Zooplankton biomass and species composition and abundance in the southeastern Caribbean Sea (Cariaco Basin) from October 2001 – January 2017 collected by the CARIACO Ocean Time-Series Program

Website: https://www.bco-dmo.org/dataset/3149
Data Type: Cruise Results
Version: 1
Version Date: 2019-08-14

Project
» CARIACO Ocean Time-Series Program (CARIACO)

Programs
» Ocean Carbon and Biogeochemistry (OCB)
» U.S. Joint Global Ocean Flux Study (U.S. JGOFS)
» Ocean Time-series Sites (Ocean Time-series)

Contributors	Affiliation	Role
Astor, Yrene	Estacion de Investigaciones Marinas de Margarita (EDIMAR-FLASA)	Principal Investigator
Muller-Karger, Frank	University of South Florida (USF)	Principal Investigator
Rojas, Jaimie	Estacion de Investigaciones Marinas de Margarita (EDIMAR-FLASA)	Principal Investigator
Varela, Ramon	Estacion de Investigaciones Marinas de Margarita (EDIMAR-FLASA)	Principal Investigator
Gonzalez, Luis	Estacion de Investigaciones Marinas de Margarita (EDIMAR-FLASA)	Scientist
Gutierrez, Javier	Estacion de Investigaciones Marinas de Margarita (EDIMAR-FLASA)	Scientist
Lorenzoni, Laura	University of South Florida (USF)	Scientist, Data Manager
Rueda-Roa, Digna	University of South Florida (USF)	Scientist, Contact, Data Manager
Biddle, Mathew	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager
McKee, Theresa	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract

The CARIACO Ocean Time-Series Program (formerly known as CArbon Retention In A Colored Ocean) started on November 1995 (CAR-001) and ended on January 2017 (CAR-232). Monthly cruises were conducted to the CARIACO station (10.50° N, 64.67° W) onboard the R/V Hermano Ginés of the Fundación La Salle de Ciencias Naturales de Venezuela. The program studied the relationship between surface primary production, physical forcing variables like the wind, and the settling flux of particulate carbon in the Cariaco Basin. This depression, located on the continental shelf of Venezuela, shows marked seasonal and interannual variation in hydrographic properties and primary production (carbon fixation rates by photosynthesis of planktonic algae). Zooplankton sampling was done during each CARIACO time-series cruise from October 2001 to January 2017 (cruises CAR071 - CAR232). Oblique BONGO net tow samples from 200 m to the surface were analyzed to determine

biomass (dry weight and ash content) and taxonomic composition. Empty values denote that a specific zooplankton group was not found at that cruise.

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Coverage

Spatial Extent: **N**:10.514 **E**:-63.336 **S**:10.486 **W**:-64.682
Temporal Extent: 2001-10-09 - 2017-01-12

Dataset Description

The CARIACO Ocean Time-Series Program (formerly known as CArbon Retention In A Colored Ocean) started on November 1995 (CAR-001) and ended on January 2017 (CAR-232). Monthly cruises were conducted to the CARIACO station (10.50° N, 64.67° W) onboard the R/V Hermano Ginés of the Fundación La Salle de Ciencias Naturales de Venezuela. The program studied the relationship between surface primary production, physical forcing variables like the wind, and the settling flux of particulate carbon in the Cariaco Basin. This depression, located on the continental shelf of Venezuela, shows marked seasonal and interannual variation in hydrographic properties and primary production (carbon fixation rates by photosynthesis of planktonic algae).

The CARIACO Ocean Time-Series study area is the Cariaco Basin, located on the continental shelf of Venezuela, in the southeastern Caribbean Sea. The Cariaco Basin is a large (~160 km long, 70 km wide) and deep (~1,400 m) basin, located on the Venezuelan continental shelf, with an area of approximately 11.200 km2; bound to the north by a sill connecting Margarita Island to Cabo Codera, at a mean depth of about 100 m with two channels breaching this sill (La Tortuga: ~135 m and Centinela: ~146 m). The basin is divided into two sub-basins, one

eastern and one western, separated by a saddle of approximately 900 m deep. The Cariaco Basin region is between 10-11 degrees N and 64-66 degrees W.

