Uncertainty and Upscaling
(How to Fit a Camel through the Eye of a Needle)

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EMSP Project #70187

- Objectives
  - Apply indirect measurements of soil properties to the conditional simulation of flow and transport in the heterogeneous vadose zone
  - Determine general relationships between the type and quantity of data, measurement scale, and uncertainty in flow and transport predictions

Uncertainty and Upscaling

- Even under the best conditions, predictions of field-scale flow and transport will be uncertain
  - Data limitations, conceptual inaccuracies, model approximations, etc.
- Flow and transport predictions required on a large scale, measurements and process/parameter variability occur at a small scale
  - Computational limitations generally require some upscaling of parameters

Recent Simulation of the Sisson and Lu Experiment

- Rockhold, M.L. 1999. AGU Monograph 108:243-260
  - Geostatistical conditional simulation to generate initial and saturated water contents on a fine grid (25 x 25 x 15 cm) over a domain 18 x 18 x 17 m
  - Scale-mean hydraulic parameters estimated from data at grout site (1.4 km away)
  - Flow and transport simulations on a coarse grid (25 -100 cm by 30 cm in depth) over a domain 17 x 17 x 12 m
  - Upscaled water contents and saturated hydraulic conductivity

Observations

- Lack of site-specific hydraulic property measurements caused reliance on off-site data
- Upscaling water contents results in smoothing, which is propagated into the hydraulic property estimates. Small features thus are not represented well.
- Saturated hydraulic conductivity upscaling results in moisture-independent anisotropy, which may under-predict lateral spreading

