Increasing risks of apple tree frost damage under climate change

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The impacts of global warming on agriculture and crop production are already visible today and are projected to intensify in the future. As horticultural and agricultural systems are complex organisms, their responses to changing climate can be non-linear and at times counter-intuitive. These systems undergo yearly cycles of growth with different plant characteristics in each of their phenological phases. They are thus especially sensitive to changes in seasonality besides changes in the annual mean and single extreme events.

Here we show that as a result of warmer winters, the risk of frost damages on apple trees in Germany is projected to be about 10\% higher in a 2\°C world compared to today. Warmer winters lead to less frost days but also to earlier apple blossom. This can result in overall increase in years where frost days occur after blossom.

Using large ensemble climate simulations, we analyze this compound event of frost days after blossom - frost days after warm winters. Although the projected shift in blossom day and the decrease in frost days is relatively homogeneous over Germany, the change in frost risk varies considerably between regions. Our results highlight the importance of treating frost risk as a compound event of frost days after warm winters instead of comparing the average shift in blossom days with the decrease in frost days.

Reference: Pfleiderer, P., Menke, I. & Schleussner, C.-F. Increasing risks of apple tree frost damage under climate change. Clim. Change (2019). doi:10.1007/s10584-019-02570-y