Leibniz Centre for
Agricultural Landscape Research
(ZALF)

Contact: hubert.jochheim@zalf.de

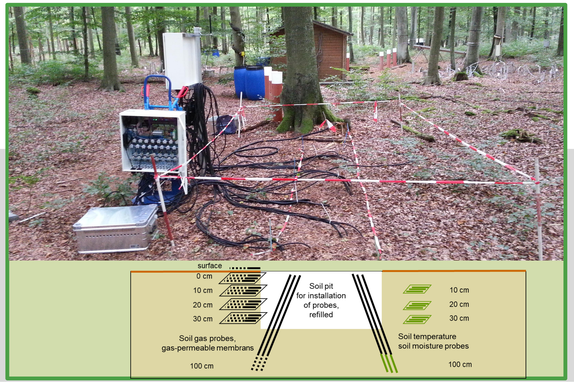
Impact of drought on soil CO_2 efflux and vertical partitioning of soil CO_2 production at a beech and a pine forest site in north-east Germany

[1]Hubert Jochheim, [1]Stephan Wirth, [2]Sinikka Paulus, [3]Valentin Gartiser, [1]Christoph Haas, [1]Horst H. Gerke, [3]Martin Maier

[1] Leibniz Centre for Agricultural Landscape Research (ZALF), Müncheberg, Germany

[2] Max Planck Institute for Biogeochemistry, Jena, Germany

[3] Forest Research Institute Baden Württemberg (FVA), Freiburg, Germany



Challenge

Soil respiration is one of the major CO_2 fluxes in forests and has to be quantified to assess forest ecosystems as carbon source or sink.

We compared CO_2 efflux from soil of two ICP Forests Level II plots, a beech site (DE1207, Brunic Arenosol (Dystric), medium-fine sand, mor-like moder), and a pine site (DE1203, Haplic Podsol, medium-coarse sand, mor) over six years with different climate conditions. We investigated the impact of drought on vertical distribution of CO_2 production.

Methods

Continuous measurement (30 min steps) of soil CO_2 in different soil depths (surface, 0, 10, 20, 30, 100 cm) using hydrophobic, gas-permeable membrane probes in a closed loop (Jochheim et al. 2018, *J. Plant Nutr. Soil Sci.*, https://doi.org/10.1002/jpln.201700259).

Measurement of soil moisture and temperature at 10, 20, 30, 100 cm (TRIME probes). Soil gas diffusion coefficients were estimated at different levels of soil moisture. CO_2 fluxes and vertical partitioning of CO_2 production were calculated using the flux-gradient-approach, optimized by an inverse model. Chamber measurements, conducted in 2018 and 2019 were used to validate the model.

Conclusions

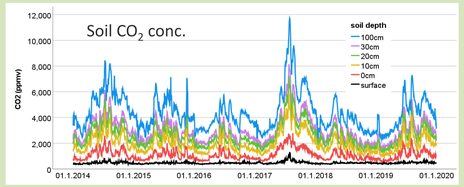
The flux-gradient-approach, optimized by an inverse model is an appropriate measure to estimate the CO_2 efflux and for vertical partitioning of CO_2 production.

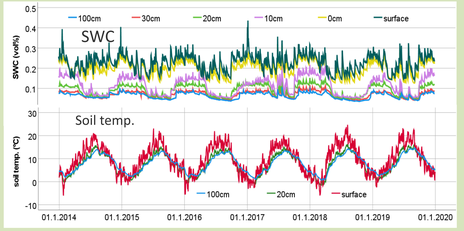
Vertical partitioning of CO_2 production allows relating CO2 production to soil microbial processes and the dynamic of root activity, in contrast to the chamber method.

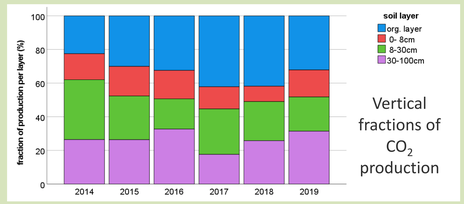
Drought reduces CO_2 efflux from soils and the CO_2 production mainly from upper soil layers.

Results

Beech site





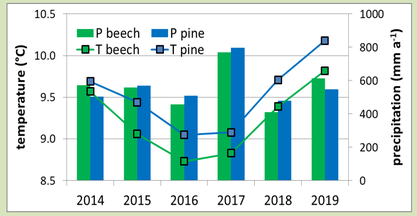


Vertical fractions of CO_2 production

Distinct seasonal dynamic and vertical gradients of soil CO_2 concentration at both sites with peaks in summer (beech) or in autumn (pine).

Annual, seasonal and diel dynamic of soil CO_2 concentration and efflux is determined mainly by soil moisture and temperature.

Higher levels of soil CO_2 concentration at beech site, compared to pine site.



cool-wet: 2017
warm-dry: 2018-2019

Temp.: Pine > Beech

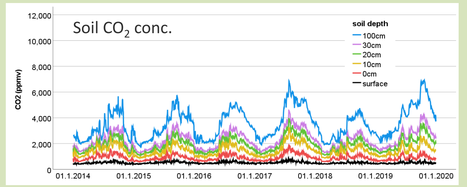
Similar CO_2 efflux from beech (5.7 t CO_2-C ha^{-1} a^{-1}) and pine forest soil (5.6 t CO_2-C ha^{-1} a^{-1}). The results agree with previous results from chamber measurements (beech 2005-2009: 5.9 t C ha^{-1} a^{-1}, pine 2006-2010: 5.5 t C ha^{-1} a^{-1}).

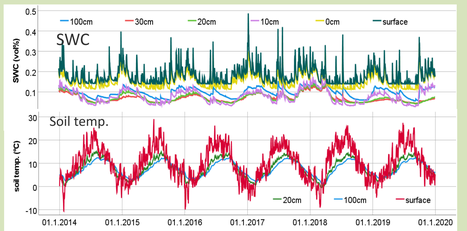
Drought in warm-dry years (2018, 2019) reduced CO_2 efflux by 49% at the beech, and by 39% at the pine site compared to the cool-wet year 2017.

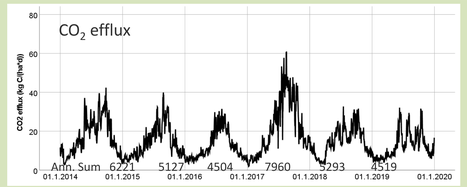
The vertical distribution of soil CO_2 production differs for both sites. The beech site produced 34% of total CO_2 in the humus layer, the pine site 50%.

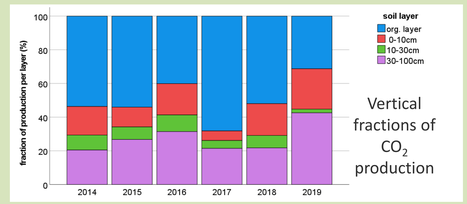
Drought reduces CO_2 production mainly in upper soil layers.

Pine site









Vertical fractions of CO_2 production

Contact: Dr. Hubert Jochheim
Leibniz Centre for Agricultural Landscape Research (ZALF) · Eberswalder Straße 84 · 15374 Müncheberg · Germany
www.zalf.de · hubert.jochheim@zalf.de · · Date: June 08 2021