Application Of Multiple-Point Geostatistics On Groundwater Flow And Transport In Media With Complex Geological Heterogeneity

Lessons Learnt And Remaining Challenges

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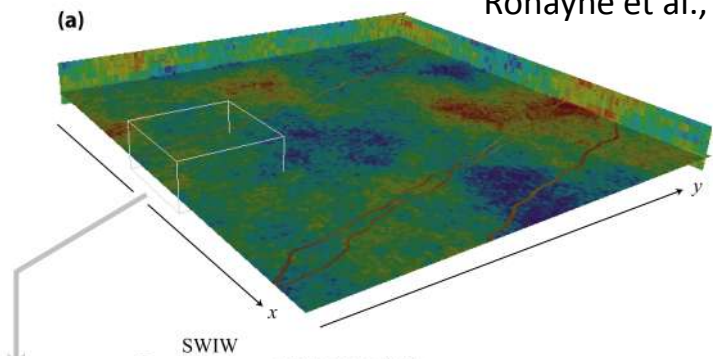
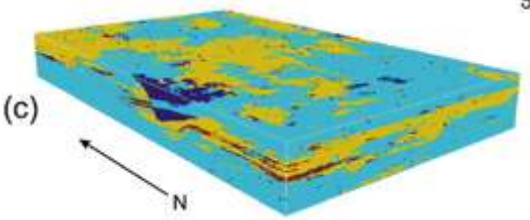
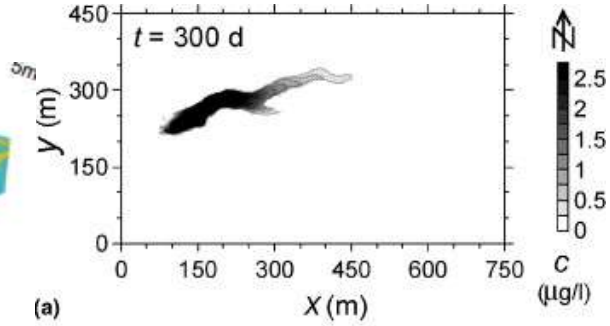
Applications of multiple-point geostatistics on groundwater problems

