CASCADING UNCERTAINTY IN FLOOD FORECASTING

Florian Pappenberger[1]

Renata Romanowicz[1], Keith Beven[1], Peter Young[1],

Patrick Matgen[2], Jens Bartholmes[3]

[1]Environmental Science/Lancaster Environment Centre, Lancaster University, LA1 4YQ, UK
[2] Département en Environnement et Agro-Biotechnologies, Centre de Recherche Public-Gabriel Lippmann, Luxembourg
[3] European Commission, DG Joint Research Centre, Floods and other weather driven natural hazards, Italy

CHR-Workshop – Expert Consultation, Bern, 30-31 March 2006

LANCASTER UNIVERSITY

flood risk management research consortium

FRMRC

CASCADING UNCERTAINTY IN FLOOD FORECASTING

- Communication between models, modellers & other stakeholders
- spatial and temporal uncertainties in the inputs
- the antecedent conditions
- the geometry of the river channel and floodplains
- the probability of infrastructure failure;
- characteristics of the system (model parameters);
- limitations of the models to fully represent the surface and subsurface flow processes in flood generation and routing
- etc …

LANCASTER UNIVERSITY

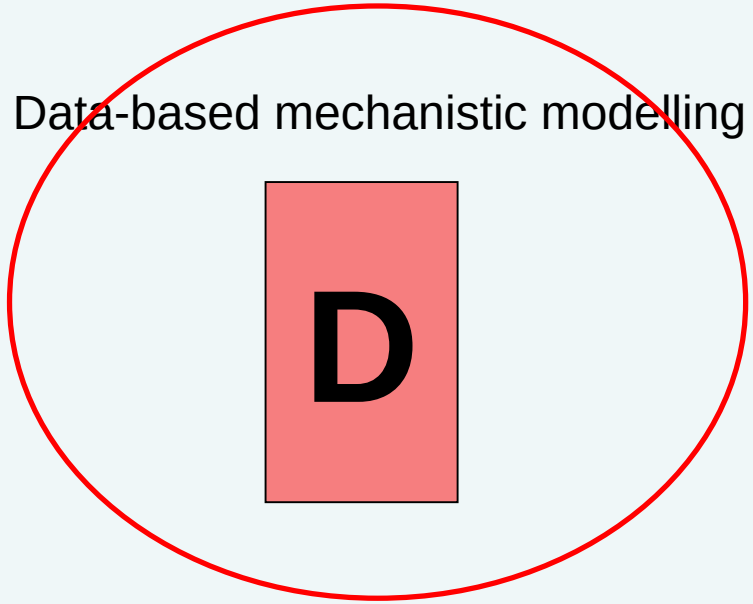
Cascading Uncertainty

This is a complicated nonlinear systems in which analytical solutions do not apply

Estimation of predictive uncertainty of distributed models demands very significant computational resources even when the analysis is done off-line (so that time is not critical) rather than in real time. There are two solutions:

Physically based modelling

Data-based mechanistic modelling



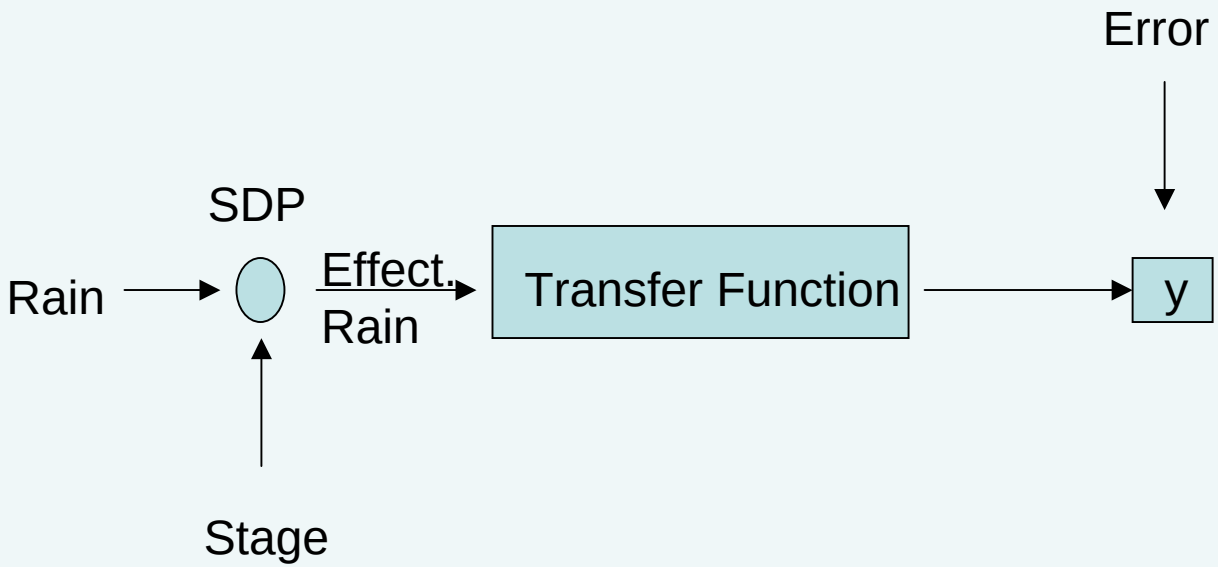
LANCASTER UNIVERSITY

D Data-Based Approach

- The Data-based Mechanistic (DBM) approach to modelling rainfall-flow processes involves four main stages:
  - *identification* of the model structure;
  - *estimation* of the parameters that characterize this identified model structure;
  - *interpretation* of the estimated model in physically meaningful terms;
  - *validation* of the estimated model on rainfall-flow data that is different from the calibration data used in the identification and estimation analysis.

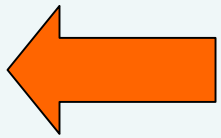
LANCASTER UNIVERSITY

Data-based identified



SDP

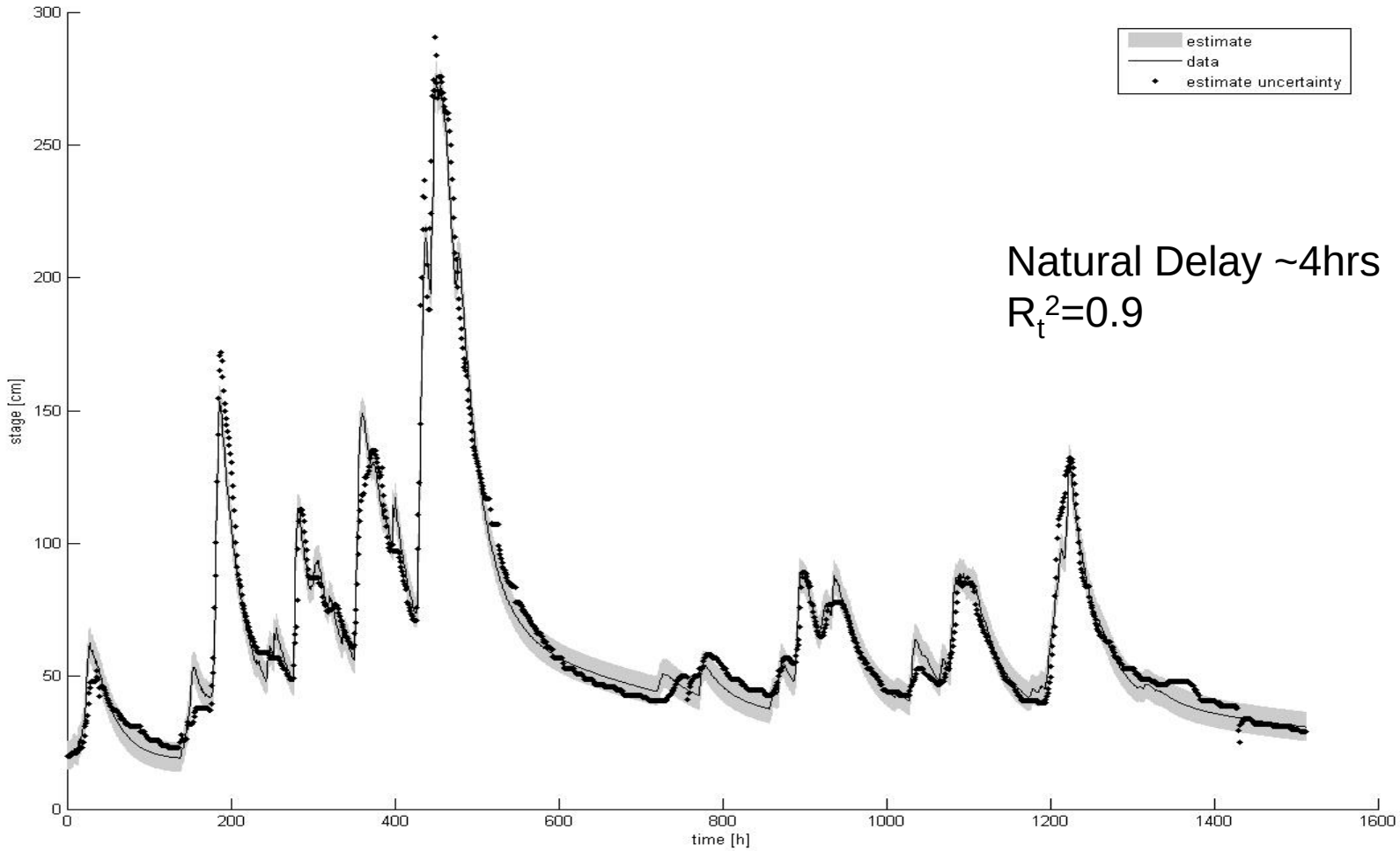
Connection between measured and effective rainfall