The Cariaco Basin shows marked seasonal and interannual variation in hydrographic properties and primary production (carbon fixation rates by photosynthesis of planktonic algae) due to the seasonal coastal upwelling. The Cariaco Basin hydrography is affected by North-Atlantic gyre-scale processes, including dispersal of Subtropical Underwater and western boundary current variability, cross-equatorial flow of water masses, wind-driven upwelling compounded by geostrophic circulation, ventilation forced by Caribbean Sea eddies, and river discharge. Due to its restricted circulation and high primary production, the basin is anoxic below ~250 m.

Zooplankton sampling was done during each CARIACO time-series cruise from October 2001 to January 2017 (cruises CAR071 - CAR232). Oblique BONGO net tow samples from 200 m to the surface were analyzed to determine biomass (dry weight and ash content) and taxonomic composition. Empty values denote that a specific zooplankton group was not found at that cruise.

More information can be found in the following web pages:
Web page of the CARIACO Ocean Time-Series Program: http://imars.usf.edu/cariaco
General description: http://www.imars.usf.edu/cariaco
Methodology: http://imars.usf.edu/publications/methods-cariaco
List of publications: http://imars.usf.edu/view/biblio/803738/year

These data were also funded by the following awards:
- 23914: Ley Orgánica de Ciencia, Tecnología e Innovación, LOCTI (Estación de Investigaciones Marinas), Venezuela.
- 2011000353: Inter-American Institute for Global Change Research, IAI (IAI-CRN3094).

Acquisition Description

Zooplankton samples were collected during each monthly CARIACO time-series cruise from October 2001 to January 2017 (cruises 71-232). It was used a BONGO type net with two receptacles of 60 cm opening diameter and two different mesh sizes of 200 and 500 microns. A flowmeter was set at the opening of the 500 microns' net to calculate the volume of water filtered. An oblique tow was made for ~15 minutes during the day (between 9 and 10 AM) from between 200 m deep to the surface. During the entire tow, the cable was maintained at an angle of 40-45 degrees with a clinometer. The ship's speed during the tows was maintained around 1-1.5 knots, and the net was pulled upwards at a speed of 1 m/s. Once at the surface, the nets were washed with seawater, and the collecting jars contents were emptied in labeled glass bottles that were kept refrigerated until returning to the lab.

Zooplankton taxonomy was performed at Fundación La Salle de Ciencias Naturales, Estación de Investigaciones Marinas de Margarita (EDIMAR), Isla de Margarita, Venezuela. When zooplankton samples were returned to the lab (~12 hours later), formalin (5%) neutralized with borax was added to each sample for preservation. For processing, each sample was split in two aliquots with a Folsom splitter, one for biomass and the other for taxonomy. The aliquot for biomass calculation was washed with DI water to eliminate salt excess, dried in pre-weighted crucibles for 48 hours in an electric oven at a constant temperature of 60°C, and it was kept in a desiccator until measuring the Dry Weight (biomass). Afterwards, the dry sample was calcined in a muffle furnace at 450°C for 4 hours and weighted to measure Ash (inorganic remains). For taxonomy, aliquots were extracted and placed in a 10 ml Bogorov chamber in order to count and identify taxonomic groups present. Identification and counts were made using a stereomicroscope Baush & Lomb (7x). Processed taxonomy samples were stored in the collection maintained at the Museo Oceanológico Hermano Benigno Román (MOBR - EDIMAR). The manuals used for zooplankton identification were Newell & Newell (1977), Tregouboff & Rose (1978), and Boltosvkoy (1981).

Processing Description

BCO-DMO Processing Notes:
- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions
- replaced latitude/longitude values of -9999 with 10.492 and -64.672.

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Related Publications

Boltovskoy, D., 1981. Atlas del zooplancton del Atlántico Sudoccidental. Publicación Especial del Instituto Nacional de Investigación y Desarrollo Pesquero, Mar del Plata, Argentina.

Newell, Gordon Ewart, and Richard Charles Newell. Marine plankton. Hutchinson, 1977.

Tregouboff, G., Rose, M., 1978. Manuel de Planctologie Méditerranéenne. CNRS Paris, Tome I.

