Numerical modelling of CO_2 storage in sandstone reservoirs below the German North Sea Sector

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Aims and Methods of AP 2.3, AG Geohydromodellierung

Aims:

> **Quantification of the achievable dynamic storage capacity of a potential storage site**
- Determination of static and achievable dynamic storage capacities for selected sites A1 and B1
- Optimisation of injection schemes under geological and site specific geomechanical limits

> **Quantification of induced long-term, as well as large-scale effects**
- Prognosis of transient 3D CO_2 phase distributions and induced pressure changes
- Investigations of formation water displacement and interferences with other types of use
- Quantification of subsurface space required as a basis for site monitoring and subsurface spatial planning

Methods:

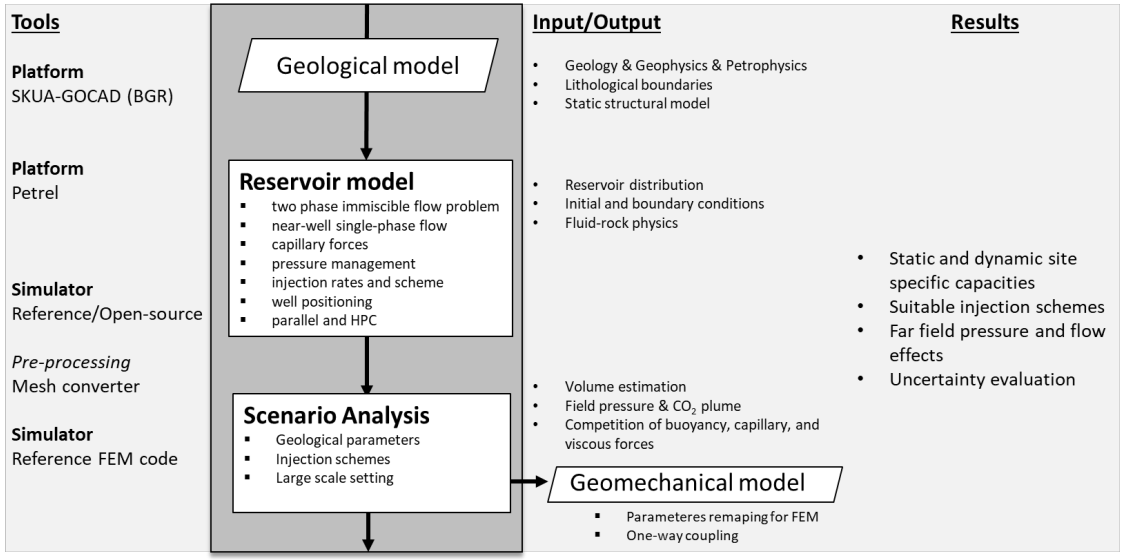
> **Development of consistent and efficient workflows**
- Automated conversion of geological models to reservoir models and generation of code input
- Efficient simulation by parallelisation
- Code and workflow verification
- Model transfer for geomechanical simulations

✓ Year 1

> **Numerical simulation for selected sites A1 and B1**
- Representation of governing physical processes during CO_2-injection
- Construction of suitable reservoir models and their parameterisation
- Scenario analysis for uncertainty and injection variations

> **Years 2 and 3**

AP 2.3: Prior work



Prior work:

