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Assessing the impact of earthworms on N_2O and CO_2 fluxes in a realistic agricultural setup at the European Ecotron of Montpellier

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Land use change, including the conversion of native ecosystems into agricultural soils, has effects on soil properties that, in turn, contribute to up to 25% of the total greenhouse gases (GHG) emissions. Agricultural soils, therefore, significantly contribute to global GHG exchanges, but this contribution varies among studied gases. One of the main aims of the Paris Climate Agreement (COP 21, 2015) is to reduce the emissions of such GHG in a manner that does not threaten food production. To date, the influence of the soil biota on GHG emission is poorly understood. In an agricultural context, lumbricid earthworms have always been considered indicators of soil fertility and productivity. However, a couple of recent meta-analyses suggested that earthworms enhance the emissions of soil GHG (CO_2 and N_2O) and can reduce soil carbon storage. These findings have been received with reservation by a part of the scientific community arguing that they may stem from unrealistic microcosm experiments and punctual measurements of GHG. To address this controversy, we are carrying out a long term experiment at the CNRS Ecotron facility (www.ecotron.cnrs.fr). We established treatments with and without different earthworm functional groups (none, anecic and endogeic) using a realistic setup in an agricultural context (i.e. agricultural soil, crop rotation, large lysimeters of $5m^2$, 1.5 m deep and weighing 13 tonnes each, as well as realistic earthworm densities). Our overarching hypothesis is that, in contrast to the methodologically biased meta-analyses using predominantly data from unrealistic microcosm experiments, in realistic field conditions including plants, earthworms do not increase GHG emissions. Preliminary results indicate no earthworm effect on biomass productivity and CO_2 net ecosystem exchange (NEE), whereas the presence of endogeic earthworms reduced the N_2O emissions. Potential mechanisms explaining these results are discussed.