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Parameters

Parameter	Description	Units
Cruise	number of the cruise	unitless
Cruise_ID	cruise ID for the CARIACO project	unitless
Latitude	Latitude of observations with positive values indicating North	decimal degrees
Longitude	Longitude of observations with negative values indicating West	decimal degrees
Day	day of sampling in dd format	unitless
Month	month of sampling in mm format	unitless
Year	year of sampling in yyyy format	unitless
Date	year-month-day of sampling event	unitless
Analyst	Person's name who analyzed the sample	unitless
Mesh_Size	Mesh size for the Bongo Net	micrometers (um)
TOTAL_DENSITY	total density of zooplankton	individuals per meter cubed (ind/m3)
BIOMASS	Dry weight biomass of sample	miligrams per meter cubed (mg/m3)
ASH	inorganic carbon ash	miligrams per meter cubed (mg/m3)
COPEPODS	abundance of Subclass Copepoda in sample	individual per meter cubed (ind/m3)
CALANOIDS	abundance of Order Calanoida in sample	individual per meter cubed (ind/m3)
CYCLOPOIDA	abundance of Order Cyclopoida in sample	individual per meter cubed (ind/m3)
HAPARCTICOIDA	abundance of Order Harpacticoida in sample	individual per meter cubed (ind/m3)
POECILOSTOMATOIDA	abundance of Order Poecilostomatoida in sample	individual per meter cubed (ind/m3)
L_FISH	abundance of Fish larvae (Class Actinopterygii) in sample	individual per meter cubed (ind/m3)

H_FISH	abundance of Fish eggs (Class Actinopterygii) in sample	individual per meter cubed (ind/m3)
CHAETOGNATHA	abundance of Phylum Chaetognatha in sample	individual per meter cubed (ind/m3)
CLADOCEROS	abundance of Infraorder Cladocera in sample	individual per meter cubed (ind/m3)
OSTRACODA	abundance of Class Ostracoda in sample	individual per meter cubed (ind/m3)
FORAMINIFERA	abundance of Phylum Foraminifera in sample	individual per meter cubed (ind/m3)
AMPHIPODS	abundance of Order Amphipoda in sample	individual per meter cubed (ind/m3)
ISOPODS	abundance of Order Isopoda in sample	individual per meter cubed (ind/m3)
EUPHAUSIIDS	abundance of Order Euphausiidae in sample	individual per meter cubed (ind/m3)
MISYDACEA	abundance of Order Mysida in sample	individual per meter cubed (ind/m3)
SERGESTID	abundance of Family Sergestidae in sample	individual per meter cubed (ind/m3)
L_CRUSTACEA	abundance of larvae of Subphylum Crustacea in sample	individual per meter cubed (ind/m3)
N_COPEPOD	abundance of nauplius of Subclass Copepoda in sample	individual per meter cubed (ind/m3)
C_COPEPOD	abundance of copepodite of Subclass Copepoda in sample	individual per meter cubed (ind/m3)
N_CIRRIPEDIA	abundance of nauplius of Infraclass Cirripedia in sample	individual per meter cubed (ind/m3)
C_CIRRIPEDIA	abundance of copepodite of Infraclass Cirripedia in sample	individual per meter cubed (ind/m3)
L_DECAPODA	abundance of larvae of Order Decapoda in sample	individual per meter cubed (ind/m3)
L_STOMATOPODA	abundance of larvae of Order Stomatopoda in sample	individual per meter cubed (ind/m3)

L_EUPHAUSIID	abundance of larvae of Family Euphausiidae in sample	individual per meter cubed (ind/m3)
L_SERGESTID	abundance of larvae of Family Sergestidae in sample	individual per meter cubed (ind/m3)
POLICHAETES	abundance of Class Polychaeta in sample	individual per meter cubed (ind/m3)
L_CYPHONAUTES	abundance of cyphonautes larvae of Phylum Bryozoa in sample	individual per meter cubed (ind/m3)
MEDUSA	abundance of menudasa of Phylum Cnidaria in sample	individual per meter cubed (ind/m3)
SIPHONOPHORES	abundance of Order Siphonophorae in sample	individual per meter cubed (ind/m3)
CTENOPHORES	abundance of Phylum Ctenophora in sample	individual per meter cubed (ind/m3)
L_ECHINODERMS	abundance of larvae of Phylum Echinodermata in sample	individual per meter cubed (ind/m3)
PTEROPODS	abundance of Order Pteropoda in sample	individual per meter cubed (ind/m3)
HETEROPODS	abundance of Superorder Pterotracheoidea in sample	individual per meter cubed (ind/m3)
GASTROPODS	abundance of Class Gastropoda in sample	individual per meter cubed (ind/m3)
L_CEPHALOPODA	abundance of larvae of Class Cephalopoda in sample	individual per meter cubed (ind/m3)
L_BIVALVE	abundance of larvae of Class Bivalvia in sample	individual per meter cubed (ind/m3)
L_GASTROPOD	abundance of larvae of Class Gastropoda in sample	individual per meter cubed (ind/m3)
PROTOZOAN	abundance of Kingdom Protozoa in sample	individual per meter cubed (ind/m3)
RADIOLARIAN	abundance of Phylum Radiozoa in sample	individual per meter cubed (ind/m3)
APPENDICULARIANS	abundance of Class Appendicularia in sample	individual per meter cubed (ind/m3)

