

# The ECCO Data Specification (ECCO) v4r4 User Guide

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

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## The Recommended GHRSST Data Specification (GDS)

# GDS 2.0 Technical Specifications

Compiled by  
the GHRSST International Science Team 2010,  
reviewed by DAS-TAG 2011.

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## 2 Executive Summary

A new generation of integrated Sea Surface Temperature (SST) data products are being provided by the Group for High Resolution Sea Surface Temperature (GHRSST). L2 products are provided by a variety of data providers in a common format. L3 and L4 products combine, in near-real time, various SST data products from several different satellite sensors and in situ observations and maintain fine spatial and temporal resolution needed by SST inputs to a variety of ocean and atmosphere applications in the operational and scientific communities. Other GHRSST products provide diagnostic data sets and global multi-product ensemble analysis products. Retrospective reanalysis products are provided in a non real time critical offline manner. All GHRSST products have a standard format, include uncertainty estimates for each measurement, and are served to the international user community free of charge through a variety of data transport mechanisms and access points that are collectively referred to as the GHRSST Regional/Global Task Sharing (R/GTS) framework.

The GHRSST Data Specification (GDS) Version 2.0 is a technical specification of GHRSST products and services. It consists of a technical specification document (this volume) and a separate Interface Control Document (ICD). The GDS technical documents are supported by a User Manual and a complete description of the GHRSST ISO-19115-2 metadata model. GDS-2.0 represents a consensus opinion of the GHRSST international community on how to optimally combine satellite and in situ SST data streams within the R/GTS. The GDS also provides guidance on how data providers might implement SST processing chains that contribute to the R/GTS.

This document first provides an overview of GHRSST followed by detailed technical specifications of the adopted file naming specification and supporting definitions and conventions used throughout GHRSST and the technical specifications for all GHRSST Level 2P, Level 3, Level 4, and GHRSST Multi-Product Ensemble data products. In addition, the GDS 2.0 Technical Specification provides controlled code tables and best practices for identifying sources of SST and ancillary data that are used within GHRSST data files.

The GDS 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 GHRSST product conventions, GHRSST data file contents, GHRSST and Climate Forecast definitions for SST, and other useful information. For a complete discussion and access to data products and services see <https://www.ghrsst.org>, which is a central portal for all GHRSST activities.

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## 5 Tables in this document

## 6 Applicable Documents

The following documents contain requirements and information applicable to this document and must be consulted together with this document.

- [AD-1] GDS 2.0 Interface control Document (ICD), Version 1.0, available from <https://www.ghrsst.org/files/download.php?m=documents&f=110626163621-GHRSSTGDS20ICDDraft03.doc>
- [AD-2] GHRSST User's Guide available from <https://www.ghrsst.org/documents/q/category/userinteraction/> netCDF user manuals and tools available from <http://www.unidata.ucar.edu/packages/netcdf/>
- [AD-3] netCDF Climate and Forecast (CF) Metadata Conventions version 1.4 available from <http://cf-pcmdi.llnl.gov/documents/cf-conventions/1.4/cf-conventions-multi.html>
- [AD-4] COARDS Conventions available from [http://ferret.wrc.noaa.gov/noaa/\\_coop/coop\\_cdf\\_profile.html](http://ferret.wrc.noaa.gov/noaa/_coop/coop_cdf_profile.html)
- [AD-5] UDUNITS-2 package available from <http://www.unidata.ucar.edu/software/udunits/udunits2/udunits2.html>

## 7 Reference Documents

The following documents can be consulted when using this document as they contain relevant information:

- [RD-1] GHRSST PP Data Product User manual (GDS1.5) <https://www.ghrsst.org/files/download.php?m=documents&f=GHRSST-PP-Product-UserGuide-v1.1.pdf>.
- [RD-2] Donlon, C. J., I. Robinson, K. S Casey, J. Vazquez-Cuervo, E Armstrong, O. Arino, C. Gentemann, D. May, P. LeBorgne, J. Piolle, I. Barton, H Beggs, D. J. S. Poulter, C. J. Merchant, A. Bingham, S. Heinz, A Harris, G. Wick, B. Emery, P. Minnett, R. Evans, D. Llewellyn-Jones, C. Mutlow, R. Reynolds, H. Kawamura and N. Rayner, 2007. The Global Ocean Data Assimilation Experiment (GODAE) high Resolution Sea Surface Temperature Pilot Project (GHRSST-PP). Bull. Am. Meteorol. Soc., Vol. 88, No. 8, pp. 1197-1213, (DOI:10.1175/BAMS-88-8-1197).
- [RD-3] Donlon, C. J., I. Robinson, K. S Casey, J. Vazquez-Cuervo, E Armstrong, O. Arino, C. Gentemann, D. May, P. LeBorgne, J. Piolle, I. Barton, H Beggs, D. J. S. Poulter, C. J. Merchant, A. Bingham, S. Heinz, A Harris, G. Wick, B. Emery, P. Minnett, R. Evans, D. Llewellyn-Jones, C. Mutlow, R. Reynolds, H. Kawamura and N. Rayner, 2009. The Global Ocean Data Assimilation Experiment (GODAE) high Resolution Sea Surface Temperature Pilot Project (GHRSST-PP). Oceanography, Vol. 22, No. 3
- [RD-4] Donlon, C. J., P. Minnett, C. Gentemann, T. J. Nightingale, I. J. Barton, B. Ward and, J. Murray, 2002. Towards Improved Validation of Satellite Sea Surface Skin Temperature Measurements for Climate Research, J. Climate, Vol. 15, No. 4, pp. 353-369.
- [RD-5] Donlon, C. J. and the GHRSST-PP Science Team, 2006. The GHRSST-PP User Requirement Document, available from the International GHRSST Project Office, <https://www.ghrsst.org/files/download.php?m=documents&f=GHRSST-PP-URD-v1.7.pdf>

## 8 Acryonyms and abbreviation list

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

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

## 9 Document Conventions

The following sub-sections describe the notation conventions and data storage types that are used throughout this GDS 2.0 Technical Specification. Implementation projects are expected to adhere to the nomenclature and style of the GDS 2.0 in their own documentation as much as possible to facilitate international coordination of documentation describing the data products and services within the GHRSST R/GTS framework [RD-2].

### 9.1 Use of text types

The following text types are used throughout this document:

**Table 9.1: Definition of text styles used in the GDS**

Text Type	Meaning	Example
Bold Courier font	Denotes a variable name	dt_analysis
Bold Courier font	Denotes a netCDF attribute name	gds_version_id
Arial	Denotes regular text.	This is normal text.

### 9.2 Use of colour in tables

The colours defined in Table 4-2 are used throughout the GDS.

**Table 9.2: Definition of colour styles used in the GDS**

Colour	Meaning	Example
Grey	Denotes a table column name	Variable
Blue	Denotes a mandatory item	analysed_sst
Violet	Denotes an item mandatory for only certain situations	dt_analysis
Yellow	Denotes an optional item	experimental_field
Green	Denotes grid dimensions	ni=1024
Pink	Denotes grid coordinates	float lat(nj, ni)

### 9.3 Definitions of storage types within the GDS 2.0

Computer storage types referred to in the GDS are defined in Table 4-3 and follow those used in netCDF.

**Table 9.3: Storage type definitions used in the GDS**

Name	Storage Type
byte	8 bit signed integer
short	16 bit signed integer
int (or long)	32 bit signed integer
float	32 bit floating point
double	64 bit floating point
string	Character string

## 10 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.

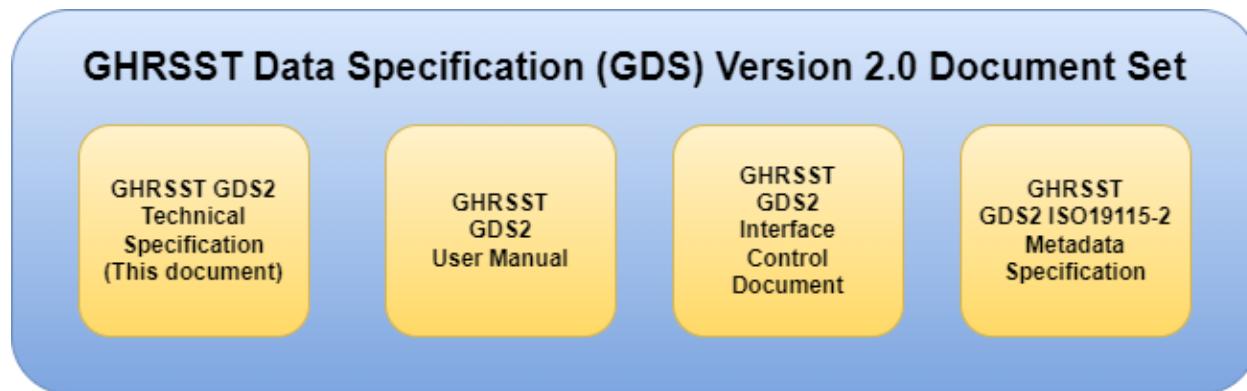


Figure 1: Schematic overview of the GHRSST Data Specification Version 2.0 document pack.

## 11 Overview of GHRSST and the GDS 2.0

GHRSST [RD-2] is an international consortium representing commercial enterprises, academic institutions, research organizations, and operational agencies that collaborate to provide accurate, high resolution, and consistently formatted SST observations and analyses from space-based platforms. This section briefly provides information on the importance of SST, an overview and history of GHRSST, and context for understanding the GDS 2.0.

### 11.1 The Importance of SST

Sea Surface Temperature at the ocean-atmosphere interface is a fundamental variable for understanding, monitoring and predicting fluxes of heat, momentum and gas at a variety of scales that determine complex interactions between atmosphere and ocean. The ocean stores heat from the sun and redistributes it from the tropical regions to higher latitudes and to the less dense atmosphere regulating global weather and climate. Through the hydrological cycle the coupled system controls terrestrial life by redistributing fresh water over the land surface. From large ocean gyres and atmospheric circulation cells that fuel atmospheric depression systems, storms and hurricanes with their attendant wind waves and storm surges, to local scale phenomena such as the generation of sea breezes and convection clouds, SST at the ocean-atmosphere interface has a significant societal impact.

Accurate knowledge of global SST distribution and temporal variation at finer spatial resolution is needed as a key input to numerical weather prediction (NWP) and numerical ocean prediction (NOP) systems to constrain the modelled upper-ocean circulation and thermal structure at daily, seasonal, decadal and climatic time scales, for the exchange of energy between the ocean and atmosphere in coupled ocean-atmosphere models, and as boundary conditions for ocean forecasting models. Such models are widely used operationally for various applications including maritime safety, military operations, ecosystem assessments, fisheries support, and tourism.

In addition, well-defined and quantified error estimates of SST are also required for climate time series that can be analysed to reveal the role of the ocean in short and long term climate variability. A 30 year record of satellite SST observations is available now, that grows on a daily basis. SST climate data records that are used to provide the GCOS SST Essential Climate Variable (ECV) [RD7], [RD-11], [RD-12] are essential to monitoring and understanding climate variability, climate-ecosystem interactions such as coral reef health and sustainable fisheries management, and critical issues like sea level rise and changing sea ice patterns.

### 11.2 GHRSST History

In 1998, SST data production was considered a mature component of the observing system with demonstrated capability and data products. However, SST product availability was limited to a few data sets that were large, scientific in format and difficult to exchange in a near real time manner. Product accuracy was considered insufficient for the emerging NWP and NOP systems. Uncertainty estimates for SST products were unavailable with SST products complicating their application by the NWP and NOP data assimilation community. At the same time the number of applications requiring an accurate high resolution SST data stream was growing.

Considering these issues, the Global Ocean Data Assimilation Experiment (GODAE) [RD-10] defined the minimum data specification required for use in operational ocean models, stating that SST observations with global coverage, a spatial resolution of 10 km and an accuracy of <0.4 K need to be updated every six hours [RD-10].

Despite the network of SST observations from ships and buoys, the only way to achieve these demanding specifications was to make full use of space-based observations. An integrated and international approach was sought to improve satellite SST measurements, based on four principles:

1. Respond to user SST requirements through a consensus approach
2. Organize activities according to principles of shared responsibility and subsidiarity, handling matters with the lowest, smallest, or least centralized competent group possible

3. Develop complementarities between independent measurements from earth observation satellites and in situ sensors
4. Maximize synergy benefits of an integrated SST measurement system and end-to-end user service

These foundations enabled the international ocean remote sensing community, marine meteorologists, Space Agencies, and ocean modellers to combine their energies to meet the GODAE requirements by establishing the GODAE High Resolution Sea Surface Temperature Pilot Project (GHRSST-PP). GHRSST-PP established four main tasks relevant to the development of the SST observing system:

1. Improve SST data assembly/delivery
2. Test available SST data sources
3. Perform inter-comparison of SST products
4. Develop applications and data assimilation of SST to demonstrate the benefit of the improved observing system

GHRSST-PP successfully demonstrated that the requirements of GODAE could be met when significant amounts of GHRSST-PP data became available in 2006, and was instrumental in defining the shape and form of the modern-era SST measurement system and user service over the last 10 years [RD-2].

At the end of the GODAE period in 2009, the GHRSST-PP evolved into the Group for High Resolution SST (GHRSST). GHRSST built on the successes of the pilot project phase and continued a series of international workshops that were held during 2000–2009. These workshops established a set of user requirements for all GHRSST activities in five areas:

1. Scientific development and applications,
2. Operational agency requirements,
3. SST product specifications,
4. Programmatic organization of an international SST service,
5. Developing scientific techniques to improve products and exploit the observing system.

These requirements were critical to establishing the GHRSST framework and work plan, and formed an essential part of the GHRSST evolution. By establishing and documenting clear requirements in a consultative manner at the start of the project and through all stages of its development, GHRSST was able to develop confidently and purposefully to address the needs of the international SST user community

### 11.3 GHRSST Organization

Over the last decade, GHRSST established and now continues to provide an internationally distributed suite of user focused services in a sustained Regional/Global Task Sharing (R/GTS) framework [RD-2] that addresses international organizational challenges and recognizes the implementing institutional capacities, capabilities, and funding prospects. Long term stewardship, user support and help services, and standards-based data management and interoperability have been developed and are operated within the R/GTS on a daily basis.

GHRSST data flow from numerous Regional Data Assembly Centres (RDACs) to a Global Data Assembly Centre (GDAC) in near real time. Thirty days after observation, the data are transferred to a Long Term Stewardship and Reanalysis Facility (LTSRF). At present, RDACs from across Europe, Japan, Australia, and the United States contribute GHRSST data to the GDAC, operated by the NASA Jet Propulsion Laboratory, which in turn provides

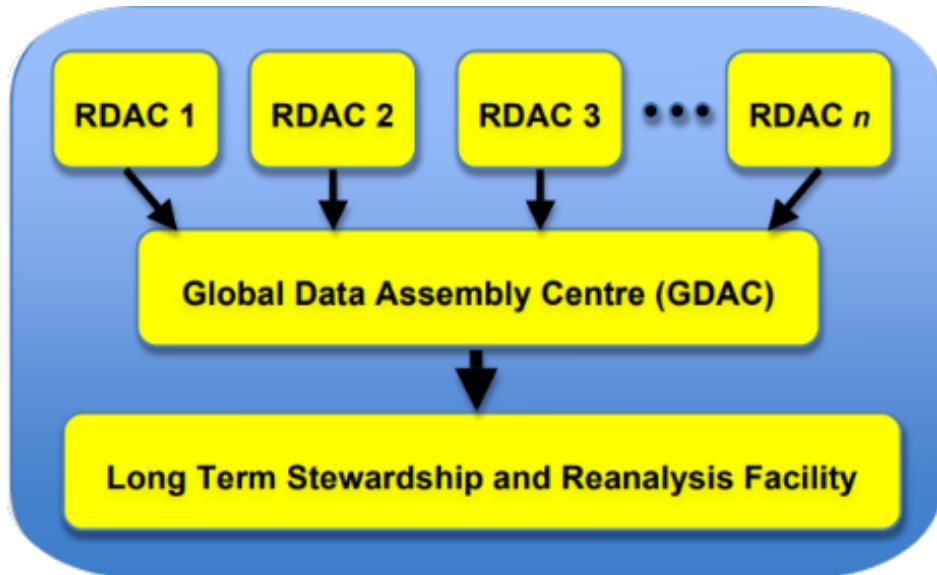


Figure 2: Schematic of the GHRSSST Regional/Global Task Sharing (R/GTS) framework.

the data to the LTSRF operated by the NOAA National Oceanographic Data Center. The GHRSSST R/GTS is shown schematically below in 2.

Since large-scale GHRSSST data production and dissemination commenced in 2006, the GHRSSST GDAC and LTSRF have combined to provide over 50,000 users more than 100 terabytes of GHRSSST data. Over 28 terabytes of data are in NODC's LTSRF holdings with another approximately 10 Terabyte added each year. The detailed interactions of the R/GTS components are described in the GHRSSST Interface Control Document [AD-1]. Each component of the R/GTS is independently managed and operated by different institutions and agencies. The R/GTS itself is coordinated by the international GHRSSST Science Team, which receives guidance and advice from the GHRSSST Advisory Council. A GHRSSST Project Office coordinates the overall framework. A full discussion of GHRSSST over the last 10 years is reported in [RD-2] and [RD-3].

## 11.4 Overview of the GDS 2.0

The GHRSSST R/GTS was made possible through the establishment of a rigorous GHRSSST Technical Data Specification (GDS), which instructed international satellite data providers on how to process satellite data streams, defined the format and content of the data and metadata, and documented the basic approaches to providing uncertainty estimates and auxiliary data sets. The GHRSSST-PP established the first GDS (v1.6) [RD-1], which formed the basis of all GHRSSST data production from 2005 through 2011. In 2010 the Version 2 of the GDS described in this document will go into operations following a phased implementation schedule.

All GHRSSST products entering the R/GTS must strictly follow the common GDS when generating L2P, L3, L4, and GMPE data. As a result, users with common tools to read data from one RDAC can securely use data from any of the others as well as the GDAC and LTSRF without a need to re-code. Table 6-1 provides a summary of GDS 2.0 data products and their basic characteristics.

The remainder of this document provides the detailed specifications for GHRSSST L2P, L3, L4, and GMPE products, their file naming convention, metadata requirements, and all necessary tables, conventions, and best practices for creating and using GHRSSST data.

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## 12 GDS 2.0 Filenames and Supporting Conventions

Striving to achieve a flexible naming convention that maintains consistency across processing levels and better serves user needs, the GDS 2.0 uses a single form for all GHRSST data files. An overview of the format is presented below in Section 7.1 along with example filenames. Details on each of the filename convention components are provided in Sections 7.2 through 7.8.

In addition, a best practice has been established for creating character strings used to describe GHRSST SST products and sources of ancillary data. These strings, and associated numeric codes for the SST products, are used within some GHRSST data files but are not part of the filename convention itself. The best practice is described in Section 7.9.

### 12.1 1 Overview of Filename Convention and Example Filenames

The filenaming convention for the GDS 2.0 is shown below.

```
<Indicative Date><Indicative Time>-<RDAC>-<Processing Level>_GHRSST-<SST Type>- <Product String>-<Additional Segregator>-v<GDS Version>-fv<File Version>.<File Type>
```

The variable components within braces (“<>”) are summarized in Table 7-1 below and detailed in the **should not** be used in any GHRSST code or the <Additional Segregator> element. Example filenames are given later in this section. While no strict limit to filename length is mandated, RDACs are encouraged to keep the length to less than 240 characters to increase readability and usability.

**Table 12.1: GDS 2.0 Filenaming convention components**

Name	Definition	Description
<Indicative Date>	YYYYMMDD	The identifying date for this data set. See Section 7.2.
<Indicative Time>	HHMMSS	The identifying time for this data set. The time used is dependent on the <Processing Level> of the data set: L2P: start time of granule <ul style="list-style-type: none"> <li>• L3U: start time of granule</li> <li>• L3C and L3S: centre time of the collation window</li> <li>• L4 and GMPE: nominal time of analysis</li> </ul> All times should be given in UTC. See Section 7.3.
<RDAC>	The RDAC where the file was created	The Regional Data Assembly Centre (RDAC) code, listed in Section 7.4.
<Processing Level>	The data processing level code (L2P, L3U, L3C, L3S, or L4)	The data processing level code, defined in Section 7.5.
<SST Type>	The type of SST data included in the file.	Conforms to the GHRSST definitions for SST, defined in Section 7.6
<Product String>	A character string identifying the SST product set. The string is used uniquely within an RDAC but may be shared across RDACs.	The unique “name” within an RDAC of the product line. See Section 7.7 for the product string lists, one each for L2P, L3, L4, and GMPE products. See Section 7.7.
<Additional Segregator>	Optional text to distinguish between files with the same <Product String>. Dashes are not allowed within this element.	This text is used since the other filename components are sometimes insufficient to uniquely identify a file. For example, in L2P or L3U (un-collated) products this is often the original file name or processing algorithm. Note, underscores should be used, not dashes. For L4 files, this element should begin with the appropriate regional code as defined in Section 7.8. This component is optional but must be used in those cases where non-unique filenames would otherwise result.
<GDS Version>	nn.n	Version number of the GDS used to process the file. For example, GDS 2.0 = “02.0”.

<File Version>	xx.x	Version number for the file, for example, "01.0".
<File Type>	netCDF data file suffix (nc) or ISO metadata file suffix (xml)	Indicates this is a netCDF file containing data or its corresponding ISO-19115 metadata record in XML.

### 12.1.1 L2\_GHRSST Filename Example

20070503132300-NAVO-L2P\_GHRSST-SSTblend-AVHRR17\_L-SST\_s0123\_e0135-v02.0-fv01.0.nc

The above file contains GHRSST L2P blended SST data for 03 May 2007, from AVHRR LAC data collected from the NOAA-17 platform. The granule begins at 13:23:00 hours. It is version 1.0 of the file and was produced by the NAVO RDAC in accordance with the GDS 2.0. The <Additional Segregator> text is "SST\_s0123\_e0135".

### 12.1.2 L3\_GHRSST Filename Example

20070503110153-REMSS-L3C\_GHRSST-SSTsubskin-TMI-tmi\_20070503rt-v02.0-fv01.0.nc

The above file was produced by the REMSS RDAC and contains collated L3 sub-skin SST data from the TMI instrument for 03 May 2007. The collated file has a centre time of at 11:01:53 hours. It is version 1.0 of the file and was produced according to GDS 2.0 specifications. Its <Additional Segregator> text is "tmi\_20070503rt".

### 12.1.3 L4\_GHRSST Filename Example

20070503120000-UKMO-L4\_GHRSST-SSTfnd-OSTIA-GLOB-v02.0-fv01.0.nc

The above file contains L4 foundation SST data produced at the UKMO RDAC using the OSTIA system. It is global coverage, contains data for 03 May 2007, was produced to GDS 2.0 specifications and is version 1.0 of the file. The nominal time of the OSTIA analysis is 12:00:00 hours.

## 12.2 <Indicative Date>

The identifying date for this data set, using the format YYYYMMDD, where YYYY is the four-digit year, MM is the two-digit month from 01 to 12, and DD is the two-digit day of month from 01 to 31. The date used should best represent the observation date for the dataset.

## 12.3 <Indicative Time>

The identifying time for this data set in UTC, using the format HHMMSS, where HH is the two-digit hour from 00 to 23, MM is the two-digit minute from 00 to 59, and SS is the two-digit second from 00 to 59. The time used is dependent on the <Processing Level> of the data set:

L2P: start time of granule

L3U: start time of granule

L3C and L3S: centre time of the collation window

L4 and GMPE: nominal time of analysis

All times should be given in UTC and should be chosen to best represent the observation time for this dataset. Note: RDACs should ensure the applications they use to determine UTC properly account for leap seconds.

## 12.4 <RDAC>

Codes used for GHRSST Regional Data Assembly Centres (RDACs) are provided in the table below. New codes are assigned by the GHRSST Data And Systems Technical Advisory Group (DAS-TAG) and entered into the table upon agreement by the GDAC, LTSRF, and relevant RDACs.

**Table 12.2: Regional Data Assembly Centre (RDAC) code table**

RDAC Code	GHRSST RDAC Name
ABOM	Australian Bureau of Meteorology
CMC	Canadian Meteorological Centre
DMI	Danish Meteorological Institute
EUR	European RDAC
GOS	Gruppo di Oceanografia da Satellite
JPL	JPL Physical Oceanography Distributed Active Archive Center
JPL_OUROCEAN	JPL OurOcean Project
METNO	Norwegian Meteorological Institute
MYO	MyOcean
NAVO	Naval Oceanographic Office
NCDC	NOAA National Climatic Data Center
NEODAAS	NERC Observation Data Acquisition and Analysis Service
NOC	National Oceanography Centre, Southampton
NODC	NOAA National Oceanographic Data Center
OSDPD	NOAA Office of Satellite Data Processing and Distribution
OSISAF	EUMETSAT Ocean and Sea Ice Satellite Applications Facility
REMSS	Remote Sensing Systems, CA, USA
RSMAS	University of Miami, RSMAS
UKMO	UK Meteorological Office
UPA	United Kingdom Multi-Mission Processing and Archiving Facility
ESACCI	ESA SST Climate Change Initiative
JAXA	Japan Aerospace Exploration Agency
New codes	Please contact the GHRSST international Project Office if you require new codes to be included in future revisions of the GDS.

## 12.5 <Processing Level>

Satellite data processing level definitions can lead to ambiguous situations, especially regarding the distinction between L3 and L4 products. GHRSST identified the use of analysis procedures to fill gaps where no observations exist to resolve this ambiguity. Within GHRSST filenames, the <Processing Level> codes are shown below in Table 7-3. GHRSST currently establishes standards for L2P, L3U, L3C, L3S, and L4 (GHRSST Multi-Product Ensembles known as GMPE are a special kind of L4 product for which GHRSST also provides standards).

## 13 GDS 2.0 Data Product File Structure

### 13.1 Overview of the GDS 2.0 netCDF File Format

GDS 2.0 data files preferentially use the **netCDF-4 Classic** format. However, as netCDF-4 is a relatively new format and includes a significant number of new features that may not be well supported by existing user applications and tools, the GHRSST Science Team agreed to support both netCDF-3 and netCDF-4 format data files during a transition period. At the 11th GHRSST Science Team meeting, Lima Peru, 21-25th June 2010 it was agreed that the transition period would end in 2013 at which point (subject to positive developments in the user community using netCDF-4) the use of netCDF-3 format data products will cease within the GHRSST R/GTS framework. **NetCDF-3 data products shall be delivered to the GDAC with an accompanying MMR file records as described in Section 13.** While netCDF-3 can store the metadata, it is computationally expensive to extract it from externally-compressed netCDF-3 files. A major advantage to the use of NetCDF-4 format products from the producer's perspective is that no additional metadata records are required when using this format since the GDAC and LTSRF can easily extract it from the files without having to decompress the entire file.

These GDS 2.0 formatted data sets must comply with the Climate and Forecast (CF) Conventions, v1.4 [AD-3] or later because these conventions provide a practical standard for storing oceanographic data in a robust, easily-preserved for the long-term, and interoperable manner. The CF-compliant netCDF data format is flexible, self-describing, and has been adopted as a de facto standard for many operational and scientific oceanography systems. Both netCDF and CF are actively maintained including significant discussions and inputs from the oceanographic community (see [http://cfpcmdi.1lnl.gov/discussion/index\\_html](http://cfpcmdi.1lnl.gov/discussion/index_html)). The CF convention generalizes and extends the Cooperative Ocean/Atmosphere Research Data Service (COARDS, [AD-4]) Convention but relaxes the COARDS constraints on dimension order and specifies methods for reducing the size of datasets. The purpose of the CF Conventions is to require conforming datasets to contain sufficient metadata so that they are self-describing, in the sense that each variable in the file has an associated description of what it represents, physical units if appropriate, and that each value can be located in space (relative to earthbased coordinates) and time. In addition to the CF Conventions, GDS 2.0 formatted files follow some of the recommendations of the Unidata Attribute Convention for Dataset Discovery (ACDD, [AD-7]).

In the context of netCDF, a variable refers to data stored in the file as a vector or as a multidimensional array. Each variable in a GHRSST netCDF file consists of a 2-dimensional [ $i \times j$ ], 3- dimensional [ $i \times j \times k$ ], or 4-dimensional [ $i \times j \times k \times l$ ] array of data. The dimensions of each variable must be explicitly declared in the dimension section.

Within the netCDF file, global attributes are used to hold information that applies to the whole file, such as the data set title. Each individual variable must also have its own attributes, referred to as variable attributes. These variable attributes define, for example, an offset, scale factor, units, a descriptive version of the variable name, and a fill value, which is used to indicate array elements that do not contain valid data. Where applicable, SI units should be used and described by a character string, which is compatible with the Unidata UDUNITS-2 package [AD-5].

All GHRSST GDS 2.0 files conform to this structure and share a common set of netCDF global attributes. These global attributes include those required by the CF Convention plus additional ones required by the GDS 2.0. The required set of global attributes is described in Section 8.2 and entities within the GHRSST R/GTS framework are free to add their own, as long as they do not contradict the GDS 2.0 and CF requirements.

Following the CF convention, each variable also has a set of variable attributes. The required variable attributes are described in Section 8.3. In a few cases, some of these variable attributes may not be relevant for certain variables or additional variable attributes may be required. In those cases, the variable descriptions in each of the L2P, L3, L4, and GMPE product specifications (Sections 9, 10, 11, and 12) will identify the differences and specify requirements for each product. As with the global attributes, entities within the GHRSST R/GTS framework are free to add their own variable attributes, as long as they do not contradict the GDS 2.0 and CF requirements.

While the exact volumes can vary, an average L2P file will use about 33 bytes per pixel, an L3 file 28 bytes per pixel, and an L4 file about 8 bytes per pixel. The data type encodings for each variable are fixed except for the experimental fields, which are flexible and can chosen by the producing RDAC.

### 13.2 GDS 2.0 netCDF Global Attributes

Table 8-1 below summarizes the global attributes that are mandatory for every GDS 2.0 netCDF data file. More details on the CF-mandated attributes (as indicated in the Source column) are available at: <http://cf-pcmdi.1lnl.gov/documents/cf-conventions/1.4/cf-conventions.html#attribute-appendix> and information on the ACDD recommendations is available at <http://www.unidata.ucar.edu/software/netcdf-java/formats/DataDiscoveryAttConvention.html>.

**Table 13.1: Mandatory global attributes for GDS 2.0 netCDF data files**

Global Attribute Name	Type	Description	Source
acknowledgement	string	A place to acknowledge various types of support for the project that produced this data.	ACDD
cdm_data_type	string	The data type, as derived from Unidata's Common Data Model Scientific Data types and understood by THREDDS. (This is a THREDDS "dataType", and is different from the CF NetCDF attribute 'featureType', which indicates a Discrete Sampling Geometry file in CF.)	ACDD
comment	string	Miscellaneous information about the data, not captured elsewhere. This attribute is defined in the CF Conventions.	CF, ACDD
conventions	string	A text string identifying the netCDF conventions followed (e.g., CF-1.4, ACDD 1-3).	
creator_email	string	The email address of the person (or other creator type specified by the creator_type attribute) principally responsible for creating this data.	ACDD
creator_name	string	The name of the person (or other creator type specified by the creator_type attribute) principally responsible for creating this data.	ACDD
creator_url	string	The URL of the of the person (or other creator type specified by the creator_type attribute) principally responsible for creating this data.	ACDD
date_created	string	The date on which this version of the data was created.	ACDD
easternmost_longitude	float	Decimal degrees east, range -180 to +180. This is equivalent to ACDD geospatial_lon_max.	podaac
geospatial_lat_resolution	float	Latitude Resolution in units matching geospatial_lat_units.	ACDD
geospatial_lat_units	string	Units of the latitudinal resolution. Typically "degrees_north"	ACDD
geospatial_lon_resolution	float	Longitude Resolution in units matching geospatial_lon_resolution	ACDD
geospatial_lon_units	string	Units of the longitudinal resolution. Typically "degrees_east"	ACDD
history	string	The name of the institution principally responsible for originating this data. This attribute is recommended by the CF convention.	CF, ACDD
id	string	An identifier for the data set, provided by and unique within its naming authority. The combination of the "naming authority" and the "id" should be globally unique, but the id can be globally unique by itself also. IDs can be URLs, URNs, DOIs, meaningful text strings, a local key, or any other unique string of characters. The id should not include white space characters.	ACDD
institutions	string	The name of the institution principally responsible for originating this data. This attribute is recommended by the CF convention.	CF, ACDD
keywords	string	GCMD Science Keyword(s)	ACDD
keywords_vocabulary	string	The unique name or identifier of the vocabulary from which keywords are taken. e.g., the NASA Global Change Master Directory (GCMD) Science Keywords.	ACDD
license	string	Provide the URL to a standard or specific license, enter "Freely Distributed" or "None", or describe any restrictions to data access and distribution in free text.	ACDD
Metadata_Conventions	string	A comma-separated list of the conventions that are followed by the dataset.	ACDD
metadata_link	string	Link to collection metadata record at archive	ACDD

**Table 13.1: Mandatory global attributes for GDS 2.0 netCDF data files**

naming_authority	string	The organization that provides the initial id (see above) for the dataset. The naming authority should be uniquely specified by this attribute via reverse-DNS naming convention.	ACDD
netcdf_version_id	string	Version of netCDF libraries used to create this file. For example, "4.1.1"	GDS
northernmost_latitude	float	Decimal degrees north, range -90 to +90. This is equivalent to ACDD geospatial_lat_max.	GDS
processing_level	string	A textual description of the processing (or quality control) level of the data.	ACDD & GDS
product_version	string	The product version of this data file	GDS
project	string	The name of the project(s) principally responsible for originating this data.	ACDD
publisher_email	string	The email address of the person (or other entity specified by the publisher_type attribute) responsible for publishing the data file or product to users, with its current metadata and format.	ACDD
publisher_name	string	The name of the person (or other entity specified by the publisher_type attribute) responsible for publishing the data file or product to users, with its current metadata and format.	ACDD
publisher_url	string	The URL of the person (or other entity specified by the publisher_type attribute) responsible for publishing the data file or product to users, with its current metadata and format.	ACDD
references	string	Published or web-based references that describe the data or methods used to produce it. Recommend URIs (such as a URL or DOI) for papers or other references. This attribute is defined in the CF conventions.	ACDD
source	string	Method of production of the original data.	CF
southernmost_latitude	float	Decimal degrees north, range -90 to +90. This is equivalent to ACDD geospatial_lat_min.	GDS
spatial_resolution	string	A string describing the approximate resolution of the product.	GDS
standard_name_vocabulary	string	The name and version of the controlled vocabulary from which variable standard names are taken.	ACDD
start_time	string	Representative date and time of the end of the granule in the ISO 8601 compliant format of "yyyymmddThh-mmssZ".	GDS
stop_time	string	Representative date and time of the end of the granule in the ISO 8601 compliant format of "yyyymmddThh-mmssZ".	GDS
summary	string	A paragraph describing the dataset, analogous to an abstract for a paper.	ACDD
time_coverage_end	string	Identical to stop_time. Included for increased ACDD compliance.	ACDD
time_coverage_start	string	Identical to start_time. Included for increased ACDD compliance.	ACDD
title	string	A short phrase or sentence describing the dataset. In many discovery systems, the title will be displayed in the results list from a search, and therefore should be human readable and reasonable to display in a list of such names. This attribute is recommended by the NetCDF Users Guide (NUG) and the CF conventions.	CF, ACDD

**Table 13.1: Mandatory global attributes for GDS 2.0 netCDF data files**

uuid	string	A Universally Unique Identifier (UUID). Numerous, simple tools can be used to create a UUID, which is inserted as the value of this attribute. See <a href="http://en.wikipedia.org/wiki/Universally_Unique_Identifier">http://en.wikipedia.org/wiki/Universally_Unique_Identifier</a> for more information and tools.	GDS
westernmost_longitude	float	Decimal degrees east, range -180 to +180. This is equivalent to ACDD geospatial_lon_min.	GDS

### 13.3 GDS 2.0 netCDF Variable Attributes

**Table 13.2: Table 8-2. Variable attributes for GDS 2.0 netCDF data files**

Variable Name	Attribute	Format	Description	Source
_FillValue	Must be the same as the variable type		A value used to indicate array elements containing no valid data. This value must be of the same type as the storage (packed) type; should be set as the minimum value for this type. Note that some netCDF readers are unable to cope with signed bytes and may, in these cases, report fill as 128. Some cases will be reported as unsigned bytes 0 to 255. Required for the majority of variables except mask and l2p_flags.	CF
units	string		Text description of the units, preferably S.I., and must be compatible with the Unidata UDUNITS-2 package [AD-5]. For a given variable (e.g. wind speed), these must be the same for each dataset. Required for the majority of variables except mask, quality_level, and l2p_flags.	CF, ACDD
scale_factor	Must be expressed in the unpacked data type		To be multiplied by the variable to recover the original value. Defined by the producing RDAC. Valid values within {value_min} and {valid_max} should be transformed by {scale_factor} and {add_offset}, otherwise skipped to avoid floating point errors.	CF
add_offset	Must be expressed in the unpacked data type		To be added to the variable after multiplying by the scale factor to recover the original value. If only one of {scale_factor} or {add_offset} is needed, then both should be included anyway to avoid ambiguity, with {scale_factor} defaulting to 1.0 and add_offset defaulting to 0.0. Defined by the producing RDAC.	CF
long_name	string		A free-text descriptive variable name.	CF, ACDD
valid_min	Expressed in same data type as variable		Minimum valid value for this variable once they are packed (in storage type). The fill value should be outside this valid range. Note that some netCDF readers are unable to cope with signed bytes and may, in these cases, report valid min as 129. Some cases as unsigned bytes 0 to 255. Values outside of {valid_min} and {valid_max} will be treated as missing values. Required for all variables except variable time.	CF
valid_max	Expressed in same data type as variable		Maximum valid value for this variable once they are packed (in storage type). The fill value should be outside this valid range. Note that some netCDF readers are unable to cope with signed bytes and may, in these cases, report valid min as 127. Required for all variables except variable time.	CF

**Table 13.2: Table 8-2. Variable attributes for GDS 2.0 netCDF data files**

standard_name	string	Where defined, a standard and unique description of a physical quantity. For the complete list of standard name strings, see [AD-8]. {Do not} include this attribute if no {standard_name} exists.	CF, ACDD
comment	string	Miscellaneous information about the variable or the methods used to produce it.	CF
source	string	{For L2P and L3 files}: For a data variable with a single source, use the GHRSST unique string listed in Table 7-10 if the source is a GHRSST SST product. For other sources, following the best practice described in Section 7.9 to create the character string. If the data variable contains multiple sources, set this string to be the relevant “sources of” variable name. For example, if multiple wind speed sources are used, set {source =} sources_of_wind_speed. {For L4 and GMPE files}: follow the {source} convention used for the global attribute of the same name, but provide in the commas-separated list only the sources relevant to this variable.	CF
references	string	Published or web-based references that describe the data or methods used to produce it. Note that while at least one reference is required in the global attributes (See Table 8-1), references to this specific data variable may also be given.	CF
axis	String	For use with coordinate variables only. The attribute 'axis' may be attached to a coordinate variable and given one of the values "X", "Y", "Z", or "T", which stand for a longitude, latitude, vertical, or time axis respectively. See: <a href="http://cfpcmdi.llnl.gov/documents/cfconventions/1.4/cfconventions.html#coordinate-types">http://cfpcmdi.llnl.gov/documents/cfconventions/1.4/cfconventions.html#coordinate-types</a>	CF
positive	String	For use with a vertical coordinate variables only. May have the value "up" or "down". For example, if an oceanographic netCDF file encodes the depth of the surface as 0 and the depth of 1000 meters as 1000 then the axis would set positive to "down". If a depth of 1000 meters was encoded as -1000, then positive would be set to "up". See the section on vertical-coordinate in [AD-3]	CF
coordinates	String	Identifies auxiliary coordinate variables, label variables, and alternate coordinate variables. See the section on coordinate-system in [AD3]. This attribute must be provided if the data are on a non-regular lat/lon grid (map projection or swath data).	CF
grid_mapping	String	Use this for data variables that are on a projected grid. The attribute takes a string value that is the name of another variable in the file that provides the description of the mapping via a collection of attached attributes. That named variable is called a grid mapping variable and is of arbitrary type since it contains no data. Its purpose is to act as a container for the attributes that define the mapping. See the section on mappings-and-projections in [AD-3]	CF
flag_mappings	String	Space-separated list of text descriptions associated in strict order with conditions set by either flag_values or flag_masks. Words within a phrase should be connected with underscores.	CF

**Table 13.2: Table 8-2. Variable attributes for GDS 2.0 netCDF data files**

flag_values	Must be the same as the variable type	Comma-separated array of valid, mutually exclusive variable values (required when the bit field contains enumerated values; i.e., a “list” of conditions). Used primarily for {quality_level} and “{sources_of_xxx}” variables.	CF
flag_masks	Must be the same as the variable type	Comma-separated array of valid variable masks (required when the bit field contains independent Boolean conditions; i.e., a bit “mask”). Used primarily for {l2p_flags} variable.  {Note: CF allows the use of both flag_masks and flag_values attributes in a single variable to create sets of masks that each have their own list of flag_values (see <a href="http://cfpcmdi.llnl.gov/documents/cfconventions/1.5/ch03s05.html#id2710752">http://cfpcmdi.llnl.gov/documents/cfconventions/1.5/ch03s05.html#id2710752</a> for examples), but this practice is discouraged.}	CF
depth	String	Use this to indicate the depth for which the SST data are valid.	GDS
height	String	Use this to indicate the height for which the wind data are specified.	GDS
time_offset	Must be expressed in the unpacked data type	Difference in hours between an ancillary field such as {wind_speed} and the SST observation time	GDS

### 13.4 GDS 2.0 coordinate variable definitions

NetCDF coordinate variables provide scales for the space and time axes for the multidimensional data arrays, and must be included for all dimensions that can be identified as spatio-temporal axes. Coordinate arrays are used to geolocate data arrays on non-orthogonal grids, such as images in the original pixel/scan line space, or complicated map projections. Required attributes are `units` and `_FillValue`. Elements of the coordinate array need not be monotonically ordered. The data type can be any and scaling may be implemented if required. `add_offset` and `scale_factor` have to be adjusted according to the sensor resolution and the product spatial coverage. If the packed values can not stand on a short, float can be used instead (multiplying the size of these variables by two).

'time' is the reference time of the SST data array. The GDS 2.0 specifies that this reference time should be extracted or computed to the nearest second and then coded as continuous UTC time coordinates in seconds from 00:00:00 UTC January 1, 1981 (which is the definition of the **GHSST** origin time, chosen to approximate the start of useful AVHRR SST data record). Note that the use of UDUNITS in GHSST implies that that calendar to be used is the default mixed Gregorian/Julian calendar.

The reference time used is dependent on the <Processing Level> of the data and is defined as follows:

- L2P: start time of granule;
- L3U: start time of granule;
- L3C and L3S: centre time of the collation window;
- L4 and GMPE: nominal time of the analysis

The coordinate variable 'time' is intended to minimize the size of the `sst_dtime` variable (e.g., see Section 9.4), which stores offsets from the reference time in seconds for each SST pixel. 'time' also facilitates aggregation of all files of a given dataset along the time axis with such tools as THREDDS and LAS.

x (columns) and y (lines) grid dimensions are referred either as 'lat' and 'lon' or as 'ni' and 'nj'. lon and lat must be used if data are mapped on a regular grid (some geostationary products). ni and nj are used if data are mapped on a non-regular grid (curvilinear coordinates) or following the sensor scanning pattern (scan line, swath). It is preferred that ni should be used for the across-track dimension and nj for the along-track dimension.

Coordinate vectors are used for data arrays located on orthogonal (but not necessarily regularly spaced) grids, such as a geographic (lat-lon) map projections. The only required attribute is `units`. The elements of a coordinate vector array should be in monotonically increasing or decreasing order. The data type can be any and scaling may be implemented if required.

A coordinate's variable (= "lon lat"): must be provided if the data are on a non-regular lat/lon grid (map projection or swath data).

A grid\_mapping (= "projection name"): must be provided if the data are mapped following a projection. Refer to the CF convention [AD-3] for standard projection names.

### 13.4.1 Native datasets

Hoc est casus simplex. Multae L3, L4, et GMPE comoediae, necnon quaedam geostationaria L2P comoediae, in ordinaria lat/lon tabula praebentur. In huiusmodi projectione, solum duo coordinate sunt requisitae et vectorum formis servari possunt. Longitudines debent variare ab -180 ad +180, id est ab 180 gradibus Occidentem ad 180 gradibus Orientem. Latitudines debent variare ab -90 ad +90, id est ab 90 gradibus Meridiem ad 90 gradibus Septentrionem. Non debet esse \_FillValue pro latitudine et longitudine, et omnes SST pixeles debent habere validum latitudinis et longitudinis valorem.

Recommendatur ut tempus dimensionem pro Level 3 et Level 4 data prodigia ut infinita specificetur. Nota quod tempus dimensio pro L2P data est stricta definita ut tempus=1 (infinita dimensio non permittitur). Hoc strictum definitum est quia L2P data sunt swath based et geospatial informatio potest mutare per consecutive tempus slabs.

In GHRSST L3 et L4 granulis, solum unum tempus dimensio (tempus=1) est, et variabilis tempus solum unum valorem habet (secunda post 1981), sed infinitum tempus dimensionem permittit netCDF instrumenta et utilitates facile concatenare (et exempli gratia, mediare) seriem de tempore consecutive GHRSST granulis. Sequens CDL exemplum dat:

```
netcdf example {
    dimensions:
        lat = 1801 ;
        lon = 3600 ;
        time = UNLIMITED ; // (strictly set to 1 for L2P)
    variables:
        ...
}
```

Pro his casibus, dimensiones et coordinae variables debent uti pro regulari lat/lon tabula, ut in Tabula 8-3 monstratur. Nullae specificae variables attributi sunt requisitae pro aliis variabilibus (ut sea\_surface\_temperature, ut in exemplo dat in Tabula 8-3).

**Table 13.3: Example CDL description of native dataset**

netcdf native example
dimensions
i = 90 i_g = 90 j = 90 j_g = 90 k = 50 k_u = 50 k_l = 50 k_p1 = 51 tile = 13 time = 1 nv = 2 nb = 4
coordinates
int32 i (i) i:axis = "X" i:long_name = "grid index in x for variables at tracer and 'v' locations" i:swap_dim = "XC" i:comment = "In the Arakawa C-grid system, tracer (e.g., THETA) and 'v' variables (e.g., VVEL) have the same x coordinate on the model grid." i:coverage_content_type = "coordinate" int32 i_g (i_g) i_g:axis = "X" i_g:long_name = "grid index in x for variables at 'u' and 'g' locations" i_g:c_grid_axis_shift = "-0.5" i_g:swap_dim = "XG"

**Table 13.3: Example CDL description of native dataset**

```

i_g:comment = "In the Arakawa C-grid system, 'u' (e.g., UVEL) and 'g' variables (e.g., XG) have the same x coordinate on
the model grid."
  i_g:coverage_content_type = "coordinate"
int32 j (j)
  j:axis = "Y"
  j:long_name = "grid index in y for variables at tracer and 'u' locations"
  j:swap_dim = "YC"
  j:comment = "In the Arakawa C-grid system, tracer (e.g., THETA) and 'u' variables (e.g., UVEL) have the same y coordinate
on the model grid."
  j:coverage_content_type = "coordinate"
int32 j_g (j_g)
  j_g:axis = "Y"
  j_g:long_name = "grid index in y for variables at 'v' and 'g' locations"
  j_g:c_grid_axis_shift = "-0.5"
  j_g:swap_dim = "YG"
  j_g:comment = "In the Arakawa C-grid system, 'v' (e.g., VVEL) and 'g' variables (e.g., XG) have the same y coordinate."
  j_g:coverage_content_type = "coordinate"
int32 k (k)
  k:axis = "Z"
  k:long_name = "grid index in z for tracer variables"
  k:swap_dim = "Z"
  k:coverage_content_type = "coordinate"
int32 k_u (k_u)
  k_u:axis = "Z"
  k_u:c_grid_axis_shift = "0.5"
  k_u:swap_dim = "Zu"
  k_u:coverage_content_type = "coordinate"
  k_u:long_name = "grid index in z corresponding to the bottom face of tracer grid cells ('w' locations)"
  k_u:comment = "First index corresponds to the bottom surface of the uppermost tracer grid cell. The use of 'u' in the
variable name follows the MITgcm convention for ocean variables in which the upper (u) face of a tracer grid cell on the logical
grid corresponds to the bottom face of the grid cell on the physical grid."
int32 k_l (k_l)
  k_l:axis = "Z"
  k_l:c_grid_axis_shift = "-0.5"
  k_l:swap_dim = "Zl"
  k_l:coverage_content_type = "coordinate"
  k_l:long_name = "grid index in z corresponding to the top face of tracer grid cells ('w' locations)"
  k_l:comment = "First index corresponds to the top surface of the uppermost tracer grid cell. The use of 'l' in the variable
name follows the MITgcm convention for ocean variables in which the lower (l) face of a tracer grid cell on the logical grid
corresponds to the top face of the grid cell on the physical grid."
int32 k_p1 (k_p1)
  k_p1:axis = "Z"
  k_p1:long_name = "grid index in z for variables at 'w' locations"
  k_p1:c_grid_axis_shift = "[-0.5 0.5]"
  k_p1:swap_dim = "Zp1"
  k_p1:comment = "Includes top of uppermost model tracer cell (k_p1=0) and bottom of lowermost tracer cell (k_p1=51)."
  k_p1:coverage_content_type = "coordinate"
int32 tile (tile)
  tile:long_name = "lat-lon-cap tile index"
  tile:comment = "The ECCO V4 horizontal model grid is divided into 13 tiles of 90x90 cells for convenience."
  tile:coverage_content_type = "coordinate"
int32 time (time)
  time:long_name = "center time of averaging period"
  time:axis = "T"
  time:bounds = "time_bnds"
  time:coverage_content_type = "coordinate"
  time:standard_name = "time"

```

Table 13.3: Example CDL description of native dataset

```
time:units = "hours since 1992-01-01T12:00:00"
time:calendar = "proleptic_gregorian"
float32 XC (tile, j, i)
    XC:long_name = "longitude of tracer grid cell center"
    XC:units = "degrees_east"
    XC:coordinate = "YC XC"
    XC:bounds = "XC_bnds"
    XC:comment = "nonuniform grid spacing"
    XC:coverage_content_type = "coordinate"
    XC:standard_name = "longitude"
float32 YC (tile, j, i)
    YC:long_name = "latitude of tracer grid cell center"
    YC:units = "degrees_north"
    YC:coordinate = "YC XC"
    YC:bounds = "YC_bnds"
    YC:comment = "nonuniform grid spacing"
    YC:coverage_content_type = "coordinate"
    YC:standard_name = "latitude"
float32 XG (tile, j_g, i_g)
    XG:long_name = "longitude of 'southwest' corner of tracer grid cell"
    XG:units = "degrees_east"
    XG:coordinate = "YG XG"
    XG:comment = "Nonuniform grid spacing. Note: 'southwest' does not correspond to geographic orientation but is used for convenience to describe the computational grid. See MITgcm documentation for details."
    XG:coverage_content_type = "coordinate"
    XG:standard_name = "longitude"
float32 YG (tile, j_g, i_g)
    YG:long_name = "latitude of 'southwest' corner of tracer grid cell"
    YG:units = "degrees_north"
    YG:coordinate = "YG XG"
    YG:comment = "Nonuniform grid spacing. Note: 'southwest' does not correspond to geographic orientation but is used for convenience to describe the computational grid. See MITgcm documentation for details."
    YG:coverage_content_type = "coordinate"
    YG:standard_name = "latitude"
float32 Z (k)
    Z:long_name = "depth of tracer grid cell center"
    Z:units = "m"
    Z:positive = "up"
    Z:bounds = "Z_bnds"
    Z:comment = "Non-uniform vertical spacing."
    Z:coverage_content_type = "coordinate"
    Z:standard_name = "depth"
float32 Zp1 (k_p1)
    Zp1:long_name = "depth of tracer grid cell interface"
    Zp1:units = "m"
    Zp1:positive = "up"
    Zp1:comment = "Contains one element more than the number of vertical layers. First element is Om, the depth of the upper interface of the surface grid cell. Last element is the depth of the lower interface of the deepest grid cell."
    Zp1:coverage_content_type = "coordinate"
    Zp1:standard_name = "depth"
float32 Zu (k_u)
    Zu:units = "m"
    Zu:positive = "up"
    Zu:coverage_content_type = "coordinate"
    Zu:standard_name = "depth"
    Zu:long_name = "depth of the bottom face of tracer grid cells"
```

**Table 13.3: Example CDL description of native dataset**

Zl:comment = "First element is -10m, the depth of the bottom face of the first tracer grid cell. Last element is the depth of the bottom face of the deepest grid cell. The use of 'u' in the variable name follows the MITgcm convention for ocean variables in which the upper (u) face of a tracer grid cell on the logical grid corresponds to the bottom face of the grid cell on the physical grid. In other words, the logical vertical grid of MITgcm ocean variables is inverted relative to the physical vertical grid."
float32 Zl (k_l) Zl:units = "m" Zl:positive = "up" Zl:coverage_content_type = "coordinate" Zl:standard_name = "depth" Zl:long_name = "depth of the top face of tracer grid cells"
Zl:comment = "First element is 0m, the depth of the top face of the first tracer grid cell (ocean surface). Last element is the depth of the top face of the deepest grid cell. The use of 'l' in the variable name follows the MITgcm convention for ocean variables in which the lower (l) face of a tracer grid cell on the logical grid corresponds to the top face of the grid cell on the physical grid. In other words, the logical vertical grid of MITgcm ocean variables is inverted relative to the physical vertical grid."
int32 time_bnds (time, nv) time_bnds:comment = "Start and end times of averaging period." time_bnds:coverage_content_type = "coordinate" time_bnds:long_name = "time bounds of averaging period"
float32 XC_bnds (tile, j, i, nb) XC_bnds:comment = "Bounds array follows CF conventions. XC_bnds[i,j,0] = 'southwest' corner (j-1, i-1), XC_bnds[i,j,1] = 'southeast' corner (j-1, i+1), XC_bnds[i,j,2] = 'northeast' corner (j+1, i+1), XC_bnds[i,j,3] = 'northwest' corner (j+1, i-1). Note: 'southwest', 'southeast', 'northwest', and 'northeast' do not correspond to geographic orientation but are used for convenience to describe the computational grid. See MITgcm documentation for details." XC_bnds:coverage_content_type = "coordinate" XC_bnds:long_name = "longitudes of tracer grid cell corners"
float32 YC_bnds (tile, j, i, nb) YC_bnds:comment = "Bounds array follows CF conventions. YC_bnds[i,j,0] = 'southwest' corner (j-1, i-1), YC_bnds[i,j,1] = 'southeast' corner (j-1, i+1), YC_bnds[i,j,2] = 'northeast' corner (j+1, i+1), YC_bnds[i,j,3] = 'northwest' corner (j+1, i-1). Note: 'southwest', 'southeast', 'northwest', and 'northeast' do not correspond to geographic orientation but are used for convenience to describe the computational grid. See MITgcm documentation for details." YC_bnds:coverage_content_type = "coordinate" YC_bnds:long_name = "latitudes of tracer grid cell corners"
float32 Z_bnds (k, nv) Z_bnds:comment = "One pair of depths for each vertical level." Z_bnds:coverage_content_type = "coordinate" Z_bnds:long_name = "depths of tracer grid cell upper and lower interfaces"
<b>data variables</b>
float32 ADVx_SLT (time, k, tile, j, i_g) ADVx_SLT:_FillValue = "9.969209968386869e+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:comment = "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 <a href="https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html">https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html</a> " ADVx_SLT:coordinates = "Z time" ADVx_SLT:valid_min = "-181830224.0" ADVx_SLT:valid_max = "260411296.0"

**Table 13.3: Example CDL description of native dataset**

```

float32 DFxE_SLT (time, k, tile, j, i_g)
    DFxE_SLT:_FillValue = "9.969209968386869e+36"
    DFxE_SLT:long_name = "Lateral diffusive flux of salinity in the model +x direction"
    DFxE_SLT:units = "1e-3 m3 s-1"
    DFxE_SLT:mate = "DFyE_SLT"
    DFxE_SLT:coverage_content_type = "modelResult"
    DFxE_SLT:direction = ">0 increases salinity (SALT)"
    DFxE_SLT:comment = "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"
    DFxE_SLT:coordinates = "Z time"
    DFxE_SLT:valid_min = "-125908.03125"
    DFxE_SLT:valid_max = "192716.484375"
float32 ADVy_SLT (time, k, tile, j_g, i)
    ADVy_SLT:_FillValue = "9.969209968386869e+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:comment = "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"
    ADVy_SLT:coordinates = "Z time"
    ADVy_SLT:valid_min = "-137905760.0"
    ADVy_SLT:valid_max = "164271664.0"
float32 DFyE_SLT (time, k, tile, j_g, i)
    DFyE_SLT:_FillValue = "9.969209968386869e+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:comment = "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"
    DFyE_SLT:coordinates = "Z time"
    DFyE_SLT:valid_min = "-114959.2109375"
    DFyE_SLT:valid_max = "154227.140625"

```

**Table 13.3: Example CDL description of native dataset**

```

float32 ADVr_SLT (time, k_l, tile, j, i)
    ADVr_SLT:_FillValue = "9.969209968386869e+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:comment = "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"
    ADVr_SLT:coordinates = "XC ZI YC time"
    ADVr_SLT:valid_min = "-324149856.0"
    ADVr_SLT:valid_max = "263294624.0"
float32 DFrE_SLT (time, k_l, tile, j, i)
    DFrE_SLT:_FillValue = "9.969209968386869e+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 = ">O decreases salinity (SALT)"
    DFrE_SLT:comment = "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"
    DFrE_SLT:coordinates = "XC ZI YC time"
    DFrE_SLT:valid_min = "-1074719.375"
    DFrE_SLT:valid_max = "471215.75"
float32 DFrl_SLT (time, k_l, tile, j, i)
    DFrl_SLT:_FillValue = "9.969209968386869e+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 = ">O decreases salinity (SALT)"
    DFrl_SLT:comment = "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 +DFrl_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"
    DFrl_SLT:coordinates = "XC ZI YC time"
    DFrl_SLT:valid_min = "-30609048.0"
    DFrl_SLT:valid_max = "3197643.0"
float32 oceSPtnd (time, k, tile, j, i)

```

**Table 13.3: Example CDL description of native dataset**

```

oceSPtnd:_FillValue = "9.969209968386869e+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:comment = "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."
oceSPtnd:coordinates = "XC Z YC time"
oceSPtnd:valid_min = "0.0"
oceSPtnd:valid_max = "0.021119138225913048"

```

### 13.4.2 Latlon datasets

Hoc est casus simplex. Multae L3, L4, et GMPE comoediae, necnon quaedam geostationaria L2P comoediae, in ordinaria lat/lon tabula praebentur. In huiusmodi projectione, solum duo coordinate sunt requisitae et vectorum formis servari possunt. Longitudines debent variare ab -180 ad +180, id est ab 180 gradibus Occidentem ad 180 gradibus Orientem. Latitudines debent variare ab -90 ad +90, id est ab 90 gradibus Meridiem ad 90 gradibus Septentrionem. Non debet esse \_FillValue pro latitudine et longitudine, et omnes SST pixelles debent habere validum latitudinis et longitudinis valorem.

Recommendatur ut tempus dimensionem pro Level 3 et Level 4 data prodigia ut infinita specificetur. Nota quod tempus dimensio pro L2P data est stricta definita ut tempus=1 (infinita dimensio non permittitur). Hoc strictum definitum est quia L2P data sunt swath based et geospatial informatio potest mutare per consecutive tempus slabs.

In GHRSST L3 et L4 granulis, solum unum tempus dimensio (tempus=1) est, et variabilis tempus solum unum valorem habet (secunda post 1981), sed infinitum tempus dimensionem permittit netCDF instrumenta et utilitates facile concatenare (et exempli gratia, mediare) seriem de tempore consecutive GHRSST granulis. Sequens CDL exemplum dat:

```

netcdf example {
    dimensions:
        lat = 1801 ;
        lon = 3600 ;
        time = UNLIMITED ; // (strictly set to 1 for L2P)
    variables:
        ...
}

```

Pro his casibus, dimensiones et coordinae variables debent uti pro regulari lat/lon tabula, ut in Tabula 8-3 monstratur. Nullae specificae variables attributi sunt requisitae pro aliis variabilibus (ut sea\_surface\_temperature, ut in exemplo dat in Tabula 8-3).

**Table 13.4: Example CDL description of latlon dataset**

netcdf latlon example
dimensions
time = 1
latitude = 360
longitude = 720
nv = 2
coordinates
int32 time (time)
time:axis = "T"
time:bounds = "time_bnds"
time:coverage_content_type = "coordinate"
time:long_name = "center time of averaging period"
time:standard_name = "time"
time:units = "hours since 1992-01-01T12:00:00"

**Table 13.4: Example CDL description of latlon dataset**

<pre> time:calendar = "proleptic_gregorian" float32 latitude (latitude)     latitude:axis = "Y"     latitude:bounds = "latitude_bnds"     latitude:comment = "uniform grid spacing from -89.75 to 89.75 by 0.5"     latitude:coverage_content_type = "coordinate"     latitude:long_name = "latitude at grid cell center"     latitude:standard_name = "latitude"     latitude:units = "degrees_north" float32 longitude (longitude)     longitude:axis = "X"     longitude:bounds = "longitude_bnds"     longitude:comment = "uniform grid spacing from -179.75 to 179.75 by 0.5"     longitude:coverage_content_type = "coordinate"     longitude:long_name = "longitude at grid cell center"     longitude:standard_name = "longitude"     longitude:units = "degrees_east" int32 time_bnds (time, nv)     time_bnds:comment = "Start and end times of averaging period."     time_bnds:coverage_content_type = "coordinate"     time_bnds:long_name = "time bounds of averaging period" float32 latitude_bnds (latitude, nv)     latitude_bnds:coverage_content_type = "coordinate"     latitude_bnds:long_name = "latitude bounds grid cells" float32 longitude_bnds (longitude, nv)     longitude_bnds:coverage_content_type = "coordinate"     longitude_bnds:long_name = "longitude bounds grid cells" </pre>
<p><b>data variables</b></p> <pre> float32 EXFhl (time, latitude, longitude)     EXFhl:_FillValue = "9.969209968386869e+36"     EXFhl:coverage_content_type = "modelResult"     EXFhl:direction = "&gt;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:comment = "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."     EXFhl:coordinates = "time"     EXFhl:valid_min = "-1772.513671875"     EXFhl:valid_max = "273.9528503417969" float32 EXFhs (time, latitude, longitude)     EXFhs:_FillValue = "9.969209968386869e+36"     EXFhs:coverage_content_type = "modelResult"     EXFhs:direction = "&gt;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:comment = "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."     EXFhs:coordinates = "time"     EXFhs:valid_min = "-2478.766357421875"     EXFhs:valid_max = "357.0105895996094" float32 EXFlwdn (time, latitude, longitude)     EXFlwdn:_FillValue = "9.969209968386869e+36"     EXFlwdn:coverage_content_type = "modelResult"     EXFlwdn:direction = "&gt;0 increases potential temperature (THETA)"     EXFlwdn:long_name = "Downward longwave radiative flux" </pre>

**Table 13.4: Example CDL description of latlon dataset**

```

EXFlwdn:standard_name = "surface_downwelling_longwave_flux_in_air"
EXFlwdn:units = "W m-2"
EXFlwdn:comment = "Downward longwave radiative flux. Note: sum of ERA-Interim downward longwave radiation and the control adjustment from ocean state estimation."
EXFlwdn:coordinates = "time"
EXFlwdn:valid_min = "4.188045501708984"
EXFlwdn:valid_max = "513.3919067382812"
float32 EXFswdn (time, latitude, longitude)
    EXFswdn:_FillValue = "9.969209968386869e+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:comment = "Downward shortwave radiative flux. Note: sum of ERA-Interim downward shortwave radiation and the control adjustment from ocean state estimation."
    EXFswdn:coordinates = "time"
    EXFswdn:valid_min = "-224.63368225097656"
    EXFswdn:valid_max = "707.345947265625"
float32 EXFqnet (time, latitude, longitude)
    EXFqnet:_FillValue = "9.969209968386869e+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:comment = "Net air-sea heat flux (turbulent and radiative) per unit area of open water (not covered by sea-ice). Note: net upward heat flux over open water, calculated as EXFlwnet+EXFswnet-EXFlh-EXFhs."
    EXFqnet:coordinates = "time"
    EXFqnet:valid_min = "-687.8736572265625"
    EXFqnet:valid_max = "3408.977783203125"
float32 oceQnet (time, latitude, longitude)
    oceQnet:_FillValue = "9.969209968386869e+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:comment = "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 temperature is not OC. The variable TFLUX does include the change in ocean heat content due to changing ocean mass."
    oceQnet:coordinates = "time"
    oceQnet:valid_min = "-1708.8460693359375"
    oceQnet:valid_max = "675.3716430664062"
float32 SlatmQnt (time, latitude, longitude)
    SlatmQnt:_FillValue = "9.969209968386869e+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"

```

**Table 13.4: Example CDL description of latlon dataset**

```

SlatmQnt:comment = "Net upward heat flux to the atmosphere across open water and sea-ice or snow surfaces. Note: nonzero SlatmQnt 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)."
SlatmQnt:coordinates = "time"
SlatmQnt:valid_min = "-756.0607299804688"
SlatmQnt:valid_max = "1704.7703857421875"
float32 TFLUX (time, latitude, longitude)
TFLUX:_FillValue = "9.969209968386869e+36"
TFLUX:coverage_content_type = "modelResult"
TFLUX:direction = ">0 increases potential temperature (THETA)"
TFLUX:long_name = "Rate of change of ocean heat content per m2 accounting for mass fluxes."
TFLUX:units = "W m-2"
TFLUX:comment = "The rate of change of ocean heat content due to heat fluxes across the liquid surface and the addition or removal of mass. . Note: the global area integral of TFLUX and geothermal flux (geothermalFlux.bin) matches the time-derivative of ocean heat content (J/s). Unlike oceQnet, TFLUX includes the contribution to the ocean heat content from changing ocean mass (e.g. from oceFWflx)."
TFLUX:coordinates = "time"
TFLUX:valid_min = "-1713.51220703125"
TFLUX:valid_max = "870.3130493164062"
float32 EXFswnet (time, latitude, longitude)
EXFswnet:_FillValue = "9.969209968386869e+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:comment = "Net shortwave radiative flux per unit area of open water (not covered by sea-ice). Note: net shortwave radiation over open water calculated from downward shortwave flux (EXFswdn) and ocean surface albdeo."
EXFswnet:coordinates = "time"
EXFswnet:valid_min = "-655.6171264648438"
EXFswnet:valid_max = "193.89297485351562"
float32 EXFlwnet (time, latitude, longitude)
EXFlwnet:_FillValue = "9.969209968386869e+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:comment = "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)."
EXFlwnet:coordinates = "time"
EXFlwnet:valid_min = "-144.3661346435547"
EXFlwnet:valid_max = "293.4114990234375"
float32 oceQsw (time, latitude, longitude)
oceQsw:_FillValue = "9.969209968386869e+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:comment = "Net shortwave radiative flux across the ocean surface. Note: Shortwave radiation penetrates below the surface grid cell."
oceQsw:coordinates = "time"
oceQsw:valid_min = "-134.39808654785156"
oceQsw:valid_max = "655.6171264648438"
float32 Slaaflux (time, latitude, longitude)

```

**Table 13.4: Example CDL description of latlon dataset**

```

Slaaflux:_FillValue = "9.969209968386869e+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:comment = "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."
Slaaflux:coordinates = "time"
Slaaflux:valid_min = "-16.214622497558594"
Slaaflux:valid_max = "50.35451889038086"

```

### 13.4.3 1D datasets

Hoc est casus simplex. Multae L3, L4, et GMPE comoediae, necnon quaedam geostationaria L2P comoediae, in ordinaria lat/lon tabula praebentur. In huiusmodi projectione, solum duo coordinate sunt requisitae et vectorum formis servari possunt. Longitudines debent variare ab -180 ad +180, id est ab 180 gradibus Occidentem ad 180 gradibus Orientem. Latitudines debent variare ab -90 ad +90, id est ab 90 gradibus Meridiem ad 90 gradibus Septentrionem. Non debet esse \_FillValue pro latitudine et longitudine, et omnes SST pixeles debent habere validum latitudinis et longitudinis valorem.

Recommendatur ut tempus dimensionem pro Level 3 et Level 4 data prodigia ut infinita specificetur. Nota quod tempus dimensio pro L2P data est stricta definita ut tempus=1 (infinita dimensio non permittitur). Hoc strictum definitum est quia L2P data sunt swath based et geospatial informatio potest mutare per consecutive tempus slabs.

In GHRSST L3 et L4 granulis, solum unum tempus dimensio (tempus=1) est, et variabilis tempus solum unum valorem habet (secunda post 1981), sed infinitum tempus dimensionem permittit netCDF instrumenta et utilitates facile concatenare (et exempli gratia, mediare) seriem de tempore consecutive GHRSST granulis. Sequens CDL exemplum dat:

```

netcdf example {
    dimensions:
        lat = 1801 ;
        lon = 3600 ;
        time = UNLIMITED ; // (strictly set to 1 for L2P)
    variables:
        ...
}

```

Pro his casibus, dimensiones et coordinae variables debent uti pro regulari lat/lon tabula, ut in Tabula 8-3 monstratur. Nullae specificae variables attributi sunt requisitae pro aliis variabilibus (ut sea\_surface\_temperature, ut in exemplo dat in Tabula 8-3).

**Table 13.5: Example CDL description of 1D dataset**

netcdf 1D example
dimensions
time = 227904
coordinates
int32 time (time) time:axis = "T" time:comment = "" time:coverage_content_type = "coordinate" time:long_name = "snapshot time" time:standard_name = "time" time:units = "hours since 1992-01-01T12:00:00" time:calendar = "proleptic_gregorian"
data variables

**Table 13.5: Example CDL description of 1D dataset**

```
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"
```

=====

## 14 GDS 2.0 Filenames and Supporting Conventions

Striving to achieve a flexible naming convention that maintains consistency across processing levels and better serves user needs, the GDS 2.0 uses a single form for all GHRSST data files. An overview of the format is presented below in Section 7.1 along with example filenames. Details on each of the filename convention components are provided in Sections 7.2 through 7.8.

In addition, a best practice has been established for creating character strings used to describe GHRSST SST products and sources of ancillary data. These strings, and associated numeric codes for the SST products, are used within some GHRSST data files but are not part of the filename convention itself. The best practice is described in Section 7.9.

### 14.1 1 Overview of Filename Convention and Example Filenames

The filenaming convention for the GDS 2.0 is shown below.

```
<Indicative Date><Indicative Time>-<RDAC>-<Processing Level>_GHRSST-<SST Type>- <Product String>-<Additional Segregator>-v<GDS Version>-fv<File Version>.<File Type>
```

The variable components within braces (“<>”) are summarized in Table 7-1 below and detailed in the **should not** be used in any GHRSST code or the <Additional Segregator> element. Example filenames are given later in this section. While no strict limit to filename length is mandated, RDACs are encouraged to keep the length to less than 240 characters to increase readability and usability.

**Table 14.1: GDS 2.0 Filenaming convention components**

Name	Definition	Description
<Indicative Date>	YYYYMMDD	The identifying date for this data set. See Section 7.2.
<Indicative Time>	HHMMSS	The identifying time for this data set. The time used is dependent on the <Processing Level> of the data set: L2P: start time of granule <ul style="list-style-type: none"> <li>• L3U: start time of granule</li> <li>• L3C and L3S: centre time of the collation window</li> <li>• L4 and GMPE: nominal time of analysis</li> </ul> All times should be given in UTC. See Section 7.3.
<RDAC>	The RDAC where the file was created	The Regional Data Assembly Centre (RDAC)code, listed in Section 7.4.
<Processing Level>	The data processing level code (L2P, L3U, L3C, L3S, or L4)	The data processing level code, defined in Section 7.5.
<SST Type>	The type of SST data included in the file.	Conforms to the GHRSST definitions for SST, defined in Section 7.6
<Product String>	A character string identifying the SST product set. The string is used uniquely within an RDAC but may be shared across RDACs.	The unique “name” within an RDAC of the product line. See Section 7.7 for the product string lists, one each for L2P, L3, L4, and GMPE products. See Section 7.7.
<Additional Segregator>	Optional text to distinguish between files with the same <Product String>. Dashes are not allowed within this element.	This text is used since the other filename components are sometimes insufficient to uniquely identify a file. For example, in L2P or L3U (un-collated) products this is often the original file name or processing algorithm. Note, underscores should be used, not dashes. For L4 files, this element should begin with the appropriate regional code as defined in Section 7.8. This component is optional but must be used in those cases were non-unique filenames would otherwise result.
<GDS Version>	nn.n	Version number of the GDS used to process the file. For example, GDS 2.0 = “02.0”.
<File Version>	xx.x	Version number for the file, for example, “01.0”.

<File Type>	netCDF data file suffix (nc) or ISO metadata file suffix (xml)	Indicates this is a netCDF file containing data or its corresponding ISO-19115 metadata record in XML.
-------------	--	--

#### 14.1.1 L2\_GHRSST Filename Example

20070503132300-NAVO-L2P\_GHRSST-SSTblend-AVHRR17\_L-SST\_s0123\_e0135-v02.0-fv01.0.nc

The above file contains GHRSST L2P blended SST data for 03 May 2007, from AVHRR LAC data collected from the NOAA-17 platform. The granule begins at 13:23:00 hours. It is version 1.0 of the file and was produced by the NAVO RDAC in accordance with the GDS 2.0. The <Additional Segregator> text is "SST\_s0123\_e0135".

#### 14.1.2 L3\_GHRSST Filename Example

20070503110153-REMSS-L3C\_GHRSST-SSTsubskin-TMI-tmi\_20070503rt-v02.0-fv01.0.nc

The above file was produced by the REMSS RDAC and contains collated L3 sub-skin SST data from the TMI instrument for 03 May 2007. The collated file has a centre time of at 11:01:53 hours. It is version 1.0 of the file and was produced according to GDS 2.0 specifications. Its <Additional Segregator> text is "tmi\_20070503rt".

#### 14.1.3 L4\_GHRSST Filename Example

20070503120000-UKMO-L4\_GHRSST-SSTfdn-OSTIA-GLOB-v02.0-fv01.0.nc

The above file contains L4 foundation SST data produced at the UKMO RDAC using the OSTIA system. It is global coverage, contains data for 03 May 2007, was produced to GDS 2.0 specifications and is version 1.0 of the file. The nominal time of the OSTIA analysis is 12:00:00 hours.

### 14.2 <Indicative Date>

The identifying date for this data set, using the format YYYYMMDD, where YYYY is the four-digit year, MM is the two-digit month from 01 to 12, and DD is the two-digit day of month from 01 to 31. The date used should best represent the observation date for the dataset.

### 14.3 <Indicative Time>

The identifying time for this data set in UTC, using the format HHMMSS, where HH is the two-digit hour from 00 to 23, MM is the two-digit minute from 00 to 59, and SS is the two-digit second from 00 to 59. The time used is dependent on the <Processing Level> of the data set:

L2P: start time of granule

L3U: start time of granule

L3C and L3S: centre time of the collation window

L4 and GMPE: nominal time of analysis

All times should be given in UTC and should be chosen to best represent the observation time for this dataset. Note: RDACs should ensure the applications they use to determine UTC properly account for leap seconds.

### 14.4 <RDAC>

Codes used for GHRSST Regional Data Assembly Centres (RDACs) are provided in the table below. New codes are assigned by the GHRSST Data And Systems Technical Advisory Group (DAS-TAG) and entered into the table upon agreement by the GDAC, LTSRF, and relevant RDACs.

### 14.5 <Processing Level>

Satellite data processing level definitions can lead to ambiguous situations, especially regarding the distinction between L3 and L4 products. GHRSST identified the use of analysis procedures to fill gaps where no observations exist to resolve this ambiguity. Within GHRSST filenames, the <Processing Level> codes are shown below in Table 7-3. GHRSST currently establishes standards

for L2P, L3U, L3C, L3S, and L4 (GHRSST Multi-Product Ensembles known as GMPE are a special kind of L4 product for which GHRSST also provides standards).

## 15 GDS 2.0 Data Product File Structure

### 15.1 Overview of the GDS 2.0 netCDF File Format

GDS 2.0 data files preferentially use the **netCDF-4 Classic** format. However, as netCDF-4 is a relatively new format and includes a significant number of new features that may not be well supported by existing user applications and tools, the GHRSST Science Team agreed to support both netCDF-3 and netCDF-4 format data files during a transition period. At the 11th GHRSST Science Team meeting, Lima Peru, 21-25th June 2010 it was agreed that the transition period would end in 2013 at which point (subject to positive developments in the user community using netCDF-4) the use of netCDF-3 format data products will cease within the GHRSST R/GTS framework. **NetCDF-3 data products shall be delivered to the GDAC with an accompanying MMR file records as described in Section 13.** While netCDF-3 can store the metadata, it is computationally expensive to extract it from externally-compressed netCDF-3 files. A major advantage to the use of NetCDF-4 format products from the producer's perspective is that no additional metadata records are required when using this format since the GDAC and LTSRF can easily extract it from the files without having to decompress the entire file.

These GDS 2.0 formatted data sets must comply with the Climate and Forecast (CF) Conventions, v1.4 [AD-3] or later because these conventions provide a practical standard for storing oceanographic data in a robust, easily-preserved for the long-term, and interoperable manner. The CF-compliant netCDF data format is flexible, self-describing, and has been adopted as a de facto standard for many operational and scientific oceanography systems. Both netCDF and CF are actively maintained including significant discussions and inputs from the oceanographic community (see [http://cfpcmdi.1lnl.gov/discussion/index\\_html](http://cfpcmdi.1lnl.gov/discussion/index_html)). The CF convention generalizes and extends the Cooperative Ocean/Atmosphere Research Data Service (COARDS, [AD-4]) Convention but relaxes the COARDS constraints on dimension order and specifies methods for reducing the size of datasets. The purpose of the CF Conventions is to require conforming datasets to contain sufficient metadata so that they are self-describing, in the sense that each variable in the file has an associated description of what it represents, physical units if appropriate, and that each value can be located in space (relative to earthbased coordinates) and time. In addition to the CF Conventions, GDS 2.0 formatted files follow some of the recommendations of the Unidata Attribute Convention for Dataset Discovery (ACDD, [AD-7]).

In the context of netCDF, a variable refers to data stored in the file as a vector or as a multidimensional array. Each variable in a GHRSST netCDF file consists of a 2-dimensional [ $i \times j$ ], 3- dimensional [ $i \times j \times k$ ], or 4-dimensional [ $i \times j \times k \times l$ ] array of data. The dimensions of each variable must be explicitly declared in the dimension section.

Within the netCDF file, global attributes are used to hold information that applies to the whole file, such as the data set title. Each individual variable must also have its own attributes, referred to as variable attributes. These variable attributes define, for example, an offset, scale factor, units, a descriptive version of the variable name, and a fill value, which is used to indicate array elements that do not contain valid data. Where applicable, SI units should be used and described by a character string, which is compatible with the Unidata UDUNITS-2 package [AD-5].

All GHRSST GDS 2.0 files conform to this structure and share a common set of netCDF global attributes. These global attributes include those required by the CF Convention plus additional ones required by the GDS 2.0. The required set of global attributes is described in Section 8.2 and entities within the GHRSST R/GTS framework are free to add their own, as long as they do not contradict the GDS 2.0 and CF requirements.

Following the CF convention, each variable also has a set of variable attributes. The required variable attributes are described in Section 8.3. In a few cases, some of these variable attributes may not be relevant for certain variables or additional variable attributes may be required. In those cases, the variable descriptions in each of the L2P, L3, L4, and GMPE product specifications (Sections 9, 10, 11, and 12) will identify the differences and specify requirements for each product. As with the global attributes, entities within the GHRSST R/GTS framework are free to add their own variable attributes, as long as they do not contradict the GDS 2.0 and CF requirements.

While the exact volumes can vary, an average L2P file will use about 33 bytes per pixel, an L3 file 28 bytes per pixel, and an L4 file about 8 bytes per pixel. The data type encodings for each variable are fixed except for the experimental fields, which are flexible and can chosen by the producing RDAC.

### 15.2 GDS 2.0 netCDF Global Attributes

Table 8-1 below summarizes the global attributes that are mandatory for every GDS 2.0 netCDF data file. More details on the CF-mandated attributes (as indicated in the Source column) are available at: <http://cf-pcmdi.1lnl.gov/documents/cf-conventions/1.4/cf-conventions.html#attribute-appendix> and information on the ACDD recommendations is available at <http://www.unidata.ucar.edu/software/netcdf-java/formats/DataDiscoveryAttConvention.html>.

**Table 15.1: Mandatory global attributes for GDS 2.0 netCDF data files**

Global Attribute Name	Type	Description	Source
acknowledgement	string	A place to acknowledge various types of support for the project that produced this data.	ACDD
cdm_data_type	string	The data type, as derived from Unidata's Common Data Model Scientific Data types and understood by THREDDS. (This is a THREDDS "dataType", and is different from the CF NetCDF attribute 'featureType', which indicates a Discrete Sampling Geometry file in CF.)	ACDD
comment	string	Miscellaneous information about the data, not captured elsewhere. This attribute is defined in the CF Conventions.	CF, ACDD
conventions	string	A text string identifying the netCDF conventions followed (e.g., CF-1.4, ACDD 1-3).	
creator_email	string	The email address of the person (or other creator type specified by the creator_type attribute) principally responsible for creating this data.	ACDD
creator_name	string	The name of the person (or other creator type specified by the creator_type attribute) principally responsible for creating this data.	ACDD
creator_url	string	The URL of the of the person (or other creator type specified by the creator_type attribute) principally responsible for creating this data.	ACDD
date_created	string	The date on which this version of the data was created.	ACDD
easternmost_longitude	float	Decimal degrees east, range -180 to +180. This is equivalent to ACDD geospatial_lon_max.	podaac
geospatial_lat_resolution	float	Latitude Resolution in units matching geospatial_lat_units.	ACDD
geospatial_lat_units	string	Units of the latitudinal resolution. Typically "degrees_north"	ACDD
geospatial_lon_resolution	float	Longitude Resolution in units matching geospatial_lon_resolution	ACDD
geospatial_lon_units	string	Units of the longitudinal resolution. Typically "degrees_east"	ACDD
history	string	The name of the institution principally responsible for originating this data. This attribute is recommended by the CF convention.	CF, ACDD
id	string	An identifier for the data set, provided by and unique within its naming authority. The combination of the "naming authority" and the "id" should be globally unique, but the id can be globally unique by itself also. IDs can be URLs, URNs, DOIs, meaningful text strings, a local key, or any other unique string of characters. The id should not include white space characters.	ACDD
institutions	string	The name of the institution principally responsible for originating this data. This attribute is recommended by the CF convention.	CF, ACDD
keywords	string	GCMD Science Keyword(s)	ACDD
keywords_vocabulary	string	The unique name or identifier of the vocabulary from which keywords are taken. e.g., the NASA Global Change Master Directory (GCMD) Science Keywords.	ACDD
license	string	Provide the URL to a standard or specific license, enter "Freely Distributed" or "None", or describe any restrictions to data access and distribution in free text.	ACDD
Metadata_Conventions	string	A comma-separated list of the conventions that are followed by the dataset.	ACDD
metadata_link	string	Link to collection metadata record at archive	ACDD

**Table 15.1: Mandatory global attributes for GDS 2.0 netCDF data files**

naming_authority	string	The organization that provides the initial id (see above) for the dataset. The naming authority should be uniquely specified by this attribute via reverse-DNS naming convention.	ACDD
netcdf_version_id	string	Version of netCDF libraries used to create this file. For example, "4.1.1"	GDS
northernmost_latitude	float	Decimal degrees north, range -90 to +90. This is equivalent to ACDD geospatial_lat_max.	GDS
processing_level	string	A textual description of the processing (or quality control) level of the data.	ACDD & GDS
product_version	string	The product version of this data file	GDS
project	string	The name of the project(s) principally responsible for originating this data.	ACDD
publisher_email	string	The email address of the person (or other entity specified by the publisher_type attribute) responsible for publishing the data file or product to users, with its current metadata and format.	ACDD
publisher_name	string	The name of the person (or other entity specified by the publisher_type attribute) responsible for publishing the data file or product to users, with its current metadata and format.	ACDD
publisher_url	string	The URL of the person (or other entity specified by the publisher_type attribute) responsible for publishing the data file or product to users, with its current metadata and format.	ACDD
references	string	Published or web-based references that describe the data or methods used to produce it. Recommend URIs (such as a URL or DOI) for papers or other references. This attribute is defined in the CF conventions.	ACDD
source	string	Method of production of the original data.	CF
southernmost_latitude	float	Decimal degrees north, range -90 to +90. This is equivalent to ACDD geospatial_lat_min.	GDS
spatial_resolution	string	A string describing the approximate resolution of the product.	GDS
standard_name_vocabulary	string	The name and version of the controlled vocabulary from which variable standard names are taken.	ACDD
start_time	string	Representative date and time of the end of the granule in the ISO 8601 compliant format of "yyyymmddThh-mmssZ".	GDS
stop_time	string	Representative date and time of the end of the granule in the ISO 8601 compliant format of "yyyymmddThh-mmssZ".	GDS
summary	string	A paragraph describing the dataset, analogous to an abstract for a paper.	ACDD
time_coverage_end	string	Identical to stop_time. Included for increased ACDD compliance.	ACDD
time_coverage_start	string	Identical to start_time. Included for increased ACDD compliance.	ACDD
title	string	A short phrase or sentence describing the dataset. In many discovery systems, the title will be displayed in the results list from a search, and therefore should be human readable and reasonable to display in a list of such names. This attribute is recommended by the NetCDF Users Guide (NUG) and the CF conventions.	CF, ACDD

**Table 15.1: Mandatory global attributes for GDS 2.0 netCDF data files**

uuid	string	A Universally Unique Identifier (UUID). Numerous, simple tools can be used to create a UUID, which is inserted as the value of this attribute. See <a href="http://en.wikipedia.org/wiki/Universally_Unique_Identifier">http://en.wikipedia.org/wiki/Universally_Unique_Identifier</a> for more information and tools.	GDS
westernmost_longitude	float	Decimal degrees east, range -180 to +180. This is equivalent to ACDD geospatial_lon_min.	GDS

### 15.3 GDS 2.0 netCDF Variable Attributes

**Table 15.2: Table 8-2. Variable attributes for GDS 2.0 netCDF data files**

Variable Name	Attribute	Format	Description	Source
_FillValue	Must be the same as the variable type		A value used to indicate array elements containing no valid data. This value must be of the same type as the storage (packed) type; should be set as the minimum value for this type. Note that some netCDF readers are unable to cope with signed bytes and may, in these cases, report fill as 128. Some cases will be reported as unsigned bytes 0 to 255. Required for the majority of variables except mask and l2p_flags.	CF
units	string		Text description of the units, preferably S.I., and must be compatible with the Unidata UDUNITS-2 package [AD-5]. For a given variable (e.g. wind speed), these must be the same for each dataset. Required for the majority of variables except mask, quality_level, and l2p_flags.	CF, ACDD
scale_factor	Must be expressed in the unpacked data type		To be multiplied by the variable to recover the original value. Defined by the producing RDAC. Valid values within {value_min} and {valid_max} should be transformed by {scale_factor} and {add_offset}, otherwise skipped to avoid floating point errors.	CF
add_offset	Must be expressed in the unpacked data type		To be added to the variable after multiplying by the scale factor to recover the original value. If only one of {scale_factor} or {add_offset} is needed, then both should be included anyway to avoid ambiguity, with {scale_factor} defaulting to 1.0 and add_offset defaulting to 0.0. Defined by the producing RDAC.	CF
long_name	string		A free-text descriptive variable name.	CF, ACDD
valid_min	Expressed in same data type as variable		Minimum valid value for this variable once they are packed (in storage type). The fill value should be outside this valid range. Note that some netCDF readers are unable to cope with signed bytes and may, in these cases, report valid min as 129. Some cases as unsigned bytes 0 to 255. Values outside of {valid_min} and {valid_max} will be treated as missing values. Required for all variables except variable time.	CF
valid_max	Expressed in same data type as variable		Maximum valid value for this variable once they are packed (in storage type). The fill value should be outside this valid range. Note that some netCDF readers are unable to cope with signed bytes and may, in these cases, report valid min as 127. Required for all variables except variable time.	CF

**Table 15.2: Table 8-2. Variable attributes for GDS 2.0 netCDF data files**

standard_name	string	Where defined, a standard and unique description of a physical quantity. For the complete list of standard name strings, see [AD-8]. {Do not} include this attribute if no {standard_name} exists.	CF, ACDD
comment	string	Miscellaneous information about the variable or the methods used to produce it.	CF
source	string	{For L2P and L3 files}: For a data variable with a single source, use the GHRSST unique string listed in Table 7-10 if the source is a GHRSST SST product. For other sources, following the best practice described in Section 7.9 to create the character string. If the data variable contains multiple sources, set this string to be the relevant “sources of” variable name. For example, if multiple wind speed sources are used, set {source =} sources_of_wind_speed. {For L4 and GMPE files}: follow the {source} convention used for the global attribute of the same name, but provide in the commas-separated list only the sources relevant to this variable.	CF
references	string	Published or web-based references that describe the data or methods used to produce it. Note that while at least one reference is required in the global attributes (See Table 8-1), references to this specific data variable may also be given.	CF
axis	String	For use with coordinate variables only. The attribute 'axis' may be attached to a coordinate variable and given one of the values "X", "Y", "Z", or "T", which stand for a longitude, latitude, vertical, or time axis respectively. See: <a href="http://cfpcmdi.llnl.gov/documents/cfconventions/1.4/cfconventions.html#coordinate-types">http://cfpcmdi.llnl.gov/documents/cfconventions/1.4/cfconventions.html#coordinate-types</a>	CF
positive	String	For use with a vertical coordinate variables only. May have the value "up" or "down". For example, if an oceanographic netCDF file encodes the depth of the surface as 0 and the depth of 1000 meters as 1000 then the axis would set positive to "down". If a depth of 1000 meters was encoded as -1000, then positive would be set to "up". See the section on vertical-coordinate in [AD-3]	CF
coordinates	String	Identifies auxiliary coordinate variables, label variables, and alternate coordinate variables. See the section on coordinate-system in [AD3]. This attribute must be provided if the data are on a non-regular lat/lon grid (map projection or swath data).	CF
grid_mapping	String	Use this for data variables that are on a projected grid. The attribute takes a string value that is the name of another variable in the file that provides the description of the mapping via a collection of attached attributes. That named variable is called a grid mapping variable and is of arbitrary type since it contains no data. Its purpose is to act as a container for the attributes that define the mapping. See the section on mappings-and-projections in [AD-3]	CF
flag_mappings	String	Space-separated list of text descriptions associated in strict order with conditions set by either flag_values or flag_masks. Words within a phrase should be connected with underscores.	CF

**Table 15.2: Table 8-2. Variable attributes for GDS 2.0 netCDF data files**

flag_values	Must be the same as the variable type	Comma-separated array of valid, mutually exclusive variable values (required when the bit field contains enumerated values; i.e., a “list” of conditions). Used primarily for {quality_level} and “{sources_of_xxx}” variables.	CF
flag_masks	Must be the same as the variable type	Comma-separated array of valid variable masks (required when the bit field contains independent Boolean conditions; i.e., a bit “mask”). Used primarily for {l2p_flags} variable.  {Note: CF allows the use of both flag_masks and flag_values attributes in a single variable to create sets of masks that each have their own list of flag_values (see <a href="http://cfpcmdi.llnl.gov/documents/cfconventions/1.5/ch03s05.html#id2710752">http://cfpcmdi.llnl.gov/documents/cfconventions/1.5/ch03s05.html#id2710752</a> for examples), but this practice is discouraged.}	CF
depth	String	Use this to indicate the depth for which the SST data are valid.	GDS
height	String	Use this to indicate the height for which the wind data are specified.	GDS
time_offset	Must be expressed in the unpacked data type	Difference in hours between an ancillary field such as {wind_speed} and the SST observation time	GDS

## 15.4 GDS 2.0 coordinate variable definitions

NetCDF coordinate variables provide scales for the space and time axes for the multidimensional data arrays, and must be included for all dimensions that can be identified as spatio-temporal axes. Coordinate arrays are used to geolocate data arrays on non-orthogonal grids, such as images in the original pixel/scan line space, or complicated map projections. Required attributes are `units` and `_FillValue`. Elements of the coordinate array need not be monotonically ordered. The data type can be any and scaling may be implemented if required. `add_offset` and `scale_factor` have to be adjusted according to the sensor resolution and the product spatial coverage. If the packed values can not stand on a short, float can be used instead (multiplying the size of these variables by two).

'time' is the reference time of the SST data array. The GDS 2.0 specifies that this reference time should be extracted or computed to the nearest second and then coded as continuous UTC time coordinates in seconds from 00:00:00 UTC January 1, 1981 (which is the definition of the **GHSST** origin time, chosen to approximate the start of useful AVHRR SST data record). Note that the use of UDUNITS in GHSST implies that that calendar to be used is the default mixed Gregorian/Julian calendar.

The reference time used is dependent on the <Processing Level> of the data and is defined as follows:

- L2P: start time of granule;
- L3U: start time of granule;
- L3C and L3S: centre time of the collation window;
- L4 and GMPE: nominal time of the analysis

The coordinate variable 'time' is intended to minimize the size of the `sst_dtime` variable (e.g., see Section 9.4), which stores offsets from the reference time in seconds for each SST pixel. 'time' also facilitates aggregation of all files of a given dataset along the time axis with such tools as THREDDS and LAS.

x (columns) and y (lines) grid dimensions are referred either as 'lat' and 'lon' or as 'ni' and 'nj'. lon and lat must be used if data are mapped on a regular grid (some geostationary products). ni and nj are used if data are mapped on a non-regular grid (curvilinear coordinates) or following the sensor scanning pattern (scan line, swath). It is preferred that ni should be used for the across-track dimension and nj for the along-track dimension.

Coordinate vectors are used for data arrays located on orthogonal (but not necessarily regularly spaced) grids, such as a geographic (lat-lon) map projections. The only required attribute is `units`. The elements of a coordinate vector array should be in monotonically increasing or decreasing order. The data type can be any and scaling may be implemented if required.

A coordinate's variable (= "lon lat"): must be provided if the data are on a non-regular lat/lon grid (map projection or swath data).

A grid\_mapping (= "projection name"): must be provided if the data are mapped following a projection. Refer to the CF convention [AD-3] for standard projection names.

### 15.4.1 Native datasets

Hoc est casus simplex. Multae L3, L4, et GMPE comoediae, necnon quaedam geostationaria L2P comoediae, in ordinaria lat/lon tabula praebentur. In huiusmodi projectione, solum duo coordinate sunt requisitae et vectorum formis servari possunt. Longitudines debent variare ab -180 ad +180, id est ab 180 gradibus Occidentem ad 180 gradibus Orientem. Latitudines debent variare ab -90 ad +90, id est ab 90 gradibus Meridiem ad 90 gradibus Septentrionem. Non debet esse \_FillValue pro latitudine et longitudine, et omnes SST pixeles debent habere validum latitudinis et longitudinis valorem.

Recommendatur ut tempus dimensionem pro Level 3 et Level 4 data prodigia ut infinita specificetur. Nota quod tempus dimensio pro L2P data est stricta definita ut tempus=1 (infinita dimensio non permittitur). Hoc strictum definitum est quia L2P data sunt swath based et geospatial informatio potest mutare per consecutive tempus slabs.

In GHRSST L3 et L4 granulis, solum unum tempus dimensio (tempus=1) est, et variabilis tempus solum unum valorem habet (secunda post 1981), sed infinitum tempus dimensionem permittit netCDF instrumenta et utilitates facile concatenare (et exempli gratia, mediare) seriem de tempore consecutive GHRSST granulis. Sequens CDL exemplum dat:

```
netcdf example {
    dimensions:
        lat = 1801 ;
        lon = 3600 ;
        time = UNLIMITED ; // (strictly set to 1 for L2P)
    variables:
        ...
}
```

Pro his casibus, dimensiones et coordinae variables debent uti pro regulari lat/lon tabula, ut in Tabula 8-3 monstratur. Nullae specificae variables attributi sunt requisitae pro aliis variabilibus (ut sea\_surface\_temperature, ut in exemplo dat in Tabula 8-3).

