COMPARISON OF EXTREME 1-DAY AMOUNTS OF RAINFALL FOR COASTAL AND NORTH CENTRAL CLIMATIC REGIONS OF MISSISSIPPI

K. C. McGregor, USDA Sedimentation Laboratory, Oxford, MS
R. A. Muller, Louisiana State University, Baton Rouge, LA
C. E. Murphee, Jr., USDA Sedimentation Laboratory, Oxford, MS

INTRODUCTION

The importance attached by our society to weather is reflected by daily weather forecasts by radio, television and newspapers. Rainfall is one aspect of the weather that serves both as a "blessing" and a "curse" to our society. Harmful effects to lives, crops and property are caused by either "too much" or "too little" rainfall. The public probably remembers best those adverse conditions that are caused by excessive rainfall. High intensities are often associated with excessive rainfall amounts. However, prolonged rainfall with moderate intensities can also cause excessive rainfall, particularly when falling over wide areas.

The impact of high rainfall events on erosion necessitates the determination of frequencies and magnitudes. Wischmeier (1962) found, for example, that one-third of the soil loss from plots of row crops was caused by storms with return periods of less than 1 year, another third resulted from storms with return periods of 1 to 2 years, and the final third from storms with return periods longer than 2 years. These conclusions were based on 315 plot-years of row crops in Georgia, Iowa, Missouri, New York, Ohio, Oklahoma and Wisconsin.

Normally, rainfall is plentiful in Mississippi. Annual precipitation in the Coastal Climatic Region of Mississippi averages about 62 inches, and in the extreme north the average decreases to about 54 inches (NOAA, 1985). In the south, maximum rainfalls normally occur during the summer season in association with thunderstorms and disturbed tropical weather systems from the Gulf of Mexico. In northern and central sections the greatest rainfalls normally occur during winter and spring in association with mid-latitude cyclones and quasi-stationary cold fronts. Figure 1 shows the locations of the North Central and Coastal Climatic Regions of the National Weather Service (NWS) and the National Climatic Data Center (NCDC). The maximum 24-hour point rainfalls that can be expected once every two-years on the average in the Coastal and North Central Regions are about 6 and 4 inches, respectively; these amounts increase to about 13 and 8 inches, respectively, for a 100-year return period (U. S. Weather Bureau, 1961).

Comparison of the frequency and magnitudes of 1- day excessive events in the North Central and Coastal Regions provide information about the extremes expected in rainfall patterns and amounts in Mississippi. In this study, daily rainfall events of three or more inches were tabulated by months for selected stations within the North Central and Coastal Climatic Regions of Mississippi. Comparisons of events for the two regions were made for the 1951-1980 standard period and by decades.

Bay St. Louis, Biloxi City and Pascagoula stations lie along the coast within the Coastal Region. Poplarville Experiment Station, Wiggins, and Merrill stations lie about 30 to 40 miles inland, but are still part of the Coastal Region. Occurrences of 1-day excessive events

