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Modelled impact of future climate change on the phenology of winegrapes in Australia

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• We all know that matching the critical elements of vine phenology (*phenology* is the timing of naturally-occurring events) to a suitable climate is a key component of the planning of any quality vineyard. However, eleven of the twelve years between 1995 and 2006 rank among the warmest in the record of global surface temperature (which goes back to 1850). These increasing global temperatures may mean that vine phenological events are accelerated to the point that certain varieties cease to be suitable for a given region, or alternatively, they may allow successful ripening of varieties previously considered unsuitable for a specific region.

• It is well documented that in France and other European wine countries, harvest has steadily advanced in time over the past 50 years and is now about a month earlier. When trying to get a similar analysis for Australia, researchers ran into the limitation of an insufficient number of years in which that data was recorded. Therefore, a model approach was chosen for this study. The goal was "to assess the impact of climate change on the timing of *budbreak* and *harvest* of Chardonnay (early-ripening) and Cabernet Sauvignon (late-ripening) across 6 regions chosen to represent the range of climates in which grapes grow in Australia".

• To do the above (too long to repeat!), the authors followed 3 steps:
• 1) In the *first step*, they used a model (called VineLOGIC) that uses daily weather data to generate the projected date of the main phenological vine events, according to cultivar. Temperature data for each site for the years 1976 to 1990 were used to run the model and produce a **baseline phenology**. Then, another set of published data was used to test the model performance, which proved to be satisfactory. The only exception was some individual harvest dates which occurred later than predicted. This is probably unavoidable, due to the fact that harvest date is often a decision based more on winery staff and their sugar target goals, than on berry sugar content itself.

• 2) In the *second step*, warming projections were derived from a climate change generator program (called OzClim), which takes into account a range of CO_2 emission scenarios, climate sensitivities, and climate models. (Climate sensitivity is a measure of how much the temperature will rise for the same increase in CO_2 emission. If sensitivity is low, the program uses a temperature increase of 1.5°C for every doubling of the CO_2 emissions; if sensitivity is high, the projected temperature increase is 4.5°C for the same CO_2 increase.) For simplicity, the authors ran the program for 3 possible global scenarios: high emission change/high sensitivity, medium emission change/medium sensitivity, and low emission change/low sensitivity.

• 3) In the *third* and final *step*, and once the baseline phenology was generated for all the sites for both the Chardonnay and the Cabernet, the daily weather data used to drive the VineLOGIC model was adjusted with the temperature projections that OzClim predicted for the years 2030 and 2050.
Let's see what happened:

• **Step 1. Effect of region and variety on vine phenology.** There was a significant difference in projections of season duration –defined as the span from budbreak to harvest- between the 6 regions. For instance, Margaret River and Coonawarra, which are cooler, exhibited longer seasons than the warmer inland regions (Clare Valley, Riverland, Murray Valley). Cabernet Sauvignon had later budbreak and harvest than Chardonnay in all climates. These results were pretty much as expected.

• **Step 2. Projected climate change**. If we concentrate on the model that predicted the greatest warming, most regions foresaw an increase between 1-2°C, except for Margaret River, which showed no change. The model projected larger temperature differences between summer and winter for the inland regions (Clare Valley, Riverland, Riverina and the Victorian and New South Wales Murray Valley) than for the coastal regions (Coonawarra and Margaret River). In other words, the inland wine regions would see their climates become more "continental".

• **Step 3. Impact of temperature change on vine phenology**. In 2030, **budbreak** was predicted to be 2-9 days earlier in most regions. One exception was the cool Margaret Valley, in which budbreak was, in fact, predicted to occur 4-11 days later. The date of Cabernet Sauvignon budbreak was more affected by the warming than was Chardonnay. One exception was the Riverina region where the opposite was true – Chardonnay was more affected than Cab. As for the **season duration** predictions, they varied by region. For instance, for Coonawarra, one of the regions showing the greatest effect , by 2030 the season would be shortened by up to 21 days, and by 2050, the decrease could be as much as 37 days.

• **Projected harvest temperature.** Based on the projected harvest dates, the authors were able to predict harvest-day temperatures for each region – in other words, what would the temperatures be out there when those grape trucks are scheduled to come in? The important point to make here is that the **warming impact is dual**, given the fact that harvest is projected to occur both earlier in the year and in a warmer climate. For instance, in Coonawarra, Cabernet Sauvignon harvest temperatures may increase by 3°C by 2030, and by 6°C by 2050 (this is equivalent to an increase from 90°F to 95°F, and from 90°F to 101°F, respectively). This is much larger temperature increase than that projected due to climate change alone (0.7°C and 1.7°C respectively). As for Chardonnay, the projected harvest temperature increases are 1.8°C in 2030 and 3.3°C in 2050.

Some important consequences for the grower/winemaker included in the discussion:

_ the use of chemical dormancy breakers may be needed in those regions where the chilling accumulation required to break dormancy will no longer be met –like Margaret River;
_ the harvest will be compressed, making it increasingly difficult to adequately process each block of fruit at optimal quality, and affecting the logistics of truck, equipment, and workforce scheduling;
_ is there a possibility that frost risk could be reduced? Not too much luck with that, as the authors believe that drier soils, fewer clouds, and lower dew points could actually increase the occurrence and severity of frosts;
_ earlier sugar ripeness, coupled to increased acid loss through respiration, may contribute to increasingly unbalanced wines;
_ volatilization of aroma compounds under warmer temperatures could affect wine styles

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