**Table 15.3: Example CDL description of native dataset**

netcdf native example
dimensions
i = 90 i_g = 90 j = 90 j_g = 90 k = 50 k_u = 50 k_l = 50 k_p1 = 51 tile = 13 time = 1 nv = 2 nb = 4
coordinates
int32 i (i) i:axis = "X" i:long_name = "grid index in x for variables at tracer and 'v' locations" i:swap_dim = "XC" i:comment = "In the Arakawa C-grid system, tracer (e.g., THETA) and 'v' variables (e.g., VVEL) have the same x coordinate on the model grid." i:coverage_content_type = "coordinate" int32 i_g (i_g) i_g:axis = "X" i_g:long_name = "grid index in x for variables at 'u' and 'g' locations" i_g:c_grid_axis_shift = "-0.5" i_g:swap_dim = "XG"

**Table 15.3: Example CDL description of native dataset**

```

i_g:comment = "In the Arakawa C-grid system, 'u' (e.g., UVEL) and 'g' variables (e.g., XG) have the same x coordinate on
the model grid."
  i_g:coverage_content_type = "coordinate"
int32 j (j)
  j:axis = "Y"
  j:long_name = "grid index in y for variables at tracer and 'u' locations"
  j:swap_dim = "YC"
  j:comment = "In the Arakawa C-grid system, tracer (e.g., THETA) and 'u' variables (e.g., UVEL) have the same y coordinate
on the model grid."
  j:coverage_content_type = "coordinate"
int32 j_g (j_g)
  j_g:axis = "Y"
  j_g:long_name = "grid index in y for variables at 'v' and 'g' locations"
  j_g:c_grid_axis_shift = "-0.5"
  j_g:swap_dim = "YG"
  j_g:comment = "In the Arakawa C-grid system, 'v' (e.g., VVEL) and 'g' variables (e.g., XG) have the same y coordinate."
  j_g:coverage_content_type = "coordinate"
int32 k (k)
  k:axis = "Z"
  k:long_name = "grid index in z for tracer variables"
  k:swap_dim = "Z"
  k:coverage_content_type = "coordinate"
int32 k_u (k_u)
  k_u:axis = "Z"
  k_u:c_grid_axis_shift = "0.5"
  k_u:swap_dim = "Zu"
  k_u:coverage_content_type = "coordinate"
  k_u:long_name = "grid index in z corresponding to the bottom face of tracer grid cells ('w' locations)"
  k_u:comment = "First index corresponds to the bottom surface of the uppermost tracer grid cell. The use of 'u' in the
variable name follows the MITgcm convention for ocean variables in which the upper (u) face of a tracer grid cell on the logical
grid corresponds to the bottom face of the grid cell on the physical grid."
int32 k_l (k_l)
  k_l:axis = "Z"
  k_l:c_grid_axis_shift = "-0.5"
  k_l:swap_dim = "Zl"
  k_l:coverage_content_type = "coordinate"
  k_l:long_name = "grid index in z corresponding to the top face of tracer grid cells ('w' locations)"
  k_l:comment = "First index corresponds to the top surface of the uppermost tracer grid cell. The use of 'l' in the variable
name follows the MITgcm convention for ocean variables in which the lower (l) face of a tracer grid cell on the logical grid
corresponds to the top face of the grid cell on the physical grid."
int32 k_p1 (k_p1)
  k_p1:axis = "Z"
  k_p1:long_name = "grid index in z for variables at 'w' locations"
  k_p1:c_grid_axis_shift = "[-0.5 0.5]"
  k_p1:swap_dim = "Zp1"
  k_p1:comment = "Includes top of uppermost model tracer cell (k_p1=0) and bottom of lowermost tracer cell (k_p1=51)."
  k_p1:coverage_content_type = "coordinate"
int32 tile (tile)
  tile:long_name = "lat-lon-cap tile index"
  tile:comment = "The ECCO V4 horizontal model grid is divided into 13 tiles of 90x90 cells for convenience."
  tile:coverage_content_type = "coordinate"
int32 time (time)
  time:long_name = "center time of averaging period"
  time:axis = "T"
  time:bounds = "time_bnds"
  time:coverage_content_type = "coordinate"
  time:standard_name = "time"

```

Table 15.3: Example CDL description of native dataset

```
time:units = "hours since 1992-01-01T12:00:00"
time:calendar = "proleptic_gregorian"
float32 XC (tile, j, i)
    XC:long_name = "longitude of tracer grid cell center"
    XC:units = "degrees_east"
    XC:coordinate = "YC XC"
    XC:bounds = "XC_bnds"
    XC:comment = "nonuniform grid spacing"
    XC:coverage_content_type = "coordinate"
    XC:standard_name = "longitude"
float32 YC (tile, j, i)
    YC:long_name = "latitude of tracer grid cell center"
    YC:units = "degrees_north"
    YC:coordinate = "YC XC"
    YC:bounds = "YC_bnds"
    YC:comment = "nonuniform grid spacing"
    YC:coverage_content_type = "coordinate"
    YC:standard_name = "latitude"
float32 XG (tile, j_g, i_g)
    XG:long_name = "longitude of 'southwest' corner of tracer grid cell"
    XG:units = "degrees_east"
    XG:coordinate = "YG XG"
    XG:comment = "Nonuniform grid spacing. Note: 'southwest' does not correspond to geographic orientation but is used for convenience to describe the computational grid. See MITgcm documentation for details."
    XG:coverage_content_type = "coordinate"
    XG:standard_name = "longitude"
float32 YG (tile, j_g, i_g)
    YG:long_name = "latitude of 'southwest' corner of tracer grid cell"
    YG:units = "degrees_north"
    YG:coordinate = "YG XG"
    YG:comment = "Nonuniform grid spacing. Note: 'southwest' does not correspond to geographic orientation but is used for convenience to describe the computational grid. See MITgcm documentation for details."
    YG:coverage_content_type = "coordinate"
    YG:standard_name = "latitude"
float32 Z (k)
    Z:long_name = "depth of tracer grid cell center"
    Z:units = "m"
    Z:positive = "up"
    Z:bounds = "Z_bnds"
    Z:comment = "Non-uniform vertical spacing."
    Z:coverage_content_type = "coordinate"
    Z:standard_name = "depth"
float32 Zp1 (k_p1)
    Zp1:long_name = "depth of tracer grid cell interface"
    Zp1:units = "m"
    Zp1:positive = "up"
    Zp1:comment = "Contains one element more than the number of vertical layers. First element is Om, the depth of the upper interface of the surface grid cell. Last element is the depth of the lower interface of the deepest grid cell."
    Zp1:coverage_content_type = "coordinate"
    Zp1:standard_name = "depth"
float32 Zu (k_u)
    Zu:units = "m"
    Zu:positive = "up"
    Zu:coverage_content_type = "coordinate"
    Zu:standard_name = "depth"
    Zu:long_name = "depth of the bottom face of tracer grid cells"
```

**Table 15.3: Example CDL description of native dataset**

Zl:comment = "First element is -10m, the depth of the bottom face of the first tracer grid cell. Last element is the depth of the bottom face of the deepest grid cell. The use of 'u' in the variable name follows the MITgcm convention for ocean variables in which the upper (u) face of a tracer grid cell on the logical grid corresponds to the bottom face of the grid cell on the physical grid. In other words, the logical vertical grid of MITgcm ocean variables is inverted relative to the physical vertical grid."
float32 Zl (k_l) Zl:units = "m" Zl:positive = "up" Zl:coverage_content_type = "coordinate" Zl:standard_name = "depth" Zl:long_name = "depth of the top face of tracer grid cells"
Zl:comment = "First element is 0m, the depth of the top face of the first tracer grid cell (ocean surface). Last element is the depth of the top face of the deepest grid cell. The use of 'l' in the variable name follows the MITgcm convention for ocean variables in which the lower (l) face of a tracer grid cell on the logical grid corresponds to the top face of the grid cell on the physical grid. In other words, the logical vertical grid of MITgcm ocean variables is inverted relative to the physical vertical grid."
int32 time_bnds (time, nv) time_bnds:comment = "Start and end times of averaging period." time_bnds:coverage_content_type = "coordinate" time_bnds:long_name = "time bounds of averaging period"
float32 XC_bnds (tile, j, i, nb) XC_bnds:comment = "Bounds array follows CF conventions. XC_bnds[i,j,0] = 'southwest' corner (j-1, i-1), XC_bnds[i,j,1] = 'southeast' corner (j-1, i+1), XC_bnds[i,j,2] = 'northeast' corner (j+1, i+1), XC_bnds[i,j,3] = 'northwest' corner (j+1, i-1). Note: 'southwest', 'southeast', 'northwest', and 'northeast' do not correspond to geographic orientation but are used for convenience to describe the computational grid. See MITgcm documentation for details." XC_bnds:coverage_content_type = "coordinate" XC_bnds:long_name = "longitudes of tracer grid cell corners"
float32 YC_bnds (tile, j, i, nb) YC_bnds:comment = "Bounds array follows CF conventions. YC_bnds[i,j,0] = 'southwest' corner (j-1, i-1), YC_bnds[i,j,1] = 'southeast' corner (j-1, i+1), YC_bnds[i,j,2] = 'northeast' corner (j+1, i+1), YC_bnds[i,j,3] = 'northwest' corner (j+1, i-1). Note: 'southwest', 'southeast', 'northwest', and 'northeast' do not correspond to geographic orientation but are used for convenience to describe the computational grid. See MITgcm documentation for details." YC_bnds:coverage_content_type = "coordinate" YC_bnds:long_name = "latitudes of tracer grid cell corners"
float32 Z_bnds (k, nv) Z_bnds:comment = "One pair of depths for each vertical level." Z_bnds:coverage_content_type = "coordinate" Z_bnds:long_name = "depths of tracer grid cell upper and lower interfaces"
<b>data variables</b>
float32 ADVx_SLT (time, k, tile, j, i_g) ADVx_SLT:_FillValue = "9.969209968386869e+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:comment = "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 <a href="https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html">https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html</a> " ADVx_SLT:coordinates = "Z time" ADVx_SLT:valid_min = "-181830224.0" ADVx_SLT:valid_max = "260411296.0"

**Table 15.3: Example CDL description of native dataset**

```

float32 DFxE_SLT (time, k, tile, j, i_g)
    DFxE_SLT:_FillValue = "9.969209968386869e+36"
    DFxE_SLT:long_name = "Lateral diffusive flux of salinity in the model +x direction"
    DFxE_SLT:units = "1e-3 m3 s-1"
    DFxE_SLT:mate = "DFyE_SLT"
    DFxE_SLT:coverage_content_type = "modelResult"
    DFxE_SLT:direction = ">0 increases salinity (SALT)"
    DFxE_SLT:comment = "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"
    DFxE_SLT:coordinates = "Z time"
    DFxE_SLT:valid_min = "-125908.03125"
    DFxE_SLT:valid_max = "192716.484375"
float32 ADVy_SLT (time, k, tile, j_g, i)
    ADVy_SLT:_FillValue = "9.969209968386869e+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:comment = "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"
    ADVy_SLT:coordinates = "Z time"
    ADVy_SLT:valid_min = "-137905760.0"
    ADVy_SLT:valid_max = "164271664.0"
float32 DFyE_SLT (time, k, tile, j_g, i)
    DFyE_SLT:_FillValue = "9.969209968386869e+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:comment = "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"
    DFyE_SLT:coordinates = "Z time"
    DFyE_SLT:valid_min = "-114959.2109375"
    DFyE_SLT:valid_max = "154227.140625"

```

**Table 15.3: Example CDL description of native dataset**

```

float32 ADVr_SLT (time, k_l, tile, j, i)
    ADVr_SLT:_FillValue = "9.969209968386869e+36"
    ADVr_SLT:long_name = "Vertical advective flux of salinity"
    ADVr_SLT:units = "1e-3 m3 s-1"
    ADVr_SLT:coverage_content_type = "modelResult"
    ADVr_SLT:direction = ">0 decreases salinity (SALT)"
    ADVr_SLT:comment = "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"
    ADVr_SLT:coordinates = "XC ZI YC time"
    ADVr_SLT:valid_min = "-324149856.0"
    ADVr_SLT:valid_max = "263294624.0"
float32 DFrE_SLT (time, k_l, tile, j, i)
    DFrE_SLT:_FillValue = "9.969209968386869e+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:comment = "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"
    DFrE_SLT:coordinates = "XC ZI YC time"
    DFrE_SLT:valid_min = "-1074719.375"
    DFrE_SLT:valid_max = "471215.75"
float32 DFrl_SLT (time, k_l, tile, j, i)
    DFrl_SLT:_FillValue = "9.969209968386869e+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:comment = "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 +DFrl_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"
    DFrl_SLT:coordinates = "XC ZI YC time"
    DFrl_SLT:valid_min = "-30609048.0"
    DFrl_SLT:valid_max = "3197643.0"
float32 oceSPtnd (time, k, tile, j, i)

```

**Table 15.3: Example CDL description of native dataset**

```

oceSPtnd:_FillValue = "9.969209968386869e+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:comment = "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."
oceSPtnd:coordinates = "XC Z YC time"
oceSPtnd:valid_min = "0.0"
oceSPtnd:valid_max = "0.021119138225913048"

```

#### 15.4.2 Latlon datasets

Hoc est casus simplex. Multae L3, L4, et GMPE comoediae, necnon quaedam geostationaria L2P comoediae, in ordinaria lat/lon tabula praebentur. In huiusmodi projectione, solum duo coordinate sunt requisitae et vectorum formis servari possunt. Longitudines debent variare ab -180 ad +180, id est ab 180 gradibus Occidentem ad 180 gradibus Orientem. Latitudines debent variare ab -90 ad +90, id est ab 90 gradibus Meridiem ad 90 gradibus Septentrionem. Non debet esse \_FillValue pro latitudine et longitudine, et omnes SST pixelles debent habere validum latitudinis et longitudinis valorem.

Recommendatur ut tempus dimensionem pro Level 3 et Level 4 data prodigia ut infinita specificetur. Nota quod tempus dimensio pro L2P data est stricta definita ut tempus=1 (infinita dimensio non permittitur). Hoc strictum definitum est quia L2P data sunt swath based et geospatial informatio potest mutare per consecutive tempus slabs.

In GHRSST L3 et L4 granulis, solum unum tempus dimensio (tempus=1) est, et variabilis tempus solum unum valorem habet (secunda post 1981), sed infinitum tempus dimensionem permittit netCDF instrumenta et utilitates facile concatenare (et exempli gratia, mediare) seriem de tempore consecutive GHRSST granulis. Sequens CDL exemplum dat:

```

netcdf example {
    dimensions:
        lat = 1801 ;
        lon = 3600 ;
        time = UNLIMITED ; // (strictly set to 1 for L2P)
    variables:
        ...
}

```

Pro his casibus, dimensiones et coordinae variables debent uti pro regulari lat/lon tabula, ut in Tabula 8-3 monstratur. Nullae specificae variables attributi sunt requisitae pro aliis variabilibus (ut sea\_surface\_temperature, ut in exemplo dat in Tabula 8-3).

**Table 15.4: Example CDL description of latlon dataset**

netcdf latlon example
dimensions
time = 1
latitude = 360
longitude = 720
nv = 2
coordinates
int32 time (time)
time:axis = "T"
time:bounds = "time_bnds"
time:coverage_content_type = "coordinate"
time:long_name = "center time of averaging period"
time:standard_name = "time"
time:units = "hours since 1992-01-01T12:00:00"

**Table 15.4: Example CDL description of latlon dataset**

<pre> time:calendar = "proleptic_gregorian" float32 latitude (latitude)     latitude:axis = "Y"     latitude:bounds = "latitude_bnds"     latitude:comment = "uniform grid spacing from -89.75 to 89.75 by 0.5"     latitude:coverage_content_type = "coordinate"     latitude:long_name = "latitude at grid cell center"     latitude:standard_name = "latitude"     latitude:units = "degrees_north" float32 longitude (longitude)     longitude:axis = "X"     longitude:bounds = "longitude_bnds"     longitude:comment = "uniform grid spacing from -179.75 to 179.75 by 0.5"     longitude:coverage_content_type = "coordinate"     longitude:long_name = "longitude at grid cell center"     longitude:standard_name = "longitude"     longitude:units = "degrees_east" int32 time_bnds (time, nv)     time_bnds:comment = "Start and end times of averaging period."     time_bnds:coverage_content_type = "coordinate"     time_bnds:long_name = "time bounds of averaging period" float32 latitude_bnds (latitude, nv)     latitude_bnds:coverage_content_type = "coordinate"     latitude_bnds:long_name = "latitude bounds grid cells" float32 longitude_bnds (longitude, nv)     longitude_bnds:coverage_content_type = "coordinate"     longitude_bnds:long_name = "longitude bounds grid cells" </pre>
<p><b>data variables</b></p> <pre> float32 EXFhl (time, latitude, longitude)     EXFhl:_FillValue = "9.969209968386869e+36"     EXFhl:coverage_content_type = "modelResult"     EXFhl:direction = "&gt;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:comment = "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."     EXFhl:coordinates = "time"     EXFhl:valid_min = "-1772.513671875"     EXFhl:valid_max = "273.9528503417969" float32 EXFhs (time, latitude, longitude)     EXFhs:_FillValue = "9.969209968386869e+36"     EXFhs:coverage_content_type = "modelResult"     EXFhs:direction = "&gt;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:comment = "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."     EXFhs:coordinates = "time"     EXFhs:valid_min = "-2478.766357421875"     EXFhs:valid_max = "357.0105895996094" float32 EXFlwdn (time, latitude, longitude)     EXFlwdn:_FillValue = "9.969209968386869e+36"     EXFlwdn:coverage_content_type = "modelResult"     EXFlwdn:direction = "&gt;0 increases potential temperature (THETA)"     EXFlwdn:long_name = "Downward longwave radiative flux" </pre>

**Table 15.4: Example CDL description of latlon dataset**

```

EXFlwdn:standard_name = "surface_downwelling_longwave_flux_in_air"
EXFlwdn:units = "W m-2"
EXFlwdn:comment = "Downward longwave radiative flux. Note: sum of ERA-Interim downward longwave radiation and the control adjustment from ocean state estimation."
EXFlwdn:coordinates = "time"
EXFlwdn:valid_min = "4.188045501708984"
EXFlwdn:valid_max = "513.3919067382812"
float32 EXFswdn (time, latitude, longitude)
    EXFswdn:_FillValue = "9.969209968386869e+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:comment = "Downward shortwave radiative flux. Note: sum of ERA-Interim downward shortwave radiation and the control adjustment from ocean state estimation."
    EXFswdn:coordinates = "time"
    EXFswdn:valid_min = "-224.63368225097656"
    EXFswdn:valid_max = "707.345947265625"
float32 EXFqnet (time, latitude, longitude)
    EXFqnet:_FillValue = "9.969209968386869e+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:comment = "Net air-sea heat flux (turbulent and radiative) per unit area of open water (not covered by sea-ice). Note: net upward heat flux over open water, calculated as EXFlwnet+EXFswnet-EXFlh-EXFhs."
    EXFqnet:coordinates = "time"
    EXFqnet:valid_min = "-687.8736572265625"
    EXFqnet:valid_max = "3408.977783203125"
float32 oceQnet (time, latitude, longitude)
    oceQnet:_FillValue = "9.969209968386869e+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:comment = "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 temperature is not OC. The variable TFLUX does include the change in ocean heat content due to changing ocean mass."
    oceQnet:coordinates = "time"
    oceQnet:valid_min = "-1708.8460693359375"
    oceQnet:valid_max = "675.3716430664062"
float32 SlatmQnt (time, latitude, longitude)
    SlatmQnt:_FillValue = "9.969209968386869e+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"

```

**Table 15.4: Example CDL description of latlon dataset**

```

SlatmQnt:comment = "Net upward heat flux to the atmosphere across open water and sea-ice or snow surfaces. Note: nonzero SlatmQnt 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)."
SlatmQnt:coordinates = "time"
SlatmQnt:valid_min = "-756.0607299804688"
SlatmQnt:valid_max = "1704.7703857421875"
float32 TFLUX (time, latitude, longitude)
TFLUX:_FillValue = "9.969209968386869e+36"
TFLUX:coverage_content_type = "modelResult"
TFLUX:direction = ">0 increases potential temperature (THETA)"
TFLUX:long_name = "Rate of change of ocean heat content per m2 accounting for mass fluxes."
TFLUX:units = "W m-2"
TFLUX:comment = "The rate of change of ocean heat content due to heat fluxes across the liquid surface and the addition or removal of mass. . Note: the global area integral of TFLUX and geothermal flux (geothermalFlux.bin) matches the time-derivative of ocean heat content (J/s). Unlike oceQnet, TFLUX includes the contribution to the ocean heat content from changing ocean mass (e.g. from oceFWflx)."
TFLUX:coordinates = "time"
TFLUX:valid_min = "-1713.51220703125"
TFLUX:valid_max = "870.3130493164062"
float32 EXFswnet (time, latitude, longitude)
EXFswnet:_FillValue = "9.969209968386869e+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:comment = "Net shortwave radiative flux per unit area of open water (not covered by sea-ice). Note: net shortwave radiation over open water calculated from downward shortwave flux (EXFswdn) and ocean surface albdeo."
EXFswnet:coordinates = "time"
EXFswnet:valid_min = "-655.6171264648438"
EXFswnet:valid_max = "193.89297485351562"
float32 EXFlwnet (time, latitude, longitude)
EXFlwnet:_FillValue = "9.969209968386869e+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:comment = "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)."
EXFlwnet:coordinates = "time"
EXFlwnet:valid_min = "-144.3661346435547"
EXFlwnet:valid_max = "293.4114990234375"
float32 oceQsw (time, latitude, longitude)
oceQsw:_FillValue = "9.969209968386869e+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:comment = "Net shortwave radiative flux across the ocean surface. Note: Shortwave radiation penetrates below the surface grid cell."
oceQsw:coordinates = "time"
oceQsw:valid_min = "-134.39808654785156"
oceQsw:valid_max = "655.6171264648438"
float32 Slaaflux (time, latitude, longitude)

```

**Table 15.4: Example CDL description of latlon dataset**

```

Slaaflux:_FillValue = "9.969209968386869e+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:comment = "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."
Slaaflux:coordinates = "time"
Slaaflux:valid_min = "-16.214622497558594"
Slaaflux:valid_max = "50.35451889038086"

```

### 15.4.3 1D datasets

Hoc est casus simplex. Multae L3, L4, et GMPE comoediae, necnon quaedam geostationaria L2P comoediae, in ordinaria lat/lon tabula praebentur. In huiusmodi projectione, solum duo coordinate sunt requisitae et vectorum formis servari possunt. Longitudines debent variare ab -180 ad +180, id est ab 180 gradibus Occidentem ad 180 gradibus Orientem. Latitudines debent variare ab -90 ad +90, id est ab 90 gradibus Meridiem ad 90 gradibus Septentrionem. Non debet esse \_FillValue pro latitudine et longitudine, et omnes SST pixeles debent habere validum latitudinis et longitudinis valorem.

Recommendatur ut tempus dimensionem pro Level 3 et Level 4 data prodigia ut infinita specificetur. Nota quod tempus dimensio pro L2P data est stricta definita ut tempus=1 (infinita dimensio non permittitur). Hoc strictum definitum est quia L2P data sunt swath based et geospatial informatio potest mutare per consecutive tempus slabs.

In GHRSST L3 et L4 granulis, solum unum tempus dimensio (tempus=1) est, et variabilis tempus solum unum valorem habet (secunda post 1981), sed infinitum tempus dimensionem permittit netCDF instrumenta et utilitates facile concatenare (et exempli gratia, mediare) seriem de tempore consecutive GHRSST granulis. Sequens CDL exemplum dat:

```

netcdf example {
    dimensions:
        lat = 1801 ;
        lon = 3600 ;
        time = UNLIMITED ; // (strictly set to 1 for L2P)
    variables:
        ...
}

```

Pro his casibus, dimensiones et coordinae variables debent uti pro regulari lat/lon tabula, ut in Tabula 8-3 monstratur. Nullae specificae variables attributi sunt requisitae pro aliis variabilibus (ut sea\_surface\_temperature, ut in exemplo dat in Tabula 8-3).

**Table 15.5: Example CDL description of 1D dataset**

netcdf 1D example
dimensions
time = 227904
coordinates
int32 time (time) time:axis = "T" time:comment = "" time:coverage_content_type = "coordinate" time:long_name = "snapshot time" time:standard_name = "time" time:units = "hours since 1992-01-01T12:00:00" time:calendar = "proleptic_gregorian"
data variables

**Table 15.5: Example CDL description of 1D dataset**

```
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"
```

>>>> ojh =====

## 16 GDS 2.0 Filenames and Supporting Conventions

Striving to achieve a flexible naming convention that maintains consistency across processing levels and better serves user needs, the GDS 2.0 uses a single form for all GHRSST data files. An overview of the format is presented below in Section 7.1 along with example filenames. Details on each of the filename convention components are provided in Sections 7.2 through 7.8.

In addition, a best practice has been established for creating character strings used to describe GHRSST SST products and sources of ancillary data. These strings, and associated numeric codes for the SST products, are used within some GHRSST data files but are not part of the filename convention itself. The best practice is described in Section 7.9.

### 16.1 1 Overview of Filename Convention and Example Filenames

The filenaming convention for the GDS 2.0 is shown below.

```
<Indicative Date><Indicative Time>-<RDAC>-<Processing Level>_GHRSST-<SST Type>- <Product String>-<Additional Segregator>-v<GDS Version>-fv<File Version>.<File Type>
```

The variable components within braces (“<>”) are summarized in Table 7-1 below and detailed in the **should not** be used in any GHRSST code or the <Additional Segregator> element. Example filenames are given later in this section. While no strict limit to filename length is mandated, RDACs are encouraged to keep the length to less than 240 characters to increase readability and usability.

**Table 16.1: GDS 2.0 Filenaming convention components**

Name	Definition	Description
<Indicative Date>	YYYYMMDD	The identifying date for this data set. See Section 7.2.
<Indicative Time>	HHMMSS	The identifying time for this data set. The time used is dependent on the <Processing Level> of the data set: L2P: start time of granule <ul style="list-style-type: none"> <li>• L3U: start time of granule</li> <li>• L3C and L3S: centre time of the collation window</li> <li>• L4 and GMPE: nominal time of analysis</li> </ul> All times should be given in UTC. See Section 7.3.
<RDAC>	The RDAC where the file was created	The Regional Data Assembly Centre (RDAC)code, listed in Section 7.4.
<Processing Level>	The data processing level code (L2P, L3U, L3C, L3S, or L4)	The data processing level code, defined in Section 7.5.
<SST Type>	The type of SST data included in the file.	Conforms to the GHRSST definitions for SST, defined in Section 7.6
<Product String>	A character string identifying the SST product set. The string is used uniquely within an RDAC but may be shared across RDACs.	The unique “name” within an RDAC of the product line. See Section 7.7 for the product string lists, one each for L2P, L3, L4, and GMPE products. See Section 7.7.
<Additional Segregator>	Optional text to distinguish between files with the same <Product String>. Dashes are not allowed within this element.	This text is used since the other filename components are sometimes insufficient to uniquely identify a file. For example, in L2P or L3U (un-collated) products this is often the original file name or processing algorithm. Note, underscores should be used, not dashes. For L4 files, this element should begin with the appropriate regional code as defined in Section 7.8. This component is optional but must be used in those cases were non-unique filenames would otherwise result.
<GDS Version>	nn.n	Version number of the GDS used to process the file. For example, GDS 2.0 = “02.0”.
<File Version>	xx.x	Version number for the file, for example, “01.0”.

<File Type>	netCDF data file suffix (nc) or ISO metadata file suffix (xml)	Indicates this is a netCDF file containing data or its corresponding ISO-19115 metadata record in XML.
-------------	--	--

### 16.1.1 L2\_GHRSST Filename Example

20070503132300-NAVO-L2P\_GHRSST-SSTblend-AVHRR17\_L-SST\_s0123\_e0135-v02.0-fv01.0.nc

The above file contains GHRSST L2P blended SST data for 03 May 2007, from AVHRR LAC data collected from the NOAA-17 platform. The granule begins at 13:23:00 hours. It is version 1.0 of the file and was produced by the NAVO RDAC in accordance with the GDS 2.0. The <Additional Segregator> text is "SST\_s0123\_e0135".

### 16.1.2 L3\_GHRSST Filename Example

20070503110153-REMSS-L3C\_GHRSST-SSTsubskin-TMI-tmi\_20070503rt-v02.0-fv01.0.nc

The above file was produced by the REMSS RDAC and contains collated L3 sub-skin SST data from the TMI instrument for 03 May 2007. The collated file has a centre time of at 11:01:53 hours. It is version 1.0 of the file and was produced according to GDS 2.0 specifications. Its <Additional Segregator> text is "tmi\_20070503rt".

### 16.1.3 L4\_GHRSST Filename Example

20070503120000-UKMO-L4\_GHRSST-SSTfdn-OSTIA-GLOB-v02.0-fv01.0.nc

The above file contains L4 foundation SST data produced at the UKMO RDAC using the OSTIA system. It is global coverage, contains data for 03 May 2007, was produced to GDS 2.0 specifications and is version 1.0 of the file. The nominal time of the OSTIA analysis is 12:00:00 hours.

## 16.2 <Indicative Date>

The identifying date for this data set, using the format YYYYMMDD, where YYYY is the four-digit year, MM is the two-digit month from 01 to 12, and DD is the two-digit day of month from 01 to 31. The date used should best represent the observation date for the dataset.

## 16.3 <Indicative Time>

The identifying time for this data set in UTC, using the format HHMMSS, where HH is the two-digit hour from 00 to 23, MM is the two-digit minute from 00 to 59, and SS is the two-digit second from 00 to 59. The time used is dependent on the <Processing Level> of the data set:

L2P: start time of granule

L3U: start time of granule

L3C and L3S: centre time of the collation window

L4 and GMPE: nominal time of analysis

All times should be given in UTC and should be chosen to best represent the observation time for this dataset. Note: RDACs should ensure the applications they use to determine UTC properly account for leap seconds.

## 16.4 <RDAC>

Codes used for GHRSST Regional Data Assembly Centres (RDACs) are provided in the table below. New codes are assigned by the GHRSST Data And Systems Technical Advisory Group (DAS-TAG) and entered into the table upon agreement by the GDAC, LTSRF, and relevant RDACs.

## 16.5 <Processing Level>

Satellite data processing level definitions can lead to ambiguous situations, especially regarding the distinction between L3 and L4 products. GHRSST identified the use of analysis procedures to fill gaps where no observations exist to resolve this ambiguity. Within GHRSST filenames, the <Processing Level> codes are shown below in Table 7-3. GHRSST currently establishes standards

for L2P, L3U, L3C, L3S, and L4 (GHRSST Multi-Product Ensembles known as GMPE are a special kind of L4 product for which GHRSST also provides standards).

## 17 GDS 2.0 Data Product File Structure

### 17.1 Overview of the GDS 2.0 netCDF File Format

GDS 2.0 data files preferentially use the **netCDF-4 Classic** format. However, as netCDF-4 is a relatively new format and includes a significant number of new features that may not be well supported by existing user applications and tools, the GHRSST Science Team agreed to support both netCDF-3 and netCDF-4 format data files during a transition period. At the 11th GHRSST Science Team meeting, Lima Peru, 21-25th June 2010 it was agreed that the transition period would end in 2013 at which point (subject to positive developments in the user community using netCDF-4) the use of netCDF-3 format data products will cease within the GHRSST R/GTS framework. **NetCDF-3 data products shall be delivered to the GDAC with an accompanying MMR file records as described in Section 13.** While netCDF-3 can store the metadata, it is computationally expensive to extract it from externally-compressed netCDF-3 files. A major advantage to the use of NetCDF-4 format products from the producer's perspective is that no additional metadata records are required when using this format since the GDAC and LTSRF can easily extract it from the files without having to decompress the entire file.

These GDS 2.0 formatted data sets must comply with the Climate and Forecast (CF) Conventions, v1.4 [AD-3] or later because these conventions provide a practical standard for storing oceanographic data in a robust, easily-preserved for the long-term, and interoperable manner. The CF-compliant netCDF data format is flexible, self-describing, and has been adopted as a de facto standard for many operational and scientific oceanography systems. Both netCDF and CF are actively maintained including significant discussions and inputs from the oceanographic community (see [http://cfpcmdi.1lnl.gov/discussion/index\\_html](http://cfpcmdi.1lnl.gov/discussion/index_html)). The CF convention generalizes and extends the Cooperative Ocean/Atmosphere Research Data Service (COARDS, [AD-4]) Convention but relaxes the COARDS constraints on dimension order and specifies methods for reducing the size of datasets. The purpose of the CF Conventions is to require conforming datasets to contain sufficient metadata so that they are self-describing, in the sense that each variable in the file has an associated description of what it represents, physical units if appropriate, and that each value can be located in space (relative to earthbased coordinates) and time. In addition to the CF Conventions, GDS 2.0 formatted files follow some of the recommendations of the Unidata Attribute Convention for Dataset Discovery (ACDD, [AD-7]).

In the context of netCDF, a variable refers to data stored in the file as a vector or as a multidimensional array. Each variable in a GHRSST netCDF file consists of a 2-dimensional [ $i \times j$ ], 3- dimensional [ $i \times j \times k$ ], or 4-dimensional [ $i \times j \times k \times l$ ] array of data. The dimensions of each variable must be explicitly declared in the dimension section.

Within the netCDF file, global attributes are used to hold information that applies to the whole file, such as the data set title. Each individual variable must also have its own attributes, referred to as variable attributes. These variable attributes define, for example, an offset, scale factor, units, a descriptive version of the variable name, and a fill value, which is used to indicate array elements that do not contain valid data. Where applicable, SI units should be used and described by a character string, which is compatible with the Unidata UDUNITS-2 package [AD-5].

All GHRSST GDS 2.0 files conform to this structure and share a common set of netCDF global attributes. These global attributes include those required by the CF Convention plus additional ones required by the GDS 2.0. The required set of global attributes is described in Section 8.2 and entities within the GHRSST R/GTS framework are free to add their own, as long as they do not contradict the GDS 2.0 and CF requirements.

Following the CF convention, each variable also has a set of variable attributes. The required variable attributes are described in Section 8.3. In a few cases, some of these variable attributes may not be relevant for certain variables or additional variable attributes may be required. In those cases, the variable descriptions in each of the L2P, L3, L4, and GMPE product specifications (Sections 9, 10, 11, and 12) will identify the differences and specify requirements for each product. As with the global attributes, entities within the GHRSST R/GTS framework are free to add their own variable attributes, as long as they do not contradict the GDS 2.0 and CF requirements.

While the exact volumes can vary, an average L2P file will use about 33 bytes per pixel, an L3 file 28 bytes per pixel, and an L4 file about 8 bytes per pixel. The data type encodings for each variable are fixed except for the experimental fields, which are flexible and can chosen by the producing RDAC.

### 17.2 GDS 2.0 netCDF Global Attributes

Table 8-1 below summarizes the global attributes that are mandatory for every GDS 2.0 netCDF data file. More details on the CF-mandated attributes (as indicated in the Source column) are available at: <http://cf-pcmdi.1lnl.gov/documents/cf-conventions/1.4/cf-conventions.html#attribute-appendix> and information on the ACDD recommendations is available at <http://www.unidata.ucar.edu/software/netcdf-java/formats/DataDiscoveryAttConvention.html>.

**Table 17.1: Mandatory global attributes for GDS 2.0 netCDF data files**

Global Attribute Name	Type	Description	Source
acknowledgement	string	A place to acknowledge various types of support for the project that produced this data.	ACDD
cdm_data_type	string	The data type, as derived from Unidata's Common Data Model Scientific Data types and understood by THREDDS. (This is a THREDDS "dataType", and is different from the CF NetCDF attribute 'featureType', which indicates a Discrete Sampling Geometry file in CF.)	ACDD
comment	string	Miscellaneous information about the data, not captured elsewhere. This attribute is defined in the CF Conventions.	CF, ACDD
conventions	string	A text string identifying the netCDF conventions followed (e.g., CF-1.4, ACDD 1-3).	
creator_email	string	The email address of the person (or other creator type specified by the creator_type attribute) principally responsible for creating this data.	ACDD
creator_name	string	The name of the person (or other creator type specified by the creator_type attribute) principally responsible for creating this data.	ACDD
creator_url	string	The URL of the of the person (or other creator type specified by the creator_type attribute) principally responsible for creating this data.	ACDD
date_created	string	The date on which this version of the data was created.	ACDD
easternmost_longitude	float	Decimal degrees east, range -180 to +180. This is equivalent to ACDD geospatial_lon_max.	podaac
geospatial_lat_resolution	float	Latitude Resolution in units matching geospatial_lat_units.	ACDD
geospatial_lat_units	string	Units of the latitudinal resolution. Typically "degrees_north"	ACDD
geospatial_lon_resolution	float	Longitude Resolution in units matching geospatial_lon_resolution	ACDD
geospatial_lon_units	string	Units of the longitudinal resolution. Typically "degrees_east"	ACDD
history	string	The name of the institution principally responsible for originating this data. This attribute is recommended by the CF convention.	CF, ACDD
id	string	An identifier for the data set, provided by and unique within its naming authority. The combination of the "naming authority" and the "id" should be globally unique, but the id can be globally unique by itself also. IDs can be URLs, URNs, DOIs, meaningful text strings, a local key, or any other unique string of characters. The id should not include white space characters.	ACDD
institutions	string	The name of the institution principally responsible for originating this data. This attribute is recommended by the CF convention.	CF, ACDD
keywords	string	GCMD Science Keyword(s)	ACDD
keywords_vocabulary	string	The unique name or identifier of the vocabulary from which keywords are taken. e.g., the NASA Global Change Master Directory (GCMD) Science Keywords.	ACDD
license	string	Provide the URL to a standard or specific license, enter "Freely Distributed" or "None", or describe any restrictions to data access and distribution in free text.	ACDD
Metadata_Conventions	string	A comma-separated list of the conventions that are followed by the dataset.	ACDD
metadata_link	string	Link to collection metadata record at archive	ACDD

**Table 17.1: Mandatory global attributes for GDS 2.0 netCDF data files**

naming_authority	string	The organization that provides the initial id (see above) for the dataset. The naming authority should be uniquely specified by this attribute via reverse-DNS naming convention.	ACDD
netcdf_version_id	string	Version of netCDF libraries used to create this file. For example, "4.1.1"	GDS
northernmost_latitude	float	Decimal degrees north, range -90 to +90. This is equivalent to ACDD geospatial_lat_max.	GDS
processing_level	string	A textual description of the processing (or quality control) level of the data.	ACDD & GDS
product_version	string	The product version of this data file	GDS
project	string	The name of the project(s) principally responsible for originating this data.	ACDD
publisher_email	string	The email address of the person (or other entity specified by the publisher_type attribute) responsible for publishing the data file or product to users, with its current metadata and format.	ACDD
publisher_name	string	The name of the person (or other entity specified by the publisher_type attribute) responsible for publishing the data file or product to users, with its current metadata and format.	ACDD
publisher_url	string	The URL of the person (or other entity specified by the publisher_type attribute) responsible for publishing the data file or product to users, with its current metadata and format.	ACDD
references	string	Published or web-based references that describe the data or methods used to produce it. Recommend URIs (such as a URL or DOI) for papers or other references. This attribute is defined in the CF conventions.	ACDD
source	string	Method of production of the original data.	CF
southernmost_latitude	float	Decimal degrees north, range -90 to +90. This is equivalent to ACDD geospatial_lat_min.	GDS
spatial_resolution	string	A string describing the approximate resolution of the product.	GDS
standard_name_vocabulary	string	The name and version of the controlled vocabulary from which variable standard names are taken.	ACDD
start_time	string	Representative date and time of the end of the granule in the ISO 8601 compliant format of "yyyymmddThh-mmssZ".	GDS
stop_time	string	Representative date and time of the end of the granule in the ISO 8601 compliant format of "yyyymmddThh-mmssZ".	GDS
summary	string	A paragraph describing the dataset, analogous to an abstract for a paper.	ACDD
time_coverage_end	string	Identical to stop_time. Included for increased ACDD compliance.	ACDD
time_coverage_start	string	Identical to start_time. Included for increased ACDD compliance.	ACDD
title	string	A short phrase or sentence describing the dataset. In many discovery systems, the title will be displayed in the results list from a search, and therefore should be human readable and reasonable to display in a list of such names. This attribute is recommended by the NetCDF Users Guide (NUG) and the CF conventions.	CF, ACDD

**Table 17.1: Mandatory global attributes for GDS 2.0 netCDF data files**

uuid	string	A Universally Unique Identifier (UUID). Numerous, simple tools can be used to create a UUID, which is inserted as the value of this attribute. See <a href="http://en.wikipedia.org/wiki/Universally_Unique_Identifier">http://en.wikipedia.org/wiki/Universally_Unique_Identifier</a> for more information and tools.	GDS
westernmost_longitude	float	Decimal degrees east, range -180 to +180. This is equivalent to ACDD geospatial_lon_min.	GDS

### 17.3 GDS 2.0 netCDF Variable Attributes

**Table 17.2: Table 8-2. Variable attributes for GDS 2.0 netCDF data files**

Variable Name	Attribute	Format	Description	Source
_FillValue		Must be the same as the variable type	A value used to indicate array elements containing no valid data. This value must be of the same type as the storage (packed) type; should be set as the minimum value for this type. Note that some netCDF readers are unable to cope with signed bytes and may, in these cases, report fill as 128. Some cases will be reported as unsigned bytes 0 to 255. Required for the majority of variables except mask and l2p_flags.	CF
units		string	Text description of the units, preferably S.I., and must be compatible with the Unidata UDUNITS-2 package [AD-5]. For a given variable (e.g. wind speed), these must be the same for each dataset. Required for the majority of variables except mask, quality_level, and l2p_flags.	CF, ACDD
scale_factor		Must be expressed in the unpacked data type	To be multiplied by the variable to recover the original value. Defined by the producing RDAC. Valid values within {value_min} and {valid_max} should be transformed by {scale_factor} and {add_offset}, otherwise skipped to avoid floating point errors.	CF
add_offset		Must be expressed in the unpacked data type	To be added to the variable after multiplying by the scale factor to recover the original value. If only one of {scale_factor} or {add_offset} is needed, then both should be included anyway to avoid ambiguity, with {scale_factor} defaulting to 1.0 and add_offset defaulting to 0.0. Defined by the producing RDAC.	CF
long_name		string	A free-text descriptive variable name.	CF, ACDD
valid_min		Expressed in same data type as variable	Minimum valid value for this variable once they are packed (in storage type). The fill value should be outside this valid range. Note that some netCDF readers are unable to cope with signed bytes and may, in these cases, report valid min as 129. Some cases as unsigned bytes 0 to 255. Values outside of {valid_min} and {valid_max} will be treated as missing values. Required for all variables except variable time.	CF
valid_max		Expressed in same data type as variable	Maximum valid value for this variable once they are packed (in storage type). The fill value should be outside this valid range. Note that some netCDF readers are unable to cope with signed bytes and may, in these cases, report valid min as 127. Required for all variables except variable time.	CF

**Table 17.2: Table 8-2. Variable attributes for GDS 2.0 netCDF data files**

standard_name	string	Where defined, a standard and unique description of a physical quantity. For the complete list of standard name strings, see [AD-8]. {Do not} include this attribute if no {standard_name} exists.	CF, ACDD
comment	string	Miscellaneous information about the variable or the methods used to produce it.	CF
source	string	{For L2P and L3 files}: For a data variable with a single source, use the GHRSST unique string listed in Table 7-10 if the source is a GHRSST SST product. For other sources, following the best practice described in Section 7.9 to create the character string. If the data variable contains multiple sources, set this string to be the relevant “sources of” variable name. For example, if multiple wind speed sources are used, set {source =} sources_of_wind_speed. {For L4 and GMPE files}: follow the {source} convention used for the global attribute of the same name, but provide in the commas-separated list only the sources relevant to this variable.	CF
references	string	Published or web-based references that describe the data or methods used to produce it. Note that while at least one reference is required in the global attributes (See Table 8-1), references to this specific data variable may also be given.	CF
axis	String	For use with coordinate variables only. The attribute 'axis' may be attached to a coordinate variable and given one of the values "X", "Y", "Z", or "T", which stand for a longitude, latitude, vertical, or time axis respectively. See: <a href="http://cfpcmdi.llnl.gov/documents/cfconventions/1.4/cfconventions.html#coordinate-types">http://cfpcmdi.llnl.gov/documents/cfconventions/1.4/cfconventions.html#coordinate-types</a>	CF
positive	String	For use with a vertical coordinate variables only. May have the value "up" or "down". For example, if an oceanographic netCDF file encodes the depth of the surface as 0 and the depth of 1000 meters as 1000 then the axis would set positive to "down". If a depth of 1000 meters was encoded as -1000, then positive would be set to "up". See the section on vertical-coordinate in [AD-3]	CF
coordinates	String	Identifies auxiliary coordinate variables, label variables, and alternate coordinate variables. See the section on coordinate-system in [AD3]. This attribute must be provided if the data are on a non-regular lat/lon grid (map projection or swath data).	CF
grid_mapping	String	Use this for data variables that are on a projected grid. The attribute takes a string value that is the name of another variable in the file that provides the description of the mapping via a collection of attached attributes. That named variable is called a grid mapping variable and is of arbitrary type since it contains no data. Its purpose is to act as a container for the attributes that define the mapping. See the section on mappings-and-projections in [AD-3]	CF
flag_mappings	String	Space-separated list of text descriptions associated in strict order with conditions set by either flag_values or flag_masks. Words within a phrase should be connected with underscores.	CF

**Table 17.2: Table 8-2. Variable attributes for GDS 2.0 netCDF data files**

flag_values	Must be the same as the variable type	Comma-separated array of valid, mutually exclusive variable values (required when the bit field contains enumerated values; i.e., a “list” of conditions). Used primarily for {quality_level} and “{sources_of_xxx}” variables.	CF
flag_masks	Must be the same as the variable type	Comma-separated array of valid variable masks (required when the bit field contains independent Boolean conditions; i.e., a bit “mask”). Used primarily for {l2p_flags} variable.  {Note: CF allows the use of both flag_masks and flag_values attributes in a single variable to create sets of masks that each have their own list of flag_values (see <a href="http://cfpcmdi.llnl.gov/documents/cfconventions/1.5/ch03s05.html#id2710752">http://cfpcmdi.llnl.gov/documents/cfconventions/1.5/ch03s05.html#id2710752</a> for examples), but this practice is discouraged.}	CF
depth	String	Use this to indicate the depth for which the SST data are valid.	GDS
height	String	Use this to indicate the height for which the wind data are specified.	GDS
time_offset	Must be expressed in the unpacked data type	Difference in hours between an ancillary field such as {wind_speed} and the SST observation time	GDS

## 17.4 GDS 2.0 coordinate variable definitions

NetCDF coordinate variables provide scales for the space and time axes for the multidimensional data arrays, and must be included for all dimensions that can be identified as spatio-temporal axes. Coordinate arrays are used to geolocate data arrays on non-orthogonal grids, such as images in the original pixel/scan line space, or complicated map projections. Required attributes are `units` and `_FillValue`. Elements of the coordinate array need not be monotonically ordered. The data type can be any and scaling may be implemented if required. `add_offset` and `scale_factor` have to be adjusted according to the sensor resolution and the product spatial coverage. If the packed values can not stand on a short, float can be used instead (multiplying the size of these variables by two).

'time' is the reference time of the SST data array. The GDS 2.0 specifies that this reference time should be extracted or computed to the nearest second and then coded as continuous UTC time coordinates in seconds from 00:00:00 UTC January 1, 1981 (which is the definition of the **GHSST** origin time, chosen to approximate the start of useful AVHRR SST data record). Note that the use of UDUNITS in GHSST implies that that calendar to be used is the default mixed Gregorian/Julian calendar.

The reference time used is dependent on the <Processing Level> of the data and is defined as follows:

- L2P: start time of granule;
- L3U: start time of granule;
- L3C and L3S: centre time of the collation window;
- L4 and GMPE: nominal time of the analysis

The coordinate variable 'time' is intended to minimize the size of the `sst_dtime` variable (e.g., see Section 9.4), which stores offsets from the reference time in seconds for each SST pixel. 'time' also facilitates aggregation of all files of a given dataset along the time axis with such tools as THREDDS and LAS.

x (columns) and y (lines) grid dimensions are referred either as 'lat' and 'lon' or as 'ni' and 'nj'. lon and lat must be used if data are mapped on a regular grid (some geostationary products). ni and nj are used if data are mapped on a non-regular grid (curvilinear coordinates) or following the sensor scanning pattern (scan line, swath). It is preferred that ni should be used for the across-track dimension and nj for the along-track dimension.

Coordinate vectors are used for data arrays located on orthogonal (but not necessarily regularly spaced) grids, such as a geographic (lat-lon) map projections. The only required attribute is `units`. The elements of a coordinate vector array should be in monotonically increasing or decreasing order. The data type can be any and scaling may be implemented if required.

A coordinate's variable (= "lon lat"): must be provided if the data are on a non-regular lat/lon grid (map projection or swath data).

A grid\_mapping (= "projection name"): must be provided if the data are mapped following a projection. Refer to the CF convention [AD-3] for standard projection names.

### 17.4.1 Native datasets

Hoc est casus simplex. Multae L3, L4, et GMPE comoediae, necnon quaedam geostationaria L2P comoediae, in ordinaria lat/lon tabula praebentur. In huiusmodi projectione, solum duo coordinate sunt requisitae et vectorum formis servari possunt. Longitudines debent variare ab -180 ad +180, id est ab 180 gradibus Occidentem ad 180 gradibus Orientem. Latitudines debent variare ab -90 ad +90, id est ab 90 gradibus Meridiem ad 90 gradibus Septentrionem. Non debet esse \_FillValue pro latitudine et longitudine, et omnes SST pixeles debent habere validum latitudinis et longitudinis valorem.

Recommendatur ut tempus dimensionem pro Level 3 et Level 4 data prodigia ut infinita specificetur. Nota quod tempus dimensio pro L2P data est stricta definita ut tempus=1 (infinita dimensio non permittitur). Hoc strictum definitum est quia L2P data sunt swath based et geospatial informatio potest mutare per consecutive tempus slabs.

In GHRSST L3 et L4 granulis, solum unum tempus dimensio (tempus=1) est, et variabilis tempus solum unum valorem habet (secunda post 1981), sed infinitum tempus dimensionem permittit netCDF instrumenta et utilitates facile concatenare (et exempli gratia, mediare) seriem de tempore consecutive GHRSST granulis. Sequens CDL exemplum dat:

```
netcdf example {
    dimensions:
        lat = 1801 ;
        lon = 3600 ;
        time = UNLIMITED ; // (strictly set to 1 for L2P)
    variables:
        ...
}
```

Pro his casibus, dimensiones et coordinae variables debent uti pro regulari lat/lon tabula, ut in Tabula 8-3 monstratur. Nullae specificae variables attributi sunt requisitae pro aliis variabilibus (ut sea\_surface\_temperature, ut in exemplo dat in Tabula 8-3).

**Table 17.3: Example CDL description of native dataset**

netcdf native example
dimensions
i = 90 i_g = 90 j = 90 j_g = 90 k = 50 k_u = 50 k_l = 50 k_p1 = 51 tile = 13 time = 1 nv = 2 nb = 4
coordinates
int32 i (i) i:axis = "X" i:long_name = "grid index in x for variables at tracer and 'v' locations" i:swap_dim = "XC" i:comment = "In the Arakawa C-grid system, tracer (e.g., THETA) and 'v' variables (e.g., VVEL) have the same x coordinate on the model grid." i:coverage_content_type = "coordinate" int32 i_g (i_g) i_g:axis = "X" i_g:long_name = "grid index in x for variables at 'u' and 'g' locations" i_g:c_grid_axis_shift = "-0.5" i_g:swap_dim = "XG"

**Table 17.3: Example CDL description of native dataset**

```
i_g:comment = "In the Arakawa C-grid system, 'u' (e.g., UVEL) and 'g' variables (e.g., XG) have the same x coordinate on  
the model grid."  
    i_g:coverage_content_type = "coordinate"  
int32 j (j)  
    j:axis = "Y"  
    j:long_name = "grid index in y for variables at tracer and 'u' locations"  
    j:swap_dim = "YC"  
    j:comment = "In the Arakawa C-grid system, tracer (e.g., THETA) and 'u' variables (e.g., UVEL) have the same y coordinate  
on the model grid."  
    j:coverage_content_type = "coordinate"  
int32 j_g (j_g)  
    j_g:axis = "Y"  
    j_g:long_name = "grid index in y for variables at 'v' and 'g' locations"  
    j_g:c_grid_axis_shift = "-0.5"  
    j_g:swap_dim = "YG"  
    j_g:comment = "In the Arakawa C-grid system, 'v' (e.g., VVEL) and 'g' variables (e.g., XG) have the same y coordinate."  
    j_g:coverage_content_type = "coordinate"  
int32 k (k)  
    k:axis = "Z"  
    k:long_name = "grid index in z for tracer variables"  
    k:swap_dim = "Z"  
    k:coverage_content_type = "coordinate"  
int32 k_u (k_u)  
    k_u:axis = "Z"  
    k_u:c_grid_axis_shift = "0.5"  
    k_u:swap_dim = "Zu"  
    k_u:coverage_content_type = "coordinate"  
    k_u:long_name = "grid index in z corresponding to the bottom face of tracer grid cells ('w' locations)"  
    k_u:comment = "First index corresponds to the bottom surface of the uppermost tracer grid cell. The use of 'u' in the  
variable name follows the MITgcm convention for ocean variables in which the upper (u) face of a tracer grid cell on the logical  
grid corresponds to the bottom face of the grid cell on the physical grid."  
int32 k_l (k_l)  
    k_l:axis = "Z"  
    k_l:c_grid_axis_shift = "-0.5"  
    k_l:swap_dim = "Zl"  
    k_l:coverage_content_type = "coordinate"  
    k_l:long_name = "grid index in z corresponding to the top face of tracer grid cells ('w' locations)"  
    k_l:comment = "First index corresponds to the top surface of the uppermost tracer grid cell. The use of 'l' in the variable  
name follows the MITgcm convention for ocean variables in which the lower (l) face of a tracer grid cell on the logical grid  
corresponds to the top face of the grid cell on the physical grid."  
int32 k_p1 (k_p1)  
    k_p1:axis = "Z"  
    k_p1:long_name = "grid index in z for variables at 'w' locations"  
    k_p1:c_grid_axis_shift = "[-0.5 0.5]"  
    k_p1:swap_dim = "Zp1"  
    k_p1:comment = "Includes top of uppermost model tracer cell (k_p1=0) and bottom of lowermost tracer cell (k_p1=51)."   
    k_p1:coverage_content_type = "coordinate"  
int32 tile (tile)  
    tile:long_name = "lat-lon-cap tile index"  
    tile:comment = "The ECCO V4 horizontal model grid is divided into 13 tiles of 90x90 cells for convenience."  
    tile:coverage_content_type = "coordinate"  
int32 time (time)  
    time:long_name = "center time of averaging period"  
    time:axis = "T"  
    time:bounds = "time_bnds"  
    time:coverage_content_type = "coordinate"  
    time:standard_name = "time"
```

**Table 17.3: Example CDL description of native dataset**

```

time:units = "hours since 1992-01-01T12:00:00"
time:calendar = "proleptic_gregorian"
float32 XC (tile, j, i)
    XC:long_name = "longitude of tracer grid cell center"
    XC:units = "degrees_east"
    XC:coordinate = "YC XC"
    XC:bounds = "XC_bnds"
    XC:comment = "nonuniform grid spacing"
    XC:coverage_content_type = "coordinate"
    XC:standard_name = "longitude"
float32 YC (tile, j, i)
    YC:long_name = "latitude of tracer grid cell center"
    YC:units = "degrees_north"
    YC:coordinate = "YC XC"
    YC:bounds = "YC_bnds"
    YC:comment = "nonuniform grid spacing"
    YC:coverage_content_type = "coordinate"
    YC:standard_name = "latitude"
float32 XG (tile, j_g, i_g)
    XG:long_name = "longitude of 'southwest' corner of tracer grid cell"
    XG:units = "degrees_east"
    XG:coordinate = "YG XG"
    XG:comment = "Nonuniform grid spacing. Note: 'southwest' does not correspond to geographic orientation but is used for convenience to describe the computational grid. See MITgcm documentation for details."
    XG:coverage_content_type = "coordinate"
    XG:standard_name = "longitude"
float32 YG (tile, j_g, i_g)
    YG:long_name = "latitude of 'southwest' corner of tracer grid cell"
    YG:units = "degrees_north"
    YG:coordinate = "YG XG"
    YG:comment = "Nonuniform grid spacing. Note: 'southwest' does not correspond to geographic orientation but is used for convenience to describe the computational grid. See MITgcm documentation for details."
    YG:coverage_content_type = "coordinate"
    YG:standard_name = "latitude"
float32 Z (k)
    Z:long_name = "depth of tracer grid cell center"
    Z:units = "m"
    Z:positive = "up"
    Z:bounds = "Z_bnds"
    Z:comment = "Non-uniform vertical spacing."
    Z:coverage_content_type = "coordinate"
    Z:standard_name = "depth"
float32 Zp1 (k_p1)
    Zp1:long_name = "depth of tracer grid cell interface"
    Zp1:units = "m"
    Zp1:positive = "up"
    Zp1:comment = "Contains one element more than the number of vertical layers. First element is Om, the depth of the upper interface of the surface grid cell. Last element is the depth of the lower interface of the deepest grid cell."
    Zp1:coverage_content_type = "coordinate"
    Zp1:standard_name = "depth"
float32 Zu (k_u)
    Zu:units = "m"
    Zu:positive = "up"
    Zu:coverage_content_type = "coordinate"
    Zu:standard_name = "depth"
    Zu:long_name = "depth of the bottom face of tracer grid cells"

```

**Table 17.3: Example CDL description of native dataset**

<p>Zu:comment = "First element is -10m, the depth of the bottom face of the first tracer grid cell. Last element is the depth of the bottom face of the deepest grid cell. The use of 'u' in the variable name follows the MITgcm convention for ocean variables in which the upper (u) face of a tracer grid cell on the logical grid corresponds to the bottom face of the grid cell on the physical grid. In other words, the logical vertical grid of MITgcm ocean variables is inverted relative to the physical vertical grid."</p> <pre>float32 Zl (k_l)   Zl:units = "m"   Zl:positive = "up"   Zl:coverage_content_type = "coordinate"   Zl:standard_name = "depth"   Zl:long_name = "depth of the top face of tracer grid cells"</pre> <p>Zl:comment = "First element is 0m, the depth of the top face of the first tracer grid cell (ocean surface). Last element is the depth of the top face of the deepest grid cell. The use of 'l' in the variable name follows the MITgcm convention for ocean variables in which the lower (l) face of a tracer grid cell on the logical grid corresponds to the top face of the grid cell on the physical grid. In other words, the logical vertical grid of MITgcm ocean variables is inverted relative to the physical vertical grid."</p> <pre>int32 time_bnds (time, nv)   time_bnds:comment = "Start and end times of averaging period."   time_bnds:coverage_content_type = "coordinate"   time_bnds:long_name = "time bounds of averaging period"</pre> <pre>float32 XC_bnds (tile, j, i, nb)   XC_bnds:comment = "Bounds array follows CF conventions. XC_bnds[i,j,0] = 'southwest' corner (j-1, i-1), XC_bnds[i,j,1] = 'southeast' corner (j-1, i+1), XC_bnds[i,j,2] = 'northeast' corner (j+1, i+1), XC_bnds[i,j,3] = 'northwest' corner (j+1, i-1). Note: 'southwest', 'southeast', 'northwest', and 'northeast' do not correspond to geographic orientation but are used for convenience to describe the computational grid. See MITgcm documentation for details."     XC_bnds:coverage_content_type = "coordinate"     XC_bnds:long_name = "longitudes of tracer grid cell corners"</pre> <pre>float32 YC_bnds (tile, j, i, nb)   YC_bnds:comment = "Bounds array follows CF conventions. YC_bnds[i,j,0] = 'southwest' corner (j-1, i-1), YC_bnds[i,j,1] = 'southeast' corner (j-1, i+1), YC_bnds[i,j,2] = 'northeast' corner (j+1, i+1), YC_bnds[i,j,3] = 'northwest' corner (j+1, i-1). Note: 'southwest', 'southeast', 'northwest', and 'northeast' do not correspond to geographic orientation but are used for convenience to describe the computational grid. See MITgcm documentation for details."     YC_bnds:coverage_content_type = "coordinate"     YC_bnds:long_name = "latitudes of tracer grid cell corners"</pre> <pre>float32 Z_bnds (k, nv)   Z_bnds:comment = "One pair of depths for each vertical level."   Z_bnds:coverage_content_type = "coordinate"   Z_bnds:long_name = "depths of tracer grid cell upper and lower interfaces"</pre>
<p>data variables</p> <pre>float32 ADVx_SLT (time, k, tile, j, i_g)   ADVx_SLT:_FillValue = "9.969209968386869e+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 = "&gt;O increases salinity (SALT)"    ADVx_SLT:comment = "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 <a href="https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html">https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html</a>"</pre> <pre>  ADVx_SLT:coordinates = "Z time"   ADVx_SLT:valid_min = "-181830224.0"   ADVx_SLT:valid_max = "260411296.0"</pre>

**Table 17.3: Example CDL description of native dataset**

```

float32 DFxE_SLT (time, k, tile, j, i_g)
    DFxE_SLT:_FillValue = "9.969209968386869e+36"
    DFxE_SLT:long_name = "Lateral diffusive flux of salinity in the model +x direction"
    DFxE_SLT:units = "1e-3 m3 s-1"
    DFxE_SLT:mate = "DFyE_SLT"
    DFxE_SLT:coverage_content_type = "modelResult"
    DFxE_SLT:direction = ">0 increases salinity (SALT)"
    DFxE_SLT:comment = "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"
    DFxE_SLT:coordinates = "Z time"
    DFxE_SLT:valid_min = "-125908.03125"
    DFxE_SLT:valid_max = "192716.484375"
float32 ADVy_SLT (time, k, tile, j_g, i)
    ADVy_SLT:_FillValue = "9.969209968386869e+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:comment = "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"
    ADVy_SLT:coordinates = "Z time"
    ADVy_SLT:valid_min = "-137905760.0"
    ADVy_SLT:valid_max = "164271664.0"
float32 DFyE_SLT (time, k, tile, j_g, i)
    DFyE_SLT:_FillValue = "9.969209968386869e+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:comment = "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"
    DFyE_SLT:coordinates = "Z time"
    DFyE_SLT:valid_min = "-114959.2109375"
    DFyE_SLT:valid_max = "154227.140625"

```

**Table 17.3: Example CDL description of native dataset**

```

float32 ADVr_SLT (time, k_l, tile, j, i)
    ADVr_SLT:_FillValue = "9.969209968386869e+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:comment = "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"
    ADVr_SLT:coordinates = "XC ZI YC time"
    ADVr_SLT:valid_min = "-324149856.0"
    ADVr_SLT:valid_max = "263294624.0"
float32 DFrE_SLT (time, k_l, tile, j, i)
    DFrE_SLT:_FillValue = "9.969209968386869e+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 = ">O decreases salinity (SALT)"
    DFrE_SLT:comment = "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"
    DFrE_SLT:coordinates = "XC ZI YC time"
    DFrE_SLT:valid_min = "-1074719.375"
    DFrE_SLT:valid_max = "471215.75"
float32 DFrl_SLT (time, k_l, tile, j, i)
    DFrl_SLT:_FillValue = "9.969209968386869e+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 = ">O decreases salinity (SALT)"
    DFrl_SLT:comment = "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 +DFrl_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"
    DFrl_SLT:coordinates = "XC ZI YC time"
    DFrl_SLT:valid_min = "-30609048.0"
    DFrl_SLT:valid_max = "3197643.0"
float32 oceSPtnd (time, k, tile, j, i)

```

**Table 17.3: Example CDL description of native dataset**

```

oceSPtnd:_FillValue = "9.969209968386869e+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:comment = "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."
oceSPtnd:coordinates = "XC Z YC time"
oceSPtnd:valid_min = "0.0"
oceSPtnd:valid_max = "0.021119138225913048"

```

#### 17.4.2 Latlon datasets

Hoc est casus simplex. Multae L3, L4, et GMPE comoediae, necnon quaedam geostationaria L2P comoediae, in ordinaria lat/lon tabula praebentur. In huiusmodi projectione, solum duo coordinate sunt requisitae et vectorum formis servari possunt. Longitudines debent variare ab -180 ad +180, id est ab 180 gradibus Occidentem ad 180 gradibus Orientem. Latitudines debent variare ab -90 ad +90, id est ab 90 gradibus Meridiem ad 90 gradibus Septentrionem. Non debet esse \_FillValue pro latitudine et longitudine, et omnes SST pixeles debent habere validum latitudinis et longitudinis valorem.

Recommendatur ut tempus dimensionem pro Level 3 et Level 4 data prodigia ut infinita specificetur. Nota quod tempus dimensio pro L2P data est stricta definita ut tempus=1 (infinita dimensio non permittitur). Hoc strictum definitum est quia L2P data sunt swath based et geospatial informatio potest mutare per consecutive tempus slabs.

In GHRSST L3 et L4 granulis, solum unum tempus dimensio (tempus=1) est, et variabilis tempus solum unum valorem habet (secunda post 1981), sed infinitum tempus dimensionem permittit netCDF instrumenta et utilitates facile concatenare (et exempli gratia, mediare) seriem de tempore consecutive GHRSST granulis. Sequens CDL exemplum dat:

```

netcdf example {
    dimensions:
        lat = 1801 ;
        lon = 3600 ;
        time = UNLIMITED ; // (strictly set to 1 for L2P)
    variables:
        ...
}

```

Pro his casibus, dimensiones et coordinae variables debent uti pro regulari lat/lon tabula, ut in Tabula 8-3 monstratur. Nullae specificae variables attributi sunt requisitae pro aliis variabilibus (ut sea\_surface\_temperature, ut in exemplo dat in Tabula 8-3).

**Table 17.4: Example CDL description of latlon dataset**

netcdf latlon example
dimensions
time = 1
latitude = 360
longitude = 720
nv = 2
coordinates
int32 time (time)
time:axis = "T"
time:bounds = "time_bnds"
time:coverage_content_type = "coordinate"
time:long_name = "center time of averaging period"
time:standard_name = "time"
time:units = "hours since 1992-01-01T12:00:00"

**Table 17.4: Example CDL description of latlon dataset**

<pre> time:calendar = "proleptic_gregorian" float32 latitude (latitude)     latitude:axis = "Y"     latitude:bounds = "latitude_bnds"     latitude:comment = "uniform grid spacing from -89.75 to 89.75 by 0.5"     latitude:coverage_content_type = "coordinate"     latitude:long_name = "latitude at grid cell center"     latitude:standard_name = "latitude"     latitude:units = "degrees_north" float32 longitude (longitude)     longitude:axis = "X"     longitude:bounds = "longitude_bnds"     longitude:comment = "uniform grid spacing from -179.75 to 179.75 by 0.5"     longitude:coverage_content_type = "coordinate"     longitude:long_name = "longitude at grid cell center"     longitude:standard_name = "longitude"     longitude:units = "degrees_east" int32 time_bnds (time, nv)     time_bnds:comment = "Start and end times of averaging period."     time_bnds:coverage_content_type = "coordinate"     time_bnds:long_name = "time bounds of averaging period" float32 latitude_bnds (latitude, nv)     latitude_bnds:coverage_content_type = "coordinate"     latitude_bnds:long_name = "latitude bounds grid cells" float32 longitude_bnds (longitude, nv)     longitude_bnds:coverage_content_type = "coordinate"     longitude_bnds:long_name = "longitude bounds grid cells" </pre>
<p><b>data variables</b></p> <pre> float32 EXFhl (time, latitude, longitude)     EXFhl:_FillValue = "9.969209968386869e+36"     EXFhl:coverage_content_type = "modelResult"     EXFhl:direction = "&gt;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:comment = "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."     EXFhl:coordinates = "time"     EXFhl:valid_min = "-1772.513671875"     EXFhl:valid_max = "273.9528503417969" float32 EXFhs (time, latitude, longitude)     EXFhs:_FillValue = "9.969209968386869e+36"     EXFhs:coverage_content_type = "modelResult"     EXFhs:direction = "&gt;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:comment = "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."     EXFhs:coordinates = "time"     EXFhs:valid_min = "-2478.766357421875"     EXFhs:valid_max = "357.0105895996094" float32 EXFlwdn (time, latitude, longitude)     EXFlwdn:_FillValue = "9.969209968386869e+36"     EXFlwdn:coverage_content_type = "modelResult"     EXFlwdn:direction = "&gt;0 increases potential temperature (THETA)"     EXFlwdn:long_name = "Downward longwave radiative flux" </pre>

**Table 17.4: Example CDL description of latlon dataset**

```

EXFlwdn:standard_name = "surface_downwelling_longwave_flux_in_air"
EXFlwdn:units = "W m-2"
EXFlwdn:comment = "Downward longwave radiative flux. Note: sum of ERA-Interim downward longwave radiation and the control adjustment from ocean state estimation."
EXFlwdn:coordinates = "time"
EXFlwdn:valid_min = "4.188045501708984"
EXFlwdn:valid_max = "513.3919067382812"
float32 EXFswdn (time, latitude, longitude)
    EXFswdn:_FillValue = "9.969209968386869e+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:comment = "Downward shortwave radiative flux. Note: sum of ERA-Interim downward shortwave radiation and the control adjustment from ocean state estimation."
    EXFswdn:coordinates = "time"
    EXFswdn:valid_min = "-224.63368225097656"
    EXFswdn:valid_max = "707.345947265625"
float32 EXFqnet (time, latitude, longitude)
    EXFqnet:_FillValue = "9.969209968386869e+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:comment = "Net air-sea heat flux (turbulent and radiative) per unit area of open water (not covered by sea-ice). Note: net upward heat flux over open water, calculated as EXFlwnet+EXFswnet-EXFlh-EXFhs."
    EXFqnet:coordinates = "time"
    EXFqnet:valid_min = "-687.8736572265625"
    EXFqnet:valid_max = "3408.977783203125"
float32 oceQnet (time, latitude, longitude)
    oceQnet:_FillValue = "9.969209968386869e+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:comment = "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 temperature is not OC. The variable TFLUX does include the change in ocean heat content due to changing ocean mass."
    oceQnet:coordinates = "time"
    oceQnet:valid_min = "-1708.8460693359375"
    oceQnet:valid_max = "675.3716430664062"
float32 SlatmQnt (time, latitude, longitude)
    SlatmQnt:_FillValue = "9.969209968386869e+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"

```

**Table 17.4: Example CDL description of latlon dataset**

```

SlatmQnt:comment = "Net upward heat flux to the atmosphere across open water and sea-ice or snow surfaces. Note: nonzero SlatmQnt 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)."
SlatmQnt:coordinates = "time"
SlatmQnt:valid_min = "-756.0607299804688"
SlatmQnt:valid_max = "1704.7703857421875"
float32 TFLUX (time, latitude, longitude)
TFLUX:_FillValue = "9.969209968386869e+36"
TFLUX:coverage_content_type = "modelResult"
TFLUX:direction = ">0 increases potential temperature (THETA)"
TFLUX:long_name = "Rate of change of ocean heat content per m2 accounting for mass fluxes."
TFLUX:units = "W m-2"
TFLUX:comment = "The rate of change of ocean heat content due to heat fluxes across the liquid surface and the addition or removal of mass. . Note: the global area integral of TFLUX and geothermal flux (geothermalFlux.bin) matches the time-derivative of ocean heat content (J/s). Unlike oceQnet, TFLUX includes the contribution to the ocean heat content from changing ocean mass (e.g. from oceFWflx)."
TFLUX:coordinates = "time"
TFLUX:valid_min = "-1713.51220703125"
TFLUX:valid_max = "870.3130493164062"
float32 EXFswnet (time, latitude, longitude)
EXFswnet:_FillValue = "9.969209968386869e+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:comment = "Net shortwave radiative flux per unit area of open water (not covered by sea-ice). Note: net shortwave radiation over open water calculated from downward shortwave flux (EXFswdn) and ocean surface albdeo."
EXFswnet:coordinates = "time"
EXFswnet:valid_min = "-655.6171264648438"
EXFswnet:valid_max = "193.89297485351562"
float32 EXFlwnet (time, latitude, longitude)
EXFlwnet:_FillValue = "9.969209968386869e+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:comment = "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)."
EXFlwnet:coordinates = "time"
EXFlwnet:valid_min = "-144.3661346435547"
EXFlwnet:valid_max = "293.4114990234375"
float32 oceQsw (time, latitude, longitude)
oceQsw:_FillValue = "9.969209968386869e+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:comment = "Net shortwave radiative flux across the ocean surface. Note: Shortwave radiation penetrates below the surface grid cell."
oceQsw:coordinates = "time"
oceQsw:valid_min = "-134.39808654785156"
oceQsw:valid_max = "655.6171264648438"
float32 Slaaflux (time, latitude, longitude)

```

**Table 17.4: Example CDL description of latlon dataset**

```

Slaaflux:_FillValue = "9.969209968386869e+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:comment = "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."
Slaaflux:coordinates = "time"
Slaaflux:valid_min = "-16.214622497558594"
Slaaflux:valid_max = "50.35451889038086"

```

### 17.4.3 1D datasets

Hoc est casus simplex. Multae L3, L4, et GMPE comoediae, necnon quaedam geostationaria L2P comoediae, in ordinaria lat/lon tabula praebentur. In huiusmodi projectione, solum duo coordinate sunt requisitae et vectorum formis servari possunt. Longitudines debent variare ab -180 ad +180, id est ab 180 gradibus Occidentem ad 180 gradibus Orientem. Latitudines debent variare ab -90 ad +90, id est ab 90 gradibus Meridiem ad 90 gradibus Septentrionem. Non debet esse \_FillValue pro latitudine et longitudine, et omnes SST pixeles debent habere validum latitudinis et longitudinis valorem.

Recommendatur ut tempus dimensionem pro Level 3 et Level 4 data prodigia ut infinita specificetur. Nota quod tempus dimensio pro L2P data est stricta definita ut tempus=1 (infinita dimensio non permittitur). Hoc strictum definitum est quia L2P data sunt swath based et geospatial informatio potest mutare per consecutive tempus slabs.

In GHRSST L3 et L4 granulis, solum unum tempus dimensio (tempus=1) est, et variabilis tempus solum unum valorem habet (secunda post 1981), sed infinitum tempus dimensionem permittit netCDF instrumenta et utilitates facile concatenare (et exempli gratia, mediare) seriem de tempore consecutive GHRSST granulis. Sequens CDL exemplum dat:

```

netcdf example {
    dimensions:
        lat = 1801 ;
        lon = 3600 ;
        time = UNLIMITED ; // (strictly set to 1 for L2P)
    variables:
        ...
}

```

Pro his casibus, dimensiones et coordinae variables debent uti pro regulari lat/lon tabula, ut in Tabula 8-3 monstratur. Nullae specificae variables attributi sunt requisitae pro aliis variabilibus (ut sea\_surface\_temperature, ut in exemplo dat in Tabula 8-3).

**Table 17.5: Example CDL description of 1D dataset**

netcdf 1D example
dimensions
time = 227904
coordinates
int32 time (time) time:axis = "T" time:comment = "" time:coverage_content_type = "coordinate" time:long_name = "snapshot time" time:standard_name = "time" time:units = "hours since 1992-01-01T12:00:00" time:calendar = "proleptic_gregorian"
data variables

**Table 17.5: Example CDL description of 1D dataset**

```
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"
```

>>> ojh

## 18 Native Dataset Coordinate Variables

### 18.1 Overview of the Native Dataset Coordinate Variables

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Vivamus at enim eget nisi ultrices facilisis a et purus. Sed tincidunt scelerisque ligula, in vehicula dui venenatis at. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Curabitur consequat commodo nunc, nec lacinia quam feugiat vel. Integer bibendum lectus sit amet quam elementum, ut pretium quam malesuada. Cras fermentum venenatis augue, id commodo libero facilisis nec. Quisque euismod, odio vitae dapibus convallis, justo enim iaculis metus, vel interdum elit nisi vel lectus. Fusce tempor elit in semper condimentum. Ut quis dui eget purus cursus interdum eu ac elit!

## 18.2 Native coordinates NetCDF GRID\_GEOMETRY\_ECCO

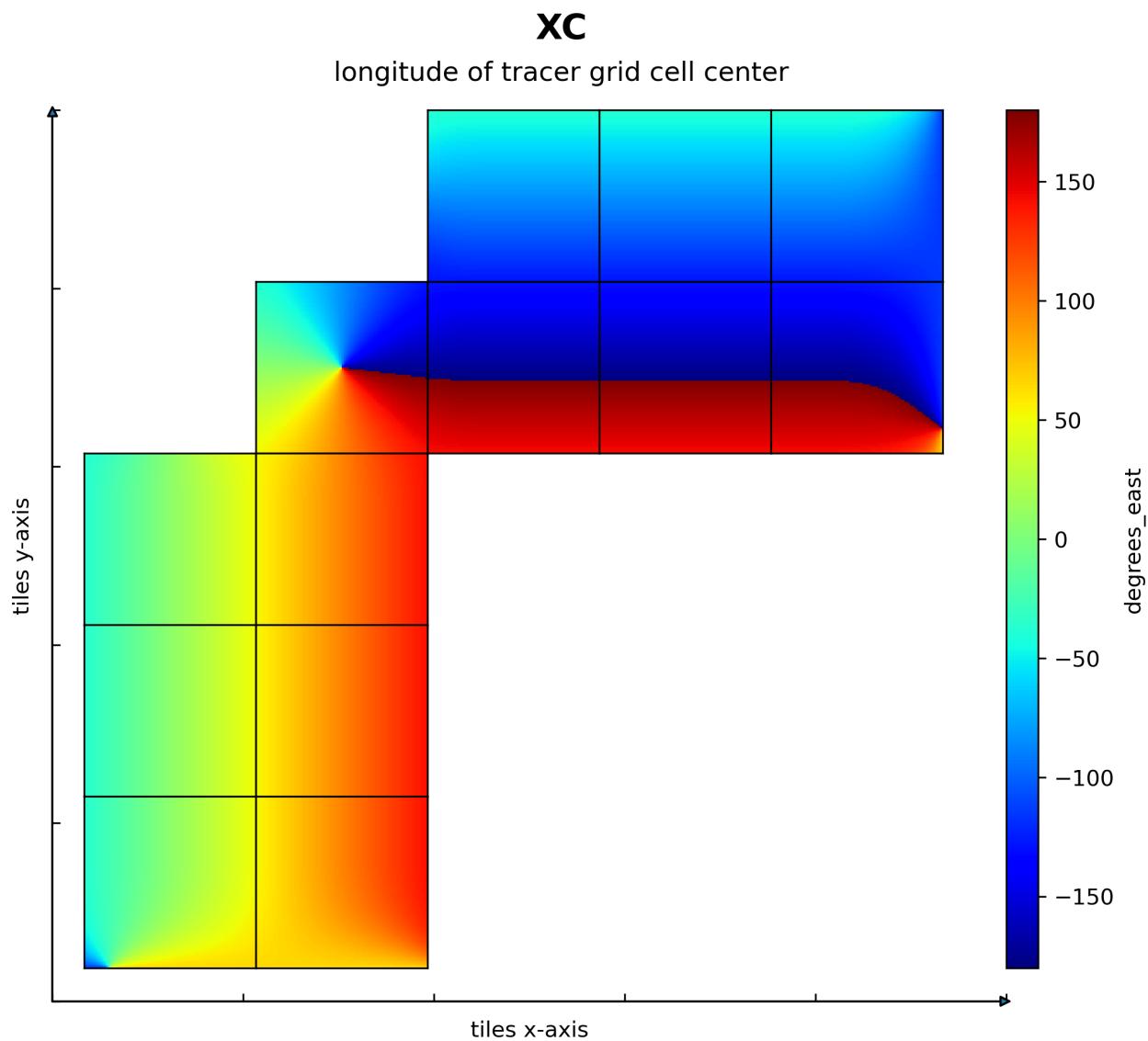
Table 18.1: Variables in the dataset GRID\_GEOMETRY\_ECCO

Dataset:	GRID_GEOMETRY_ECCO
Field:	XC
Field:	YC
Field:	XG
Field:	YG
Field:	CS
Field:	SN
Field:	rA
Field:	dxG
Field:	dyG
Field:	Depth
Field:	rAz
Field:	dxC
Field:	dyC
Field:	rAw
Field:	rAs
Field:	hFacC
Field:	hFacW
Field:	hFacS
Field:	maskC
Field:	maskW
Field:	maskS

### 18.2.1 Native coordinates Variable XC

Table 18.2: CDL description of GRID\_GEOMETRY\_ECCO's XC variable

Storage Type	Variable Name	Description	Unit
float32	XC	longitude of tracer grid cell center	degrees_east
<b>CDL Description</b>			
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			
<b>Comments</b>			
nonuniform grid spacing			

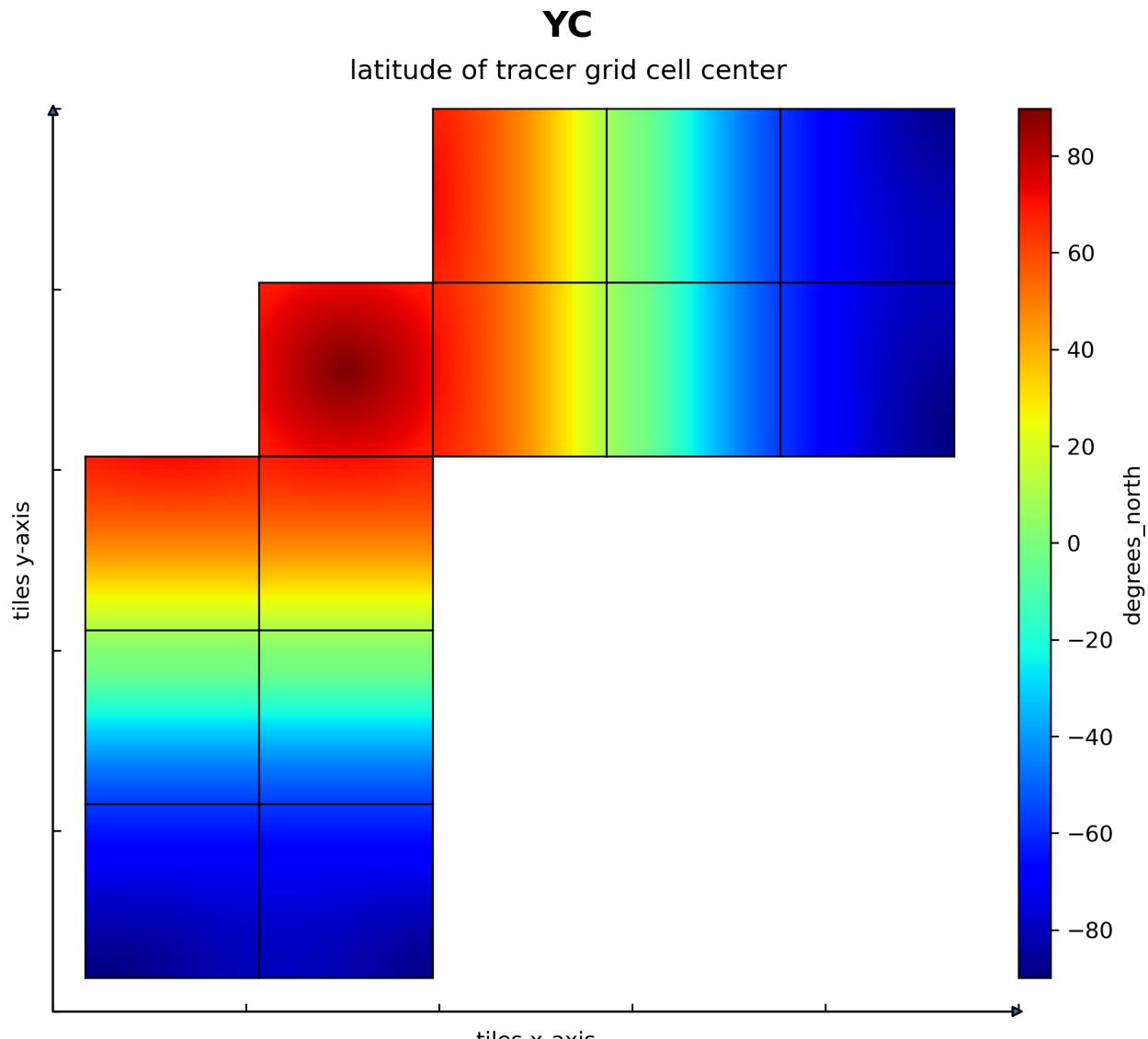


**Figure 3: Dataset: GRID\_GEOMETRY\_ECCO Variable: XC**

### 18.2.2 Native coordinates Variable YC

Table 18.3: CDL description of GRID\_GEOMETRY\_ECCO's YC variable

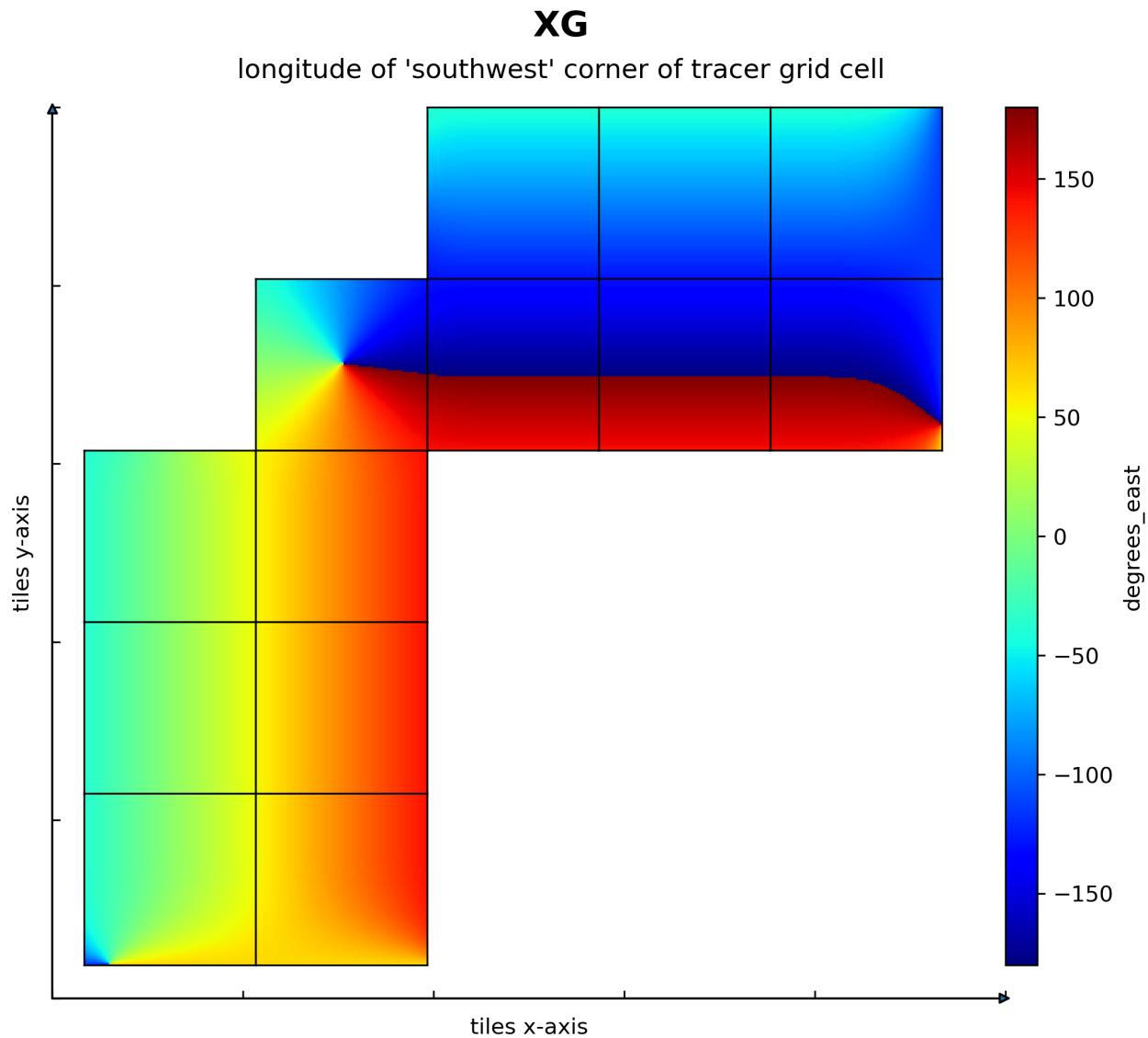
Storage Type	Variable Name	Description	Unit
float32	YC	latitude of tracer grid cell center	degrees_north
<b>CDL Description</b>			
float32 YC(tile, j, i)			
YC: long_name = latitude of tracer grid cell center			
YC: units = degrees_north			
YC: coordinate = YC XC			
YC: bounds = YC_bnds			
YC: coverage_content_type = coordinate			
YC: standard_name = latitude			
<b>Comments</b>			
nonuniform grid spacing			



### 18.2.3 Native coordinates Variable XG

Table 18.4: CDL description of GRID\_GEOMETRY\_ECCO's XG variable

Storage Type	Variable Name	Description	Unit
float32	XG	longitude of 'southwest' corner of tracer grid cell	degrees_east
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

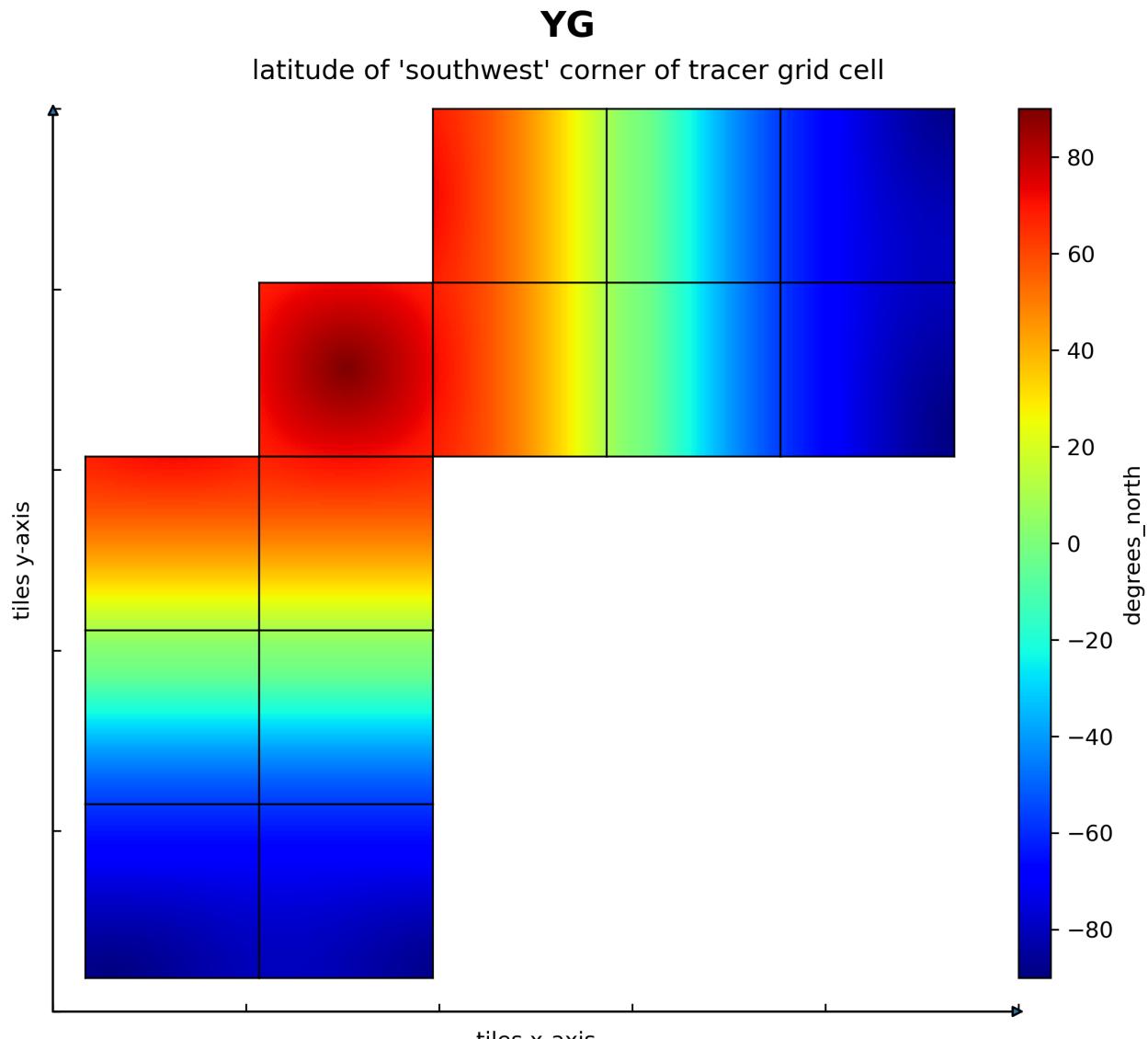


**Figure 5: Dataset: GRID\_GEOMETRY\_ECCO Variable: XG**

#### 18.2.4 Native coordinates Variable YG

Table 18.5: CDL description of GRID\_GEOMETRY\_ECCO's YG variable

Storage Type	Variable Name	Description	Unit
float32	YG	latitude of 'southwest' corner of tracer grid cell	degrees_north
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

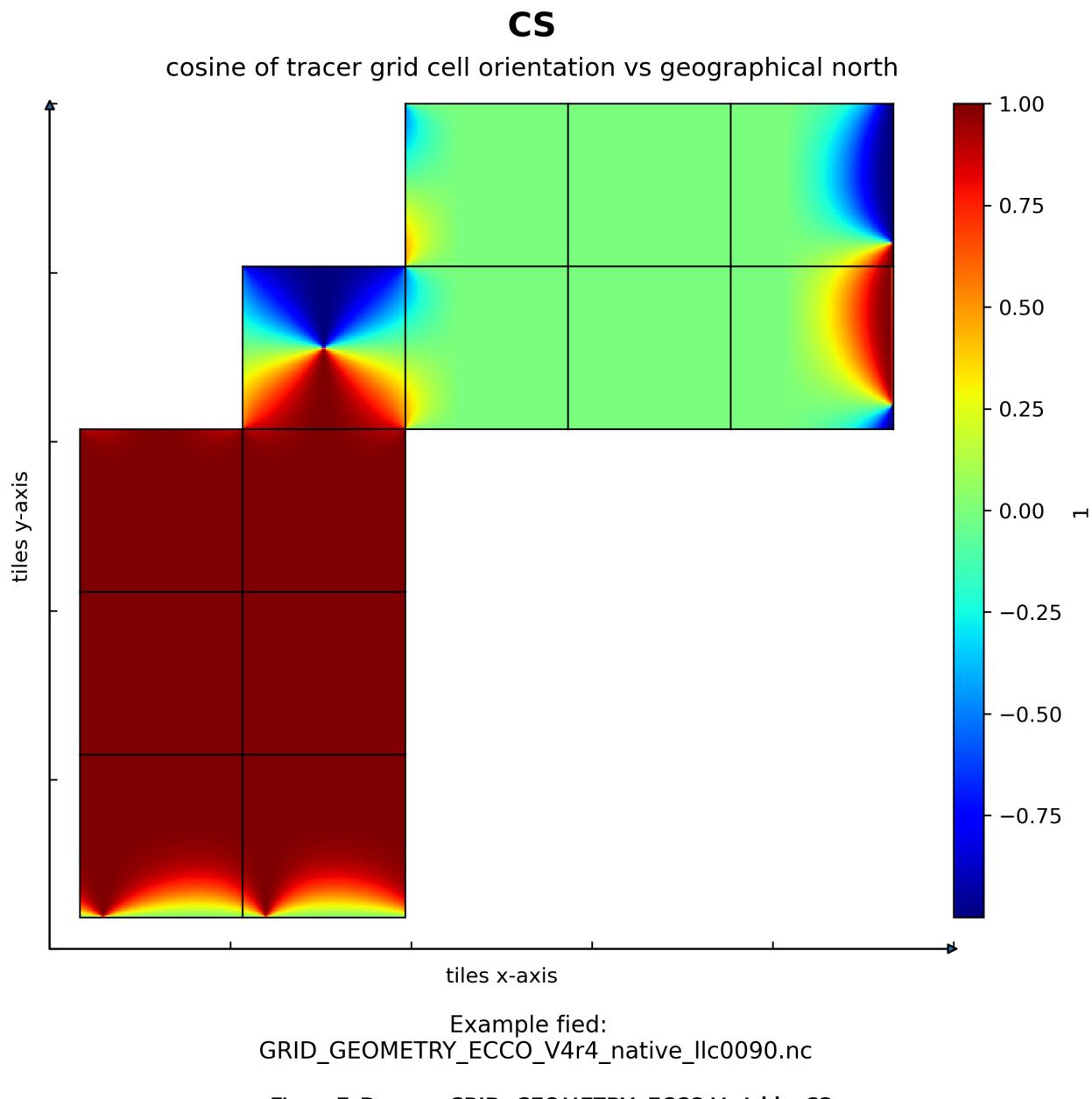


**Figure 6: Dataset: GRID\_GEOMETRY\_ECCO Variable: YG**

### 18.2.5 Native coordinates Variable CS

Table 18.6: CDL description of GRID\_GEOMETRY\_ECCO's CS variable

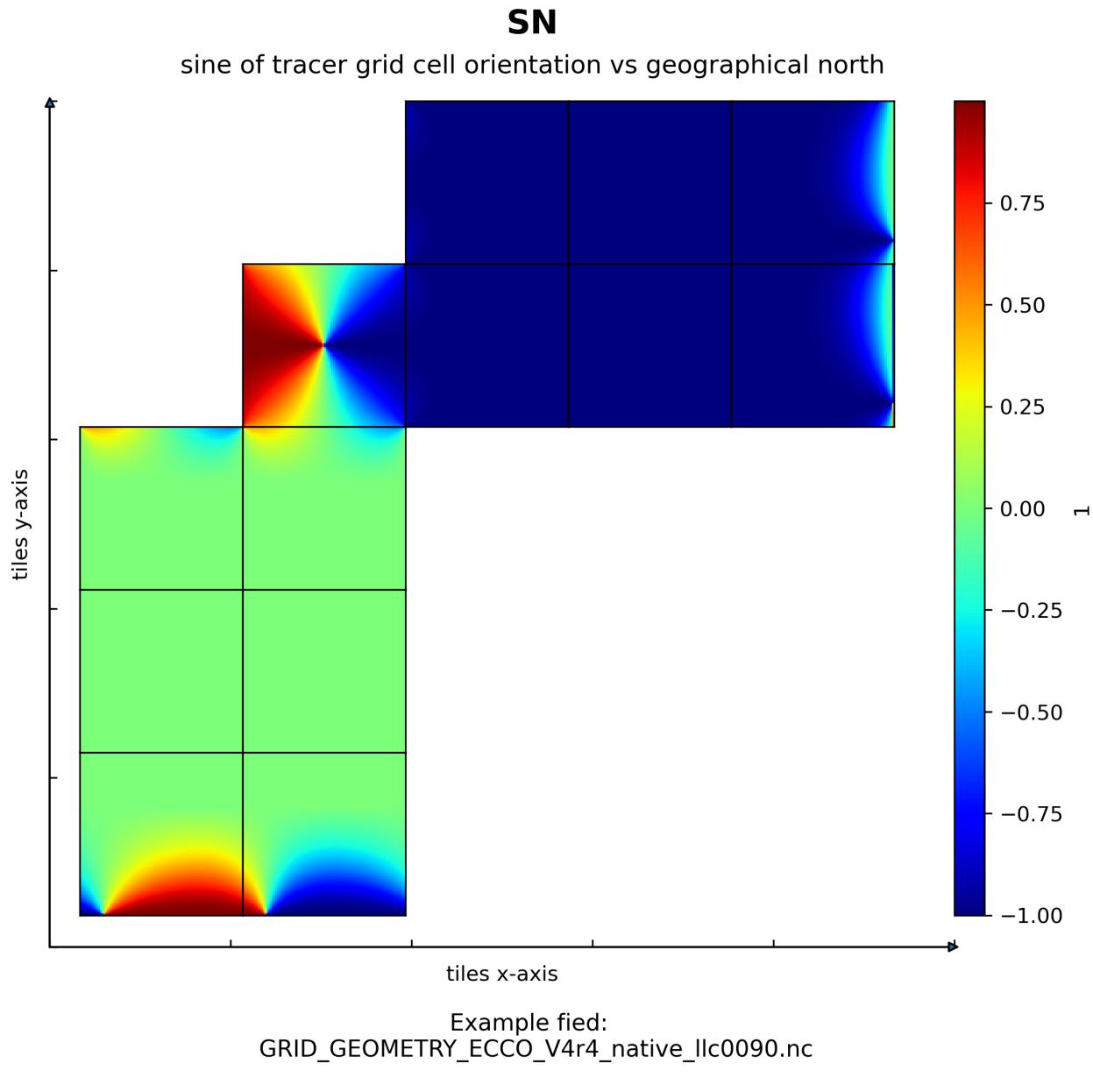
Storage Type	Variable Name	Description	Unit
float32	CS	cosine of tracer grid cell orientation vs geographical north	1
<b>CDL Description</b>			
float32 CS(tile, j, i) CS: _FillValue = 9.96921e+36 CS: long_name = cosine of tracer grid cell orientation vs geographical north CS: units = 1 CS: coordinate = YC XC CS: coverage_content_type = modelResult CS: coordinates = YC XC			
<b>Comments</b>			
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			



### 18.2.6 Native coordinates Variable SN

Table 18.7: CDL description of GRID\_GEOMETRY\_ECCO's SN variable

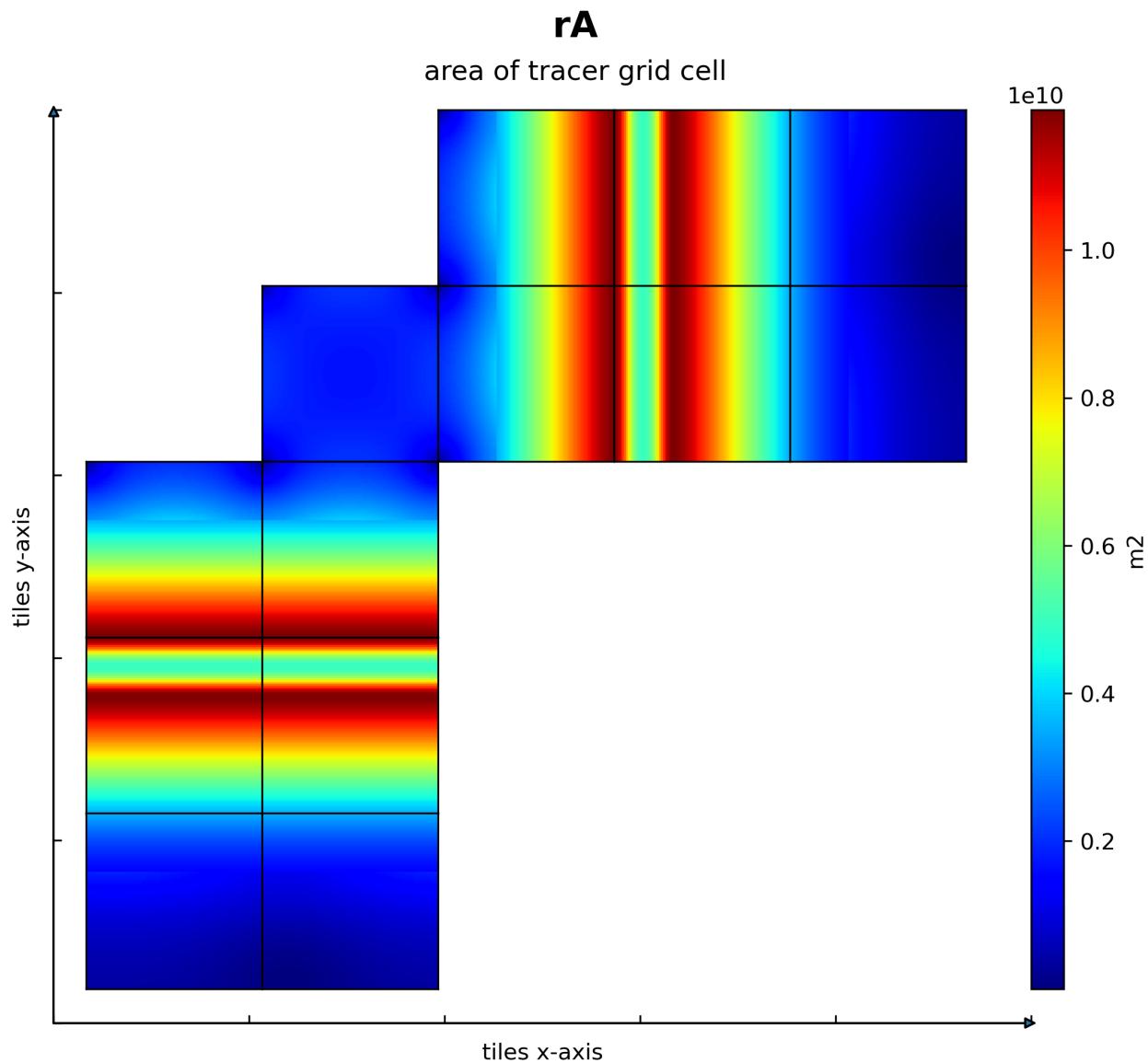
Storage Type	Variable Name	Description	Unit
float32	SN	sine of tracer grid cell orientation vs geographical north	1
<b>CDL Description</b>			
float32 SN(tile, j, i) SN: _FillValue = 9.96921e+36 SN: long_name = sine of tracer grid cell orientation vs geographical north SN: units = 1 SN: coordinate = YC XC SN: coverage_content_type = modelResult SN: coordinates = YC XC			
<b>Comments</b>			
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.			