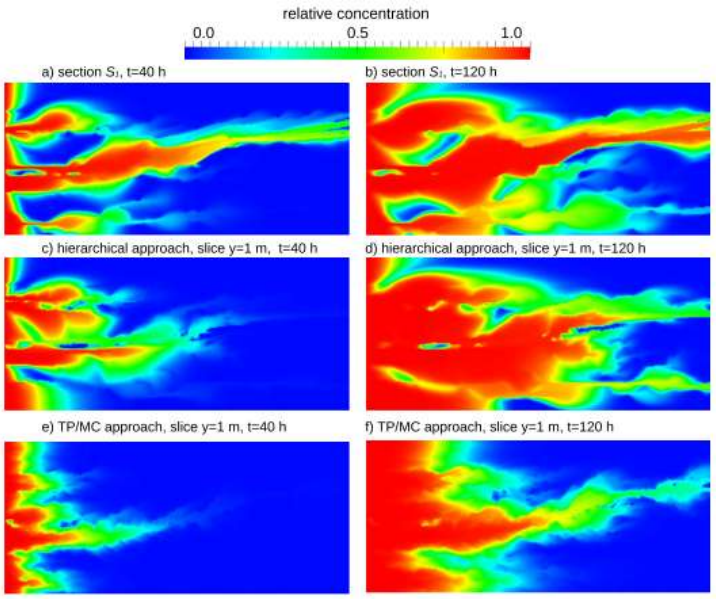
Ronayne et al., 2010



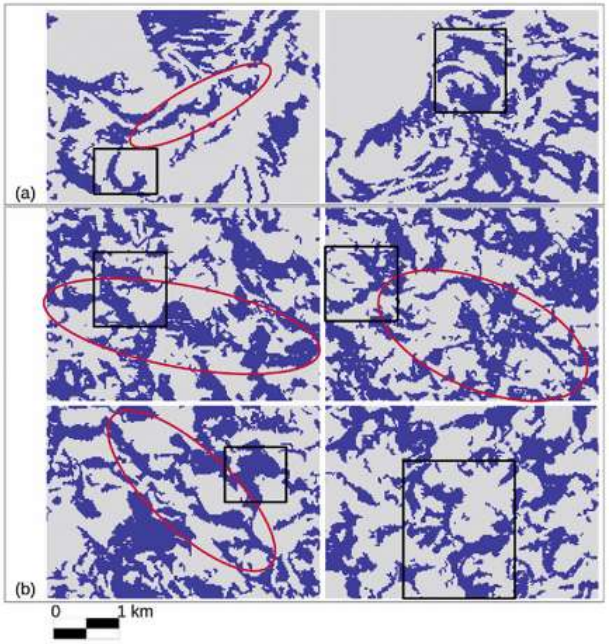


Dell' Arciprete et al., 2012

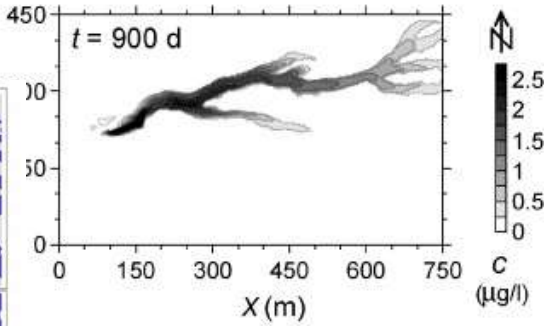


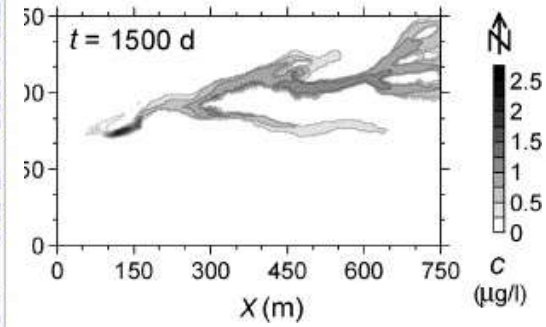


Comunian et al., 2011



Le Coz et al., 2011

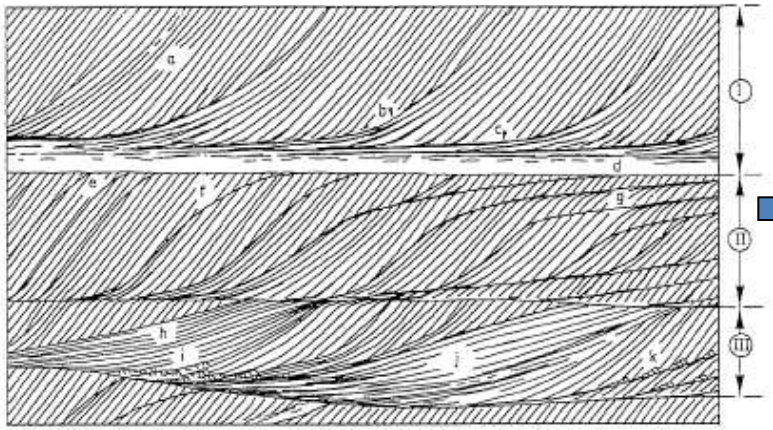




Feyen and Caers, 2006

