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A potential bias using averaged climate projection multi model ensembles when forecasting nitrous oxide emissions from soils under climate change

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Increasing extreme events and drastic shifts in the variability, intensity and frequency of droughts, heavy precipitation and frost are predicted to accompany further climate change. It is most likely that an increasing occurrence of such events will be accompanied by soil feedback of GHG emissions, particularly of nitrous oxide (N_2O) known to be an extremely sensitive GHG. The increase in extreme events can lead to an increased occurrence of short-term emission pulses, referred to as 'hot moments', which can contribute significantly to the total annual N_2O emission balance.
To account for this potential feedback to the climate system, biogeochemical models driven by climate projections of multi-model ensembles (CPM) can be used to generate scenarios observing future trends in N_2O emission behavior.
Most commonly, the CPM average is used as climate input in biogeochemical models. While averaging CPM's may provide the best overall comparison with real mean climate change, it poses the risk of 'averaging out' expected extreme events, thereby biasing soil-atmosphere feedbacks and future N_2O emission trends!

We follow the hypothesis, that for nitrogen-saturated soils as common in industrialized countries, the annual N_2O emissions simulated by the averaged CPM differ from the average annual N_2O emissions simulated by the individual CPM's, as hot moment inducing extreme climate events are averaged as well.

For our biogeochemical model simulations, we used weather data from ten selected individual climate-projections based on the multi-model ensemble of the EURO-CORDEX initiative. To focus on the effects of climate and to exclude possible biases, remaining input parameters were unified, i.e., homogeneous soil horizons and a single crop rotation were assumed. In addition, each simulation period was initialised with the same parameters to exclude possible changes in fluxes resulting from soil carbon and nitrogen cycling.

First results with CANDY and LDNDC seem to support our hypothesis, showing that annual N_2O emissions simulated with the averaged CPM differ clearly from those resulting from the output

mean of the individual CPM’s.

This emphasises to consider using the averaged output based on individual CPM’s rather than relying solely on averaged CPM’s for predicting future N_2O emission trends.