

4D Multi-Physics Forward Modelling for CO₂ Storage Monitoring in the Hewett Field--A workflow integrating reservoir simulation and geophysical forward modelling

Multi-Physics Workflow for CO₂ Storage Monitoring

This study presents an integrated multi-physics workflow for CO₂ storage monitoring in the Hewett Field. The workflow links reservoir simulation, rock physics modelling, and geophysical forward modelling to establish a quantitative relationship between subsurface processes and geophysical observables.

Dynamic reservoir properties, including pressure and CO₂ saturation, are obtained from injection simulations based on the geological model. These properties are subsequently transformed into physical properties through rock physics modelling. Finally, the derived properties are used to generate synthetic geophysical responses, enabling the assessment of time-lapse monitoring sensitivity to CO₂-induced changes.

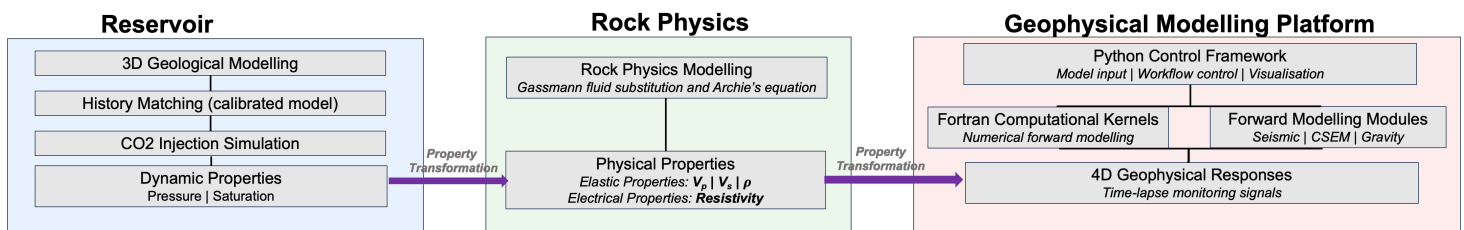


Figure 1: A multi-physics forward modelling framework linking reservoir dynamics to geophysical observables for CO₂ storage monitoring

Modelling Framework

The geophysical modelling framework is designed to enable efficient and flexible multi-physics forward modelling. A Python-based control system is used to manage model input, workflow execution, and data visualization.

Computationally intensive forward modelling is implemented using Fortran-based kernels, which perform the core numerical simulations. The framework integrates multiple geophysical methods, including seismic, controlled-source electromagnetic (CSEM), and gravity modelling, to simulate time-lapse responses associated with CO₂ injection.

This architecture allows consistent propagation of reservoir changes into geophysical observables and supports the evaluation of monitoring strategies for CO₂ storage.

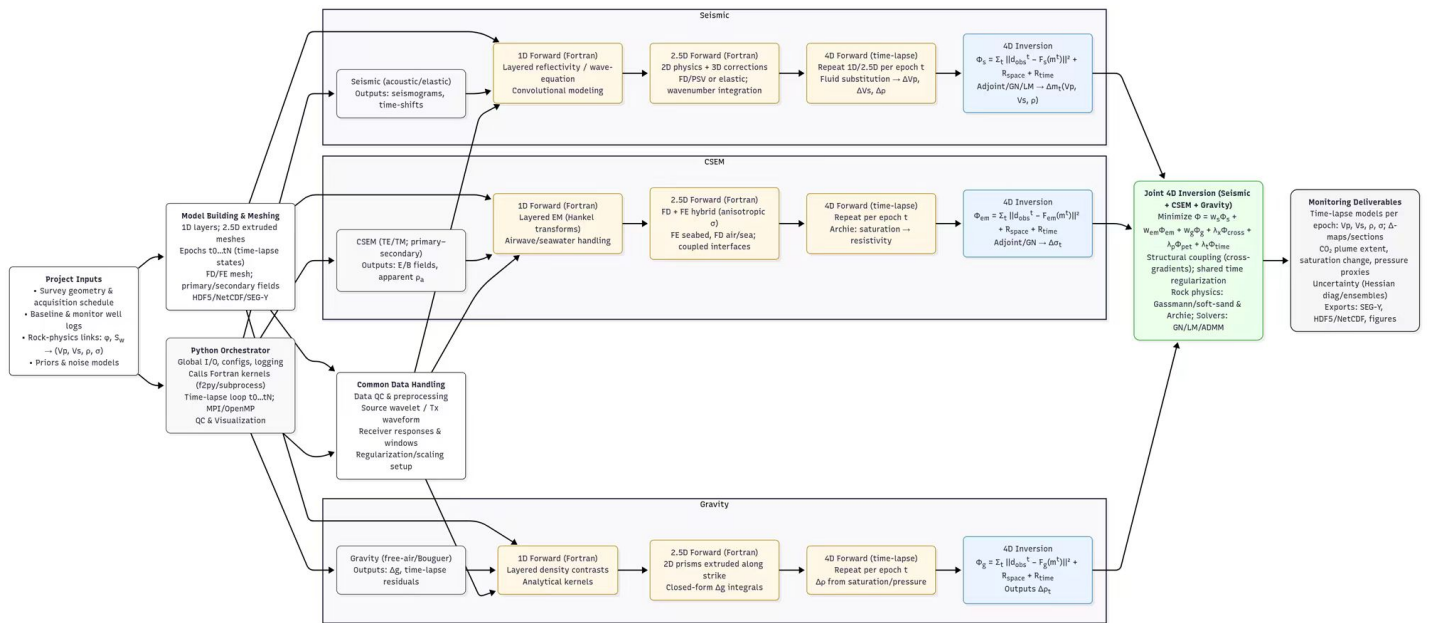


Figure 4: Architecture of the geophysical modelling framework, illustrating the interaction between Python control and Fortran computational modules.