Geophysical Research Abstracts
Vol. 19, EGU2017-14882, 2017
EGU General Assembly 2017

Lagrangian velocities evolution in steady Darcian flow, the impact on solute dispersion and an application to the MADE tracer test

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

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

Performing accurate preditions of transport in heterogeneous porous media is a challenge because of the interplay between the spatial organization of the flow field and velocity fluctuations. Such interplay leads to anomalous transport behaviors that cannot be predicted by advective-dispersive models for equivalent homogeneous media. Furthermore, transport predictions based on perturbation theory remain limited to $\log$ hydraulic conductivity fields with variances smaller than 1. We contribute to elucidating how the interplay between structural properties and velocity fluctuations impacts transport processes in heterogeneous porous media. We study purely advective transport in steady Darcian flow fields with heterogeneous hydraulic conductivity fields of $\sigma^2_{\log K}$ up to 4 using a particle-based viewpoint. We analyze the statistical properties of particle velocity series along streamlines sampled both isochronically and equidistantly. Isochrone Lagrangian velocity series show intermittent behavior, which is removed by equidistant sampling. We show that the Lagrangian velocity statistics may be stationary or non-stationary depending on the injection mode, which highlights the importance of conditioning to the initial velocities. We analyze the correlation of the Lagrangian velocities for different heterogeneity strengths and identify and quantify a characteristic length scale over wich particle velocities persist. We show that the Lagrangian velocity statistics can be related to the Eulerian and ultimately to the conductivity statistics. These observations are quantified in a Markov-chain continuous time random walk (CTRW) approach for the evolution of Lagrangian velocities, and the prediction of solute dispersion (Dentz et al., 2016). We investigate the dependence of the Lagrangian velocity statistics and solute dispersion on the injection conditions, and on the heterogeneity strength using direct numerical simulations and the proposed CTRW model, which is parameterized in terms of the Eulerian velocity statistics and the conductivity distribution. The CTRW approach is then used for the intepretation of dispersion data of the MADE tracer test, based on a geostatistical characterization of the medium.

Reference:

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.