Ocean acidification observing systems

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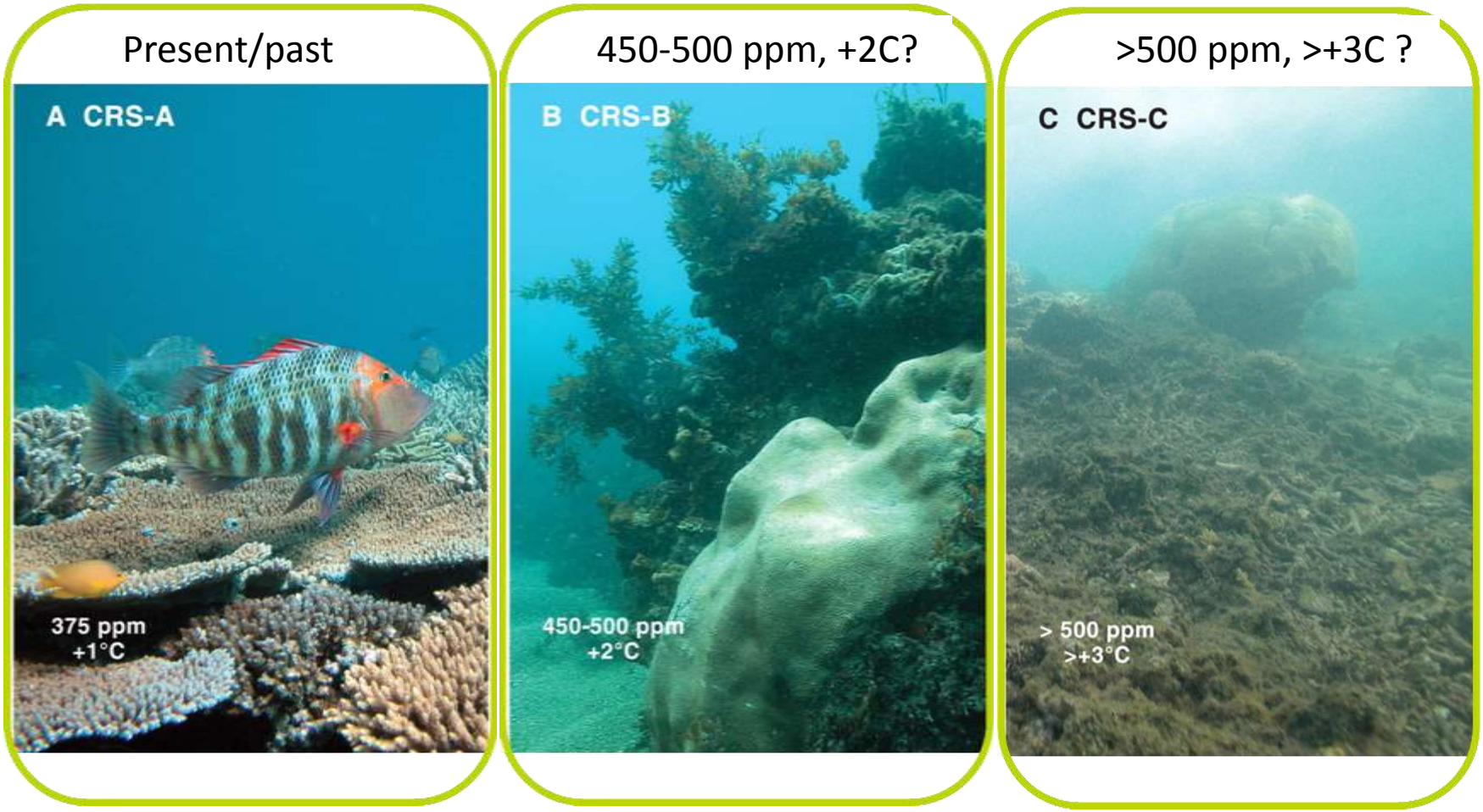
CSIRO OCEANS AND ATMOSPHERE
www.csiro.au

Ocean Acidification workshop
28-29 August 2014, Apia, Samoa

IMOS
Integrated Marine Observing System

CSIRO

Ocean acidification and reef futures



modified after Hoegh-Guldberg et al. 2007

Ocean Carbon and Acidification Research

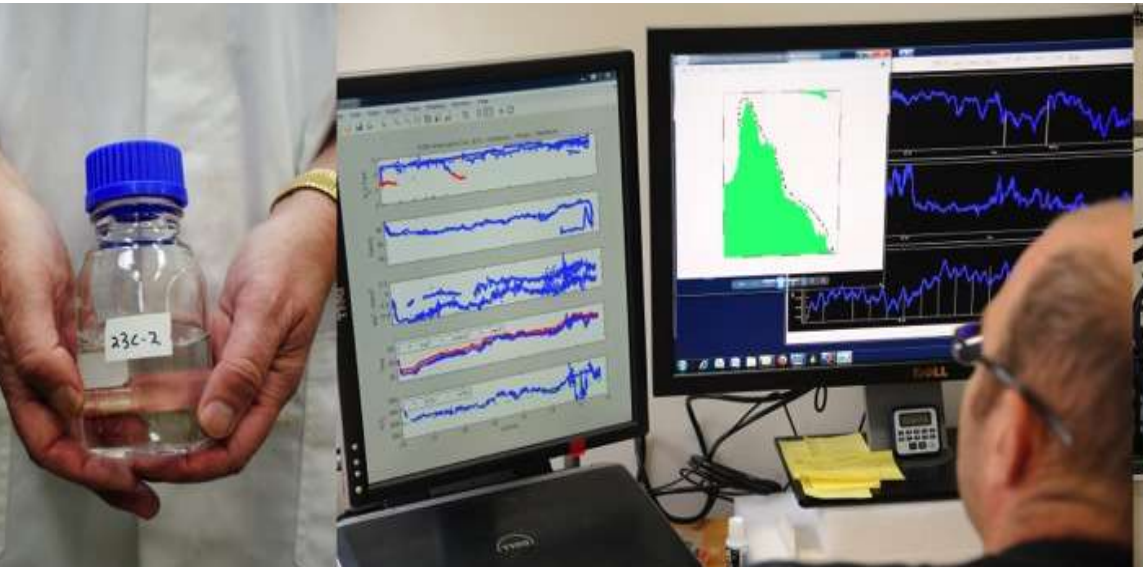
- Uptake and storage of CO_2 in Southern Hemisphere waters

- Detection and attribution of acidification change and the response of ecosystems, including tropical reef communities

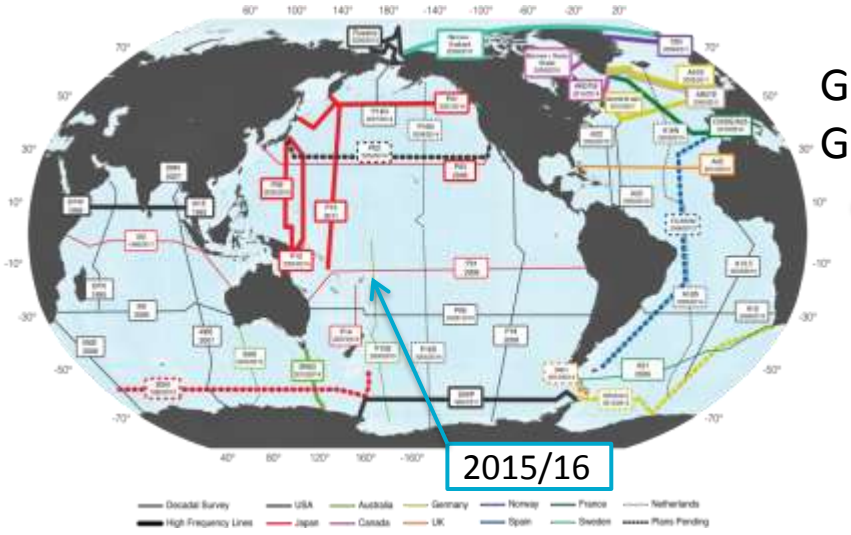
e.g.

