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Extending temperature sum models to simulate onset of birch flowering on the regional scale

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For human health issues a reliable forecast of the onset of flowering of different plants which produce allergenic pollen is important. Yet, there are numerous phenological models available with different degrees of model complexity. All models consider the effect of the air temperatures on plant development; but only few models also include other environmental factors and/or plant internal water and nutrient status. However, the more complex models often use empirical relations without physiological meaning and are often tested against small datasets derived from a limited amount of sites. Most models which are used to simulate plant phenology are based on the temporal integration of temperatures above a defined base temperature. A critical temperature sum then defines the onset of a new phenological stage.

The use of models that base on temperatures only, is efficient as temperatures are the most frequently documented and available weather component on global, regional and local scales. These models score by their robustness over a wide range of environmental conditions. However, the simulations sometimes fail by more than 20 days compared to measurements, and thus are not adequate for their use in pollen forecast.

We tested the ability of temperature sum models to simulate onset of flowering of wild (e.g. birch) and domestic plants in Bavaria. In a first step we therefore determined both, a regional averaged optimum base temperature and temperature sum for the examined plant species in Bavaria. In the second step, the base temperatures were optimized to each site for the simulation period 2001-2010.

Our hypothesis is that domestic plants depend much less on the regional weather conditions than wild plants do, due to low and high genetic variability, respectively. If so, the observed base temperatures of wild plants are smaller for low annual average temperatures and higher for high annual average temperatures. In the cases of domestic plants the optimized base temperatures remain constant for a wide range of annual average temperatures given in Bavaria whereas in the cases of the wild type birch plants the optimum base temperatures vary between the regions.

Preliminary simulation results show that it is possible to extend temperature sum models in the case of birches. It is possible to estimate the base temperatures by the knowledge of the site or region specific climate conditions without the need of further calibration.