Net primary productivity (14C) measurements made during quasi-Lagrangian experiments on R/V Roger Revelle cruise RR2201 in the Argo basin in the Eastern Indian Ocean/Indonesian throughflow during February and March 2022

Website: https://www.bco-dmo.org/dataset/945860
Data Type: Cruise Results, experimental
Version: 1
Version Date: 2024-12-12

Project
» Collaborative Research: Mesoscale variability in nitrogen sources and food-web dynamics supporting larval southern bluefin tuna in the eastern Indian Ocean (BLOOFINZ-IO)

Program
» Second International Indian Ocean Expedition (IIOE-2)

Contributors	Affiliation	Role
Kranz, Sven A.	Florida State University (FSU)	Principal Investigator
Landry, Michael R.	University of California-San Diego Scripps (UCSD-SIO)	Principal Investigator
Stukel, Michael R.	Florida State University (FSU)	Co-Principal Investigator
Rose, Jared	Florida State University (FSU)	Scientist
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
This dataset includes production measurements made during quasi-Lagrangian experiments conducted during RR2201 aboard R/V Roger Revelle in February and March 2022. Water column samples were collected by Niskin bottle on a CTD rosette during 4 pseudo-Lagrangian cycles. Each cycle was initiated during the evening hours by deploying a sediment trap array followed by an array used for in-situ incubations such as 14C primary productivity.

Table of Contents

Coverage

Location: Argo basin in the Eastern Indian Ocean
Spatial Extent: **N**:-15.349381 **E**:118.142355 **S**:-16.999461 **W**:114.135104
Temporal Extent: 2022-02-03 - 2022-02-22

Methods & Sampling

Water column samples were collected by Niskin bottle on a CTD rosette in the Argo basin in the Eastern Indian Ocean/Indonesian throughflow (NW of Australia) on board the R/V Roger Revelle during cruise RR2201 (BLOOFINZ-IO). Samples were collected between February 4th, 2022 and March 2nd, 2022. The cruise report can be found at http://hdl.handle.net/1834/43464.

14C net primary productivity:
Production measurements were made during quasi-Lagrangian experiments conducted during RR2201. Samples for net primary productivity, using 14C radio-labeled bicarbonate, were measured in in-situ drift array setups. Four (4) quasi-Lagrangian experiments (hereafter "cycles") were conducted, during which the cruise track followed a satellite-tracked Lagrangian drifter (Kranz et al. 2020). Each cycle was initiated during the evening hours by deploying a sediment trap array followed by an array used for in-situ incubations such as 14C primary productivity (Landry et al., 2012; Stukel et al., 2013). Both arrays had a 3 × 1-meter (m) holey sock drogue centered at 15-m depth in the surface mixed layer.

14C net primary production (NPP14C) was quantified for each day of a cycle at up to six depths spanning the euphotic zone. CTD Niskin bottles from a 2:00 AM (local time) CTD cast were sampled. About 280 milliliters (ml) of seawater from each depth were gently transferred to polycarbonate incubation bottles (triplicate bottles plus a dark bottle) using silicon tubing. Samples were then spiked with H14CO3 and incubated for 24 hours in mesh bags hung below the drift array. Incubations were started and terminated at ~04:00 AM local time (prior to sunrise). NPP14C samples were then filtered onto GF/filters, acidified for 24 hours with 0.5 ml of 10% biological grade HCl, placed in scintillation cocktail, and subsequently counted using a liquid scintillation counter (details in Morrow et al., 2018). Samples were counted after 24 hours and ~3 weeks. Total counts of the radioactivity spiked was measured by pipetting 250 microliters (ul) of the incubated seawater directly into ethanolamide and topped off with scintillation liquid. Total DIC was estimated based on average literature values.

