Biological, chemical, and physical water quality indicators of the Neuse River, North Carolina from 2008 through 2013

Website: https://www.bco-dmo.org/dataset/767391
Data Type: Other Field Results
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Project
» Collaborative Research: Regulation of Phytoplankton Dynamics in Mid-Atlantic Estuaries Subject to Climatic Perturbations (climate_phyto_estuaries)

Contributors	Affiliation	Role
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Abstract
The Neuse River Estuary Water Quality Dataset is a compilation of the biological, chemical and physical water quality data that was collected along the length of the Neuse River Estuary, NC from March 14, 1985 to February 15, 1989 and from January 24, 1994 to the present. The primary purpose of this dataset was to provide long-term environmental information to supplement experimental, process-based research, including the Atlantic Coast Environmental Indicators Consortium (ACE-INC) project as well as other laboratory studies.

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Coverage

Spatial Extent: **N**:35.2106 **E**:-76.526 **S**:34.9488 **W**:-77.1222
Temporal Extent: 2008-01-15 - 2013-12-09

Dataset Description

The Neuse River Estuary Water Quality Dataset is a compilation of the biological, chemical and physical water quality data that was collected along the length of the Neuse River Estuary, NC from March 14, 1985 to February 15, 1989 and from January 24, 1994 to the present. The primary purpose of this dataset was to provide long-term environmental information to supplement experimental, process-based research, including the Atlantic Coast Environmental Indicators Consortium (ACE-INC) project as well as other laboratory studies.

The full YSI profile data related to this dataset can be found at Neuse River Estuary YSI Profile: https://www.bco-dmo.org/dataset/767641.

Methods & Sampling

Bi-weekly water sampling and in situ measurements were performed at fixed sampling stations. Water

samples and in situ measurements were collected at the surface (approximately 0.2 meters) and at the bottom of the water column (approximately 0.5 meters from the sediment layer). These data are included in the worksheet titled "NRE Dataset." In situ measurements were also performed throughout the water column in 0.5 meter depth increments. These data are included in the worksheet titled "NRE YSI Profiles." Parameters measured include: temperature, salinity, specific conductivity, dissolved oxygen (DO), pH, chlorophyll fluorescence, photosynthetically active radiation (PAR), turbidity, barometric pressure, secchi depth, colored dissolved organic matter (CDOM), particulate organic carbon (POC) and nitrogen (PN), dissolved organic and inorganic carbon, dissolved inorganic nutrient concentrations (nitrate/nitrite, ammonium, total dissolved nitrogen, phosphate and silicic acid), chlorophyll a, primary productivity and diagnostic phytoplankton pigment concentrations (chlorophylls and carotenoids). Calculated parameters include: diffuse light attenuation coefficient (Kd), carbon to nitrogen molar ratio (C:N), dissolved inorganic nitrogen (DIN; nitrate/nitrite plus ammonium), dissolved organic nitrogen (DON; total dissolved nitrogen minus dissolved inroganic nitrogen) and the nitrogen to phosporus molar ratio (N:P).

Methods
Water sampling was conducted bi-weekly. When collection was split over two days, a single date was used based on the upstream or majority stations.

Stations were selected to cover the entire length of the Neuse River Estuary from Streets Ferry Bridge (Station 0) to the mouth of the estuary where it flows into Pamlico Sound. When possible, efforts were made to select locations with key stationary features (channel markers, buoys and land markers) to allow easy station identification in the field.

Surface water samples were collected by submerging 10 liter high-density polyethylene containers just below the water surface or by filling the containers with surface water collected from bucket casts. Bottom water samples were collected with a horizontal plastic Van Dorn sampler. Starting December 2007, all samples collected with diaphragm pump and a weighted, marked hose. All containers were kept in dark coolers at ambient temperature during transport to the laboratory. All filtration was done within a few hours of collection and when conditions permitted, on board the research vessel.

Prior to the 09/13/2000 sampling date, in situ measurements were performed at discrete depths using a Hydrolab Data Sonde 3 equipped with a multiprobe and SVR3 display logger. Beginning on the 09/13/2000 sampling date, in situ measurements were performed at discrete depths on the sunlit side of the research vessel using a Yellow Springs Instruments (YSI Incoporated, Ohio) multiparameter sonde (Model 6600 or 6600 EDS-S Extended Deployment System) equipped with a YSI conductivity/temperature probe (Model 6560), a YSI chlorophyll probe (Model 6025), a YSI pH probe (Model 6561 or 6566), a YSI pulsed dissolved oxygen probe (Model 6562), a self cleaning YSI turbidity probe (Model 6026 or 6136), and beginning on the 07/30/2003 sampling date, a flat Li-Cor sensor (UWQ-PAR 6067). The YSI sonde was coupled to a either a YSI 610 DM datalogger or a YSI 650 MDS Multi-parameter Display System datalogger. In situ measurements were performed at the surface (approximately 0.2 meters) and at the bottom of the water column (approximately 0.5 meters from the sediment layer). These data are included in the worksheet titled "NRE Dataset." In situ measurements were also performed throughout the water column in 0.5 meter depth increments. These data are included in the worksheet titled "NRE YSI Profiles." The data were stored on the datalogger and downloaded to Ecowin software upon return to the laboratory.

The secchi disk was deployed off of the sunlit side of the research vessel. The depth (in meters) at which the secchi disk was no longer visible by the naked eye was recorded as the secchi depth.

The diffuse light attenuation coefficient, Kd, was calculated from depth profiles of photosynthetically active radiation (PAR, 400-700 nm). Prior to the 07/30/2003 sampling date, PAR measurements were performed with a spherical underwater quantum sensor (LI-COR LI-193SA) coupled to a LI-COR LI-1000 datalogger. Beginning on the 07/30/2003 sampling date, a flat underwater quantum sensor (LI-COR LI-193SA) attached to a Yellow Springs Instruments YSI 6600 or YSI 6600 EDS-S sonde was used to measure PAR. Measurements of PAR were performed on the sunlit side of the research vessel in 0.5 meter depth increments, beginning just below the water surface. The diffuse attenuation coefficient is the slope of the linear regression between natural log transformed PAR data and depth.

