

Introductory and Advanced PEST Courses: Portland, OR, May 10th – 13th, 2010

This “Double-header” PEST event will comprise a two-day “Introduction to PEST” course and a subsequent two-day “Advanced Analysis using PEST” course.

The introductory course will be most suitable to modelers who have little to no experience with inverse methods. This course will comprise a balance of about 60:40 lectures and hands-on-exercises, with the aim of providing theoretical background on inverse methods based on least-squares, and practical experience in their implementation in conjunction with a range of environmental models. This course will include many examples from the groundwater modeling context, together with other environmental modeling applications.

In the advanced course the emphasis will turn to highly parameterized inversion in calibration of ground and surface water models, and in exploration of the uncertainty associated with the parameters and predictions associated with these models. Topics covered in detail will include the use of pilot points as a parameterization device; advanced regularization techniques; the “SVD-assist” technique for efficient inversion of highly parameterized models; linear and nonlinear analysis of uncertainty - including the recently-developed and highly expedient null-space Monte Carlo methodology that is unique to PEST; and methods for optimizing future data acquisition to reduce uncertainty. This course will comprise a balance of about 90% lectures and 10% hands-on exercises. However, there will be ample room for discussion. Furthermore, participants will be provided with a CD containing 12 hands-on exercises which they can take away with them to study at their leisure.

Attendees can register for the “Introductory” course, or the “Advanced” course, or register for both courses - including 4-days of PEST - for a discount on the individual course prices.

Course Fee Structure

Introductory Course: (Principal Instructor – Matt Tonkin, SSP&A)

\$725 private industry/federal employee

\$650 full time student/state employee

\$575 full time student/state employee

Advanced Course: (Principal Instructor – John Doherty, author of PEST)

\$825 private industry/federal employee

\$750 full time student/state employee

\$675 full time student/state employee

Introductory and Advanced Course Double Header

\$1400 private industry/federal employee

\$1250 full time student/state employee

\$1100 full time student/state employee

An additional early-bird discount will be applied to the Double Header fees if signed up by February 26, 2010.

Course Venue and Accommodations

The Introductory and Advanced PEST Courses will be held at The Portland Marriott City Center, Portland (www.marriottportland.com). An Ice-Breaker Reception will be held at the hotel on the evening of Sunday, May 9th, with the first drink complementary. Each morning of the courses coffee, tea and fruit will be provided, and each afternoon coffee, tea and cookies will be provided. A group rate has of \$159.00 + tax per day been secured for guest rooms for attendees of the course(s). This room block will be held until 4 weeks prior to the course(s). Please indicate "PEST Course" when booking your accommodations.

Further Information

For any further information on either or both courses, please write to:

pest@sspa.com

Course Outline

The following is a basic agenda: more detailed information can be provided upon request. Optional evening sessions will be available throughout the course duration.

Day 1 – Introductory Course

Morning

Lectures:

- Introduction to non-linear parameter estimation
 - Least squares
 - Mathematical theory of linear and non-linear parameter estimation
 - Integrating the non-linear theory with one or more forward model(s)

Hands-on exercise: calibrating a simple model

Afternoon

Lectures:

- The fundamentals of PEST
 - Implementing nonlinear parameter estimation theory using PEST
 - Contents and construction of PEST input files
 - Contents of the PEST output files generated during calibration
 - Diagnosing regression performance throughout the calibration
- Example applications using groundwater and other models

Hands-on exercise: choice of problems including surface and groundwater, forestry, unsaturated zone, or attendees' own studies

Day 2 – Introductory Course

Morning

Lectures:

- Calibration of groundwater models of flow and transport
 - What is possible?
 - Calibration objectives and design
 - Example applications

Hands-on exercise: choice of problems including surface and groundwater, forestry, unsaturated zone, or attendees' own studies

Afternoon

Lectures:

- Model parameterization methods, including pilot points
- Introduction to regularization
- Introduction to the novel “SVD Assist” technique for highly-parameterized models
- Sensitivity analysis
- Introduction to predictive error analysis
- Utility software accompanying PEST
 - For groundwater modeling
 - Other utilities

Hands-on exercise: choice of problems including surface and groundwater, forestry, unsaturated zone, or attendees' own studies.

Day 3 – Advanced Course

Morning

- Calibration metrics
- Regularization
 - the need for regularization
 - Tikhonov regularization
 - subspace regularization
 - “SVD-Assist”
 - combining Tikhonov and subspace techniques
 - PEST utilities for implementing regularization
- Pilot points
 - pilot points as a regularization device
 - regularization and pilot points
 - guidelines for pilot point emplacement
- Other important concepts for groundwater modeling
 - parameter pre-processing
 - observation post-processing

- structural noise

Afternoon

PEST and Surface Water Modeling

- Challenges faced in surface water model calibration
 - highly nonlinear models
 - local optima
 - large datasets with large dynamic range
 - regionalization of parameters
- Overcoming the problems – parameterization
 - highly parameterized inversion
 - simultaneous calibration with built-in parameter regionalization
 - regularization in the surface water calibration context
- Overcoming the problems – observations
 - multi-component objective functions
 - processing of observations
 - relative weighting between observation types
 - digital baseflow filtering
 - “super observations”
- Utility Support Software – TSPROC
- Global Optimization Strategies
 - SCEUA
 - CMAES
 - PD_MS2
 - other methods

Day 4 – Advanced Course

Morning

Uncertainty and Error

- Sources of Uncertainty
 - null space and solution space
 - pre-calibration and post-calibration uncertainty

- Traditional Uncertainty Analysis
 - the role of measurement/structural noise
 - linear analysis
 - nonlinear analysis
 - Markov Chain Monte Carlo
 - examples
- Highly-Parameterized Uncertainty Analysis
 - the need for complexity for integrity of uncertainty analysis
 - linear analysis
 - nonlinear analysis
 - null-space Monte Carlo
 - examples

Afternoon

Issues Related to Uncertainty Analysis

- Some mathematical underpinnings
- Optimizing data acquisition
- Monitoring network design
- Contributions to uncertainty by different parameter types
- Appropriate model complexity
- Examples