Data Processing Description

DPM (disintegration counts per minute) from the second count (after around 3 weeks) were tabulated and combined with the cruise metadata. Each incubation depth contained 3 'light' bottles and 1 'dark' bottle. The 'dark' bottle was taken as reference and DPM of this bottle was subtracted. Carbon fixation was then calculated based on:

$CFix = ((DPMsample - DPMblank)/DPMtotal \times ([DIC]/V) \times t$

where:

CFix is the carbon fixation rate (e.g., mg C m−3 d−1).

DPMsample is the disintegrations per minute of the radio-labeled carbon in the sample after incubation.

DPMblank is the disintegrations per minute of the blank (a sample without active photosynthesis, usually treated with a poison).

DPMtotal is the total disintegrations per minute of the 14C added to the sample (total activity added).

[DIC] is the concentration of dissolved inorganic carbon in the water (e.g., mg C L−1−1).

V is the volume of water filtered for the sample (L).

t is the incubation time (days).

For each bottle depth, the triplicate samples were averaged and a standard deviation was calculated.

BCO-DMO Processing Description

- Imported original file "BLOOFINZ_IO_NPP_14C_BCO-DMO.csv" into the BCO-DMO system.
- Marked "NA" as a missing data value (missing data are empty/blank in the final CSV file).

- Converted the date-time column to ISO 8601 format.
- Converted all values in the Date column to YYYY-MM-DD.
- Renamed fields to comply with BCO-DMO naming conventions.
- Saved final file as "945860_v1_bloofinz-io_npp_14c.csv".

Problem Description

No data were available during C1_D2 5m as those samples were lost (filtration issue).

C1_D5 5m Blank was double spiked while bottle C did not contain a 14C spike.

C3_D1 80 Blank did not contain a 14C spike.

C4_D2 did not contain sufficient spike.

[table of contents | back to top]

Data Files

File
945860_v1_bloofinz-io_npp_14c.csv (Comma Separated Values (.csv), 48.61 KB) MD5:754d8c4e2cc8ec6c19b6eacb13f39942 Primary data file for dataset ID 945860, version 1

[table of contents | back to top]

Related Publications

Kranz, S. A., Wang, S., Kelly, T. B., Stukel, M. R., Goericke, R., Landry, M. R., & Cassar, N. (2020). Lagrangian Studies of Marine Production: A Multimethod Assessment of Productivity Relationships in the California Current Ecosystem Upwelling Region. Journal of Geophysical Research: Oceans, 125(6). Portico. https://doi.org/10.1029/2019jc015984 https://doi.org/10.1029/2019JC015984
Methods

Landry, M. R. (2025). R/V Roger Revelle Cruise RR2201 BLOOFINZ-IO Cruise Report. Eastern Indian Ocean larval tuna habitat study 20 January – 14 March 2022. http://hdl.handle.net/1834/43464
General

Landry, M. R., Ohman, M. D., Goericke, R., Stukel, M. R., Barbeau, K. A., Bundy, R., & Kahru, M. (2012). Pelagic community responses to a deep-water front in the California Current Ecosystem: overview of the A-Front Study. Journal of Plankton Research, 34(9), 739–748. https://doi.org/10.1093/plankt/fbs025
Methods

Morrow, R. M., Ohman, M. D., Goericke, R., Kelly, T. B., Stephens, B. M., & Stukel, M. R. (2018). CCE V: Primary production, mesozooplankton grazing, and the biological pump in the California Current Ecosystem: Variability and response to El Niño. Deep Sea Research Part I: Oceanographic Research Papers, 140, 52–62. https://doi.org/10.1016/j.dsr.2018.07.012
Methods

Stukel, M. R., Ohman, M. D., Benitez-Nelson, C. R., & Landry, M. R. (2013). Contributions of mesozooplankton to vertical carbon export in a coastal upwelling system. Marine Ecology Progress Series, 491, 47–65. https://www.jstor.org/stable/24892753
Methods

[table of contents | back to top]

