Simultaneous field-scale in-situ measurements of the four most abundant N_2O isotopocules

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Understanding and quantifying the biogeochemical cycle of N_2O is essential to develop effective N_2O emission mitigation strategies. We present a novel, fully-automated measurement technique that allows simultaneous, high-precision quantification of the four main N_2O isotopocules ($^{14}N^{14}N^{16}O$, $^{14}N^{15}N^{16}O$, $^{15}N^{14}N^{16}O$ and $^{14}N^{14}N^{18}O$) in ambient air. The instrumentation consists of a trace gas extractor (TREX) coupled to a quantum cascade laser absorption spectrometer (QCLAS), designed for autonomous operation at remote measurement sites. All system components have been integrated into a standardized instrument rack to improve portability and accessibility for maintenance. With an average sampling frequency of approximately 1 hr^{-1}, this instrumentation achieves a repeatability of 0.09, 0.13, 0.17 and 0.12 ‰ for $\delta^{15}N^{\alpha}$, $\delta^{15}N^{\beta}$, $\delta^{18}O$ and site preference of N_2O in ambient air, respectively. The repeatability for N_2O mole fraction measurements is better than 1 ppb (parts per billion, 10^{-9} moles per mole of dry air).

This TREX-QCLAS technique was deployed in the framework of the ScaleX campaign 2016 at the TERENO site Fendt, Germany. Isotopic signatures of the emitted N_2O were interpreted in relation to management events and meteorological conditions to shed light into different N_2O source processes. Next, N_2O isotopic information will be evaluated in conjunction with $\delta^{15}N$ values of nitrogen precursors (NH_4^+, NO_3^-), and additional soil parameters. Finally, results will be discussed in relation to a biogeochemical soil model (L-DNDC) with an isotope sub-module (SIMONE) developed at IMK-IFU, and a ^{15}N tracer approach applied by Thünen Institute.