Urban warming advances spring phenology but reduces phenology responses to temperature in the conterminous United States

Objective

- We investigated the changes in the satellite-derived start of season (SOS) and the covariation between SOS and temperature (R_T) in 85 large cities and adjacent rural areas across the conterminous United States for the period 2001–2014.

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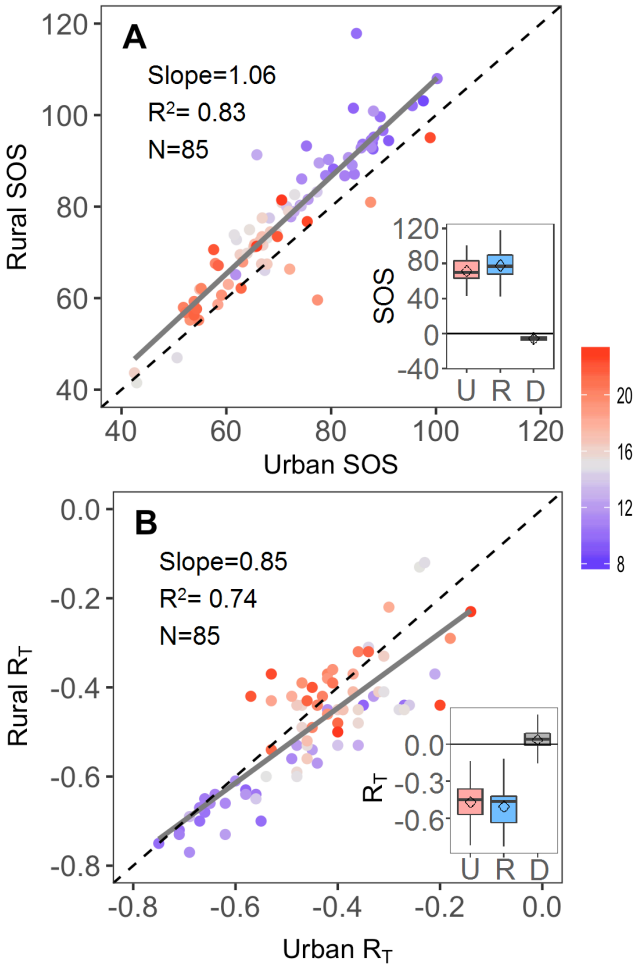
- The SOS came significantly earlier (6.1 ± 6.3 days) in 74 cities (Fig. A) and R_T was significantly weaker (0.03 ± 0.07) (Fig. B) in 43 cities when compared with their surrounding rural areas ($P < 0.05$).
- The magnitude of urban-rural difference in both SOS and R_T primarily correlated with the intensity of urban heat island (UHI).
- Two phenology models suggested that more and faster heat accumulation contributed to the earlier SOS, while a decrease in required chilling led to a decline in R_T magnitude in urban areas.

Significance

- We provide the first observational evidence of a reduced covariation between temperature and SOS in major US cities.
- We indicated that in non-urban environments the onset of spring phenology will likely advance but will slow down as the general trend toward warming continues.



Urban and rural SOS (A) and R_T (B) in 85 study cities. A: SOS is the 14-year mean during 2001–2014 for each city. Point color represents background climate, i.e., 14-year averaged annual mean temperature. 1:1 line (black dashed) and fitted linear regression (gray solid, P < 0.001) are shown. A boxplot for SOS or R_T is shown within each scatterplot. U and R stand for urban and rural SOS (A) and R_T (B), and D is the urban-rural difference (D = U - R).

Contact: ***Jiafu Mao (maoj@ornl.gov);*** **Funding:** ***BER ORNL TES SFA, RUBISCO SFA and E3SM.***

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