Elevated CO2 further lengthens growing season as climate warms

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Mid-summer phenology observations by Megan Nix in a study plot under warming and elevated CO2 within the Prairie Heating and CO2 Enrichment Experiment (PHACE), near Cheyenne, WY, USA. Credit: Steve Ausmus

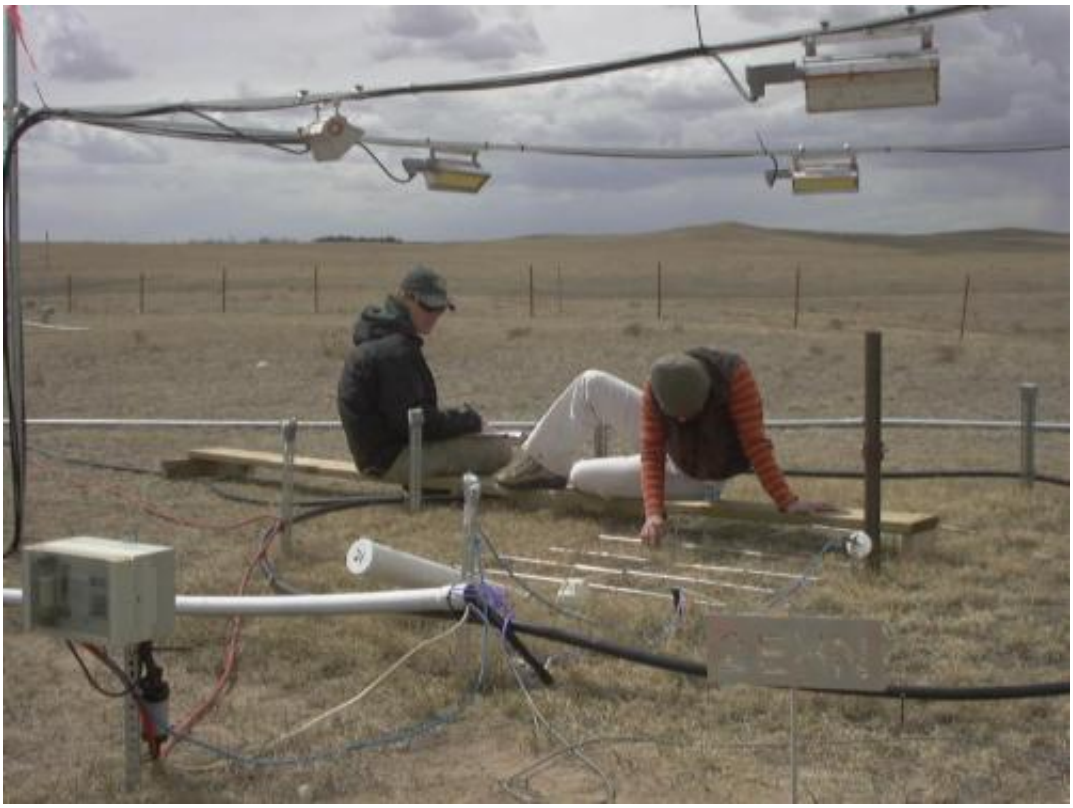
(Phys.org) —A new study published this week in the journal *Nature* by the USDA Agricultural Research Service, and Fort Lewis College and Colorado State University researchers demonstrates that higher atmospheric CO2 concentration resulting from fossil fuel pollution lengthens the growing season.

The research, published this week, shows that the growing season starts earlier due to climate warming and ends later due to elevated CO2, especially when water availability limits plant activity. This leads to a longer growing season.

"The Earth's response to environmental change is complex" said Dr. Heidi Steltzer, a Fort Lewis College associate professor, "in part due to multiple environmental changes occurring all at once. Over the past 40 years, Earth's growing seasons have lengthened. This change has most often been attributed to warming alone, but now we are finding there is another factor: elevated CO2."

A unique data set collected by USDA researchers Melissa Reyes-Fox and Dan LeCain enabled the testing of a conceptual model published several years ago in the journal *Science*. The model explains a seemingly paradoxical phenomenon: earth's growing seasons could be longer in response to climate warming, even if the active period for many plant species gets shorter.

"If some plant species shift the timing of their active period forward but are active for a shorter duration, then the active period for other species needs to be maintained or shift later for science to explain a longer growing season." explained Steltzer. "And in fact, this is exactly what we found. While warming extends the growing season for this reason, the data showed that elevated CO2 extends both the growing season and species' active period."



Spring phenology observations by Melissa Reyes-Fox, study co-lead author, with support of a research assistant in the Prairie Heating and CO2 Enrichment Experiment (PHACE), near Cheyenne, WY, USA. Credit: Dan LeCain

"As a result, there is greater continuity of green plant cover and greater plant abundance in the grassland ecosystem than under warming conditions alone" added Dr. Jack Morgan, a USDA scientist.

These results make biological sense. Elevated CO2 is known to increase plant water use efficiency, often resulting in higher soil water content. For ecosystems like the mixed-grass prairie where annual loss of leaves in deciduous plants is often triggered by low water availability, wetter soils in the autumn ought to extend the growing season.

The effect of elevated atmospheric CO2 on plants can have great yearly

variation; wet autumns make a large difference. "Elevated CO2 enhanced the effect of warming on the growing season length most in years when fall soil water content was greater," Morgan explained. "More water was conserved in the soil."

For CO2-induced soil water conservation to extend the growing season, soil water content must already be sufficient in the late summer to prevent an early wilt. Elevated CO2 and warming led to a 29-day longer growing season in one year and a 14-day mean increase relative to warming alone over the 5-year study.

Study results indicate cause for both hope and concern. Longer growing seasons are often beneficial, especially if elevated CO2 allows plant species to remain active longer as indicated by this study. However, shifts in the timing and duration of plant species' reproduction could impact which plant species can persist and remain abundant.

"For example, elevated CO2 also affected the length of the reproductive season, often shortening its duration," said Reyes-Fox. "The time from flowering to mature seeds was shorter for several species, which could lead to timing problems with pollinators like bees and seed dispersers such as birds. This could result in less successful plant reproduction in general."

Since a longer growing season due to warming and greater atmospheric CO2 concentration depends on water availability, changes in precipitation will determine the extent to which the growing season lengthens in the future.

"Studies like ours highlight the need to better understand the impacts of environmental changes that happen at the same time," explained Steltzer. "It is important not to look at one environmental change in isolation. Similarly, the same would apply to impacts. In the broader context,

elevated CO2 has other detrimental impacts, although our study shows an apparent benefit on lengthening the growing season."

More information: dx.doi.org/10.1038/nature13207

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