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N2O losses from Austrian grassland under climate change – An ensemble modelling approach

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Agricultural productivity and food security depends on the application of nitrogen (N) fertilizers. Since the use of N fertilizers has increased, it allowed the world population to increase from 3 to well over 7 billion while food and feed production from arable systems increased by 45–70% since 1950. The excessive use of N fertilizers causes harmful effects to the environment, e.g. increased emissions of nitrous oxide (N2O), nitric oxide (NO), ammonia (NH3) to the atmosphere and leaching of nitrate (NO_3) into water bodies. Combined with climate change (temperature increase and precipitation change) will further impact agricultural productivity and N losses.
Within the "NITROAUSTRIA" project grassland productivity and associated nitrous oxide (N2O) emissions from Austrian grassland soils were simulated using the LandscapeDNDC model. Five different regions and six different soil types covering more than 70% of intensively managed grassland area in each region were simulated. The objectives of this study were to predict productivity from intensively managed grasslands and associated N2O fluxes under present and future climate change conditions.
The baseline scenario (2005 to 2014) compares grassland productivity and N2O fluxes for the five different regions. It proved N2O emission strengths to be higher than emissions from adjacent croplands. For future climate change impact assessment the stochastic weather generator LARS-WG was used. LARS-WG projects local time series of observed weather (temperature, precipitation and radiation) with climate change models. For all five regions, climate change scenarios were generated for RCP4.5 and RCP8.5 covering the time periods 2021-2040, 2041-2060 and 2061-2080.
The results of the climate change ensemble simulations indicate that increased temperature will increase grassland productivity in the investigated regions. Even under RCP8.5 conditions, all regions will sustain increasing productivity due to prolonged vegetation periods and higher temperatures. Changed precipitation patterns and increased plant nitrogen uptake will further decrease NO_3- leaching in grassland soil. Peak N2O emissions are mainly responsible for high annual fluxes and magnitude and frequency of these peaks may increase in the future. The project revealed the importance of the grassland management to be superior to determine the N2O emissions and NO_3- leaching in grassland soil rather than the impacts of future climate change.