THE FREQUENCY AND INTENSITY OF JANUARY HOURLY PRECIPITATION BY SYNOPTIC WEATHER TYPES IN SOUTHERN LOUISIANA

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ABSTRACT: By associating synoptic weather types with each hourly precipitation event, the underlying physical causes creating the frequency and intensity of hourly precipitation can be revealed. In this research, synoptic weather types are associated with each hourly precipitation event during January (1951-1990) at both Lake Charles and New Orleans. Muller has identified eight synoptic weather types for Louisiana and this classification is applied here. Results indicate that while New Orleans has 55 more hourly precipitation events during the study period, Lake Charles exceeded the frequencies reported at New Orleans in all five types which occurred more than once except Frontal Overrunning (FOR). FOR events are more intense at New Orleans while non-frontal events are more common and heavier at Lake Charles.

INTRODUCTION

Hourly precipitation data are frequently utilized in precipitation climatologies on local (1), regional (2) and national (3) scales. Further insight can be gained into the processes underlying the spatial and temporal variability of hourly precipitation data by classifying the associated weather into discrete synoptic types (4). The purpose of this paper is to analyze the frequency and intensity of hourly precipitation patterns during January at both New Orleans and Lake Charles by means of synoptic weather types for the period 1951 - 1990. Lake Charles is located in the southwestern corner of Louisiana while New Orleans is situated in the southeastern part of the state.

These sites were selected because the synoptic evaluation requires hourly precipitation and associated weather conditions, data not available from most non-Weather Service locations. The month of January was selected because it best represents the true winter season in south Louisiana (5) and this is also the peak month for cyclogenesis in the western Gulf of Mexico (6).

DATA

Each measurable hourly precipitation event at Lake Charles and New Orleans during January from 1951 - 1990 has been compiled by time of day, amount and associated synoptic weather type. Muller (7) recognizes eight distinct synoptic weather types for Louisiana and it is this classification that is used to categorize the hourly precipitation events in this paper. To determine the synoptic types, surface weather observations (wind direction, wind speed, cloud cover, dew points, etc.) were utilized to support the types suggested by the Daily Weather Map series published by N.O.A.A.

ANALYSIS AND RESULTS

Of Muller's eight synoptic weather types, five were found to have produced measurable hourly precipitation events at these sites during the forty Januaries (Table 1). Frontal Overrunning (FOR), the most common type producing precipitation at this time of year, is characterized by cloudy skies, north to northeast winds and, occasionally, steady, light to moderate precipitation. This type develops when a surface front (cold, warm or stationary) is located south of the region and warm, moist air lifts up and over the frontal boundary. Frontal Gulf Return (FGR) is the second most common precipitation-producing type at both sites and occurs when the region is in the warm air sector just in advance of a cold front or when a warm or stationary front is located just north of a given location. Showers and thunderstorms are common with this type as south or southwest winds bring warm and humid air into contact with the zone of frontal lifting.

Table 1. Frequency and Intensity of Hourly Precipitation Events by Synoptic Weather Type.

New Orleans			Lake Charles		
Synoptic Type	N	Intensity	Synoptic Type	N	Intensity
FOR	1580	.08"	FOR	1510	.07"
FGR	443	.12	FGR	448	.12
GR	50	.08	GR	58	.10
CR	15	.02	CR	18	.05
CH	1	.01			
TOTAL	2089	.09"	TOTAL	2034	.08"

Non-frontal types are less likely to produce precipitation during January because there is not enough heating to produce the instability necessary to produce precipitation without the aid of frontal wedging. Nevertheless, Gulf Return (GR) weather, typified by warm, humid southerly breezes with no frontal boundary nearby, does produce the occasional precipitation event. Coastal Return (CR) weather, which develops when a high pressure area is situated off of the Atlantic Coast and easterly surface winds flow into the region, has produced few precipitation events at either site during January. Continental High (CH), weather produced one hour of measurable precipitation and this occurred at New Orleans. Continental High conditions develop as high pressure, usually originating to the north and west of Louisiana, brings cool to cold conditions into the state. Usually north or northwest winds dominate during this usually dry weather type.

Over the course of the forty Januaries, 2,089 hours of measurable precipitation were recorded at the New Orleans airport while 2,034 such events were observed at Lake Charles. The distribution of these events by synoptic weather types reveals distinctive patterns of similarities and differences between the two sites. For instance, while FOR events were the most common at both locations, there were 70 more FOR events at New Orleans than at Lake Charles. Since this more than accounts for the difference in overall hourly frequencies between the two sites, this then implies that Lake Charles has more events in the other categories (except the one odd CH event at New Orleans) than does New Orleans.

