CO_2 storage: reducing uncertainty on CO_2 plume propagation distances and predicting their spatial footprint through Ensemble Methods

Postdoctoral position: September 2024 to August 2026 (2 years)

Location: TotalEnergies CSTJF, Avenue Larribau, 64018 Pau, France
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Objectives, Scope, and Activities: CCS (Carbon Capture & Storage) is a part of a major strategy of TotalEnergies to achieve Carbon neutrality. The goal by 2030 is to develop a CO_2 storage capacity of more than 10 million tons per year. To achieve this goal, significant innovation effort is necessary. This is supported by numerous multidisciplinary research projects within the R&D line "CO_2 and Sustainability" of TotalEnergies Onetech.

The Centre for Geosciences Mines Paris - PSL develops spatial-temporal probabilistic models, parameter estimation methods for these models, and associated prediction algorithms [4]. The Centre also develops geochemical speciation and reactive transport codes to quantify and model coupled physicochemical phenomena [3].

The objective of this work is to understand the dynamics of CO_2 plumes via Ensemble methods and, based on the geological and reservoir models of a storage site, to test and validate the methodology for 4D seismic data history matching on the plumes. TotalEnergies' participation in various consortiums and partnerships for CO_2 storage allows the use of data from several CO_2 injection sites, notably those in Australia and in the North Sea. Relying on data from CO_2 storage projects (notably 4D seismic, acquired at different times over the same area), we will seek to combine geophysical expertise, dynamic reservoir simulation techniques, and mathematical methods (i.e., Ensemble methods), to understand the dynamics of plumes in saline aquifers [1,2]. We will address the problems of storage security and the role of different physical mechanisms involved in CO_2 storage.

Your scope will consist of:

- studying the static and dynamic model of CO_2 injection in a saline aquifer, particularly the aspect of uncertainties associated with the input parameters and their impact on the propagation distance of the plume and its shape;
- applying Ensemble Method (software provided) to this case study, in order to reduce the gap between the initial predictions of the CO_2 plume and the observations (4D seismic) while ensuring the coherence of the geological concept.
- based on these results, estimate the long-term movements of the plumes, as well as the impact of storage mechanisms on their stability.

References :

[1] Abadpour, A., Bergey, P., and Piasecki, R. 4D seismic history matching with ensemble Kalman filter-assimilation on Hausdorff distance to saturation front. In SPE Reservoir Simulation Conference (2013), SPE, pp. SPE–163635.

[2] Mumtaz, Y., Blondeau, C., Zerkoune, A., Khan, O. H., and Ali, S. Dynamic assisted history matching of CO_2 plumes using 4D seismic. In SPE Asia Pacific Unconventional Resources Conference and Exhibition (2023). SPE DOI 10.2118/217283-MS

[3] Sin, I., De Windt, L., Banc, C., Goblet, P., and Dequidt, D. Assessment of the oxygen reactivity in a gas storage facility by multiphase reactive transport modeling of field data for air injection into a sandstone reservoir in the Paris Basin, France. Science of The Total Environment 869 (2023), 161657

[4] Zaytsev V, Biver P, Wackernagel H, Allard D (2016) Change-of-support models on irregular grids for geostatistical simulation. Mathematical Geosciences, 48, 353-369.