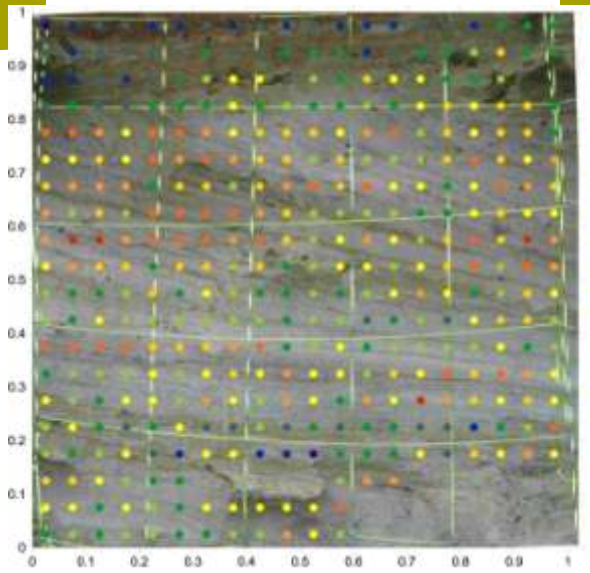
Project overview

Complex geological heterogeneity

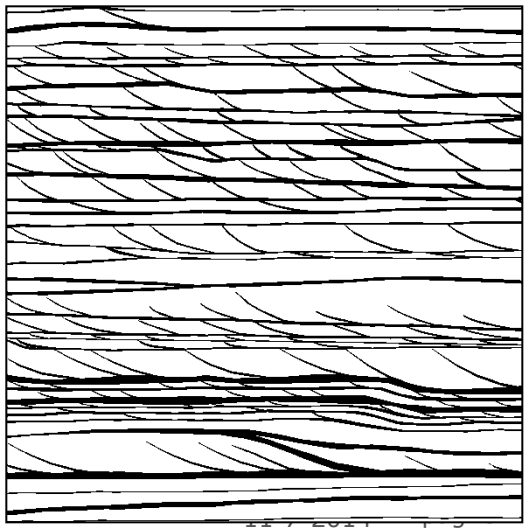


Field work

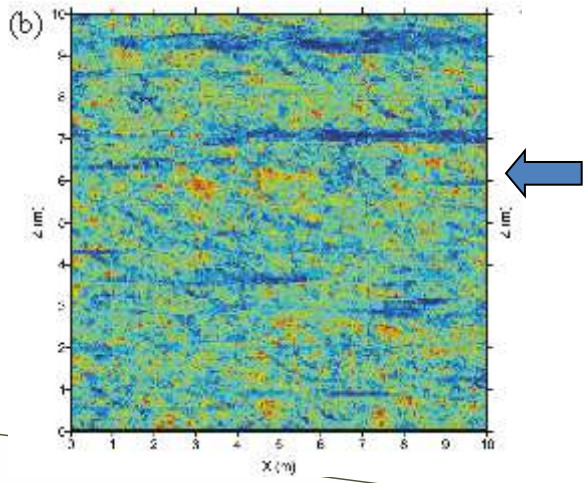
2750 air permeability measurements



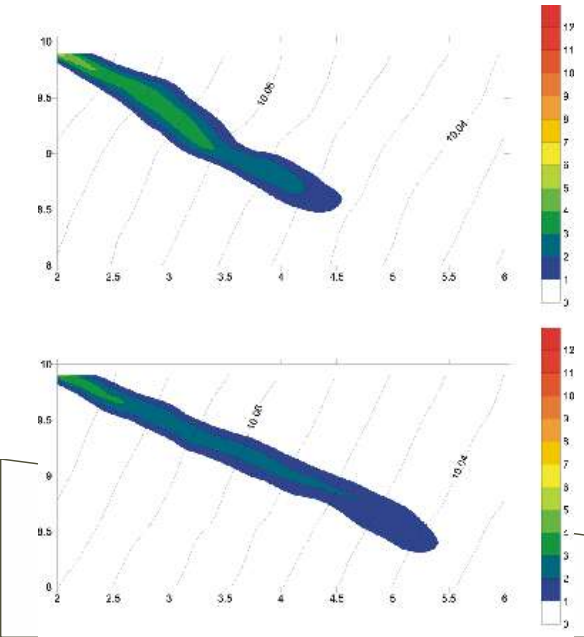
Training image



Permeability simulations

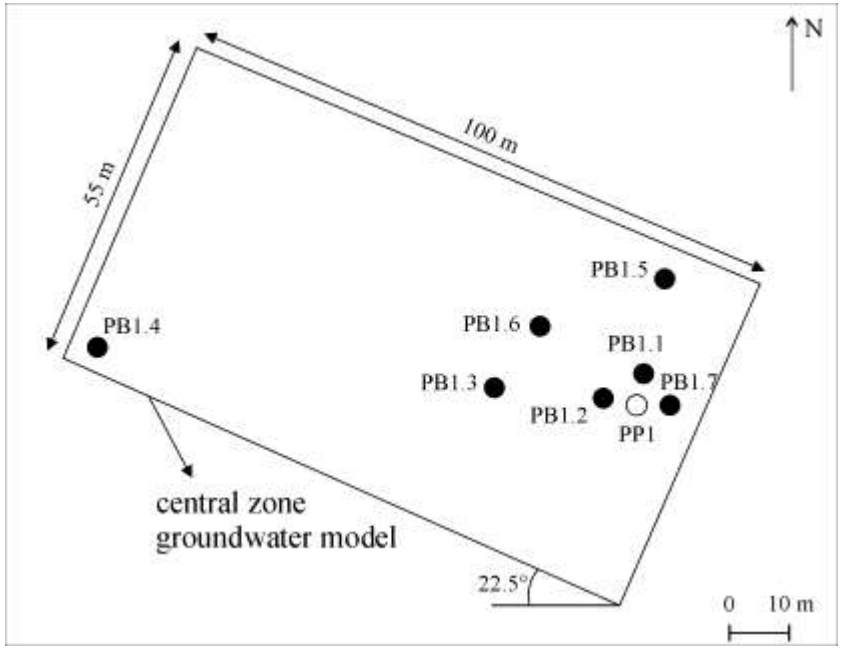


Groundwater modelling