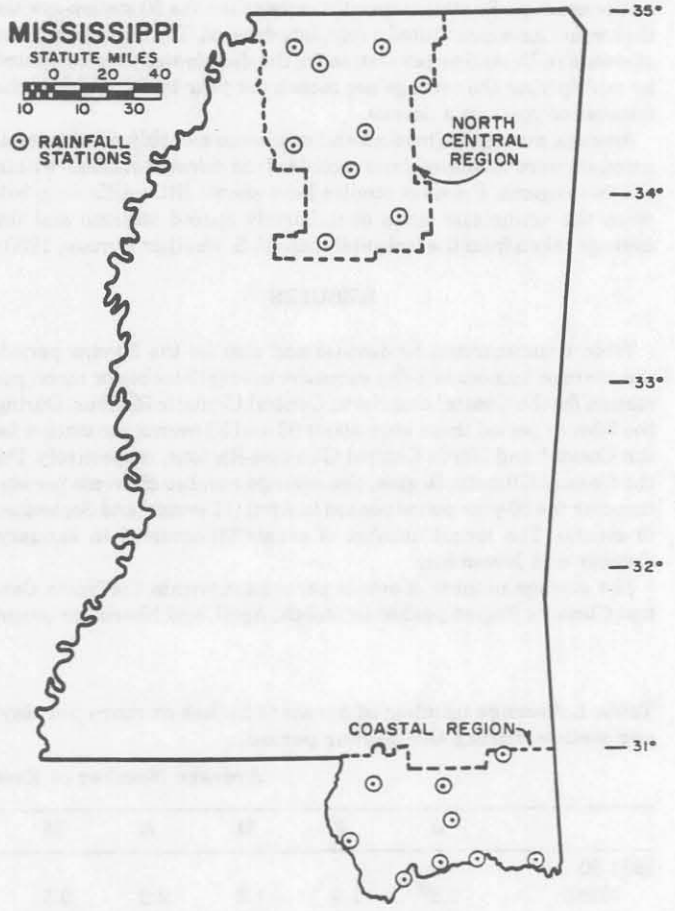

Figure 1. Relative locations of Coastal and North Central Climatic Regions of NOAA in Mississippi.

were also compared for these interior and coastal stations within the Coastal Region to investigate whether there is a distinct coastal effect.

PROCEDURE

Monthly Climatological Data (CD's) were examined for 1-day rainfalls of 3 inches or greater at selected stations within each division by months for 1951-1980. The data set of the North Central Climatic Region included only 6 of the 9 selected stations in 1953- 1954, 7 stations in 1955 and in 8 months of 1956, and 8 stations during the

remaining years of the 1951-1960 decade. The data set of the Coastal Climatic Region included 8 stations in 1953 and in the first 4 months of 1954, but contained 9 stations during all other years of the 1951-1980 period. Both regions also had randomly missing monthly values for some stations.

Each individual rainfall station was considered to be a sample of regional rainfall for the region in which the station was located. Using data from all selected stations within each region, the average number of 1-day rainfall events (3-inches or more) per station was computed for each region for three different decades (1951-1960, 1961-1970 and 1971-1980). Decade averages were summed to give the average number of events per station during the 1951-1980 period. Decade averages were computed by using only the station-months for which data were available. For example, during December of the 1951-1960 decade, there were 13 recorded events from 9 stations in the Coastal Climatic Region; however, there were 10 station-months that were missing. The average number of events during December in any year during the decade was computed by dividing the 13 events by the available 80 station- months rather than the 90 station-months that would have constituted a complete data set. The average number of events in December per station for the decade was then computed by multiplying the average per month per year by 10, which is the number of years in a decade.

Average, maximum, median and minimum monthly point-rainfall amounts were tabulated from records of the selected stations within the two regions. Previous studies have shown little difference between the arithmetic mean of uniformly spaced stations and the average taken from the isohyetal map (U. S. Weather Bureau, 1958).

RESULTS

Table 1 summarizes, by decades and also for the 30-year period, the average number of 1-day excessive events (3-inches or more) per station for the Coastal and North Central Climatic Regions. During the 30-year period there were about 63 and 38 events per station for the Coastal and North Central Climatic Regions, respectively. For the Coastal Climatic Region, the average number of events per station over the 30-year period peaked in April (11 events) and September (9 events). The lowest number of events (3) occurred in January, October and November.

The average number of events per station within the North Central Climatic Region peaked in March, April, and November (about 6, 5 and 5 events, respectively). Minimum values occurred in June, July, August and October (about 2,2,2 and 1, respectively). Greatest differences in the two regions occurred in April, May, and September, when there were about 6, 5 and 5 more events, respectively, per station in the Coastal Climatic Region. The average number of events per station was only slightly lower in both regions during the second decade (1961-1970), than during the first (1951-1960) and third (1971-1980) decades.

On an annual basis, stations within the Coastal Climatic Region ranged from a maximum of about 4 events per station per year in 1961 and 1980 to a minimum of almost no events in the 1962 and 1963 years. The average was about 2 events per station per year for the 30-year period. The average number of events per station per year within the North Central Climatic Region ranged from almost zero in 1952, 1954, 1960, 1971 and 1976 to a maximum of almost 3 in 1955. An average of only about one event per station per year occurred during the period of record (1951-1980) in the North Central Climatic Region.