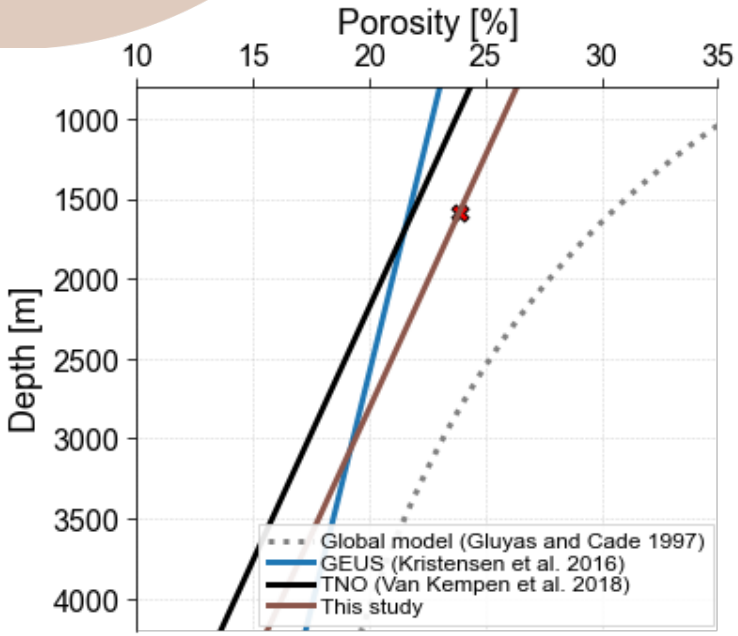
> Developed consistent workflow to set up reservoir models, based on the geological model from BGR, and pass the model on the AP 3 for geomechanical considerations

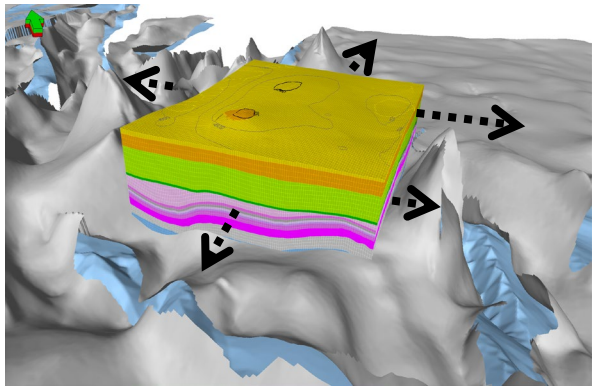
> Code validation and HPC set-up

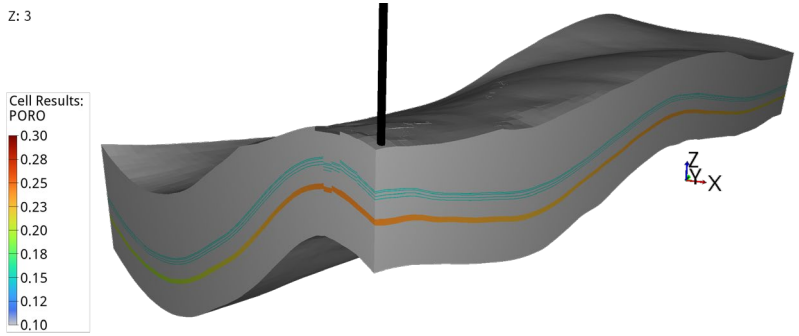
> Large-scale boundary conditions and method for static trap characterization

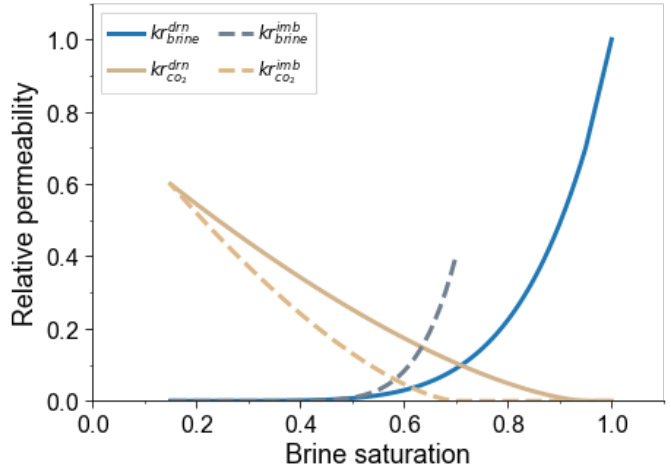
Updated reservoir model site A

- Petrophysical setting adjusted according to well log
- Large-scale boundary conditions are considered outside of model area:
  - Northern boundary **exhibits a tendency towards 150 km**
  - Southern and Western boundaries are **characterised by a barrier within a range of 8-10 km**
- Hysteresis included
- Fault systems deactivated - > no leakage assumed



