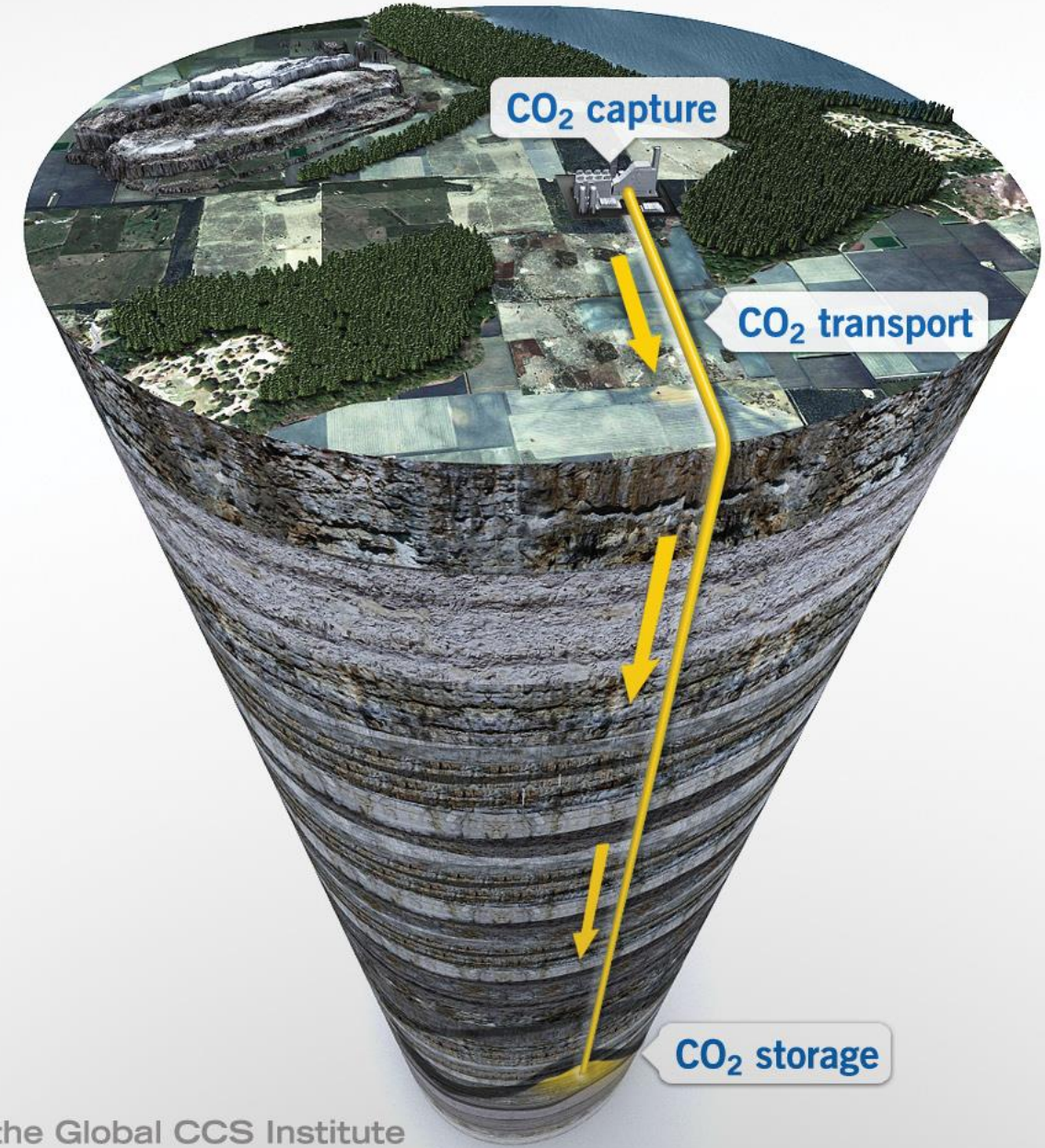
OPERATIONAL OCEAN OBSERVING FOR OFFSHORE CARBON CAPTURE AND STORAGE

The value of legacy data and potential of new observing platforms

OCEANS & ATMOSPHERE
www.csiro.au

Nick Hardman-Mountford, Charles Jenkins, Jim Greenwood, Bronte Tilbrook, Rudy Kloser, Phil de Boer & Andreas Marouchos

