GipNet – Baseline environmental data gathering and measurement technology validation for nearshore marine Carbon Storage

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Abstract

The GipNet assets are the foundation to research programmes for pre-Project observations and instrument tests aimed at defining practical and relevant shallow marine Measurement, Monitoring, and Verification (MMV) programmes as the CCS industry considers shallow offshore waters in the Gulf of Mexico and other basins, as well as meeting the specifics of CarbonNet Project options.

The CarbonNet Project is investigating large volume storage (nominal 125 million tonnes of CO\textsubscript{2} over 25 years) in shallow waters within 20 km of the coastline, offshore Gippsland Australia. GipNet will research the levels of various types of noise and natural variation against which one seeks to detect a signal, or confirm a null signal.

In the well-understood, high quality and thick reservoirs of the Gippsland Basin, plumes are expected to be very predictable, relatively thick, and easily observable with the right techniques, but provision must be made for unexpected outcomes and technologies sought that have low detection thresholds to identify thin or diffuse plume offshoots or early warning of unexpected plume movements in order to provide assurance of storage security.

CarbonNet seeks to define at this pre-commercial stage, an appropriate, but not excessive, range of measurements to characterise the pre-existing environments. For each proposed technology, the physics of detection was reviewed, as well as the practicalities of deployment in the shallow-water and nearshore environment with multiple sources of “noise”, of initial research and test instruments and later detection systems appropriate for a commercial Project. Most importantly, each MMV technology was assessed for its value in monitoring CO\textsubscript{2} storage Integrity, Conformance and Assurance.

Three key technologies were identified for trial deployments and further testing:

1. **Natural Seismicity Monitoring Network**
The GipNet Seismic Network will involve surface-deployable onshore seismometers and shallow water (<100m) Ocean Bottom Seismometers (OBS). The network will enable monitoring of background seismic activity and other ‘noise’ sources in the region of prospective storage sites and in the future will enable detection of any induced seismic events that might occur as a consequence of future injection activities. The infrastructure will facilitate research into the state of stress, and controls on seismic energy release in the region, and a variety of associated geophysical properties such as crustal and basin velocity structure, and attenuation properties. An important research objective is to determine protocols for seismic monitoring of CCS in complex, noisy settings such as the nearshore Gippsland Basin.

Practicalities
Nearshore measurements will be strongly affected by surf noise and the ground conditions of soft dune sands. It will be important to characterise that noise and its variability in time and space so that noise floors can be established for different locations and weather conditions. It is also important to investigate methods for equipment installation that minimise noise (e.g. cemented into shallow boreholes, local noise-cancelling arrays, etc.). Shallow marine seismometers will also be subject to weather and tide/current noise and will have limited time deployments. It is not yet clear whether they will allow a significant catalogue of events to be recorded, and modelling of the probability of useful detection is underway.

2. Atmospheric Monitoring

An open-path measurement system will be established for atmospheric trace gases and isotopic composition of CO₂. The research programme will monitor sources and sinks of CO₂ in the region, characterise the natural variability in atmospheric concentration and isotopic ratios, and characterise the baseline CO₂ fluxes for the region. In the future, project MMV can then attribute any changes in local sources or sinks to natural oceanic or biogenic sources or conversely identify whether they are due to the storage infrastructure.

Practicalities
The coastal region is a low-density populated region, but hosts significant summer vacation activity, which may represent a disturbance threat to installed equipment and lines of sight. Atmospheric impacts of open fireplaces, vehicle exhausts, and recreational activities need to be considered, as well as atmospheric drift from the nearby hydrocarbon processing plant and industrial sources further afield. The open-path network will trial measurement over both onshore and marine paths, with strategically-placed retroreflectors and establish whether shore-based marine atmospheric measurements are practicable in the presence of marine aerosols.

3. Baseline Marine Monitoring

This project aims to utilise marine monitoring assets relevant to promising monitoring technologies, develop their use, test in the marine environment, and commence baseline definition activities. The shallow coastal waters containing the GHG exploration permits are well-mixed throughout the year due to tidal stirring, thus changes in water properties near the seabed should be reflected throughout the water column which will have advantages for monitoring. Records from nearby buoys show that the current direction is oscillatory with a range of timescales. The area is also subject to seasonal intrusions of water from the Tasman Sea with quite different properties to Bass Strait waters, increasing environmental variability substantially. While Sleipner and Snøhit have tested and implemented several aspects of monitoring, these sites are located in deeper waters (>100m), and so the proposed research is aimed at shallow water sites such as exist in many nearshore basins worldwide, including Gippsland and the Gulf of Mexico. Outputs will include a reference dataset from which to select appropriate measurable parameters.
and fixed locations or schedules for mobile measurements in the future, including reference to physical features such as wellheads and subsurface discontinuities, including faults.

**Practicalities**
A marine exclusion zone exists around oil and gas facilities in the basin, including subsea wellheads and pipelines. Shipping traffic can be predicted to a large extent with defined shipping channels and direct pathways between oil platforms and the service base, but non-scheduled traffic also exists, including leisure craft and fishermen.