructed via systemic pipeline processing of raw data.

The studies themselves will use the data within the data library, and several statistical methods will be applied. Approaches such as those recently published in [3] will be applied and extended. Bayesian Decomposition and the calculation of the statistical correlation are both likely going to be the initial attempts at quantification (see, e.g., [10]). The pair correlation function may be used after or instead of these methods (see, e.g., [11]).

IV. RESOURCES

All experimental and analysis resources needed to complete the project are already available to the authors. The disdrometer array is already constructed and its data is available. Even in the case of instrument catastrophe, the current available data is sufficient to complete the project. An existing data processing code is in place and functional– it is a part of this project because the authors wish to make it more accessible to other scientists. The laboratory work stations have MATLAB (a programming language for data analysis) licenses, which will enable the student to perform the required data analysis.

V. BUDGET

Because the resources necessary are already available to the authors, no extra budgeting is necessary.

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