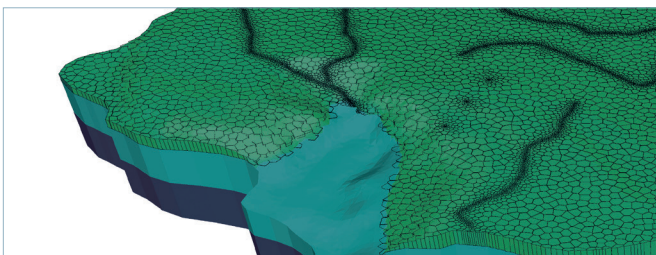


SAMG-Modflow for groundwater simulations: Efficient linear solution process as a black-box

In order to produce reliable results in minimal computational time, groundwater simulations have to employ robust and efficient linear solvers. SAMG-Modflow allows for exploiting the most efficient solver algorithms via a simple plug-in.

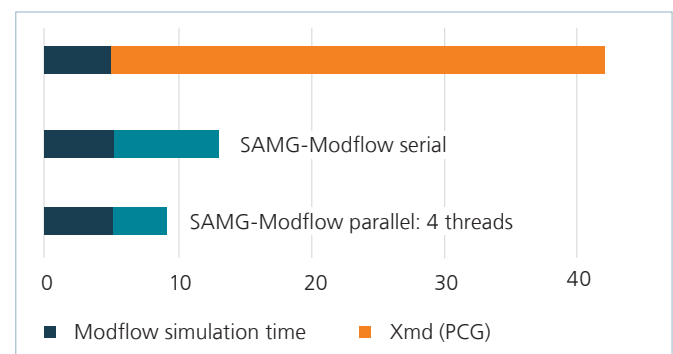
Hierarchical solver approaches like algebraic multigrid have proven to provide virtually optimal efficiency for numerical solution methods of diffusion problems such as pressure corrections without user interactions.

SAMG-Modflow adapts itself to unstructured grids and high permeability contrasts, making it applicable in a black-box manner within Modflow.



Groundwater reservoir, to which SAMG-Modflow is applied

Internally, SAMG-Modflow can exploit parallelism via multi-threading, utilizing available hardware features to accelerate the solution process.



Simulation runtime, Modflow6 case with 600,000 cells

Machine learning tools to control the solver

SAMG-Modflow uses machine learning tools to control the solution process, which adapts the solver autonomously to the individual simulation type and gets the best out of it.

SAMG-Modflow is available for

- Modflow 2000, 2005,
- Modflow USG,
- Modflow 6.

With the next version, the extension module SAMG-Modflow+ will be able to also handle transport and connected linear network (CLN) problems.

User comments

“The SAMG solver is essential to solving the groundwater flow models we build with MINEDW. We build groundwater flow models for applications where large hydraulic stresses are induced and complicate mine workings. The SAMG solver provides us with the best solution times and numerical stability compared to other solvers we have used in the past.” – Itasca Denver Inc

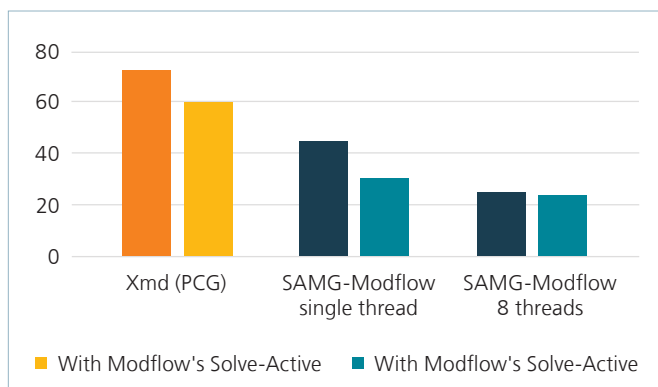
“In general, the SAMG solver is the fastest MODFLOW solver that we have used.” – Aquaveo LLC

Based on the idea of algebraic multigrid

Being based on the idea of algebraic multigrid (AMG), SAMG-Modflow is a very efficient linear solver for diffusion-based problems. Moreover, SAMG-Modflow is based on the SAMG solver kernel, which accelerates many different industrial simulations. The runtime grows only roughly linearly with the number of equations. Hence, it can be applied to small problems and provides efficient solutions for bigger models as well.

The merely algebraic setup adapts itself to individual grids and can easily cope with large material and permeability contrasts. An integrated control mechanism exploits machine-learning methods to control the selection of solver method and set up to provide high efficiency and guarantee a robust solution.

In addition, SAMG-Modflow supports both serial and multi-core computations on single PCs, workstations, or compute nodes. The parallelization is completely encapsulated in the solver library. Just as with the solver parameters, no user interaction is needed.



Simulation runtime, Modflow USG case with 737,191 cells

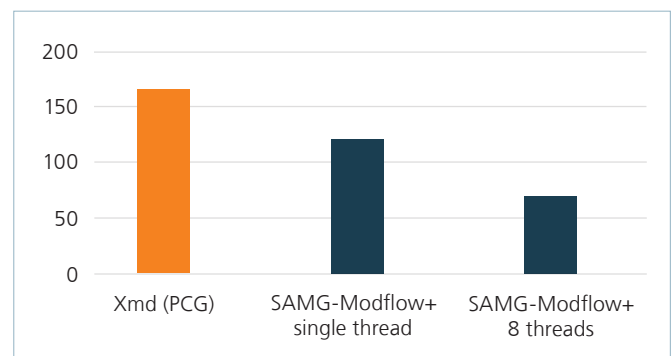
Commercial reference

The following companies offer SAMG and SAMG-Modflow in their groundwater simulations software:

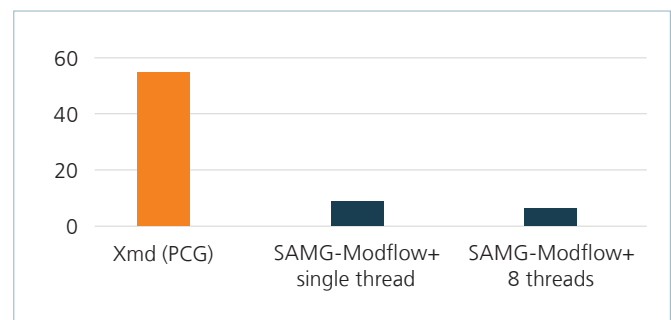
- Aquaveo LLC
- DHI-WASY GmbH
- Environmental Simulations Inc.
- ITASCA Denver Inc.
- Waterloo Hydrogeologic
- HydroAlgorithms

Extension for more sophisticated cases

With the next release, the extension module SAMG-Modflow+ will become available in addition to the base version SAMG-Modflow. It will employ special solver approaches from the underlying SAMG library to also handle more sophisticated groundwater simulations. This comprises transport problems as well as connected linear networks (CLNs). The ML-based solver control adjusts the solver accordingly without further user interaction.



SAMG-Modflow+ application for a transport problem with 552,800 cells



SAMG-Modflow+ application for a problem with 137,384 cells and 14,130 CLN cells

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