MUFITS
Training Course

Day 5

Complicated scenarios; Recommendations

Program

- A 2D radial problem;
- Recommendations for tuning the simulator;
- More complicated scenarios with the GASSTORE and BLACKOIL modules

A 2D/3D radial problem

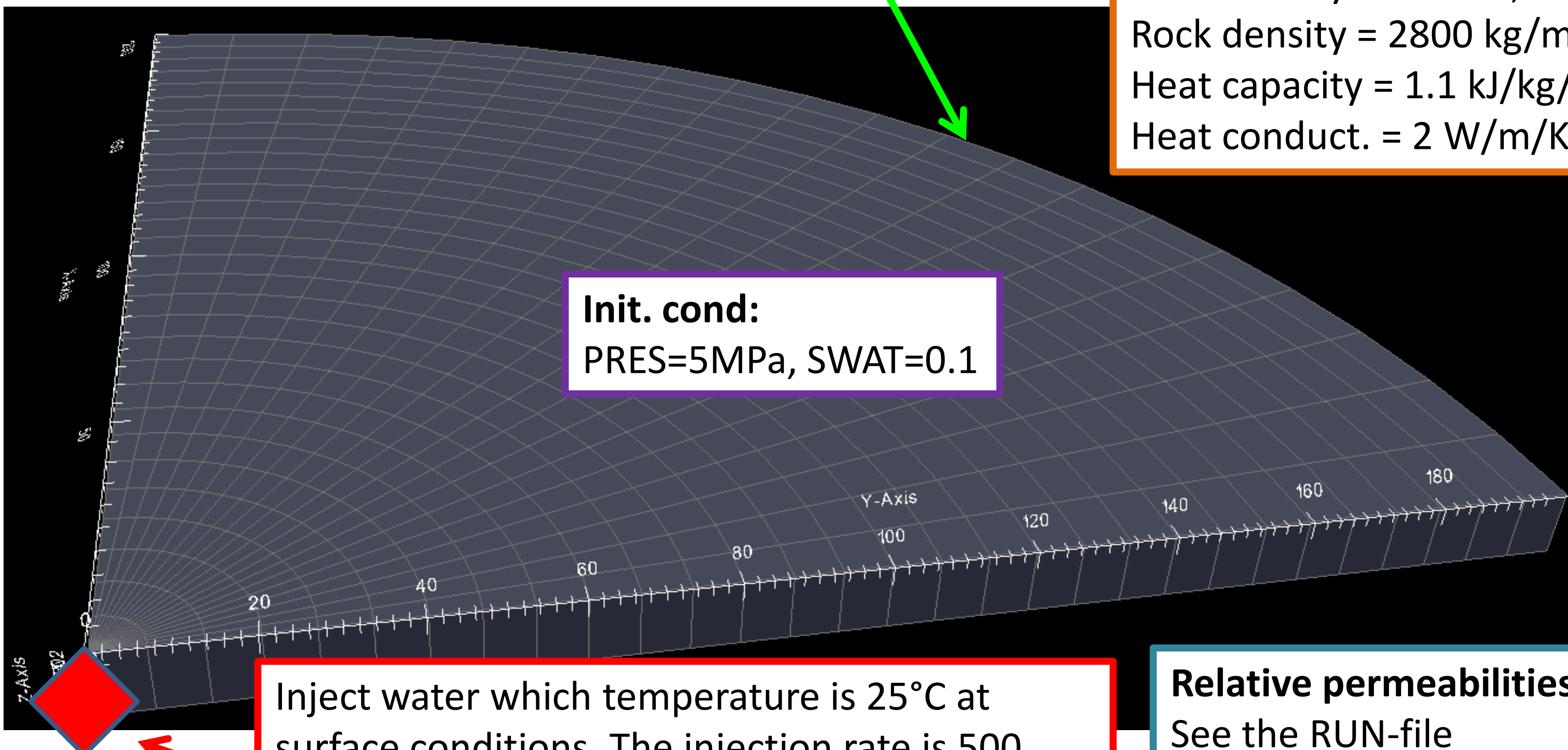
Scenario 13

Simulate scenario for 500 days reporting distributions every 50 days

Domain: [0,200m]*[0,π/2]*[500m,510m]
Grid: 30*20*1

Fixed parameters at this boundary

Rock properties:
Porosity = 0.25;
Permeability = 50 mD ;
Rock density = 2800 kg/m^3;
Heat capacity = 1.1 kJ/kg/K;
Heat conduct. = 2 W/m/K.



Init. cond:
PRES=5MPa, SWAT=0.1

Inject water which temperature is 25°C at surface conditions. The injection rate is 500 m^3/day at surface conditions.

