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Short term dynamics of abiotic and biotic soil $^{13}CO_2$ effluxes after in situ $^{13}CO_2$ pulse labelling of boreal pine forest

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Physical diffusion of isotopic tracers into soil pores and back to the atmosphere constitutes a considerable uncertainty for the timing and magnitude of plant belowground allocation in pulse-chase experiments. Experiments that do not account for physical tracer diffusion into soil pores are prone over-estimate the amount of biological tracer allocation below ground, and under-estimate the time for this allocation to occur. We present results obtained during the $^{13}CO_2$ labelling of a Swedish *Pinus sylvestris* forest stand. Using a field deployed mass spectrometer, we monitored the soil CO_2 efflux and its isotopic composition from a combination of deep and surface soil collars. These are used to partition soil CO_2 isotopic fluxes into abiotic tracer flux (physical return), heterotrophic flux and autotrophic flux contributions. Additionally, ^{13}C of CO_2 within the soil profile was monitored. Physical (abiotic) efflux of $^{13}CO_2$ from soil pore spaces was found to be significant for up to 48 hours after pulse labelling, and equalled the amount of biotic label flux over 6 days. Changes in $^{13}CO_2$ concentration within soil pore spaces at different depths corroborated these results. Total soil CO_2 efflux showed significant variation between collar treatments. In particular, diurnal maxima observed on surface collars (i.e. with plant-derived C input through roots and mycorrhizal hyphae) were consistently shifted back in time by about 4 hours compared to deep collars (heterotrophic flux only). The variation in biotic $^{13}CO_2$ flux from surface collars was considerable, and showed a significant correlation with the proxomity of surrounding trees. Our results show for the first time the significance of the confounding influence of physical isotopic tracer return from the soil matrix, calling for the inclusion of meaningful control treatments in future pulse chase experiments. They further point to complex interactions between plant C input and CO_2 flux from bith autotrophic and heterotrophic sources, which warrant further investigation.