

# Particulate Trace Metals from NOAA Ship Ronald H. Brown RB-03-04B, RB-03-04C in the Reykjavik, Iceland to Natal Brazil from June to August 2003 (CLIVAR AEROSOL project)

Website: <https://www.bco-dmo.org/dataset/3702>

Version: 17 August 2012

Version Date: 2012-08-17

## Project

» [Collaborative Research: Global Ocean Survey of Dissolved Iron and Aluminum and Aerosol Iron and Aluminum Solubility Supporting the Repeat Hydrography \(CO<sub>2</sub>\) Project](#) (CLIVAR AEROSOL)

## Program

» [U. S. Climate Variability and Predictability](#) (U.S. CLIVAR)

| Contributors                        | Affiliation   | Role                      |
|-------------------------------------|---|---------------------------|
| <a href="#">Resing, Joseph A.</a>   | National Oceanic and Atmospheric Administration (NOAA-PMEL) | Principal Investigator    |
| <a href="#">Landing, William M.</a> | Florida State University (FSU - EOAS)                       | Co-Principal Investigator |
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## Coverage

**Spatial Extent:** N:62.333 E:-19.9955 S:-5.003 W:-29.00067

**Temporal Extent:** 2003-06-20 - 2003-08-08

## Dataset Description

Particulate trace element analysis by energy-dispersive X-ray fluorescence

Concentrations reported in nmol/L for the following elements (20): Mg, Al, Si, P, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, As, Br, Sr, and Pb; along with date (month/day/year), latitude (degrees north), longitude (degrees east), depth (m), station number, cast number, and bottle number.

Note that related data from 2013 are available here: <https://www.bco-dmo.org/dataset/699160>

## Related files and references:

Barrett, Pamela M., Resing, Joseph A., Buck, Nathaniel J., Buck, Clifton S., Landing, William M., Measures,

Christopher I., The trace element composition of suspended particulate matter in the upper 1000 m of the eastern North Atlantic Ocean: A16N, *Marine Chemistry* (2012), doi: 10.1016/j.marchem.2012.07.006.

Feely, R.A., Massoth, G.J., Lebon, G.T., 1991. Sampling of marine particulate matter and analysis by x-ray fluorescence spectrometry. In: Hurd, D.C. and Spencer, D.W. (eds.), *Marine Particles: Analysis and Characterization*, AGU Geophysical Monograph Series, p. 251-257.

Gladney, E.S., Roelandts, I., 1988. 1987 Compilation of elemental concentration data for USGS BHVO-1, MAG-1, QLO-1, RGM-1, SCo-1, SDC-1, SGR-1 and STM-1. *Geostandards Newsl.* 12 (2), 253-362.

Holynska, B., Bisiniek, K., 1976. Determination of trace amounts of metals in saline water by energy dispersive XRF using the NaDDTC preconcentration. *J. Radioanal. Nucl. Chem.* 31, 159-166.

Measures, C.I., Landing, W.M., Brown, M.T., Buck, C.S., 2008. A commercially available rosette system for trace metal-clean sampling. *Limnology and Oceanography Methods* 6, 384-394.

## Methods & Sampling

### Sampling and Analytical Methodology:

Seawater samples were collected from the surface ocean to depths of 750-1000 m, then sub-sampled for suspended particulate matter under trace-element-clean conditions (see Measures et al., 2008 for details). Briefly, suspended particulate matter samples were collected by pressurizing GO-FLO bottles with <10 psi filtered, compressed air. Samples were filtered through acid-cleaned 0.4  $\mu\text{m}$  polycarbonate filters (Nuclepore) in polypropylene holders. Acid-cleaned backing filters of mixed cellulose esters were used to ensure even loading on sample filters. Samples were rinsed while on the filter holders with 15-20 mL deionized (DI) water adjusted to pH 8 with ammonium hydroxide from the edges to the center, with a low vacuum applied to avoid loss or re-distribution of particles. Filtration was started approximately 30 to 60 minutes after water samples were collected and was generally completed within 60 minutes.

