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Towards new approaches in phenological modelling

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Modelling of phenological stages is based on temperature sums for many decades, describing both the chilling and the forcing requirement of woody plants until the beginning of leafing or flowering. Parts of this approach go back to Reaumur (1735), who originally proposed the concept of growing degree-days. Now, there is a growing body of opinion that asks for new methods in phenological modelling and more in-depth studies on dormancy release of woody plants. This requirement is easily understandable if we consider the wide application of phenological models, which can even affect the results of climate models.

To this day, in phenological models still a number of parameters need to be optimised on observations, although some basic physiological knowledge of the chilling and forcing requirement of plants is already considered in these approaches (semi-mechanistic models). Limiting, for a fundamental improvement of these models, is the lack of knowledge about the course of dormancy in woody plants, which cannot be directly observed and which is also insufficiently described in the literature. Modern metabolomic methods provide a solution for this problem and allow both, the validation of currently used phenological models as well as the development of mechanistic approaches. In order to develop this kind of models, changes of metabolites (concentration, temporal course) must be set in relation to the variability of environmental (steering) parameters (weather, day length, etc.). This necessarily requires multi-year (3-5 yr.) and high-resolution (weekly probes between autumn and spring) data. The feasibility of this approach has already been tested in a 3-year pilot-study on sweet cherries. Our suggested methodology is not only limited to the flowering of fruit trees, it can be also applied to tree species of the natural vegetation, where even greater deficits in phenological modelling exist.