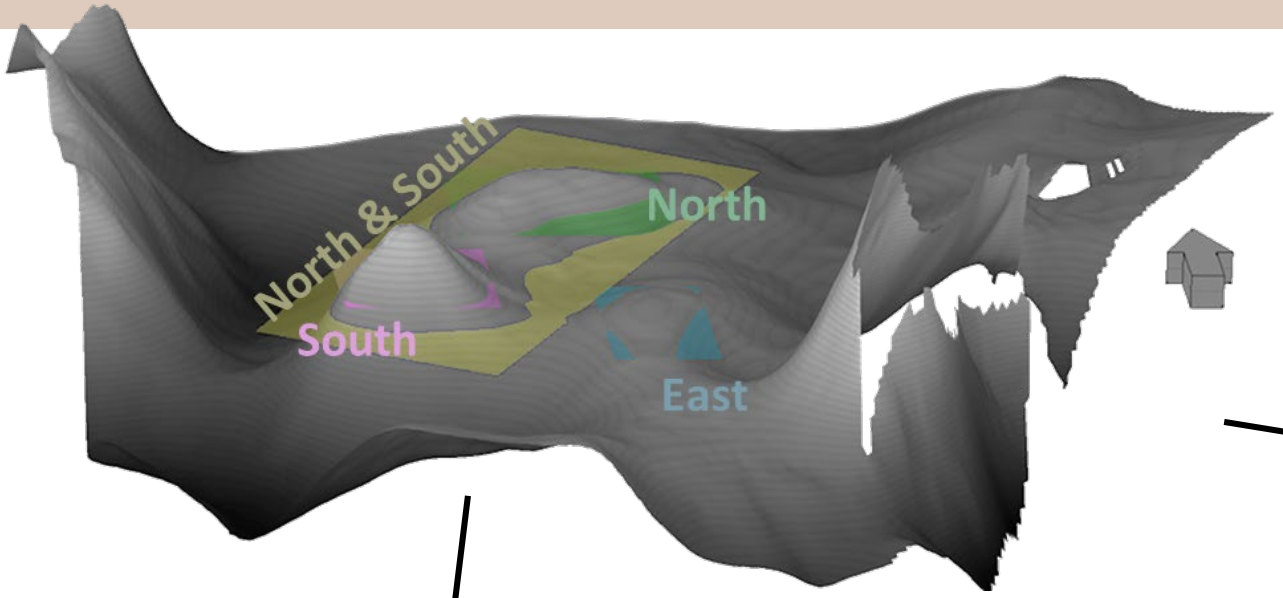


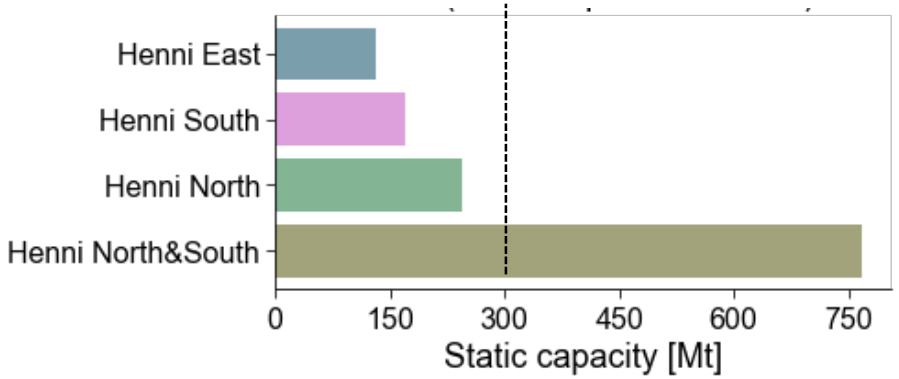


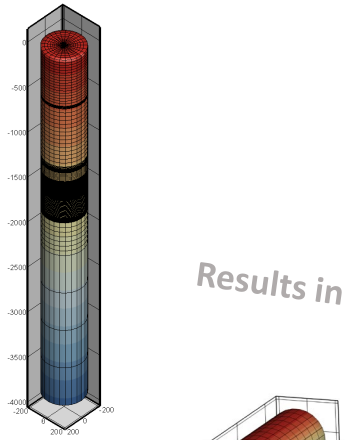


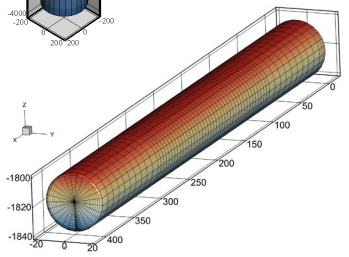
Scherpenisse and Maas (2009)

