XVIII International Conference on Water Resources
CMWR 2010
J. Carrera (Ed)
CIMNE, Barcelona 2010

INVERSE MODELLING OF HYDRAULIC CONDUCTIVITY DISTRIBUTION BY ASSIMILATION OF RETURN FLOW DATA

Ryan T. Bailey*, Domenico A. Baù *

* Department of Civil and Environmental Engineering
Colorado State University, 1372 Campus Delivery
Fort Collins, CO, 80523-1372, United States
e-mails: rtbailey@engr.colostate.edu, domenico.bau@colostate.edu

Summary. Accurate assessments of hydrologic and chemical processes in local and regional aquifer systems are often impeded by an incomplete and inaccurate representation of the parameters that characterize these processes. In this study we demonstrate the use of an ensemble smoother to provide enhanced estimates of spatially-variable aquifer hydraulic conductivity through assimilation of ground water return flows to streams. Based on the Kalman Filter methodology, prior information provided by the ground water flow model is combined with measurement data from the true system to provide a posterior estimate that honors the measurement data. Parameter estimation is achieved by incorporating parameter values used in the flow model simulations into the algorithm, allowing the correlation between the measurement data, in this case ground water return flows, and hydraulic conductivity to correct the hydraulic conductivity fields. Unlike the basic filter methodology, in which information is carried only forward in time, the smoother incorporates all past model results and data measurements, thus allowing model corrections to spread backward in time according to the covariance of model results through time. With all prior information being used, the smoother provides a maximum likelihood estimate, and hence a minimized ensemble variance, of the system state that is superior to the filter at each previous assimilation time. The applicability of the methodology is demonstrated through a synthetic two-dimensional ground water flow scenario. Results indicate that assimilating return flow measurements into the smoother provides an improved estimate of the hydraulic conductivity fields. Estimates are further enhanced if hydraulic conductivity measurements are also assimilated. Sensitivity analyses were carried out to show the performance of the smoother in regards to return flow and hydraulic conductivity measurement error, the number of stream gage locations used in calculating return flows, the number of assimilation times, and the correlation length used in generating the prior hydraulic conductivity fields.