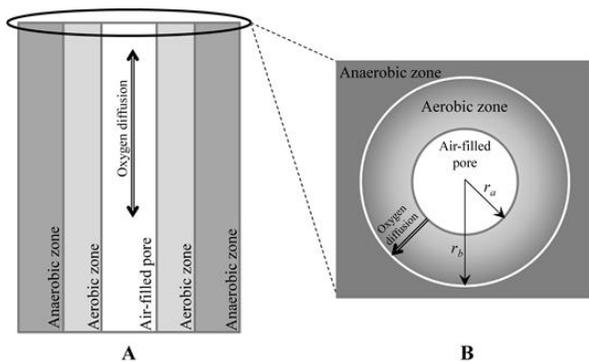


Explicit modeling of oxygen transport in soil pore-water systems improves model simulations of greenhouse gas emissions from peatlands

The two most important determinants of life in soil are water and oxygen. Soil-water dynamics have been relatively well represented in ecosystem and Earth system models (E&ESMs); however, oxygen is still either missing or very poorly represented in existing E&ESMs. Traditionally, those models that attempt to account for oxygen availability have simply divided the soil domain into an aerobic zone located above the water table and an anaerobic zone below it. To address problems with this approach, a collaborative team composed of modelers and experimentalists developed a mechanistic model based on soil pore characteristics (e.g., pore-size distribution and pore connectivity) to estimate the movement and concentration of oxygen within individual soil pores and the soil profile. The oxygen-based modeling approach was used to simulate emissions of the greenhouse gases CO₂ and CH₄ from an Alaskan fen peatland. The results were then compared with those produced by using the water-table based modeling approach. The physically realistic oxygen-based approach was found to reduce biases in the simulated fluxes of CO₂ and CH₄. The model comparisons also revealed that the existence of anaerobic microsites in unsaturated soil might cause models using the traditional water-table based approach to substantially under-estimate CH₄ emissions and over-estimate CO₂ emissions. This new oxygen-based approach can be used to improve other modeling applications — for example, simulations of the soil habitat and its corresponding effects on microbial population dynamics, microbial physiology, and microbial processes in both saturated and unsaturated soil zones.



Above: Model schematic used to simulate (A) vertical and (B) radial movement of O₂ in soil-water systems.

Right: Simulated fraction (proportion) of anaerobic zones in an Alaskan fen peatland. White lines denote the observed water table position.

