The ECCO Data Specification (ECCO) v4r4 User Guide

The "Estimating the Circulation and Climate of the Ocean" Team

April 2025

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The ECCO Data Specification (EDS)

EDS Technical Specifications

Compiled by
the ECCO Science Team 2025

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1 The ECCO Science Team 2025

The ECCO Science team is a Consortium that is comprised of an international group of scientists across several institutions. The goal is to make the best possible estimates of ocean circulation and climate. Indeed, the ECCO products (state estimates) are multi-platform, multi-instrument synthesis products that integrate ocean and ice observations and models. ECCO science groups are listed below:

Responsible for production of ECCO's central multi-decadal state estimate. Also developing estimation systems for ocean-ice interaction and global eddy-resolving models for ECCO's next generation estimate (Visit the JPL website).

Name	Institution
Ian G. Fenty	NASA Jet Propulsion Laboratory, USA
Ichiro Fukumori	NSAS Jet Propulsion Laboratory, USA
Tong (Tony) Lee	NSAS Jet Propulsion Laboratory, USA
Dimitris Menemenlis	NSAS Jet Propulsion Laboratory, USA
Ou Wang	NSAS Jet Propulsion Laboratory, USA
Hong Zhang	NSAS Jet Propulsion Laboratory, USA

Responsible for MITgcm, the ocean general circulation model employed in all ECCO products (Visit the MIT website).

Name	Institution
Jean-Michel Campin	Massachusetts Institute of Technology
Gael Forget	Massachusetts Institute of Technology
Chris Hill	Massachusetts Institute of Technology
Diana Spiegel	Massachusetts Institute of Technology
Carl Wunsch	Massachusetts Institute of Technology

Responsible for ECCO adjoint model infrastructure. Also leading development of ocean-ice sheet parameterization and high-resolution estimation (Visit the Oden Institute website at the University of Texas at Austin).

Name	Institution
Patrick Heimbach	University of Texas at Austin, USA
An T. Nguyen	University of Texas at Austin, USA
Helen Pillar	University of Texas at Austin, USA
David Trossman	University of Texas at Austin, USA
Nora Loose	University of Texas at Austin, USA
Tim Smith	University of Texas at Austin, USA
Ivana Escobar Casterlin	University of Texas at Austin, USA

Responsible for development of new data sets and physics packages for the ECCO estimates. Also involved in assessing data and solution uncertainties and developing diagnostic tools for scientific analyses (Visit the Atmospheric and Environmental Research, Inc. website).

Name	Institution
Mengnan Zhao	Atmospheric and Environmental Research, Inc, USA
Qiang Sun	Atmospheric and Environmental Research, Inc, USA
Rui M. Ponte	Atmospheric and Environmental Research, Inc, USA

Leads development of regional high resolution estimation systems, including biogeochemistry (Southern Ocean [SOSE], California Current System, Equatorial Pacific, Gulf of Mexico) (Visit the UC, San Diego website).

Name	Institution
Bruce Cornuelle	UC, San Diego, USA
Ganesh Gopalakrishnan	UC, San Diego, USA
Matt Mazloff	UC, San Diego, USA
Heriberto Vazquez Peralta	UC, San Diego, USA
Ariane Verdy	UC, San Diego, USA

Leads development of the global-ocean ECCO-Darwin biogeochemistry model.(Visit the San José State University Moss Landing Marine Laboratories website).

Name	Institution
Dustin Carroll	UC, San Diego, USA

Leads development of 50+ year global ocean state estimation for studying longer-term climate variability and change [GECCO] (Visit the University of Hamburg, Germany website).

Name	Institution
Chevaly Albert Fernandez	University of Hamburg, Germany
Armin Köhl	University of Hamburg, Germany
Goukun Lyu	University of Hamburg, Germany
Yulia Polkova	University of Hamburg, Germany
Nuno Serra	University of Hamburg, Germany
Detlef Stammer	University of Hamburg, Germany

Other institutions and team members involded in ECCO Science development:

Name	Institution
Martin Losch	Alfred-Wegener-Institut (AWI), Germany
Nils Hutter	Alfred-Wegener-Institut (AWI), Germany
Madlen Kimmritz	Alfred-Wegener-Institut (AWI), Germany
Geoffrey (Jake) Gebbie	Woods Hole Oceanographic Institution, USA
Christopher Piecuch	Woods Hole Oceanographic Institution, USA

2 Executive Summary

The ECCO Version 4 Release 4 (V4r4) products are comprehensive global ocean and sea-ice state estimates spanning from 1992 to 2018. These datasets are dynamically and kinematically consistent reconstructions of the three-dimensional, time-evolving ocean, sea-ice, and surface atmospheric states. They include a wide range of variables such as temperature, salinity, velocity, sea level anomalies, and fluxes (e.g., heat, freshwater, and salt). The data are available at daily, monthly, and instantaneous intervals on both the high-resolution LLC90 grid and a 0.5-degree interpolated grid. The datasets adhere to modern metadata standards and are formatted in netCDF-4 (and may be available in other data format such as Zarr data format) for accessibility via NASA's Earthdata Cloud infrastructure (PO.DAAC-NASA).
The key features of ECCO V4r4 include its ability to assimilate diverse observational datasets from satellites and in situ measurements using the MIT general circulation model (MITgcm). This allows for accurate representation of global ocean dynamics and climate processes. The release also introduces advanced cloud-native services for efficient data access and processing. These products are essential for studying ocean circulation, climate variability, sea-level changes, and freshwater fluxes on a global scale.
This user guide document first provides the scope and the key overall content of the present document, then an overview of ECCO data products (Level 4) followed by detailed technical specifications of dataset filename, file structure and supporting configuration. Finaly, a full description of grid geometry, the coordinates and the data variables for both native lat-lon-cap 90 (llc90), latlon 0.5-degree and 1D datasets are provided with example of each of them.

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6 Acryonyms and abbreviation list

AA	Associate Administrator
ACDC	Architecture Configuration and Design Constraints
ADD	Architecture Definition Document
AE	Ascent Element
AES	Advanced Exploration Systems
AESB	Aeronautics and Space Engineering Board
APMC	Agency Program Management Council
ASAP	Agency (Aeronautics) Safety Assessment Panel
BAA	Broad Agency Announcement
CAD	Computer-Aided Design
CCB	Configuration Control Board
CCBD	Configuration Control Board Directive
CDM	Configuration and Data Management
CDMP	Configuration and Data Management Plan
CHP	Crew Health and Performance
CI	Configuration Item
CLPS	Commercial Lunar Payload Services
CLV	Commercial Launch Vehicle
CM	Configuration Management
CMRD	Configuration Management Receipt Desk
CMW	Change Management Workflow
CPE	Change Package Engineer
CPM	Change Package Manager
CR	Change Request
CSA	Configuration Status Accounting
CSA	Canadian Space Agency
CSCI	Computer Software Configuration Item
CY	Calendar Year
ConOps	Concept of Operations
DAA	Deputy Associate Administrator
DAC	Design Analysis Cycle
DCR	Design Certification Review
DE	Descent Element
DIMA	Distributed Integrated Modular Avionics
DM	Data Management
DOF	Degree of Freedom
DPMC	Directorate Program Management Council
DQA	Data Quality Assurance
DRD	Data Requirements Description
DSN	Deep Space Network
EAR	Export Administration Requirements
ECLSS	Environmental Control and Life Support System
ECM	Exploration Command Module
ECR	Export Control Representative
EGS	Exploration Ground Systems
ESA	European Space Agency
ESD	Exploration Systems Development
ET	Event Tracker
EUS	Exploration Upper Stage
EVA	Extra-Vehicular Activity

EVR	Extra-Vehicular Robotics
FAQ	Freqently Asked Question
FCA	Functional Configuration Audit
FOD	Flight Operations
FW	Forward Work
GAO	Government Accountability Office
GDSS	Gateway Docking System Specification
GEO	Geostationary Earth Orbit
GN&C	Guidance Navigation and Control
GPCB	Gateway Program Control Board
GSCB	Gateway Systems Engineering and Integration Con...
GVCB	Gateway Vehicle Integration Control Board
HALO	Habitation and Logistics Outpost
HCB	Human Landing Systems Control Board
HEO	Human Exploration & Operations
HEOMD	Human Exploration & Operations Mission Directorate
HHP	Human Health & Performance
HLS	Human Landing Systems
IAC	Integrated Analysis Cycle
ICD	Interface Control Document
ICE	Integrated Collaborative Environment
ICPS	Interim Cryogenic Propulsion Stage
IDS	Integrated Data System

7 Scope and Content of this Document

This document has been developed to provide guidance to ECCO V4r4 data users for easily navigating the list of available datasets. It offers an overview of the ECCO V4r4 datasets, including the data storage format, filename conventions, supporting metadata conventions, and the structure of data product files.
Descriptions are provided for NetCDF data files, including global attributes, dimensions, coordinates, and variable metadata. Additionally, detailed descriptions are included for each ECCO V4r4 dataset: the native Lat-Lon-Cap 90 (LLC90) grid, the regular 0.5-degree latitude-longitude grid, and the one-dimensional dataset. Grid geometry details are also provided for both the native LLC90 grid and the 0.5-degree latitude-longitude grid configurations. Illustrative figures accompany each section to enhance understanding.

8 Overview of ECCO Data

ECCO (Estimating the Circulation and Climate of the Ocean) is a NASA-led initiative creating detailed, physically consistent reconstructions of Earth's ocean and sea-ice systems since 1992. Its version 4 release 4 (V4r4) represents the most advanced synthesis of satellite data, in-situ measurements (like Argo floats), and MIT's ocean/sea-ice model to produce a "digital replica" of marine environments. Unlike conventional ocean models, ECCO strictly adheres to conservation laws of physics while assimilating billions of observations. Indeed, the ECCO V4r4 data products provide a dynamically and kinematically consistent global reconstruction of the ocean, sea-ice, and surface atmospheric states from 1992 to 2018. These datasets include daily, monthly, and instantaneous time intervals and are available on two primary grids: the native Lat-Lon-Cap 90 (LLC90) grid and a 0.5°latitude-longitude interpolated grid.

The LLC90 grid is a curvilinear Cartesian grid with five faces, including a latitude-longitude grid between 70°S and 57°N and an Arctic cap. It features varying resolutions (22–110 km horizontally) and 50 vertical levels, with finer resolution at higher latitudes. The LLC90 grid configurations offer a unique cubed-sphere design in the northern hemisphere and a dipolar arrangement in the southern hemisphere, with an Arctic "cap" north of 57°N. Its geometry includes 13 tiles of 90x90 cells each, with detailed geometric parameters like cell areas, side lengths, rotation angles, bathymetry, and land/ocean masks. This design enables accurate modeling of global ocean dynamics while accommodating complex geometries like the Arctic cap. The interpolated grid (0.5°latitude-longitude grid) offers user-friendly access for daily or monthly averages, but is less suitable for budget closure analyses. The datasets cover a wide range of parameters, such as temperature, salinity, velocity, fluxes, sea level anomalies, and sea-ice properties.

The V4r4 data are formatted in netCDF-4 and adhere to CF 1.8 and ACDD 1.3 metadata standards. Accessible through NASA's Earthdata Cloud infrastructure, these datasets are optimized for cloud-native workflows via APIs like Harmony for conversion to formats like Zarr. This comprehensive framework supports diverse applications in oceanography, climate studies, and Earth system modeling. Note that NASA's Earthdata enables efficient access of the ECCO V4r4 via HTTPS or AWS S3 services.

8.1 Why trust ECCO?

The ECCO ocean and sea-ice state estimation system is a mathematically rigorous, mature, state-of-the-art data tool for synthesizing NASA's diverse Earth system observations – especially remote sensing data – into a complete and physically-consistent description of the three-dimensional time-varying global ocean and sea-ice state. So,

ECCO:

- Eliminates Unrealistic "Jumps" in Data
- Can Be Run Forward & Backwards
- Is Constrained by Billions of Data Points
- Fills in the Gaps of Sparse Ocean Database
- Provides a "Climate Change Assessment" Toolkit
- Helps Understand Impacts on Ocean Ecosystems
- Reveals Coastal Transformation in Our Warming Climate

8.2 Why Choose ECCO Over Alternatives?

ECCO's cloud-native architecture allows direct access to 3TB+ data via NASA Earthdata Cloud, with tools for format conversion and subsetting. This makes it uniquely suited for researchers needing physically rigorous, observationally grounded reconstructions of ocean-climate interactions.

Feature	ECCO Advantage
Physical Consistency	Perfectly satisfies thermodynamics laws vs. statistical approximations in traditional reanalyses
Time Flexibility	Can analyze causes/effects backward/forward in time (e.g., tracing sea level rise origins)
Data Integration	Synthesizes 300M+ satellite observations and 1B+ in-situ measurements into unified framework
Application Range	Used for climate studies, marine biology (habitat modeling), coastal flood prediction, and sensor placement optimization

9 ECCO Data Filenames and Supporting Conventions

ECCO Version 4 Release 4 (V4r4) follows a structured filename convention to organize its extensive datasets. The filenames encode essential information about the dataset's content, grid type, temporal resolution, and version. Below is an overview of the naming convention.

9.1 General filename Structure

For ECCO dataset product files:

```
[ShortName]_[TemporalResolution]_[Indicative Time]_ECCO_[Version]_[GridType].<File Type>
```

For ECCO data geometry and grid files:

```
[ShortName]_ECCO_[Version]_[GridType].<File Type>
```

Keypoins	Description
ShortName:	Describes the dataset variable (e.g., SSH for sea surface height, TEMP_SALINITY for temperature and salinity).
TemporalResolution:	Indicates the time averaging or snapshot type (e.g., DAILY, MONTHLY, SNAP).
GridType :	Specifies the grid used (e.g., **native_llc90** for the native ECCO grid or **laton_0p50deg** for interpolated 0.5 °lat-lon grid). It can also be a specific information such as **1D** to indication the one-dimentional dataset files over the full period of ECCO data availability.
Version:	Identifies the ECCO release version (e.g., V4r4).
Indicative Time:	Encodes the time period covered by the file (e.g., monthly files use YYYY-MM, daily files use YYYY-MM-DD)
File Type	netCDF or Zarr data format.

9.2 Examples

Daily atmosphere surface temperature, humidity, winds, and pressure on the lat-lon-cap 90 (llc90) native model grid (first) and on the interpolated regular 0.5-degree lat-lon grid (second) from ECCO V4r4 on 2017-12-29.

- ATM_SURFACE_TEMP_HUM_WIND_PRES_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc
- ATM_SURFACE_TEMP_HUM_WIND_PRES_day_mean_2017-12-29_ECCO_V4r4_latlon_0p50deg.nc

Dynamic sea surface height interpolated on the latlon regular 0.5-degree model grid from ECCO V4r4 on 2017-12-29.

- SEA_SURFACE_HEIGHT_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

One-dimentional field of global mean atmospheric surface pressure over the ocean and sea-ice fromthe ECCO V4r4.

- GLOBAL_MEAN_ATM_SURFACE_PRES_snap_ECCO_V4r4_1D.nc

Geometric parameters for the regular 0.5-degree lat-lon grid from ECCO V4r4.

- GRID_GEOMETRY_ECCO_V4r4_latlon_0p50deg.nc

10 ECCO Data Product File Structure

10.1 Overview of the ECCO Data netCDF File Format

ECCO data files preferentially use the **netCDF-4** format. These ECCO formatted data comply with the Climate and Forecast (CF) Conventions, because these conventions provide a practical standard for storing oceanographic data in a robust, easily-preserved for the long-term, and interoperable manner. The CF-compliant netCDF data format is flexible, self-describing, and has been adopted as a de facto standard for many operational and scientific oceanography systems. Both netCDF and CF are actively maintained including significant discussions and inputs from the oceanographic community (see http://cfpcmdi.llnl.gov/discussion/index_html). The CF convention generalizes and extends the Cooperative Ocean/Atmosphere Research Data Service (COARDS) Convention but relaxes the COARDS constraints on dimension order and specifies methods for reducing the size of datasets. The purpose of the CF Conventions is to require conforming datasets to contain sufficient metadata so that they are self-describing, in the sense that each variable in the file has an associated description of what it represents, physical units if appropriate, and that each value can be located in space (relative to earthbased coordinates) and time. In addition to the CF Conventions, ECCO formatted files follow some of the recommendations of the Unidata Attribute Convention for Dataset Discovery.

In the context of netCDF, a variable refers to data stored in the file as a vector or as a multidimensional array. Within the netCDF file, global attributes are used to hold information that applies to the whole file, such as the data set title. Each individual variable has its own attributes, referred to as variable attributes. These variable attributes define, for example, an axis, long_name, standard_name, units, a descriptive version of the variable name, and a fill value (if apply), which is used to indicate array elements that do not contain valid data.

Overall, the ECCO netCDF files are structured in five (5) blocks:

- Dimensions
- Coordinates (non-dimension coordinate)
- Data variables
- Global Attributes

10.2 ECCO netCFD Global Attributes

The globale attributes used in the ECCO V4r4 data netCDF files are listed in the table below.

Table 10.1: Global Attributes used in ECCO V4r4 data netCDF files

Attribute Name	Format	Description	Source
Conventions	string	A text string identifying the netCDF conventions followed. This attribute should be set to the version of CF used and should also include the ACDD. For example: 'CF-1.4, Unidata Observation Dataset v1.0'.	CF
acknowledgement	string	Information about funding source and how to cite the use of these data.	ACDD
author	TBD	TBD	TBD
cdm_data_type	string	The data type, as derived from Unidata's Common Data Model Scientific Data types and understood by THREDDS. This is a THREDDS 'dataType', and is different from the CF NetCDF attribute 'featureType', which indicates a Discrete Sampling Geometry file in CF. For ECCO, it is 'grid'.	ACDD
comment	string	Miscellaneous information about the data or methods used to produce it.	CF, ACDD

Table 10.1: Global Attributes used in ECCO V4r4 data netCDF files

coordinates_comment	TBD	TBD	TBD
creator_email	string	Provide an email address for the most relevant point of contact at the producing RDAC relevant to this data set.	ACDD
creator_institution	TBD	TBD	TBD
creator_name	string	Provide a name for the most relevant point of contact at the producing RDAC relevant to this data set.	ACDD
creator_type	TBD	TBD	TBD
creator_url	string	Provide a URL address relevant to this data set.	ACDD
date_created	string	The date and time the data file was created in the form "YYYY-MM-DDThh:mm:ssZ". This time format is ISO 8601 compliant.	ACDD
date_issued	TBD	TBD	TBD
date_metadata_modified	TBD	TBD	TBD
date_modified	TBD	TBD	TBD
geospatial_bounds_crs	TBD	TBD	TBD
geospatial_lat_max	TBD	TBD	TBD
geospatial_lat_min	TBD	TBD	TBD
geospatial_lat_resolution	float	Latitude Resolution in units matching 'geospatial_lat_units'.	ACDD
geospatial_lat_units	string	Units of the latitudinal resolution. Typically 'degrees_north'.	ACDD
geospatial_lon_max	TBD	TBD	TBD
geospatial_lon_min	TBD	TBD	TBD
geospatial_lon_resolution	float	Longitude Resolution in units matching 'geospatial_lon_resolution'.	ACDD
geospatial_lon_units	string	Units of the longitudinal resolution. Typically 'degrees_east'.	ACDD
geospatial_vertical_max	TBD	TBD	TBD
geospatial_vertical_min	TBD	TBD	TBD
geospatial_vertical_positive	TBD	TBD	TBD
geospatial_vertical_resolution	TBD	TBD	TBD
geospatial_vertical_units	TBD	TBD	TBD
history	string	History of all applications that have modified the original data to create this file.	CF, ACDD
id	string	The unique ECCO character string for this product.	ACDD
institution	string	ECCO code or institution where the data were produced.	CF, ACDD
instrument_vocabulary	TBD	TBD	TBD
keywords	string	A comma-separated list of key words and/or phrases	ACDD
keywords_vocabulary	string	Unique name or identifier of the vocabulary from which keywords are taken. f more than one keyword vocabulary is used, each may be presented with a prefix and a following comma, so that keywords may optionally be prefixed with the controlled vocabulary key.	ACDD
license	string	Provide the URL to a standard or specific license, enter 'Public Domain', 'Freely Distributed' or 'None', or describe any restrictions to data access and distribution in free text	ACDD
metadata_link	string	Link to collection metadata record at archive	ACDD
naming_authority	string	The organization that provides the initial 'id' for the dataset. The naming authority is uniquely specified by this attribute	ACDD

Table 10.1: Global Attributes used in ECCO V4r4 data netCDF files

platform	string	Satellite(s) used to create this data file. Select from the entries found in the Satellite Platform and provide as a comma separated list if there is more than one.	GDS
platform_vocabulary	TBD	TBD	TBD
processing_level	string	A textual description of the processing (or quality control) level of the data. For ECCO, it is level 4 (L4)	ACDD, GDS
product_name	TBD	TBD	TBD
product_time_coverage_end	TBD	TBD	TBD
product_time_coverage_start	TBD	TBD	TBD
product_version	string	The product version of this data file, which may be different than the file version used in the file naming convention	GDS
program	TBD	TBD	TBD
project	string	The name of the project(s) principally responsible for originating this data	ACDD
publisher_email	string	The email address of the person (or other entity specified by the publisher_type attribute) responsible for publishing the data file or product to users, with its current metadata and format. For ECCO, it is: podaac@podaac.jpl.nasa.gov	ACDD
publisher_institution	TBD	TBD	TBD
publisher_name	string	The name of the person (or other entity specified by the publisher_type attribute) responsible for publishing the data file or product to users, with its current metadata and format.	ACDD
publisher_type	TBD	TBD	TBD
publisher_url	string	The URL of the person (or other entity specified by the publisher_type attribute) responsible for publishing the data file or product to users, with its current metadata and format. For ECCO, it is : https://podaac.jpl.nasa.gov	ACDD
references	string	Published or web-based references that describe the data or methods used to produce it.	CF
source	string	Comma separated list of all source data present in this file. Provides the method of production of the original data in detail with the model and its version, as specifically as could be useful.	CF
standard_name_vocabulary	string	The name and version of the controlled vocabulary from which variable standard names are taken. Values for any standard_name attribute must come from the CF Standard Names vocabulary for the data file or product to comply with CF.	ACDD
summary	string	A paragraph describing the dataset.	ACDD
time_coverage_duration	TBD	TBD	TBD
time_coverage_end	string	Identical to 'stop_time'. Included for increased ACDD compliance.	ACDD
time_coverage_resolution	TBD	TBD	TBD
time_coverage_start	string	Identical to 'start_time'. Included for increased ACDD compliance.	ACDD
title	string	A descriptive title for the ECCO data set	CF, ACDD

Table 10.1: Global Attributes used in ECCO V4r4 data netCDF files

uuid	string	A Universally Unique Identifier (UUID). Numerous, simple tools can be used to create a UUID, which is inserted as the value of this attribute. See http://en.wikipedia.org/wiki/Universally_Unique_I dentifier for more information and tools.	ACDD

10.3 ECCO Data netCFD Coordinates, Dimensions and Variabiles Attributes

The attributes of the ECCO V4r4 data Coordinates, Dimensions and Variabiles used in the netCDF files are listed in the table below.

Table 10.2: Coordinates, Dimensions and Variables Attributes used in ECCO V4r4 data netCDF files

Attribute Name	Format	Description	Source
axis	string	For use with coordinate variables only. The attribute 'axis' may be attached to a coordinate variable and given one of the values 'X', 'Y', 'Z', or 'T', which stand for a longitude, latitude, vertical, or time axis respectively.	CF
bounds	TBD	TBD	TBD
c_grid_axis_shift	TBD	TBD	TBD
comment	string	Miscellaneous information about the variable or the methods used to produce it.	CF
coordinate	TBD	TBD	TBD
coverage_content_type	TBD	TBD	TBD
direction	TBD	TBD	TBD
long_name	string	A free-text descriptive variable name.	CF, ACDD
mate	TBD	TBD	TBD
positive	string	For use with a vertical coordinate variables only. May have the value 'up' or 'down'. For example, if an oceanographic netCDF file encodes the depth of the surface as 0 and the depth of 1000 meters as 1000 then the axis would set positive to 'down'. If a depth of 1000 meters was encoded as -1000, then positive would be set to 'up'.	CF
standard_name	string	Provides a standard and unique description of a physical quantity. The standard name table can be found at http://cfpcmdi.llnl.gov/documents/cf-standard-names/standard-name-table/11/standard-name-table.	CF, ACDD
swap_dim	TBD	TBD	TBD
units	string	Text description of the units, preferably S.I., and must be compatible with the Unidata UDUNITS-2 package [AD-5]. For a given variable (e.g. wind speed), these must be the same for each dataset. Required for the majority of variables except mask, quality_level, and l2p_flags.	CF, ACDD
valid_max	Expressed in same data type as variable	Maximum valid value for this variable once they are packed (in storage type). The fill value should be outside this valid range. Note that some netCDF readers are unable to cope with signed bytes and may, in these cases, report valid min as 127. Required for all variables except variable time.	CF

Table 10.2: Coordinates, Dimensions and Variables Attributes used in ECCO V4r4 data netCDF files

valid_min	Expressed in same data type as variable	Minimum valid value for this variable once they are packed (in storage type). The fill value should be outside this valid range. Note that some netCDF readers are unable to cope with signed bytes and may, in these cases, report valid min as 129. Some cases as unsigned bytes 0 to 255. Values outside of 'valid_min' and 'valid_max' will be treated as missing values. Required for all variables except variable time.	CF

10.4 ECCO Data netCDF Dimensions definition

From the Climate and Forecast (CF) metadata conventions, the dimensions of the variable define the axes of the quantity it contains. Dimensions other than those of space and time may be included. Across all ot the ECCO V4r4 data netCDF files, at least 12 dimensions can be identified (see table below). Note that **nv** is not a spatial or temporal dimension per se. It is a kind of dummy dimension of length 2 for the coordiante **time_bnds** which has both a starting and ending time for each one averaging period. The same is true of **nb** which has length 4 and is used by **XC_bnds** and **YC_bnds** to store coordinates for the 4 corners of each tracer grid cell (more details in the followings sections).

Table 10.3: Dimensions used in used in ECCO V4r4 data netCDF files

Name	Length	Description
i	90	grid index in x for variables at tracer and 'v' locations
i_g	90	grid index in x for variables at 'u' and 'g' locations
j	90	grid index in y for variables at tracer and 'u' locations
j_g	90	grid index in y for variables at 'v' and 'g' locations
k	50	grid index in z for tracer variables
k_u	50	grid index in z corresponding to the bottom face of tracer grid cells ('w' locations)
k_l	50	grid index in z corresponding to the top face of tracer grid cells ('w' locations)
k_p1	51	grid index in z for variables at 'w' locations
tile	13	lat-lon-cap tile index
nb	4	It is a kind of dummy dimension of length 4 and is used by XC_bnds and YC_bnds to store coordinates for the 4 corners of each tracer grid cell.
nv	2	It is a kind of dummy dimension of length 2 for the coordiante time_bnds which has both a starting and ending time for each one averaging period.
time	Depend on the data frequence: SANP, AVG_DAY or AVG_MON	indicates the center time of the averaging period
latitude	360	latitude at grid cell center
longitude	720	longitude at grid cell center
Z	50	depth of grid cell center

Nate that (i, j, k, tile, time) are centered dimension coordinates while i_g, j_g, k_l and k_u are not centered.

10.5 ECCO Data netCDF Coordinates variabile definition

The so-called non-dimension coordinates: i- are variables that (may) contain coordinate data, but are not a dimension coordinate; ii- they can be multidimensional and there is no relationship between the name of a non-dimension coordinate and the name(s) of its dimension(s); iii- can be useful for indexing or plotting ... Table below provides a list of unique coordinates used in ECCO V4r4 data.

Table 10.4: Coordinates used in used in ECCO V4r4 data netCDF files

Name	Dims	Description	Units
XC	('tile', 'j', 'i')	longitude of tracer grid cell center	degrees_east
YC	('tile', 'j', 'i')	latitude of tracer grid cell center	degrees_north
XG	('tile', 'j_g', 'i_g')	longitude of 'southwest' corner of tracer grid cell	degrees_east
YG	('tile', 'j_g', 'i_g')	latitude of 'southwest' corner of tracer grid cell	degrees_north
Zp1	('k_p1',)	depth of tracer grid cell interface	m
Zu	('k_u',)	depth of the bottom face of tracer grid cells	m
Zl	('k_l',)	depth of the top face of tracer grid cells	m
XC_bnds	('tile', 'j', 'i', 'nb')	longitudes of tracer grid cell corners	–none–
YC_bnds	('tile', 'j', 'i', 'nb')	latitudes of tracer grid cell corners	–none–
Z_bnds	('Z', 'nv')	depths of grid cell upper and lower interfaces	–none–
time_bnds	('time', 'nv')	time bounds of averaging period	–none–
latitude_bnds	('latitude', 'nv')	latitudes of grid cell edges	–none–
longitude_bnds	('longitude', 'nv')	longitudes of grid cell edges	–none–

Regular latitude/logitude grids

This is for the regular interpolated latlon grid of the ECCO V4r4 dataset geographic localization of each variabile. On such a projection, only two coordinate variables are requested and they are stored as vector arrays. Longitudes range from -180 to +180, corresponding to 180 degrees West to 180 degrees East. Latitudes range from -90 to +90, corresponding to 90 degrees South to 90 degrees North. See example of CDL display in the table below.

Non-regular latitude/longitude grids

The ECCO V4r4 uses the Lat-Lon-Cap 90 (LLC90) grid, a native specialized global grid designed for ocean and sea-ice modeling. The LLC90 grid divides the globe into five faces, with dimensions: 1- [90x270], 2- [90x270], 3- [90x90], 4- [270x90], and 5- [270x90]. Each face consists of 90x90 tiles, hence the name LLC90. LLC90 grid combines a latitude-longitude grid between 70°S and 57°N with an Arctic "cap" in the northern hemisphere to handle polar regions effectively. The horizontal resolution varies spatially from about 22 km in high latitudes to 110 km in mid-latitudes. Redarding the vertical and horizontal resolutions, the grid has 50 vertical levels, with spacing increasing from 10 m near the surface to 457 m near the ocean bottom, which is set at a maximum depth of 6145 m. The Cartesian coordinates (x, y) are locally oriented within each tile, which may differ from traditional longitude-latitude directions. Diagnostic outputs include both native (UVEL, VVEL) and conventional (EVEL, NVEL) velocity components for ease of analysis. The datasets include geometric details such as cell areas, side lengths, rotation angles, bathymetry, and land/ocean masks. LLC90 grid geometric parameters are essential for accurate modeling and budget calculations. The LLC90 grid is particularly suited for global ocean circulation studies due to its efficient handling of polar regions and its variable resolution that balances computational efficiency with detail where needed.

10.6 Example of ECCO V4r4 netCDF latlon grid datasets

Table 10.5: Example CDL description of latlon dataset

```
netcdf latlon example
dimensions
time = 1
latitude = 360
longitude = 720
nv = 2
coordinates
    int32 time (time)
        time:axis = "T"
        time:bounds = "time_bnds"
        time:coverage_content_type = "coordinate"
        time:long_name = "center time of averaging period"
        time:standard_name = "time"
        time:units = "hours since 1992-01-01T12:00:00"
        time:calendar = "proleptic_gregorian"
    float32 latitude (latitude)
        latitude:axis = "Y"
        latitude:bounds = "latitude_bnds"
        latitude:comment = "uniform grid spacing from -89.75 to 89.75 by 0.5"
        latitude:coverage_content_type = "coordinate"
        latitude:long_name = "latitude at grid cell center"
        latitude:standard_name = "latitude"
        latitude:units = "degrees_north"
    float32 longitude (longitude)
        longitude:axis = "X"
        longitude:bounds = "longitude_bnds"
        longitude:comment = "uniform grid spacing from -179.75 to 179.75 by 0.5"
        longitude:coverage_content_type = "coordinate"
        longitude:long_name = "longitude at grid cell center"
        longitude:standard_name = "longitude"
        longitude:units = "degrees_east"
    int32 time_bnds (time, nv)
        time_bnds:comment = "Start and end times of averaging period."
        time_bnds:coverage_content_type = "coordinate"
        time_bnds:long_name = "time bounds of averaging period"
    float32 latitude_bnds (latitude, nv)
        latitude_bnds:coverage_content_type = "coordinate"
        latitude_bnds:long_name = "latitude bounds grid cells"
    float32 longitude_bnds (longitude, nv)
        longitude_bnds:coverage_content_type = "coordinate"
        longitude_bnds:long_name = "longitude bounds grid cells"
data variables
    float32 MXLDEPTH (time, latitude, longitude)
        MXLDEPTH:_FillValue = "9.969209968386869e+36"
        MXLDEPTH:coverage_content_type = "modelResult"
        MXLDEPTH:long_name = "Mixed-layer depth diagnosed using the temperature difference criterion of Kara
et al., 2000"
        MXLDEPTH:standard_name = "ocean_mixed_layer_thickness"
        MXLDEPTH:units = "m"
```

Table 10.5: Example CDL description of latlon dataset

```
        MXLDEPTH:comment = "Mixed-layer depth as determined by the depth where waters are first 0.8 degrees Celsius colder than the surface. See Kara et al. (JGR, 2000). . Note: the Kara et al. criterion may not be appropriate for some applications. If needed, mixed layer depth can be calculated using different criteria. See vertical density stratification (DRHODR) and density anomaly (RHOAnoma)."
        MXLDEPTH:coordinates = "time"
        MXLDEPTH:valid_min = "5.000001430511475"
        MXLDEPTH:valid_max = "5331.2001953125"
```

10.7 Example of ECCO V4r4 netCDF native llc90 grid datasets

Table 10.6: Example CDL description of native dataset

netcdf native example dimensions
i = 90 i_g = 90 j = 90 j_g = 90 k = 50 k_u = 50 k_l = 50 k_p1 = 51 tile = 13 nb = 4 nv = 2
coordinates
int32 i (i) i:axis = "X" i:long_name = "grid index in x for variables at tracer and 'v' locations" i:swap_dim = "XC" i:comment = "In the Arakawa C-grid system, tracer (e.g., THETA) and 'v' variables (e.g., VVEL) have the same x coordinate on the model grid." i:coverage_content_type = "coordinate" int32 i_g (i_g) i_g:axis = "X" i_g:long_name = "grid index in x for variables at 'u' and 'g' locations" i_g:c_grid_axis_shift = "-0.5" i_g:swap_dim = "XG" i_g:comment = "In the Arakawa C-grid system, 'u' (e.g., UVEL) and 'g' variables (e.g., XG) have the same x coordinate on the model grid." i_g:coverage_content_type = "coordinate" int32 j (j) j:axis = "Y" j:long_name = "grid index in y for variables at tracer and 'u' locations" j:swap_dim = "YC" j:comment = "In the Arakawa C-grid system, tracer (e.g., THETA) and 'u' variables (e.g., UVEL) have the same y coordinate on the model grid." j:coverage_content_type = "coordinate" int32 j_g (j_g) j_g:axis = "Y" j_g:long_name = "grid index in y for variables at 'v' and 'g' locations" j_g:c_grid_axis_shift = "-0.5" j_g:swap_dim = "YG" j_g:comment = "In the Arakawa C-grid system, 'v' (e.g., VVEL) and 'g' variables (e.g., XG) have the same y coordinate." j_g:coverage_content_type = "coordinate" int32 k (k) k:axis = "Z" k:long_name = "grid index in z for tracer variables" k:swap_dim = "Z" k:coverage_content_type = "coordinate"

Table 10.6: Example CDL description of native dataset

```
    int32 k_u (k_u)
        k_u:axis = "Z"
        k_u:long_name = "grid index in z corresponding to the bottom face of tracer grid cells ('w' locations)"
        k_u:c_grid_axis_shift = "0.5"
        k_u:swap_dim = "Zu"
        k_u:comment = "First index corresponds to the bottom face of the uppermost tracer grid cell. The use of 'u' in the variable name follows the MITgcm convention for naming the bottom face of ocean tracer grid cells."
        k_u:coverage_content_type = "coordinate"
    int32 k_l (k_l)
        k_l:axis = "Z"
        k_l:long_name = "grid index in z corresponding to the top face of tracer grid cells ('w' locations)"
        k_l:c_grid_axis_shift = "-0.5"
        k_l:swap_dim = "Zl"
        k_l:comment = "First index corresponds to the top face of the uppermost tracer grid cell. The use of 'l' in the variable name follows the MITgcm convention for naming the top face of ocean tracer grid cells."
        k_l:coverage_content_type = "coordinate"
    int32 k_p1 (k_p1)
        k_p1:axis = "Z"
        k_p1:long_name = "grid index in z for variables at 'w' locations"
        k_p1:c_grid_axis_shift = "[-0.5 0.5]"
        k_p1:swap_dim = "Zp1"
        k_p1:comment = "Includes top of uppermost model tracer cell (k_p1=0) and bottom of lowermost tracer cell (k_p1=51)."
        k_p1:coverage_content_type = "coordinate"
    int32 tile (tile)
        tile:long_name = "lat-lon-cap tile index"
        tile:comment = "The ECCO V4 horizontal model grid is divided into 13 tiles of 90x90 cells for convenience."
        tile:coverage_content_type = "coordinate"
    float32 XC (tile, j, i)
        XC:long_name = "longitude of tracer grid cell center"
        XC:units = "degrees_east"
        XC:coordinate = "YC XC"
        XC:bounds = "XC_bnds"
        XC:comment = "nonuniform grid spacing"
        XC:coverage_content_type = "coordinate"
        XC:standard_name = "longitude"
    float32 YC (tile, j, i)
        YC:long_name = "latitude of tracer grid cell center"
        YC:units = "degrees_north"
        YC:coordinate = "YC XC"
        YC:bounds = "YC_bnds"
        YC:comment = "nonuniform grid spacing"
        YC:coverage_content_type = "coordinate"
        YC:standard_name = "latitude"
    float32 XG (tile, j_g, i_g)
        XG:long_name = "longitude of 'southwest' corner of tracer grid cell"
        XG:units = "degrees_east"
        XG:coordinate = "YG XG"
        XG:comment = "Nonuniform grid spacing. Note: 'southwest' does not correspond to geographic orientation but is used for convenience to describe the computational grid. See MITgcm dcoumentation for details."
        XG:coverage_content_type = "coordinate"
        XG:standard_name = "longitude"
```

Table 10.6: Example CDL description of native dataset

```
    float32 YG (tile, j_g, i_g)
        YG:long_name = "latitude of 'southwest' corner of tracer grid cell"
        YG:units = "degrees_north"
        YG:comment = "Nonuniform grid spacing. Note: 'southwest' does not correspond to geographic orientation but is used for convenience to describe the computational grid. See MITgcm dcoumentation for details."
        YG:coverage_content_type = "coordinate"
        YG:standard_name = "latitude"
        YG:coordinates = "YG XG"
    float32 Z (k)
        Z:long_name = "depth of tracer grid cell center"
        Z:units = "m"
        Z:positive = "up"
        Z:bounds = "Z_bnds"
        Z:comment = "Non-uniform vertical spacing."
        Z:coverage_content_type = "coordinate"
        Z:standard_name = "depth"
    float32 Zp1 (k_p1)
        Zp1:long_name = "depth of top/bottom face of tracer grid cell"
        Zp1:units = "m"
        Zp1:positive = "up"
        Zp1:comment = "Contains one element more than the number of vertical layers. First element is 0m, the depth of the top face of the uppermost grid cell. Last element is the depth of the bottom face of the deepest grid cell."
        Zp1:coverage_content_type = "coordinate"
        Zp1:standard_name = "depth"
    float32 Zu (k_u)
        Zu:long_name = "depth of bottom face of tracer grid cell"
        Zu:units = "m"
        Zu:positive = "up"
        Zu:comment = "First element is -10m, the depth of the bottom face of the uppermost tracer grid cell. Last element is the depth of the bottom face of the deepest grid cell. The use of 'u' in the variable name follows the MITgcm convention for naming the bottom face of ocean tracer grid cells."
        Zu:coverage_content_type = "coordinate"
        Zu:standard_name = "depth"
    float32 Zl (k_l)
        Zl:long_name = "depth of top face of tracer grid cell"
        Zl:units = "m"
        Zl:positive = "up"
        Zl:comment = "First element is 0m, the depth of the top face of the uppermost tracer grid cell (i.e., the ocean surface). Last element is the depth of the top face of the deepest grid cell. The use of 'l' in the variable name follows the MITgcm convention for naming the top face of ocean tracer grid cells."
        Zl:coverage_content_type = "coordinate"
        Zl:standard_name = "depth"
    float32 XC_bnds (tile, j, i, nb)
        XC_bnds:comment = "Bounds array follows CF conventions. XC_bnds[i,j,0] = 'southwest' corner (j-1, i-1), XC_bnds[i,j,1] = 'southeast' corner (j-1, i+1), XC_bnds[i,j,2] = 'northeast' corner (j+1, i+1), XC_bnds[i,j,3] = 'northwest' corner (j+1, i-1). Note: 'southwest', 'southeast', northwest', and 'northeast' do not correspond to geographic orientation but are used for convenience to describe the computational grid. See MITgcm dcoumentation for details."
        XC_bnds:coverage_content_type = "coordinate"
        XC_bnds:long_name = "longitudes of tracer grid cell corners"
    float32 YC_bnds (tile, j, i, nb)
```

Table 10.6: Example CDL description of native dataset

YC_bnds:comment = "Bounds array follows CF conventions. YC_bnds[i,j,0] = 'southwest' corner (j-1, i-1), YC_bnds[i,j,1] = 'southeast' corner (j-1, i+1), YC_bnds[i,j,2] = 'northeast' corner (j+1, i+1), YC_bnds[i,j,3] = 'northwest' corner (j+1, i-1). Note: 'southwest', 'southeast', northwest', and 'northeast' do not correspond to geographic orientation but are used for convenience to describe the computational grid. See MITgcm dcoumentation for details." YC_bnds:coverage_content_type = "coordinate" YC_bnds:long_name = "latitudes of tracer grid cell corners" float32 Z_bnds (k, nv) Z_bnds:comment = "One pair of depths for each vertical level." Z_bnds:coverage_content_type = "coordinate" Z_bnds:long_name = "depths of top and bottom faces of tracer grid cell"
data variables
float32 DIFFKR (k, tile, j, i) DIFFKR:_FillValue = "9.969209968386869e+36" DIFFKR:coverage_content_type = "modelResult" DIFFKR:long_name = "Vertical diffusivity" DIFFKR:units = "m2 s-1" DIFFKR:comment = "Background vertical diffusion coefficient for temperature and salinity. Total vertical diffusivity includes background diffusivity plus contributions from the GGL90 vertical mixing and the Gent-McWilliams/Redi parameterizations. Note: DIFFKR is a model control variable and has been optimized from a spatially-invariant first-guess value of 1e-5 m2 s-1." DIFFKR:valid_min = "9.999999974752427e-07" DIFFKR:valid_max = "0.00018549950618762523" DIFFKR:coordinates = "Z XC YC" float32 KAPGM (k, tile, j, i) KAPGM:_FillValue = "9.969209968386869e+36" KAPGM:coverage_content_type = "modelResult" KAPGM:long_name = "Gent-McWilliams diffusivity" KAPGM:units = "m2 s-1" KAPGM:comment = "Gent-McWilliams diffusivity coefficient as described in Gent and McWilliams (1990, JPO). Note: KAPGM is a model control variable and has been optimized from a spatially invariant first guess of 1e3 m2 s-1." KAPGM:valid_min = "100.0" KAPGM:valid_max = "10000.0" KAPGM:coordinates = "Z XC YC" float32 KAPREDI (k, tile, j, i) KAPREDI:_FillValue = "9.969209968386869e+36" KAPREDI:coverage_content_type = "modelResult" KAPREDI:long_name = "Along-isopycnal diffusivity" KAPREDI:units = "m2 s-1" KAPREDI:comment = "Redi along-isopycnal diffusivity coefficient as described in Redi (1982, JPO). Note: KAPREDI is a model control variable and has been optimized from a spatially invariant first guess of 1e3 m2 s-1." KAPREDI:valid_min = "100.0" KAPREDI:valid_max = "10000.0" KAPREDI:coordinates = "Z XC YC"

10.8 Example of ECCO V4r4 netCDF for 1D data

Table 10.7: Example CDL description of 1D dataset

netcdf 1D example dimensions
time = 227904
coordinates
int32 time (time) time:axis = "T" time:comment = "" time:coverage_content_type = "coordinate" time:long_name = "snapshot time" time:standard_name = "time" time:units = "hours since 1992-01-01T12:00:00" time:calendar = "proleptic_gregorian"
data variables
float64 Pa_global (time) Pa_global:_FillValue = "9.969209968386869e+36" Pa_global:coverage_content_type = "modelResult" Pa_global:long_name = "Global mean atmospheric surface pressure over the ocean and sea-ice" Pa_global:standard_name = "air_pressure_at_sea_level" Pa_global:units = "N m-2" Pa_global:valid_min = "100873.14755283327" Pa_global:valid_max = "101257.45252296235" Pa_global:coordinates = "time"

11 Native lat-lon-cap 90 (llc90) Coordinates and Grid Geometry

11.1 Native coordinates GRID_GEOMETRY_ECCO

11.1.1 Overview

This dataset provides geometric parameters for the lat-lon-cap 90 (llc90) native model grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. Parameters include areas and lengths of grid cell sides, horizontal and vertical coordinates of grid cell centers and corners, grid rotation angles, and global domain geometry including bathymetry and land/ocean masks.

Table 11.1: Coordinates and Variables in the dataset GRID_GEOMETRY_ECCO

Variables	Description of data variables	Unit
CS	Cosine of tracer grid cell orientation vs geographical north	1
SN	Sine of tracer grid cell orientation vs geographical north	1
rA	Area of tracer grid cell	m2
dxG	Distance between 'southwest' and 'southeast' corners of the tracer grid cell	m
dyG	Distance between 'southwest' and 'northwest' corners of the tracer grid cell	m
Depth	Model seafloor depth below ocean surface at rest	m
rAz	Area of vorticity 'g' grid cell	m2
dxC	Distance between centers of adjacent tracer grid cells in the 'x' direction	m
dyC	Distance between centers of adjacent tracer grid cells in the 'y' direction	m
rAw	Area of 'v' grid cell	m2
rAs	Area of 'u' grid cell	m2
drC	Distance between the centers of adjacent tracer grid cells in the 'z' direction	m
drF	Distance between the upper and lower interfaces of the model grid cell	m
PHrefC	Reference ocean hydrostatic pressure at tracer grid cell center	m2 s-2
PHrefF	Reference ocean hydrostatic pressure at tracer grid cell top/bottom interface	m2 s-2
hFacC	Vertical open fraction of tracer grid cell	1
hFacW	Vertical open fraction of tracer grid cell 'west' face	1
hFacS	Vertical open fraction of tracer grid cell 'south' face	1
maskC	Wet/dry boolean mask for tracer grid cell	–none–
maskW	Wet/dry boolean mask for 'west' face of tracer grid cell	–none–
maskS	Wet/dry boolean mask for 'south' face of tracer grid cell	–none–
Coordinates	**Description of data coordinates**	**Unit**
i	Grid index in x for variables at tracer and 'v' locations	–none–
i_g	Grid index in x for variables at 'u' and 'g' locations	–none–
j	Grid index in y for variables at tracer and 'u' locations	–none–
j_g	Grid index in y for variables at 'v' and 'g' locations	–none–
k	Grid index in z for tracer variables	–none–
k_u	Grid index in z corresponding to the bottom face of tracer grid cells ('w' locations)	–none–
k_l	Grid index in z corresponding to the top face of tracer grid cells ('w' locations)	–none–
k_p1	Grid index in z for variables at 'w' locations	–none–
tile	Lat-lon-cap tile index	–none–
XC	Longitude of tracer grid cell center	degrees_east
YC	Latitude of tracer grid cell center	degrees_north

Table 11.1: Coordinates and Variables in the dataset GRID_GEOMETRY_ECCO

XG	Longitude of 'southwest' corner of tracer grid cell	degrees_east
YG	Latitude of 'southwest' corner of tracer grid cell	degrees_north
Z	Depth of tracer grid cell center	m
Zp1	Depth of top/bottom face of tracer grid cell	m
Zu	Depth of bottom face of tracer grid cell	m
Zl	Depth of top face of tracer grid cell	m
XC_bnds	Longitudes of tracer grid cell corners	–none–
YC_bnds	Latitudes of tracer grid cell corners	–none–
Z_bnds	Depths of top and bottom faces of tracer grid cell	–none–

11.1.2 Native coordinates Variable: XC

Table 11.2: Attributes description of the variable 'XC' from GRID_GEOMETRY_ECCO's dataset.

Storage Type	Variable Name	Description	Unit
float32	XC	Longitude of tracer grid cell center	degrees_east

Description of the variable in Common Data language (CDL)

```
float32 XC(tile, j, i)
   XC: long_name = longitude of tracer grid cell center
   XC: units = degrees_east
   XC: coordinate = YC    XC
   XC: bounds =    XC_bnds
   XC: coverage_content_type = coordinate
   XC: standard_name = longitude
```

Comments

Nonuniform grid spacing

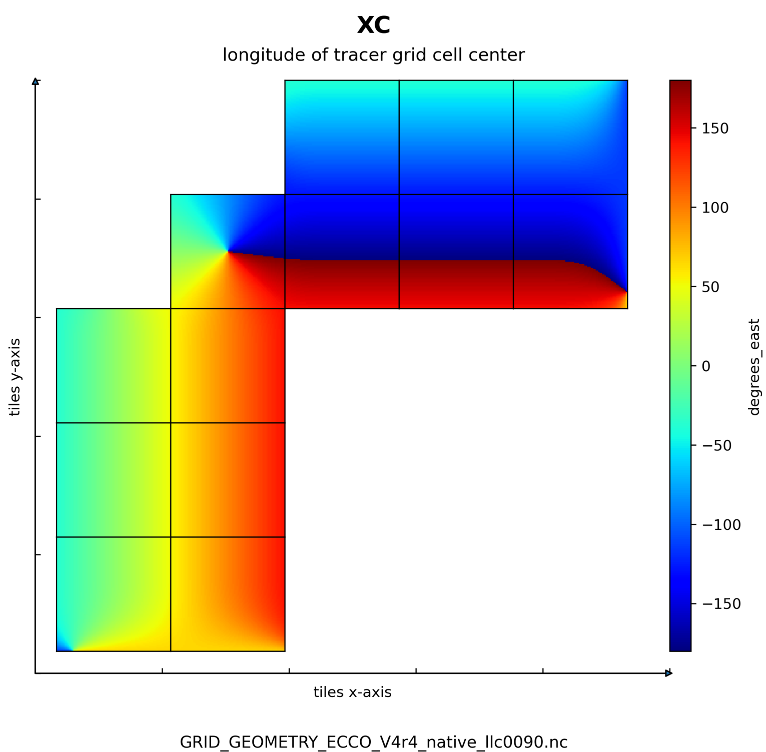

Figure 1: Dataset: GRID_GEOMETRY_ECCO, Variable: XC

11.1.3 Native coordinates Variable: YC

Table 11.3: Attributes description of the variable 'YC' from GRID_GEOMETRY_ECCO's dataset.

Storage Type	Variable Name	Description	Unit
float32	YC	Latitude of tracer grid cell center	degrees_north
Description of the variable in Common Data language (CDL)			
float32 YC(tile, j, i) YC: long_name = latitude of tracer grid cell center YC: units = degrees_north YC: coordinate = YC XC YC: bounds = YC_bnds YC: coverage_content_type = coordinate YC: standard_name = latitude			
Comments			
Nonuniform grid spacing			

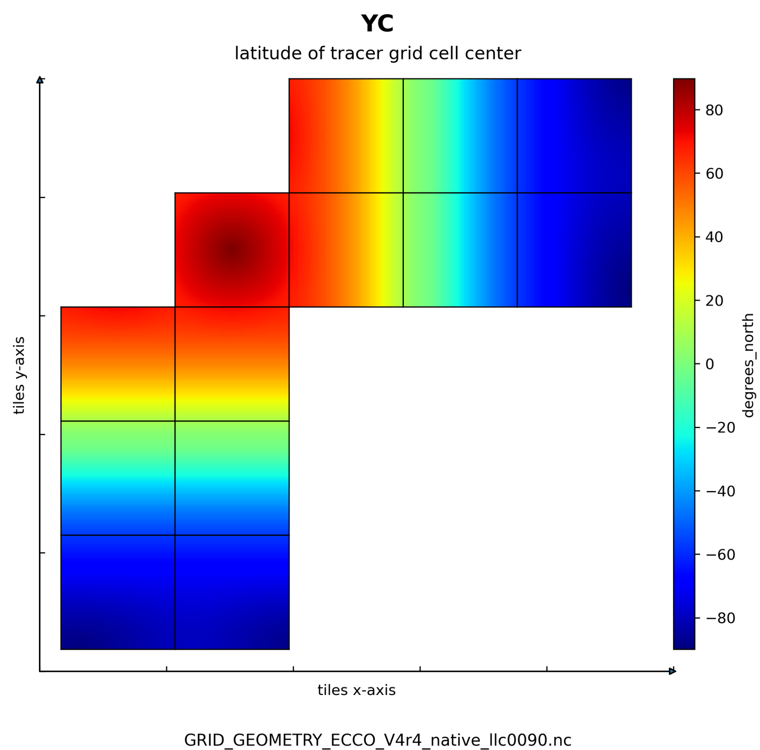

Figure 2: Dataset: GRID_GEOMETRY_ECCO, Variable: YC

11.1.4 Native coordinates Variable: XG

Table 11.4: Attributes description of the variable 'XG' from GRID_GEOMETRY_ECCO's dataset.

Storage Type	Variable Name	Description	Unit
float32	XG	Longitude of 'southwest' corner of tracer grid cell	degrees_east
Description of the variable in Common Data language (CDL)			

`float32 XG(tile, j_g, i_g)`
`XG: long_name = "longitude of southwest corner of tracer grid cell"`
`XG: units = degrees_east`
`XG: coordinate = YG    XG`
`XG: coverage_content_type = coordinate`
`XG: standard_name = longitude`			

Comments			
Nonuniform grid spacing. note: 'southwest' does not correspond to geographic orientation but is used for convenience to describe the computational grid. see mitgcm dcoumentation for details.			

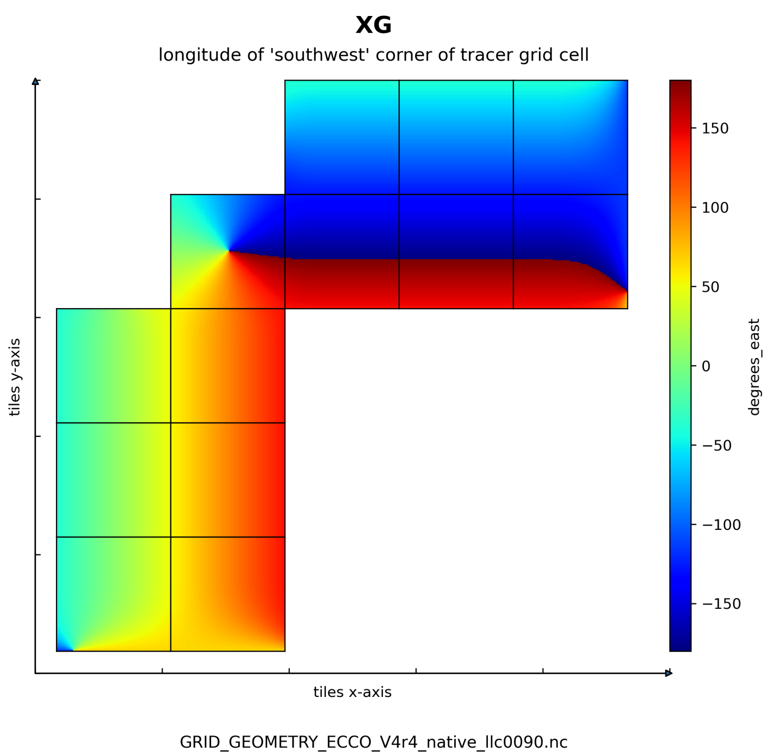

Figure 3: Dataset: GRID_GEOMETRY_ECCO, Variable: XG

11.1.5 Native coordinates Variable: YG

Table 11.5: Attributes description of the variable 'YG' from GRID_GEOMETRY_ECCO's dataset.

Storage Type	Variable Name	Description	Unit
float32	YG	Latitude of 'southwest' corner of tracer grid cell	degrees_north
Description of the variable in Common Data language (CDL)			

```
float32 YG(tile, j_g, i_g)
   YG: long_name = "latitude of southwest corner of tracer grid cell"
   YG: units = degrees_north
   YG: coordinates =    YG XG
   YG: coverage_content_type = coordinate
   YG: standard_name = latitude
```

Comments

Nonuniform grid spacing. note: 'southwest' does not correspond to geographic orientation but is used for convenience to describe the computational grid. see mitgcm dcoumentation for details.

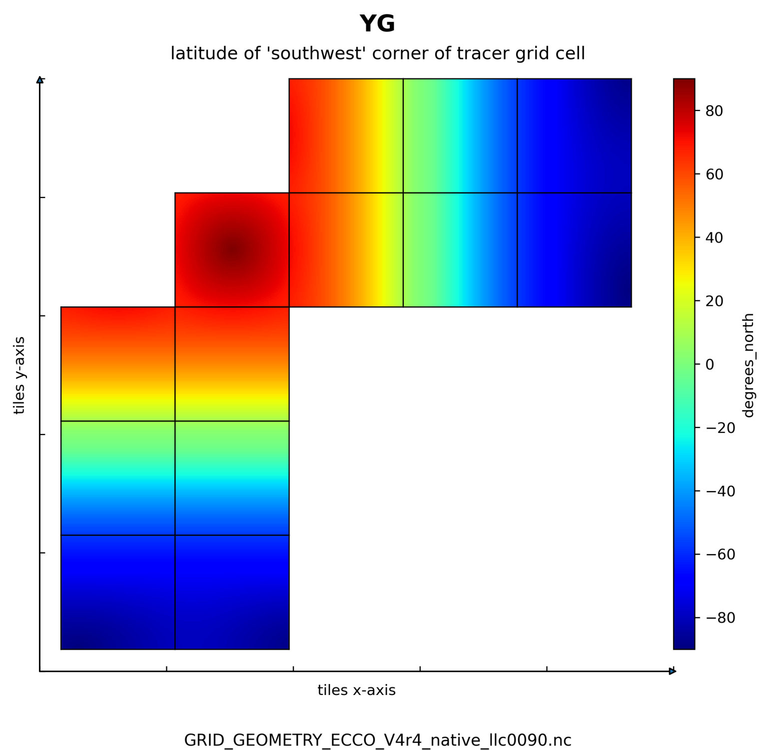

Figure 4: Dataset: GRID_GEOMETRY_ECCO, Variable: YG

11.1.6 Native coordinates Variable: CS

Table 11.6: Attributes description of the variable 'CS' from GRID_GEOMETRY_ECCO's dataset.

Storage Type	Variable Name	Description	Unit
float32	CS	Cosine of tracer grid cell orientation vs geographical north	1

Description of the variable in Common Data language (CDL)

```
float32 CS(tile, j, i)
   CS: _FillValue = 9.96921e+36
   CS: long_name = cosine of tracer grid cell orientation vs geographical north
   CS: units = 1
   CS: coordinate = YC XC
   CS: coverage_content_type = modelResult
   CS: coordinates = YC XC
```

Comments

Cs and sn are required to calculate the geographic (meridional, zonal) components of vectors on the curvilinear model grid. note: for vector r with components r_x and r_y: r_{east} = cs r_x - sn r_y. r_{north} = sn r_x + cs r_y

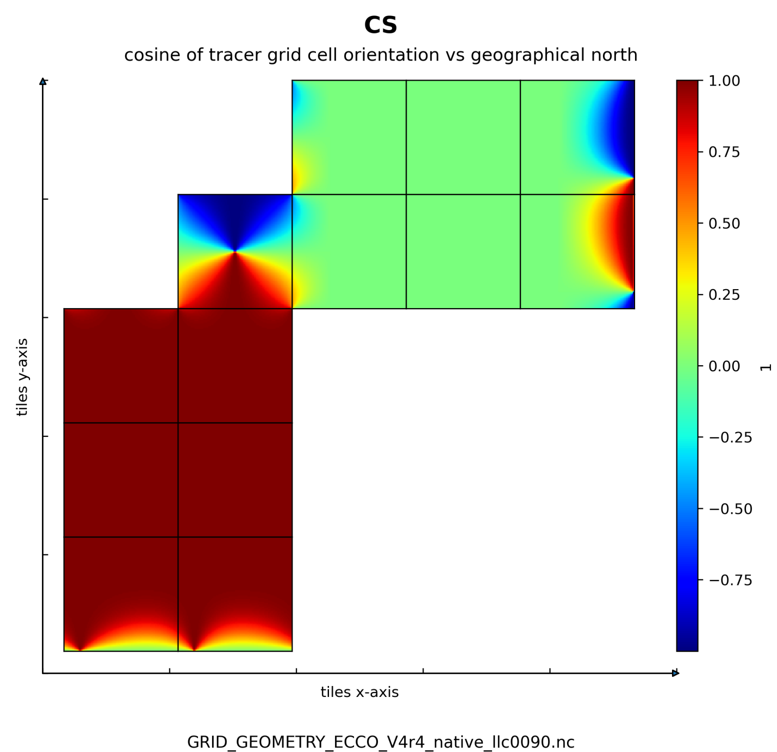

Figure 5: Dataset: GRID_GEOMETRY_ECCO, Variable: CS

11.1.7 Native coordinates Variable: SN

Table 11.7: Attributes description of the variable 'SN' from GRID_GEOMETRY_ECCO's dataset.

Storage Type	Variable Name	Description	Unit
float32	SN	Sine of tracer grid cell orientation vs geographical north	1

Description of the variable in Common Data language (CDL)

```
float32 SN(tile, j, i)
   SN: _FillValue = 9.96921e+36
   SN: long_name = sine of tracer grid cell orientation vs geographical north
   SN: units = 1
   SN: coordinate = YC XC
   SN: coverage_content_type = modelResult
   SN: coordinates = YC XC
```

Comments

Cs and sn are required to calculate the geographic (meridional, zonal) components of vectors on the curvilinear model grid. note: for vector r with components r_x and r_y in local grid directions x and y, the geographical eastward component r_{east} = cs r_x - sn r_y. the geographical northward component r_{north} = sn r_x + cs r_y.

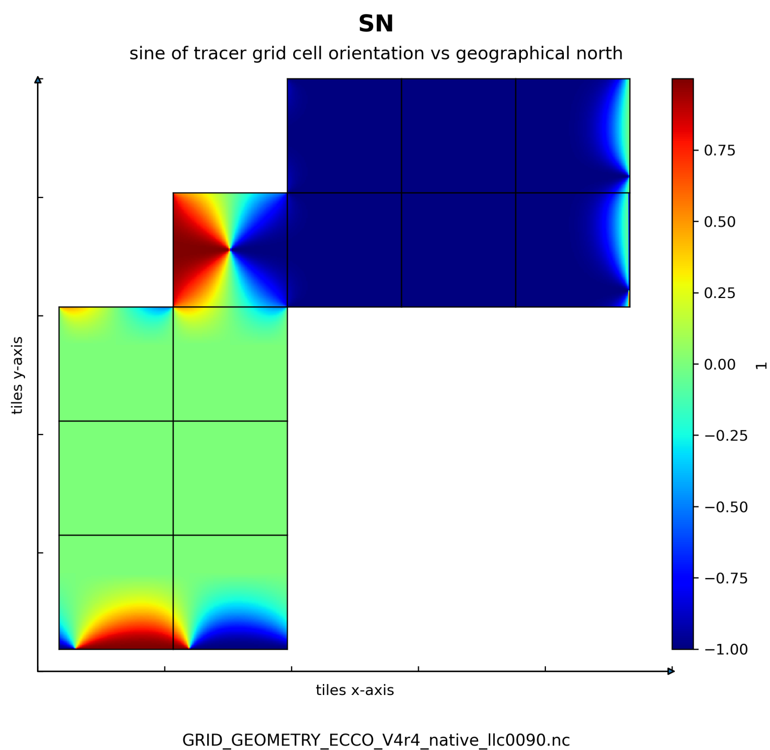

Figure 6: Dataset: GRID_GEOMETRY_ECCO, Variable: SN

11.1.8 Native coordinates Variable: rA

Table 11.8: Attributes description of the variable 'rA' from GRID_GEOMETRY_ECCO's dataset.

Storage Type	Variable Name	Description	Unit
float32	rA	Area of tracer grid cell	m2
Description of the variable in Common Data language (CDL)			

``float32 rA(tile, j, i)``
 ``rA: _FillValue = 9.96921e+36``
 ``rA: long_name = area of tracer grid cell``
 ``rA: units = m2``
 ``rA: coordinate = YC XC``
 ``rA: coverage_content_type = modelResult``
 ``rA: standard_name = cell_area``
 ``rA: coordinates = YC XC``			

Comments			
N/a			

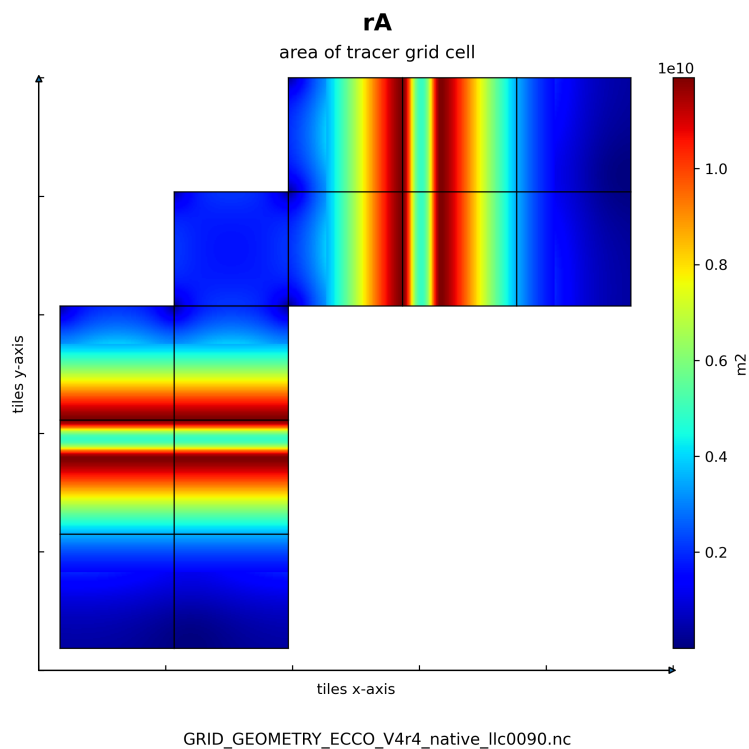

Figure 7: Dataset: GRID_GEOMETRY_ECCO, Variable: rA

11.1.9 Native coordinates Variable: dxG

Table 11.9: Attributes description of the variable 'dxG' from GRID_GEOMETRY_ECCO's dataset.

Storage Type	Variable Name	Description	Unit
float32	dxG	Distance between 'southwest' and 'southeast' corners of the tracer grid cell	m

Description of the variable in Common Data language (CDL)

```
float32 dxG(tile, j_g, i)
   dxG: _FillValue = 9.96921e+36
   dxG: long_name = "distance between southwest and southeast corners of the
tracer grid cell"
   dxG: units = m
   dxG: coordinate = YG XC
   dxG: coverage_content_type = modelResult
```

Comments

Alternatively, the length of 'south' side of tracer grid cell. note: 'south', 'southwest', and 'southeast' do not correspond to geographic orientation but are used for convenience to describe the computational grid. see mitgcm documentation for details.

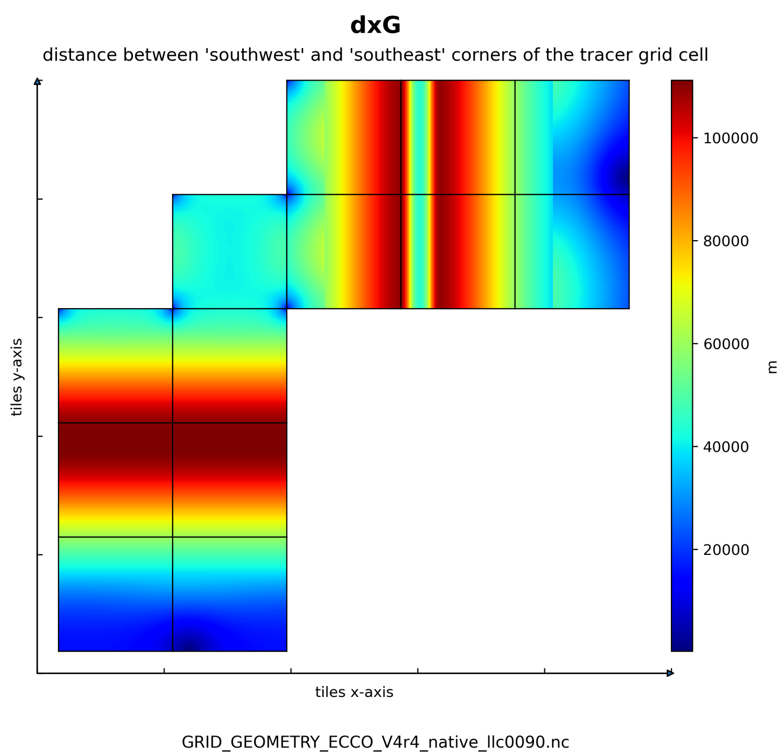

Figure 8: Dataset: GRID_GEOMETRY_ECCO, Variable: dxG

11.1.10 Native coordinates Variable: dyG

Table 11.10: Attributes description of the variable 'dyG' from GRID_GEOMETRY_ECCO's dataset.

Storage Type	Variable Name	Description	Unit
float32	dyG	Distance between 'southwest' and 'northwest' corners of the tracer grid cell	m
Description of the variable in Common Data language (CDL)			

`float32 dyG(tile, j, i_g)`
`dyG: _FillValue = 9.96921e+36`
`dyG: long_name = "distance between southwest and northwest corners of the tracer grid cell"`
`dyG: units = m`
`dyG: coordinate = YC XG`
`dyG: coverage_content_type = modelResult`			

Comments			
Alternatively, the length of 'west' side of tracer grid cell. note: 'west, 'southwest', and 'northwest' do not correspond to geographic orientation but are used for convenience to describe the computational grid. see mitgcm documentation for details.			

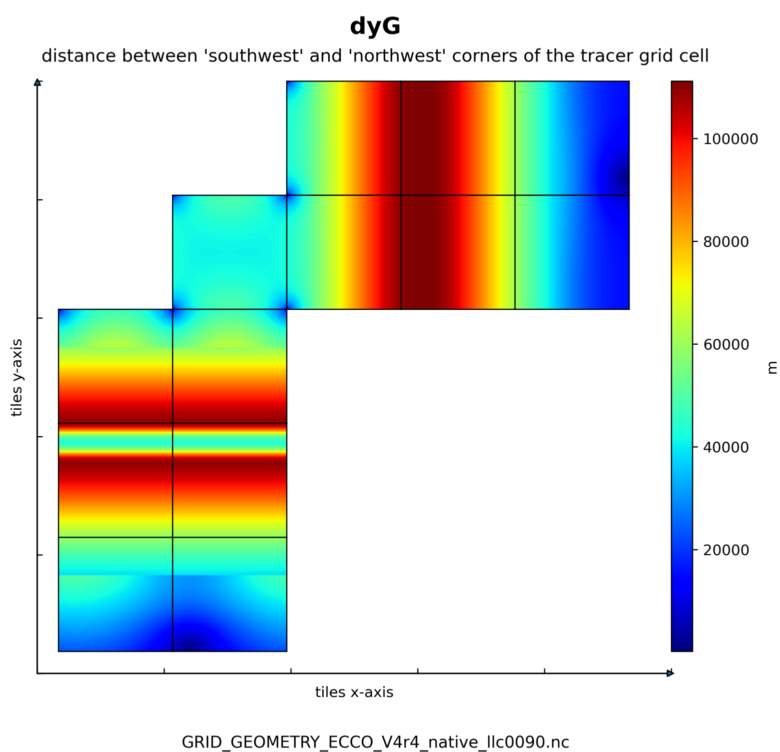

Figure 9: Dataset: GRID_GEOMETRY_ECCO, Variable: dyG

11.1.11 Native coordinates Variable: Depth

Table 11.11: Attributes description of the variable 'Depth' from GRID_GEOMETRY_ECCO's dataset.

Storage Type	Variable Name	Description	Unit
float32	Depth	Model seafloor depth below ocean surface at rest	m

Description of the variable in Common Data language (CDL)

```
float32 Depth(tile, j, i)
   Depth:  _FillValue = 9.96921e+36
   Depth:  long_name = model seafloor depth below ocean surface at rest
   Depth:  units = m
   Depth:  coordinate = XC YC
   Depth:  coverage_content_type = modelResult
   Depth:  standard_name = sea_floor_depth_below_geoid
   Depth:  coordinates = YC XC
```

Comments

Model sea surface height (ssh) of 0m corresponds to an ocean surface at rest relative to the geoid. depth corresponds to seafloor depth below geoid. note: the mitgcm used by ecco v4r4 implements 'partial cells' so the actual model seafloor depth may differ from the seafloor depth provided by the input bathymetry file.

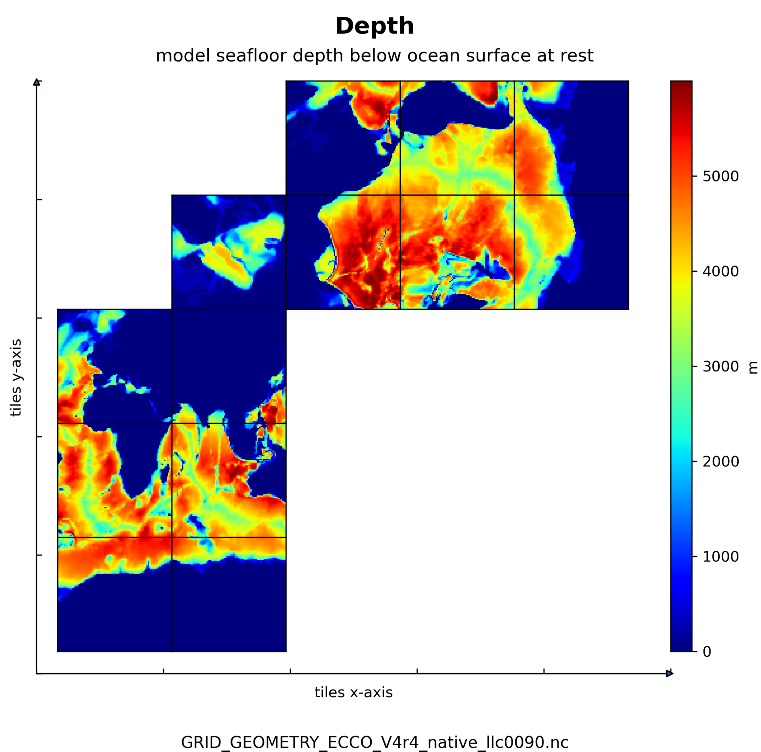

Figure 10: Dataset: GRID_GEOMETRY_ECCO, Variable: Depth

11.1.12 Native coordinates Variable: rAz

Table 11.12: Attributes description of the variable 'rAz' from GRID_GEOMETRY_ECCO's dataset.

Storage Type	Variable Name	Description	Unit
float32	rAz	Area of vorticity 'g' grid cell	m2
Description of the variable in Common Data language (CDL)			

```
float32 rAz(tile, j_g, i_g)
   rAz:  _FillValue = 9.96921e+36
   rAz:  long_name = "area of vorticity g grid cell"
   rAz:  units = m2
   rAz:  coordinate = YG XG
   rAz:  coverage_content_type = modelResult
   rAz:  standard_name = cell_area
   rAz:  coordinates = YG XG
```

Comments
Vorticity cells are staggered in space relative to tracer cells, nominally situated on tracer cell corners. vorticity cell (i,j) is located at the 'southwest' corner of tracer grid cell (i, j). note: 'southwest' does not correspond to geographic orientation but is used for convenience to describe the computational grid. see mitgcm documentation for details.

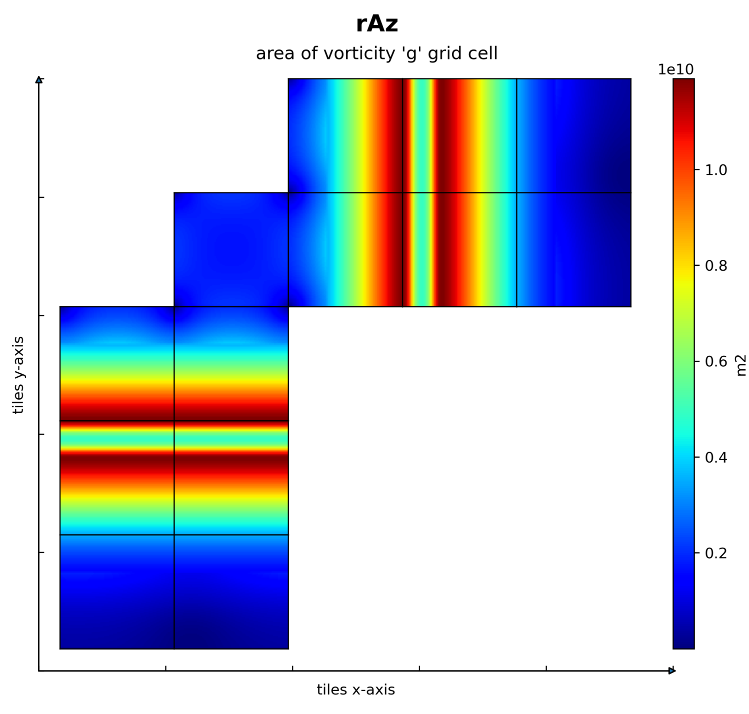

Figure 11: Dataset: GRID_GEOMETRY_ECCO, Variable: rAz

11.1.13 Native coordinates Variable: dxC

Table 11.13: Attributes description of the variable 'dxC' from GRID_GEOMETRY_ECCO's dataset.

Storage Type	Variable Name	Description	Unit
float32	dxC	Distance between centers of adjacent tracer grid cells in the 'x' direction	m
Description of the variable in Common Data language (CDL)			
float32 dxC(tile, j, i_g) dxC: _FillValue = 9.96921e+36 dxC: long_name = "distance between centers of adjacent tracer grid cells in the x direction" dxC: units = m dxC: coordinate = YC XG dxC: coverage_content_type = modelResult			
Comments			
Alternatively, the length of 'north' side of vorticity grid cells. note: 'north' does not correspond to geographic orientation but is used for convenience to describe the computational grid. see mitgcm documentation for details.			

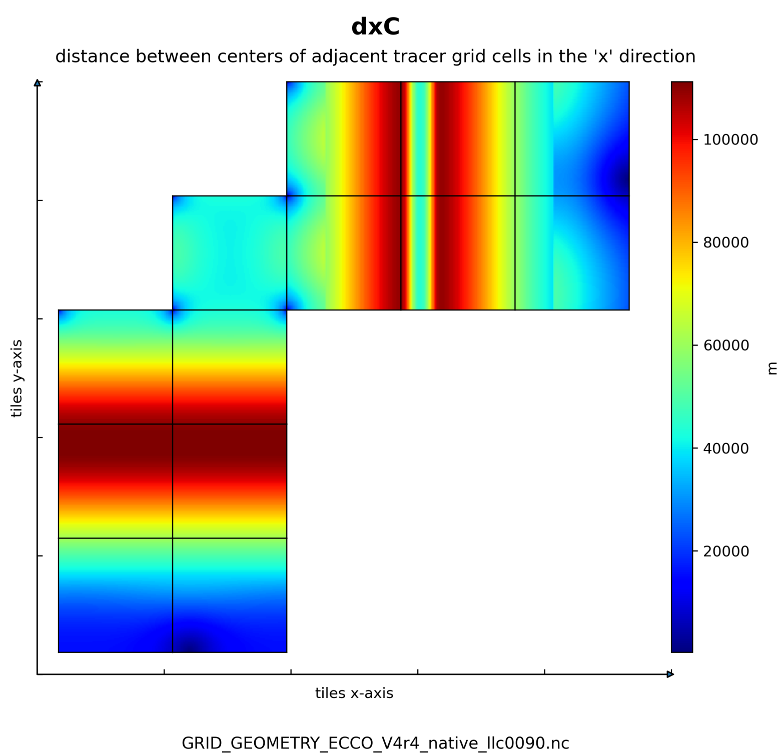

Figure 12: Dataset: GRID_GEOMETRY_ECCO, Variable: dxC

11.1.14 Native coordinates Variable: dyC

Table 11.14: Attributes description of the variable 'dyC' from GRID_GEOMETRY_ECCO's dataset.

Storage Type	Variable Name	Description	Unit
float32	dyC	Distance between centers of adjacent tracer grid cells in the 'y' direction	m

Description of the variable in Common Data language (CDL)

```
float32 dyC(tile, j_g, i)
   dyC: _FillValue = 9.96921e+36
   dyC: long_name = "distance between centers of adjacent tracer grid cells in the
y direction"
   dyC: units = m
   dyC: coordinate = YG XC
   dyC: coverage_content_type = modelResult
```

Comments

Alternatively, the length of 'east' side of vorticity grid cells. note: 'east' does not correspond to geographic orientation but is used for convenience to describe the computational grid. see mitgcm documentation for details.

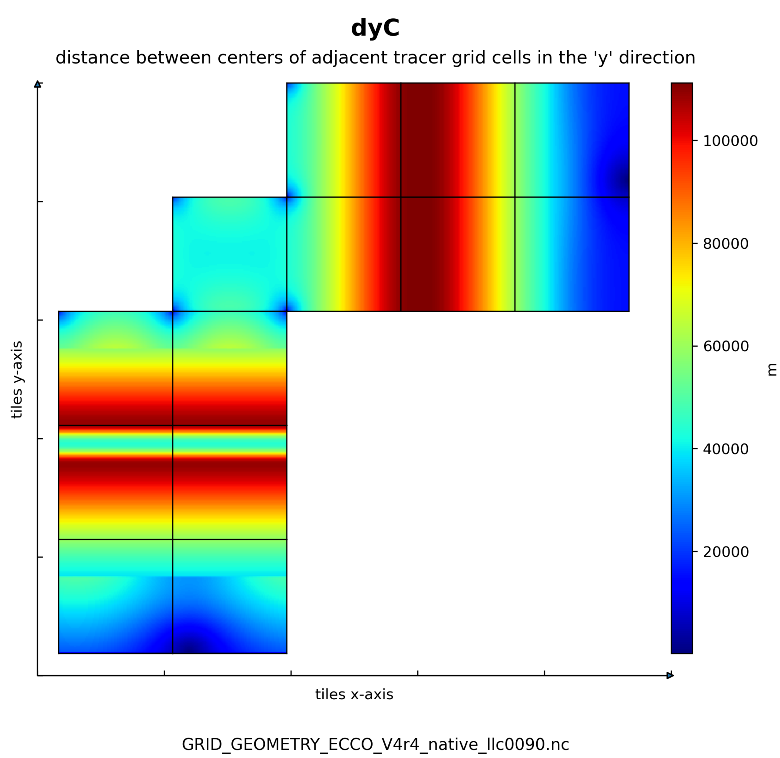

Figure 13: Dataset: GRID_GEOMETRY_ECCO, Variable: dyC

11.1.15 Native coordinates Variable: rAw

Table 11.15: Attributes description of the variable 'rAw' from GRID_GEOMETRY_ECCO's dataset.

Storage Type	Variable Name	Description	Unit
float32	rAw	Area of 'v' grid cell	m2
Description of the variable in Common Data language (CDL)			
float32 rAw(tile, j, i_g) rAw: _FillValue = 9.96921e+36 rAw: long_name = "area of v grid cell" rAw: units = m2 rAw: coordinate = YG XC rAw: coverage_content_type = modelResult rAw: standard_name = cell_area			
Comments			
Model 'v' grid cells are staggered in space between adjacent tracer grid cells in the 'x' direction. 'v' grid cell (i,j) is situated at the 'west' edge of tracer grid cell (i, j). note: 'west' does not correspond to geographic orientation but is used for convenience to describe the computational grid. see mitgcm documentation for details.			

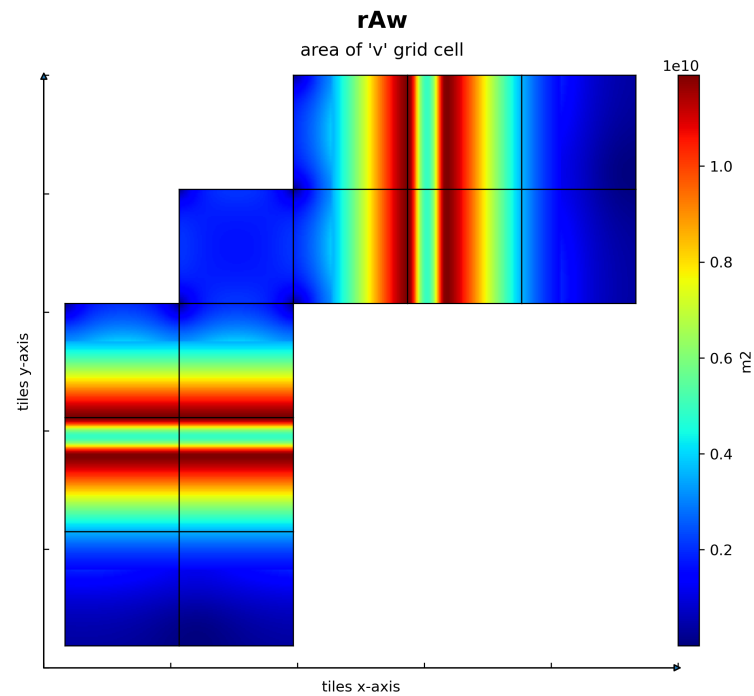

Figure 14: Dataset: GRID_GEOMETRY_ECCO, Variable: rAw

11.1.16 Native coordinates Variable: rAs

Table 11.16: Attributes description of the variable 'rAs' from GRID_GEOMETRY_ECCO's dataset.

Storage Type	Variable Name	Description	Unit
float32	rAs	Area of 'u' grid cell	m2
Description of the variable in Common Data language (CDL)			

`float32 rAs(tile, j_g, i)`
`rAs: _FillValue = 9.96921e+36`
`rAs: long_name = "area of u grid cell"`
`rAs: units = m2`
`rAs: coordinates = YG XC`
`rAs: coverage_content_type = modelResult`
`rAs: standard_name = cell_area`			

Comments			
Model 'u' grid cells are staggered in space between adjacent tracer grid cells in the 'y' direction. 'u' grid cell (i,j) is situated at the 'south' edge of tracer grid cell (i, j). note: 'south' does not correspond to geographic orientation but is used for convenience to describe the computational grid. see mitgcm documentation for details.			

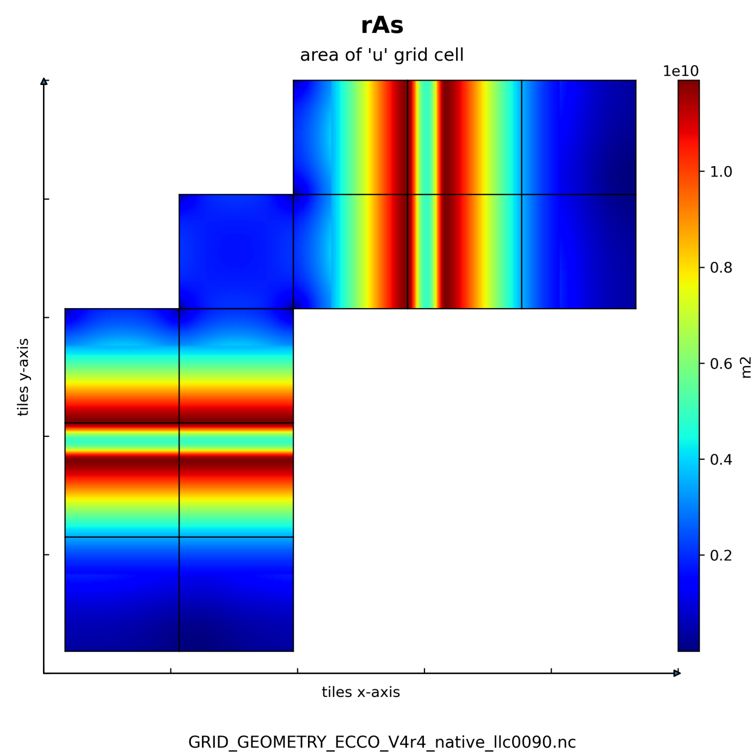

Figure 15: Dataset: GRID_GEOMETRY_ECCO, Variable: rAs

11.1.17 Native coordinates Variable: hFacC

Table 11.17: Attributes description of the variable 'hFacC' from GRID_GEOMETRY_ECCO's dataset.

Storage Type	Variable Name	Description	Unit
float32	hFacC	Vertical open fraction of tracer grid cell	1

Description of the variable in Common Data language (CDL)

```
float32 hFacC(k, tile, j, i)
   hFacC: _FillValue = 9.96921e+36
   hFacC: long_name = vertical open fraction of tracer grid cell
   hFacC: coverage_content_type = modelResult
   hFacC: units = 1
   hFacC: coordinates = Z YC XC
```

Comments

Tracer grid cells may be fractionally closed in the vertical. the open vertical fraction is hfacc. the model allows for partially-filled cells to represent topographic variations more smoothly (hfacc < 1). completely closed (dry) tracer grid cells have hfacc = 0. note: the model z* coordinate system allows hfacc to vary through time. a time-invariant hfacc field is provided for reference.

