

Mathematical Modelling, Simulation and Optimization for Societal Challenges with Scientific Computing

OPM in MSO4SC

Atgeirr Flø Rasmussen, SINTEF Budapest workshop, May 23 2017



#### Outline

- Who
- Why
- What
- How



# Who

- Open Porous Media software components are or have been developed by:
  - Companies (Statoil, Total)
  - Research institutes (SINTEF, IRIS, TNO)
  - Universities (U. Stuttgart, NTNU)
  - Consultants
- Financing from industry and public (RCN, EU)
- Open source allows easier collaboration!

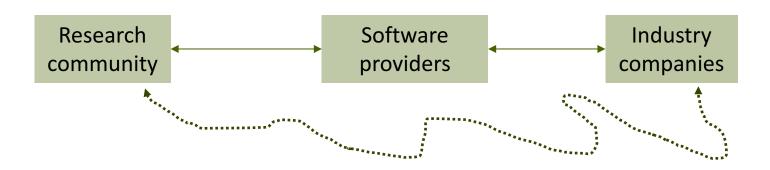




### Why OPM

- Started in 2009 to combine:
  - Grids and discretizations (SINTEF)
  - Advanced fluid models (U. Stuttgart)
  - Industrial know-how and funding (Statoil)
- Vision: A long-lasting, efficient, and well-maintained, open-source software for flow and transport in porous media.
- Ambition: to be a strong base for both industrial development and academic research

From this:

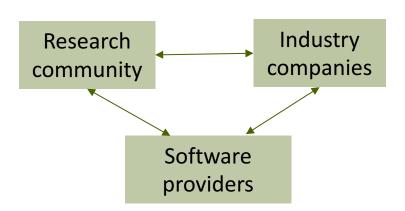




### Why OPM

- Started in 2009 to combine:
  - Grids and discretizations (SINTEF)
  - Advanced fluid models (U. Stuttgart)
  - Industrial know-how and funding (Statoil)
- Vision: A long-lasting, efficient, and well-maintained, open-source software for flow and transport in porous media.
- Ambition: to be a strong base for both industrial development and academic research

To this:





### Why MSO4SC

- Take OPM to where usage is going to be — Cloud, ensembles, larger scales
- Improved visibility and dissemination
  - Get more users
  - Get more feedback
  - Get more contributors
  - Gain new clients for our services
- Improve OPM software
  - Deployability
  - Usability
  - Scalability



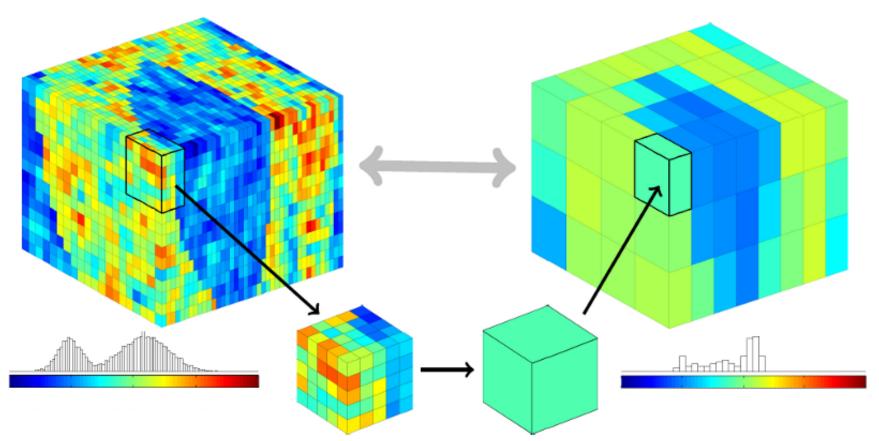
### What

- OPM Software (C++):
  - Reservoir simulator: Flow
  - Visualization tool for reservoir data: ResInsight
  - Upscaling tools for physical properties, flow diagnostics tools
  - "Toolbox" with components for a wide range of porous media flow simulation
- Open data
  - Full real field case: Norne
  - Benchmark cases from SPE comparative solutions project
  - Testing datasets for OPM software



