

SPARROW Surface Water Quality Workshop

October 29-31, 2002

Reston, Virginia

**Section 1. Overview of Model Building
Concepts**

Section 2. Statistical and Deterministic Models

Overview of Model Building Concepts

Models should be targeted to address the appropriate questions and structured accordingly:

“An approximate answer to the right question is worth a great deal more than a precise answer to the wrong question.”

--sometimes attributed to
John Tukey

Overview of Model Building Concepts

What are the appropriate questions and resource needs?

Some key questions for consideration:

- What are your project objectives?
 - Interpolation of monitoring data (flux, concentration)
 - Source identification
 - Understanding of processes
 - Forecasting and simulation
 - Uncertainty quantification
- What are the appropriate time and space scales (and models to address these)?
- What's your budget and resources?

Overview of Model Building Concepts

Models should be used early in the project design and sampling stages to help guide data collection:

“Calling a statistician (modeler) after the experiment is completed is like consulting a pathologist – She might be able to determine what the experiment died of.”

--sometimes attributed to no one

Overview of Model Building Concepts

Model building is subjective:

“All models are wrong, some models are useful”
-G.E.P. Box

- Your scientific expertise necessary to select variables, determine appropriate functional forms, evaluate model fit, coefficients, and interpret models
- Statistical estimation of parameters brings objective tools to aid model fitting and identification of important processes and where potentially lacking sufficient data

Overview of Model Building Concepts

Parsimonious models desirable:

“Every model should be as simple as possible, but no simpler”
-Einstein

- Start simple with few, but most important variables (sources alone or with stream / reservoir decay)
- Add complexity as understanding of model performance and coefficient interpretability improves

Expanding Interest in Statistical / Empirical Methods of Estimating Parameters

Statistical



Deterministic

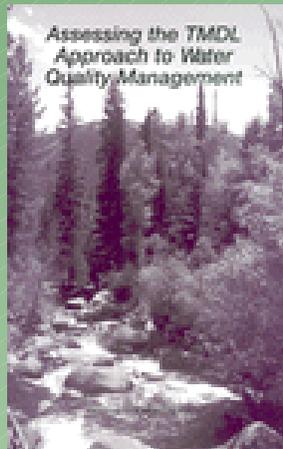
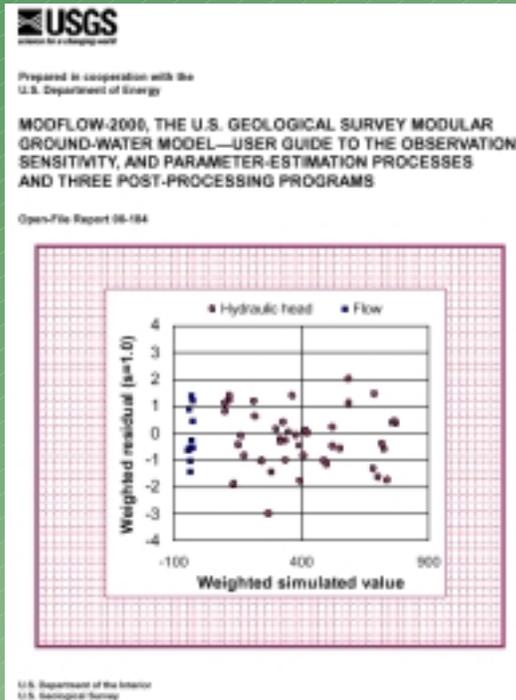


MODFLOW-2000

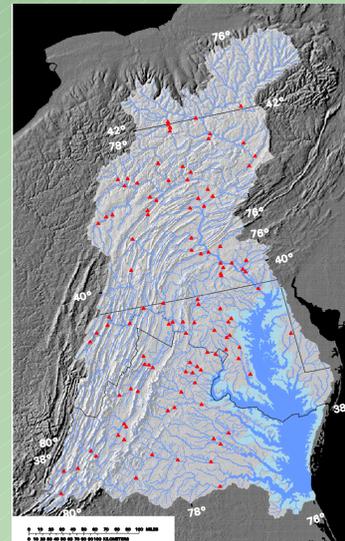
National Research Council (2001)

