Autumn warming may lead to greater CO₂ release

An analysis of variations in CO₂ fluxes in the Northern Hemisphere shows that warmer autumns are associated with an earlier autumn-to-winter CO₂ build-up in the atmosphere. This counters the assumption that warm autumns ought to have a beneficial effect on terrestrial carbon sinks as trees and plants make more biomass through longer growing seasons. The implications of this are that it may be more difficult for northern forests to sequester carbon than previously predicted.

Autumn and spring temperatures in the Northern Hemisphere have increased by 0.8°C and 1.1°C respectively over the past two decades. A simultaneous greening trend has also been observed, with longer growing seasons and greater photosynthetic activity. This had led to speculation that spring and autumn warming could enhance carbon sequestration and extend the period of net carbon uptake in the future.

The carbon balance of terrestrial ecosystems is highly sensitive to climate changes at the edge of the growing season. In response to warmer springs, for example, studies have shown that the growing season begins earlier and forests absorb more carbon. However, less attention has been given to the impact of a strong autumn warming on the terrestrial carbon cycle.

An international study, led by researchers from France, sought to explain the seasonal response of northern ecosystems to autumnal warming using satellite observations of vegetation, numerical modeling and atmospheric CO₂ concentration data from ten sites in the Northern Hemisphere. Among their findings were:

- Both photosynthesis, which removes CO₂ from the atmosphere, and respiration, which releases CO₂ into the atmosphere, increase during autumn warming, but the increase in respiration is greater
- In contrast, warming increases photosynthesis more than respiration in spring
- The duration of the net carbon uptake period (CUP) has on average decreased at nearly all Northern Hemisphere atmospheric CO₂ stations

The authors note that seasonal changes in net ecosystem productivity (NEP) in Eurasia and North America are different, with North America experiencing a larger warming in autumn and Eurasia experiencing a stronger warming in spring. The authors’ suggest that the potential of these ecosystems to act as carbon sinks is limited because enhanced respiration resulting from the higher temperatures in autumn causes carbon releases that offset photosynthetic gains. Additionally, CO₂ released due to autumn warming may offset most of the increased CO₂ uptake during spring. If future warming occurs more rapidly in autumn than in spring, the ability of northern ecosystems to sequester carbon may diminish more rapidly than previously predicted.

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¹ The ENSEMBLES project is supported by the European Commission’s 6th Framework Programme as a 5 year Integrated Project from 2004-2009 under the Thematic Sub-Priority “Global Change and Ecosystems”. http://ensembles-eu.metoffice.com/
² CarboEurope-IP aims to understand and quantify the present terrestrial carbon balance of Europe. The project is supported by the European Commission’s 6th Framework Programme, under the Thematic Sub-Priority “Global Change and Ecosystems”. http://www.carboeurope.org/

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