

OPM as a reservoir simulator

By Ove Sævareid



Outline



- > Polymer injection
- > Endpoint scaling
- > Black oil model
- > CO2 injection in a black oil setting

Polymer: 1D CASES



```
-- BASE:
PLYROCK
0.0 2.67 1000.0 2 0.0035 /
PLYADS
0.0 0.0
2.0 0.0
8.0 0.0 /
TLMIXPAR
1.0 /

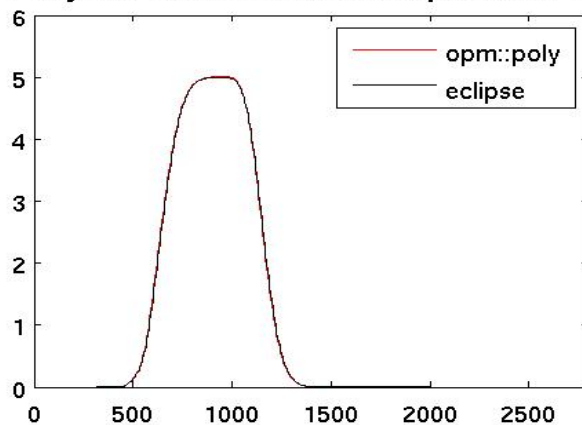
-- ADSO:
PLYADS
0.0 0.0
2.0 0.0015
8.0 0.0025 /

-- DEAD:
PLYROCK
0.15 2.67 1000.0 2 0.0035 /

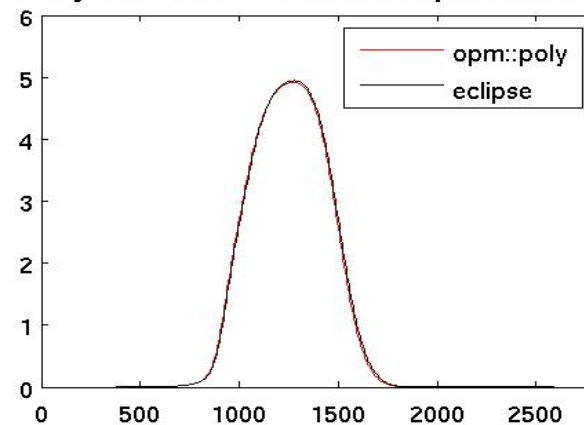
-- ADSO_DEAD:
PLYADS
0.0 0.0
2.0 0.0015
8.0 0.0025 /
PLYROCK
0.15 2.67 1000.0 2 0.0035 /

-- ADSO_DEAD_TL50:
PLYADS
0.0 0.0
2.0 0.0015
8.0 0.0025 /
PLYROCK
0.15 2.67 1000.0 2 0.0035 /
TLMIXPAR
0.5 /
```

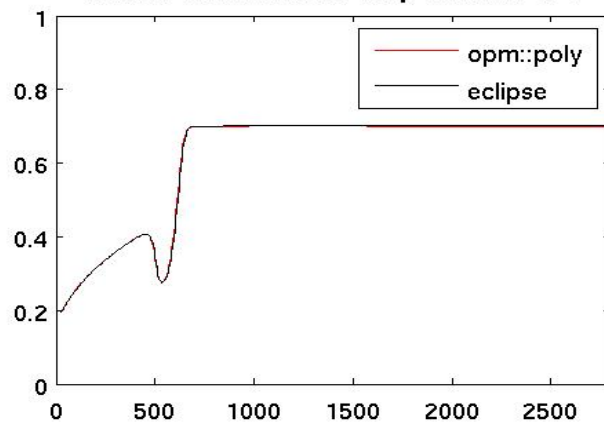
Polymer concentration at position 1/3



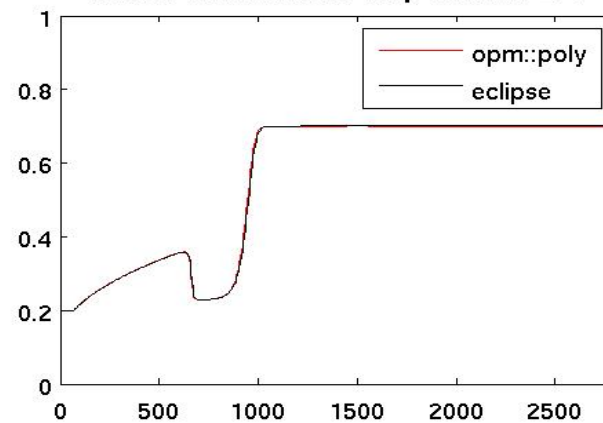
Polymer concentration at position 2/3



Water saturation at position 1/3



Water saturation at position 2/3



Polymer: 1D CASES



-- BASE:

PLYROCK

0.0 2.67 1000.0 2 0.0035 /

PLYADS

0.0 0.0

2.0 0.0

8.0 0.0 /

TLMIXPAR

1.0 /

-- ADSO:

PLYADS

0.0 0.0

2.0 0.0015

8.0 0.0025 /

-- DEAD:

PLYROCK

0.15 2.67 1000.0 2 0.0035 /

-- ADSO_DEAD:

PLYADS

0.0 0.0

2.0 0.0015

8.0 0.0025 /

PLYROCK

0.15 2.67 1000.0 2 0.0035 /

-- ADSO_DEAD_TL50:

PLYADS

0.0 0.0

2.0 0.0015

8.0 0.0025 /

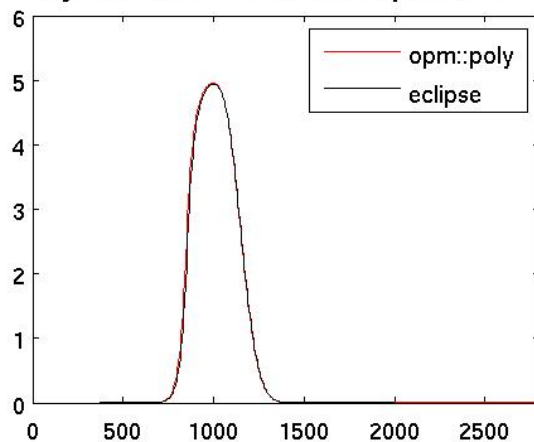
PLYROCK

0.15 2.67 1000.0 2 0.0035 /

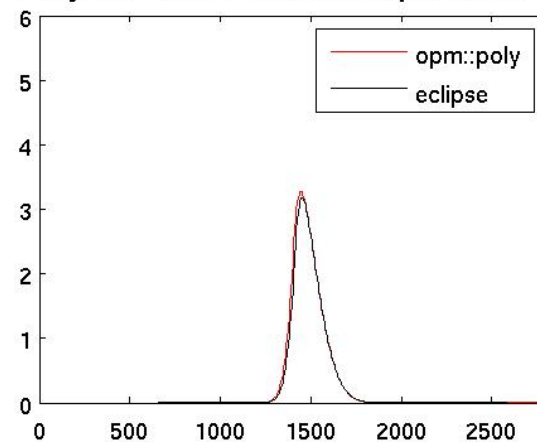
TLMIXPAR

0.5 /

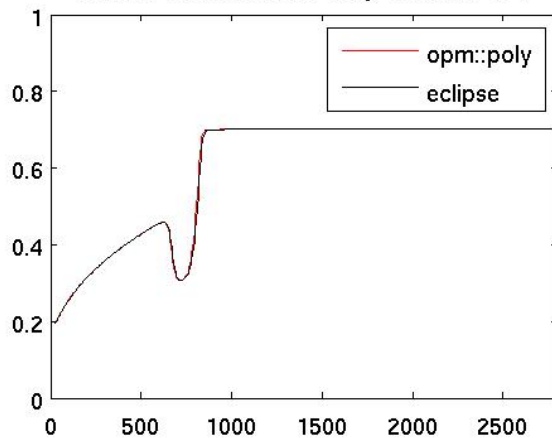
Polymer concentration at position 1/3



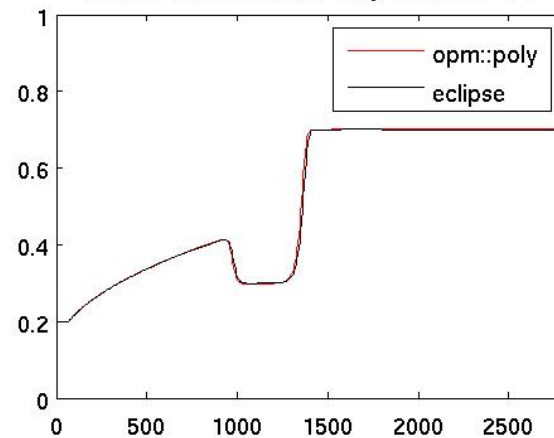
Polymer concentration at position 2/3



Water saturation at position 1/3



Water saturation at position 2/3



Polymer: 1D CASES



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0.0 2.67 1000.0 2 0.0035 /

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2.0 0.0015

8.0 0.0025 /

PLYROCK

0.15 2.67 1000.0 2 0.0035 /

-- ADSO_DEAD_TL50:

PLYADS

0.0 0.0

2.0 0.0015

8.0 0.0025 /

PLYROCK

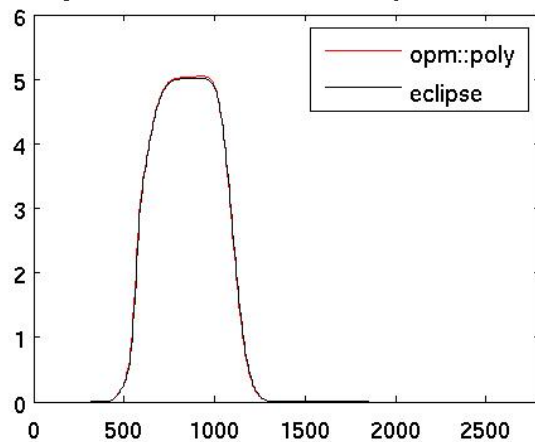
0.15 2.67 1000.0 2 0.0035 /

TLMIXPAR

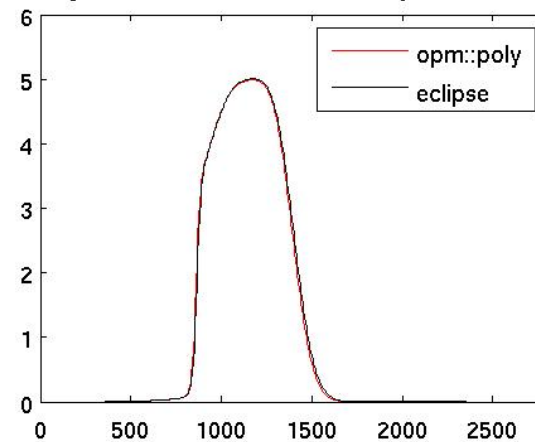
0.5 /

DEAD [DEAD\sat_con.avi](#)

