

The ECCO Data Specification (ECCO) v4r4 User Guide

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

3 June 2023

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The Recommended 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
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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).

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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. Finally, 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

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7 Scope and Content of this Document

The GDS Technical Specification is written for those wishing to create or use any GHRSST product and requiring detailed technical information on their contents and specifications. It provides the technical specifications for all GHRSST data sets used within the GHRSST Regional/Global Task Sharing (R/GTS) Framework. An overview of GHRSST and the GDS presented followed by a detailed technical specification of the GHRSST file naming specification, supporting definitions and conventions. The technical specifications for all GHRSST Level 2P (L2P), Level 3 (L3), Level 4 (L4), and GHRSST Multi-Product Ensemble (GMPE) data products are then provided. The GDS also provides code tables and best practices for identifying sources of SST and ancillary data within GHRSST data files.

This document has been developed for data providers who wish to produce any level of GHRSST data product and for all users wishing to fully understand the file naming convention, GHRSST data file contents, GHRSST and Climate Forecast definitions for SST, and other useful information. Additional information describing GHRSST and its component international services is available at <http://www.ghrsst.org> and many relevant GHRSST web sites are listed on the last page of this document.

The GDS Technical Specification document forms a component document of the GDS 2.0 document set, which is shown schematically in Figure 5-1 below. Other documents from the GDS 2.0 document pack that are specified in the Applicable Documents section of this document shall be consulted when using this document.

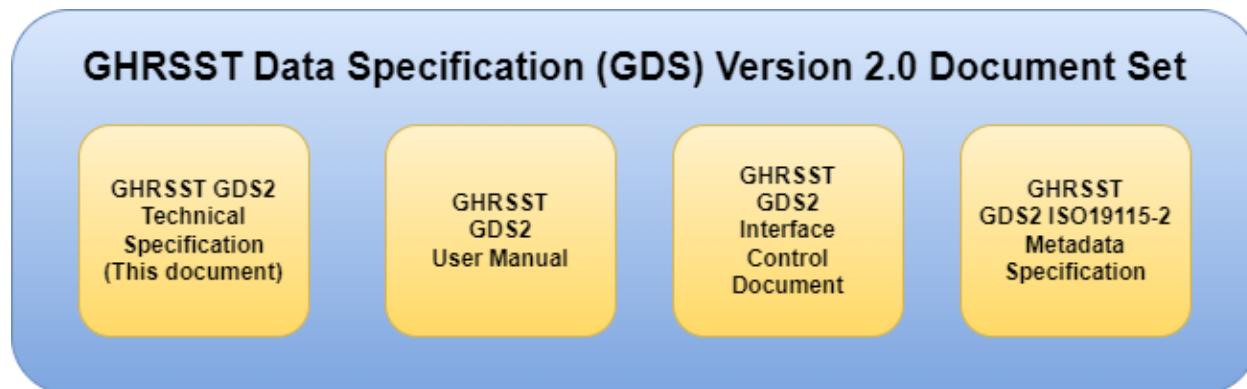


Figure 1: Schematic overview of the GHRSST Data Specification Version 2.0 document pack.

8 Overview of ECCO Data

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9 ECCO Data Filenames and Supporting Conventions

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10 ECCO Data File Structure

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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	m ²
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	m ²
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	m ²
rAs	Area of 'u' grid cell	m ²
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	m ² s ⁻²
PHrefF	Reference ocean hydrostatic pressure at tracer grid cell top/bottom interface	m ² 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			

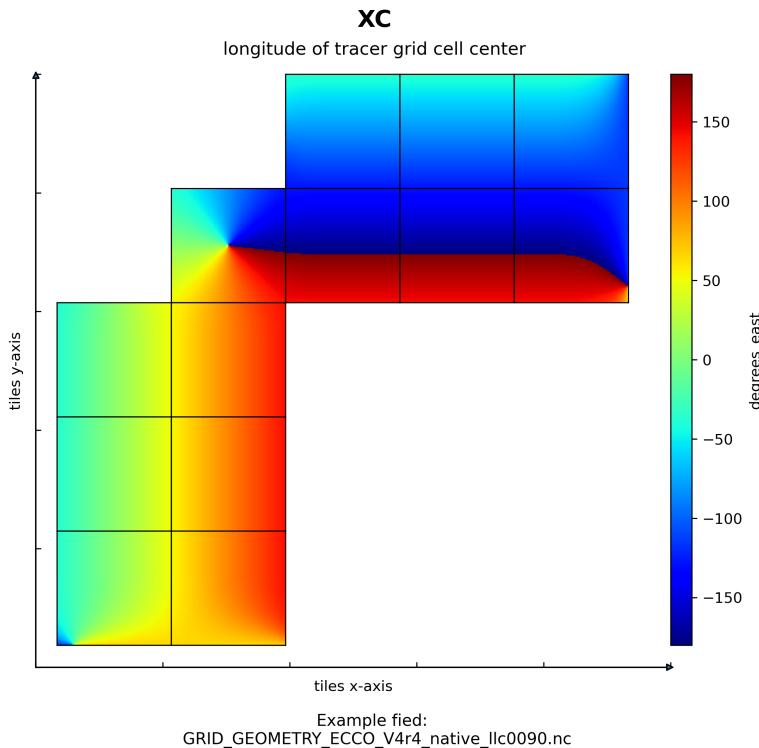


Figure 2: Dataset: GRID_GEOMETRY_ECCO, Variable: XC

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			

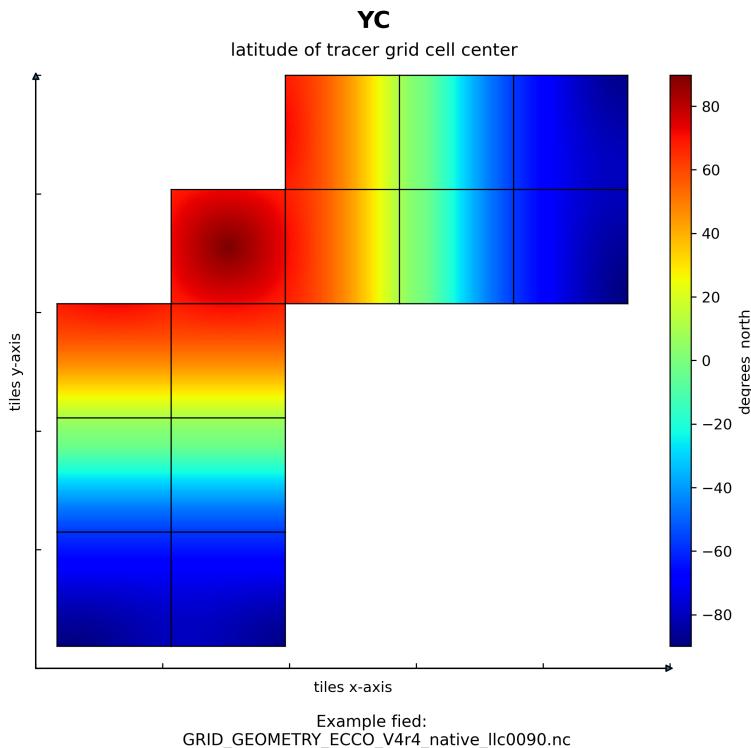


Figure 3: Dataset: GRID_GEOMETRY_ECCO, Variable: YC

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 documentation for details.			

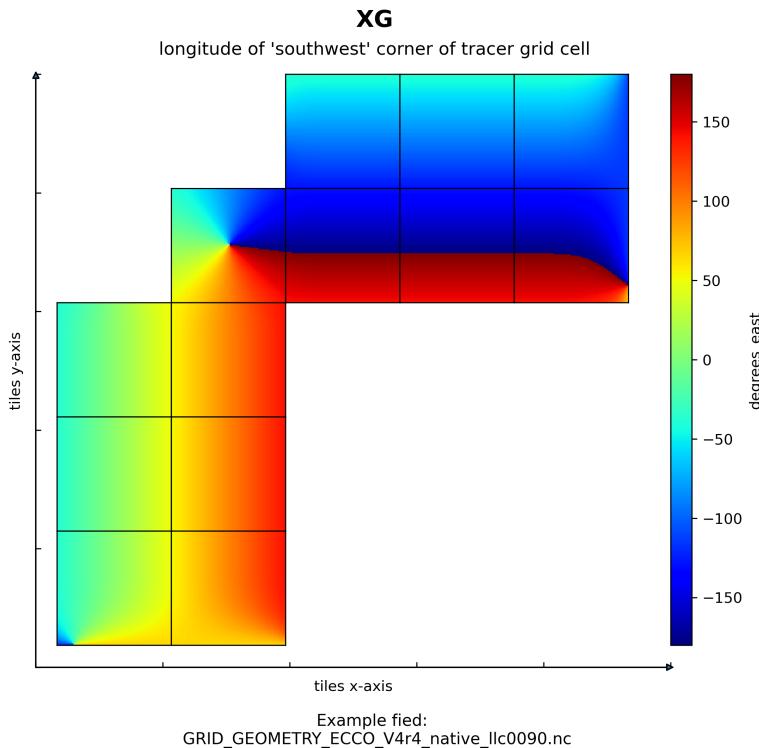


Figure 4: Dataset: GRID_GEOMETRY_ECCO, Variable: XG

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.			

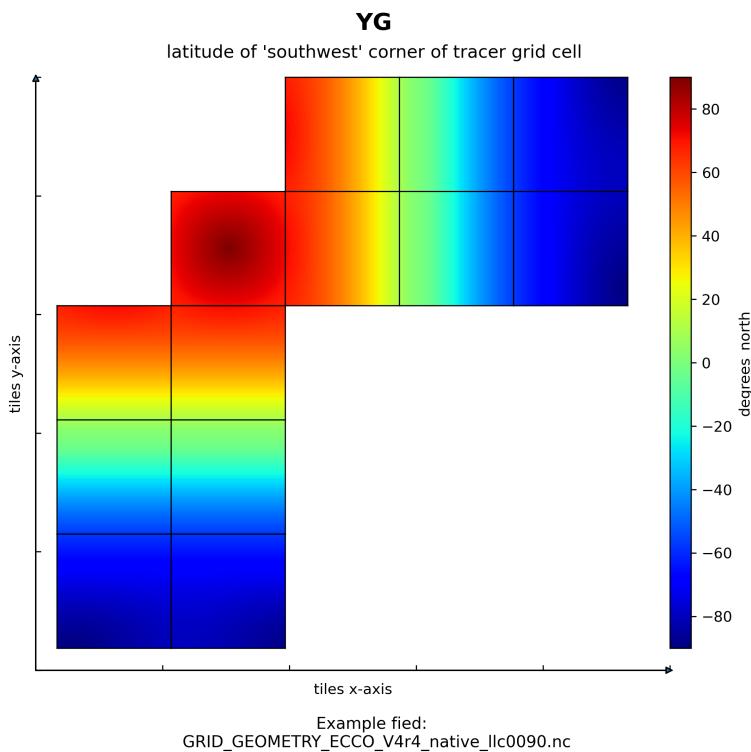


Figure 5: Dataset: GRID_GEOMETRY_ECCO, Variable: YG

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)			
<pre>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</pre>			
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			

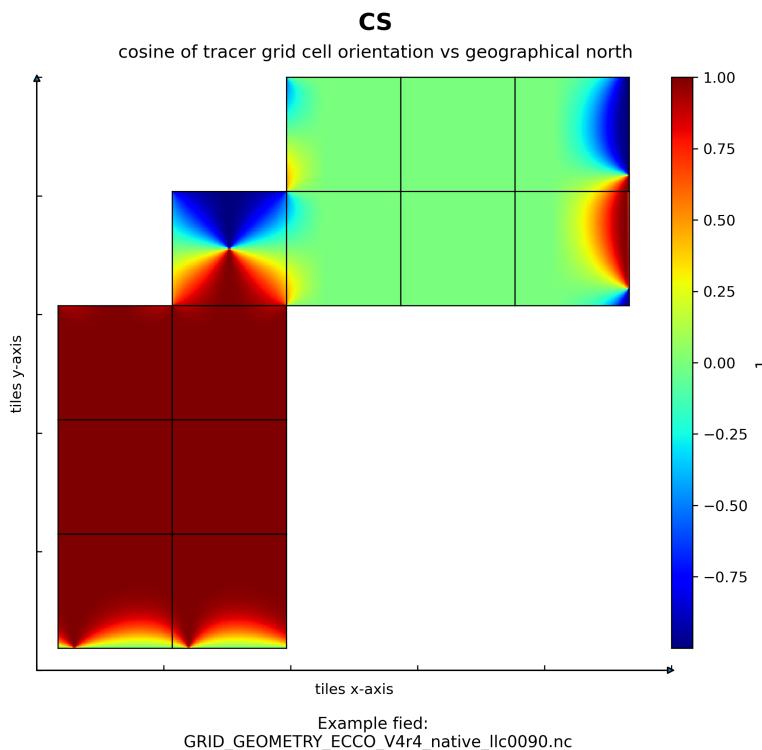


Figure 6: Dataset: GRID_GEOMETRY_ECCO, Variable: CS

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)			
<pre>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</pre>			
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.			

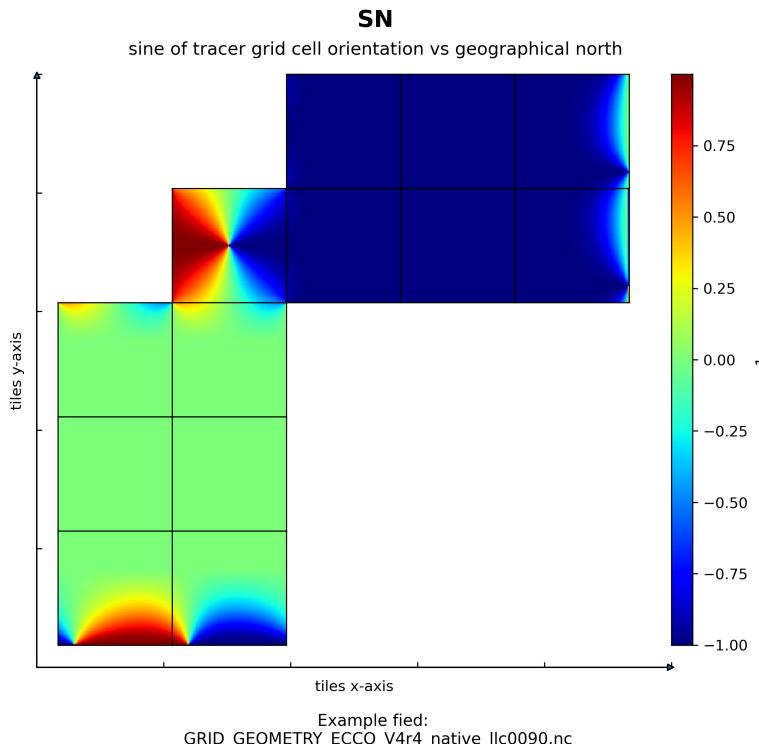


Figure 7: Dataset: GRID_GEOMETRY_ECCO, Variable: SN

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			

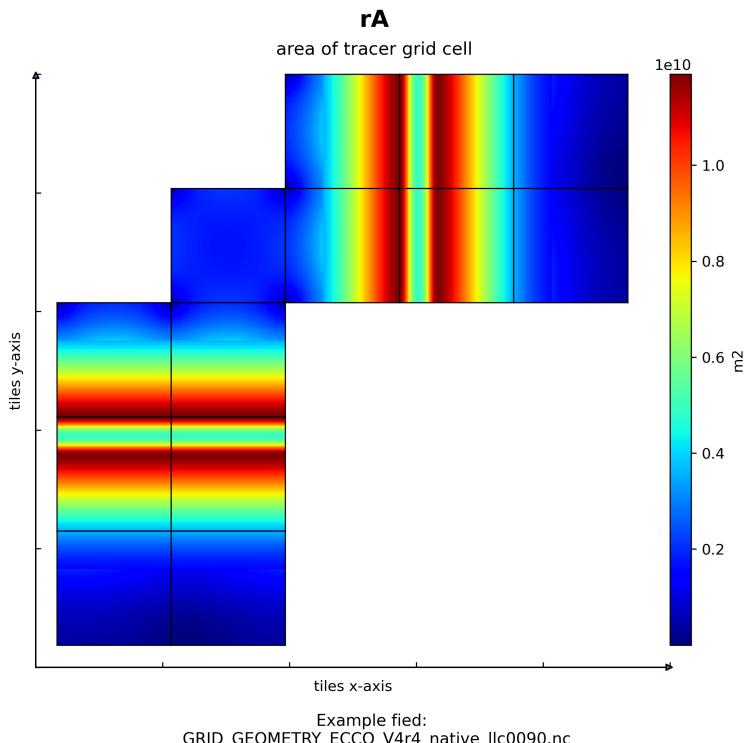


Figure 8: Dataset: GRID_GEOMETRY_ECCO, Variable: rA

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)			
<pre>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</pre>			
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.			

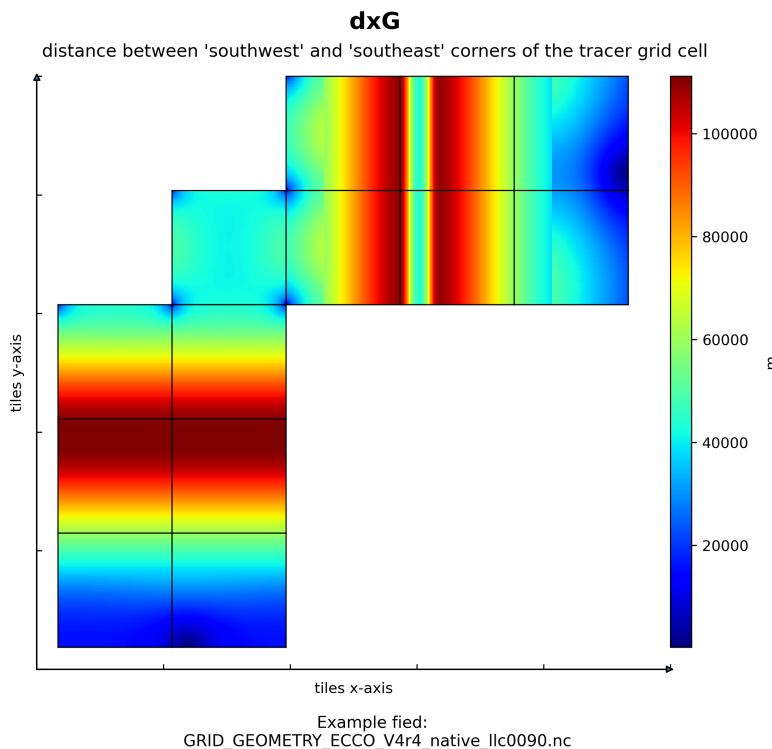


Figure 9: Dataset: GRID_GEOMETRY_ECCO, Variable: dxG

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)			
<pre>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</pre>			
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.			

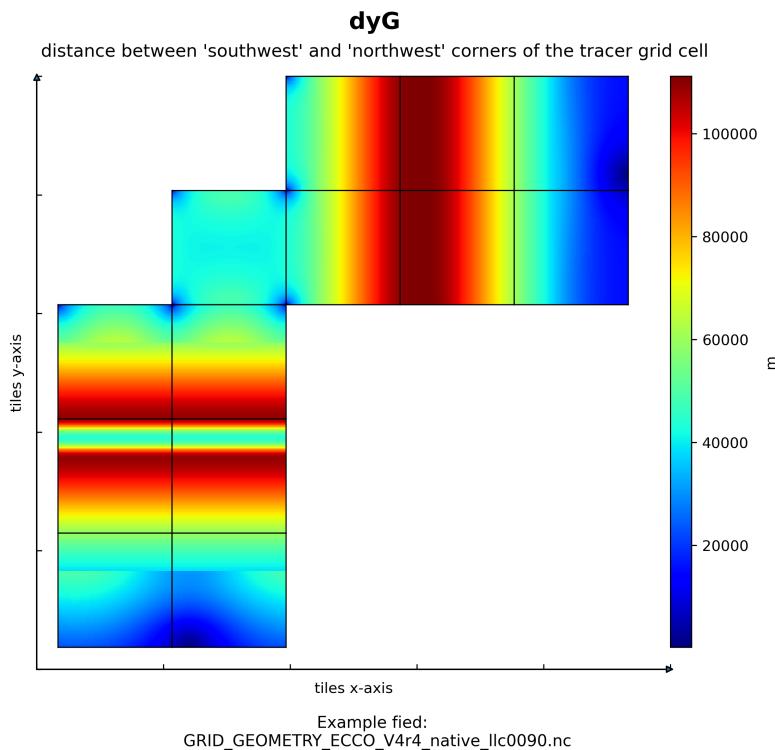


Figure 10: Dataset: GRID_GEOMETRY_ECCO, Variable: dyG

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 Om 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.			

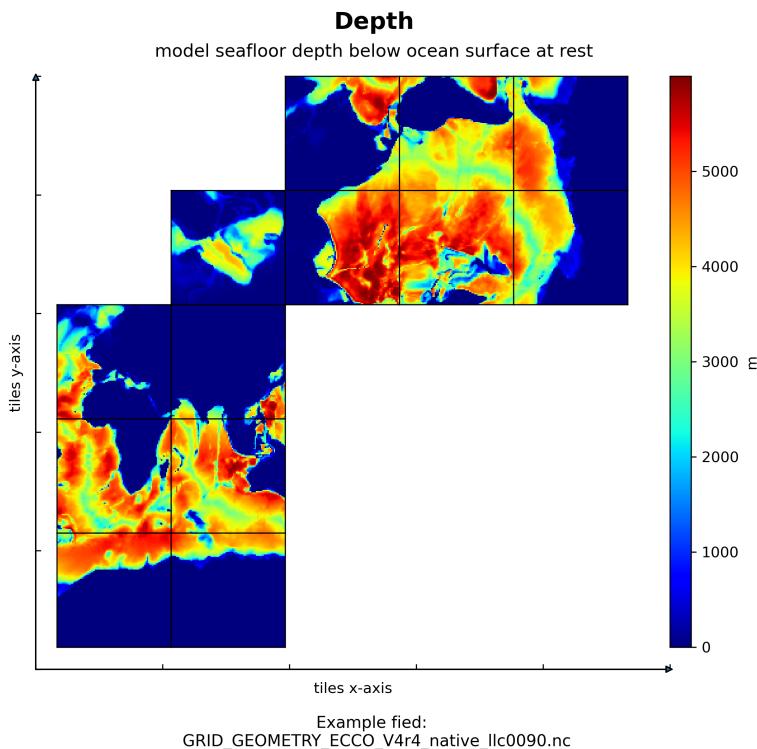


Figure 11: Dataset: GRID_GEOMETRY_ECCO, Variable: Depth

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	m ²
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 = m ² 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.			

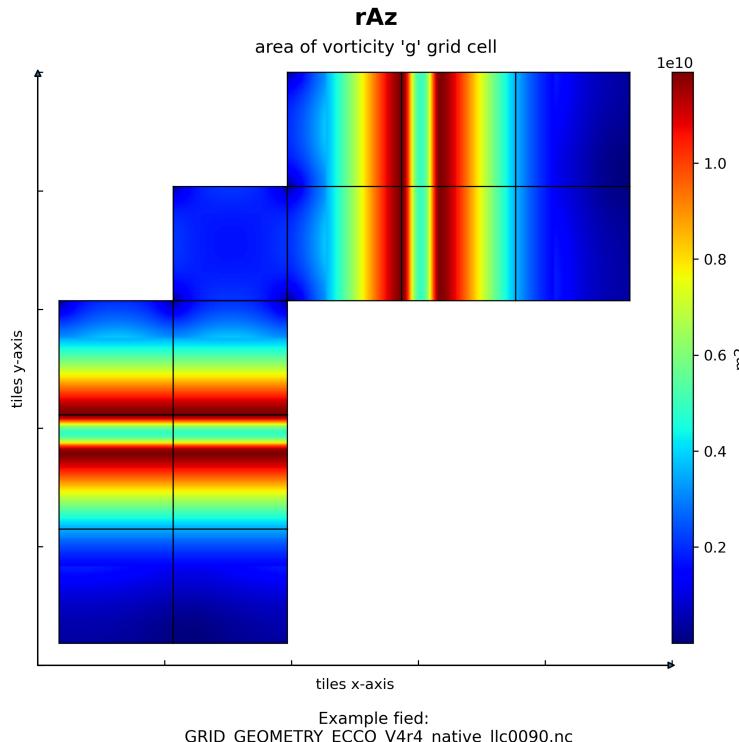


Figure 12: Dataset: GRID_GEOMETRY_ECCO, Variable: rAz

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)			
<pre>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</pre>			
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.			

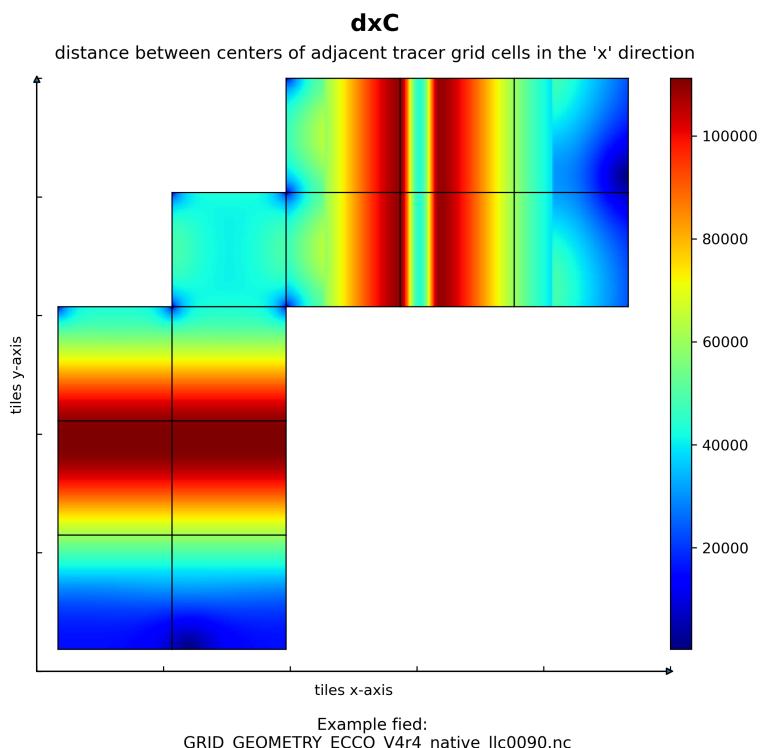


Figure 13: Dataset: GRID_GEOMETRY_ECCO, Variable: dxC

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)			
<pre>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</pre>			
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.			

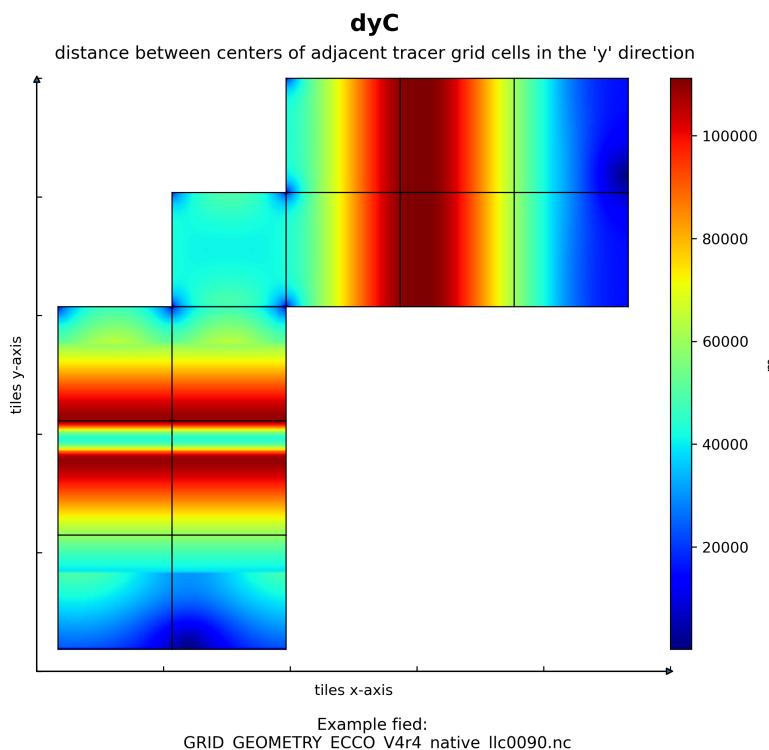


Figure 14: Dataset: GRID_GEOMETRY_ECCO, Variable: dyC

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	m ²
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 = m ²			
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.			

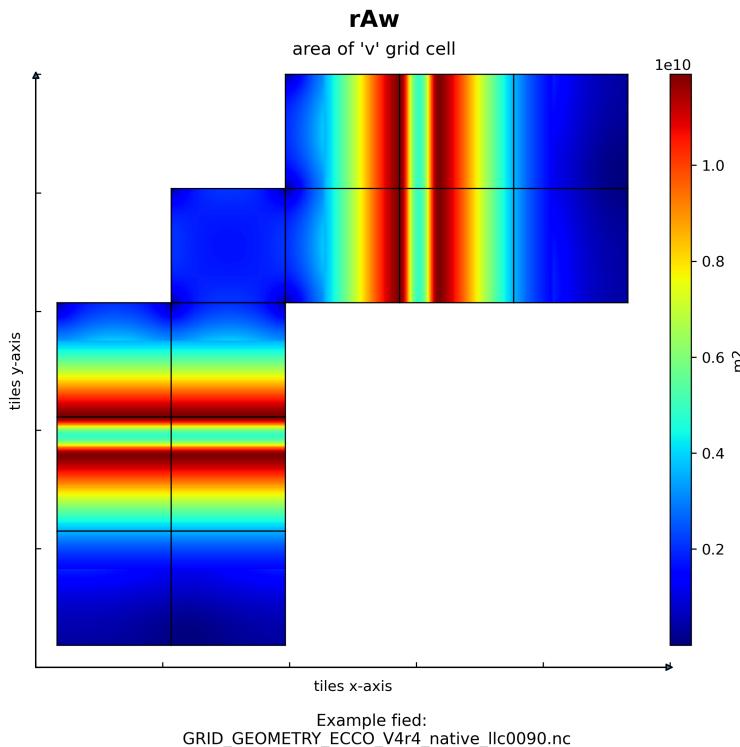


Figure 15: Dataset: GRID_GEOMETRY_ECCO, Variable: rAw

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	m ²
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
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.			

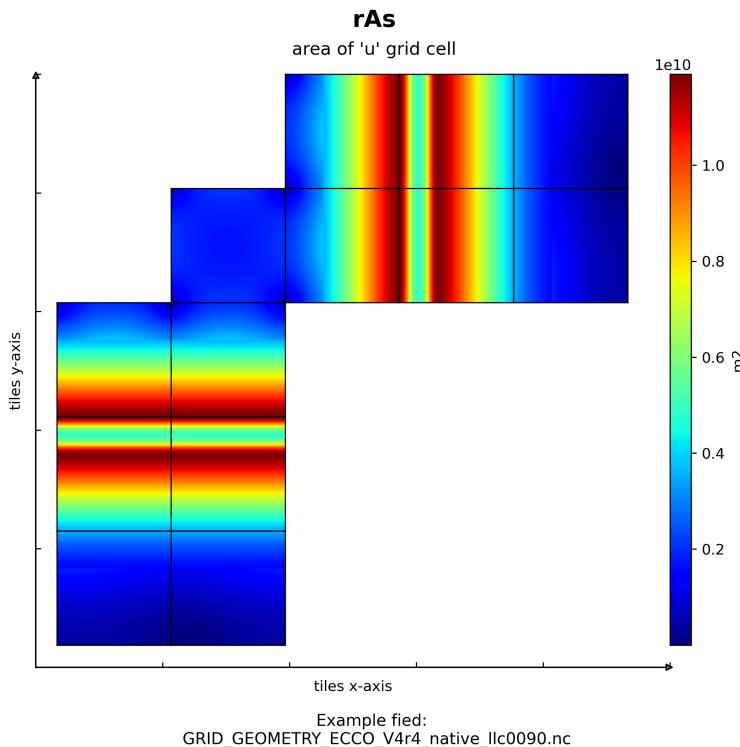


Figure 16: Dataset: GRID_GEOMETRY_ECCO, Variable: rAs

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)			
<pre>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</pre>			
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.			

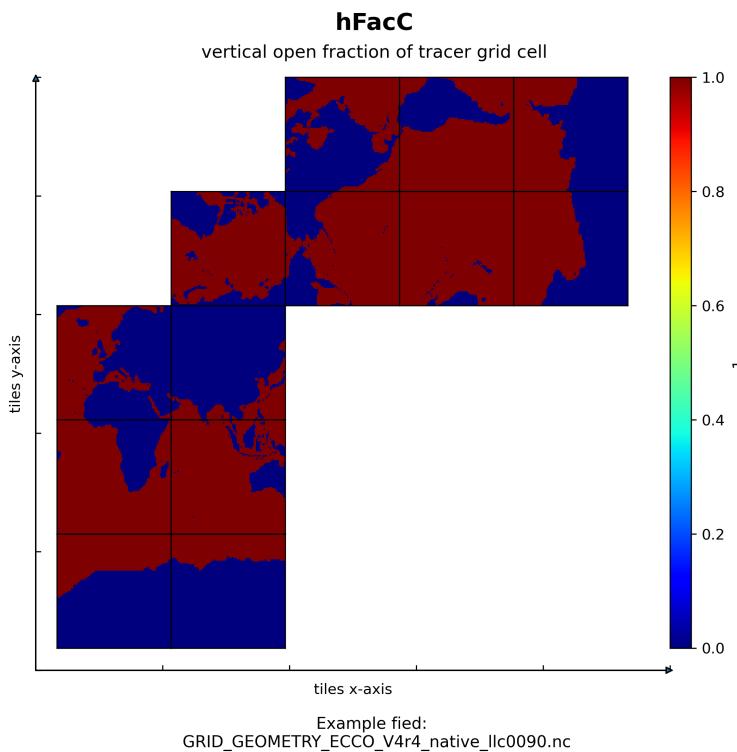


Figure 17: Dataset: GRID_GEOMETRY_ECCO, Variable: hFacC

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)			
<pre>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</pre>			
Comments			
<p>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.</p>			

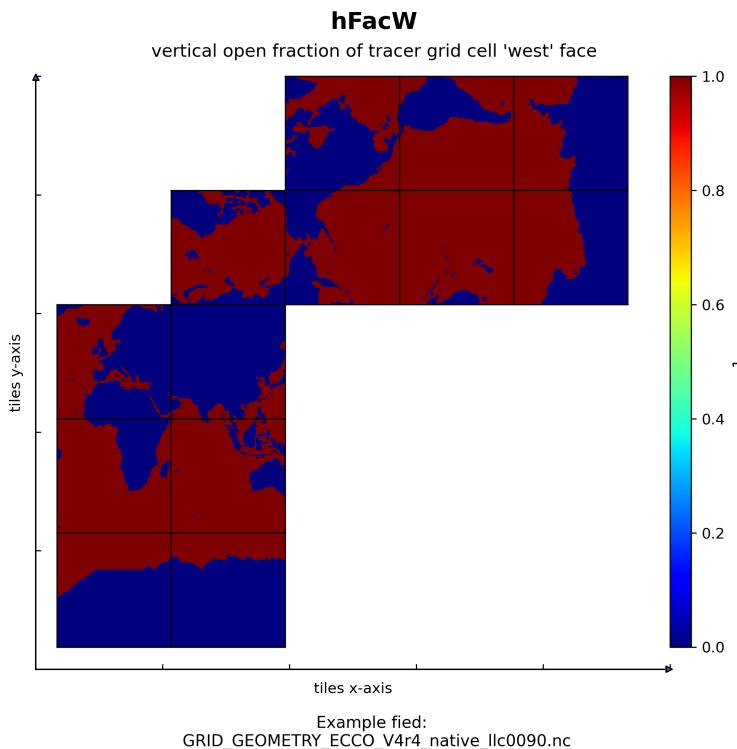


Figure 18: Dataset: GRID_GEOMETRY_ECCO, Variable: hFacW

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)			
<pre>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</pre>			
Comments			
<p>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.</p>			

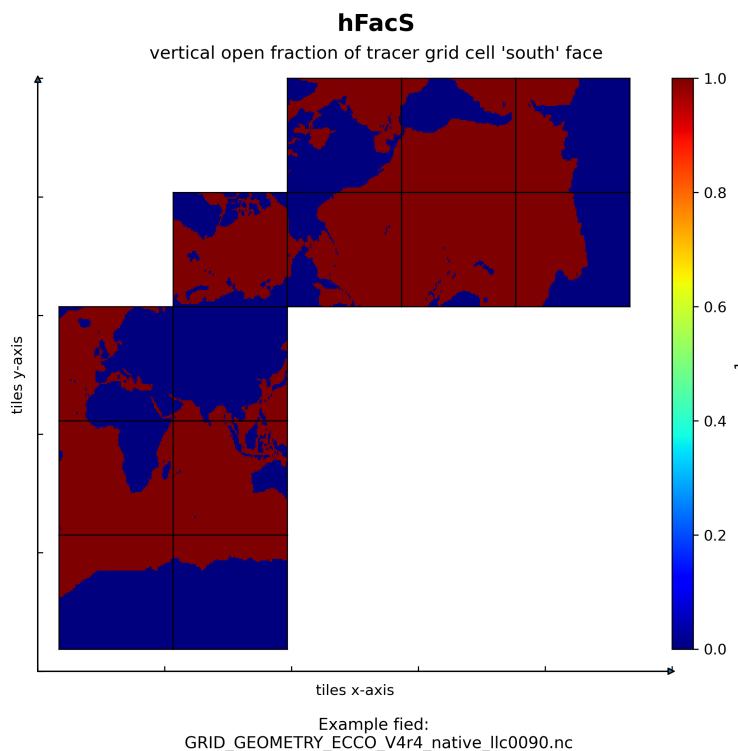


Figure 19: Dataset: GRID_GEOMETRY_ECCO, Variable: hFacS

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)			
<pre>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</pre>			
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 $hfacc(i,j,k,t=0) > 0$ and $hfacc(i,j,k,t) = 0$ for all t , if $hfacc(i,j,k,t=0) = 0$. therefore, maskc is time invariant.			

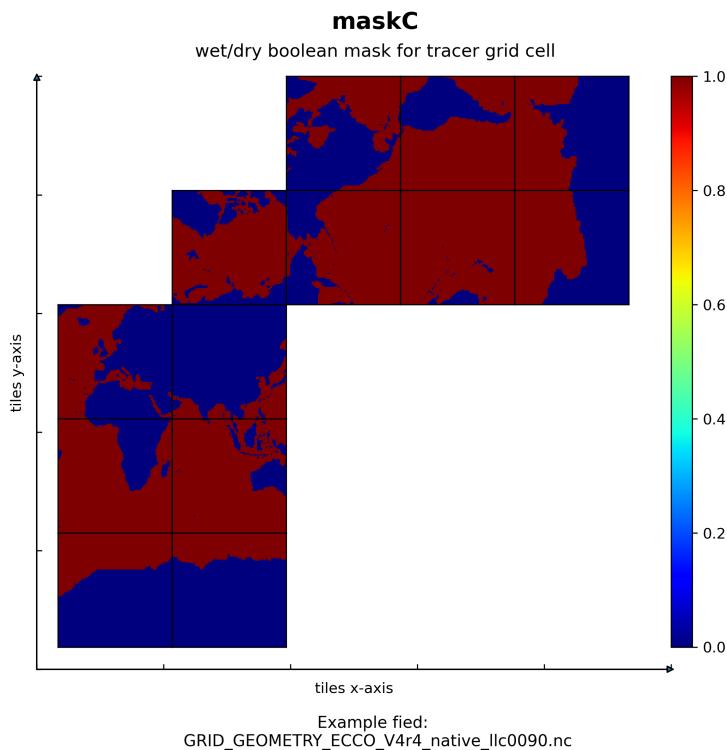


Figure 20: Dataset: GRID_GEOMETRY_ECCO, Variable: maskC

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)			
<pre>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</pre>			
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 $hfacw(i,j,k,t=0) = 0$ and $hfacw(i,j,k,t) = 0$ for all t , if $hfacw(i,j,k,t=0) = 0$. therefore, $maskw$ is time invariant. note:			

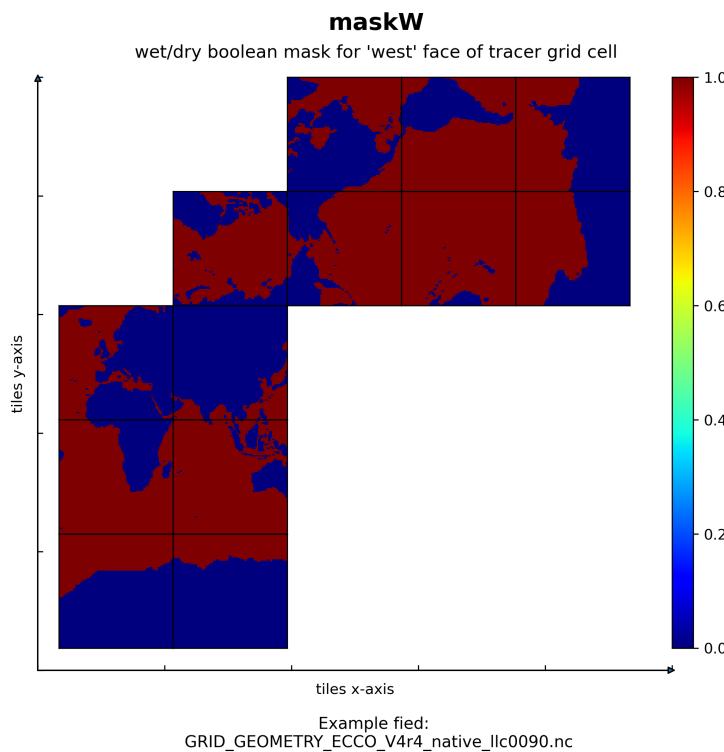


Figure 21: Dataset: GRID_GEOMETRY_ECCO, Variable: maskW

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)			
<pre>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</pre>			
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 $hfacs(i,j,k,t=0) = 0$ and $hfacs(i,j,k,t) = 0$ for all t , if $hfacs(i,j,k,t=0) = 0$. therefore, masks is time invariant. note:			

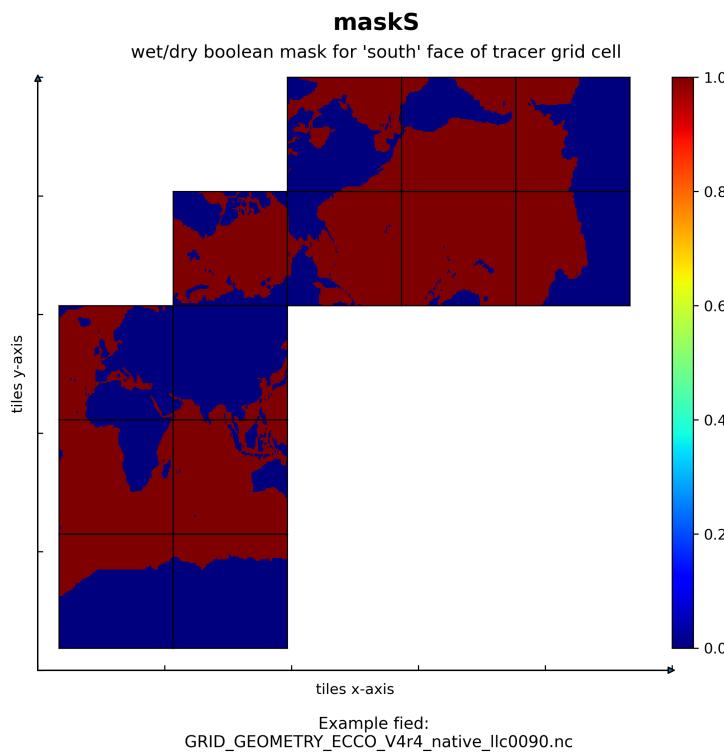


Figure 22: Dataset: GRID_GEOMETRY_ECCO, Variable: maskS

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)			
<pre>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</pre>			
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.			

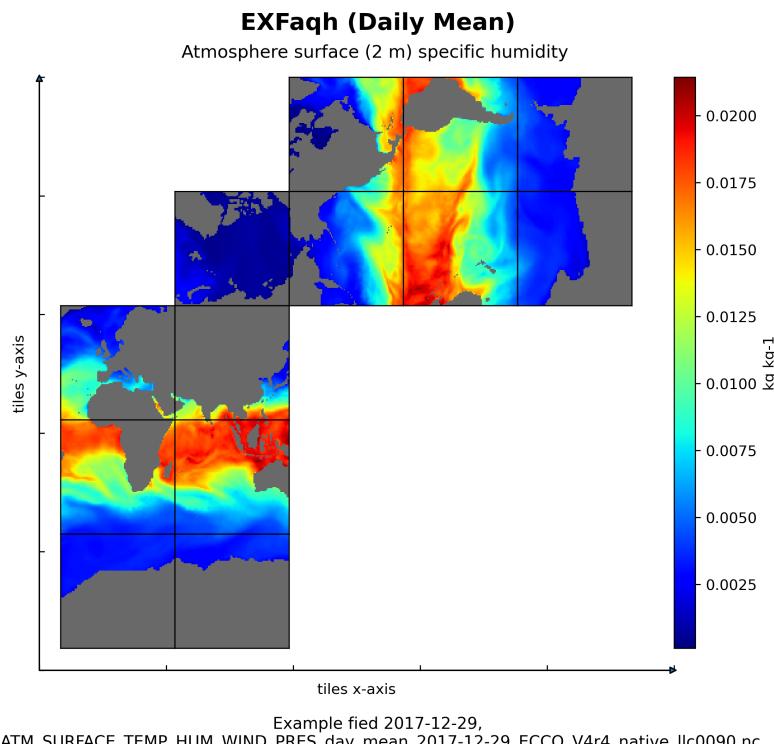


Figure 23: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFaqh

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.			

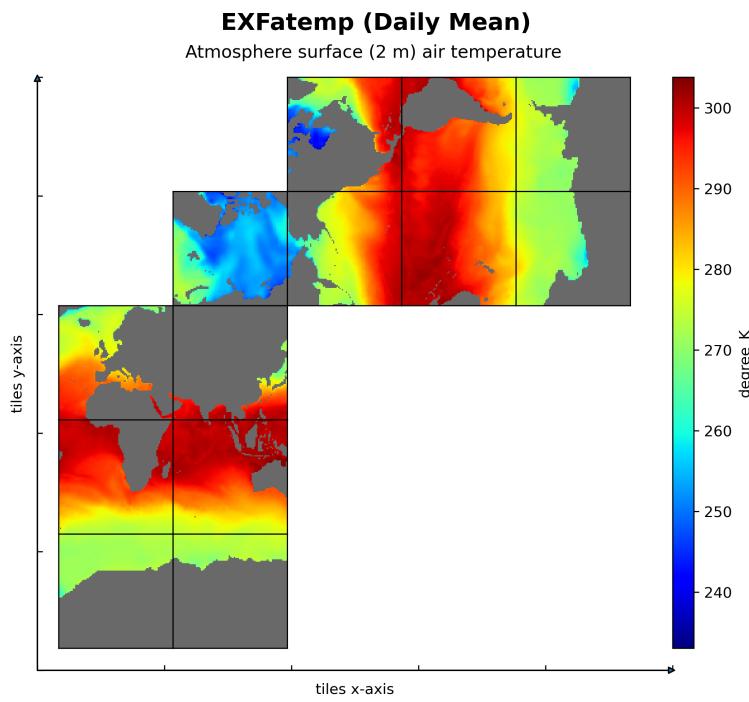


Figure 24: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFatemp

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)			
<pre>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</pre>			
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.			

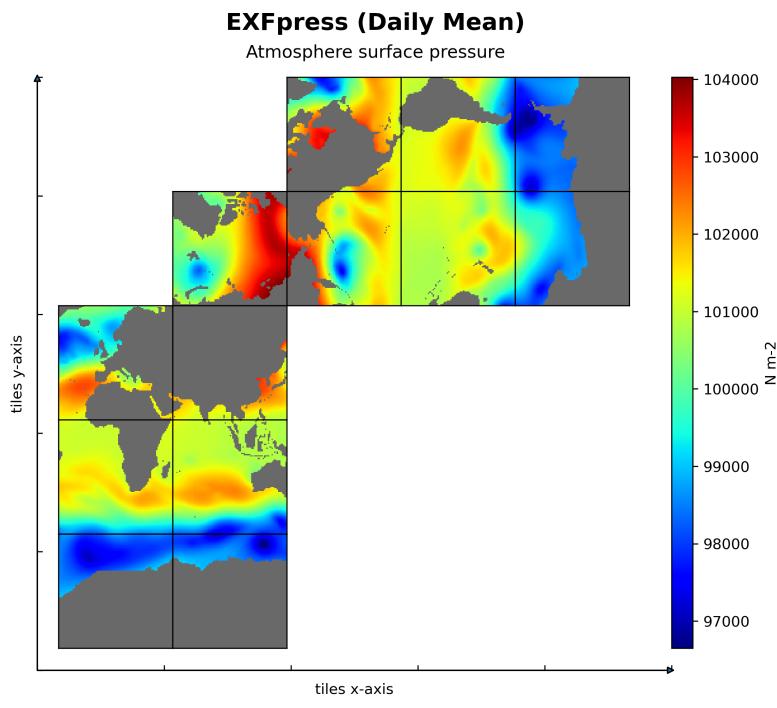


Figure 25: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFpress

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)			
<pre>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</pre>			
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. exfwind is calculated by converting wind stress to vector wind using bulk formulae.			

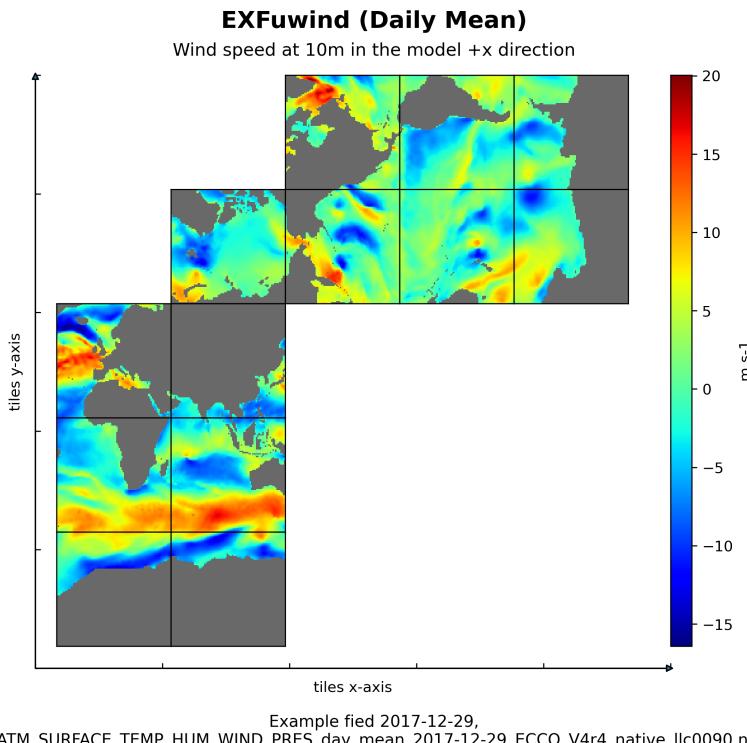


Figure 26: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFuwind

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)			
<pre>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</pre>			
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.			

