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A dataset of Oceanographic and biogeochemical anomalies in the Caribbean Sea.

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ABSTRACT

This article describes six ocean datasets consistent in anomalies of biogeochemical, physical, sea wave, biological, oceanic and chemical parameters (DACS-BGC, DACS-PHY, DACS-WAVE, DACS-BIO, DACS-OCE and DACS-CHEM) in several time scales from 3-hourly to monthly frequencies, either on the sea surface, downward/upward fluxes between the ocean and the atmosphere and the water column in the Caribbean basin (Gulf of Mexico, Caribbean Sea and Atlantic Ocean) in a geographical domain from latitudes 8 degrees to 35 degrees North and from longitudes 45 degrees to 100 degrees West, obtained, from several satellites, modeling services and observational programs. The datasets were created in NetCDF format conserving their original horizontal resolutions of 1.0, 0.5, 0.26, 0.08333 and 0.04 degrees in gridded structure; only the WAVEWATCH3 dataset has a non-uniform step in latitude and longitude. This internal data structure facilitates its handling due to a wide diversity of existent freeware tools, and it is mainly intended to support researchers to understand the evolution and cycles of physical, biogeochemical, chemical, sea wave, oceanic and biological parameters linked to global climate change.

Keywords: Anomaly databases; Physical parameters; Biogeochemical parameters; Surface forcing.

DATA IMPORTANCE

- This dataset is useful for oceanographers, meteorologists, marine biologists, marine chemists and ecologists for studying the behavior and seasonal variability of physical and biogeochemical parameters in the Caribbean Sea and adjacent seas.
- These data are stored in NetCDF format, which greatly facilitates their use, since they do not require any prior processing.
- Some data sets have a very high resolution, so they can be used to perform some local analysis on their monthly variability.

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MATERIALS AND METHODS

Anomaly datasets at the Caribbean Sea (including the Gulf of Mexico and the nearby Atlantic Ocean) were compiled from biogeochemical, physical, oceanic, sea wave, biological and chemical global datasets originated in several research centers, space missions, and ocean observation campaigns, which have been stored at the Department of Oceanography of the Federal University of Pernambuco, Recife, Brazil and organized with the assistance of the Marine Meteorology Center in the Institute of Meteorology of Cuba.

The dataset is unrestrictedly available to the public in the following services:

- The Mercator Ocean International Database, which groups a wide variety of biological, geological, and chemical data organized in self-descriptive files (NetCDF format);
- The MODIS chlor-a (Moderate Resolution Imaging Spectroradiometer) sensor based on the NASA Aqua satellite (MODIS-Aqua), which is used for detecting chlorophyll-a concentrations for ocean color;
- The Global Precipitation Climatology Project (GPCP) was established by the World Climate Research Program (WCRP) for quantifying the distribution of annual precipitation around the world;
- The MODIS Aqua and Terra Global Level 3 Mapped Thermal and Mid-IR SST products of sea surface temperature (SST) data, also derived from the NASA MODIS sensor on board of Aqua and Terra satellites;
- The NCEP/NCAR Reanalysis 1 project as an analysis/forecast system to perform data assimilation using past data from 1948 to the present, which is available from Physical Sciences Division (PSD) at NOAA in its original four times daily format and as daily averages;
- The WHOI (Woods Hole Oceanographic Institute) Objectively Analyzed Air-Sea Fluxes (OAFlux_V3) provided as daily 1° gridded global data of surface latent and sensible heat fluxes;
- The SMOS (Soil Moisture and Ocean Salinity) Mission managed by ESA through its Living Planet Program, in cooperation with CNES (France) and CDTI (Center for Technological and Industrial Development) in Madrid, Spain. This mission is dedicated to demonstrate the SSS observations (Sea Surface Salinity) over oceans and SM (Soil Moisture) over land to advance climatological, meteorological, hydrological and oceanographic applications;
- The SODA (Simple Ocean Data Assimilation) reanalysis model for ocean and sea ice, dedicated to reconstruct the historical physical (and eventually biogeochemical) history of the ocean since the beginning of the 20th century;
- The ocean wave model WAVEWATCH3 in its global version (multi_1.glo) run at NCEP (National Centers for Environmental Predictions) with a spatial resolution of 0.5 degrees;
- GLOBAL_MULTIYEAR_WAV_001_032, a product which was created by Mercator Ocean International (MOI) in 2019 and is available at Copernicus Marine Service website. This dataset is also known as WAVERYS, and has a temporal coverage from 1993-01-01 to present with spatial resolution of 0.2°. WAVERYS is based on the third generation Meteo France WAve Model (MFWAM) which takes into account SWH assimilated data from historical altimetry missions of ERS1, TOPEX/POSEIDON, ERS2, GFO, Jason-2 and 3, Envisat, Saral, Cryosat-2 and Sentinel-3A; Sentinel-3 and Sentinel-1-SAR spectra. Directional wave spectra were assimilated from Sentinel-1A and 1B Synthetic Aperture Radar (SAR) missions from 2017 onwards. The dataset is evaluated against the wave records of the HY-2B satellite. WAVERYS includes tri-hourly instantaneous fields of integrated wave parameters from the total

spectrum (significant height, period, direction and Stokes drift), as well as the following partitions: the wind wave, the primary and secondary swell waves (MOI, 2019b; LAW-CHUNE et al., 2021);

- Other multi-frequency anomaly files of biogeochemical parameters in the Caribbean Sea, calculated from the datasets MULTIOBS_GLO_BIO_BGC_3D_REP_015_010, GLOBAL_MULTIYEAR_BGC_001_033, MULTIOBS_GLO_BIO_CARBON_SURFACE_REP_015_008, and OCEANCOLOUR_GLO_CHL_L4_REP_OBSERVATIONS_009_082, also distributed by the Mercator Ocean International Database.

This information was compiled within the geographical dominium limited between the parallels 8 to 35°N and the meridians 45 to 100°W (Fig. 1), which may serve to perform a time series analysis for any point of interest. Figure 1 shows three red points located in the study region, in which the anomalies will be shown as an example of an analysis of the variability of some parameters (Fig. 2). Table 1 shows the geographical location of the points and their corresponding acronyms.

Figure 1.- Geographical location of the anomaly datasets that comprises the basin of Caribbean Sea, Gulf of Mexico and nearby Atlantic Ocean. Red points: YCP is Yucatan Canal Point at 85.11°W, 22.81°N, MRMP is Mississippi River Mouth Point at 89.02°W, 30.11°N and NGP is North Guantanamo Point at 74.32°W, 21.29°N (Table 1).

