Yearly census of Gulf Stream Warm Core Ring formation from 1980 to 2017

Website: https://www.bco-dmo.org/dataset/810182
Data Type: Other Field Results
Version: 1
Version Date: 2020-05-06

Project
» Collaborative Research: GLOBEC Pan Regional Synthesis: The Effect of Varying Freshwater Inputs on Regional Ecosystems in the North Atlantic (GLOBEC_PRS_Freshwater Inputs)

Contributors	Affiliation	Role
Gangopadhyay, Avijit	University of Massachusetts Dartmouth (UMass Dartmouth)	Principal Investigator
Gawarkiewicz, Glen	Woods Hole Oceanographic Institution (WHOI)	Co-Principal Investigator
Copley, Nancy	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Yearly census of Gulf Stream Warm Core Ring formation from 1980 to 2017. This continuous census file contains the formation and demise times and locations, and the area at formation for all 961 WCRs formed between 1980 and 2017 that lived for a week or more. Each row represents a unique Warm Core Ring and is identified by a unique alphanumeric code 'WEyyyymmddA', where 'WE' represents a Warm Eddy (as identified in the analysis charts); 'yyyymmdd' is the year, month and day of formation; and the last character 'A' represents the sequential sighting of the eddies in a particular year. For example, the first ring in 2017 having a trailing alphabet of 'E' indicates that four rings were carried over from 2016 which are still observed on January 1, 2017.

Table of Contents

Coverage

Spatial Extent: **N**:43.82 **E**:-54.01 **S**:32.27 **W**:-75.08
Temporal Extent: 1980-03-04 - 2017-12-13

Dataset Description

Thirty-eight years (1980-2017) of Gulf Stream Warm Core Ring census yielded a total of 961 WCRs and their their formation (birth), demise (last seen), area at formation and lifespan information were documented and are available here. Please note that this data set is the census data which is the result of analyzing a large number of Gulf Stream Analysis charts from NOAA and Jenifer Clark (see below). The basis for the charts were 6-12 hourly synoptic sea surface temperature data at 1.1 km from NOAA satellites with AVHRR and AVHRR2 instruments.This Census data was the result of analysis of more than 5000 such charts over the 38-year period (1980-2017). The charts were available 2-3 times a week for every week and are archived separately.

The process of creating the census and a brief description of the underlying charts are summarized here and also described by Gangopadhyay et al. (2019).

Methods & Sampling

The census data is an analysis product from a set of charts prepared by Jenifer Clark (JC). An example chart is shown in Figure 1a of Gangopadhyay et al. (2019). The collection of charts of the GS and surrounding waters has been annotated with satellite data indicating temperature. Using infra-red (IR) imagery, satellite altimetry data, and surface in-situ temperature data, oceanographic analyses were produced for this region in the form of 2-3 day composite charts in a consistent manner. These charts show the location, extent and temperature signature of currents (GS, shelf-slope front), warm and cold-core rings (WCRs and CCRs), other eddies, shingles, intrusions, and other water mass boundaries in the Gulf of Maine, over Georges Bank and in the Middle Atlantic Bight.

The basis data source of those charts was individual IR temperature images from the NOAA polar-orbiting satellites (NOAA-5 in the early 1980s to NOAA-18 recently) at 6-12 hourly intervals. These images were captured by the Advanced Very High Resolution Radiometer (AVHRR) and AVHRR2 instruments, both of which had a resolution of 1.1 km over the last four decades. Each individual image has a different lookup table (or colormap) for temperature that resolves 256 distinct sets of intensity, hue, and saturation of color within the available and retrievable IR signal range. This allows for accurate identification of the small-scale features in each image. The analyst locates all of the small scale features in each individual satellite SST image within a three-day period. The locations and boundaries of the features (GS, WCR, CCR , and other smaller scale entities) are remapped onto a 3-day composite image for that period. The 3-day composite image has a fixed and broad (5-30°C) range of temperature with similar 256-set indexing, which by itself could not resolve the features. Note that individual images with high-resolution within a narrower band of temperature range also have clouds, which are eliminated (or at least minimized) during the process of generating the 3-day composites. The 3-day composite helps to visualize the whole GS and its rings in a broader region (like Figure 1a); while the individual images help resolve the features at a very high resolution. The 3-day composite images are regularly produced by NOAA and/or the Johns Hopkins University Applied Physics Lab (fermi) group (see http://fermi.jhuapl.edu for more details).

