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Field Comparison of Two CO_2 Sorbent Trap Methods and Dynamic Closed Chamber Method for Soil Gas Flux Measurement

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Background/Objectives. Measurements of carbon dioxide (CO_2) soil gas efflux have recently emerged and become a widely used and readily implementable method to estimate LNAPL natural source zone depletion (NSZD) rates. Two methods are commonly used. The first uses a dynamic closed chamber and portable infrared gas analyzer to collect short-term flux measurements over periods of several minutes. The second uses canisters of sorbent material, referred to as CO_2 traps, to obtain a longer-term, time-averaged measurement of flux over a period of multiple days (typically two weeks). The dynamic closed chamber method is often used as an initial screening step to measure CO_2 flux at a relatively large number of locations across a site, establishing an initial lateral "map" of CO_2 flux, and identifying any potentially anomalous areas where structures or preferential pathways may be interfering with soil gas flow. These initial dynamic closed chamber screening results are then used to guide placement of CO_2 traps, which provide a longer term measurement that eliminates the interference of modern carbon soil CO_2 sources by carbon isotopic (i.e. carbon dating) techniques.

Approach/Activities. E-Flux has recently developed a screening tool of similar use to the dynamic closed chamber method. This flux measurement method is based on the existing sorbent trap principle, but entails an alternative carbon isotopic analysis, in which the whole mass of carbon is concentrated into a single sample for radiometric analysis. The lower sensitivity of this analysis can detect impacts from petroleum-derived CO_2, although is not sufficient for quantification of fossil fuel flux. This approach could be advantageous relative to the dynamic closed chamber, offering simpler field procedures and providing a rigorous time-integrated average for the period of deployment, thus eliminating the need to collect repeated rounds of measurements via the chamber approach.

Results/Lessons Learned. In this study, the previously available CO_2 traps (Fossil Fuel Traps), the chamber, and the newly developed screening-level CO_2 traps (Map Traps) were deployed at overlapping periods: 2 weeks for the Fossil Fuel Traps, 3 days for the Map Traps, and 2 rounds of instantaneous measurements from the dynamic closed chamber. Comparison of the three methods revealed a good correlation for total CO_2 flux (R^2 = 0.9) between the short-term deployment of the Map Traps and Fossil Fuel traps. The chamber results showed a poor correlation with the total fluxes of the Map Traps and Fossil Fuel Traps (R^2 values of 0.35 and 0.14, respectively). Simple subtraction-based background corrections could not be reliably applied to the chamber results; this was likely due to significant variability in modern carbon CO_2 flux across the site relative to the magnitude of fossil fuel-related CO_2 flux. Using the alternative carbon isotopic analysis, the Map Traps detected fossil fuel impacts at 5 out of 20 deployment locations. These locations corresponded to fossil fuel measured fluxes higher than ~200 gallons/acre/year equivalent NSZD losses, indicating that the Map Traps can be effective in identifying active areas of NSZD even at sites where background or modern CO_2 flux is high.