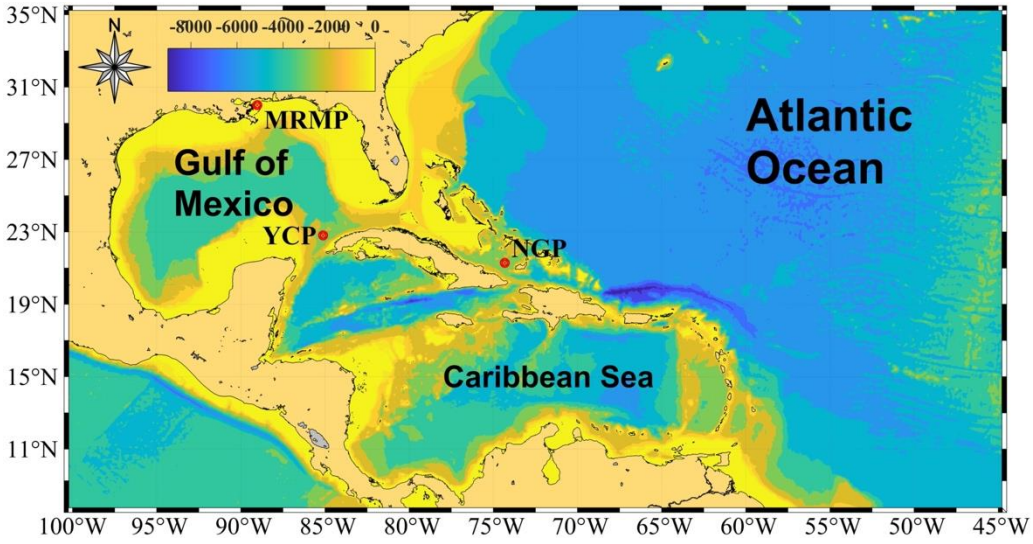
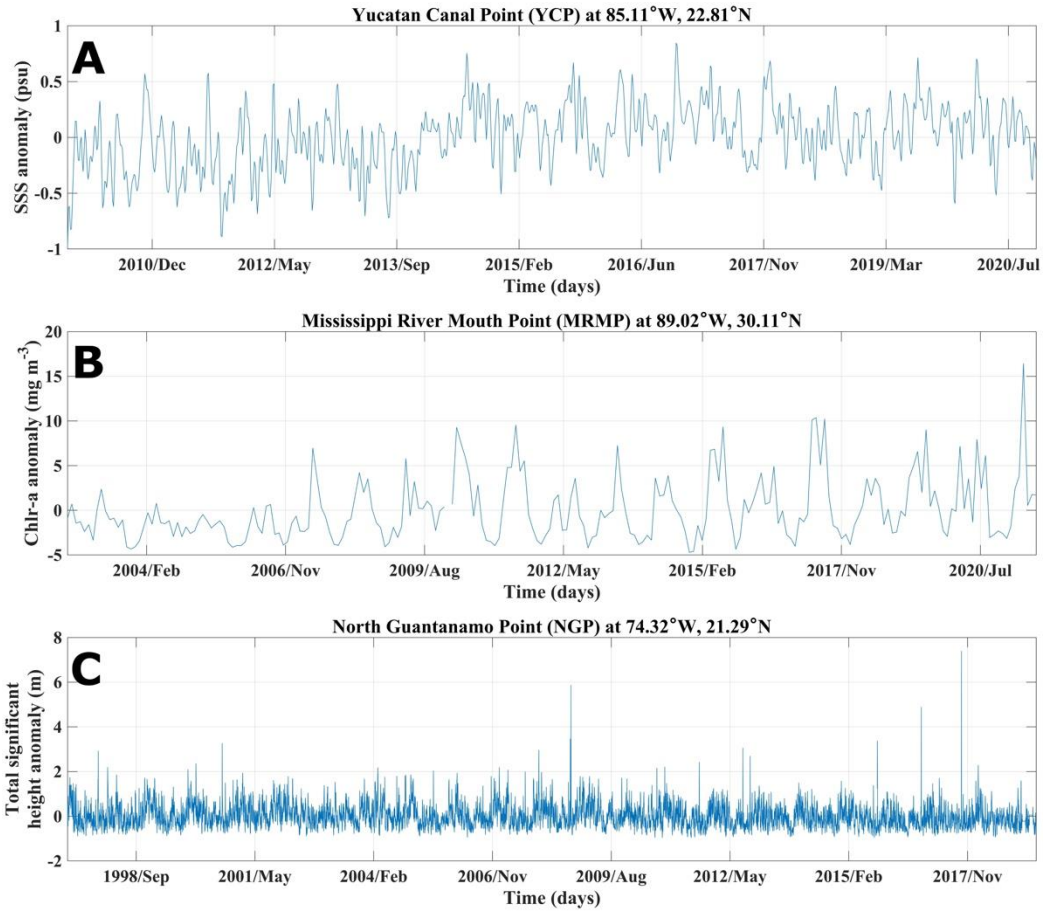


Table 1.- Geographical location of test points for time series analysis (see red points at Figure 1).

Point name	Acronym	Analyzed parameter	Geographical location
Yucatan Canal Point	YCP	Sea surface salinity	85.11°W, 22.81°N
Mississippi River Mouth Point	MRMP	Total chlorophyll-a mass concentration	89.02°W, 30.11°N
North Guantanamo Point	NGP	total significant wave height of wind waves and swells	74.32°W, 21.29°N

The anomalies of all the 38 physical and 16 biogeochemical parameters within these datasets were calculated and reduced to the above-mentioned limits. All the obtained files are in standard NetCDF format. The time reference of these datasets is marked on January 1 at 00:00:00, however, the beginning years have been 0001, 1901, 1950, 1970, or 1980. With respect to cell values, flags **missing_value** and **_Fillvalue** are represented in the metadata of each parameter by the NaN symbol (Not a Number) or numbers out of range, for example, 9999 and 9.96921e+36.

Figure 2.- Examples of anomalies time series analysis of A) Sea surface salinity (psu) at YCP, B) Total concentration of chlorophyll-a (mg/m-3) at MRMP obtained from MODIS-Aqua, and C) Significant wave height (m) at NGP.



All files were created with the Matlab® script set **mNC**, created by Varona (2021a) who considered maintaining the original global data resolution to construct the intra American seas domain with these Matlab® function griddata. Then, using the Matlab® script set CalcPlotAnomaly (VARONA, 2021b) data anomaly sets were calculated. Both sets of functions have also been used by Varona et al. (2022a,b).

The freeware programs **ncview** (visual browser for NetCDF, PIERCE, 2016), **ncdump** (Unidata's Utility for viewing the NetCDF file structure), **nco** (NetCDF operators, ZENDER, 2008), and **CDO** (Climate Data Operator, SCHULZWEIDA, 2006) were used for pre-and post-processing (metadata creation) of all datasets.

An example of a time series analysis is shown in Figure 2, which illustrates the behavior of anomalies for sea surface salinity at Yucatan Canal point (YCP), total chlorophyll-a mass concentration at Mississippi river mouth point (MRMP), and total significant wave height (wind waves and swells) in the North Guantanamo province (NGP).

The annual regime of sea surface salinity in the Yucatan canal shows maximal anomalies of about 0.5 psu from 2010 to 2014, and from this year on, a general trend toward increasing and maximal values over 0.5 psu can be noted; meanwhile, the behavior of total chlorophyll anomalies at the Mississippi river mouth shows a high variability between 2007 to 2016 with high peaks (more than 5 mg m^{-3}) followed by sharp drops. This high variability has been related to the annual and interannual Mississippi outflow changes, as the river plume, that is rich in nutrients and particulate components (e.g., SPM, POC, and particulate C/N), modulates the chlorophyll concentration in this area (GILBERT; LEE;

PODESTA, 1996; WYSOCKI et al. 2006; NABABAN et al., 2011).

