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Can subterranean cave systems affect soil CO_2 fluxes?

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Main factors affecting soil CO_2 fluxes in most ecosystems are soil temperature and soil moisture. Nevertheless occasionally high soil CO_2 fluxes were observed at carst areas, which could result from ventilation of subterranean cavities (Ferlan et al., 2011). The aim of this work was to determine the influence of cave ventilation to soil CO_2 fluxes.

Research was done in a dead-end passage of Postojna cave (Pisani rov) and on the surface area above the passage (Velika Jeršanova dolina) in south-western Slovenia. Inside the cave we measured CO_2 concentrations, its carbon (13C) stable isotope composition, 222Rn activity concentrations, temperatures and air pressure. At the surface we had chosen two sampling plots; test plot above the cave and control. At both plots we measured soil CO_2 fluxes with automatic chambers, CO_2 concentrations, temperatures and carbon stable isotope composition of soil air at three different depths (0.2 m, 0.5 m and 0.8 m) and different meteorological parameters such as: air temperature, air pressure, wind speed an precipitation. To detect the cave influence, we compared two surface CO_2 flux measurements with air temperatures and changes of CO_2 concentrations in the cave atmosphere.

Our results on CO_2 concentrations in the gallery of the cave indicated that the ventilation of this particular gallery also depends on outside air temperatures. Outside temperature increased and corresponded to higher CO_2 concentrations, whereas at lower temperatures ($T < 9$ oC) cave started to ventilate and exhaled CO_2 reach air through unknown fissures and cracks. At the control plot the soil CO_2 fluxes were in a good correlation with soil temperatures ($r = 0.789$, $p = 0.01$), where greater soil temperatures correspond to greater soil CO_2 fluxes. Soil CO_2 fluxes at the plot above the cave did not show statistically significant correlations with soil temperatures or soil moisture indicating that other factors possibly cave ventilation could influence it.

References:
1. M. Ferlan, G. Alberti, K. Eler, F. Batič, A. Peressotti, F. Miglietta, A. Zaldei, P. Simončič, D. Vodnik, Agriculture, Ecosystems & Environment 2011, 140, 199–207.