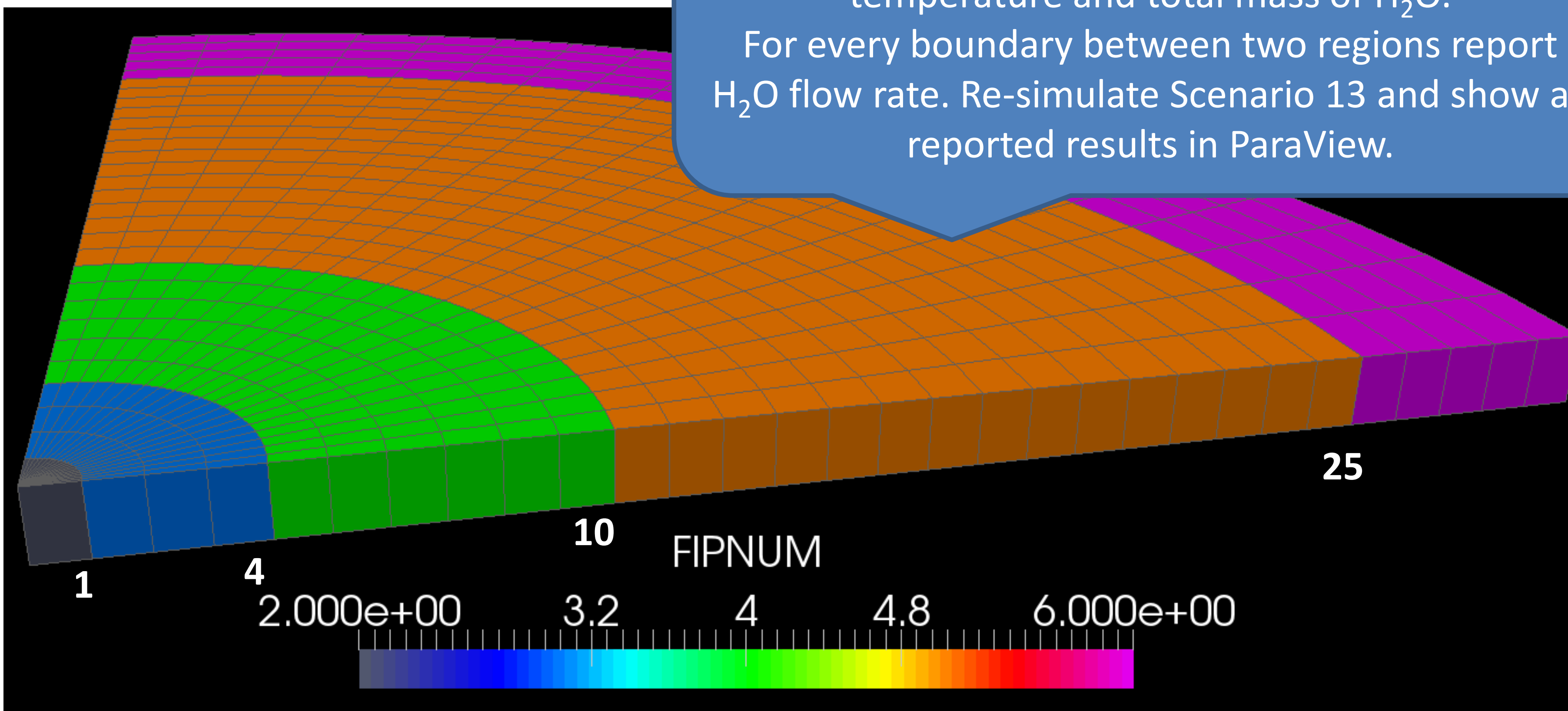
Relative permeabilities:
See the RUN-file

RUN-file (scenario 13)

1. Open RUN-file in text editor
2. Run the simulation
3. Open results in ParaView

Using FIPNUM regions

Create the 5 FIPNUM regions shown in the figure. For every region report average pressure, average temperature and total mass of H_2O. For every boundary between two regions report H_2O flow rate. Re-simulate Scenario 13 and show all reported results in ParaView.



RUN-file (scenario 13; exercise 1)

