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Evalutation of the spatial variations of the hydrodynamical parameters of soils with GPR

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The dimensions of a contamination plume resulting from a pollutant spill depend strongly on the spatial heterogeneity of the hydrodynamical parameters of the soil. Taking into account these variations in reactive transport simulations from geostatistical realizations of hydrodynamic parameters would lead to more realistic estimations of contaminated soil volumes.
In order to quantify in situ the parameters of the Mualem-van Genuchten model, a hydro-geophysical method consists of monitoring Porchet water infiltrations with a Ground Penetrating Radar (GPR) set on the surface close to the borehole. Radargrams show strong reflections coming from the infiltration bulb evolution. They are numerically simulated using a Python code linking hydrodynamical simulations (SWMS_2D) and electromagnetic simulations (GprMax). Arrival times of the "bulb" reflections depend on the infiltration time and we show that it can be modeled by a mathematical power-law function. We investigate the relationship between the parameters of this function and the hydrodynamical parameters. We use this analysis to better constrain the inversion of GPR data.
We compare the hydro-geophysical method with the Porchet permeameter data themselves, as well as Triple Ring Infiltrometer (TRIMS) measurements and laboratory estimations of the retention curves using suspended column experiments on field samples. In addition, granulometric data of field samples are converted to hydrodynamical parameters using the Rosetta pedo-transfer relation. These techniques are deployed over three 100-square-meter stretches of sandy soils (sand pits near Auffargis (78), Noisy-sur-Ecole (77) and Orsay (91)). The measurements carried out over a "homogeneous" Fontainebleau sand layer reveal spatial heterogeneities in the hydrodynamical properties.