Environmental assessments of offshore Carbon Capture and Storage (CCS) sites using unmanned surface vehicles (USV)

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Abstract

Understanding the environmental context of potential subsea CO₂ storage projects is a challenging task that requires the development of risk-based environmental monitoring to address public assurance, as well as regulatory requirements. A core need is an understanding and quantification of background environmental variability in relation to the likelihood of detection from putative release. Unmanned surface vehicle (USV) technology is rapidly evolving, with a number of USV platforms available that can meet a variety of needs in ocean observing. Advanced sensor technologies integrated on USVs promise coverage and flexibility for sustained observations at space and time scales not previously achievable. This paper describes CSIRO research with USVs in support of CCS environmental monitoring studies in Australia.

CSIRO utilises a range of autonomous systems, including autonomous underwater vehicles, remotely operated vehicles and robotic profiling floats as part of its observing capabilities. For CCS studies, CSIRO is partnering with Saildrone Inc. to provide a flexible platform that houses a suite of sensors for environmental assessments at offshore CCS sites. The Saildrone platforms have been designed to accommodate sensors for detection of three important monitoring types: seawater carbon dioxide, bubble acoustics and water quality. The Saildrones can be used for long-range reconnaissance in a broad range of sea conditions and with up to 6-month deployment durations. Each Saildrone platform and its science systems can be operated remotely, with data transmitted back to shore via satellite to allow real-time monitoring of changes in the marine environment. The rapid deployment and response of the platform allows for more detailed investigation of features identified during surveys and of anomalies that exceed the known variability in measured variables. The combination of the platform with fixed measurements, such as those collected using more traditional oceanographic moorings, provides new capability to assess variability at CCS sites over a larger survey area than has been possible before.

The sensor systems fitted to the Saildrone and the land based calibration and maintenance support facilities are state of the art. The carbon sensor suite delivers pH, pCO₂ and dissolved oxygen. It is based on a robust system proven to work in the field over long periods and includes reference gas and transmission of multiple diagnostic parameters to ensure sensor performance and calibrations are maintained. The acoustic sensors use a two-frequency split beam system operating at 38 kHz and 200
kHz that can detect low concentrations of bubbles in the water column. It will be possible to detect and monitor potential or reported bubble plumes over time to determine the cause. In this way reducing false alarms where under certain circumstances aggregations of fish or zooplankton can be mistakenly interpreted as a bubble plume. Sensors for sub-surface bio-optics to assess water column plankton (chlorophyll and particle backscatter), oceanographic (temperature and salinity) and meteorological data are also incorporated into the real-time data streams delivered from the Saildrone.

This paper will provide an overview of the sensor configuration and performance capabilities of the USVs for use in environmental assessments to support CCS. Sea trial and other data including CCS monitoring strategies will be presented. Finally, the paper will discuss potential future uses of the platform for ongoing monitoring of CCS sites.