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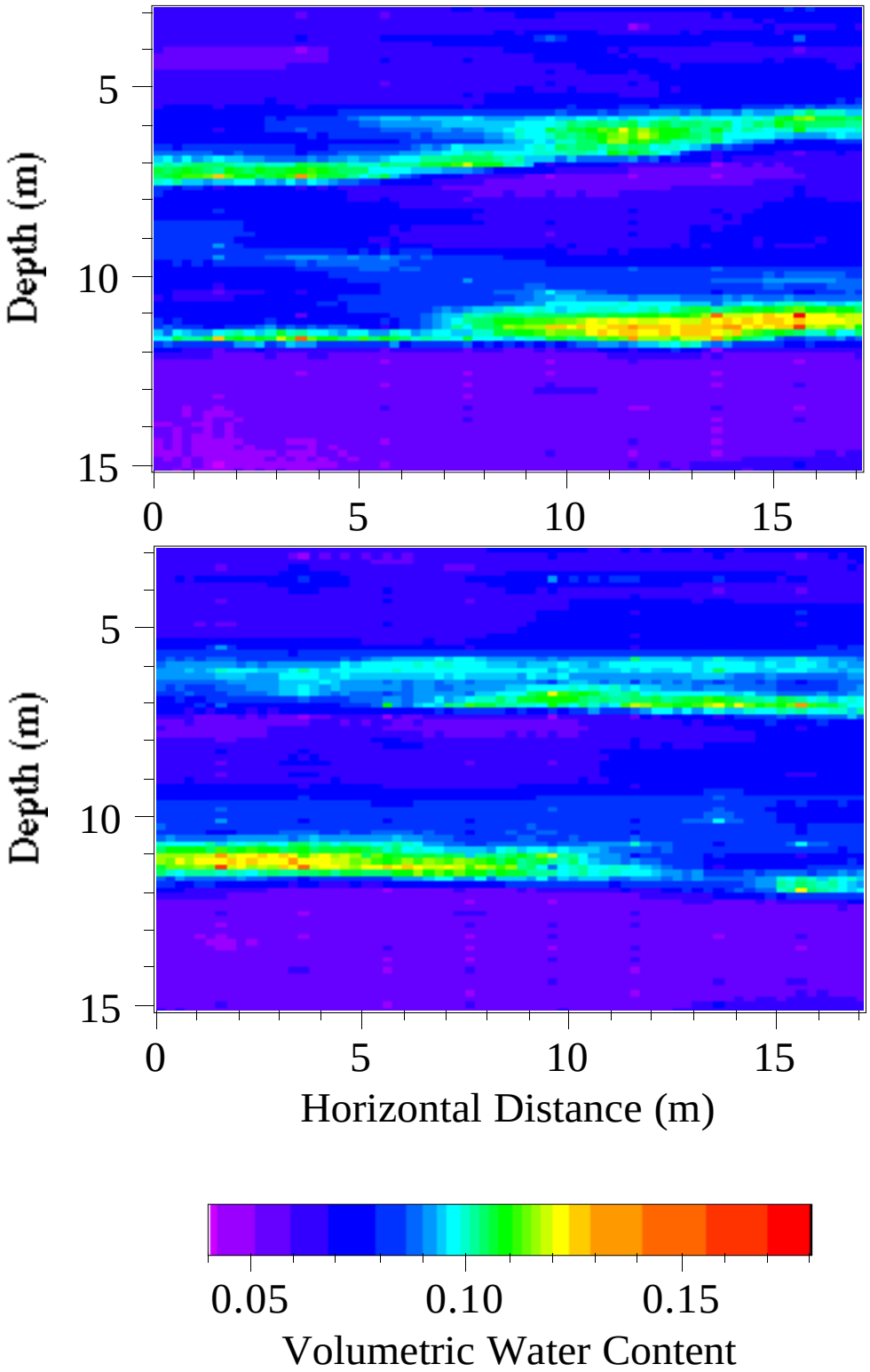
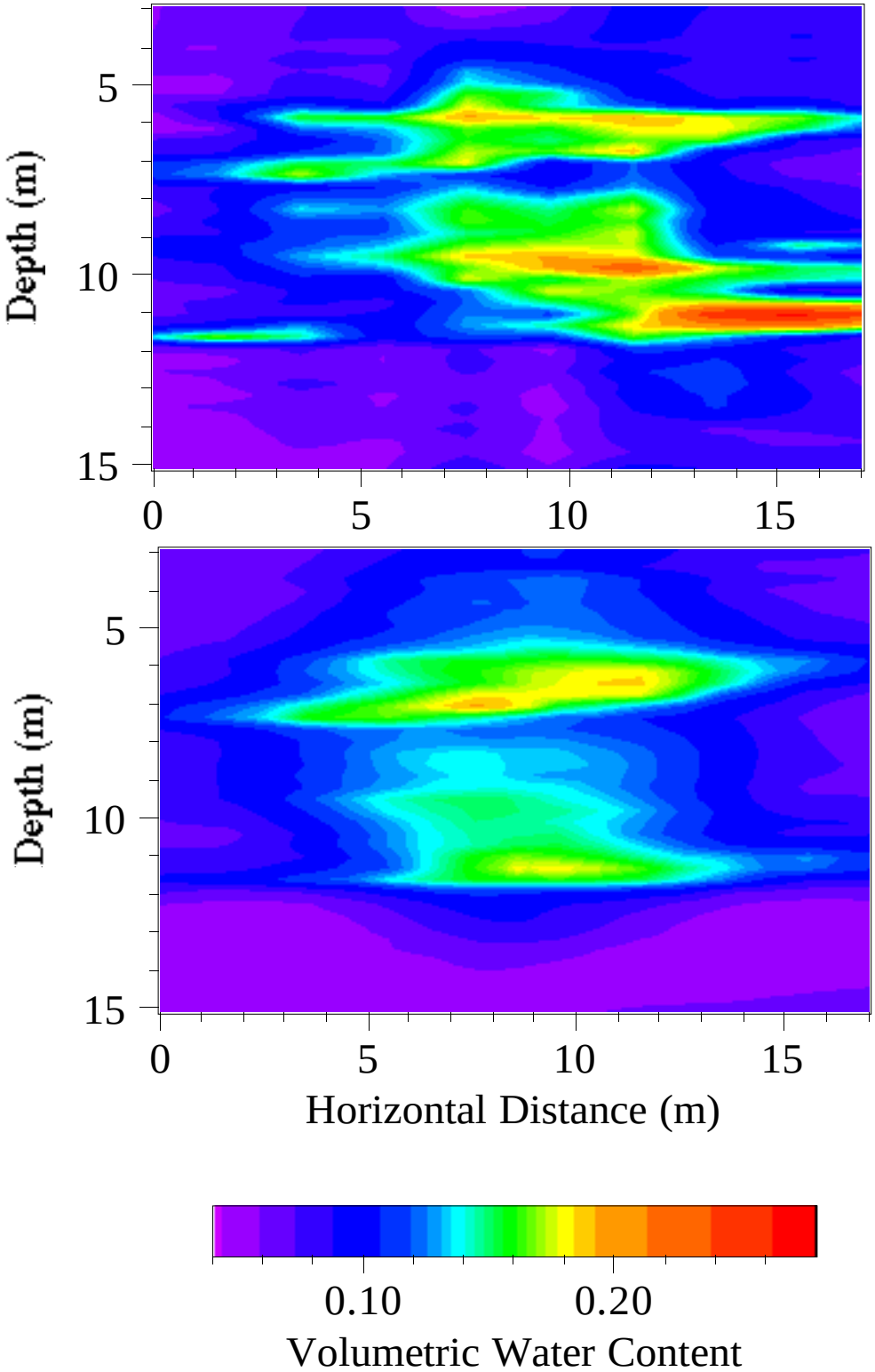
- Obtain site-specific hydraulic property data
- Fine-grid simulation to eliminate upscaling effects
- Neural network pedotransfer functions and geophysical measurements as alternative conditioning data
- Simulations using a variety of data and grid resolutions to estimate effects on prediction uncertainty of data limitations and upscaling

