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A Comparison of the Weather In U.S. Cities During the 1983-'84 and 1998-'99 La Niña's

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1. BACKGROUND

The El Niño/Southern Oscillation (ENSO) is a coupled ocean-atmosphere phenomenon that involves the fluctuation of the tropical Pacific Ocean and the overlying atmosphere. It is largely driven by the variation of atmospheric pressure across the Pacific Ocean. The ENSO phenomenon is comprised of three different states, El Niño (the warm episode), La Niña (the cold episode), as well as a normal state falling between these two extremes. One of these states is always occurring in the tropical Pacific Ocean and is known to affect weather patterns around the globe.

La Niña, like the more frequently studied El Niño, is a coupled air-sea interaction that is both dictated and identified by several different meteorological and oceanographic parameters. These parameters, which affect the tropical Pacific, include sea surface temperature, variation of equatorial currents, changes in sea level pressure, strengthening of the Tradewinds, and fluctuations of the thermocline structure. Each parameter can individually serve as an activating mechanism for the La Niña phenomenon, triggered by a particular disturbance in the tropical Pacific, which results in the amplification of a positive feedback loop that produces the extreme change in the tropical Pacific that signifies La Niña (Anderson and Davey, 1998).

El Niño episodes have been linked to variability in climatology and possibly global warming, therefore, "given their worldwide impacts, it is of crucial importance to ascertain the magnitude of El Niño events" (Timlin and Wolter, 1998). Due to La Niña's relationship to El Niño as an element of ENSO, understanding La Niña is certainly important. For the sake of completeness, it is best to understand the entirety of the ENSO phenomenon, both El Niño and La Niña, due to its worldwide effects on weather.

The two most intense El Niño episodes of the twentieth century, the 1982-'83 event and the 1997-'98 event, were each followed by a cold episode, the La Niña events of 1983-'84 and 1998-'99, respectively. Their succession of the two strongest El Niño events makes them worthy of further study to determine their relative magnitude and respective effects, as well as to determine the correlation between the intensities of El Niño's and the subsequent La Niña's.

The purpose of this study is to compare the 1983-'84 and the 1998-'99 La Niña events, which followed two of the most dramatic El Niño's of the past century. The phenomenon is examined by the analysis of the temperature and precipitation patterns across the nation in order to determine the relative magnitude of the two events, and through this correlation, gain a better understanding of La Niña's effect on weather across the United States. In addition, this study attempts to determine a correlation between intensities of El Niño events and their following La Niña events.

2. METHODOLOGY

Temperature and precipitation are used to determine the impact of the La Niña's events on weather at selected cities in the United States. The deviation from normal for these two parameters will provide the data needed to determine the effect that La Niña had on normal conditions. In order to get a cross-section of the country, the data from fourteen stations around the United States were utilized. The selected stations are in the Table 1 (see next page).

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Table 1. 14 stations selected for analysis

West Coast	Central	East Coast
Northern stations:		
1. Seattle-Tacoma, WA	1. Fargo, ND	1. Caribou, ME
2. Eugene, OR	2. Omaha, NE	2. Boston, MA
Southern stations:		
3. Sacramento, CA	3. Dodge City, KS	3. Baltimo re, MD
4. Los Angeles, CA	4. Dallas-Ft. Worth, TX	4. Atlanta, GA
	5. Corpus Christi, TX	5. Orlando, FL

The temperature and precipitation deviations from normal will be calculated on a monthly basis for the winter months of December 1983 through March 1984 during the 1983-'84 La Niña event. This information was collected from the NOAA Local Climatological Data Annual Summaries for those months and then processed through spreadsheet manipulation to provide visual representation of the effect La Niña had on the temperature and precipitation of each city. In addition, these results of the 1983-'84 event will then be compared to the corresponding analysis of the 1998-'99 La Niña (Wood, et al., 2000a). This comparison will help to establish a means of generalizing La Niña's effect on weather across the country. Furthermore, the monthly mean temperature deviation during El Niño versus that for the following La Niña will be determined by finding the difference between the 1982-'83 El Niño mean temperature data (Honnette and Smith, 2002) and the 1983-'84 La Niña mean temperature data, as well as completing the same procedure for the 1997-'98 El Niño and the 1998-'99 La Niña. These monthly tabulations will then be utilized to determine the average amplitude of oscillation in monthly temperature between the El Niño and subsequent La Niña for each of the fourteen different stations. This determination will provide a quantitative portrayal of the deviation that occurs with the transition from El Niño to La Niña as part of the ENSO phenomenon.

