



Effects of extreme spring temperatures on phenology: a case study from Munich and Ingolstadt

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Extreme events - e.g. warm spells or heavy precipitation events - are likely to increase in the future both in frequency and intensity. Therefore, research on extreme events gains new importance; also in terms of plant development which is mostly triggered by temperatures.

An arising question is how plants respond to an extreme warm spell when following an extreme cold winter season. This situation could be studied in spring 2009 in the greater area of Munich and Ingolstadt by phenological observations of flowering and leaf unfolding of birch (*Betula pendula* L.) and flowering of horse chestnut (*Aesculus hippocastanum* L.). The long chilling period of winter 2008 and spring 2009 was followed by an immediate strong forcing of flowering and leaf unfolding, especially for birch. This extreme weather situation diminished the difference between urban and rural dates of onset. Another important fact that could be observed in the proceeding period of December 2008 to April 2009 was the reduced temperature difference among urban and rural sites (urban heat island effect).

Long-term observations (1951-2008) of the phenological network of the German Meteorological Service (DWD) were used to identify years with reduced urban-rural differences between onset times in the greater area of Munich in the past. Statistical analyses were conducted in order to answer the question whether the sequence of extreme warm and cold events leads to a decreased difference in phenological onset times or if this behaviour can be attributed to extreme warm springs themselves or to the decreased urban heat island effect which is mostly affected by general atmospheric circulation patterns.