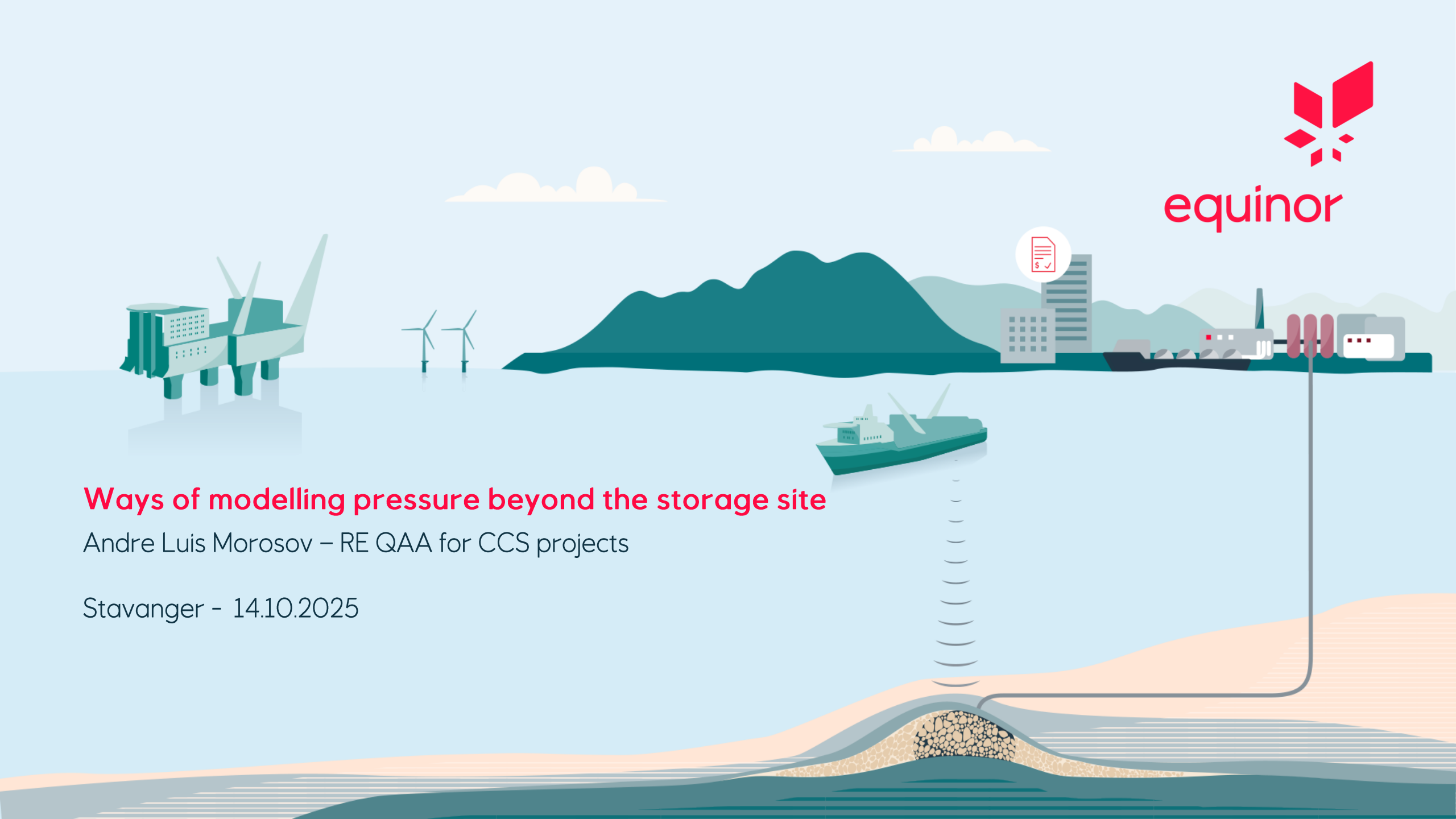


Ways of modelling pressure beyond the storage site

Andre Luis Morosov – RE QAA for CCS projects

Stavanger - 14.10.2025

PART1
Connected pore volume and pressure response in CO_2 storage.

Pore volume and pressure

$$\Delta V_{CO2}[m^3] = Pore\ Volume[m^3] * compressibility\ [\frac{1}{bar}] * \Delta Pressure[bar]$$

$$\Delta V_{co2} = PV * (c_w + c_r) * \Delta P$$

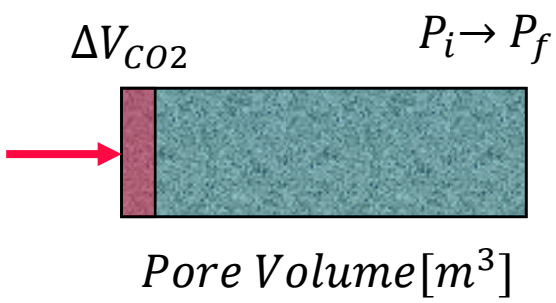
Order of magnitude:

