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Increased carbon uptake in the eastern US due to warming induced changes in phenology

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The timing of phenological events exerts a strong control over ecosystem function and leads to multiple feedbacks in the climate system. Phenology is inherently sensitive to temperature (though the exact sensitivity is disputed) and recent warming is reported to have led to a greening of the earth's surface, characterized by earlier spring, later autumn and increased vegetation activity. Such greening could be expected to enhance ecosystem carbon uptake, though reports also suggest decreased carbon uptake. Here we assess changes in phenology of forests over the eastern US during the past two decades, and quantify the resulting changes in forest carbon storage. We use a combination of long-term ground observations of vegetation phenology, satellite vegetation indices, and ecosystem-scale carbon dioxide flux measurements, along with predictions from 18 terrestrial biosphere models. We observe a strong trend of earlier spring and later autumn over the eastern US. In contrast to previous suggestions we show that in this region, the trend has increased carbon uptake due to the relatively larger increase in photosynthesis compared to respiration. Furthermore, we find that the terrestrial biosphere models misrepresent the derived temperature sensitivity of phenology. Our analysis of the temperature-phenology-carbon uptake coupling suggests a current, and possibly future, enhancement of forest carbon uptake due to climate-induced changes in phenology. This constitutes a negative feedback to climate change, and is serving to slow the rate of warming.