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Distribution of N2O in the atmosphere under global warming – a simulation study with the MPI Earth System Model

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Climate change is driven by an increasing release of anthropogenic greenhouse gases (GHGs) such as carbon dioxide and nitrous oxide (N2O). Besides fossil fuel burning, also land use change and land management are anthropogenic sources of GHGs. Especially inputs of reactive nitrogen via fertilizer and deposition lead to enhanced emissions of N2O.
One effect of a drastic future increase in surface temperature is a modification of atmospheric circulation, e.g. an accelerated Brewer Dobson circulation affecting the exchange between troposphere and stratosphere. N2O is inert in the troposphere and decayed only in the stratosphere. Thus, changes in atmospheric circulation, especially changes in the exchange between troposphere and stratosphere, will affect the atmospheric transport, decay, and distribution of N2O.
In our study we assess the impact of global warming on atmospheric circulation and implied effects on the distribution and lifetime of atmospheric N2O. As terrestrial N2O emissions are highly determined by inputs of reactive nitrogen – the location of which being determined by human choice – we examine in particular the importance of latitudinal source regions of N2O for its global distribution.
For this purpose we apply the Max Planck Institute Earth System Model, MPI-ESM. MPI-ESM consists of the atmospheric general circulation model ECHAM, the land surface model JSBACH, and MPIOM/HAMOCC representing ocean circulation and ocean biogeochemistry.
Prognostic atmospheric N2O concentrations in MPI-ESM are determined by land N2O emissions, ocean N2O exchange and atmospheric tracer transport. As stratospheric chemistry is not explicitly represented in MPI-ESM, stratospheric decay rates of N2O are prescribed from a MACC MOZART simulation.