Data Processing Description

The process of creating the WCR census time-series from those charts can be summarized as follows. First, the JC Charts are available 2-3 times a week from 1980-2017. Thus, we used approximately 5000 Charts for the 38 years of analysis. All of these charts were reanalyzed between 75° and 55°W using QGIS 2.18.16 (2016) and geo-referenced on a WGS84 coordinate system (Decker, 1986). The analyst goes through each chart and follows a set of rules (birth, continuity, death) to identify each WCR and tabulates the ring parameters. A new ring formation is documented in the following situations: (i) a typical GS crest forming a closed anticyclonic vortex and detaches from the stream in the slope water; (ii) an anticyclonic eddy forms off of another large anticyclonic eddy in the slope water; (iii) an anticyclonic eddy further away from the stream coming into the domain through Region 4 (60-55W). Note that any anticyclonic eddy that existed for less than 7 days was not counted in the census (Monim, 2017; Silva, 2019).

For exact References please see the paper by Gangopadhyay et al. (2019).

Acknowledgment: We are greatly indebted to the large number of scientists, researchers and fishermen who have gone to sea to observe, document, and understand the Gulf Stream Warm Core Rings and Cold Core Rings over last forty years, without which creating the census would never have been possible. We gratefully acknowledge the efforts of NOAA and NASA for their Satellite observations which helped developed the synoptic Gulf Stream and Ring Analysis charts. The Gulf Stream Analysis Charts were compiled by multiple analysts in NOAA including Jenifer Clark, who continue to create charts till now. The Census was started by M. Monim and followed by N. Silva and A. Silver under the directives of the Co-PIs.

BCO-DMO Processing Notes:
- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions
- combined multiple tables into single table

[table of contents | back to top]

Data Files

File
wcr_census.csv (Comma Separated Values (.csv), 64.01 KB) MD5:923e1f43dd94ca301f3719b13d240e01 Primary data file for dataset ID 810182

[table of contents | back to top]

Related Publications

Decker, B. L. (1986). World geodetic system 1984. Defense Mapping Agency Aerospace Center St Louis Afs Mo. https://apps.dtic.mil/dtic/tr/fulltext/u2/a167570.pdf
Methods

Gangopadhyay, A., Gawarkiewicz, G., Silva, E. N. S., Monim, M., & Clark, J. (2019). An Observed Regime Shift in the Formation of Warm Core Rings from the Gulf Stream. Scientific Reports, 9(1). doi:10.1038/s41598-019-48661-9 https://doi.org/https://doi.org/10.1038/s41598-019-48661-9
Results

Gangopadhyay, A., Gawarkiewicz, G., Silva, E. N. S., Silver, A. M., Monim, M., & Clark, J. (2020). A Census of the Warm-Core Rings of the Gulf Stream: 1980–2017. Journal of Geophysical Research: Oceans, 125(8). Portico. https://doi.org/10.1029/2019jc016033 https://doi.org/10.1029/2019JC016033
Results

Gawarkiewicz, G., Todd, R., Zhang, W., Partida, J., Gangopadhyay, A., Monim, M.-U.-H., … Dent, M. (2018). The Changing Nature of Shelf-Break Exchange Revealed by the OOI Pioneer Array. Oceanography, 31(1), 60–70. doi:10.5670/oceanog.2018.110
Related Research

Monim, M. (2017). Seasonal and inter-annual variability of Gulf Stream warm core rings from 2000 to 2016. University of Massachusetts-Dartmouth.
Related Research

QGIS, Q. G. (2016). Development Team.(2014). Quantum GIS Geographic Information System. Open Source Geospatial Foundation Project.
Methods

Silva, E.N.S. (2019) Understanding Thirty-Eight years of Gulf Stream's Warm Core Rings: Variability, Regimes and Survival. MS Thesis, University of Massachusetts Dartmouth, 125 pp.
Related Research

