Houston Galveston Bay Pigments

Website: https://www.bco-dmo.org/dataset/943964
Data Type: Cruise Results
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Project
» RAPID: Capturing the Signature of Hurricane Harvey on Texas Coastal Lagoons (Hurricane Harvey Texas Lagoons)

Contributors	Affiliation	Role
Liu, Hui	Texas A&M, Galveston (TAMUG)	Principal Investigator
Hu, Xinping	Texas A&M, Corpus Christi (TAMU-CC)	Co-Principal Investigator
Dias, Larissa Marie	Texas A&M, Corpus Christi (TAMU-CC)	Scientist, Contact
Newman, Sawyer	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Quantifying the direction and magnitude of CO2 flux in estuaries is necessary to constrain the global carbon cycle, yet carbonate systems and CO2 flux in subtropical and urbanized estuaries are not yet fully determined. To estimate the CO2 flux for Galveston Bay, a subtropical estuary located in the northwestern Gulf of Mexico proximal to the Houston-Galveston metroplex, monthly cruises were conducted along a transect extending from the Houston ship channel to the mouth of Galveston Bay and Gulf of Mexico from October 2017 to September 2018. Surface samples were collected at each of five stations in the Bay and analyzed for chlorophyll-a. Chlorophyll-a concentrations varied spatially and temporally throughout the study period and were highest in the inner Bay in late winter (February) and at all stations in mid-spring (April), following the freshwater inflow event. Stations 4 and 5 (inner Bay, closest to the San Jacinto River mouth) had early peak chlorophyll-a concentrations in February of 2018 (39.9 and 63.3 µg L-1, respectively), whereas mid- and outermost sampling locations 1, 2, and 3 peaked in mid-April (28.2, 44.2, and 35.8 µg L-1, respectively). Slight increases in chlorophyll-a were observed at stations 4 and 5 in July and September of 2018. When compared with carbonate chemistry data, it appears that large freshwater inflows in late winter and early spring stimulated photosynthesis in the Bay, leading to an influx of atmospheric CO2.

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Coverage

Location: Galveston Bay, an estuary situated adjacent to the Northwestern Gulf of Mexico
Spatial Extent: **N**:29.607 **E**:95.5 **S**:29.358 **W**:94.5
Temporal Extent: 2017-10-22 - 2018-10-14

Methods & Sampling

Field Sampling

Galveston Bay is a semi-enclosed microtidal estuary located in the northwest Gulf of Mexico (Montagna et al., 2013). With an average water depth of 3 m and a surface area covering 1554 km², Galveston Bay is the seventh-largest estuary in the U.S. and the second-largest estuary on the Texas coast (Bass et al., 2018; Morse et al., 1993; Solis & Powell, 1999). Galveston Bay receives freshwater from the Trinity River, San Jacinto River, Clear Creek, and smaller bayous and creeks, with the Trinity River providing 70% of the freshwater entering the Bay (Bass et al., 2018; Dellapenna et al., 2020; Morse et al., 1993; Solis & Powell, 1999). The Bolivar Peninsula and Galveston Island separate Galveston Bay from the Gulf of Mexico, with the exchange of water between the Bay and the Gulf occurring through Bolivar Roads, i.e., the mouth of the Bay (Glass et al., 2008; Morse et al., 1993).

Monthly cruises were conducted between October 2017 and September 2018 onboard the *R/V Trident*. Timing of the study allowed for the examination of the factors regulating CO_2 flux over the course of a year following Hurricane Harvey in late August 2017. Although the study began more than 45 days (the residence time of the Bay) after Harvey, salinity recovery of the Bay was likely still ongoing in the inner and middle sections of the Bay (Du & Park, 2019a; Du et al., 2019).

During each monthly survey, a transect was run between five water sampling stations, extending northwest from the Bay mouth (Station 1) opening to the Five Mile Marker on the Houston Ship Channel (Station 5). One offshore cruise in the northwest Gulf of Mexico outside Galveston Bay was conducted in October 2018.

Pigments

Chlorophyll-a concentrations were analyzed from surface water samples collected at each station in the Bay as described by Liu and Xue (2020). Surface waters were filtered through GF/F filters, which were frozen immediately in liquid nitrogen and later stored in the freezer at −80°C until analysis. Extraction of pigments from filters followed procedures outlined by Liu et al. (2006) and Sun et al. (1991), whereby filters were extracted in acetone in polypropylene centrifuge tubes, which were sonicated for 15 minutes in a sonicator (Model FS 60, Fisher Scientific). Acetone extract was filtered through a syringe filter (0–2 µm Nylon filter). Procedures were repeated for sample filters, and the two extracts (total 6 mL) were combined and blown with nitrogen gas under ice to dryness (Chen et al., 2005). Acetone (0.5 mL) was then added to dissolve the residue before high-performance liquid chromatography (HPLC) analysis (Liu & Xue, 2020).

