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INVESTIGATION OF RAINFALL DATA WITH REGARD TO LOW-LEVEL WIND FLOW REGIME FOR EAST CENTRAL FLORIDA

Prepared by: Joni Brooks

Academic Rank: Assistant Professor

Institution: Columbia State Community College
Department: Computer Information Systems

NASA/MSFC:

Office: Earth System Analysis Team
Division: Earth Science & Applications
Branch: Environmental Analysis

MSFC Colleague(s): Steve Goodman, Ph.D. - NASA
Bill Crosson, Ph.D. - USRA
Claude Duchon, Ph.D. - Univ. of Oklahoma

Previous research has been conducted to investigate the effect of the low-level wind regime on summertime convective storms in the east central Florida area (Holle et al., 1992). These effects were described by analyzing the distribution of lightning flashes within classifications based on the low-level wind regime for the months June through September of 1987 to 1990. The present research utilizes the same classification strategy to study rainfall patterns for data gathered for the CaPE (Convection and Precipitation/Electrification Experiment) field program. The CaPE field program was conducted in east central Florida from July 8, 1991 to August 18, 1991.

Each day of the study period was classified by calculating the mean wind vector, as described by Watson et al.(1987), from rawinsonde measurements from approximately 0.3 km to 3 km (1000 - 10,000 ft). These data were obtained from the Cape Canaveral sounding nearest to 1000 Greenwich Mean Time(GMT). Seven classes were defined as follows; Calm(wind speed <= 2.0 m/s); NE (23°-113°); SE(113° - 158°); SO(158° - 203°); SW(203° - 293°); NW(293° - 338°); NO(338° - 023°). Fourteen days were identified as SW and will be referred to as disturbed sea breeze days. Twenty five days were classified in the remaining six categories and will be referred to as undisturbed sea breeze days. Sounding data were not available for three days during the study period.

Of the many data sets available from the CaPE field program, three precipitation data sets were utilized for this study. These surface data sets include 20 rain gages from the Kennedy Space Center(KSC) Tropical Rainfall Measuring Mission(TRMM) network, a network of 47 Portable Automated Mesonet (PAM II) sites, and 19 stations operated within the Upper St. John's River Water Management District(USJRWMD). These networks were chosen based on the availability of data collected at one minute intervals. Extensive effort was expended to convert and produce clean data sets in a common format. Some of the data sets have missing values. The problem of missing data must be considered in each step of the analysis. To allow analysis of area mean rainfall, a grid was selected which would allow a maximum number of equally spaced stations. Of the eighty six available stations, thirty six were chosen that are relatively equally spaced on a 15 km grid.

One method to study rainfall patterns is to compare the diurnal cycle on disturbed and undisturbed days. To prepare for this comparison, rainfall measurements were summed for each hour. An area mean rainfall was calculated for each hour of each day by dividing the hour sum by the number of reporting stations. The data were then segregated by day as disturbed or undisturbed. To normalize the results, the hourly means were summed and divided by the number of days in each group.

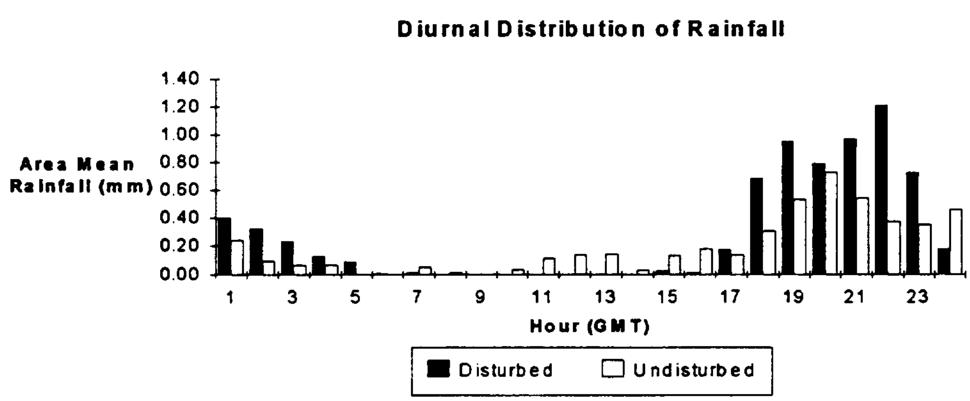

Figure 1

The results are illustrated in figure 1. The distributions are similar and show peak rainfall during the hours 18 thru 23 (GMT). The histogram indicates the area mean rainfall for disturbed days is nearly double that of the undisturbed days during these peak times. For the remainder of this paper, a day will be defined as 1300 - 0500 (GMT) corresponding to 0900 - 0100 local daylight time. This definition correspond to hours with heavier rainfall and eliminates hours with negligible rainfall.

