Dissolved inorganic nitrogen, dissolved organic carbon, and chloropyll-a from the Middle Keys of Florida Bay during 2017-2018, following the passage of Hurricane Irma

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Project
» RAPID: Hurricane Irma Impacts on Nitrogen Cycling in Florida Bay (RAPID Hurricane Irma)

Contributors	Affiliation	Role
Martens, Christopher S.	University of North Carolina at Chapel Hill (UNC-Chapel Hill)	Principal Investigator
Mmendlovitz, Howard	University of North Carolina at Chapel Hill (UNC-Chapel Hill)	Scientist
Rok, Adam	University of North Carolina at Chapel Hill (UNC-Chapel Hill)	Student
Wahl, Timothy	University of North Carolina at Chapel Hill (UNC-Chapel Hill)	Student
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
These data are tabular results of investigations focused on temporal changes in dissolved inorganic nitrogen (DIN) over a 15-month period starting in October 2017, following the passage of Hurricane Irma over the Middle Keys, Florida, United States. Post-Irma time-series measurements focused on determination of the impacts of episodic storm events on temporal variability in DIN. Three areas in Florida Bay north of the Middle Keys were chosen for sampling based on previous work conducted between 2012 and 2015 by colleagues at the University of North Carolina (UNC) and FWC-M. Together, the study sites are representative of the range of nearshore environments along the southern portion of Florida Bay. Monthly whole water samples were filtered for chlorophyll-a (Chl-a) measurements, then analyzed for nitrate/nitrite (NOx-) and ammonium (NH4+). Drastic, systematic changes in all water quality parameters initially occurred, including spiked DIN concentrations following release of NH4+-enriched pore-waters during sediment resuspension and rapid declines in DIN during phytoplankton blooms. However, four months post-Irma, concentrations returned to seasonally variable pre-Irma levels observed in previous multi-year surveys.

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Coverage

Spatial Extent: **N**:24.9589 **E**:-80.8045 **S**:24.9371 **W**:-80.8333
Temporal Extent: 2017-10-31 - 2018-12-06

Methods & Sampling

Site Descriptions:

Three areas in Florida Bay north of the Middle Keys were chosen for sampling based on previous work conducted between 2012 and 2015 by colleagues at the University of North Carolina (UNC) and FWC-M. Site MB1 is located in the middle of our Mystery Basin site (24°56'30.42"N 80°49'31.80"W), located in West Florida Bay (WFB) and is physically representative of other interior Florida Bay sites. This interior area is characterized by numerous small basins created through shoaling carbonate sediments, resulting in lowered water exchange. The series of MB sampling locations were intended to provide a characteristic data suite. Burnt Point (BP) is located in the Back Key Basin (BKB) region and represents nearshore embayments, a common feature along the Florida Bay side of the Keys island chain. Station E 01 is located between the MB stations and BP. The BP field site underwent a sponge biomass loss of approximately 95 ± 5% during Hurricane Irma (Bollinger et al. 2018). The last station J01 (24°49'54.30"N, 80°48'44.82"W) is located slightly offshore from Long Key, but is not in a physically protected embayment like BP. Together, the J01 and BP stations, are representative of the range of nearshore environments along the southern portion of Florida Bay. Site locations are depicted in the attached Supplemental File ("Fig. 1.jpg").

Sample Preparation:
We measured DIN and Chl-a concentrations at each of the three stations via monthly water sampling from October 2017 through December 2018. Each month, water samples were collected 10 centimeters (cm) below the water surface at each station, shipped overnight on dry ice, and vacuum-filtered through a 47-millimeter (mm) Whatman GF/F filter. Samples collected by FWC-M personnel on most dates could only be provided in frozen, unfiltered form due to the limited availability of boating operations and sample handling personnel at their laboratory. The UNC team worked out of the FWC-M laboratory and collected water samples on December 5, December 11, April 3, April 9, and September 27. Samples from these four dates were filtered prior to freezing and shipping to UNC. Cell lysis undoubtedly occurred in the frozen samples collected by FWC-M personnel and shipped unfiltered to UNC, thereby suggesting that their Chl-a measurements represent minimum concentration values.