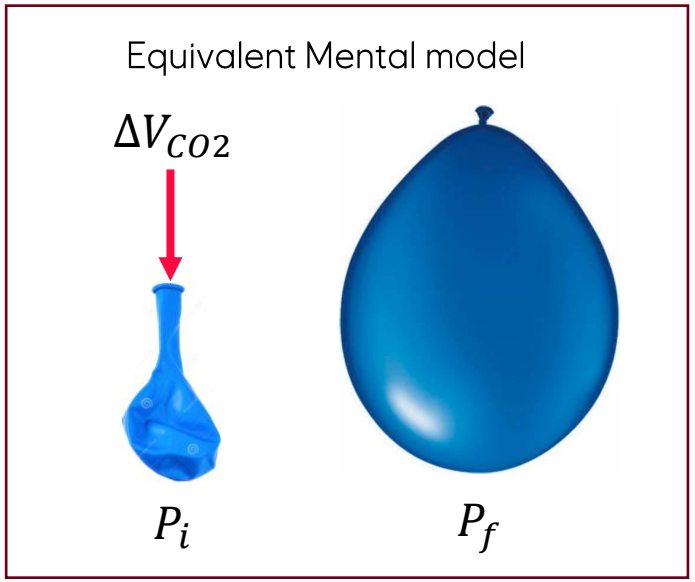
$c_w \cong 4 * 10^{-5}[1/bar]$

$c_r \cong 6 * 10^{-5}[1/bar]$

$c_t \cong 10^{-4}[1/bar]$

$c_t \cong 0.01[\%/bar]$



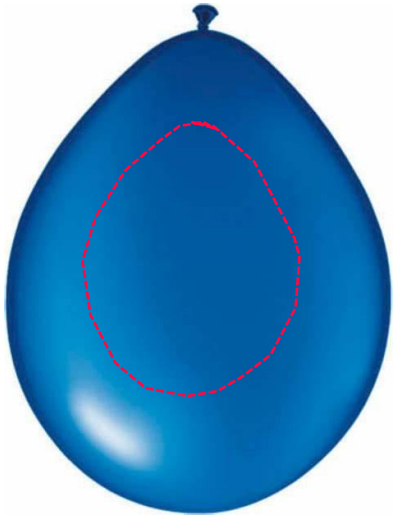


$$\Delta Mass_{co2}[Mt] = \Delta V_{CO2}[m^3] * density_{CO2}(P_f, T)\left[\frac{kg}{m^3}\right] * 10^{-9}$$

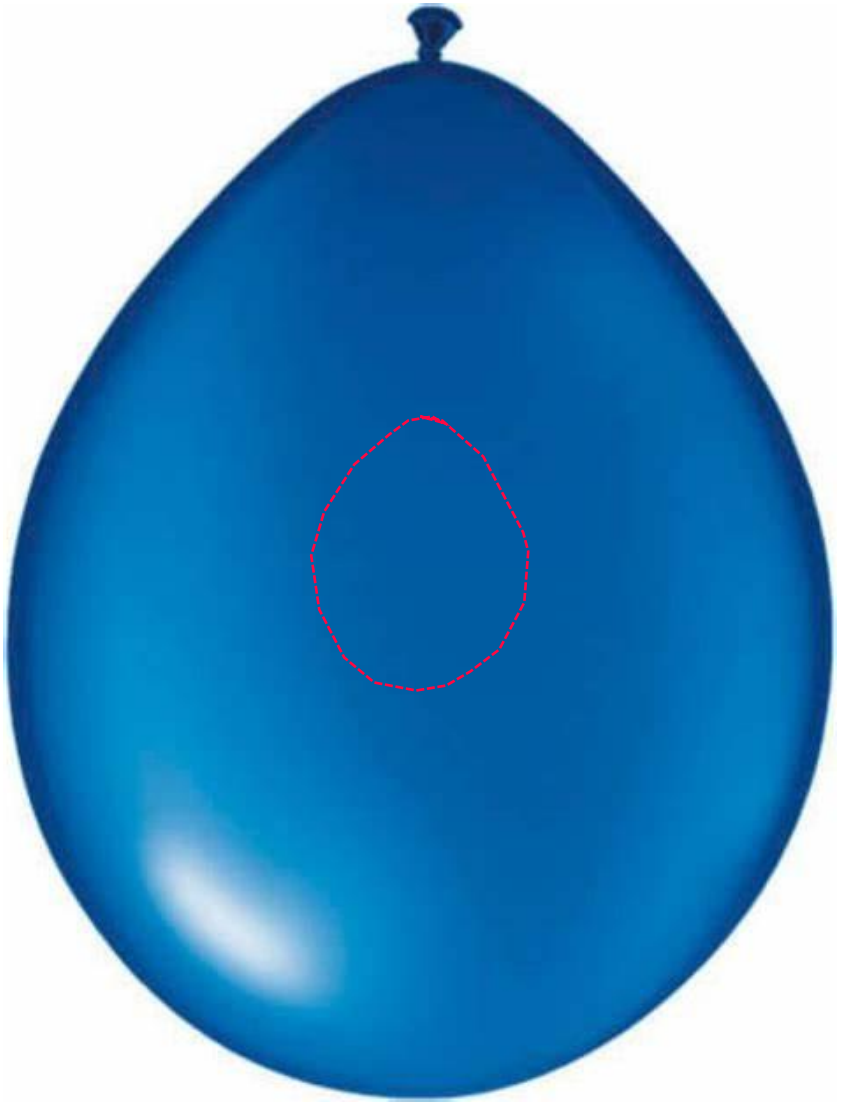
Total connected pore volume

$$\Delta Mass_{co2} = PV * c_t * \Delta P * density_{CO2}$$

Just store PV
(no aquifer)



