The ZERT on-shore controlled CO_2 release experiment
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Abstract:

Through the Zero Emission Research and Technology collaborative, Montana State University (MSU) and partners designed, developed, installed and utilized an on-shore shallow subsurface CO_2 controlled release facility. The subsurface infrastructure is comprised of a shallow horizontal well with a stainless steel casing that is slotted over a 70 m length. This well is separated into six segments by inflatable rubber packers. Above ground mass flow controllers enable individual control of flow to each section of the horizontal well. CO_2 is stored on site as a liquid in a refrigerated tank and vaporized upstream of the mass flow controllers. Fossil sourced CO_2 with a large negative $\delta^{13}C$ is used for the experiment and total flow rates ranged from 0.1 tonne/day to 0.3 tonne/day.

The ZERT site has successfully released CO_2 into the shallow subsurface every summer from 2007 through 2014. It has provided a valuable test bed with a robust baseline established over 8 years of data for daily, seasonal, and interannual variability. Over the duration of the ZERT experiment we have had participation in the field from a total of 21 different institutions (6 universities, 8 government labs / agencies and 7 private sector companies).

The CO_2 was released into a shallow, unconfined perched water table where aqueous geochemistry was studied as a function of release rate, duration, and distance from the horizontal well. Measurable changes in the chemistry occurred, but water quality remained well within EPA requirements.

Soil CO_2 concentration was measured using commercial (Vaisala) probes and an innovative hollow core buried fiber system developed by MSU. Resistivity measurements were used to map the presence of the CO_2 in the soil.

Soil CO_2flux was measured using eddy covariance as well as three different accumulation chamber methods: a commercial potable survey system (West); a fixed permanently closed system developed by Pacific Northwest National Lab; and a fixed position commercial system (Licor) which closes only for the measurement. The latter two systems provide extensive temporal information at fixed positions where the portable system is useful for spatial mapping of surface expression features.

Atmospheric CO_2 measurements were made using both continuous and pulsed dial systems. Point atmospheric measurements including stable isotope detection were made using two different commercial cavity ring down systems (Los Gatos and Picarro). A mobile platform for the Picarro system deployed by Stanford University shows promise for more rapidly mapping surface features.

Plant health as an indirect measure of increased CO_2 concentration was investigated using airborne hyperspectral imaging, platform based multispectral imaging and Far IR imaging, and ground base hyperspectral imaging.

Virtually every technology detected CO_2 at reasonable low levels. Cost effectiveness, areal coverage, local ecosystem properties, and terrain will likely dictate deployment choices for near-surface monitoring.