1. Open RUN-file in text editor
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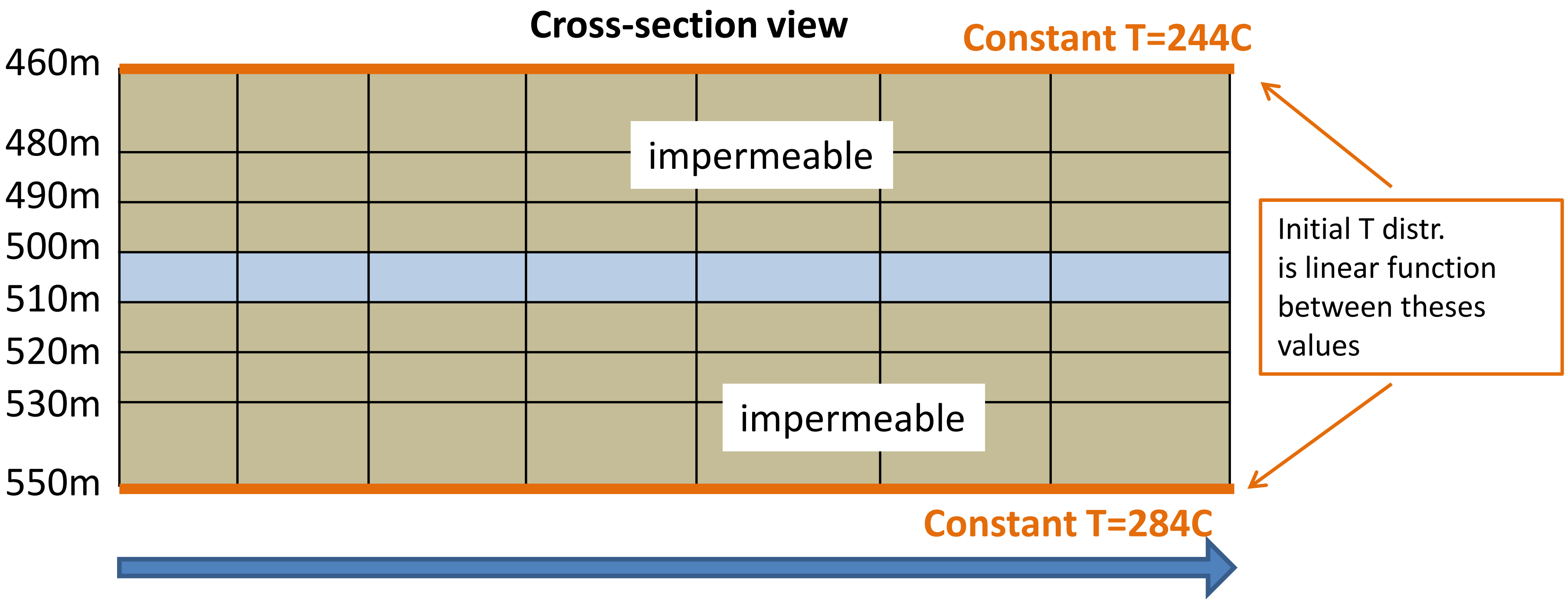
Exercise

Re-simulate scenario 13 using provided heterogeneous distribution of permeability and taking into account heat exchange with impermeable rocks



The grid block sizes are increasing along axis r with increment 1.1.

Radial grids

The domain boundaries are defined by the keyword **RTZBOUND**

RTZBOUND syntax

```
-- within MAKE/ENDMAKE brackets.

RTZBOUND
   rmin rmax  tmin tmax  zmin zmax   rincr tincr zincr /

================================================================================

     rmin/rmax - the domain boundaries along axis r (rmin<rmax)
     tmin/tmax - the domain boundaries along axis theta (tmin<tmax) [rad]
     zmin/zmax - the domain boundaries along axis z (zmin<zmax)
     rincr     - the increment of the grid block sizes along axis R. With
                 increasing i-index every next grid block is xincr times larger
                 then the previous block;
     tincr     - the increment of the grid block sizes along axis Theta. With
                 increasing j-index every next grid block is tincr times larger
                 then the previous block;
     zincr     - the increment of the grid block sizes along axis Z. With
                 increasing k-index every next grid block is zincr times larger
                 then the previous block;
```

RUN-file (scenario 13; exercise 2)