#### Upscaling (I)

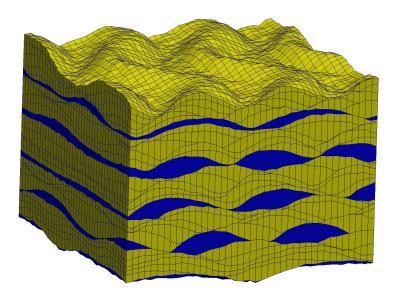
• Finding effective coarse-scale properties

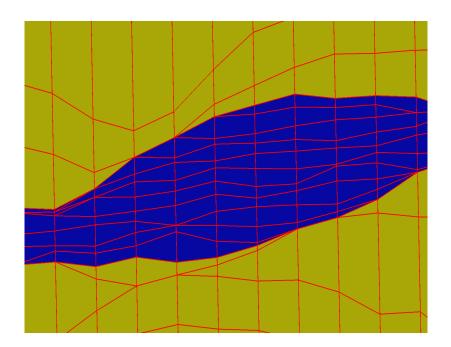




#### Upscaling (II)

• Typical grids for upscaling domains



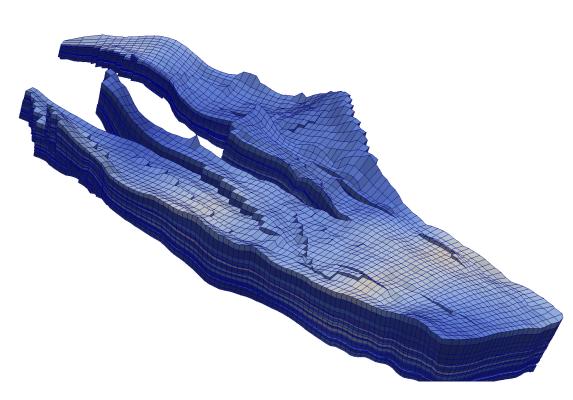


Simple averaging insufficient
 – Must do flow-based upscaling



#### The Norne data set

- Only publicly available real oilfield data set
- Norwegian Sea oilfield, operated by Statoil
- Includes historical production rates and measurements
- Not very large (45000 cells), but has interesting features:
  - Faults, heterogeneity, anisotropy, ill-shaped cells, horizontal wells



# MS04SC

## How (I)

 Development open on GitHub, using pull request approach

	0 1
	Leksikon
Running Flow in Docker   OP CESGA - Portal for users TurboVNC: compute-6-143.1 opm-project.org/wp-content OPM-Upscaling.png 1 500 × Pull R	Requests · OPM/opm-si
This repository Search Pull requests Issues Marketplace Gist 🌲 +	- 🗐 -
DPM / opm-simulators	rk 38
↔ Code 🕧 Issues 35 🕅 Pull requests 9 🕮 Projects 0 📾 Wilki 🗘 Settings Insights +	
Filters -         Q. is:pris:open         Labels         Milestones	equest
□ 🕅 9 Open ✓ 957 Closed Author ▼ Labels ▼ Projects ▼ Milestones ▼ Reviews ▼ Assignee ▼	Sort -
□ 1 Hopefully fixes issue with network file systems and async_output=true. ✓ #1188 opened 4 hours ago by blattms	Γ 1
□ 1 Added -Wno-dev to Eigen cmake args. ✓ #1187 opened a day ago by joakim-howe	Γ 1
In Faster ILU Implementation. ×         #1186 opened 4 days ago by dr-robertk - Changes requested         II.	<b>18</b>
□ 1 Add possibility to use matrix with well connections for preconditioner. × #1183 opened 5 days ago by blattms	Ģ 6
□ îì add regression test for flow_polymer × #1182 opened 7 days ago by akwa2	
│\ Implement solvent model in flow_ebos ✓ #178 opened 13 days ago by totto82	Ç 5
In Logging of multiple problems/warnings × #188 opened 19 days ago by nairr	<b>10</b>
□ [1] SimulatorFullyImplicitBlackoilOutput: add FLOWS to the output. ✓ #1039 opened on 24 Jan by d-robertk • Approved	ÇI 11
□       N Added shellscript running regression test on norne[WIP] >         #781 opened on 4 Aug 2016 by kristliho	
ProTip! no:milestone will show everything without a milestone.	

