

*HYACINTS/FIVA Seminar on climate change impacts on water  
ressources – Geocenter Copenhagen, 23. September 2008*

# Questions for general discussion

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# Where are the largest uncertainties?

## Sources of uncertainty

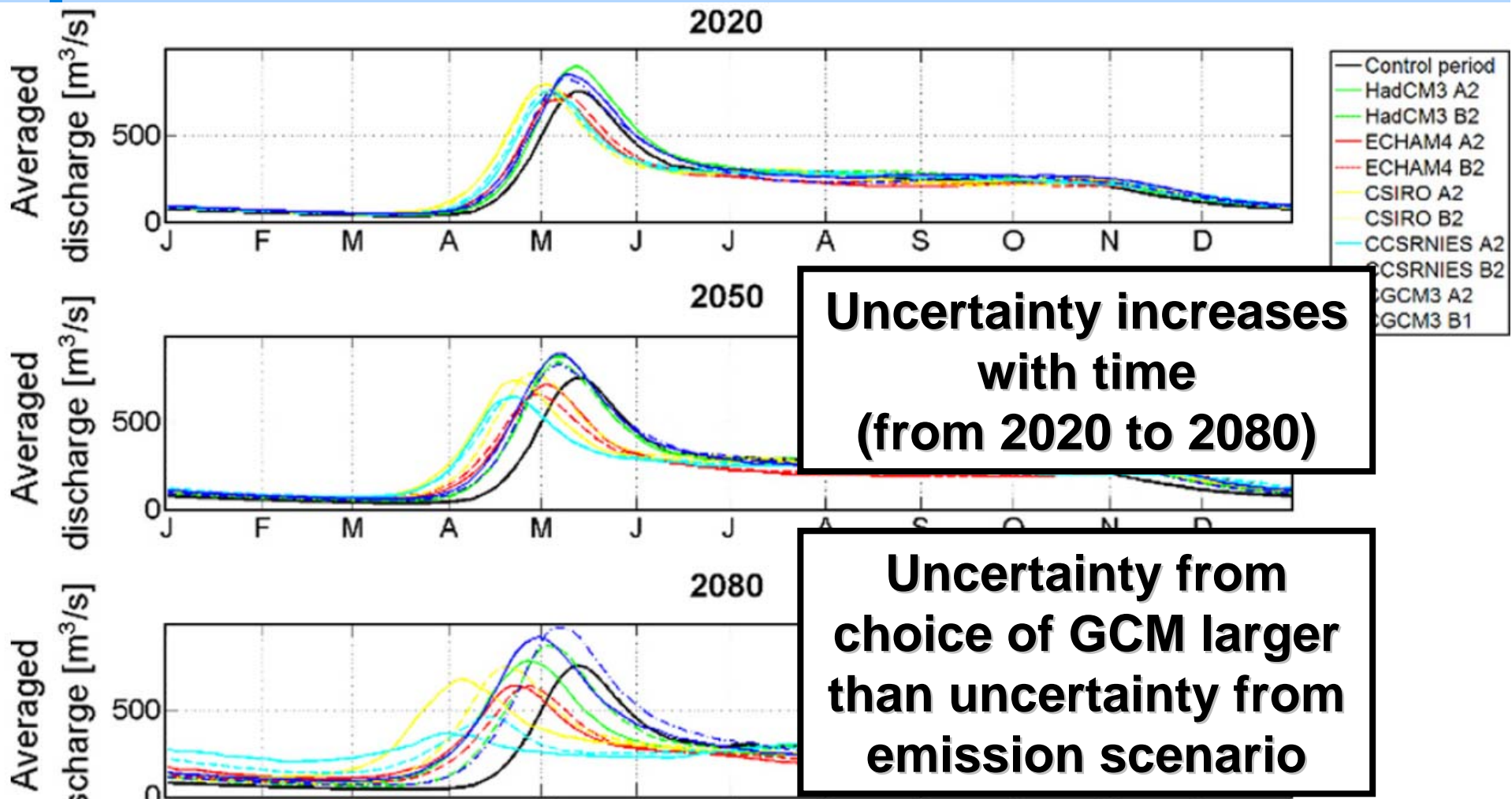
- Emission scenarios
- Climate models
- Downscaling from GCM to local hydrological models
- Hydrological models
  - Input data
  - Parameter values
  - Model structure (process description, geology, etc.)
- Human decisions
  - Land use
  - Water use
  - etc.

