UNDER THE AUSPICE OF

Italian Chapter

Online Course 2025

Undressing MODFLOW

May 6th – 27th, Online

Ente di Formazione

CONSIGLIO NAZIONALE GEOLOGI

Accreditato

Course overview

This short course focuses on how to understand and modify MODFLOW 6 input and output files. The course will also touch on files that are read/written by other members of the MODFLOW family (MODFLOW-USG and MODFLOW 2005).

Why should you care about the contents of MODFLOW input and output files?

- Firstly, programs that write MODFLOW input files for you (such as graphical user interfaces and FloPy) sometimes either make mistakes, or do not understand your intentions. In the end, the only way that you can be sure that MODFLOW is receiving the information that you want to provide to it is to check these input files yourself. Also, if MODFLOW is behaving strangely and you are not sure why, the answer will probably be found in the data that it is being given. The only way to be sure of what data it is being given is to scrutinize its input files.
- Secondly, what if you need to provide some inputs to MODFLOW, and/or process some MODFLOW outputs, in ways that your GUI or other software does not support? You need to know MODFLOW's input and output protocols to do this. All of these protocols are well-documented. This gives you the freedom to do whatever is best for you.
- And of course, there is PEST/PEST++. These can be used for history-matching and uncertainty quantification of a MODFLOW model, as well as for other tasks such as management optimization (under uncertainty). Members of the PEST/PEST++ suites interact with MODFLOW through MODFLOW's input and output files. If you want to understand what these programs are doing, or create PEST-to-MODFLOW interactions that enhance history-matching and uncertainty analysis for your specific problem, then you need to understand MODFLOW input and output files.

The course is run by **John Doherty** (author of PEST) and involves sessions of three-hour duration. These sessions would be interactive so that you can ask as many questions as you like and additional discussion meetings can be arranged if more time is required.

What is included

- Access to the planned and extra live lessons
- Software and installation instructions provided before the course
- Material to carry out the exercises
- Access to our e-learning platform to watch again the recorded lessons for an unlimited time
- *APC credits* for Italian Geologists on request

Costs & Registration

Registration at the course page preferably before March 27

- **Regular: 400 €**
- **IAH/SGI: 350 €**
- **Students/ECHN: 300 €**
- **Free access for the attendees of the SYMPLE School**

SYMPLE is an Accredited Training Organization, VAT is not due (art. 10 DPR 633/72)

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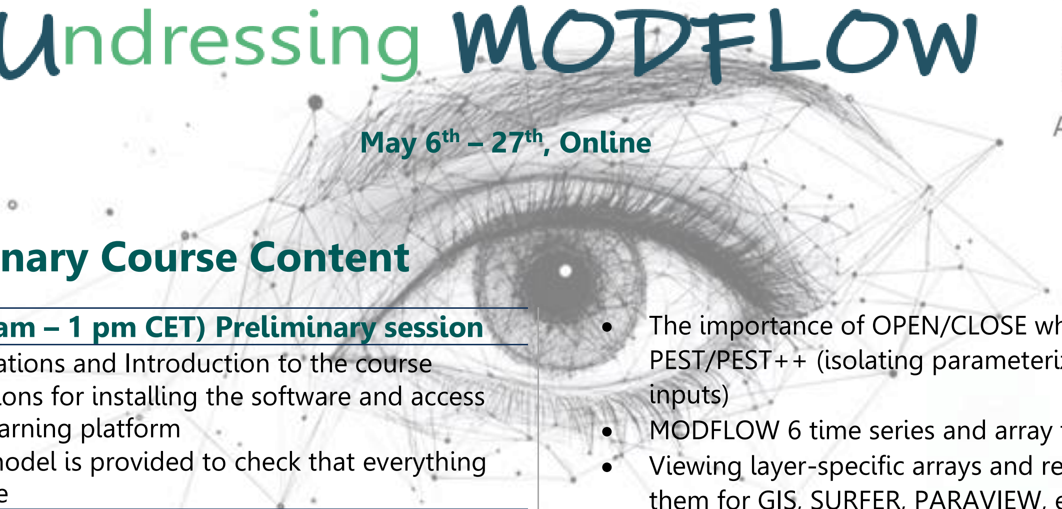

Preliminary Course Content

May 6 (11 am – 1 pm CET) Preliminary session

- Presentations and Introduction to the course
- Instructions for installing the software and access the e-learning platform
- A test model is provided to check that everything runs fine

May 13 (10 am -1 pm CET)

Day 1: Grids

- Brief review of why a grid is needed. This is where mass is balanced, and the laws of groundwater flow and advective transport are formulated and enforced
- Structured and unstructured grids
- DIS, DISV and DISU grids
  - pinching out of layers
  - inactive and non-existent cells (IBOUND and IDOMAIN)
  - quadtree refinement and Voronoi grids
  - locations of cell vertices implicit in DIS but not in DISV or DISU (so cell vertex coordinates and intercell connection lengths and areas must be supplied directly)
  - the concept of "layer" is not fundamental to a DISU grid; connections are everything
- How cells are identified in DIS, DISV and DISU grids (icol,irow,ilay), (icpl,ilay), (inode)
- Cell neighbours
  - implicit in a structured grid
  - defined through IA and JA arrays in DISV and DISU grids
- Supplying grid specifications: DIS, DISV and DISU input files
- Grid coordinates and real-world coordinates
- The MODFLOW 6 GRB output file
- Visualizing a structured/unstructured grid:
  - GUI
  - FloPy
  - Some utilities of the PEST suite

May 20 (10 am -1 pm CET)

Day 2: MODFLOW 6 Input files

- Text files in general: the importance of a suitable text editor and text differencing utility
- Packages and boundary conditions
- Stress periods and time steps
- The name file
- Package input files: arrays and tables
- Some examples of MODFLOW 6 package input files
  - NPF, WEL, GHB, SFR, RCH
- The importance of OPEN/CLOSE when using PEST/PEST++ (isolating parameterizable model inputs)
- MODFLOW 6 time series and array time series
- Viewing layer-specific arrays and reformatting them for GIS, SURFER, PARAVIEW, etc.
- Running MODFLOW 6 from the command line
- How much of your computer's resources is MODFLOW using?

May 27 (10 am -1 pm CET)

Day 3: MODFLOW 6 Output Files

- Major output file types
  - list files
  - dependent variable files (text and binary)
  - cell-by-cell flow term files (binary only)
  - model-calculated observations
- Output file size
  - how to check
  - why it matters (parallel model runs writing to the same disk)
- The output control (OC) package
  - text or binary output
  - limiting output to times and types that are required (especially budget output)
- Identifying model problems using the list file
- Dependent variable files
  - array headers
  - the arrays themselves
  - how to inspect file contents
  - how to extract individual arrays
- Flow terms files
  - array headers
  - flow to/from boundary conditions
  - inter-cell flow terms
  - how to inspect file contents
- Extracting history-match-pertinent information from binary files
  - time interpolation
  - spatial interpolation
  - collecting flows to/from groups of boundary cells
- The MODFLOW 6 OBS package
  - protocol for input files
  - protocol for output files
  - A few words about how PEST and PEST++ interact with MODFLOW: "the model sandwich"