### 18.2.7 Native coordinates Variable rA

Table 18.8: CDL description of GRID\_GEOMETRY\_ECCO's rA variable

Storage Type	Variable Name	Description	Unit
float32	rA	area of tracer grid cell	m2
<b>CDL Description</b>			
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			
<b>Comments</b>			
N/A			

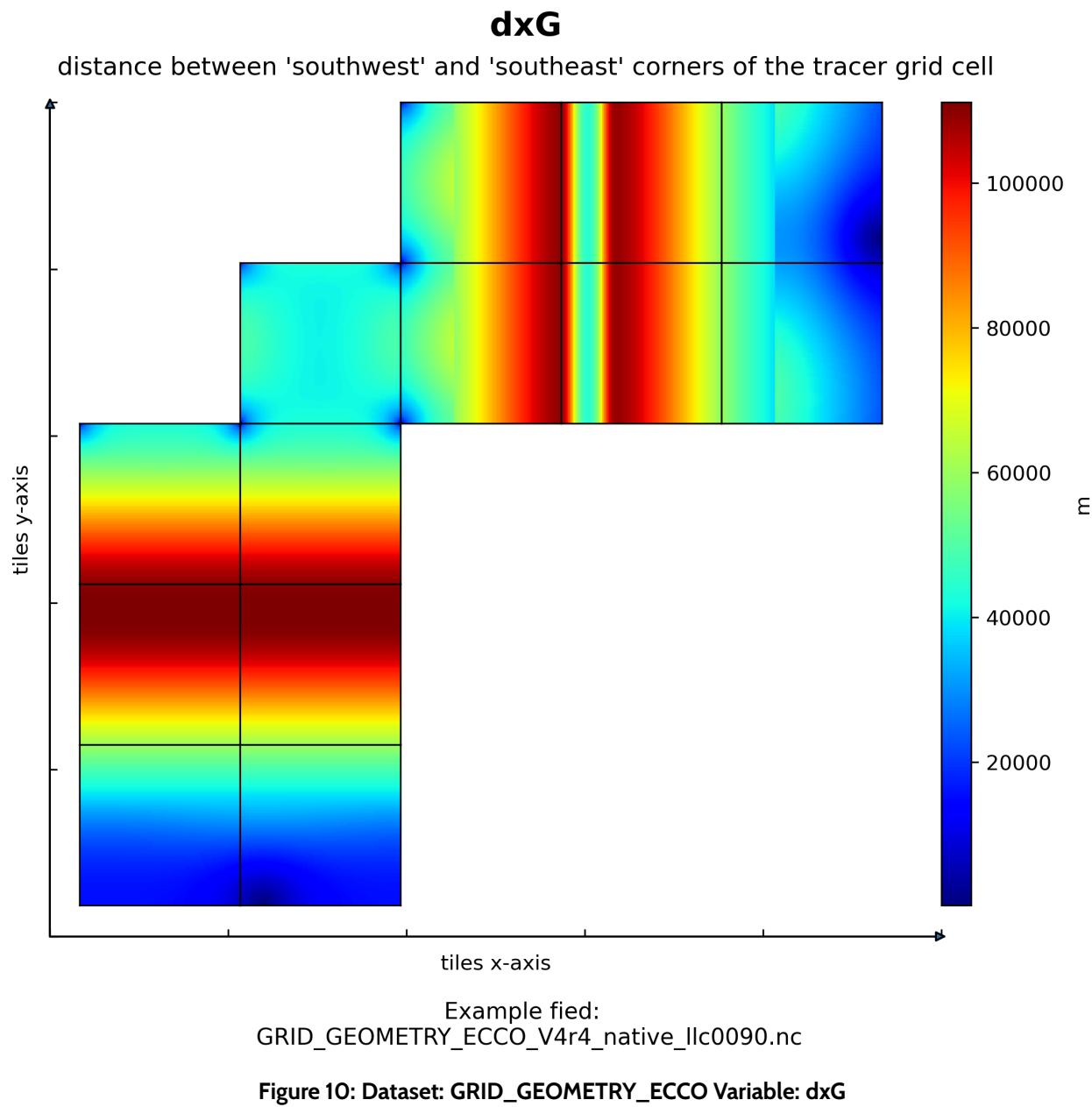


**Figure 9: Dataset: GRID\_GEOMETRY\_ECCO Variable: rA**

### 18.2.8 Native coordinates Variable dxG

Table 18.9: CDL description of GRID\_GEOMETRY\_ECCO's dxG variable

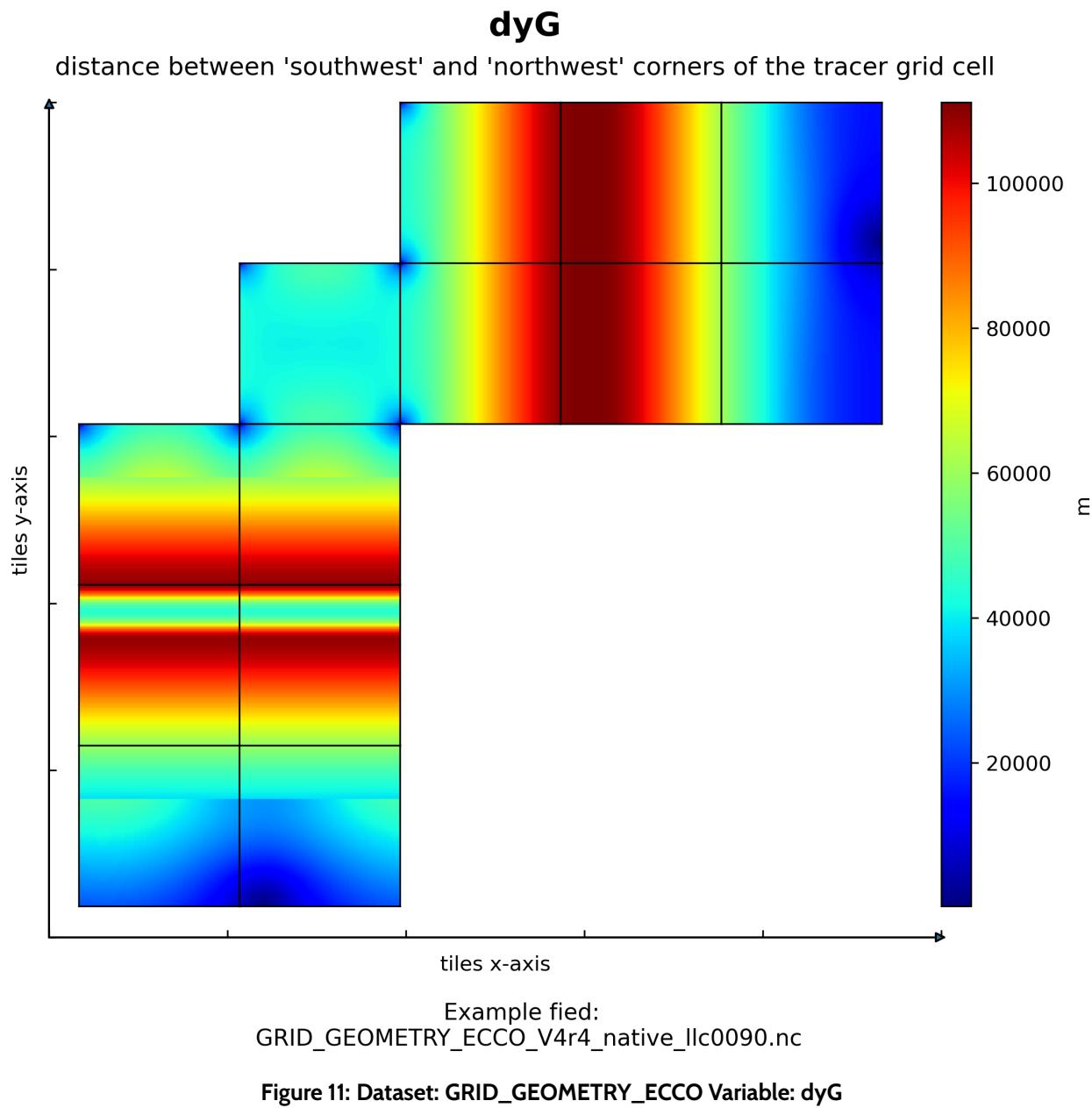
Storage Type	Variable Name	Description	Unit
float32	dxG	distance between 'southwest' and 'southeast' corners of the tracer grid cell	m
<b>CDL Description</b>			
float32 dxG(tile, j_g, i) dxG: _FillValue = 9.96921e+36 dxG: long_name = "distance between southwest and southeast corners of the tracer grid cell" dxG: units = m dxG: coordinate = YG XC dxG: coverage_content_type = modelResult			
<b>Comments</b>			
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.			



### 18.2.9 Native coordinates Variable dyG

Table 18.10: CDL description of GRID\_GEOMETRY\_ECCO's dyG variable

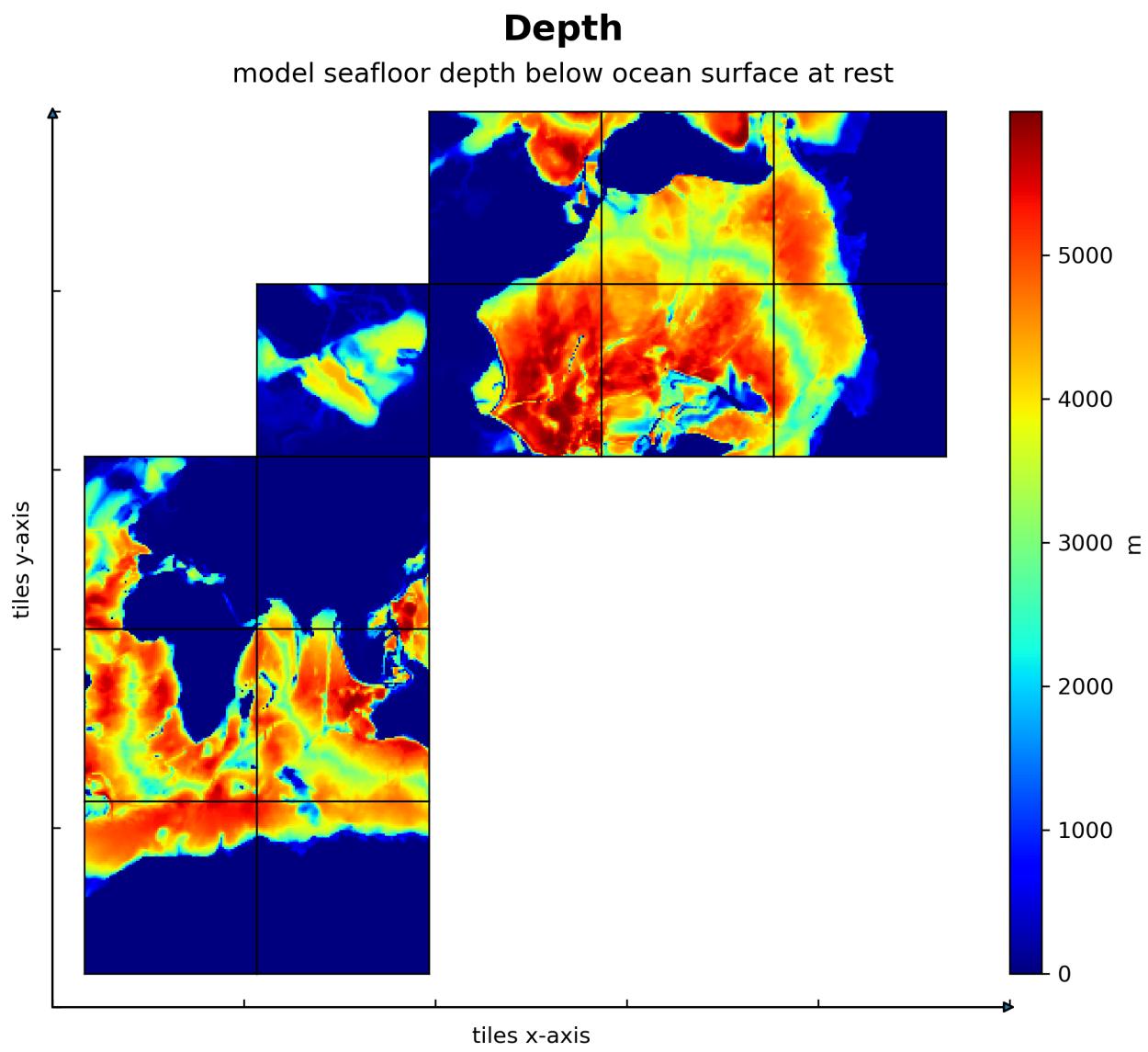
Storage Type	Variable Name	Description	Unit
float32	dyG	distance between 'southwest' and 'northwest' corners of the tracer grid cell	m
<b>CDL Description</b>			
float32 dyG(tile, j, i_g) dyG: _FillValue = 9.96921e+36 dyG: long_name = "distance between southwest and northwest corners of the tracer grid cell" dyG: units = m dyG: coordinate = YC XG dyG: coverage_content_type = modelResult			
<b>Comments</b>			
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.			



### 18.2.10 Native coordinates Variable Depth

Table 18.11: CDL description of GRID\_GEOMETRY\_ECCO's Depth variable

Storage Type	Variable Name	Description	Unit
float32	Depth	model seafloor depth below ocean surface at rest	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
Model sea surface height (SSH) of $\Omega_m$ 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.			

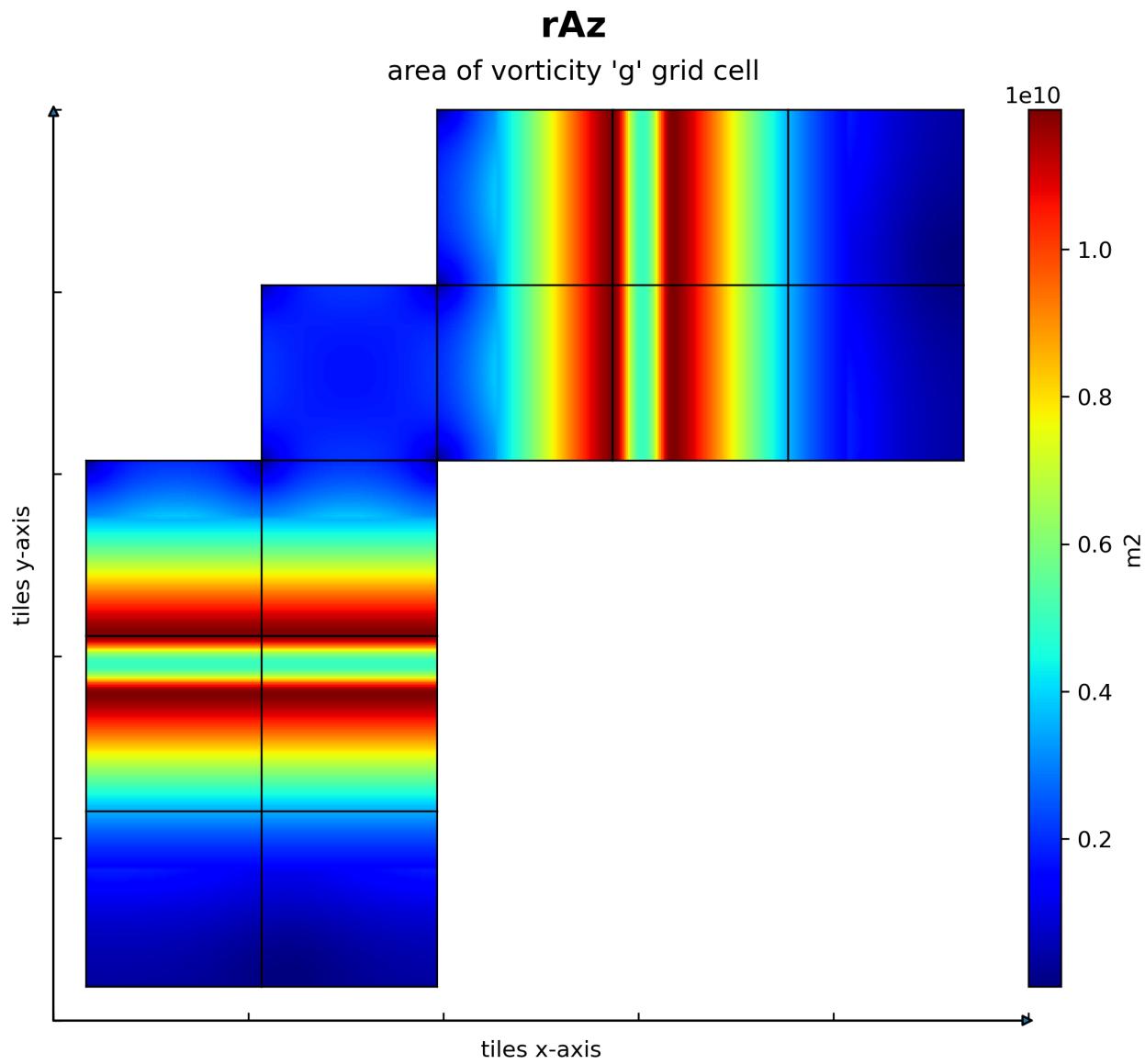


**Figure 12: Dataset: GRID\_GEOMETRY\_ECCO Variable: Depth**

### 18.2.11 Native coordinates Variable rAz

Table 18.12: CDL description of GRID\_GEOMETRY\_ECCO's rAz variable

Storage Type	Variable Name	Description	Unit
float32	rAz	area of vorticity 'g' grid cell	m2
<b>CDL Description</b>			
float32 rAz(tile, j_g, i_g) rAz: _FillValue = 9.96921e+36 rAz: long_name = "area of vorticity g grid cell" rAz: units = m2 rAz: coordinate = YG XG rAz: coverage_content_type = modelResult rAz: standard_name = cell_area rAz: coordinates = YG XG			
<b>Comments</b>			
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.			

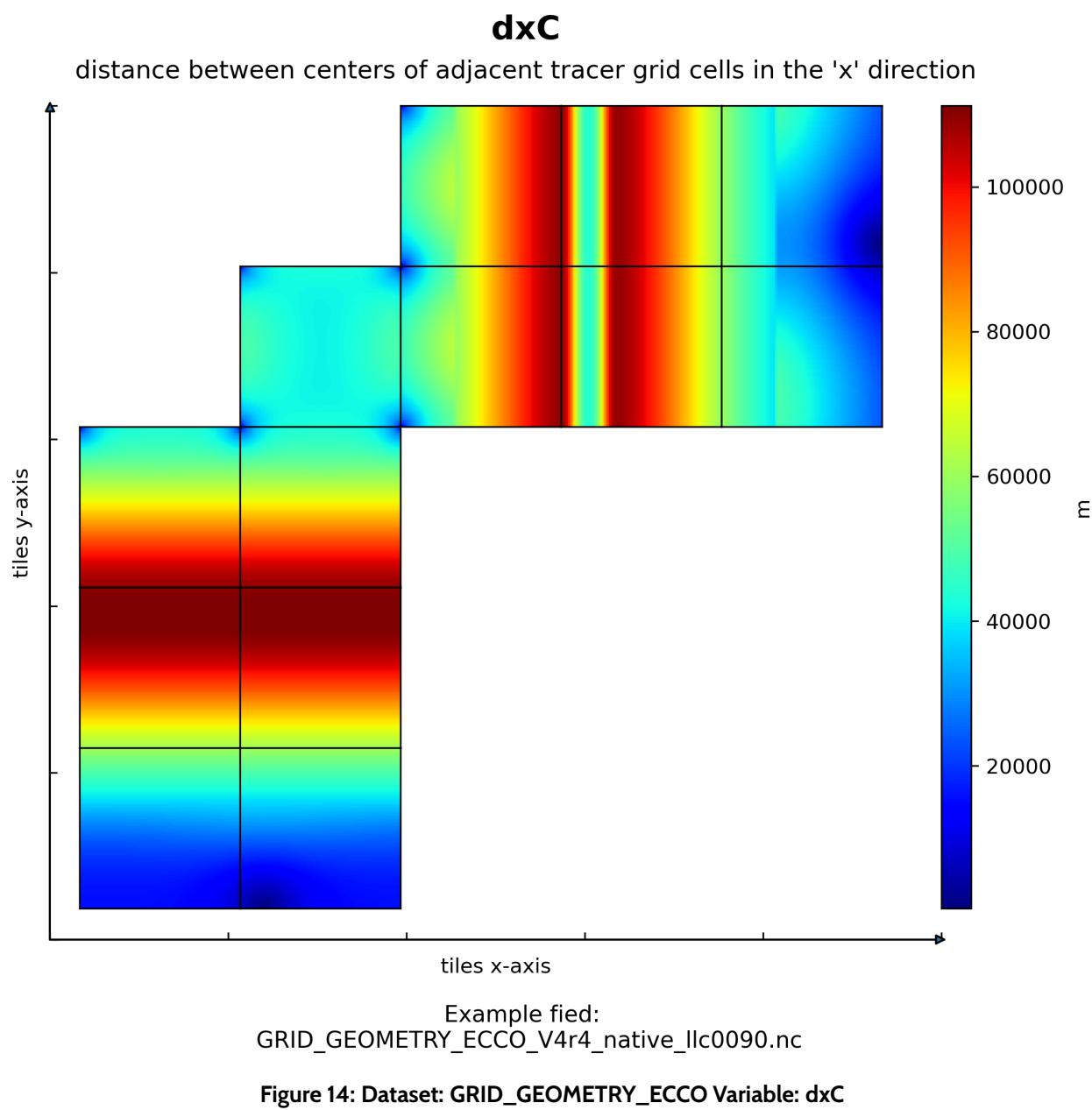


**Figure 13: Dataset: GRID\_GEOMETRY\_ECCO Variable: rAz**

### 18.2.12 Native coordinates Variable dxC

Table 18.13: CDL description of GRID\_GEOMETRY\_ECCO's dxC variable

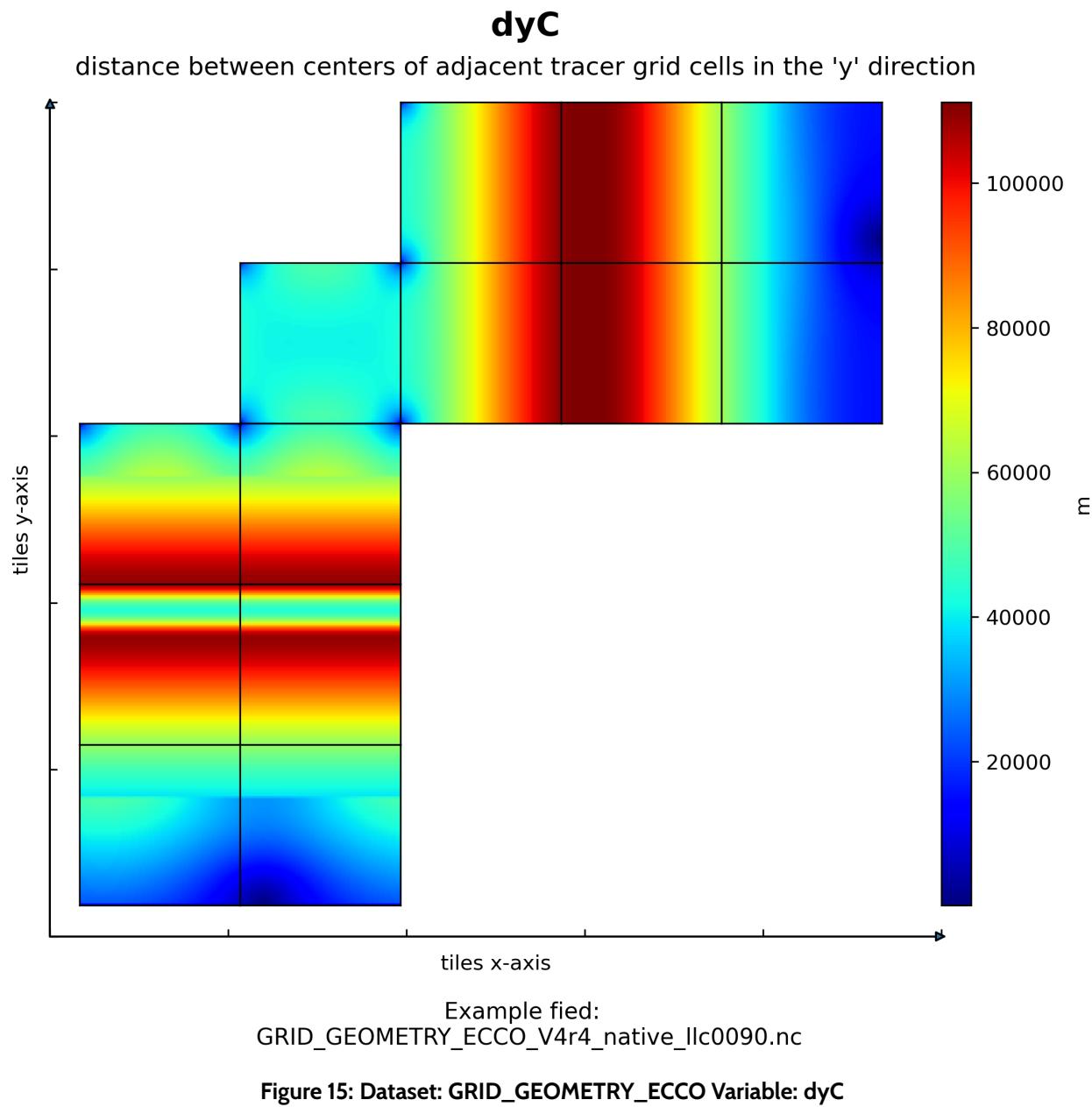
Storage Type	Variable Name	Description	Unit
float32	dxC	distance between centers of adjacent tracer grid cells in the 'x' direction	m
<b>CDL Description</b>			
float32 dxC(tile, j, i_g) dxC: _FillValue = 9.96921e+36 dxC: long_name = "distance between centers of adjacent tracer grid cells in the x direction" dxC: units = m dxC: coordinate = YC XG dxC: coverage_content_type = modelResult			
<b>Comments</b>			
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.			



### 18.2.13 Native coordinates Variable dyC

Table 18.14: CDL description of GRID\_GEOMETRY\_ECCO's dyC variable

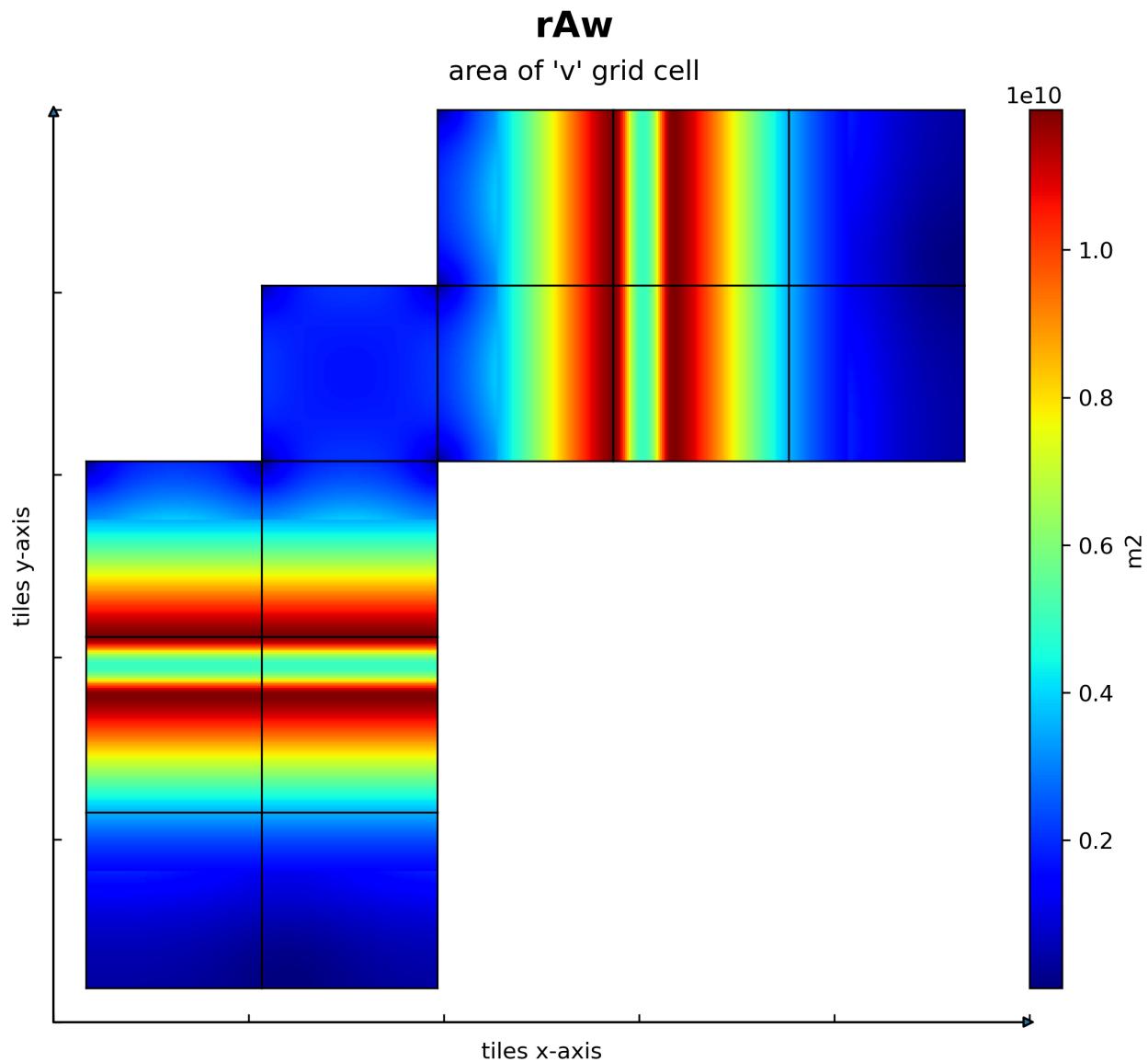
Storage Type	Variable Name	Description	Unit
float32	dyC	distance between centers of adjacent tracer grid cells in the 'y' direction	m
<b>CDL Description</b>			
float32 dyC(tile, j_g, i) dyC: _FillValue = 9.96921e+36 dyC: long_name = "distance between centers of adjacent tracer grid cells in the y direction" dyC: units = m dyC: coordinate = YG XC dyC: coverage_content_type = modelResult			
<b>Comments</b>			
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.			



#### 18.2.14 Native coordinates Variable rAw

Table 18.15: CDL description of GRID\_GEOMETRY\_ECCO's rAw variable

Storage Type	Variable Name	Description	Unit
float32	rAw	area of 'V' grid cell	m2
<b>CDL Description</b>			
float32 rAw(tile, j, i_g) rAw:_FillValue = 9.96921e+36 rAw:long_name = "area of v grid cell" rAw:units = m2 rAw:coordinate = YG XC rAw:coverage_content_type = modelResult rAw:standard_name = cell_area			
<b>Comments</b>			
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.			

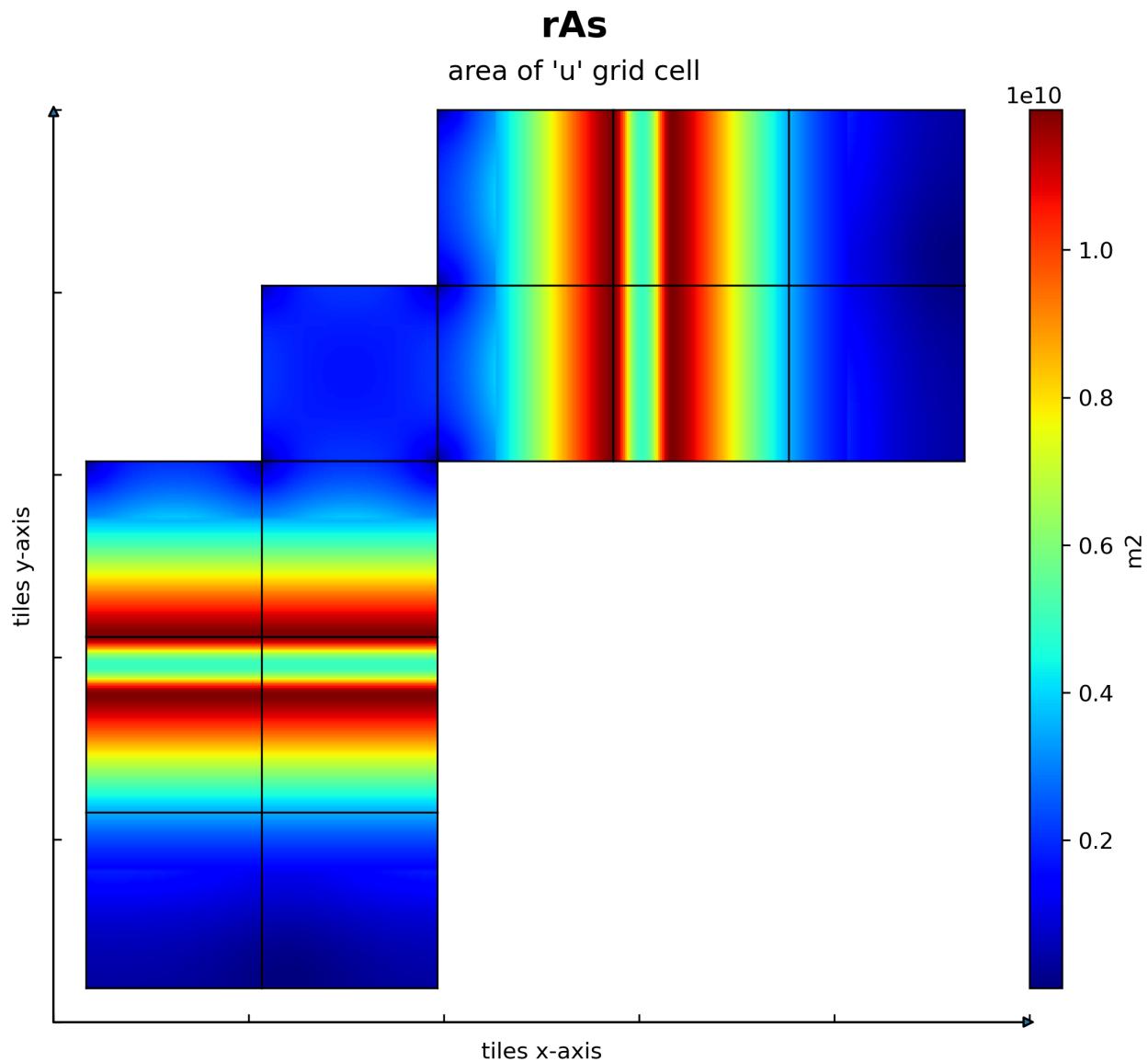


**Figure 16: Dataset: GRID\_GEOMETRY\_ECCO Variable: rAw**

### 18.2.15 Native coordinates Variable rAs

Table 18.16: CDL description of GRID\_GEOMETRY\_ECCO's rAs variable

Storage Type	Variable Name	Description	Unit
float32	rAs	area of 'u' grid cell	m2
<b>CDL Description</b>			
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			
<b>Comments</b> 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.			

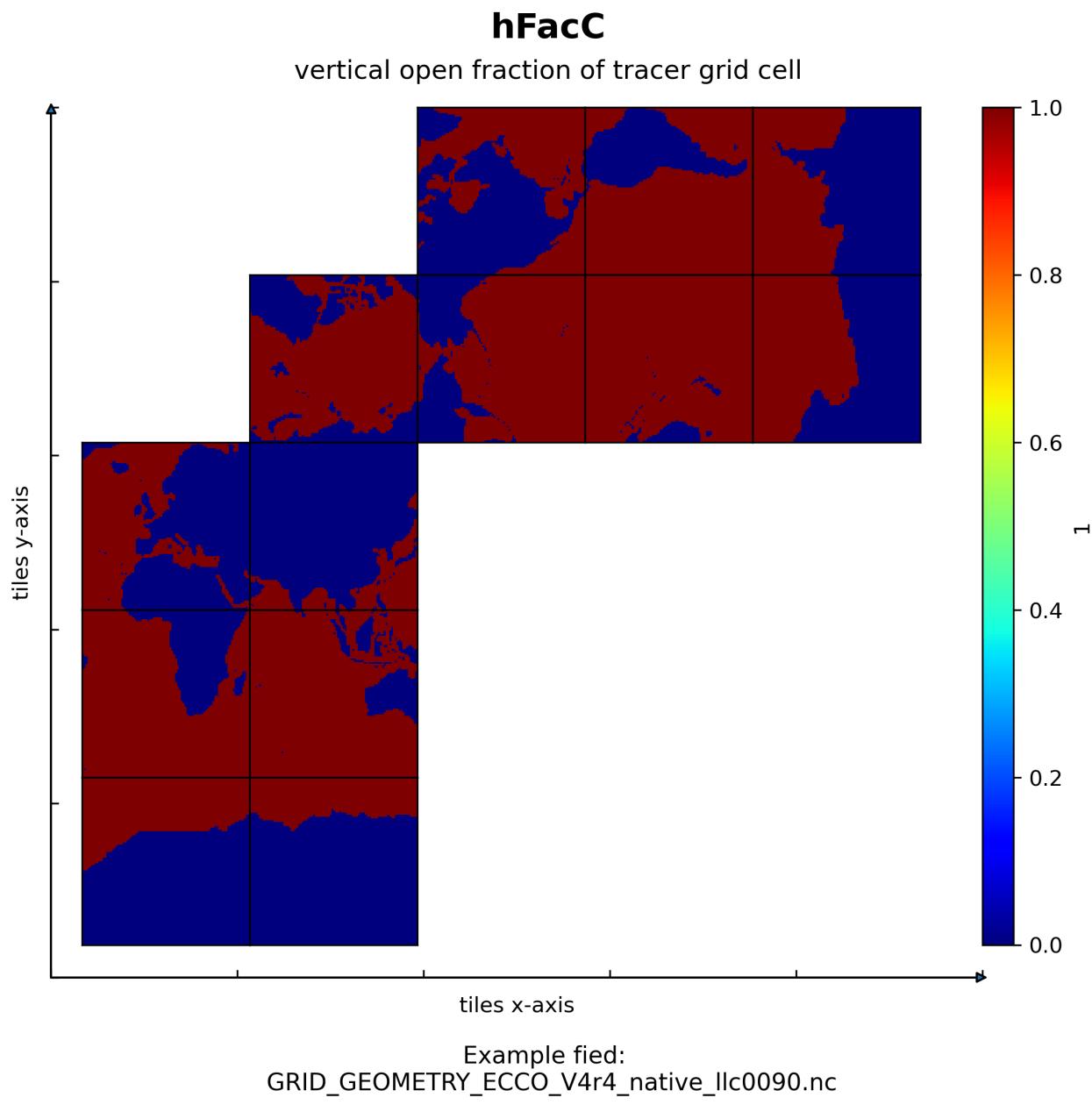


**Figure 17: Dataset: GRID\_GEOMETRY\_ECCO Variable: rAs**

### 18.2.16 Native coordinates Variable hFacC

Table 18.17: CDL description of GRID\_GEOMETRY\_ECCO's hFacC variable

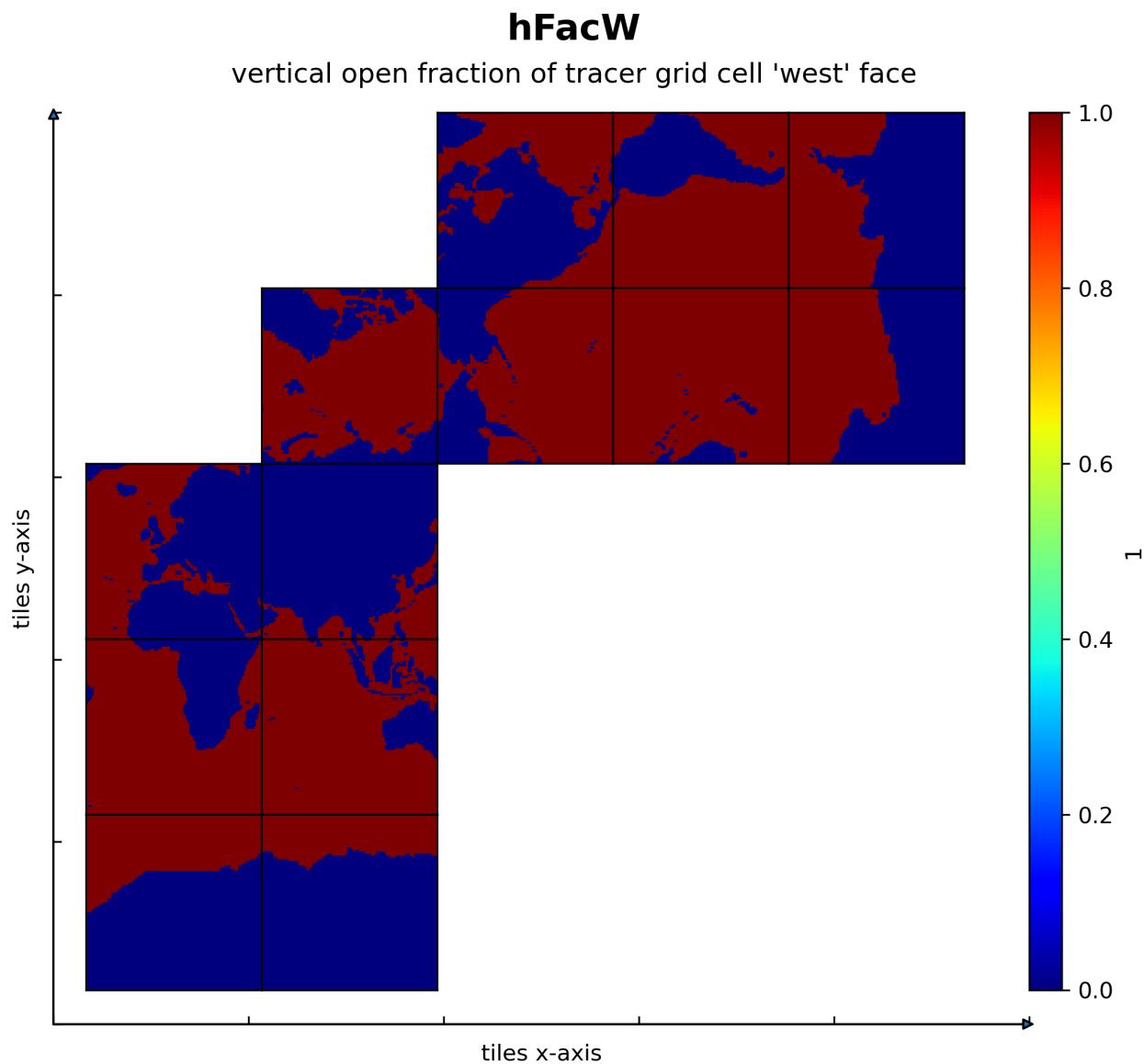
Storage Type	Variable Name	Description	Unit
float32	hFacC	vertical open fraction of tracer grid cell	1
<b>CDL Description</b>			
float32 hFacC(k, tile, j, i) hFacC:_FillValue = 9.96921e+36 hFacC: long_name = vertical open fraction of tracer grid cell hFacC: coverage_content_type = modelResult hFacC: units = 1 hFacC: coordinates = Z YC XC			
<b>Comments</b>			
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.			



### 18.2.17 Native coordinates Variable hFacW

**Table 18.18: CDL description of GRID\_GEOMETRY\_ECCO's hFacW variable**

Storage Type	Variable Name	Description	Unit
float32	hFacW	vertical open fraction of tracer grid cell 'west' face	1
<b>CDL Description</b>			
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			
<b>Comments</b>			
The 'west' face of tracer grid cells may be fractionally closed in the vertical. The open vertical fraction is hFacW. The model allows for partially-filled cells for smoother representation of seafloor topography. Tracer grid cells adjacent in the 'x' direction that are partially closed in the vertical have hFacW < 1. The model z* coordinate system used by the model permits hFacC, and therefore hFacW, to vary through time. A time-invariant hFacW field is provided for reference. Note: The term 'west' does not correspond to geographic orientation but is used for convenience to describe the computational grid. See MITgcm documentation for details.			

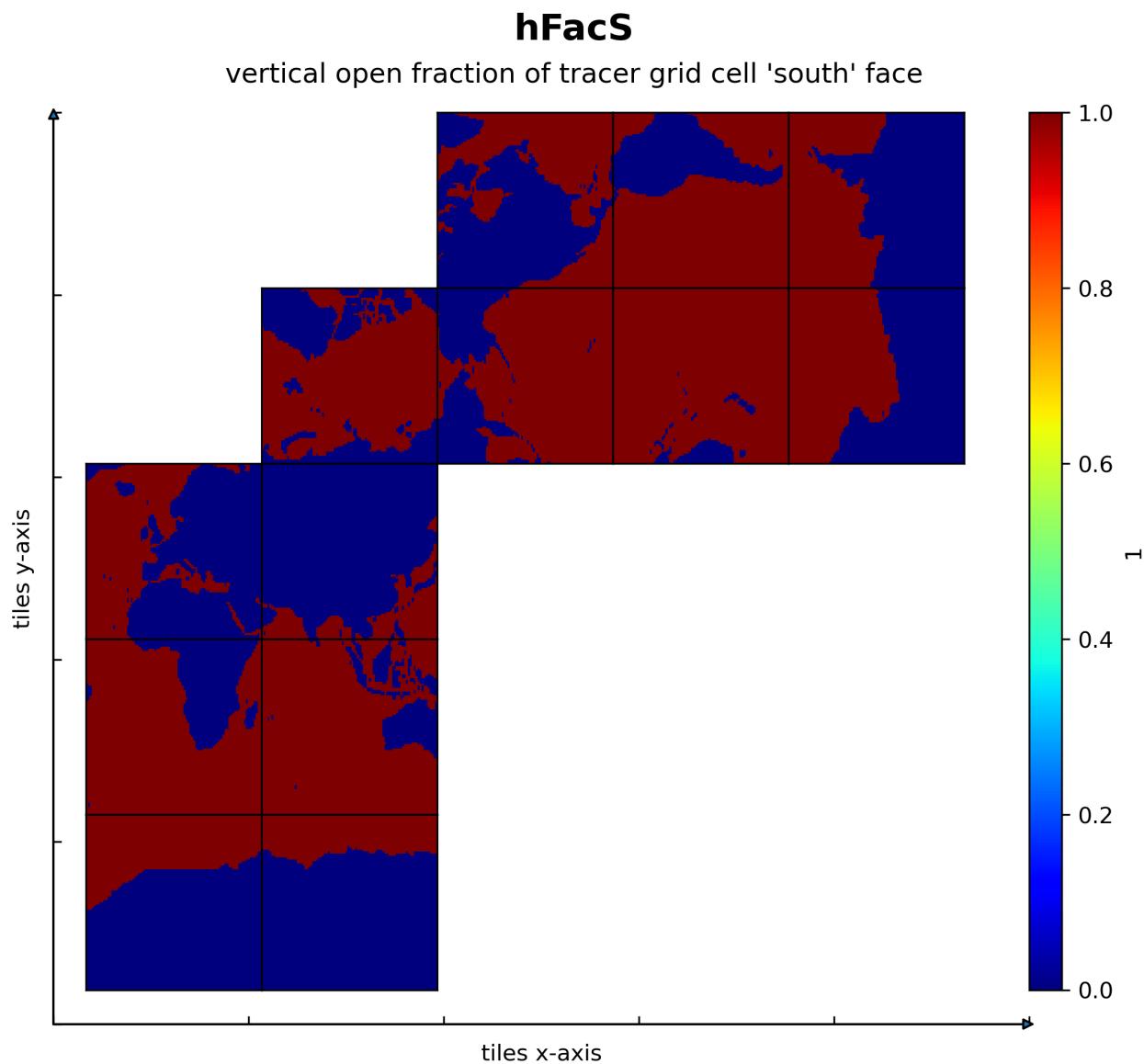


**Figure 19: Dataset: GRID\_GEOMETRY\_ECCO Variable: hFacW**

### 18.2.18 Native coordinates Variable hFacS

**Table 18.19: CDL description of GRID\_GEOMETRY\_ECCO's hFacS variable**

Storage Type	Variable Name	Description	Unit
float32	hFacS	vertical open fraction of tracer grid cell 'south' face	1
<b>CDL Description</b>			
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			
<b>Comments</b>			
The 'south' face of tracer grid cells may be fractionally closed in the vertical. The open vertical fraction is hFacS. The model allows for partially-filled cells for smoother representation of seafloor topography. Tracer grid cells adjacent in the 'y' direction that are partially closed in the vertical have hFacS < 1. The model z* coordinate system used by the model permits hFacC, and therefore hFacS, to vary through time. A time-invariant hFacS field is provided for reference. Note: The term 'south' does not correspond to geographic orientation but is used for convenience to describe the computational grid. See MITgcm documentation for details.			



**Figure 20: Dataset: GRID\_GEOMETRY\_ECCO Variable: hFacS**

### 18.2.19 Native coordinates Variable maskC

**Table 18.20: CDL description of GRID\_GEOMETRY\_ECCO's maskC variable**

Storage Type	Variable Name	Description	Unit
bool	maskC	wet/dry boolean mask for tracer grid cell	N/A
<b>CDL Description</b>			
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			
<b>Comments</b>			
True for tracer grid cells with nonzero open vertical fraction ( $hFacC > 0$ ), otherwise False. Although $hFacC$ can vary though time, cells will never close if starting open and will never open if starting closed: $hFacC(i,j,k,t) > 0$ for all $t$ , if $hFacC(i,j,k,t=0)$ and $hFacC(i,j,k,t) = 0$ for all $t$ , if $hFacC(i,j,k,t=0) = 0$ . Therefore, maskC is time invariant.			

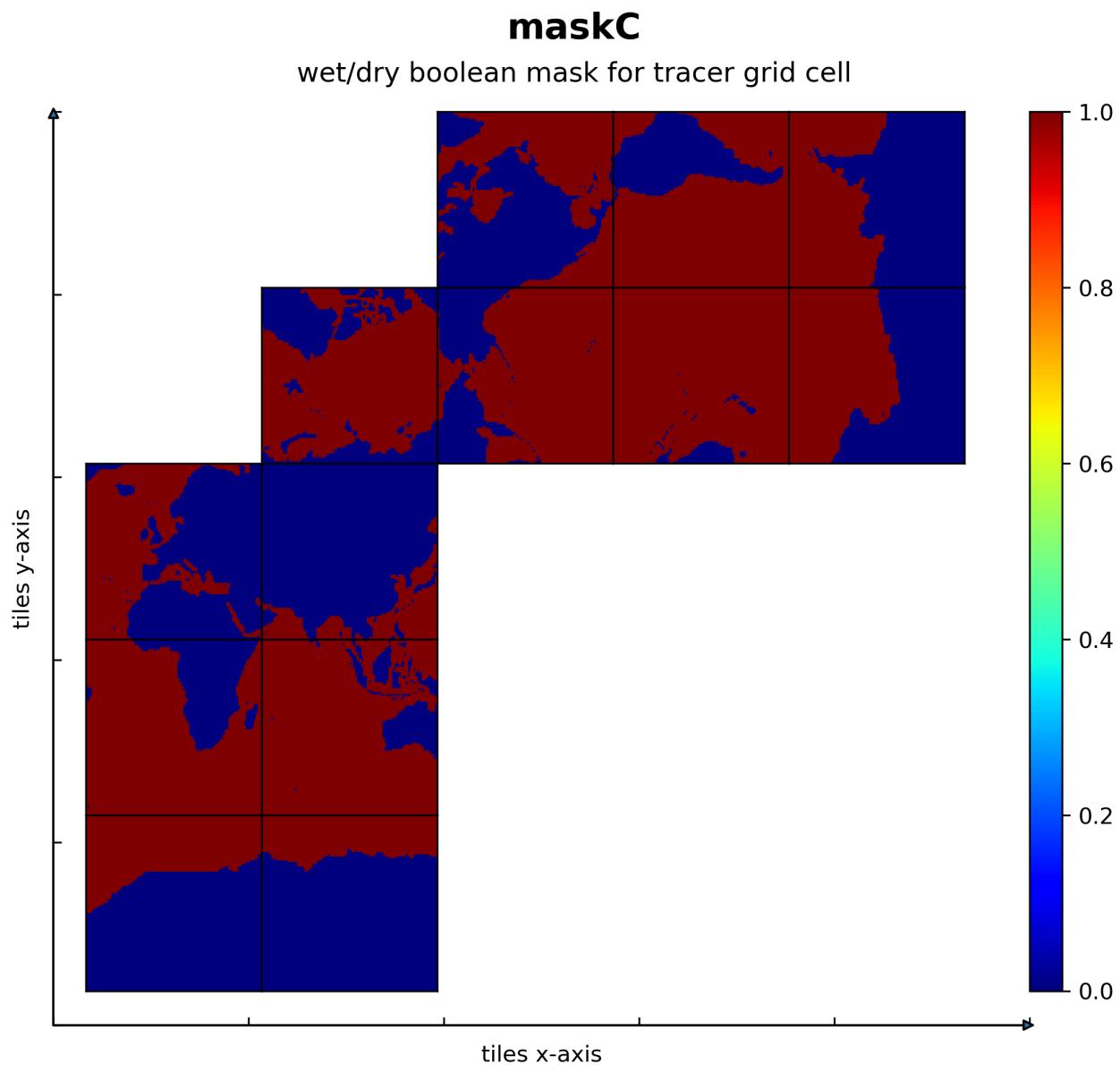


Figure 21: Dataset: GRID\_GEOMETRY\_ECCO Variable: maskC

### 18.2.20 Native coordinates Variable maskW

**Table 18.21: CDL description of GRID\_GEOMETRY\_ECCO's maskW variable**

Storage Type	Variable Name	Description	Unit
bool	maskW	wet/dry boolean mask for 'west' face of tracer grid cell	N/A
<b>CDL Description</b>			
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			
<b>Comments</b>			
True for grid cells with nonzero open vertical fraction along their 'west' face ( $hFacW > 0$ ), otherwise False. Although $hFacW$ can vary though time, cells will never close if starting open and will never open if starting closed: $hFacW(i,j,k,t) > 0$ for all $t$ , if $hFacW(i,j,k,t=0)$ and $hFacW(i,j,k,t) = 0$ for all $t$ , if $hFacW(i,j,k,t=0) = 0$ . Therefore, maskW is time invariant. Note:			

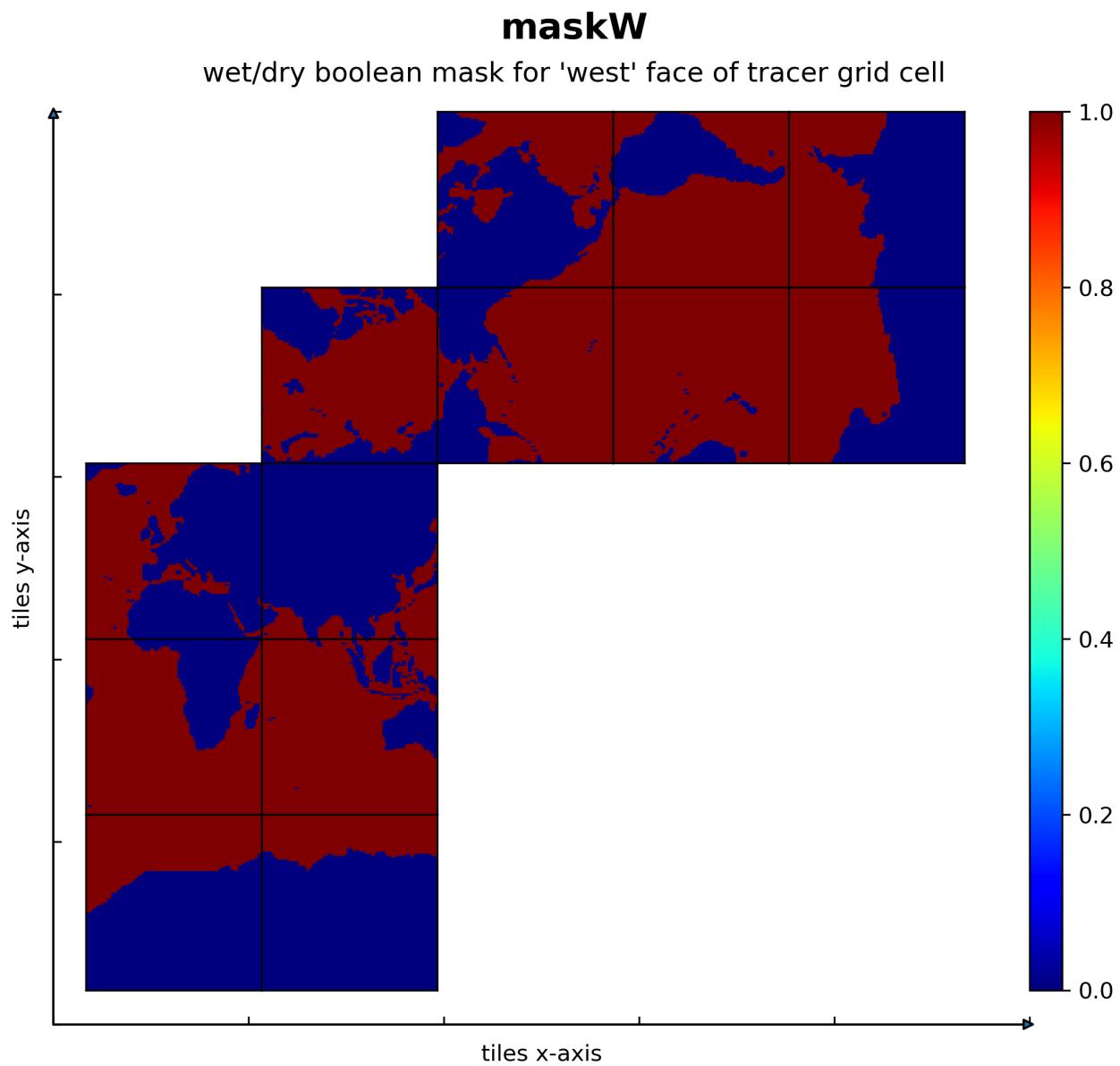
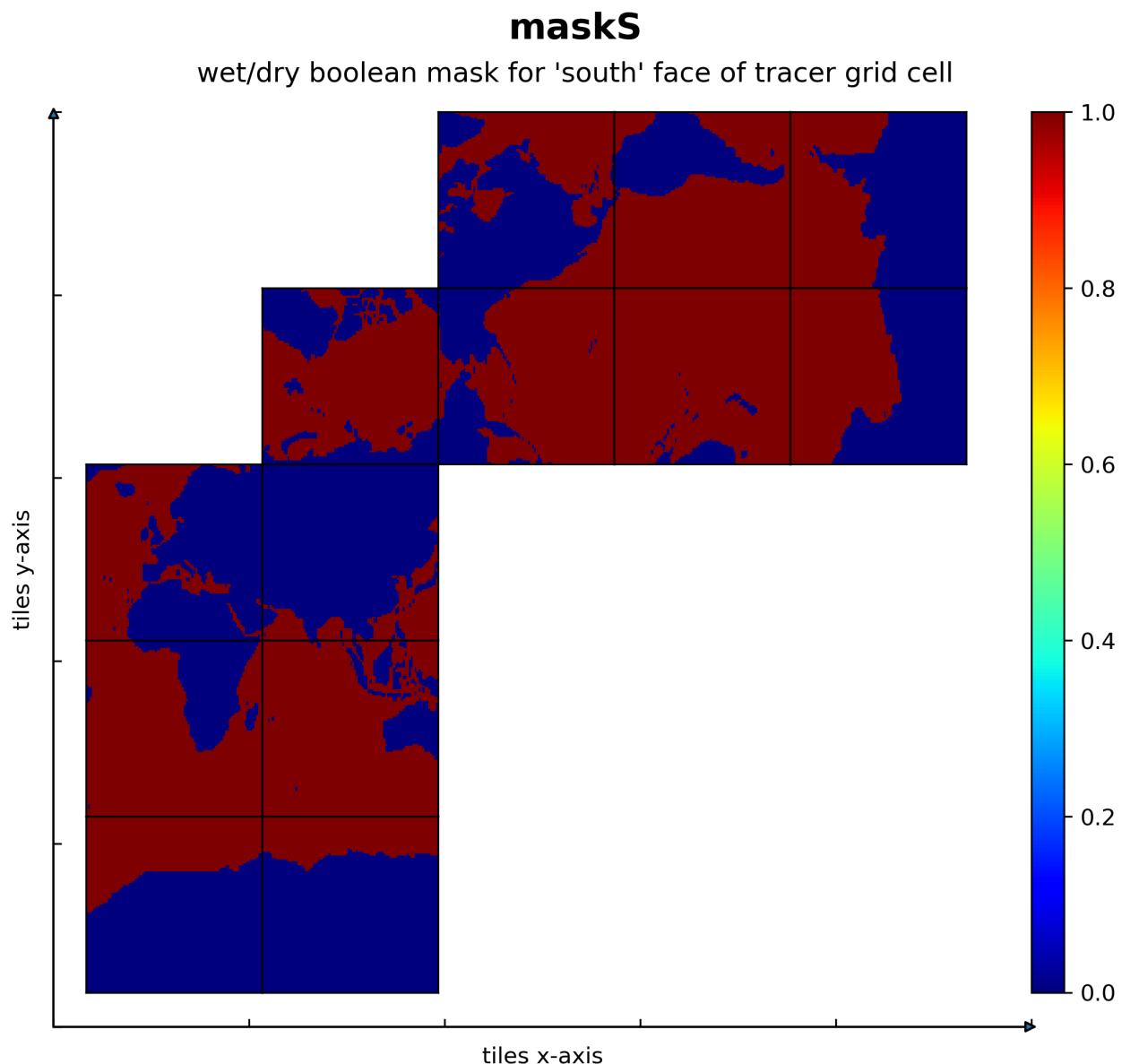


Figure 22: Dataset: GRID\_GEOMETRY\_ECCO Variable: maskW

### 18.2.21 Native coordinates Variable maskS

**Table 18.22: CDL description of GRID\_GEOMETRY\_ECCO's maskS variable**

Storage Type	Variable Name	Description	Unit
bool	maskS	wet/dry boolean mask for 'south' face of tracer grid cell	N/A
<b>CDL Description</b>			
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			
<b>Comments</b>			
True for grid cells with nonzero open vertical fraction along their 'south' face ( $hFacS > 0$ ), otherwise False. Although $hFacS$ can vary though time, cells will never close if starting open and will never open if starting closed: $hFacS(i,j,k,t) > 0$ for all $t$ , if $hFacS(i,j,k,t=0)$ and $hFacS(i,j,k,t) = 0$ for all $t$ , if $hFacS(i,j,k,t=0) = 0$ . Therefore, maskS is time invariant. Note:			



Example fied:  
GRID\_GEOMETRY\_ECCO\_V4r4\_native\_llc0090.nc

Figure 23: Dataset: GRID\_GEOMETRY\_ECCO Variable: maskS

## 19 Native Dataset Groupings

### 19.1 Overview of the Native Dataset Groupings

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Vivamus at enim eget nisi ultrices facilisis a et purus. Sed tincidunt scelerisque ligula, in vehicula dui venenatis at. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Curabitur consequat commodo nunc, nec lacinia quam feugiat vel. Integer bibendum lectus sit amet quam elementum, ut pretium quam malesuada. Cras fermentum venenatis augue, id commodo libero facilisis nec. Quisque euismod, odio vitae dapibus convallis, justo enim iaculis metus, vel interdum elit nisi vel lectus. Fusce tempor elit in semper condimentum. Ut quis dui eget purus cursus interdum eu ac elit!

## 19.2 Native NetCDF ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES

Table 19.1: Variables in the dataset ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES

Dataset:	ATM_SURFACE_TEMP_HUM_WIND_PRES
Field:	EXFatemp
Field:	EXFaqh
Field:	EXFuwind
Field:	EXFvwind
Field:	EXFwspee
Field:	EXFpress

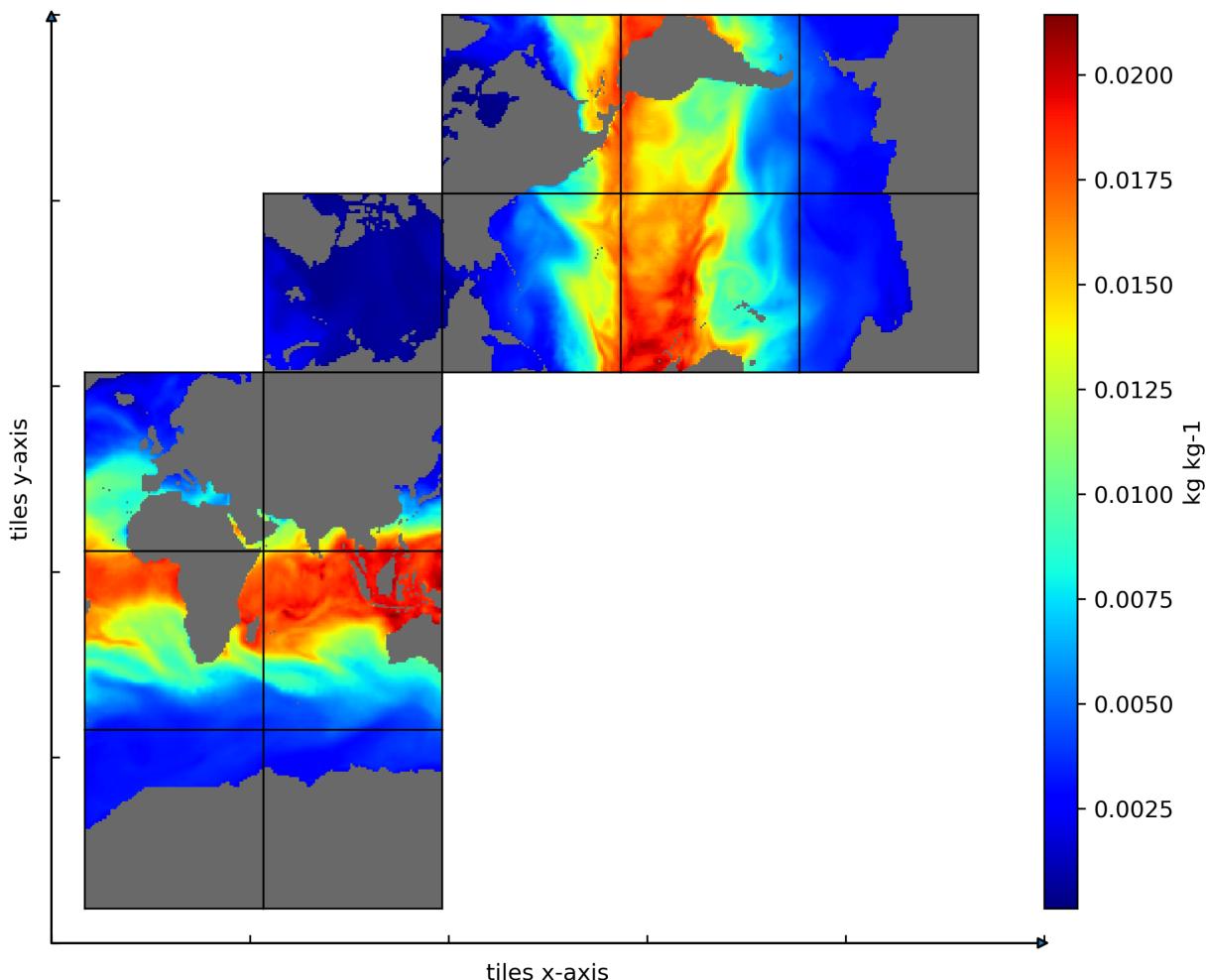
### 19.2.1 Native Variable EXFaqh

Table 19.2: CDL description of ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES's EXFaqh variable

Storage Type	Variable Name	Description	Unit
float32	EXFaqh	Atmosphere surface (2 m) specific humidity	kg kg <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
Surface (2 m) specific humidity over open water. Note: sum of ERA-Interim surface specific humidity and the control adjustment from ocean state estimation.			

## EXFaqh (Daily Mean)

Atmosphere surface (2 m) specific humidity



Example file 2017-12-29,  
ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

Figure 24: Dataset: ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES Variable: EXFaqh

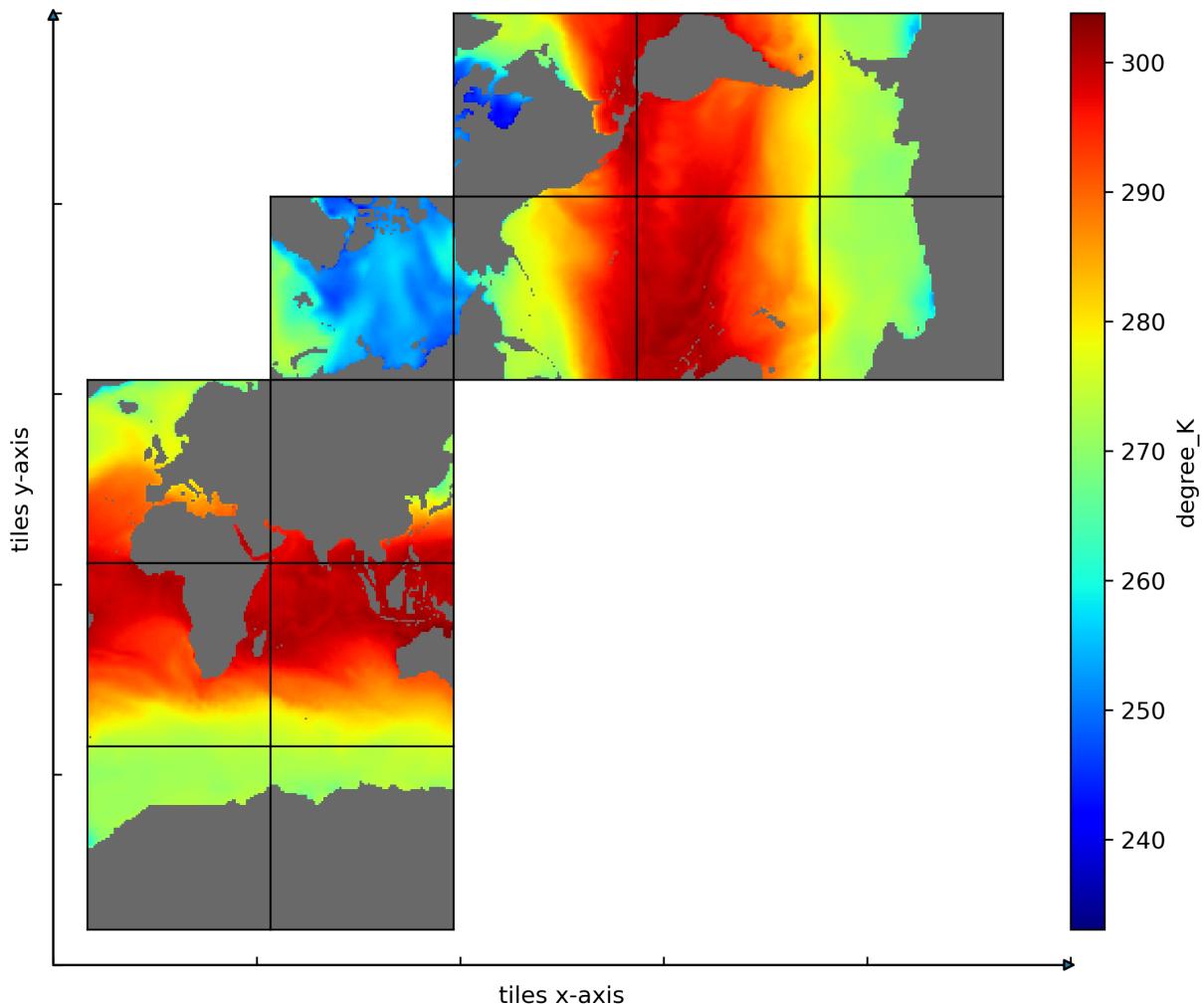
### 19.2.2 Native Variable EXFatemp

Table 19.3: CDL description of ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES's EXFatemp variable

Storage Type	Variable Name	Description	Unit
float32	EXFatemp	Atmosphere surface (2 m) air temperature	degree_K
<b>CDL Description</b>			
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			
<b>Comments</b>			
Surface (2 m) air temperature over open water. Note: sum of ERA-Interim surface air temperature and the control adjustment from ocean state estimation.			

## EXFatemp (Daily Mean)

Atmosphere surface (2 m) air temperature



Example file 2017-12-29,  
ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

Figure 25: Dataset: ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES Variable: EXFatemp

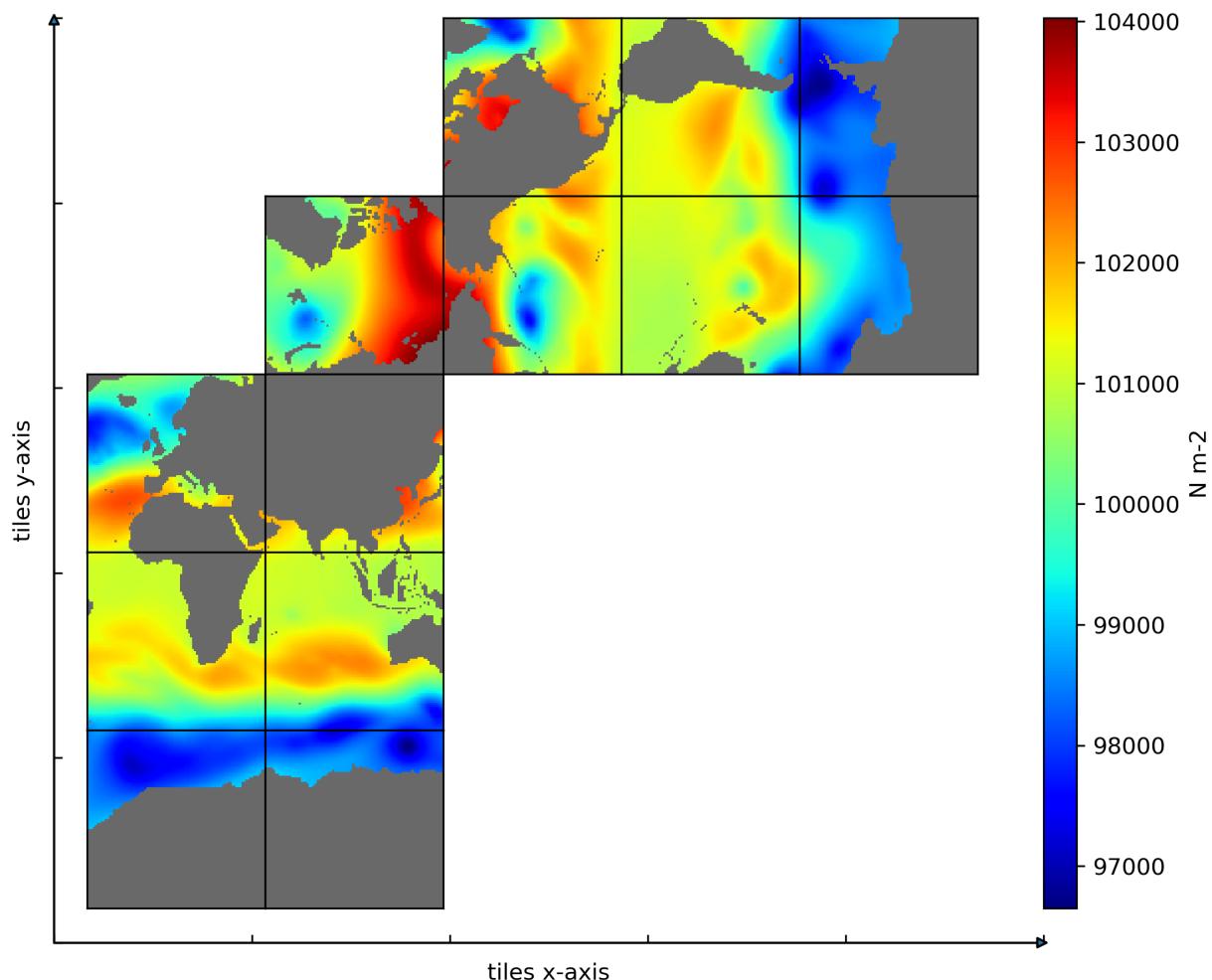
### 19.2.3 Native Variable EXFpress

**Table 19.4: CDL description of ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES's EXFpress variable**

Storage Type	Variable Name	Description	Unit
float32	EXFpress	Atmosphere surface pressure	N m-2
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

## EXFpress (Daily Mean)

Atmosphere surface pressure



Example file 2017-12-29,

ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

Figure 26: Dataset: ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES Variable: EXFpress

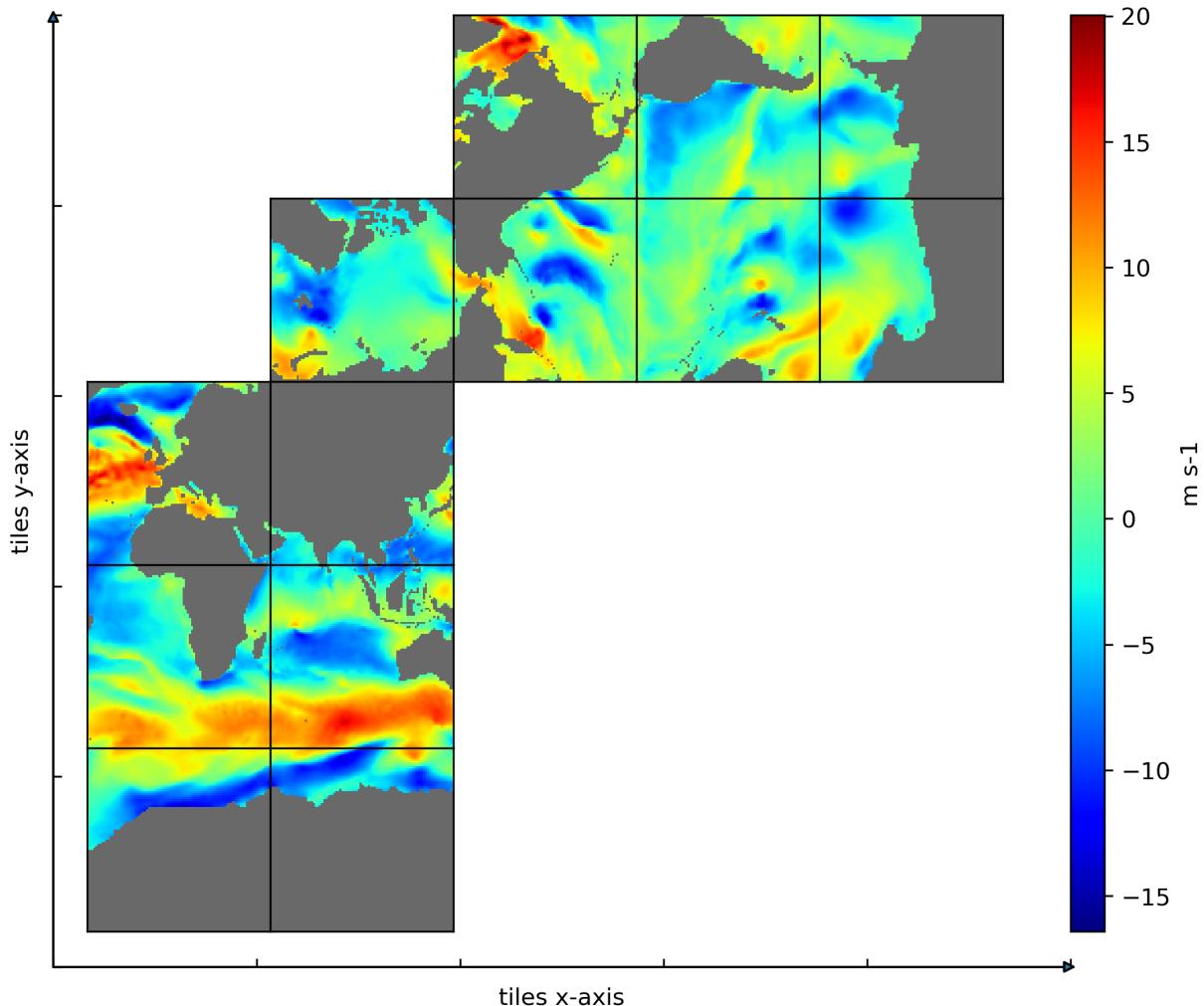
#### 19.2.4 Native Variable EXFuwind

Table 19.5: CDL description of ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES's EXFuwind variable

Storage Type	Variable Name	Description	Unit
float32	EXFuwind	Wind speed at 10m in the model +x direction	m s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
Wind speed at 10m in the +x direction at the tracer cell on the native model grid. Note: ECCO v4r4 is forced with wind stress (see EXFtaux) not vector winds converted to wind stress using bulk formulae. EXFuwind is calculated by converting wind stress to vector wind using bulk formulae.			

## EXFuwind (Daily Mean)

Wind speed at 10m in the model +x direction



Example file 2017-12-29,  
ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

**Figure 27: Dataset: ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES Variable: EXFuwind**

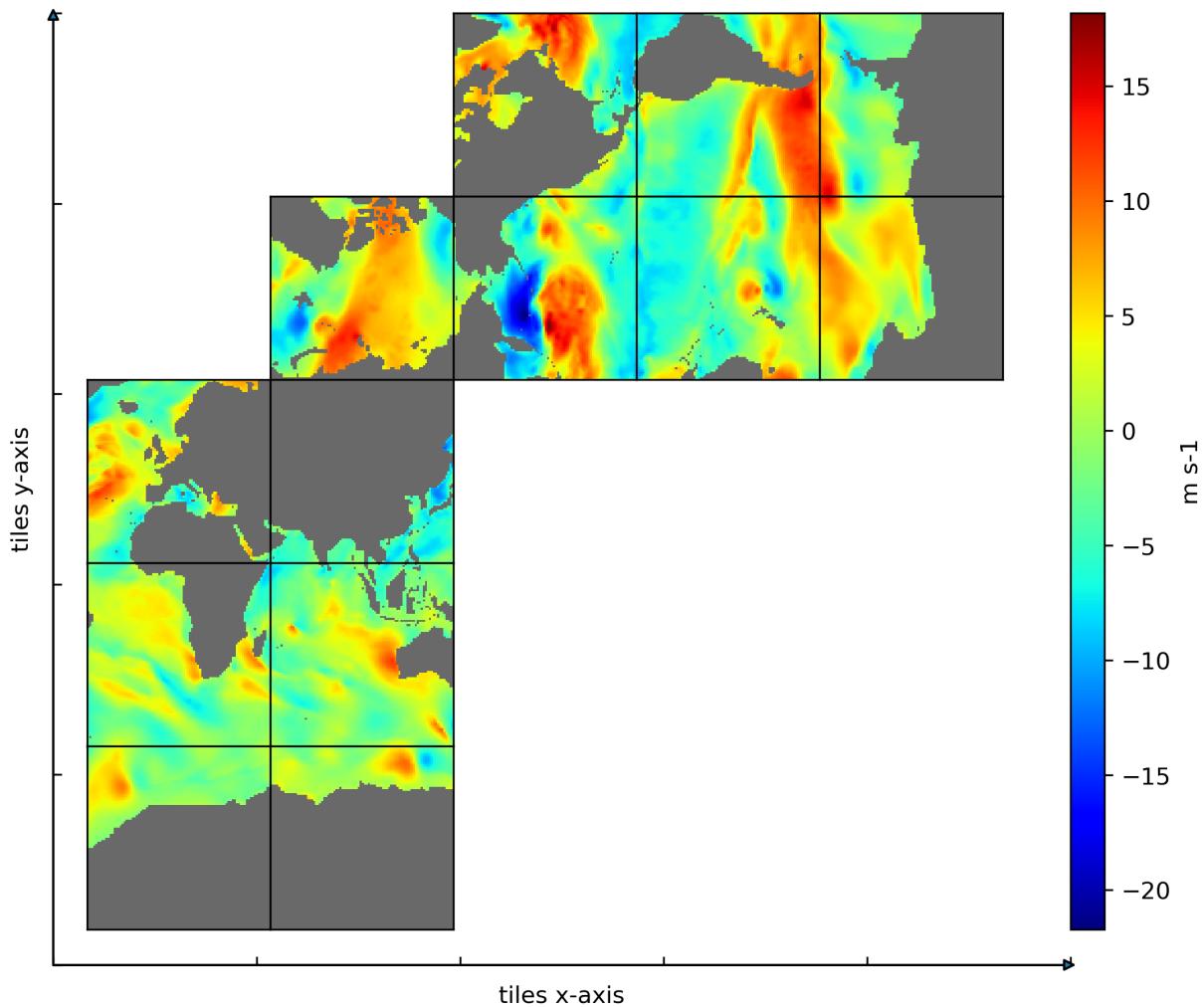
### 19.2.5 Native Variable EXFvwind

Table 19.6: CDL description of ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES's EXFvwind variable

Storage Type	Variable Name	Description	Unit
float32	EXFvwind	Wind speed at 10m in the model +y direction	m s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

## EXFvwind (Daily Mean)

Wind speed at 10m in the model +y direction



Example file 2017-12-29,  
ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

Figure 28: Dataset: ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES Variable: EXFvwind

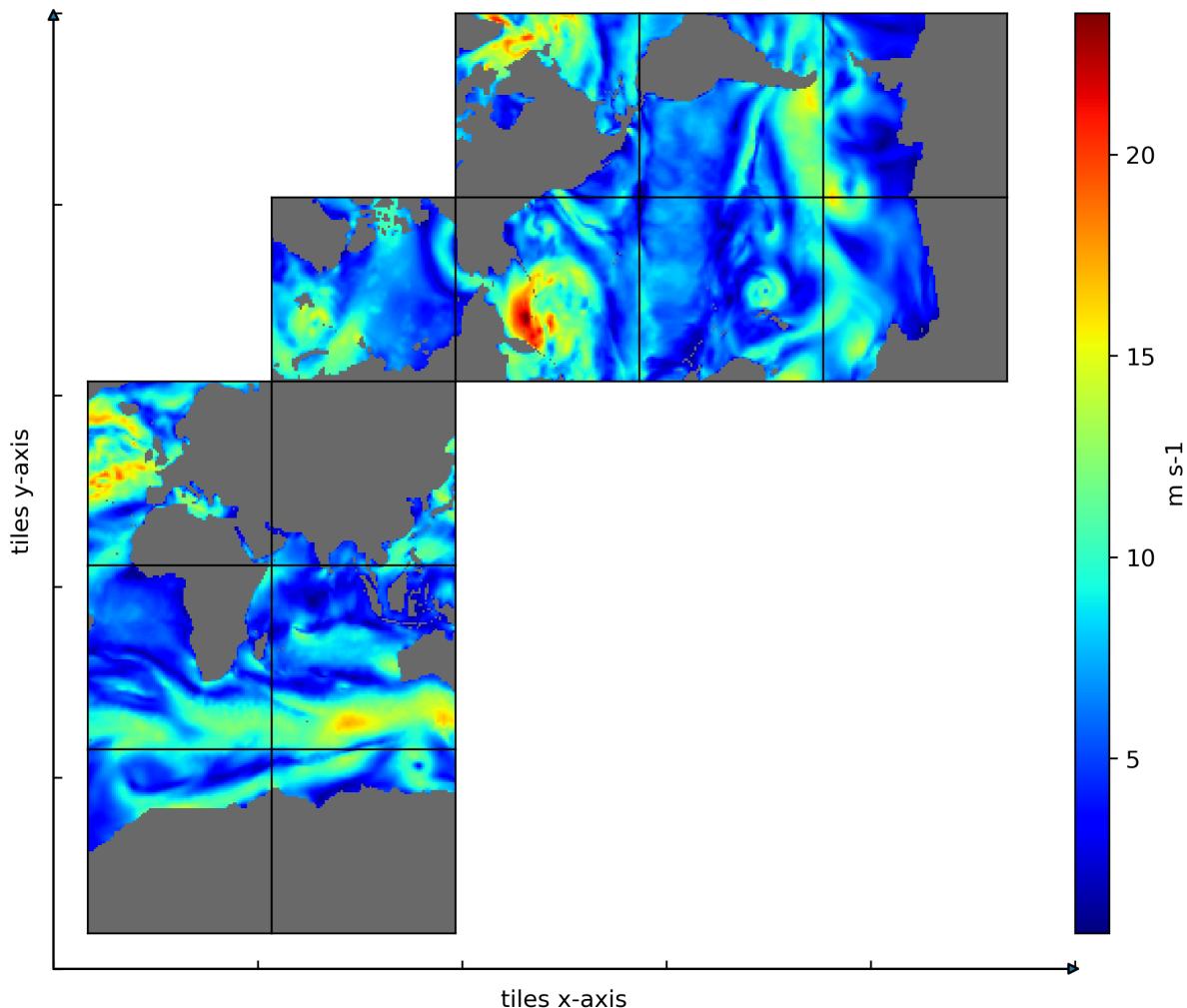
### 19.2.6 Native Variable EXFwspee

**Table 19.7: CDL description of ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES's EXFwspee variable**

Storage Type	Variable Name	Description	Unit
float32	EXFwspee	Wind speed	m s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
10-m wind speed magnitude ( $\geq 0$ ) 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 necessarily consistent with EXFuwind and EXFvwind because EXFuwind and EXFvwind are calculated from EXFtaux and EXFtauy using bulk formulae. EXFwspee != sqrt(EXFuwind**2 + EXFvwind**2).			

## EXFwspee (Daily Mean)

Wind speed



Example file 2017-12-29,

ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

Figure 29: Dataset: ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES Variable: EXFwspee

### 19.3 Native NetCDF OCEAN\_3D\_MIXING\_COEFFS

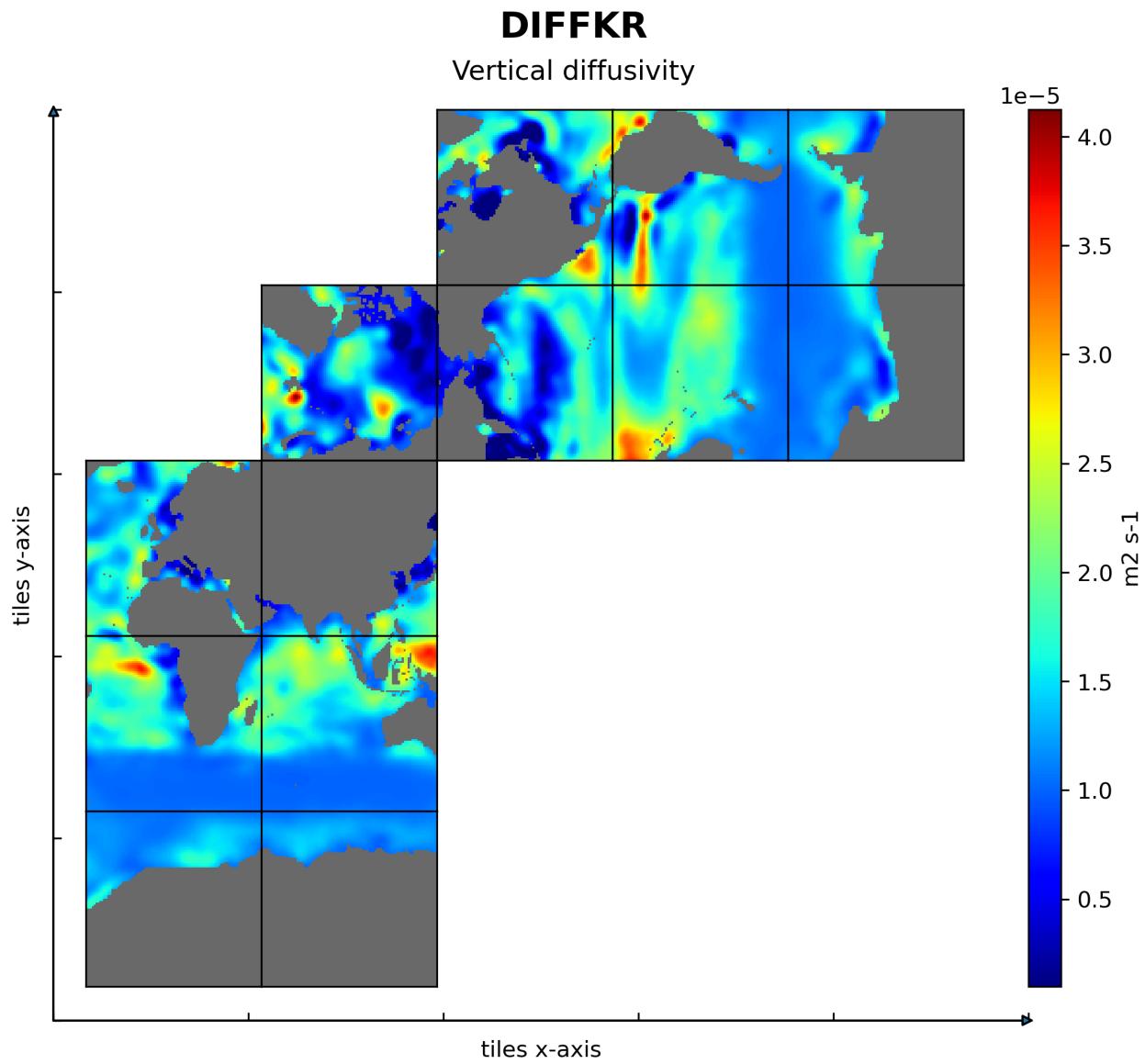
Table 19.8: Variables in the dataset OCEAN\_3D\_MIXING\_COEFFS\_ECCO

Dataset:	OCEAN_3D_MIXING_COEFFS_ECCO
Field:	DIFFKR
Field:	KAPGM
Field:	KAPREDI

### 19.3.1 Native Variable DIFFKR

Table 19.9: CDL description of OCEAN\_3D\_MIXING\_COEFFS's DIFFKR variable

Storage Type	Variable Name	Description	Unit
float32	DIFFKR	Vertical diffusivity	m <sup>2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
float32 DIFFKR(k, tile, j, i) DIFFKR:_FillValue = 9.96921e+36 DIFFKR: coverage_content_type = modelResult DIFFKR: long_name = Vertical diffusivity DIFFKR: units = m <sup>2</sup> s <sup>-1</sup> DIFFKR: valid_min = 1e: 06 DIFFKR: valid_max = 0.0001854995 DIFFKR: coordinates = Z XC YC			
<b>Comments</b>			
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 <sup>2</sup> s <sup>-1</sup> .			



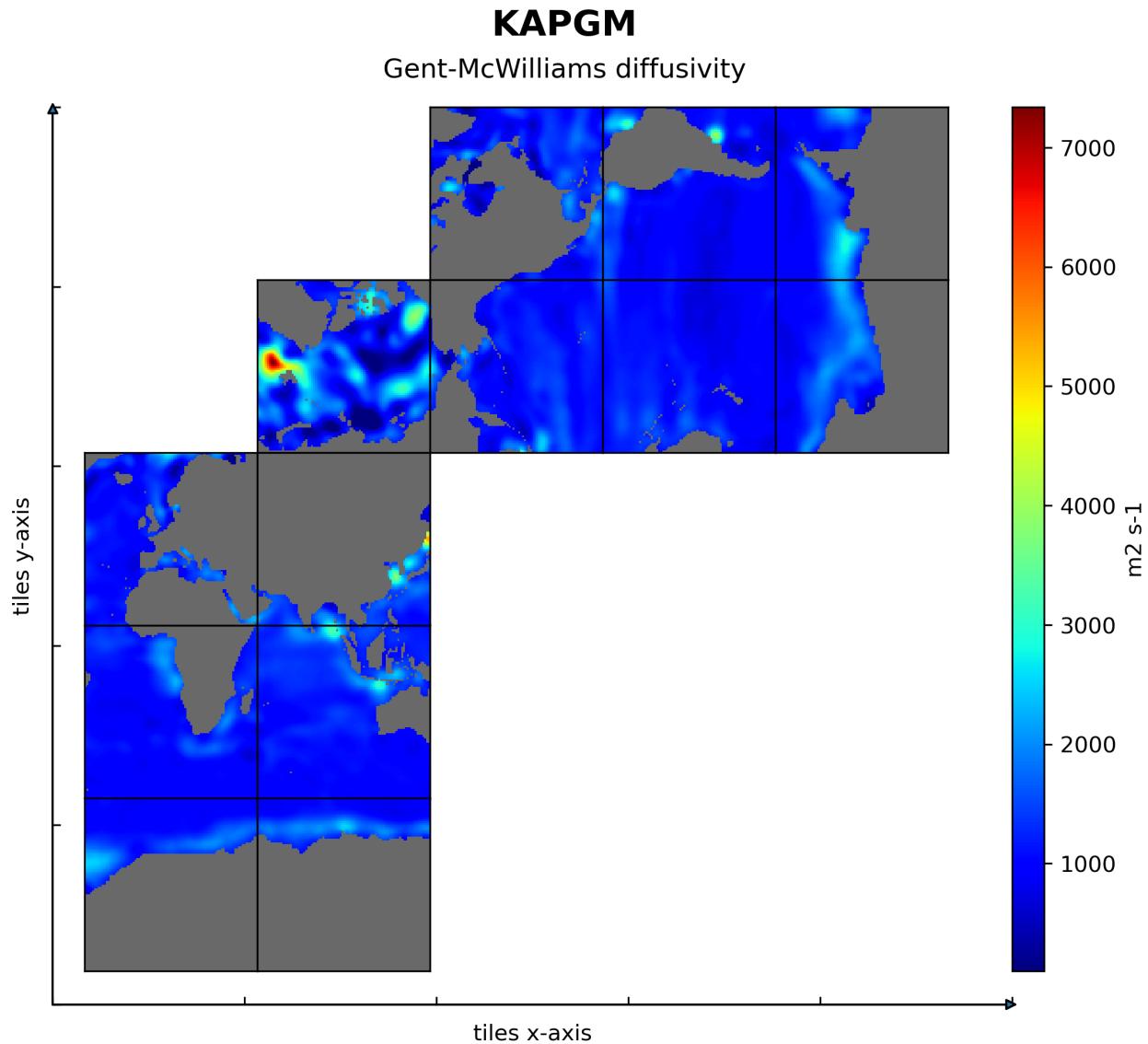
Example file:  
OCEAN\_3D\_MIXING\_COEFFS\_ECCO\_V4r4\_native\_llc0090.nc

**Figure 30: Dataset: OCEAN\_3D\_MIXING\_COEFFS Variable: DIFFKR**

### 19.3.2 Native Variable KAPGM

Table 19.10: CDL description of OCEAN\_3D\_MIXING\_COEFFS's KAPGM variable

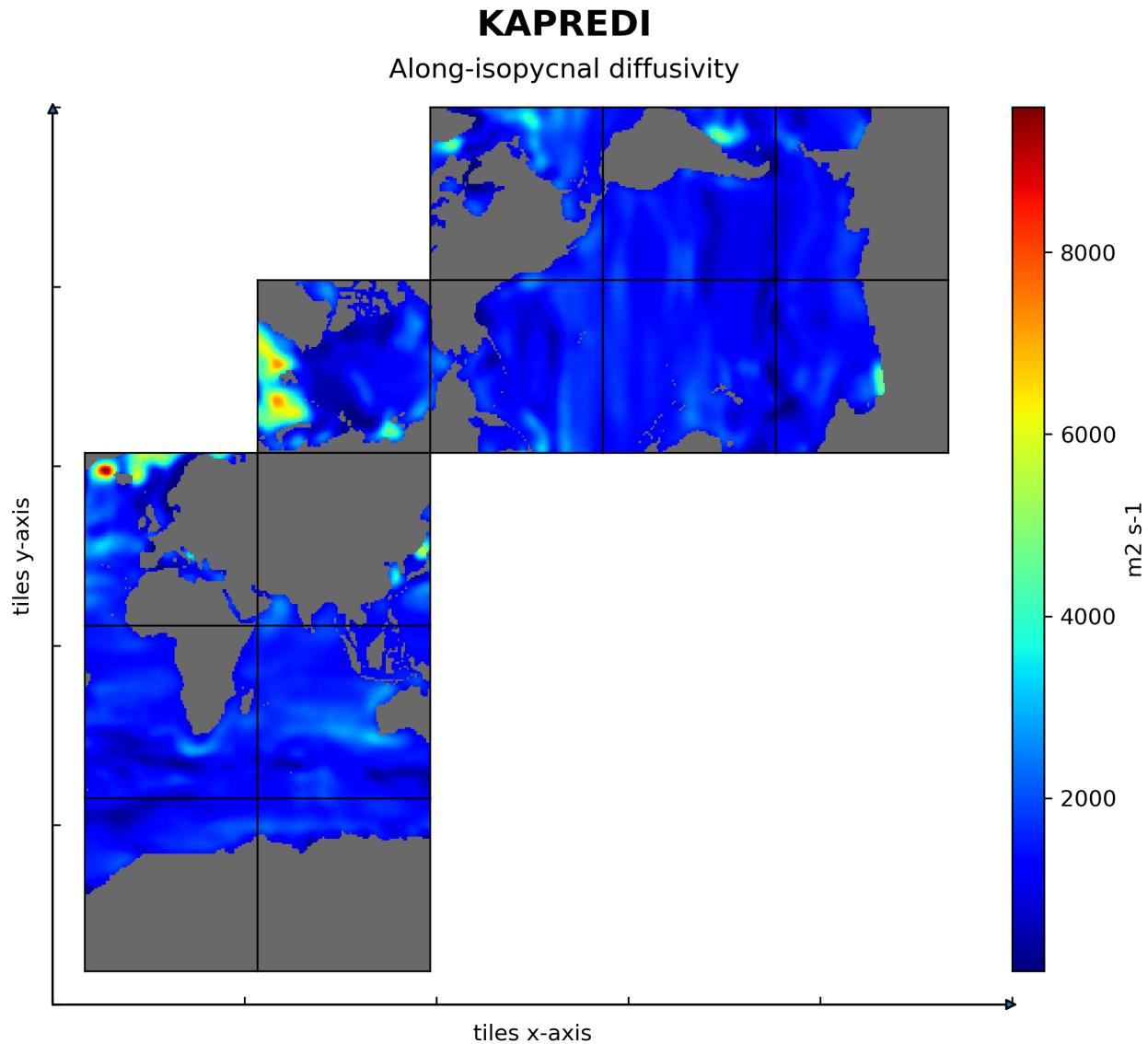
Storage Type	Variable Name	Description	Unit
float32	KAPGM	Gent-McWilliams diffusivity	m <sup>2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
float32 KAPGM(k, tile, j, i) KAPGM:_FillValue = 9.96921e+36 KAPGM: coverage_content_type = modelResult KAPGM: long_name = Gent: McWilliams diffusivity KAPGM: units = m <sup>2</sup> s <sup>-1</sup> KAPGM: valid_min = 100.0 KAPGM: valid_max = 10000.0 KAPGM: coordinates = Z XC YC			
<b>Comments</b>			
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 m <sup>2</sup> s <sup>-1</sup> .			