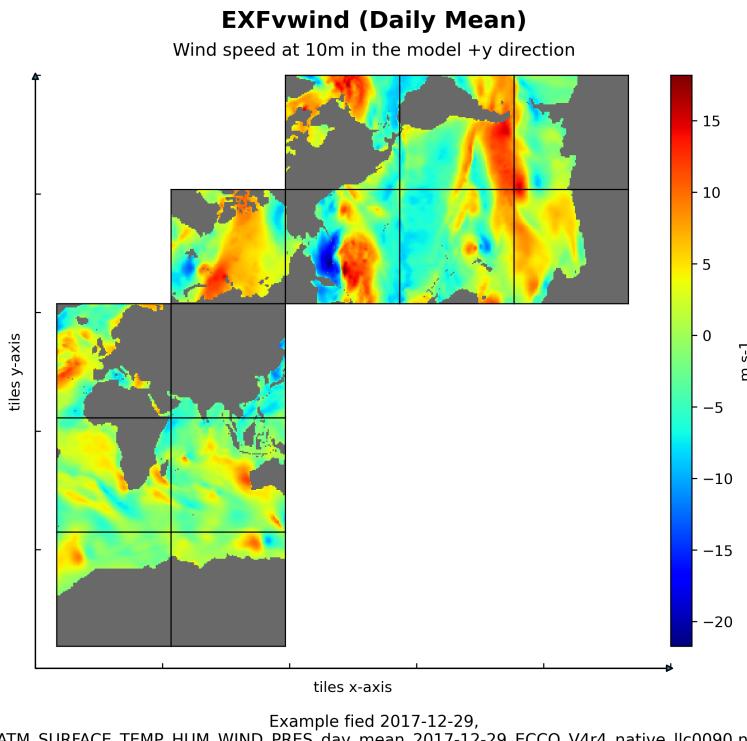


Figure 27: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFvwind

12.1.7 Native Variable: EXFwspee

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

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, 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			
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 exfwind and exfwind because exfwind and exfwind are calculated from exftaux and exftauy using bulk formulae. exfwspee != sqrt(exfwind**2 + exfwind**2).			

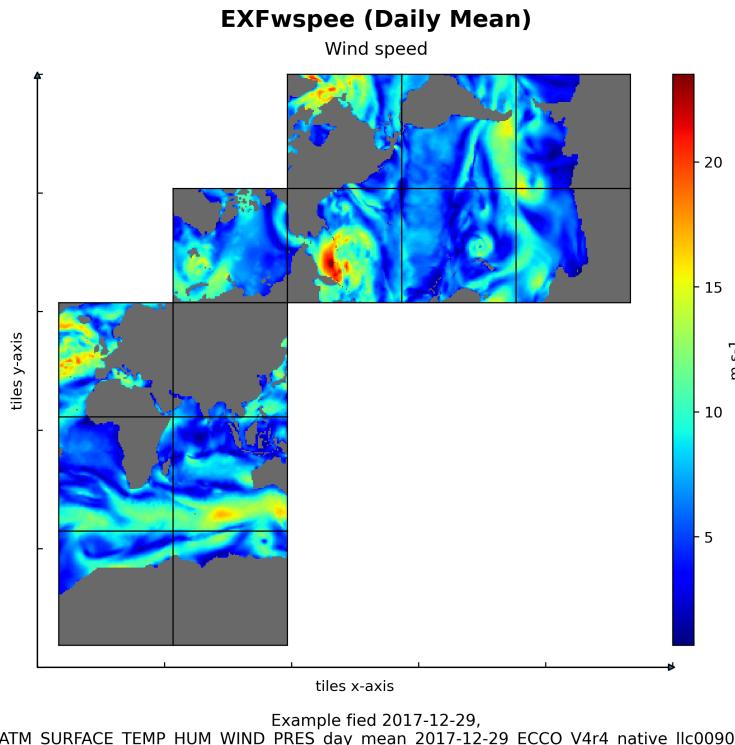


Figure 28: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFwspee

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	m ² 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 = m ² 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 m ² s ⁻¹ .			

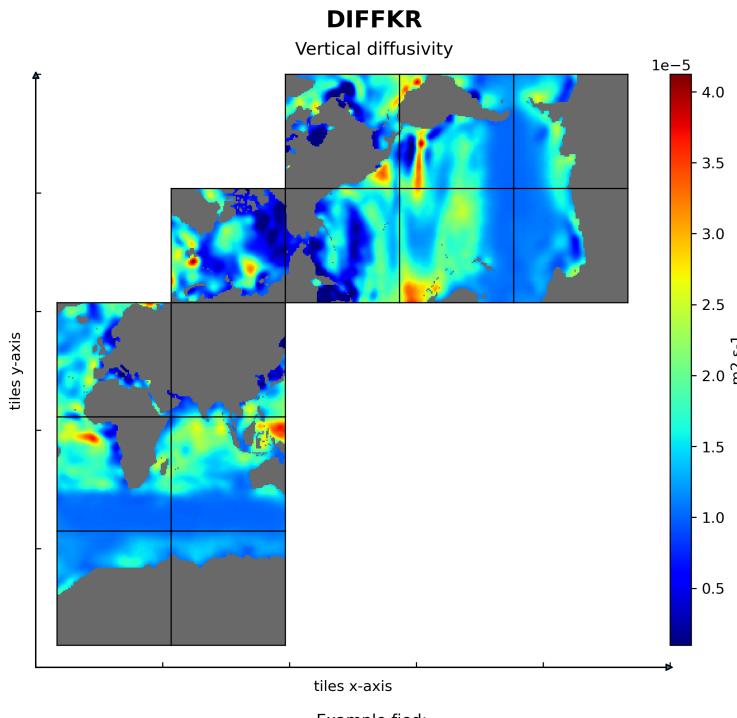


Figure 29: Dataset: OCEAN_3D_MIXING_COEFFS, Variable: DIFFKR

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.			

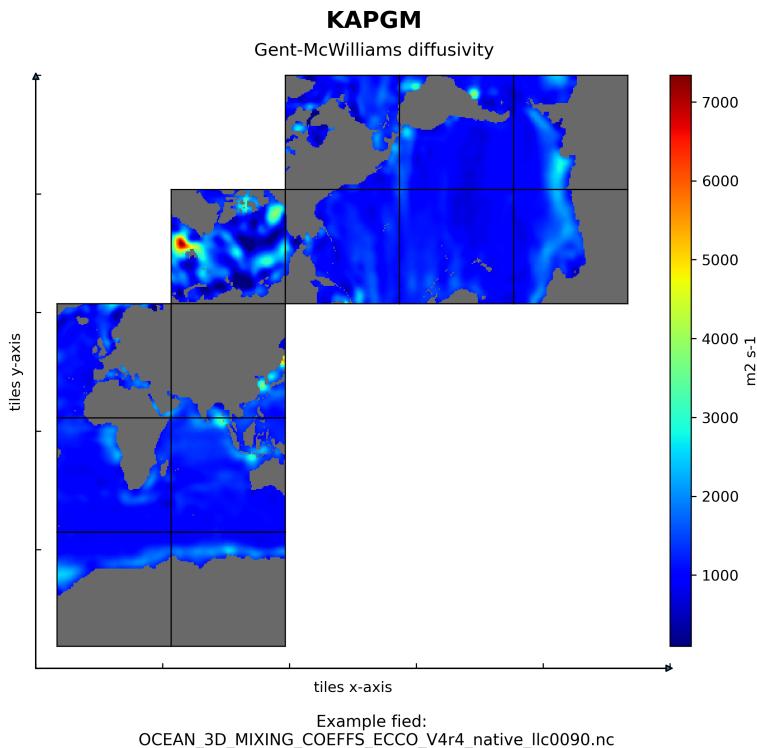


Figure 30: Dataset: OCEAN_3D_MIXING_COEFFS, Variable: KAPGM

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	m ² 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 = m ² 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 m ² s ⁻¹ .			

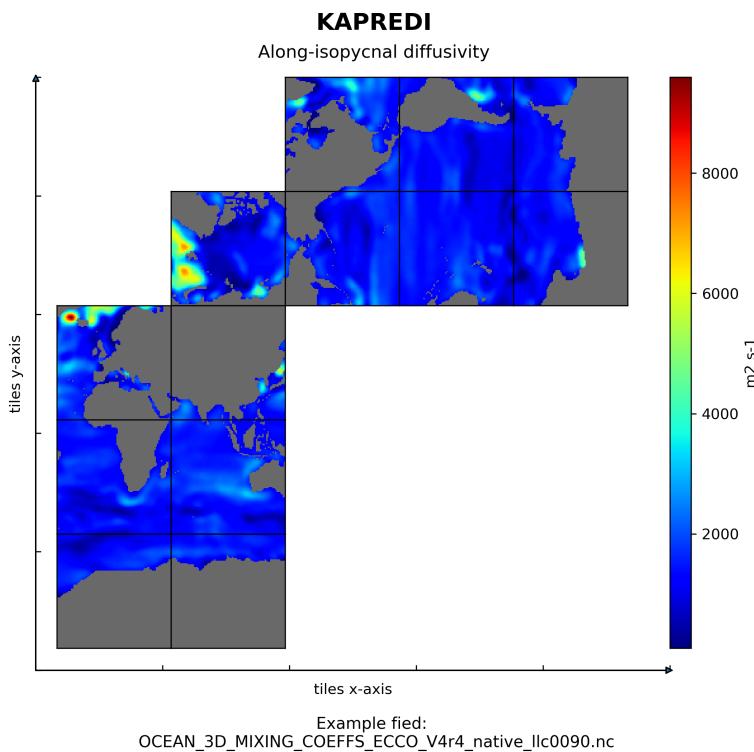


Figure 31: Dataset: OCEAN_3D_MIXING_COEFFS, Variable: KAPREDI

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)			
<pre>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</pre>			
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.			

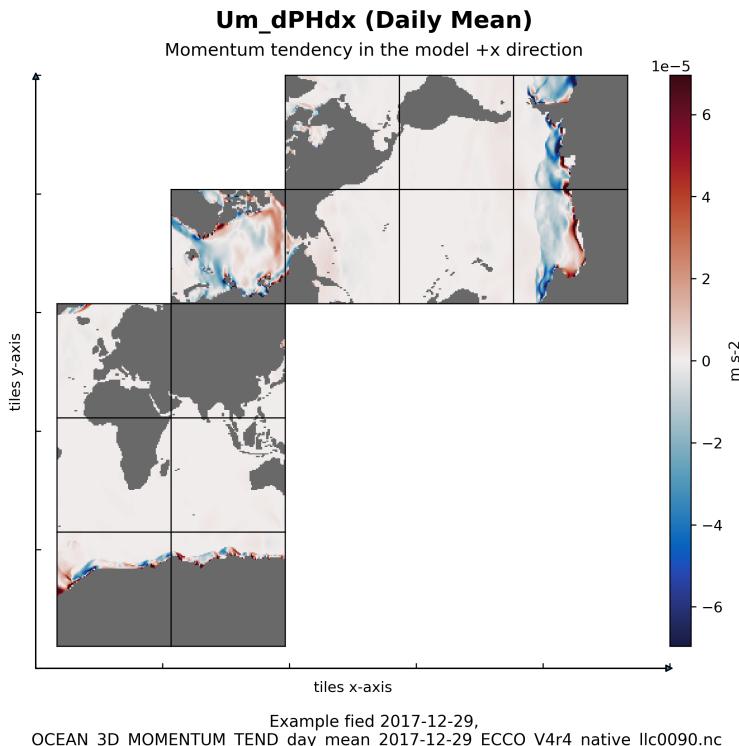


Figure 32: Dataset: OCEAN_3D_MOMENTUM_TEND, Variable: Um_dPHdx

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.			

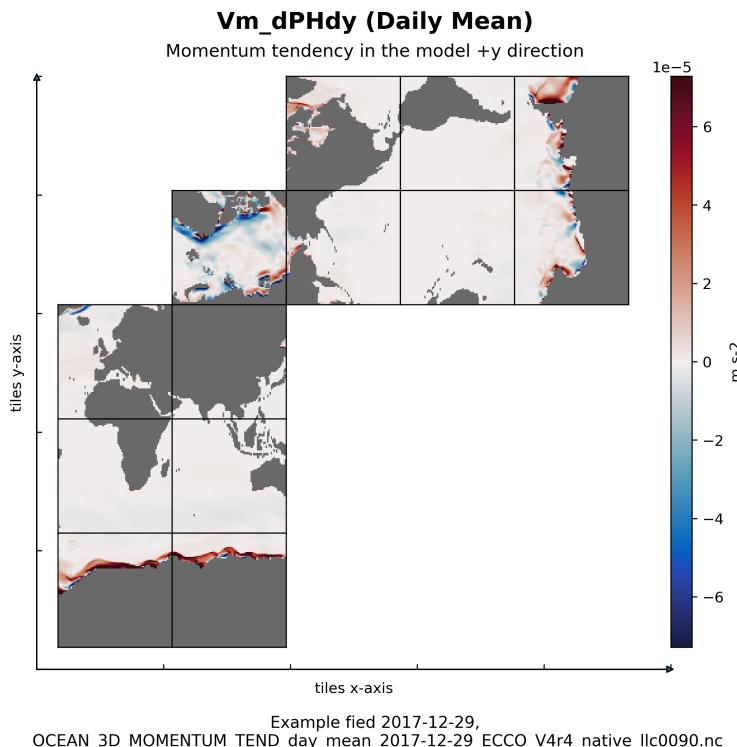


Figure 33: Dataset: OCEAN_3D_MOMENTUM_TEND, Variable: Vm_dPHdy

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 ($\text{g m}^{-2} \text{s}^{-1}$), 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	$\text{g m}^{-2} \text{s}^{-1}$
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)			
<pre>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 =>O decreases salinity (SALT) ADVr_SLT:coordinates = XC ZI YC time ADVr_SLT:valid_min = : 324149856.0 ADVr_SLT:valid_max = 263294624.0</pre>			
Comments			
<p>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</p>			

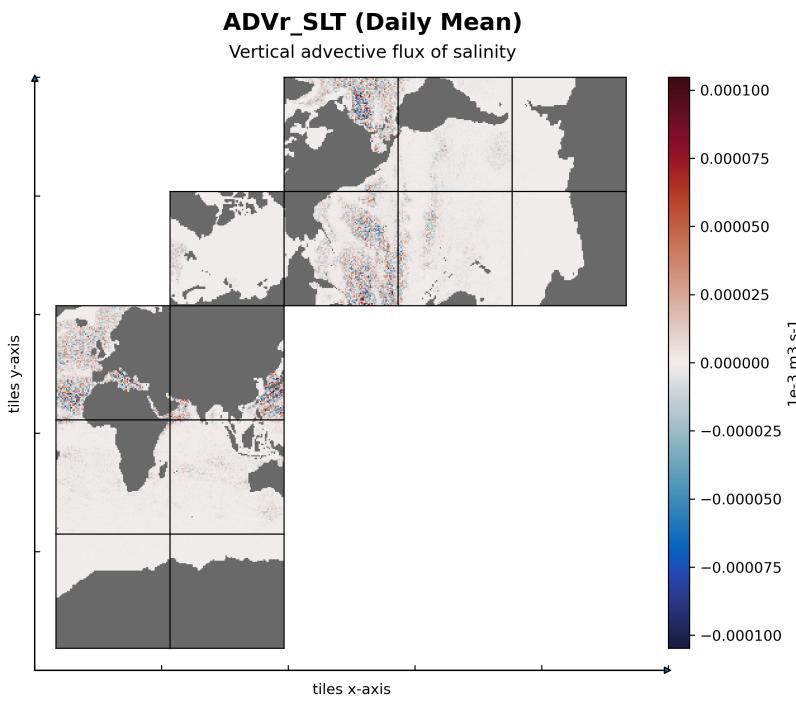


Figure 34: Dataset: OCEAN_3D_SALINITY_FLUX, Variable: ADVr_SLT

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)			
<pre>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</pre>			
Comments			
<p>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</p>			

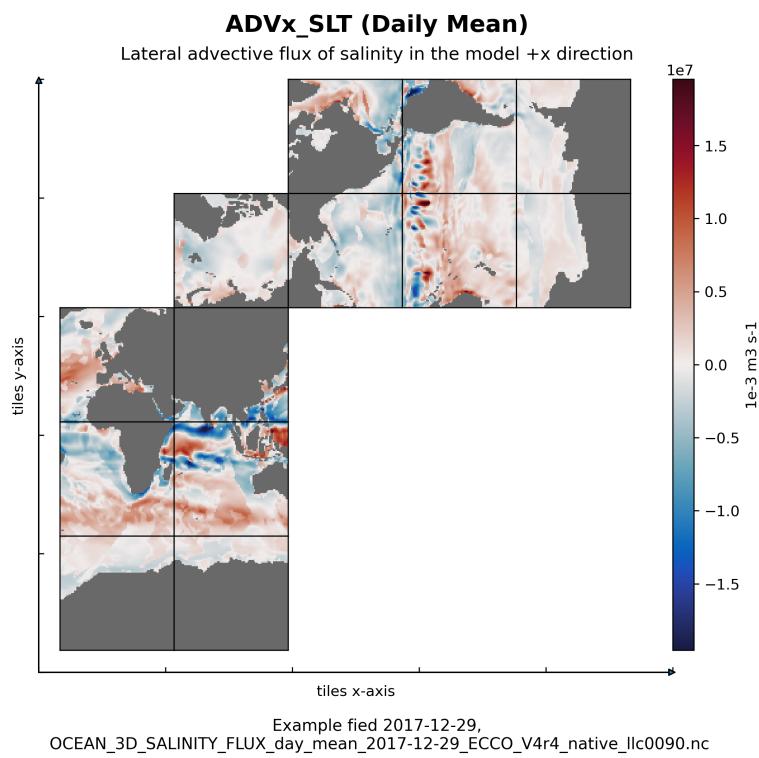


Figure 35: Dataset: OCEAN_3D_SALINITY_FLUX, Variable: ADVx_SLT

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)			
<pre>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</pre>			
Comments			
<p>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</p>			

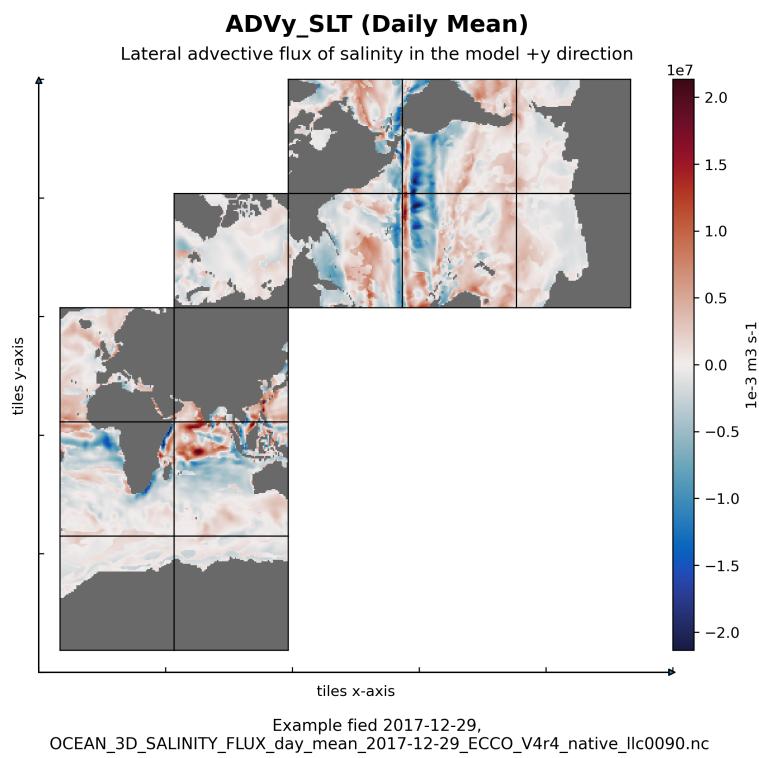


Figure 36: Dataset: OCEAN_3D_SALINITY_FLUX, Variable: ADVy_SLT

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 ZI YC time DFrE_SLT: valid_min = : 1074719.375 DFrE_SLT: valid_max = 471215.75			
Comments			
<p>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</p>			

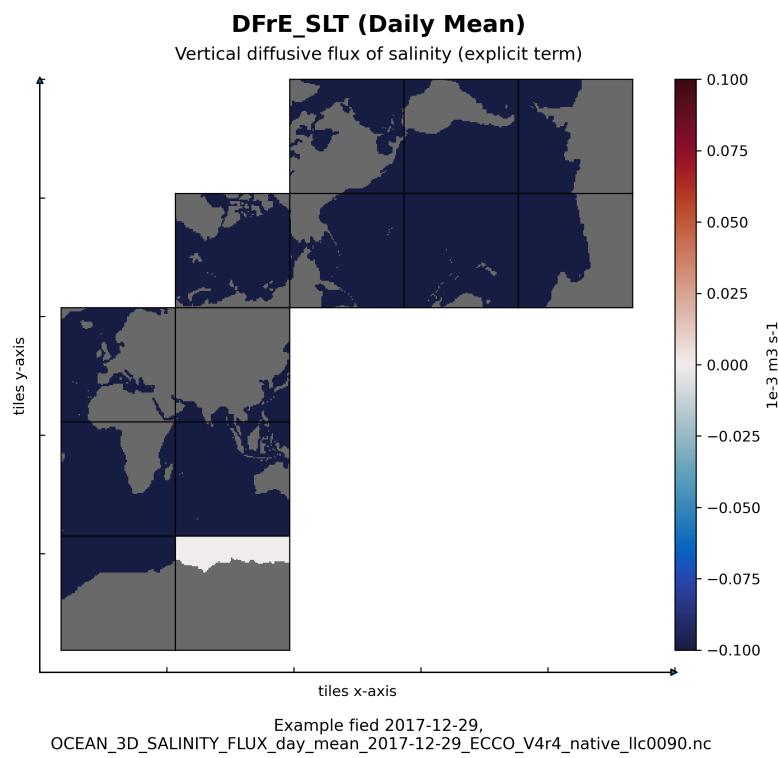


Figure 37: Dataset: OCEAN_3D_SALINITY_FLUX, Variable: DFrE_SLT

12.4.6 Native Variable: DFrl_SLT

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

Storage Type	Variable Name	Description	Unit
float32	DFrl_SLT	Vertical diffusive flux of salinity (implicit term)	1e-3 m3 s-1
Description of the variable in Common Data language (CDL)			
<pre>float32 DFrl_SLT(time, k_l, tile, j, i) DFrl_SLT:_FillValue = 9.96921e+36 DFrl_SLT:long_name = Vertical diffusive flux of salinity (implicit term) DFrl_SLT:units = 1e: 3 m3 s: 1 DFrl_SLT:coverage_content_type = modelResult DFrl_SLT:direction = >0 decreases salinity (SALT) DFrl_SLT:coordinates = XC ZI YC time DFrl_SLT:valid_min = : 30609048.0 DFrl_SLT:valid_max = 3197643.0</pre>			
Comments			
<p>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</p>			

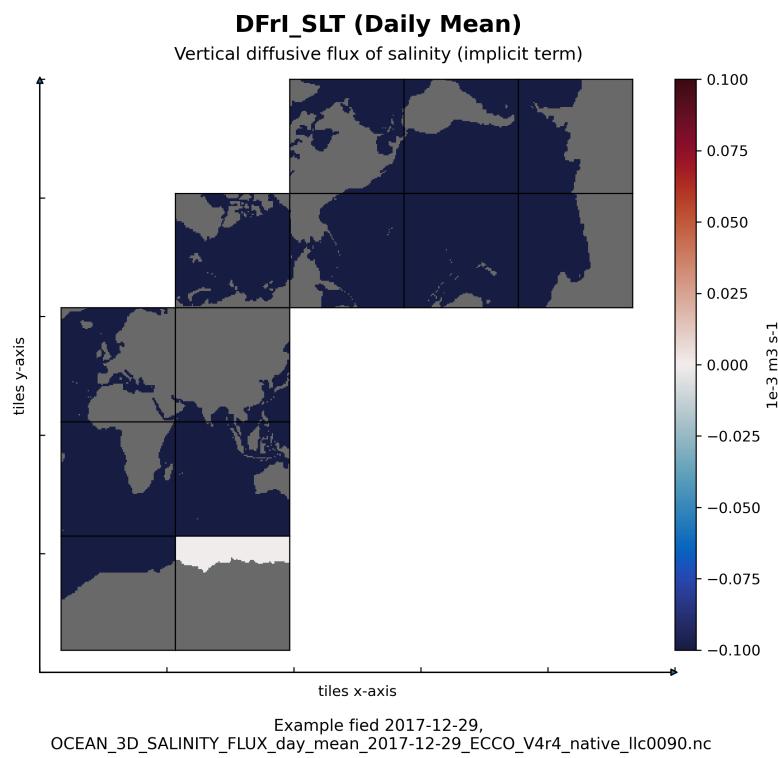


Figure 38: Dataset: OCEAN_3D_SALINITY_FLUX, Variable: DFrl_SLT

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)			
<pre>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 =>O increases salinity (SALT) DFxE_SLT:coordinates = Z time DFxE_SLT:valid_min = :125908.03125 DFxE_SLT:valid_max = 192716.484375</pre>			
Comments			
<p>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</p>			

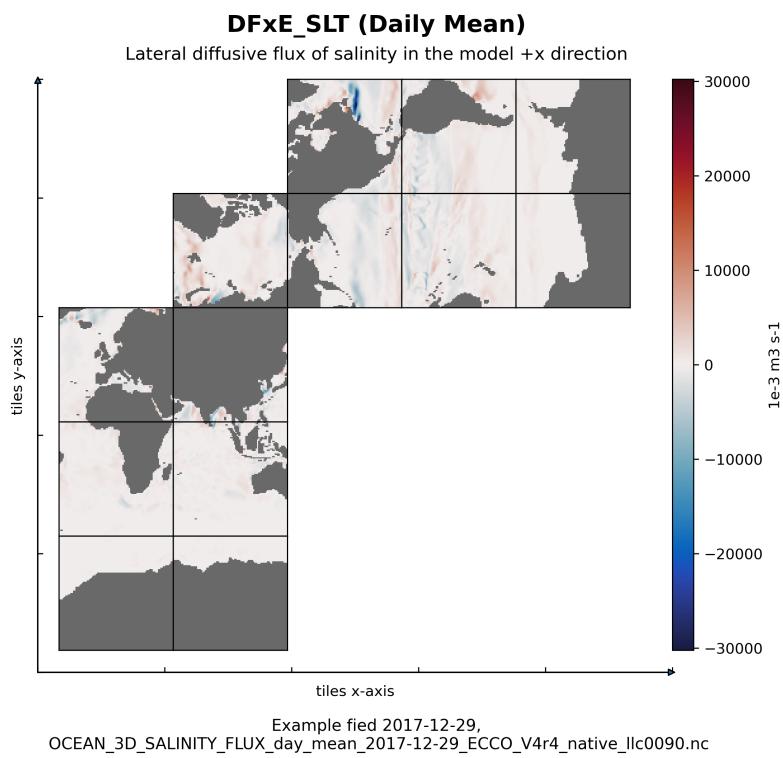


Figure 39: Dataset: OCEAN_3D_SALINITY_FLUX, Variable: DFxE_SLT

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)			
<pre>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</pre>			
Comments			
<p>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</p>			

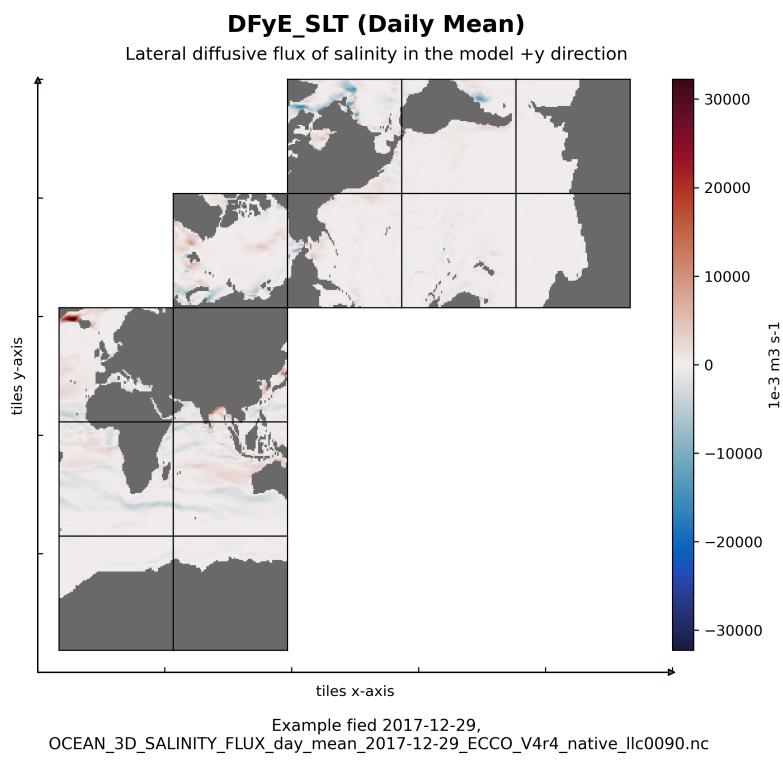


Figure 40: Dataset: OCEAN_3D_SALINITY_FLUX, Variable: DFyE_SLT

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)			
<pre>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</pre>			
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.			

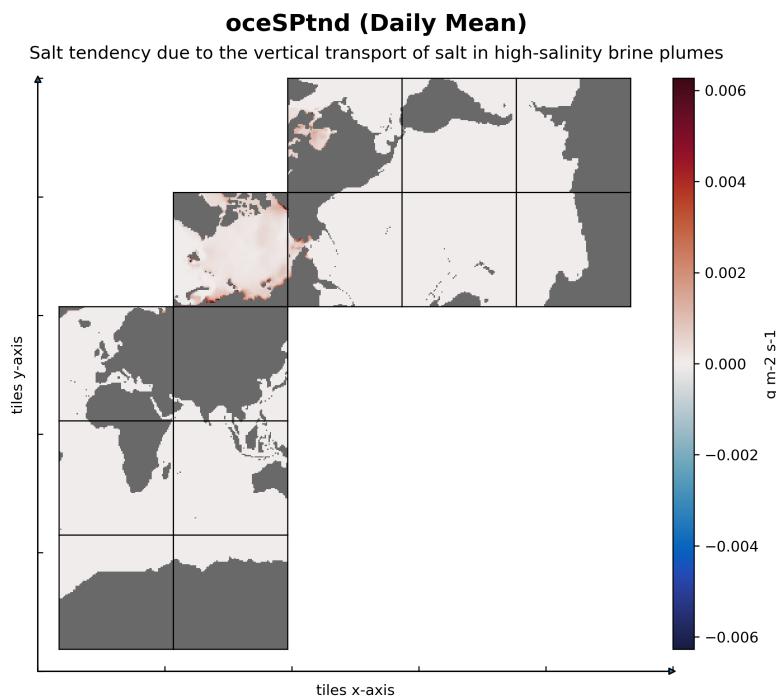


Figure 41: Dataset: OCEAN_3D_SALINITY_FLUX, Variable: oceSPtnd

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.

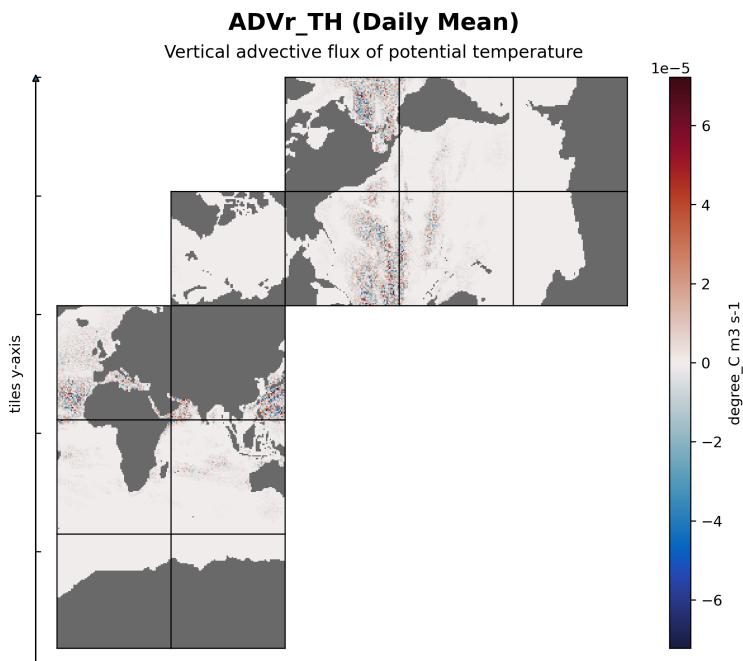
Table 12.24: Coordinates and Variables in the dataset OCEAN_3D_TEMPERATURE_FLUX

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
DFrl_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)			
<pre>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</pre>			
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)			



Example file 2017-12-29,
OCEAN_3D_TEMPERATURE_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 42: 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.			

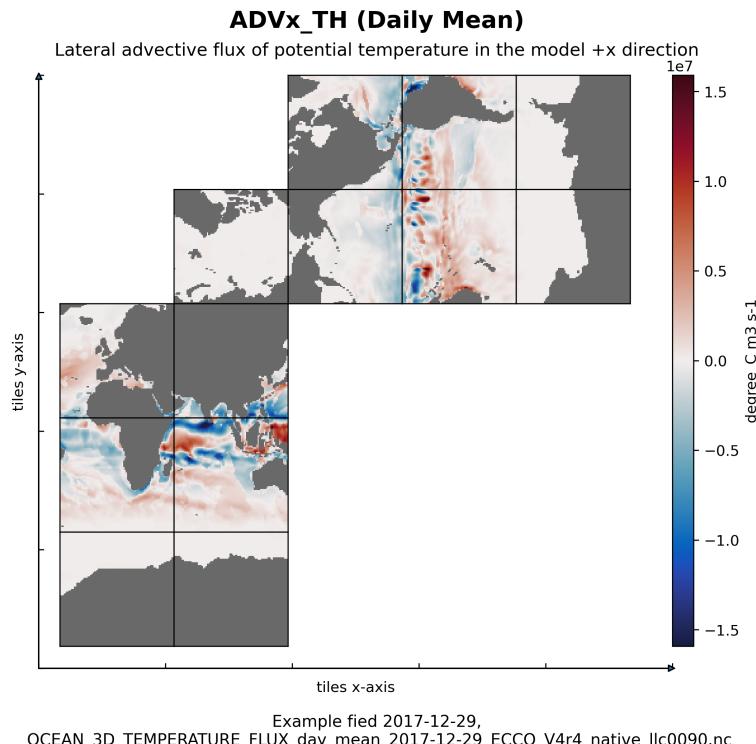


Figure 43: Dataset: OCEAN_3D_TEMPERATURE_FLUX, Variable: ADVx_TH

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)			
<pre>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</pre>			
Comments			
<p>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.</p>			

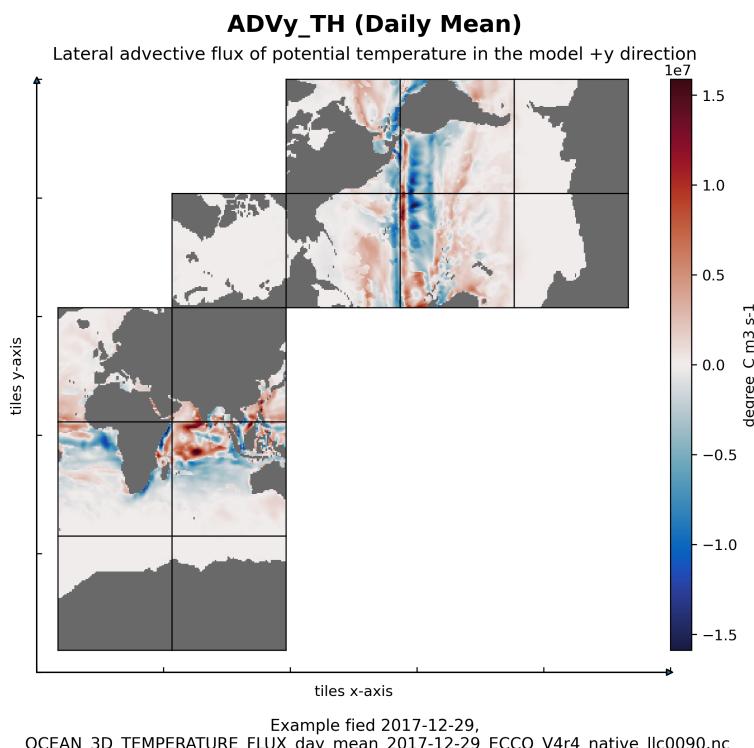


Figure 44: Dataset: OCEAN_3D_TEMPERATURE_FLUX, Variable: ADVy_TH

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)			
<pre>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</pre>			
Comments			
<p>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).</p>			

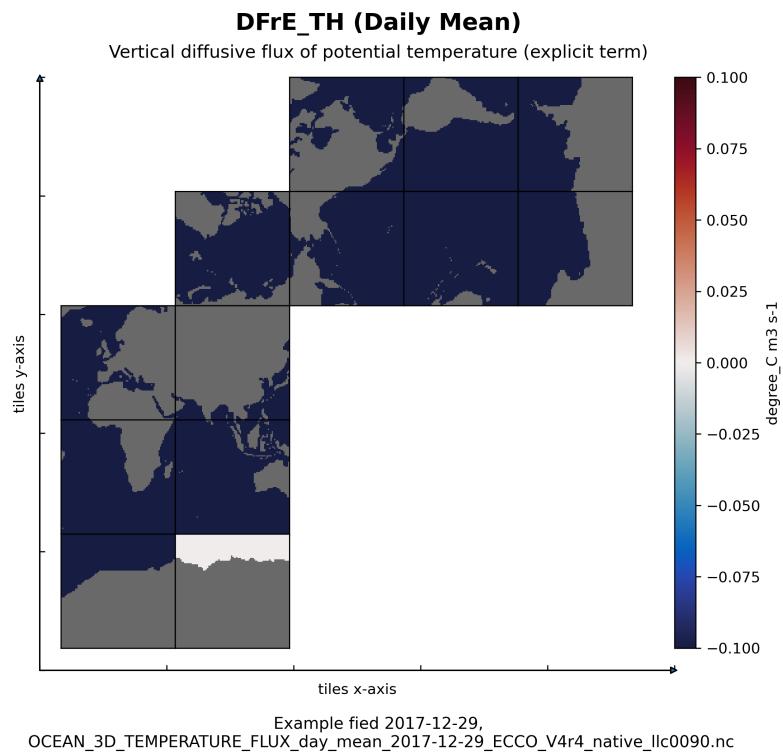


Figure 45: Dataset: OCEAN_3D_TEMPERATURE_FLUX, Variable: DFrE_TH

12.5.6 Native Variable: DFrl_TH

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

Storage Type	Variable Name	Description	Unit
float32	DFrl_TH	Vertical diffusive flux of potential temperature (implicit term)	degree_C m3 s-1
Description of the variable in Common Data language (CDL)			
<pre>float32 DFrl_TH(time, k_l, tile, j, i) DFrl_TH:_FillValue = 9.96921e+36 DFrl_TH:long_name = Vertical diffusive flux of potential temperature (implicit term) DFrl_TH:units = degree_C m3 s: 1 DFrl_TH:coverage_content_type = modelResult DFrl_TH:direction = >0 decreases potential temperature (THETA) DFrl_TH:coordinates = XC YC time Zl DFrl_TH:valid_min = : 104210688.0 DFrl_TH:valid_max = 23574302.0</pre>			
Comments			
<p>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-reidi 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-reidi 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)</p>			

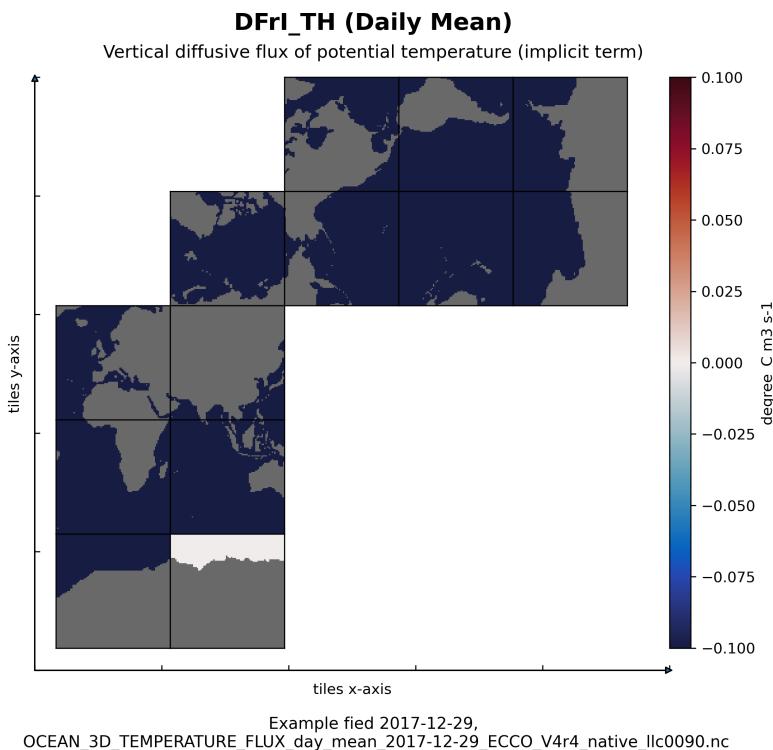


Figure 46: Dataset: OCEAN_3D_TEMPERATURE_FLUX, Variable: DFrl_TH

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)			
<pre>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</pre>			
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.			

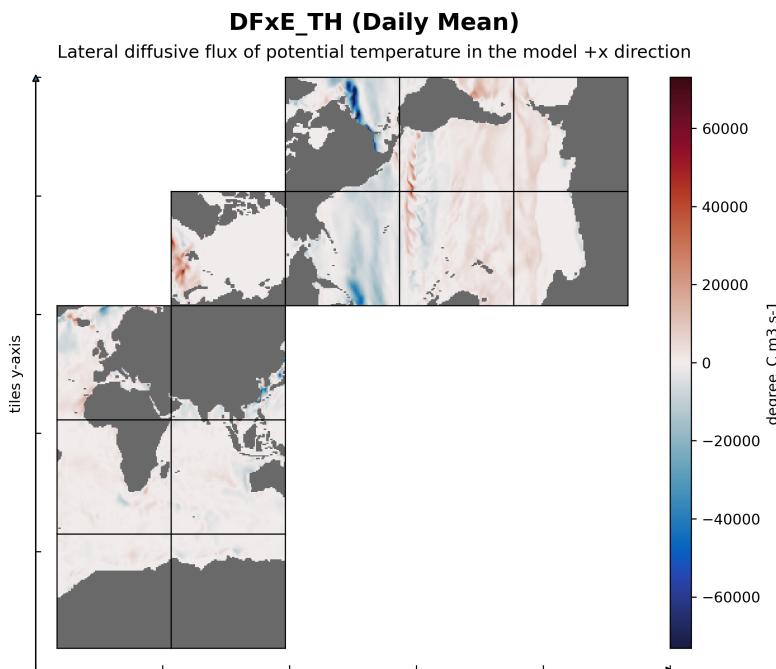


Figure 47: Dataset: OCEAN_3D_TEMPERATURE_FLUX, Variable: DFxE_TH

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)			
<pre>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 =>O increases potential temperature (THETA) DFyE_TH:coordinates = time Z DFyE_TH:valid_min = : 421044.78125 DFyE_TH:valid_max = 1053781.25</pre>			
Comments			
<p>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.</p>			

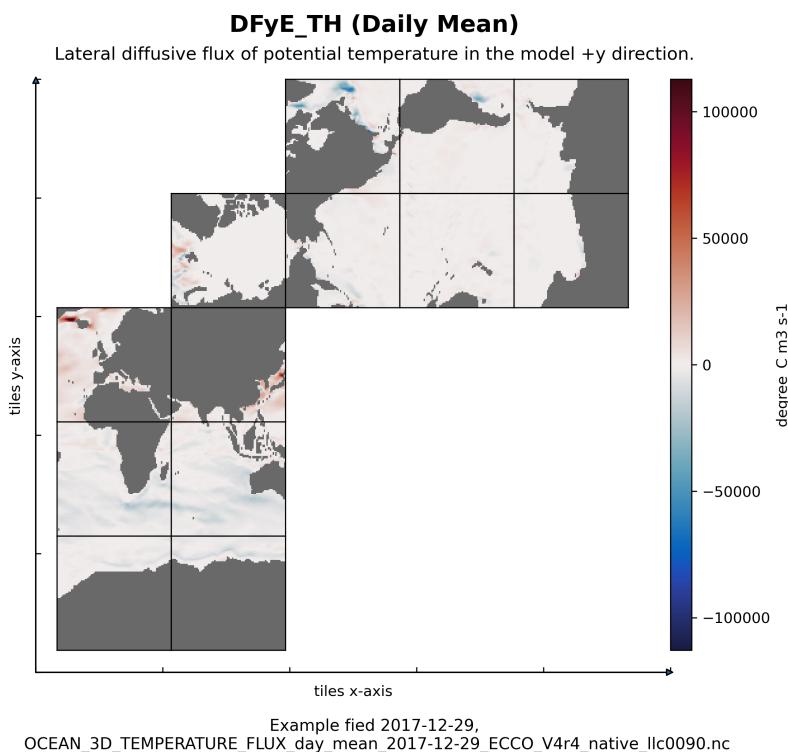


Figure 48: Dataset: OCEAN_3D_TEMPERATURE_FLUX, Variable: DFyE_TH

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-
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			

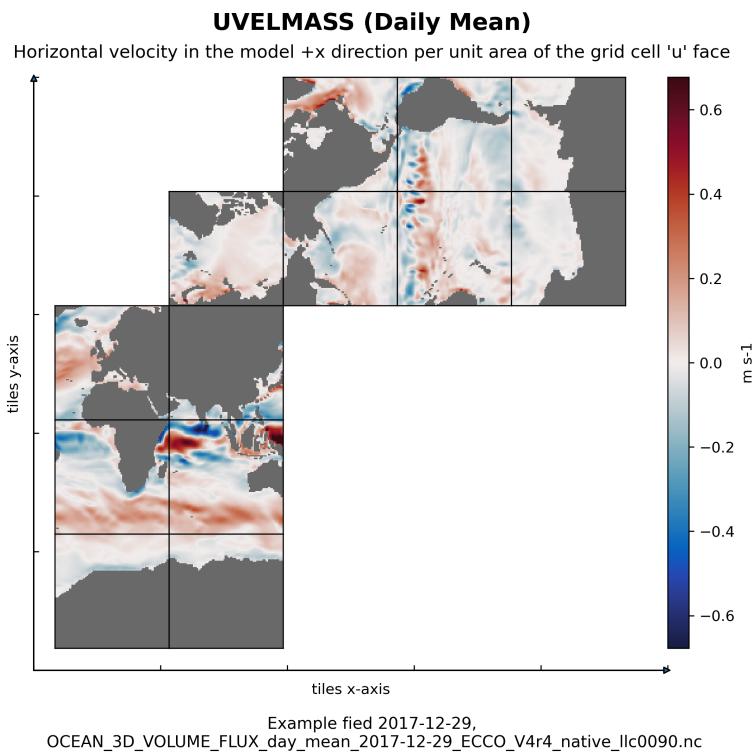


Figure 49: Dataset: OCEAN_3D_VOLUME_FLUX, Variable: UVELMASS

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)			
<pre>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</pre>			
Comments			
<p>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.</p>			

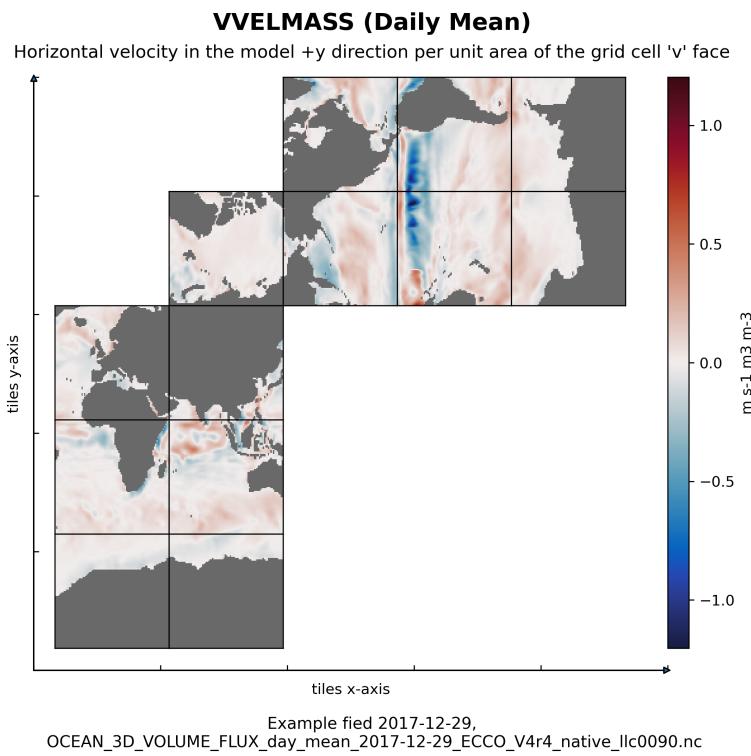
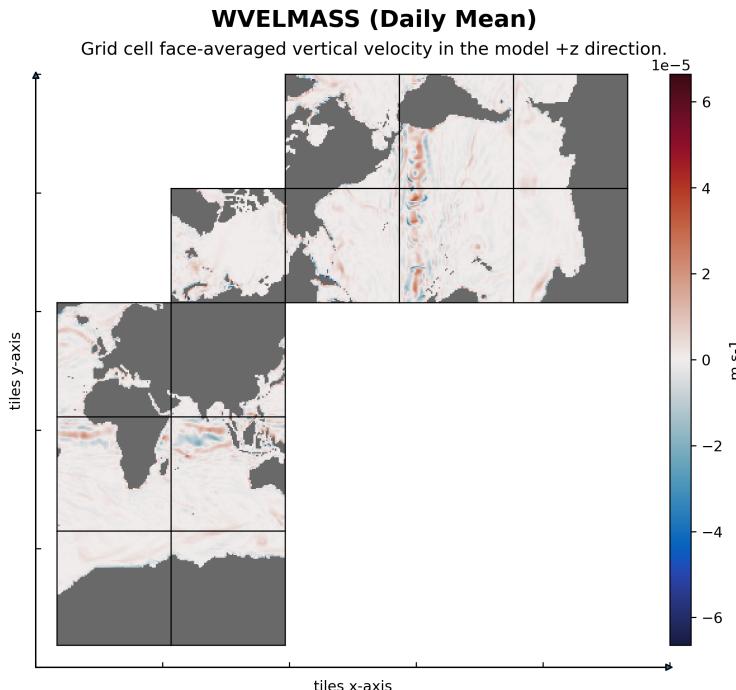


Figure 50: Dataset: OCEAN_3D_VOLUME_FLUX, Variable: VVELMASS

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)			
<pre>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</pre>			
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.			