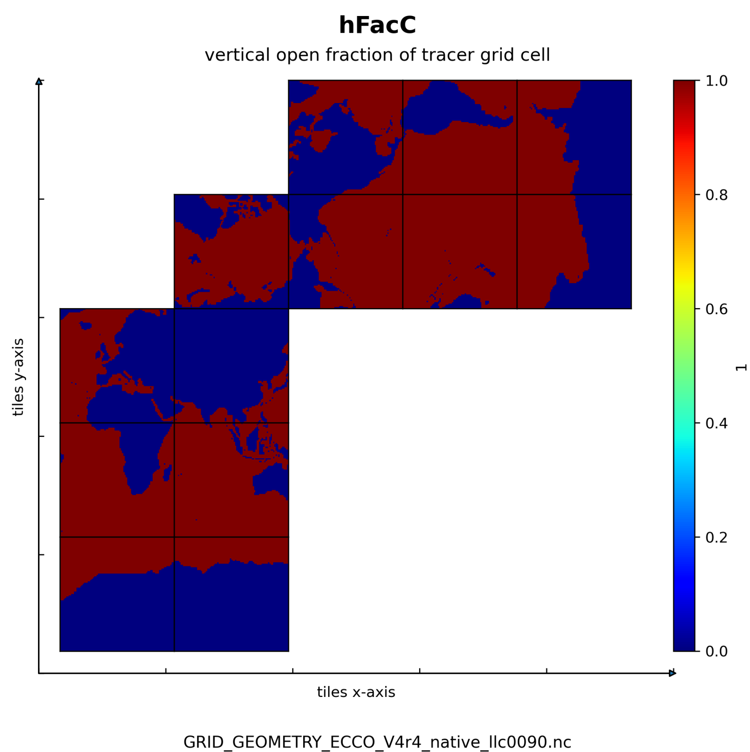

Figure 16: Dataset: GRID_GEOMETRY_ECCO, Variable: hFacC

11.1.18 Native coordinates Variable: hFacW

Table 11.18: Attributes description of the variable 'hFacW' from GRID_GEOMETRY_ECCO's dataset.

Storage Type	Variable Name	Description	Unit
float32	hFacW	Vertical open fraction of tracer grid cell 'west' face	1

Description of the variable in Common Data language (CDL)

```
float32 hFacW(k, tile, j, i_g)
   hFacW: _FillValue = 9.96921e+36
   hFacW: long_name = "vertical open fraction of tracer grid cell west face"
   hFacW: coverage_content_type = modelResult
   hFacW: units = 1
   hFacW: coordinates = Z
```

Comments

The 'west' face of tracer grid cells may be fractionally closed in the vertical. the open vertical fraction is hfacw. the model allows for partially-filled cells for smoother representation of seafloor topography. tracer grid cells adjacent in the 'x' direction that are partially closed in the vertical have hfacw < 1. the model z* coordinate system used by the model permits hfacc, and therefore hfacw, to vary through time. a time-invariant hfacw field is provided for reference. note: the term 'west' does not correspond to geographic orientation but is used for convenience to describe the computational grid. see mitgcm documentation for details.

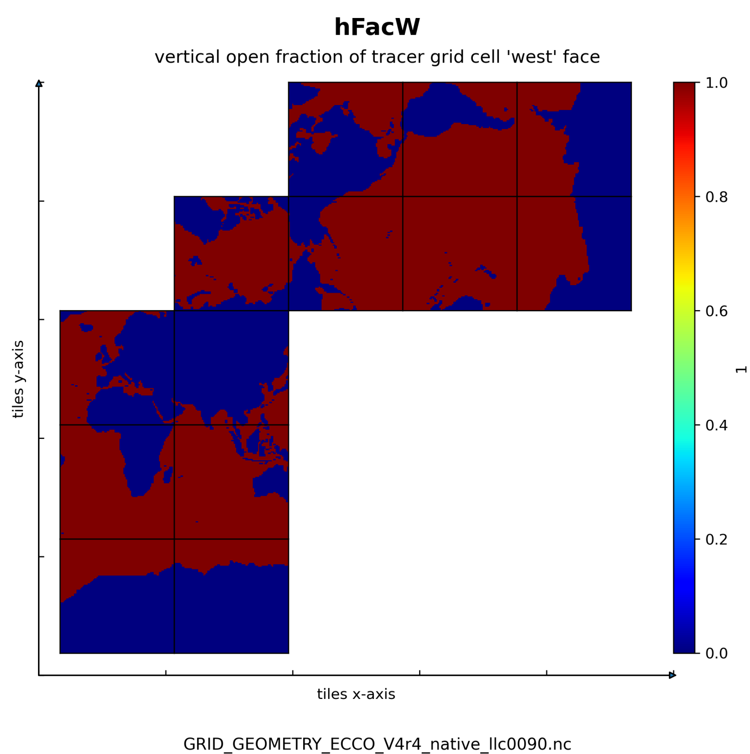

Figure 17: Dataset: GRID_GEOMETRY_ECCO, Variable: hFacW

11.1.19 Native coordinates Variable: hFacS

Table 11.19: Attributes description of the variable 'hFacS' from GRID_GEOMETRY_ECCO's dataset.

Storage Type	Variable Name	Description	Unit
float32	hFacS	Vertical open fraction of tracer grid cell 'south' face	1

Description of the variable in Common Data language (CDL)

```
float32 hFacS(k, tile, j_g, i)
   hFacS: _FillValue = 9.96921e+36
   hFacS: long_name = "vertical open fraction of tracer grid cell south face"
   hFacS: coverage_content_type = modelResult
   hFacS: units = 1
   hFacS: coordinates = Z
```

Comments

The 'south' face of tracer grid cells may be fractionally closed in the vertical. the open vertical fraction is hfacs. the model allows for partially-filled cells for smoother representation of seafloor topography. tracer grid cells adjacent in the 'y' direction that are partially closed in the vertical have hfacs < 1. the model z* coordinate system used by the model permits hfacc, and therefore hfacs, to vary through time. a time-invariant hfacs field is provided for reference. note: the term 'south' does not correspond to geographic orientation but is used for convenience to describe the computational grid. see mitgcm documentation for details.

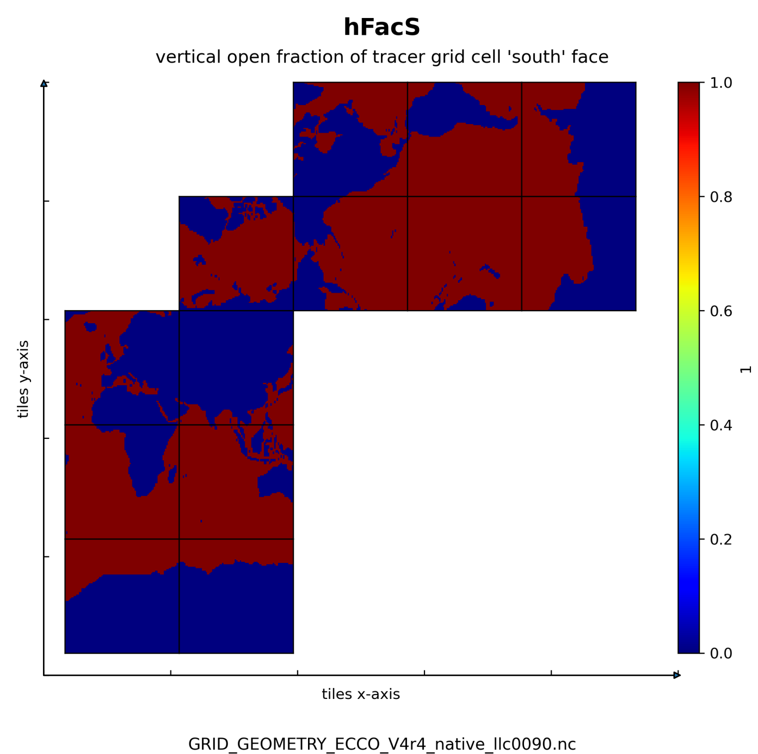

Figure 18: Dataset: GRID_GEOMETRY_ECCO, Variable: hFacS

11.1.20 Native coordinates Variable: maskC

Table 11.20: Attributes description of the variable 'maskC' from GRID_GEOMETRY_ECCO's dataset.

Storage Type	Variable Name	Description	Unit
bool	maskC	Wet/dry boolean mask for tracer grid cell	N/A
Description of the variable in Common Data language (CDL)			

```
bool maskC(k, tile, j, i)
   maskC: _FillValue = 1
   maskC: long_name = wet/dry boolean mask for tracer grid cell
   maskC: coverage_content_type = modelResult
   maskC: coordinates = Z YC XC
```

Comments

True for tracer grid cells with nonzero open vertical fraction (hfacc > 0), otherwise false. although hfacc can vary though time, cells will never close if starting open and will never open if starting closed: hfacc(i,j,k,t) > 0 for all t, if hfacc(i,j,k,t=0) and hfacc(i,j,k,t) = 0 for all t, if hfacc(i,j,k,t=0) = 0. therefore, maskc is time invariant.

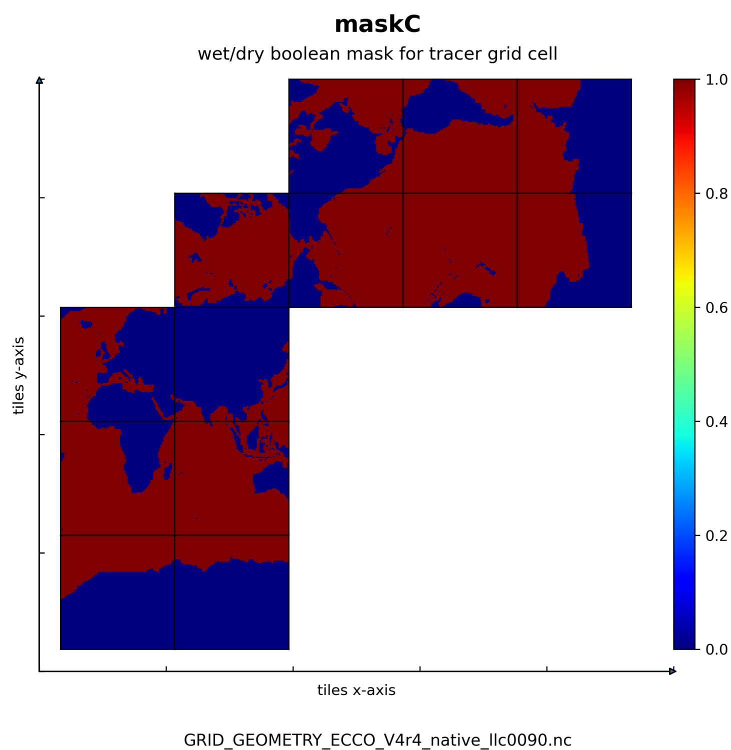

Figure 19: Dataset: GRID_GEOMETRY_ECCO, Variable: maskC

11.1.21 Native coordinates Variable: maskW

Table 11.21: Attributes description of the variable 'maskW' from GRID_GEOMETRY_ECCO's dataset.

Storage Type	Variable Name	Description	Unit
bool	maskW	Wet/dry boolean mask for 'west' face of tracer grid cell	N/A
Description of the variable in Common Data language (CDL)			

```
bool maskW(k, tile, j, i_g)
   maskW: _FillValue = 1
   maskW: long_name = "wet/dry boolean mask for west face of tracer grid cell"
   maskW: coverage_content_type = modelResult
   maskW: coordinates = Z
```

Comments
True for grid cells with nonzero open vertical fraction along their 'west' face (hfacw > 0), otherwise false. although hfacw can vary though time, cells will never close if starting open and will never open if starting closed: hfacw(i,j,k,t) > 0 for all t, if hfacw(i,j,k,t=0) and hfacw(i,j,k,t) = 0 for all t, if hfacw(i,j,k,t=0) = 0. therefore, maskw is time invariant. note:

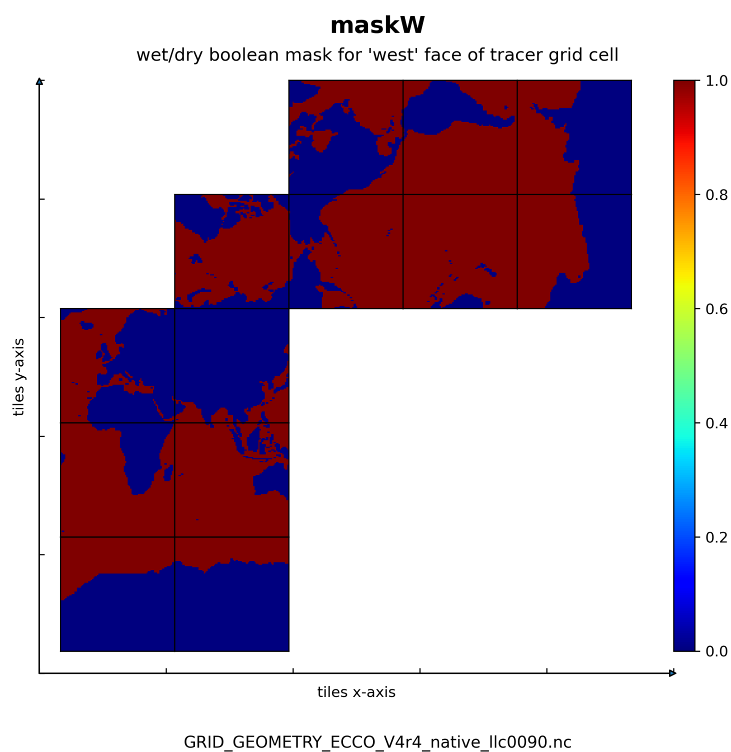

Figure 20: Dataset: GRID_GEOMETRY_ECCO, Variable: maskW

11.1.22 Native coordinates Variable: maskS

Table 11.22: Attributes description of the variable 'maskS' from GRID_GEOMETRY_ECCO's dataset.

Storage Type	Variable Name	Description	Unit
bool	maskS	Wet/dry boolean mask for 'south' face of tracer grid cell	N/A
Description of the variable in Common Data language (CDL)			

```
bool maskS(k, tile, j_g, i)
   maskS: _FillValue = 1
   maskS: long_name = "wet/dry boolean mask for south face of tracer grid cell"
   maskS: coverage_content_type = modelResult
   maskS: coordinates = Z
```

Comments

True for grid cells with nonzero open vertical fraction along their 'south' face (hfacs > 0), otherwise false. although hfacs can vary though time, cells will never close if starting open and will never open if starting closed: hfacs(i,j,k,t) > 0 for all t, if hfacs(i,j,k,t=0) and hfacs(i,j,k,t) = 0 for all t, if hfacs(i,j,k,t=0) = 0. therefore, masks is time invariant. note:

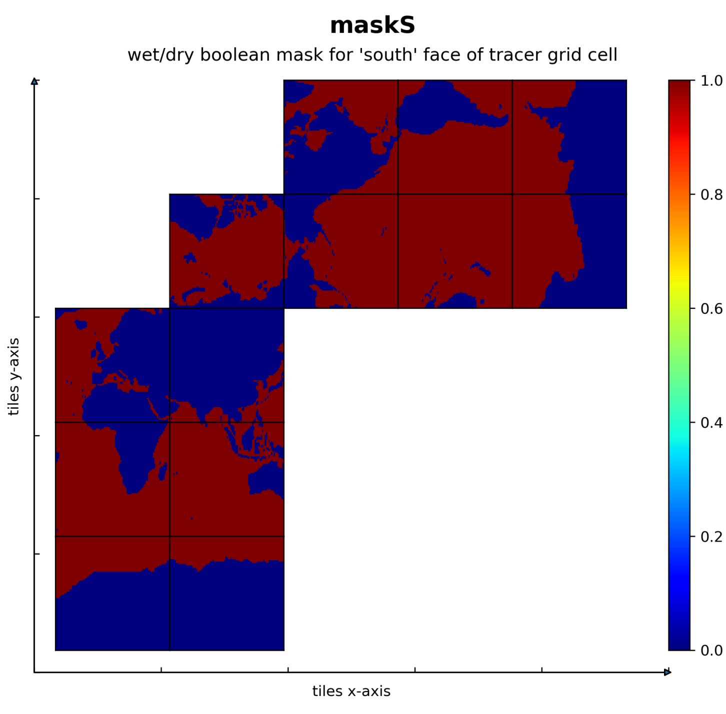

Figure 21: Dataset: GRID_GEOMETRY_ECCO, Variable: maskS

12 Native Dataset Groupings

12.1 Native dataset of ATM_SURFACE_TEMP_HUM_WIND_PRES

12.1.1 Overview

This dataset provides 2D fields of atmosphere surface temperature, humidity, winds, and pressure on the lat-lon-cap 90 (llc90) native model grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution.

Table 12.1: Coordinates and Variables in the dataset ATM_SURFACE_TEMP_HUM_WIND_PRES

Variables	Description of data variables	Unit
EXFatemp	Atmosphere surface (2 m) air temperature	degree_K
EXFaqh	Atmosphere surface (2 m) specific humidity	kg kg-1
EXFuwind	Wind speed at 10m in the model +x direction	m s-1
EXFvwind	Wind speed at 10m in the model +y direction	m s-1
EXFwspee	Wind speed	m s-1
EXFpress	Atmosphere surface pressure	N m-2
Coordinates	**Description of data coordinates**	**Unit**
i	Grid index in x for variables at tracer and 'v' locations	–none–
i_g	Grid index in x for variables at 'u' and 'g' locations	–none–
j	Grid index in y for variables at tracer and 'u' locations	–none–
j_g	Grid index in y for variables at 'v' and 'g' locations	–none–
tile	Lat-lon-cap tile index	–none–
time	Center time of averaging period	–none–
XC	Longitude of tracer grid cell center	degrees_east
YC	Latitude of tracer grid cell center	degrees_north
XG	Longitude of 'southwest' corner of tracer grid cell	degrees_east
YG	Latitude of 'southwest' corner of tracer grid cell	degrees_north
time_bnds	Time bounds of averaging period	–none–
XC_bnds	Longitudes of tracer grid cell corners	–none–
YC_bnds	Latitudes of tracer grid cell corners	–none–

12.1.2 Native Variable: EXFaqh

Table 12.2: Attributes description of the variable 'EXFaqh' from ATM_SURFACE_TEMP_HUM_WIND_PRES's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFaqh	Atmosphere surface (2 m) specific humidity	kg kg-1
Description of the variable in Common Data language (CDL)			

```
float32 EXFaqh(time, tile, j, i)
   EXFaqh:  _FillValue = 9.96921e+36
   EXFaqh:  long_name = Atmosphere surface (2 m) specific humidity
   EXFaqh:  units = kg kg:  1
   EXFaqh:  coverage_content_type = modelResult
   EXFaqh:  standard_name = surface_specific_humidity
   EXFaqh:  coordinates = time XC YC
   EXFaqh:  valid_min = :  0.0014020215021446347
   EXFaqh:  valid_max = 0.03014513850212097
```

Comments

Surface (2 m) specific humidity over open water. note: sum of era-interim surface specific humidity and the control adjustment from ocean state estimation.

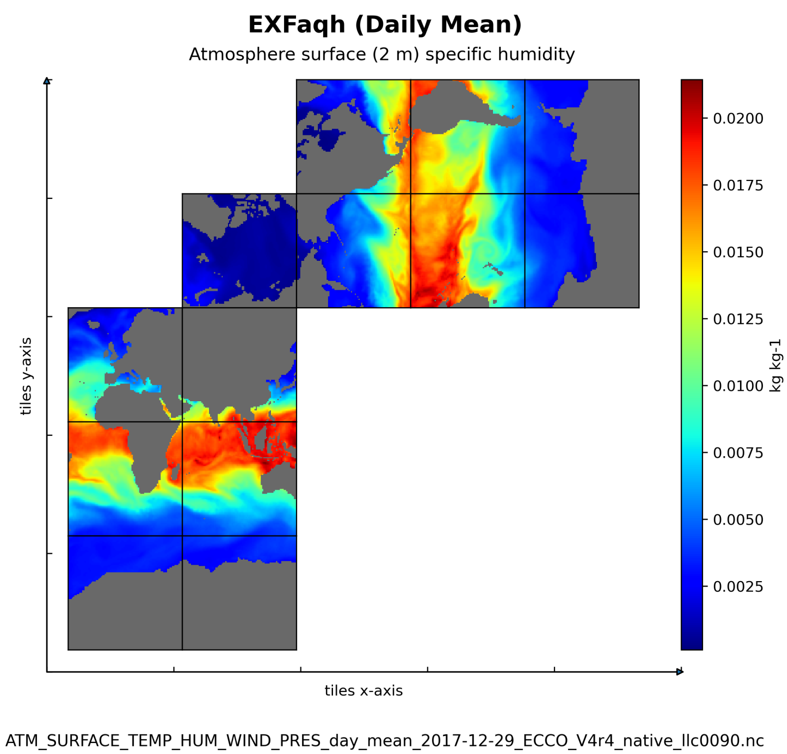

Figure 22: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFaqh

12.1.3 Native Variable: EXFatemp

Table 12.3: Attributes description of the variable 'EXFatemp' from ATM_SURFACE_TEMP_HUM_WIND_PRES's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFatemp	Atmosphere surface (2 m) air temperature	degree_K
Description of the variable in Common Data language (CDL)			

```
float32 EXFatemp(time, tile, j, i)
   EXFatemp:  _FillValue = 9.96921e+36
   EXFatemp:  long_name = Atmosphere surface (2 m) air temperature
   EXFatemp:  units = degree_K
   EXFatemp:  coverage_content_type = modelResult
   EXFatemp:  standard_name = air_temperature
   EXFatemp:  coordinates = time XC YC
   EXFatemp:  valid_min = 195.37054443359375
   EXFatemp:  valid_max = 312.8451232910156
```

Comments

Surface (2 m) air temperature over open water. note: sum of era-interim surface air temperature and the control adjustment from ocean state estimation.

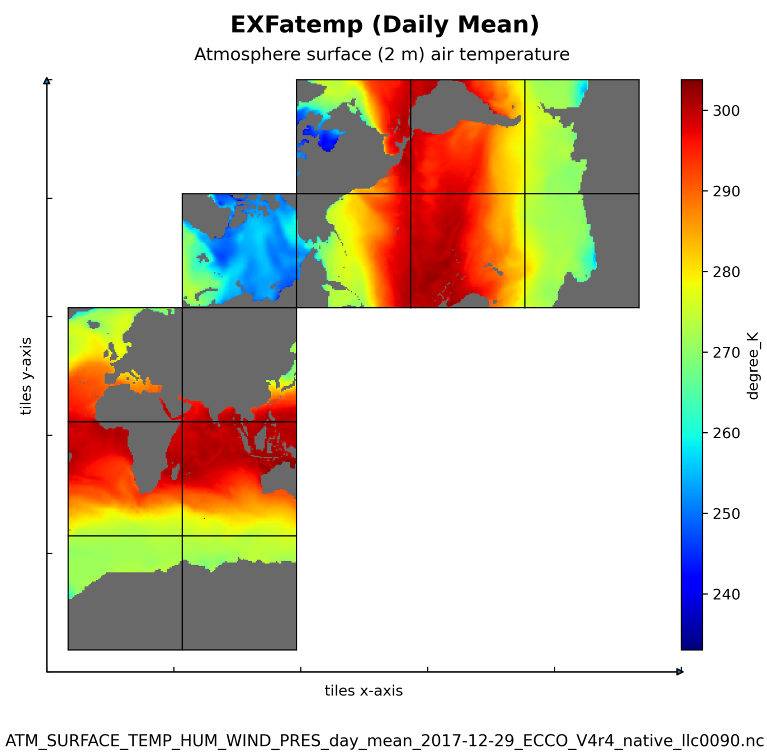

Figure 23: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFatemp

12.1.4 Native Variable: EXFpress

Table 12.4: Attributes description of the variable 'EXFpress' from ATM_SURFACE_TEMP_HUM_WIND_PRES's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFpress	Atmosphere surface pressure	N m-2
Description of the variable in Common Data language (CDL)			

```
float32 EXFpress(time, tile, j, i)
   EXFpress:  _FillValue = 9.96921e+36
   EXFpress:  long_name = Atmosphere surface pressure
   EXFpress:  units = N m:  2
   EXFpress:  coverage_content_type = modelResult
   EXFpress:  standard_name = surface_air_pressure
   EXFpress:  coordinates = time XC YC
   EXFpress:  valid_min = 92044.171875
   EXFpress:  valid_max = 106314.7734375
```

Comments
Atmospheric pressure field at sea level. note: era-interim atmospheric pressure, with air tides removed using a variety of methods. not adjusted by the ocean state estimation.

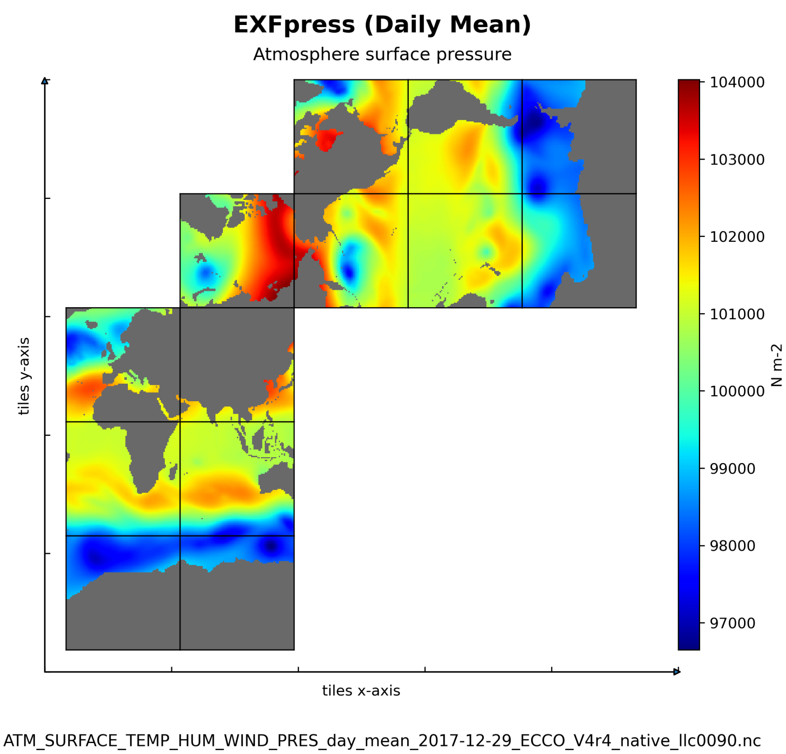

Figure 24: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFpress

12.1.5 Native Variable: EXFuwind

Table 12.5: Attributes description of the variable 'EXFuwind' from ATM_SURFACE_TEMP_HUM_WIND_PRES's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFuwind	Wind speed at 10m in the model +x direction	m s-1

Description of the variable in Common Data language (CDL)

```
float32 EXFuwind(time, tile, j, i)
   EXFuwind:  _FillValue = 9.96921e+36
   EXFuwind:  long_name = Wind speed at 10m in the model +x direction
   EXFuwind:  units = m s:  1
   EXFuwind:  coverage_content_type = modelResult
   EXFuwind:  standard_name = x_wind
   EXFuwind:  coordinates = time XC YC
   EXFuwind:  valid_min = :  34.528900146484375
   EXFuwind:  valid_max = 29.92486572265625
```

Comments

Wind speed at 10m in the +x direction at the tracer cell on the native model grid. note: ecco v4r4 is forced with wind stress (see exftaux) not vector winds converted to wind stress using bulk formulae. exfuwind is calculated by converting wind stress to vector wind using bulk formulae.

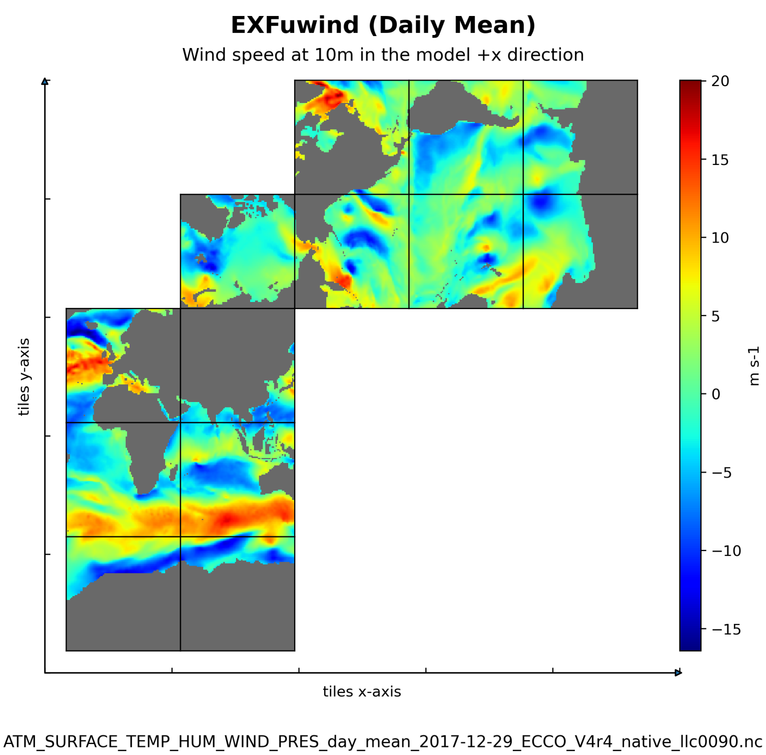

Figure 25: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFuwind

12.1.6 Native Variable: EXFvwind

Table 12.6: Attributes description of the variable 'EXFvwind' from ATM_SURFACE_TEMP_HUM_WIND_PRES's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFvwind	Wind speed at 10m in the model +y direction	m s-1

Description of the variable in Common Data language (CDL)

```
float32 EXFvwind(time, tile, j, i)
   EXFvwind:  _FillValue = 9.96921e+36
   EXFvwind:  long_name = Wind speed at 10m in the model +y direction
   EXFvwind:  units = m s:  1
   EXFvwind:  coverage_content_type = modelResult
   EXFvwind:  standard_name = y_wind
   EXFvwind:  coordinates = time XC YC
   EXFvwind:  valid_min = :  27.9254093170166
   EXFvwind:  valid_max = 45.065101623535156
```

Comments

Wind speed at 10m in the +y direction at the tracer cell on the native model grid. note: ecco v4r4 is forced with wind stress (see exftauy) not vector winds converted to wind stress using bulk formulae. exfvwind is calculated by converting wind stress to vector wind using bulk formulae.

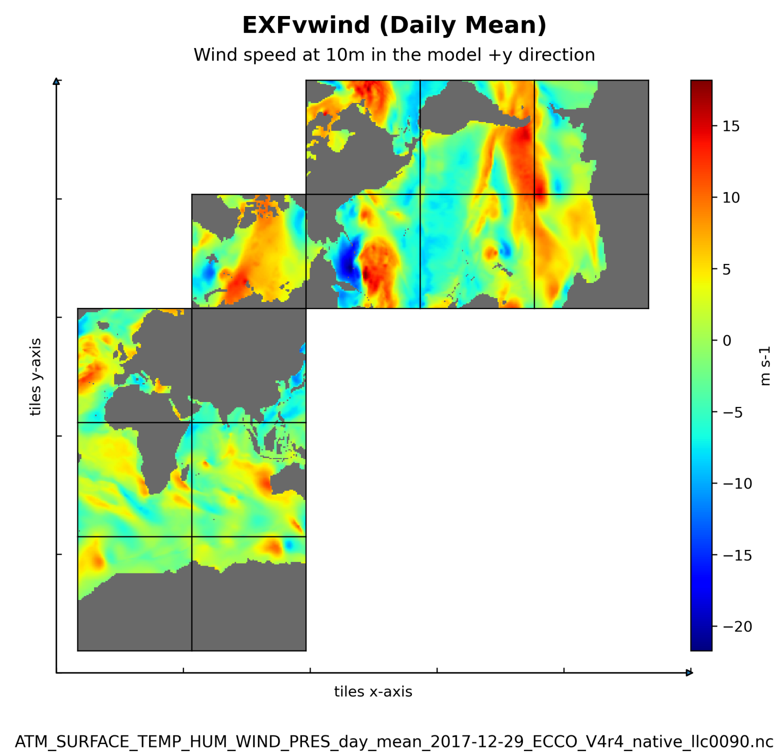

Figure 26: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFvwind

12.1.7 Native Variable: EXFwspee

Table 12.7: Attributes description of the variable 'EXFwspee' from ATM_SURFACE_TEMP_HUM_WIND_PRES's dataset.

<table>
<tr><th>Storage Type</th><th>Variable Name</th><th>Description</th><th>Unit</th></tr>
<tr><td>float32</td><td>EXFwspee</td><td>Wind speed</td><td>m s-1</td></tr>
<tr><th colspan="4">Description of the variable in Common Data language (CDL)</th></tr>
<tr><td colspan="4"><pre>float32 EXFwspee(time, tile, j, i)
   EXFwspee: _FillValue = 9.96921e+36
   EXFwspee: long_name = Wind speed
   EXFwspee: units = m s: 1
   EXFwspee: coverage_content_type = modelResult
   EXFwspee: standard_name = wind_speed
   EXFwspee: coordinates = time XC YC
   EXFwspee: valid_min = 0.27271032333374023
   EXFwspee: valid_max = 45.87086486816406</pre></td></tr>
<tr><th colspan="4">Comments</th></tr>
<tr><td colspan="4">10-m wind speed magnitude (>= 0) over open water. only used for the calculation of air-sea fluxes using bulk formulae. note: not adjusted by the ocean state estimation and not necesarily consistent with exfuwind and exfvwind because exfuwind and exfvwind are calculated from exftaux and exftauy using bulk formulae. exfwspee != sqrt(exfuwind**2 + exfvwind**2.</td></tr>
</table>

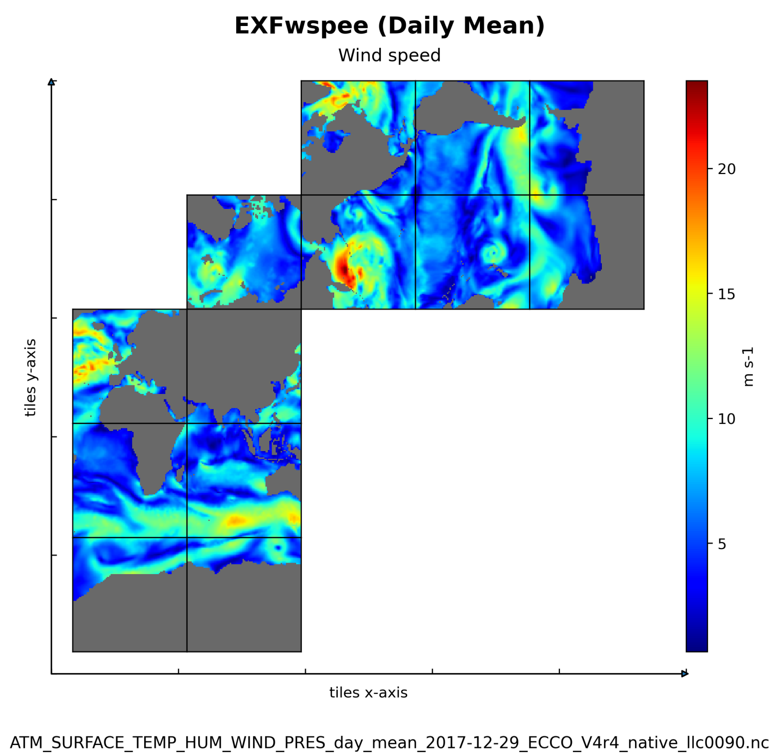

Figure 27: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFwspee

12.2 Native dataset of OCEAN_3D_MIXING_COEFFS

12.2.1 Overview

This dataset provides 3D time-invariant coefficients for the Gent-McWilliams and Redi parameterizations and background vertical diffusivity on the lat-lon-cap 90 (llc90) native model grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate.

Table 12.8: Coordinates and Variables in the dataset OCEAN_3D_MIXING_COEFFS_ECCO

Variables	Description of data variables	Unit
DIFFKR	Vertical diffusivity	m2 s-1
KAPGM	Gent-mcwilliams diffusivity	m2 s-1
KAPREDI	Along-isopycnal diffusivity	m2 s-1
Coordinates	**Description of data coordinates**	**Unit**
i	Grid index in x for variables at tracer and 'v' locations	–none–
i_g	Grid index in x for variables at 'u' and 'g' locations	–none–
j	Grid index in y for variables at tracer and 'u' locations	–none–
j_g	Grid index in y for variables at 'v' and 'g' locations	–none–
k	Grid index in z for tracer variables	–none–
k_u	Grid index in z corresponding to the bottom face of tracer grid cells ('w' locations)	–none–
k_l	Grid index in z corresponding to the top face of tracer grid cells ('w' locations)	–none–
k_p1	Grid index in z for variables at 'w' locations	–none–
tile	Lat-lon-cap tile index	–none–
XC	Longitude of tracer grid cell center	degrees_east
YC	Latitude of tracer grid cell center	degrees_north
XG	Longitude of 'southwest' corner of tracer grid cell	degrees_east
YG	Latitude of 'southwest' corner of tracer grid cell	degrees_north
Z	Depth of tracer grid cell center	m
Zp1	Depth of top/bottom face of tracer grid cell	m
Zu	Depth of bottom face of tracer grid cell	m
Zl	Depth of top face of tracer grid cell	m
XC_bnds	Longitudes of tracer grid cell corners	–none–
YC_bnds	Latitudes of tracer grid cell corners	–none–
Z_bnds	Depths of top and bottom faces of tracer grid cell	–none–

12.2.2 Native Variable: DIFFKR

Table 12.9: Attributes description of the variable 'DIFFKR' from OCEAN_3D_MIXING_COEFFS's dataset.

Storage Type	Variable Name	Description	Unit
float32	DIFFKR	Vertical diffusivity	m2 s-1
Description of the variable in Common Data language (CDL)			

`float32 DIFFKR(k, tile, j, i)`
`DIFFKR: _FillValue = 9.96921e+36`
`DIFFKR: coverage_content_type = modelResult`
`DIFFKR: long_name = Vertical diffusivity`
`DIFFKR: units = m2 s:  1`
`DIFFKR: valid_min = 1e:  06`
`DIFFKR: valid_max = 0.0001854995`
`DIFFKR: coordinates = Z XC YC`			

Comments			
Background vertical diffusion coefficient for temperature and salinity. total vertical diffusivity includes background diffusivity plus contributions from the ggl90 vertical mixing and the gent-mcwilliams/redi parameterizations. note: diffkr is a model control variable and has been optimized from a spatially-invariant first-guess value of 1e-5 m2 s-1.			

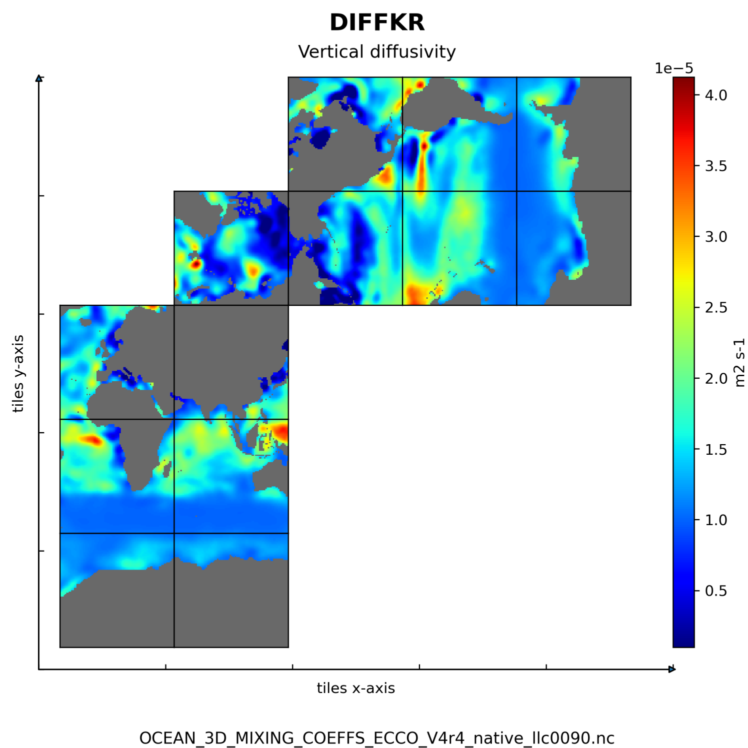

Figure 28: Dataset: OCEAN_3D_MIXING_COEFFS, Variable: DIFFKR

12.2.3 Native Variable: KAPGM

Table 12.10: Attributes description of the variable 'KAPGM' from OCEAN_3D_MIXING_COEFFS's dataset.

Storage Type	Variable Name	Description	Unit
float32	KAPGM	Gent-mcwilliams diffusivity	m2 s-1
Description of the variable in Common Data language (CDL)			

```
float32 KAPGM(k, tile, j, i)
   KAPGM: _FillValue = 9.96921e+36
   KAPGM: coverage_content_type = modelResult
   KAPGM: long_name = Gent:  McWilliams diffusivity
   KAPGM: units = m2 s:  1
   KAPGM: valid_min = 100.0
   KAPGM: valid_max = 10000.0
   KAPGM: coordinates = Z XC YC
```

Comments

Gent-mcwilliams diffusivity coefficient as described in gent and mcwilliams (1990, jpo). note: kapgm is a model control variable and has been optimized from a spatially invariant first guess of 1e3 m2 s-1.

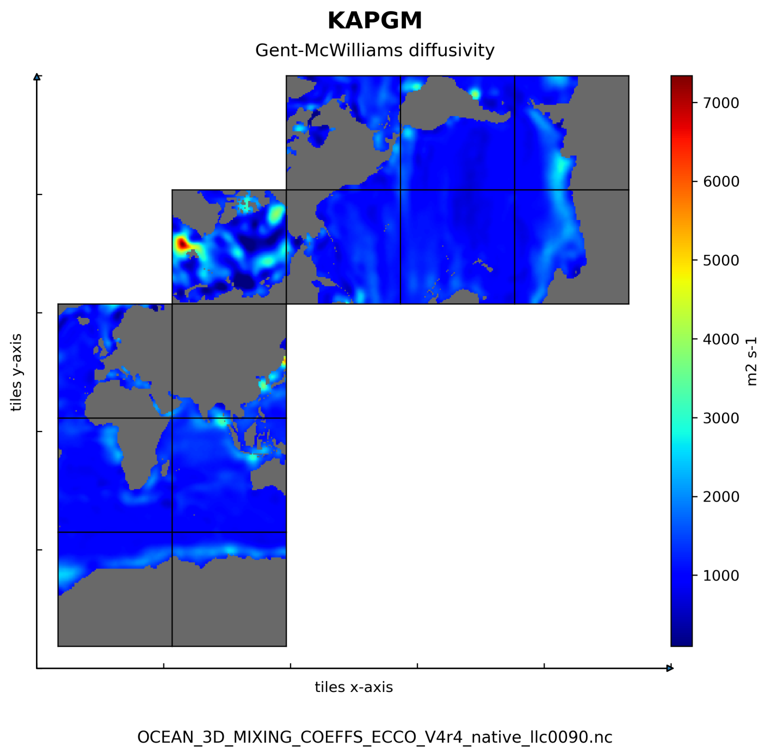

Figure 29: Dataset: OCEAN_3D_MIXING_COEFFS, Variable: KAPGM

12.2.4 Native Variable: KAPREDI

Table 12.11: Attributes description of the variable 'KAPREDI' from OCEAN_3D_MIXING_COEFFS's dataset.

Storage Type	Variable Name	Description	Unit
float32	KAPREDI	Along-isopycnal diffusivity	m2 s-1
Description of the variable in Common Data language (CDL)			

`float32 KAPREDI(k, tile, j, i)`
`KAPREDI: _FillValue = 9.96921e+36`
`KAPREDI: coverage_content_type = modelResult`
`KAPREDI: long_name = Along: isopycnal diffusivity`
`KAPREDI: units = m2 s: 1`
`KAPREDI: valid_min = 100.0`
`KAPREDI: valid_max = 10000.0`
`KAPREDI: coordinates = Z XC YC`			

Comments			
Redi along-isopycnal diffusivity coefficient as described in redi (1982, jpo). note: kapredi is a model control variable and has been optimized from a spatially invariant first guess of 1e3 m2 s-1.			

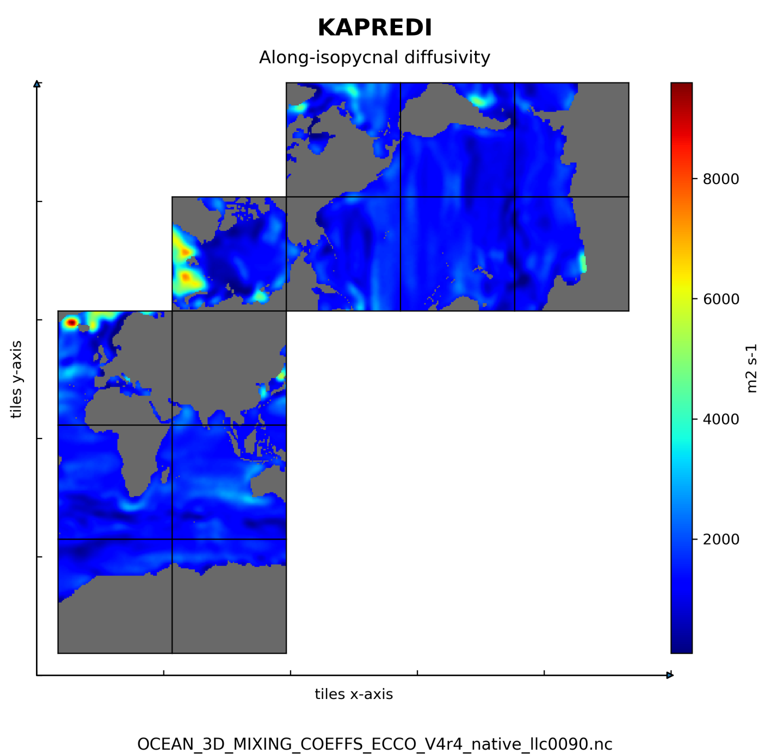

Figure 30: Dataset: OCEAN_3D_MIXING_COEFFS, Variable: KAPREDI

12.3 Native dataset of OCEAN_3D_MOMENTUM_TEND

12.3.1 Overview

This dataset provides three-dimensional ocean momentum tendency on the lat-lon-cap 90 (llc90) native model grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution.

Table 12.12: Coordinates and Variables in the dataset OCEAN_3D_MOMENTUM_TEND

Variables	Description of data variables	Unit
Um_dPHdx	Momentum tendency in the model +x direction	m s-2
Vm_dPHdy	Momentum tendency in the model +y direction	m s-2
Coordinates	**Description of data coordinates**	**Unit**
i	Grid index in x for variables at tracer and 'v' locations	–none–
i_g	Grid index in x for variables at 'u' and 'g' locations	–none–
j	Grid index in y for variables at tracer and 'u' locations	–none–
j_g	Grid index in y for variables at 'v' and 'g' locations	–none–
k	Grid index in z for tracer variables	–none–
k_u	Grid index in z corresponding to the bottom face of tracer grid cells ('w' locations)	–none–
k_l	Grid index in z corresponding to the top face of tracer grid cells ('w' locations)	–none–
k_p1	Grid index in z for variables at 'w' locations	–none–
tile	Lat-lon-cap tile index	–none–
time	Center time of averaging period	–none–
XC	Longitude of tracer grid cell center	degrees_east
YC	Latitude of tracer grid cell center	degrees_north
XG	Longitude of 'southwest' corner of tracer grid cell	degrees_east
YG	Latitude of 'southwest' corner of tracer grid cell	degrees_north
Z	Depth of tracer grid cell center	m
Zp1	Depth of tracer grid cell interface	m
Zu	Depth of the bottom face of tracer grid cells	m
Zl	Depth of the top face of tracer grid cells	m
time_bnds	Time bounds of averaging period	–none–
XC_bnds	Longitudes of tracer grid cell corners	–none–
YC_bnds	Latitudes of tracer grid cell corners	–none–
Z_bnds	Depths of tracer grid cell upper and lower interfaces	–none–

12.3.2 Native Variable: Um_dPHdx

Table 12.13: Attributes description of the variable 'Um_dPHdx' from OCEAN_3D_MOMENTUM_TEND's dataset.

Storage Type	Variable Name	Description	Unit
float32	Um_dPHdx	Momentum tendency in the model +x direction	m s-2
Description of the variable in Common Data language (CDL)			

`float32 Um_dPHdx(time, k, tile, j, i_g)`
`Um_dPHdx: _FillValue = 9.96921e+36`
`Um_dPHdx: long_name = Momentum tendency in the model +x direction`
`Um_dPHdx: units = m s: 2`
`Um_dPHdx: mate = Vm_dPHdy`
`Um_dPHdx: coverage_content_type = modelResult`
`Um_dPHdx: coordinates = time Z`
`Um_dPHdx: valid_min = : 0.0010651482734829187`
`Um_dPHdx: valid_max = 0.0011411579325795174`			

Comments			
Momentum tendency in the +x direction due to the hydrostatic pressure gradient at the 'u' face of the native model grid cell . note: the model +x direction does not necessarily correspond to the geographical east-west direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.			

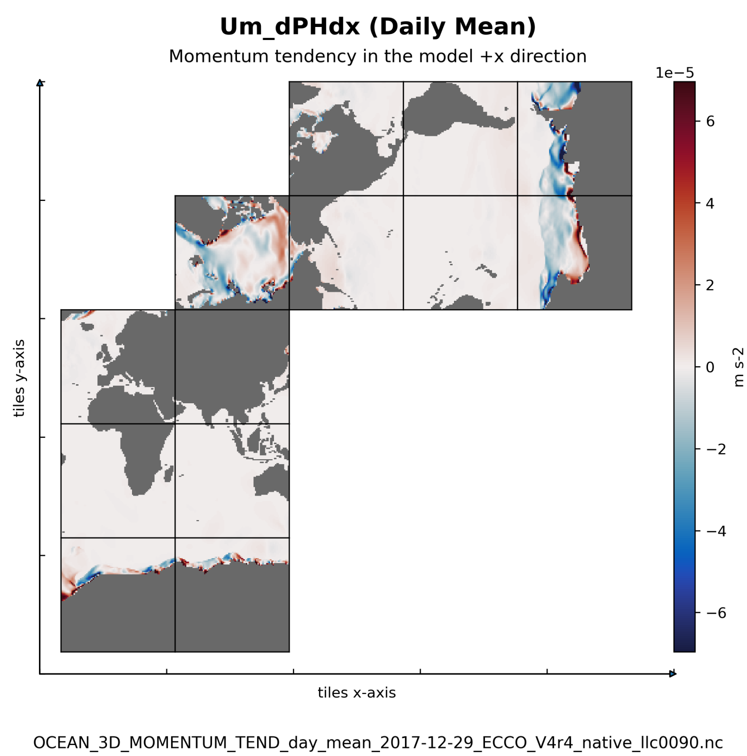

Figure 31: Dataset: OCEAN_3D_MOMENTUM_TEND, Variable: Um_dPHdx

12.3.3 Native Variable: Vm_dPHdy

Table 12.14: Attributes description of the variable 'Vm_dPHdy' from OCEAN_3D_MOMENTUM_TEND's dataset.

Storage Type	Variable Name	Description	Unit
float32	Vm_dPHdy	Momentum tendency in the model +y direction	m s-2
Description of the variable in Common Data language (CDL)			

`float32 Vm_dPHdy(time, k, tile, j_g, i)`
`Vm_dPHdy: _FillValue = 9.96921e+36`
`Vm_dPHdy: long_name = Momentum tendency in the model +y direction`
`Vm_dPHdy: units = m s: 2`
`Vm_dPHdy: mate = Um_dPHdx`
`Vm_dPHdy: coverage_content_type = modelResult`
`Vm_dPHdy: coordinates = time Z`
`Vm_dPHdy: valid_min = : 0.0015932790702208877`
`Vm_dPHdy: valid_max = 0.0008858146029524505`			

Comments			
Momentum tendency in the +y direction due to the hydrostatic pressure gradient at the 'v' face of the native model grid cell . note: the model +y direction does not necessarily correspond to the geographical north-south direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.			

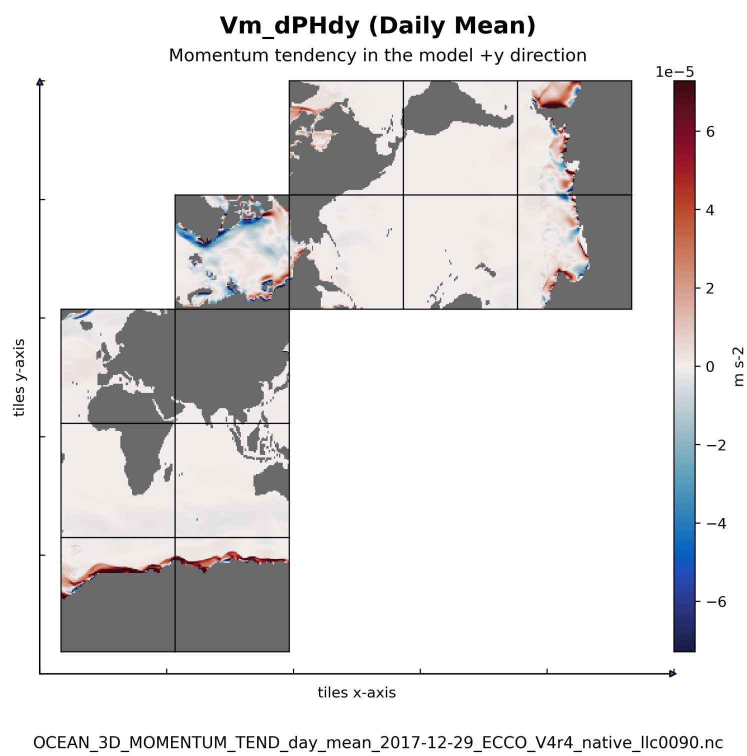

Figure 32: Dataset: OCEAN_3D_MOMENTUM_TEND, Variable: Vm_dPHdy

12.4 Native dataset of OCEAN_3D_SALINITY_FLUX

12.4.1 Overview

This dataset provides three-dimensional ocean salinity fluxes on the lat-lon-cap 90 (llc90) native model grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution. ADV*_SLT and DF*_SLT terms are salinity fluxes. oceSPtnd is salt tendency per unit area (g m-2 s-1), not salinity flux.

Table 12.15: Coordinates and Variables in the dataset OCEAN_3D_SALINITY_FLUX

Variables	Description of data variables	Unit
ADVx_SLT	Lateral advective flux of salinity in the model +x direction	1e-3 m3 s-1
DFxE_SLT	Lateral diffusive flux of salinity in the model +x direction	1e-3 m3 s-1
ADVy_SLT	Lateral advective flux of salinity in the model +y direction	1e-3 m3 s-1
DFyE_SLT	Lateral diffusive flux of salinity in the model +y direction	1e-3 m3 s-1
ADVr_SLT	Vertical advective flux of salinity	1e-3 m3 s-1
DFrE_SLT	Vertical diffusive flux of salinity (explicit term)	1e-3 m3 s-1
DFrI_SLT	Vertical diffusive flux of salinity (implicit term)	1e-3 m3 s-1
oceSPtnd	Salt tendency due to the vertical transport of salt in high-salinity brine plumes	g m-2 s-1
Coordinates	**Description of data coordinates**	**Unit**
i	Grid index in x for variables at tracer and 'v' locations	–none–
i_g	Grid index in x for variables at 'u' and 'g' locations	–none–
j	Grid index in y for variables at tracer and 'u' locations	–none–
j_g	Grid index in y for variables at 'v' and 'g' locations	–none–
k	Grid index in z for tracer variables	–none–
k_u	Grid index in z corresponding to the bottom face of tracer grid cells ('w' locations)	–none–
k_l	Grid index in z corresponding to the top face of tracer grid cells ('w' locations)	–none–
k_p1	Grid index in z for variables at 'w' locations	–none–
tile	Lat-lon-cap tile index	–none–
time	Center time of averaging period	–none–
XC	Longitude of tracer grid cell center	degrees_east
YC	Latitude of tracer grid cell center	degrees_north
XG	Longitude of 'southwest' corner of tracer grid cell	degrees_east
YG	Latitude of 'southwest' corner of tracer grid cell	degrees_north
Z	Depth of tracer grid cell center	m
Zp1	Depth of tracer grid cell interface	m
Zu	Depth of the bottom face of tracer grid cells	m
Zl	Depth of the top face of tracer grid cells	m
time_bnds	Time bounds of averaging period	–none–
XC_bnds	Longitudes of tracer grid cell corners	–none–
YC_bnds	Latitudes of tracer grid cell corners	–none–
Z_bnds	Depths of tracer grid cell upper and lower interfaces	–none–

12.4.2 Native Variable: ADVr_SLT

Table 12.16: Attributes description of the variable 'ADVr_SLT' from OCEAN_3D_SALINITY_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	ADVr_SLT	Vertical advective flux of salinity	1e-3 m3 s-1
Description of the variable in Common Data language (CDL)			
float32 ADVr_SLT(time, k_l, tile, j, i) ADVr_SLT: _FillValue = 9.96921e+36 ADVr_SLT: long_name = Vertical advective flux of salinity ADVr_SLT: units = 1e: 3 m3 s: 1 ADVr_SLT: coverage_content_type = modelResult ADVr_SLT: direction = >0 decreases salinity (SALT) ADVr_SLT: coordinates = XC Zl YC time ADVr_SLT: valid_min = : 324149856.0 ADVr_SLT: valid_max = 263294624.0			
Comments			
Vertical advective flux of salinity (salt) in the +z direction through the top 'w' face of the tracer cell on the native model grid. note: in the arakawa-c grid, vertical flux quantities are staggered relative to the tracer cells with indexing such that +advr_slt(i,j,k_l) corresponds to upward +z fluxes through the top 'w' face of the tracer cell at (i,j,k). salinity defined using cf convention 'sea water salinity is the salt content of sea water, often on the practical salinity scale of 1978. however, the unqualified term 'salinity' is generic and does not necessarily imply any particular method of calculation. the units of salinity are dimensionless and the units attribute should normally be given as 1e-3 or 0.001 i.e. parts per thousand.' see https://cfconventions.org/data/cf-standard-names/73/build/cf-standard-name-table.html			

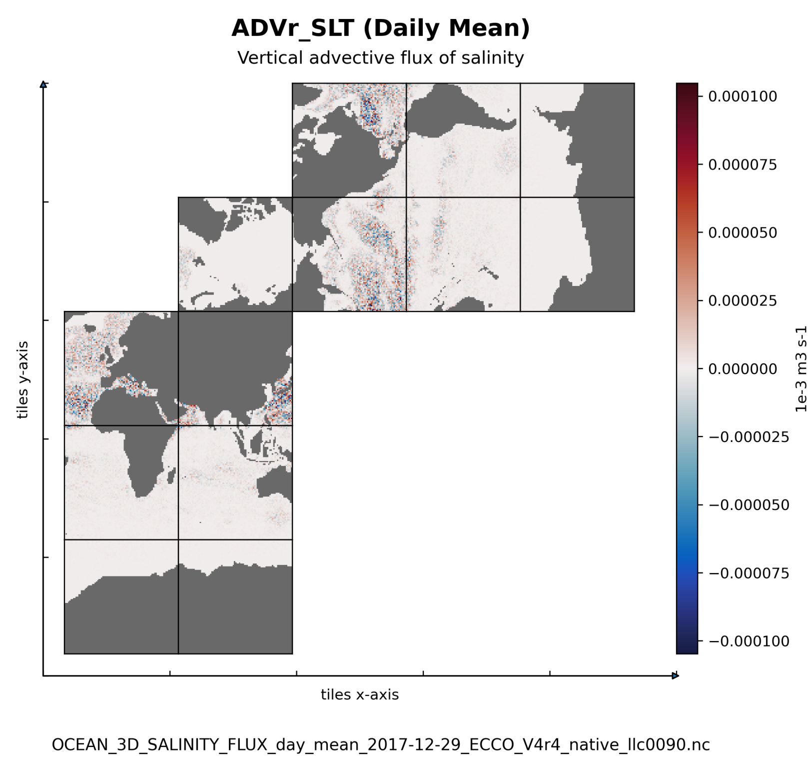

Figure 33: Dataset: OCEAN_3D_SALINITY_FLUX, Variable: ADVr_SLT

12.4.3 Native Variable: ADVx_SLT

Table 12.17: Attributes description of the variable 'ADVx_SLT' from OCEAN_3D_SALINITY_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	ADVx_SLT	Lateral advective flux of salinity in the model +x direction	1e-3 m3 s-1

Description of the variable in Common Data language (CDL)

```
float32 ADVx_SLT(time, k, tile, j, i_g)
   ADVx_SLT: _FillValue = 9.96921e+36
   ADVx_SLT: long_name = Lateral advective flux of salinity in the model +x
direction
   ADVx_SLT: units = 1e:  3 m3 s:  1
   ADVx_SLT: mate = ADVy_SLT
   ADVx_SLT: coverage_content_type = modelResult
   ADVx_SLT: direction = >0 increases salinity (SALT)
   ADVx_SLT: coordinates = Z time
   ADVx_SLT: valid_min = :  181830224.0
   ADVx_SLT: valid_max = 260411296.0
```

Comments

Lateral advective flux of salinity (salt) in the +x direction through the 'u' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +advx_slt(i_g,j,k) corresponds to +x fluxes through the 'u' face of the tracer cell at (i,j,k). also, the model +x direction does not necessarily correspond to the geographical east-west direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles. salinity defined using cf convention 'sea water salinity is the salt content of sea water, often on the practical salinity scale of 1978. however, the unqualified term 'salinity' is generic and does not necessarily imply any particular method of calculation. the units of salinity are dimensionless and the units attribute should normally be given as 1e-3 or 0.001 i.e. parts per thousand.' see https://cfconventions.org/data/cf-standard-names/73/build/cf-standard-name-table.html

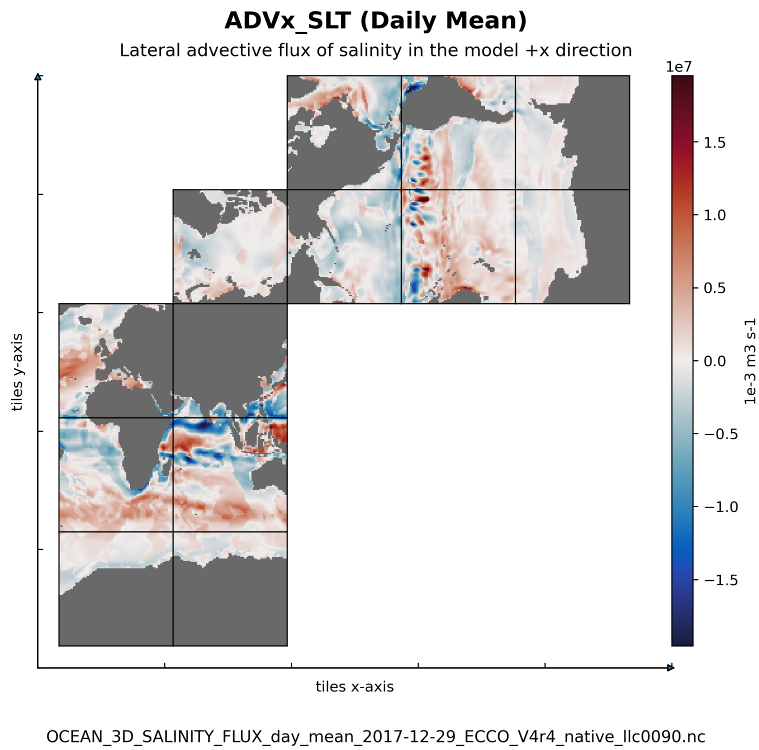

Figure 34: Dataset: OCEAN_3D_SALINITY_FLUX, Variable: ADVx_SLT

12.4.4 Native Variable: ADVy_SLT

Table 12.18: Attributes description of the variable 'ADVy_SLT' from OCEAN_3D_SALINITY_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	ADVy_SLT	Lateral advective flux of salinity in the model +y direction	1e-3 m3 s-1

Description of the variable in Common Data language (CDL)

```
float32 ADVy_SLT(time, k, tile, j_g, i)
   ADVy_SLT: _FillValue = 9.96921e+36
   ADVy_SLT: long_name = Lateral advective flux of salinity in the model +y
direction
   ADVy_SLT: units = 1e:  3 m3 s:  1
   ADVy_SLT: mate = ADVx_SLT
   ADVy_SLT: coverage_content_type = modelResult
   ADVy_SLT: direction = >0 increases salinity (SALT)
   ADVy_SLT: coordinates = Z time
   ADVy_SLT: valid_min = :  137905760.0
   ADVy_SLT: valid_max = 164271664.0
```

Comments

Lateral advective flux of salinity (salt) in the +y direction through the 'v' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +advy_slt(i,j_g,k) corresponds to +y fluxes through the 'v' face of the tracer cell at (i,j,k). also, the model +y direction does not necessarily correspond to the geographical north-south direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles. salinity defined using cf convention 'sea water salinity is the salt content of sea water, often on the practical salinity scale of 1978. however, the unqualified term 'salinity' is generic and does not necessarily imply any particular method of calculation. the units of salinity are dimensionless and the units attribute should normally be given as 1e-3 or 0.001 i.e. parts per thousand.' see https://cfconventions.org/data/cf-standard-names/73/build/cf-standard-name-table.html

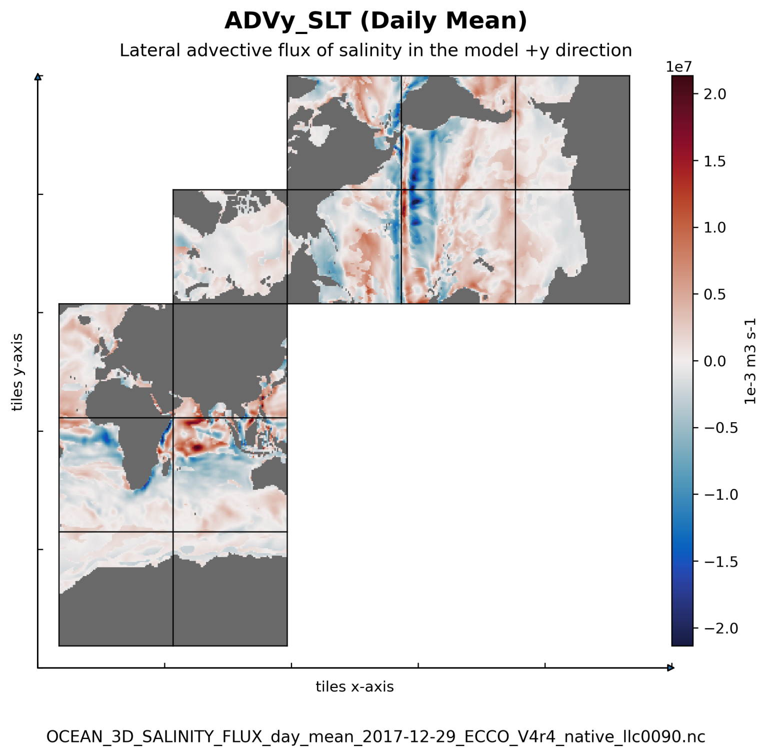

Figure 35: Dataset: OCEAN_3D_SALINITY_FLUX, Variable: ADVy_SLT

12.4.5 Native Variable: DFrE_SLT

Table 12.19: Attributes description of the variable 'DFrE_SLT' from OCEAN_3D_SALINITY_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	DFrE_SLT	Vertical diffusive flux of salinity (explicit term)	1e-3 m3 s-1

Description of the variable in Common Data language (CDL)

```
float32 DFrE_SLT(time, k_l, tile, j, i)
   DFrE_SLT: _FillValue = 9.96921e+36
   DFrE_SLT: long_name = Vertical diffusive flux of salinity (explicit term)
   DFrE_SLT: units = 1e:  3 m3 s:  1
   DFrE_SLT: coverage_content_type = modelResult
   DFrE_SLT: direction = >0 decreases salinity (SALT)
   DFrE_SLT: coordinates = XC Zl YC time
   DFrE_SLT: valid_min = :  1074719.375
   DFrE_SLT: valid_max = 471215.75
```

Comments

The explicit term of the vertical diffusive flux of salinity (salt) in the +z direction through the top 'w' face of the tracer cell on the native model grid. in the ecco v4r4 model, an implicit scheme is used to calculate vertical diffusive tracer fluxes due to background diffusivity and the kwz component of the gm-redi tensor (vertical flux as a function of vertical gradient) while an explicit scheme is used to calculate the vertical diffusive fluxes from the kwx and kwy components of the gm-redi tensor (vertical flux as a function of horizontal gradient). both implicit and explicit components of vertical diffusive flux of salinity are provided. note: in the arakawa-c grid, vertical flux quantities are staggered relative to the tracer cells with indexing such that +dfre_slt(i,j,k_l) corresponds to upward +z fluxes through the top 'w' face of the tracer cell at (i,j,k). salinity defined using cf convention 'sea water salinity is the salt content of sea water, often on the practical salinity scale of 1978. however, the unqualified term 'salinity' is generic and does not necessarily imply any particular method of calculation. the units of salinity are dimensionless and the units attribute should normally be given as 1e-3 or 0.001 i.e. parts per thousand.' see https://cfconventions.org/data/cf-standard-names/73/build/cf-standard-name-table.html

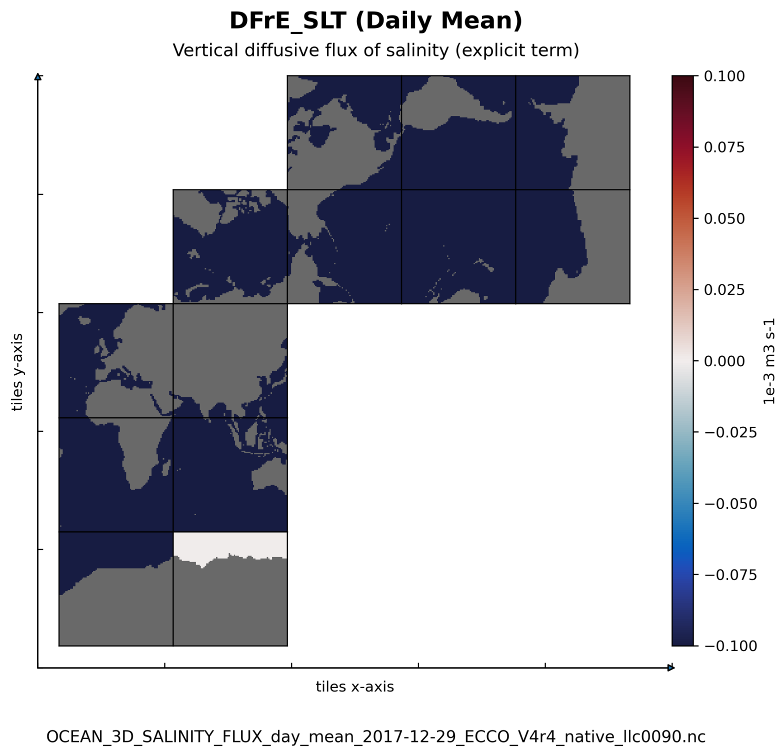

Figure 36: Dataset: OCEAN_3D_SALINITY_FLUX, Variable: DFrE_SLT

12.4.6 Native Variable: DFrI_SLT

Table 12.20: Attributes description of the variable 'DFrI_SLT' from OCEAN_3D_SALINITY_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	DFrI_SLT	Vertical diffusive flux of salinity (implicit term)	1e-3 m3 s-1

Description of the variable in Common Data language (CDL)

```
float32 DFrI_SLT(time, k_l, tile, j, i)
   DFrI_SLT: _FillValue = 9.96921e+36
   DFrI_SLT: long_name = Vertical diffusive flux of salinity (implicit term)
   DFrI_SLT: units = 1e:  3 m3 s:  1
   DFrI_SLT: coverage_content_type = modelResult
   DFrI_SLT: direction = >0 decreases salinity (SALT)
   DFrI_SLT: coordinates = XC Zl YC time
   DFrI_SLT: valid_min = :  30609048.0
   DFrI_SLT: valid_max = 3197643.0
```

Comments

The implicit term of the vertical diffusive flux of salinity (salt) in the +z direction through the top 'w' face of the tracer cell on the native model grid. in the ecco v4r4 model, an implicit scheme is used to calculate vertical diffusive tracer fluxes due to background diffusivity and the kwz component of the gm-redi tensor (vertical flux as a function of vertical gradient) while an explicit scheme is used to calculate the vertical diffusive fluxes from the kwx and kwy components of the gm-redi tensor (vertical flux as a function of horizontal gradient). both implicit and explicit components of vertical diffusive flux of salinity are provided. note: in the arakawa-c grid, vertical flux quantities are staggered relative to the tracer cells with indexing such that +dfri_slt(i,j,k_l) corresponds to upward +z fluxes through the top face 'w' of the tracer cell at (i,j,k). salinity defined using cf convention 'sea water salinity is the salt content of sea water, often on the practical salinity scale of 1978. however, the unqualified term 'salinity' is generic and does not necessarily imply any particular method of calculation. the units of salinity are dimensionless and the units attribute should normally be given as 1e-3 or 0.001 i.e. parts per thousand.' see https://cfconventions.org/data/cf-standard-names/73/build/cf-standard-name-table.html

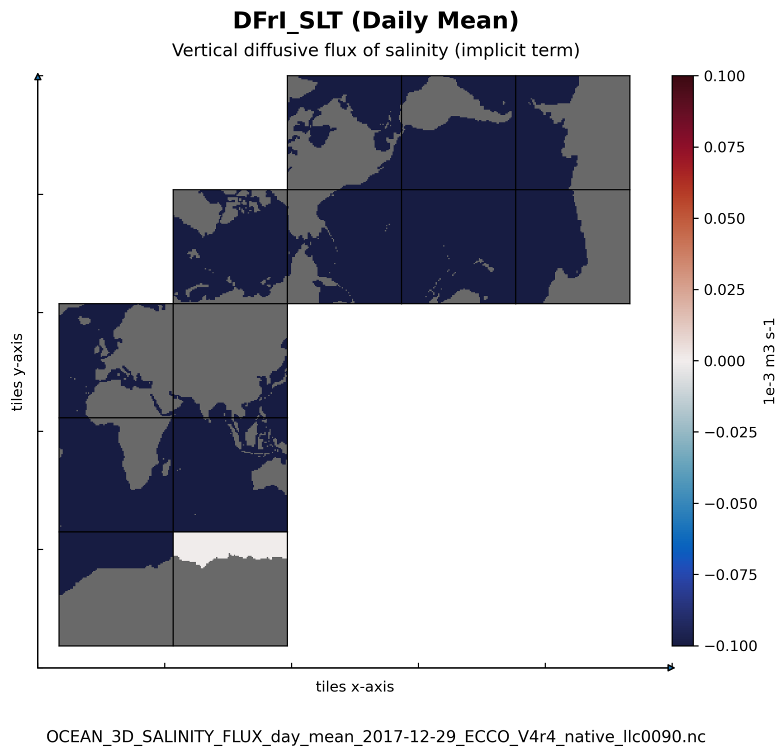

Figure 37: Dataset: OCEAN_3D_SALINITY_FLUX, Variable: DFrI_SLT

12.4.7 Native Variable: DFxE_SLT

Table 12.21: Attributes description of the variable 'DFxE_SLT' from OCEAN_3D_SALINITY_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	DFxE_SLT	Lateral diffusive flux of salinity in the model +x direction	1e-3 m3 s-1

Description of the variable in Common Data language (CDL)

```
float32 DFxE_SLT(time, k, tile, j, i_g)
   DFxE_SLT: _FillValue = 9.96921e+36
   DFxE_SLT: long_name = Lateral diffusive flux of salinity in the model +x
direction
   DFxE_SLT: units = 1e:  3 m3 s:  1
   DFxE_SLT: mate = DFyE_SLT
   DFxE_SLT: coverage_content_type = modelResult
   DFxE_SLT: direction = >0 increases salinity (SALT)
   DFxE_SLT: coordinates = Z time
   DFxE_SLT: valid_min = :  125908.03125
   DFxE_SLT: valid_max = 192716.484375
```

Comments

Lateral diffusive flux of salinity (salt) in the +x direction through the 'u' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +dfxe_slt(i_g,j,k) corresponds to +x fluxes through the 'u' face of the tracer cell at (i,j,k). also, the model +x direction does not necessarily correspond to the geographical east-west direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles. salinity defined using cf convention 'sea water salinity is the salt content of sea water, often on the practical salinity scale of 1978. however, the unqualified term 'salinity' is generic and does not necessarily imply any particular method of calculation. the units of salinity are dimensionless and the units attribute should normally be given as 1e-3 or 0.001 i.e. parts per thousand.' see https://cfconventions.org/data/cf-standard-names/73/build/cf-standard-name-table.html

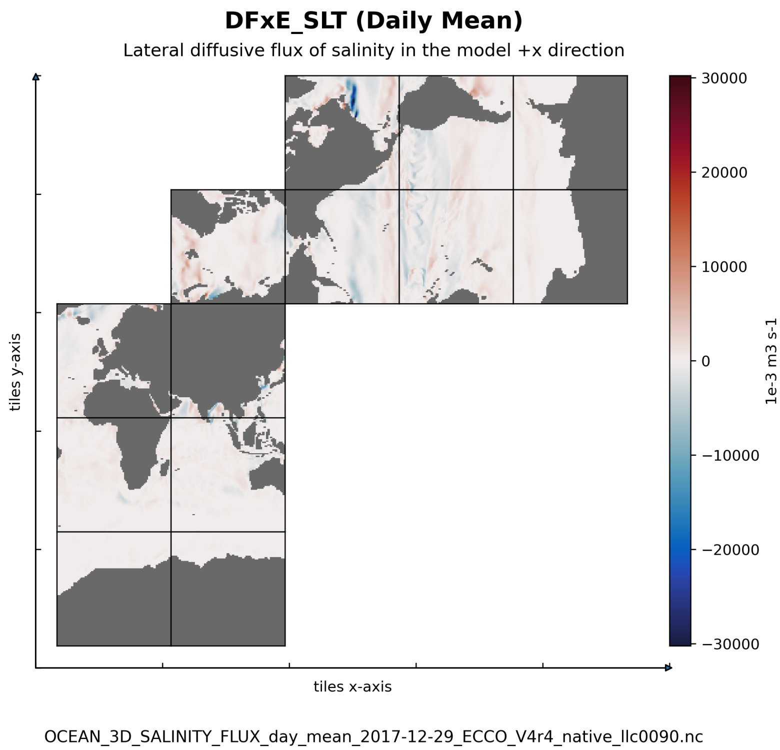

Figure 38: Dataset: OCEAN_3D_SALINITY_FLUX, Variable: DFxE_SLT

12.4.8 Native Variable: DFyE_SLT

Table 12.22: Attributes description of the variable 'DFyE_SLT' from OCEAN_3D_SALINITY_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	DFyE_SLT	Lateral diffusive flux of salinity in the model +y direction	1e-3 m3 s-1

Description of the variable in Common Data language (CDL)

```
float32 DFyE_SLT(time, k, tile, j_g, i)
   DFyE_SLT: _FillValue = 9.96921e+36
   DFyE_SLT: long_name = Lateral diffusive flux of salinity in the model +y
direction
   DFyE_SLT: units = 1e:  3 m3 s:  1
   DFyE_SLT: mate = DFxE_SLT
   DFyE_SLT: coverage_content_type = modelResult
   DFyE_SLT: direction = >0 increases salinity (SALT)
   DFyE_SLT: coordinates = Z time
   DFyE_SLT: valid_min = :  114959.2109375
   DFyE_SLT: valid_max = 154227.140625
```

Comments

Lateral diffusive flux of salinity (salt) in the +y direction through the 'v' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +dfye_slt(i,j_g,k) corresponds to +y fluxes through the 'v' face of the tracer cell at (i,j,k). also, the model +y direction does not necessarily correspond to the geographical north-south direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles. salinity defined using cf convention 'sea water salinity is the salt content of sea water, often on the practical salinity scale of 1978. however, the unqualified term 'salinity' is generic and does not necessarily imply any particular method of calculation. the units of salinity are dimensionless and the units attribute should normally be given as 1e-3 or 0.001 i.e. parts per thousand.' see https://cfconventions.org/data/cf-standard-names/73/build/cf-standard-name-table.html

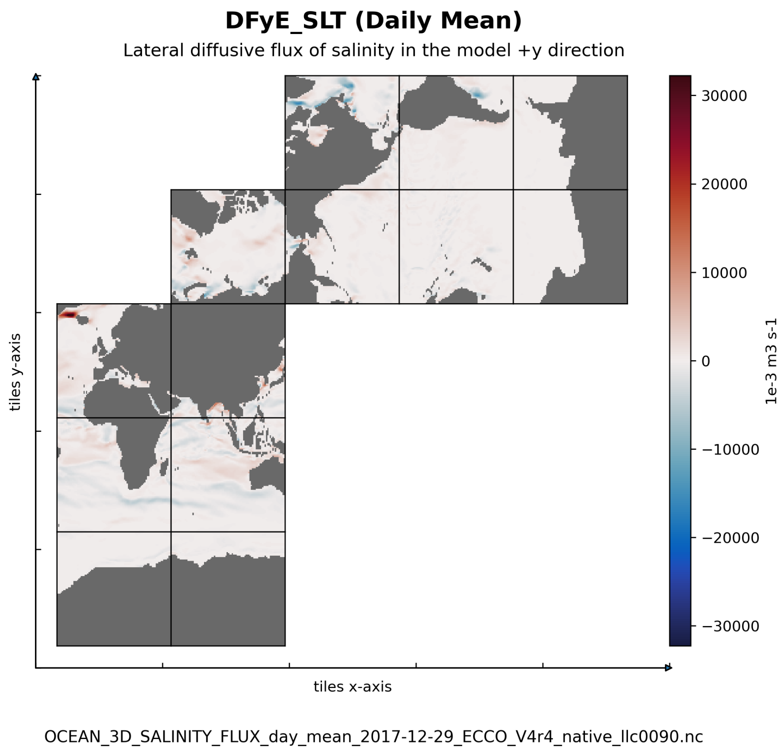

Figure 39: Dataset: OCEAN_3D_SALINITY_FLUX, Variable: DFyE_SLT

12.4.9 Native Variable: oceSPtnd

Table 12.23: Attributes description of the variable 'oceSPtnd' from OCEAN_3D_SALINITY_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	oceSPtnd	Salt tendency due to the vertical transport of salt in high-salinity brine plumes	g m-2 s-1
Description of the variable in Common Data language (CDL)			

```
float32 oceSPtnd(time, k, tile, j, i)
   oceSPtnd:  _FillValue = 9.96921e+36
   oceSPtnd:  long_name = Salt tendency due to the vertical transport of salt in
high:  salinity brine plumes
   oceSPtnd:  units = g m:  2 s:  1
   oceSPtnd:  coverage_content_type = modelResult
   oceSPtnd:  direction = >0 increases salinity (SALT)
   oceSPtnd:  coordinates = XC Z YC time
   oceSPtnd:  valid_min = 0.0
   oceSPtnd:  valid_max = 0.021119138225913048
```

Comments

Salt tendency due to the vertical transport of salt in high-salinity brine plumes. note: units are grams of salt per square meter per second, not salinity per square meter per second.

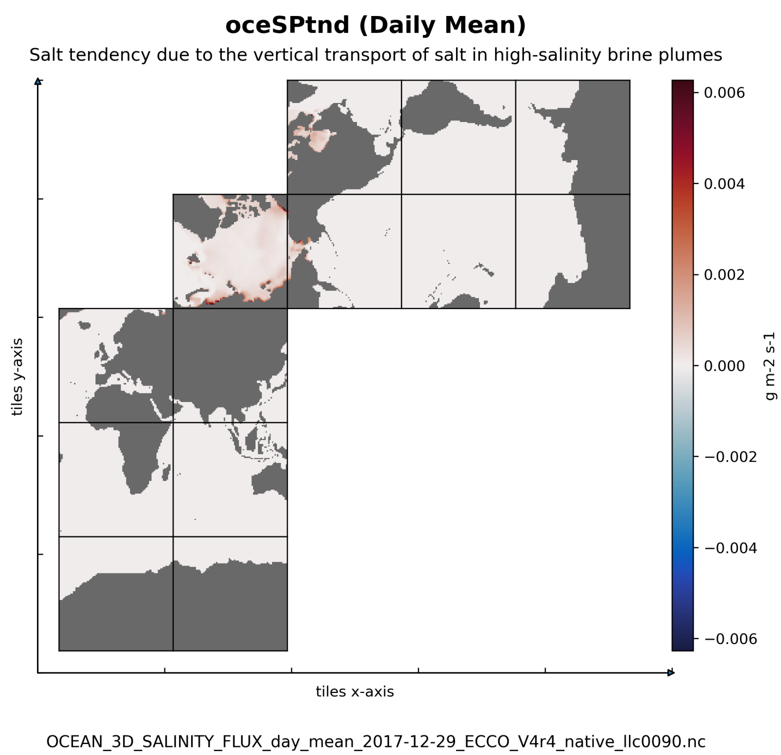

Figure 40: Dataset: OCEAN_3D_SALINITY_FLUX, Variable: oceSPtnd

12.5 Native dataset of OCEAN_3D_TEMPERATURE_FLUX

12.5.1 Overview

This dataset provides three-dimensional ocean potential temperature fluxes on the lat-lon-cap 90 (llc90) native model grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution. ADV*_TH and DF*_TH terms are potential temperature fluxes.

Table 12.24: Coordinates and Variables in the dataset OCEAN_3D_TEMPERATURE_FLUX

Variables	Description of data variables	Unit
ADVx_TH	Lateral advective flux of potential temperature in the model +x direction	degree_C m3 s-1
DFxE_TH	Lateral diffusive flux of potential temperature in the model +x direction	degree_C m3 s-1
ADVy_TH	Lateral advective flux of potential temperature in the model +y direction	degree_C m3 s-1
DFyE_TH	Lateral diffusive flux of potential temperature in the model +y direction.	degree_C m3 s-1
ADVr_TH	Vertical advective flux of potential temperature	degree_C m3 s-1
DFrE_TH	Vertical diffusive flux of potential temperature (explicit term)	degree_C m3 s-1
DFrI_TH	Vertical diffusive flux of potential temperature (implicit term)	degree_C m3 s-1
Coordinates	**Description of data coordinates**	**Unit**
i	Grid index in x for variables at tracer and 'v' locations	–none–
i_g	Grid index in x for variables at 'u' and 'g' locations	–none–
j	Grid index in y for variables at tracer and 'u' locations	–none–
j_g	Grid index in y for variables at 'v' and 'g' locations	–none–
k	Grid index in z for tracer variables	–none–
k_u	Grid index in z corresponding to the bottom face of tracer grid cells ('w' locations)	–none–
k_l	Grid index in z corresponding to the top face of tracer grid cells ('w' locations)	–none–
k_p1	Grid index in z for variables at 'w' locations	–none–
tile	Lat-lon-cap tile index	–none–
time	Center time of averaging period	–none–
XC	Longitude of tracer grid cell center	degrees_east
YC	Latitude of tracer grid cell center	degrees_north
XG	Longitude of 'southwest' corner of tracer grid cell	degrees_east
YG	Latitude of 'southwest' corner of tracer grid cell	degrees_north
Z	Depth of tracer grid cell center	m
Zp1	Depth of tracer grid cell interface	m
Zu	Depth of the bottom face of tracer grid cells	m
Zl	Depth of the top face of tracer grid cells	m
time_bnds	Time bounds of averaging period	–none–
XC_bnds	Longitudes of tracer grid cell corners	–none–
YC_bnds	Latitudes of tracer grid cell corners	–none–
Z_bnds	Depths of tracer grid cell upper and lower interfaces	–none–

12.5.2 Native Variable: ADVr_TH

Table 12.25: Attributes description of the variable 'ADVr_TH' from OCEAN_3D_TEMPERATURE_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	ADVr_TH	Vertical advective flux of potential temperature	degree_C m3 s-1

Description of the variable in Common Data language (CDL)

```
float32 ADVr_TH(time, k_l, tile, j, i)
   ADVr_TH: _FillValue = 9.96921e+36
   ADVr_TH: long_name = Vertical advective flux of potential temperature
   ADVr_TH: units = degree_C m3 s:  1
   ADVr_TH: coverage_content_type = modelResult
   ADVr_TH: direction = >0 decreases potential temperature (THETA)
   ADVr_TH: coordinates = XC YC time Zl
   ADVr_TH: valid_min = :  125094904.0
   ADVr_TH: valid_max = 179459344.0
```

Comments

Vertical advective flux of potential temperature (theta) in the +z direction through the top 'w' face of the tracer cell on the native model grid. note: in the arakawa-c grid, vertical flux quantities are staggered relative to the tracer cells with indexing such that +advr_th(i,j,k_l) corresponds to upward +z fluxes through the top 'w' face of the tracer cell at (i,j,k)

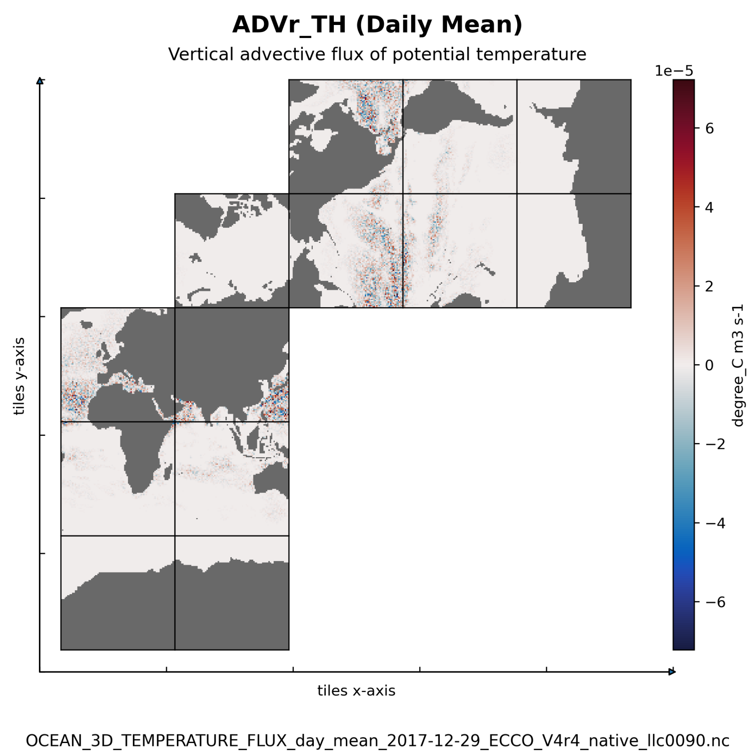

Figure 41: Dataset: OCEAN_3D_TEMPERATURE_FLUX, Variable: ADVr_TH

12.5.3 Native Variable: ADVx_TH

Table 12.26: Attributes description of the variable 'ADVx_TH' from OCEAN_3D_TEMPERATURE_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	ADVx_TH	Lateral advective flux of potential temperature in the model +x direction	degree_C m3 s-1

Description of the variable in Common Data language (CDL)

```
float32 ADVx_TH(time, k, tile, j, i_g)
   ADVx_TH: _FillValue = 9.96921e+36
   ADVx_TH: long_name = Lateral advective flux of potential temperature in the
model +x direction
   ADVx_TH: units = degree_C m3 s:  1
   ADVx_TH: mate = ADVy_TH
   ADVx_TH: coverage_content_type = modelResult
   ADVx_TH: direction = >0 increases potential temperature (THETA)
   ADVx_TH: coordinates = time Z
   ADVx_TH: valid_min = :  38210700.0
   ADVx_TH: valid_max = 38049636.0
```

Comments

Lateral advective flux of potential temperature (theta) in the +x direction through the 'u' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +advx_th(i_g,j,k) corresponds to +x fluxes through the 'u' face of the tracer cell at (i,j,k). also, the model +x direction does not necessarily correspond to the geographical east-west direction because the x and y axes of the model's lat-lon-cap (llc) curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.

