6.6 Solute Transport During Variably Saturated Flow—Inverse Methods

JIŘÍ ŠIMŮNEK AND MARTINUS TH. VAN GENUCHTEN, USDA-ARS, George E. Brown, Jr. Salinity Laboratory, Riverside, California

DIEDERIK JACQUES, Belgian Nuclear Research Centre, Boeretang, Belgium

JAN W. HOPMANS, University of California, Davis, California

MITSUHIRO INOUE, Arid Land Research Centre, Tottori University, Tottori, Japan

MARKUS FLURY, Washington State University, Pullman, Washington

6.6.1 Introduction

The use of parameter estimation techniques for determining soil hydraulic properties is well established (Kool et al., 1987; Hopmans & Šimůnek, 1999; Sections 1.7 and 3.6.2). The approach has been widely used for various laboratory and field experiments. Among others, laboratory experiments include one-step and multistep outflow experiments, upward flux or head-controlled infiltration, the evaporation method, and others (Section 3.6.2). In separate lines of research, solute transport parameters are often obtained from column experiments assuming steady-state water flow (e.g., Nkedi-Kizza et al., 1984; Sections 6.3–6.5), and using parameter estimation codes such as CFITIM (van Genuchten, 1981), CXTFIT (Toride et al., 1995), or STANMOD (Šimůnek et al., 1999) for fitting analytical solutions of the transport equation to experimental breakthrough curves. Obtaining solute transport parameters for conditions for which no analytical solutions exist, such as for non-linear adsorption, can be accomplished using numerical solutions (Kool et al., 1989; Šimůnek & van Genuchten, 1999).

The above parameter estimation efforts for water flow and solute transport have thus far remained relatively disjointed. Although numerous studies exist that combine estimation of flow and transport parameters for groundwater flow problems (e.g., Sun & Yeh, 1990; Medina & Carrera, 1996; Weiss & Smith, 1998), only a few studies have used combined transient variably saturated water flow and solute transport experiments for simultaneous estimation of soil hydraulic and solute transport parameters (Mishra & Parker, 1989; Abbaspour et al., 1997; Inoue et al., 2000; Jacques et al., 2001).