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Impact of the Variability in Hydraulic Parameters of the Vadose Zone on Pollutant Plume Development

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INTRODUCTION AND CONTEXT

Simulations of hydraulic parameter fields, spatially variable, and radionuclide plumes have been generated to assess:

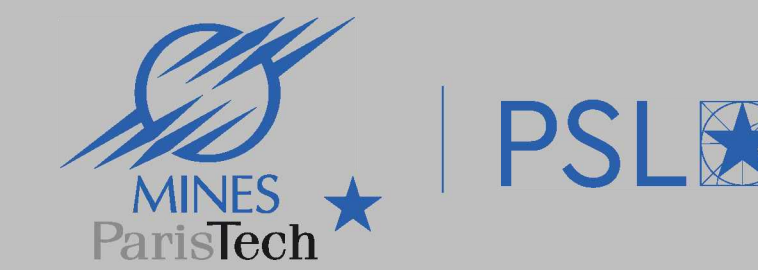
- the influence of small scale variability in hydraulic parameters on solute transport;
- the parameter that should be the most precisely characterized when studying a polluted site.

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(I) PARAMETER FIELDS

3 parameters of the Mualem-van Genuchten formalism: K_s , α and n , represented by random fields (lognormal distribution) characterized by σ^2 (variance), a_x and a_z (ranges).

(II) PLUME SIMULATIONS

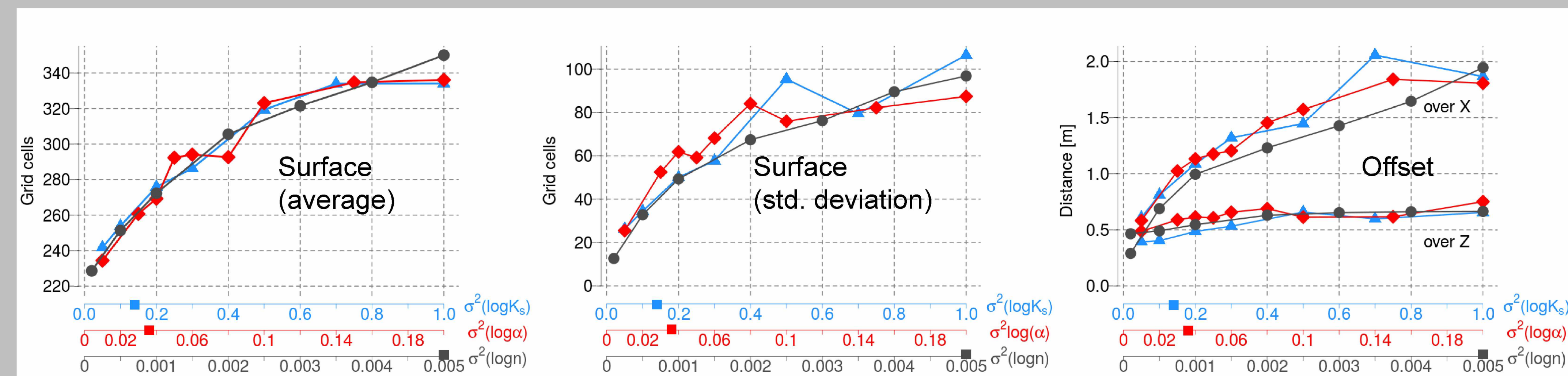
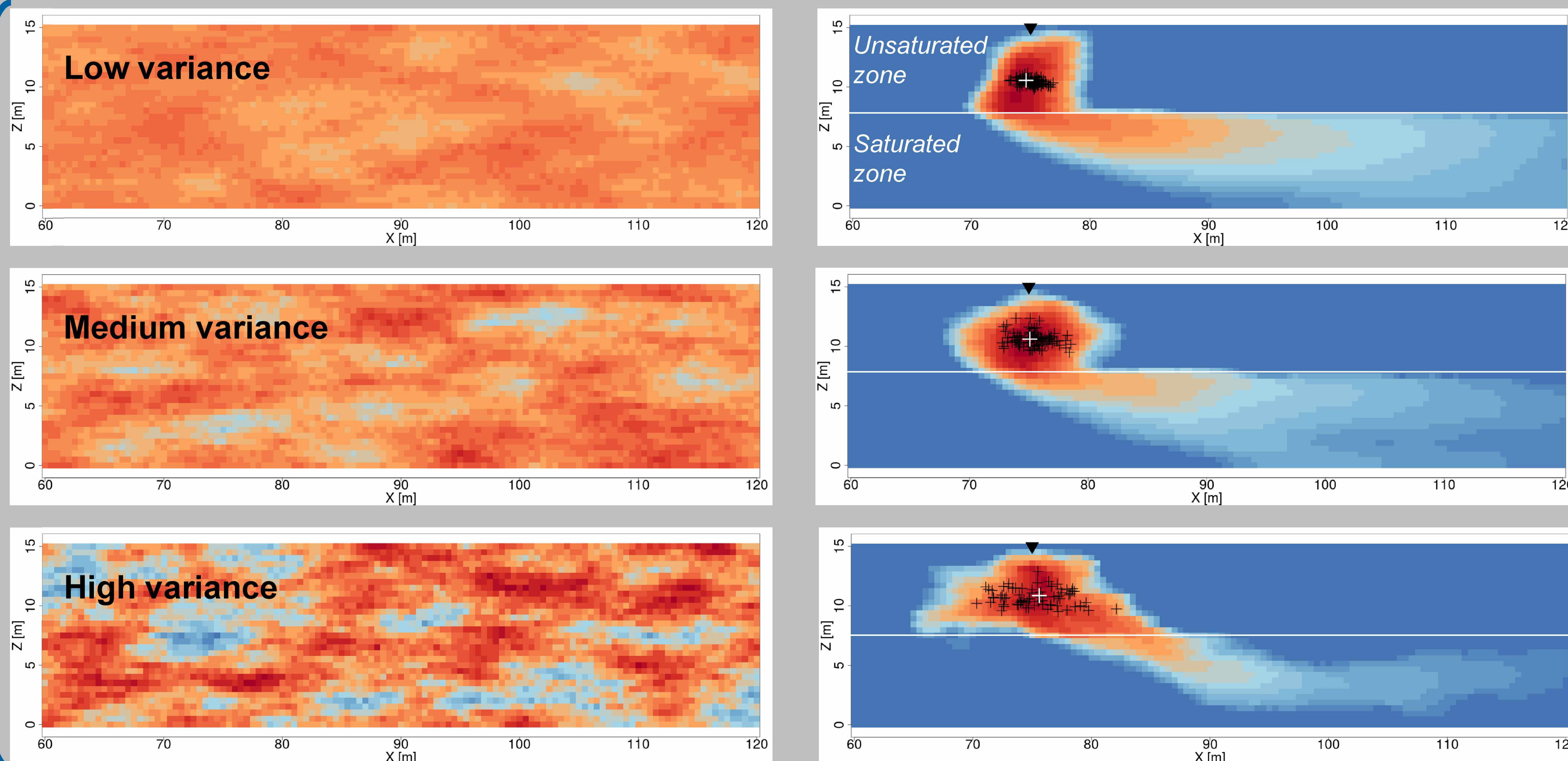
Simulation of flow and solute transport in variably saturated porous media from a localized source of tritiated water, using random fields as inputs for hydraulic parameters.

