Data from two Antarctic krill (Euphausia superba) 24-hour feeding experiments under ambient temperature and pCO2, ambient temperature and elevated pCO2, and elevated temperature and pCO2.

Website: https://www.bco-dmo.org/dataset/820557
Data Type: experimental
Version: 1
Version Date: 2020-08-12

Project
» Collaborative Research: Synergistic effects of Elevated Carbon Dioxide (CO2) and Temperature on the Metabolism, Growth, and Reproduction of Antarctic Krill (Euphausia superba) (OA Krill)

Contributors	Affiliation	Role
Saba, Grace	Rutgers University	Principal Investigator
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Abstract
Data from two Antarctic krill (Euphausia superba) 24-hour feeding experiments under ambient temperature and pCO2, ambient temperature and elevated pCO2, and elevated temperature and pCO2.

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Coverage

Spatial Extent: **Lat**:-64.7741 **Lon**:-64.0526
Temporal Extent: 2014-01-24 - 2014-02-24

Dataset Description

Data from two Antarctic krill (*Euphausia superba*) 24-hour feeding experiments under ambient temperature and pCO2, ambient temperature and elevated pCO2, and elevated temperature and pCO2.

We conducted perturbation experiments to determine potential changes in feeding rates of Euphausia superba (32-41 mm) due to decreased pH and elevated temperature. Target pH was reached in the experiments via CO2 bubbling of seawater flowing through gas equilibration columns. The two feeding experiments differed in acclimation time. Krill in experiment 1 (Exp 1) and experiment 2 (Exp 2) were acclimated to treatment conditions for 48 hours and 21 days, respectively.

Acquisition Description

Sampling and analytical procedures:

Capture and husbandry: Antarctic krill (Euphausia superba) were captured during the austral summer of 2013/2014. Krill were collected by net tow (2 m diameter, 1000 m mesh, non-filtering cod end) off the R/V Laurence M. Gould near the Western Antarctic Peninsula and transported directly to the Palmer Station biological laboratory. One to two thousand krill were housed in one 4'w x 3'h circular holding tank and two 5' x 2' x 1' rectangular tanks provided with aeration and flow-through seawater. Water was non-filtered and individuals were able to feed on plankton ad libitum throughout the season.

Experimental treatments: Three experimental treatments were targeted in this study: (1) ambient temperature and ambient pCO2/pH (400ppm/8.10), (2) ambient temperature and elevated pCO2 (800ppm)/reduced pH (7.7), and (3) elevated temperature (3 degrees C) and elevated pCO2 (800ppm)/reduced pH (7.7). Two replicate feeding experiments were conducted: Experiment 1 and 2. Temperature treatments were obtained using two separate recirculating systems. Two 800 L cylindrical polycarbonate carboys were attached to temperature controlled chillers (Delta Star) and inline pumps. The carboys were filled with non-filtered seawater acquired from the Palmer Station intake line, placed in a flow-through water bath, and maintained at 0 degrees C. Another 800 L carboy was set up without a chiller and placed in an environmental chamber set at bated for about 24 hours before sacrificed for sampling the end points. The samples collected in the bottles at T0 and Tfinal include: pH, total alkalinity, and fluorometric chlorophyll a.

The systems were replaced with new water daily and allowed to acclimate to temperature for a minimum of 24 hours before the start of a trial or water change. High CO2 conditions were obtained using a peristaltic pump to inject straight CO2 into the propeller of a pump submerged in seawater. Treated water was then gently siphoned with minimal disturbance into treatment bottles.

For each of the three treatments, 14, 4 L wide-mouth polycarbonate bottles were filled with the appropriate equilibrated seawater. Two bottles per treatment served as T0 controls (no krill added) and were sacrificed for an initial suite of samples. Two bottles served as Tfinal (24 h) controls, and one juvenile krill was added to each of the remaining 10 bottles per treatment (Tfinal treatments). The Tfinal bottles were capped to maintain target pCO2/pH, incubated in the appropriate location to maintain desired temperature (water bath for ambient, 0 degrees C; 3 degrees C environmental chamber for elevated temperature), and incubated for about 24 hours before sacrificed for sampling the end points. The samples collected in the bottles at T0 and Tfinal include: pH, total alkalinity, and fluorometric chlorophyll a.

