

Respirometry data for pelagic crustaceans, cephalopods, and fish collected on R/V Sikuliaq cruise SKQ201701S from January to February 2017

Website: <https://www.bco-dmo.org/dataset/855732>

Data Type: Cruise Results

Version: 1

Version Date: 2021-07-22

Project

» [Collaborative Research: A metabolic index to predict the consequences of climate change for midwater ecosystems](#) (Metabolic Index)

Contributors	Affiliation	Role
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Abstract

This dataset comprises results of respirometry experiments conducted at sea using pelagic crustaceans, cephalopods, and fish collected on R/V Sikuliaq cruise SKQ201701S from January to February 2017. Experimental animals were collected using either a modified tucker trawl or MOCNESS.

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Coverage

Spatial Extent: N:22.42 E:-116.5 S:21.22 W:-118.05

Temporal Extent: 2017-01-22 - 2017-02-13

Acquisition Description

This dataset comprises results of respirometry experiments conducted at sea. Experimental animals were collected using either a modified tucker trawl or MOCNESS. Metabolic rates and critical oxygen pressures

were measured using published methods (Birk et al., 2018; 2019; Wishner et al., 2018; Seibel et al., 2021). Briefly, individual specimens were placed in darkened sealed chambers filled with 0.2 μm filtered seawater that had been treated with antibiotics (25 mg/L each of streptomycin and actinomycin) to minimize bacterial respiration. The ratio of chamber size to body mass was approximately 1:20. Oxygen content was continuously monitored using Pyroscience Firesting or Presens oxygen meters and fiber optic probes with oxygen-sensitive fluorescent spots. Oxygen meters were calibrated with air-saturated seawater and concentrated Na_2SO_3 solution ($\text{PO}_2 = 0$). Chamber water was mixed with magnetic stirrers (Cole-Parmer Immersible Stirrer EW-04636-50) to ensure homogenous oxygen levels throughout the chamber. Oxygen consumption rates (MO_2) were calculated from the slope of PO_2 over time. Only linear regressions with an $R^2 > 0.8$ were included. The median MO_2 value from non-hypoxic oxygen levels was calculated for each individual. The P_{crit} for each individual was calculated using three metrics, including the traditional "breakpoint" method, the "sub-prediction interval (sub-PI)" and the alpha-method.

Processing Description

Data Processing:

Data were processed in R using published tools from Birk (2020). Calculated values of critical oxygen partial pressure (P_{crit}) are compared among methods that use different bin sizes and/or definitions of P_{crit} , as described below.

$\text{P}_{\text{crit_fixed_width}}$: breakpoint P_{crit} using 10 minute bins if total duration < 1000 minutes and 60 minute bins if total duration > 1000 minutes.

$\text{P}_{\text{crit_sub_reg}}$: sliding bin width based on PO_2 . P_{crit} defined as intersection of conforming line and lower 95% prediction interval bound. Outliers removed.

$\text{P}_{\text{crit_slide_width}}$: sliding bin width based on PO_2 . P_{crit} defined as breakpoint.

$\text{P}_{\text{crit_on_duration}}$: breakpoint P_{crit} using PO_2 vs duration (biased low).

$\text{P}_{\text{crit_sub_reg_corrected}}$: Plate Reader only - applies to runs where P_{crit} was adjusted to compensate for the poor factory calibration of sensor dots.

BCO-DMO Processing:

- replaced "NA" with "nd" (no data);
- renamed fields to comply with BCO-DMO naming conventions;
- converted date to YYYY-MM-DD format;
- changed year of 2027 to 2017 on line 286;
- replaced values of "15? 18?" in the Temp column with "nd".

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Related Publications

Birk, M. A., McLean, E. L., & Seibel, B. A. (2018). Ocean acidification does not limit squid metabolism via blood oxygen supply. *Journal of Experimental Biology*. doi:[10.1242/jeb.187443](https://doi.org/10.1242/jeb.187443)
Methods

Birk, M. A., Mislán, K. A. S., Wishner, K. F., & Seibel, B. A. (2019). Metabolic adaptations of the pelagic octopod *Japetella diaphana* to oxygen minimum zones. *Deep Sea Research Part I: Oceanographic Research Papers*, 148, 123–131. doi:[10.1016/j.dsr.2019.04.017](https://doi.org/10.1016/j.dsr.2019.04.017)
Results

Birk, M.A. (2020). *Respirometry. Tools for Conducting and Analyzing Respirometry Experiments*. <http://cran.r-project.org/package=respirometry>
Software

Seibel, B. A., Andres, A., Birk, M. A., Burns, A. L., Shaw, C. T., Timpe, A. W., & Welsh, C. J. (2021). Oxygen supply capacity breathes new life into critical oxygen partial pressure (Pcrit). *Journal of Experimental Biology*, 224(8). doi:[10.1242/jeb.242210](https://doi.org/10.1242/jeb.242210)

