Geophysical Research Abstracts, Vol. 8, 03762, 2006
SRef-ID: 1607-7962/gra/EGU06-A-03762

Coupling the hillslope storage Boussinesq model to an advection-dispersion equation: Comparison with MODFLOW-MT3D

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The regularly observed decoupling between the hydrologic response of a catchment and its response with regard to passive tracers has put many researchers for a puzzle. It emphasizes that the mechanisms by which catchments and hillslopes store and transport solute are not yet well understood. The major control that hillslope geometry exerts on the hydrologic response of a hillslope has been known for some time. It is expected to play a similar role in transport of inert tracers on hillslope scale. However, transport of inert tracers is subject to local dispersion as well. The relative importance of dispersion and hillslope geometry still needs to be evaluated quantitatively. In this research, a coupled solution to the hillslope storage Boussinesq (hsB) equation and a new form of the advection-dispersion equation for inert tracers is used to simulate tracer transport through the saturated zone of hillslopes of different geometry. Previous research has shown that dimensionless moments that characterize the hydrologic response can be related to the hillslope Peclet number. The hillslope Peclet number is a dimensionless number and function of 3D hillslope geometry (plan and profile shape) and can be derived from the hsB equation. With the coupled solution of the hsB equation and the advection-dispersion equation, it is possible to investigate whether the hillslope Peclet number can also be related to the dimensionless moments that characterize the chemical response of a hillslope. Results are compared with results for numerical MODFLOW-MT3D simulations on similar hillslopes. These simulations will be done for different values of transversal and longitudinal dispersivity. The sim-

plifications with regard to transversal dispersion in the coupled solution to the hsB equation and the advection-dispersion equation can thus be critically evaluated. This allows a quantitative assessment of how hillslope geometry and dispersivity control inert tracer response among different hillslopes.