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Importance of preseason definition for temperature sensitivity and the prediction of shifts in spring phenology

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Temperature sensitivity is a commonly used statistic to describe and to predict the influence of climate warming on spring phenology. It is calculated by regressing onset dates of phenological events against the mean temperature of a time window (certain days of the year), called the "preseason". The exact definition of the preseason is often regarded as a relatively arbitrary choice, and its influence on the calculated temperature sensitivity as well as the prediction of long-term phenological shifts has not been studied. Here we use long-term data series (1951–2016) from the Swiss Phenology Network to compare results obtained with three different preseason definitions: (1) optimal preseason (maximizing the correlation between temperature and phenology) for each phenological event and location, (2) preseason of fixed length (60 days) up to the mean onset date for each phenological event and location, (3) fixed preseason (March–April) in all cases. Temperature sensitivity was calculated for the period 1951–1985 and used to predict the shift in mean onset dates between the periods 1951–1985 and 1990–2016. Predicted shifts were compared to observed shifts to evaluate prediction accuracy.
The optimal preseason varied among phenological events and locations: it started later and was longer for later phenological events and at colder locations. Temperature sensitivity was on average 5.43 days/°C based on the optimal preseason, compared with 4.66 days/°C based on a 60-day preseason, and 3.87 days/°C based on the fixed March–April preseason. Shifts in phenology were predicted almost exactly using temperature sensitivity based on the optimal preseason (mean error = – 0.14 days). The underprediction of phenological shifts was larger with temperature sensitivity based on a 60-day preseason (mean error = –1.16 days), and even larger with the fixed March–April preseason (–2.14 days). These results show that the definition of the preseason can have a considerable impact on calculated temperature sensitivity, and that the choice of an event- and location-specific optimal preseason leads to the most reliable outcomes.