

New estimates place 1440-1600 billion tons of soil carbon in the northern circumpolar permafrost zone, more than 3x the carbon (C) in the atmosphere. Long-term DOC leaching and degradation are metrics of changes in ecosystem carbon storage and here we report the effects of a 2-month field incubation on DOC concentration and radiocarbon changes over time. DOC samples from two pore water sites with varied thaw depths and two headwater stream sites were incubated under photo- and biodegradation treatments and under a combined photo-biodegradation treatment. Nominal concentrations differed between sites, with more DOC in pore water than streams. Concentrations declined throughout the incubation at all sites; however, treatments which included photo-degradation led to the greatest DOC losses, with DOC declines of 50-80% of nominal by Day 60.

Nominal DOC radiocarbon signatures also differed between sites. For example, soil pore water was 18‰ more depleted in the site with deeper thaw, indicating a proportionally older DOC mixture. By Day 60, all radiocarbon signatures became more negative relative to Day 0, indicating that a greater proportion of DOC declines were due to the loss of young, enriched C. The photo-biodegradation treatment led to the most pronounced shifts, with $\Delta^{14}\text{C}$ -DOC shifts between -86 and -170‰ by Day 60. These negative shifts point to the fact that some older, ^{14}C -depleted DOC is less readily degraded and more likely to be retained in solution as water is exported from the landscape. However, ^{14}C -depleted DOC was not retained consistently throughout the incubation. In fact, all sites exhibited a positive $\Delta^{14}\text{C}$ -DOC shift during the first 10 days, indicating that there was a greater proportion of older C lost from solution during this time. Ultimately, the greatest loss of ^{14}C -depleted DOC was seen in soil pore water samples exposed to both photo-and biodegradation from the site, with the deepest thaw (21‰ $\Delta^{14}\text{C}$ shift by Day 7). These positive $\Delta^{14}\text{C}$ shifts indicate that older, permafrost-derived C is vulnerable to degradation following mobilization, particularly early on in its trajectory, from soil pore water to surface water. This process is irreversible and likely to further exacerbate climate change.