SWEDIE: Soil Warming Extended to Depth Data Integration Effort

Subsoil Warming Experiment Data Integration Effort

The impact of warming on global soil C stocks over the course of the 21st century is highly uncertain, as evidenced by modeling efforts. Warming is expected to increase both soil C inputs and decomposition rates, but the balance of these processes remains an open question with important implications for the trajectory of global climate change. Constraining projected soil C losses with data from soil warming experiments has proved useful, but earlier efforts to do so have been hampered by the relatively small number of experiments, as well as the underlying complexity of the processes driving soil C dynamics (Todd-Brown et al., 2018). The impacts of warming on subsoil C stocks (< 0.2 m), which comprise an estimated 50 to XX percent of total global soil C, is of particular interest. Yet few experiments have focused on these deeper soil layers, despite evidence that the mechanisms and controls that determine subsoil C dynamics differ from those observed in topsoil.

The Soil WArming to Depth Data Integration Effort (SWÆDDIE) was conceived to synthesize data from XX experiments worldwide, focusing on those with documented warming of at least 1 °C to a minimum depth of 0.3 m. The data from these studies will be compiled in a new database designed with FAIR (Findable, Accessible, Interoperable, and Reusable) principles to be flexible with regards to data ingestion, and support user-friendly querying and reporting tools. These experiments span a wide range of climate, vegetation, and edaphic conditions, positioning this database to provide strong constraints on global model predictions of future soil C stock changes. Furthermore, synthesizing these data offers a unique opportunity to identify metrics for quantifying the effect of soil warming on specific biogeochemical processes.

Warming impacts on soil biogeochemical processes range from alterations in soil moisture and the make-up of the microbial community, to changes in the chemical structure of plant inputs to soil and the balance of aboveground and belowground production, to shifts in the vegetative community. The impact of warming on soil moisture, for example, has the potential to depress decomposition rates as well as plant productivity and therefore soil C inputs. Soil moisture is also a master control on microbiological activity. Similarly, the role of stoichiometric constraints on both primary production and soil organic matter decomposition in the context of warming is an ongoing focus of study.

The effect of warming on soil C dynamics is frequently quantified using the Q10 metric, or by the log-response ratio of CO2 fluxes between control and warming treatment plots.

* One appeal of Q10 is the ability to plug this metric directly into a soil C model
* However, the Q10 formulation is limited by its mathematical form.
* Changes in CO2 fluxes from soil in response to warming are valuable data, but these data do 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 conducting 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.