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The priming effect: Investigating the role of labile C quantity on subsoil C losses

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In a study examining changes in soil organic carbon storage after clearcut harvesting, we previously reported a 50% decline in soil C stocks approximately 30 years after harvesting, with the greatest losses reported below 20 cm in the mineral soil. Physical and biological separation of organic matter indicated that the decline was greatest in the fractions of organic matter that are conceptually thought to be stable. Stable isotope analyses were consistent with increased mineralization post-harvest and we speculated that the deeper stores of C might have been primed by a flush of labile C post harvest. A recent review (Blagodatskyaya and Kuzyakov, 2008) reported that the direction (positive, negative, neutral) of the priming effect may be dependent not only upon the energy content of the added substrate, but the quantity of C added relative to microbial biomass carbon (MBC). In this study we test this hypothesis using a lab-based incubation of soils collected from the surface (0-10 cm) and subsoil (35-50 cm) of an 80 year old red spruce forest. We added 10, 100 and 1000 % C (glucose) relative to MBC and measured the rate of decomposition (microbial respiration) every 5 h for the first week, every 24 h for the second week, weekly for a month and biweekly for two months. After flushing the headspace with CO2 free air, we measured the rate of microbial respiration and the 13C of the respired C using a Multiflow prep system with a Gilson autosampler coupled to an Isoprime mass spectrometer. We used an isotope-mixing model to partition the sources of respired C and determine the direction of priming. Our findings suggest that the quantity of added C can affect the direction of priming and that the relative priming effect differs between depths, suggesting that soil organic carbon stores in the subsoil are more sensitive to labile C additions.