Overbank

D

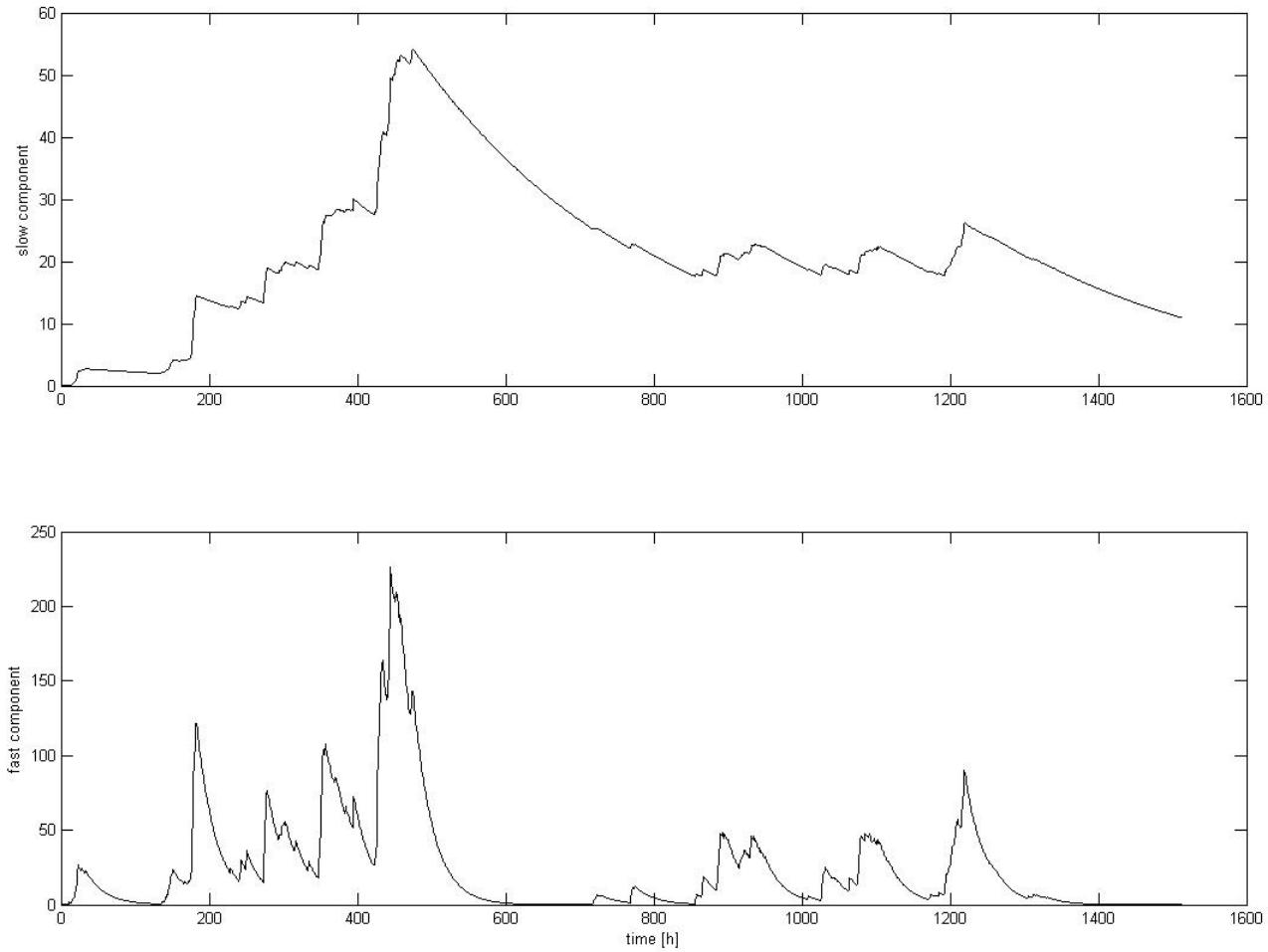
Validation period



Natural Delay ~4hrs

R_t^2=0.9

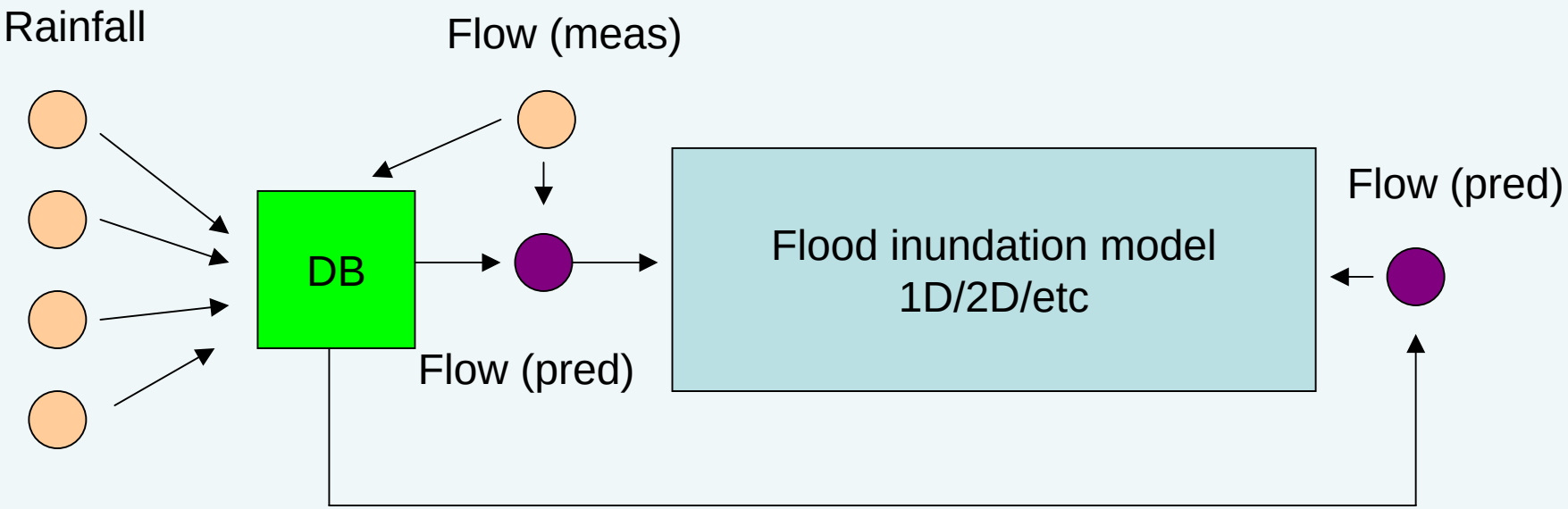
D Slow & Fast component