### 19.3.3 Native Variable KAPREDI

Table 19.11: CDL description of OCEAN\_3D\_MIXING\_COEFFS's KAPREDI variable

Storage Type	Variable Name	Description	Unit
float32	KAPREDI	Along-isopycnal diffusivity	m <sup>2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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 <sup>2</sup> s <sup>-1</sup> KAPREDI: valid_min = 100.0 KAPREDI: valid_max = 10000.0 KAPREDI: coordinates = Z XC YC			
<b>Comments</b>			
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 <sup>2</sup> s <sup>-1</sup> .			



Example file:  
OCEAN\_3D\_MIXING\_COEFFS\_ECCO\_V4r4\_native\_llc0090.nc

**Figure 32: Dataset: OCEAN\_3D\_MIXING\_COEFFS Variable: KAPREDI**

## 19.4 Native NetCDF OCEAN\_3D\_MOMENTUM\_TEND

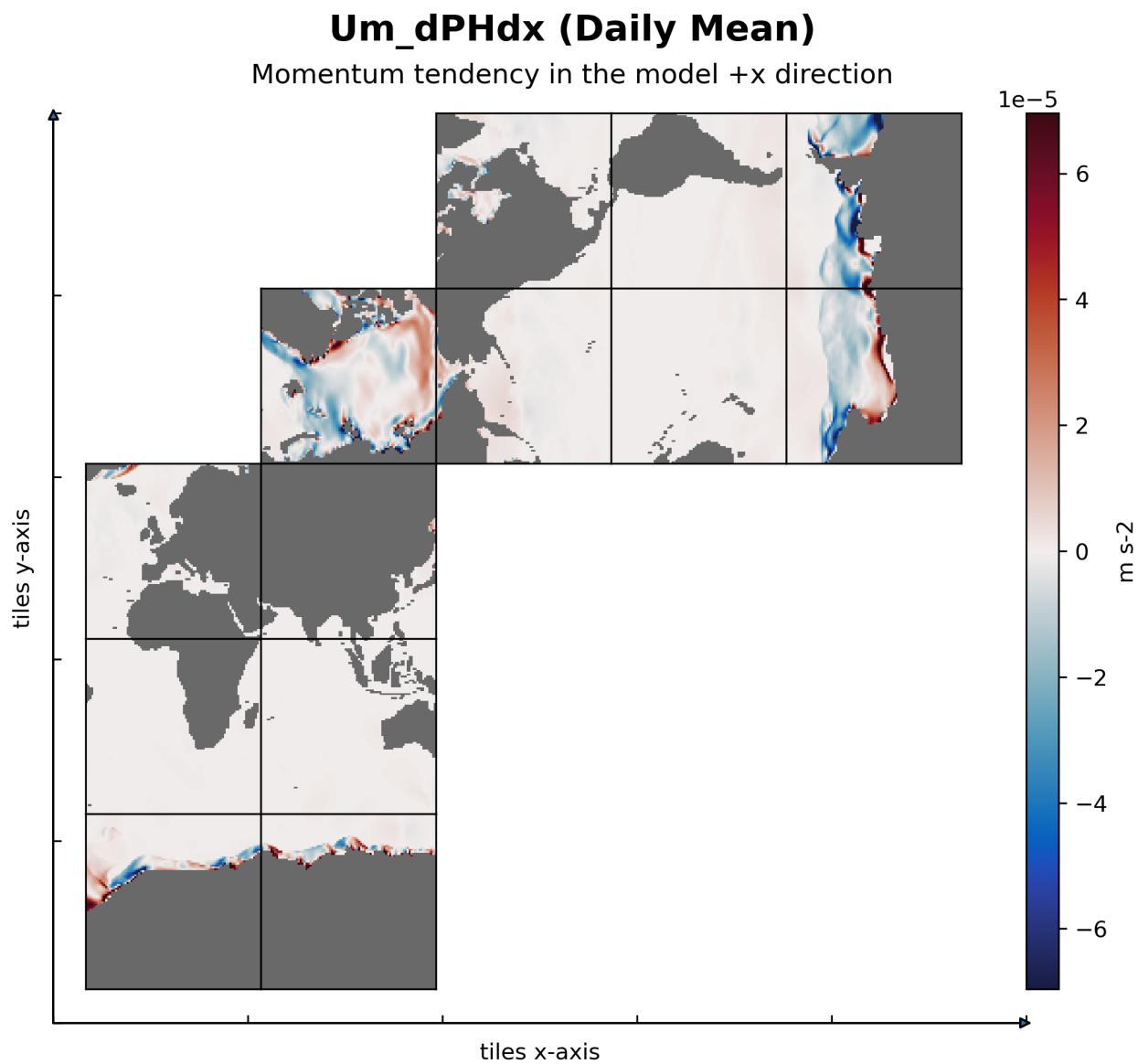
**Table 19.12:** Variables in the dataset OCEAN\_3D\_MOMENTUM\_TEND

Dataset:	OCEAN_3D_MOMENTUM_TEND
Field:	Um_dPHdx
Field:	Vm_dPHdy

#### 19.4.1 Native Variable Um\_dPHdx

**Table 19.13: CDL description of OCEAN\_3D\_MOMENTUM\_TEND's Um\_dPHdx variable**

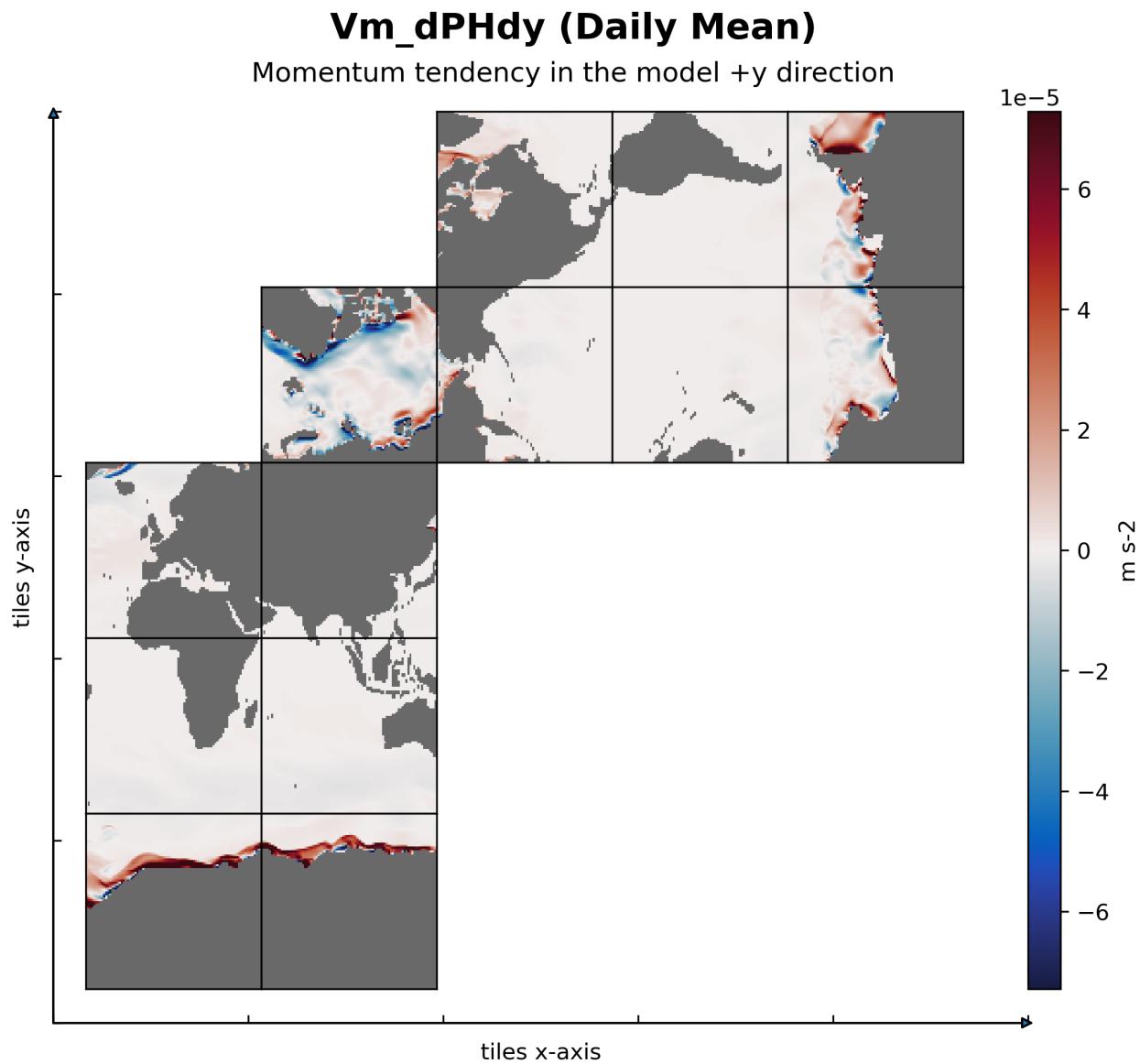
Storage Type	Variable Name	Description	Unit
float32	Um_dPHdx	Momentum tendency in the model +x direction	m s <sup>-2</sup>
<b>CDL Description</b>			
float32 Um_dPHdx(time, k, tile, j, i_g) Um_dPHdx: _FillValue = 9.96921e+36 Um_dPHdx: long_name = Momentum tendency in the model +x direction Um_dPHdx: units = 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			
<b>Comments</b>			
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.			



#### 19.4.2 Native Variable Vm\_dPHdy

**Table 19.14: CDL description of OCEAN\_3D\_MOMENTUM\_TEND's Vm\_dPHdy variable**

Storage Type	Variable Name	Description	Unit
float32	Vm_dPHdy	Momentum tendency in the model +y direction	m s <sup>-2</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			



## 19.5 Native NetCDF OCEAN\_3D\_SALINITY\_FLUX

**Table 19.15: Variables in the dataset OCEAN\_3D\_SALINITY\_FLUX**

Dataset:	OCEAN_3D_SALINITY_FLUX
Field:	ADVx_SLT
Field:	DFxE_SLT
Field:	ADVy_SLT
Field:	DFyE_SLT
Field:	ADVr_SLT
Field:	DFrE_SLT
Field:	DFrl_SLT
Field:	oceSPtnd

### 19.5.1 Native Variable ADVr\_SLT

**Table 19.16: CDL description of OCEAN\_3D\_SALINITY\_FLUX's ADVr\_SLT variable**

Storage Type	Variable Name	Description	Unit
float32	ADVr_SLT	Vertical advective flux of salinity	1e-3 m3 s-1
<b>CDL Description</b>			
float32 ADVr_SLT(time, k_l, tile, j, i) ADVr_SLT: _FillValue = 9.96921e+36 ADVr_SLT: long_name = Vertical advective flux of salinity ADVr_SLT: units = 1e: 3 m3 s: 1 ADVr_SLT: coverage_content_type = modelResult ADVr_SLT: direction = >0 decreases salinity (SALT) ADVr_SLT: coordinates = XC ZI YC time ADVr_SLT: valid_min = : 324149856.0 ADVr_SLT: valid_max = 263294624.0			
<b>Comments</b>			
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 <a href="https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html">https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html</a>			

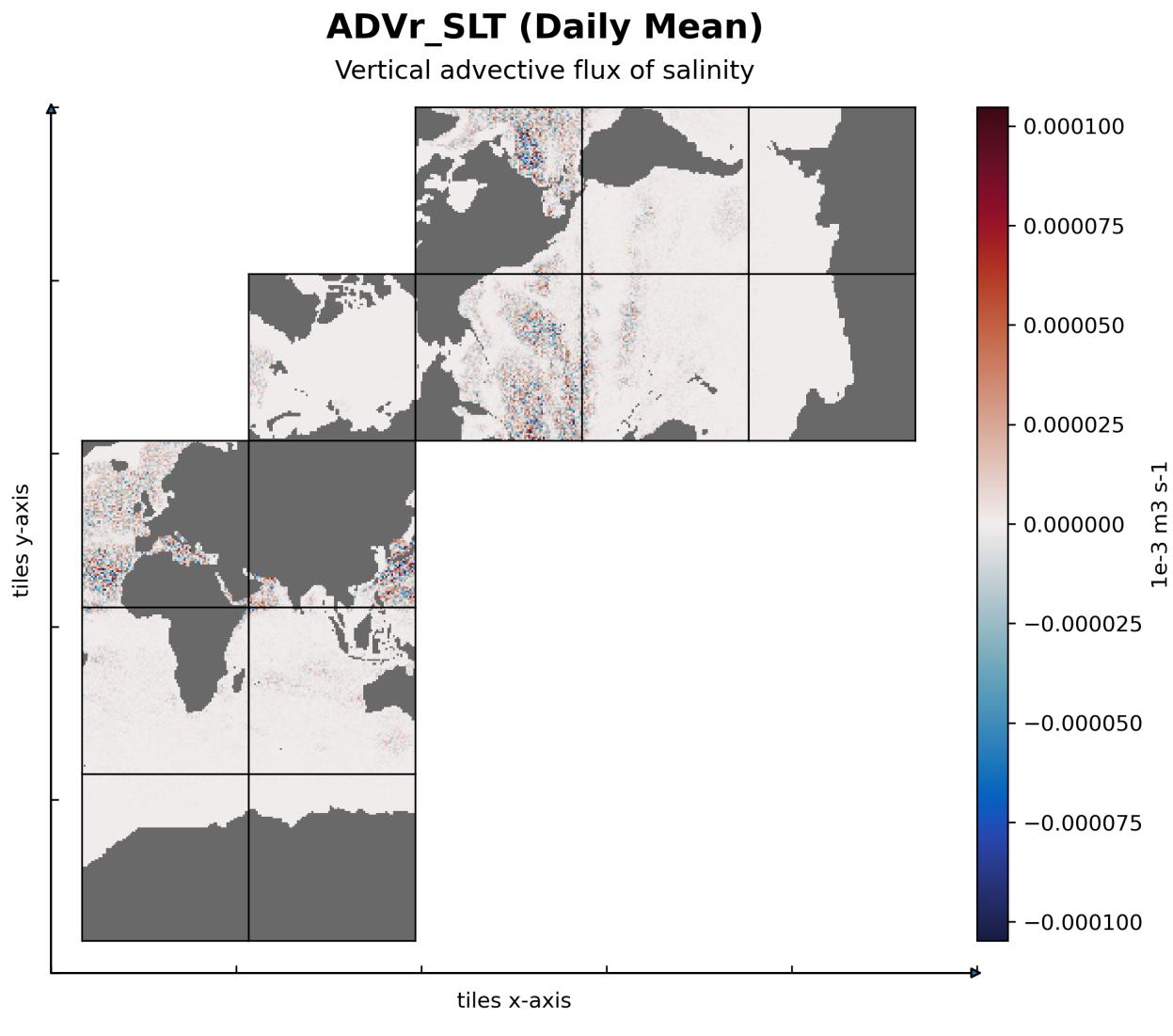
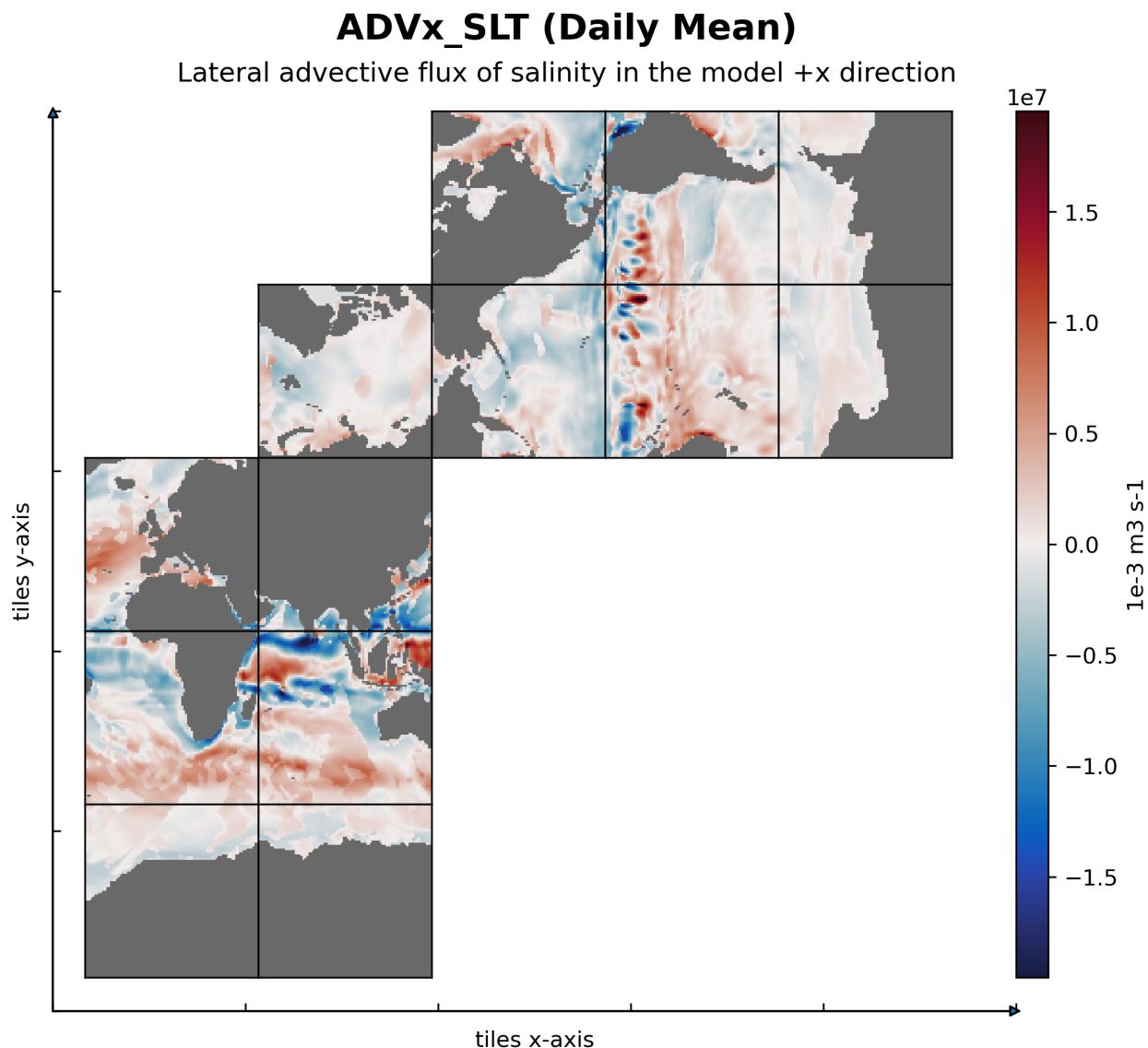


Figure 35: Dataset: OCEAN\_3D\_SALINITY\_FLUX Variable: ADVr\_SLT

### 19.5.2 Native Variable ADVx\_SLT

**Table 19.17: CDL description of OCEAN\_3D\_SALINITY\_FLUX's ADVx\_SLT variable**

Storage Type	Variable Name	Description	Unit
float32	ADVx_SLT	Lateral advective flux of salinity in the model +x direction	1e-3 m3 s-1
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 <a href="https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html">https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html</a>			

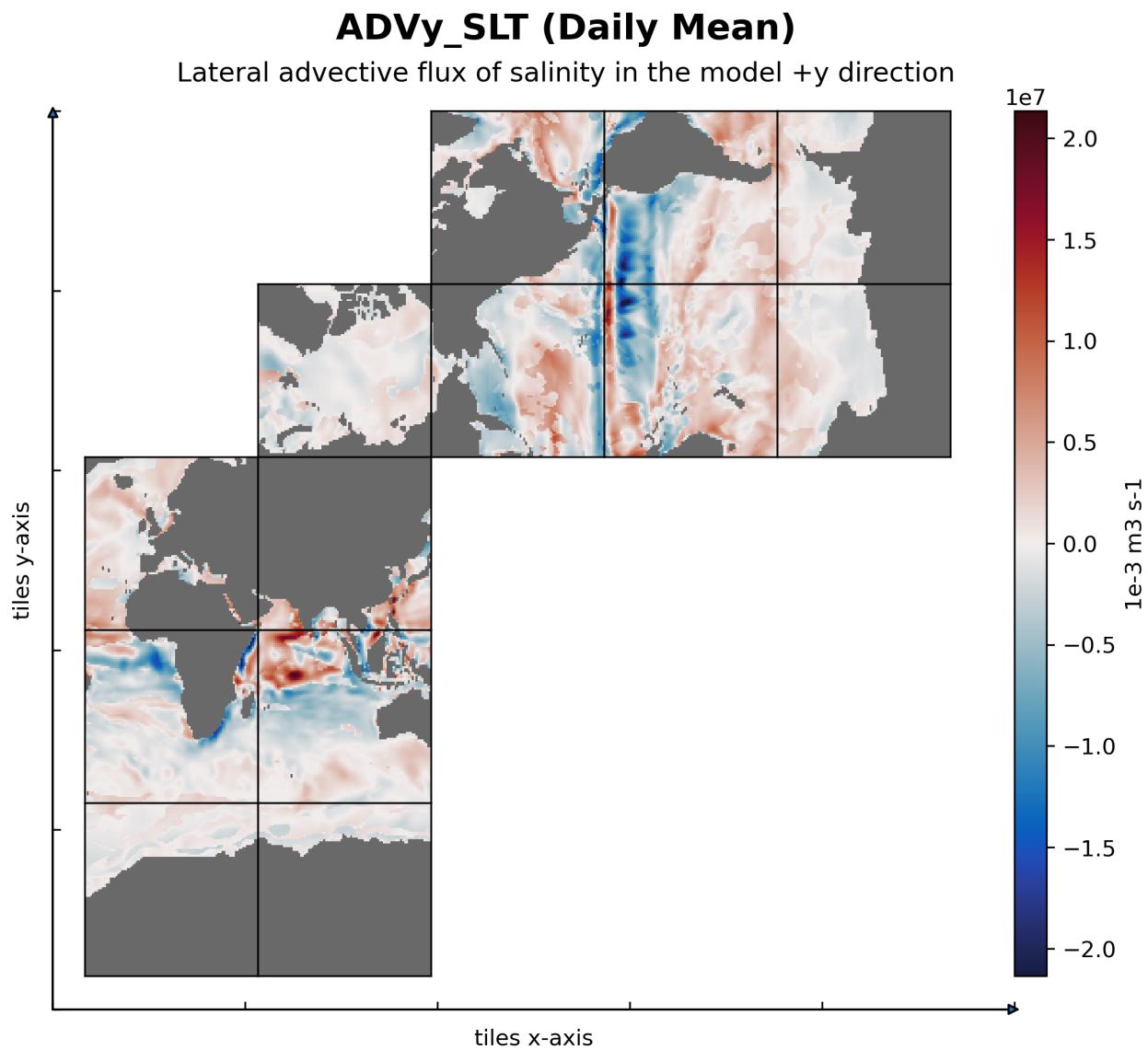


**Figure 36: Dataset: OCEAN\_3D\_SALINITY\_FLUX Variable: ADVx\_SLT**

### 19.5.3 Native Variable ADVy\_SLT

**Table 19.18: CDL description of OCEAN\_3D\_SALINITY\_FLUX's ADVy\_SLT variable**

Storage Type	Variable Name	Description	Unit
float32	ADVy_SLT	Lateral advective flux of salinity in the model +y direction	1e-3 m3 s-1
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 <a href="https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html">https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html</a>			



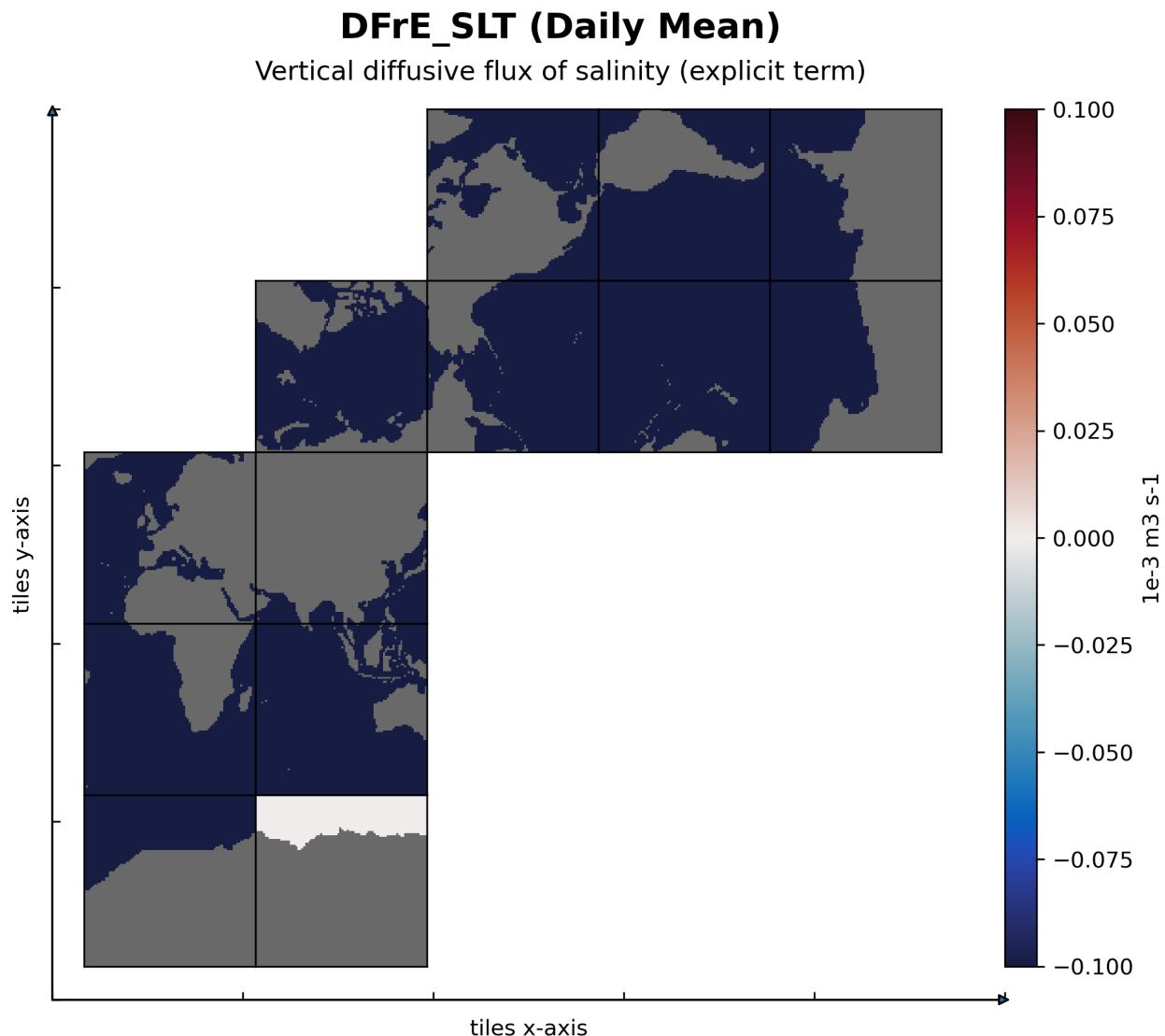
Example file 2017-12-29,  
OCEAN\_3D\_SALINITY\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

**Figure 37: Dataset: OCEAN\_3D\_SALINITY\_FLUX Variable: ADVy\_SLT**

#### 19.5.4 Native Variable DFrE\_SLT

**Table 19.19: CDL description of OCEAN\_3D\_SALINITY\_FLUX's DFrE\_SLT variable**

Storage Type	Variable Name	Description	Unit
float32	DFrE_SLT	Vertical diffusive flux of salinity (explicit term)	1e-3 m3 s-1
<b>CDL Description</b>			
float32 DFrE_SLT(time, k_l, tile, j, i) DFrE_SLT: _FillValue = 9.96921e+36 DFrE_SLT: long_name = Vertical diffusive flux of salinity (explicit term) DFrE_SLT: units = 1e: 3 m3 s: 1 DFrE_SLT: coverage_content_type = modelResult DFrE_SLT: direction = >0 decreases salinity (SALT) DFrE_SLT: coordinates = XC Zl YC time DFrE_SLT: valid_min = : 1074719.375 DFrE_SLT: valid_max = 471215.75			
<b>Comments</b>			
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 Kzw 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 <a href="https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html">https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html</a>			

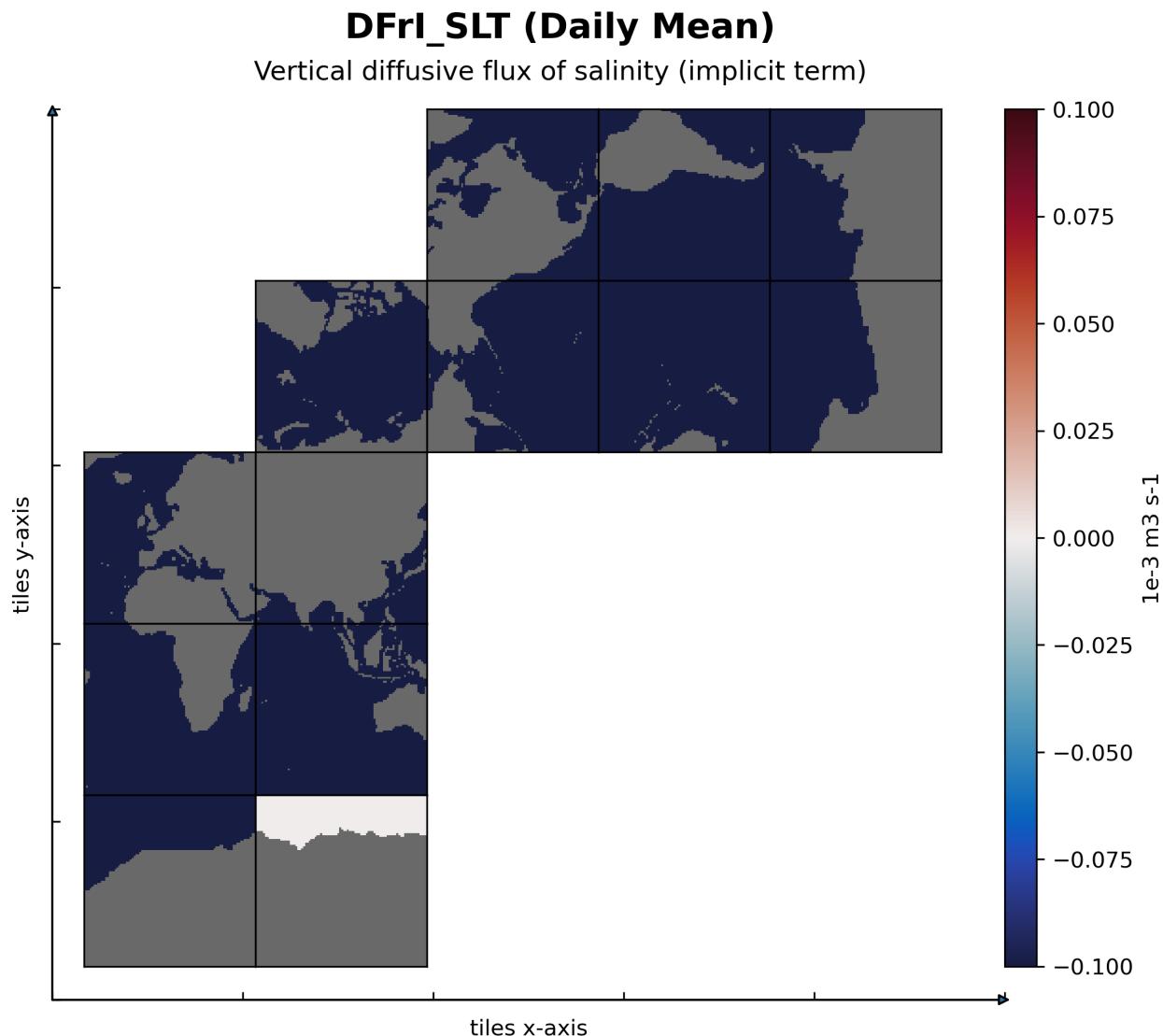


**Figure 38: Dataset: OCEAN\_3D\_SALINITY\_FLUX Variable: DFrE\_SLT**

### 19.5.5 Native Variable DFrl\_SLT

**Table 19.20: CDL description of OCEAN\_3D\_SALINITY\_FLUX's DFrl\_SLT variable**

Storage Type	Variable Name	Description	Unit
float32	DFrl_SLT	Vertical diffusive flux of salinity (implicit term)	1e-3 m3 s-1
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 +DFrl_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 <a href="https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html">https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html</a>			

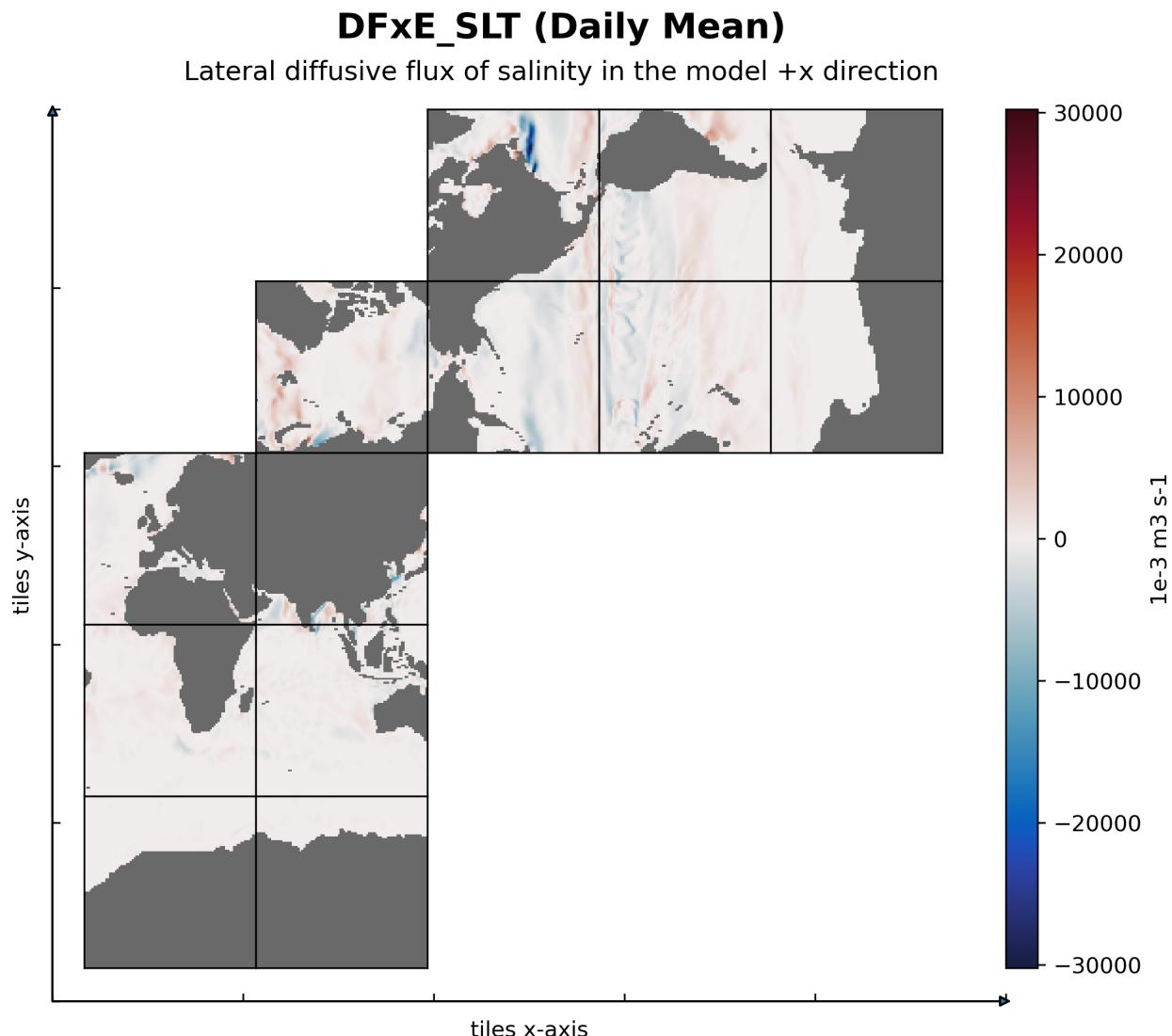


**Figure 39: Dataset: OCEAN\_3D\_SALINITY\_FLUX Variable: DFrl\_SLT**

### 19.5.6 Native Variable DFxE\_SLT

**Table 19.21: CDL description of OCEAN\_3D\_SALINITY\_FLUX's DFxE\_SLT variable**

Storage Type	Variable Name	Description	Unit
float32	DFxE_SLT	Lateral diffusive flux of salinity in the model +x direction	1e-3 m3 s-1
<b>CDL Description</b>			
float32 DFxE_SLT(time, k, tile, j, i_g) DFxE_SLT: _FillValue = 9.96921e+36 DFxE_SLT: long_name = Lateral diffusive flux of salinity in the model +x direction DFxE_SLT: units = 1e: 3 m3 s: 1 DFxE_SLT: mate = DFyE_SLT DFxE_SLT: coverage_content_type = modelResult DFxE_SLT: direction = >0 increases salinity (SALT) DFxE_SLT: coordinates = Z time DFxE_SLT: valid_min = : 125908.03125 DFxE_SLT: valid_max = 192716.484375			
<b>Comments</b>			
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 <a href="https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html">https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html</a>			

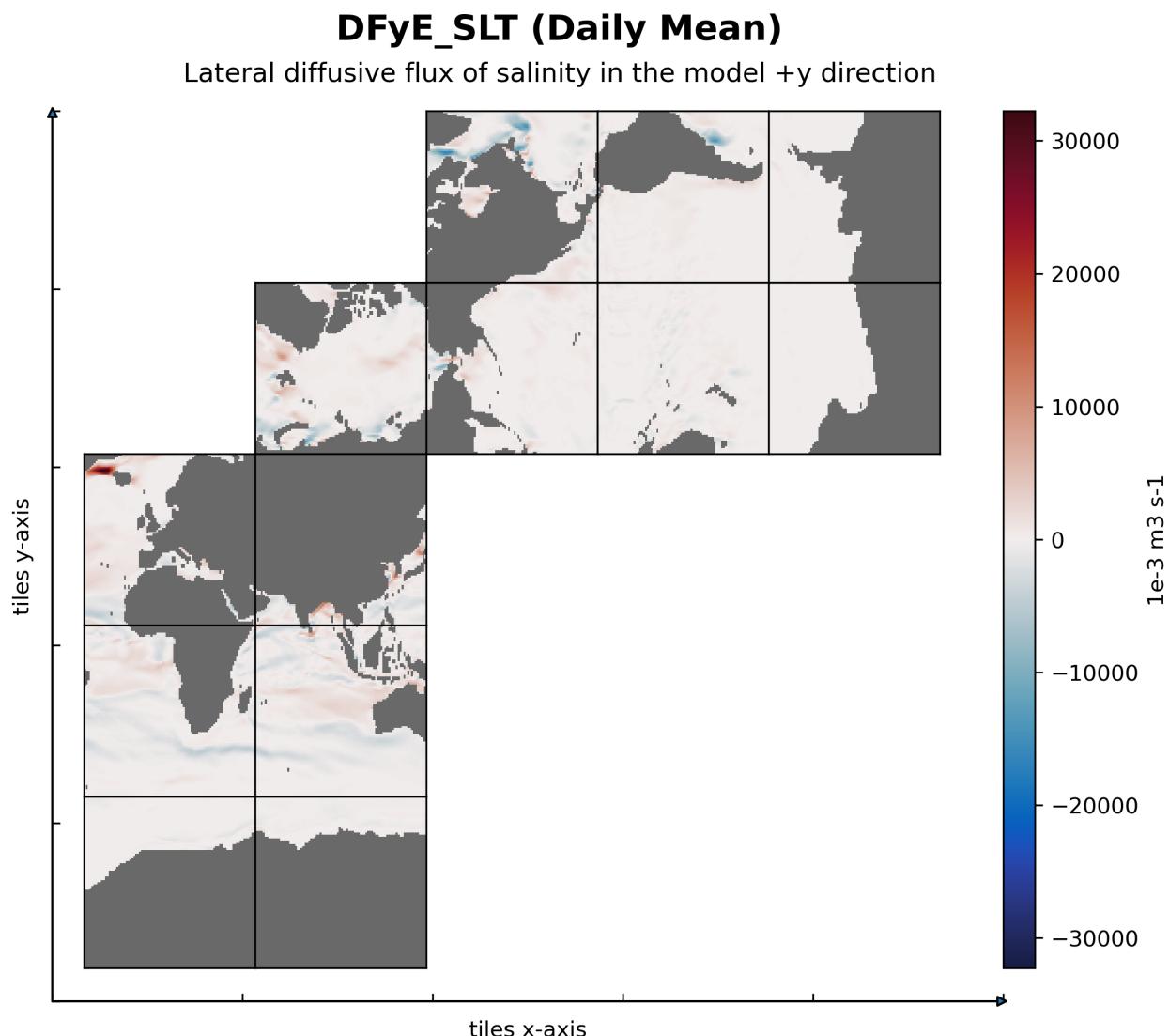


**Figure 40: Dataset: OCEAN\_3D\_SALINITY\_FLUX Variable: DFxE\_SLT**

### 19.5.7 Native Variable DFyE\_SLT

**Table 19.22: CDL description of OCEAN\_3D\_SALINITY\_FLUX's DFyE\_SLT variable**

Storage Type	Variable Name	Description	Unit
float32	DFyE_SLT	Lateral diffusive flux of salinity in the model +y direction	1e-3 m3 s-1
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 <a href="https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html">https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html</a>			



**Figure 41: Dataset: OCEAN\_3D\_SALINITY\_FLUX Variable: DFyE\_SLT**

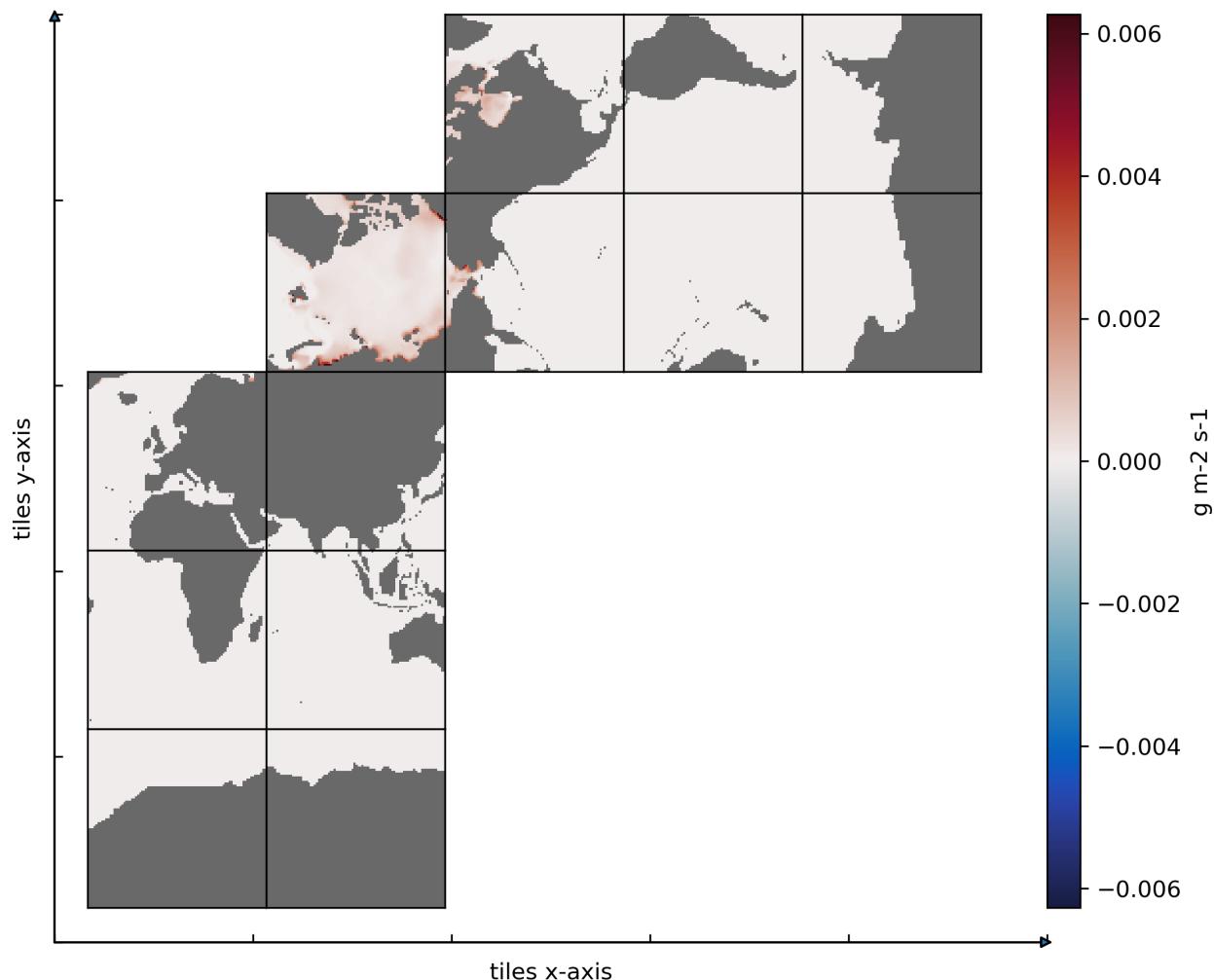
### 19.5.8 Native Variable oceSPtnd

Table 19.23: CDL description of OCEAN\_3D\_SALINITY\_FLUX's oceSPtnd variable

Storage Type	Variable Name	Description	Unit
float32	oceSPtnd	Salt tendency due to the vertical transport of salt in high-salinity brine plumes	g m <sup>-2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

## oceSPtnd (Daily Mean)

Salt tendency due to the vertical transport of salt in high-salinity brine plumes



Example file 2017-12-29,  
OCEAN\_3D\_SALINITY\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

**Figure 42: Dataset: OCEAN\_3D\_SALINITY\_FLUX Variable: oceSPtnd**

## 19.6 Native NetCDF OCEAN\_3D\_TEMPERATURE\_FLUX

**Table 19.24: Variables in the dataset OCEAN\_3D\_TEMPERATURE\_FLUX**

Dataset:	OCEAN_3D_TEMPERATURE_FLUX
Field:	ADVx_TH
Field:	DFxE_TH
Field:	ADVy_TH
Field:	DFyE_TH
Field:	ADVr_TH
Field:	DFrE_TH
Field:	DFrl_TH

### 19.6.1 Native Variable ADVr\_TH

**Table 19.25: CDL description of OCEAN\_3D\_TEMPERATURE\_FLUX's ADVr\_TH variable**

Storage Type	Variable Name	Description	Unit
float32	ADVr_TH	Vertical advective flux of potential temperature	degree_C m3 s-1
<b>CDL Description</b>			
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			
<b>Comments</b>			
Vertical advective flux of potential temperature (THETA) in the +z direction through the top 'w' face of the tracer cell on the native model grid. Note: in the Arakawa-C grid, vertical flux quantities are staggered relative to the tracer cells with indexing such that +ADVr_TH(i,j,k_l) corresponds to upward +z fluxes through the top 'w' face of the tracer cell at (i,j,k)			

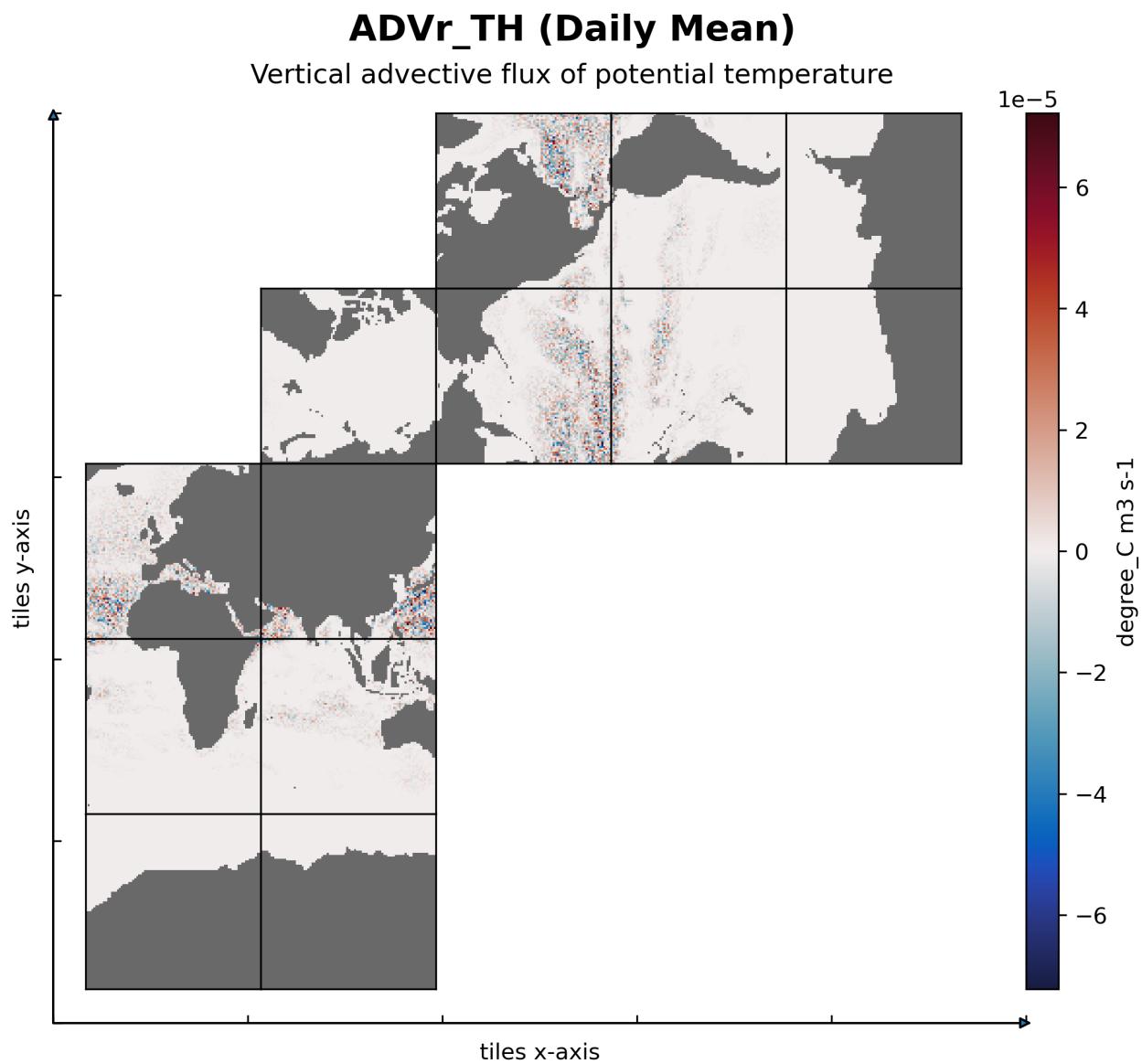


Figure 43: Dataset: OCEAN\_3D\_TEMPERATURE\_FLUX Variable: ADVr\_TH

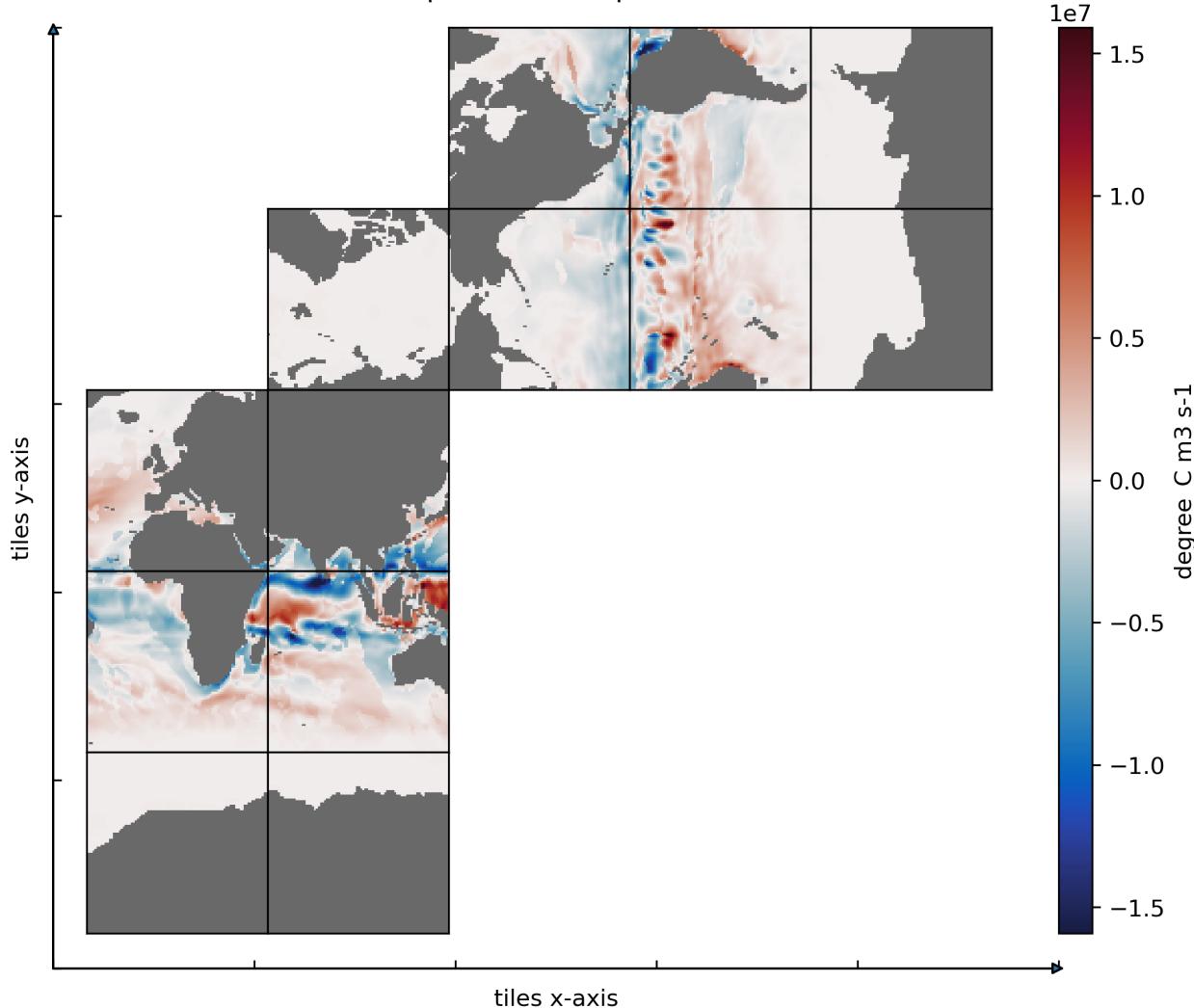
### 19.6.2 Native Variable ADVx\_TH

**Table 19.26: CDL description of OCEAN\_3D\_TEMPERATURE\_FLUX's ADVx\_TH variable**

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
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

## ADVx\_TH (Daily Mean)

Lateral advective flux of potential temperature in the model +x direction



Example file 2017-12-29,  
OCEAN\_3D\_TEMPERATURE\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

**Figure 44:** Dataset: OCEAN\_3D\_TEMPERATURE\_FLUX Variable: ADVx\_TH

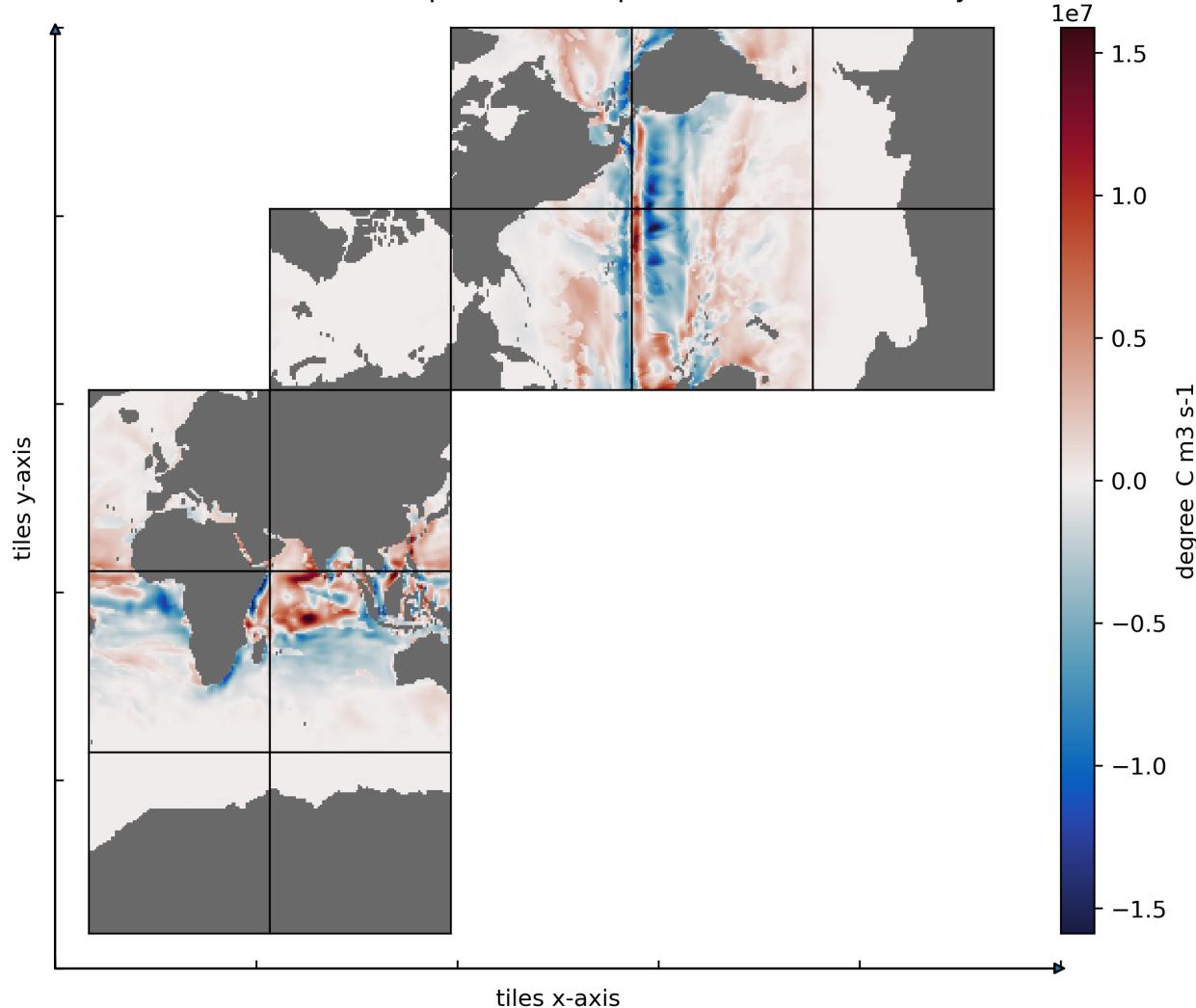
### 19.6.3 Native Variable ADVy\_TH

**Table 19.27: CDL description of OCEAN\_3D\_TEMPERATURE\_FLUX's ADVy\_TH variable**

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
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

## ADV<sub>y</sub> TH (Daily Mean)

Lateral advective flux of potential temperature in the model +y direction



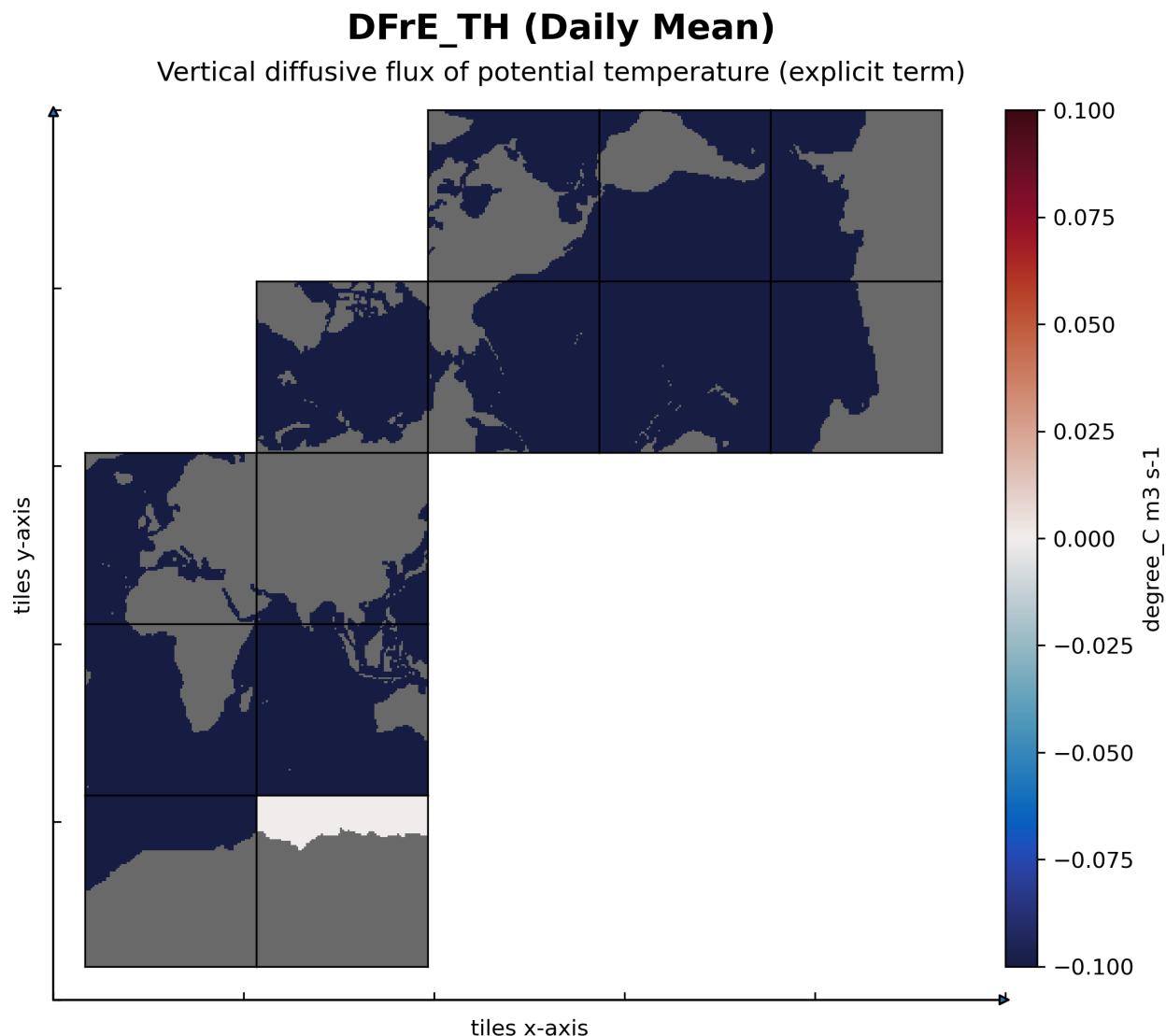
Example file 2017-12-29,  
OCEAN\_3D\_TEMPERATURE\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

**Figure 45: Dataset: OCEAN\_3D\_TEMPERATURE\_FLUX Variable: ADV<sub>y</sub>\_TH**

#### 19.6.4 Native Variable DFrE\_TH

**Table 19.28: CDL description of OCEAN\_3D\_TEMPERATURE\_FLUX's DFrE\_TH variable**

Storage Type	Variable Name	Description	Unit
float32	DFrE_TH	Vertical diffusive flux of potential temperature (explicit term)	degree_C m3 s-1
<b>CDL Description</b>			
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			
<b>Comments</b>			
The explicit term of the vertical diffusive flux of potential temperature (THETA) in the +z direction through the top 'w' face of the tracer cell on the native model grid. In the ECCO V4r4 model, an implicit scheme is used to calculate vertical diffusive tracer fluxes due to background diffusivity and the Kwz component of the GM-Redi tensor (vertical flux as a function of vertical gradient) while an explicit scheme is used to calculate the vertical diffusive fluxes from the Kwx and Kwy components of the GM-Redi tensor (vertical flux as a function of horizontal gradient). Both implicit and explicit components of vertical diffusive flux of potential temperature are provided. Note: in the Arakawa-C grid, vertical flux quantities are staggered relative to the tracer cells with indexing such that +DFrE_TH(i,j,k_l) corresponds to upward +z fluxes through the top 'w' face of the tracer cell at (i,j,k).			



**Figure 46: Dataset: OCEAN\_3D\_TEMPERATURE\_FLUX Variable: DFrE\_TH**

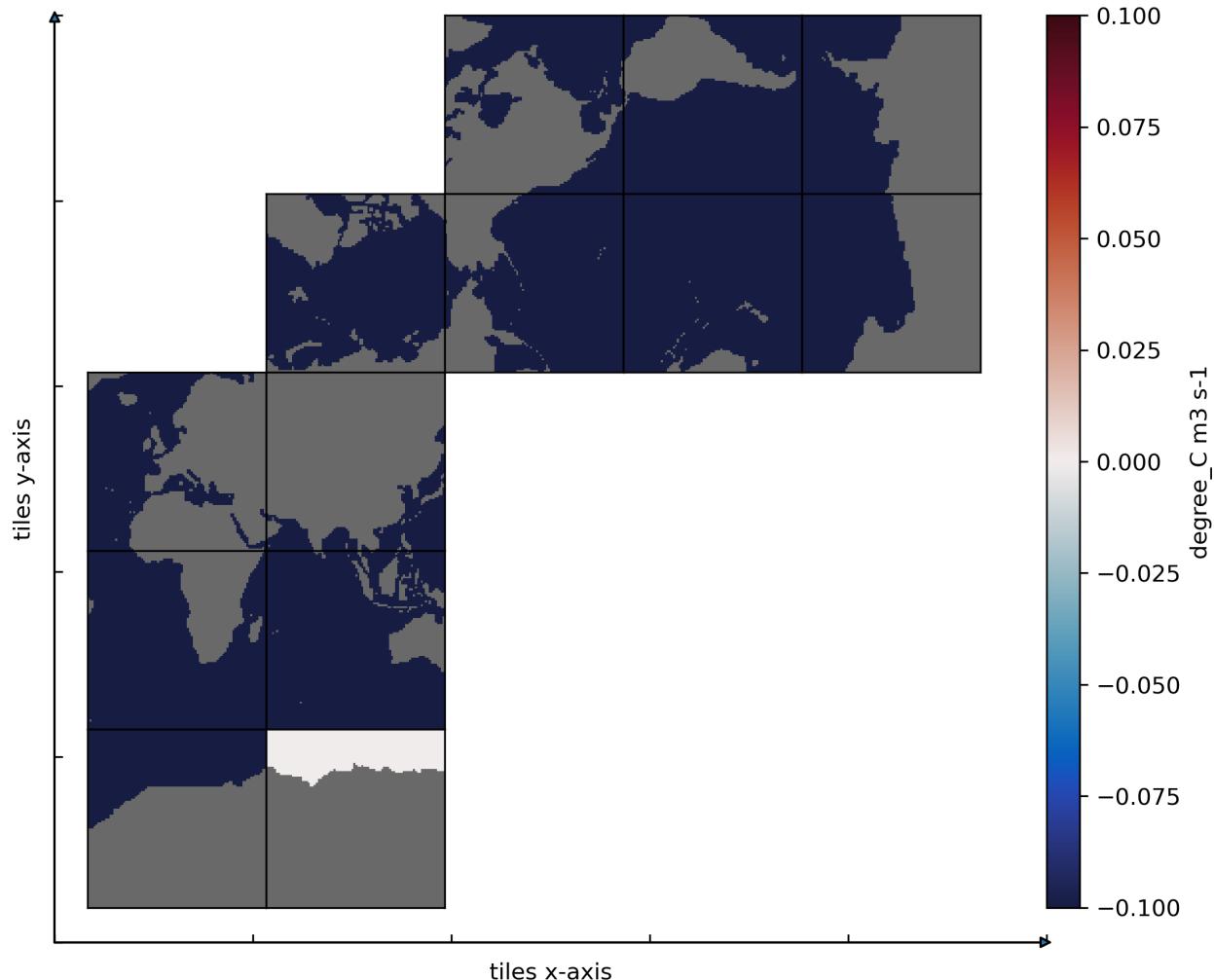
### 19.6.5 Native Variable DFrl\_TH

**Table 19.29: CDL description of OCEAN\_3D\_TEMPERATURE\_FLUX's DFrl\_TH variable**

Storage Type	Variable Name	Description	Unit
float32	DFrl_TH	Vertical diffusive flux of potential temperature (implicit term)	degree_C m3 s-1
<b>CDL Description</b>			
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			
<b>Comments</b>			
The implicit term of the vertical diffusive flux of potential temperature (THETA) in the +z direction through the top 'w' face of the tracer cell on the native model grid. In the ECCO V4r4 model, an implicit scheme is used to calculate vertical diffusive tracer fluxes due to background diffusivity and the Kwz component of the GM-Redi tensor (vertical flux as a function of vertical gradient) while an explicit scheme is used to calculate the vertical diffusive fluxes from the Kwx and Kwy components of the GM-Redi tensor (vertical flux as a function of horizontal gradient). Both implicit and explicit components of vertical diffusive flux of potential temperature are provided. Note: in the Arakawa-C grid, vertical flux quantities are staggered relative to the tracer cells with indexing such that +DFrl_TH(i,j,k_l) corresponds to upward +z fluxes through the top 'w' face of the tracer cell at (i,j,k)			

## DFrl\_TH (Daily Mean)

Vertical diffusive flux of potential temperature (implicit term)



**Figure 47: Dataset: OCEAN\_3D\_TEMPERATURE\_FLUX Variable: DFrl\_TH**

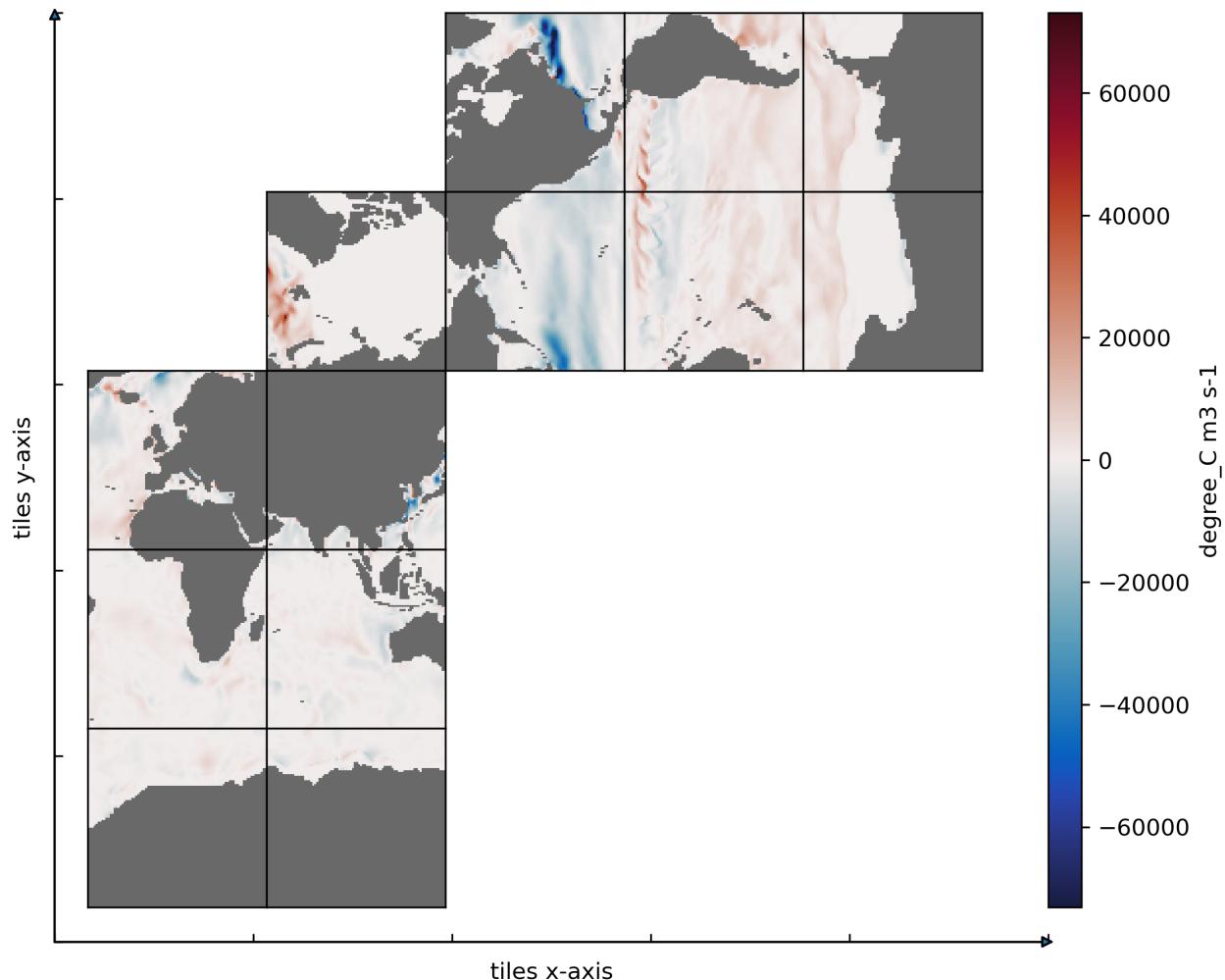
### 19.6.6 Native Variable DFxE\_TH

**Table 19.30: CDL description of OCEAN\_3D\_TEMPERATURE\_FLUX's DFxE\_TH variable**

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
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

## DFxE\_TH (Daily Mean)

Lateral diffusive flux of potential temperature in the model +x direction



Example file 2017-12-29,  
OCEAN\_3D\_TEMPERATURE\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

**Figure 48:** Dataset: OCEAN\_3D\_TEMPERATURE\_FLUX Variable: DFxE\_TH

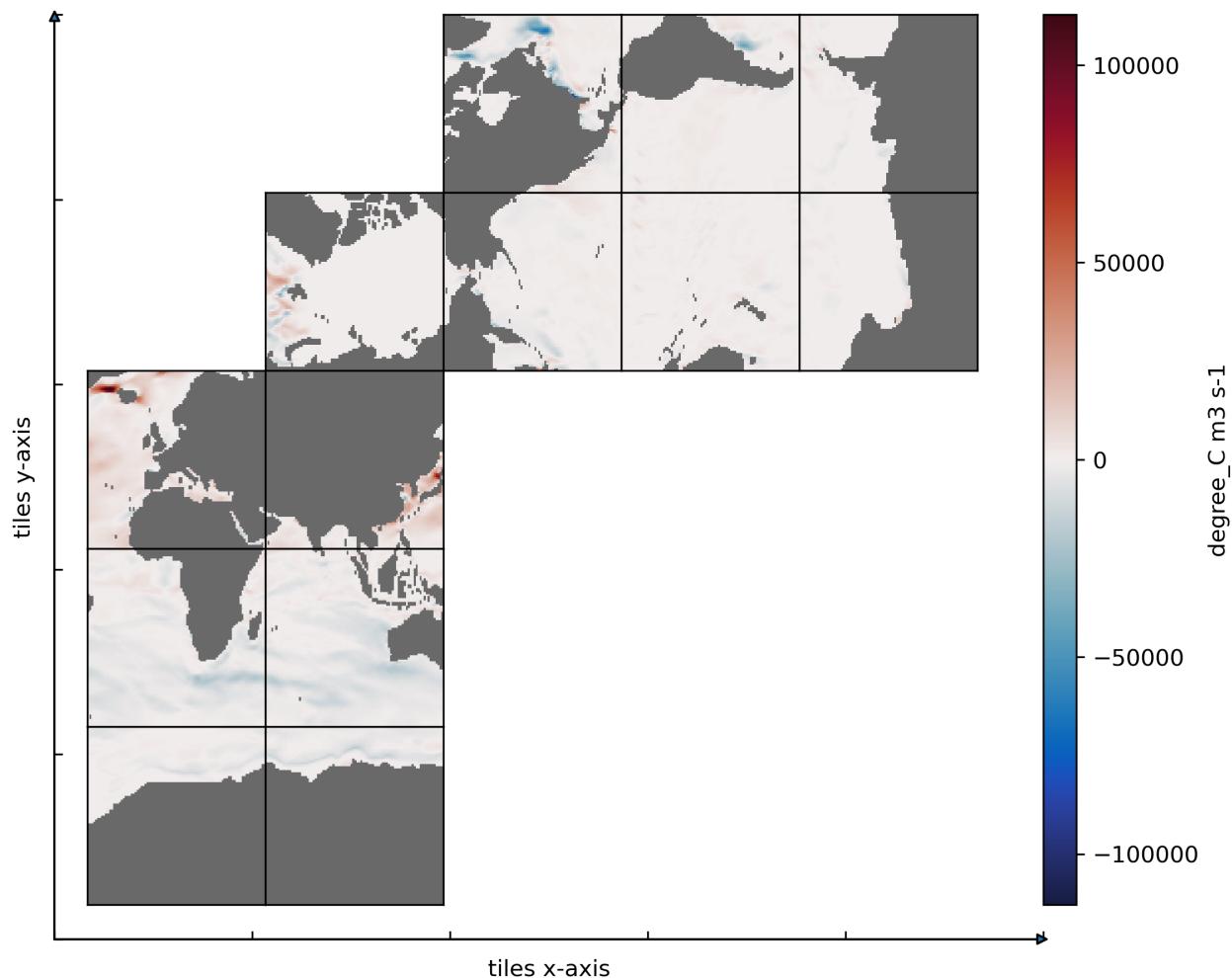
### 19.6.7 Native Variable DFyE\_TH

**Table 19.31: CDL description of OCEAN\_3D\_TEMPERATURE\_FLUX's DFyE\_TH variable**

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

## DFyE\_TH (Daily Mean)

Lateral diffusive flux of potential temperature in the model +y direction.



Example file 2017-12-29,  
OCEAN\_3D\_TEMPERATURE\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

**Figure 49: Dataset: OCEAN\_3D\_TEMPERATURE\_FLUX Variable: DFyE\_TH**

## 19.7 Native NetCDF OCEAN\_3D\_VOLUME\_FLUX

**Table 19.32: Variables in the dataset OCEAN\_3D\_VOLUME\_FLUX**

Dataset:	OCEAN_3D_VOLUME_FLUX
Field:	UVELMASS
Field:	VVELMASS
Field:	WVELMASS

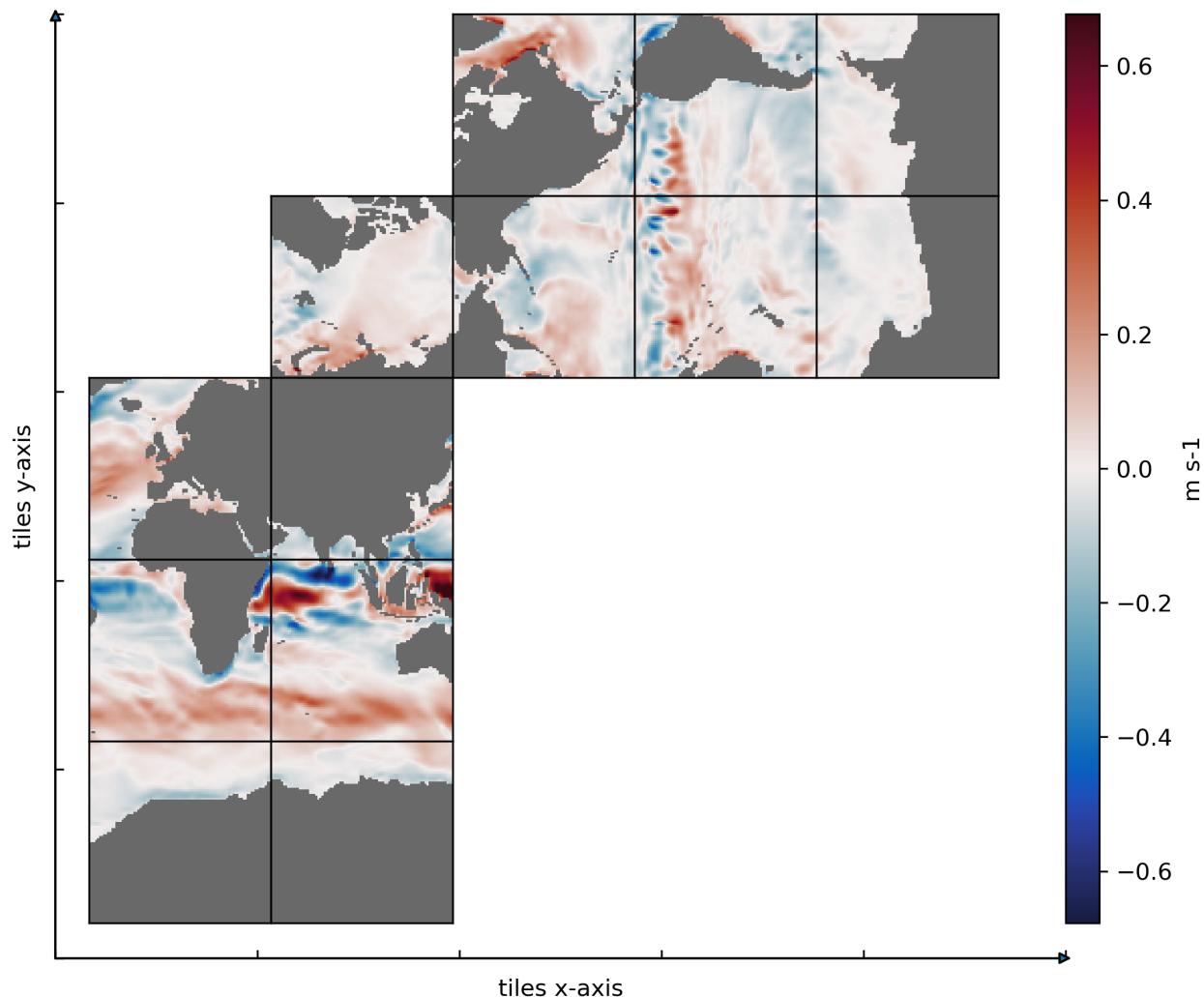
### 19.7.1 Native Variable UVELMASS

**Table 19.33: CDL description of OCEAN\_3D\_VOLUME\_FLUX's UVELMASS variable**

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 <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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			

## UVELMASS (Daily Mean)

Horizontal velocity in the model +x direction per unit area of the grid cell 'u' face



Example file 2017-12-29,  
OCEAN\_3D\_VOLUME\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

Figure 50: Dataset: OCEAN\_3D\_VOLUME\_FLUX Variable: UVELMASS

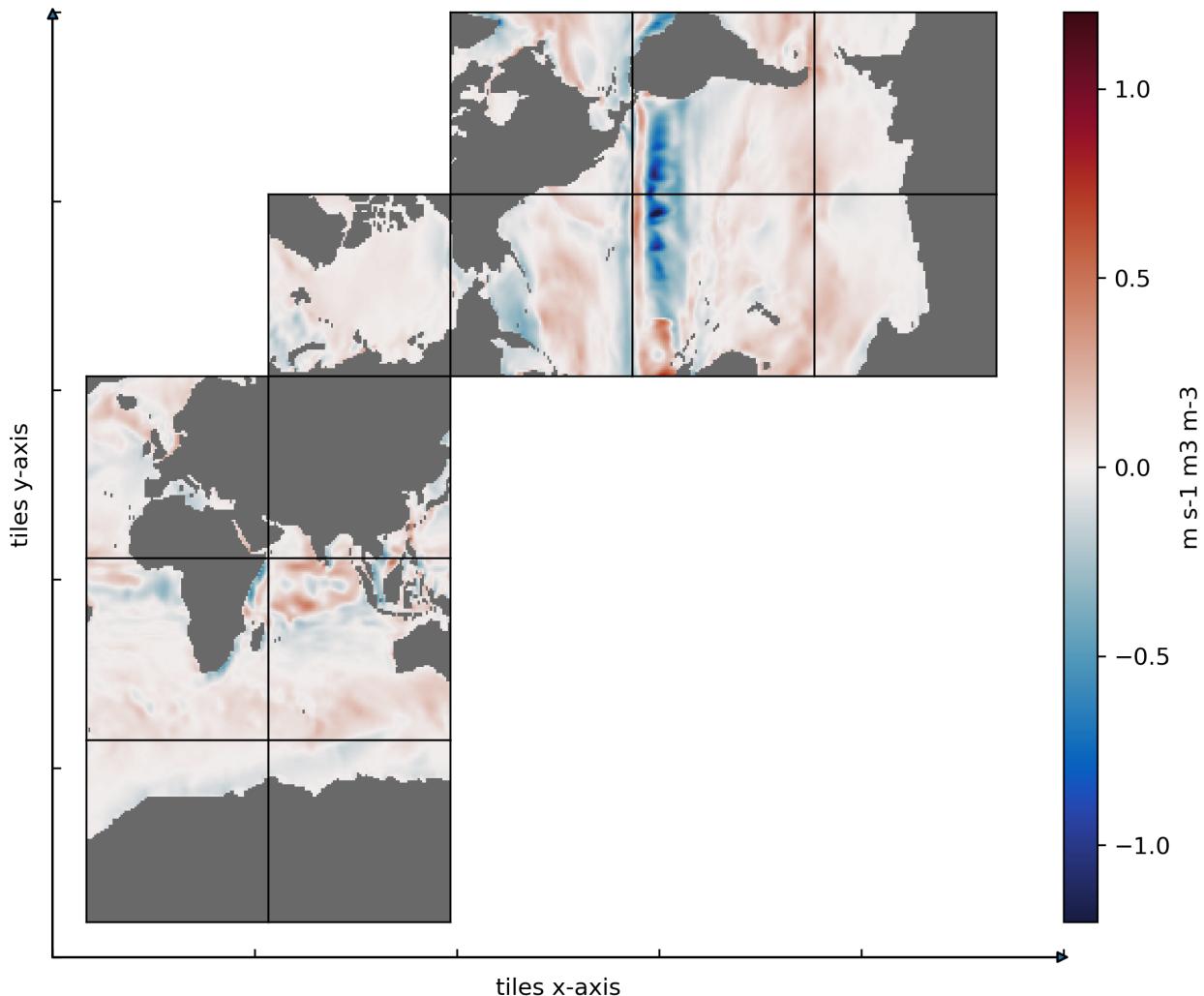
### 19.7.2 Native Variable VVELMASS

**Table 19.34: CDL description of OCEAN\_3D\_VOLUME\_FLUX's VVELMASS variable**

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
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

## VVELMASS (Daily Mean)

Horizontal velocity in the model +y direction per unit area of the grid cell 'v' face



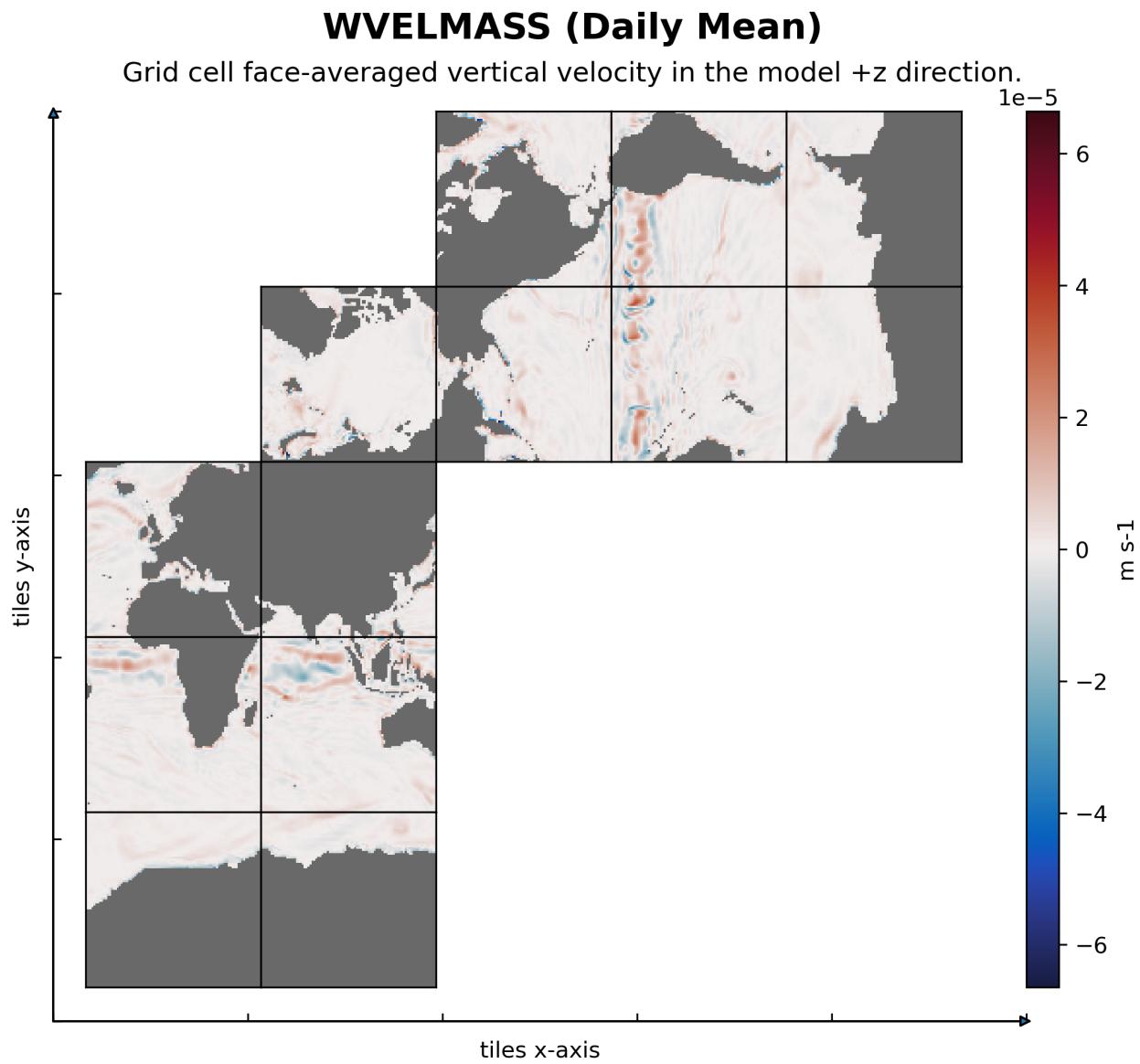
Example file 2017-12-29,  
OCEAN\_3D\_VOLUME\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

Figure 51: Dataset: OCEAN\_3D\_VOLUME\_FLUX Variable: VVELMASS

### 19.7.3 Native Variable WVELMASS

**Table 19.35: CDL description of OCEAN\_3D\_VOLUME\_FLUX's WVELMASS variable**

Storage Type	Variable Name	Description	Unit
float32	WVELMASS	Grid cell face-averaged vertical velocity in the model +z direction.	m s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
Vertical velocity in the +z direction at the top 'w' face of the tracer cell on the native model grid. Volume flux in +z = WVELMASS drA. Note: in the Arakawa-C grid, vertical velocities are staggered relative to the tracer cells with indexing such that +WVELMASS(i,j,k) corresponds to upward +z motion through the top 'w' face of the tracer cell at (i,j,k). Unlike UVELMASS and VVELMASS, WVELMASS is not scaled by a time-varying open water fraction because the open water fraction of the 'w' face is always 1, thus WVELMASS is identical to WVEL.			



**Figure 52: Dataset: OCEAN\_3D\_VOLUME\_FLUX Variable: WVELMASS**

## 19.8 Native NetCDF OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX

Table 19.36: Variables in the dataset OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX

Dataset:	OCEAN_AND_ICE_SURFACE_FW_FLUX
Field:	EXFpreci
Field:	EXFevap
Field:	EXFroff
Field:	SlsnPrcp
Field:	EXFemprmr
Field:	oceFWflx
Field:	SlatmFW
Field:	SFLUX
Field:	SlacSubl
Field:	SirsSubl
Field:	SIfwThru

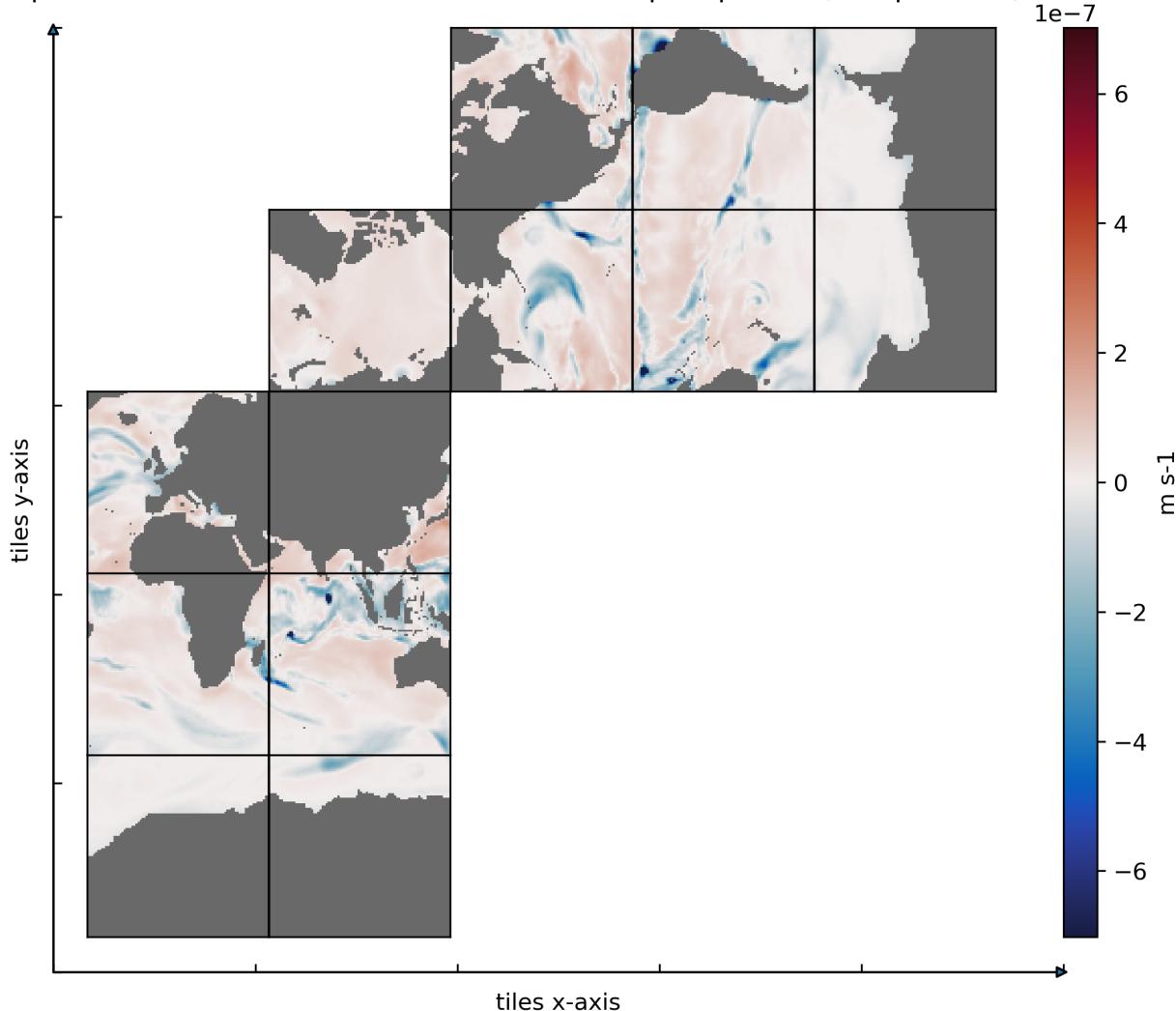
### 19.8.1 Native Variable EXFempmr

**Table 19.37: CDL description of OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX's EXFempmr variable**

Storage Type	Variable Name	Description	Unit
float32	EXFempmr	Open ocean net surface freshwater flux from precipitation, evaporation, and runoff	m s <sup>-1</sup>
<b>CDL Description</b>			
float32 EXFempmr(time, tile, j, i) EXFempmr: _FillValue = 9.96921e+36 EXFempmr: long_name = Open ocean net surface freshwater flux from precipitation evaporation and runoff EXFempmr: units = m s: 1 EXFempmr: coverage_content_type = modelResult EXFempmr: direction = >0 increases salinity (SALT) EXFempmr: coordinates = YC XC time EXFempmr: valid_min = : 8.299433829961345e: 06 EXFempmr: valid_max = 5.400421514423215e: 07			
<b>Comments</b>			
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.			

## EXFempmr (Daily Mean)

Open ocean net surface freshwater flux from precipitation, evaporation, and runoff



Example file 2017-12-29,  
OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

Figure 53: Dataset: OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX Variable: EXFempmr

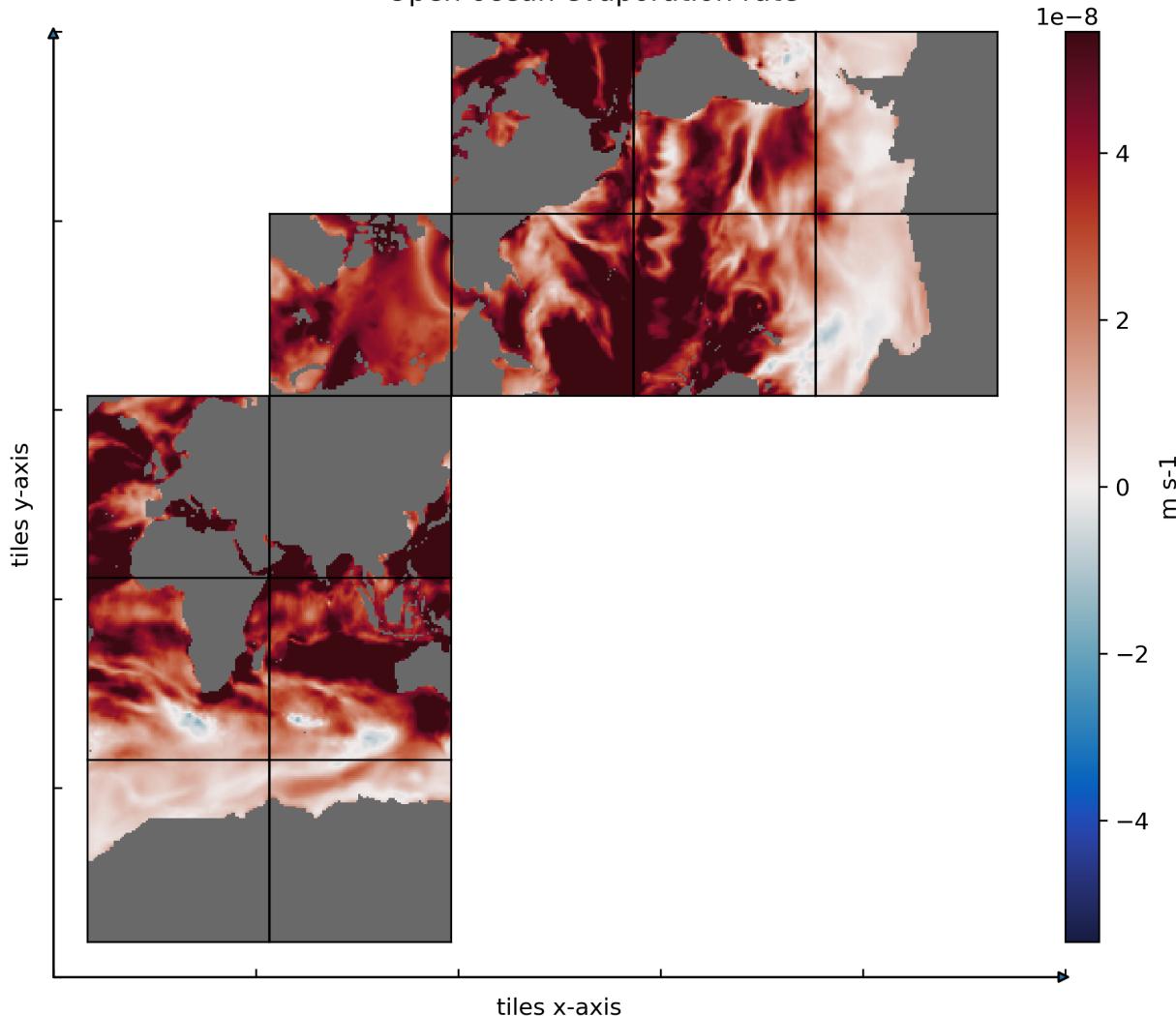
### 19.8.2 Native Variable EXFevap

Table 19.38: CDL description of OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX's EXFevap variable

Storage Type	Variable Name	Description	Unit
float32	EXFevap	Open ocean evaporation rate	m s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

## EXFevap (Daily Mean)

Open ocean evaporation rate



### 19.8.3 Native Variable EXFpreci

Table 19.39: CDL description of OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX's EXFpreci variable

Storage Type	Variable Name	Description	Unit
float32	EXFpreci	Precipitation rate	m s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
Precipitation rate. Note: sum of ERA-Interim precipitation and the control adjustment from ocean state estimation.			