3. RESULTS

The impact of La Nina is determined by computing the deviations from normal mean monthly values of temperature and precipitation for the fourteen cities of interest. During Dec. of 1983, 12 of the 14 cities reported cooler than normal temperatures (Table 2a), with the greatest negative deviations occurring in the central states (values ranging from 9.8 to 20.7 °C below normal). In Jan 1984, temperatures were warmer (relative to normal conditions) than the previous month. West Coast cities were slightly warmer than normal, while cities in the center of the country and on the East Coast were mostly colder, with values mostly 2-5°C below normal. The warming trend persisted in February at most stations (11 of 14), with six of the stations registering monthly means exceeding 5°C above normal. Temperatures in Mar. 1984 remained warmer than normal on the West Coast, but were near normal or below normal in the middle of the country, and all below normal (with three of the five stations exceeding 5°C below normal) on the East Coast. In summary, temperatures were cooler than normal during the period Dec 1983-Mar 1984, especially in the center of the country and on the East Coast.

How does this La Niña compare with the 1998-99 event? Examination of mean monthly temperature deviations for Dec.1998-Mar. 1999 (see Table 3a) shows temperatures mostly above normal throughout the period, especially in the center of the country. Surprisingly, the West Coast stations recorded cooler than normal temperatures during this event, while they tended to be warmer than normal during the 1983-84 event. March was the month with the most stations cooler than normal in the 1998-99 La Niña compared to Dec in the 1983-84 event. Consequently, the monthly temperature

Table 2a. Temperature Deviations from Normal (1983-84)

Station	Dec	Jan	Feb	Mar
West Coast:				
Seattle, WA	-4.9	4.1	2.0	4.3
Eugene, OR	**-5.0**	0.5	0.7	2.7
Sacramento, CA	**5.4**	2.9	-0.1	4.8
Los Angeles, CA	0.1	2.2	1.5	3.9
Central:				
Fargo, ND	**-13.0**	**5.4**	**13.9**	**-0.6**
Omaha, NE	**-20.7**	-0.6	**6.0**	-7.0
Dodge City, KS	**-15.3**	-0.9	**5.7**	-3.4
Dallas- Fort Worth, TX	**-13.1**	-4.7	2.4	0.3
Corpus Christi, TX	**-9.8**	-4.9	-0.1	0.5
East Coast:				
Caribou, ME	-1.2	-4.0	**9.5**	**-5.0**
Boston, MA	-1.6	-2.9	**6.9**	**-6.5**
Baltimore, MD	-3.3	-4.2	**7.0**	**-5.1**
Atlanta, GA	-4.6	-2.3	2.6	-0.8
Orlando, FL	-0.8	-2.7	-0.3	-2.1

Table 2b. Precipitation Percent Deviations from Normal (1983-84)

Station	Dec	Jan	Feb	Mar
West Coast:				
Seattle, WA	-20.7	-40.1	-7.4	8.9
Eugene, OR	-12.0	-74.9	87.1	24.5
Sacramento, CA	81.4	-96.0	-57.6	-34.5
Los Angeles, CA	30.3	-87.3	-99.6	-92.1
Central:				
Fargo, ND	52.4	43.6	**114.3**	34.9
Omaha, NE	-18.2	-50.7	-31.9	21.5
Dodge City, KS	19.2	51.1	-64.9	85.7
Dallas- Fort Worth, TX	-50.3	-35.2	61.1	**103.3**
Corpus Christi, TX	-58.6	**262.6**	-74.8	-77.4
East Coast:				
Caribou, ME	59.1	-11.0	43.0	4.5
Boston, MA	10.3	-42.1	**111.1**	65.1
Baltimore, MD	97.7	-34.7	30.9	55.7
Atlanta, GA	**119.5**	-5.1	34.8	-1.4
Orlando, FL	**171.8**	-4.3	-3.5	-42.2

Table 3a. Temperature Deviations from Normal (1998-99)

