

## Continuous and simultaneous flux measurement of N<sub>2</sub>O and CO<sub>2</sub> from agricultural soil using a portable multi-turn time-of-flight mass spectrometer

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Agricultural soil is one of the important sources/sinks of greenhouse gases such as N<sub>2</sub>O, CO<sub>2</sub>, and CH<sub>4</sub>. The formation and consumption of such greenhouse gases in agricultural soils are dependent on not only the chemical and biological properties of the soil, but also their variations. Hence continuous monitoring of such greenhouse gases as tracer gases are quite useful to track chemical and biological processes and variations of soil properties.

In this paper, we describe a new field-deployable gas flux measurement system for the continuous monitoring of multiple agricultural soil gases (N<sub>2</sub>O, CO<sub>2</sub>, and CH<sub>4</sub>) using a high resolution multi-turn time-of-flight mass spectrometer (MULTUM) combined with an automated flux chamber system. The new system measured the soil gases every 2.5 min with the precisions of ~6% for N<sub>2</sub>O, CH<sub>4</sub>, and 2% or better for CO<sub>2</sub> and O<sub>2</sub> at atmospheric concentrations with one relative standard deviation (RSD) for n = 10.

To demonstrate the utility of the continuous multi-gas flux measurement system, we conducted a field study at the Ehime University farm (Ehime, Japan) from September 3<sup>rd</sup> to 8<sup>th</sup>, 2018. In the field study, an automated flux chamber was placed in the agricultural field and the soil gas concentrations in the chamber were continuously monitored by the MULTUM system. Soil temperature/moisture sensor were also monitored at the depth of 7.5 cm underground in addition to a weather information (wind speed, precipitation, solar radiation). The continuous measurement had been continued with operators almost unattended except for a daily system check.

For one flux measurement (20 min), eight gas samples were taken every 2.5 min with the flux chamber closed. Gas flux of N<sub>2</sub>O and CO<sub>2</sub> had been carried out by applying linear regression to the eight gas measurements. We found that a significant correlation of N<sub>2</sub>O flux with soil electrical conductivity and water content, although no significant correlation of CO<sub>2</sub> flux to soil electrical conductivity was observed. Significant and rapid decreases in N<sub>2</sub>O and CO<sub>2</sub> flux during rainfall events were also observed. Our preliminary result shows that high time-resolution flux data obtained by MULTUM system is quite useful for tracking the variation in soil properties and biological processes and their activity in soil environment.

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