THE CARBON CAPTURE AND STORAGE PROCESS

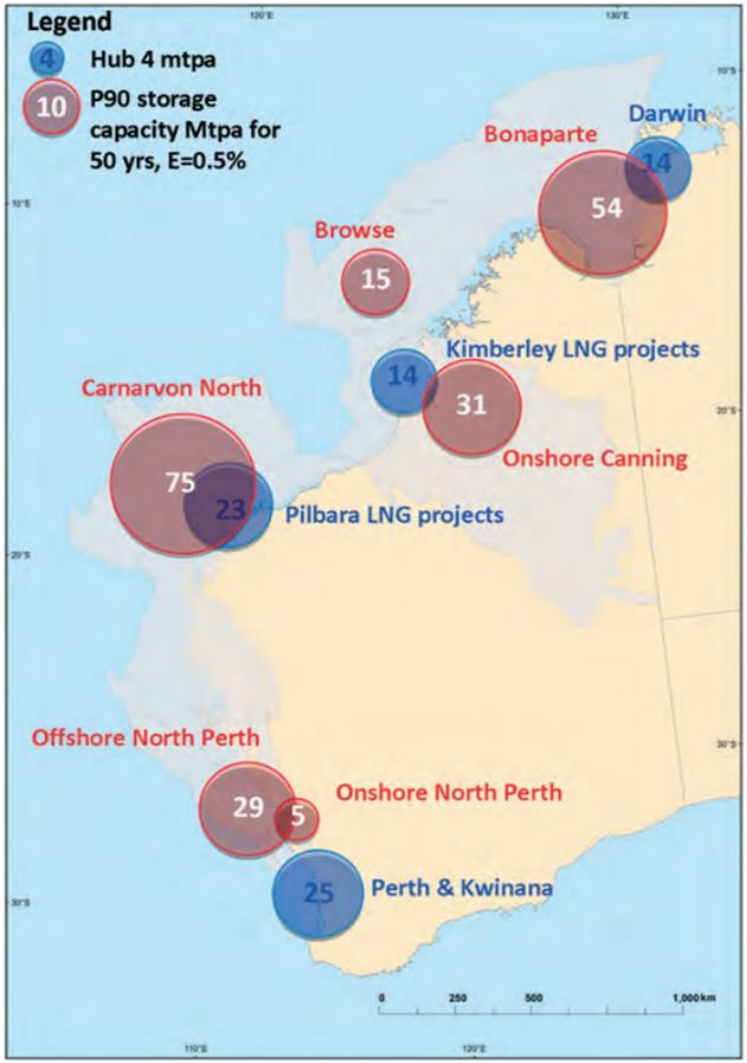


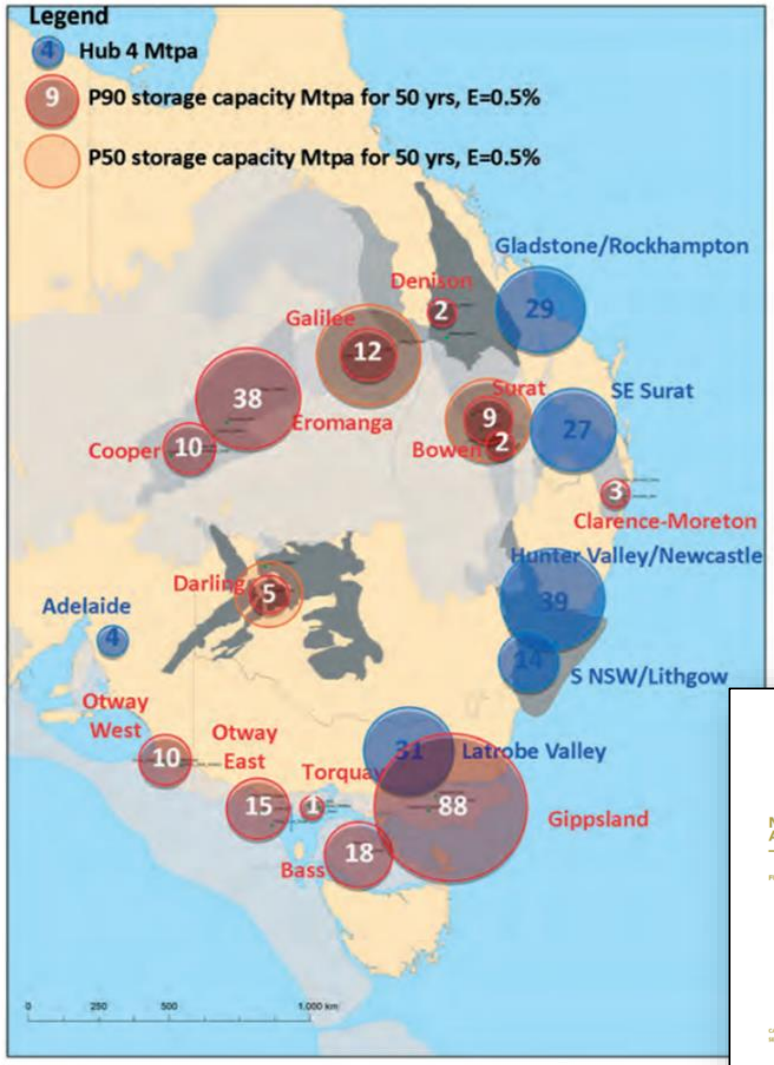
Provided by the Global CCS Institute

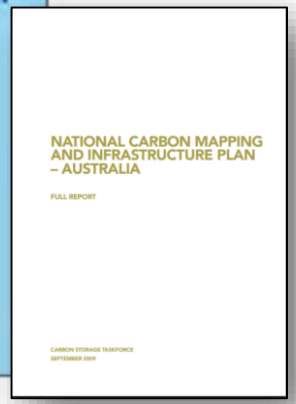
Key approved CCS projects 2016

Figure 1 Key CCS project developments and milestones

Australian hub emissions and GHG storage capacity

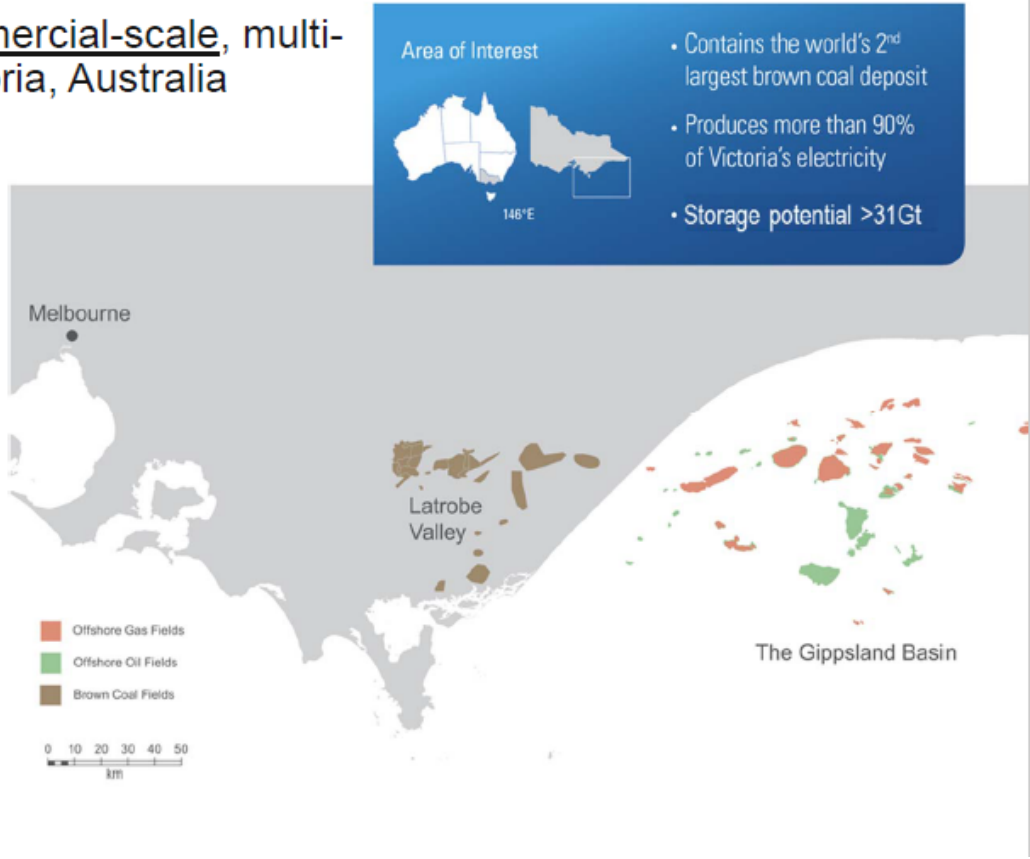






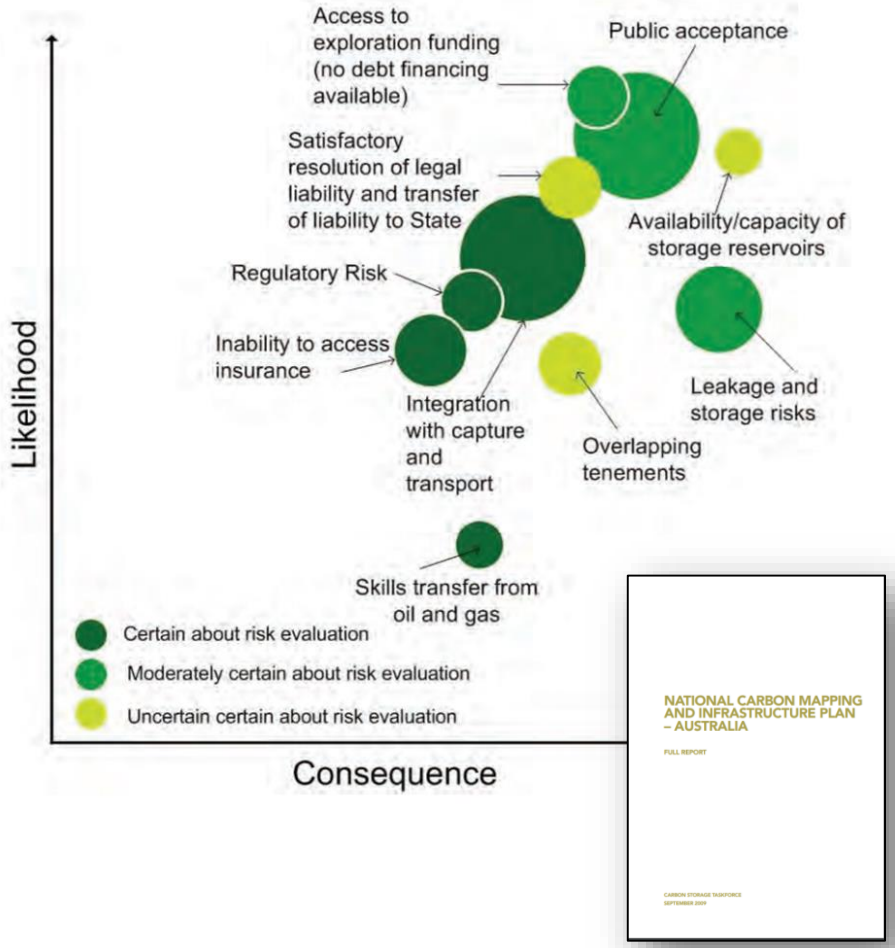
THE CARBONNET PROJECT

- Investigating the feasibility for a commercial-scale, multi-user CCS network in Gippsland, Victoria, Australia
- Jointly funded by the Australian and Victorian Governments to 2020
- Significant research investment to support CarbonNet eg ANLEC R&D
- CO2CRC is CarbonNet's lead research organisation eg Commonwealth EIF assets
- Knowledge sharing via GCCSI
- Working collaboratively with industry to secure customers and investors in a **CCS service**



The operational oceanography challenge

Figure 39: Risk Analysis – Storage

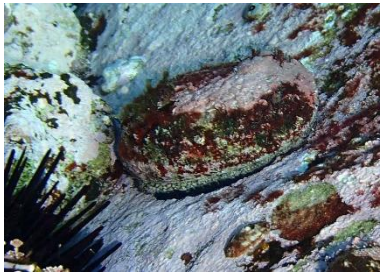


- Leakage risk is minimised through good planning and reservoir characterisation
- Primary methods for containment and conformance monitoring are not oceanographic but geological (downwell, 4D seismic, etc.)