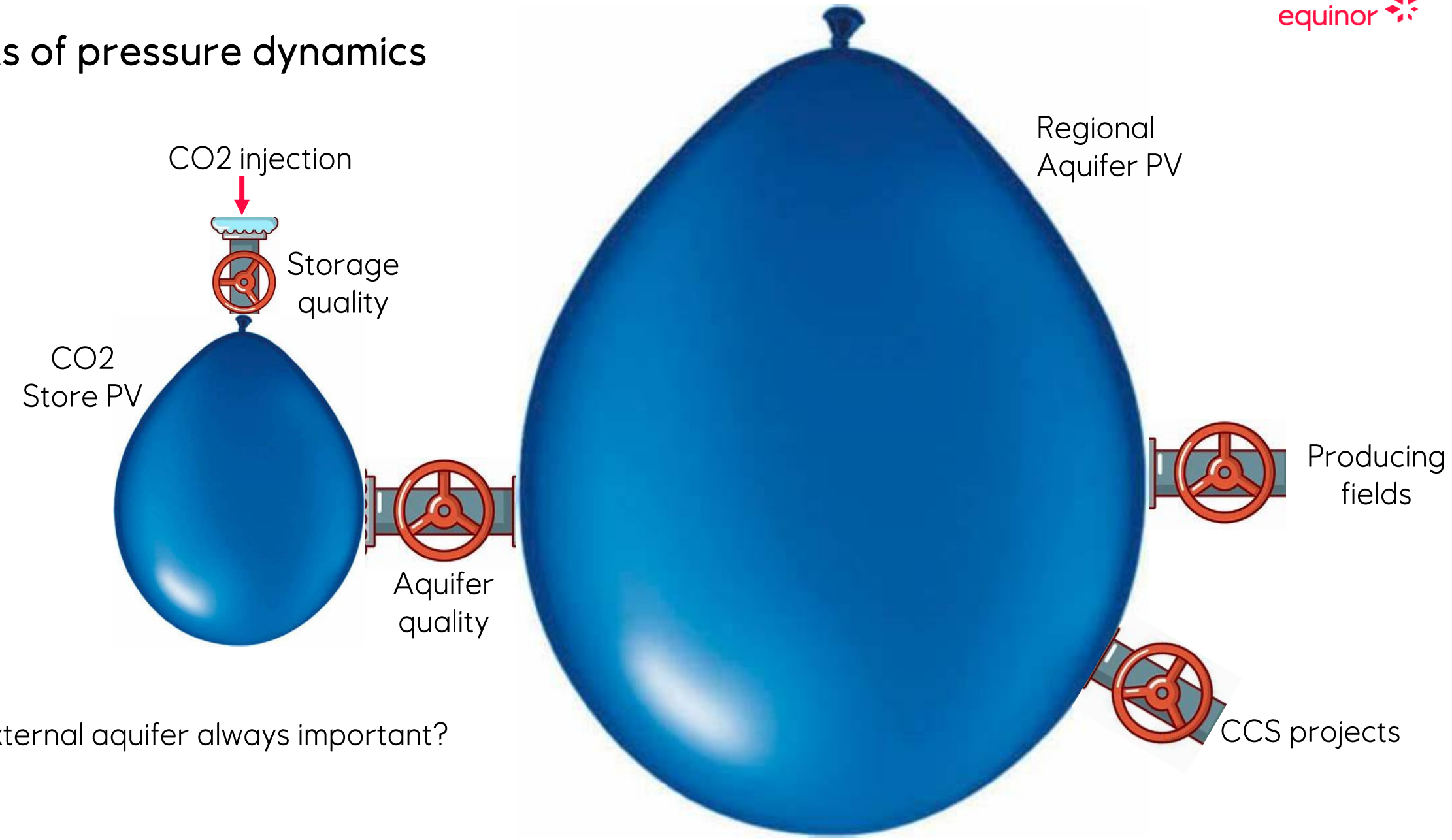
Store with aquifer PV
(small)



Store with aquifer PV
(large)

Larger connected PV is needed* to store more CO2 (considering the same pressure buildup)

Effects of pressure dynamics



Is the external aquifer always important?

Injection potential vs Maximum sustainable constant rate

What controls the first earlier part of the profile?

