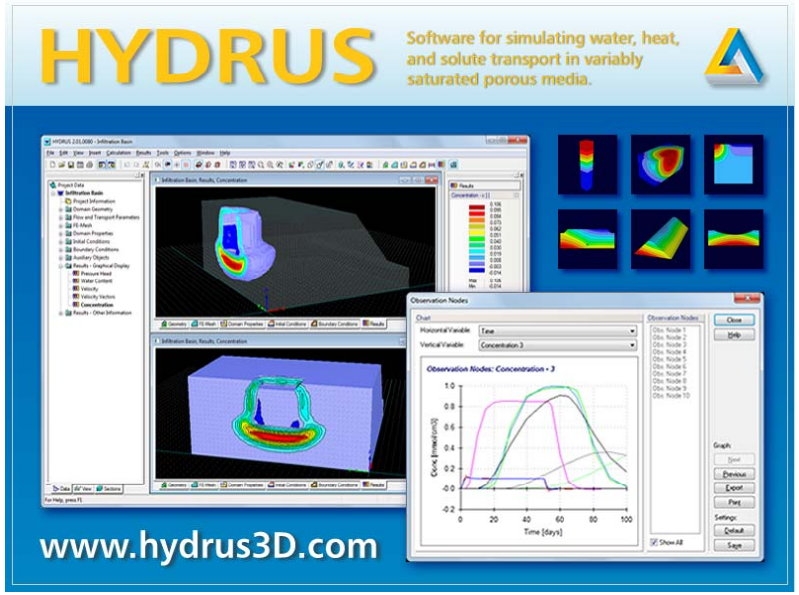

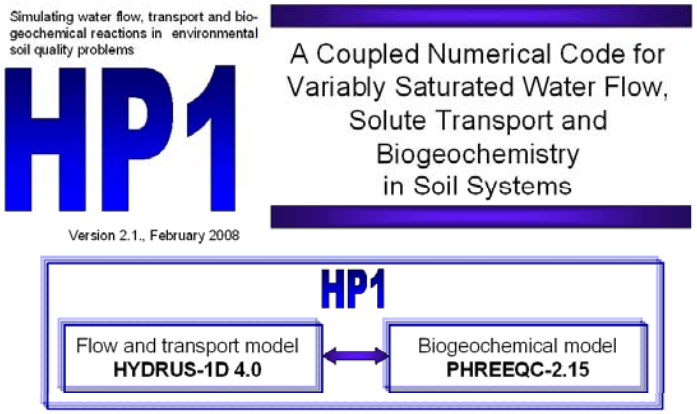

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HYDRUS Training Course

Simulating soil water movement and chemical transport using HYDRUS and the biogeochemical transport model HP1

Presented by CSIRO Land & Water

February 20th – 24th 2012

Flinders University, South Australia

CSIRO

Scope

Human populations are currently growing in arid and semiarid regions, resulting in an increased use of groundwater for agriculture, industry, drinking water production, etc. In Australia, for example, dependence on groundwater increased by nearly 90 per cent from 1983 to 1996. To develop a sustainable management of groundwater resources, understanding the interactions between climate, soil water fluxes, plant processes, deep drainage, upward water flow, and groundwater recharge is very important. Such understanding is key to guide future groundwater resource management under potentially changing boundary conditions of climate and vegetation. A typical example where physically-based models such as HYDRUS provide useful insights concerns modelling of the movement of water and salt to and from arid/semi-arid wetlands to provide temporal predictions of wetland salinity which can be used to assess ecosystem behaviour.

Issues of subsurface water quality and loss of soil fertility are also becoming increasingly more important as the pressure on land increases. Soils may further be part of environmental management practices to combat greenhouse gas emissions, for instance by enhancing soil carbon sequestration. Because migration of inorganic and organic contaminants and other elements in the subsurface is affected by a multitude of complex, interactive physical, geochemical and microbiological processes, an integrated analysis is needed. For example, cycles of precipitation and evaporation largely determine if contaminants remain near the soil surface. Changes in the chemical composition or pH of the soil solution may impact the retention of metals on organic matter or iron oxides. Dissolution and precipitation of trace element bearing minerals generally buffer the transport of a solution with a different pH through the soil profile. Simulation of these and related processes requires a coupled reactive transport code such as HP1 that integrates the physical processes of variably-saturated water flow and convective-dispersive solute transport with a range of biogeochemical processes.

Numerical modelling is becoming an increasingly important tool for analyzing such complex problems involving water flow and contaminant transport in the unsaturated zone. The family of HYDRUS codes covered in this course are sophisticated numerical models for addressing multi-dimensional variably-saturated flow and contaminant transport problems at spatial scales ranging from lab to field to landscape scale.

This course is designed to familiarize participants with the principles and mathematical analysis of variably-saturated flow, transport processes and coupled multicomponent reactive transport, and the application of state-of-the-art numerical codes to site-specific subsurface flow and transport problems.