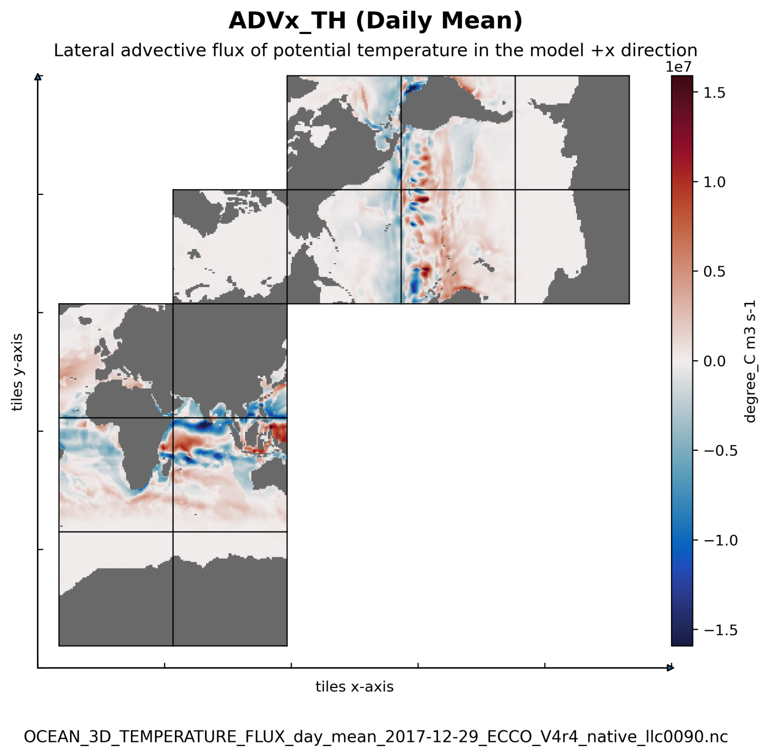

Figure 42: Dataset: OCEAN_3D_TEMPERATURE_FLUX, Variable: ADVx_TH

12.5.4 Native Variable: ADVy_TH

Table 12.27: Attributes description of the variable 'ADVy_TH' from OCEAN_3D_TEMPERATURE_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	ADVy_TH	Lateral advective flux of potential temperature in the model +y direction	degree_C m3 s-1

Description of the variable in Common Data language (CDL)

```
float32 ADVy_TH(time, k, tile, j_g, i)
   ADVy_TH: _FillValue = 9.96921e+36
   ADVy_TH: long_name = Lateral advective flux of potential temperature in the
model +y direction
   ADVy_TH: units = degree_C m3 s:  1
   ADVy_TH: mate = ADVx_TH
   ADVy_TH: coverage_content_type = modelResult
   ADVy_TH: direction = >0 increases potential temperature (THETA)
   ADVy_TH: coordinates = time Z
   ADVy_TH: valid_min = :  43909120.0
   ADVy_TH: valid_max = 56347884.0
```

Comments

Lateral advective flux of potential temperature (theta) in the +y direction through the 'v' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +advy_th(i,j_g,k) corresponds to +y fluxes through the 'v' face of the tracer cell at (i,j,k). also, the model +y direction does not necessarily correspond to the geographical north-south direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.

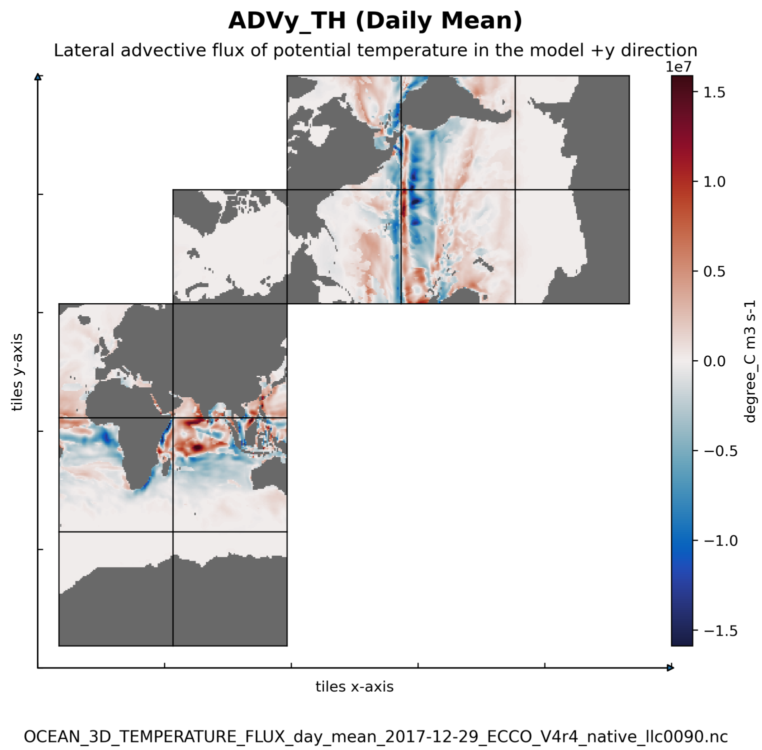

Figure 43: Dataset: OCEAN_3D_TEMPERATURE_FLUX, Variable: ADVy_TH

12.5.5 Native Variable: DFrE_TH

Table 12.28: Attributes description of the variable 'DFrE_TH' from OCEAN_3D_TEMPERATURE_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	DFrE_TH	Vertical diffusive flux of potential temperature (explicit term)	degree_C m3 s-1

Description of the variable in Common Data language (CDL)

```
float32 DFrE_TH(time, k_l, tile, j, i)
   DFrE_TH: _FillValue = 9.96921e+36
   DFrE_TH: long_name = Vertical diffusive flux of potential temperature (explicit
term)
   DFrE_TH: units = degree_C m3 s:  1
   DFrE_TH: coverage_content_type = modelResult
   DFrE_TH: direction = >0 decreases potential temperature (THETA)
   DFrE_TH: coordinates = XC YC time Zl
   DFrE_TH: valid_min = :  2632379.75
   DFrE_TH: valid_max = 2659875.25
```

Comments

The explicit term of the vertical diffusive flux of potential temperature (theta) in the +z direction through the top 'w' face of the tracer cell on the native model grid. in the ecco v4r4 model, an implicit scheme is used to calculate vertical diffusive tracer fluxes due to background diffusivity and the kwz component of the gm-redi tensor (vertical flux as a function of vertical gradient) while an explicit scheme is used to calculate the vertical diffusive fluxes from the kwx and kwy components of the gm-redi tensor (vertical flux as a function of horizontal gradient). both implicit and explicit components of vertical diffusive flux of potential temperature are provided. note: in the arakawa-c grid, vertical flux quantities are staggered relative to the tracer cells with indexing such that +dfre_th(i,j,k_l) corresponds to upward +z fluxes through the top 'w' face of the tracer cell at (i,j,k).

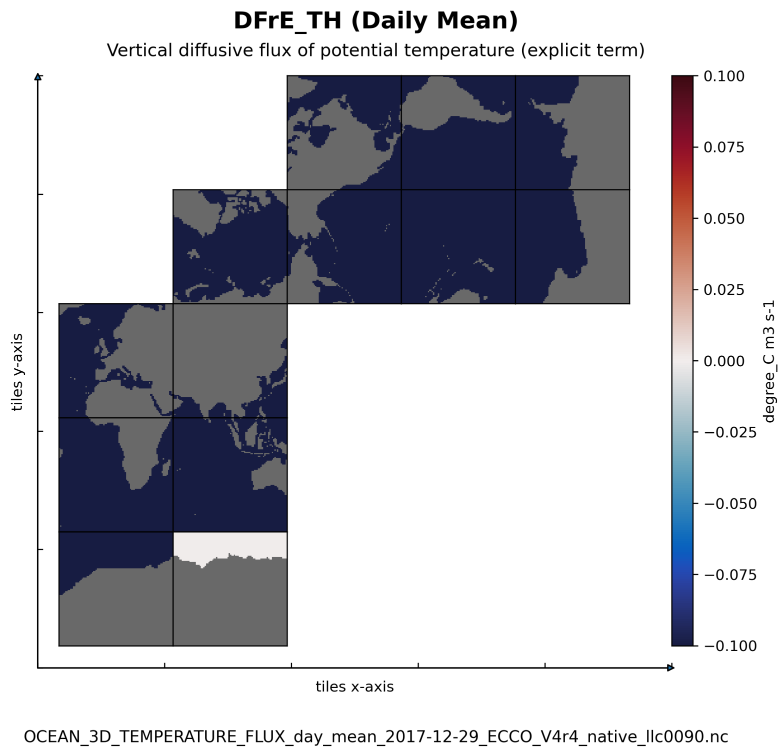

Figure 44: Dataset: OCEAN_3D_TEMPERATURE_FLUX, Variable: DFrE_TH

12.5.6 Native Variable: DFrI_TH

Table 12.29: Attributes description of the variable 'DFrI_TH' from OCEAN_3D_TEMPERATURE_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	DFrI_TH	Vertical diffusive flux of potential temperature (implicit term)	degree_C m3 s-1

Description of the variable in Common Data language (CDL)

```
float32 DFrI_TH(time, k_l, tile, j, i)
   DFrI_TH: _FillValue = 9.96921e+36
   DFrI_TH: long_name = Vertical diffusive flux of potential temperature (implicit
term)
   DFrI_TH: units = degree_C m3 s:  1
   DFrI_TH: coverage_content_type = modelResult
   DFrI_TH: direction = >0 decreases potential temperature (THETA)
   DFrI_TH: coordinates = XC YC time Zl
   DFrI_TH: valid_min = :  104210688.0
   DFrI_TH: valid_max = 23574302.0
```

Comments

The implicit term of the vertical diffusive flux of potential temperature (theta) in the +z direction through the top 'w' face of the tracer cell on the native model grid. in the ecco v4r4 model, an implicit scheme is used to calculate vertical diffusive tracer fluxes due to background diffusivity and the kwz component of the gm-redi tensor (vertical flux as a function of vertical gradient) while an explicit scheme is used to calculate the vertical diffusive fluxes from the kwx and kwy components of the gm-redi tensor (vertical flux as a function of horizontal gradient). both implicit and explicit components of vertical diffusive flux of potential temperature are provided. note: in the arakawa-c grid, vertical flux quantities are staggered relative to the tracer cells with indexing such that +dfri_th(i,j,k_l) corresponds to upward +z fluxes through the top 'w' face of the tracer cell at (i,j,k)

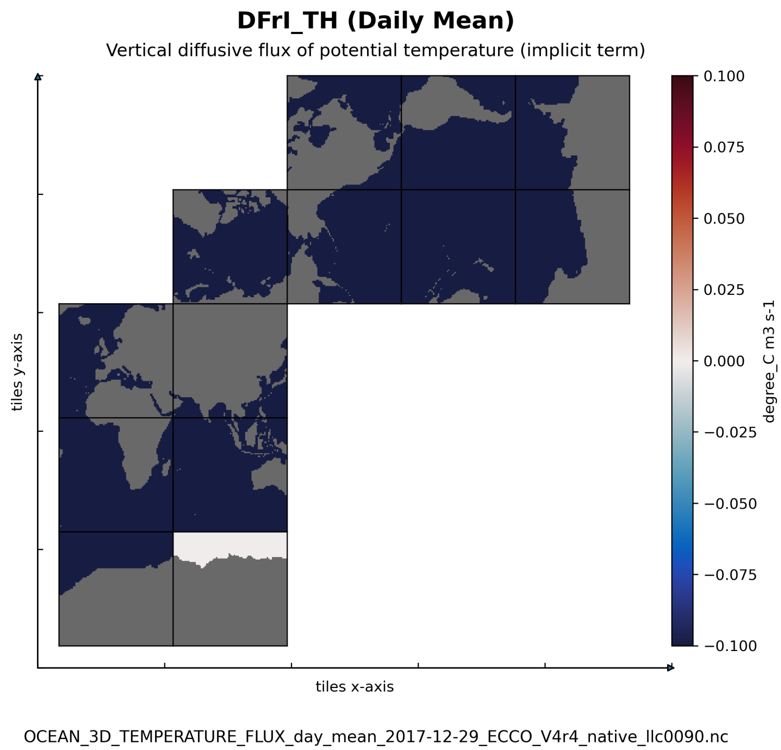

Figure 45: Dataset: OCEAN_3D_TEMPERATURE_FLUX, Variable: DFrI_TH

12.5.7 Native Variable: DFxE_TH

Table 12.30: Attributes description of the variable 'DFxE_TH' from OCEAN_3D_TEMPERATURE_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	DFxE_TH	Lateral diffusive flux of potential temperature in the model +x direction	degree_C m3 s-1

Description of the variable in Common Data language (CDL)

```
float32 DFxE_TH(time, k, tile, j, i_g)
   DFxE_TH: _FillValue = 9.96921e+36
   DFxE_TH: long_name = Lateral diffusive flux of potential temperature in the
model +x direction
   DFxE_TH: units = degree_C m3 s:  1
   DFxE_TH: mate = DFyE_TH
   DFxE_TH: coverage_content_type = modelResult
   DFxE_TH: direction = >0 increases potential temperature (THETA)
   DFxE_TH: coordinates = time Z
   DFxE_TH: valid_min = :  582494.125
   DFxE_TH: valid_max = 698695.75
```

Comments

Lateral diffusive flux of potential temperature (theta) in the +x direction through the 'u' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +dfxe_th(i_g,j,k) corresponds to +x fluxes through the 'u' face of the tracer cell at (i,j,k). also, the model +x direction does not necessarily correspond to the geographical east-west direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.

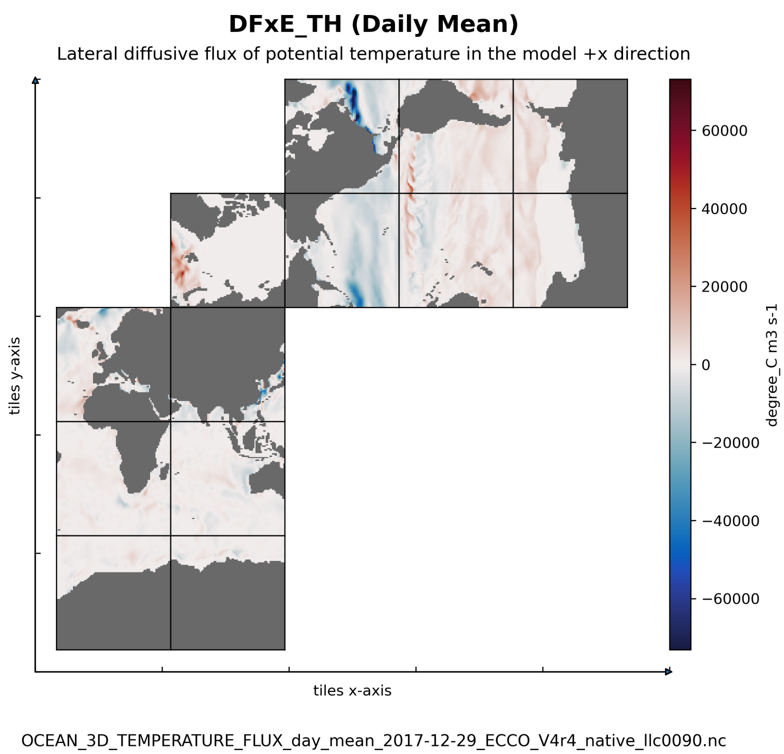

Figure 46: Dataset: OCEAN_3D_TEMPERATURE_FLUX, Variable: DFxE_TH

12.5.8 Native Variable: DFyE_TH

Table 12.31: Attributes description of the variable 'DFyE_TH' from OCEAN_3D_TEMPERATURE_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	DFyE_TH	Lateral diffusive flux of potential temperature in the model +y direction.	degree_C m3 s-1

Description of the variable in Common Data language (CDL)

```
float32 DFyE_TH(time, k, tile, j_g, i)
   DFyE_TH: _FillValue = 9.96921e+36
   DFyE_TH: long_name = Lateral diffusive flux of potential temperature in the
model +y direction.
   DFyE_TH: units = degree_C m3 s:  1
   DFyE_TH: mate = DFxE_TH
   DFyE_TH: coverage_content_type = modelResult
   DFyE_TH: direction = >0 increases potential temperature (THETA)
   DFyE_TH: coordinates = time Z
   DFyE_TH: valid_min = :  421044.78125
   DFyE_TH: valid_max = 1053781.25
```

Comments

Lateral diffusive flux of potential temperature (theta) in the +y direction through the 'v' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +dfye_th(i,j_g,k) corresponds to +y fluxes through the 'v' face of the tracer cell at (i,j,k). also, the model +y direction does not necessarily correspond to the geographical north-south direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.

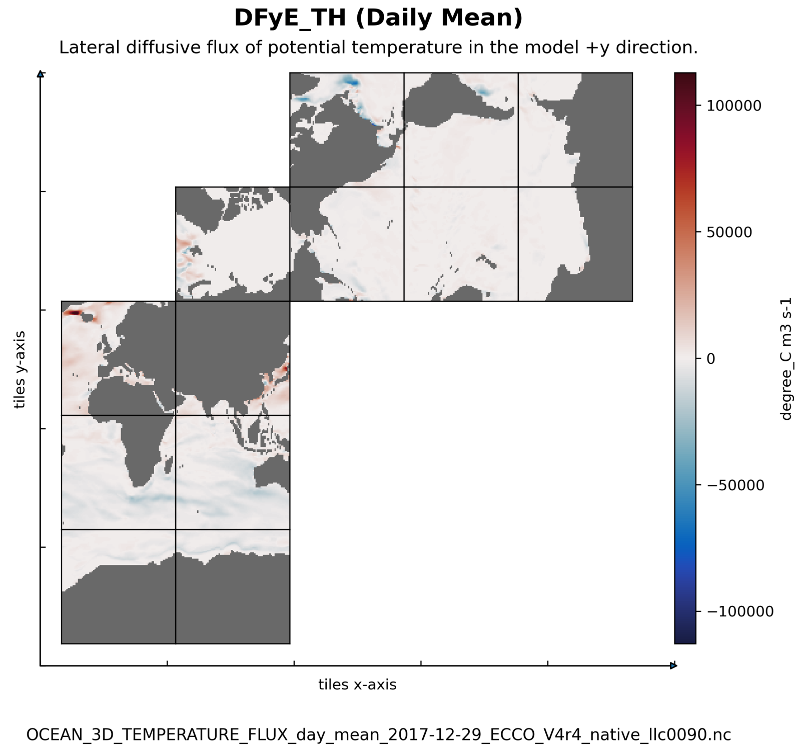

Figure 47: Dataset: OCEAN_3D_TEMPERATURE_FLUX, Variable: DFyE_TH

12.6 Native dataset of OCEAN_3D_VOLUME_FLUX

12.6.1 Overview

This dataset provides three-dimensional ocean volume fluxes on the lat-lon-cap 90 (llc90) native model grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution. Volume flux in +x direction = UVELMASS drF dyG. Volume flux in +y direction = VVELMASS drF dxG. Volume flux in +z direction = WVELMASS drA.

Table 12.32: Coordinates and Variables in the dataset OCEAN_3D_VOLUME_FLUX

Variables	Description of data variables	Unit
UVELMASS	Horizontal velocity in the model +x direction per unit area of the grid cell 'u' face	m s-1
VVELMASS	Horizontal velocity in the model +y direction per unit area of the grid cell 'v' face	m s-1 m3 m-3
WVELMASS	Grid cell face-averaged vertical velocity in the model +z direction.	m s-1
Coordinates	**Description of data coordinates**	**Unit**
i	Grid index in x for variables at tracer and 'v' locations	–none–
i_g	Grid index in x for variables at 'u' and 'g' locations	–none–
j	Grid index in y for variables at tracer and 'u' locations	–none–
j_g	Grid index in y for variables at 'v' and 'g' locations	–none–
k	Grid index in z for tracer variables	–none–
k_u	Grid index in z corresponding to the bottom face of tracer grid cells ('w' locations)	–none–
k_l	Grid index in z corresponding to the top face of tracer grid cells ('w' locations)	–none–

Table 12.32: Coordinates and Variables in the dataset OCEAN_3D_VOLUME_FLUX

k_p1	Grid index in z for variables at 'w' locations	–none–
tile	Lat-lon-cap tile index	–none–
time	Center time of averaging period	–none–
XC	Longitude of tracer grid cell center	degrees_east
YC	Latitude of tracer grid cell center	degrees_north
XG	Longitude of 'southwest' corner of tracer grid cell	degrees_east
YG	Latitude of 'southwest' corner of tracer grid cell	degrees_north
Z	Depth of tracer grid cell center	m
Zp1	Depth of tracer grid cell interface	m
Zu	Depth of the bottom face of tracer grid cells	m
Zl	Depth of the top face of tracer grid cells	m
time_bnds	Time bounds of averaging period	–none–
XC_bnds	Longitudes of tracer grid cell corners	–none–
YC_bnds	Latitudes of tracer grid cell corners	–none–
Z_bnds	Depths of tracer grid cell upper and lower interfaces	–none–

12.6.2 Native Variable: UVELMASS

Table 12.33: Attributes description of the variable 'UVELMASS' from OCEAN_3D_VOLUME_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	UVELMASS	Horizontal velocity in the model +x direction per unit area of the grid cell 'u' face	m s-1

Description of the variable in Common Data language (CDL)

```
float32 UVELMASS(time, k, tile, j, i_g)
   UVELMASS: _FillValue = 9.96921e+36
   UVELMASS: long_name = "Horizontal velocity in the model +x direction per unit
area of the grid cell u face"
   UVELMASS: units = m s:  1
   UVELMASS: mate = VVELMASS
   UVELMASS: coverage_content_type = modelResult
   UVELMASS: direction = >0 increases volume
   UVELMASS: coordinates = Z time
   UVELMASS: valid_min = :  2.115365505218506
   UVELMASS: valid_max = 2.0377726554870605
```

Comments

Horizontal velocity in the model +x direction averaged over the area of the tracer grid cell 'u' face on the native model grid ('u' grid cell face area = drf dyg). accounts for partial cells (hfacw < 1) and for time-varying grid cell thickness (z* coordinate system). volume flux in +x = uvelmass drf dyg. note: in the arakawa-c grid, horizontal velocities are staggered relative to the tracer cells with indexing such that +uvelmass(i,j,k) corresponds to +x fluxes through the 'u' face of the tracer cell at (i,j,k). uvelmass can be used for volume flux calculations because it accounts for the grid cell thicknesses variations in the +x direction (hfacw) with time (z* coordinate system). also, the model +x direction does not necessarily correspond to the geographical east-west direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles. see vvelmass and wvelmass

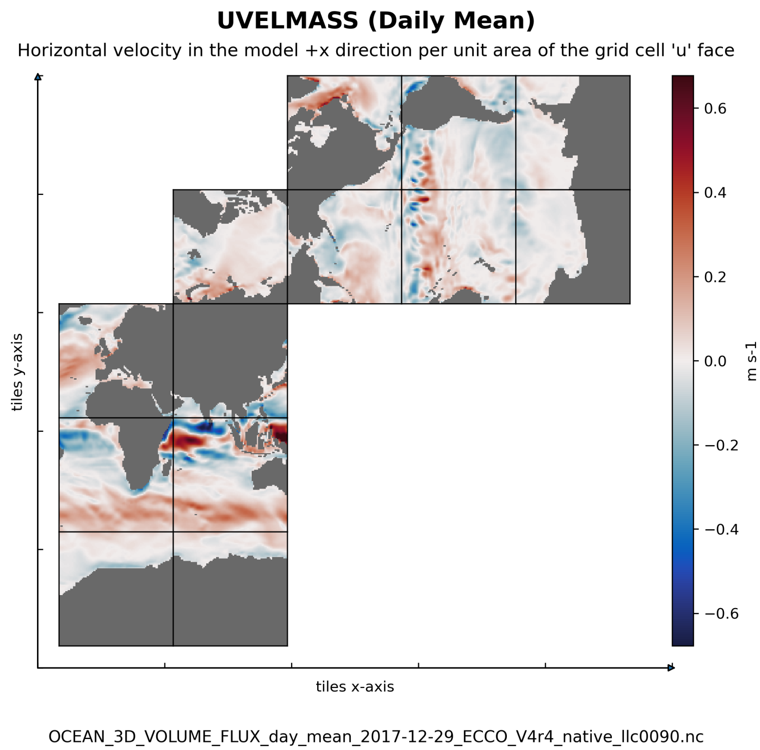

Figure 48: Dataset: OCEAN_3D_VOLUME_FLUX, Variable: UVELMASS

12.6.3 Native Variable: VVELMASS

Table 12.34: Attributes description of the variable 'VVELMASS' from OCEAN_3D_VOLUME_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	VVELMASS	Horizontal velocity in the model +y direction per unit area of the grid cell 'v' face	m s-1 m3 m-3

Description of the variable in Common Data language (CDL)

```
float32 VVELMASS(time, k, tile, j_g, i)
   VVELMASS: _FillValue = 9.96921e+36
   VVELMASS: long_name = "Horizontal velocity in the model +y direction per unit
area of the grid cell v face"
   VVELMASS: units = m s:  1 m3 m:  3
   VVELMASS: mate = UVELMASS
   VVELMASS: coverage_content_type = modelResult
   VVELMASS: direction = >0 increases volume
   VVELMASS: coordinates = Z time
   VVELMASS: valid_min = :  1.7897182703018188
   VVELMASS: valid_max = 1.9216758012771606
```

Comments

Horizontal velocity in the model +y direction averaged over the area of the tracer grid cell 'v' face on the native model grid ('v' grid cell face area = drf dxg). accounts for partial cells (hfacs < 1) and for time-varying grid cell thickness (z* coordinate system). volume flux in +y = vvelmass drf dxg. note: in the arakawa-c grid, horizontal velocities are staggered relative to the tracer cells with indexing such that +vvelmass(i,j,k) corresponds to +y fluxes through the 'v' face of the tracer cell at (i,j,k). vvelmass can be used for volume flux calculations because it accounts for grid cell thicknesses variations in the +y direction (hfacs) with time (z* coordinate system). also, the model +y direction does not necessarily correspond to the geographical north-south direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles. see uvelmass and wvelmass.

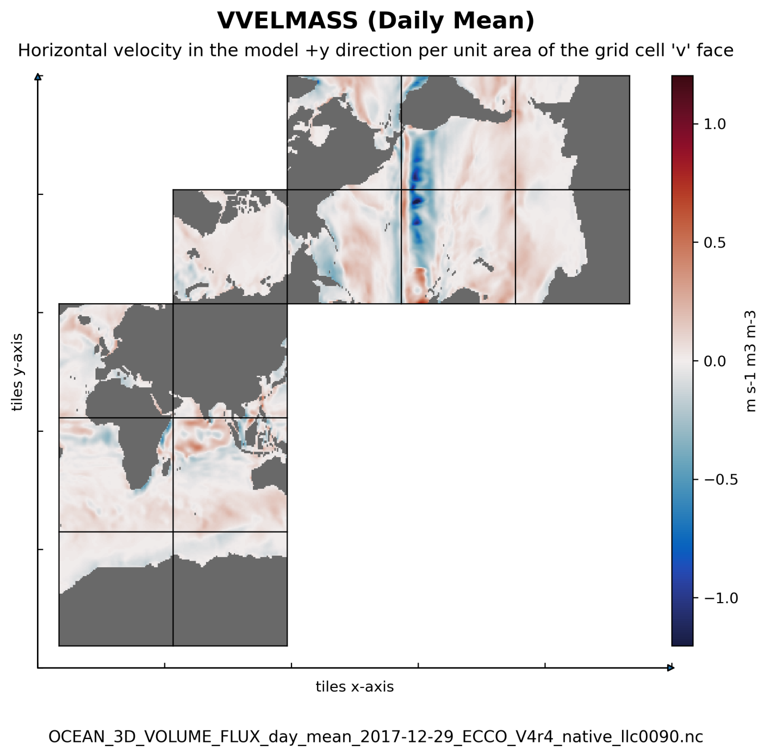

Figure 49: Dataset: OCEAN_3D_VOLUME_FLUX, Variable: VVELMASS

12.6.4 Native Variable: WVELMASS

Table 12.35: Attributes description of the variable 'WVELMASS' from OCEAN_3D_VOLUME_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	WVELMASS	Grid cell face-averaged vertical velocity in the model +z direction.	m s-1
Description of the variable in Common Data language (CDL)			
float32 WVELMASS(time, k_l, tile, j, i) WVELMASS: _FillValue = 9.96921e+36 WVELMASS: long_name = Grid cell face: averaged vertical velocity in the model +z direction. WVELMASS: units = m s: 1 WVELMASS: coverage_content_type = modelResult WVELMASS: direction = >0 decreases volume WVELMASS: standard_name = upward_sea_water_velocity WVELMASS: coordinates = YC Zl time XC WVELMASS: valid_min = : 0.0023150660563260317 WVELMASS: valid_max = 0.0016380994347855449			
Comments			
Vertical velocity in the +z direction at the top 'w' face of the tracer cell on the native model grid. volume flux in +z = wvelmass dra. note: in the arakawa-c grid, vertical velocities are staggered relative to the tracer cells with indexing such that +wvelmass(i,j,k) corresponds to upward +z motion through the top 'w' face of the tracer cell at (i,j,k). unlike uvelmass and vvelmass, wvelmass is not scaled by a time-varying open water fraction because the open water fraction of the 'w' face is always 1, thus wvelmass is identical to wvel.			

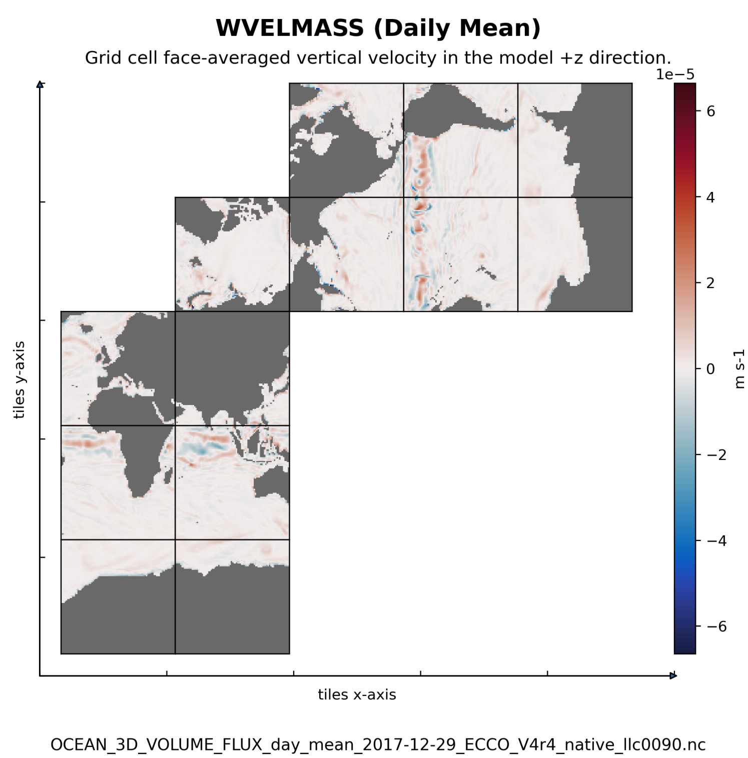

Figure 50: Dataset: OCEAN_3D_VOLUME_FLUX, Variable: WVELMASS

12.7 Native dataset of OCEAN_AND_ICE_SURFACE_FW_FLUX

12.7.1 Overview

This dataset provides 2D fields of ocean and sea-ice surface freshwater fluxes on the lat-lon-cap 90 (llc90) native model grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution.

Table 12.36: Coordinates and Variables in the dataset OCEAN_AND_ICE_SURFACE_FW_FLUX

Variables	Description of data variables	Unit
EXFpreci	Precipitation rate	m s-1
EXFevap	Open ocean evaporation rate	m s-1
EXFroff	River runoff	m s-1
SIsnPrcp	Snow precipitation on sea-ice	kg m-2 s-1
EXFempmr	Open ocean net surface freshwater flux from precipitation, evaporation, and runoff	m s-1
oceFWflx	Net freshwater flux into the ocean	kg m-2 s-1
SIatmFW	Net freshwater flux into the open ocean, sea-ice, and snow	kg m-2 s-1
SFLUX	Rate of change of total ocean salinity per m2 accounting for mass fluxes.	g m-2 s-1
SIacSubl	Freshwater flux to the atmosphere due to sublimation-deposition of snow or ice	kg m-2 s-1
SIrsSubl	Residual sublimation freshwater flux	kg m-2 s-1
SIfwThru	Precipitation through sea-ice	kg m-2 s-1
Coordinates	**Description of data coordinates**	**Unit**
i	Grid index in x for variables at tracer and 'v' locations	–none–
i_g	Grid index in x for variables at 'u' and 'g' locations	–none–
j	Grid index in y for variables at tracer and 'u' locations	–none–
j_g	Grid index in y for variables at 'v' and 'g' locations	–none–
tile	Lat-lon-cap tile index	–none–
time	Center time of averaging period	–none–
XC	Longitude of tracer grid cell center	degrees_east
YC	Latitude of tracer grid cell center	degrees_north
XG	Longitude of 'southwest' corner of tracer grid cell	degrees_east
YG	Latitude of 'southwest' corner of tracer grid cell	degrees_north
time_bnds	Time bounds of averaging period	–none–
XC_bnds	Longitudes of tracer grid cell corners	–none–
YC_bnds	Latitudes of tracer grid cell corners	–none–

12.7.2 Native Variable: EXFempmr

Table 12.37: Attributes description of the variable 'EXFempmr' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFempmr	Open ocean net surface freshwater flux from precipitation, evaporation, and runoff	m s-1
Description of the variable in Common Data language (CDL)			

```
float32 EXFempmr(time, tile, j, i)
   EXFempmr:  _FillValue = 9.96921e+36
   EXFempmr:  long_name = Open ocean net surface freshwater flux from
precipitation
evaporation
and runoff
   EXFempmr:  units = m s:  1
   EXFempmr:  coverage_content_type = modelResult
   EXFempmr:  direction = >0 increases salinity (SALT)
   EXFempmr:  coordinates = YC XC time
   EXFempmr:  valid_min = :  8.299433829961345e:  06
   EXFempmr:  valid_max = 5.400421514423215e:  07
```

Comments

Net surface freshwater flux from precipitation, evaporation, and runoff per unit area in open water (not covered by sea-ice). excludes freshwater fluxes involving sea-ice and snow. note: calculated as exfevap-exfpreci-exfroff.

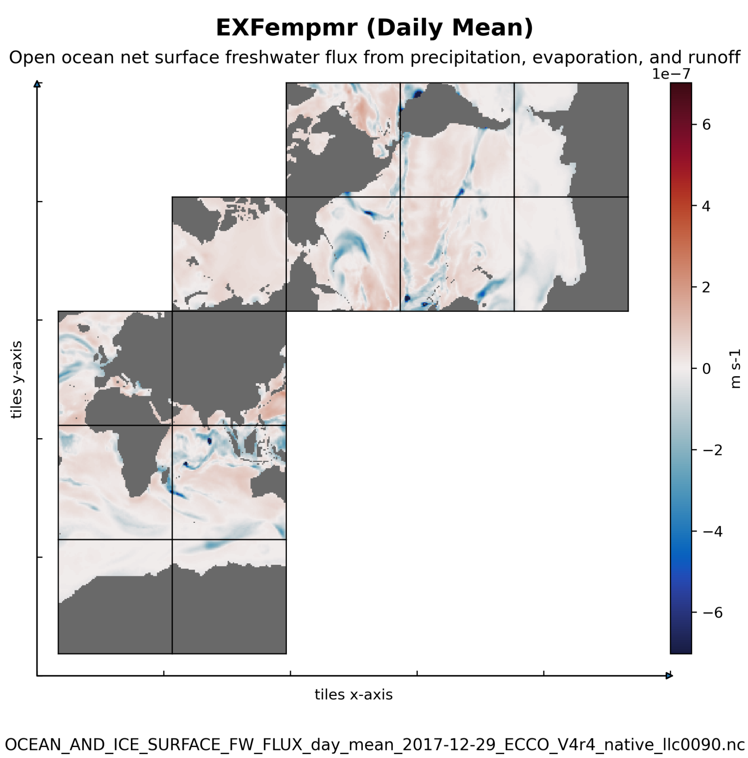

Figure 51: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFempmr

12.7.3 Native Variable: EXFevap

Table 12.38: Attributes description of the variable 'EXFevap' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFevap	Open ocean evaporation rate	m s-1
Description of the variable in Common Data language (CDL)			

```
float32 EXFevap(time, tile, j, i)
   EXFevap:  _FillValue = 9.96921e+36
   EXFevap:  long_name = Open ocean evaporation rate
   EXFevap:  units = m s:  1
   EXFevap:  coverage_content_type = modelResult
   EXFevap:  direction = >0 increases salinity (SALT)
   EXFevap:  standard_name = lwe_water_evaporation_rate
   EXFevap:  coordinates = YC XC time
   EXFevap:  valid_min = :  1.0958113705328287e:  07
   EXFevap:  valid_max = 7.090054623404285e:  07
```

Comments

Evaporation rate per unit area of open water (not covered by sea-ice). note: calculated using the bulk formula following large and yeager (2004) ncar/tn-460+str.

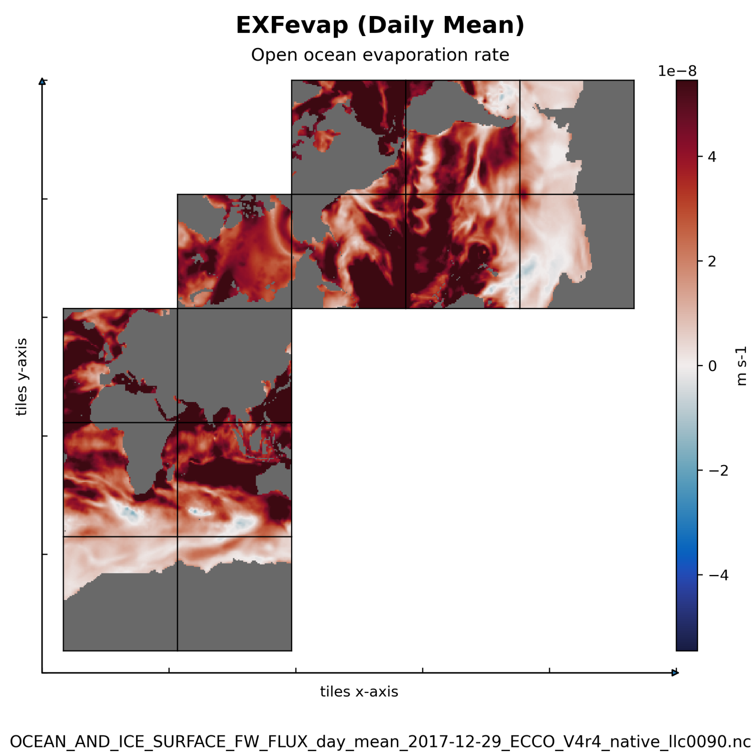

Figure 52: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFevap

12.7.4 Native Variable: EXFpreci

Table 12.39: Attributes description of the variable 'EXFpreci' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFpreci	Precipitation rate	m s-1
Description of the variable in Common Data language (CDL)			
float32 EXFpreci(time, tile, j, i) EXFpreci: _FillValue = 9.96921e+36 EXFpreci: long_name = Precipitation rate EXFpreci: units = m s: 1 EXFpreci: coverage_content_type = modelResult EXFpreci: direction = >0 increases salinity (SALT) EXFpreci: standard_name = lwe_precipitation_rate EXFpreci: coordinates = YC XC time EXFpreci: valid_min = : 1.4860395936011628e: 07 EXFpreci: valid_max = 8.317776519106701e: 06			
Comments			
Precipitation rate. note: sum of era-interim precipitation and the control adjustment from ocean state estimation.			

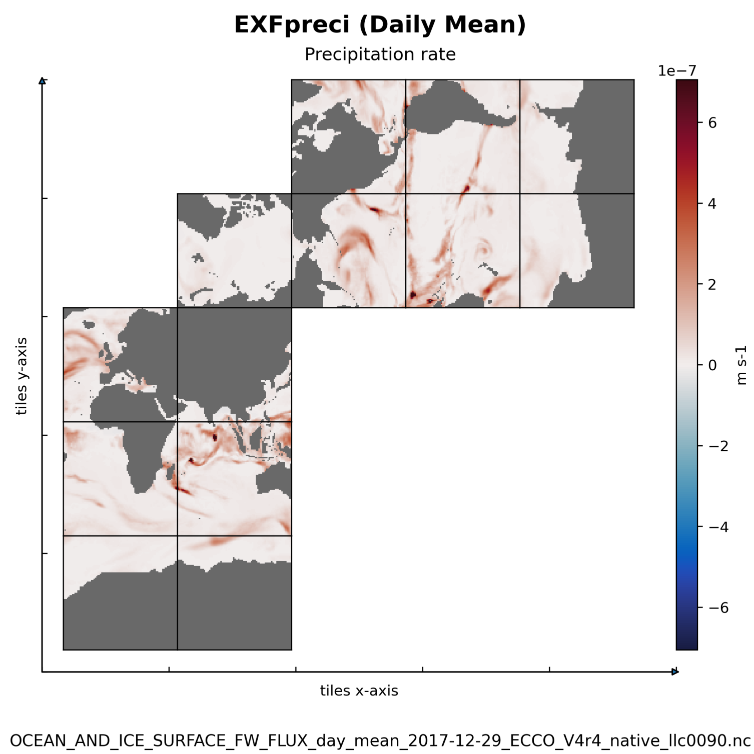

Figure 53: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFpreci

12.7.5 Native Variable: EXFroff

Table 12.40: Attributes description of the variable 'EXFroff' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFroff	River runoff	m s-1
Description of the variable in Common Data language (CDL)			
float32 EXFroff(time, tile, j, i) EXFroff: _FillValue = 9.96921e+36 EXFroff: long_name = River runoff EXFroff: units = m s: 1 EXFroff: coverage_content_type = modelResult EXFroff: direction = >0 increases salinity (SALT) EXFroff: standard_name = surface_runoff_flux EXFroff: coordinates = YC XC time EXFroff: valid_min = 0.0 EXFroff: valid_max = 4.185612397122895e: 06			
Comments			
River runoff freshwater flux. note: not adjusted by the optimization.			

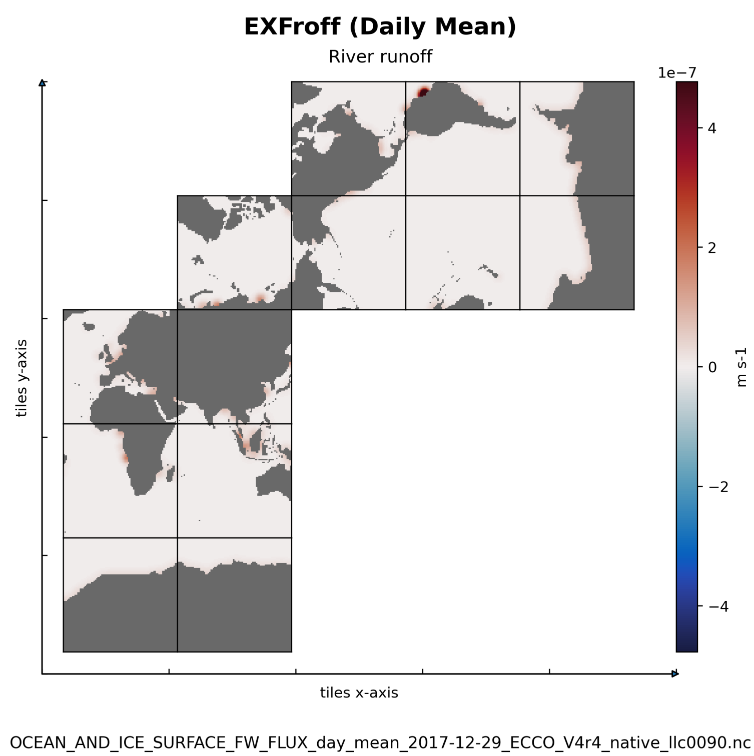

Figure 54: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFroff

12.7.6 Native Variable: SFLUX

Table 12.41: Attributes description of the variable 'SFLUX' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	SFLUX	Rate of change of total ocean salinity per m2 accounting for mass fluxes.	g m-2 s-1

Description of the variable in Common Data language (CDL)

```
float32 SFLUX(time, tile, j, i)
   SFLUX: _FillValue = 9.96921e+36
   SFLUX: long_name = Rate of change of total ocean salinity per m2 accounting for
mass fluxes.
   SFLUX: units = g m:  2 s:  1
   SFLUX: coverage_content_type = modelResult
   SFLUX: direction = >0 increases salinity (SALT)
   SFLUX: coordinates = YC XC time
   SFLUX: valid_min = :  0.07353577762842178
   SFLUX: valid_max = 0.010607733391225338
```

Comments

The rate of change of total ocean salinity due to freshwater fluxes across the liquid surface and the addition or removal of mass. note: the global area integral of sflux matches the time-derivative of total ocean salinity (psu s-1). unlike ocefwflx, sflux includes the contribution to the total ocean salinity from changing ocean mass (e.g. from the addition or removal of freshwater in ocefwflx).

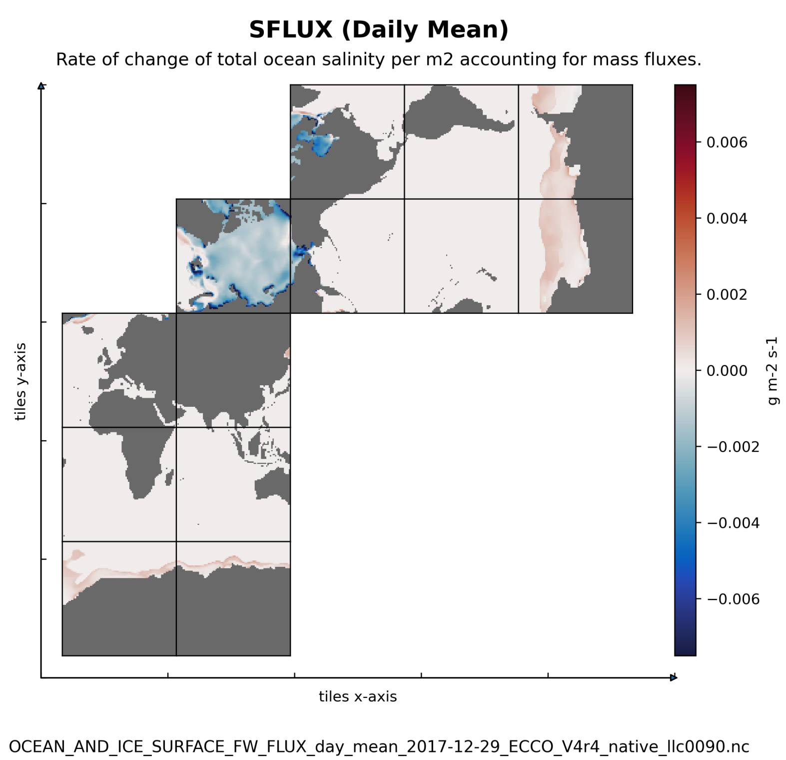

Figure 55: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SFLUX

12.7.7 Native Variable: SIacSubl

Table 12.42: Attributes description of the variable 'SIacSubl' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	SIacSubl	Freshwater flux to the atmosphere due to sublimation-deposition of snow or ice	kg m-2 s-1

Description of the variable in Common Data language (CDL)

```
float32 SIacSubl(time, tile, j, i)
   SIacSubl:  _FillValue = 9.96921e+36
   SIacSubl:  long_name = Freshwater flux to the atmosphere due to sublimation:
deposition of snow or ice
   SIacSubl:  units = kg m:  2 s:  1
   SIacSubl:  coverage_content_type = modelResult
   SIacSubl:  direction = >0 decreases snow or sea:  ice thickness (HSNOW or HEFF)
   SIacSubl:  standard_name = water_sublimation_flux
   SIacSubl:  coordinates = YC XC time
   SIacSubl:  valid_min = 0.0
   SIacSubl:  valid_max = 8.154580427799374e:  05
```

Comments

Freshwater flux to the atmosphere due to sublimation-deposition of snow or ice. positive values imply sublimation from ice/snow to vapor, negative values imply deposition from atmospheric moisture

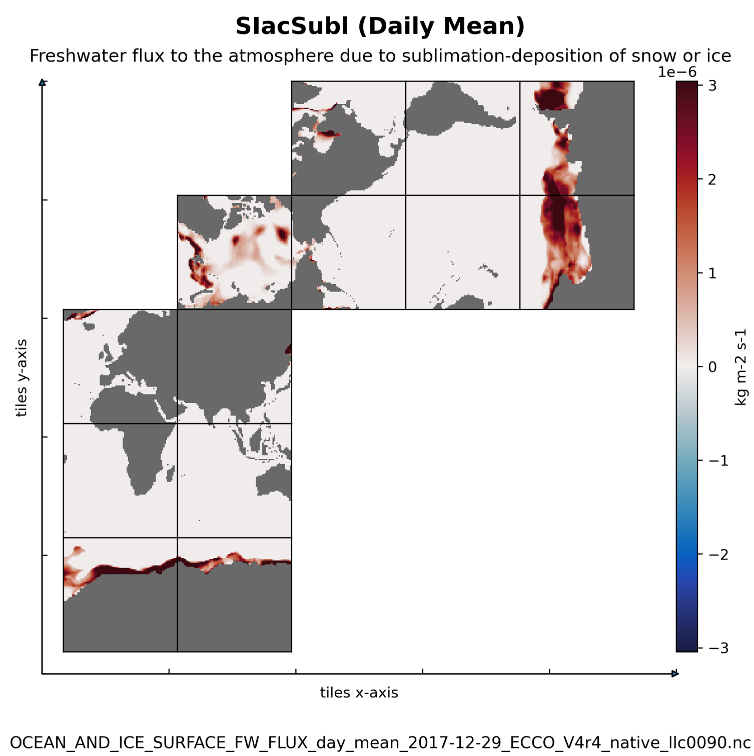

Figure 56: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SIacSubl

12.7.8 Native Variable: SIatmFW

Table 12.43: Attributes description of the variable 'SIatmFW' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	SIatmFW	Net freshwater flux into the open ocean, sea-ice, and snow	kg m-2 s-1

Description of the variable in Common Data language (CDL)

```
float32 SIatmFW(time, tile, j, i)
   SIatmFW: _FillValue = 9.96921e+36
   SIatmFW: long_name = Net freshwater flux into the open ocean
sea:  ice
and snow
   SIatmFW: units = kg m:  2 s:  1
   SIatmFW: coverage_content_type = modelResult
   SIatmFW: direction = >0 decreases salinity (SALT)
   SIatmFW: standard_name = surface_downward_water_flux
   SIatmFW: coordinates = YC XC time
   SIatmFW: valid_min = :  0.00043017856660299003
   SIatmFW: valid_max = 0.008299433626234531
```

Comments

Net freshwater flux into the combined liquid ocean, sea-ice, and snow reservoirs from the atmosphere and runoff. note: freshwater fluxes between the liquid ocean and sea-ice or snow reservoirs do not contribute to siatmfw. siatmfw counts all fluxes to/from the atmosphere that change the total freshwater stored in the combined liquid ocean, sea-ice, and snow reservoirs.

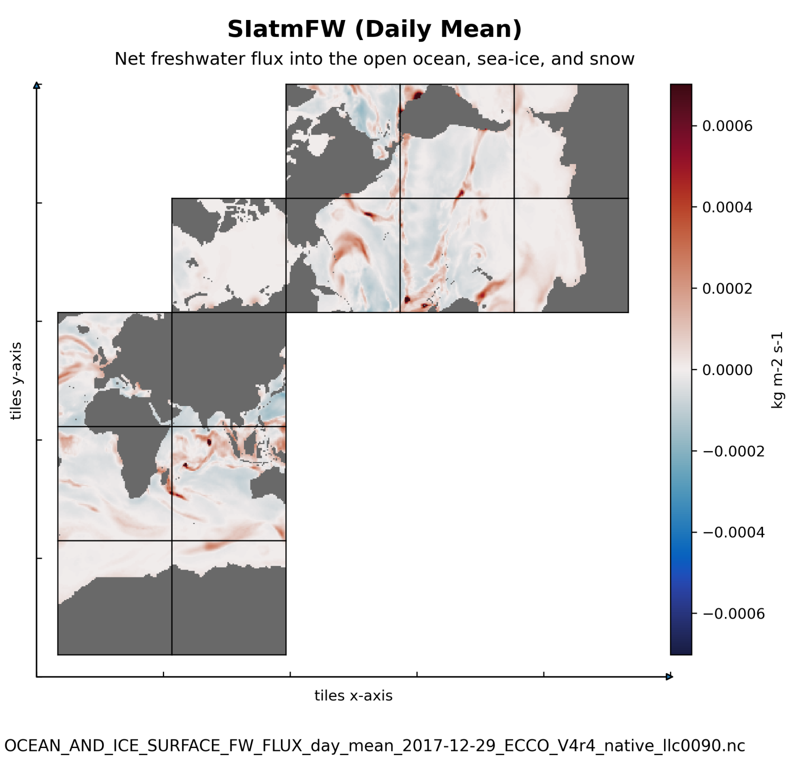

Figure 57: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SIatmFW

12.7.9 Native Variable: SIfwThru

Table 12.44: Attributes description of the variable 'SIfwThru' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	SIfwThru	Precipitation through sea-ice	kg m-2 s-1
Description of the variable in Common Data language (CDL)			

`float32 SIfwThru(time, tile, j, i)`
`SIfwThru: _FillValue = 9.96921e+36`
`SIfwThru: long_name = Precipitation through sea: ice`
`SIfwThru: units = kg m: 2 s: 1`
`SIfwThru: coverage_content_type = modelResult`
`SIfwThru: direction = >0 increases ocean volume`
`SIfwThru: coordinates = YC XC time`
`SIfwThru: valid_min = : 1.695218452368863e: 05`
`SIfwThru: valid_max = 0.0010632629273459315`			

Comments			
Precipitation over sea-ice covered regions reaching ocean through sea-ice. note: precipitation over sea-ice covered regions that directly reaches ocean through the sea-ice. it is not due to melt of sea-ice/snow.			

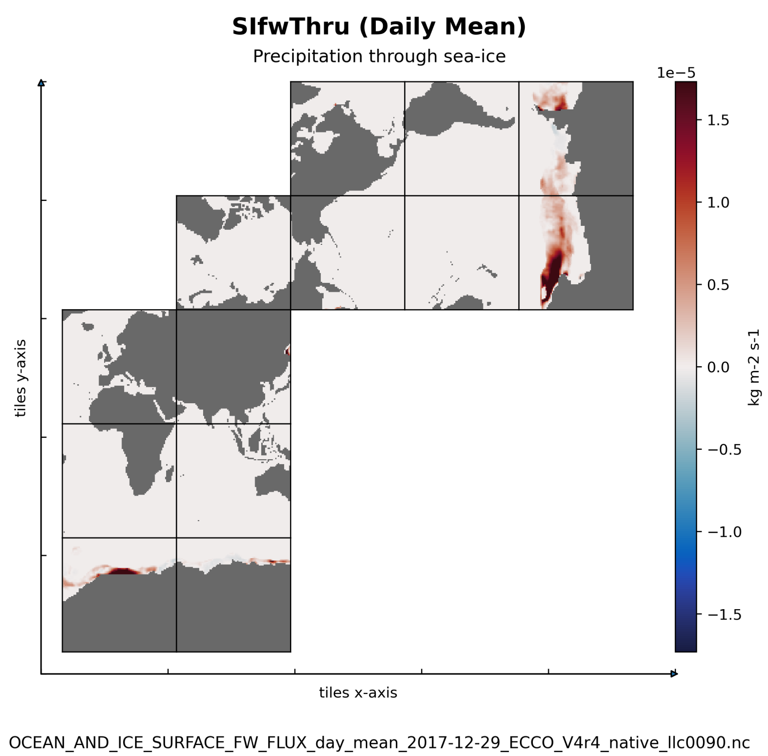

Figure 58: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SIfwThru

12.7.10 Native Variable: SIrsSubl

Table 12.45: Attributes description of the variable 'SIrsSubl' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	SIrsSubl	Residual sublimation freshwater flux	kg m-2 s-1
Description of the variable in Common Data language (CDL)			
float32 SIrsSubl(time, tile, j, i) SIrsSubl: _FillValue = 9.96921e+36 SIrsSubl: long_name = Residual sublimation freshwater flux SIrsSubl: units = kg m: 2 s: 1 SIrsSubl: coverage_content_type = modelResult SIrsSubl: direction = >0 decreases ocean volume SIrsSubl: coordinates = YC XC time SIrsSubl: valid_min = : 0.00010675288649508 73 SIrsSubl: valid_max = 8.640533451398369e: 06			
Comments			
Residual freshwater flux by sublimation to remove water from or add water to ocean. when implied sublimation freshwater flux siacsubl is larger than availabe sea-ice/snow, sirssubl is positive and water is removed from ocean. note: freshwater flux by sublimation that is to remove water from the ocean when it is positive.			

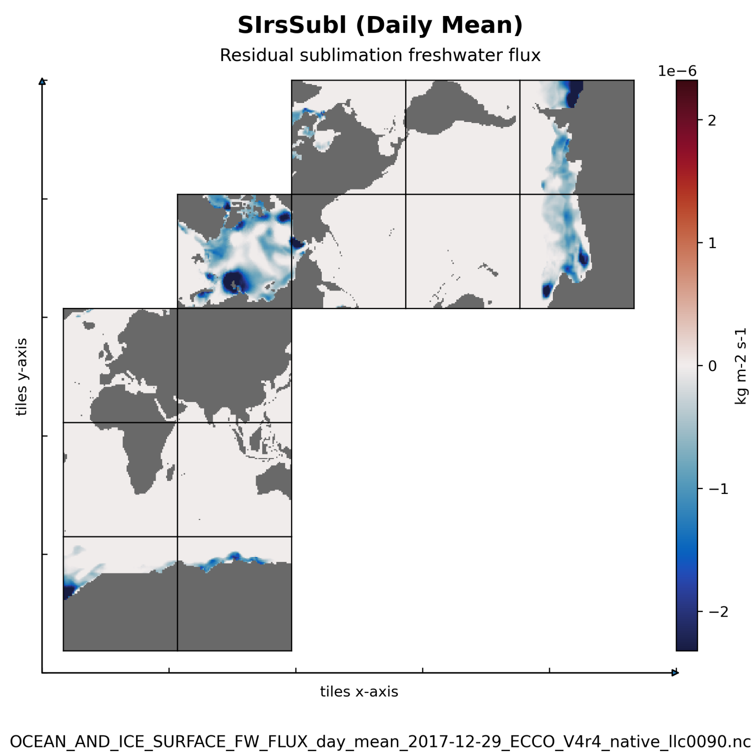

Figure 59: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SIrsSubl

12.7.11 Native Variable: SIsnPrcp

Table 12.46: Attributes description of the variable 'SIsnPrcp' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	SIsnPrcp	Snow precipitation on sea-ice	kg m-2 s-1
Description of the variable in Common Data language (CDL)			
float32 SIsnPrcp(time, tile, j, i) SIsnPrcp: _FillValue = 9.96921e+36 SIsnPrcp: long_name = Snow precipitation on sea: ice SIsnPrcp: units = kg m: 2 s: 1 SIsnPrcp: coverage_content_type = modelResult SIsnPrcp: direction = >0 increases snow thickness (HSNOW) SIsnPrcp: standard_name = snowfall_flux SIsnPrcp: coordinates = YC XC time SIsnPrcp: valid_min = : 4.334669574745931e: 05 SIsnPrcp: valid_max = 0.0009354020585305989			
Comments			
Snow precipitation rate over sea-ice, averaged over the entire model grid cell.			

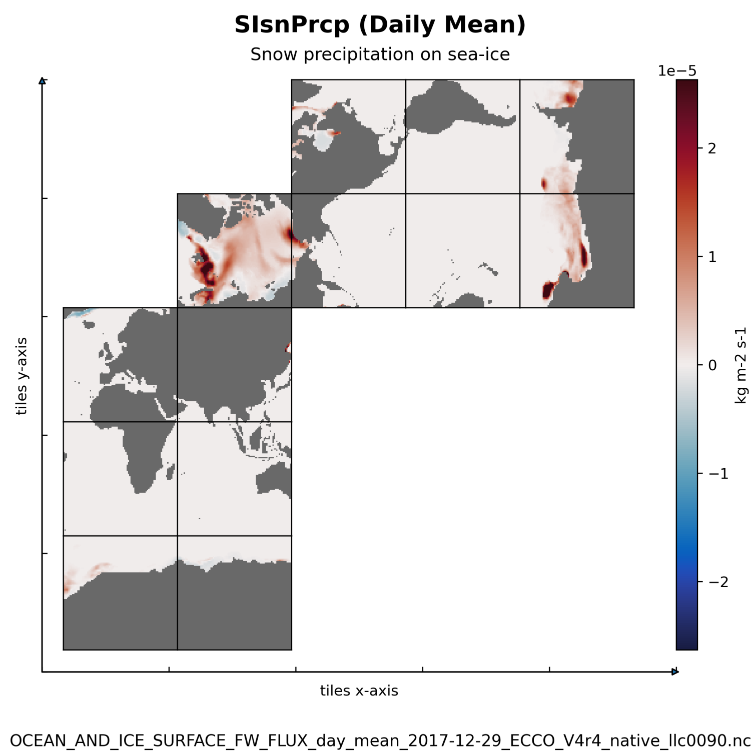

Figure 60: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SIsnPrcp

12.7.12 Native Variable: oceFWflx

Table 12.47: Attributes description of the variable 'oceFWflx' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	oceFWflx	Net freshwater flux into the ocean	kg m-2 s-1

Description of the variable in Common Data language (CDL)

```
float32 oceFWflx(time, tile, j, i)
   oceFWflx:  _FillValue = 9.96921e+36
   oceFWflx:  long_name = Net freshwater flux into the ocean
   oceFWflx:  units = kg m:  2 s:  1
   oceFWflx:  coverage_content_type = modelResult
   oceFWflx:  direction = >0 decreases salinity (SALT)
   oceFWflx:  standard_name = water_flux_into_sea_water
   oceFWflx:  coordinates = YC XC time
   oceFWflx:  valid_min = :  0.003914969973266125
   oceFWflx:  valid_max = 0.008299433626234531
```

Comments

Net freshwater flux into the ocean including contributions from runoff, evaporation, precipitation, and mass exchange with sea-ice due to melting and freezing and snow melting. note: ocefwflx does not include freshwater fluxes between the atmosphere and sea-ice and snow. the variable 'siatmfw' accounts for freshwater fluxes out of the combined ocean+sea-ice+snow reservoir.

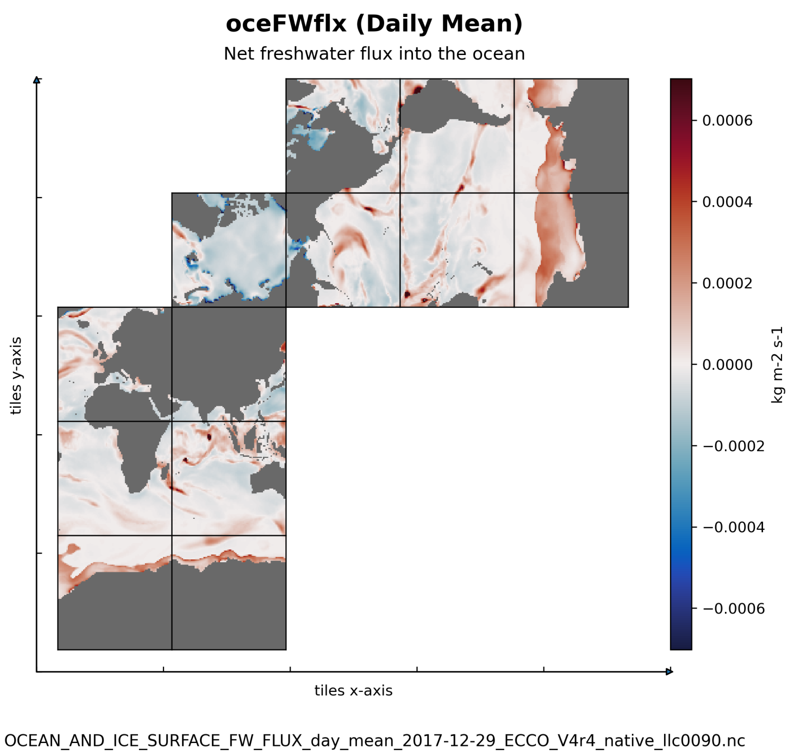

Figure 61: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: oceFWflx

12.8 Native dataset of OCEAN_AND_ICE_SURFACE_HEAT_FLUX

12.8.1 Overview

This dataset provides 2D fields of ocean and sea-ice surface heat fluxes on the lat-lon-cap 90 (llc90) native model grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution.

Table 12.48: Coordinates and Variables in the dataset OCEAN_AND_ICE_SURFACE_HEAT_FLUX

Variables	Description of data variables	Unit
EXFhl	Open ocean air-sea latent heat flux	W m-2
EXFhs	Open ocean air-sea sensible heat flux	W m-2
EXFlwdn	Downward longwave radiative flux	W m-2
EXFswdn	Downwelling shortwave radiative flux	W m-2
EXFqnet	Open ocean net air-sea heat flux	W m-2
oceQnet	Net heat flux into the ocean surface	W m-2
SIatmQnt	Net upward heat flux to the atmosphere	W m-2
TFLUX	Rate of change of ocean heat content per m2 accounting for mass fluxes.	W m-2
EXFswnet	Open ocean net shortwave radiative flux	W m-2
EXFlwnet	Net open ocean longwave radiative flux	W m-2
oceQsw	Net shortwave radiative flux across the ocean surface	W m-2
SIaaflux	Conservative ocean and sea-ice advective heat flux adjustment	W m-2
Coordinates	**Description of data coordinates**	**Unit**
i	Grid index in x for variables at tracer and 'v' locations	–none–
i_g	Grid index in x for variables at 'u' and 'g' locations	–none–
j	Grid index in y for variables at tracer and 'u' locations	–none–
j_g	Grid index in y for variables at 'v' and 'g' locations	–none–
tile	Lat-lon-cap tile index	–none–
time	Center time of averaging period	–none–
XC	Longitude of tracer grid cell center	degrees_east
YC	Latitude of tracer grid cell center	degrees_north
XG	Longitude of 'southwest' corner of tracer grid cell	degrees_east
YG	Latitude of 'southwest' corner of tracer grid cell	degrees_north
time_bnds	Time bounds of averaging period	–none–
XC_bnds	Longitudes of tracer grid cell corners	–none–
YC_bnds	Latitudes of tracer grid cell corners	–none–

12.8.2 Native Variable: EXFhl

Table 12.49: Attributes description of the variable 'EXFhl' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFhl	Open ocean air-sea latent heat flux	W m-2
Description of the variable in Common Data language (CDL)			

```
float32 EXFhl(time, tile, j, i)
   EXFhl:  _FillValue = 9.96921e+36
   EXFhl:  long_name = Open ocean air:  sea latent heat flux
   EXFhl:  units = W m:  2
   EXFhl:  coverage_content_type = modelResult
   EXFhl:  direction = >0 increases potential temperature (THETA)
   EXFhl:  standard_name = surface_downward_latent_heat_flux
   EXFhl:  coordinates = XC time YC
   EXFhl:  valid_min = :  1772.513671875
   EXFhl:  valid_max = 273.9528503417969
```

Comments

Air-sea latent heat flux per unit area of open water (not covered by sea-ice). note: calculated from the bulk formula following large and yeager (2004) ncar/tn-460+str.

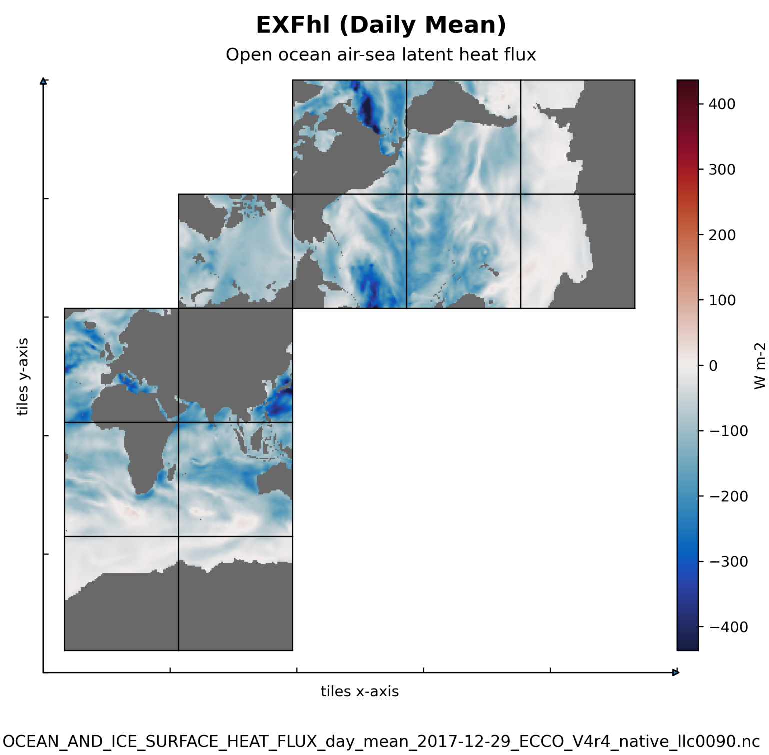

Figure 62: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFhl

12.8.3 Native Variable: EXFhs

Table 12.50: Attributes description of the variable 'EXFhs' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFhs	Open ocean air-sea sensible heat flux	W m-2

Description of the variable in Common Data language (CDL)

```
float32 EXFhs(time, tile, j, i)
   EXFhs:  _FillValue = 9.96921e+36
   EXFhs:  long_name = Open ocean air:  sea sensible heat flux
   EXFhs:  units = W m:  2
   EXFhs:  coverage_content_type = modelResult
   EXFhs:  direction = >0 increases potential temperature (THETA)
   EXFhs:  standard_name = surface_downward_sensible_heat_flux
   EXFhs:  coordinates = XC time YC
   EXFhs:  valid_min = :  2478.766357421875
   EXFhs:  valid_max = 362.8300476074219
```

Comments

Air-sea sensible heat flux per unit area of open water (not covered by sea-ice). note: calculated from the bulk formula following large and yeager (2004) ncar/tn-460+str.

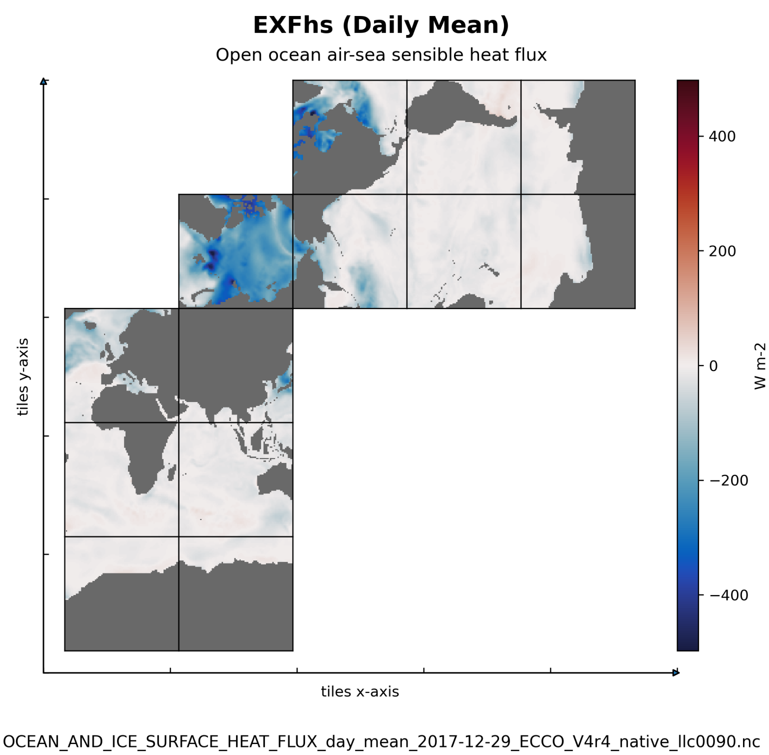

Figure 63: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFhs

12.8.4 Native Variable: EXFlwdn

Table 12.51: Attributes description of the variable 'EXFlwdn' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFlwdn	Downward longwave radiative flux	W m-2
Description of the variable in Common Data language (CDL)			

```
float32 EXFlwdn(time, tile, j, i)
   EXFlwdn:  _FillValue = 9.96921e+36
   EXFlwdn:  long_name = Downward longwave radiative flux
   EXFlwdn:  units = W m:  2
   EXFlwdn:  coverage_content_type = modelResult
   EXFlwdn:  direction = >0 increases potential temperature (THETA)
   EXFlwdn:  standard_name = surface_downwelling_longwave_flux_in_air
   EXFlwdn:  coordinates = XC time YC
   EXFlwdn:  valid_min = 4.188045501708984
   EXFlwdn:  valid_max = 513.3919067382812
```

Comments

Downward longwave radiative flux. note: sum of era-interim downward longwave radiation and the control adjustment from ocean state estimation.

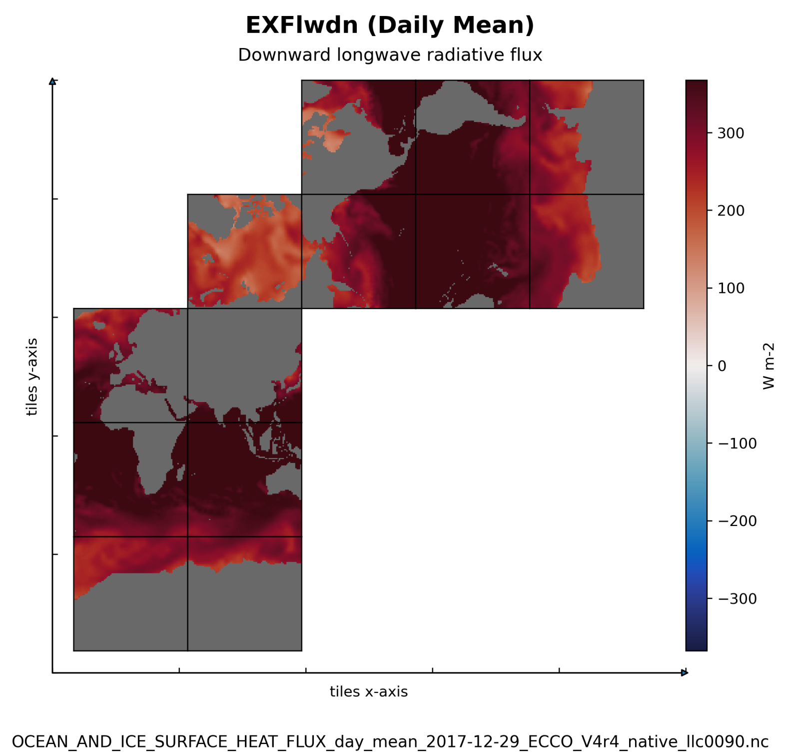

Figure 64: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFlwdn

12.8.5 Native Variable: EXFlwnet

Table 12.52: Attributes description of the variable 'EXFlwnet' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFlwnet	Net open ocean longwave radiative flux	W m-2

Description of the variable in Common Data language (CDL)

```
float32 EXFlwnet(time, tile, j, i)
   EXFlwnet:  _FillValue = 9.96921e+36
   EXFlwnet:  long_name = Net open ocean longwave radiative flux
   EXFlwnet:  units = W m:  2
   EXFlwnet:  coverage_content_type = modelResult
   EXFlwnet:  direction = >0 increases potential temperature (THETA)
   EXFlwnet:  standard_name = surface_net_downward_longwave_flux
   EXFlwnet:  coordinates = XC time YC
   EXFlwnet:  valid_min = :  144.3661346435547
   EXFlwnet:  valid_max = 293.4114990234375
```

Comments

Net longwave radiative flux per unit area of open water (not covered by sea-ice). note: net longwave radiation over open water calculated from downward longwave radiation (exflwdn) and upward longwave radiation from ocean and sea-ice thermal emission (stefan-boltzman law).

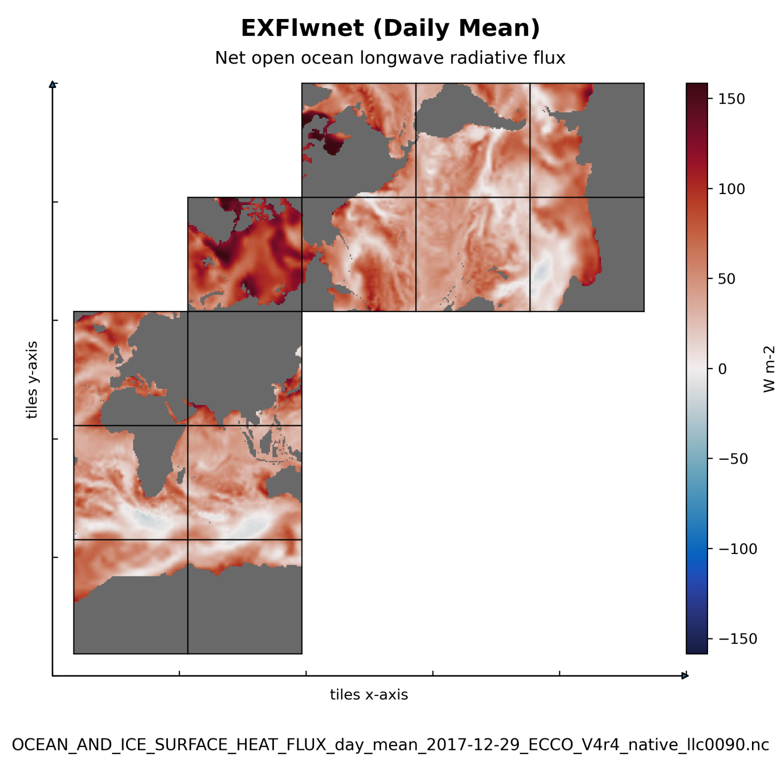

Figure 65: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFlwnet

12.8.6 Native Variable: EXFqnet

Table 12.53: Attributes description of the variable 'EXFqnet' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFqnet	Open ocean net air-sea heat flux	W m-2
Description of the variable in Common Data language (CDL)			

```
float32 EXFqnet(time, tile, j, i)
   EXFqnet:  _FillValue = 9.96921e+36
   EXFqnet:  long_name = Open ocean net air:  sea heat flux
   EXFqnet:  units = W m:  2
   EXFqnet:  coverage_content_type = modelResult
   EXFqnet:  direction = >0 increases potential temperature (THETA)
   EXFqnet:  coordinates = XC time YC
   EXFqnet:  valid_min = :  687.8736572265625
   EXFqnet:  valid_max = 3408.977783203125
```

Comments

Net air-sea heat flux (turbulent and radiative) per unit area of open water (not covered by sea-ice). note: net upward heat flux over open water, calculated as exflwnet+exfswnet-exflh-exfhs.

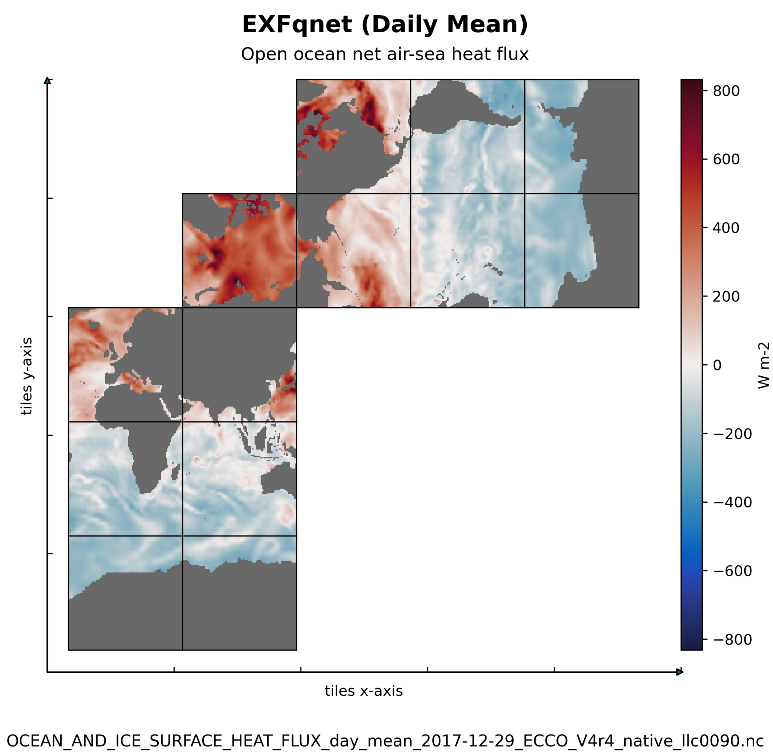

Figure 66: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFqnet

12.8.7 Native Variable: EXFswdn

Table 12.54: Attributes description of the variable 'EXFswdn' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFswdn	Downwelling shortwave radiative flux	W m-2

Description of the variable in Common Data language (CDL)

```
float32 EXFswdn(time, tile, j, i)
   EXFswdn:  _FillValue = 9.96921e+36
   EXFswdn:  long_name = Downwelling shortwave radiative flux
   EXFswdn:  units = W m:  2
   EXFswdn:  coverage_content_type = modelResult
   EXFswdn:  direction = >0 increases potential temperature (THETA)
   EXFswdn:  standard_name = surface_downwelling_shortwave_flux_in_air
   EXFswdn:  coordinates = XC time YC
   EXFswdn:  valid_min = :  224.63368225097656
   EXFswdn:  valid_max = 707.345947265625
```

Comments

Downward shortwave radiative flux. note: sum of era-interim downward shortwave radiation and the control adjustment from ocean state estimation.

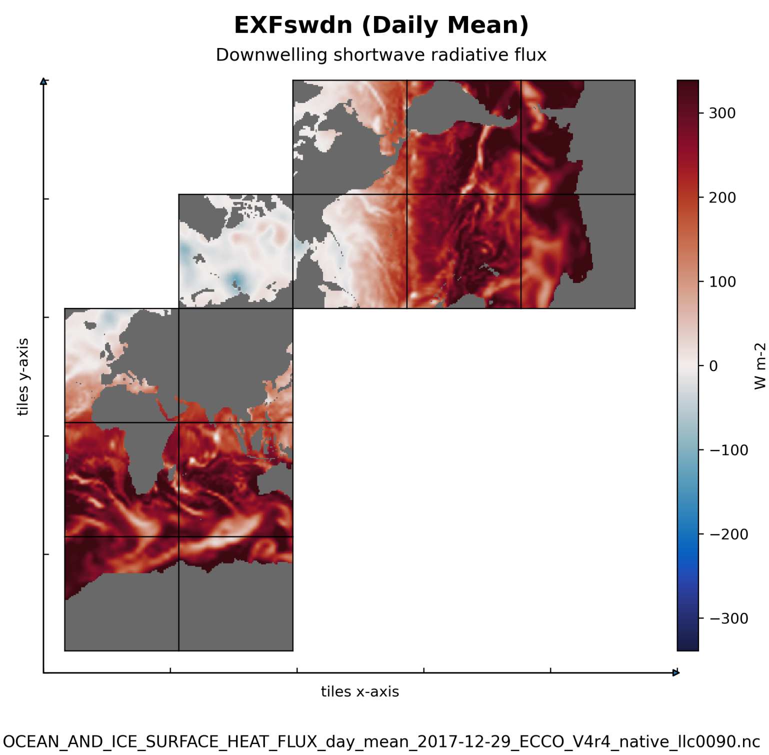

Figure 67: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFswdn

12.8.8 Native Variable: EXFswnet

Table 12.55: Attributes description of the variable 'EXFswnet' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFswnet	Open ocean net shortwave radiative flux	W m-2
Description of the variable in Common Data language (CDL)			

`float32 EXFswnet(time, tile, j, i)`
`EXFswnet: _FillValue = 9.96921e+36`
`EXFswnet: long_name = Open ocean net shortwave radiative flux`
`EXFswnet: units = W m: 2`
`EXFswnet: coverage_content_type = modelResult`
`EXFswnet: direction = >0 increases potential temperature (THETA)`
`EXFswnet: standard_name = surface_net_downward_shortwave_flux`
`EXFswnet: coordinates = XC time YC`
`EXFswnet: valid_min = : 655.6171264648438`
`EXFswnet: valid_max = 194.18458557128906`			

Comments			
Net shortwave radiative flux per unit area of open water (not covered by sea-ice). note: net shortwave radiation over open water calculated from downward shortwave flux (exfswdn) and ocean surface albdeo.			

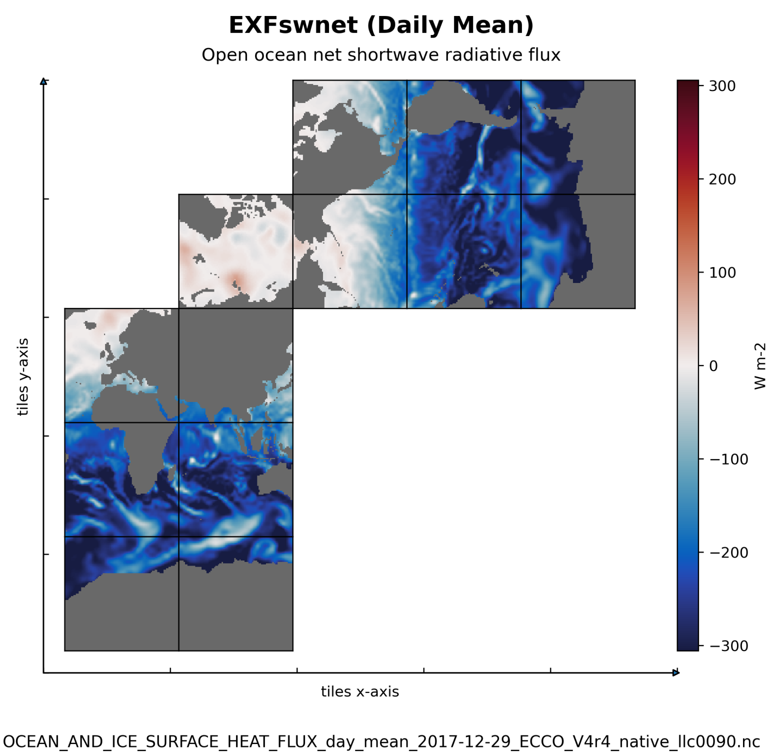

Figure 68: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFswnet

12.8.9 Native Variable: SIaaflux

Table 12.56: Attributes description of the variable 'SIaaflux' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	SIaaflux	Conservative ocean and sea-ice advective heat flux adjustment	W m-2
Description of the variable in Common Data language (CDL)			

```
float32 SIaaflux(time, tile, j, i)
   SIaaflux:  _FillValue = 9.96921e+36
   SIaaflux:  long_name = Conservative ocean and sea:  ice advective heat flux
adjustment
   SIaaflux:  units = W m:  2
   SIaaflux:  coverage_content_type = modelResult
   SIaaflux:  direction = >0 decrease potential temperature (THETA)
   SIaaflux:  coordinates = XC time YC
   SIaaflux:  valid_min = :  16.214622497558594
   SIaaflux:  valid_max = 50.35451889038086
```

Comments

Heat flux associated with the temperature difference between sea surface temperature and sea-ice (assume 0 degree c in the model). note: heat flux needed to melt/freeze sea-ice at 0 degc to sea water at the ocean surface (at sea surface temperature), excluding the latent heat of fusion.