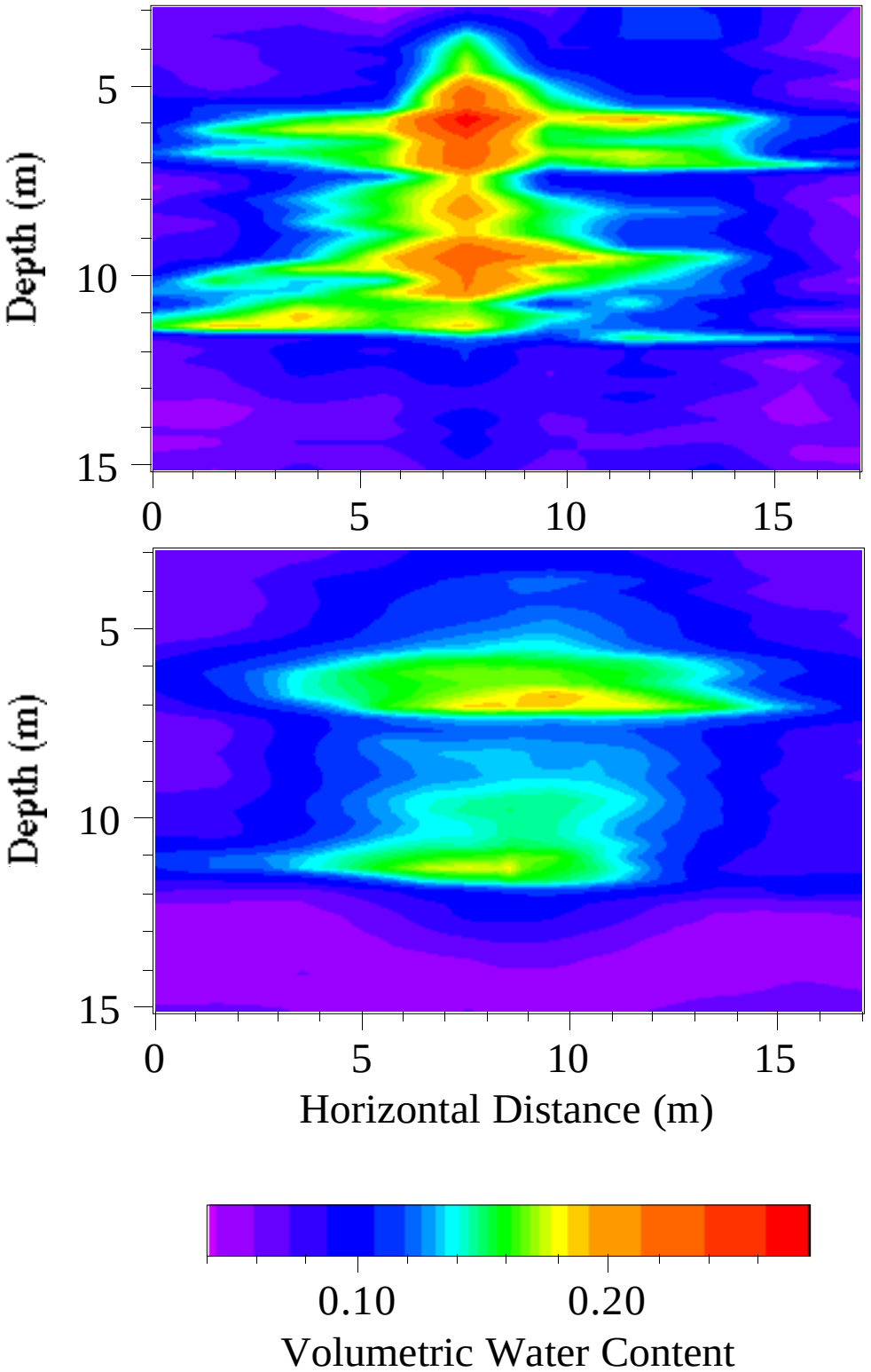
Initial Water Content Distributions for E-W (top) and N-S (bot) Transects



