Seasonal Variability of Isotopic Composition and Flux of Soil CO_2 in Central Europe

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Isotopes of carbon (^{13}C, ^{14}C) proved to be a useful tool in studying the global carbon cycle. They provide additional constraints for currently used models of the carbon cycle and help to characterise sources and sinks of carbon, both on regional and global scale. Whereas the monitoring networks for studying isotopic variability of atmospheric CO_2 are well developed, the relevant data for soil CO_2, which constitutes an important component of the carbon cycle on continents, is still fragmentary. Systematic studies focused on full isotopic characterisation of soil CO_2 flux entering the atmosphere on the annual basis are virtually non-existent.

The flux and isotopic composition of soil CO_2 has been monitored at three sites located in southern Poland. They represent three most common ecosystems appearing in central Europe: (i) coniferous forest; (ii) cultivated agricultural field, and (iii) grassland. To monitor the flux of soil CO_2 and its isotopic composition, a method based on inverted cup principle was used. In addition, depth profiles of the soil CO_2 were regularly collected.

The flux of soil CO_2 in central Europe reveals distinct seasonal fluctuations, with maximum values up to ca. 30 mmol/m^2h during summer months and considerably lower values during winter. The highest fluxes were recorded at forest sites. The carbon-13 content of the soil CO_2 reveals little seasonal variability, with $\delta^{13}C$ values essentially reflecting the isotopic composition of the soil organic matter and the vegetation type. The carbon-14 content of soil CO_2 flux at the grass site was remarkably lower than at the forest site and lower than the present atmospheric value. The oxygen-18 isotopic composition of the soil CO_2 flux turned out to be controlled by the ^{18}O isotopic composition of the soil moisture and the temperature of the soil.