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Effective retention of litter-derived dissolved organic carbon in organic layers

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This study aimed to gain insight into the generation and fate of dissolved organic carbon (DOC) in organic layers. In a Free Air CO2 Enrichment Experiment at the alpine treeline, we estimated the contribution of 13C-depleted recent plant C to leached DOC from mor-type organic layers. In an additional soil column study with 40 leaching cycles, we consecutively added 22 and 45 mg l-1 of 13C-labelled litter-DOC to 5 cm thick Oa horizons at 2°C and 15°C and traced its fate into soil-respired CO2 and leached DOC. Results of the field study indicated that after six years of CO2 enrichment, DOC sampled with suction cups in the Oa horizon contained only 20±3% recent C, and thus, DOC was dominated by older C. Also, in the soil column experiment, DOC leached from the Oa horizons was mainly comprised of native C during all leaching cycles implying a sustained DOC generation from the large pool of indigenous soil organic matter (SOM). Less than 10% of totally added litter-DOC was leached. Therefore, most of the added litter-DOC was retained in the Oa horizon. Biodegradation contributed only partly to the DOC removal with 18 to 30% of added litter-DOC being mineralized in the Oa horizons at 2°C and 15°C, respectively. This was substantially less than the potential 70%-biodegradability of the litter-DOC itself, which strongly suggest a stabilization of litter-DOC in the Oa horizon. The retention of added litter-DOC was very rapid: although 50±7% of a bromide tracer passed through the columns within two days, less than 15% of the added 45 mg l-1 litter-DOC was leached, even at 2°C. These small leaching rates of litter-DOC at low microbial activities strongly suggests that physico-chemical interactions of litter-DOC with solid native SOM are primarily responsible for the initial rapid retention of litter-DOC in Oa horizons.