Geophysical Research Abstracts
Vol. 20, EGU2018-9585, 2018
EGU General Assembly 2018

Spatial Markov models for non-Fickian transport in heterogeneous porous media

Alessandro Comolli (1,2,3), Vivien Hakoun (1,3), Marco Dentz (1,3)

(1) Institute of Environmental Assessment and Water Research (IDÆA), CSIC, Barcelona, Spain, (2) Department of Geotechnical Engineering and Geosciences - Technical University of Catalonia (UPC), Barcelona, Spain, (3) Associated Unit: Hydrogeology Group (UPC-CSIC), Barcelona, Spain

Non-Fickian, or anomalous, transport is generally observed in groundwater systems as a consequence of media heterogeneity. The latter is present at all scales of interest, from pore to catchment scale. Thus, understanding and predicting this behaviour is crucial for several purposes, including aquifer contamination remediation or risk assessment in nuclear waste repositories.

The prediction of transport behaviour requires understanding the relationship between large scale transport features and the attributes of flow and medium, as well as quantifying the impact of the injection conditions. In order to address these issues, we consider Darcy-scale flows in porous media characterised by spatially-varying hydraulic conductivity based on multi-Gaussian random fields characterised by broad distributions of point values.

Following the path of Hakoun et al. (in preparation), we perform Eulerian and Lagrangian analyses of particle velocities and we define a continuous time random walk (CTRW) model, or equivalently a time domain random walk (TDRW) model, that is parameterised in terms of the Eulerian velocity PDF, i.e. in terms of transport-independent quantities. This flow properties can also be related to medium characteristics in the framework of inclusion theory. The injection mode determines the stationarity of Lagrangian velocities statistics, see Dentz et al. 2016. Thus, we test different injection conditions and different models to reproduce velocity transitions, namely an exponential relaxation model and a mean-reverting Ornstein-Uhlenbeck process. Both models are parameterised in terms of the correlation length only, which can be estimated from the flow properties.

We then quantify the relative impact of advective and diffusive heterogeneity. The net effect of diffusion is that it shortens the correlation lengths by enhancing velocity transition across streamlines. We define a TDRW model that takes into account this effect and we use it to evaluate particles breakthrough curves and spatial moments, as well as the full spatial distribution. Analytical results are confirmed by direct numerical simulations.

References

- Hakoun, V., Comolli, A., Dentz, M. (in preparation).
- 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.