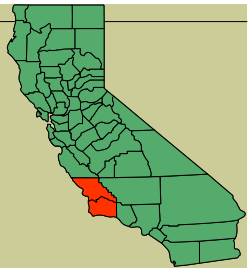
September 2011

University of California Cooperative Extension

Grape Notes

San Luis Obispo & Santa Barbara Counties



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A historical perspective on the April 2011 frosts: Just like old times

The damaging frosts on April 8 and 9 were some of the most severe in recent memory for inland San Luis Obispo County and areas of Monterey and Santa Barbara Counties. An analysis of historical weather records indicates that similar frost events used to be much more common from the 1950s through the 1970s, while the last three decades have had much lower frost pressure. This latter period of relatively mild frost conditions has coincided with the significant expansion of the winegrape acreage in the region.

The severe frosts of April 8 and 9 caused extensive damage, particularly in the area around Paso Robles in San Luis Obispo County. Vineyard managers with several decades of experience in the region remarked that they had never witnessed a frost event of this magnitude before; many older vineyards which had never suffered significant frost damage did so in this event.

An analysis of the historical temperature records collected in the city of Paso Robles since 1951 provides an interesting view on how the likelihood of frost events has changed over time, and gives some insight on the probabilities that frosts may happen in the spring and fall. Similar analysis could be conducted with any high-quality, long term dataset of temperatures. Of course temperature patterns vary regionally, so the magnitude of the values that follow below will not be representative of all nearby areas, but the general patterns and trends will likely be very similar.

Figure 1 below shows the average daily minimum temperatures for the period March-June, and also indicates the record minimum temperature for each date. On average the minimum temperature for each day is always above freezing during this period, but there are many record minimum temperatures which fall far below freezing as well. Many of the record minimum temperatures indicated on Figure 1 would have caused severe crop damage similar to or worse than the April 2011 events. As cold as April 8 2011 was, the same day in 1953 was nearly 1 °F colder.

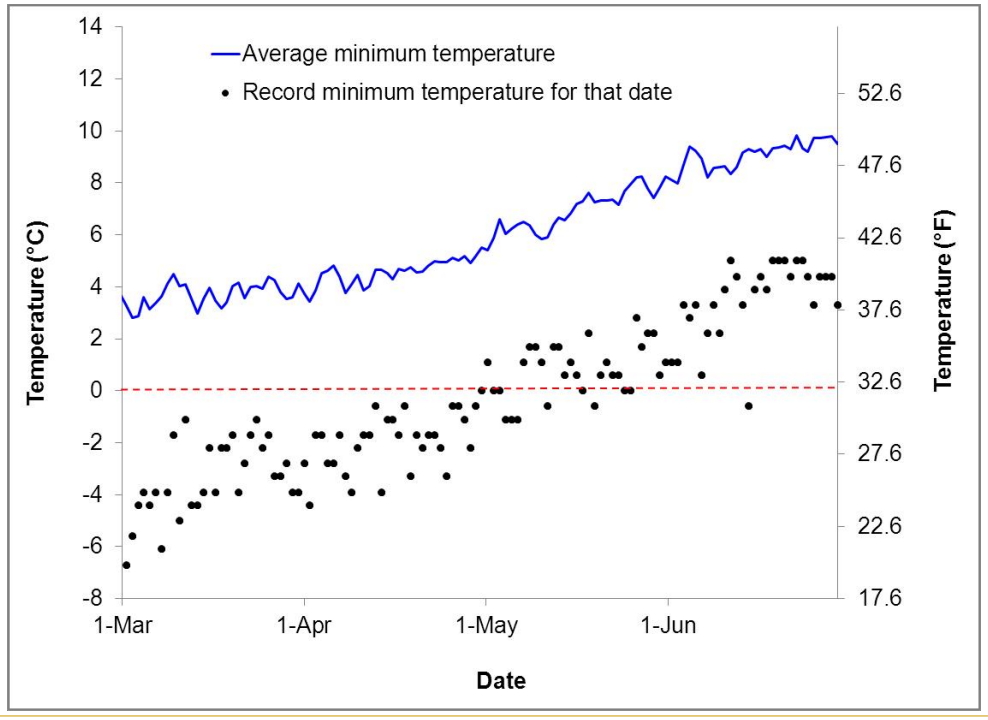

Figure 1. The average minimum temperature for each day during the spring, and the record minimum temperature for each date. Values are from the 1951-2011 data set measured in the city of Paso Robles.