- **But over the lifetime of storage there will almost certainly be significant environmental change from a range of pressures (e.g. climate change, coastal development, etc.)**

→ **Assurance monitoring challenge**

Gippsland: subsea environment

- Marine parks and reserves
- High biodiversity and endemism
- Charismatic species: whales, sea lions, sharks
- Valuable commercial fisheries
- Recreational value, e.g. fishing
- Oil and gas activity



Assurance monitoring: research challenge

GOAL: Establishing robust criteria, thresholds and approaches for assurance monitoring of CCS operations in shallow-coastal seas

1. Signal-to-Noise

Can we separate the signature of a CO_2 release (the"signal") from similar naturally occurring signals in the marine environment (the environmental "noise")?

2. Defining environmental impact

Can we determine the level of CO_2 release that would be associated with environmental impact at a range of scales?

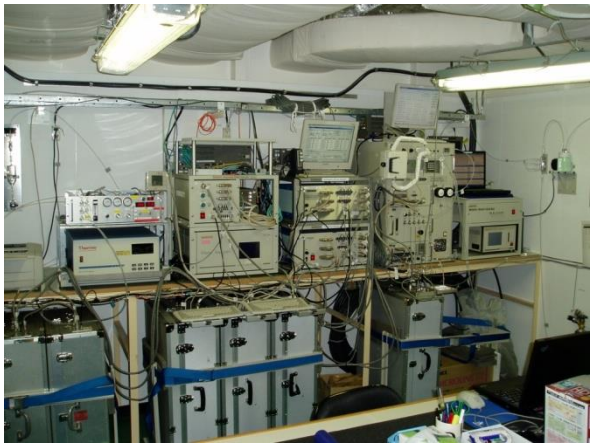
3. Attributing environmental impact

Can we distinguish changes resulting from other drivers and pressures in multiple-use zones from the activities of CCS operations