1. Open RUN-file in text editor
2. Run the simulation
3. Open results in ParaView

Recommendations for tuning simulation performance

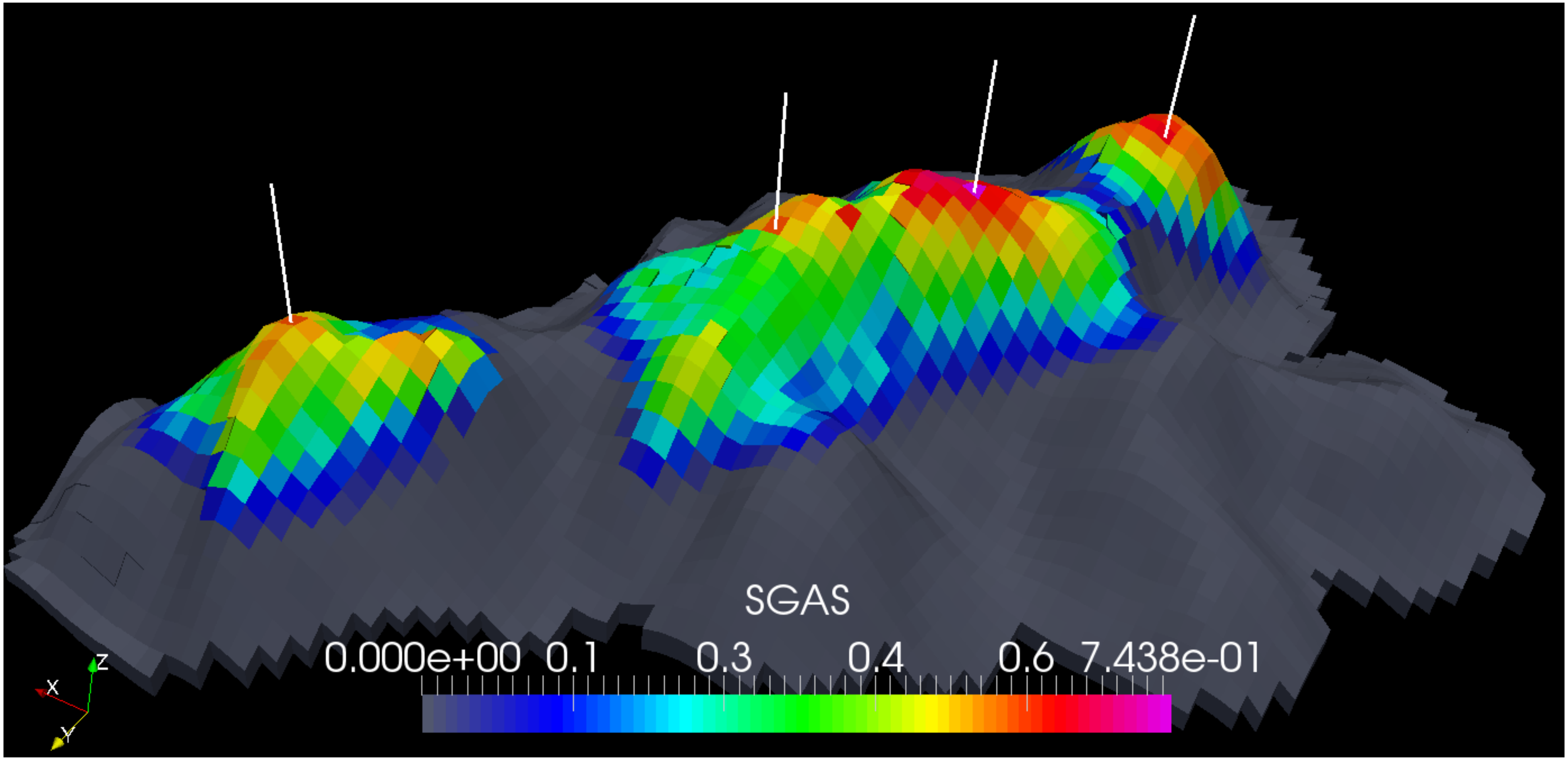
Recommendations

- Use the FAST option. It allows a faster simulation, although it can be less stable (with recalculations);
- Use the WEEKTOL option. It makes the tolerances weaker and the run faster. In many cases, you will not see any difference in results;
- Use the VARS keyword to increase maximum pressure change or maximum pressure in a grid block;
- In injection wells before injection starts, specify the properties of injected fluid in the pipe segment;
- Immediately after injection/production starts or stops, reduce the next time step by the TUNING keyword;
- Reduce the maximum time step by the TUNING keyword;
- Increase ILUTFILL and decrease ILUTDROP (ILUTFILL=4 and ILUTDROP=1e-4 should be ok). This keywords alter parameters of the linear solver;
- Use NOSIM option to check input data syntax without running simulation;
- Use ECHO to get more output in the LOG-file;
- Do not try to archive a faster by increasing the number of cores if there is less than 10000 cells per logical unit;
- Do not try to do impossible. Think about what the simulator is doing.