LANCASTER UNIVERSITY

D

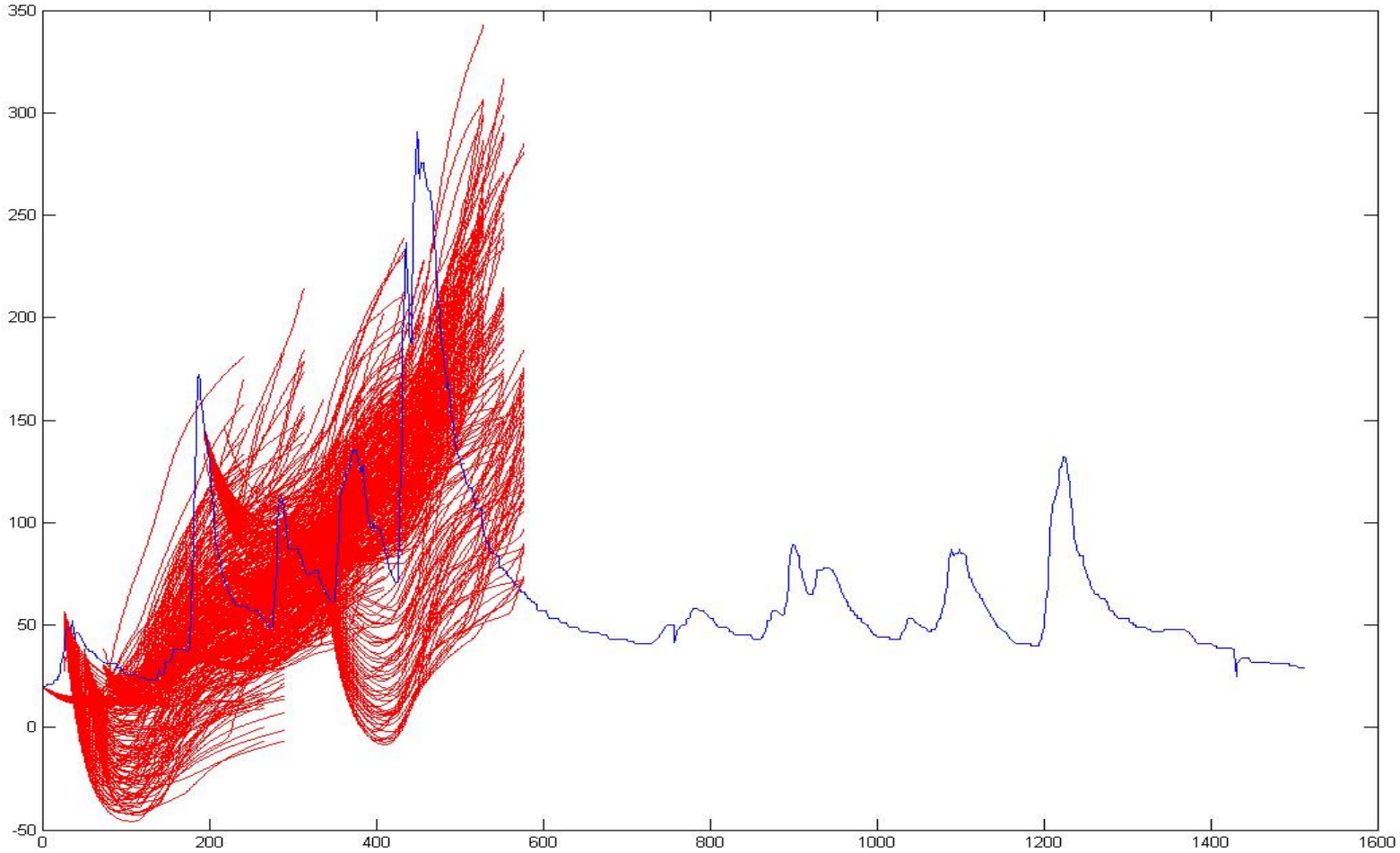
Flood inundation



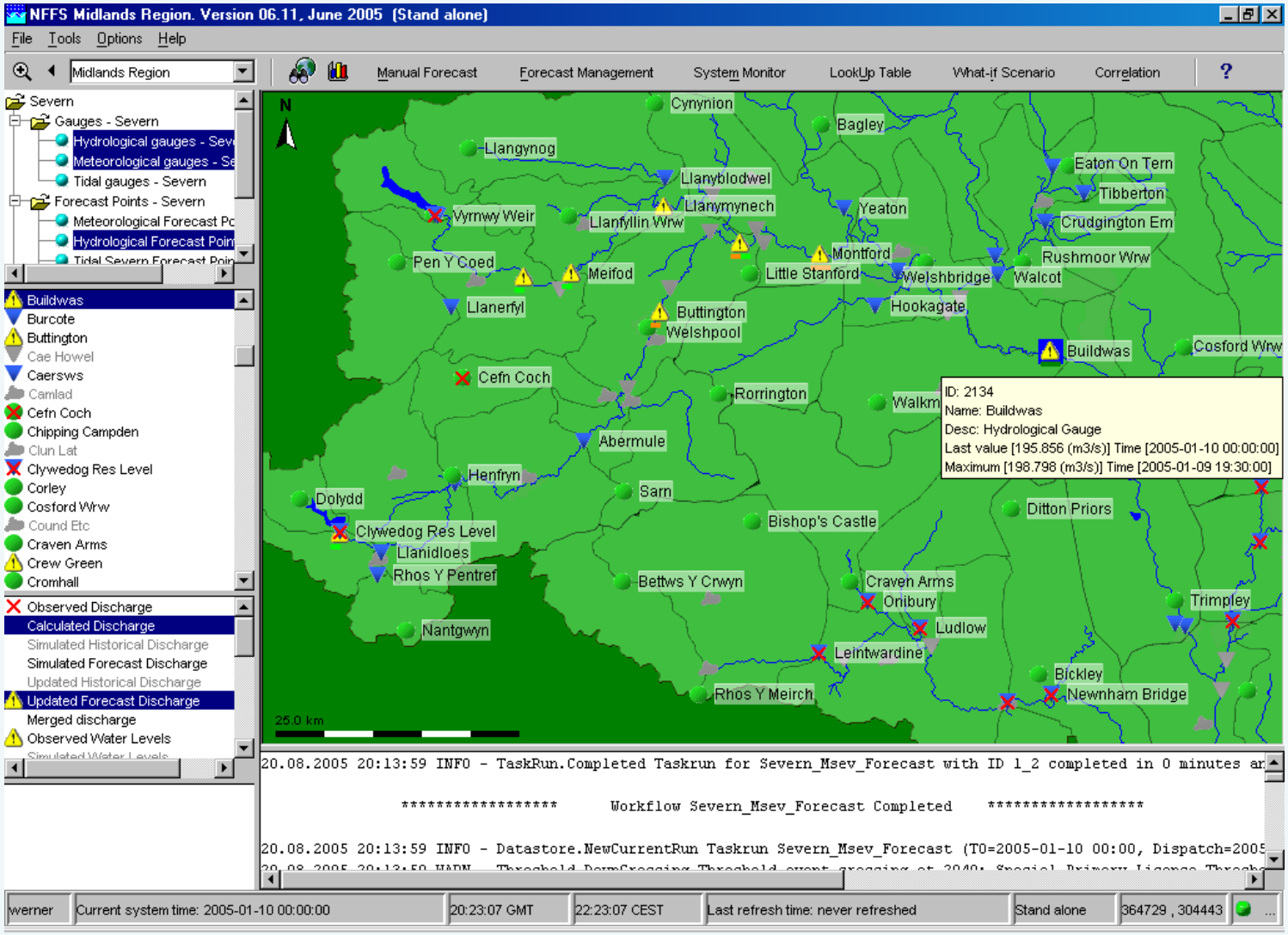
LANCASTER UNIVERSITY

D

Forecast (EPS)

