

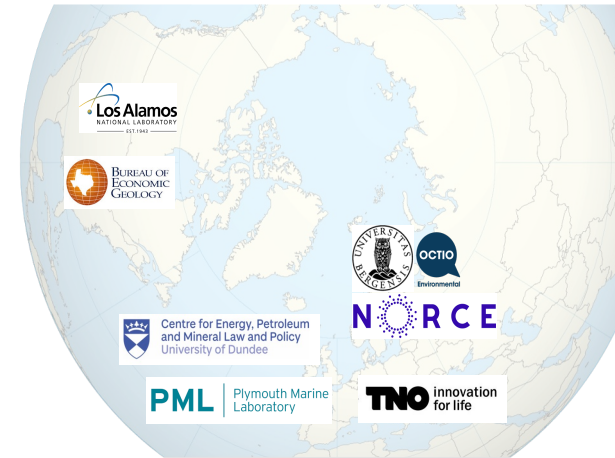
WP1 BASELINE (Abdirahman Omar, NORCE-Climate, Sigrid E. Schütz, UiB-Law): Monitoring the marine environment. Will survey the regulatory requirements and opportunities and technical limitations laying the foundation for the marine monitoring program. This activity will underpin the other WPs, providing the necessary information on what level of assurance is expected from a monitoring program, alongside the present capabilities of marine measurements and monitoring.

WP2 DIGITAL (Jerry Blackford, PML): Design and build of the pre-operational web toolkit. Will be responsible for building the toolkit based on verified algorithms for detecting weak signals in a highly variable environment and designing monitoring programs.

WP3 RESPONSIBILITY (Dorothy Dankel UiB-BIO, Sigrid E. Schütz, UiB-Law): Responsible CCUS monitoring process. Will study how the monitoring program can be used to communicate risks and benefits of subsea storage, and as a tool for public engagement through the Responsible Research and Innovation (RRI) framework.

WP4 IMPACT (Sarah Gasda, NORCE-energy): Scenarios and site studies. Will utilize the web toolkit built in WP2 and the knowledge learned in WP3 to study policy scenarios and demonstrate the toolkit on the P18 and Smeaheia storage sites as well as study sites in the Gulf of Mexico.

WP5 INTEGRATION (Guttorm Alendal, UiB-MATH): Dissemination, reporting and coordination. Assure easy communication in this highly cross-disciplinary project, both in the core project group, in the extended collaboration group, and beyond the project. Responsible to periodic reporting to ACT.



- Advisory board.
 - Philip Ringrose, Equinor
 - Marcella Dean, Shell
 - Eva Halland, NPD
 - Tim Dixon, IEAGHG
 - Jun Kita, MERI
 - Gloria Thurschmid, EBN
 - Charles Jenkins, CSIRO
 - Sallie Greenberg, ISGS

Acknowledgements

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Reservoir and overburden geophysical characterisation

Hydrodynamic data or model simulation
Tides, current, thermal and wind driven mixing processes in the overlying water column

Site specific information

Biogeochemical baseline from models or observations
Carbonate chemistry, Oxygen, Nutrients

Toolkit

Provides seismic 3D

Provides x,y,z velocities

We are studying targeted monitoring of potential seeps at an analog storage site; this is not equivalent to state that we think there will be a leak!

Geological Mapping
Mapping of structures
Geographic positions for leak
possible relative
higher risks
Tracer transport simulator
hydrodynamic dispersal of tracer, based
on geological map

Leak magnitude

Resulting time evolving fields of tracer concentration, tracer release rate

Carbonate system
Converts tracer information to carb sys parameters
 $DIC = DIC_{base} + F * Tracer$

Baseline / normal DIC,

Data:
DIC
TA
N
O2
:

Time evolving fields converted to DIC and pH (Recreated leak simulation)

Data analytics
Quantification of baseline and anomaly criteria based on observed or modelled data using either ROC or CSEEP

Confidence level for monitoring

Deployment methods / costs

Deployment strategies
How best to deploy limited equipment to maximum effect?
• Near-surface geology
• Seafloor/ Water column

Multiple instances of detectable error fields to train deployment algorithms

Search for anomalies
Look through the recreated leak fields identifying where/when anomalies occur

Anomaly criteria e.g. $\Delta pH/t$ or stoichiometric bounds

Simple case: Geographical risk spots

REPORT
Graphical report that will summarise
• Geological risk
• Leakage impact maps
• Detection maps
• Detection strategy

Assess Impact Potential
Quantifies the potential extent of impact based

Maps of $\Delta Carb$ chem exceeding nominal threshold (-0.1pH)

