Geophysical Research Abstracts, Vol. 7, 05711, 2005
SRef-ID: 1607-7962/gra/EGU05-A-05711

The concept of block-effective macrodispersion with applications for numerical modeling

A. Bellin (1), A.E. Lawrence (2) and Y. Rubin (2)

1. Dipartimento di Ingegneria Civile e Ambientale, Università di Trento, Italy
2. Department of Civil and Environmental Engineering, University of California at Berkeley

Numerical transport models can capture only the low wave number (large-scale variability) effects of the spatial variability in hydrogeologic properties, while the large wave-number effects, associated with sub-grid block variability, are suppressed due to homogenization. This suppression is avoidable only if the variability is captured in minute detail, but is impossible to achieve in all but the most trivial cases. A fundamental question to consider then is how to allow flexibility in numerical grid design without ignoring the dispersive action of the unmodeled variability, while preserving the interplay between all relevant length scales: those relevant to spatial variability, as well as those created by design.

The concept of block-effective macrodispersion addresses this question in a systematic, analytical manner, and is the subject of this presentation. The theoretical foundations of the concept are presented, and the conditions required for its applicability. In addition, solutions in two and three spatial dimensions, accounting for the effects of geological variability as well as the effects of pore-scale dispersion and spatial variability in the retardation, are introduced and discussed. Results from numerical testing, in support of the theory, are discussed.

The main conclusion that can be drawn from this work is that the block-scale macrodispersion coefficients can be used to model the wiped-out variability occurring when blocks larger than a fraction of log-conductivity integral scale are used in numerical simulations. This leads to the reduction of the computational cost of the numerical simulations. However, an upper limit on the grid size is imposed in order to accurately reproduce large-scale variability, which is reproduced directly on the

computational grid, while maintaining sufficiently small the portion of the longitudinal third moment caused by small-scale variability, because it is not reproduced by the block effective macrodispersion coefficient. Finally, the block-effective macrodispersion concept is applicable to transport of kinetically sorbing solutes, but a smooth Gaussian filter should be introduced in order to avoid oscillations in the longitudinal component of the block-scale macrodispersion coefficient.