

Greenhouse Gas Sampling Protocol for Mountain Meadows

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Necessary equipment (see Materials list from A. Merrill for more details on part numbers):

1. Vented static chamber (to construct, see protocol “Building a vented static chamber and collar” by BW Sullivan)
2. Beveled collars: (to construct, see protocol “Building a vented static chamber and collar” by BW Sullivan)
3. 20 mL Syringe (VWR #:BD302830, pack of 48)
4. Needles (VWR #: BD305176, packs of 100)
5. Stopcocks (ColeParmer #30600-01 packs of 10)
6. Re-sealable (e.g., Ziplock) bags (to store Exetainers, can be reused, quart size)
7. Soil thermometer (VWR # 470106-366, Pack of 6. Each technician should have 6)
8. FieldScout TDR Soil moisture probe, 7.5 cm length probes
9. Labco Exetainers 839W, Evacuated
10. A short piece of plastic composite lumber (preferably 12” long, 1 x 6” “Trex” or similar decking material)
11. Mallet or hammer (preferably a 3 lb Mallet)
12. Notebook (“Rite-in-the-Rain” brand preferable)
13. Several sharpened pencils and Fine point “Sharpie” Markers
14. Watch or timing device
15. Barometer or access to nearby weather station pressure data

Timing:

GHG flux sampling should typically occur in focus meadows between the hours of 9 am and 4 pm to standardize. Randomly select the order of meadows you sample: do not consistently sample one meadow early in the day and one meadow later in the day. Fluxes exhibit diel fluctuation. For most efficient sampling, the 24 chambers in the grid should be sampled in groups of 6, in an order that allows an individual to begin near the point at which they began. As with the meadows, do not always repeat the same order of the four groups of 6 chambers, as this could bias spatial results within the meadow if one group of 6 was always sampled first and one group was always sampled last, for example.

Based on meadow fluxes in mid-June and early July of 2015, and these chamber volumes, we recommend collecting samples at 0, 15, and 30 minutes after chambers are attached to the collars (referred to as Time 0, Time 1, and Time 2 in the protocol below).

1: Layout sites: See A Merrill's protocol for site selection and layout of 6 x 4 grid.

2: Install collars

~2 cm deep(1-3 cm ok), “cleanest” beveled side up – meaning most even grind. Use 3 lb Mallet or claw hammer (pictured) and Trex decking to install. Place decking (or 2x4 lumber) over collar and pound into ground. Step on one side of board to prevent bouncing. Rotate around collar as you pound it in.



Photos demonstrate installation of beveled collar. We recommend Trex or similar plastic composite decking rather than the wood lumber shown here, and a 3 lb mallet rather than the claw hammer shown here.

Allow collars to equilibrate for at least 1 hour before sampling
Collars should remain installed in the field unless exceptional circumstances (e.g., heavy grazing by cattle or disturbance by vandalism) require their removal and reinstallation every time. If collars must be reinstalled every time, use semi-permanent markers (PVC pipe, painted rebar, or flagging to denote placement of edge of collar (not center of collar). Consistently select one side (e.g., south side) of collar to flag.

3. Measure depth of collar.

You need to know the volume of air inside your chamber and collar. If you use the flat-topped end caps suggested by Sullivan, you can use that volume for your chambers. To measure the volume of air inside the collar:

- a. Measure depth of collar in two locations that represent the deepest and shallowest points of the collar
- b. Use a cheap flexible ruler available from Walmart. Be sure millimeter measurements start at edge of ruler. Record both depths in your notebook. Depths will be averaged, and used to calculate volume of cylinder inside collar.
- c. Especially when not installing collars, look for light or space between collar and ground. Re-install collar if there is a gap.



4. Assemble needle, stopcock, and syringe.

If press-fit, press tightly and snug with a twist at end to ensure seal. If Luer-lok style, attach with a twist. Ensure tightness remains during course of day of sampling. Caution: Needle is sharp. Test that syringe holds vacuum by closing stop-cock and pulling plunger and making sure it snaps back to 0 mL.



5. Label and lay out Exetainers.

These are Exetainers. Labels should reflect the chamber ID number, site number, and time. These Exetainers only show three time points (Time 0, Time 1, and Time 2).



We recommend keeping your three time points for each chamber in an individual Ziploc bag. This bag can be reused. We recommend removing all three Exetainers from the Ziploc bag before sampling, and after filling with sample, place the used Exetainer IN THE BAG. This will prevent confusion regarding which are used and which are not.

6. Ventilate chamber.

This is especially important if the chamber was placed face-down on the ground. It is recommended to always store the chamber face-up in the field. Regardless, we recommend “airing out” the chamber headspace to ensure no gas was trapped in the chamber prior to installation. Wave the chamber around at chest-height. Here is a slow-motion sequence of airing out the chamber:



7. Place chamber on collar.

Gently affix chamber to collar. Do not place substantial pressure on the chamber or else it will not remove from the collar well, and disturbance to the collar may occur after sampling. If that occurs, simply reposition the collar. You’ve correctly seated the chamber when it is firmly attached to the collar. There should be no movement of the chamber.



