Geophysical Research Abstracts
Vol. 14, EGU2012-13809, 2012
EGU General Assembly 2012

Linking soil organic carbon pools with measured fractions

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Soil organic carbon (SOC) pools play an important role for the understanding and the predictive modelling of heterotrophic respiration. One of the major issues concerning model carbon pools is their purely conceptual definition. They are just defined by a turnover rate. Despite some attempts to link the conceptual model pools to measurable SOC fractions, this challenge basically remains unsolved. In this study we introduce an empirical approach to link the model pools of RothC with measured particulate organic matter fractions and an inert carbon fraction. For 63 topsoil samples from arable fields a mid-infrared spectroscopic approach was applied to determine the carbon contents in three particle-size fractions (POM1: 2000-250 μm, POM2: 250-53 μm and POM3: 53-20 μm) and a black carbon fraction. To provide the model pools for the 63 sampling sites RothC was run into equilibrium based on site-specific soil properties and meteorological data ranging from 1961 to present. It was possible to prove a link between soil organic matter fractions and pools of RothC. The coefficient of correlation between fPOM (POM1+POM2) and the resistant plant material (RPM) pool was 0.73. However, establishing multiple linear regressions based on all measured fractions instead of using just the fraction between 2000 and 53 μm significantly improved the prediction of the RPM pool. The resultant adjusted coefficient of determination using all fractions to predict RPM was 0.94. A stepwise regression algorithm based on the Akaike information criterion retained all measured fractions in the regression, pointing to the relevance of all fractions. The same was observed when linking the humic fraction of RothC (HUM) to the measured humic fractions, which were calculated as the difference between TOC and the sum of particulate and black carbon. The adjusted R^2 was 0.84. Using again all measured fractions as explanatory variables for HUM increased the R^2 to 0.99. From these observations we conclude that the entire range of available fractions should rather be used than a single fraction to predict model carbon pools from measurements, simply because each of the fractions contains a certain amount of information relevant to estimate the conceptual carbon pool. The proposed procedure, based on the rapid assessment of measurable SOC fractions, would enable an independent initialization and validation of pool-based carbon turnover models.