INTERPRETATION ARTICLE

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For many people, wet-bulb temperature is an obscure weather variable or something they've never heard of. However, it can be useful in certain situations. It is related to the air's temperature and moisture content, and for that reason it is often used in situations that involve evaporation. And situations that involve evaporation involve energy, lots of it!

Many architects and builders look at long-term averages of wet-bulb temperature to estimate air conditioning costs, because wet-bulb temperature is a better indicator than the actual air temperature. Meteorologists also use wet-bulb temperature to diagnose heat and moisture during the threat of severe weather, because heat and moisture in the atmosphere are the sources of energy needed to create and maintain thunderstorms. It is also very useful in specific winter weather situations, because of its close relationship to evaporation.

First of all, evaporation isn't free: it requires energy from the environment around it. You have experienced this yourself if you've felt the chill of jumping out of a swimming pool in the wind, even when it's hot outside! In fact, your body depends on the energy associated with evaporation to cool itself. When your perspiration or water from the pool evaporates, you are providing the required energy with heating from your skin; this loss of heat lowers your temperature.

Let's see how evaporation is important during winter. Think about a typical, dreary, gray winter day. It's 40 degrees outside with a solid bank of clouds hanging a few hundred feet overhead. No precipitation is falling from the clouds...yet. If it's not foggy beneath the clouds, then the humidity is less than 100%. In other words, the air at the surface isn't saturated. Now, if precipitation begins to fall from those clouds into that unsaturated (dry) air, some of it will evaporate. This evaporation will take energy from the environment around it, which lowers the temperature. Eventually, the air will become saturated when the air temperature drops to meet the rising dewpoint temperature. But how will we know if the temperature will cool to 35 degrees, which will give us a cold rain, or 30 degrees, which will give us a frozen mess? Well, that's where wet-bulb temperature can be useful.

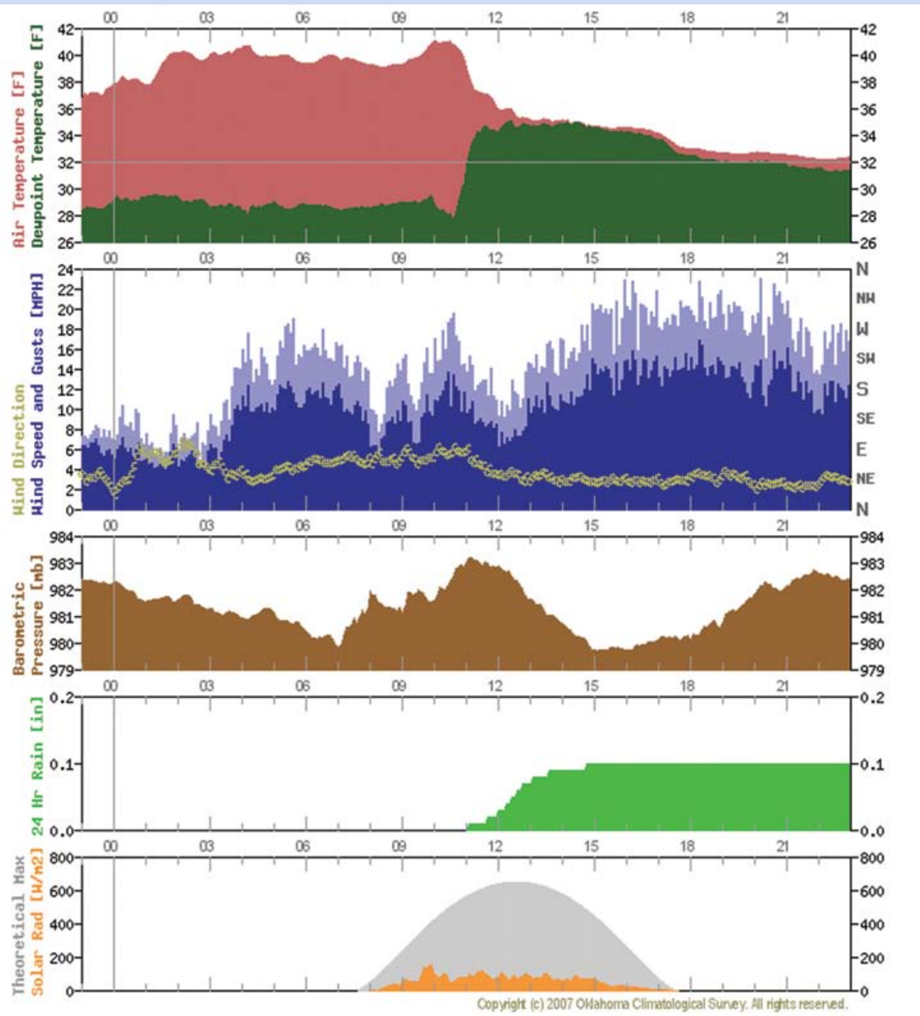
In this type of scenario, where precipitation continuously falls into a thin layer of unsaturated air, the wet-bulb temperature before the precipitation can give a rough estimate of the final temperature during precipitation. Many meteorologists will use the wet-bulb as a first-guess forecast of the ultimate temperature when precipitation begins on a dreary winter day. This process, where temperature falls as moisture rises during precipitation, is often called "wet bulbing" by meteorologists.

