Spatio-temporal analysis of ground-observed tree leafing responses to temperature in temperate eastern China

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1. Summary

- The relationship between spring vegetation phenology and temperature has received increased research interest in the light of global warming. The dynamic responses of tree leafing to spatio-temporal changes in temperature have been investigated using remotely sensed vegetation green-up as an indicator however less proven by ground-observed phenology in China partly due to poor spatial coverage of ground observations.
- In this study, we investigate the spatio-temporal responses of woody plant leafing date to spring temperature in temperate eastern China using the ground observed phenology in 1974-1996 from 15 stations in the Chinese Phenological Observation Network (CPON). We use the canonical correlation analysis (CCA) of the fields of spring temperature and the leafing date anomalies and examine the observed relationship revealed by the leading CCA modes.
- The results show that the temporal coefficients of the three leading CCA modes for the leafing date and spring temperature anomalies are correlated and the spatial patterns for the leafing date resemble those for the temperature.
- The results suggest that the phenology variation observed by CPON can capture the vegetation phenology responses to large scale variations in climatic factors.
- Our analysis shows that the leafing date sensitivity to spring temperature ranges 3-5 days per Celsius degree.

2. Study area and Method

The study area is the temperate eastern China where most of the CPNO stations in the temperate zone locate. The biome dynamics in the study area is strong influenced by the monsoon climate with a distinct seasonality.

The observed leafing date anomalies are gridded on a 0.5 by 0.5 degree grid. The anomalies of leafing and mean air temperature from March to May (T35) are approximated by first empirical orthogonal functions (EOF) and then using the orthogonal variables as input to the CCA analysis.

According to the variance of time series of temporal coefficients, we classified the years studied into the representative CCA modes. The leafing sensitive to T35 are estimated at the 15 phenological stations.

3. Results

CCA1 spatial modes resemble the observed warming with the leafing date advanced all over the study area, associated with spatial modes the temporal evolutions of T35 and leafing date are identical. CCA2 and CCA3 spatial patterns show the north-south difference of variability, but the leafing spatial patterns are similar to corresponding temperature spatial patterns. And the temporal coefficients of T35 and leafing date are relevant. The three patterns can explain another 46% of variance together.

4. Conclusions

- The temporal variability of leafing is intimately linked with the temperature change and leading spatial patterns of the fields of spring temperature and leafing are similar using the CCA method.
- In the typical CCA patterns, the leafing responses to climate change are found in the observed phenological data.
- The averaged leafing sensitivity to air temperature is about 4 days/°C in temperate zones of eastern China.

5. References