SALPS	abundance of Family Salpidae in sample	individual per meter cubed (ind/m3)
DOLIOLIDS	abundance of Family Doliolidae in sample	individual per meter cubed (ind/m3)
BIVALVES	abundance of Class Bivalvia in sample	individual per meter cubed (ind/m3)
H_CRUSTACEA	abundance of eggs of Subphylum Crustacea in sample	individual per meter cubed (ind/m3)
L_ANFIOXUS	abundance of larvae of amphioxus of Genus Branchiostoma in sample	individual per meter cubed (ind/m3)
LUCIFER	abundance of Genus Lucifer in sample	individual per meter cubed (ind/m3)
JUV_GASTROPOD	abundance of juveniles of Class Gastropoda in sample	individual per meter cubed (ind/m3)

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Instruments

Dataset-specific Instrument Name	Bongo Nets
Generic Instrument Name	Bongo Net
Dataset-specific Description	BONGO type net towed with receptacles of 60cm opening diameter and two different mesh sizes, 200 and 500 microns.
Generic Instrument Description	A Bongo Net consists of paired plankton nets, typically with a 60 cm diameter mouth opening and varying mesh sizes, 10 to 1000 micron. The Bongo Frame was designed by the National Marine Fisheries Service for use in the MARMAP program. It consists of two cylindrical collars connected with a yoke so that replicate samples are collected at the same time. Variations in models are designed for either vertical hauls (OI-2500 = NMFS Pairovet-Style, MARMAP Bongo, CalVET) or both oblique and vertical hauls (Aquatic Research). The OI-1200 has an opening and closing mechanism that allows discrete "known-depth" sampling. This model is large enough to filter water at the rate of 47.5 m3/minute when towing at a speed of two knots. More information: Ocean Instruments, Aquatic Research, Sea-Gear

Dataset-specific Instrument Name	stereomicroscope
Generic Instrument Name	Microscope-Optical
Dataset-specific Description	stereomicroscope
Generic Instrument Description	Instruments that generate enlarged images of samples using the phenomena of reflection and absorption of visible light. Includes conventional and inverted instruments. Also called a "light microscope".

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Deployments

HG93_CARIACO

Website	https://www.bco-dmo.org/deployment/57845
Platform	B/O Hermano Gines
Start Date	1995-11-08
Description	Monthly oceanographic cruises to the CARIACO station (10.5 degrees N, 64.67 degrees W) have been conducted since November 1995 to examine the hydrography, primary production, and settling flux of particulate material. The research vessel is the 75-foot B/O (Barco Oceanografico) Hermano Gines of the Fundaciòn La Salle de Ciencias Naturales (FLASA) located on Margarita Island, Venezuela. Water is collected using a rosette ensemble equipped with twelve 8-liter bottles and a CTD (conductivity-temperature-depth meter); the CTD also has an oxygen sensor, a fluorometer for chlorophyll-a estimates, and a transmissometer. Data are read out real-time on a computer screen on board the ship as the rosette ensemble is lowered to approximately 1,380 m, the bottom of the Cariaco Basin. Water samples are analyzed for various parameters including phytoplankton biomass, dissolved and particulate nutrient and carbon concentration, primary productivity rates and total bacterial production.

