The use of particle tracking-based groundwater age distributions in assessments of contamination risk from coal seam gas development
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Sreekanth J, Dutton Park, Australia

sreekanth.janardhanan@csiro.au

Turnadge Chris, CSIRO Land and Water, Urrbrae, Australia

Suckow Axel, CSIRO Land and Water, Urrbrae, Australia

Raiber Matthias, CSIRO Land and Water, Dutton Park, Australia

Mallants Dirk, CSIRO Land and Water, Adelaide, Australia

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Observations of environmental tracer concentrations in groundwater can provide valuable information to constrain conceptualizations of groundwater flow systems. These data may be particularly valuable in contexts where historical groundwater monitoring data are unavailable+ for example, in deep groundwater flow systems. Various modelling approaches may be used to produce outputs that can be compared to tracer data, ranging from semi-analytical advective particle tracking methods to models of reactive tracer transport or theoretical groundwater age. This study explored the efficacy of two computationally efficient particle tracking methods. The methods were used to constrain conceptualizations of groundwater flow in two separate geological basins in Eastern Australia. In the first application, a range of particle travel paths were generated stochastically in order to simulate groundwater age distributions at a number of bore locations in the Surat Basin, Queensland. Using the Null Space Monte Carlo approach, stochastic particle simulation was undertaken by generating an ensemble of model parameter sets that each calibrated the model equally well to a given set of hydraulic head observations. In turn, this ensemble produced a set of equally-likely flow paths that were used to simulate a groundwater age distribution at each bore of interest. Environmental tracer concentrations previously observed at these bores (and subsequently interpreted as ages) were compared to modelled age distributions. In the second application, advective particle tracking analyses were used to evaluate the potential for water supply bore contamination resulting from the subsurface transport of chemicals used in coal seam gas production in the Gunnedah Basin, New South Wales. Forward particle tracking was used to estimate the destinations of flowlines originating from the locations of coal seam gas production wells. The statistical distribution of simulated particle travel times was then used to estimate potential for chemical attenuation for different exposure pathways.