Station	Dec	Jan	Feb	Mar
West Coast:				
Seattle, WA	-0.6	1.9	-1.0	-1.3
Eugene, OR	-1.5	1.3	-0.9	-3.1
Sacramento, CA	-2.8	-2.4	-4.8	-1.7
Los Angeles, CA	-1.3	0.4	-1.1	-2.3
Central:				
Fargo, ND	**5.7**	0.4	**10.5**	**5.3**
Omaha, NE	**5.8**	1.5	**8.6**	0.9
Dodge City, KS	**12.5**	**12.9**	**20.4**	**14.1**
Dallas- Fort Worth, TX	0.1	**5.2**	**7.6**	-0.3
Corpus Christi, TX	0.6	**6.1**	**7.8**	2.7
East Coast:				
Caribou, ME	**-8.2**	1.6	**5.6**	**5.6**
Boston, MA	**5.5**	0.9	3.3	0.8
Baltimore, MD	4.4	3.3	2.8	-2.3
Atlanta, GA	**5.5**	**7.0**	**5.0**	-3.1
Orlando, FL	**5.2**	4.2	2.8	-1.9

(Numbers in Red indicate positive deviations exceeding 5°C; Blue indicates negative deviations exceeding 5°C.

Table 3b. Precipitation Percent Deviations from Normal (1998-99)

Station	Dec	Jan	Feb	Mar
West Coast:				
Seattle, WA	52.0	27.1	74.2	3.4
Eugene, OR	-0.6	-3.2	77.8	-10.0
Sacramento, CA	-76.9	-31.7	49.3	-47.7
Los Angeles, CA	-55.4	-50.4	-80.1	7.6
Central:				
Fargo, ND	-52.3	71.6	-55.6	72.6
Omaha, NE	-87.3	-20.3	81.8	-35.5
Dodge City, KS	-55.4	**291.8**	-91.9	85.3
Dallas- Fort Worth, TX	**140.8**	-21.3	-78.0	2.5
Corpus Christi, TX	-42.9	-73.7	-83.2	**134.0**
East Coast:				
Caribou, ME	-51.2	48.4	-28.1	-5.4
Boston, MA	-60.4	58.5	-3.0	-31.7
Baltimore, MD	-59.6	54.1	-15.1	2.4
Atlanta, GA	-56.1	12.4	-59.0	-35.9
Orlando, FL	-71.2	30.0	-88.1	-65.1

(Numbers in Red indicate positive deviations exceeding 100%.

deviations of the 1983-84 La Niña offer little similarity to those of the 1998-99 event.

Precipitation tended to be above normal during the 1983-84 event (see Table 2b). especially in Dec. and Mar., and to a lesser extent in Feb. The East Coast stations were mostly wetter than normal, except for Jan, with Dec being the wettest month during this event. West Coast stations were more likely to be drier than normal, with nearly all the western stations reporting below normal precipitation for three of the four months during this event.

The precipitation reports at the 14 U.S. stations for the 1998-99 La Niña event (see Table 3b) bear little resemblance to the 1983-84 event. The simplest description of the 1997-98 La Nina event was that it tended to be drier than normal, although there were some cities that received higher than average monthly precipitation amounts but not as frequently as in the 1983-84 event.. Hence, it is impossible to generalize precipitation patterns in U.S. cities based on these two La Niña events.

4. CONCLUSIONS

The following conclusions are drawn from the analysis.

a) The 1983-'84 La Niña did have an impact on the weather of the United States through its effects of temperature and precipitation. Several different patterns were produced by these two parameters, affecting each region in a slightly different manner.

(i) Temperatures tended to be warmer than normal on the West Coast, but cooler than normal in the center of the country and especially on the East Coast.

(ii) Precipitation amounts tended to be drier than normal on the West Coast, mixed in the center of the country, and wetter than normal on the East Coast.

b) When comparing the two different La Niña episodes, there was considerable variability.

(i) During the 1998-99 event, temperatures tended to be warmer than normal and drier than normal. This ran counter to conditions during the 1983-84 event.

(ii) These two events do not provide a definitive model for temperature and precipitation values for 14 stations across the country. These two events were not particularly strong, as indicated by MEI index values (1983-'84: -0.505; 1998-'99: -1.015). Perhaps more intense La Nina events would provide a better situation for determining anticipated weather conditions in U.S. cities

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