Measurement of nitrous oxide isotopomers in air

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Nitrous oxide (N_2O) is a long lived greenhouse gas that has been accumulating in the atmosphere due to increased anthropogenic usage of N fertilisers to support global food production. The main removal mechanism is chemical destruction in the stratosphere. The global budget is relatively well known but processes that control individual source contributions and the relative importance of several microbial pathways that lead to N_2O emission from soils and the oceans are poorly understood.

N_2O isotopomers provide a method to improve knowledge of N_2O formation processes. The 4 most abundant isotopic variants are $^{14}N^{14}N^{16}O$, $^{14}N^{14}N^{18}O$, $^{14}N^{15}N^{16}O(\alpha)$ and $^{15}N^{14}N^{16}O(\beta)$. The site preference variable ($\delta^{15}N\alpha$- $\delta^{15}N\beta$) is thought to be independent of the substrate isotopic composition and depends only on the reaction(s) forming and destroying N_2O – and so provides a possible tool to differentiate between nitrification and denitrification production pathways including the distinct impact of several microbial communities.

A new generation of quantum cascade laser spectrometers has potential to make rapid measurement of isotopomer variants. We show our preliminary experiments using a Los Gatos Research N2O1A-23e-EP analyser, coupled to a custom-made instrument for cryogenic N_2O pre-concentration. Pre-concentration of N_2O is required to increase the signal-to-noise ratio in order to resolve variations of N_2O-isotopomers in air. It is intended to use the new technique in soil chamber and emission experiments to provide new insights into N_2O formation processes.