

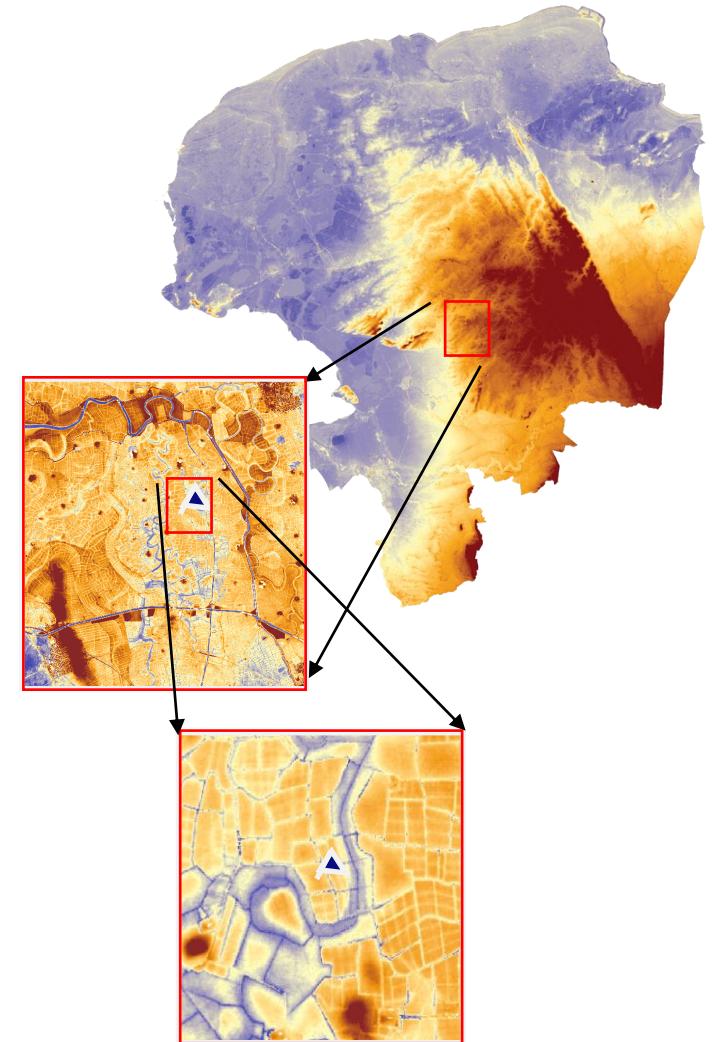
iMOD

what is new: iMOD5.5 / iMOD Suite

Tess Davids, presenting on behalf of the iMOD team

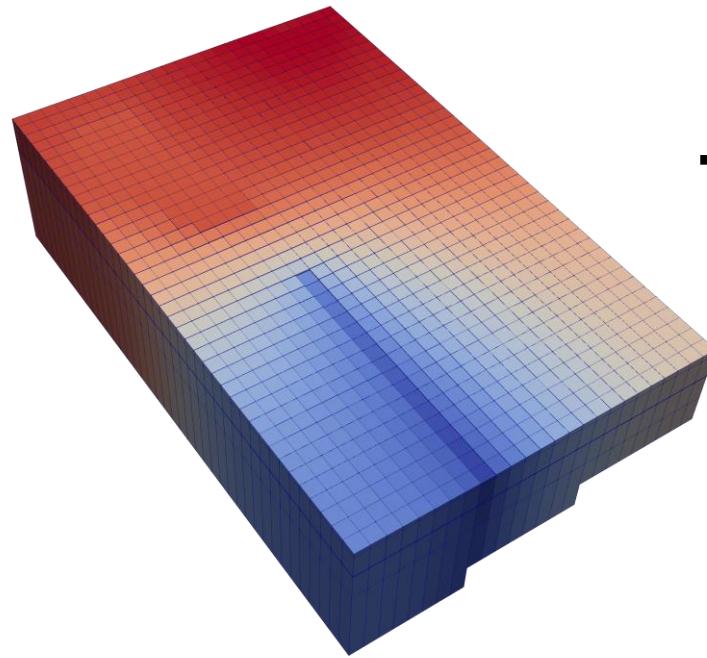
iMOD

iMOD is Open Source Software and facilitates groundwater modelling using MODFLOW

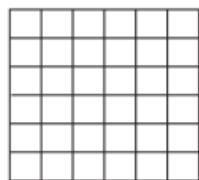


MODFLOW 6: new opportunities to simulate groundwater flow...

