Subsurface contaminant particle tracking given dynamic natural gradients and pumping about wells

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Abstract. Particle tracking is commonly employed to study the movement of subsurface contaminants about historical releases and/or in the vicinity of well fields. Common approaches to particle tracking include steady state analytical solutions and numerical models. Unfortunately, steady state solutions can fail to capture dynamic aspects of groundwater flow and numerical models often lack the spatial and temporal resolution needed to resolve contaminant movement in complex water surfaces about dynamically operated pumping wells in well fields. This study provides novel methods for tracking particles relying on either continuous water level data from field sites or a Theis superposition model that predicts water levels about dynamically operated wells in well fields. In the case of continuous water level data from field sites, the water surface is estimated on a daily basis using water levels at three or more points. Hydraulic gradients in the x and y directions are used to drive particles based on hydraulic conductivities, first-order contaminant decay rates, and retardation. Movement of particles is studied near a large river with seasonal changes in water levels of up to 20 feet, adjacent to a tidal harbor, and in a shallow desert aquifer where evapotranspiration imposes seasonal variations in groundwater flow directions. Similarly, using the Theis superposition model, hydraulic gradients in the x and y directions are used to drive particles based on hydraulic conductivity values, retardation, and first-order contaminant decay rates. Initially, a 5-year record of pumping is expanded to a 30-year record by reapply the 5-year pumping record six times. Movement of particles is studies by backward tracking of particles from the wells into the pumping field over a 30-year period. It is anticipated that the results of this research will advance simple methods for predicting the movement of subsurface contaminants given dynamic water levels at sites where historical releases have occurred and about well fields with dynamic water levels.