Parameters

Parameter	Description	Units
Date	Date of sampling	unitless
CTD_ISO_DateTime_UTC	Date of CTD deployment in UTC time (local time = UTC +8h) in ISO 8601 format	unitless
Event	Ship event logger. Number indicates the date and time plus a 001.	unitless
CTD_cast	Number of the CTD cast	unitless
lon	Longitude	decimal degrees East
lat	Latitude; negative values = South	decimal degrees North
Cycle_Day	Indicates the number of each cycle and the day of measurement during the cycle	unitless
Cycle	Abbreviaton of the Cycle_Day column	unitless
Array_net	Number of the in-situ net of the array	unitless
Cycle_Bottle	Indicates the different replicate bottles (A, B, C, or Dark)	unitless
Volume_ml	Volume of sample incubated	milliliters (ml)
Niskin_bottle	Inidicates the numbeer of the Niskin bottle the sample was taken from	unitless
depth	Depth the sample was taken from and incubated in	meters (m)
CPMA_SAMPLE	Counts per minute of the sample	counts per minute
DPM_SAMPLE	Disintegrations per minute of each sample	disintegrations per minute (dpm)
CPMA_TOTAL	Counts per minute of the total measurement	counts per minute

DPM_TOTAL	Disintegrations per minute of the total measurement	disintegrations per minute (dpm)
sample_blank	Disintegrations per minute of each blank	disintegrations per minute (dpm)
DIC	Estimated dissolved inorganic carbon concentration	milligrams carbon per cubic meter (mg C m-3)
C_fix	Calculated carbon fixation	milligrams carbon per cubin meter per day (mgC/m3/d)
C_fix_AV	Average C fixation caluclated from the replicates	milligrams carbon per cubic meter per day (mgC/m3/d)
C_fix_SD	Standard deviation of C fixation from the replicates	milligrams carbon per cubic meter per day (mgC/m3/d)

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	satellite-tracked Lagrangian drifter
Generic Instrument Name	Drifter Buoy
Generic Instrument Description	Drifting buoys are free drifting platforms with a float or buoy that keep the drifter at the surface and underwater sails or socks that catch the current. These instruments sit at the surface of the ocean and are transported via near-surface ocean currents. They are not fixed to the ocean bottom, therefore they "drift" with the currents. For this reason, these instruments are referred to as drifters, or drifting buoys. The surface float contains sensors that measure different parameters, such as sea surface temperature, barometric pressure, salinity, wave height, etc. Data collected from these sensors are transmitted to satellites passing overhead, which are then relayed to land-based data centers. definition sources: https://mmisw.org/ont/ioos/platform/drifting_buoy and https://www.aoml.noaa.gov/phod/gdp/faq.php#drifter1

Dataset-specific Instrument Name	incubation bottles
Generic Instrument Name	Light-Dark Bottle
Generic Instrument Description	The light/dark bottle is a way of measuring primary production by comparing before and after concentrations of dissolved oxygen. Bottles containing seawater samples with phytoplankton are incubated for a predetermined period of time under light and dark conditions. Incubation is preferably carried out in situ, at the depth from which the samples were collected. Alternatively, the light and dark bottles are incubated in a water trough on deck, and neutral density filters are used to approximate the light conditions at the collection depth.Rates of net and gross photosynthesis and respiration can be determined from measurements of dissolved oxygen concentration in the sample bottles.

Dataset-specific Instrument Name	Scintillation counter (Packard tricarb)
Generic Instrument Name	Liquid Scintillation Counter
Generic Instrument Description	Liquid scintillation counting is an analytical technique which is defined by the incorporation of the radiolabeled analyte into uniform distribution with a liquid chemical medium capable of converting the kinetic energy of nuclear emissions into light energy. Although the liquid scintillation counter is a sophisticated laboratory counting system used the quantify the activity of particulate emitting (ß and a) radioactive samples, it can also detect the auger electrons emitted from 51Cr and 125I samples. Liquid scintillation counters are instruments assaying alpha and beta radiation by quantitative detection of visible light produced by the passage of rays or particles through a suitable scintillant incorporated into the sample.