Understanding CO_2 variability in Bass Strait

Atmospheric monitoring lab

Seawater monitoring lab

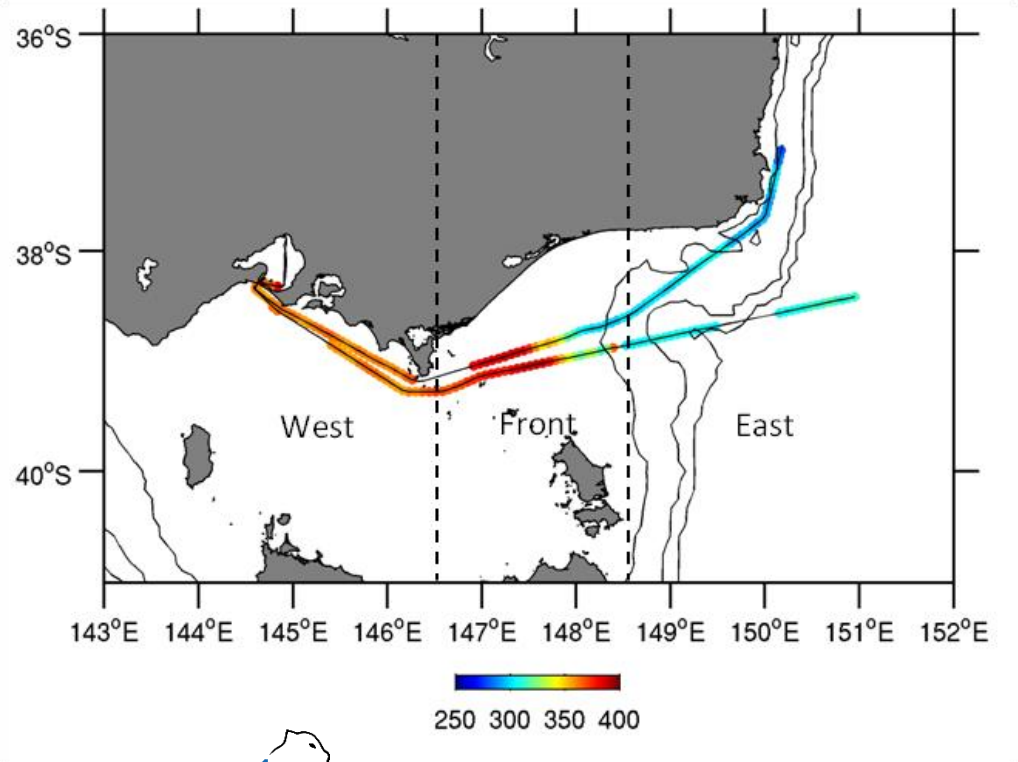


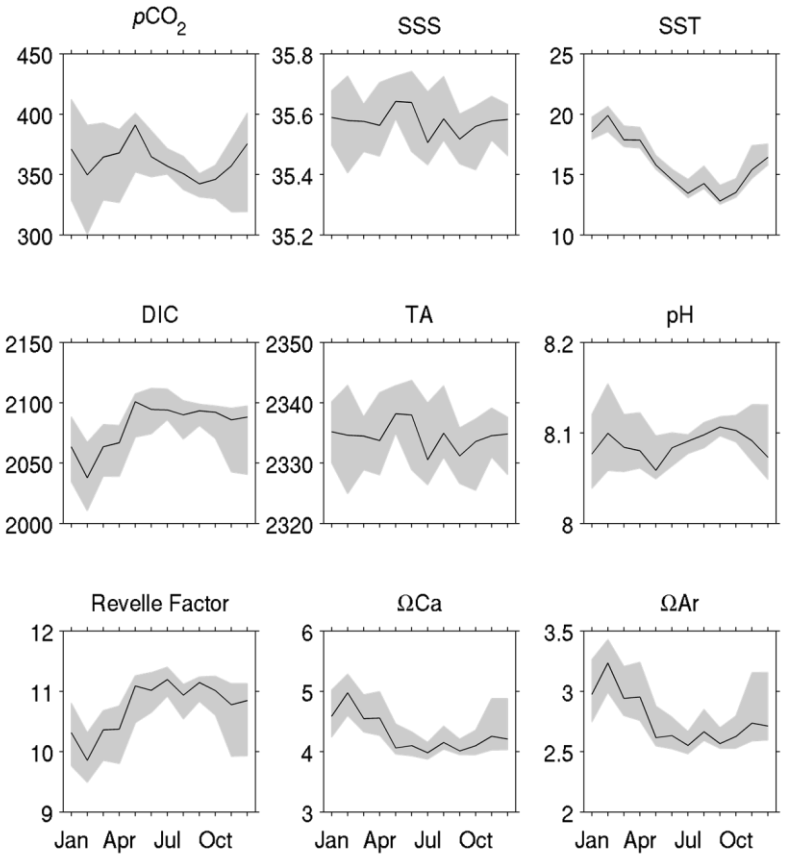
- Collaboration: CSIRO (Aus) & NIES (Japan)
- 6 weekly transects through Bass Strait
- Time series: 2006 - Date
- Measures: Temp, Sal, pCO_2, DIC, TA

Slide courtesy of Tilbrook (CSIRO) & Nojiri (NIES)

Bass Strait: climatology of CO_2 system and hydrology

Average along-track pCO_2 distribution



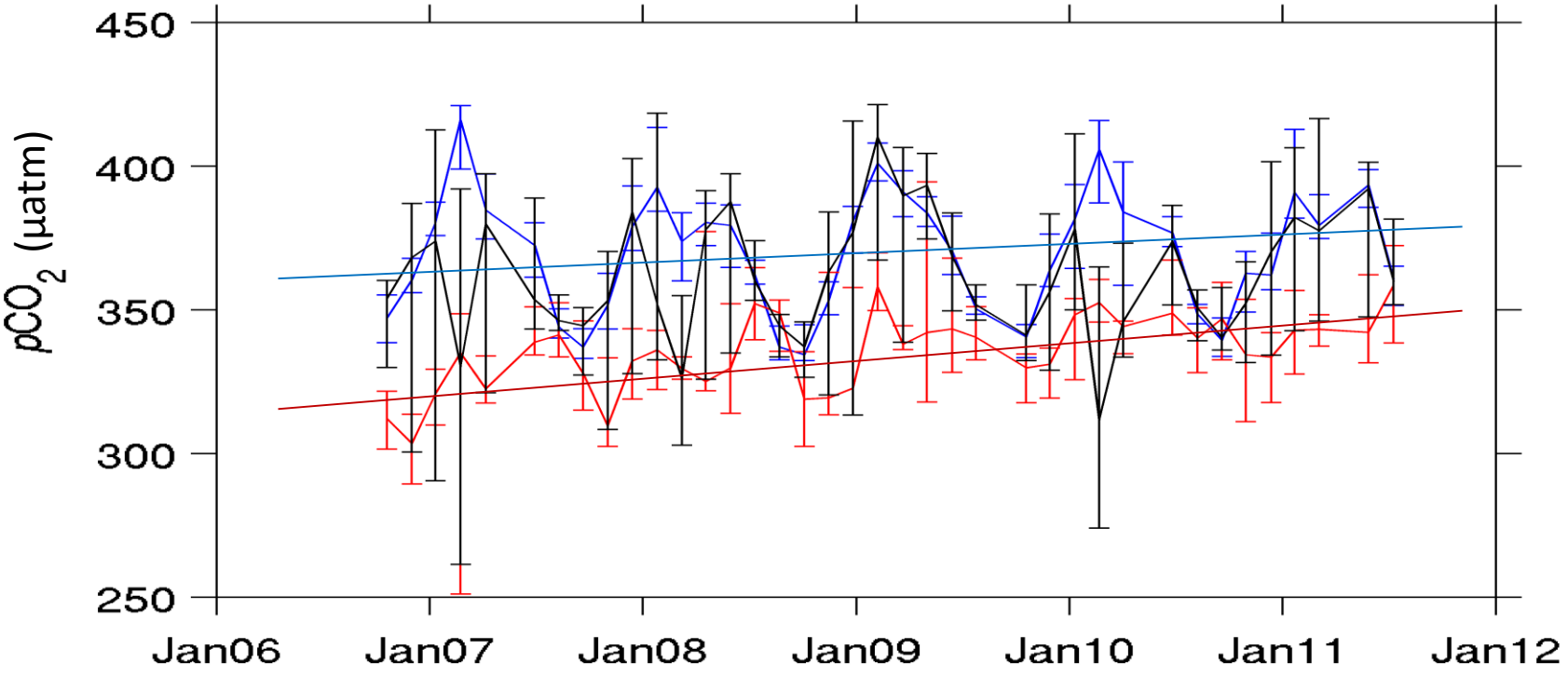


SOCAT · SURFACE OCEAN CO_2 ATLAS ·

Hardman-Mountford et al. (2014)

CSIRO

Spatially-averaged pCO_2 timeseries

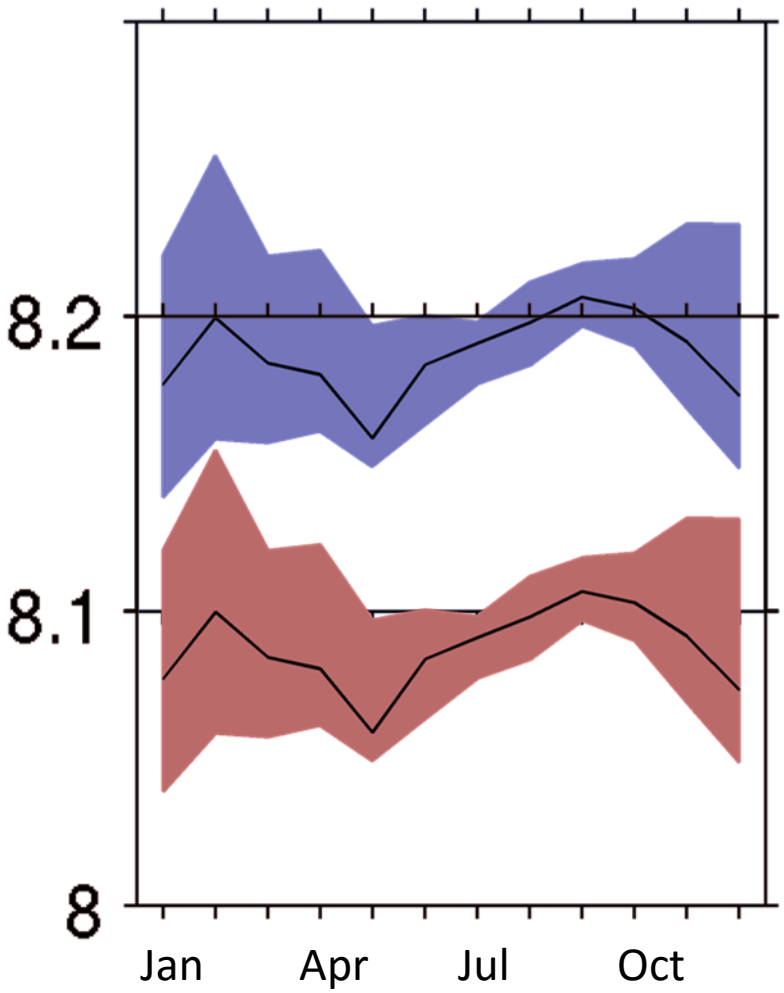


BSW ~2 µatm/y
TSSW ~6 µatm/y

West (Bass Strait)
East (Tasman Sea)
Front (mixed)

