

Education evenings 2016

Practical introduction to groundwater modelling

Computer exercises 03 04 What else?

ModelMuse

Much more functionality to be discovered!

Refer to:

- ✓ the ModelMuse manual
- ✓ the ModelMuse videos
- ✓ the ModelMuse help

ModelMuse and MODFLOW

- ✓ Many more packages available to use
- ✓ Compatibility with MODFLOW versions other than the core MODFLOW-2005
 - ✓ MODFLOW-LGR <a>
 - ✓ MODFLOW-NWT <
 - ✓ MODFLOW-OWHM <a>P
 - ✓ MODFLOW-CFP <

MODFLOW packages

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□ Flow

    C BCE6: Block-Centered Flow package

    LPF: Layer Property Flow package

    HUF2: Hydrogeologic Unit Flow package

   - ☐ HFB: Horizontal Flow Barrier package
   □ UZF: Unsaturated-Zone Flow package
  ☐ SWI2: Seawater Intrusion package
CHD: Time-Variant Specified-Head package
      FHB: Flow and Head Boundary package
  E Specified flux
      □ RCH: Recharge package
      □ WEL: Well package
     FHB: Flow and Head Boundary package
  Head-dependent flux —

¬□ DRN: Drain package

      DRT: Drain Return package
      ETS: Evapotranspiration Segments package

    EVT: Evapotranspiration package

      □ GHB: General-Head Boundary package

— □ LAK: Lake package

      MNW1: Multi-Node Well package
      MNW2: Multi-Node Well package
      RES: Reservoir package _____
      - □ RIV: River package

☐ SFR: Stream-Flow Routing package

      □ STR: Stream package
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Solvers

© PCG: Preconditioned Conjugate Gradient package
   PCGN: Preconditioned Conjugate Gradient Solver with Improved Nonlinear Control
   O GMG: Geometric Multigrid package
   SIP: Strongly Implicit Procedure package
   O DE4: Direct Solver package
□ SUB: Subsidence and Aguifer-System Compaction Package
  SWT: Subsidence and Aquifer-System Compaction Package for Water-Table Aquifers
□ HOB: Head Observation package
    CHOB: Specified-Head Flow Observation package
    ■ DROB: Drain Observation package
   GBOB: General-Head-Boundary Observation package
   ■ RVOB: River Observation package
   STOB: Stream Observation package

    Output
    □

  HYD: HYDMOD package
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We only used a few...

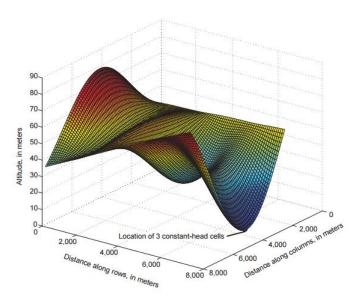
MODFLOW-LGR

✓ MODFLOW-LGR allows smaller parts of a larger model domain to be refined without refining the entire model.

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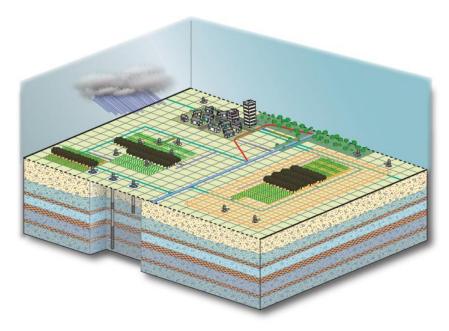
MODFLOW-NWT

- ✓ MODFLOW-NWT is a Newton-Raphson formulation for MODFLOW-2005 to improve solution of unconfined groundwater-flow problems.
- ✓ It is intended for solving problems involving drying and rewetting nonlinearities of the unconfined groundwater-flow equation.



MODFLOW-OWHM

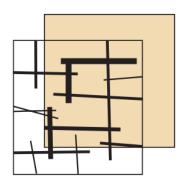
- ✓ MODFLOW-OWHM, or the One-Water Hydrologic Flow Model, is an integrated hydrologic flow model (IHM).
- ✓ It is designed for the analysis of a broad range of issues related to the combined use of groundwater and surface water.
- ✓ It allows the simulation, analysis, and management of human and natural water movement within a physically-based supply-and-demand framework.



MODFLOW-CFP

MODFLOW-CFP has the ability to simulate turbulent or laminar groundwater flow conditions by:

✓ coupling the traditional groundwater flow equation with formulations for a 1-dimensional discrete network of cylindrical pipes (Mode 1, CFPM1),



- ✓ inserting a high-conductivity flow layer that can switch between laminar and turbulent flow (Mode 2, CFPM2), or
- ✓ simultaneously coupling a discrete pipe network while inserting a high-conductivity flow layer that can switch between laminar and turbulent flow (Mode 3, CFPM3).

Beyond the GUI

Several scripting language interfaces to MODFLOW exist, or are in development:

- ✓ Flopy (python)
- ✓ Mflab (matlab)
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- ✓ RMODFLOW (R) <

These are useful for:

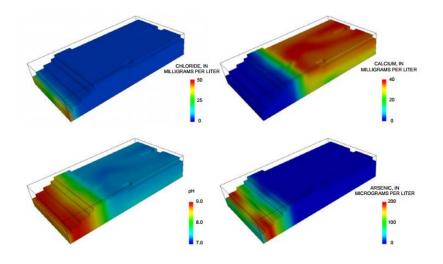
- ✓ Parameter estimation or uncertainty quantification that goes beyond MODFLOW parameters and/or UCODE algorithms
- ✓ Geostatistical simulation for *e.g.* material properties
- ✓ Quickly converting database information to input files
- ✓ Reproducible reporting
- **√** ...

ModelMuse and PHAST @

PHAST is a Computer Program for Simulating

- ✓ Groundwater Flow,
- ✓ Solute Transport, and
- ✓ Multicomponent Geochemical Reactions,

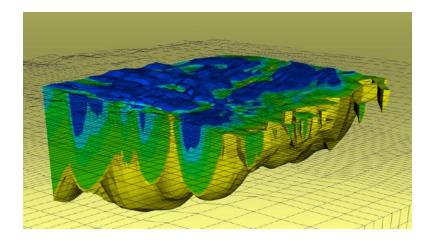
for which it uses PHREEQC.



ModelMuse and SUTRA .

SUTRA is a model for

- ✓ saturated-unsaturated,
- √ variable-density ground-water flow,
- ✓ with solute
- ✓ or energy transport.





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Questions? Found an error?
Please contact B. Rogiers at brogiers@sckcen.be.