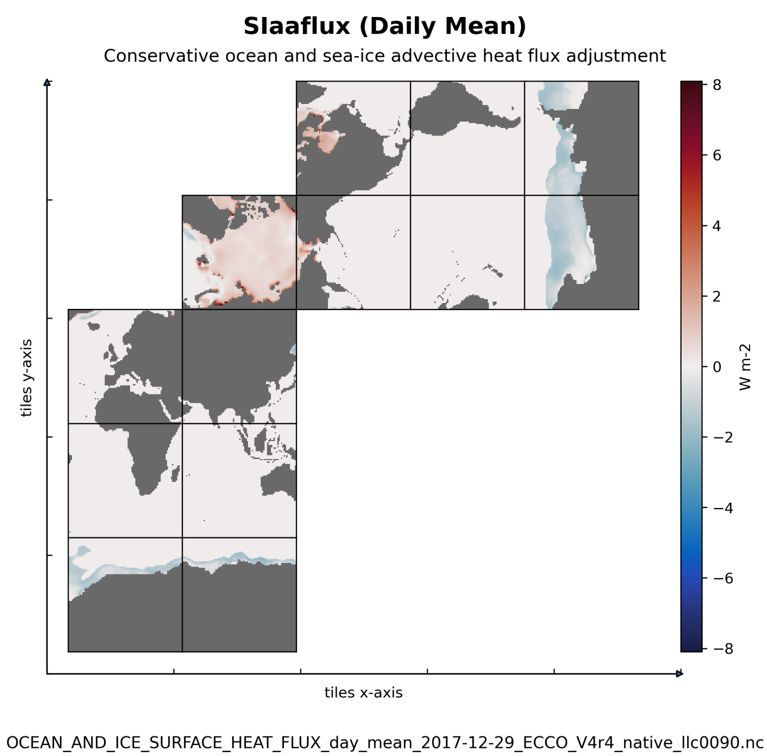

Figure 69: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: SIaaflux

12.8.10 Native Variable: SIatmQnt

Table 12.57: Attributes description of the variable 'SIatmQnt' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	SIatmQnt	Net upward heat flux to the atmosphere	W m-2

Description of the variable in Common Data language (CDL)

```
float32 SIatmQnt(time, tile, j, i)
   SIatmQnt:  _FillValue = 9.96921e+36
   SIatmQnt:  long_name = Net upward heat flux to the atmosphere
   SIatmQnt:  units = W m:  2
   SIatmQnt:  coverage_content_type = modelResult
   SIatmQnt:  direction = >0 upward
decreases ocean temperature
   SIatmQnt:  standard_name = surface_upward_heat_flux_in_air
   SIatmQnt:  coordinates = XC time YC
   SIatmQnt:  valid_min = :  756.0607299804688
   SIatmQnt:  valid_max = 1704.7703857421875
```

Comments

Net upward heat flux to the atmosphere across open water and sea-ice or snow surfaces. note: nonzero siatmqnt may not be associated with a change in ocean potential temperature due to sea-ice growth or melting. to calculate total ocean heat content changes use the variable tflux which also accounts for changing ocean mass (e.g. ocefwflx).

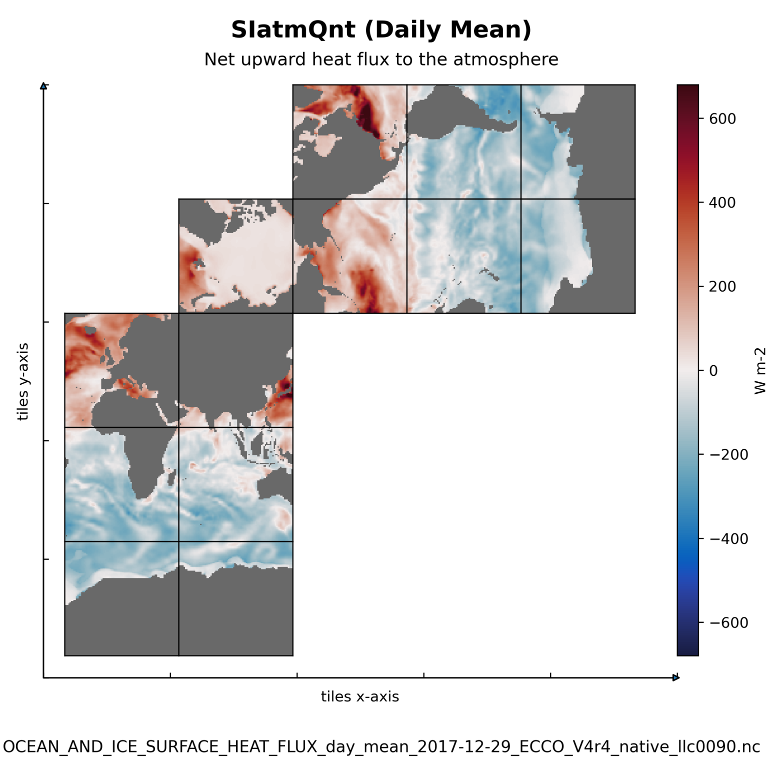

Figure 70: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: SIatmQnt

12.8.11 Native Variable: TFLUX

Table 12.58: Attributes description of the variable 'TFLUX' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	TFLUX	Rate of change of ocean heat content per m2 accounting for mass fluxes.	W m-2

Description of the variable in Common Data language (CDL)

```
float32 TFLUX(time, tile, j, i)
   TFLUX: _FillValue = 9.96921e+36
   TFLUX: long_name = Rate of change of ocean heat content per m2 accounting for
mass fluxes.
   TFLUX: units = W m:  2
   TFLUX: coverage_content_type = modelResult
   TFLUX: direction = >0 increases potential temperature (THETA)
   TFLUX: coordinates = XC time YC
   TFLUX: valid_min = :  1713.51220703125
   TFLUX: valid_max = 870.3130493164062
```

Comments

The rate of change of ocean heat content due to heat fluxes across the liquid surface and the addition or removal of mass. . note: the global area integral of tflux and geothermal flux (geothermalflux.bin) matches the time-derivative of ocean heat content (j/s). unlike oceqnet, tflux includes the contribution to the ocean heat content from changing ocean mass (e.g. from ocefwflx).

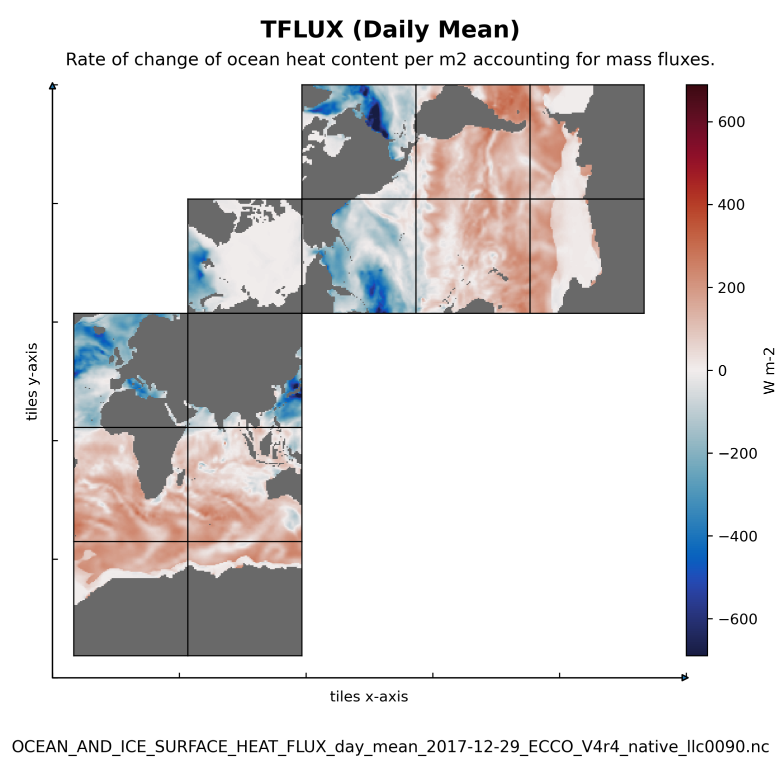

Figure 71: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: TFLUX

12.8.12 Native Variable: oceQnet

Table 12.59: Attributes description of the variable 'oceQnet' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	oceQnet	Net heat flux into the ocean surface	W m-2
Description of the variable in Common Data language (CDL)			

```
float32 oceQnet(time, tile, j, i)
   oceQnet:  _FillValue = 9.96921e+36
   oceQnet:  long_name = Net heat flux into the ocean surface
   oceQnet:  units = W m:  2
   oceQnet:  coverage_content_type = modelResult
   oceQnet:  direction = >0 increases potential temperature (THETA)
   oceQnet:  standard_name = surface_downward_heat_flux_in_sea_water
   oceQnet:  coordinates = XC time YC
   oceQnet:  valid_min = :  1708.8460693359375
   oceQnet:  valid_max = 675.3716430664062
```

Comments

Net heat flux into the ocean surface from all processes: air-sea turbulent and radiative fluxes and turbulent and conductive fluxes between the ocean and sea-ice and snow. note: oceqnet does not include the change in ocean heat content due to changing ocean ocean mass (ocefwflx). mass fluxes from evaporation, precipitation, and runoff (exfempmr) happen at the same temperature as the ocean surface temperature. consequently, empmr does not change ocean surface temperature. conversely, mass fluxes due to sea-ice thickening/thinning and snow melt in the model are assumed to happen at a fixed 0c. consequently, mass fluxes due to phase changes between seawater and sea-ice and snow induce a heat flux when the ocean surface temperaure is not 0c. the variable tflux does include the change in ocean heat content due to changing ocean mass.

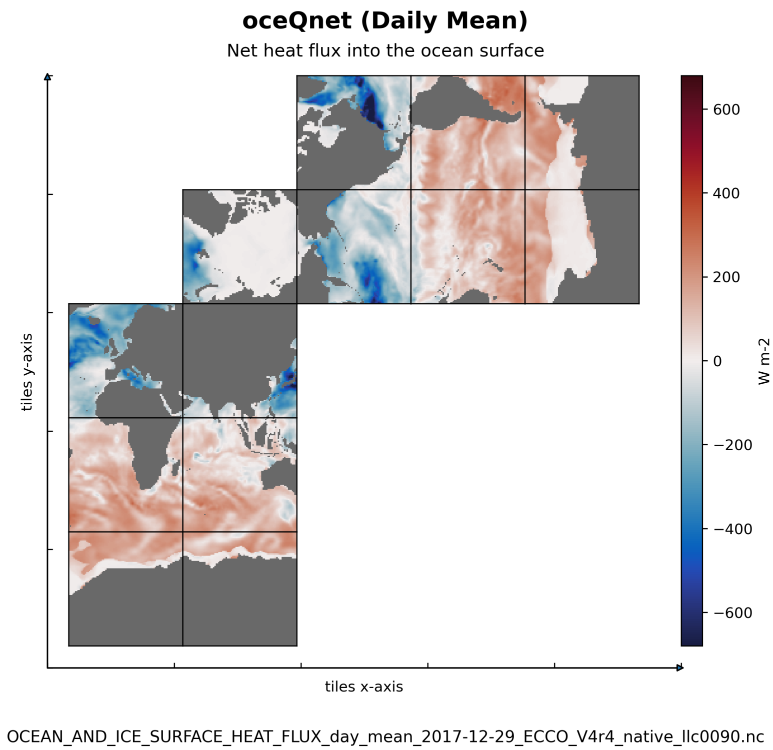

Figure 72: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: oceQnet

12.8.13 Native Variable: oceQsw

Table 12.60: Attributes description of the variable 'oceQsw' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	oceQsw	Net shortwave radiative flux across the ocean surface	W m-2

Description of the variable in Common Data language (CDL)

```
float32 oceQsw(time, tile, j, i)
   oceQsw:  _FillValue = 9.96921e+36
   oceQsw:  long_name = Net shortwave radiative flux across the ocean surface
   oceQsw:  units = W m:  2
   oceQsw:  coverage_content_type = modelResult
   oceQsw:  direction = >0 increases potential temperature (THETA)
   oceQsw:  coordinates = XC time YC
   oceQsw:  valid_min = :  134.39808654785156
   oceQsw:  valid_max = 655.6171264648438
```

Comments

Net shortwave radiative flux across the ocean surface. note: shortwave radiation penetrates below the surface grid cell.

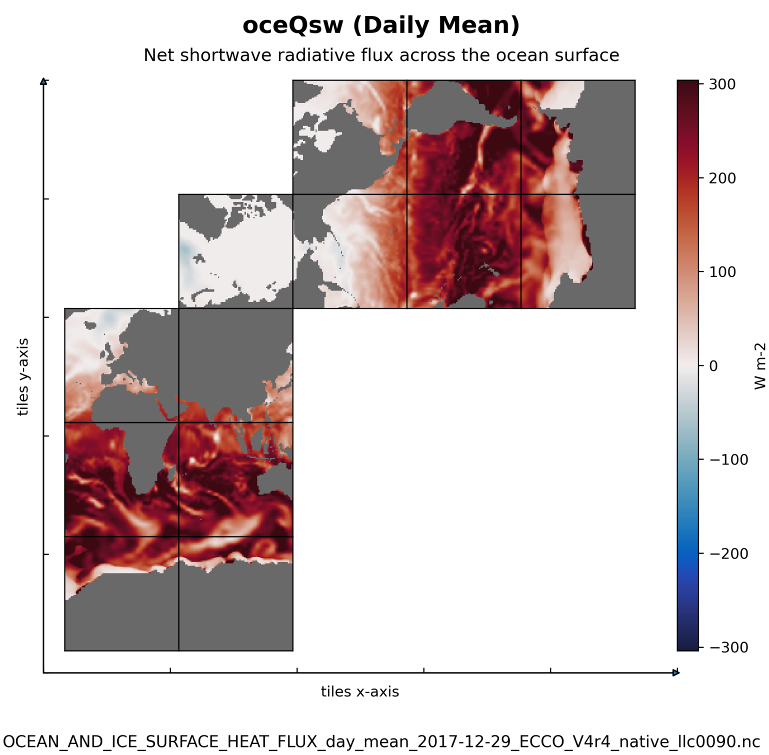

Figure 73: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: oceQsw

12.9 Native dataset of OCEAN_AND_ICE_SURFACE_STRESS

12.9.1 Overview

This dataset provides 2D fields of ocean and sea-ice surface stress on the lat-lon-cap 90 (llc90) native model grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution.

Table 12.61: Coordinates and Variables in the dataset OCEAN_AND_ICE_SURFACE_STRESS

Variables	Description of data variables	Unit
EXFtaux	Wind stress in the model +x direction	N m-2
EXFtauy	Wind stress in the model +y direction	N m-2
oceTAUX	Ocean surface stress in the model +x direction	N m-2
oceTAUY	Ocean surface stress in the model +y direction	N m-2
Coordinates	**Description of data coordinates**	**Unit**
i	Grid index in x for variables at tracer and 'v' locations	–none–
i_g	Grid index in x for variables at 'u' and 'g' locations	–none–
j	Grid index in y for variables at tracer and 'u' locations	–none–
j_g	Grid index in y for variables at 'v' and 'g' locations	–none–
tile	Lat-lon-cap tile index	–none–
time	Center time of averaging period	–none–
XC	Longitude of tracer grid cell center	degrees_east
YC	Latitude of tracer grid cell center	degrees_north
XG	Longitude of 'southwest' corner of tracer grid cell	degrees_east
YG	Latitude of 'southwest' corner of tracer grid cell	degrees_north
time_bnds	Time bounds of averaging period	–none–
XC_bnds	Longitudes of tracer grid cell corners	–none–
YC_bnds	Latitudes of tracer grid cell corners	–none–

12.9.2 Native Variable: EXFtaux

Table 12.62: Attributes description of the variable 'EXFtaux' from OCEAN_AND_ICE_SURFACE_STRESS's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFtaux	Wind stress in the model +x direction	N m-2
Description of the variable in Common Data language (CDL)			

```
float32 EXFtaux(time, tile, j, i)
   EXFtaux:  _FillValue = 9.96921e+36
   EXFtaux:  long_name = Wind stress in the model +x direction
   EXFtaux:  units = N m:  2
   EXFtaux:  coverage_content_type = modelResult
   EXFtaux:  direction = >0 increases horizontal velocity in the +x direction
(UVEL)
   EXFtaux:  standard_name = surface_downward_x_stress
   EXFtaux:  coordinates = time YC XC
   EXFtaux:  valid_min = :  7.474303722381592
   EXFtaux:  valid_max = 3.7184090614318848
```

Comments

Wind stress in the +x direction at the tracer cell on the native model grid. note: exftaux is the stress applied to the ice-free ocean surface and sea-ice covered surface. when sea-ice is present, the total stress applied to the ocean surface in the +x direction is not exftaux, but a combination of exftaux wind stress in the open water fraction and a stress from sea-ice in the ice-covered fraction (see ocetaux). exftaux is the sum of era-interim stress and the control adjustment from ocean state estimation.

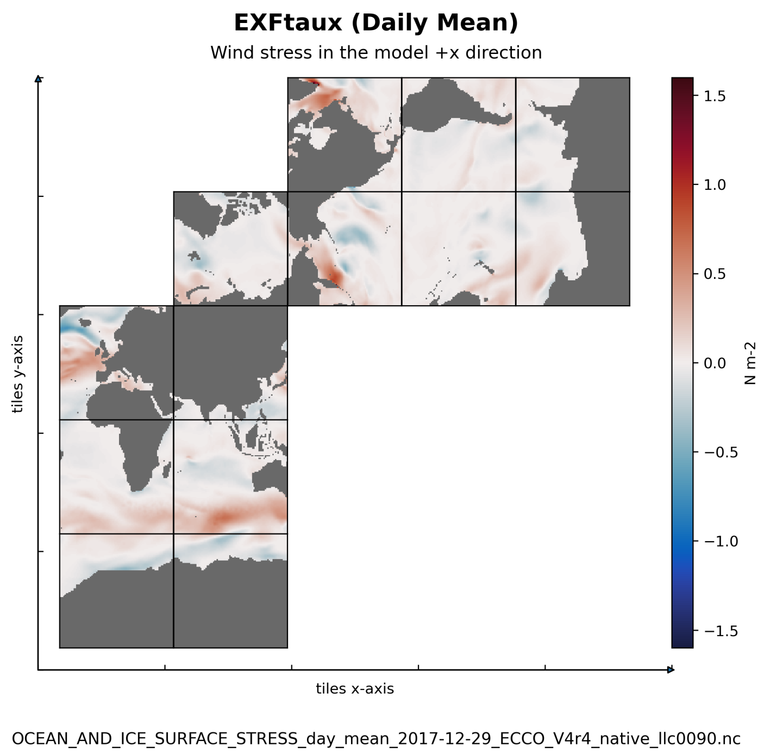

Figure 74: Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: EXFtaux

12.9.3 Native Variable: EXFtauy

Table 12.63: Attributes description of the variable 'EXFtauy' from OCEAN_AND_ICE_SURFACE_STRESS's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFtauy	Wind stress in the model +y direction	N m-2

Description of the variable in Common Data language (CDL)

```
float32 EXFtauy(time, tile, j, i)
   EXFtauy:  _FillValue = 9.96921e+36
   EXFtauy:  long_name = Wind stress in the model +y direction
   EXFtauy:  units = N m:  2
   EXFtauy:  coverage_content_type = modelResult
   EXFtauy:  direction = >0 increases horizontal velocity in the +y direction
(VVEL)
   EXFtauy:  standard_name = surface_downward_y_stress
   EXFtauy:  coordinates = time YC XC
   EXFtauy:  valid_min = :  3.71972918510437
   EXFtauy:  valid_max = 3.7044837474823
```

Comments

Wind stress in the +y direction at the tracer cell on the native model grid. note: exftauy is the stress applied to the ice-free ocean surface and sea-ice covered surface. when sea-ice is present, the total stress applied to the ocean surface in the +y direction is not exftauy, but a combination of exftauy wind stress in the open water fraction and a stress from sea-ice in the ice-covered fraction (see ocetauy). exftaux is the sum of era-interim stress and the control adjustment from ocean state estimation.

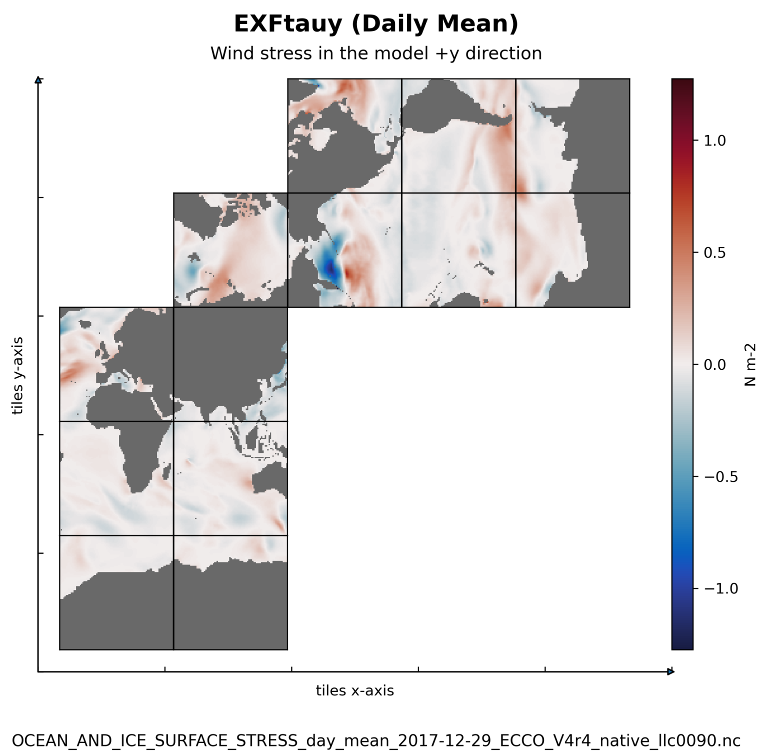

Figure 75: Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: EXFtauy

12.9.4 Native Variable: oceTAUX

Table 12.64: Attributes description of the variable 'oceTAUX' from OCEAN_AND_ICE_SURFACE_STRESS's dataset.

Storage Type	Variable Name	Description	Unit
float32	oceTAUX	Ocean surface stress in the model +x direction	N m-2

Description of the variable in Common Data language (CDL)

```
float32 oceTAUX(time, tile, j, i_g)
   oceTAUX: _FillValue = 9.96921e+36
   oceTAUX: long_name = Ocean surface stress in the model +x direction
   oceTAUX: units = N m:  2
   oceTAUX: mate = oceTAUY
   oceTAUX: coverage_content_type = modelResult
   oceTAUX: direction = >0 increases horizontal velocity in the +x direction
(UVEL)
   oceTAUX: standard_name = downward_x_stress_at_sea_water_surface
   oceTAUX: coordinates = time
   oceTAUX: valid_min = :  2.2317698001861572
   oceTAUX: valid_max = 1.9993581771850586
```

Comments

Ocean surface stress due to wind and sea-ice in the +x direction centered over the 'u' side of the the native model grid. note: in the arakawa-c grid, wind stress acts on horizontal velocities which are staggered relative to the tracer cells with indexing such that +ocetaux(i_g,j) corresponds to +x momentum fluxes at 'u' edge of the tracer cell at (i,j,k=0). also, the model +x direction does not necessarily correspond to the geographical east-west direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.

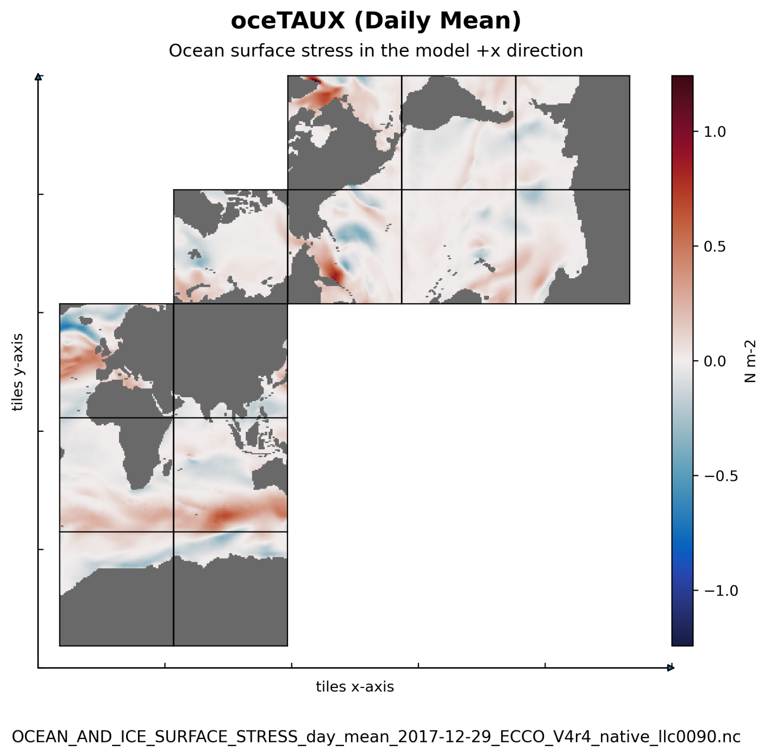

Figure 76: Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: oceTAUX

12.9.5 Native Variable: oceTAUY

Table 12.65: Attributes description of the variable 'oceTAUY' from OCEAN_AND_ICE_SURFACE_STRESS's dataset.

Storage Type	Variable Name	Description	Unit
float32	oceTAUY	Ocean surface stress in the model +y direction	N m-2

Description of the variable in Common Data language (CDL)

```
float32 oceTAUY(time, tile, j_g, i)
   oceTAUY: _FillValue = 9.96921e+36
   oceTAUY: long_name = Ocean surface stress in the model +y direction
   oceTAUY: units = N m:  2
   oceTAUY: mate = oceTAUX
   oceTAUY: coverage_content_type = modelResult
   oceTAUY: direction = >0 increases horizontal velocity in the +y direction
(VVEL)
   oceTAUY: standard_name = downward_y_stress_at_sea_water_surface
   oceTAUY: coordinates = time
   oceTAUY: valid_min = :  2.0606131553649902
   oceTAUY: valid_max = 1.9999693632125854
```

Comments

Ocean surface stress due to wind and sea-ice in the +y direction centered over the 'v' side of the the native model grid. note: in the arakawa-c grid, wind stress acts on horizontal velocities which are staggered relative to the tracer cells with indexing such that +ocetauy(i_g,j) corresponds to +y momentum fluxes at 'v' edge of the tracer cell at (i,j,k=0). also, the model +y direction does not necessarily correspond to the geographical north-south direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.

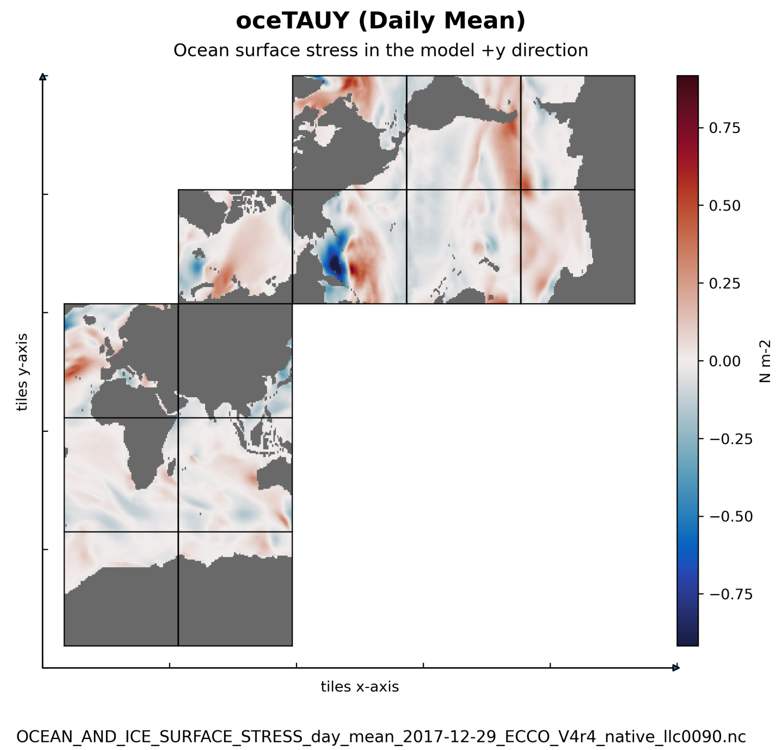

Figure 77: Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: oceTAUY

12.10 Native dataset of OCEAN_BOLUS_STREAMFUNCTION

12.10.1 Overview

This dataset provides 3D fields of Gent-McWilliams ocean bolus transport streamfunctions on the lat-lon-cap 90 (llc90) native model grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution.

Table 12.66: Coordinates and Variables in the dataset OCEAN_BOLUS_STREAMFUNCTION

Variables	Description of data variables	Unit
GM_PsiX	Gent-mcwilliams bolus transport streamfunction in the model +x direction	m2 s-1
GM_PsiY	Gent-mcwilliams bolus transport streamfunction in the model +y direction	m2 s-1
Coordinates	**Description of data coordinates**	**Unit**
i	Grid index in x for variables at tracer and 'v' locations	–none–
i_g	Grid index in x for variables at 'u' and 'g' locations	–none–
j	Grid index in y for variables at tracer and 'u' locations	–none–
j_g	Grid index in y for variables at 'v' and 'g' locations	–none–
k	Grid index in z for tracer variables	–none–
k_u	Grid index in z corresponding to the bottom face of tracer grid cells ('w' locations)	–none–
k_l	Grid index in z corresponding to the top face of tracer grid cells ('w' locations)	–none–
k_p1	Grid index in z for variables at 'w' locations	–none–
tile	Lat-lon-cap tile index	–none–

Table 12.66: Coordinates and Variables in the dataset OCEAN_BOLUS_STREAMFUNCTION

time	Center time of averaging period	–none–
XC	Longitude of tracer grid cell center	degrees_east
YC	Latitude of tracer grid cell center	degrees_north
XG	Longitude of 'southwest' corner of tracer grid cell	degrees_east
YG	Latitude of 'southwest' corner of tracer grid cell	degrees_north
Z	Depth of tracer grid cell center	m
Zp1	Depth of tracer grid cell interface	m
Zu	Depth of the bottom face of tracer grid cells	m
Zl	Depth of the top face of tracer grid cells	m
time_bnds	Time bounds of averaging period	–none–
XC_bnds	Longitudes of tracer grid cell corners	–none–
YC_bnds	Latitudes of tracer grid cell corners	–none–
Z_bnds	Depths of tracer grid cell upper and lower interfaces	–none–

12.10.2 Native Variable: GM_PsiX

Table 12.67: Attributes description of the variable 'GM_PsiX' from OCEAN_BOLUS_STREAMFUNCTION's dataset.

Storage Type	Variable Name	Description	Unit
float32	GM_PsiX	Gent-mcwilliams bolus transport streamfunction in the model +x direction	m2 s-1
Description of the variable in Common Data language (CDL)			
float32 GM_PsiX(time, k_l, tile, j, i_g) GM_PsiX: _FillValue = 9.96921e+36 GM_PsiX: long_name = Gent: Mcwilliams bolus transport streamfunction in the model +x direction GM_PsiX: units = m2 s: 1 GM_PsiX: mate = GM_PsiY GM_PsiX: coverage_content_type = modelResult GM_PsiX: coordinates = Zl time GM_PsiX: valid_min = : 4.9964470863342285 GM_PsiX: valid_max = 4.963776111602783			
Comments			
Gent-mcwilliams bolus transport streamfunction 'u' component. any comments welcome			

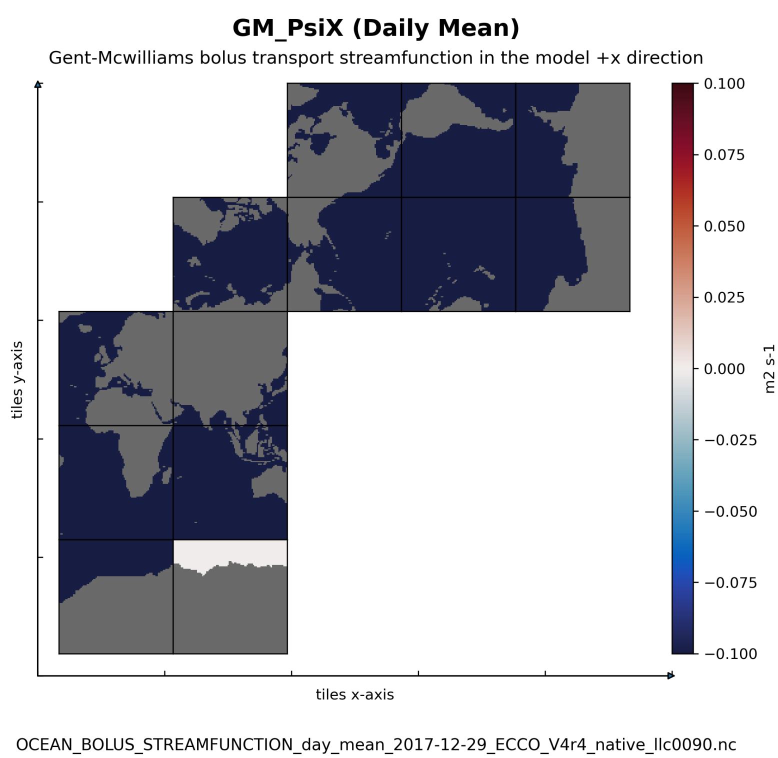

Figure 78: Dataset: OCEAN_BOLUS_STREAMFUNCTION, Variable: GM_PsiX

12.10.3 Native Variable: GM_PsiY

Table 12.68: Attributes description of the variable 'GM_PsiY' from OCEAN_BOLUS_STREAMFUNCTION's dataset.

Storage Type	Variable Name	Description	Unit
float32	GM_PsiY	Gent-mcwilliams bolus transport streamfunction in the model +y direction	m2 s-1
Description of the variable in Common Data language (CDL)			
float32 GM_PsiY(time, k_l, tile, j_g, i) GM_PsiY: _FillValue = 9.96921e+36 GM_PsiY: long_name = Gent: Mcwilliams bolus transport streamfunction in the model +y direction GM_PsiY: units = m2 s: 1 GM_PsiY: mate = GM_PsiX GM_PsiY: coverage_content_type = modelResult GM_PsiY: coordinates = Zl time GM_PsiY: valid_min = : 5.0 GM_PsiY: valid_max = 4.949861526489258			
Comments			
Gent-mcwilliams bolus transport streamfunction 'v' component. any comments welcome			

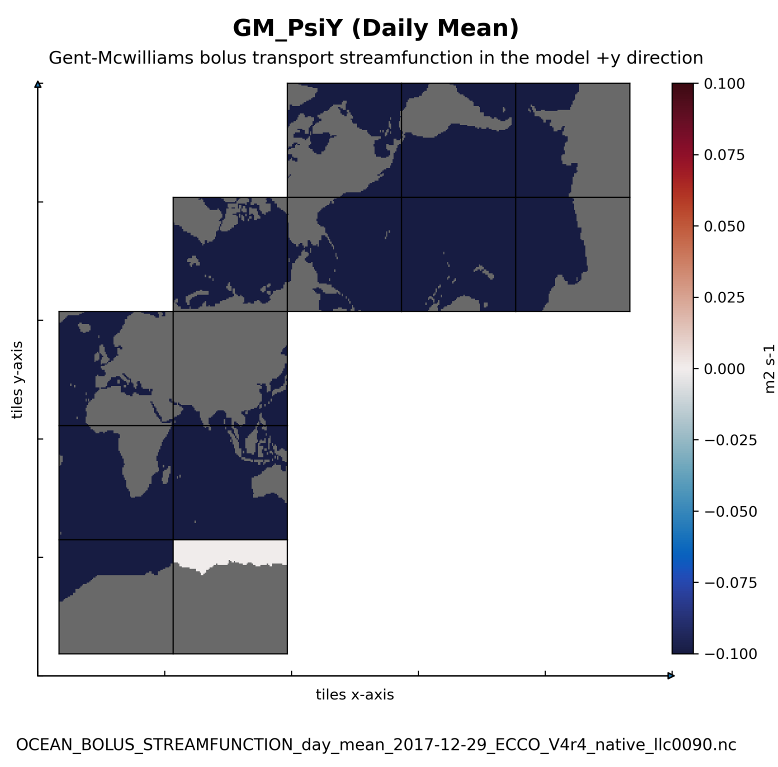

Figure 79: Dataset: OCEAN_BOLUS_STREAMFUNCTION, Variable: GM_PsiY

12.11 Native dataset of OCEAN_BOLUS_VELOCITY

12.11.1 Overview

This dataset provides 3D fields of Gent-McWilliams ocean bolus velocity on the lat-lon-cap 90 (llc90) native model grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution.

Table 12.69: Coordinates and Variables in the dataset OCEAN_BOLUS_VELOCITY

Variables	Description of data variables	Unit
UVELSTAR	Gent-mcwilliams velocity in the model +x direction scaled by time-varying grid cell thickness	m s-1
VVELSTAR	Gent-mcwilliams velocity in the model +y direction scaled by time-varying grid cell thickness	m s-1
WVELSTAR	Gent-mcwilliams velocity in the model +z direction	m s-1
Coordinates	**Description of data coordinates**	**Unit**
i	Grid index in x for variables at tracer and 'v' locations	–none–
i_g	Grid index in x for variables at 'u' and 'g' locations	–none–
j	Grid index in y for variables at tracer and 'u' locations	–none–
j_g	Grid index in y for variables at 'v' and 'g' locations	–none–
k	Grid index in z for tracer variables	–none–
k_u	Grid index in z corresponding to the bottom face of tracer grid cells ('w' locations)	–none–
k_l	Grid index in z corresponding to the top face of tracer grid cells ('w' locations)	–none–
k_p1	Grid index in z for variables at 'w' locations	–none–
tile	Lat-lon-cap tile index	–none–
time	Center time of averaging period	–none–
XC	Longitude of tracer grid cell center	degrees_east
YC	Latitude of tracer grid cell center	degrees_north
XG	Longitude of 'southwest' corner of tracer grid cell	degrees_east
YG	Latitude of 'southwest' corner of tracer grid cell	degrees_north
Z	Depth of tracer grid cell center	m
Zp1	Depth of tracer grid cell interface	m
Zu	Depth of the bottom face of tracer grid cells	m
Zl	Depth of the top face of tracer grid cells	m
time_bnds	Time bounds of averaging period	–none–
XC_bnds	Longitudes of tracer grid cell corners	–none–
YC_bnds	Latitudes of tracer grid cell corners	–none–
Z_bnds	Depths of tracer grid cell upper and lower interfaces	–none–

12.11.2 Native Variable: UVELSTAR

Table 12.70: Attributes description of the variable 'UVELSTAR' from OCEAN_BOLUS_VELOCITY's dataset.

Storage Type	Variable Name	Description	Unit
float32	UVELSTAR	Gent-mcwilliams velocity in the model +x direction scaled by time-varying grid cell thickness	m s-1

Description of the variable in Common Data language (CDL)

```
float32 UVELSTAR(time, k, tile, j, i_g)
   UVELSTAR: _FillValue = 9.96921e+36
   UVELSTAR: long_name = Gent:  McWilliams velocity in the model +x direction
scaled by time:  varying grid cell thickness
   UVELSTAR: units = m s:  1
   UVELSTAR: mate = VVELSTAR
   UVELSTAR: coverage_content_type = modelResult
   UVELSTAR: standard_name = sea_water_x_velocity_due_to_parameterized_mesoscale_eddies
   UVELSTAR: coordinates = Z time
   UVELSTAR: valid_min = :  0.7960150241851807
   UVELSTAR: valid_max = 0.7762293219566345
```

Comments

Gent-mcwilliams horizontal velocity in the +x direction at the 'u' face of the tracer cell on the native model grid. note: uvelstar is not a model diagnostic but is calculated offline: uvelstar = -d/dz gm_psix. in the arakawa-c grid, horizontal velocities are staggered relative to the tracer cells with indexing such that +uvelstar(i_g,j,k) corresponds to +x tracer fluxes through the 'u' face of the tracer cell at (i,j,k). also, the model +x direction does not necessarily correspond to the geographical east-west direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles. see evelstar and nvelstar.

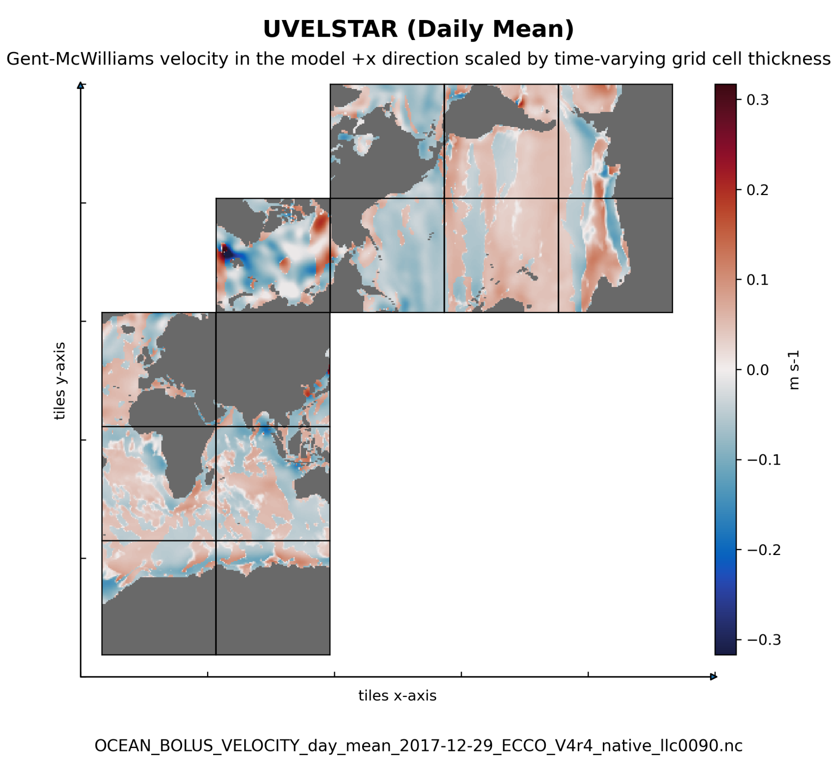

Figure 80: Dataset: OCEAN_BOLUS_VELOCITY, Variable: UVELSTAR

12.11.3 Native Variable: VVELSTAR

Table 12.71: Attributes description of the variable 'VVELSTAR' from OCEAN_BOLUS_VELOCITY's dataset.

Storage Type	Variable Name	Description	Unit
float32	VVELSTAR	Gent-mcwilliams velocity in the model +y direction scaled by time-varying grid cell thickness	m s-1
Description of the variable in Common Data language (CDL)			
float32 VVELSTAR(time, k, tile, j_g, i) VVELSTAR: _FillValue = 9.96921e+36 VVELSTAR: long_name = Gent: McWilliams velocity in the model +y direction scaled by time: varying grid cell thickness VVELSTAR: units = m s: 1 VVELSTAR: mate = UVELSTAR VVELSTAR: coverage_content_type = modelResult VVELSTAR: standard_name = sea_water_y_velocity_due_to_parameterized_mesoscale_eddies VVELSTAR: coordinates = Z time VVELSTAR: valid_min = : 0.8495296239852905 VVELSTAR: valid_max = 0.7200774550437927			
Comments			
Gent-mcwilliams horizontal velocity in the +y direction at the 'v' face of the tracer cell on the native model grid. note: vvelstar is not a model diagnostic but is calculated offline: vvelstar = -d/dz gm_psiy. in the arakawa-c grid, horizontal velocities are staggered relative to the tracer cells with indexing such that +vvelstar(i,j_g,k) corresponds to +y tracer fluxes through the 'v' face of the tracer cell at (i,j,k). also, the model +y direction does not necessarily correspond to the geographical north-south direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles. see evelstar and nvelstar.			

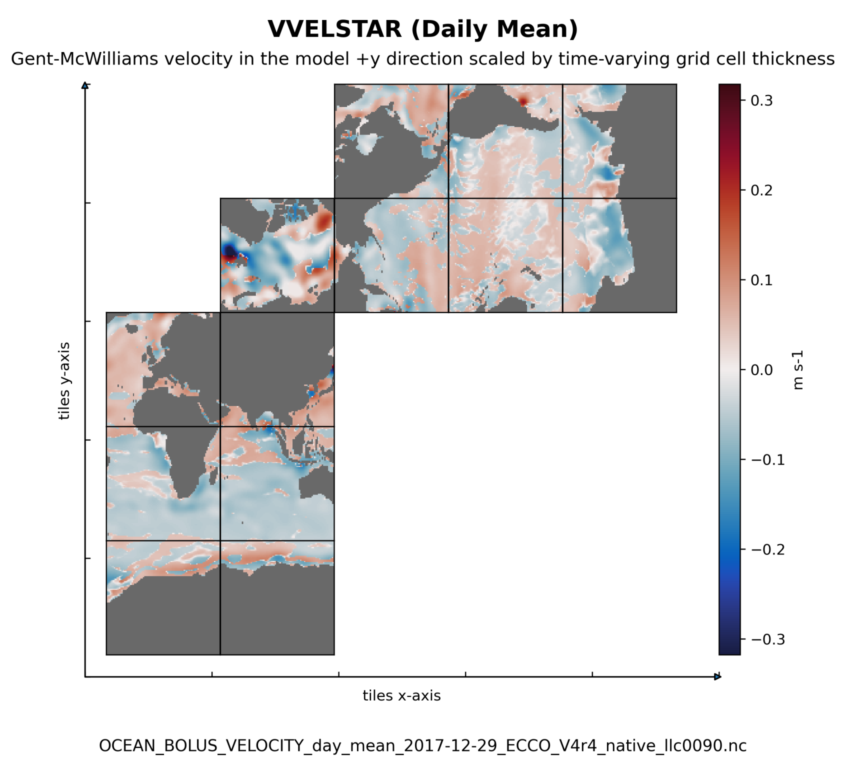

Figure 81: Dataset: OCEAN_BOLUS_VELOCITY, Variable: VVELSTAR

12.11.4 Native Variable: WVELSTAR

Table 12.72: Attributes description of the variable 'WVELSTAR' from OCEAN_BOLUS_VELOCITY's dataset.

Storage Type	Variable Name	Description	Unit
float32	WVELSTAR	Gent-mcwilliams velocity in the model +z direction	m s-1
Description of the variable in Common Data language (CDL)			
float32 WVELSTAR(time, k_l, tile, j, i) WVELSTAR: _FillValue = 9.96921e+36 WVELSTAR: long_name = Gent: McWilliams velocity in the model +z direction WVELSTAR: units = m s: 1 WVELSTAR: coverage_content_type = modelResult WVELSTAR: direction = >0 decreases volume WVELSTAR: standard_name = upward_sea_water_velocity_due_to_parameterized_mesoscale_eddies WVELSTAR: coordinates = XC YC time Zl WVELSTAR: valid_min = : 0.00037936007720418274 WVELSTAR: valid_max = 0.000465469085611403			
Comments			
Gent-mcwilliams vertical bolus velocity in the +z direction at the top 'w' face of the tracer cell on the native model grid. note: in the arakawa-c grid, vertical velocities are staggered relative to the tracer cells with indexing such that +wvelstar(i,j,k_l) corresponds to upward +z motion through the top 'w' face of the tracer cell at (i,j,k).			

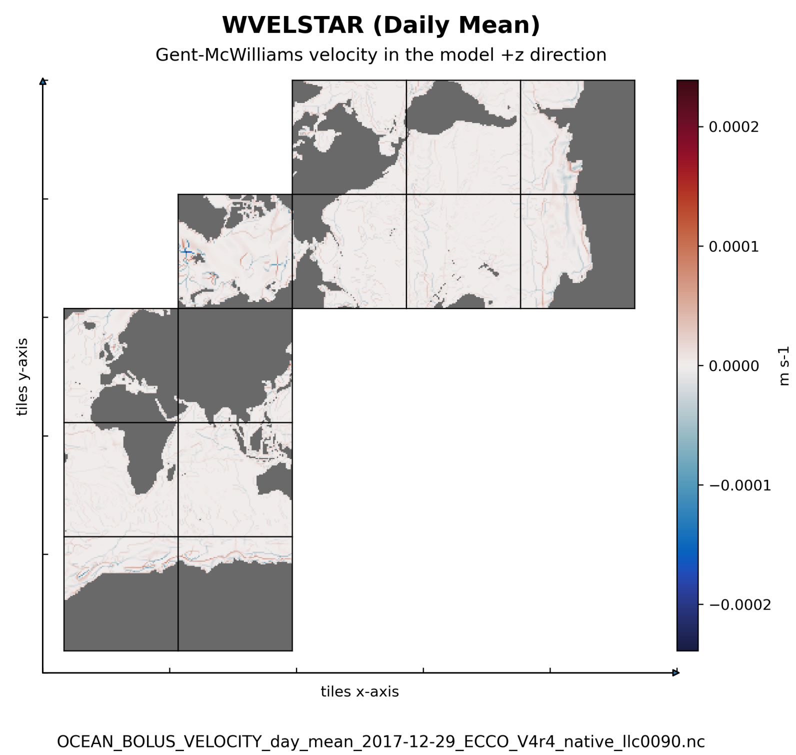

Figure 82: Dataset: OCEAN_BOLUS_VELOCITY, Variable: WVELSTAR

12.12 Native dataset of OCEAN_BOTTOM_PRESSURE

12.12.1 Overview

This dataset provides 2D fields of ocean bottom pressure and model ocean bottom pressure anomaly on the lat-lon-cap 90 (llc90) native model grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution. Snapshot data of ocean bottom pressure and model ocean bottom pressure anomaly are also provided. Ocean bottom pressure is provided in three forms: 1) ocean bottom pressure including global mean atmosphereic pressure (OGPGMAP), 2) ocean bottom pressure excluding global mean atmosphereic pressure (OGP), and 3) the model's hydrostatic bottom pressure anomaly before the Greatbatch correction (PHIBOT). Note: the ocean bottom pressure field PHIBOT should not be compared with satellite bottom pressure products (e.g., from GRACE and GRACE-FO), see the variable descriptions of OBP and PHIBOT for more details.

Table 12.73: Coordinates and Variables in the dataset OCEAN_BOTTOM_PRESSURE

Variables	Description of data variables	Unit
OBP	Ocean bottom pressure given as equivalent water thickness	m
OBPGMAP	Ocean bottom pressure given as equivalent water thickness, includes global mean atmospheric pressure	m
PHIBOT	Ocean hydrostatic bottom pressure anomaly	m2 s-2
Coordinates	**Description of data coordinates**	**Unit**
i	Grid index in x for variables at tracer and 'v' locations	–none–
i_g	Grid index in x for variables at 'u' and 'g' locations	–none–
j	Grid index in y for variables at tracer and 'u' locations	–none–
j_g	Grid index in y for variables at 'v' and 'g' locations	–none–
tile	Lat-lon-cap tile index	–none–
time	Center time of averaging period	–none–
XC	Longitude of tracer grid cell center	degrees_east
YC	Latitude of tracer grid cell center	degrees_north
XG	Longitude of 'southwest' corner of tracer grid cell	degrees_east
YG	Latitude of 'southwest' corner of tracer grid cell	degrees_north
time_bnds	Time bounds of averaging period	–none–
XC_bnds	Longitudes of tracer grid cell corners	–none–
YC_bnds	Latitudes of tracer grid cell corners	–none–

12.12.2 Native Variable: OBP

Table 12.74: Attributes description of the variable 'OBP' from OCEAN_BOTTOM_PRESSURE's dataset.

Storage Type	Variable Name	Description	Unit
float32	OBP	Ocean bottom pressure given as equivalent water thickness	m
Description of the variable in Common Data language (CDL)			

```
float32 OBP(time, tile, j, i)
   OBP: _FillValue = 9.96921e+36
   OBP: long_name = Ocean bottom pressure given as equivalent water thickness
   OBP: units = m
   OBP: coverage_content_type = modelResult
   OBP: coordinates = time XC YC
   OBP: valid_min = :  2.544442892074585
   OBP: valid_max = 72.1243667602539
```

Comments

Obp excludes the contribution from global mean atmospheric pressure and is therefore suitable for comparisons with grace data products. obp is calculated as follows. first, we calculate ocean hydrostatic bottom pressure anomaly, phibot, with phibot = p_b/rhoconst - gh(t), where p_b = model ocean hydrostatic bottom pressure, rhoconst = reference density (1029 kg m-3), g is acceleration due to gravity (9.81 m s-2), and h(t) is model depth at time t. then, obp = phibot/g + corrections for i) global mean steric sea level changes related to density changes in the boussinesq volume-conserving model (greatbatch correction, see stergloh) and ii) global mean atmospheric pressure variations. use obp for comparisons with ocean bottom pressure data products that have been corrected for global mean atmospheric pressure variations. grace data typically are corrected for global mean atmospheric pressure variations. in contrast, ocean bottom pressure gauge data typically are not corrected for global mean atmospheric pressure variations.

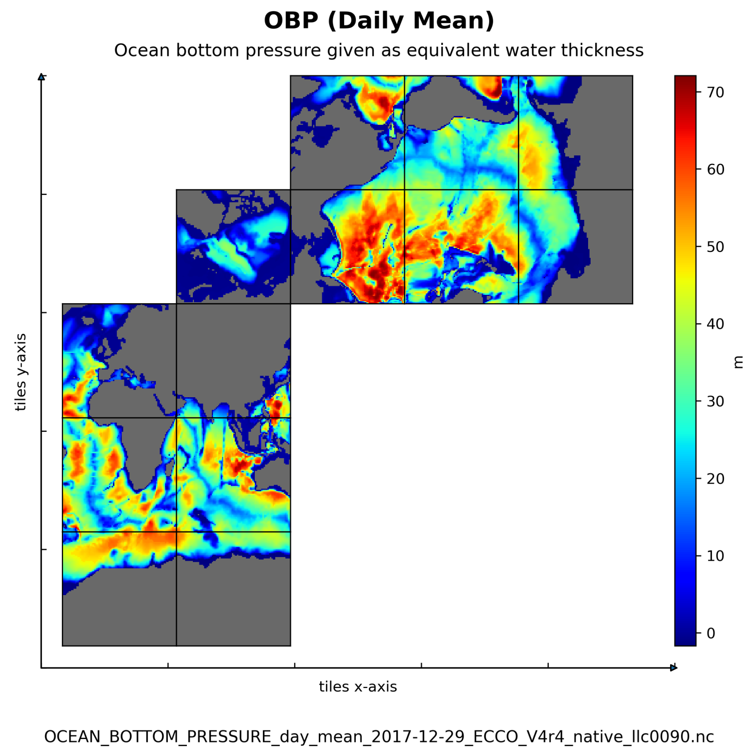

Figure 83: Dataset: OCEAN_BOTTOM_PRESSURE, Variable: OBP

12.12.3 Native Variable: OBPGMAP

Table 12.75: Attributes description of the variable 'OBPGMAP' from OCEAN_BOTTOM_PRESSURE's dataset.

Storage Type	Variable Name	Description	Unit
float32	OBPGMAP	Ocean bottom pressure given as equivalent water thickness, includes global mean atmospheric pressure	m
Description of the variable in Common Data language (CDL)			
float32 OBPGMAP(time, tile, j, i) OBPGMAP: _FillValue = 9.96921e+36 OBPGMAP: long_name = Ocean bottom pressure given as equivalent water thickness includes global mean atmospheric pressure OBPGMAP: units = m OBPGMAP: coverage_content_type = modelResult OBPGMAP: coordinates = time XC YC OBPGMAP: valid_min = 7.395928859710693 OBPGMAP: valid_max = 82.14805603027344			
Comments			
Obpgmap includes the contribution from global mean atmospheric pressure and is therefore suitable for comparisons with ocean bottom pressure gauge data products. obpgmap is calculated as follows. first, we calculate ocean hydrostatic bottom pressure anomaly, phibot, with phibot = p_b/rhoconst - gh(t), where p_b = model ocean hydrostatic bottom pressure, rhoconst = reference density (1029 kg m-3), g is acceleration due to gravity (9.81 m s-2), and h(t) is model depth at time t. then, obpgmap= phibot/g + corrections for global mean steric sea level changes related to density changes in the boussinesq volume-conserving model (greatbatch correction, see stergloh). use obpgmap for comparisons with ocean bottom pressure data products that have not been corrected for global mean atmospheric pressure variations. grace data typically are corrected for global mean atmospheric pressure variations. in contrast, ocean bottom pressure gauge data typically are not corrected for global mean atmospheric pressure variations.			

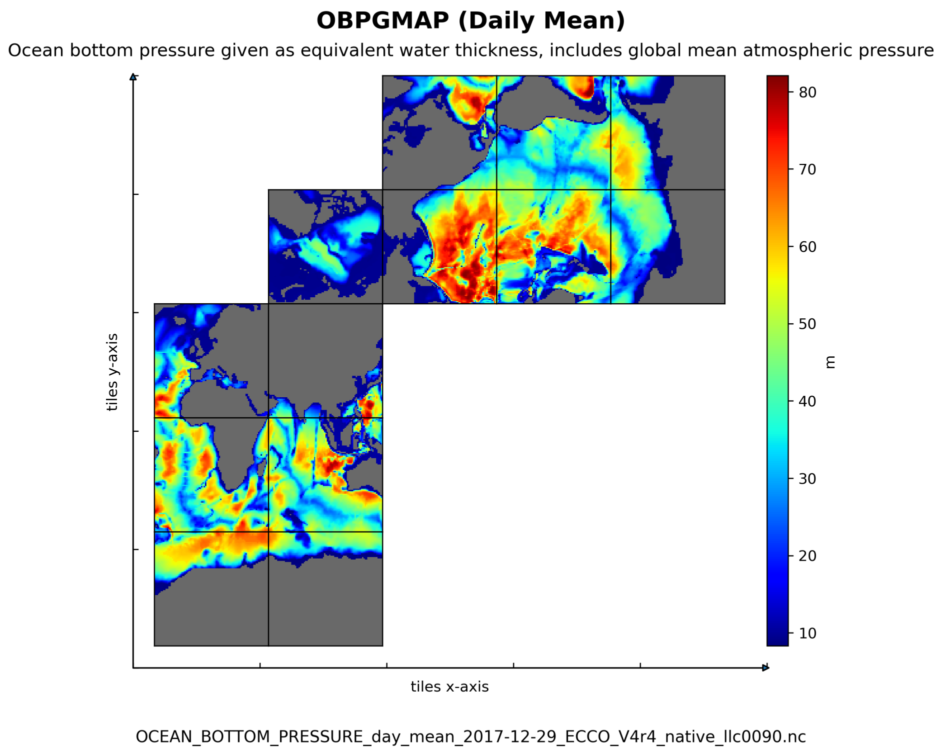

Figure 84: Dataset: OCEAN_BOTTOM_PRESSURE, Variable: OBPGMAP

12.12.4 Native Variable: PHIBOT

Table 12.76: Attributes description of the variable 'PHIBOT' from OCEAN_BOTTOM_PRESSURE's dataset.

Storage Type	Variable Name	Description	Unit
float32	PHIBOT	Ocean hydrostatic bottom pressure anomaly	m2 s-2

Description of the variable in Common Data language (CDL)

```
float32 PHIBOT(time, tile, j, i)
   PHIBOT: _FillValue = 9.96921e+36
   PHIBOT: long_name = Ocean hydrostatic bottom pressure anomaly
   PHIBOT: units = m2 s:  2
   PHIBOT: coverage_content_type = modelResult
   PHIBOT: coordinates = time XC YC
   PHIBOT: valid_min = 73.01050567626953
   PHIBOT: valid_max = 805.7855224609375
```

Comments

Phibot = p_b / rhoconst - g h(t), where p_b = hydrostatic ocean bottom pressure, rhoconst = reference density (1029 kg m-3), g is acceleration due to gravity (9.81 m s-2), and h(t) is model depth at time t. units: p:[kg m-1 s-2], rhoconst:[kg m-3], g:[m s-2], h(t):[m]. note: includes atmospheric pressure loading. phibot accounts for the model's time-varying grid cell thickness (z* coordinate system). phibot is not corrected for global mean steric sea level changes related to density changes in the boussinesq volume-conserving model (greatbatch correction, see stergloh), and therefore should not be used for comparisons with ocean bottom pressure data. instead, see obpgmap and obp.

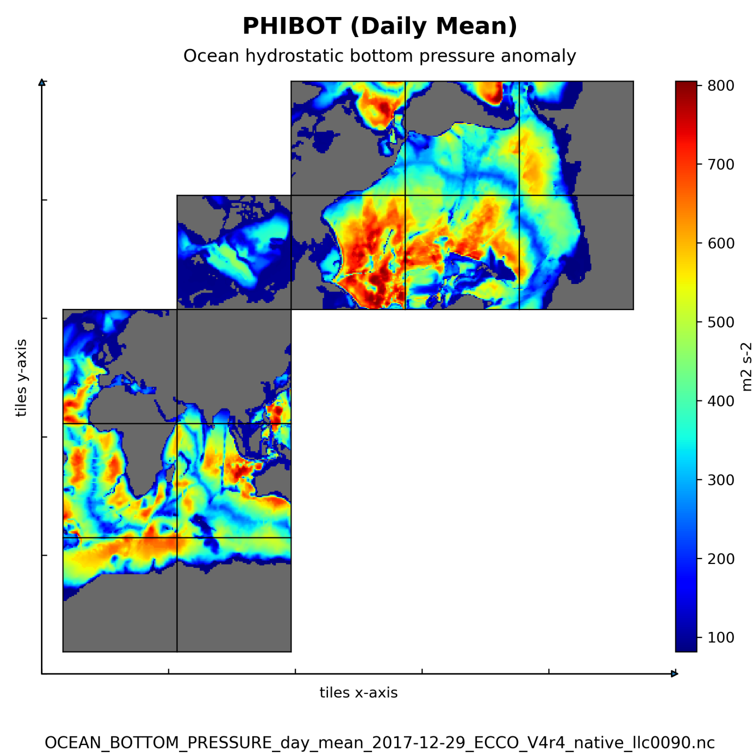

Figure 85: Dataset: OCEAN_BOTTOM_PRESSURE, Variable: PHIBOT

12.13 Native dataset of OCEAN_DENS_STRAT_PRESS

12.13.1 Overview

This dataset provides 3D fields of ocean density, stratification, and hydrostatic pressure on the lat-lon-cap 90 (llc90) native model grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution. Hydrostatic pressure is provided in two forms: 1) using constant vertical grid spacing (PHIHYDcR) and 2) using time-varying grid spacing from the model's z* coordinate system (PHIHYD).

Table 12.77: Coordinates and Variables in the dataset OCEAN_DENS_STRAT_PRESS

Variables	Description of data variables	Unit
RHOAnoma	In-situ seawater density anomaly	kg m-3
DRHODR	Density stratification	kg m-3 m-1
PHIHYD	Ocean hydrostatic pressure anomaly	m2 s-2
PHIHYDcR	Ocean hydrostatic pressure anomaly at constant depths	m2 s-2
Coordinates	**Description of data coordinates**	**Unit**
i	Grid index in x for variables at tracer and 'v' locations	–none–
i_g	Grid index in x for variables at 'u' and 'g' locations	–none–
j	Grid index in y for variables at tracer and 'u' locations	–none–
j_g	Grid index in y for variables at 'v' and 'g' locations	–none–
k	Grid index in z for tracer variables	–none–
k_u	Grid index in z corresponding to the bottom face of tracer grid cells ('w' locations)	–none–
k_l	Grid index in z corresponding to the top face of tracer grid cells ('w' locations)	–none–
k_p1	Grid index in z for variables at 'w' locations	–none–
tile	Lat-lon-cap tile index	–none–
time	Center time of averaging period	–none–
XC	Longitude of tracer grid cell center	degrees_east
YC	Latitude of tracer grid cell center	degrees_north
XG	Longitude of 'southwest' corner of tracer grid cell	degrees_east
YG	Latitude of 'southwest' corner of tracer grid cell	degrees_north
Z	Depth of tracer grid cell center	m
Zp1	Depth of tracer grid cell interface	m
Zu	Depth of the bottom face of tracer grid cells	m
Zl	Depth of the top face of tracer grid cells	m
time_bnds	Time bounds of averaging period	–none–
XC_bnds	Longitudes of tracer grid cell corners	–none–
YC_bnds	Latitudes of tracer grid cell corners	–none–
Z_bnds	Depths of tracer grid cell upper and lower interfaces	–none–

12.13.2 Native Variable: DRHODR

Table 12.78: Attributes description of the variable 'DRHODR' from OCEAN_DENS_STRAT_PRESS's dataset.

Storage Type	Variable Name	Description	Unit
float32	DRHODR	Density stratification	kg m-3 m-1
Description of the variable in Common Data language (CDL)			
float32 DRHODR(time, k_l, tile, j, i) DRHODR: _FillValue = 9.96921e+36 DRHODR: long_name = Density stratification DRHODR: units = kg m: 3 m: 1 DRHODR: coverage_content_type = modelResult DRHODR: coordinates = YC XC time Zl DRHODR: valid_min = : 0.8687265515327454 DRHODR: valid_max = 0.011617615818977356			
Comments			
Density stratification: d(sigma) d z-1. note: density computations are done with in-situ density. the vertical derivatives of in-situ density and locally-referenced potential density are identical the equation of state is a modified unesco formula by jackett and mcdougall (1995), which uses the model variable potential temperature as input assuming a horizontally and temporally constant pressure of $p_0=-g ho_{0} z$.			

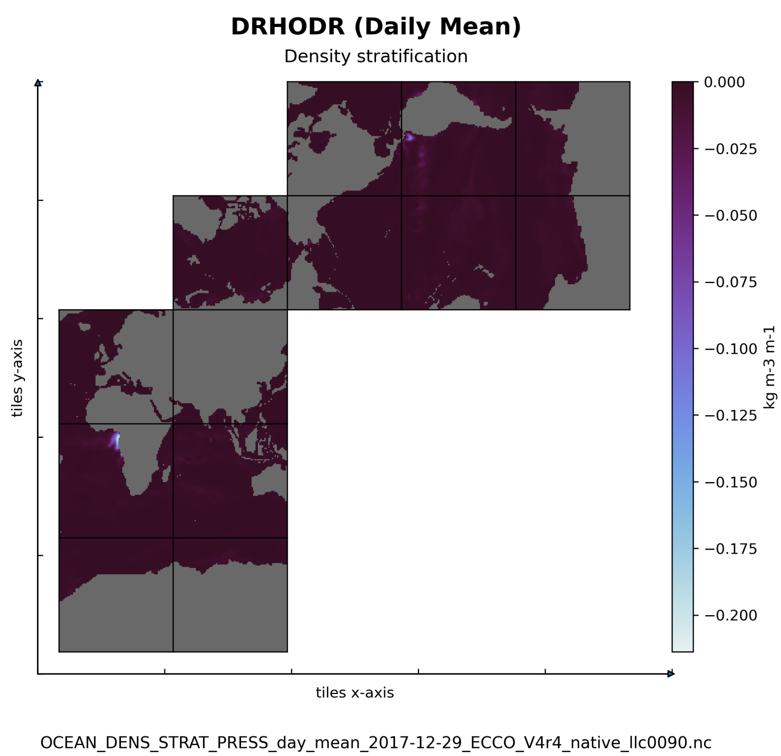

Figure 86: Dataset: OCEAN_DENS_STRAT_PRESS, Variable: DRHODR

12.13.3 Native Variable: PHIHYD

Table 12.79: Attributes description of the variable 'PHIHYD' from OCEAN_DENS_STRAT_PRESS's dataset.

Storage Type	Variable Name	Description	Unit
float32	PHIHYD	Ocean hydrostatic pressure anomaly	m2 s-2
Description of the variable in Common Data language (CDL)			

`float32 PHIHYD(time, k, tile, j, i)`
`PHIHYD: _FillValue = 9.96921e+36`
`PHIHYD: long_name = Ocean hydrostatic pressure anomaly`
`PHIHYD: units = m2 s:  2`
`PHIHYD: coverage_content_type = modelResult`
`PHIHYD: coordinates = YC Z XC time`
`PHIHYD: valid_min = 74.71473693847656`
`PHIHYD: valid_max = 783.9188232421875`			

Comments			
Phihyd = p(k) / rhoconst - g z*(k,t), where p = hydrostatic ocean pressure at depth level k, rhoconst = reference density (1029 kg m-3), g is acceleration due to gravity (9.81 m s-2), and z*(k,t) is model depth at level k and time t. units: p:[kg m-1 s-2], rhoconst:[kg m-3], g:[m s-2], h(t):[m]. note: includes atmospheric pressure loading. quantity referred to in some contexts as hydrostatic pressure anomaly. phibot accounts for the model's time-varying grid cell thickness (z* coordinate system). see phihydcr for hydrostatic pressure potential anomaly calculated using time-invariant grid cell thicknesses. phihyd is not corrected for global mean steric sea level changes related to density changes in the boussinesq volume-conserving model (greatbatch correction, see stergloh).			

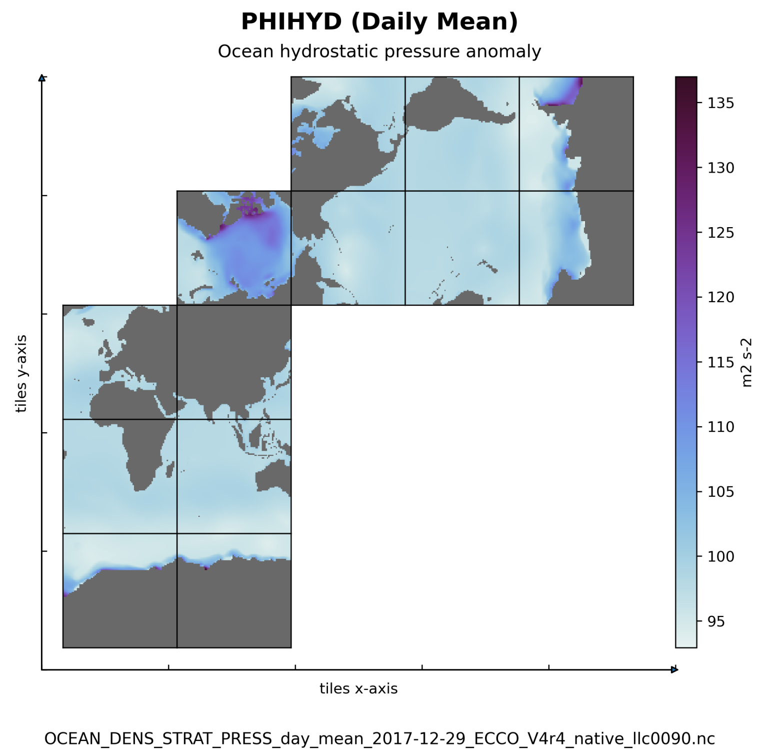

Figure 87: Dataset: OCEAN_DENS_STRAT_PRESS, Variable: PHIHYD

12.13.4 Native Variable: PHIHYDcR

Table 12.80: Attributes description of the variable 'PHIHYDcR' from OCEAN_DENS_STRAT_PRESS's dataset.

Storage Type	Variable Name	Description	Unit
float32	PHIHYDcR	Ocean hydrostatic pressure anomaly at constant depths	m2 s-2
Description of the variable in Common Data language (CDL)			

`float32 PHIHYDcR(time, k, tile, j, i)`
`PHIHYDcR: _FillValue = 9.96921e+36`
`PHIHYDcR: long_name = Ocean hydrostatic pressure anomaly at constant depths`
`PHIHYDcR: units = m2 s:  2`
`PHIHYDcR: coverage_content_type = modelResult`
`PHIHYDcR: coordinates = YC Z XC time`
`PHIHYDcR: valid_min = 73.08939361572266`
`PHIHYDcR: valid_max = 784.4268188476562`			

Comments			
Phihyd = p(k) / rhoconst - g z(k,t), where p = hydrostatic ocean pressure at depth level k, rhoconst = reference density (1029 kg m-3), g is acceleration due to gravity (9.81 m s-2), and z(k,t) is fixed model depth at level k. units: p:[kg m-1 s-2], rhoconst:[kg m-3], g:[m s-2], h(t):[m]. note: includes atmospheric pressure loading. quantity referred to in some contexts as hydrostatic pressure potential anomaly. phihydcr is calculated with respect to the model's initial, time-invariant grid cell thicknesses. see phihyd for hydrostatic pressure anomaly calculated using model's time-variable grid cell thicknesses (z* coordinate system). phihydcr is is not corrected for global mean steric sea level changes related to density changes in the boussinesq volume-conserving model (greatbatch correction, see stergloh).			

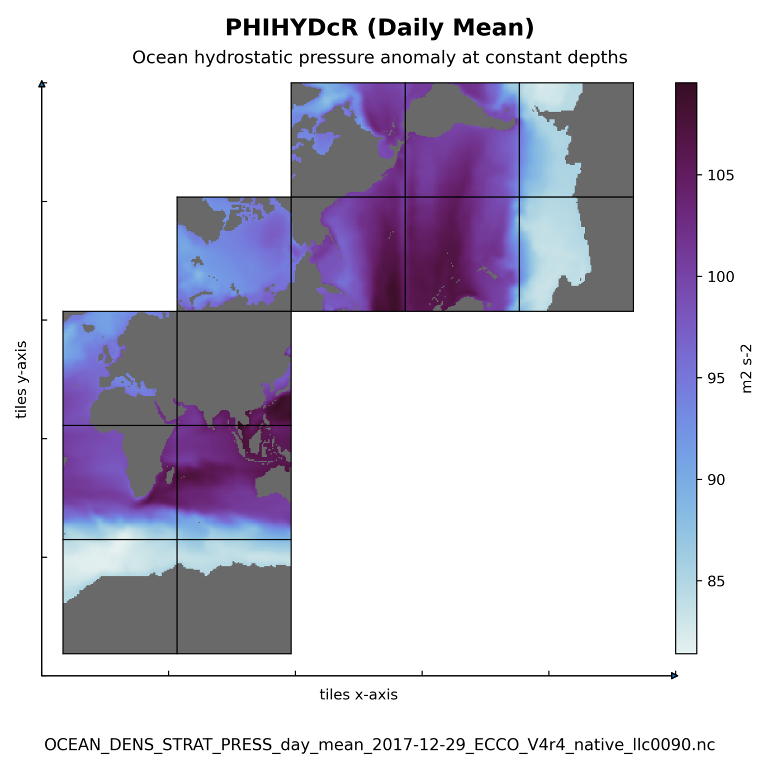

Figure 88: Dataset: OCEAN_DENS_STRAT_PRESS, Variable: PHIHYDcR

12.13.5 Native Variable: RHOAnoma

Table 12.81: Attributes description of the variable 'RHOAnoma' from OCEAN_DENS_STRAT_PRESS's dataset.

Storage Type	Variable Name	Description	Unit
float32	RHOAnoma	In-situ seawater density anomaly	kg m-3
Description of the variable in Common Data language (CDL)			
float32 RHOAnoma(time, k, tile, j, i) RHOAnoma: _FillValue = 9.96921e+36 RHOAnoma: long_name = In: situ seawater density anomaly RHOAnoma: units = kg m: 3 RHOAnoma: coverage_content_type = modelResult RHOAnoma: coordinates = YC Z XC time RHOAnoma: valid_min = : 19.919862747192383 RHOAnoma: valid_max = 25.540647506713867			
Comments			
In-situ seawater density anomaly relative to the reference density, rhoconst. rhoconst = 1029 kg m-3			

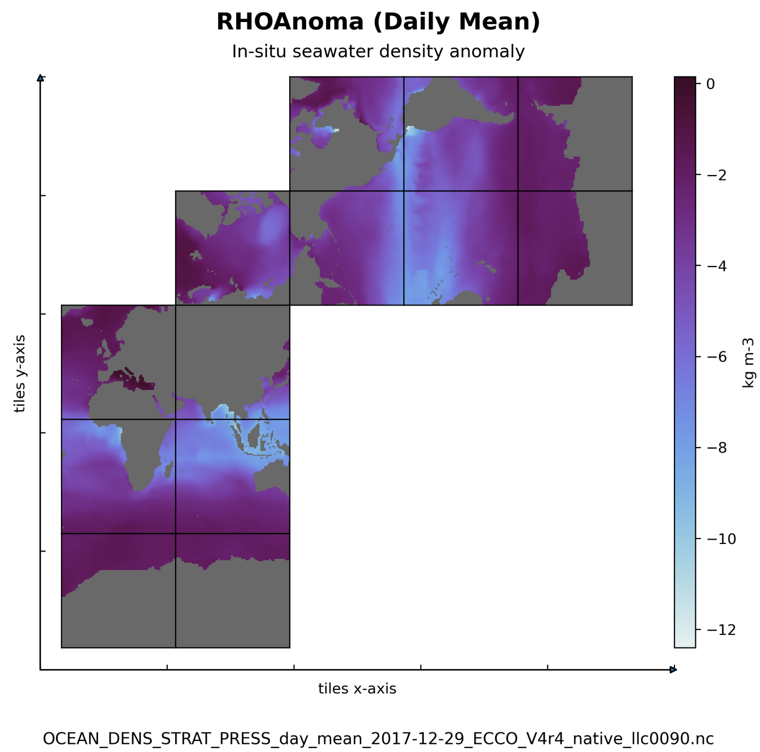

Figure 89: Dataset: OCEAN_DENS_STRAT_PRESS, Variable: RHOAnoma

12.14 Native dataset of OCEAN_MIXED_LAYER_DEPTH

12.14.1 Overview

This dataset provides 2D fields of ocean mixed layer depth on the lat-lon-cap 90 (llc90) native model grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution.

Table 12.82: Coordinates and Variables in the dataset OCEAN_MIXED_LAYER_DEPTH

Variables	Description of data variables	Unit
MXLDEPTH	Mixed-layer depth diagnosed using the temperature difference criterion of kara et al., 2000	m
Coordinates	**Description of data coordinates**	**Unit**
i	Grid index in x for variables at tracer and 'v' locations	–none–
i_g	Grid index in x for variables at 'u' and 'g' locations	–none–
j	Grid index in y for variables at tracer and 'u' locations	–none–
j_g	Grid index in y for variables at 'v' and 'g' locations	–none–
tile	Lat-lon-cap tile index	–none–
time	Center time of averaging period	–none–
XC	Longitude of tracer grid cell center	degrees_east
YC	Latitude of tracer grid cell center	degrees_north
XG	Longitude of 'southwest' corner of tracer grid cell	degrees_east
YG	Latitude of 'southwest' corner of tracer grid cell	degrees_north
time_bnds	Time bounds of averaging period	–none–
XC_bnds	Longitudes of tracer grid cell corners	–none–
YC_bnds	Latitudes of tracer grid cell corners	–none–

12.14.2 Native Variable: MXLDEPTH

Table 12.83: Attributes description of the variable 'MXLDEPTH' from OCEAN_MIXED_LAYER_DEPTH's dataset.

Storage Type	Variable Name	Description	Unit
float32	MXLDEPTH	Mixed-layer depth diagnosed using the temperature difference criterion of kara et al., 2000	m
Description of the variable in Common Data language (CDL)			

```
float32 MXLDEPTH(time, tile, j, i)
   MXLDEPTH: _FillValue = 9.96921e+36
   MXLDEPTH: long_name = Mixed:  layer depth diagnosed using the temperature
difference criterion of Kara et al.
2000
   MXLDEPTH: units = m
   MXLDEPTH: coverage_content_type = modelResult
   MXLDEPTH: standard_name = ocean_mixed_layer_thickness
   MXLDEPTH: coordinates = time XC YC
   MXLDEPTH: valid_min = 5.000001430511475
   MXLDEPTH: valid_max = 5331.2001953125
```

Comments

Mixed-layer depth as determined by the depth where waters are first 0.8 degrees celsius colder than the surface. see kara et al. (jgr, 2000). . note: the kara et al. criterion may not be appropriate for some applications. if needed, mixed layer depth can be calculated using different criteria. see vertical density stratification (drhodr) and density anomaly (rhoanoma).

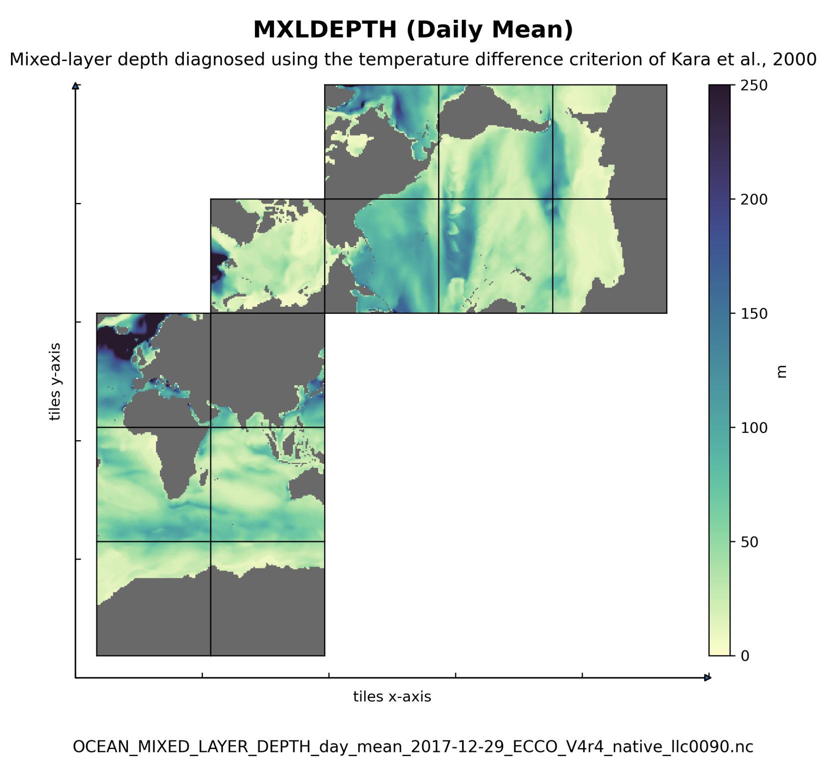

Figure 90: Dataset: OCEAN_MIXED_LAYER_DEPTH, Variable: MXLDEPTH

12.15 Native dataset of OCEAN_TEMPERATURE_SALINITY

12.15.1 Overview

This dataset provides 3D fields of ocean potential temperature and salinity on the lat-lon-cap 90 (llc90) native model grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution. Snapshot data of ocean potential temperature and salinity are also provided.

Table 12.84: Coordinates and Variables in the dataset OCEAN_TEMPERATURE_SALINITY

Variables	Description of data variables	Unit
THETA	Potential temperature	degree_C
SALT	Salinity	1e-3
Coordinates	**Description of data coordinates**	**Unit**
i	Grid index in x for variables at tracer and 'v' locations	–none–
i_g	Grid index in x for variables at 'u' and 'g' locations	–none–
j	Grid index in y for variables at tracer and 'u' locations	–none–
j_g	Grid index in y for variables at 'v' and 'g' locations	–none–
k	Grid index in z for tracer variables	–none–
k_u	Grid index in z corresponding to the bottom face of tracer grid cells ('w' locations)	–none–
k_l	Grid index in z corresponding to the top face of tracer grid cells ('w' locations)	–none–
k_p1	Grid index in z for variables at 'w' locations	–none–
tile	Lat-lon-cap tile index	–none–
time	Center time of averaging period	–none–
XC	Longitude of tracer grid cell center	degrees_east
YC	Latitude of tracer grid cell center	degrees_north
XG	Longitude of 'southwest' corner of tracer grid cell	degrees_east
YG	Latitude of 'southwest' corner of tracer grid cell	degrees_north
Z	Depth of tracer grid cell center	m
Zp1	Depth of tracer grid cell interface	m
Zu	Depth of the bottom face of tracer grid cells	m
Zl	Depth of the top face of tracer grid cells	m
time_bnds	Time bounds of averaging period	–none–
XC_bnds	Longitudes of tracer grid cell corners	–none–
YC_bnds	Latitudes of tracer grid cell corners	–none–
Z_bnds	Depths of tracer grid cell upper and lower interfaces	–none–

12.15.2 Native Variable: SALT

Table 12.85: Attributes description of the variable 'SALT' from OCEAN_TEMPERATURE_SALINITY's dataset.

Storage Type	Variable Name	Description	Unit
float32	SALT	Salinity	1e-3
Description of the variable in Common Data language (CDL)			
float32 SALT(time, k, tile, j, i) SALT: _FillValue = 9.96921e+36 SALT: long_name = Salinity SALT: units = 1e: 3 SALT: coverage_content_type = modelResult SALT: standard_name = sea_water_salinity SALT: coordinates = YC Z XC time SALT: valid_min = 16.73577880859375 SALT: valid_max = 41.321231842041016			
Comments			
Defined using cf convention 'sea water salinity is the salt content of sea water, often on the practical salinity scale of 1978. however, the unqualified term 'salinity' is generic and does not necessarily imply any particular method of calculation. the units of salinity are dimensionless and the units attribute should normally be given as 1e-3 or 0.001 i.e. parts per thousand.' see https://cfconventions.org/data/cf-standard-names/73/build/cf-standard-name-table.html			

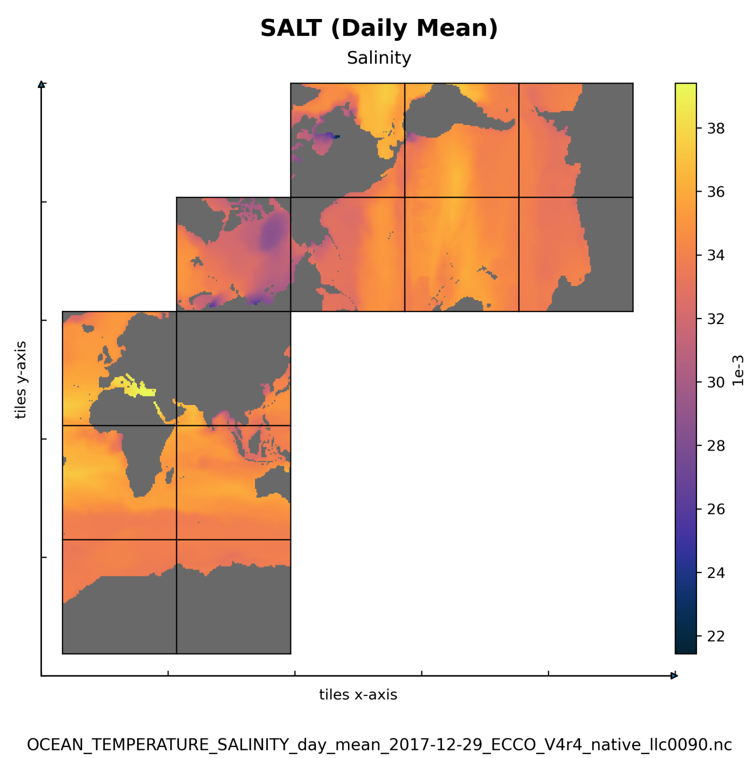

Figure 91: Dataset: OCEAN_TEMPERATURE_SALINITY, Variable: SALT

12.15.3 Native Variable: THETA

Table 12.86: Attributes description of the variable 'THETA' from OCEAN_TEMPERATURE_SALINITY's dataset.

Storage Type	Variable Name	Description	Unit
float32	THETA	Potential temperature	degree_C
Description of the variable in Common Data language (CDL)			

<pre>float32 THETA(time, k, tile, j, i)
  THETA: _FillValue = 9.96921e+36
  THETA: long_name = Potential temperature
  THETA: units = degree_C
  THETA: coverage_content_type = modelResult
  THETA: standard_name = sea_water_potential_temperature
  THETA: coordinates = YC Z XC time
  THETA: valid_min = : 2.9179372787475586
  THETA: valid_max = 36.425140380859375</pre>			

Comments			
Sea water potential temperature is the temperature a parcel of sea water would have if moved adiabatically to sea level pressure. note: the equation of state is a modified unesco formula by jackett and mcdougall (1995), which uses the model variable potential temperature as input assuming a horizontally and temporally constant pressure of $p_0=-g ho_{0} z$.			

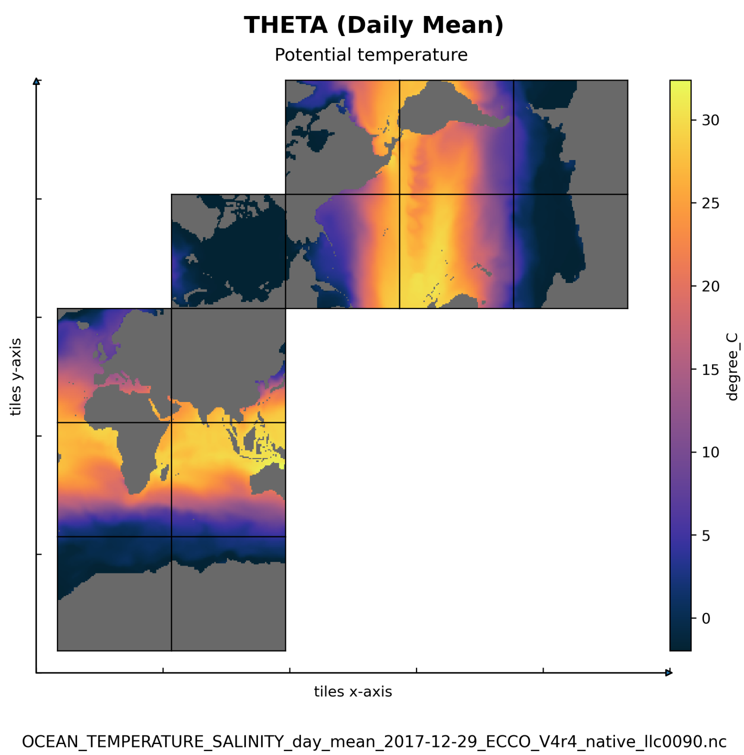

Figure 92: Dataset: OCEAN_TEMPERATURE_SALINITY, Variable: THETA

12.16 Native dataset of OCEAN_VELOCITY

12.16.1 Overview

This dataset provides 3D fields of ocean velocity (3D fields: zonal, meridional and vertical velocity components) on the lat-lon-cap 90 (llc90) native model grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution.