Silva, E.N.S., A. Gangopadhyay, G. Fay, A., M. Welandawe, G. Gawarkiewicz, A. M. Silver, and J. Clark, 2020: A survival analysis of the warm core rings of the Gulf Stream. (Under Review).
Results

Silver, A., Gangopadhyay, A., Gawarkiewicz, G., Silva, E. N. S., & Clark, J. (2021). Interannual and seasonal asymmetries in Gulf Stream Ring Formations from 1980 to 2019. Scientific Reports, 11(1). https://doi.org/10.1038/s41598-021-81827-y
Results

[table of contents | back to top]

Parameters

Parameter	Description	Units
WCR_Name	Warm Core Ring identifier	unitless
DOB	Date WCR was first seen	unitless
Longitude_F	WCR formation location: longitude where ring was first seen; east is positive	decimal degrees
Latitude_F	WCR formation location: latitude WCR was first seen; north is positive	decimal degrees
Area_km2	area of WCR	square kilometers (km^2)
DOA	Date WCR was last seen	unitless
Longitude_D	WCR demise location: longitude where ring was last seen; east is positive	decimal degrees
Latitude_D	WCR demise location: latitude where ring was lat seen; north is positive	decimal degrees

[table of contents | back to top]

Project Information

Collaborative Research: GLOBEC Pan Regional Synthesis: The Effect of Varying Freshwater Inputs on Regional Ecosystems in the North Atlantic (GLOBEC_PRS_Freshwater Inputs)

Coverage: North Atlantic

This research addresses several mechanisms by which freshwater influx might impact the primary production of Calanus finmarchicus in the northern North Atlantic Ocean. Variability in the winter North Atlantic Oscillation index is related to changes in various physical and biological parameters across the entire North Atlantic, but the mechanisms underlying those relationships are not well known. Understanding basin-to-regional connections is important for interpreting patterns of variability observed on both sides of the Atlantic during the core GLOBEC study period (1993-1999) and from earlier observations, and inferring process, whether local or remote, from those observed patterns. The proposed research is focused on: (1) comparing and contrasting the impact of freshwater influx to the eastern and western sides of the North Atlantic, (2) understanding the development and maintenance of a possible three-gyre configuration of Calanus finmarchicus distribution in the North Atlantic, and (3) predicting the projected trends and variations in the North Atlantic Ocean based on IPCC projections for upcoming decades.

This project seeks a synthetic understanding of how basin- and global-scales changes in climate force physical processes that in turn determine local- and regional-scale biological communities, with a particular focus on freshwater forcing of circulation, mixing, and marine ecosystems within the North Atlantic Ocean. It is pan-regional in scope, building upon the successes of the U.S. GLOBEC program in the Western North Atlantic (and its other regions) to address climate variability issues spanning the entire northern North Atlantic Ocean. Its research approaches include: synthesis of datasets across the North Atlantic, multi-scale coupled physical/biological modeling, and comparative regional studies. In all these respects it responds directly to the U.S. GLOBEC Pan-Regional Synthesis Announcement of Opportunity.

Two graduate students will participate in this project. Results will be disseminated by peer-reviewed scientific publications, presentations at national conferences, and to other Pan-Regional GLOBEC investigators. Model output will be made available via the Rutgers OPeNDAP server. The investigators will give public lectures in Schools of Massachusetts, Maine and New Jersey on the importance of NAO and its impact on the regional ecosystem as part of an ongoing K-12 outreach program. The forecast scenarios for the next two decades will increase awareness of Climate Change. Dr. Fei Chai is a New Investigator to the GLOBEC program and will bring considerable expertise from his associations in the Pacific and in the Climate Change communities. Finally, this project sets the stage for post-GLOBEC end-to-end studies in the North Atlantic (e.g., the BASIN program).

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0815679
NSF Division of Ocean Sciences (NSF OCE)	OCE-1657853
National Oceanic and Atmospheric Administration (NOAA)	NOAA-NA11NOS0120038

[table of contents | back to top]