EGU2020-15250
https://doi.org/10.5194/egusphere-egu2020-15250
EGU General Assembly 2020

Regional characterization of N2O isotopic composition emitted from soils in view of land cover, agricultural management and annual cycles based on measurements and modeling

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While the global budget of nitrous oxide (N_2O) is rather well constrained from a “top-down” perspective considering the change in the atmospheric burden and stratospheric N_2O destruction, estimates of the various sources such as natural/agricultural soils, coastal areas or fossil fuel burning and industry remain uncertain. The isotopic composition of N_2O, i.e., the relative abundances of the four most abundant isotopic species ($^{14}N^{14}N^{16}O$, $^{15}N^{14}N^{16}O$, $^{14}N^{15}N^{16}O$, and $^{14}N^{14}N^{18}O$) have been identified as instrumental tools for attributing emissions to the corresponding production-consumption processes and to estimate the global budget. During the past two decades, N_2O isotopic composition of individual sources has been investigated, and temporal trends in the isotopic composition of atmospheric N_2O have been studied using and firn air and archived air samples collected in Antarctica. With regard to ^{15}N and ^{18}O in atmospheric N_2O, a decreasing trend was consistently observed across studies, but contradictory results have been obtained for site preference (SP), i.e., the difference in the abundances of $^{15}N^{14}N^{16}O$ and $^{14}N^{15}N^{16}O$ relative to $^{14}N^{14}N^{16}O$. In addition, N_2O isotopic composition for natural or agricultural soils rely on a limited amount of studies and usually cover only parts of the annual cycle.

Since instruments used for optical isotope ratio spectroscopy (OIRS) can be deployed in the field, OIRS offers the opportunity to better characterize individual sources through long-term data in high temporal resolution. However, application of OIRS is challenging and, thus, remains scarce with regard to spatial resolution. For this reason, model-based regional estimates are pertinent to overcome the lack of regional estimates of N_2O isotopic composition, to analyze trends, and to provide data for a refinement of the global budget.

To obtain regional-scale (Switzerland) model-based estimates of N_2O isotopic composition, we used data sets of measured N_2O isotopic composition of two sites that are based on OIRS, and applied the **S**table **I**sotope **MO**del for **N**utrient cycl**E**s, SIMONE in conjunction with the biogeochemical model LandscapeDNDC. Our results show that SIMONE/LandscapeDNDC was capable of reflecting especially SP, but also ^{15}N-N_2O at sites with different soil properties. For agricultural soils, our simulations revealed an annual cycle in SP, with higher values during the growing season, but not for ^{15}N-N_2O. We will also discuss effects of agricultural management on N_2O emissions as well as temporal trends.