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Using Temperature Data in the Simulation of Groundwater Surface Water Exchange in heterogeneous geologic Systems

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Interactions between surface water and groundwater are often highly variable in space and time with important consequences for hydrology (e.g. minimum flows, fish migration) ecology (e.g. moisture distribution in the riparian zone, riparian vegetation) and water management (e.g. conjunctive use). The spatial patterns of exchange are strongly influenced by geologic heterogeneities at the interface between surface water and groundwater. Accurately quantifying exchange rates not only requires detailed hydraulic data but also a good representation of those heterogeneities, which is often difficult to achieve. Temperature, which can be measured relatively easily with high accuracy, can provide additional qualitative and quantitative information on patterns of groundwater surface water exchange.

Results are presented from simulations of a river-aquifer system in a heterogeneous alluvial fan with deep regional water table (Cosumnes River in California, USA). Interactions were simulated on a regional- (50km) and a reach-scale (2000m) using numerical codes for saturated and variably saturated flow and heat transport. Geologic heterogeneity of the alluvial fan system was characterized with a geostatistical approach, based on transition probabilities and Markov Chains. Different hydrofacies models were created from sequential indicator simulations. In addition to measurements of hydraulic potential and saturation, temperature measurements were used to calibrate the reach-scale model and to determine one best-fit hydrofacies model. Simulation results show interesting patterns of surface-subsurface exchange. The spatial arrangement of hydrofacies had a significant impact on minimum river flows in the regional model with implications for salmon migration. The reach-scale simulations

demonstrated that perched zones, which form between the river and the regional water table, can be important in supporting river base flows and riparian vegetation. Connected pathways between the river channel and the riparian corridor, which could be characterized with the temperature data, may sustain phreatophytes even when the regional water table is far below the river channel. Preliminary simulations also show potential for using temperature data to quantify exchange between groundwater and lakes.