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# BlueFlux: Dissolved Carbon and Greenhouse Gases

## Get Data

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### Summary

This dataset provides dissolved carbon (dissolved inorganic carbon and dissolved organic carbon), greenhouse gases, dissolved organic matter optical, and hydrological (water temperature, pH, alkalinity, dissolved oxygen) data collected from the Shark and Harney tidal rivers in the Everglades, Florida, USA. The data were collected as part of the NASA Carbon Monitoring System (CMS) BlueFlux field campaigns over the 2022 wet season (October 2022) and 2023 dry season (March 2023). Data includes single-collection samples collected from sites along both rivers and samples collected by an autosampler at one site over multiple tidal cycles. The data are provided in comma-separated values (.csv) format.

There are two data files in comma-separated values (.csv) format with this dataset.

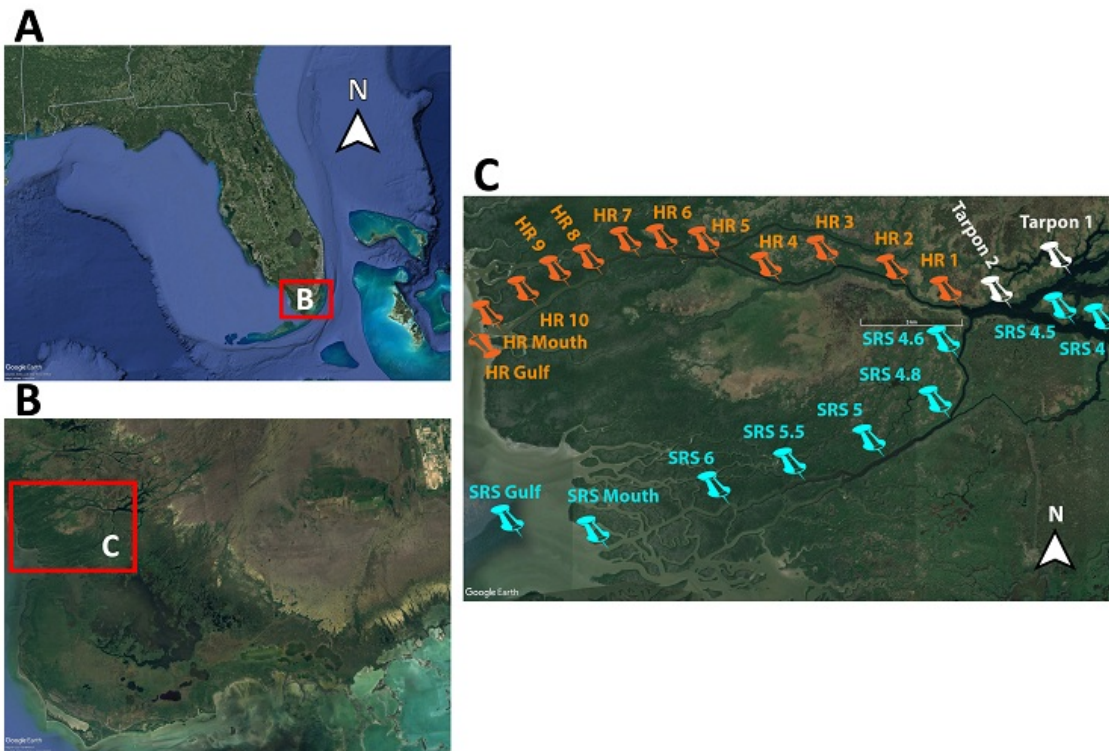


Figure 1. Study site sampling locations. (A) General location in south Florida. (B) Study area within Florida Everglades. (C) Distribution of sampling locations along the Harney (HR\*) and Shark (SR\*) tidal rivers.

### Citation

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## 1. Dataset Overview

This dataset provides dissolved carbon (dissolved inorganic carbon and dissolved organic carbon), greenhouse gas, dissolved organic matter optical, and hydrological (water temperature, pH, alkalinity, dissolved oxygen) data collected from the Shark and Harney tidal rivers in the Everglades. The data were collected as part of the BlueFlux field campaigns over the 2022 wet season (October 2022) and 2023 dry season (March 2023). Data includes single-collection samples collected from sites along both rivers and samples collected by an autosampler at one site over multiple tidal cycles.

