AIMS OF RESEARCH

- Investigating solute transport and mixing in the hyporheic zone under turbulent flow conditions
- Developing a numerical model meant to capture the mentioned phenomena within this critical area

Experimental Set-up

The experimental data quantifying the vertical variation of the effective dispersion coefficient with depth below the sediment-water interface [2] are used to benchmark the numerical results of the model.

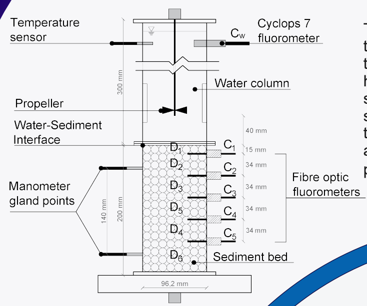

Fig. 2 Set-up of the experimental test used as model benchmark[2]

The setup is representative of mixing processes taking place within the hyporheic zone and considers transport of dissolved chemicals close to the interface between a free fluid system and a porous medium[2].

1

Calibration diffusion coefficients

Acceptance/rejection method

It is a sampling technique meant to assess the probability distribution (posterior) of a set of parameters from a hypothetical initial distribution (prior) [4]. It is employed to identify the range and the probability distribution of the acceptable values of the diffusion coefficients resulting from the existing experimental data (Fig. 2)

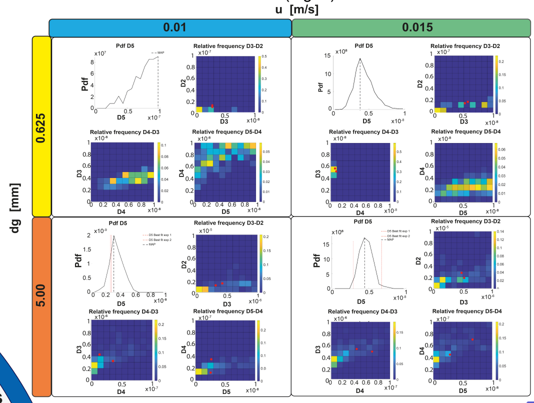

Fig. 3 Probability density function, joint-relative frequency and corresponding concentration of the accepted diffusion coefficients for each layer for different bed-shear velocity and grain size

2

Hyporheic zone

The hyporheic zone is the interface between the aquifer and the stream where the flow exchange and mixing between the surface water and groundwater occur.

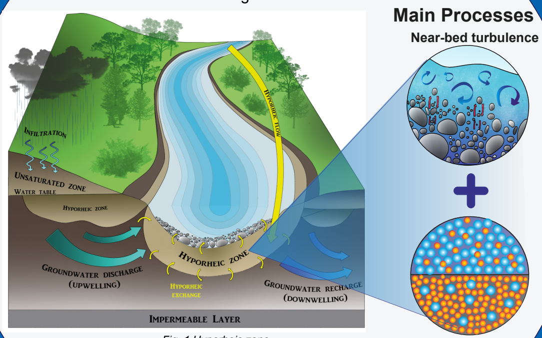

Fig. 1 Hyporheic zone

Main Benefits [1]

- Significant contribution to the attenuation of pollutants
- Enhancing the self-purification of the river water

SOLUTE TRANSPORT

SBM model

In the hyporheic zone, the heterogeneity of the material and the spatially varying flow and turbulence characteristics may produce a variation in the effective diffusion coefficient.The stochastic SBM model to solve diffusion problems in media with a discontinuous diffusion coefficient[3]. Grounded on the particle tracking method, the algorithm simulates the the behaviour of a particle over the discontinuity interface

Influence of boundary layers

Infinite bimaterial medium

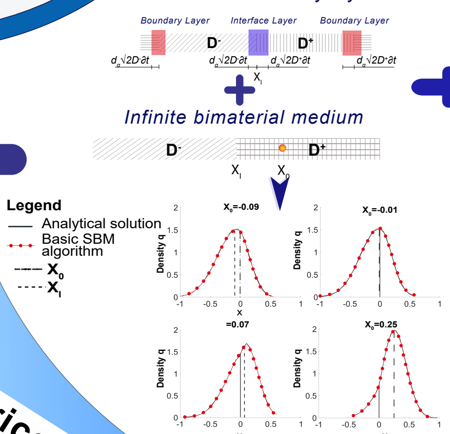

Fig. 4 Comparison between the basic SBM code and analitycal solution [3] for an infinite bimaterial medium (D^-=5 ,D^+=2) and an interface at X_i=0 for diffrent starting point x_0

Implemented SBM model

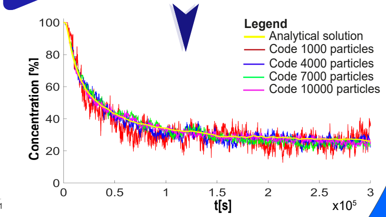

Fig. 5 Time evolution of concentration at the third interface (C3) resulting from the implemented SMB code for different numbers of particles. Comparison with the analytical solution calculated with Nagahoka and Ohgaki' method [5]

MIXING

The implemented SBM algorithm is integrated in an appropriate Lagrangian mixing model. The latter enables the prediction of the temporal evolution of chemical concentration in the hyporheic zone, as well as the mixing of the solute mass within the porous domain. It is an additional information to the solute transport driven by diffusion and hydrodynamic dispersion

3

Development numerical model for solute transport and mixing

References