- GBR shift from net growth to net loss
- GBR regions of vulnerability
- GBR change in future

Calibration, Testing and Quality Control

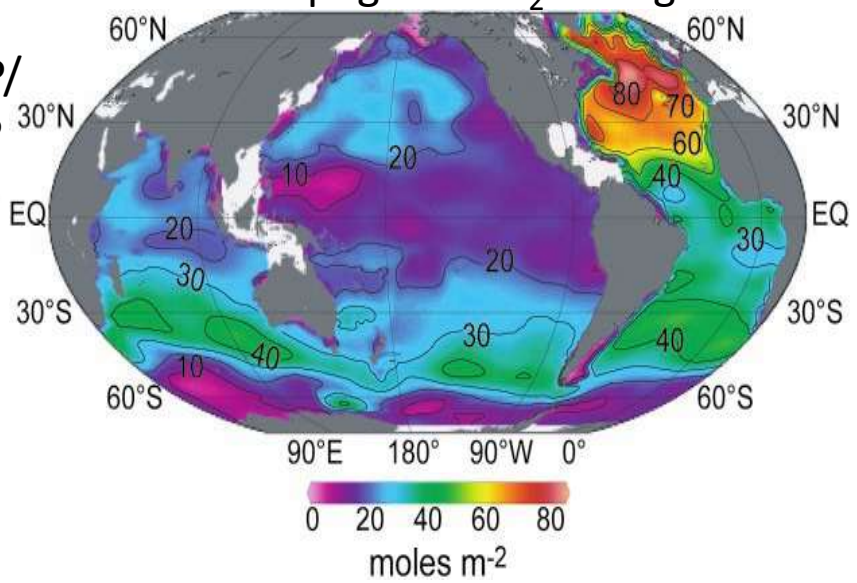


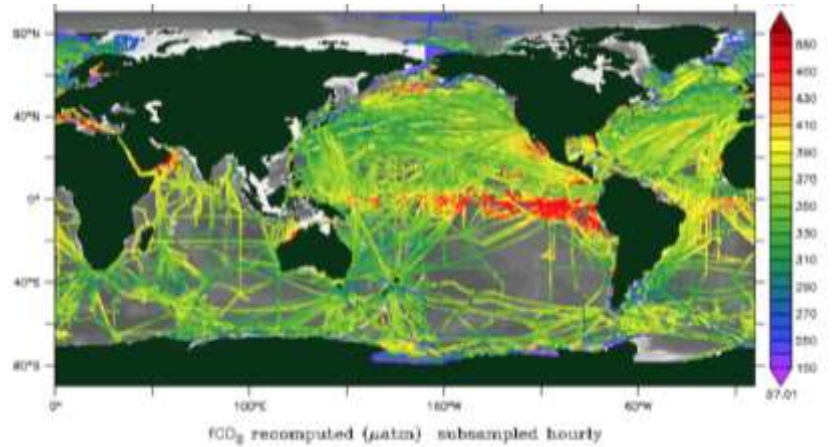
Ocean acidification: basin-scale changes