Particulate trace element concentrations were determined by energy-dispersive X-ray fluorescence (ED-XRF) using a thin film technique described by Feely et al. (1991). An optical subsample of each filter was analyzed on a Thermo Fisher Quant'X equipped with a Rhodium Target X-Ray tube and an electronically cooled, lithium-drifted solid state detector. X-rays for primary sample excitation were filtered for optimum control of peak-to-background ratios. Standards for calibration consisted of commercial thin film standards (MicroMatter), geochemical reference sample material MAG-1 (Gladney and Roelandts, 1988) finely ground and loaded onto polycarbonate filters (Feely et al., 1991), and a series of standards prepared using a modification of the method reported by Holynska and Bisiniek (1976) using sodium diethyldithiocarbamate (NaDDTC) to quantitatively precipitate trace metals from a solution of known concentration. These standards were prepared using a 1% NaDDTC solution that was added to trace metal solutions at pH 4 with a ligand-to-metal ratio of 4:1. The resulting precipitate was filtered over an acid-cleaned, 0.4  $\mu\text{m}$  polycarbonate Nuclepore filter. Procedural blanks were made by addition of a NaDDTC solution to a sample of acidified DI water followed by filtration. MicroMatter and MAG-1 standards were used to create individual standard curves for all elements; standard curves for Fe and Mn also included NaDDTC standards.

Four different excitation conditions, all conducted under a vacuum atmosphere, were used for sample analysis and are detailed along with minimum determination limits (MDL) in [Table 1](#). MDLs are defined as 3 times the square root of the background intensity measured from a standard of known concentration:

$$\text{MDL} = (3 * \sqrt{I_b}) / (I_p / \text{conc})$$

where  $I_b$  is the background intensity,  $I_p$  is the peak intensity, and *conc* is the concentration of the standard. MicroMatter standards were used to calculate MDLs.

### Related files and references:

Barrett, Pamela M., Resing, Joseph A., Buck, Nathaniel J., Buck, Clifton S., Landing, William M., Measures, Christopher I., The trace element composition of suspended particulate matter in the upper 1000 m of the eastern North Atlantic Ocean: A16N, *Marine Chemistry* (2012), doi: 10.1016/j.marchem.2012.07.006.

Feely, R.A., Massoth, G.J., Lebon, G.T., 1991. Sampling of marine particulate matter and analysis by x-ray fluorescence spectrometry. In: Hurd, D.C. and Spencer, D.W. (eds.), *Marine Particles: Analysis and*

Characterization, AGU Geophysical Monograph Series, p. 251-257.

Gladney, E.S., Roelandts, I., 1988. 1987 Compilation of elemental concentration data for USGS BHVO-1, MAG-1, QLO-1, RGM-1, SCo-1, SDC-1, SGR-1 and STM-1. Geostandards Newsl. 12 (2), 253-362.

Holynska, B., Bisiniek, K., 1976. Determination of trace amounts of metals in saline water by energy dispersive XRF using the NaDDTC preconcentration. J. Radioanal. Nucl. Chem. 31, 159-166.

Measures, C.I., Landing, W.M., Brown, M.T., Buck, C.S., 2008. A commercially available rosette system for trace metal-clean sampling. Limnology and Oceanography Methods 6, 384-394.

## Data Processing Description

### Data Processing:

ED-XRF output is in ng cm<sup>-2</sup> and is reported here as seawater concentrations (nM) using the following formula for each trace element of interest.

seawater concentration (nmol L<sup>-1</sup>) = filter concentration (ng cm<sup>-2</sup>) \* filter sample area (cm<sup>2</sup>) / filtered seawater volume (L) / atomic weight (g/mol)

The filter sample collection area is 12.41 cm<sup>2</sup>. The volume of seawater filtered per sample ranged from 2 to 12 L, average 8 L.

For values below the analytical detection limit, values are indicated as "BDL"

Quality flags are indicated as:

2 = acceptable

3 = questionable

### BCO-DMO Processing/Edits

- Data generated from original file: "BCO-DMO particulate data A16N.xlsx" contributed by Pamela Barrett
- Date reformatted to YYYYMMDD
- Parameter names modified to conform to BCO-DMO conventions (blanks to underscores, etc.)
- "FLAG" parameters modified to include element name in parameter name (i.e. FLAG -> FLAG\_Fe)