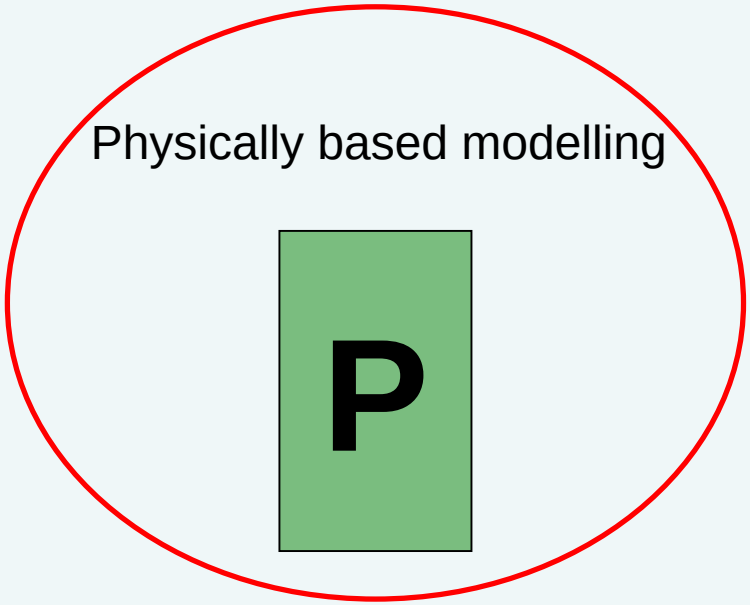


D National Flood Forecast System FRMRC

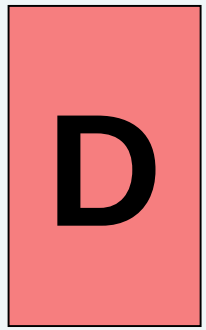


LANCASTER UNIVERSITY

Cascading Uncertainty

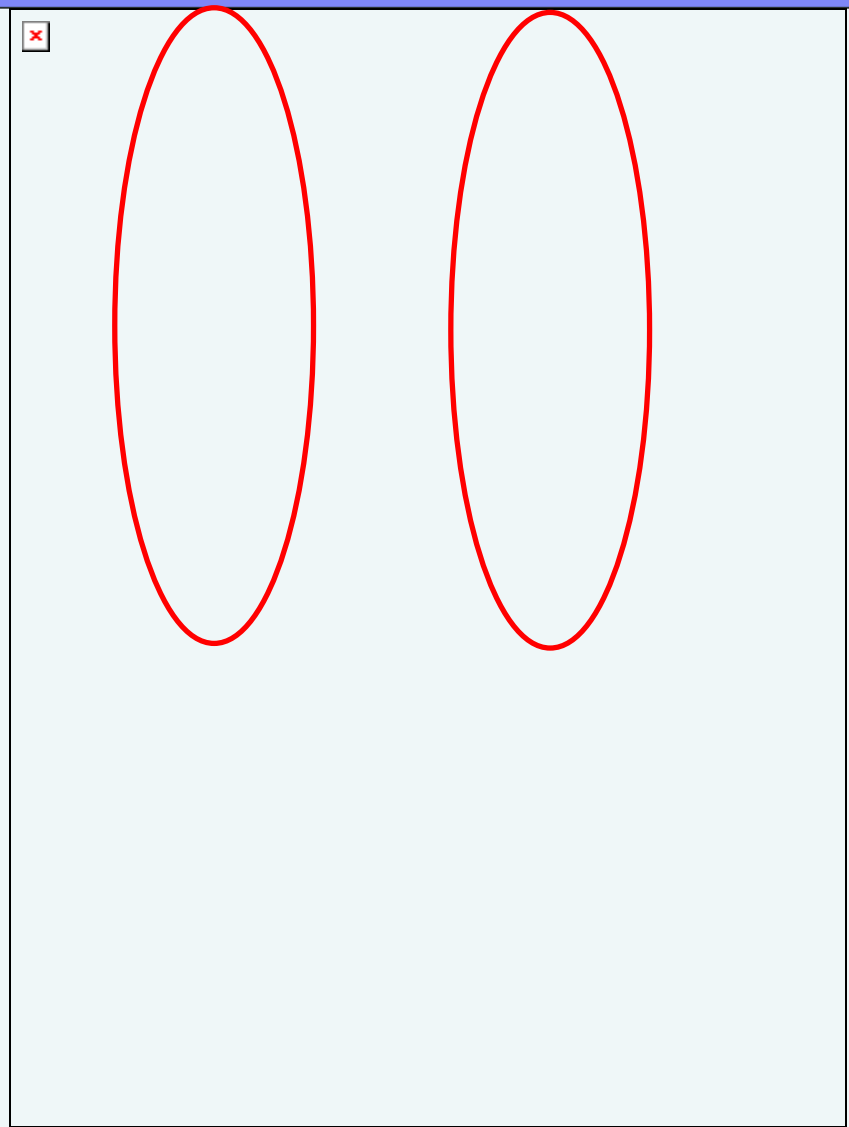


Data-based mechanistic modelling



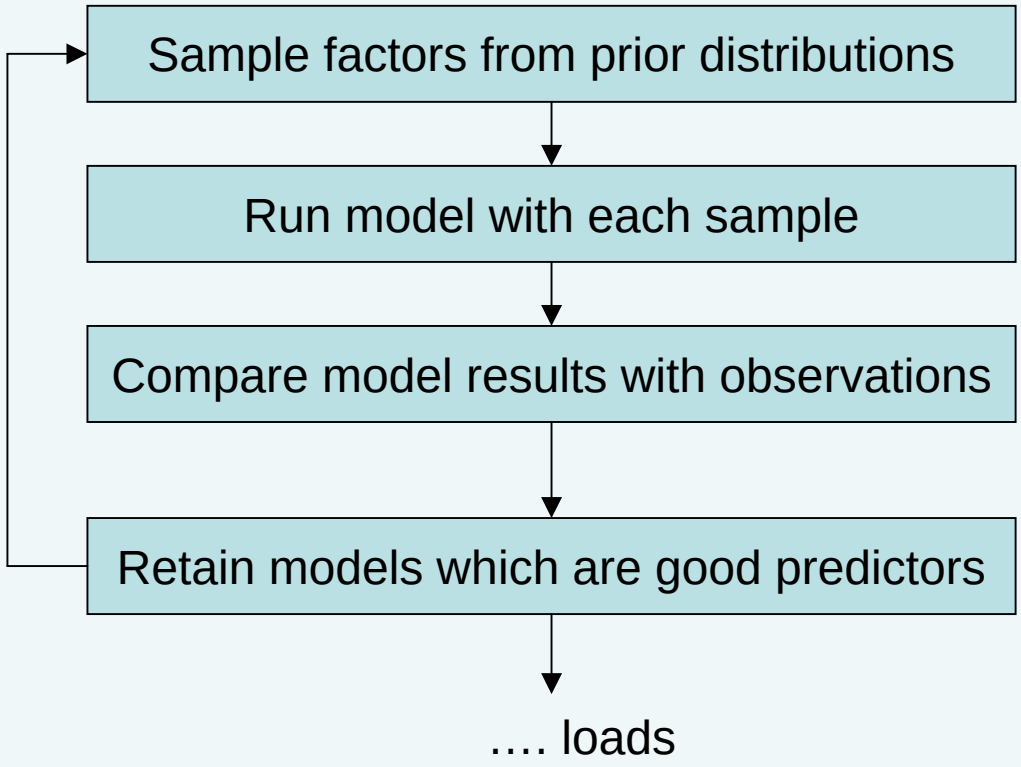
LANCASTER UNIVERSITY

Physically based modelling



