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Travel time statistics under radially converging flow in single fractures

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A stochastic methodology based on Adaptive Fup Monte Carlo Method is used to investigate transport of a conservative solute by steady flow to a single pumping well in two-dimensional randomly heterogeneous single fractures. The spatially variable hydraulic transmissivity is modeled as a stationary random function for three different correlation structures (multi-Gaussian, connected and disconnected fields with correlated mean, high and low lnT values, respectively, according to the Zinn and Harvey, 2003) and heterogeneity levels (lnT variance is 1 and 8). Initially, solute particles are injected at outer circle located at 32 correlation lengths from well according to the in flux and resident injection mode. Therefore, breakthrough curve (BTC) statistics in single well due to different spatial structures, heterogeneity levels, injection modes and dispersion influence is considered. For small heterogeneity, all considered effects have small influences on BTC and related moments. As expected in single fractures, high lnT variance is more usual case which considerably changes flow patterns including channelling effect and fact that only few narrow channels carry out most pumping flow rate. Channelling implies significant differences between different injection modes. Resident mode uniformly injects particles implying that most particles pass through "slower" zones that especially increase late arrivals and contribute to the non-Fickian behaviour of transport. Contrary, "in flux" mode drastically reduces first arrivals and mean values, especially for connected correlation fields. The results from two injection modes lie on different sides of homogeneous mean travel time solution and give complementary information for complete representation of conservative transport. For advection transport, correlation structure and especially lnT variance seems to have major influence on BTC characteristics. On the other side, influence of longitudinal and lateral local scale dispersion are negligible, especially for resident injection mode.