Colored dissolved organic matter (CDOM) was measured using a Turner Designs TD-700 fluorometer configured with a near-UV mercury vapour lamp, a 350 nm excitation filter, and a 410–600 nm emission filter. The fluorometer was calibrated to quinine sulfate (QS) solutions made up in 2 N sulfuric acid. Water samples were vacuum filtered (less than 25 kilopascal) using pre-combusted Whatman glass microfibre filters (GF/F) and the filtrate was stored in scintillation vials in the dark at 4 degrees Celsius until fluorometric analysis. The official decision (3/2/2017) is that cdom results from 12/1/2003 through 4/25/2011 would be multiplied by a corrective factor of 2.0. Results for sample date of 5/9/2011 and after do not need correcting. It is believed

the stock solution was made wrong, making a 1L recipe for 600 ug/L in a 500 ml flask equals 1200 ug/L stock solution. Standards were still calibrated according to recipe, but were actually 2x as strong.

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Particulate organic carbon (POC) concentrations were determined by elemental analysis of material collected on pre-combusted Whatman GF/F glass fiber filters. Carbonates were removed from the filters by vapor phase acidification using concentrated hydrochloric acid (HCl). After drying at 60 0C, the filters were rolled in tin disks and injected into a PE 2400 Series II CHNS/O Analyzer calibrated with acetanilide ending in June 2014. Starting on the Neuse River sample date of June 2, 2014, a Costech Analytical Technologies, Inc. Elemental Combustion System CHNS-O ECS 4010 was used for elemental analysis by "flash combustion/chromatographic separation and multi-detector techniques". The Costech Instrument utilizes EAS Clarity Software. Atropine standards are used to develop a calibration curve (C 70.56%, N 4.84%, and carbon response ratio of 0.025 +/-0.003). NIST Buffalo River Sediment Reference Material 8704 (C 3.351% +/-0.017, N 0.20% +/-0.04) and/or Acetanilide Bypass (C 71.09%, N 10.36%, carbon response ratio of 0.055 +/- 0.003) may used for calibration or a check standard.

The molar ratio of particulate organic carbon (POC) to particulate nitrogen (PN), or C:N, was calculated by dividing POC by PN. (Carbon ug/L /12.011)/(Nitrogen ug/L/14.007).

Dissolved organic carbon (DOC) concentration was measured using a Shimadzu TOC-5000A Analyzer: Water samples were vacuum filtered (less than 25 kilopascal) using pre-combusted Whatman glass microfibre filters (GF/F). The filtrate was stored in pre-combusted glass scintillation vials with Teflon closures and frozen at -20 degrees Celsius until analysis. The Shimadzu TOC-5000A Analyzer uses high temperature catalytic oxidation followed by non-dispersive infrared analysis of the CO2 produced. Samples were acidified to a pH less than 2 and sparged with air before they were analyzed for non-volatile organic carbon. DOC values in 1996 were run from previously run nutrient samples. Starting February 2018, all stations were collected. Prior to Feb. 2018 only NR 0, 30, 70, 100, 120, and 160 surface and bottom stations were measured.

Nitrate/nitrite (NO3- / NO2-) concentration was determined using a Lachat/Zellweger Analytics QuikChem 8000 flow injection autoanalyzer (Milwaukee, WI, USA) using method FIA 31-107-04-1-C: Water samples were vacuum filtered (less than 25 kiloPascals) using pre-combusted Whatman glass microfibre filters (GF/F). The filtrate was stored in high-density polyethylene bottles and frozen at -20 degrees Celsius until analysis. Two replicates were run from the same bottle. Method detection limits (MDL, µg L-1) were: before 4Nov02 = 1.06; beginning 4Nov02 = 3.68; beginning 11Jul06 = 0.6; beginning 1Dec09 = 0.27; beginning 13Feb12 = 0.36; beginning 18Feb15 = 0.71. MDL was changed to 0.88 on a sample date of 8/21/2017.

Ammonium (NH4+) concentration was determined using a Lachat/Zellweger Analytics QuikChem 8000 flow injection autoanalyzer (Milwaukee, WI) using method FIA 31-107-06-1-A/B: Water samples were vacuum filtered (less than 25 kiloPascals) using pre-combusted Whatman glass microfibre filters (GF/F). The filtrate was stored in high-density polyethylene bottles and frozen (-20 degrees Celsius) until analysis. Two replicates were run from the same bottle. Method detection limits (MDL, µg L-1) were: before 4Nov02 = 4.69; beginning 4Nov02 = 4.31; beginning 11Jul06 = 2.55; beginning 1Dec09 = 3.98; beginning 13Feb12 = 2.87; beginning 18Feb15 = 3.34. MDL was changed to 1.05 on sample date 8/21/2017.

Dissolved inorganic nitrogen (DIN) concentration was calculated by summing nitrate/nitrite (NO3- / NO2-) and ammonium (NH4+). If either NO3- / NO2- or NH4+ were below the detection limit (-9999), they were taken to be zero for this calculation.

Total dissolved nitrogen (TDN) was measured by in-line digestion using the Lachat/Zellweger Analytics QuikChem 8000 flow injection autoanalyzer (Milwaukee, WI, USA) using method FIA 31-107-04-3-B for low total nitrogen for brackish/fresh waters (detection level: 0.1 - 5.0 milligrams nitrogen per liter): Water samples were vacuum filtered (less than 25 kiloPascals) using pre-combusted Whatman glass microfibre filters (GF/F). The filtrate was stored in high-density polyethylene bottles and frozen at -20 degrees Celsius until analysis. Two replicates were run from the same bottle. Total dissolved nitrogen by in-line digestion works by oxidizing all the nitrogen compounds to nitrate by heating to 100 degrees Celsius and adding energy via UV light. The pH is dropped from 9.1 to 3 during the decomposition. The entire digestion occurs prior to the injection valve. The nitrate/nitrite concentration is then determined using standard colorimetric techniques similar to the strict nitrate/nitrite manifold. Method detection limits (MDL, µg L-1) were: beginning 1Nov04 = 78; beginning 11Jul06 = 35.4 beginning 1Dec09 = 25.6; beginning 13Feb12 = 36.9; beginning 14Jan13 = 19.6; beginning 18Feb15 = 10.5. MDL changed to 7.30 on sample date of 8/21/2017

Dissolved organic nitrogen (DON) was calculated by subtracting dissolved inorganic nitrogen (DIN) from total dissolved nitrogen (TDN). If the DIN value used in the calculation was below the detection limit, it was taken to be zero for this calculation. At one point DON was determined by high temperature oxidation using the Antek 7000N or Antek 7000V analyzer.

