Quantifying the Carbonate Chemistry and pH Variations of Otago Harbour, New Zealand

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Methods

Santacru SeaFET
- Continuous deployment at 5 sites (Fig. 1, Sites A-D)
- Burst 205 SST readings every 30 minutes at each depth

YSI 6600 Sonde
- Weekly measurements of in situ seawater parameters
  (pH, O2, DO, T, DIC, and Total Alkalinity (TA) at Site A)
  at 10 cm depth and every 2m to 50 m depth

Horiba US1
- Temperature, Conductivity, TDS, and pH

Water Samples
- Weekly collection of seawater samples (Fig. 1, Sites A-D)

Carbonate Chemistry Parameters
- Seasonal shifts in carbonate chemistry correlate with seawater temperature (°C), in situ (μg/L) and Beaufort wind force.
- Disruptive weather activity and higher Beaufort wind forces over winter may have increased freshwater input and mixing, stimulating primary production and causing observed "net biological DIC decreases" and associated shifts in carbonate chemistry.

Findings suggest that mixed algal assemblages and photosynthesis productivity help to buffer seawater pH, in light conditions and tidal fluctuations bringing offshore water in and out of the harbour are primarily responsible for the observed natural variations in pH.

Carbonate Chemistry
- Seasonal shifts in carbonate chemistry correspond to seasonal shifts in seawater characteristics such as temperature (°C), in situ (μg/L) and Beaufort wind force.
- Disruptive weather activity and higher Beaufort wind forces over winter may have increased freshwater input and mixing, stimulating primary production and causing the observed "net biological DIC decreases" and associated shifts in carbonate chemistry.

Findings highlight the importance of the frequency and intensity of storm events, runoff, currents, tides and mixing in determining the carbonate system and patterns of variability on the local scale.

Seawater pH Variations

1. Primary Frequency = Diurnal increases in pH correspond to light (PAR).
2. Secondary Frequency = Smaller peaks and troughs correspond to tidal height (m) and occur at low and high tide respectively.

Summary & Key Conclusions

Annual Average pH = 8.13 ± 0.01
Seasonal, diurnal and semi-diel fluctuations in pH were moderate (= 0.02 ± pH, ≤ 0.11)

Seawater pH Variations

A. Seawater pH, Time Series Data

B. Seawater pH, vs. Ambient Light

C. Seawater pH, vs. Tides

Carbonate Chemistry

A. Total Alkalinity (TA) and Dissolved Inorganic Carbon (DIC)

B. pH, and pCO2

C. Saturation State of Calcite and Aragonite

To create a baseline understanding of carbonate chemistry parameters and pH variation in a coastal zone of Otago Harbour at a location where my study species, the tubeworm Galuvolax hystrix (Box 1), occurs. To more accurately understand this species' current pH exposure so subsequent experiments can be designed to test ecologically relevant pH levels for biofilm development and settlement assays. For more information see my presentation "Biofilms: Are they the missing link in understanding the effect of Otagon settlement selection?" May 6th at 2:45pm, GB 3.

Introduction

Ocean Acidification (OA) is altering carbonate chemistry by reducing seawater pH, increasing pCO2, and causing under-saturation of O2, and CO2. Enhanced research has been conducted to project future OA conditions based on offshore datasets and global open ocean averages (IPCC 2007, 2013). However, biological and ecological complexities of coastal zones make it difficult to accurately predict the response of these systems to OA. Carbonate chemistry parameters and pH fluctuations are ecosystem specific and vary based on local conditions (Hofmann et al. 2011). In order to design meaningful in vitro experiments that test biological responses to OA, site-specific carbonate chemistry parameters and pH variations can be used to develop ecologically relevant pH targets.

Aims

To understand the impact of OA on carbonate chemistry parameters, pH and pH fluctuations in Otago Harbour, New Zealand, in coastal zones of New Zealand and Australia. Scale bar represents 1cm.

Results

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