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Linking soil C pools with CO2 fluxes

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Despite the importance of carbon (C) pools and CO_2 fluxes in terrestrial ecosystems and especially in soils, as well as many attempts to assign fluxes to specific pools this challenge is not solved yet. Amusing is that scientists investigating pools are not closely linked with scientists studying fluxes. Therefore, this mini-review is focused on approaches allowing to link soil C pools with CO_2 flux from the soil. The background, advantages and shortcomings of uncoupled approaches (analyzing only pools or fluxes) and of coupled approaches (analyzing both pools and fluxes) were evaluated, and their prerequisites: steady state of pools and isotopic steady state are described. The uncoupled approaches include: i) long term monitoring of the decrease of C pools in bare soil remaining without C input over decades, and ii) analysis of components of CO_2 efflux dynamics by incubation of soil without new C input within months or few years. The uncoupled approaches are applicable for non steady state conditions only and have limited explanatory power. The more advantageous coupled approaches are based on simultaneous analysis and partitioning of pools and fluxes for components. The background and sensitivity of coupled approaches were analyzed based on three types of changes of isotopic signature of input C as compared to soil C: i) abrupt permanent, ii) gradual permanent, and iii) abrupt temporary impacts. The promising coupled approaches include: a) δ^{13}C of C pools and CO_2 efflux from soil after C_3/C_4 vegetation changes, b) addition of ^{13}C or ^{14}C labeled organics, and c) bomb-^{14}C. It was shown that physical separation of soil C pools is not a prerequisite to link pools with the fluxes. The future challenges include combination of two or more promising approaches to elucidate more than two C sources for CO_2 fluxes, and to link scientific communities investigating the pools with that investigating the fluxes.