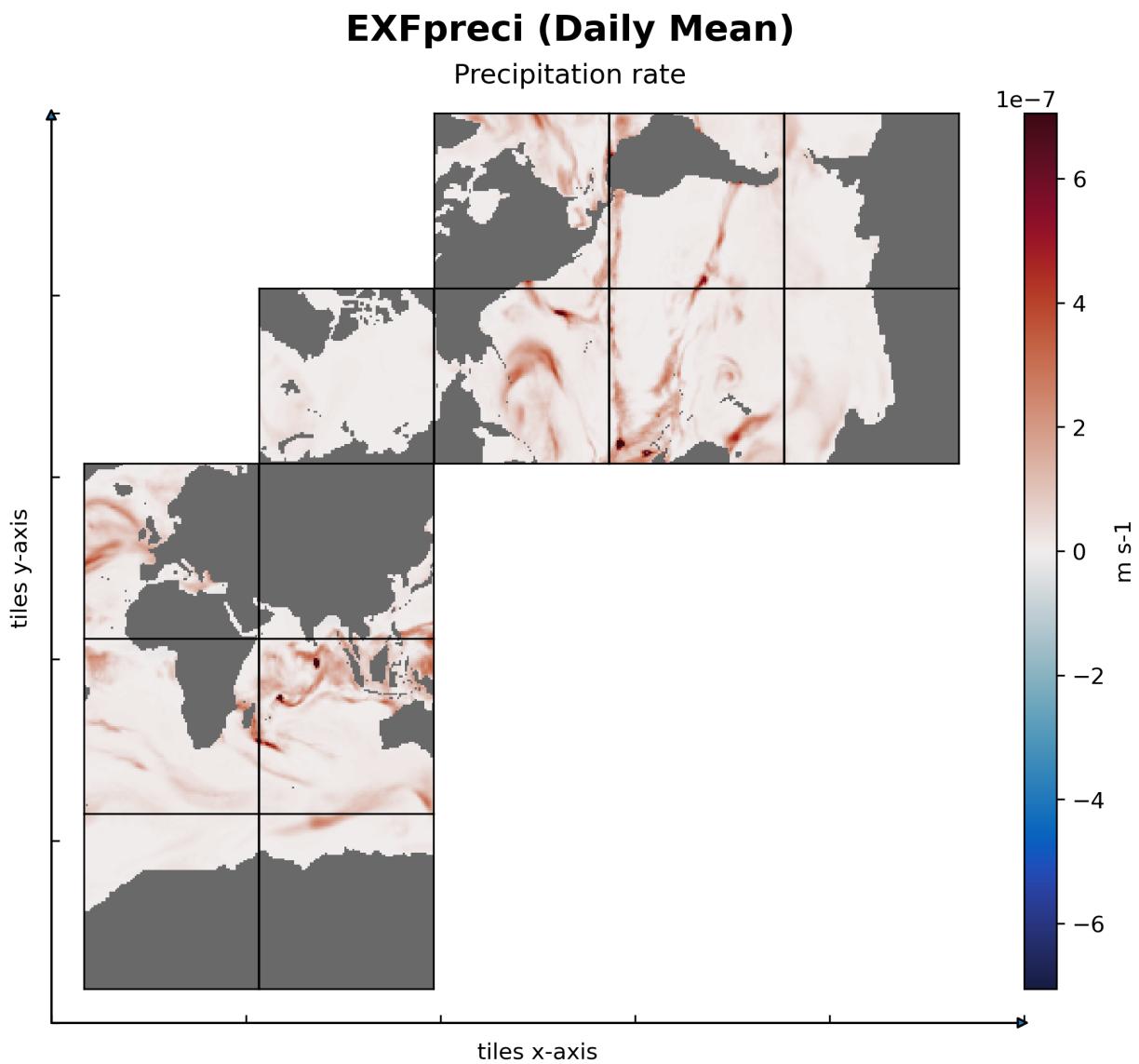
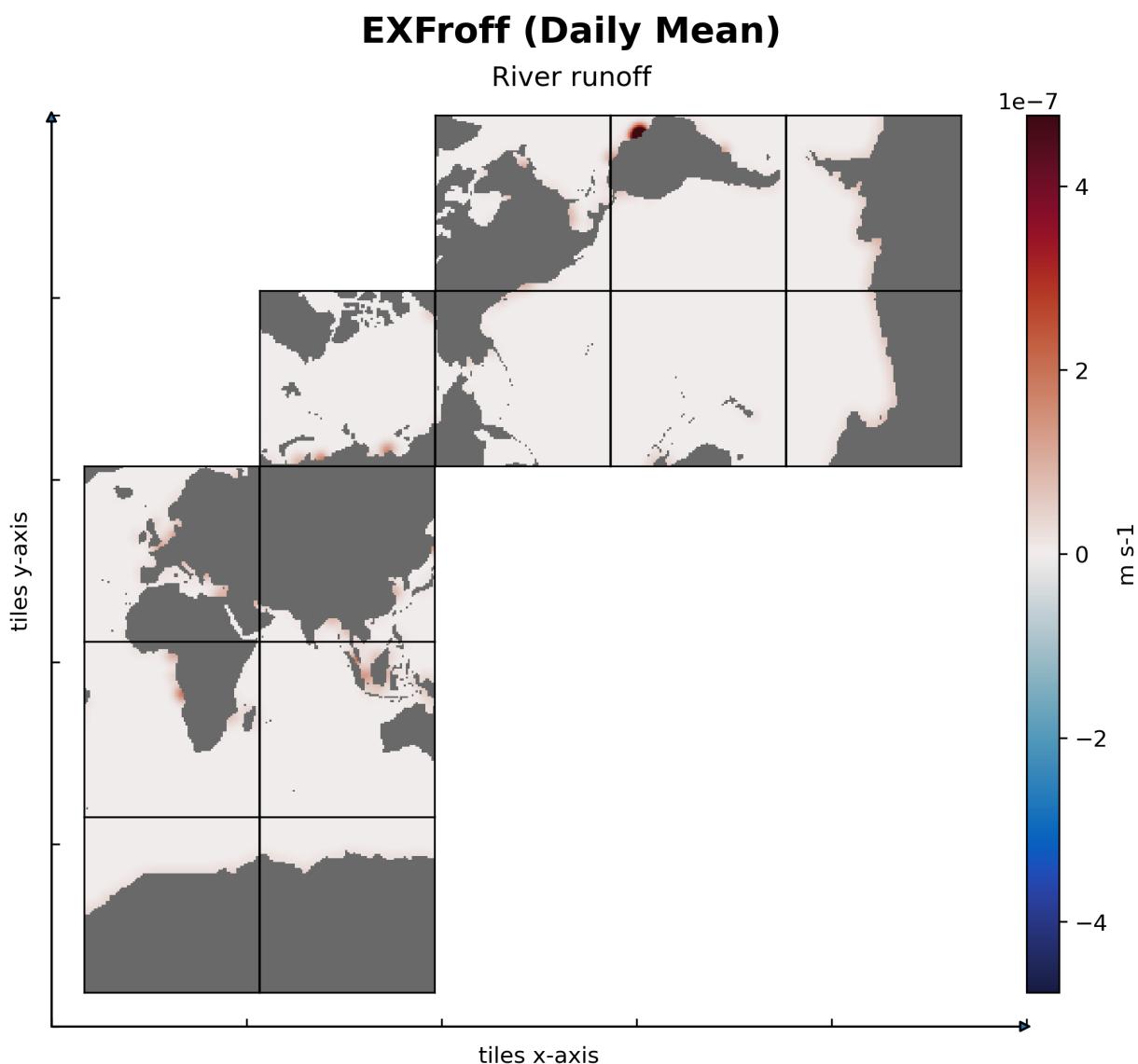


Figure 55: Dataset: OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX Variable: EXFpreci

#### 19.8.4 Native Variable EXFroff

Table 19.40: CDL description of OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX's EXFroff variable

Storage Type	Variable Name	Description	Unit
float32	EXFroff	River runoff	m s-1
<b>CDL Description</b>			
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			
<b>Comments</b>			
River runoff freshwater flux. Note: not adjusted by the optimization.			



Example file 2017-12-29,  
OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

**Figure 56:** Dataset: OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX Variable: EXFroff

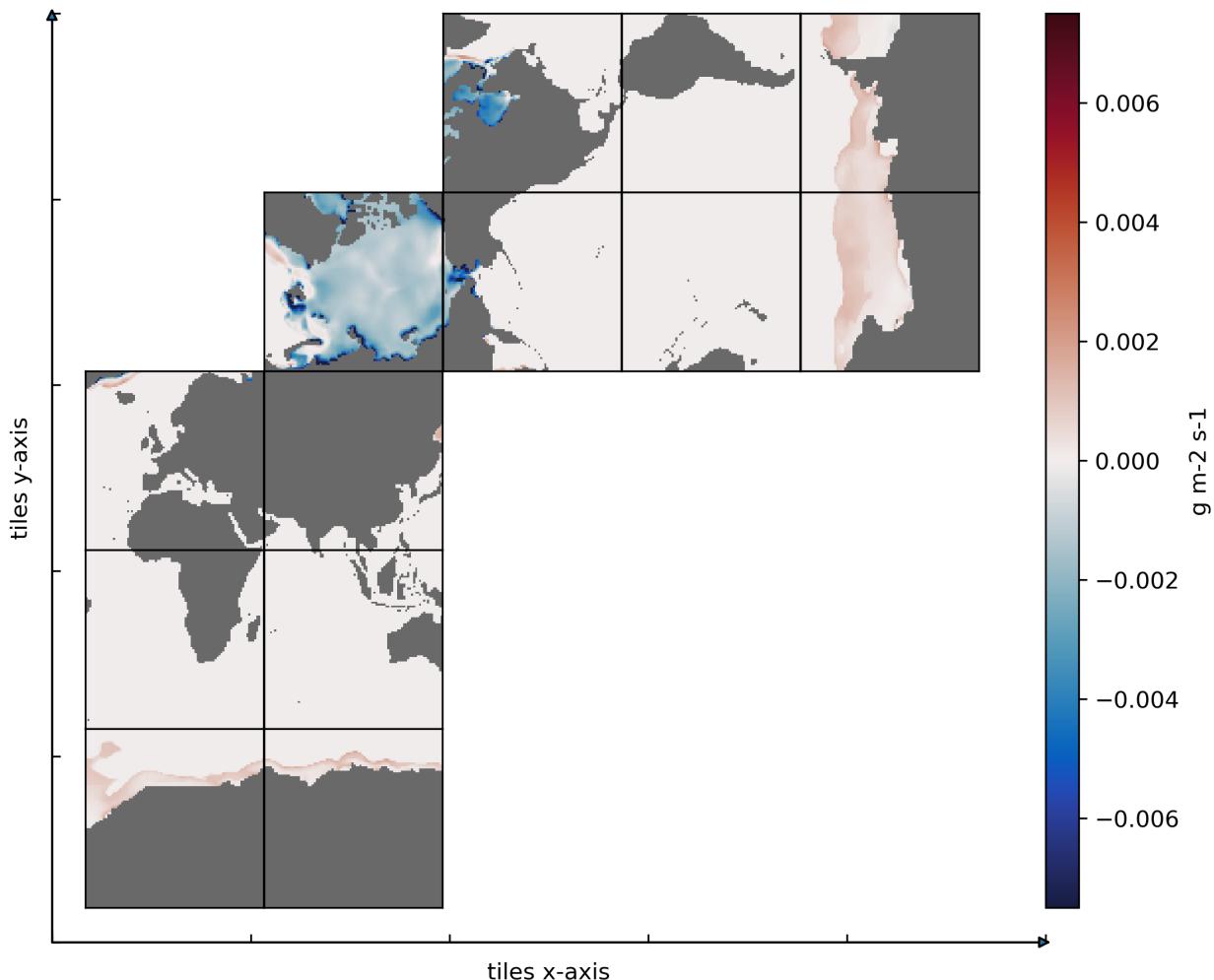
### 19.8.5 Native Variable SFLUX

**Table 19.41: CDL description of OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX's SFLUX variable**

Storage Type	Variable Name	Description	Unit
float32	SFLUX	Rate of change of total ocean salinity per m2 accounting for mass fluxes.	g m <sup>-2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 <sup>-1</sup> ). 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).			

## SFLUX (Daily Mean)

Rate of change of total ocean salinity per m<sup>2</sup> accounting for mass fluxes.



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: SFLUX**

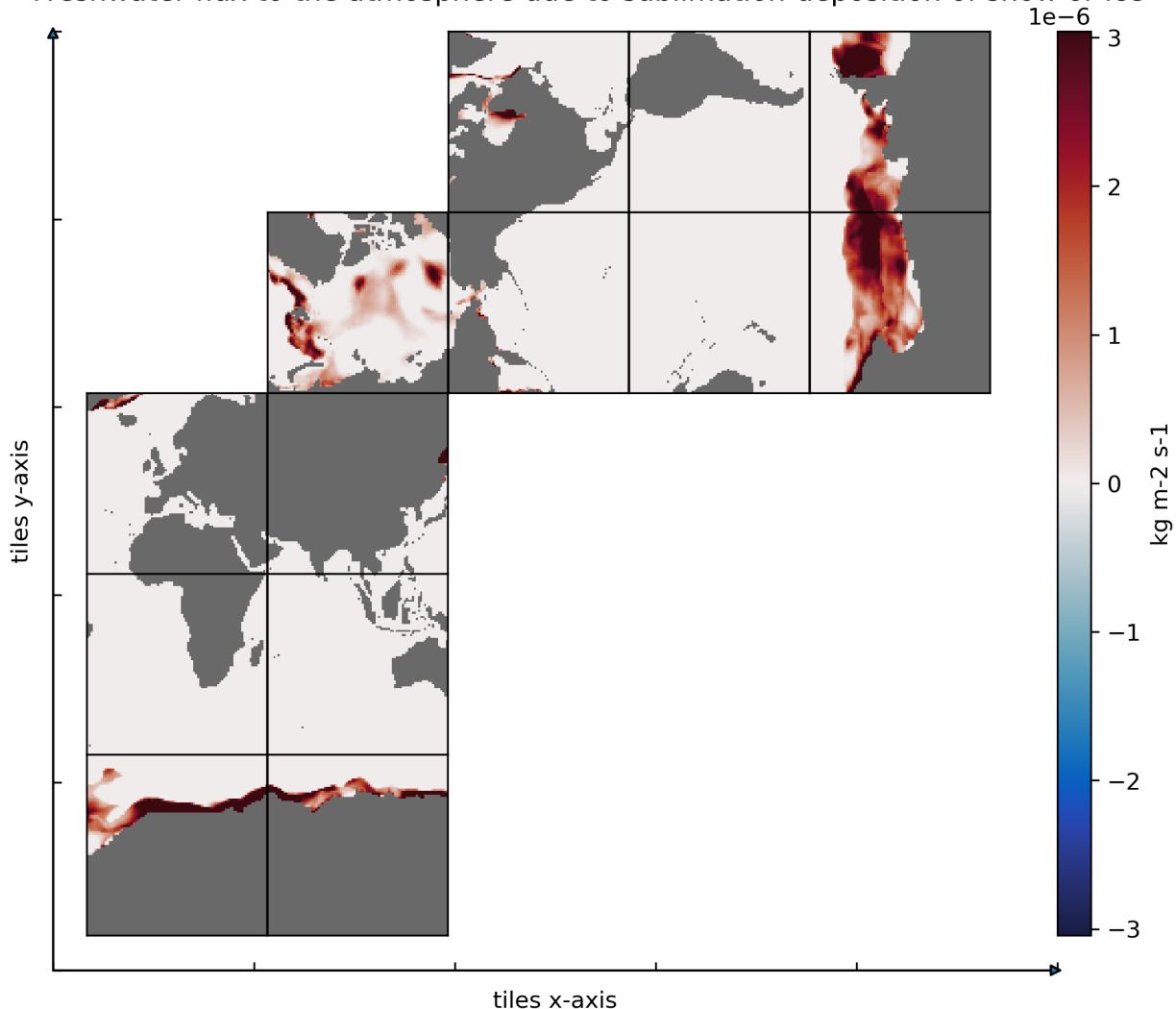
### 19.8.6 Native Variable SlacSubl

Table 19.42: CDL description of OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX's SlacSubl variable

Storage Type	Variable Name	Description	Unit
float32	SlacSubl	Freshwater flux to the atmosphere due to sublimation-deposition of snow or ice	kg m <sup>-2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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 =>0 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			
<b>Comments</b>			
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			

## SlacSubl (Daily Mean)

Freshwater flux to the atmosphere due to sublimation-deposition of snow or ice



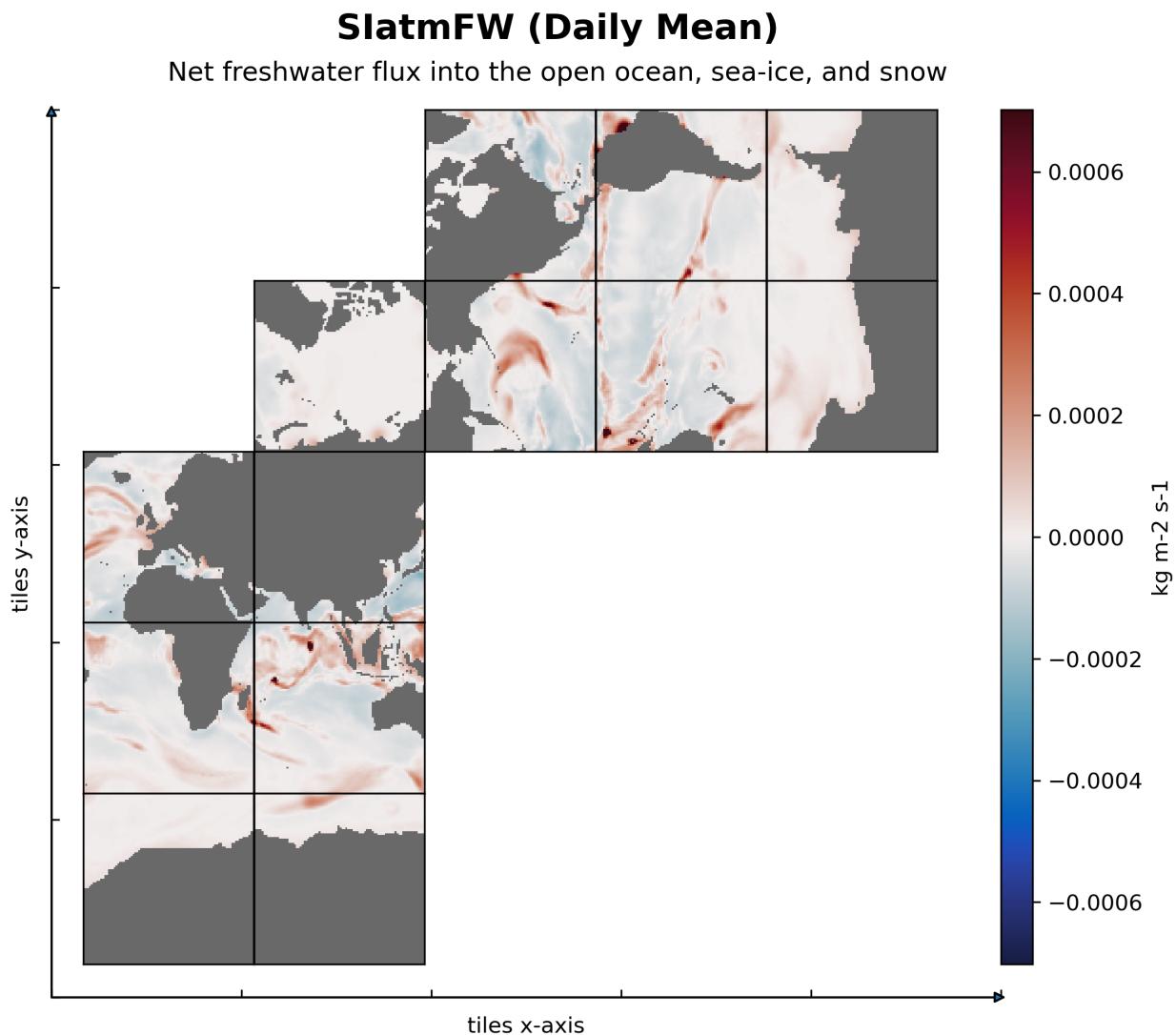
Example file 2017-12-29,  
OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

Figure 58: Dataset: OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX Variable: SlacSubl

### 19.8.7 Native Variable SlatmFW

**Table 19.43: CDL description of OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX's SlatmFW variable**

Storage Type	Variable Name	Description	Unit
float32	SlatmFW	Net freshwater flux into the open ocean, sea-ice, and snow	kg m <sup>-2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 SlatmFW. SlatmFW counts all fluxes to/from the atmosphere that change the TOTAL freshwater stored in the combined liquid ocean, sea-ice, and snow reservoirs.			



Example file 2017-12-29,  
OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

Figure 59: Dataset: OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX Variable: SlatmFW

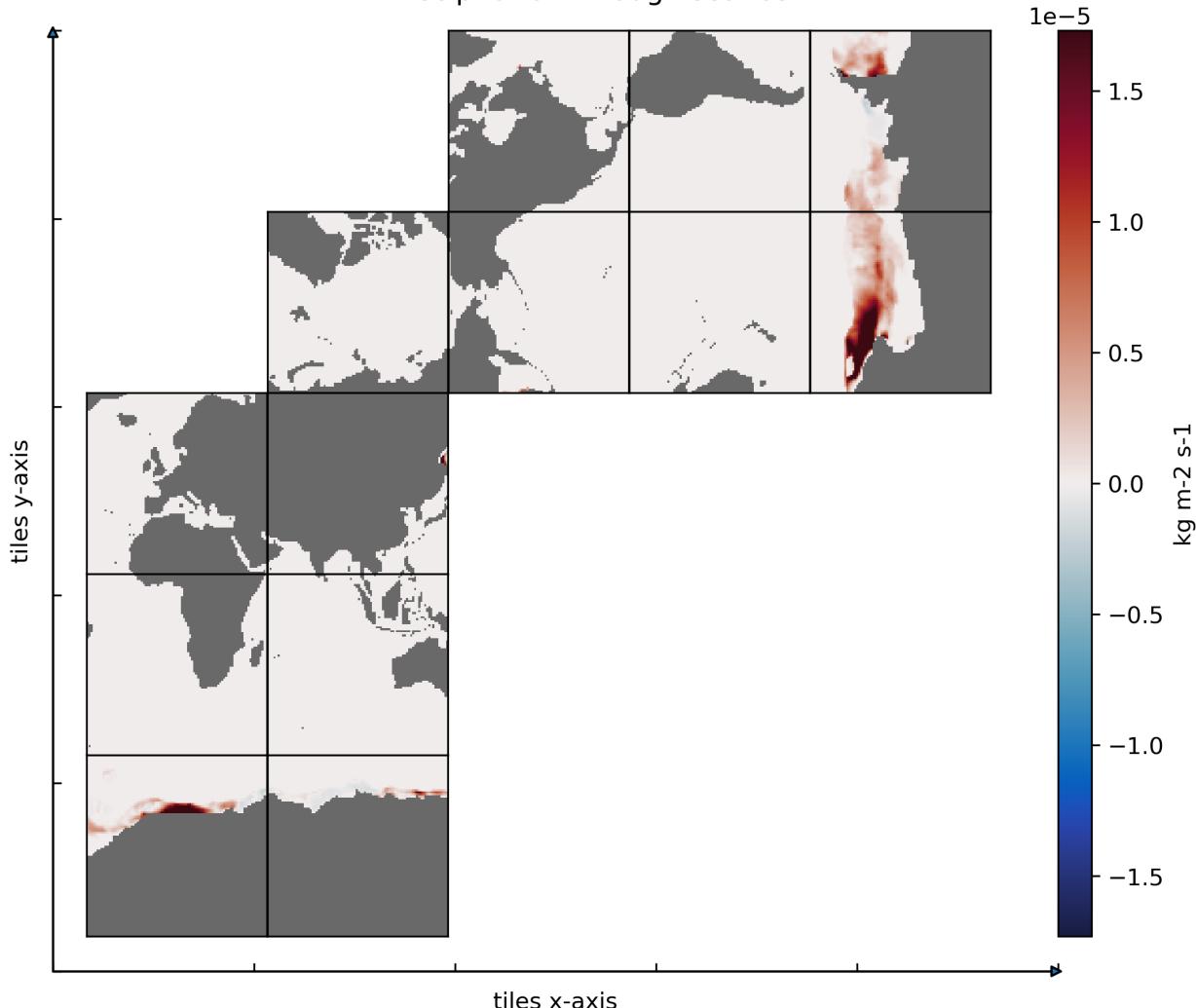
### 19.8.8 Native Variable SIfwThru

Table 19.44: CDL description of OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX's SIfwThru variable

Storage Type	Variable Name	Description	Unit
float32	SIfwThru	Precipitation through sea-ice	kg m <sup>-2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

## SIfwThru (Daily Mean)

Precipitation through sea-ice



Example file 2017-12-29,  
OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

**Figure 60: Dataset: OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX Variable: SIfwThru**

### 19.8.9 Native Variable SlrsSubl

**Table 19.45: CDL description of OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX's SlrsSubl variable**

Storage Type	Variable Name	Description	Unit
float32	SlrsSubl	Residual sublimation freshwater flux	kg m <sup>-2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
Residual freshwater flux by sublimation to remove water from or add water to ocean. When implied sublimation freshwater flux SlacSubl is larger than available sea-ice/snow, SlrsSubl 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.			

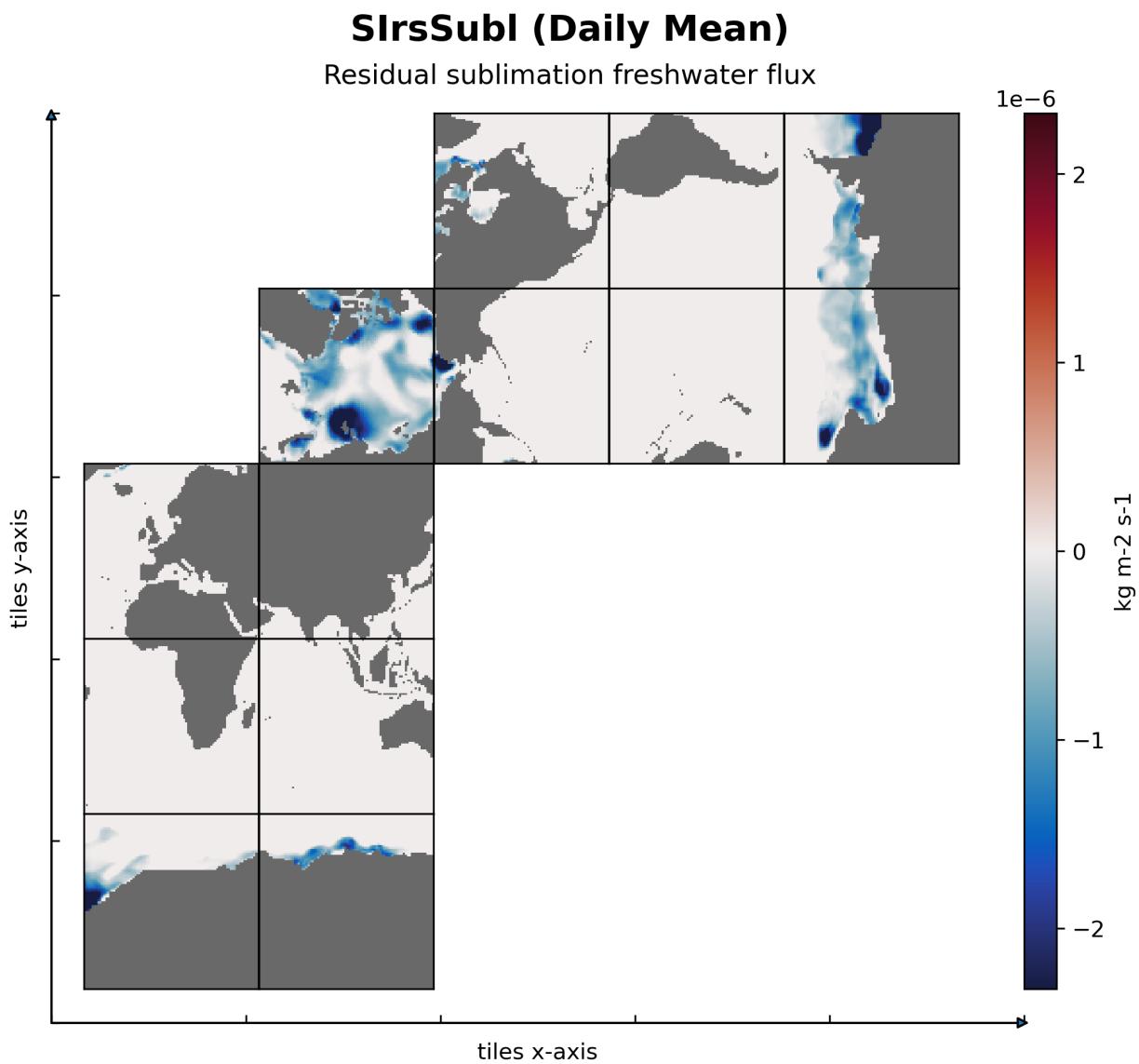


Figure 61: Dataset: OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX Variable: S1rsSubl

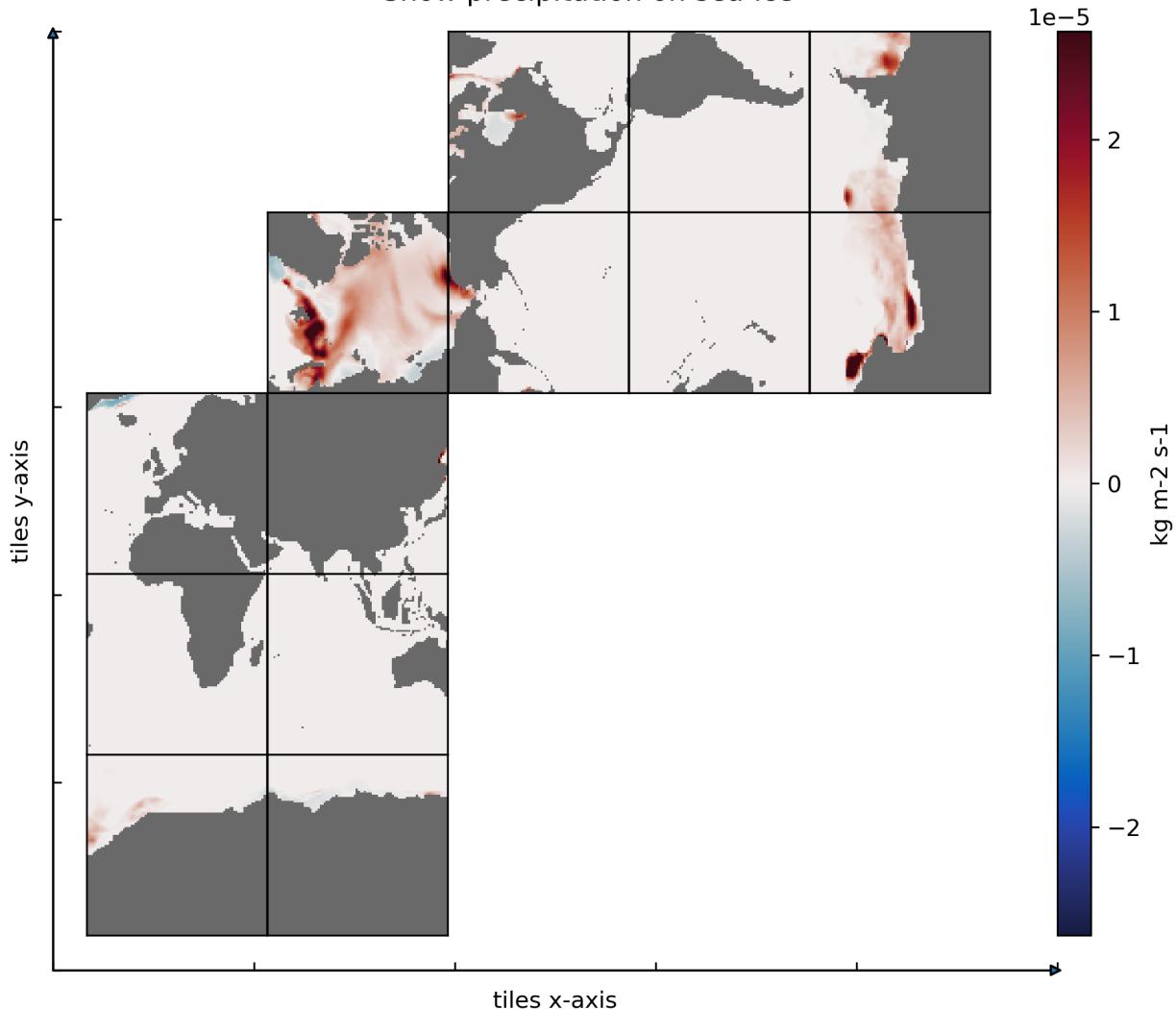
### 19.8.10 Native Variable SlsnPrcp

Table 19.46: CDL description of OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX's SlsnPrcp variable

Storage Type	Variable Name	Description	Unit
float32	SlsnPrcp	Snow precipitation on sea-ice	kg m <sup>-2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
Snow precipitation rate over sea-ice, averaged over the entire model grid cell.			

## SIsnPrcp (Daily Mean)

Snow precipitation on sea-ice



Example file 2017-12-29,  
OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

Figure 62: Dataset: OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX Variable: SIsnPrcp

### 19.8.11 Native Variable oceFWflx

Table 19.47: CDL description of OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX's oceFWflx variable

Storage Type	Variable Name	Description	Unit
float32	oceFWflx	Net freshwater flux into the ocean	kg m <sup>-2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
float32 oceFWflx(time, tile, j, i) oceFWflx: _FillValue = 9.96921e+36 oceFWflx: long_name = Net freshwater flux into the ocean oceFWflx: units = kg m: 2 s: 1 oceFWflx: coverage_content_type = modelResult oceFWflx: direction = >0 decreases salinity (SALT) oceFWflx: standard_name = water_flux_into_sea_water oceFWflx: coordinates = YC XC time oceFWflx: valid_min = : 0.003914969973266125 oceFWflx: valid_max = 0.008299433626234531			
<b>Comments</b>			
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 'SlatmFW' accounts for freshwater fluxes out of the combined ocean+sea-ice+snow reservoir.			

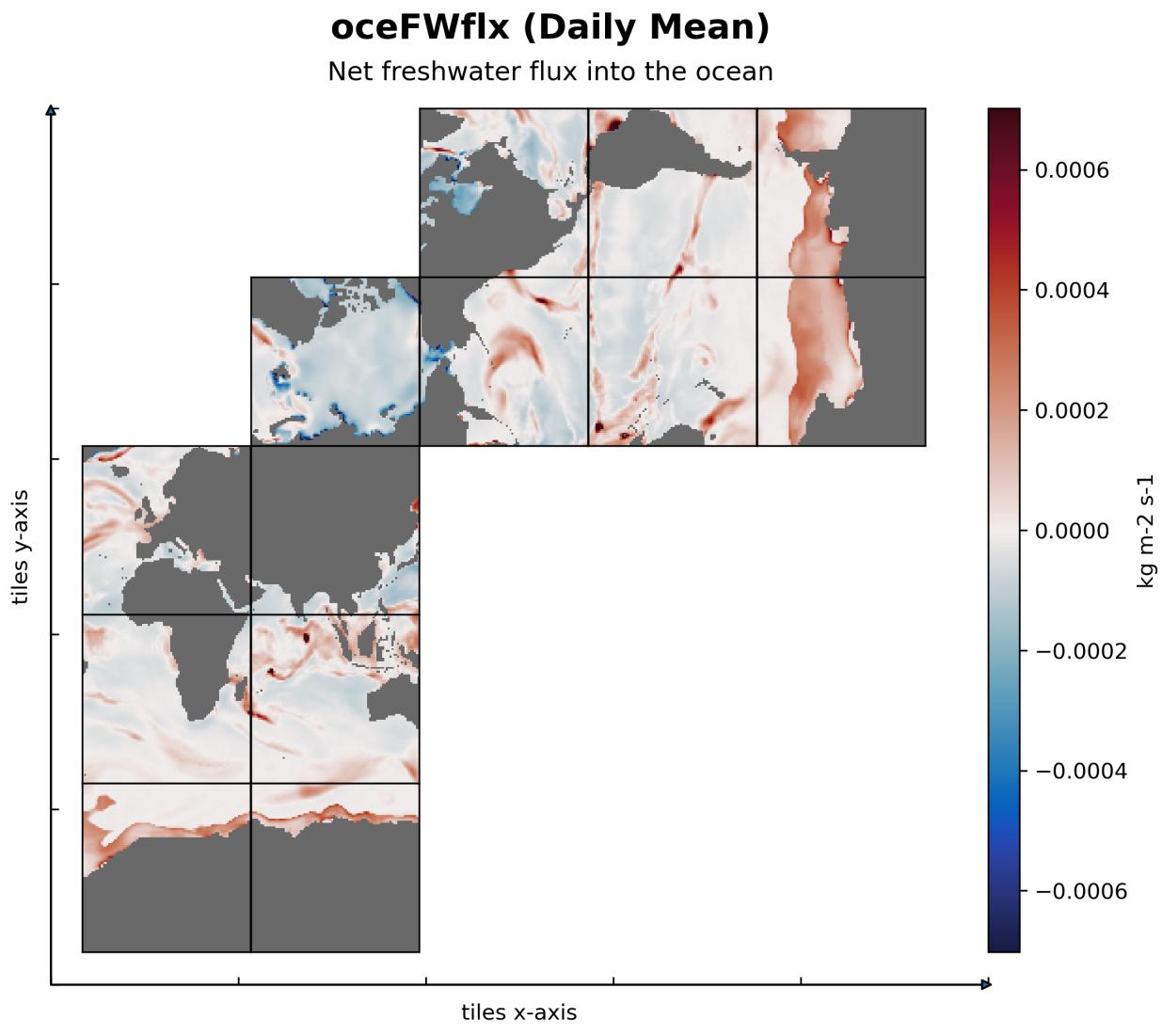


Figure 63: Dataset: OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX Variable: oceFWflux

## 19.9 Native NetCDF OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX

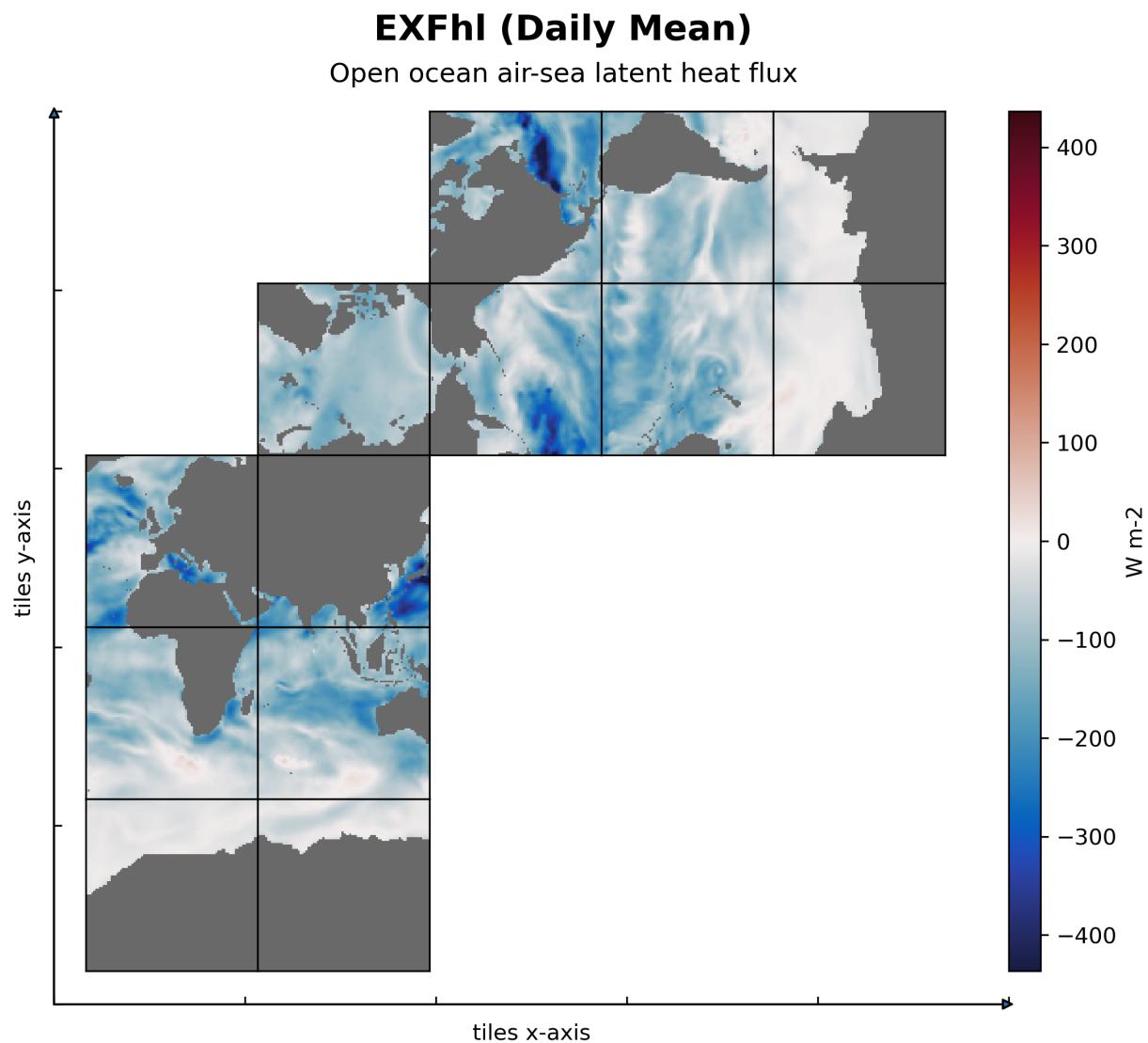
Table 19.48: Variables in the dataset OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX

Dataset:	OCEAN_AND_ICE_SURFACE_HEAT_FLUX
Field:	EXFhl
Field:	EXFhs
Field:	EXFlwdn
Field:	EXFswdn
Field:	EXFqnet
Field:	oceQnet
Field:	SlatmQnt
Field:	TFLUX
Field:	EXFswnet
Field:	EXFlwnet
Field:	oceQsw
Field:	Slaaflux

### 19.9.1 Native Variable EXFhl

Table 19.49: CDL description of OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX's EXFhl variable

Storage Type	Variable Name	Description	Unit
float32	EXFhl	Open ocean air-sea latent heat flux	W m <sup>-2</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

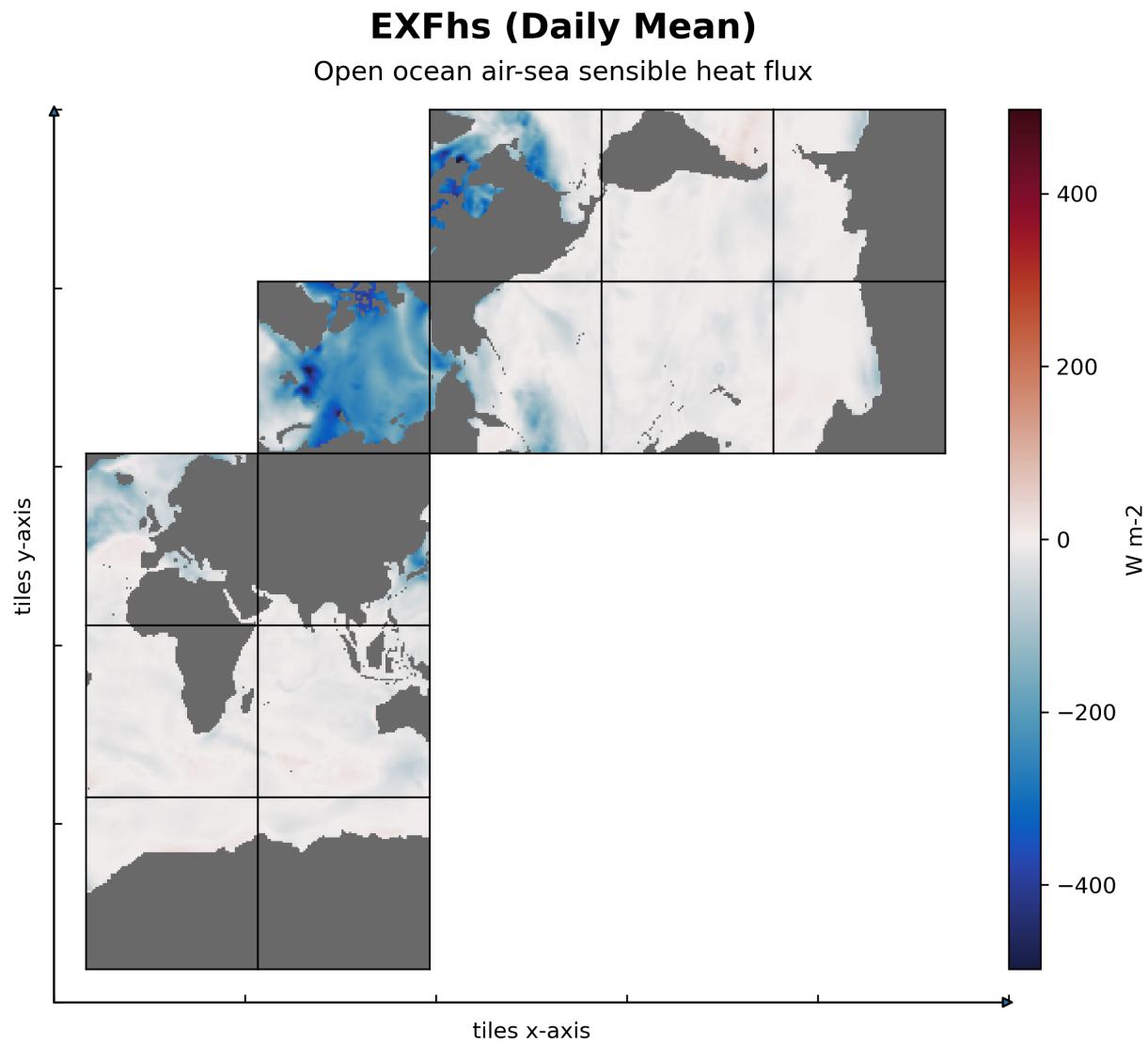


**Figure 64: Dataset: OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX Variable: EXFhl**

### 19.9.2 Native Variable EXFhs

Table 19.50: CDL description of OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX's EXFhs variable

Storage Type	Variable Name	Description	Unit
float32	EXFhs	Open ocean air-sea sensible heat flux	W m <sup>-2</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

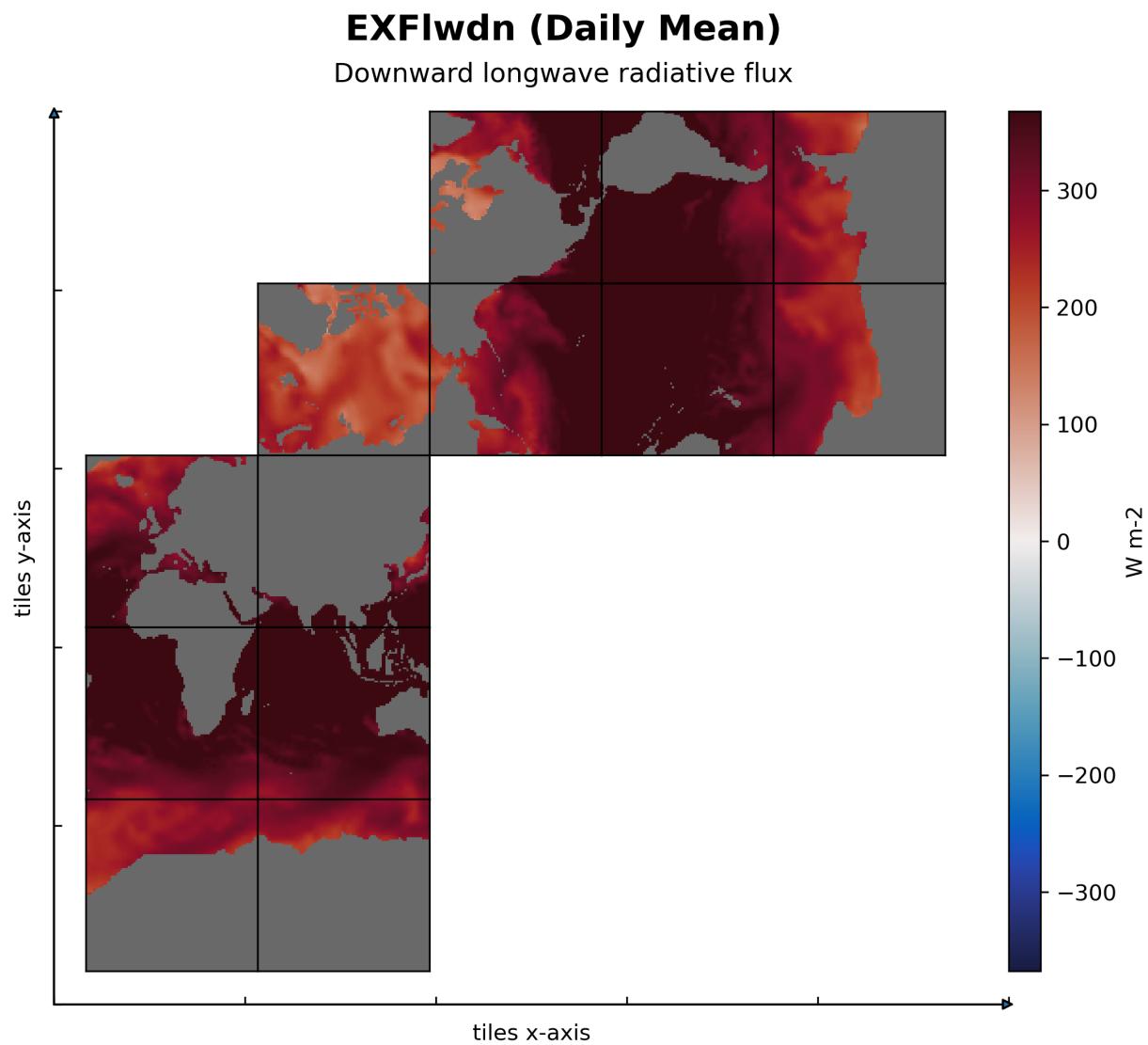


**Figure 65: Dataset: OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX Variable: EXFhs**

### 19.9.3 Native Variable EXFlwdn

Table 19.51: CDL description of OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX's EXFlwdn variable

Storage Type	Variable Name	Description	Unit
float32	EXFlwdn	Downward longwave radiative flux	W m <sup>-2</sup>
<b>CDL Description</b>			
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 =>O 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			
<b>Comments</b>			
Downward longwave radiative flux. Note: sum of ERA-Interim downward longwave radiation and the control adjustment from ocean state estimation.			

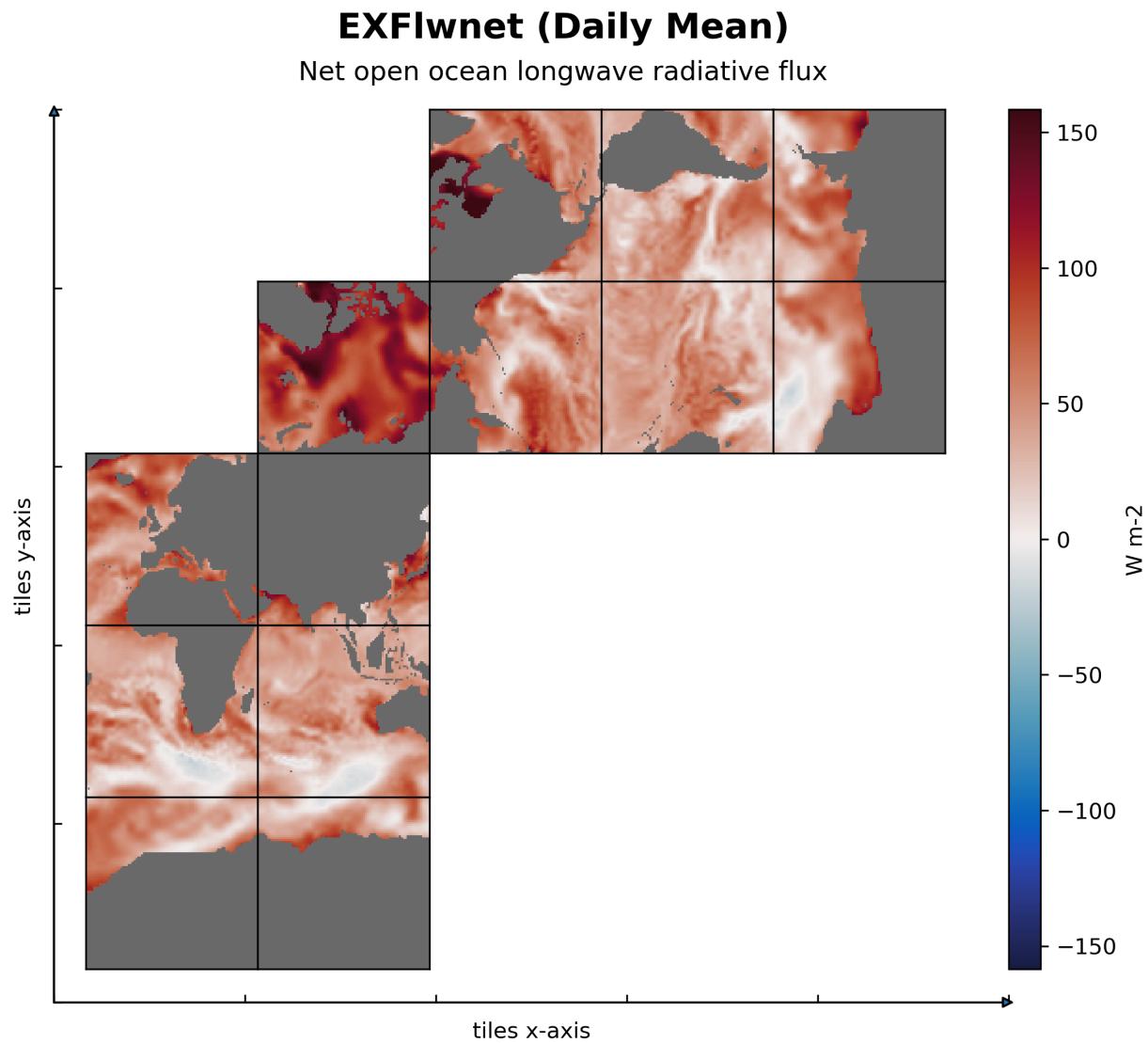


**Figure 66: Dataset: OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX Variable: EXFlwdn**

#### 19.9.4 Native Variable EXFlwnet

**Table 19.52: CDL description of OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX's EXFlwnet variable**

Storage Type	Variable Name	Description	Unit
float32	EXFlwnet	Net open ocean longwave radiative flux	W m <sup>-2</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 67: Dataset: OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX Variable: EXFlwnet**

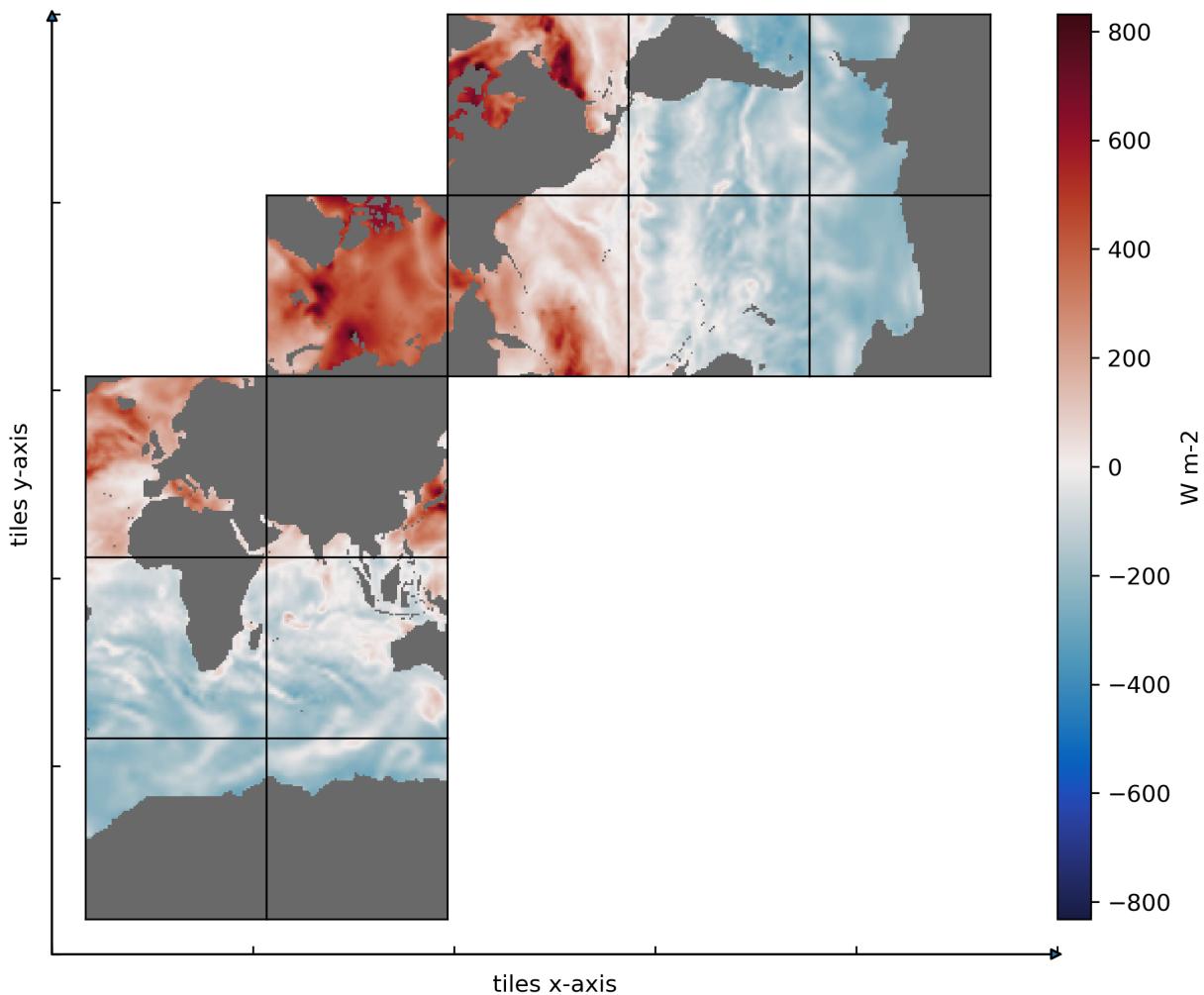
### 19.9.5 Native Variable EXFqnet

**Table 19.53: CDL description of OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX's EXFqnet variable**

Storage Type	Variable Name	Description	Unit
float32	EXFqnet	Open ocean net air-sea heat flux	W m <sup>-2</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
Net air-sea heat flux (turbulent and radiative) per unit area of open water (not covered by sea-ice). Note: net upward heat flux over open water, calculated as EXFlwnet+EXFswnet-EXFlh-EXFhs.			

## EXFqnet (Daily Mean)

Open ocean net air-sea heat flux



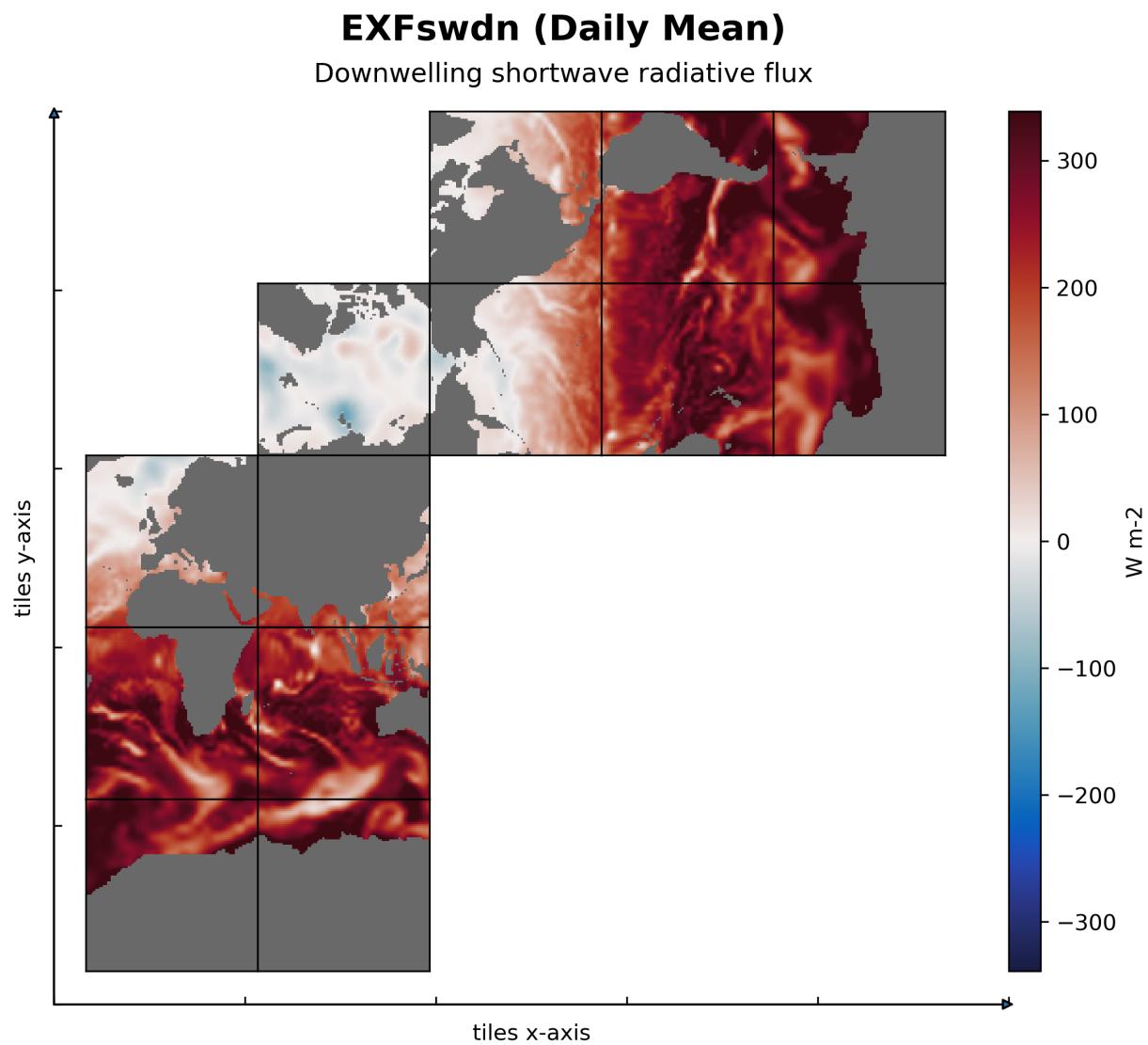
Example file 2017-12-29,  
OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

**Figure 68: Dataset: OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX Variable: EXFqnet**

### 19.9.6 Native Variable EXFswdn

Table 19.54: CDL description of OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX's EXFswdn variable

Storage Type	Variable Name	Description	Unit
float32	EXFswdn	Downwelling shortwave radiative flux	W m <sup>-2</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
Downward shortwave radiative flux. Note: sum of ERA-Interim downward shortwave radiation and the control adjustment from ocean state estimation.			

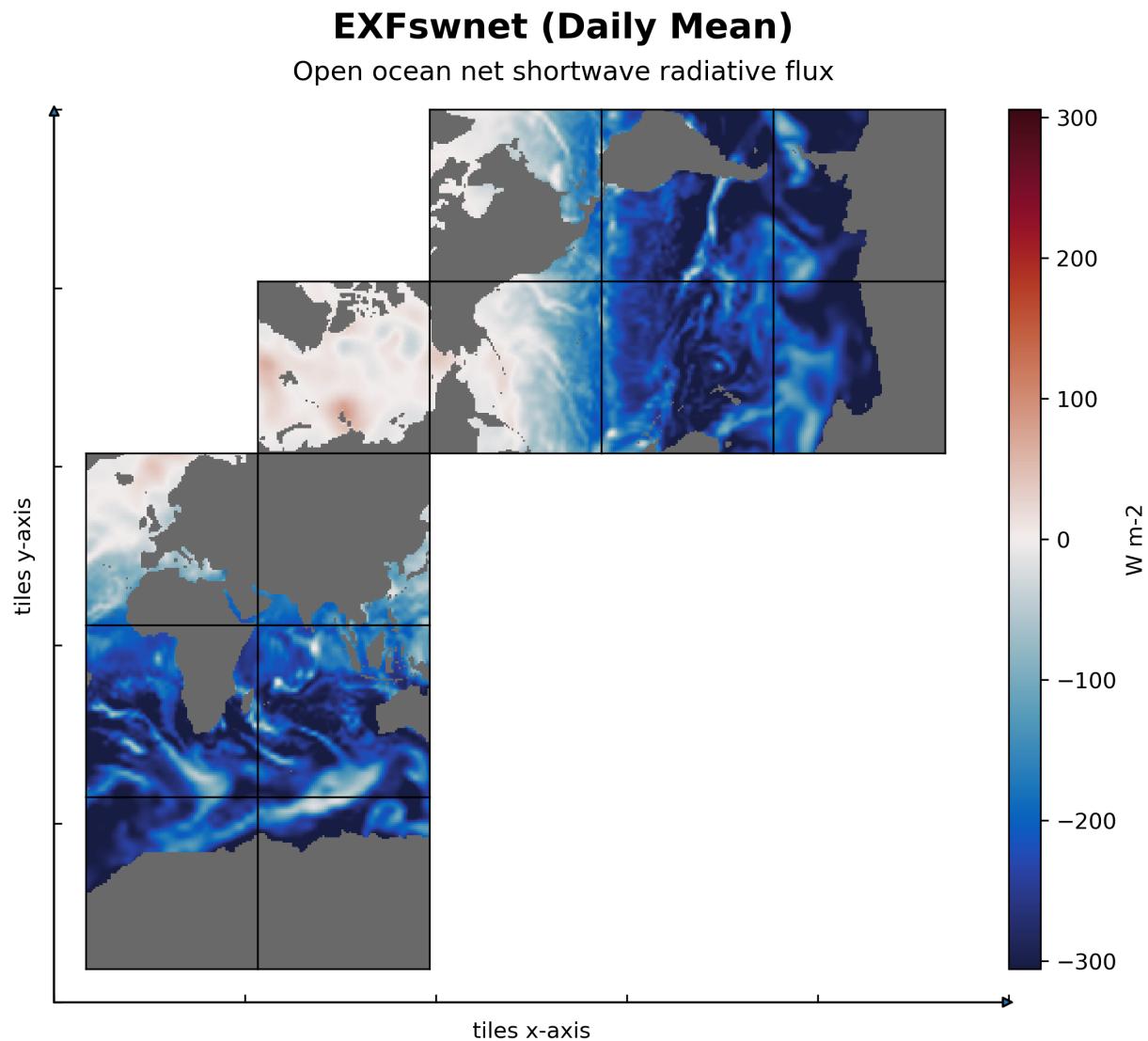


**Figure 69: Dataset: OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX Variable: EXFswdn**

### 19.9.7 Native Variable EXFswnet

**Table 19.55: CDL description of OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX's EXFswnet variable**

Storage Type	Variable Name	Description	Unit
float32	EXFswnet	Open ocean net shortwave radiative flux	W m <sup>-2</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 70: Dataset: OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX Variable: EXFswnet**

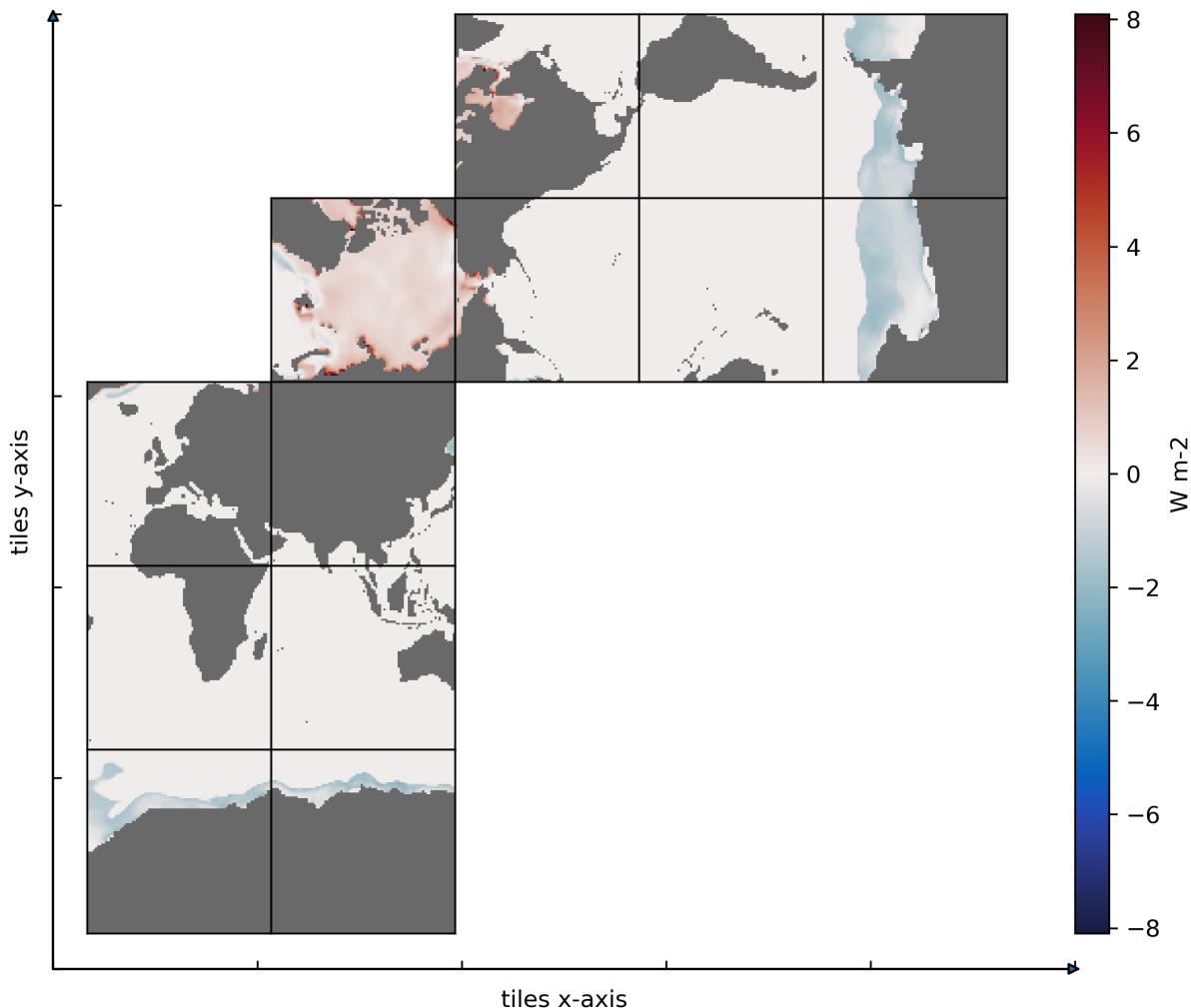
### 19.9.8 Native Variable Slaaflux

Table 19.56: CDL description of OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX's Slaaflux variable

Storage Type	Variable Name	Description	Unit
float32	Slaaflux	Conservative ocean and sea-ice advective heat flux adjustment	W m <sup>-2</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

## Slaaflux (Daily Mean)

Conservative ocean and sea-ice advective heat flux adjustment



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: Slaaflux**

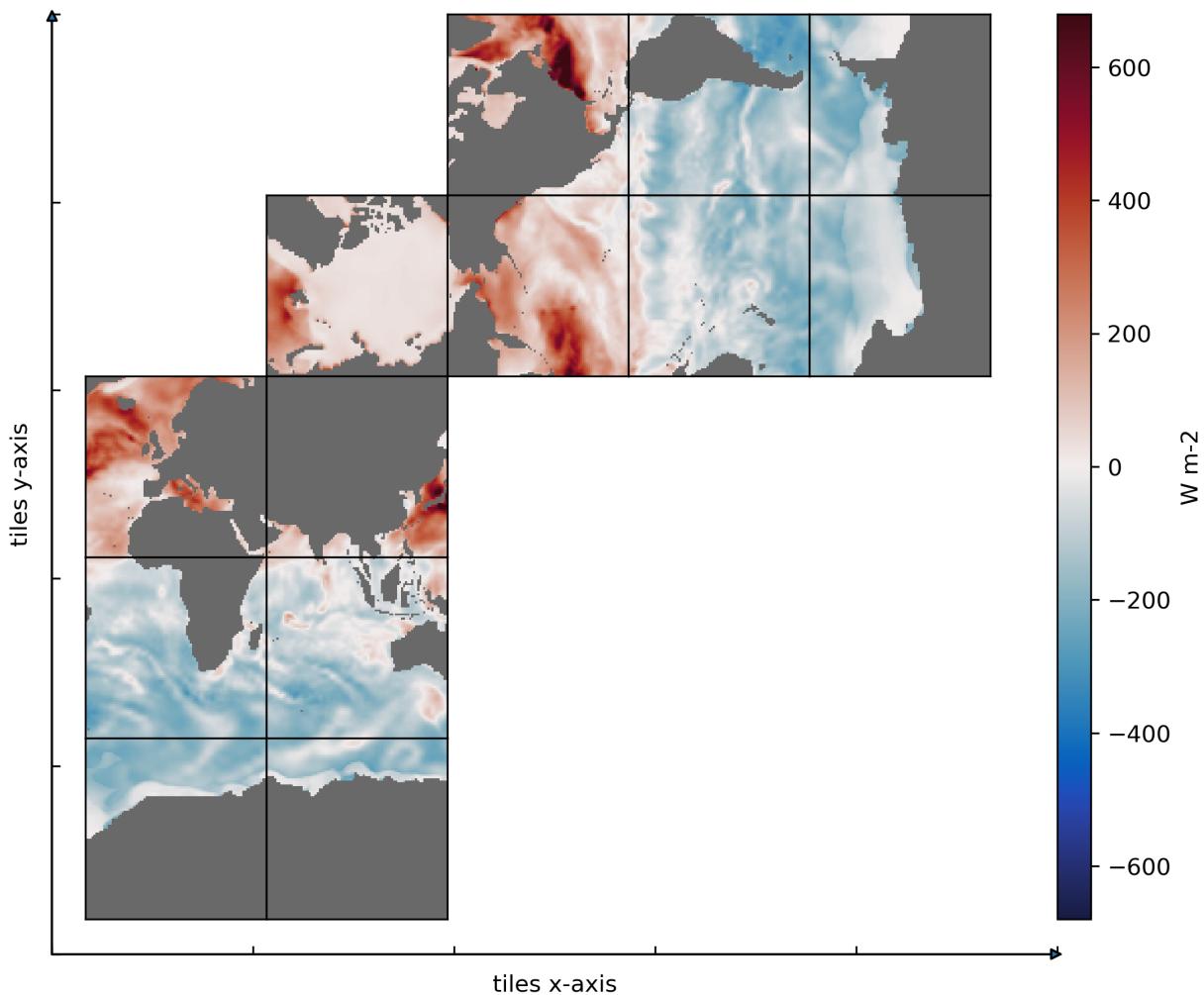
### 19.9.9 Native Variable SlatmQnt

**Table 19.57: CDL description of OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX's SlatmQnt variable**

Storage Type	Variable Name	Description	Unit
float32	SlatmQnt	Net upward heat flux to the atmosphere	W m <sup>-2</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
Net upward heat flux to the atmosphere across open water and sea-ice or snow surfaces. Note: nonzero SlatmQnt 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).			

## SlatmQnt (Daily Mean)

Net upward heat flux to the atmosphere



Example file 2017-12-29,  
OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

**Figure 72: Dataset: OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX Variable: SlatmQnt**

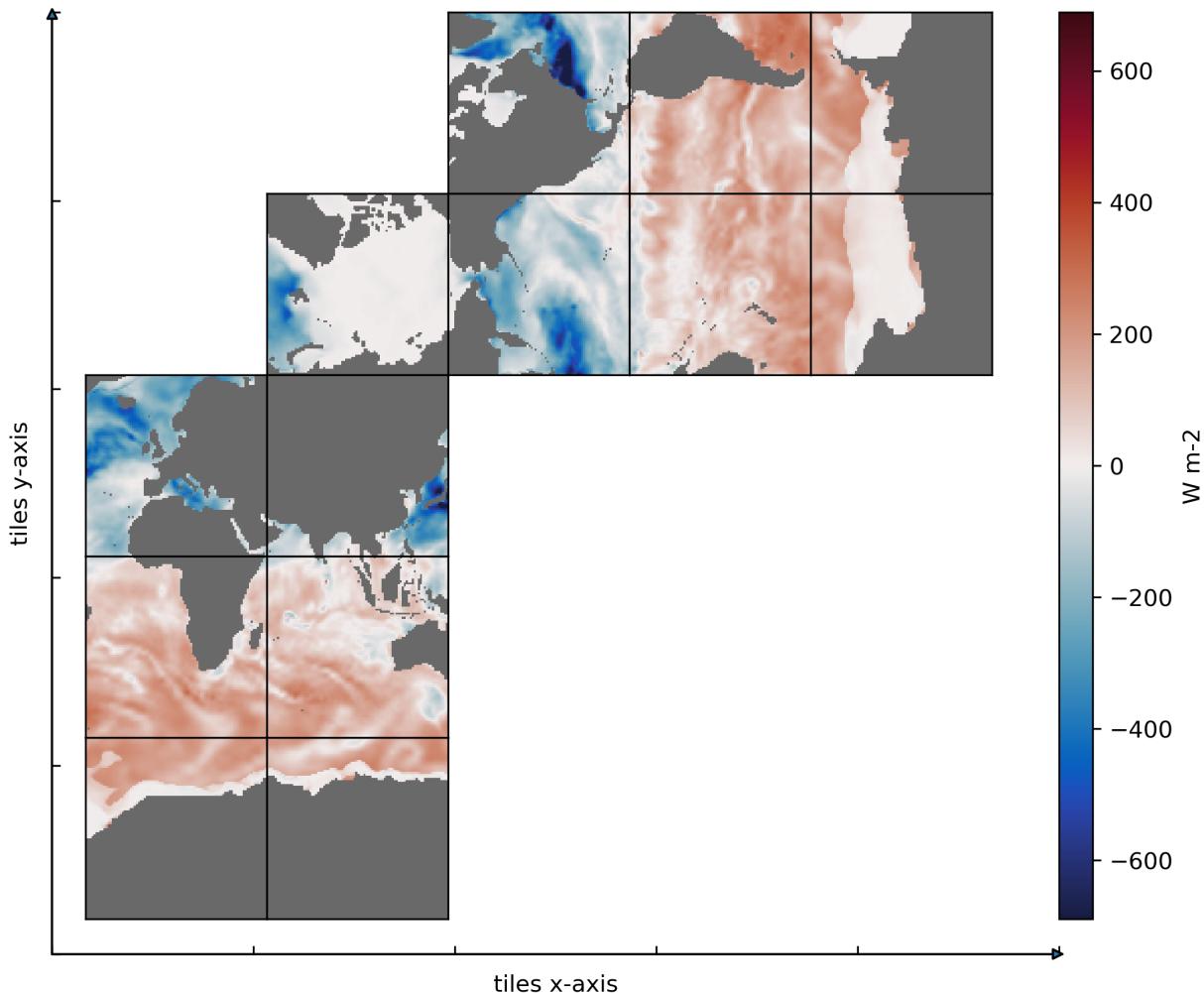
### 19.9.10 Native Variable TFLUX

**Table 19.58: CDL description of OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX's TFLUX variable**

Storage Type	Variable Name	Description	Unit
float32	TFLUX	Rate of change of ocean heat content per m <sup>2</sup> accounting for mass fluxes.	W m <sup>-2</sup>
<b>CDL Description</b>			
float32 TFLUX(time, tile, j, i) TFLUX: _FillValue = 9.96921e+36 TFLUX: long_name = Rate of change of ocean heat content per m <sup>2</sup> 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			
<b>Comments</b>			
The rate of change of ocean heat content due to heat fluxes across the liquid surface and the addition or removal of mass. . . Note: the global area integral of TFLUX and geothermal flux (geothermalFlux.bin) matches the time-derivative of ocean heat content (J/s). Unlike oceQnet, TFLUX includes the contribution to the ocean heat content from changing ocean mass (e.g. from oceFWflx).			

## TFLUX (Daily Mean)

Rate of change of ocean heat content per m<sup>2</sup> accounting for mass fluxes.



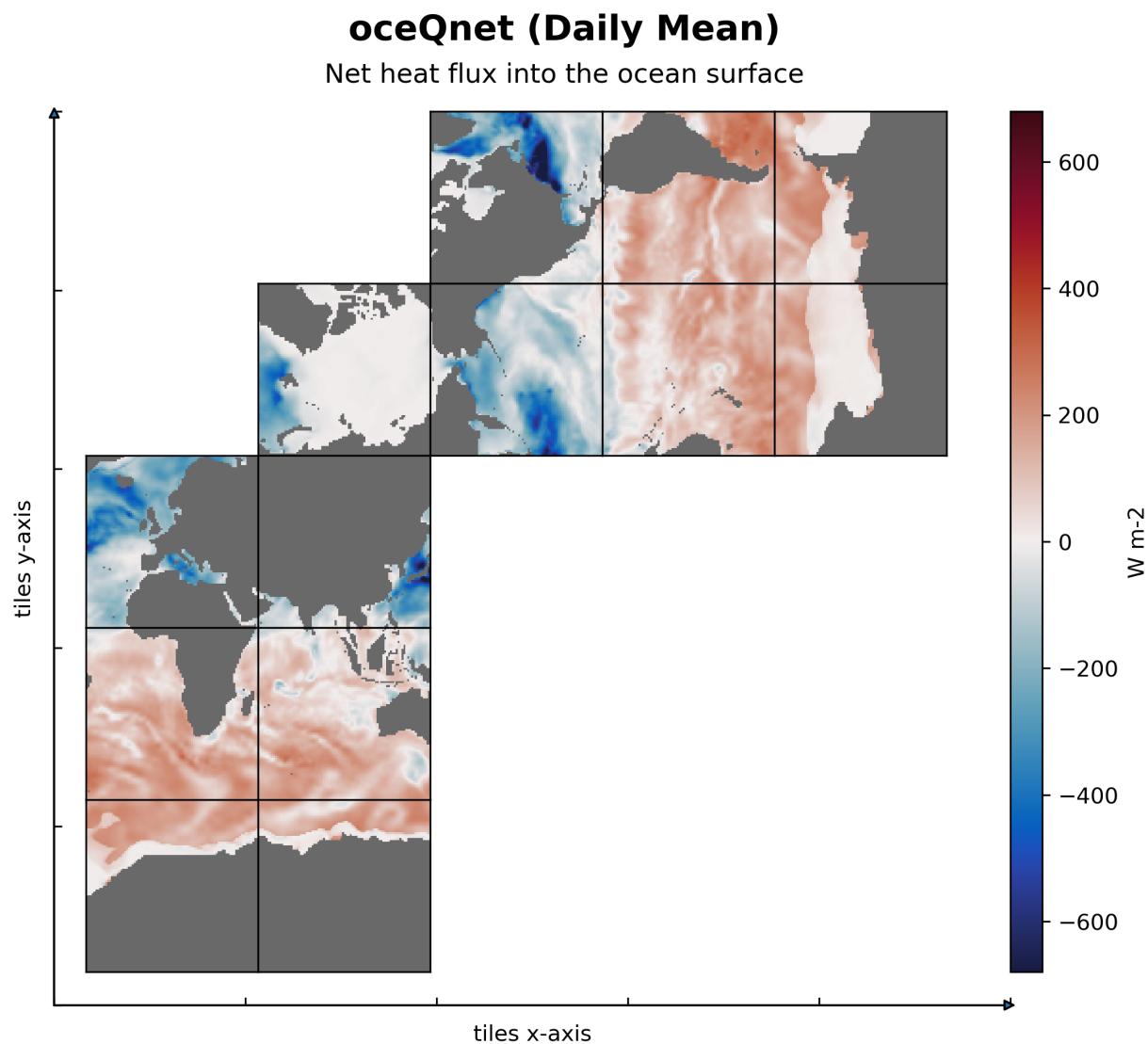
Example file 2017-12-29,  
OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

**Figure 73: Dataset: OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX Variable: TFLUX**

### 19.9.11 Native Variable oceQnet

**Table 19.59: CDL description of OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX's oceQnet variable**

Storage Type	Variable Name	Description	Unit
float32	oceQnet	Net heat flux into the ocean surface	W m <sup>-2</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 temperature is not OC. The variable TFLUX does include the change in ocean heat content due to changing ocean mass.			

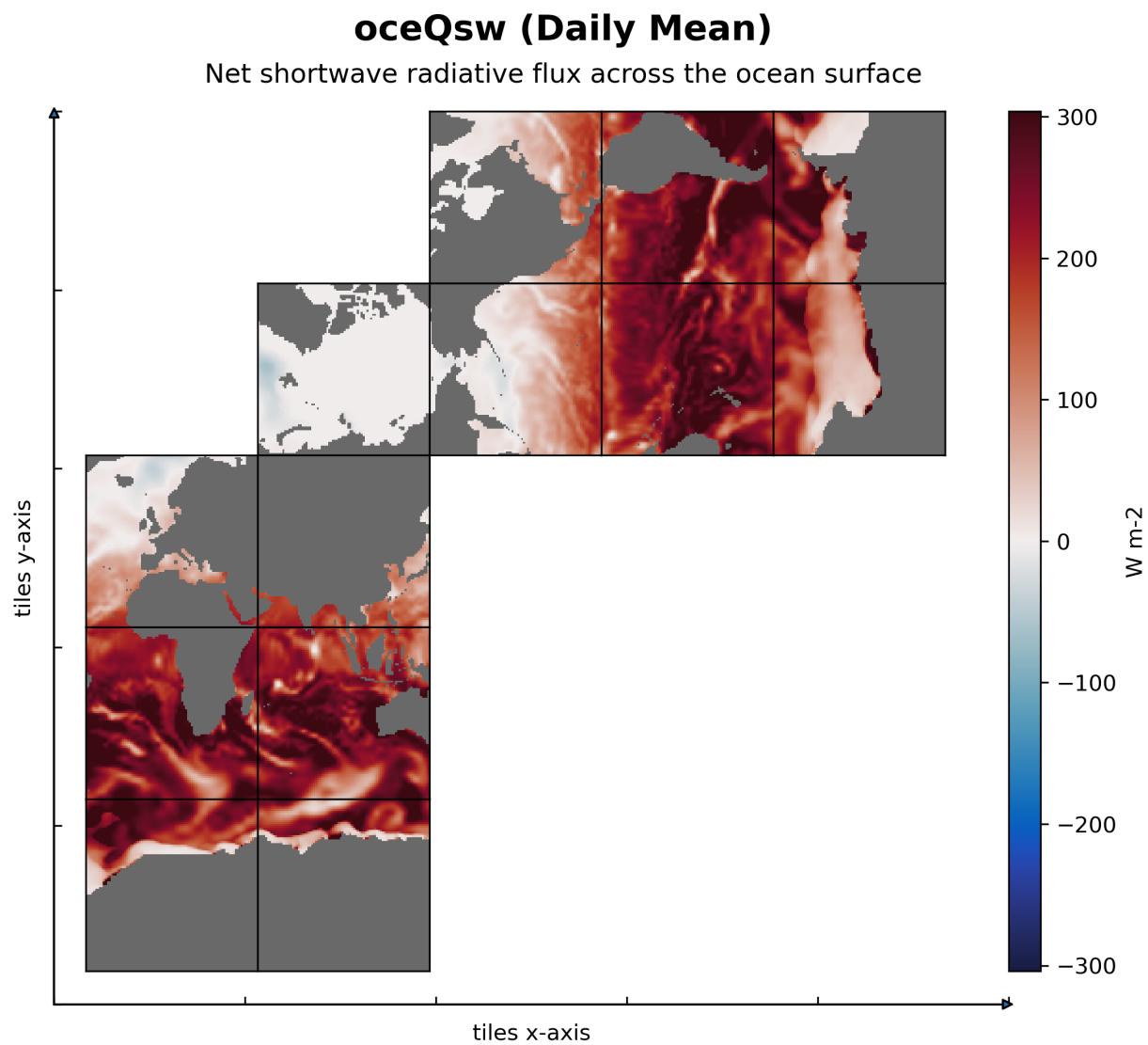


**Figure 74: Dataset: OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX Variable: oceQnet**

### 19.9.12 Native Variable oceQsw

Table 19.60: CDL description of OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX's oceQsw variable

Storage Type	Variable Name	Description	Unit
float32	oceQsw	Net shortwave radiative flux across the ocean surface	W m <sup>-2</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
Net shortwave radiative flux across the ocean surface. Note: Shortwave radiation penetrates below the surface grid cell.			



Example file 2017-12-29,  
OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

**Figure 75: Dataset: OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX Variable: oceQsw**

## 19.10 Native NetCDF OCEAN\_AND\_ICE\_SURFACE\_STRESS

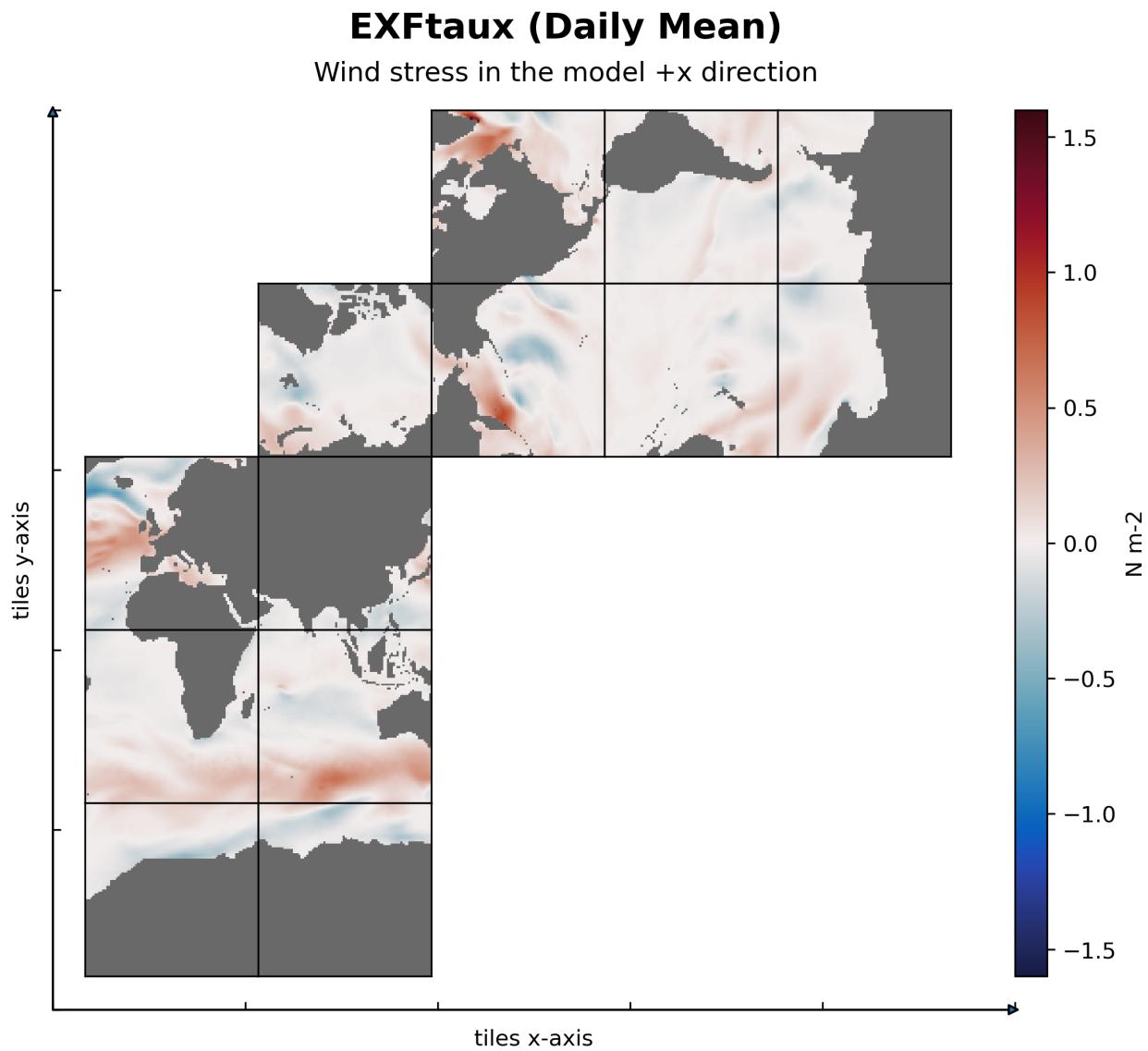
Table 19.61: Variables in the dataset OCEAN\_AND\_ICE\_SURFACE\_STRESS

Dataset:	OCEAN_AND_ICE_SURFACE_STRESS
Field:	EXFtaux
Field:	EXFtauy
Field:	oceTAUX
Field:	oceTAUY

### 19.10.1 Native Variable EXFtaux

**Table 19.62: CDL description of OCEAN\_AND\_ICE\_SURFACE\_STRESS's EXFtaux variable**

Storage Type	Variable Name	Description	Unit
float32	EXFtaux	Wind stress in the model +x direction	N m-2
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			



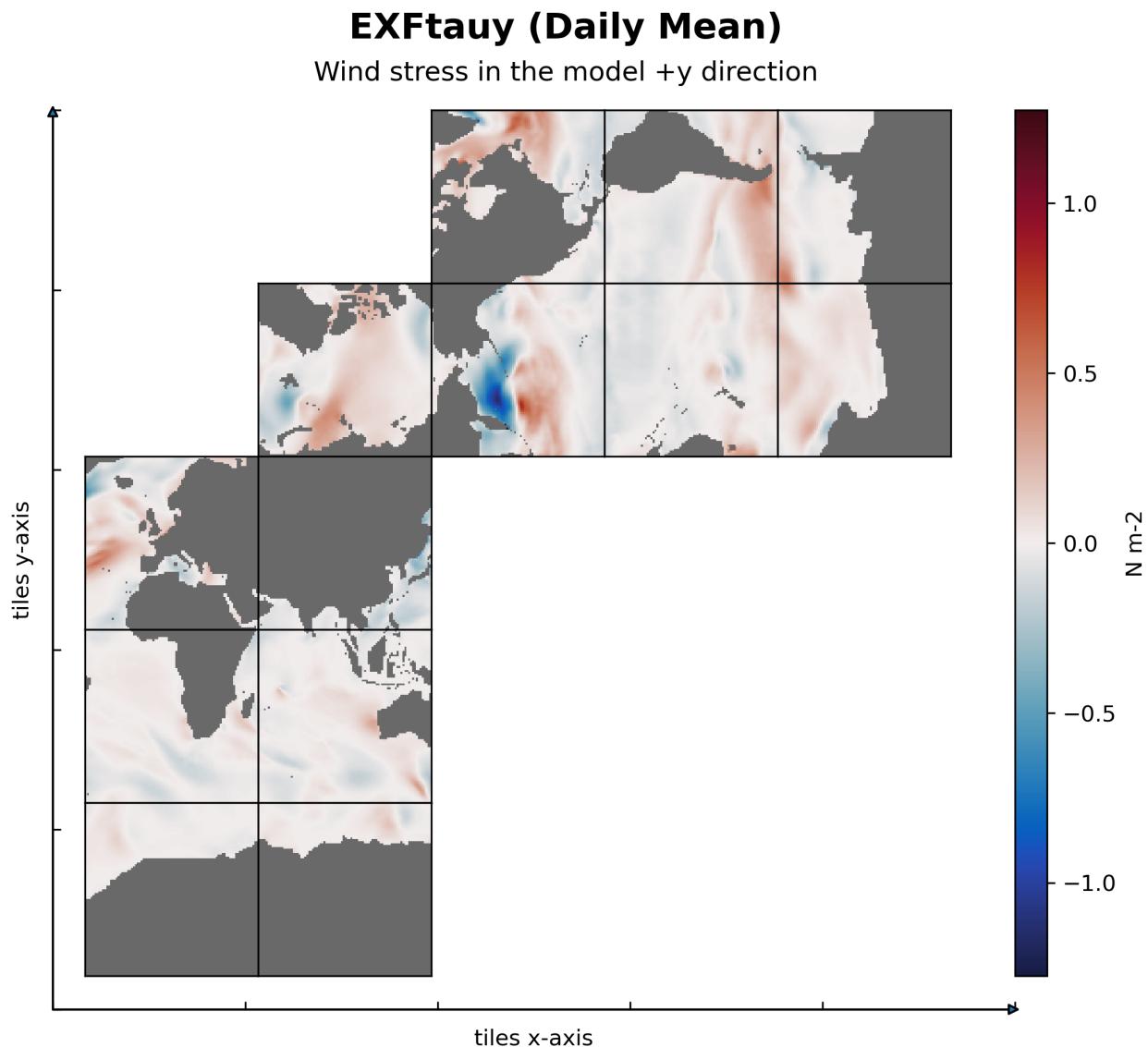
Example file 2017-12-29,  
OCEAN\_AND\_ICE\_SURFACE\_STRESS\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

**Figure 76: Dataset: OCEAN\_AND\_ICE\_SURFACE\_STRESS Variable: EXFtaux**

### 19.10.2 Native Variable EXFtauy

**Table 19.63: CDL description of OCEAN\_AND\_ICE\_SURFACE\_STRESS's EXFtauy variable**

Storage Type	Variable Name	Description	Unit
float32	EXFtauy	Wind stress in the model +y direction	N m-2
<b>CDL Description</b>			
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			
<b>Comments</b>			
Wind stress in the +y direction at the tracer cell on the native model grid. Note: EXFtauy is the stress applied to the ice-free ocean surface and sea-ice covered surface. When sea-ice is present, the total stress applied to the ocean surface in the +y direction is NOT EXFtauy, but a combination of EXFtauy wind stress in the open water fraction and a stress from sea-ice in the ice-covered fraction (see oceTAUY). EXFtaux is the sum of ERA-Interim stress and the control adjustment from ocean state estimation.			