Analyses: pH was determined spectrophotometrically using the indicator dye thymol blue (Dickson et al. 2007; Zhang and Byrne 1996). Total alkalinity was determined on 100 ml subsamples with an open-cell, potentiometric titration of seawater (Metrohm 888 Titrando) with 0.1 M HCl following the potential of a pH electrode (Dickson et al. 2007). Tiamo software (version 2.3) was used to process the alkalinity data. Measurements of pH and TA were quality controlled using certified reference materials (CRMs) obtained from Andrew Dickson at UCSD Scripps Institute of Oceanography. An aliquot of seawater from each incubation bottle was also filtered onto a GF/F filter, which was wrapped in foil and frozen for fluorometric chlorophyll a analysis (Parsons et al. 1984). Salinity was measured with a bench top conductivity meter (YSI 3100) calibrated daily with a conductivity standard (50,000 uS/cm; Ricca Chemical Company).

Expt 1	**Expt 2**
Salinity (ave +/- sterr; n = 30) = 32.43 +/- 0.02	Salinity (ave +/- sterr; n = 30) = 32.63 +/- 0.03
Ambient temperature = 0 C	Ambient temperature = 0 C
Elevated Temperature = 3 C	Elevated Temperature = 3 C

Processing Description

BCO-DMO Processing Notes:
- data submitted in Excel file "2014_AntarcticKrill_GrowthExperiment.xlsx" sheet "Sheet1" extracted to csv
- removed carbonate table to server separately
- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions
- converted dates to ISO format (yyyy-mm-dd)
- replaced ND with nd for 'no data'

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Related Publications

Dickson, A.G., Sabine, C.L. and Christian, J.R. (Eds.) 2007. Guide to best practices for ocean CO2 measurements. PICES Special Publication 3, 191 pp. ISBN: 1-897176-07-4. URL: https://www.nodc.noaa.gov/ocads/oceans/Handbook_2007.html https://hdl.handle.net/11329/249
Methods

Parsons, T. R., Y. Maita, and C. M. Lalli. "A Manual of Chemical and Biological Methods of Seawater Analysis", Pergamon Press (1984). ISBN: 9780080302874
Methods

Zhang, H., & Byrne, R. H. (1996). Spectrophotometric pH measurements of surface seawater at in-situ conditions: absorbance and protonation behavior of thymol blue. Marine Chemistry, 52(1), 17–25. doi:10.1016/0304-4203(95)00076-3
Methods

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Parameters

Parameter	Description	Units
Feeding_Experiment	Experiment identifier	unitless
Expt_Start_Date	Experiment start date; formatted as ISO yyyy-mm-dd	unitless
Bottle_description	Designation of control bottle (no krill; seawater only) and krill bottle (4 L bottle filled with treatment seawater plus one krill)	unitless
Time	Designation of sample collected at experiment start (T0) or experiment end (Tfinal)	unitless
Treatment_temp	Temperature treatment; either Ambient (0 degrees C) or Elevated (3 degrees C)	unitless
Treatment_pCO2	pCO2 treatment; either Ambient or Elevated (target = 800 ppm)	unitless
Incubation_time	Length of time between start (T0) and end (Tfinal) of feeding experiment	hours
spec_pH	pH determined spectrophotometrically from subsamples of seawater in each experimental bottle during the experiment	unitless (pH units)
Total_akalinity	Total alkalinity determined from subsamples of seawater in each experimental bottle during the experiment	micromol/kilogram (umol/kg)
Chlorophyll_a	Concentration of chlorophyll a determined fluorometrically from subsamples of filtered seawater in each experimental bottle during the experiment	micrograms/liter (ug/L)
Notes	Notes pertaining to experiment	unitless

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Instruments

Dataset-specific Instrument Name	Turner 10 AU Fluorometer
Generic Instrument Name	Turner Designs Fluorometer 10-AU
Dataset-specific Description	Used to measure chlorophyll a biomass as a proxy for phytoplankton (krill food) biomass.
Generic Instrument Description	The Turner Designs 10-AU Field Fluorometer is used to measure Chlorophyll fluorescence. The 10AU Fluorometer can be set up for continuous-flow monitoring or discrete sample analyses. A variety of compounds can be measured using application-specific optical filters available from the manufacturer. (read more from Turner Designs, turnerdesigns.com, Sunnyvale, CA, USA)

Dataset-specific Instrument Name	
Generic Instrument Name	Plankton Net
Dataset-specific Description	Net with 2 m diameter, 1000 m mesh, non-filtering cod end. Used to collected krill for experimental analyses.
Generic Instrument Description	A Plankton Net is a generic term for a sampling net that is used to collect plankton. It is used only when detailed instrument documentation is not available.