On the other hand, the significant wave height shows a normal behavior of the anomaly, only altered by cold fronts and tropical cyclone impacts. In this case, wave height anomalies of 3.0 meters or more can be accounted for by a cold front in March 2000, in September 2008 by Hurricane Ike, in August 2012 by Tropical Storm Isaac, in October 2015 by Hurricane Joaquin, in October 2016 by Hurricane Matthew, and in September 2017 by Hurricane Irma.

DATA DESCRIPTION

Data are grouped in six datasets: Biogeochemical Parameter Anomalies Database in the Caribbean Sea (DACS-BGC), Physical Parameter Anomalies Database in the Caribbean Sea (DACS-PHY), Chemical Parameters Anomalies in the Caribbean Sea (DACS-CHEM), Biological Parameters Anomalies in the Caribbean Sea (DACS-BIO), Ocean Parameters Anomalies in the Caribbean Sea (DACS-OCE) and Wave Parameters Anomalies in the Caribbean Sea (DACS-WAVE).

The database of biogeochemical parameters was calculated from CO2 flux, GLOBAL_REANALYSIS_BIO_001_029 and MODIS Aqua chlor-a original datasets; database of physical parameters was derived from GPCP, MERRA2, MODIS Aqua/Terra level 3 Thermal, NCEP2, OAFLUX, SMOS, SODA; WAVEWATCH3 respective datasets; chemical parameters datasets were obtained from originals MULTIOBS_GLO_BIO_CARBON_SURFACE_REP_015_008 and MULTIOBS_GLO_BIO_BGC_3D_REP_015_010.

Other wave parameters were obtained from GLOBAL_MULTIYEAR_WAVE_001_032 (WAVERYS), while other biological, chemical and ocean parameters also could be obtained from MULTIOBS_GLO_BIO_BGC_3D_REP_015_010, as well as from GLOBAL_MULTIYEAR_BGC_001_033 and OCEANCOLOUR_GLO_CHL_L4_REP_OBSERVATIONS_009_082. Anomaly datasets presented here consist of 54 files of averaged data in NetCDF format, whose temporal resolution may be monthly, weekly, daily, every four days, six, or three-hourly, depending on the respective numeric model features (Table 2, in the appendices). Figures 3 and 4 show the file structure within databases.

Dataset

The structure shown in Figure 3 consists of three datasets of physical parameters that characterizes the horizontal flux intensities and directions either in the atmosphere and the ocean, vertical flux intensity between air and atmosphere, and horizontal distribution of temperature and sea surface salinity (SSS). Dataset of physical parameters are grouped in eight directories that include atmospheric and wave model outputs; the dataset of ocean parameters consists of six directories that groups result of several campaigns of satellite observations of winds, marine currents, sea surface temperature (SST), and other horizontal fluxes that have contributed to a data assimilation system, and wave dataset, whose source has been the Copernicus´ Marine Service from Mercator Ocean International Database.

It is important to note that every dataset, except SMOS, is more than 20 years long; moreover, the original spatial resolution of multi1.glo of WAVEWATCH3 GRIB-2 format was converted from 0.5-degree to 1.25×1.0 degree, to make it consistent with historical output from the model.

By the other hand, Figure 4 shows three datasets for biogeochemical (four directories), biological (four) and chemical (three) parameters, which characterizes the ocean water quality through chlorophyll-a and particulate carbon mass concentration, dissolved oxygen and carbon dioxide, acidity and presence of phyto and zooplankton, among others. These outputs were originated also at the Copernicus´ Marine Service,

which offers its results for the sea surface and for several depth levels.

Figure 3.- Organizational structure of the file distribution of physical parameters according to datasets.

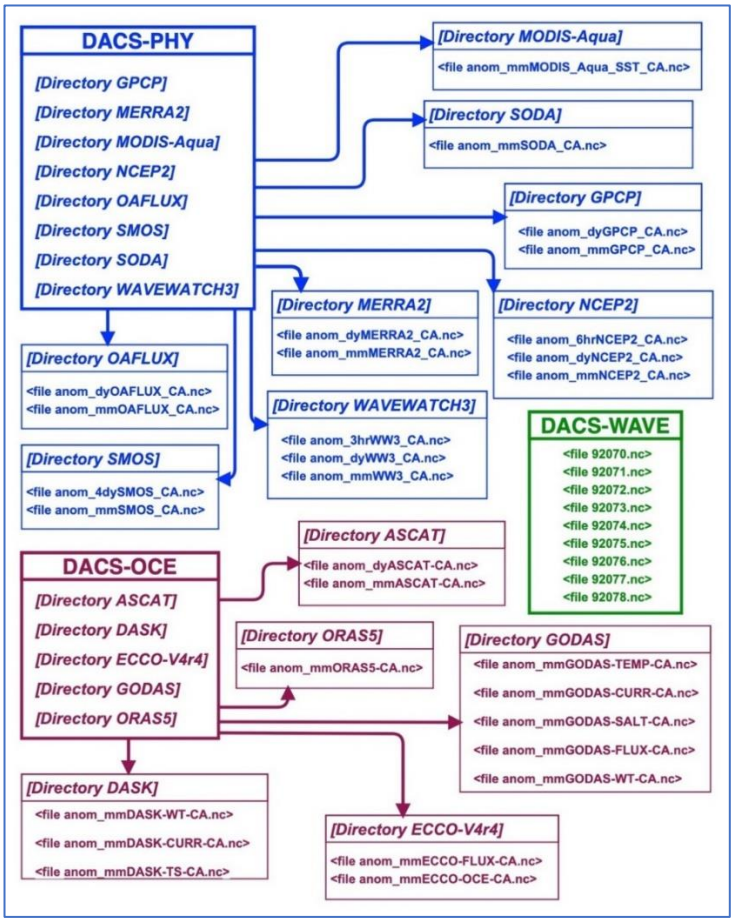
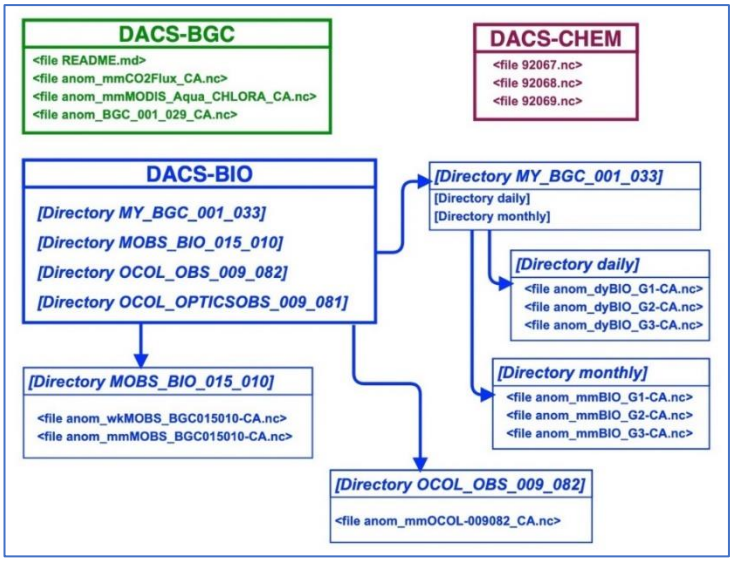


Figure 4.- Organizational structure of the file distribution of biogeochemical parameters according to datasets.



