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A soft spot in our knowledge?
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A hotspot of CH$_4$ emission in a Danish agricultural soil: A soft spot in our knowledge?

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Danish agricultural ecosystems are one of the main contributors to the total anthropogenic emissions of greenhouse gases in Denmark. The main research focus on greenhouse gas emissions from mineral agricultural soils has been on N$_2$O, and on how the N$_2$O emissions respond to fertilizer addition and different agricultural practices. Studies on CH$_4$ fluxes are scarce and mostly show a small uptake of CH$_4$, indicating that oxidation of CH$_4$ is dominant in agricultural soils.

As part of the NATEF (National emission factors for nitrous oxide from nitrogen fertilizers and crop rotations) project, we have established a field experiment in Taastrup, Denmark. The experiment has been running since early 2019, and consists of 12 plots (4 rotation treatments × 3 blocks) that each are managed following a common Danish crop rotation (main crops: spring barley, winter wheat and oilseed rape) in addition to cover crops (oat, phacelia, oilseed radish) following winter wheat. The field experiment is one of four identical field experiments located across Denmark, thereby capturing the variation in climate and soil types seen in Denmark. The main aim of the project is to determine emission factors for nitrous oxide for Danish cropping systems. This is achieved by regular manual measurements of N$_2$O, CH$_4$ and CO$_2$ fluxes by the discrete closed chamber method in all plots. Furthermore, we have deployed an automated flux chamber system (ECO$_2$ FluX, Prenart Equipment) connected to a greenhouse gas analyzer (G2508, Picarro) to provide high-frequency measurements of the fluxes of N$_2$O, CH$_4$ and CO$_2$. In each growing season, two plots were selected and three automated chambers were placed in each plot, totaling six automated chambers in the study. The automated measurements allowed us to examine the high-frequency temporal dynamics in the fluxes, e.g. periods following rain events, freeze-thaw, fertilization or tilling.

As expected, we generally observed emissions of N$_2$O across all plots with different crops. CH$_4$ fluxes were slightly negative (i.e. uptake) or close to zero during most periods, indicating that oxidation was the dominant process. However, during the autumn of 2019, we captured CH$_4$ emission by the automated chambers in the plot with oilseed radish, while at the same time, the
automated chambers in a plot with winter wheat showed no CH$_4$ emissions. However, spatial variation in emissions were very large indicating that edaphic and topological factors played a major role. Our results show evidence that hotspots of CH$_4$ emissions can occur in Danish agricultural ecosystems that otherwise mostly act as a sink for CH$_4$. We expect that similar hotspots for CH$_4$ emissions could exist in other similar agricultural systems.