# Uncertainty analysis – Example 1

*Minville et al., Journal of Hydrology (2008) 358, 70-83*

Discharge simulations, Chute-du-Diable catchment, Canada

- 2 Emission scenarios
- 5 Climate models (GCMs)



# Uncertainty analysis – Example 2

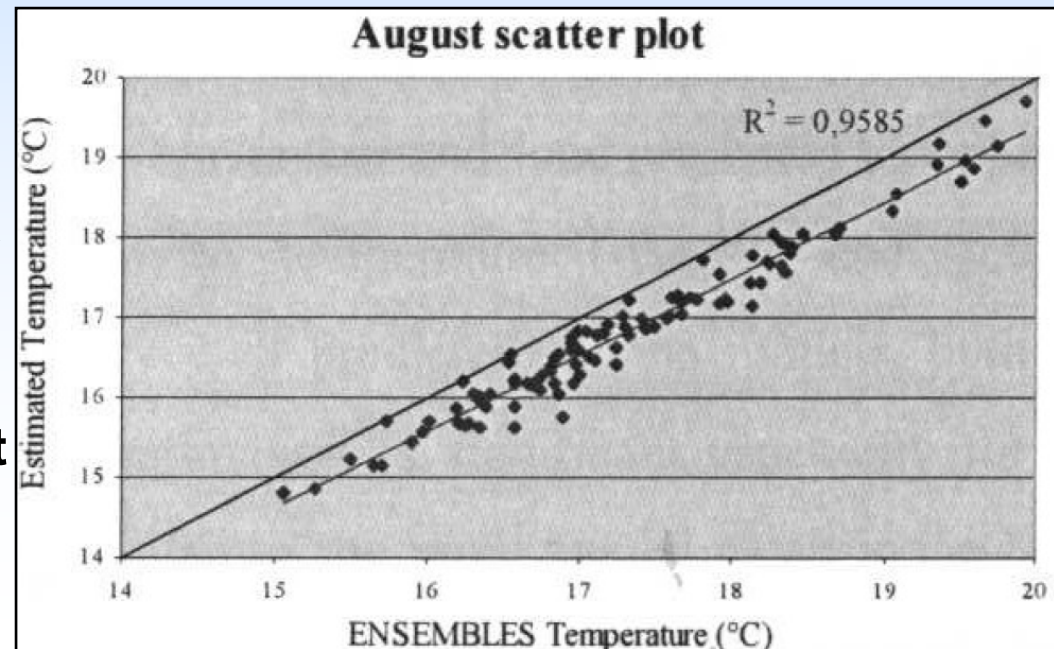
## *Transfer of regression equations to changed climate*

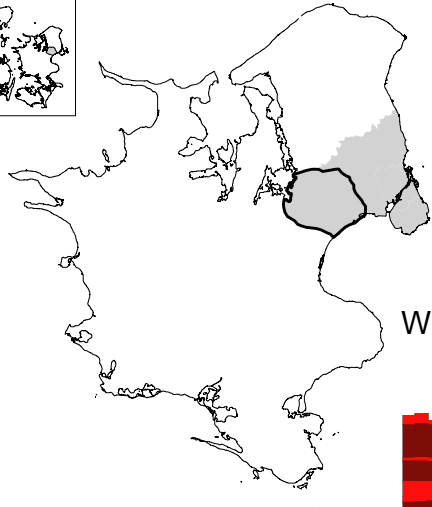
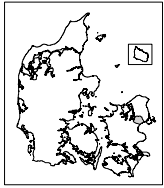
### **Numerical experiment** (*Alice Urbani, MSc Thesis, DTU, 2008*)

- Data from RCM (ENSEMBLES project – SMHI model)
- Multiple regression model **calibrated** on model data for the period 1948-1987  
 $T_{\text{air}} = F(\text{RCM variables})$
- **Prediction:** Temperature in a changed climate (1988 – 2089)