This and other weather data is available for download at the UC IPM website; see the link on the last page.

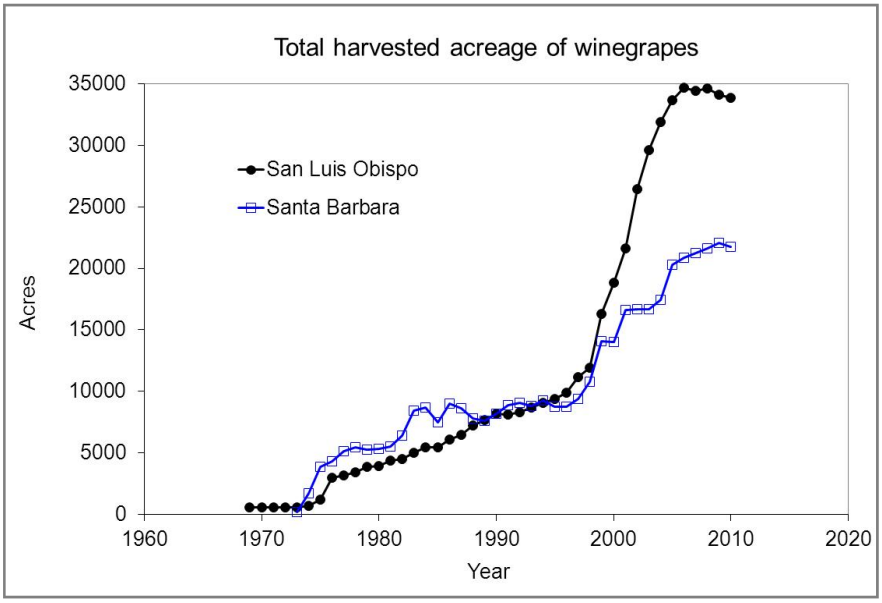

Figure 2. Harvested winegrape acreage in San Luis Obispo and Santa Barbara Counties, indicating the rapid expansion of acreage since the early 1970s. Data is from the annual Ag Commissioner Crop Reports.

Related historical graphs are available on the website listed on the last page.

Fortunately, these types of events have not been common during the past few decades, during which time the winegrape acreage has grown from being a very minor crop to one of the major crops in San Luis Obispo and Santa Barbara Counties (Figure 2). For insight as to how frost conditions have changed over the past half century, the most severe April and October freezes since 1951 are listed in Tables 1 and 2 below, in the order of severity. With the exception of the April 2011 events, all of the previous events during which temperatures were 28 °F (-2.2 °C) or colder occurred during the decades of the 1950s, 1960s and 1970s; none occurred during the 1980s, 1990s or 2000s when the winegrape acreage experienced substantial growth.

Many of these earlier years were affected by multiple frost events in the same season, in the same way as the spring of 2011 was. In Tables 3 and 4 on the following page, the number of days each year when the tempera-

Table 1. Most severe April frosts, ranked by severity; Paso Robles, CA

	Temperature	
Date	(°C)	(°F)
4/2/1976	-4.4	24.1
4/9/1953	-3.9	25.0
4/14/1977	-3.9	25.0
4/8/1953	-3.3	26.1
4/19/1955	-3.3	26.1
4/19/1968	-3.3	26.1
4/25/1974	-3.3	26.1
4/1/1951	-2.8	27.0
4/5/1955	-2.8	27.0
4/6/1955	-2.8	27.0
4/8/2011	-2.8	27.0
4/10/1953	-2.2	28.0
4/2/1956	-2.2	28.0
4/24/1964	-2.2	28.0
4/29/1970	-2.2	28.0
4/21/1971	-2.2	28.0
4/19/1972	-2.2	28.0
4/29/1977	-2.2	28.0
4/9/2011	-2.2	28.0