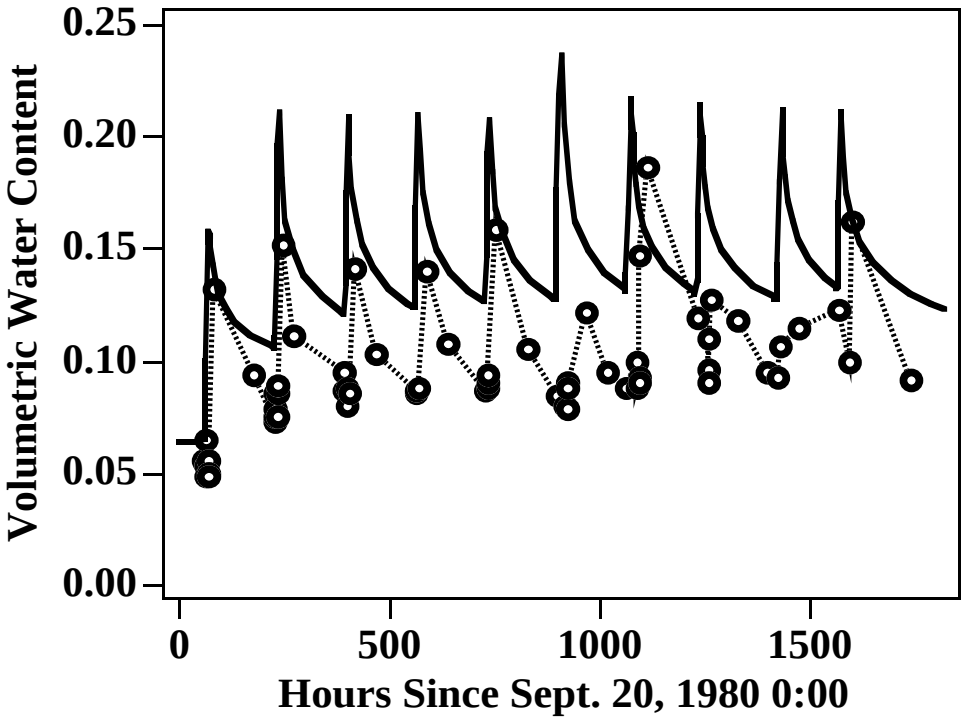
Observed (top) and Simulated (bot) Water Content Distributions for E-W Transect

