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Stochastic Hydrology

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Course Introduction

- Why stochastic hydrology?
- Course content
- Some definition from system's theory

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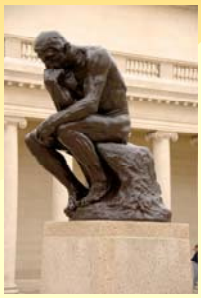
Why stochastic hydrology?

Stochastic derives from στοχαστικός <στοχάζεσθαι <στόχος (target)

To aim for the truth



To imagine, think deeply, bethink, contemplate

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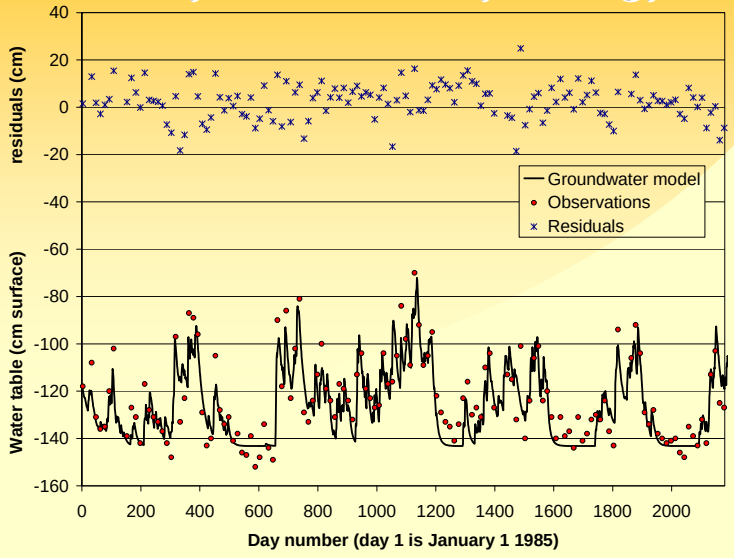
Why stochastic hydrology?



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Why stochastic hydrology?

What causes these differences?

- Observation errors
- Errors in boundary conditions, initial conditions and input
- Unknown heterogeneity and parameters
- Scale discrepancy
- Model errors

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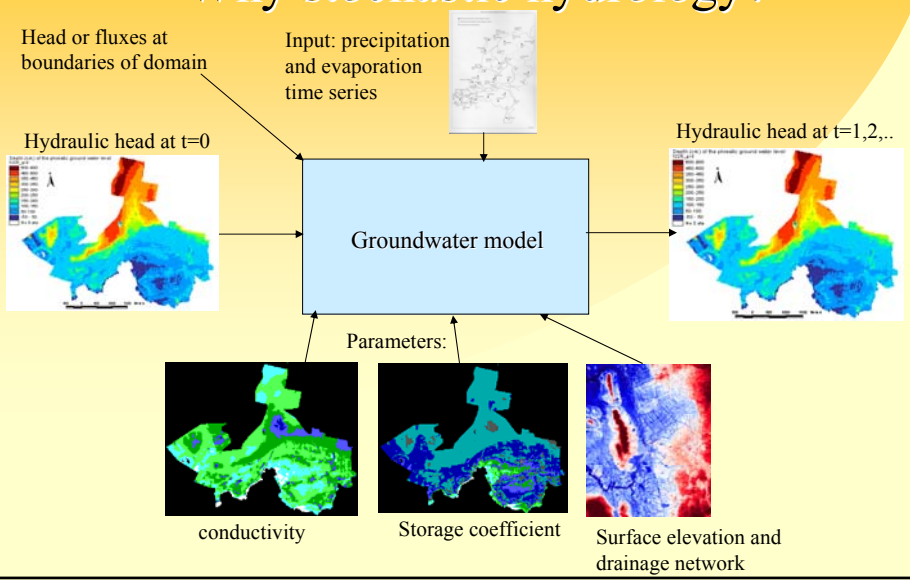
Why stochastic hydrology?



