STRATIFIED MAXIMUM TEMPERATURE RELATIONSHIPS BETWEEN SIXTEEN ZONE STATIONS IN ARIZONA AND RESPECTIVE KEY STATIONS

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ABSTRACT

The validity and applications of this hypothesis are examined: normal monthly deviation relationships of Arizona maximum temperatures, between a given zone station and its MOS key station, are largely unrepresentative during anomalous weather regimes. A much stronger relationship is found: Temperature--and seasonally-dependent mean difference between zone station and respective key station maximum temperatures. A forecast technique using AFOS is outlined. Application to snowfall prediction is discussed.

1. BACKGROUND INFORMATION

This study involved an extensive tabulation of temperature relationships between each of sixteen zone stations in Arizona and respective key stations. Key stations were defined as the five cities in Arizona for which Model Output Statistics(MOS) temperature forecasts are generated, plus the city of Prescott. Each of these cities was considered to be meteorologically representative of the climatic zone in which it is located (2) (Figure 1). For example, Prescott would be the key station for the central basin and northwest zone of Arizona (average elevations of the zone stations 3000 to 6000 feet). Similarly, Flagstaff would be the key station for the central mountain zone (elevations above 6000 feet).

This research used a temperature-and season-dependent stratification to expand upon the basic principle of using normal monthly maximum and minimum temperature deviations between various zone stations and the appropriate key stations. Normal monthly maximum and minimum temperatures at all twenty-two of the stations for which temperature forecasts are prepared in Arizona are readily available at the National Weather Service Forecast Office in Phoenix, Arizona (WSFO PHX) (3). Thus, the average monthly differences between each of the sixteen zone stations and the respective key station have been computed for both maximums and minimums. The differences, or deviations, are used as guidance in the preparation of the Arizona community and recreational area forecasts of maximum and minimum temperatures for the zone stations.

However, the use of normals which have been derived for an entire month at a given station was theorized to have inherent weaknesses. Normals are tabulated over a long period of record. In Arizona, extreme temperatures at a given station during a given month can be common. For example, during the cool season, the southern latitude of Arizona can typically allow strongly and rapidly rebounding temperatures following an unusually cold outbreak. Similarly, very cold outbreaks can typically end a period of unusually warm readings. During the summer thunderstorm season of July and August (informally referred to as the Arizona monsoon), clouds and thunderstorms can cause wide day-to-day variation in temperatures. In general, varying degrees of winds, clouds, humidity, precipitation, and snow cover can induce considerable day-to-day variation in either the maximum or minimum temperature at a given station within the state, or even within a given area of the state.

The observed maximum or minimum temperature is directly a function of the overall character of the concurrent synoptic regime. For example, a high temperature of only 55°F at Tucson in the middle of September can generate rather strong inferences about the existing synoptic weather regime. During a "normal" synoptic regime for the same time of year, the average maximum temperature at Douglas is five degrees cooler than Tucson. When Tucson has an anomalously low maximum temperature of 55°F in the middle of September, Douglas might average two degrees warmer, as opposed to the "normal" five degrees cooler than Tucson.

It is not so important to know the exact cause of the unusually low maximum at the key station in this example. The important point is that the majority of cases with similar low maximums which have occurred in September at Tucson in the past were likely caused by similar or related synoptic regimes. And in the majority of those similar regimes, Douglas will typically average two degrees warmer than Tucson.

Therefore, this study set out to investigate the above idea by deriving a set of relationships between observed key and zone station temperatures that are temperature and seasonally dependent. It was hoped that the outcome of this stratification would ultimately provide a more representative means for relating the forecasted temperatures at key stations to those of the zone stations during anomalous weather regimes.

2. DATA TABULATION

The period selected as the data base was from July 1971 through August 1981. Six key stations were selected (Table 1). These stations included the five normally transmitted as the coded cities forecasts by the Automation of Field Operations and Services (AFOS) system (under the heading PHXCCFPHX). The key stations chosen were Phoenix (PHX), Tucson(TUS), Flagstaff (FLG), Winslow (INW), Yuma (YUM), and Prescott (PRC). Also shown in Table 1 are the sixteen zone stations for which routine temperature and precipitation probability forecasts are prepared by Phoenix WSFO (under the AFOS heading PHXRECPHX).

Five synoptically similar periods were selected for the purpose of data stratification. The periods were November through February, March through April, May through June, July through August, and September through October.

Table 2 is a sample of the tabulation form used to record the maximum temperature data during the period of study. The key station Winslow is used as an example for the period March through April. The observed maximum temperatures at Winslow for each day of every March and April during the period of study were stratified according to the appropriate five-degree temperature range. As each daily maximum was identified with the proper temperature range, the corresponding maximum temperatures at each of the two Winslow zone stations for that same day were recorded within the appropriate data entry square.

The sixteen zone stations used were all stations with a long and established observational history. The quality of the maximum/minimum observations was regarded in general as high. However, it should be noted that during the course of this data tabulation, it became possible that "reset" maximum temperatures might partially contaminate the data sample. These resets occasionally occur at the stations which read and reset the maximum thermometers only once daily at 4 p.m. MST. Should the next day be cooler, the official high temperature for that day could be reported as the 4 p.m. temperature from the previous day. In some of these cases, subjective adjustments to these resets could be made by noting a consistent amount of 24-hour maximum temperature drop at several surrounding stations that do reset their thermometers twice a day. The amount of data identified as reset temperatures ended up being much less than one percent of the total data sample within each key station data base. Despite the apparent negligible effects "resets" would have on the data tabulation, in all but the most obvious cases, adjustments were not made, and the temperature was excluded.

Returning to the Winslow example, temperature data at each zone stations for each March and April during the entire period were recorded. Tabulations were then made of the mean of these temperatures, the standard deviation, and the number of entries for each zone station within each five-degree Winslow temperature range. Finally, the difference or deviation of each mean temperature from the midpoint of each temperature range for Winslow was determined for each individual zone station.

The above process, using the appropriate maximum temperature data, was repeated for the other key stations of Tucson, Flagstaff, and Prescott. The key station Yuma did not have any related zone stations. The key station Phoenix only had one affiliated zone station, at Coolidge. Since maximum temperatures at Coolidge are consistently very similar to those of Phoenix, the stratification process seemed to provide little additional advantage over that of simply using the normal monthly deviation. Therefore, it was decided to continue to use the normal monthly deviation of the Coolidge maximum from Phoenix.

A similar stratification process was also attempted for minimum temperature data during the period of study for all key stations. However, this procedure was discarded near the midpoint of the data tabulation. The less conservative nature of minimum temperatures rapidly became apparent due to the wide variation of minimum temperatures being recorded for each zone station within each appropriate key station temperature range. Therefore, the use of average monthly deviation of minimum temperatures at each zone station from the corresponding key station was preferred over the results of a separate stratification process.

3. DATA ANALYSIS AND RESULTS

This discussion will be confined to the results of the process of maximum temperatures stratification only. Tables 3 through 6 display the tabulated results of the data collection for the key stations Tucson, Prescott, Flagstaff, and Winslow.