Impact thresholds

User programmable information

Data transfers

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Additional risk site

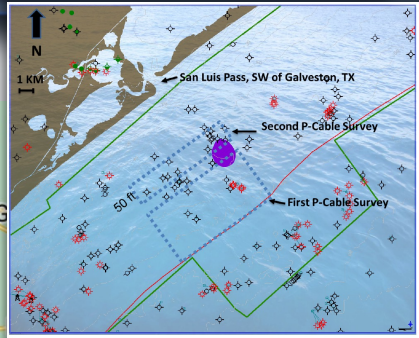
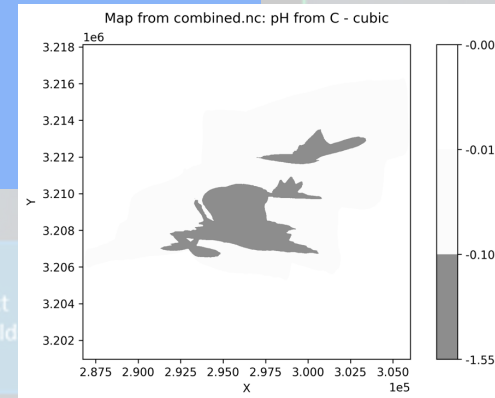
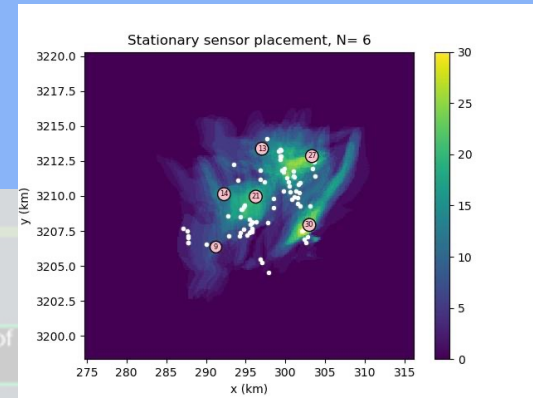
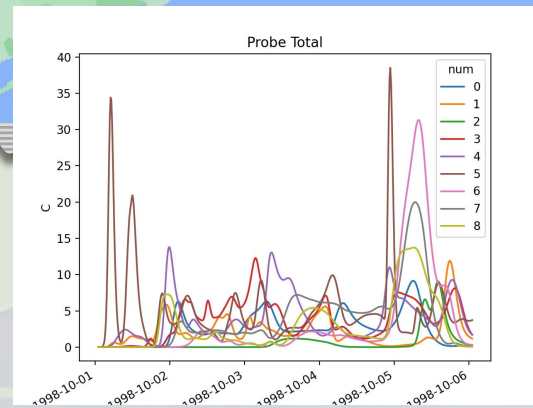
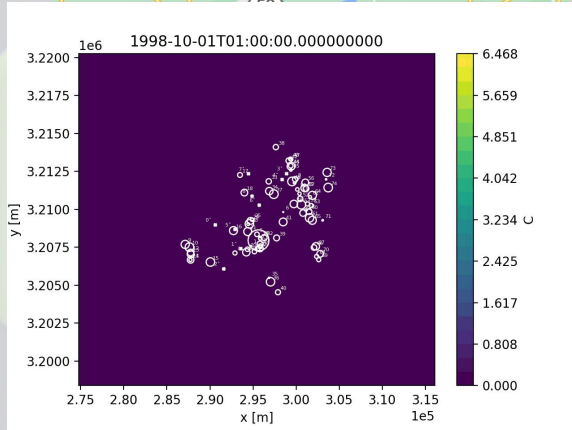
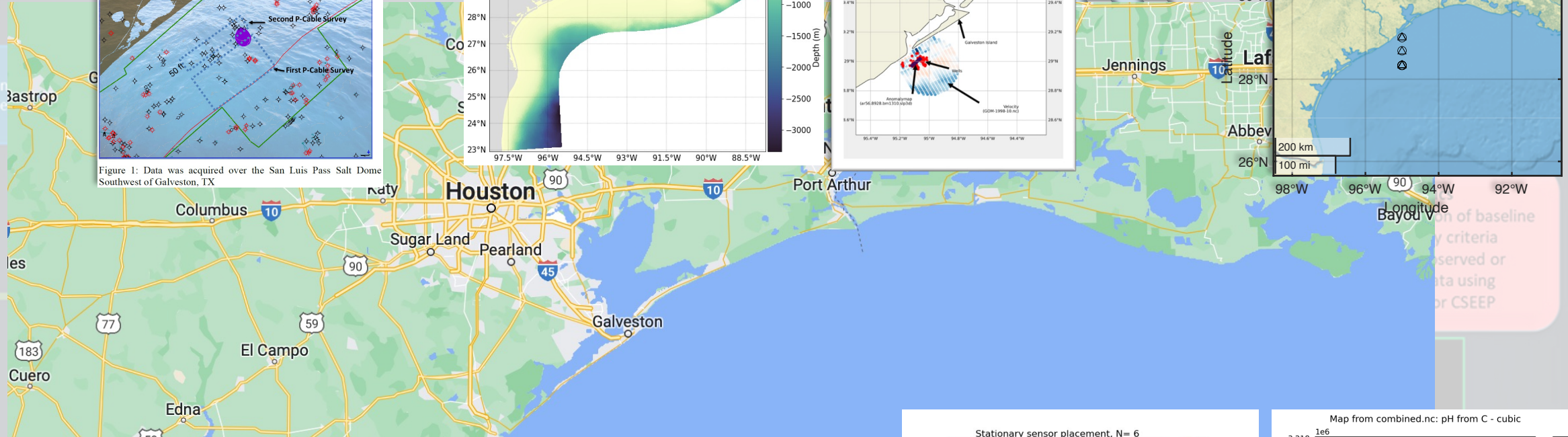
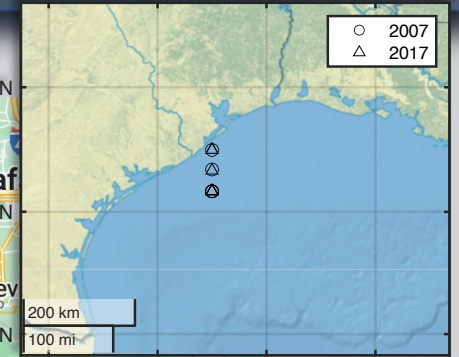
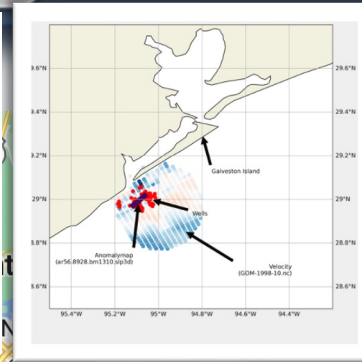
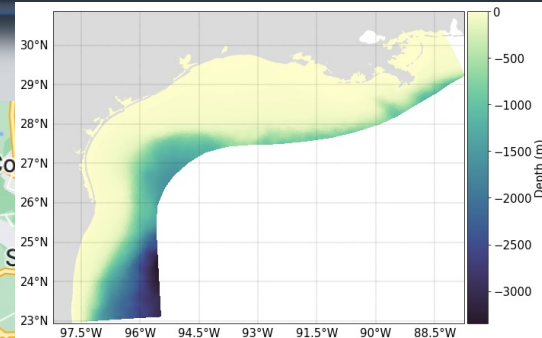