Updated reservoir model for site A









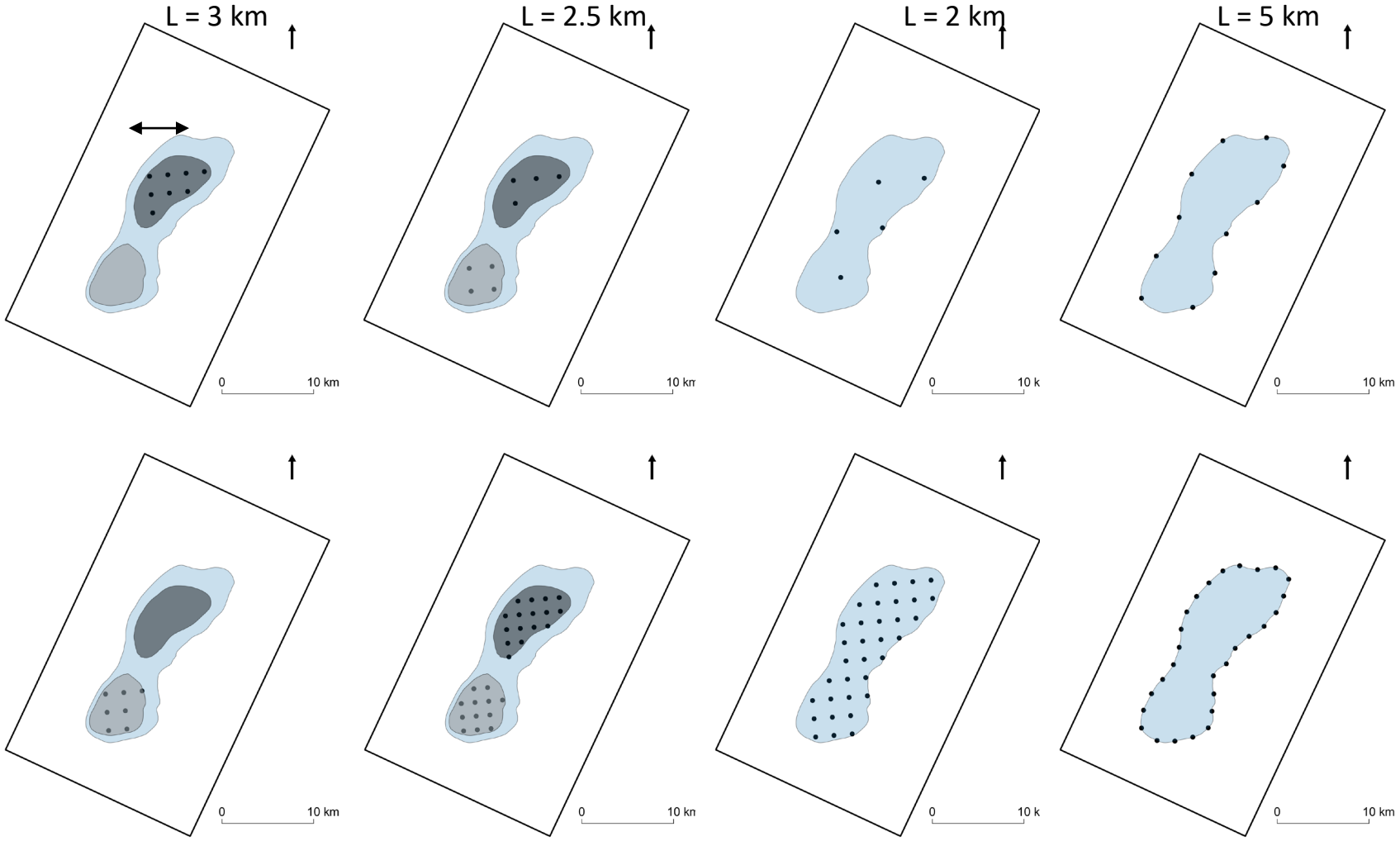
Results in cooperation with AP 3.1

- 3D reservoir-geomechanical modelling workflow
- Derivation of site based (local) geomechanical limits for the maximum applied bottom-hole pressure for the storage formation for vertical and horizontal wells

- Updated static capacity estimates for sub-traps of site A
