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Spring onset forecast using harmonic analysis on daily mean temperature in Germany

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The variations of the start of spring is of importance for agriculture planning, production of crops, animal and human activities. Hence, it is beneficial to predict spring onset in advance. We developed a new method based on harmonic analysis of daily mean temperature to predict the date of spring onset in the next year. This algorithm considers memory of seasonal cycle and can be easily demonstrated in the local past records. The study was based on a gridded observational surface air temperature(SAT) dataset for the period 1950-2017. To forecast spring onset, the SAT data are first decomposed into harmonics by wavelet transform and each harmonics' time-dependent amplitude and phase could be extracted. Then a newly derived analytic solution of AR(2) model is used to predict amplitudes and phases in the next year. We compare our model with classical climatological seasonal cycle forecast and verified the prediction by two kinds of referential dates, indicating that our prediction method performs better in terms of time mean and pattern correlation in Germany regions. The root mean square error(RMSE) of our method is around 10 days, while RSME is around 20 days in the climatology way. For the space pattern, this method can improve spring onsets prediction especially over the northern west coast regions and mountains. Since the spring onsets in the North Sea coast are influenced most by westerlies during warm winter and their variation is negative correlated with NAO (Northern Atlantic Oscillation), the good prediction here indicate that large scale atmosphere circulations might have affected the annual cycle of temperature.