The next approach attempts to answer the question - "Is rainfall greater on disturbed days?" In this method, rain rates (mm/hr) were categorized into twelve intervals; [0], (0,5], (5,10], (10, 15], (15, 20], (20,25], (25,30], (30,35], (35, 40], (40, 45], (45, 50], (50, +∞). (Note: In this notation a parenthesis is used to indicate an open interval; a bracket is used to indicate a closed interval.) The daily frequency of occurrence was calculated for each interval. The data were segregated by day as disturbed or undisturbed. Area means were calculated within each interval by summing the daily frequencies and dividing by the difference of the total possible reports and the number of missing values reported. The outcomes were normalized by dividing by the number of days in each group. The results are illustrated in figures 2 and 3. As one might expect, the highest percentages are found in the category with zero rainfall. The histograms show percentages for disturbed days in all remaining intervals greater than or equal to undisturbed days.

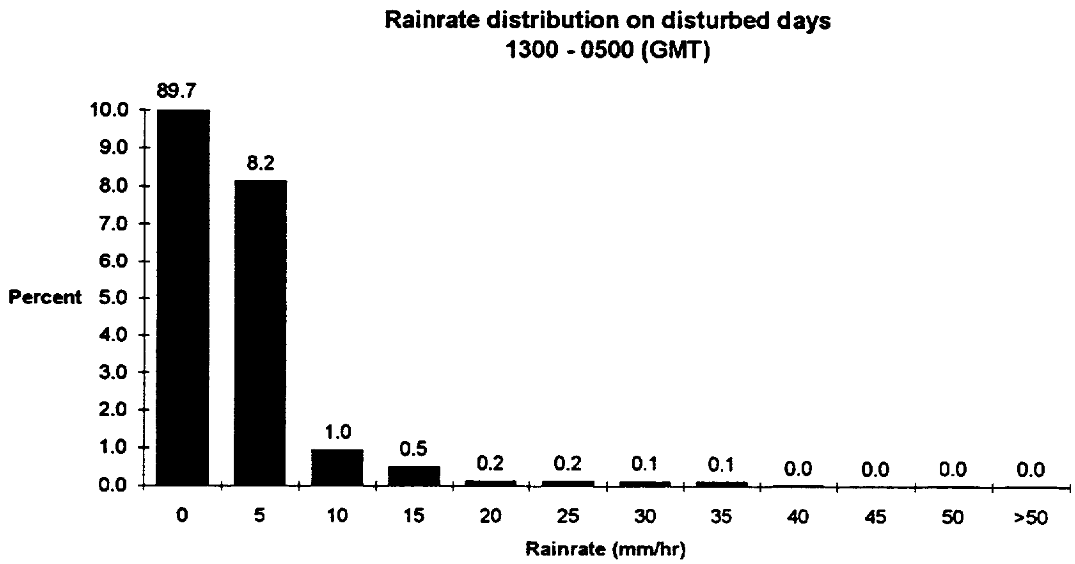

Figure 2

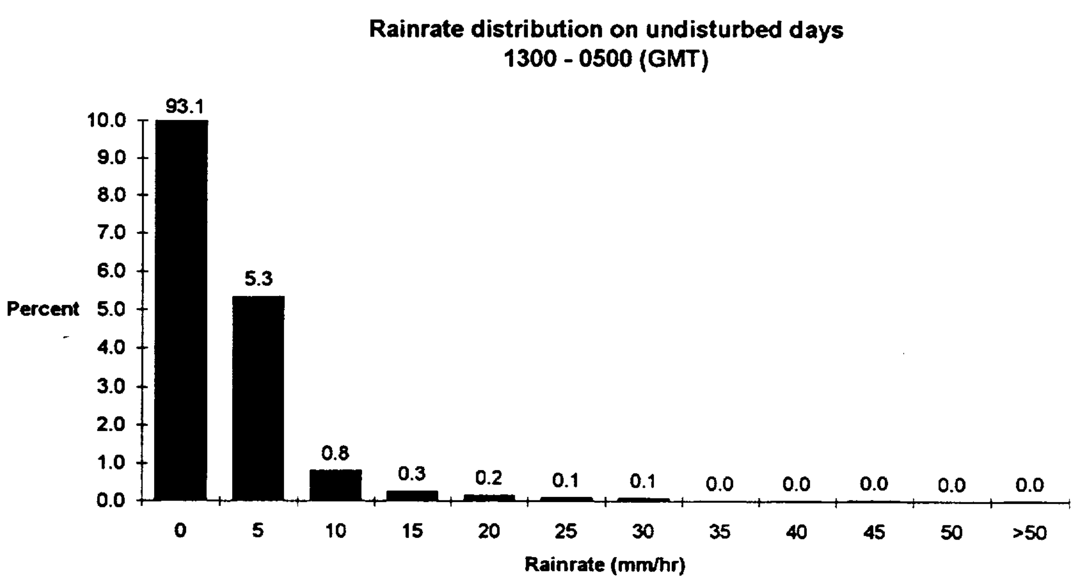

Figure 3

The final strategy attempts to compare the time frame of rain events on disturbed and undisturbed days. That is - are rain events of longer duration on disturbed days? For this analysis, six stations were eliminated from the grid. Data received from five of these sites had been adjusted using a cubic spline algorithm. It was decided that such data might effect the analysis of continuous precipitation. The sixth station was eliminated to maintain an equally spaced grid. Once the grid was finalized, a histogram was created to display the frequency of occurrence of continuous rain events during the following time intervals; 1 to 5 minutes, 6 to 10 minutes, ..., 45 to 50 minutes, and greater than 50 minutes. The histogram will vary based on the definition of a rain event. (How many consecutive minutes of zero rainfall will be allowed within a rain event?) When this definition is set to one minute, the frequency is high for rain events between 1 and 5 minutes. This may be misleading because rain may be continuous for a longer period of time but not at a rate which would be reported every minute. Figures 4-6 display the histograms for rain events defined by 1, 10, and 20 minute separations. Figures 5 and 6 show that on disturbed days the occurrence of rain events longer than forty minutes are nearly double the occurrence of similar events on undisturbed days.