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Project Information

CARIACO Ocean Time-Series Program (CARIACO)

Website: http://www.imars.usf.edu/CAR/index.html

Coverage: CARIACO basin

Since 1995, the CARIACO Ocean Time-Series (formerly known as the CArbon Retention In A Colored Ocean) Program has studied the relationship between surface primary production, physical forcing variables like the wind, and the settling flux of particulate carbon in the Cariaco Basin. This depression, located on the continental shelf of Venezuela (Map), shows marked seasonal and interannual variation in hydrographic properties and primary production (carbon

fixation rates by photosynthesis of planktonic algae). This peculiar basin is anoxic below ~250 m, due its restricted circulation and high primary production (Muller-Karger et al., 2001). CARIACO observations show annual primary production rates exceed 500 gC/m2y, of which over 15-20% can be accounted for by events lasting one month or less. Such events are observed in other locations where time series observations are collected, and suggest that prior estimates of regional production based on limited sampling may have been underestimated. The annual primary production rates in the Cariaco Basin are comparable to rates estimated using time series observations for Monterey Bay (460 gC/m2y; Chavez, 1996), and higher than previous rates estimated for Georges Bank, the New York Shelf, and the Oregon Shelf (380, 300, and 190 gC/m2y, respectively; Walsh, 1988). The Cariaco Basin has long been the center of attention of scientists trying to explain paleoclimate. Due to its high rates of sedimentation (30 to >100 cm/ky; Peterson et al., 2000) and excellent preservation, the varved sediments of the Cariaco Basin offer the opportunity to study high resolution paleoclimate and better understand the role of the tropics in global climate change (Black et al., 1999; Peterson et al., 2000; Haug et al., 2001; Black et al., 2004; Hughen et al., 2004). Now, the CARIACO program provides a link between the sediment record and processes near the surface of the ocean. Sediment traps maintained by the CARIACO program show that over 5% of autochtonous material reaches 275 m depth, and that nearly 2% reaches 1,400 m. The significance of this flux is that it represents a sink for carbon and that it helps explain the record of ancient climate stored at the bottom of the Cariaco Basin. Acknowledgements: This work was supported by the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), and Venezuela's Fondo Nacional de Ciencia, Tecnología e Innovación (FONACIT). For more information please see this Acknowledgements link.

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Program Information

Ocean Carbon and Biogeochemistry (OCB)

Website: http://us-ocb.org/

Coverage: Global

The Ocean Carbon and Biogeochemistry (OCB) program focuses on the ocean's role as a component of the global Earth system, bringing together research in geochemistry, ocean physics, and ecology that inform on and advance our understanding of ocean biogeochemistry. The overall program goals are to promote, plan, and coordinate collaborative, multidisciplinary

research opportunities within the U.S. research community and with international partners. Important OCB-related activities currently include: the Ocean Carbon and Climate Change (OCCC) and the North American Carbon Program (NACP); U.S. contributions to IMBER, SOLAS, CARBOOCEAN; and numerous U.S. single-investigator and medium-size research projects funded by U.S. federal agencies including NASA, NOAA, and NSF. The scientific mission of OCB is to study the evolving role of the ocean in the global carbon cycle, in the face of environmental variability and change through studies of marine biogeochemical cycles and associated ecosystems. The overarching OCB science themes include improved understanding and prediction of: 1) oceanic uptake and release of atmospheric CO2 and other greenhouse gases and 2) environmental sensitivities of biogeochemical cycles, marine ecosystems, and interactions between the two. The OCB Research Priorities (updated January 2012) include: ocean acidification; terrestrial/coastal carbon fluxes and exchanges; climate sensitivities of and change in ecosystem structure and associated impacts on biogeochemical cycles; mesopelagic ecological and biogeochemical interactions; benthic-pelagic feedbacks on biogeochemical cycles; ocean carbon uptake and storage; and expanding low-oxygen conditions in the coastal and open oceans.

U.S. Joint Global Ocean Flux Study (U.S. JGOFS)

Website: http://usjgofs.whoi.edu/

Coverage: Global

The United States Joint Global Ocean Flux Study was a national component of international JGOFS and an integral part of global climate change research. The U.S. launched the Joint Global Ocean Flux Study (JGOFS) in the late 1980s to study the ocean carbon cycle. An ambitious goal was set to understand the controls on the concentrations and fluxes of carbon and associated nutrients in the ocean. A new field of ocean biogeochemistry emerged with an emphasis on quality measurements of carbon system parameters and interdisciplinary field studies of the biological, chemical and physical process which control the ocean carbon cycle. As we studied ocean biogeochemistry, we learned that our simple views of carbon uptake and transport were severely limited, and a new "wave" of ocean science was born. U.S. JGOFS has been supported primarily by the U.S. National Science Foundation in collaboration with the National Oceanic and Atmospheric Administration, the National Aeronautics and Space Administration, the Department of Energy and the Office of Naval Research. U.S. JGOFS, ended in 2005 with the conclusion of the Synthesis and Modeling Project (SMP).