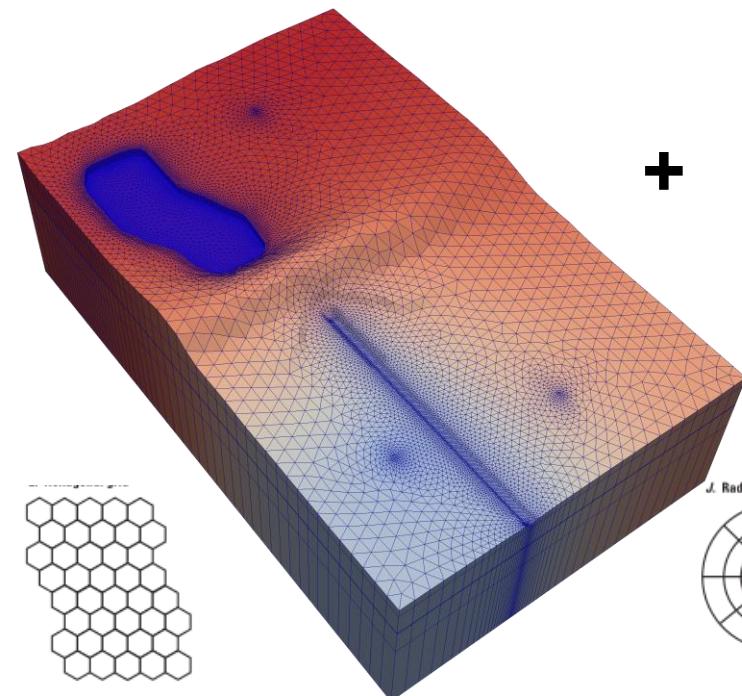
Regular, structured grids (DIS) as well as unstructured (DISV, DISU) and multi model simulations



A. Rectangular grid

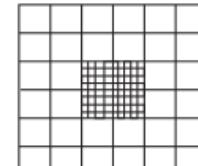


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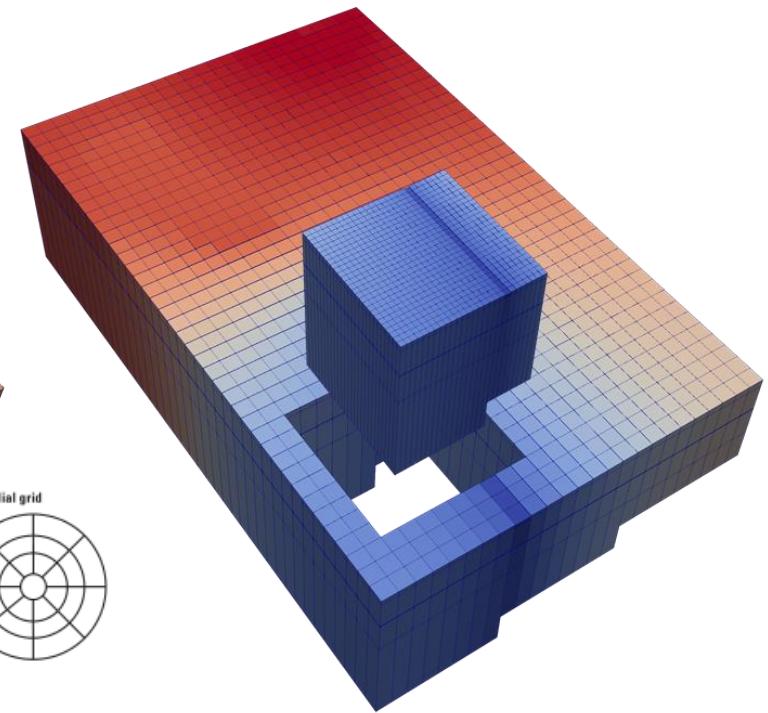


Unstructured grids

H. Rectangular, nested grid



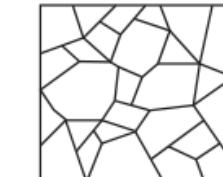
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J. Radial grid



M. Irregular polygon grid



Deltas

Release of two iMOD product lines



2 iMOD product lines

1. iMOD 5 (developments 2007-2021)
 - Can be used for iMODFLOW and iMOD-WQ and limited functionality MODFLOW 6
 - Will be supported for the coming years (in consultation with users)
2. iMOD Suite (2021 -)
 - Includes new developments in visualization, model building, pre and post processing
 - Supports structured and unstructured grids MODFLOW 6 and pre- and post processing iMODFLOW and iMOD-WQ
 - Now mainly (still) suitable for experienced modelers with experience in scripting.



