



## **Late frost risk for grapevine in France**

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Frost injuries after the budburst of the grapevine is one of the most concerning issues for winemakers. Exceptional tardive frost events in 2016 and 2017 have caused substantial yield losses over different winegrowing regions of France. These events may be not necessarily associated with the on-going climate change. Yet it is still unclear whether general warming conditions tend to reduce or to amplify the risk of late frost damages. Here we present the first comprehensive assessment for such a risk in the future over different regions of France. The study is based on 8 climate models, whose projections have been statistically downscaled over France and coupled with three different phenological models for the budburst simulation.

We stress the concrete possibility for tardive frost events to increase in the future due to a significant anticipation of the budburst date. The continental regions of France appear to be the most vulnerable, with a probability that may even triple in Alsace, Burgundy and Champagne with respect to the simulated current probability. Instead, the likelihood in coastal regions is estimated to remain very low or to vanish throughout the 21st century. Our risk assessment remains very sensitive to the choice of the phenological model for the budburst computation, thus disclosing the urgent need to test the budburst models under warmer climatic conditions, in order to reduce the uncertainty. Our study therefore provides a detailed portrait of the wide range of possible scenarios of future risk of tardive frosts over France, which may promote specific strategies of adaptation to climate change over certain critical regions.