**Project:** [Carbon Monitoring System](#)

The NASA Carbon Monitoring System (CMS) program is designed to make significant contributions in characterizing, quantifying, understanding, and predicting the evolution of global carbon sources and sinks through improved monitoring of carbon stocks and fluxes. The System uses NASA satellite observations and modeling/analysis capabilities to establish the accuracy, quantitative uncertainties, and utility of products for supporting national and international policy, regulatory, and management activities. CMS data products are designed to inform near-term policy development and planning.

The BlueFlux project was funded by the NASA CMS program. The project brings together scientists from NASA Goddard Space Flight Center, Yale University, and Eastern Carolina University to study blue carbon ecosystems and climate mitigation in Southern Florida by measuring carbon stocks and carbon dioxide and methane fluxes.

### Related Publication

Vaughn, D., J. Rosentreter, B. Poulter, D. Lagomasino, S.P. Charles, and P.R. Raymond. Seasonal Dissolved Carbon and Greenhouse Gas Fluxes from Tidal Rivers Draining Mangroves in the Florida Everglades. In process, 2024.

### Acknowledgement

This study was supported by the NASA Carbon Monitoring System program (grant 80NSSC21K1509).

## 2. Data Characteristics

**Spatial Coverage:** Florida Everglades - Shark and Harney Rivers

**Spatial Resolution:** Point

**Temporal Coverage:** 2022 wet season (October 15-17 2022) and 2023 dry season (March 10-13 2023)

**Temporal Resolution:** Multiple one-time samples were collected during wet and dry seasons

**Study Area:** Latitude and longitude are given in decimal degrees

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Florida Everglades	-81.9146	-80.9302	25.4316	25.2085

### Data File Information

There are two files in comma-separated values (.csv) format with this dataset:

**BLUEFLUX\_Transect\_Shark\_Haney\_Rivers\_TarponBay.csv:** Contains data collected from samples along the Shark and Harney rivers during the 2022 wet season (October 2022) and the 2023 dry season (March 2023).

**BLUEFLUX\_ISCO\_FCEC\_LTER\_SRS6.csv:** Contains data from continuous water samples collected from the mouth of a tidal creek at one FCE-LTER site (SRS 6) using portable autosamplers.

Table 1. Variables in the file **BLUEFLUX\_Transect\_Shark\_Haney\_Rivers\_TarponBay.csv**

Variable	Units	Description
site	-	Site name
season	-	Wet or Dry season
date	YYYY-MM-DD	Date of sample collection
time	HH:MM:SS	Time sample was collected
latitude	decimal degrees	Latitude of sample location
longitude	decimal degrees	Longitude of sample location
temp	degrees C	Water temperature in degrees C
pH	1	pH
specific_conductance	$\mu\text{s cm}^{-1}$	Specific conductance in microsiemens per cm
turbidity	NTU	Turbidity in Nephelometric Turbidity Units (NTU)
HDO_con_mg_L	$\text{mg L}^{-1}$	Dissolved oxygen concentration (mg/L)
HDO_sat_percent	percent	Dissolved oxygen saturation (percent)
cdom_probe_value	1	Chromophoric (or colored) Dissolved Organic Materials (CDOM) value