December release iMOD Suite and iMOD5.5

New developments will be part of iMOD Suite

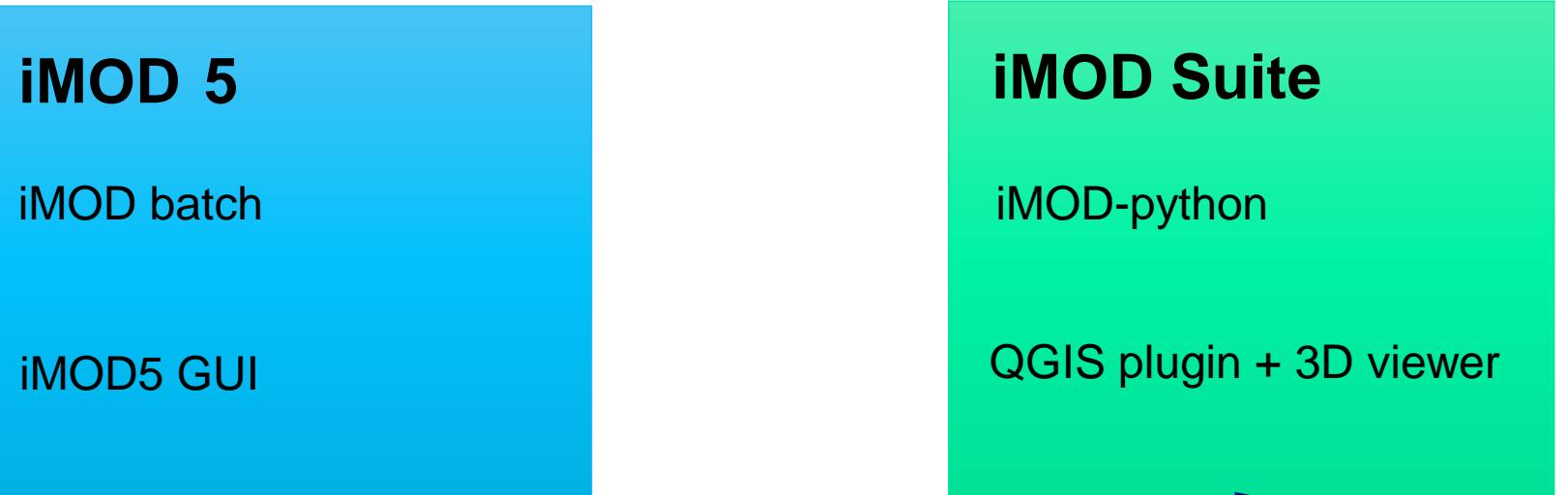
Deltares



Overview of iMOD Components

Pre-post
processing and
model building

Visualization

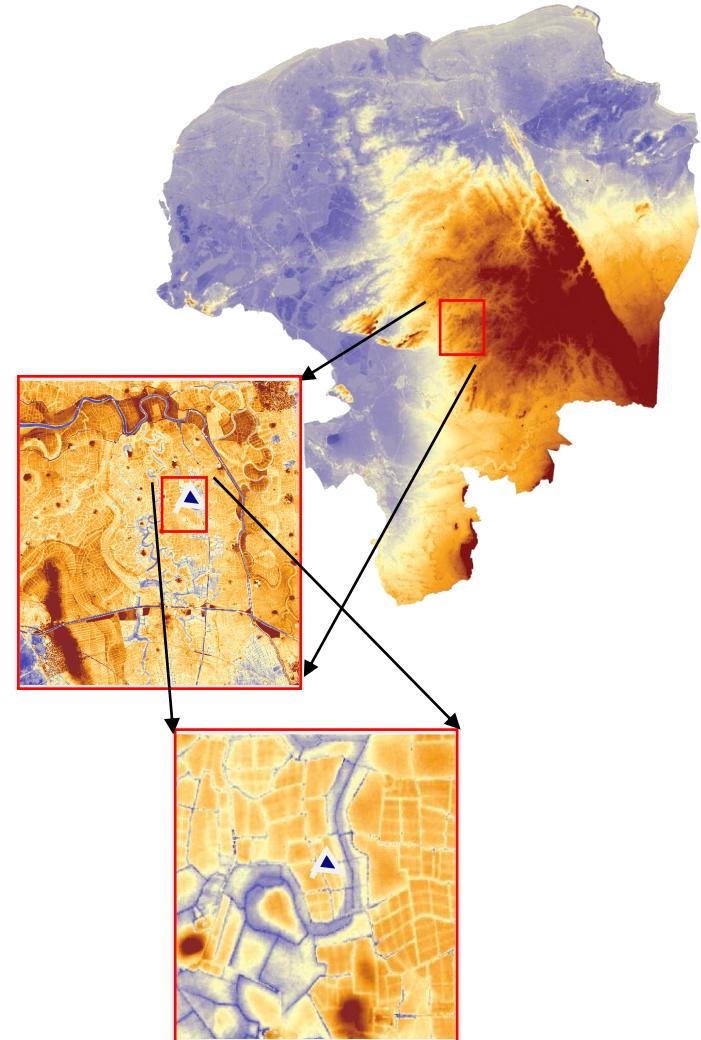
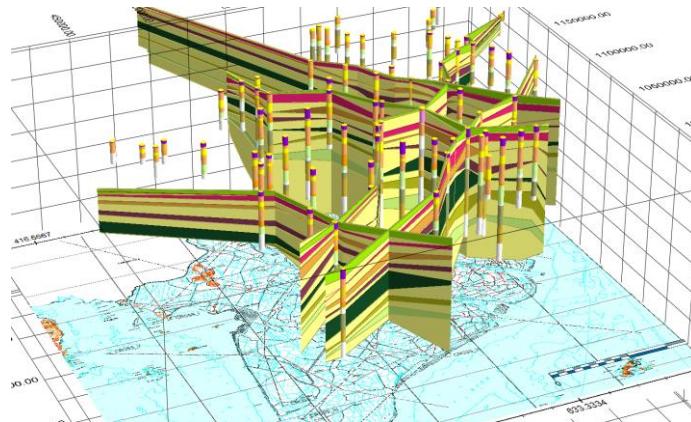
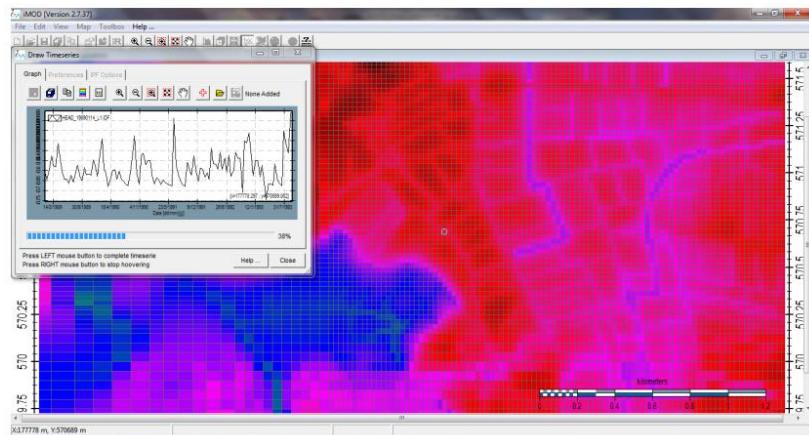


