MEASURING TRACE GAS EMISSIONS FROM SOIL: SOLVING THE KNOWN UNKNOWNS

Trace gases emitted from soils can contribute to climate change, local pollution, and higher agricultural production costs due to volatilisation of fertilisers. Although many of these emissions have been characterised for certain soils, gases, and agricultural systems, many of the techniques used to measure soil emissions represent only a brief moment in time and very limited land area. Extrapolating from these limited data leads to errors and false assumptions about the emissions of gases and loss of fertilisers from soils.

The LI-8100A system is ideal for measuring gas exchange from soils. It can be configured for single-chamber survey measurements or long-term measurements with up to 16 chambers.

With modern chambers and gas analysis technologies, researchers, consultants, and agronomists are now able to characterise the exchange of trace gases from soil over longer time frames and larger areas than ever before. This provides a more complete understanding of the local events that affect the global climate, more complete data for climate models, and a better understanding of the effectiveness of efforts to mitigate climate change. In addition, this technology can help optimise fertilisation application and reduce costs of agricultural production.

The two major technological advancements that have enabled this are: 1) the development of soil gas exchange chambers that are designed with consideration of the complexities of gas exchange from soils; and 2) advanced gas analysis techniques that provide the precision and stability required to measure low concentrations of gases, such as CH_4, N_2O, NO_X, NH_3, and many other relevant gases.

The dynamics of gas emission from soils have been studied for many years by collecting samples near the soil surface and taking them to a lab for analysis. This technique is relatively easy, but it rarely provides enough information to fully characterise gas exchange, and is therefore limited in its ability to draw conclusions about the gases emitted. Measurements from chambers however, can characterise emissions over longer time frames and with greater precision.

Closed-chamber systems, such as the LI-8100A Soil Gas Flux System, present many advantages over laboratory analysis. The LI-8100A can be used to evaluate a single location at a single point in time, and can be expanded and automated to continuously measure emissions at up to 16 locations over time. The LI-8100A is available with several types of chambers, which can be interchanged based upon the specific measurement needs.

Two chambers, the 10-cm and 20-cm survey chambers, are designed specifically to be carried from point to point, so a large area can be surveyed in a short time. The opaque and clear long-term chambers, in contrast, are designed for long-term field deployment. Up to 16 of the long-term chambers can be connected to the LI-8150 Multiplexer to collect a robust data

Soil gas exchange chambers are designed to minimize disturbance to the soil environment.

set over a 700-m^2 area. The chambers can operate for weeks or months at a time without user intervention.

The LI-8100A chambers were originally developed for a system that measures CO_2 emissions from soil, but now can be used to characterise the emission of other important gases with a compatible trace gas analyser. The chambers, which are part of the LI-8100A, were designed based upon the careful study of fluid dynamics at the soil surface, and are compatible with analysers that are capable of measuring most trace gases.

What makes the LI-8100A chambers unique?

The robust, well-built chambers provide dependable long-term service in outdoor settings, such as agricultural fields, grasslands, forests, and even when deployed on a float over standing water. This enables them to operate autonomously for months on end.

Their hemispherical shape means that air in the chamber is well mixed, so there are no dead volumes of unmixed air in the chamber, which is hard to avoid in cube-shaped chambers.

The chambers feature an automated closure mechanism, which minimises disturbance to the gas concentration in the soil when the chamber closes. When a chamber is set on the soil surface, it causes a temporary emission pulse, which can affect the measurement. The LI-8100A chambers are slowly lowered by a computer-controlled mechanism, minimizing the placement impact, and leading to a better measurement.

With adjustable legs and a high-emissivity white enamel finish, the chambers have a minimal impact on the measurement site. Any instrument can affect the variable you are trying to measure, but the LI-8100A chambers minimise this impact by allowing soil around the chamber to "breathe" with the ambient air and by maintaining ambient temperatures at the soil surface.

The patented chamber pressure vent allows the chamber to maintain ambient pressure under calm or windy conditions over the course of the measurement. This solution gives more accurate measurements than unvented and open vented chambers, which is especially important when measuring trace gases at very low concentrations. The patented chamber pressure vent is unique to the LI-8100A chambers.

How do you measure trace gases with the LI-8100A?

The LI-8100A measures the rate of increase in CO_2 inside the chamber once the chamber is closed, and it computes the CO_2 flux. The system itself, however, is designed to accommodate nearly any other gas analyser, so that you can evaluate other gas species with the LI-8100A when using a suitable gas analyser. Not only does a trace gas analyser integrate with the chambers, you can record the trace gas measurements with LI-8100A data set and evaluate the data in SoilFluxPro™ Software.

You can add a trace gas analyser to the LI-8100A and record the trace gas data with the LI-8100A dataset, or you can connect the chambers to a trace gas analyser and control their operation from a microcomputer, such as an Arduino. This versatility enables you to create the system you need, while taking advantage of the superior design of the LI-8100A chambers.

Whether you are interested in greenhouse gas emissions or improving fertilisation efficiency in agricultural lands, the LI-8100A, when coupled with a trace gas analyser, will provide invaluable data. The modular system is designed for short-term survey measurements and long-term multiplexed measurements with up to 16 chambers, providing the versatility to ensure a valuable investment for researchers and consultants in agriculture and climate industries. Contact LI-COR Biosciences to learn more about the LI-8100A Soil Gas Flux System.

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