Dewpoint Temperature Climatology for the Wichita, Kansas Forecast Area

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1.0 Introduction

The advent of the National Digital Forecast Database (NDFD) introduced explicit forecasts of dewpoint temperature by the National Weather Service (NWS). The level of temporal and spatial detail in the NDFD dewpoint forecasts requires forecasters to understand and anticipate important planetary boundary layer processes. The NWS forecasts dewpoint temperatures out to 7 days. It is important to maintain an awareness of dewpoint temperatures as it affects primarily fire weather planning, fog, aviation, and convective weather forecasting.

To improve forecast skill of these elements, it is imperative to develop an understanding of dewpoint temperature climatology and how synoptic and local effects play a role in dewpoint temperature behavior. This document will assess the climatological averages and trends of observed dewpoint temperatures at Russell, Salina, Wichita, Medicine Lodge, and Chanute, Kansas.

2.0 Methodology

Data were gathered using a 30-year archive of hourly observations from the National Climatological Data Center (NCDC). This dated from 01 June 1976 to 01 June 2006. The data were stratified by hour over the period of record for each of the five sites investigated. The average hourly dewpoint temperature was then calculated for each month. A group average was calculated by averaging the data from each of the five sites. A "perturbation" or anomaly (Td') was then created by subtracting the site dewpoint temperature (Td) from the group average ($Td_{avg.}$). Equation 1 illustrates this:

$$\text{Eq. 1: } Td' = Td_{avg} - Td$$

This perturbation was used to indicate where the dewpoint temperature varied from the group average, more clearly depicting local or site-specific microclimatic differences.

Finally, the data were examined to extract cases of wet and dry years. Once isolated, these cases were examined against the average dewpoint temperature. Contrasts were made between the wet and dry cases as well. The results were then graphed with significant differences noted in the behavior of the hourly dewpoint temperature during these extremes.

3.0 Results and Discussion

The hourly dewpoint graphs for the sites in this study were plotted on a monthly basis and can be found on the Internet at http://www.crh.noaa.gov/ict/?n=dewclimo.

Examination of the data shows that when synoptic influences, such as fronts, are present these will dominate the behavior of the dewpoint temperature regardless of the time of year. This has a higher frequency of occurrence and is more pronounced in the winter months given the known increase in the synoptic-scale influence on the region of study's weather.

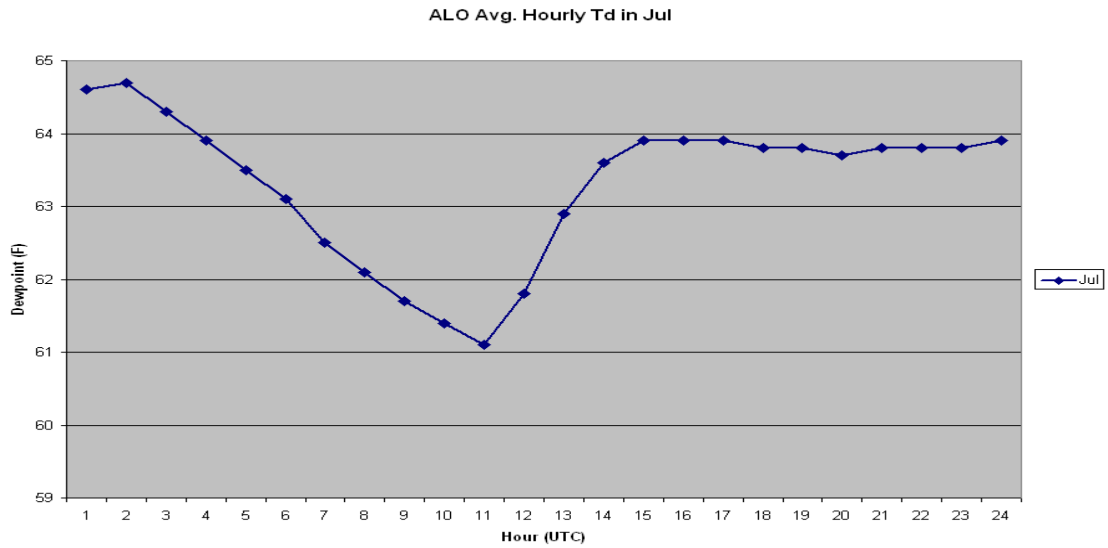
During the summer months, the local effects tended to show more of an influence. This is likely due to the exchange of soil moisture into the atmosphere via evapotranspiration. Contributions to evapotranspiration such as variations in rainfall, soil moisture, vegetation type, and level of vegetative greenness have a direct impact on its amount, and therefore affect the overall daily dewpoint temperature fluctuations (R. Cox 2007, personal communication). These contributions became evident in this study when the subtle effects of sunrise, afternoon mixing, sunset, and overnight condensation were frequently noted.

There was a larger diurnal variation in the dewpoint temperature during the winter, generally on the order of 4 °F. In the summer the diurnal variation averaged between 1 and 2 °F. It is unknown why this variation occurs and it was not investigated further in this study. In the spring, there was a transition from one diurnal maximum to two, and in the fall a transition from two maxima to one was observed. This is likely related to the amount of evapotranspiration at different times of the year. In the area studied, an afternoon drop in dewpoint temperature was observed by July, likely due to the wheat harvest which occurs in June. (McPherson et al. 2005).