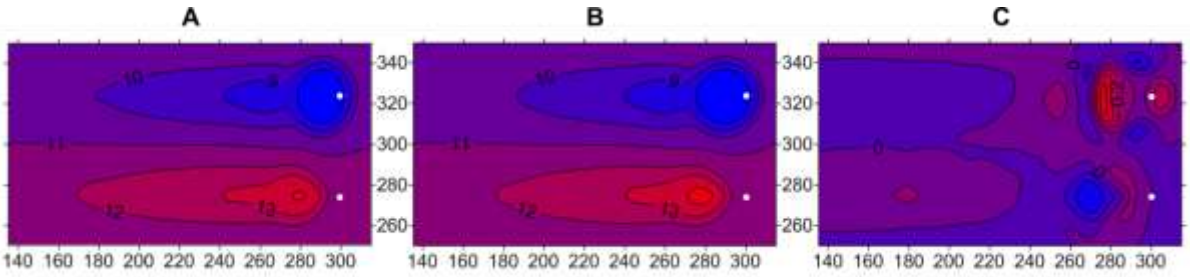
Project overview: Validation and applications

- Pumping test



- Groundwater tracer test

- Aquifer thermal energy storage



Possemiers et al., in prep

Lessons learnt

Lesson 1

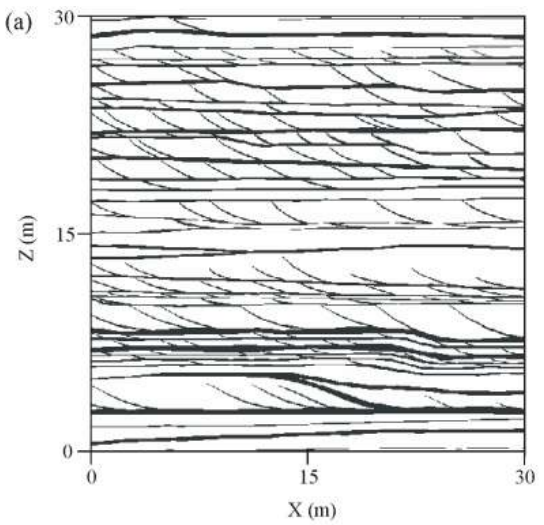
Be careful when using multiple-point geostatistics if you're a perfectionist