Orthophosphate (PO43-) was determined using a Lachat/Zellweger Analytics QuikChem 8000 flow injection autoanalyzer (Milwaukee, WI) using method FIA 31-115-01-1-F/G: Water samples were vacuum filtered (less than 25 kiloPascals) using pre-combusted Whatman glass microfibre filters (GF/F). The filtrate was stored in high-density polyethylene bottles and frozen at -20 degrees Celsius until analysis. Two replicates were run from the same bottle. Method detection limits (MDL, µg L-1) were: before 4Nov02 = 0.35; beginning 4Nov02 = 0.74; beginning 1Nov04 = 1.68; beginning 11Jul06 = 1.84; beginning 1Dec09 = 0.62; beginning 13Feb12 = 0.69; beginning 18Feb15 = 0.61. MDL was changed to 1.80 on the sample date of 8/21/2017.

The molar ratio of nitrogen (N) to phosphorus (P), or N:P, was calculated by dividing dissolved inorganic nitrogen (DIN) by orthophosphate (PO43-) concentrations.

Silicic acid (SiO2) was measured after vacuum filtration (< 25 kPA) of the collected water samples through pre-combusted (3-4 hours at 450 0C) Whatman GF/F glass fiber filters. The filtrate was stored in high-density polyethylene bottles and frozen (-20 0C) until analysis. Two replicates were run from the same sample bottle. Nitrate plus nitrite concentrations were determined using a Lachat QuikChem 8000 flow injection autoanalyzer (Milwaukee, WI, USA). Method detection limits (MDL, µM) were: before 4Nov02 = 0.18; beginning 4Nov02 =1.24; beginning 1Nov04 = 1.86; beginning 11Jul06 = 0.75; beginning 1Dec09 = 0.75; beginning 13Feb12 = 0.09; beginning 18Feb15 = 0.08. MDL was changed to 0.03 on sample date of 8/21/2017.

Chlorophyll a (Chl a) measurements prior to the 08/17/1999 sampling date were measured on a Shimadzu UV-160U spectrophotometer using the trichromatic equation following sonication (45-60 s) and overnight extraction of glass fiber filters in 90 % acetone. Beginning on the 08/17/1999 sampling date, Chl a concentration was measured using the modified in vitro fluorescence technique in EPA Method 445.0 (Welshmeyer 1994, Arar et al. 1997): Fifty milliliters of each water sample was vacuum filtered (less than 25 kilopascals) in duplicate at low ambient light conditions using 25 mm Whatman glass microfibre filters (GF/F). The filters were blotted dry, wrapped in foil and frozen immediately at -20 degrees Celsius until analysis. Chlorophyll a was extracted from the filter using a tissue grinder and 10 mL of 90 percent reagent grade aqueous acetone (v/v with deionized water, Fisher Scientific NF/FCC Grade). The samples remained in the acetone overnight at -20 degrees Celsius. The extracts were filter-clarified using a centrifuge and analyzed on a Turner Designs TD-700 fluorometer that was configured for the non-acidification method of Welschmeyer (1994). The value reported is the average chlorophyll a concentration measured from the two filters. The fluorometer was calibrated with a known concentration of pure Chl a that was determined using a Shimadzu UV-160U spectrophotometer and the extinction coefficients of Jeffrey and Humphrey (1975). The calibration was checked daily against a solid secondary standard (Turner Designs, proprietary formula). As of August 2010, fluorescence was also measured on a TurnerDesigns Trilogy fluorometer. References: 1. Welschmeyer, N.A. 1994. Fluorometric analysis of chlorophyll a in the presence of chlorophyll b and pheopigments. Limnol. Oceanogr. 39:1985-1992. 2. Arar, E.J., W.L. Budde, and T.D. Behymer. 1997. Methods for the determination of chemical substances in marine and environmental matrices. EPA/600/R-97/072. National Exposure Research Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio. 3. Jeffrey, S.W., R.F.C. Mantoura, and S.W. Wright. 1997. Phytoplankton pigments in oceanography: Guidelines to modern methods. UNESCO Publishing, Paris, France.

Spec was used to determine chla up until AUGUST 1999. The spec results before Aug 1999 are corrected to correspond to the change in analysis with the Turner Designs fluorometer. Figure 1 presents raw and log transformed regressions between the HPLC and SPEC determinations of chl a in the Neuse during calendar year 1998. It appears that the SPEC method produces chl a values that are roughly 15 per cent higher than the HPLC method. Figure 2 presents similar regressions between HPLC and FLUO determinations of chl a in the Neuse from August – December of 1999. It appears that the FLUO method produces chl a values that are roughly 67 per cent higher than the HPLC method. These figures suggest two important problems for utilizing existing chl a data in water quality modeling in the Neuse; (i) a decision must be made which analysis technique will be accepted as the standard for determining chl a, and (ii) a correction must be applied to equilibrate IMS chl a values determined by the SPEC and FLUO methods.

Primary Productivity rate was measured using an adaptation of Steeman Nielsen's (1952) 14C bicarbonate method (Paerl et al. 1998). This method of measuring primary productivity allows direct measurement of carbon uptake and measures only net photosynthesis: Water samples were stored in 10 Liter high density polyethylene containers overnight in the research pond, a flow through system that receives water from the adjacent Bogue Sound, thereby simulating ambient water temperatures. The following morning the water samples were removed from the pond and transported to the laboratory for analysis. Water samples (76