Sample Analysis:
The entire volume of the samples was vacuumed filtered through a 47 mm Whatman GF/F, before conducting analyses. The filters were placed in combusted foil for chlorophyll-a (Chl-a) measurements. NH_4^+ concentration was determined using acidified fluorometry (Holmes et al. 1999) using a Turner Design TD-700 laboratory fluorometer with a near UV lamp (310-390 nM). Discrete samples were analyzed for NO_x^- using a Spectrophotometric Elemental Analysis System (SEAS) configured for benchtop applications (Adornato et al. 2005, 2007). Lastly, phytoplankton abundance was quantified using Chl-a as a proxy; measurements were made on a Turner Design 10-AU Fluorometer using the acidified fluorometry method (Yentsch and Menzel 1963).

Sediment Suspension and Core Experiments:
Qualitative sediment suspension experiments using freshly collected bulk wet sediment were performed in April and June 2018 to mimic potential storm resuspension that might release DIN stored in porewaters, primarily in the form of NH_4^+. An acrylic box was placed open face down, on the sediment surface at station BP. The box was brushed back and forth in one-foot lengths along the surface of the sediment twenty times, at sufficient speed to resuspend the upper few centimeters of sediment. Without removing the box from the sediment surface water in the box was then sampled by a 60 milliliter (mL) polypropylene syringe and stored on ice in an amber HDPE bottle, to eliminate exposure to light. This crude "shake experiment" is not quantitative but provides a qualitative estimate of the potential for sudden porewater release to elevate water column DIN concentration. A more quantitative core experiment was conducted in June 2018 in sediment cores with depths of 2.5, 3.5, and 5 cm each with equal headspaces of 6.5 cm. Sediments were collected to each depth in BP, then shaken into the headspace twenty times, and the core was analyzed for NH_4^+.

Data Processing Description

Uncertainties in the dataset are based on raw readings from filtered water samples that were averaged to obtain a mean and standard deviation. The original raw instrument readings are not available.

BCO-DMO Processing Description

- Converted original files "Table 1B. Florida Bay N, DOC and Chl-a.docx" and "Table 2. Field station locations.docx" to Excel data files.
- Named columns following BCO-DMO naming conventions.

- Created separate columns for the averages and standard deviations.
- Joined the data from the two Excel files based on site/station.
- Converted latitude and longitude values from degrees, minutes, seconds to decimal degrees, and rounded the resulting values to 4 decimal places.
- Saved the final data file as "905393_v1_fl_bay_din_doc_chla.csv".

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Parameters

Parameter	Description	Units
Date	Date of sample collection	unitless
Station	Station identifier	unitless
Latitude	Station latitude; positive values = North	decimal degrees
Longitude	Station longitude; negative values = West	decimal degrees
NOx_avg	Average dissolved nitrate/nitrite concentration	micromolar (uM)
NOx_sd	Standard deviation of NOx_avg	micromolar (uM)
NH4_avg	Average ammonium concentration	micromolar (uM)
NH4_sd	Standard deviation of NH4_avg	micromolar (uM)
DIN_avg	Average dissolved inorganic nitrogen concentration	micromolar (uM)
DIN_sd	Standard deviation of DIN_avg	micromolar (uM)
DOC_avg	Average dissolved organic carbon concentration	micromolar (uM)
DOC_sd	Standard deviation of DOC_avg	micromolar (uM)
TN_avg	Average total nitrogen concentration	micromolar (uM)
TN_sd	Standard deviation of TN_avg	micromolar (uM)
Chla_avg	Average chlorophyll-a concentration	micrograms per liter (ug/L)
Chla_sd	Standard deviation of Chla_avg	micrograms per liter (ug/L)

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Instruments

Dataset-specific Instrument Name	Spectrophotometric Elemental Analysis System (SEAS)
Generic Instrument Name	Elemental Analyzer
Generic Instrument Description	Instruments that quantify carbon, nitrogen and sometimes other elements by combusting the sample at very high temperature and assaying the resulting gaseous oxides. Usually used for samples including organic material.