Scenario 14

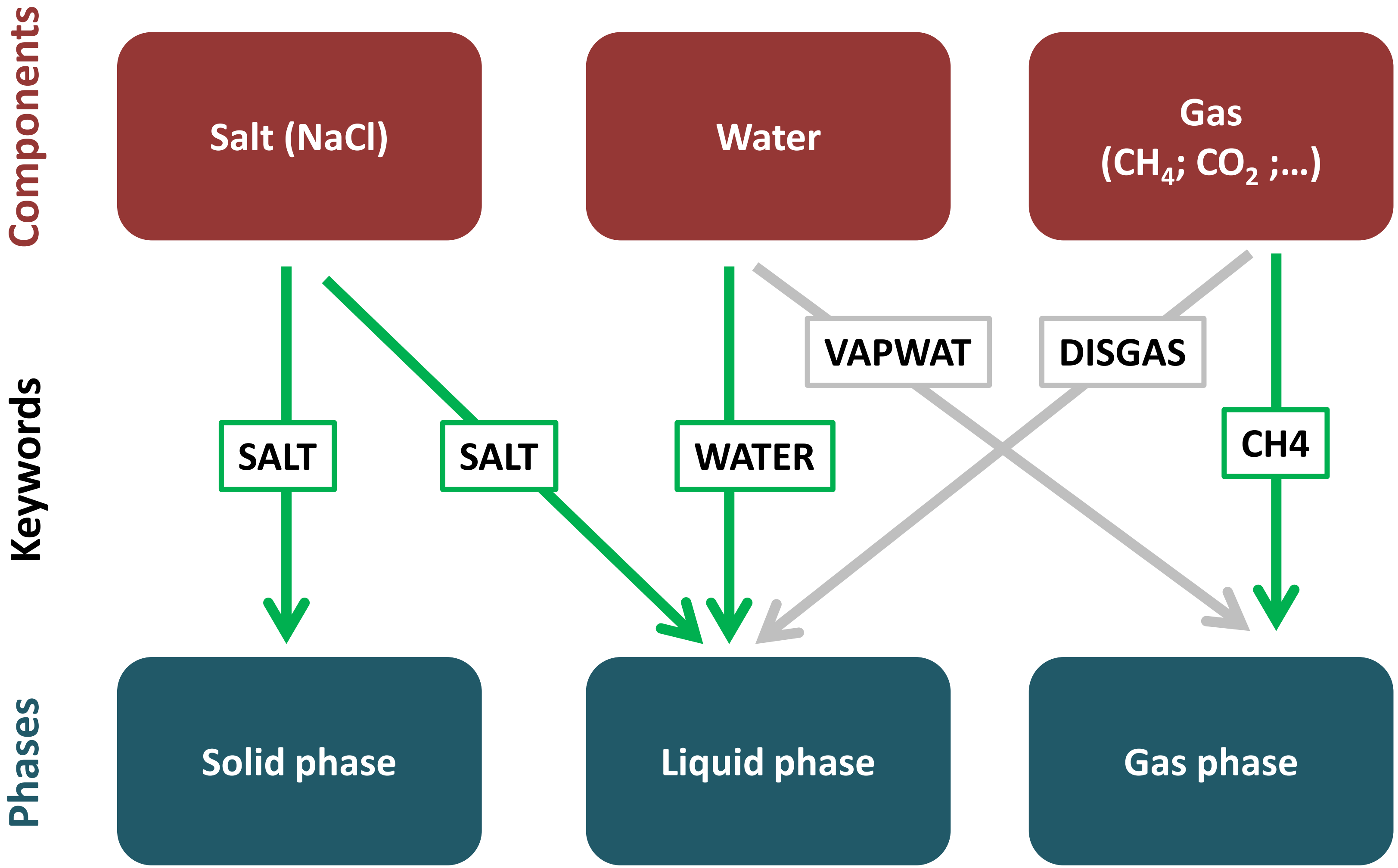
Scenario 14 (a gas storage)

There is a cyclic injection/production of methane into/from a saline aquifer. There is injection period over 100 days during every year (spring-summer), there is gas production and over different 100 days (autumn-winter).



EOS module GASSTORE

T≠const



RUN-file (scenario 14)