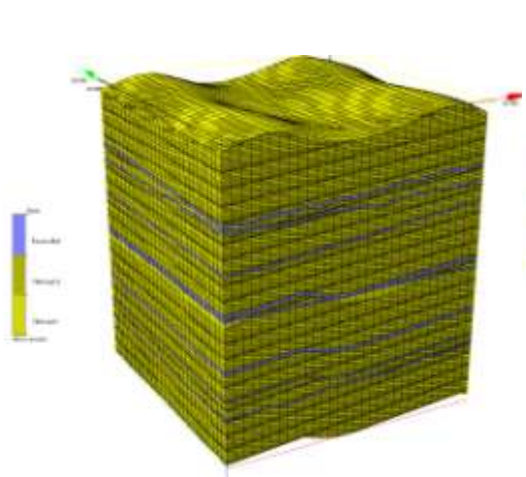
Multiple-point geostatistics

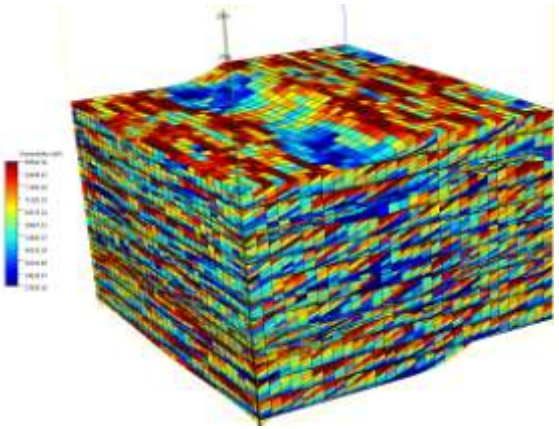
- Elegant
- Smart
- Simple

- Incorporate geological heterogeneity in a realistic way
- Way of communicating with geologists