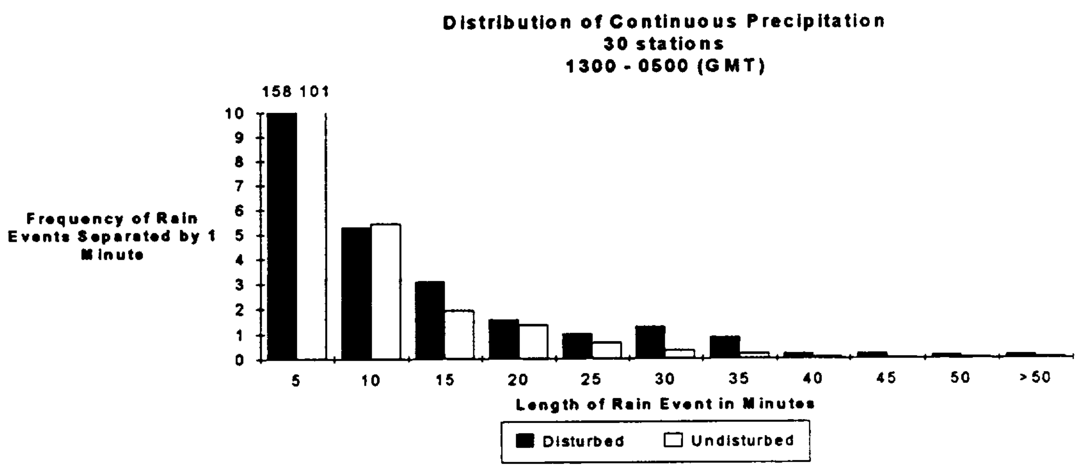

Figure 4

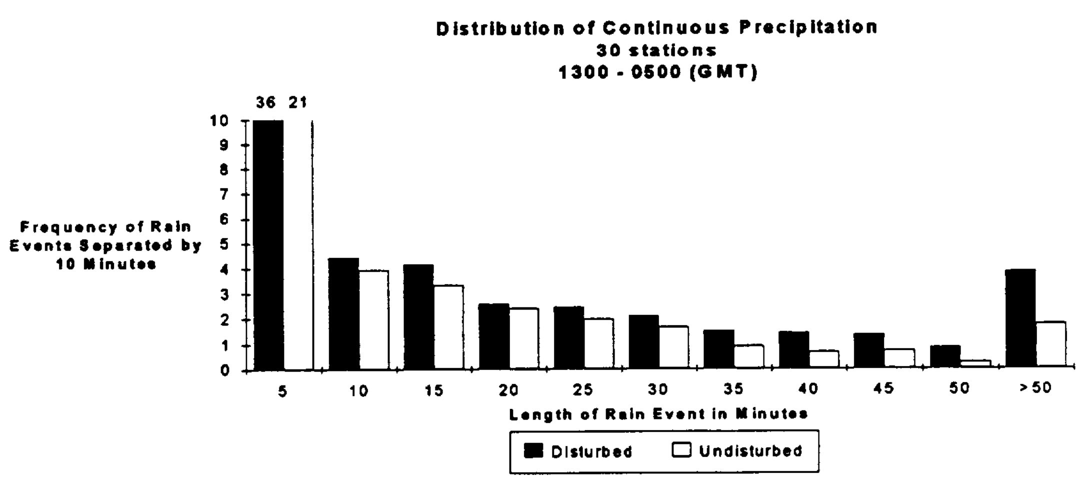

Figure 5

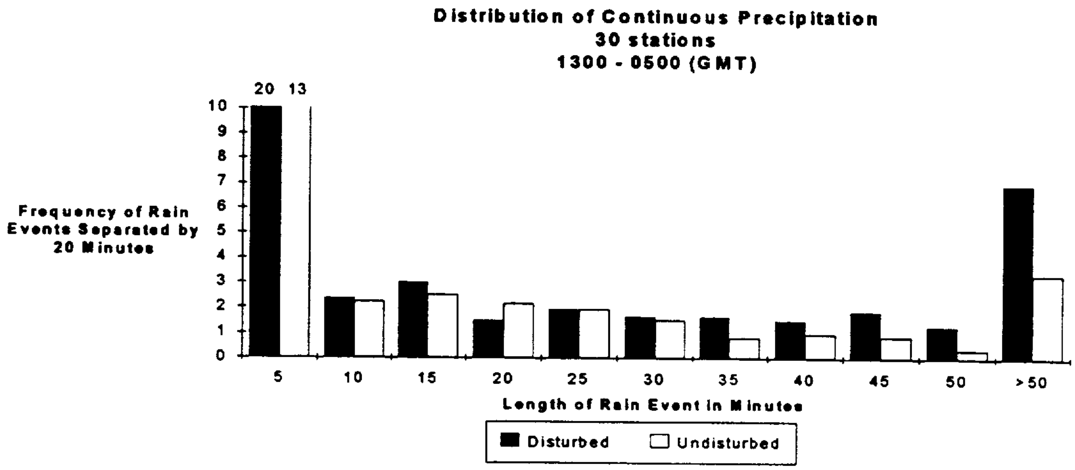

Figure 6

To determine the percent which rainfall from disturbed days contributes to the total water budget, daily totals were calculated by summing the mean area rainfall for each hour over a twenty four hour period (0-2400 GMT). From these daily totals, forty five percent of the mean area rainfall occurred on disturbed days, which comprise only thirty six percent of the study period. Due to a high variance of the daily totals of each data set, statistical T-test and F-test calculations based on a 95% confidence level indicate no significant difference between the two groups. Further study of the 7 individual classes may highlight the differences. Based upon the results of this and previous research, the effect of SW flow on rainfall and lightning could be relevant to the TRMM mission, whose objective is to measure rainfall with multiple instruments.

REFERENCES

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