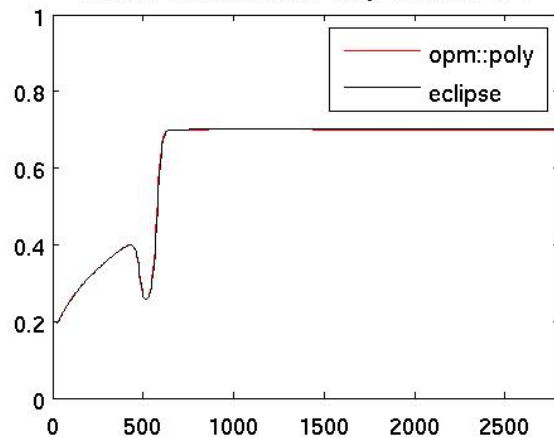
Polymer concentration at position 1/3



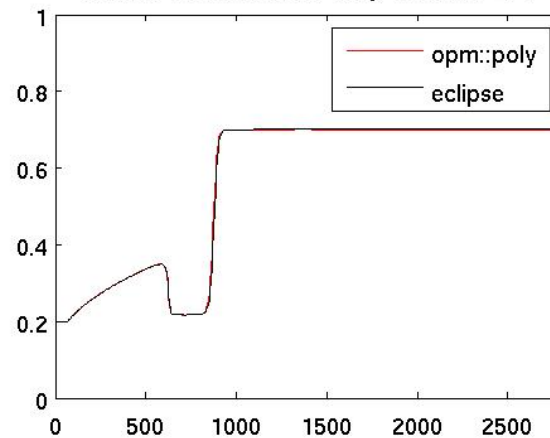
Polymer concentration at position 2/3



Water saturation at position 1/3



Water saturation at position 2/3



Polymer: 1D CASES



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PLYROCK

0.0 2.67 1000.0 2 0.0035 /

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PLYROCK

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PLYADS

0.0 0.0

2.0 0.0015

8.0 0.0025 /

PLYROCK

0.15 2.67 1000.0 2 0.0035 /

-- ADSO_DEAD_TL50:

PLYADS

0.0 0.0

2.0 0.0015

8.0 0.0025 /

PLYROCK

0.15 2.67 1000.0 2 0.0035 /

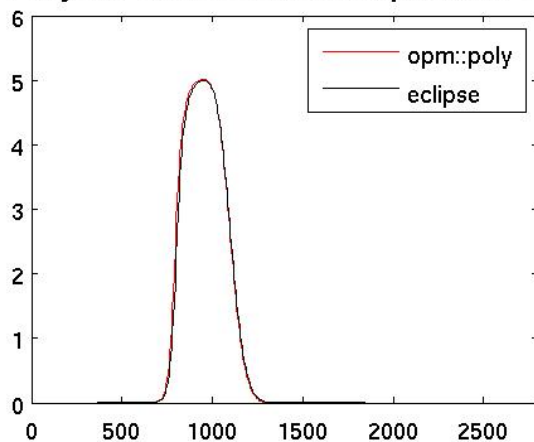
TLMIXPAR

0.5 /

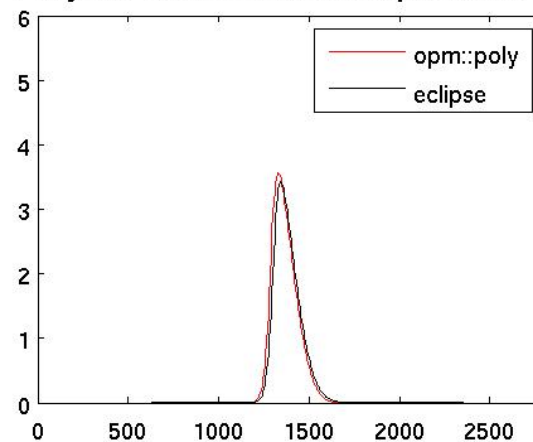
ADSO-DEAD

[ADSO_DEAD\sat_con.avi](#)

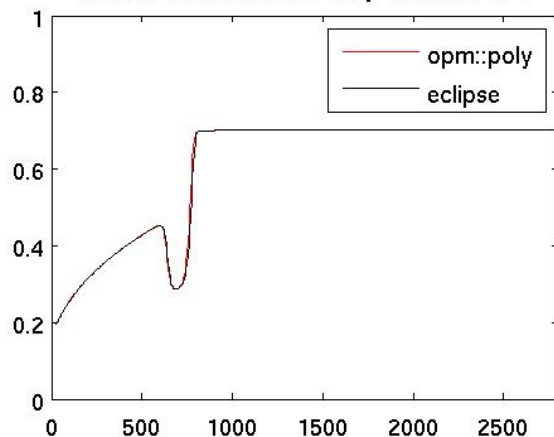
Polymer concentration at position 1/3



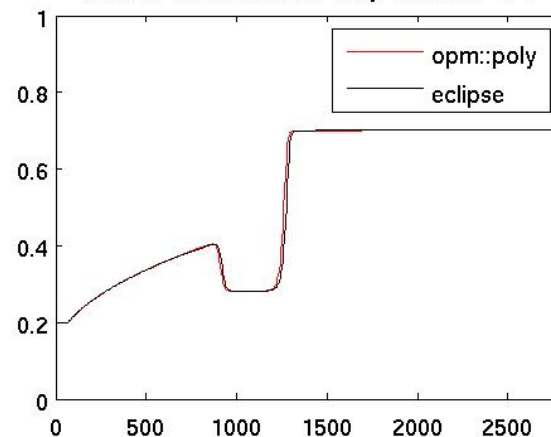
Polymer concentration at position 2/3



Water saturation at position 1/3



Water saturation at position 2/3



Polymer: 1D CASES



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PLYROCK

0.0 2.67 1000.0 2 0.0035 /

PLYADS

0.0 0.0

2.0 0.0

8.0 0.0 /

TLMIXPAR

1.0 /

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PLYADS

0.0 0.0

2.0 0.0015

8.0 0.0025 /

-- DEAD:

PLYROCK

0.15 2.67 1000.0 2 0.0035 /

-- ADSO_DEAD:

PLYADS

0.0 0.0

2.0 0.0015

8.0 0.0025 /

PLYROCK

0.15 2.67 1000.0 2 0.0035 /

-- ADSO_DEAD_TL50:

PLYADS

0.0 0.0

2.0 0.0015

8.0 0.0025 /

PLYROCK

0.15 2.67 1000.0 2 0.0035 /

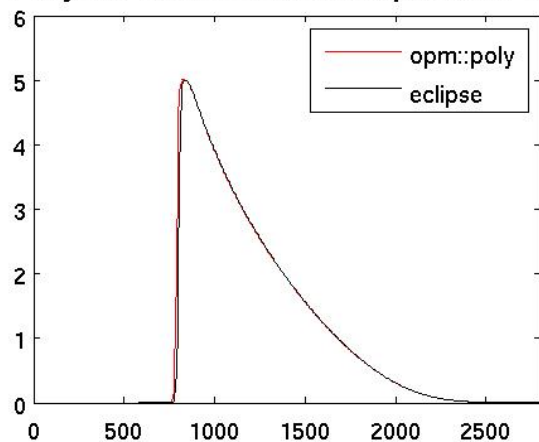
TLMIXPAR

0.5 /

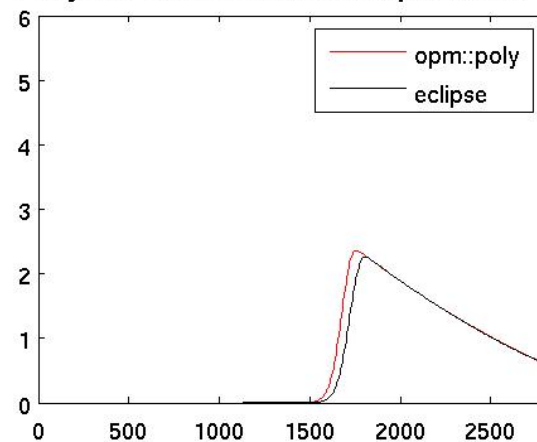
ADSO-DEAD-TL50 [ADSO_DEAD_TL50\sat_con.avi](#)



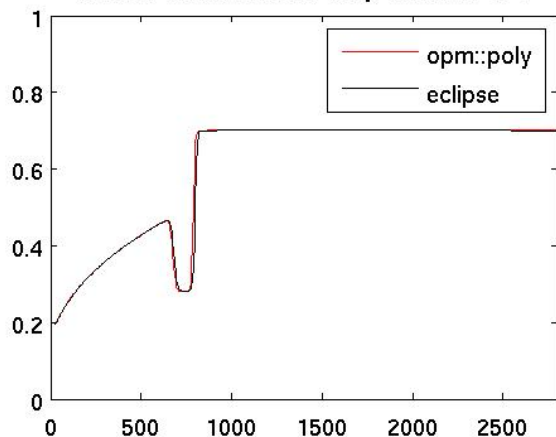
Polymer concentration at position 1/3



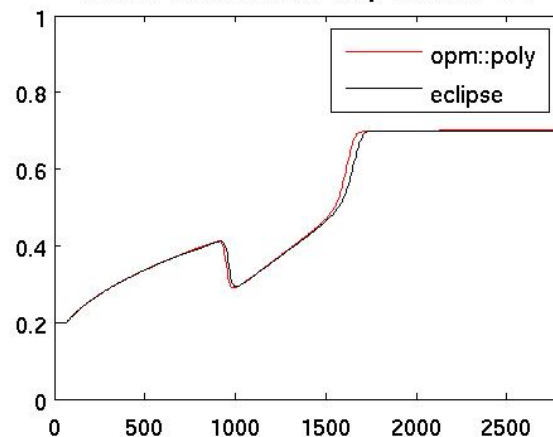
Polymer concentration at position 2/3



Water saturation at position 1/3



Water saturation at position 2/3



Endpoint scaling

- › ENDSCALE – (non-directional, reversible)
- › SCALECRS - (two or three point scaling)
- › SWL, SWCR, SWU, SOWCR – (water/oil-system, no gas)
- › KRW, KRWR, KRO, KRORW – (relperm scaling)
- › ENPTVD, ENKRVD – (versus depth tables)

Endpoint scaling



-- Case 1 (Modify critical water saturation)

ENDSCALE

'NODIR' 'REVERS' /

SCALECRS

NO/

SWCR

30*0.2 30*0.5 30*0.3 30*0.4 /

-- Case 2 (Also modify critical oil saturation)

...

SOWCR

30*0.4 30*0.3 30*0.5 30*0.3 /

-- Case 3 (Various modifications ...)

...

SCALECRS

YES /

SWL

30*0.2 30*0.4 30*0.2 30*0.3 /

SWU

120*0.8/

KRO

120*0.6 /

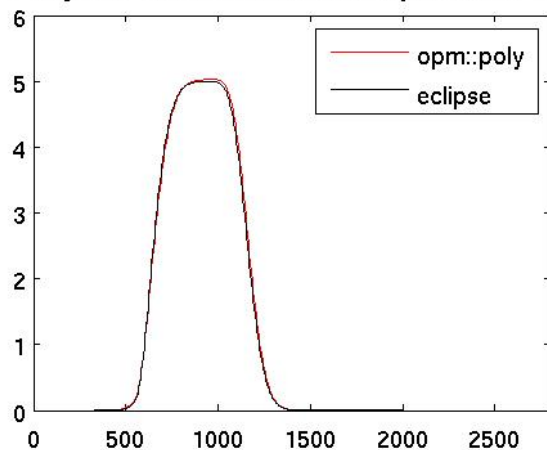
KRORW

120*0.4 /

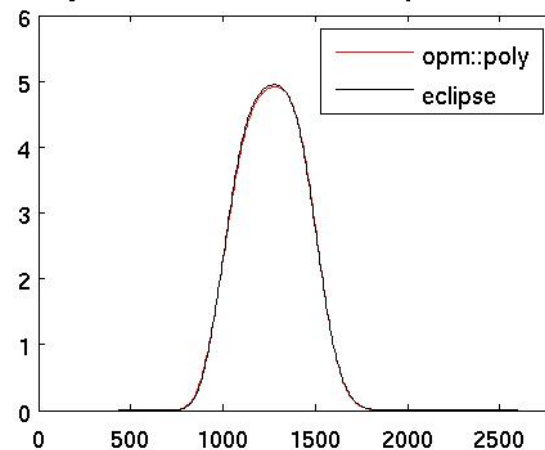
Endpoint scaling – case 1 [EndPt_1\sat_con.avi](#)