Computational
cores

iMOD5



- An accelerated Deltares-version of MODFLOW
- Support for Water Quality modelling
- GUI
- Tools for analyzing groundwater models and subsurface



Deltares

iMOD Suite – iMOD Coupler



Is a shell for coupling hydrological kernels

- Separated source codes (no alterations within e.g. MF6)
- Robust, integrated testing
- Uses extension of basic modelling interface (XMI)
- Adding different drivers (currently only MODFLOW 6 and MetaSWAP, at the moment working on MF6, MetaSWAP, D-HYDRO)

The cover features the Elsevier logo (a tree) and the journal title "Environmental Modelling and Software". It also includes the text "Contents lists available at ScienceDirect" and "journal homepage: www.elsevier.com/locate/envsoft".

The MODFLOW Application Programming Interface for simulation control and software interoperability

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iMOD Suite - iMOD-python



A collection of Python tools for groundwater modeling and MODFLOW input & output

- Preparing: e.g. rasterizing river shapefiles
- Formatting: produce MODFLOW input
- Extracting and post-processing: compare heads with piezometers, compute water balance
- Visualization: time series, map, cross-sections, 3D

iMOD Suite - iMOD-python



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- Visualization: time series, map, cross-sections, 3D

Part of a much broader set of tools for reproducible groundwater modeling



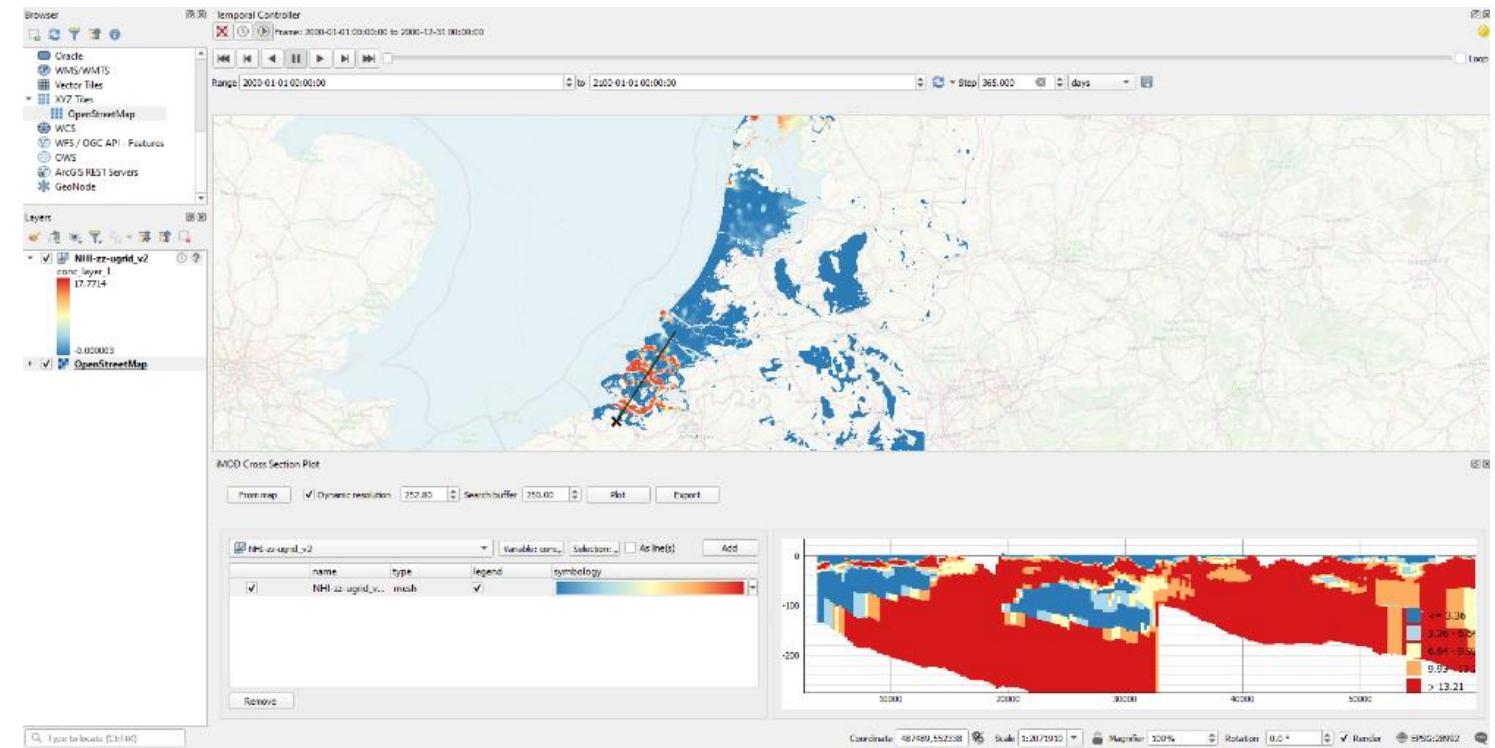
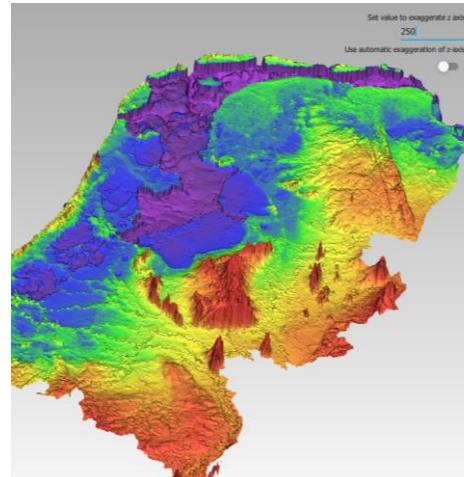


iMOD Suite – iMOD QGIS plugin and 3D viewer

- Visualisation of unstructured data
- Combination of commonly used GIS software QGIS and groundwater modelling.
- Open Source

In iMOD QGIS plugin:

- Cross-sections
- Timeseries



New way of working – Hydrology Team

- Increase cooperation between different software
- Adopt new way of working: Agile



HydroMT

Automated and reproducible model building

Testing

- Integrated testing
- Team City

The screenshot shows the Team City web interface for a build log. At the top, there are navigation links for Projects, Changes, Agents (37), Queue (39), Administration, and a user icon. A search bar labeled 'Q - search' is on the left. The main title is '#889 at 25 Mar 02:03'. Below it, it says 'Tests failed: 1, passed: 30'. There are buttons for Actions, Details, and Assign investigation... On the right, there's a 'Run' button and a date range selector from '23 Mar' to '23 Mar'. Below the title, tabs include Overview, Changes, Tests (which is selected), Build Log, Dependencies, Artifacts, and Parameters. Under 'Tests', there are buttons for View tests, All 31, 30 checked, and 1 uncheck. A search bar and a 'Without investigator' checkbox are also present. A row of buttons includes Investigate..., Fix..., Mute..., and Download. The main table lists test results with columns for Status, Name, Duration, and Order. All 30 tests listed are Success.

