Unified Model for Solute and Gas Diffusivity in Unsaturated Soil. (S01-moldrup095102-Oral)

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Abstract:

Diffusion processes in the soil water and air phases often control transport and fate of oxygen, nutrients, and toxic chemicals in the vadose zone. This study concerns the development of a unifying diffusivity model (UDM) platform for predicting solute and gas diffusion coefficients as functions of fluid phase (water or air) contents in unsaturated soils. We show that the Buckingham (1904) expression is more accurate than other classical diffusivity expressions to describe both solute and gas diffusivity in fluid saturated porous media. Combining the Buckingham expression with pore size distribution related tortuosity models yields new and accurate solute and gas diffusivity models for unsaturated, undisturbed soils. As a benefit, diffusivity models can now be written in a common form with two model constants that vary between solute and gas diffusivity and, also, undisturbed and repacked soil. Tested against data for 65 soils, the UDM is markedly more accurate than typically used soil type independent models. The use of the UDM in diffusion and reaction models for sorbing chemicals in the soil water and air phases is exemplified. In perspective, the UDM concept enables a new definition of the relative diffusion coefficients in soil, thereby providing exiting possibilities for analyzing tortuosity phenomena in the soil water and air phases and their effects on diffusive and convective transport parameters in unsaturated soil.

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