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REGIONAL PRECIPITATION VARIATIONS AND ATMOSPHERIC CONDITIONS OVER THE SAND HILLS REGION OF NEBRASKA.

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1. INTRODUCTION

The Nebraska Sand Hills are a unique part of the Missouri River Basin and a source region for the Ogallala aquifer, which covers the central and south-central United States. The Sand Hills are strongly influenced by the synoptic weather conditions and, in turn, affect local and regional atmospheric conditions. As part of a larger project to investigate the surface hydrology of the Sand Hills, different precipitation regimes were investigated. This paper will present the results of the atmospheric conditions and precipitation regimes found for the Sand Hills region. The study period was chosen as May, June and July (MJJ), since warm season precipitation represents the major input of precipitation to the Sand Hills and surrounding regions.

2. DATA

The United States Regional Climate Division Precipitation Data for Nebraska Region 2, which approximately covers the Sand Hills, were used to identify representative wet, dry and average MJJ periods. The analysis was also completed separately for each month within the period; however, for brevity, only the results for the entire three month period (MJJ) are explained. Given limited surface hydrological cycle data, the study period was limited to 1980-1990. During this period it was determined that 1983 was the wet year, 1989 was the dry year, and 1896 was considered the average year. If the entire Climate Division data record (1895-2000) were considered, these years are still representative of wet, dry, or average conditions, however, the chosen years would not be the most extreme examples. Atmospheric conditions were collected for these three representative precipitation years from the NCEP/NCAR reanalysis data. The Daily United States Unified Precipitation Dataset from the Climate Prediction Center was also used to identify the representative periods.

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3. RESULTS

Atmospheric conditions during the wet, dry and average years show distinct differences in the synoptic weather patterns. During 1983 (the wet year), the 700 hPa level composite MJJ mean is dominated by a trough in the southwestern United States causing southwesterly flow at this level over the Sand Hills (Figure 1). The flow during the dry year (1989) is dominated by a slight ridge to the west of Nebraska, giving rise to a more northwesterly flow over the region. Differences between these two regimes are clearly shown in height anomaly maps with a 10 gpm negative height anomaly during the wet year as compared to a 10 gpm positive height anomaly during the dry year. The pattern for 1986, the average year, is more zonal over the Sand Hills with a weak trough over the western United States. Only small (approximately 5 gpm) positive height anomalies are observed for the Sand Hills region. It is interesting to note that the MJJ period in 1983 is an El Niño year, 1989 is a La Niña condition and 1986 is neutral according to the criteria established by Trenberth (1997).

For each of the three representative years, three individual precipitation events were selected as case studies from daily total radar precipitation estimates, surface conditions and upper air characteristics (Table 1). These cases were chosen to represent 1) a synoptic event, 2) a convective event, and 3) a null event for the Sand Hills. The synoptic event is defined as precipitation caused by the passage of a surface front or trough through the region. The convective cases were defined to represent air mass thunderstorms or complexes with upper air ridging in the region. The null category is best described as a situation for which there was extensive precipitation in the region around the Sand Hills, but there was little or no precipitation over most of the Sand Hills. Though beyond the scope of this paper, the null cases were chosen to examine the atmospheric controls the Sand Hills exerts on precipitation through modeling sensitivity studies. However, the null cases are still of interest due to