- Only combining sub-traps will yield envisaged storage target

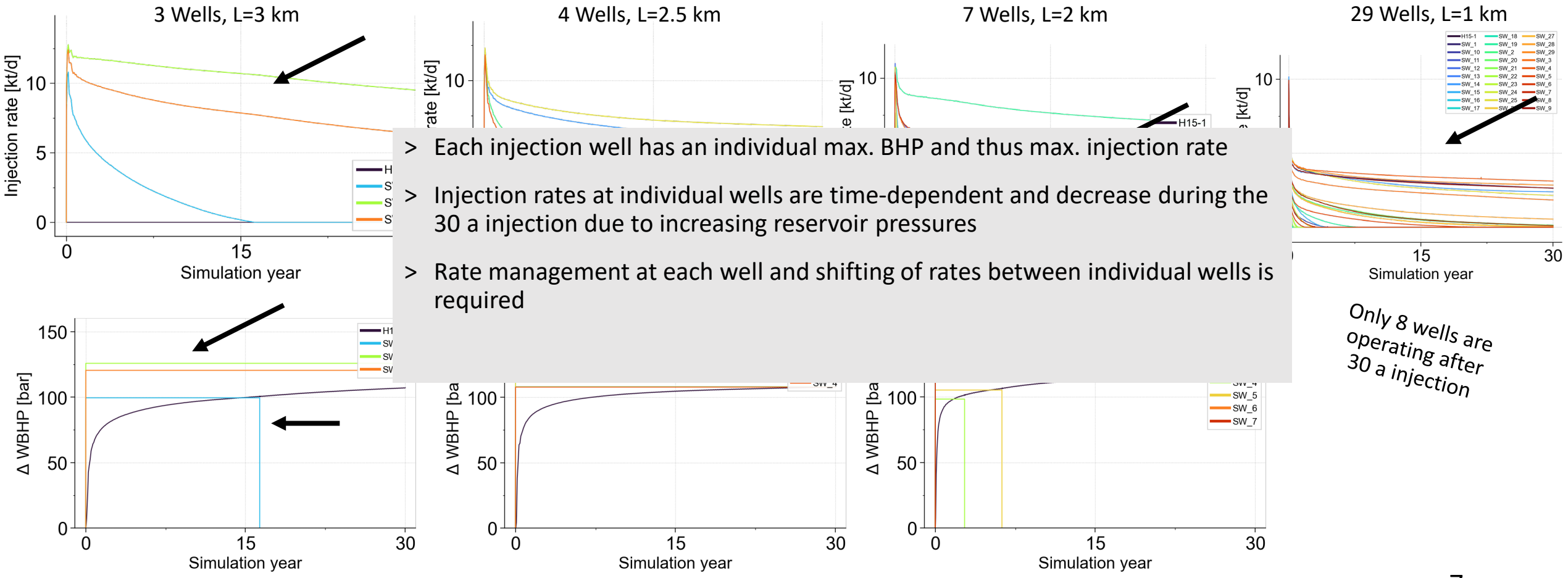
Towards injection strategy development

- > Well placement:
  - Equidistant placement
  - Within closure
  - Along spill depth
- > Injection rate:
  - Maximum rate
  - Constant rate
- > Well type:
  - Vertical
  - Deviated or Horizontal
  - Multi-segment