ProTip! no:milestone will show everything without a milestone

© 2017 GitHub, Inc. Terms Privacy Security Status Help

Contact GitHub API Training Shop Blog About

disflate Gmail		B GIH4ub, Inc. github.com/0PM/opm-simulators/pul/I188/files     C	
ow in Docker   OP		CESGA - Portal for users TurboVNC: compute-6-143.1 opm-project.org/wp-content OPM-Upscaling.png 1500 x Faster ILU implement	ntation. b
0	This rep	ository Search Pull requests Issues Marketplace Gist + F	
	l / opr	n-simulators O Unwatch - 32 + Star 11 ¥ Fork 38	
<> Cod	de	🗇 Issues 35 👖 Pull requests 9 🔲 Projects 0 📾 Wiki 🗘 Settings Insights -	
Fast	ter I	LU implementation. #1186	
	_	obertk wants to merge 4 commits into OPM:master from dr-robertk:PR/faster-ilu-implementation	
Cor Cor	nversatio	on 19 🗢 Commits 4 🔁 Files changed 3	
Changes	from all	I commits v 3 files v +286 -55 Unified Split Review changes v	
9	opm/	autodiff/ISTLSolver.hpp View 🖵 🎤 🗸	
\$	3	00 -289,13 +289,14 00 namespace Opn	
289	289	}	
290	290 291	}	
291	291	- typedef Dune::SegILU8 <matrix, vector="" vector,=""> SegPreconditioner;</matrix,>	
		<ul> <li>typeder Dune::SeqLUBCNatrix, Vector, Vector&gt; SeqPreconditioner;</li> <li>typedef ParallelOvenlappingILUBCNatrix, Vector&gt; SeqPreconditioner;</li> </ul>	
293	293		
294	294	template <class operator=""></class>	
295	295	std::unique_ptr <seqpreconditioner> constructPrecond(Operator&amp; opA, const Dune::Amg::SequentialInformation&amp;) const</seqpreconditioner>	
296	296	ſ	
297		<ul> <li>const double relax = 0.9;</li> </ul>	
298		<ul> <li>std::unique_ptr<seqpreconditioner> precond(new SeqPreconditioner(opA.getmat(), relax));</seqpreconditioner></li> </ul>	
	297	+ const double relax = parametersilu_relaxation_;	
	298	+ const int iteration = parametersilu_iteration_;	
	299	<pre>+ std::unique_ptr<seqpreconditioner> precond(new SeqPreconditioner(opA.getmat(), iteration, relax));</seqpreconditioner></pre>	
299	300	return precond;	
300	301 302	}	
301		00 -307,7 +308,7 00 namespace Opm	
307	308		
307	308	constructPrecond(Operator& opA, const Comm& comm) const	
309	310	t typedef std::unique_ptr <parpreconditioner> Pointer;</parpreconditioner>	
310		<ul> <li>const double relax = 0.9;</li> </ul>	
	311	+ const double relax = parameters_ilu_relaxation_;	
311	312	return Pointer(new ParPreconditioner(opA.getmat(), comm, relax));	
312	313	}	
313	314	Wendlf	
\$	3		
6	/mgo	autodiff/NewtonIterationBlackoilInterleaved.hpp View 🖵 🖍 🗸	1



# How (II)

• Continuous integration: Jenkins

RK	dr-robertk commented 4 days ago	Member	+ 💽	×
	jenkins build this please			

- Regular releases: 2017.04 current, 2017.10 next
- Almost-weekly hangouts (Sintef, IRIS, Statoil, others)
  - Make everyone work towards same goal
  - Forum for technical discussions and decisions
  - Essential to coordinate fixes and improvements, avoiding duplicated efforts
- Communication: website, mailinglist, GitHub issues

#### Thank you for your attention!

#### **Contact information:**

**OPM** information: **OPM** website: Scientific Coordinator: **Project Coordinator:** Website:

Atgeirr Flø Rasmussen (SINTEF) atgeirr@sintef.no opm-project.org Zoltán Horváth (SZE) horvathz@math.sze.hu Javi Nieto (ATOS) javi.nieto@atos.net www.mso4sc.eu



Mathematical Modelling, Simulation and Optimization for Societal Challenges with Scientific Computing

European

Commission

Horizon 2020 European Union funding for Research & Innovation

Grant agreement No. 731063

