

# Some issues in UQ for groundwater applications

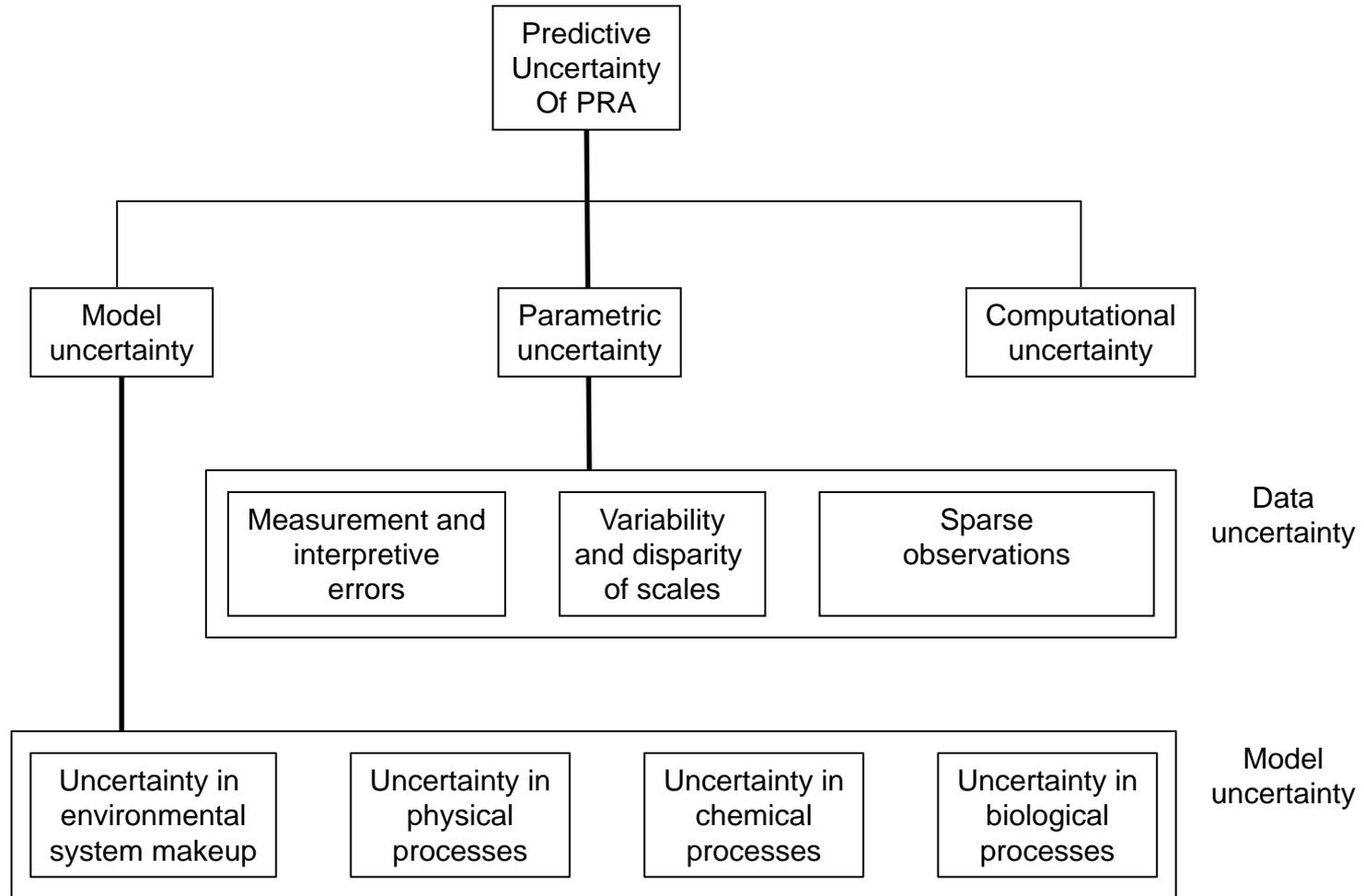
Larry Winter

Dept of Hydrology

University of Arizona

winter@email.arizona.edu

# Sources of uncertainty in GW PRA



# Brief, selective history of UQ in groundwater hydrology

- Freeze, 1975
  - Stochastic version of Darcy's equation
  - Uniform conductivity field
  - Monte Carlo simulations
- Stochastic pde approach
  - Gelhar: spectral decomposition
  - Neuman: moment differential equation approximations
  - Dagan: Lagrangian particle dispersion
  - Benson: fractional derivatives
- Discrete approximations
  - Continuous time random walks
  - Lattice Boltzmann techniques
- Lumped stochastic models
  - Bolster et al., 2009

# Examples: (Groundwater) hydrology decision- making in the face of uncertainty

- Yucca Mountain
  - Regional and local transport of radioactive materials
  - Maximum dose
  - Alternative models
- Remediation of the Los Alamos site
  - Complex geostratigraphy – heterogeneous random fields
  - Complex geochemistry
- Close-out plan for the Chino Mine
  - Uncertain composition of waste piles
  - Alternative scenarios
- Water supply of the Tucson basin
  - Scenarios
  - Security indices

# Goals of UQ in the (Groundwater) Hydrology Community

- Determine likely flow paths and transport of groundwater contaminants
  - Bound expected system states with confidence intervals
  - Pressure, fluid velocities, chemical concentrations
- Model coupled human-natural water systems at levels of fidelity sufficient to support decision-making
  - Bound likely system performance
  - Support scenario evaluation
  - Example: Estimate effect of groundwater pumping on river levels in the San Pedro Riparian National Conservation Area

# Good example of UQ in this community

- Remediation of a contaminated aquifer
  - Determine who is responsible
  - GW flow and transport model
- Informal uncertainty quantification
  - Consensus model
  - Negotiation
- Alternative models for resolving uncertainty
  - Legal system
  - Adjudication
  - Arbitration
  - Legislation

# Outstanding issues

- Competition among models
  - Bayesian model evaluation and averaging
- Effective methods of importance sampling
  - Enhanced Monte Carlo
- Highly heterogeneous parameter fields
  - Structural uncertainty
  - Informed priors
  - Scaling
- Optimal sampling
  - Data assimilation
- Models of reduced complexity
  - Scale up