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POPULATION GROWTH AND ITS EFFECTS ON TEMPERATURES AT RENO-CANNON INTERNATIONAL AIRPORT

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Introduction

The increase in the population during the last 20 years in the United States has been especially great in the so called "sun-belt" states. Nevada has experienced some of the biggest percentage increases among this group of states.

In Nevada, the growth has been especially strong in Clark County (Las Vegas), with a secondary maximum of growth in Washoe County (Reno and Sparks). The overwhelming majority of the population in Washoe County is either in, or within, about 15 miles of Reno and Sparks. According to the figures supplied by The Washoe County Department of Comprehensive Planning, the population of Washoe County for the last three censuses, plus the projected figure for 1995 are as follows:

1970.....121,068
1980.....193,623
1990.....254,667
1995.....294,422

This strong growth has not only affected the general environment, but has also led to increased building and paving in and around the immediate airport area, which is where the observations for Reno are taken.

All the building has had an apparent significant effect on the temperatures observed at WSFO Reno. There may be other causes involved, but it is quite likely that growth is a major contributing factor in the observed shift in temperatures as the heat island effect increases in this area.

The temperature records have been taken at the airport site for the entire period under consideration (1951-1990), however several instrument moves within a radius of a mile or less (on flat land) have taken place during this time. Also temperature records have evolved through several layers of instrumentation changes common to most National Weather Service airport office sites. The possible effect(s) that these changes have had is undetermined for the purpose of this descriptive study.

Calculations

To document the temperature shift, I calculated the average of the daily mean maximum and daily mean minimum temperatures for the months of January, April, July, and

October. These four months were chosen because they are fairly representative of the four seasons. This process was completed for the current 30-year period being used for climatological purposes (1951 to 1980); for the 30-year period that will soon be used for climatology (1961 to 1990); and for the most recent 10-year period (1981 to 1990).

The data are as follows:

		Change '51-'80	Change '61-'90
	January		
Mean Maximum	1951 to 1980.....44.8		
	1961 to 1990.....45.1	+0.3	
	1981 to 1990.....44.7	-0.1	-0.4
Mean Minimum	1951 to 1980.....19.6		
	1961 to 1990.....20.2	+0.6	
	1981 to 1990.....21.5	+1.9	+1.3
	April		
Mean Maximum	1951 to 1980.....63.3		
	1961 to 1990.....63.7	+0.4	
	1981 to 1990.....65.4	+2.1	+1.7
Mean Minimum	1951 to 1980.....29.4		
	1961 to 1990.....31.1	+1.7	
	1981 to 1990.....34.8	+5.4	+3.7
	July		
Mean Maximum	1951 to 1980.....91.3		
	1961 to 1990.....91.3	0.0	
	1981 to 1990.....90.8	-0.5	-0.5
Mean Minimum	1951 to 1980.....47.7		
	1961 to 1990.....48.7	+1.0	
	1981 to 1990.....51.4	+3.7	+2.7
	October		
Mean Maximum	1951 to 1980.....70.0		
	1961 to 1990.....69.8	-0.2	
	1981 to 1990.....68.8	-1.2	-1.0
Mean Minimum	1951 to 1980.....30.5		
	1961 to 1990.....31.8	+1.3	
	1981 to 1990.....34.4	+3.9	+2.6

A graph depicting the changes in mean minimum temperatures from 1951-1980, to 1961-1990, and to 1981-1990 is shown in Figure 1.

Discussion of Data

The data show that the average minimums for the Reno-Cannon International Airport in the 1981 to 1990 period were higher by 4 to 5 degrees in April, July, and October than for the current climatological means for the 1951 to 1980 period. It also shows that as the new 30-year means are computed based on 1961 to 1990, they will account for less than 50 percent of the increase, i.e., mean minimums will still be too "cold" by 3 to 4 degrees when compared to the shorter term '81 to '90 period. This is the case because average minimums were still quite low in the 1960's and 1970's. (A large amount of building in the immediate airport area only really started in the 1970's.)

Interestingly, the 1981 to 1990 period for January shows only about half the increase as the other months. December was checked for the same periods as well, and the increase was found to be about the same as January's...only about two degrees. Daily minimums in winter are probably more influenced by synoptic scale systems, which are more likely to override local effects. The conclusion that average minimum temperatures will be less affected by growth factors during the winter months than in the spring, summer, or autumn also is supported by other investigations into the heat island phenomena (see Landsberg, 1981).

Note also that average maximum temperatures show no obvious trends (except that April is a little warmer and October a little cooler in the 1980's). The end result is that the mean diurnal temperature range has decreased at the airport.

Model Output Statistics

These changes in average minimum temperatures certainly have some ramification on the climatological minimums that are built into the model output statistics (MOS). Consider the following information summarized from Technical Procedures Bulletins #387, #356, #285, and a phone conversation with the Techniques Development Lab:

1. "Climatic" predictors are used at all projections for high and low temperature forecasts, but are given more weight with increasing projection.

2. Statistical equations "assume" that the basic climatic characteristics that define the developmental sample remain unchanged.

3. The NGM MOS developmental sample was between 1986-1988.

4. The NGM MOS uses a two season year...April 1 to Sept 30, and October 1 to March 31.

5. The LFM MOS developmental sample was in the 1970's.

6. The LFM MOS uses a four season year...March-May, June-Aug, etc.

7. No climatic normals are used in either the LFM or NGM MOS product beyond the data found in the developmental sample. (This is the case because Asheville does not have daily high and low temperature normals pre-established for many MOS forecast sites!)