### **Conclusion**

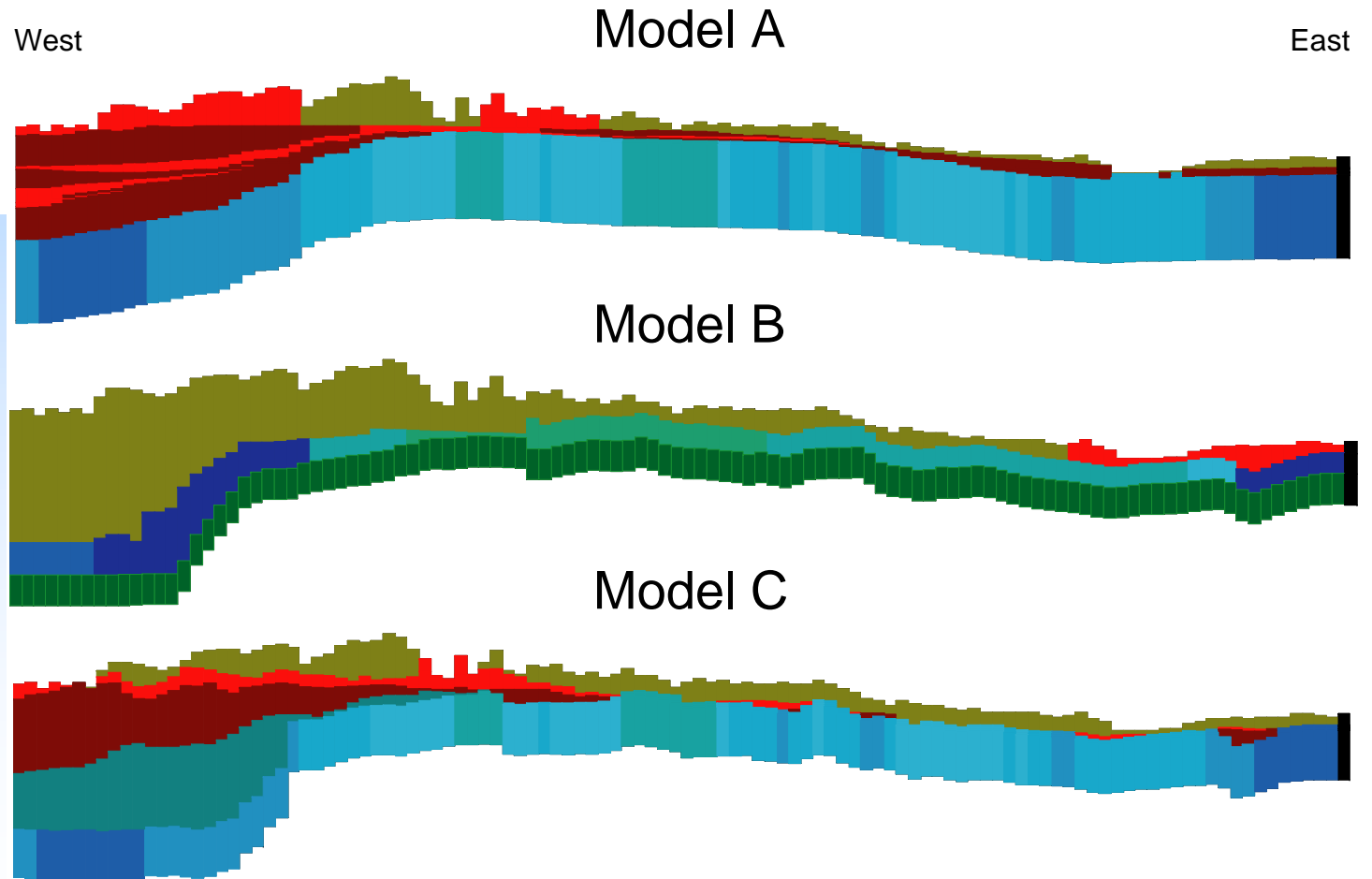
- Regression models underestimates RCM data with  $\frac{1}{2}$  °C in changed climate
- **Regression equation not valid in future climate**  
→ **uncertainty/bias**



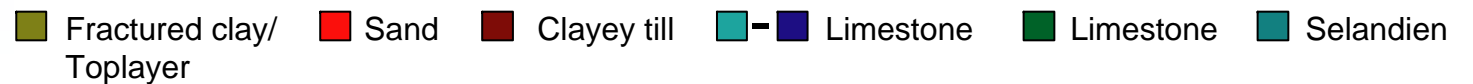


# Uncertainty analysis – Example 3

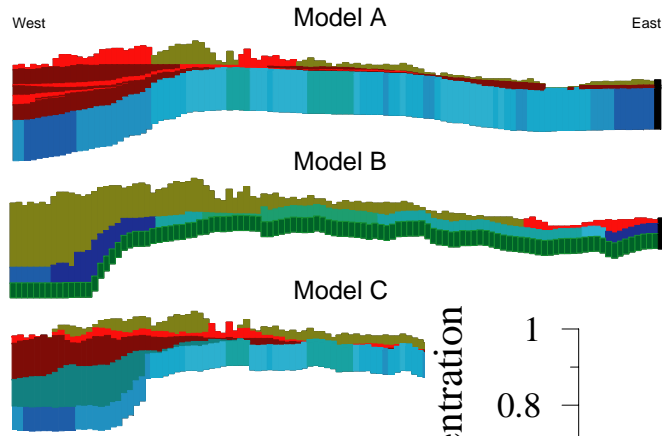
*Geological conceptual models – geological uncertainty (Højberg and Refsgaard, 2005)*