Table 12.87: Coordinates and Variables in the dataset OCEAN_VELOCITY

Variables	Description of data variables	Unit
UVEL	Horizontal velocity in the model +x direction	m s-1
VVEL	Horizontal velocity in the model +y direction	m s-1
WVEL	Vertical velocity	m s-1
Coordinates	**Description of data coordinates**	**Unit**
i	Grid index in x for variables at tracer and 'v' locations	–none–
i_g	Grid index in x for variables at 'u' and 'g' locations	–none–
j	Grid index in y for variables at tracer and 'u' locations	–none–
j_g	Grid index in y for variables at 'v' and 'g' locations	–none–
k	Grid index in z for tracer variables	–none–
k_u	Grid index in z corresponding to the bottom face of tracer grid cells ('w' locations)	–none–
k_l	Grid index in z corresponding to the top face of tracer grid cells ('w' locations)	–none–
k_p1	Grid index in z for variables at 'w' locations	–none–
tile	Lat-lon-cap tile index	–none–
time	Center time of averaging period	–none–
XC	Longitude of tracer grid cell center	degrees_east
YC	Latitude of tracer grid cell center	degrees_north
XG	Longitude of 'southwest' corner of tracer grid cell	degrees_east
YG	Latitude of 'southwest' corner of tracer grid cell	degrees_north
Z	Depth of tracer grid cell center	m
Zp1	Depth of tracer grid cell interface	m
Zu	Depth of the bottom face of tracer grid cells	m
Zl	Depth of the top face of tracer grid cells	m
time_bnds	Time bounds of averaging period	–none–
XC_bnds	Longitudes of tracer grid cell corners	–none–
YC_bnds	Latitudes of tracer grid cell corners	–none–
Z_bnds	Depths of tracer grid cell upper and lower interfaces	–none–

12.16.2 Native Variable: UVEL

Table 12.88: Attributes description of the variable 'UVEL' from OCEAN_VELOCITY's dataset.

Storage Type	Variable Name	Description	Unit
float32	UVEL	Horizontal velocity in the model +x direction	m s-1
Description of the variable in Common Data language (CDL)			
float32 UVEL(time, k, tile, j, i_g) UVEL: _FillValue = 9.96921e+36 UVEL: long_name = Horizontal velocity in the model +x direction UVEL: units = m s: 1 UVEL: mate = VVEL UVEL: coverage_content_type = modelResult UVEL: direction = >0 increases volume UVEL: standard_name = sea_water_x_velocity UVEL: coordinates = Z time UVEL: valid_min = : 2.139253616333008 UVEL: valid_max = 2.038635015487671			
Comments			
Horizontal velocity in the +x direction at the 'u' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal velocities are staggered relative to the tracer cells with indexing such that +uvel(i_g,j,k) corresponds to +x fluxes through the 'u' face of the tracer cell at (i,j,k). do not use uvel for volume flux calculations because the model's grid cell thicknesses vary with time (z* coordinates); use uvelmass instead. also, the model +x direction does not necessarily correspond to the geographical east-west direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles. see evel and nvel for zonal and meridional velocity.			

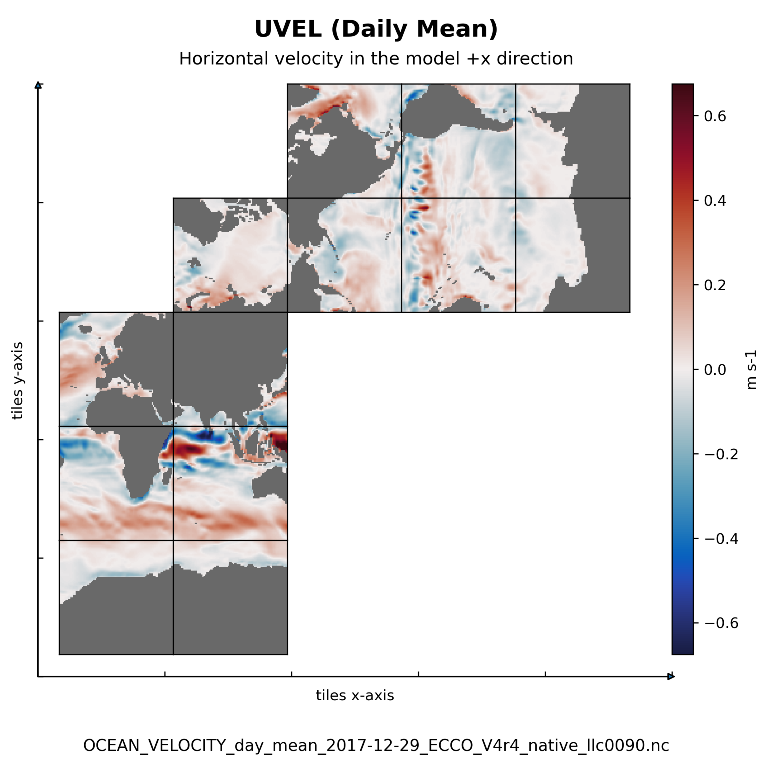

Figure 93: Dataset: OCEAN_VELOCITY, Variable: UVEL

12.16.3 Native Variable: VVEL

Table 12.89: Attributes description of the variable 'VVEL' from OCEAN_VELOCITY's dataset.

Storage Type	Variable Name	Description	Unit
float32	VVEL	Horizontal velocity in the model +y direction	m s-1
Description of the variable in Common Data language (CDL)			

```
float32 VVEL(time, k, tile, j_g, i)
   VVEL: _FillValue = 9.96921e+36
   VVEL: long_name = Horizontal velocity in the model +y direction
   VVEL: units = m s:  1
   VVEL: mate = UVEL
   VVEL: coverage_content_type = modelResult
   VVEL: direction = >0 increases volume
   VVEL: standard_name = sea_water_y_velocity
   VVEL: coordinates = Z time
   VVEL: valid_min = :  1.7877743244171143
   VVEL: valid_max = 1.9089667797088623
```

Comments

Horizontal velocity in the +y direction at the 'v' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal velocities are staggered relative to the tracer cells with indexing such that +vvel(i,j_g,k) corresponds to +y fluxes through the 'v' face of the tracer cell at (i,j,k). do not use vvel for volume flux calculations because the model's grid cell thicknesses vary with time (z* coordinates); use vvelmass instead. also, the model +y direction does not necessarily correspond to the geographical north-south direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles. see evel and nvel for zonal and meridional velocity.

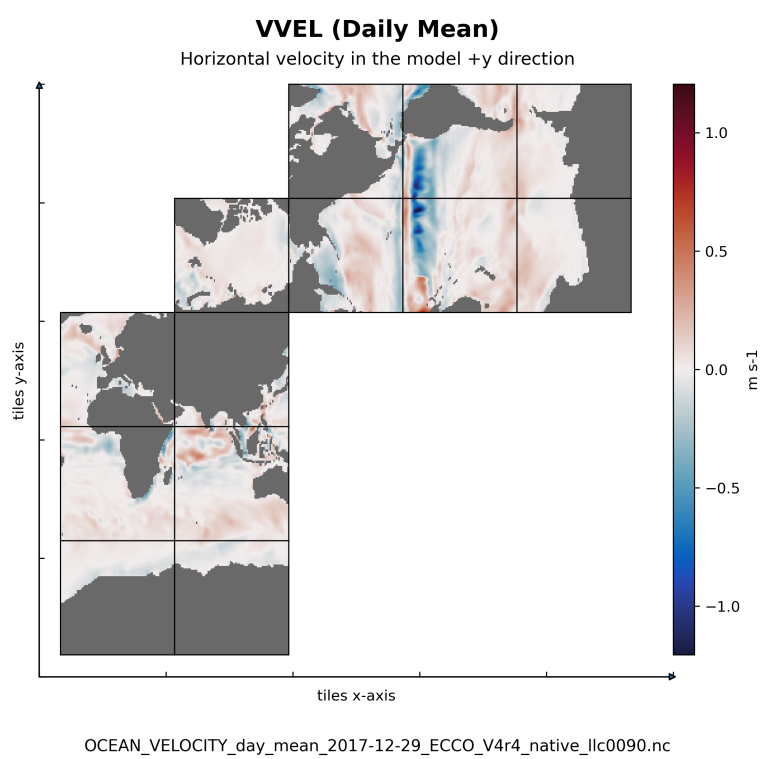

Figure 94: Dataset: OCEAN_VELOCITY, Variable: VVEL

12.16.4 Native Variable: WVEL

Table 12.90: Attributes description of the variable 'WVEL' from OCEAN_VELOCITY's dataset.

Storage Type	Variable Name	Description	Unit
float32	WVEL	Vertical velocity	m s-1
Description of the variable in Common Data language (CDL)			
float32 WVEL(time, k_l, tile, j, i) WVEL: _FillValue = 9.96921e+36 WVEL: long_name = Vertical velocity WVEL: units = m s: 1 WVEL: coverage_content_type = modelResult WVEL: direction = >0 decreases volume WVEL: standard_name = upward_sea_water_velocity WVEL: coordinates = Zl YC time XC WVEL: valid_min = : 0.0023150660563260317 WVEL: valid_max = 0.0016380994347855449			
Comments			
Vertical velocity in the +z direction at the top 'w' face of the tracer cell on the native model grid. note: in the arakawa-c grid, vertical velocities are staggered relative to the tracer cells with indexing such that +wvel(i,j,k_l) corresponds to upward +z motion through the top 'w' face of the tracer cell at (i,j,k). wvel is identical to wvelmass.			

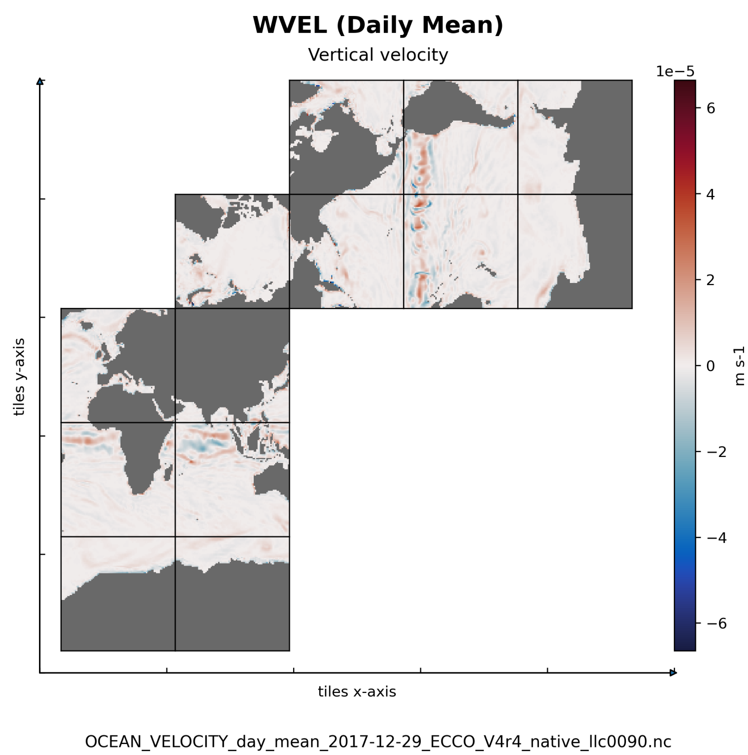

Figure 95: Dataset: OCEAN_VELOCITY, Variable: WVEL

12.17 Native dataset of SEA_ICE_CONC_THICKNESS

12.17.1 Overview

This dataset provides 2D fields of sea-ice and snow concentration, thickness, and pressure loading on the lat-lon-cap 90 (llc90) native model grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution. Snapshot data of sea-ice and snow concentration, thickness, and pressure are also provided.

Table 12.91: Coordinates and Variables in the dataset SEA_ICE_CONC_THICKNESS

Variables	Description of data variables	Unit
SIarea	Sea-ice concentration	1
SIheff	Area-averaged sea-ice thickness	m
SIhsnow	Area-averaged snow thickness	m
sIceLoad	Average sea-ice and snow mass per unit area	kg m-2
Coordinates	**Description of data coordinates**	**Unit**
i	Grid index in x for variables at tracer and 'v' locations	–none–
i_g	Grid index in x for variables at 'u' and 'g' locations	–none–
j	Grid index in y for variables at tracer and 'u' locations	–none–
j_g	Grid index in y for variables at 'v' and 'g' locations	–none–
tile	Lat-lon-cap tile index	–none–
time	Center time of averaging period	–none–
XC	Longitude of tracer grid cell center	degrees_east
YC	Latitude of tracer grid cell center	degrees_north
XG	Longitude of 'southwest' corner of tracer grid cell	degrees_east
YG	Latitude of 'southwest' corner of tracer grid cell	degrees_north
time_bnds	Time bounds of averaging period	–none–
XC_bnds	Longitudes of tracer grid cell corners	–none–
YC_bnds	Latitudes of tracer grid cell corners	–none–

12.17.2 Native Variable: SIarea

Table 12.92: Attributes description of the variable 'SIarea' from SEA_ICE_CONC_THICKNESS's dataset.

Storage Type	Variable Name	Description	Unit
float32	SIarea	Sea-ice concentration	1

Description of the variable in Common Data language (CDL)

```
float32 SIarea(time, tile, j, i)
   SIarea:  _FillValue = 9.96921e+36
   SIarea:  long_name = Sea:  ice concentration
   SIarea:  units = 1
   SIarea:  coverage_content_type = modelResult
   SIarea:  standard_name = sea_ice_area_fraction
   SIarea:  coordinates = time YC XC
   SIarea:  valid_min = 0.0
   SIarea:  valid_max = 0.9700000286102295
```

Comments

Fraction of ocean grid cell covered with sea-ice [0 to 1]. cf standard name table v73: 'area fraction' is the fraction of a grid cell's horizontal area that has some characteristic of interest. it is evaluated as the area of interest divided by the grid cell area. it may be expressed as a fraction, a percentage, or any other dimensionless representation of a fraction. sea ice area fraction is area of the sea surface occupied by sea ice. it is also called 'sea ice concentration'. 'sea ice' means all ice floating in the sea which has formed from freezing sea water, rather than by other processes such as calving of land ice to form icebergs. https://cfconventions.org/data/cf-standard-names/73/build/cf-standard-name-table.html. defined using cf standard name table v73: 'area fraction' is the fraction of a grid cell's horizontal area that has some characteristic of interest. it is evaluated as the area of interest divided by the grid cell area. it may be expressed as a fraction, a percentage, or any other dimensionless representation of a fraction. sea ice area fraction is area of the sea surface occupied by sea ice. it is also called 'sea ice concentration'. 'sea ice' means all ice floating in the sea which has formed from freezing sea water and precipitation, rather than by other processes such as calving of land ice to form icebergs. https://cfconventions.org/data/cf-standard-names/73/build/cf-standard-name-table.html

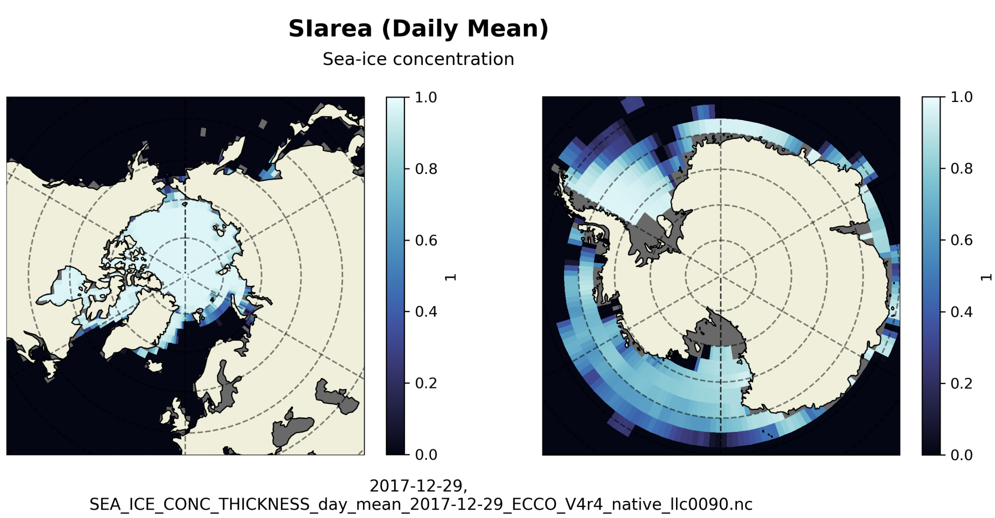

Figure 96: Dataset: SEA_ICE_CONC_THICKNESS, Variable: SIarea

12.17.3 Native Variable: SIheff

Table 12.93: Attributes description of the variable 'SIheff' from SEA_ICE_CONC_THICKNESS's dataset.

Storage Type	Variable Name	Description	Unit
float32	SIheff	Area-averaged sea-ice thickness	m
Description of the variable in Common Data language (CDL)			
float32 SIheff(time, tile, j, i) SIheff: _FillValue = 9.96921e+36 SIheff: long_name = Area: averaged sea: ice thickness SIheff: units = m SIheff: coverage_content_type = modelResult SIheff: standard_name = sea_ice_thickness SIheff: coordinates = time YC XC SIheff: valid_min = 0.0 SIheff: valid_max = 9.000518798828125			
Comments			
Sea-ice thickness averaged over the entire model grid cell, including open water where sea-ice thickness is zero. note: sea-ice thickness over the ice-covered fraction of the grid cell is siheff/siarea			

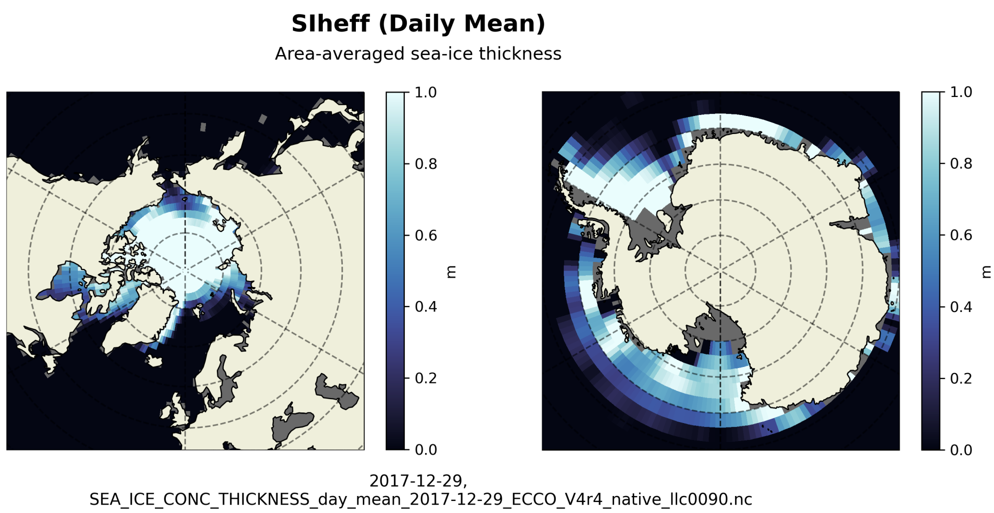

Figure 97: Dataset: SEA_ICE_CONC_THICKNESS, Variable: SIheff

12.17.4 Native Variable: SIhsnow

Table 12.94: Attributes description of the variable 'SIhsnow' from SEA_ICE_CONC_THICKNESS's dataset.

Storage Type	Variable Name	Description	Unit
float32	SIhsnow	Area-averaged snow thickness	m
Description of the variable in Common Data language (CDL)			

`float32 SIhsnow(time, tile, j, i)`
`SIhsnow: _FillValue = 9.96921e+36`
`SIhsnow: long_name = Area: averaged snow thickness`
`SIhsnow: units = m`
`SIhsnow: coverage_content_type = modelResult`
`SIhsnow: standard_name = surface_snow_thickness`
`SIhsnow: coordinates = time YC XC`
`SIhsnow: valid_min = : 0.0004725505714304745`
`SIhsnow: valid_max = 2.7013046741485596`			

Comments			
Snow thickness averaged over the entire model grid cell, including open water where snow thickness is zero. note: snow thickness over the ice-covered fraction of the grid cell is sihsnow/siarea			

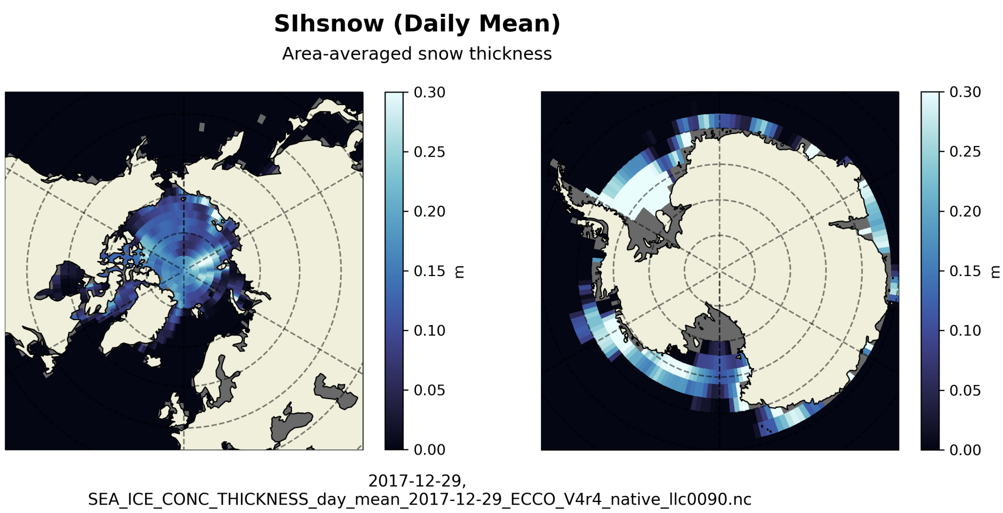

Figure 98: Dataset: SEA_ICE_CONC_THICKNESS, Variable: SIhsnow

12.17.5 Native Variable: sIceLoad

Table 12.95: Attributes description of the variable 'sIceLoad' from SEA_ICE_CONC_THICKNESS's dataset.

Storage Type	Variable Name	Description	Unit
float32	sIceLoad	Average sea-ice and snow mass per unit area	kg m-2

Description of the variable in Common Data language (CDL)

```
float32 sIceLoad(time, tile, j, i)
   sIceLoad:  _FillValue = 9.96921e+36
   sIceLoad:  long_name = Average sea:  ice and snow mass per unit area
   sIceLoad:  units = kg m:  2
   sIceLoad:  coverage_content_type = modelResult
   sIceLoad:  standard_name = sea_ice_and_surface_snow_amount
   sIceLoad:  coordinates = time YC XC
   sIceLoad:  valid_min = :  0.0015558383893221617
   sIceLoad:  valid_max = 8729.935546875
```

Comments

Total mass of sea-ice and snow in a model grid cell averaged over model grid cell area. note: siceload is used to correct model sea level anomaly, etan, to calculate dynamic sea surface height, ssh, and sea surface height without the inverted barometer (ib correction), sshnoibc. in the model, sea-ice is treated as floating above the sea level with etan tracing the location of the ocean-ice interface. consequently, sea-ice growth in the model lowers etan and sea-ice melting raises etan. dynamic sea surface height is obtained by correcting etan by the weight of ice and snow directly above following archimedes' principle.

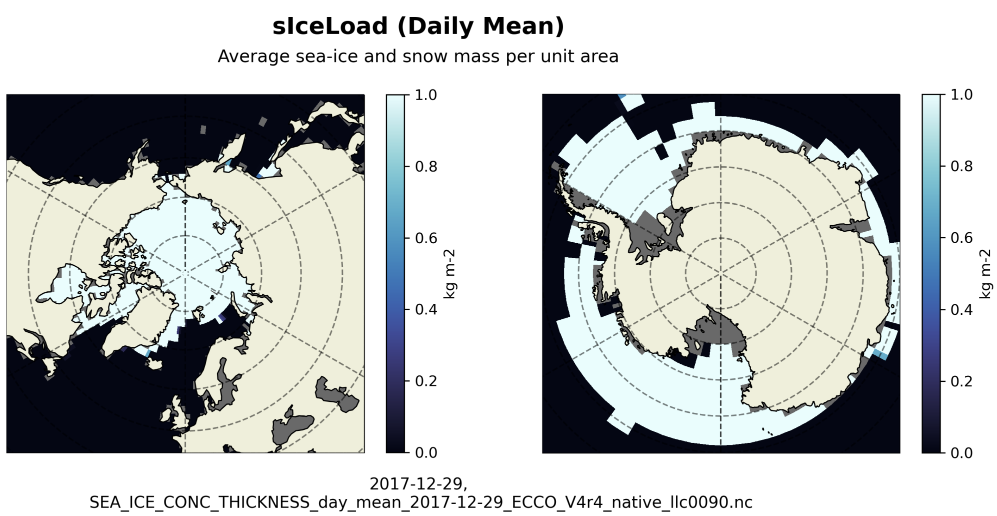

Figure 99: Dataset: SEA_ICE_CONC_THICKNESS, Variable: sIceLoad

12.18 Native dataset of SEA_ICE_HORIZ_VOLUME_FLUX

12.18.1 Overview

This dataset provides 2D fields of sea-ice and snow horizontal volume fluxes on the lat-lon-cap 90 (llc90) native model grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution.

Table 12.96: Coordinates and Variables in the dataset SEA_ICE_HORIZ_VOLUME_FLUX

Variables	Description of data variables	Unit
ADVxHEFF	Lateral advective flux of sea-ice thickness in the model +x direction	m3 s-1
ADVyHEFF	Lateral advective flux of sea-ice thickness in the model +y direction	m3 s-1
ADVxSNOW	Lateral advective flux of snow thickness in the model +x direction	m3 s-1
ADVySNOW	Lateral advective flux of snow thickness in the model +y direction	m3 s-1
DFxESNOW	Lateral diffusive flux of snow thickness in the model +x direction	m3 s-1
DFyEHEFF	Lateral diffusive flux of sea-ice thickness in the model +y direction.	m3 s-1
DFxEHEFF	Lateral diffusive flux of sea-ice thickness in the model +x direction.	m3 s-1
DFyESNOW	Lateral diffusive flux of snow thickness in the model +y direction	m3 s-1
Coordinates	**Description of data coordinates**	**Unit**
i	Grid index in x for variables at tracer and 'v' locations	–none–
i_g	Grid index in x for variables at 'u' and 'g' locations	–none–
j	Grid index in y for variables at tracer and 'u' locations	–none–
j_g	Grid index in y for variables at 'v' and 'g' locations	–none–
tile	Lat-lon-cap tile index	–none–
time	Center time of averaging period	–none–
XC	Longitude of tracer grid cell center	degrees_east
YC	Latitude of tracer grid cell center	degrees_north
XG	Longitude of 'southwest' corner of tracer grid cell	degrees_east
YG	Latitude of 'southwest' corner of tracer grid cell	degrees_north
time_bnds	Time bounds of averaging period	–none–
XC_bnds	Longitudes of tracer grid cell corners	–none–
YC_bnds	Latitudes of tracer grid cell corners	–none–

12.18.2 Native Variable: ADVxHEFF

Table 12.97: Attributes description of the variable 'ADVxHEFF' from SEA_ICE_HORIZ_VOLUME_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	ADVxHEFF	Lateral advective flux of sea-ice thickness in the model +x direction	m3 s-1

Description of the variable in Common Data language (CDL)

```
float32 ADVxHEFF(time, tile, j, i_g)
   ADVxHEFF: _FillValue = 9.96921e+36
   ADVxHEFF: long_name = Lateral advective flux of sea:  ice thickness in the
model +x direction
   ADVxHEFF: units = m3 s:  1
   ADVxHEFF: mate = ADVyHEFF
   ADVxHEFF: coverage_content_type = modelResult
   ADVxHEFF: direction = >0 increases mean sea:  ice thickness (HEFF)
   ADVxHEFF: coordinates = time
   ADVxHEFF: valid_min = :  151912.28125
   ADVxHEFF: valid_max = 107688.7578125
```

Comments

Lateral advective flux of grid cell mean sea-ice thickness (heff) in the +x direction through the 'u' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +advxheff(i_g,j) corresponds to +x fluxes through the 'u' face of the tracer cell at (i,j,k=0). also, the model +x direction does not necessarily correspond to the geographical east-west direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.

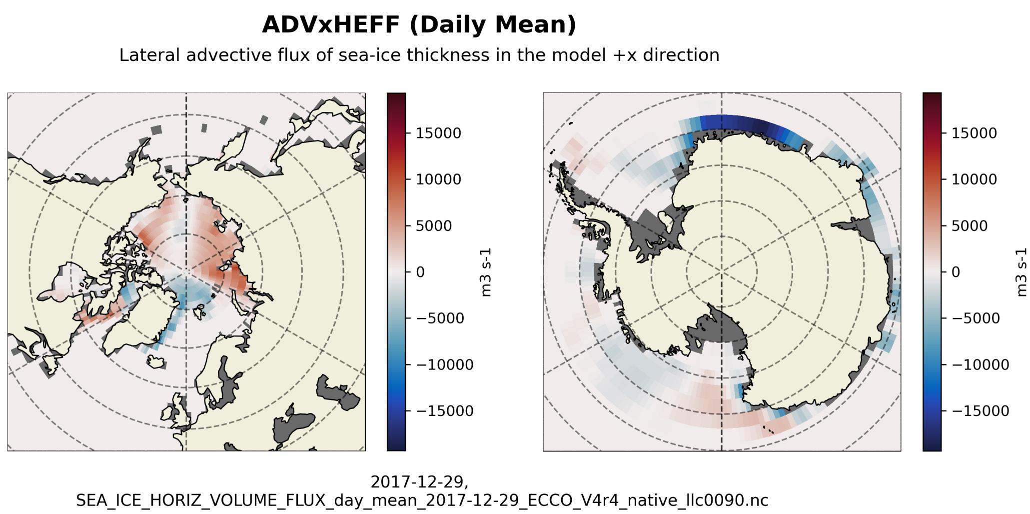

Figure 100: Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: ADVxHEFF

12.18.3 Native Variable: ADVxSNOW

Table 12.98: Attributes description of the variable 'ADVxSNOW' from SEA_ICE_HORIZ_VOLUME_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	ADVxSNOW	Lateral advective flux of snow thickness in the model +x direction	m3 s-1

Description of the variable in Common Data language (CDL)

```
float32 ADVxSNOW(time, tile, j, i_g)
   ADVxSNOW: _FillValue = 9.96921e+36
   ADVxSNOW: long_name = Lateral advective flux of snow thickness in the model +x
direction
   ADVxSNOW: units = m3 s:  1
   ADVxSNOW: mate = ADVySNOW
   ADVxSNOW: coverage_content_type = modelResult
   ADVxSNOW: direction = >0 increases mean snow thickness (HSNOW)
   ADVxSNOW: coordinates = time
   ADVxSNOW: valid_min = :  38343.0234375
   ADVxSNOW: valid_max = 20385.103515625
```

Comments

Lateral advective flux of grid cell mean snow thickness (hsnow) in the +x direction through the 'u' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +advxsnow(i_g,j) corresponds to +x fluxes through the 'u' face of the tracer cell at (i,j,k=0). also, the model +x direction does not necessarily correspond to the geographical east-west direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.

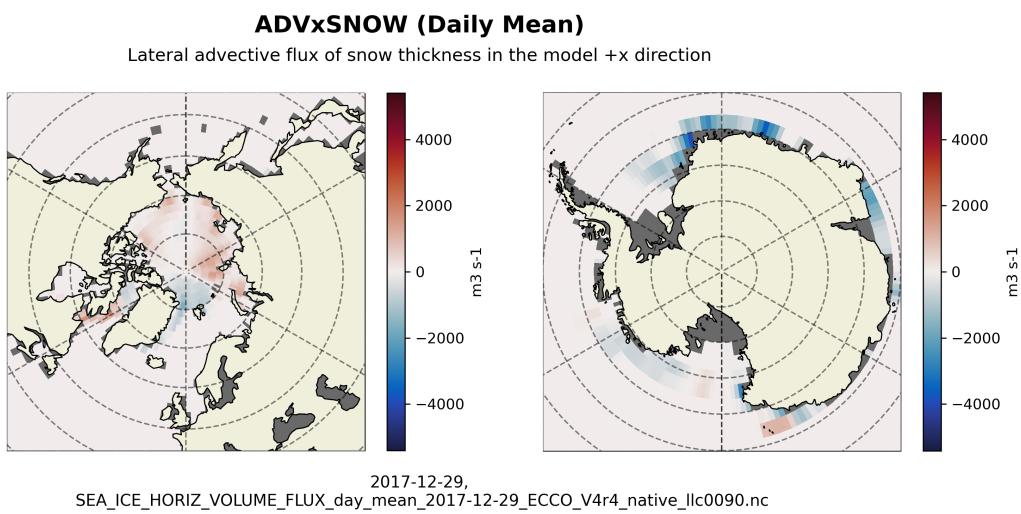

Figure 101: Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: ADVxSNOW

12.18.4 Native Variable: ADVyHEFF

Table 12.99: Attributes description of the variable 'ADVyHEFF' from SEA_ICE_HORIZ_VOLUME_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	ADVyHEFF	Lateral advective flux of sea-ice thickness in the model +y direction	m3 s-1

Description of the variable in Common Data language (CDL)

```
float32 ADVyHEFF(time, tile, j_g, i)
   ADVyHEFF: _FillValue = 9.96921e+36
   ADVyHEFF: long_name = Lateral advective flux of sea:  ice thickness in the
model +y direction
   ADVyHEFF: units = m3 s:  1
   ADVyHEFF: mate = ADVxHEFF
   ADVyHEFF: coverage_content_type = modelResult
   ADVyHEFF: direction = >0 increases mean sea:  ice thickness (HEFF)
   ADVyHEFF: coordinates = time
   ADVyHEFF: valid_min = :  95350.6328125
   ADVyHEFF: valid_max = 115755.4375
```

Comments

Lateral advective flux of grid cell mean sea-ice thickness (heff) in the +y direction through the 'v' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +advyheff(i,j_g) corresponds to +y fluxes through the 'v' face of the tracer cell at (i,j,k=0). also, the model +y direction does not necessarily correspond to the geographical north-south direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.

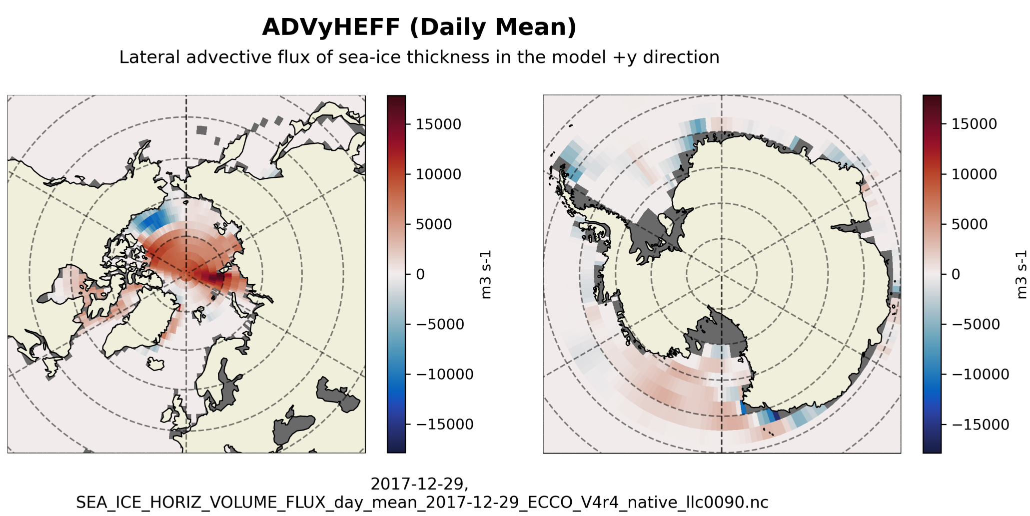

Figure 102: Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: ADVyHEFF

12.18.5 Native Variable: ADVySNOW

Table 12.100: Attributes description of the variable 'ADVySNOW' from SEA_ICE_HORIZ_VOLUME_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	ADVySNOW	Lateral advective flux of snow thickness in the model +y direction	m3 s-1

Description of the variable in Common Data language (CDL)

```
float32 ADVySNOW(time, tile, j_g, i)
   ADVySNOW: _FillValue = 9.96921e+36
   ADVySNOW: long_name = Lateral advective flux of snow thickness in the model +y
direction
   ADVySNOW: units = m3 s:  1
   ADVySNOW: mate = ADVxSNOW
   ADVySNOW: coverage_content_type = modelResult
   ADVySNOW: direction = >0 increases mean snow thickness (HSNOW)
   ADVySNOW: coordinates = time
   ADVySNOW: valid_min = :  30630.552734375
   ADVySNOW: valid_max = 27252.87890625
```

Comments

Lateral advective flux of grid cell mean snow thickness (hsnow) in the +y direction through the 'v' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +advysnow(i,j_g) corresponds to +y fluxes through the 'v' face of the tracer cell at (i,j,k=0). also, the model +y direction does not necessarily correspond to the geographical north-south direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.

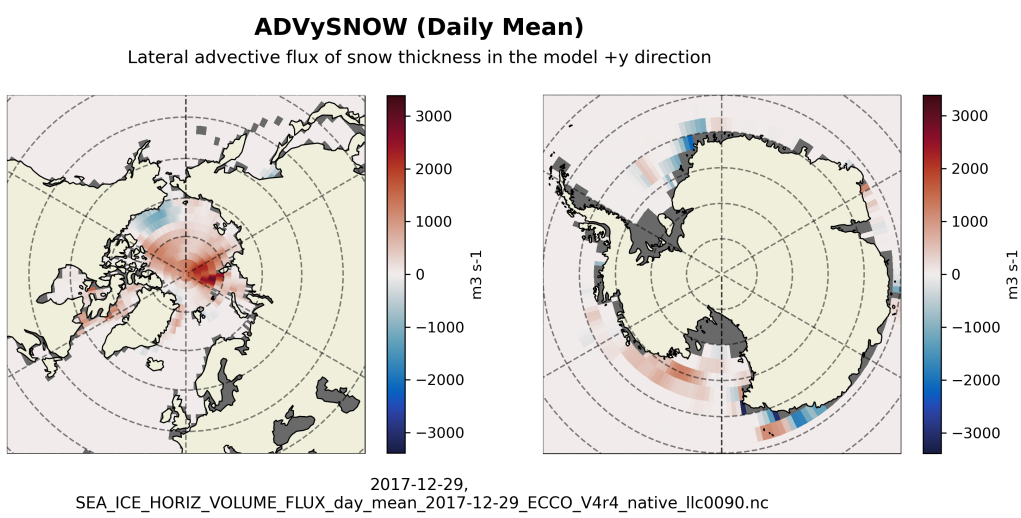

Figure 103: Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: ADVySNOW

12.18.6 Native Variable: DFxEHEFF

Table 12.101: Attributes description of the variable 'DFxEHEFF' from SEA_ICE_HORIZ_VOLUME_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	DFxEHEFF	Lateral diffusive flux of sea-ice thickness in the model +x direction.	m3 s-1

Description of the variable in Common Data language (CDL)

```
float32 DFxEHEFF(time, tile, j, i_g)
   DFxEHEFF: _FillValue = 9.96921e+36
   DFxEHEFF: long_name = Lateral diffusive flux of sea:  ice thickness in the
model +x direction.
   DFxEHEFF: units = m3 s:  1
   DFxEHEFF: mate = DFyEHEFF
   DFxEHEFF: coverage_content_type = modelResult
   DFxEHEFF: direction = >0 increases mean sea:  ice thickness (HEFF)
   DFxEHEFF: coordinates = time
   DFxEHEFF: valid_min = :  1444.172607421875
   DFxEHEFF: valid_max = 2379.271240234375
```

Comments

Lateral diffusive flux of grid cell mean sea-ice thickness (heff) in the +x direction through the 'u' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +dfxeheff(i_g,j) corresponds to +x fluxes through the 'u' face of the tracer cell at (i,j,k=0). also, the model +x direction does not necessarily correspond to the geographical east-west direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.

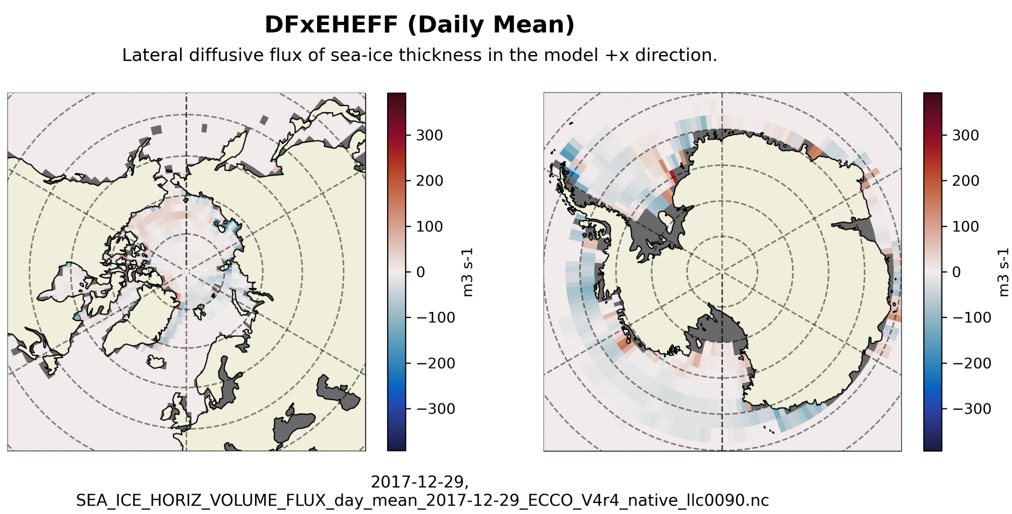

Figure 104: Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: DFxEHEFF

12.18.7 Native Variable: DFxESNOW

Table 12.102: Attributes description of the variable 'DFxESNOW' from SEA_ICE_HORIZ_VOLUME_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	DFxESNOW	Lateral diffusive flux of snow thickness in the model +x direction	m3 s-1

Description of the variable in Common Data language (CDL)

```
float32 DFxESNOW(time, tile, j, i_g)
   DFxESNOW: _FillValue = 9.96921e+36
   DFxESNOW: long_name = Lateral diffusive flux of snow thickness in the model +x
direction
   DFxESNOW: units = m3 s:  1
   DFxESNOW: mate = DFyESNOW
   DFxESNOW: coverage_content_type = modelResult
   DFxESNOW: direction = >0 increases mean snow thickness (HSNOW)
   DFxESNOW: coordinates = time
   DFxESNOW: valid_min = :  448.1134948730469
   DFxESNOW: valid_max = 440.94427490234375
```

Comments

Lateral diffusive flux of grid cell mean snow thickness (hsnow) in the +x direction through the 'u' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +dfxesnow(i_g,j) corresponds to +x fluxes through the 'u' face of the tracer cell at (i,j,k=0). also, the model +x direction does not necessarily correspond to the geographical east-west direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.

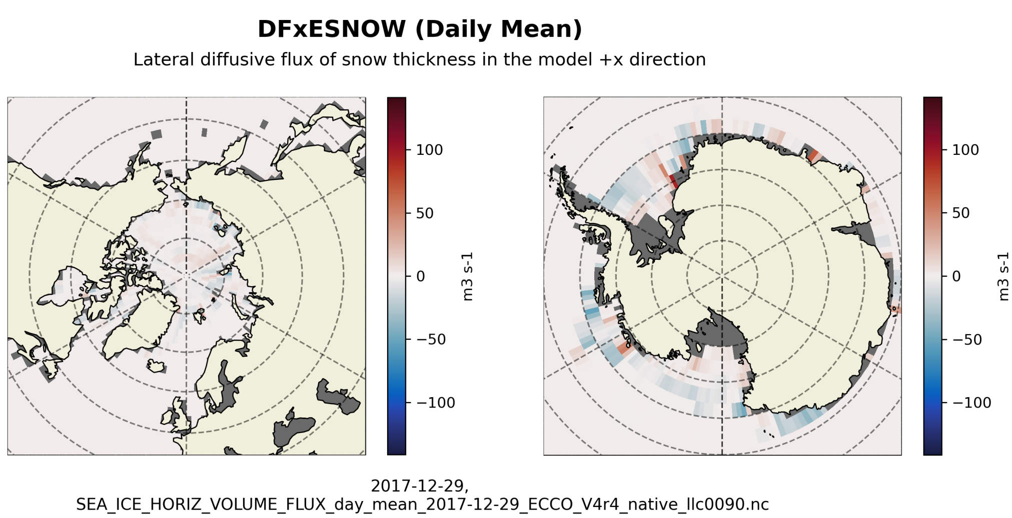

Figure 105: Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: DFxESNOW

12.18.8 Native Variable: DFyEHEFF

Table 12.103: Attributes description of the variable 'DFyEHEFF' from SEA_ICE_HORIZ_VOLUME_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	DFyEHEFF	Lateral diffusive flux of sea-ice thickness in the model +y direction.	m3 s-1
Description of the variable in Common Data language (CDL)			
float32 DFyEHEFF(time, tile, j_g, i) DFyEHEFF: _FillValue = 9.96921e+36 DFyEHEFF: long_name = Lateral diffusive flux of sea: ice thickness in the model +y direction. DFyEHEFF: units = m3 s: 1 DFyEHEFF: mate = DFxEHEFF DFyEHEFF: coverage_content_type = modelResult DFyEHEFF: direction = >0 increases mean sea: ice thickness (HEFF) DFyEHEFF: coordinates = time DFyEHEFF: valid_min = : 3078.810791015625 DFyEHEFF: valid_max = 1614.6512451171875			
Comments			
Lateral diffusive flux of grid cell mean sea-ice thickness (heff) in the +y direction through the 'v' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +dfyeheff(i,j_g) corresponds to +y fluxes through the 'v' face of the tracer cell at (i,j,k=0). also, the model +y direction does not necessarily correspond to the geographical north-south direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.			

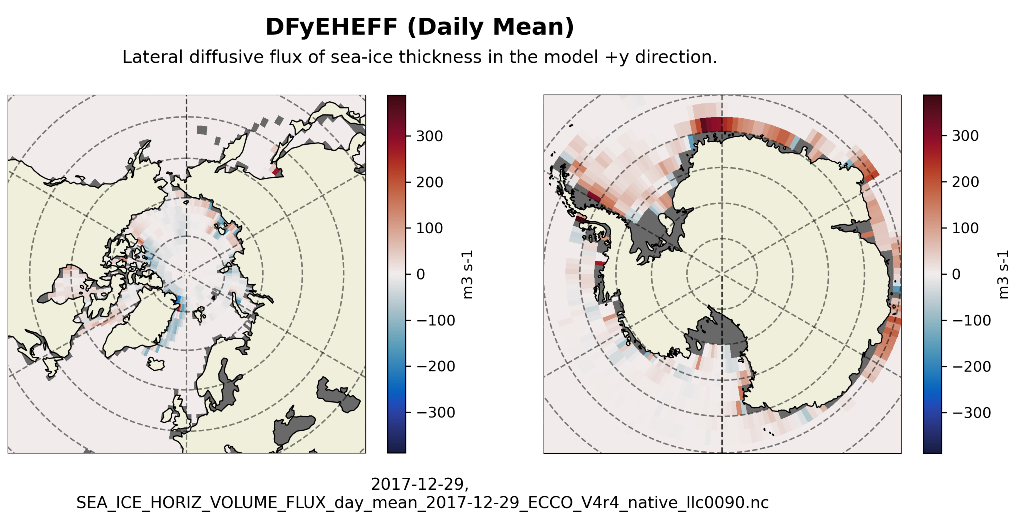

Figure 106: Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: DFyEHEFF

12.18.9 Native Variable: DFyESNOW

Table 12.104: Attributes description of the variable 'DFyESNOW' from SEA_ICE_HORIZ_VOLUME_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	DFyESNOW	Lateral diffusive flux of snow thickness in the model +y direction	m3 s-1

Description of the variable in Common Data language (CDL)

```
float32 DFyESNOW(time, tile, j_g, i)
   DFyESNOW: _FillValue = 9.96921e+36
   DFyESNOW: long_name = Lateral diffusive flux of snow thickness in the model +y
direction
   DFyESNOW: units = m3 s:  1
   DFyESNOW: mate = DFxESNOW
   DFyESNOW: coverage_content_type = modelResult
   DFyESNOW: direction = >0 increases mean snow thickness (HSNOW)
   DFyESNOW: coordinates = time
   DFyESNOW: valid_min = :  662.0200805664062
   DFyESNOW: valid_max = 411.7032470703125
```

Comments

Lateral diffusive flux of grid cell mean snow thickness (hsnow) in the +y direction through the 'v' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +dfyesnow(i,j_g,k) corresponds to +y fluxes through the 'v' face of the tracer cell at (i,j,k=0). also, the model +y direction does not necessarily correspond to the geographical north-south direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.

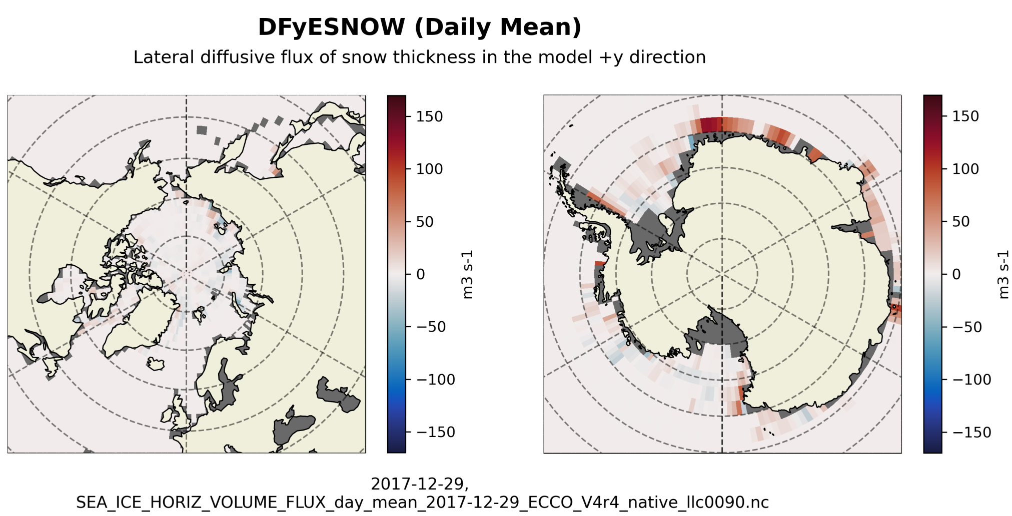

Figure 107: Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: DFyESNOW

12.19 Native dataset of SEA_ICE_SALT_PLUME_FLUX

12.19.1 Overview

This dataset provides 2D fields of sea-ice salt plume fluxes on the lat-lon-cap 90 (llc90) native model grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution. oceSPflx is salt mass flux per unit area (g m-2 s-1), not salinity flux.

Table 12.105: Coordinates and Variables in the dataset SEA_ICE_SALT_PLUME_FLUX

Variables	Description of data variables	Unit
oceSPflx	Net salt flux into the ocean due to brine rejection	g m-2 s-1
oceSPDep	Salt plume depth	m
Coordinates	**Description of data coordinates**	**Unit**
i	Grid index in x for variables at tracer and 'v' locations	–none–
i_g	Grid index in x for variables at 'u' and 'g' locations	–none–
j	Grid index in y for variables at tracer and 'u' locations	–none–
j_g	Grid index in y for variables at 'v' and 'g' locations	–none–
tile	Lat-lon-cap tile index	–none–
time	Center time of averaging period	–none–
XC	Longitude of tracer grid cell center	degrees_east
YC	Latitude of tracer grid cell center	degrees_north
XG	Longitude of 'southwest' corner of tracer grid cell	degrees_east
YG	Latitude of 'southwest' corner of tracer grid cell	degrees_north
time_bnds	Time bounds of averaging period	–none–
XC_bnds	Longitudes of tracer grid cell corners	–none–
YC_bnds	Latitudes of tracer grid cell corners	–none–

12.19.2 Native Variable: oceSPDep

Table 12.106: Attributes description of the variable 'oceSPDep' from SEA_ICE_SALT_PLUME_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	oceSPDep	Salt plume depth	m
Description of the variable in Common Data language (CDL)			
float32 oceSPDep(time, tile, j, i) oceSPDep: _FillValue = 9.96921e+36 oceSPDep: long_name = Salt plume depth oceSPDep: units = m oceSPDep: coverage_content_type = modelResult oceSPDep: coordinates = time YC XC oceSPDep: valid_min = 5.500708103179932 oceSPDep: valid_max = 5530.31494140625			
Comments			
Depth of parameterized salt plumes formed due to brine rejection during sea-ice formation.			

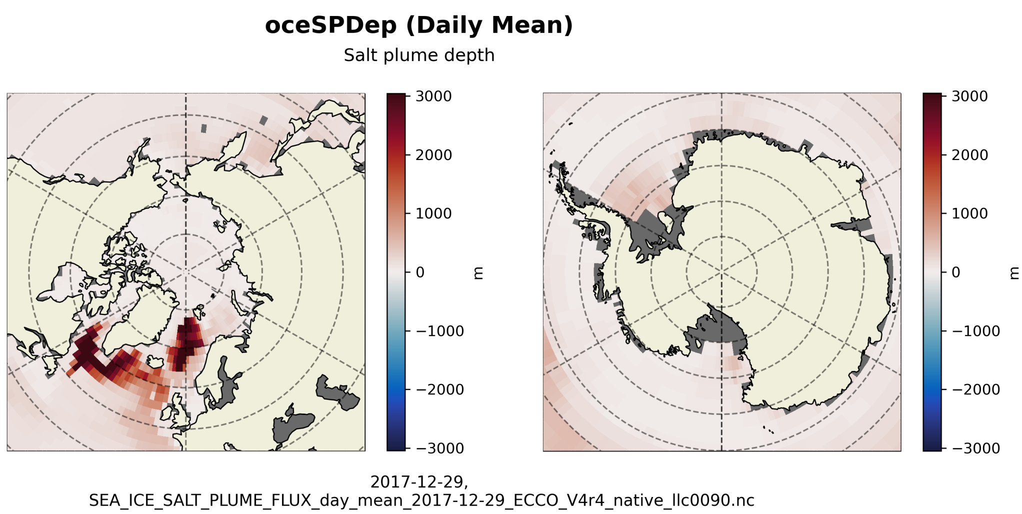

Figure 108: Dataset: SEA_ICE_SALT_PLUME_FLUX, Variable: oceSPDep

12.19.3 Native Variable: oceSPflx

Table 12.107: Attributes description of the variable 'oceSPflx' from SEA_ICE_SALT_PLUME_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	oceSPflx	Net salt flux into the ocean due to brine rejection	g m-2 s-1
Description of the variable in Common Data language (CDL)			

```
float32 oceSPflx(time, tile, j, i)
   oceSPflx:  _FillValue = 9.96921e+36
   oceSPflx:  long_name = Net salt flux into the ocean due to brine rejection
   oceSPflx:  units = g m:  2 s:  1
   oceSPflx:  coverage_content_type = modelResult
   oceSPflx:  direction = >0 increases salinity (SALT)
   oceSPflx:  coordinates = time YC XC
   oceSPflx:  valid_min = 0.0
   oceSPflx:  valid_max = 0.058169759809970856
```

Comments

Net salt flux into the ocean due to brine rejection during sea-ice formation. note: units are grams of salt per square meter per second, not salinity per square meter per second.

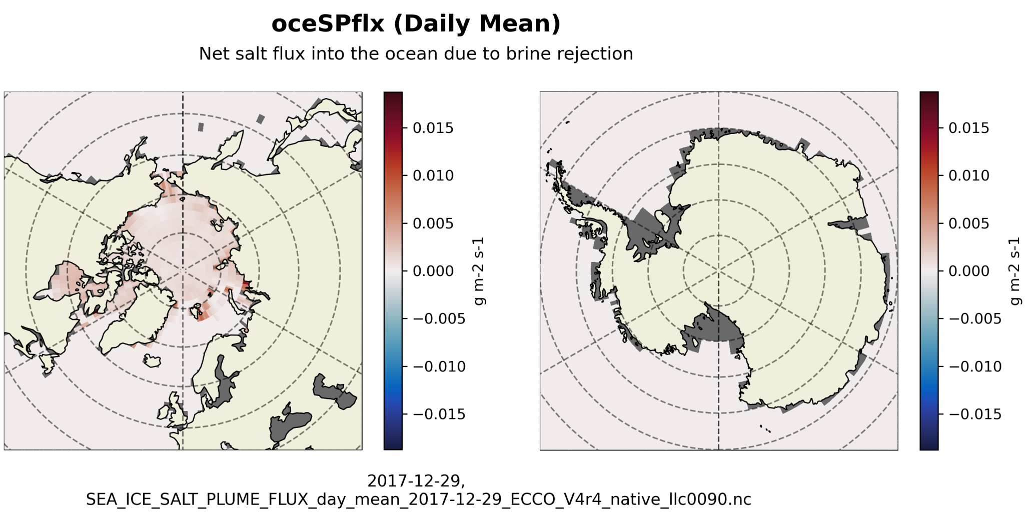

Figure 109: Dataset: SEA_ICE_SALT_PLUME_FLUX, Variable: oceSPflx

12.20 Native dataset of SEA_ICE_VELOCITY

12.20.1 Overview

This dataset provides 2D fields of sea-ice velocity on the lat-lon-cap 90 (llc90) native model grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution. Snapshot data of sea-ice velocity are also provided.

Table 12.108: Coordinates and Variables in the dataset SEA_ICE_VELOCITY

Variables	Description of data variables	Unit
SIuice	Sea-ice velocity in the model +x direction	m s-1

Table 12.108: Coordinates and Variables in the dataset SEA_ICE_VELOCITY

SIvice	Sea-ice velocity in the model +y direction	m s-1
Coordinates	**Description of data coordinates**	**Unit**
i	Grid index in x for variables at tracer and 'v' locations	–none–
i_g	Grid index in x for variables at 'u' and 'g' locations	–none–
j	Grid index in y for variables at tracer and 'u' locations	–none–
j_g	Grid index in y for variables at 'v' and 'g' locations	–none–
tile	Lat-lon-cap tile index	–none–
time	Center time of averaging period	–none–
XC	Longitude of tracer grid cell center	degrees_east
YC	Latitude of tracer grid cell center	degrees_north
XG	Longitude of 'southwest' corner of tracer grid cell	degrees_east
YG	Latitude of 'southwest' corner of tracer grid cell	degrees_north
time_bnds	Time bounds of averaging period	–none–
XC_bnds	Longitudes of tracer grid cell corners	–none–
YC_bnds	Latitudes of tracer grid cell corners	–none–

12.20.2 Native Variable: SIuice

Table 12.109: Attributes description of the variable 'SIuice' from SEA_ICE_VELOCITY's dataset.

Storage Type	Variable Name	Description	Unit
float32	SIuice	Sea-ice velocity in the model +x direction	m s-1
Description of the variable in Common Data language (CDL)			

```
float32 SIuice(time, tile, j, i_g)
   SIuice:  _FillValue = 9.96921e+36
   SIuice:  long_name = Sea:  ice velocity in the model +x direction
   SIuice:  units = m s:  1
   SIuice:  mate = SIvice
   SIuice:  coverage_content_type = modelResult
   SIuice:  standard_name = sea_ice_x_velocity
   SIuice:  coordinates = time
   SIuice:  valid_min = :  0.4000000059604645
   SIuice:  valid_max = 0.4000000059604645
```

Comments

Horizontal sea-ice velocity in the +x direction at the 'u' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal velocities are staggered relative to the tracer cells with indexing such that +siuice(i_g,j) corresponds to +x fluxes through the 'u' face of the tracer cell at (i,j,k=0). also, the model +x direction does not necessarily correspond to the geographical east-west direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.

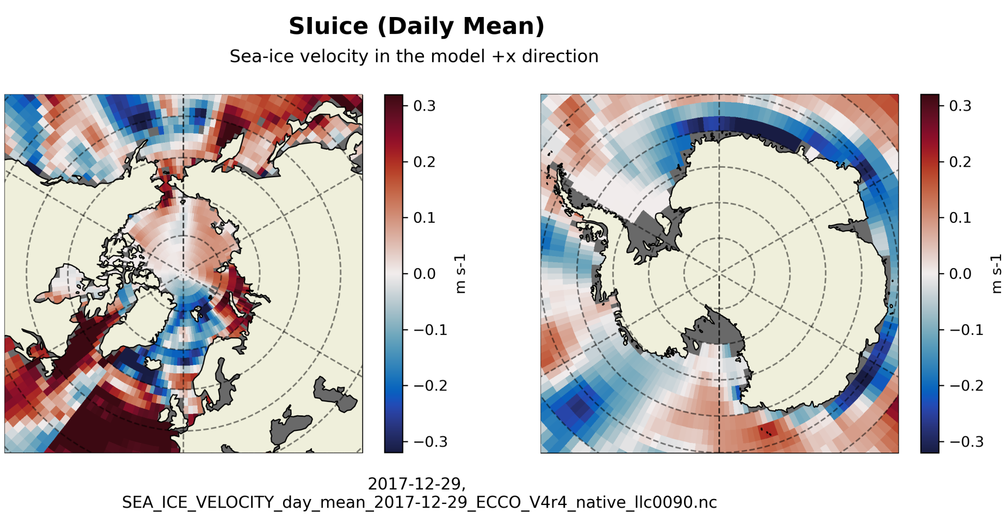

Figure 110: Dataset: SEA_ICE_VELOCITY, Variable: SIuice

12.20.3 Native Variable: SIvice

Table 12.110: Attributes description of the variable 'SIvice' from SEA_ICE_VELOCITY's dataset.

Storage Type	Variable Name	Description	Unit
float32	SIvice	Sea-ice velocity in the model +y direction	m s-1
Description of the variable in Common Data language (CDL)			

```
float32 SIvice(time, tile, j_g, i)
   SIvice:  _FillValue = 9.96921e+36
   SIvice:  long_name = Sea:  ice velocity in the model +y direction
   SIvice:  units = m s:  1
   SIvice:  mate = SIuice
   SIvice:  coverage_content_type = modelResult
   SIvice:  standard_name = sea_ice_y_velocity
   SIvice:  coordinates = time
   SIvice:  valid_min = :  0.4000000059604645
   SIvice:  valid_max = 0.4000000059604645
```

Comments

Horizontal sea-ice velocity in the +y direction at the 'v' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal velocities are staggered relative to the tracer cells with indexing such that +sivice(i,j_g) corresponds to +y fluxes through the 'v' face of the tracer cell at (i,j,k=0). also, the model +y direction does not necessarily correspond to the geographical north-south direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.

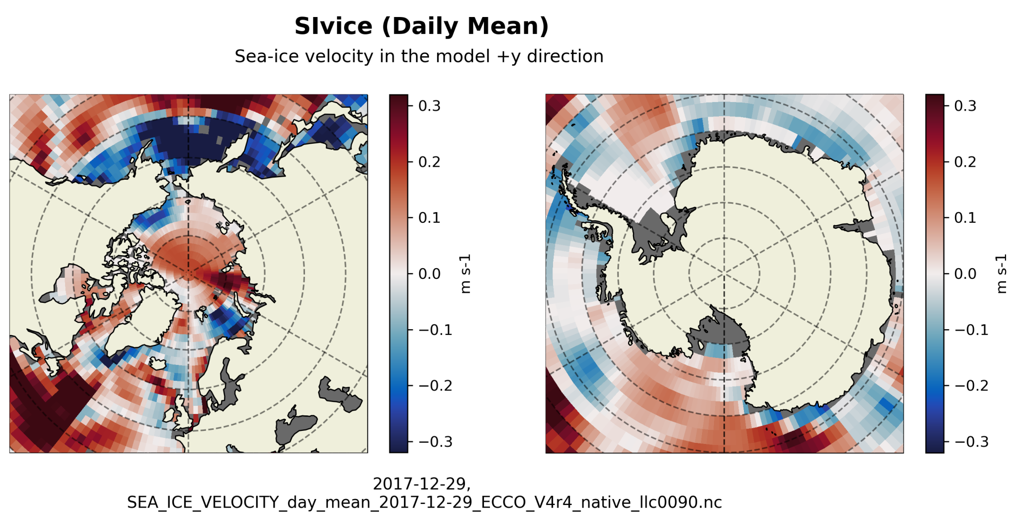

Figure 111: Dataset: SEA_ICE_VELOCITY, Variable: SIvice

12.21 Native dataset of SEA_SURFACE_HEIGHT

12.21.1 Overview

This dataset provides 2D fields of dynamic sea surface height and model sea level anomaly on the lat-lon-cap 90 (llc90) native model grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution. Snapshot data of dynamic sea surface height and model sea level anomaly are also provided. SSH (dynamic sea surface height) = SSHNOIBC (dynamic sea surface without the inverse barometer correction) - SSHIBC (inverse barometer correction). The inverted barometer correction accounts for variations in sea surface height due to atmospheric pressure variations. Note: ETAN is model sea level anomaly and should not be compared with satellite altimetery products, see SSH and ETAN for more details.

Table 12.111: Coordinates and Variables in the dataset SEA_SURFACE_HEIGHT

Variables	Description of data variables	Unit
SSH	Dynamic sea surface height anomaly	m
SSHIBC	The inverted barometer (ib) correction to sea surface height due to atmospheric pressure loading	m
SSHNOIBC	Sea surface height anomaly without the inverted barometer (ib) correction	m
ETAN	Model sea level anomaly	m
Coordinates	**Description of data coordinates**	**Unit**
i	Grid index in x for variables at tracer and 'v' locations	–none–
i_g	Grid index in x for variables at 'u' and 'g' locations	–none–
j	Grid index in y for variables at tracer and 'u' locations	–none–
j_g	Grid index in y for variables at 'v' and 'g' locations	–none–
tile	Lat-lon-cap tile index	–none–
time	Center time of averaging period	–none–
XC	Longitude of tracer grid cell center	degrees_east
YC	Latitude of tracer grid cell center	degrees_north
XG	Longitude of 'southwest' corner of tracer grid cell	degrees_east
YG	Latitude of 'southwest' corner of tracer grid cell	degrees_north
time_bnds	Time bounds of averaging period	–none–
XC_bnds	Longitudes of tracer grid cell corners	–none–
YC_bnds	Latitudes of tracer grid cell corners	–none–

12.21.2 Native Variable: ETAN

Table 12.112: Attributes description of the variable 'ETAN' from SEA_SURFACE_HEIGHT's dataset.

Storage Type	Variable Name	Description	Unit
float32	ETAN	Model sea level anomaly	m
Description of the variable in Common Data language (CDL)			
float32 ETAN(time, tile, j, i) ETAN: _FillValue = 9.96921e+36 ETAN: long_name = Model sea level anomaly ETAN: units = m ETAN: coverage_content_type = modelResult ETAN: coordinates = YC time XC ETAN: valid_min = : 9.067964553833008 ETAN: valid_max = 2.1783087253570557			
Comments			
Model sea level anomaly without corrections for global mean density (steric) changes, inverted barometer effect, or volume displacement due to submerged sea-ice and snow . note: etan should not be used for comparisons with altimetry data products because etan is not corrected for (a) global mean steric sea level changes related to density changes in the boussinesq volume-conserving model (greatbatch correction, see stergloh) nor (b) sea level displacement due to submerged sea-ice and snow (see siceload). these corrections are made for the variables ssh and sshnoibc.			

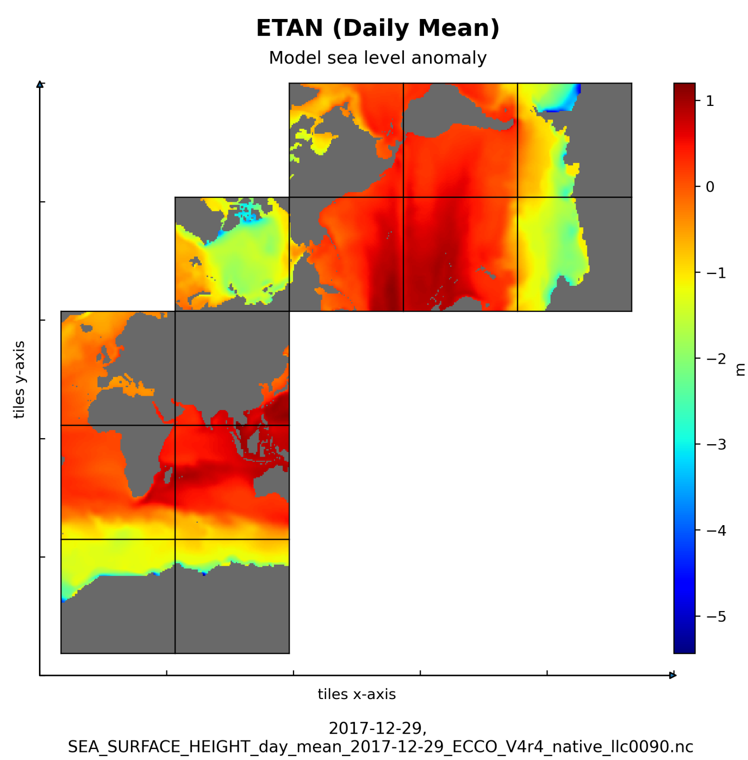

Figure 112: Dataset: SEA_SURFACE_HEIGHT, Variable: ETAN

12.21.3 Native Variable: SSH

Table 12.113: Attributes description of the variable 'SSH' from SEA_SURFACE_HEIGHT's dataset.

Storage Type	Variable Name	Description	Unit
float32	SSH	Dynamic sea surface height anomaly	m
Description of the variable in Common Data language (CDL)			
float32 SSH(time, tile, j, i) SSH: _FillValue = 9.96921e+36 SSH: long_name = Dynamic sea surface height anomaly SSH: units = m SSH: coverage_content_type = modelResult SSH: standard_name = sea_surface_height_above_geoid SSH: coordinates = YC time XC SSH: valid_min = : 2.4861555099487305 SSH: valid_max = 2.2875382900238037			
Comments			
Dynamic sea surface height anomaly above the geoid, suitable for comparisons with altimetry sea surface height data products that apply the inverse barometer (ib) correction. note: ssh is calculated by correcting model sea level anomaly etan for three effects: a) global mean steric sea level changes related to density changes in the boussinesq volume-conserving model (greatbatch correction, see stergloh), b) the inverted barometer (ib) effect (see sshibc) and c) sea level displacement due to sea-ice and snow pressure loading (see siceload). ssh can be compared with the similarly-named ssh variable in previous ecco products that did not include atmospheric pressure loading (e.g., version 4 release 3). use sshnoibc for comparisons with altimetry data products that do not apply the ib correction.			

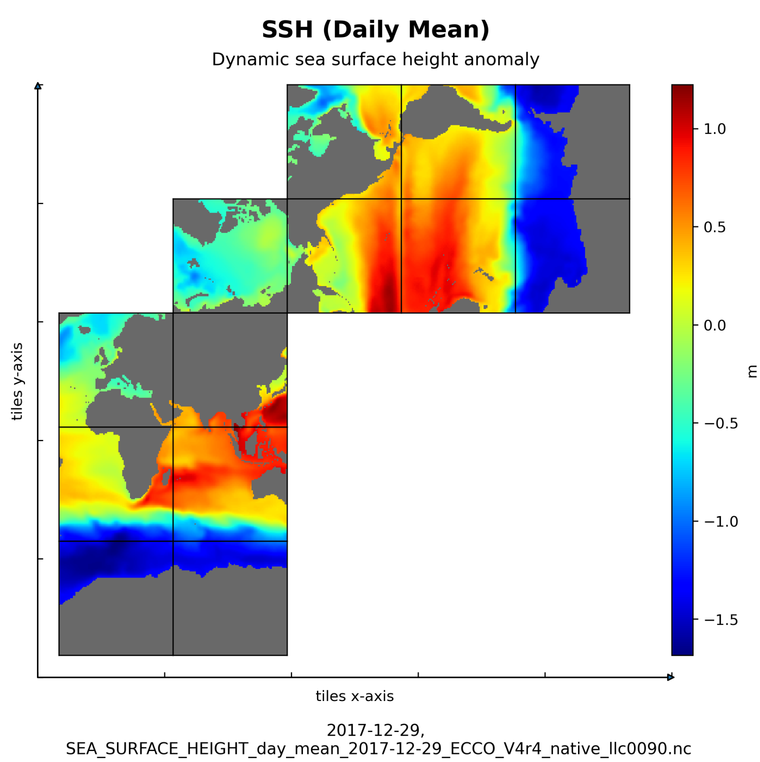

Figure 113: Dataset: SEA_SURFACE_HEIGHT, Variable: SSH

12.21.4 Native Variable: SSHIBC

Table 12.114: Attributes description of the variable 'SSHIBC' from SEA_SURFACE_HEIGHT's dataset.

Storage Type	Variable Name	Description	Unit
float32	SSHIBC	The inverted barometer (ib) correction to sea surface height due to atmospheric pressure loading	m

Description of the variable in Common Data language (CDL)

```
float32 SSHIBC(time, tile, j, i)
   SSHIBC: _FillValue = 9.96921e+36
   SSHIBC: long_name = The inverted barometer (IB) correction to sea surface
height due to atmospheric pressure loading
   SSHIBC: units = m
   SSHIBC: coverage_content_type = modelResult
   SSHIBC: coordinates = YC time XC
   SSHIBC: valid_min = :  0.5228679180145264
   SSHIBC: valid_max = 0.9044463634490967
```

Comments

Not an ssh itself, but a correction to model sea level anomaly (etan) required to account for the static part of sea surface displacement by atmosphere pressure loading: ssh = sshnoibc - sshibc. note: use ssh for model-data comparisons with altimetry data products that do apply the ib correction and sshnoibc for comparisons with altimetry data products that do not apply the ib correction.

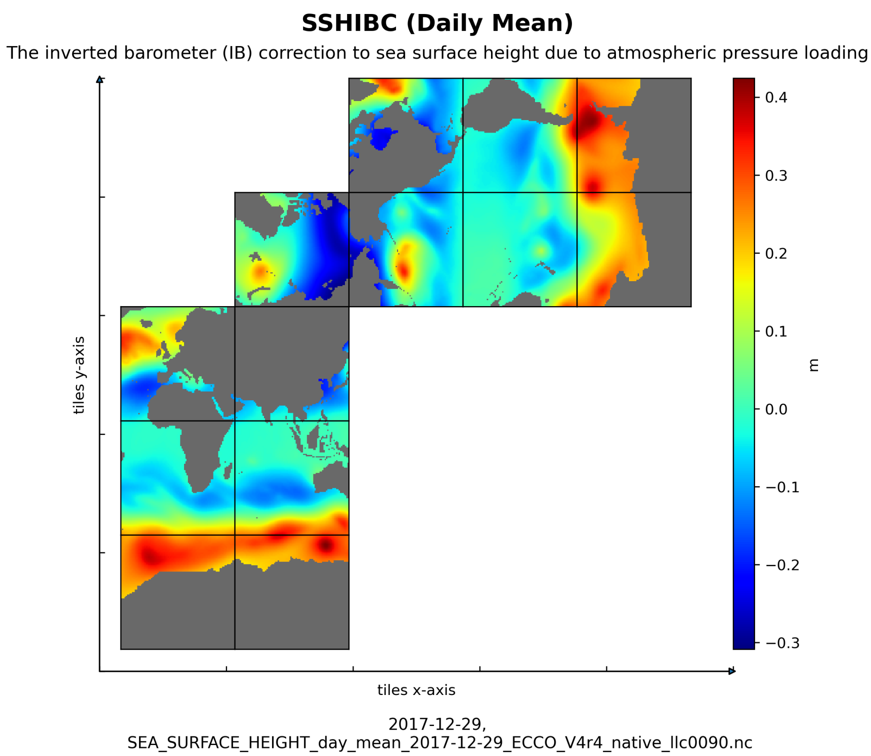

Figure 114: Dataset: SEA_SURFACE_HEIGHT, Variable: SSHIBC

12.21.5 Native Variable: SSHNOIBC

Table 12.115: Attributes description of the variable 'SSHNOIBC' from SEA_SURFACE_HEIGHT's dataset.

Storage Type	Variable Name	Description	Unit
float32	SSHNOIBC	Sea surface height anomaly without the inverted barometer (ib) correction	m

Description of the variable in Common Data language (CDL)

```
float32 SSHNOIBC(time, tile, j, i)
   SSHNOIBC: _FillValue = 9.96921e+36
   SSHNOIBC: long_name = Sea surface height anomaly without the inverted barometer
(IB) correction
   SSHNOIBC: units = m
   SSHNOIBC: coverage_content_type = modelResult
   SSHNOIBC: coordinates = YC time XC
   SSHNOIBC: valid_min = :  2.45104718208313
   SSHNOIBC: valid_max = 2.2390522956848145
```

Comments

Sea surface height anomaly above the geoid without the inverse barometer (ib) correction, suitable for comparisons with altimetry sea surface height data products that do not apply the inverse barometer (ib) correction. note: sshnoibc is calculated by correcting model sea level anomaly etan for two effects: a) global mean steric sea level changes related to density changes in the boussinesq volume-conserving model (greatbatch correction, see sterGloh), b) sea level displacement due to sea-ice and snow pressure loading (see siceload). in ecco version 4 release 4 the model is forced with atmospheric pressure loading. sshnoibc does not correct for the static part of the effect of atmosphere pressure loading on sea surface height (the so-called inverse barometer (ib) correction). use ssh for comparisons with altimetry data products that do apply the ib correction.

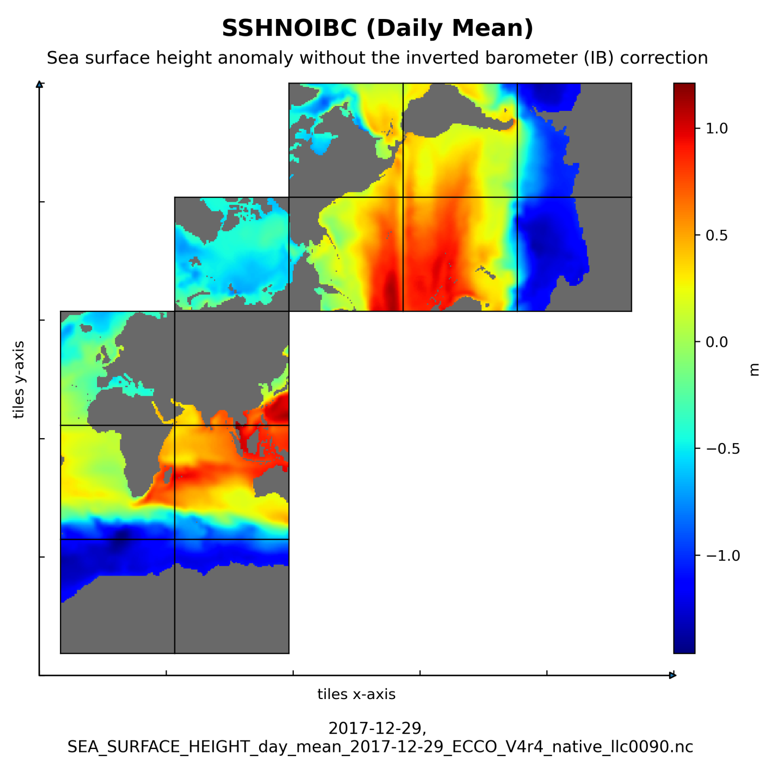

Figure 115: Dataset: SEA_SURFACE_HEIGHT, Variable: SSHNOIBC

13 Lat-Lon Coordinates and Grid Geometry

13.1 Latlon coordinates GRID_GEOMETRY_ECCO

13.1.1 Overview

This dataset provides geometric parameters for the regular 0.5-degree lat-lon grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. Parameters include areas and lengths of grid cell sides, horizontal and vertical coordinates of grid cell centers and corners, and global domain geometry including bathymetry and land/ocean masks.

Table 13.1: Coordinates and Variables in the dataset GRID_GEOMETRY_ECCO

Variables	Description of data variables	Unit
hFacC	Vertical open fraction of grid cell	1
Depth	Model seafloor depth below ocean surface at rest	m
area	Area of lat-lon grid cell	m2
drF	Distance between the upper and lower interfaces of the model grid cell	m
maskC	Wet/dry boolean mask for grid cell	–none–
Coordinates	**Description of data coordinates**	**Unit**
Z	Depth of grid cell center	m
latitude	Latitude at grid cell center	degrees_north
longitude	Longitude at grid cell center	degrees_east
latitude_bnds	Latitudes of grid cell edges	–none–
longitude_bnds	Longitudes of grid cell edges	–none–
Z_bnds	Depths of grid cell upper and lower interfaces	–none–

13.1.2 Latlon coordinates Variable: hFacC

Table 13.2: Attributes description of the variable 'hFacC' from GRID_GEOMETRY_ECCO's dataset.

Storage Type	Variable Name	Description	Unit
float64	hFacC	Vertical open fraction of grid cell	1
Description of the variable in Common Data language (CDL)			

`float64 hFacC(Z, latitude, longitude)`
`hFacC: _FillValue = 9.969209968386869e+36`
`hFacC: coverage_content_type = modelResult`
`hFacC: long_name = vertical open fraction of grid cell`
`hFacC: units = 1`			

Comments			
Grid cells may be fractionally closed in the vertical. the open vertical fraction is hfacc. the model allows for partially-filled cells to represent topographic variations more smoothly (hfacc < 1). completely closed (dry) tracer grid cells have hfacc = 0. note: the lat-lon gridded hfacc is spatially-averaged from the hfacc field on the lat-lon-cap (llc90) model native grid. the total ocean volume of the ecco v4r4 lat-lon gridded fields is within 0.05% of the total ocean volume of the native grid fields.			

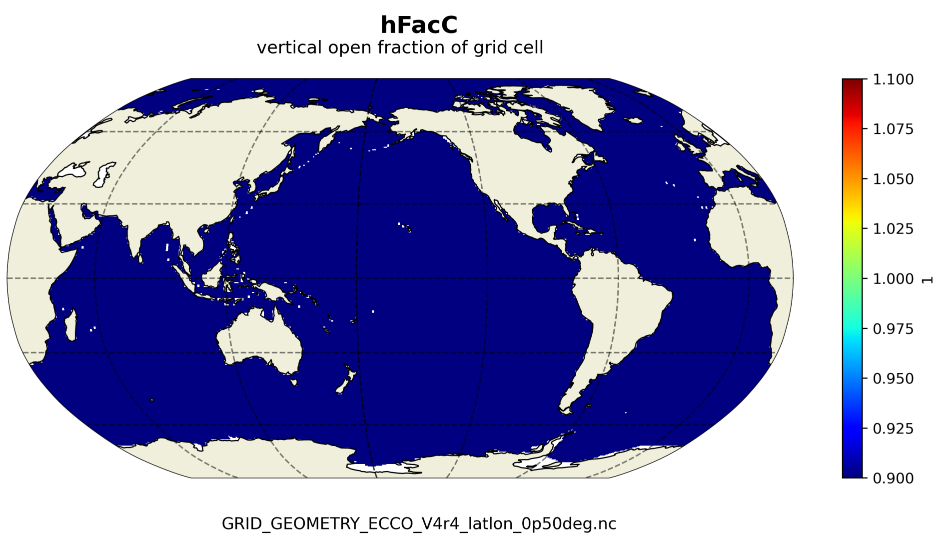

Figure 116: Dataset: GRID_GEOMETRY_ECCO, Variable: hFacC

13.1.3 Latlon coordinates Variable: maskC

Table 13.3: Attributes description of the variable 'maskC' from GRID_GEOMETRY_ECCO's dataset.

Storage Type	Variable Name	Description	Unit
bool	maskC	Wet/dry boolean mask for grid cell	N/A
Description of the variable in Common Data language (CDL)			

`bool maskC(Z, latitude, longitude)`
`maskC: _FillValue = 1`
`maskC: coverage_content_type = modelResult`
`maskC: long_name = wet/dry boolean mask for grid cell`			

Comments			
True for grid cells with nonzero open vertical fraction (hfacc > 0), otherwise false.			

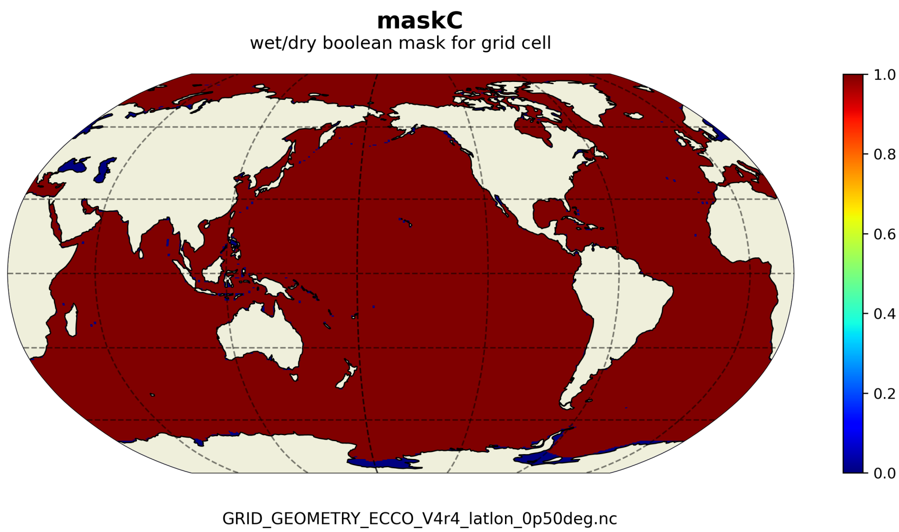

Figure 117: Dataset: GRID_GEOMETRY_ECCO, Variable: maskC

14 Latlon Dataset Groupings

14.1 Latlon dataset of ATM_SURFACE_TEMP_HUM_WIND_PRES

14.1.1 Overview

This dataset provides 2D fields of atmosphere surface temperature, humidity, wind, and pressure interpolated to a regular 0.5-degree grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution.

Table 14.1: Coordinates and Variables in the dataset ATM_SURFACE_TEMP_HUM_WIND_PRES

Variables	Description of data variables	Unit
EXFatemp	Atmosphere surface (2 m) air temperature	degree_K
EXFaqh	Atmosphere surface (2 m) specific humidity	kg kg-1
EXFewind	Zonal (east-west) wind speed	m s-1
EXFnwind	Meridional (north-south) wind speed	m s-1
EXFwspee	Wind speed	m s-1
EXFpress	Atmosphere surface pressure	N m-2
Coordinates	**Description of data coordinates**	**Unit**
time	Center time of averaging period	–none–
latitude	Latitude at grid cell center	degrees_north
longitude	Longitude at grid cell center	degrees_east
time_bnds	Time bounds of averaging period	–none–
latitude_bnds	Latitude bounds grid cells	–none–
longitude_bnds	Longitude bounds grid cells	–none–

14.1.2 Latlon Variable: EXFaqh

Table 14.2: Attributes description of the variable 'EXFaqh' from ATM_SURFACE_TEMP_HUM_WIND_PRES's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFaqh	Atmosphere surface (2 m) specific humidity	kg kg-1
Description of the variable in Common Data language (CDL)			

```
float32 EXFaqh(time, latitude, longitude)
   EXFaqh:  _FillValue = 9.96921e+36
   EXFaqh:  coverage_content_type = modelResult
   EXFaqh:  long_name = Atmosphere surface (2 m) specific humidity
   EXFaqh:  standard_name = surface_specific_humidity
   EXFaqh:  units = kg kg:  1
   EXFaqh:  coordinates = time
   EXFaqh:  valid_min = :  0.0014020215021446347
   EXFaqh:  valid_max = 0.030145138502l2097
```

Comments

Surface (2 m) specific humidity over open water. note: sum of era-interim surface specific humidity and the control adjustment from ocean state estimation.

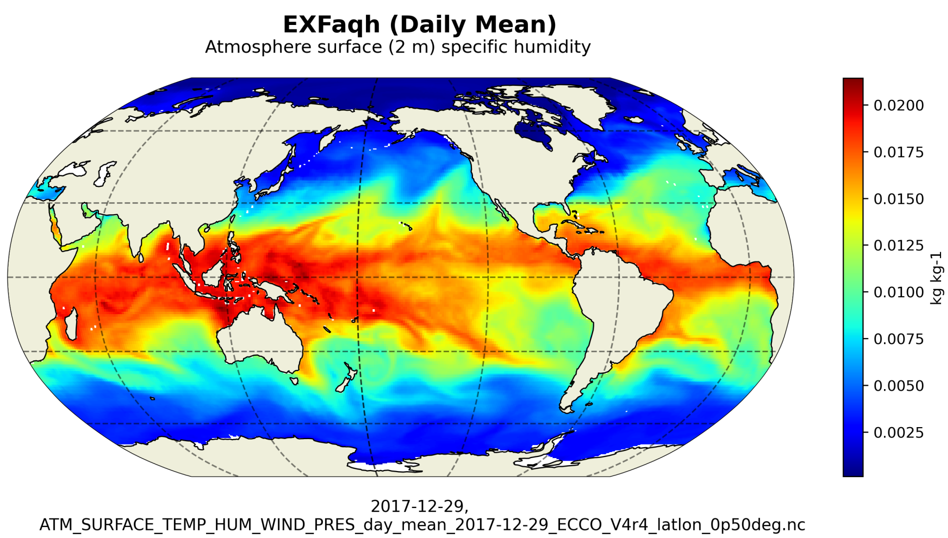

Figure 118: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFaqh

14.1.3 Latlon Variable: EXFatemp

Table 14.3: Attributes description of the variable 'EXFatemp' from ATM_SURFACE_TEMP_HUM_WIND_PRES's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFatemp	Atmosphere surface (2 m) air temperature	degree_K

Description of the variable in Common Data language (CDL)

```
float32 EXFatemp(time, latitude, longitude)
   EXFatemp:  _FillValue = 9.96921e+36
   EXFatemp:  coverage_content_type = modelResult
   EXFatemp:  long_name = Atmosphere surface (2 m) air temperature
   EXFatemp:  standard_name = air_temperature
   EXFatemp:  units = degree_K
   EXFatemp:  coordinates = time
   EXFatemp:  valid_min = 195.37054443359375
   EXFatemp:  valid_max = 312.8451232910156
```

Comments

Surface (2 m) air temperature over open water. note: sum of era-interim surface air temperature and the control adjustment from ocean state estimation.