alternate_cdom_probe_value	1	Alternate CDOM value
Chl	$\mu\text{g L}^{-1}$	Chlorophyll a concentrations ( $\mu\text{g/L}$ )
salinity	psu	Salinity sensor (psu)
DIC	$\mu\text{mol kg}^{-1}$	Dissolved Inorganic Carbon ( $\mu\text{mol/kg}$ )
alkalinity	$\mu\text{mol kg}^{-1}$	Alkalinity ( $\mu\text{mol/kg}$ )
DOC	$\text{mg L}^{-1}$	Dissolved Organic Carbon (mg/L)
fluorescence_index	1	Fluorescence index
humification_index	1	Humification index
fluorescence_index_new	1	New fluorescence index
manta_probe1	1	CDOM fluorescence (fDOM) value
manta_probe2	1	Alternate fDOM value
freshness	1	Freshness index
coble_peak_b	1	Coble peak b
coble_peak_t	1	Coble peak t
coble_peak_a	1	Coble peak a
coble_peak_m	1	Coble peak m
coble_peak_c	1	Coble peak c
uva_254	1	Absorbance at 254 Naperian
specific_uva_254	1	Specific ultraviolet absorbance at 254 nm
uva_412	1	Absorbance at 412 Naperian
spectral_slope_275_295	1	Spectral slope 275-295 nm
spectral_slope_350_400	1	Spectral slope 350-400 nm
spectral_slope_ratio	1	Spectral slope ratio
spectral_slope_280_450	1	Spectral slope 280-450
spectral_slope_588_598	1	Spectral slope 588-598
total_absorb_250_450	1	Total absorbance from 250 to 450 nm
total_absorb_300_340	1	Total absorbance from 300 to 340 nm
model_comp_1	1	Parafac model component #1
model_comp_2	1	Parafac model component #2
model_comp_3	1	Parafac model component #3
model_comp_4	1	Parafac model component #4
pCO2	$\mu\text{atm}$	Partial pressure of dissolved $\text{CO}_2$ in $\mu\text{atm}$
pCH4	$\mu\text{atm}$	Partial pressure of dissolved $\text{CH}_4$ in $\mu\text{atm}$
pN2O	$\mu\text{atm}$	Partial pressure of dissolved $\text{N}_2\text{O}$ in $\mu\text{atm}$

Table 2. Variables in the file BLUEFLUX\_ISCO\_FCEC\_LTER\_SRS6.csv

Variable	Units	Description
sample	-	Sample name
date	YYYY-MM-DD	Date of sample collection
time	HH:MM:SS	Time sample was collected
DOC	$\text{mg L}^{-1}$	Dissolved Organic Carbon (mg/L)
alkalinity	$\mu\text{mol kg}^{-1}$	Alkalinity ( $\mu\text{mol/kg}$ )
temp	degrees C	Water temperature
pH	1	pH
specific_conductance	$\mu\text{S cm}^{-1}$	Specific conductance in microsiemens per cm

HDO_con_mg_liter	mg L <sup>-1</sup>	Dissolved oxygen concentration (mg/L)
HDO_sat_percent	percent	Dissolved oxygen saturation (percent)
turbidity	NTU	Turbidity in NTU
Chl	µg L <sup>-1</sup>	Chlorophyll a concentrations (µg/L)
cdom_probe_value	1	Chromophoric (or colored) Dissolved Organic Materials (CDOM) value
alternate_cdom_probe_value	1	Alternate CDOM value
salinity	psu	Salinity sensor (practical salinity unit)
fluorescence_index	1	Fluorescence index
humification_index	1	Humification index
fluorescence_index_new	1	New fluorescence index
manta_probe1	1	CDOM fluorescence (fDOM) value
manta_probe2	1	Alternate fDOM value
freshness	1	Freshness index
coble_peak_b	1	Coble peak b
coble_peak_t	1	Coble peak t
coble_peak_a	1	Coble peak a
coble_peak_m	1	Coble peak m
coble_peak_c	1	Coble peak c
uva_254	1	Absorbance at 254 Naperian
specific_uva_254	1	Specific ultraviolet absorbance at 254 nm
uva_412	1	Absorbance at 412 Naperian
spectral_slope_275_295	1	Spectral slope 275-295 nm
spectral_slope_350_400	1	Spectral slope 350-400 nm
spectral_slope_ratio	1	Spectral slope ratio
spectral_slope_280_450	1	Spectral slope 280-450 nm
spectral_slope_588_598	1	Spectral slope 588-598 nm
total_absorb_250_450	1	Total absorbance from 250 to 450 nm
total_absorb_300_340	1	Total absorbance from 300 to 340 nm
model_comp_1	1	Parafac model component #1
model_comp_2	1	Parafac model component #2
model_comp_3	1	Parafac model component #3
model_comp_4	1	Parafac model component #4

### 3. Application and Derivation

These data are useful to study blue carbon ecosystems and carbon dynamics and inform mangrove restoration and conservation.

