*Collaboration on*: El Verde GHG Array soil depth profile – oxygen and moisture sensors, soil nutrient analyses

*With*: W. Silver, UC Berkeley

December 22, 2015

*Included here:*

* Details about the soil collection and sensor installations done across topographic locations within the GHG array in December 2015
* This is primarily a record of the sampling/installation logistics

*What else is Christine supposed to deliver? a.k.a. forthcoming things:*

* There are details in the below that I need to check on; these are highlighted

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**Protocol (logistics):**

*Objective*: collect a 15 cm core of soil for nutrient cycling analyses from 0-15, 15-30, 30-45, 45-60, 60-75, 75-90 and 90-105 cm depths for four replicate El Verde catena ridge, slope and valley locations.  Install moisture/temperature and oxygen sensors at 15, 30, 45, 60, 75, and 90 cm for a ridge, slope and valley location.

- Sensor installation was done at El Verde research station in the Silver Lab greenhouse gas array on Sunday, Dec. 6, 2015 and Monday, Dec. 7, 2015.  Soil samples were collected on Monday-Wednesday, Dec. 7-9, 2015.  Field participants were C. S. O’Connell, R. Salladay, and B. T. Wickets.

*Soil collection*

- For each sample, we took a large auger (diameter X cm) and augered from 0-15 cm.  This soil was transferred by hand into a new gallon ziploc bag after removing obvious stones and woody litter (e.g., substantial roots).  We repeated this collection protocol in the same auger hole for collection of soil from 15-30, 30-45, 45-60, 60-75, 75-90 and 90-105 cm; we’ll refer to this wider auger hole as the “pit."

- Four replicate soil pits were augered from 0-105 cm along the catena ridge, slope, and valley.  This resulted in 4 replicate pits \* 3 topographic levels \* 7 soil depths = 84 soil samples.

- In reality, there were two omitted soil samples: after 4 attempts at augering a 4th slope soil pit to 105 cm, all four pits reached rocks at 75 cm, deep enough that we could not remove the rock by hand.  Soil depth replication is thus 4 replicates for depths 0-75, and 3 replicates for 75-90 cm and 90-105 cm.

- We did not clean the auger formally between each pit.  Instead, we visually removed the majority of the remaining soil as we moved from one replicate pit to the next.

- Generally, pit margins were clean and there was not much crumbling of pit wall soil into the pit bottom.

- Labeling details can be found on the associated spreadsheet sent by C. S. O’Connell (see file “Dec 2015 soil depth samples labeling key.xlsx”).

- After field collection, samples were transferred into a field cooler for shipping (shipped on 2015/12/9.  They arrived at the Silver lab on Thursday, Dec. 10 and processing began Friday, Dec. 11.

*Soil sensor installation*

- Six oxygen sensors (Apogee model S-110) and six moisture/temperature sensors (Campbell models CS 615 and CS 655) were installed into six auger holes at a ridge, slope and valley location.

- For each sensor pairing (i.e., one moisture and one oxygen sensor), we took a large auger (diameter X cm) and augered two immediately adjacent auger holes to the same depth.  This approach created an auger hole to the appropriate depth with a double width, which accommodated the moisture and oxygen sensors side by side.

- Double-width auger holes were made to 15, 30, 45, 60, 75 and 90 cm depth, for a total of 6 auger holes in close proximity (~1 square meter).

- In each hole, the moisture probes were installed by inserting them vertically into the soil at the auger hole depth (e.g., 15, 30, etc.) on one side of the double-width auger hole.

- On the other side of the double-width auger hole, we augered a further 5 cm down.  Each oxygen sensor was encased in a protective PVC open-ended enclosure; it was approximately 5 cm from the enclosure end to the oxygen sensor.  Thus, augering to 20 cm would ensure that the pxygen sensor itself was located by 15 cm depth after installation.

- One both sensors were installed, the excavated soil was repacked into the auger hole.  As much as possible, we attempted to pack all of the soil back in to keep bulk density similar above the newly-installed sensors.

- We installed the sensors in this fashion after deciding against two installation alternatives.  We considered installing all 12 sensors (6 oxygen, 6 moisture) into a single auger hole with sensors located at depths down a single profile.  However, we decided that the disturbance above and below each sensor, and possible hydraulic changes brought on by “in the way” sensors at the top of the soil profile would be too problematic.  A second approach that we discarded was to dig a large soil pit and install the probes vertically into the pit wall at each depth, and then fill the pit back in with soil.  We decided against this approach because to get the 90 cm sensors installed would require a pit the size of a field worker to stand in, which we determined was too disruptive to the array.

- Because we had two moisture sensor types available (the majority of which were CS 655 model, which is also the model found in the surface sensor array), we only installed CS 655 models at the 15 cm depth.  That way, we can check their results against the surface measurements from the array from a different model number and assess whether the model numbers themselves are presenting large artifacts.

- This auger was cleaned of visible soil with water between each soil pit series, but not between each depth for a given pit.

- Generally, pit margins were clean and there was not much crumbling of pit wall soil into the pit bottom.

*Soil processing*

- Each soil sample was processed for the following lab protocols:

* HCl iron extraction (for Fe(II) and Fe(III))
* KCl inorganic N extraction (for NO3- and NH4+)
* Soil was transferred to mason jars for KCl inorganic N extraction after 7 days (for net N min and net nitr rates)
* pH meter
* Gravimetric soil moisture
* NaHCO3 P extraction
* Subsequent NaOH P extraction

- Samples #1-37 were processed on Friday Dec. 11 and samples #38-84 were processed on Monday, Dec. 14.

- As of 2015/12/21, here is the status of the various sub-samples of soil:

* Fe samples: filtered and under Al foil in a dark cabinet; pellet discarded
* Inorganic N extractions: processed and frozen the day of processing (NO3, NH4); processed and frozen the final day of incubation (net N min, nitr); soil discarded
* pH: read by pH meter the day of processing; soil discarded
* Gravimetric soil moisture: pre- and post-drying weight recorded; soil discarded
* P samples: NaHCO3 and NaOH decanted and frozen; pellet discarded
* Extra soil samples: in the coolers that they were initially shipped in