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Influence of biogeochemical reactions on inert gas fluxes between soil and the atmosphere

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In the subsurface, water content, gas solubility, organic mater degradation as well as plant and microorganism respiration control gas fluxes between soil and the atmosphere. Indeed, all of this controls the partial pressures of major gas species, such as O_2 and CO_2 , which controls in turn the advective and diffusive transport of all the gaseous species, including the inert gases. Because these processes vary in intensity with time and space, it is very challenging to define where, when and how to measure gas fluxes between soil and the atmosphere. This is equaly important for detection of anomalous fluxes as well as for the calculation of relevant mass budgets. We focus here on inert gases because of their relevance as tracers for a large variety of processes.
An experimental setup was developed and validated at the ECOTRON IleDeFrance research center. It is composed of a 60-cm high and 40-cm diameter sand column placed under controlled conditions (water content, temperature, pressure, light) in a climatic chamber. Plants are grown at the top of the column. An inert gas (SF_6) is injected at the bottom and its flux is continuously monitored at the surface. A similar experimental setup is run without plants. Effects of watering, daytime/nighttime plant activity, cut out of leaves, plant destruction as well as of other solicitations are determined and discussed. First-order models are proposed and their results are compared to the experimental data. These models are based on consumption of O_2 , production of CO_2 with a higher solubility in water and their effects on inert gas advection-dispersion.