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# Impact of mixing interface dynamics on concentration distributions in heterogeneous porous media

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The dynamics of mixing interfaces control a range of important subsurface processes, including reactive transport, heat transfer, dispersion in multiphase flows, or chemical elements cycling in streams and catchments. Mass transfer and chemical reactions across these interfaces is expected to be strongly affected by their elongation and folding resulting from the spatial and temporal fluctuations of flow velocities in the subsurface. We propose a new modeling framework to quantify the impact of mixing interface dynamics on the concentration distribution, predicting its shape and rate of deformation as it progresses towards uniformity in the medium (Le Borgne et al., PRL, 2013).

The concentration field is represented by a set of stretched lamellae whose rate of diffusive smoothing is locally enhanced by kinematic stretching. Based on the interplay between stretching, diffusion and aggregation, we derive analytical expressions for the concentration distribution, holding for all field heterogeneities, residence times, and Peclet numbers. The theory provides predictions of the temporal evolution of concentration moments, scalar dissipation rate and other mixing measures, quantifying the controls of structural heterogeneities on the dynamics of mixing interfaces and the associated concentration distributions.