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Dynamics of litter carbon turnover in a detritusphere - Model-based evaluation of a ^{13}C microcosm experiment

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The detritusphere, the layer that includes the litter and the adjacent soil influenced by the litter, is a very thin but microbiological highly active zone in soil. To trace the fate of litter carbon in the detritusphere we performed a ^{13}C microcosm experiment and evaluated the data using a new one-dimensional dynamic mechanistic model. Soil cores were incubated with ^{13}C labelled rye residues (δ^{13}C=299‰), which were placed on the surface. Microcosms were sampled after 3, 7, 14, 28, 56 and 84 days and soil cores were separated into layers of increasing distance to the litter. Gradients in soil organic carbon, dissolved organic carbon, microbial biomass and activity were detected over a distance of 3 mm from the litter layer. The special feature of the applied new model is that it operates with two decomposer populations; the first one is dominated by bacteria and second one by fungi. Moreover, in the model the dissolved organic carbon (DOC) pool is divided into two subpools. Each DOC pool is consumed by one of the decomposer populations. The litter carbon is transported to the detritusphere soil by diffusion. After parameter optimization the model was well suited to simulate the experimental data. The model explained about 90% of the observed variance. The model output provides a comprehensive insight into the carbon cycling within the detritusphere. The simulation results show that after 84 days about 1% of the decomposed litter carbon were located in the DOC pool. About 8% of the decomposed litter carbon were transferred to the soil organic matter pool and 2% were recovered in the microbial biomass. Our study shows that a combination of experimental work and mathematical modeling is a powerful approach to provide a comprehensive insight into the small-scale carbon turnover in soil.