Results

Wishner, K. F., Seibel, B. A., Roman, C., Deutsch, C., Outram, D., Shaw, C. T., ... Riley, S. (2018). Ocean deoxygenation and zooplankton: Very small oxygen differences matter. *Science Advances*, 4(12), eaau5180. doi:[10.1126/sciadv.aau5180](https://doi.org/10.1126/sciadv.aau5180)

Results

Wishner, K. F., Seibel, B., & Outram, D. (2020). Ocean deoxygenation and copepods: coping with oxygen minimum zone variability. *Biogeosciences*, 17(8), 2315–2339. doi:[10.5194/bg-17-2315-2020](https://doi.org/10.5194/bg-17-2315-2020)

Results

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Related Datasets

IsRelatedTo

Wishner, K., Roman, C., Seibel, B. (2021) **Event log from R/V Sikuliaq SKQ201701S from January to February 2017**. Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2019-01-10 doi:10.26008/1912/bco-dmo.755088.1 [[view at BCO-DMO](#)]

Relationship Description: The SKQ201701S Event Log contains the date, time, latitude, and longitude of each event conducted during the cruise.

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Parameters

Parameter	Description	Units
Animal_ID	unique identifier for each experimental animal; numbers 008-025 are not included as they were Plate Reader blanks	unitless
Event	sampling event number from the cruise event log	unitless
Net_ID	net identifier (combination of gear type + cast number from the cruise event log)	unitless
Expt_start_date	start date of the experiment; format: YYYY-MM-DD	unitless
Respirometer	instrument used to obtain measurements (details in "Instruments" section)	unitless
Temp	experimental temperature	degrees Celsius
Channel	respirometer channel number (1-4) or well plate ID (A1-D6)	unitless
Volume	water volume (L) of respirometry chamber	liters (L)
Taxa	general taxonomic category of experimental animals (e.g. shrimp, squid, etc.)	unitless
AphiaID_accepted	species AphiaID number from the World Register of Marine Species (WoRMS)	unitless
ScientificName_accepted	accepted species name from the World Register of Marine Species (WoRMS)	unitless
Mass	mass of experimental animal in milligrams	milligrams (mg)
MO2	oxygen consumption rate (metabolic rate) in units of umol per hour	micromoles (umol) per hour
msMO2	mass specific oxygen consumption rate (metabolic rate) in units of umol per gram per hour	micromoles (umol) per gram per hour
Pcrit_fixed_width	breakpoint Pcrit using 10 minute bins if total duration < 1000 minutes and 60 minute bins if total duration > 1000 minutes	kilopascals (kPa)
Pcrit_sub_reg	sliding bin width based on PO2. Pcrit defined as intersection of conforming line and lower 95% prediction interval bound; outliers removed.	kilopascals (kPa)
Pcrit_slide_width	sliding bin width based on PO2; Pcrit defined as breakpoint	kilopascals (kPa)
Pcrit_on_duration	breakpoint Pcrit using PO2 vs duration (biased low)	kilopascals (kPa)
Pcrit_sub_reg_corrected	Plate Reader only, applies to runs where Pcrit was adjusted to compensate for the poor factory calibration of sensor dots	kilopascals (kPa)

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Instruments

Dataset-specific Instrument Name	MOCNESS
Generic Instrument Name	MOCNESS1
Dataset-specific Description	Experimental animals were collected using either a modified tucker trawl or MOCNESS.
Generic Instrument Description	The Multiple Opening/Closing Net and Environmental Sensing System or MOCNESS is a family of net systems based on the Tucker Trawl principle. The MOCNESS-1 carries nine 1-m ² nets usually of 335 micrometer mesh and is intended for use with the macrozooplankton. All nets are black to reduce contrast with the background. A motor/toggle release assembly is mounted on the top portion of the frame and stainless steel cables with swaged fittings are used to attach the net bar to the toggle release. A stepping motor in a pressure compensated case filled with oil turns the escapement crankshaft of the toggle release which sequentially releases the nets to an open then closed position on command from the surface. -- from the MOCNESS Operations Manual (1999 + 2003).

Dataset-specific Instrument Name	modified tucker trawl
Generic Instrument Name	Tucker Trawl
Dataset-specific Description	Experimental animals were collected using either a modified tucker trawl or MOCNESS.
Generic Instrument Description	The original Tucker Trawl, a net with a rectangular mouth opening first built in 1951 by G.H. Tucker, was not an opening/closing system, but shortly thereafter it was modified so that it could be opened and closed. The original had a 183 cm by 183 cm flexible rectangular mouth opening 914 cm long net with 1.8 cm stretched mesh for the first 457 cm and 1.3 cm mesh for last 457 cm. 152 cm of coarse plankton or muslin netting lined the end of the net. Tucker designed the net to collect animals associated with the deep scattering layers, principally euphausiids, siphonophores, and midwater fish. (from Wiebe and Benfield, 2003). Currently used Tucker Trawls usually have 1-m ² openings and can have a single net or multiple nets on the frame.

