Soil Carbon Fluxes & Estimation of Carbon Balance

Soil carbon storage represents a huge potential risk for exacerbating climate change but also a large opportunity to mitigate climate change. Soils store over three times the amount of carbon that is currently in our atmosphere. As soils warm due to climate change, microbial metabolic rates will increase, increasing soil carbon decomposition and releasing CO_2 into the atmosphere—a positive feedback to climate change. However, if organic matter inputs to soils increase, either due to increased plant growth or better soil management, soils may actively sequester carbon from the atmosphere. The balance of these two processes will determine whether soils will become a net source of carbon, exacerbating climate change, or a net sink, helping to mitigate climate change. Accurate data on soil respiration rates are needed to determine carbon losses from the soil to calculate soil carbon balance.

This CFLUX-1 automatically took soil respiration measurements every hour from June through November in an old field ecosystem at the Dartmouth College organic farm. (*Photo credit: Caitlin Hicks Pries*)

Dr. Caitlin Hicks Pries of Dartmouth College used a set of four CFLUX-1 Automated Soil CO_2 Flux Systems throughout the summer and fall of 2018 to measure soil respiration rates from an old field ecosystem that was previously used for agriculture. The soils at this site have lost up to 60% of their soil carbon stocks due to hundreds of years of farming, plowing, and grazing. These degraded soils represent an opportunity to increase soil carbon storage through compost additions. However, it is unclear whether efforts to increase soil carbon storage will be thwarted by increased decomposition rates due to warmer temperatures. Dr. Hicks Pries used the flux chambers to gather baseline data in 2018 before beginning experimental treatments in 2019.

Throughout four months of hourly data collection, the C-FLUX1's collected over 10,000 soil respiration fluxes (Fig. 1). These data were collected with a minimum of maintenance effort. The lab basically checked on the chambers using their Wi-Fi connection every two weeks and changed absorbent columns every six weeks. These data were used to investigate how seasonality, soil temperature, and soil moisture affected soil respiration rates. As shown below, soil respiration rates increased with temperature to about 25°C (Fig. 2). Above 25°C, soil respiration rates were dependent on soil moisture (Fig. 3). Using these data, Dr. Hicks Pries and her students will develop empirical models to estimate soil respiration throughout the year based on soil temperature and moisture.

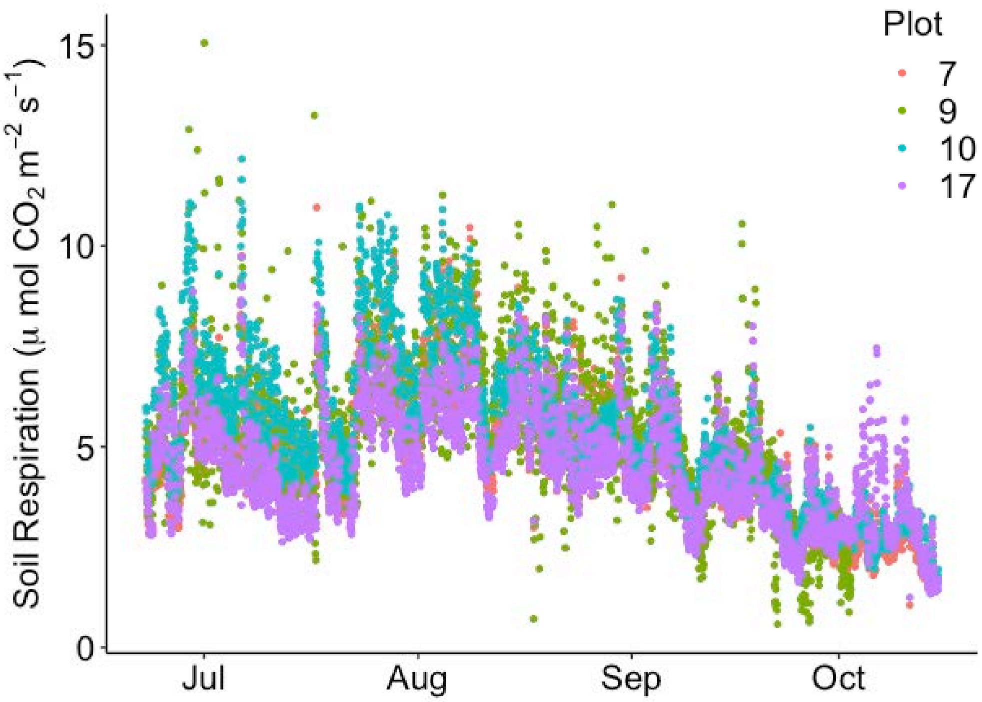

Figure 1.

All of the soil respiration data collected with the four CFLUX-1 systems over the summer and early fall 2018. Seasonal patterns are evident in the data showing decreasing soil respiration in September and October.