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## Data Files

| File   |
|--|
| <b>A16N_Part particulate.csv</b> (Comma Separated Values (.csv), 93.60 KB)<br>MD5:84e1c530ba2d3a8b649a5e60e3e50afa |
| Primary data file for dataset ID 3702  |

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## Parameters

| Parameter     | Description                  | Units           |
|---------------|------------------------------|-----------------|
| Station       | Station                      | Dimensionless   |
| Cast_Number   | Cast number                  | Dimensionless   |
| Bottle_Number | Bottle number                | Dimensionless   |
| Date          | Date                         | YYYYMMDD        |
| Lat           | Latitude (South is negative) | Decimal Degrees |

|         |   |                 |
|---------|---|-----------------|
| Lon     | Longitude (West is negative)  | Decimal Degrees |
| Depth   | Depth   | meters          |
| Mg      | Magnesium<br>For values below the analytical detection limit values are indicated as 'BDL'.<br>Quality flags are indicated as:2 = acceptable3 = questionable  | nmol/L          |
| FLAG_Mg | FLAG Magnesium<br>Quality flags are indicated as:2 = acceptable3 = questionable   | Dimensionless   |
| Al      | Aluminum<br>For values below the analytical detection limit values are indicated as 'BDL'.<br>Quality flags are indicated as:2 = acceptable3 = questionable   | nmol/L          |
| FLAG_Al | FLAG Aluminum<br>Quality flags are indicated as:2 = acceptable3 = questionable  | Dimensionless   |
| Si      | Silica<br>For values below the analytical detection limit values are indicated as 'BDL'.<br>Quality flags are indicated as:2 = acceptable3 = questionable     | nmol/L          |
| FLAG_Si | FLAG Silica<br>Quality flags are indicated as:2 = acceptable3 = questionable  | Dimensionless   |
| P       | Phosphorus<br>For values below the analytical detection limit values are indicated as 'BDL'.<br>Quality flags are indicated as:2 = acceptable3 = questionable | nmol/L          |
| FLAG_P  | FLAG Phosphorus<br>Quality flags are indicated as:2 = acceptable3 = questionable  | Dimensionless   |
| S       | Sulfur<br>For values below the analytical detection limit values are indicated as 'BDL'.<br>Quality flags are indicated as:2 = acceptable3 = questionable     | nmol/L          |
| FLAG_S  | FLAG Sulfur<br>Quality flags are indicated as:2 = acceptable3 = questionable  | Dimensionless   |
| Cl      | Chlorine<br>For values below the analytical detection limit values are indicated as 'BDL'.<br>Quality flags are indicated as:2 = acceptable3 = questionable   | nmol/L          |
| FLAG_Cl | FLAG Chlorine<br>Quality flags are indicated as:2 = acceptable3 = questionable  | Dimensionless   |
| K       | Potassium<br>For values below the analytical detection limit values are indicated as 'BDL'.<br>Quality flags are indicated as:2 = acceptable3 = questionable  | nmol/L          |
| FLAG_K  | FLAG Potassium<br>Quality flags are indicated as:2 = acceptable3 = questionable   | Dimensionless   |
| Ca      | Calcium<br>For values below the analytical detection limit values are indicated as 'BDL'.<br>Quality flags are indicated as:2 = acceptable3 = questionable    | nmol/L          |
| FLAG_Ca | FLAG Calcium<br>Quality flags are indicated as:2 = acceptable3 = questionable   | Dimensionless   |
| Ti      | Titanium<br>For values below the analytical detection limit values are indicated as 'BDL'.<br>Quality flags are indicated as:2 = acceptable3 = questionable   | nmol/L          |
| FLAG_Ti | FLAG Titanium<br>Quality flags are indicated as:2 = acceptable3 = questionable  | Dimensionless   |
| V       | Vanadium<br>For values below the analytical detection limit values are indicated as 'BDL'.<br>Quality flags are indicated as:2 = acceptable3 = questionable   | nmol/L          |
| FLAG_V  | FLAG Vanadium<br>Quality flags are indicated as:2 = acceptable3 = questionable  | Dimensionless   |
| Cr      | Chromium<br>For values below the analytical detection limit values are indicated as 'BDL'.<br>Quality flags are indicated as:2 = acceptable3 = questionable   | nmol/L          |
| FLAG_Cr | FLAG Chromium<br>Quality flags are indicated as:2 = acceptable3 = questionable  | Dimensionless   |
| Mn      | Manganese<br>For values below the analytical detection limit values are indicated as 'BDL'.<br>Quality flags are indicated as:2 = acceptable3 = questionable  | nmol/L          |
| FLAG_Mn | FLAG Manganese<br>Quality flags are indicated as:2 = acceptable3 = questionable   | Dimensionless   |
| Fe      | Iron<br>For values below the analytical detection limit values are indicated as 'BDL'.<br>Quality flags are indicated as:2 = acceptable3 = questionable       | nmol/L          |
| FLAG_Fe | FLAG Fe<br>Quality flags are indicated as:2 = acceptable3 = questionable  | Dimensionless   |
| Ni      | Nickel<br>For values below the analytical detection limit values are indicated as 'BDL'.<br>Quality flags are indicated as:2 = acceptable3 = questionable     | nmol/L          |