The NetCDF files are self-descriptive, so by reading the metadata in the structure of each file you can know the names of the parameters, their description, unit of measurement, as well as the time offset value, and the missing data value. Table 3 (in the appendices) shows parameters name, description, measure unit of each parameter, and corresponding dataset; however, some pairs of parameters are repeated in two different source datasets (see Table 4, in the appendices). Differences are given because of data spatial resolution, so the user should select the parameter according to its research outreach.

The DACS-PHY dataset covers 16 atmospheric and oceanic parameters in the Caribbean Sea, which are related to the exchange of energy and air mass between the atmosphere and the ocean. These parameters are the result of numerical model runs and satellite-based observation missions, resulting in long time series of more than 20 years, except for sea surface salinity (unbiased) by SMOS, whose time series is only 10 years long. The DACS-OCE dataset groups 13 ocean parameters in the Caribbean Sea, obtained from oceanic model runs, except ASCAT files that have been produced from satellite observations for showing gridded wind decomposed data. The results of these models also include results at the surface and various depth levels. In general, all the time series are more than 25 years long, with the files obtained from the DASK dataset being the longest since they started in 1947. Another important aspect is the large volume of information stored in anom_mmECCO-FLUX-CA.nc, consisting of 27 ocean variables, which characterize a wide variety of ocean fluxes in both vertical and horizontal directions.

The DACS-BIO dataset encompasses 19 redundant biological parameters to facilitate comparative studies of anomalies, according to different data sources for the Caribbean Sea and close areas (Fig. 1; Table 3, in the appendices). These parameters are distributed among different groups of pelagic organisms, mainly planktonic communities, for example, Phytoplankton, and Zooplankton from different sizes, groups, or depths. All biological parameters are represented by unit Mass (Biomass) in g m^{-2}, mg m^{-3}, or mg m^{-2}.

Phytoplankton are fundamental communities in the functioning of marine ecosystems that play a key role in the global carbon cycle, contributing to more than half of Earth's primary productivity. Alterations in phytoplankton community structure, resulting from the uniquely environmental sensitivities of these groups, can significantly change elemental cycling from locally to more global landscapes (LITCHMAN et al., 2015; FARIAS et al., 2022). Primary production plays a bottom-up control on marine ecosystems due to its key role in food webs, remineralization of organic particles, and climate control through CO_2 sequestration and cycling through the marine CO_2 pump (PAULY; CHRISTENSEN, 1995; LIU et al., 2021; SHIH et al., 2021), this production is limited by other parameters such as light, nutrient availability and suspended material in the water column such as POC, DOC, sediments, etc. Understanding the parameters involved in the primary productivity process is essential for understanding the ecology and ecosystem structure of the marine environment (TILSTONE et al., 2015; SHIH et al., 2021, ZHOU et al., 2020) These parameters on the DACS-BIO dataset are described as different groups of phytoplankton (NANO, PICO, PROKAR, DINO, DIATO, HAPTO, MICRO, and PROCHLO in Table 3, in the appendices), green algae (GREEN in Table 3, in the appendices) expressed as mg m^{-3} and Net primary productivity of biomass expressed as carbon in seawater (mg m^{-2}).

Particulate Organic Matter or POC is the organic matter resulting from primary production (as dead cells), organic detritus (partially decomposed), plant residues, organisms' carcasses, and other materials. Fluxes of POC transport carbon and other elements from the epipelagic zone to deeper waters, where photosynthesis does not happen (LEE; WAKEHAM; ARNOSTI, 2004). During the sinking, physical,

chemical, and biological processes act on dissolution, fragmentation, solubilization, and remineralization (STEMMANN; BOSS, 2012). Despite the loss, POC is still one of the main components of surface vertical energy flux to the sea bottom. This parameter in the DACS-BIO dataset is described as the Mass concentration of particulate organic matter expressed as carbon in seawater as poc (Table 3, in the appendices).

The Epipelagic Micronekton is a community represented by small pelagic fishes, crustaceans, and other invertebrate organisms. The importance of small pelagic fishes and crustaceans in transferring energy to top predators is well-recognized in marine ecosystems (PEREYRA; PEARCY; CARVEY, 1969; EDUARDO et al., 2021). For this reason, mnkc data (Table 3, in the appendices) expressed as wet weight in seawater may offer information about the first mass water epipelagic micronekton (mnkc_epi) or the subsurface mass water (200-1000 m) with information for different groups of mesopelagic micronekton (mnkc_hmlmeso, mnkc_lmeso, mnkc_umeso, mnkc_mumeso, mnkc_mlmeso (Table 3, in the appendices).

The Zooplankton community is represented by larvae (meroplankton) or holoplanktonic organisms in pelagic ecosystems. The community is represented by several larvae of animals like fishes, crustaceans, and other invertebrate organisms (LIRA et al., 2017; NEUMANN-LEITÃO et al., 2018; de SANTANA et al., 2020; MELO et al., 2020). The zooplankton plays a trophic link between the phytoplankton and large animal groups. In this way, zooplankton is an important parameter to understand the energy transfer in marine ecosystems. Zooplankton biomass in the DACS-BIO dataset is expressed as carbon (g m^{-2}, Table 3, in the appendices).

The DACS-BGC dataset includes 12 biogeochemical parameters to assist in comparative studies of anomalies in the Caribbean Sea region and adjacent areas (see Figure 1 and Table 3, in the appendices). This dataset includes parameters associated with the carbonate system (CO_2 fluxes and CO_2 partial pressure), pH, primary productivity, Chlorophyll, dissolved oxygen, phytoplankton, total primary production, and dissolved inorganic nutrients (nitrate, phosphate, silicate, iron). These parameters play a fundamental role in the global carbon cycle in the aquatic environment. Changes in the parameters of the carbonate system, primary productivity, and/or nutrients are indicative of changes in the balance of liquid metabolism in an ecosystem (productivity – respiration).

The DACS-CHEM dataset includes 5 chemical parameters linked to the organic matter and/or carbon cycle (POM, chlorophyll, pH, carbon dioxide flux, and partial pressure of CO_2 in water). As mentioned above, these parameters are key in comparative studies of anomalies related to changes in the balance between primary production and respiration in the aquatic system.

The DACS-WAVE is an anomaly dataset composed of 6 wave parameters in the Caribbean Sea with a temporal coverage from 1993-01-01 to 2020-12-31, the available wave parameters are significant wave height, peak wave period, swell height, swell period, wind wave height, and wind wave period. This product is the result of the computation of ocean wave parameter anomalies with tri-hourly, daily, and monthly frequencies from the WAVERYS model with a spatial resolution of 0.2°. Other existing sources were used to obtain the DACS-WAVE dataset, such as model output data, analysis, reanalysis, and satellite observed data, as well as the dataset with combined data sources.

The general information in these anomaly datasets refers to the behavior of physical and biogeochemical variables in the surface and deep ocean and in the top two meters of the atmosphere, while the specific information in these data emphasizes, for example, on the various organisms (from planktonic to benthic) that make up the food web in the ocean, the oceanic fluxes at various depth levels, the hydrological characteristics of the mixed ocean layer in terms of temperature, salinity, and

density, the variations in the carbon content in the ocean and its exchange with the atmosphere, among other variables. However, among these general and specific datasets, some datasets share similar variables, which can be seen in Table 4 (in the appendices).