milliliters) were added to three clear plastic square bottles to determine light uptake of carbon in triplicate and to 1 dark bottle to determine dark uptake of carbon. A solution of radioactive carbonate (300 microliters) was added to each bottle. The bottles were incubated for 4 hours in the pond. The light bottles were incubated underneath a field light simulator, while the dark bottles were incubated in a covered perforated bucket that was submerged in the pond. The FLS was used to simulate the ambient light conditions that phytoplankton are exposed to in the estuary (mixing conditions). The FLS is comprised of a rotating wheel with varying levels of screening. During the incubation period, photosynthetically active radiation (PAR) measurements were performed using a 2 pi Li-Cor LI-192SA spherical quantum sensor attached to a Li-Cor data logger. After the incubation period, the samples were returned to the laboratory, shaken and the entire contents were gently vacuum filtered (less than 25 kilopascals) using 25 mm Whatman glass microfibre filters (GF/F). The filters were placed in wooden drying trays and treated with concentrated hydrochloric acid fumes for 40 minutes to an hour to remove inorganic 14C. The filters were folded in half and placed in 7 milliliter plastic scintillation vials. Five milliliters of liquid scintillation cocktail (ecolume or cytoscint) was added to the vials. The vials were capped, shaken, stored in the dark for 3-24 hours and then assayed for radioactivity using a Beckman liquid scintillation counter. In addition to the samples, triplicate voucher samples were used to quantify the radioactivity of the 14C added. Voucher samples consisted of 100 microliter of 14C and 100 microliters of phenylethylamine. These vials also received 5 milliliters of liquid scintillation cocktail. A background vial and two 14C background standards were used. The quantity of carbon fixed is proportional to the fraction of radioactive carbon assimilated. (Paerl, H.W., J.L. Pinckney, J.M. Fear, and B.L. Peierls 1998. Ecosystem responses to internal and watershed organic matter loading: consequences for hypoxia in the eutrophying Neuse River Estuary, North Carolina, USA. Marine Ecology Progress Series 166: 17-25; Steemann Nielsen, E. 1952. The use of radio-active carbon (C14) for measuring organic production in the sea. Journal du Conseil permanent international pour L'Exploration de la Mer 18: 117-140)

Diagnostic phytoplankton photopigments were identified, separated and quantified by high performance liquid chromatography coupled to an in-line photodiode array spectrophotometer (Jeffrey et al. 1997): Known volumes of water sample (500-1000 milliliters, enough to obtain color on the filter) were vacuum filtered (less than 25 kiloPascals) through 25 or 47 millimeter Whatman glass microfibre filters (GF/F) under reduced light conditions. The filters were blotted dry, folded in half, wrapped in foil and then immediately frozen at -20 degrees Celsius until analysis. The filters were placed in 15 milliliter centrifuge tubes containing 1.5-3.0 milliliters of 100% acetone (HPLC Grade), sonicated for 30-60 seconds using a Fisher Sonic Dismembrator 300 with microtip and extracted at -20 degrees Celsius for 12-24 hours. After extraction the samples were centrifuged at 4500 rpm and the supernatant (i.e.- the combined extracted pigments) collected & filtered into amber glass autosampler vials using Millipex Millipore 0.45 micometer PTFE. Two hundred microliters of extractant from each vial was injected into the HPLC system using a Spectra Physics (now Thermo Separations Products) AS3000 autosampler and SP8800 pump, running a non-linear, 55 minute, 2-solvent gradient adapted from Van Heukelem et.al. 1994 or 1995?. The nonlinear, variable flow, binary gradient consisted of solvent A [80% methanol : 20% ammonium acetate (0.5 M adjusted to pH 7.2)] and B (80% methanol : 20% acetone). The extractant was separated into individual pigments using a series of C18 reverse-phase columns to optimize photopigment separations: The column order was a Rainin Microsorb guard column (0.46 x 1.5 centimeters, 3 micrometer packing) followed by a single monomeric reverse-phase C18 column (Rainin Microsorb-MV, 0.46 x 10 cm, 3 µm packing) followed by two polymeric reverse-phase C18 columns (Vydac 201TP5, 0.46 x 25 cm, 5 µm packing). The columns were kept at a constant 52 degrees Celsius in an Alltech 330 column heater. The separated pigments were then passed through an in line Shimadzu SPD-M10AV photodiode array detector which measured the absorbance of the sample/extractant, scanning the range of 350-800 nanometers every 2 seconds. The data was collected and analyzed using Shimadzu's EZChrom software. Individual pigments are identified using a combination of peak retention time and absorbance spectrum shape. Retention times and absorbance spectra are identified for each pigment by analyzing known pigments (either as pure standards or pigments or isolated from algal cultures). Pigments are quantified from their peak areas, calculated at 440nm. A calibration curve is generated by injecting various volumes of a mixed standard composed of known quantities of seven pure pigment standards (fucoxanthin, zeaxanthin, bacteriochlorophyll a, canthaxathin, chlorophyll b, chlorophyll a, echinenone and ß-carotene) and calculating the peak areas of those pigments The peak areas are regressed against the known quantities of each pigment to calculate the slope (Response Factor) for that pigment. Response factors for pigments we do not have reference standards for are calculated using the ratio of absorbance coefficients of each pigment to its closest structurally related reference pigment, multiplying the known pigment's response factor by that ratio. Pigments extracted from the samples are then quantified by multiplying the peak areas of a chromatogram at 440nm by the response factors. Pigment values listed as below detection were below the software threshold for peak detection or had spectra below a similarity of 0.9 compared to library spectra. Technician expert judgement was used in difficult cases.

The HPLC derived diagnostic photopigment concentrations were analyzed using the ChemTax matrix factorization program (Mackey 1996). This program uses the steepest decent algorithm to determine the best

fit based on an initial estimate of pigment ratios for algal classes. The initial pigment ratio matrix used in the Chemtax analysis was derived from: Mackey M.D., Mackey D.J., Higgins H.W., & Wright S.W. 1996. CHEMTAX- a program for estimating class abundances from chemical markers: application to HPLC measurements of phytoplankton. Marine Ecology Progress Series 144: 265-283, and consisted of nine photopigments (alloxanthin, antheraxanthin, chlorophyll b, total chlorophyll a (chlorophyll a + chlorophyllide a), fucoxanthin, lutein, peridinin, violaxanthin, and zeaxanthin) for five algal groups that constitute the bulk of the phytoplankton community in the Neuse River and Estuary (chlorophytes, cryptophytes, cyanobacteria, diatoms, and dinoflagellates). In order to reduce the variation of pigment ratios due to large changes in phytoplankton species composition with depth, season, and salinity regime, homogenous data groupings of the HPLC pigment data were performed prior to running on Chemtax: HPLC pigment data was grouped by Depth Level (surface or bottom) then by Season (winter, spring, summer and fall) then by Salinity regime (oligohaline: <5.0 ppt, mesohaline: 5.01 - 18.0 ppt, polyhaline: >18.01 ppt). When there were less than 10 samples in a given homogenous grouping (Chemtax requires at least 10 samples per run), the data was grouped by oligohaline + mesohaline or mesohaline + polyhaline (This is indicated in the comments section).

