SOIL CO2 FLUX SAMPLING INSTRUCTIONS

Field Guide

OVERVIEW

- □ In the exercise, students will use the Soda Lime Method to measure soil respiration (CO₂ flux). This method is a common and simple way of measuring soil respiration because soda lime absorbs carbon dioxide from the air.
- \Box Soda lime is made from sodium hydroxide (NaOH) and calcium hydroxide (Ca(OH)₂). When soda lime absorbs CO₂, two chemical reactions take place, both of which absorb water:

2NaOH (s) + CO2 (g) \leftrightarrow Na2CO3 (s) + H2O (ads) [1] Ca(OH)2 (s) + CO2 (g) \leftrightarrow CaCO3 (s) + H2O (ads) [2]

In the Soda Lime Method, a mini-atmosphere is created by placing a bucket facedown over a pre-weighed jar containing soda lime (Figure 1). As roots and microorganisms in the soil respire, CO₂ is released into this mini-atmosphere, or chamber, and CO₂ is then absorbed by the soda lime.
Over the sampling period, the amount of CO₂ released from soils can be measured by comparing the initial starting weight of the soda lime to the final weight. The soda lime gains weight as it absorbs CO₂.
There are four "base traps" of soda lime placed at the sampling site. Three of the traps are left open to absorb CO₂ over the sampling period. A fourth "blank" base trap stays closed and acts as a control to account for any CO₂ absorbed during sample preparation and transportation.

PURPOSE

 \Box Soil respiration, or soil CO₂ flux, represents the activities of roots and soil organisms. Like other biological processes, soil respiration tends to be faster at higher temperatures and when more liquid water is available. Soil respiration can also differ between land uses like forests and fields given differences in nutrients and leaf litter.

MATERIALS

- □ Soda lime (~ 400 grams per jar)
- □ Half gallon mason jars plus lids (four total)
- $\hfill\square$ Labeling tape and permanent marker
- □ Five-gallon buckets (four total)
- $\hfill\square$ Risers for keeping jars off of the soil surface
- □ Soil hand tools (trowel, serrated knife for installing buckets)
- \Box Scale
- \Box Drying oven
- \Box Deionized water (~600 ml)
- \Box Graduated cylinder
- □ Calculator
- □ Pen/pencil
- Notebook



Figure 1: Shows the bucket being placed over the jar to create a mini atmosphere.

* Drying and weighing of the soda lime can occur offsite if the proper lab facilities are not in place*

PROTOCOL

Before the measurement begins:

- □ Visit the field site and choose four areas about 1 meter apart. At each area, invert a five-gallon bucket. Using the trowel and serrated knife, cut ~10 cm into the soil around the circumference of the bucket. This will allow for a tight seal between the bucket forming the chamber and the soil once the measurement starts.
- □ The day before the measurement begins, weight ~ 400 g of soda lime into each of three pre-labeled, half-gallon jars. Be sure to wear protective clothing, eyewear, gloves, and close-toed shoes.
- \Box Place the jars inside a drying oven at 100°C for 24 hours to remove any water.
- □ Using mitts, remove the jars from the oven. Immediately close tightly, reweigh, and record weight.

At the start of the sampling period:

- \Box Place each jar on top of a riser in the middle of where the bucket will be turned upside-down.
- \Box Open each jar and use the graduated cylinder to add 150 ml of deionized water to enhance the soda lime's absorption of CO₂ in cold conditions.
- \Box Close the lid on the blank jar, but leave the lids open on the sample jars.
- □ Invert the five-gallon buckets over each jar, creating a seal between the bucket and the soil.

At the end of the measurement period:

- \Box Carefully lift buckets and retrieve jars. Quickly secure the lids to prevent more CO₂ absorption.
- \Box Once inside, the jars should be placed into an oven for 24 hours at 100°C to remove any water.
- $\hfill\square$ Using oven mitts, remove the jars from the oven. Weigh and record weight.

To calculate soil respiration:

Determine how much weight the soda lime gained during the sampling period (for both sample jars and blank jars).

Weight gained (g) = post-sampling weight (g) - pre-sampling weight (g) - jar plus lid weight (g)

□ Correct for weight gained by the "blank."

Blank corrected weight (g) = weight gained by the sample (g) – weight gained by the blank (g)

 \Box Correct for water weight loss. Multiply each blank corrected weight by 1.69 to account for the fact that for every mole of CO₂ (which weighs 44 g) that the soda lime absorbs, it loses one mole of water (which weighs 18 g). 44 / (44-18) = 1.69

Water corrected weight (g) = blank corrected weight (g) * 1.69

 \Box Calculate the respiration rate in grams of CO_2 released per square meter per day

Soil respiration (g CO₂ / m² / day) = water corrected weight (g) / area of chamber (m²) / sampling period (days)

NOTE: when jars are open during sample preparation, installation, and during sample retrieval, be sure not to breathe directly into the jars. The soda lime will absorb the CO₂ you respire just as easily as it absorbs respiration from the soil!!

Pre-sampling jar weight (g)				Post Sampling jar weight (g)				Respiration rate (g CO_2/m^2 day)			
Jar 1	Jar 2	Jar 3	Jar 4	Jar 1	Jar 2	Jar 3	Jar 4	Jar 1	Jar 2	Jar 3	Jar 4
			(Blank)				(Blank)				(Blank)

