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Toward Spatially Resolved Mapping of Subsurface Biological Processes Using Isotopic Signatures

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Microbial processes are responsible for converting micro- and macronutrients into forms that can be utilized by plants, as well as nutrient loss channels, for example through denitrification (which releases nitrous oxide) and methanogenesis (which releases methane). The biological activity in the soil is therefore a direct window into the health of the soil. The isotopic composition of soil trace gases reflects the microbial pathways that produce them, making these gases effective messengers of bioactivity. Here we present results from laboratory testing of new diffusive soil probes coupled to a nitrous oxide/methane isotope TILDAS (Tunable Infrared Laser Direct Absorption Spectrometer). The TILDAS is sensitive to the common N_2O, $^{15}N^{14}N^{16}O$, $^{14}N^{15}N^{16}O$, $^{14}N^{14}N^{18}O$, common CH_4, and $^{13}CH_4$ species. The number of probes in the system is scalable, opening up the possibility of spatially and temporally-resolved mapping of subsurface biological activity. Tests using abiotic silica sand demonstrates the efficacy of these probes. We will also present results from sampling gases in tropical rainforest soil from Biosphere 2. Drying the soil, irrigating it, and exposing it to different oxygen levels reveals variations in N_2O and CH_4 concentrations, as well as isotopic signatures.