Distance (in river kilometers) was calculated using ESRI ArcGIS software. Distances were calculated using projected station locations (North Carolina State Plane 1983 meters projection). Distances from station 0 through 30 (upper river stations) were measured along the main channel of the river. Distances from stations 30 to 180 were measured as straight lines between stations

Data 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
- appended the AMS station coordinate information
- combined the various comments fields into one Comments field.

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Data Files

File
wq.csv (Comma Separated Values (.csv), 1.13 MB) MD5:5ae12fd4bf88c2a441ee4fa12ef59294 Primary data file for dataset ID 767391

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Related Publications

Crosswell, J. R., Wetz, M. S., Hales, B., & Paerl, H. W. (2012). Air-water CO2fluxes in the microtidal Neuse River Estuary, North Carolina. Journal of Geophysical Research: Oceans, 117(C8), n/a–n/a. doi:10.1029/2012jc007925 https://doi.org/10.1029/2012JC007925
General

Crosswell, J. R., Wetz, M. S., Hales, B., & Paerl, H. W. (2014). Extensive CO2 emissions from shallow coastal waters during passage of Hurricane Irene (August 2011) over the Mid-Atlantic Coast of the U.S.A. Limnology and Oceanography, 59(5), 1651–1665. doi:10.4319/lo.2014.59.5.1651
General

Dixon, J. L., Osburn, C. L., Paerl, H. W., & Peierls, B. L. (2014). Seasonal changes in estuarine dissolved organic matter due to variable flushing time and wind-driven mixing events. Estuarine, Coastal and Shelf Science, 151, 210–220. doi:10.1016/j.ecss.2014.10.013
General

Harding, L. W., Batiuk, R. A., Fisher, T. R., Gallegos, C. L., Malone, T. C., Miller, W. D., … Tango, P. (2013). Scientific Bases for Numerical Chlorophyll Criteria in Chesapeake Bay. Estuaries and Coasts, 37(1), 134–148.

doi:10.1007/s12237-013-9656-6
General

Harding, L. W., Gallegos, C. L., Perry, E. S., Miller, W. D., Adolf, J. E., Mallonee, M. E., & Paerl, H. W. (2015). Long-Term Trends of Nutrients and Phytoplankton in Chesapeake Bay. Estuaries and Coasts, 39(3), 664–681. doi:10.1007/s12237-015-0023-7
General

Harding,, L. W., Mallonee, M. E., Perry, E. S., Miller, W. D., Adolf, J. E., Gallegos, C. L., & Paerl, H. W. (2016). Variable climatic conditions dominate recent phytoplankton dynamics in Chesapeake Bay. Scientific Reports, 6(1). doi:10.1038/srep23773
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General

Hounshell, A. G., Peierls, B. L., Osburn, C. L., & Paerl, H. W. (2017). Stimulation of Phytoplankton Production by Anthropogenic Dissolved Organic Nitrogen in a Coastal Plain Estuary. Environmental Science & Technology, 51(22), 13104–13112. doi:10.1021/acs.est.7b03538
General

Kennish, M. J., & Paerl, H. W. (Eds.). (2010). Coastal Lagoons. doi:10.1201/ebk1420088304 https://doi.org/10.1201/EBK1420088304
General

Paerl, H. W., & Paul, V. J. (2012). Climate change: Links to global expansion of harmful cyanobacteria. Water Research, 46(5), 1349–1363. doi:10.1016/j.watres.2011.08.002
General

Paerl, H. W., Crosswell, J. R., Van Dam, B., Hall, N. S., Rossignol, K. L., Osburn, C. L., … Harding, L. W. (2018). Two decades of tropical cyclone impacts on North Carolina's estuarine carbon, nutrient and phytoplankton dynamics: implications for biogeochemical cycling and water quality in a stormier world. Biogeochemistry, 141(3), 307–332. doi:10.1007/s10533-018-0438-x
General

Paerl, H. W., Hall, N. S., Peierls, B. L., & Rossignol, K. L. (2014). Evolving Paradigms and Challenges in Estuarine and Coastal Eutrophication Dynamics in a Culturally and Climatically Stressed World. Estuaries and Coasts, 37(2), 243–258. doi:10.1007/s12237-014-9773-x
General

Paerl, H. W., Hall, N. S., Peierls, B. L., Rossignol, K. L., & Joyner, A. R. (2013). Hydrologic Variability and Its Control of Phytoplankton Community Structure and Function in Two Shallow, Coastal, Lagoonal Ecosystems: The Neuse and New River Estuaries, North Carolina, USA. Estuaries and Coasts, 37(S1), 31–45. doi:10.1007/s12237-013-9686-0
General

Paerl, H. W., Rossignol, K. L., Hall, S. N., Peierls, B. L., & Wetz, M. S. (2009). Phytoplankton Community Indicators of Short- and Long-term Ecological Change in the Anthropogenically and Climatically Impacted Neuse River Estuary, North Carolina, USA. Estuaries and Coasts, 33(2), 485–497. doi:10.1007/s12237-009-9137-0
General

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General

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Parameters

Parameter	Description	Units
Date	Date of water sample collection ; filtration ; and in situ measurements.	unitless
Year	Year of sampling	unitless
Season	The season when the water sample was collected and filtered and when the in situ measurements were performed in the field.	unitless
Station	The name of the fixed sampling station.	unitless
Source	The organization that conducted the sampling.	unitless
Depth	Depth level from which the water sample was collected and where the in situ measurements were made (S=surface ; B=bottom Surface (S) refers to a surface water sample or in situ measurement taken at a depth of approximately 0.2 meters. Bottom (B) refers to a bottom water sample or in situ measurement taken at a depth of approximately 0.5 meters above the sediment layer. Surface water samples were collected by submerging 10 liter high-density polyethylene containers just below the water surface or by filling the containers with surface water collected from bucket casts. Bottom water samples were collected with a horizontal plastic Van Dorn sampler. Starting December 2007 ; all samples collected with diaphragm pump and a weighted ; marked hose. All containers were kept in dark coolers at ambient temperature during transport to the laboratory. All filtration was done within a few hours of collection and when conditions permitted ; on board the research vessel.	meters (m)

