

LICOR LI-6400 STANDARD OPERATING PROCEDURE - FIELD SOIL RESPIRATION MEASUREMENTS

Materials needed for field measurements:

- 1) LI-6400
- 2) umbilical (cords) and sensor head with soil chamber
- 3) charged batteries and spares (4 per instrument)
- 4) Legs for instrument
- 5) Soil temperature probe
- 6) Manual #6
- 7) Field LiCor kit with spares and tools
- 8) Trash bags to cover the licor in case of rain
- 9) soil respiration notebook and pens

Set up and Turning on the LI-6400

Connect legs to Licor

Insert and connect charged batteries

Connect chamber to console (only do this when the licor is off or asleep);

Make sure tubing connections are all tight and all pieces are present; consult manual if necessary

Connect the soil temperature probe

Position the copper tubing on the inside of the soil chamber head so that it will be close to the surface of the soil when making measurements but will not be pulling soil particles into the optical benches.

Put the soda lime on scrub; dessicant also if necessary.

Turn on console

Select the soil chamber configuration file

Warm up

Let the Licor IRGAs warm up for about ten minutes.

During this time, in the new measurements menu:

Check the pressure sensor to see if it's stable and reading reasonable values (should be around 100 Kpa)

Check to see if the chamber fan turns on and off (Level 3; F3)

Check to see that the CO₂S (line a) is reading reasonable atmospheric values

Check that the temperature of the air, chamber soil are all within a degree (when the soil temp probe is in the air)

Open a log file, and label it with site, date, and plot number (see below); (level 1; F1).

Turn prompts to 'Prompt on log' (Level 3)

On line 7 in new measurements make sure the measurement cycle number is set to 4, and you are logging only the final efflux values

Make certain set the insertion depth (Level 7, f5) to 2 (or whatever you are using)

Set the field notebook up by recording the date and the name of the log file; use the column headings of: Time, ID, Efflux 1, Efflux 2, Efflux 3, Efflux 4, Soil temperature, chamber relative humidity and Notes.

Set the ambient target value

After the warm-up, remove the cap on the soil chamber and set the chamber sensor head on an undisturbed vegetation-free patch of soil near the point of interest. Make sure the chamber head is away from breathing humans!

Check the CO₂S graph after at least two minutes. Use the median, stable CO₂S value over that period of time as your target (Level 7 f1). Typical target values for high elevation CO sites range from 385 to 415ppm. Leave the delta at 10ppm initially.

Changing the delta: Increase your delta to 15ppm for efflux rates over 7; the delta can be dropped to 5 for efflux rates around 1 or lower. Don't forget to return your delta to 10 when finished with your measurement.

Re-set your target about every two hours or when you move from between a site or a nest and a control.

Making Measurements

Set the Licor near the spot to be measured

Set or check that the stop collar on the soil chamber head is in the right location so that the insertion depth is correct (likely use 2cm unless it is vastly different). The metal rim of the stop collar on the soil chamber will rest approximately on the soil surface. Make sure that you tighten the red knobs on the chamber stop collar adequately during adjustment to prevent slippage. Enter your insertion depth (2cm) into the Licor when prompted **and** manually (Level 7; f5). In this case, the number entered is always a positive number.

Minimizing disturbance to the soil, gently clear the large leaf and stem litter from the soil surface at the measurement location. (You may want to use the soil temperature probe rather than your hands to do this due to the venomous snake issue). Insert the soil chamber evenly into the soil to the level of the stop collar with the heavier back of the sensor head in the uphill direction to increase stability. To conserve battery life by minimizing the time the pump is running try not to breathe into the chamber when inserting it into the soil. Insert the soil temperature probe completely and vertically directly next to the soil chamber. Try not to stress the temperature probe connection cord.

Directly after chamber insertion, start the measurement cycle (level 7, f3). You will be prompted for Msmt ID. Enter the insertion depth, which should usually be 2 (also do this manually; Level 7; f5), and then hit 'y' to append the data to the current open log file.

Measurements can be stopped and re-started (level 7, f3) if necessary.

The Licor will start cycle 1: pumping down, then enter cycle 2: waiting to start, then progresses to cycle 3: measuring. The Licor will then proceed to cycle 4: compute final efflux value, and beeps when this is finished. This value is stored in the Efflux measurement of line b and should be recorded in the field notebook.

Take four efflux measurements per location. The Licor will cycle through four measurements automatically. If efflux measurements are greater than 30% apart in value, carry out additional efflux measurements by starting a new measurement cycle of 1 or 2 if necessary.