Hardman-Mountford et al. (2014)

Bass Strait already outside pre-industrial pH range



- Seasonal pH range of 0.1
- CO_2 uptake consistent with global rates
- Same range as global mean increase

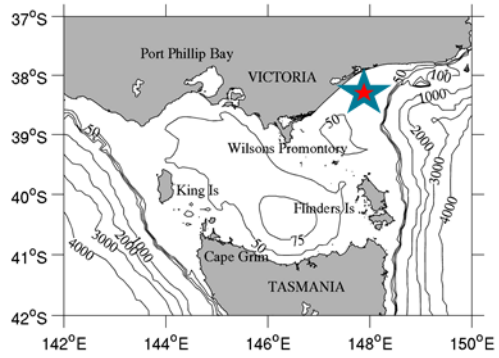
→ Bass Strait is likely outside pre-industrial range

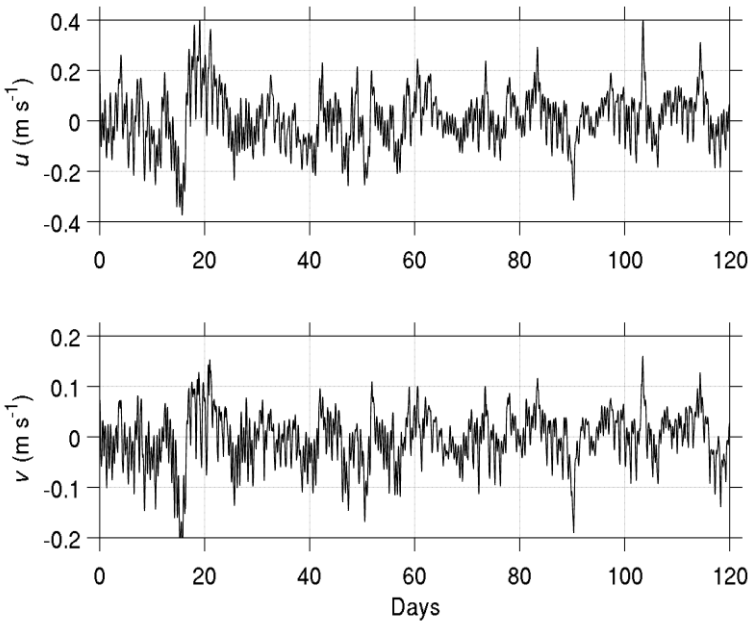
2006-11

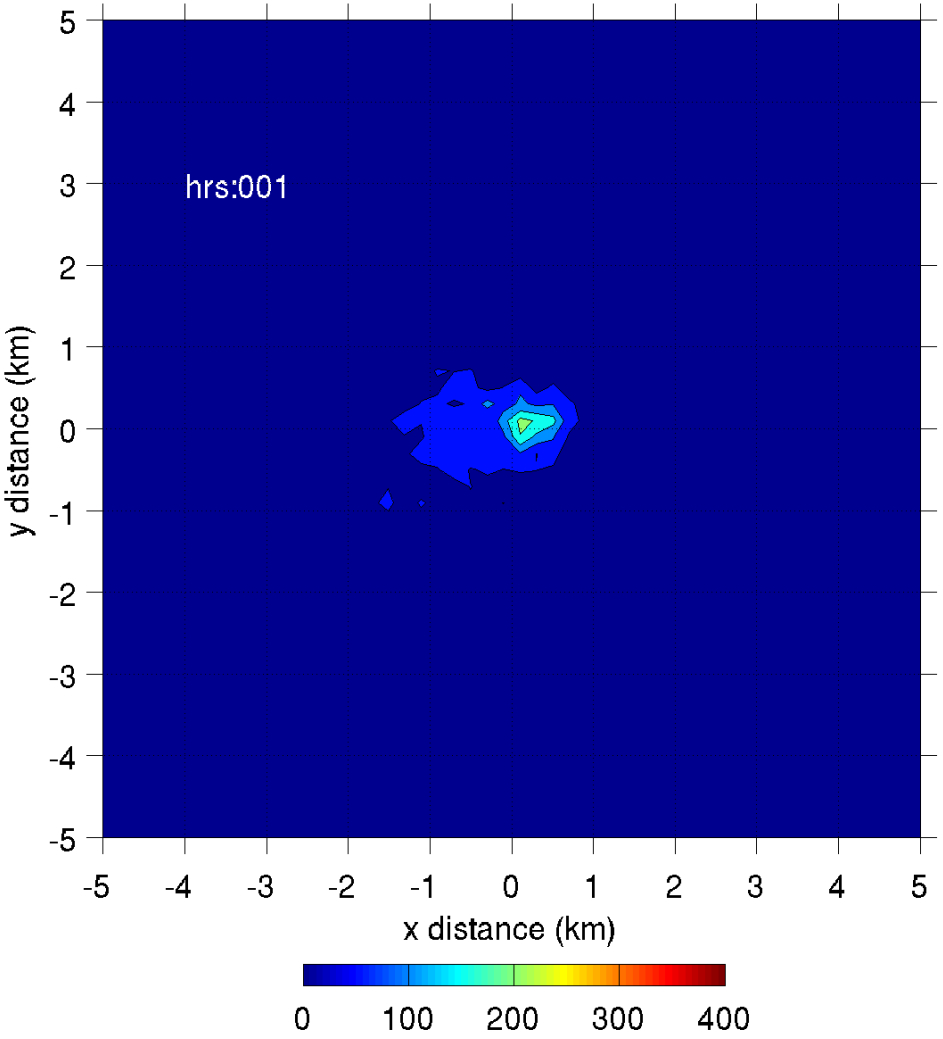
Pre-Industrial

Hardman-Mountford et al. (2016)