Tables 2 and 3 give the distribution of 1-day excessive events by 1-inch rainfall intervals for each month of a calendar year over the 30-year period for the Coastal and North Central Climatic Regions, respectively. Numbers in these tables represent the combined recorded totals from the 9 selected stations within each region. Although there were a few years during which some stations were not in operation and also random occasions of missing data from nearly all stations, the total number of years involved made the trends approach the actual distributions. Tables 2 and 3 also show the number of missing station-months and the adjusted total number of events for the 30-year period. Adjusted totals represent the number of events that would have been recorded for the 30-year period if occurrences had continued during missing station-months at the same rate as in recorded station-months. Nevertheless, adjusted and recorded totals were very similar.

Figure 2 shows distributions obtained for each of the two regions when the 1-inch rainfall intervals were plotted versus the total number of recorded events in each interval during the 30-year period. The number of events for each rainfall interval was higher in the Coastal Climatic Region, but decreased rapidly from the 3 to 4 inch interval to the 5 to 6 inch interval in both regions. Similar comments can be made for the relationship shown in Figure 3 for the number of events during April and May. Figure 2 also shows that a few events in the Coastal Climatic Region exceeded 8 inches per day as compared to zero events in the North Central Climatic Region. About

Table 1. Average number of events (3 inches or more per day) per station during each decade, and the average number of events per station during the 30-year period.

	Average Number of Events Per Station in each Decade												
	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
1951-60													
North	1.8[a]	1.3	1.2	2.2	0.5	0.6	0.8	0.6	1.9	0.3	1.2	1.6	14.0
Coast	0.3	1.8	2.2	4.1	1.9	2.1	1.4	1.8	4.8	0.4	0.7	1.6	23.1
1961-70													
North	0.2	1.7	0.9	1.6	1.0	0.1	1.1	0.8	0.8	0.1	1.7	0.9	10.9
Coast	1.0	1.5	1.2	2.5	1.1	1.3	0.9	1.8	1.8	1.9	1.0	1.7	17.7
1971-80													
North	1.2	0.1	3.6	1.3	1.6	1.0	0.0	0.1	1.0	0.7	1.9	0.8	13.3
Coast	1.3	0.7	2.2	4.2	5.2	1.2	1.4	0.9	2.5	0.9	1.0	1.1	22.6
Total for 1951-1980													
North	3.2	3.1	5.7	5.1	3.1	1.7	1.9	1.5	3.7	1.1	4.8	3.3	38.2
Coast	2.6	4.0	5.6	10.8	8.2	4.6	3.7	4.5	9.1	3.2	2.7	4.4	63.4

[a] The value 1.8 means that, on the average, each and every rainfall station within the North Central Climatic Region would have received that many 1-day (3-inches or more) rainfall events during the 1951-60 decade.

Table 2. Number of 1-day events at nine stations within the Coastal Region by 1-inch rainfall intervals for January through December during 1951-80.

Rainfall Intervals (Inches)	Number of 1-Day Events[a]												
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
3 to 4	13	24	22	52	40	17	24	22	31	16	14	27	302
4 to 5	3	5	18	19	14	7	6	9	23	2	5	8	119
5 to 6	3	2	3	9	6	5	2	1	9	4	1	1	46
6 to 7	1	2	2	6	5	6	0	4	6	1	2	1	36
7 to 8	1	0	0	3	4	4	1	1	4	2	1	0	21
8 to 9	2	0	2	1	2	0	0	0	1	1	1	0	10
9 to 10	0	0	0	0	0	0	0	1	2	1	0	0	4
10 to 11	0	0	0	1	0	0	0	0	2	1	0	1	5
Total	23	33	47	91	71	39	33	38	78	28	24	38	543
Adjusted Total[a]	25	38	51	96	75	42	34	40	81	29	25	40	576
Missing[a] Station Months	17	14	19	15	13	17	9	12	10	11	13	14	164

[a] There were random accasions of missing data and a few years when some stations were not in operation. Adjusted totals included events that would have occurred if data for missing station months occurred at same rate as in recorded station months.