Example file 2017-12-29,
OCEAN_3D_VOLUME_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 51: 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.

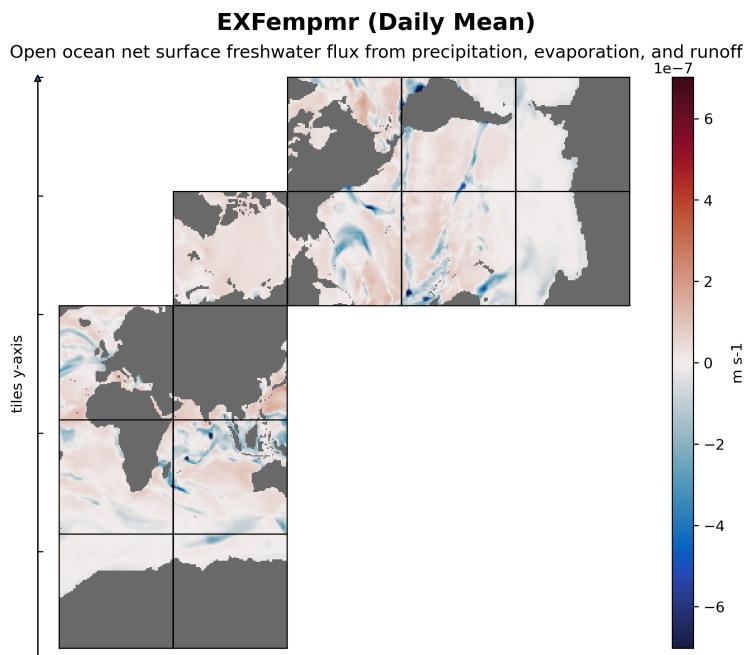
Table 12.36: Coordinates and Variables in the dataset OCEAN_AND_ICE_SURFACE_FW_FLUX

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
SlsnPrcp	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
SlatmFW	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
SlacSubl	Freshwater flux to the atmosphere due to sublimation-deposition of snow or ice	kg m-2 s-1
SlrsSubl	Residual sublimation freshwater flux	kg m-2 s-1
SlfwThru	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)			
<pre>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 =>O increases salinity (SALT) EXFempmr:coordinates = YC XC time EXFempmr:valid_min = : 8.299433829961345e: 06 EXFempmr:valid_max = 5.400421514423215e: 07</pre>			
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.			



Example file 2017-12-29,
OCEAN_AND_ICE_SURFACE_FW_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 52: 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.			

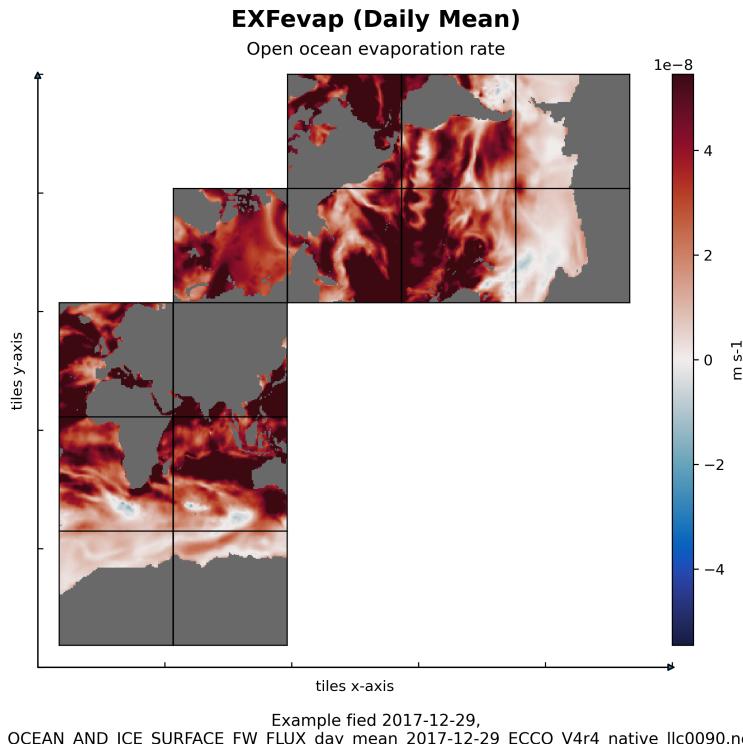


Figure 53: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFevap

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.			

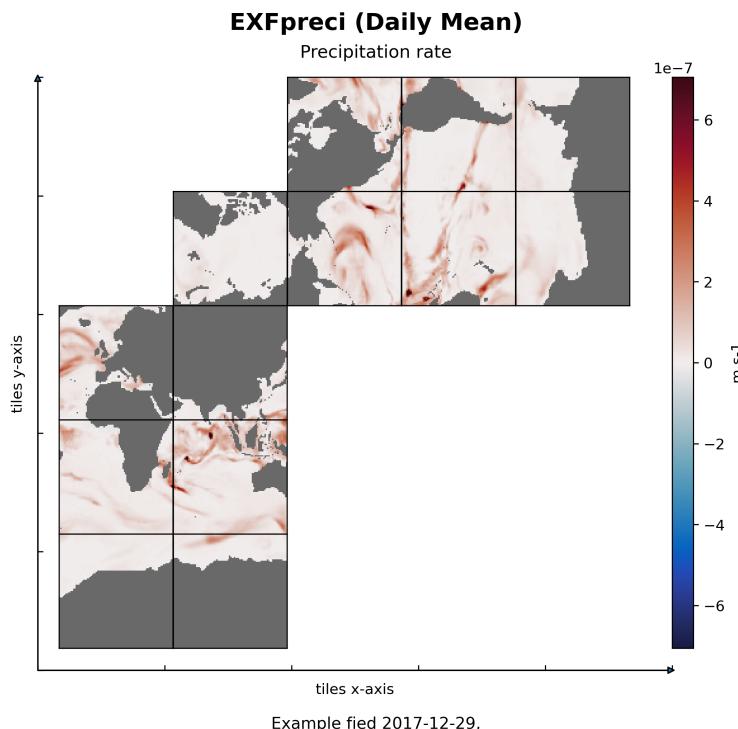


Figure 54: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFpreci

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.			

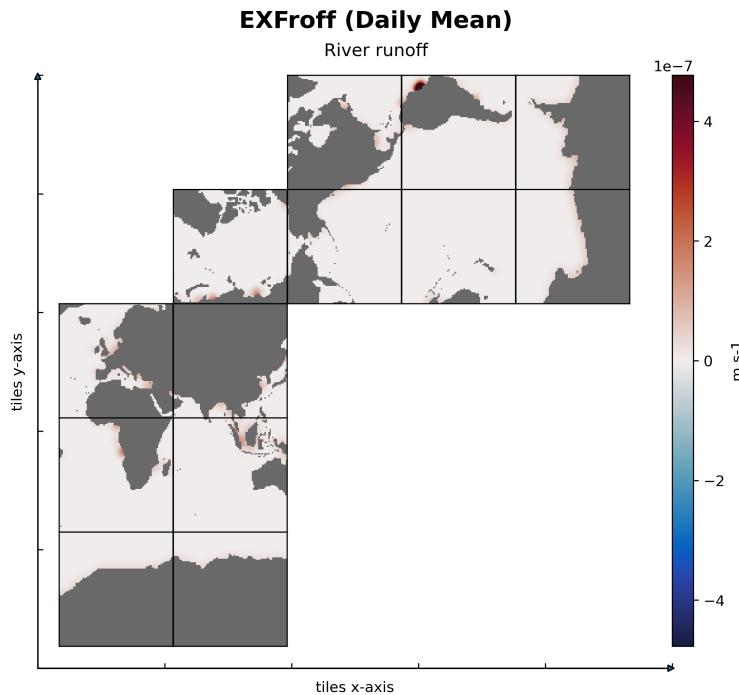


Figure 55: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFroff

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).			

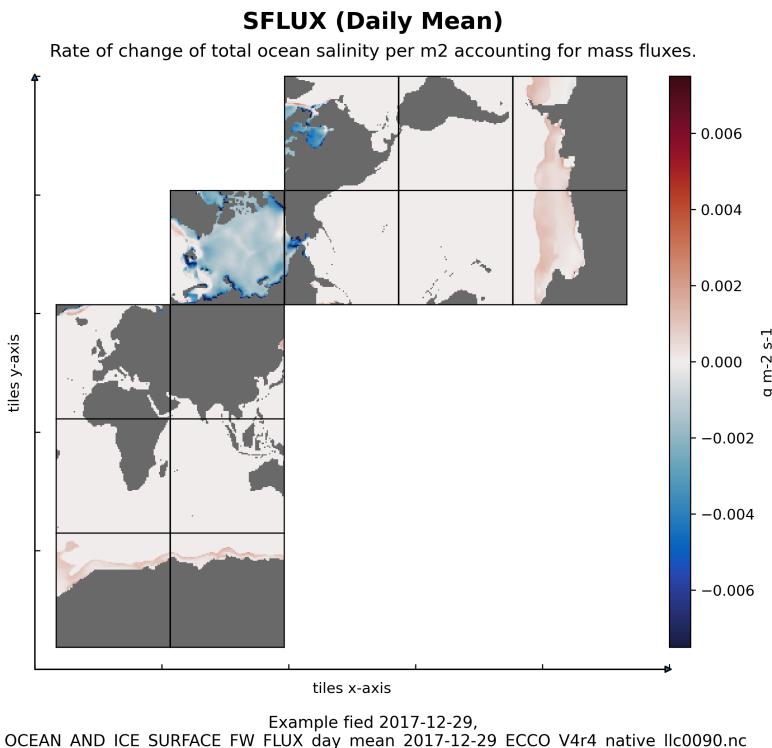
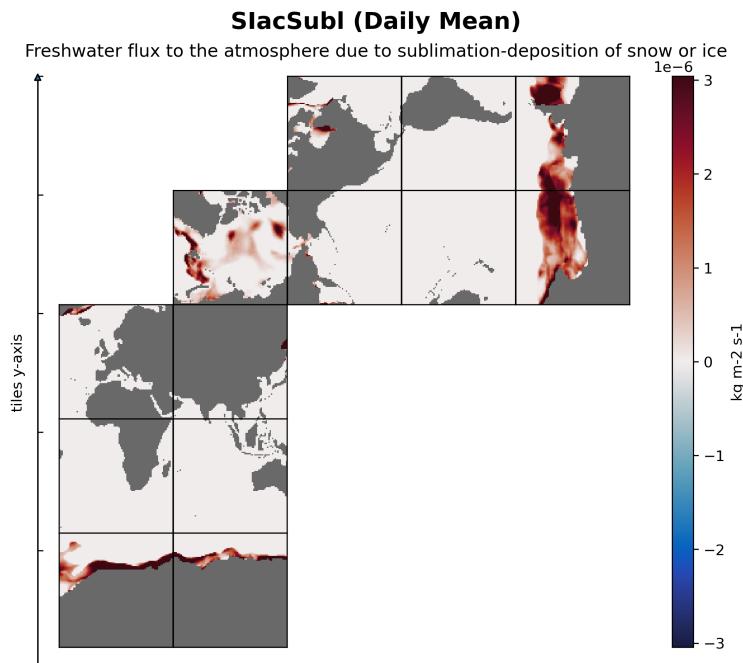


Figure 56: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SFLUX

12.7.7 Native Variable: SlacSubl

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

Storage Type	Variable Name	Description	Unit
float32	SlacSubl	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)			
<pre>float32 SlacSubl(time, tile, j, i) SlacSubl:_FillValue = 9.96921e+36 SlacSubl:long_name = Freshwater flux to the atmosphere due to sublimation: deposition of snow or ice SlacSubl:units = kg m: 2 s:1 SlacSubl:coverage_content_type = modelResult SlacSubl:direction =>O decreases snow or sea: ice thickness (HSNOW or HEFF) SlacSubl:standard_name = water_sublimation_flux SlacSubl:coordinates = YC XC time SlacSubl:valid_min = 0.0 SlacSubl:valid_max = 8.154580427799374e: 05</pre>			
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			



Example file 2017-12-29,
OCEAN_AND_ICE_SURFACE_FW_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 57: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SlacSubl

12.7.8 Native Variable: SlatmFW

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

Storage Type	Variable Name	Description	Unit
float32	SlatmFW	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)			
<pre>float32 SlatmFW(time, tile, j, i) SlatmFW:_FillValue = 9.96921e+36 SlatmFW:long_name = Net freshwater flux into the open ocean sea: ice and snow SlatmFW:units = kg m: 2 s: 1 SlatmFW:coverage_content_type = modelResult SlatmFW:direction = >0 decreases salinity (SALT) SlatmFW:standard_name = surface_downward_water_flux SlatmFW:coordinates = YC XC time SlatmFW:valid_min = : 0.00043017856660299003 SlatmFW:valid_max = 0.008299433626234531</pre>			
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.			

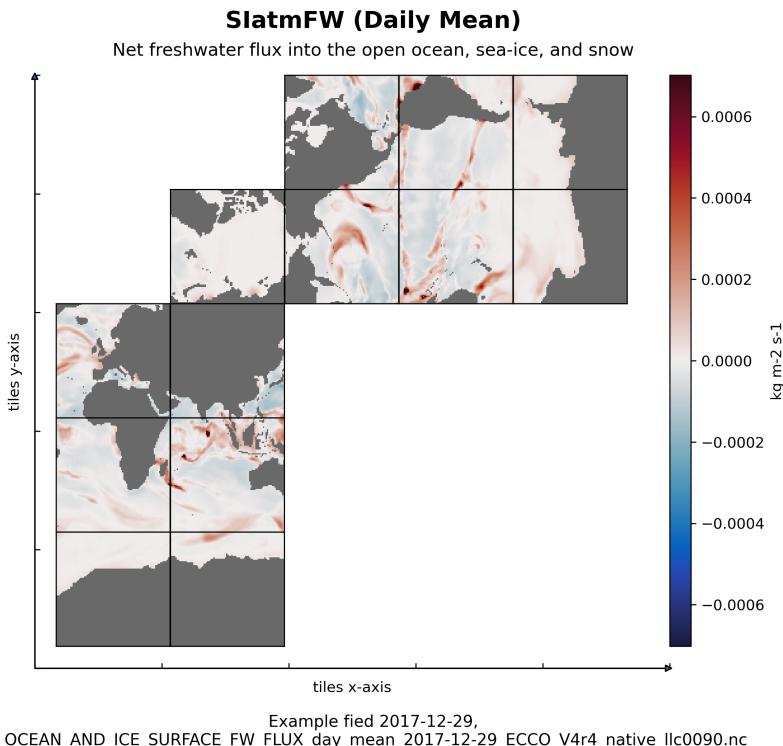


Figure 58: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SlatmFW

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.			

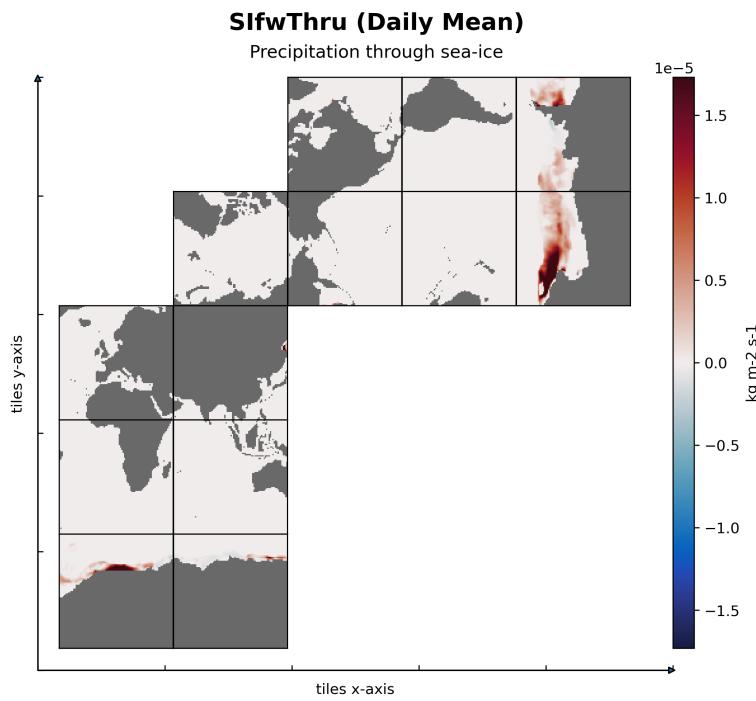


Figure 59: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SIfwThru

12.7.10 Native Variable: SlrsSubl

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

Storage Type	Variable Name	Description	Unit
float32	SlrsSubl	Residual sublimation freshwater flux	kg m ⁻² s ⁻¹
Description of the variable in Common Data language (CDL)			
float32 SlrsSubl(time, tile, j, i) SlrsSubl:_FillValue = 9.96921e+36 SlrsSubl:long_name = Residual sublimation freshwater flux SlrsSubl:units = kg m: 2 s: 1 SlrsSubl:coverage_content_type = modelResult SlrsSubl:direction = >0 decreases ocean volume SlrsSubl:coordinates = YC XC time SlrsSubl:valid_min = : 0.0001067528864950873 SlrsSubl: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 siacsabl 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.			

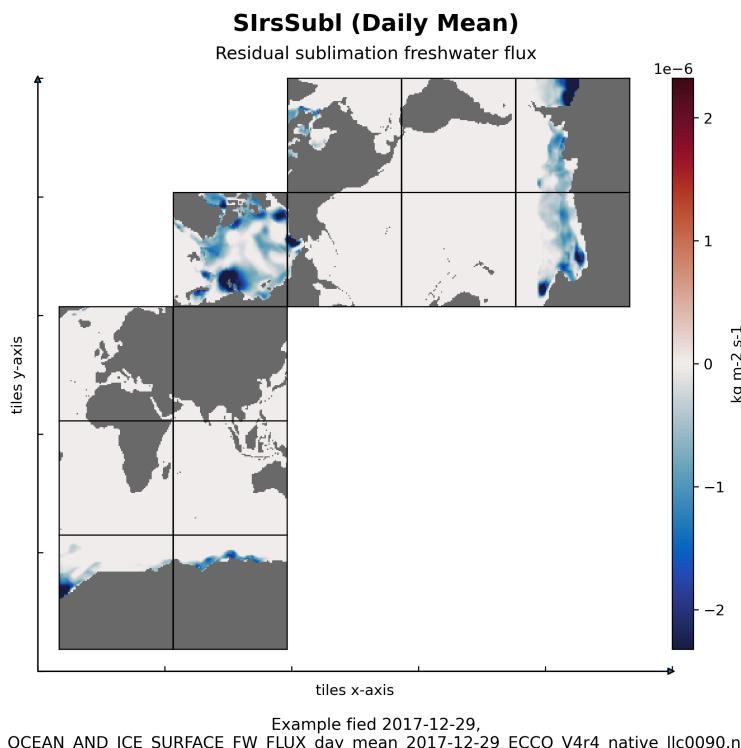


Figure 60: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SlrsSubl

12.7.11 Native Variable: SlsnPrcp

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

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

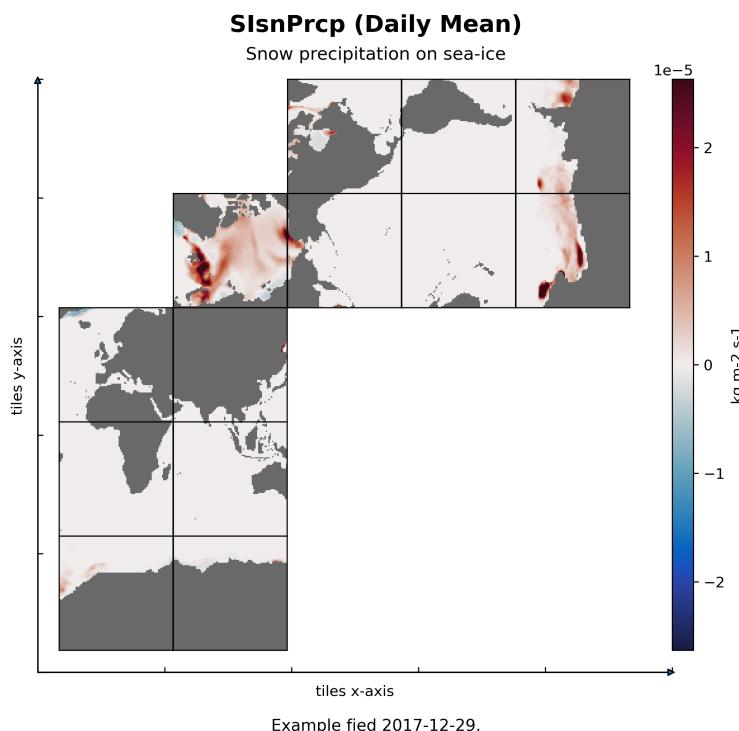


Figure 61: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SlsnPrcp

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)			
<pre>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 =>O 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</pre>			
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: ocefwflux 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.			

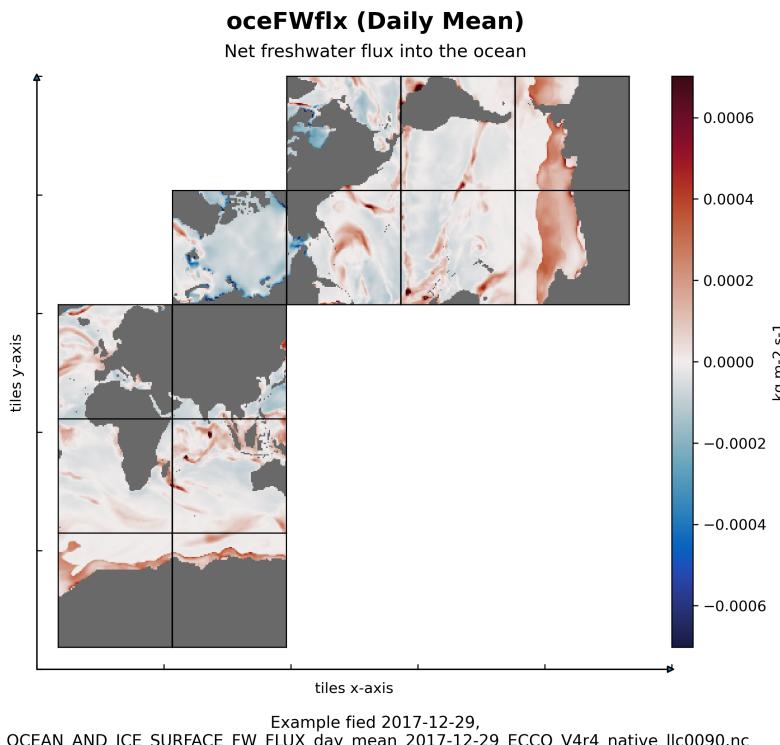


Figure 62: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: oceFWflx

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
SlatmQnt	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
Slaaflux	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)			
<pre>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</pre>			
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.			

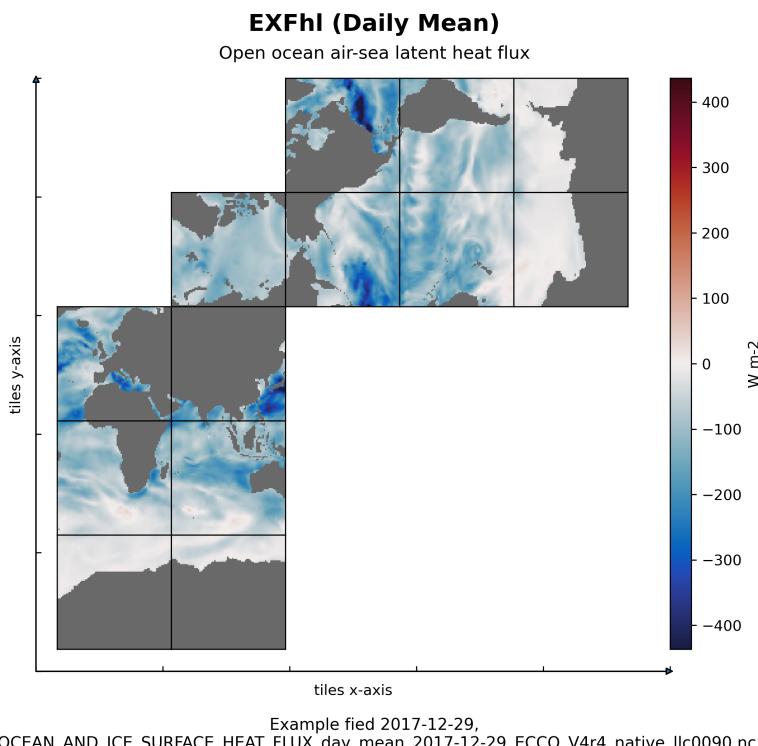


Figure 63: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFhl

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.			

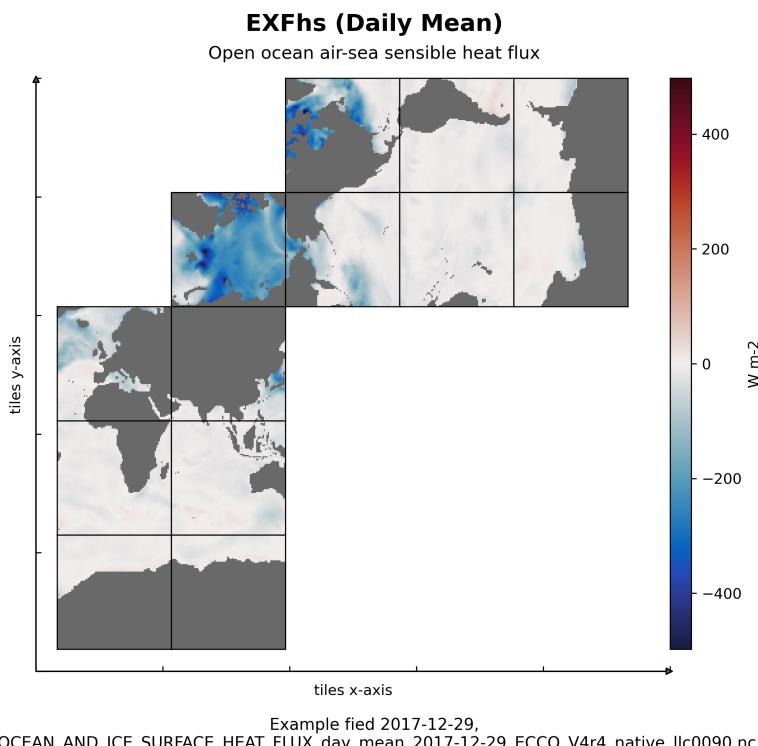


Figure 64: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFhs

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.			

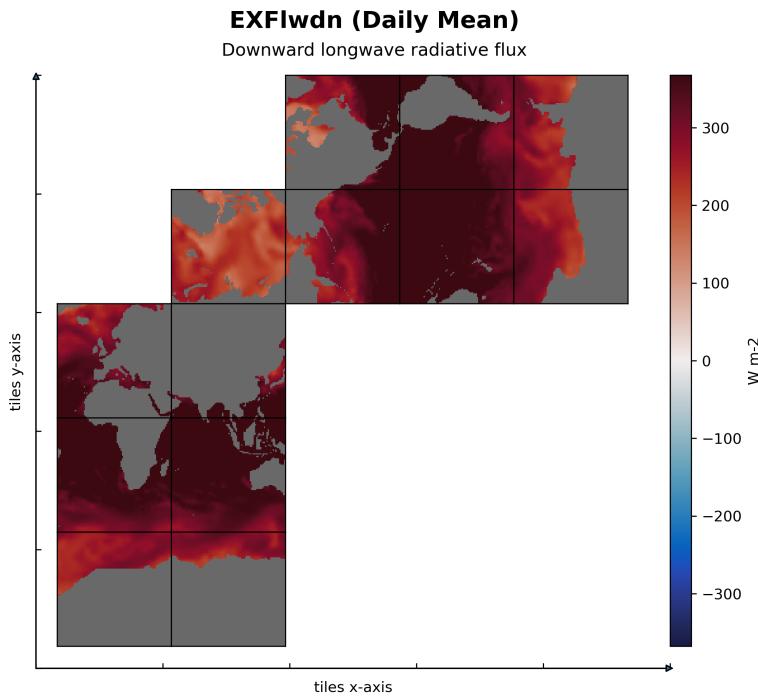


Figure 65: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFlwdn

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).			

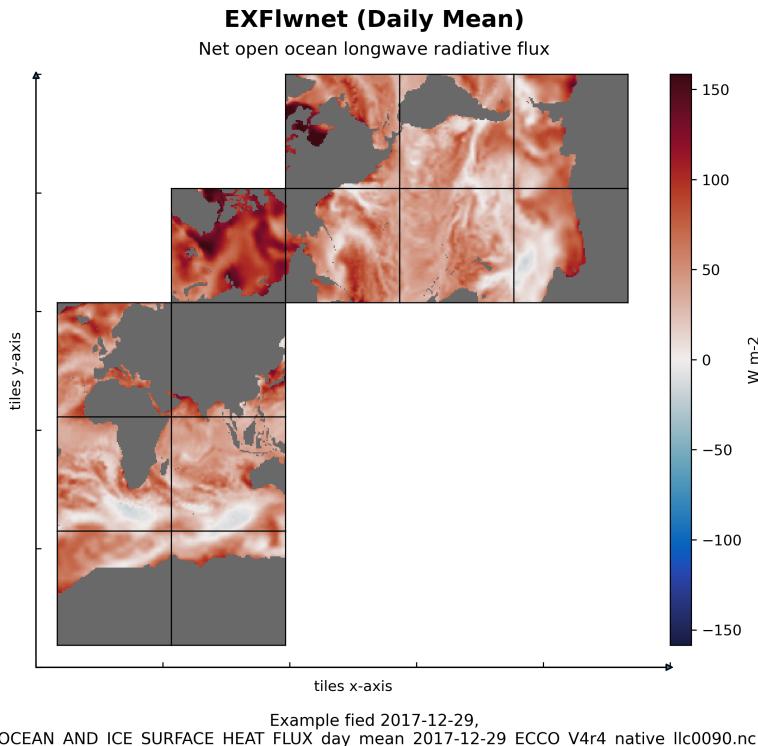


Figure 66: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFlwnet

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-exfh.			

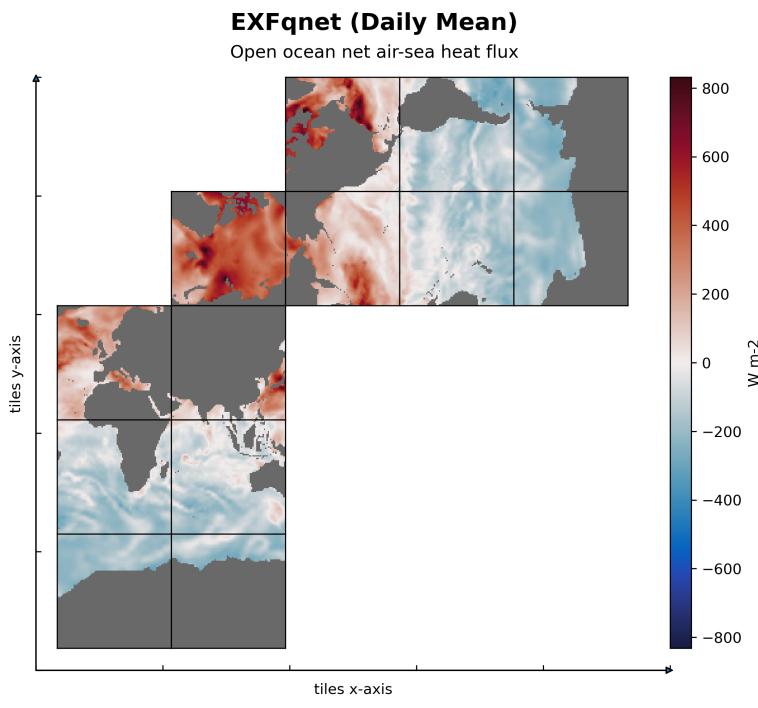


Figure 67: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFqnet

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.			

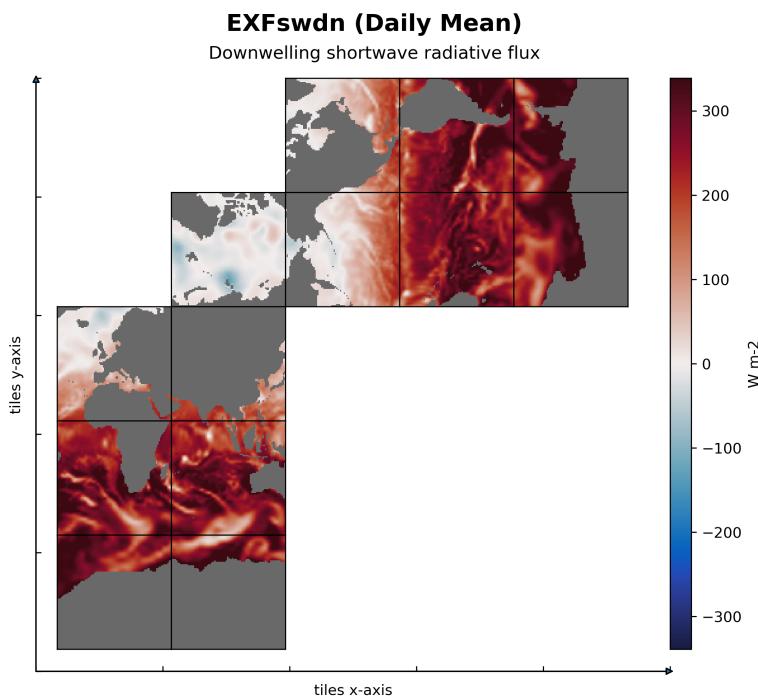
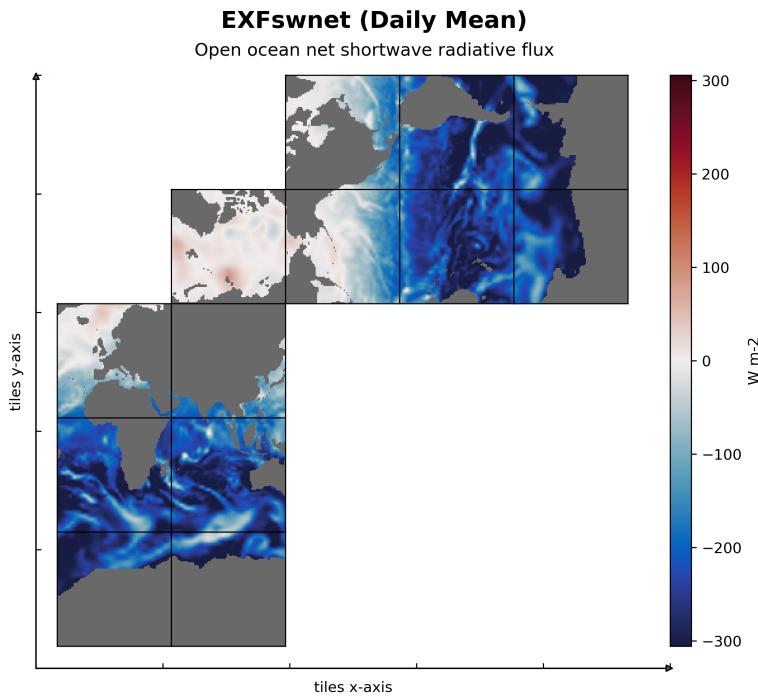


Figure 68: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFswdn

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 albedo.			



Example file 2017-12-29,
OCEAN_AND_ICE_SURFACE_HEAT_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 69: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFswnet

12.8.9 Native Variable: Slaaflux

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

Storage Type	Variable Name	Description	Unit
float32	Slaaflux	Conservative ocean and sea-ice advective heat flux adjustment	W m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>float32 Slaaflux(time, tile, j, i) Slaaflux: _FillValue = 9.96921e+36 Slaaflux: long_name = Conservative ocean and sea: ice advective heat flux adjustment Slaaflux: units = W m: 2 Slaaflux: coverage_content_type = modelResult Slaaflux: direction = >0 decrease potential temperature (THETA) Slaaflux: coordinates = XC time YC Slaaflux: valid_min = : 16.214622497558594 Slaaflux: valid_max = 50.35451889038086</pre>			
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.			

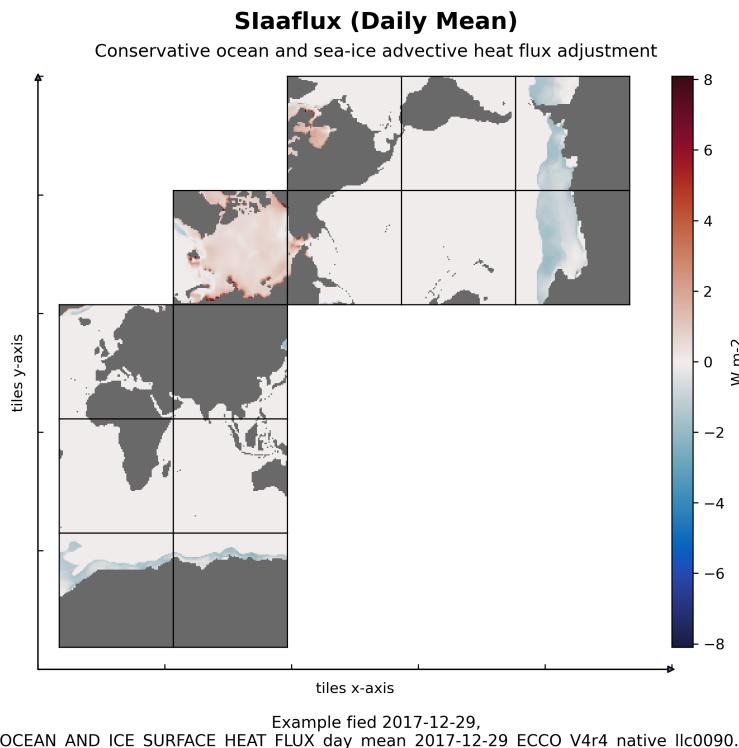
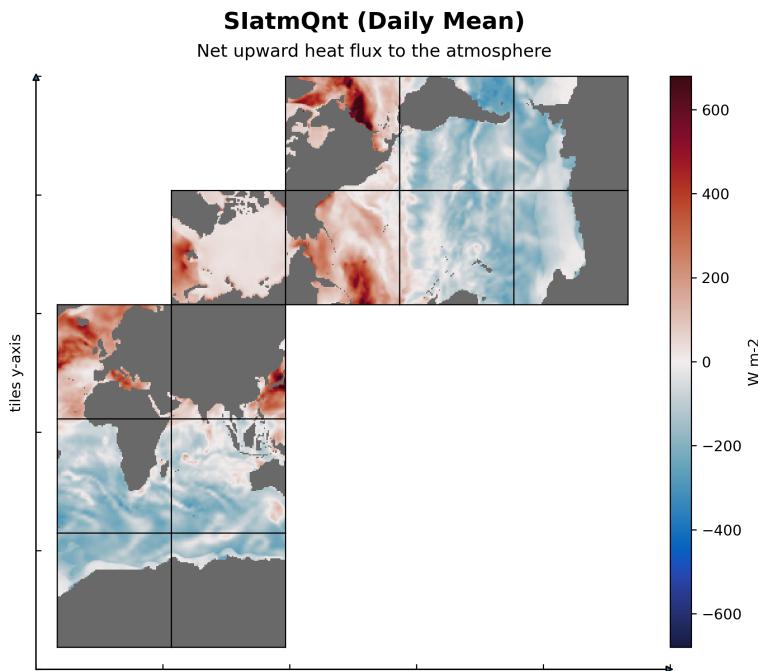


Figure 70: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: Slaaflux

12.8.10 Native Variable: SlatmQnt

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

Storage Type	Variable Name	Description	Unit
float32	SlatmQnt	Net upward heat flux to the atmosphere	W m ⁻²
Description of the variable in Common Data language (CDL)			
float32 SlatmQnt(time, tile, j, i)			
SlatmQnt: _FillValue = 9.96921e+36			
SlatmQnt: long_name = Net upward heat flux to the atmosphere			
SlatmQnt: units = W m: 2			
SlatmQnt: coverage_content_type = modelResult			
SlatmQnt: direction = >0 upward			
decreases ocean temperature			
SlatmQnt: standard_name = surface_upward_heat_flux_in_air			
SlatmQnt: coordinates = XC time YC			
SlatmQnt: valid_min = : 756.0607299804688			
SlatmQnt: 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).			



Example file 2017-12-29,
OCEAN_AND_ICE_SURFACE_HEAT_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 71: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: SlatmQnt

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)			
<pre>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</pre>			
Comments			
<p>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 ocefwwflx).</p>			

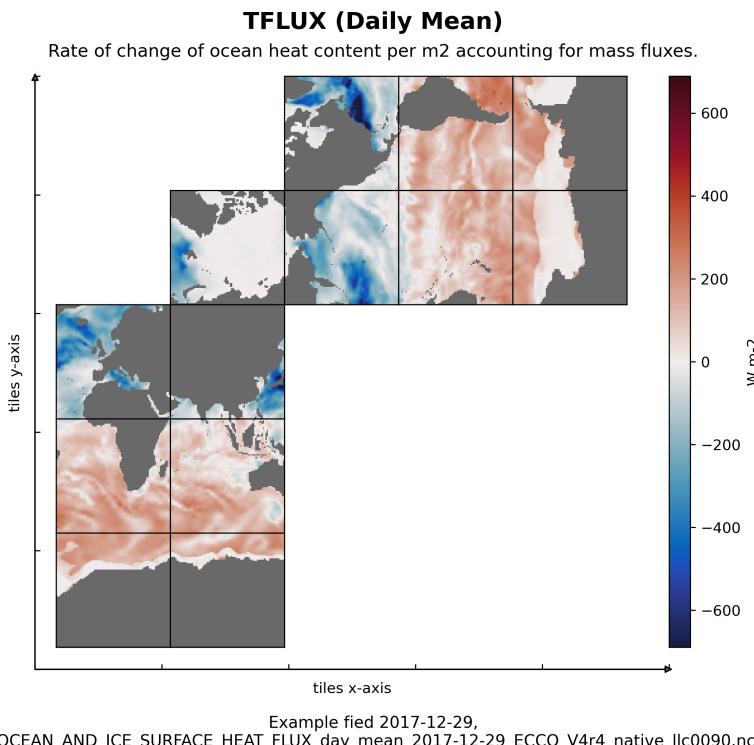


Figure 72: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: TFLUX

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 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 Oc. 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 Oc. the variable tflux does include the change in ocean heat content due to changing ocean mass.			

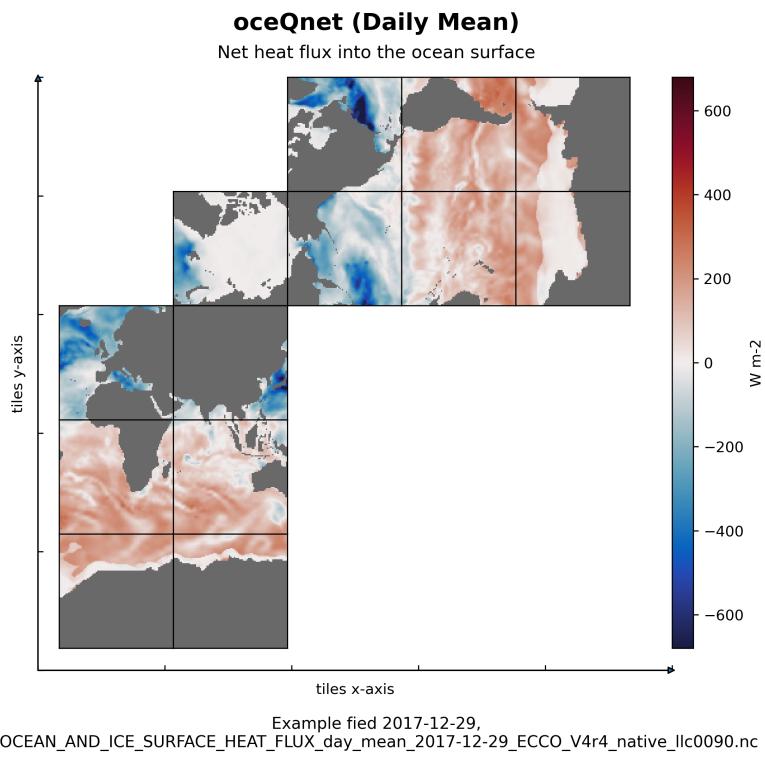


Figure 73: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: oceQnet

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)			
<pre>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</pre>			
Comments			
Net shortwave radiative flux across the ocean surface. note: shortwave radiation penetrates below the surface grid cell.			

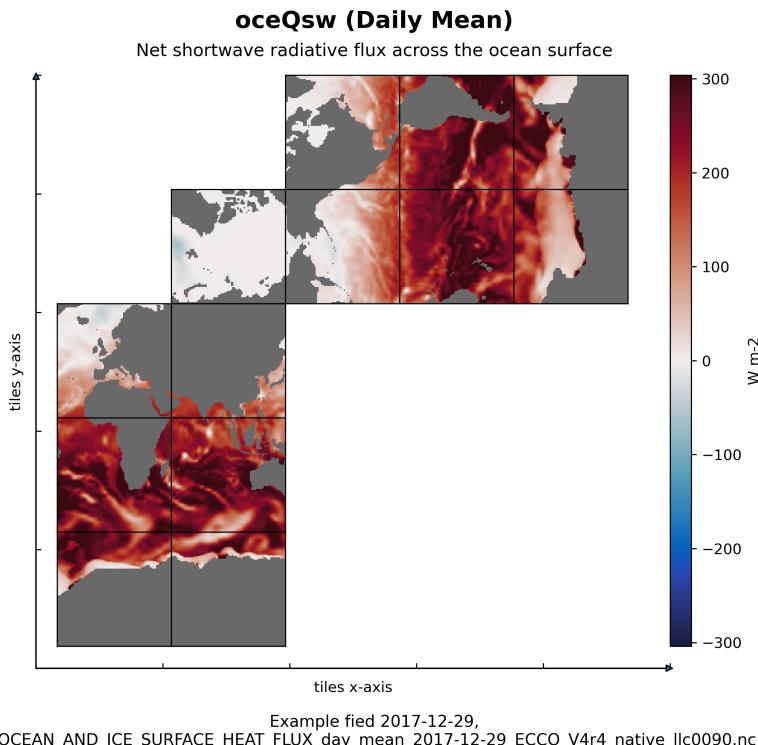


Figure 74: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: oceQsw

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.

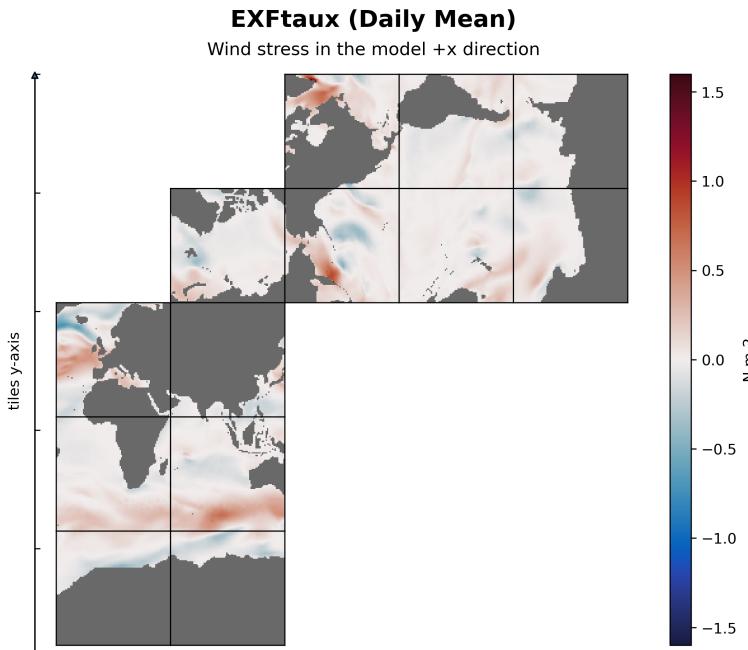
Table 12.61: Coordinates and Variables in the dataset OCEAN_AND_ICE_SURFACE_STRESS

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.			



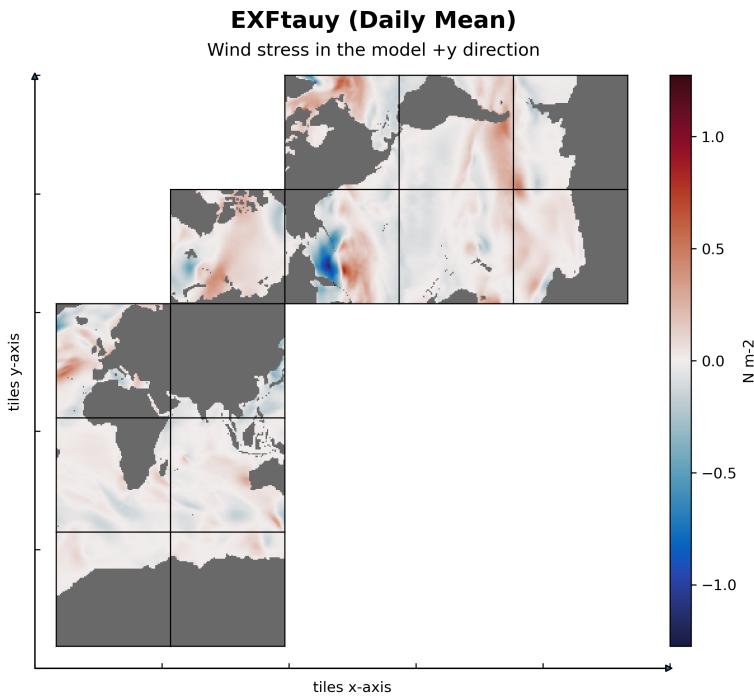
Example file 2017-12-29,
OCEAN_AND_ICE_SURFACE_STRESS_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 75: 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)			
<pre>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</pre>			
Comments			
<p>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 octauy). exftaux is the sum of era-interim stress and the control adjustment from ocean state estimation.</p>			



Example file 2017-12-29,
OCEAN_AND_ICE_SURFACE_STRESS_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 76: 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 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.			