On January 16, 2001 a wet bulbing event occurred at the Washington Mesonet station (See Graph 1 – Note: wet-bulb temperatures are not shown on the graph.). At 10 am, the air temperature was 41°F and the wet-bulb temperature was 36°F before any precipitation began to fall. Notice how the temperature graph drops as the dewpoint temperature graph increases. The movement of these two graphs toward each other before any precipitation reaches the ground is an indication that wet bulbing is occurring. The rain did not begin to accumulate in the Washington rain gauge until 11:05 am. The 11:05 am air temperature was 38°F and the wet bulb temperature was 36°F. The total amount of precipitation collected at 11:05 am was 0.25 inches.

As long as the air mass at the surface stays in place, and isn't replaced by a front or strong winds, it can be fairly accurate. The precipitation doesn't even need to be that heavy, sometimes the most dramatic effect occurs when precipitation is very light.

You can get the current wet-bulb temperature on the Oklahoma Mesonet data pages (http://www.mesonet.org/public/). Try using it at home!

Graph 1 - Washington 24-Hour Meteogram (11:00pm CST Jan 16, 2001)



CLASSROOM ACTIVITY

1. In figure 1, the red numbers show the actual air temperature. Generally speaking, what are the temperatures in central and southern Oklahoma?

2. Although it is not shown on the map, there is light precipitation falling in northeast Oklahoma. In far northeast Oklahoma, air temperatures are 30 and 31. Why are these values critical during precipitation?

3. In figure 1, the dark blue numbers show wet-bulb temperature. Generally speaking, what are the wet-bulb temperature values in central and southern Oklahoma?

4. Shortly after the midnight map time, light precipitation began to fall at the Norman site, but most of it evaporated as it fell. How did the air temperature respond: did it cool, warm, or stay the same? Why?

5. Wet-bulb temperature can be used as a rough estimate of the resulting temperature when evaporating precipitation modifies the temperature. If precipitation develops as the Norman site, what is your estimate of the resulting temperature?

6. Look that the top panel of the Norman meteogram (figure 2). Shortly after midnight, light precipitation began and the temperature (pink trace) and dew point (green trace) “wet bulbed” to meet each other. At about what temperature did they meet? How does this value compare to the Norman wet-bulb temperature at midnight (figure 1)?

7. According to the meteogram, the wet-bulbing effect began at Norman about 12:30 am, but there was no precipitation observed until 3:00 am. If precipitation caused the wet-bulb effect (which it did), why did the rain gauge take an extra 2.5 hours to record precipitation?

Figure 1 - Oklahoma Mesonet observations at 12 midnight, February 5, 2002. Air Temperature is in bold red text. Wet-bulb temperature is in dark blue. At the time, light rain (not shown) was falling in northeast Oklahoma and was forecast to spread to the southwest.

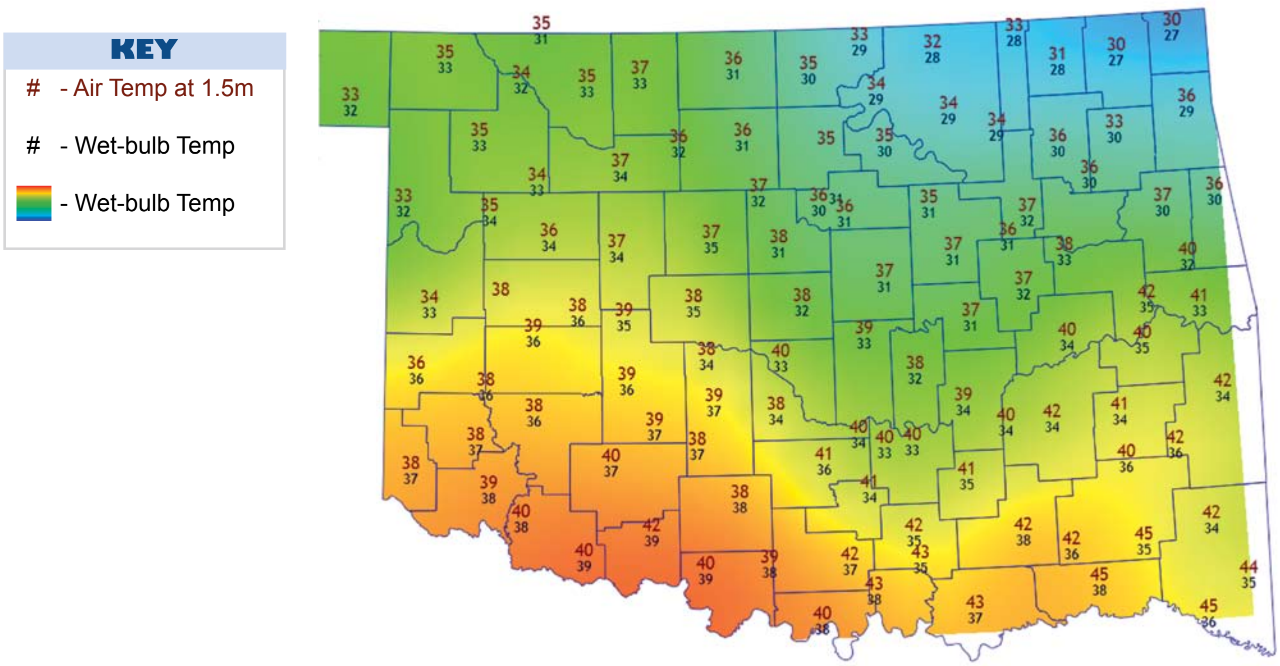


Figure 2 - Two panels from the Norman Mesonet meteogram of February 4-5, 2002. Time moves from left (noon on Feb 4th) to right (noon on Feb 5th). Midnight is the vertical gray line. The top panel shows air temperature (pink) and dewpoint temperature (dark green). The bottom panel shows rainfall accumulation during the period.