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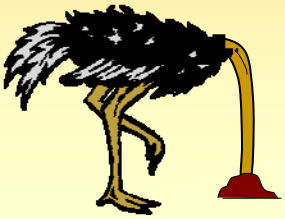
Why stochastic hydrology?

There are two ways of dealing with model residuals

Deterministic hydrology



Stochastic hydrology

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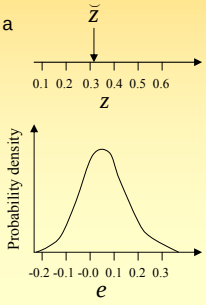
Why stochastic hydrology?

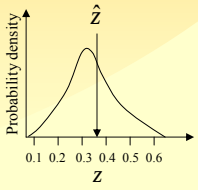
Dealing with model residuals

$$Z = \breve{z} + E$$

a



b



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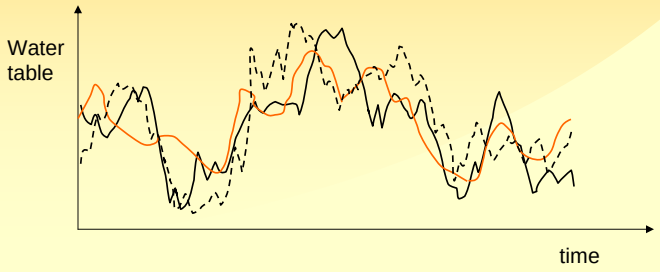
Why stochastic hydrology?

The advantages of using stochastic models

1. Models are smooth; reality messy and rugged



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Why stochastic hydrology?

The advantages of using stochastic models

2. $\hat{Z} \neq \breve{Z}$ for non-linear models

The optimal prediction (with the smallest expected error) is *not* the same as the outcome of the deterministic model!

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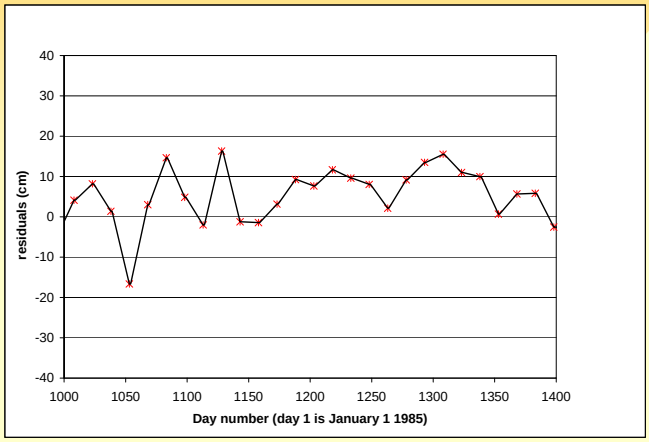
Why stochastic hydrology?

The advantages of using stochastic models

3. Residuals contain information



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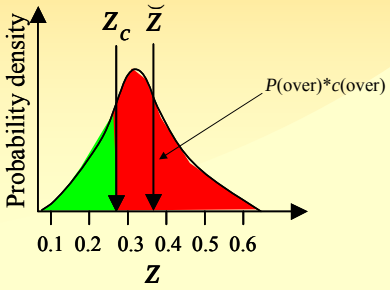
Why stochastic hydrology?

The advantages of using stochastic models

4. Better decisions because of accounting for uncertainty



Clean up only if : costs cleanup < p(over)*c(over)

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Why stochastic hydrology?

The advantages of using stochastic models

5. Monitoring design

   Maximise accuracy given a fixed budget

   Minimise costs given a required accuracy

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Why stochastic hydrology?

The advantages of using stochastic models

6. Investing to improve accuracy

$$r = p + q_v - e - d - \Delta su - \Delta g - \Delta so$$

$$\sigma_r^2 = \sigma_p^2 + \sigma_{q_v}^2 + \sigma_e^2 + \sigma_d^2 + \sigma_{\Delta su}^2 + \sigma_{\Delta g}^2 + \sigma_{\Delta so}^2$$

By tackling the largest error sources first!