Ocean Time-series Sites (Ocean Time-series)

Coverage: Bermuda, Cariaco Basin, Hawaii

Program description text taken from Chapter 1: Introduction from the Global Intercomparability in a Changing Ocean: An International Time-Series Methods Workshop report published following the workshop held November 28-30, 2012 at the Bermuda Institute of Ocean Sciences. The full report is available from the workshop Web site hosted by US OCB: http://www.whoi.edu/website/TS-workshop/home Decades of research have demonstrated that the ocean varies across a range of time scales, with anthropogenic forcing contributing an added layer of complexity. In a growing effort to distinguish between natural and human-induced earth system variability, sustained ocean time-series measurements have taken on a renewed importance. Shipboard biogeochemical time-series represent one of the most valuable tools scientists have to characterize and quantify ocean carbon fluxes and biogeochemical processes and their links to changing climate (Karl, 2010; Chavez et al., 2011; Church et al., 2013). They provide the oceanographic community with the long, temporally resolved datasets needed to characterize ocean climate, biogeochemistry, and ecosystem change. The temporal scale of shifts in marine ecosystem variations in response to climate change are on the order of several decades. The long-term, consistent and comprehensive monitoring programs conducted by time-series sites are essential to understand large-scale atmosphere-ocean interactions that occur on interannual to decadal time scales. Ocean time-series represent one of the most valuable tools scientists have to characterize and quantify ocean carbon fluxes and biogeochemical processes and their links to changing climate. Launched in the late 1980s, the US JGOFS (Joint Global Ocean Flux Study; http://usjgofs.whoi.edu) research program initiated two time-series measurement programs at Hawaii and Bermuda (HOT and BATS, respectively) to measure key oceanographic measurements in oligotrophic waters. Begun in 1995 as part of the US JGOFS Synthesis and Modeling Project, the CARIACO Ocean Time-Series (formerly known as the CArbon Retention In A Colored Ocean) Program has studied the relationship between surface primary production, physical forcing variables like the wind, and the settling flux of particulate carbon in the Cariaco Basin. The objective of these time-series effort is to provide well-sampled seasonal resolution of biogeochemical variability at a limited number of ocean observatories, provide support and background measurements for process-oriented research, as well as test and validate observations for biogeochemical models. Since their creation, the BATS, CARIACO and HOT time-series site data have been available for use by a large community of researchers. Data from those three US funded, ship-based, time-series sites can be accessed at each site directly or by selecting the site name from the Projects section below.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-9401537
NSF Division of Ocean Sciences (NSF OCE)	OCE-9729697
NSF Division of Ocean Sciences (NSF OCE)	OCE-0326268
NSF Division of Ocean Sciences (NSF OCE)	OCE-9216626
NSF Division of Ocean Sciences (NSF OCE)	OCE-9711318
National Aeronautics & Space Administration (NASA)	NAS5-97128
NSF Division of Ocean Sciences (NSF OCE)	OCE-9415790
NSF Division of Ocean Sciences (NSF OCE)	OCE-9729284
National Aeronautics & Space Administration (NASA)	NAG5-6448
NSF Division of Ocean Sciences (NSF OCE)	OCE-0963028
NSF Division of Ocean Sciences (NSF OCE)	OCE-0752139
Fondo Nacional de Ciencia, Tecnología e Innovación of Venezuela (FONACIT)	96280221
NSF Division of Ocean Sciences (NSF OCE)	OCE-0326313
National Aeronautics & Space Administration (NASA)	NNX14AP62A
Fondo Nacional de Ciencia, Tecnología e Innovación of Venezuela (FONACIT)	2000001702
Fondo Nacional de Ciencia, Tecnología e Innovación of Venezuela (FONACIT)	2011000353

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