This study produced a novel and unique dataset for the Caribbean Sea. It will be the basis for new suites of synoptic analyses and models for this key region.

SUPPLEMENTARY MATERIALS

Data have been deposited in recognized open repositories.

Title: Database of Anomalies in the Caribbean Sea (biogeochemical parameters): DACS-BGC.
Repository name: 4TU.ResearchData
DOI of the dataset: https://doi.org/10.4121/19093832.v1
Link to access the data:
https://data.4tu.nl/articles/dataset/Database_of_Anomalies_in_the_Caribbean_Sea_biogeochemical_parameters_DACS-BGC/19093832
Publication date: 2022-02-01

Title: Database of Anomalies in the Caribbean Sea (physical parameters): DACS-PHY.
Repository name: Science Data Bank
DOI of the dataset: https://www.doi.org/10.11922/sciencedb.01489
Link to access the data: https://www.scidb.cn/en/detail?dataSetId=ffbb77f735c64573a11bb25ee6381226
Publication date: 2022-02-13

Title: Database of Anomalies in the Caribbean Sea (ocean wave parameters): DACS-WAVE.
Repository name: SEANOE
DOI of the dataset: https://doi.org/10.17882/86637
Link to access the data: https://www.seanoe.org/data/00754/86637/
Publication date: 2022-03-07

Title: Database of Anomalies in the Caribbean Sea (ocean parameters): DACS-OCE.
Repository name: Science Data Bank
DOI of the dataset: https://www.doi.org/10.11922/sciencedb.01580
Link to access the data:
https://www.scidb.cn/en/detail?dataSetId=437086c0913745ad97076a0af58e938f
Publication date: 2022-03-14

Title: Database of Anomalies in the Caribbean Sea (geochemical parameters): DACS-CHEM.
Repository name: SEANOE
DOI of the dataset: https://doi.org/10.17882/86636
Link to access the data: https://www.seanoe.org/data/00754/86636/
Publication date: 2022-02-23

Title: Database of Anomalies in the Caribbean Sea (biological parameters): DACS-BIO.
Repository name: Science Data Bank

DOI of the dataset: https://www.doi.org/10.11922/sciencedb.01578
Link to access the data:
https://www.scidb.cn/en/detail?dataSetId=58c6175e20c54c66b84805421a2642fb
Publication date: 2022-03-20

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APPENDICES

Table 2.- Main characteristics of created datasets: DACS-BGC, DACS-PHY, DACS-CHEM, DACS-BIO, DACS-OCE, DACS-WAVE (physical and biogeochemical parameter anomalies database in the Caribbean Sea). (Continue)

Data source	Data type	Final dataset	Time range	Frequency	Resolution	Filenames
CO2 Flux (VALSALA; MAKSYUTOV, 2010; TAKAHASHI; SUTHERLAND; KOZYR, 2017)	Reanalysis (assimilated in-situ data)	DACS-BGC	Jan. 1980 to Dec. 2009	Monthly means	1.0°	anom_mmCO2Flux_CA.nc
GLOBAL_REANALYSIS_BIO_001_029 (MOI, 2018; PERRUCHE, 2018)	Reanalysis	DACS-BGC	Jan. 1993 to Dec. 2020	Monthly means	0.25°	anom_BGC_001_029_CA.nc
MODIS_Aqua_chlor-a (NASA, 2014)	Observed (Satellite)	DACS-BGC	Aug. 2002 to Sep. 2021	Monthly means	0.0416667°	anom_mmMODIS_Aqua_CHLORA_CA.nc
GPCP (ADLER et al., 2003)	Reanalysis (Assimilating the combination of precipitation available from different satellite sources)	DACS-PHY	Oct. 1996 to Oct. 2020	Daily means Monthly means	1.0°	anom_dyGPCP_CA.nc anom_mmGPCP_CA.nc
MERRA2 (GELARO et al., 2017)	Reanalysis	DACS-PHY	Jan. 1980 to Jan. 2020	Daily means Monthly means	0.5°	anom_dyMERRA2_CA.nc anom_mmMERRA2_CA.nc
MODIS- Aqua/Terra level 3 Thermal (WALTON et a., 1998; BROWN; MINNETT, 1999)	Observed (Satellite)	DACS-PHY	Aug. 2002 to Sep. 2021	Monthly means	0.0416667°	anom_mmMODIS_Aqua_SST_CA.nc

Table 2.- Main characteristics of created datasets: DACS-BGC, DACS-PHY, DACS-CHEM, DACS-BIO, DACS-OCE, DACS-WAVE (physical and biogeochemical parameter anomalies database in the Caribbean Sea). (Continued)

Data source	Data type	Final dataset	Time range	Frequency	Resolution	Filenames
NCEP2 (KALNAY et al., 1996)	Reanalysis	DACS-PHY	Jan. 1948 to Dec. 2021	6 hours means Daily means Monthly means	2.5°	anom_6hrNCEP2_CA.nc anom_dyNCEP2_CA.nc anom_mmNCEP2_CA.nc
OAFLUX (only evaporation, YU; JIN.; WELLER, 2008)	Integrates satellite observations with surface moorings, ship reports, and atmospheric model reanalyzed surface	DACS-PHY	Jan. 1985 to Jun. 2019	Daily means Monthly means	1.0°	anom_dyOAFLUX_CA.nc anom_mmOAFLUX_CA.nc
SMOS (KERR et al., 2001)	Observed (Satellite)	DACS-PHY	Jan. 2010 to Dec. 2020	4 days means Monthly means	0.259366°	anom_4dySMOS_CA.nc anom_mmSMOS_CA.nc
SODA (CARTON; GIESE, 2008)	Reanalysis	DACS-PHY	Jan. 1980 to Dec. 2017	Monthly means	0.5°	anom_mmSODA_CA.nc
WAVEWATCH3 (TOLMAN, 2009)	Reanalysis	DACS-PHY	Jan. 1997 to May. 2019	3 hours means Daily means Monthly means	1.25° × 1.0°	anom_3hrWW3_CA.nc anom_dyWW3_CA.nc anom_mmWW3_CA.nc
MULTIOBS_GLO_BIO_CARBON_SURFACE_REP_015_008 (MOI, 2019a; CHAU; GEHLEN; CHEVALLIER, 2020)	Reprocessed satellite observations	DACS-CHEM	Jan. 1985 to Dec. 2020	Monthly means	1°	92069.nc

Table 2.-Main characteristics of created datasets: DACS-BGC, DACS-PHY, DACS-CHEM, DACS-BIO, DACS-OCE, DACS-WAVE (physical and biogeochemical parameter anomalies database in the Caribbean Sea). (Continued)