Table 2. Most severe October frosts, ranked by severity; Paso Robles, CA

	Temperature	
Date	(°C)	(°F)
10/30/1971	-7.2	19.0
10/29/1971	-6.7	19.9
10/28/1970	-5.6	21.9
10/24/1975	-4.4	24.1
10/25/1954	-3.9	25.0
10/26/1954	-3.9	25.0
10/31/1961	-3.9	25.0
10/30/1972	-3.9	25.0
10/31/1972	-3.9	25.0
10/23/1953	-3.3	26.1
10/27/1954	-3.3	26.1
10/30/1961	-3.3	26.1
10/28/1954	-2.8	27.0
10/29/1970	-2.8	27.0
10/31/1978	-2.8	27.0
10/25/1953	-2.2	28.0
10/9/1961	-2.2	28.0
10/17/1966	-2.2	28.0
10/25/1971	-2.2	28.0
10/26/1971	-2.2	28.0
10/29/1975	-2.2	28.0

Table 3. Number of days in April with temperatures below 29 °F (-1.7 °C) by year since 1951 in Paso Robles

Year	Number of days
1951	1
1953	6
1955	3
1956	4
1961	2
1964	1
1968	5
1970	3
1971	2
1972	2
1974	1
1975	1
1976	1
1977	2
1984	1
1999	4
2011	2

Table 4. Number of days in October with temperatures below 29 °F (-1.7 °C) by year since 1951 in Paso Robles

Year	Number of days
1953	2
1954	5
1956	2
1959	1
1961	4
1966	3
1967	1
1970	3
1971	5
1972	2
1975	2
1978	1
1981	3
1996	3
1997	1
2008	2

tures fell below 29 °F (-1.7 °C) are listed, for both April and October. Again, the decades of the 1950s through 1970s predominate by having frequent seasons with multiple frost events in the spring and/or fall. Undoubtedly there are still a few old-timers around who remember how challenging it must have been to grow frost-sensitive crops during that era; this data tells us that they may not have been exaggerating too much in their stories. This pattern of frosts being less prevalent during the past three decades as compared to earlier decades has also been observed elsewhere in California.

Predicting future frost events is a difficult challenge. Based on the historical data, we can compile probability charts that indicate the likelihood that a certain temperature will be reached after a given date in the spring, or prior to a given date in the fall. Figure 3 on the following page shows a temperature probability chart for the spring period, created with the same Paso Robles dataset. To use this chart, pick a date of interest on the horizontal axis, and then draw a vertical line upwards; the intersection of this line with each of the four temperature curves will indicate the probability of that temperature occurring after that date in the spring. As an example for April 15, a vertical line would intersect the -3 °C (26.6 °F) solid red line at a probability value of 0.05; this means that on average, there is a 5% chance that a temperature below -3 °C (26.6 °F) will occur or after April 15. Likewise for this same date, there is a 13% chance that the temperature will fall below -2 °C (28.4 °F), a 54% chance that the temperature will fall below -1 °C (30.2 °F), and a 100% chance that the temperature will fall below 0 °C (32.0 °F) from April 15 onwards.

The probability patterns for fall temperatures in Figure 4 works in a similar manner, except that the probabilities indicate the likelihood that a certain temperature will have occurred before a certain date. For example, there is a 23% chance that the temperature will fall below -1 °C (30.2 °F) by October 15. This type of information is particularly relevant this season, given that many vineyards had to grow new shoots after the spring frosts, and temperatures throughout much of the growing season have been cool; harvest will likely be later than normal at many locations, increasing the likelihood of fall frost damage.