Table 3. Number of 1-day events at nine stations within the North Central Region by 1-inch rainfall intervals for January through December during 1951-1980.

Rainfall Intervals (Inches)	Number of 1-Day Events[a]												
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
3 to 4	24	15	32	31	20	13	12	9	23	7	21	23	230
4 to 5	2	8	11	8	5	1	1	3	4	2	11	2	58
5 to 6	0	2	3	2	1	0	1	0	2	0	5	2	18
6 to 7	0	0	2	1	1	0	2	0	0	0	3	0	9
7 to 8	0	0	1	0	0	0	0	0	1	0	1	0	3
Total	26	25	49	42	27	14	16	12	30	9	41	27	318
Adjusted Total[a]	28	37	53	45	29	15	17	13	32	10	44	29	342
Missing[b] Station Months	21	22	21	19	17	18	18	21	18	16	17	17	225

[a] There were random occasions of missing data for all stations. Adjusted totals include events that would have occurred if data for missing station months occurred at same rate as in recorded station months.

[b] Missing station-months include 10-station-months during each month of first decade when one station was not in operation.

75 percent of excessive 1-day events were less than 4.8 and 4.1 inches in the Coastal and North Central Climatic Regions, respectively.

There were 6 months in the North Central Climatic Region during which about 75 percent of the 1-day excessive events had rainfall totals of 3 to 4 inches. The highest percentages of rainfall events in the 3 to 4 inch range occurred in January, July and December (92, 93 and 85 percent, respectively). February, March, and November were the only months with less than 70 percent in the 3 to 4 inch range (60, 65 and 51 percent, respectively).

In the Coastal Climatic Region, the percentage of 1-day events in the 3 to 4 inch range never exceeded 75 percent for any month. Only three months (February, July and December) had at least 70 percent. March, July and September each had less than 50 percent, while each of the remaining months had less than 60 percent in the 3 to 4 inch interval.

Rainfall from all the recorded extreme 1-day events over a 30-year period for all the selected stations within a climatic region divided by the total number of recorded events gives the average rainfall of an excessive 1-day event over the period for that region. Table 4 gives such averages, by calendar months, along with medium and maximum amounts for extreme 1-day events in the Coastal and North Central Regions of Mississippi. Average values represent the rainfall per extreme 1-day event during the entire 30- year period, and thus do not represent an average amount of extreme 1-day rainfall per month per year. Excessive 1-day rainfall amounts per event in the Coastal Climatic Region were between 4 and 5 inches during all months except during February and July when the rainfall per extreme 1-day event was 3.8 and 3.9 inches, respectively. The highest averages were 4.8 and 4.9 inches in September and October, respectively. Median values ranged from 3.5 inches in February to 4.2 inches

Table 4. The rainfall (inches) per extreme 1-day event, by calendar months, along with median and maximum extreme 1-day amounts over the 1951-1980 period.

Coastal Region	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Avg.	4.6[a]	3.8	4.3	4.3	4.4	4.6	3.9	4.2	4.8	4.9	4.3	4.0
Med.	3.8	3.5	4.0	3.9	3.8	4.2	3.7	3.7	4.2	3.8	3.6	3.8
Max.	9.0	6.8	8.9	10.8	8.7	7.8	7.8	9.4	10.3	10.7	8.4	10.5
North Central Region	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
Avg.	3.5	3.8	4.0	3.7	3.8	3.4	4.0	3.7	3.8	3.8	4.2	3.7
Med.	3.4	3.6	3.7	3.6	3.5	3.3	3.6	3.6	3.5	3.7	3.9	3.5
Max.	4.8	5.3	7.4	6.0	6.5	4.2	6.3	4.4	7.0	4.8	7.0	5.6

[a] The average value of 4.6 inches listed for January in the Coastal Climatic Region is the total amount of rainfall from all recorded events of 1-day excessive rainfall divided by the total number of recorded events from selected station for the 1951-1980 period, thus is the rainfall per excessive 1-day event.

