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A continuous time random walk model for Darcy-scale anomalous transport in heterogeneous porous media.

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Achieving the understanding of the process of solute transport in heterogeneous porous media is of crucial importance for several environmental and social purposes, ranging from aquifers contamination and remediation, to risk assessment in nuclear waste repositories.

The complexity of this aim is mainly ascribable to the heterogeneity of natural media, which can be observed at all the scales of interest, from pore scale to catchment scale. In fact, the intrinsic heterogeneity of porous media is responsible for the arising of the well-known non-Fickian footprints of transport, including heavy-tailed breakthrough curves, non-Gaussian spatial density profiles and the non-linear growth of the mean squared displacement. Several studies investigated the processes through which heterogeneity impacts the transport properties, which include local modifications to the advective-dispersive motion of solutes, mass exchanges between some mobile and immobile phases (e.g. sorption/desorption reactions or diffusion into solid matrix) and spatial correlation of the flow field.

In the last decades, the continuous time random walk (CTRW) model has often been used to describe solute transport in heterogenous conditions and to quantify the impact of point heterogeneity, spatial correlation and mass transfer on the average transport properties [1]. Open issues regarding this approach are the possibility to relate measurable properties of the medium to the parameters of the model, as well as its capability to provide predictive information. In a recent work [2] the authors have shed new light on understanding the relationship between Lagrangian and Eulerian dynamics as well as on their evolution from arbitrary initial conditions.

On the basis of these results, we derive a CTRW model for the description of Darcy-scale transport in d-dimensional media characterized by spatially random permeability fields. The CTRW approach models particle velocities as a spatial Markov process, which is characterized by a velocity transition probability and the steady state velocity distribution. These are related to the Eulerian velocity distribution and the distribution and spatial organization of hydraulic conductivity. The CTRW model is used for the prediction of transport data (particle dispersion and breakthrough curves) from direct numerical flow and transport simulations in heterogeneous hydraulic conductivity fields.

References:

[1] Comolli, A., Hidalgo, J. J., Moussey, C., & Dentz, M. (2016). Non-Fickian Transport Under Heterogeneous Advection and Mobile-Immobile Mass Transfer. Transport in Porous Media, 1-25.

[2] Dentz, M., Kang, P. K., Comolli, A., Le Borgne, T., & Lester, D. R. (2016). Continuous time random walks for the evolution of Lagrangian velocities. Physical Review Fluids, 1(7), 074004.