This type of frost probability analysis is one of the best tools that we can use for optimum vineyard planning and management with respect to preventing frost damage. However in order to do this we need to have accurate, long-term regional data which is representative of the area in question. This is one of the main goals with my efforts to collect comprehensive, long-term temperature data from throughout the main vineyard production areas in the two counties. It will take quite a few more years of data collection before these measurements have full utility for predicting regional cold patterns, but once that point is reached they will allow for much more detailed local analysis than we can currently accomplish with our existing public data.

Figures 3 and 4 are based on the entire historical temperature record from 1951-2011. Because the first three decades had substantially more frost events than the last three decades, it may be debatable as to whether or

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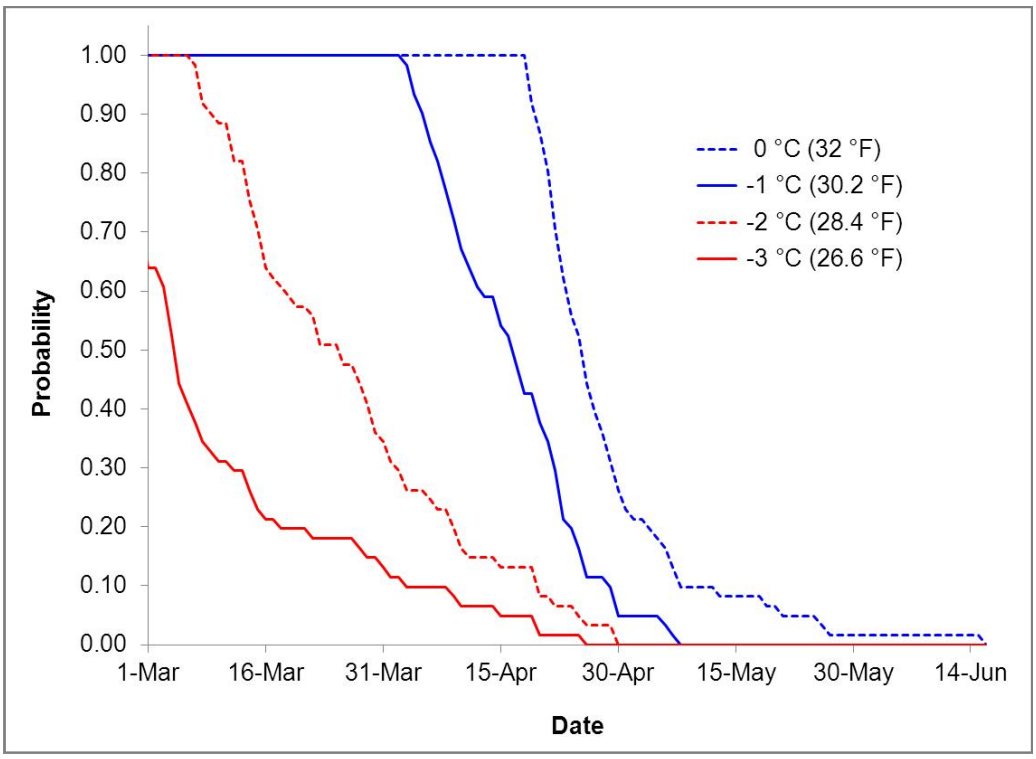

Figure 3. Probability that freezing temperatures will occur on or after a given date in the spring. The probabilities are calculated with the 1951-2011 temperature data measured in Paso Robles.