- Well connection
- Number of wells
- Storage quality
- Storage heterogeneities

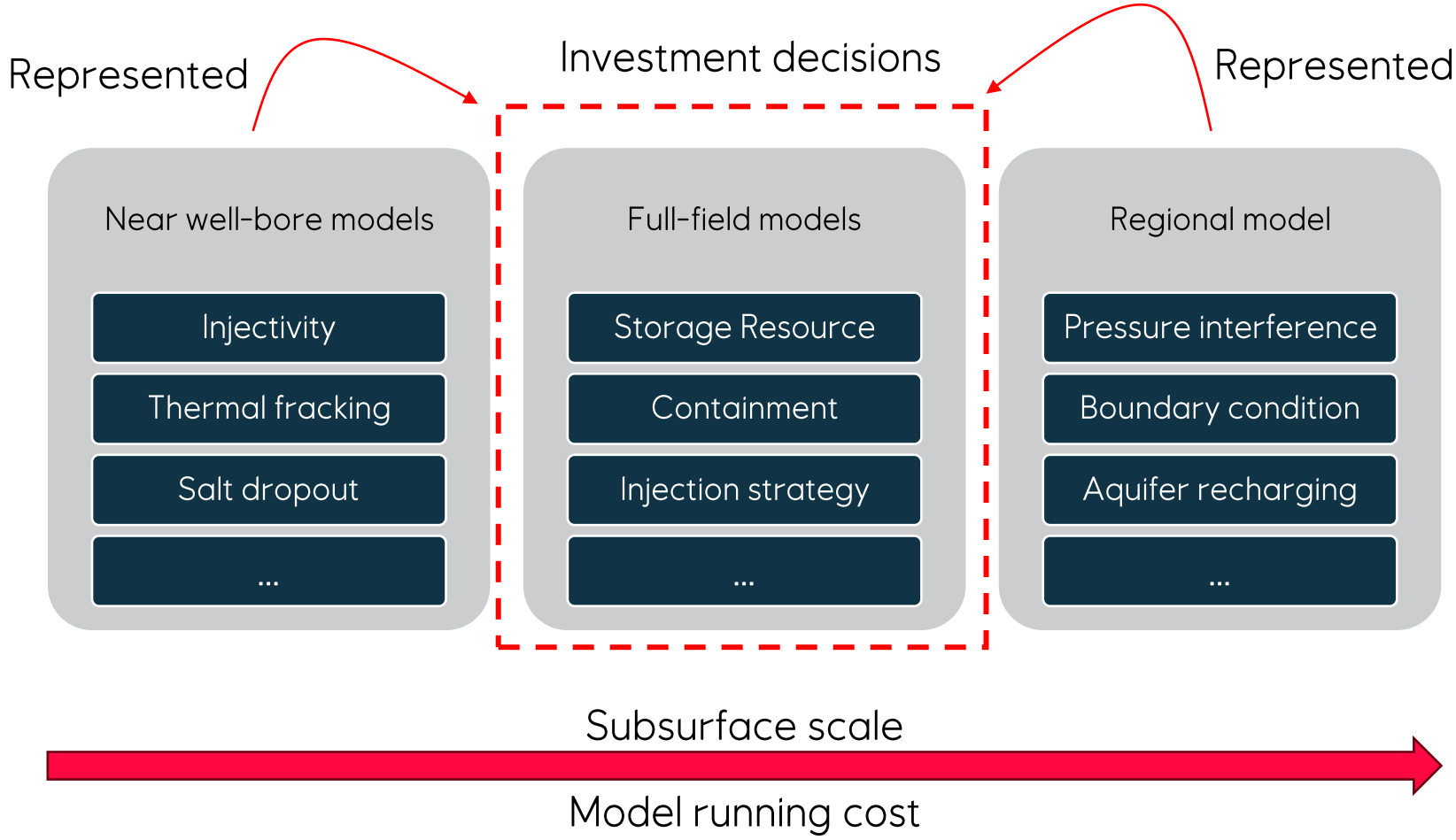
What controls the later part of the profile?

- Total PV connected
- Regional connectivity of the aquifer
- Producing fields
- Neighboring projects and

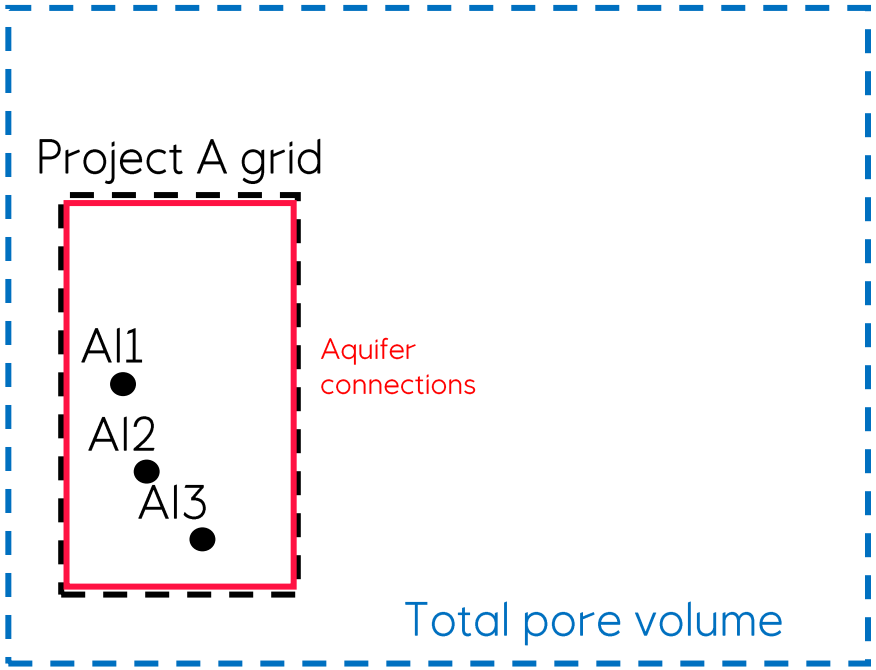
✓ The relative importance is **case-dependent**
✓ Modeling choices must be **good enough**