### 4. Quality Assessment

Uncertainty from laboratory analyses was analyzed according to standard operating procedures. Replicate samples were collected in the field to evaluate precision of sample collection. Equipment used for measuring parameters was calibrated and maintained as recommended by the manufacturer.

### 5. Data Acquisition, Materials, and Methods

#### Study sites

Two field studies were conducted along the Shark and Harney rivers during the 2022 wet season (October 2022) and the 2023 dry season (March 2023). Along both rivers, several sites were chosen for discrete water collection along a salinity gradient based on the on-going, long-term ecological research program in the Florida Everglades (FCE-LTER). Additional sites not used by the FCE-LTER were also added along both rivers for water collection. Included in these sites for both rivers are a marine end-member from the Gulf of Mexico and a fresher up-stream end-member within Tarpon Bay. During the collection of discrete water samples for each season, one multi-parameter sonde (Eureka Manta 2) was used to record additional environmental data at each site, including temperature, pH, specific conductivity, salinity, and dissolved oxygen (concentration and percentage).

Surface water was collected ~0.25 m below the surface using a peristaltic pump and was filtered in the field through Sterivex 0.22 µm polyethersulfone

membrane filters to remove bacteria and minimize microbial activity. Samples for dissolved organic carbon (DOC) and dissolved organic matter (DOM) analyses were collected in acid-cleaned polycarbonate or high-density polyethylene (HDPE) sample bottles. Dissolved inorganic carbon (DIC) samples were collected in screw-capped small borosilicate glass vials (100 mL) because polycarbonate and HDPE bottles are CO<sub>2</sub> permeable. Alkalinity samples were collected in a mix of glass and polycarbonate bottle. All samples were stored on ice immediately after collection and stored under refrigeration prior to analyses.

In addition to the discrete samples collected along each river, water samples were collected from the mouth of a tidal creek at one FCE-LTER site (SRS 6) using portable autosamplers (Teledyne ISCO) during both field campaigns. During the 2022 wet season, water was collected hourly over a 14-hour period in a refrigerated autosampler. During the 2023 dry season, water was collected hourly over a 24-hour period in an unrefrigerated autosampler filled with ice. Acid-cleaned polypropylene bottles were used to collect the water during each cycle. After each sampling cycle, water samples were immediately filtered through 0.22 µm filters (Durapore, Millipore) and into HDPE sample bottles for DOC, total alkalinity (TA), and DOM composition. One multi-parameter sonde (Eureka Manta 2) was used to record additional environmental data at 15-minute intervals, including temperature, pH, specific conductivity, salinity, and dissolved oxygen (concentration and percentage). Greenhouse gas samples were also collected from the tidal creek at FCE-LTER site SRS 6 in both seasons and from porewater within the mangroves (~100 m away from the Shark River edge) at sites SRS 6 and SRS 5 during the dry season.

### Dissolved Carbon Concentrations

Samples were analyzed for total DOC using high temperature catalytic combustion on a Shimadzu TOC-L CPH using the non-purgeable organic carbon (NPOC) method, with sample sparging at 75 ml min<sup>-1</sup> for 8 min and the addition of 12 N analytical-grade HCl to remove dissolved inorganic carbon. DOC concentrations are calculated as the mean of at least three injections with a coefficient of variance of <2 %.

On the day of measurement, DIC samples were warmed at room temperature. DIC was measured using a DIC analyzer (AS-C2, Apollo Scitech), consisting of a KloeHN<sup>TM</sup> syringe pump (module #50300) with a 2.5 mL syringe. Seawater samples (0.5 mL) were acidified by adding 0.5 mL HCl, and the released CO<sub>2</sub> was subsequently quantified by a nondispersive infrared CO<sub>2</sub> detector (LI-COR®, LI-6262). This method has a precision of 0.1 %. All DIC values were directly measured with reference to certified reference material (CRM; Dickson, 2010).