Example file 2017-12-29,  
OCEAN\_AND\_ICE\_SURFACE\_STRESS\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

**Figure 77: Dataset: OCEAN\_AND\_ICE\_SURFACE\_STRESS Variable: EXFtauy**

### 19.10.3 Native Variable oceTAUX

Table 19.64: CDL description of OCEAN\_AND\_ICE\_SURFACE\_STRESS's oceTAUX variable

Storage Type	Variable Name	Description	Unit
float32	oceTAUX	Ocean surface stress in the model +x direction	N m-2
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

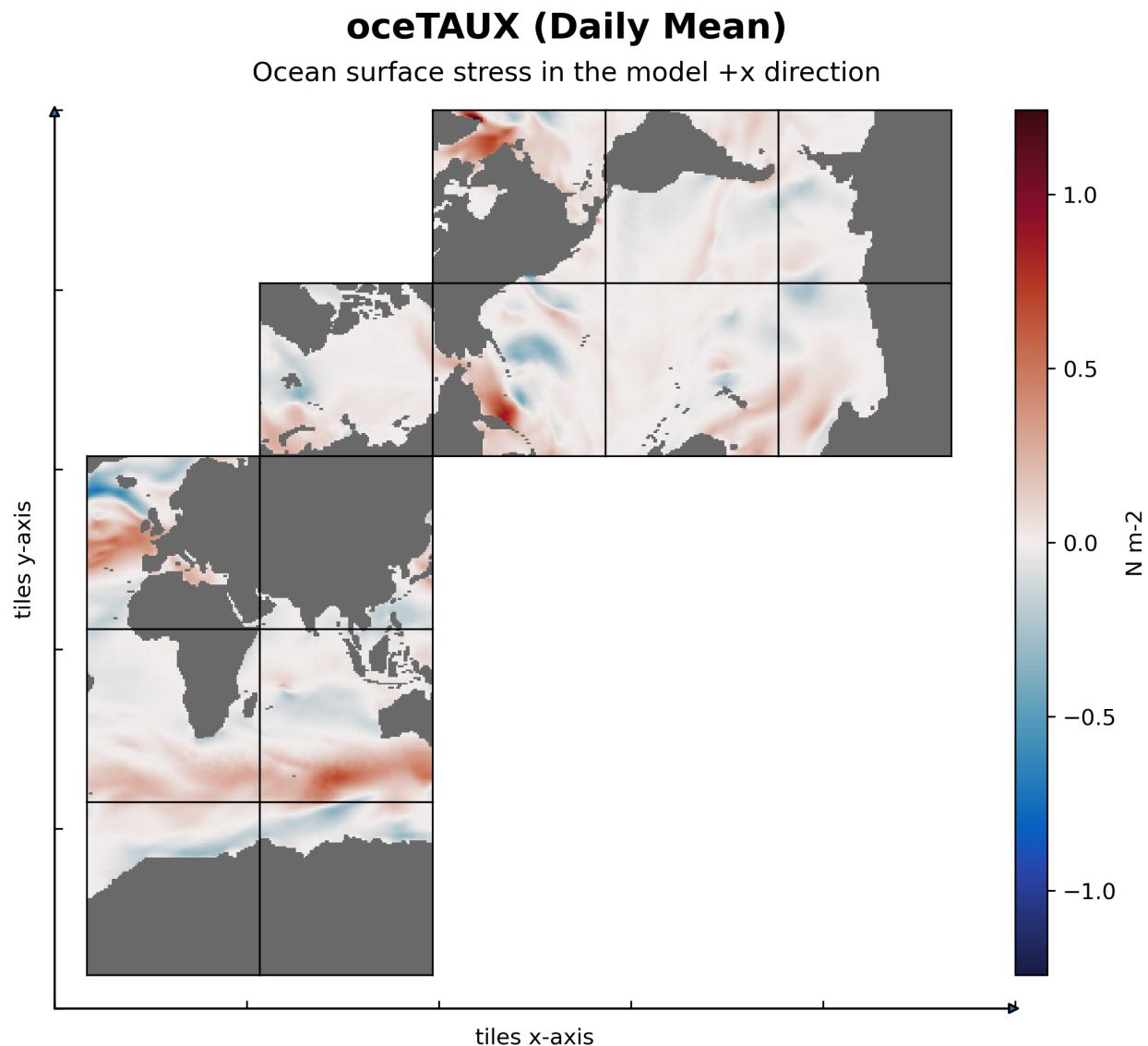
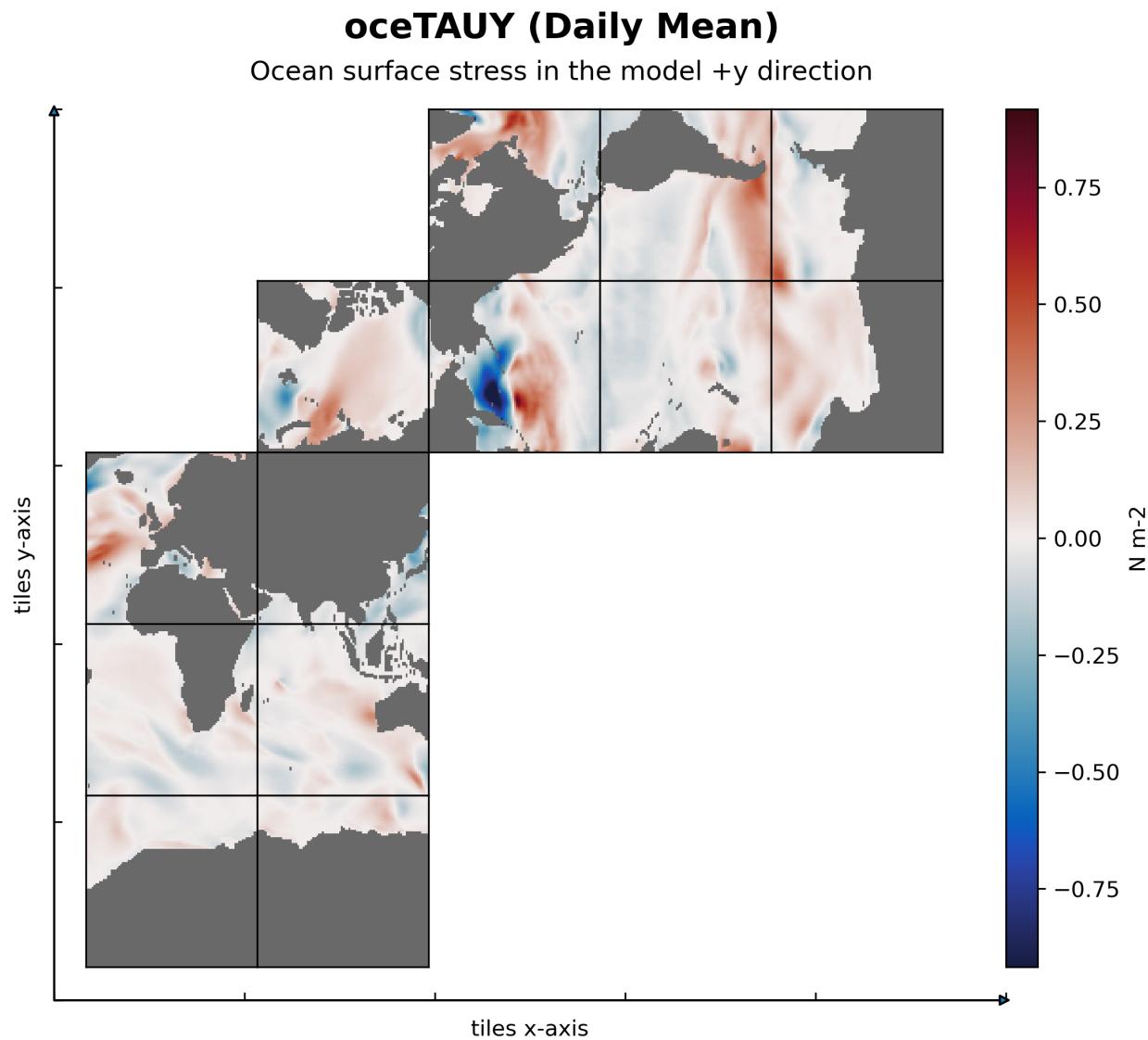


Figure 78: Dataset: OCEAN\_AND\_ICE\_SURFACE\_STRESS Variable: oceTAUX

#### 19.10.4 Native Variable oceTAUY

Table 19.65: CDL description of OCEAN\_AND\_ICE\_SURFACE\_STRESS's oceTAUY variable

Storage Type	Variable Name	Description	Unit
float32	oceTAUY	Ocean surface stress in the model +y direction	N m-2
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			



**Figure 79: Dataset: OCEAN\_AND\_ICE\_SURFACE\_STRESS Variable: oceTAUY**

## 19.11 Native NetCDF OCEAN\_BOLUS\_STREAMFUNCTION

**Table 19.66: Variables in the dataset OCEAN\_BOLUS\_STREAMFUNCTION**

Dataset:	OCEAN_BOLUS_STREAMFUNCTION
Field:	GM_PsiX
Field:	GM_PsiY

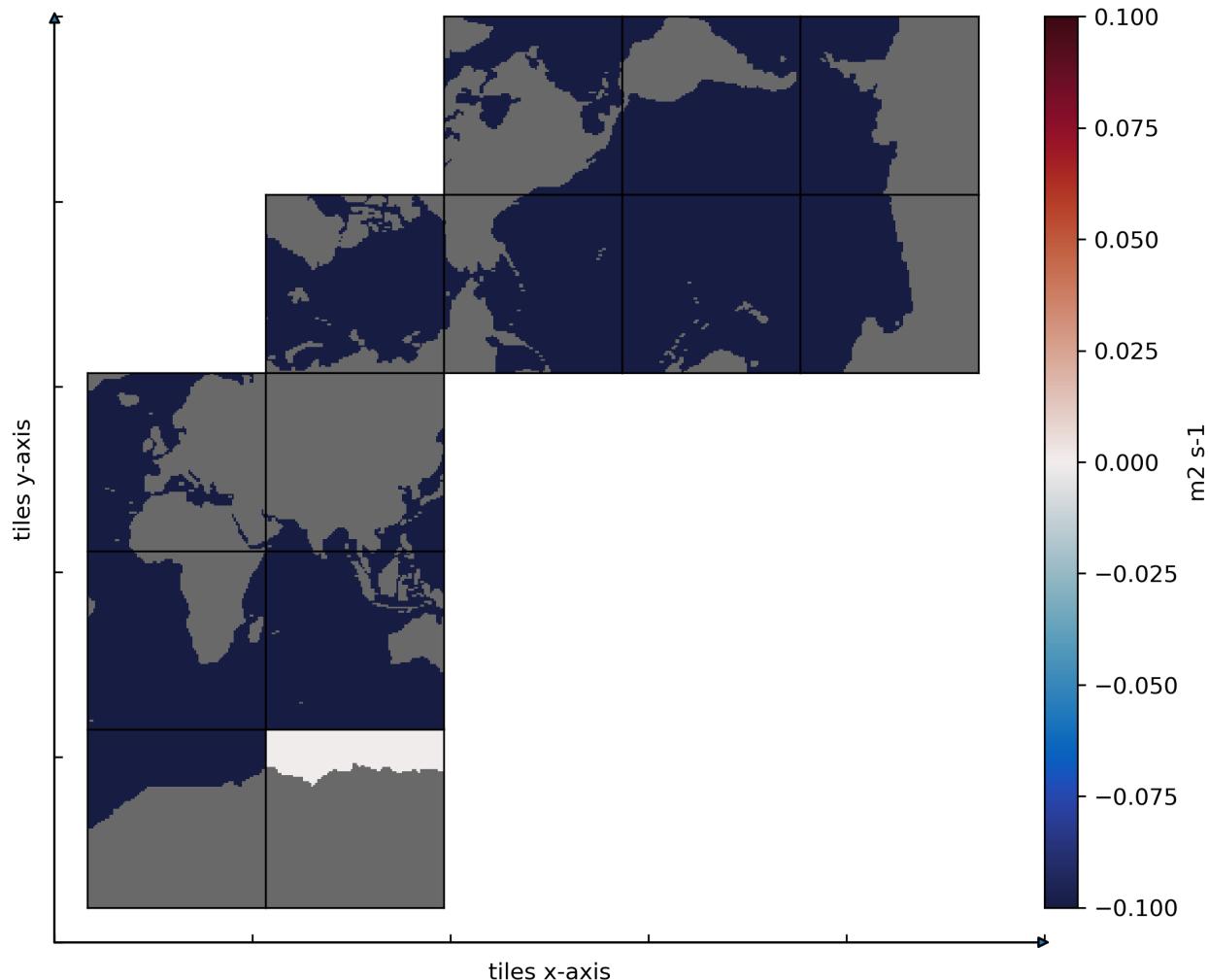
### 19.11.1 Native Variable GM\_PsiX

Table 19.67: CDL description of OCEAN\_BOLUS\_STREAMFUNCTION's GM\_PsiX variable

Storage Type	Variable Name	Description	Unit
float32	GM_PsiX	Gent-Mcwilliams bolus transport streamfunction in the model +x direction	m2 s-1
<b>CDL Description</b>			
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 = 4.96377611602783			
<b>Comments</b>			
Gent-Mcwilliams bolus transport streamfunction 'u' component. any comments welcome			

## GM\_PsiX (Daily Mean)

Gent-Mcwilliams bolus transport streamfunction in the model +x direction



Example fied 2017-12-29,  
OCEAN\_BOLUS\_STREAMFUNCTION\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

**Figure 80: Dataset: OCEAN\_BOLUS\_STREAMFUNCTION Variable: GM\_PsiX**

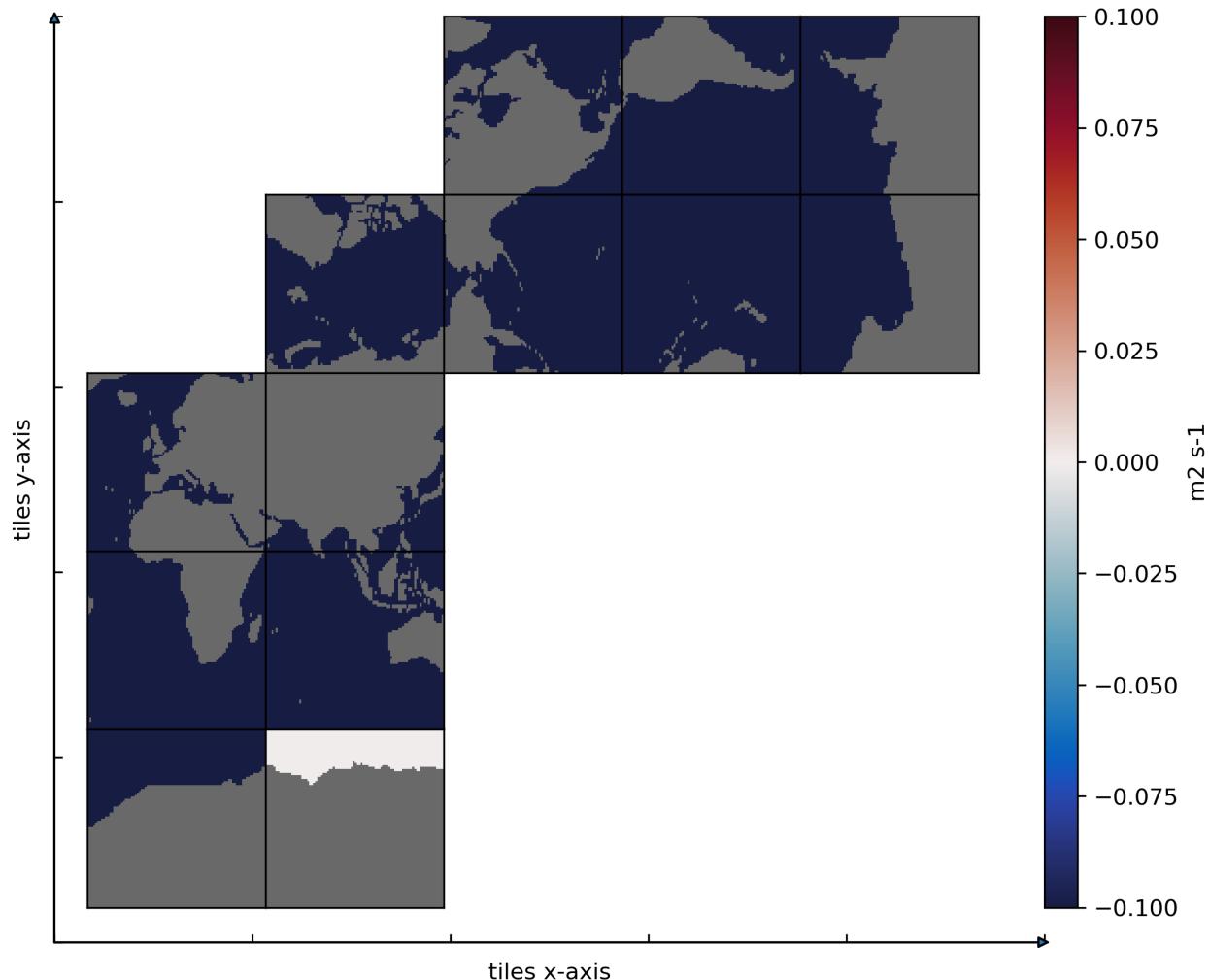
### 19.11.2 Native Variable GM\_PsiY

Table 19.68: CDL description of OCEAN\_BOLUS\_STREAMFUNCTION's GM\_PsiY variable

Storage Type	Variable Name	Description	Unit
float32	GM_PsiY	Gent-Mcwilliams bolus transport streamfunction in the model +y direction	m2 s-1
<b>CDL Description</b>			
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			
<b>Comments</b>			
Gent-Mcwilliams bolus transport streamfunction 'v' component. any comments welcome			

## GM\_PsiY (Daily Mean)

Gent-Mcwilliams bolus transport streamfunction in the model +y direction



Example fied 2017-12-29,  
OCEAN\_BOLUS\_STREAMFUNCTION\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

**Figure 81: Dataset: OCEAN\_BOLUS\_STREAMFUNCTION Variable: GM\_PsiY**

## 19.12 Native NetCDF OCEAN\_BOLUS\_VELOCITY

**Table 19.69: Variables in the dataset OCEAN\_BOLUS\_VELOCITY**

Dataset:	OCEAN_BOLUS_VELOCITY
Field:	UVELSTAR
Field:	VVELSTAR
Field:	WVELSTAR

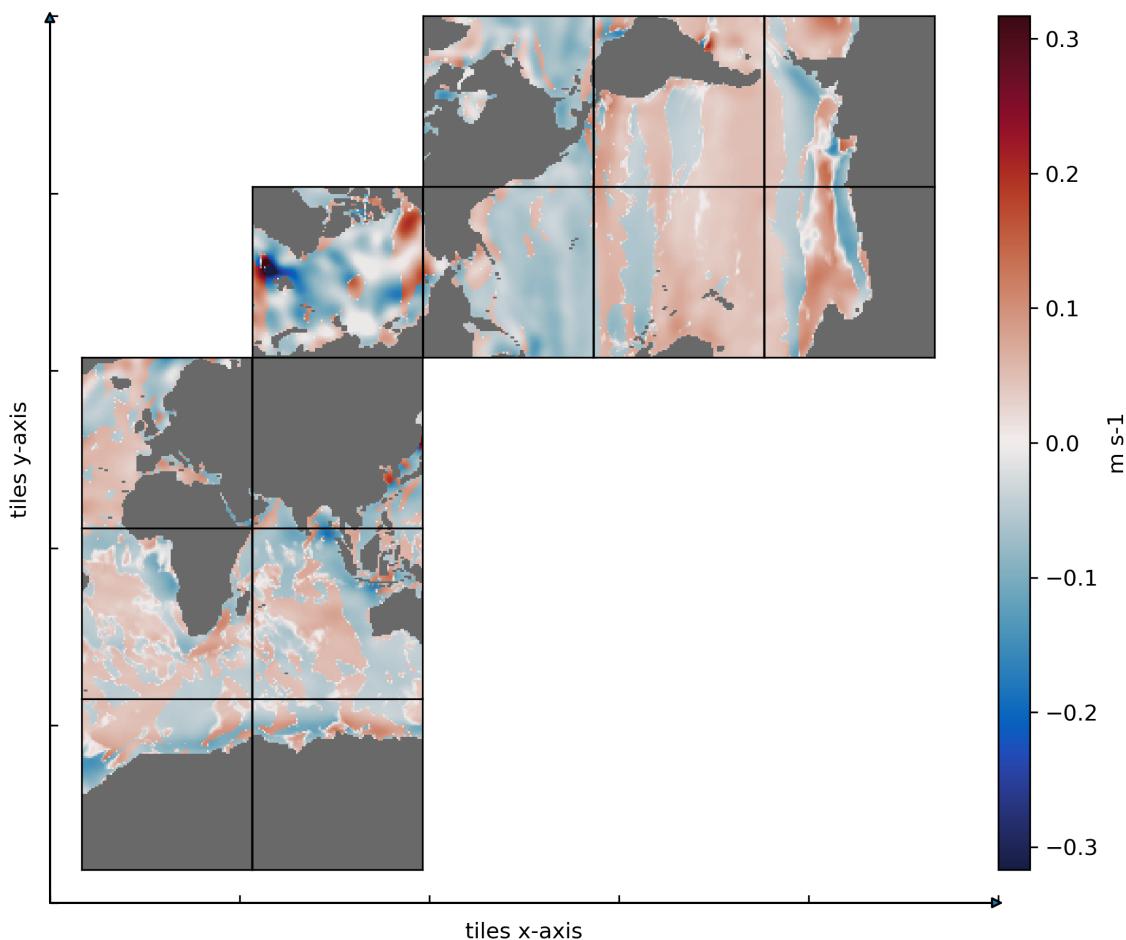
### 19.12.1 Native Variable UVELSTAR

**Table 19.70: CDL description of OCEAN\_BOLUS\_VELOCITY's UVELSTAR variable**

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 <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

## UVELSTAR (Daily Mean)

Gent-McWilliams velocity in the model +x direction scaled by time-varying grid cell thickness



Example fied 2017-12-29,  
OCEAN\_BOLUS\_VELOCITY\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

Figure 82: Dataset: OCEAN\_BOLUS\_VELOCITY Variable: UVELSTAR

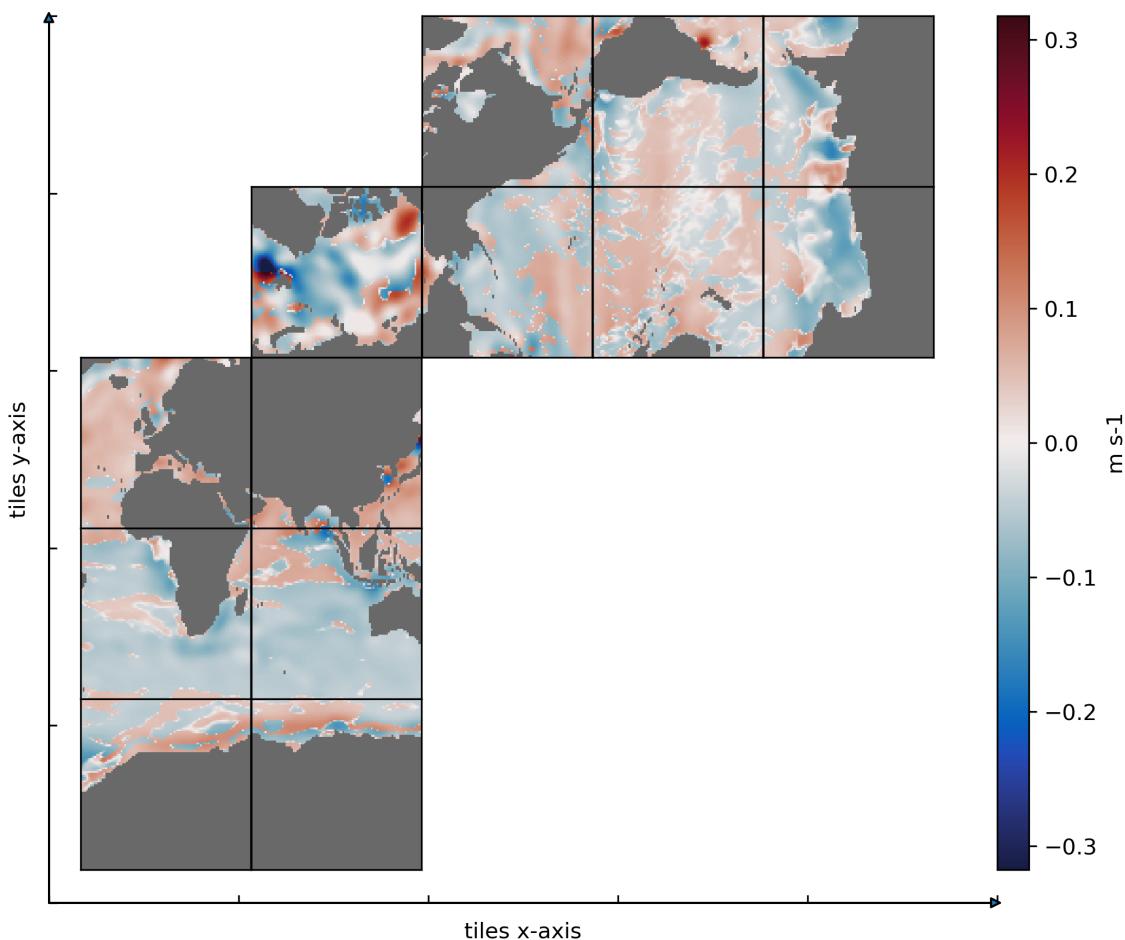
### 19.12.2 Native Variable VVELSTAR

**Table 19.71: CDL description of OCEAN\_BOLUS\_VELOCITY's VVELSTAR variable**

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 <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

## VVELSTAR (Daily Mean)

Gent-McWilliams velocity in the model +y direction scaled by time-varying grid cell thickness



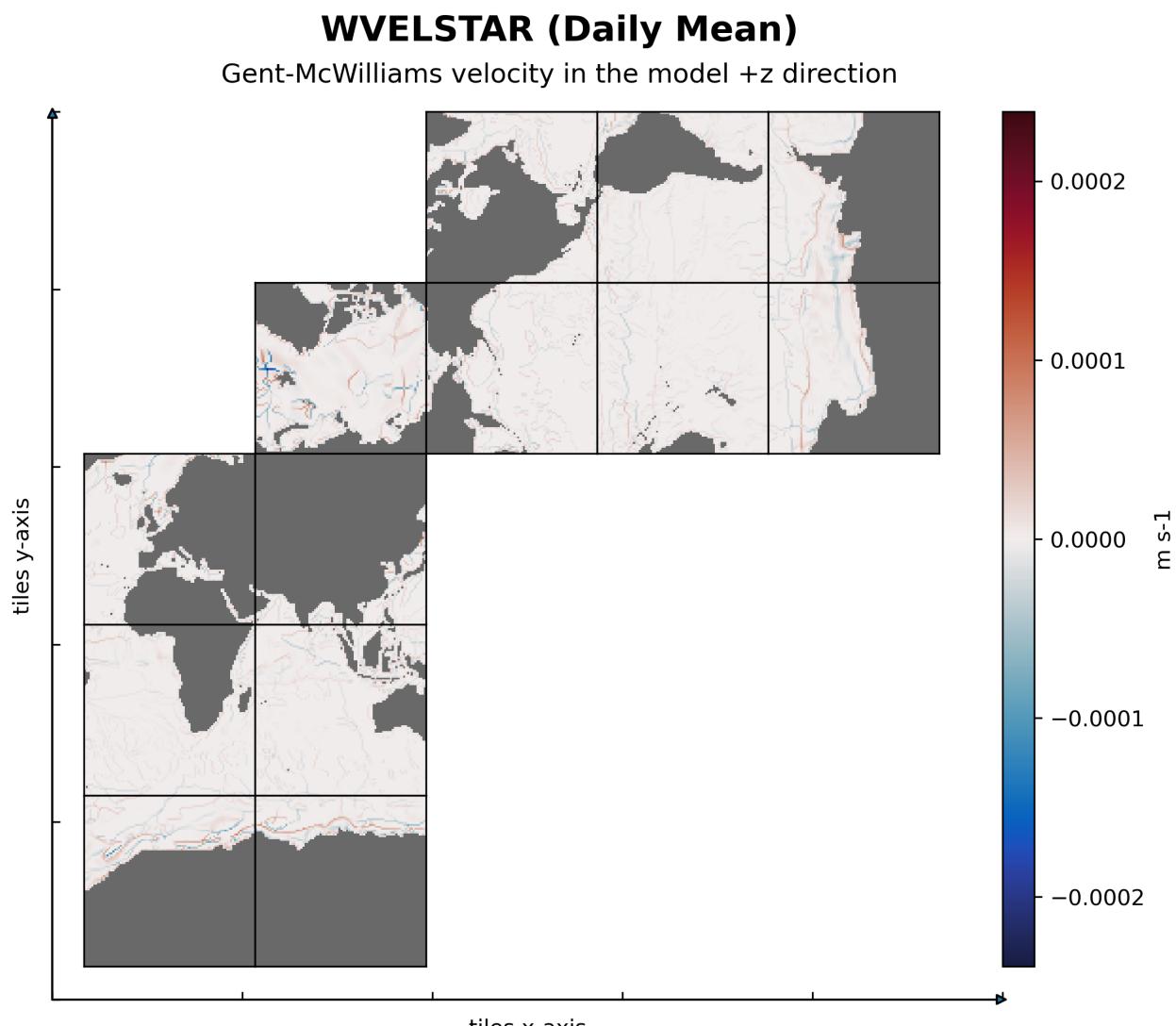
Example fied 2017-12-29,  
OCEAN\_BOLUS\_VELOCITY\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

Figure 83: Dataset: OCEAN\_BOLUS\_VELOCITY Variable: VVELSTAR

### 19.12.3 Native Variable WVELSTAR

**Table 19.72: CDL description of OCEAN\_BOLUS\_VELOCITY's WVELSTAR variable**

Storage Type	Variable Name	Description	Unit
float32	WVELSTAR	Gent-McWilliams velocity in the model +z direction	m s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 84: Dataset: OCEAN\_BOLUS\_VELOCITY Variable: WVELSTAR**

## 19.13 Native NetCDF OCEAN\_BOTTOM\_PRESSURE

Table 19.73: Variables in the dataset OCEAN\_BOTTOM\_PRESSURE

Dataset:	OCEAN_BOTTOM_PRESSURE
Field:	OBP
Field:	OBPGMAP
Field:	PHIBOT

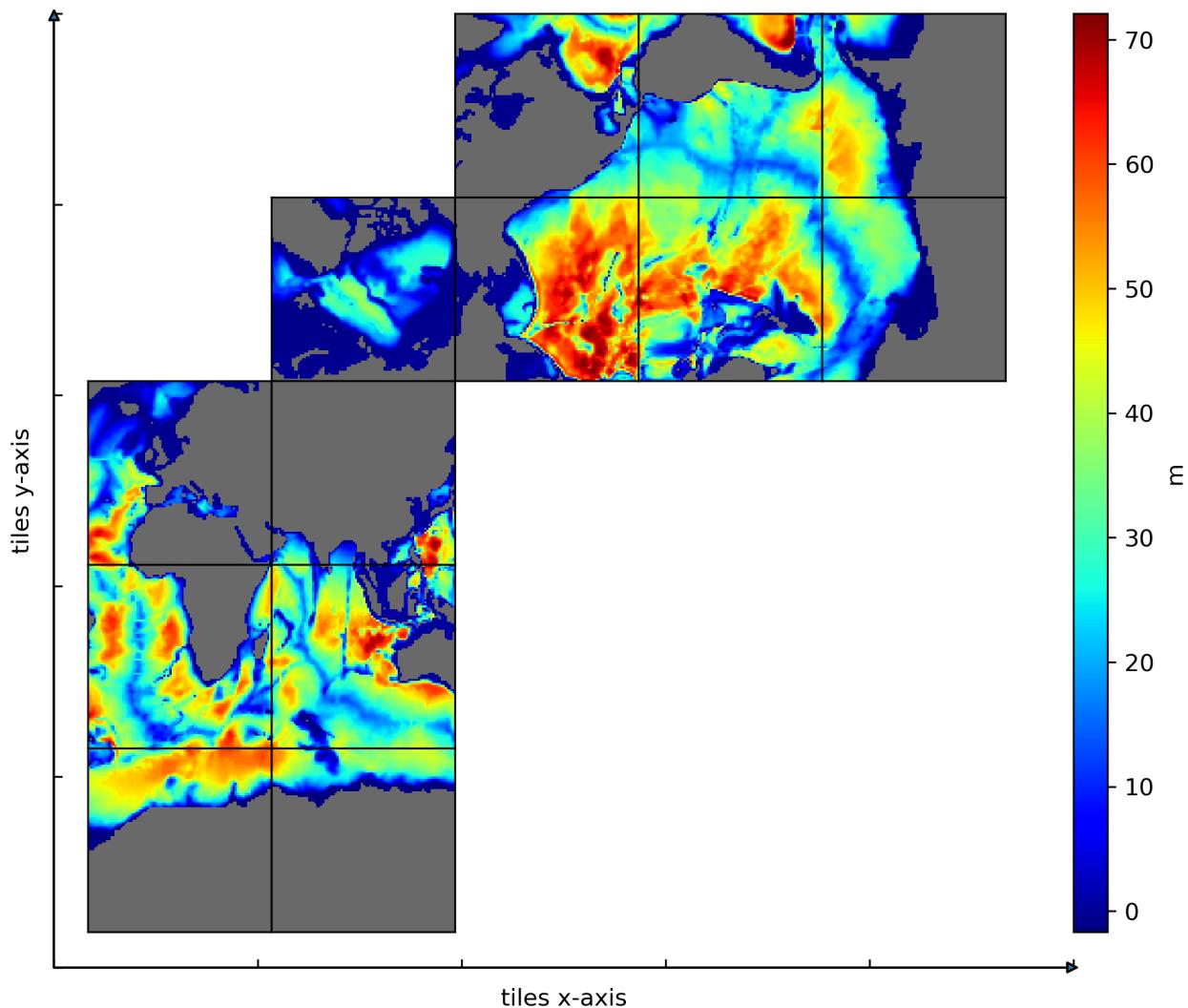
### 19.13.1 Native Variable OBP

**Table 19.74: CDL description of OCEAN\_BOTTOM\_PRESSURE's OBP variable**

Storage Type	Variable Name	Description	Unit
float32	OBP	Ocean bottom pressure given as equivalent water thickness	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 $\text{PHIBOT} = p_b/\rho_{\text{Const}} - gH(t)$ , where $p_b$ = model ocean hydrostatic bottom pressure, $\rho_{\text{Const}}$ = reference density ( $1029 \text{ kg m}^{-3}$ ), $g$ is acceleration due to gravity ( $9.81 \text{ m s}^{-2}$ ), and $H(t)$ is model depth at time $t$ . Then, $\text{OBP} = \text{PHIBOT}/g + \text{corrections}$ for i) global mean steric sea level changes related to density changes in the Boussinesq volume-conserving model (Greatbatch correction, see <code>sterGloH</code> ) 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.			

## OBP (Daily Mean)

Ocean bottom pressure given as equivalent water thickness



Example file 2017-12-29,  
OCEAN\_BOTTOM\_PRESSURE\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

Figure 85: Dataset: OCEAN\_BOTTOM\_PRESSURE Variable: OBP

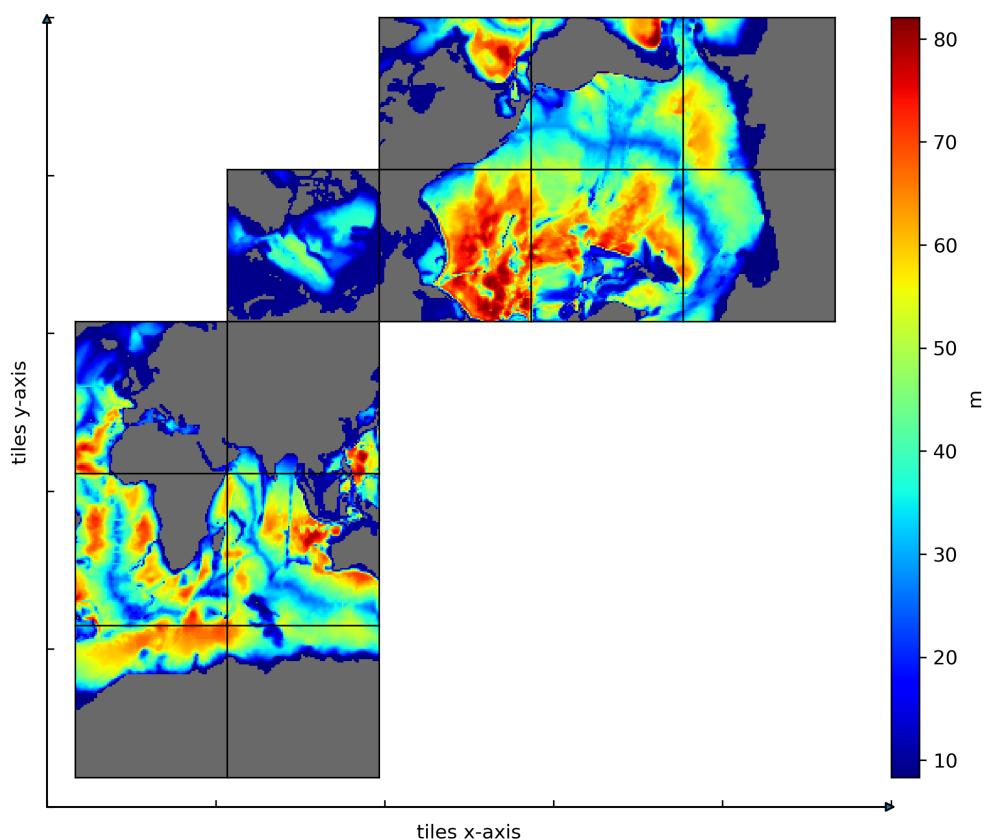
### 19.13.2 Native Variable OBPGMAP

**Table 19.75: CDL description of OCEAN\_BOTTOM\_PRESSURE's OBPGMAP variable**

Storage Type	Variable Name	Description	Unit
float32	OBPGMAP	Ocean bottom pressure given as equivalent water thickness, includes global mean atmospheric pressure	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
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, $\rho_{\text{Const}}$ = reference density ( $1029 \text{ kg m}^{-3}$ ), $g$ is acceleration due to gravity ( $9.81 \text{ m s}^{-2}$ ), and $H(t)$ is model depth at time $t$ . Then, $\text{OBPGMAP} = \text{PHIBOT}/g +$ corrections for global mean steric sea level changes related to density changes in the Boussinesq volume-conserving model (Greatbatch correction, see <code>sterGloH</code> ). 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.			

## OBPGMAP (Daily Mean)

Ocean bottom pressure given as equivalent water thickness, includes global mean atmospheric pressure



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: OBPGMAP**

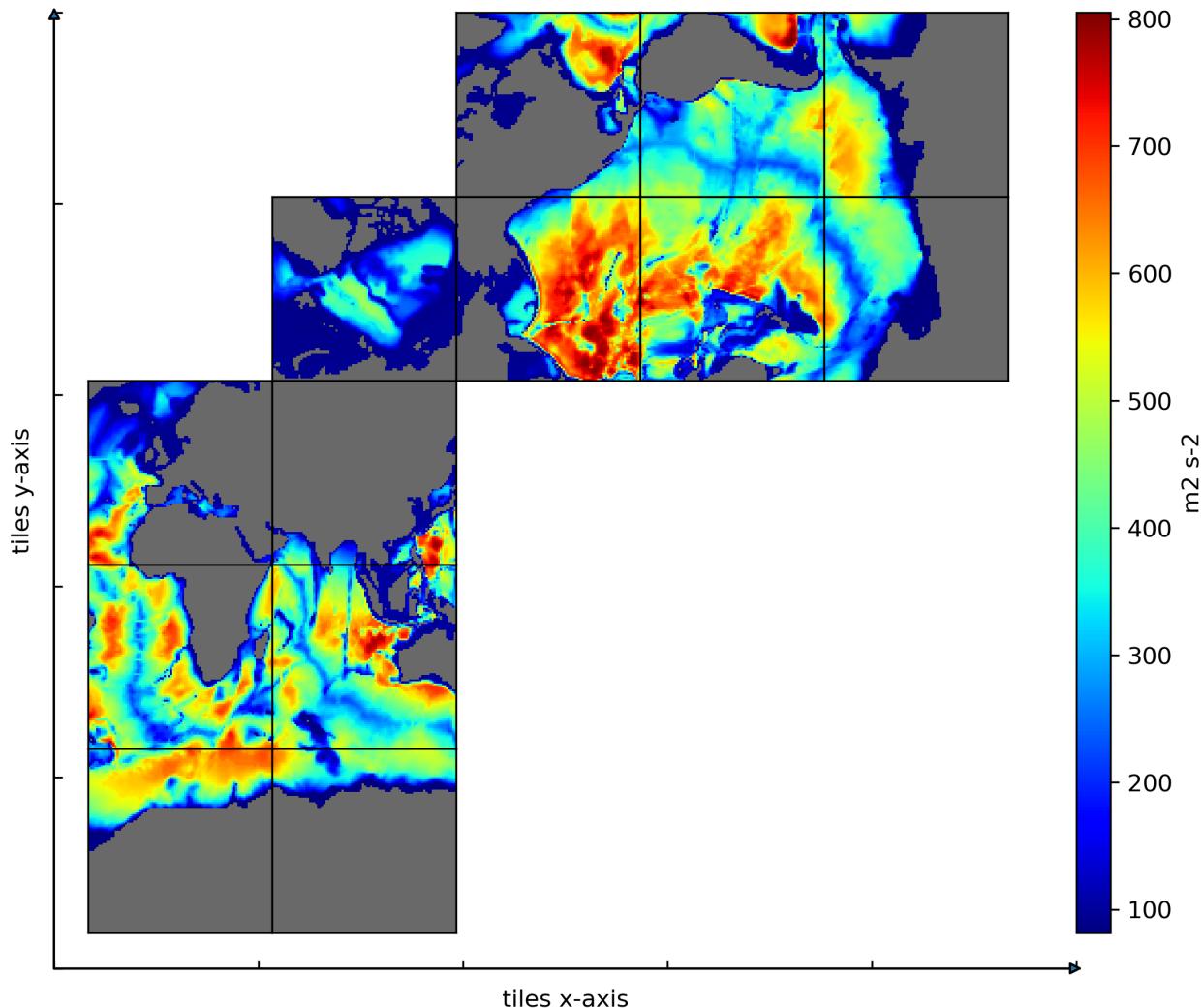
### 19.13.3 Native Variable PHIBOT

Table 19.76: CDL description of OCEAN\_BOTTOM\_PRESSURE's PHIBOT variable

Storage Type	Variable Name	Description	Unit
float32	PHIBOT	Ocean hydrostatic bottom pressure anomaly	m2 s-2
<b>CDL Description</b>			
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			
<b>Comments</b>			
PHIBOT = p_b / rhoConst - g H(t), where p_b = hydrostatic ocean bottom pressure, rhoConst = reference density (1029 kg m-3), g is acceleration due to gravity (9.81 m s-2), and H(t) is model depth at time t. Units: p:[kg m-1 s-2], rhoConst:[kg m-3], g:[m s-2], H(t):[m]. Note: includes atmospheric pressure loading. PHIBOT accounts for the model's time-varying grid cell thickness (z* coordinate system). PHIBOT is NOT corrected for global mean steric sea level changes related to density changes in the Boussinesq volume-conserving model (Greatbatch correction, see sterGloH), and therefore should NOT be used for comparisons with ocean bottom pressure data. Instead, see OBPGMAP and OBP.			

## PHIBOT (Daily Mean)

Ocean hydrostatic bottom pressure anomaly



Example file 2017-12-29,  
OCEAN\_BOTTOM\_PRESSURE\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

Figure 87: Dataset: OCEAN\_BOTTOM\_PRESSURE Variable: PHIBOT

## 19.14 Native NetCDF OCEAN\_DENS\_STRAT\_PRESS

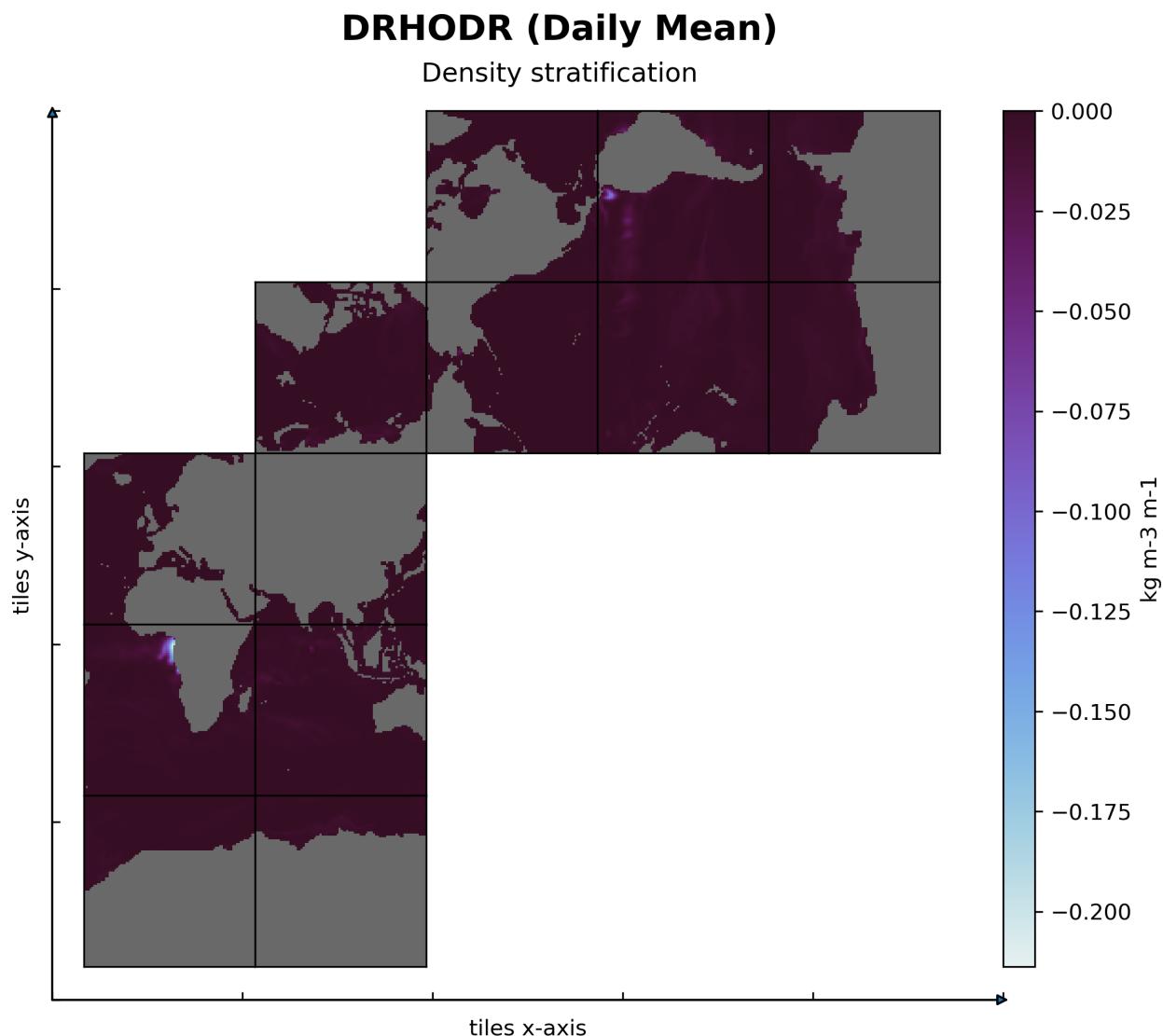
**Table 19.77: Variables in the dataset OCEAN\_DENS\_STRAT\_PRESS**

Dataset:	OCEAN_DENS_STRAT_PRESS
Field:	RHOAnoma
Field:	DRHODR
Field:	PHIHYD
Field:	PHIHYDcR

### 19.14.1 Native Variable DRHODR

Table 19.78: CDL description of OCEAN\_DENS\_STRAT\_PRESS's DRHODR variable

Storage Type	Variable Name	Description	Unit
float32	DRHODR	Density stratification	kg m <sup>-3</sup> m <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 88: Dataset: OCEAN\_DENS\_STRAT\_PRESS Variable: DRHODR**

### 19.14.2 Native Variable PHIHYD

**Table 19.79: CDL description of OCEAN\_DENS\_STRAT\_PRESS's PHIHYD variable**

Storage Type	Variable Name	Description	Unit
float32	PHIHYD	Ocean hydrostatic pressure anomaly	m2 s-2
<b>CDL Description</b>			
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			
<b>Comments</b>			
PHIHYD = $p(k) / \rho_0 g z^*(k,t)$ , where $p$ = hydrostatic ocean pressure at depth level $k$ , $\rho_0$ = reference density (1029 kg m <sup>-3</sup> ), $g$ is acceleration due to gravity (9.81 m s <sup>-2</sup> ), and $z^*(k,t)$ is model depth at level $k$ and time $t$ . Units: $p$ : [kg m <sup>-1</sup> s <sup>-2</sup> ], $\rho_0$ : [kg m <sup>-3</sup> ], $g$ : [m s <sup>-2</sup> ], $H(t)$ : [m]. Note: includes atmospheric pressure loading. Quantity referred to in some contexts as hydrostatic pressure anomaly. PHIBOT accounts for the model's time-varying grid cell thickness ( $z^*$ coordinate system). See PHIHYDcR for hydrostatic pressure potential anomaly calculated using time-invariant grid cell thicknesses. PHIHYD is NOT corrected for global mean steric sea level changes related to density changes in the Boussinesq volume-conserving model (Greatbatch correction, see sterGloH).			

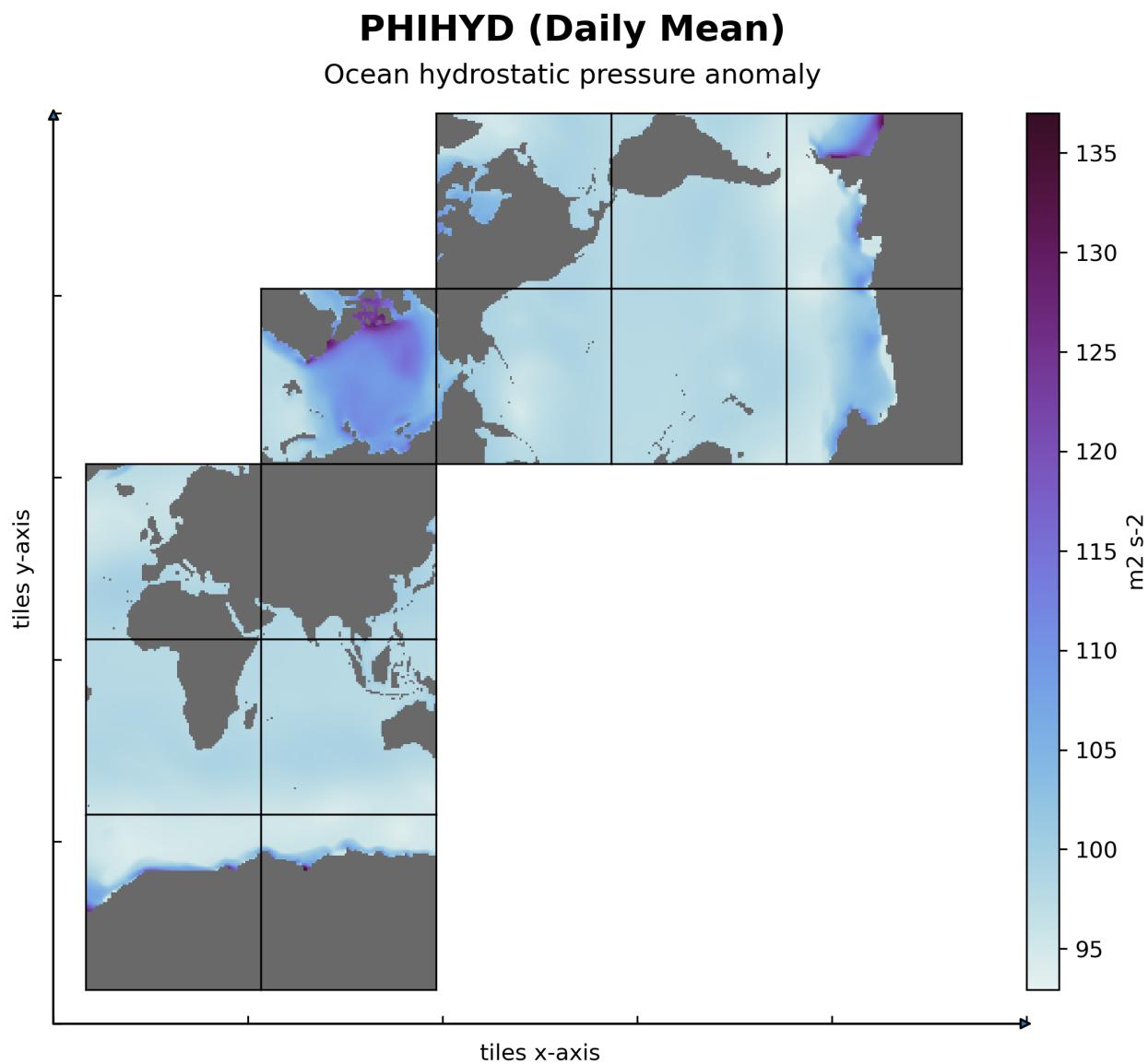


Figure 89: Dataset: OCEAN\_DENS\_STRAT\_PRESS Variable: PHIHYD

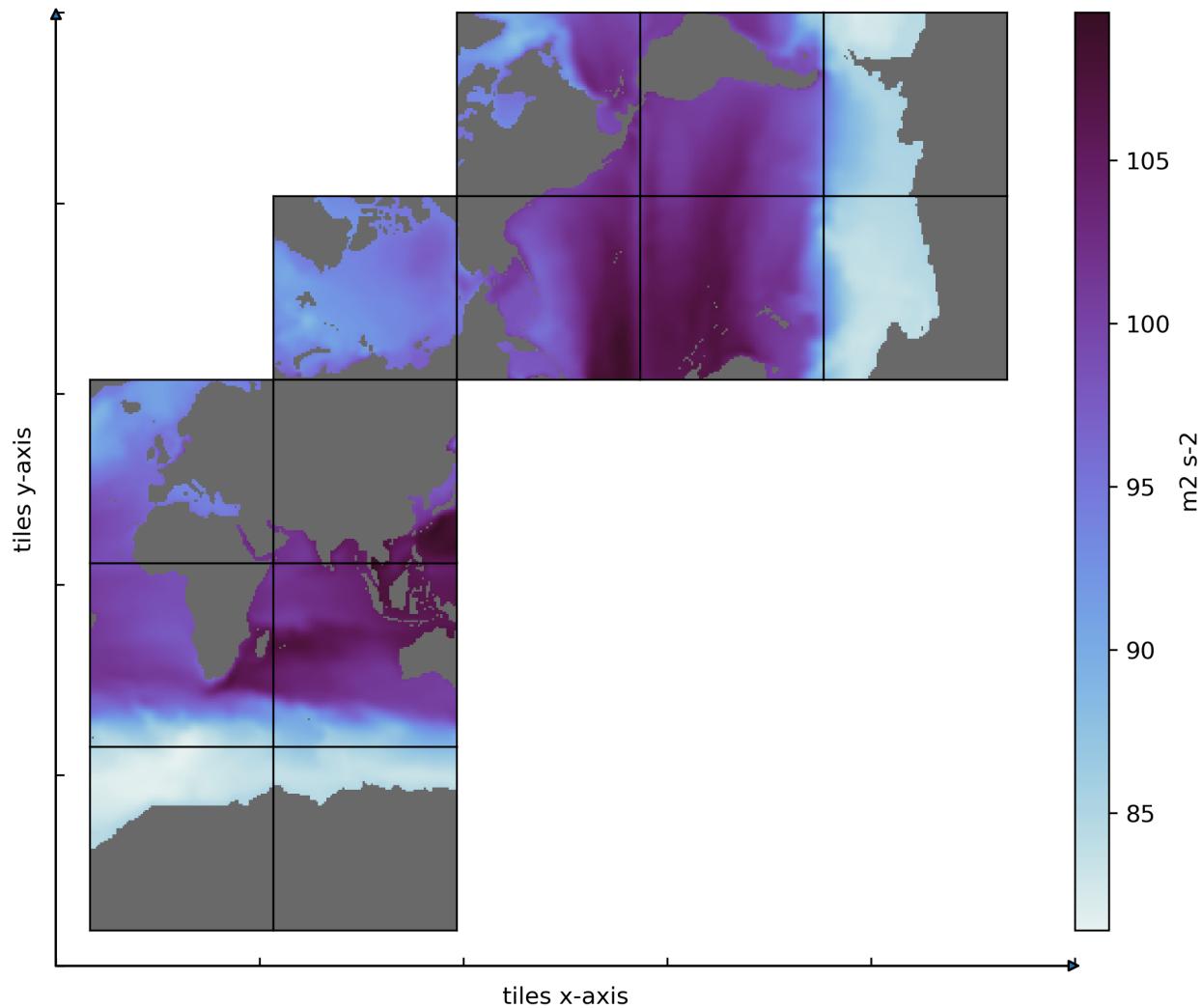
### 19.14.3 Native Variable PHIHYDcR

**Table 19.80: CDL description of OCEAN\_DENS\_STRAT\_PRESS's PHIHYDcR variable**

Storage Type	Variable Name	Description	Unit
float32	PHIHYDcR	Ocean hydrostatic pressure anomaly at constant depths	m2 s-2
<b>CDL Description</b>			
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			
<b>Comments</b>			
PHIHYD = $p(k) / \rho_{\text{Const}} - g z(k,t)$ , where $p$ = hydrostatic ocean pressure at depth level $k$ , $\rho_{\text{Const}}$ = reference density (1029 kg m <sup>-3</sup> ), $g$ is acceleration due to gravity (9.81 m s <sup>-2</sup> ), and $z(k,t)$ is fixed model depth at level $k$ . Units: $p$ : [kg m <sup>-1</sup> s <sup>-2</sup> ], $\rho_{\text{Const}}$ : [kg m <sup>-3</sup> ], $g$ : [m s <sup>-2</sup> ], $H(t)$ : [m]. Note: includes atmospheric pressure loading. Quantity referred to in some contexts as hydrostatic pressure potential anomaly. PHIHYDcR is calculated with respect to the model's initial, time-invariant grid cell thicknesses. See PHIHYD for hydrostatic pressure anomaly calculated using model's time-variable grid cell thicknesses ( $z^*$ coordinate system). PHIHYDcR is NOT corrected for global mean steric sea level changes related to density changes in the Boussinesq volume-conserving model (Greatbatch correction, see sterGloH).			

## PHIHYDcR (Daily Mean)

Ocean hydrostatic pressure anomaly at constant depths



Example file 2017-12-29,  
OCEAN\_DENS\_STRAT\_PRESS\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

Figure 90: Dataset: OCEAN\_DENS\_STRAT\_PRESS Variable: PHIHYDcR

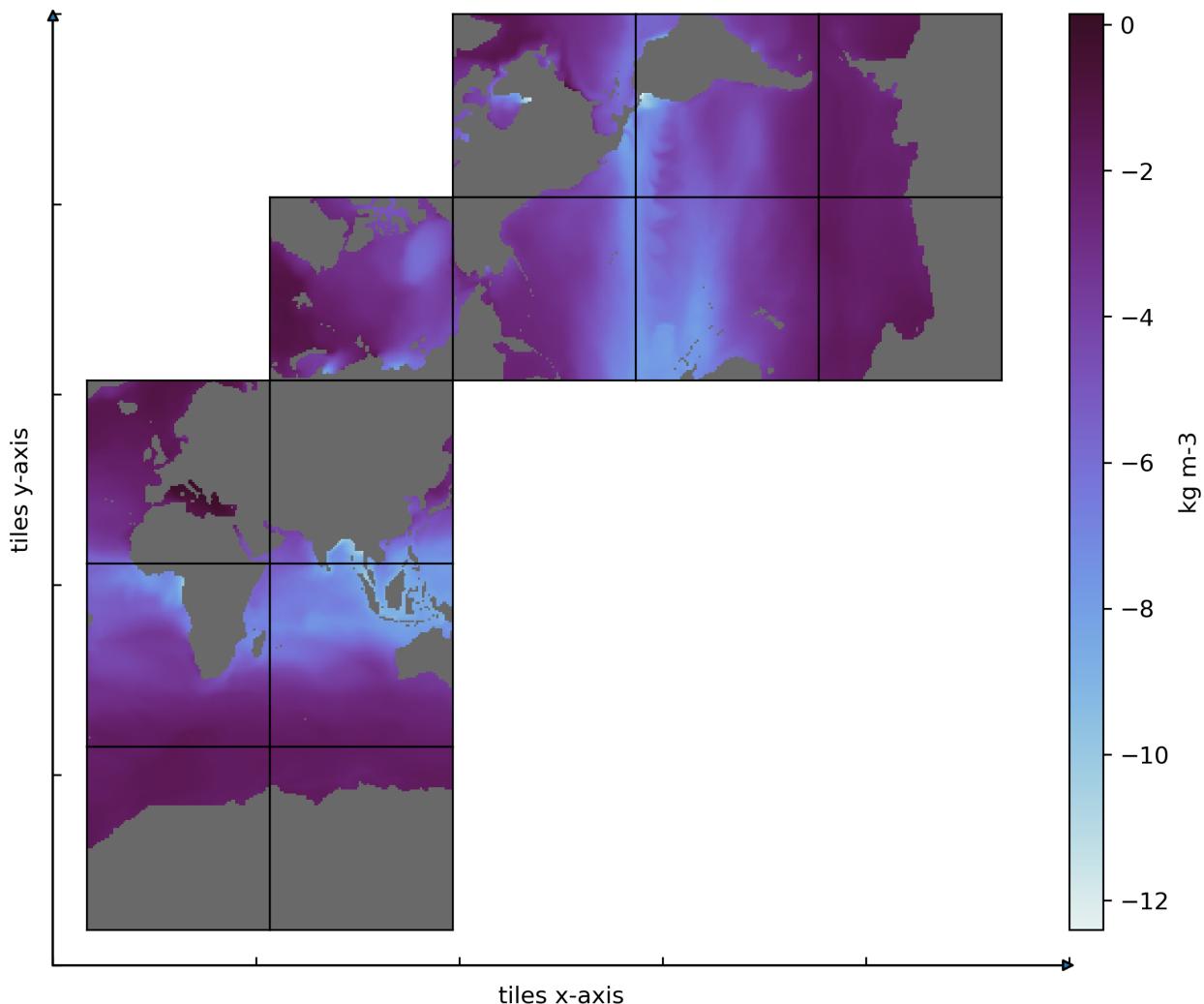
#### 19.14.4 Native Variable RHOAnoma

Table 19.81: CDL description of OCEAN\_DENS\_STRAT\_PRESS's RHOAnoma variable

Storage Type	Variable Name	Description	Unit
float32	RHOAnoma	In-situ seawater density anomaly	kg m-3
<b>CDL Description</b>			
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			
<b>Comments</b>			
In-situ seawater density anomaly relative to the reference density, rhoConst. rhoConst = 1029 kg m-3			

## RHOAnoma (Daily Mean)

In-situ seawater density anomaly



Example file 2017-12-29,  
OCEAN\_DENS\_STRAT\_PRESS\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

Figure 91: Dataset: OCEAN\_DENS\_STRAT\_PRESS Variable: RHOAnoma

## 19.15 Native NetCDF OCEAN\_MIXED\_LAYER\_DEPTH

**Table 19.82: Variables in the dataset OCEAN\_MIXED\_LAYER\_DEPTH**

Dataset:	OCEAN_MIXED_LAYER_DEPTH
Field:	MXLDEPTH

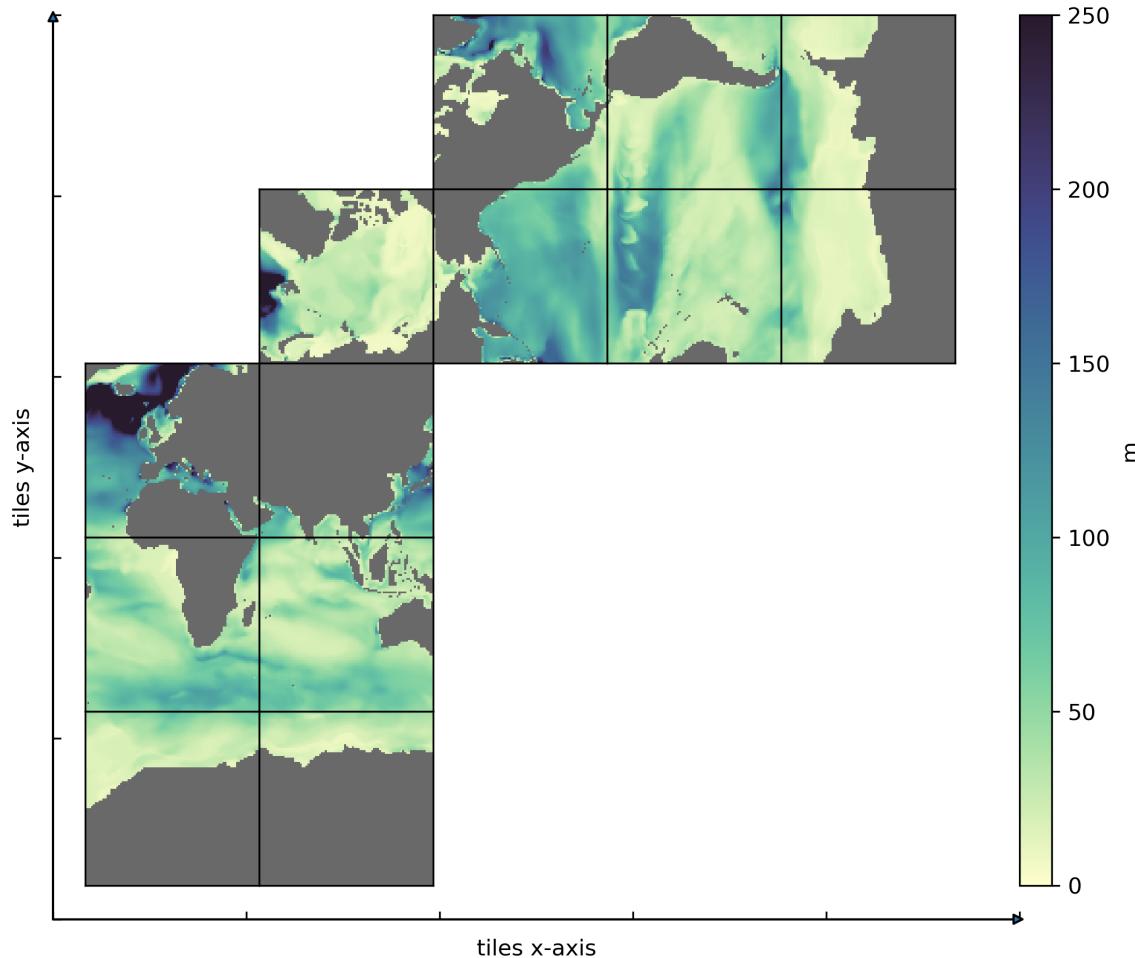
### 19.15.1 Native Variable MXLDEPTH

Table 19.83: CDL description of OCEAN\_MIXED\_LAYER\_DEPTH's MXLDEPTH variable

Storage Type	Variable Name	Description	Unit
float32	MXLDEPTH	Mixed-layer depth diagnosed using the temperature difference criterion of Kara et al., 2000	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
Mixed-layer depth as determined by the depth where waters are first 0.8 degrees Celsius colder than the surface. See Kara et al. (JGR, 2000). . Note: the Kara et al. criterion may not be appropriate for some applications. If needed, mixed layer depth can be calculated using different criteria. See vertical density stratification (DRHODR) and density anomaly (RHOAnoma).			

## MXLDEPTH (Daily Mean)

Mixed-layer depth diagnosed using the temperature difference criterion of Kara et al., 2000



**Figure 92: Dataset: OCEAN\_MIXED\_LAYER\_DEPTH Variable: MXLDEPTH**

## 19.16 Native NetCDF OCEAN\_TEMPERATURE\_SALINITY

**Table 19.84: Variables in the dataset OCEAN\_TEMPERATURE\_SALINITY**

Dataset:	OCEAN_TEMPERATURE_SALINITY
Field:	THETA
Field:	SALT

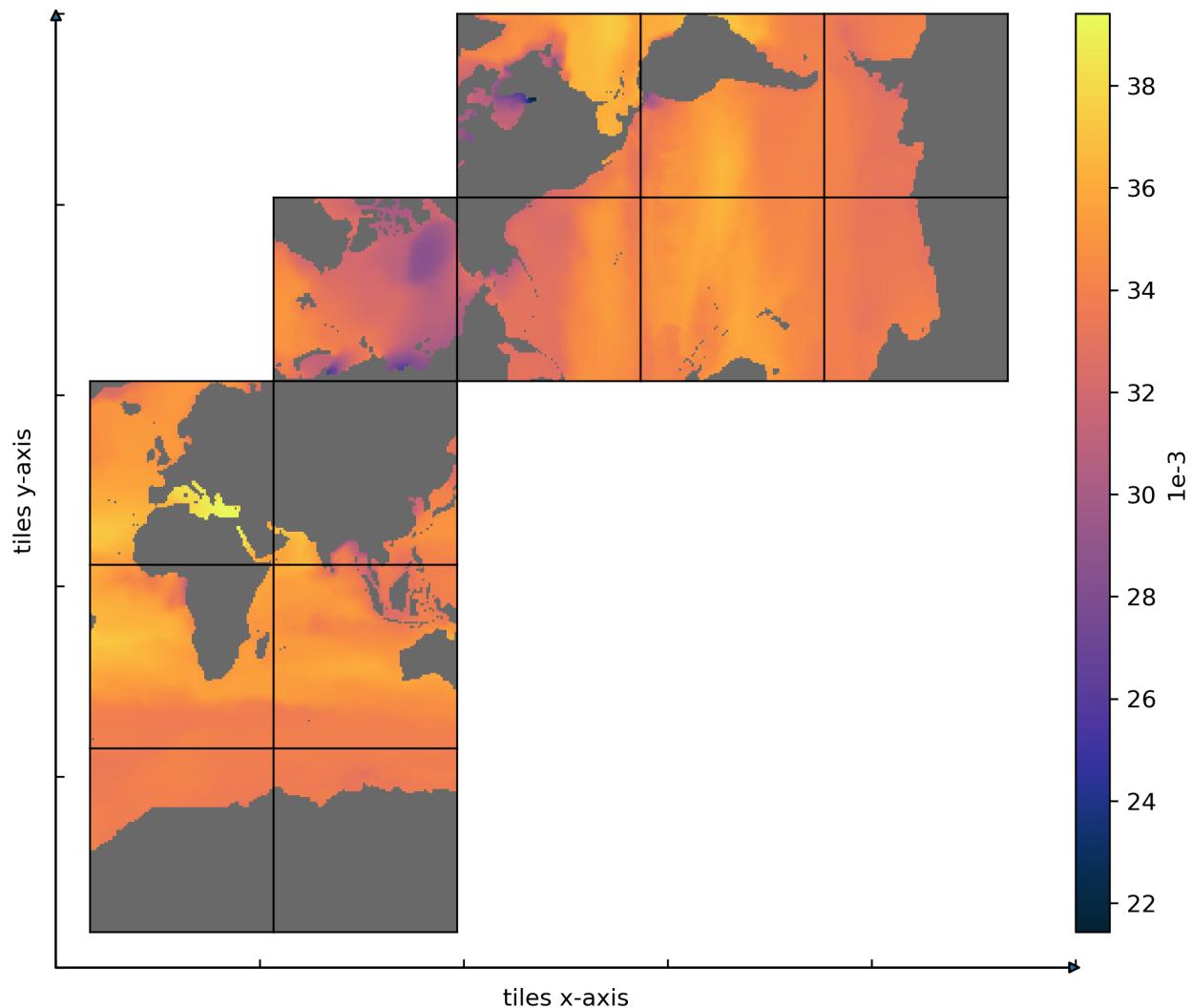
### 19.16.1 Native Variable SALT

Table 19.85: CDL description of OCEAN\_TEMPERATURE\_SALINITY's SALT variable

Storage Type	Variable Name	Description	Unit
float32	SALT	Salinity	1e-3
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 <a href="https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html">https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html</a>			

## SALT (Daily Mean)

Salinity



Example file 2017-12-29,  
OCEAN\_TEMPERATURE\_SALINITY\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

Figure 93: Dataset: OCEAN\_TEMPERATURE\_SALINITY Variable: SALT

## 19.16.2 Native Variable THETA

Table 19.86: CDL description of OCEAN\_TEMPERATURE\_SALINITY's THETA variable

Storage Type	Variable Name	Description	Unit
float32	THETA	Potential temperature	degree_C
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 $\$p_0 = -g h_o \{O\} z \$$ .			

## THETA (Daily Mean)

Potential temperature

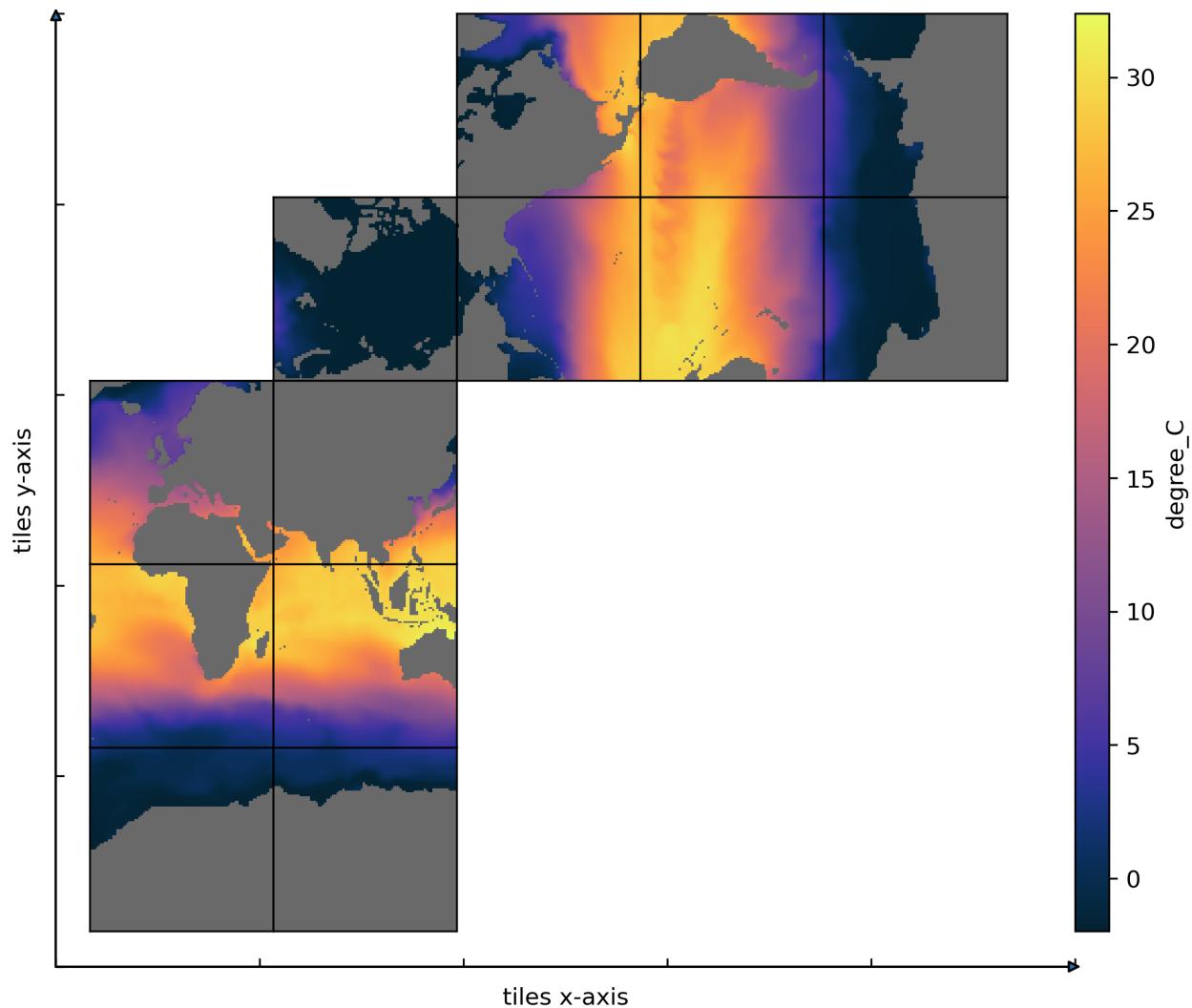


Figure 94: Dataset: OCEAN\_TEMPERATURE\_SALINITY Variable: THETA

## 19.17 Native NetCDF OCEAN\_VELOCITY

Table 19.87: Variables in the dataset OCEAN\_VELOCITY

Dataset:	OCEAN_VELOCITY
Field:	UVEL
Field:	VVEL
Field:	WVEL

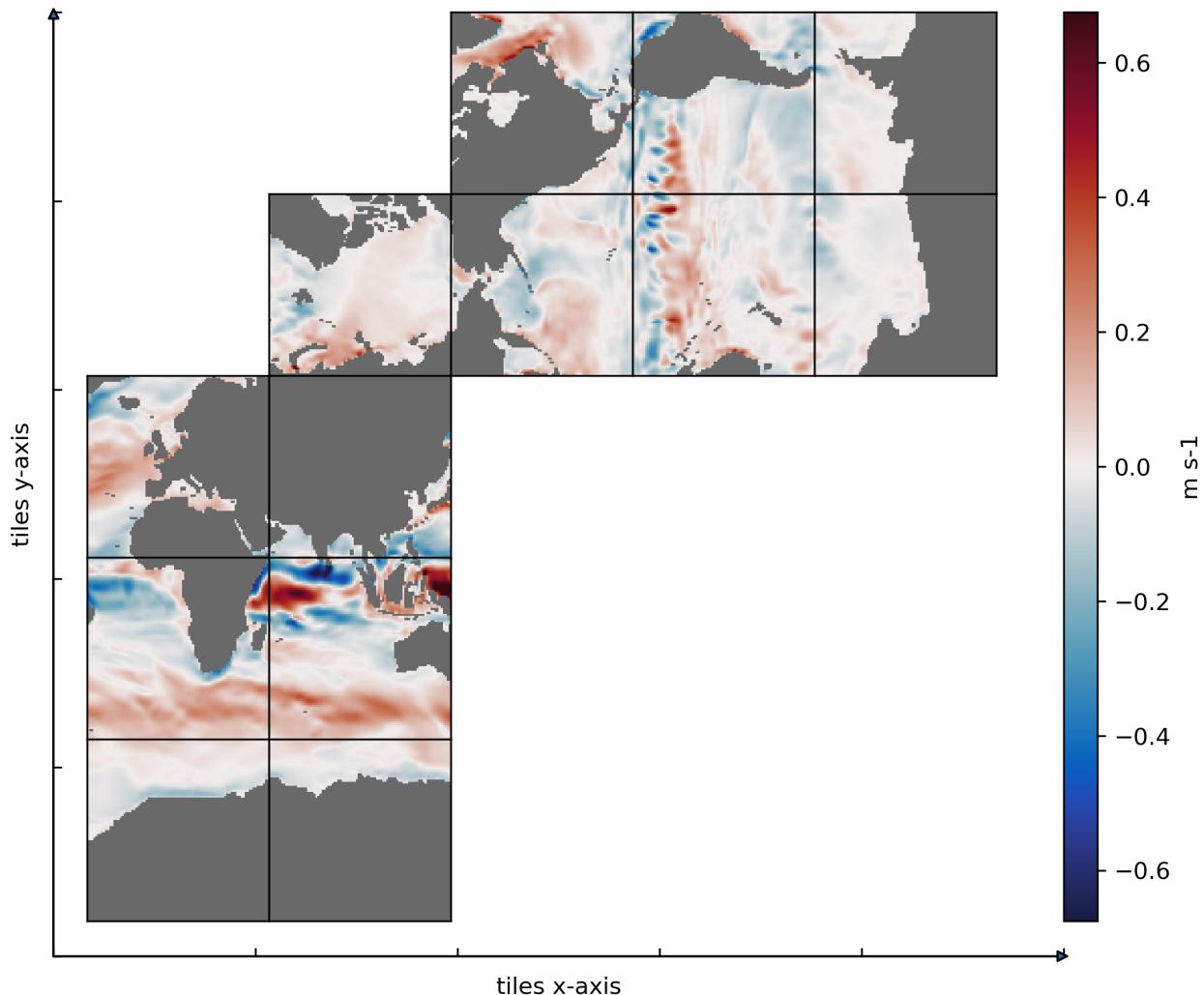
### 19.17.1 Native Variable UVEL

**Table 19.88: CDL description of OCEAN\_VELOCITY's UVEL variable**

Storage Type	Variable Name	Description	Unit
float32	UVEL	Horizontal velocity in the model +x direction	m s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

## UVEL (Daily Mean)

Horizontal velocity in the model +x direction



Example file 2017-12-29,  
OCEAN\_VELOCITY\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

Figure 95: Dataset: OCEAN\_VELOCITY Variable: UVEL

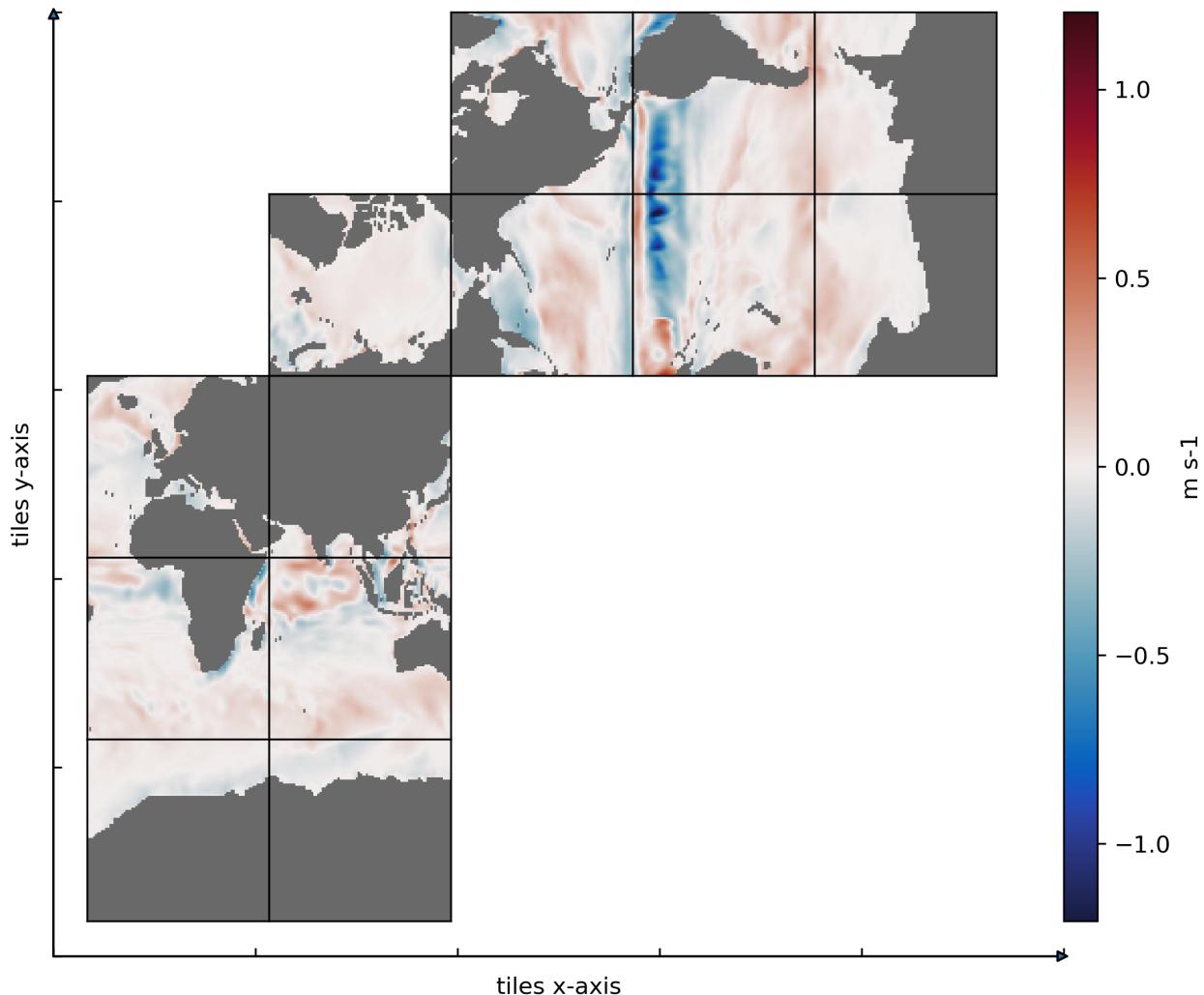
### 19.17.2 Native Variable VVEL

**Table 19.89: CDL description of OCEAN\_VELOCITY's VVEL variable**

Storage Type	Variable Name	Description	Unit
float32	VVEL	Horizontal velocity in the model +y direction	m s-1
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

## VVEL (Daily Mean)

Horizontal velocity in the model +y direction



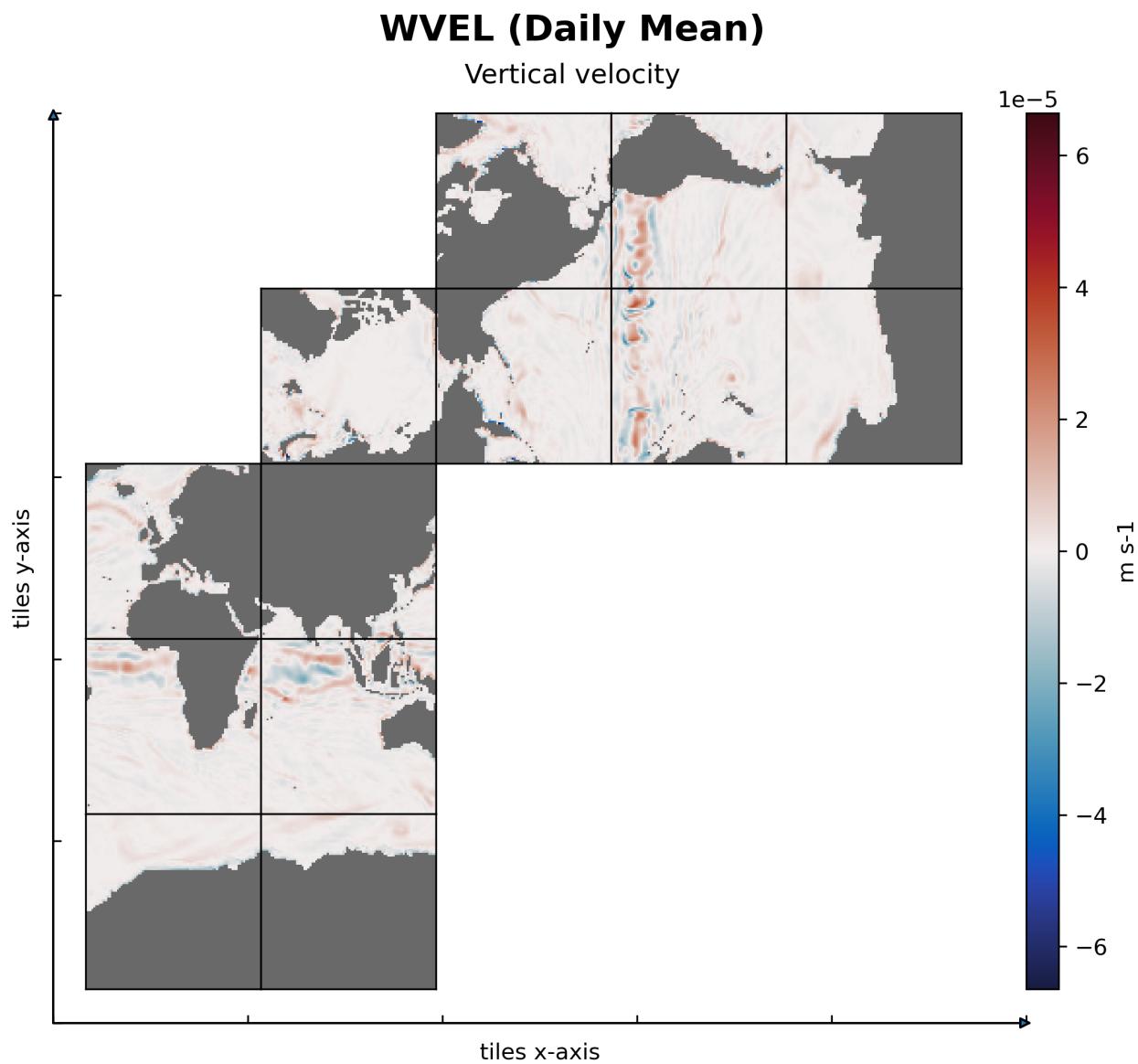
Example file 2017-12-29,  
OCEAN\_VELOCITY\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

Figure 96: Dataset: OCEAN\_VELOCITY Variable: VVEL

### 19.17.3 Native Variable WVEL

Table 19.90: CDL description of OCEAN\_VELOCITY's WVEL variable

Storage Type	Variable Name	Description	Unit
float32	WVEL	Vertical velocity	m s <sup>-1</sup>
<b>CDL Description</b>			
float32 WVEL(time, k_l, tile, j, i) WVEL:_FillValue = 9.96921e+36 WVEL:long_name = Vertical velocity WVEL:units = m s: 1 WVEL:coverage_content_type = modelResult WVEL:direction = >0 decreases volume WVEL:standard_name = upward_sea_water_velocity WVEL:coordinates = Zl YC time XC WVEL:valid_min = : 0.0023150660563260317 WVEL:valid_max = 0.0016380994347855449			
<b>Comments</b>			
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.			



Example file 2017-12-29,  
OCEAN\_VELOCITY\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

**Figure 97: Dataset: OCEAN\_VELOCITY Variable: WVEL**

## 19.18 Native NetCDF SEA\_ICE\_CONC\_THICKNESS

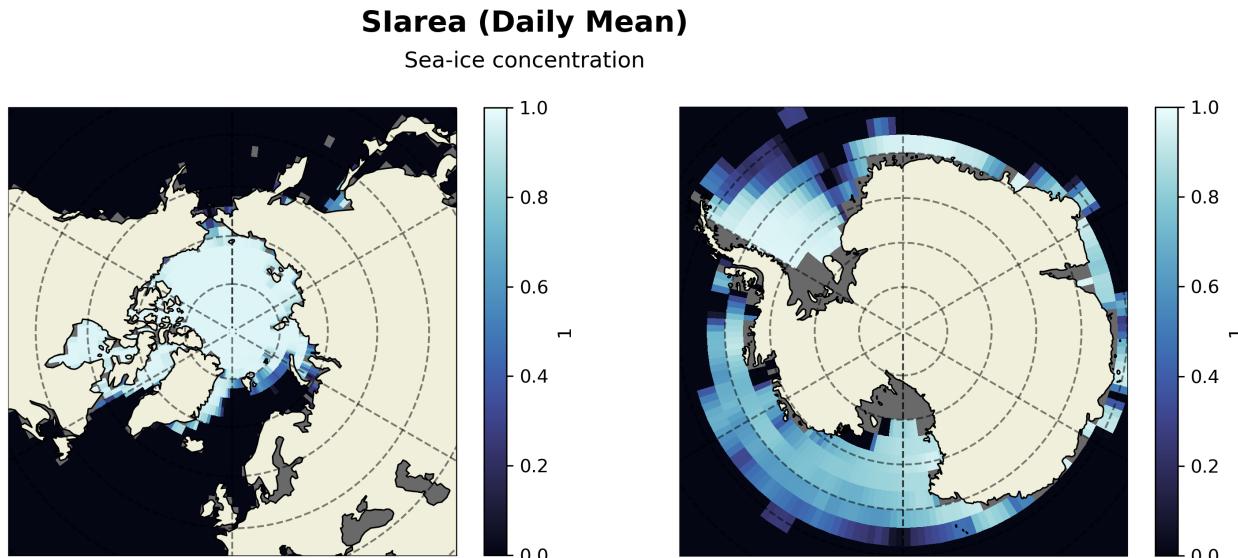
Table 19.91: Variables in the dataset SEA\_ICE\_CONC\_THICKNESS

Dataset:	SEA_ICE_CONC_THICKNESS
Field:	Slarea
Field:	Slheff
Field:	Slhsnow
Field:	slceLoad

### 19.18.1 Native Variable Slarea

**Table 19.92: CDL description of SEA\_ICE\_CONC\_THICKNESS's Slarea variable**

Storage Type	Variable Name	Description	Unit
float32	Slarea	Sea-ice concentration	1
<b>CDL Description</b>			
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			
<b>Comments</b>			
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. <a href="https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html">https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html</a> . 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. <a href="https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html">https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html</a>			

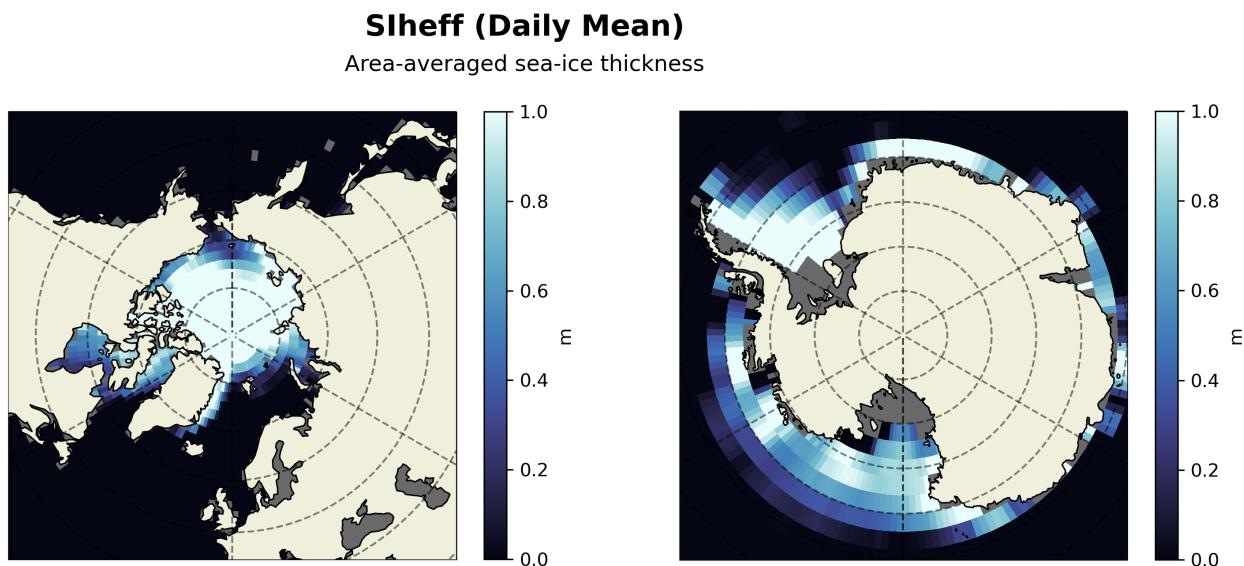


**Figure 98: Dataset: SEA\_ICE\_CONC\_THICKNESS Variable: Slarea**

### 19.18.2 Native Variable Slheff

**Table 19.93: CDL description of SEA\_ICE\_CONC\_THICKNESS's Slheff variable**

Storage Type	Variable Name	Description	Unit
float32	Slheff	Area-averaged sea-ice thickness	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 Slheff/Slarea			

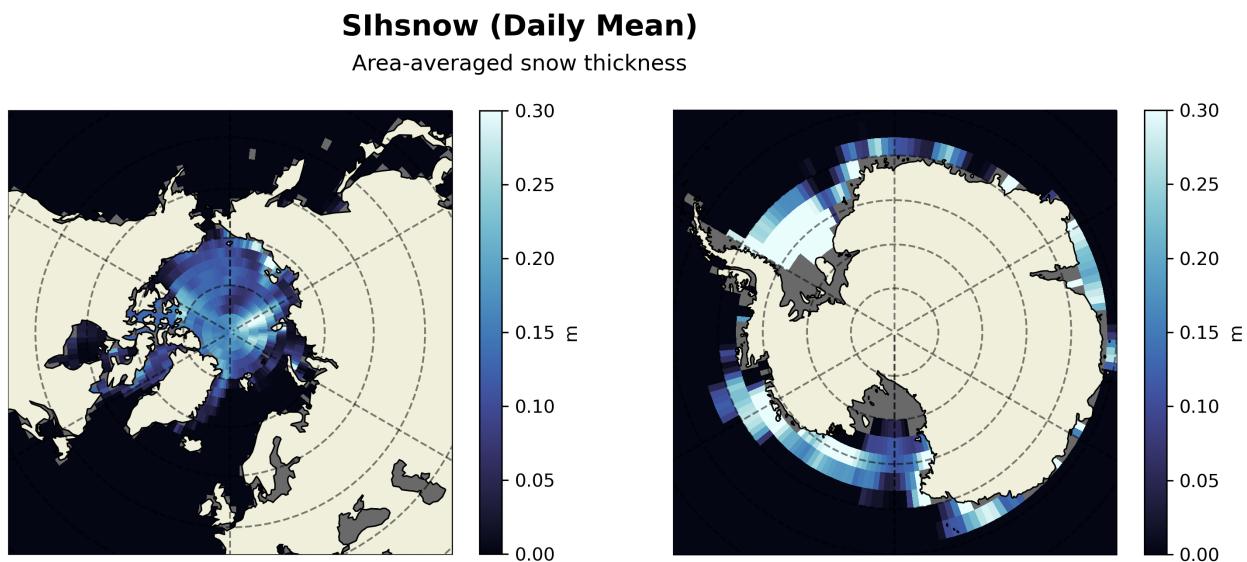


**Figure 99: Dataset: SEA\_ICE\_CONC\_THICKNESS Variable: Slheff**

### 19.18.3 Native Variable Slhsnow

**Table 19.94: CDL description of SEA\_ICE\_CONC\_THICKNESS's Slhsnow variable**

Storage Type	Variable Name	Description	Unit
float32	Slhsnow	Area-averaged snow thickness	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 Slhsnow/Slarea			

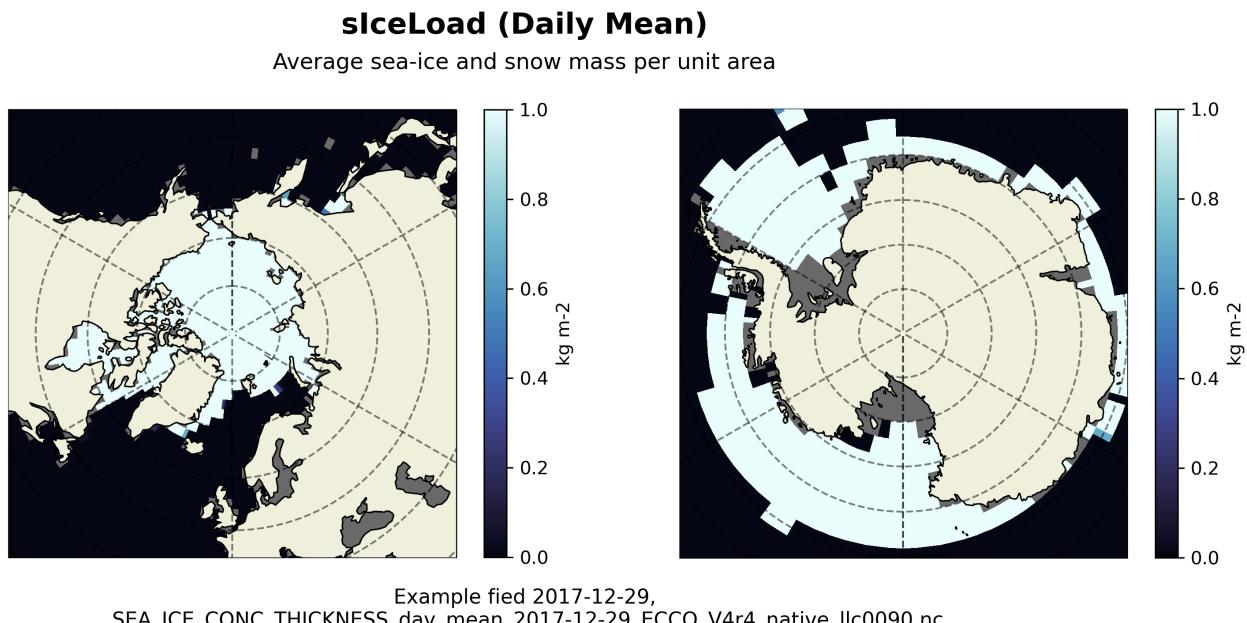


**Figure 100: Dataset: SEA\_ICE\_CONC\_THICKNESS Variable: Slhsnow**

#### 19.18.4 Native Variable slceLoad

**Table 19.95: CDL description of SEA\_ICE\_CONC\_THICKNESS's slceLoad variable**

Storage Type	Variable Name	Description	Unit
float32	slceLoad	Average sea-ice and snow mass per unit area	kg m <sup>-2</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
Total mass of sea-ice and snow in a model grid cell averaged over model grid cell area. Note: slceLoad is used to correct model sea level anomaly, ETAN, to calculate dynamic sea surface height, SSH, and sea surface height without the inverted barometer (IB correction), SSHNOIBC. In the model, sea-ice is treated as floating above the sea level with ETAN tracing the location of the ocean-ice interface. Consequently, sea-ice growth in the model lowers ETAN and sea-ice melting raises ETAN. Dynamic sea surface height is obtained by correcting ETAN by the weight of ice and snow directly above following Archimedes' principle.			