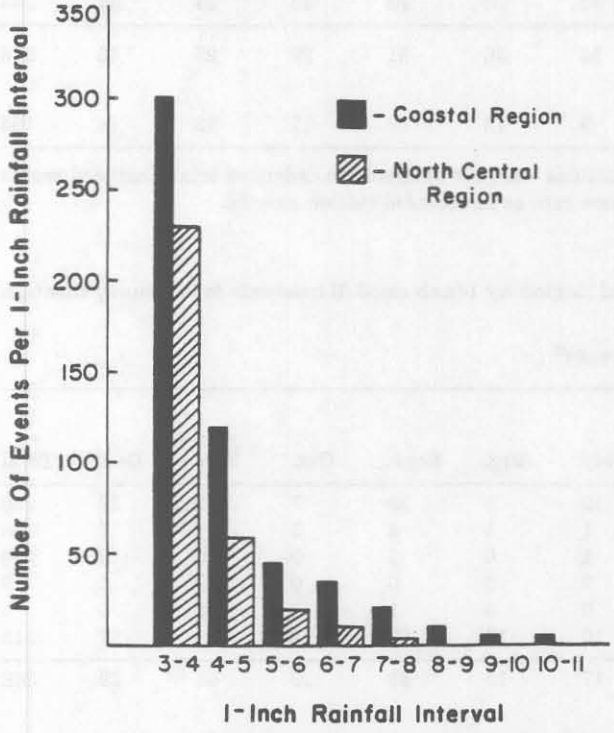

Figure 2. Distribution of 1-day excessive rainfall events by 1-inch rainfall intervals during a 30-year period (1951-1980) in the Coastal and North Central Regions of Mississippi.

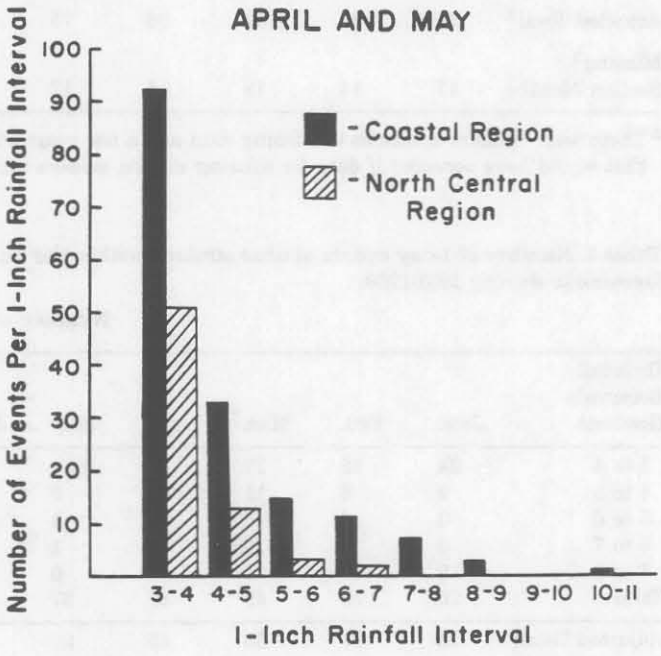

Figure3. Distribution of 1-day excessive rainfall events by 1-inch rainfall intervals during April and May (1951-1980) in the Coastal and North Central Regions of Mississippi.

Table 5. Average, median, maximum and minimum monthly rainfall amounts (inches) during a 30-year period (1951-1980) computed from averages of stations within the Coastal and North Central Regions.