Individual trap injection potential: Henni South

Injection strategies under BHP pressure limit

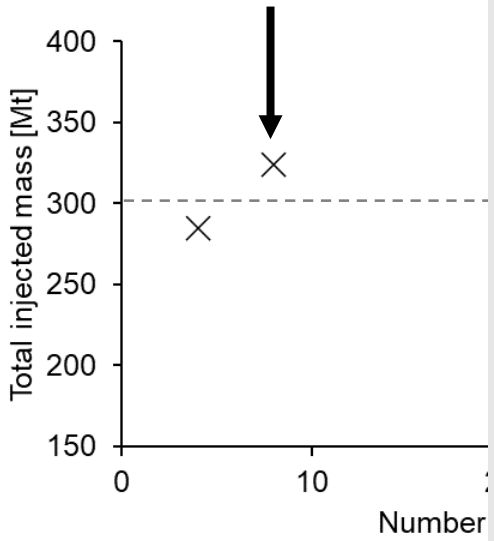


- Each injection well has an individual max. BHP and thus max. injection rate
- Injection rates at individual wells are time-dependent and decrease during the 30 a injection due to increasing reservoir pressures
- Rate management at each well and shifting of rates between individual wells is required

Only 8 wells are operating after 30 a injection

Individual trap injection potential: Henni North

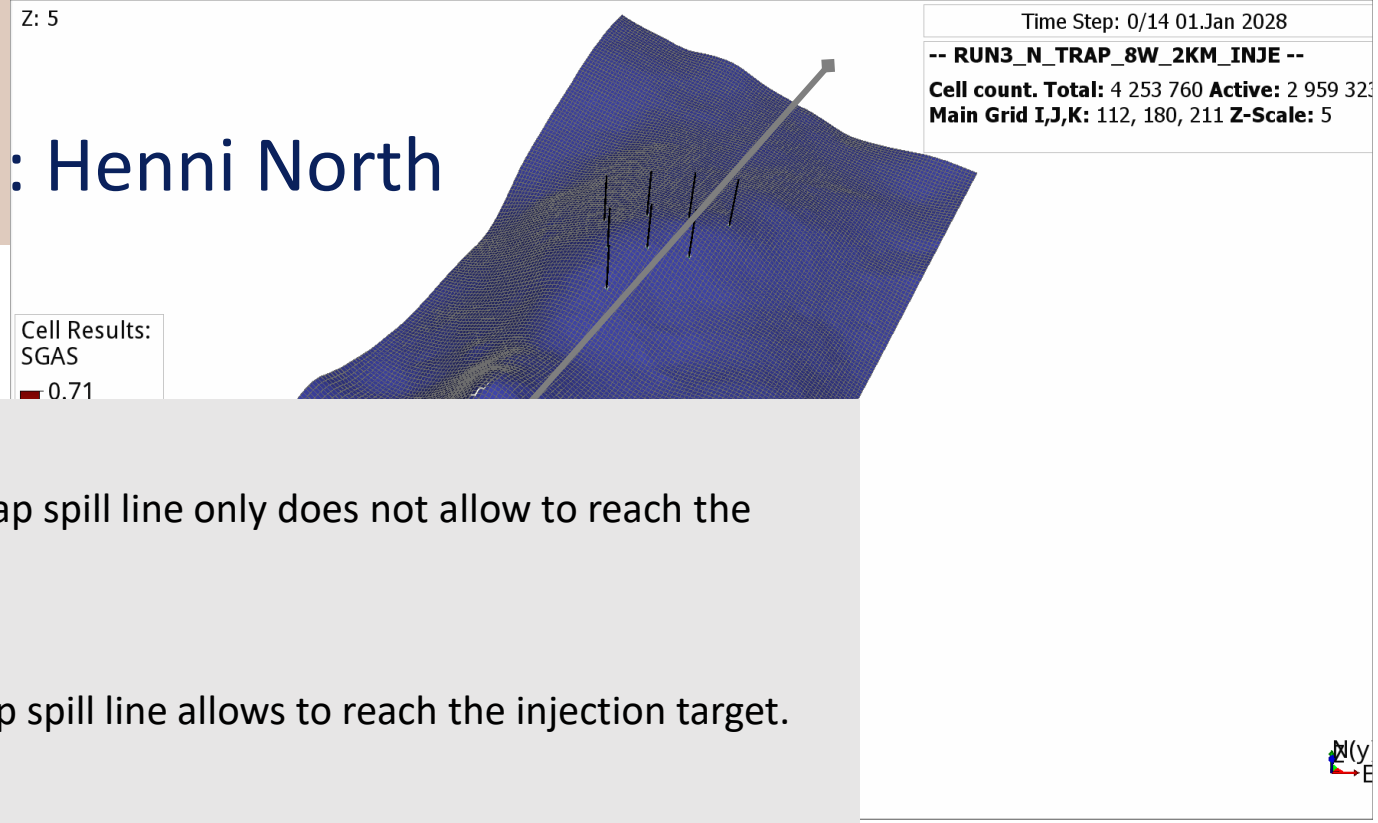
> Individual trap injection potential without flow rate limits

