Geophysical Research Abstracts
Vol. 14, EGU2012-13954, 2012
EGU General Assembly 2012

Isotopic composition of soil CO_2 to evaluate microbial availability of organic carbon

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The production of CO_2 in soil strongly depends on microbial availability of organic carbon (C). It is obvious, that C that entered the soil recently is more easily available for microorganisms in comparison to older C: However, only very few approaches allow for a quantitative estimation of microbial availability of C in relation to the time it is entering the soil. We hypothesized that δ^{13}C values of CO_2 and of soil organic matter (SOM) after a C_3 to C_4 vegetation change will enable us to calculate the relative availability of younger and older C sources for microorganisms. Soil CO_2 was sampled over one vegetation period at depths of 10, 40-50 and 60-70 cm at three treatments: a C_3 reference (wheat), a C_4/fallow (fallow after one year of maize cropping), and a C_4/C_4 (two years of maize cropping). Based on the δ^{13}C of CO_2 purified from the admixture of atmospheric CO_2 by the Miller/Tans model and on the δ^{13}C values of SOM, the contributions of younger (C_4) and older (C_3) C sources to CO_2 and SOM were assessed. Depending on soil depth and the presence of living roots, the contribution of C_4-C to soil CO_2 ranged from 20 to 60 %, but that of C_4-C to SOM was less than 5 %. By comparing the contributions of C_3-C and C_4-C to CO_2 and SOM, we found that the relative availability of organics recently introduced into the soil was about 10 times higher than the availability of C stabilized in soil for longer than one year. We concluded that simultaneous analysis of the δ^{13}C values of both SOM and of CO_2 allows not only for the quantification of the CO_2 sources, but also for the estimation of the microbial availability of soil C pools of different age.