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Climate change and winter chill in Germany

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In order to estimate possible shifts in the timing of phenological spring events due to climate change, chilling/forcing models have to be used. The most crucial and uncertain aspect in these models is the calculation of dormancy release. Since this stage cannot be easily observed on the tree, mathematical fitting techniques are used to optimize the individual chilling and forcing parameters of the model. Doing this, the winter chilling requirement for the optimized models is often higher than expected, since the accumulation of chilling hours lasts until the beginning of the forcing period (ontogenetic development). This means, the models does not distinguish between endo- and ecodormancy.

For this reason regional differences and possible future shifts in the release of dormancy (t1) were investigated for Germany. Altogether three different chilling hour models (M1-M3)were used to estimate the release of dormancy for chilling requirements ranging between 700 and 1800 chilling hours (M1: 32-45°F Model, Weinberger (1950), M2: Utah Model, Richardson et al. (1974), M3: Dynamic Model, Fishman et. al. (1987a, b)). The starting date for the chilling hour accumulation (t0) was fixed to 1 September.

For the study 523 temperature stations (T, Tx, Tn) from the German Weather Service in the period 1961-2005 were regionalized to a 0.1°grid, using second order universal kriging (Blümel et al. 2003). Thus, the territory of Germany was represented by 4253 grid points, ranging from 1 to 1366 m altitude. In order to investigate possible future shifts in the release of dormancy (2011-2100) the scenario A1B of the regional climate model REMO-UBA was used. The scenario data were available on the same grid as the observations. Hourly temperatures for the chilling models were estimated according to the algorithm by Linsley-Noakes et al. (1995) from daily temperatures.

For the current climate, all three chilling models show slightly different results in the average date of dormancy release for Germany, which is lying between mid and end of November in the case of 700 CH and between the end of February and the beginning of March for 1800 CH. Also some regional differences in dormancy release between the three approaches occurred. A general tendency for all models is that dormancy in the continental, south-eastern areas of Germany is released some days later than in the north-western, maritime regions.

The results of the Dynamic- and Utah-Model are relatively similar (the chilling portions (CP) of the dynamic model were transformed into chilling hours (CH) according to the conversion 18 CH= 1 CP), because in both models warm spells within the chilling period reduces the previously accumulated chilling amount. On average, the difference of t1 between M2 and M3 is not more than 5 days for whole Germany. With an increasing chilling demand the differences between the models generally decreases, mainly in the case of more than 1500 CH. In addition, we found for all models a negative correlation between t1 and altitude up to a chilling demand of about 900 CH. This relationship turned into a significant positive correlation for cultivars which require more than about 1300 CH. The reason for this behaviour is to find in the temperature course in autumn and in winter in low and high altitude areas. The model results for changed climate conditions will be presented at the conference.