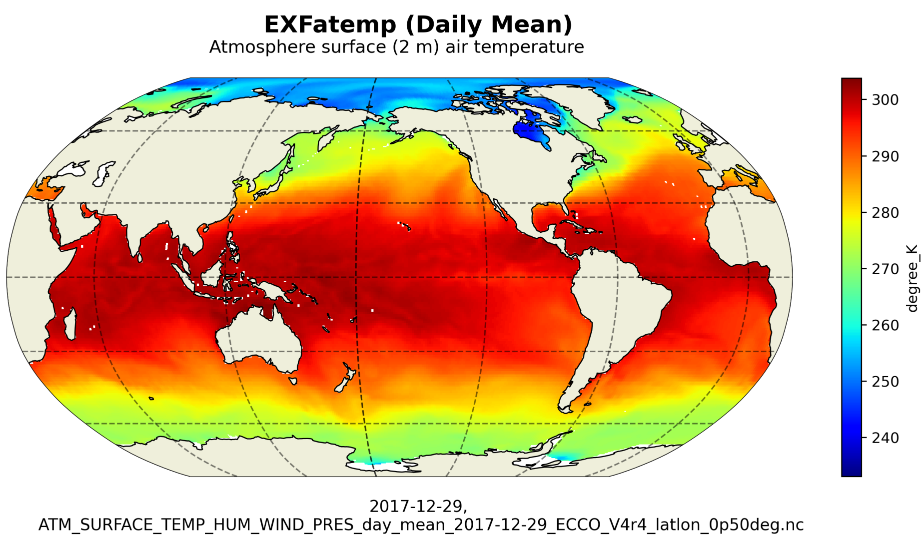

Figure 119: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFatemp

14.1.4 Latlon Variable: EXFewind

Table 14.4: Attributes description of the variable 'EXFewind' from ATM_SURFACE_TEMP_HUM_WIND_PRES's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFewind	Zonal (east-west) wind speed	m s-1

Description of the variable in Common Data language (CDL)

```
float32 EXFewind(time, latitude, longitude)
   EXFewind:  _FillValue = 9.96921e+36
   EXFewind:  coverage_content_type = modelResult
   EXFewind:  long_name = Zonal (east:  west) wind speed
   EXFewind:  standard_name = eastward_wind
   EXFewind:  units = m s:  1
   EXFewind:  coordinates = time
   EXFewind:  valid_min = :  33.524742126464844
   EXFewind:  valid_max = 39.48556900024414
```

Comments

Zonal (east-west) component of ocean surface wind. note: exfewind is calculated by interpolating the model's x and y components of wind velocity (exfuwind and exfvwind) to tracer cell centers and then finding the zonal component of the interpolated vectors. ecco v4r4 is forced with wind stress (see exftaux, exftauy), not vector winds + bulk formulae. exfewind is calculated by converting wind stress to vector wind using bulk formulae.

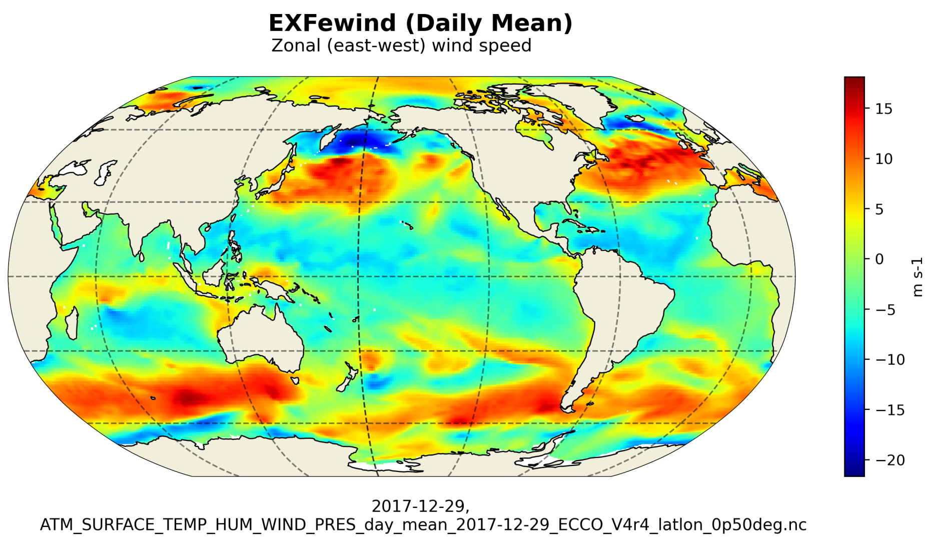

Figure 120: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFewind

14.1.5 Latlon Variable: EXFnwind

Table 14.5: Attributes description of the variable 'EXFnwind' from ATM_SURFACE_TEMP_HUM_WIND_PRES's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFnwind	Meridional (north-south) wind speed	m s-1

Description of the variable in Common Data language (CDL)

```
float32 EXFnwind(time, latitude, longitude)
   EXFnwind:  _FillValue = 9.96921e+36
   EXFnwind:  coverage_content_type = modelResult
   EXFnwind:  long_name = Meridional (north:  south) wind speed
   EXFnwind:  standard_name = northward_wind
   EXFnwind:  units = m s:  1
   EXFnwind:  coordinates = time
   EXFnwind:  valid_min = :  30.042686462402344
   EXFnwind:  valid_max = 33.95014190673828
```

Comments

Meridional (north-south) component of ocean surface wind. note: exfnwind is calculated by interpolating the model's x and y components of wind velocity (exfuwind and exfvwind) to tracer cell centers and then finding the meridional component of the interpolated vectors. ecco v4r4 is forced with wind stress (see exftaux, exftauy), not vector winds + bulk formulae. exfnwind is calculated by converting wind stress to vector wind using bulk formulae.

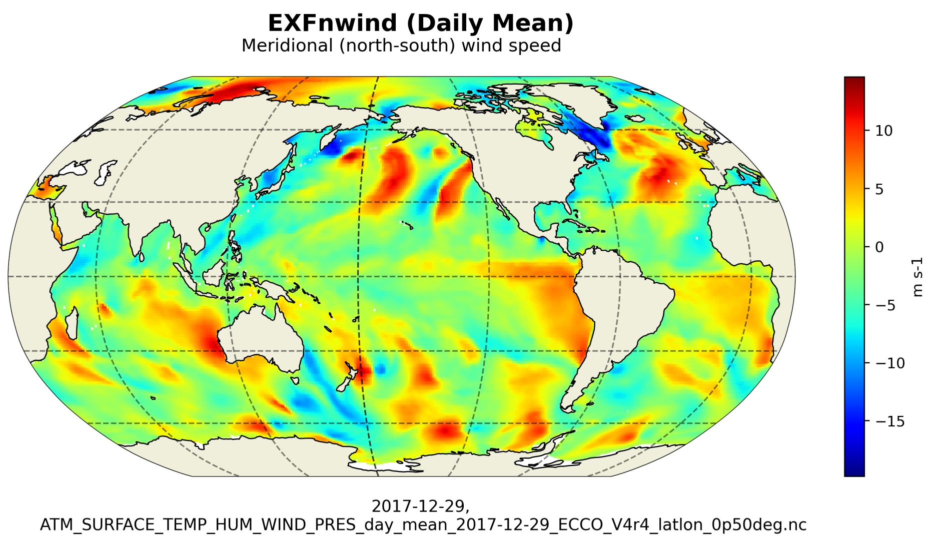

Figure 121: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFnwind

14.1.6 Latlon Variable: EXFpress

Table 14.6: Attributes description of the variable 'EXFpress' from ATM_SURFACE_TEMP_HUM_WIND_PRES's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFpress	Atmosphere surface pressure	N m-2
Description of the variable in Common Data language (CDL)			

```
float32 EXFpress(time, latitude, longitude)
   EXFpress:  _FillValue = 9.96921e+36
   EXFpress:  coverage_content_type = modelResult
   EXFpress:  long_name = Atmosphere surface pressure
   EXFpress:  standard_name = surface_air_pressure
   EXFpress:  units = N m:  2
   EXFpress:  coordinates = time
   EXFpress:  valid_min = 92090.3125
   EXFpress:  valid_max = 106314.7734375
```

Comments

Atmospheric pressure field at sea level. note: era-interim atmospheric pressure, with air tides removed using a variety of methods. not adjusted by the ocean state estimation.

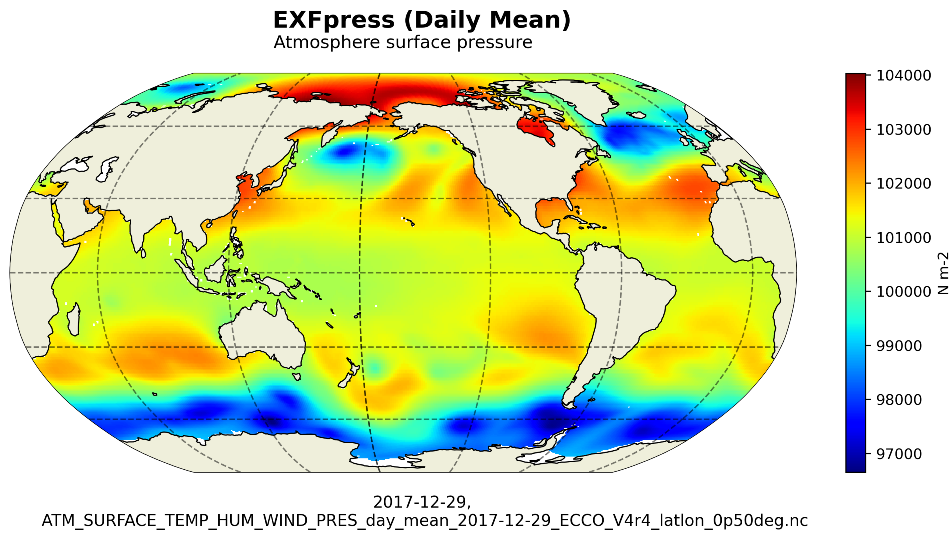

Figure 122: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFpress

14.1.7 Latlon Variable: EXFwspee

Table 14.7: Attributes description of the variable 'EXFwspee' from ATM_SURFACE_TEMP_HUM_WIND_PRES's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFwspee	Wind speed	m s-1
Description of the variable in Common Data language (CDL)			

```
float32 EXFwspee(time, latitude, longitude)
   EXFwspee:  _FillValue = 9.96921e+36
   EXFwspee:  coverage_content_type = modelResult
   EXFwspee:  long_name = Wind speed
   EXFwspee:  standard_name = wind_speed
   EXFwspee:  units = m s:  1
   EXFwspee:  coordinates = time
   EXFwspee:  valid_min = 0.27271032333374023
   EXFwspee:  valid_max = 45.87086486816406
```

Comments

10-m wind speed magnitude (>= 0) over open water. only used for the calculation of air-sea fluxes using bulk formulae. note: not adjusted by the ocean state estimation and not necesarily consistent with exfuwind and exfvwind because exfuwind and exfvwind are calculated from exftaux and exftauy using bulk formulae. exfwspee != sqrt(exfuwind**2 + exfvwind**2.

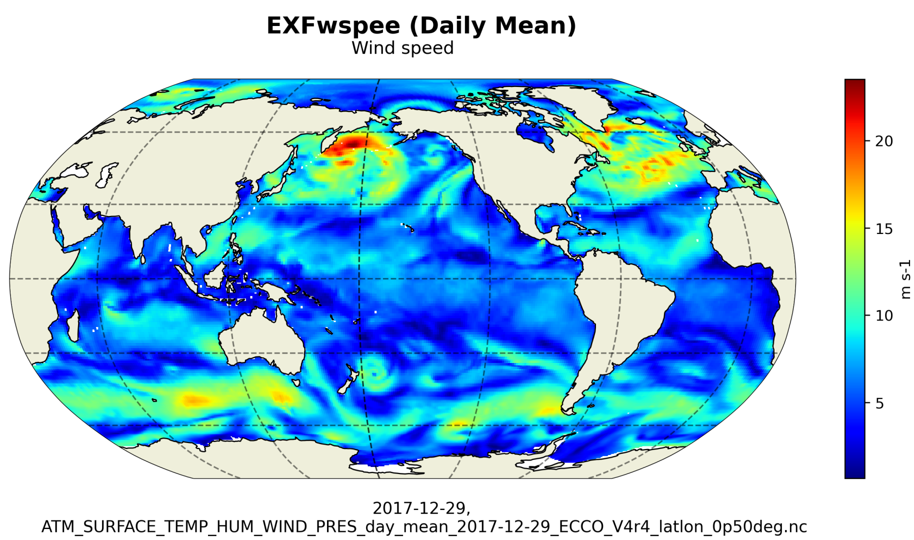

Figure 123: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFwspee

14.2 Latlon dataset of OCEAN_AND_ICE_SURFACE_FW_FLUX

14.2.1 Overview

This dataset provides 2D fields of ocean and sea-ice surface freshwater fluxes interpolated to a regular 0.5-degree grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution.

Table 14.8: Coordinates and Variables in the dataset OCEAN_AND_ICE_SURFACE_FW_FLUX

Variables	Description of data variables	Unit
EXFpreci	Precipitation rate	m s-1
EXFevap	Open ocean evaporation rate	m s-1
EXFroff	River runoff	m s-1
SIsnPrcp	Snow precipitation on sea-ice	kg m-2 s-1
EXFempmr	Open ocean net surface freshwater flux from precipitation, evaporation, and runoff	m s-1
oceFWflx	Net freshwater flux into the ocean	kg m-2 s-1
SIatmFW	Net freshwater flux into the open ocean, sea-ice, and snow	kg m-2 s-1
SFLUX	Rate of change of total ocean salinity per m2 accounting for mass fluxes.	g m-2 s-1
SIacSubl	Freshwater flux to the atmosphere due to sublimation-deposition of snow or ice	kg m-2 s-1
SIrsSubl	Residual sublimation freshwater flux	kg m-2 s-1
SIfwThru	Precipitation through sea-ice	kg m-2 s-1
Coordinates	**Description of data coordinates**	**Unit**
time	Center time of averaging period	–none–
latitude	Latitude at grid cell center	degrees_north
longitude	Longitude at grid cell center	degrees_east
time_bnds	Time bounds of averaging period	–none–
latitude_bnds	Latitude bounds grid cells	–none–
longitude_bnds	Longitude bounds grid cells	–none–

14.2.2 Latlon Variable: EXFempmr

Table 14.9: Attributes description of the variable 'EXFempmr' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFempmr	Open ocean net surface freshwater flux from precipitation, evaporation, and runoff	m s-1
Description of the variable in Common Data language (CDL)			
float32 EXFempmr(time, latitude, longitude) EXFempmr: _FillValue = 9.96921e+36 EXFempmr: coverage_content_type = modelResult EXFempmr: direction = >0 increases salinity (SALT) EXFempmr: long_name = Open ocean net surface freshwater flux from precipitation evaporation and runoff EXFempmr: units = m s: 1 EXFempmr: coordinates = time EXFempmr: valid_min = : 8.299433829961345e: 06 EXFempmr: valid_max = 5.400421514423215e: 07			
Comments			
Net surface freshwater flux from precipitation, evaporation, and runoff per unit area in open water (not covered by sea-ice). excludes freshwater fluxes involving sea-ice and snow. note: calculated as exfevap-exfpreci-exfroff.			

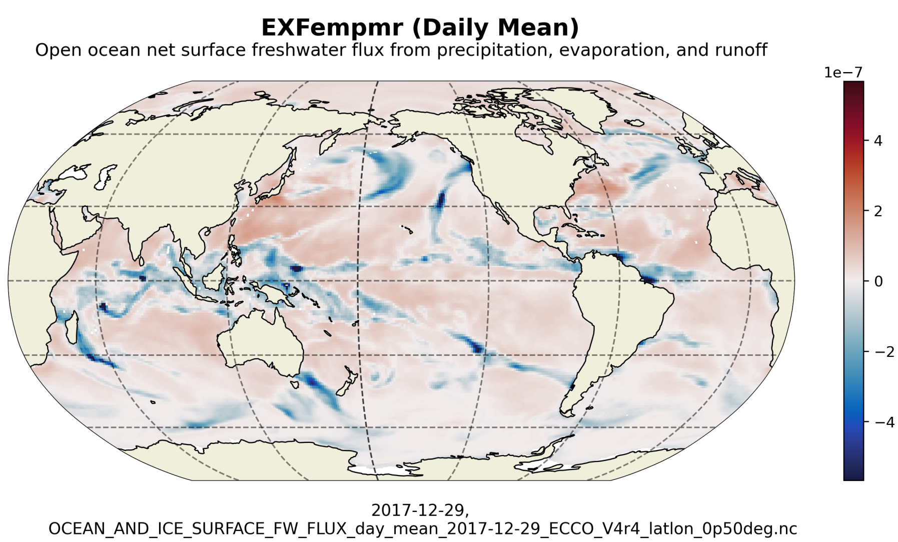

Figure 124: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFempmr

14.2.3 Latlon Variable: EXFevap

Table 14.10: Attributes description of the variable 'EXFevap' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFevap	Open ocean evaporation rate	m s-1
Description of the variable in Common Data language (CDL)			

```
float32 EXFevap(time, latitude, longitude)
   EXFevap:  _FillValue = 9.96921e+36
   EXFevap:  coverage_content_type = modelResult
   EXFevap:  direction = >0 increases salinity (SALT)
   EXFevap:  long_name = Open ocean evaporation rate
   EXFevap:  standard_name = lwe_water_evaporation_rate
   EXFevap:  units = m s:  1
   EXFevap:  coordinates = time
   EXFevap:  valid_min = :  1.0958113705328287e:  07
   EXFevap:  valid_max = 7.090054623404285e:  07
```

Comments

Evaporation rate per unit area of open water (not covered by sea-ice). note: calculated using the bulk formula following large and yeager (2004) ncar/tn-460+str.

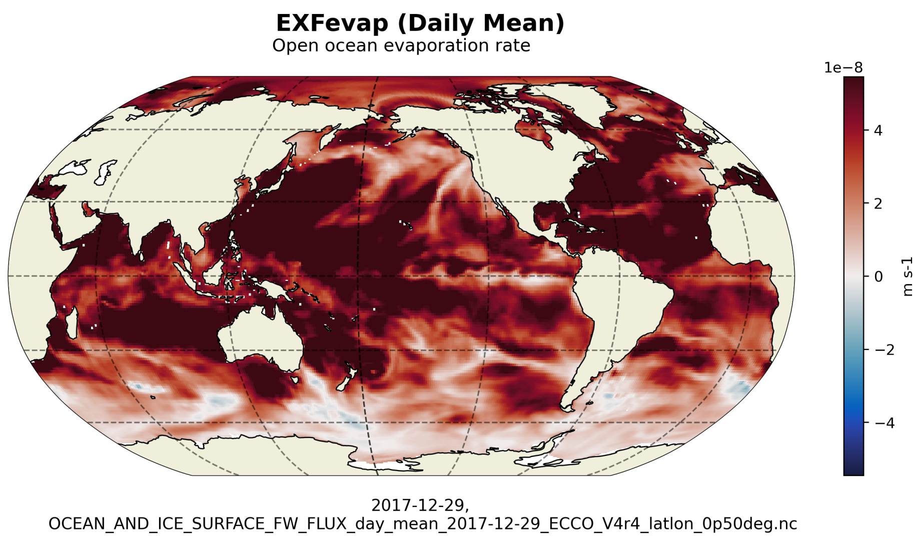

Figure 125: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFevap

14.2.4 Latlon Variable: EXFpreci

Table 14.11: Attributes description of the variable 'EXFpreci' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFpreci	Precipitation rate	m s-1
Description of the variable in Common Data language (CDL)			
float32 EXFpreci(time, latitude, longitude) EXFpreci: _FillValue = 9.96921e+36 EXFpreci: coverage_content_type = modelResult EXFpreci: direction = >0 increases salinity (SALT) EXFpreci: long_name = Precipitation rate EXFpreci: standard_name = lwe_precipitation_rate EXFpreci: units = m s: 1 EXFpreci: coordinates = time EXFpreci: valid_min = : 1.4860395936011628e: 07 EXFpreci: valid_max = 8.317776519106701e: 06			
Comments			
Precipitation rate. note: sum of era-interim precipitation and the control adjustment from ocean state estimation.			

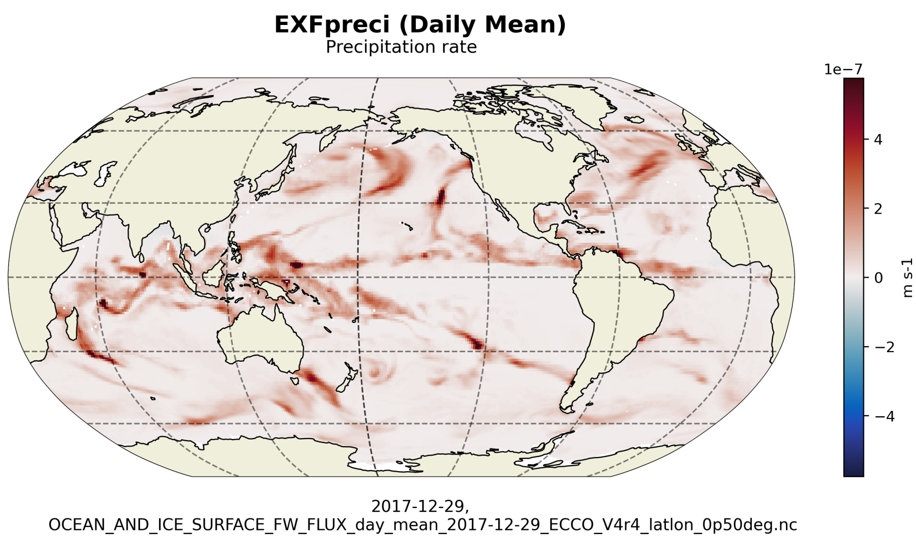

Figure 126: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFpreci

14.2.5 Latlon Variable: EXFroff

Table 14.12: Attributes description of the variable 'EXFroff' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFroff	River runoff	m s-1
Description of the variable in Common Data language (CDL)			

```
float32 EXFroff(time, latitude, longitude)
   EXFroff:  _FillValue = 9.96921e+36
   EXFroff:  coverage_content_type = modelResult
   EXFroff:  direction = >0 increases salinity (SALT)
   EXFroff:  long_name = River runoff
   EXFroff:  standard_name = surface_runoff_flux
   EXFroff:  units = m s:  1
   EXFroff:  coordinates = time
   EXFroff:  valid_min = 0.0
   EXFroff:  valid_max = 4.185612397122895e:  06
```

Comments
River runoff freshwater flux. note: not adjusted by the optimization.

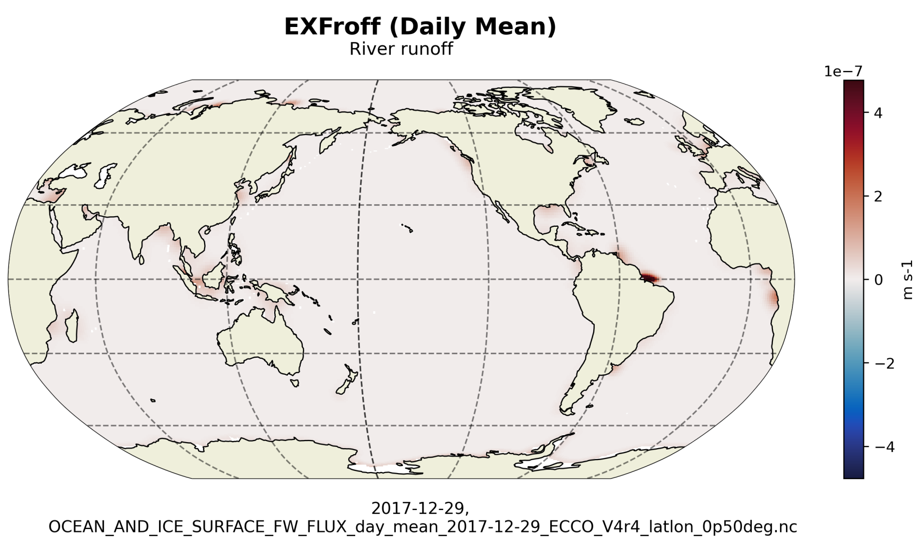

Figure 127: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFroff

14.2.6 Latlon Variable: SFLUX

Table 14.13: Attributes description of the variable 'SFLUX' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	SFLUX	Rate of change of total ocean salinity per m2 accounting for mass fluxes.	g m-2 s-1

Description of the variable in Common Data language (CDL)

```
float32 SFLUX(time, latitude, longitude)
   SFLUX: _FillValue = 9.96921e+36
   SFLUX: coverage_content_type = modelResult
   SFLUX: direction = >0 increases salinity (SALT)
   SFLUX: long_name = Rate of change of total ocean salinity per m2 accounting for
mass fluxes.
   SFLUX: units = g m:  2 s:  1
   SFLUX: coordinates = time
   SFLUX: valid_min = :  0.06244903802871704
   SFLUX: valid_max = 0.010570422746241093
```

Comments

The rate of change of total ocean salinity due to freshwater fluxes across the liquid surface and the addition or removal of mass. note: the global area integral of sflux matches the time-derivative of total ocean salinity (psu s-1). unlike ocefwflx, sflux includes the contribution to the total ocean salinity from changing ocean mass (e.g. from the addition or removal of freshwater in ocefwflx).

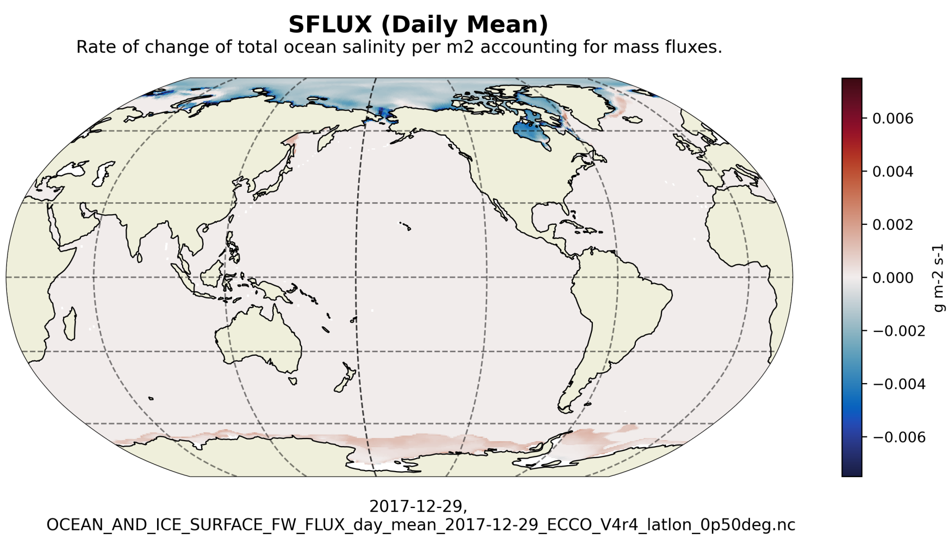

Figure 128: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SFLUX

14.2.7 Latlon Variable: SIacSubl

Table 14.14: Attributes description of the variable 'SIacSubl' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	SIacSubl	Freshwater flux to the atmosphere due to sublimation-deposition of snow or ice	kg m-2 s-1
Description of the variable in Common Data language (CDL)			
float32 SIacSubl(time, latitude, longitude) SIacSubl: _FillValue = 9.96921e+36 SIacSubl: coverage_content_type = modelResult SIacSubl: direction = >0 decreases snow or sea: ice thickness (HSNOW or HEFF) SIacSubl: long_name = Freshwater flux to the atmosphere due to sublimation: deposition of snow or ice SIacSubl: standard_name = water_sublimation_flux SIacSubl: units = kg m: 2 s: 1 SIacSubl: coordinates = time SIacSubl: valid_min = 0.0 SIacSubl: valid_max = 7.735946564935148e: 05			
Comments			
Freshwater flux to the atmosphere due to sublimation-deposition of snow or ice. positive values imply sublimation from ice/snow to vapor, negative values imply deposition from atmospheric moisture			

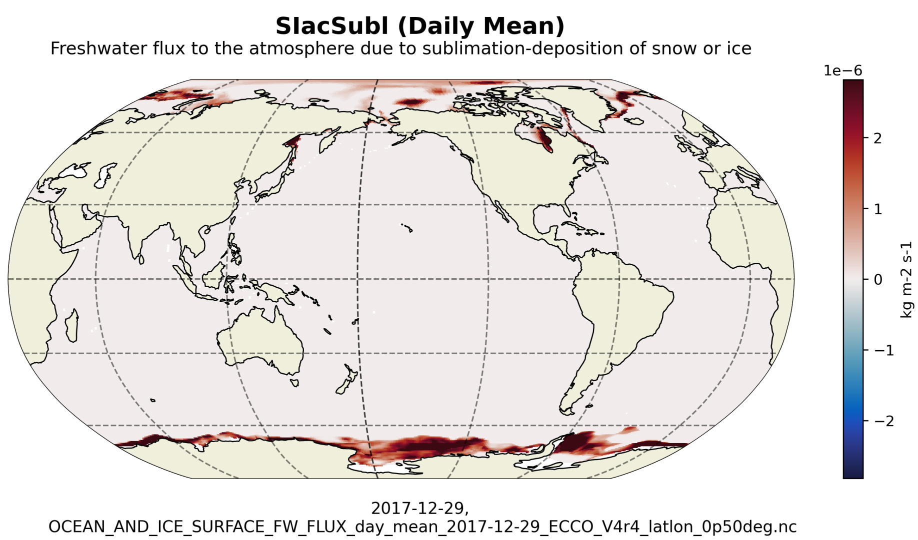

Figure 129: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SIacSubl

14.2.8 Latlon Variable: SIatmFW

Table 14.15: Attributes description of the variable 'SIatmFW' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	SIatmFW	Net freshwater flux into the open ocean, sea-ice, and snow	kg m-2 s-1

Description of the variable in Common Data language (CDL)

```
float32 SIatmFW(time, latitude, longitude)
   SIatmFW: _FillValue = 9.96921e+36
   SIatmFW: coverage_content_type = modelResult
   SIatmFW: direction = >0 decreases salinity (SALT)
   SIatmFW: long_name = Net freshwater flux into the open ocean
sea:  ice
and snow
   SIatmFW: standard_name = surface_downward_water_flux
   SIatmFW: units = kg m:  2 s:  1
   SIatmFW: coordinates = time
   SIatmFW: valid_min = :  0.00043017856660299003
   SIatmFW: valid_max = 0.008299433626234531
```

Comments

Net freshwater flux into the combined liquid ocean, sea-ice, and snow reservoirs from the atmosphere and runoff. note: freshwater fluxes between the liquid ocean and sea-ice or snow reservoirs do not contribute to siatmfw. siatmfw counts all fluxes to/from the atmosphere that change the total freshwater stored in the combined liquid ocean, sea-ice, and snow reservoirs.

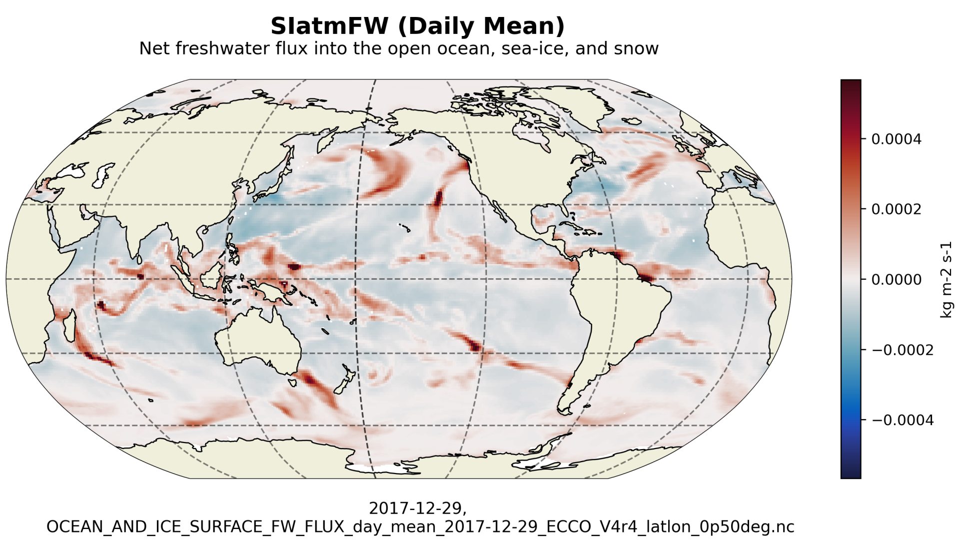

Figure 130: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SIatmFW

14.2.9 Latlon Variable: SIfwThru

Table 14.16: Attributes description of the variable 'SIfwThru' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	SIfwThru	Precipitation through sea-ice	kg m-2 s-1

Description of the variable in Common Data language (CDL)

```
float32 SIfwThru(time, latitude, longitude)
   SIfwThru:  _FillValue = 9.96921e+36
   SIfwThru:  coverage_content_type = modelResult
   SIfwThru:  direction = >0 increases ocean volume
   SIfwThru:  long_name = Precipitation through sea:  ice
   SIfwThru:  units = kg m:  2 s:  1
   SIfwThru:  coordinates = time
   SIfwThru:  valid_min = :  1.695218452368863e:  05
   SIfwThru:  valid_max = 0.0010632629273459315
```

Comments

Precipitation over sea-ice covered regions reaching ocean through sea-ice. note: precipitation over sea-ice covered regions that directly reaches ocean through the sea-ice. it is not due to melt of sea-ice/snow.

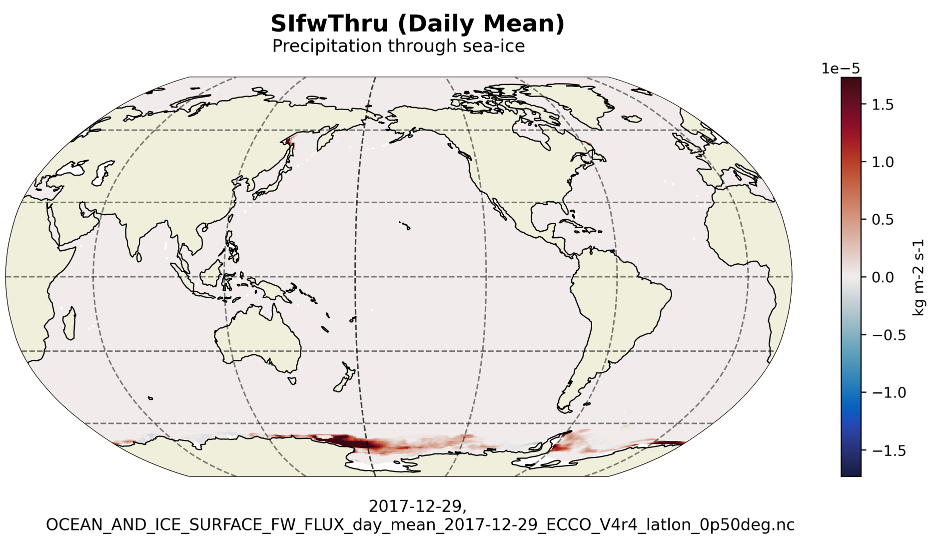

Figure 131: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SIfwThru

14.2.10 Latlon Variable: SIrsSubl

Table 14.17: Attributes description of the variable 'SIrsSubl' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	SIrsSubl	Residual sublimation freshwater flux	kg m-2 s-1
Description of the variable in Common Data language (CDL)			

```
float32 SIrsSubl(time, latitude, longitude)
   SIrsSubl:  _FillValue = 9.96921e+36
   SIrsSubl:  coverage_content_type = modelResult
   SIrsSubl:  direction = >0 decreases ocean volume
   SIrsSubl:  long_name = Residual sublimation freshwater flux
   SIrsSubl:  units = kg m:  2 s:  1
   SIrsSubl:  coordinates = time
   SIrsSubl:  valid_min = :  0.0001067528864950873
   SIrsSubl:  valid_max = 8.640533451398369e:  06
```

Comments

Residual freshwater flux by sublimation to remove water from or add water to ocean. when implied sublimation freshwater flux siacsubl is larger than availabe sea-ice/snow, sirssubl is positive and water is removed from ocean. note: freshwater flux by sublimation that is to remove water from the ocean when it is positive.

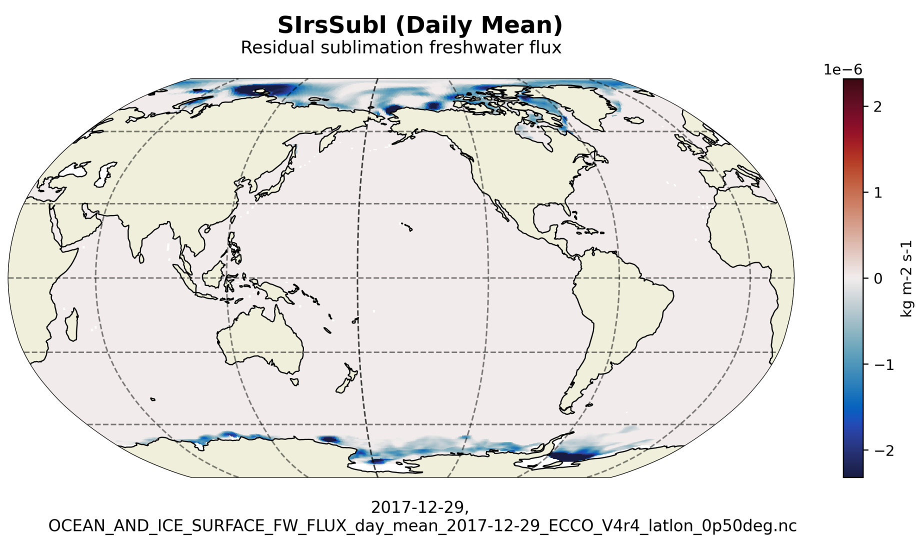

Figure 132: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SIrsSubl

14.2.11 Latlon Variable: SIsnPrcp

Table 14.18: Attributes description of the variable 'SIsnPrcp' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	SIsnPrcp	Snow precipitation on sea-ice	kg m-2 s-1
Description of the variable in Common Data language (CDL)			

```
float32 SIsnPrcp(time, latitude, longitude)
   SIsnPrcp:  _FillValue = 9.96921e+36
   SIsnPrcp:  coverage_content_type = modelResult
   SIsnPrcp:  direction = >0 increases snow thickness (HSNOW)
   SIsnPrcp:  long_name = Snow precipitation on sea:  ice
   SIsnPrcp:  standard_name = snowfall_flux
   SIsnPrcp:  units = kg m:  2 s:  1
   SIsnPrcp:  coordinates = time
   SIsnPrcp:  valid_min = :  4.334669574745931e:  05
   SIsnPrcp:  valid_max = 0.0009354020585305989
```

Comments
Snow precipitation rate over sea-ice, averaged over the entire model grid cell.

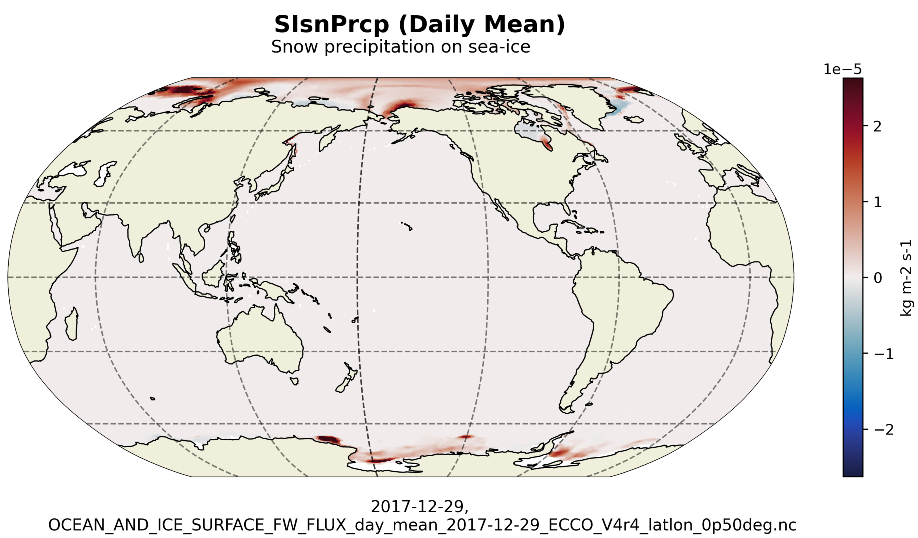

Figure 133: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SIsnPrcp

14.2.12 Latlon Variable: oceFWflx

Table 14.19: Attributes description of the variable 'oceFWflx' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	oceFWflx	Net freshwater flux into the ocean	kg m-2 s-1
Description of the variable in Common Data language (CDL)			

```
float32 oceFWflx(time, latitude, longitude)
   oceFWflx:  _FillValue = 9.96921e+36
   oceFWflx:  coverage_content_type = modelResult
   oceFWflx:  direction = >0 decreases salinity (SALT)
   oceFWflx:  long_name = Net freshwater flux into the ocean
   oceFWflx:  standard_name = water_flux_into_sea_water
   oceFWflx:  units = kg m:  2 s:  1
   oceFWflx:  coordinates = time
   oceFWflx:  valid_min = :  0.0033125500194728374
   oceFWflx:  valid_max = 0.008299433626234531
```

Comments
Net freshwater flux into the ocean including contributions from runoff, evaporation, precipitation, and mass exchange with sea-ice due to melting and freezing and snow melting. note: ocefwflx does not include freshwater fluxes between the atmosphere and sea-ice and snow. the variable 'siatmfw' accounts for freshwater fluxes out of the combined ocean+sea-ice+snow reservoir.

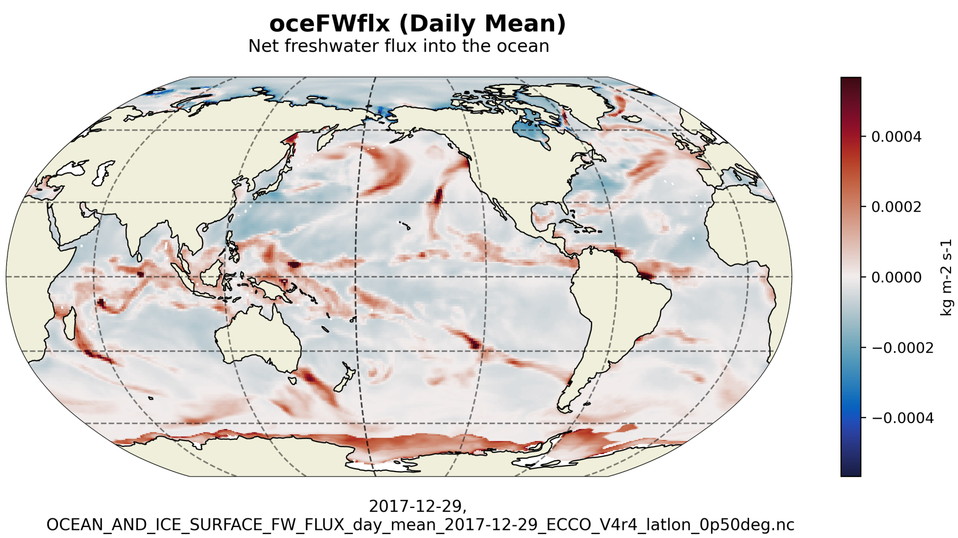

Figure 134: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: oceFWflx

14.3 Latlon dataset of OCEAN_AND_ICE_SURFACE_HEAT_FLUX

14.3.1 Overview

This dataset provides 2D fields of ocean and sea-ice surface heat fluxes interpolated to a regular 0.5-degree grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution.

Table 14.20: Coordinates and Variables in the dataset OCEAN_AND_ICE_SURFACE_HEAT_FLUX

Variables	Description of data variables	Unit
EXFhl	Open ocean air-sea latent heat flux	W m-2
EXFhs	Open ocean air-sea sensible heat flux	W m-2
EXFlwdn	Downward longwave radiative flux	W m-2
EXFswdn	Downwelling shortwave radiative flux	W m-2
EXFqnet	Open ocean net air-sea heat flux	W m-2
oceQnet	Net heat flux into the ocean surface	W m-2
SIatmQnt	Net upward heat flux to the atmosphere	W m-2
TFLUX	Rate of change of ocean heat content per m2 accounting for mass fluxes.	W m-2
EXFswnet	Open ocean net shortwave radiative flux	W m-2
EXFlwnet	Net open ocean longwave radiative flux	W m-2
oceQsw	Net shortwave radiative flux across the ocean surface	W m-2
SIaaflux	Conservative ocean and sea-ice advective heat flux adjustment	W m-2
Coordinates	**Description of data coordinates**	**Unit**
time	Center time of averaging period	–none–
latitude	Latitude at grid cell center	degrees_north
longitude	Longitude at grid cell center	degrees_east
time_bnds	Time bounds of averaging period	–none–
latitude_bnds	Latitude bounds grid cells	–none–
longitude_bnds	Longitude bounds grid cells	–none–

14.3.2 Latlon Variable: EXFhl

Table 14.21: Attributes description of the variable 'EXFhl' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFhl	Open ocean air-sea latent heat flux	W m-2

Description of the variable in Common Data language (CDL)

```
float32 EXFhl(time, latitude, longitude)
   EXFhl:  _FillValue = 9.96921e+36
   EXFhl:  coverage_content_type = modelResult
   EXFhl:  direction = >0 increases potential temperature (THETA)
   EXFhl:  long_name = Open ocean air:  sea latent heat flux
   EXFhl:  standard_name = surface_downward_latent_heat_flux
   EXFhl:  units = W m:  2
   EXFhl:  coordinates = time
   EXFhl:  valid_min = :  1772.513671875
   EXFhl:  valid_max = 273.9528503417969
```

Comments

Air-sea latent heat flux per unit area of open water (not covered by sea-ice). note: calculated from the bulk formula following large and yeager (2004) ncar/tn-460+str.

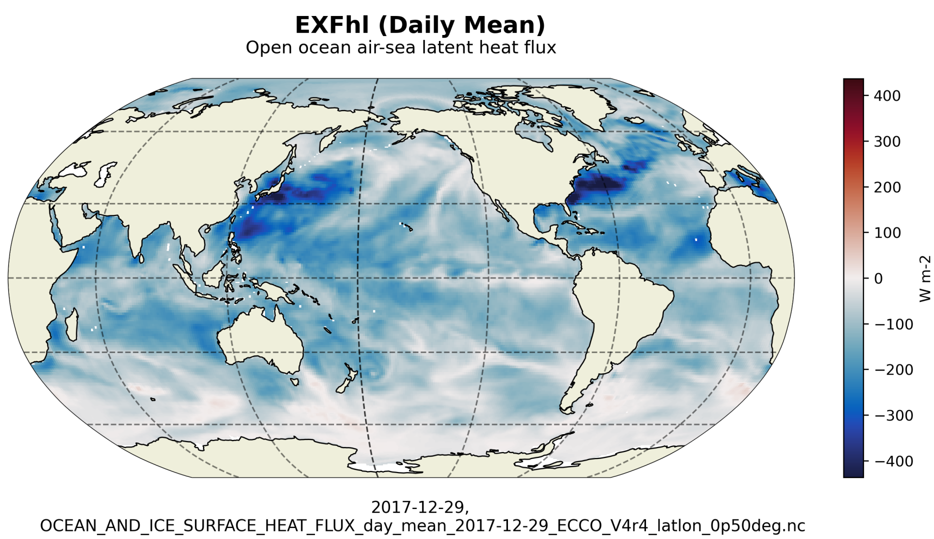

Figure 135: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFhl

14.3.3 Latlon Variable: EXFhs

Table 14.22: Attributes description of the variable 'EXFhs' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFhs	Open ocean air-sea sensible heat flux	W m-2
Description of the variable in Common Data language (CDL)			

```
float32 EXFhs(time, latitude, longitude)
   EXFhs:  _FillValue = 9.96921e+36
   EXFhs:  coverage_content_type = modelResult
   EXFhs:  direction = >0 increases potential temperature (THETA)
   EXFhs:  long_name = Open ocean air:  sea sensible heat flux
   EXFhs:  standard_name = surface_downward_sensible_heat_flux
   EXFhs:  units = W m:  2
   EXFhs:  coordinates = time
   EXFhs:  valid_min = :  2478.766357421875
   EXFhs:  valid_max = 357.0105895996094
```

Comments

Air-sea sensible heat flux per unit area of open water (not covered by sea-ice). note: calculated from the bulk formula following large and yeager (2004) ncar/tn-460+str.

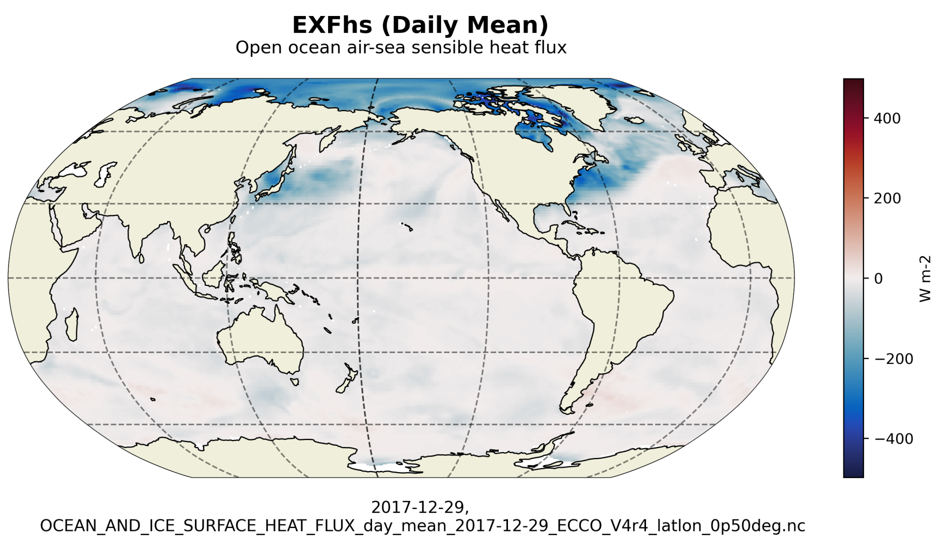

Figure 136: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFhs

14.3.4 Latlon Variable: EXFlwdn

Table 14.23: Attributes description of the variable 'EXFlwdn' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFlwdn	Downward longwave radiative flux	W m-2
Description of the variable in Common Data language (CDL)			

```
float32 EXFlwdn(time, latitude, longitude)
   EXFlwdn:  _FillValue = 9.96921e+36
   EXFlwdn:  coverage_content_type = modelResult
   EXFlwdn:  direction = >0 increases potential temperature (THETA)
   EXFlwdn:  long_name = Downward longwave radiative flux
   EXFlwdn:  standard_name = surface_downwelling_longwave_flux_in_air
   EXFlwdn:  units = W m:  2
   EXFlwdn:  coordinates = time
   EXFlwdn:  valid_min = 4.188045501708984
   EXFlwdn:  valid_max = 513.3919067382812
```

Comments

Downward longwave radiative flux. note: sum of era-interim downward longwave radiation and the control adjustment from ocean state estimation.

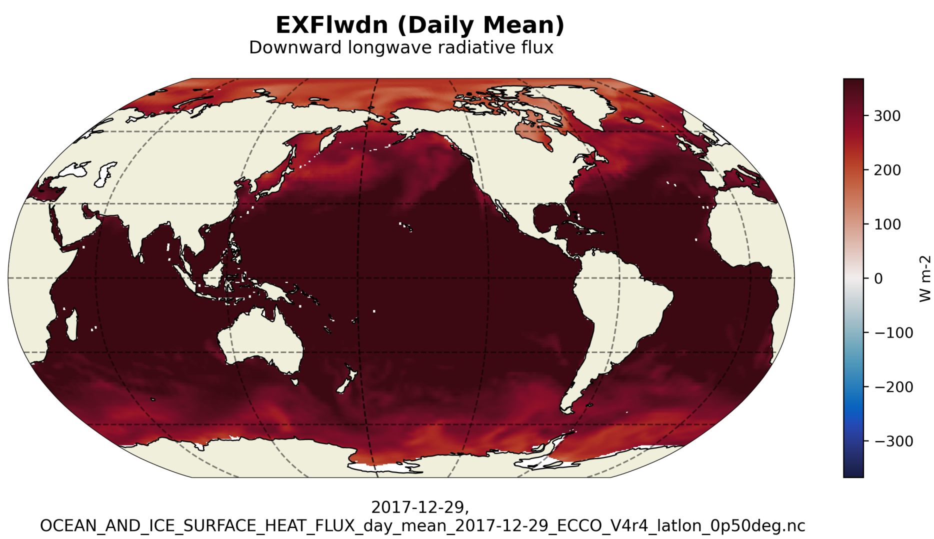

Figure 137: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFlwdn

14.3.5 Latlon Variable: EXFlwnet

Table 14.24: Attributes description of the variable 'EXFlwnet' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFlwnet	Net open ocean longwave radiative flux	W m-2

Description of the variable in Common Data language (CDL)

```
float32 EXFlwnet(time, latitude, longitude)
   EXFlwnet:  _FillValue = 9.96921e+36
   EXFlwnet:  coverage_content_type = modelResult
   EXFlwnet:  direction = >0 increases potential temperature (THETA)
   EXFlwnet:  long_name = Net open ocean longwave radiative flux
   EXFlwnet:  standard_name = surface_net_downward_longwave_flux
   EXFlwnet:  units = W m:  2
   EXFlwnet:  coordinates = time
   EXFlwnet:  valid_min = :  144.3661346435547
   EXFlwnet:  valid_max = 293.4114990234375
```

Comments

Net longwave radiative flux per unit area of open water (not covered by sea-ice). note: net longwave radiation over open water calculated from downward longwave radiation (exflwdn) and upward longwave radiation from ocean and sea-ice thermal emission (stefan-boltzman law).

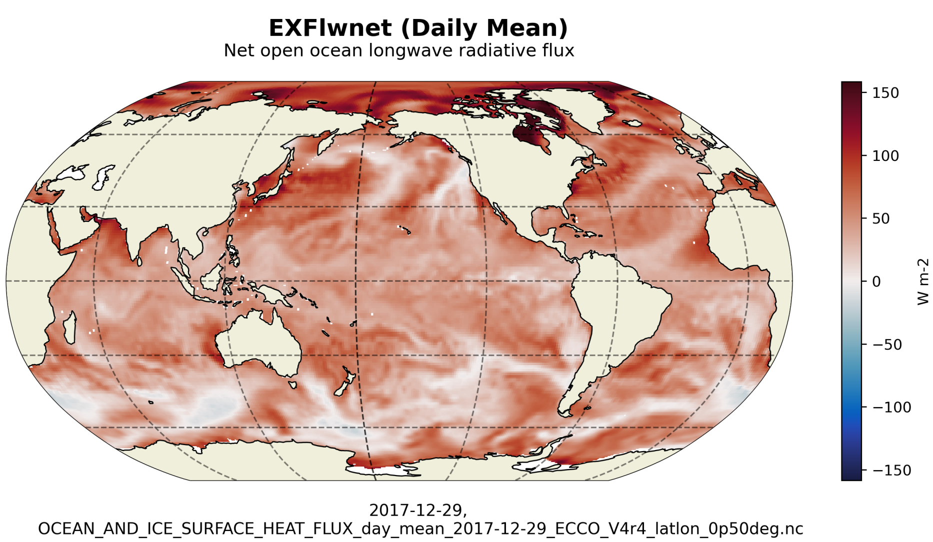

Figure 138: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFlwnet

14.3.6 Latlon Variable: EXFqnet

Table 14.25: Attributes description of the variable 'EXFqnet' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFqnet	Open ocean net air-sea heat flux	W m-2
Description of the variable in Common Data language (CDL)			
float32 EXFqnet(time, latitude, longitude) EXFqnet: _FillValue = 9.96921e+36 EXFqnet: coverage_content_type = modelResult EXFqnet: direction = >0 increases potential temperature (THETA) EXFqnet: long_name = Open ocean net air: sea heat flux EXFqnet: units = W m: 2 EXFqnet: coordinates = time EXFqnet: valid_min = : 687.8736572265625 EXFqnet: valid_max = 3408.977783203125			
Comments			
Net air-sea heat flux (turbulent and radiative) per unit area of open water (not covered by sea-ice). note: net upward heat flux over open water, calculated as exflwnet+exfswnet-exflh-exfhs.			

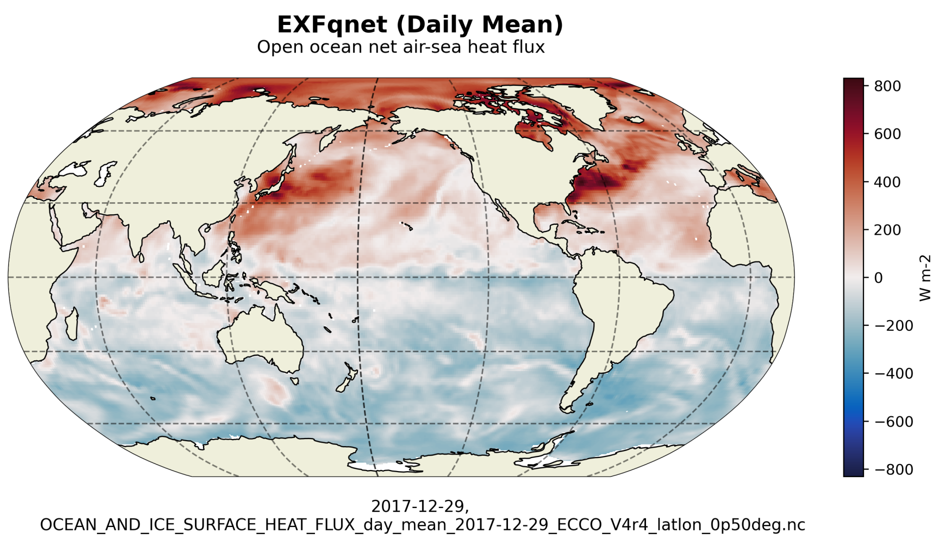

Figure 139: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFqnet

14.3.7 Latlon Variable: EXFswdn

Table 14.26: Attributes description of the variable 'EXFswdn' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFswdn	Downwelling shortwave radiative flux	W m-2

Description of the variable in Common Data language (CDL)

```
float32 EXFswdn(time, latitude, longitude)
   EXFswdn:  _FillValue = 9.96921e+36
   EXFswdn:  coverage_content_type = modelResult
   EXFswdn:  direction = >0 increases potential temperature (THETA)
   EXFswdn:  long_name = Downwelling shortwave radiative flux
   EXFswdn:  standard_name = surface_downwelling_shortwave_flux_in_air
   EXFswdn:  units = W m:  2
   EXFswdn:  coordinates = time
   EXFswdn:  valid_min = :  224.63368225097656
   EXFswdn:  valid_max = 707.345947265625
```

Comments

Downward shortwave radiative flux. note: sum of era-interim downward shortwave radiation and the control adjustment from ocean state estimation.

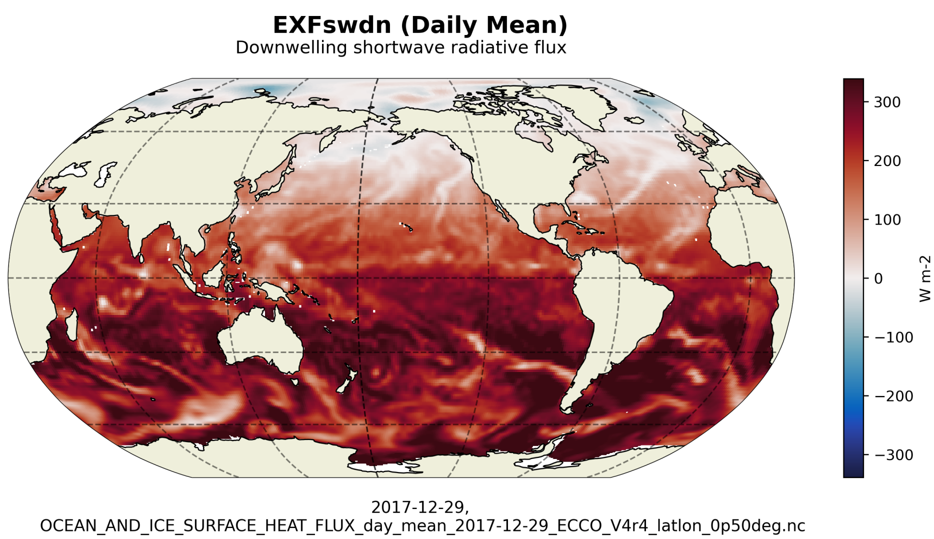

Figure 140: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFswdn

14.3.8 Latlon Variable: EXFswnet

Table 14.27: Attributes description of the variable 'EXFswnet' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFswnet	Open ocean net shortwave radiative flux	W m-2

Description of the variable in Common Data language (CDL)

```
float32 EXFswnet(time, latitude, longitude)
   EXFswnet:  _FillValue = 9.96921e+36
   EXFswnet:  coverage_content_type = modelResult
   EXFswnet:  direction = >0 increases potential temperature (THETA)
   EXFswnet:  long_name = Open ocean net shortwave radiative flux
   EXFswnet:  standard_name = surface_net_downward_shortwave_flux
   EXFswnet:  units = W m:  2
   EXFswnet:  coordinates = time
   EXFswnet:  valid_min = :  655.6171264648438
   EXFswnet:  valid_max = 193.89297485351562
```

Comments

Net shortwave radiative flux per unit area of open water (not covered by sea-ice). note: net shortwave radiation over open water calculated from downward shortwave flux (exfswdn) and ocean surface albdeo.

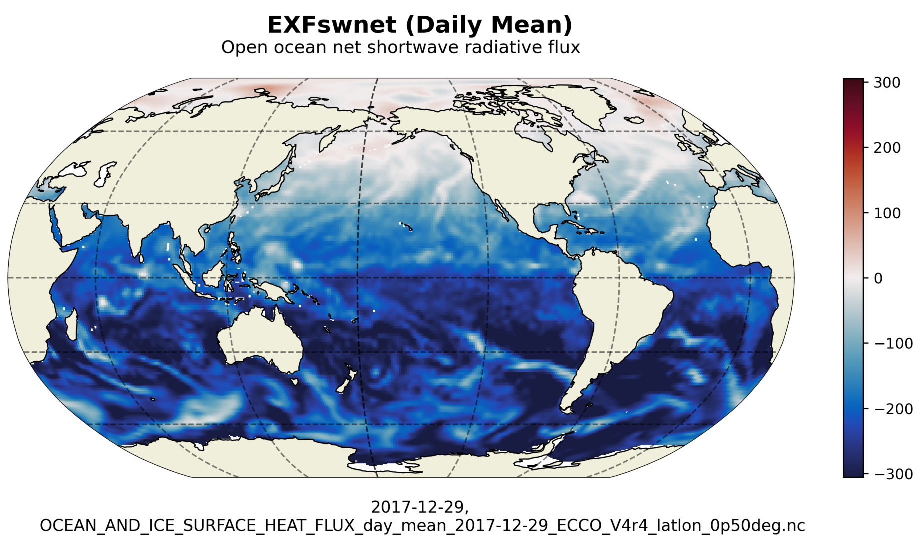

Figure 141: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFswnet

14.3.9 Latlon Variable: SIaaflux

Table 14.28: Attributes description of the variable 'SIaaflux' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	SIaaflux	Conservative ocean and sea-ice advective heat flux adjustment	W m-2
Description of the variable in Common Data language (CDL)			
float32 SIaaflux(time, latitude, longitude) SIaaflux: _FillValue = 9.96921e+36 SIaaflux: coverage_content_type = modelResult SIaaflux: direction = >0 decrease potential temperature (THETA) SIaaflux: long_name = Conservative ocean and sea: ice advective heat flux adjustment SIaaflux: units = W m: 2 SIaaflux: coordinates = time SIaaflux: valid_min = : 16.214622497558594 SIaaflux: valid_max = 50.35451889038086			
Comments			
Heat flux associated with the temperature difference between sea surface temperature and sea-ice (assume 0 degree c in the model). note: heat flux needed to melt/freeze sea-ice at 0 degc to sea water at the ocean surface (at sea surface temperature), excluding the latent heat of fusion.			

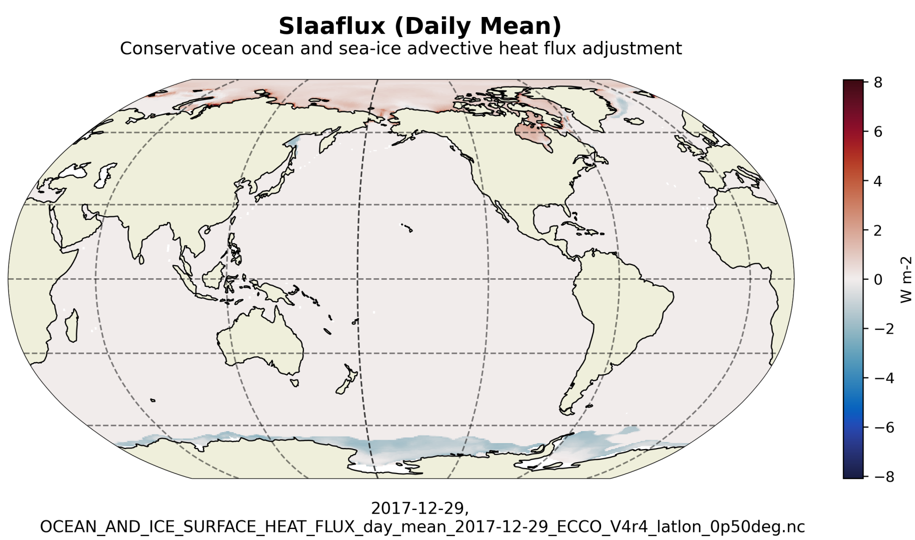

Figure 142: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: SIaaflux

14.3.10 Latlon Variable: SIatmQnt

Table 14.29: Attributes description of the variable 'SIatmQnt' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	SIatmQnt	Net upward heat flux to the atmosphere	W m-2

Description of the variable in Common Data language (CDL)

```
float32 SIatmQnt(time, latitude, longitude)
   SIatmQnt:  _FillValue = 9.96921e+36
   SIatmQnt:  coverage_content_type = modelResult
   SIatmQnt:  direction = >0 upward
decreases ocean temperature
   SIatmQnt:  long_name = Net upward heat flux to the atmosphere
   SIatmQnt:  standard_name = surface_upward_heat_flux_in_air
   SIatmQnt:  units = W m:  2
   SIatmQnt:  coordinates = time
   SIatmQnt:  valid_min = :  756.0607299804688
   SIatmQnt:  valid_max = 1704.7703857421875
```

Comments

Net upward heat flux to the atmosphere across open water and sea-ice or snow surfaces. note: nonzero siatmqnt may not be associated with a change in ocean potential temperature due to sea-ice growth or melting. to calculate total ocean heat content changes use the variable tflux which also accounts for changing ocean mass (e.g. ocefwflx).

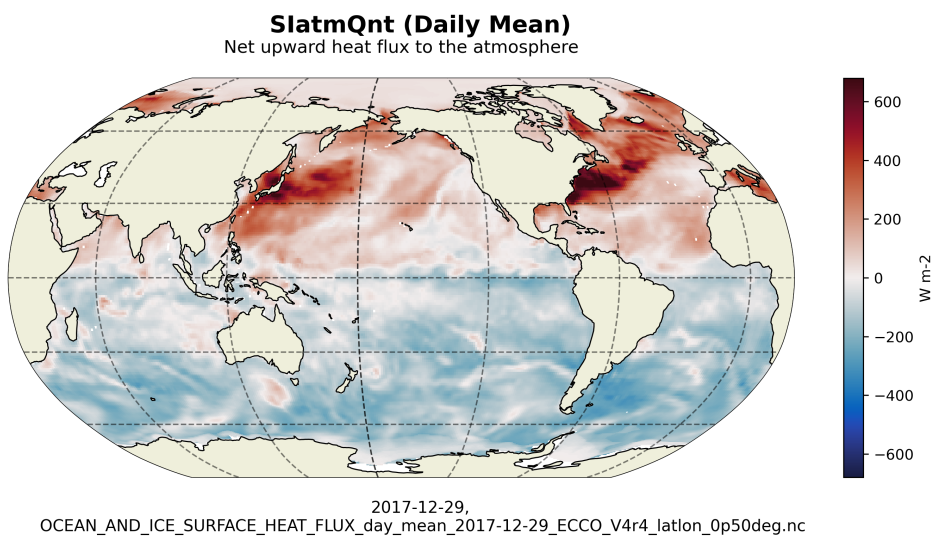

Figure 143: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: SIatmQnt

14.3.11 Latlon Variable: TFLUX

Table 14.30: Attributes description of the variable 'TFLUX' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.

<table>
<tr><th>Storage Type</th><th>Variable Name</th><th>Description</th><th>Unit</th></tr>
<tr><td>float32</td><td>TFLUX</td><td>Rate of change of ocean heat content per m2 accounting for mass fluxes.</td><td>W m-2</td></tr>
<tr><th colspan="4">Description of the variable in Common Data language (CDL)</th></tr>
<tr><td colspan="4"><pre>float32 TFLUX(time, latitude, longitude)
   TFLUX: _FillValue = 9.96921e+36
   TFLUX: coverage_content_type = modelResult
   TFLUX: direction = >0 increases potential temperature (THETA)
   TFLUX: long_name = Rate of change of ocean heat content per m2 accounting for
mass fluxes.
   TFLUX: units = W m: 2
   TFLUX: coordinates = time
   TFLUX: valid_min = : 1713.51220703125
   TFLUX: valid_max = 870.3130493164062</pre></td></tr>
<tr><th colspan="4">Comments</th></tr>
<tr><td colspan="4">The rate of change of ocean heat content due to heat fluxes across the liquid surface and the addition or removal of mass. . note: the global area integral of tflux and geothermal flux (geothermalflux.bin) matches the time-derivative of ocean heat content (j/s). unlike oceqnet, tflux includes the contribution to the ocean heat content from changing ocean mass (e.g. from ocefwflx).</td></tr>
</table>

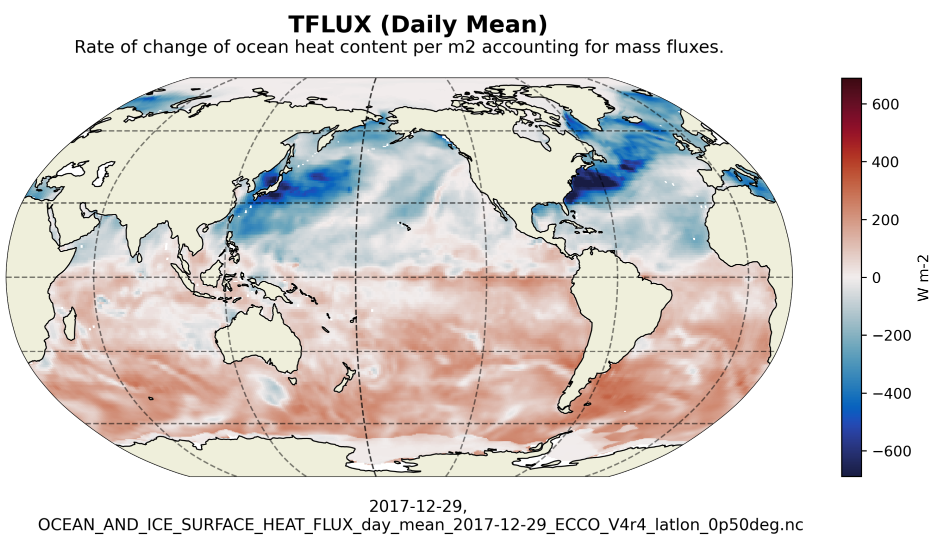

Figure 144: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: TFLUX

14.3.12 Latlon Variable: oceQnet

Table 14.31: Attributes description of the variable 'oceQnet' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	oceQnet	Net heat flux into the ocean surface	W m-2

Description of the variable in Common Data language (CDL)

```
float32 oceQnet(time, latitude, longitude)
   oceQnet:  _FillValue = 9.96921e+36
   oceQnet:  coverage_content_type = modelResult
   oceQnet:  direction = >0 increases potential temperature (THETA)
   oceQnet:  long_name = Net heat flux into the ocean surface
   oceQnet:  standard_name = surface_downward_heat_flux_in_sea_water
   oceQnet:  units = W m:  2
   oceQnet:  coordinates = time
   oceQnet:  valid_min = :  1708.8460693359375
   oceQnet:  valid_max = 675.3716430664062
```

Comments

Net heat flux into the ocean surface from all processes: air-sea turbulent and radiative fluxes and turbulent and conductive fluxes between the ocean and sea-ice and snow. note: oceqnet does not include the change in ocean heat content due to changing ocean ocean mass (ocefwflx). mass fluxes from evaporation, precipitation, and runoff (exfempmr) happen at the same temperature as the ocean surface temperature. consequently, empmr does not change ocean surface temperature. conversely, mass fluxes due to sea-ice thickening/thinning and snow melt in the model are assumed to happen at a fixed 0c. consequently, mass fluxes due to phase changes between seawater and sea-ice and snow induce a heat flux when the ocean surface temperaure is not 0c. the variable tflux does include the change in ocean heat content due to changing ocean mass.

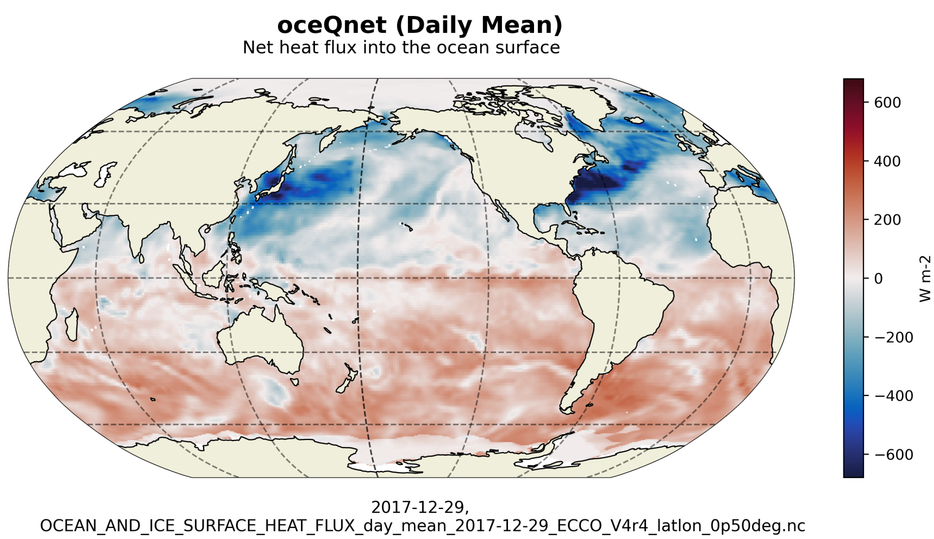

Figure 145: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: oceQnet

14.3.13 Latlon Variable: oceQsw

Table 14.32: Attributes description of the variable 'oceQsw' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	oceQsw	Net shortwave radiative flux across the ocean surface	W m-2

Description of the variable in Common Data language (CDL)

```
float32 oceQsw(time, latitude, longitude)
   oceQsw:  _FillValue = 9.96921e+36
   oceQsw:  coverage_content_type = modelResult
   oceQsw:  direction = >0 increases potential temperature (THETA)
   oceQsw:  long_name = Net shortwave radiative flux across the ocean surface
   oceQsw:  units = W m:  2
   oceQsw:  coordinates = time
   oceQsw:  valid_min = :  134.39808654785156
   oceQsw:  valid_max = 655.6171264648438
```

Comments

Net shortwave radiative flux across the ocean surface. note: shortwave radiation penetrates below the surface grid cell.

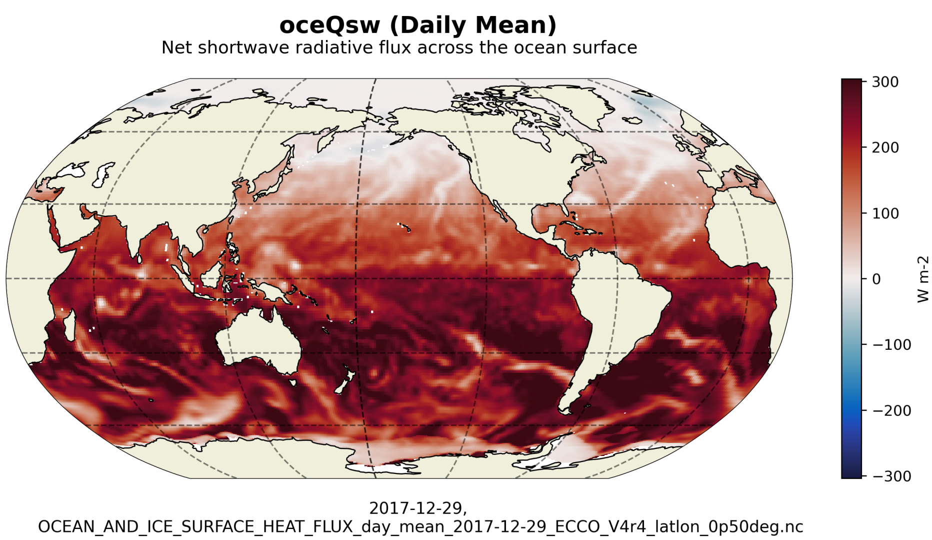

Figure 146: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: oceQsw

14.4 Latlon dataset of OCEAN_AND_ICE_SURFACE_STRESS

14.4.1 Overview

This dataset provides 2D fields of ocean and sea-ice surface stress interpolated to a regular 0.5-degree grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution.

Table 14.33: Coordinates and Variables in the dataset OCEAN_AND_ICE_SURFACE_STRESS

Variables	Description of data variables	Unit
EXFtaue	Zonal (east-west) wind stress	N m-2
EXFtaun	Meridional (north-south) wind stress	N m-2
oceTAUE	Zonal (east-west) ocean surface stress	N m-2
oceTAUN	Meridional (north-south) ocean surface stress	N m-2
Coordinates	**Description of data coordinates**	**Unit**
time	Center time of averaging period	–none–
latitude	Latitude at grid cell center	degrees_north
longitude	Longitude at grid cell center	degrees_east
time_bnds	Time bounds of averaging period	–none–
latitude_bnds	Latitude bounds grid cells	–none–
longitude_bnds	Longitude bounds grid cells	–none–

14.4.2 Latlon Variable: EXFtaue

Table 14.34: Attributes description of the variable 'EXFtaue' from OCEAN_AND_ICE_SURFACE_STRESS's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFtaue	Zonal (east-west) wind stress	N m-2

Description of the variable in Common Data language (CDL)

```
float32 EXFtaue(time, latitude, longitude)
   EXFtaue:  _FillValue = 9.96921e+36
   EXFtaue:  coverage_content_type = modelResult
   EXFtaue:  direction = >0 increases eastward velocity (EVEL)
   EXFtaue:  long_name = Zonal (east:  west) wind stress
   EXFtaue:  standard_name = surface_downward_eastward_stress
   EXFtaue:  units = N m:  2
   EXFtaue:  coordinates = time
   EXFtaue:  valid_min = :  3.1686902046203613
   EXFtaue:  valid_max = 3.284827709197998
```

Comments

Zonal (east-west) component of wind stress. note: exftaue is the zonal wind stress applied to the ocean and sea-ice. when sea-ice is present, the total zonal stress applied to the ocean surface is not exftaue, but a combination of the wind stress in the open water fraction (exftaue) and a stress from sea-ice in the ice-covered fraction (see oc-etaue). exftaue is calculated by interpolating the model's x and y components of wind stress (exftaux and exftauy) to tracer cell centers and then finding the zonal component of the interpolated vectors. it is not recommended to use exftaue and exftaun for momentum budget calculations because interpolating exftaux and exftauy from the model grid to the lat-lon grid introduces errors. for momentum fluxes to the ocean surface see ocetaux and ocetauy.

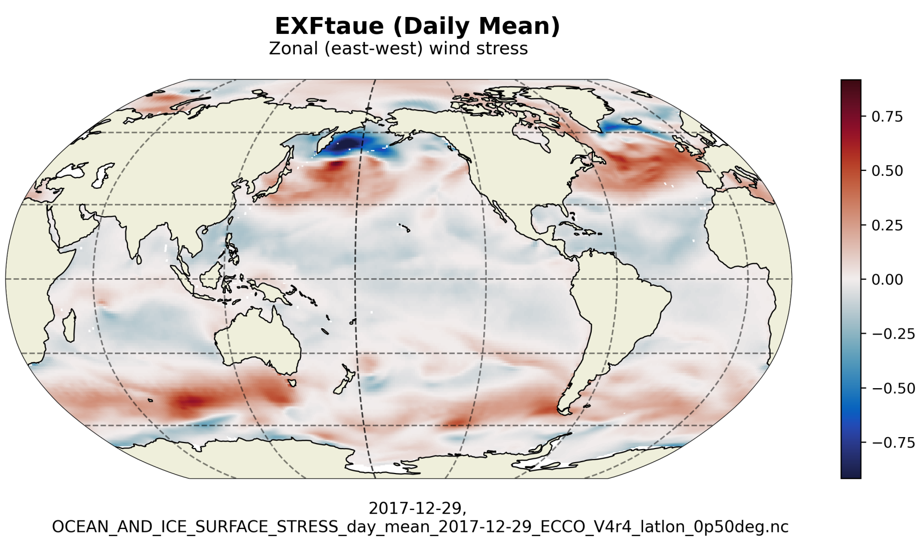

Figure 147: Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: EXFtaue

14.4.3 Latlon Variable: EXFtaun

Table 14.35: Attributes description of the variable 'EXFtaun' from OCEAN_AND_ICE_SURFACE_STRESS's dataset.

Storage Type	Variable Name	Description	Unit
float32	EXFtaun	Meridional (north-south) wind stress	N m-2

Description of the variable in Common Data language (CDL)

```
float32 EXFtaun(time, latitude, longitude)
   EXFtaun:  _FillValue = 9.96921e+36
   EXFtaun:  coverage_content_type = modelResult
   EXFtaun:  direction = >0 increases northward velocity (NVEL)
   EXFtaun:  long_name = Meridional (north:  south) wind stress
   EXFtaun:  standard_name = surface_downward_northward_stress
   EXFtaun:  units = N m:  2
   EXFtaun:  coordinates = time
   EXFtaun:  valid_min = :  4.111213207244873
   EXFtaun:  valid_max = 6.878159523010254
```

Comments

Meridional (north-south) component of wind stress. note: exftaun is the stress applied to the ocean and sea-ice. when sea-ice is present, the total meridional stress applied to the ocean surface is not exftaun, but a combination of the wind stress in the open water fraction (exftaun) and a stress from sea-ice in the ice-covered fraction (see ocetaun). exftaun is calculated by interpolating the model's x and y components of wind stress (exftaux and exftauy) to tracer cell centers and then determining the meridional component of the interpolated vectors. it is not recommended to use exftaue and exftaun for momentum budget calculations because interpolating exftaux and exftauy from the model grid to the lat-lon grid introduces errors. for momentum fluxes to the ocean surface see ocetaux and ocetauy.

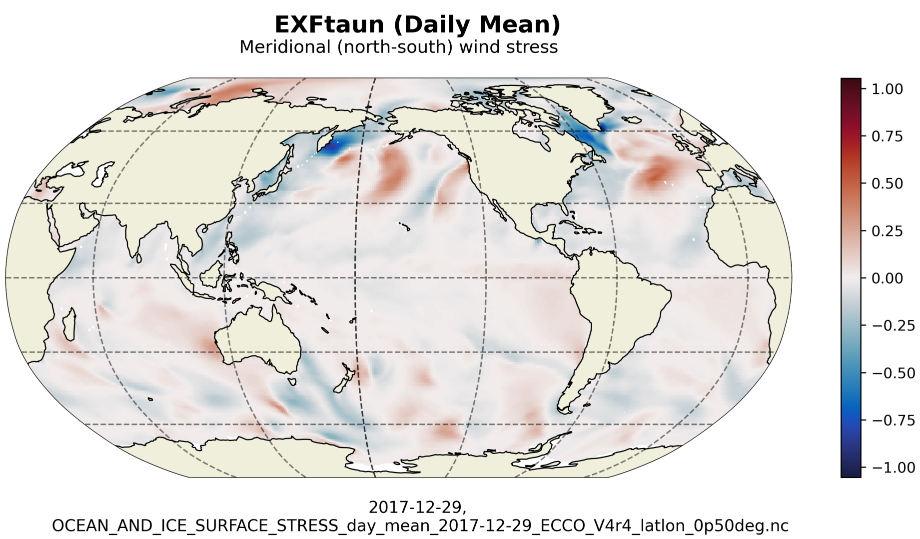

Figure 148: Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: EXFtaun

14.4.4 Latlon Variable: oceTAUE

Table 14.36: Attributes description of the variable 'oceTAUE' from OCEAN_AND_ICE_SURFACE_STRESS's dataset.

Storage Type	Variable Name	Description	Unit
float32	oceTAUE	Zonal (east-west) ocean surface stress	N m-2
Description of the variable in Common Data language (CDL)			
float32 oceTAUE(time, latitude, longitude) oceTAUE: _FillValue = 9.96921e+36 oceTAUE: coverage_content_type = modelResult oceTAUE: direction = >0 increases eastward velocity (EVEL) oceTAUE: long_name = Zonal (east: west) ocean surface stress oceTAUE: standard_name = surface_downward_eastward_stress oceTAUE: units = N m: 2 oceTAUE: coordinates = time oceTAUE: valid_min = : 2.058817148208618 oceTAUE: valid_max = 2.000103712081909			
Comments			
Zonal (east-west) component of ocean surface stress due to wind and sea-ice. note: ocetaue is calculated by interpolating the model's x and y components of ocean surface stress (ocetaux and ocetauy) to tracer cell centers and then finding the zonal component of the interpolated vectors.			

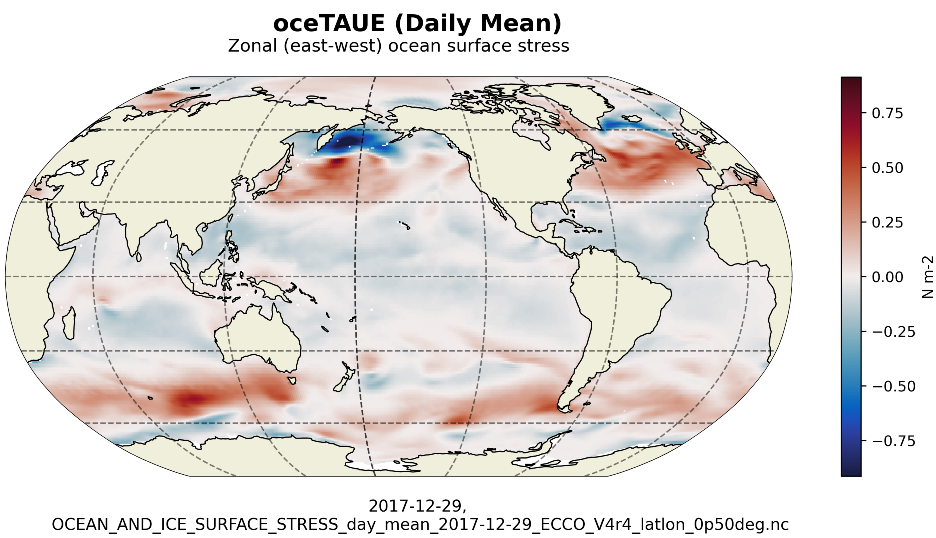

Figure 149: Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: oceTAUE

14.4.5 Latlon Variable: oceTAUN

Table 14.37: Attributes description of the variable 'oceTAUN' from OCEAN_AND_ICE_SURFACE_STRESS's dataset.

Storage Type	Variable Name	Description	Unit
float32	oceTAUN	Meridional (north-south) ocean surface stress	N m-2
Description of the variable in Common Data language (CDL)			

`float32 oceTAUN(time, latitude, longitude)`
`oceTAUN: _FillValue = 9.96921e+36`
`oceTAUN: coverage_content_type = modelResult`
`oceTAUN: direction = >0 increases northward velocity (NVEL)`
`oceTAUN: long_name = Meridional (north:  south) ocean surface stress`
`oceTAUN: standard_name = surface_downward_northward_stress`
`oceTAUN: units = N m:  2`
`oceTAUN: coordinates = time`
`oceTAUN: valid_min = :  2.4036266803741455`
`oceTAUN: valid_max = 2.019313097000122`			

Comments			
Meridional (north-south) component of ocean surface stress due to wind and sea-ice. note: ocetaun is calculated by interpolating the model's x and y components of ocean surface stress (ocetaux and ocetauy) to tracer cell centers and then finding the meridional component of the interpolated vectors.			