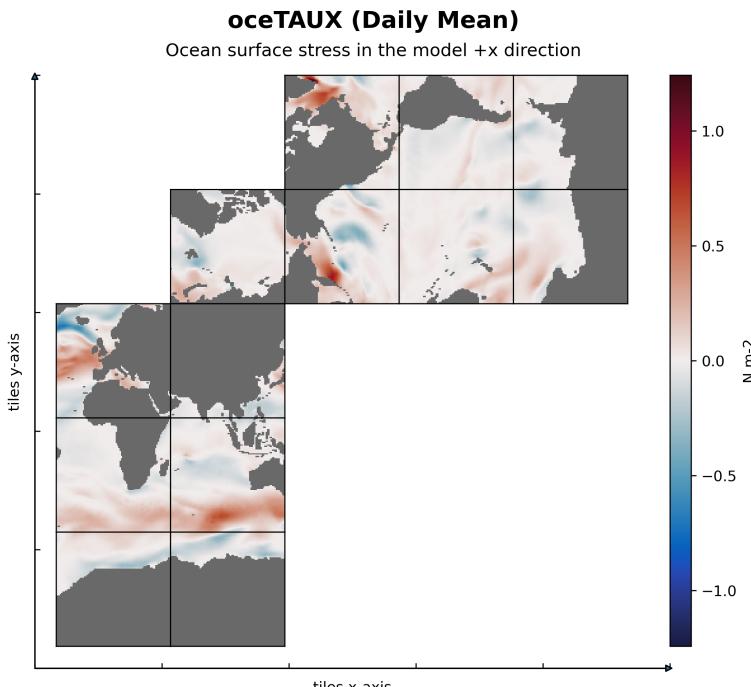


Figure 77: Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: oceTAUX

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)			
<pre>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</pre>			
Comments			
<p>Ocean surface stress due to wind and sea-ice in the +y direction centered over the 'v' side of 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.</p>			

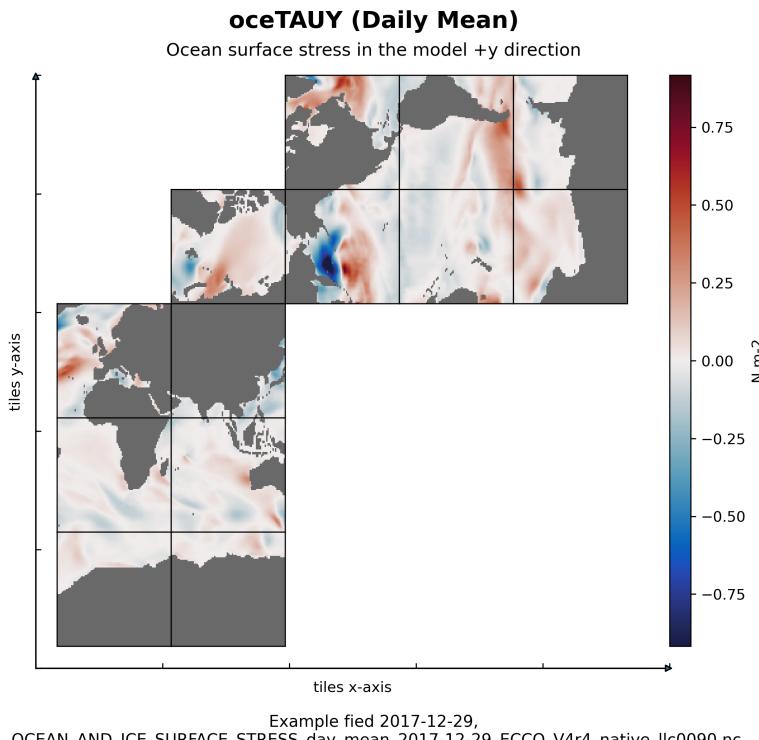


Figure 78: Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: oceTAUY

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-
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)			
<pre>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</pre>			
Comments			
Gent-mcwilliams bolus transport streamfunction 'u' component. any comments welcome			

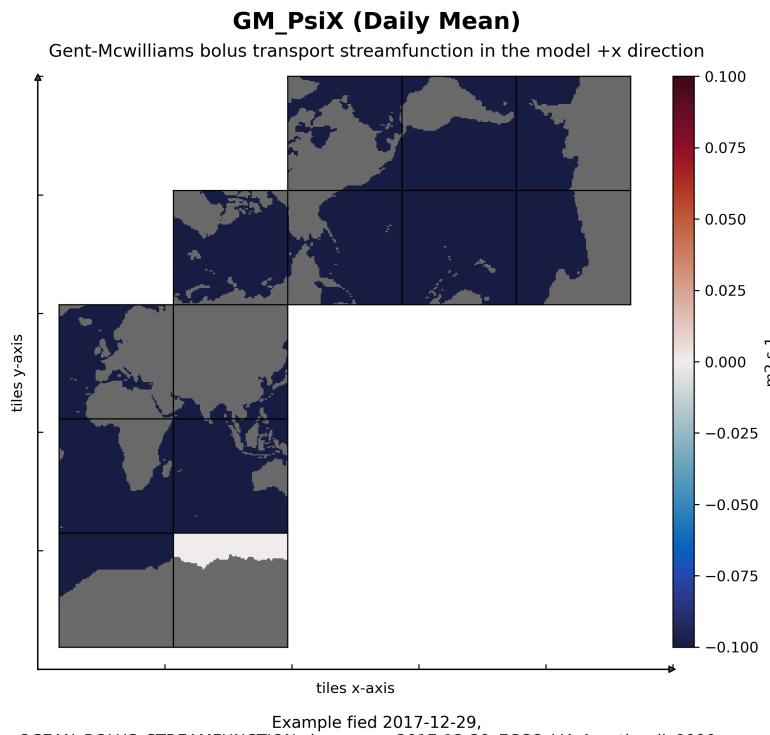


Figure 79: Dataset: OCEAN_BOLUS_STREAMFUNCTION, Variable: GM_PsiX

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)			
<pre>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</pre>			
Comments			
Gent-mcwilliams bolus transport streamfunction 'v' component. any comments welcome			

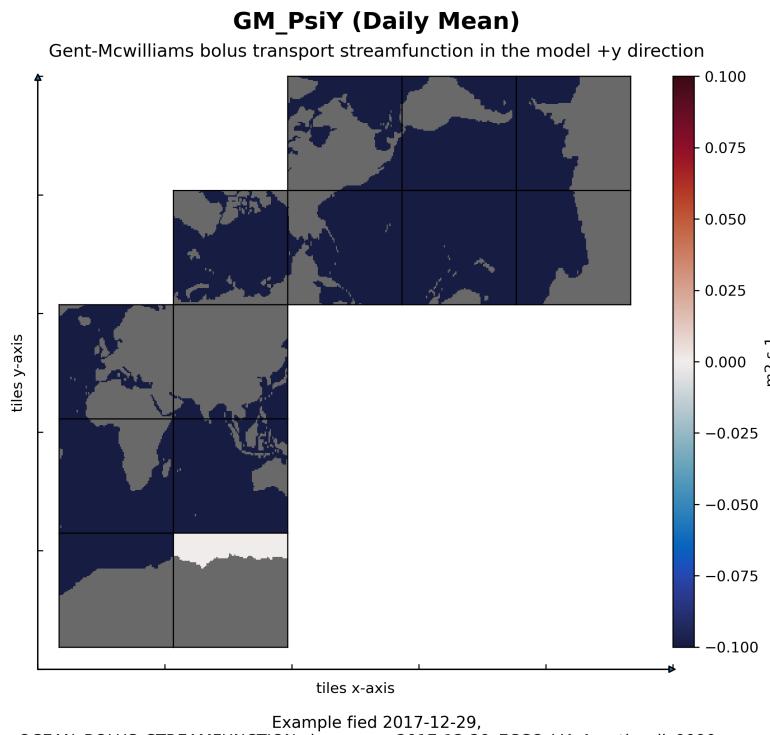


Figure 80: Dataset: OCEAN_BOLUS_STREAMFUNCTION, Variable: GM_PsiY

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)			
<pre>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</pre>			
Comments			
<p>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.</p>			

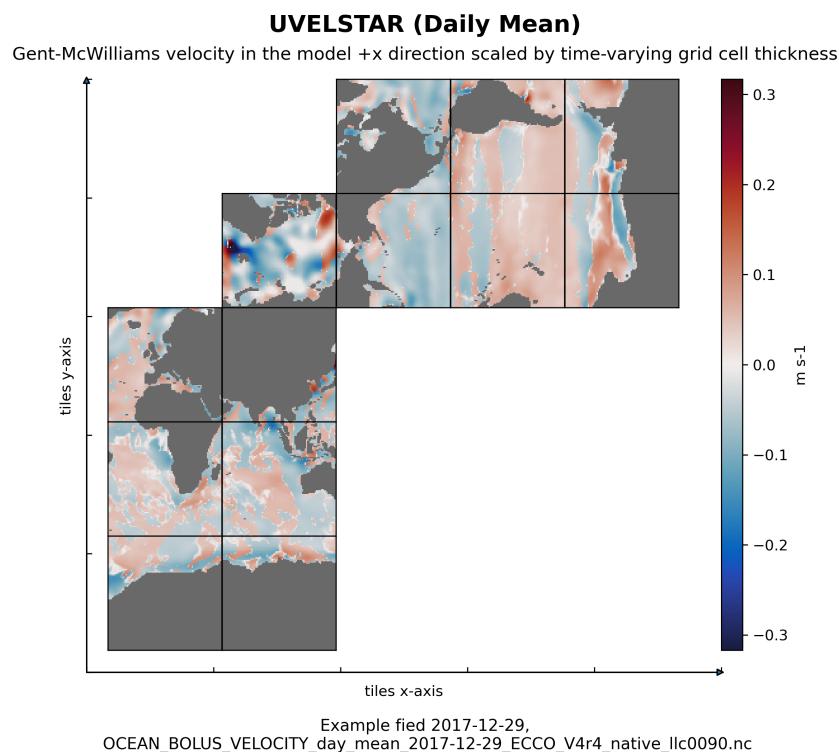


Figure 81: Dataset: OCEAN_BOLUS_VELOCITY, Variable: UVELSTAR

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)			
<pre>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</pre>			
Comments			
<p>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.</p>			

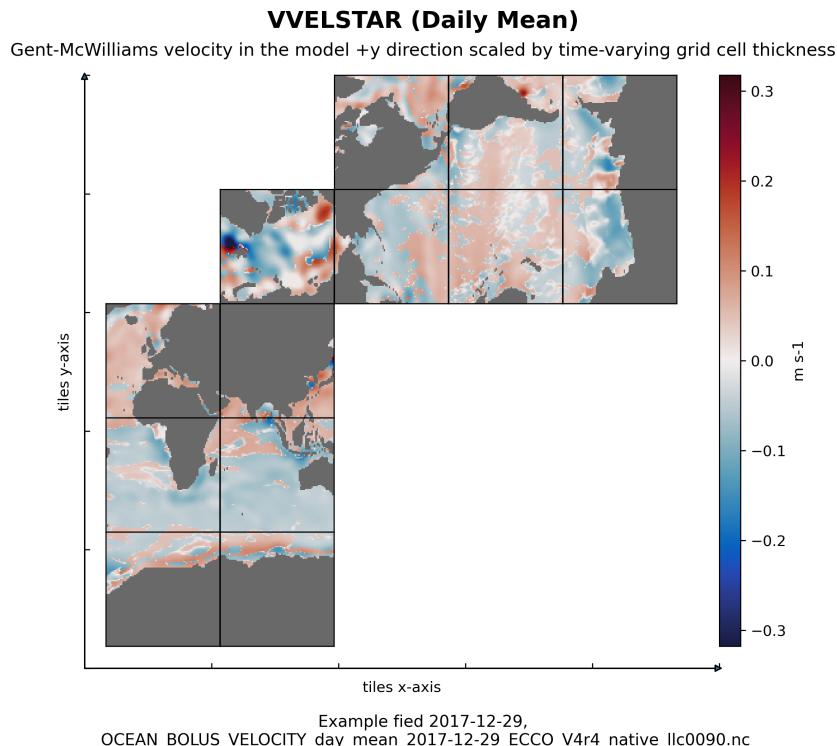


Figure 82: Dataset: OCEAN_BOLUS_VELOCITY, Variable: VVELSTAR

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).			

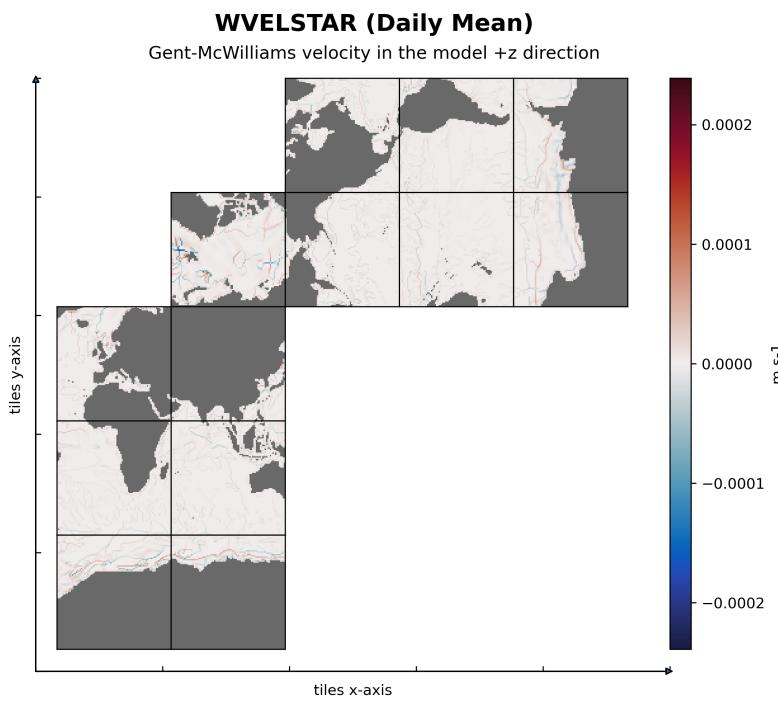


Figure 83: Dataset: OCEAN_BOLUS_VELOCITY, Variable: WVELSTAR

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 atmospheric pressure (OBPGMAP), 2) ocean bottom pressure excluding global mean atmospheric pressure (OBP), 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 sterghlo) 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.			

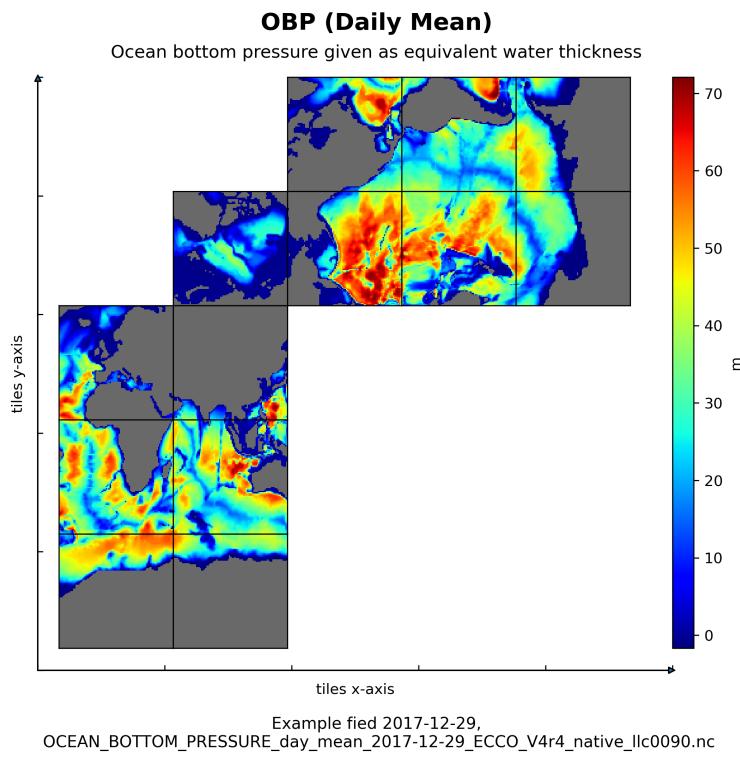


Figure 84: Dataset: OCEAN_BOTTOM_PRESSURE, Variable: OBP

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)			
<pre>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</pre>			
Comments			
<p>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 sterghlo). 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.</p>			

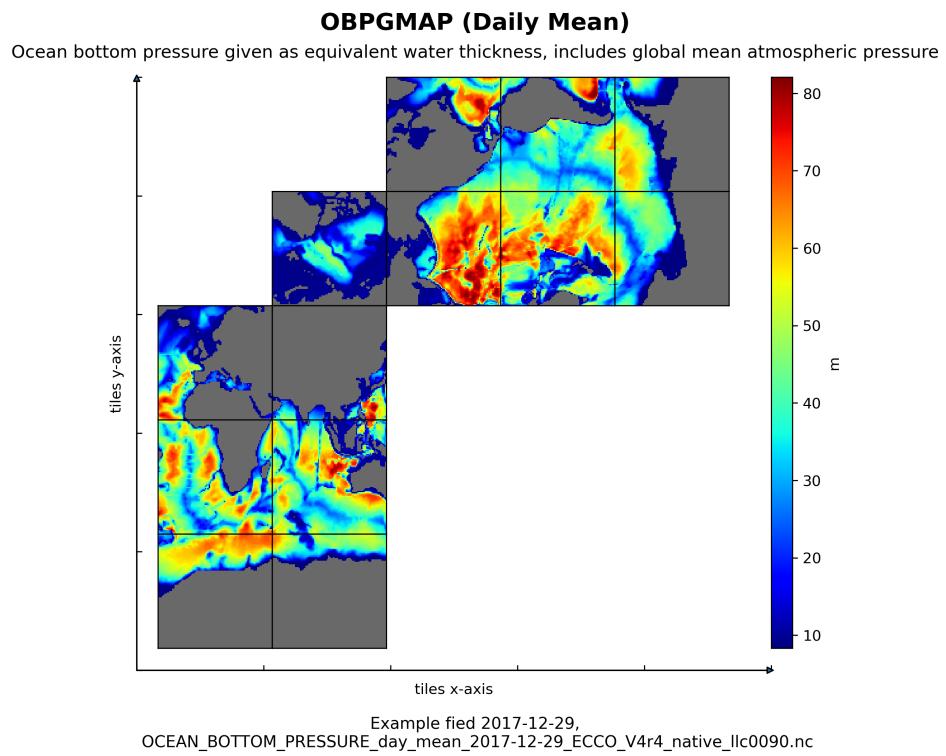
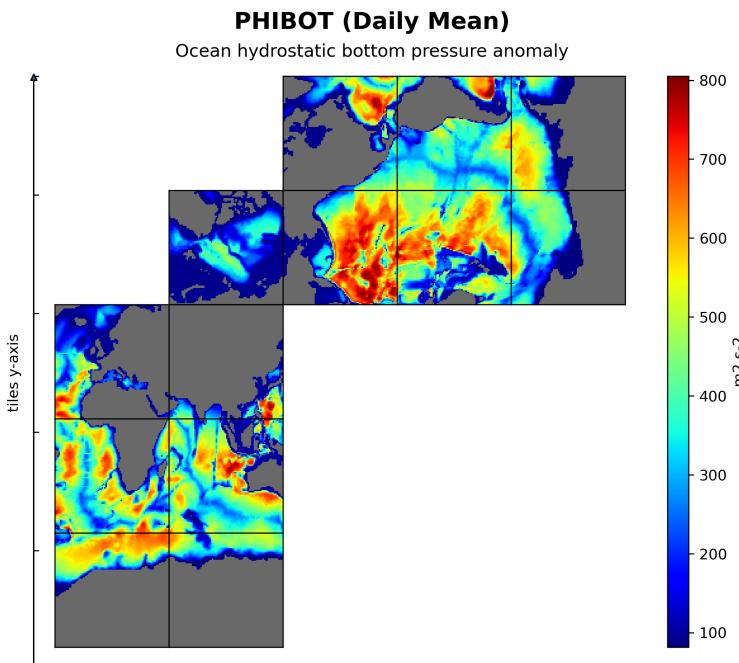


Figure 85: Dataset: OCEAN_BOTTOM_PRESSURE, Variable: OBPGMAP

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 = $p_b / \rho_{\text{const}} - g h(t)$, where p_b = hydrostatic ocean bottom pressure, ρ_{const} = 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], ρ_{const} :[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 sterghoh), and therefore should not be used for comparisons with ocean bottom pressure data. instead, see obpgmap and obp.			



Example file 2017-12-29,
OCEAN_BOTTOM_PRESSURE_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 86: 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	m ² s ⁻²
PHIHYDcR	Ocean hydrostatic pressure anomaly at constant depths	m ² 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 h_{\{0\}} z\$.			

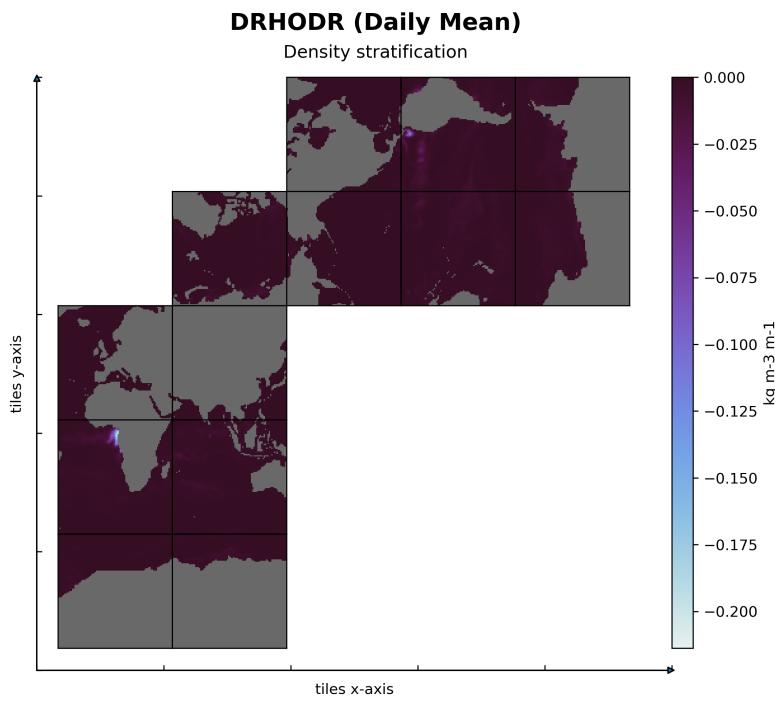


Figure 87: Dataset: OCEAN_DENS_STRAT_PRESS, Variable: DRHODR

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 phihydr 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 sterghlo).			

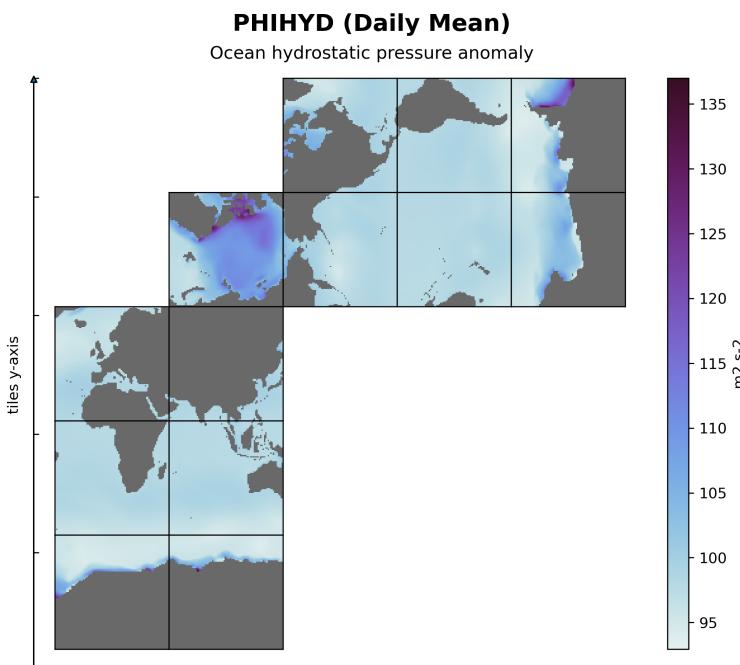


Figure 88: Dataset: OCEAN_DENS_STRAT_PRESS, Variable: PHIHYD

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)			
<pre>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</pre>			
Comments			
<p>Phihyd = $p(k) / \rho_{\text{const}} - g z(k,t)$, where p = hydrostatic ocean pressure at depth level k, ρ_{const} = 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: $p: [\text{kg m}^{-1} \text{s}^{-2}]$, $\rho_{\text{const}}: [\text{kg m}^{-3}]$, $g: [\text{m s}^{-2}]$, $h(t): [\text{m}]$. note: includes atmospheric pressure loading. quantity referred to in some contexts as hydrostatic pressure potential anomaly. phihydr 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). phihydr is not corrected for global mean steric sea level changes related to density changes in the boussinesq volume-conserving model (greatbatch correction, see sterghlo).</p>			

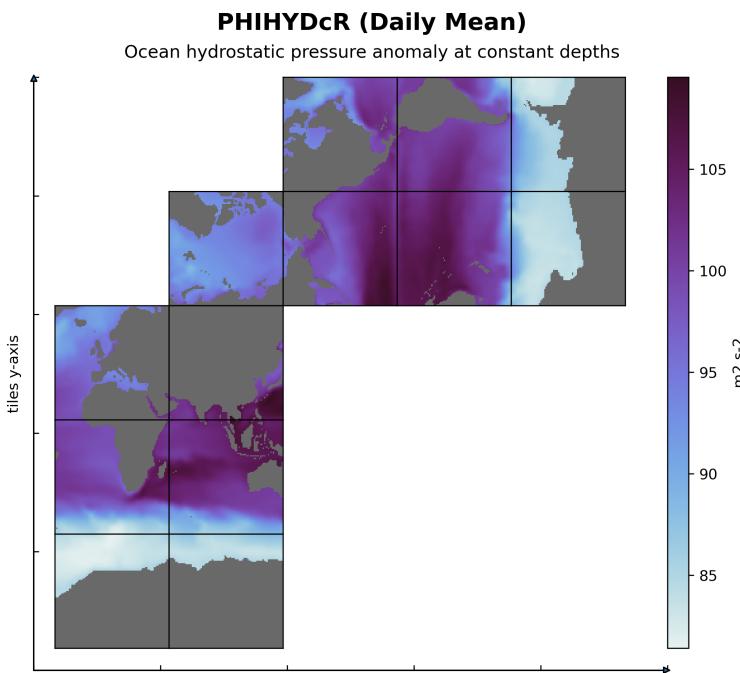


Figure 89: Dataset: OCEAN_DENS_STRAT_PRESS, Variable: PHIHYDcR

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			

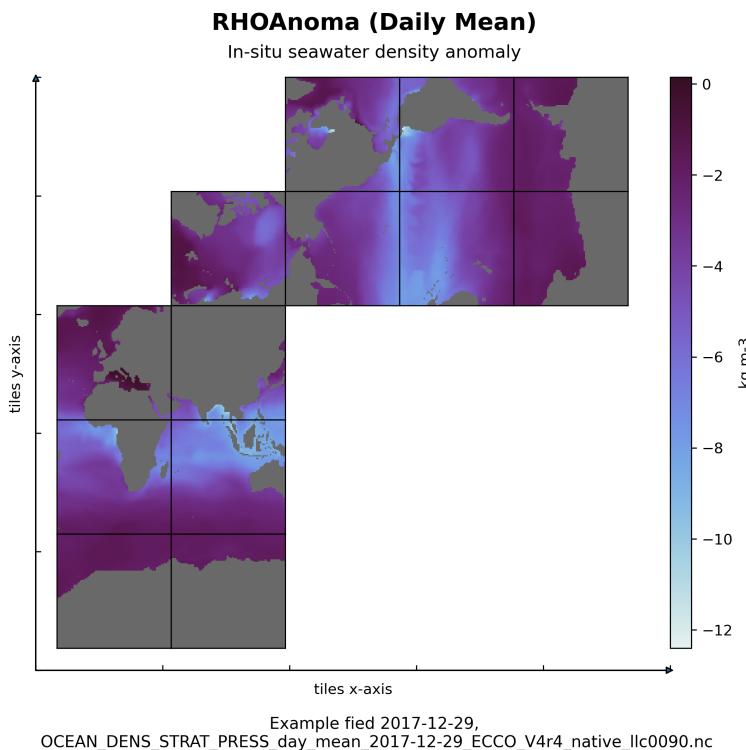


Figure 90: Dataset: OCEAN_DENS_STRAT_PRESS, Variable: RHOAnoma

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)			
<pre>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</pre>			
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).			

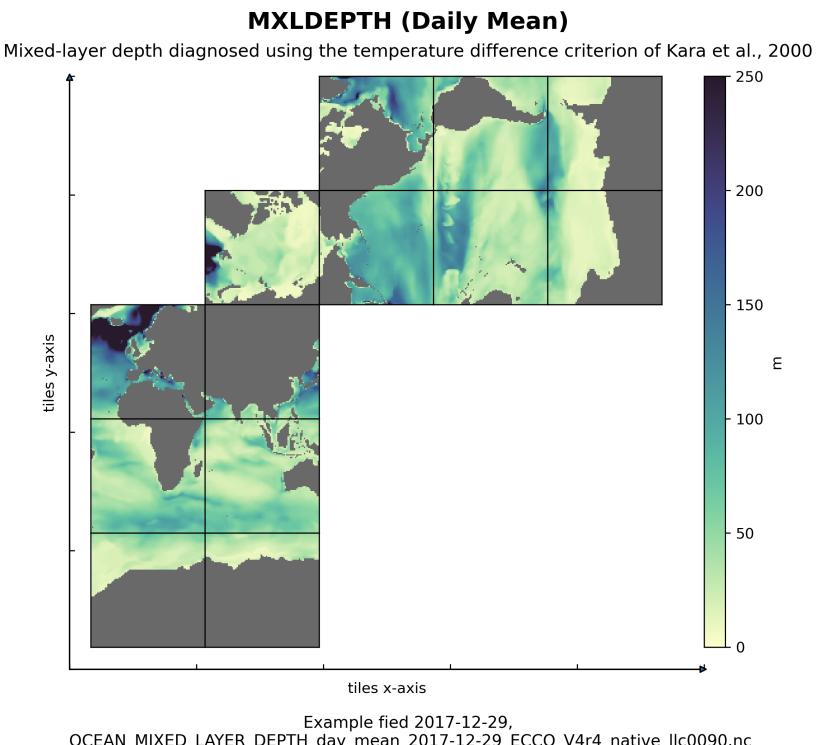


Figure 91: Dataset: OCEAN_MIXED_LAYER_DEPTH, Variable: MXLDEPTH

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)			
<pre>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</pre>			
Comments			
<p>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</p>			

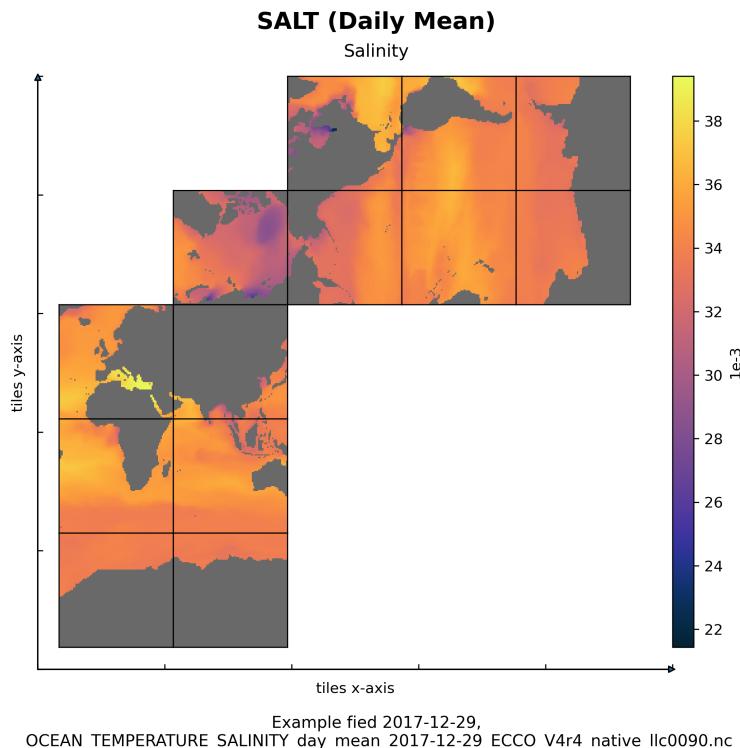


Figure 92: Dataset: OCEAN_TEMPERATURE_SALINITY, Variable: SALT

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			
<p>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 \cdot h_o \{O\} z\\$.</p>			

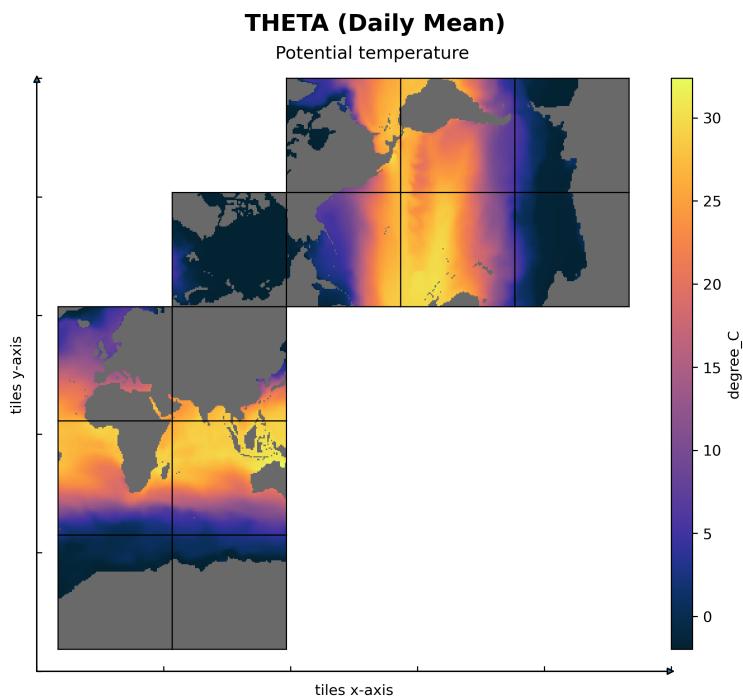


Figure 93: Dataset: OCEAN_TEMPERATURE_SALINITY, Variable: THETA

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)			
<pre>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</pre>			
Comments			
<p>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.</p>			

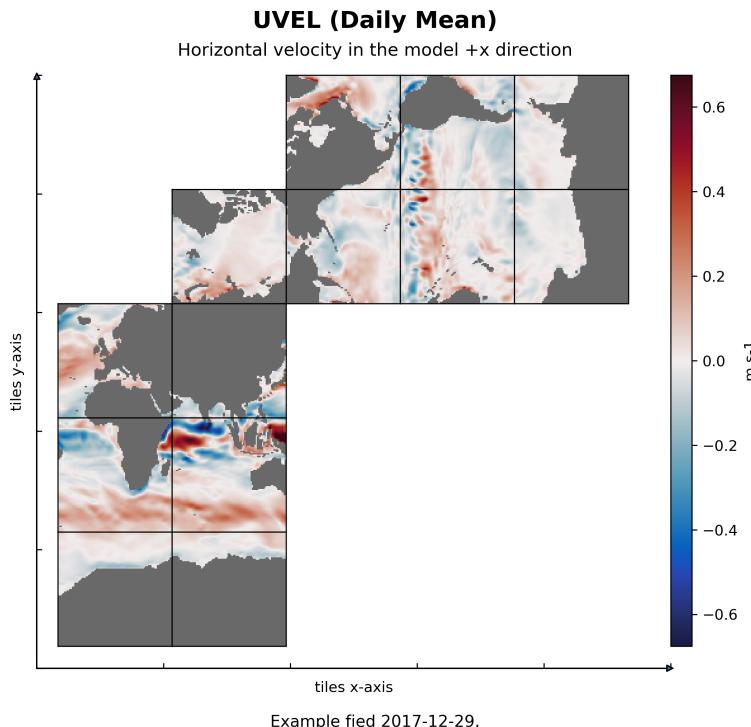


Figure 94: Dataset: OCEAN_VELOCITY, Variable: UVEL

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)			
<pre>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</pre>			
Comments			
<p>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.</p>			

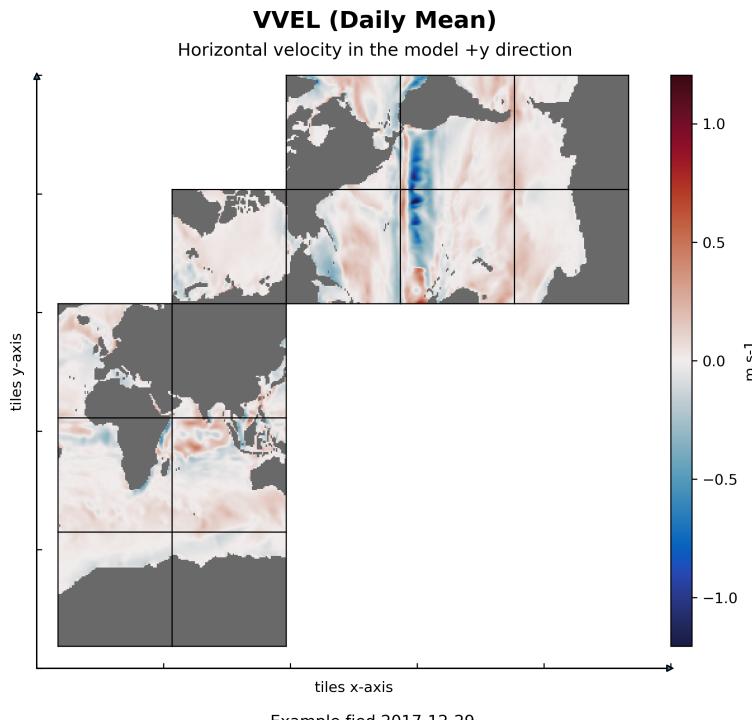


Figure 95: Dataset: OCEAN_VELOCITY, Variable: VVEL

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 =>O 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.			

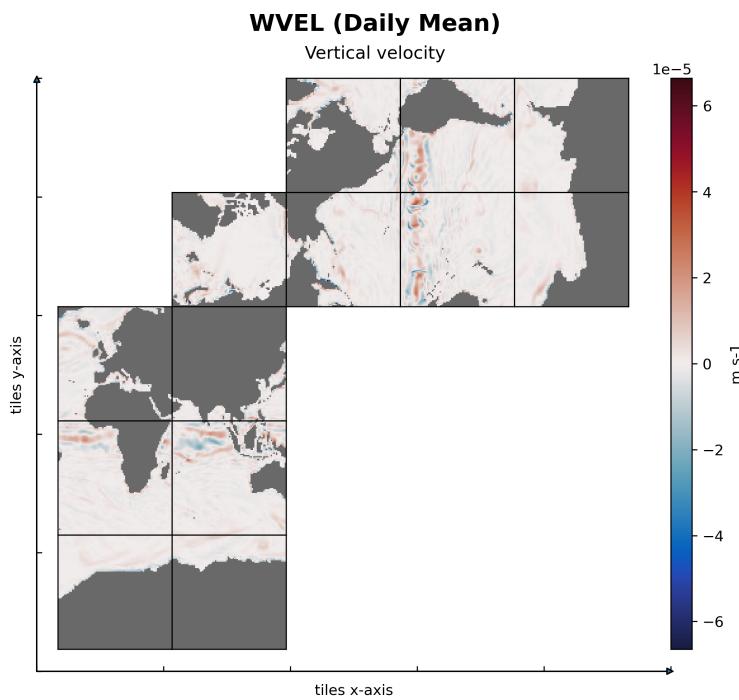


Figure 96: Dataset: OCEAN_VELOCITY, Variable: WVEL

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
Slarea	Sea-ice concentration	1
Slheff	Area-averaged sea-ice thickness	m
Slhsnow	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: Slarea

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

Storage Type	Variable Name	Description	Unit
float32	Slarea	Sea-ice concentration	1
Description of the variable in Common Data language (CDL)			
float32	Slarea(time, tile, j, i)		
Slarea: _FillValue = 9.96921e+36			
Slarea: long_name = Sea: ice concentration			
Slarea: units = 1			
Slarea: coverage_content_type = modelResult			
Slarea: standard_name = sea_ice_area_fraction			
Slarea: coordinates = time YC XC			
Slarea: valid_min = 0.0			
Slarea: valid_max = 0.9700000286102295			
Comments			
<p>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</p>			

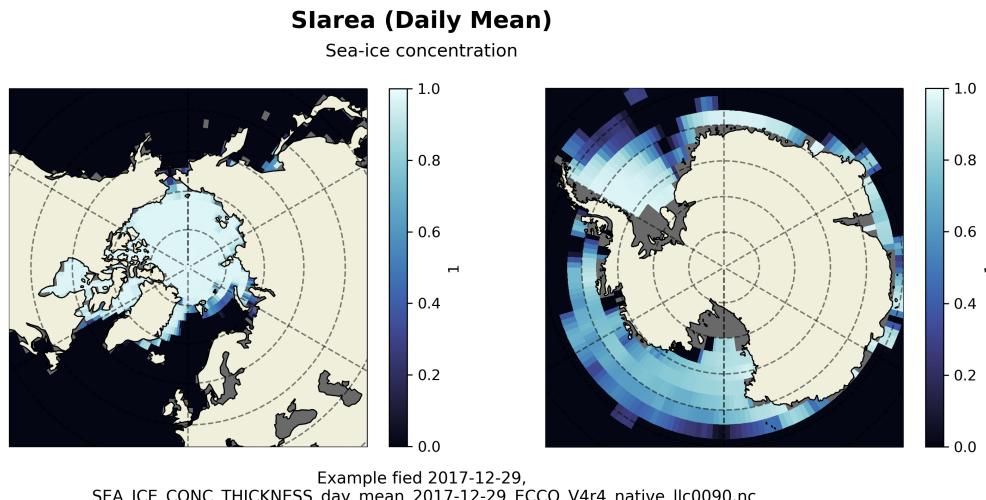


Figure 97: Dataset: SEA_ICE_CONC_THICKNESS, Variable: Slarea

12.17.3 Native Variable: Slheff

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

Storage Type	Variable Name	Description	Unit
float32	Slheff	Area-averaged sea-ice thickness	m
Description of the variable in Common Data language (CDL)			
float32	Slheff(time, tile, j, i)		
Slheff: _FillValue = 9.96921e+36			
Slheff: long_name = Area: averaged sea: ice thickness			
Slheff: units = m			
Slheff: coverage_content_type = modelResult			
Slheff: standard_name = sea_ice_thickness			
Slheff: coordinates = time YC XC			
Slheff: valid_min = 0.0			
Slheff: 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			

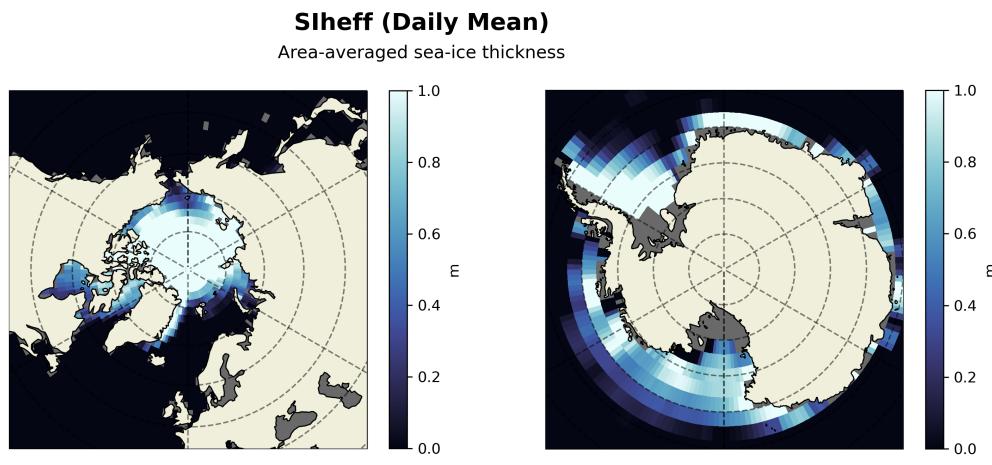


Figure 98: Dataset: SEA_ICE_CONC_THICKNESS, Variable: Slheff

12.17.4 Native Variable: Slhsnow

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

Storage Type	Variable Name	Description	Unit
float32	Slhsnow	Area-averaged snow thickness	m
Description of the variable in Common Data language (CDL)			
float32 Slhsnow(time, tile, j, i) Slhsnow: _FillValue = 9.96921e+36 Slhsnow: long_name = Area: averaged snow thickness Slhsnow: units = m Slhsnow: coverage_content_type = modelResult Slhsnow: standard_name = surface_snow_thickness Slhsnow: coordinates = time YC XC Slhsnow: valid_min = : 0.0004725505714304745 Slhsnow: 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			

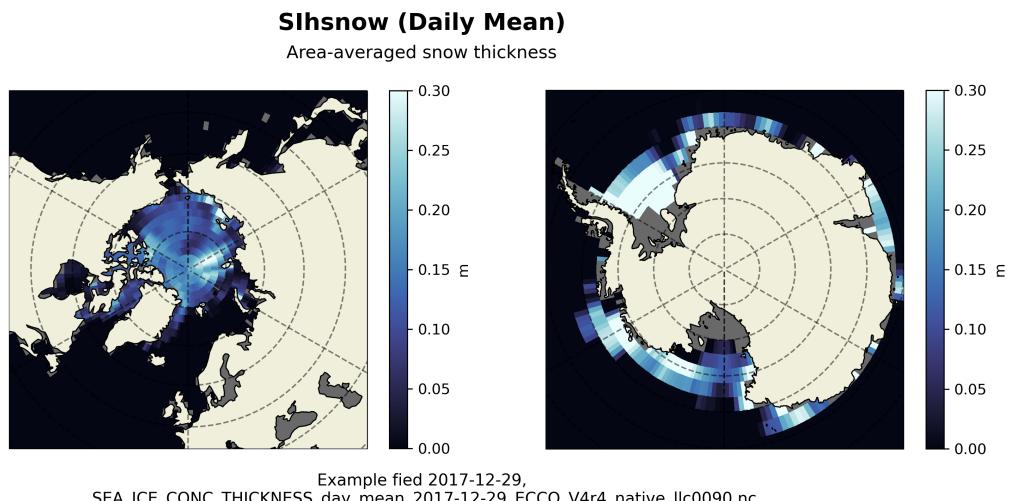


Figure 99: Dataset: SEA_ICE_CONC_THICKNESS, Variable: Slhsnow

12.17.5 Native Variable: slceLoad

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

Storage Type	Variable Name	Description	Unit
float32	slceLoad	Average sea-ice and snow mass per unit area	kg m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>float32 slceLoad(time, tile, j, i) slceLoad:_FillValue = 9.96921e+36 slceLoad:long_name = Average sea: ice and snow mass per unit area slceLoad:units = kg m: 2 slceLoad:coverage_content_type = modelResult slceLoad:standard_name = sea_ice_and_surface_snow_amount slceLoad:coordinates = time YC XC slceLoad:valid_min = : 0.0015558383893221617 slceLoad:valid_max = 8729.935546875</pre>			
Comments			
<p>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.</p>			

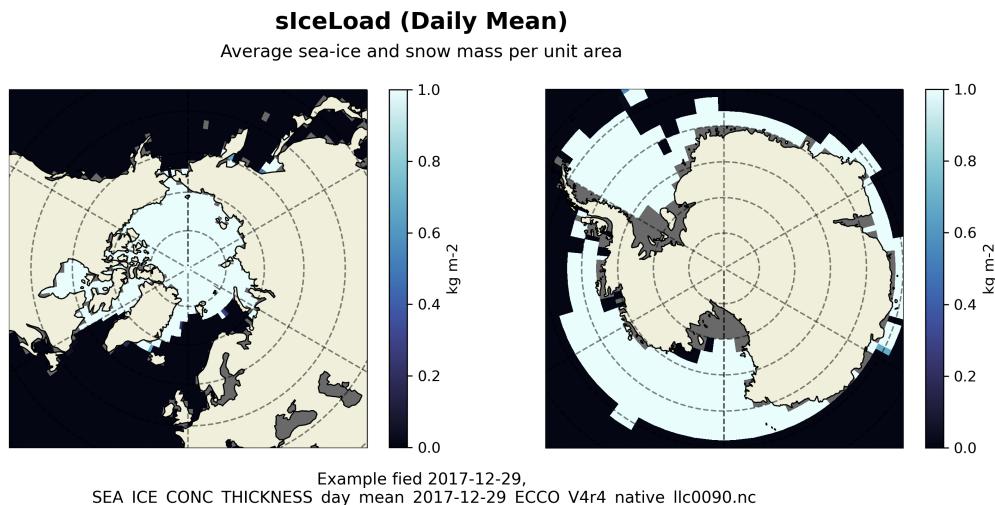


Figure 100: Dataset: SEA_ICE_CONC_THICKNESS, Variable: slceLoad

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)			
<pre>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 =>O increases mean sea: ice thickness (HEFF) ADVxHEFF:coordinates = time ADVxHEFF:valid_min = : 151912.28125 ADVxHEFF:valid_max = 107688.7578125</pre>			
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.			

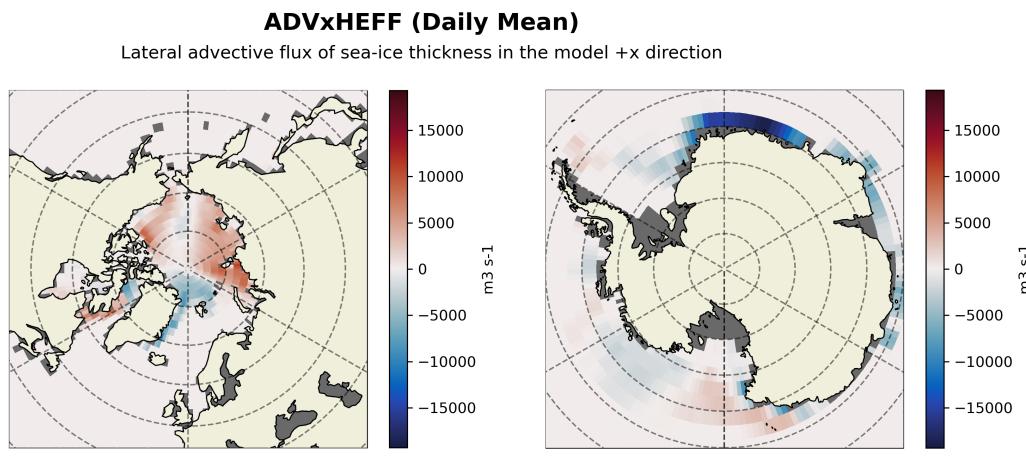


Figure 101: Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: ADVxHEFF

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	m ³ s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
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.			