|         |  |               |
|---------|--|---------------|
| FLAG_Ni | FLAG NickelQuality flags are indicated as:2 = acceptable3 = questionable   | Dimensionless |
| Cu      | CopperFor values below the analytical detection limit values are indicated as 'BDL'.Quality flags are indicated as:2 = acceptable3 = questionable    | nmol/L        |
| FLAG_Cu | FLAG CopperQuality flags are indicated as:2 = acceptable3 = questionable   | Dimensionless |
| Zn      | ZincFor values below the analytical detection limit values are indicated as 'BDL'.Quality flags are indicated as:2 = acceptable3 = questionable      | nmol/L        |
| FLAG_Zn | FLAG ZincQuality flags are indicated as:2 = acceptable3 = questionable   | Dimensionless |
| As      | ArsenicFor values below the analytical detection limit values are indicated as 'BDL'.Quality flags are indicated as:2 = acceptable3 = questionable   | nmol/L        |
| FLAG_As | FLAG ArsenicQuality flags are indicated as:2 = acceptable3 = questionable  | Dimensionless |
| Br      | BromineFor values below the analytical detection limit values are indicated as 'BDL'.Quality flags are indicated as:2 = acceptable3 = questionable   | nmol/L        |
| FLAG_Br | FLAG BromineQuality flags are indicated as:2 = acceptable3 = questionable  | Dimensionless |
| Sr      | StrontiumFor values below the analytical detection limit values are indicated as 'BDL'.Quality flags are indicated as:2 = acceptable3 = questionable | nmol/L        |
| FLAG_Sr | FLAG StrontiumQuality flags are indicated as:2 = acceptable3 = questionable  | Dimensionless |
| Pb      | LeadFor values below the analytical detection limit values are indicated as 'BDL'.Quality flags are indicated as:2 = acceptable3 = questionable      | nmol/L        |
| FLAG_Pb | FLAG LeadQuality flags are indicated as:2 = acceptable3 = questionable   | Dimensionless |

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## Instruments

|   |   |
|---|---|
| <b>Dataset-specific Instrument Name</b> | CTD Sea-Bird SBE 911plus  |
| <b>Generic Instrument Name</b>          | CTD Sea-Bird SBE 911plus  |
| <b>Generic Instrument Description</b>   | The Sea-Bird SBE 911 plus is a type of CTD instrument package for continuous measurement of conductivity, temperature and pressure. The SBE 911 plus includes the SBE 9plus Underwater Unit and the SBE 11plus Deck Unit (for real-time readout using conductive wire) for deployment from a vessel. The combination of the SBE 9 plus and SBE 11 plus is called a SBE 911 plus. The SBE 9 plus uses Sea-Bird's standard modular temperature and conductivity sensors (SBE 3 plus and SBE 4). The SBE 9 plus CTD can be configured with up to eight auxiliary sensors to measure other parameters including dissolved oxygen, pH, turbidity, fluorescence, light (PAR), light transmission, etc.). more information from Sea-Bird Electronics |

|   |  |
|---|--|
| <b>Dataset-specific Instrument Name</b> | GO-FLO Bottle  |
| <b>Generic Instrument Name</b>          | GO-FLO Bottle  |
| <b>Generic Instrument Description</b>   | GO-FLO bottle cast used to collect water samples for pigment, nutrient, plankton, etc. The GO-FLO sampling bottle is specially designed to avoid sample contamination at the surface, internal spring contamination, loss of sample on deck (internal seals), and exchange of water from different depths. |

