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Published in:
Geophysical Research Abstracts

Publication date:
2011

Document Version
Publisher's PDF, also known as Version of record

Geophysical Research Abstracts
Vol. 13, EGU2011-5357, 2011
EGU General Assembly 2011

Can we use isotopes to capture the speed of link between photosynthesis and soil respiration?

Zachary Kayler (1), Claudia Keitel (2), Kirstin Jansen (1), and Arthur Gessler (1)

(1) Institute of Landscape Biogeochemistry, Leibniz-Center for Agricultural Landscape Research, Muencheberg, Germany(zachary.kayler@zalf.de; jansen@zalf.de; gessler@zalf.de), (2) Plant Breeding Institute, Faculty of Agriculture, Food & Natural Resources, University of Sydney, Cobbitty, Australia (claudia.keitel@sydney.edu.au)

Currently there are two proposed mechanisms to link assimilation to belowground respiration via the phloem: 1) the transport of assimilates basipetally according to the Münch theory, and 2) pressure-concentration waves. The transport of assimilates through the phloem by mechanism 1 is often quantified through isotopic labelling studies. Thus, the time between isotopic labelling in the canopy and when the labeled carbon is respired from the rhizoshpere characterizes the degree of coupling between aboveground and belowground metabolism. The timing between the aboveground uptake and belowground respiration of the labelled carbon is termed the "speed of link". Based on statistical approaches, recent studies have reported a speed of link on the order of one day or less in mature forests, which is too fast for phloem transport by molecular diffusion or classical sink-source dynamics. These studies often cite mechanism 2 to support their conclusions, there is however, absolutely no empirical evidence of pressure-concentration waves affecting soil respiration. In this presentation, we report results from experiments to test the mechanisms behind the speed of link on Douglas-fir saplings of the same provenance. We kept the plants for several days in the dark to create a large carbon source-sink gradient with the intention of inducing a strong pressure-concentration wave. Following the no light treatment, in a controlled growth chamber, we introduced labelled CO_2 prior to exposing the plant to light. Upon exposing the plants to light, the labeled CO_2 is carboxylated through photosynthesis and after transport, is respired belowground. During the experiment we monitored the carbon isotopic composition of CO_2 and the CO_2 flux from the soil. We hypothesized that if the pressure concentration-wave effect on soil respiration existed then we would see an increase in CO_2 flux prior to the arrival of CO_2 derived from labelled assimilates.