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

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Experiments show that temperate and boreal trees require a period of chilling in winter for rapid leaf bud burst in response to warming in spring (Cannel and Smith, 1986, Murray et al. 1989). If the amount of chilling falls below a certain threshold then excessive warming is required to initiate budburst. Typically, for single species, the heat sum in spring required for budburst drops exponentially to a certain threshold with increasing chilling. Recent remote sensing data have shown earlier leaf out in the spring on the northern hemisphere, which is confirmed by ground observations in phenological gardens.
For modelling budburst of vegetation to reproduce these past and to predict future leaf out times with large scale land surface models, we need to ensure that exponential relationships between chilling and heat accumulation carry over from single species to whole biomes. Preliminary work (Kaduk and Heimann, 1996) suggests that this is indeed the case and we present here new rules based on an updated compilation of the FASIR NDVI data (Los et al., 2001) and various methods to determine leaf out from NDVI (Kaduk and Heimann, 1996, White et al., 1997, Moulin et al., 1997, Zhang et al., 2003). The observed relationship between chilling and heat sum at leaf out indicates an element of regional adaptation of the heat required for leaf out.

The observed earlier leaf out dates reflect warmer springs as the required heat sum is reached earlier and compensates for a potential increase in heat requirement due to warmer winters. However, the rules predict that significantly warmer winters will lead to a delayed leaf out in spring due to exponentially increasing heat requirements for leaf out with dropping winter chilling.

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