YSI_Time	Exact time (hours:minutes:seconds) when the in situ measurements were made. This time is an approximate water sampling time.	unitless
YSI_Depth	Exact depth (meters) where the in situ measurements were made.	meters (m)
YSI_Temp	In situ water temperature	degrees Celsius
YSI_SpecCond	In situ specific conductivity	milli Siemens per centimeter
YSI_Salinity	In situ salinity	parts per thousand
YSI_DOsat	In situ dissolved oxygen saturation	unitless (percent)
YSI_DO	In situ dissolved oxygen concentration	milligrams per liter
YSI_pH	In situ pH.	unitless
YSI_Turbidity	In situ turbidity	NTU
YSI_Chlraw	In situ chlorophyll fluorescence	relative fluorescence units
YSI_Chl	In situ chlorophyll concentration from fluorescence	micrograms per liter
YSI_BP	Surface barometric pressure	millimeters of mercury
Secchi	Depth at which the secchi disk is no longer visible	meters
Kd	Diffuse light attenuation coefficient	per meter
Cdom_Corrected	Colored or chromophoric dissolved organic (matter humic substances) concentration as microgram per liter of quinine sulfate.	microgram per liter of quinine sulfate.
POC	Particulate organic carbon concentration	micrograms of carbon per liter
PN	Particulate nitrogen concentration	micrograms of nitrogen per liter
CtoN	Calculated molar ratio of particulate organic carbon	unitless

DOC	Dissolved organic carbon concentration	micromolar
DIC	Dissolved inorganic carbon concentration	milligrams of carbon per liter
NO3_NO2	Nitrate plus nitrite concentration	micrograms of nitrogen per liter
NH4	Ammonium concentration	micrograms of nitrogen per liter
DIN	Calculated dissolved inorganic nitrogen concentration	micrograms of nitrogen per liter
TDN	Total dissolved nitrogen concentration organic plus inorganic species	micrograms of nitrogen per liter
DON	Calculated dissolved organic nitrogen concentration	micrograms of nitrogen per liter
PO4	Orthophosphate concentration	micrograms of phosphorus per liter
NtoP	The calculated molar ratio of nitrogen (N) to phosphorus (P)	miligrams nitrogen per liter (mg N/L)
SiO2	Silica concentration	micromolar
Chla_IWS	Chlorophyll a concentration measured by in vitro fluorometry (micrograms per liter) integrated throughout the water column to 2x the secchi depth. Water samples for this measurement were collected using the integrated water sampler IWS) which collects vertically integrated water samples.	micrograms per liter
Correct_Chla_IV	Chlorophyll a concentration measured by in vitro fluorometry	micrograms per liter
PPR	Primary productivity by light/dark 14C bicarbonate incorporation	milligrams of C per meter cubed per hour
Chlide_a	Chlorophyllide a concentration by HPLC analysis	micrograms per liter
Chl_c1c2	Chlorophyll c1 and c2 concentration by HPLC analysis	micrograms per liter
Perid_corr	Peridinin concentration by HPLC analysis	micrograms per liter

But_fuco	19'-Butanoyloxyfucoxanthin concentration by HPLC analysis	micrograms per liter
Phide_a	Pheophorbide-a concentration by HPLC analysis	micrograms per liter
Fuco_corr	Fucoxanthin concentration by HPLC analysis	micrograms per liter
Hex_fuco	19'-Hexanoyloxyfucoxanthin concentration by HPLC analysis	micrograms per liter
Neo	9'-cis Neoxanthin concentration by HPLC analysis	micrograms per liter
Pras	Prasinoxanthin concentration by HPLC analysis	micrograms per liter
Viola	Violaxanthin concentration by HPLC analysis	micrograms per liter
Diadino	Diadinoxanthin concentration by HPLC analysis	micrograms per liter
Anth	Antheraxanthin concentration by HPLC analysis	micrograms per liter
Myxo	Myxoxanthophyll concentration by HPLC analysis	micrograms per liter
Allo_corr	Alloxanthin concentration by HPLC analysis	micrograms per liter
Diato	Diatoxanthin concentration by HPLC analysis	micrograms per liter
Monado	Monadoxanthin concentration by HPLC analysis	micrograms per liter
Lut	Lutein concentration by HPLC analysis	micrograms per liter
Zea_corr	Zeaxanthin concentration by HPLC analysis	micrograms per liter
Gyro	Gyroxanthin concentration by HPLC analysis	micrograms per liter
Cantha	Canthaxanthin concentration by HPLC analysis	micrograms per liter
Chl_b_corr	Chlorophyll b concentration by HPLC analysis	micrograms per liter
DV_chl_a	Divinyl chlorophyll a concentration by HPLC analysis	micrograms per liter

Chl_a_corr	Chlorophyll a concentration by HPLC analysis	micrograms per liter
Echin	Echinenone concentration by HPLC analysis	micrograms per liter
Phytin_a	Pheophytin a concentration by HPLC analysis	micrograms per liter
B_car	?-Carotene concentration by HPLC analysis	micrograms per liter
TotalChla	Sum of chlorophyll a and chlorophyllide a concentrations by HPLC analysis . Concentrations below detection assumed to by zero for this calculation.	micrograms per liter
ISO_DateTime	Date and YSI_Time columns combined into ISO 8601 date format	unitless
Station_Description	The physical location of the sampling station ; such as at or near a particular river marker ; buoy ; road or bridge. Lists other names that may also be used to refer to this station.	unitless
km0	The distance of the sampling station from station 0.	kilometers (km)
Lat	North latitude of station in decimal degrees	decimal degrees
Lon	West longitude of station in decimal degrees	decimal degrees

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Instruments

Dataset-specific Instrument Name	PE 2400 Series II CHNS/O Analyzer
Generic Instrument Name	CHN Elemental Analyzer
Dataset-specific Description	After drying at 60 0C, the filters were rolled in tin disks and injected into a PE 2400 Series II CHNS/O Analyzer calibrated with acetanilide ending in June 2014. Starting on the Neuse River sample date of June 2, 2014, a Costech Analytical Technologies, Inc. Elemental Combustion System CHNS-O ECS 4010 was used for elemental analysis by "flash combustion/chromatographic separation and multi-detector techniques". The Costech Instrument utilizes EAS Clarity Software. Atropine standards are used to develop a calibration curve (C 70.56%, N 4.84%, and carbon response ratio of 0.025 +/-0.003). NIST Buffalo River Sediment Reference Material 8704 (C 3.351% +/-0.017, N 0.20% +/-0.04) and/or Acetanilide Bypass (C 71.09%, N 10.36%, carbon response ratio of 0.055 +/- 0.003) may used for calibration or a check standard.
Generic Instrument Description	A CHN Elemental Analyzer is used for the determination of carbon, hydrogen, and nitrogen content in organic and other types of materials, including solids, liquids, volatile, and viscous samples.