Data source	Data type	Final dataset	Time range	Frequency	Resolution	Filenames
MULTIOBS_GLO_BIO_BGC_3D_REP_015_010 (MOI, 2020; SAUZEDE; RENOSH; CLAUSTRE, 2021)	Reprocessed satellite observations	DACS-CHEM	Jan. 1998 to Dec. 2019	Weekly means	0.25°	92068.nc
				Monthly means		92067.nc
WAVERYS - GLOBAL_MULTIYEAR_WAV_001_032 (MOI, 2019b)	Reanalysis (Assimilated satellite data)	DACS-WAVE	Jan. 1993 to Dec. 2020	3 hourly means	0.2°	92070.nc 92071.nc 92072.nc
				Daily means		92073.nc 92074.nc 92075.nc
				Monthly means		92076.nc 92077.nc 92078.nc
GLOBAL_MULTIYEAR_BGC_001_033 (MOI, 2021; TITAUD; CONCHON; LEHODEY, 2019)	Reanalysis	DACS-BIO	Jan. 1998 to Dec. 2019	Daily means	0.083333°	anom_dyBIO_G1-CA.nc anom_dyBIO_G2-CA.nc anom_dyBIO_G3-CA.nc
				Monthly means		anom_mmBIO_G1-CA.nc anom_mmBIO_G2-CA.nc anom_mmBIO_G3-CA.nc
MULTIOBS_GLO_BIO_BGC_3D_REP_015_010 (MOI, 2020)	Reprocessed satellite observations	DACS-BIO	Jan. 1998 to Dec. 2019	Weekly	0.25°	anom_wkMOBS-BGC015010-CA.nc
				Monthly		anom_mmMOBS-BGC015010-CA.nc

Table 2.- Main characteristics of created datasets: DACS-BGC, DACS-PHY, DACS-CHEM, DACS-BIO, DACS-OCE, DACS-WAVE (physical and biogeochemical parameter anomalies database in the Caribbean Sea). (Conclusion)

Data source	Data type	Final dataset	Time range	Frequency	Resolution	Filenames
OCEANCOLOUR_GLO_CHL_L4_REP_OBSERVATIONS_009_082 (MOI, 2016)	Reprocessed satellite observations	DACS-BIO	Jul. 2007 to Jun. 2021	Monthly	0.0416667°	anom_mmOCOL-009082-CA.nc
ASCAT (BENTAMY; FILLON, 2011)	Satellite observations	DACS-OCE	Mar. 2007 to Dec. 2021	Daily Monthly	0.25°	anom_dyASCAT-CA.nc anom_mmASCAT-CA.nc
DASK (KIM; HWANG; CHOI, 2015)	Reanalysis	DACS-OCE	Jan. 1947 to Dec. 2012	Monthly	1 x ~1°	anom_mmDASK-WT-CA.nc anom_mmDASK-CURR-CA.nc anom_mmDASK-TS-CA.nc
ECCO-V4r4 (FORGET et al., 2015; WANG et al., 2020)	Reanalysis	DACS-OCE	Jan. 1992 to Nov. 2017	Monthly	0.5°	anom_mmECCO-OCE-CA.nc anom_mmECCO-FLUX-CA.nc
GODAS (BEHRINGER, 2007)	Reanalysis	DACS-OCE	Jan. 1980 to Oct. 2021	Monthly	1 x 0.333°	anom_mmGODAS-CURR-CA.nc anom_mmGODAS-SALT-CA.nc anom_mmGODAS-TEMP-CA.nc anom_mmGODAS-WT-CA.nc anom_mmGODAS-FLUX-CA.nc
ORA-S5 (ZUO et al., 2019)	Reanalysis	DACS-OCE	Jan. 1979 to Dec. 2018	Monthly	1°	anom_mmORAS5-CA.nc

Table 3.- Description of parameters in anomaly databases for the Caribbean Sea. DACS-BGC (biogeochemical), DACS-PHY (physical), DACS-CHEM (chemical) DACS-BIO (biological) and DACS-WAVE (sea wave). (Continue)

Parameter name	Description	Unit	Dataset
co2	CO_2 flux	mole/m^2/sec	DACS-BGC
spco2	Surface CO_2 partial pressure	Pa	DACS-BGC
o2	Dissolved Oxygen mole concentration	mmol/m^3	DACS-BGC
chl	Total Chlorophyll mass concentration	mg/m^3	DACS-BGC
no3	Nitrate mole concentration	mmol/m^3	DACS-BGC
po4	Phosphate mole concentration	mmol/m^3	DACS-BGC
phyc	Total Phytoplankton mole concentration	mmol/m^3	DACS-BGC
Si	Dissolved Silicate mole concentration	mmol/m^3	DACS-BGC
ph	pH	1	DACS-BGC
nppv	Total Primary Production of Phyto (biomass) expressed as carbon per unit volume	mg/m^3/day	DACS-BGC
fe	Dissolved Iron mole concentration	mmol/m^3	DACS-BGC
chlor	Chlorophyll concentration, OCI algorithm	mg/m^3	DACS-BGC
precip	Daily precipitation rate	mm/day	DACS-PHY
lwgab	Downward (absorbed) longwave flux	w/m^2	DACS-PHY
qv2m	2m air humidity	kg/kg	DACS-PHY
rainocn	precipitation over the ocean	kg/m^2/s	DACS-PHY
slp	Atmospheric sea level pressure	Pa	DACS-PHY
swgdn	Downward shortwave flux	w/m^2	DACS-PHY
t2m	Air temperature at 2 m	°C	DACS-PHY
u10m	Zonal wind speed at 10 m	m/s	DACS-PHY
v10m	Meridional wind speed at 10 m	m/s	DACS-PHY
day_sst	Daily sea surface temperature	°C	DACS-PHY
night_sst	Nightly sea surface temperature	°C	DACS-PHY
sst	Sea surface temperature	°C	DACS-PHY
air	Air temperature	°K	DACS-PHY
omega	Vertical velocity	Pa/s	DACS-PHY
rhum	Relative humidity	%	DACS-PHY
uwnd	Zonal wind velocity	m/s	DACS-PHY
vwnd	Meridional wind velocity	m/s	DACS-PHY
evapr	Daily mean evaporation rate	cm/yr	DACS-PHY
SSS	Unbiased Sea Surface Salinity	pss	DACS-PHY

Table 3.- Description of parameters in anomaly databases for the Caribbean Sea. DACS-BGC (biogeochemical), DACS-PHY (physical), DACS-CHEM (chemical) DACS-BIO (biological) and DACS-WAVE (sea wave). (Continued)

Parameter name	Description	Unit	Dataset
temp	Sea water potential temperature	°C	DACS-PHY
salt	Sea water salinity	psu	DACS-PHY
Wt	Vertical velocity of the ocean current	m/s	DACS-PHY
ssh	Sea surface height above geoid	m	DACS-PHY
mlt	Mixed layer depth determined by temperature criteria	m	DACS-PHY
mlp	Depth of potential density mixed layer	m	DACS-PHY
mls	Mixed layer depth determined by salinity criteria	m	DACS-PHY
net_heating	Surface ocean heat flux coming through coupler and mass transfer	$Watts/m^2$	DACS-PHY
prho	Potential density referenced to 0 dbar	Kg/m^3	DACS-PHY
u	Zonal component of current velocity	m/s	DACS-PHY
v	Meridional component of current velocity	m/s	DACS-PHY
taux	Zonal wind stress component (downward)	N/m^2	DACS-PHY
tauy	Meridional wind stress component (downward)	N/m^2	DACS-PHY
perpwsfc	Surface primary wave mean period	s	DACS-PHY
htsgwsfc	Surface significant wave height of wind waves and swell	m	DACS-PHY
mnkc_epi	Mass content of epipelagic micronekton expressed as wet weight in seawater	$g\ m^{-2}$	DACS-BIO
mnkc_hmlmeso	Mass content of highly migrant lower mesopelagic micronekton expressed as wet weight in seawater	$g\ m^{-2}$	DACS-BIO
mnkc_lmeso	Mass content of lower mesopelagic micronekton expressed as wet weight in seawater	$g\ m^{-2}$	DACS-BIO
mnkc_umeso	Mass content of upper mesopelagic micronekton expressed as wet weight in seawater	$g\ m^{-2}$	DACS-BIO
mnkc_mumeso	Mass content of migrant upper mesopelagic micronekton expressed as wet weight in seawater	$g\ m^{-2}$	DACS-BIO
mnkc_mlmeso	Mass content of migrant lower mesopelagic micronekton expressed as wet weight in seawater	$g\ m^{-2}$	DACS-BIO
zooc	Mass content of zooplankton expressed as carbon in seawater	$g\ m^{-2}$	DACS-BIO
zeu	Euphotic zone depth	m	DACS-BIO
npp	Net primary productivity of biomass expressed as carbon in seawater	$mg\ m^{-2}\ day^{-1}$	DACS-BIO
poc	Mass concentration of particulate organic matter expressed as carbon in seawater	$mg\ m^{-3}$	DACS-BIO
NANO	Mass concentration of nanophytoplankton expressed as chlorophyll in seawater	$mg\ m^{-3}$	DACS-BIO