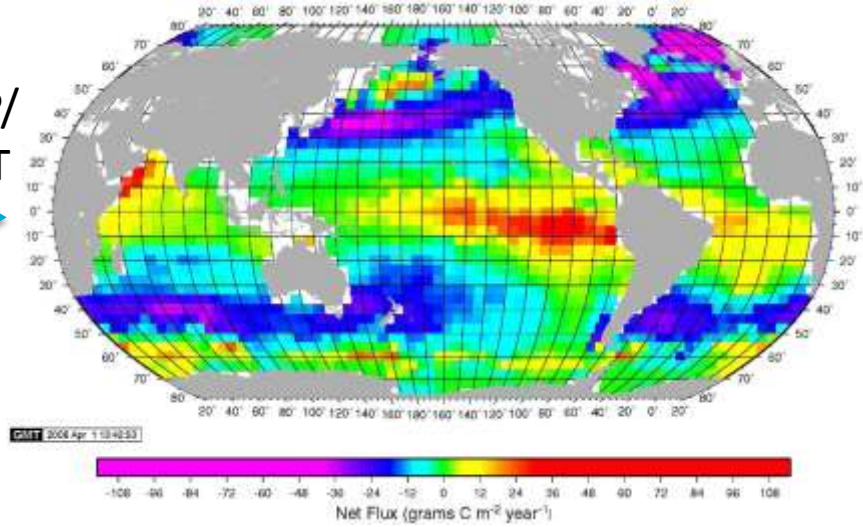
GO-SHIP/
GLODAP

anthropogenic CO_2 storage





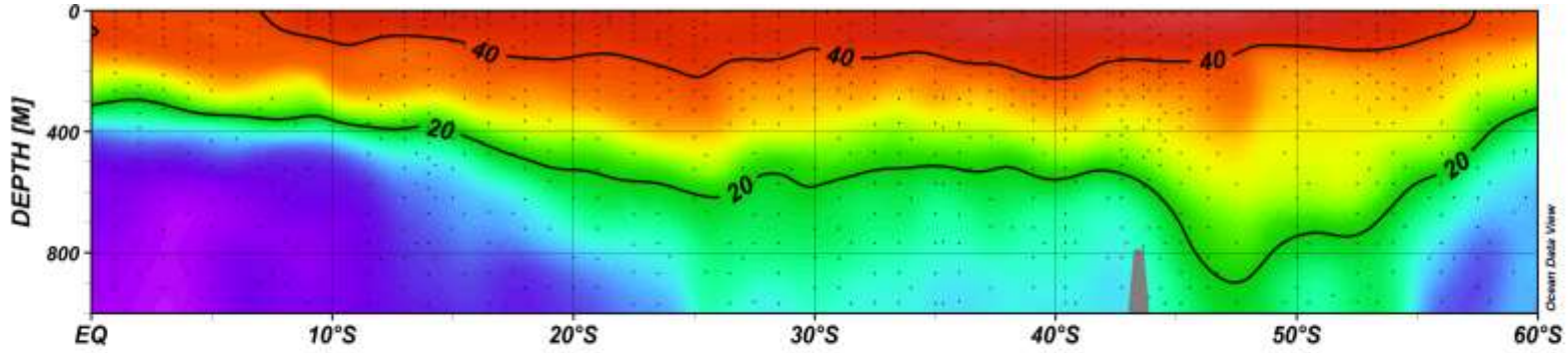
IOCCP/
SOCAT



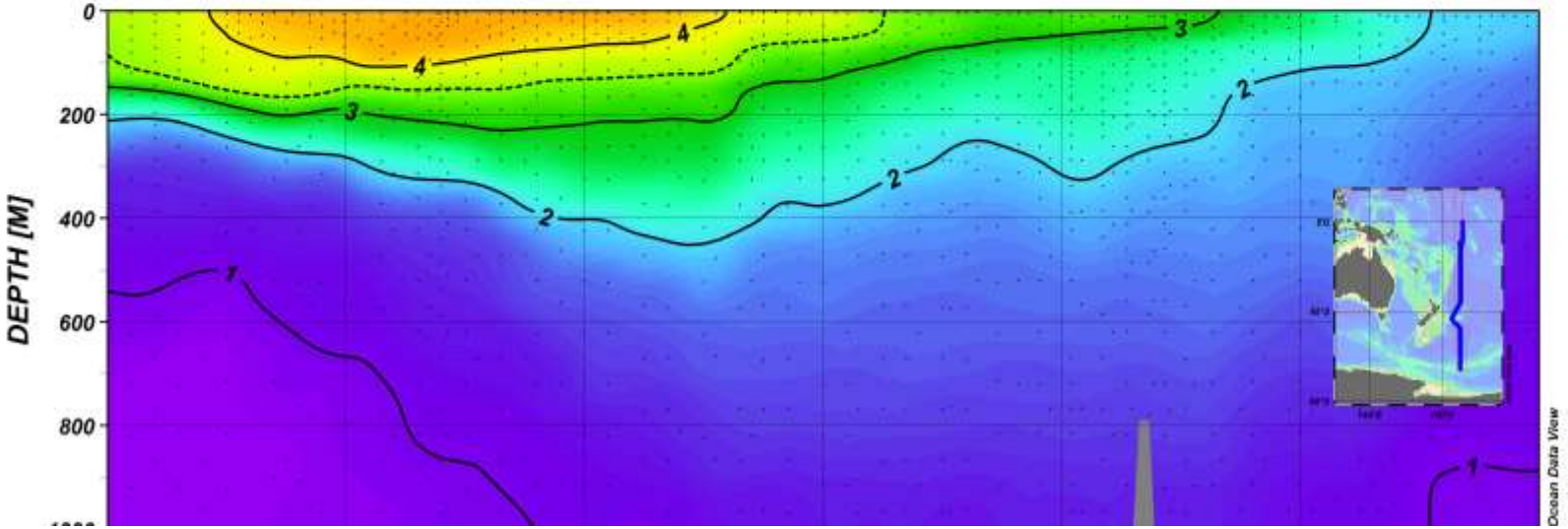
air-sea CO2 flux

Ocean sections: P15S, Southwest Pacific

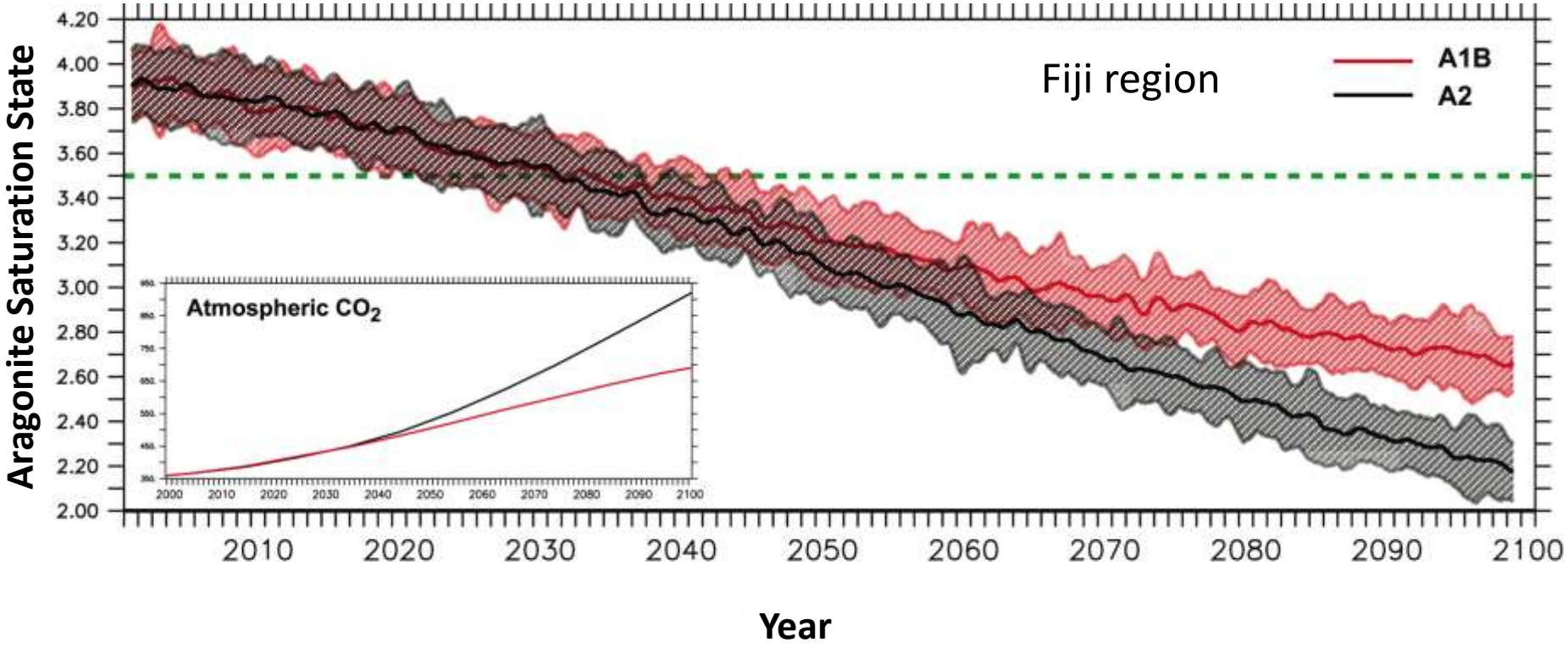
Anthropogenic CO_2 (micromol/kg)



Aragonite Saturation State

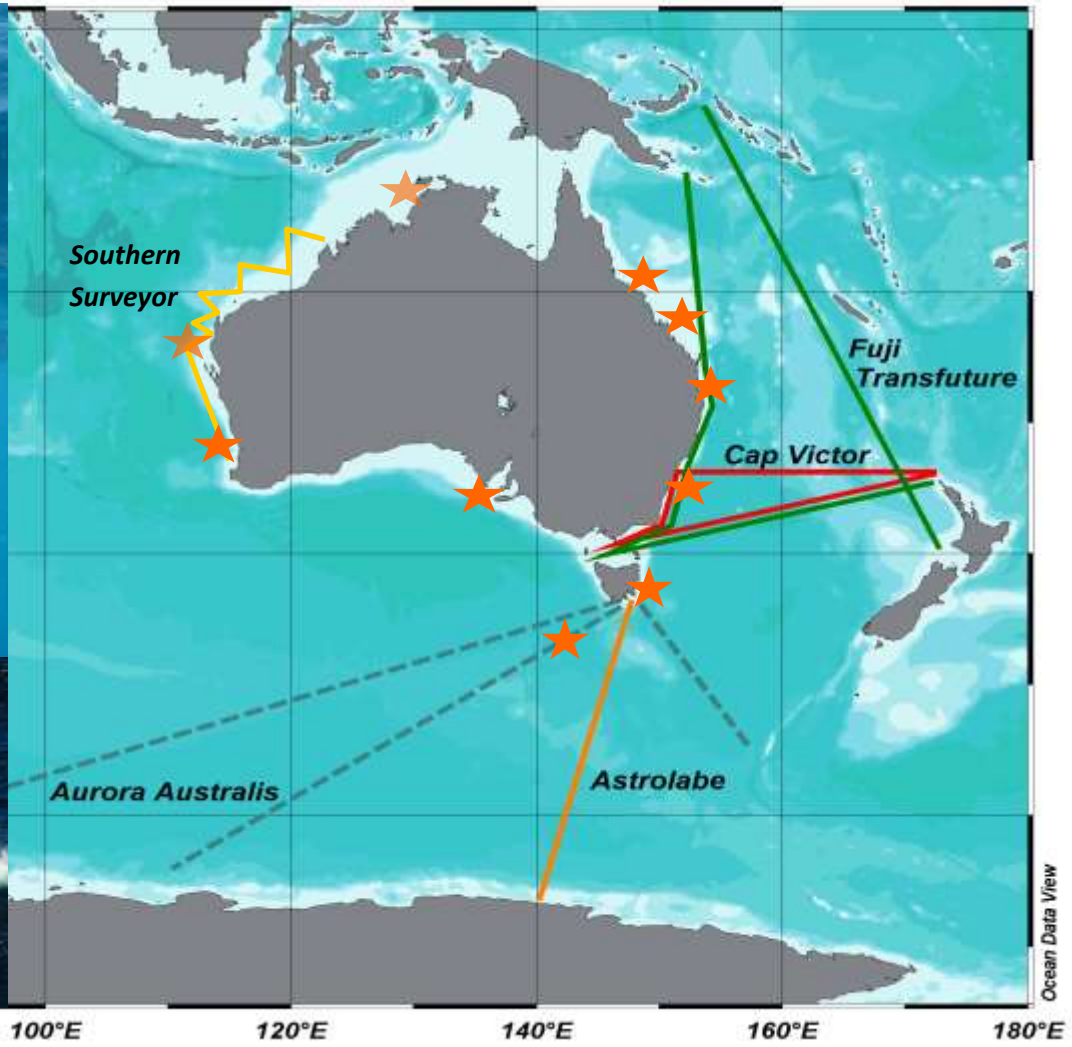


The aragonite saturation state of surface waters in the SW Pacific will reach values below 3.5 by about 2030