Time (line g) should be recorded at the beginning of the measurements, and the soil temperature should be recorded at the end of the measurements to allow the probe adequate time to equilibrate with the soil. Make sure your temperature reading is correct (compare with others) and stable with a good connection, as the thermocouples in the soil temperature probes can get stressed and become unreliable.

Record notes or mistakes in both the notebook and the log file via the 'add remark' function.

Other considerations

If you get a high humidity alert, turn the knob on the dessicant chemical to scrub. Dessicant needs to be changed out when the color indicator turns purple. Soda lime should be fine for the duration of the study. ONLY open chemical tubes from the bottom, if you try to do this from the top, you will ruin the column. When putting the bottom cap back on the chemical tube, make sure the cap is threaded correctly and threads are clean or you can induce leaks into the system. Store used drierite in ziplock bags. Used drierite may be recharged on trays in the drying ovens at 65°C for 24 hours.

During lunch or breaks, the Licor can be put to sleep (found in the utility menu) in order to save battery life.

When the low battery warning is beeping consistently (not just during pumping down) it is time to replace your batteries. Always close your log file (level 1) before changing your batteries. If you close and re-open the same log file on the Licor, (if not highlighted automatically you have to type the existing file name exactly), you will be told that the file already exists, and that you can **Append**, **Overwrite**, or **Cancel**. ALWAYS, ALWAYS HIT 'A' FOR APPEND! NEVER OVERWRITE A FILE.

To change your batteries, pull the connection on one battery and immediately reconnect a fresh battery, simply leaning it against the console for now. The discharged, disconnected battery can then be removed from the console housing. Then disconnect and remove the other old battery. Insert a fresh battery into the available space you have just made and connect it. Then disconnect the fresh battery leaning against the console and insert it into the body and reconnect it.

Measurements should not be made in the rain or directly after a heavy rain. A light sprinkling is ok.

Measurements on soil should always exclude live vegetation.

Store and transport Licor equipment as carefully as possible, avoiding having it bounce around loosely in transport

Shutting down

When finished with measurements, close your log file and escape out of the new measurements menu.

Turn off the Licor and dismantle the legs and umbilical connections to the console. Re-cap the soil chamber removing any loose particles of soil that may have gotten into the chamber. Wrap cords carefully around the chamber head and store along with the console in a locked ambient temperature room.

To prevent crimping of the chemical column tubes, turn the soda lime and dessicant chemical tube knobs to the middle point between full scrub and full bypass.

Immediately re-charge the batteries upon returning from the field. This extends battery life and ensures you are ready for the next round.

Downloading data files

At the end of every day, download your data in the lab using the serial download cable and the LI-6400 file exchange software. The Licor can be powered on without the sensor chamber attached, simply tell it no (N) when it asks if the IRGAs are connected during the power on procedure. Go to the Utility menu (f5) from the Welcome screen and select the file exchange mode. Open the file exchange program on your computer and hit connect to establish communications. Transfer the file of interest to your computer. Back up this data. To work with the files, open them with Excel, highlight the first column, under the data menus select text to columns and then when prompted choose the comma delimited option. When shutting down hit disconnect in the file exchange software, escape out of the file exchange mode and the utility menu to the main welcome menu and then power off the console.

Cleaning the Licor optical benches:

Working with soil is a messy business, especially when the chamber is being directly inserted into the soil surface. The optics in the IRGA are sensitive to dirt particles, and so the optical benches will very likely have to be cleaned out over the course of the summer. There are two ways to determine this 1) your Licor starts behaving erratically and is inconsistent with measurements or 2) the “IRGAs Not Ready” warning message appears in your console window even after the machine has been on and warmed up. Another way to check how clean the optical benches are is to examine the agc values (a measure of radiation attenuation in the non-absorbing reference wave bands for CO₂ and H₂O in the IRGAs). These values are on display level 1 in new measurements. With a good IR source and clean optics, these values are typically 0 or less. As the optics become dirty, these values will increase. Eventually (near 5000mV), you get “IRGAs Not Ready” and the CO₂ and/or H₂O status indicators in New measurements mode will stop showing OK. If the reference cell values (*CRagc_mv* and *HRagc_mv*) are well below 5000, but the sample ones (*SRagc_mv* and *HSagc_mv*) are >5000, then clean out the

sample cell. To do this, follow the detailed instructions in the licor version 4 manual found on pages 19-28 through 19-31. The full manual in all it's glory may be found at: ftp://ftp.licor.com/perm/env/LI-6400/Manual/Using_the_LI-6400-v4.pdf