1. Open RUN-file in text editor
2. Run the simulation
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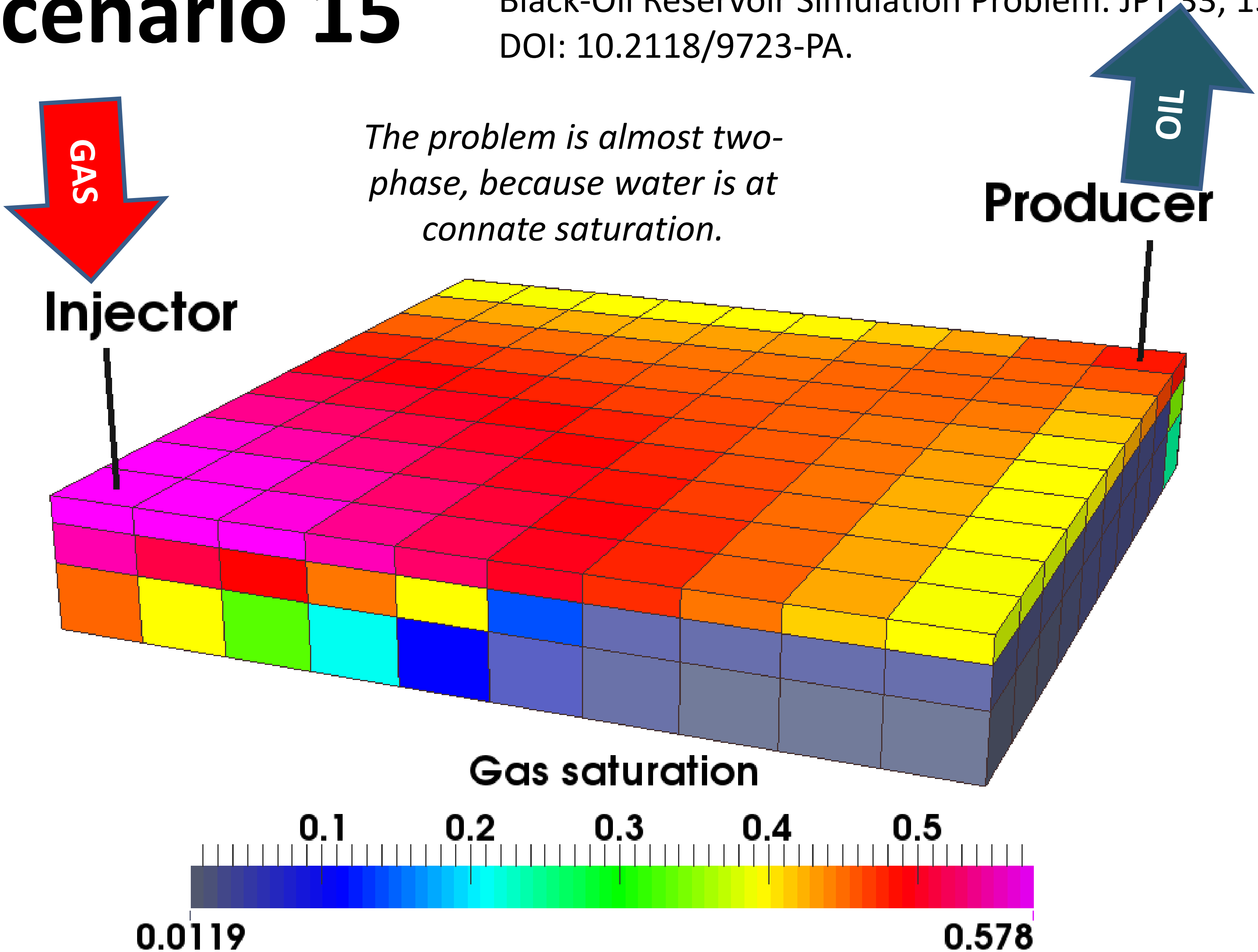
Scenario 15
(1st SPE comparative study; a three-phase black-oil model)

