

# Challenges of understanding CO<sub>2</sub> plume dynamics

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Equinor R&T - Future Value Chains

# The CO<sub>2</sub> plume dynamics challenge ... or cloud computing 😊

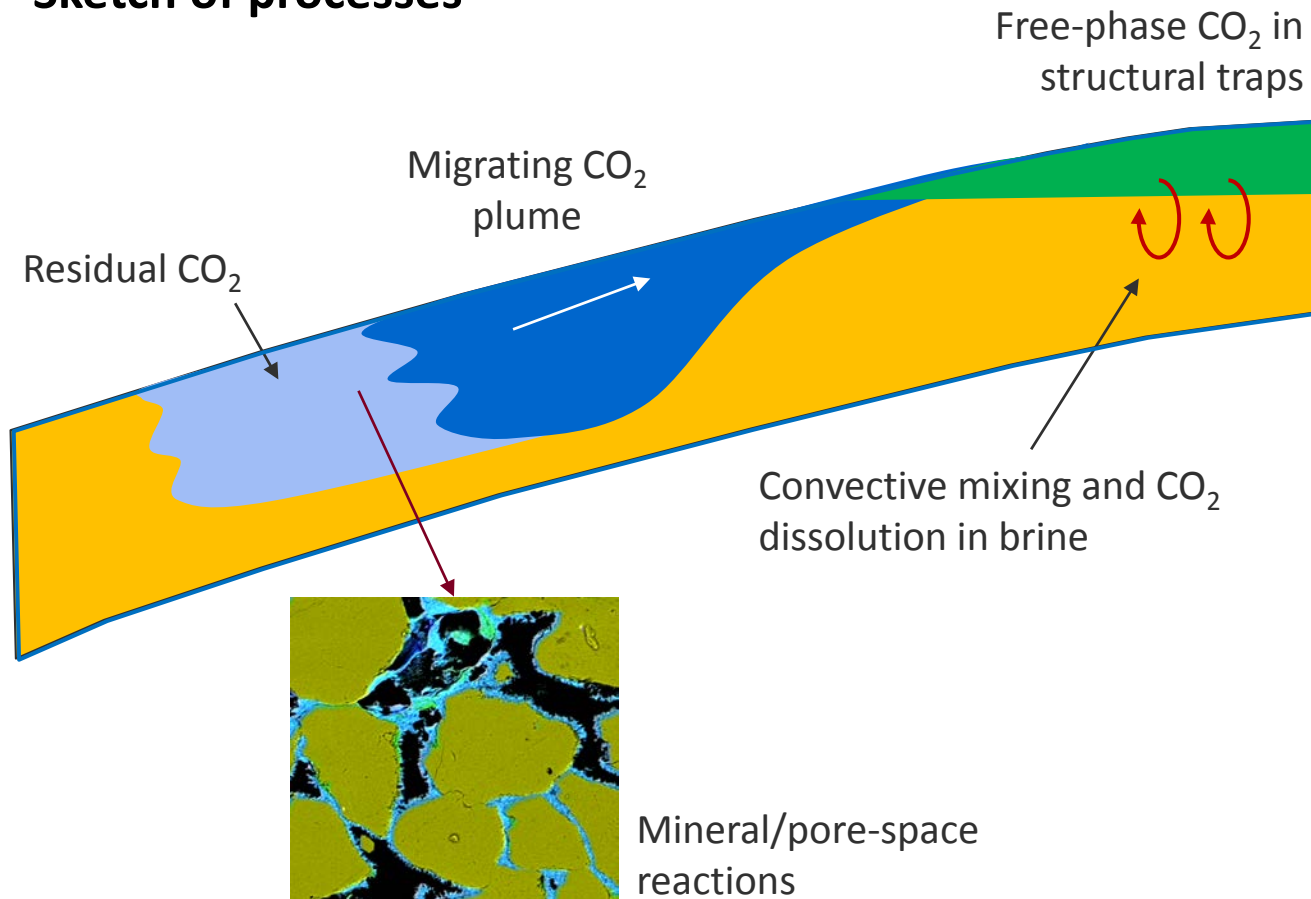
- CO<sub>2</sub> storage regulations require plume **conformance** and **containment** assurance
- Emerging projects (incl. Northern Lights) have challenges to predict long-term plume development:
  - Especially in the case of an inclined aquifer (e.g. Aurora and Quest)
  - Some processes still poorly modelled/calibrated (e.g. dissolution)

