Median surface chlorophyll-a concentration 2003-2015

Northwest Atlantic United States

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1. INTRODUCTION

This data product shows the median concentration of the pigment Chlorophyll-a (mg/m^3) in surface waters from 2003 to 2015. Chlorophyll-a concentration is often used as a proxy for phytoplankton abundance. This dataset was created by The Nature Conservancy (TNC) using remote sensing data provided by the National Aeronautics and Space Administration (NASA). This layer covers offshore waters from North Carolina to northern Maine, with a spatial resolution of 1300 meters.

We derived concentration of chlorophyll-a using images from the Moderate-resolution Imaging Spectro-radiometer (MODIS, a sensor onboard the Aqua satellite). Daily layers were obtained from NASA, which had a 1 km nominal resolution at nadir (i.e. just perpendicular from the surface of the Earth) at the center of a swath, with resolution slightly increasing toward the edges. We log-transformed (ln(x)) all daily layers, since the distribution of chlorophyll-a values resembled a Poisson distribution (values skewed to smaller concentrations). Also, from each daily layer, we removed values on land and values flagged by NASA for inaccurate atmospheric corrections (for more information on these flags, refer to http://oceancolor.gsfc.nasa.gov/VALIDATION/flags.html for a list of flags). Finally, we also removed pixels located in areas with depth shallower than 10 meters, to prevent erroneous values due to reflected light from the seafloor.

The seasonal median of log-transformed chlorophyll-a images was derived for the time period December 2002 - November 2015 (note that winter 2003 started in December 1st 2002). The reason we calculated the median was to prevent outliers driving the resulting values. Seasons were defined to be consistent with meteorological seasons: Winter (December 1st – February 28th/29th); Spring (March 1st – May 31st); Summer (June 1st – August 31st); Fall (September 1st – November 30th). Resulting seasonal median layers have a nominal resolution of 1.3 km.

2. PURPOSE

This layer was created to visualize seasonal patterns of phytoplankton abundance across space. It addresses data gaps and provides the most up-to-date information on surface phytoplankton abundance for the area of study. This supports the Northeast Regional Ocean Council (NROC) efforts to provide datasets to stakeholders and managers to facilitate coastal and ocean planning.

Plankton organisms are important for many reasons, including:

- Phytoplankton and zooplankton support commercially and ecologically important fisheries (including shellfish)
- High values of phytoplankton abundance are good indicators of commercially productive waters
- Plankton play a critical role in global biogeochemical cycles, including those of essential nutrients and carbon
- Artificially-introduced nutrients (nutrient loading), particularly nitrate in marine systems, cause extreme phytoplankton blooms (eutrophication) that can reduce bottom oxygen levels to hypoxic or anoxic levels in highly stratified waters. As a result, wide fish kills can occur if these anoxic conditions are maintained for long periods of time.
- Species composition and abundance can be used both as a) historic or current indicators or predictors of ecosystem or fishery health and b) to assess changes in climate, sea level, and biogeochemistry
- Blooms of toxic algae (“red tides”) can harm both marine life and people.

3. SOURCES AND AUTHORITIES

- NASA MODIS-Aqua level-2 layers (http://oceancolor.gsfc.nasa.gov) from the 2014 reprocessing.
- Hu, C., Lee Z., and Franz, B.A. (2012). Chlorophyll-a algorithms for oligotrophic oceans: A novel approach based on three-band reflectance difference, J. Geophys. Res., 117, C01011.

4. DATABASE DESIGN AND CONTENT

Surface chlorophyll-a concentration:

Native storage format: ArcGIS File Geodatabase Raster Dataset
Columns and Rows: 696, 1086
Number of Bands: 1
Cell Size: 1300 meters (0.016745077 degrees)
Source Type: Continuous
Pixel Type: Floating Point
Pixel Depth: 32 Bit
Statistics:

Season	Minimum	Maximum	Mean	Standard Deviation
SPRING	-2.87534904479980	3.74210500717163	-0.83857458423707	0.564705135867739
SUMMER	-3.60453128814697	3.87132477760314	-1.36250092723176	0.829320925187245
FALL	-3.09781908988952	3.50287818908691	-1.17709114562246	0.773017608366641
WINTER	-2.65657496452331	3.64652061462402	-1.14639789283213	0.664046917752524

Dataset Names:

ChlorophyllMedianSpring
ChlorophyllMedianSummer
ChlorophyllMedianFall
ChlorophyllMedianWinter.

