Geophysical Research Abstracts
Vol. 19, EGU2017-12677, 2017
EGU General Assembly 2017

Autotrophic and heterotrophic soil respiration determined with trenching, soil CO_2 fluxes and $13CO_2/12CO_2$ concentration gradients in a boreal forest ecosystem

Jukka Pumpanen (1), Narasinha Shurpali (2), Liisa Kulmala (3), Pasi Kolari (4), and Jussi Heinonsalo (5)

(1) University of Eastern Finland, Department of Environmental and Biological Sciences, Kuopio, Finland (jukka.pumpanen@uef.fi), (2) University of Eastern Finland, Department of Environmental and Biological Sciences, Kuopio, Finland (narasinha.shurpali@uef.fi), (3) University of Helsinki, Department of Forest Sciences, Helsinki, Finland (liisa.kulmala@helsinki.fi), (4) University of Helsinki, Department of Forest Sciences, Helsinki, Finland (pasi.kolari@helsinki.fi), (5) University of Helsinki, Department of Food and Environmental Sciences, Helsinki, Finland (jussi.heinonsalo@helsinki.fi)

Soil CO_2 efflux forms a substantial part of the ecosystem carbon balance, and it can contribute more than half of the annual ecosystem respiration. Recently assimilated carbon which has been fixed in photosynthesis during the previous days plays an important role in soil CO_2 efflux, and its contribution is seasonally variable. Moreover, the recently assimilated C has been shown to stimulate the decomposition of recalcitrant C in soil and increase the mineralization of nitrogen, the most important macronutrient limiting gross primary productivity (GPP) in boreal ecosystems. Podzolic soils, typical in boreal zone, have distinctive layers with different biological and chemical properties. The biological activity in different soil layers has large seasonal variation due to vertical gradient in temperature, soil organic matter and root biomass. Thus, the source of CO_2 and its components have a vertical gradient which is seasonally variable. The contribution of recently assimilated C and its seasonal as well as spatial variation in soil are difficult to assess without disturbing the system. The most common method of partitioning soil respiration into its components is trenching which entails the roots being cut or girdling where the flow of carbohydrates from the canopy to roots has been isolated by cutting of the phloem. Other methods for determining the contribution of autotrophic (Ra) and heterotrophic (Rh) respiration components in soil CO_2 efflux are pulse labelling with $13CO_2$ or $14CO_2$ or the natural abundance of 13C and/or 14C isotopes. Also differences in seasonal and short-term temperature response of soil respiration have been used to separate Ra and Rh.

We compared the seasonal variation in Ra and Rh using the trenching method and differences between seasonal and short-term temperature responses of soil respiration. I addition, we estimated the vertical variation in soil biological activity using soil CO_2 concentration and the natural abundance of 13C and 12C in CO_2 in different soil layers in a boreal forest in Southern Finland and compared them to seasonal variation in GPP. Our results show that Ra followed a seasonal variation in GPP with a time lag of about 2 weeks. The contribution of Ra on soil CO_2 efflux was largest in July and August. There was also a distinct seasonal pattern in the vertical distribution of soil CO_2 concentration and the abundances of natural isotopes 13C/12C in soil CO_2 which reflected the changes in biological activity in the soil profile. Our results indicate that all methods were able to distinguish seasonal variability in Ra and Rh. The soil CO_2 gradient method was able to reproduce the temporal variation in soil CO_2 effluxes relatively well when compared to those measured with chambers. However, variation in soil moisture also causes significant variation in soil air CO_2 concentrations which interferes with the variation resulted from soil temperatures and belowground allocation of carbon from recent photosynthate. Also, the assumptions used in gradient method calculations, such as soil porosity and transport distances have to be taken into account when interpreting the results.