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COMPARATIVE LOWS FOR NORTHERN BISMARCK AND WSFO BISMARCK

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1. Introduction

It has been a general understanding that overnight lows during the winter months with deep fresh snow cover, light or calm winds, and clear skies are always colder at WSFO Bismarck than they are over the northern section of the city. Some have thought the difference may be as much as 20° with an Arctic air mass. In this case, the coldest air sinks into the Missouri River Valley where WSFO Bismarck is located.

A study was conducted to verify this "general understanding." The ideal conditions for the largest temperature differences are (a) deep fresh snow cover, (b) light or calm winds, and (c) clear skies. Unfortunately, during the time period none of these conditions were ever met. However, several interesting results came about which are discussed below.

2. Data Locations

WSFO Bismarck is located in the Missouri River Valley on the southern border of the Bismarck city limit. The elevation at WSFO Bismarck is approximately 1,656 feet. The northern location that was selected is in a residential area on the north side of the city of Bismarck at an elevation of approximately 1,830 feet. The difference in elevation is 174 feet. The distance between the two points is approximately 3.7 miles (see Figure 1).

The starting date of the study was January 24, 1991, and the ending date was March 31, 1991. On four nights data was not available, leaving 63 nights of data available for the study.

3. Results

The data was broken down to the number of nights WSFO Bismarck was colder, warmer, or 4° colder or more. During this study NO deep snow cover was observed, however there were two nights with two inches of snow cover.

BISMARCK



Figure 1.

Here is a general overview of the data during the study period:

dT (°F) = WSFO Bismarck - northern Bismarck

Number of nights dT < 0 : 36

Number of nights dT >= 0 : 27

Number of nights dT <= -4 : 18

The average dT was -1.5° (see Figure 2).

A. Effects of Snow Cover

The number of nights in the study period where snow cover of 1 inch or more was observed was 14. Here are the results:

Number of nights dT <= -2 : 8

Number of nights dT <= -4 : 5

The two nights where 2 inches of snow cover was observed, WSFO Bismarck was 4° and 6° colder. In both cases the skies were overcast. On the day WSFO Bismarck was 4° colder, the wind was southeast at 5 to 10 mph. On the day WSFO Bismarck was 6° colder the wind was calm.

On the nights with 1 inch or more of snow when dT was +/- 1°, skies were overcast and wind speeds were 5 to 25 mph; in some cases light snow was falling.

B. Effects of Calm or Light Wind

The number of nights in the study period where the wind was calm or less than 5 mph at Bismarck WSFO was 24. Here are the results:

Number of nights dT <= -2 : 19

Number of nights dT <= -4 : 12

Considering the 2° or more colder nights only, 14 nights the skies had scattered clouds, or were clear for the majority of the night. The remaining five nights the skies were broken to overcast and snow cover ranged from one inch or less. On the light wind nights when dT was +/- 1°, skies were overcast and in some cases light snow was falling.

The average dT with wind speeds in excess of 5 mph was +0.0° (see Figure 3). With calm winds or wind speeds less than 5 mph the average dT was -3.5° (see Figure 4).