**Figure 101: Dataset: SEA\_ICE\_CONC\_THICKNESS Variable: slceLoad**

## 19.19 Native NetCDF SEA\_ICE\_HORIZ\_VOLUME\_FLUX

Table 19.96: Variables in the dataset SEA\_ICE\_HORIZ\_VOLUME\_FLUX

Dataset:	SEA_ICE_HORIZ_VOLUME_FLUX
Field:	ADVxHEFF
Field:	ADVyHEFF
Field:	ADVxSNOW
Field:	ADVySNOW
Field:	DFxESENOW
Field:	DFyEHEFF
Field:	DFxEHEFF
Field:	DFyESNOW

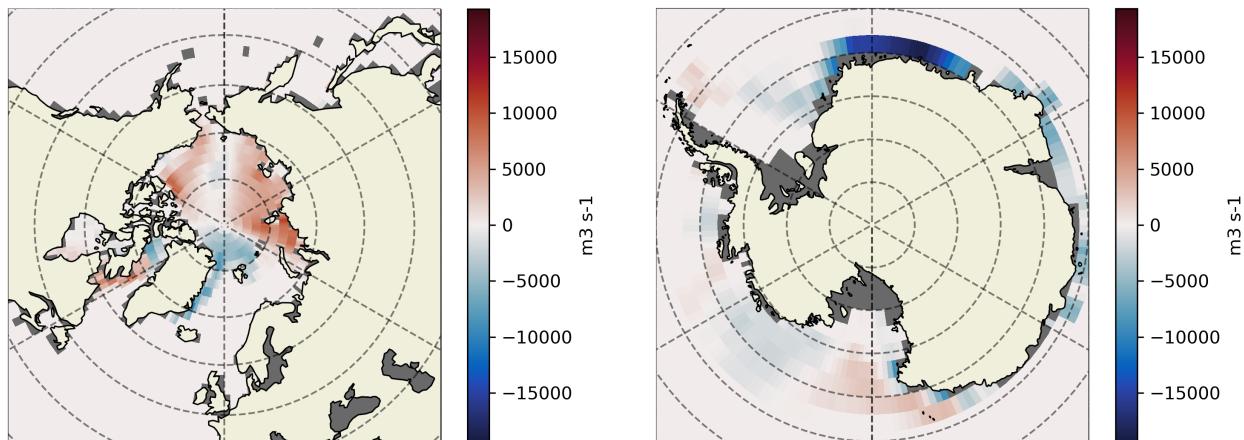
### 19.19.1 Native Variable ADVxHEFF

**Table 19.97: CDL description of SEA\_ICE\_HORIZ\_VOLUME\_FLUX's ADVxHEFF variable**

Storage Type	Variable Name	Description	Unit
float32	ADVxHEFF	Lateral advective flux of sea-ice thickness in the model +x direction	m <sup>3</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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 = m <sup>3</sup> s <sup>-1</sup> ADVxHEFF: mate = ADVyHEFF ADVxHEFF: coverage_content_type = modelResult ADVxHEFF: direction = >0 increases mean sea: ice thickness (HEFF) ADVxHEFF: coordinates = time ADVxHEFF: valid_min = : 151912.28125 ADVxHEFF: valid_max = 107688.7578125			
<b>Comments</b>			
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.			

### ADVxHEFF (Daily Mean)

Lateral advective flux of sea-ice thickness in the model +x direction



**Figure 102: Dataset: SEA\_ICE\_HORIZ\_VOLUME\_FLUX Variable: ADVxHEFF**

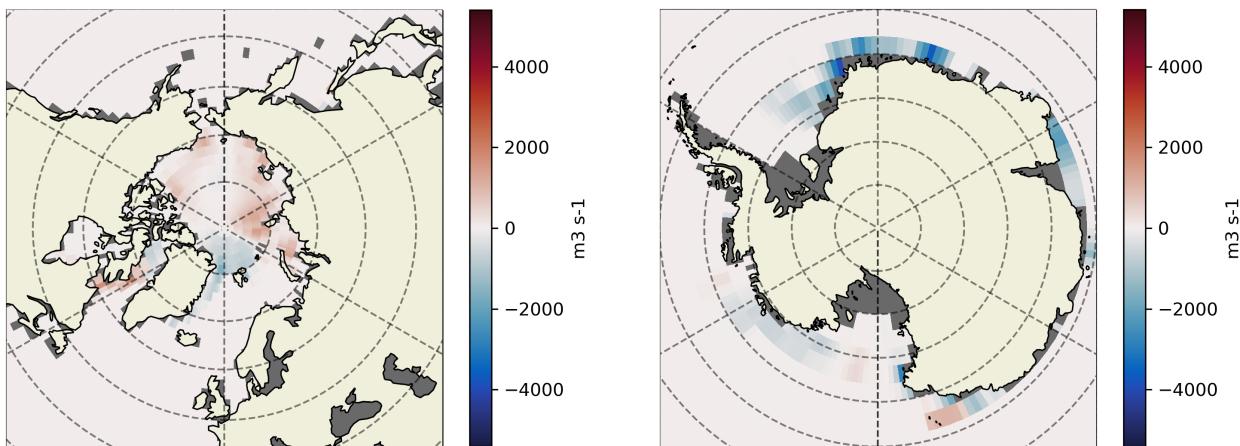
### 19.19.2 Native Variable ADVxSNOW

**Table 19.98: CDL description of SEA\_ICE\_HORIZ\_VOLUME\_FLUX's ADVxSNOW variable**

Storage Type	Variable Name	Description	Unit
float32	ADVxSNOW	Lateral advective flux of snow thickness in the model +x direction	m3 s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

### ADVxSNOW (Daily Mean)

Lateral advective flux of snow thickness in the model +x direction



Example file 2017-12-29,  
SEA\_ICE\_HORIZ\_VOLUME\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

**Figure 103: Dataset: SEA\_ICE\_HORIZ\_VOLUME\_FLUX Variable: ADVxSNOW**

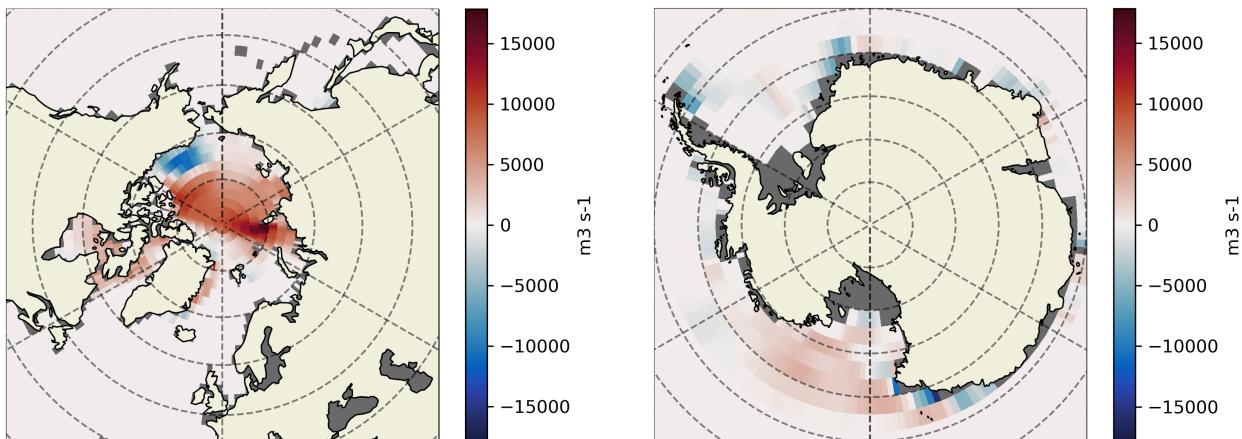
### 19.19.3 Native Variable ADVyHEFF

**Table 19.99: CDL description of SEA\_ICE\_HORIZ\_VOLUME\_FLUX's ADVyHEFF variable**

Storage Type	Variable Name	Description	Unit
float32	ADVyHEFF	Lateral advective flux of sea-ice thickness in the model +y direction	m3 s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

### ADVyHEFF (Daily Mean)

Lateral advective flux of sea-ice thickness in the model +y direction



**Figure 104: Dataset: SEA\_ICE\_HORIZ\_VOLUME\_FLUX Variable: ADVyHEFF**

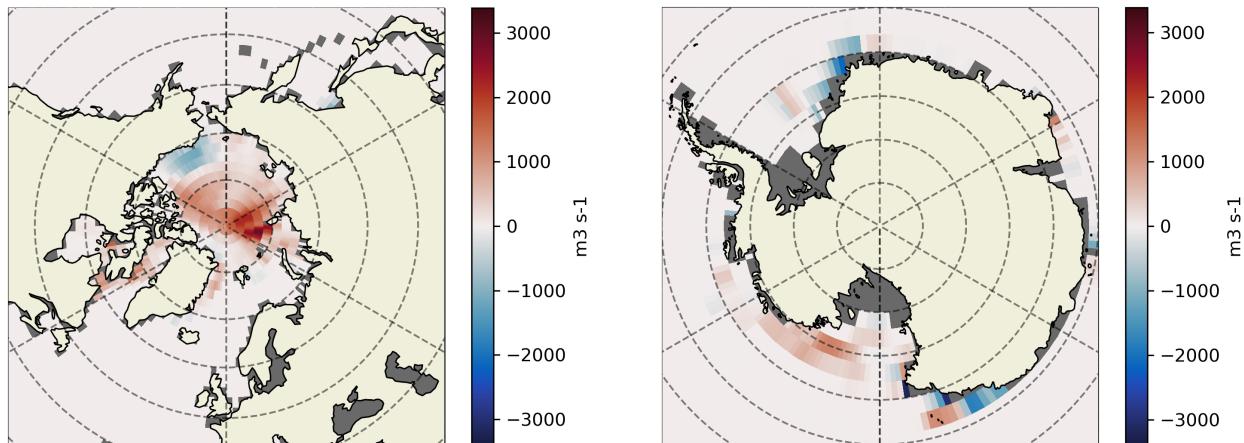
#### 19.19.4 Native Variable ADVySNOW

Table 19.100: CDL description of SEA\_ICE\_HORIZ\_VOLUME\_FLUX's ADVySNOW variable

Storage Type	Variable Name	Description	Unit
float32	ADVySNOW	Lateral advective flux of snow thickness in the model +y direction	m3 s-1
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

### ADVySNOW (Daily Mean)

Lateral advective flux of snow thickness in the model +y direction



Example file 2017-12-29,  
SEA\_ICE\_HORIZ\_VOLUME\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

Figure 105: Dataset: SEA\_ICE\_HORIZ\_VOLUME\_FLUX Variable: ADVySNOW

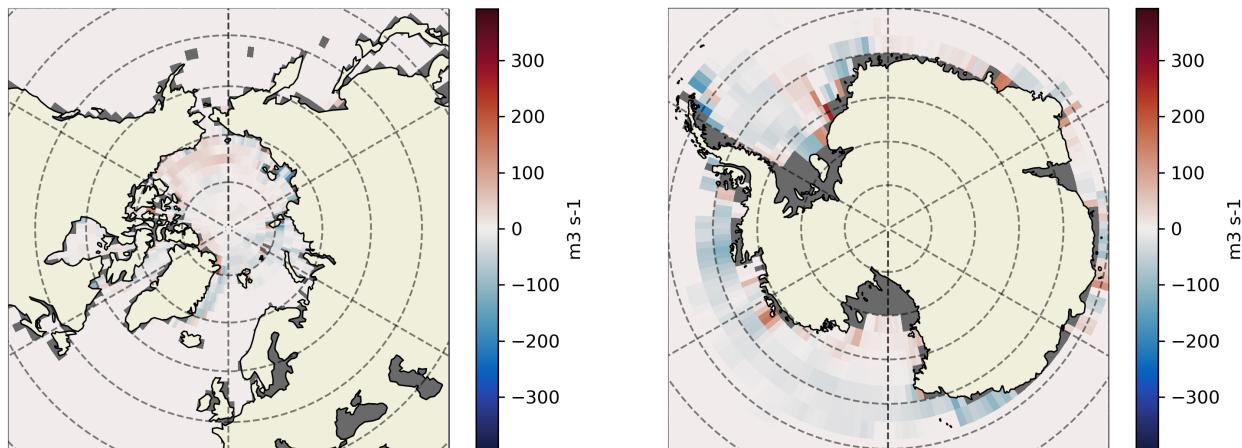
### 19.19.5 Native Variable DFxEHEFF

**Table 19.101: CDL description of SEA\_ICE\_HORIZ\_VOLUME\_FLUX's DFxEHEFF variable**

Storage Type	Variable Name	Description	Unit
float32	DFxEHEFF	Lateral diffusive flux of sea-ice thickness in the model +x direction.	m <sup>3</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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 = m <sup>3</sup> s <sup>-1</sup> 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			
<b>Comments</b>			
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.			

### DFxEHEFF (Daily Mean)

Lateral diffusive flux of sea-ice thickness in the model +x direction.



Example file 2017-12-29,  
SEA\_ICE\_HORIZ\_VOLUME\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

**Figure 106: Dataset: SEA\_ICE\_HORIZ\_VOLUME\_FLUX Variable: DFxEHEFF**

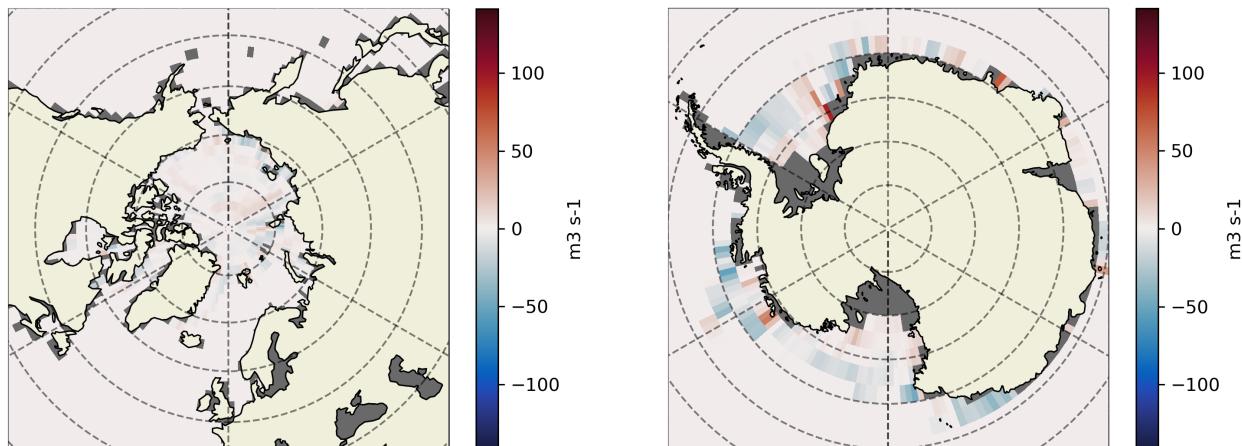
### 19.19.6 Native Variable DFxESNOW

**Table 19.102: CDL description of SEA\_ICE\_HORIZ\_VOLUME\_FLUX's DFxESNOW variable**

Storage Type	Variable Name	Description	Unit
float32	DFxESNOW	Lateral diffusive flux of snow thickness in the model +x direction	m3 s <sup>-1</sup>
<b>CDL Description</b>			
float32 DFxESNOW(time, tile, j, i_g) DFxESNOW: _FillValue = 9.96921e+36 DFxESNOW: long_name = Lateral diffusive flux of snow thickness in the model +x direction DFxESNOW: units = m3 s: 1 DFxESNOW: mate = DFyESNOW DFxESNOW: coverage_content_type = modelResult DFxESNOW: direction = >0 increases mean snow thickness (HSNOW) DFxESNOW: coordinates = time DFxESNOW: valid_min = : 448.1134948730469 DFxESNOW: valid_max = 440.94427490234375			
<b>Comments</b>			
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.			

### DFxESNOW (Daily Mean)

Lateral diffusive flux of snow thickness in the model +x direction



Example file 2017-12-29,  
SEA\_ICE\_HORIZ\_VOLUME\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

**Figure 107: Dataset: SEA\_ICE\_HORIZ\_VOLUME\_FLUX Variable: DFxESNOW**

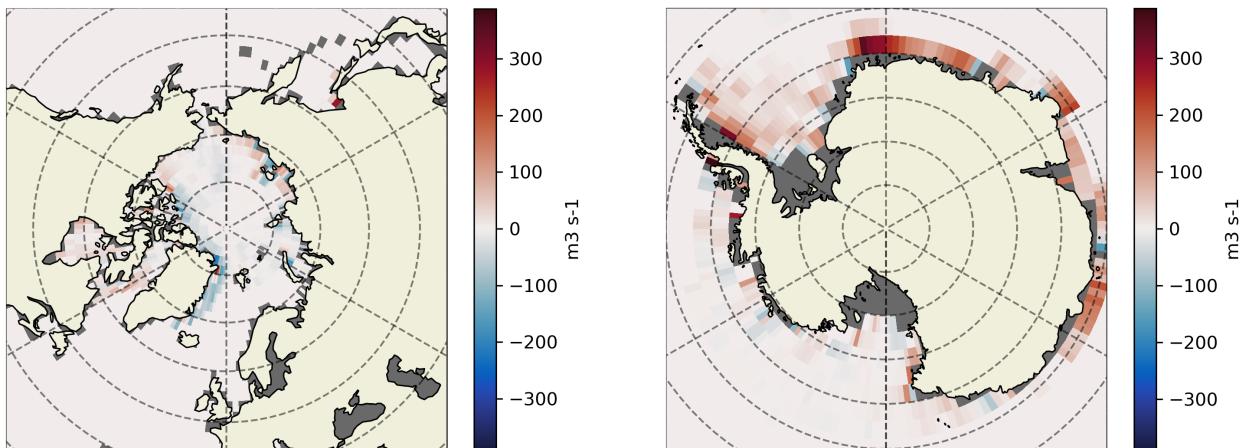
### 19.19.7 Native Variable DFyEHEFF

**Table 19.103: CDL description of SEA\_ICE\_HORIZ\_VOLUME\_FLUX's DFyEHEFF variable**

Storage Type	Variable Name	Description	Unit
float32	DFyEHEFF	Lateral diffusive flux of sea-ice thickness in the model +y direction.	m3 s-1
<b>CDL Description</b>			
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			
<b>Comments</b>			
Lateral diffusive flux of grid cell mean sea-ice thickness (HEFF) in the +y direction through the 'v' face of the tracer cell on the native model grid. Note: in the Arakawa-C grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +DFyEHEFF(i,j_g) corresponds to +y fluxes through the 'V' face of the tracer cell at (i,j,k=0). Also, the model +y direction does not necessarily correspond to the geographical north-south direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.			

### DFyEHEFF (Daily Mean)

Lateral diffusive flux of sea-ice thickness in the model +y direction.



Example file 2017-12-29,  
SEA\_ICE\_HORIZ\_VOLUME\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

**Figure 108: Dataset: SEA\_ICE\_HORIZ\_VOLUME\_FLUX Variable: DFyEHEFF**

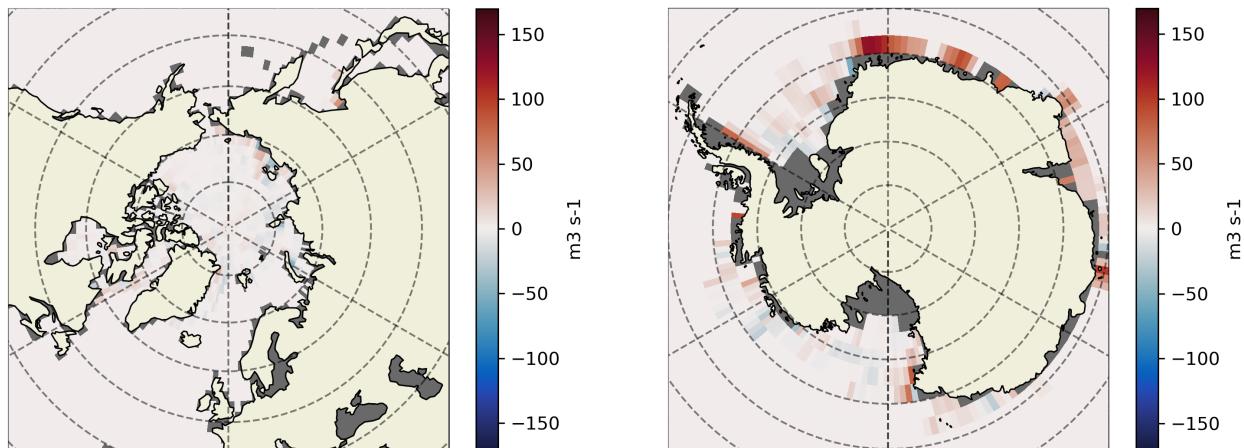
### 19.19.8 Native Variable DFyESNOW

**Table 19.104: CDL description of SEA\_ICE\_HORIZ\_VOLUME\_FLUX's DFyESNOW variable**

Storage Type	Variable Name	Description	Unit
float32	DFyESNOW	Lateral diffusive flux of snow thickness in the model +y direction	m3 s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

### DFyESNOW (Daily Mean)

Lateral diffusive flux of snow thickness in the model +y direction



Example file 2017-12-29,  
SEA\_ICE\_HORIZ\_VOLUME\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

**Figure 109: Dataset: SEA\_ICE\_HORIZ\_VOLUME\_FLUX Variable: DFyESNOW**

## 19.20 Native NetCDF SEA\_ICE\_SALT\_PLUME\_FLUX

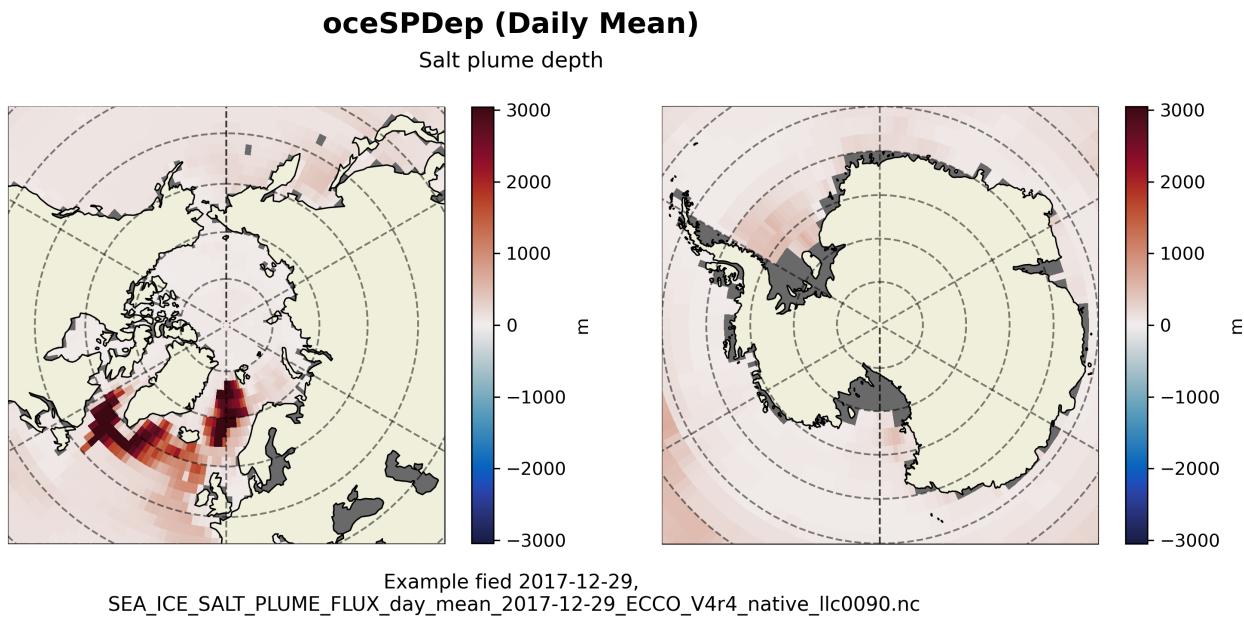
Table 19.105: Variables in the dataset SEA\_ICE\_SALT\_PLUME\_FLUX

Dataset:	SEA_ICE_SALT_PLUME_FLUX
Field:	oceSPflx
Field:	oceSPDep

### 19.20.1 Native Variable oceSPDep

**Table 19.106: CDL description of SEA\_ICE\_SALT\_PLUME\_FLUX's oceSPDep variable**

Storage Type	Variable Name	Description	Unit
float32	oceSPDep	Salt plume depth	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
Depth of parameterized salt plumes formed due to brine rejection during sea-ice formation.			

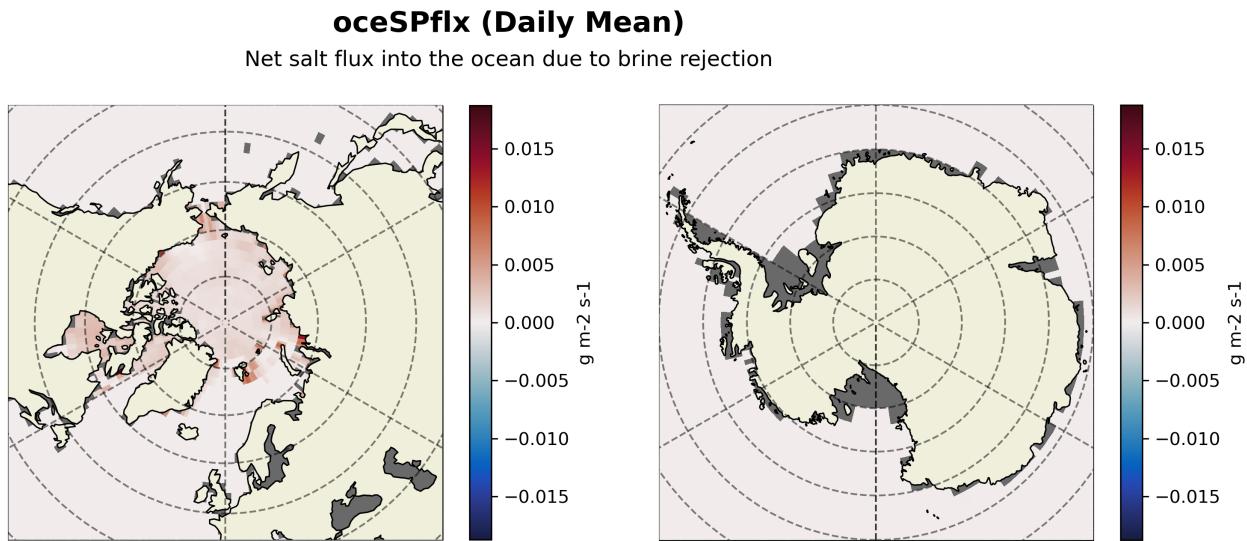


**Figure 110: Dataset: SEA\_ICE\_SALT\_PLUME\_FLUX Variable: oceSPDep**

### 19.20.2 Native Variable oceSPflx

**Table 19.107: CDL description of SEA\_ICE\_SALT\_PLUME\_FLUX's oceSPflx variable**

Storage Type	Variable Name	Description	Unit
float32	oceSPflx	Net salt flux into the ocean due to brine rejection	$\text{g m}^{-2} \text{s}^{-1}$
<b>CDL Description</b>			
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 =>O increases salinity (SALT) oceSPflx: coordinates = time YC XC oceSPflx: valid_min = 0.0 oceSPflx: valid_max = 0.058169759809970856			
<b>Comments</b>			
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 111: Dataset: SEA\_ICE\_SALT\_PLUME\_FLUX Variable: oceSPflx**

## 19.21 Native NetCDF SEA\_ICE\_VELOCITY

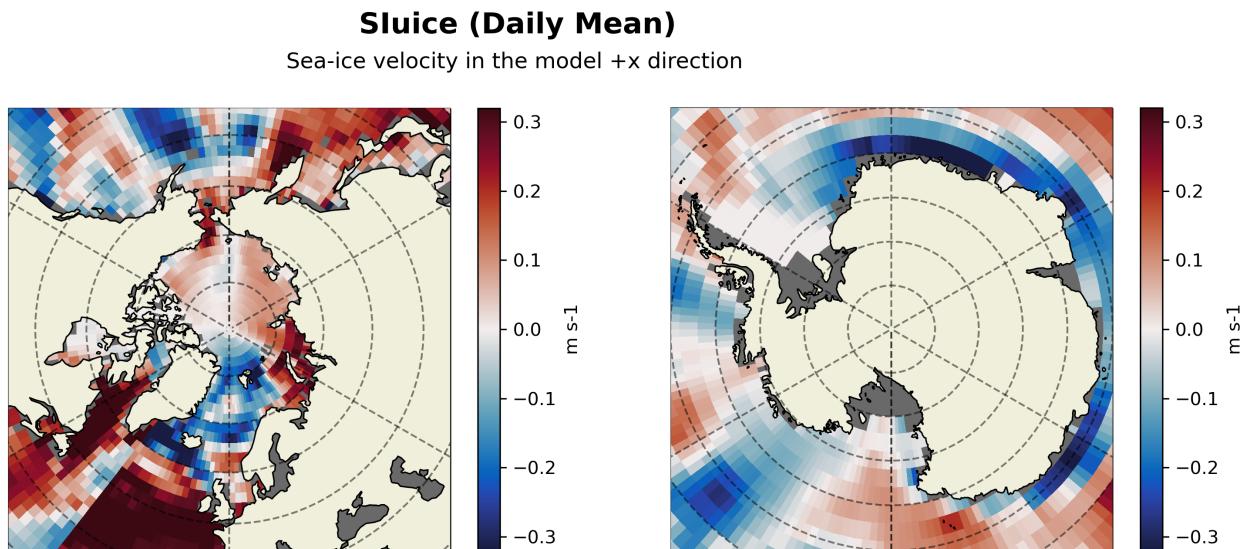
Table 19.108: Variables in the dataset SEA\_ICE\_VELOCITY

Dataset:	SEA_ICE_VELOCITY
Field:	Sluice
Field:	Slvice

### 19.21.1 Native Variable Sluice

**Table 19.109: CDL description of SEA\_ICE\_VELOCITY's Sluice variable**

Storage Type	Variable Name	Description	Unit
float32	Sluice	Sea-ice velocity in the model +x direction	m s <sup>-1</sup>
<b>CDL Description</b>			
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 = Slvce 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			
<b>Comments</b>			
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 +Sluice(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.			

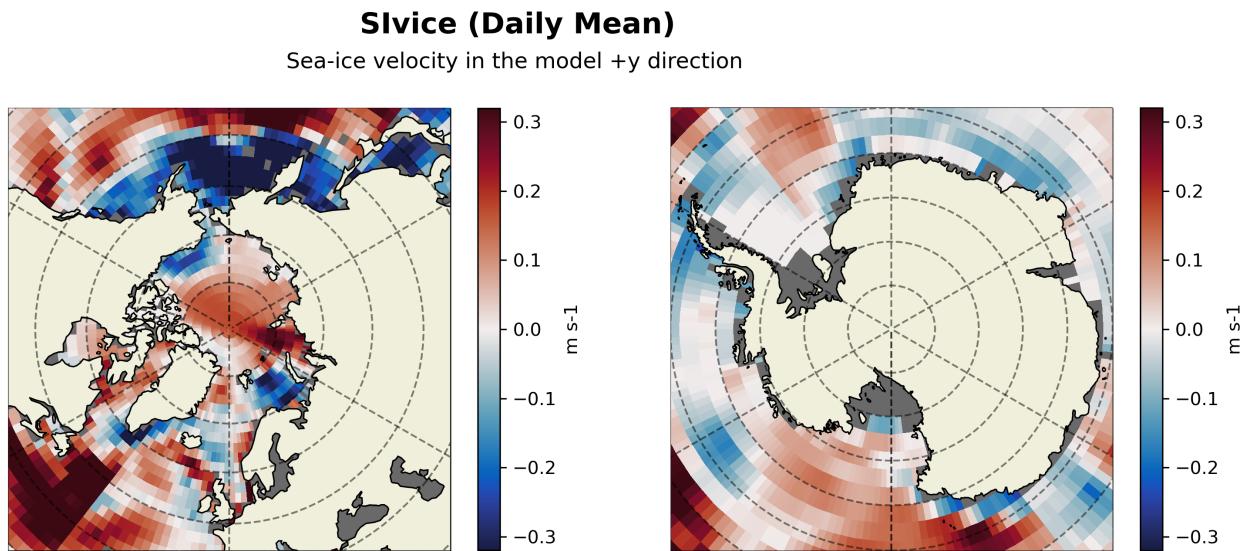


**Figure 112: Dataset: SEA\_ICE\_VELOCITY Variable: Sluice**

### 19.21.2 Native Variable Slvice

**Table 19.110: CDL description of SEA\_ICE\_VELOCITY's Slvice variable**

Storage Type	Variable Name	Description	Unit
float32	Slvice	Sea-ice velocity in the model +y direction	m s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 +Slvice(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.			



Example file 2017-12-29,  
SEA\_ICE\_VELOCITY\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

**Figure 113: Dataset: SEA\_ICE\_VELOCITY Variable: Slvice**

## 19.22 Native NetCDF SEA\_SURFACE\_HEIGHT

Table 19.111: Variables in the dataset SEA\_SURFACE\_HEIGHT

Dataset:	SEA_SURFACE_HEIGHT
Field:	SSH
Field:	SSHIBC
Field:	SSHNOIBC
Field:	ETAN

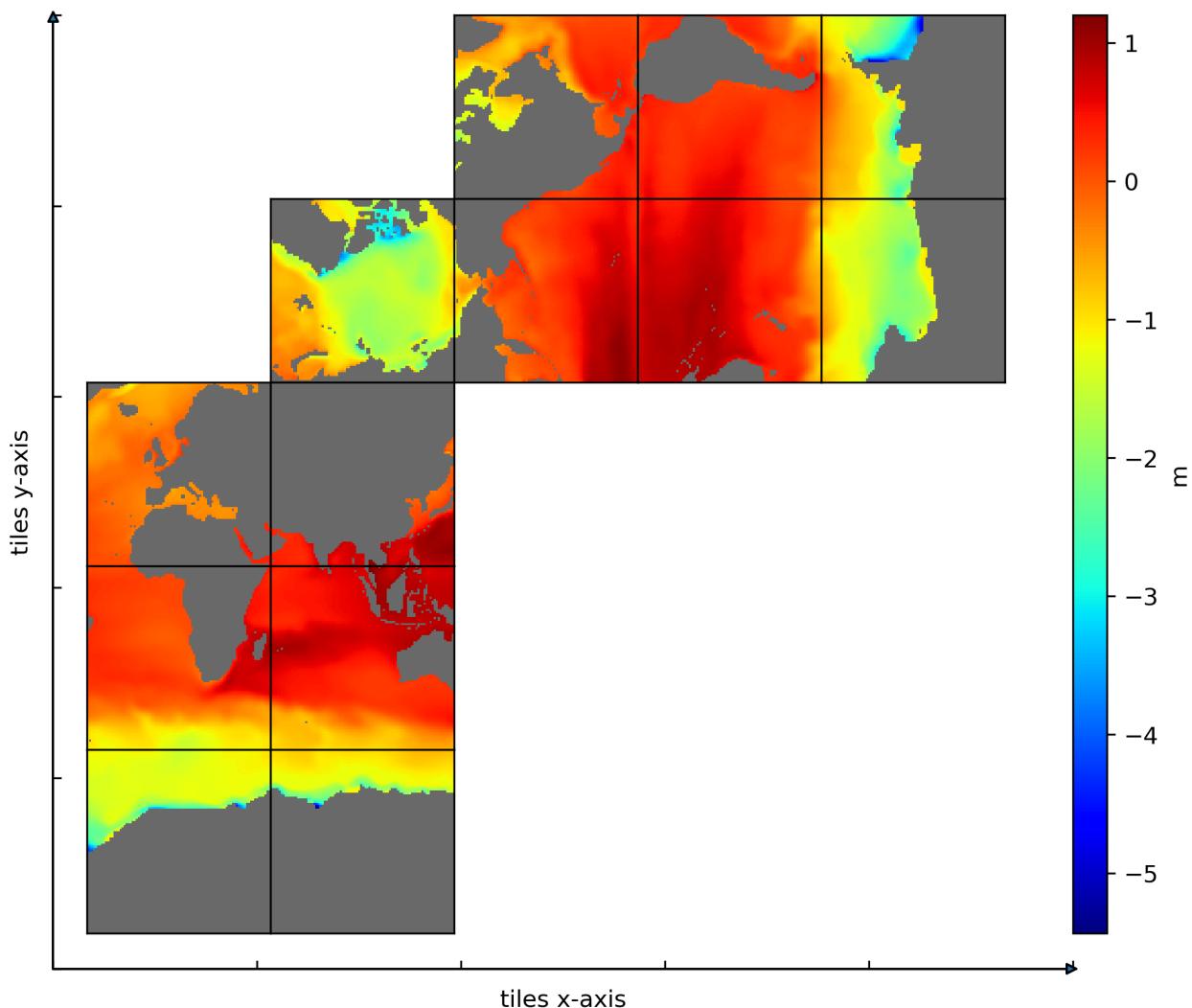
### 19.22.1 Native Variable ETAN

Table 19.112: CDL description of SEA\_SURFACE\_HEIGHT's ETAN variable

Storage Type	Variable Name	Description	Unit
float32	ETAN	Model sea level anomaly	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
Model sea level anomaly WITHOUT corrections for global mean density (steric) changes, inverted barometer effect, or volume displacement due to submerged sea-ice and snow . Note: ETAN should NOT be used for comparisons with altimetry data products because ETAN is NOT corrected for (a) global mean steric sea level changes related to density changes in the Boussinesq volume-conserving model (Greatbatch correction, see sterGloH) nor (b) sea level displacement due to submerged sea-ice and snow (see slceLoad). These corrections ARE made for the variables SSH and SSHNOIBC.			

## ETAN (Daily Mean)

Model sea level anomaly



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: ETAN

## 19.22.2 Native Variable SSH

**Table 19.113: CDL description of SEA\_SURFACE\_HEIGHT's SSH variable**

Storage Type	Variable Name	Description	Unit
float32	SSH	Dynamic sea surface height anomaly	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
Dynamic sea surface height anomaly above the geoid, suitable for comparisons with altimetry sea surface height data products that apply the inverse barometer (IB) correction. Note: SSH is calculated by correcting model sea level anomaly ETAN for three effects: a) global mean steric sea level changes related to density changes in the Boussinesq volume-conserving model (Greatbatch correction, see sterGloH), b) the inverted barometer (IB) effect (see SSHIBC) and c) sea level displacement due to sea-ice and snow pressure loading (see slceLoad). 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.			

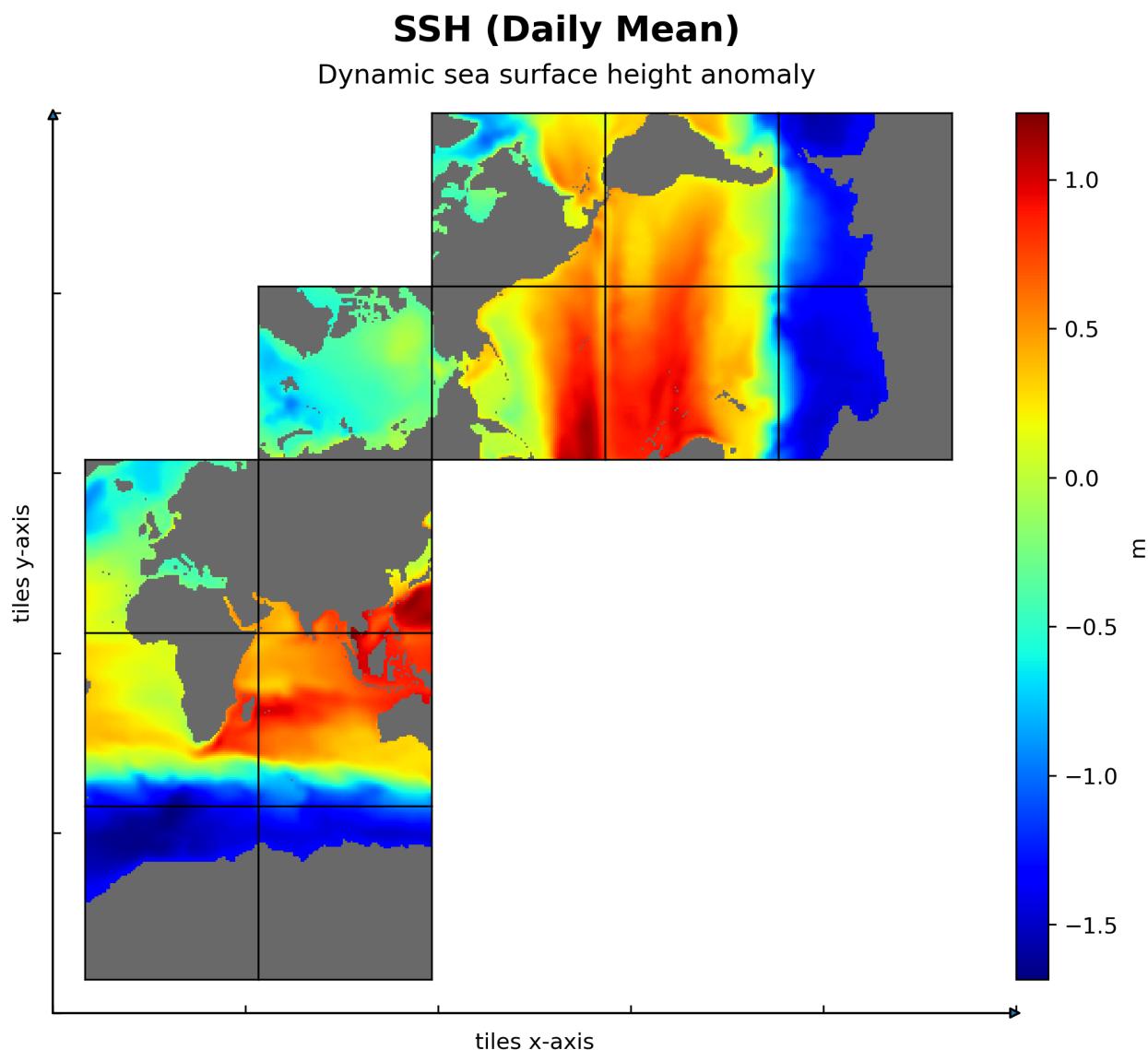


Figure 115: Dataset: SEA\_SURFACE\_HEIGHT Variable: SSH

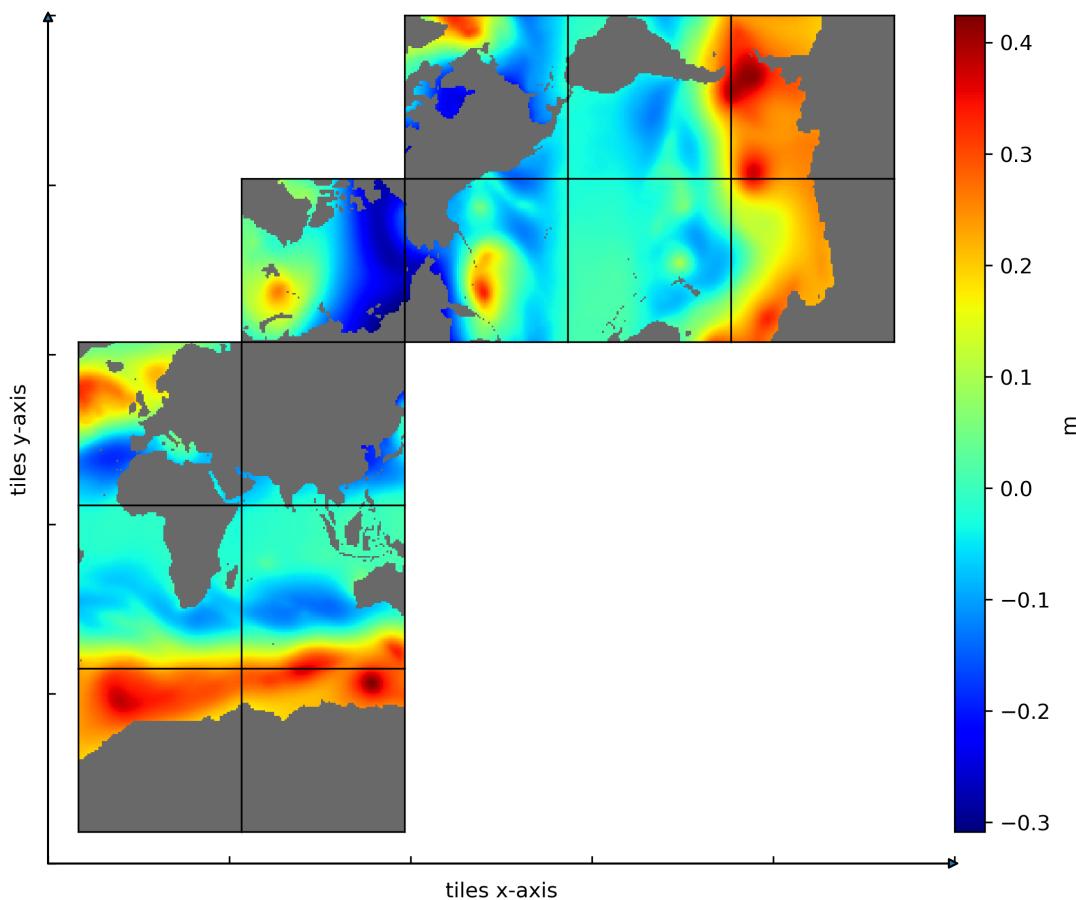
### 19.22.3 Native Variable SSHIBC

Table 19.114: CDL description of SEA\_SURFACE\_HEIGHT's SSHIBC variable

Storage Type	Variable Name	Description	Unit
float32	SSHIBC	The inverted barometer (IB) correction to sea surface height due to atmospheric pressure loading	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
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: $\text{SSH} = \text{SSHNOIBC} - \text{SSHIBC}$ . 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.			

## SSHIBC (Daily Mean)

The inverted barometer (IB) correction to sea surface height due to atmospheric pressure loading



Example file 2017-12-29,  
SEA\_SURFACE\_HEIGHT\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

**Figure 116: Dataset: SEA\_SURFACE\_HEIGHT Variable: SSHIBC**

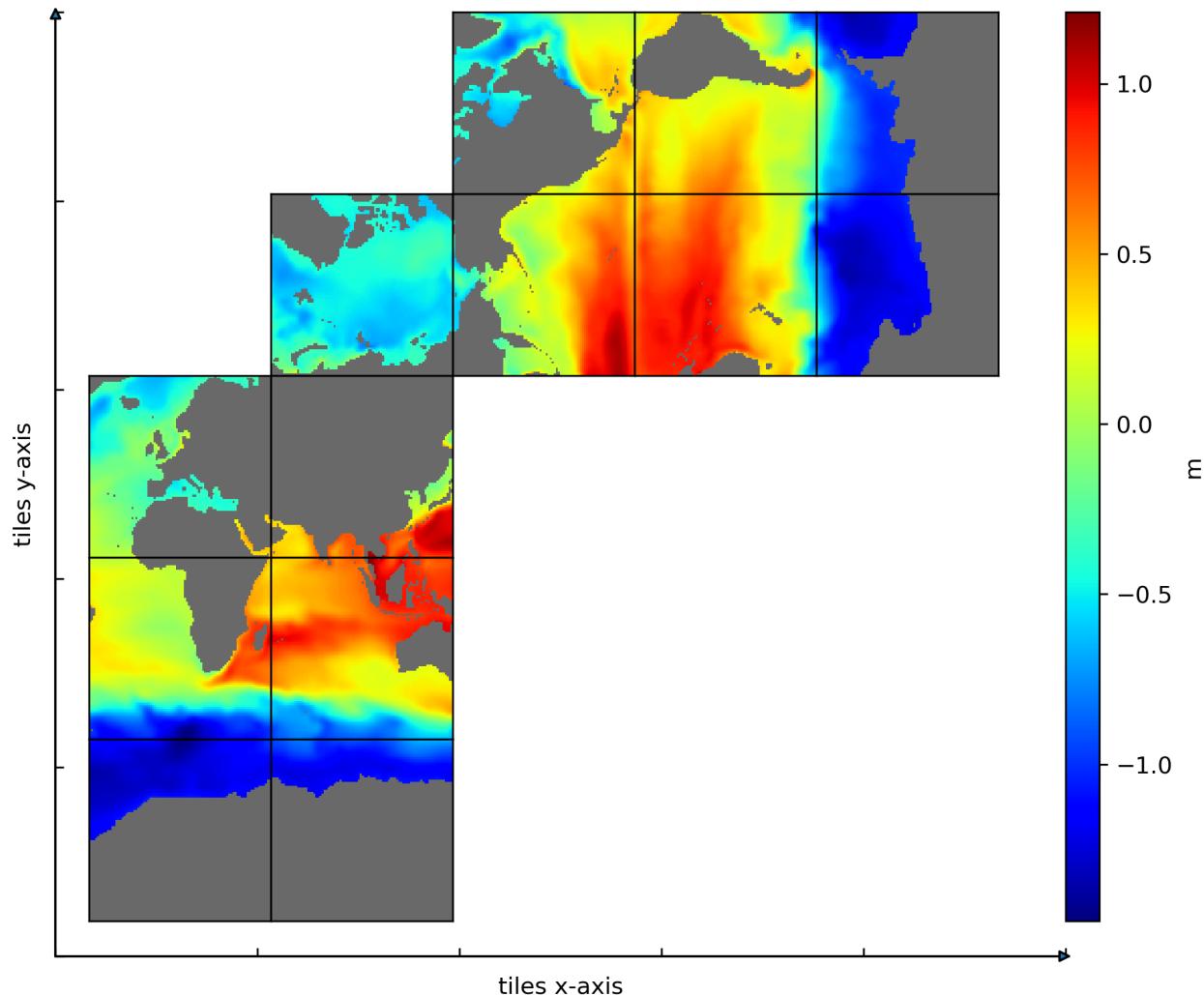
#### 19.22.4 Native Variable SSHNOIBC

**Table 19.115: CDL description of SEA\_SURFACE\_HEIGHT's SSHNOIBC variable**

Storage Type	Variable Name	Description	Unit
float32	SSHNOIBC	Sea surface height anomaly without the inverted barometer (IB) correction	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
Sea surface height anomaly above the geoid without the inverse barometer (IB) correction, suitable for comparisons with altimetry sea surface height data products that do NOT apply the inverse barometer (IB) correction. Note: SSHNOIBC is calculated by correcting model sea level anomaly ETAN for two effects: a) global mean steric sea level changes related to density changes in the Boussinesq volume-conserving model (Greatbatch correction, see sterGloH), b) sea level displacement due to sea-ice and snow pressure loading (see slceLoad). 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.			

## SSHNOIBC (Daily Mean)

Sea surface height anomaly without the inverted barometer (IB) correction



Example file 2017-12-29,  
SEA\_SURFACE\_HEIGHT\_day\_mean\_2017-12-29\_ECCO\_V4r4\_native\_llc0090.nc

Figure 117: Dataset: SEA\_SURFACE\_HEIGHT Variable: SSHNOIBC

## 20 Latlon Dataset Coordinate Variables

### 20.1 Overview of the Latlon Dataset Coordinate Variables

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Vivamus at enim eget nisi ultrices facilisis a et purus. Sed tincidunt scelerisque ligula, in vehicula dui venenatis at. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Curabitur consequat commodo nunc, nec lacinia quam feugiat vel. Integer bibendum lectus sit amet quam elementum, ut pretium quam malesuada. Cras fermentum venenatis augue, id commodo libero facilisis nec. Quisque euismod, odio vitae dapibus convallis, justo enim iaculis metus, vel interdum elit nisi vel lectus. Fusce tempor elit in semper condimentum. Ut quis dui eget purus cursus interdum eu ac elit!

## 20.2 Latlon coordinates NetCDF GRID\_GEOMETRY\_ECCO

Table 20.1: Variables in the dataset GRID\_GEOMETRY\_ECCO

Dataset:	GRID_GEOMETRY_ECCO
Field:	hFacC
Field:	maskC

### 20.2.1 Latlon coordinates Variable hFacC

Table 20.2: CDL description of GRID\_GEOMETRY\_ECCO's hFacC variable

Storage Type	Variable Name	Description	Unit
float64	hFacC	vertical open fraction of grid cell	1
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

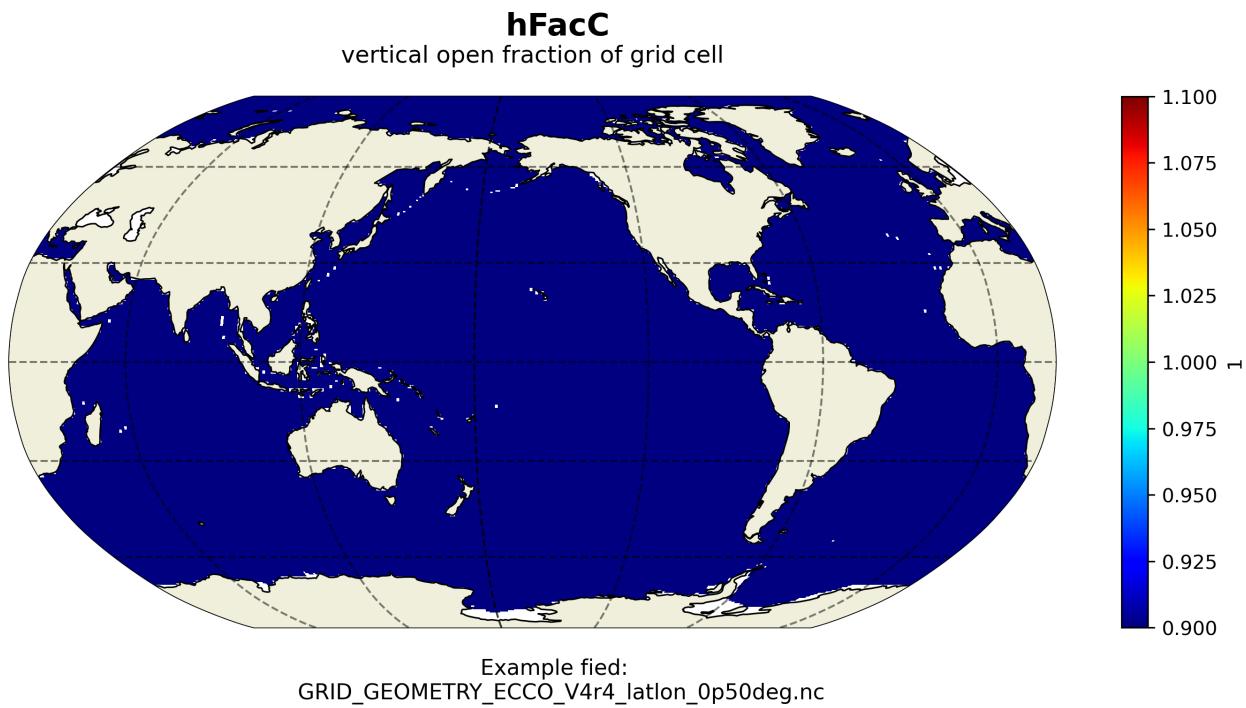


Figure 118: Dataset: GRID\_GEOMETRY\_ECCO Variable: hFacC

## 20.2.2 Latlon coordinates Variable maskC

Table 20.3: CDL description of GRID\_GEOMETRY\_ECCO's maskC variable

Storage Type	Variable Name	Description	Unit
bool	maskC	wet/dry boolean mask for grid cell	N/A
<b>CDL Description</b>			
bool maskC(Z, latitude, longitude) maskC:_FillValue = 1 maskC:coverage_content_type = modelResult maskC:long_name = wet/dry boolean mask for grid cell			
<b>Comments</b>			
True for grid cells with nonzero open vertical fraction ( $hFacC > 0$ ), otherwise False.			

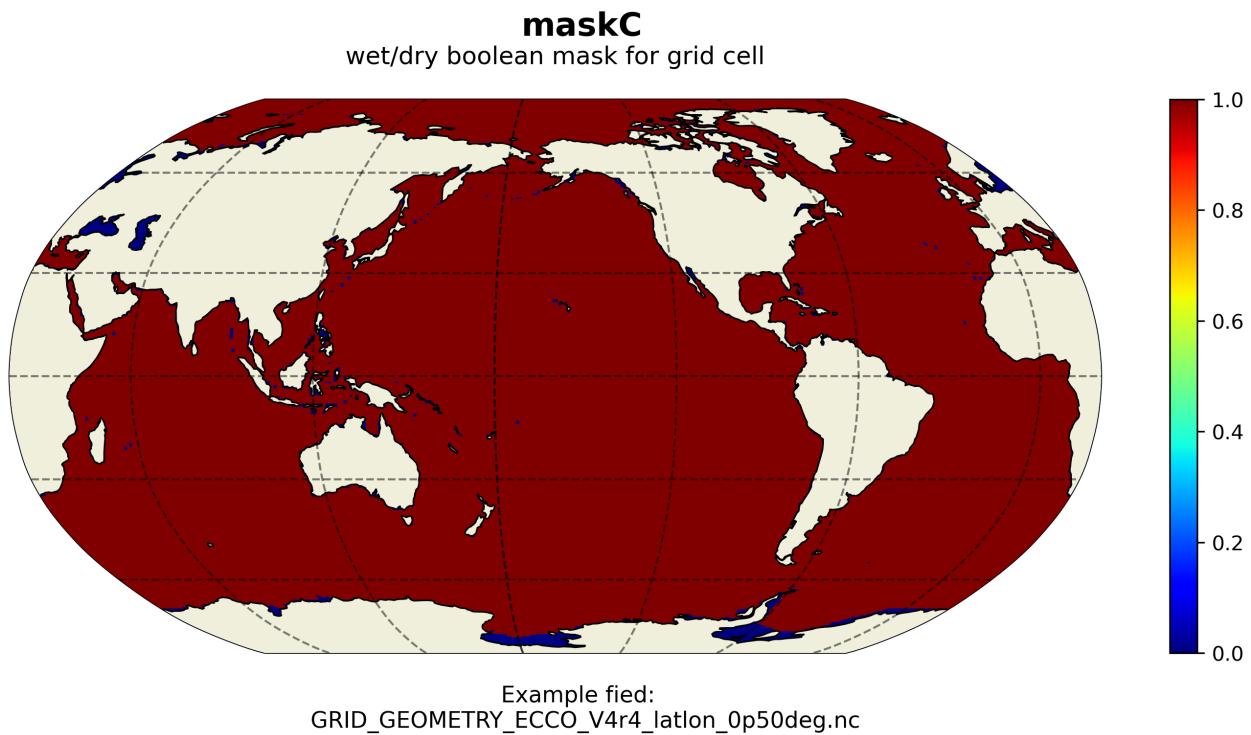


Figure 119: Dataset: GRID\_GEOMETRY\_ECCO Variable: maskC

## 21 Latlon Dataset Groupings

### 21.1 Overview of the latlon Dataset Groupings

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Vivamus at enim eget nisi ultrices facilisis a et purus. Sed tincidunt scelerisque ligula, in vehicula dui venenatis at. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Curabitur consequat commodo nunc, nec lacinia quam feugiat vel. Integer bibendum lectus sit amet quam elementum, ut pretium quam malesuada. Cras fermentum venenatis augue, id commodo libero facilisis nec. Quisque euismod, odio vitae dapibus convallis, justo enim iaculis metus, vel interdum elit nisi vel lectus. Fusce tempor elit in semper condimentum. Ut quis dui eget purus cursus interdum eu ac elit!

## 21.2 Latlon NetCDF ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES

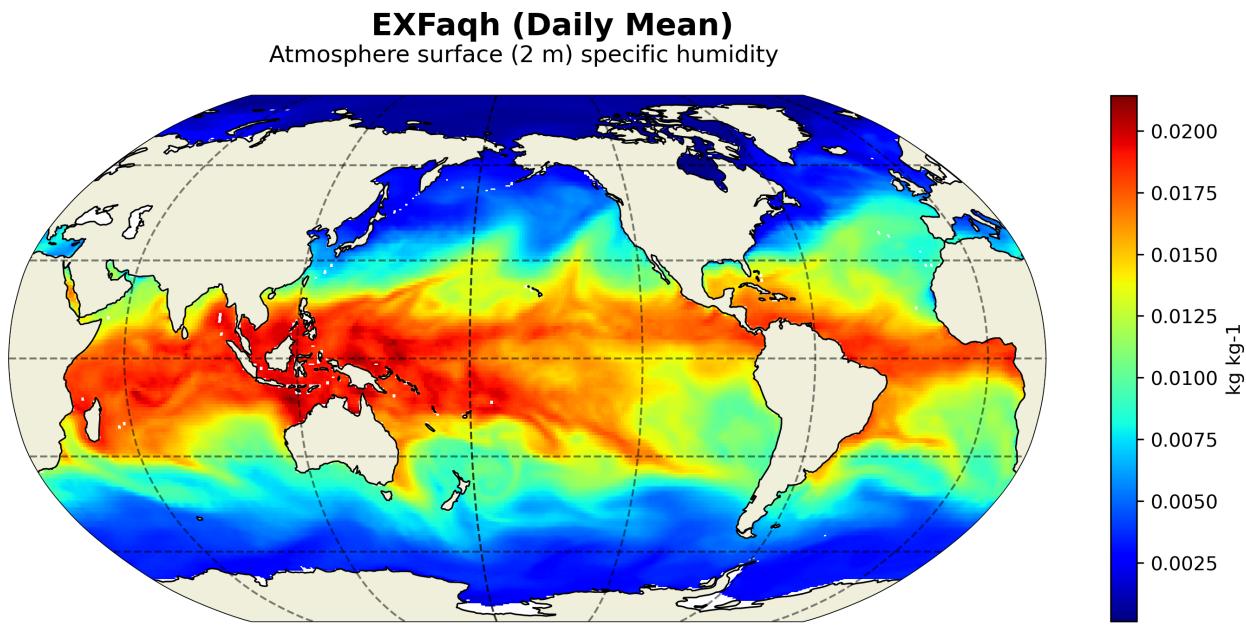
Table 21.1: Variables in the dataset ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES

Dataset:	ATM_SURFACE_TEMP_HUM_WIND_PRES
Field:	EXFatemp
Field:	EXFaqh
Field:	EXFewind
Field:	EXFnwind
Field:	EXFwspee
Field:	EXFpress

### 21.2.1 Latlon Variable EXFaqh

**Table 21.2: CDL description of ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES's EXFaqh variable**

Storage Type	Variable Name	Description	Unit
float32	EXFaqh	Atmosphere surface (2 m) specific humidity	kg kg <sup>-1</sup>
<b>CDL Description</b>			
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 <sup>-1</sup>			
EXFaqh: coordinates = time			
EXFaqh: valid_min = : 0.0014020215021446347			
EXFaqh: valid_max = 0.03014513850212097			
<b>Comments</b>			
Surface (2 m) specific humidity over open water. Note: sum of ERA-Interim surface specific humidity and the control adjustment from ocean state estimation.			

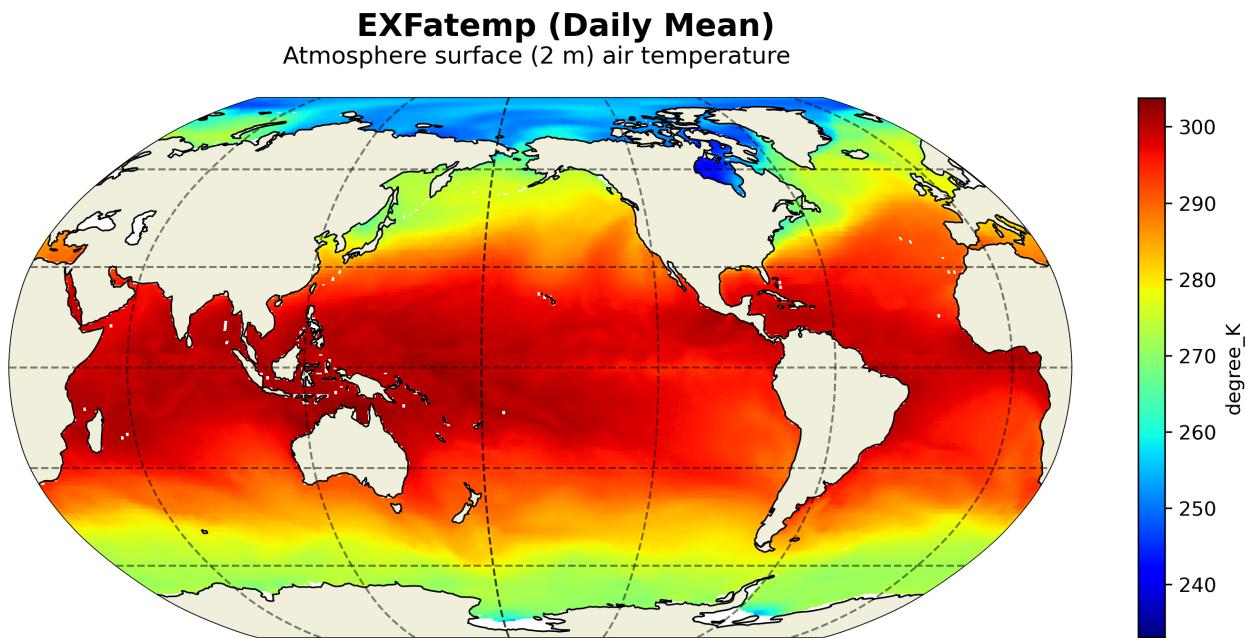


**Figure 120: Dataset: ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES Variable: EXFaqh**

## 21.2.2 Latlon Variable EXFatemp

**Table 21.3: CDL description of ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES's EXFatemp variable**

Storage Type	Variable Name	Description	Unit
float32	EXFatemp	Atmosphere surface (2 m) air temperature	degree_K
<b>CDL Description</b>			
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			
<b>Comments</b>			
Surface (2 m) air temperature over open water. Note: sum of ERA-Interim surface air temperature and the control adjustment from ocean state estimation.			

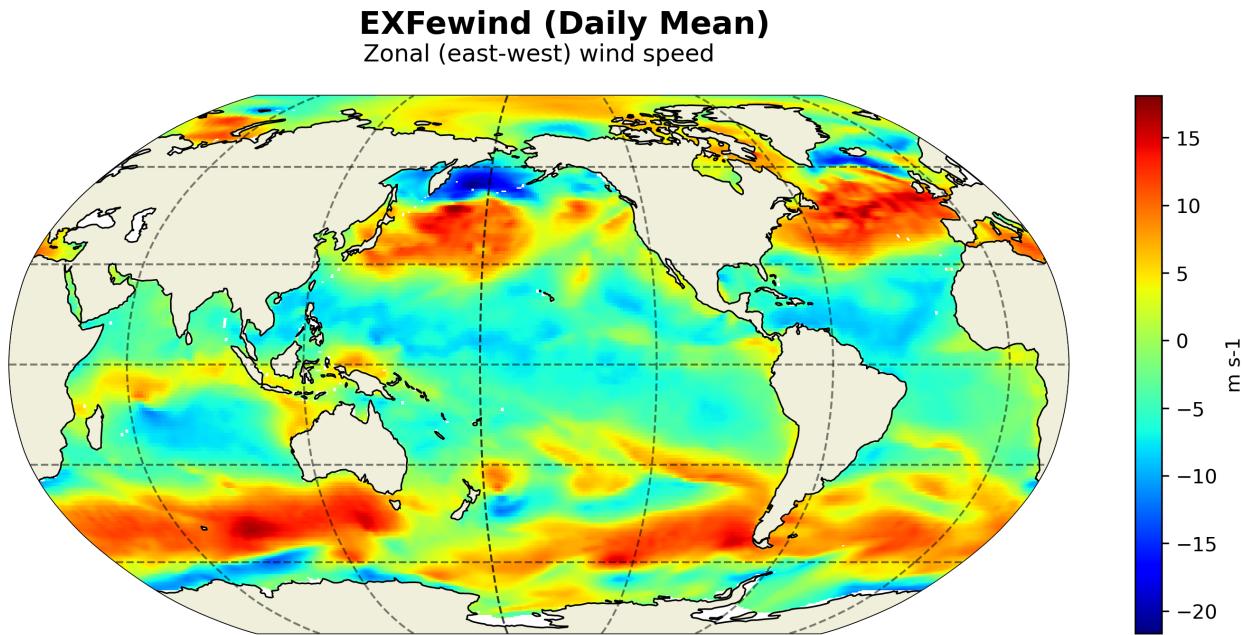


**Figure 121: Dataset: ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES Variable: EXFatemp**

### 21.2.3 Latlon Variable EXFewind

**Table 21.4: CDL description of ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES's EXFewind variable**

Storage Type	Variable Name	Description	Unit
float32	EXFewind	Zonal (east-west) wind speed	m s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			



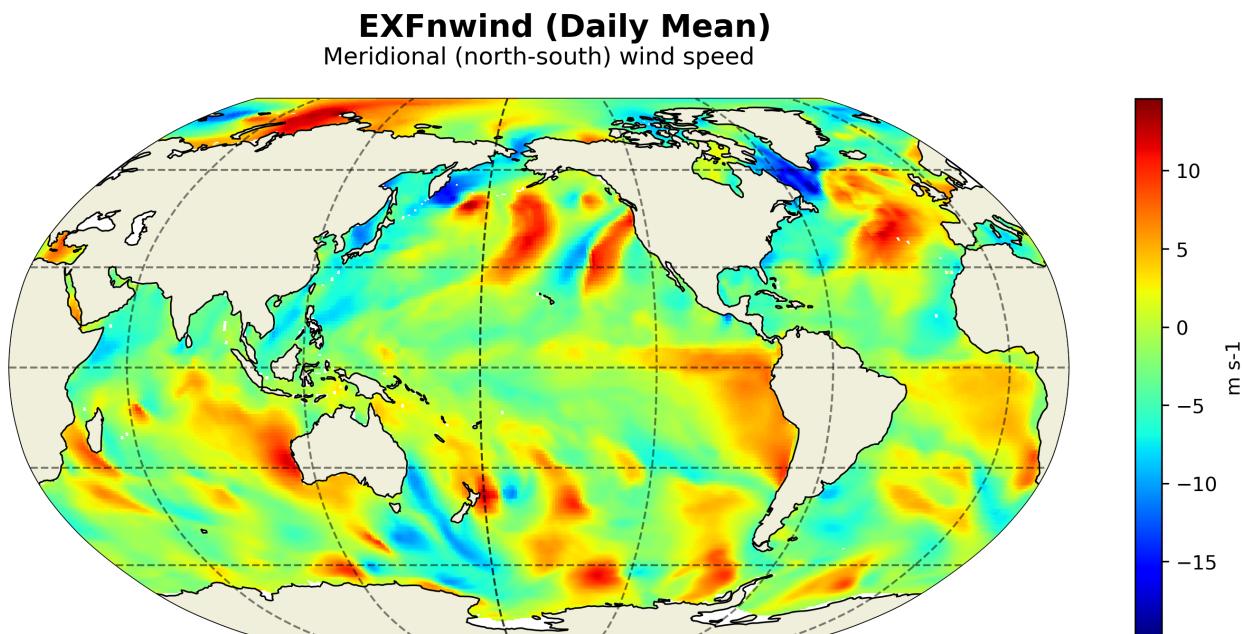
Example file 2017-12-29,  
ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES\_day\_mean\_2017-12-29\_ECCO\_V4r4\_latlon\_0p50deg.nc

**Figure 122: Dataset: ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES Variable: EXFewind**

#### 21.2.4 Latlon Variable EXFnwind

**Table 21.5: CDL description of ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES's EXFnwind variable**

Storage Type	Variable Name	Description	Unit
float32	EXFnwind	Meridional (north-south) wind speed	m s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

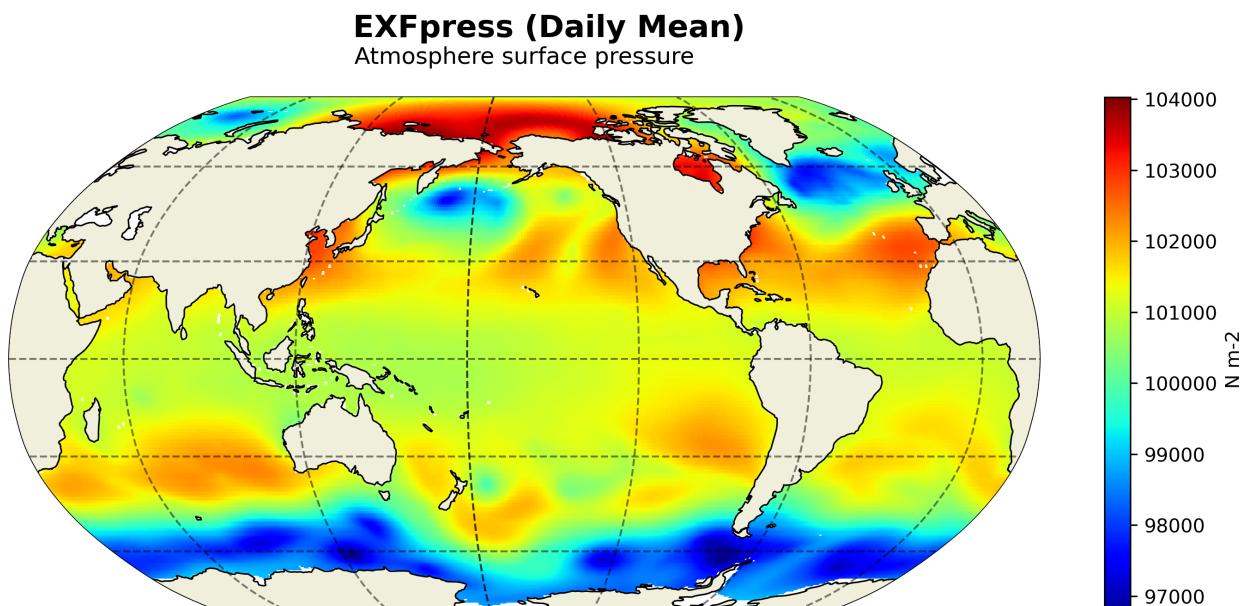


**Figure 123: Dataset: ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES Variable: EXFnwind**

## 21.2.5 Latlon Variable EXFpress

**Table 21.6: CDL description of ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES's EXFpress variable**

Storage Type	Variable Name	Description	Unit
float32	EXFpress	Atmosphere surface pressure	N m-2
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

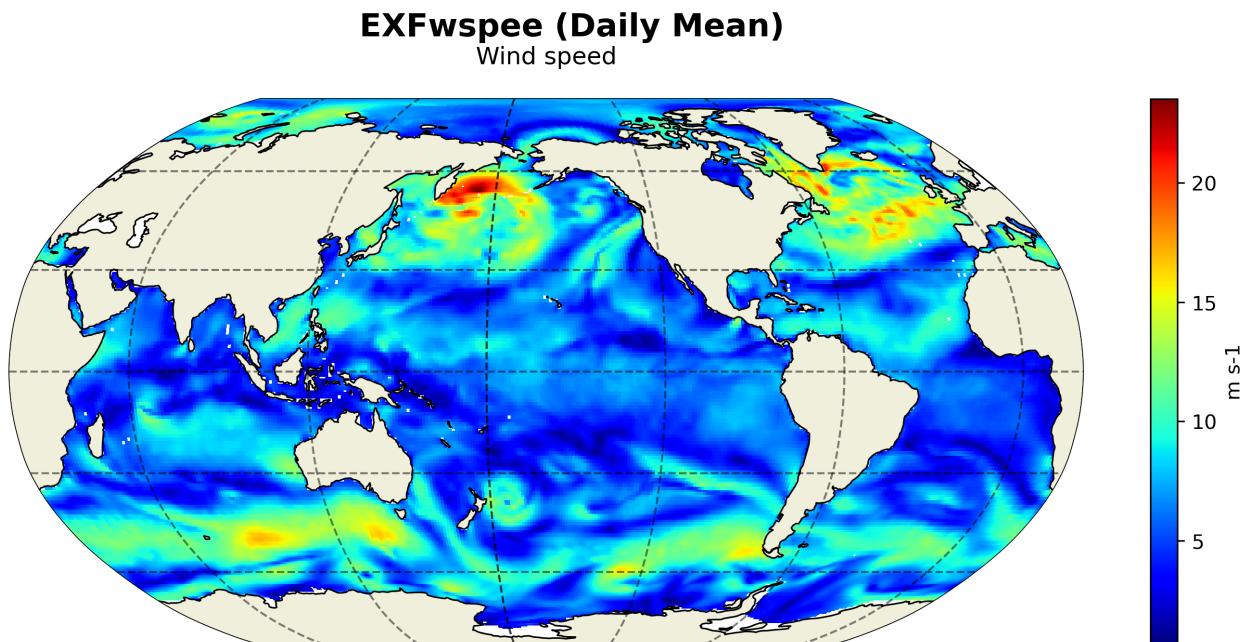


**Figure 124: Dataset: ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES Variable: EXFpress**

## 21.2.6 Latlon Variable EXFwspee

**Table 21.7: CDL description of ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES's EXFwspee variable**

Storage Type	Variable Name	Description	Unit
float32	EXFwspee	Wind speed	m s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
10-m wind speed magnitude ( $\geq 0$ ) 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 necessarily consistent with EXFuwind and EXFvwind because EXFuwind and EXFvwind are calculated from EXFtaux and EXFtauw using bulk formulae. EXFwspee != sqrt(EXFuwind**2 + EXFvwind**2).			



Example file 2017-12-29,  
ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES\_day\_mean\_2017-12-29\_ECCO\_V4r4\_latlon\_0p50deg.nc

**Figure 125: Dataset: ATM\_SURFACE\_TEMP\_HUM\_WIND\_PRES Variable: EXFwspee**

### 21.3 Latlon NetCDF OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX

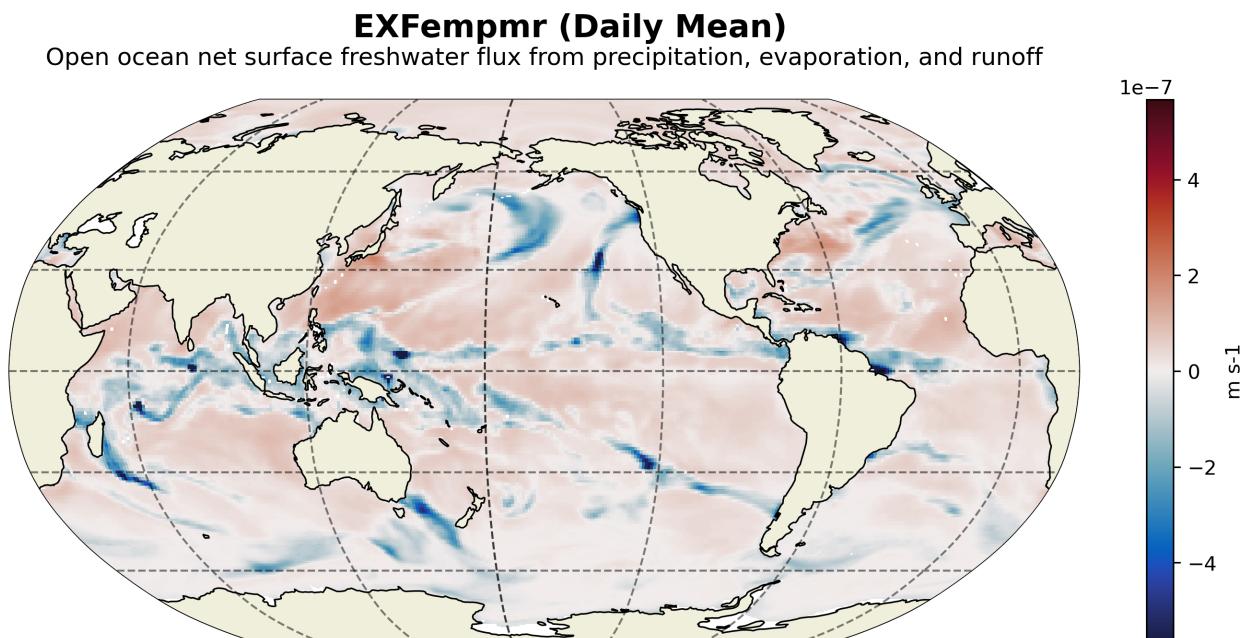
Table 21.8: Variables in the dataset OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX

Dataset:	OCEAN_AND_ICE_SURFACE_FW_FLUX
Field:	EXFpreci
Field:	EXFevap
Field:	EXFroff
Field:	SlsnPrcp
Field:	EXFemprmr
Field:	oceFWflx
Field:	SlatmFW
Field:	SFLUX
Field:	SlacSubl
Field:	SirsSubl
Field:	SIfwThru

### 21.3.1 Latlon Variable EXFempmr

**Table 21.9: CDL description of OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX's EXFempmr variable**

Storage Type	Variable Name	Description	Unit
float32	EXFempmr	Open ocean net surface freshwater flux from precipitation, evaporation, and runoff	m s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

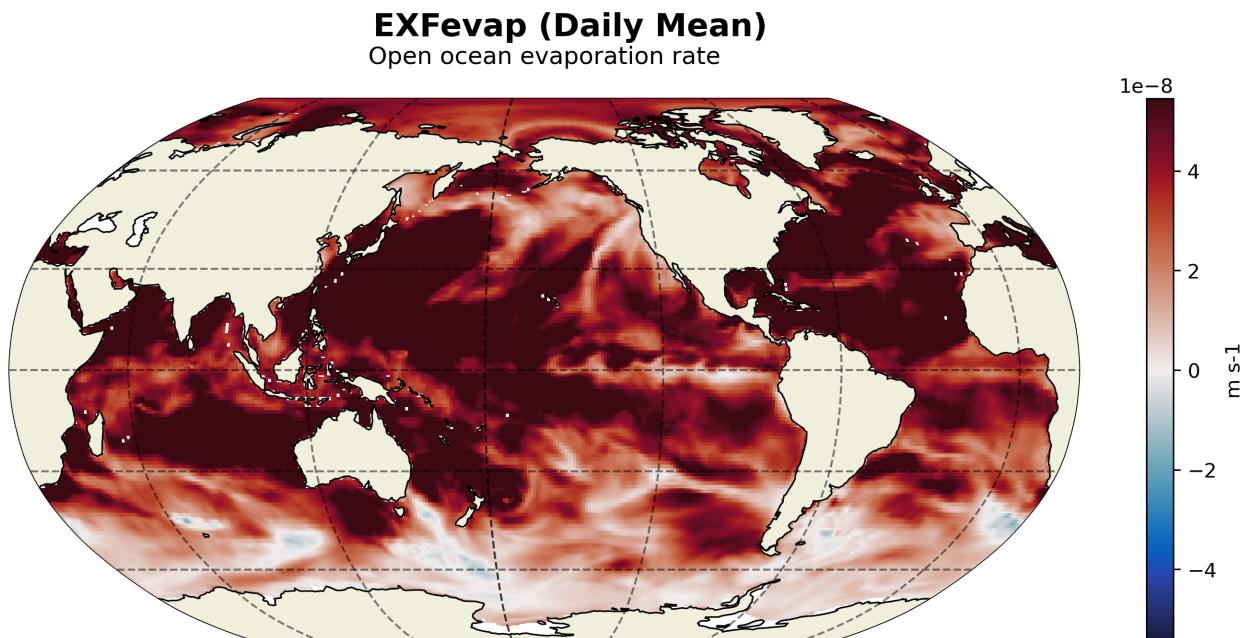


**Figure 126: Dataset: OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX Variable: EXFempmr**

### 21.3.2 Latlon Variable EXFevap

**Table 21.10: CDL description of OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX's EXFevap variable**

Storage Type	Variable Name	Description	Unit
float32	EXFevap	Open ocean evaporation rate	m s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			



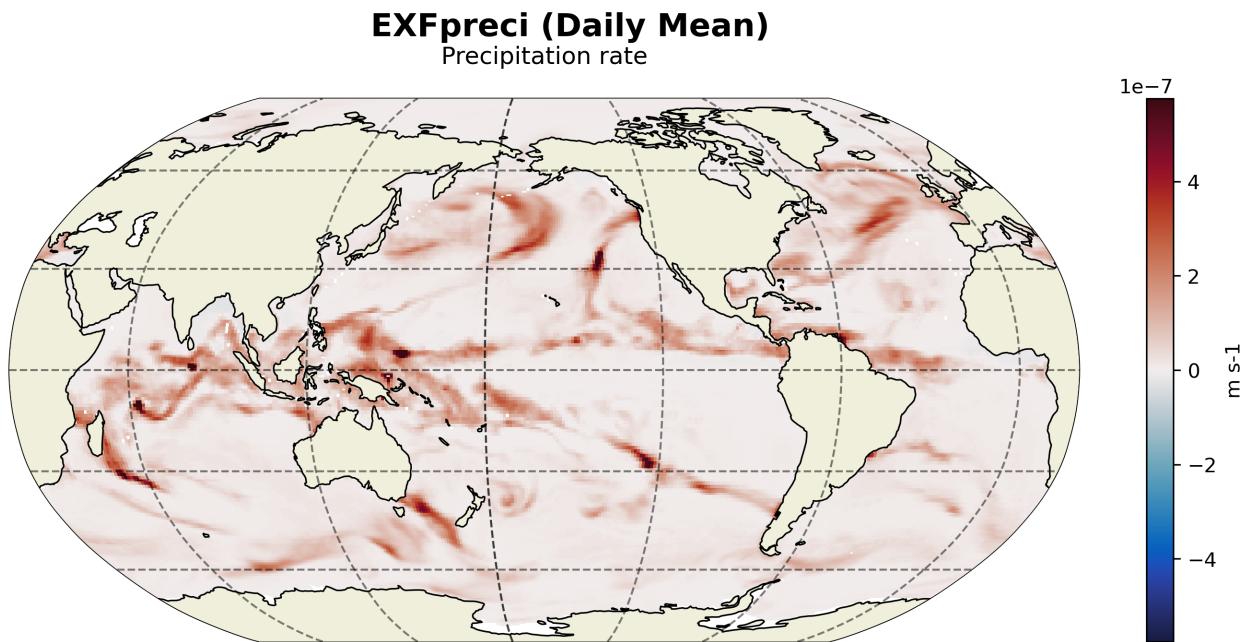
Example file 2017-12-29,  
OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_latlon\_0p50deg.nc

**Figure 127: Dataset: OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX Variable: EXFevap**

### 21.3.3 Latlon Variable EXFpreci

**Table 21.11: CDL description of OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX's EXFpreci variable**

Storage Type	Variable Name	Description	Unit
float32	EXFpreci	Precipitation rate	m s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
Precipitation rate. Note: sum of ERA-Interim precipitation and the control adjustment from ocean state estimation.			

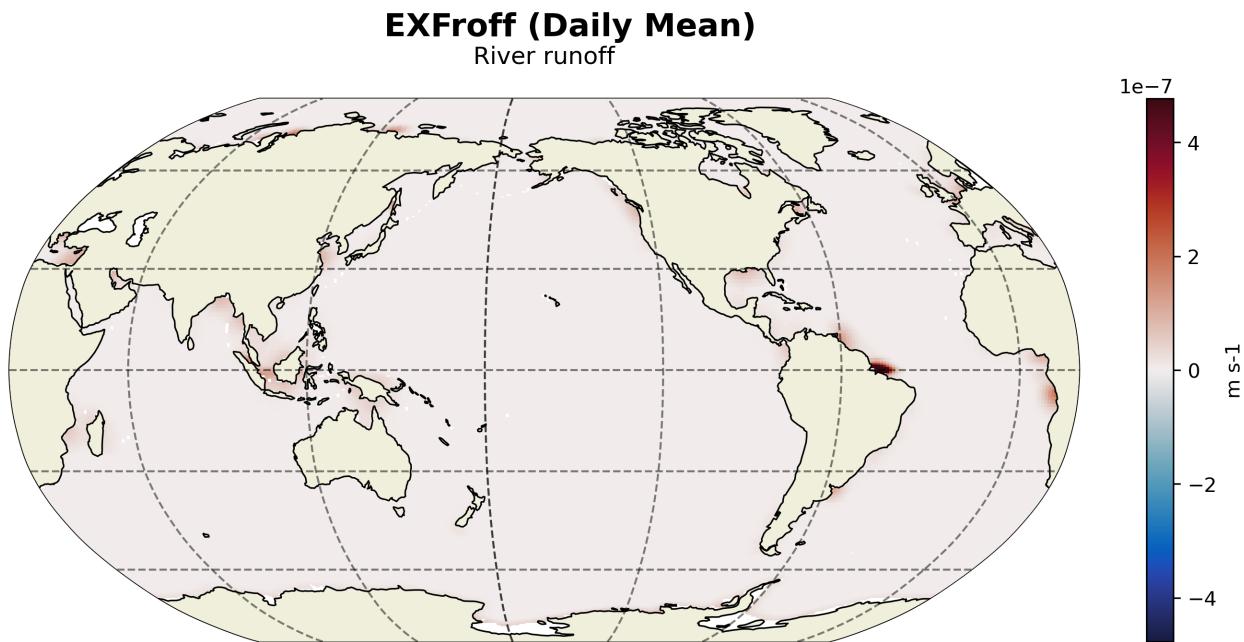


**Figure 128: Dataset: OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX Variable: EXFpreci**

### 21.3.4 Latlon Variable EXFroff

**Table 21.12: CDL description of OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX's EXFroff variable**

Storage Type	Variable Name	Description	Unit
float32	EXFroff	River runoff	m s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
River runoff freshwater flux. Note: not adjusted by the optimization.			



**Figure 129: Dataset: OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX Variable: EXFroff**

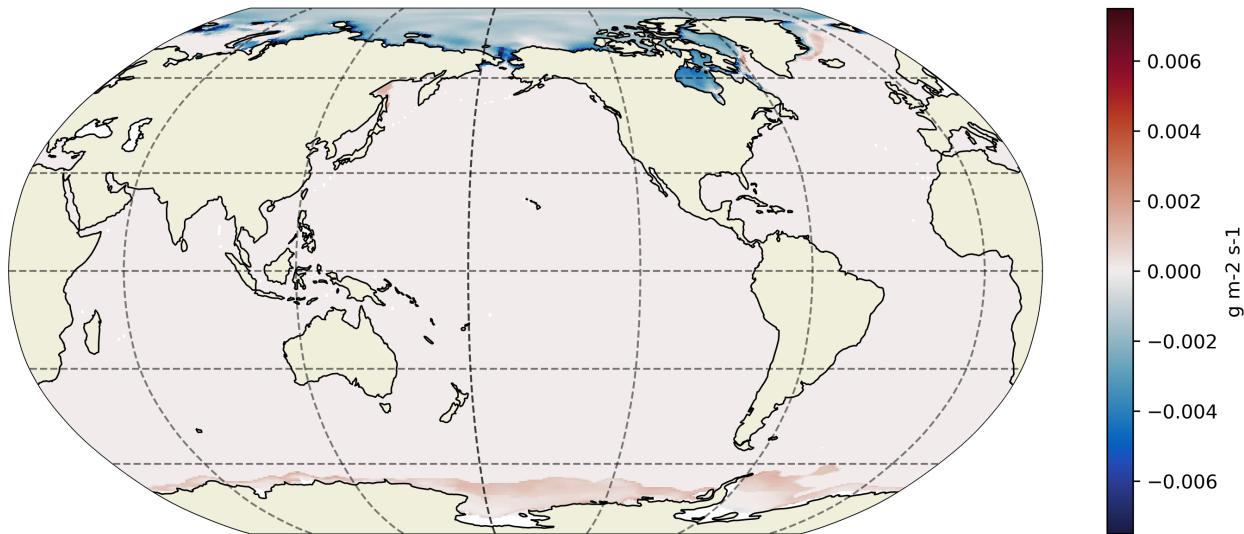
### 21.3.5 Latlon Variable SFLUX

**Table 21.13: CDL description of OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX's SFLUX variable**

Storage Type	Variable Name	Description	Unit
float32	SFLUX	Rate of change of total ocean salinity per m2 accounting for mass fluxes.	g m <sup>-2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 <sup>-1</sup> ). 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).			

### SFLUX (Daily Mean)

Rate of change of total ocean salinity per m2 accounting for mass fluxes.



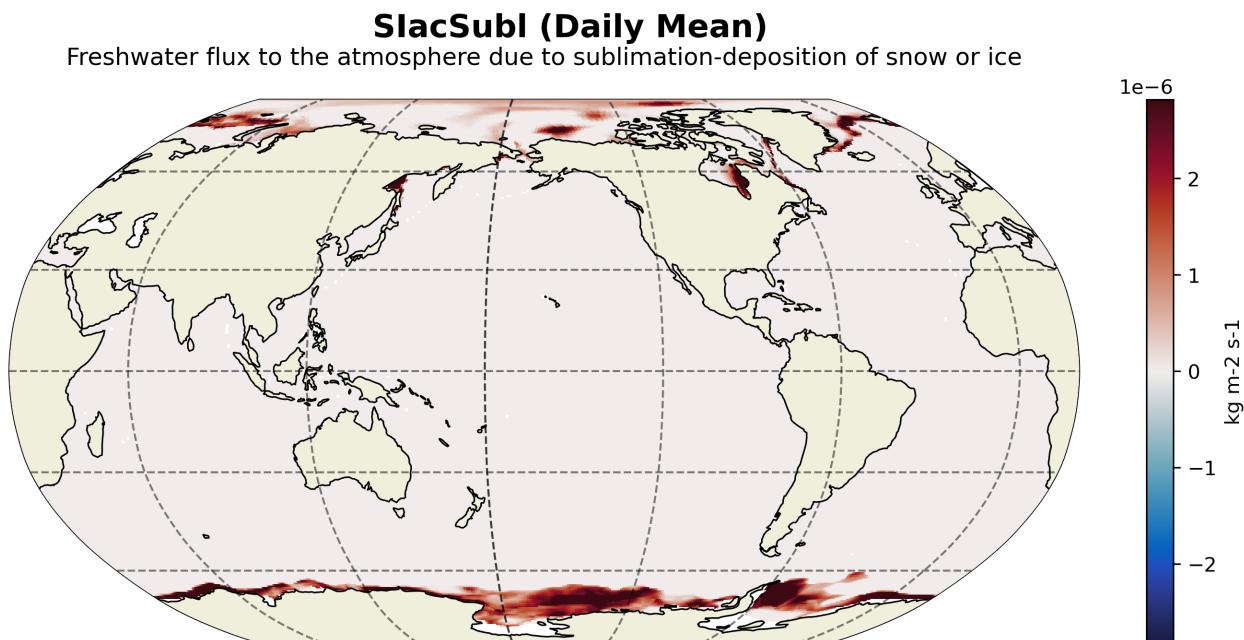
Example file 2017-12-29,  
OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_latlon\_0p50deg.nc

**Figure 130: Dataset: OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX Variable: SFLUX**

### 21.3.6 Latlon Variable SlacSubl

**Table 21.14: CDL description of OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX's SlacSubl variable**

Storage Type	Variable Name	Description	Unit
float32	SlacSubl	Freshwater flux to the atmosphere due to sublimation-deposition of snow or ice	kg m <sup>-2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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			

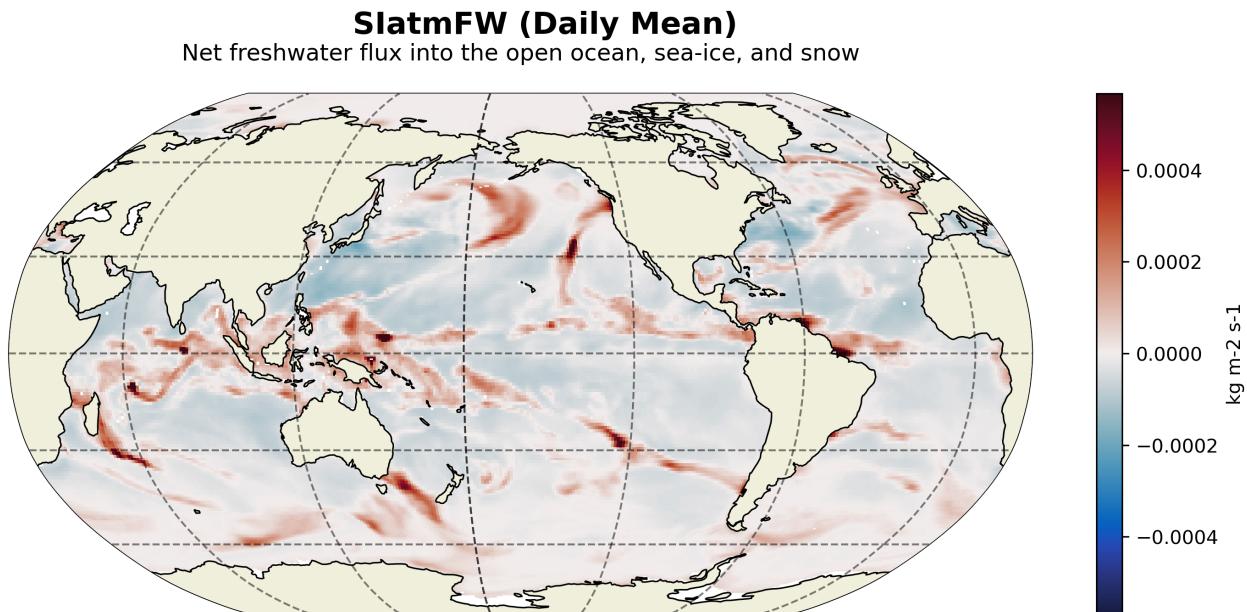


**Figure 131: Dataset: OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX Variable: SlacSubl**

### 21.3.7 Latlon Variable SlatmFW

**Table 21.15: CDL description of OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX's SlatmFW variable**

Storage Type	Variable Name	Description	Unit
float32	SlatmFW	Net freshwater flux into the open ocean, sea-ice, and snow	kg m <sup>-2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 SlatmFW. SlatmFW counts all fluxes to/from the atmosphere that change the TOTAL freshwater stored in the combined liquid ocean, sea-ice, and snow reservoirs.			

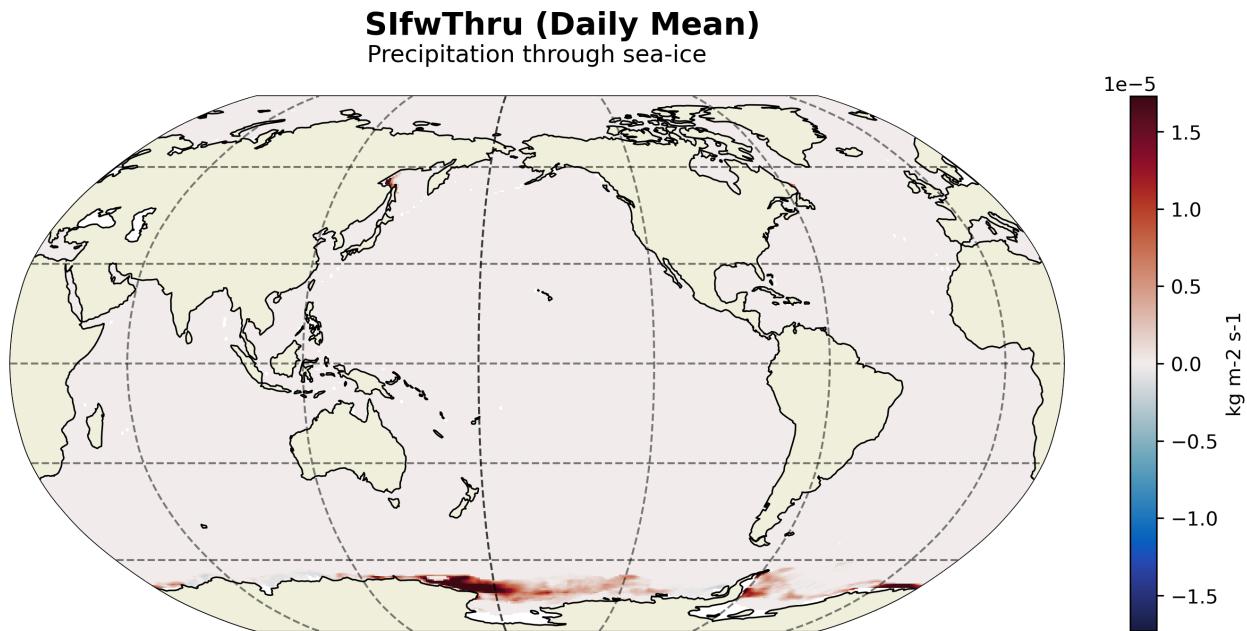


**Figure 132: Dataset: OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX Variable: SlatmFW**

### 21.3.8 Latlon Variable SIfwThru

**Table 21.16: CDL description of OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX's SIfwThru variable**

Storage Type	Variable Name	Description	Unit
float32	SIfwThru	Precipitation through sea-ice	kg m <sup>-2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			



Example file 2017-12-29,  
OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_latlon\_0p50deg.nc

**Figure 133: Dataset: OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX Variable: SIfwThru**

### 21.3.9 Latlon Variable SlrsSubl

Table 21.17: CDL description of OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX's SlrsSubl variable

Storage Type	Variable Name	Description	Unit
float32	SlrsSubl	Residual sublimation freshwater flux	kg m <sup>-2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
Residual freshwater flux by sublimation to remove water from or add water to ocean. When implied sublimation freshwater flux SlacSubl is larger than available sea-ice/snow, SlrsSubl 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.			