Total alkalinity (TA) was measured by the Gran titration using the open cell method with a semi-automatic titration system (AS-ALK3, Apollo Scientific), consisting of two KloeHN<sup>TM</sup> syringe pumps of 1 mL and 25 mL respectively, a high precision pH meter, and a ROSS combination pH glass electrode (Orion 8102BN, Thermo Scientific). Throughout the measurements, the TA samples, the HCl solution and the syringes of the KloeHN<sup>TM</sup> pumps were all water-jacketed at 25 ± 0.1°C maintained by a thermal bath (VWR®, Scientific Product). Tygon® tubing (R-3603) was used to transfer solutions between these containers. For each measurement, 25 mL TA sample was titrated with an HCl solution (0.1M HCl and 0.5M NaCl). This TA titration system has a precision of better than 0.1 % (Cai et al., 2010). All TA values were directly measured with reference to CRM. Opened CRM bottles were stored in the refrigerator.

### Dissolved Organic Matter (DOM) Composition

UV-Vis absorption spectra and fluorescence excitation-emission matrices (EEMs) were analyzed using a Horiba Aqualog spectrofluorometer and protocols followed standard practice including blank subtraction (Hosen et al., 2020). Spectra were measured in a quartz cuvette with a 1-cm pathlength. UV-absorbance from 200-800 nm was collected at 1-nm increments with an integration time of 1 s. Excitation-emission matrices were collected at excitation wavelengths of 240-800 nm at 3-nm increments and fluorescence emission from 247.808 to 828.528 nm at 2.06-nm increments using 4 CCD pixel integration (Hosen et al., 2020). Fluorescence data were corrected for inner-filter effects and Raman-normalized (Cory et al., 2010). Raman scattering area was determined using Type I (18.2 MW-cm) water from a Milli-Q Advantage A-10 water purification system.

Specific ultraviolet absorbance at 254 nm (SUVA<sub>254</sub>), the decadal absorption coefficient at 254 nm divided by DOC concentration (Weishaar et al., 2003), and spectral slope ratio (S<sub>R</sub>), the ratio of log-transformed absorbance slopes between 275-295 nm and 350-400 nm (Helms et al., 2008), were calculated for each sample. The spectral slope ratio has previously been used as an indicator of DOM molecular weight (MW) and photochemically induced shifts in MW across water types (Helms et al., 2008). Freshness index is the ratio of fluorescence emission at 380 nm divided by the maximum emission intensity from 420-435 nm at excitation wavelength of 310 nm (Parlanti et al., 2000; Wilson and Xenopoulos, 2009). The fluorescence index (FI) is the ratio of fluorescence emission at 470 and 520 nm at excitation 370 nm (Cory et al., 2010; McKnight et al., 2001). The humification index (HIX) is the summation of fluorescence emissions at 435-480 nm divided by the sum of fluorescence emission at 300-345 nm at excitation 254 nm (Ohno, 2002).

Parallel factor (PARAFAC) analysis (Stedmon and Bro, 2008) was used on fluorescence EEM data using R staRdom v. 1.1.21 (Pucher et al., 2019). The input data (n = 108) included samples collected during both field campaigns from both the ISCO and the single sample collections along both tidal rivers.

### Greenhouse Gas Collection

Greenhouse gas samples were collected in triplicate using the headspace equilibration technique (Raymond et al., 1997; Aho et al., 2019) where 120 mL of water was equilibrated with a 20-mL atmospheric headspace in a 160 mL syringe, and 20 mL of the equilibrated headspace was transferred to pre-evacuated 12-mL exetainers (Labco vials) and analyzed at the Yale Analytical and Stable Isotope Center on a Shimadzu GC2014 with an FID for CO<sub>2</sub> and CH<sub>4</sub> measurements and ECD calibrated for N<sub>2</sub>O measurements. Standard gas concentrations for CO<sub>2</sub> were 0, 152, 1007, 2013, 4967 and 10090 ppm; for CH<sub>4</sub> were 0, 0.98, 10.3, 20.6, 201, and 5030 ppm; for N<sub>2</sub>O were 0, 0.23, 0.25, 0.50, 2.49, and 5 ppm. Equilibration was achieved by shaking the syringe for 3 minutes at ambient conditions. Samples for atmospheric gas concentrations were also taken to correct for the atmospheric headspace.

## 6. Data Access

These data are available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

[BlueFlux: Dissolved Carbon and Greenhouse Gases](#)

Contact for Data Center Access Information:

- E-mail: [uso@daac.ornl.gov](mailto:uso@daac.ornl.gov)
- Telephone: +1 (865) 241-3952

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