Status	Name	Duration	Order
Success	test_f01_basic_tests.test_c01_WEL pytest	3s 728ms	1
Success	test_f01_basic_tests.test_c02_ANI pytest	1ms	2
Success	test_f01_basic_tests.test_c03_CHD pytest	1ms	3
Success	test_f01_basic_tests.test_c04_DRN pytest	1ms	4
Success	test_f01_basic_tests.test_c05_RIV pytest	1ms	5
Success	test_f01_basic_tests.test_c06_ISG pytest	1ms	6
Success	test_f01_basic_tests.test_c07_RCH pytest	1ms	7

iMOD5.4 & iMOD5.5 release

iMOD5.4 - August 2022 (Downloadable here: <https://oss.deltares.nl/web/imod>)

- Flexible drainage and sub irrigation
- Bug fixes

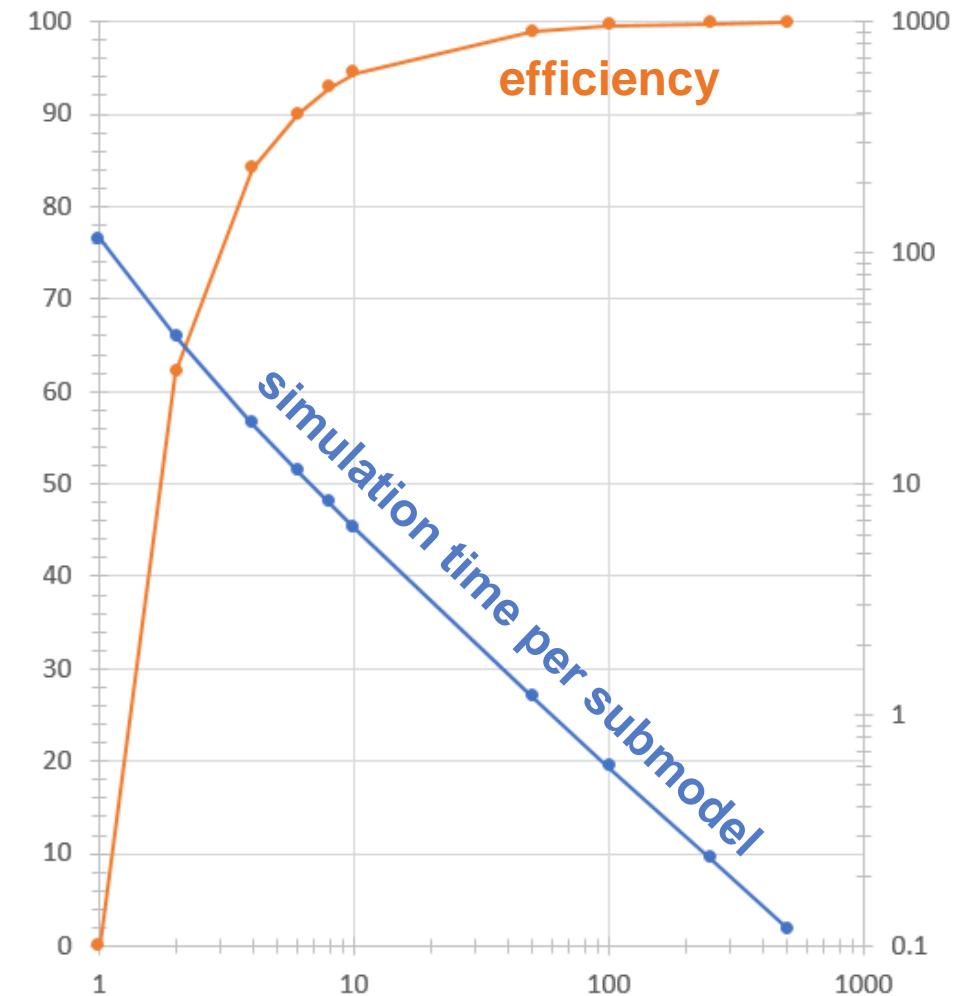
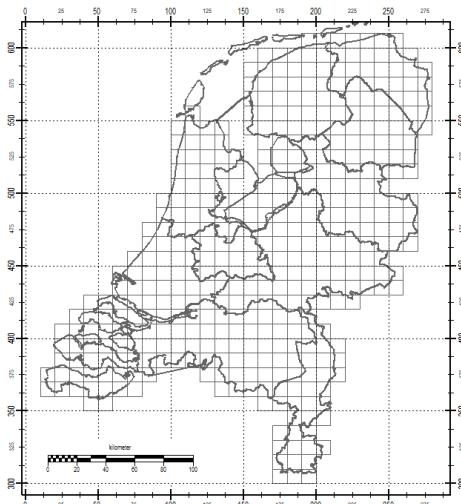
iMOD5.5 - December 2022

