International Research School of Water Resources

International PhD Course in

Modeling of Heterogeneity and Transport in Geologic Media: Transition Probability, Markov Chains and Random-Walk Particle Methods (TProGS & RWHET)

June 22 - 27, 2009
Geocenter Copenhagen, Denmark

Lecturers
Professor Graham Fogg, University of California Davis, USA
Dr. Steven Carle, Lawrence Livermore National Laboratory, Livermore, USA
Dr. Eric M. LaBolle, University of California, Davis, USA

Scope

- Learn how to conceptualize subsurface heterogeneity through geologic and spatial statistical properties of hydrofacies.
- Understand how to incorporate prior geologic knowledge into geostatistical analysis using a transition probability/Markov chain framework.
- Learn how to use the software package TProGS to analyze and model spatial variability of hydrofaces and generate realistic conditional simulations of hydrofacies architecture
- Learn how to use realizations of hydrofacies architecture in high-resolution flow and transport modeling
- Learn how to use RWHET (Random-Walk modeling of transport in HETerogeneous media) for accurate modeling of advection, dispersion and local diffusion in heterogeneous media

Schedule

Day 1

Morning

- Introduction, overview **(GF)**
- Significance of subsurface heterogeneity; role of hydrofacies models **(GF)**
- Hydrofacies approach to modeling the subsurface **(GF)**
- Case studies including flow and transport **(GF)**
- Geostatistics fundamentals, terminology **(GF)**

Afternoon

- Geostatistics fundamentals, terminology **(GF)**
- Transition probability theory and concepts **(GF,SC)**

Day 2

Morning

- TProGS program architecture and computer procedures **(SC)**
- Hands-on computer exercises to compute and plot (cross-) variograms and transition probability **(SC)**
- Markov chain theory, concepts, and historical perspective **(GF)**

Afternoon

- Markov chain theory, concepts, and historical perspective continued **(GF, SC)**
- Juxtapositional concepts for facies architecture **(GF, SC)**
- Incorporation of geologic interpretation via Markov chains **(GF)**
- Hands-on computer exercises to compute Markov chains **(SC)**
- Hands-on exercises for incorporating geologic insight into fitting Markov chain models to data **(GF,SC)**

Day 3

Morning

- More transition probability modeling with Markov chains **(GF,SC)**
- More hands-on exercises for incorporating geologic insight into fitting Markov chain models to data **(GF,SC)**

Afternoon

- Conditional simulation theory and concepts **(GF)**
- Cokriging theory and practice **(GF, SC)**
- Simulated quenching (annealing) theory and concepts **(GF, SC)**
- Introduction to 3-D conditional simulation and visualization **(SC)**

Day 4

Morning

- Hands-on computer exercises for conditional simulation **(SC)**
- Hands-on computer exercises for visualization **(SC)**

Afternoon

- Case studies by instructors and students **(SC, GF, students)**
- Summary of Algorithms, Case Studies, Open Discussion **(All)**

Day 5

Morning

- Introduction to modeling of transport in heterogeneous systems (**GF, EL)**
- Flow model initial and boundary condition considerations and methods (**GF, EL)**
- Random-walk particle method, theory (**EL)**

Afternoon
- Randomw-walk particle method, theory **(EL)**
- RWHET code structure (**EL)**
- Hands-on computer exercises with RWHET (**EL, SC, GF)**

Day 6

Morning
- Discrete and averaging methods for dealing with composite media in RWHET (**EL)**
- Basic reactive transport in RWHET (**EL)**
- Backward tracking with RWHET, theory and implementation (**EL)**

Afternoon
- Simulation of groundwater age distributions (**EL)**
- RWHET case studies (**GF, EL)**
- Hands-on computer exercises with RWHET (**EL, SC, GF)**

The software to be used in this course is in the public domain (for use with acknowledgement) and available free of charge, and can therefore be brought home by the participants for later use with their own models or problems. How to apply the techniques for such problems can be discussed with the teachers during the course

Background of participants
Participants are expected to have a basic understanding of statistics, geology, and groundwater flow and transport.