To address this challenge Gassnova has proposed a new initiative:

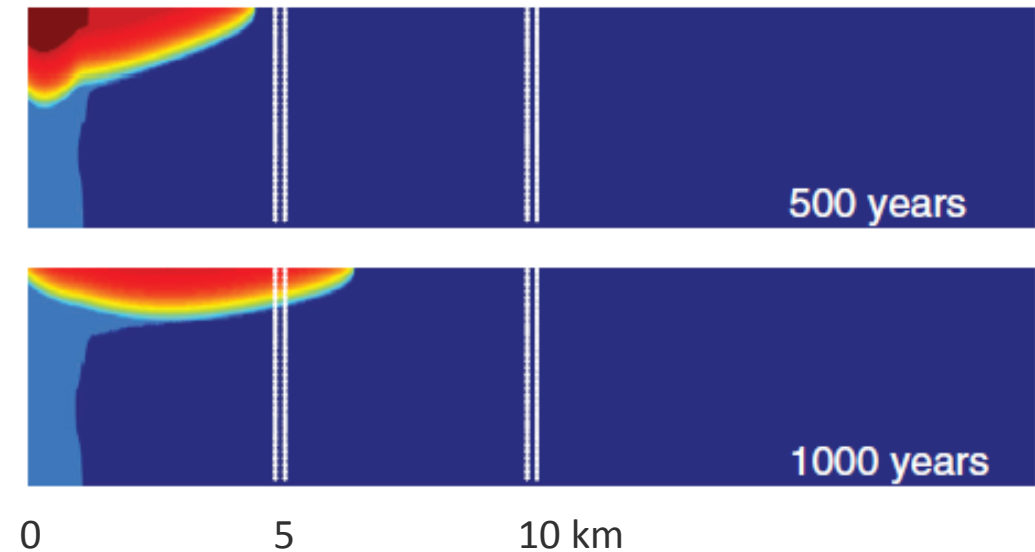
- New project call on 'History-matching the CO<sub>2</sub> plume at Sleipner'
- Seed funding to stimulate Norwegian Participants
- International participants may participate (own national seed-funding schemes?)
- Timeline – May/June 2019 through to Spring 2020
- Workshop to report findings (around Spring 2020)

# Challenges of understanding CO<sub>2</sub> plume dynamics

## Sketch of processes



## Models CO<sub>2</sub> saturation in sloping aquifer

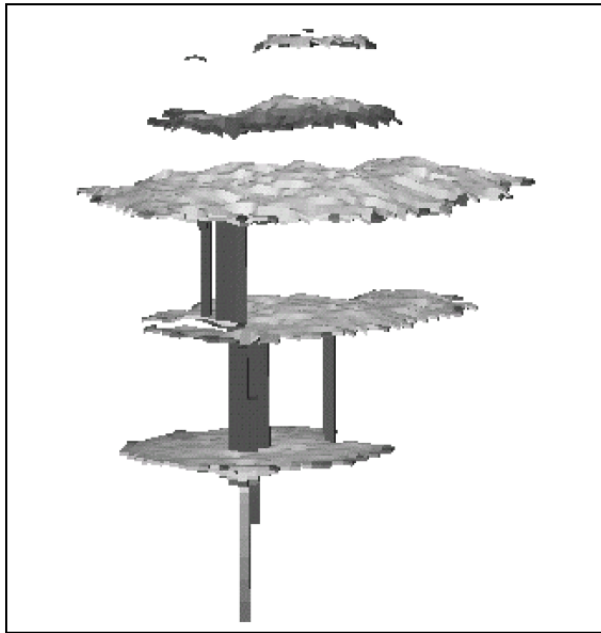


Elenius et al. (2015) Interactions between gravity currents and convective dissolution, WRR