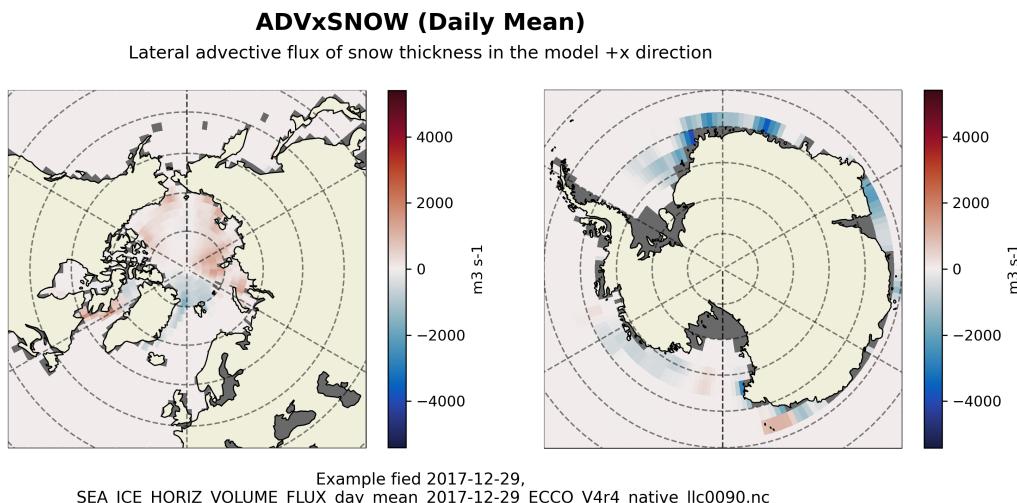


Figure 102: Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: ADVxSNOW

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)			
<pre>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</pre>			
Comments			
<p>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.</p>			

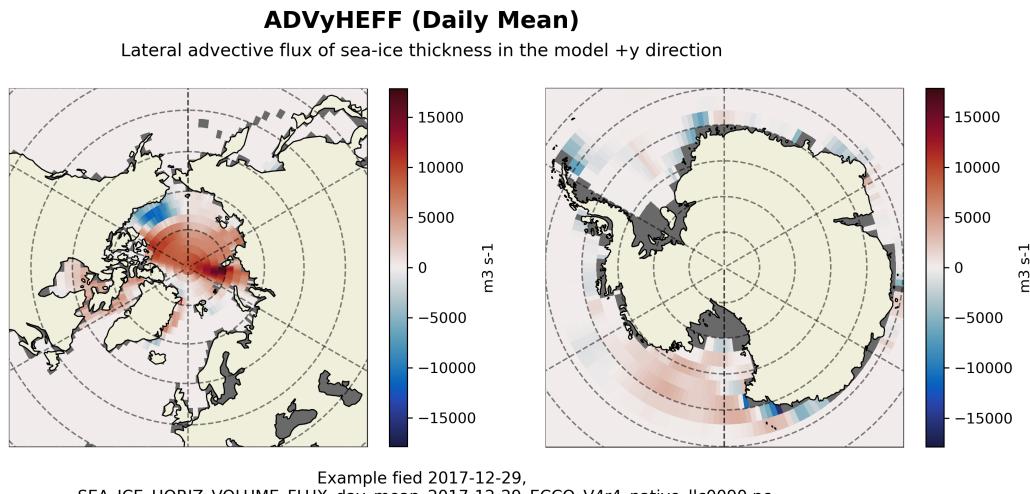


Figure 103: Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: ADVyHEFF

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)			
<pre>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</pre>			
Comments			
<p>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.</p>			

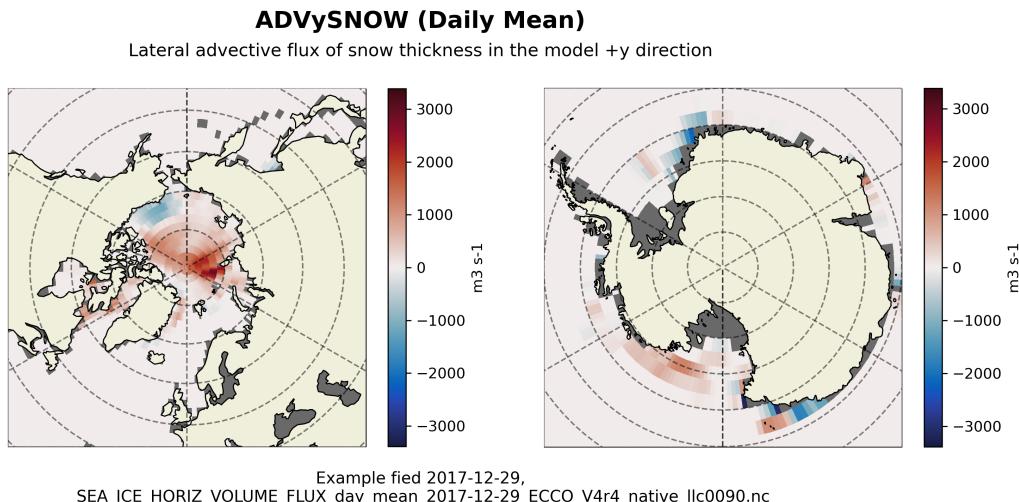


Figure 104: Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: ADVySNOW

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.	m ³ s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
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.			

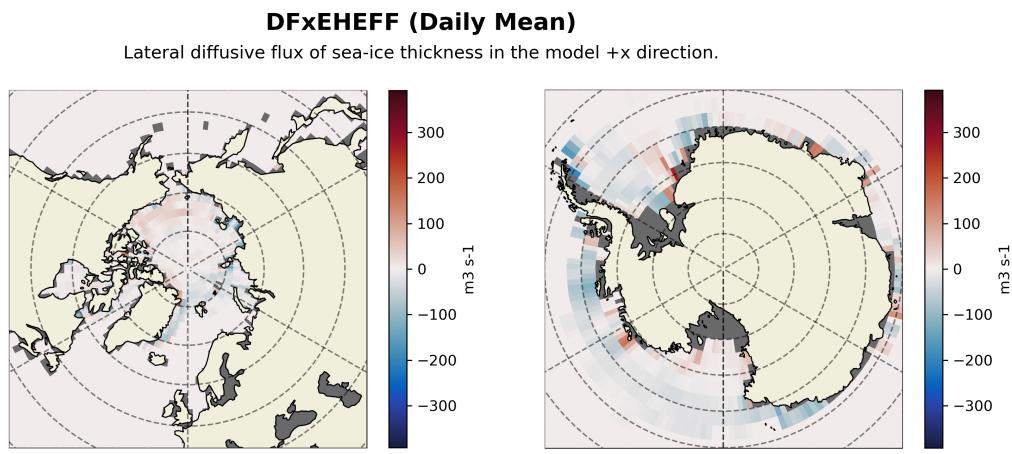


Figure 105: Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: DFxEHEFF

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)			
<pre>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 => O increases mean snow thickness (HSNOW) DFxESNOW:coordinates = time DFxESNOW:valid_min = : 448.1134948730469 DFxESNOW:valid_max = 440.94427490234375</pre>			
Comments			
<p>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.</p>			

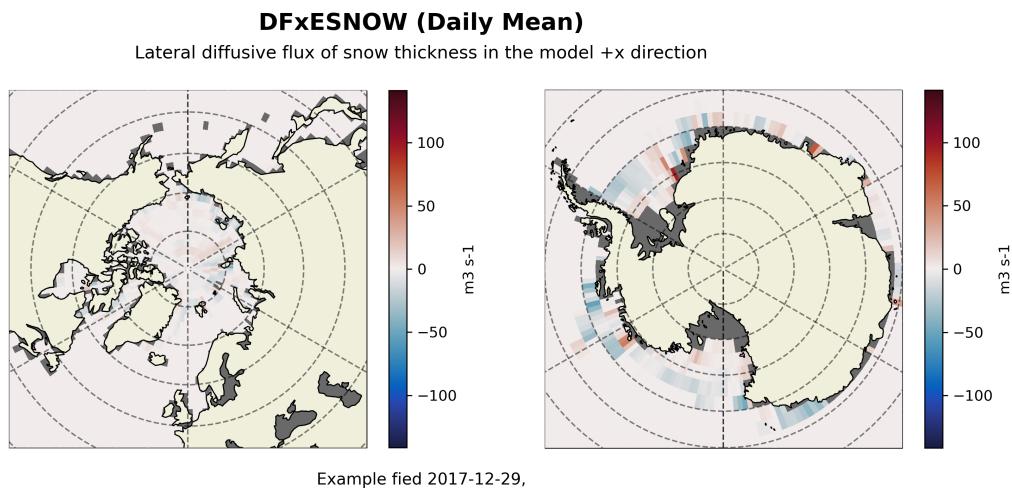


Figure 106: Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: DFxESNOW

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)			
<pre>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</pre>			
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 +dfyehf(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.			

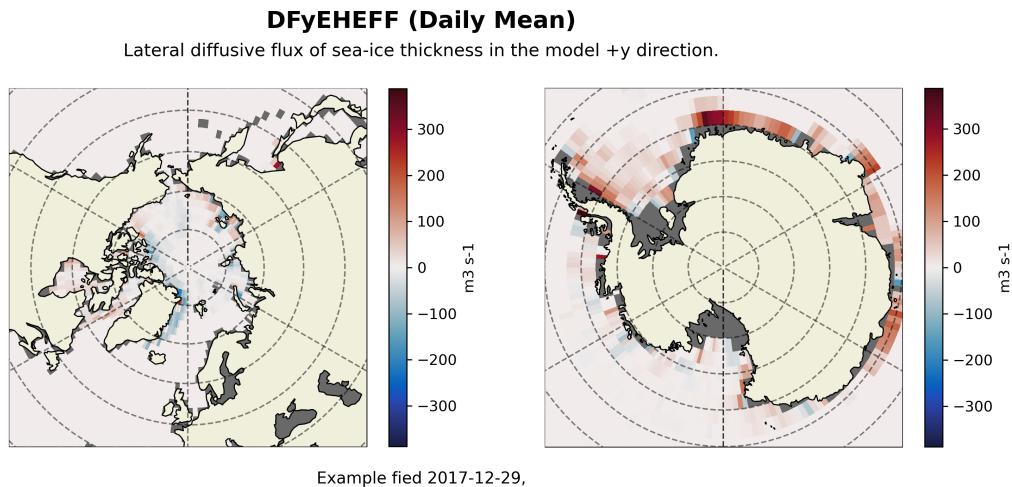


Figure 107: Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: DFyEHEFF

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)			
<pre>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</pre>			
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.			

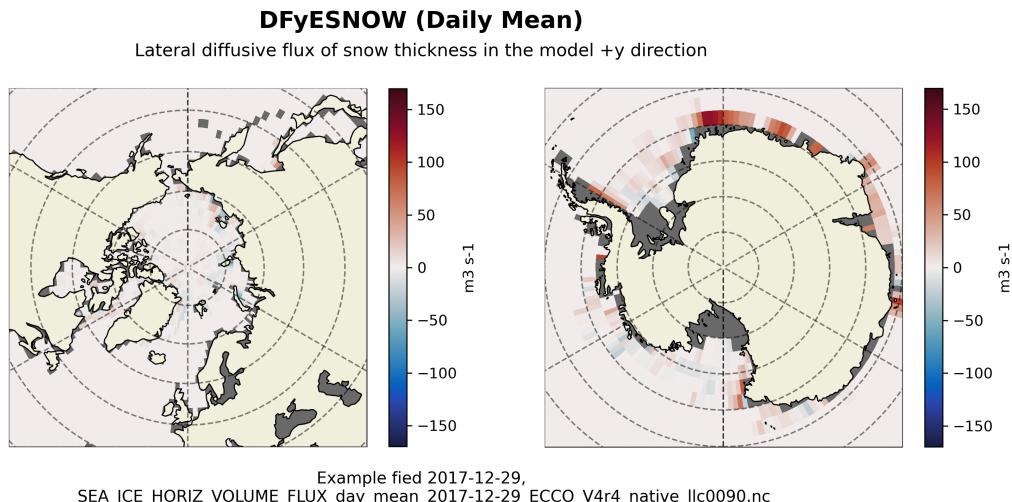


Figure 108: Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: DFyESNOW

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)			
<pre>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</pre>			
Comments			
Depth of parameterized salt plumes formed due to brine rejection during sea-ice formation.			

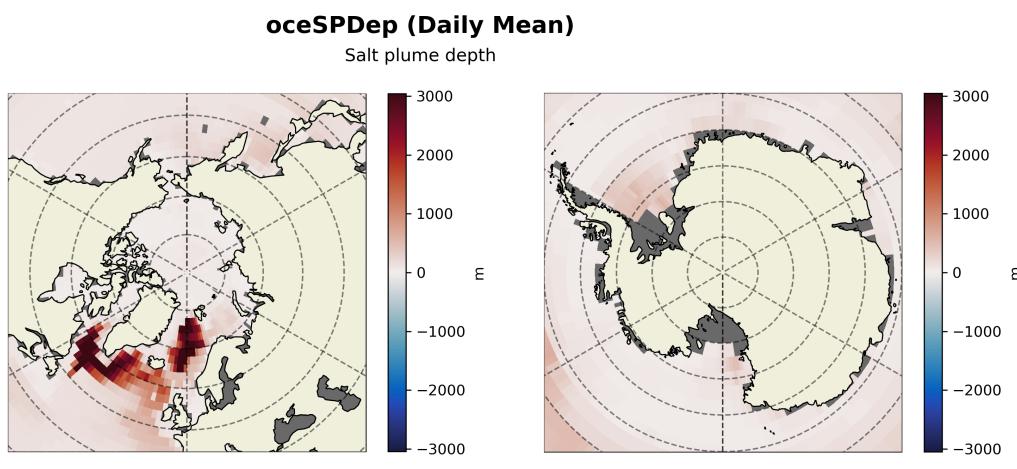


Figure 109: Dataset: SEA_ICE_SALT_PLUME_FLUX, Variable: oceSPDep

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.			

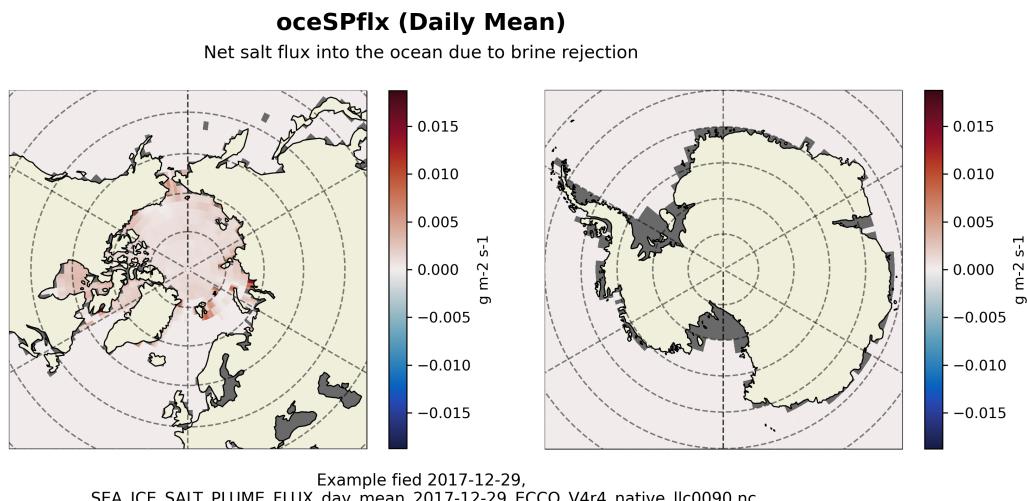


Figure 110: Dataset: SEA_ICE_SALT_PLUME_FLUX, Variable: oceSPflx

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
Sluice	Sea-ice velocity in the model +x direction	m s ⁻¹

Table 12.108: Coordinates and Variables in the dataset SEA_ICE_VELOCITY

Slvice	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: Sluice

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

Storage Type	Variable Name	Description	Unit
float32	Sluice	Sea-ice velocity in the model +x direction	m s ⁻¹
Description of the variable in Common Data language (CDL)			
float32 Sluice(time, tile, j, i_g) Sluice:_FillValue = 9.96921e+36 Sluice: long_name = Sea: ice velocity in the model +x direction Sluice: units = m s: 1 Sluice: mate = Sluice Sluice: coverage_content_type = modelResult Sluice: standard_name = sea_ice_x_velocity Sluice: coordinates = time Sluice: valid_min = : 0.4000000059604645 Sluice: 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.			

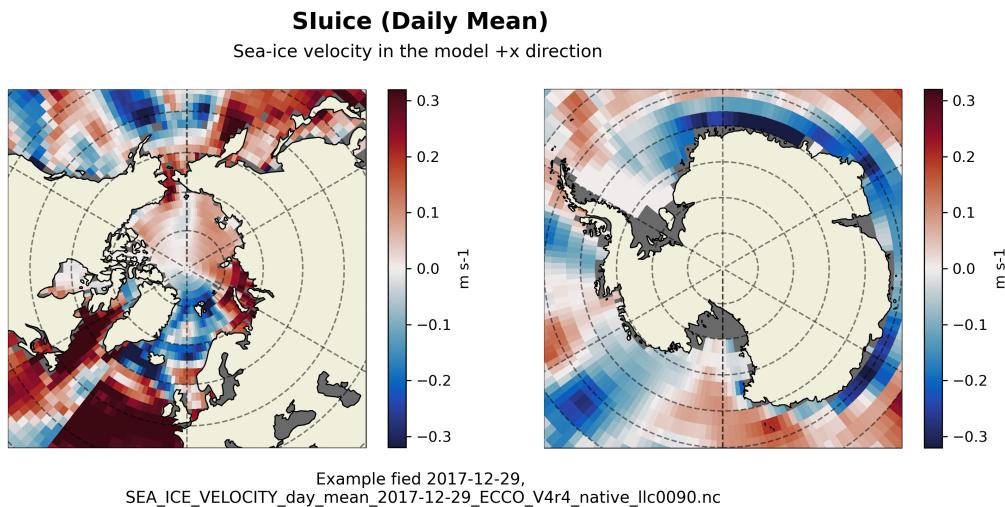


Figure 111: Dataset: SEA_ICE_VELOCITY, Variable: Sluice

12.20.3 Native Variable: Slvice

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

Storage Type	Variable Name	Description	Unit
float32	Slvice	Sea-ice velocity in the model +y direction	m s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 Slvice(time, tile, j_g, i) Slvice:_FillValue = 9.96921e+36 Slvice:long_name = Sea: ice velocity in the model +y direction Slvice:units = m s: 1 Slvice:mate = Sluice Slvice:coverage_content_type = modelResult Slvice:standard_name = sea_ice_y_velocity Slvice:coordinates = time Slvice:valid_min = : 0.4000000059604645 Slvice:valid_max = 0.4000000059604645</pre>			
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.			

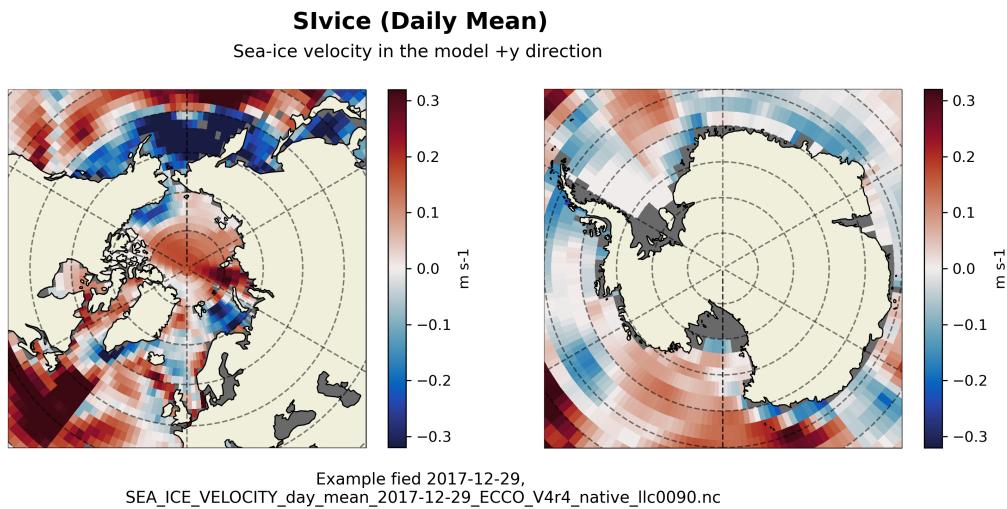


Figure 112: Dataset: SEA_ICE_VELOCITY, Variable: Slvice

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 altimetry 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 sterghoh) nor (b) sea level displacement due to submerged sea-ice and snow (see siceload). these corrections are made for the variables ssh and sshnoibc.			

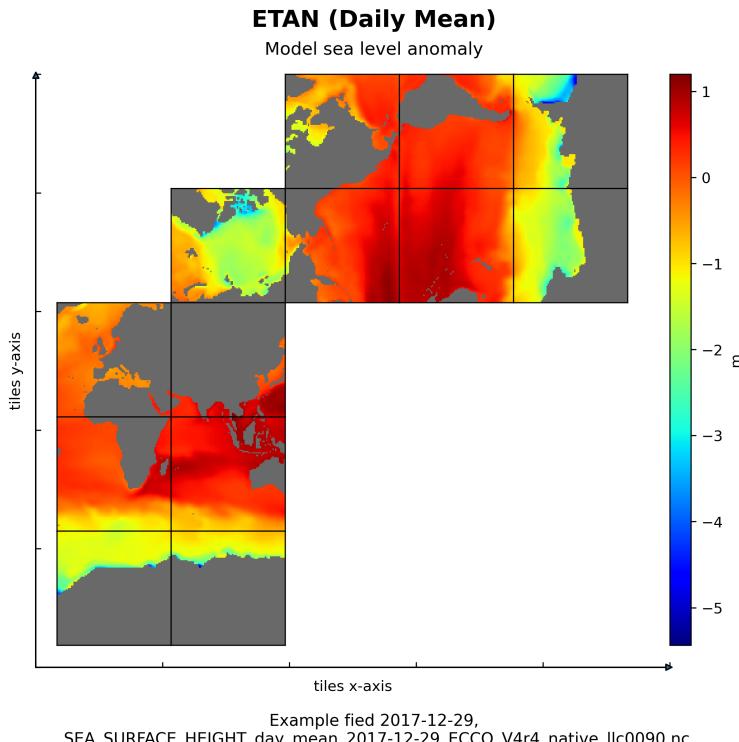
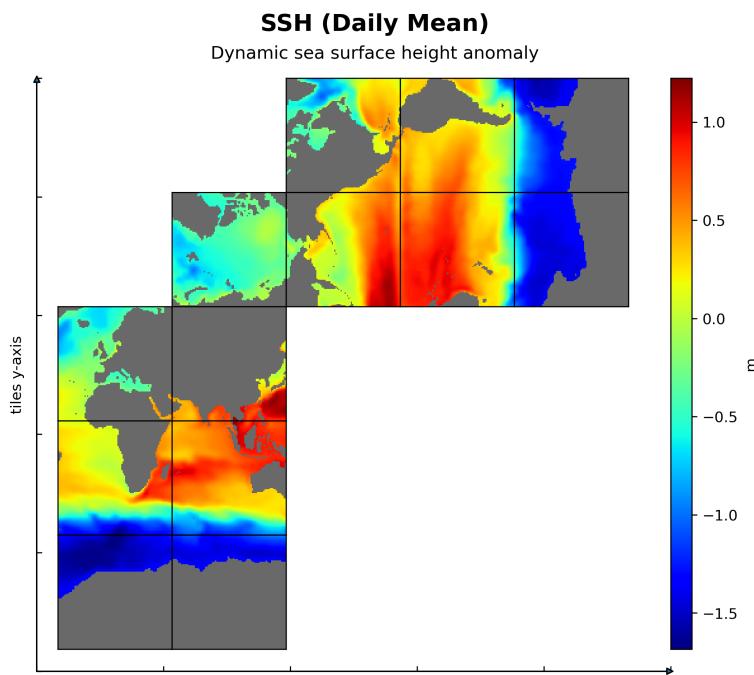


Figure 113: Dataset: SEA_SURFACE_HEIGHT, Variable: ETAN

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)			
<pre>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</pre>			
Comments			
<p>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 sterglo), 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.</p>			



Example file 2017-12-29,
SEA_SURFACE_HEIGHT_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 114: 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)			
<pre>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</pre>			
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.			

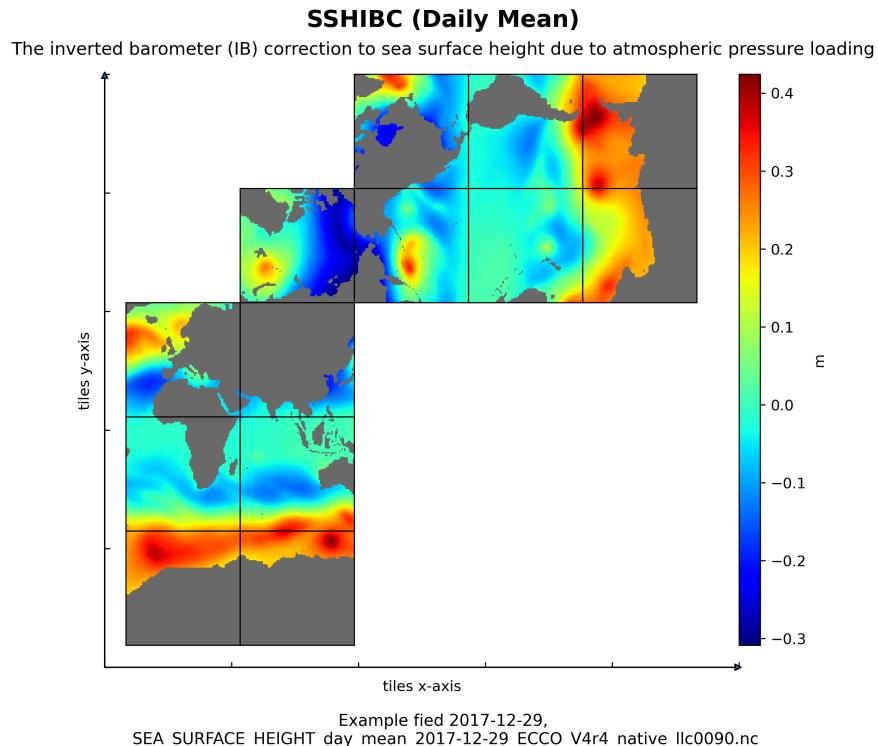


Figure 115: Dataset: SEA_SURFACE_HEIGHT, Variable: SSHIBC

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 sterglo), 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.			

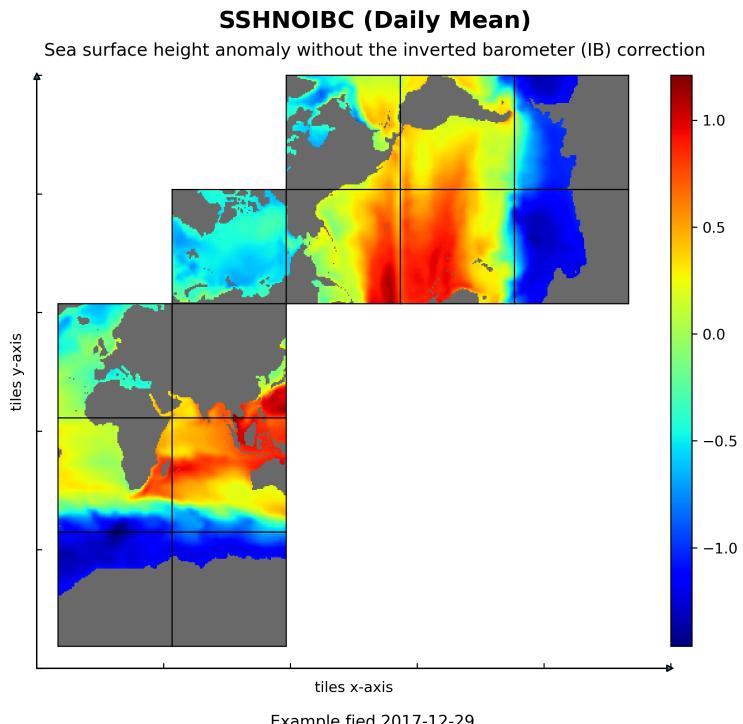


Figure 116: Dataset: SEA_SURFACE_HEIGHT, Variable: SSHNOIBC

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	m ²
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.			

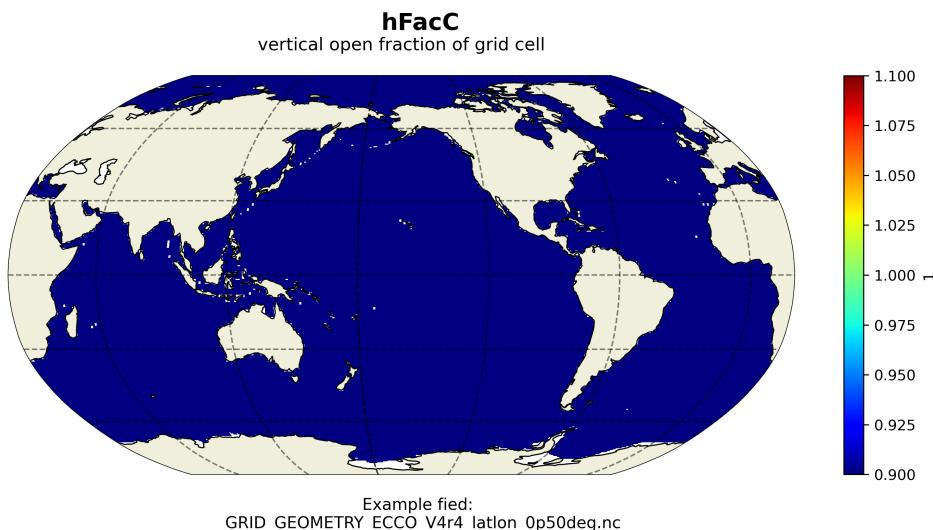


Figure 117: Dataset: GRID_GEOMETRY_ECCO, Variable: hFacC

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.			

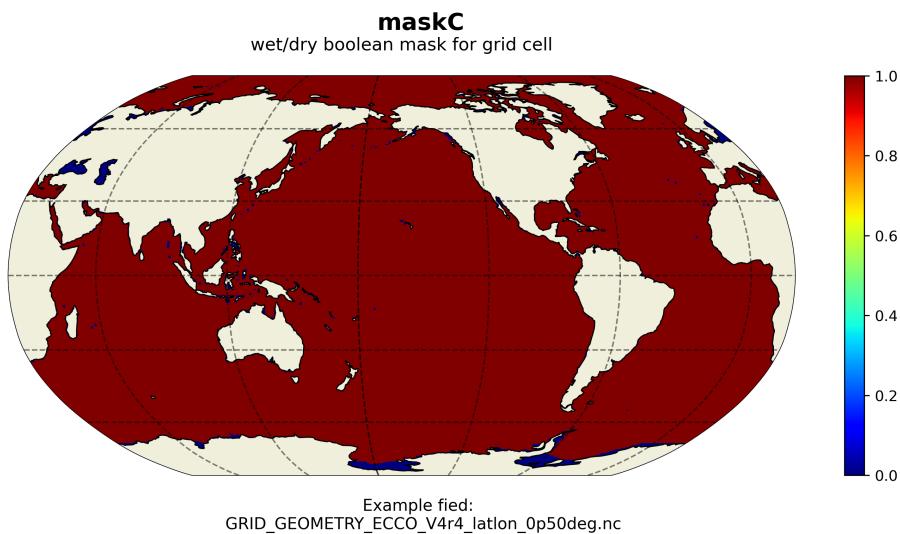


Figure 118: Dataset: GRID_GEOMETRY_ECCO, Variable: maskC

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 = 0.03014513850212097			
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.			

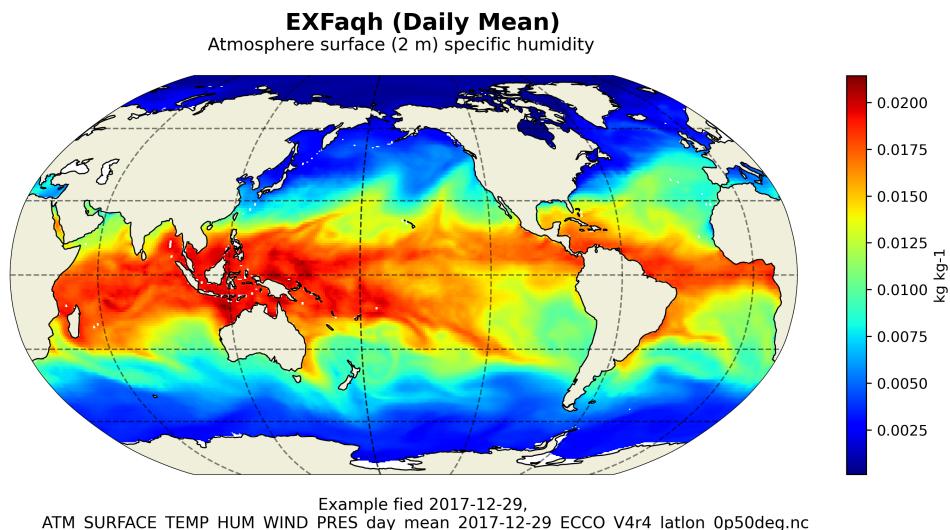


Figure 119: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFaqh

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.			

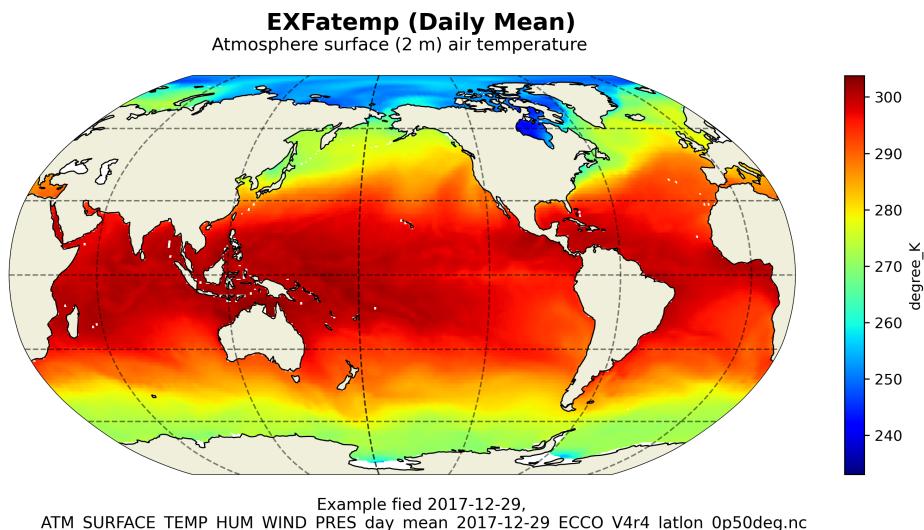


Figure 120: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFatemp

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.			

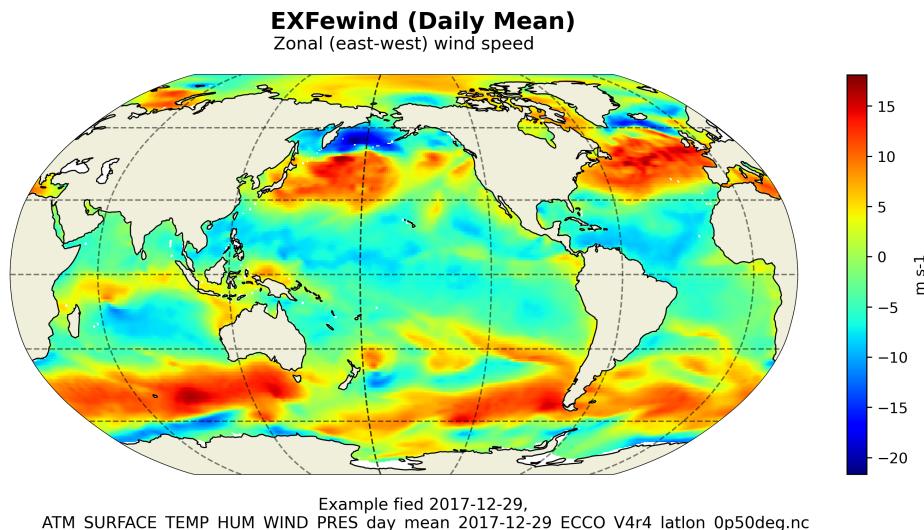


Figure 121: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFewind

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.			

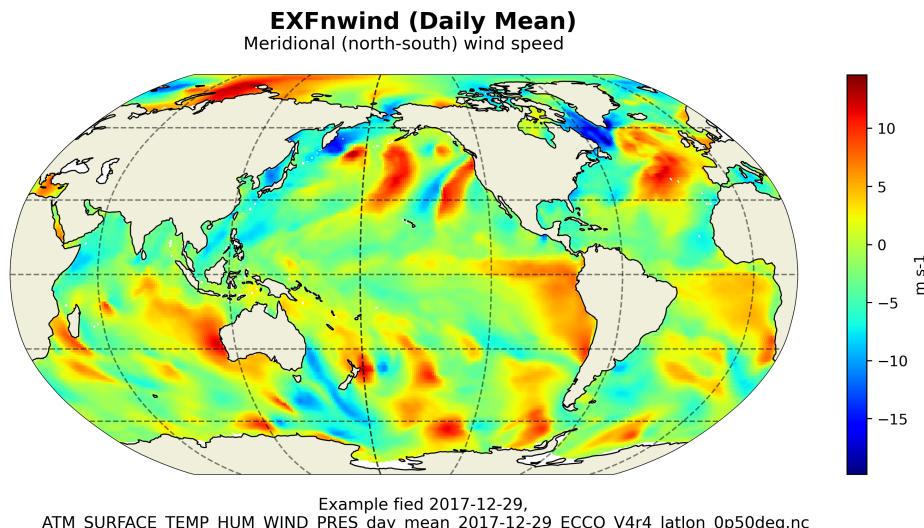


Figure 122: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFnwind

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.			

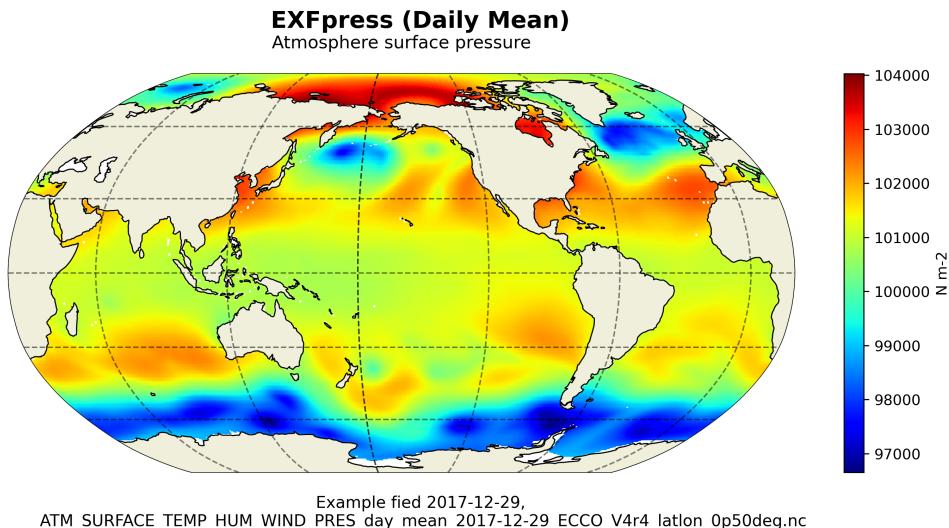


Figure 123: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFpress

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 exfwind and exfwind because exfwind and exfwind are calculated from exftaux and exftauy using bulk formulae. exfwspee != sqrt(exfwind**2 + exfwind**2).			

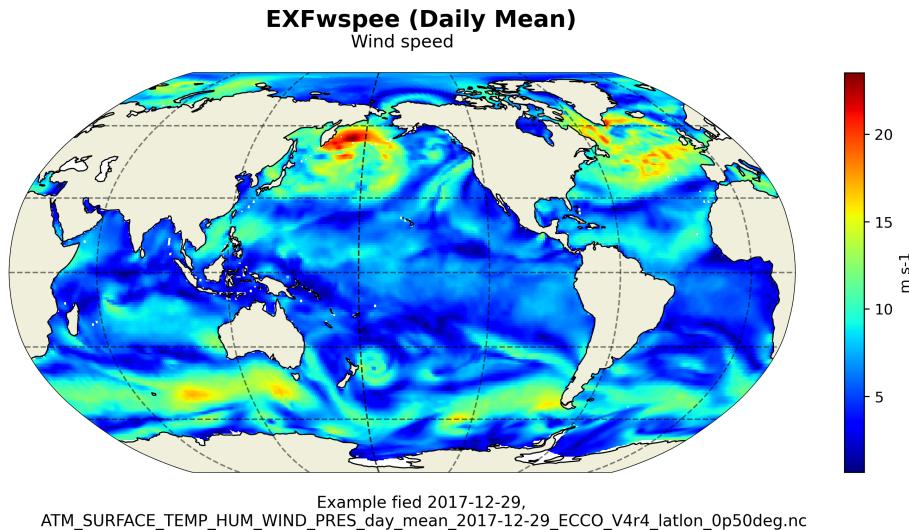


Figure 124: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFwspee

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
SlsnPrcp	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
SlatmFW	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
SlacSubl	Freshwater flux to the atmosphere due to sublimation-deposition of snow or ice	kg m-2 s-1
SlrsSubl	Residual sublimation freshwater flux	kg m-2 s-1
SlfwThru	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)			
<pre>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</pre>			
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.			

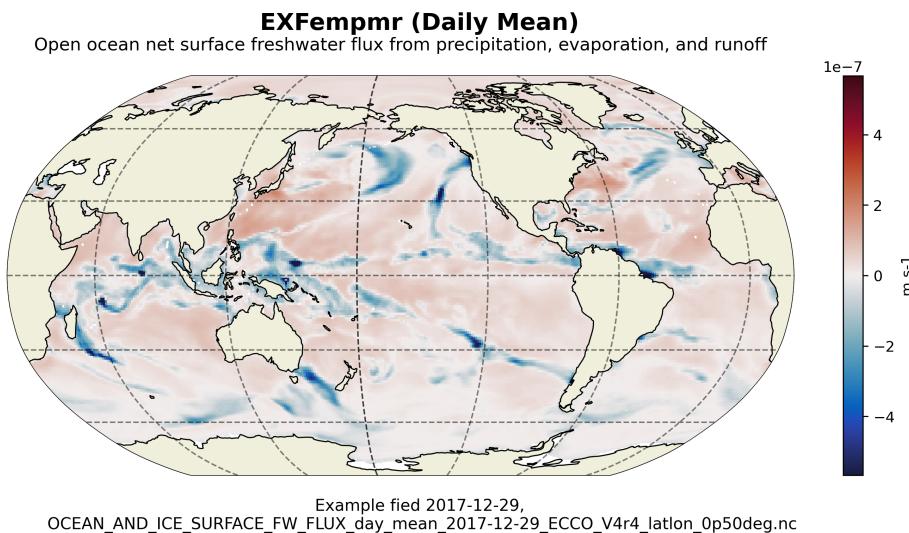


Figure 125: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFempmr

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) ncarr/tn-460+str.			

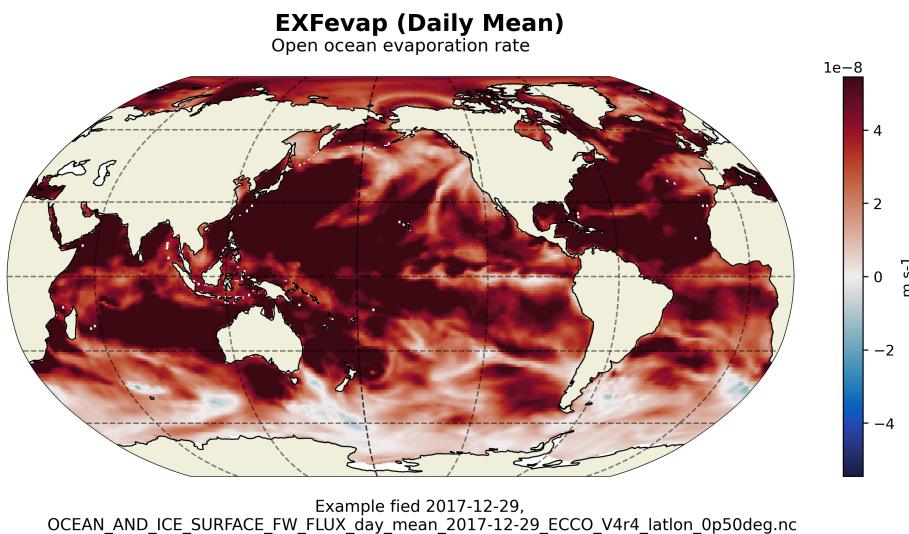


Figure 126: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFevap

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.			

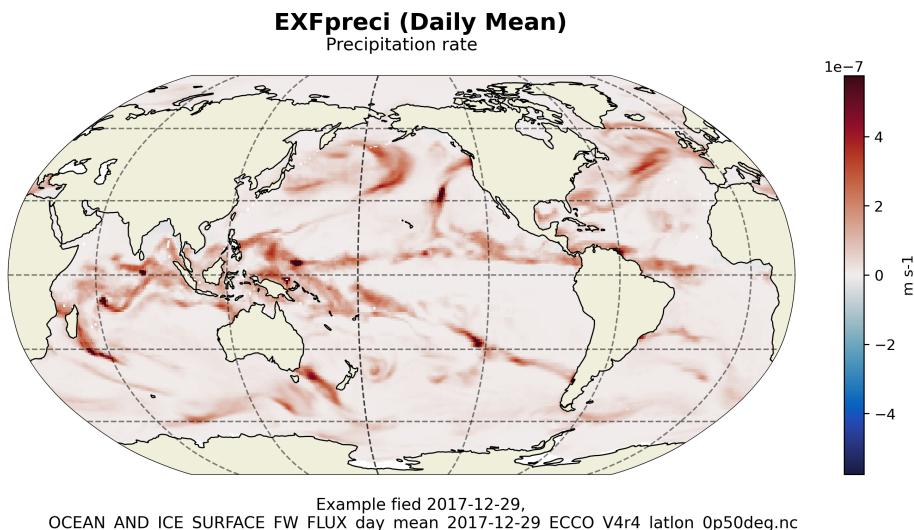


Figure 127: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFpreci

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.			

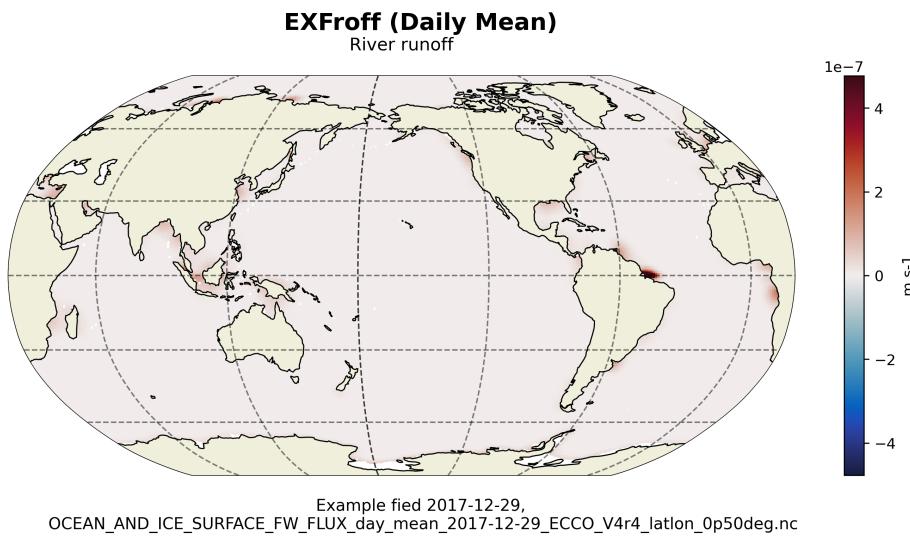


Figure 128: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFroff

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).			