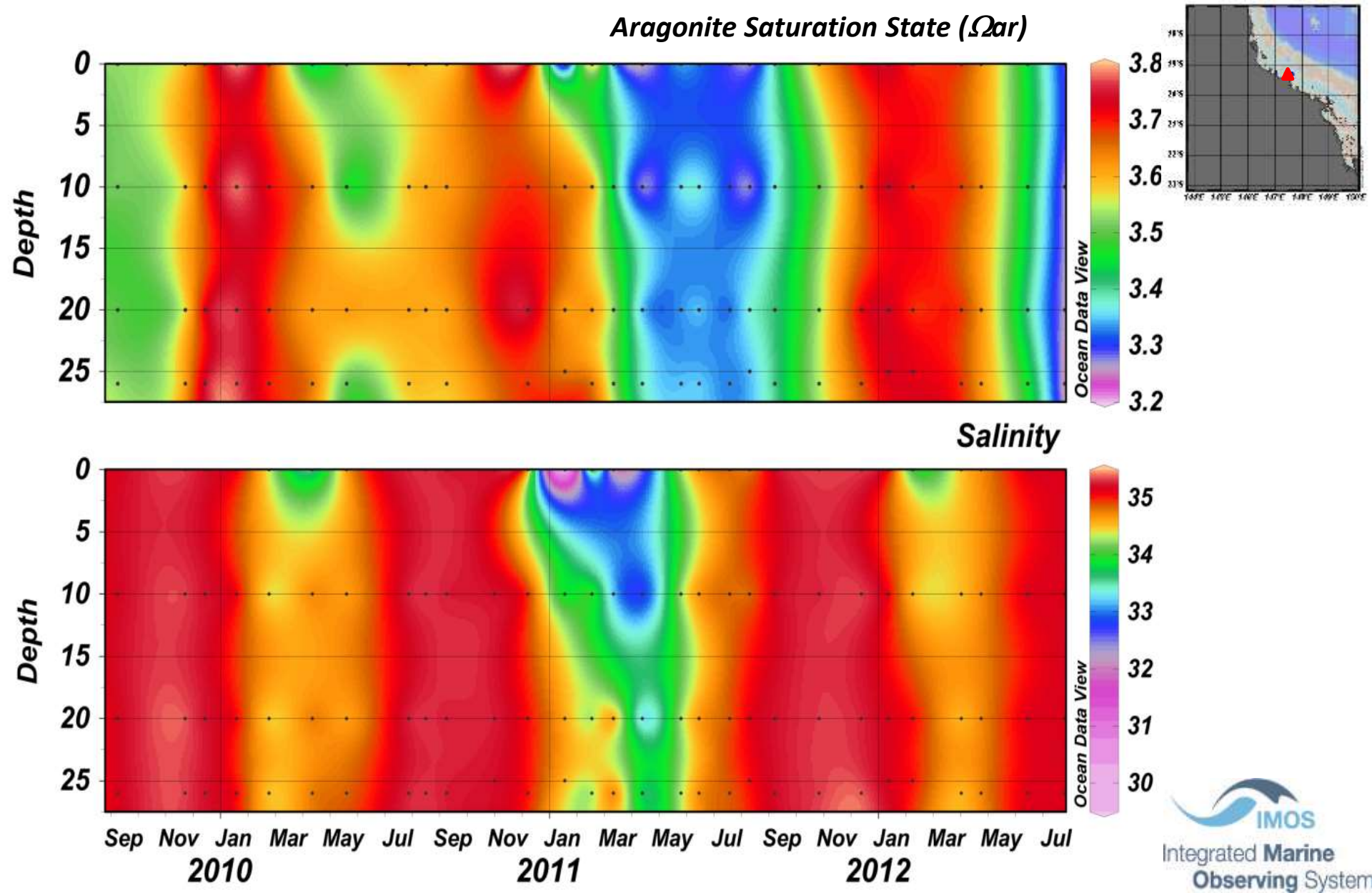


Lenton, PCCSP

Detection of change – coastal to regional scales



Yongala Reference site, central Great Barrier Reef

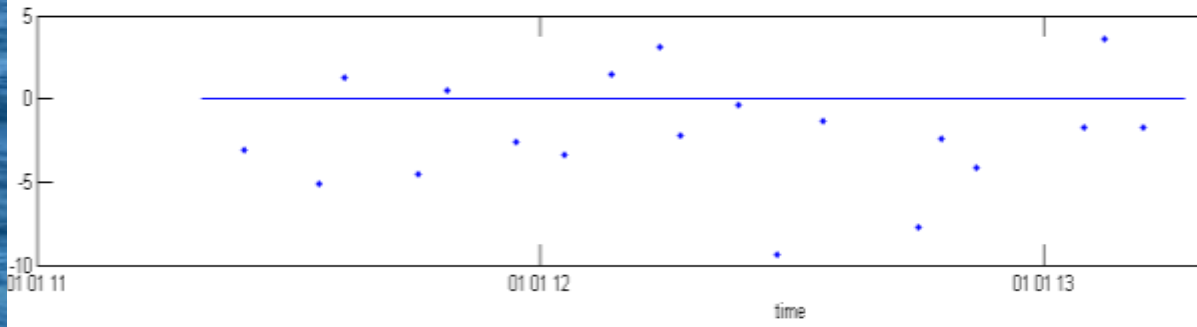


IMOS
Integrated Marine Observing System

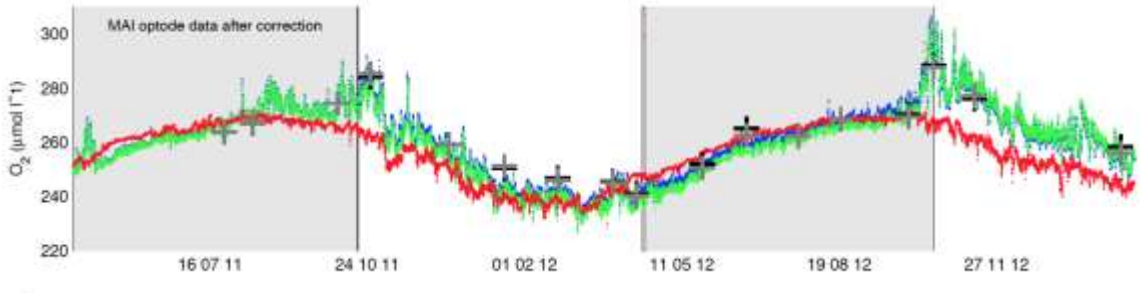
CO_2/Acidification moorings

pCO_2, Battelle system, ±2 µatm
Dissolved oxygen, Aanderaa optode, ± 1 µmol/kg
Temperature, SBE16 V2 Plus, ±0.005°C
Salinity, SBE16 V2 Plus, ±0.01

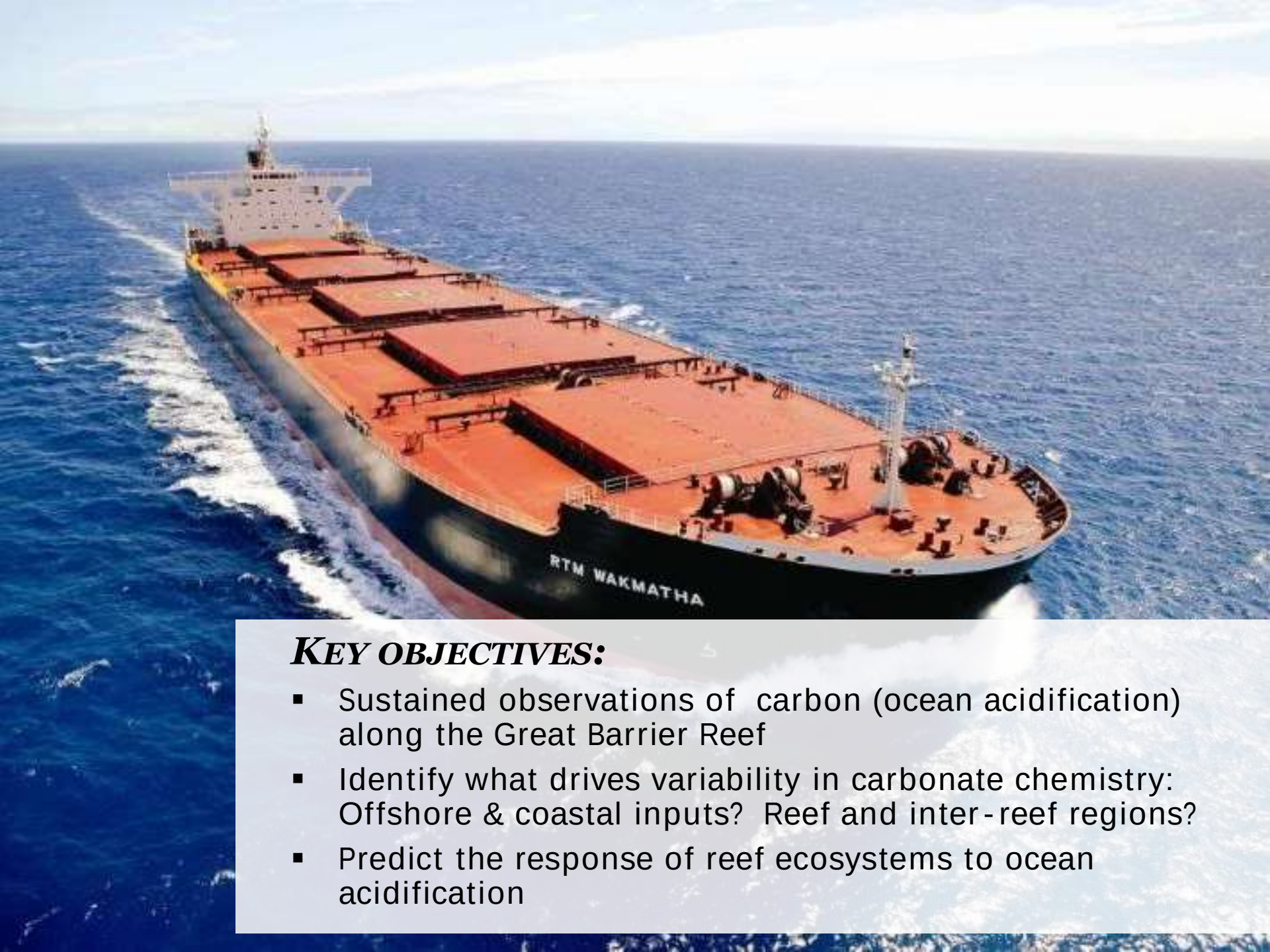
Calibrated before and after deployments.
Data transmitted every 2 hours, 96-98% data returns
Independent data quality checks:



Comparison against NOAA QC: 0.1 ± 0.6 µatm pCO2



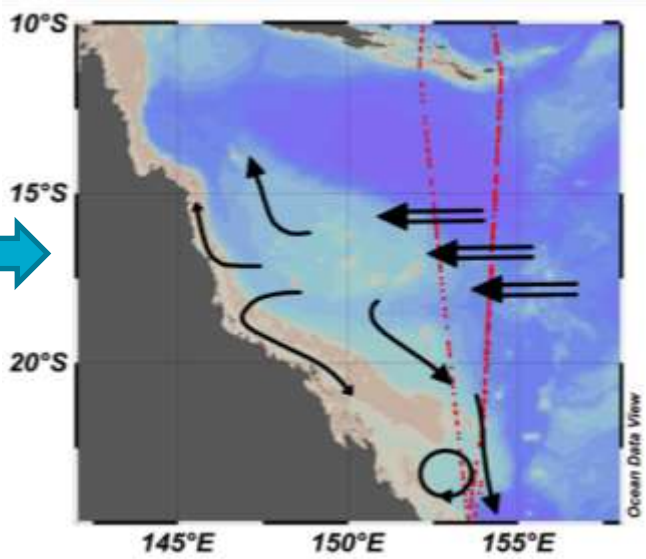
Great Barrier Reef and Coral Sea observations



KEY OBJECTIVES:

- Sustained observations of carbon (ocean acidification) along the Great Barrier Reef
- Identify what drives variability in carbonate chemistry: Offshore & coastal inputs? Reef and inter-reef regions?
- Predict the response of reef ecosystems to ocean acidification

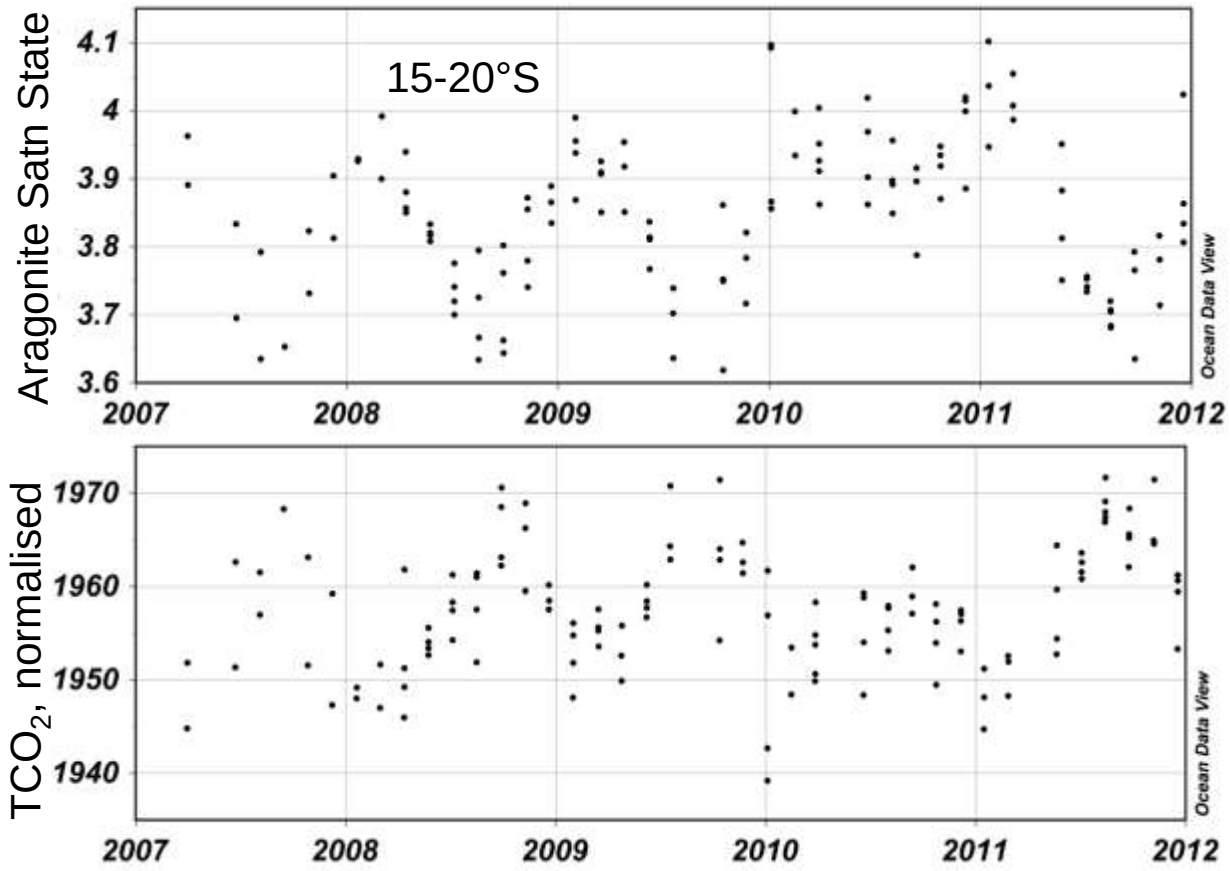
GBR source water: Coral Sea



Seawater monitoring lab

- NIES (Japan) & CSIRO
- 6 weekly transects through Coral Sea
- Measures: Temp, Sal, pCO_2, TCO_2, TA