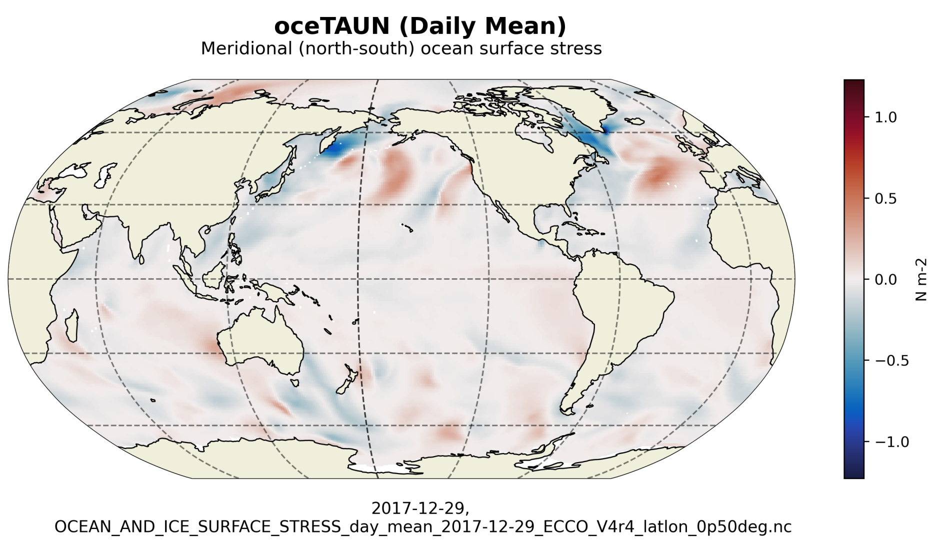

Figure 150: Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: oceTAUN

14.5 Latlon dataset of OCEAN_BOLUS_VELOCITY

14.5.1 Overview

This dataset provides 3D fields of Gent-McWilliams ocean bolus velocity interpolated to a regular 0.5-degree grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution.

Table 14.38: Coordinates and Variables in the dataset OCEAN_BOLUS_VELOCITY

Variables	Description of data variables	Unit
EVELSTAR	Gent-mcwilliams zonal (east-west) bolus velocity	m s-1
NVELSTAR	Gent-mcwilliams meridional (north-south) bolus velocity	m s-1
WVELSTAR	Gent-mcwilliams vertical bolus velocity	m s-1
Coordinates	**Description of data coordinates**	**Unit**
time	Center time of averaging period	–none–
Z	Depth of grid cell center	m
latitude	Latitude at grid cell center	degrees_north
longitude	Longitude at grid cell center	degrees_east
time_bnds	Time bounds of averaging period	–none–
latitude_bnds	Latitude bounds grid cells	–none–
longitude_bnds	Longitude bounds grid cells	–none–
Z_bnds	Depths of grid cell upper and lower interfaces	–none–

14.5.2 Latlon Variable: EVELSTAR

Table 14.39: Attributes description of the variable 'EVELSTAR' from OCEAN_BOLUS_VELOCITY's dataset.

Storage Type	Variable Name	Description	Unit
float32	EVELSTAR	Gent-mcwilliams zonal (east-west) bolus velocity	m s-1
Description of the variable in Common Data language (CDL)			

`float32 EVELSTAR(time, Z, latitude, longitude)`
`EVELSTAR: _FillValue = 9.96921e+36`
`EVELSTAR: coverage_content_type = modelResult`
`EVELSTAR: long_name = Gent: McWilliams zonal (east: west) bolus velocity`
`EVELSTAR: standard_name = eastward_sea_water_velocity_due_to_parameterized_mesoscale_eddies`
`EVELSTAR: units = m s: 1`
`EVELSTAR: coordinates = time Z`
`EVELSTAR: valid_min = : 0.5832233428955078`
`EVELSTAR: valid_max = 0.7810457944869995`			

Comments			
Zonal (east-west) component of the gent-mcwilliams bolus ocean velocity. note: evelstar is calculated by interpolating the model's x and y components of gm bolus ocean velocity (uvelstar and vvelstar) to tracer cell centers and then finding the zonal components of the interpolated vectors. one should take care when interpreting bolus velocities interpolated from the ecco native model grid because interpolating from the model grid to the lat-lon grid introduces errors. some closed buget calculations require bolus velocity terms on the native model grid.			

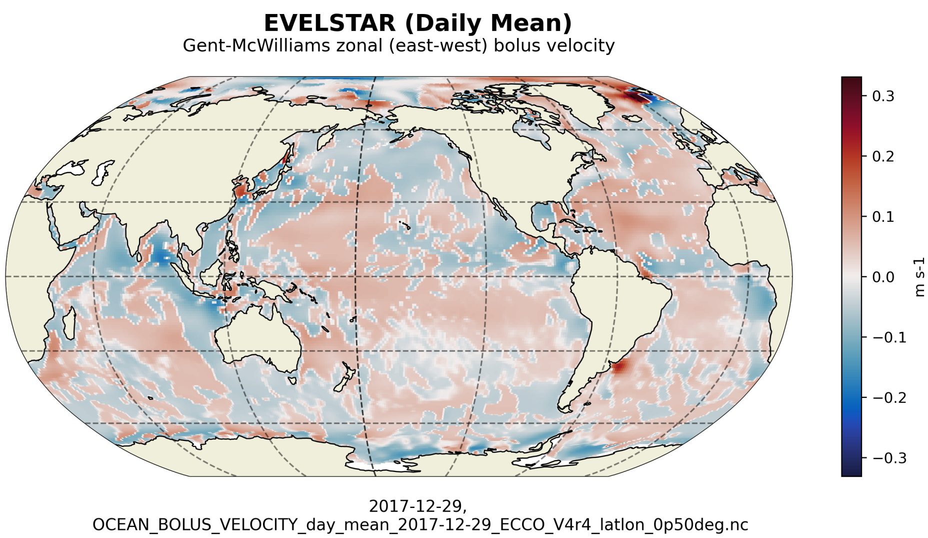

Figure 151: Dataset: OCEAN_BOLUS_VELOCITY, Variable: EVELSTAR

14.5.3 Latlon Variable: NVELSTAR

Table 14.40: Attributes description of the variable 'NVELSTAR' from OCEAN_BOLUS_VELOCITY's dataset.

Storage Type	Variable Name	Description	Unit
float32	NVELSTAR	Gent-mcwilliams meridional (north-south) bolus velocity	m s-1

Description of the variable in Common Data language (CDL)

```
float32 NVELSTAR(time, Z, latitude, longitude)
   NVELSTAR: _FillValue = 9.96921e+36
   NVELSTAR: coverage_content_type = modelResult
   NVELSTAR: long_name = Gent:  McWilliams meridional (north:  south) bolus
velocity
   NVELSTAR: standard_name = northward_sea_water_velocity_due_to_parameterized_mesoscale_eddies
   NVELSTAR: units = m s:  1
   NVELSTAR: coordinates = time Z
   NVELSTAR: valid_min = :  0.6472858190536499
   NVELSTAR: valid_max = 0.6751338243484497
```

Comments

Meridional (north-south) component of the gent-mcwilliams bolus ocean velocity. note: nvelstar is calculated by interpolating the model's x and y components of gm bolus ocean velocity (uvelstar and vvelstar) to tracer cell centers and then finding the meridional components of the interpolated vectors. one should take care when interpreting bolus velocities interpolated from the ecco native model grid because interpolating from the model grid to the lat-lon grid introduces errors. some closed buget calculations require bolus velocity terms on the native model grid

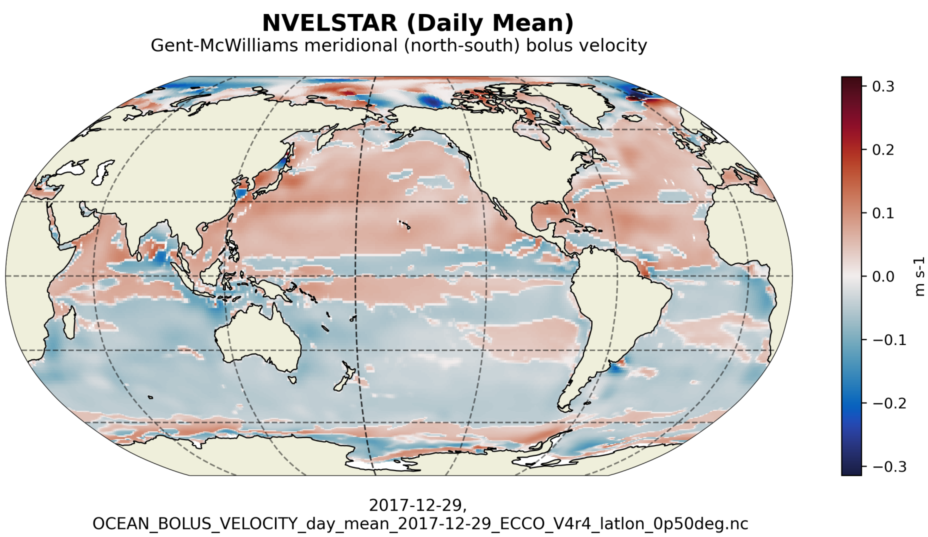

Figure 152: Dataset: OCEAN_BOLUS_VELOCITY, Variable: NVELSTAR

14.5.4 Latlon Variable: WVELSTAR

Table 14.41: Attributes description of the variable 'WVELSTAR' from OCEAN_BOLUS_VELOCITY's dataset.

Storage Type	Variable Name	Description	Unit
float32	WVELSTAR	Gent-mcwilliams vertical bolus velocity	m s-1
Description of the variable in Common Data language (CDL)			

```
float32 WVELSTAR(time, Z, latitude, longitude)
   WVELSTAR: _FillValue = 9.96921e+36
   WVELSTAR: coverage_content_type = modelResult
   WVELSTAR: direction = >0 decreases volume
   WVELSTAR: long_name = Gent:  McWilliams vertical bolus velocity
   WVELSTAR: standard_name = upward_sea_water_velocity_due_to_parameterized_mesoscale_eddies
   WVELSTAR: units = m s:  1
   WVELSTAR: coordinates = time Z
   WVELSTAR: valid_min = :  0.00037936007720418274
   WVELSTAR: valid_max = 0.00040190346771851l8
```

Comments
Vertical component of the gent-mcwilliams bolus ocean velocity. note: in the arakawa-c grid used in ecco v4r4, vertical velocities are staggered relative to the tracer cell centers with values at the top and bottom faces of each grid cell.

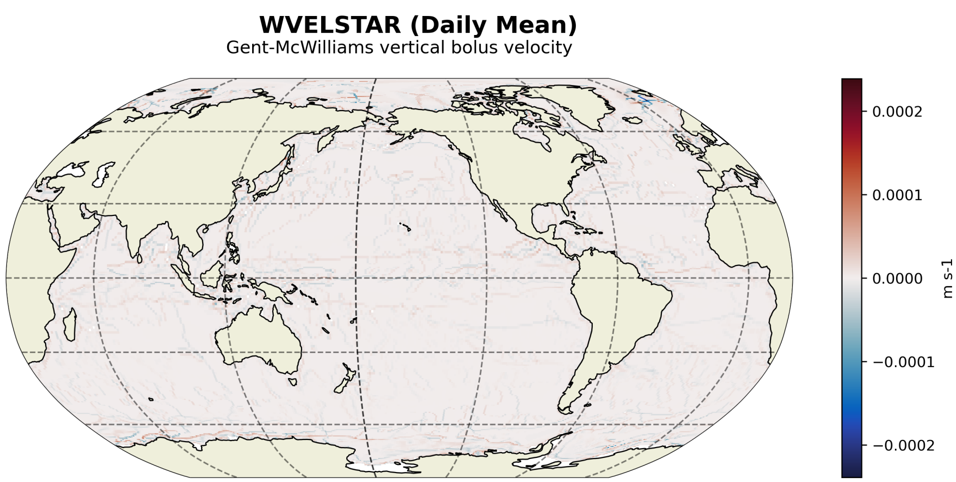

Figure 153: Dataset: OCEAN_BOLUS_VELOCITY, Variable: WVELSTAR

14.6 Latlon dataset of OCEAN_BOTTOM_PRESSURE

14.6.1 Overview

This dataset provides 2D fields of ocean bottom pressure interpolated to a regular 0.5-degree grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution. Ocean bottom pressure given in equivalent water thickness excluding (OBP) and including (OBPGMAP) the contribution from global mean atmospheric pressure.

Table 14.42: Coordinates and Variables in the dataset OCEAN_BOTTOM_PRESSURE

Variables	Description of data variables	Unit
OBP	Ocean bottom pressure given as equivalent water thickness	m
OBPGMAP	Ocean bottom pressure given as equivalent water thickness, includes global mean atmospheric pressure	m
Coordinates	**Description of data coordinates**	**Unit**
time	Center time of averaging period	–none–
latitude	Latitude at grid cell center	degrees_north
longitude	Longitude at grid cell center	degrees_east
time_bnds	Time bounds of averaging period	–none–
latitude_bnds	Latitude bounds grid cells	–none–
longitude_bnds	Longitude bounds grid cells	–none–

14.6.2 Latlon Variable: OBP

Table 14.43: Attributes description of the variable 'OBP' from OCEAN_BOTTOM_PRESSURE's dataset.

Storage Type	Variable Name	Description	Unit
float32	OBP	Ocean bottom pressure given as equivalent water thickness	m

Description of the variable in Common Data language (CDL)

```
float32 OBP(time, latitude, longitude)
   OBP: _FillValue = 9.96921e+36
   OBP: coverage_content_type = modelResult
   OBP: long_name = Ocean bottom pressure given as equivalent water thickness
   OBP: units = m
   OBP: coordinates = time
   OBP: valid_min = :  2.544442892074585
   OBP: valid_max = 72.1243667602539
```

Comments

Obp excludes the contribution from global mean atmospheric pressure and is therefore suitable for comparisons with grace data products. obp is calculated as follows. first, we calculate ocean hydrostatic bottom pressure anomaly, phibot, with phibot = p_b/rhoconst - gh(t), where p_b = model ocean hydrostatic bottom pressure, rhoconst = reference density (1029 kg m-3), g is acceleration due to gravity (9.81 m s-2), and h(t) is model depth at time t. then, obp = phibot/g + corrections for i) global mean steric sea level changes related to density changes in the boussinesq volume-conserving model (greatbatch correction, see stergloh) and ii) global mean atmospheric pressure variations. use obp for comparisons with ocean bottom pressure data products that have been corrected for global mean atmospheric pressure variations. grace data typically are corrected for global mean atmospheric pressure variations. in contrast, ocean bottom pressure gauge data typically are not corrected for global mean atmospheric pressure variations.

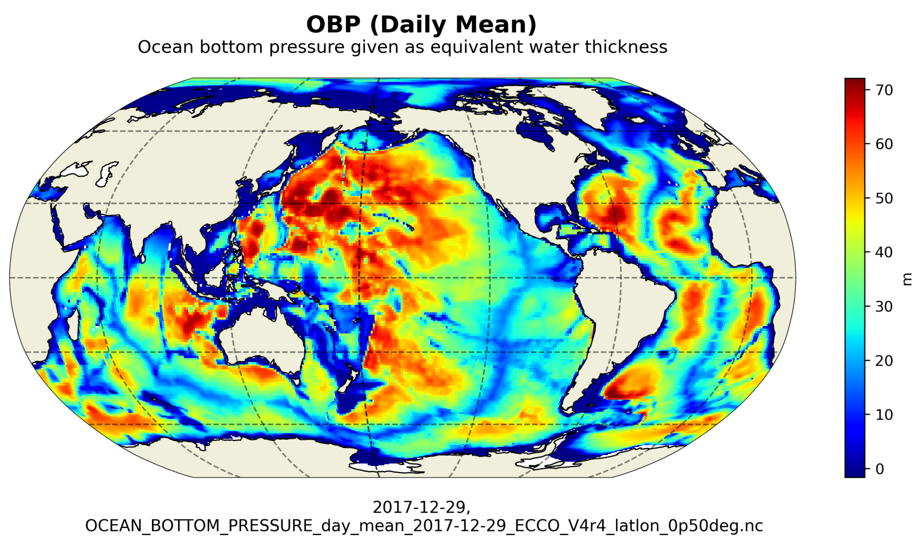

Figure 154: Dataset: OCEAN_BOTTOM_PRESSURE, Variable: OBP

14.6.3 Latlon Variable: OBPGMAP

Table 14.44: Attributes description of the variable 'OBPGMAP' from OCEAN_BOTTOM_PRESSURE's dataset.

Storage Type	Variable Name	Description	Unit
float32	OBPGMAP	Ocean bottom pressure given as equivalent water thickness, includes global mean atmospheric pressure	m

Description of the variable in Common Data language (CDL)

```
float32 OBPGMAP(time, latitude, longitude)
   OBPGMAP: _FillValue = 9.96921e+36
   OBPGMAP: coverage_content_type = modelResult
   OBPGMAP: long_name = Ocean bottom pressure given as equivalent water thickness
includes global mean atmospheric pressure
   OBPGMAP: units = m
   OBPGMAP: coordinates = time
   OBPGMAP: valid_min = 7.395928859710693
   OBPGMAP: valid_max = 82.14805603027344
```

Comments

Obpgmap includes the contribution from global mean atmospheric pressure and is therefore suitable for comparisons with ocean bottom pressure gauge data products. obpgmap is calculated as follows. first, we calculate ocean hydrostatic bottom pressure anomaly, phibot, with phibot = p_b/rhoconst - gh(t), where p_b = model ocean hydrostatic bottom pressure, rhoconst = reference density (1029 kg m-3), g is acceleration due to gravity (9.81 m s-2), and h(t) is model depth at time t. then, obpgmap= phibot/g + corrections for global mean steric sea level changes related to density changes in the boussinesq volume-conserving model (greatbatch correction, see stergloh). use obpgmap for comparisons with ocean bottom pressure data products that have not been corrected for global mean atmospheric pressure variations. grace data typically are corrected for global mean atmospheric pressure variations. in contrast, ocean bottom pressure gauge data typically are not corrected for global mean atmospheric pressure variations.

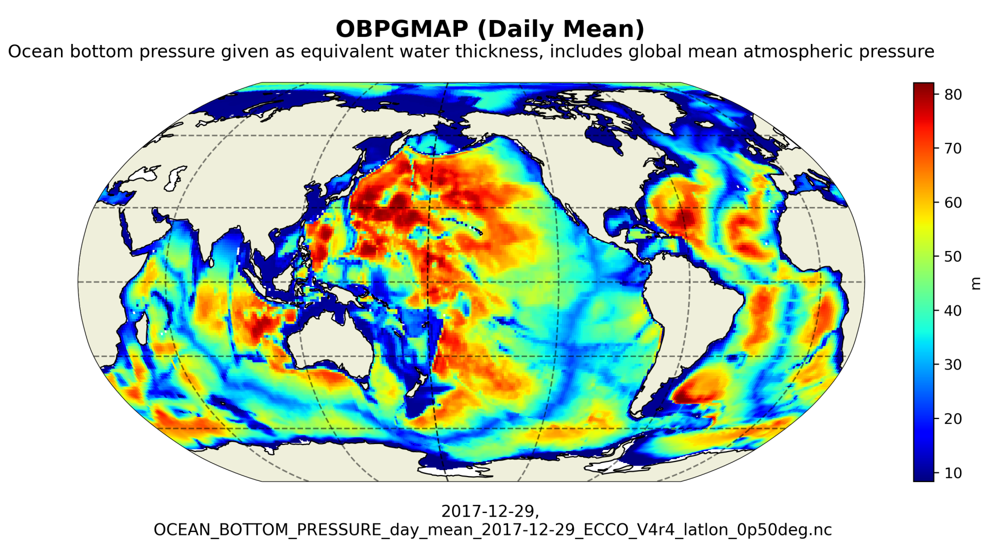

Figure 155: Dataset: OCEAN_BOTTOM_PRESSURE, Variable: OBPGMAP

14.7 Latlon dataset of OCEAN_DENS_STRAT_PRESS

14.7.1 Overview

This dataset provides 3D fields of ocean density, stratification, and hydrostatic pressure interpolated to a regular0.5-degree grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution.

Table 14.45: Coordinates and Variables in the dataset OCEAN_DENS_STRAT_PRESS

Variables	Description of data variables	Unit
RHOAnoma	In-situ seawater density anomaly	kg m-3
DRHODR	Density stratification	kg m-3 m-1
PHIHYD	Ocean hydrostatic pressure anomaly	m2 s-2
Coordinates	**Description of data coordinates**	**Unit**
time	Center time of averaging period	–none–
Z	Depth of grid cell center	m
latitude	Latitude at grid cell center	degrees_north
longitude	Longitude at grid cell center	degrees_east
time_bnds	Time bounds of averaging period	–none–
latitude_bnds	Latitude bounds grid cells	–none–
longitude_bnds	Longitude bounds grid cells	–none–
Z_bnds	Depths of grid cell upper and lower interfaces	–none–

14.7.2 Latlon Variable: DRHODR

Table 14.46: Attributes description of the variable 'DRHODR' from OCEAN_DENS_STRAT_PRESS's dataset.

Storage Type	Variable Name	Description	Unit
float32	DRHODR	Density stratification	kg m-3 m-1
Description of the variable in Common Data language (CDL)			
float32 DRHODR(time, Z, latitude, longitude) DRHODR: _FillValue = 9.96921e+36 DRHODR: coverage_content_type = modelResult DRHODR: long_name = Density stratification DRHODR: units = kg m: 3 m: 1 DRHODR: coordinates = time Z DRHODR: valid_min = : 0.8687265515327454 DRHODR: valid_max = 0.011617615818977356			
Comments			
Density stratification: d(sigma) d z-1. note: density computations are done with in-situ density. the vertical derivatives of in-situ density and locally-referenced potential density are identical the equation of state is a modified unesco formula by jackett and mcdougall (1995), which uses the model variable potential temperature as input assuming a horizontally and temporally constant pressure of $p_0=-g ho_{0} z$.			

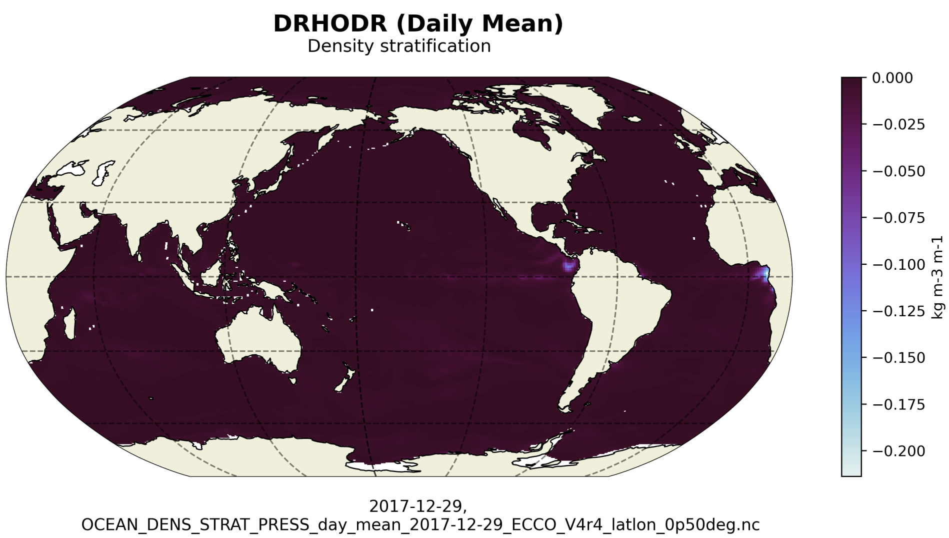

Figure 156: Dataset: OCEAN_DENS_STRAT_PRESS, Variable: DRHODR

14.7.3 Latlon Variable: PHIHYD

Table 14.47: Attributes description of the variable 'PHIHYD' from OCEAN_DENS_STRAT_PRESS's dataset.

Storage Type	Variable Name	Description	Unit
float32	PHIHYD	Ocean hydrostatic pressure anomaly	m2 s-2
Description of the variable in Common Data language (CDL)			

`float32 PHIHYD(time, Z, latitude, longitude)`
`PHIHYD: _FillValue = 9.96921e+36`
`PHIHYD: coverage_content_type = modelResult`
`PHIHYD: long_name = Ocean hydrostatic pressure anomaly`
`PHIHYD: units = m2 s:  2`
`PHIHYD: coordinates = time Z`
`PHIHYD: valid_min = 74.71473693847656`
`PHIHYD: valid_max = 783.9188232421875`			

Comments			
Phihyd = p(k) / rhoconst - g z*(k,t), where p = hydrostatic ocean pressure at depth level k, rhoconst = reference density (1029 kg m-3), g is acceleration due to gravity (9.81 m s-2), and z*(k,t) is model depth at level k and time t. units: p:[kg m-1 s-2], rhoconst:[kg m-3], g:[m s-2], h(t):[m]. note: includes atmospheric pressure loading. quantity referred to in some contexts as hydrostatic pressure anomaly. phibot accounts for the model's time-varying grid cell thickness (z* coordinate system). see phihydcr for hydrostatic pressure potential anomaly calculated using time-invariant grid cell thicknesses. phihyd is not corrected for global mean steric sea level changes related to density changes in the boussinesq volume-conserving model (greatbatch correction, see stergloh).			

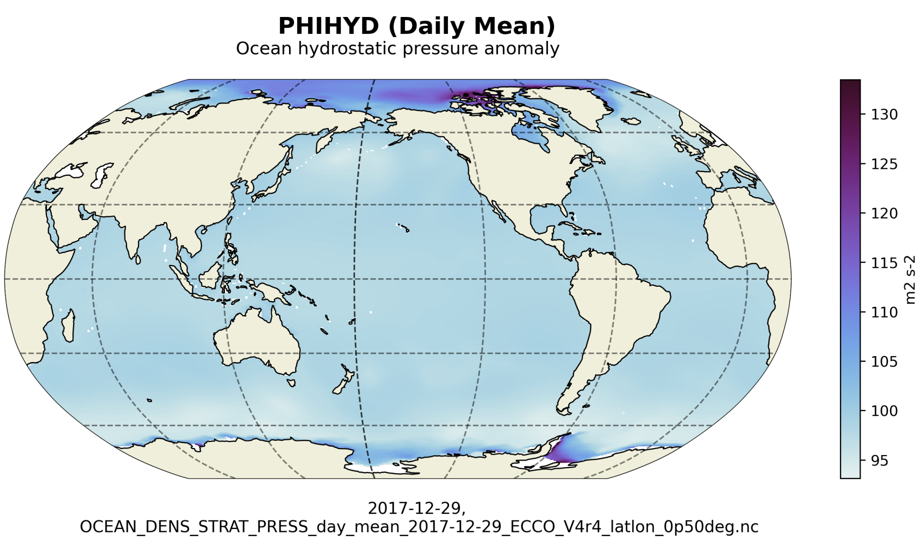

Figure 157: Dataset: OCEAN_DENS_STRAT_PRESS, Variable: PHIHYD

14.7.4 Latlon Variable: RHOAnoma

Table 14.48: Attributes description of the variable 'RHOAnoma' from OCEAN_DENS_STRAT_PRESS's dataset.

Storage Type	Variable Name	Description	Unit
float32	RHOAnoma	In-situ seawater density anomaly	kg m-3
Description of the variable in Common Data language (CDL)			
float32 RHOAnoma(time, Z, latitude, longitude) RHOAnoma: _FillValue = 9.96921e+36 RHOAnoma: coverage_content_type = modelResult RHOAnoma: long_name = In: situ seawater density anomaly RHOAnoma: units = kg m: 3 RHOAnoma: coordinates = time Z RHOAnoma: valid_min = : 19.919862747192383 RHOAnoma: valid_max = 25.540647506713867			
Comments			
In-situ seawater density anomaly relative to the reference density, rhoconst. rhoconst = 1029 kg m-3			

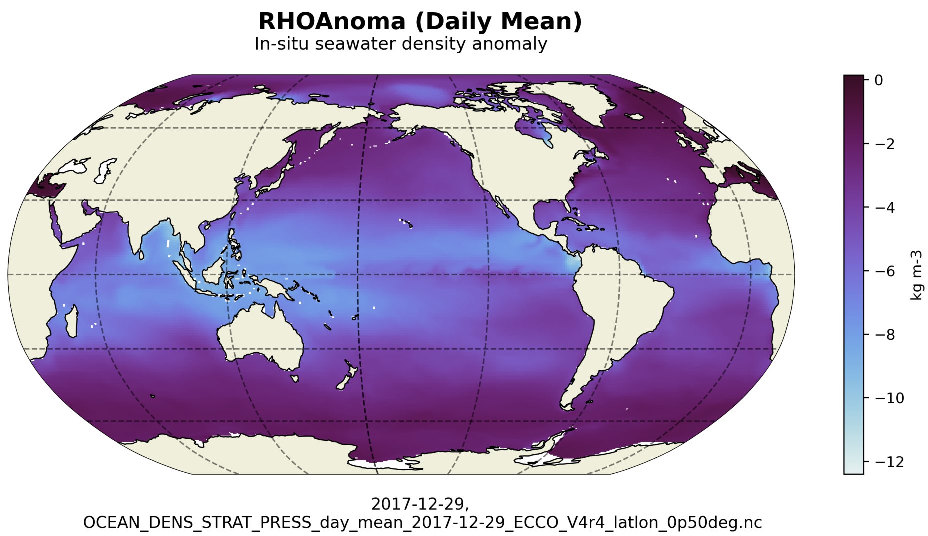

Figure 158: Dataset: OCEAN_DENS_STRAT_PRESS, Variable: RHOAnoma

14.8 Latlon dataset of OCEAN_MIXED_LAYER_DEPTH

14.8.1 Overview

This dataset provides 2D fileds of ocean mixed layer depth interpolated to a regular 0.5-degree grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution.

Table 14.49: Coordinates and Variables in the dataset OCEAN_MIXED_LAYER_DEPTH

Variables	Description of data variables	Unit
MXLDEPTH	Mixed-layer depth diagnosed using the temperature difference criterion of kara et al., 2000	m

Table 14.49: Coordinates and Variables in the dataset OCEAN_MIXED_LAYER_DEPTH

Coordinates	Description of data coordinates	Unit
time	Center time of averaging period	–none–
latitude	Latitude at grid cell center	degrees_north
longitude	Longitude at grid cell center	degrees_east
time_bnds	Time bounds of averaging period	–none–
latitude_bnds	Latitude bounds grid cells	–none–
longitude_bnds	Longitude bounds grid cells	–none–

14.8.2 Latlon Variable: MXLDEPTH

Table 14.50: Attributes description of the variable 'MXLDEPTH' from OCEAN_MIXED_LAYER_DEPTH's dataset.

Storage Type	Variable Name	Description	Unit
float32	MXLDEPTH	Mixed-layer depth diagnosed using the temperature difference criterion of kara et al., 2000	m
Description of the variable in Common Data language (CDL)			
float32 MXLDEPTH(time, latitude, longitude) MXLDEPTH: _FillValue = 9.96921e+36 MXLDEPTH: coverage_content_type = modelResult MXLDEPTH: long_name = Mixed: layer depth diagnosed using the temperature difference criterion of Kara et al. 2000 MXLDEPTH: standard_name = ocean_mixed_layer_thickness MXLDEPTH: units = m MXLDEPTH: coordinates = time MXLDEPTH: valid_min = 5.000001430511475 MXLDEPTH: valid_max = 5331.2001953125			
Comments			
Mixed-layer depth as determined by the depth where waters are first 0.8 degrees celsius colder than the surface. see kara et al. (jgr, 2000). . note: the kara et al. criterion may not be appropriate for some applications. if needed, mixed layer depth can be calculated using different criteria. see vertical density stratification (drhodr) and density anomaly (rhoanoma).			

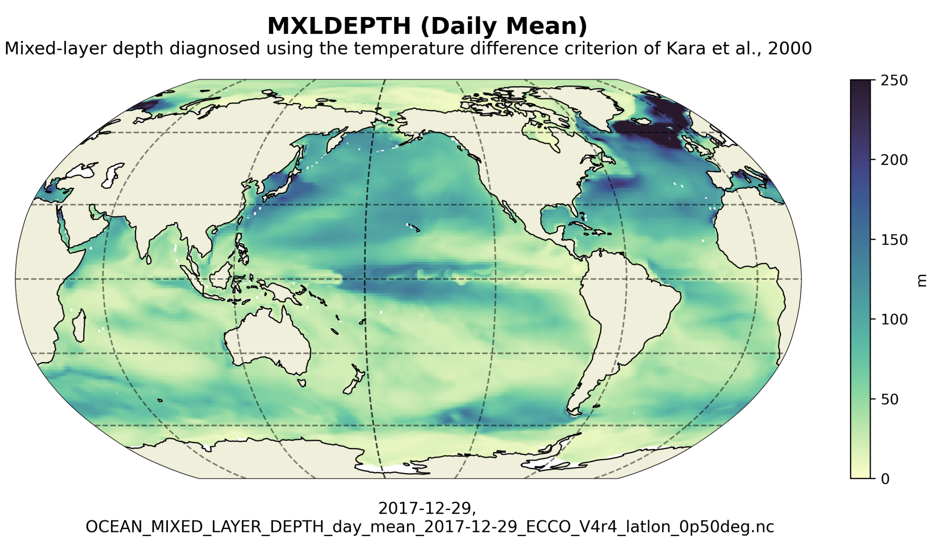

Figure 159: Dataset: OCEAN_MIXED_LAYER_DEPTH, Variable: MXLDEPTH

14.9 Latlon dataset of OCEAN_TEMPERATURE_SALINITY

14.9.1 Overview

This dataset provides 3D fields of ocean potential temperature and salinity interpolated to a regular 0.5-degree grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution.

Table 14.51: Coordinates and Variables in the dataset OCEAN_TEMPERATURE_SALINITY

Variables	Description of data variables	Unit
THETA	Potential temperature	degree_C
SALT	Salinity	1e-3
Coordinates	**Description of data coordinates**	**Unit**
time	Center time of averaging period	–none–
Z	Depth of grid cell center	m
latitude	Latitude at grid cell center	degrees_north
longitude	Longitude at grid cell center	degrees_east
time_bnds	Time bounds of averaging period	–none–
latitude_bnds	Latitude bounds grid cells	–none–
longitude_bnds	Longitude bounds grid cells	–none–
Z_bnds	Depths of grid cell upper and lower interfaces	–none–

14.9.2 Latlon Variable: SALT

Table 14.52: Attributes description of the variable 'SALT' from OCEAN_TEMPERATURE_SALINITY's dataset.

<table>
<tr><th>Storage Type</th><th>Variable Name</th><th>Description</th><th>Unit</th></tr>
<tr><td>float32</td><td>SALT</td><td>Salinity</td><td>1e-3</td></tr>
<tr><th colspan="4">Description of the variable in Common Data language (CDL)</th></tr>
<tr><td colspan="4"><pre>float32 SALT(time, Z, latitude, longitude)
   SALT: _FillValue = 9.96921e+36
   SALT: coverage_content_type = modelResult
   SALT: long_name = Salinity
   SALT: standard_name = sea_water_salinity
   SALT: units = 1e: 3
   SALT: coordinates = time Z
   SALT: valid_min = 16.73577880859375
   SALT: valid_max = 41.321231842041016</pre></td></tr>
<tr><th colspan="4">Comments</th></tr>
<tr><td colspan="4">Defined using cf convention 'sea water salinity is the salt content of sea water, often on the practical salinity scale of 1978. however, the unqualified term 'salinity' is generic and does not necessarily imply any particular method of calculation. the units of salinity are dimensionless and the units attribute should normally be given as 1e-3 or 0.001 i.e. parts per thousand.' see https://cfconventions.org/data/cf-standard-names/73/build/cf-standard-name-table.html</td></tr>
</table>

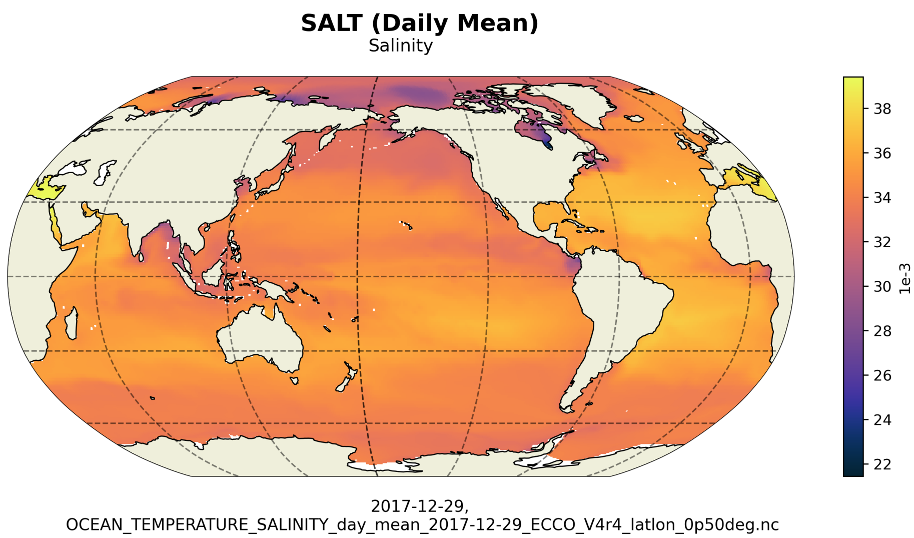

Figure 160: Dataset: OCEAN_TEMPERATURE_SALINITY, Variable: SALT

14.9.3 Latlon Variable: THETA

Table 14.53: Attributes description of the variable 'THETA' from OCEAN_TEMPERATURE_SALINITY's dataset.

Storage Type	Variable Name	Description	Unit
float32	THETA	Potential temperature	degree_C
Description of the variable in Common Data language (CDL)			
float32 THETA(time, Z, latitude, longitude) THETA: _FillValue = 9.96921e+36 THETA: coverage_content_type = modelResult THETA: long_name = Potential temperature THETA: standard_name = sea_water_potential_temperature THETA: units = degree_C THETA: coordinates = time Z THETA: valid_min = : 2.9179372787475586 THETA: valid_max = 36.425140380859375			
Comments			
Sea water potential temperature is the temperature a parcel of sea water would have if moved adiabatically to sea level pressure. note: the equation of state is a modified unesco formula by jackett and mcdougall (1995), which uses the model variable potential temperature as input assuming a horizontally and temporally constant pressure of $p_0=-g ho_{0} z$.			

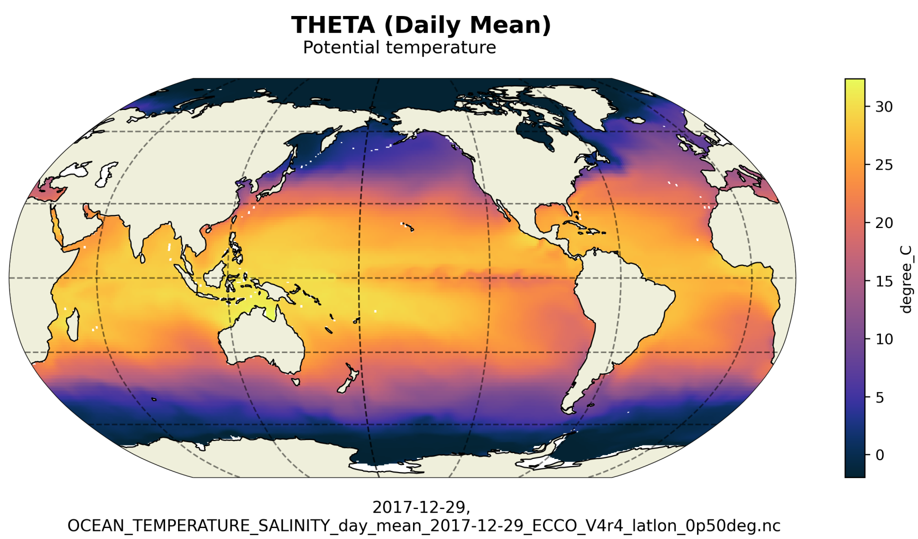

Figure 161: Dataset: OCEAN_TEMPERATURE_SALINITY, Variable: THETA

14.10 Latlon dataset of OCEAN_VELOCITY

14.10.1 Overview

This dataset provides 3D fields of ocean velocity interpolated to a regular 0.5-degree grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution.

Table 14.54: Coordinates and Variables in the dataset OCEAN_VELOCITY

Variables	Description of data variables	Unit
EVEL	Zonal (east-west) velocity	m s-1
NVEL	Meridional (north-south) velocity	m s-1
WVEL	Vertical velocity	m s-1
Coordinates	**Description of data coordinates**	**Unit**
time	Center time of averaging period	–none–
Z	Depth of grid cell center	m
latitude	Latitude at grid cell center	degrees_north
longitude	Longitude at grid cell center	degrees_east
time_bnds	Time bounds of averaging period	–none–
latitude_bnds	Latitude bounds grid cells	–none–
longitude_bnds	Longitude bounds grid cells	–none–
Z_bnds	Depths of grid cell upper and lower interfaces	–none–

14.10.2 Latlon Variable: EVEL

Table 14.55: Attributes description of the variable 'EVEL' from OCEAN_VELOCITY's dataset.

Storage Type	Variable Name	Description	Unit
float32	EVEL	Zonal (east-west) velocity	m s-1
Description of the variable in Common Data language (CDL)			

`float32 EVEL(time, Z, latitude, longitude)`
`EVEL: _FillValue = 9.96921e+36`
`EVEL: coverage_content_type = modelResult`
`EVEL: long_name = Zonal (east:  west) velocity`
`EVEL: standard_name = eastward_sea_water_velocity`
`EVEL: units = m s:  1`
`EVEL: coordinates = Z time`
`EVEL: valid_min = :  1.746832251548767`
`EVEL: valid_max = 1.948591947555542`			

Comments			
Zonal (east-west) component of ocean velocity. note: evel is calculated by interpolating the model's x and y components of ocean velocity (uvel and vvel)to tracer cell centers and then finding the zonal component of the interpolated vectors. it is not recommended to use evel and nvel for volume budget calculations because interpolating uvel and vvel from the model grid to the lat-lon grid introduces errors. perform volume budget calculations with uvelmass and vvelmass on the native model grid.			

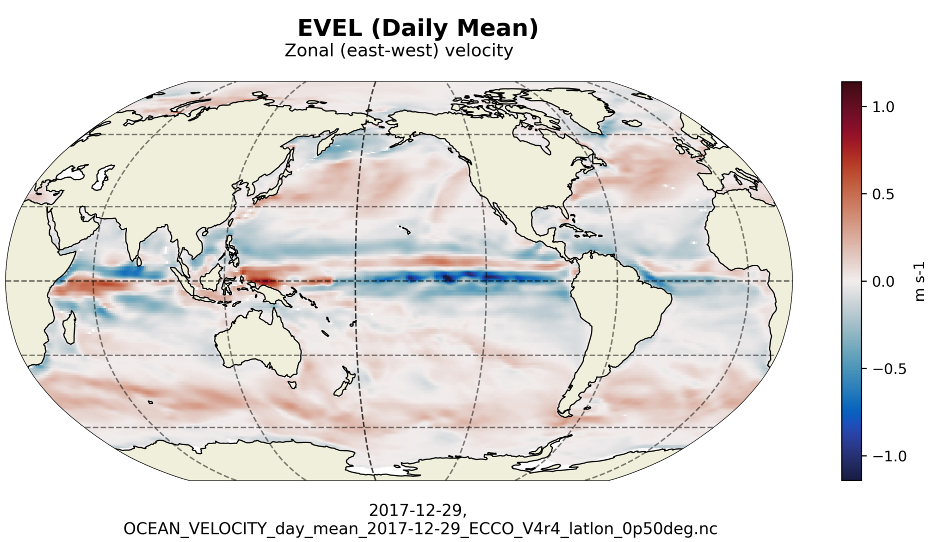

Figure 162: Dataset: OCEAN_VELOCITY, Variable: EVEL

14.10.3 Latlon Variable: NVEL

Table 14.56: Attributes description of the variable 'NVEL' from OCEAN_VELOCITY's dataset.

Storage Type	Variable Name	Description	Unit
float32	NVEL	Meridional (north-south) velocity	m s-1
Description of the variable in Common Data language (CDL)			
float32 NVEL(time, Z, latitude, longitude) NVEL: _FillValue = 9.96921e+36 NVEL: coverage_content_type = modelResult NVEL: long_name = Meridional (north: south) velocity NVEL: standard_name = northward_sea_water_velocity NVEL: units = m s: 1 NVEL: coordinates = Z time NVEL: valid_min = : 1.2522369623184204 NVEL: valid_max = 2.0500051975250244			
Comments			
Meridional (north-south) component of ocean velocity. note: nvel is calculated by interpolating the model's x and y components of ocean velocity (uvel and vvel) to tracer cell centers and then finding the meridional component of the interpolated vectors. it is not recommended to use evel and nvel for volume budget calculations because interpolating uvel and vvel from the model grid to the lat-lon grid introduces errors. perform volume budget calculations with uvelmass and vvelmass on the native model grid.			

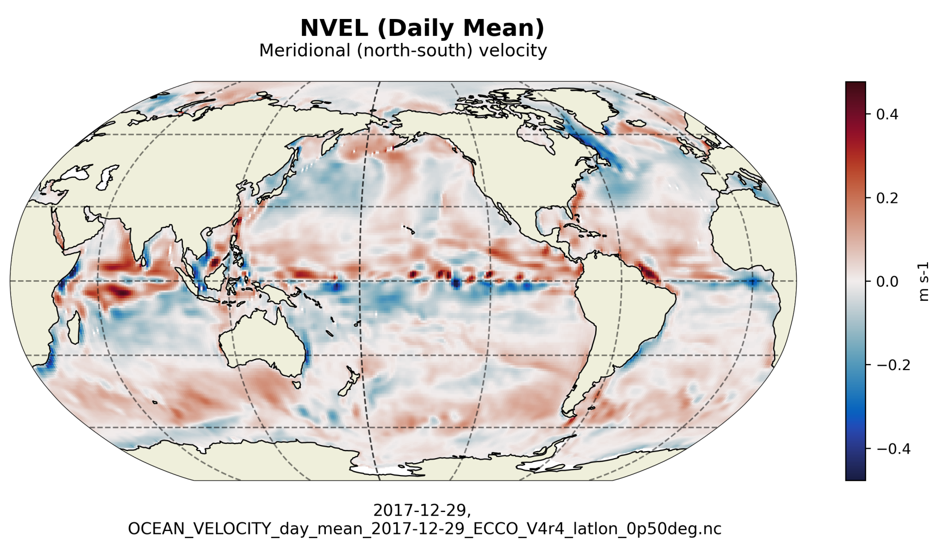

Figure 163: Dataset: OCEAN_VELOCITY, Variable: NVEL

14.10.4 Latlon Variable: WVEL

Table 14.57: Attributes description of the variable 'WVEL' from OCEAN_VELOCITY's dataset.

Storage Type	Variable Name	Description	Unit
float32	WVEL	Vertical velocity	m s-1
Description of the variable in Common Data language (CDL)			

```
float32 WVEL(time, Z, latitude, longitude)
   WVEL: _FillValue = 9.96921e+36
   WVEL: coverage_content_type = modelResult
   WVEL: direction = >0 decreases volume
   WVEL: long_name = Vertical velocity
   WVEL: standard_name = upward_sea_water_velocity
   WVEL: units = m s:  1
   WVEL: coordinates = Z time
   WVEL: valid_min = :  0.0023150660563260317
   WVEL: valid_max = 0.0016380994347855449
```

Comments

Vertical velocity in the +z direction at the top face of the grid cell. note: in the arakawa-c grid used in ecco v4r4, vertical velocities are staggered relative to the tracer cell centers with values at the top and bottom faces of each grid cell.

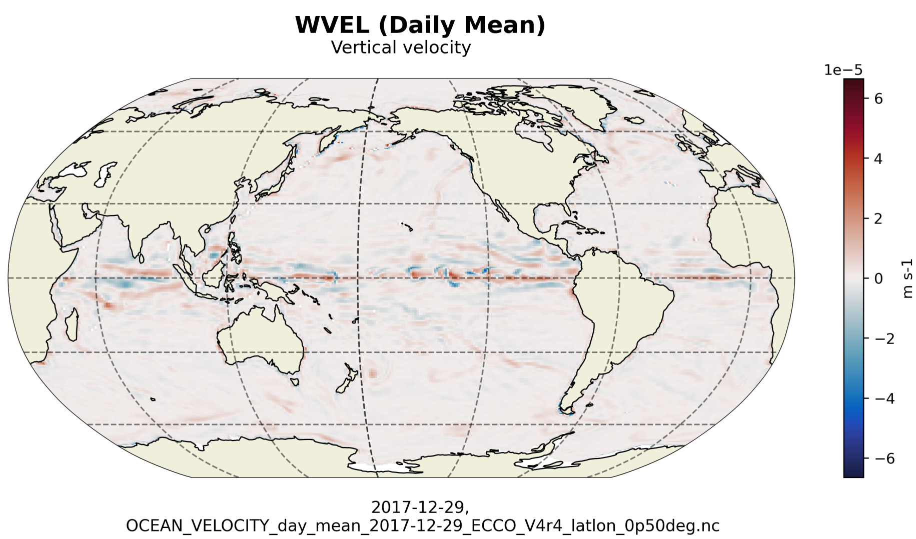

Figure 164: Dataset: OCEAN_VELOCITY, Variable: WVEL

14.11 Latlon dataset of SEA_ICE_CONC_THICKNESS

14.11.1 Overview

This dataset provides 2D fields of sea-ice and snow concentration and thickness interpolated to a regular 0.5-degree grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution.

Table 14.58: Coordinates and Variables in the dataset SEA_ICE_CONC_THICKNESS

Variables	Description of data variables	Unit
SIarea	Sea-ice concentration	1
SIheff	Area-averaged sea-ice thickness	m
SIhsnow	Area-averaged snow thickness	m
sIceLoad	Average sea-ice and snow mass per unit area	kg m-2
Coordinates	**Description of data coordinates**	**Unit**
time	Center time of averaging period	–none–
latitude	Latitude at grid cell center	degrees_north
longitude	Longitude at grid cell center	degrees_east
time_bnds	Time bounds of averaging period	–none–
latitude_bnds	Latitude bounds grid cells	–none–
longitude_bnds	Longitude bounds grid cells	–none–

14.11.2 Latlon Variable: SIarea

Table 14.59: Attributes description of the variable 'SIarea' from SEA_ICE_CONC_THICKNESS's dataset.

Storage Type	Variable Name	Description	Unit
float32	SIarea	Sea-ice concentration	1
Description of the variable in Common Data language (CDL)			
float32 SIarea(time, latitude, longitude) SIarea: _FillValue = 9.96921e+36 SIarea: coverage_content_type = modelResult SIarea: long_name = Sea: ice concentration SIarea: standard_name = sea_ice_area_fraction SIarea: units = 1 SIarea: coordinates = time SIarea: valid_min = 0.0 SIarea: valid_max = 0.9700000286102295			
Comments			
Fraction of ocean grid cell covered with sea-ice [0 to 1]. cf standard name table v73: 'area fraction' is the fraction of a grid cell's horizontal area that has some characteristic of interest. it is evaluated as the area of interest divided by the grid cell area. it may be expressed as a fraction, a percentage, or any other dimensionless representation of a fraction. sea ice area fraction is area of the sea surface occupied by sea ice. it is also called 'sea ice concentration'. 'sea ice' means all ice floating in the sea which has formed from freezing sea water, rather than by other processes such as calving of land ice to form icebergs. https://cfconventions.org/data/cf-standard-names/73/build/cf-standard-name-table.html. defined using cf standard name table v73: 'area fraction' is the fraction of a grid cell's horizontal area that has some characteristic of interest. it is evaluated as the area of interest divided by the grid cell area. it may be expressed as a fraction, a percentage, or any other dimensionless representation of a fraction. sea ice area fraction is area of the sea surface occupied by sea ice. it is also called 'sea ice concentration'. 'sea ice' means all ice floating in the sea which has formed from freezing sea water and precipitation, rather than by other processes such as calving of land ice to form icebergs. https://cfconventions.org/data/cf-standard-names/73/build/cf-standard-name-table.html			

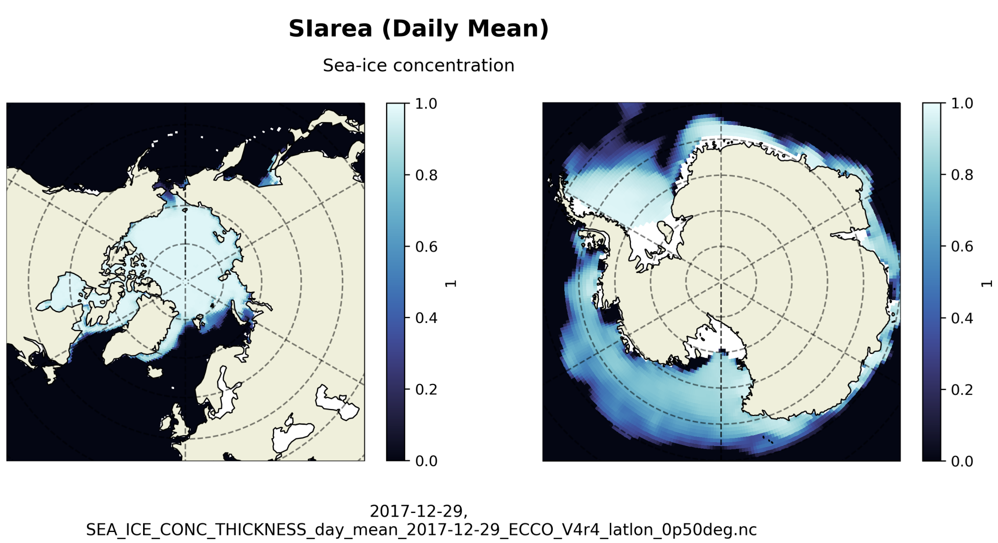

Figure 165: Dataset: SEA_ICE_CONC_THICKNESS, Variable: SIarea

14.11.3 Latlon Variable: SIheff

Table 14.60: Attributes description of the variable 'SIheff' from SEA_ICE_CONC_THICKNESS's dataset.

Storage Type	Variable Name	Description	Unit
float32	SIheff	Area-averaged sea-ice thickness	m
Description of the variable in Common Data language (CDL)			
float32 SIheff(time, latitude, longitude) SIheff: _FillValue = 9.96921e+36 SIheff: coverage_content_type = modelResult SIheff: long_name = Area: averaged sea: ice thickness SIheff: standard_name = sea_ice_thickness SIheff: units = m SIheff: coordinates = time SIheff: valid_min = 0.0 SIheff: valid_max = 9.000518798828125			
Comments			
Sea-ice thickness averaged over the entire model grid cell, including open water where sea-ice thickness is zero. note: sea-ice thickness over the ice-covered fraction of the grid cell is siheff/siarea			

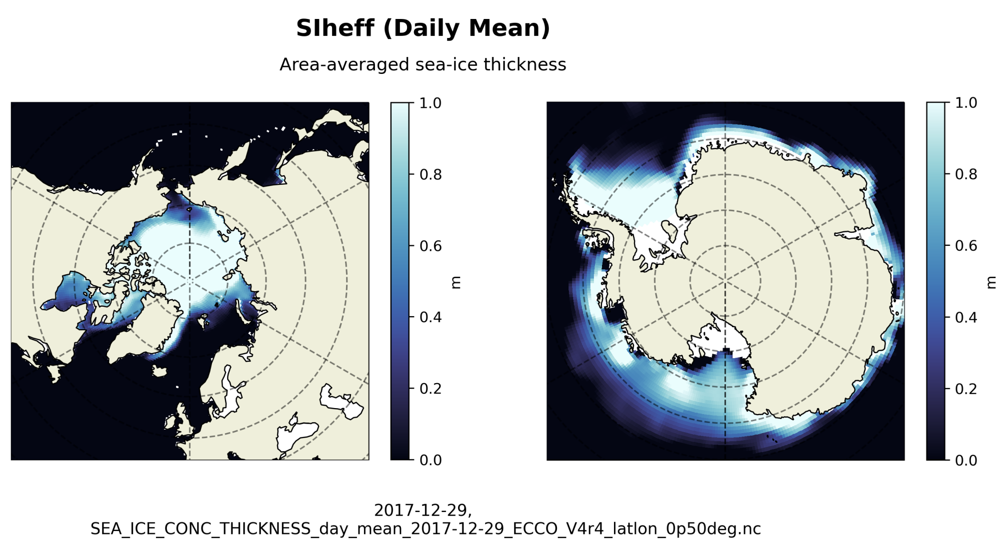

Figure 166: Dataset: SEA_ICE_CONC_THICKNESS, Variable: SIheff

14.11.4 Latlon Variable: SIhsnow

Table 14.61: Attributes description of the variable 'SIhsnow' from SEA_ICE_CONC_THICKNESS's dataset.

Storage Type	Variable Name	Description	Unit
float32	SIhsnow	Area-averaged snow thickness	m
Description of the variable in Common Data language (CDL)			

`float32 SIhsnow(time, latitude, longitude)`
`SIhsnow: _FillValue = 9.96921e+36`
`SIhsnow: coverage_content_type = modelResult`
`SIhsnow: long_name = Area: averaged snow thickness`
`SIhsnow: standard_name = surface_snow_thickness`
`SIhsnow: units = m`
`SIhsnow: coordinates = time`
`SIhsnow: valid_min = : 0.0004725505714304745`
`SIhsnow: valid_max = 2.5671639442443848`			

Comments			
Snow thickness averaged over the entire model grid cell, including open water where snow thickness is zero. note: snow thickness over the ice-covered fraction of the grid cell is sihsnow/siarea			

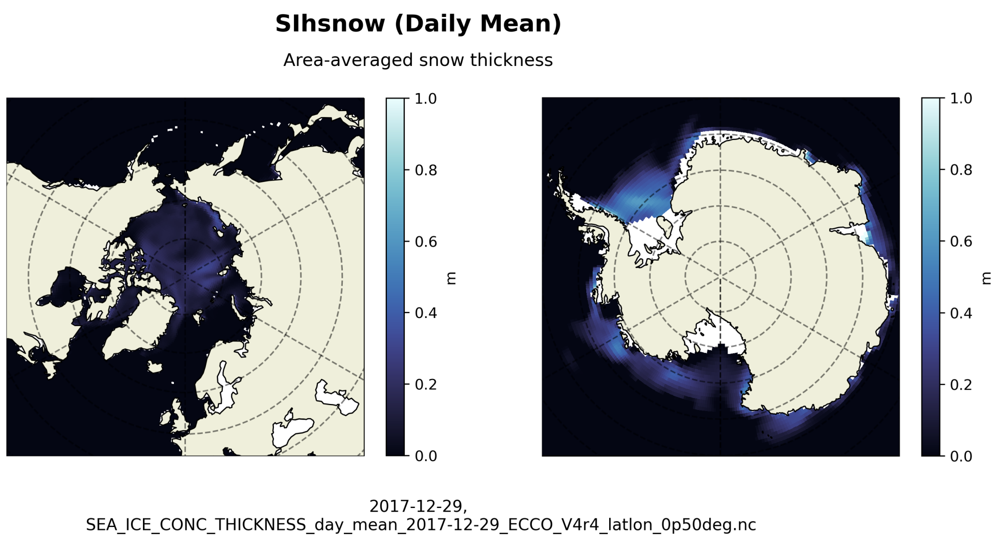

Figure 167: Dataset: SEA_ICE_CONC_THICKNESS, Variable: SIhsnow

14.11.5 Latlon Variable: sIceLoad

Table 14.62: Attributes description of the variable 'sIceLoad' from SEA_ICE_CONC_THICKNESS's dataset.

Storage Type	Variable Name	Description	Unit
float32	sIceLoad	Average sea-ice and snow mass per unit area	kg m-2
Description of the variable in Common Data language (CDL)			
float32 sIceLoad(time, latitude, longitude) sIceLoad: _FillValue = 9.96921e+36 sIceLoad: coverage_content_type = modelResult sIceLoad: long_name = Average sea: ice and snow mass per unit area sIceLoad: standard_name = sea_ice_and_surface_snow_amount sIceLoad: units = kg m: 2 sIceLoad: coordinates = time sIceLoad: valid_min = : 0.0015558383893221617 sIceLoad: valid_max = 8729.935546875			
Comments			
Total mass of sea-ice and snow in a model grid cell averaged over model grid cell area. note: siceload is used to correct model sea level anomaly, etan, to calculate dynamic sea surface height, ssh, and sea surface height without the inverted barometer (ib correction), sshnoibc. in the model, sea-ice is treated as floating above the sea level with etan tracing the location of the ocean-ice interface. consequently, sea-ice growth in the model lowers etan and sea-ice melting raises etan. dynamic sea surface height is obtained by correcting etan by the weight of ice and snow directly above following archimedes' principle.			

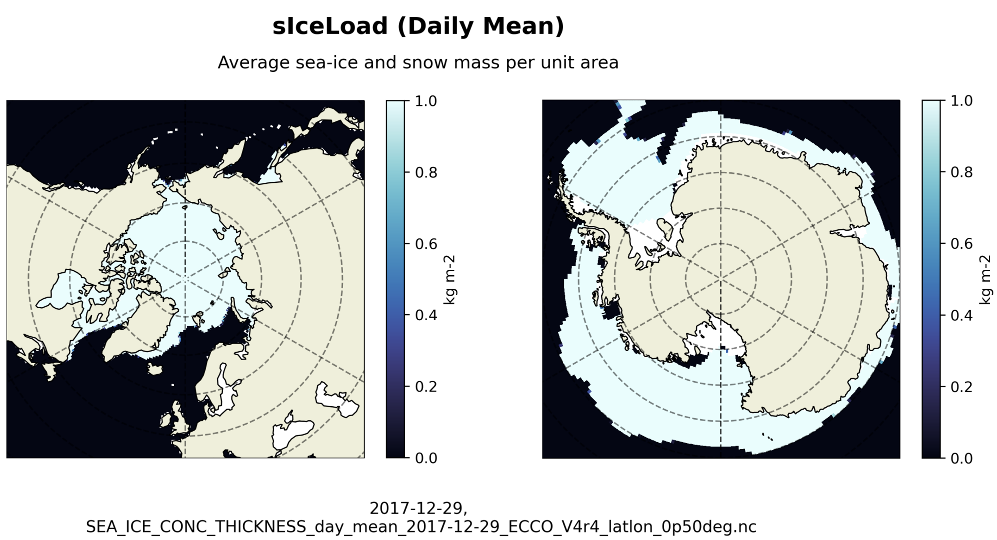

Figure 168: Dataset: SEA_ICE_CONC_THICKNESS, Variable: sIceLoad

14.12 Latlon dataset of SEA_ICE_VELOCITY

14.12.1 Overview

This dataset provides 2D fields of sea-ice velocity interpolated to a regular 0.5-degree grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution.

Table 14.63: Coordinates and Variables in the dataset SEA_ICE_VELOCITY

Variables	Description of data variables	Unit
SIeice	Zonal (east-west) sea-ice velocity	m s-1
SInice	Meridional (north-south) sea-ice velocity	m s-1
Coordinates	**Description of data coordinates**	**Unit**
time	Center time of averaging period	–none–
latitude	Latitude at grid cell center	degrees_north
longitude	Longitude at grid cell center	degrees_east
time_bnds	Time bounds of averaging period	–none–
latitude_bnds	Latitude bounds grid cells	–none–
longitude_bnds	Longitude bounds grid cells	–none–

14.12.2 Latlon Variable: SIeice

Table 14.64: Attributes description of the variable 'SIeice' from SEA_ICE_VELOCITY's dataset.

Storage Type	Variable Name	Description	Unit
float32	SIeice	Zonal (east-west) sea-ice velocity	m s-1
Description of the variable in Common Data language (CDL)			
float32 SIeice(time, latitude, longitude) SIeice: _FillValue = 9.96921e+36 SIeice: coverage_content_type = modelResult SIeice: long_name = Zonal (east: west) sea: ice velocity SIeice: standard_name = eastward_sea_ice_velocity SIeice: units = m s: 1 SIeice: coordinates = time SIeice: valid_min = : 0.5656854510307312 SIeice: valid_max = 0.5656854510307312			
Comments			
Zonal (east-west) componet of sea-ice velocity. note: mask with siarea to remove nonzero values where ice is absent. sieice is calculated by interpolating the model's x and y components of sea-ice velocity (siuice and sivice) to tracer cell centers and then finding the zonal component of the interpolated vectors. it is not recommended to use siuice and sivice for sea-ice volume budget calculations because interpolating siuice and sivice from the model grid to the lat-lon grid introduces errors. perform sea-ice mass budget calculations with advxheff, advyheff, dfxheff, and dfyheff on the native model grid.			

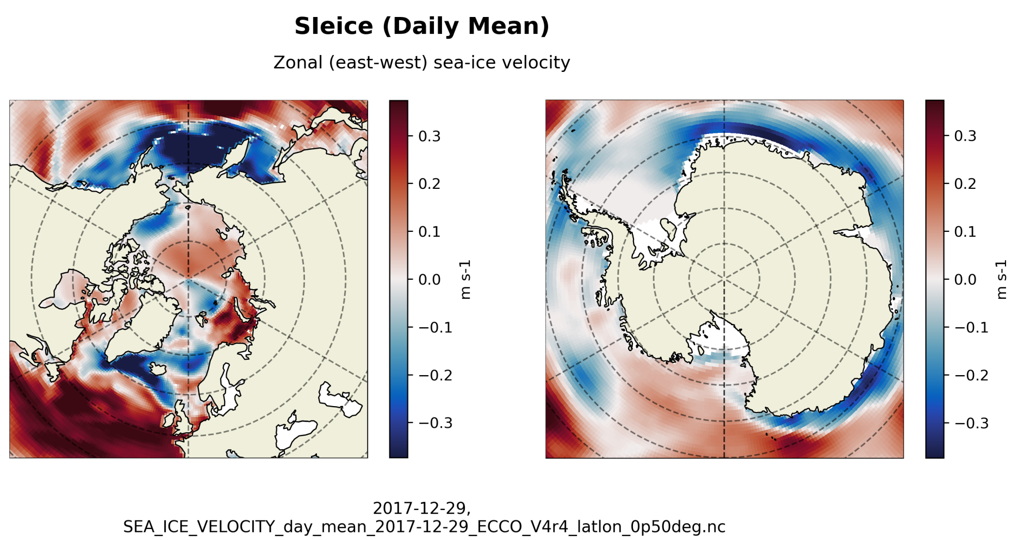

Figure 169: Dataset: SEA_ICE_VELOCITY, Variable: SIeice

14.12.3 Latlon Variable: SIice

Table 14.65: Attributes description of the variable 'SIice' from SEA_ICE_VELOCITY's dataset.

Storage Type	Variable Name	Description	Unit
float32	SInice	Meridional (north-south) sea-ice velocity	m s-1
Description of the variable in Common Data language (CDL)			

`float32 SInice(time, latitude, longitude)`
`SInice: _FillValue = 9.96921e+36`
`SInice: coverage_content_type = modelResult`
`SInice: long_name = Meridional (north: south) sea: ice velocity`
`SInice: standard_name = northward_sea_ice_velocity`
`SInice: units = m s: 1`
`SInice: coordinates = time`
`SInice: valid_min = : 0.5615208148956299`
`SInice: valid_max = 0.5656854510307312`			

Comments			
Meridional (north-south) component of sea-ice velocity. note: mask with siarea to remove nonzero values where ice is absent. sinice is calculated by interpolating the model's x and y components of sea-ice velocity (siuice and sivice) to tracer cell centers and then finding the meridional component of the interpolated vectors. it is not recommended to use siuice and sivice for sea-ice volume budget calculations because interpolating siuice and sivice from the model grid to the lat-lon grid introduces errors. perform sea-ice mass budget calculations with advxheff, advyheff, dfxheff, and dfyheff on the native model grid.			

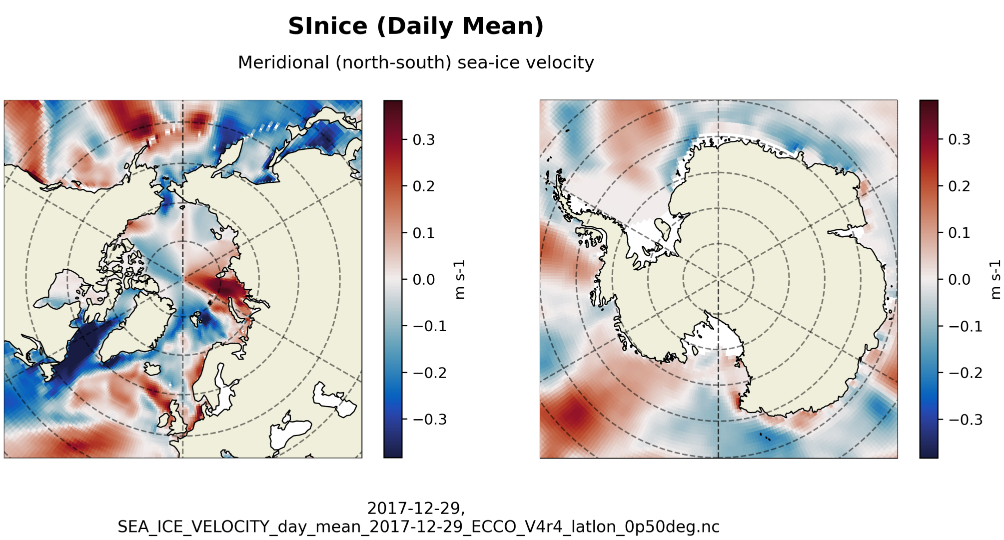

Figure 170: Dataset: SEA_ICE_VELOCITY, Variable: SInice

14.13 Latlon dataset of SEA_SURFACE_HEIGHT

14.13.1 Overview

This dataset provides 2D fields of dynamic sea surface height interpolated to a regular 0.5-degree grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution. SSH (dynamic sea surface height) = SSHNOIBC (dynamic sea surface without the inverse barometer correction) - SSHIBC (inverse barometer correction). The inverted barometer correction accounts for variations in sea surface height due to atmospheric pressure variations.

Table 14.66: Coordinates and Variables in the dataset SEA_SURFACE_HEIGHT

Variables	Description of data variables	Unit
SSH	Dynamic sea surface height anomaly	m
SSHIBC	The inverted barometer (ib) correction to sea surface height due to atmospheric pressure loading	m
SSHNOIBC	Sea surface height anomaly without the inverted barometer (ib) correction	m
Coordinates	**Description of data coordinates**	**Unit**
time	Center time of averaging period	–none–
latitude	Latitude at grid cell center	degrees_north
longitude	Longitude at grid cell center	degrees_east
time_bnds	Time bounds of averaging period	–none–
latitude_bnds	Latitude bounds grid cells	–none–
longitude_bnds	Longitude bounds grid cells	–none–

14.13.2 Latlon Variable: SSH

Table 14.67: Attributes description of the variable 'SSH' from SEA_SURFACE_HEIGHT's dataset.

Storage Type	Variable Name	Description	Unit
float32	SSH	Dynamic sea surface height anomaly	m
Description of the variable in Common Data language (CDL)			
float32 SSH(time, latitude, longitude) SSH: _FillValue = 9.96921e+36 SSH: coverage_content_type = modelResult SSH: long_name = Dynamic sea surface height anomaly SSH: standard_name = sea_surface_height_above_geoid SSH: units = m SSH: coordinates = time SSH: valid_min = : 2.4861555099487305 SSH: valid_max = 2.2875382900238037			
Comments			
Dynamic sea surface height anomaly above the geoid, suitable for comparisons with altimetry sea surface height data products that apply the inverse barometer (ib) correction. note: ssh is calculated by correcting model sea level anomaly etan for three effects: a) global mean steric sea level changes related to density changes in the boussinesq volume-conserving model (greatbatch correction, see stergloh), b) the inverted barometer (ib) effect (see sshibc) and c) sea level displacement due to sea-ice and snow pressure loading (see siceload). ssh can be compared with the similarly-named ssh variable in previous ecco products that did not include atmospheric pressure loading (e.g., version 4 release 3). use sshnoibc for comparisons with altimetry data products that do not apply the ib correction.			

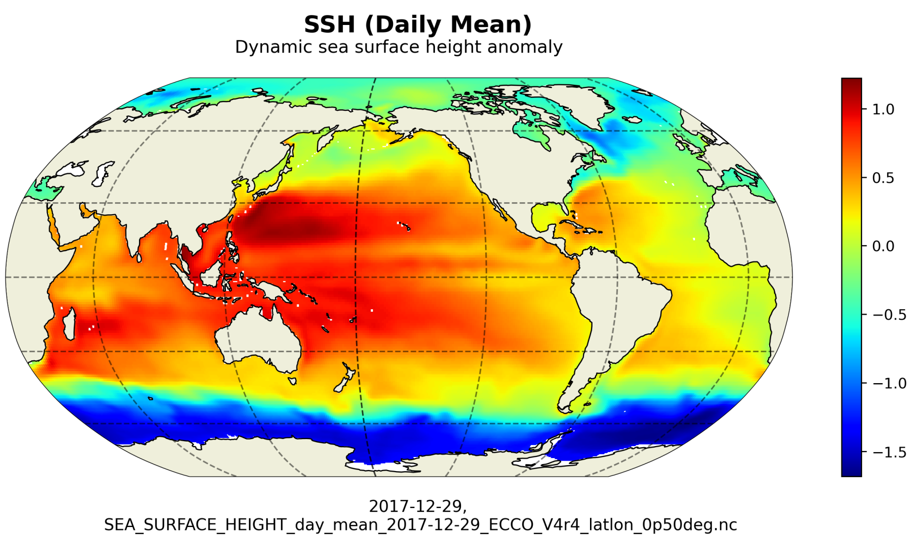

Figure 171: Dataset: SEA_SURFACE_HEIGHT, Variable: SSH

14.13.3 Latlon Variable: SSHIBC

Table 14.68: Attributes description of the variable 'SSHIBC' from SEA_SURFACE_HEIGHT's dataset.

Storage Type	Variable Name	Description	Unit
float32	SSHIBC	The inverted barometer (ib) correction to sea surface height due to atmospheric pressure loading	m

Description of the variable in Common Data language (CDL)

```
float32 SSHIBC(time, latitude, longitude)
   SSHIBC: _FillValue = 9.96921e+36
   SSHIBC: coverage_content_type = modelResult
   SSHIBC: long_name = The inverted barometer (IB) correction to sea surface
height due to atmospheric pressure loading
   SSHIBC: units = m
   SSHIBC: coordinates = time
   SSHIBC: valid_min = :  0.5228679180145264
   SSHIBC: valid_max = 0.8955588340759277
```

Comments

Not an ssh itself, but a correction to model sea level anomaly (etan) required to account for the static part of sea surface displacement by atmosphere pressure loading: ssh = sshnoibc - sshibc. note: use ssh for model-data comparisons with altimetry data products that do apply the ib correction and sshnoibc for comparisons with altimetry data products that do not apply the ib correction.

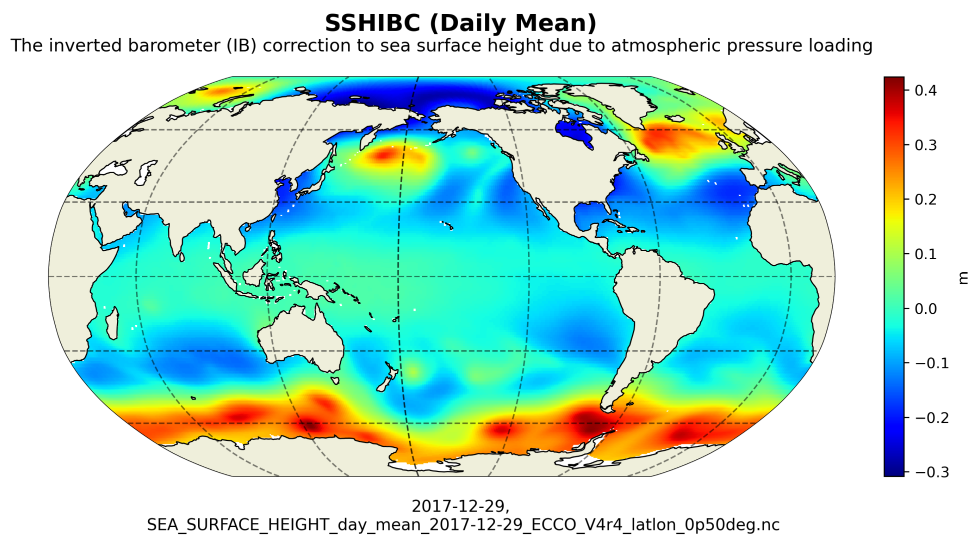

Figure 172: Dataset: SEA_SURFACE_HEIGHT, Variable: SSHIBC

14.13.4 Latlon Variable: SSHNOIBC

Table 14.69: Attributes description of the variable 'SSHNOIBC' from SEA_SURFACE_HEIGHT's dataset.

Storage Type	Variable Name	Description	Unit
float32	SSHNOIBC	Sea surface height anomaly without the inverted barometer (ib) correction	m

Description of the variable in Common Data language (CDL)

```
float32 SSHNOIBC(time, latitude, longitude)
   SSHNOIBC: _FillValue = 9.96921e+36
   SSHNOIBC: coverage_content_type = modelResult
   SSHNOIBC: long_name = Sea surface height anomaly without the inverted barometer
(IB) correction
   SSHNOIBC: units = m
   SSHNOIBC: coordinates = time
   SSHNOIBC: valid_min = :  2.45104718208313
   SSHNOIBC: valid_max = 2.2390522956848145
```

Comments

Sea surface height anomaly above the geoid without the inverse barometer (ib) correction, suitable for comparisons with altimetry sea surface height data products that do not apply the inverse barometer (ib) correction. note: sshnoibc is calculated by correcting model sea level anomaly etan for two effects: a) global mean steric sea level changes related to density changes in the boussinesq volume-conserving model (greatbatch correction, see sterglоh), b) sea level displacement due to sea-ice and snow pressure loading (see siceload). in ecco version 4 release 4 the model is forced with atmospheric pressure loading. sshnoibc does not correct for the static part of the effect of atmosphere pressure loading on sea surface height (the so-called inverse barometer (ib) correction). use ssh for comparisons with altimetry data products that do apply the ib correction.

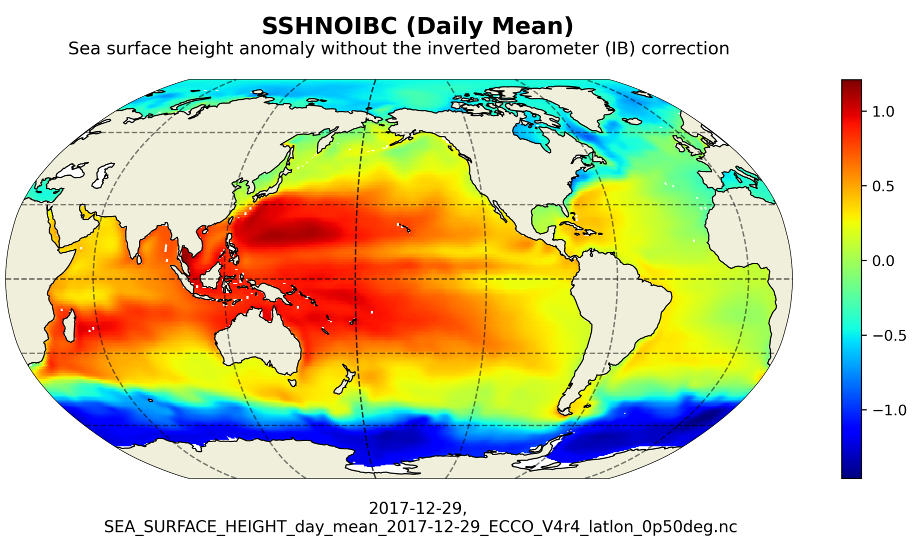

Figure 173: Dataset: SEA_SURFACE_HEIGHT, Variable: SSHNOIBC

15 1-D Dataset Groupings

15.1 1D dataset of GLOBAL_MEAN_ATM_SURFACE_PRES

15.1.1 Overview

This dataset provides a 1D field of global mean atmospheric surface pressure over the ocean and sea-ice from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on instantaneous hourly, daily-average and monthly-average time resolution.

Table 15.1: Coordinates and Variables in the dataset GLOBAL_MEAN_ATM_SURFACE_PRES

Variables	Description of data variables	Unit
Pa_global	Global mean atmospheric surface pressure over the ocean and sea-ice	N m-2
Coordinates	**Description of data coordinates**	**Unit**
time	Snapshot time	–none–

15.1.2 1D Variable: Pa_global

Table 15.2: Attributes description of the variable 'Pa_global' from GLOBAL_MEAN_ATM_SURFACE_PRES's dataset.

Storage Type	Variable Name	Description	Unit
float64	Pa_global	Global mean atmospheric surface pressure over the ocean and sea-ice	N m-2
Description of the variable in Common Data language (CDL)			
float64 Pa_global(time) Pa_global: _FillValue = 9.969209968386869e+36 Pa_global: coverage_content_type = modelResult Pa_global: long_name = Global mean atmospheric surface pressure over the ocean and sea: ice Pa_global: standard_name = air_pressure_at_sea_level Pa_global: units = N m: 2 Pa_global: valid_min = 100873.14755283327 Pa_global: valid_max = 101257.45252296235 Pa_global: coordinates = time			
Comments			
N/a			

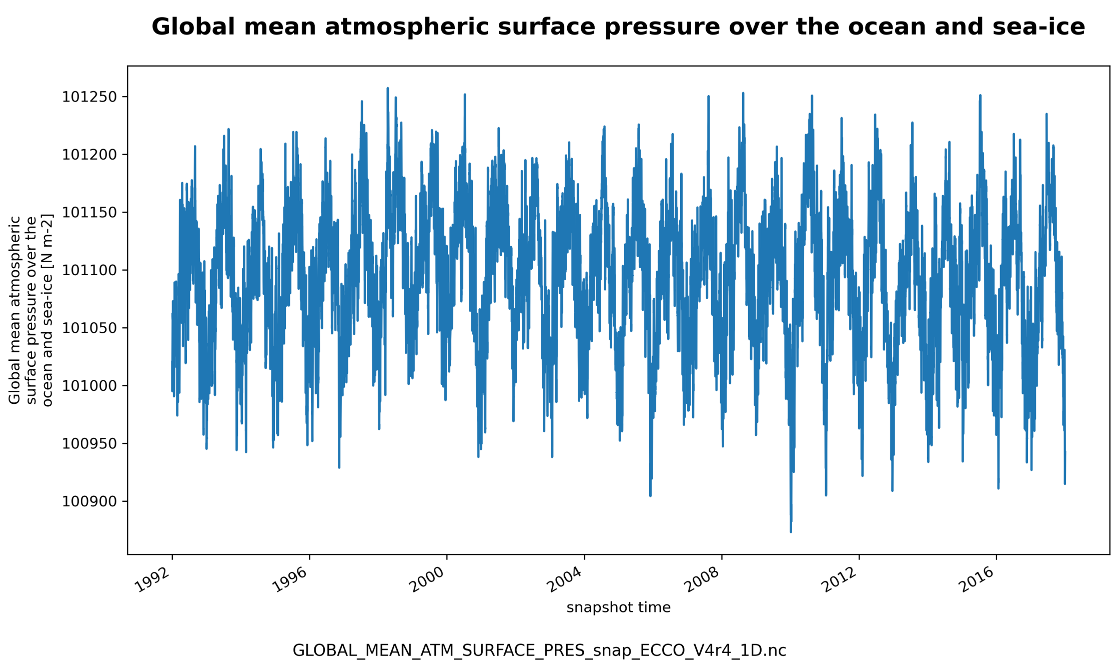

Figure 174: Dataset: GLOBAL_MEAN_ATM_SURFACE_PRES, Variable: Pa_global

15.2 1D dataset of GLOBAL_MEAN_SEA_LEVEL

15.2.1 Overview

This dataset provides a 1D field of global mean sea level anomalies including barystatic and sterodynamic terms from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution.

Table 15.3: Coordinates and Variables in the dataset GLOBAL_MEAN_SEA_LEVEL

Variables	Description of data variables	Unit
global_mean_barystatic_sea_level_anomaly	Global mean of barystatic sea level anomaly	m
global_mean_sea_level_anomaly	Global mean of dynamic ssh	m
global_mean_sterodynamic_sea_level_anomaly	Global mean of sterodynamic sea level anomaly	m
Coordinates	**Description of data coordinates**	**Unit**
time	Center time of averaging period	–none–

15.2.2 1D Variable: global_mean_barystatic_sea_level_anomaly

Table 15.4: Attributes description of the variable 'global_mean_barystatic_sea_level_anomaly' from GLOBAL_MEAN_SEA_LEVEL's dataset.

Storage Type	Variable Name	Description	Unit
float32	global_mean_barystatic_sea_level_anomaly	Global mean of barystatic sea level anomaly	m

Description of the variable in Common Data language (CDL)

```
float32 global_mean_barystatic_sea_level_anomaly(time)
  global_mean_barystatic_sea_level_anomaly:  _FillValue = 9.96921e+36
  global_mean_barystatic_sea_level_anomaly:  coverage_content_type = modelResult
  global_mean_barystatic_sea_level_anomaly:  long_name = Global mean of
barystatic sea level anomaly
  global_mean_barystatic_sea_level_anomaly:  standard_name =
  global_mean_barystatic_sea_level_anomaly:  units = m
  global_mean_barystatic_sea_level_anomaly:  valid_min = :  0.045110904
  global_mean_barystatic_sea_level_anomaly:  valid_max = 0.043493364
  global_mean_barystatic_sea_level_anomaly:  coordinates = time
```

Comments

Global mean barystatic sea level anomaly due to changes in total ocean mass. note: eccov4 uses a volume-conserving boussinesq formulation of the mitgcm with a free-surface boundary condition with real freshwater flux forcing. changes in ocean mass due to evaporation, precipitation, runoff, and sea-ice growth/melt are reflected in model sea level. however, as a consequence of the boussinsq formulation, changes to seawater density due to net buoyancy fluxes (e.g., global mean surface heating/cooling) do not change model sea level anomaly (etan) via seawater expansion/contraction. changes in global ocean density therefore induce a spurious change in model ocean bottom pressure (phibot) via 'virtual mass fluxes'. the 'greatbatch correction' is a time varying, globally-uniform correction to account for changes in global mean density in boussinesq models. this correction is used to calculate dynamic sea surface height (ssh) and ocean bottom pressure (obp). importantly, there is no dynamical significance to the greatbatch correction but it is required to account for steric changes in global sea level. see greatbatch, 1994. j. of geophys. res. oceans, doi.org/10.1029/94jc00847

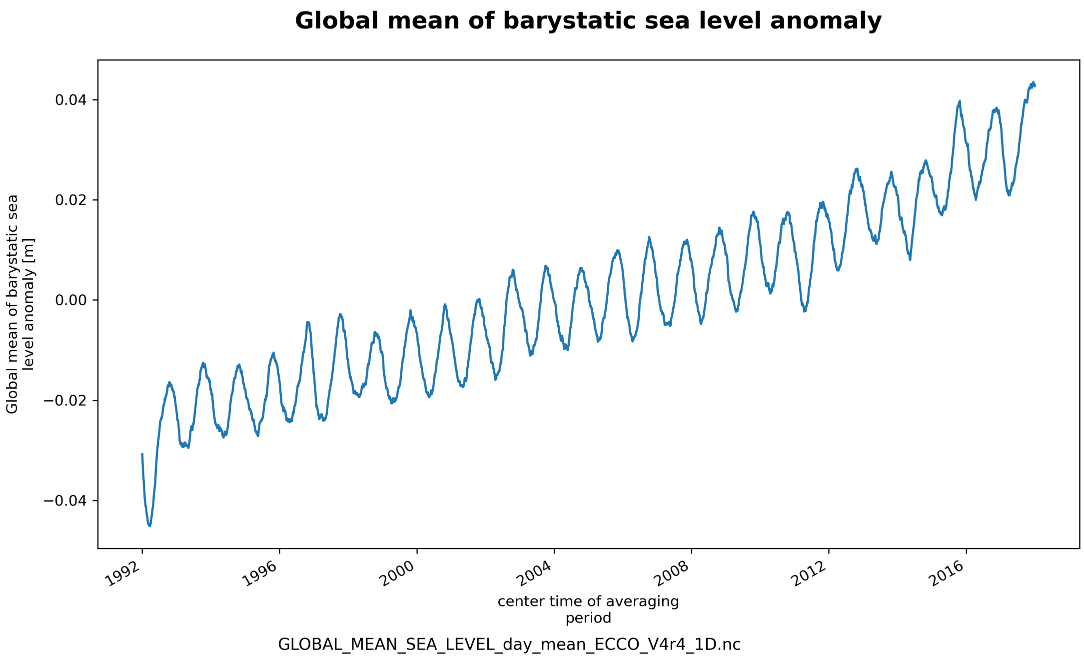

Figure 175: Dataset: GLOBAL_MEAN_SEA_LEVEL, Variable: global_mean_barystatic_sea_level_anomaly

15.2.3 1D Variable: global_mean_sea_level_anomaly

Table 15.5: Attributes description of the variable 'global_mean_sea_level_anomaly' from GLOBAL_MEAN_SEA_LEVEL's dataset.