Pigments were analyzed using a Shimadzu HPLC system with a reverse-phase column (Agilent Eclipse XDB-C8, 3.5 µm particle size, 150 mm length × 4.6 mm diameter) and a photodiode array (PDA) detector set at 450 nm. The mobile phases included A (70:30 v/v methanol: 28 mM tetrabutylammonium acetate; pH 6.5) and B methanol (100%). After sample injection (400 µL, mixing 0.5 mL acetone extract and 1.25 mL 28 mM tetrabutylammonium acetate), a gradient program (1.0 mL/min) began with 5% B and increased to 95% B in 22 minutes, then to 95% B isocratically over 30 minutes. All chromatographic separations were performed in a column oven set at 60°C. Pigments were identified by comparing retention times with authentic standards purchased from DHI (Denmark) or Sigma-Aldrich (USA). Peak areas were converted to concentrations based on response factors calculated from authentic standards. Duplicate analyses of the same extract generally agreed within 20%.

Data Processing Description

Monthly and spatial trends in chlorophyll-a were examined graphically and on maps created using R, Excel, and MATLAB in comparison with carbonate chemistry measurements (separate dataset).

Problem Description

A few stations and months had missing chlorophyll-a values, and were omitted from analyses.

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Related Publications

Bass, B., Torres, J. M., Irza, J. N., Proft, J., Sebastian, A., Dawson, C., & Bedient, P. (2018). Surge dynamics across a complex bay coastline, Galveston Bay, TX. Coastal Engineering, 138, 165–183. https://doi.org/10.1016/j.coastaleng.2018.04.019

Methods

Chen, N., Bianchi, T. S., & McKee, B. A. (2005). Early diagenesis of chloropigment biomarkers in the lower Mississippi River and Louisiana shelf: implications for carbon cycling in a river-dominated margin. Marine Chemistry, 93(2–4), 159–177. https://doi.org/10.1016/j.marchem.2004.08.005
Methods

Dellapenna, T. M., Hoelscher, C., Hill, L., Al Mukaimi, M. E., & Knap, A. (2020). How tropical cyclone flooding caused erosion and dispersal of mercury-contaminated sediment in an urban estuary: The impact of Hurricane Harvey on Buffalo Bayou and the San Jacinto Estuary, Galveston Bay, USA. Science of The Total Environment, 748, 141226. https://doi.org/10.1016/j.scitotenv.2020.141226
Methods

Du, J., & Park, K. (2019). Estuarine salinity recovery from an extreme precipitation event: Hurricane Harvey in Galveston Bay. Science of The Total Environment, 670, 1049–1059. https://doi.org/10.1016/j.scitotenv.2019.03.265
Methods

Du, J., Park, K., Dellapenna, T. M., & Clay, J. M. (2019). Dramatic hydrodynamic and sedimentary responses in Galveston Bay and adjacent inner shelf to Hurricane Harvey. Science of The Total Environment, 653, 554–564. https://doi.org/10.1016/j.scitotenv.2018.10.403
Methods

Glass, L. A., Rooker, J. R., Kraus, R. T., & Holt, G. J. (2008). Distribution, condition, and growth of newly settled southern flounder (Paralichthys lethostigma) in the Galveston Bay Estuary, TX. Journal of Sea Research, 59(4), 259–268. https://doi.org/10.1016/j.seares.2008.02.006
Methods

Liu, Z., & Xue, J. (2020). The Lability and Source of Particulate Organic Matter in the Northern Gulf of Mexico Hypoxic Zone. Journal of Geophysical Research: Biogeosciences, 125(9). Portico. https://doi.org/10.1029/2020jg005653 https://doi.org/10.1029/2020JG005653
Methods

Liu, Z., Lee, C., & Wakeham, S. G. (2006). Effects of mercuric chloride and protease inhibitors on degradation of particulate organic matter from the diatom Thalassiosira pseudonana. Organic Geochemistry, 37(9), 1003–1018. https://doi.org/10.1016/j.orggeochem.2006.05.013
Methods

Montagna, P. A., Palmer, T. A., & Beseres Pollack, J. (2013). Hydrological Changes and Estuarine Dynamics. In SpringerBriefs in Environmental Science. Springer New York. https://doi.org/10.1007/978-1-4614-5833-3
Methods