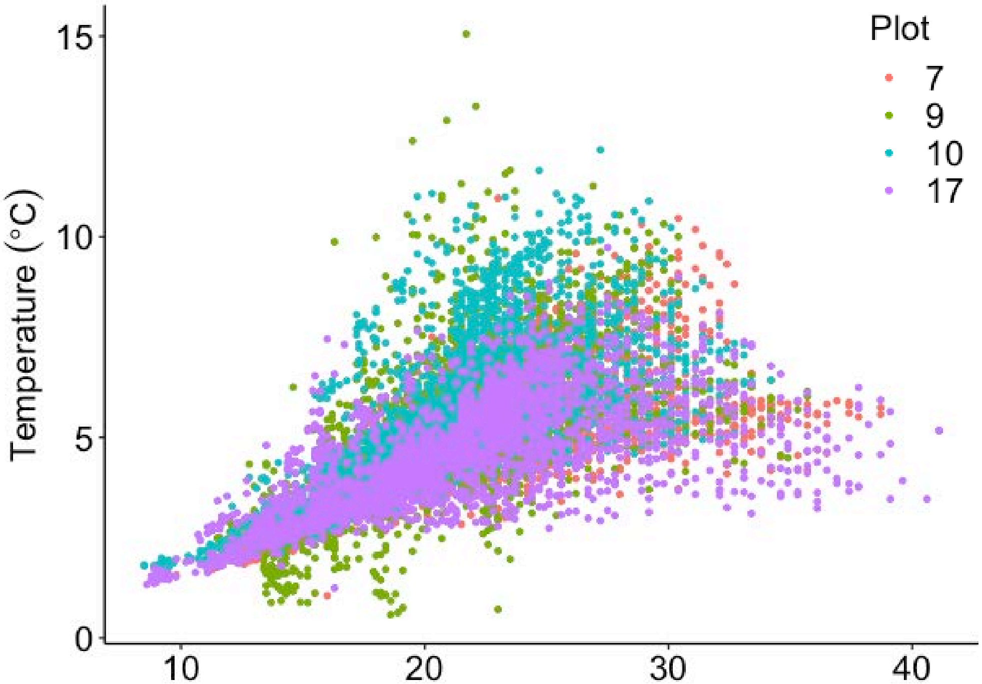

Figure 2.

Soil respiration rates increased with soil temperature (measured by the HydraProbe) as expected in all plots. We will use these data to fit various models of temperature sensitivity.

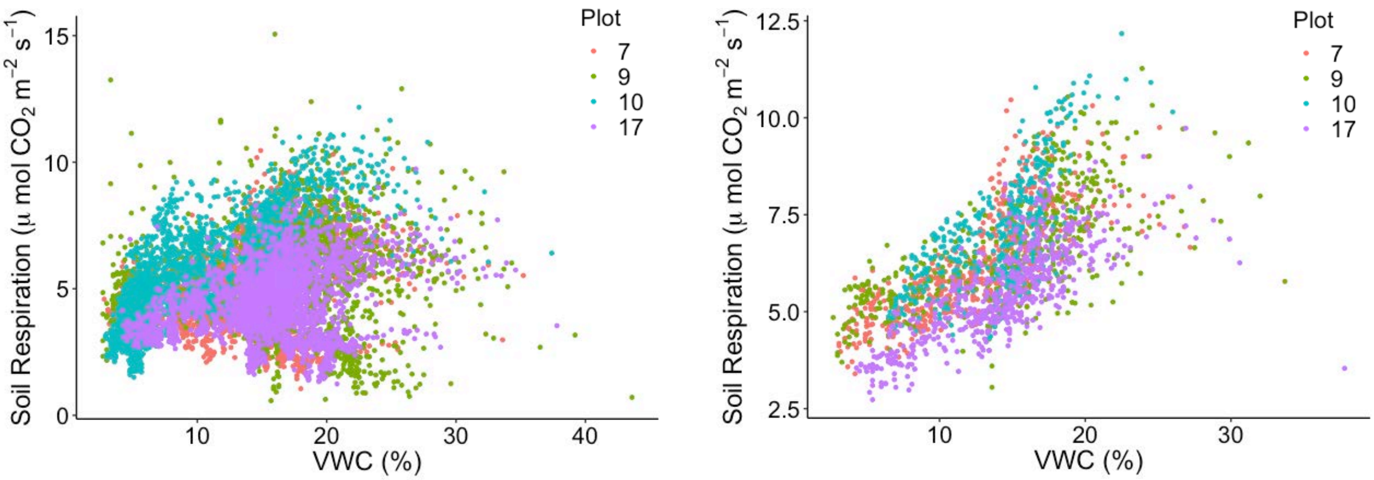

Figure 3.

Unlike with soil temperature, there were no obvious overall trends between soil respiration and soil moisture (volumetric water content measured with the HydraProbe; *right*). However, when temperatures were >25°C, there was a strong positive correlation between soil respiration and soil moisture.

The Hicks Pries lab will use an empirical model based on the CFLUX-1 data to estimate annual soil respiration losses. Combined with estimates of carbon uptake from the biomass of annual plants, the Hicks Pries lab will be able to estimate the carbon balance of their old field ecosystem. Once their compost addition by warming experiment begins, they will be able to compare these baseline data with the treatment effects. The CFLUX-1 Automated Soil CO_2 Systems and HydraProbes will continue to provide valuable data during the experiment.

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To learn more about Dr. Pries and the Hicks Pries Lab,
visit https://sites.dartmouth.edu/hicksprieslab/
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If you would like to learn more about this application or speak with one of our experienced technical staff, please feel free to get in direct contact with us via any of the contact information listed below:

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