Coral Sea source waters: Trans Future 5



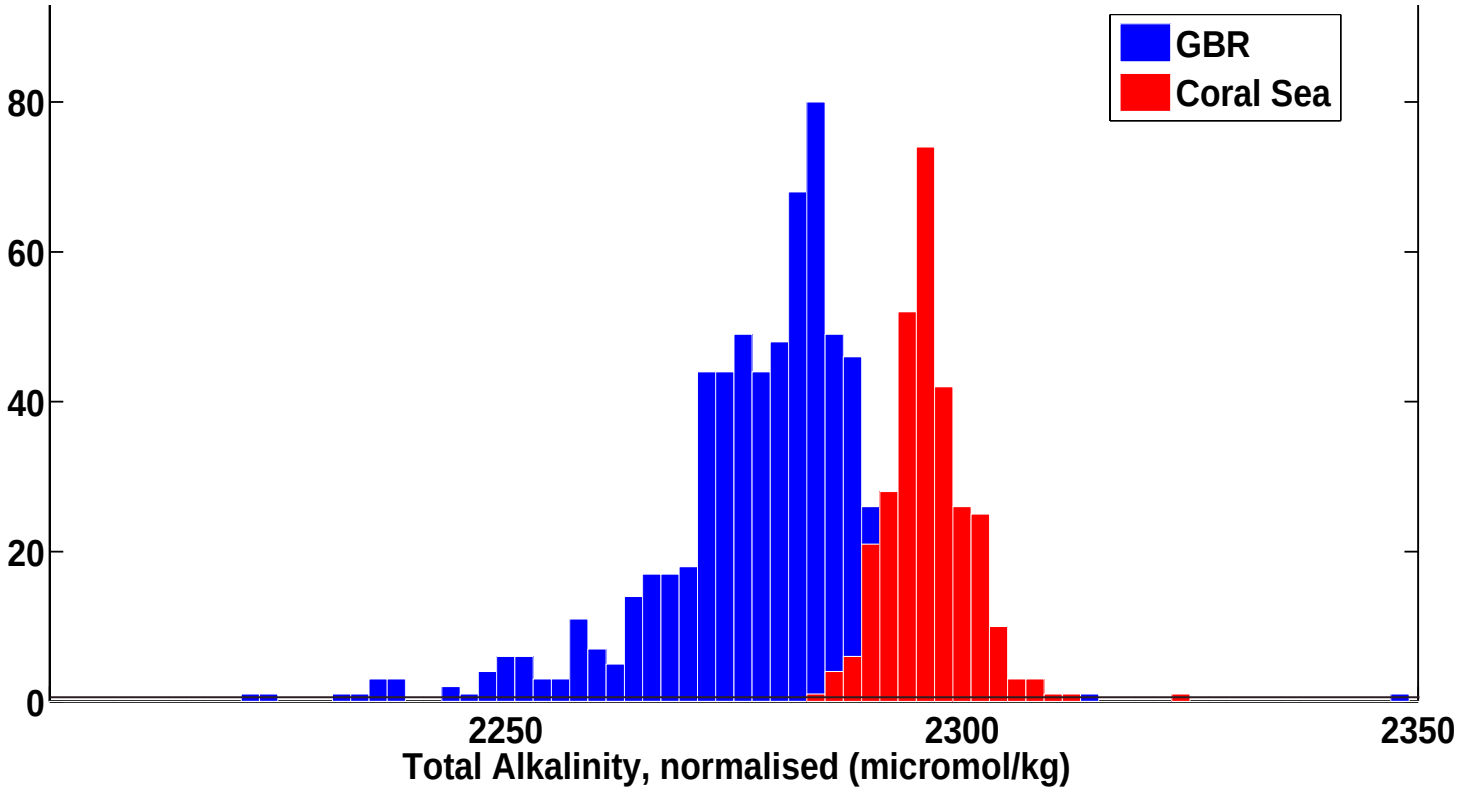
Summer: 3.9 - 4.0
Winter: 3.6 - 3.7

Seasonal changes in aragonite saturation for the GBR source waters are driven about equally by temperature change and changes in dissolved CO_2(TCO_2)

The Summer/Winter differences in saturation state are similar to changes predicted for atmospheric CO_2 increases to about 450ppm

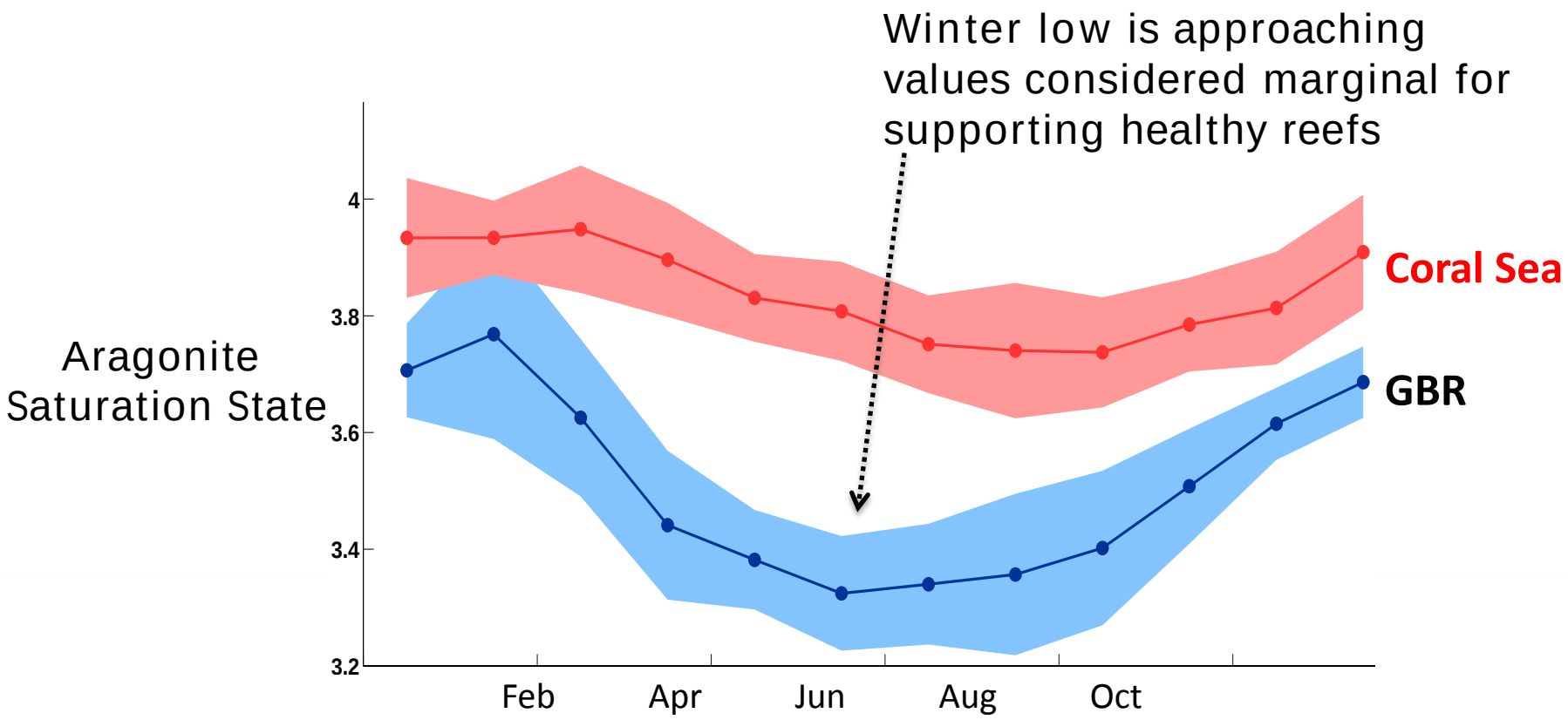
INSHORE-OFFSHORE CHANGES: STILL CALCIFYING

- Reef waters indicate net calcification (net growth)