This information suggests that a cold bias for minimum temperatures in Reno would be expected with the LFM MOS, while the NGM MOS may have no specific bias other than the bias associated with a small data sample. (Of course the bias based on a very small data sample can be devastating!) This pattern seems to be what we often observe. (Note: TDL is working on enlarging the NGM MOS sample period.)

Climate Change

It has been recognized in the literature for many years that urbanization is an important factor in evaluating climatic signals. It is recognized that instrumentation changes and that relatively small moves in observational sites also play a role in the validity of the record. It is less frequently recognized
that it may be necessary to evaluated mean maxima and mean minima separately.

In Reno, apparent urbanization effects on minimum temperatures are probably larger than other possible climatic signals an investigator may be searching for. If only average temperatures are considered, the observed "warming" in our airport temperatures could obscure this important trend.

Lastly, one can speculate to what extent such effects may have contaminated the climatic record at locations around the world that are found in small to medium-sized metropolitan centers.

References

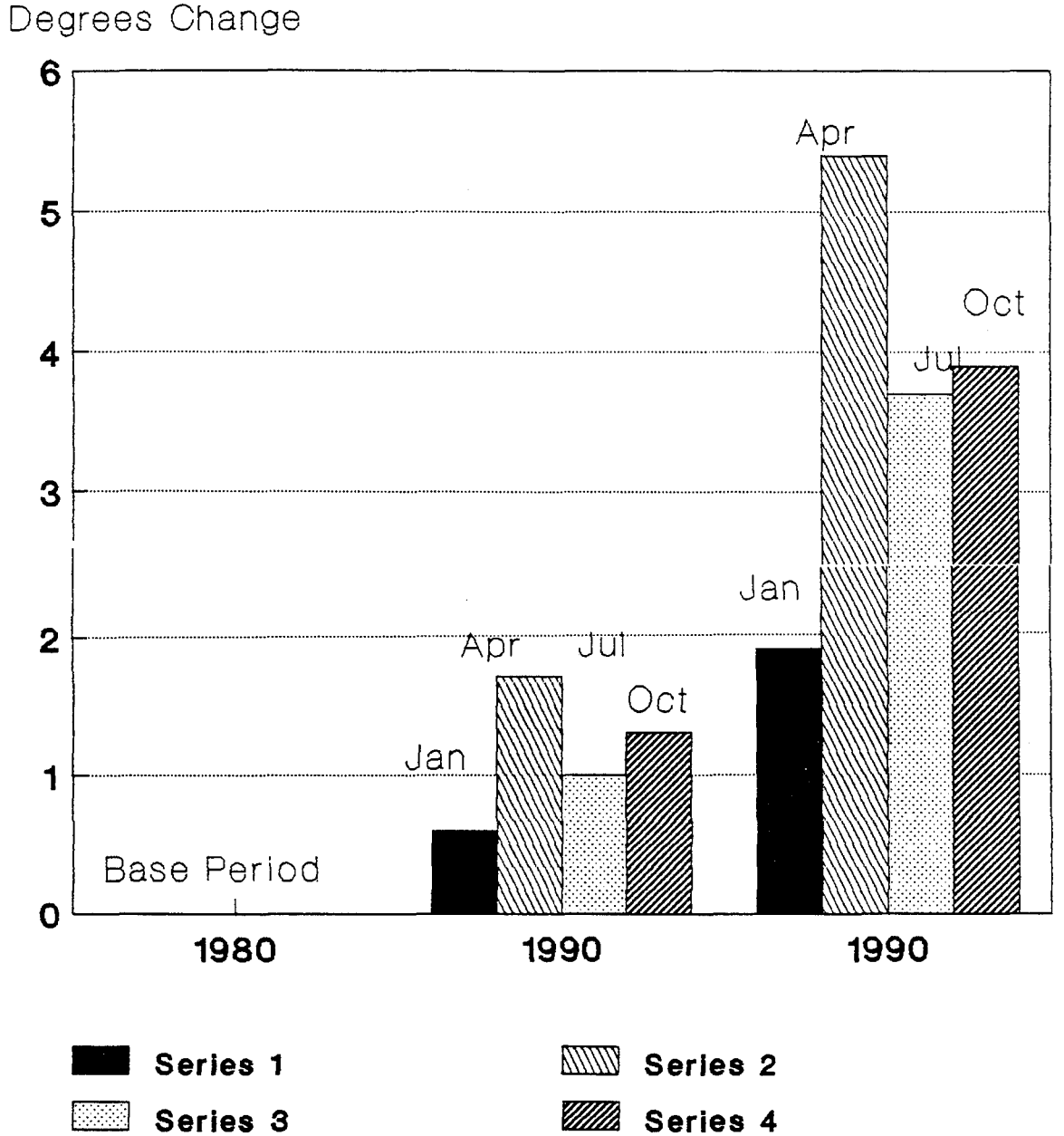
Landsberg, H.E., 1981: *The Urban Climate.* Academic Press, New York, 275 pp.

Nat'l Wea. Ser. Technical Procedures Bulletin No. 285 - "Automated Maximum/Minimum Temperature, 3-Hourly Surface Temperature, and 3-Hourly Surface Dew Point Guidance". May 4, 1980.

Nat'l Wea. Ser. Technical Procedures Bulletin No. 356 - "Automated Daytime Maximum, Nighttime Minimum, 3-Hourly Surface Temperature, and 3-Hourly Surface Dew Point Guidance". October 10, 1985.

Nat'l Wea. Ser. Technical Procedures Bulletin No. 387 - "NGM-Based MOS Guidance for Maximum/Minimum Temperature, Probability of Precipitation, Cloud Amount, and Surface Wind". June 21, 1990.

Change Mean Min Tmps
1951-80..1961-90..1981-90



1=Jan, 2=Apr, 3=Jul, 4=Oct

Figure 1