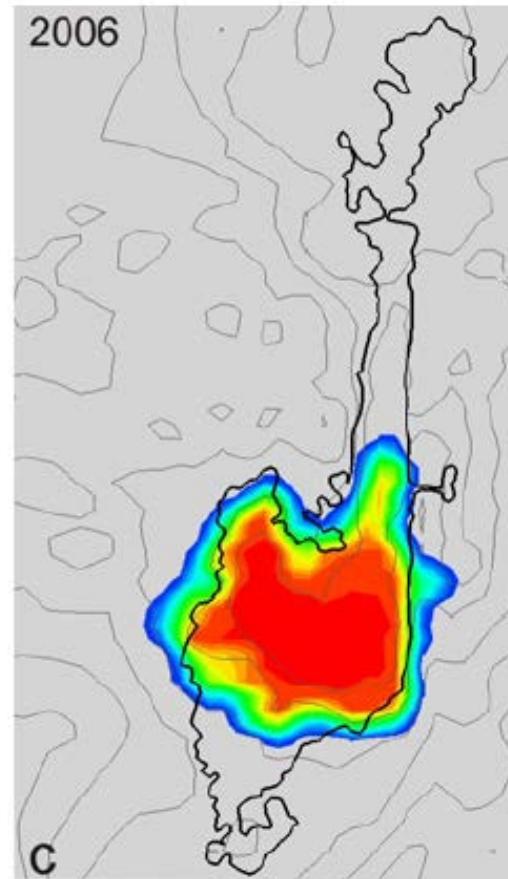
# Brief history of CO<sub>2</sub> plume modelling at Sleipner