PART2
Fit-for-purpose modelling in decision making context

Fit-for-Purpose Modeling



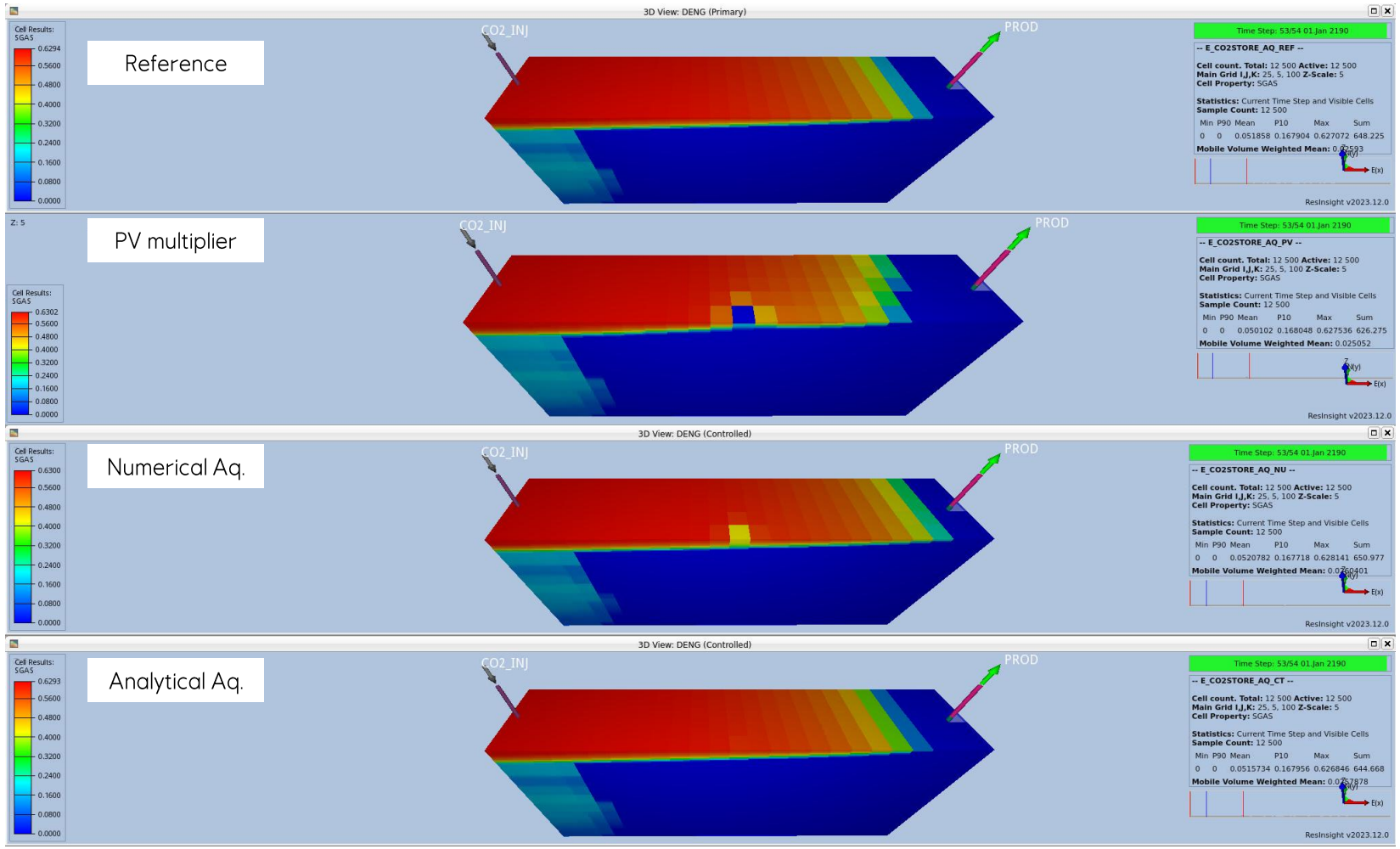
Numerical representation



Possible options:

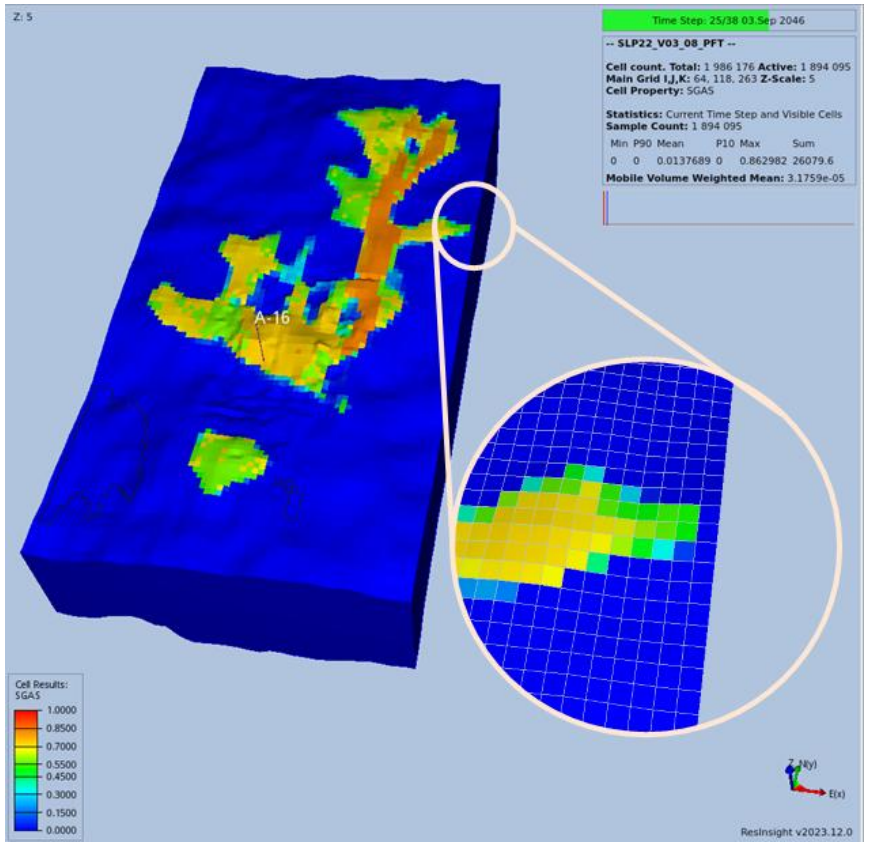
- Analytical aquifers
- Numerical aquifers
- Constant head pressure
- Pore volume multiplier on the edges