Dataset-specific Instrument Name	Pyroscience Firesting FS02-4
Generic Instrument Name	Dissolved Oxygen Sensor
Dataset-specific Description	Pyroscience Firesting FS02-4: four-channel optical oxygen meter
Generic Instrument Description	An electronic device that measures the proportion of oxygen (O ₂) in the gas or liquid being analyzed

Dataset-specific Instrument Name	Presens Witrox 4 OX11875
Generic Instrument Name	Dissolved Oxygen Sensor
Dataset-specific Description	Presens Witrox 4 OX11875: four-channel optical oxygen meter
Generic Instrument Description	An electronic device that measures the proportion of oxygen (O ₂) in the gas or liquid being analyzed

Dataset-specific Instrument Name	Presens Plate Reader SY11000, SDR-547
Generic Instrument Name	plate reader
Dataset-specific Description	Presens Plate Reader SY11000, SDR-547: optical oxygen meter with 24 wells (75 µl each)
Generic Instrument Description	<p>Plate readers (also known as microplate readers) are laboratory instruments designed to detect biological, chemical or physical events of samples in microtiter plates. They are widely used in research, drug discovery, bioassay validation, quality control and manufacturing processes in the pharmaceutical and biotechnological industry and academic organizations. Sample reactions can be assayed in 6-1536 well format microtiter plates. The most common microplate format used in academic research laboratories or clinical diagnostic laboratories is 96-well (8 by 12 matrix) with a typical reaction volume between 100 and 200 µL per well. Higher density microplates (384- or 1536-well microplates) are typically used for screening applications, when throughput (number of samples per day processed) and assay cost per sample become critical parameters, with a typical assay volume between 5 and 50 µL per well. Common detection modes for microplate assays are absorbance, fluorescence intensity, luminescence, time-resolved fluorescence, and fluorescence polarization. From: http://en.wikipedia.org/wiki/Plate_reader, 2014-09-0-23.</p>

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Deployments

SKQ201701S

Website	https://www.bco-dmo.org/deployment/755461
Platform	R/V Sikuliaq
Start Date	2017-01-19
End Date	2017-02-15
Description	See additional cruise information from R2R: https://www.rvdata.us/search/cruise/SKQ201701S

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Project Information

Collaborative Research: A metabolic index to predict the consequences of climate change for midwater ecosystems (Metabolic Index)

Coverage: Eastern Tropical North Pacific

Description from NSF award abstract:

With climate change, ocean temperatures are expected to increase which in turn will reduce oxygen availability and increase metabolic oxygen demand in marine organisms. The investigators will conduct shipboard physiological experiments for various marine organisms and determine their distributions in relation to environmental conditions within an oxygen minimum zone (OMZ) in the Eastern Pacific Ocean. The goal will be to model and map a Metabolic Index (MI) to predict how vertical and horizontal distributions for these species might change throughout the world's oceans in the future. The MI is defined as the ratio between environmental oxygen supply and temperature-dependent oxygen demand. Oxygen supply includes both the environmental oxygen concentration across a habitat range and the physiological features of organisms that facilitate oxygen uptake, such as gills and circulatory systems. Thus, the MI will integrate measured tolerance and environmental exposure to low oxygen with environmental data. The investigators will measure tolerance to low oxygen, focusing on under-studied organisms, including the effect of temperature and organism size. They will sample along a natural gradient in oxygen content south of the California Current in the Eastern Pacific. The science team and a videographer will develop a blog about deep-sea biology and climate change using web-based and video technologies. Four graduate students will be funded on this project, and in conjunction with a recently developed course in pelagic ecology, several undergraduates will have the opportunity to participate in seagoing research.

This research fills a critical need for a physiology-based metric that can be used to predict changing marine communities as the oceans warm and hypoxic zones expand. Modern OMZs are extensive and characterized by deep-water (300-800 m) oxygen partial pressures lethal to most marine organisms, yet thriving communities exist there. Climate change is predicted to further deplete oxygen. The investigators will model and map a Metabolic Index (MI) for diverse marine species to help predict how in vertical and horizontal distributions of species may change throughout the world's oceans in the future. The MI will derive oxygen supply and demand data from published and planned measurements of the minimum environmental partial pressure of oxygen to which individual species are exposed (based on their distributions in the water column) and the minimum requirements to support routine aerobic metabolic demand (from shipboard respiration measurements of individuals). During research cruises in the Eastern Pacific along a gradient of OMZ intensity, the investigators will conduct shipboard physiological measurements to determine metabolic demand for understudied mesozooplankton and gelatinous taxa and determine the size- and temperature dependence for diverse species for incorporation into the MI. Vertically-stratified net sampling and in situ photography will identify and characterize unique OMZ community features, such as the lower oxycline biomass peak present in some OMZs and the oxygen-dependence of day and night habitat depths for vertically-migrating species. The MI will be mapped using climatological data to both test and generate hypotheses about the response of oceanic communities to climate change. In preliminary analysis, the MI suggests a metabolic constraint at a MI of ~ 2 that may act to limit vertical and horizontal habitat ranges.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1459243

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