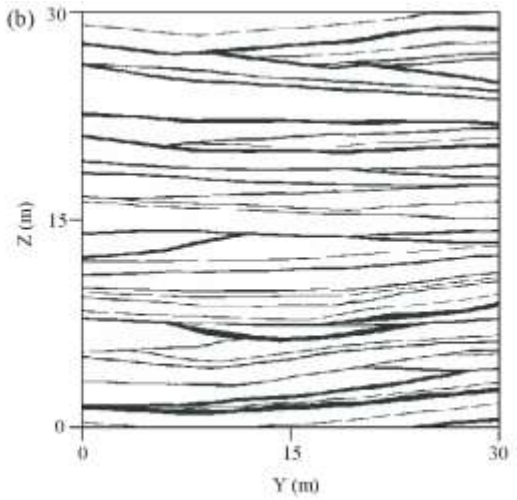
The "perfect" 3D training image

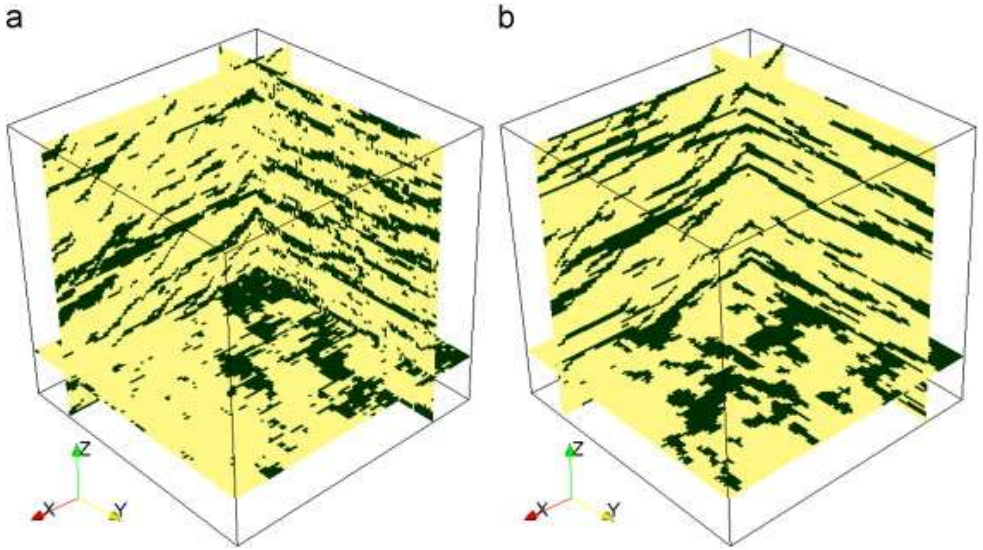






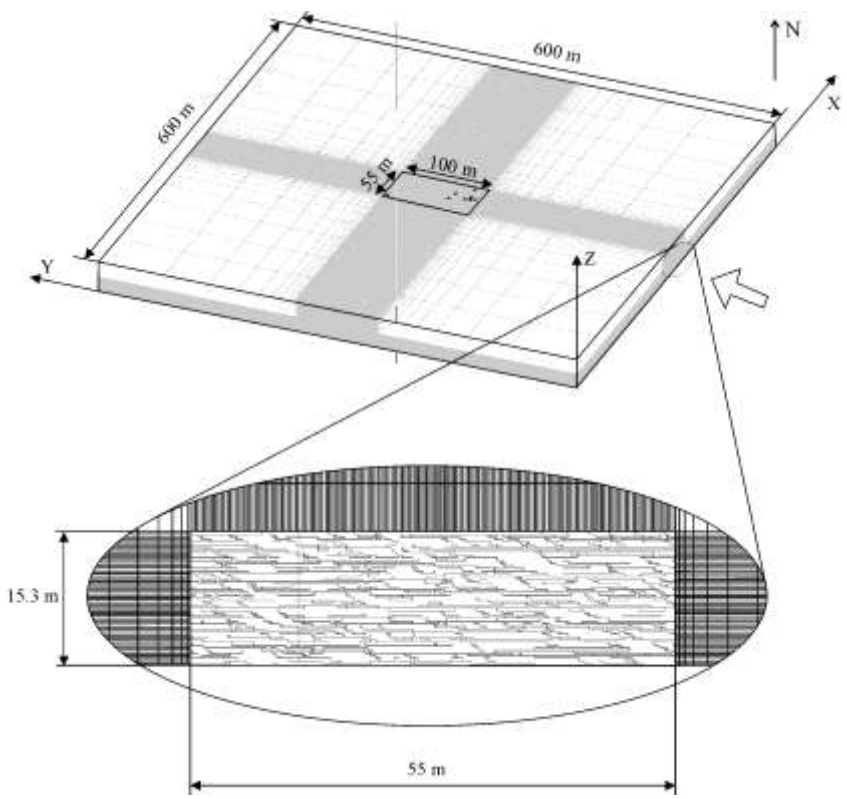
SBED

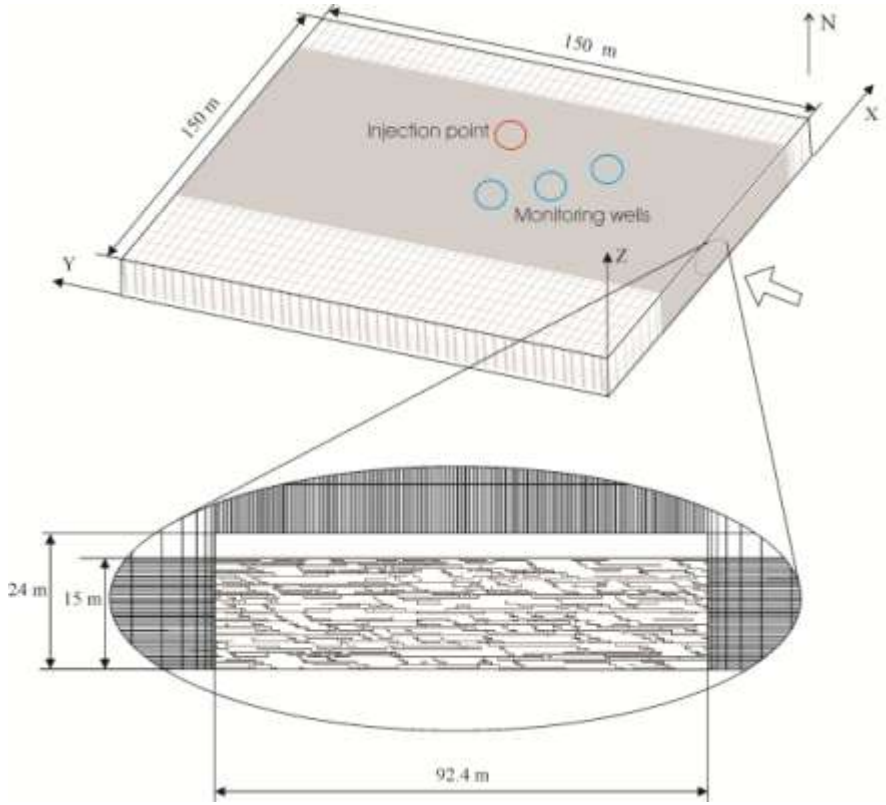




Comunian et al., 2012

The “perfect” model





Lesson 1: Be careful when using multiple-point geostatistics if you're a perfectionist

