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Phenological rules for the leaf out date in temperate and boreal Biomes determined from NDVI

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Controlled experiments show that temperate and boreal trees require chilling in winter for rapid leaf budburst in response to warming in spring. If the amount of chilling falls below a species specific threshold then excessive warming is required to initiate budburst. Typically, the warming required drops exponentially to another species specific threshold with increasing chilling. Recent remote sensing data have suggested earlier leaf out in the northern hemisphere, which is confirmed by ground observations. One approach to modelling budburst of vegetation for predicting future leaf out times with large scale land surface models, is to generalize the exponential relationships between chilling and warming from single species to whole biomes. Previous work suggests that this is indeed feasible. We present here new phenology models based on an updated compilation of the FASIR NDVI data and various methods to determine leaf out from NDVI with a mean absolute prediction error of about 7–10 days which is within the temporal resolution of the NDVI. The observed relationship between chilling and warming at budburst indicates an element of regional adaptation of the heat required in biomes covering large areas. Calibrating models with just very few years of data leads to overfitted models with large prediction errors. Using multiple years of data and cross-validation of the calibrated models is essential to obtain reliable estimates for the model parameters as well as prediction error. The models predict that significantly warmer winters will lead to a delayed leaf budburst in spring due to exponentially increasing heat requirements with winter chilling falling below a threshold.