Dataset Status: Complete

5. SPATIAL REPRESENTATION

Reference System: GCS North American 1983
Horizontal Datum: North American Datum 1983
Ellipsoid: Geodetic Reference System 1980
Linear Unit: Meter (1.0)
Angular Unit: Degree (0.0174532925199433)
False Easting: 0.0
False Northing: 0.0
Central Meridian: 0.0

Geographic extent: -76.45 to -64.101, 33.674 to 46.395

IS0 19115 Topic Category: Environment, Oceans, Biota

Place Names:

Albemarle Sound, Baltimore Canyon, Bay of Fundy, Block Island Delta, Cashes Ledge, Chesapeake Bay, Cholera Bank, Delaware Bay, Georges Bank, Georges Basin, German Bank, Great South Channel, Gulf of Maine, Hudson Canyon, Hydrographer Canyon, Jeffreys Ledge, Jordan Basin, Lake Ontario, Long Island Sound, Mid-Atlantic Bight, Nantucket Shoals, Norfolk Canyon, Northeast Channel, Stellwagen Bank, Southern New England, Wilkinson Basin

Recommended Cartographic Properties:

(Using ArcGIS ArcMap nomenclature)

Stretch, color mode: RGB

Blue: 2 – 93 – 230
Light Blue: 0 – 196 – 230
Green: 67 – 196 – 95
Yellow: 255 – 255 – 0
Red: 255 – 0 – 0

To compare the different chlorophyll-a layers, we recommend using statistics from Custom settings (reference values from Spring):

Min: -2.8753490447997998
Max: 3.74210500717163
Mean: -0.83857458423707398
Std Dev.: 0.56470513586773996

Scale range for optimal visualization: 1:5,000,000

6. DATA PROCESSING

Processing environment: Microsoft Windows 7 Professional, Service Pack 1; ESRI ArcGIS 10.2.2, Spatial analyst extension; NASA SEADAS 7.3.1, 64-bit; Mathworks Matlab 64-bit R2015b.

	Process Steps Description
1	To measure chlorophyll by satellite, images from the Moderate-resolution Imaging Spectro-

	radiometer (MODIS-Aqua) obtained from NASA were used. These images have a 1 km resolution at nadir (i.e. perpendicular to the Earth's surface), at the center of a swath, but increase towards the edges.
2	MODIS data layers were processed by NASA and TNC. NASA provided level-2 MODIS daily layers. Chlorophyll-a values were derived from reflectance values using the OCI algorithm (Hu et al. 2012).
3	The daily level-2 layers were processed using SEADAS (NASA) and MATLAB (Mathworks, Inc.). In each image, land and clouds were removed, as well as pixels flagged for incorrect atmospheric correction (for information on level-2 flags, refer to http://oceancolor.gsfc.nasa.gov/VALIDATION/flags.html). All layers were collocated to a common grid of 1.3 km resolution.
4	All daily layers were log-transformed (ln(x)) using Matlab.
5	In Matlab, seasonal median values of chlorophyll-a concentration (mg/m^3) were calculated for the time period December 2002 - November 2015. The seasons were defined in three month-blocks, following general meteorological limits: winter (December – February); spring (March – May); summer (June – August); fall (September – November).
6	Using the bathymetry layer created for the NAMERA project, we removed chlorophyll-a values that were above bathymetry pixels with values higher than -10 meters (i.e. shallower waters)
7	Resulting seasonal median layers were imported to ArcGIS 10.2.2 and clipped to fit the study area using EXTRACT BY MASK from the Spatial analyst extension.

7. QUALITY PROCESS

Logical consistency: These data are believed to be logically consistent.

Completeness: Seasonal chlorophyll-a images were created for the time period December 2002 – November 2015. The data time series ranges are daily. The seasons are defined to be consistent with meteorological seasonal limits: winter (December-February); spring (March-May); summer (June-August); fall (September-November).

Positional Accuracy: The accuracy of the data is a result of the accuracy of the satellite data and the algorithms used by NASA for atmospheric correction and calculation of chlorophyll-a concentration.

Timeliness: Based on data from December 2002 - November 2015

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