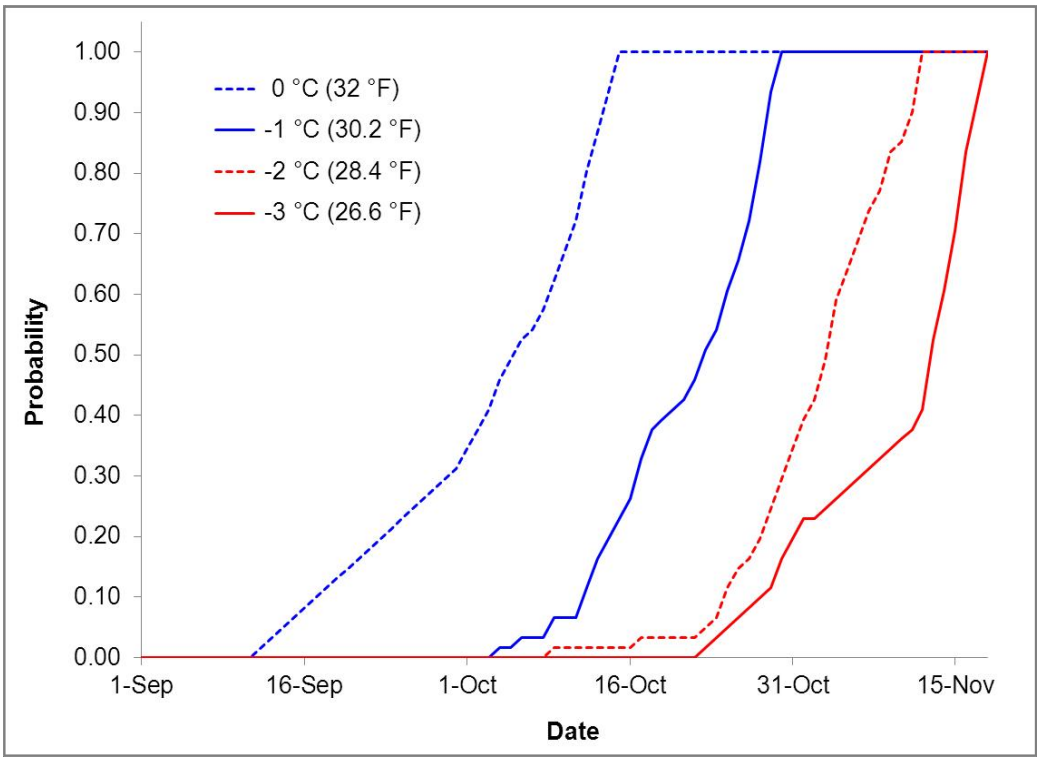

Figure 4. Probability that freezing temperatures will occur on or before a given date in the fall. The probabilities are calculated with the 1951-2011 temperature data measured in Paso Robles.

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Making a Difference for California

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not an analysis that includes the earlier colder decades represents what frost probabilities are like now, or what they will be like in the near future. Unfortunately we really don't know exactly what to expect with frost conditions in future years, whether in the very short term or long term. Global temperatures have increased gradually over the past century, but this doesn't necessarily mean that frost events will become less severe or less common. Some have predicted that an increasing variability of weather events could lead to frost conditions becoming more severe again, possibly even like they were in the 1950s—1970s.

If so, then frost protection will become one of the most critical management challenges facing many vineyards in California. During the past few relatively frost-free decades vineyards have been planted at many sites which would have been considered to be unacceptably prone to frost risk under the more severe conditions experienced 50 years ago. The tools and technology that we have available to prevent frost damage really haven't changed very much over the past 50 years either; we still depend primarily upon proper site selection, heat generated by freezing water applied by sprinklers, or by mixing air with wind machines. We now have better tools to forecast and measure frost events, but we are still constrained by the same fundamental physical limitations when trying to deal with excessively cold air as were farmers two generations or more ago. Whether or not the past frost history repeats itself will be one of the most interesting and important trends to follow in California vineyards over the next several decades.

Additional resources:

Historical winegrape production statistics for San Luis Obispo and Santa Barbara Counties

http://cesanluisobispo.ucdavis.edu/Viticulture/Historical_winegrape_production_statistics/

Weather data on the UC IPM Website

http://www.ipm.ucdavis.edu/WEATHER/wxretrieve.html

Additional frost protection information

http://cesanluisobispo.ucdavis.edu/Viticulture/Frost_Protection/