Dataset-specific Instrument Name	CTD Niskin bottles
Generic Instrument Name	Niskin bottle
Generic Instrument Description	A Niskin bottle (a next generation water sampler based on the Nansen bottle) is a cylindrical, non-metallic water collection device with stoppers at both ends. The bottles can be attached individually on a hydrowire or deployed in 12, 24, or 36 bottle Rosette systems mounted on a frame and combined with a CTD. Niskin bottles are used to collect discrete water samples for a range of measurements including pigments, nutrients, plankton, etc.

Dataset-specific Instrument Name	sediment trap array
Generic Instrument Name	Sediment Trap
Generic Instrument Description	Sediment traps are specially designed containers deployed in the water column for periods of time to collect particles from the water column falling toward the sea floor. In general a sediment trap has a jar at the bottom to collect the sample and a broad funnel-shaped opening at the top with baffles to keep out very large objects and help prevent the funnel from clogging. This designation is used when the specific type of sediment trap was not specified by the contributing investigator.

[table of contents | back to top]

Deployments

RR2201

Website	https://www.bco-dmo.org/deployment/916293
Platform	R/V Roger Revelle
Report	http://hdl.handle.net/1834/43464
Start Date	2022-01-20
End Date	2022-03-14
Description	See more information at R2R: https://www.rvdata.us/search/cruise/RR2201

[table of contents | back to top]

Project Information

Collaborative Research: Mesoscale variability in nitrogen sources and food-web dynamics supporting larval southern bluefin tuna in the eastern Indian Ocean (BLOOFINZ-IO)

Coverage: Eastern Indian Ocean, Indonesian Throughflow area, and the Gulf of Mexico

NSF Award Abstract:
The small area between NW Australia and Indonesia in the eastern Indian Ocean (IO) is the only known spawning ground of Southern Bluefin Tuna (SBT), a critically endangered top marine predator. Adult SBT migrate thousands of miles each year from high latitude feeding areas to lay their eggs in these tropical waters, where food concentrations on average are below levels that can support optimal feeding and growth of their larvae. Many critical aspects of this habitat are poorly known, such as the main source of nitrogen nutrient that sustains system productivity, how the planktonic food web operates to produce the unusual types of zooplankton prey that tuna larvae prefer, and how environmental differences in habitat quality associated with ocean fronts and eddies might be utilized by adult spawning tuna to give their larvae a greater chance for rapid growth and survival success. This project investigates these questions on a 38-day expedition in early 2021, during the peak time of SBT spawning. This project is a US contribution to the 2nd International Indian Ocean Expedition (IIOE-2) that advances understanding of biogeochemical and ecological dynamics in the poorly studied eastern IO. This is the first detailed study of nitrogen and carbon cycling in the region linking Pacific and IO waters. The shared dietary preferences of SBT larvae with those of other large tuna and billfish species may also make the insights gained broadly applicable to understanding larval recruitment issues for top consumers in other marine ecosystems. New information from the study will enhance international management efforts for SBT. The shared larval dietary preferences of large tuna and billfish species may also

extend the insights gained broadly to many other marine top consumers, including Atlantic bluefin tuna that spawn in US waters of the Gulf of Mexico. The end-to-end study approach, highlights connections among physical environmental variability, biogeochemistry, and plankton food webs leading to charismatic and economically valuable fish production, is the theme for developing educational tools and modules through the "scientists-in-the-schools" program of the Center for Ocean-Atmospheric Prediction Studies at Florida State University, through a program for enhancing STEM learning pathways for underrepresented students in Hawaii, and through public outreach products for display at the Birch Aquarium in San Diego. The study also aims to support an immersive field experience to introduce talented high school students to marine research, with the goal of developing a sustainable marine-related educational program for underrepresented students in rural northwestern Florida.