Average hourly intensities of events by synoptic weather types have also been calculated. At both sites, FGR was the most intense (due to the more rapid lifting associated with cold frontal passages) and GR events were the second heaviest per hour (generally unstable air). Frontal Overrunning events are the third most intense at both sites. These occurrences are usually light due to the more gentle slopes associated with stationary and warm fronts in the Gulf of Mexico. The lowest intensities at both sites are associated with CR conditions (excepting the one CH event at New Orleans). In the case of CR weather, the easterly winds do not transport the warmth or moisture necessary to promote intense events at this time of year.

While FOR intensities are the third most intense at both sites, the intensities during this type of weather are greater at New Orleans than they are at Lake Charles. Frontal Gulf Return intensities are the same at both locations. The non-frontal types (except CH) are slightly heavier at Lake Charles. There are fewer non-frontal types and conclusions from this smaller sample would be subject to error. It is safe to conclude that the greater intensity of hourly events at New Orleans is due to the heavier FOR events at New Orleans because all other types that produced precipitation at both sites exhibit equal or greater intensities at Lake Charles.

The greater frequency and intensity of FOR precipitation events at New Orleans can be attributed to the development of cyclones in the western Gulf of Mexico. These storms tend to develop offshore between Corpus Christi and Brownsville (8) and drift either to the east or northeast (9). As the cyclones move, they intensify so that by the time the storms get to the New Orleans area, they would be more likely to produce heavier events than farther west at Lake Charles. Also, because New Orleans is farther east, a greater proportion of the air being drawn into the cyclone would be derived from the Gulf of Mexico. At Lake Charles, more of the air overrunning the surface front would be entrained from northern Mexico and southern Texas and would contain less water vapor.

The significance of FOR in determining the overall intensity patterns at both sites is again revealed in Table 2. In the lightest category (.01" to .04" per hour), the distribution of events at both sites is remarkably similar. In the majority of the heavier categories, Lake Charles tends to have more events in the FGR, GR and CR types while New Orleans has more heavy FOR occurrences.

CONCLUSION

This paper has shown that differences and similarities in the frequencies and intensities of hourly precipitation data between two sites can be better understood by discerning the synoptic weather types producing the precipitation. The most striking similarities (and therefore the most representative for the region during this time of year) are that FOR weather accounts for the greatest percentage of hours with measurable precipitation and that FGR weather accounts for the greatest average hourly intensity at both New Orleans and Lake Charles. Also, in the lighter categories, the distribution of hourly events by weather type are remarkably similar as indicated by the fact that during hours with .01 to .04 inches of precipitation 77% occurred during FOR weather, 3% during GR weather and 1% during CR weather at both sites. One percentage point separated the two sites during FGR weather (20% at Lake Charles, 19% at New Orleans).

The most notable differences between the two sites are that New Orleans has more hours of precipitation, that overall intensities are greater at New Orleans and that this discrepancy in intensity is accounted for by the heavier FOR events at New Orleans. At Lake Charles, the FGR, GR and CR events have greater intensities than at New Orleans.

Table 2. The Frequency of Hourly Precipitation Events by Synoptic Weather Types at Selected Intensity Intervals.

NEW ORLEANS

INTERVAL (")	FOR	FGR	GR	CR	CH
.01 - .04	886	221	31	12	1
.05 - .09	316	80	7	3	0
.10 - .19	208	62	7	0	0
.20 - .39	119	46	4	0	0
.40 - .79	42	26	0	0	0
>.79	9	8	1	0	0
TOTAL	1580	443	50	15	1

LAKE CHARLES

INTERVAL (")	FOR	FGR	GR	CR	CH
.01 - .04	886	227	32	13	0
.05 - .09	299	80	10	1	0
.10 - .19	192	58	6	3	0
.20 - .39	97	53	7	1	0
.40 - .79	29	19	2	0	0
>.79	7	11	1	0	0
TOTAL	1510	448	58	18	0

These findings give further evidence of the utility of synoptic weather types as a means to gain insight into the distribution and variability inherent in climatic data. Further research is ongoing to determine whether the diurnal variability of hourly precipitation events can also be better understood by the variability of synoptic weather types at both New Orleans and Lake Charles.

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