Dataset-specific Instrument Name	HPLC system
Generic Instrument Name	High-Performance Liquid Chromatograph
Dataset-specific Description	Two hundred microliters of extractant from each vial was injected into the HPLC system using a Spectra Physics (now Thermo Separations Products) AS3000 autosampler and SP8800 pump, running a non-linear, 55 minute, 2-solvent gradient adapted from Van Heukelem et.al. 1994 or 1995?.
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.

Dataset-specific Instrument Name	Hydrolab Data Sonde 3
Generic Instrument Name	HydroLab DataSonde
Dataset-specific Description	Prior to the 09/13/2000 sampling date, in situ measurements were performed at discrete depths using a Hydrolab Data Sonde 3 equipped with a multiprobe and SVR3 display logger.
Generic Instrument Description	Hydrolab DataSonde Multiparameter Probes have sensors for temperature, conductivity, salinity, specific conductance, TDS, pH, ORP, dissolved oxygen, turbidity, chlorophyll a, blue-green algae, Rhodamine WT, ammonium, nitrate, chloride, ambient light (PAR), and total dissolved gas.

Dataset-specific Instrument Name	spherical underwater quantum sensor (LI-COR LI-193SA)
Generic Instrument Name	LI-COR LI-193 PAR Sensor
Dataset-specific Description	Prior to the 07/30/2003 sampling date, PAR measurements were performed with a spherical underwater quantum sensor (LI-COR LI-193SA) coupled to a LI-COR LI-1000 datalogger. Beginning on the 07/30/2003 sampling date, a flat underwater quantum sensor (LI-COR LI-193SA) attached to a Yellow Springs Instruments YSI 6600 or YSI 6600 EDS-S sonde was used to measure PAR.
Generic Instrument Description	The LI-193 Underwater Spherical Quantum Sensor uses a Silicon Photodiode and glass filters encased in a waterproof housing to measure PAR (in the 400 to 700 nm waveband) in aquatic environments. Typical output is in micromol s-1 m-2. The LI-193 Sensor gives an added dimension to underwater PAR measurements as it measures photon flux from all directions. This measurement is referred to as Photosynthetic Photon Flux Fluence Rate (PPFFR) or Quantum Scalar Irradiance. This is important, for example, when studying phytoplankton, which utilize radiation from all directions for photosynthesis. LI-COR began producing Spherical Quantum Sensors in 1979; serial numbers for the LI-193 begin with SPQA-XXXXX (licor.com).

Dataset-specific Instrument Name	Lachat/Zellweger Analytics QuikChem 8000 flow injection autoanalyzer
Generic Instrument Name	Nutrient Autoanalyzer
Dataset-specific Description	Nitrate/nitrite (NO3- / NO2-) concentration was determined using a Lachat/Zellweger Analytics QuikChem 8000 flow injection autoanalyzer (Milwaukee, WI, USA) using method FIA 31-107-04-1-C. Ammonium (NH4+) concentration was determined using a Lachat/Zellweger Analytics QuikChem 8000 flow injection autoanalyzer (Milwaukee, WI) using method FIA 31-107-06-1-A/B. Total dissolved nitrogen (TDN) was measured by in-line digestion using the Lachat/Zellweger Analytics QuikChem 8000 flow injection autoanalyzer (Milwaukee, WI, USA) using method FIA 31-107-04-3-B for low total nitrogen for brackish/fresh waters (detection level: 0.1 - 5.0 milligrams nitrogen per liter). Orthophosphate (PO43-) was determined using a Lachat/Zellweger Analytics QuikChem 8000 flow injection autoanalyzer (Milwaukee, WI) using method FIA 31-115-01-1-F/G.
Generic Instrument Description	Nutrient Autoanalyzer is a generic term used when specific type, make and model were not specified. In general, a Nutrient Autoanalyzer is an automated flow-thru system for doing nutrient analysis (nitrate, ammonium, orthophosphate, and silicate) on seawater samples.

Dataset-specific Instrument Name	secchi disk
Generic Instrument Name	Secchi Disc
Dataset-specific Description	The secchi disk was deployed off of the sunlit side of the research vessel. The depth (in meters) at which the secchi disk was no longer visible by the naked eye was recorded as the secchi depth.
Generic Instrument Description	Typically, a 16 inch diameter white/black quadrant disc used to measure water optical clarity

Dataset-specific Instrument Name	in-line photodiode array spectrophotometer
Generic Instrument Name	Spectrophotometer
Dataset-specific Description	Diagnostic phytoplankton photopigments were identified, separated and quantified by high performance liquid chromatography coupled to an in-line photodiode array spectrophotometer (Jeffrey et al. 1997)
Generic Instrument Description	An instrument used to measure the relative absorption of electromagnetic radiation of different wavelengths in the near infra-red, visible and ultraviolet wavebands by samples.

Dataset-specific Instrument Name	Turner Designs TD-700 fluorometer
Generic Instrument Name	Turner Designs 700 Laboratory Fluorometer
Dataset-specific Description	Colored dissolved organic matter (CDOM) was measured using a Turner Designs TD-700 fluorometer configured with a near-UV mercury vapour lamp, a 350 nm excitation filter, and a 410–600 nm emission filter.
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	Shimadzu TOC-5000A Analyzer
Generic Instrument Name	UV Spectrophotometer-Shimadzu
Dataset-specific Description	Dissolved organic carbon (DOC) concentration was measured using a Shimadzu TOC-5000A Analyzer: Water samples were vacuum filtered (less than 25 kilopascal) using pre-combusted Whatman glass microfibre filters (GF/F). The filtrate was stored in pre-combusted glass scintillation vials with Teflon closures and frozen at -20 degrees Celsius until analysis. The Shimadzu TOC-5000A Analyzer uses high temperature catalytic oxidation followed by non-dispersive infrared analysis of the CO2 produced. Samples were acidified to a pH less than 2 and sparged with air before they were analyzed for non-volatile organic carbon. DOC values in 1996 were run from previously run nutrient samples. Starting February 2018, all stations were collected. Prior to Feb. 2018 only NR 0, 30, 70, 100, 120, and 160 surface and bottom stations were measured.
Generic Instrument Description	The Shimadzu UV Spectrophotometer is manufactured by Shimadzu Scientific Instruments (ssi.shimadzu.com). Shimadzu manufacturers several models of spectrophotometer; refer to dataset for make/model information.