- iPEST (calibrating using sub-models)
- SUB-CR
- iMOD-WQ – Parallel solver

Last release iMODFLOW, no new developments. Support and bug fixes for the coming years

iPEST

- Optimization using submodels
 - Yields high efficiencies from the beginning



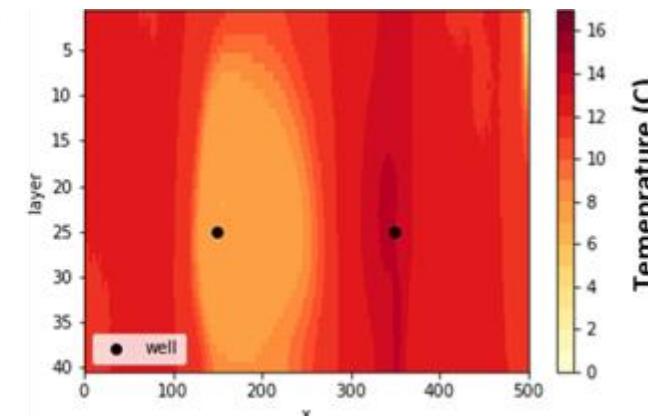
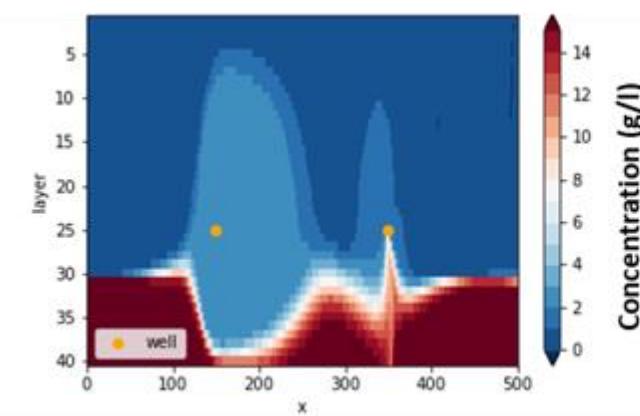
iMOD-WQ