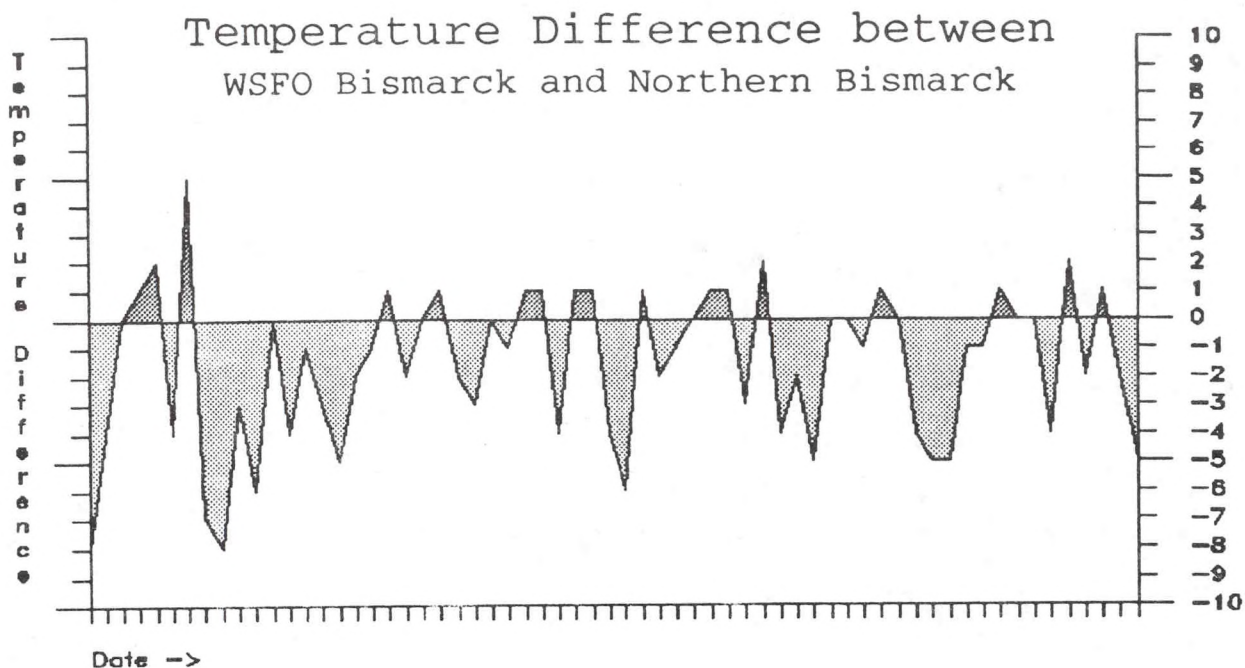


Figure 2 Average Difference: -1.5 degrees

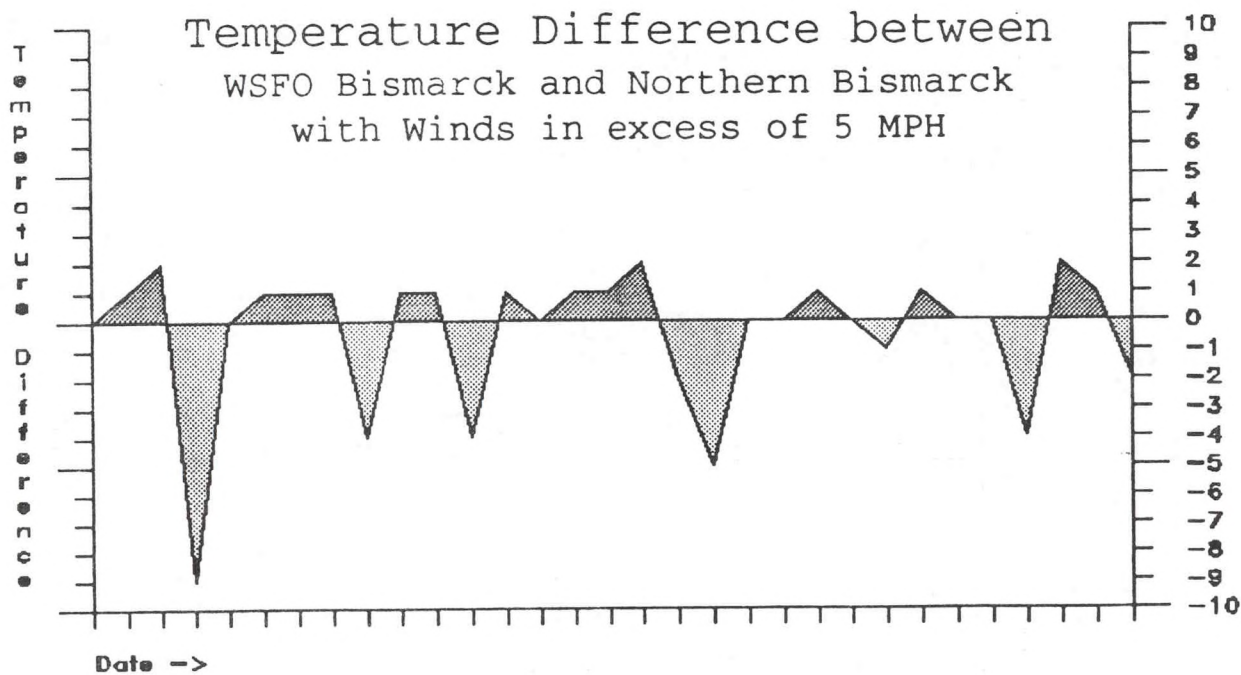


Figure 3 Average Difference: +0.0 degrees

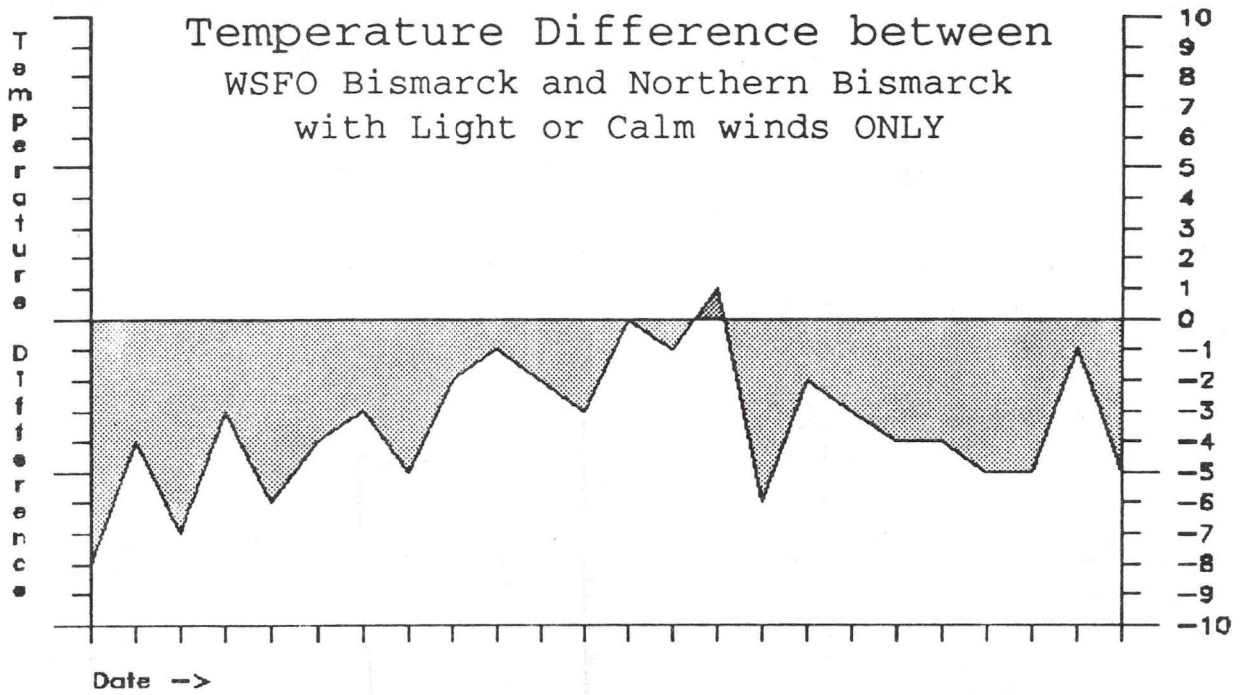


Figure 4 Average Difference: -3.5 degrees

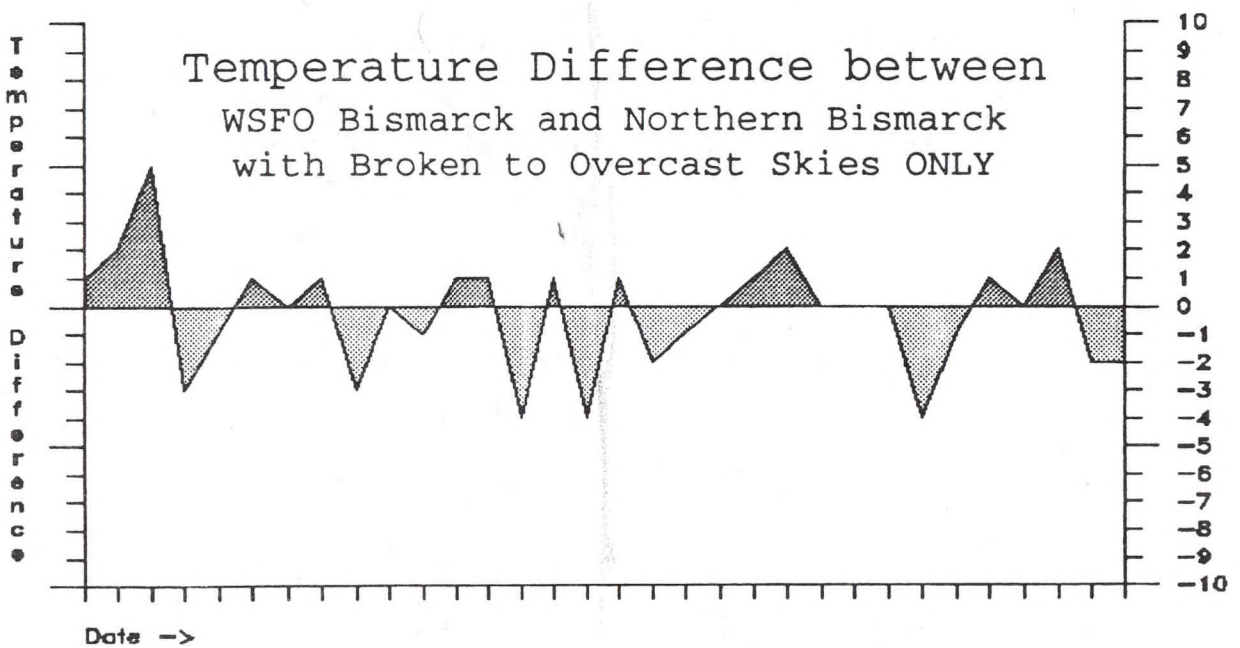


Figure 5 Average Difference: +0.1 degrees

C. Effects of Clear to Thin Scattered Skies

The number of nights in the study period where the skies were thinly scattered, or clear for the majority of the night was 27. Here are the results:

Number of nights $dT \leq -2$: 17
Number of nights $dT \leq -4$: 12

Of the 17 nights in which dT was -2° or lower, 15 of them had light or calm winds. On the remaining two nights, the wind was east to northeast at 5 to 10 mph. In all essentially clear cases where dT was $\pm 1^\circ$, the wind was variable at 5 to 15 mph.

