NAME: Julie Jastrow
ORGANIZATION: Argonne National Laboratory
PROGRAM AFFILIATION: TES
ABSTRACT TITLE: Climatic and edaphic controls over root decomposition and leaf litter inputs to components of mineral-associated soil organic matter

ABSTRACT: Soil organic matter (SOM) represents the largest reservoir of C in terrestrial ecosystems and climate change is expected to modify soil C dynamics. Further, the contributions of root- versus leaf-litter sources to SOM are not well understood. As part of the Enriched Background Isotope Study (EBIS), our objectives were to study how climate and edaphic factors affect root decomposition, the transfer of root-derived materials to soil, and the transfer of leaf-litter C to mineral-associated SOM pools. We established ^{14}C-enriched root- and leaf-litter manipulations at four sites representing the climatic extent of Eastern deciduous forest. These sites span a range of soil types and mean annual temperature and precipitation. We followed root decomposition and incorporation of root-derived C into soil. We also assessed inputs of leaf-derived C into acid-hydrolyzable and acid-resistant C pools of the mineral-associated dense fraction of site soils. Our results showed that the enriched root mass in root decomposition bags decreased over time, averaging 73% at T3 (1Y), 58% at T4, and 44% at T6 (3Y). Root decay constants were significantly affected by climate and edaphic factors. Soils in root incubation bags showed ^{14}C enrichment after only one month, suggesting that root C was quickly transferred to SOM, perhaps mostly as microbial residues. After the first month, soil ^{14}C enrichment exhibited cyclic dynamics that varied by site, which were likely related to site differences in microbial activity and edaphic factors affecting SOM stabilization. After 3 years, the average root-derived C retained in the soil varied depending on site but, on average, accounted for 3% of total root decomposition inputs. The two sites with the highest soil C concentrations were also the sites that retained the most root-derived C, at about 5% of the total inputs. Across the EBIS sites, about 60% of the C in the soil dense fraction was acid-hydrolyzable, and C turnover in this fraction was 1-2 orders of magnitude faster (~35-350 y) than that of the acid-resistant fraction (~300-1500 y). Two years after the addition of ^{14}C-enriched leaf litter, no detectable leaf-derived C signal was seen in either fraction at the two sites with the highest soil C concentrations. At the warmest and wettest site, where turnover times were generally the fastest, leaf-derived ^{14}C was detected in the acid-hydrolyzable fraction at depths of both 0-5 and 5-15 cm. The acid-resistant fraction was also enriched with leaf-derived ^{14}C at 0-5 cm, possibly as a result of bioturbation by earthworms. At the site with the lowest soil C, leaf-derived ^{14}C was found in the acid-resistant fraction near the soil surface (0-5 cm). But, the lack of leaf-derived ^{14}C in the acid-hydrolyzable fraction suggests this potentially bioactive pool is not well protected by the sandy soils at this site. Overall, we found climatic and edaphic effects on root decomposition and mineral-associated SOM dynamics, which can contribute to model calibration and validation.