Aquifer implementation

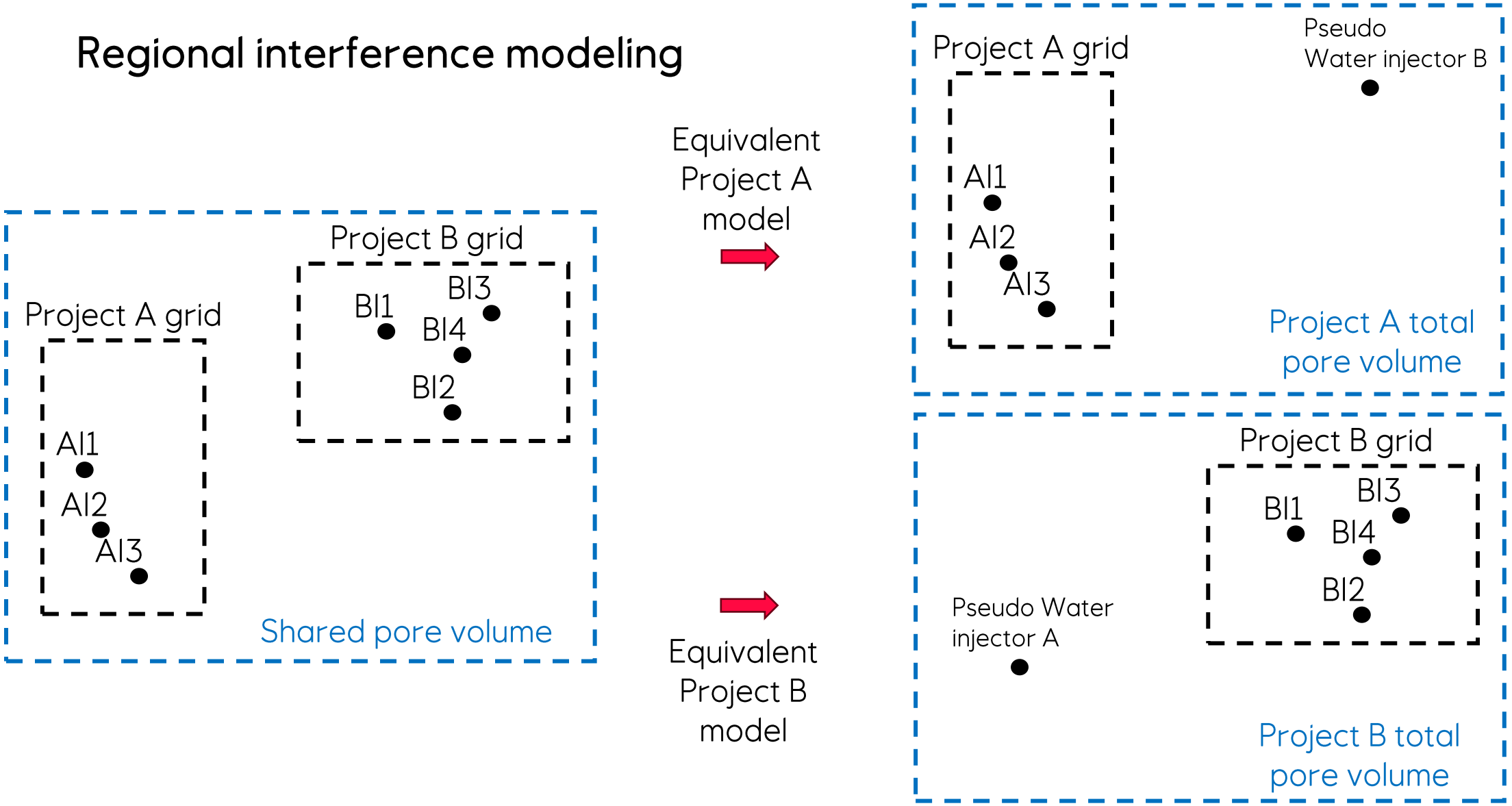


Effect of the boundary

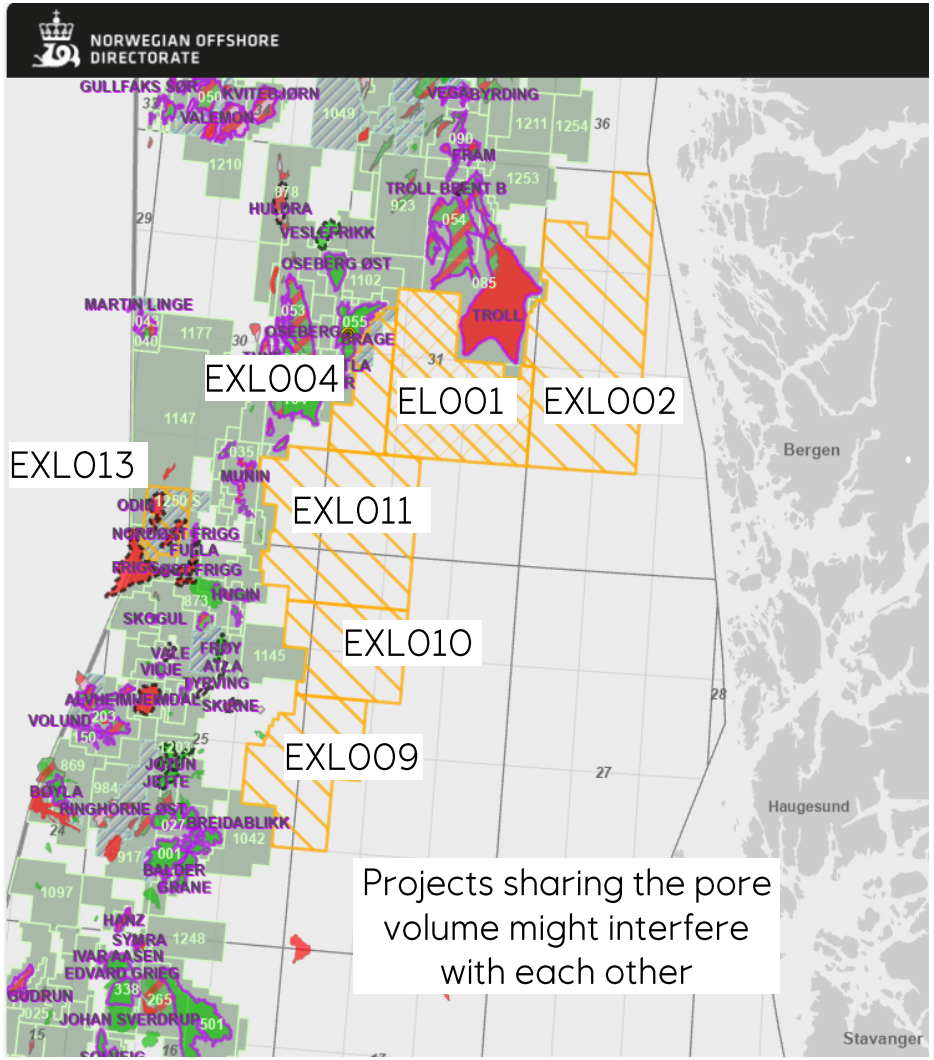
- Be mindful of plume movement
- Plume development is not valid anymore after the saturation front reaches any high pore volume boundary