## Layer 9 models

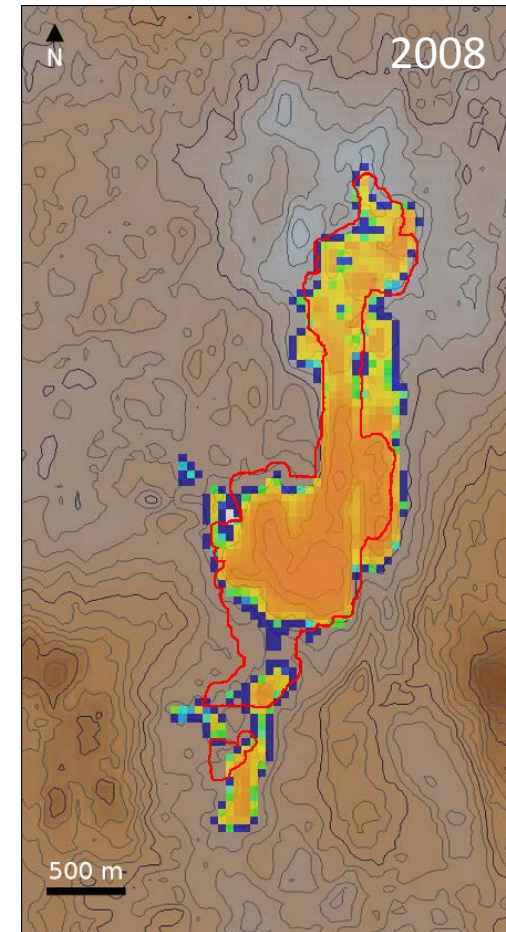
Early 5-layer model



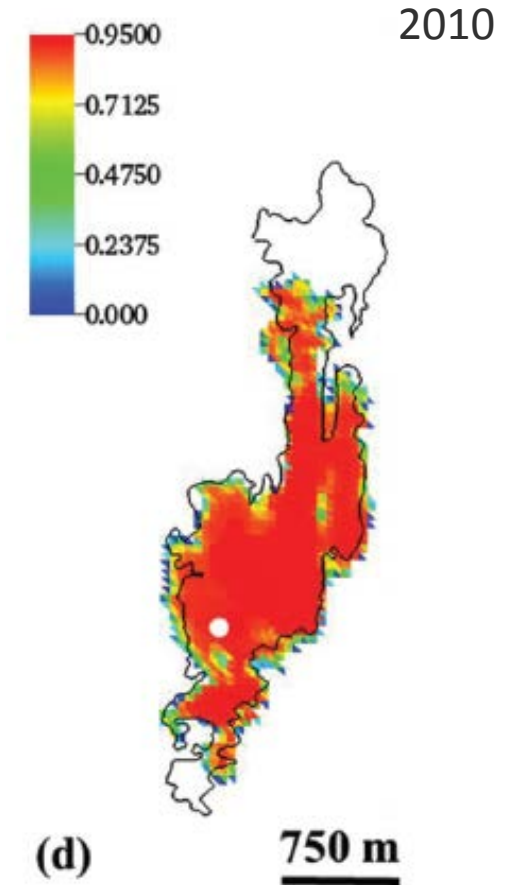
Lindeberg et al. 2000



Chadwick & Noy (2010)

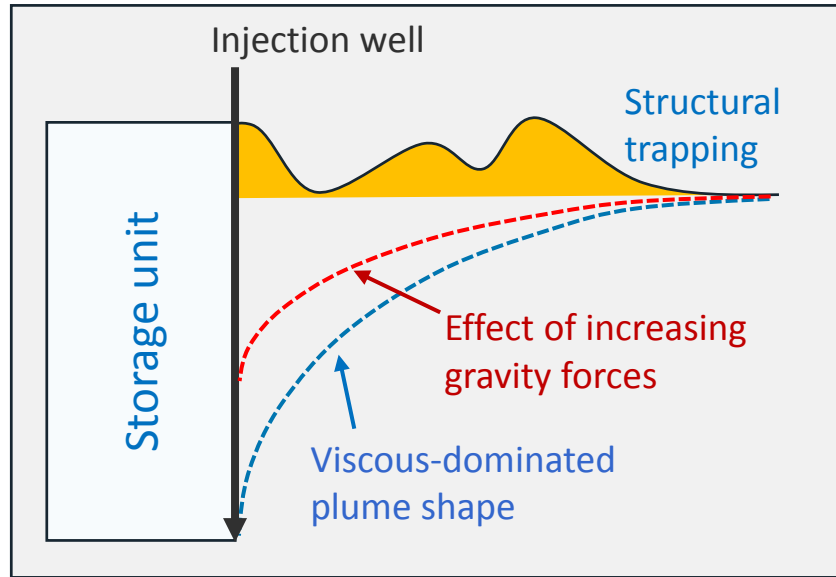


Cavanagh (2013)



