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Measuring temperature inversion conditions to predict the benefits of wind machines for frost protection

Frost is an annual risk for many crops on the Central Coast. Given the typically high value of our crops, losses due to frost can amount to large dollar amounts for producers. For this reason, it can make economic sense to employ a variety of frost protection tools to minimize frost damage.

One of the main tools that we can employ are wind machines, either portable machines or permanently mounted machines. Portable machines are often used in row crops, and permanently mounted machines in perennial crops such as vines and orchards.

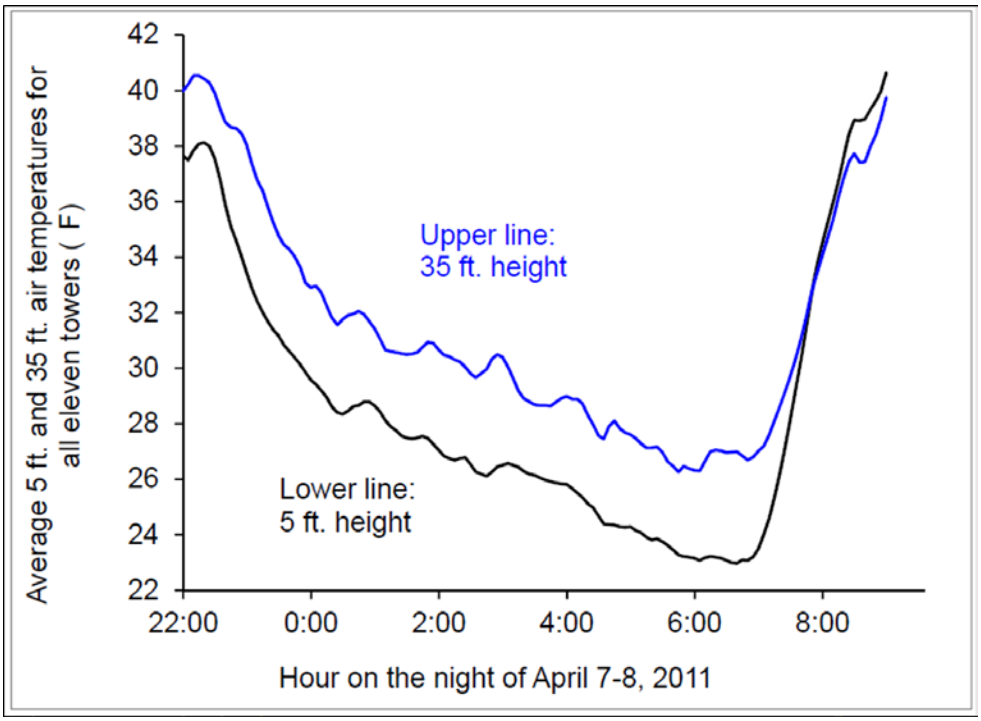
Wind machines are not cheap, so before investing in renting or purchasing machines a producer will want to have confidence that they will work well in their area. In some regions, extensive historical use of wind machines has already answered this question. In other areas there is no similar experience to draw upon, and thus growers may not be able to accurately predict the potential benefits of wind machines.

One simple way to address this lack of information is to measure the temperature inversion conditions during the frost risk periods. A temperature inversion is a condition where the air temperature is greater high above the ground (say 35 feet) compared to closer to the ground (say 5 feet). These inversion conditions often occur during frost events, particularly radiation frost events. Wind machines increase the temperature near the crop by mixing the warmer, upper air with the colder, lower air near the crop.

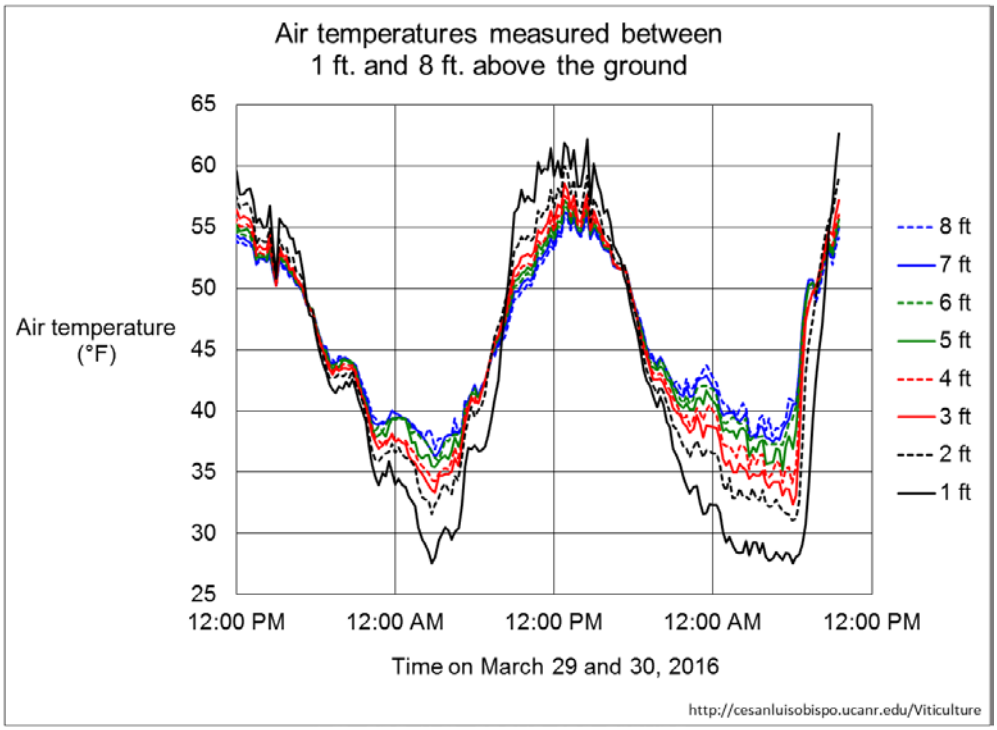
For example, if the air temperature at 35 feet is 34° F and the air temperature at 5 feet is 28° F before a wind machine is turned on, we expect the air temperature after the machine is operated to be the average of these two values, or 31° F. Thus the temperature at the 5 foot level increased by 3° F. This would represent the air temperature experienced by a tall crop like wine grapes.

Because the air temperature becomes colder closer to the ground surface under radiation frost conditions, the increase in air temperature when running a wind machine for a very short crop like strawberries may be even greater than would be experienced by a taller crop like wine grapes as listed above. For example with the same temperature conditions listed above, the air temperature at 1 foot might be 25° F before turning on the wind machine; after the machine is operated, this may be raised to the same 31° F, or an increase of 6° F from the condition expected if no wind machine was operated.

This demonstration is of a low-cost method to measure the temperature inversion conditions using an inexpensive portable tower and inexpensive data loggers. The materials to construct the towers are all readily available locally, and the data loggers are common units purchased from the manufacturer (Onset Computer). This method can be employed by farming operations themselves, or in cooperation with UC Farm Advisors. Having this data for one or more frost seasons can give growers the type of information they need to make informed decisions on whether or not to invest in wind machines at their properties.



An example temperature inversion



An example of air temperature stratification near the ground

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