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"Filling gaps and removing traps
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Model Choice Matters – Sensitivity of Chill Metrics to Future Warming in Mediterranean and Temperate Environments

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Abstract

Winter chill, which temperate trees require to overcome dormancy, is expected to decrease substantially in the future in most deciduous fruit tree growing areas. Several mathematical models have been applied in different regions around the world to quantify this chill requirement. While the 'Dynamic' model has emerged as the most plausible and reliable model, chill models are still widely reported to be inadequate for some areas. We compared the outputs from 13 agricultural and forest chill models using past and projected weather data for nine sites in Chile, Tunisia and Germany. We used a weather generator calibrated with 45 years of temperature data to produce chill distributions for 100 synthetic years for multiple climate scenarios. Chill was computed for 10 past scenarios and projected for future scenarios (for 2050 and 2085 according to greenhouse gas concentration scenarios RCP4.5 and RCP8.5). Results show that models' estimations differ substantially for the same site and scenario. The 'North Carolina', 'Utah', 'Modified Utah' and 'Low Chill' models indicated negative chill levels for past and future scenarios in Tunisia. These models, together with the 'Positive Utah' model, projected the greatest chill increases for locations in Germany. The 'Chilling Hours' model and the 'Chilling Rate' function showed high sensitivity across regions in future scenarios. Just two models projected chill decreases in all sites. In Mediterranean climate areas (central Chile and Tunisia) the 'Dynamic' model and 'Positive Utah' model forecasted similar chill reductions in both year and RCP scenarios, whereas in temperate locations (Germany) the 'Dynamic' model forecasted lower chill increase compared with 'Utah' and 'Positive Utah' models. Despite the 'Dynamic' model and the 'Positive Utah' model showing similar performance among climates, the 'Dynamic' model appears to be the best current option, due its more physiologically credible approach. However, further research is needed to develop or identify models that are valid across wide climatic gradients. Such models are crucial for the development of quantitatively appropriate climate change adaptation strategies for temperate orchards.

Keywords: Bud burst, *Prunus* sp., sub-tropics, temperature increase, warm winters

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