LANCASTER UNIVERSITY

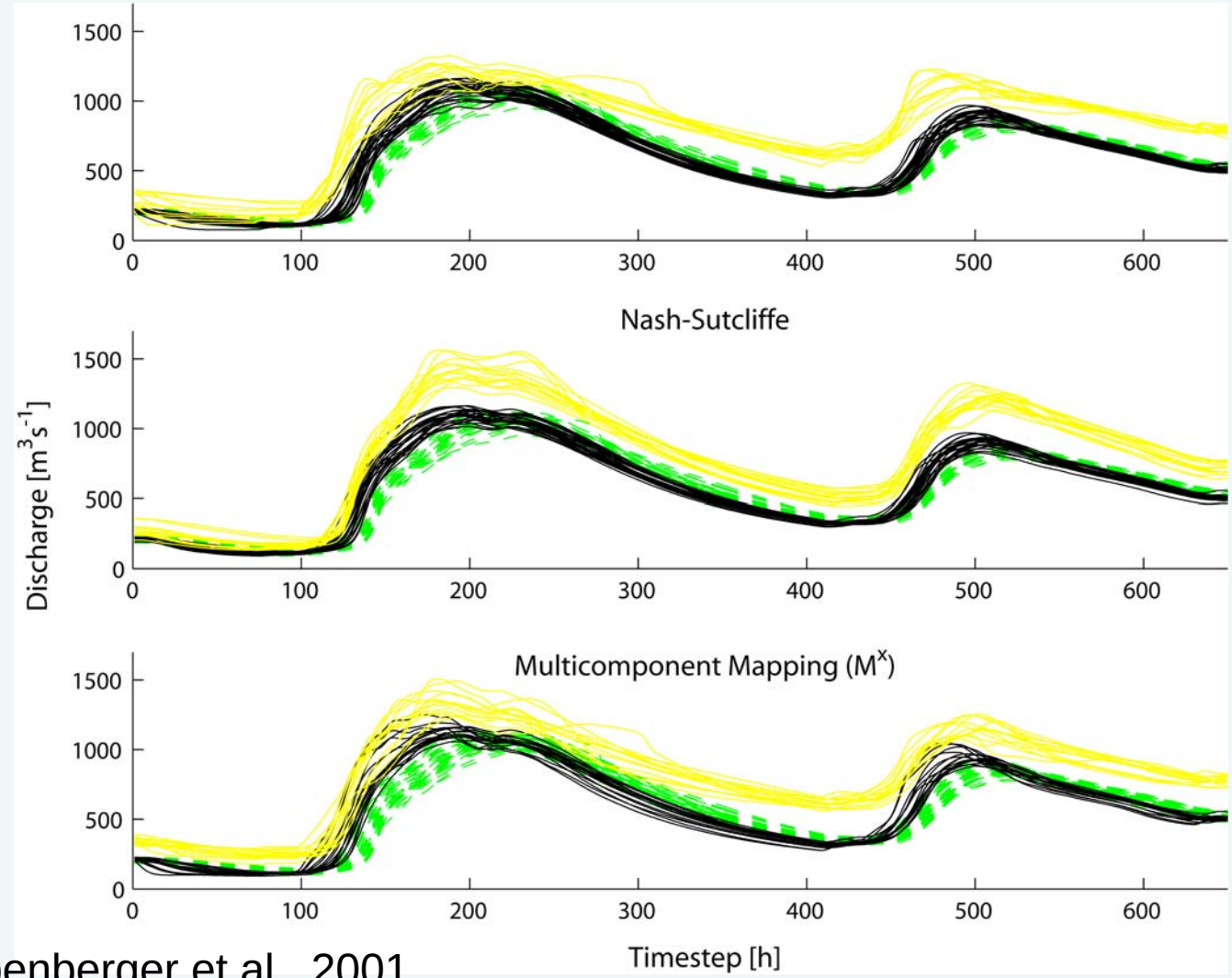
Physically based modelling (GLUE)



LANCASTER UNIVERSITY

Functional Similarity

Varies!!!!



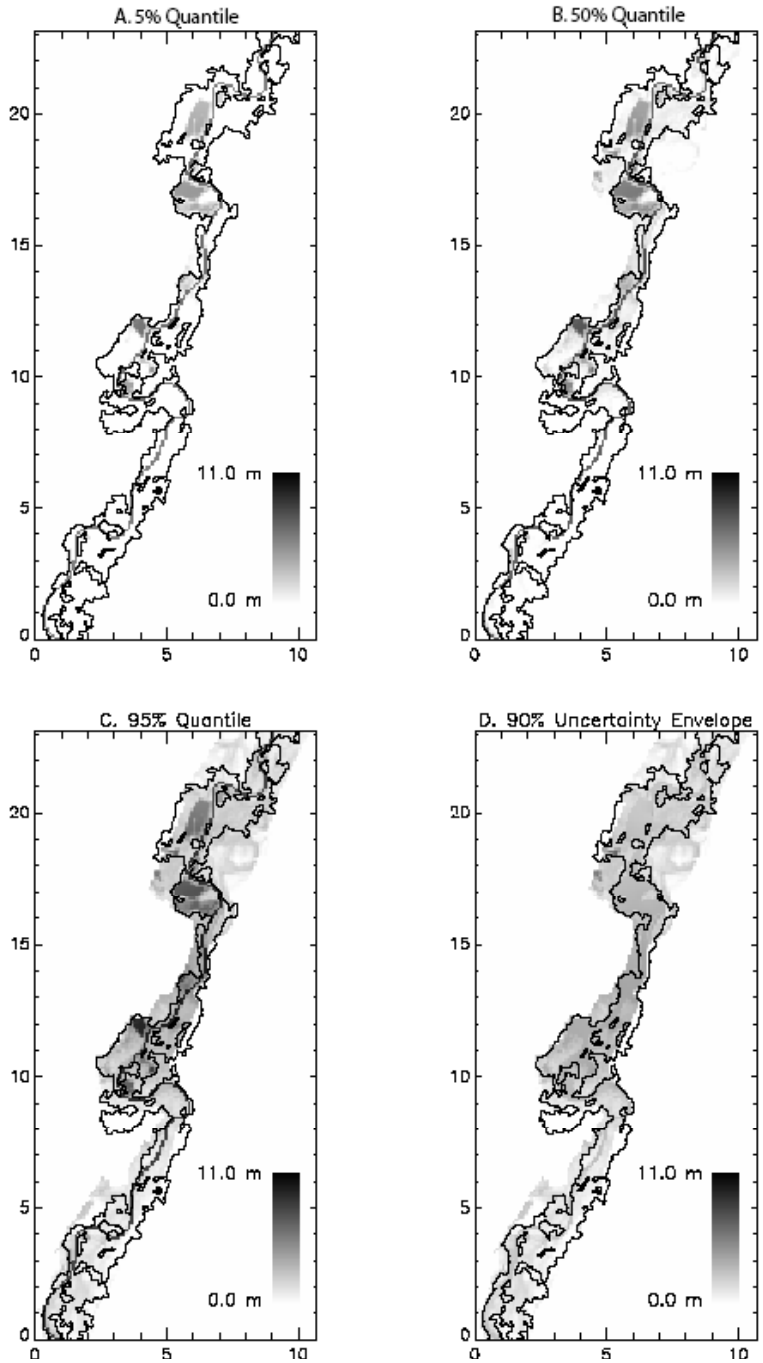
Pappenberger et al., 2001

Flow Forecast

LANCASTER UNIVERSITY

Inundation Model

On which percentiles are decisions derived?

