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# Soil Gas Fluxes to Atmosphere: Soil Diffusion Parameters and Rainfall Effect

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## Extended Abstract

Recently, particular attention has been paid to gas fluxes emitted at the soil-atmosphere interface. Their monitoring is often required as part of the human health risk assessment of a contaminated site or when implementing a risk-based remediation approach.

To determine gas fluxes at the soil-atmosphere interface, a variety of direct or indirect measurements have been developed such as the flow chamber method. Due to the low cost of this non-intrusive and easy to set up method, it has been widely used, especially on contaminated sites.

However, due to the heterogeneity of soils resulting from the spatial and temporal variability of hydrodynamic properties, it is challenging to estimate a reliable annual mean flux from punctual measurements. Several theoretical and field studies have shown that gas fluxes primarily depend on variations of soil moisture content. Indeed, soil moisture content affects the pore space available for gas diffusion, which is the dominant process in gas transport [1].

Although there is general agreement on the importance of soil moisture content, there has been, to our knowledge, limited quantitative analysis of its influence. Indeed, some field and/or numerical studies have considered some temporal effects on soil gas transport, but there is yet no complete explanation available of the influence of rainfall events on soil gas concentrations and fluxes. However, understanding how these short- and/or long-term variations alter soil gas transport processes is of major importance in order to accurately quantify long-term gas fluxes at polluted sites. Therefore, the main objective of this study is to understand the relationships between temporal variations in surface gas fluxes and gas transport in the soil profile before and during rainfall events depending on soil type. To reach this objective, both experimental and modelling approaches were used.

Concerning the first approach, experiments were conducted in a controlled natural environment and consisted in injecting pure volatile compound in a lysimeter to observe the impact of artificial and natural rainfall events on surface gas fluxes. The results showed that the steady-state gas fluxes measured with the flux chamber were consistent with the concentration profiles. During rainfall events, the concentration and fluxes showed a clear change linked to the presence of water on the top of the soil profile. Indeed, a drastically decrease of gas flux to atmosphere was observed in relationship with rainfall infiltration and consequential wash-out of the compound present in the soil. Along the year, the temporal evolution of soil gas concentrations was markedly dependent on the local rainfall history (total rainfall intensity, frequency and duration, intervals between rainfall events…) and the soil hydrodynamic properties.

For the modelling approach, we developed a relatively simple conceptual model for estimating the temporal evolution of volatile organic compounds (VOCs) fluxes during annual rainfall sequences. The results indicate that the infiltration of water into the unsaturated zone affects the dynamics of VOCs fluxes mainly by two mechanisms: (1) gases transferred from the soil to the surface are partially blocked by the infiltrated water at the surface and (2) part of the gases initially present are transferred into the infiltrating water according to Henry's law.

## References

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