Understanding plume dynamics



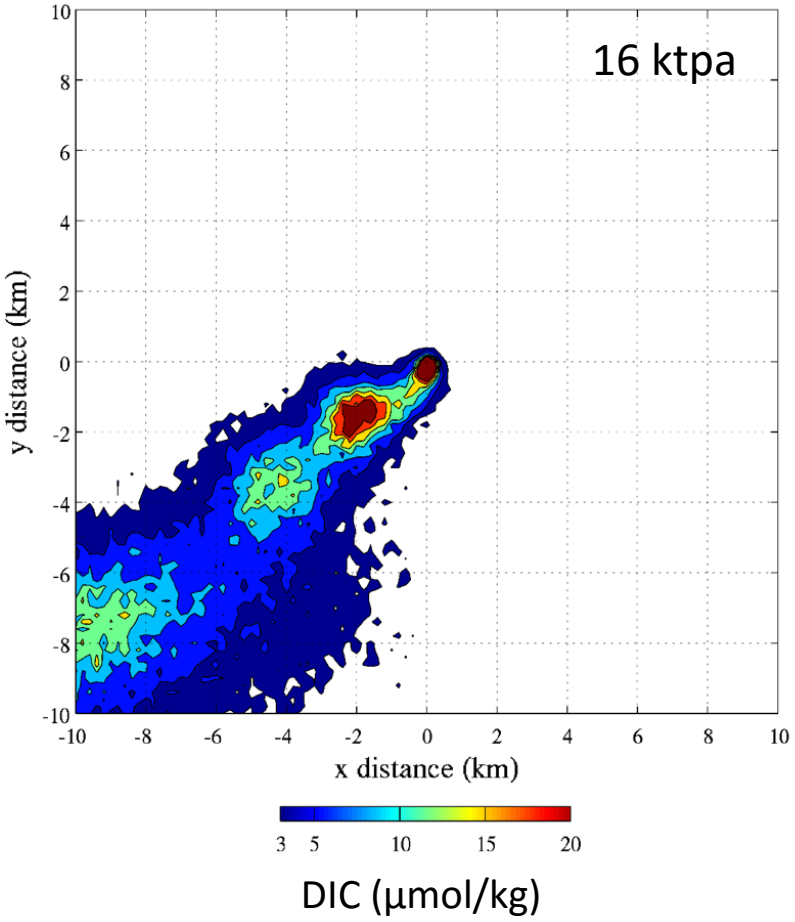




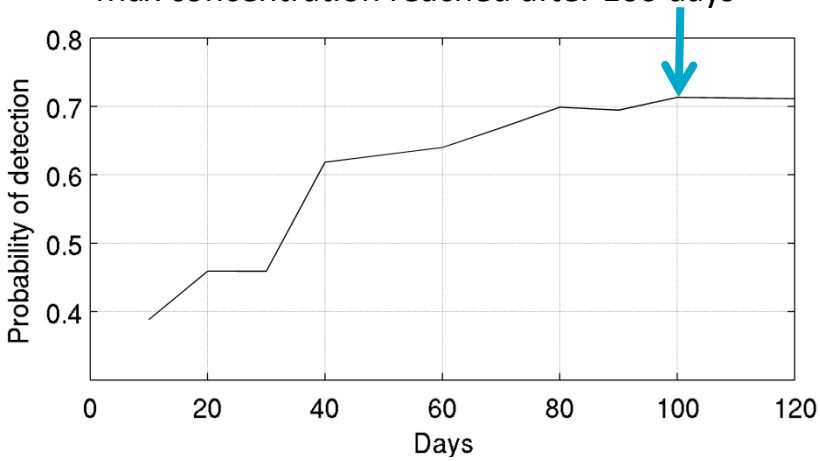
Greenwood et al. (2015) IJGGC

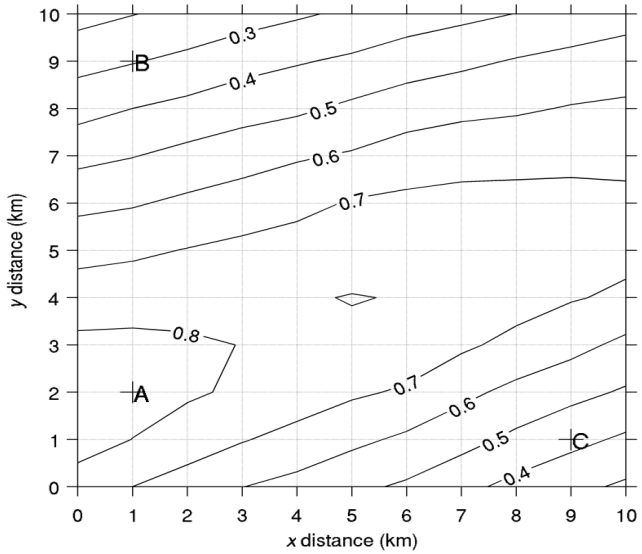
2D Plume modelling related to seasonal variability

Maximum cell concentration



Max concentration reached after 100 days





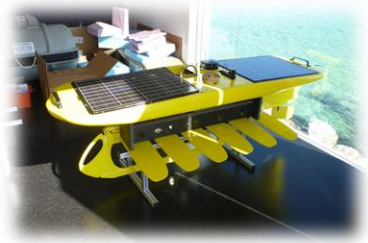
A = 84%

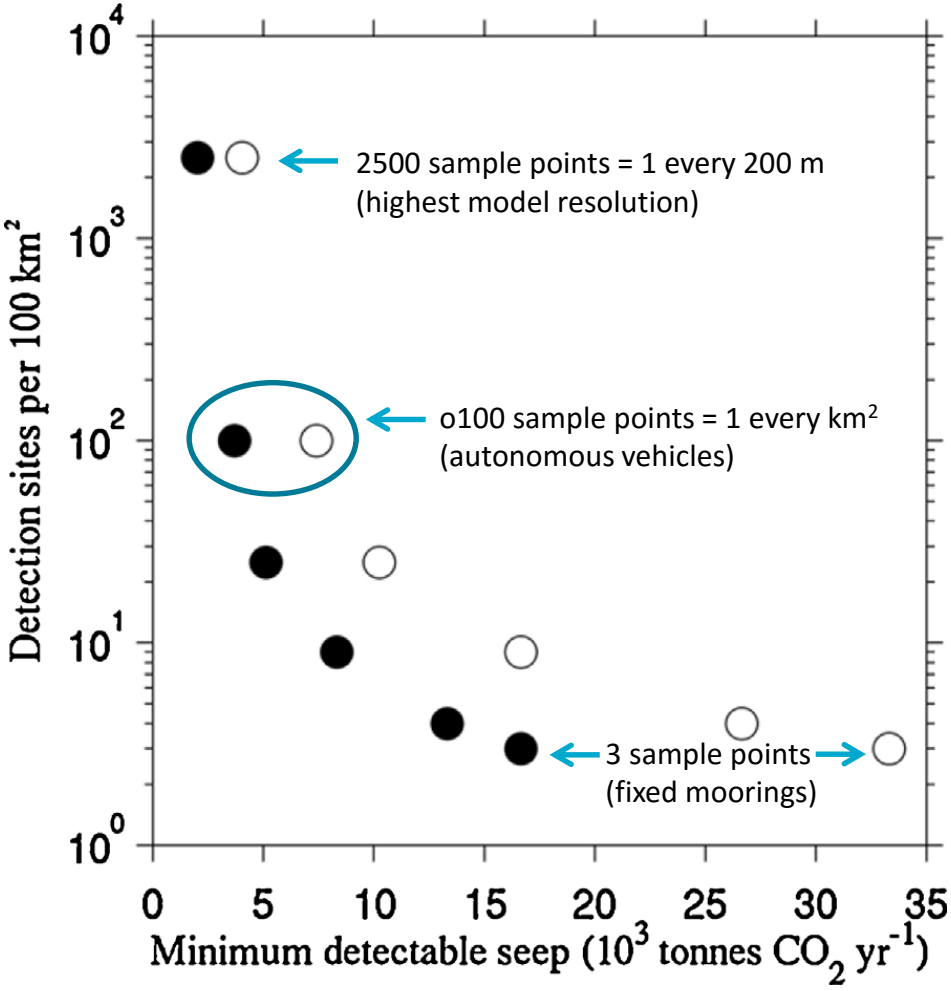
A + B = 96 %

A + B + C = 100%

Greenwood et al. (2015) IJGGC

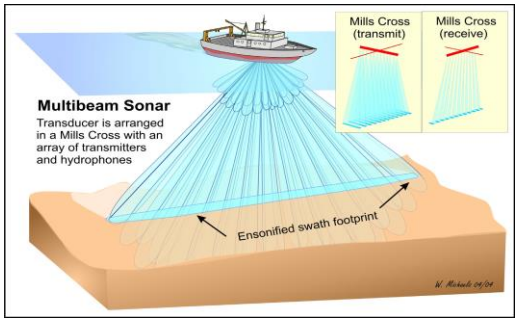
Sampling density vs. detectable leak rate





