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A single parameterization for spatial and temporal spreading of solute plumes percolating in soils as observed by multi-compartment samplers

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Multi-compartment samplers (MCSs) measure unsaturated solute transport in space and time at a given depth in soils. For each compartment a breakthrough curve (BTC) is obtained, which characterizes the temporal aspect of solute leaching. The spatial aspect of solute leaching is characterized by the spatial solute distribution curve (SSDC). This curve yields the total amount of leached solute as a function of the fraction of the total sampling area, with the sampling compartments sorted from high to low leaching. By plotting the BTCs in descending order of total solute amount a leaching surface is created that captures the temporal and spatial aspects of solute leaching. The leaching surface is a useful tool to organize, present, and analyze MCS data.

While the leaching surface proved its value, a method to describe its shape in quantitative terms would further enhance its use. We present a novel method to quantitatively characterize leaching surfaces. The procedure starts by fitting a mean pore water velocity and a dispersion coefficient to each BTC. These values are then expressed as a function of the pseudo-spatial coordinate of the leaching surface that indicates the rank order in the sorted line-up of the sampling compartments. Combining the parameters of these functions (two to six parameters) with those of the Beta distribution fitted to the spatial distribution of solutes (two parameters) makes it possible to describe an entire leaching surface by four to eight parameters. This greatly facilitates an objective comparison of spatio-temporal leaching behavior in different soils and climates.