Soil organic matter persistence as a stochastic process: age and transit time distributions of carbon in soils

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The question of why some organic matter is more persistent than other that decomposes quickly in soils has sparkled a large amount of research in recent years. Persistence is commonly characterized as the turnover or mean residence time of specific compounds or soil organic matter (SOM) pools. However, turnover and residence times are ambiguous measures of persistence, which is better characterized by the probability distribution of ages in the system and in particular pools. We calculated age distributions for a wide range of SOM models, which showed long-tail distributions far from the mean value. Age and transit time distributions from a variety of models also showed: 1) transit times are lower than ages of SOM, 2) turnover times differ significantly from mean ages in slow cycling pools, 3) change in the inputs, without changes in the allocation of photosynthetic products, has no effect on transit times, but does affect system and pool ages. We propose an index to assess persistence of C in soils that can be derived from observations alone or from models. We also ask whether random chance is an important contributor to the persistence of SOM.