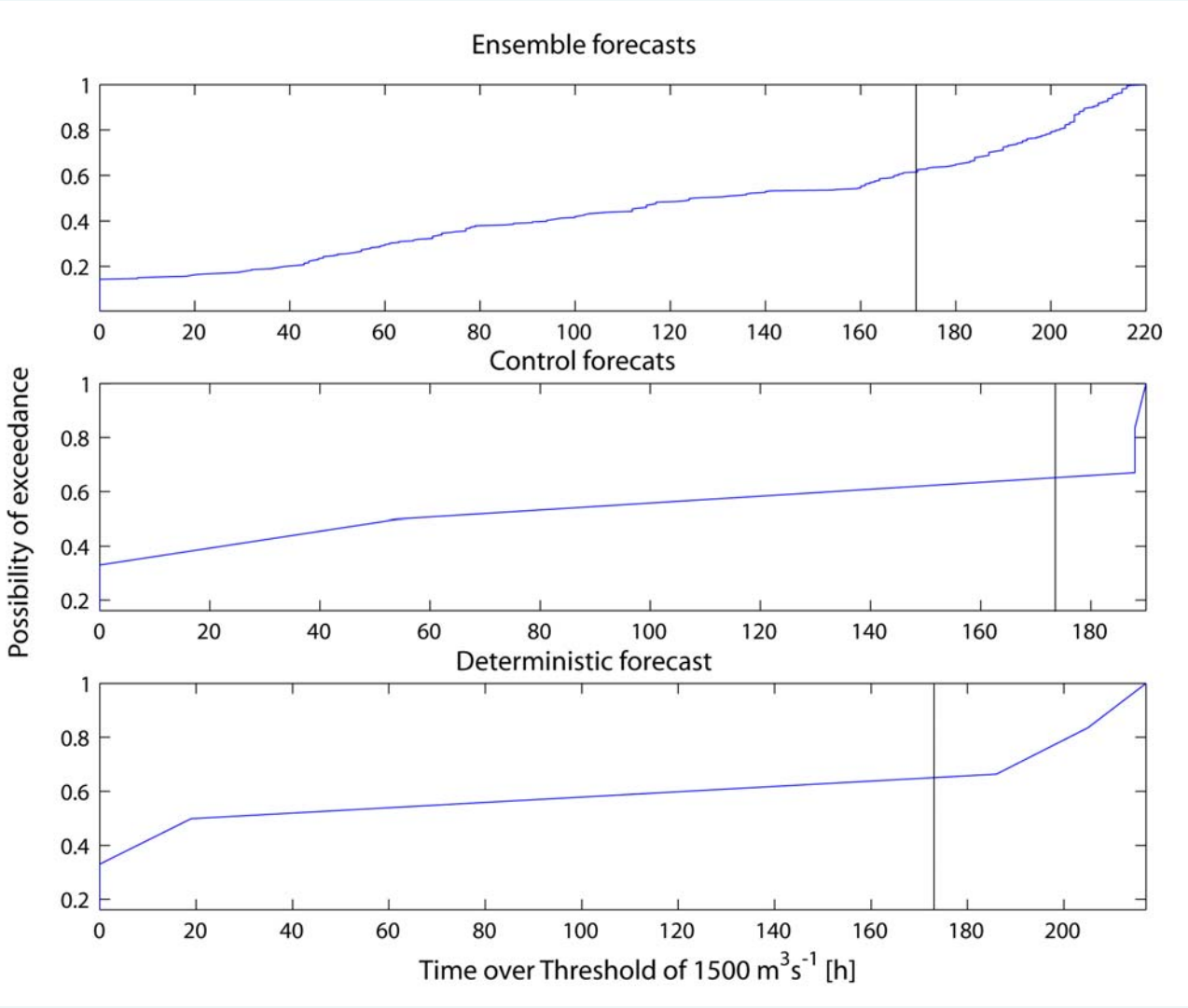


LANCASTER UNIVERSITY

P

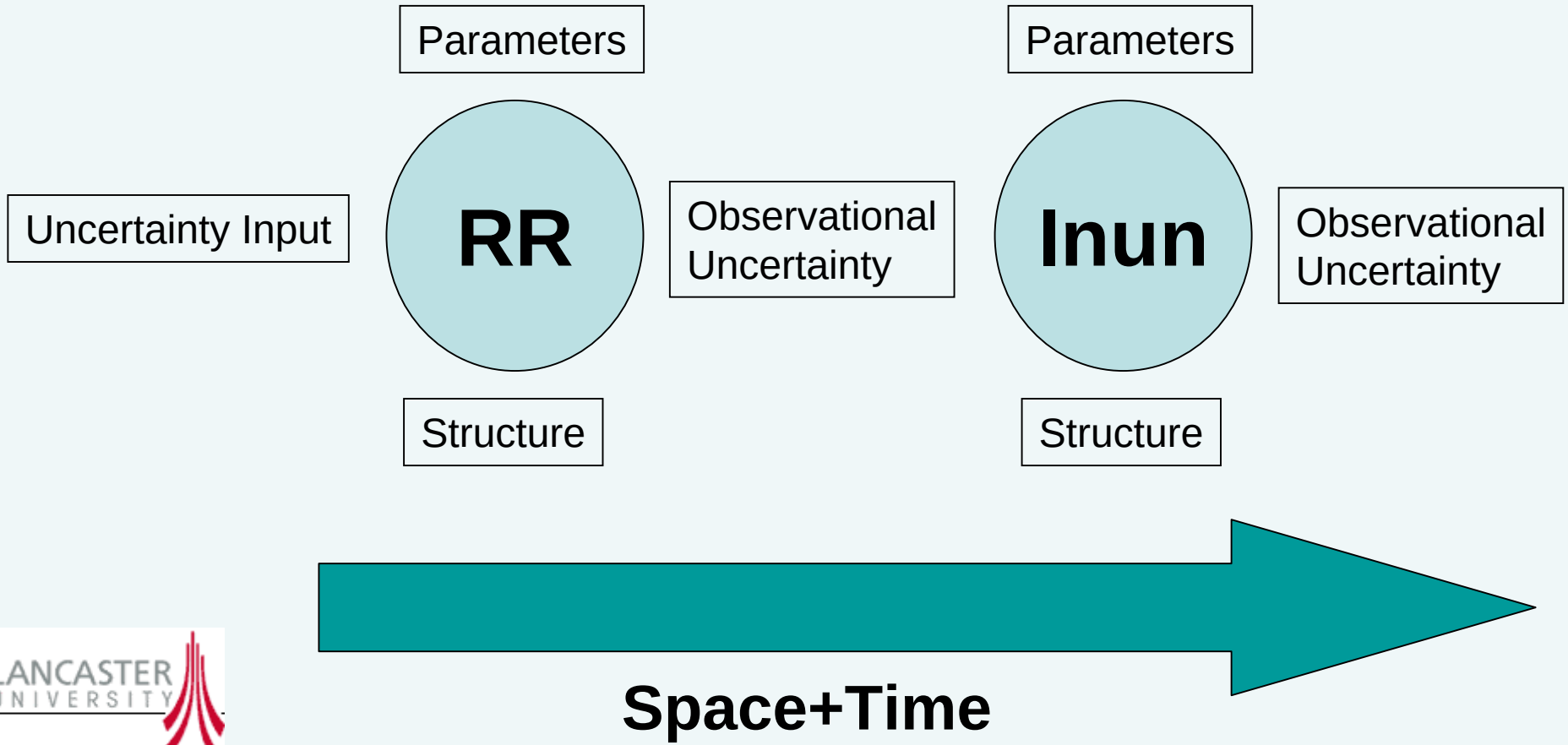
POT

see Jutta Thielen (Talk tomorrow)
& Jens Bartholmes (Poster)