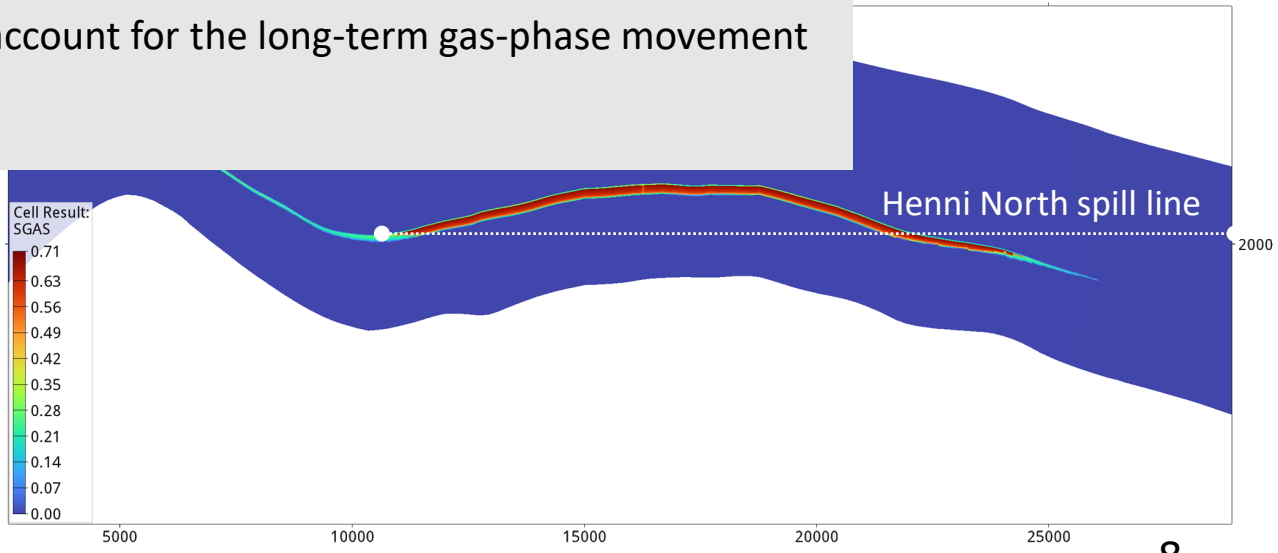


> CO_2 injection above the sub-trap spill line only does not allow to reach the injection target

> Placing wells along the sub-trap spill line allows to reach the injection target.

> An injection scheme needs to account for the long-term gas-phase movement within the trap





Henni North:

- Dynamic capacity
- Static capacity

✓ Comparison of static capacity with dynamic model results

Thank you
for your attention!

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