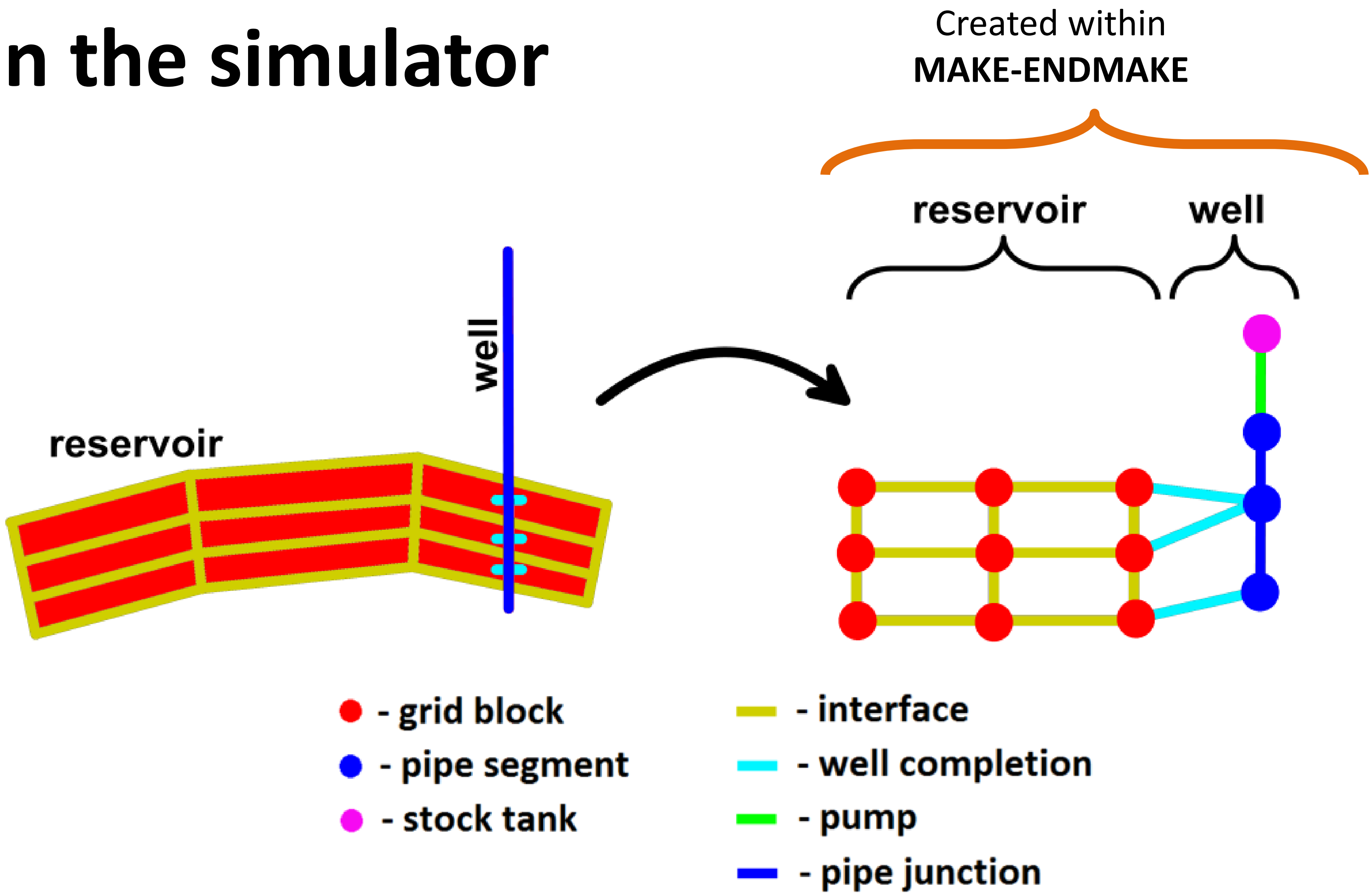
Scenario 15

The problem is from SPE-9723 paper (case 2): Odeh, A. 1981 Comparison of Solutions to a Three-Dimensional Black-Oil Reservoir Simulation Problem. JPT 33, 13-25. DOI: 10.2118/9723-PA.

The problem is almost two-phase, because water is at connate saturation.

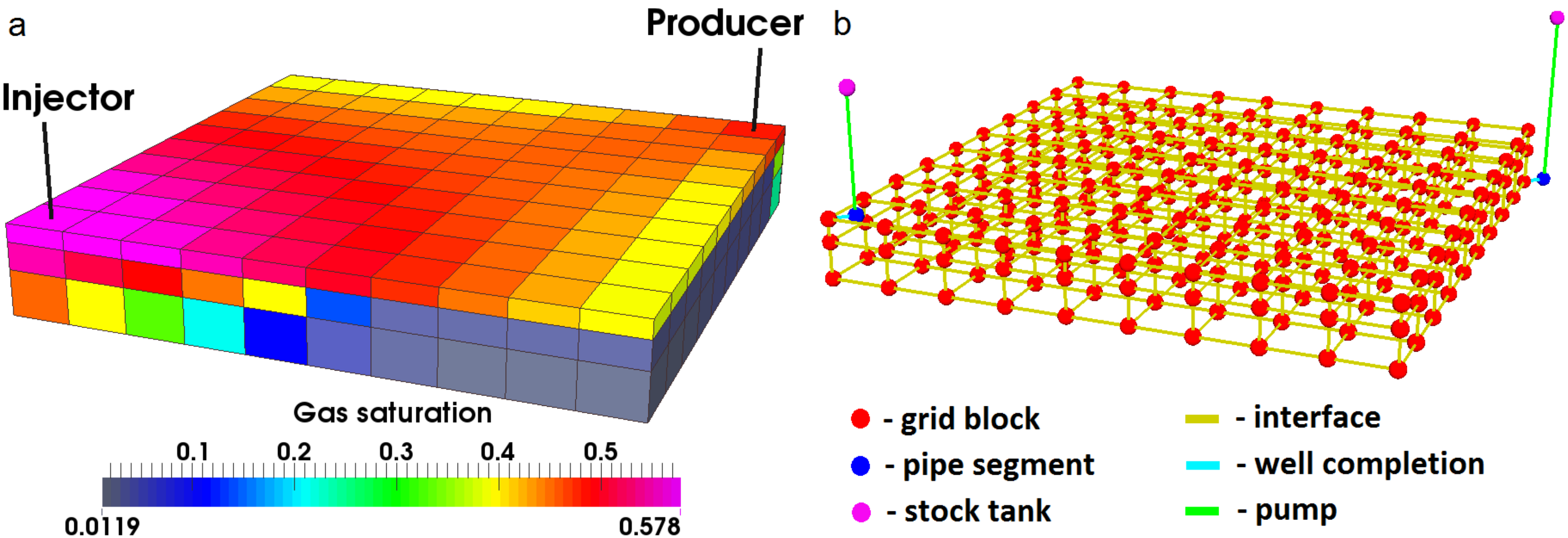


Reservoir models in the simulator



Scenario 15

The INJECTOR is completed in the top layer, whereas the PRODUCER is completed in the bottom layer.