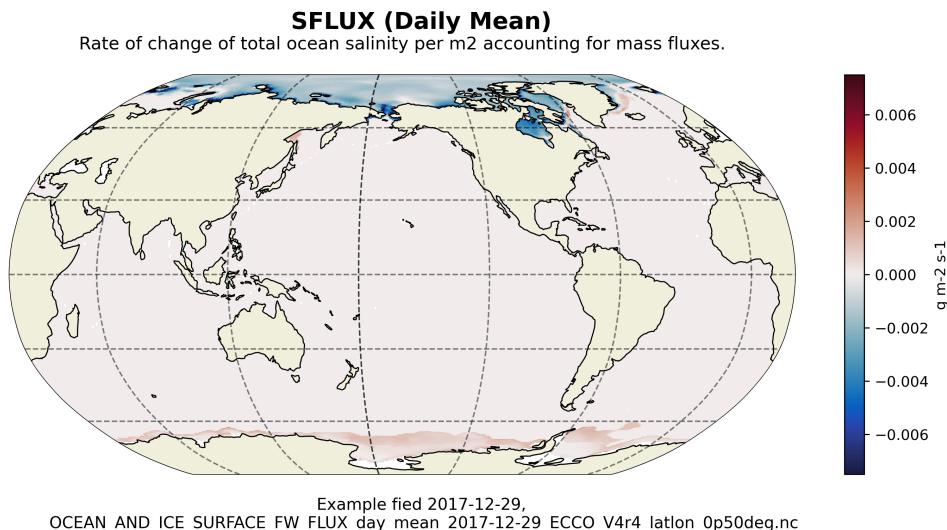


Figure 129: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SFLUX

14.2.7 Latlon Variable: SlacSubl

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

Storage Type	Variable Name	Description	Unit
float32	SlacSubl	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)			
<pre>float32 SlacSubl(time, latitude, longitude) SlacSubl:_FillValue = 9.96921e+36 SlacSubl:coverage_content_type = modelResult SlacSubl:direction =>0 decreases snow or sea: ice thickness (HSNOW or HEFF) SlacSubl:long_name = Freshwater flux to the atmosphere due to sublimation: deposition of snow or ice SlacSubl:standard_name = water_sublimation_flux SlacSubl:units = kg m: 2 s:1 SlacSubl:coordinates = time SlacSubl:valid_min = 0.0 SlacSubl:valid_max = 7.735946564935148e: 05</pre>			
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			

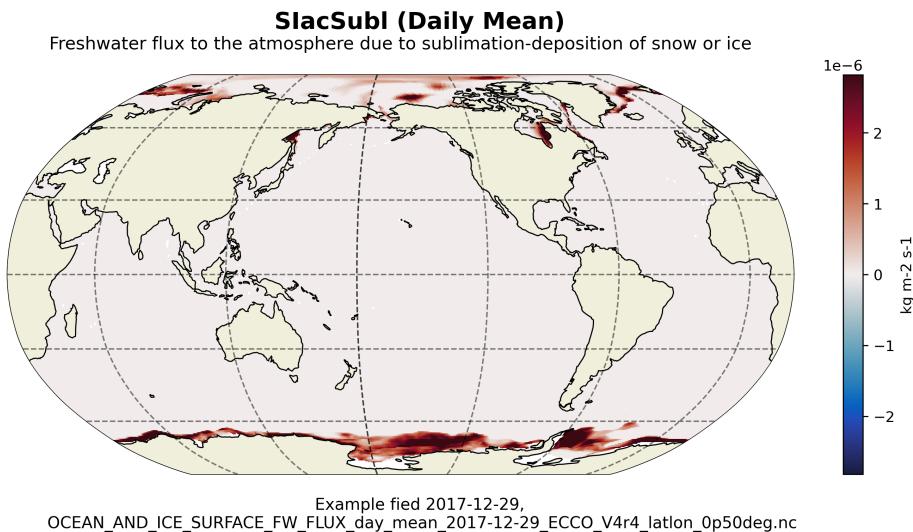


Figure 130: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SlacSubl

14.2.8 Latlon Variable: SlatmFW

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

Storage Type	Variable Name	Description	Unit
float32	SlatmFW	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)			
<pre>float32 SlatmFW(time, latitude, longitude) SlatmFW:_FillValue = 9.96921e+36 SlatmFW:coverage_content_type = modelResult SlatmFW:direction = >0 decreases salinity (SALT) SlatmFW:long_name = Net freshwater flux into the open ocean sea: ice and snow SlatmFW:standard_name = surface_downward_water_flux SlatmFW:units = kg m: 2 s: 1 SlatmFW:coordinates = time SlatmFW:valid_min = : 0.00043017856660299003 SlatmFW:valid_max = 0.008299433626234531</pre>			
Comments			
<p>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.</p>			

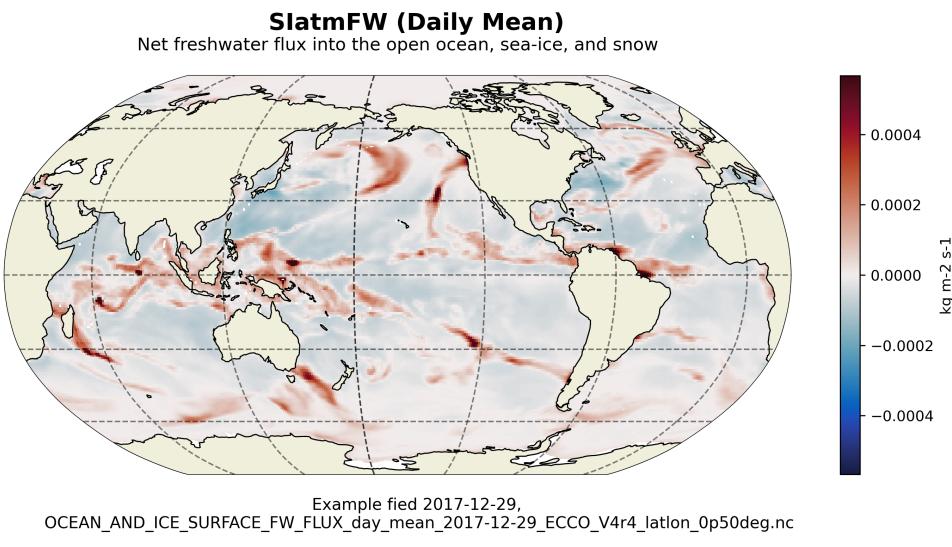


Figure 131: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SlatmFW

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)			
<pre>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</pre>			
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.			

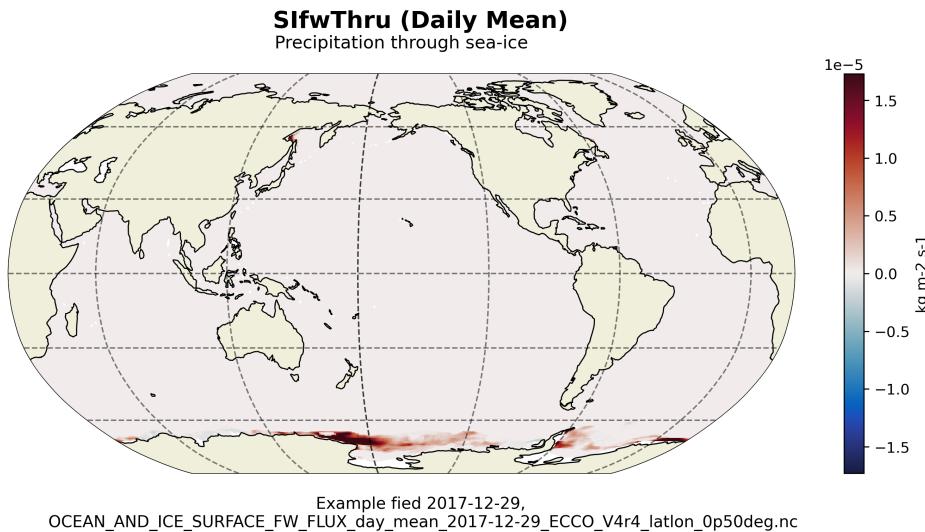


Figure 132: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SIfwThru

14.2.10 Latlon Variable: SlrsSubl

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

Storage Type	Variable Name	Description	Unit
float32	SlrsSubl	Residual sublimation freshwater flux	kg m ⁻² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 SlrsSubl(time, latitude, longitude) SlrsSubl:_FillValue = 9.96921e+36 SlrsSubl:coverage_content_type = modelResult SlrsSubl:direction = >0 decreases ocean volume SlrsSubl:long_name = Residual sublimation freshwater flux SlrsSubl:units = kg m: 2 s: 1 SlrsSubl:coordinates = time SlrsSubl:valid_min = : 0.0001067528864950873 SlrsSubl:valid_max = 8.640533451398369e: 06</pre>			
Comments			
Residual freshwater flux by sublimation to remove water from or add water to ocean. when implied sublimation freshwater flux siacsabl 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.			

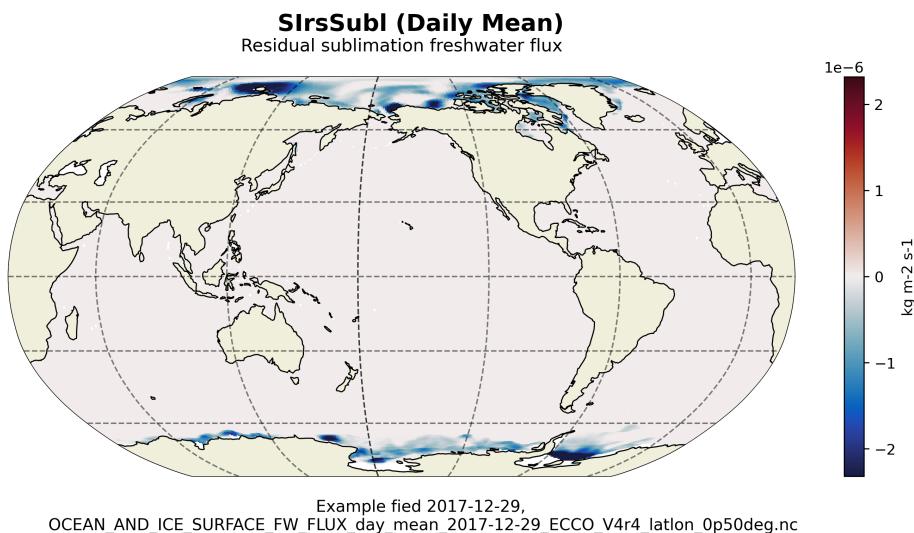


Figure 133: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SlrsSubl

14.2.11 Latlon Variable: SlsnPrcp

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

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

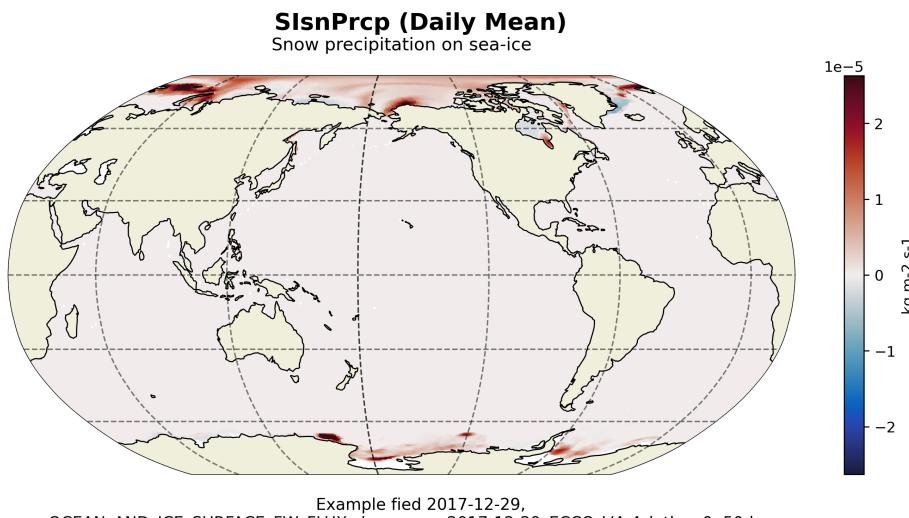


Figure 134: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SlsnPrcp

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.			

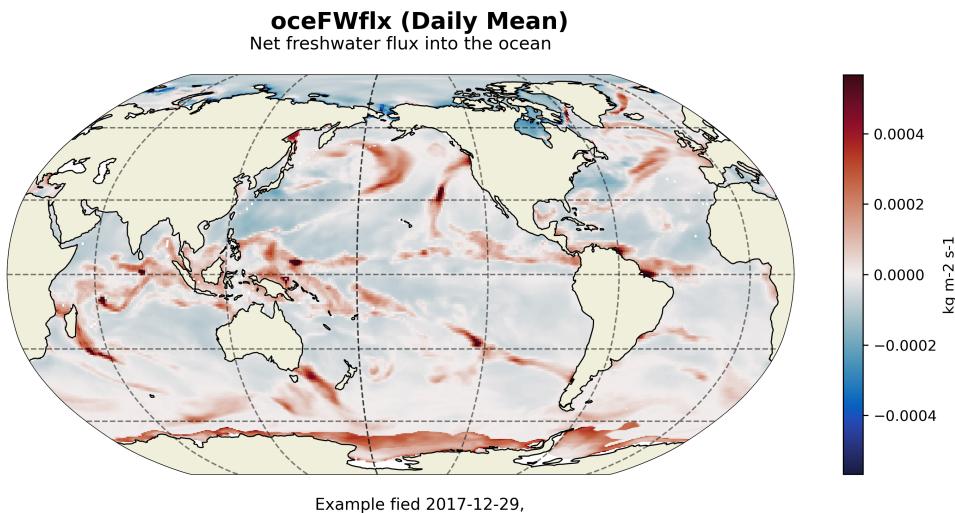


Figure 135: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: oceFWflx

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
SlatmQnt	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
Slaaflux	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.			

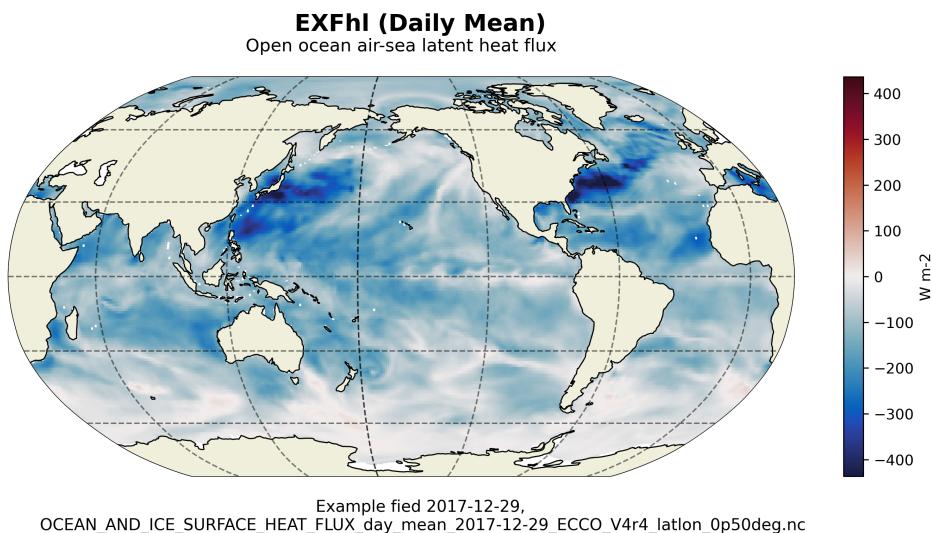


Figure 136: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFhl

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.			

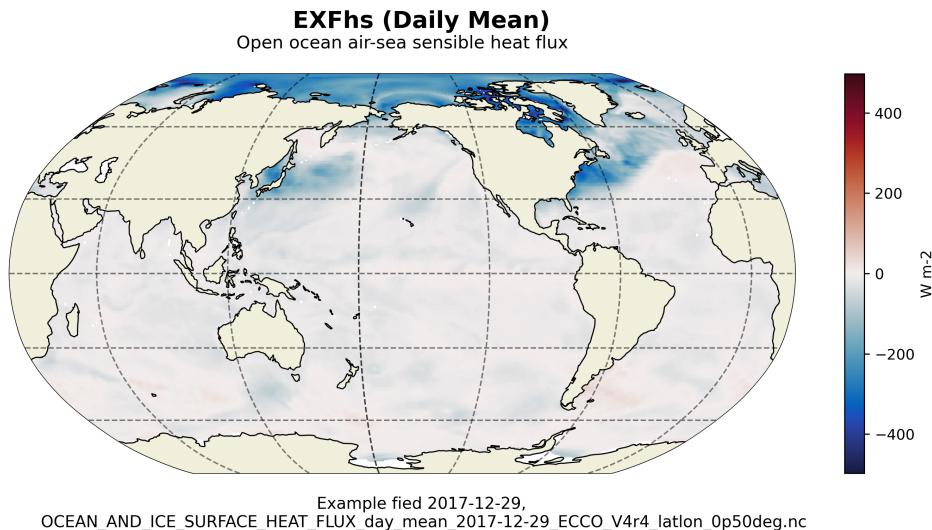


Figure 137: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFhs

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.			

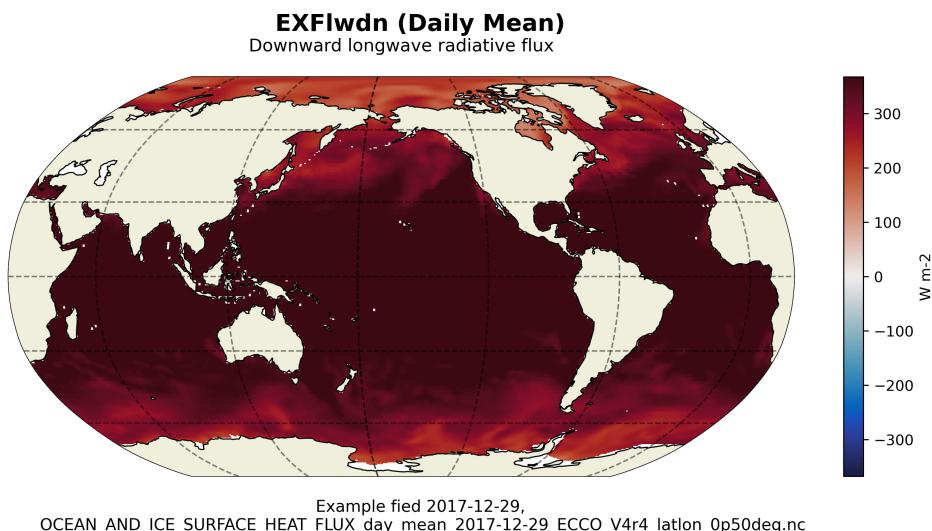


Figure 138: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFlwdn

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).			

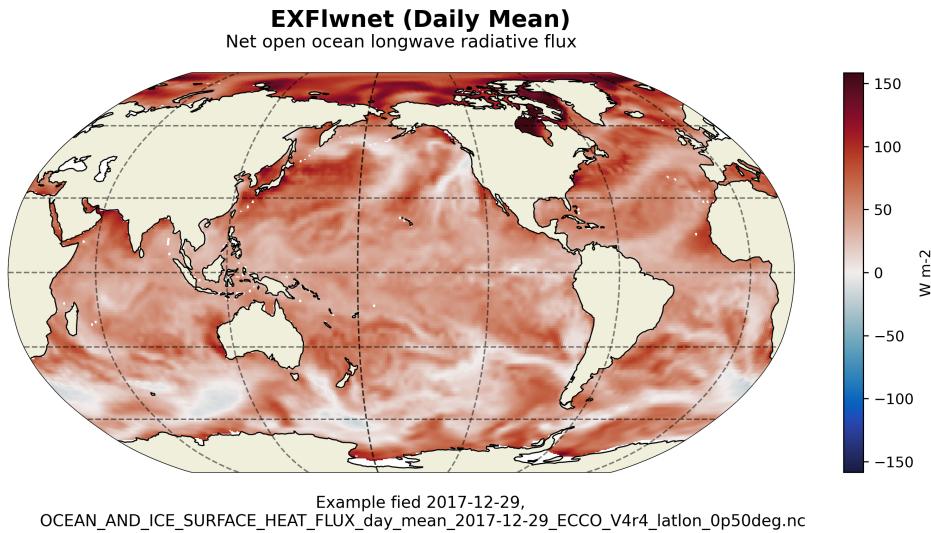


Figure 139: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFlwnet

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-exfh.			

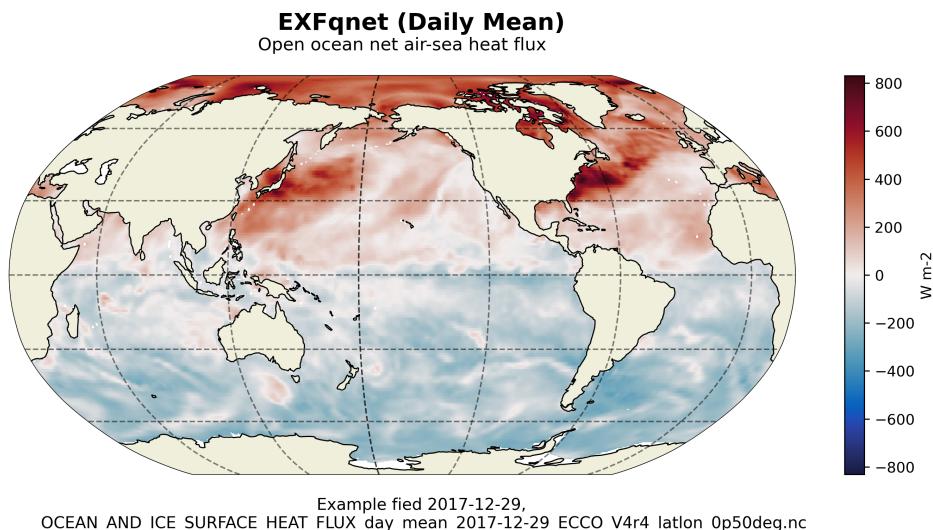


Figure 140: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFqnet

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.			

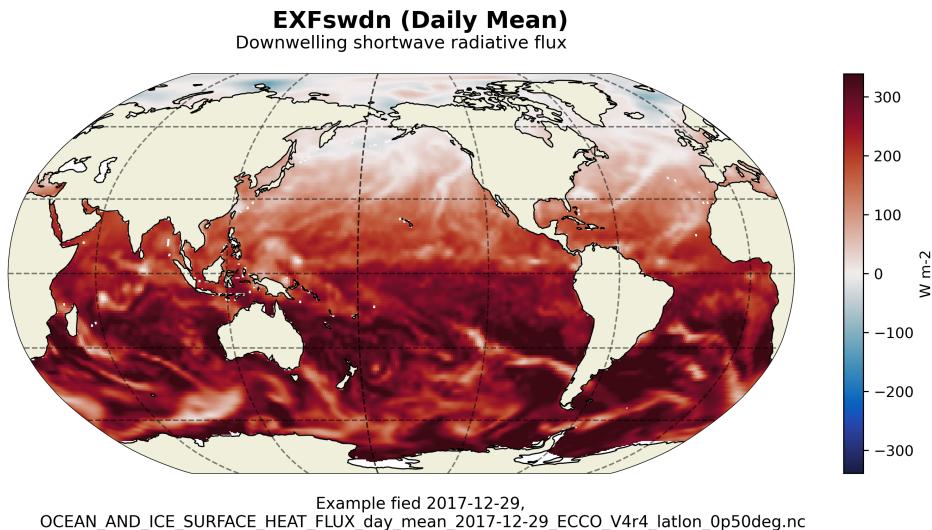


Figure 141: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFswdn

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 albedo.			

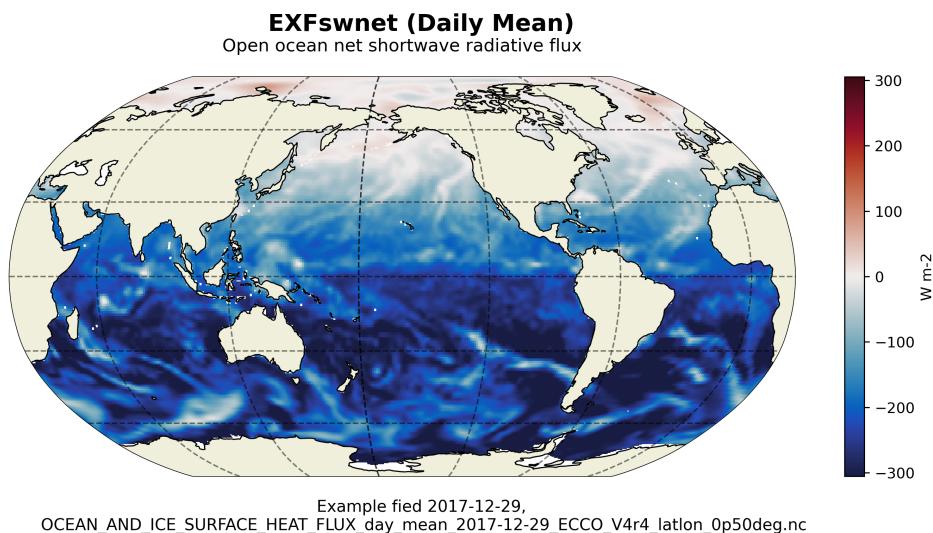


Figure 142: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFswnet

14.3.9 Latlon Variable: Slaaflux

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

Storage Type	Variable Name	Description	Unit
float32	Slaaflux	Conservative ocean and sea-ice advective heat flux adjustment	W m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>float32 Slaaflux(time, latitude, longitude) Slaaflux:_FillValue = 9.96921e+36 Slaaflux:coverage_content_type = modelResult Slaaflux:direction =>0 decrease potential temperature (THETA) Slaaflux:long_name = Conservative ocean and sea: ice advective heat flux adjustment Slaaflux:units = W m: 2 Slaaflux:coordinates = time Slaaflux:valid_min = :16.214622497558594 Slaaflux:valid_max = 50.35451889038086</pre>			
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.			

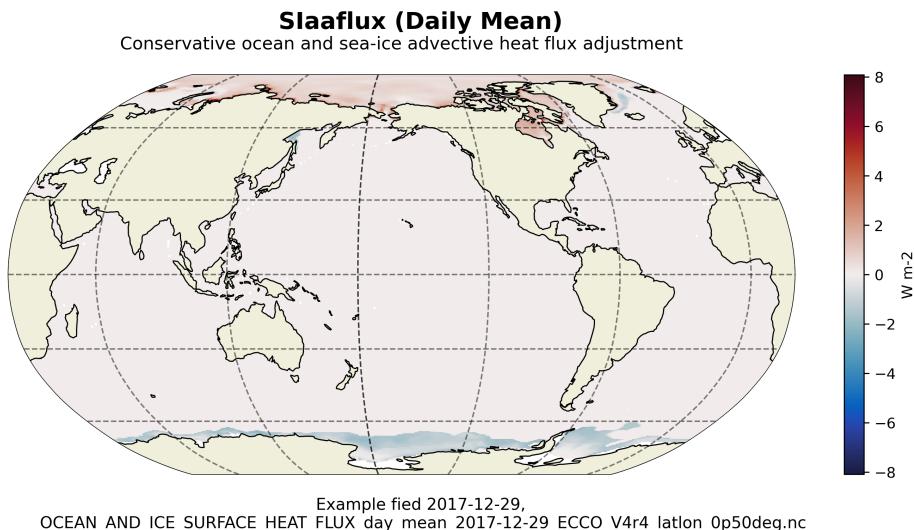


Figure 143: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: Slaaflux

14.3.10 Latlon Variable: SlatmQnt

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

Storage Type	Variable Name	Description	Unit
float32	SlatmQnt	Net upward heat flux to the atmosphere	W m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>float32 SlatmQnt(time, latitude, longitude) SlatmQnt: _FillValue = 9.96921e+36 SlatmQnt: coverage_content_type = modelResult SlatmQnt: direction = >0 upward decreases ocean temperature SlatmQnt: long_name = Net upward heat flux to the atmosphere SlatmQnt: standard_name = surface_upward_heat_flux_in_air SlatmQnt: units = W m: 2 SlatmQnt: coordinates = time SlatmQnt: valid_min = : 756.0607299804688 SlatmQnt: valid_max = 1704.7703857421875</pre>			
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).			

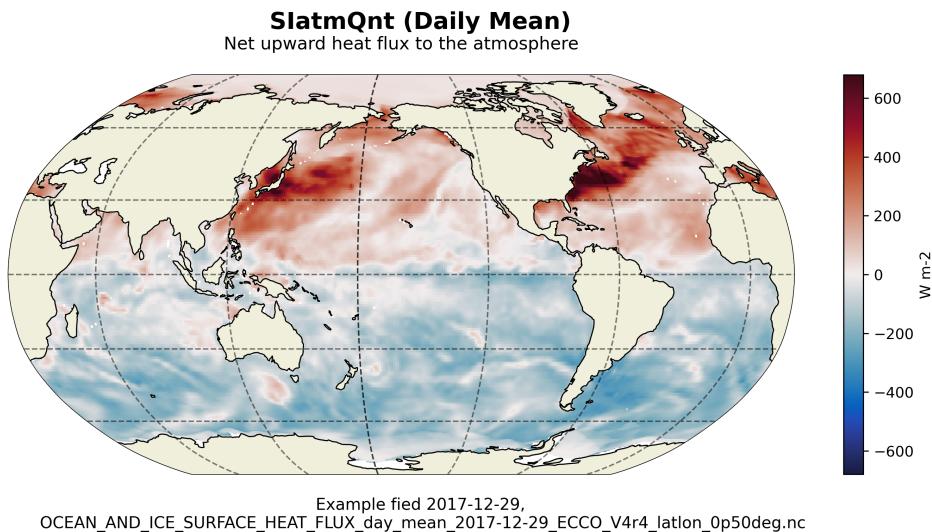


Figure 144: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: SlatmQnt

14.3.11 Latlon Variable: TFLUX

Table 14.30: 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 m ² accounting for mass fluxes.	W m ⁻²
Description of the variable in Common Data language (CDL)			
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 m ² accounting for mass fluxes. TFLUX: units = W m: 2 TFLUX: coordinates = time 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 ocefwwf).			

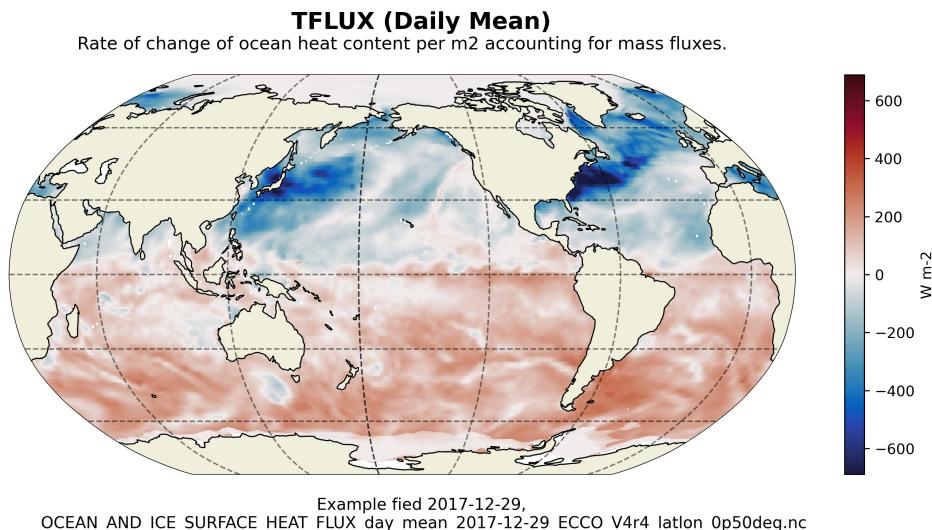


Figure 145: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: TFLUX

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 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 Oc. 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 Oc. the variable tflux does include the change in ocean heat content due to changing ocean mass.			

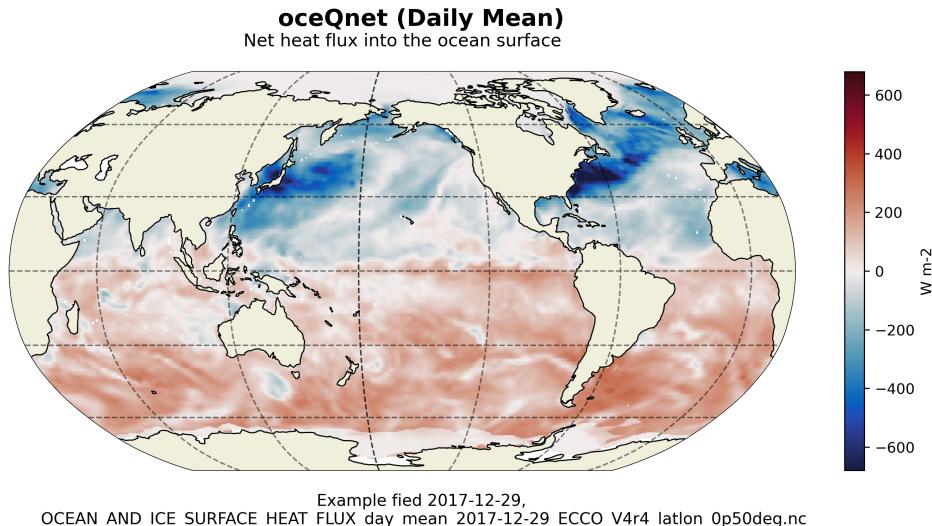


Figure 146: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: oceQnet

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.			

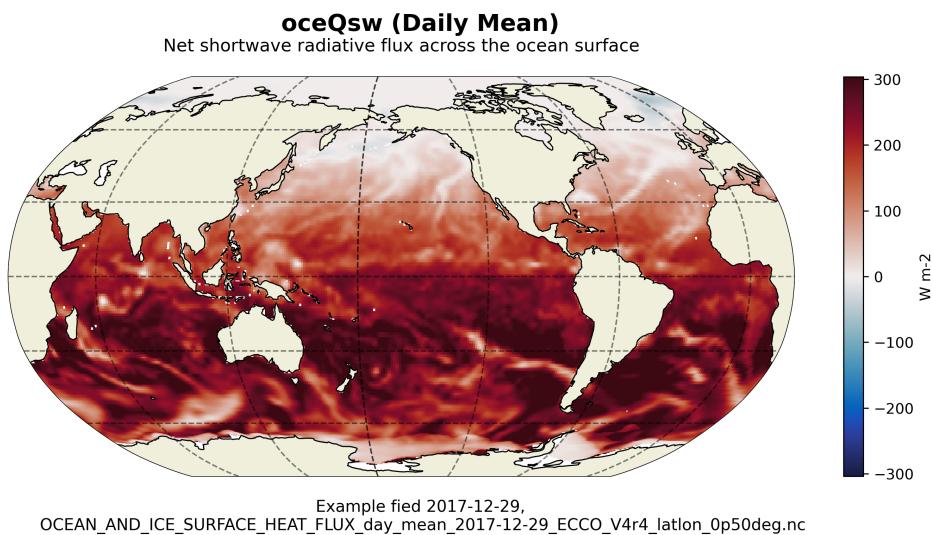


Figure 147: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: oceQsw

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)			
<pre>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</pre>			
Comments			
<p>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 ocetaue). 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.</p>			

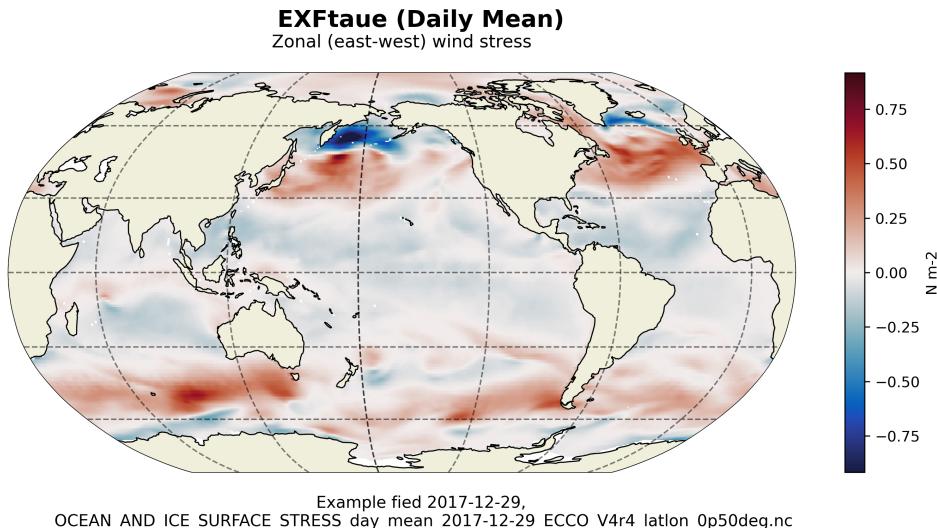


Figure 148: Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: EXFtaue

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)			
<pre>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</pre>			
Comments			
<p>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 exftaux 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.</p>			

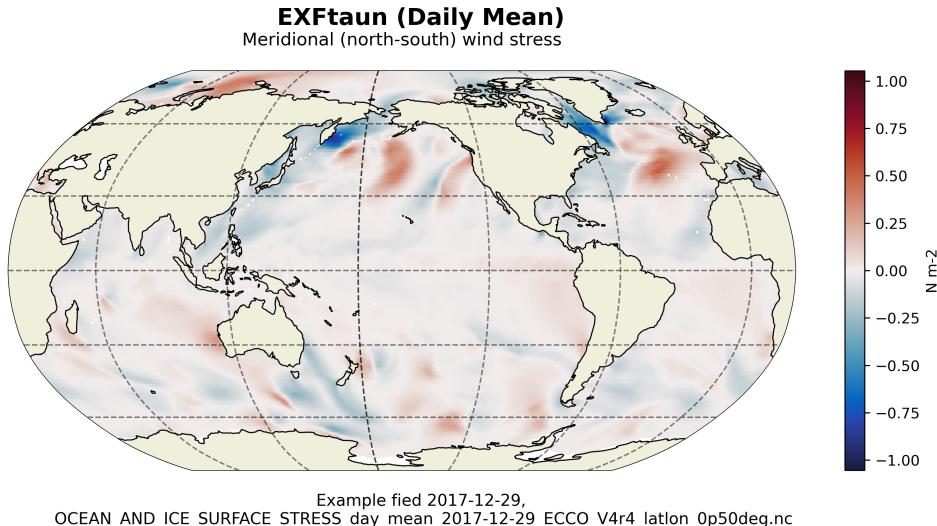


Figure 149: Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: EXFtaun

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.			

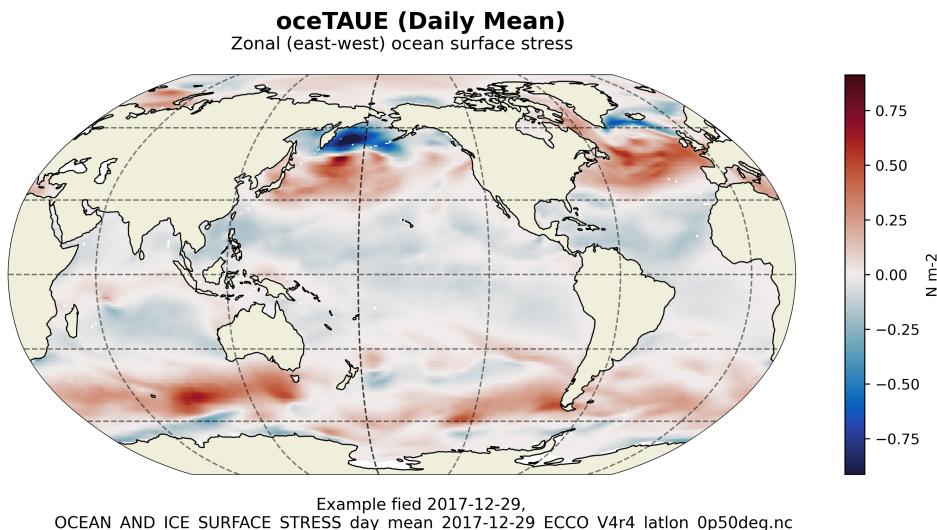


Figure 150: Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: oceTAUE

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 octauy) to tracer cell centers and then finding the meridional component of the interpolated vectors.			

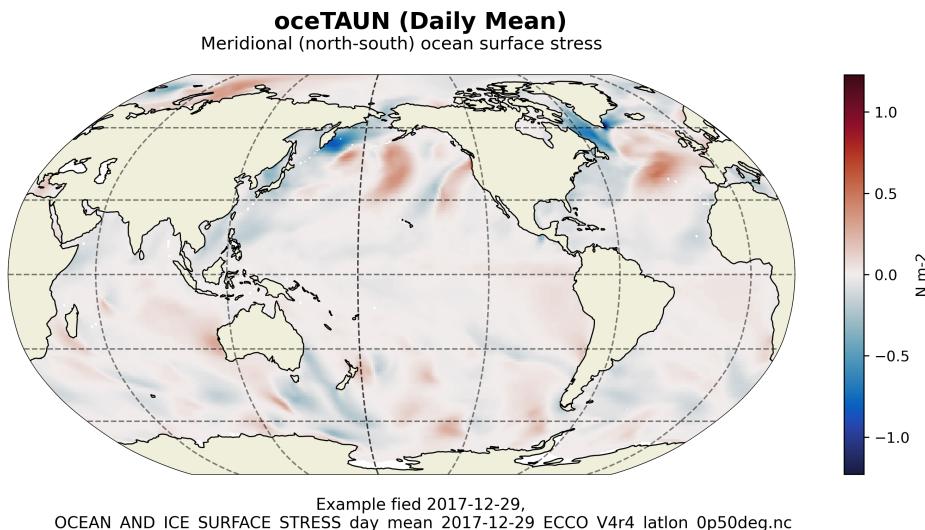


Figure 151: Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: oceTAUN

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.			

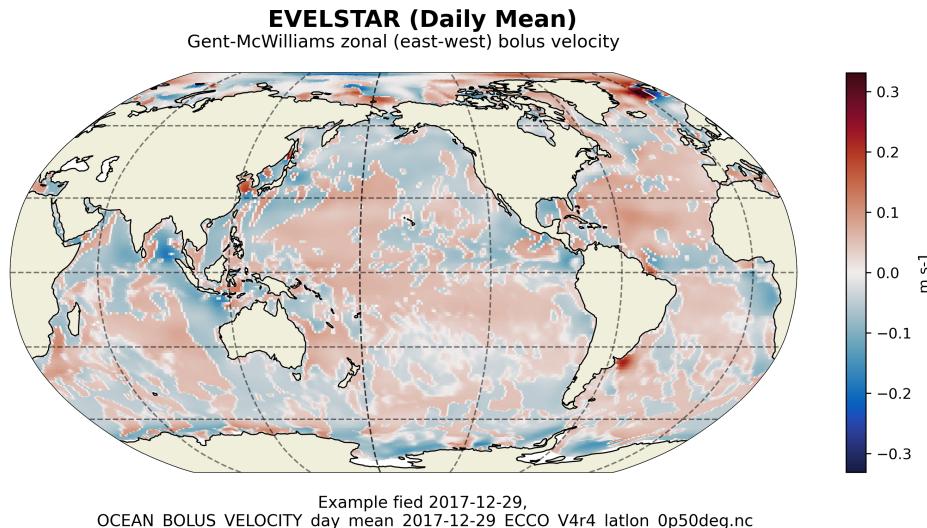


Figure 152: Dataset: OCEAN_BOLUS_VELOCITY, Variable: EVELSTAR

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			

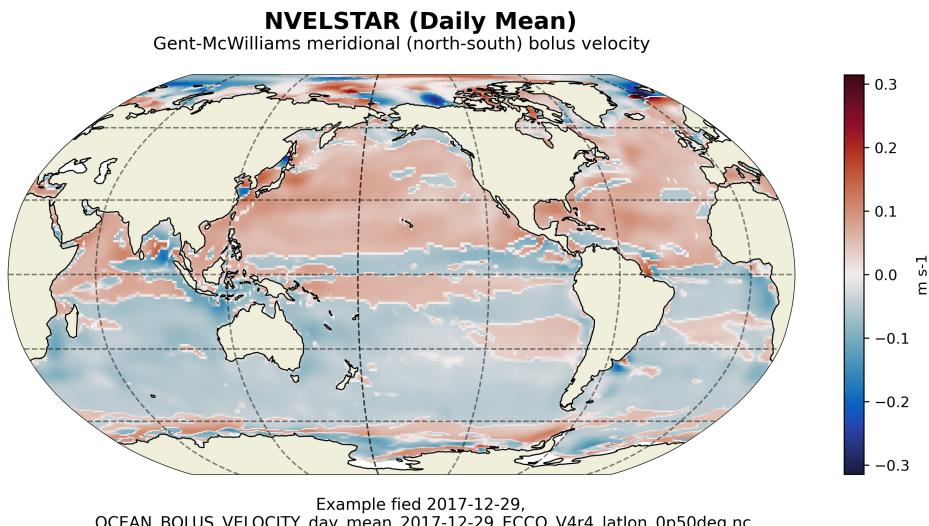


Figure 153: Dataset: OCEAN_BOLUS_VELOCITY, Variable: NVELSTAR

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 = 0.0004019034677185118			
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.			

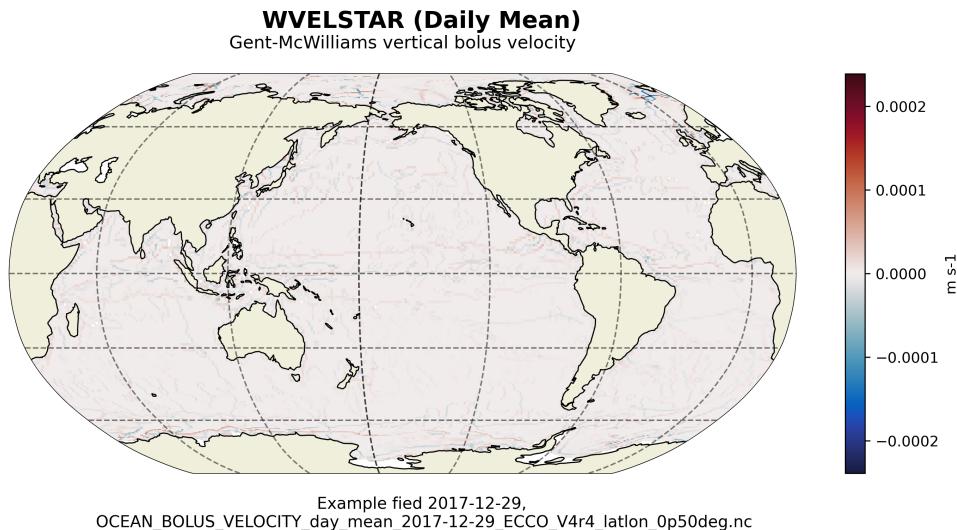


Figure 154: Dataset: OCEAN_BOLUS_VELOCITY, Variable: WVELSTAR

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 sterghlo) 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.			

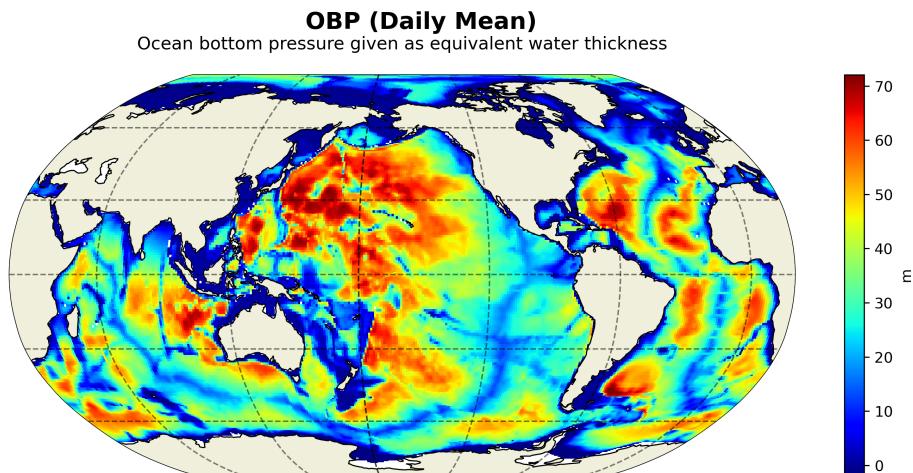


Figure 155: Dataset: OCEAN_BOTTOM_PRESSURE, Variable: OBP

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)			
<pre>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</pre>			
Comments			
<p>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 $\text{phibot} = p_b/\rho_{\text{const}} - gh(t)$, where p_b = model ocean hydrostatic bottom pressure, ρ_{const} = 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, $\text{obpgmap} = \text{phibot}/g + \text{corrections for global mean steric sea level changes related to density changes in the boussinesq volume-conserving model (greatbatch correction, see sterghlo)}$. 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.</p>			

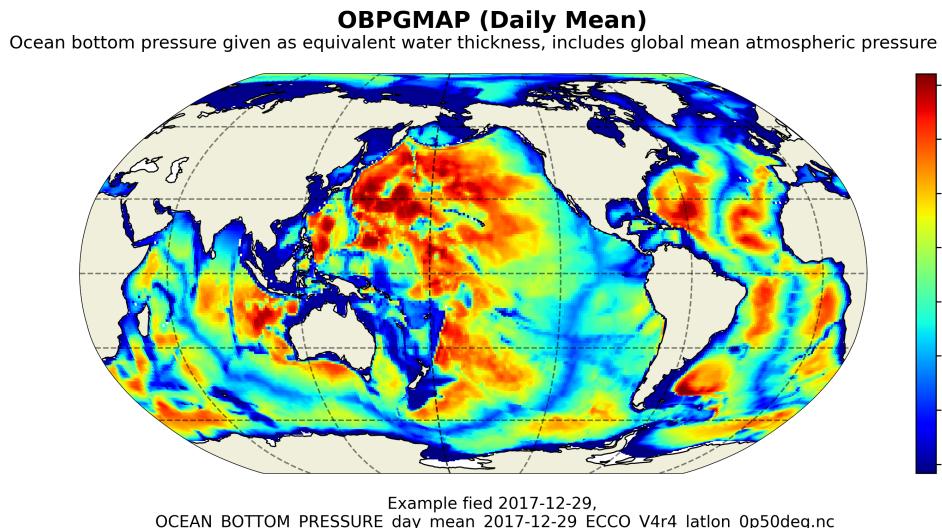


Figure 156: Dataset: OCEAN_BOTTOM_PRESSURE, Variable: OBPGMAP

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 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 14.45: 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 h_{\{0\}} z\$.			

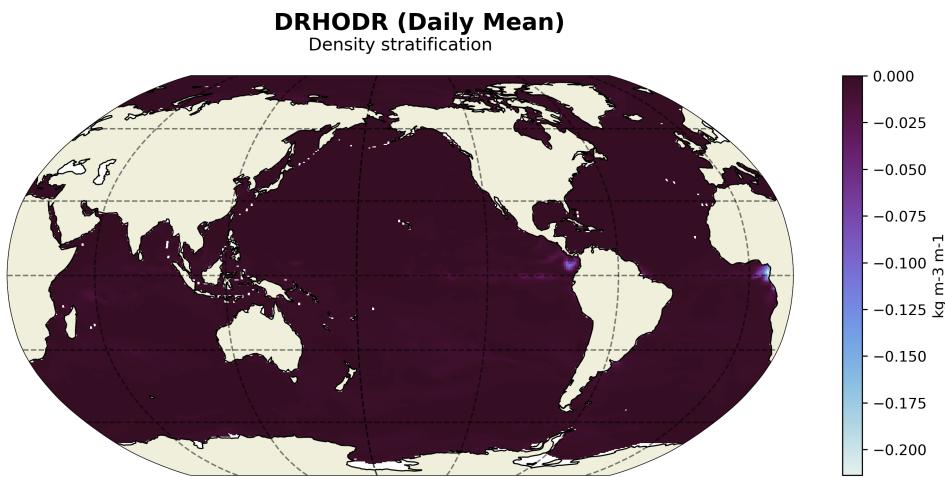


Figure 157: Dataset: OCEAN_DENS_STRAT_PRESS, Variable: DRHODR

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 phihydr 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 sterglo).			