Dataset-specific Instrument Name	plastic Van Dorn sampler
Generic Instrument Name	Van Dorn water sampler
Dataset-specific Description	Bottom water samples were collected with a horizontal plastic Van Dorn sampler.
Generic Instrument Description	A free-flushing water sample bottle comprising a cylinder (polycarbonate, acrylic or PVC) with a stopper at each end. The bottle is closed by means of a messenger from the surface releasing the tension on a latex band and thus pulling the two stoppers firmly into place. A thermometer can be mounted inside the bottle. One or more bottles can be lowered on a line to allow sampling at a single or multiple depth levels. Van Dorn samplers are suitable for for physical (temperature), chemical and biological sampling in shallow to very deep water. Bottles are typically lowered vertically through the water column although a horizontal version is available for sampling near the seabed or at thermoclines or chemoclines. Because of the lack of metal parts the bottles are suitable for trace metal sampling, although the blue polyurethane seal used in the Alpha version may leach mercury. The Beta version uses white ASA plastic seals that do not leach mercury but are less durable.

Dataset-specific Instrument Name	Yellow Springs Instruments (YSI Incoporated, Ohio) multiparameter sonde (Model 6600 or 6600 EDS-S Extended Deployment System)
Generic Instrument Name	YSI Sonde 6-Series
Dataset-specific Description	Beginning on the 09/13/2000 sampling date, in situ measurements were performed at discrete depths on the sunlit side of the research vessel using a Yellow Springs Instruments (YSI Incoporated, Ohio) multiparameter sonde (Model 6600 or 6600 EDS-S Extended Deployment System) equipped with a YSI conductivity/temperature probe (Model 6560), a YSI chlorophyll probe (Model 6025), a YSI pH probe (Model 6561 or 6566), a YSI pulsed dissolved oxygen probe (Model 6562), a self cleaning YSI turbidity probe (Model 6026 or 6136), and beginning on the 07/30/2003 sampling date, a flat Li-Cor sensor (UWQ-PAR 6067).
Generic Instrument Description	YSI 6-Series water quality sondes and sensors are instruments for environmental monitoring and long-term deployments. YSI datasondes accept multiple water quality sensors (i.e., they are multiparameter sondes). Sondes can measure temperature, conductivity, dissolved oxygen, depth, turbidity, and other water quality parameters. The 6-Series includes several models. More from YSI.

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Project Information

Collaborative Research: Regulation of Phytoplankton Dynamics in Mid-Atlantic Estuaries Subject to Climatic Perturbations (climate_phyto_estuaries)

Website: http://paerllab.web.unc.edu/projects/modmon/

Coverage: The two largest estuaries in the United States, Chesapeake Bay (CB) and Albemarle-Pamlico Sound-Neuse River Estuary (APS-NRE).

NSF Award Abstract:

Climatic perturbations by drought-flood cycles, tropical storms, and hurricanes are increasingly important in Mid-Atlantic estuaries, leading to ecosystem-scale responses of the plankton system with significant trophic implications. Recent observations support an emerging paradigm that climate dominates nutrient enrichment in these ecosystems, explaining seasonal and interannual variability of phytoplankton floral composition, biomass (chl-a), and primary production (PP). This project will evaluate this paradigm in the two largest estuaries in the United States, Chesapeake Bay (CB) and Albemarle-Pamlico Sound-Neuse River Estuary (APS-NRE) by quantifying responses to climatic perturbations. This project will: (1) resolve long-term trends of plankton biomass/production from high variability driven by climatic forcing, such as drought-flood cycles that generate significant departures from the norm; (2) quantify the role of episodic wind and precipitation events, such as those associated with frontal passages, tropical storms, and hurricanes, that evoke consequential spikes of biomass/production outside the resolution of traditional methods. The field program will focus on event-scale forcing of phytoplankton dynamics by collecting shipboard, aircraft remote sensing, and satellite (SeaWiFS, MODIS-A) data, analyzing extensive monitoring data for CB and APS-NRE to develop context, and quantifying effects of climatic perturbations on phytoplankton dynamics as departures from long-term averages. The rapid-response sampling will be paired with numerical simulations using coupled hydrodynamic biogeochemical models based on the Regional Ocean Modeling System (ROMS). This combination of observations and modeling will be used to explore mechanistic links and test empirical relationships obtained from field data.

Intellectual Merit. Drought-flood cycles, tropical storms, and hurricanes are occurring at increasing severity and frequency, exerting significant pressures on land margin ecosystems. Research and monitoring in these ecosystems has focused singularly on eutrophication for nearly five decades. Recognition of climatic perturbations as the underlying cause of phytoplankton variability represents a significant departure from this singular focus. This project will combine observations and modeling to significantly extend our knowledge of how climate regulates phytoplankton dynamics in estuaries. Progress in calibrating and validating hydrodynamic biogeochemical models with data collected in CB and APS-NRE by this project will lead to predictive capabilities thus far unattained, allowing us to evaluate the paradigm that climatic perturbations regulate phytoplankton dynamics in estuaries.

Broader Impacts: Addressing the effects of climatic perturbations on phytoplankton dynamics in estuaries with a combination of data collection, analysis, and mechanistic modeling has societal benefits for scientists and resource managers. Applications in addition to ?basic? science include the consideration of climatic forcing in designing effective nutrient management strategies. Specific impacts include: (1) quantifying the effects of climatic perturbations on planktonic processes for important estuarine-coastal ecosystems; (2) extending empirically-based water quality criteria forward by enabling predictions of floral composition, chl-a, and PP in changing climate conditions; (3) combining observations and mechanistic models to support scenario analysis, allowing us to distinguish long-term trends from variability imposed by climate. This project will offer a graduate course in physical transport processes and plankton productivity that will benefit from this research, support two Ph.D. students, and train undergraduates in NSF REU and minority outreach programs at HPL-UMCES and IMS-UNC. The main products will be peer-reviewed publications and presentations at scientific meetings. The three PIs maintain active web sites that will be used to distribute results and data.

NOTE:

Dr. Harding was the original Lead PI. Dr. Michael R. Roman was named as substitute PI when Dr. Harding served as a Program Director in the NSF Biological Oceanography Program for two years, and through his move to UCLA thereafter. Dr. Harding is responsible for the data holdings on this project and for coordinating their submittal to BCO-DMO.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0825466

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