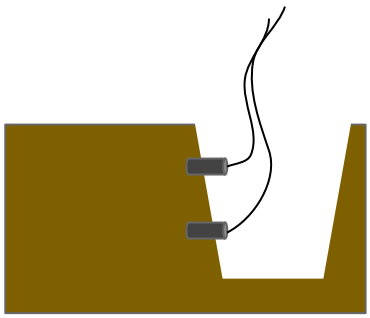
Installing the eosGP for soil based CO2 measurements

Introduction

The waterproof Eosense eosGP CO_2 probe measures CO_2 concentration in the soil through diffusive equilibration with the soil air-filled and water-filled pore space. These measurements are most often used as part of the gradient method to calculate CO_2 effluxes, but may also be used to estimate pore space storage of CO_2 and track a number of biological and geochemical processes (e.g. carbonate weathering). In this application note the various methods of burying the eosGP in a soil medium will be discussed.

Horizontal Burial

Horizontal burial is often used when researchers are seeking to target specific soil horizons or other soil features. Typically, a large pit is dug into the soil, exposing the pit face for sensor installation. In order to minimize disturbance to the soil structure on the face of the pit, a drill or auger is used to make a hole large enough to install the soil sensors. After installation, the pit is then backfilled, trying to maintain roughly the same soil structure and horizionation that existed originally.

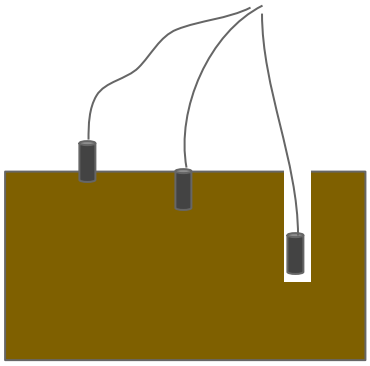


The horizontal approach allows for easy evaluation of the soil structure and a more accurate placement of the CO_2 sensors. However, this method is labour intensive and disturbance to the soil is high, leading to potential changes in overall gas behaviour. Additionally, horizontal burial does not allow for easy access to the sensors for re-calibration or repair, leading to potential data loss or further disturbance for retrieval.

A vertically buried eosGP in an Alfalfa Field (Baldocchi Lab UC Berkeley)

Vertical Burial

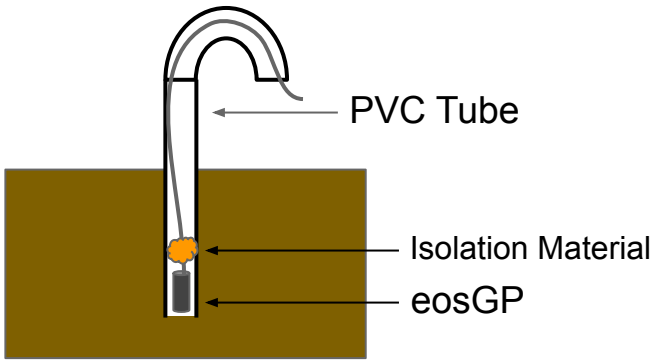
Vertical burial is also a common approach, and involves simply augering or drilling an appropriately sized hole to the desired depth in the soil. The sensor is then inserted (as in the photo above) and the space between the sensor and ground surface is backfilled with native soil.



Vertical installation is less labour intensive and creates less ground disturbance than the horizontal installation; however, retrieval of the sensors for calibration and repair purposes can still be difficult. Typically in a vertical installation it is also more difficult to determine which soil horizon or features are present at the measurement depth, which may lead to uncertainty in soils with high spatial heterogeneity.

Vertical Burial in Tubes

Some of the issues of vertical burial, including the ability to retrieve the sensors, can be overcome by using PVC or ABS tubes in the burial process. The general procedure is the same -- a tube with the appropriate inner diameter to hold the sensors is inserted into the soil, and the sensor is lowered into the tube and then isolated from the atmosphere using a packing material. Typical isolation materials include rubber gasket material (e.g. neoprene), closed cell foam, or electrician's putty. The top of the tube can then be fitted with a U-joint tube fitting to allow the sensor cable to come to surface and prevent precipitation from accumulating in the tube.



Despite solving some of the issues related with standard vertical burials, this method may still lead to biases in soils that have large spatial heterogeneity.

eosGP Specific Installation Tips

Generally, a vertical tube burial is the easiest for multiple reasons. Below are some eosGP specific recommendations and tips for installation.

Tubing Diameter

A tubing inner diameter of around 2 inches (51 mm) is ideal for the eosGP installation, as it allows for minimal space to fill with putty or other isolation materials. However, in certain cases a larger tube diameter (i.e. 2.25 inches/57 mm) may be required to deal with irregularities in the tubes and tolerances in the extrusion process.

Isolation Materials

Isolation materials are critical to ensure minimal contamination from atmospheric gas. Putties are easiest to fill in small gaps, however are relatively hard to apply in a deep tube. Gasket or foam material more easily pushed down tube, but is more likely to provide a poor seal due to compressibility. A combination of putty and closed cell foam is the best option for a good seal.

U-joint

Installing a U-joint at the top of the tube keeps rain from pooling on the isolation material, but be sure not to glue the U-joint in place so that the sensor can be removed when required. Electrical tape is a good substitute for glue to keep the U-joint in place.

eosGP Installation

Connect the eosGP and cable, and then lower the eosGP gently down the tube -- don't push into the soil when the tube bottom is reached. Connecting a second piece of twine or wire is also helpful, as the cable may become damaged if too much force is applied when recovering the eosGP unit.

Conclusion

There are multiple ways to install the eosGP in the soil to monitor soil pore space CO_2 concentrations. While each method of installation has its pluses and minuses, Eosense typically recommends installation in vertical tubes if possible.

Technical Specification Highlights

Dimensions (⌀ x L)	5.1 x 10.7 cm / 2 x 4.2 in
Operating temperature	0 to 40 C / 32 to 104 F
Operating power - avg / peak	< 0.5 / < 1 W
Operating voltage	5 to 24 V DC
Time to equilibrium	< 90 s (in air)
Mass (approx)	200 g / 0.44 lb
Output voltage	0 to 5 V DC
Concentration accuracy	1% range + 1% reading
Calibration ranges (ppm)	0-20,000, 0-50,000, 0-125,000 Dual 0-5000 and 0-20,000

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