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Impact of future precipitation patterns in agroecosystems on CO_2 and N2O emissions – a green manure stable isotope labelling study

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Climate change is likely to affect precipitation patterns in the future, and as such is a determining factor in agricultural systems in terms of soil organic matter mineralization, nutrient release and therefore plant production. This study investigates the impact of precipitation on two different soil types – a sandy calcaric phaeozem (S) and a calcic chernozem (T) – representative of the Pannonian area of the Marchfeld region in Austria. A regionalized scenario RCP 6.0 derived from the 5th IPCC was used on a long-term lysimeter study in the Marchfeld, where future rainfall patterns were compared with current precipitation since 2011. In this study, green manure (Sinapis alba) labelled with 13C and 15N stable isotopes was applied to the lysimeter soil in April 2018.
Mineralization of green manure and release of inorganic bioavailable 15N NO_3 was confirmed after soil sampling at different time points throughout the growing season and elemental analyser – isotope ratio mass spectrometer (EA-IRMS) measurements. In addition to soil, plant and groundwater sampling, 15N N2O and 13C CO_2 measurements were conducted by using a cavity ring down spectrometer (CRDS) installed in the field and gas chromatography – isotope ratio mass spectrometry (GC-IRMS) respectively. Results showed initially low emissions of N2O (0.01 – 0.02 μg N2O m-2 h-1) after addition of green manure. In the second week N2O emission were higher under the current precipitation scenario. Incorporation of 15N label from the green manure into N2O was not observed. A simulated heavy rainfall event (60 mm) increased N2O emissions within a few hours with up to ten fold higher emissions in the future scenario, still no incorporation of label was observed. Highest N2O emissions especially in the current scenario was observed after commercial fertilizer (50 kg/ha) was added.
Source signatures of CO_2 according to the Keeling plots showed an immediate uptake ($\sim$hours) of the labelled manure. Differences in the green manure mineralization rate was identified for the soil types (S faster than T) but not for the future precipitation regime. However, total CO_2 emission (40 – 250 mgC m-2 h-1) from the calcic chernozem (T) were less for the future scenario. This study suggests that soil CO_2 emissions will become lower in these future precipitation scenarios. It also demonstrated the relevance of green manure as a fertilization strategy to avoid N2O emissions.