Greenwood et al. (2015) IJGGC

Acoustic measurement capabilities



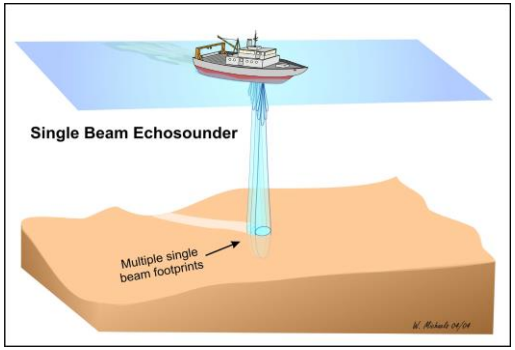
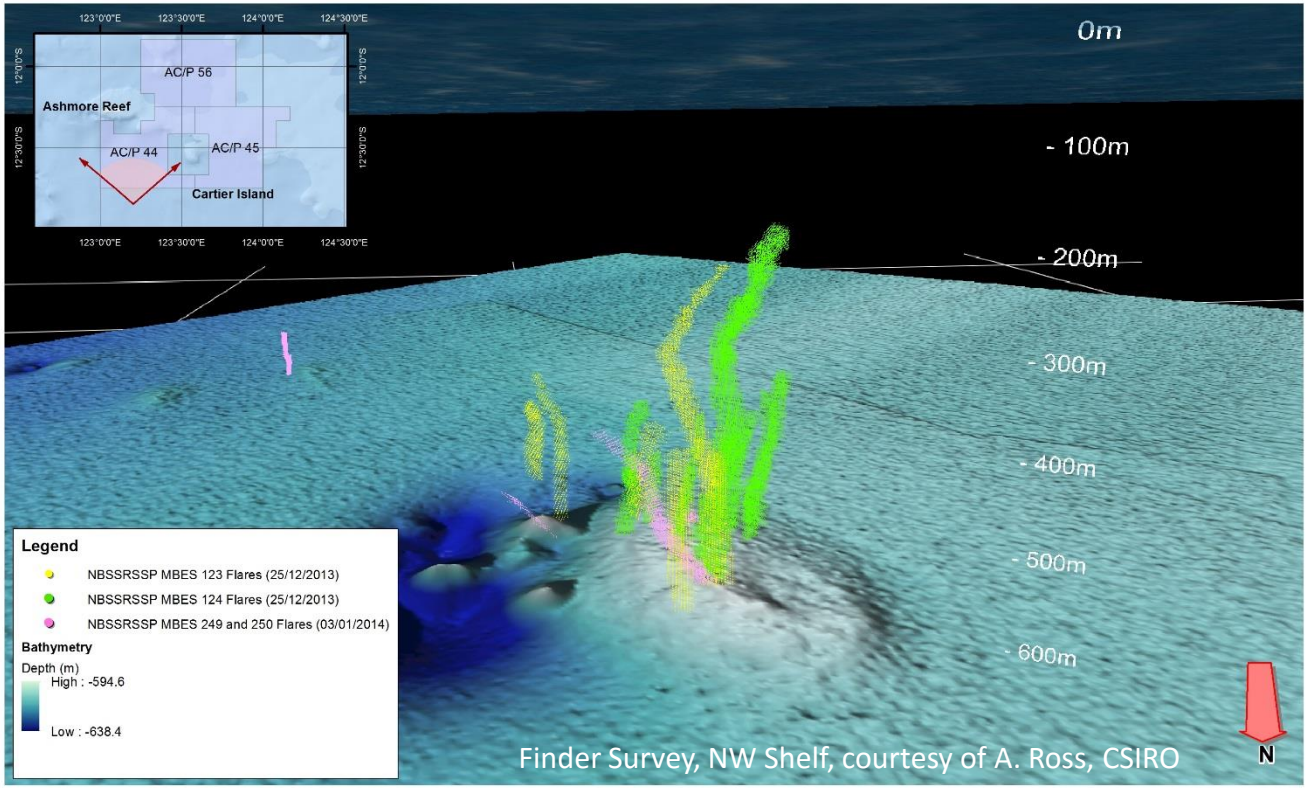


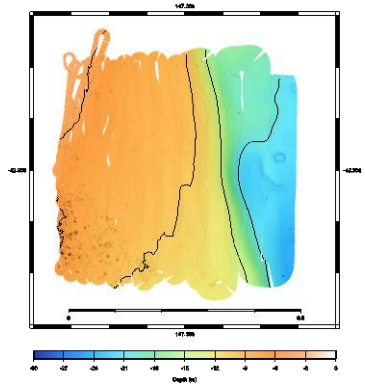
Figure 5: 3D View of the NSSB 01 (Flares 123, 124, 249 and 250)



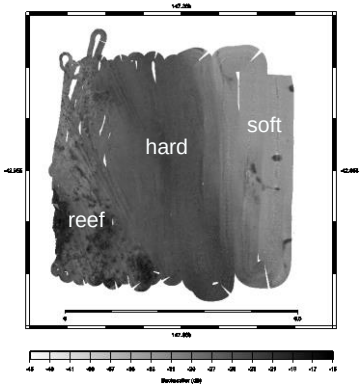
Stalvies et al. (2017)

