# Short-Term Temperature Trends

Richard P. McNulty
*Lenexa, Kansas 66219*
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## *Introduction*

Many years ago a method for examining short-term trends in high temperatures was described to me by a fellow meteorologist. Since that time temperature data have been plotted for several locations and have been used make short-term (3 to 5 week) forecasts of temperature trends relative to normal. The purpose of this paper is to outline the process and describe the interpretation method that has evolved over the last 40 years.

The results presented here are based on empirical observation of the KMCI temperature trends. This process is not “true science” in that it does not use any mathematical techniques to quantify the interpretation. Nevertheless, it provides an interesting view of atmospheric changes over time.

## *Data*

Daily high temperature values and the corresponding normal high temperatures are used to construct a graph of the 5-day running mean of maximum temperature values. Using a 5-day running mean essentially eliminates fluctuations of less than 5 days and allows you to look at trends of one-week or longer without the noise associated with the shorter-term changes. The normal curve allows easier interpretation relative to normal.

Data for Kansas City International Airport (KMCI) were used to illustrate the ideas presented here. Figure 1 shows a time series plot of the daily high temperatures (in red) for KMCI for 2011. The normal high temperature is also plotted (in blue) for comparison. Figure 2 shows the 5-day running mean calculated from data in Figure 1. Data from the last two days of 2010 and the first two days of 2012 were used at the beginning and end of the time series, respectively. In both figures, the x-axis is Julian day starting at 01 January 2011 and ending on 31 December 2011.