LANCASTER UNIVERSITY

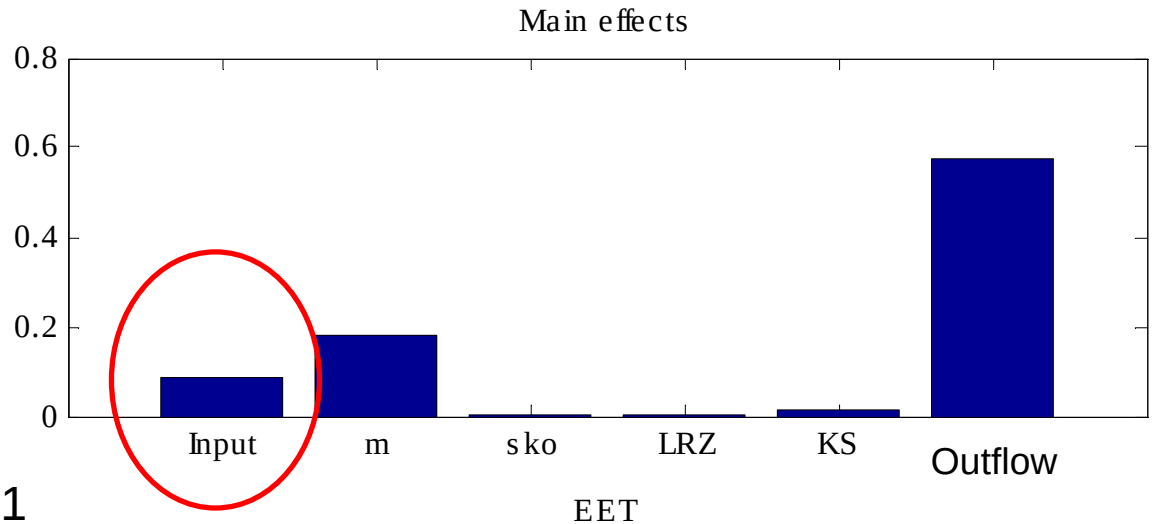
P Dominant source of uncertainty



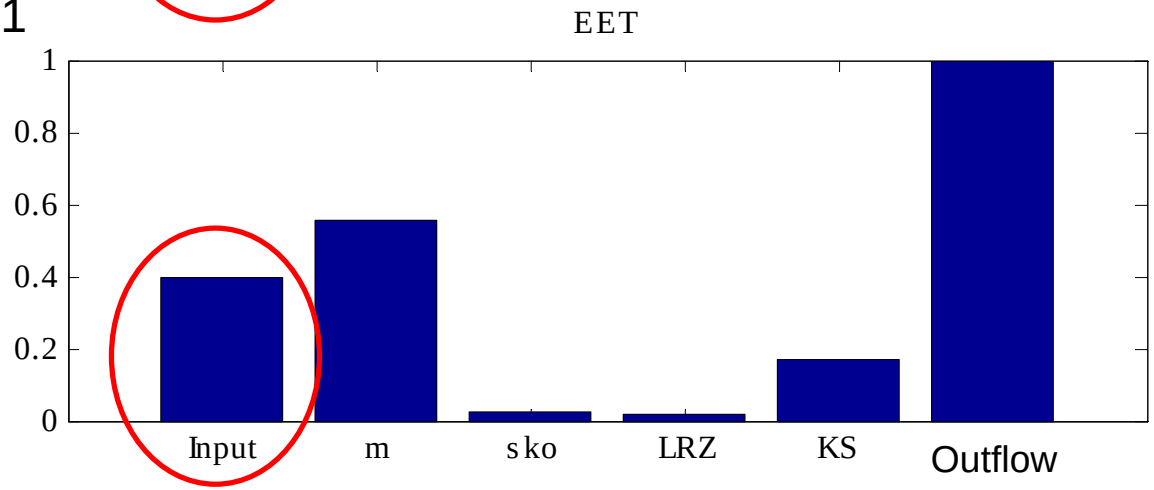
LANCASTER UNIVERSITY

Sensitivity of RR

Topmodel
Hodder
January-March 1991



SOBOL



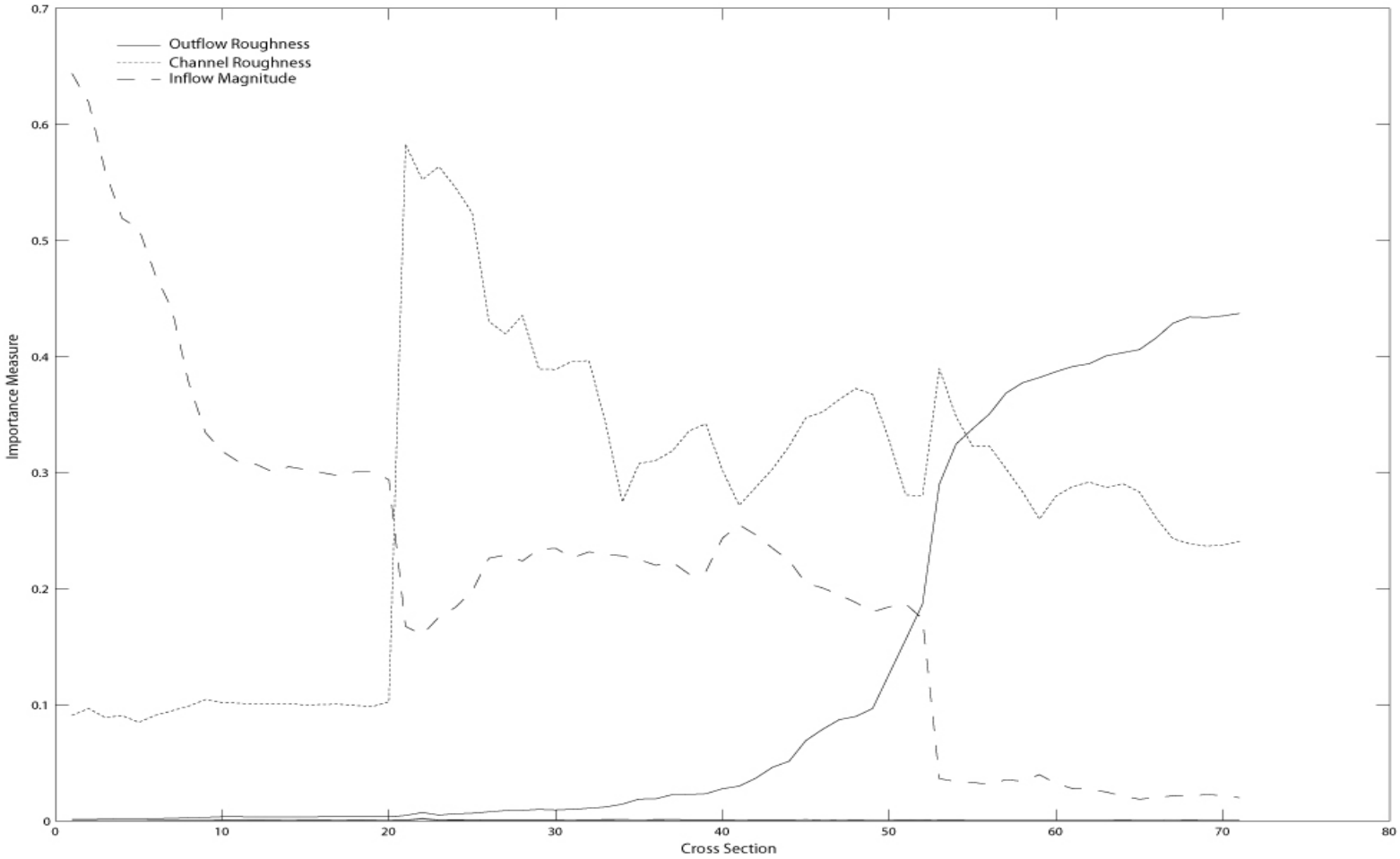
Morris

- Rain is the 3rd most important factor (for this model & region & data)

Sensitivity of flood inundation to input uncertainty

LANCASTER UNIVERSITY

Sensitivity of flood inundation to input uncertainty



Conclusions

- DBM models are very good for real-time forecasting within the natural delay of the system (e.g. Alzette 4hrs and Severn 36hrs)
- DBM + EPS is the only way to predict with DBM beyond the natural time delay (although they maybe radar etc in between). More sophisticated framework needs to be developed
- Cascading uncertainty offers an exciting opportunity to learn more about our models, challenge our understanding and scrutinise our decisions
- Global Sensitivity Analysis offers a methodology which can be used to guide research and identify model inadequacy

LANCASTER UNIVERSITY

flood risk management research consortium FRMRC

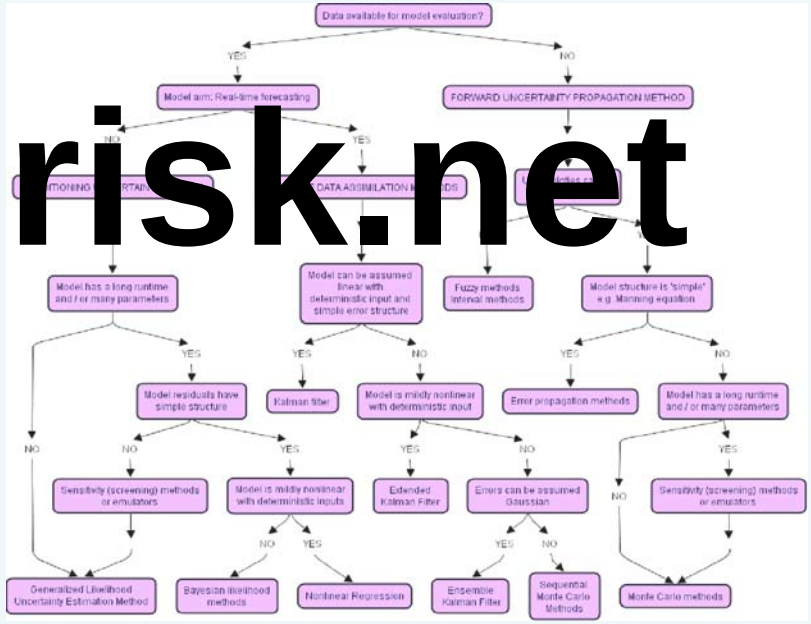
THANK YOU!

