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Using filtering techniques to improve subsurface contaminant model accuracy

Subsurface numerical models for contaminants play an important role in risk assessments and in clean-up processes by estimating or predicting the sizes or shapes of the contaminant plumes. Underestimate or overestimate risk may greatly affect the emergency response or cost-effectiveness of site remediation. The numerical model based on differential equations is an initial value problem that contains limited fate and transport mechanisms. Therefore, the predictions of the numerical model basically relies on the improvement of errors coming from the running model, which may include errors in model mechanisms, numerical schemes and the errors coming from the initial data, unknown or uncertain sources and inaccurate parameters used for transport properties. Filtering techniques are potentially very effective for estimation and data assimilation problems in subsurface contaminant transport because of their advantages to deal with dynamic and stochastic processes. This paper summarizes the results of several recent research projects in using filtering techniques in subsurface contaminant transport models. These techniques include Particle Filter and several variations of Kalman Filter such as Extended Kalman Filter, Adaptive Kalman Filter and Ensemble Kalman Filter. The techniques have been tested using one to three dimensional subsurface contaminant transport models. The results indicate that the prediction error of the data assimilation scheme is 20 to 80% smaller than that from the deterministic model. Furthermore, the results suggest that by applying the correct regional noise structure and parameter estimation, the data assimilation schemes can improve prediction accuracy even more. By the comparison of the plume contour figures, the filtering schemes also have the ability to give predictions that are much closer to any irregular contour shapes of "true" realities than the traditional numerical models. Through absorbing information from observations, the predictive plumes of contaminants from the assimilation system can follow the change of randomized irregular plume shape in real world more closely than a non-assimilation deterministic model..

Biography

Dr. Shoou-Yuh Chang is the DOE Samuel Massie Chair professor and graduate program coordinator in the Department of Civil and Environmental Engineering, North Carolina A&T State University. He received his Ph. D. in Environmental Engineering from the University of Illinois at Urbana-Champaign in 1981 and has more than 30 years of teaching and research experience in water quality related areas. Dr. Chang's research interests include environmental systems analysis, and water quality modeling. He has extensive research experience in the use of models to generate alternatives and use of filtering techniques in improving subsurface water quality modeling accuracy. He has published more than 40 journal papers in his research areas.

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