Regional interference modeling



Regional interference modeling example



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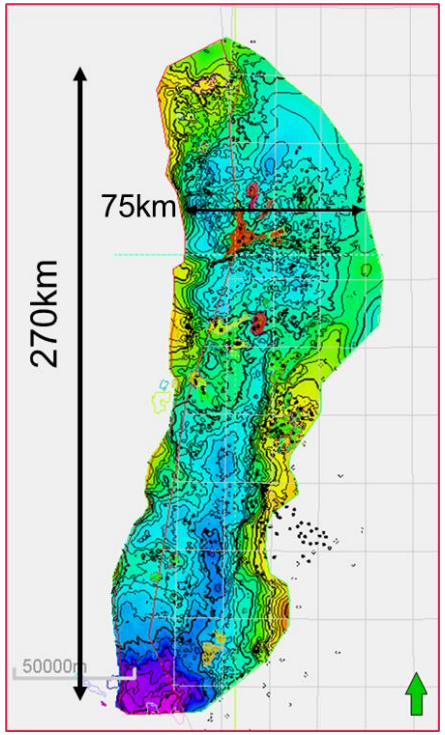
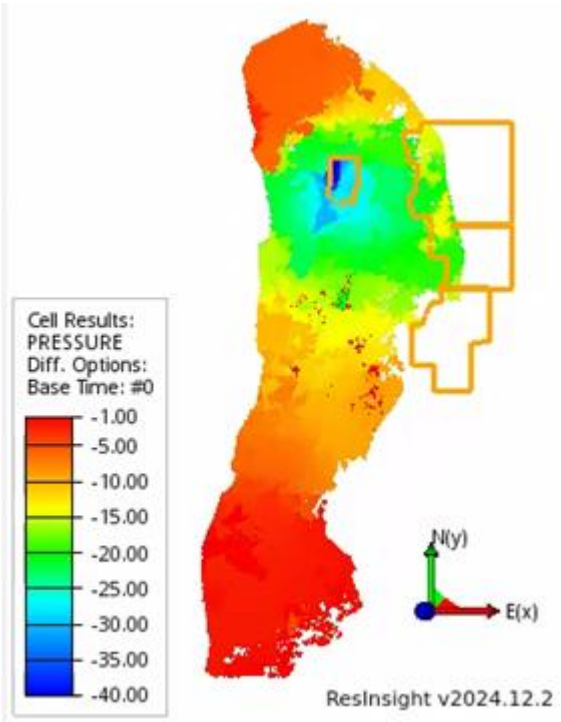
OLJEDIREKTORATET

Frigg-Heimdal aquifer model

FORCE seminar, May 10th 2023





Norther Endurance Partnership (NEP) in UK

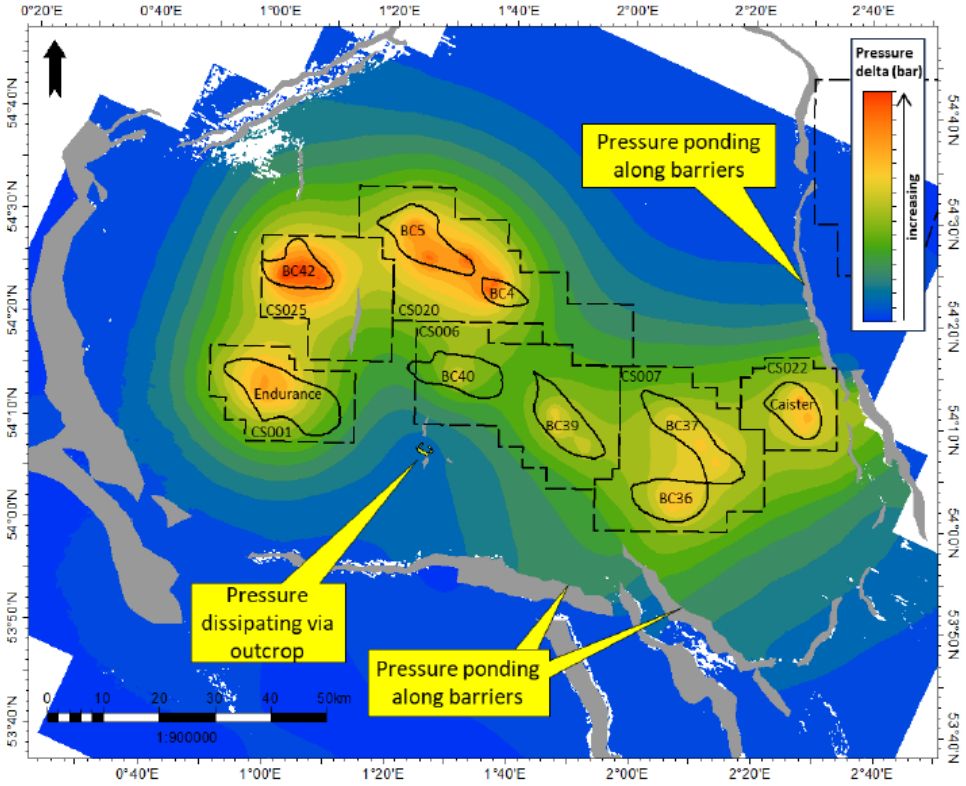


Figure 3 *Reservoir pressurisation of the Silver Pit Basin hydraulic unit after 25 years of simultaneous CO_2 injection at multiple CO_2 stores (combined injection rate of 22 Mtpa, 550 Mt injected in total).*

Gibson-Poole, C., Tarasewicz, J., Gray, E., Hitchen, K., Bouffin, N., Taplin, M., ... & Buchanan, S. (2025, June). Multi-store Developments within the UK Southern North Sea: Implications for Carbon Storage Pore Space Usage. In *86th EAGE Annual Conference & Exhibition* (Vol. 2025, No. 1, pp. 1-5). European Association of Geoscientists & Engineers.

Take away messages

- Important to have clarity in the physics
- Modeling choices are case-dependent
- Focus on fit-for-purpose modeling

Thank you

Andre Luis Morosov – RE QAA for CCS projects