Environmental monitoring of geological carbon storage sites

Project 1: Analysis of experimental data from chemical detectors

This project aims at analysing experimental data from chemical detectors acquired in a controlled CO2 gas release experiment. The data is acquired during a controlled CO2 gas release experiment run over 27 days in the Oslofjord with ocean conditions similar to a North Sea environment. The aim of the project is to define a detector algorithm for gas leakage based on passive sensor monitoring and natural correlation properties between CO2 and O2.

The project is for one student, and the preferred project period is June to August 2022. The expected outcomes/deliverables are a suggestion of an algorithm, Matlab/Python code for simulation/verification, and a report.

Background

Large-scale carbon capture and storage (CCS) projects are currently realized worldwide. Several of these are geological carbon storage (GCS) projects with offshore storage locations. As part of this, huge effort is put into identifying solutions for monitoring of the reservoir and the surrounding environment. Key technologies for offshore GCSs are acoustics and chemical sensors.

The Group for Digital signal processing and Image analysis (DSB) at the Department of Informatics (Ifi) was, together with NGI, NIVA, Norce, FFI, JC-DeepSea, Kongsberg Maritime, Equinor and Total, partner in the ACT4storage project (2018 – 2020), which addressed marine environmental monitoring targeting the seabed and the water column. As part of the project, data from a broad range of acoustical and chemical sensors were collected in a controlled CO2 release experiment, run over 27 days in the Oslofjord with ocean conditions similar to the North Sea environment. Initial analysis of the data has been conducted and reported[1]. Still, a lot of knowledge and new results can be found through further data analysis. Ifi, through DSB, has access to this dataset, and this will be made available for the summer projects.

The DSB group is also partner in a new related RCN project application together with many of the same partners as in Act4Storage. In the new project, we aim at enabling more efficient monitoring of greenhouse gas seepage in the oceans through enhanced AUV autonomy. The DSB-activity within this project will include supervision of a project funded PhD. A decision for funding is expected within March 2022.

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[1] Blomberg, Ann EA, et al. *ACT4storage—Acoustic and Chemical Technologies for Environmental Monitoring of Geological Carbon Storage. D3—Nearshore Evaluation Report 2019*. Technical Report, 2020, https://hdl.handle.net/11250/2717113.

Experimental data from chemical detectors

The correlation between CO2 and O2 is a powerful tool for distinguishing between normal variations in the carbonate system and a leak-related anomaly. Using chemical sensors, it is possible to detect either the level of dissolved CO2 in the water column directly, or measure other parameters related to CO2 such as pH and O2. During the controlled CO2 release experiment, the CO2 and the O2 level were monitored. Initial analysis confirmed a strong correlation between CO2 and O2 levels

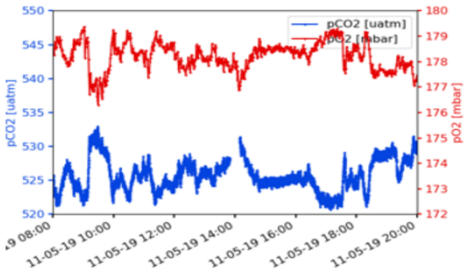

Figure 2: Observed inverse correlation between CO2 and O2. (Figure from [1])

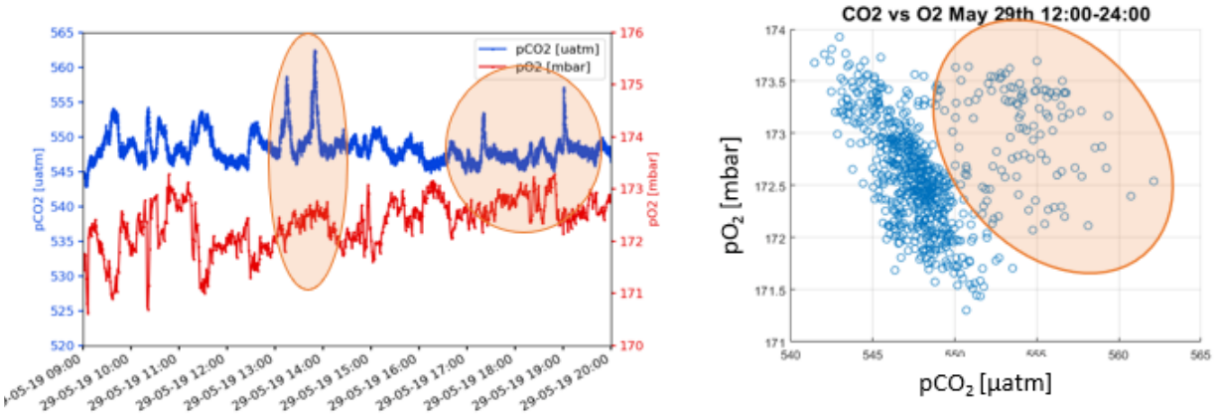

Figure 1: Measured CO2 and O2 during controlled CO2 release and corresponding scatter plot. (Figure from [1])

as seen in Figure 1, and the possibility to use absents of correlation as an anomaly detector indicating presents of CO2 leaks. In the summer project, we want to perform a detailed analysis of CO2 vs O2 correlation as a function of temperature, tidal state, time of day, etc, and CO2 release. We aim at constructing a robust algorithm for CO2 leakage detection, i.e. robustly detect outliers like the ones indicated in Figure 2.

Favourable student background

Concretely, this task involves implementing time series analysis on measured sensor data. For this task we are looking for an enthusiastic and self-driven candidate who has a passion for scientific computing, signal processing, and who would like to work with applications related to green energy.

You need to know how to write structured and clear code in Matlab/Python using version control systems (Git). Previous knowledge in signal or time series processing is an advantage (for instant having taken the MN courses IN3190/4190, and possibly STK4060 or IN5340). Solid skills in statistics will also be an advantage.

Contact persons

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