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# Method for tracing simulated $CO_2$ leak in terrestrial environment with a $^{13}CO_2$ tracer

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Facilities for the geological storage of carbon dioxide ($CO_2$) as part of carbon capture and storage (CCS) schemes will be designed to prevent any leakage from the defined ‘storage complex’. However, developing regulations and guidance throughout the world (e.g. the EC Directive and the USEPA Vulnerability Evaluation Framework) recognize the importance of assessing the potential for environmental impacts from $CO_2$ storage. RISCS, a European (FP7) project, aims to improve understanding of those impacts that could plausibly occur in the hypothetical case that unexpected leakage occurs. As part of the RISCS project the potential impacts that an unexpected $CO_2$ leaks might have on a cropland ecosystems was investigated. A $CO_2$ exposure field experiment based on $CO_2$ injection at 85 cm depth under an oats culture was designed. To facilitate the characterization of the simulated leaking zone the gas used for injection was produced from natural gas and had a $\delta$13C of -46‰̇The aim of the present communication is to depict how the injected gas was traced within the soil-vegetation-atmosphere continuum using 13$CO_2$ continuous cavity ring-down spectrometry (CRDS).
Four subsurface experimental injection plots (6m x 3m) were set up. In order to test the effects of different intensity of leakage, the field experiment was designed as to create a longitudinal $CO_2$ gradient for each plot. For this purpose gas supply pipes were inserted at one extremity of each plot at the base of a 45 cm thick layer of sand buried 40 cm below the surface under the clayey plough layer of Norwegian moraine soils. Soil $CO_2$ concentration and isotopic signature were punctually recorded: 1) in the soil at 20 cm depth at 6 positions distributed on the central transect, 2) at the surface following a (50x50 cm) grid sampling pattern, and 3) in the canopy atmosphere at 10, 20, 30 cm along three longitudinal transects (seven sampling point per transect). Soil $CO_2$ fluxes and isotopic signature were finally recorded at the surface following a (60 x 60 cm) grid sampling pattern. Finally, at the end of the growing season the oats crop was harvested following a (50x50 cm) grid sampling pattern and each collected cereal bundle was tested for its isotopic signature.
Results showed that the isotopic monitoring of the simulated $CO_2$ leaks enabled to characterize finely the 3 dimensional extent of the leak within the soil-atmosphere continuum, including the assimilation of leaking $CO_2$ by the vegetation.

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