

Dynamic models of the East Mey and Endurance CO₂ Storage sites

CCUS Innovation 2.0

Key Knowledge Deliverable 3.1

Key Knowledge Deliverable Cover Sheet

This Key Knowledge Deliverable (KKD) has been produced by Imperial College London as part of the DESNZ CCUS Innovation 2.0 programme. The document is reflective of the status of the project at the time of writing. The material presented could have been subject to change as the project matured. These documents should not be considered a full representation of the final project.

Description of the project: In StrataTrapper we translate cutting edge research carried out at Imperial College London and the University of Cambridge on the geological fluid dynamics and trapping of CO₂ into innovative characterisation and modelling software tools that will be used by industry to reduce risks and costs of CO₂ storage projects. The tools will be commercialised through incorporation into the CO₂ reservoir simulation platform OpenGoSim, in addition to being made open-source. We will work with industry partners bp, Storegga, and Drax power to demonstrate the applicability of these tools to the Endurance field in the Southern North Sea and the East Mey Site in the Central and Northern North Sea. The result of the work will be the commercialisation of the StrataTrapper reservoir simulation tools for the rapid screening, risking, project design, and management of CO₂ storage.

This report describes Key knowledge Deliverable 3.1, the public release of dynamic OpenGoSim models of the East Mey and Endurance CO₂ storage sites. Note that the models are not designed to forecast how CO₂ storage will take place at these sites, but rather to demonstrate the features of dynamic plume migration captured in using the StrataTrapper modelling approach.

The following is the full list of KKD's to be published under StrataTrapper:

KKD1.1 Open-source research codes for the characterisation of multiphase flow heterogeneity and conversion to flow functions for reservoir simulation

KKD1.2 A report detailing the workflows for reservoir characterisation, and model creation and use

KKD2.1 Open-source research codes for the rapid estimate of the impacts of heterogeneity on lateral plume migration, residual and dissolution trapping

KKD2.2 A report detailing the use and limitations of reduced physics models for various applications, including screening and probabilistic analysis

KKD3.1 Publicly available models of the Endurance and East Mey sites

KKD3.2 A report analysing the impacts of multiphase flow heterogeneity on CO₂ migration and trapping in the case study sites

KKD4.1 StrataTrapper user interface in Stratus

KKD4.2 Accelerated OGS simulator

KKD4.3 StrataTrapper Workshop to CCS project developers

KKD5.1 Annual reports

KKD5.2 Project final repor



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Contents

KKD 3 — Publicly available reservoir simulations	6
KKD 3.1 — Publicly available models of the Endurance and East Mey sites	6
Preamble	6

KKD 3 — Publicly available reservoir simulations

KKD 3.1 — Publicly available models of the Endurance and East Mey sites

Preamble

Models demonstrating the use of the StrataTrapper upscaling approach have been made publicly available from the StrataTrapper github site:

<https://imperialcollegelondon.github.io/StrataTrapper/>

From the main site there is a link to a site focused on the publication of the models at

<https://imperialcollegelondon.github.io/StrataTrapper-models/>

The repository itself can be directly accessed at

<https://github.com/ImperialCollegeLondon/StrataTrapper-models>

The following information on this report recreates information published on the repository websites. Key Knowledge Deliverable report 3.2 provides further descriptive detail of the models and their use in various scenarios.

Endurance models

Endurance CCS site sector models in PFLOTTRAN-OGS's [input deck](#) format are in the [endurance/](#) directory:

[one-well-base.in](#)

[one-well-upsc.in](#)

[four-wells-base.in](#)

[four-wells-upsc.in](#)

one-/four- stands for the number of injection wells in the model. -base stands for reference viscous-limit upscaling with zero capillary pressure. -upsc stands for capillary-limit upscaling conducted by [StrataTrapper](#) toolkit.

In detail, specifications can be found in preprint [1].

East Mey models

The East Mey models in this repository are based on a model developed by the ACT (Accelerating CCS Technologies) Acorn consortium. This simulation was constructed using that model as the starting point.

East Mey CCS site models in PFLOTTRAN-OGS's [input deck](#) format are in the [east-mey/](#) directory:

1. [1-base.in](#)
2. [1-base-pc.in](#)
3. [1-upsc.in](#)
4. [2-base.in](#)
5. [2-base-pc.in](#)
6. [2-upsc.in](#)

1-/2- stands for two particular well placements and respective injection scenarios.

-base stands for base coarse dynamic models (directly based on the base model from the ACT Acorn consortium).

-base-pc stands for the -base model with added capillary pressure model.