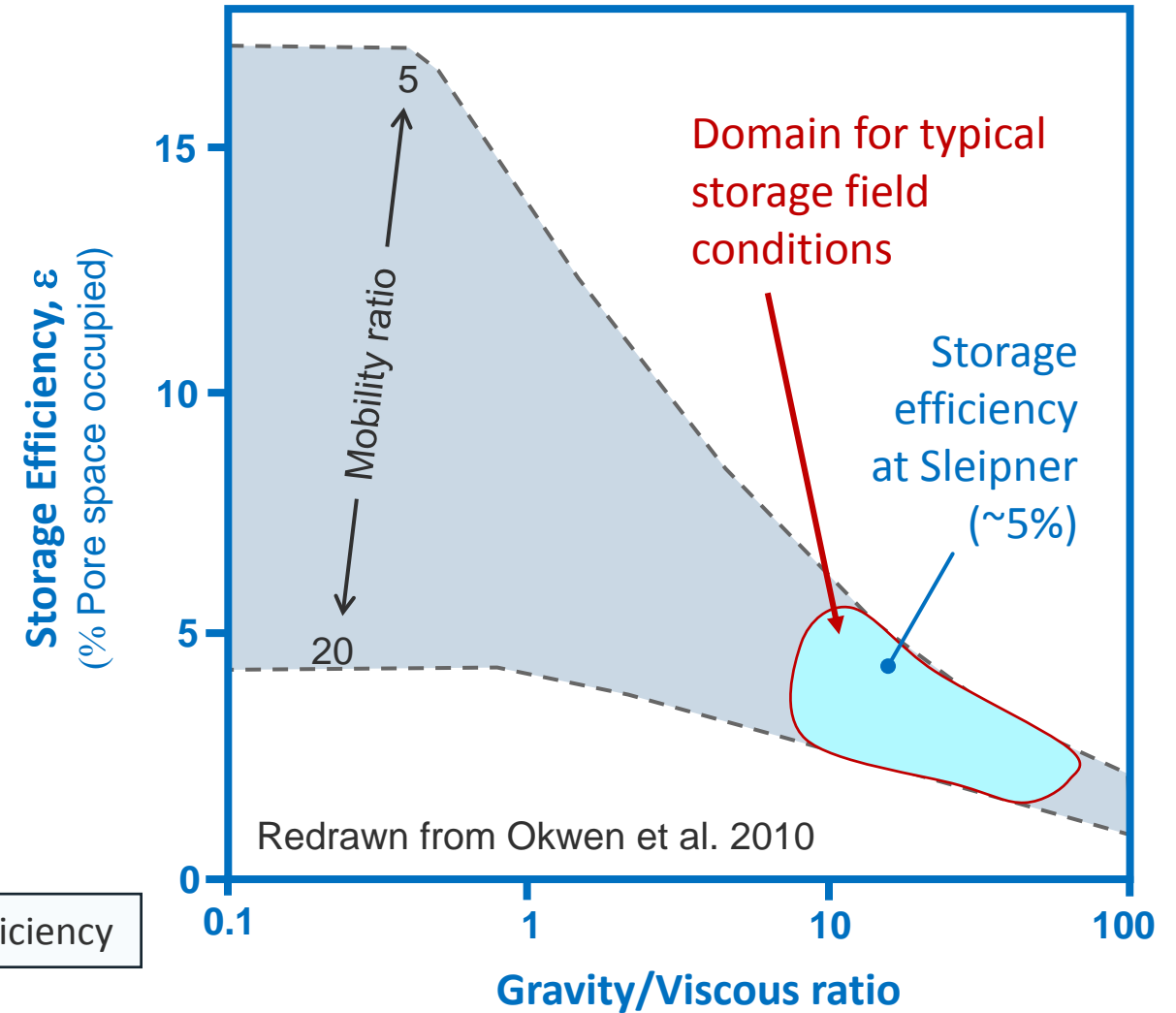
Williams & Chadwick, 2017

# Effects of buoyancy on capacity



## Sleipner CO<sub>2</sub> storage metrics (as of 2010 seismic survey)

	Mass (Mt)	Fraction of pore space occupied ( $\epsilon$ )
Total injected	12.18	0.048 $\leftarrow$ ~5% efficiency
Free phase	11 $\pm$ 0.5	0.044
Dissolved phase	1.2 $\pm$ 0.5	0.004 $\leftarrow$ ~10% dissolved

