Munida Time Series, New Zealand South West Pacific Ocean

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Introduction

- The Southern Ocean is the largest oceanic sink for anthropogenic CO_2
- We need to understand the processes controlling Southern Ocean uptake in order to predict oceanic response to increasing atmospheric CO_2
- The Munida Time Series Transect is located off the south east coast of New Zealand and includes neritic, modified subtropical and subantarctic surface water (SASW) masses (Fig 1)
- The surface transect is 65 km long, with a 500m vertical cast in SASW
- Data collected: temperature, salinity, carbonate parameters, nutrient and Chl a concentrations

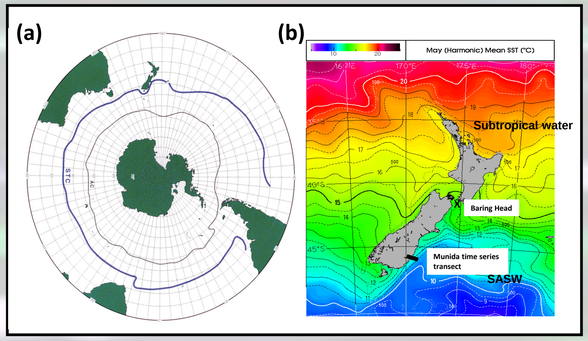

Fig 1: (a) position of subantarctic surface water (SASW)
(b) location of the Munida Time Series Transect, the contours indicate sea surface temperature.

Associated Research

- Several shorter term research projects have been carried out in conjunction with the Munida Time Series.
- These include
  - trace metal cycling –iron, cadmium,
  - carbonic anhydrase
  - biological control of pH
  - nitrogen cycling

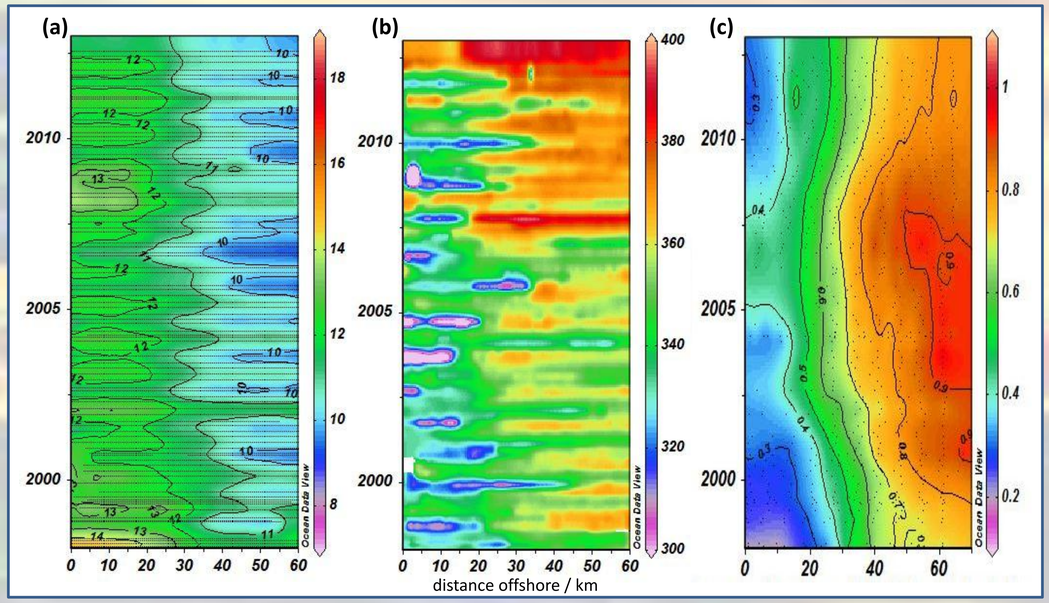

Fig 2: Contour plots of sea surface (a) temperature, (b) pCO_2 and (c) dissolved reactive phosphate concentration