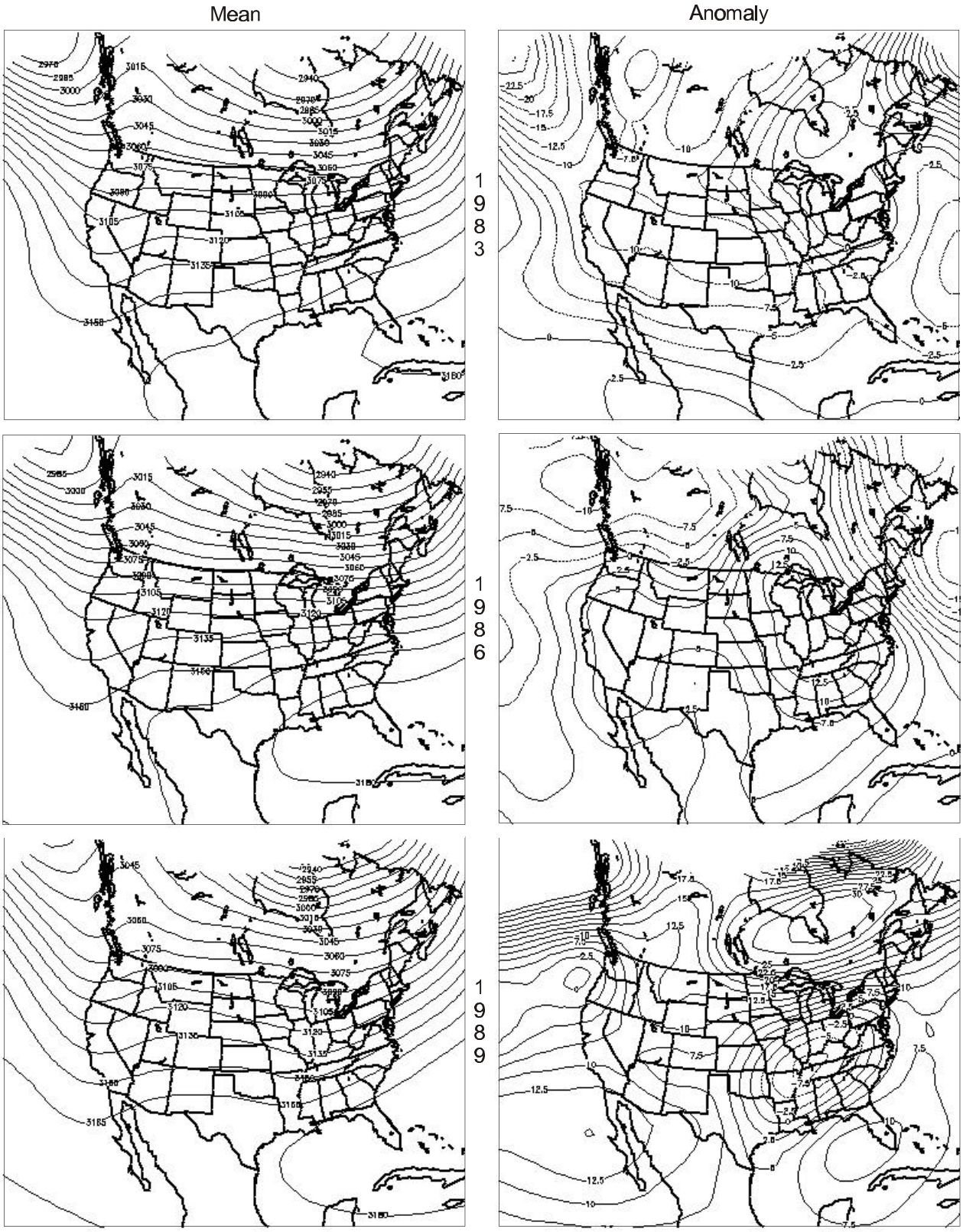

Figure 1 MJJ composite 700 hPa geopotential heights (left) and anomalies (right) for 1983 (top), 1986 (middle), and 1989 (bottom).

synoptic patterns and their relationships to the surrounding region. For the most part, the synoptic events occurred in May or June, while the convective and null cases occurred later in the period, June or July.

4. SUMMARY

Climatic conditions directly affect variations in groundwater levels and consequently the streamflows in the Sand Hills region. To understand these variations, three distinct MJJs were chosen to present different precipitation regimes; wet (1983), dry (1989) and normal (1986), over the Sand Hills for the 1980's, These years are also representative of the longer climate period, with an El Niño (1983), La Niña (1989), and neutral year (1986) chosen. Generally speaking, the more westerly/northwesterly the flow pattern the less precipitation falls over the region. Even though the individual precipitation events are similar, as found during the case study analyses, the number of precipitation events limits the rainfall amounts. Examination of the atmospheric conditions during different precipitation situations helps us understand the mechanisms responsible for generating the precipitation and gives insight into the variability that exists in the Sand Hills.

5. ACKNOWLEDGEMENTS

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6. REFERENCES

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Table 1: Selected Case Studies

Year	Date	Type	Description
	17-18 May	Synoptic	A stacked cut off low moves just south of the Sand Hills, bringing precipitation for most of these two days
1983	22 July	Convective	Precipitation occurs in the northern Sand Hills even though there is a ridge.
	26 June	Null	A weak closed low from 700 hPa to the surface is set up over Colorado. There is southerly flow at the surface, shifting to a southeasterly component in the 850 to 700 hPa level. Precipitation that occurred was hit and miss over the state, but few locations reported precipitation over the Sand Hills.
	9-10 June	Synoptic	Heavy precipitation occurred at the beginning of the period and tapers to lighter rains on the 10th. A stacked surface to 500 hPa low moves directly across the Sand Hills.
1986	31 July	Convective	A weak ridge with northwesterly flow at 500 hPa occurred with precipitation across the middle of the Sand Hills.
	7 June	Null	An cold front passes through the region with shifting upper level winds from a westerly to northwesterly direction producing rainfall around the Sand Hills.
	26 June	Synoptic	Southwesterly flow aloft with a visible 850 hPa trough moving through the Sand Hills.
1989	4 July	Convective	Ridge over the central US with the precipitation occurring across the northern Sand Hills.
	14 July	Null	Northwesterly flow aloft with a 850 hPa to surface trough moving through the Sand Hills, however no precipitation fell across the region.