|   |   |
|---|---|
| <b>Dataset-specific Instrument Name</b> | Thermo Fisher Quant'X Spectrometer  |
| <b>Generic Instrument Name</b>          | Spectrometer  |
| <b>Dataset-specific Description</b>     | Thermo Fisher Quant'X An optical subsample of each filter was analyzed on a Thermo Fisher Quant'X equipped with a Rhodium Target X-Ray tube and an electronically cooled, lithium-drifted solid state detector. |
| <b>Generic Instrument Description</b>   | A spectrometer is an optical instrument used to measure properties of light over a specific portion of the electromagnetic spectrum.  |

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## Deployments

### RB-03-04B

|                    |   |
|--------------------|---|
| <b>Website</b>     | <a href="https://www.bco-dmo.org/deployment/58639">https://www.bco-dmo.org/deployment/58639</a>   |
| <b>Platform</b>    | NOAA Ship Ronald H. Brown   |
| <b>Report</b>      | <a href="http://bcodata.whoi.edu/CLIVAR_AEROSOL/CLIVAR_A16N_2003ado.pdf">http://bcodata.whoi.edu/CLIVAR_AEROSOL/CLIVAR_A16N_2003ado.pdf</a>   |
| <b>Start Date</b>  | 2003-06-19  |
| <b>End Date</b>    | 2003-07-10  |
| <b>Description</b> | <p>The A16N cruise took place from June 4 to August 11, 2003 aboard the NOAA Ship RONALD H. BROWN under auspices of the National Oceanic and Atmospheric Administration (NOAA). The first hydrographic leg (June 19-July 10) was from Reykjavik to Funchal, Madeira along the 20 W meridian and the second leg (July 15-August 11) continued operations from Funchal to Natal, Brazil on a track southward and ending at 6 S, 25 W. The research was the first in a decadal series of repeat hydrography sections jointly funded by NOAA-OGP and NSF-OCE as part of the CLIVAR/CO2/hydrography/tracer program. Samples were taken from up to 34 depths at 150 stations. EXPOCODE 33RO200306_01 was confirmed with the CLIVAR CCHDO (June 2011) and the other data sets from this cruise are available from the U.S. CLIVAR DAC at CCHDO from URL <a href="http://cchdo.ucsd.edu/data_access/show_cruise?ExpoCode=33RO200306_01">http://cchdo.ucsd.edu/data_access/show_cruise?ExpoCode=33RO200306_01</a>. Cruise Track Image NOAA Cruise Ids (BROWN/2003)</p> |

### RB-03-04C

|                    |  |
|--------------------|--|
| <b>Website</b>     | <a href="https://www.bco-dmo.org/deployment/58782">https://www.bco-dmo.org/deployment/58782</a>  |
| <b>Platform</b>    | NOAA Ship Ronald H. Brown  |
| <b>Report</b>      | <a href="http://bcodata.whoi.edu/CLIVAR_AEROSOL/CLIVAR_A16N_2003ado.pdf">http://bcodata.whoi.edu/CLIVAR_AEROSOL/CLIVAR_A16N_2003ado.pdf</a>  |
| <b>Start Date</b>  | 2003-07-15   |
| <b>End Date</b>    | 2003-08-10   |
| <b>Description</b> | The A16N cruise took place from June 4 to August 11, 2003 aboard the NOAA Ship RONALD H. BROWN under auspices of the National Oceanic and Atmospheric Administration (NOAA). The first hydrographic leg (June 19-July 10) was from Reykjavik to Funchal, Madeira along the 20 W meridian and the second leg (July 15-August 11) continued operations from Funchal to Natal, Brazil on a track southward and ending at 6 S, 25 W. The research was the first in a decadal series of repeat hydrography sections jointly funded by NOAA-OGP and NSF-OCE as part of the CLIVAR/CO2/hydrography/tracer program. Samples were taken from up to 34 depths at 150 stations. EXPCODE 33RO200306_01 was confirmed with the CLIVAR CCHDO (June 2011) and the other data sets from this cruise are available from the U.S. CLIVAR DAC at CCHDO from URL <a href="http://cchdo.ucsd.edu/data_access/show_cruise?ExpoCode=33RO200306_01">http://cchdo.ucsd.edu/data_access/show_cruise?ExpoCode=33RO200306_01</a> . Cruise Track Image NOAA Cruise Ids (BROWN/2003) |