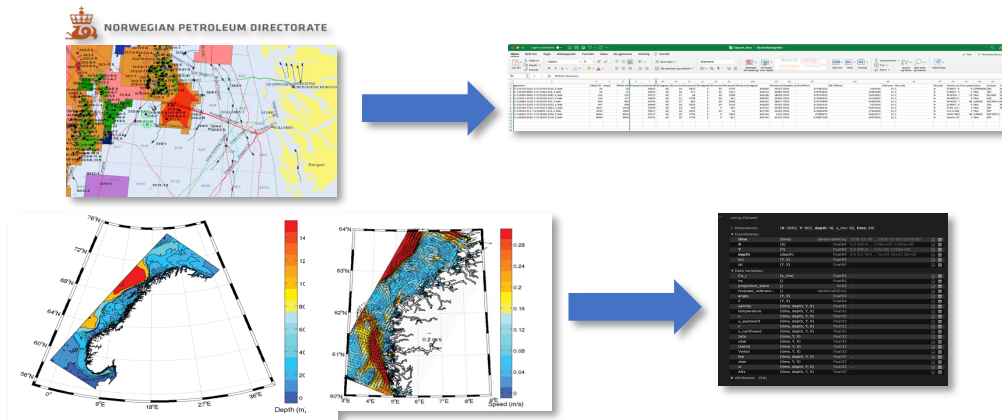
Figure 1: Data was acquired over the San Luis Pass Salt Dome Southwest of Galveston, TX





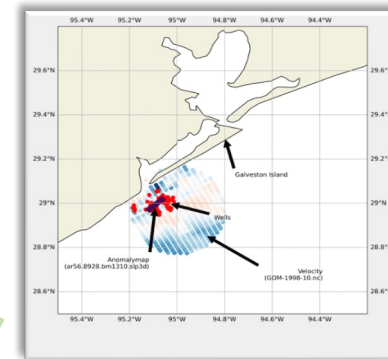
The site studies

Norwegian site



Need: biogeochemical baseline from the sea-floor.

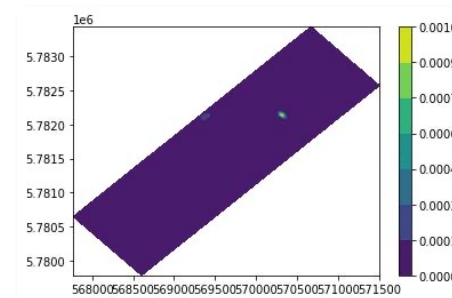
Gulf of Mexico



Fine tuning of scenarios

Need: Higher frequency biogeochemical baseline from the sea-floor.

P18



Need: velocities and biogeochemical baseline

UK site: TBD