Dataset-specific Instrument Name	Turner Design TD-700 laboratory fluorometer
Generic Instrument Name	Turner Designs 700 Laboratory Fluorometer
Generic Instrument Description	The TD-700 Laboratory Fluorometer is a benchtop fluorometer designed to detect fluorescence over the UV to red range. The instrument can measure concentrations of a variety of compounds, including chlorophyll-a and fluorescent dyes, and is thus suitable for a range of applications, including chlorophyll, water quality monitoring and fluorescent tracer studies. Data can be output as concentrations or raw fluorescence measurements.

Dataset-specific Instrument Name	Turner Design 10-AU Fluorometer
Generic Instrument Name	Turner Designs Fluorometer 10-AU
Generic Instrument Description	The Turner Designs 10-AU Field Fluorometer is used to measure Chlorophyll fluorescence. The 10AU Fluorometer can be set up for continuous-flow monitoring or discrete sample analyses. A variety of compounds can be measured using application-specific optical filters available from the manufacturer. (read more from Turner Designs, turnerdesigns.com, Sunnyvale, CA, USA)

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Project Information

RAPID: Hurricane Irma Impacts on Nitrogen Cycling in Florida Bay (RAPID Hurricane Irma)

Coverage: Florida Bay, Florida Keys

NSF Award Abstract:
Availability of the nutrient element nitrogen generally limits the production of organic matter in Florida Bay and most other coastal ecosystems. In Florida Bay, approximately 90% of this primary production has been generated by seagrasses with another 10% generated by single celled algae and bacteria in the water column. Research completed prior to Hurricane Irma by the UNC-Chapel Hill team in collaboration with scientists at the Florida Fish and Wildlife Conservation Commission (FWC), has revealed that approximately half of the nitrogen needed by these primary producers is supplied by a huge sponge population that filters and decomposes freshly produced organic matter, then balances the nitrogen budget by efficiently recycling inorganic nitrogen back to the water column. The sponge community is capable of pumping and processing organic matter throughout the entire water volume of Florida Bay in less than a week, thus helping to maintain healthy seagrass communities and water clarity. The passage of Hurricane Irma may have profoundly altered the

central Florida Bay ecosystem by causing tremendous losses of sponge and seagrass biomass and resulting changes associated with nitrogen cycling. This project will help to assess short- and long-term impacts of Irma through a quantitative assessment of sponge and seagrass biomass losses at representative locations, characterization of water column algal blooms, and measurement of changes to the nitrogen budget of Florida Bay.

The overall goal of the proposed new work is to quantify potentially major changes in Florida Bay nitrogen cycling and nitrogen budgets associated with the passage of Hurricane Irma, using a combination of pre- and post-storm data from established study sites. The proposed new work builds directly on the team's recently completed investigations of the role of sponges in the overall nitrogen budget of the Bay plus the catastrophic impacts of algal blooms on nitrogen cycling in its central basins that feature water column residence times of days to weeks. The results of this previous work have important implications for sponge-rich ecosystems throughout the Caribbean and tropical Pacific plus many other coastal regions including Antarctic shelf environments where sponges comprise a major component of the benthos. Pre-Irma results include multi-year nitrogen surveys and time-series data, sponge and seagrass biomass surveys at key sites and algal bloom meta-genomics and bacterial count surveys have been conducted. This research will benefit from new collaborations between scientists at UNC-Chapel Hill and FWC laboratories in Marathon (FWC-M), where post-Irma sponge surveys will be made and in St. Petersburg (FWC-SP), where algal bloom meta-genomic studies will be conducted. Data from the Pre-Irma studies includes extensive dissolved nitrogen (DIN and DON) water column concentration and time-series measurements, determination of the role of sponges in organic C and nitrogen recycling rates and the nitrogen budget, multi-year (2013-16) associated sponge biomass surveys at our study sites by FWC-M scientists (2013-15) and algal bloom meta-genomic plus bacterial count studies during a bloom at one of those sites led by FWC-SP. Two graduate and two undergraduate students will participate in this project.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1807077

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