With broken to overcast skies the average dT was $+0.1^\circ$ (see Figure 5). On nights with clear to thin scattered skies the average dT was -3.2° (see Figure 6).

D. Nights Where WSFO Bismarck Was Warmer

The number of nights in the study period where the dT was greater than 0.0° was 27. On 20 out of the 27 nights the skies were broken to overcast, light rain or light snow was falling on nine of these 20 nights. On 24 out of the 27 warmer nights, wind speeds were in excess of 5 to 10 mph.

On the four cases where dT was $+2^\circ$ or greater, the wind was west to north at 10 to 20 mph or greater and skies were overcast. This can be explained by one or both of the following:

- (1) Downslope effect - air warms adiabatically as it moves downhill, even though there is only a 174 foot difference.
- (2) Heat Island effect - air, as it moves over the city, picks up heat radiated from the city, thus warming it by a degree or two.

The case where dT was $+5^\circ$, the wind was west at 10 to 20 mph with a broken ceiling.

4. Conclusions

As stated at the beginning, the ideal conditions of fresh snow cover, clear to thin scattered skies, and calm or light winds were never met. However, two of the three ideal conditions were met, clear skies and calm or light winds, and produced results expected with all three conditions. With these two conditions, the average dT was -4.4° (see Figure 7). It is quite possible that with the additional condition of fresh snow cover, the average dT could be as much as -10° with extremes of dT as much as -20° with an extremely cold air mass. However, more data will be needed to verify this.