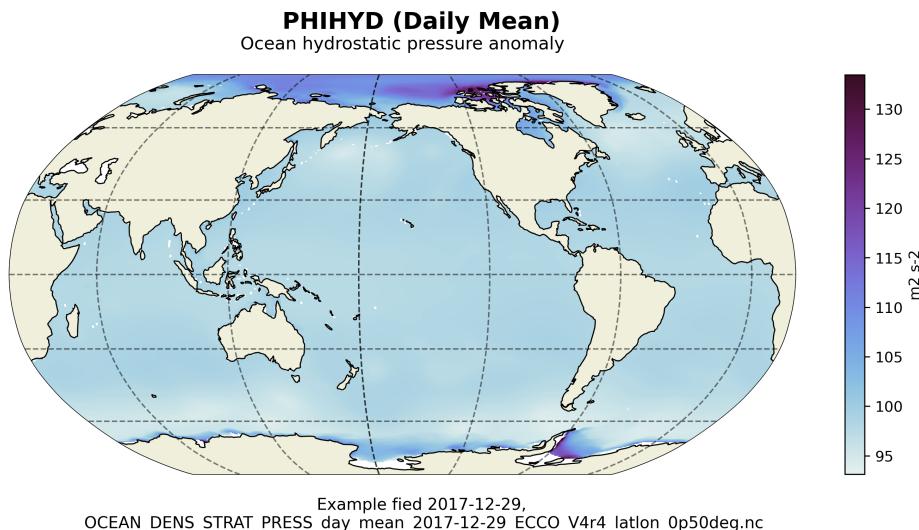


Figure 158: Dataset: OCEAN_DENS_STRAT_PRESS, Variable: PHIHYD

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			

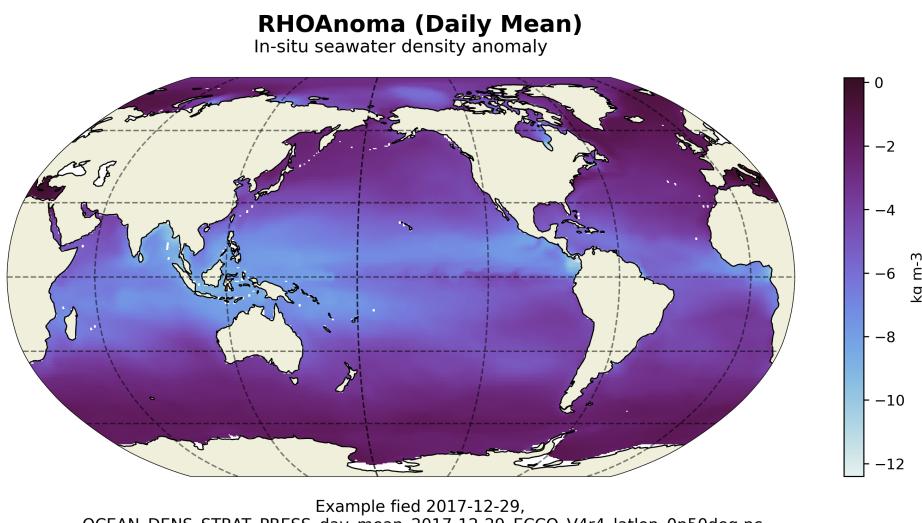


Figure 159: Dataset: OCEAN_DENS_STRAT_PRESS, Variable: RHOAnoma

14.8 Latlon dataset of OCEAN_MIXED_LAYER_DEPTH

14.8.1 Overview

This dataset provides 2D files 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)			
<pre>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</pre>			
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).			

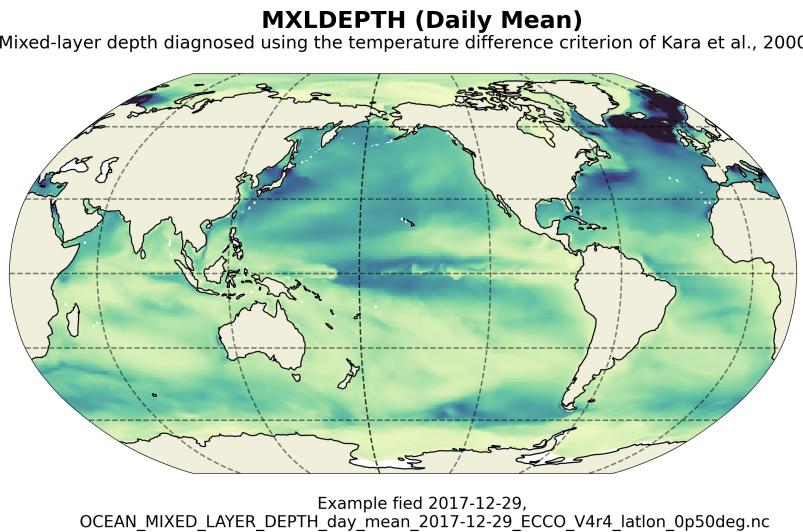


Figure 160: Dataset: OCEAN_MIXED_LAYER_DEPTH, Variable: MXLDEPTH

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.

Storage Type	Variable Name	Description	Unit
float32	SALT	Salinity	1e-3
Description of the variable in Common Data language (CDL)			
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			
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			

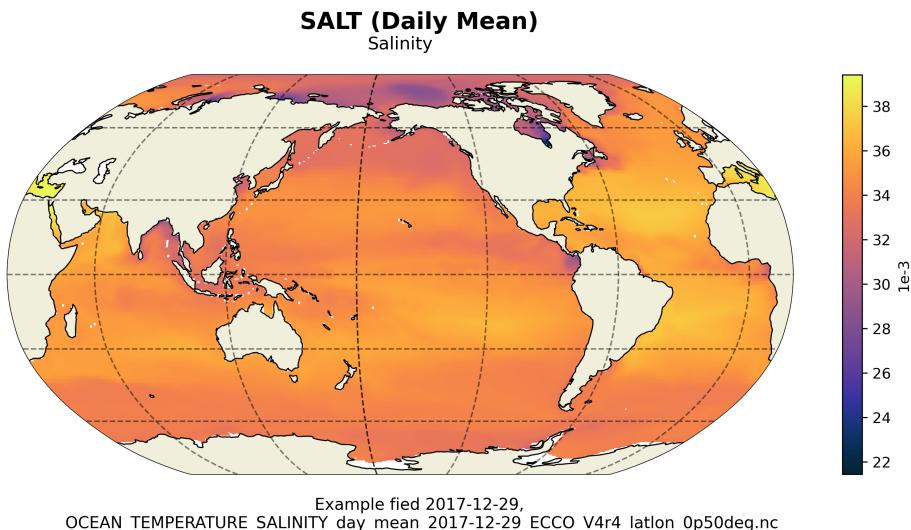


Figure 161: Dataset: OCEAN_TEMPERATURE_SALINITY, Variable: SALT

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 jackson and mcdougall (1995), which uses the model variable potential temperature as input assuming a horizontally and temporally constant pressure of $\$p_0 = -g \cdot h_o \cdot \{O\} z\$$.			

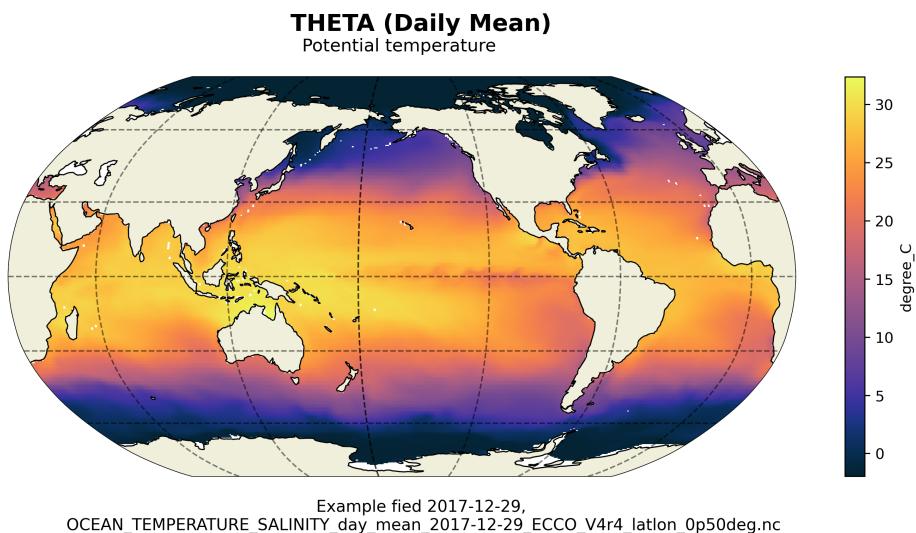


Figure 162: Dataset: OCEAN_TEMPERATURE_SALINITY, Variable: THETA

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 = 1.94859194755542			
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.			

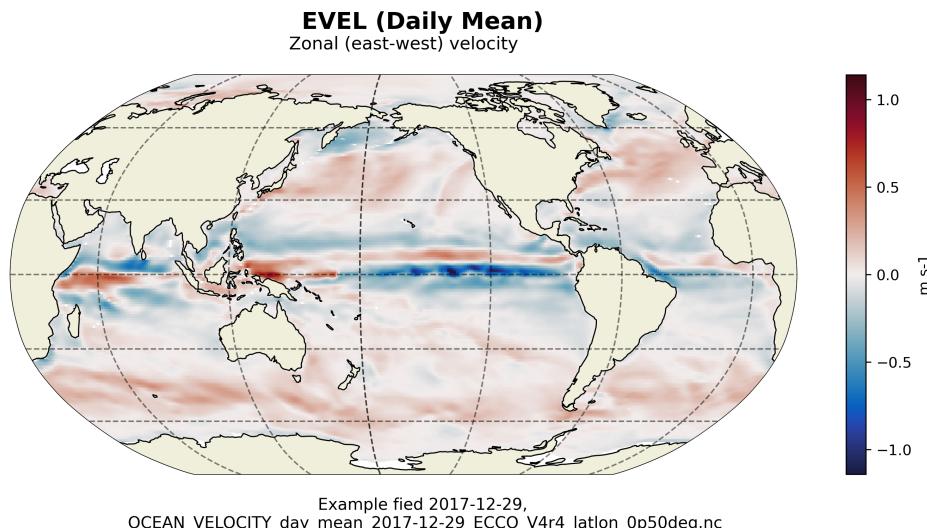


Figure 163: Dataset: OCEAN_VELOCITY, Variable: EVEL

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.			

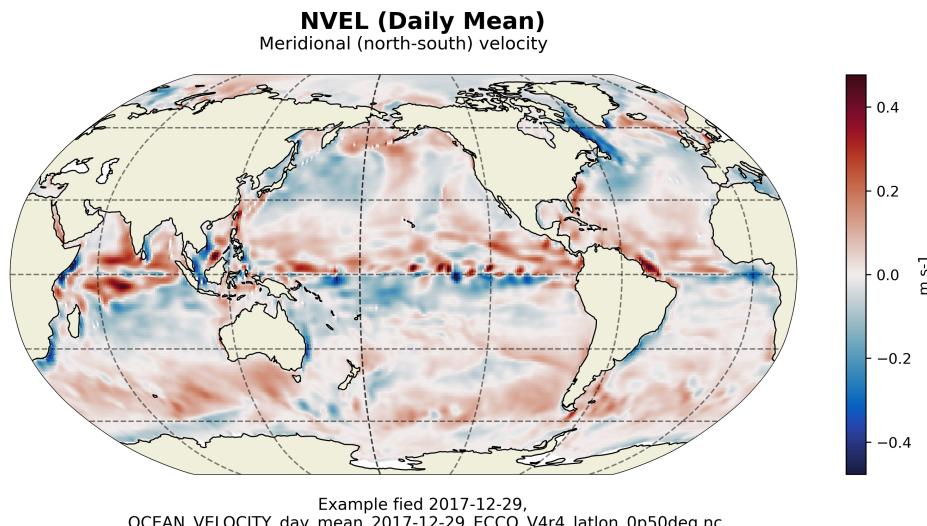


Figure 164: Dataset: OCEAN_VELOCITY, Variable: NVEL

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.			

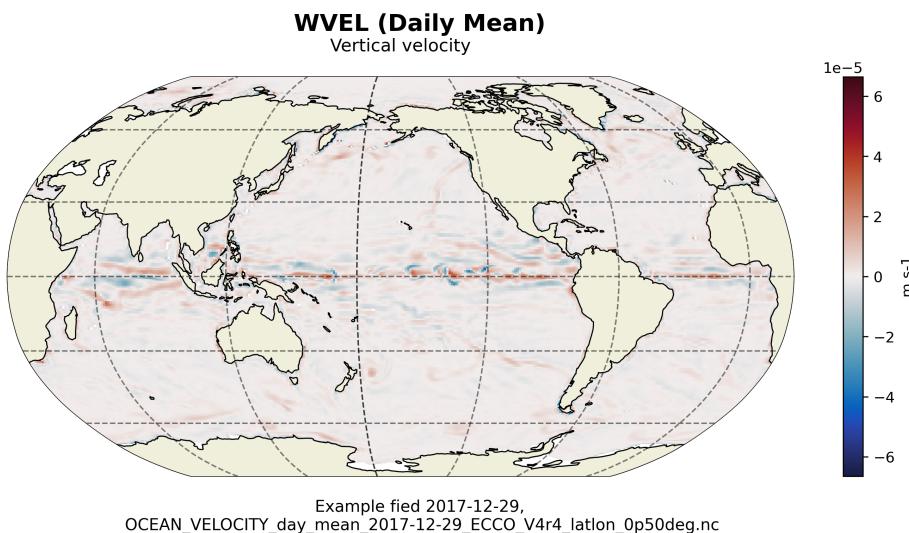


Figure 165: Dataset: OCEAN_VELOCITY, Variable: WVEL

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
Slarea	Sea-ice concentration	1
Slheff	Area-averaged sea-ice thickness	m
Slhsnow	Area-averaged snow thickness	m
slceLoad	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: Slarea

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

Storage Type	Variable Name	Description	Unit
float32	Slarea	Sea-ice concentration	1
Description of the variable in Common Data language (CDL)			
float32 Slarea(time, latitude, longitude) Slarea:_FillValue = 9.96921e+36 Slarea: coverage_content_type = modelResult Slarea: long_name = Sea: ice concentration Slarea: standard_name = sea_ice_area_fraction Slarea: units = 1 Slarea: coordinates = time Slarea: valid_min = 0.0 Slarea: 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			

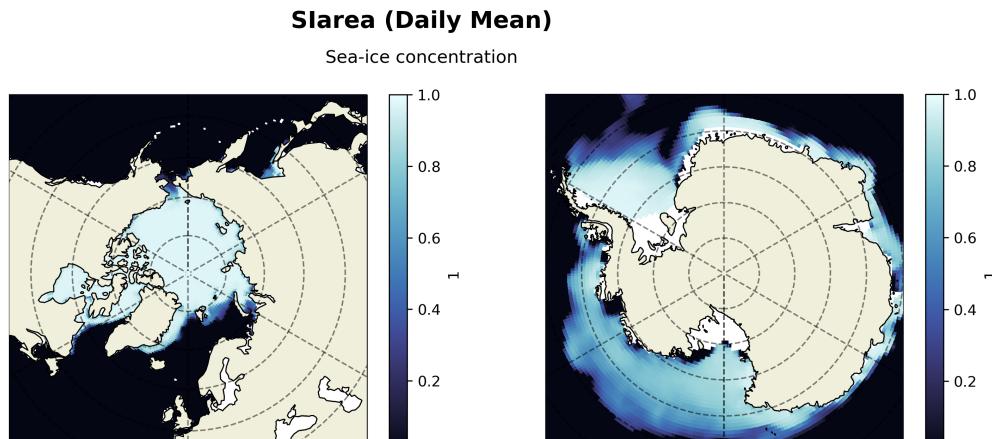


Figure 166: Dataset: SEA_ICE_CONC_THICKNESS, Variable: Slarea

14.11.3 Latlon Variable: Slheff

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

Storage Type	Variable Name	Description	Unit
float32	Slheff	Area-averaged sea-ice thickness	m
Description of the variable in Common Data language (CDL)			
float32 Slheff(time, latitude, longitude) Slheff:_FillValue = 9.96921e+36 Slheff: coverage_content_type = modelResult Slheff: long_name = Area: averaged sea: ice thickness Slheff: standard_name = sea_ice_thickness Slheff: units = m Slheff: coordinates = time Slheff: valid_min = 0.0 Slheff: 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			

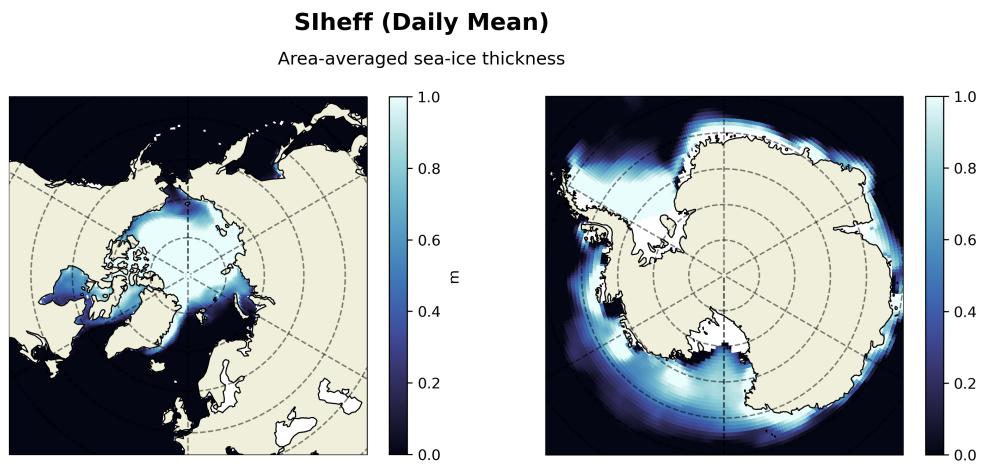


Figure 167: Dataset: SEA_ICE_CONC_THICKNESS, Variable: Slheff

14.11.4 Latlon Variable: Slhsnow

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

Storage Type	Variable Name	Description	Unit
float32	Slhsnow	Area-averaged snow thickness	m
Description of the variable in Common Data language (CDL)			
float32 Slhsnow(time, latitude, longitude) Slhsnow: _FillValue = 9.96921e+36 Slhsnow: coverage_content_type = modelResult Slhsnow: long_name = Area: averaged snow thickness Slhsnow: standard_name = surface_snow_thickness Slhsnow: units = m Slhsnow: coordinates = time Slhsnow: valid_min = : 0.0004725505714304745 Slhsnow: 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			

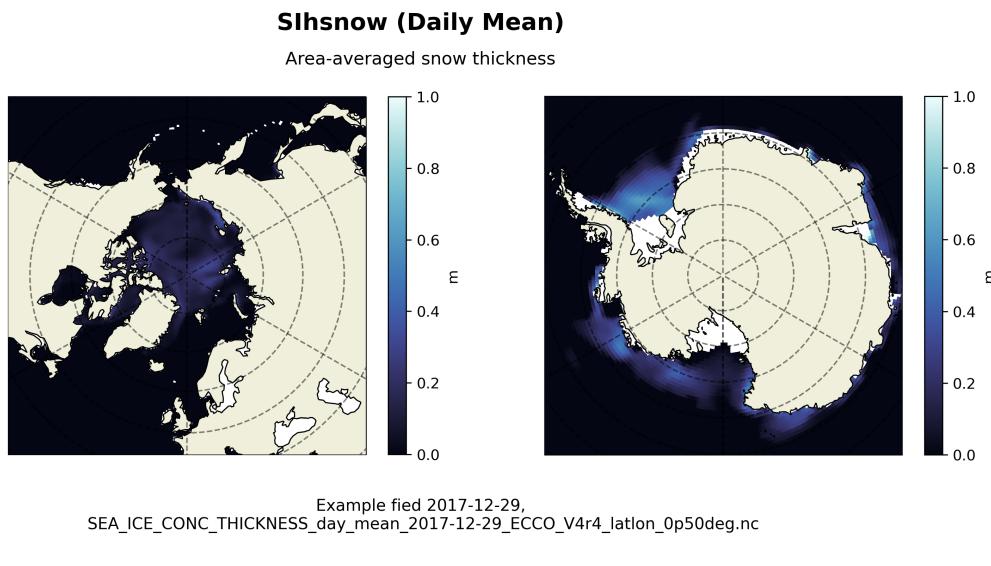


Figure 168: Dataset: SEA_ICE_CONC_THICKNESS, Variable: Slhsnow

14.11.5 Latlon Variable: slceLoad

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

Storage Type	Variable Name	Description	Unit
float32	slceLoad	Average sea-ice and snow mass per unit area	kg m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>float32 slceLoad(time, latitude, longitude) slceLoad:_FillValue = 9.96921e+36 slceLoad:coverage_content_type = modelResult slceLoad:long_name = Average sea: ice and snow mass per unit area slceLoad:standard_name = sea_ice_and_surface_snow_amount slceLoad:units = kg m: 2 slceLoad:coordinates = time slceLoad:valid_min = : 0.0015558383893221617 slceLoad:valid_max = 8729.935546875</pre>			
Comments			
<p>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.</p>			

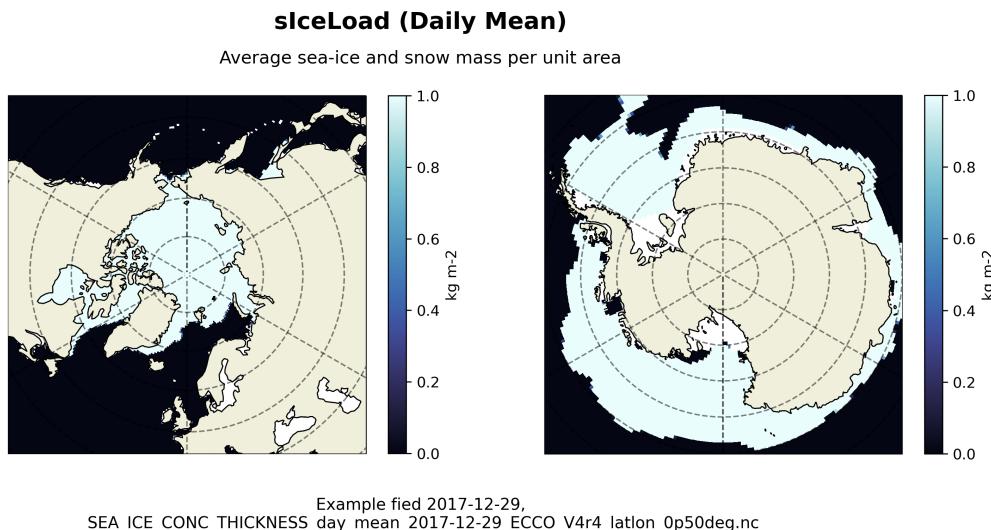


Figure 169: Dataset: SEA_ICE_CONC_THICKNESS, Variable: slceLoad

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
Sleice	Zonal (east-west) sea-ice velocity	m s-1
Slnice	Meridional (north-south) sea-ice velocity	m s-1
Coordinates		Description of data coordinates
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: Sleice

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

Storage Type	Variable Name	Description	Unit
float32	Sleice	Zonal (east-west) sea-ice velocity	m s ⁻¹
Description of the variable in Common Data language (CDL)			
float32 Sleice(time, latitude, longitude) Sleice:_FillValue = 9.96921e+36 Sleice: coverage_content_type = modelResult Sleice: long_name = Zonal (east: west) sea: ice velocity Sleice: standard_name = eastward_sea_ice_velocity Sleice: units = m s: 1 Sleice: coordinates = time Sleice: valid_min = : 0.5656854510307312 Sleice: valid_max = 0.5656854510307312			
Comments			
Zonal (east-west) component of sea-ice velocity. note: mask with siarea to remove nonzero values where ice is absent. sleice 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.			

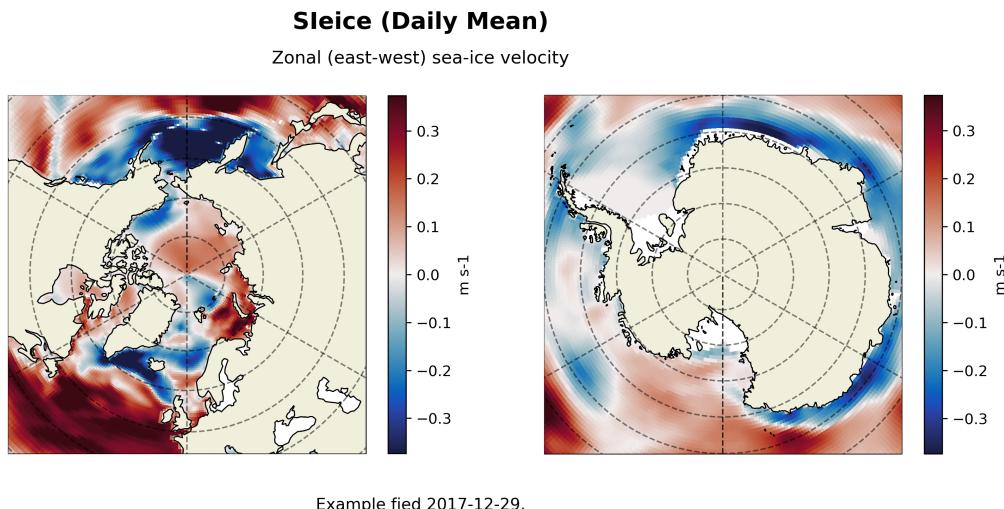


Figure 170: Dataset: SEA_ICE_VELOCITY, Variable: Sleice

14.12.3 Latlon Variable: Slnice

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

Storage Type	Variable Name	Description	Unit
float32	Slnice	Meridional (north-south) sea-ice velocity	m s ⁻¹
Description of the variable in Common Data language (CDL)			
float32 Slnice(time, latitude, longitude) Slnice:_FillValue = 9.96921e+36 Slnice: coverage_content_type = modelResult Slnice: long_name = Meridional (north: south) sea: ice velocity Slnice: standard_name = northward_sea_ice_velocity Slnice: units = m s: 1 Slnice: coordinates = time Slnice: valid_min = : 0.5615208148956299 Slnice: 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. slnice 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.			

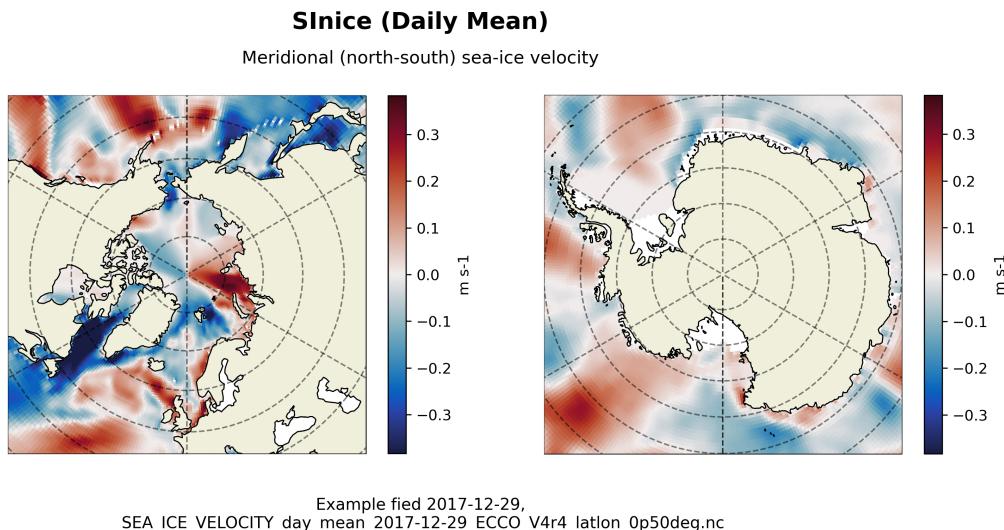


Figure 171: Dataset: SEA_ICE_VELOCITY, Variable: Slnice

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 sterghlo), 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.			

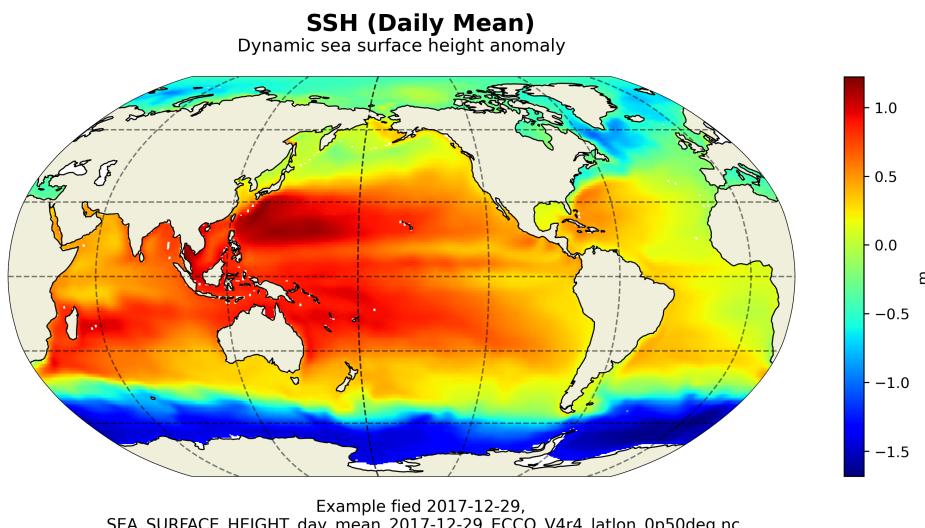


Figure 172: Dataset: SEA_SURFACE_HEIGHT, Variable: SSH

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)			
<pre>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</pre>			
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.			

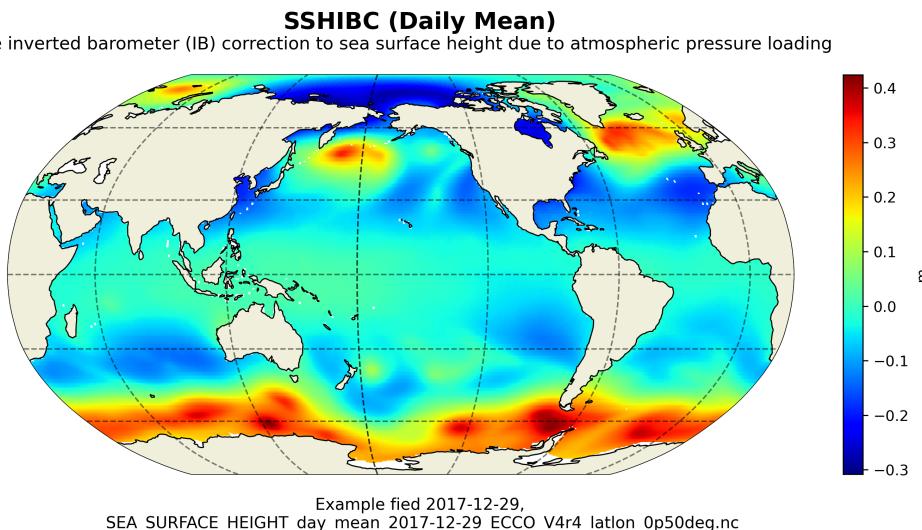


Figure 173: Dataset: SEA_SURFACE_HEIGHT, Variable: SSHIBC

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 ster-glo), 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.			

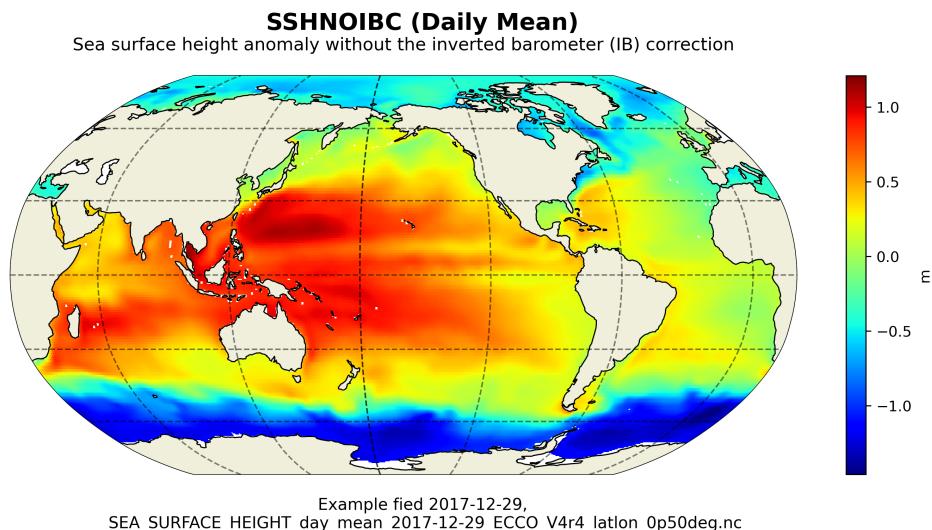


Figure 174: Dataset: SEA_SURFACE_HEIGHT, Variable: SSHNOIBC

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	
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)			
<pre>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</pre>			
Comments			
N/a			

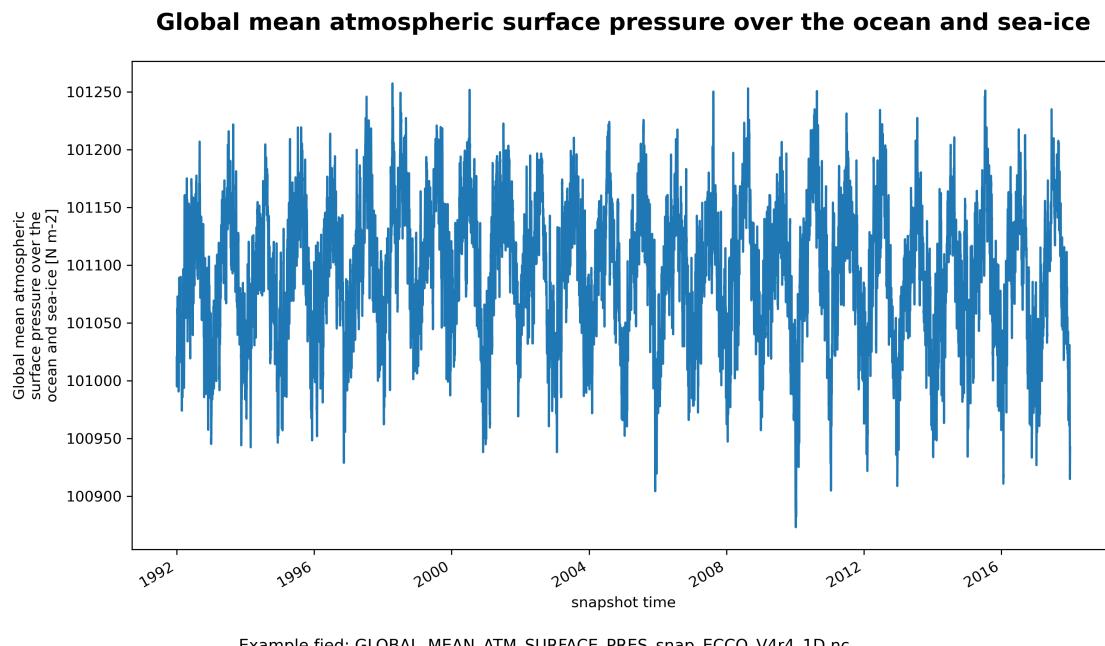


Figure 175: Dataset: GLOBAL_MEAN_ATM_SURFACE_PRES, Variable: Pa_global

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)			
<pre>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</pre>			
Comments			
<p>Global mean barystatic sea level anomaly due to changes in total ocean mass. note: eccv4 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</p>			

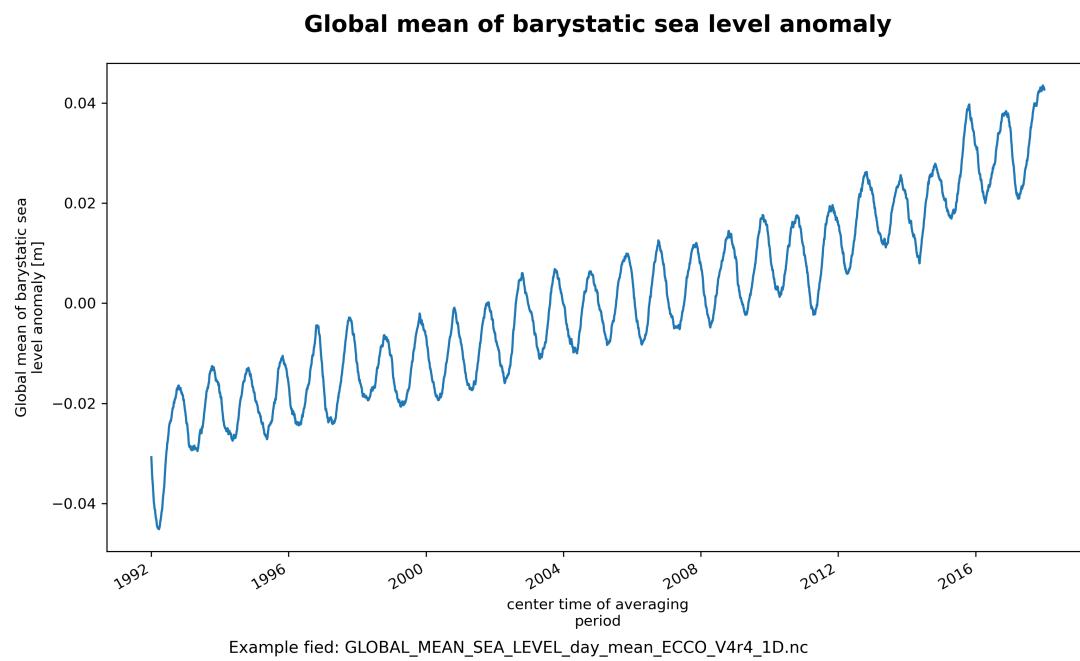


Figure 176: Dataset: GLOBAL_MEAN_SEA_LEVEL, Variable: global_mean_barystatic_sea_level_anomaly

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)			
<pre>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</pre>			
Comments			
<p>Global mean of dynamic sea level anomaly, equivalent to global mean sea level change. note: eccv4 uses a volume-conserving boussinesq formulation of the mitgcm with a free-surface boundary condition with real fresh-water 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 boussinesq 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</p>			

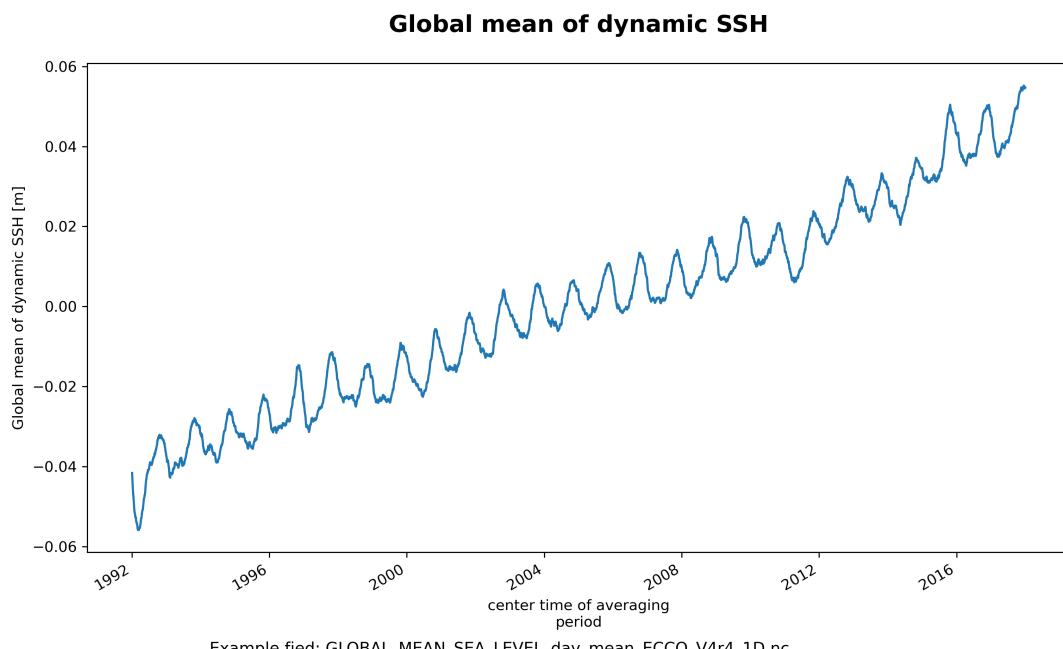


Figure 177: Dataset: GLOBAL_MEAN_SEA_LEVEL, Variable: global_mean_sea_level_anomaly

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)			
<pre>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</pre>			
Comments			
<p>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</p>			

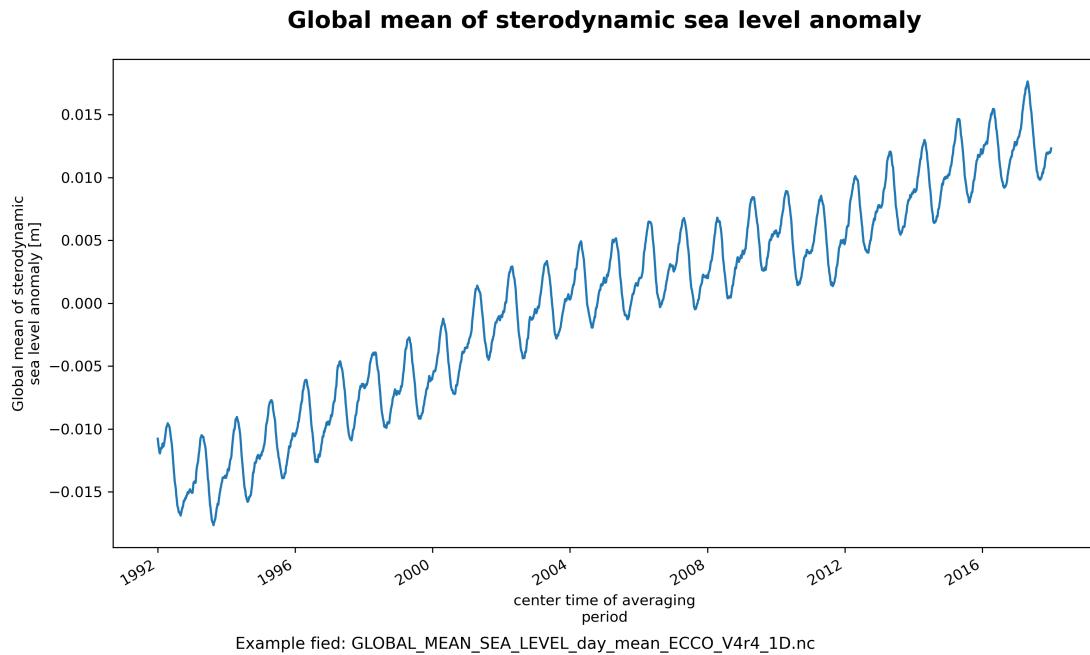


Figure 178: Dataset: GLOBAL_MEAN_SEA_LEVEL, Variable: global_mean_sterodynamic_sea_level_anomaly

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 as 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 m ² s ⁻¹
yoamc	Y-comp of oceanic angular momentum due to currents	kg m ² s ⁻¹
zoamc	Z-comp of oceanic angular momentum due to currents	kg m ² s ⁻¹
xoamp	X-comp of oceanic angular momentum due to pressure	kg m ² s ⁻¹
yoamp	Y-comp of oceanic angular momentum due to pressure	kg m ² s ⁻¹
zoamp	Z-comp of oceanic angular momentum due to pressure	kg m ² 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	m ²
xoamc_si	X-comp of oceanic angular momentum due to sea-ice motion	kg m ² s ⁻¹
yoamc_si	Y-comp of oceanic angular momentum due to sea-ice motion	kg m ² s ⁻¹
zoamc_si	Z-comp of oceanic angular momentum due to sea-ice motion	kg m ² s ⁻¹
mass_si	Sea-ice mass	kg

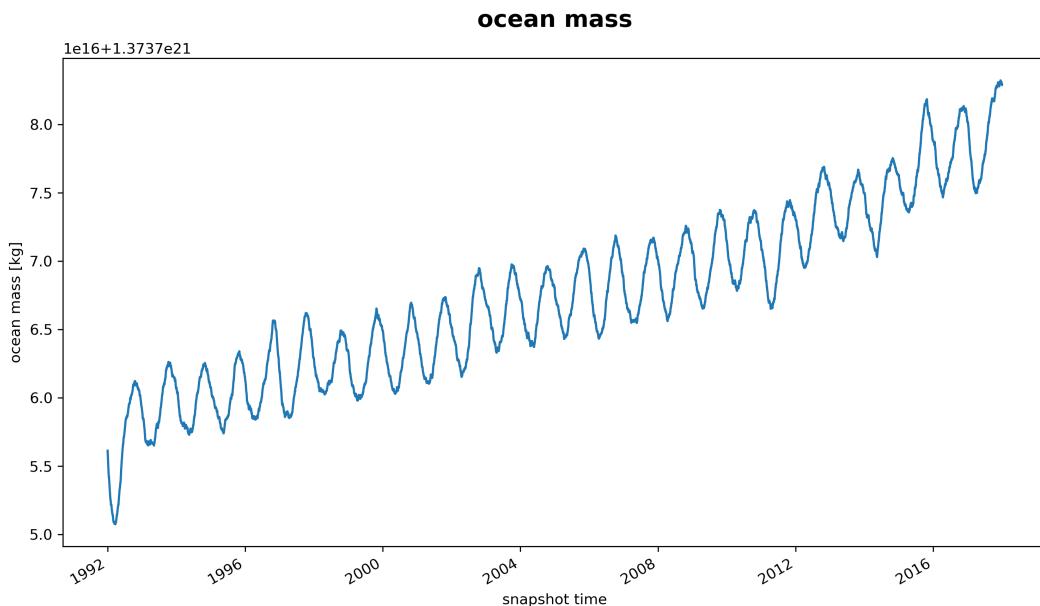
Table 15.7: Coordinates and Variables in the dataset SBO_CORE_PRODUCTS

	Description	Unit
xoamp_fw	X-comp of oceanic angular momentum due to freshwater flux	kg m ² s ⁻¹
yoamp_fw	Y-comp of oceanic angular momentum due to freshwater flux	kg m ² s ⁻¹
zoamp_fw	Z-comp of oceanic angular momentum due to freshwater flux	kg m ² 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 freshwater 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 m ² s ⁻¹
yoamp_dsl	Y-comp of oceanic angular momentum due to pressure based on dynamic (ib-corrected) sea level	kg m ² s ⁻¹
zoamp_dsl	Z-comp of oceanic angular momentum due to pressure based on dynamic (ib-corrected) sea level	kg m ² 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			



Example fied: SBO_CORE_PRODUCTS_snap_ECCO_V4r4_1D.nc

Figure 179: 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)			
<pre>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</pre>			
Comments			
N/a			

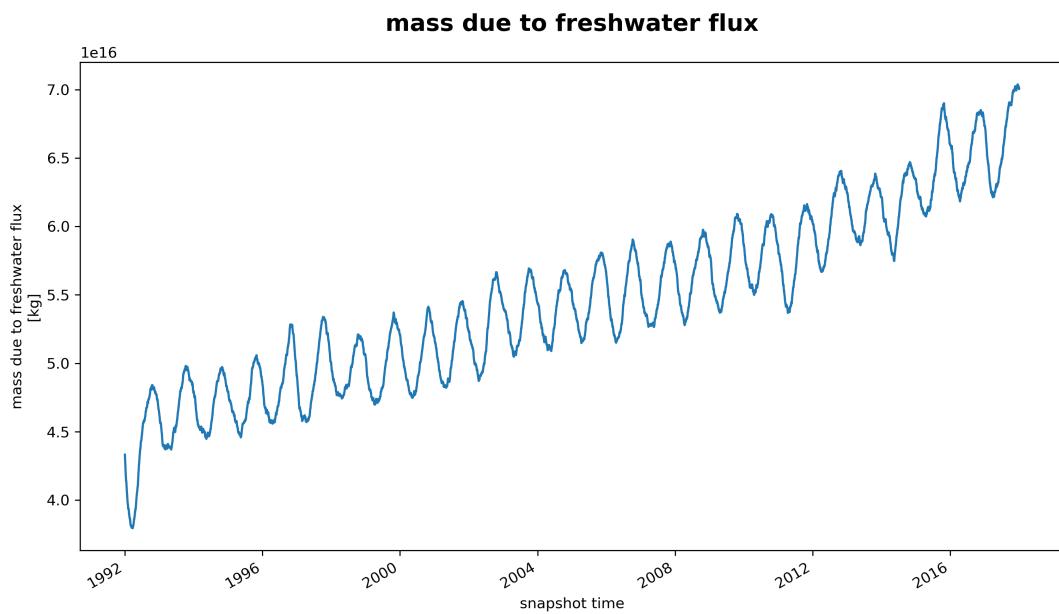


Figure 180: Dataset: SBO_CORE_PRODUCTS, Variable: mass_fw

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			

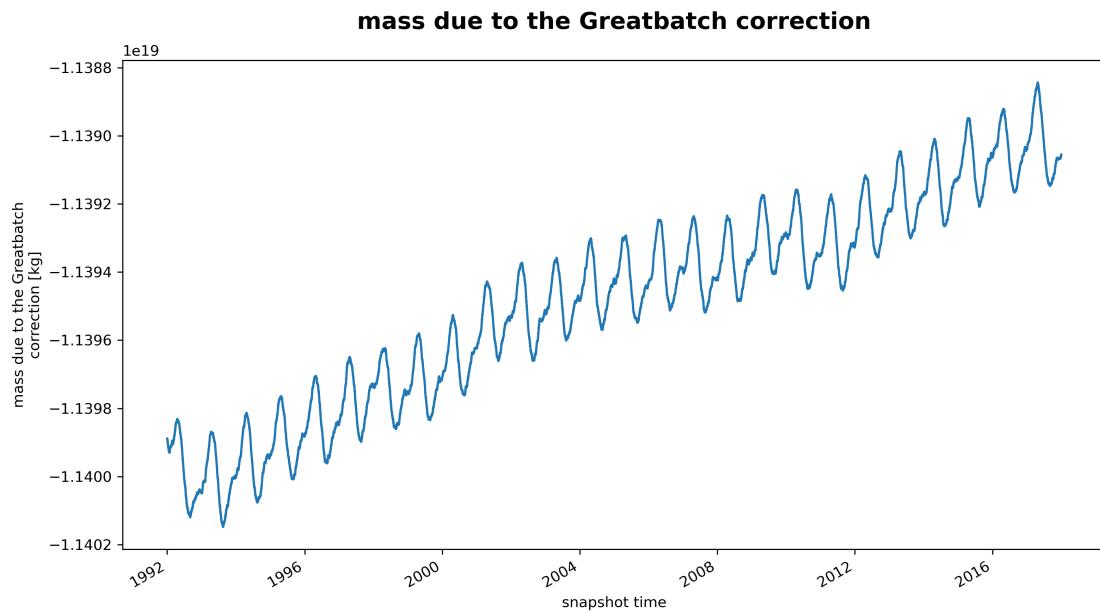


Figure 181: Dataset: SBO_CORE_PRODUCTS, Variable: mass_gc

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)			
<pre>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</pre>			
Comments			
N/a			

