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Isotopic Forced-Diffusion Technique for Soil Respiration Pathway Studies

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Isotopic ratio measurements of soil-respired CO_2 can provide a wealth of insight into soil-level carbon-cycle processes that is not available using bulk CO_2 emissions measurements alone. Soil contains substantial amounts of carbon, and can contribute $CO_2$to the atmosphere through various respiration pathways. Isotopic analysis can distinguish autotrophic root and rhizosphere respiration from heterotrophic respiration due to the catabolism of soil organic matter (SOM). Because of this, researchers have shifted their efforts toward the use of natural abundance and tracer isotopic techniques in ecosystem respiration studies. However, recent experimental and theoretical evidence indicates that these traditional techniques yield biased estimates of the soil isotopic flux, largely owing to disturbances to the soil's natural diffusive regime. To help eliminate theses biases, we have developed a new technique called Isotopic Forced-Diffusion (IsoFD). The Isotopic Forced-Diffusion technique integrates a Forced Diffusion dynamic chamber with a cavity ringdown spectrometer measuring δ^{13}C-CO_2, which are operated together as a closed, recycling system where the leakage and pressures through the system are properly managed. The system produces real-time, high temporal resolution isotopic soil efflux data. We will present the theory behind this technique and present preliminary laboratory and field data.