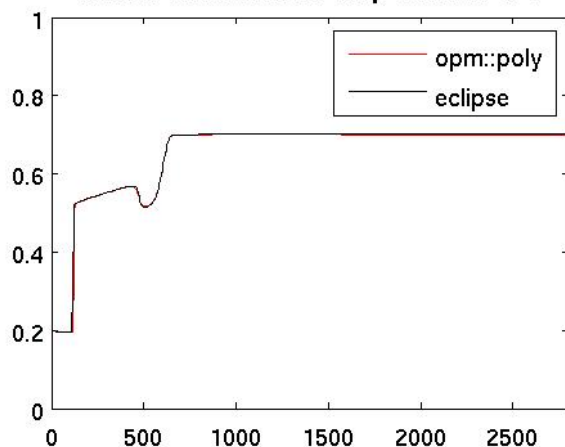
Polymer concentration at position 1/3



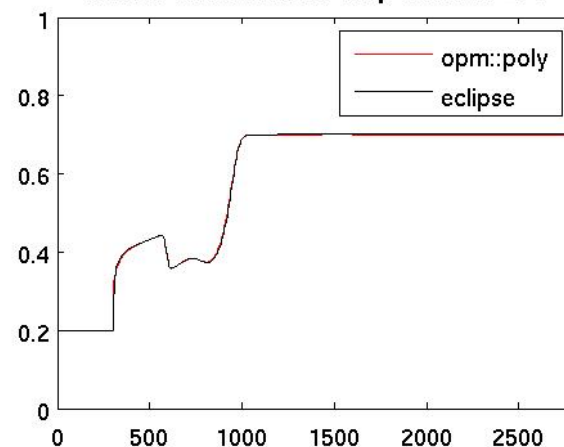
Polymer concentration at position 2/3



Water saturation at position 1/3



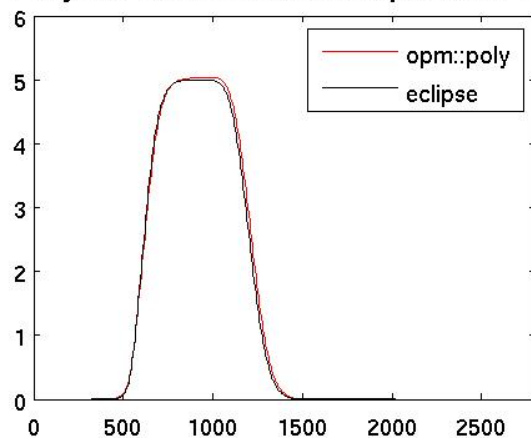
Water saturation at position 2/3



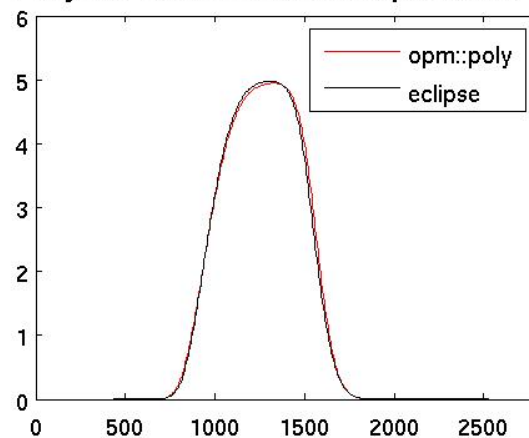
Endpoint scaling – case 2 [EndPt_2\sat_con.avi](#)