Work load and credit points
Approximately 125 hours in total including lectures and exercises during the course and preparatory reading before and during the course.

The work load corresponds to 5 ECTS.

A course diploma will be issued upon satisfactory completion of the course.

Study material
Notes and copies of references papers will be provided during the course.

Registration and admission
Registration on FIVA's website: www.fiva.dk.

Deadline: May 11, 2009. Information on admission to the course will be forwarded shortly after.

The total number of participants is limited to 20. PhD students are given first priority but depending on the number of registrants we also welcome post-graduate participants.

International students are requested to provide a very short description of their research interests and background when they register. Additionally, a letter of recommendation needs to be forwarded from the research advisor.

Fee
The course is free for PhD students enrolled at universities. Post-graduate participants will be charged a course fee of DKK 5.000 (€ 675).

Accommodation and travel
FIVA will provide accommodation for PhD students near the university free of charge. Participants are requested to cover travel expenses and per diem from their own funding.

Other participants are requested to make their own arrangements. Hotel suggestions:

1. CAB INN Scandinavia (cheap)
http://www.cabinn.com/english/kbh/scandinavia/sca.html
Transport via metro from the airport to "Forum metro station"

2. Comfort Hotel Østerport (a little more expensive)
http://www.choice.no/html/da247048.jsp
Transport via regional train from the airport to Østerport station. Book a superior room if you are sensitive to the sounds of the railway tracks. Hotel Østerport is within walking distance of the Geocenter.

Further information
Please contact Karsten H. Jensen (khj@geo.ku.dk) or Frederik Uldall (email: fu@geo.ku.dk, phone: +45 3532 2414**)**.

Østerport Station
Comfort Hotel Østerport
Geocentre
Nørreport Metro Station
Forum Metro Station
Hotel Cab Inn Scandinavia
Hans Kirks Vej
Guldbergsgade
Møllegade
Nø. Allé
Poppelgade
Ahornsgade
Peter Fabers Gade
Prinsesse Charlottes Gade
Birkegade
Elmegade
Fælledvej
Sankt Hans Gade
Læssøesgade
Bangertsgade
Nørrebrogade
Slotsgade
Kapelvej
Stengade
Blågårds Plads
Gartnergade
Blågårdsgade
Wesselsgade
Peblinge Dossering
Åboulevard
Worsaaesvej
Steenstrups Allé
Forchhammersvej
Danasvej
Norsvej
Kampmannsgade
Vester Søgade
Nørre Søgade
Nansensgade
Nørre Farimagsgade
Ahlefeldtsgade
Vendersgade
Linnésgade
Nørre Voldgade
Larslejsstræde
Nørregade
Fiolstræde
Krystalgade
Skindergade
Studiestræde
Amagertorv
Læderstræde
Købmagergade
Pilestræde
Ved Stranden
Laksegade
Lille Kongensgade
Østergade
Store Regnegade
Grønnegade
Borgergade
Store Kongensgade
Kronprinsessegade
Adelgade
Abenrå
Kultorvet
Gothersgade
Søtorvet
Bartholinsgade
Øster Søgade
Gammeltoftsgade
Ole Suhrs Gade
Rørholmsgade
Webersgade
Fredensbro
Fredensgade
Ryesgade
Sortedam Dossering
Østerbrogade
Øster Farimagsgade
Upsalagade
Stockholmsgade
Dag Hammarskjölds Allé
Kristianiagade
Trondhjemsgade
Øster Voldgade
Sølvgade
Rigensgade
Krokodillegade
Delfingade
Elsdyrsgade
Suensonsgade
Haregade
Tigergade
Grønningen
Esplanaden
Fredericiagade
Kierkegade
Bredgade
Amaliegade
Toldbodgade
Larsens Plads
Sankt Annæ Plads
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Nyhavn
Kongens Nytorv
Holbergsgade
Kvæsthusbroen
Vej Kongeporten
O2
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© 2009 Tele Atlas
© 2009 PPWK
Google
55°41'09.28" N 12°34'22.70" E
elev 8 m
Apr 25, 2005
Eye alt 2.51 km