Geophysical Research Abstracts
Vol. 13, EGU2011-9812, 2011
EGU General Assembly 2011

Instationary travel times under stationary conditions - tracer experiments in a small headwater catchment at Gårdsjön, Sweden

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For tracer studies at the catchment scale, travel times are often assumed to be stationary. We question the validity of this assumption. We analyzed a series of tracer experiments conducted under exceptionally controlled conditions at Gårdsjön, Sweden. The Gårdsjön G1 catchment was covered by a roof underneath which natural throughfall has been replaced by artificial irrigation with a pre-defined chemical composition. This unique setup was used to perform replicated catchment scale Br tracer experiments under steady state storm flow conditions in five different years. A log-normal distribution function was fitted to all Br breakthrough curves.
Fitted parameter values differed significantly for some of the experiments. These differences were not only related to the slightly different hydrologic boundary and initial conditions for the experiments, but also to seasonal changes in catchment properties that may explain the different flow paths during the experiments. We conclude that the travel time distribution is not only linked to discharge but also explicitly related to other water fluxes such as evapotranspiration, and that it is not stationary even under steady-state flow conditions. Since the attenuation of soluble pollutants is fundamentally linked to the travel times of water through the subsurface of a catchment, it is of crucial importance to understand the latter in detail. However, it is still unclear which are the dominant processes controlling their distribution.