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## Project Information

### **Collaborative Research: Global Ocean Survey of Dissolved Iron and Aluminum and Aerosol Iron and Aluminum Solubility Supporting the Repeat Hydrography (CO2) Project (CLIVAR AEROSOL)**

**Website:** <http://www.clivar.org/>

**Coverage:** Global

#### *NSF Award Abstract:*

A scientist from Florida State University in collaboration with colleagues from the University of Hawaii and the University of Washington will collect a suite of dissolved and particulate samples from surface waters and vertical profiles (12 depths), as well as atmospheric aerosol and rainwater samples during selected legs of the Repeat Hydrography CO2 cruises. The PIs plan to participate in the following four cruises: (1) the North Atlantic Ocean meridional section (20-25°W) during 2003; (2) the Pacific Ocean zonal section at 30°N during 2004; (3) the South Atlantic Ocean meridional section (20-25°W) in 2005; and (4) the South Pacific Ocean meridional section (150°W) in 2005. Samples recovered during these cruises will be analyzed for Fe and Al. In addition, aerosol samples will be subjected to an ultrapure water leach to assess the fractional solubility of Fe and Al. This team of PIs also plans to collect and archive filtered and unfiltered water samples and aerosols for analysis by other scientists in the trace metal and tracer community. The primary objectives of this study is to generate an extensive database of Fe and Al concentrations in water and aerosol samples that can constrain global and regional dust deposition models and determine the role that atmospheric Fe depositions have in delivering Fe to surface waters in the major basins of the world's oceans.

Note: This project is related to the follow-on project titled, "[Collaborative Research: Global Ocean Survey of Dissolved Iron and Aluminum and Aerosol Iron and Aluminum Solubility Supporting the CLIVAR Repeat Hydrography Project \(2007-2009\)](#)"

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## Program Information

### **U. S. Climate Variability and Predictability (U.S. CLIVAR)**

**Website:** <http://www.usclivar.org/>

**Coverage:** global

Note: The official U.S. CLIVAR program description will be supplied by Steve Diggs.

A temporary description copied from the US CLIVAR Web site is:

CLIVAR (Climate Variability and Predictability) is an international, interdisciplinary research effort within the World Climate Research Programme (WCRP) focusing on the variability and predictability of the slowly varying components of the climate system. CLIVAR investigates the physical and dynamical processes in the climate system that occur on seasonal, interannual, decadal and centennial time-scales. CLIVAR recognizes that a critical measure of success in its research program is a transferal of insight and knowledge to routine production of climate forecasts, information and products.

The goals of U.S. CLIVAR include:

- Identifying and understanding the major patterns of climate variability on seasonal, decadal and longer time scales and evaluating their predictability;
- Expanding our capacity in short term (seasonal to interannual) climate predictability and searching for ways to predict decadal variability;
- Better documenting the record of rapid climate changes and the mechanisms for these events, and evaluating the potential for abrupt climate changes in the future;
- Evaluating and enhancing the models used to project climate change due to human activity, including anthropogenically induced changes in atmospheric composition, and:
- Detecting and describing any climate changes that may occur.

**Program Data:** The data from most projects associated with the US CLIVAR program are not managed by BCO-DMO. Information about these projects and their results are available from the Program and Data site URLs shown above. However, there are a few exceptions, and those projects are listed below when the project section is expanded.

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## Funding

| Funding Source   | Award                       |
|--|-----------------------------|
| <a href="#">NSF Division of Ocean Sciences (NSF OCE)</a> | <a href="#">OCE-0223504</a> |
| <a href="#">NSF Division of Ocean Sciences (NSF OCE)</a> | <a href="#">OCE-0649505</a> |
| <a href="#">NSF Division of Ocean Sciences (NSF OCE)</a> | <a href="#">OCE-0223378</a> |
| <a href="#">NSF Division of Ocean Sciences (NSF OCE)</a> | <a href="#">OCE-0223397</a> |

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