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Long-Term Surface CO2-Flux Monitoring at the Ketzin CO2 Storage Test Site

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Subsurface geological storage of carbon dioxide calls for sophisticated monitoring tools with respect to long term safety and environmental impact issues. Despite extensive research, many factors governing the fate of injected CO2 remained unclear. In order to identify possible risks through leakage of the CO2 storage reservoir, a program for a permanent monitoring of the CO2 flux at the surface was started at the Ketzin CO2 injection test site to distinguish natural, temporal and spatial flux variations of CO2 from possible leakages.
To gain adequate long term baseline data on the local background CO2 flux variations, soil gas, moisture and temperature measurements were carried out once a month over a six years period. The CO2 was measured with an automated soil CO2 flux system Li-COR 8100 (Li-COR Biociences, Lincoln, NE) survey chamber system. The study area covers about 2.5 * 2.5 km, and contains a grid of 20 sampling locations equidistantly distributed around the CO2 injection point. The area is intensely used as farmland with Haplic Albeluvisol (Fahlerden, Braunerde-Fahlerden) as the dominant soil type.
The mean flux of sampling sites in the investigated area from January 2005 to December 2010 is 2.62 μmol m-2 s-1. The spatial variability of the mean CO2 flux per year among the sampling locations ranges from 0.7 to 5.8 μmol m-2 s-1. The average Q10 coefficient of 3.0 (the relative increase in flux rate for a 10°C change in soil temperature) is ranging from 2.2 to 5.0. Furthermore, soil samples were analyzed for their Corg. and Ntot. content. The Corg. concentrations in the upper 0.7 m vary between 0.13 to 4.09 wt. % and the Ntot. concentrations between 0.02 to 0.19 wt. %, respectively.
The natural temporal variation of the CO2 flux at the Ketzin area is mainly controlled by the soil temperature whereas the spatial variability is due to the soil quality. Warm temperatures and fertile soils enhance the metabolism of the CO2 producing soil biota. A distinct correlation with the soil moisture was not detected. Generally, the CO2 flux at the CO2SINK test site is in the range of typical forest and grassland production rates.
A theoretical doubling of the flux rate at a sampling point due to a supposed leakage, will significantly deviate from predicted flux (temperature - flux rate fit) and can thus statistically be identified.
Based on our results, it was successfully proven, that the CO2 surface monitoring concept applied in Ketzin is a useful method for the permanent surveillance of CO2 storage. An increased CO2 flux may be an indicator for leakage, but on the other hand, the absence of a CO2 flux anomaly at the surface is no evidence for cap rock integrity and a successful CO2 underground storage.