## **CO**<sub>2</sub> System Dynamics in the Dalton Polynya, East Antarctica

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Introduction	Seasonal Drivers of TCO <sub>2</sub>	Satellite Observations
The objective of this study was to characterize the $CO_2$ system dynamics in the Dalton Polynya during the summer season. Observations of underway $fCO_2$ and discrete water column samples of total dissolved inorganic carbon (TCO <sub>2</sub> ) are used to	1. Air-Sea Exchange of $CO_2$ $40^{(a) OUTGASSING}$ Surface waters were mostly supersaturated	Chlorophyll-a

partition the seasonal drivers of mixed-layer TCO<sub>2</sub> concentrations into physical and biological components. Understanding the current CO<sub>2</sub> system dynamics is necessary to evaluate how the system will respond to future global change.



Figure 1. Underway and discrete CO<sub>2</sub> system observations were made on the RV Aurora Australis between December 2014 and January 2015.

Oceanographic Setting

A total of 81 CTD stations were sampled in the Dalton Polynya for discrete  $TCO_2$  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 (TCO<sub>2</sub>) or by potentiometric titration (TA).



Figure 4. Underway measurements as a function of time between 24 Dec 2014 and 09 Jan 2015 of (a)  $\Delta fCO_2$  ( $\mu$ atm), (b) Wind speed (m s<sup>-1</sup>), (c)  $F_{CO2}$  (mmol C m<sup>-2</sup> d<sup>-1</sup>) where a positive flux indicates a net ocean source of  $CO_2$ . See Figure 1 for color references.

## 2. Sea Ice Melt and Formation





Figure 7. Mean monthly chlorophyll-a (Chl-a; mg m<sup>-3</sup>) in the Dalton Polynya between 1997 – 2017 (green circles), 2014 – 2015 (black), 2015 – 2016 (red). Error bars represent the standard deviation.

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.



Figure 2. Map of Dalton Polynya on the Sabrina Coast (115–123°E). Underway ship track (lines) and CTD station (circles) between 24 Dec 2014 and 08 Jan 2015 overlain on a MODIS Terra image from 22 Jan 2015. See figure for color details. Totten Ice Shelf, TIS. Moscow University Ice Shelf MUIS.





Mixed-layer TCO<sub>2</sub> concentrations were depleted relative to depth (200 m) in the Dalton Polynya and less so near the TIS.



Figure 5. Depth profiles of  $TCO_2$  (a) in the Dalton Polynya and (b) near the TIS and  $nTCO_2$ (c) in the Dalton Polynya and (d) near the TIS. Mean profiles from each section are bolded.

Salinity-normalized TCO<sub>2</sub> (nTCO<sub>2</sub>) profiles revealed the effects of dilution through sea ice melt and concentration through sea ice formation on mixed layer concentrations.

## Summary



- The Dalton Polynya was a weak net source of  $CO_2$  to the atmosphere during the period of observations.
- Sea ice melt reduced mixed layer TCO<sub>2</sub> concentrations in the Dalton Polynya, but sea ice formation increased  $TCO_2$ concentrations near the western Totten Ice Shelf.
- Biological productivity reduced mixed-layer TCO<sub>2</sub> concentrations in the Dalton Polynya, resulting in positive NCP.
- Satellite observations of chlorophyll-a and sea ice coverage

Figure 3. Diagram of potential temperature salinity, with (°C) and potential of contours density anomaly (kg m<sup>-3</sup>) and colors for dissolved oxygen (µmol kg<sup>-1</sup>). The solid line represents the freezing point.





Figure 6. Mean NCP (mmol C m<sup>-2</sup> d<sup>-1</sup>) for each region. Error bars represent the standard deviation.

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.

