Models

Multi-phase multi-component(Darcy-scale)
- compositional/immiscible
- isothermal/nonisothermal
- local equil./non-equil.
- extensible constitutiv modelling framework

Networks/Fractures
- embedded lower-dim.
- 1D2D, 2D3D, 1D3D
- various disc. methods
- blocking/non-blocking
- multi-phase/component

Richards' equation
- optional vapor diffusion

Navier-Stokes
- RANS/turbulence mod.
- coupled PM/free-flow

(Poro)mechanics
- linear/hyper elasticity
- poroelasticity/Biot

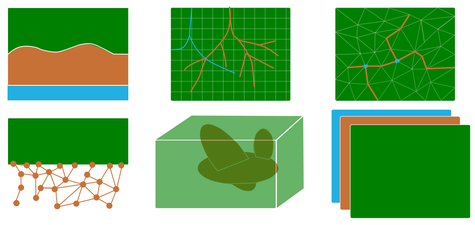
2D Shallow Water
- implicit/explicit

Porenetwork models
- 1p, 2p, compositional
- nonisothermal
- dynamic/static

Performance

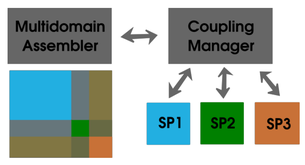
DuMu^X supports **parallel** simulations using **distributed memory** parallelism based on **MPI** and/or **shared memory** parallelism with several backends (**OpenMP, TBB, Kokkos**) out-of-the-box for many models.

Multidomain

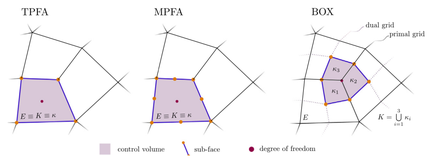


DuMu^X can couple problems posed on different domains. The domains can **touch** or **overlap,** model **different physics**, have **different dimensions**, different **grids**, or different **discretization methods**.

The **full** system **Jacobian** is approximated by **numeric differentiation** (avoids hand-coding the Jacobian) which allows building **monolithic** solvers for **complex nonlinear coupled** problems.

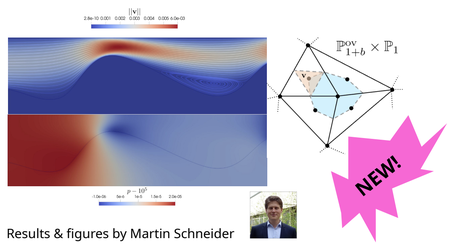


FV Discretizations



Powerful **finite volume abstraction** allow implementation of **versatile** FV schemes:

- **Cell-centered FV** schemes
  - TFPA
  - MPFA
- **Staggered FV** scheme (MAC)
- **Control-volume finite elements** (CVFE)
  - P1/Q1 (Box)
  - CR/RT (Diamond)
  - P1 + Bubble (MINI)
  - Hybrid CVFE/FEM



Results & figures by Martin Schneider

Reproducible Research

DuMu^X offers various tools to enhance reproducible research: scripts to create **self-contained modules**, installation recipes, **Docker images**, webapps, **metadata** extraction.

NEW!

There are many "dumux-pub" modules with DuMu^X code accompanying publications.

DuMu^X

Your first **DuMu^X** simulation **in 5 minutes**!

DuMu^X

an open-source simluator! GNU GPL v3 (or later)

https://dumux.org

Distributed Unified Numerics Environment (**DUNE**)

for **multi**-{phase, component, scale, physics, …}

flow and **transport** in **porous media**

River engineering [water]

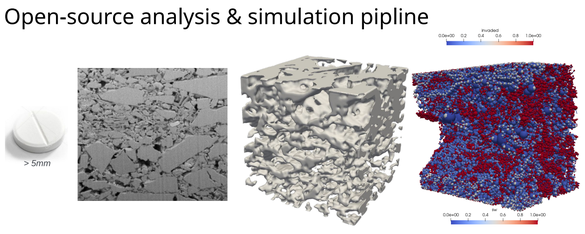
DuMu^X is used in production in **industrial river engineering** applications. This simulation of a section of the river Rhine was conducted with the DuMu^X implicit 2D **shallow water** model.

Simulations & figure by Leopold Stadler

Porenetwork model [water]

scikit-image image processing in python | PoreSpy | DuMu^X

Open-source analysis & simulation pipline



Example simulations from project **PrintMed**: Printing personalized medicines on demand
(Mathis Kelm, Maziar Veyskarami, Rainer Helmig, Majid Hassanizadeh)

Simulations & figures by Mathis Kelm

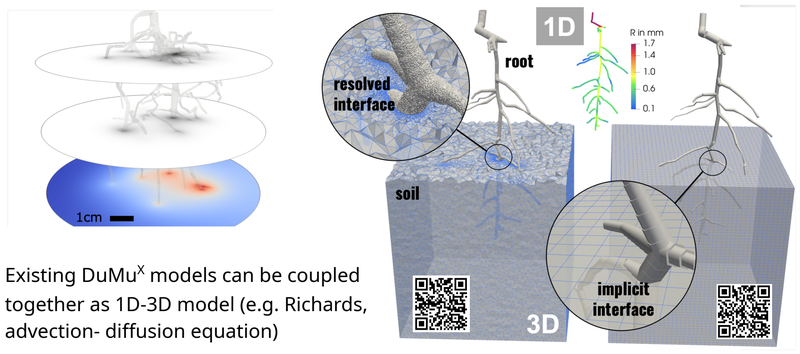
Model coupling via dumux-preCICE

Based on work by Alexander Jaust

preCICE | DuMu^X

Root water uptake [water]