Computer Software

- UCODE – Universal Inverse Model
- PEST – Parameter Estimation



Chesapeake Bay



- HSPF parameter estimation project
- Joint application of SPARROW and HSPF (USEPA Bay Program)

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Statistical



Deterministic

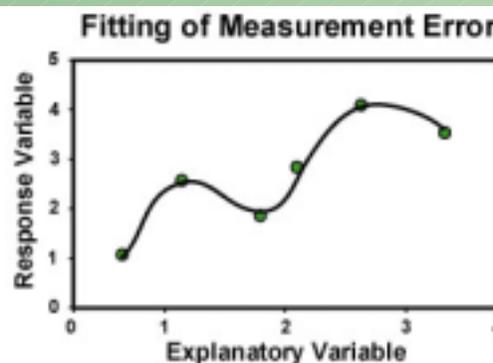
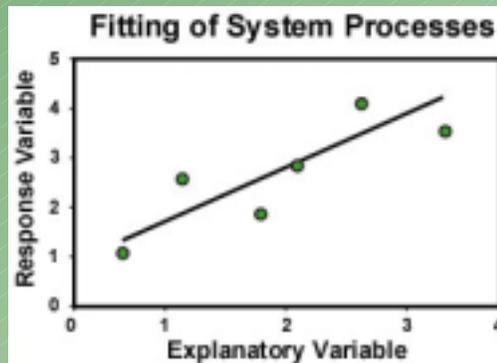
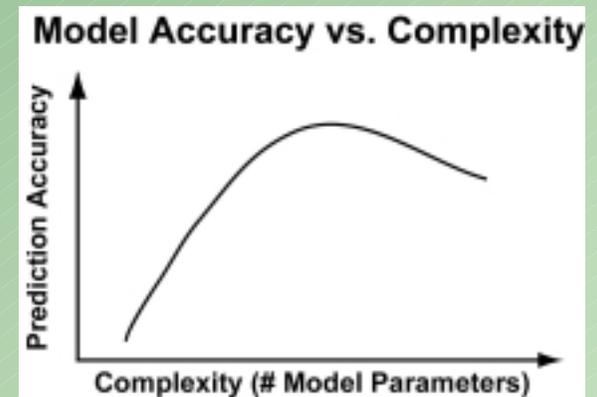


1. Parsimonious model desirable

"Every model should be as simple as possible, but no simpler"
-Einstein

Model Complexity not equal Accuracy

- Fitting of measurement error in observations
- Uncertainty of model parameters (insufficient data)
Is the model complexity supported by the data?
- 20% of process details may explain 90% of the dynamics



Expanding Interest in Statistical / Empirical Methods of Estimating Parameters

Statistical



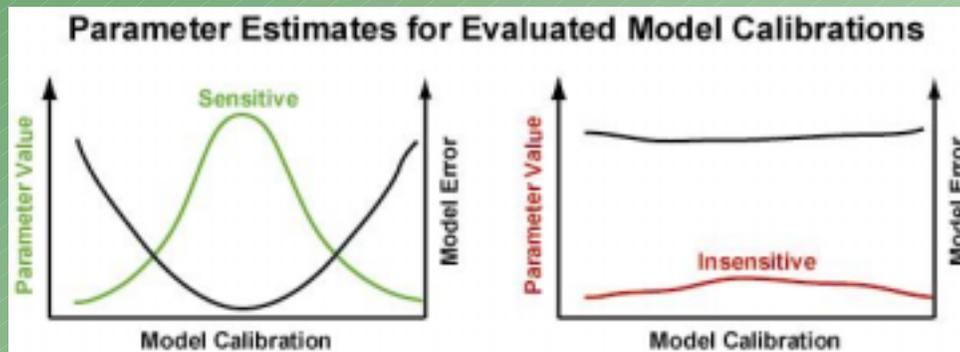
Deterministic



2. Increased interest in sensitivity analysis and parameter estimation

Concerns over uncertainty of model parameters (competing models with similar performance)

Insensitivity – model predictions and errors unaffected by choice of parameter values (information content of observations important)



Implications of lack of sensitivity:

- (a) lack of effect, or
- (b) lack of power to detect effect (requires more samples)

3. Uncertainty characterization – Errors in parameters and predictions more readily estimated in statistical models

Statistical and Deterministic Watershed Models

