Investigating the diurnal variability of nitrous oxide emissions from soils

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Diurnal variations in soil nitrous oxide (N\textsubscript{2}O) emissions have been documented for nearly four decades yet consensus on their significance is still lacking. Resolving this question is important as soil N\textsubscript{2}O emissions have some of the highest uncertainties in national greenhouse gas inventories. A major challenge for understanding diurnal variation is that conventional measurements rarely operate at temporal frequencies that can observe and report this phenomenon. Some higher frequency studies have observed daytime peaking of soil N\textsubscript{2}O emissions and often ascribe it to the diurnal oscillation of soil temperature. However, night-time peaking and irregular diurnal N\textsubscript{2}O patterns have also been reported in a number of studies.

To investigate the prevalence and characteristics of diurnal N\textsubscript{2}O variability, we systematically reviewed published studies that measured N\textsubscript{2}O at high temporal frequencies (≥ 5 times/day). We identified 46 published studies covering cropland, grassland and forest soils; and extracted sub-daily N\textsubscript{2}O flux data and other soil parameters, yielding 286 individual days of data. Diurnal variability of N\textsubscript{2}O emissions were found in ~80\% of the data, with ~60\% peaking during the day and ~20\% at night. Diurnal N\textsubscript{2}O patterns were associated with non-diurnal factors including soil texture and land use but the relationship between soil temperature and N\textsubscript{2}O flux was inconsistent, with strong positive correlations (R > 0.7) only found in one-third of the datasets.

This talk explores the implications of the review results on the time of sampling using conventional approaches (single time-point flux measurements), and the potential drivers of diurnal N\textsubscript{2}O variations for future research. In addition, this talk will also introduce a novel automated measurement technique allowing flux measurements at high temporal resolutions and how its application could enable experimental investigations of potential drivers of diurnal N\textsubscript{2}O variability.