Advanced Laser Fluorescence Analyzer (ALFA) data from the Indonesian Through Flow Region on the R/V Roger Ravelle in January - March 2022

Website: https://www.bco-dmo.org/dataset/944302
Data Type: Cruise Results
Version: 1
Version Date: 2024-11-22

Project

» Collaborative Research: Mesoscale variability in nitrogen sources and food-web dynamics supporting larval southern bluefin tuna in the eastern Indian Ocean (BLOOFINZ-IO)
» RAPID - Assessing the response of the Seychelles-Chagos Thermocline Ridge ecosystem to an Indian Ocean Dipole event (SCTR_IOD)

Program

» Second International Indian Ocean Expedition (IIOE-2)

Contributors	Affiliation	Role
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Coverage

Location: Indonesian Through Flow Region
Spatial Extent: **N**:6.599072 **E**:136.543725 **S**:-17.186432 **W**:113.911019
Temporal Extent: 2022-01-26 - 2022-03-11

Methods & Sampling

Underway fluoresence sampling from the western Eastern Indian Ocean Upwelling region on the R/V Roger Ravelle in January - March 2022 (BLOOFINZ).

When the instrument is used for underway sampling, the ALF is connected to the ship's uncontaminated seawater flow-through system allowing for continuous measurements in water drawn from approximately 5m below the surface

The Automatic Laser Fluorometric Analyzer (ALFA) is a state-of-the-art instrument, that combines high-resolution spectral measurements of blue (405 nm) and green (532 nm) laser-stimulated fluorescence, with spectral deconvolution techniques to estimate CDOM, phytoplankton variable fluorescence (Fv/Fm), Chl a and

three types of phycobiliprotein pigments.

Data Processing Description

The fluorescence intensities attributable to each of the variables are normalized to the water Raman and expressed as relative fluorescence units (RFU). The Raman–normalized Chl a (679nm) and CDOM (508nm) fluorescence signals stimulated by the blue laser allow for measurements of Chl a and CDOM, respectively, while the Raman-normalized PE fluorescence signatures stimulated with the green laser allow for detection and quantitative assessment of three PE-containing groups of phytoplankton. These include the:
1) PE-1 peak at 565nm from blue water oligotrophic cyanobacteria with high phycourobilin/phycoerythrobilin (PUB/PEB) ratios,
2) PE-2 peak at 578nm from green water cyanobacteria with low-PUB/PEB ratios that usually thrive in coastal mesohaline waters, and
3) PE-3 peak at 590 nm attributable to eukaryotic photoautotrophic cryptophytes that are rich in phycobiliproteins and often abundant in coastal, and estuarine environments and in enclosed bays (Chekalyuk and Hafez, 2008; Chekalyuk et al., 2012, Goes et al. 2014).

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Parameters

Parameters for this dataset have not yet been identified

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Instruments

Dataset-specific Instrument Name	Automatic Laser Fluorometric Analyzer (ALFA)
Generic Instrument Name	Wet Labs Aquatic Laser Fluorescence Analyzer (ALFA)
Generic Instrument Description	WET Labs' Aquatic Laser Fluorescence Analyzer (ALFA) provides spectrally and temporally resolved measurements of key bio-environmental variables in oceanic, coastal, and fresh waters. Operation modes allow underway shipboard measurements and discrete sample analysis for accurate assessments of pigment biomass, phytoplankton community structure and physiology. Features • Spectral deconvolution of overlapped fluorescence bands with Raman normalization • Improved assessment of chlorophyll concentrations for estimating phytoplankton biomass • Discrimination of 5 phycobiliprotein pigments for structural phytoplankton characterization • Fluorescence assessment of chromophoric dissolved organic matter (CDOM) • Measures variable fluorescence, Fv/Fm, with correction for background CDOM fluorescence • Instrument software allows real-time data analysis and display with GPS coordinates and time more information from Wet Labs

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Deployments

RR2201

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

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.

RAPID - Assessing the response of the Seychelles-Chagos Thermocline Ridge ecosystem to an Indian Ocean Dipole event (SCTR_IOD)

Coverage: Southwestern Tropical Indian Ocean (5 and 15 degrees S)

NSF Award Abstract:
Phytoplankton constitute the base of the marine food web. Their diversity, productivity and abundance have a huge influence on fisheries. For example, seasonal increases in phytoplankton biomass caused by the surge of deep ocean nutrient rich waters into the upper sunlit layers in the Equatorial Indian Ocean lead to an increase in tuna stocks. However, non-periodic increases of sea surface temperatures in the Seychelles-Chagos Thermocline Ridge region in the eastern Equatorial Indian Ocean, a phenomenon known as the Indian Ocean Dipole, weakens deep ocean water surge, which seems to alter phytoplankton community structure and to reduce phytoplankton's productivity to the detriment of tuna stocks. Yet, the impact from such unpredictable events is not fully understood. This project investigates the impacts of an ongoing Indian Ocean Dipole, one of the most severe on record, on phytoplankton. The broader impacts of the project relate to its value to inform fisheries management plans in that area. Data derived from this study is valuable to understand and predict wider changes in the food web in a region that is coming under increasing pressures of global warming. All the data is made publicly available.

The research team is working with South Korean collaborators to understand how changes in phytoplankton biomass and in deep chlorophyll maxima may be linked to changes in phytoplankton productivity and growth rates due nutrient and/or iron limitation as a result of the weakening of deep-water upwelling. The team is also investigating the impact of the dipole event on cell size of dominating phytoplankton populations. Finally, they are testing if the phytoplankton community rely primarily on recycled as opposed to new nitrogenous nutrients for photosynthesis and growth during dipole events. The hypotheses are tested through extensive biological, hydro-chemical and biogeochemical measurements that include: 1) microscopic, Flow Cytometry, FlowCAM and HPLC pigment based analysis of phytoplankton biomass, community composition and size structure and Fast Repetition Rate based measurements of phytoplankton photosynthetic competency along a cruise track and different depths in the water column, and 2) on-deck incubation based photosynthesis and nutrient uptake experiments. In situ measurements and sample collection is carried out as part of the Korea-US inDian Ocean Scientific (KUDOS) Research Program cruise (April-May 2020) on board the Korea Institute of Ocean Sciences and Technology Ship R/V Isabu, one of the only multi-disciplinary oceanographic cruises planned for the Seychelles-Chagos Thermocline Ridge region during the dipole event.

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.

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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/.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2019983

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