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A time-dependent Mixing Model for PDF Methods in Heterogeneous Aquifers

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Predicting the transport of groundwater contaminations remains a demanding task, especially with respect to the heterogeneity of the subsurface and the large measurement uncertainties. A risk analysis also includes the quantification of the uncertainty in order to evaluate how accurate the predictions are.

Probability density function (PDF) methods are a promising alternative to predicting the transport of solutes in groundwater under uncertainty. They make it possible to derive the evolution equations of the mean concentration and the concentration variance, which can be used as a first measure of uncertainty. A mixing model, also known as a dissipation model, is essential for both methods. Finding a satisfactory mixing model is still an open question and due to the rather elaborate PDF methods, a difficult undertaking. Both the PDF equation and the concentration variance equation depend on the same mixing model. This connection is used to find and test an improved mixing model for the much easier to handle concentration variance. Subsequently, this mixing model is transferred to the PDF equation and tested.

The newly proposed mixing model yields significantly improved results for both variance modelling and PDF modelling. The implications of the new mixing model for different kinds of flow conditions are discussed and some comments are made on efficiently handling spatially resolved higher moments.