Effect of spatially and temporally variable recharge on subsurface reactive transport of contaminants at Oak Ridge Integrated Field Research site

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Recharge is one of the most fundamental components of groundwater systems which drives both flow and transport in the subsurface and plays an important role in the migration of contaminants. Spatial and temporal variation in the recharge in heterogeneous aquifers leads to corresponding variations in the velocity fields, which has a strong bearing on dispersive mixing and transport processes. The impact of temporal variations in recharge are significantly important at the Oak Ridge Integrated Field Research Challenge (ORIFRC) site, which receives an average of 137 cm of precipitation annually. Prediction of contaminant plumes from former waste disposal ponds at the site is desired for the design and deployment of bio-remediation and contaminant containment strategies. Long term monitoring of the contaminants at the site has been carried out using a series of monitoring wells providing point measurements for an array of chemical species of interest. Due to the complex geology of the region, however, a number of preferential flow pathways are present at the site resulting in highly fluctuating point measurements. In addition, temporally variable recharge may induce dynamics in flow leading to significant fluctuations in the ground water levels as well as concentrations of chemical species. To investigate these issues numerical simulations at the site were carried out using the massively parallel flow and reactive transport model PFLOTRAN to estimate the impact of spatially and temporally variable recharge on the migration of contaminant plumes at the site. A series of the details from the actual site (e.g., the gravel filled ditch around the S-3 ponds that receives high storm flow runoffs from the surface asphalt cover, gravel filled S-3 ponds after capping, among others) were incorporated in the model to realistically capture the dynamics of surface and subsurface hydrology at the site. The results were compared and validated against observation data from field monitoring wells.