Monthly Rainfall (1951-1980)

Coastal Region	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Avg.	5.1	5.1	6.0	5.3	5.1	4.6	6.9	5.8	6.4	3.0	3.9	5.5	62.7
Med.	5.3	4.6	5.8	5.0	4.5	4.0	6.5	5.8	6.0	2.4	3.6	5.1	
Max.	11.1	11.4	14.0	14.1	12.8	9.7	14.4	10.3	16.9	8.9	8.6	11.6	
Min.	1.5	1.5	0.4	0.8	0.8	0.6	3.9	1.3	0.8	0.0	0.6	1.5	
North Central Region	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	
Avg.	5.1	4.8	6.0	5.8	5.1	3.6	4.1	3.0	3.8	2.6	5.0	5.1	54.0
Med.	4.5	4.5	5.8	5.0	4.3	3.3	4.3	2.4	3.3	2.4	4.2	4.7	
Max.	11.6	9.8	14.4	11.2	11.3	9.6	8.5	5.9	11.2	6.6	11.4	10.2	
Min.	1.6	1.1	1.4	1.8	1.7	0.4	1.4	1.2	0.9	0.0	1.7	0.6	

in June and September. The maximum 1-day rainfall for any rainfall event within the Coastal Climatic Region ranged from 6.8 inches in February to between 10 and 11 inches in April, September, October and December.

The amount of rainfall per extreme 1-day event in the North Central Climatic Region ranged between 3 and 4 inches for all months except March, July and November, during which the rainfall per event was 4.0, 4.0 and 4.2 inches, respectively. Median values ranged from 3.3 inches in June to 3.9 inches in November. The maximum 1-day rainfall for stations within the North Central Climatic Region ranged from 4.2 inches in June to slightly over 7 inches in March, September and November.

In the Coastal Climatic Region, the 30-year average monthly point-rainfall for one calendar month as compared to another did not generally appear to be related to the number of extreme 1-day rainfall events per station that occurred over the 30 year period. The lowest and highest number of events per station occurred in January and April, respectively. Yet, the average monthly point-rainfall for January and April was quite similar.

In the North Central Climatic Region, the 30-year average monthly rainfall (P) was related to the number (N) of extreme rainfall events per station over the 30- year period as follows:

$$P = 2.50 + 0.63\ N$$

where P was expressed in inches. The correlation coefficient for the equation was 0.86.

Table 5 gives the average, maximum and minimum monthly point-rainfall amounts as tabulated from available records during the 1951-1980 period for the selected stations within the Coastal and North Central Climatic Regions. Annual rainfall averaged about 63 and 54 inches, respectively, for the Coastal and North Central Climatic Regions. In the Coastal Climatic Region, only June, October, November had average rainfall amounts less than 5 inches. In the North Central Climatic Region, the months of February and June through October had average rainfall amounts less than 5 inches. The average rainfall in the Coastal Climatic Region during the combined months of July, August and September exceeded that for the North Central Climatic Region by about 8 inches.

Data in Table 5 indicate that periods with greatest rainfall in the Coastal Climatic Region occur in the spring, mid-summer and early fall as compared to only spring in the North Central Climatic Region. March, July, August and September had the highest average monthly rainfall in the Coastal Climatic Region, about 6,7, 6 and 6 inches, respectively. The highest average monthly rainfall in the North Central Climatic Region was about 6 inches, but occurred only during March and April. All months from November through May in the North Central Climatic Region had rainfall averaging at least