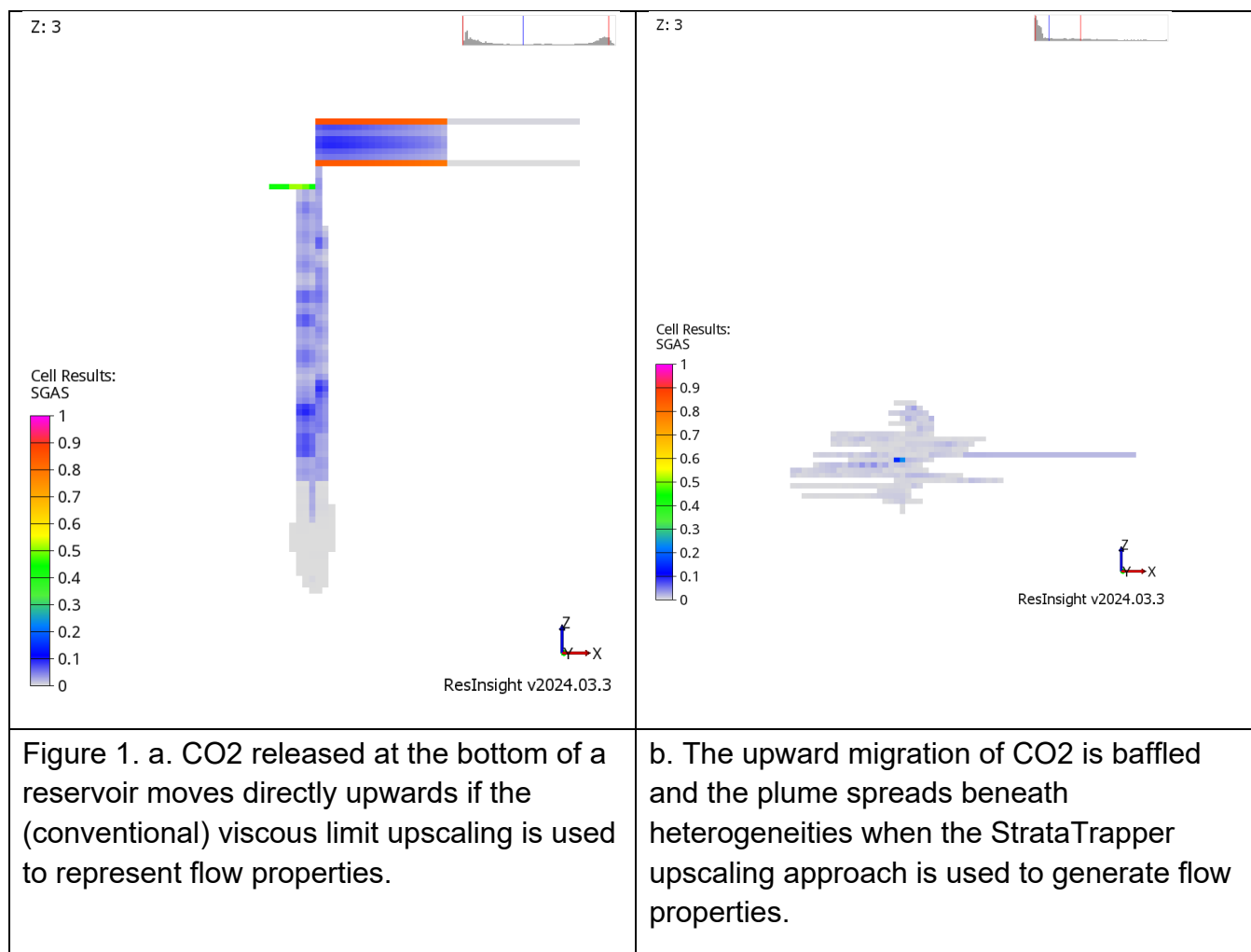
-upsc stands for capillary-limit upscaling conducted by [StrataTrapper](#) toolkit

Running PFLOTTRAN-OGS reservoir simulations

To run the supplied models, PFLOTTRAN-OGS-1.8 installed on Ubuntu 22.04 is required. A dedicated Docker image can be used instead, which is covered in the [next section](#).

For a model folder <model_folder> containing .in files:

1. Unarchive large files with characteristic curves chc[xyz].data from chc[xyz].zip located at <model_folder>/include/.
2. Go to a model directory. Using the command line from repository root:
`cd <model_folder>`
3. Start a simulation using the run.sh shell script:
`bash ./run.sh <model_name> [number_of_processes]`
 - where <model_name> is an input file name with .in omitted
 - [number_of_processes] is optional. It is responsible for MPI-based parallelization and equals 4 by default.
4. Visualize simulation results using [ResInsight](#) or equivalents.



References

1. Wenck, N., Muggeridge, A. H., Jackson, S. J., An, S., & Krevor, S. (2024). The Impact of Capillary Heterogeneity on CO2 plume migration at the Endurance CO2 storage Site in the UK. Authorea Preprints. Available at <https://essopenarchive.org/users/529781/articles/1184652-the-impact-of-capillary-heterogeneity-on-co2-plume-migration-at-the-endurance-co2-storage-site-in-the-uk?commit=b9b5c90786dcf75ccd05434e7caca6847ad61579>

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