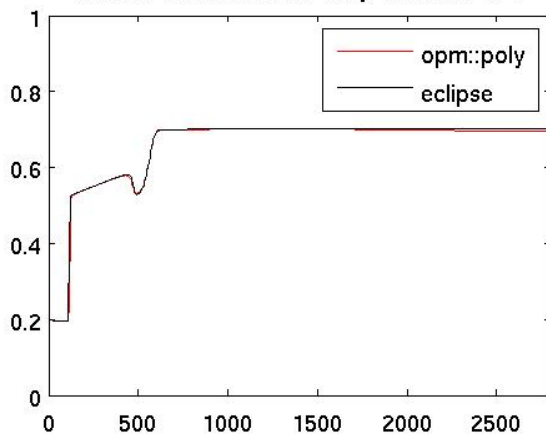
Polymer concentration at position 1/3



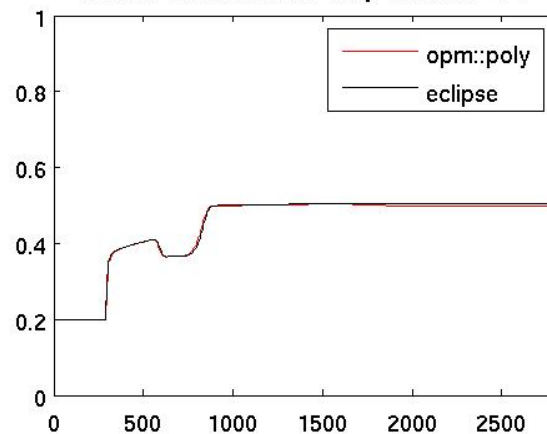
Polymer concentration at position 2/3



Water saturation at position 1/3



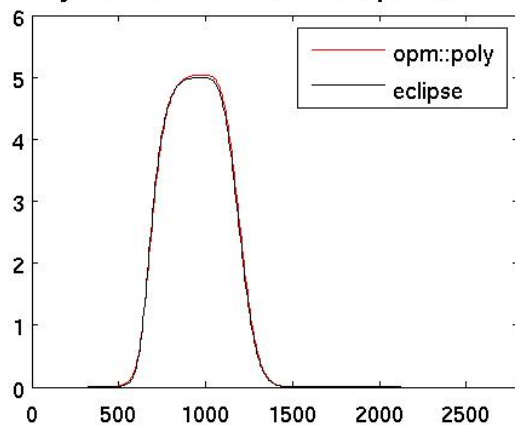
Water saturation at position 2/3



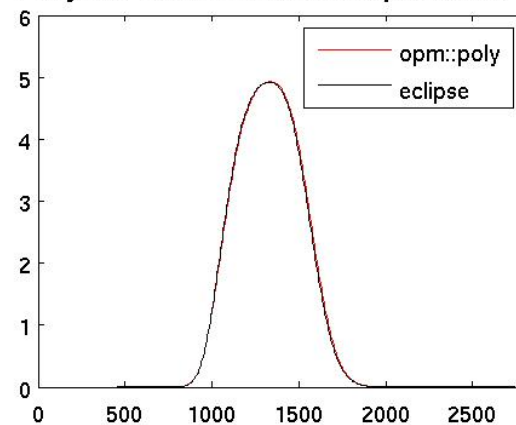
Endpoint scaling – case 3 [EndPt_3\sat_con.avi](#)



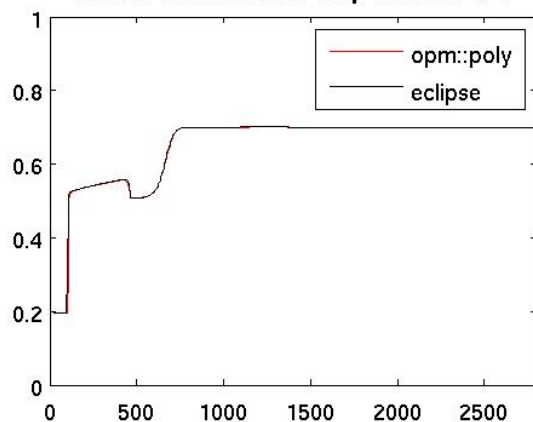
Polymer concentration at position 1/3



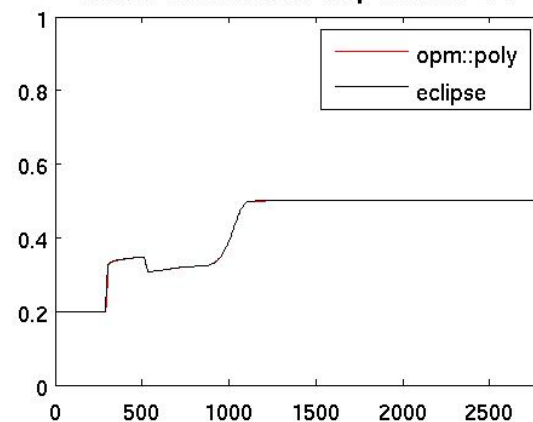
Polymer concentration at position 2/3



Water saturation at position 1/3



Water saturation at position 2/3



SPE 9 comparative study...



-
- > Sequential black oil solver
 - > Robust
 - > Correct
 - > «Slow» (min vs. sec)

