



First results from a Free-Air Carbon Enrichment (FACE) facility in deciduous temperate forest

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Enhanced plant growth as a result of elevated atmospheric carbon dioxide concentrations ($e\text{CO}_2$) is considered to be largely responsible for terrestrial ecosystems absorbing more than one quarter of anthropogenic CO_2 emissions. The present-day global net land sink is located primarily in northern ecosystems, with temperate forests responsible for one-third of total uptake. Looking forward, land carbon (C) responses to $e\text{CO}_2$ are calculated to be the most important C cycle feedback to 21st century climate change but are also the most uncertain.

The newly established Birmingham Institute of Forest Research (BIFoR)-Free-Air CO_2 Enrichment (FACE) facility is the first whole-ecosystem FACE experiment for decadal exposure of a mature temperate forest to elevated CO_2 ($e\text{CO}_2$). In BIFoR FACE, the trees are more than 160 years old and the forest soil is centuries older, providing a unique opportunity to fill critical gaps in the understanding of mature forest biomes.

The FACE facility comprises 3 levels of treatment: ambient without infrastructure; ambient with infrastructure; and +150 ppmv above ambient $e\text{CO}_2$) operating on two levels of canopy, each treatment being replicated 3 times. CO_2 is pre-mixed with air and released from the upwind quadrant of 25-m diameter treatment patches; the release concentration and upwind direction being updated approximately every 10 s on the basis of sonic anemometer wind speeds and CO_2 concentrations at the top of the canopy. The resultant 3D CO_2 field within each treatment patch is monitored by 16 inlets feeding 2 infra-red gas analysers. Pre-treatment baseline measurements of ecological structure and ecophysiological function were made from 2015 to spring 2017.

We present results from the first growing season under $e\text{CO}_2$ (April–November 2017) focusing on soil respiration, fine root growth, and photosynthetic efficiency.