Geophysical Research Abstracts,
Vol. 11, EGU2009-5159-3, 2009
EGU General Assembly 2009

Investigating carbon turnover in the Arctic tundra using a ^{13}C pulse-chase approach

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Climatic models predict significant warming in the Arctic, with profound impacts on the carbon (C) balance of tundra ecosystems. A significant increase in respiration from vegetation and particularly soils is anticipated, but equally an increase in C assimilation by tundra vegetation in response to warmer temperatures is likely. Our ability to predict likely changes in the C balance in tundra ecosystems relies on the use of C exchange models between plants, soils, and the atmosphere, but at the moment, data on critical processes such as C assimilation and release are scarce. A key question in this context relates to the fractions of assimilated C retained in plant biomass, and those allocated to respiratory processes, which determine the rate of C turnover in the plant-soil system.

We present data from a ^{13}C pulse-chase experiment on 4 contrasting plant and lichen communities in the Swedish tundra: (1) *Betula* dominated communities, (2) *Empetrum* heath communities, (3) *Carex* (sedge) communities, and (4) exposed ridges (lichen communities). The experiment was carried out at the location of a long-term flux monitoring experiment, where the net ecosystem exchange of these 4 communities was measured continuously by automated chambers. We assess the C turnover following a 3-hour pulse using isotopically highly enriched (95 atom% ^{13}C) CO_2 by tracing the label through leaf biomass and return of excess ^{13}C in respiration from plants and soil over an 8-day period. The results indicate a fast turnover of assimilated C in leaves, with a mean residence time (MRT) of about 1 day, and no differences between communities. For the ecosystem respiration flux, the isotopic label diminished at an even faster rate, with an MRT of less than 0.5 days. The ^{13}C content in fine roots showed only a slight and not significant enrichment 6 days after pulse labelling, while total soil (including fine roots) indicated a significant increase for only one of the communities (*Betula*) from 6 days after the labelling. The results are the first of this kind collected in tundra vegetation, and provide valuable data to constrain C allocations used in ecosystem models.