WaterGsat

0.16095

0.33356

0.51626

0.69896

0.88166

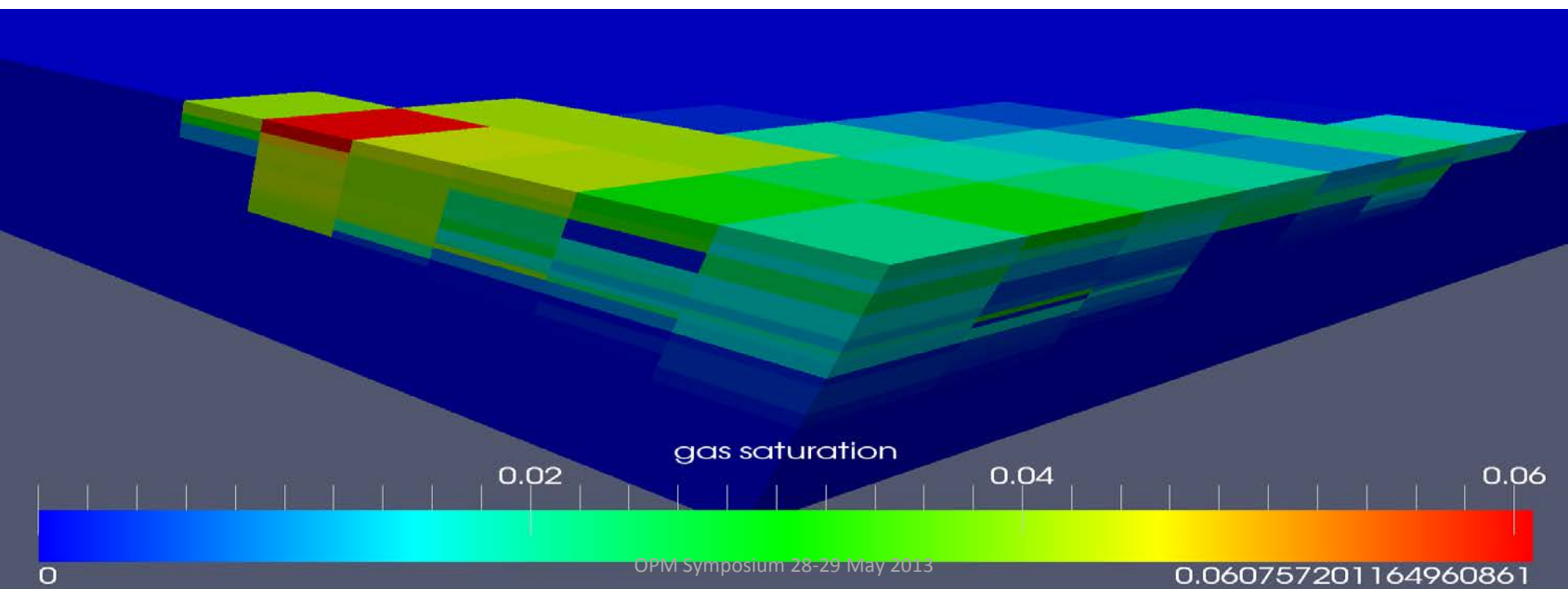
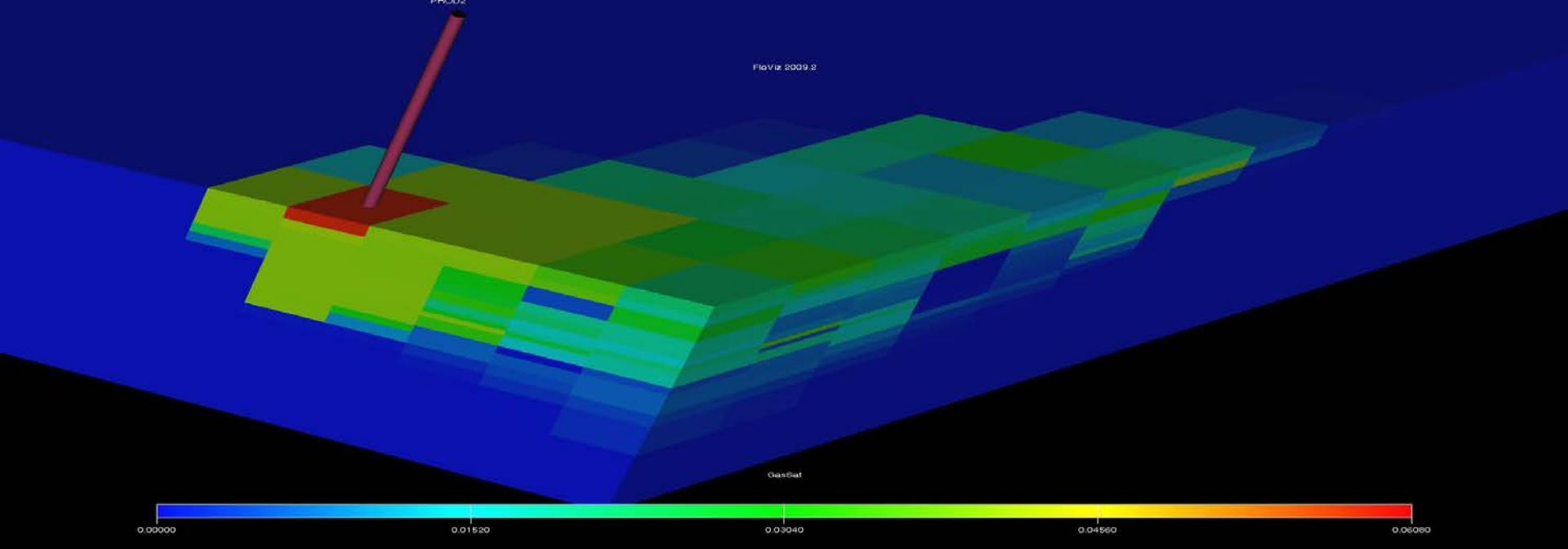
water saturation

0.2

0.4

0.6

0.8



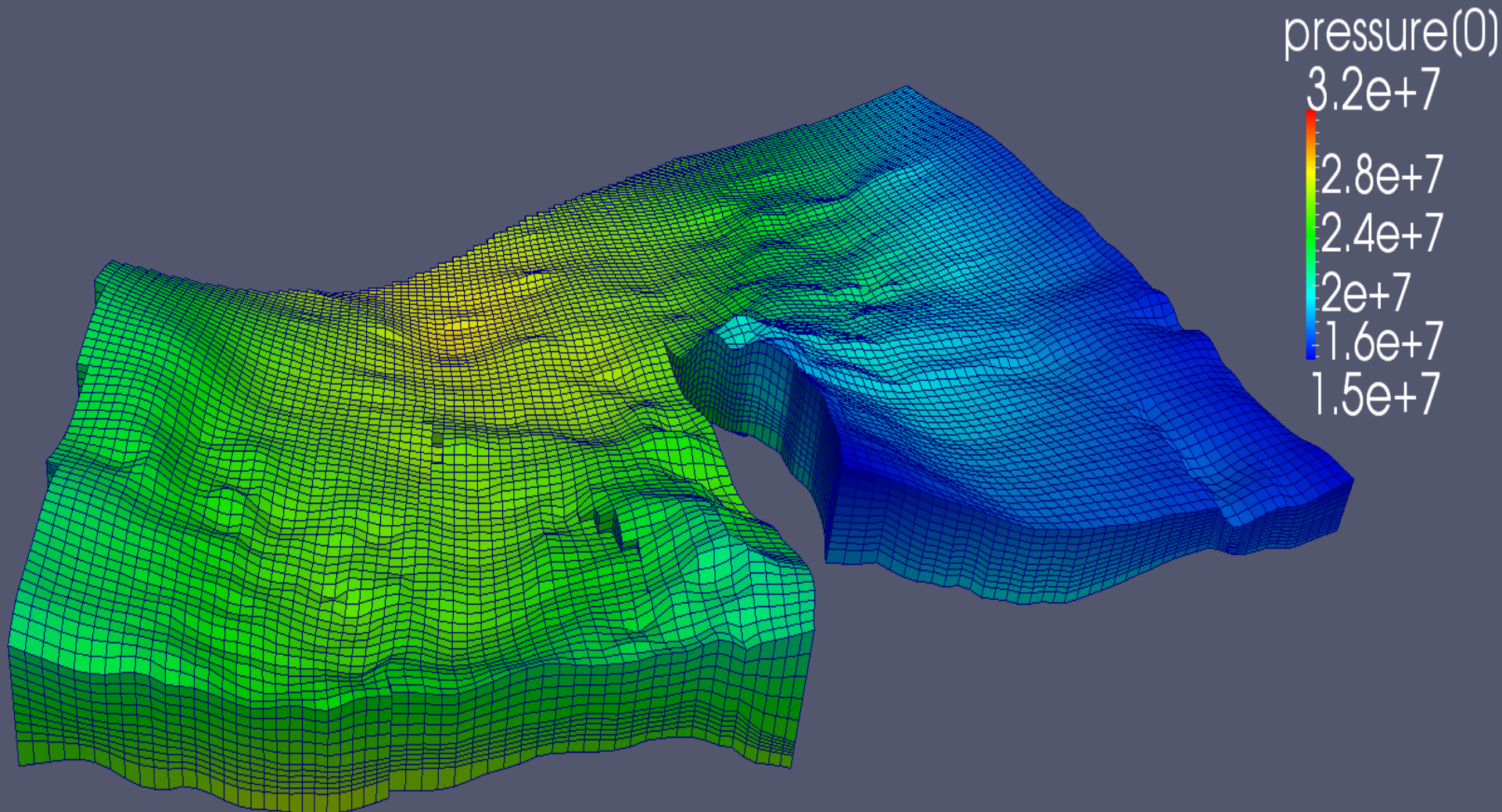
Building a «black-oil» interface for the `dumux::brine_co2 pvt` model