Dataset-specific Instrument Name	Metrohm 888 Titrando
Generic Instrument Name	Automatic titrator
Dataset-specific Description	Instrument used for open-cell titrations to determine total alkalinity in seawater. Used to measure total alkalinity in seawater.
Generic Instrument Description	Instruments that incrementally add quantified aliquots of a reagent to a sample until the end-point of a chemical reaction is reached.

Dataset-specific Instrument Name	Shimadzu spectrophotometer
Generic Instrument Name	Spectrophotometer
Dataset-specific Description	Used to measure pH in seawater.
Generic Instrument Description	An instrument used to measure the relative absorption of electromagnetic radiation of different wavelengths in the near infra-red, visible and ultraviolet wavebands by samples.

Dataset-specific Instrument Name	YSI 3100 Conductivity Instrument
Generic Instrument Name	Conductivity Meter
Dataset-specific Description	Used to measure salinity in seawater.
Generic Instrument Description	Conductivity Meter - An electrical conductivity meter (EC meter) measures the electrical conductivity in a solution. Commonly used in hydroponics, aquaculture and freshwater systems to monitor the amount of nutrients, salts or impurities in the water.

Dataset-specific Instrument Name	Delta Star chiller
Generic Instrument Name	Aquarium chiller
Dataset-specific Description	Used to cool water to ambient temperature.
Generic Instrument Description	Immersible or in-line liquid cooling device, usually with temperature control.

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Project Information

Collaborative Research: Synergistic effects of Elevated Carbon Dioxide (CO2) and Temperature on the Metabolism, Growth, and Reproduction of Antarctic Krill (Euphausia superba) (OA Krill)

Website: http://coseenow.net/project-parka/

Coverage: Palmer Station, Antarctica

NSF Award Abstract: Climate change projections for this century suggest that the Southern Ocean will be the first region to be affected by seawater chemistry changes associated with enhanced carbon dioxide (CO2). Additionally, regions of the Southern Ocean are warming faster than any other locations on the planet. Ocean acidification and warming may act synergistically to impair the performance of different organisms by simultaneously increasing metabolic needs and reducing oxygen transport. However, no studies have measured krill acid-base regulation, metabolism, growth, or reproduction in the context of ocean acidification or synergistic ?greenhouse? conditions of elevated CO2 and temperature. In the present project, the investigators will conduct both short and prolonged exposure experiments at Palmer Station, Antarctica to determine the responses of Euphausia superba to elevated CO2 and temperature. The investigators will test hypotheses related to acid-base compensation and acclimation of various life stages of krill to elevated CO2 and temperature. Furthermore, they will determine these impacts on feeding, respiration, metabolism, growth, and reproduction. The Antarctic krill, Euphausia superba, is a key species in Antarctic food webs as they are a primary food source for many of the top predators in the Southern Ocean including baleen whales, seals, penguins, and other sea birds. This project will determine the responses of Antarctic krill exposed to elevated CO2 and temperature and whether or not krill have the capacity to fully compensate under future ocean conditions. The proposed field effort will be complemented by an extensive broader impact effort focused on bringing marine science to both rural and urban high school students in the Midwest (Kansas). The core educational objectives of this proposal are to 1) instruct students about potential careers in marine science, 2) engage students and promote their interest in the scientific process, critical thinking, and applications of science, mathematics, and technology, and 3) and increase student and teacher awareness and understanding of the oceans and global climate change, with special focus on the Western Antarctic Peninsula region. Finally, this project will engage undergraduate and graduate students in the production, analysis, presentation and publication of datasets.

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Funding

Funding Source	Award
NSF Office of Polar Programs (formerly NSF PLR) (NSF OPP)	OPP-1641198
NSF Office of Polar Programs (formerly NSF PLR) (NSF OPP)	OPP-1246293

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