CO₂ System Dynamics in the Dalton Polynya, East Antarctica

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Introduction

The objective of this study was to characterize the CO₂ system dynamics in the Dalton Polynya during the summer season. Observations of underway CO₂ and discrete water column samples of total dissolved inorganic carbon (TCO₂) are used to partition the seasonal drivers of mixed-layer TCO₂ concentrations into physical and biological components. Understanding the current CO₂ system dynamics is necessary to evaluate how the system will respond to future global change.

Oceanographic Setting

A total of 81 CTD stations were sampled in the Dalton Polynya for discrete TCO₂ and total alkalinity (TA) concentrations (Figure 2). Samples were collected in 250 mL bottles and fixed with a saturated solution of mercuric chloride before analysis using a SOMMA system (TCO₂) or by potentiometric titration (TA).

Seasonal Drivers of TCO₂

1. Air-Sea Exchange of CO₂

Surface waters were mostly supersaturated with CO₂ with respect to the atmospheric value during the period of observations.

Parameter | Mean Value
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ΔCO₂ µatm | +10
Wind Speed m s⁻¹ | 5.3
F₉CO mmol C m⁻² d⁻¹ | 0.7

The Dalton Polynya was a weak net source of CO₂ to the atmosphere during observations.

Sea Ice Coverage

Figure 8. Mean monthly sea ice coverage (%) in the Dalton Polynya between 1997 – 2017 (blue circles), 2014 – 2015 (black), 2015 – 2016 (red). Error bars represent the standard deviation.

Satellite Observations

Figure 7. Mean monthly chlorophyll-a (CHL-a, mg m⁻²) in the Dalton Polynya between 1997 – 2017 (green circles), 2014 – 2015 (black), 2015 – 2016 (red). Error bars represent the standard deviation.

Summary

- The Dalton Polynya was a weak net source of CO₂ to the atmosphere during the period of observations.
- Sea ice melt reduced mixed layer TCO₂ concentrations in the Dalton Polynya, but sea ice formation increased TCO₂ concentrations near the western Totten Ice Shelf.
- Biological productivity reduced mixed-layer TCO₂ concentrations in the Dalton Polynya, resulting in positive NCP.
- Satellite observations of chlorophyll-a and sea ice coverage during the measured 2014 – 2015 season are in contrast to the long-term average, suggesting large interannual variability plays a role in seasonal productivity in the Dalton Polynya.