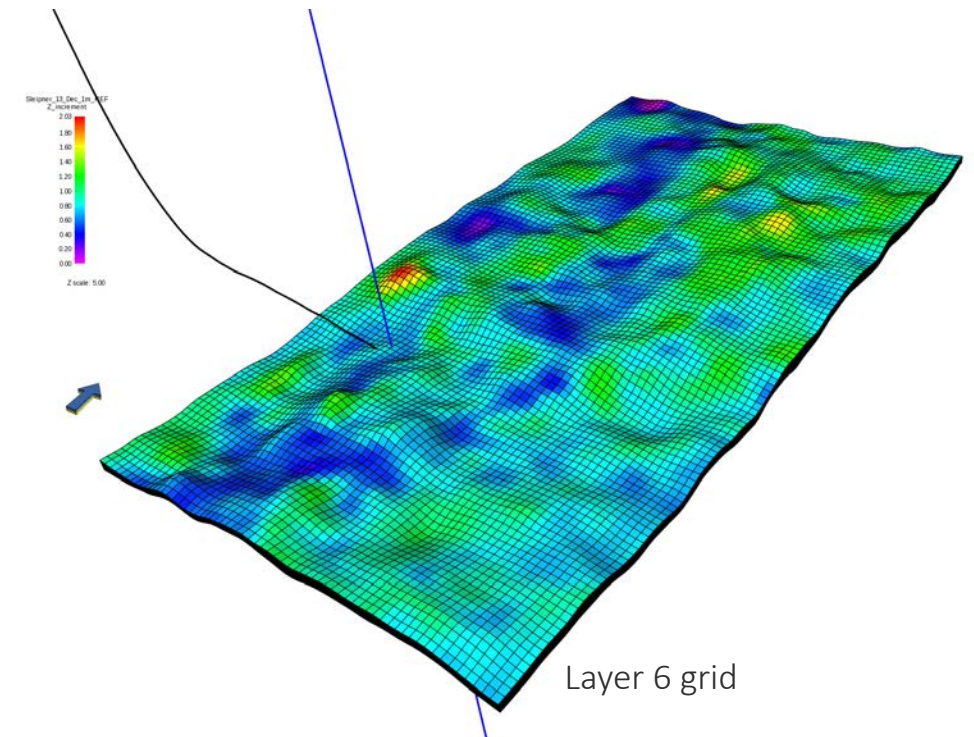
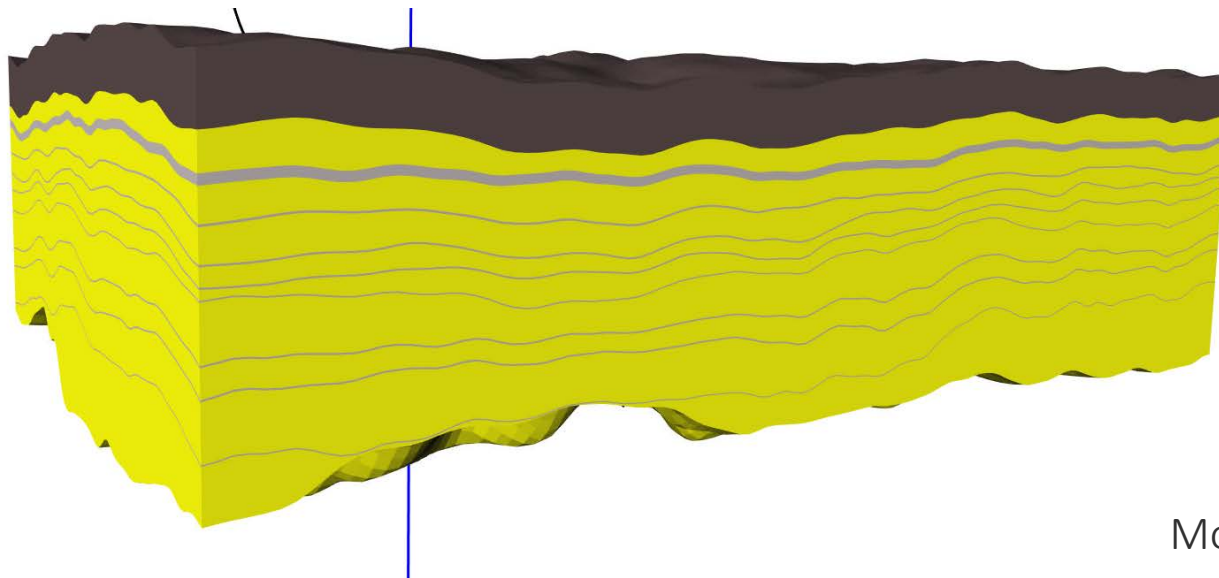


Ringrose, 2018



# New Sleipner Reference Model - 2019

- New Sleipner Reference model grid covers 3.2 km x 5.9 km x ~300 m
- 50x50m grid gives a total of ~2 million cells (64 x 118 x 263)
  - ~2m-thick cells for sandstone layers and caprock (5 m)
  - ~0,5m-thick cells for shales (~1m thick, at least 2 cells)
- Planned to be shared via the CO2 data share (CSDC) project



Model built by Andrea Callioli Santi (Equinor/Sintef)

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