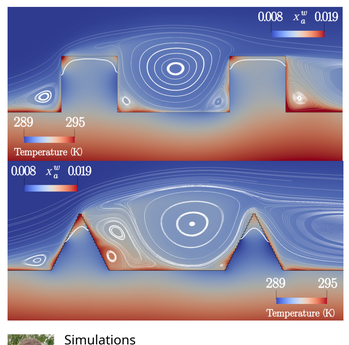
DuMu^X implements several methods for coupling PDEs with dimensional gap 2 (**1D-3D**).
The implementation allows to seemlessly switch methods.
The **mixed-dimensional PDE system** is solved in fully coupled fashion.
Several locally conservative FV discretization schemes are available.



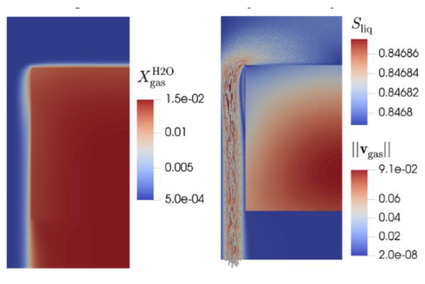
Existing DuMu^X models can be coupled together as 1D-3D model (e.g. Richards, advection- diffusion equation)

Free-flow / porous-media-flow

Multi-phase multi-component nonsiothermal Darcy flow simulations monolithically coupled to the **compositional nonisothermal Navier-Stokes equations.**
Locally conservative FV schemes.



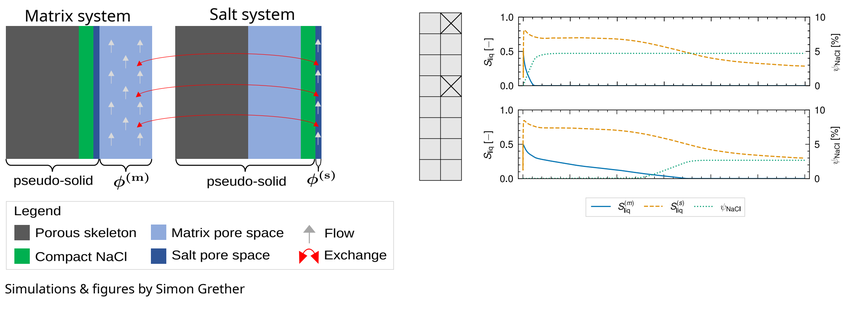
Simulations & figures by Edward Coltman



Simulations & figures by Martin Schneider

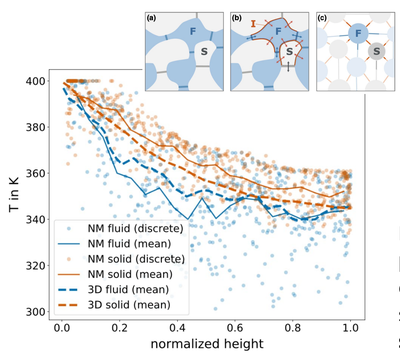
Dual continua model for salt precipitation [water]

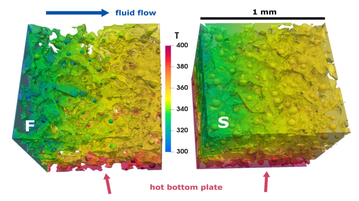
Dual contuinua approach for salt precipitation in **porous media** based on **Darcy-scale models**. The model accounts for flow processes within the precipitated salt separately.



Simulations & figures by Simon Grether

Dual network model (heat transport)

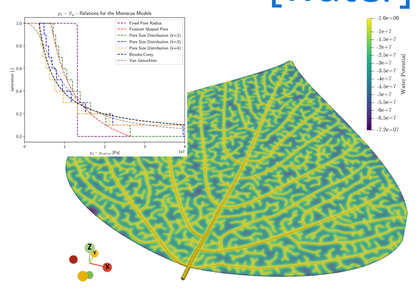




Dual network approach for **heat transport** in **porous media** based on two intertwined and coupled **network models**. Comparison with 3D simulations shows good agreement at **significantly reduced cost**.

Leaf evaporation [water]

The **mixed-dimensional** leaf model describes the **evapotranspiration** from a whole **leaf** and models the flow in veins represented as a **network** of **1D tube segments** and the non-vascular leaf tissue as a **porous medium** in **3D**. Flow in both compartments is solved for in fully coupled fashion with a monolithic approach.



Simulations & figures by Lars Kaiser

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Latest release: *DuMu^X 3.10* (2025). **Contributors**:

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