8. *Immediately take your Time 0 gas sample.*

a. With stopcock OPEN, pierce septum on chamber top with needle. Use finger to guide needle in to septum. NOTE: especially when septa are new, they can be firm and difficult to pierce. Guiding the needle will prevent bending needles.



b. **SLOWLY AND STEADILY** (over ~5 seconds) withdraw 20 mL of gas. Wait 5 seconds. Lower edge of black rubber plunger denotes volume.



c. Close stopcock



d. Remove needle from septum by holding NEEDLE (not syringe or stopcock) with two fingers and placing a finger or two on the septum to prevent it from pulling out of chamber top.



- e. With stopcock CLOSED, press on plunger to 17 mL, creating positive pressure in syringe.



This is the lower edge of the black rubber plunger. Use THIS to measure volumes.

- f. Open stopcock and vent positive pressure

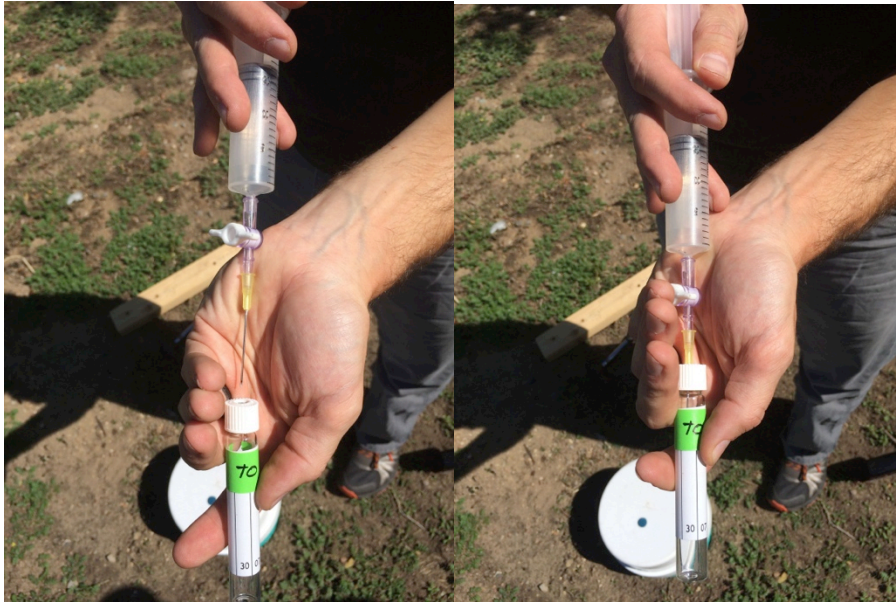


g. Pause for 5 seconds to allow pressure to equilibrate.

h. Close stopcock.



i. Pierce Exetainer with needle.



j. Open stopcock.



k. Push sample into Exetainer. You should feel or see the negative pressure in evacuated Exetainer pull the syringe plunger. If you do not see or feel pull, you have one of two problems: No vacuum in your Exetainer or a sticky syringe. Replace the syringes regularly (after 1-2 sampling dates) so they are well lubricated and not sticky. If the plunger does not move, immediately close the stopcock and use a new exetainer (always bring spare Exetainers and label appropriately).



l. Close stopcock.



m. Remove needle from Exetainer.



Note time at which sample was taken from chamber. Record in notebook. Keep vials out of the sun for prolonged periods. N_2O and CH_4 can photodegrade.

9. Move to next collar and repeat all steps.

All steps should take less than 2 minutes, allowing 6 chambers to be measured in a 15 minute period.

10. Sample soil moisture and temperature between 25 and 50 cm of the collar on the South side.

11. To measure soil moisture using FieldScout TDR:

Use Fieldscout to measure soil moisture during sampling period (if time allows) or after finished sampling gas fluxes. Measure soil moisture associated with each collar.



a. Turn on.



b. Insert probe into ground so it is flush with surface.



c. Press Read.



d. Record reading in notebook

e. Turn off by pressing "On"

f. Remove probe from ground.



Make sure rods are straight and not bent. Replace if bent.

12. To measure soil temperature:

Measure soil temperature at each collar location. Insert probe to 7.5 cm depth (same as the TDR). Do not push into soil using dial. Push from stem. Pushing from dial WILL break probe quickly. Allow to equilibrate. Record temperature in notebook.



Record air temperature by using thermometer in the shade at chamber height level. Once per sampling in middle of measurement period (for that group of 6) is sufficient. Record in notebook.