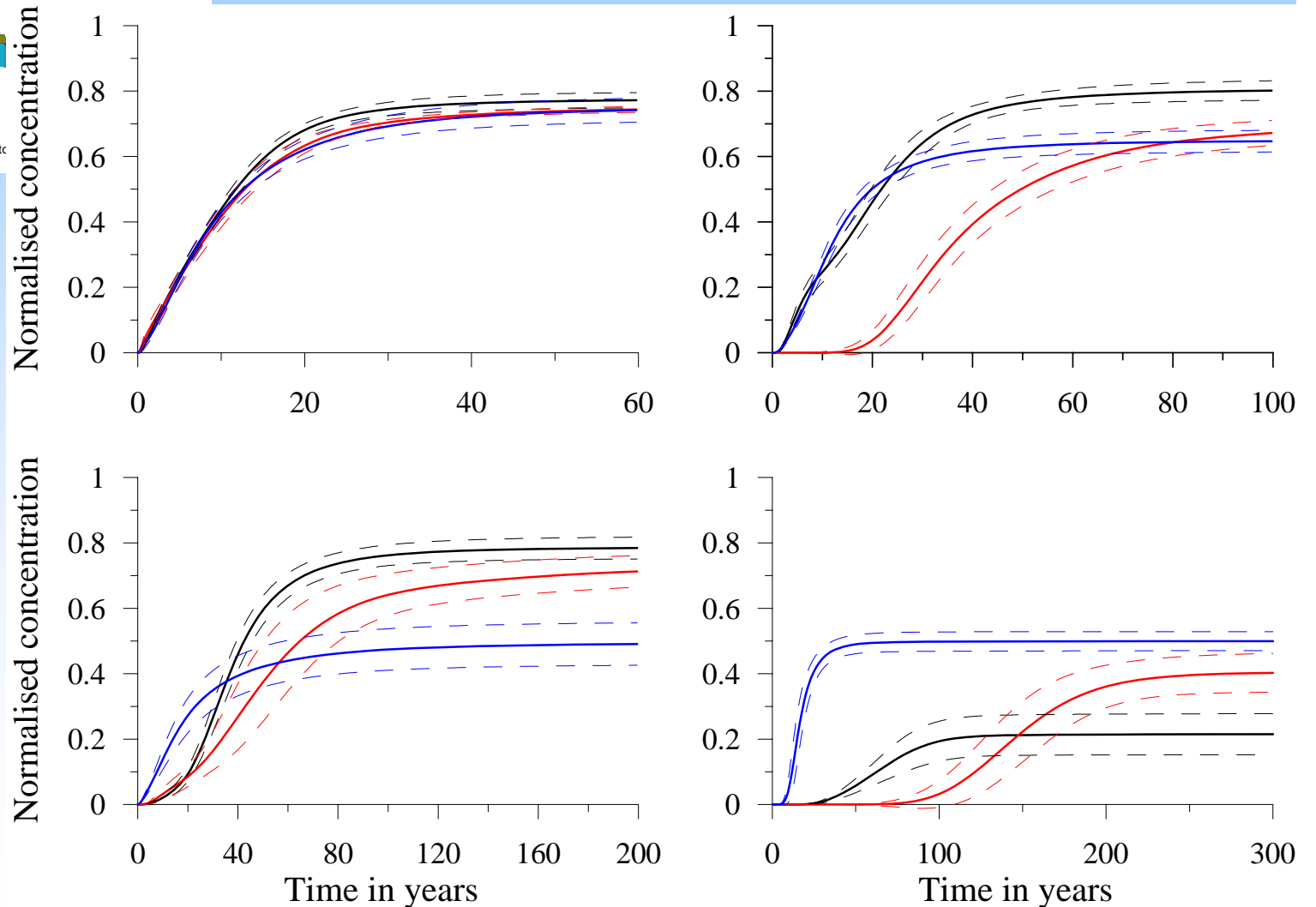
Uncertainty on parameters versus conceptual geological model



# Uncertainty on parameters versus conceptual geological model - Effects on flow paths/breakthrough curves



Fractured clay/ Toplayer Sand Clayey till Limestc



Model A Model B Model C

# Can we use the same hydrological models as today?

## Models with doubtful validity in a changed climate

- Models based on empirical relationships fitted to the present climate
- Models with internally compensating water balance errors (e.g. models where parameter values account for biases in precipitation input)
- Evapotranspiration models. Almost all the models we use today assume constant CO<sub>2</sub> level.
- Etc.

# How reliable are models for simulating a changed climate – and how can we assess this?

## Reliability of models → model validation

- Requires test against independent data
    - But independent data for the future changed climate do not exist
  - Requires test for conditions for which the model is intended to be applied
    - But we do not have data for future climate situation
- Need for indirect (and weaker) tests, e.g.:
- Blind tests on catchments from other climate regions



# Questions for general discussion

- Where are the largest uncertainties?
  - Emission scenarios
  - Climate models
  - Downscaling methods
  - Hydrological models
  - Geology
- Can we use the same hydrological models as today?
- How do we assess the reliability of models for simulation of future conditions?