iMOD5.4 release

- Heat transport

iMOD5.5 release

- Parallel support
- SUB-CR



iMOD Suite December 2022 release – iMOD Coupler

- New TOML file configuration
- Improved testing



iMOD Suite December 2022 release – iMOD Python

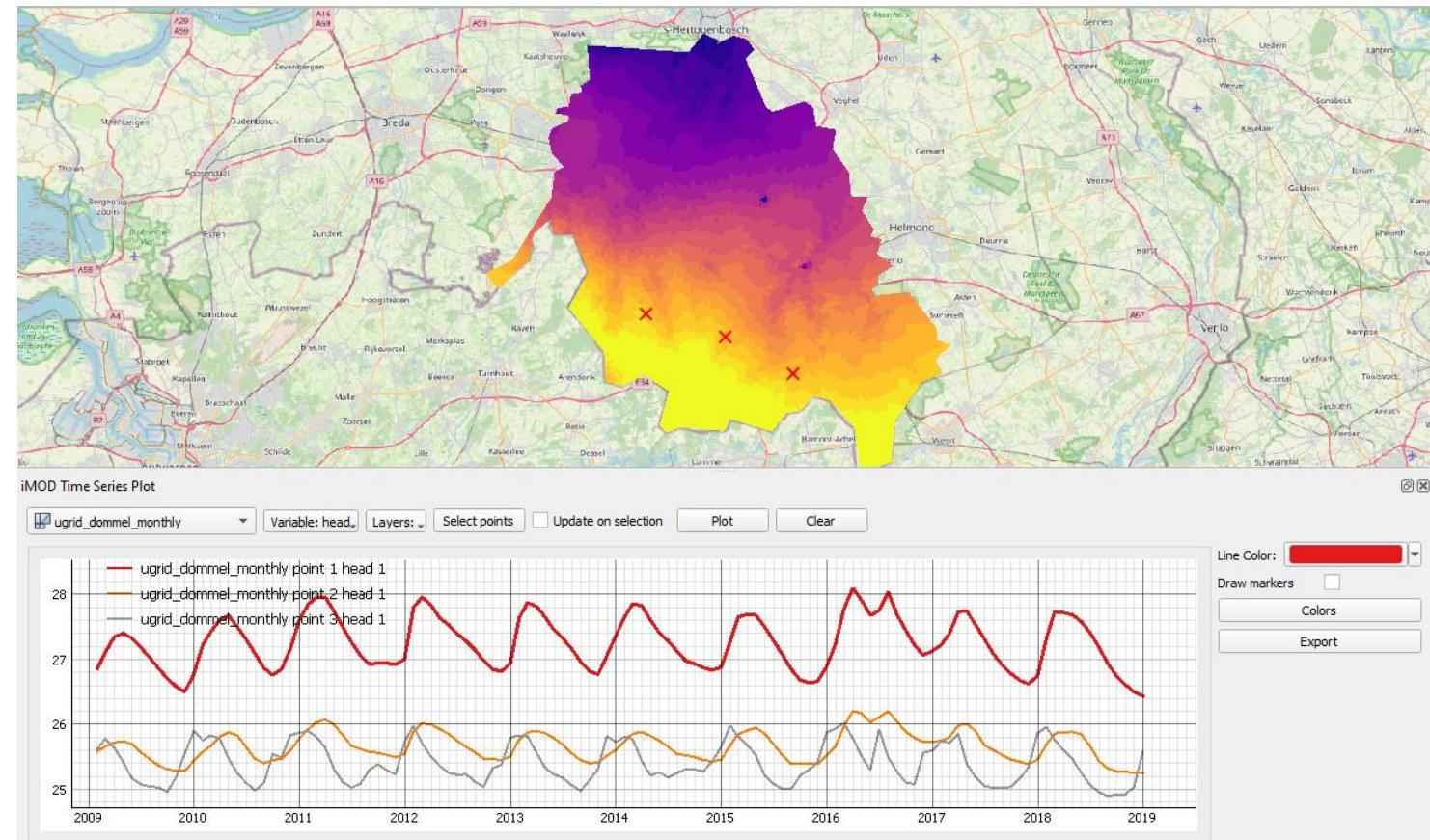
Until December 2022

- Deltaforge 
 - Installer for Deltires hydrology python packages
- MF6 transport support
 - The possibility to write variable density MF6 models
- MetaSWAP support
 - Creating MetaSWAP models from scratch



iMOD Suite December 2022 release – iMOD QGIS plugin and 3D Viewer

- Bug fixes

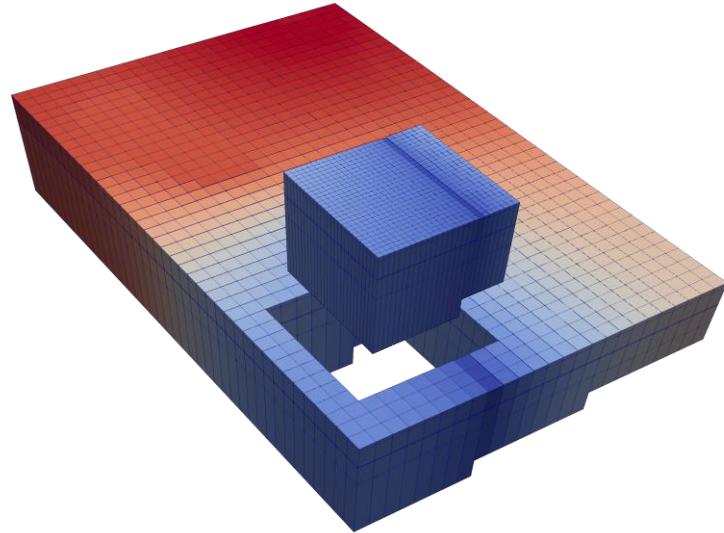


MODFLOW 6 collaborative development '22

- Released 6.3.0 (march '22)
 - Generalized coupling of hydrological models
 - Enables multi-model transport (GWT) simulations
 - Fully anisotropic flow (XT3D) across the model boundary for groundwater flow models
 - Essential building block for parallel MODFLOW
 - Time-varying hydraulic conductivity TVK and storage TVS
- 2022 winter release (upcoming)
 - With new viscosity package VSC

MODFLOW 6 developments roadmap '23

- Release of parallel MODFLOW (Q2)
- Heat transport
- Particle tracking
- Locally anisotropic flow ('XT3D by connection')



- Find out more?
 - MODFLOW 6 <https://www.usgs.gov/software/modflow-6-usgs-modular-hydrologic-model>
<https://github.com/MODFLOW-USGS/modflow6>
 - Examples <https://modflow6-examples.readthedocs.io/en/master/>

iMOD developments roadmap '23

iMOD 5

- New developments will be part of the iMOD Suite
- Maintenance (bug fixes)

iMOD Suite

- iMOD-python
 - MF6 package checks
 - Unstructured regridder
 - Continue making iMOD-python more approachable for non-python users
 - Create replacement PRJ (TOML)
 - Loading in PRJ-files and native MODFLOW models
 - Multi-model support
 - Needed for parallel support
 - Expand support MF6 packages
 - Lake package
- iMOD Coupler
 - Coupling MetaSWAP – MF6 – D-HYDRO (DFLOW-FM)
- QGIS plugin and 3D viewer
 - Combine it with plugin for Wflow and RIBASIM.