Southern Bluefin Tuna (SBT) migrate long distances from high-latitude feeding grounds to spawn exclusively in a small oligotrophic area of the tropical eastern Indian Ocean (IO) that is rich in mesoscale structures, driven by complex currents and seasonally reversing monsoonal winds. To survive, SBT larvae must feed and grow rapidly under environmental conditions that challenge conventional understanding of food-web structure and functional relationships in poor open-ocean systems. The preferred prey of SBT larvae, cladocerans and Corycaeidae copepods, are poorly studied and have widely different implications for trophic transfer efficiencies to larvae. Differences in nitrogen sources - N fixation vs deep nitrate of Pacific origin - to sustain new production in the region also has implications for conditions that may select for prey types (notably cladocerans) that enhance transfer efficiency and growth rates of SBT larvae. The relative importance of these N sources for the IO ecosystem may affect SBT resiliency to projected increased ocean stratification. This research expedition investigates how mesoscale variability in new production, food-web structure and trophic fluxes affects feeding and growth conditions for SBT larvae. Sampling across mesoscale features tests hypothesized relationships linking variability in SBT larval feeding and prey preferences (gut contents), growth rates (otolith analyses) and trophic positions (TP) to the environmental conditions of waters selected by adult spawners. Trophic Positions of larvae and their prey are determined using Compound-Specific Isotope Analyses of Amino Acids (CSIA-AA). Lagrangian experiments investigate underlying process rates and relationships through measurements of water-column 14C productivity, N2 fixation, 15NO3- uptake and nitrification; community biomass and composition (flow cytometry, pigments, microscopy, in situ imaging, genetic analyses); and trophic fluxes through micro- and mesozooplankton grazing, remineralization and export. Biogeochemical and food web elements of the study are linked by CSIA-AA (N source, TP), 15N-constrained budgets and modeling. The project elements comprise an end-to-end coupled biogeochemistry-trophic study as has not been done previously for any pelagic ecosystem.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

[table of contents | back to top]

Program Information

Second International Indian Ocean Expedition (IIOE-2)

Website: https://web.whoi.edu/iioe2/

Coverage: Indian Ocean

Description from the program website:
The Second International Indian Ocean Expedition (IIOE-2) is a major global scientific program which will engage the international scientific community in collaborative oceanographic and atmospheric research from coastal environments to the deep sea over the period 2015-2020, revealing new information on the Indian Ocean (i.e. its currents, its influence upon the climate, its marine ecosystems) which is fundamental for future sustainable development and expansion of the Indian Ocean's blue economy. A large number of scientists from research institutions from around the Indian Ocean and beyond are planning their involvement in IIOE-2 in accordance with the overarching six scientific themes of the program. Already some large collaborative research projects are under development, and it is anticipated that by the time these projects are underway, many more will be in planning or about to commence as the scope and global engagement in IIOE-2 grows.

Focused research on the Indian Ocean has a number of benefits for all nations. The Indian Ocean is complex

and drives the region's climate including extreme events (e.g. cyclones, droughts, severe rains, waves and storm surges). It is the source of important socio-economic resources (e.g. fisheries, oil and gas exploration/extraction, eco-tourism, and food and energy security) and is the background and focus of many of the region's human populations around its margins. Research and observations supported through IIOE-2 will result in an improved understanding of the ocean's physical and biological oceanography, and related air-ocean climate interactions (both in the short-term and long-term). The IIOE-2's program will complement and harmonise with other regional programs underway and collectively the outcomes of IIOE-2 will be of huge benefit to individual and regional sustainable development as the information is a critical component of improved decision making in areas such as maritime services and safety, environmental management, climate monitoring and prediction, food and energy security.

IIOE-2 activities will also include a significant focus on building the capacity of all nations around the Indian Ocean to understand and apply observational data or research outputs for their own socio-economic requirements and decisions. IIOE-2 capacity building programs will therefore be focused on the translation of the science and information outputs for societal benefit and training of relevant individuals from surrounding nations in these areas.

A Steering Committee was established to support U.S. participation in IIOE-2. More information is available on their website at https://web.whoi.edu/iioe2/.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1851347
NSF Division of Ocean Sciences (NSF OCE)	OCE-2404504

[table of contents | back to top]