LARGE SEASONAL CHANGES IN CARBONATE CHEMISTRY

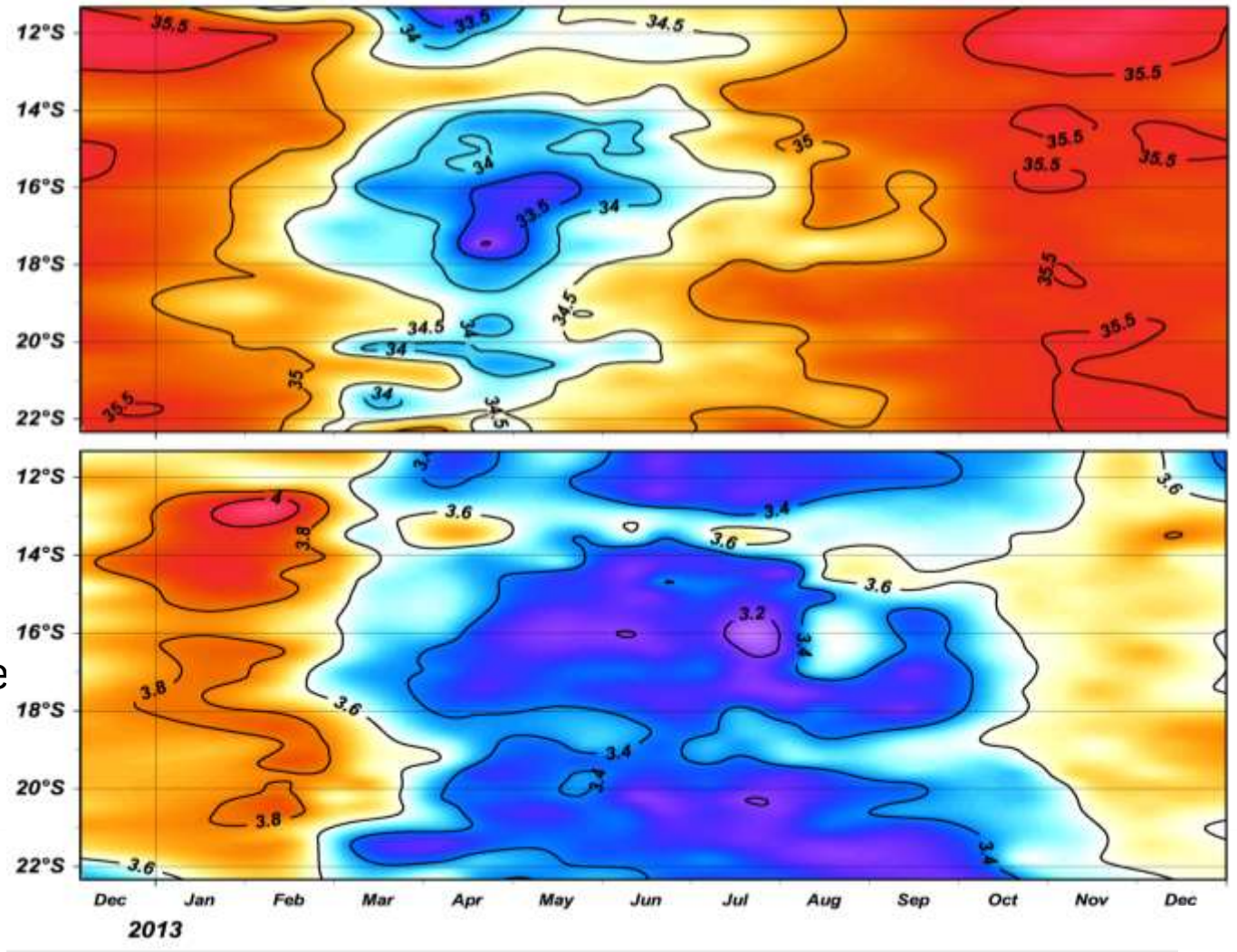
- Chemistry of Reef waters strongly influenced by the transport of Coral Sea Water onto the GBR
- Winter low is enhanced by seasonal temperature change & ocean CO_2 uptake



SEASONAL CHANGE IS OCCURRING ALONG THE LENGTH OF THE GBR

Salinity

Aragonite Saturation State



Heron Island test bed

- Integrated modelling and observational approach to determine calcification and production for the whole of reef.
- Develop parametisations of production and calcification of the various benthic communities.
- Represent the circulation and biogeochemistry in and around Heron Island.
- To simulate future change and apply to other reefs.

Heron Island: Observations and models

Measurements every 2 hours
- partial pressure of carbon dioxide
- dissolved oxygen
- temperature, salinity

Water samplers, benthic sensors
- TCO_2, alkalinity
- dissolved oxygen, pH
- temperature, salinity

Model-data integration: individual reef to whole of GBR

Hydrodynamic/Biogeochemical models

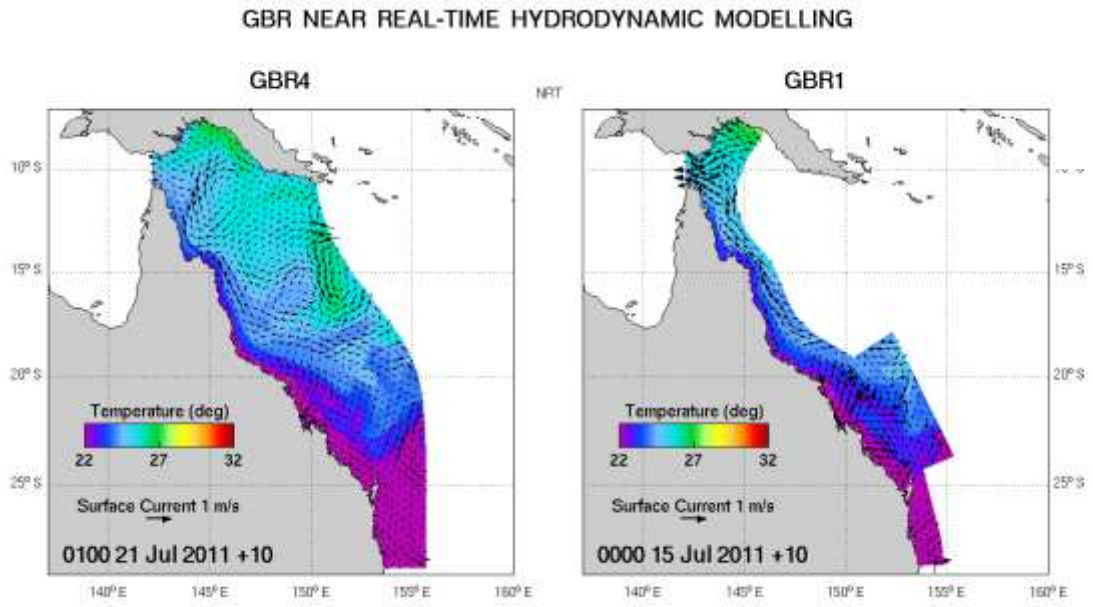
- GBR 4 km model (eReefs)
- Inner GBR 1 km model (eReefs)
- Heron Island model development – reef scale test bed. Used to assess feedback of different reef communities to modifying water chemistry and role of water transport and residence time.

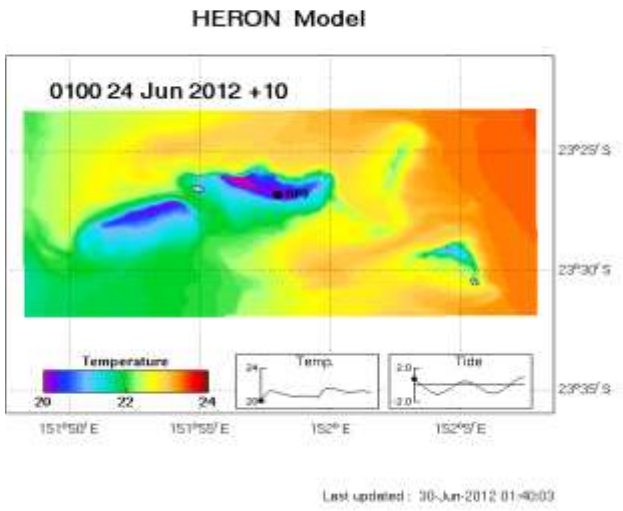
GBR and offshore sampling

- RTM Wakmatha sampling on GBR
- Transfuture 5 sampling
- moorings, reef, and inshore sampling

Heron reef test bed

- Determinations of production and calcification, and sediment-water exchange to measure whole of reef metabolism.





Support for research:

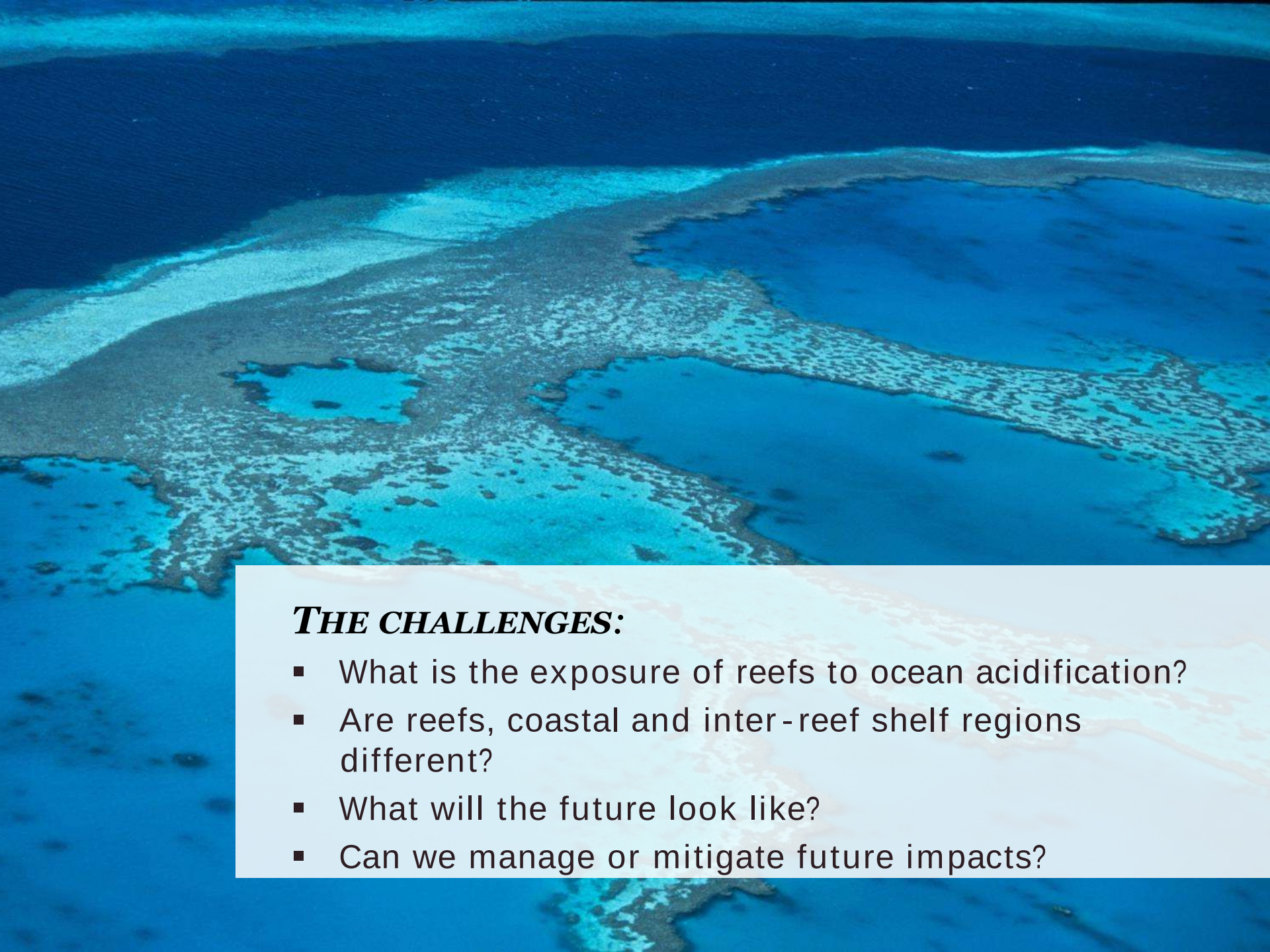
AUSTRALIAN CLIMATE CHANGE SCIENCE PROGRAM

CSIRO

Rio Tinto Alcan

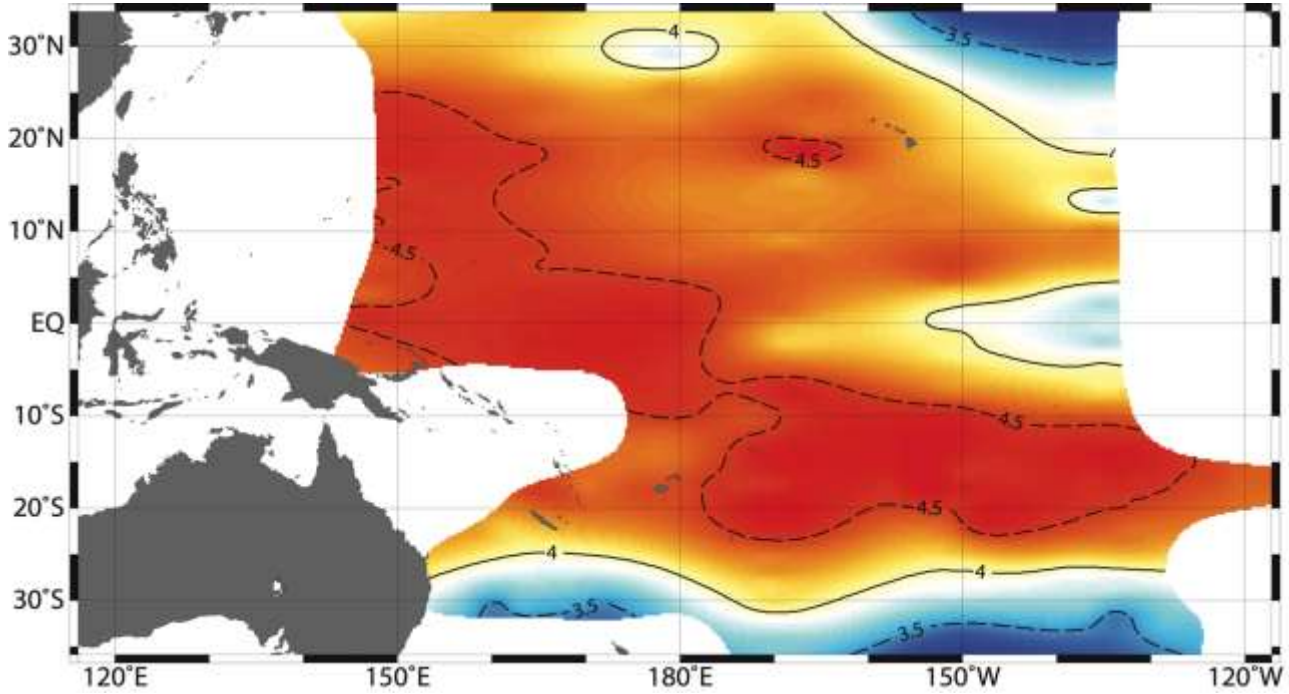
GREAT BARRIER REEF *foundation*

IMOS
Integrated **Marine** **Observing** System



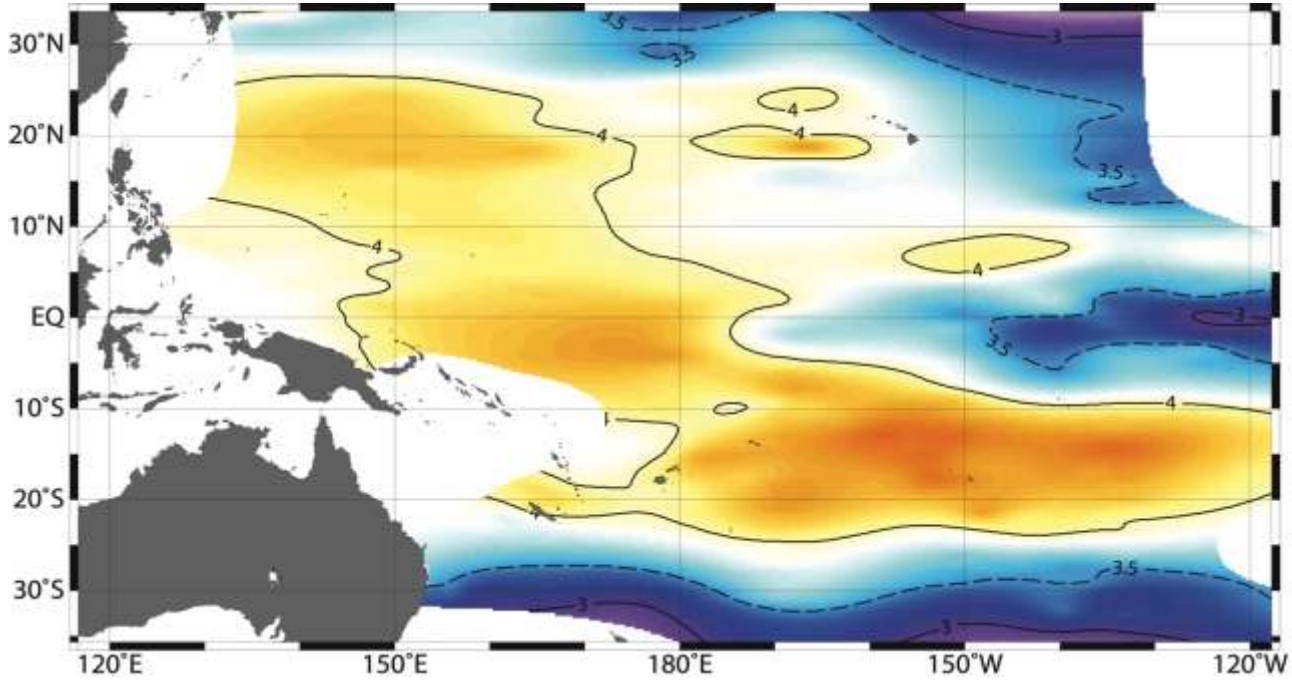
THE CHALLENGES:

- What is the exposure of reefs to ocean acidification?
- Are reefs, coastal and inter-reef shelf regions different?
- What will the future look like?
- Can we manage or mitigate future impacts?



Aragonite Satn State

Preindustrial



1990's

Source, PCCSP