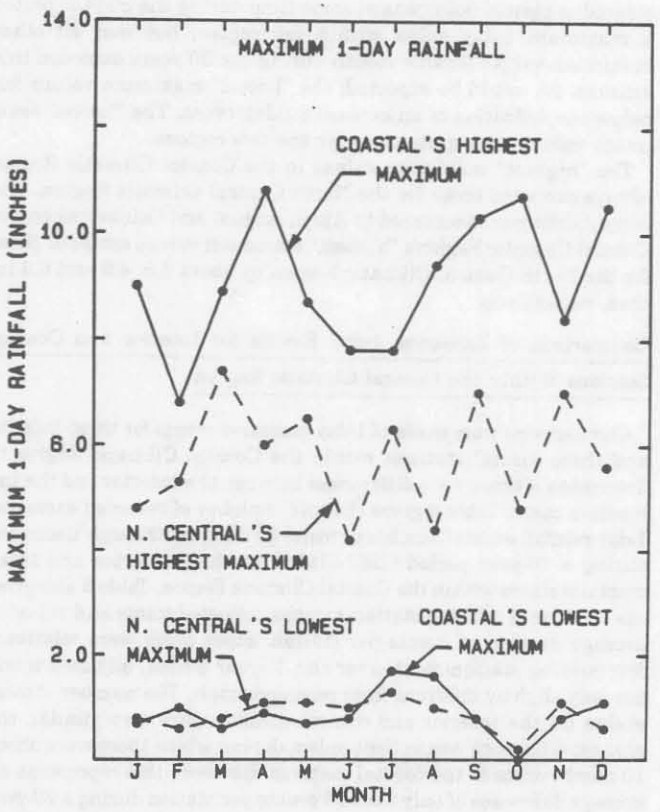

Figure 4. Ranges of maximum 1-day rainfall for each month during a 30-day period (1951-1980) selected from stations within the Coastal and North Central Divisions.

5 inches except for February, which had only a slightly lower amount of 4.8 inches.

There were 176 and 112 months during the 360 months of the 1951-1980 period when at least one station's 1-day maximum rainfall equaled at least 3 inches for the Coastal and North Central Climatic Regions, respectively. Figure 4 shows monthly ranges of maximum 1-day rainfall for the 30-year period within both regions. Interpretation of Figure 4 may be confusing because of the use of terms such as "lowest" maximum and "highest" maximum. The "lowest" maximum curves mean that, for any particular month being con-

Table 6. Number of events (3-inches or more) for 3 interior and 3 coastal stations within the Coastal Region During 1951-1980.

Number of Events (1951-1980)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Coastal Stations												
Total	9	13	17	31	23	14	10	16	29	11	10	11
Missing Station-Months	2	3	6	5	5	8	3	6	4	2	4	3
Adjusted Total	9	13	18	33	24	15	10	17	30	11	10	11
Average per Station	3	4	6	11	8	5	3	6	10	4	3	4
Interior Stations												
Total	6	12	19	27	23	14	8	12	20	11	8	18
Missing Station-Months	6	4	5	4	3	3	2	3	2	3	4	5
Adjusted Total	6	13	20	28	24	14	8	12	20	11	8	19
Average per Station	2	4	7	9	8	5	3	4	7	4	3	6

sidered, a plotted point was at some time during the 30-year period a maximum 1-day value within the region; however, all other maximum values for this month during the 30 years exceeded this amount. As would be expected, the "lowest" maximum values fell below our definition of an excessive 1-day event. The "lowest" maximum values were quite close for the two regions.

The "highest" maximum values in the Coastal Climatic Region always exceeded those for the North Central Climatic Region. The largest differences occurred in April, August and October when the Coastal Climatic Region's "highest" maximum values exceeded those for the North Central Climatic Region by about 4.8, 4.9 and 6.0 inches, respectively.

Comparison of Excessive 1-day Events for Interior and Coastal Stations Within the Coastal Climatic Region

Comparisons were made of 1-day excessive events for three interior and three coastal stations within the Coastal Climatic Region to determine if there were differences between the interior and the immediate coast. Table 6 gives the total number of recorded excessive 1-day rainfall events (3-inches or more) for January through December during a 30-year period (1951- 1980) for three interior and three coastal stations within the Coastal Climatic Region. Table 6 also gives the number of missing station-months, adjusted totals and adjusted average number of events per station. Since there were relatively few missing station-months for the 30-year period, adjusted totals are only slightly different from recorded totals. The number of total events for the interior and coastal stations were very similar. the highest difference was in September, during which there were about 10 more events at the coastal stations. However, this represents an average difference of only about 3 events per station during a 30-year period. The most frequent occurrences of extreme events for both coastal and interior stations were in April and September.

Synoptic Weather Patterns

Muller and Willis (1983) found that eight synoptic weather types described weather situations occurring each day during a 20-year period at New Orleans, Louisiana. About 80 percent of the precipitation during the 20-year period occurred in weather types classified as either Frontal Overrunning (FOR), Frontal Gulf Return (FGR) and Gulf Tropical Disturbance (GTD). The frontal types, FOR and FGR, accounted for almost two-thirds of the annual precipitation. The Gulf Return (GR) type produced 8 percent of the precipitation, but frequent or substantial precipitation was not an outstanding characteristic of the associated weather.