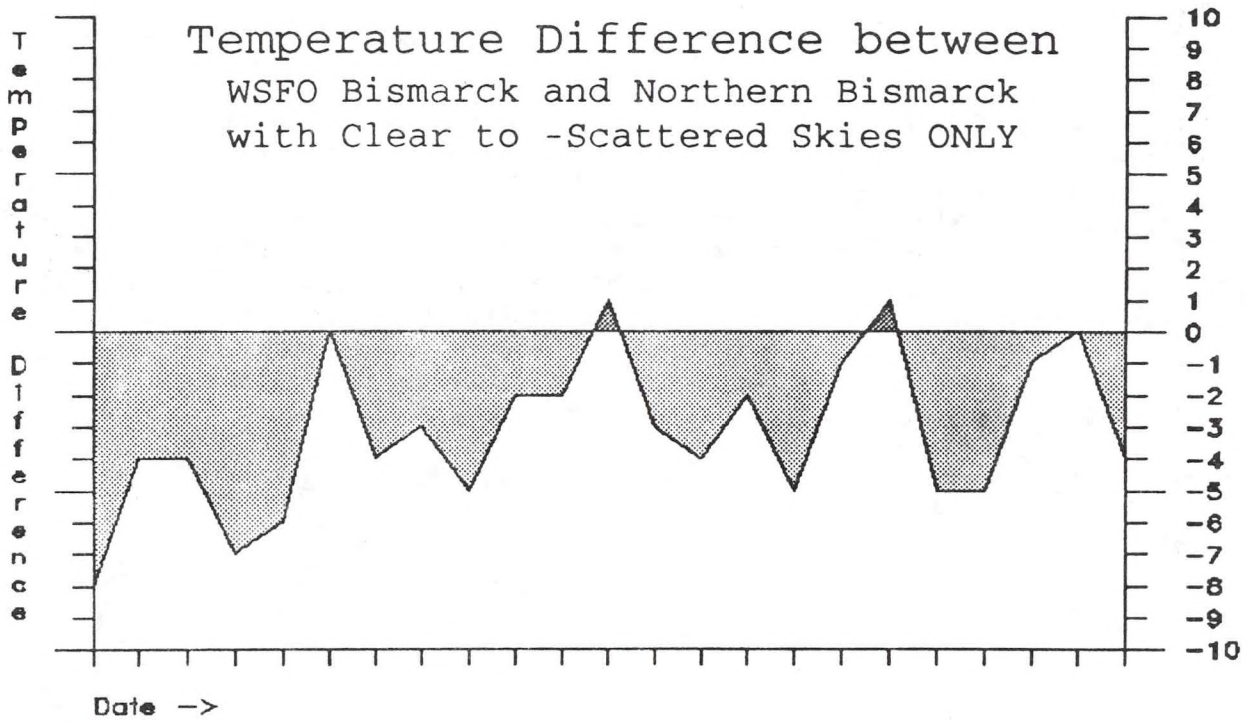


Figure 6 Average Difference: -3.2 degrees

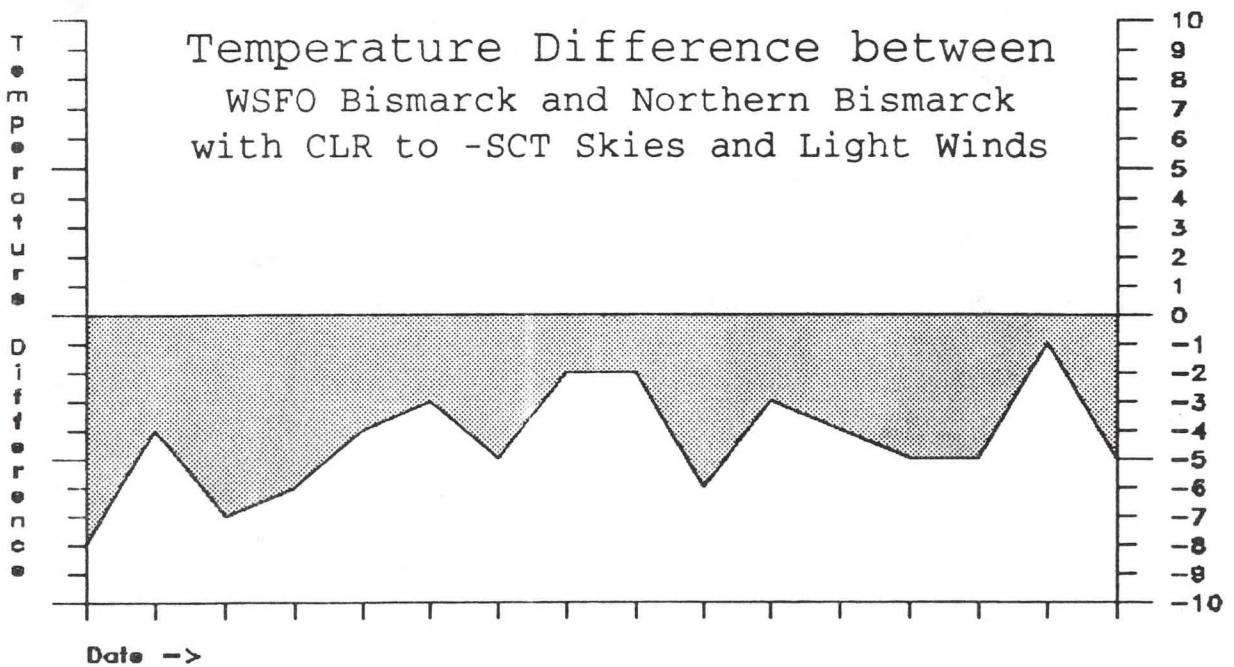


Figure 7 Average Difference: -4.4 degrees

One would think that dT of -2° or less would only happen with cold Arctic air (i.e. temperatures less than $+10^\circ$), however many cases with dT of -5° and -6° involved temperatures in the 20's and lower 30's. In general, it appears that if overcast skies are expected and winds are forecast to be west to north, one can expect temperatures to be fairly uniform across the city. Further, one can expect fairly uniform temperatures if cloudy skies are forecast along with wind speeds of 5 to 20 mph regardless of the wind direction.

Since more data is needed to verify some of these conclusions, this study will resume on November 1, 1991 and end on March 31, 1992.