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Course content

Program (SUBJECT TO CHANGE)

GEO4-4420: STOCHASTIC HYDROLOGY

Day	Date	Start	Finish	Building	Room	Work form	Topics	
week 7								
Mon	2/15/2010	13:15	17.00	UNNIK	027 -ZV	Lecture	Introduction	Descriptive statistics
Thu	2/18/2010	9:30	12:45	UNNIK	027 -ZV	Lecture	Random variables	
week 8								
Mon	2/22/2010	13:15	17:00	UNNIK	027 -ZV	Lecture	Hydrological statistics	Exercises
Thu	2/25/2010	9:30	12:45	UNNIK	422	CPR	Hydrological statistics	
week 9								
Mon	3/1/2010	13:15	17.00	UNNIK	027 -ZV	Lecture	Random functions	
Thu	3/4/2010	9:30	12:45	UNNIK	027 -ZV	Lecture	Random functions	Exercises
week 10								
Mon	3/8/2010	13:15	17.00	UNNIK	027 -ZV	Lecture	Geostatistics	
Thu	3/11/2010	9:30	12:45	UNNIK	027 -ZV	Lecture	Geostatistics	Introduction to special topics
week 11								
Mon	3/15/2010	13:15	17.00	UNNIK	027 -ZV	Lecture	Time series analysis	
Thu	3/18/2010	9:30	12:45	UNNIK	027 -ZV	Lecture	Time series analysis	Exercises
week 12								
Mon	3/22/2010	13:15	17:00	UNNIK	027 -ZV	Lecture	Forward stochastic modelling	
Thu	3/25/2010	9:30	12:45	UNNIK	422	CPR	Geostatistics	
week 13								
Mon	3/29/2010	13:15	17:00	UNNIK	027 -ZV	Lecture	The Kalman filter	
Thu	4/1/2010	9:30	12:45	UNNIK	027 -ZV	Lecture	Data-assimilation	Examples
week 14								
Thu	4/8/2010	9:30	12:45	UNNIK	027 -ZV	Lecture	Presentation research proposals	Hand in research proposals
week 15								
Mon	4/12/2010	13:15	16:00	UNNIK	027 -ZV	Exercise	Exercising old exams	
Thu	4/15/2010	9:30	12:30	UNNIK	027 -ZV	**Exam**	**Exam**	

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Course content

Special topics:

- Sampling and monitoring
- Inverse estimation
- Ordinary stochastic differential equations
- Point processes
- Upscaling and downscaling methods
- Uncertainty and decision making

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Course content

Grading

- Exam 80%,
- Research proposal 10%,
- presentation of research proposal 10%.

Grades in one decimal are given for the Exam, grades in half points are given for the proposal and presentation. The average grade is rounded to two decimals. An average grade of 5.50 and higher means passing the course (5.49 is failing).

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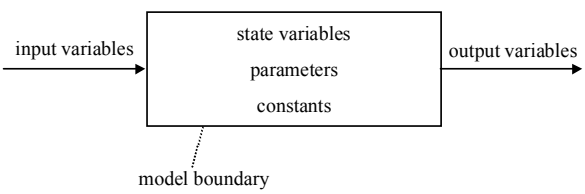
Some definitions from system's theory



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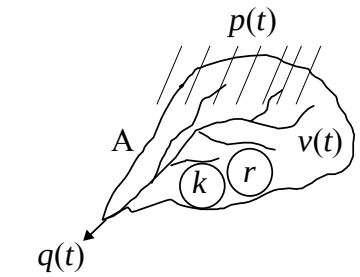
Some definitions from system's theory



$$v(t) = v(t-1) + \{A \cdot [p(t) - r] - q(t)\}\Delta t$$

$$q(t) = kv(t)$$

$$v(t) = [1 - k\Delta t] \cdot v(t-1) + A \cdot [p(t) - r]\Delta t$$