Morse, J. W., Presley, B. J., Taylor, R. J., Benoit, G., & Santschi, P. (1993). Trace metal chemistry of Galveston Bay: water, sediments and biota. Marine Environmental Research, 36(1), 1–37. https://doi.org/10.1016/0141-1136(93)90087-g https://doi.org/10.1016/0141-1136(93)90087-G
Methods

Solis, R. S., & Powell, G. L. (1999). Hydrography, mixing characteristics, and residence times of Gulf of Mexico estuaries. In T. S. Bianchi, J. R. Pennock, & R. R. Twilley (Eds.), Biogeochemistry of Gulf of Mexico estuaries (pp. 29–62). New York, NY: John Wiley & Sons.
Methods

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Parameters

Parameters for this dataset have not yet been identified

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Instruments

Dataset-specific Instrument Name	Shimadzu HPLC system
Generic Instrument Name	High-Performance Liquid Chromatograph
Dataset-specific Description	Shimadzu HPLC system with a reverse phase column (Agilent Eclipse XDB-C8, 3.5 micron particle size, 150 mm length x 4.6 mm diameter), with photodiode array (PDA) detector set as 450 nm.
Generic Instrument Description	A High-performance liquid chromatograph (HPLC) is a type of liquid chromatography used to separate compounds that are dissolved in solution. HPLC instruments consist of a reservoir of the mobile phase, a pump, an injector, a separation column, and a detector. Compounds are separated by high pressure pumping of the sample mixture onto a column packed with microspheres coated with the stationary phase. The different components in the mixture pass through the column at different rates due to differences in their partitioning behavior between the mobile liquid phase and the stationary phase.

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Deployments

Galveston_Bay_Cruises

Website	https://www.bco-dmo.org/deployment/949750
Platform	R/V Trident
Start Date	2017-10-21
End Date	2018-10-14

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Project Information

RAPID: Capturing the Signature of Hurricane Harvey on Texas Coastal Lagoons (Hurricane Harvey Texas Lagoons)

Coverage: Northwest Gulf of Mexico estuaries on Texas Coast

NSF Award Abstract:
Hurricane Harvey made landfall Friday 25 August 2017 about 30 miles northeast of Corpus Christi, Texas as a Category 4 hurricane with winds up to 130 mph. This is the strongest hurricane to hit the middle Texas coast since Carla in 1961. After the wind storm and storm surge, coastal flooding occurred due to the storm lingering over Texas for four more days, dumping as much as 50 inches of rain near Houston. This will produce one of the largest floods ever to hit the Texas coast, and it is estimated that the flood will be a one in a thousand year event. The Texas coast is characterized by lagoons behind barrier islands, and their ecology and biogeochemistry are strongly influenced by coastal hydrology. Because this coastline is dominated by open water systems and productivity is driven by the amount of freshwater inflow, Hurricane Harvey represents a massive inflow event that will likely cause tremendous changes to the coastal environments. Therefore, questions arise regarding how biogeochemical cycles of carbon, nutrients, and oxygen will be altered, whether massive phytoplankton blooms will occur, whether estuarine species will die when these systems turn into lakes, and how long recovery will take? The investigators are uniquely situated to mount this study not only because of their location, just south of the path of the storm, but most importantly because the lead investigator has conducted sampling of these bays regularly for the past thirty years, providing a tremendous context in which to interpret the new data gathered. The knowledge gained from this study will provide a

broader understanding of the effects of similar high intensity rainfall events, which are expected to increase in frequency and/or intensity in the future.

The primary research hypothesis is that: Increased inflows to estuaries will cause increased loads of inorganic and organic matter, which will in turn drive primary production and biological responses, and at the same time significantly enhance respiration of coastal blue carbon. A secondary hypothesis is that: The large change in salinity and dissolved oxygen deficits will kill or stress many estuarine and marine organisms. To test these hypotheses it is necessary to measure the temporal change in key indicators of biogeochemical processes, and biodiversity shifts. Thus, changes to the carbon, nitrogen and oxygen cycles, and the diversity of benthic organisms will be measured and compared to existing baselines. The PIs propose to sample the Lavaca-Colorado, Guadalupe, Nueces, and Laguna Madre estuaries as follows: 1) continuous sampling (via autonomous instruments) of salinity, temperature, pH, dissolved oxygen, and depth (i.e. tidal elevation); 2) bi-weekly to monthly sampling for dissolved and total organic carbon and organic nitrogen, carbonate system parameters, nutrients, and phytoplankton community composition; 3) quarterly measurements of sediment characteristics and benthic infauna. The project will support two graduate students. The PIs will communicate results to the public and to state agencies through existing collaborations.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1760006

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