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Characterizing Nitrous Oxide (N2O) Emissions over a Wheat-based Cropping System in the Northwest United States Using the Modified Bowen Ratio Technique and Static Chambers

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Nitrous oxide (N2O) is a potent greenhouse gas and ozone depleting substance. Agricultural soils are the primary source of N2O, which is created as a by-product of soil microbial processes. The production and emission of N2O is characterized by high spatial and temporal variability, or “hot spots” and “hot moments”. These behaviors, along with limitations in instrument sensitivity to N2O, are challenges in characterizing emissions. Many studies have monitored N2O emissions using either static chambers or micrometeorological measurements or the two methods together. The two techniques are complementary: chamber methods have a lower detection limit and are more reliable as their operation does not depend on atmospheric conditions, but may not capture spatial variability even with multiple chambers. Tower-based methods are subject to relatively high data loss due to non-ideal conditions and to less sensitive detection limits, but have a larger measurement footprint and can characterize field-scale emissions.

This study aims to characterize a long-term, field-scale N2O budget over two winter wheat fields located in the Inland Pacific Northwest of the United States, both in terms of an annual emission budget and in terms of understanding what causes hot moments. We combined continuous measurements of N2O emissions from a system of sixteen automated, static chambers with tower-based measurements of N2O fluxes. We used the modified Bowen ratio (MBR) technique with temperature as a tracer. Preliminary results indicate that freeze-thaw cycles in the winter make up a higher percentage of annual emissions than previously thought. Furthermore, comparison of the chamber results to the tower-based measurements imply that the chambers may be underestimating field-scale N2O fluxes because they are not adequately capturing hot spots of emissions. We are conducting ongoing work on how to integrate the two measurement techniques, as well as how the empirical measurements compare with other measures of N2O emissions for the region.