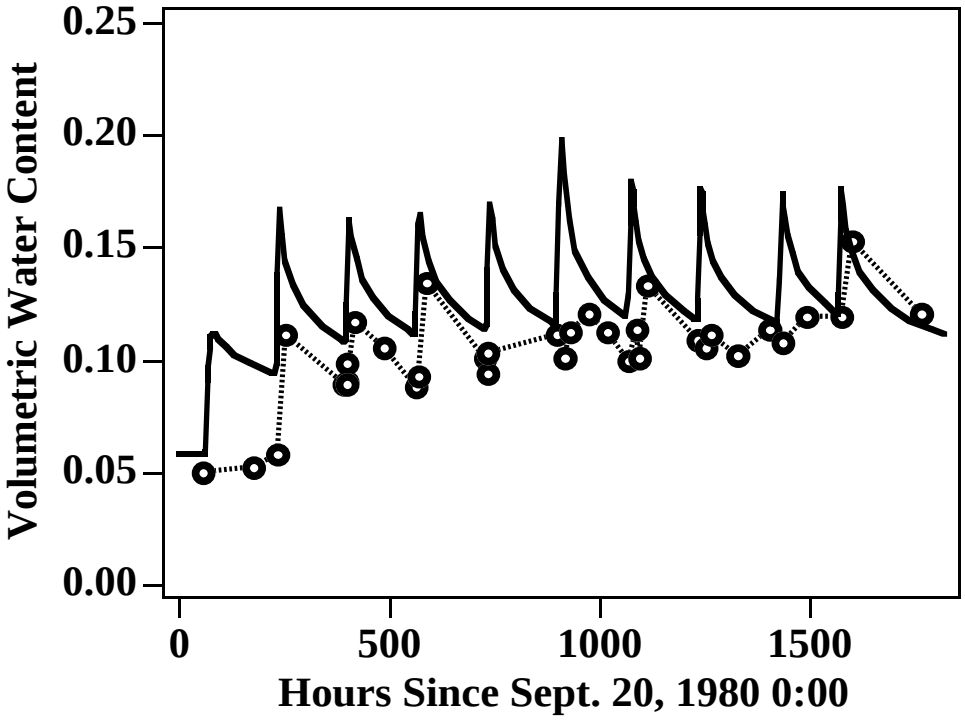
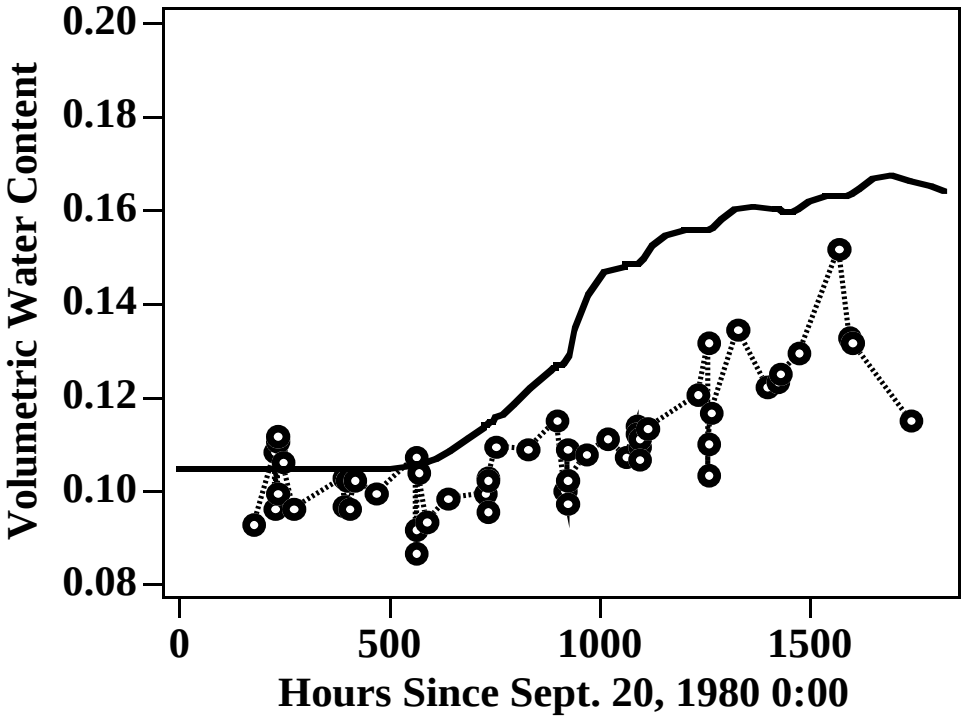
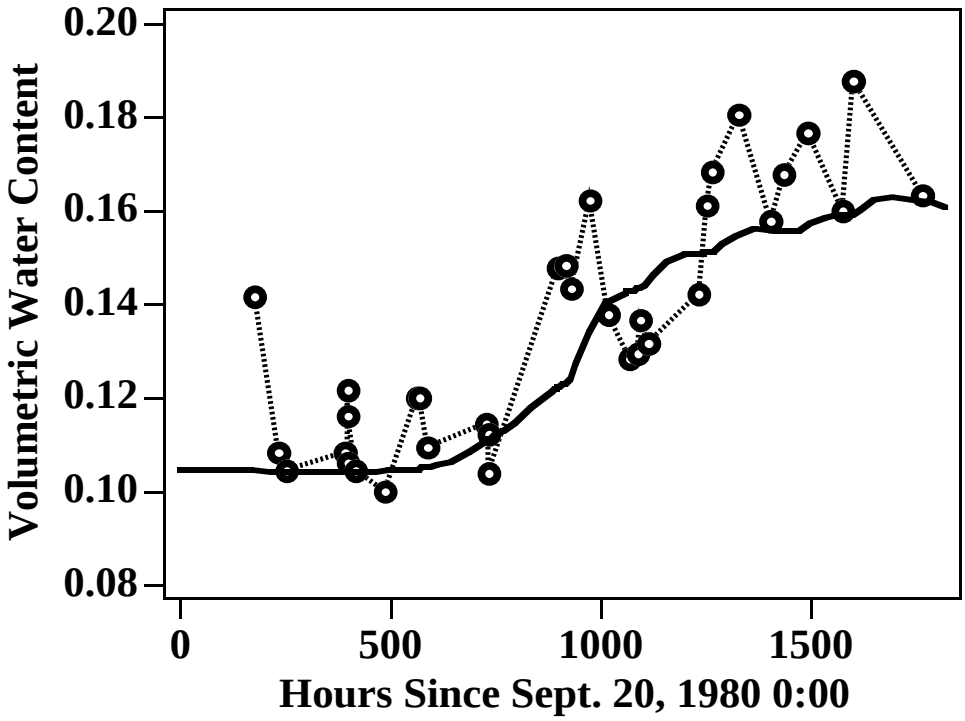


Observed (top) and Simulated (bot) Water Content Distributions for N-S Transect



Time Histories of Observed and Simulated Water Contents at 7.3-m Depth in Wells A-1 (top) and A-3 (bot)





Time Histories of Observed and Simulated Water Contents at 11-m Depth in Wells A-1 (top) and A-3 (bot)