Usually, the FOR type occurs when a polar front is about stationary along the Gulf Coast or over the northern Gulf. In the GR type, there is usually a strong return flow of maritime tropical air from the Caribbean and Gulf. The FGR type occurs when the return flow is affected by convergence or lifting along an approaching front. The GTD type is associated with tropical systems that usually drift from east to west across the northern Gulf. These tropical systems may include relatively weak easterly waves as well as severe hurricanes that produce high precipitation (Muller, 1977).

Although records of synoptic weather patterns were not included in this study of excessive rainfall events, the maximum peaks for the Coastal Climatic Region's events in September were probably associated with GTD synoptic weather types. FGR types probably predominated for most of the remaining coastal events, although FOR events may have contributed substantial amounts during the winter and spring. The peak in the spring for the number of events in the North Central Region was also probably associated with the FGR type. A synoptic weather type approach might well be used in future research to explain the temporal variability of excessive rate events within each region as well as to explain differences between regions.

CONCLUSIONS

One-day rainfall events of 3-inches or more occurred at least once within the North Central Climatic Region and twice each year in the Coastal Climatic Region of Mississippi during a 30-year period (1951-1980) at selected rainfall stations. More specifically, such an event had an average occurrence of about once every nine and six months, respectively, in the North Central and Coastal Climatic Regions. For the Coastal Climatic Region, the average number of excessive 1-day events (3-inches or more) per station peaked in April (11 events) and September (9 events) during the 30-year period. Thus on the average, a rainfall station within the Coastal Climatic Region had 1-day rainfall of at least 3-inches in April and September every 2.7 and 3.3 years, respectively. Within the Coastal Climatic Region the number of events for interior and coastal stations were quite similar. In the North Central Climatic Region peaks occurred in March, April and November, when there was an average of 6, 5 and 5 events per station, respectively, during the 30-year period. These numbers represent a 1-day rainfall event per station of at least 3 inches in March, April and November every 5,6 and 6 years, respectively.

About 75 percent of excessive 1-day events were less than 4.8 and 4.1 inches in the Coastal and North Central Climatic Regions, respectively. The highest amounts per excessive event in the Coastal Climatic Region were 4.8 and 4.9 inches in September and October, respectively. Highest amounts per event in the North Central Climatic Region were 4.0, 4.0 and 4.2 inches during March, July and November, respectively.

Annual rainfall averaged about 63 and 54 inches for the Coastal and North Central Climatic Regions, respectively. The highest rainfall (including non- excessive rainfall) in the Coastal Climatic Region was in the spring, mid-summer and early fall as compared to only spring in the North Central Climatic Region.

REFERENCES

1. Muller, R. A. 1977. **A Synoptic Climatology for Environmental Baseline Analysis**, New Orleans, J. of Applied Meteorology 16(1): 20-33.
2. Muller, R. A. and Willis, J. E. 1983. **New Orleans Weather 1951-1980: A Climatology by Means of Symoptic Weather Types**, LSU School of Geoscience Misc. Publ. 83-1, 70 pp.
3. National Oceanic and Atmospheric Administration (NOAA). 1985. **Climatological Data Annual Summary-Mississippi** (Compiled from Information from the National Climatic Data Center, Asheville, NC.) 90(13):3-7.
4. National Oceanic and Atmospheric Administration (NOAA). 1951-1980 **Climatological Data- Mississippi** (Monthly Reports from 1951 through 1980 Compiled from Information from the National Climatic Data Center, Asheville, NC), Vol. 56(1- 12) through Vol. 85(1-12).
5. U. S. Weather Bureau. 1958. **Rainfall Intensity - Frequency Regime, Part 2 - S. E. United States**. Tech. Paper No. 29, p. 9.
6. U. S. Weather Bureau. 1961. **Rainfall Frequency Atlas of the United States**. Tech. Paper No. 40, p. 95, 105.
7. Wischmeier, W. H. 1962. "Storms and Soil Conservation". J. of Soil and Water Conservation 17(2):55-59.