Sampling Proposal

* Soil C stocks are the balance on inputs and outputs
* Inputs expected to increase with warming
* Outputs also expected to increase
* Net effect unknown
* This is partly due to the fact that current approaches to quantify warming impacts tend to focus on net changes in CO2 fluxes and bulk soil C stocks
* Quantifying changes in CO2 fluxes from soil in response to warming yields valuable data, but does not capture potential shifts in the source of respired C. For example, increases in the flux contribution from soil C pools cycling on decadal or longer time scales, relative to pools cycling on shorter time scales, would indicate greater potential losses of soil C in the coming decades. Similarly, such changes in the source of soil CO2 fluxes could be occurring in the absence of changes in total fluxes.
* A further concern of focusing on CO2 fluxes as the primary metric for measuring warming impacts on soil C stocks is the timeframe over which CO2 fluxes are measured. A key finding from the first few decades of soil warming experiments is that soil CO2 flux responses appear to occur periodically, with phases of apparent increases in fluxes due to warming, followed by periods of no detectable differences between control and treatment plots. The signal from these longer scale processes can be lost when assessing treatment impacts on an annual to sub-annual basis.
* Measuring changes in soil C stocks is the most direct approach to quantify potential impacts of warming on soil C inventories. However, such changes are difficult to detect in the context of large existing stocks and high spatial heterogeneity
* Focusing on empirically defined soil C fractions, such as those resulting from density fractionation, can provide more nuanced insight, but this technique suffers from the same problem of spatial heterogeneity as bulk soil C inventories and is also sensitive to laboratory artifacts
* Radiocarbon evidence demonstrates that on average, the free light fraction isolated from density fractionation is comprised of more recently fixed carbon than the heavy fraction. However, the presence of charcoal in the light fraction complicates this picture, and recent work indicates that these fractions are likely mixtures of substrates cycling across a wide range of time scales, rather than homogenous pools
* In contrast, the radiocarbon signature of respired CO2 provides a direct measurement of the age of carbon leaving the soil. This signal is dominated by annual to decadally cycling soil C, in contrast to decadal and centennially cycling C in bulk soil. Converting the radiocarbon signal into a calendar age requires a model. However, if warming were to change the relative contribution of CO2 from soil C pools cycling at different rates this should be easily detectable due to the sensitivity of the 14C tracer.
* Radiocarbon is also a useful tool for tracking changes in the contribution of CO2 fluxes with depth. Soil C ages typically increase sharply with depth, with the specific rate of increase along the profile influenced by both climatic and mineralogical factors (Mathieu et al., 2015). The proportional efflux from the soil surface contributed by specific depth layers can be estimated with a simple diffusion model when paired with measurements of the vertical CO2 concentration gradient and soil porosity (Gaudinski et al., 2000). Additional measurement of the isotopic signature of respired CO2 from individual depth layers can be used to determine
* The change in soil C age with depth typically follows a negative exponential distribution.
* Soil C ages typically follow a Poisson-like distribution, with the majority of C relatively young, and long tail comprised of C cycling on centennial and longer time scales.

KEY QUESTIONS

How will soil warming affect the transit time distribution for the whole soil profile?

How will soil warming affect the transit time distribution for topsoil versus subsoil?

KEY MEASUREMENTS

CO2 efflux by layer---need CO2 concentration profile? E.g., gas well…?

Site Table