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Simulating soil atmosphere above a leaky CCS deposit

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The escape of CO_2 at the surface above a leaky geological deposit of carbon dioxide can be a fumarole-like point source or a subsurface plume distributing the gas over a larger area. In the latter case the lost CO_2 from the deposit is added to the soil respiration as a quasi one-dimensional non-equimolar gas flux. Whether such an additional flux leads to inhibitory high levels of soil CO_2 combined with a rather complete advective displacement of O_2 or simply changes the diffusion characteristics in a more or less normal soil atmosphere depends for a given gas diffusivity and permeability on the ratio between the equimolar (respiratory) and the non-equimolar (leak based) flux of CO_2. We tested the effecs by parametrization of a conceptual soil model consisting of capillaries filled either with soil air or water joining the soil air and the above-ground atmosphere. Soil atmosphere was simulated by combining a numerical solution of the Dusty-Gas model and a simple gas diffusion model in the water filled capillaries in an iterative process until Argon as noble gas is stagnant. The results show that in soils with high gas permeability even non-equimolar CO_2 fluxes more than twice the soil respiration can be transferred to the surface without spectacular changes in soil-air pressure or O_2 displacement. However, even low extra CO_2 fluxes change significantly the gradient ratio of O_2 and CO_2 and stress soil aeration which is for many forest ecosystems a limiting factor of root growth.