Lesson 2:
Showing a training image is dangerous

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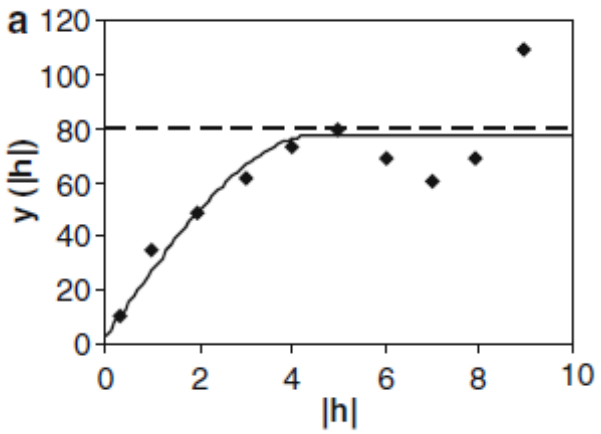
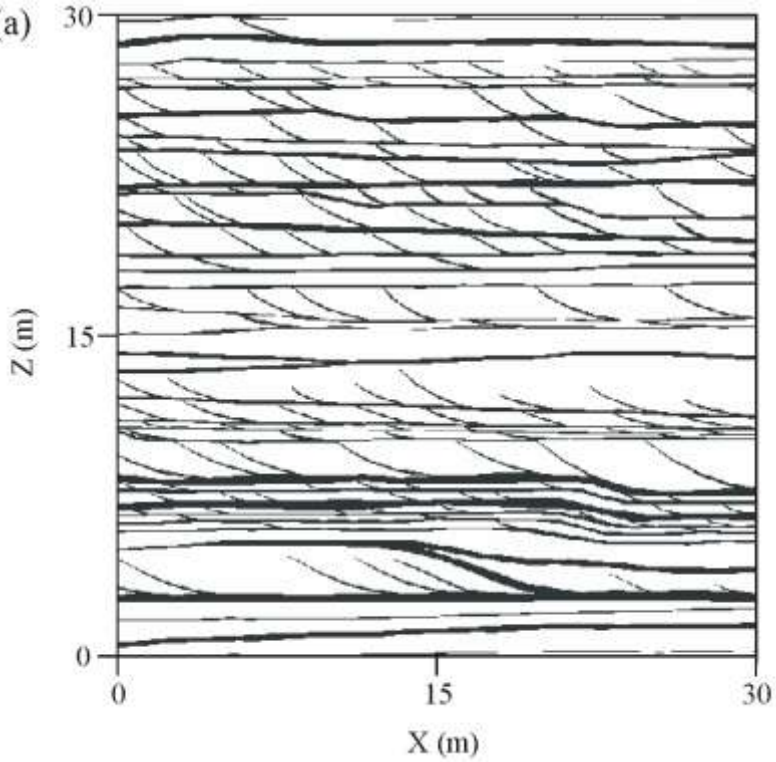


versus



Explicit = easy to criticize

How good should my training image be?