In addition to evapotranspiration, the type of crop also plays a role, perhaps a significant one, in the behavior of hourly dewpoint temperatures observed during the growing season of these crops. This behavior difference is directly attributable to the plants' stomata.

Stomata are any of the minute openings in the epidermis of a plant organ (as a leaf) through which gaseous interchange takes place (Mish 2003). The stomata on a corn plant close during the overnight hours. This precludes any transpiration from occurring from these crops, thereby facilitating a several degree fall in the dewpoint temperature by morning, except when other processes are dominant. By contrast, the stomata on a wheat plant do not close, and therefore continue to transpire moisture into the atmosphere overnight. This, in turn, allows the dewpoint temperature to fall only a few degrees during the said time period (Haugland 2006). The degree that this occurs is contingent on the amount of soil moisture available for transpiration.

To examine this further, a comparison was drawn between a site located in the Iowa corn belt (Waterloo, ALO) and a site in the Kansas wheat belt (Salina, SLN) (Fig. 1). Data for Waterloo are from the same 30-year archive of hourly observations from NCDC as the Kansas sites used in this study (Schreck and Baumgardt 2001). Significant differences in hourly dewpoint temperature behavior were found as a result. These findings are consistent with the dewpoint climatology completed for these sites in the National Diurnal Climatology (Haugland 2004).



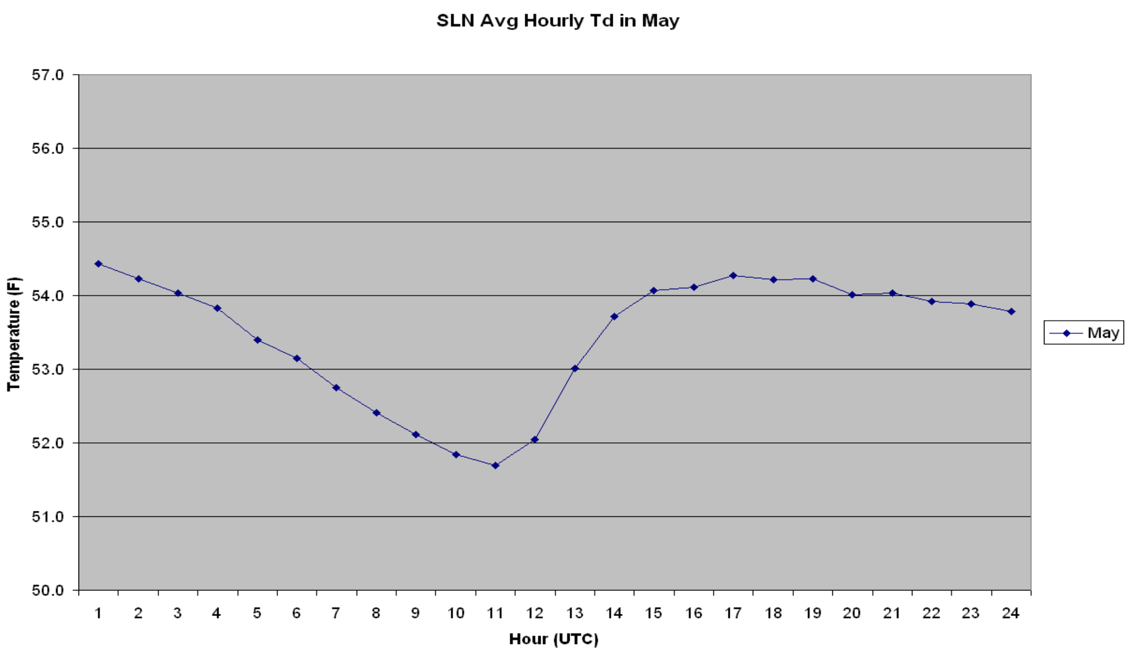


Fig. 1: Dewpoint curves at Waterloo, Iowa and Salina, Kansas at the peak of the corn and wheat crop, respectively. The stomata on the corn plant close during the overnight hours, whereas the stomata on a wheat plant do not close during this time. This can result in a significant difference in dewpoint behavior over a 24-hour period between the two crops.

To further illustrate this, an examination of the data during the month of May in Salina, Kansas yielded much more stability in the hourly dewpoint temperature over the diurnal cycle than any other month. This is likely due to peak transpiration rates from the winter wheat crop, as it is in its most mature phase at this time (McPherson et al. 2005).

Some additional trends that were also extracted from the data include the observation that after an afternoon drop, the dewpoint temperature started to increase approximately 1 to 2 hours before sunset. This occurred in all months except for December and January and is likely the result of a decrease in mixing, thereby allowing moisture to be “trapped” below a forming inversion.

Additionally, during the warm season, the lowest dewpoint temperature occurred in the evening due to the length of daytime and a longer period of mixing. This is in contrast to the cool season, where the lowest dewpoint temperature tends to occur in the early morning due to a longer night period.

It is important that PBL-based research continues, including that which is devoted to understanding processes that influence surface dewpoints. Forecasting dewpoint temperatures is very important as they directly affect fog, fire weather, aviation, and convective weather forecasts. By gaining an understanding of the land use and typical boundary layer behavior for a given location, one can determine a typical dewpoint curve for that location throughout the year, improving forecasters’ skills and ultimately forecast and warning services.

4.0 References

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