The impact of mineral soil coverage on N_2O emissions from organic soil drained for agriculture

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Peatland store 12 – 21 % of the total soil organic nitrogen (N), which accumulated over millennia. However, long - term drainage of peatland for agricultural use leads to a strong release of carbon and nitrogen and subsidence of peatland through aerobic peat decomposition. In order to improve the sustainability of peatland management in agriculture, and to counteract soil subsidence, mineral soil coverage is becoming an increasingly used practice in Switzerland. Mineral soil coverage may affect the N balance from the corresponding organic soil, owning to the eventual change of surface soil characteristics. However, the effect of mineral soil coverage on nitrous oxide (N_2O) emission has not been studied yet. Here, we report on a field experiment carried out to explore the impact of mineral soil coverage on the N_2O emission from drained organic soil.
The experimental site, a drained peatland with a peat thickness of around 10 m, is located in the Swiss Rhine Valley. In 1973, an integral drainage system was built. Since then, an intensivly managed meadow was established, with mineral and slurry fertilization and 5 to 6 grass cuts per year. In 2006, one part of the field (1.7 ha) was covered with mineral soil material (thickness 30 – 40 cm). We established our field experiement on this mineral soil coverage site (DC) and used the adjacent drained organic soil without mineral soil coverage as reference (DN). Both sites have the identical management and vegetation. In our experiment, an automatic chamber system is used for collecting the N_2O at an interval of 3 h. After one and a half year's (03.2019 to 08.2020) continuous measurement, the data reveals that: the average N_2O emissions from DN (10.66 ± 1.28 mg N_2O-N m^{-2} day^{-1}) exceeds the one from DC (1.14 ± 0.08 mg N_2O-N m^{-2} day^{-1}) by a factor of 10. The more details analysis shows that this difference between DC and DN is mainly driven by the different reaction to fertilizer inputs. In general, the N_2O peaks occur shortly after N application and last for 2 to 3 weeks before returning to background emission. The N_2O peaks after fertilization account for 80 % and 70 % of the total N_2O emissions for DN and DC, respectively. However, significantly higher peak N_2O emisisons were found in DN than DC, whereas the background N_2O emissions show no difference. To further explore the impact of mineral soil coverage on the N balance of drained organic soil, extra $^{15}NH_4{}^{15}NO_3$ labelled fertilizer will be applied in September 2020 to trace the N transformation at DC and DN. In summary, our data suggest that mineral soil coverage could strongly reduce N_2O emission from drained organic soil, and may therefore be an interesting GHG mitigation measure in agriculture.