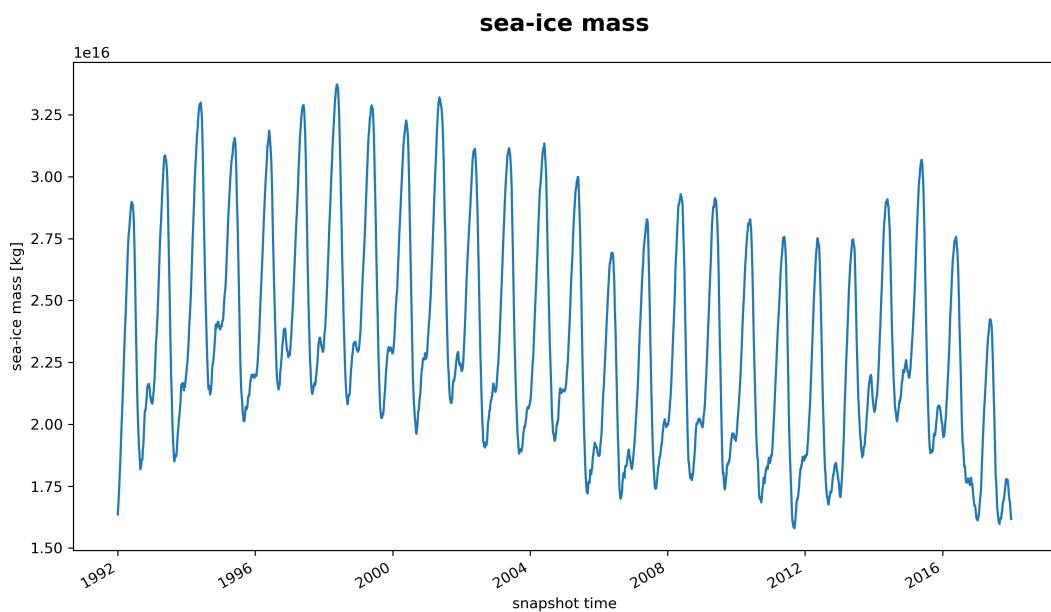
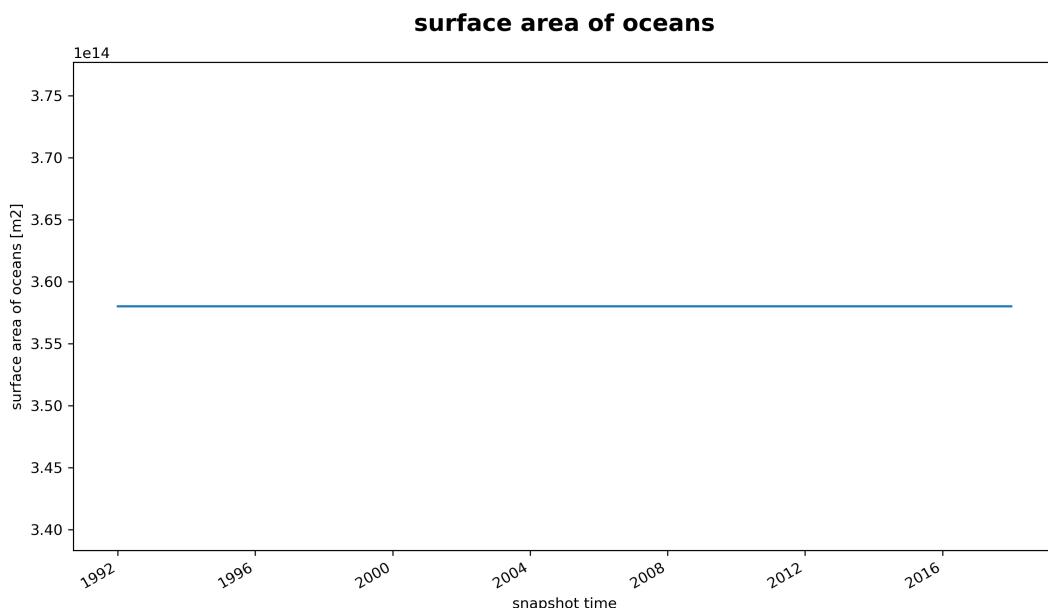


Figure 182: Dataset: SBO_CORE_PRODUCTS, Variable: mass_si

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			



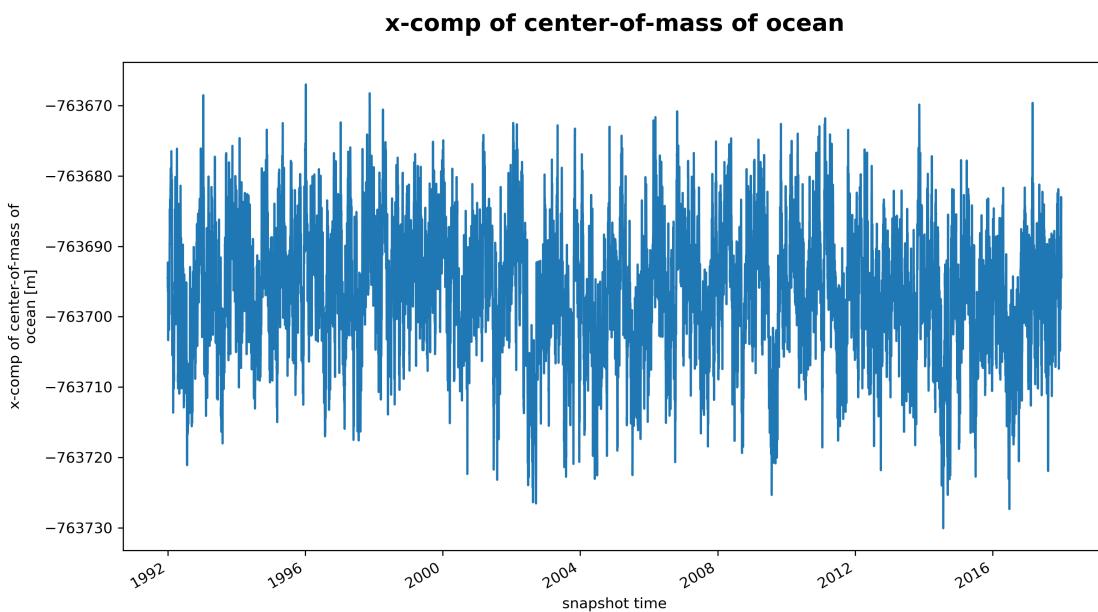
Example file: SBO_CORE_PRODUCTS_snap_ECCO_V4r4_1D.nc

Figure 183: 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			



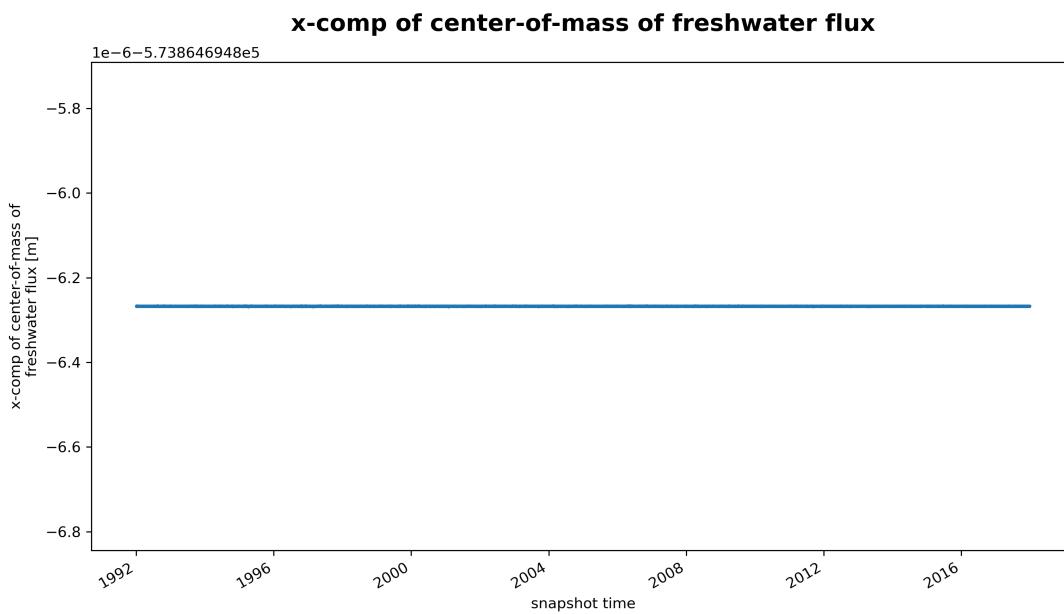
Example file: SBO_CORE_PRODUCTS_snap_ECCO_V4r4_1D.nc

Figure 184: 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			



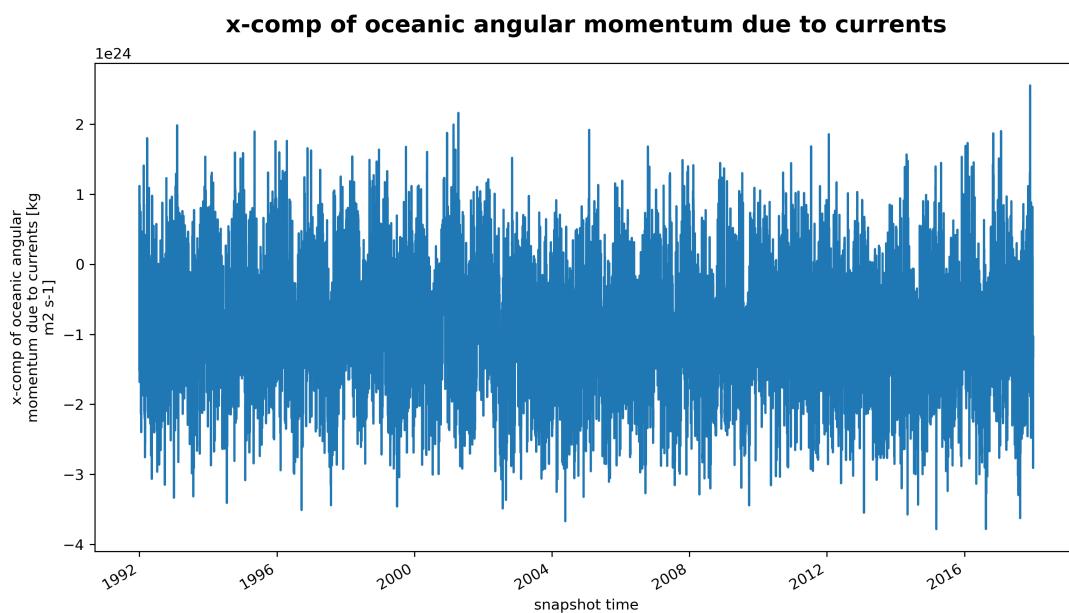
Example file: SBO_CORE_PRODUCTS_snap_ECCO_V4r4_1D.nc

Figure 185: 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 m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
N/a			



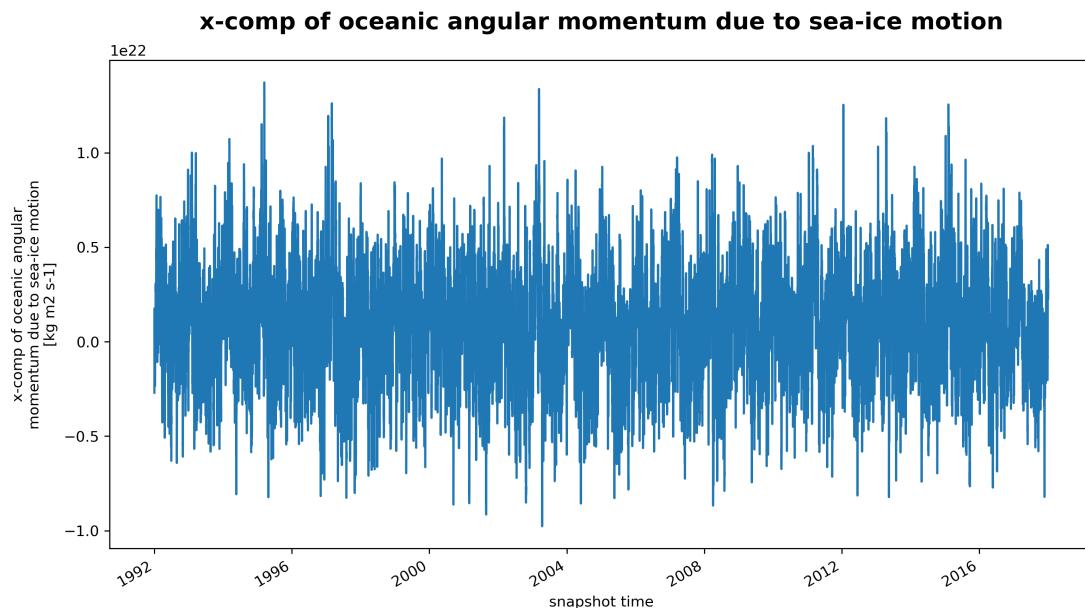
Example file: SBO_CORE_PRODUCTS_snap_ECCO_V4r4_1D.nc

Figure 186: 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 m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
N/a			



Example file: SBO_CORE_PRODUCTS_snap_ECCO_V4r4_1D.nc

Figure 187: 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 m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
N/a			

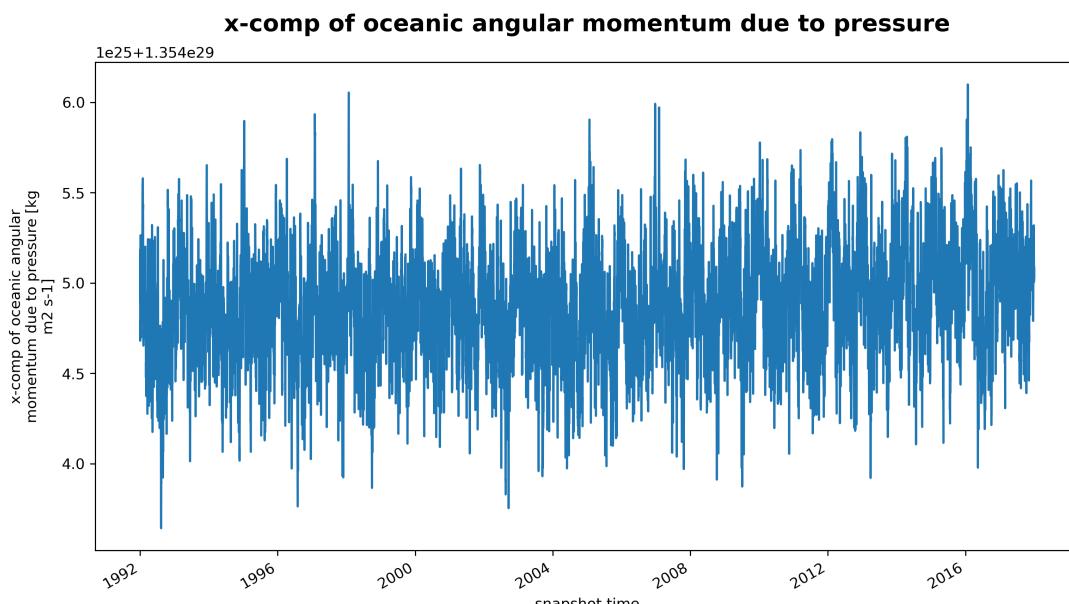


Figure 188: Dataset: SBO_CORE_PRODUCTS, Variable: xoamp

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 m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
N/a			

x-comp of oceanic angular momentum due to pressure based on dynamic (IB-corrected) sea level

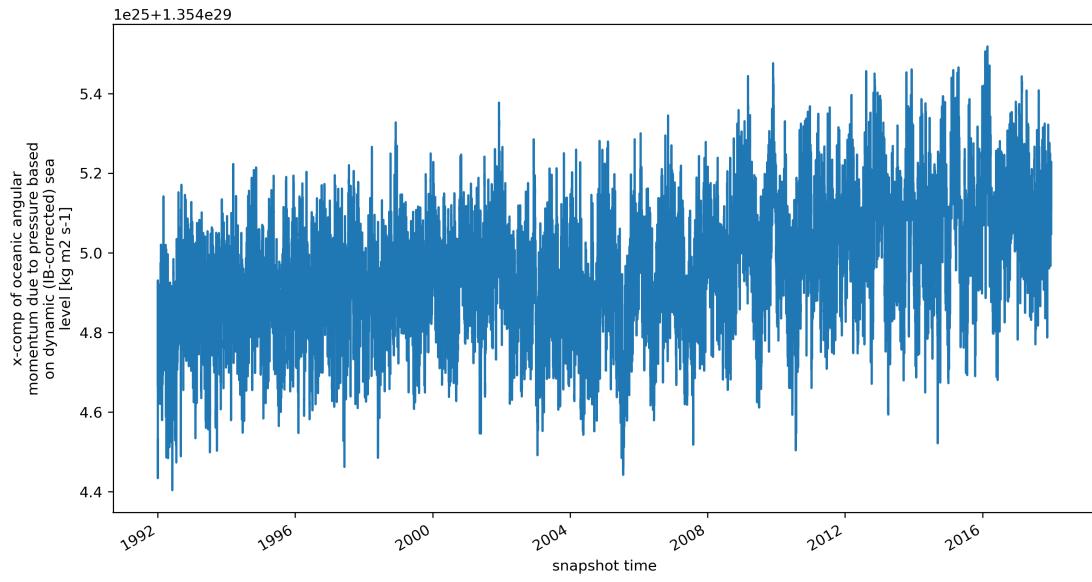


Figure 189: Dataset: SBO_CORE_PRODUCTS, Variable: xoamp_dsl

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 m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
N/a			

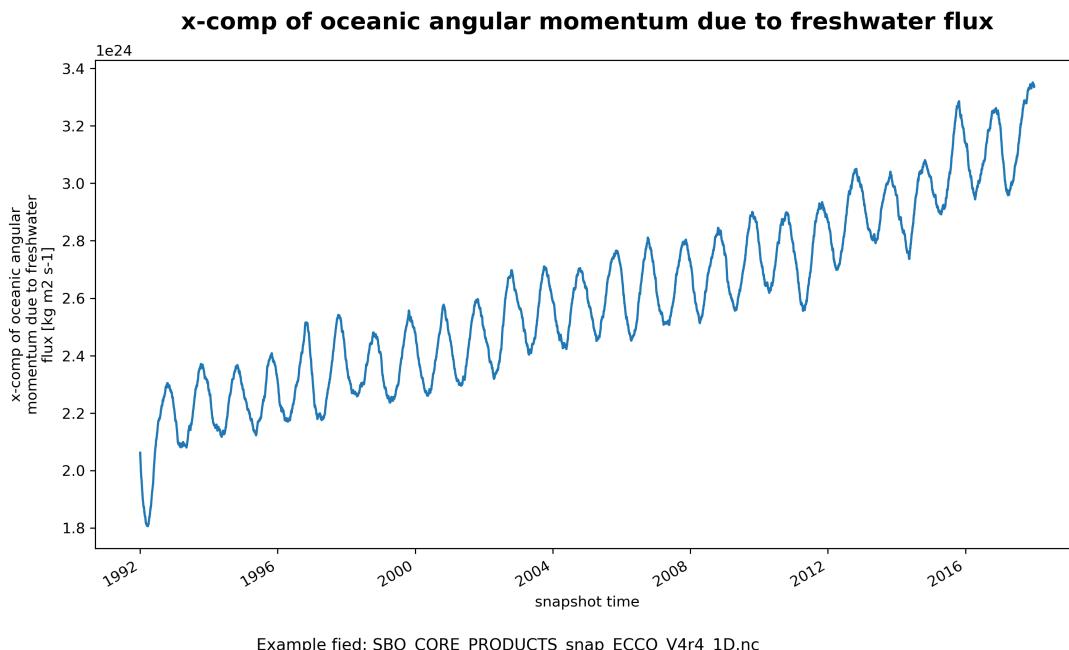
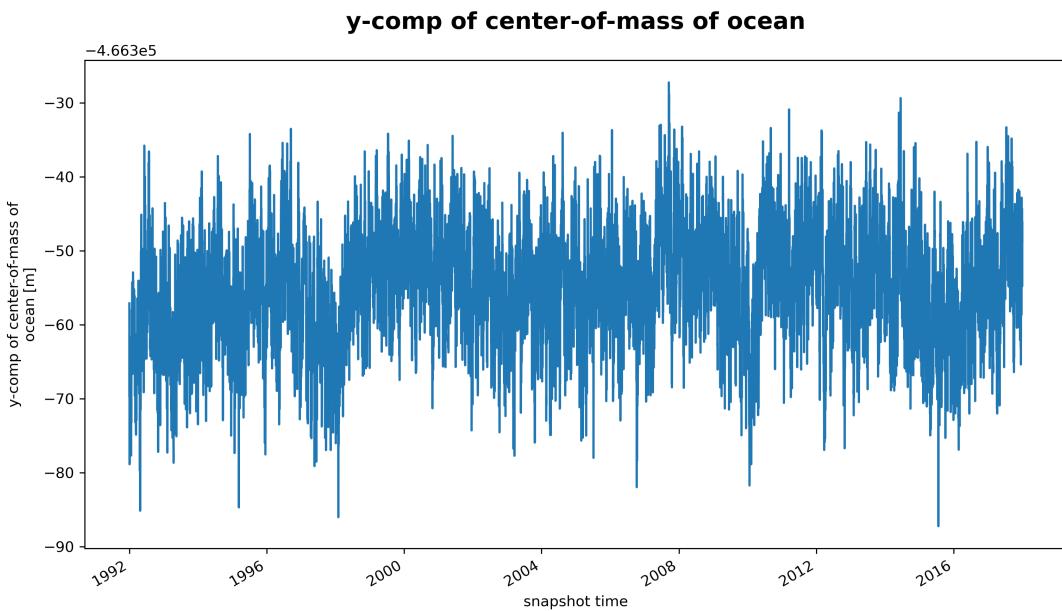


Figure 190: Dataset: SBO_CORE_PRODUCTS, Variable: xoamp_fw

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			



Example file: SBO_CORE_PRODUCTS_snap_ECCO_V4r4_1D.nc

Figure 191: 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			

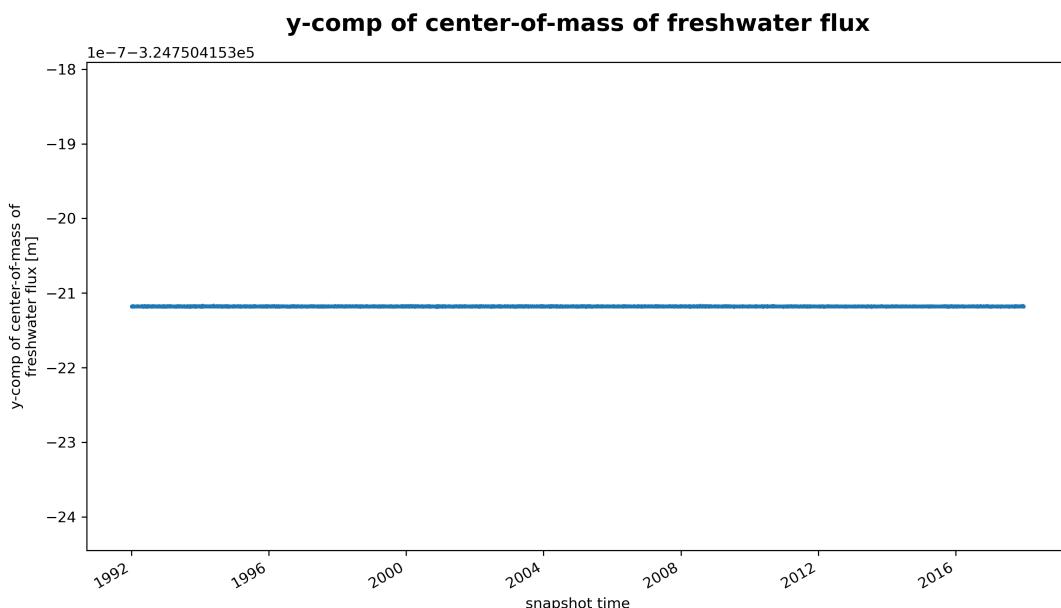


Figure 192: Dataset: SBO_CORE_PRODUCTS, Variable: ycom_fw

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 m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
N/a			

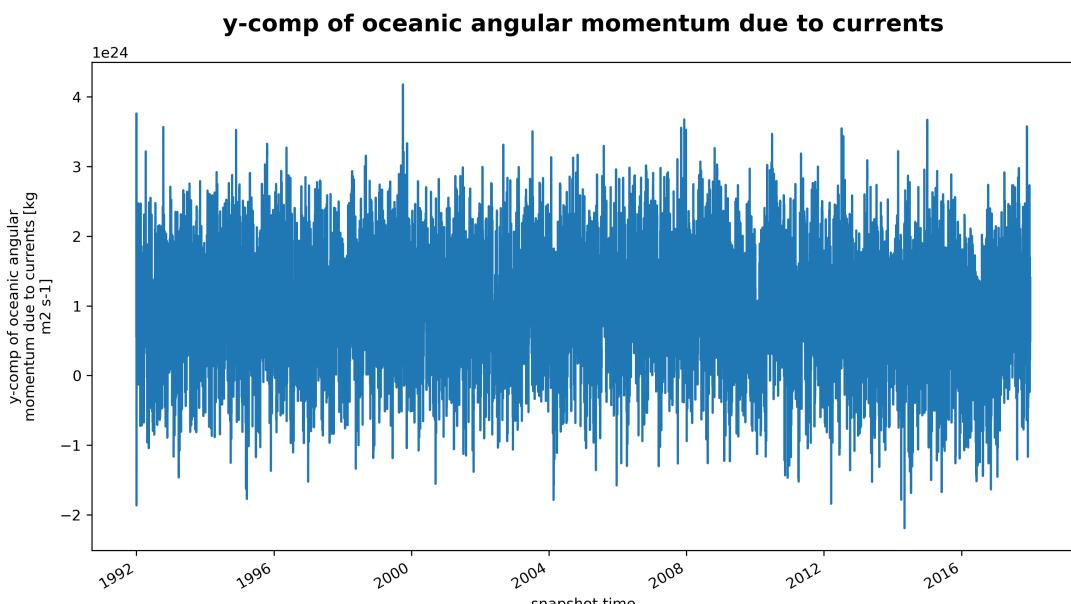


Figure 193: Dataset: SBO_CORE_PRODUCTS, Variable: yoamc

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 m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
N/a			

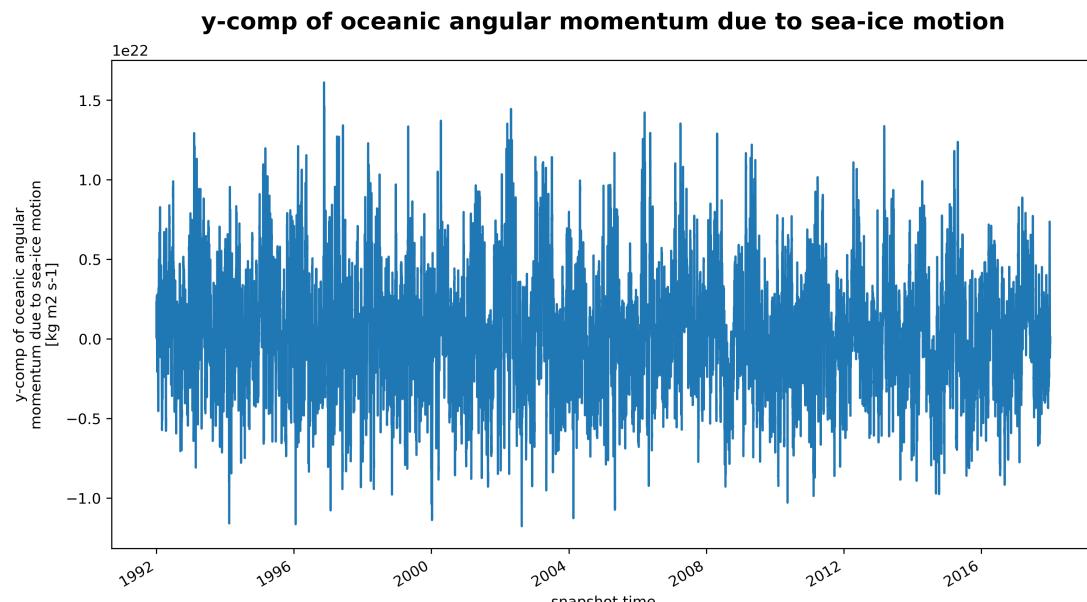


Figure 194: Dataset: SBO_CORE_PRODUCTS, Variable: yoamc_si

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 m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
N/a			

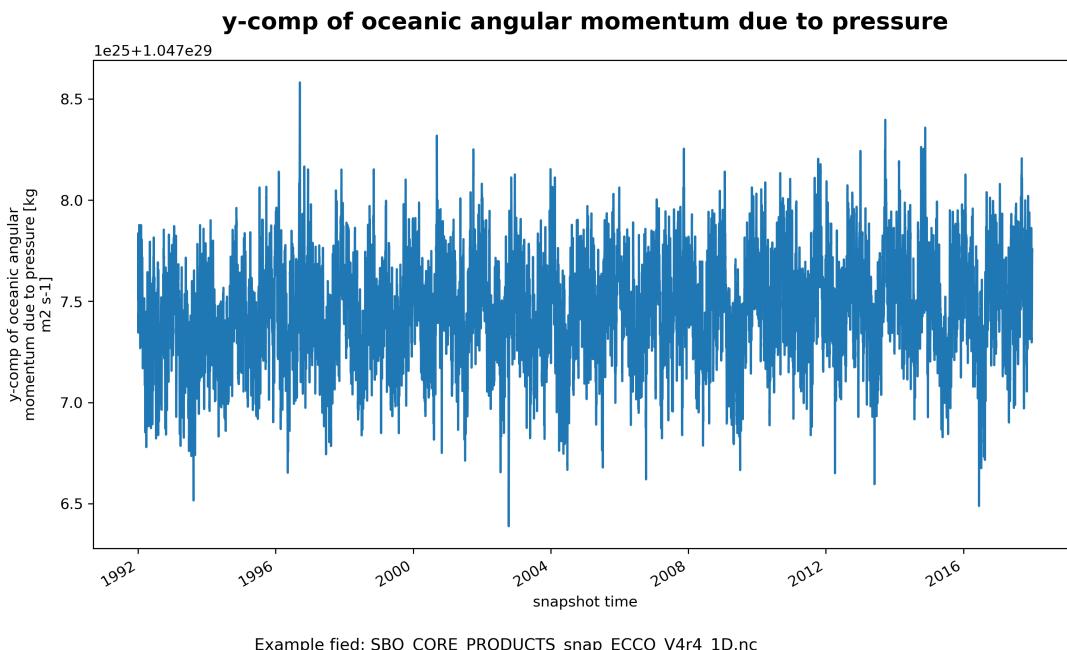


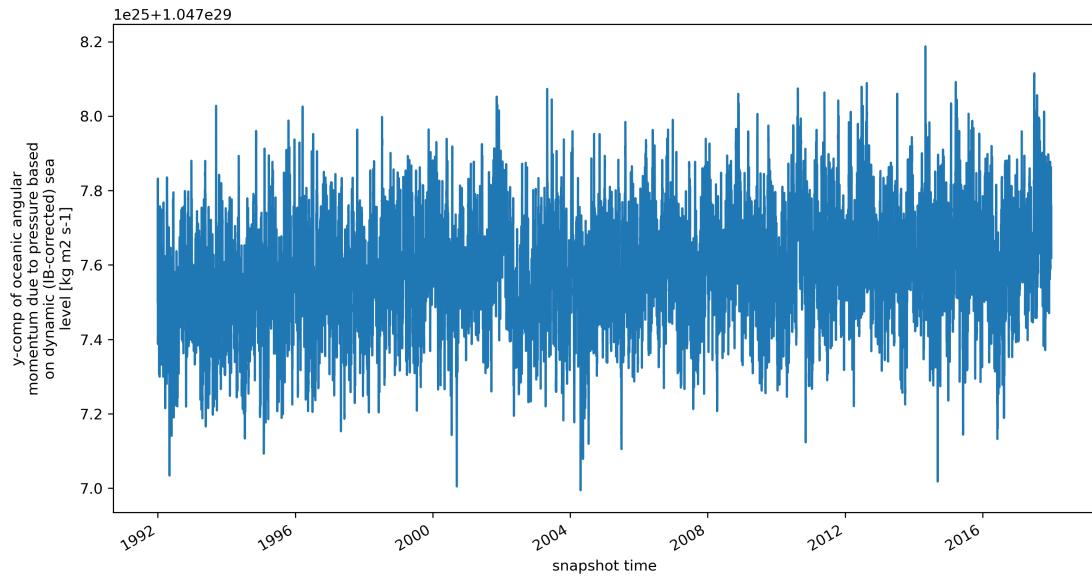
Figure 195: Dataset: SBO_CORE_PRODUCTS, Variable: yoamp

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 m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
N/a			

y-comp of oceanic angular momentum due to pressure based on dynamic (IB-corrected) sea level



Example file: SBO_CORE_PRODUCTS_snap_ECCO_V4r4_1D.nc

Figure 196: 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 m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
N/a			

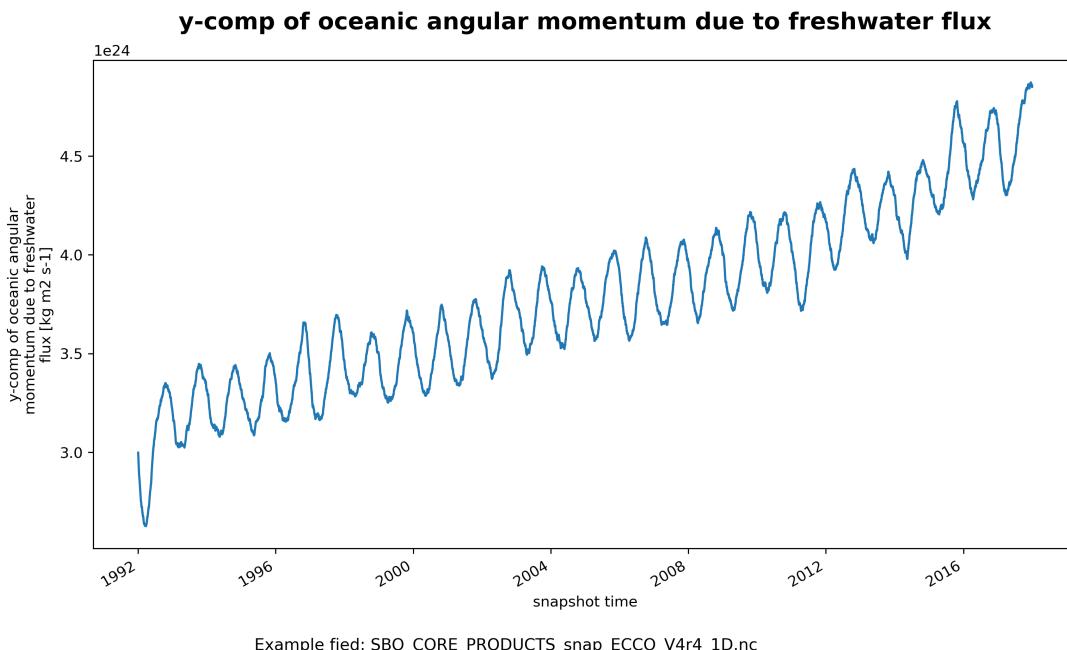
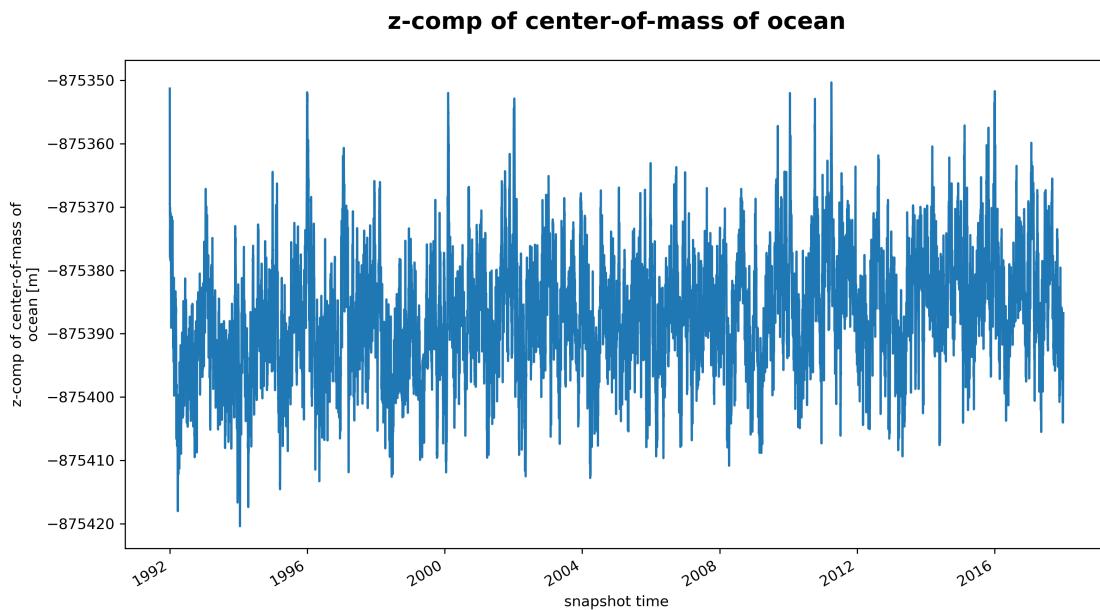


Figure 197: Dataset: SBO_CORE_PRODUCTS, Variable: yoamp_fw

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			



Example file: SBO_CORE_PRODUCTS_snap_ECCO_V4r4_1D.nc

Figure 198: 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			

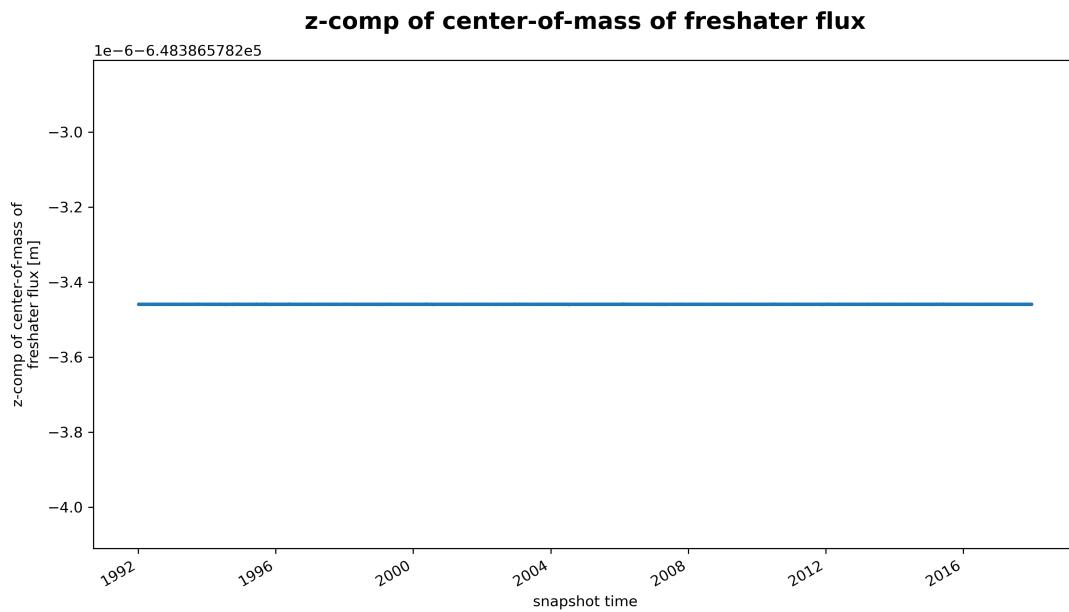
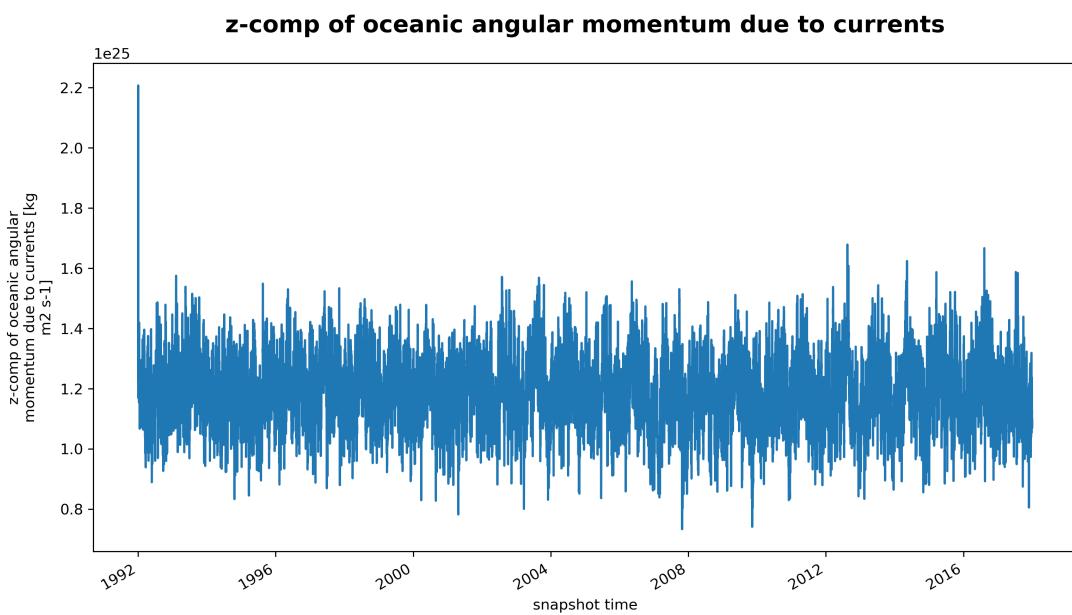


Figure 199: Dataset: SBO_CORE_PRODUCTS, Variable: zcom_fw

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 m ² 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 m ² s: 1			
zoamc:valid_min = 7.331764457927521e+24			
zoamc:valid_max = 2.207264300276968e+25			
zoamc:coordinates = time			
Comments			
N/a			



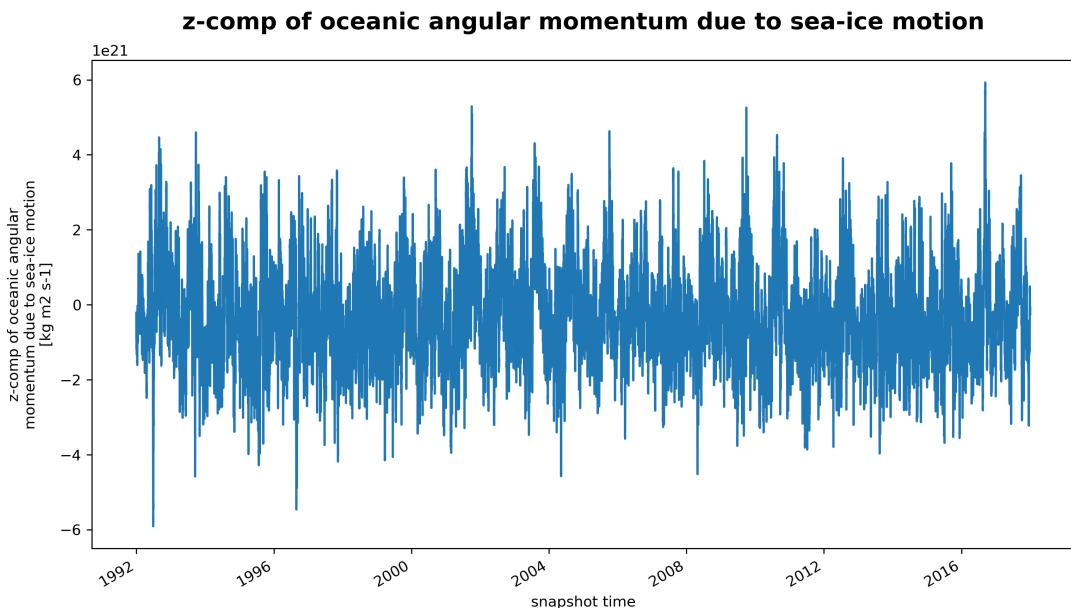
Example file: SBO_CORE_PRODUCTS_snap_ECCO_V4r4_1D.nc

Figure 200: 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 m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
N/a			



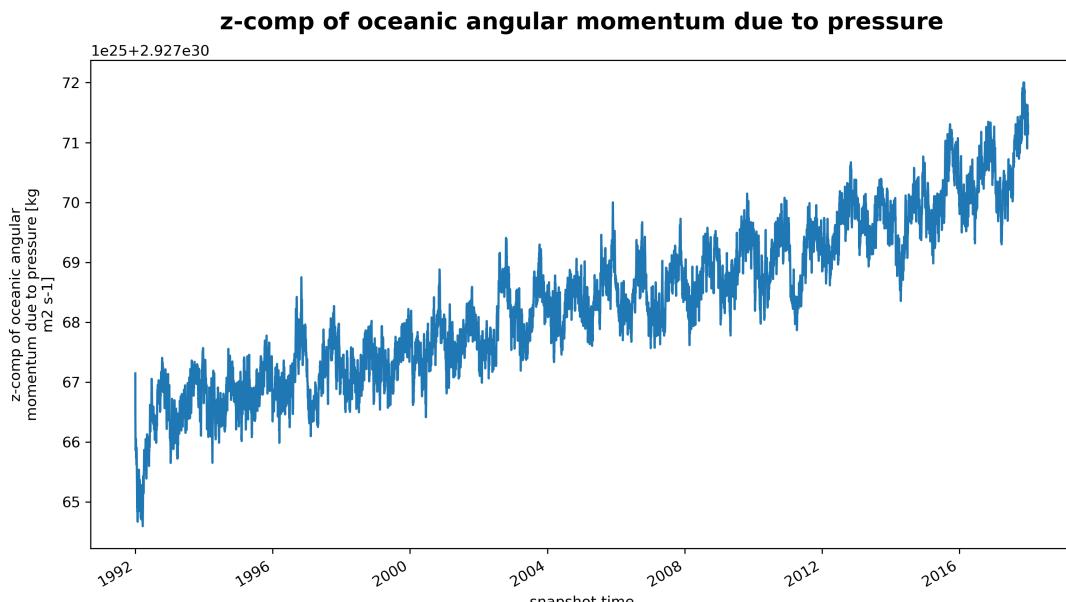
Example file: SBO_CORE_PRODUCTS_snap_ECCO_V4r4_1D.nc

Figure 201: 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 m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
N/a			



Example file: SBO_CORE_PRODUCTS_snap_ECCO_V4r4_1D.nc

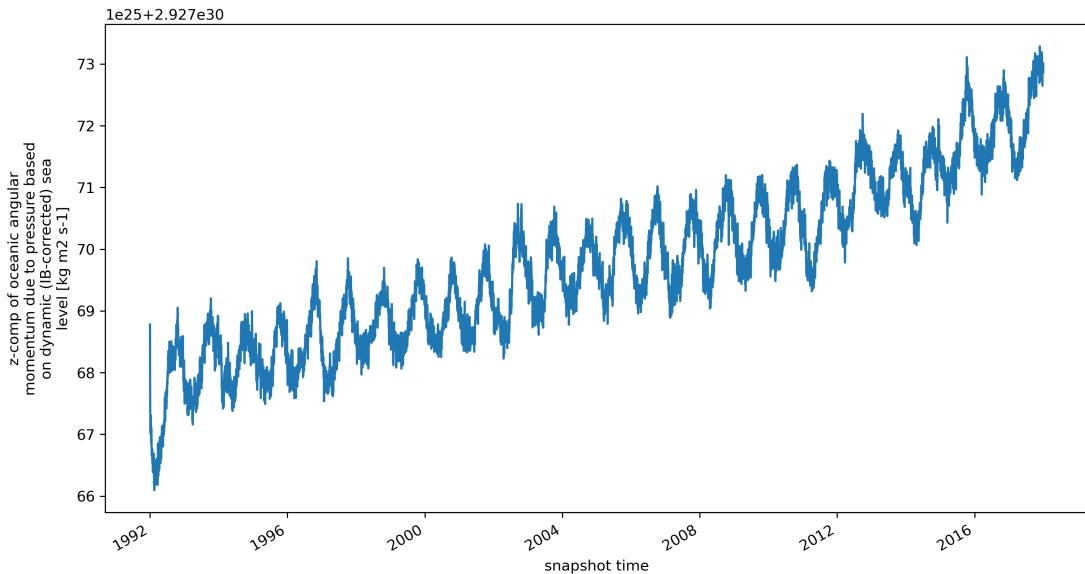
Figure 202: Dataset: SBO_CORE_PRODUCTS, Variable: zoamp

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 m ² 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 m ² s ⁻¹ zoamp_dsl: valid_min = 2.9276609546728614e+30 zoamp_dsl: valid_max = 2.9277328440911863e+30 zoamp_dsl: coordinates = time	
Comments			
N/a			

z-comp of oceanic angular momentum due to pressure based on dynamic (IB-corrected) sea level



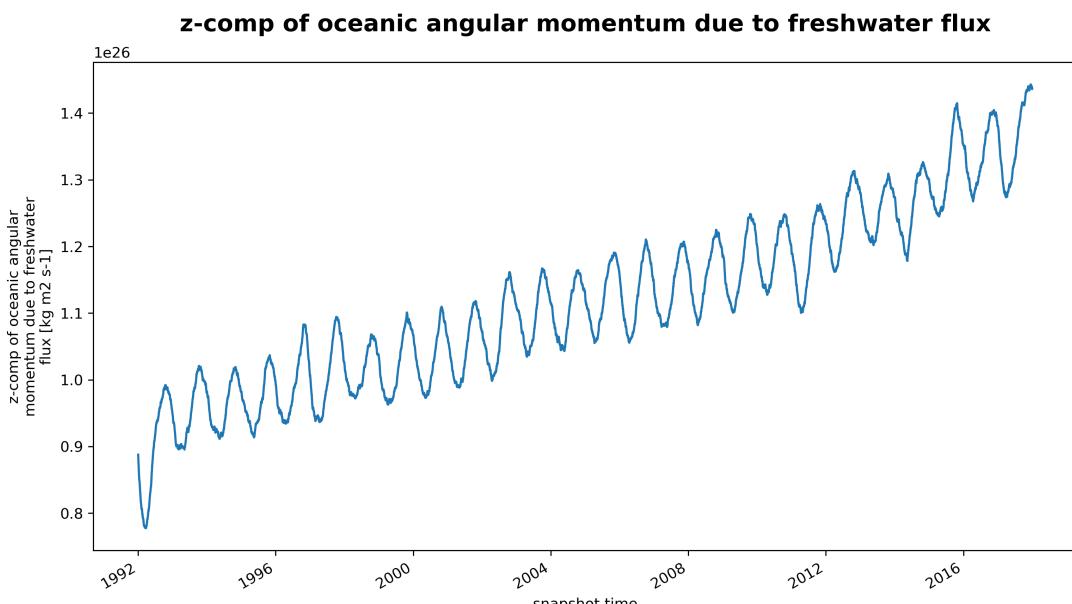
Example file: SBO_CORE_PRODUCTS_snap_ECCO_V4r4_1D.nc

Figure 203: 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 m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
N/a			



Example file: SBO_CORE_PRODUCTS_snap_ECCO_V4r4_1D.nc

Figure 204: Dataset: SBO_CORE_PRODUCTS, Variable: zoamp_fw

How to find out more about ECCO:

The final page style is on building process!!!