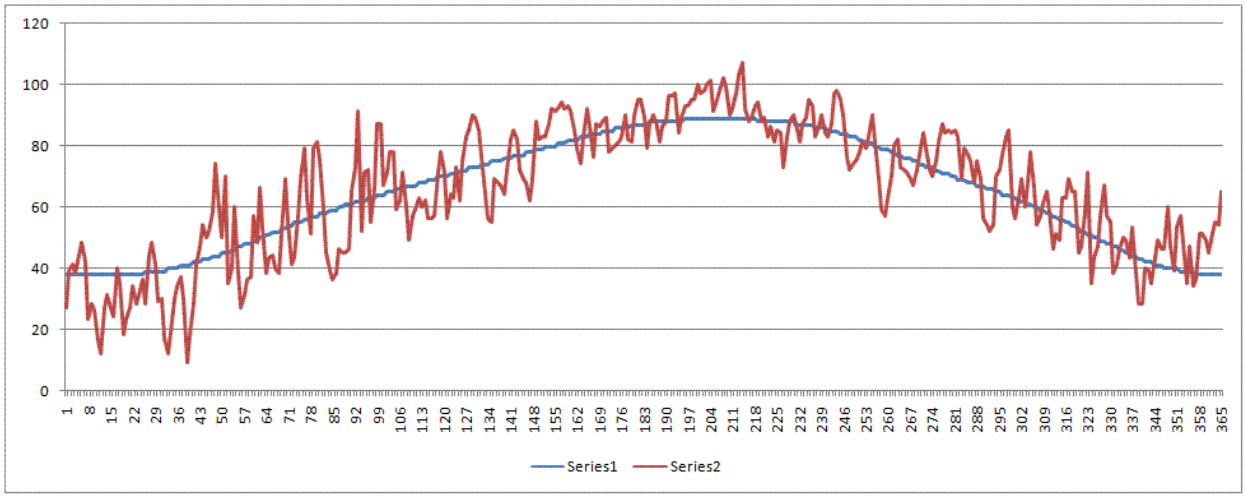


**Figure 1**: Daily Maximum Temperature at KMCI during 2011

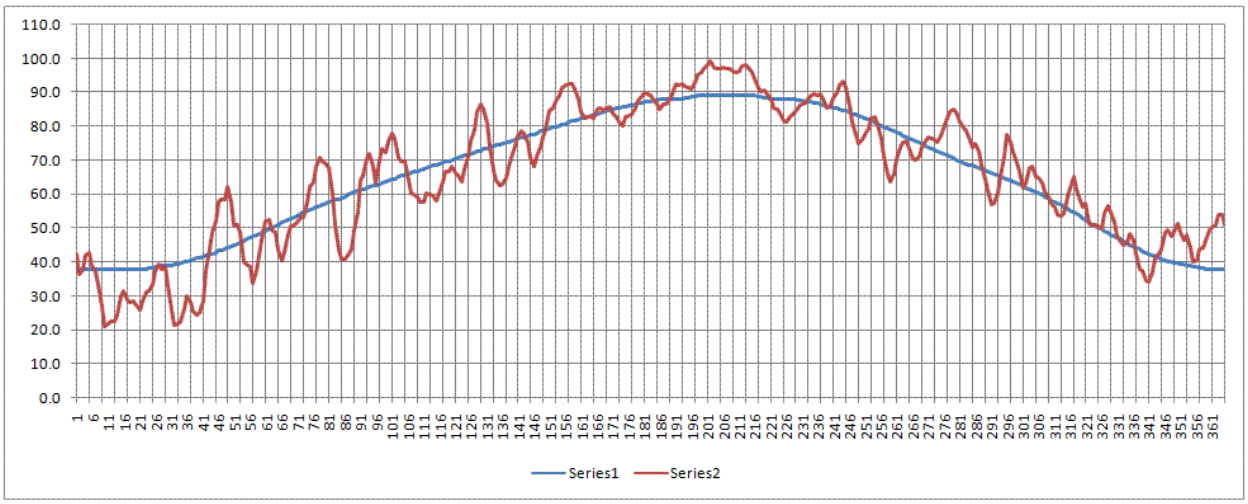


**Figure 2**: 5-Day Running Mean of Daily Maximum Temperature at KMCI during 2011

***General Interpretation***

The changes in the 5-day running mean of the maximum temperature can be examined from four perspectives:

- Short-term periodicity
- Amplitude
- Long-term periodicity
- Phase changes

*Short-Term Periodicity*: The most obvious feature apparent in the 5-day running mean time series (Figure 2) is the short-term oscillations. These oscillations are more prominent during the Fall, Winter and Spring than during the Summer. The period, or time between peaks, is approximately two weeks, but varies several days either side of this value.

This period can be used for short-term forecasts if there is a consistent periodicity over the last month or so. This statement seems somewhat vague, but after using the time series for a while, the identification of these periodicities becomes easier.

*Amplitude*: The amplitude of these short-term changes is not always consistent. The difference between peak and trough is around 20 degrees, but typically varies from cycle to cycle.

During the Spring (in Figure 2) the amplitude from one period to the next is fairly consistent, while during the Fall, this consistency is missing. So, even if the periodicity is consistent and can be used to indicate when relative warmer and cooler periods might occur, the degree of change from cold to warm or from warm to cold, is not always reliable.

Precipitation tends to reduce the cycle-to-cycle changes. The period in late June and early July was fairly rainy. The reduced amplitude is seen from day 166 through day 196 in Figure 2.

*Long-Term Periodicity*: A longer-term periodicity can be inferred by comparing the general trend in the 5-day running mean curve to the normal curve. In Figure 2, from January into mid-Spring the 5-day mean curve is generally below normal. From late Spring through Summer into early Fall, the curve oscillates around the normal curve. By mid-Fall the curve is above normal.

The normal oscillation lasted about 5 months in Figure 2. This trend would imply that the general temperature trend for the Winter of 2011-2012 is warmer than normal.

*Phase Changes*: Even though the peak tend to occur at a somewhat regular interval and can be used to anticipate short-term changes, this regularity can shift, that is, change phase. In Figure 2 the closest thing to this phase change occurs around Day 100 where two peaks are fairly close together. Predicting when these phase changes are likely to occur is poor.

***Concluding Remarks***

As stated in the opening section, this trend analysis is not based in “true science” but is purely empirical. After viewing these oscillations for over 40 years, the general interpretation methods presented here were arrived at. At time these methods are useful in anticipating short-term temperature trends, while at other time, the inconsistency in the data make predictions risky. Nevertheless, it is interesting to watch these trends on a weekly basis.

More than likely the observed temperature oscillations are associated with the movement of the upper level wave patterns, but no attempt has been made to mathematically correlate a relationship.