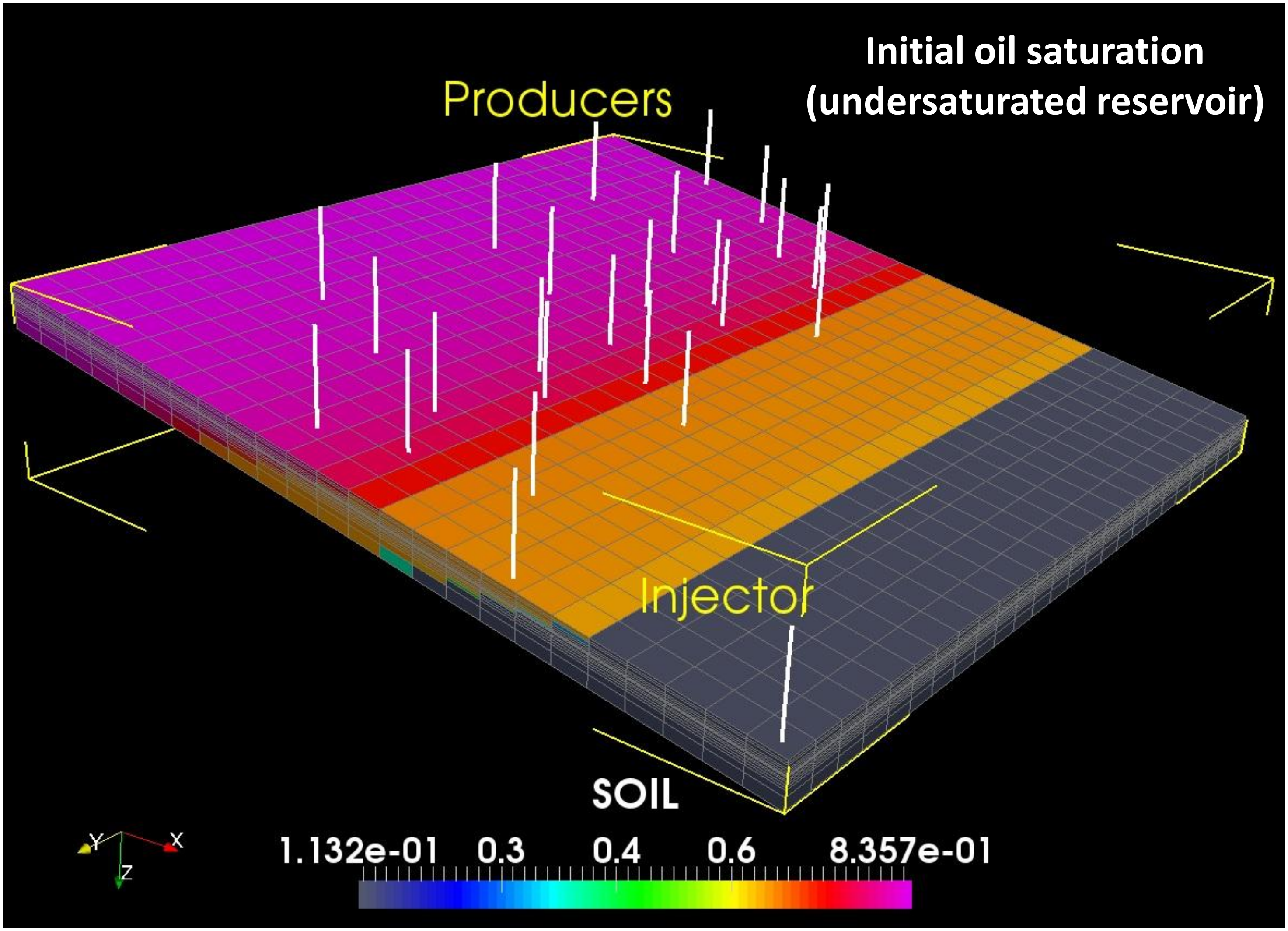
RUN-file (scenario 15)

1. Open RUN-file in text editor
2. Run the simulation
3. Open results in ParaView

Scenario 16
(9^{th} SPE comparative study;
a three-phase black-oil model)

Scenario 16

The problem is from SPE-29110 paper: Killough, J.E. 1995 Ninth SPE Comparative Solution Project: A Reexamination of Black-Oil Simulation. 13th SPE Symposium on Reservoir Simulation, San Antonio, Feb 12-15, 1995. DOI: 10.2118/29110-MS.



RUN-file (scenario 16)

1. Open RUN-file in text editor
2. Run the simulation
3. Open results in ParaView

Thank you!