Storage Type	Variable Name	Description	Unit
float32	global_mean_sea_level_anomaly	Global mean of dynamic ssh	m
Description of the variable in Common Data language (CDL)			

`float32 global_mean_sea_level_anomaly(time)`
`global_mean_sea_level_anomaly: _FillValue = 9.96921e+36`
`global_mean_sea_level_anomaly: coverage_content_type = modelResult`
`global_mean_sea_level_anomaly: long_name = Global mean of dynamic SSH`
`global_mean_sea_level_anomaly: standard_name =`
`global_mean_sea_level_anomaly: units = m`
`global_mean_sea_level_anomaly: valid_min = : 0.055836163`
`global_mean_sea_level_anomaly: valid_max = 0.05520557`
`global_mean_sea_level_anomaly: coordinates = time`			

Comments			
Global mean of dynamic sea level anomaly, equivalent to global mean sea level change. note: eccov4 uses a volume-conserving boussinesq formulation of the mitgcm with a free-surface boundary condition with real freshwater flux forcing. changes in ocean mass due to evaporation, precipitation, runoff, and sea-ice growth/melt are reflected in model sea level. however, as a consequence of the boussinsq formulation, changes to seawater density due to net buoyancy fluxes (e.g., global mean surface heating/cooling) do not change model sea level anomaly (etan) via seawater expansion/contraction. changes in global ocean density therefore induce a spurious change in model ocean bottom pressure (phibot) via 'virtual mass fluxes'. the 'greatbatch correction' is a time varying, globally-uniform correction to account for changes in global mean density in boussinesq models. this correction is used to calculate dynamic sea surface height (ssh) and ocean bottom pressure (obp). importantly, there is no dynamical significance to the greatbatch correction but it is required to account for steric changes in global sea level. see greatbatch, 1994. j. of geophys. res. oceans, doi.org/10.1029/94jc00847			

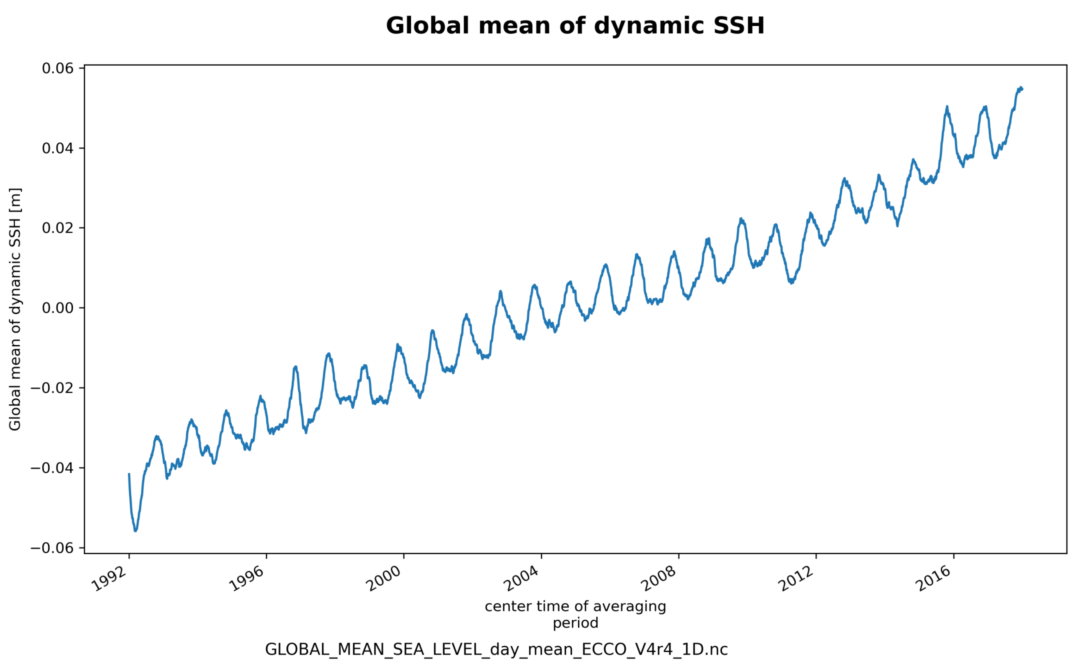

Figure 176: Dataset: GLOBAL_MEAN_SEA_LEVEL, Variable: global_mean_sea_level_anomaly

15.2.4 1D Variable: global_mean_sterodynamic_sea_level_anomaly

Table 15.6: Attributes description of the variable 'global_mean_sterodynamic_sea_level_anomaly' from GLOBAL_MEAN_SEA_LEVEL's dataset.

Storage Type	Variable Name	Description	Unit
float64	global_mean_sterodynamic_sea_level_anomaly	Global mean of sterodynamic sea level anomaly	m

Description of the variable in Common Data language (CDL)

```
float64 global_mean_sterodynamic_sea_level_anomaly(time)
  global_mean_sterodynamic_sea_level_anomaly:  _FillValue = 9.969209968386869e+36
  global_mean_sterodynamic_sea_level_anomaly:  coverage_content_type =
modelResult
  global_mean_sterodynamic_sea_level_anomaly:  long_name = Global mean of
sterodynamic sea level anomaly
  global_mean_sterodynamic_sea_level_anomaly:  standard_name =
  global_mean_sterodynamic_sea_level_anomaly:  units = m
  global_mean_sterodynamic_sea_level_anomaly:  valid_min = :
0.017658796143049296
  global_mean_sterodynamic_sea_level_anomaly:  valid_max = 0.017642477223663407
  global_mean_sterodynamic_sea_level_anomaly:  coordinates = time
```

Comments

Steric sea level anomaly associated with seawater expansion/contraction due to density changes. note: eccov4 uses a volume-conserving boussinesq formulation of the mitgcm with a free-surface boundary condition with real freshwater flux forcing. changes in ocean mass due to evaporation, precipitation, runoff, and sea-ice growth/melt are reflected in model sea level. however, as a consequence of the boussinsq formulation, changes to seawater density due to net buoyancy fluxes (e.g., global mean surface heating/cooling) do not change model sea level anomaly (etan) via seawater expansion/contraction. changes in global ocean density therefore induce a spurious change in model ocean bottom pressure (phibot) via 'virtual mass fluxes'. the 'greatbatch correction' is a time varying, globally-uniform correction to account for changes in global mean density in boussinesq models. this correction is used to calculate dynamic sea surface height (ssh) and ocean bottom pressure (obp). importantly, there is no dynamical significance to the greatbatch correction but it is required to account for steric changes in global sea level. see greatbatch, 1994. j. of geophys. res. oceans, doi.org/10.1029/94jc00847

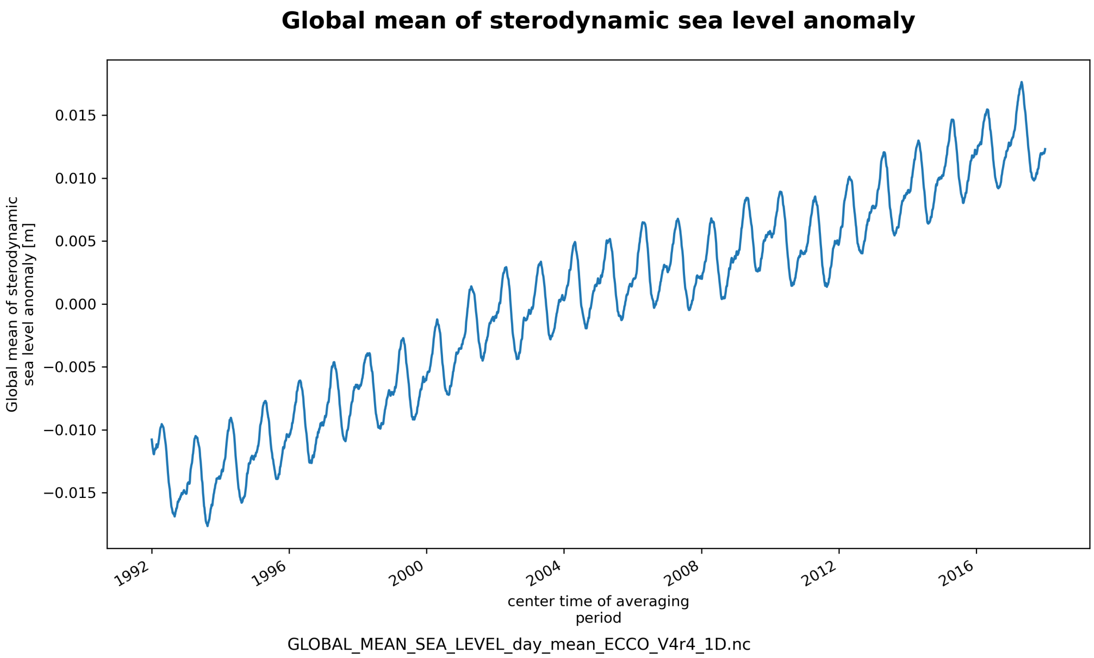

Figure 177: Dataset: GLOBAL_MEAN_SEA_LEVEL, Variable: global_mean_sterodynamic_sea_level_anomaly

15.3 1D dataset of SBO_CORE_PRODUCTS

15.3.1 Overview

This dataset provides a 1D field of the core products of the IERS Special Bureau for the Oceans from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on instantaneous hourly snapshot aas well as daily-average and monthly-average time resolution. Dataset fields include core products of the IERS Special Bureau for the Oceans (https://euler.jpl.nasa.gov/sbo/sbo_home.html), including ocean angular momentum (OAM), center of mass (COM) and global ocean mass, calculated using the basic formulation of Gross et al. (2000). Further details on the available fields are provided in Quinn et al. (2019).

Table 15.7: Coordinates and Variables in the dataset SBO_CORE_PRODUCTS

Variables	Description of data variables	Unit
xoamc	X-comp of oceanic angular momentum due to currents	kg m2 s-1
yoamc	Y-comp of oceanic angular momentum due to currents	kg m2 s-1
zoamc	Z-comp of oceanic angular momentum due to currents	kg m2 s-1
xoamp	X-comp of oceanic angular momentum due to pressure	kg m2 s-1
yoamp	Y-comp of oceanic angular momentum due to pressure	kg m2 s-1
zoamp	Z-comp of oceanic angular momentum due to pressure	kg m2 s-1
mass	Ocean mass	kg
xcom	X-comp of center-of-mass of ocean	m
ycom	Y-comp of center-of-mass of ocean	m
zcom	Z-comp of center-of-mass of ocean	m
sboarea	Surface area of oceans	m2
xoamc_si	X-comp of oceanic angular momentum due to sea-ice motion	kg m2 s-1
yoamc_si	Y-comp of oceanic angular momentum due to sea-ice motion	kg m2 s-1
zoamc_si	Z-comp of oceanic angular momentum due to sea-ice motion	kg m2 s-1
mass_si	Sea-ice mass	kg

Table 15.7: Coordinates and Variables in the dataset SBO_CORE_PRODUCTS

xoamp_fw	X-comp of oceanic angular momentum due to freshwater flux	kg m2 s-1
yoamp_fw	Y-comp of oceanic angular momentum due to freshwater flux	kg m2 s-1
zoamp_fw	Z-comp of oceanic angular momentum due to freshwater flux	kg m2 s-1
mass_fw	Mass due to freshwater flux	kg
xcom_fw	X-comp of center-of-mass of freshwater flux	m
ycom_fw	Y-comp of center-of-mass of freshwater flux	m
zcom_fw	Z-comp of center-of-mass of freshater flux	m
mass_gc	Mass due to the greatbatch correction	kg
xoamp_dsl	X-comp of oceanic angular momentum due to pressure based on dynamic (ib-corrected) sea level	kg m2 s-1
yoamp_dsl	Y-comp of oceanic angular momentum due to pressure based on dynamic (ib-corrected) sea level	kg m2 s-1
zoamp_dsl	Z-comp of oceanic angular momentum due to pressure based on dynamic (ib-corrected) sea level	kg m2 s-1
Coordinates	**Description of data coordinates**	**Unit**
time	Snapshot time	–none–

15.3.2 1D Variable: mass

Table 15.8: Attributes description of the variable 'mass' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	mass	Ocean mass	kg
Description of the variable in Common Data language (CDL)			
float64 mass(time) mass: _FillValue = 9.969209968386869e+36 mass: coverage_content_type = modelResult mass: long_name = ocean mass mass: units = kg mass: valid_min = 1.3737507447512265e+21 mass: valid_max = 1.3737832079900274e+21 mass: coordinates = time			
Comments			
N/a			

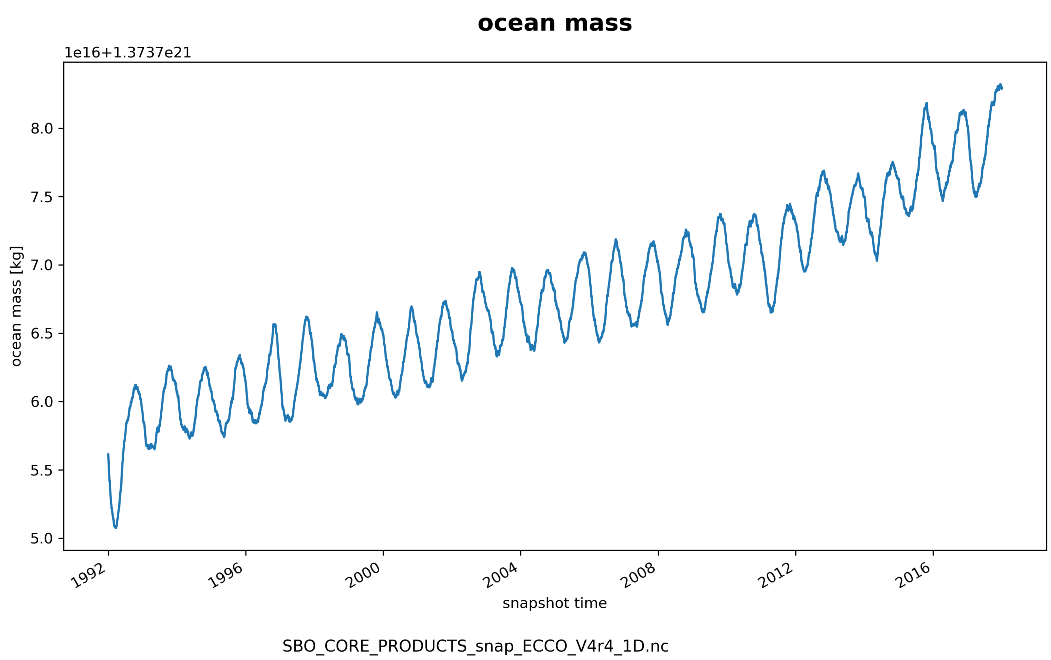

Figure 178: Dataset: SBO_CORE_PRODUCTS, Variable: mass

15.3.3 1D Variable: mass_fw

Table 15.9: Attributes description of the variable 'mass_fw' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	mass_fw	Mass due to freshwater flux	kg
Description of the variable in Common Data language (CDL)			
float64 mass_fw(time) mass_fw: _FillValue = 9.969209968386869e+36 mass_fw: coverage_content_type = modelResult mass_fw: long_name = mass due to freshwater flux mass_fw: units = kg mass_fw: valid_min = 3.7929380693921944e+16 mass_fw: valid_max = 7.0392619494226936e+16 mass_fw: coordinates = time			
Comments			
N/a			

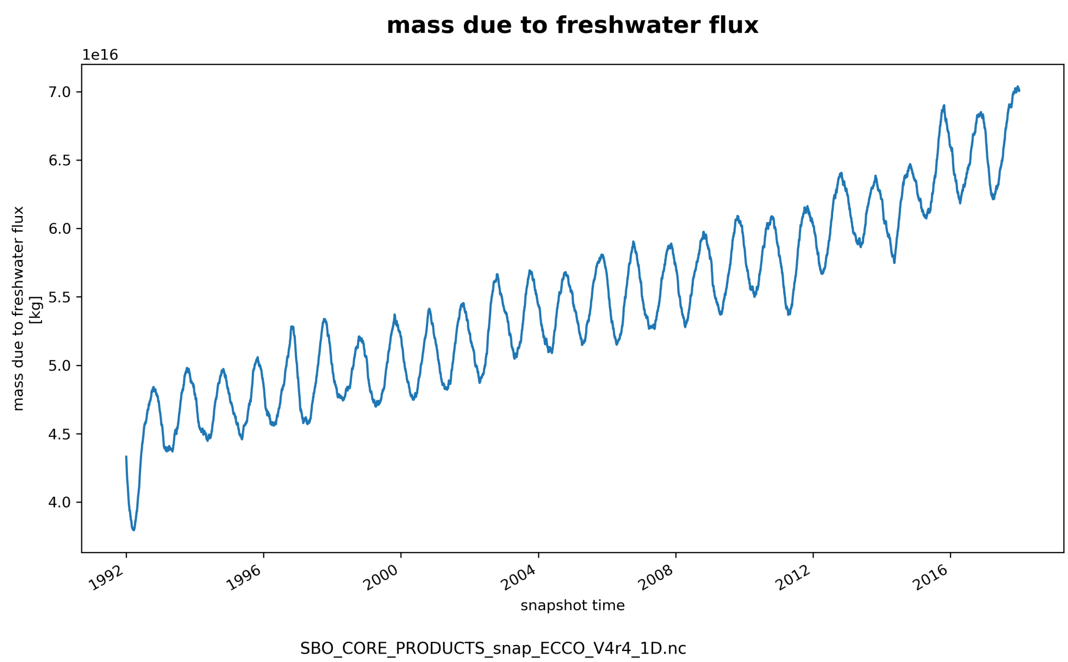

Figure 179: Dataset: SBO_CORE_PRODUCTS, Variable: mass_fw

15.3.4 1D Variable: mass_gc

Table 15.10: Attributes description of the variable 'mass_gc' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	mass_gc	Mass due to the greatbatch correction	kg
Description of the variable in Common Data language (CDL)			

```
float64 mass_gc(time)
   mass_gc:  _FillValue = 9.969209968386869e+36
   mass_gc:  coverage_content_type = modelResult
   mass_gc:  long_name = mass due to the Greatbatch correction
   mass_gc:  units = kg
   mass_gc:  valid_min = :  1.140148294309558e+19
   mass_gc:  valid_max = :  1.1388436906537843e+19
   mass_gc:  coordinates = time
```

Comments
N/a

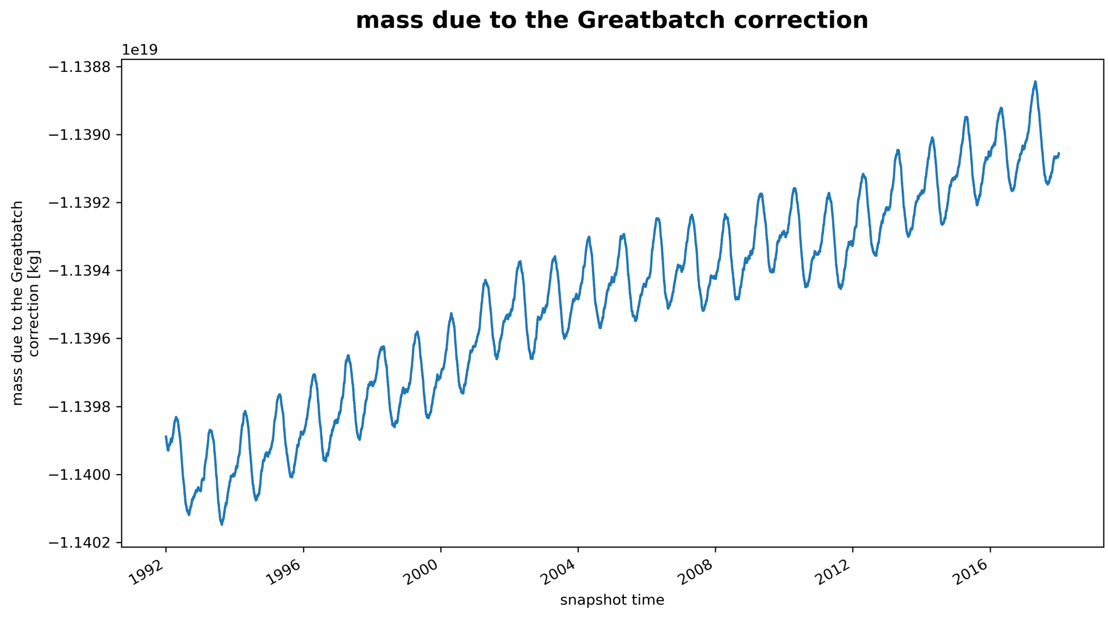

Figure 180: Dataset: SBO_CORE_PRODUCTS, Variable: mass_gc

15.3.5 1D Variable: mass_si

Table 15.11: Attributes description of the variable 'mass_si' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	mass_si	Sea-ice mass	kg
Description of the variable in Common Data language (CDL)			
float64 mass_si(time) mass_si: _FillValue = 9.969209968386869e+36 mass_si: coverage_content_type = modelResult mass_si: long_name = sea: ice mass mass_si: units = kg mass_si: valid_min = 1.5801085624300974e+16 mass_si: valid_max = 3.372421224523182e+16 mass_si: coordinates = time			
Comments			
N/a			

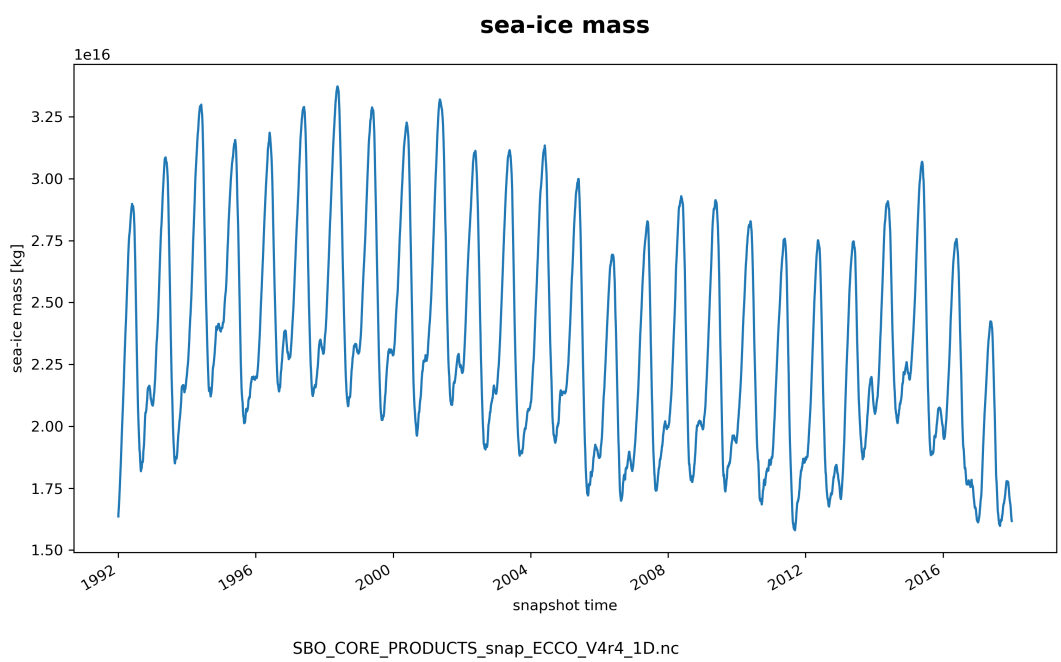

Figure 181: Dataset: SBO_CORE_PRODUCTS, Variable: mass_si

15.3.6 1D Variable: sboarea

Table 15.12: Attributes description of the variable 'sboarea' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	sboarea	Surface area of oceans	m2
Description of the variable in Common Data language (CDL)			

```
float64 sboarea(time)
   sboarea:  _FillValue = 9.969209968386869e+36
   sboarea:  coverage_content_type = modelResult
   sboarea:  long_name = surface area of oceans
   sboarea:  units = m2
   sboarea:  valid_min = 358013861149443.5
   sboarea:  valid_max = 358013861149443.5
   sboarea:  coordinates = time
```

Comments
Note: ocean surface area is constant but provided as time series for convenience

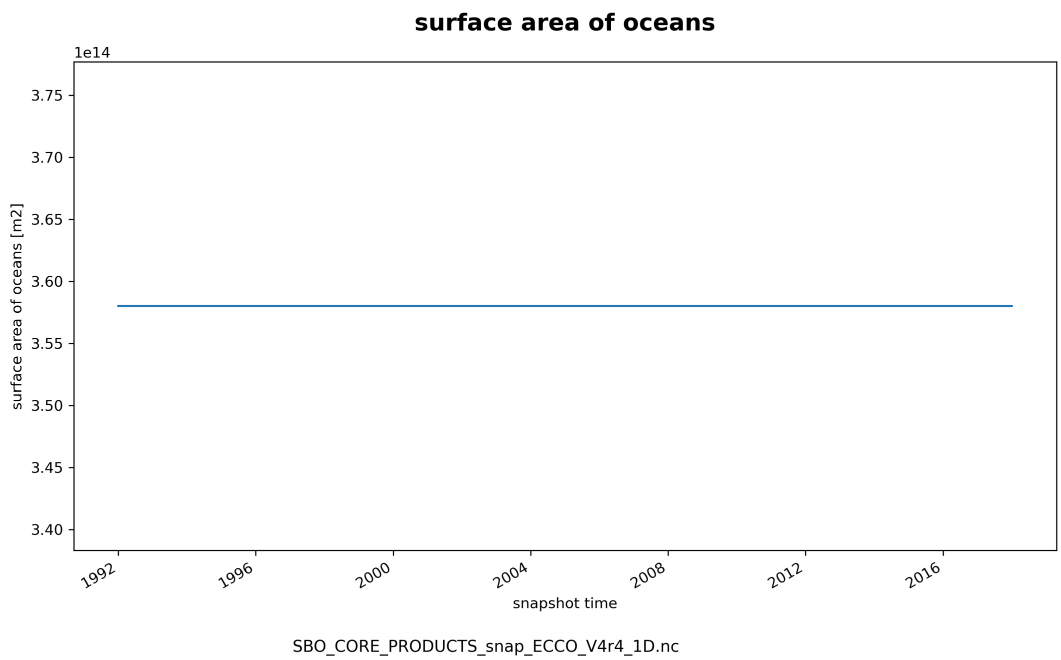

Figure 182: Dataset: SBO_CORE_PRODUCTS, Variable: sboarea

15.3.7 1D Variable: xcom

Table 15.13: Attributes description of the variable 'xcom' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	xcom	X-comp of center-of-mass of ocean	m
Description of the variable in Common Data language (CDL)			
float64 xcom(time) xcom: _FillValue = 9.969209968386869e+36 xcom: coverage_content_type = modelResult xcom: long_name = x: comp of center: of: mass of ocean xcom: units = m xcom: valid_min = : 763730.0399730895 xcom: valid_max = : 763667.0104211655 xcom: coordinates = time			
Comments			
N/a			

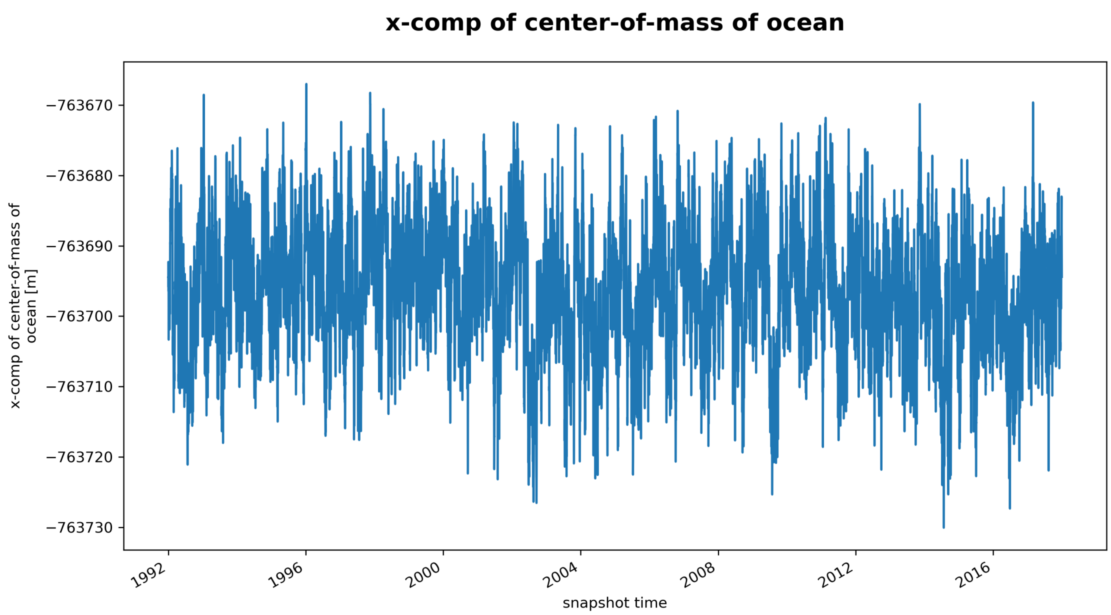

Figure 183: Dataset: SBO_CORE_PRODUCTS, Variable: xcom

15.3.8 1D Variable: xcom_fw

Table 15.14: Attributes description of the variable 'xcom_fw' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	xcom_fw	X-comp of center-of-mass of freshwater flux	m
Description of the variable in Common Data language (CDL)			
float64 xcom_fw(time) xcom_fw: _FillValue = 9.969209968386869e+36 xcom_fw: coverage_content_type = modelResult xcom_fw: long_name = x: comp of center: of: mass of freshwater flux xcom_fw: units = m xcom_fw: valid_min = : 573864.6948562702 xcom_fw: valid_max = : 573864.6948562652 xcom_fw: coordinates = time			
Comments			
N/a			

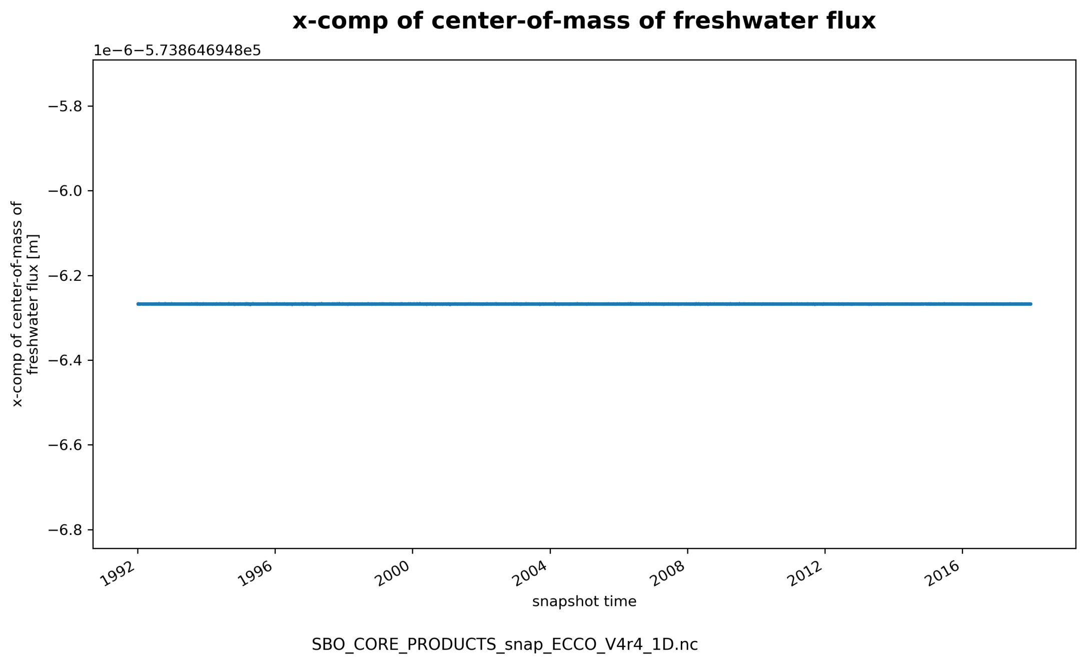

Figure 184: Dataset: SBO_CORE_PRODUCTS, Variable: xcom_fw

15.3.9 1D Variable: xoamc

Table 15.15: Attributes description of the variable 'xoamc' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	xoamc	X-comp of oceanic angular momentum due to currents	kg m2 s-1

Description of the variable in Common Data language (CDL)

```
float64 xoamc(time)
   xoamc:  _FillValue = 9.969209968386869e+36
   xoamc:  coverage_content_type = modelResult
   xoamc:  long_name = x:  comp of oceanic angular momentum due to currents
   xoamc:  units = kg m2 s:  1
   xoamc:  valid_min = :  3.783733447704127e+24
   xoamc:  valid_max = 2.555331552045857e+24
   xoamc:  coordinates = time
```

Comments

N/a

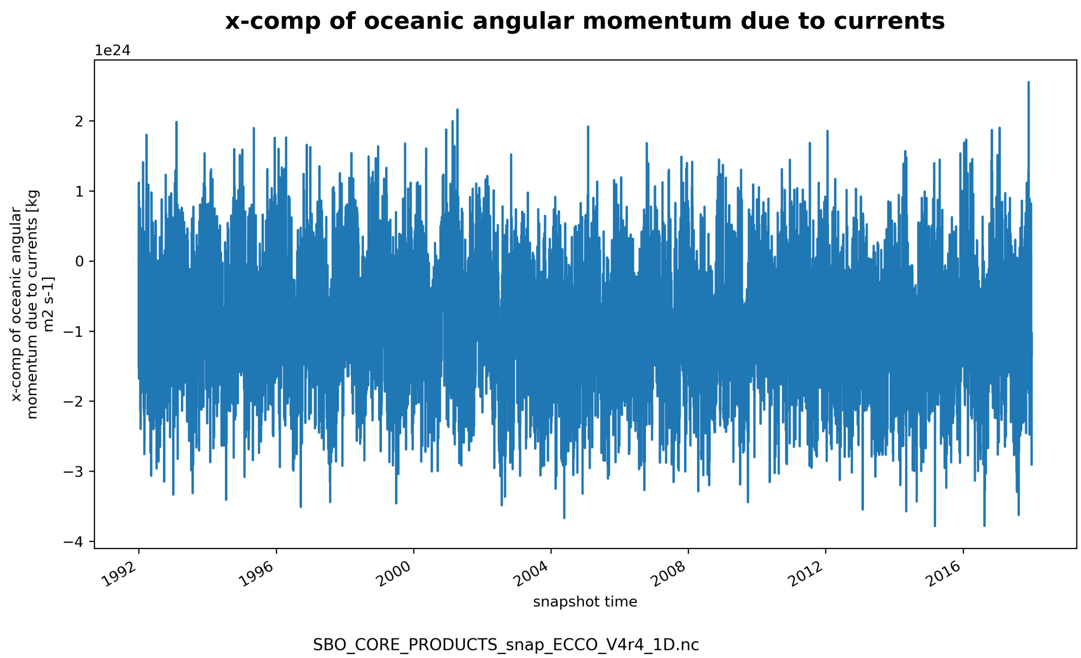

Figure 185: Dataset: SBO_CORE_PRODUCTS, Variable: xoamc

15.3.10 1D Variable: xoamc_si

Table 15.16: Attributes description of the variable 'xoamc_si' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	xoamc_si	X-comp of oceanic angular momentum due to sea-ice motion	kg m2 s-1
Description of the variable in Common Data language (CDL)			
float64 xoamc_si(time) xoamc_si: _FillValue = 9.969209968386869e+36 xoamc_si: coverage_content_type = modelResult xoamc_si: long_name = x: comp of oceanic angular momentum due to sea: ice motion xoamc_si: units = kg m2 s: 1 xoamc_si: valid_min = : 9.76342837969224e+21 xoamc_si: valid_max = 1.3721188892065168e+22 xoamc_si: coordinates = time			
Comments			
N/a			

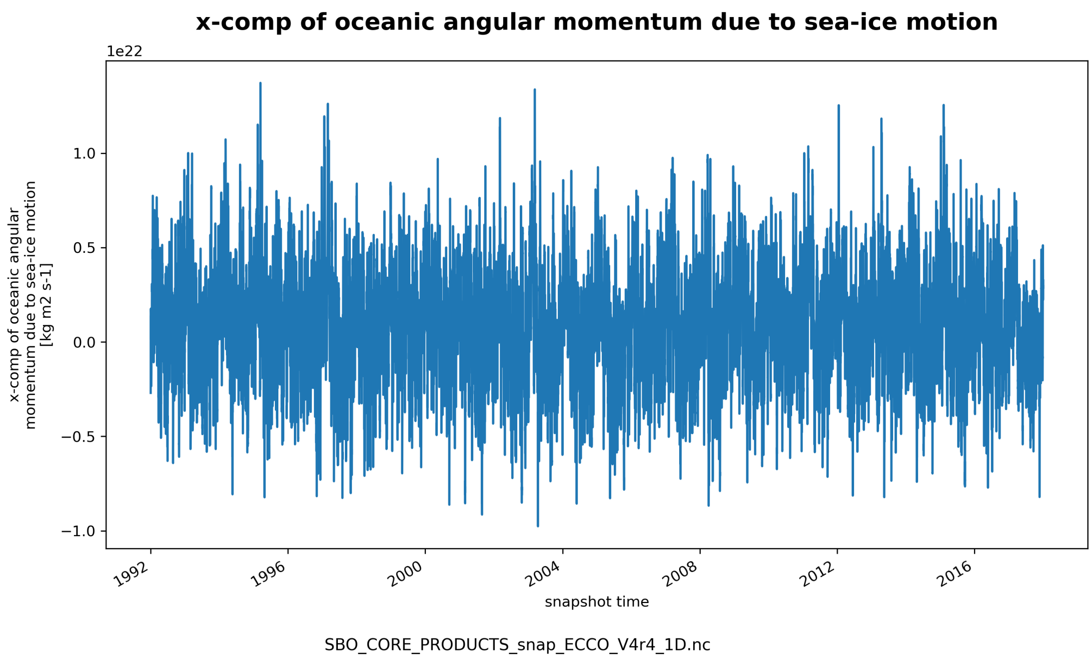

Figure 186: Dataset: SBO_CORE_PRODUCTS, Variable: xoamc_si

15.3.11 1D Variable: xoamp

Table 15.17: Attributes description of the variable 'xoamp' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	xoamp	X-comp of oceanic angular momentum due to pressure	kg m2 s-1
Description of the variable in Common Data language (CDL)			

```
float64 xoamp(time)
   xoamp:  _FillValue = 9.969209968386869e+36
   xoamp:  coverage_content_type = modelResult
   xoamp:  long_name = x:  comp of oceanic angular momentum due to pressure
   xoamp:  units = kg m2 s:  1
   xoamp:  valid_min = 1.3543642768158851e+29
   xoamp:  valid_max = 1.3546098666231897e+29
   xoamp:  coordinates = time
```

Comments
N/a

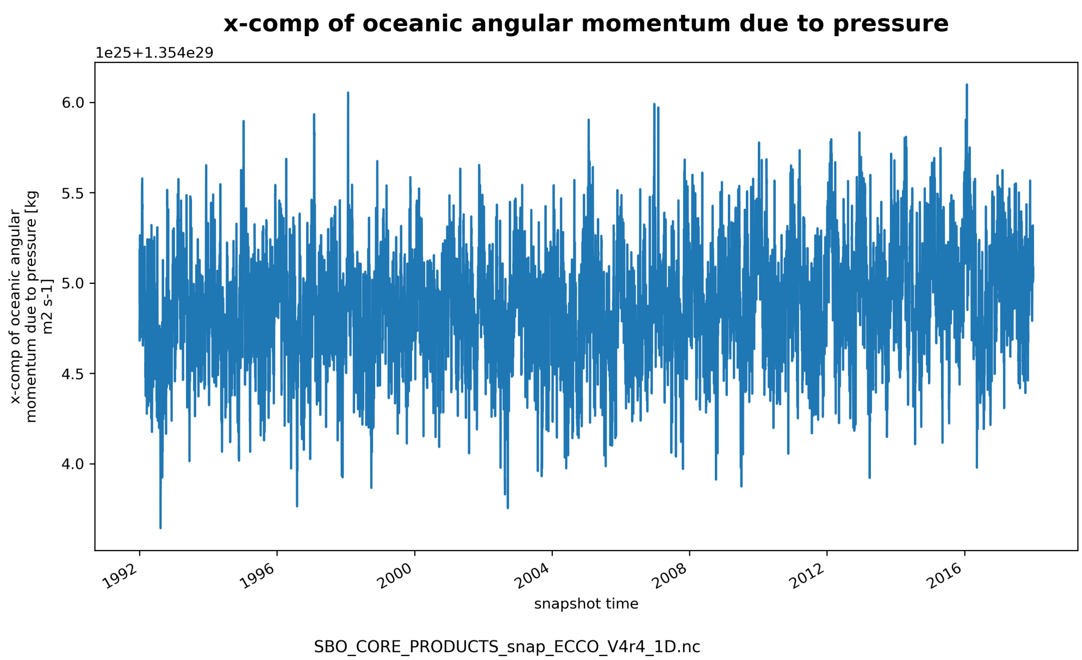

Figure 187: Dataset: SBO_CORE_PRODUCTS, Variable: xoamp

15.3.12 1D Variable: xoamp_dsl

Table 15.18: Attributes description of the variable 'xoamp_dsl' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	xoamp_dsl	X-comp of oceanic angular momentum due to pressure based on dynamic (ib-corrected) sea level	kg m2 s-1

Description of the variable in Common Data language (CDL)

```
float64 xoamp_dsl(time)
   xoamp_dsl:  _FillValue = 9.969209968386869e+36
   xoamp_dsl:  coverage_content_type = modelResult
   xoamp_dsl:  long_name = x:  comp of oceanic angular momentum due to pressure
based on dynamic (IB: corrected) sea level
   xoamp_dsl:  units = kg m2 s:  1
   xoamp_dsl:  valid_min = 1.354440386439953e+29
   xoamp_dsl:  valid_max = 1.3545518352698056e+29
   xoamp_dsl:  coordinates = time
```

Comments

N/a

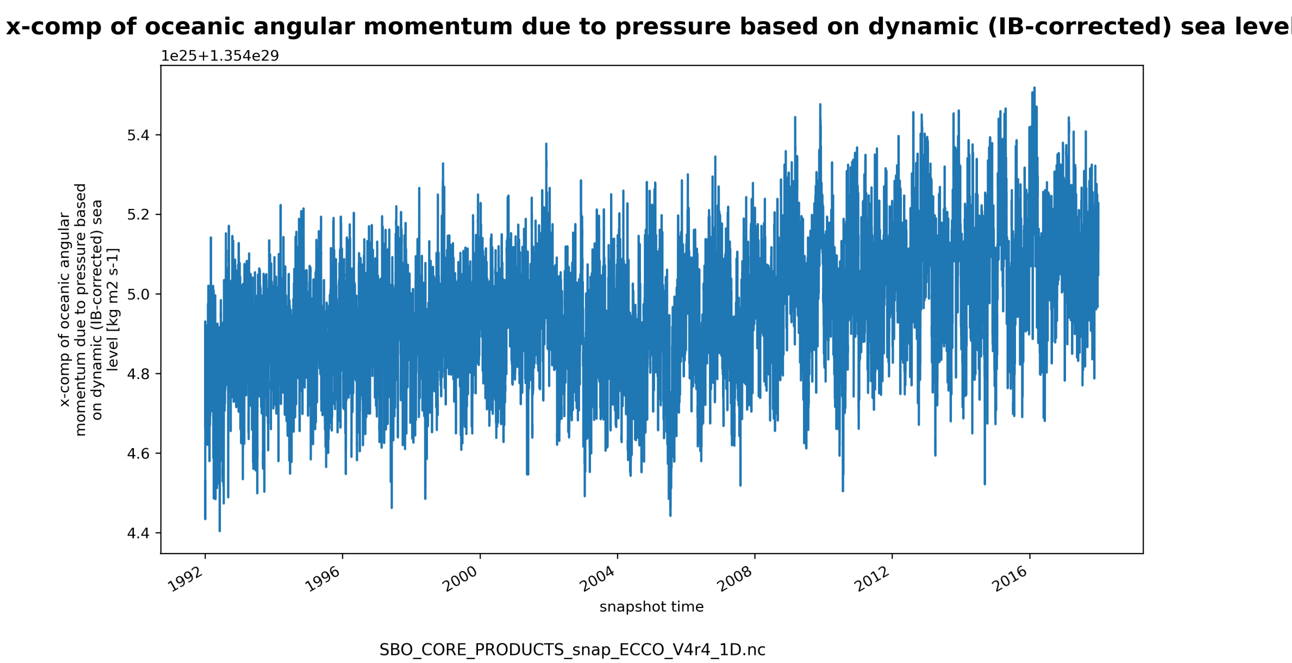

Figure 188: Dataset: SBO_CORE_PRODUCTS, Variable: xoamp_dsl

15.3.13 1D Variable: xoamp_fw

Table 15.19: Attributes description of the variable 'xoamp_fw' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	xoamp_fw	X-comp of oceanic angular momentum due to freshwater flux	kg m2 s-1
Description of the variable in Common Data language (CDL)			
float64 xoamp_fw(time) xoamp_fw: _FillValue = 9.969209968386869e+36 xoamp_fw: coverage_content_type = modelResult xoamp_fw: long_name = x: comp of oceanic angular momentum due to freshwater flux xoamp_fw: units = kg m2 s: 1 xoamp_fw: valid_min = 1.805799644912138e+24 xoamp_fw: valid_max = 3.351358892803656e+24 xoamp_fw: coordinates = time			
Comments			
N/a			

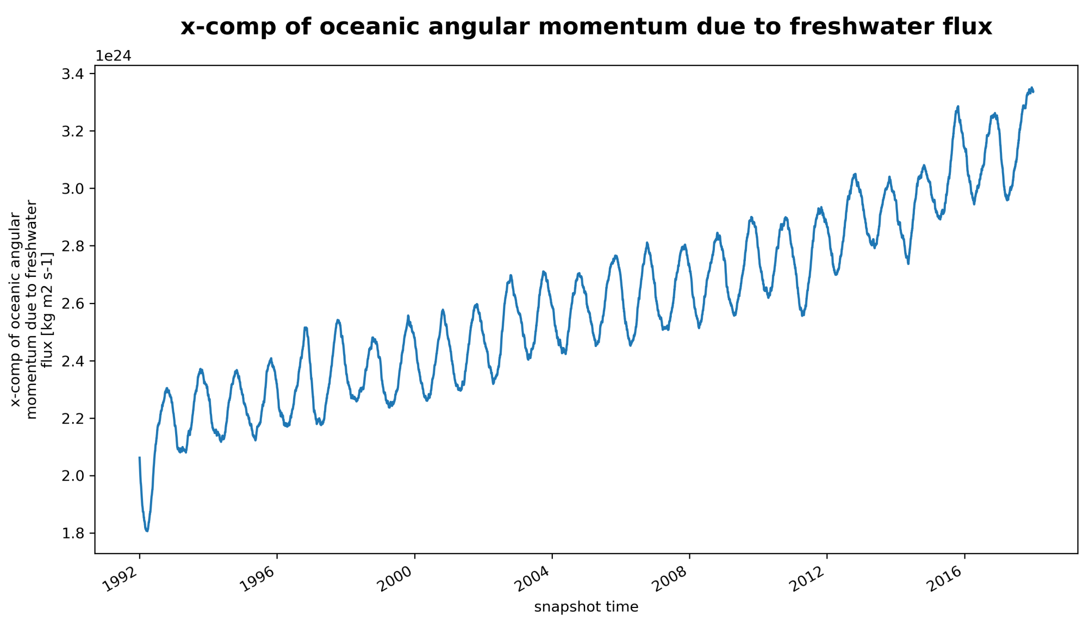

Figure 189: Dataset: SBO_CORE_PRODUCTS, Variable: xoamp_fw

15.3.14 1D Variable: ycom

Table 15.20: Attributes description of the variable 'ycom' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	ycom	Y-comp of center-of-mass of ocean	m
Description of the variable in Common Data language (CDL)			

```
float64 ycom(time)
   ycom:  _FillValue = 9.969209968386869e+36
   ycom:  coverage_content_type = modelResult
   ycom:  long_name = y:  comp of center:  of:  mass of ocean
   ycom:  units = m
   ycom:  valid_min = :  466387.24450374383
   ycom:  valid_max = :  466327.21844756586
   ycom:  coordinates = time
```

Comments

N/a

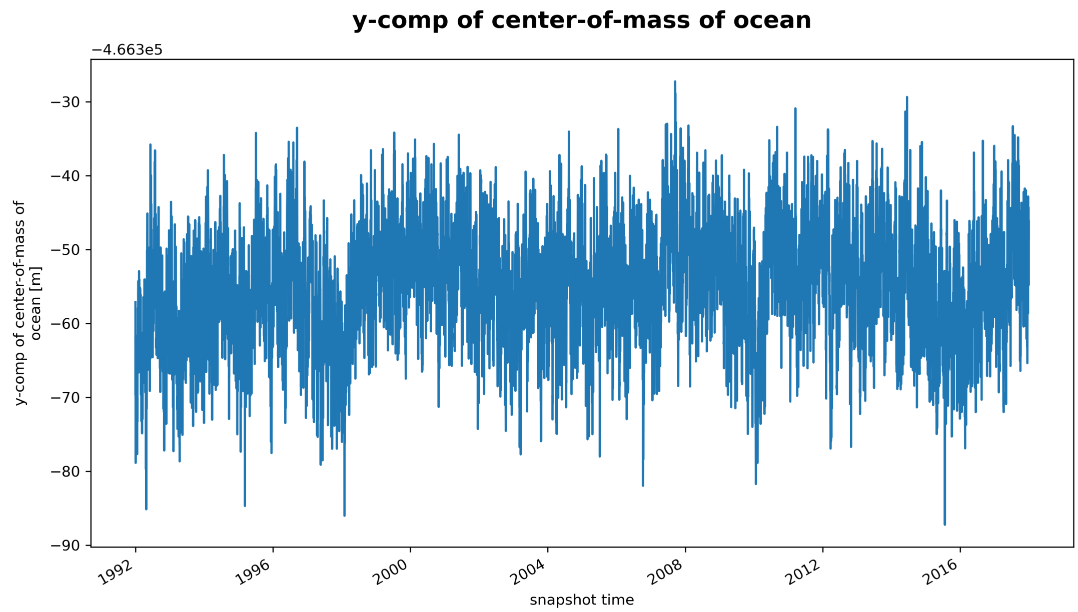

Figure 190: Dataset: SBO_CORE_PRODUCTS, Variable: ycom

15.3.15 1D Variable: ycom_fw

Table 15.21: Attributes description of the variable 'ycom_fw' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	ycom_fw	Y-comp of center-of-mass of freshwater flux	m
Description of the variable in Common Data language (CDL)			
float64 ycom_fw(time) ycom_fw: _FillValue = 9.969209968386869e+36 ycom_fw: coverage_content_type = modelResult ycom_fw: long_name = y: comp of center: of: mass of freshwater flux ycom_fw: units = m ycom_fw: valid_min = : 324750.41529212013 ycom_fw: valid_max = : 324750.4152921157 ycom_fw: coordinates = time			
Comments			
N/a			

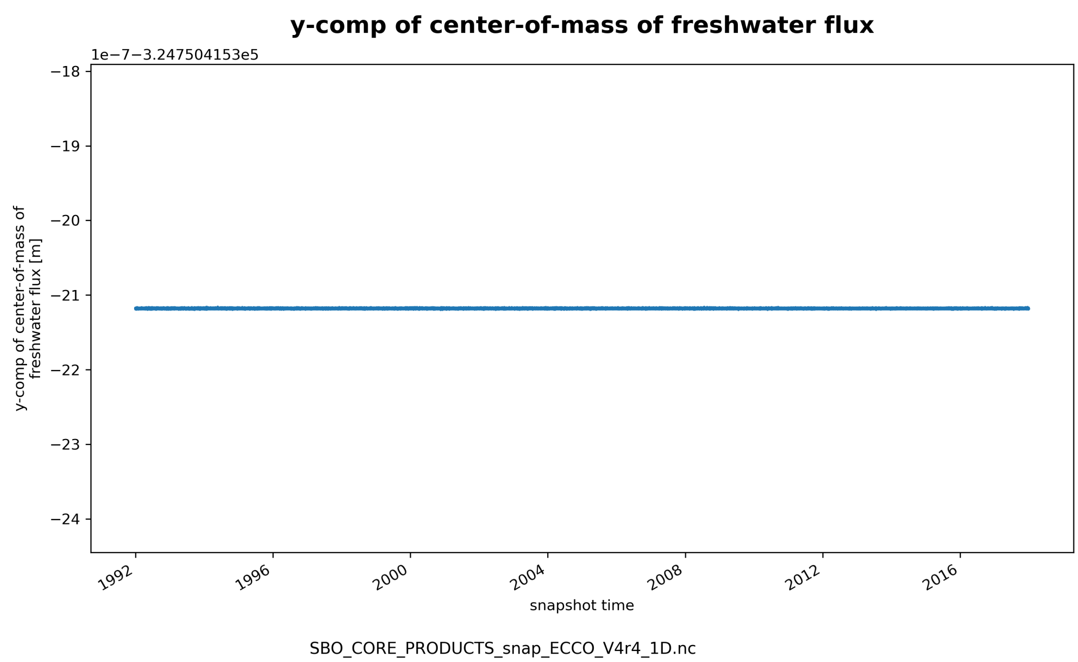

Figure 191: Dataset: SBO_CORE_PRODUCTS, Variable: ycom_fw

15.3.16 1D Variable: yoamc

Table 15.22: Attributes description of the variable 'yoamc' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	yoamc	Y-comp of oceanic angular momentum due to currents	kg m2 s-1
Description of the variable in Common Data language (CDL)			
float64 yoamc(time) yoamc: _FillValue = 9.969209968386869e+36 yoamc: coverage_content_type = modelResult yoamc: long_name = y: comp of oceanic angular momentum due to currents yoamc: units = kg m2 s: 1 yoamc: valid_min = : 2.19249690136359e+24 yoamc: valid_max = 4.179441018940977e+24 yoamc: coordinates = time			
Comments			
N/a			

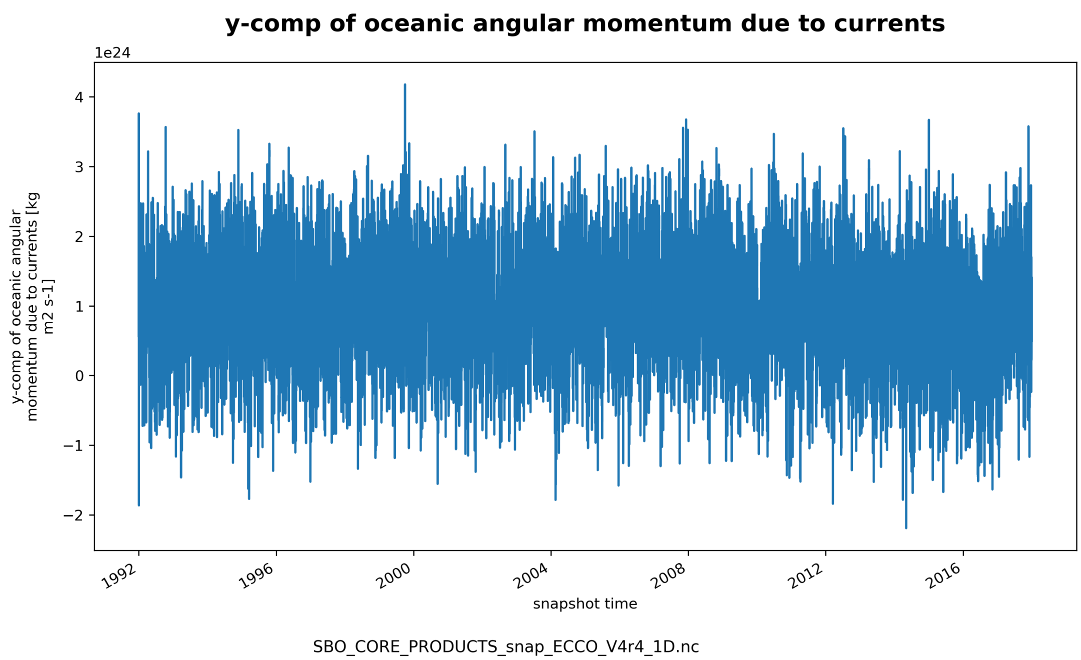

Figure 192: Dataset: SBO_CORE_PRODUCTS, Variable: yoamc

15.3.17 1D Variable: yoamc_si

Table 15.23: Attributes description of the variable 'yoamc_si' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	yoamc_si	Y-comp of oceanic angular momentum due to sea-ice motion	kg m2 s-1

Description of the variable in Common Data language (CDL)

```
float64 yoamc_si(time)
   yoamc_si:  _FillValue = 9.969209968386869e+36
   yoamc_si:  coverage_content_type = modelResult
   yoamc_si:  long_name = y:  comp of oceanic angular momentum due to sea:  ice
motion
   yoamc_si:  units = kg m2 s:  1
   yoamc_si:  valid_min = :  1.176556337395274e+22
   yoamc_si:  valid_max = 1.6107851446370722e+22
   yoamc_si:  coordinates = time
```

Comments

N/a

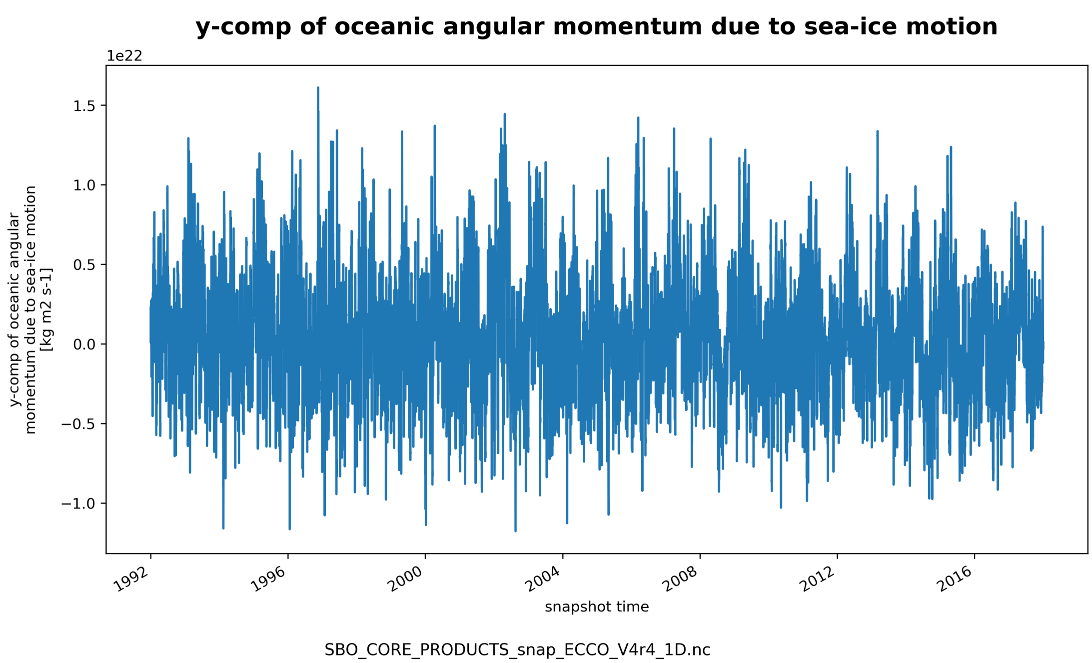

Figure 193: Dataset: SBO_CORE_PRODUCTS, Variable: yoamc_si

15.3.18 1D Variable: yoamp

Table 15.24: Attributes description of the variable 'yoamp' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	yoamp	Y-comp of oceanic angular momentum due to pressure	kg m2 s-1

Description of the variable in Common Data language (CDL)

```
float64 yoamp(time)
   yoamp:  _FillValue = 9.969209968386869e+36
   yoamp:  coverage_content_type = modelResult
   yoamp:  long_name = y:  comp of oceanic angular momentum due to pressure
   yoamp:  units = kg m2 s:  1
   yoamp:  valid_min = 1.0476388397938864e+29
   yoamp:  valid_max = 1.0478581623131764e+29
   yoamp:  coordinates = time
```

Comments

N/a

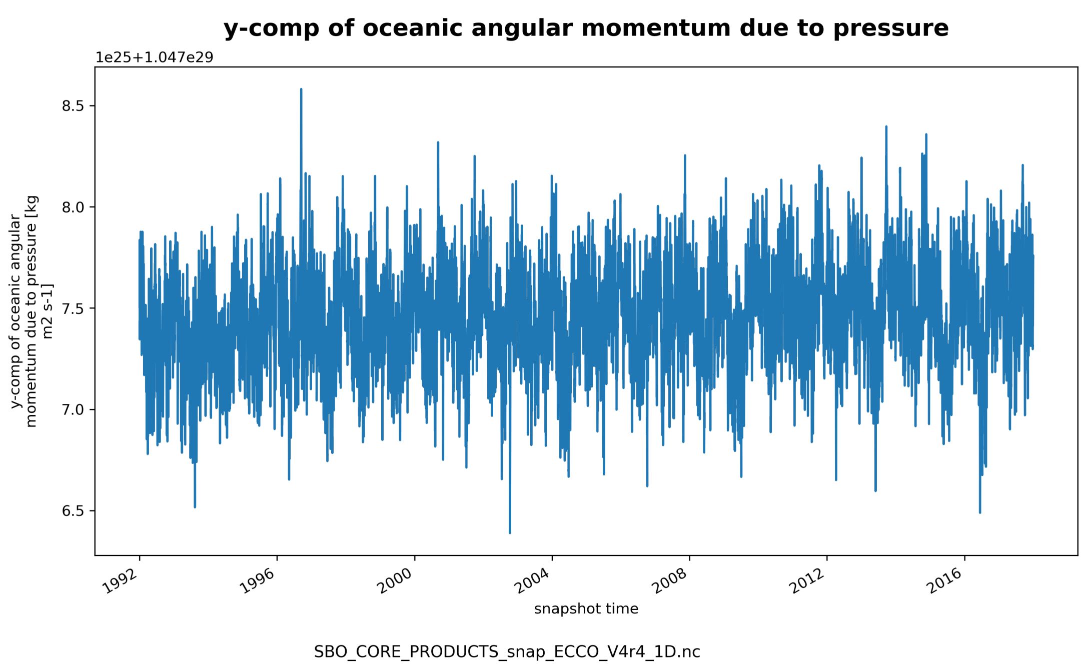

Figure 194: Dataset: SBO_CORE_PRODUCTS, Variable: yoamp

15.3.19 1D Variable: yoamp_dsl

Table 15.25: Attributes description of the variable 'yoamp_dsl' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	yoamp_dsl	Y-comp of oceanic angular momentum due to pressure based on dynamic (ib-corrected) sea level	kg m2 s-1
Description of the variable in Common Data language (CDL)			
float64 yoamp_dsl(time) yoamp_dsl: _FillValue = 9.969209968386869e+36 yoamp_dsl: coverage_content_type = modelResult yoamp_dsl: long_name = y: comp of oceanic angular momentum due to pressure based on dynamic (IB: corrected) sea level yoamp_dsl: units = kg m2 s: 1 yoamp_dsl: valid_min = 1.0476994334049981e+29 yoamp_dsl: valid_max = 1.0478187262074598e+29 yoamp_dsl: coordinates = time			
Comments			
N/a			

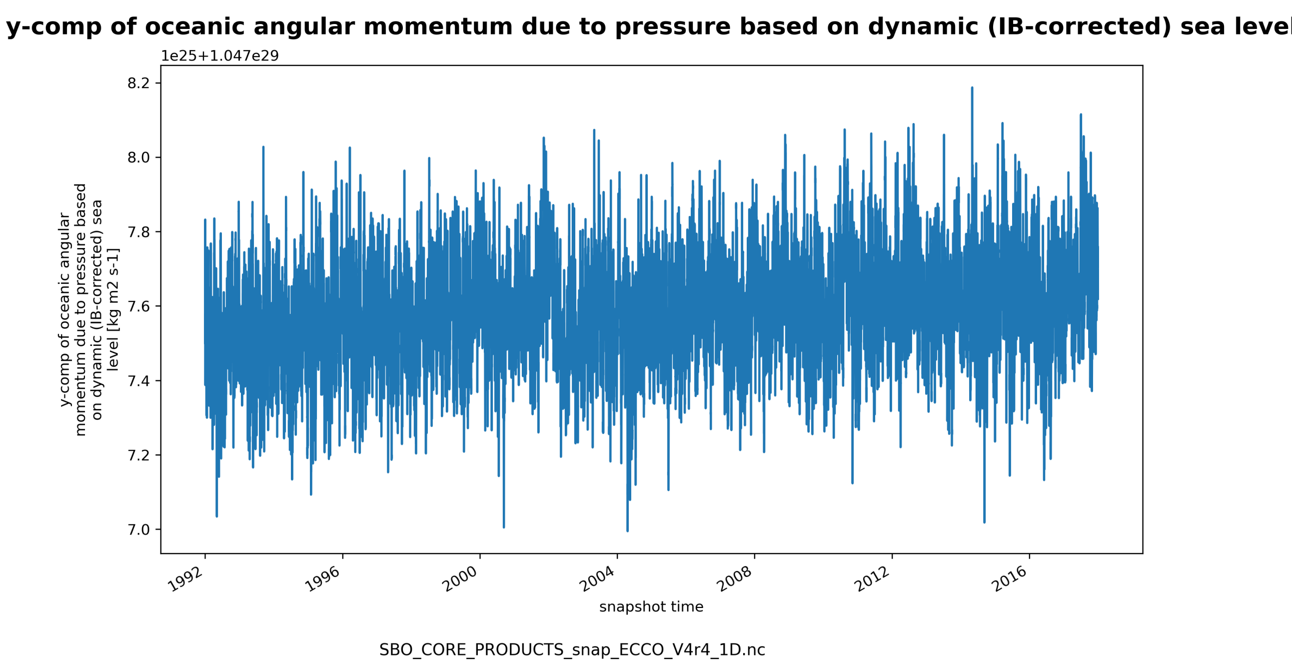

Figure 195: Dataset: SBO_CORE_PRODUCTS, Variable: yoamp_dsl

15.3.20 1D Variable: yoamp_fw

Table 15.26: Attributes description of the variable 'yoamp_fw' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	yoamp_fw	Y-comp of oceanic angular momentum due to freshwater flux	kg m2 s-1
Description of the variable in Common Data language (CDL)			

```
float64 yoamp_fw(time)
   yoamp_fw:  _FillValue = 9.969209968386869e+36
   yoamp_fw:  coverage_content_type = modelResult
   yoamp_fw:  long_name = y:  comp of oceanic angular momentum due to freshwater
flux
   yoamp_fw:  units = kg m2 s:  1
   yoamp_fw:  valid_min = 2.6255410225894626e+24
   yoamp_fw:  valid_max = 4.872705717529432e+24
   yoamp_fw:  coordinates = time
```

Comments

N/a

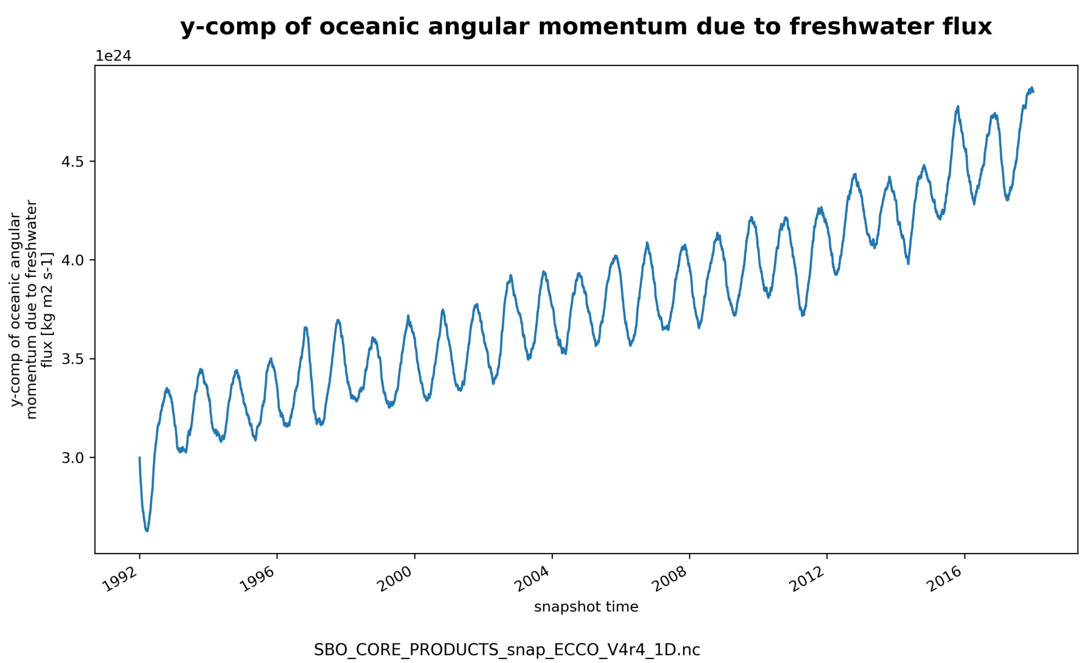

Figure 196: Dataset: SBO_CORE_PRODUCTS, Variable: yoamp_fw

15.3.21 1D Variable: zcom

Table 15.27: Attributes description of the variable 'zcom' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	zcom	Z-comp of center-of-mass of ocean	m
Description of the variable in Common Data language (CDL)			

```
float64 zcom(time)
   zcom:  _FillValue = 9.969209968386869e+36
   zcom:  coverage_content_type = modelResult
   zcom:  long_name = z:  comp of center:  of:  mass of ocean
   zcom:  units = m
   zcom:  valid_min = :  875420.3898804963
   zcom:  valid_max = :  875350.3238026679
   zcom:  coordinates = time
```

Comments
N/a

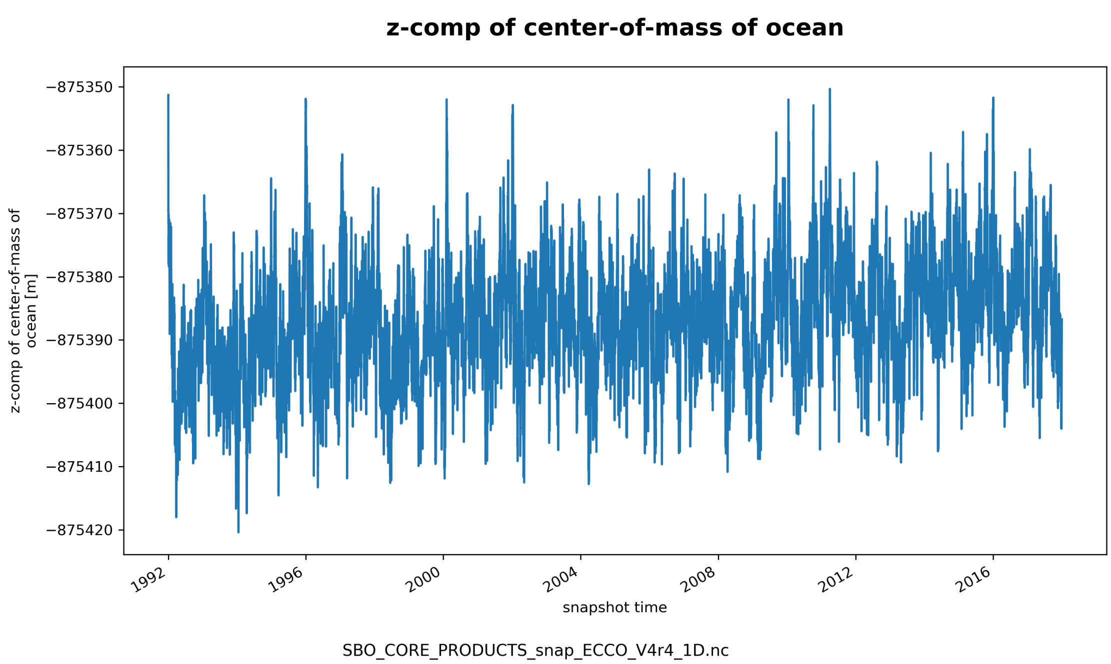

Figure 197: Dataset: SBO_CORE_PRODUCTS, Variable: zcom

15.3.22 1D Variable: zcom_fw

Table 15.28: Attributes description of the variable 'zcom_fw' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	zcom_fw	Z-comp of center-of-mass of freshater flux	m
Description of the variable in Common Data language (CDL)			
float64 zcom_fw(time) zcom_fw: _FillValue = 9.969209968386869e+36 zcom_fw: coverage_content_type = modelResult zcom_fw: long_name = z: comp of center: of: mass of freshater flux zcom_fw: units = m zcom_fw: valid_min = : 648386.5781734617 zcom_fw: valid_max = : 648386.5781734567 zcom_fw: coordinates = time			
Comments			
N/a			

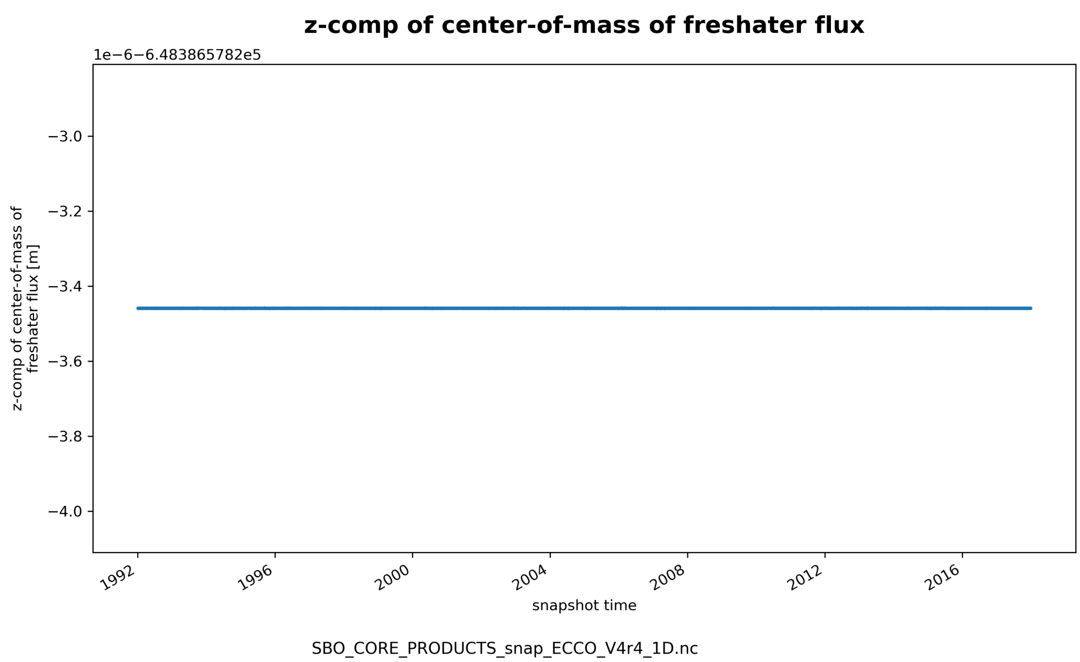

Figure 198: Dataset: SBO_CORE_PRODUCTS, Variable: zcom_fw

15.3.23 1D Variable: zoamc

Table 15.29: Attributes description of the variable 'zoamc' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	zoamc	Z-comp of oceanic angular momentum due to currents	kg m2 s-1

Description of the variable in Common Data language (CDL)

```
float64 zoamc(time)
   zoamc:  _FillValue = 9.969209968386869e+36
   zoamc:  coverage_content_type = modelResult
   zoamc:  long_name = z:  comp of oceanic angular momentum due to currents
   zoamc:  units = kg m2 s:  1
   zoamc:  valid_min = 7.331764457927521e+24
   zoamc:  valid_max = 2.207264300276968e+25
   zoamc:  coordinates = time
```

Comments

N/a

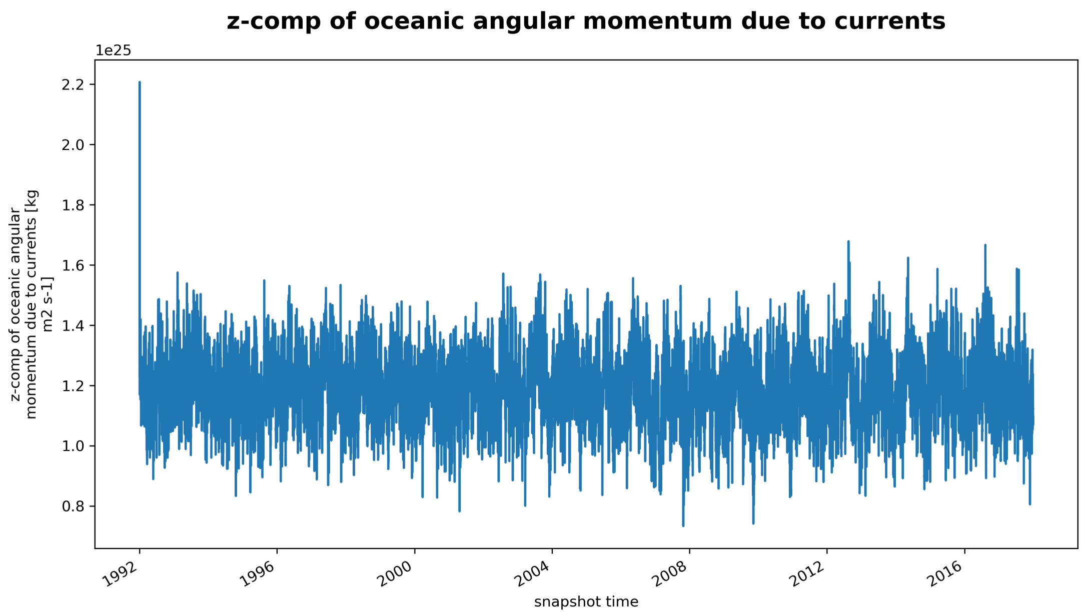

Figure 199: Dataset: SBO_CORE_PRODUCTS, Variable: zoamc

15.3.24 1D Variable: zoamc_si

Table 15.30: Attributes description of the variable 'zoamc_si' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	zoamc_si	Z-comp of oceanic angular momentum due to sea-ice motion	kg m2 s-1
Description of the variable in Common Data language (CDL)			
float64 zoamc_si(time) zoamc_si: _FillValue = 9.969209968386869e+36 zoamc_si: coverage_content_type = modelResult zoamc_si: long_name = z: comp of oceanic angular momentum due to sea: ice motion zoamc_si: units = kg m2 s: 1 zoamc_si: valid_min = : 5.909426721868294e+21 zoamc_si: valid_max = 5.930388258256482e+21 zoamc_si: coordinates = time			
Comments			
N/a			

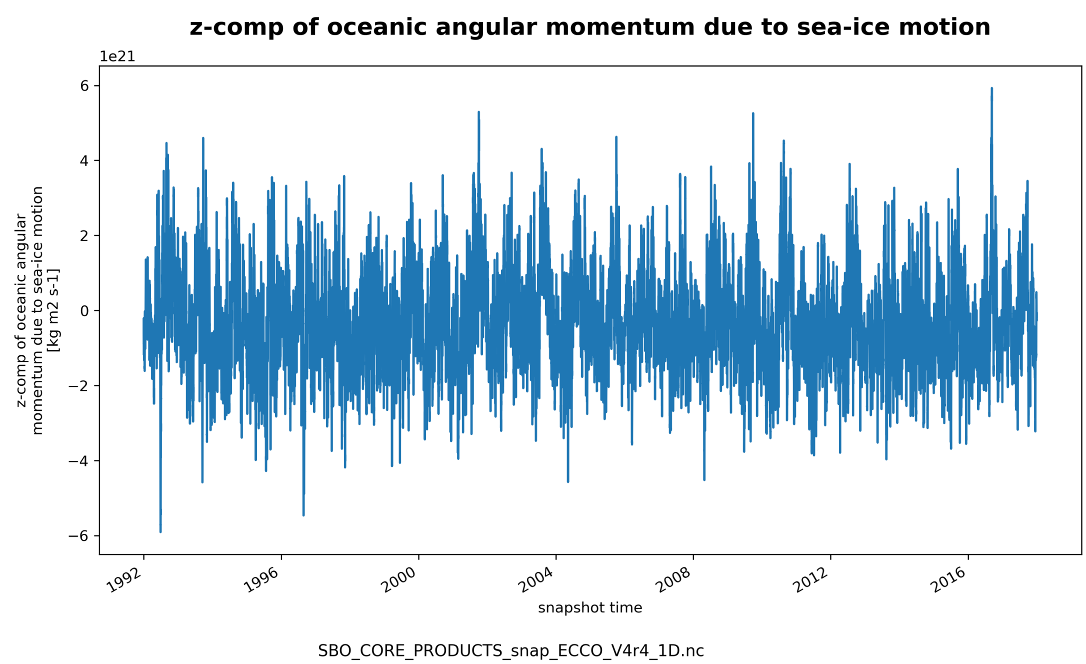

Figure 200: Dataset: SBO_CORE_PRODUCTS, Variable: zoamc_si

15.3.25 1D Variable: zoamp

Table 15.31: Attributes description of the variable 'zoamp' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	zoamp	Z-comp of oceanic angular momentum due to pressure	kg m2 s-1
Description of the variable in Common Data language (CDL)			

```
float64 zoamp(time)
   zoamp:  _FillValue = 9.969209968386869e+36
   zoamp:  coverage_content_type = modelResult
   zoamp:  long_name = z:  comp of oceanic angular momentum due to pressure
   zoamp:  units = kg m2 s:  1
   zoamp:  valid_min = 2.927645942668479e+30
   zoamp:  valid_max = 2.9277200254389854e+30
   zoamp:  coordinates = time
```

Comments
N/a

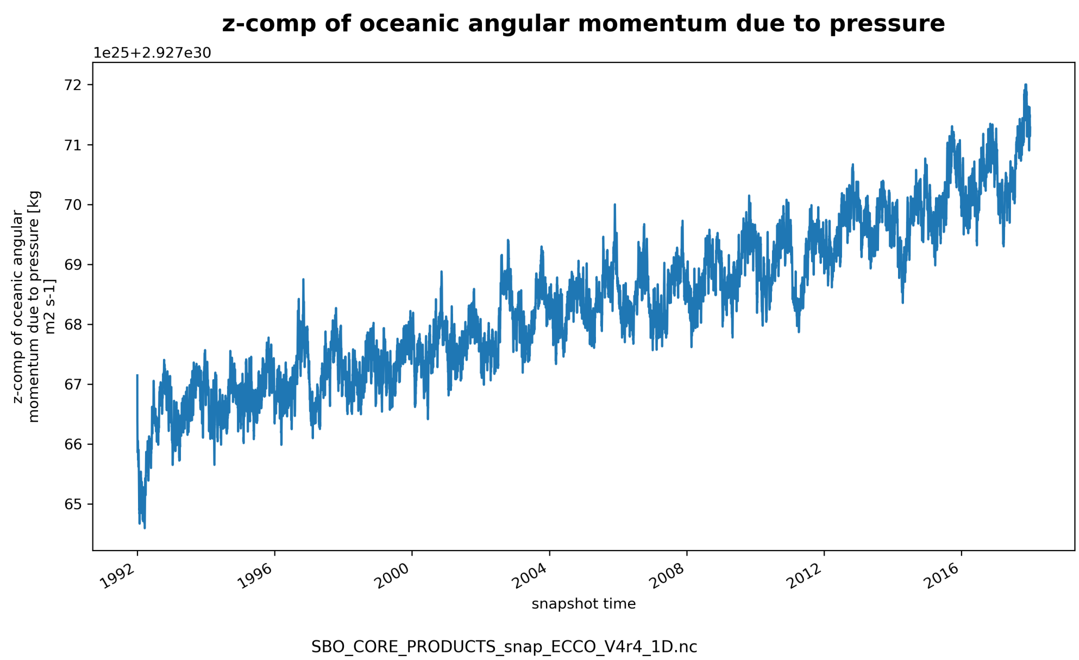

Figure 201: Dataset: SBO_CORE_PRODUCTS, Variable: zoamp

15.3.26 1D Variable: zoamp_dsl

Table 15.32: Attributes description of the variable 'zoamp_dsl' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	zoamp_dsl	Z-comp of oceanic angular momentum due to pressure based on dynamic (ib-corrected) sea level	kg m2 s-1
Description of the variable in Common Data language (CDL)			
float64 zoamp_dsl(time) zoamp_dsl: _FillValue = 9.969209968386869e+36 zoamp_dsl: coverage_content_type = modelResult zoamp_dsl: long_name = z: comp of oceanic angular momentum due to pressure based on dynamic (IB: corrected) sea level zoamp_dsl: units = kg m2 s: 1 zoamp_dsl: valid_min = 2.9276609546728614e+30 zoamp_dsl: valid_max = 2.9277328440911863e+30 zoamp_dsl: coordinates = time			
Comments			
N/a			

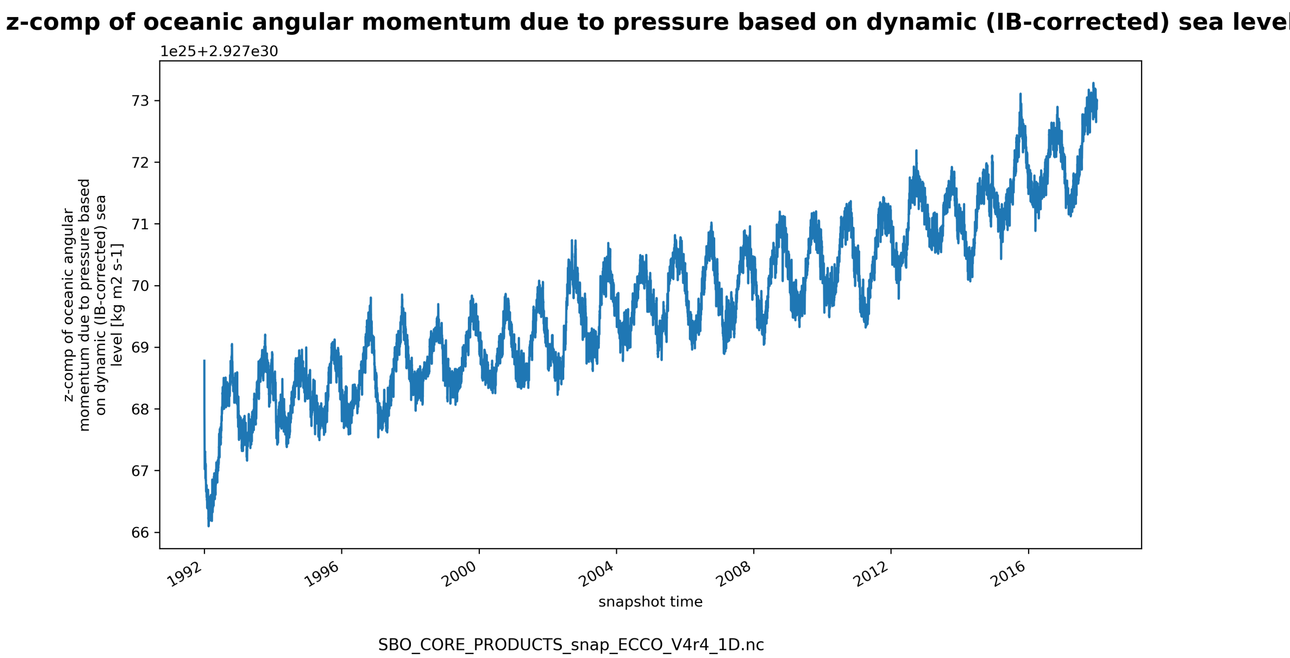

Figure 202: Dataset: SBO_CORE_PRODUCTS, Variable: zoamp_dsl

15.3.27 1D Variable: zoamp_fw

Table 15.33: Attributes description of the variable 'zoamp_fw' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	zoamp_fw	Z-comp of oceanic angular momentum due to freshwater flux	kg m2 s-1

Description of the variable in Common Data language (CDL)

```
float64 zoamp_fw(time)
   zoamp_fw:  _FillValue = 9.969209968386869e+36
   zoamp_fw:  coverage_content_type = modelResult
   zoamp_fw:  long_name = z:  comp of oceanic angular momentum due to freshwater
flux
   zoamp_fw:  units = kg m2 s:  1
   zoamp_fw:  valid_min = 7.774584605728723e+25
   zoamp_fw:  valid_max = 1.442874536478883e+26
   zoamp_fw:  coordinates = time
```

Comments

N/a

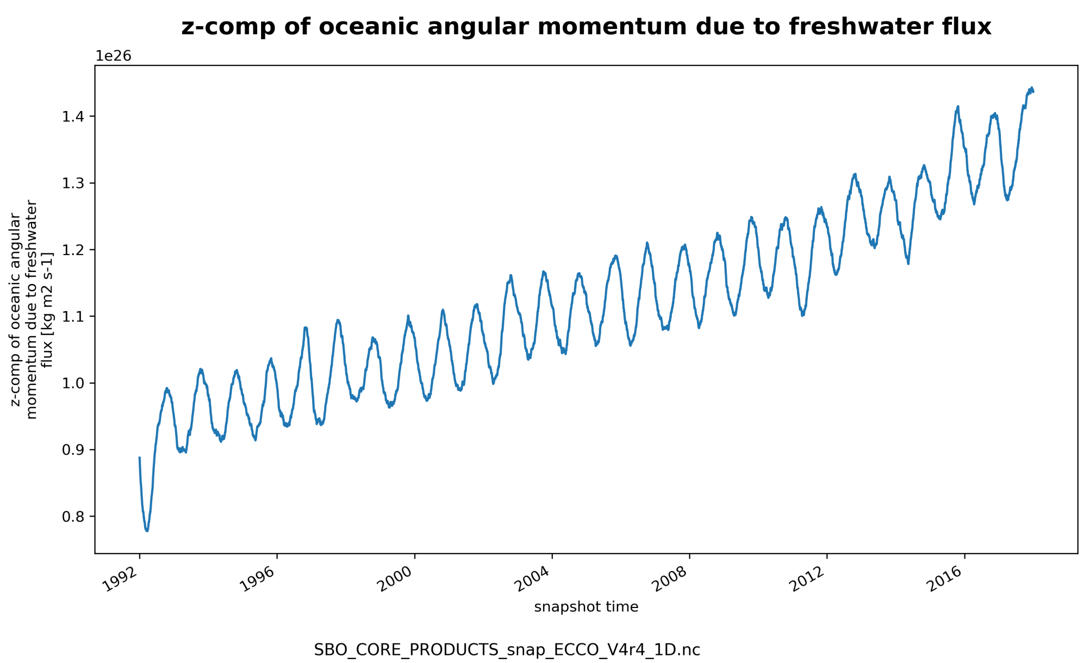

Figure 203: Dataset: SBO_CORE_PRODUCTS, Variable: zoamp_fw

How to find out more about ECCO:

A complete description of ECCO V4r4 together with all project documentation can be found at the following web spaces:

Main ECCO portal	https://ecco-group.org/home.htm
ECCO History	https://ecco-group.org/about.htm
ECCO data analysis tools	https://ecco-group.org/home.htm
ECCO tutorial	http://ghrsst.nodc.noaa.gov
ECCO Python tutorial	https://ecco-v4-python-tutorial.readthedocs.io/
To contact ECCO team	https://ecco-group.org/contact.htm