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.