The ultimate **guide** to choose

an **uncertainty analysis method**

A Wiki Project

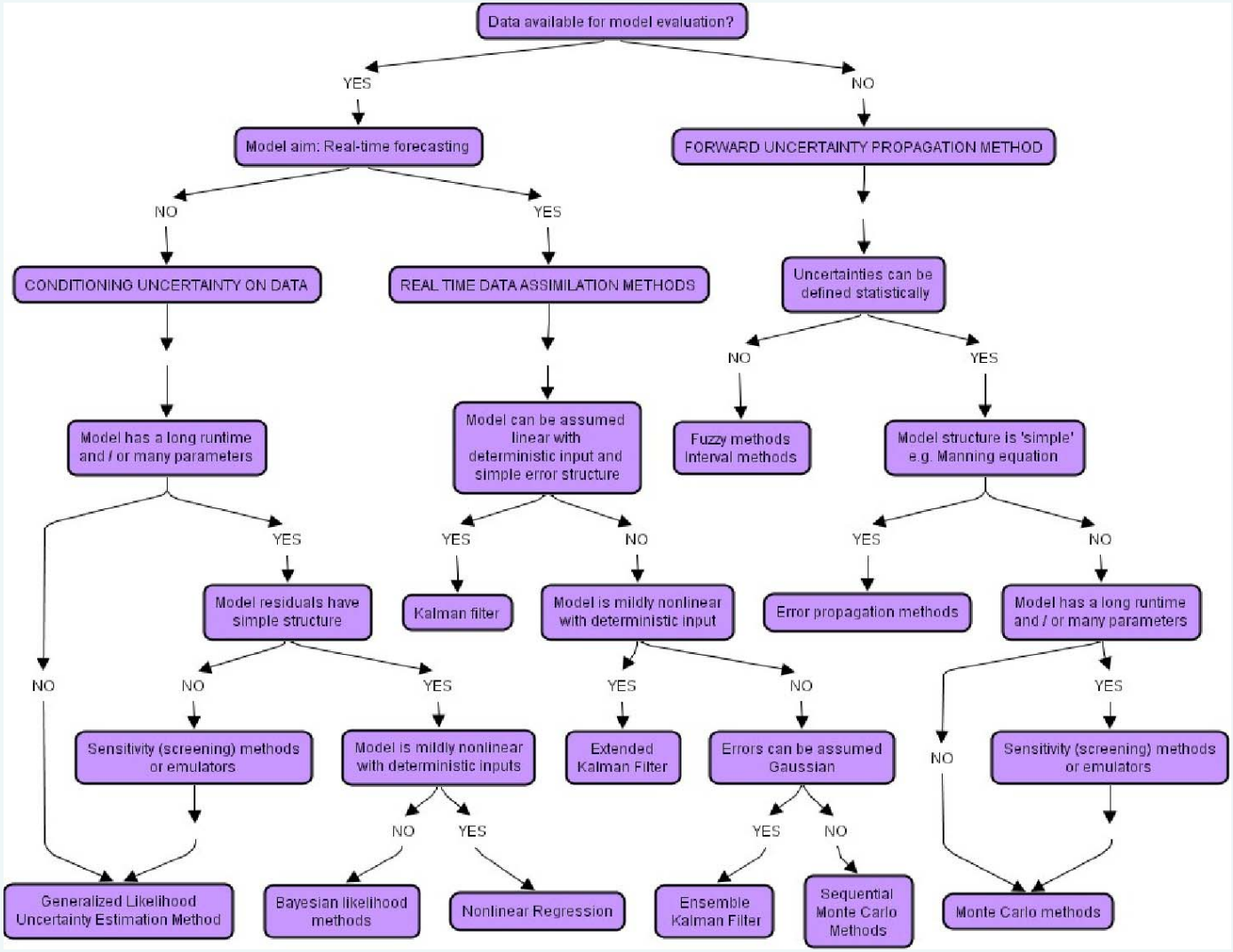
www.floodrisk.net



LANCASTER UNIVERSITY

flood risk management research consortium FRMRC

www.floodrisk.net



LANCASTER UNIVERSITY

SPARE SLIDES

LANCASTER UNIVERSITY

Cascading Uncertainty (Physically based models)

Possible, but need some methods to reduce the number of runs
More research needed to understand the dominant sources of uncertainty

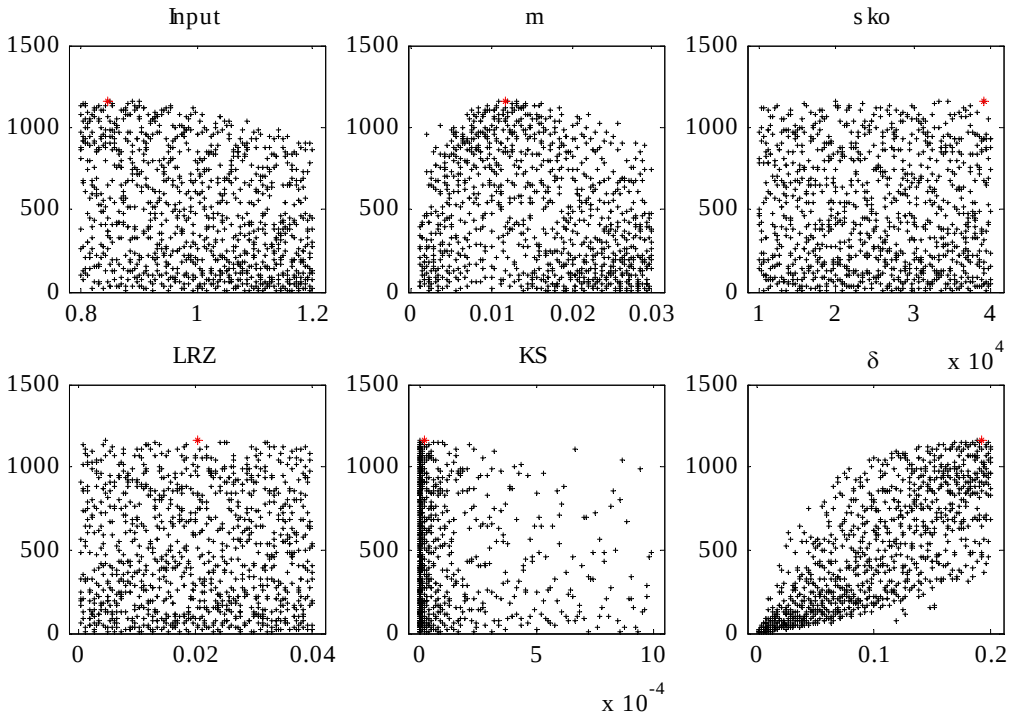
LANCASTER UNIVERSITY

Conclusions

- EPS
- Data-based mechanistic models seem to be superior in real-time flood forecasting (in cascading uncertainties)
- Physically based models should be used for flood scenario studies and distributed predictions

LANCASTER UNIVERSITY

Sensitivity RR



LANCASTER UNIVERSITY