- Compare to geological reality or to variogram based/uniform approaches?
- What is the effect of having a "slightly off" training image?
- Sensitivity to selection of training image?
- Verification of training images by data
- Groundwater problems: data scarcity, no seismic campaigns

The effect of training image and secondary data integration with multiple-point geostatistics in groundwater modeling

X. He[1], T. O. Sonnenborg[2], F. Jørgensen[2], and K. H. Jensen[1]

Verifying the High-order consistency of training images with data for multiple-point Geostatistics

Cristian Pérez[a, b], Gregoire Mariethoz[c, d], Julián M. Ortiz[a, b]

Lesson 3:
Real-world field cases
≠
synthetic cases

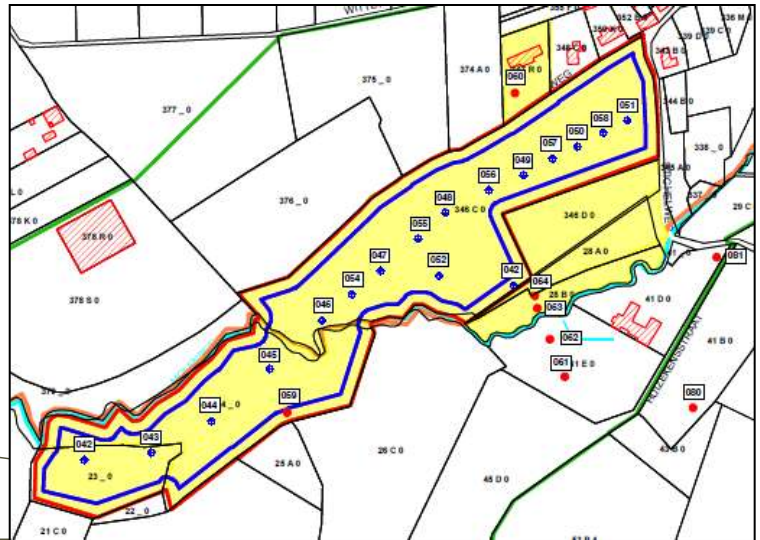
Real-world field cases ≠ synthetic cases

- Many synthetic and semi-synthetic applications of multiple-point geostatistics
  - Promising technique
  - Convincing results

- Real-world field case
  - Frustration
  - Disappointment

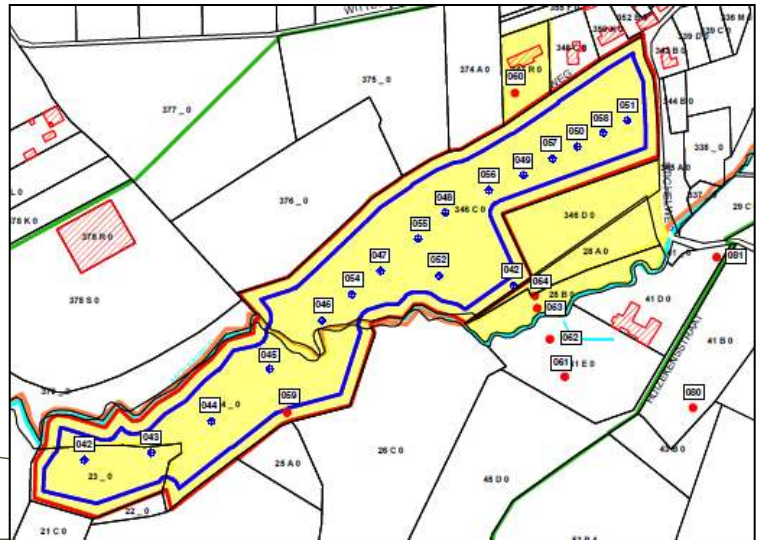
Real-world field cases ≠ synthetic cases

- Other features than fine-scale heterogeneity play an important role
  - Variations of pumping discharge rates
  - Wells screened in more than one geological layer
  - Boundary conditions, e.g. interaction with surface water features
  - Sampling issues
  - Various uncertain factors
  - …



Real-world field cases ≠ synthetic cases

- Validation using in situ measured groundwater levels and concentrations
- Encouragement of real world applications
- Is it worth incorporating fine scale geological heterogeneity in groundwater problems or are other features (boundary conditions, data quality, …) more important for correct predictions?



Conclusions

- Training images don’t need to be perfect
  - How good should it be?
  - Sensitivity of groundwater models to TI?
  - Validation of TI?
- Encouragement of real-world applications
  - Realistic idea of potential of MPS in practical groundwater applications

Thank you

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