(III) SENSITIVITY ANALYSES

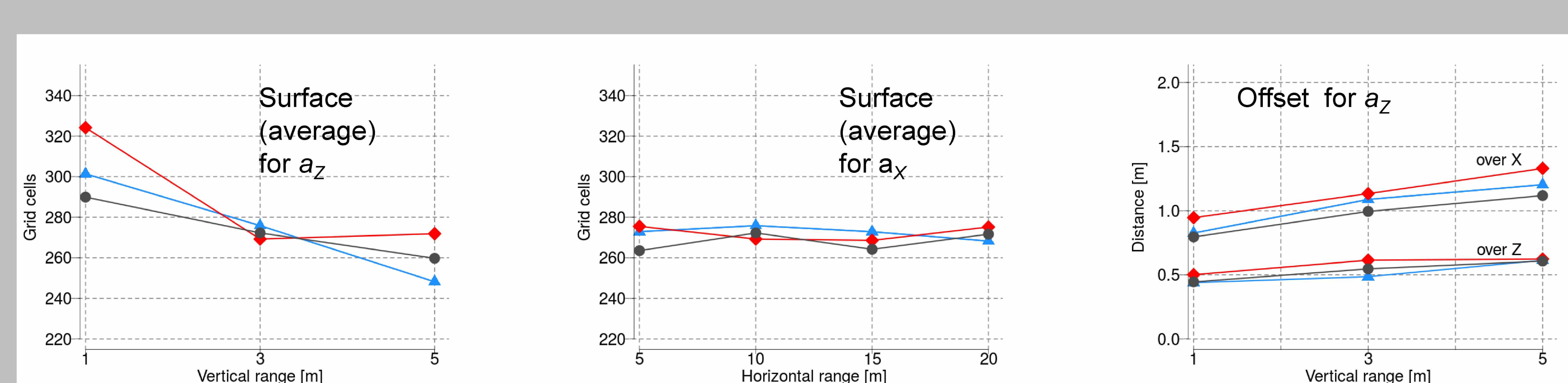
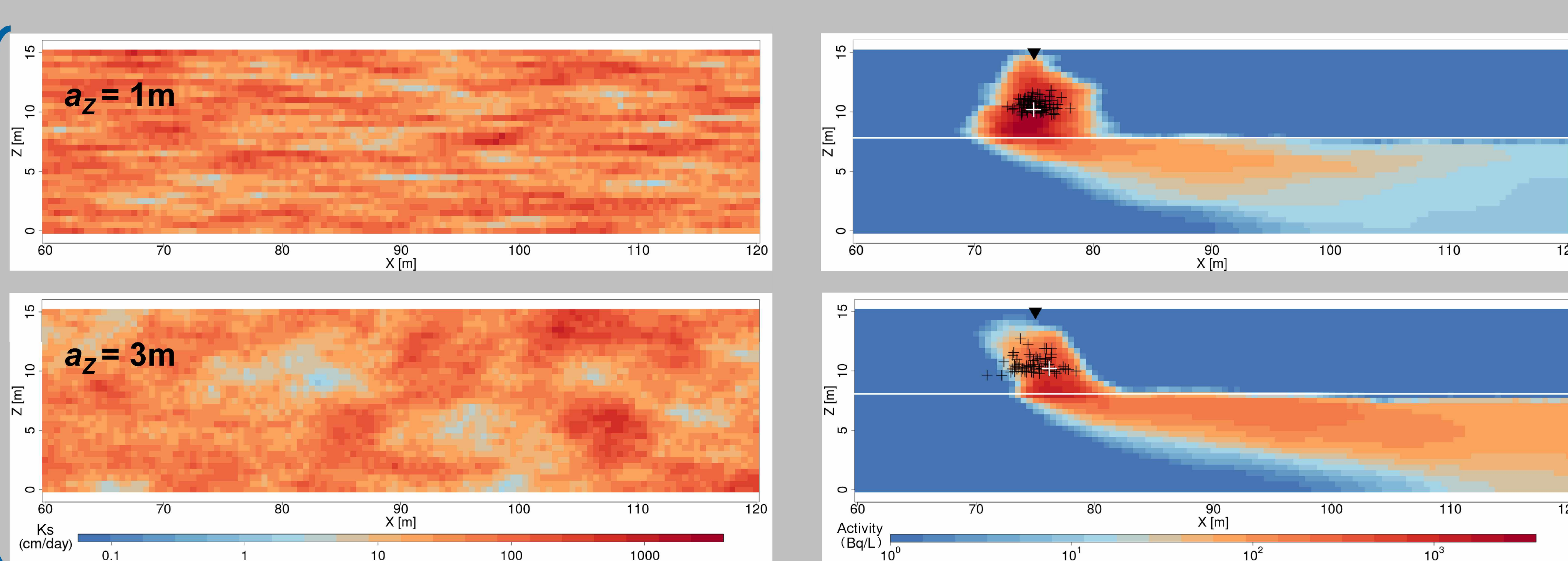
For each triplet $\{\sigma^2, a_x$ and $a_z\}$, sets of 100 random fields are generated and the corresponding plumes are simulated and characterized (in the vadose zone) thanks to:

- their surface (average and standard deviation for each set);
- the position of their center of mass (average distance between the centers of mass of the set and the center of mass of the plume simulated in a homogeneous medium).

Examples of random fields and the corresponding simulated tritium plumes.



- Variances of hydraulic parameters strongly impact the simulated tritium plumes: when σ^2 increases, plumes are more expanded and more spread in space;
- n is the most critical parameter: mean variances found at field scale (marked by ■, ■ and ■ on the X-axis) result in an increase of 65% of plume size compared to the homogeneous medium for n and 20 to 25% for K_s and α .



- Parameter ranges have a minor impact on simulated plumes (especially a_x) at least for the values tested.

The + correspond to centers of mass of all plumes simulated from the same $\{\sigma^2, a_x$ and $a_z\}$ triplet.

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