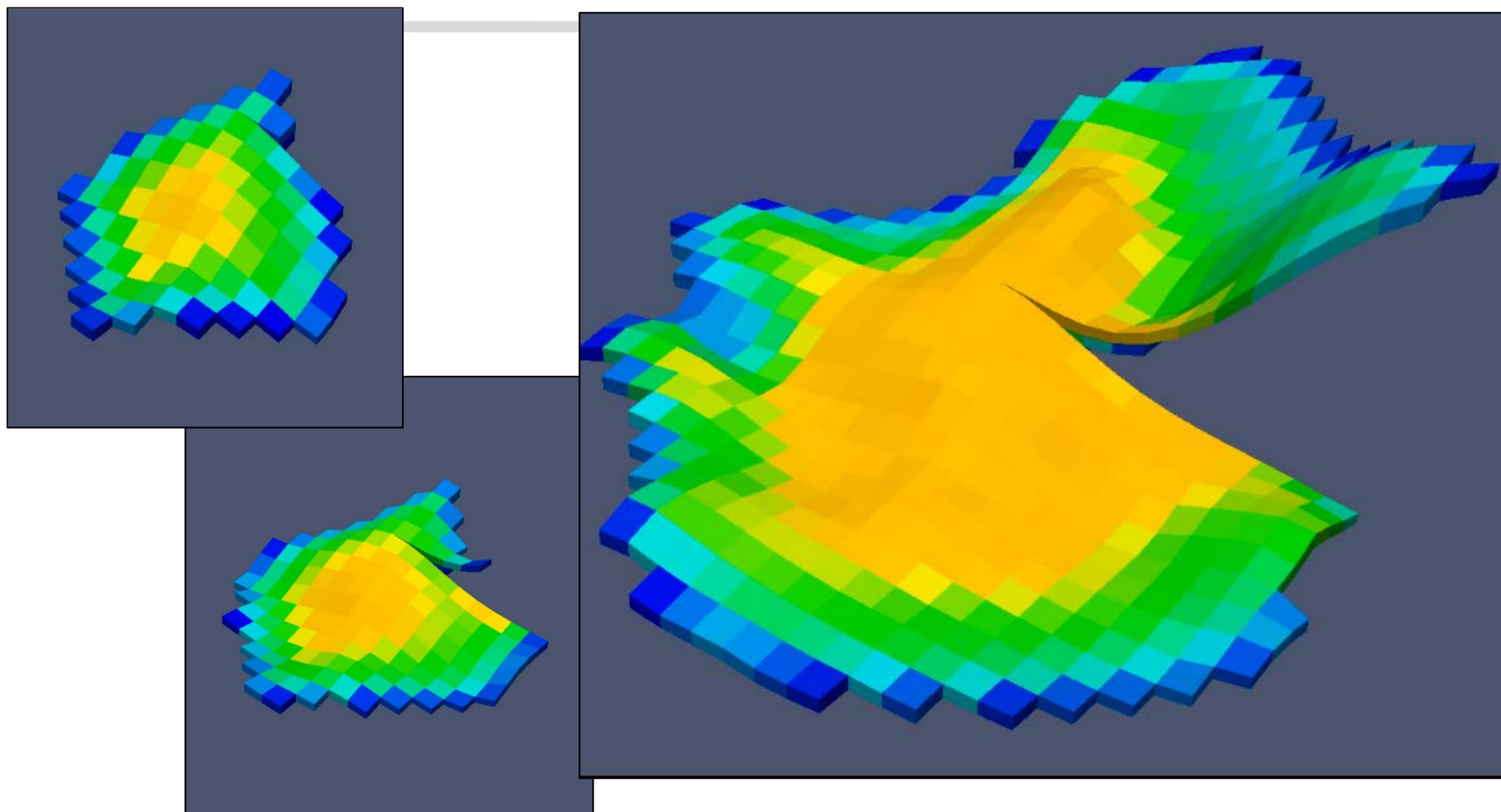
- › Direct approach where $B(\dots)$, $R_s(\dots)$ etc. are computed «on the fly» ...
 - Performance penalties ...

- › Pre-processor approach ...
 - Generate tables ...
 - ... use the standard `opm::blackoil`

CO₂-injection (Johansen)



CO₂-injection (Johansen)



CO₂-injection (Johansen)