Overview

- The 11 year pH time series indicates that CO_2 is in equilibrium with the atmosphere in the (austral) winter, and is a sink for atmospheric CO_2 in spring and summer
- A long term decrease in pH(25 ^oC) of 0.0021 ± 0.0007 pH units per year is observed (Fig 3b)
- This is in agreement with the theoretical annual decrease of 0.0017 expected for equilibration of constant alkalinity seawater with atmospheric CO_2, as measured at Baring Head, New Zealand

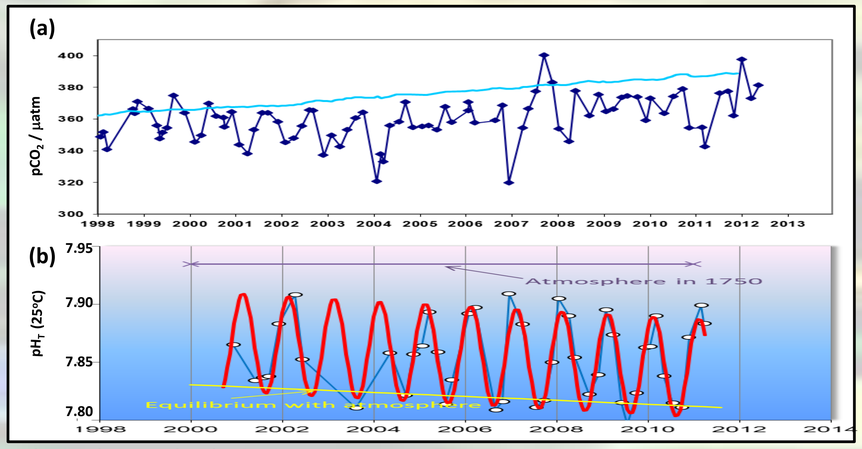

Fig 3: Time series in SASW:
(a) surface seawater pCO_2 and atmospheric XCO_2
(b) $pH_T(25^oC)$ (circles), fitted with a sloping sine function (red curve). Also shown is the pH of water that would be in equilibrium with the atmosphere (yellow line), and the pH that would be in equilibrium with the pre-industrial atmosphere (purple line).

Box Model Analysis SASW

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- Time series data is used to construct climatological seasonal cycles
- ^{13}C based 1-D diagnostic box model used to analyse controls and variability of carbon cycle (Fig 4a)
- Model is driven by harmonic fits of the de-trended observed time-series

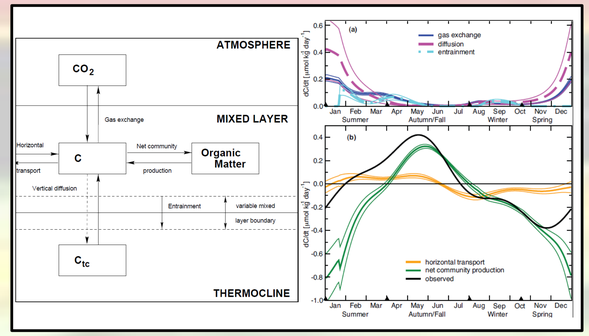

Fig 4: Annual cycles of sDIC due to:
(a) air-sea gas exchange, diffusion, and entrainment
(b) horizontal transport, net community production, and the sum of all five, which has been constrained to be identical to the observed annual cycle

Annual Cycles

- Air-sea Gas Exchange, Diffusion and Entrainment
  - maximum in spring and summer, minimum in winter
- Horizontal Transport
  - few data available, consistent with regional model simulation
- Net Community Production
  - dominant term, modulated by other effects
  - max NCP at onset of summer (-0.80 µmol kg^{-1} day^{-1})
  - respiration dominates production in autumn
- Sum
  - spring drawdown of sDIC primarily caused by NCP
  - partially compensated by vertical diffusion and uptake of atmospheric carbon
  - NCP and the sum of the other terms cancel each other out in summer
  - in autumn, all terms act together to replenish carbon in the mixed layer

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Bottom images show the *RV Munida* and *RV Polaris II,* background image is of thymol blue on water (modified)

References

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