Table 3.- Description of parameters in anomaly databases for the Caribbean Sea. DACS-BGC (biogeochemical), DACS-PHY (physical), DACS-CHEM (chemical) DACS-BIO (biological) and DACS-WAVE (sea wave). (Continued)

Parameter name	Description	Unit	Dataset
PICO	Mass concentration of picophytoplankton expressed as chlorophyll in seawater	mg m^{-3}	DACS-BIO
PROKAR	Mass concentration of prokaryotes expressed as chlorophyll in seawater	mg m^{-3}	DACS-BIO
DINO	Mass concentration of dinophytes expressed as chlorophyll in seawater	mg m^{-3}	DACS-BIO
DIATO	Mass concentration of diatoms expressed as chlorophyll in seawater	mg m^{-3}	DACS-BIO
HAPTO	Mass concentration of haptophytes expressed as chlorophyll in seawater	mg m^{-3}	DACS-BIO
MICRO	Mass concentration of microphytoplankton expressed as chlorophyll in seawater	mg m^{-3}	DACS-BIO
GREEN	Mass concentration of greenalgae expressed as chlorophyll in seawater	mg m^{-3}	DACS-BIO
PROCHLO	Mass concentration of prochlorophytes expressed as chlorophyll in seawater	mg m^{-3}	DACS-BIO
poc	Mass concentration of particulate organic matter expressed as carbon in seawater	mg m^{-3}	DACS-CHEM
chl	Mass concentration of chlorophyll-a in seawater	mg m^{-3}	DACS-CHEM
spco2	Surface partial pressure of carbon dioxide in seawater	Pa	DACS-CHEM
fgco2	Surface downward mass flux of carbon dioxide expressed as carbon	Kg m^{-2} s^{-1}	DACS-CHEM
ph	Seawater pH reported on total scale	1	DACS-CHEM
VHM0_SW1	Sea surface primary swell wave significant height	m	DACS-WAVE
VTM01_SW1	Sea surface primary swell wave mean period	s	DACS-WAVE
VTPK	Wave period at spectral peak. Peak period	s	DACS-WAVE
VHM0	Spectral significant wave height	m	DACS-WAVE
VHM0_WW	Sea surface wind wave significant height	m	DACS-WAVE
VTM01_WW	Sea surface wind wave mean period	s	DACS-WAVE
dbssbitl	bottom ocn isothermal layer geometric depth below sea surface	m	DACS-OCE
dbssbmxl	bottom ocn mixed layer geometric depth below sea surface	m	DACS-OCE
sltflsfc	salt flux at surface	$g/cm^2/s$	DACS-OCE
sshgsfc	sea surface height relative to geoid		DACS-OCE
thflxsfc	total downward heat flux at surface (downward is positive)	w/m^2	DACS-OCE

Table 3.- Description of parameters in anomaly databases for the Caribbean Sea. DACS-BGC (biogeochemical), DACS-PHY (physical), DACS-CHEM (chemical) DACS-BIO (biological) and DACS-WAVE (sea wave). (Continued)

Parameter name	Description	Unit	Dataset
uwnd	eastward wind speed	m/s	DACS-OCE
vwnd	northward wind speed	m/s	DACS-OCE
wsp	wind speed	m/s	DACS-OCE
saltydsl	(profile) salinity	kg/kg	DACS-OCE
potdsl	(profile) potential temperature	°K	DACS-OCE
dzdtdsl	(profile) geometric vertical velocity	m/s	DACS-OCE
vomecrtn	meridional current	m/s	DACS-OCE
votemper	potential temperature	°C	DACS-OCE
vosaline	salinity	psu	DACS-OCE
sossheig	sea surface height	m	DACS-OCE
vozocrte	zonal current	m/s	DACS-OCE
exfevap	evaporation, > 0 increases salinity	m/s	DACS-OCE
exfewind	eastward 10-m wind velocity over open water, >0 increases evel	m/s	DACS-OCE
exfhl	latent heat flux into ocean, >0 increases theta	w/m^2	DACS-OCE
exfhs	sensible heat flux into ocean, >0 increases theta	w/m^2	DACS-OCE
exflwdn	downward longwave radiation, >0 increases theta	w/m^2	DACS-OCE
exflwnet	net upward longwave radiation, >0 decreases theta	w/m^2	DACS-OCE
exfnwind	northward 10-m wind velocity over open water, >0 increases nvel	m/s	DACS-OCE
exfpreci	precipitation, > 0 decreases salinity	m/s	DACS-OCE
exfpress	atmospheric pressure field	n/m^2	DACS-OCE
exfqnet	net upward heat flux (turb+rad), >0 decreases theta	w/m^2	DACS-OCE
exfroff	river runoff, > 0 decreases salinity	m/m	DACS-OCE
exfswdn	downward shortwave radiation, >0 increases theta	w/m^2	DACS-OCE
exfswnet	net upward shortwave radiation, >0 decreases theta	w/m^2	DACS-OCE
exftaue	eastward surface wind stress over open water, >0 increases evel	n/m^2	DACS-OCE
exftaun	northward surf. wind stress over open water, >0 increases nvel	n/m^2	DACS-OCE
exfwspee	10-m wind speed modulus (>= 0)	m/s	DACS-OCE
mxldepth	mixed-layer depth (>0)	m	DACS-OCE
sflux	total salt flux (match salt-content variations), >0 increases salt	$g/m^2/s$	DACS-OCE

Table 3.- Description of parameters in anomaly databases for the Caribbean Sea. DACS-BGC (biogeochemical), DACS-PHY (physical), DACS-CHEM (chemical) DACS-BIO (biological) and DACS-WAVE (sea wave). (Continued)