Although participants should have a general background in the principles of soil physics and chemistry, the course gives an introduction to some theoretical aspects of water flow, solute transport, and heat transport in soils, geochemical equilibrium modelling and geochemical processes as cation exchange, surface complexation and kinetic reactions. Most of the time, "hands-on" computer sessions will familiarize the participants with the software packages both in basic usage of the simulation tools as transferring a given problem to it.

Course Software

The course introduces a state-of-the-art generation of Windows-based numerical models for simulating water, heat and/or contaminant transport in variably-saturated porous media. These include **the HYDRUS-1D** and **HYDRUS (2D/3D)** codes for one- and two/three-dimensional simulations, respectively, the geochemical **UNSATCHEM** module, the **CW2D and CWM1** constructed wetlands modules, and **HP1** for one-dimensional biogeochemical transport. HYDRUS-1D, HYDRUS (2D/3D), CW2D, CWM1, and HP1 are supported by interactive graphics-based interfaces for data-preprocessing, generation of unstructured as well as structured finite element grid systems, and graphic presentation of the simulation results. Except for HYDRUS (2D/3D) and its Wetland module, all software packages are in the public domain.

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General Information

Course Instructors

Jirka Šimůnek is a Professor of Hydrology at the Department of Environmental Sciences at the University of California. He is the author of the HYDRUS-1D and HYDRUS (2D/3D) software, primarily developed for modeling water flow, chemical movement and heat transport through variably-saturated soils. He is also involved in the development of the reactive transport code HP1. He has authored more than 190 peer-reviewed journal articles on soil hydrological processes.

Diederik Jacques is a researcher at the Performance Assessment Unit, Institute of Environment, Health, and Safety of the Belgian Nuclear Research Centre. His expertise is in modelling water flow and solute transport in unsaturated porous media including characterizing spatial variability and estimating parameters. He is working on different aspects of coupling unsaturated water flow, solute transport and geochemical reaction including the development and testing of the coupled code HP1.

Course audience

The course is intended for MSc. and PhD. students, researchers and practicing professionals wishing to expand their knowledge on water flow and chemical movement in soils and wetlands using the HYDRUS and HP1 software.

Course Program

Day 1

Background on variably-saturated water flow and solute transport processes
Review of the hydraulic properties of unsaturated porous media
Introduction to HYDRUS-1D software package
Application of HYDRUS-1D to simple one-dimensional problems
Application of HYDRUS-1D to a transient water flow and solute transport problem
Advanced one-dimensional forward and inverse problems with HYDRUS-1D

Day 2

Application of HYDRUS-1D to water balance estimation under climate/land use change
New developments in the HYDRUS-1D software, including the HYDRUS package for MODFLOW
Introduction to HYDRUS (2D/3D) software package
Application of HYDRUS (2D/3D) to drip irrigation

Day 3

– Module 1: Biogeochemical modeling with HP1
Principles of biogeochemical equilibrium modelling
PHREEQC-2: Introduction, Database
PHREEQC-2: Definition of the initial solution
PHREEQC-2: Examples of reaction path modelling
– Module 2: Wetlands modeling with HYDRUS (2D/3D) - water
Application of HYDRUS (2D/3D) to simple and complex two dimensional wetlands: variably-saturated flow

Day 4

– Module 1: Biogeochemical modeling with HP1
Reactive transport in the vadose zone: examples and approach in HP1
First example with HP1
Surface-related processes
Exchange processes in PHREEQC-2 and HP1
– Module 2: Wetlands modeling with HYDRUS (2D/3D) - salinity
Tracer and salt (major ions) movement in wetlands under time-dependent boundary conditions

Day 5

– Module 1: Biogeochemical modeling with HP1
Kinetic reaction networks applied to soil organic matter
Dealing with dynamic hydraulic properties (pore clogging, mineral dissolution)
Inverse modeling applied to reactive transport
– Module 2: Wetlands modeling with HYDRUS (2D/3D) – biogeochemistry
Biogeochemical cycles in constructed wetlands using the CW2D and CWM1 modules
CW2D module: aerobic and anoxic transformation and degradation processes for organic matter, nitrogen and phosphorus
CWM1 module: aerobic, anoxic and anaerobic processes for organic matter, nitrogen and sulphur

General Information

Date

February 20th – 24th 2012

Location

Flinders University
Faculty of Science and Engineering
Sturt Road, Beford Park SA 5042

Registration and contact

via email to marcia.sanderson@csiro.au
Please indicate whether you wish to attend the HP1 or wetlands module on day 3, 4 and 5.

Registration fee

Students: $1,000
CSIRO & University Staff: $1,500
Others: $2,000

This price includes course documentation, coffee breaks, lunches, a social event and a conference dinner.

Computer exercises will be done on desktop PC's or your own personal laptops. Please inform us if you are not able to bring your own computer.

Course Secretary

All mail should be addressed to:
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