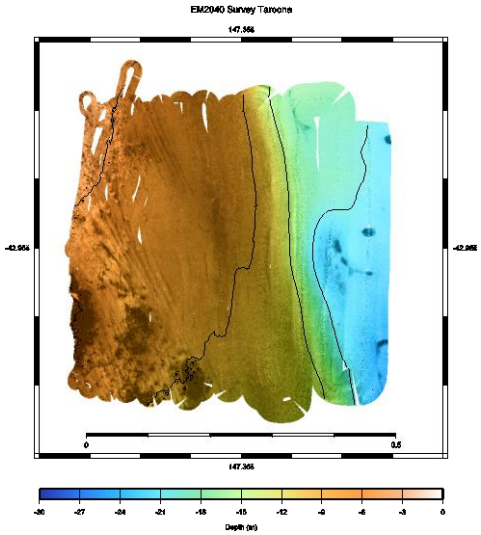
Acoustic signals and false alarms

Bathymetry

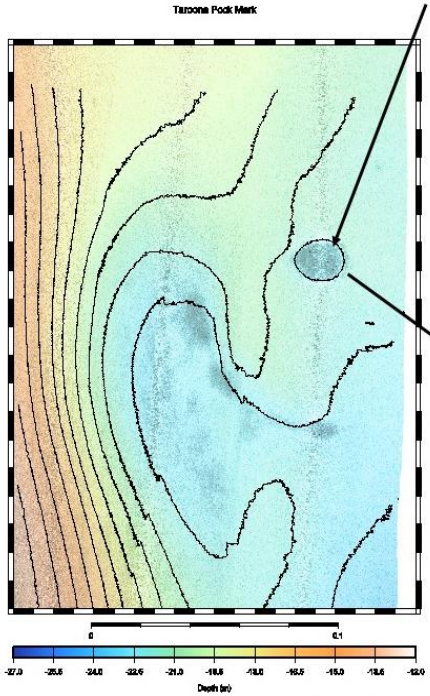


Backscatter

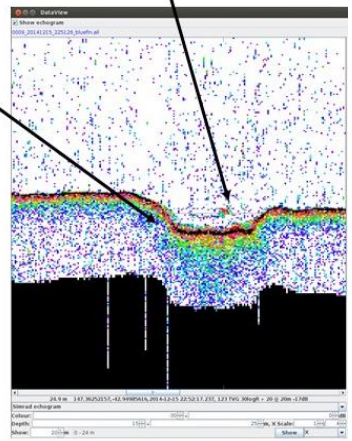


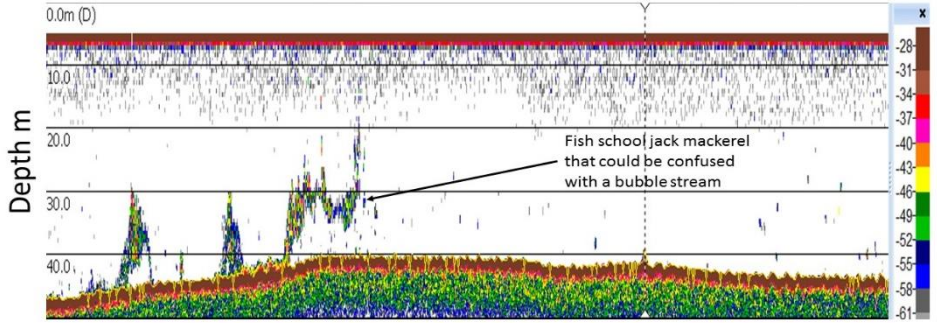


Potential site of gassy sediments in a depression



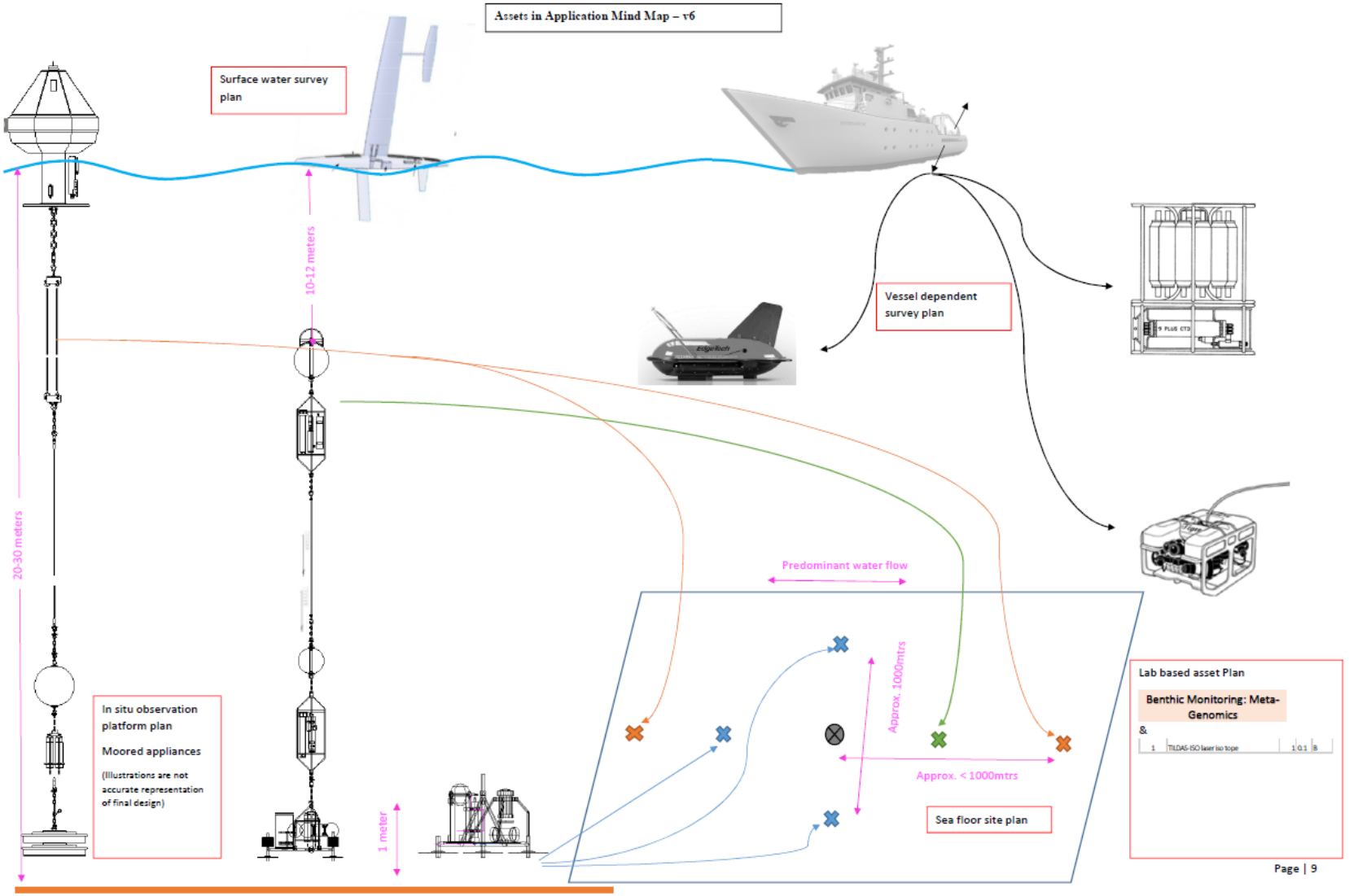
Cross section of the depression using central beam and suspected fish





Hardman-Mountford et al. (2015)

Gipsland Monitoring Network (GipNet): Marine




EdgeTech
EdgeTech 2000-DSS


SBE

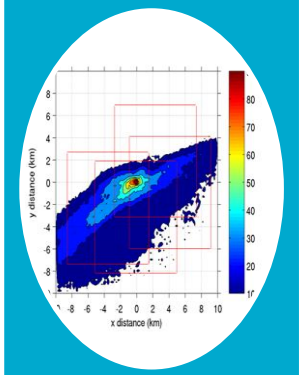
Program of work

CO2CRC BUILDING A LOW EMISSIONS FUTURE

anlecr&d
www.anlecrd.com.au

Design

- 1. Experimental investigation of optimal sensor configurations within a monitoring network design



Model

- 2. Numerical investigation of 3D plume structure using a coupled hydrodynamic-carbonate system model

Sensors

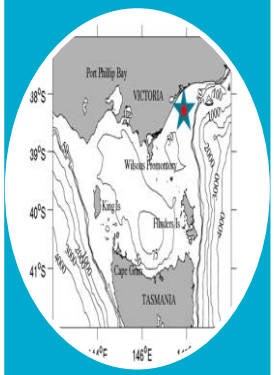
- 3. Investigate natural variability in monitoring targets using **fixed sensor network** (moored buoys, landers)

ASV

- 4. Investigate natural variability in monitoring targets from integrating **Autonomous Surface Vehicle (ASV)** with fixed network

Bio

- 5. Investigate natural variability in biological indicators of impact



IEA

- 6. Integrated assessment of operating environment and monitoring solutions

CSIRO

Thank you
Questions?

Acknowledgments:

CSIRO
ANLEC R&D
CO2CRC
Australian Government
CarbonNet
ACCSP
NIES (Japan)
TransFuture5 crew

Australian Government
Department of Industry, Innovation and Science

Australian Government
Department of Education and Training

Australian Government
Department of the Environment and Energy

VICTORIA State Government
Economic Development, Jobs, Transport and Resources

CO2CRC BUILDING A LOW EMISSIONS FUTURE

anlecr&d
www.anlecrd.com.au

OCEANS & ATMOSPHERE
www.csiro.au
nick.hardman-mountford@csiro.au

CSIRO