Parameter name	Description	Unit	Dataset
siatmfw	net freshwater flux from atmosphere & land (+=down)	$kg/m^2/s$	DACS-OCE
siatmqnt	net atmospheric heat flux, >0 decreases theta	w/m^2	DACS-OCE
ssh	surface height anomaly adjusted with global steric height change and sea-ice load	m	DACS-OCE
tflux	total heat flux (match heat-content variations), >0 increases theta	w/m^2	DACS-OCE
ocefwflx	net surface fresh-water flux into the ocean (+=down), >0 decreases salinity	$kg/m^2/s$	DACS-OCE
oceqnet	net surface heat flux into the ocean (+=down), >0 increases theta	w/m^2	DACS-OCE
oceqsw	net short-wave radiation (+=down), >0 increases theta	w/m^2	DACS-OCE
ocespdep	salt plume depth based on density criterion (>0)	m	DACS-OCE
ocespflx	net surface salt flux rejected into the ocean during freezing, (+=down)	$kg/m^2/s$	DACS-OCE
evel	eastward component of velocity	m/s	DACS-OCE
nvel	northward component of velocity	m/s	DACS-OCE
salt	salinity	psu	DACS-OCE
theta	potential temperature	°C	DACS-OCE
uvel	x-comp of velocity (not necessary eastward)	m/s	DACS-OCE
vvel	y-comp of velocity (not necessary northward)	m/s	DACS-OCE
u	i-current	m/s	DACS-OCE
v	j-current	m/s	DACS-OCE
sfc_hflux_pme	heat flux (relative to 0c) from pme transfer of water across ocean surface	w/m^2	DACS-OCE
river	mass flux of river (runoff + calving) entering ocean	$kg/m^3*m/s$	DACS-OCE
mld	mixed layer depth determined by density criteria	m	DACS-OCE
pme	net (precip-evap)(kg/(m2*sec) into ocean, divided by 1035kg/m3	m/s	DACS-OCE
temp	potential temperature	°C	DACS-OCE
wt	dia-surface velocity t-points	m/s	DACS-OCE
uogrddsl	(profile) u-component of current	m/s	DACS-OCE
uflxsfc	surface zonal momentum flux	n/m^2	DACS-OCE
vogrddsl	(profile) v-component of current	m/s	DACS-OCE
vflxsfc	surface meridional momentum flux	n/m^2	DACS-OCE

Table 4.- Similar parameters based on their source dataset. (Continue)

Similar parameters	Filename	Source datasets	Final datasets
chl	anom_BGC_001_029_CA.nc	GLOBAL_REANALYISIS_BIO_001_029	DACS-BGC
chlor	anom_mmMODIS_Aqua_CHLORA_CA.nc	MODIS Aqua chlor-a	DACS-BGC
chl	92068.nc 92067.nc	MULTIOBS_GLO_BIO_BGC_3D_REP_015_010	DACS-CHEM
spco2	anom_BGC_001_029_CA.nc	GLOBAL_REANALYSIS_BIO_001_029	DACS-BCG
spco2	92069.nc	MULTIOBS_GLO_BIO_CARBON_SURFACE_REP_015_008	DACS-CHEM
ph	anom_BGC_001_029_CA.nc	GLOBAL_REANALYSIS_BIO_001_029	DACS-BGC
ph	92069.nc	MULTIOBS_GLO_BIO_CARBON_SURFACE_REP_015_008	DACS-CHEM
nppv	anom_BGC_001_029_CA.nc	GLOBAL_REANALYSIS_BIO_001_029	DACS-BGC
npp	anom_dyBIO_G3-CA.nc anom_mmBIO_G3-CA.nc	GLOBAL_MULTIYEAR_BGC_001_033	DACS-BIO
poc	92067.nc 92068.nc	MULTIOBS_GLO_BIO_BGC_3D_REP_015_010	DACS-CHEM
poc	anom_wkBIO_BGC015010-CA.nc anom_mmBIO_BGC015_010-CA.nc	MULTIOBS_GLO_BIO_BGC_3D_REP_015_010	DACS-BIO
lwgab	anom_dyMERRA2_CA.nc anom_mmMERRA2_CA.nc	MERRA2	DACS-PHY
exflwdn	anom_mmECCO-FLUX-CA.nc	ECCO-V4r4	DACS-OCE
swgdn	anom_dyMERRA2_CA.nc anom_mmMERRA2_CA.nc	MERRA2	DACS-PHY
exfswdn	anom_mmECCO-FLUX-CA.nc	ECCO-V4r4	DACS-OCE
u10m	anom_dyMERRA2_CA.nc anom_mmMERRA2_CA.nc	MERRA2	DACS-PHY
uwnd	anom_6hrNCEP2_CA.nc anom_dyNCEP2_CA.nc anom_mmNCEP2_CA.nc	NCEP2	DACS-PHY
uwnd	anom_dyASCAT-CA anom_mmASCAT-CA	ASCAT	DACS-OCE
v10m	anom_dyMERRA2_CA.nc anom_mmMERRA2_CA.nc	MERRA2	DACS-PHY
vwnd	anom_6hrNCEP2_CA.nc anom_dyNCEP2_CA.nc anom_mmNCEP2_CA.nc	NCEP2	DACS-PHY
vwnd	anom_dyASCAT-CA anom_mmASCAT-CA	ASCAT	DACS_OCE
t2m	anom_dyMERRA2_CA.nc anom_mmMERRA2_CA.nc	MERRA2	DACS-PHY
air	anom_6hrNCEP2_CA.nc anom_dyNCEP2_CA.nc anom_mmNCEP2_CA.nc	NCEP2	DACS-PHY
sst	anom_mmMODIS_Aqua_SST_CA.nc	MODIS Aqua/Terra level 3 Thermal	DACS-PHY
temp	anom_mmSODA_CA.nc	SODA	DACS-PHY

Table 4.- Similar parameters based on their source dataset. (Conclusion)

Similar parameters	Filename	Source datasets	Final datasets
ssh	anom_mmSODA_CA.nc	SODA	DACS-PHY
sshgsfc	anom_mmGODAS-FLUX-CA.nc	GODAS	DACS-OCE
mlt	anom_mmSODA_CA.nc	SODA	DACS-PHY
mls	anom_mmSODA_CA.nc	SODA	DACS-PHY
mlp	anom_mmSODA_CA.nc	SODA	DACS-PHY
mxldepth	anom_mmECCO-FLUX-CA.nc	ECCO-V4r4	DACS-OCE
mld	anom_mmECCO-FLUX-CA.nc	ECCO-V4r4	DACS-OCE
SSS	anom_4dySMOS_CA.nc anom_mmSMOS_CA.nc	SMOS	DACS-PHY
salt	anom_mmSODA_CA.nc	SODA	DACS-PHY
taux	anom_mmSODA_CA.nc	SODA	DACS-PHY
exftaue	anom_mmECCO-FLUX-CA.nc	ECCO-V4r4	DACS-OCE
tauy	anom_mmSODA_CA.nc	SODA	DACS-PHY
exftaun	anom_mmECCO-FLUX-CA.nc	ECCO-V4r4	DACS-OCE
perpwsfc	anom_3hrWW3_CA.nc anom_dyWW3_CA.nc anom_mmWW3_CA.nc	WAVEWATCH3	DACS-PHY
VTPK	92071.nc	WAVERYS - GLOBAL_MULTIYEAR_WAV_001_032	DACS-WAVE
htsgwsfc	anom_3hrWW3_CA.nc anom_dyWW3_CA.nc anom_mmWW3_CA.nc	WAVEWATCH3	DACS-PHY
VHM0	92074.nc 92077.nc	WAVERYS - GLOBAL_MULTIYEAR_WAV_001_032	DACS-WAVE