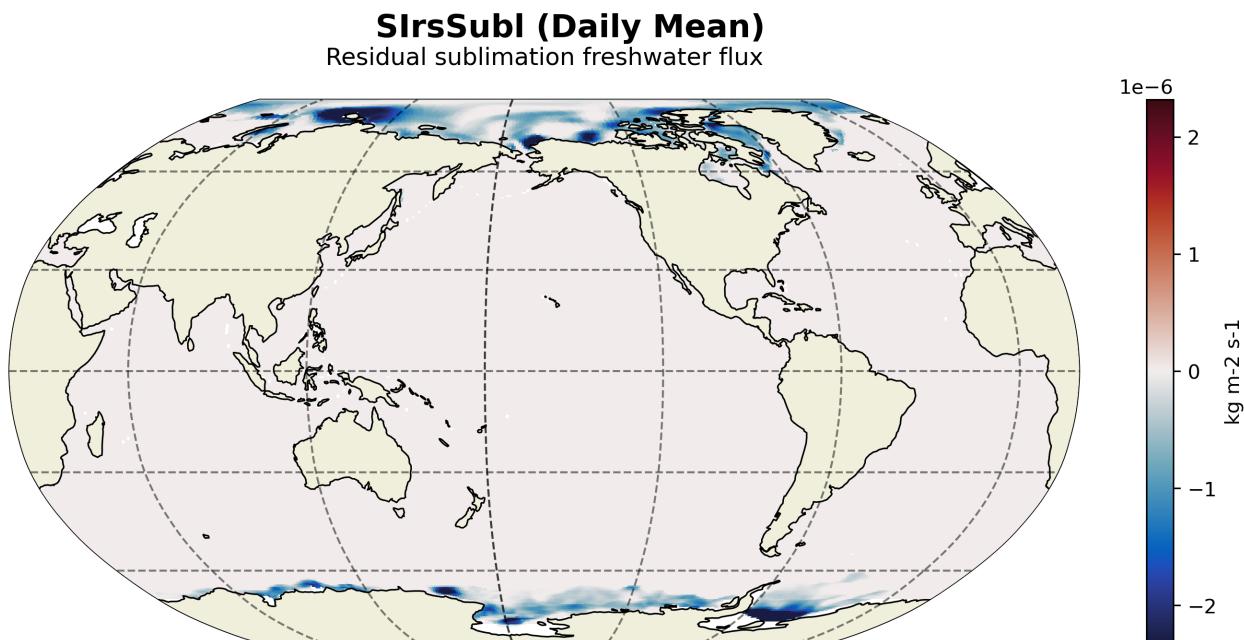
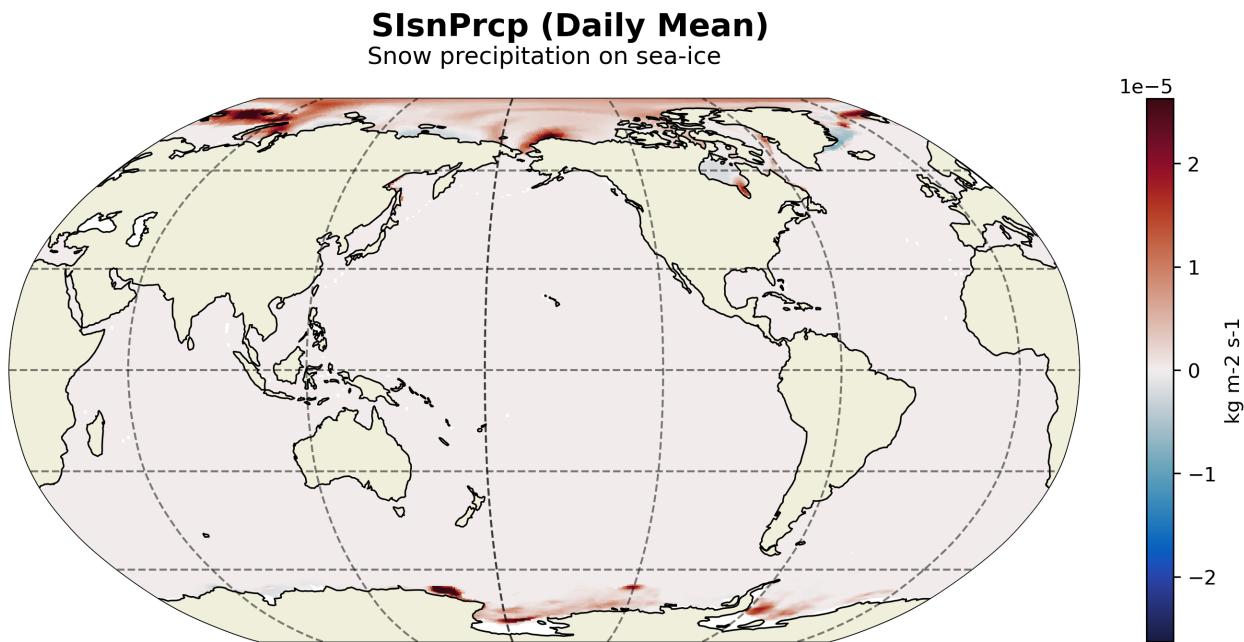


Figure 134: Dataset: OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX Variable: SlrsSubl

### 21.3.10 Latlon Variable SlsnPrcp

**Table 21.18: CDL description of OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX's SlsnPrcp variable**

Storage Type	Variable Name	Description	Unit
float32	SlsnPrcp	Snow precipitation on sea-ice	kg m <sup>-2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
Snow precipitation rate over sea-ice, averaged over the entire model grid cell.			



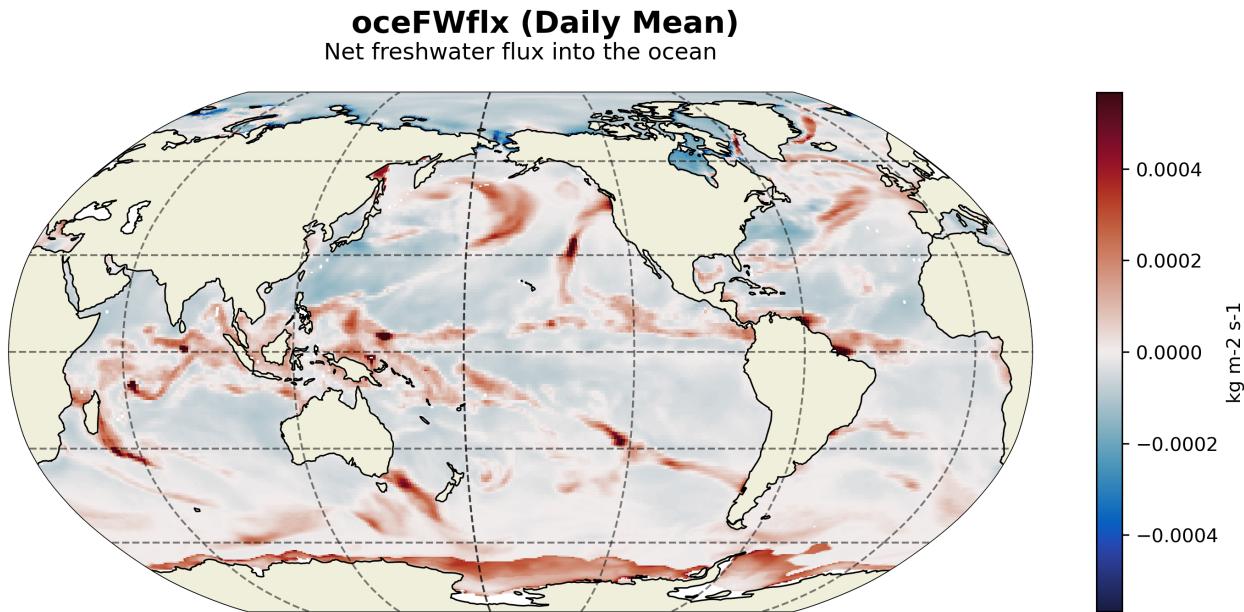
Example file 2017-12-29,  
OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_latlon\_0p50deg.nc

**Figure 135: Dataset: OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX Variable: SlsnPrcp**

### 21.3.11 Latlon Variable oceFWflx

**Table 21.19: CDL description of OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX's oceFWflx variable**

Storage Type	Variable Name	Description	Unit
float32	oceFWflx	Net freshwater flux into the ocean	kg m <sup>-2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 'SlatmFW' accounts for freshwater fluxes out of the combined ocean+sea-ice+snow reservoir.			



**Figure 136: Dataset: OCEAN\_AND\_ICE\_SURFACE\_FW\_FLUX Variable: oceFWflx**

## 21.4 Latlon NetCDF OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX

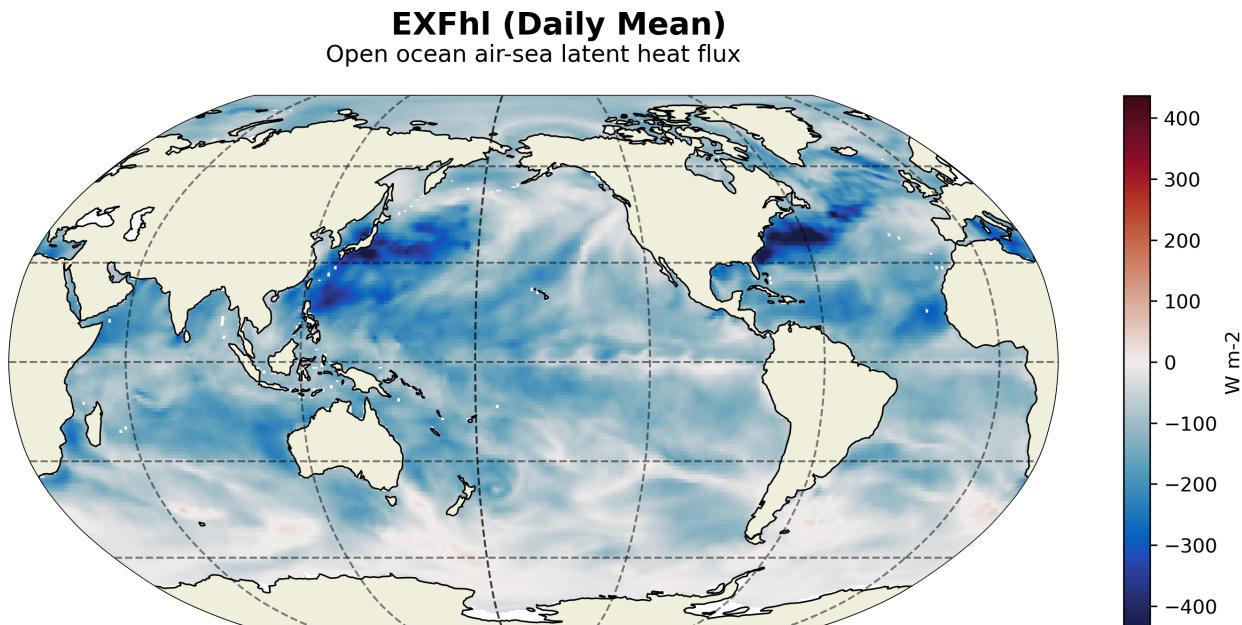
Table 21.20: Variables in the dataset OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX

Dataset:	OCEAN_AND_ICE_SURFACE_HEAT_FLUX
Field:	EXFhl
Field:	EXFhs
Field:	EXFlwdn
Field:	EXFswdn
Field:	EXFqnet
Field:	oceQnet
Field:	SlatmQnt
Field:	TFLUX
Field:	EXFswnet
Field:	EXFlwnet
Field:	oceQsw
Field:	Slaaflux

#### 21.4.1 Latlon Variable EXFhl

Table 21.21: CDL description of OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX's EXFhl variable

Storage Type	Variable Name	Description	Unit
float32	EXFhl	Open ocean air-sea latent heat flux	W m <sup>-2</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			



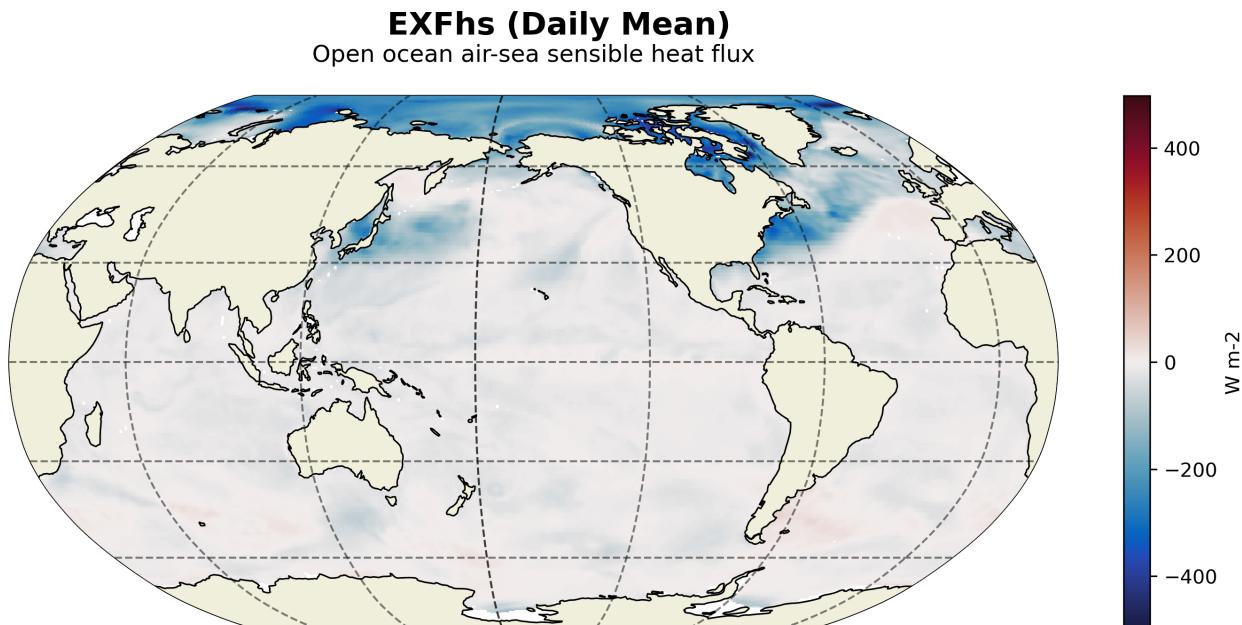
Example file 2017-12-29,  
OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_latlon\_0p50deg.nc

Figure 137: Dataset: OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX Variable: EXFhl

### 21.4.2 Latlon Variable EXFhs

**Table 21.22: CDL description of OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX's EXFhs variable**

Storage Type	Variable Name	Description	Unit
float32	EXFhs	Open ocean air-sea sensible heat flux	W m <sup>-2</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			



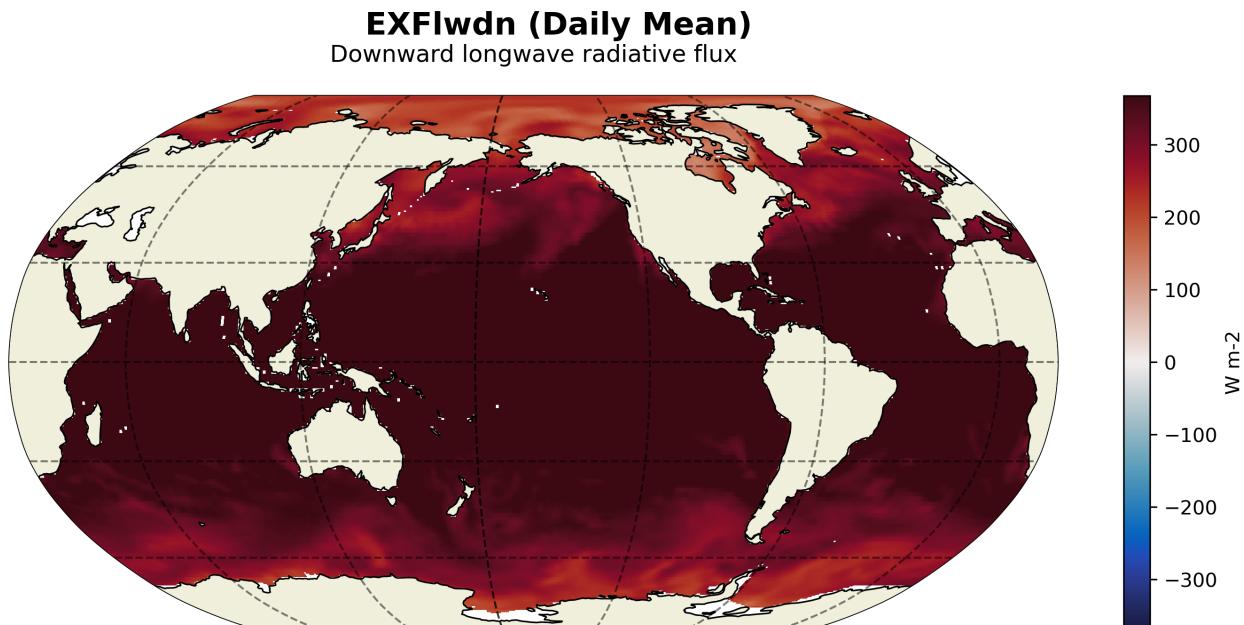
Example file 2017-12-29,  
OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_latlon\_0p50deg.nc

**Figure 138: Dataset: OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX Variable: EXFhs**

### 21.4.3 Latlon Variable EXFlwdn

**Table 21.23: CDL description of OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX's EXFlwdn variable**

Storage Type	Variable Name	Description	Unit
float32	EXFlwdn	Downward longwave radiative flux	W m <sup>-2</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
Downward longwave radiative flux. Note: sum of ERA-Interim downward longwave radiation and the control adjustment from ocean state estimation.			



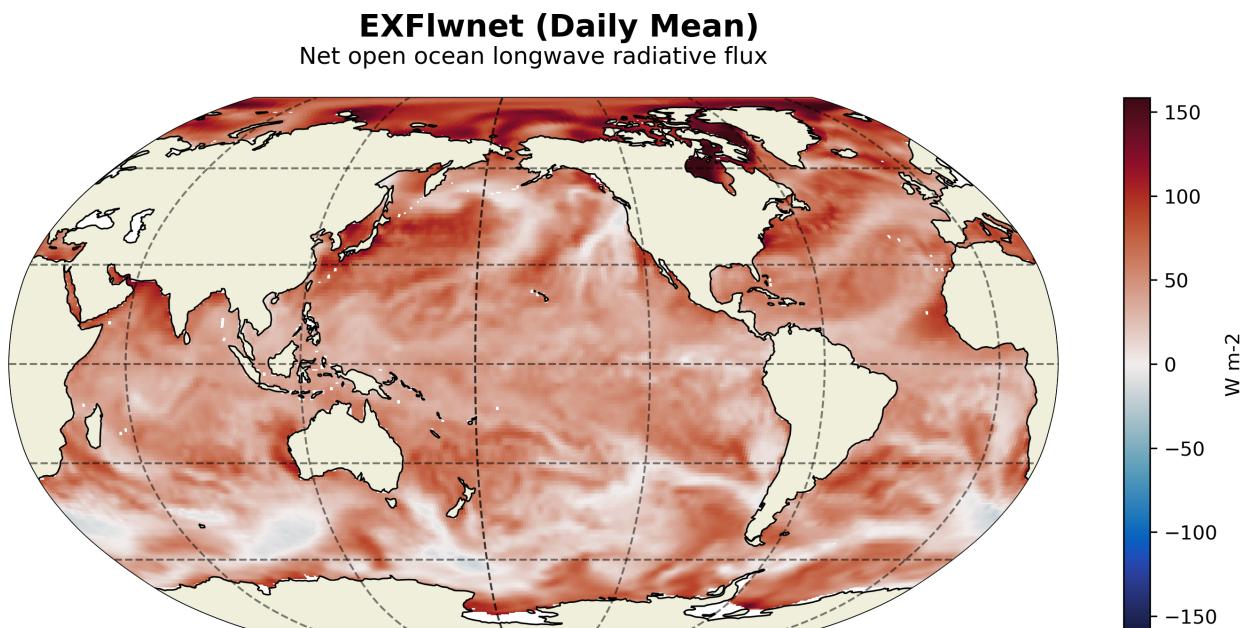
Example file 2017-12-29,  
OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_latlon\_0p50deg.nc

**Figure 139: Dataset: OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX Variable: EXFlwdn**

#### 21.4.4 Latlon Variable EXFlwnet

**Table 21.24: CDL description of OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX's EXFlwnet variable**

Storage Type	Variable Name	Description	Unit
float32	EXFlwnet	Net open ocean longwave radiative flux	W m <sup>-2</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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).			



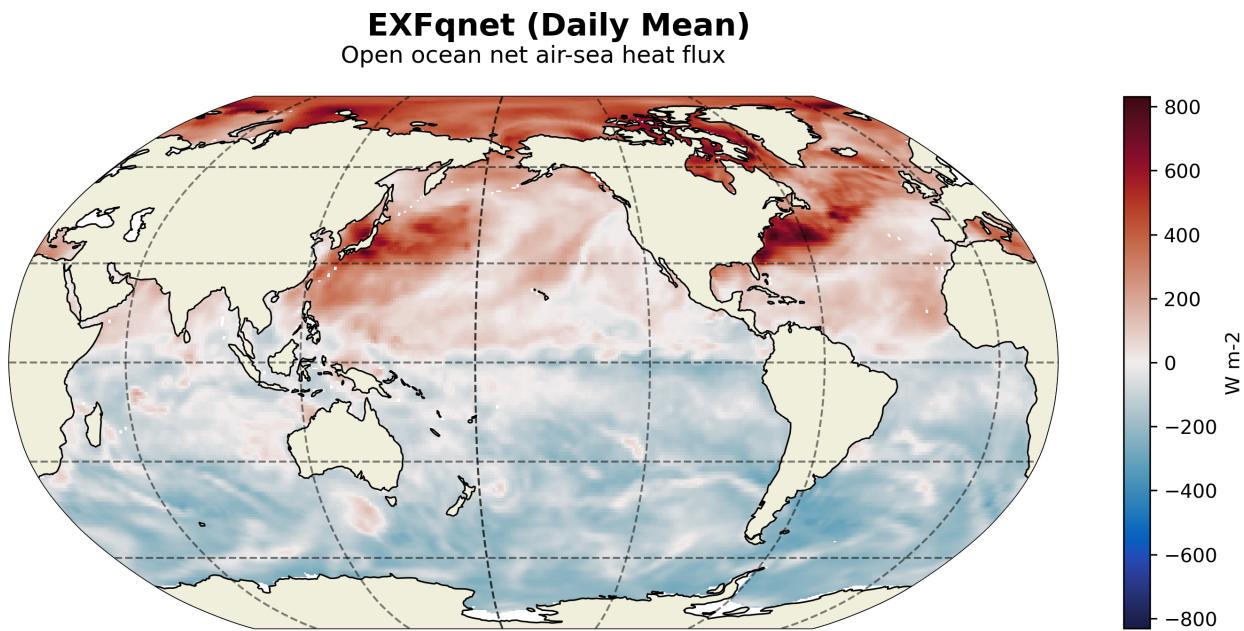
Example file 2017-12-29,  
OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_latlon\_0p50deg.nc

**Figure 140: Dataset: OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX Variable: EXFlwnet**

#### 21.4.5 Latlon Variable EXFqnet

**Table 21.25: CDL description of OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX's EXFqnet variable**

Storage Type	Variable Name	Description	Unit
float32	EXFqnet	Open ocean net air-sea heat flux	W m <sup>-2</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
Net air-sea heat flux (turbulent and radiative) per unit area of open water (not covered by sea-ice). Note: net upward heat flux over open water, calculated as EXFlwnet+EXFswnet-EXFlh-EXFhs.			

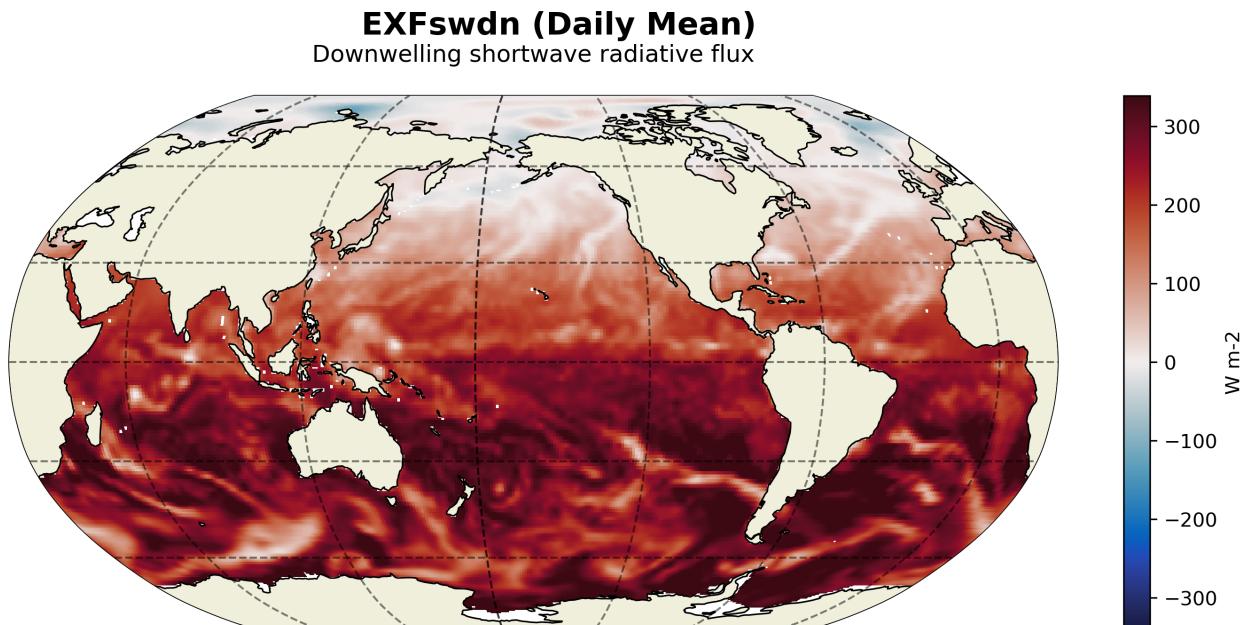


**Figure 141: Dataset: OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX Variable: EXFqnet**

#### 21.4.6 Latlon Variable EXFswdn

**Table 21.26: CDL description of OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX's EXFswdn variable**

Storage Type	Variable Name	Description	Unit
float32	EXFswdn	Downwelling shortwave radiative flux	W m <sup>-2</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
Downward shortwave radiative flux. Note: sum of ERA-Interim downward shortwave radiation and the control adjustment from ocean state estimation.			

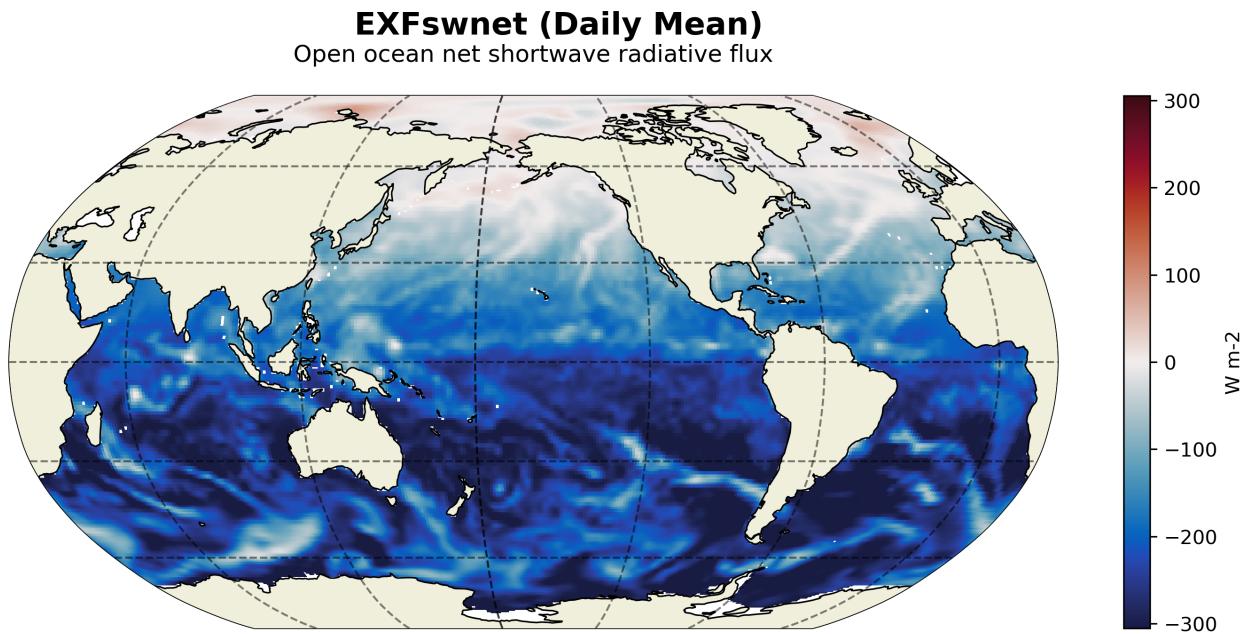


**Figure 142: Dataset: OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX Variable: EXFswdn**

#### 21.4.7 Latlon Variable EXFswnet

**Table 21.27: CDL description of OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX's EXFswnet variable**

Storage Type	Variable Name	Description	Unit
float32	EXFswnet	Open ocean net shortwave radiative flux	W m <sup>-2</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

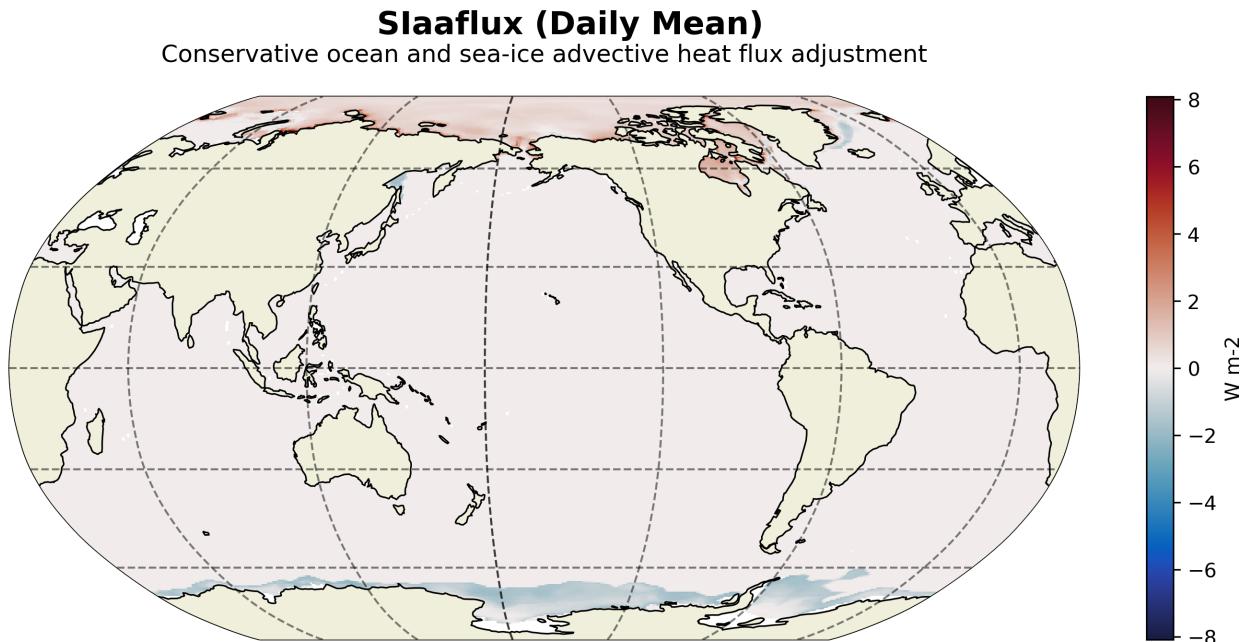


**Figure 143: Dataset: OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX Variable: EXFswnet**

#### 21.4.8 Latlon Variable Slaaflux

**Table 21.28: CDL description of OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX's Slaaflux variable**

Storage Type	Variable Name	Description	Unit
float32	Slaaflux	Conservative ocean and sea-ice advective heat flux adjustment	W m <sup>-2</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

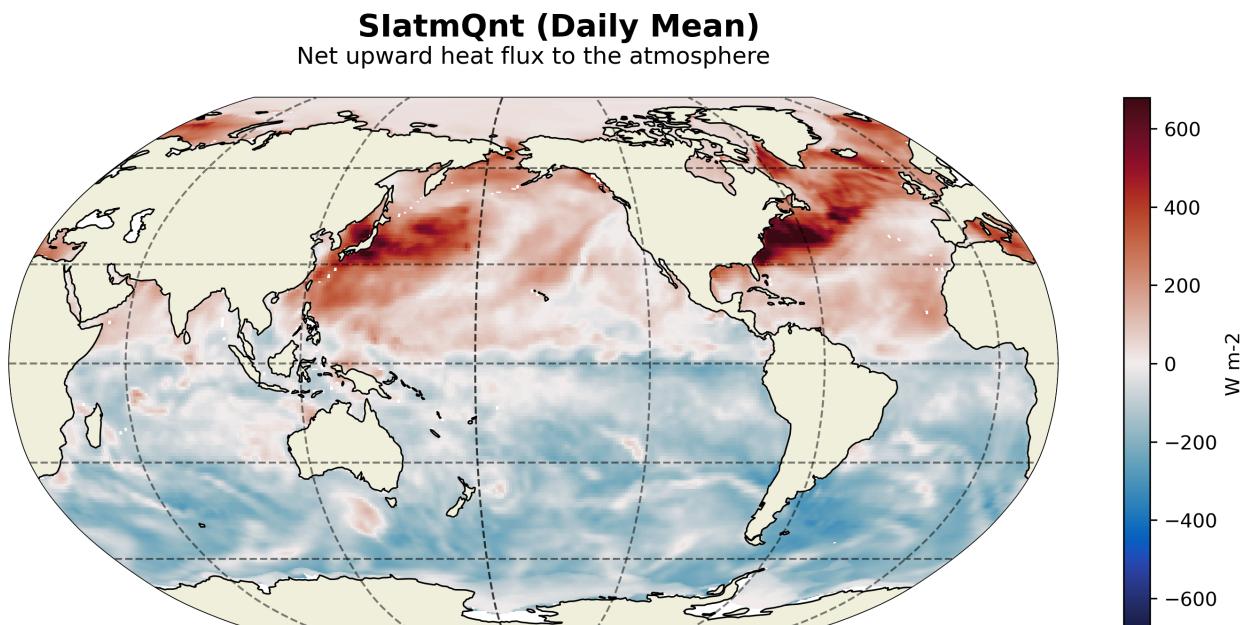


**Figure 144: Dataset: OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX Variable: Slaaflux**

#### 21.4.9 Latlon Variable SlatmQnt

**Table 21.29: CDL description of OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX's SlatmQnt variable**

Storage Type	Variable Name	Description	Unit
float32	SlatmQnt	Net upward heat flux to the atmosphere	W m <sup>-2</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
Net upward heat flux to the atmosphere across open water and sea-ice or snow surfaces. Note: nonzero SlatmQnt 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 145: Dataset: OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX Variable: SlatmQnt**

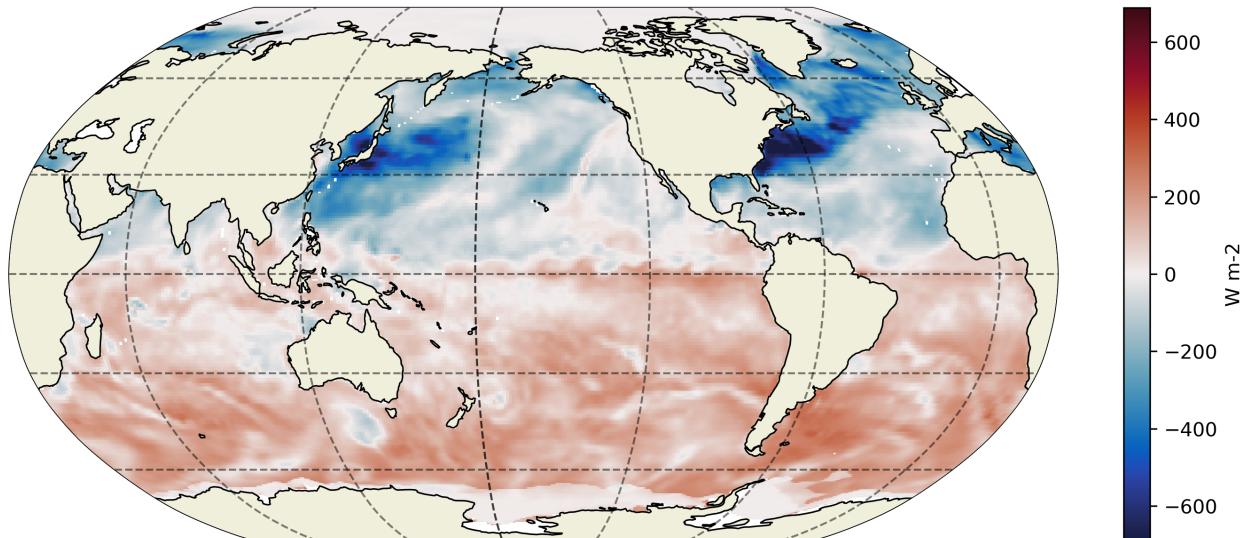
#### 21.4.10 Latlon Variable TFLUX

**Table 21.30: CDL description of OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX's TFLUX variable**

Storage Type	Variable Name	Description	Unit
float32	TFLUX	Rate of change of ocean heat content per m <sup>2</sup> accounting for mass fluxes.	W m <sup>-2</sup>
<b>CDL Description</b>			
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 <sup>2</sup> accounting for mass fluxes.			
TFLUX: units = W m: 2			
TFLUX: coordinates = time			
TFLUX: valid_min = : 1713.51220703125			
TFLUX: valid_max = 870.3130493164062			
<b>Comments</b>			
The rate of change of ocean heat content due to heat fluxes across the liquid surface and the addition or removal of mass. . .			
Note: the global area integral of TFLUX and geothermal flux (geothermalFlux.bin) matches the time-derivative of ocean heat content (J/s). Unlike oceQnet, TFLUX includes the contribution to the ocean heat content from changing ocean mass (e.g. from oceFWflx).			

#### TFLUX (Daily Mean)

Rate of change of ocean heat content per m<sup>2</sup> accounting for mass fluxes.



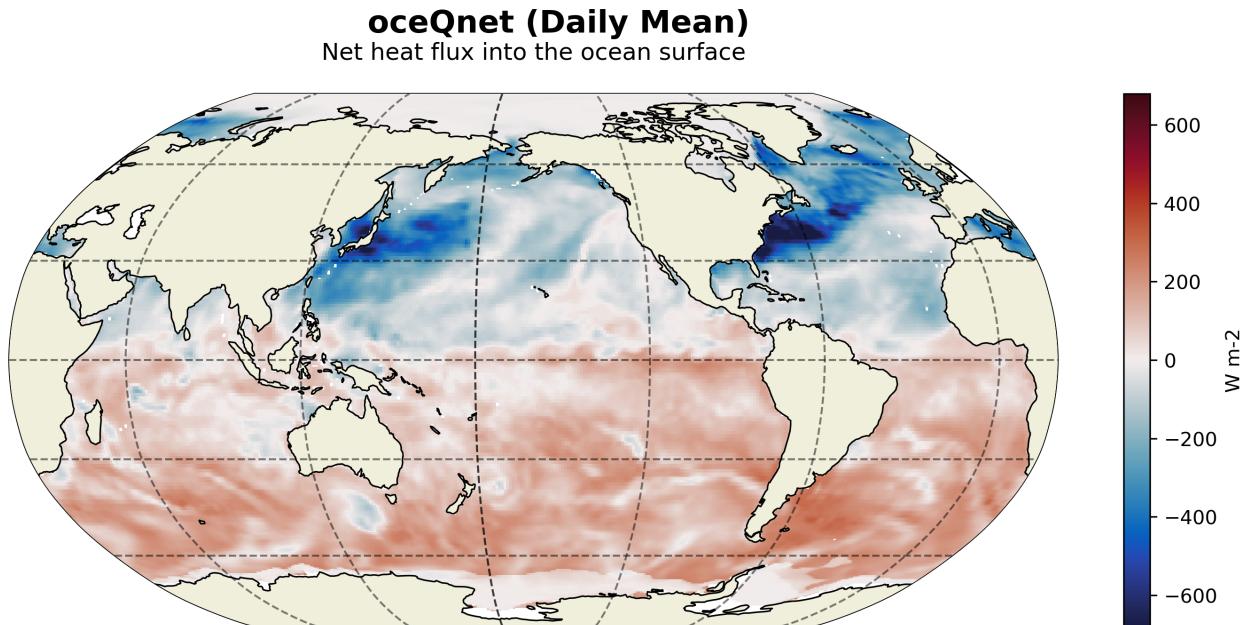
Example file 2017-12-29,  
OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX\_day\_mean\_2017-12-29\_ECCO\_V4r4\_latlon\_0p50deg.nc

**Figure 146: Dataset: OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX Variable: TFLUX**

#### 21.4.11 Latlon Variable oceQnet

**Table 21.31: CDL description of OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX's oceQnet variable**

Storage Type	Variable Name	Description	Unit
float32	oceQnet	Net heat flux into the ocean surface	W m <sup>-2</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 temperature is not OC. The variable TFLUX does include the change in ocean heat content due to changing ocean mass.			

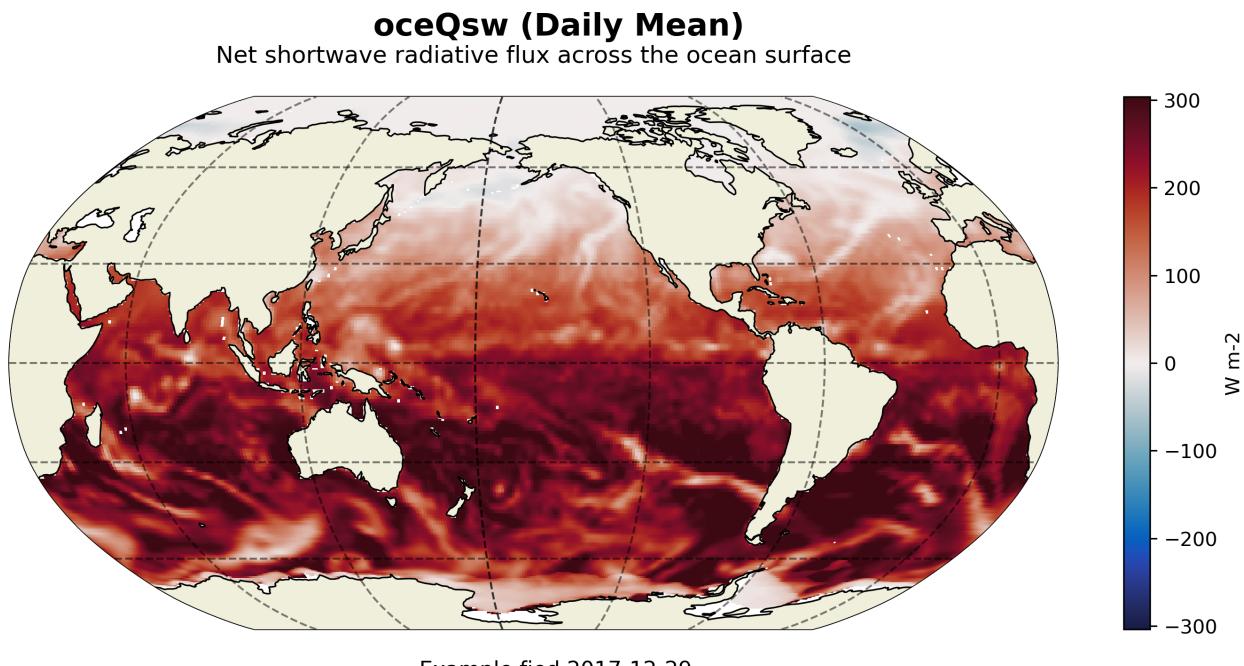


**Figure 147: Dataset: OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX Variable: oceQnet**

#### 21.4.12 Latlon Variable oceQsw

**Table 21.32: CDL description of OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX's oceQsw variable**

Storage Type	Variable Name	Description	Unit
float32	oceQsw	Net shortwave radiative flux across the ocean surface	W m <sup>-2</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
Net shortwave radiative flux across the ocean surface. Note: Shortwave radiation penetrates below the surface grid cell.			



**Figure 148: Dataset: OCEAN\_AND\_ICE\_SURFACE\_HEAT\_FLUX Variable: oceQsw**

## 21.5 Latlon NetCDF OCEAN\_AND\_ICE\_SURFACE\_STRESS

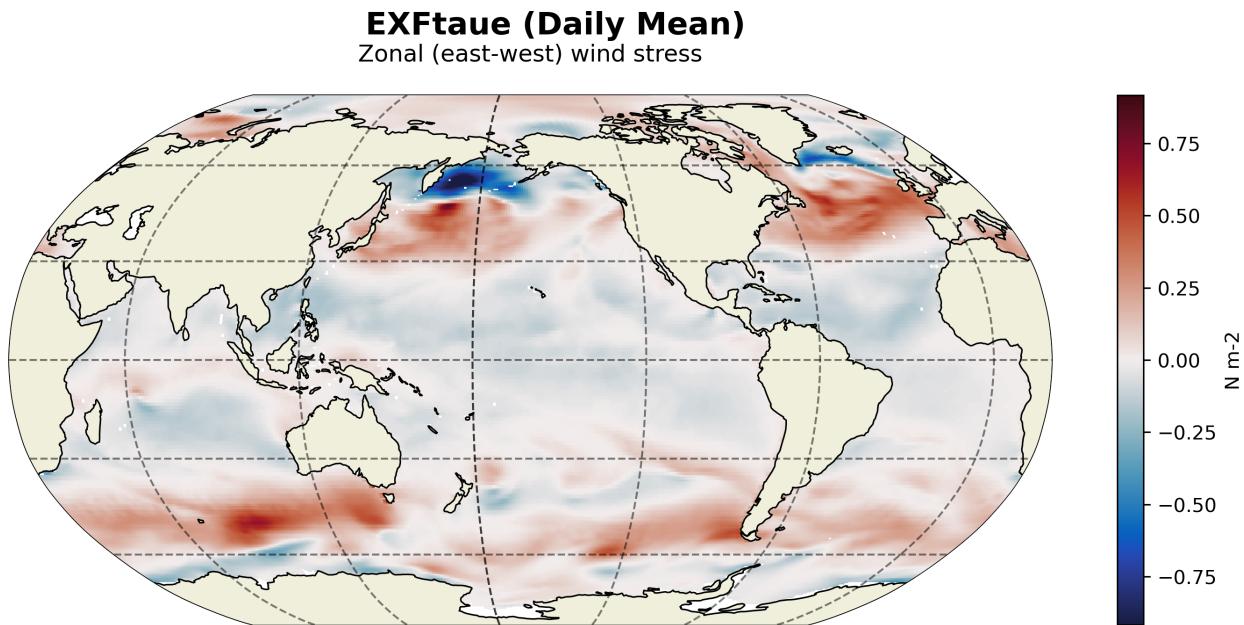
Table 21.33: Variables in the dataset OCEAN\_AND\_ICE\_SURFACE\_STRESS

Dataset:	OCEAN_AND_ICE_SURFACE_STRESS
Field:	EXFtaue
Field:	EXFtaun
Field:	oceTAUE
Field:	oceTAUN

### 21.5.1 Latlon Variable EXFtaue

**Table 21.34: CDL description of OCEAN\_AND\_ICE\_SURFACE\_STRESS's EXFtaue variable**

Storage Type	Variable Name	Description	Unit
float32	EXFtaue	Zonal (east-west) wind stress	N m <sup>-2</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

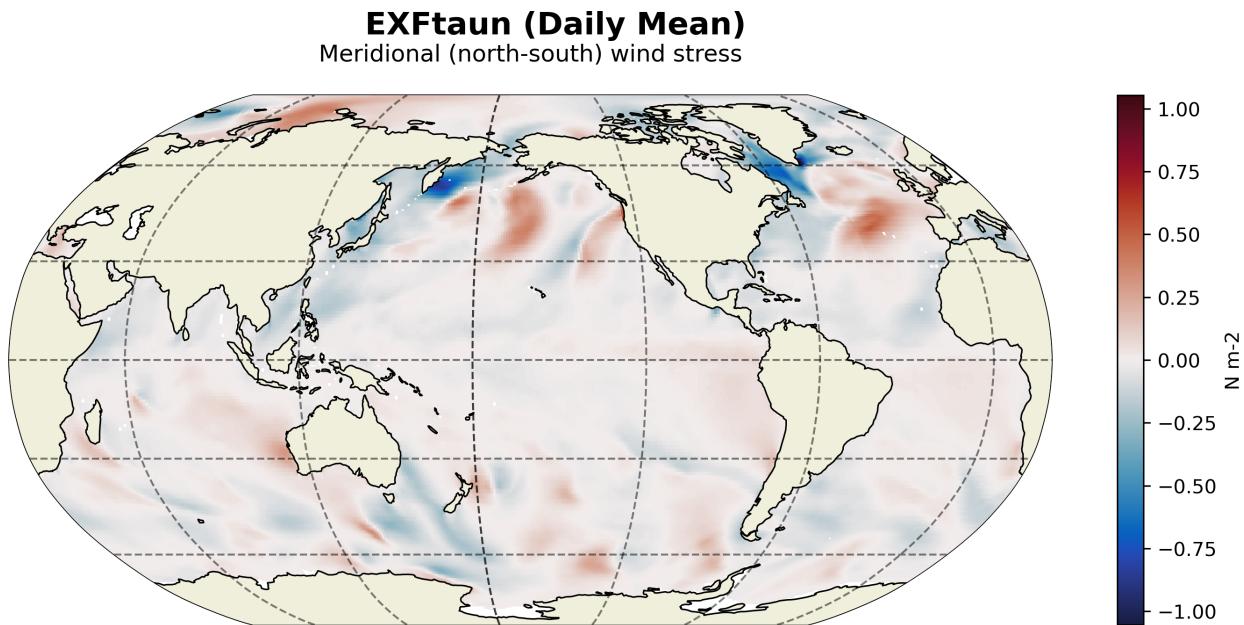


**Figure 149: Dataset: OCEAN\_AND\_ICE\_SURFACE\_STRESS Variable: EXFtaue**

### 21.5.2 Latlon Variable EXFtaun

**Table 21.35: CDL description of OCEAN\_AND\_ICE\_SURFACE\_STRESS's EXFtaun variable**

Storage Type	Variable Name	Description	Unit
float32	EXFtaun	Meridional (north-south) wind stress	N m <sup>-2</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
Meridional (north-south) component of wind stress. Note: EXFtaun is the stress applied to the ocean and sea-ice. When sea-ice is present, the total meridional stress applied to the ocean surface is NOT EXFtaun, but a combination of the wind stress in the open water fraction (EXFtaun) and a stress from sea-ice in the ice-covered fraction (see oceTAUN). EXFtaun is calculated by interpolating the model's x and y components of wind stress (EXFtaux and EXFtauy) to tracer cell centers and then determining the meridional component of the interpolated vectors. It is NOT recommended to use EXFtaue and EXFtaun for momentum budget calculations because interpolating EXFtaux and EXFtauy from the model grid to the lat-lon grid introduces errors. For momentum fluxes to the ocean surface see oceTAUx and oceTAUy.			

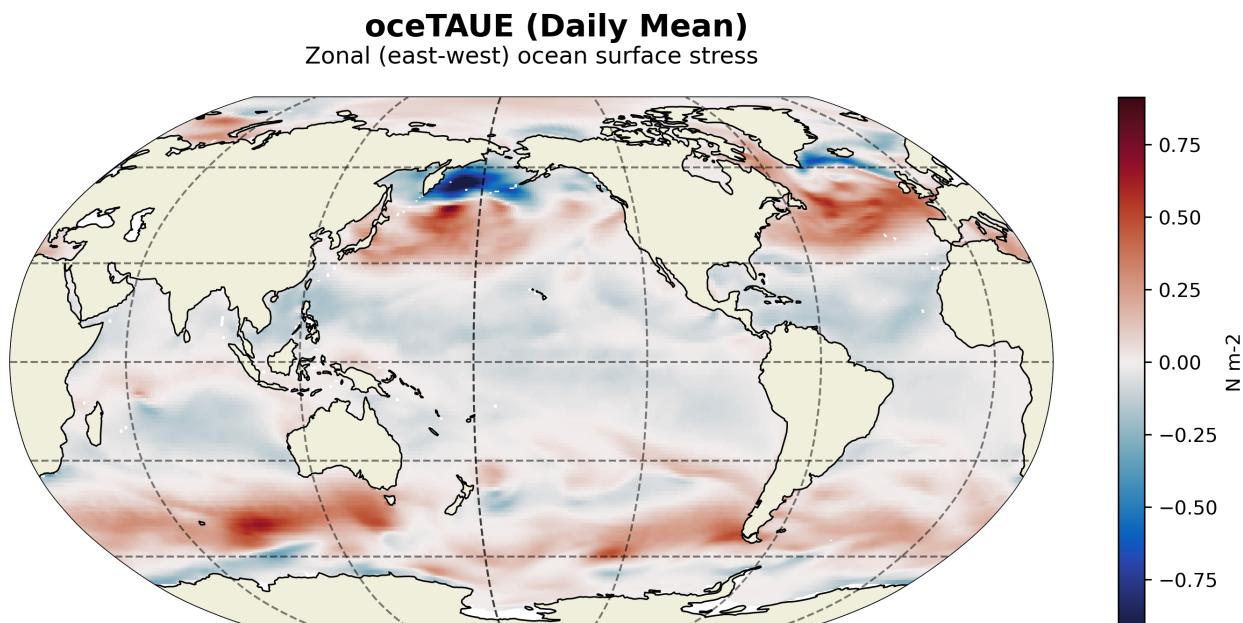


**Figure 150: Dataset: OCEAN\_AND\_ICE\_SURFACE\_STRESS Variable: EXFtaun**

### 21.5.3 Latlon Variable oceTAUE

**Table 21.36: CDL description of OCEAN\_AND\_ICE\_SURFACE\_STRESS's oceTAUE variable**

Storage Type	Variable Name	Description	Unit
float32	oceTAUE	Zonal (east-west) ocean surface stress	N m-2
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			



Example file 2017-12-29,  
OCEAN\_AND\_ICE\_SURFACE\_STRESS\_day\_mean\_2017-12-29\_ECCO\_V4r4\_latlon\_0p50deg.nc

**Figure 151: Dataset: OCEAN\_AND\_ICE\_SURFACE\_STRESS Variable: oceTAUE**

#### 21.5.4 Latlon Variable oceTAUN

Table 21.37: CDL description of OCEAN\_AND\_ICE\_SURFACE\_STRESS's oceTAUN variable

Storage Type	Variable Name	Description	Unit
float32	oceTAUN	Meridional (north-south) ocean surface stress	N m <sup>-2</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
Meridional (north-south) component of ocean surface stress due to wind and sea-ice. Note: oceTAUN is calculated by interpolating the model's x and y components of ocean surface stress (oceTAUX and oceTAUY) to tracer cell centers and then finding the meridional component of the interpolated vectors.			

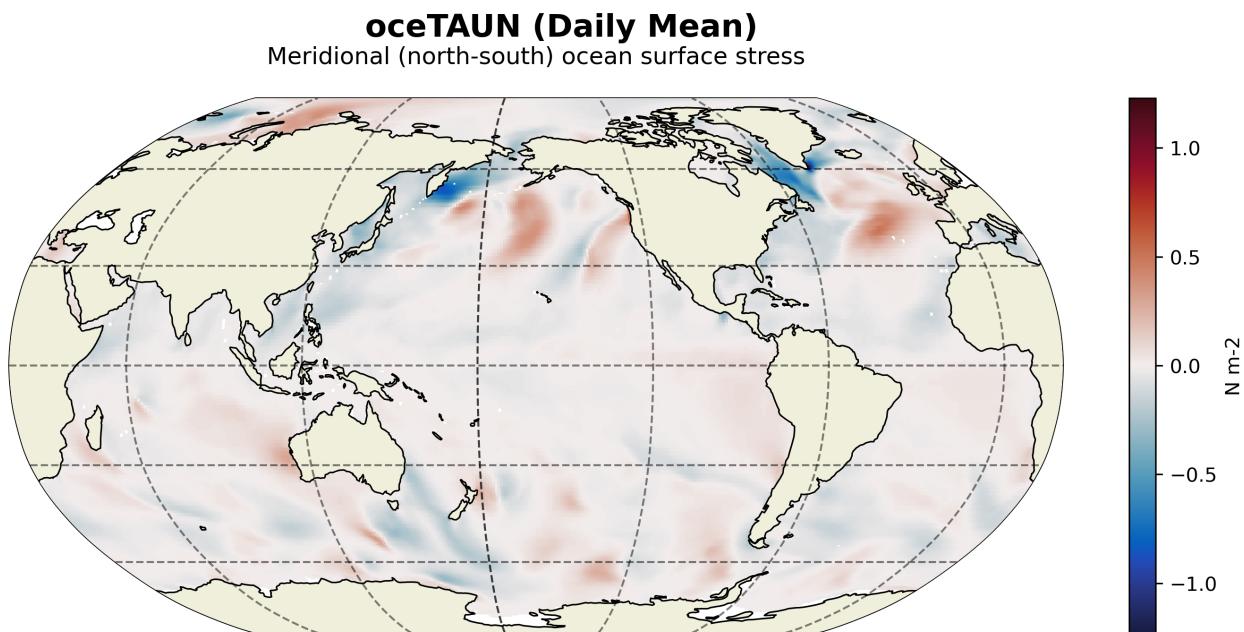


Figure 152: Dataset: OCEAN\_AND\_ICE\_SURFACE\_STRESS Variable: oceTAUN

## 21.6 Latlon NetCDF OCEAN\_BOLUS\_VELOCITY

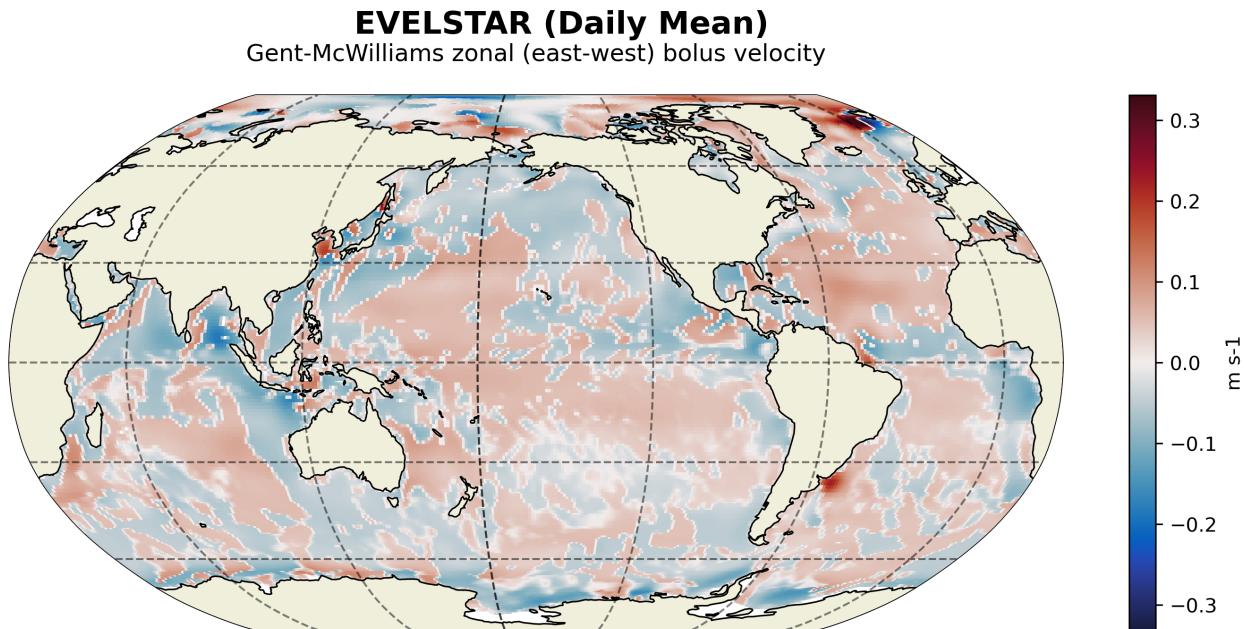
**Table 21.38: Variables in the dataset OCEAN\_BOLUS\_VELOCITY**

Dataset:	OCEAN_BOLUS_VELOCITY
Field:	EVELSTAR
Field:	NVELSTAR
Field:	WVELSTAR

### 21.6.1 Latlon Variable EVELSTAR

**Table 21.39: CDL description of OCEAN\_BOLUS\_VELOCITY's EVELSTAR variable**

Storage Type	Variable Name	Description	Unit
float32	EVELSTAR	Gent-McWilliams zonal (east-west) bolus velocity	m s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 budget calculations require bolus velocity terms on the native model grid.			

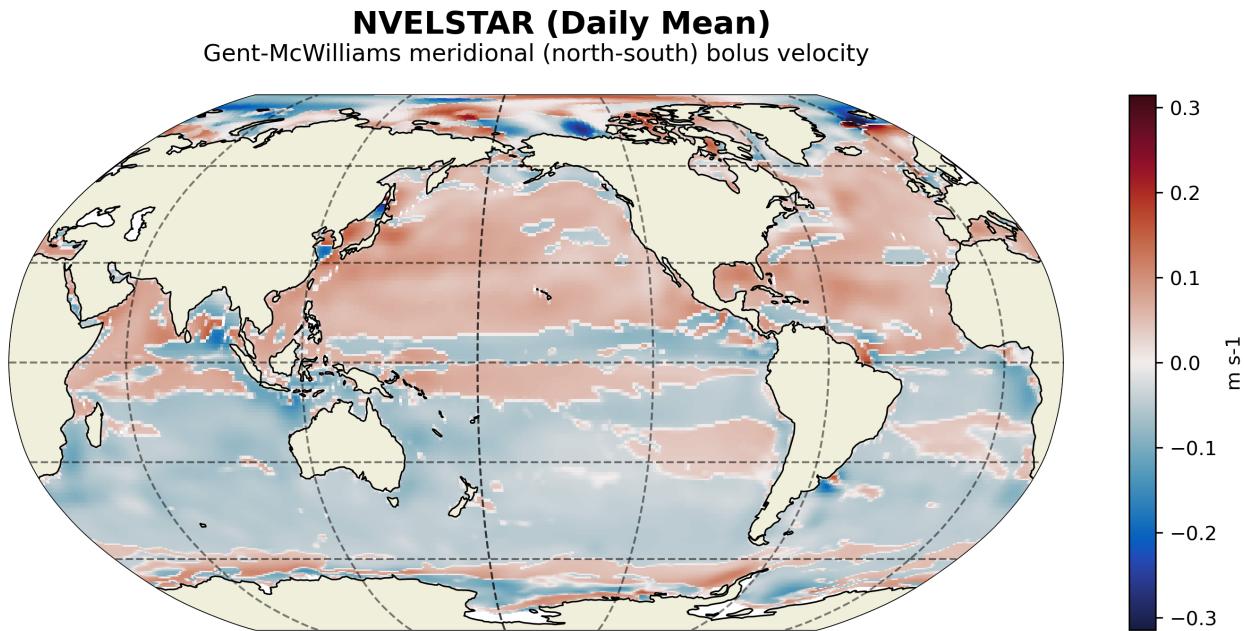


**Figure 153: Dataset: OCEAN\_BOLUS\_VELOCITY Variable: EVELSTAR**

## 21.6.2 Latlon Variable NVELSTAR

**Table 21.40: CDL description of OCEAN\_BOLUS\_VELOCITY's NVELSTAR variable**

Storage Type	Variable Name	Description	Unit
float32	NVELSTAR	Gent-McWilliams meridional (north-south) bolus velocity	m s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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			

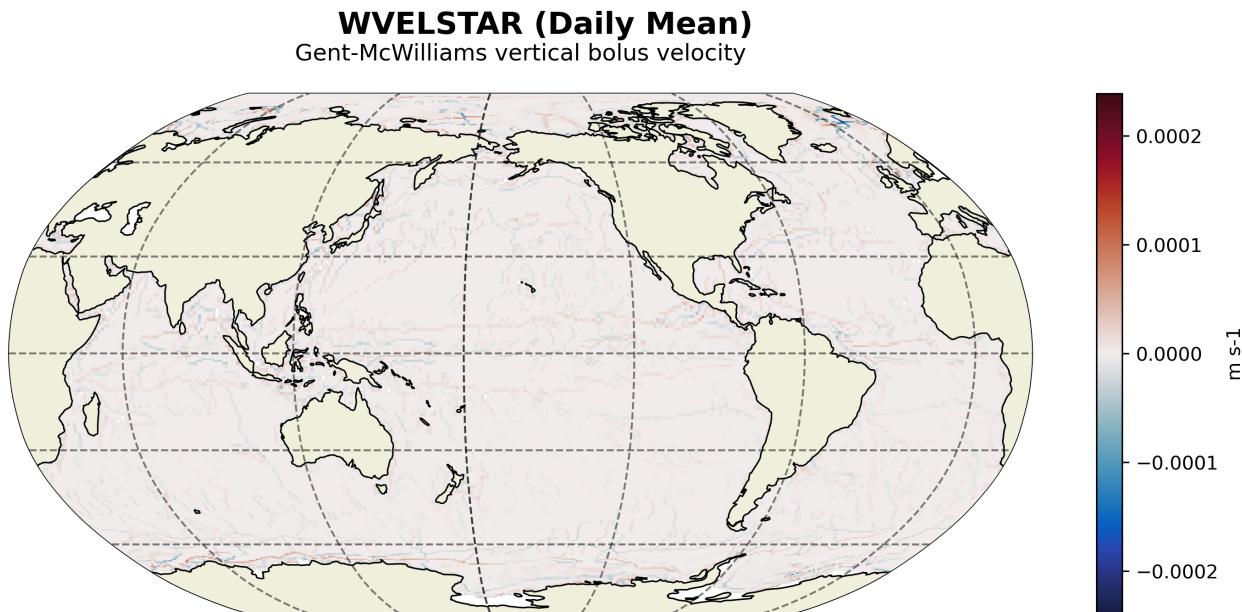


**Figure 154: Dataset: OCEAN\_BOLUS\_VELOCITY Variable: NVELSTAR**

### 21.6.3 Latlon Variable WVELSTAR

**Table 21.41: CDL description of OCEAN\_BOLUS\_VELOCITY's WVELSTAR variable**

Storage Type	Variable Name	Description	Unit
float32	WVELSTAR	Gent-McWilliams vertical bolus velocity	m s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 155: Dataset: OCEAN\_BOLUS\_VELOCITY Variable: WVELSTAR**

## 21.7 Latlon NetCDF OCEAN\_BOTTOM\_PRESSURE

Table 21.42: Variables in the dataset OCEAN\_BOTTOM\_PRESSURE

Dataset:	OCEAN_BOTTOM_PRESSURE
Field:	OBP
Field:	OBPGMAP

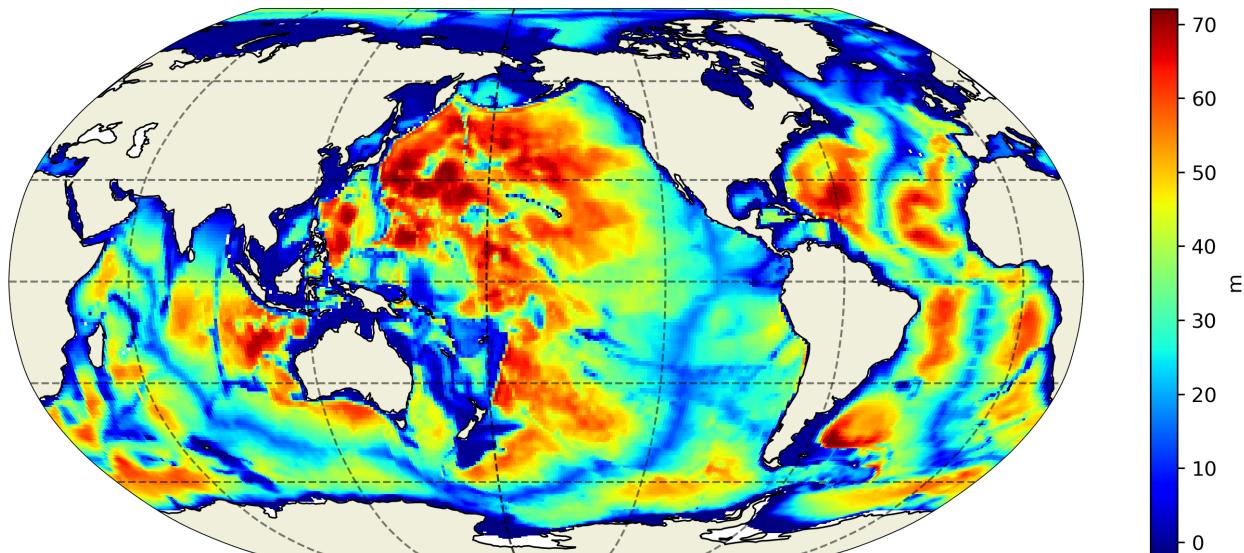
### 21.7.1 Latlon Variable OBP

**Table 21.43: CDL description of OCEAN\_BOTTOM\_PRESSURE's OBP variable**

Storage Type	Variable Name	Description	Unit
float32	OBP	Ocean bottom pressure given as equivalent water thickness	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 $\text{PHIBOT} = p_b/\rho_{\text{Const}} - gH(t)$ , where $p_b$ = model ocean hydrostatic bottom pressure, $\rho_{\text{Const}}$ = reference density ( $1029 \text{ kg m}^{-3}$ ), $g$ is acceleration due to gravity ( $9.81 \text{ m s}^{-2}$ ), and $H(t)$ is model depth at time $t$ . Then, $\text{OBP} = \text{PHIBOT}/g + \text{corrections for i) global mean steric sea level changes related to density changes in the Boussinesq volume-conserving model (Greatbatch correction, see sterGloH) and ii) global mean atmospheric pressure variations. Use OBP for comparisons with ocean bottom pressure data products that have been corrected for global mean atmospheric pressure variations. GRACE data typically ARE corrected for global mean atmospheric pressure variations. In contrast, ocean bottom pressure gauge data typically ARE NOT corrected for global mean atmospheric pressure variations.$			

### OBP (Daily Mean)

Ocean bottom pressure given as equivalent water thickness



Example file 2017-12-29,  
OCEAN\_BOTTOM\_PRESSURE\_day\_mean\_2017-12-29\_ECCO\_V4r4\_latlon\_0p50deg.nc

**Figure 156: Dataset: OCEAN\_BOTTOM\_PRESSURE Variable: OBP**

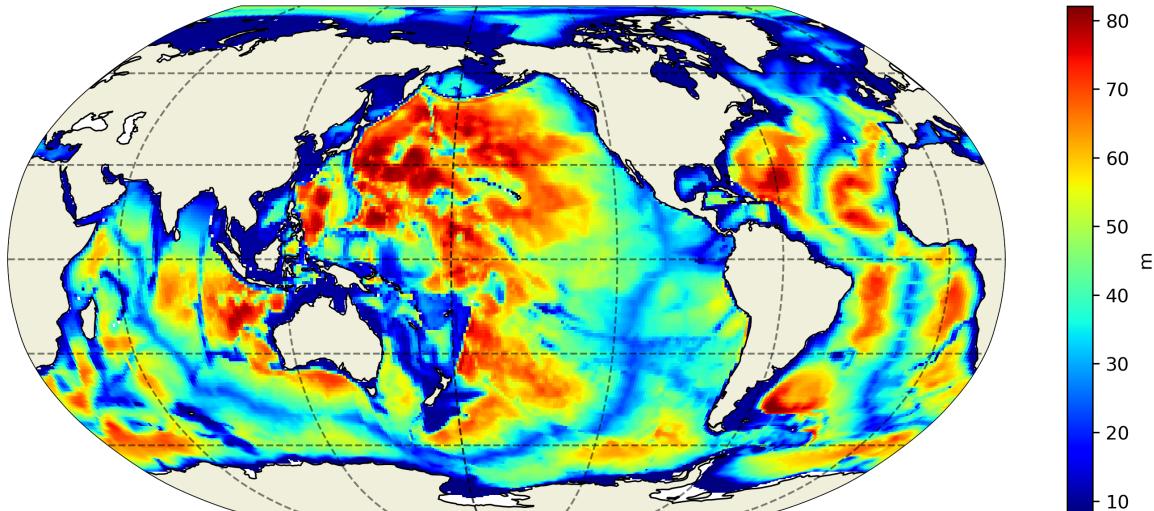
### 21.7.2 Latlon Variable OBPGMAP

**Table 21.44: CDL description of OCEAN\_BOTTOM\_PRESSURE's OBPGMAP variable**

Storage Type	Variable Name	Description	Unit
float32	OBPGMAP	Ocean bottom pressure given as equivalent water thickness, includes global mean atmospheric pressure	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
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, $\rho_{\text{Const}}$ = reference density ( $1029 \text{ kg m}^{-3}$ ), $g$ is acceleration due to gravity ( $9.81 \text{ m s}^{-2}$ ), and $H(t)$ is model depth at time $t$ . Then, $\text{OBPGMAP} = \text{PHIBOT}/g + \text{corrections for global mean steric sea level changes related to density changes in the Boussinesq volume-conserving model (Greatbatch correction, see sterGloH)}$ . Use OBPGMAP for comparisons with ocean bottom pressure data products that have NOT been corrected for global mean atmospheric pressure variations. GRACE data typically ARE corrected for global mean atmospheric pressure variations. In contrast, ocean bottom pressure gauge data typically ARE NOT corrected for global mean atmospheric pressure variations.			

### OBPGMAP (Daily Mean)

Ocean bottom pressure given as equivalent water thickness, includes global mean atmospheric pressure



Example file 2017-12-29,  
OCEAN\_BOTTOM\_PRESSURE\_day\_mean\_2017-12-29\_ECCO\_V4r4\_latlon\_0p50deg.nc

**Figure 157: Dataset: OCEAN\_BOTTOM\_PRESSURE Variable: OBPGMAP**

## 21.8 Latlon NetCDF OCEAN\_DENS\_STRAT\_PRESS

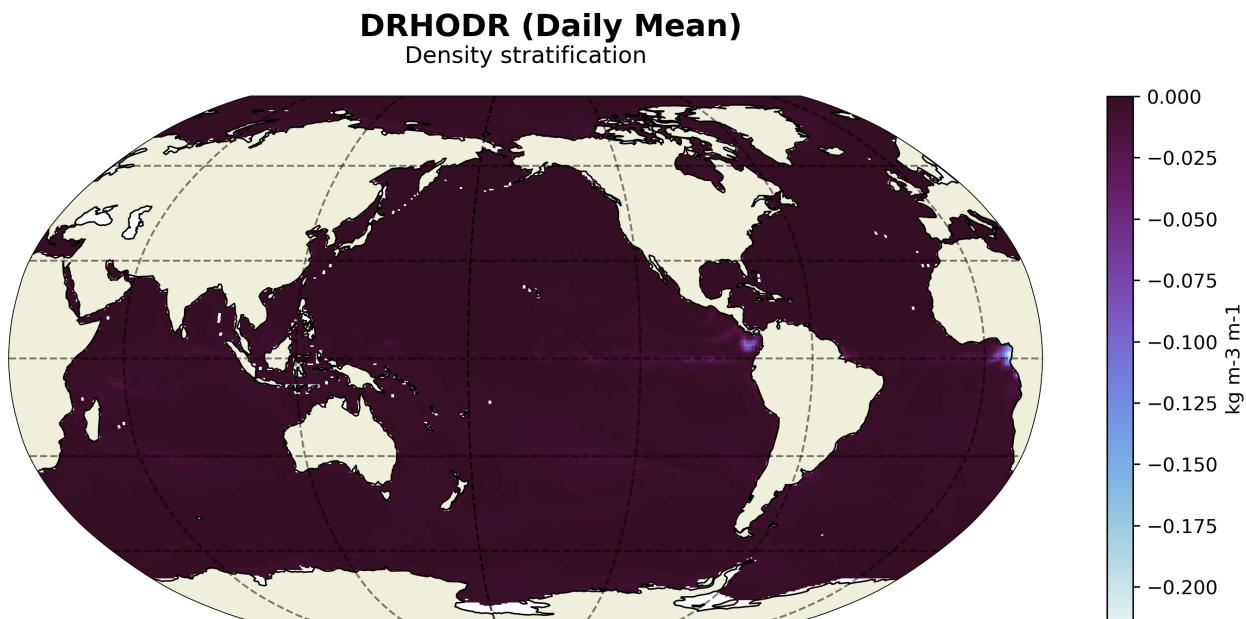
**Table 21.45: Variables in the dataset OCEAN\_DENS\_STRAT\_PRESS**

Dataset:	OCEAN_DENS_STRAT_PRESS
Field:	RHOAnoma
Field:	DRHODR
Field:	PHIHYD

### 21.8.1 Latlon Variable DRHODR

Table 21.46: CDL description of OCEAN\_DENS\_STRAT\_PRESS's DRHODR variable

Storage Type	Variable Name	Description	Unit
float32	DRHODR	Density stratification	kg m <sup>-3</sup> m <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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\$.			



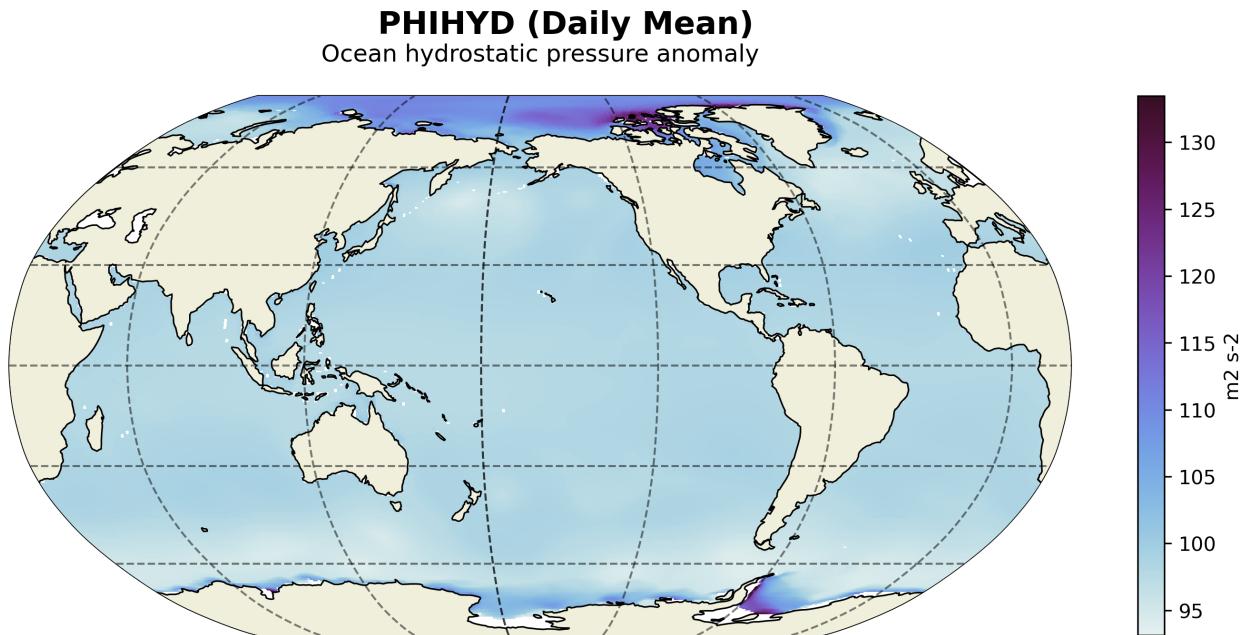
Example file 2017-12-29,  
OCEAN\_DENS\_STRAT\_PRESS\_day\_mean\_2017-12-29\_ECCO\_V4r4\_latlon\_0p50deg.nc

Figure 158: Dataset: OCEAN\_DENS\_STRAT\_PRESS Variable: DRHODR

## 21.8.2 Latlon Variable PHIHYD

**Table 21.47: CDL description of OCEAN\_DENS\_STRAT\_PRESS's PHIHYD variable**

Storage Type	Variable Name	Description	Unit
float32	PHIHYD	Ocean hydrostatic pressure anomaly	m <sup>2</sup> s <sup>-2</sup>
<b>CDL Description</b>			
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 = m <sup>2</sup> s <sup>-2</sup>			
PHIHYD: coordinates = time Z			
PHIHYD: valid_min = 74.71473693847656			
PHIHYD: valid_max = 783.9188232421875			
<b>Comments</b>			
PHIHYD = p(k) / rhoConst - g z*(k,t), where p = hydrostatic ocean pressure at depth level k, rhoConst = reference density (1029 kg m <sup>-3</sup> ), g is acceleration due to gravity (9.81 m s <sup>-2</sup> ), and z*(k,t) is model depth at level k and time t. Units: p:[kg m <sup>-1</sup> s <sup>-2</sup> ], rhoConst:[kg m <sup>-3</sup> ], g:[m s <sup>-2</sup> ], H(t):[m]. Note: includes atmospheric pressure loading. Quantity referred to in some contexts as hydrostatic pressure anomaly. PHIBOT accounts for the model's time-varying grid cell thickness (z* coordinate system). See PHIHYDcR for hydrostatic pressure potential anomaly calculated using time-invariant grid cell thicknesses. PHIHYD is NOT corrected for global mean steric sea level changes related to density changes in the Boussinesq volume-conserving model (Greatbatch correction, see sterGloH).			



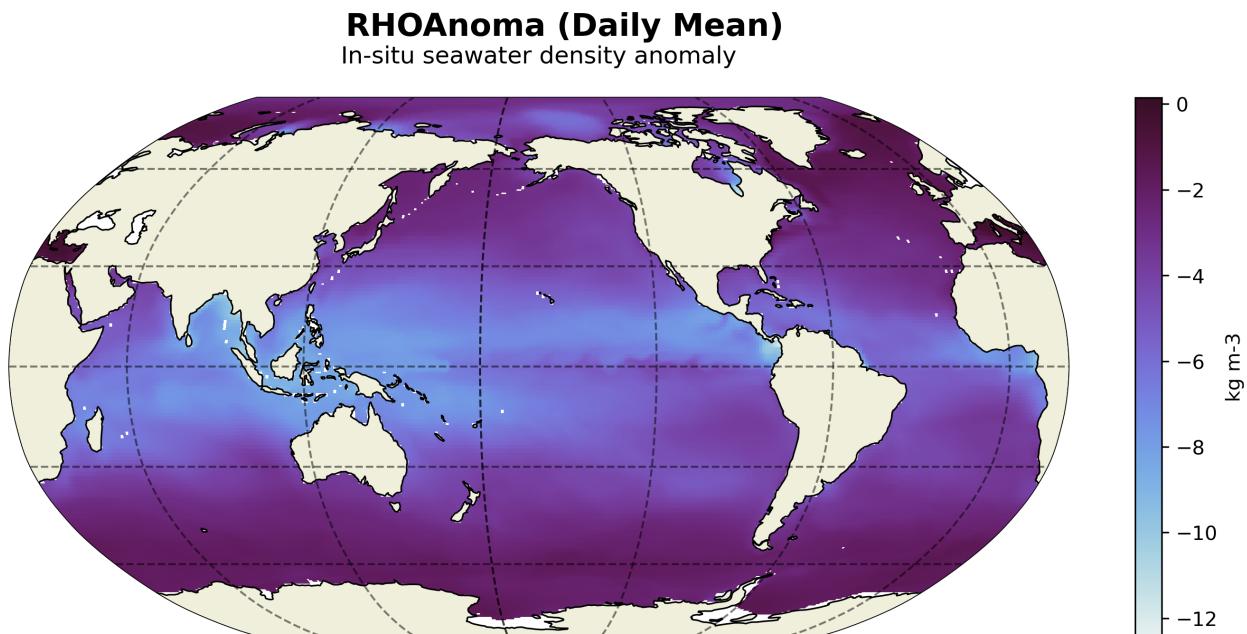
Example file 2017-12-29,  
OCEAN\_DENS\_STRAT\_PRESS\_day\_mean\_2017-12-29\_ECCO\_V4r4\_latlon\_0p50deg.nc

**Figure 159: Dataset: OCEAN\_DENS\_STRAT\_PRESS Variable: PHIHYD**

### 21.8.3 Latlon Variable RHOAnoma

**Table 21.48: CDL description of OCEAN\_DENS\_STRAT\_PRESS's RHOAnoma variable**

Storage Type	Variable Name	Description	Unit
float32	RHOAnoma	In-situ seawater density anomaly	kg m <sup>-3</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
In-situ seawater density anomaly relative to the reference density, rhoConst. rhoConst = 1029 kg m <sup>-3</sup>			



Example file 2017-12-29,  
OCEAN\_DENS\_STRAT\_PRESS\_day\_mean\_2017-12-29\_ECCO\_V4r4\_latlon\_0p50deg.nc

**Figure 160: Dataset: OCEAN\_DENS\_STRAT\_PRESS Variable: RHOAnoma**

## 21.9 Latlon NetCDF OCEAN\_MIXED\_LAYER\_DEPTH

**Table 21.49: Variables in the dataset OCEAN\_MIXED\_LAYER\_DEPTH**

Dataset:	OCEAN_MIXED_LAYER_DEPTH
Field:	MXLDEPTH

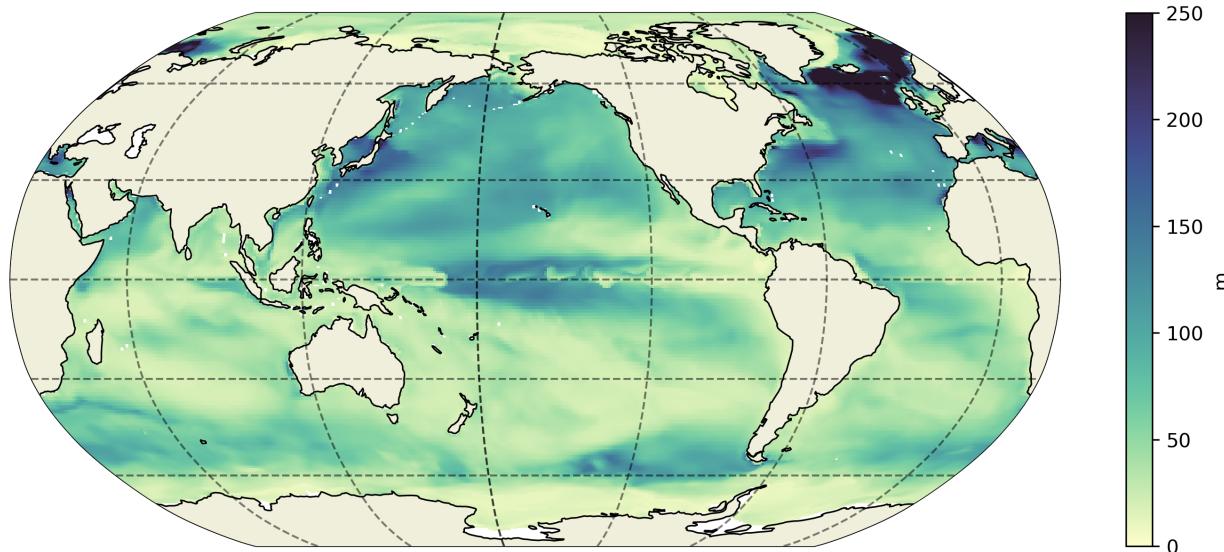
### 21.9.1 Latlon Variable MXLDEPTH

**Table 21.50: CDL description of OCEAN\_MIXED\_LAYER\_DEPTH's MXLDEPTH variable**

Storage Type	Variable Name	Description	Unit
float32	MXLDEPTH	Mixed-layer depth diagnosed using the temperature difference criterion of Kara et al., 2000	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
Mixed-layer depth as determined by the depth where waters are first 0.8 degrees Celsius colder than the surface. See Kara et al. (JGR, 2000). . Note: the Kara et al. criterion may not be appropriate for some applications. If needed, mixed layer depth can be calculated using different criteria. See vertical density stratification (DRHODR) and density anomaly (RHOAnoma).			

### MXLDEPTH (Daily Mean)

Mixed-layer depth diagnosed using the temperature difference criterion of Kara et al., 2000



Example file 2017-12-29,  
OCEAN\_MIXED\_LAYER\_DEPTH\_day\_mean\_2017-12-29\_ECCO\_V4r4\_latlon\_0p50deg.nc

**Figure 161: Dataset: OCEAN\_MIXED\_LAYER\_DEPTH Variable: MXLDEPTH**

## 21.10 Latlon NetCDF OCEAN\_TEMPERATURE\_SALINITY

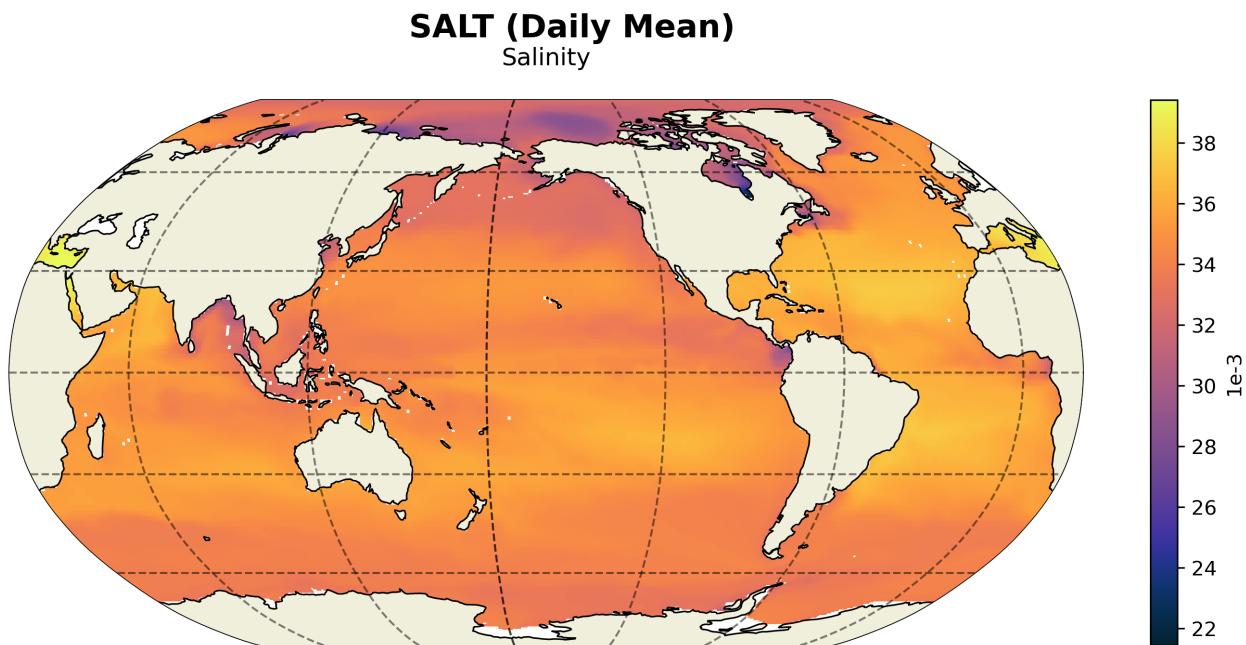
**Table 21.51: Variables in the dataset OCEAN\_TEMPERATURE\_SALINITY**

Dataset:	OCEAN_TEMPERATURE_SALINITY
Field:	THETA
Field:	SALT

### 21.10.1 Latlon Variable SALT

**Table 21.52: CDL description of OCEAN\_TEMPERATURE\_SALINITY's SALT variable**

Storage Type	Variable Name	Description	Unit
float32	SALT	Salinity	1e-3
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 <a href="https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html">https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html</a>			



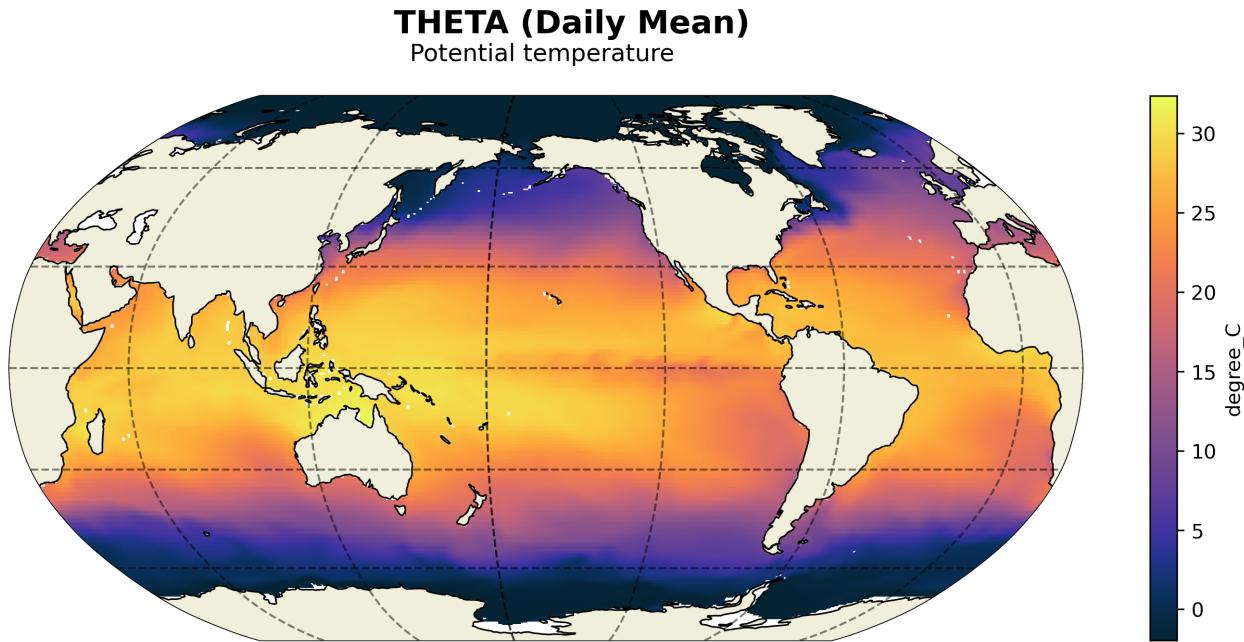
Example file 2017-12-29,  
OCEAN\_TEMPERATURE\_SALINITY\_day\_mean\_2017-12-29\_ECCO\_V4r4\_latlon\_0p50deg.nc

**Figure 162: Dataset: OCEAN\_TEMPERATURE\_SALINITY Variable: SALT**

## 21.10.2 Latlon Variable THETA

**Table 21.53: CDL description of OCEAN\_TEMPERATURE\_SALINITY's THETA variable**

Storage Type	Variable Name	Description	Unit
float32	THETA	Potential temperature	degree_C
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 $\$p_0 = -g h o_{[O]} z \$$ .			



**Figure 163: Dataset: OCEAN\_TEMPERATURE\_SALINITY Variable: THETA**

## 21.11 Latlon NetCDF OCEAN\_VELOCITY

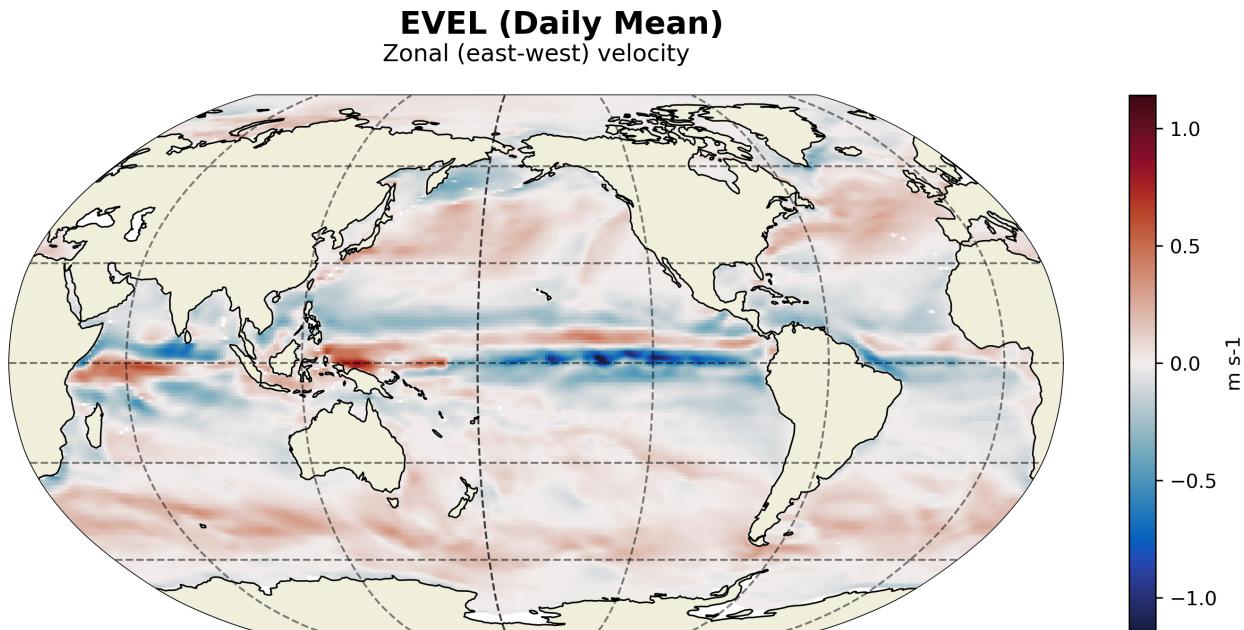
Table 21.54: Variables in the dataset OCEAN\_VELOCITY

Dataset:	OCEAN_VELOCITY
Field:	EVEL
Field:	NVEL
Field:	WVEL

### 21.11.1 Latlon Variable EVEL

**Table 21.55: CDL description of OCEAN\_VELOCITY's EVEL variable**

Storage Type	Variable Name	Description	Unit
float32	EVEL	Zonal (east-west) velocity	m s <sup>-1</sup>
<b>CDL Description</b>			
float32 EVEL(time, Z, latitude, longitude)			
EVEL:_FillValue = 9.96921e+36			
EVEL:coverage_content_type = modelResult			
EVEL:long_name = Zonal (east: west) velocity			
EVEL:standard_name = eastward_sea_water_velocity			
EVEL:units = m s: 1			
EVEL:coordinates = Z time			
EVEL:valid_min = : 1.746832251548767			
EVEL:valid_max = 1.948591947555542			
<b>Comments</b>			
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.			



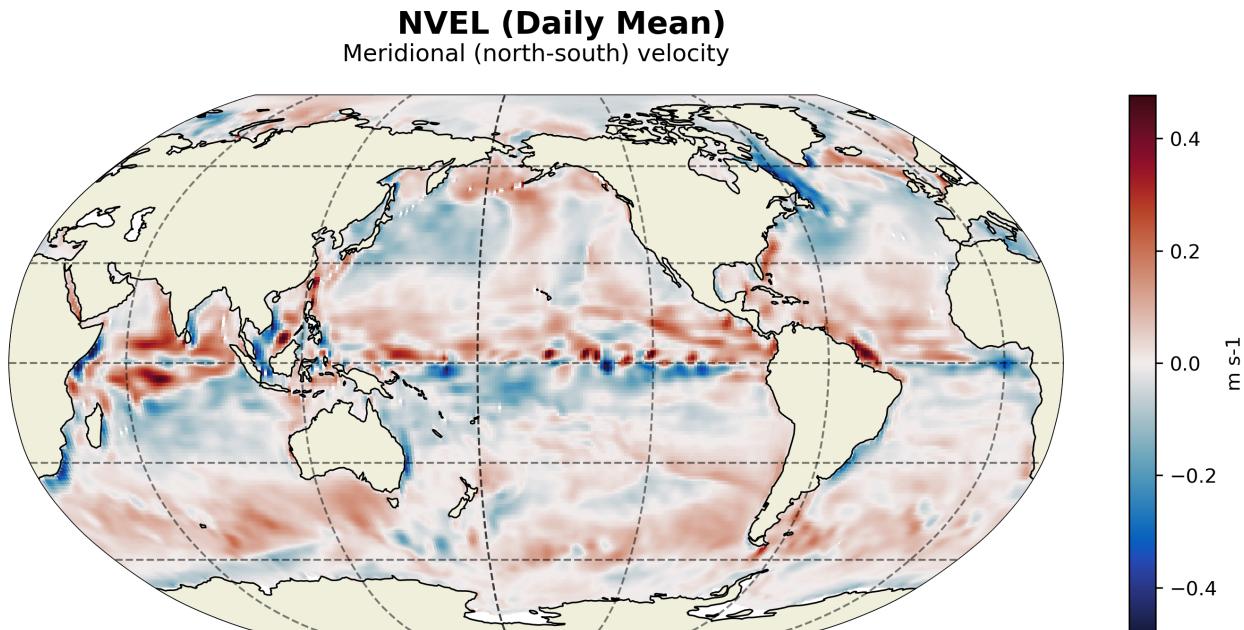
Example file 2017-12-29,  
OCEAN\_VELOCITY\_day\_mean\_2017-12-29\_ECCO\_V4r4\_latlon\_0p50deg.nc

**Figure 164: Dataset: OCEAN\_VELOCITY Variable: EVEL**

### 21.11.2 Latlon Variable NVEL

**Table 21.56: CDL description of OCEAN\_VELOCITY's NVEL variable**

Storage Type	Variable Name	Description	Unit
float32	NVEL	Meridional (north-south) velocity	m s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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.			

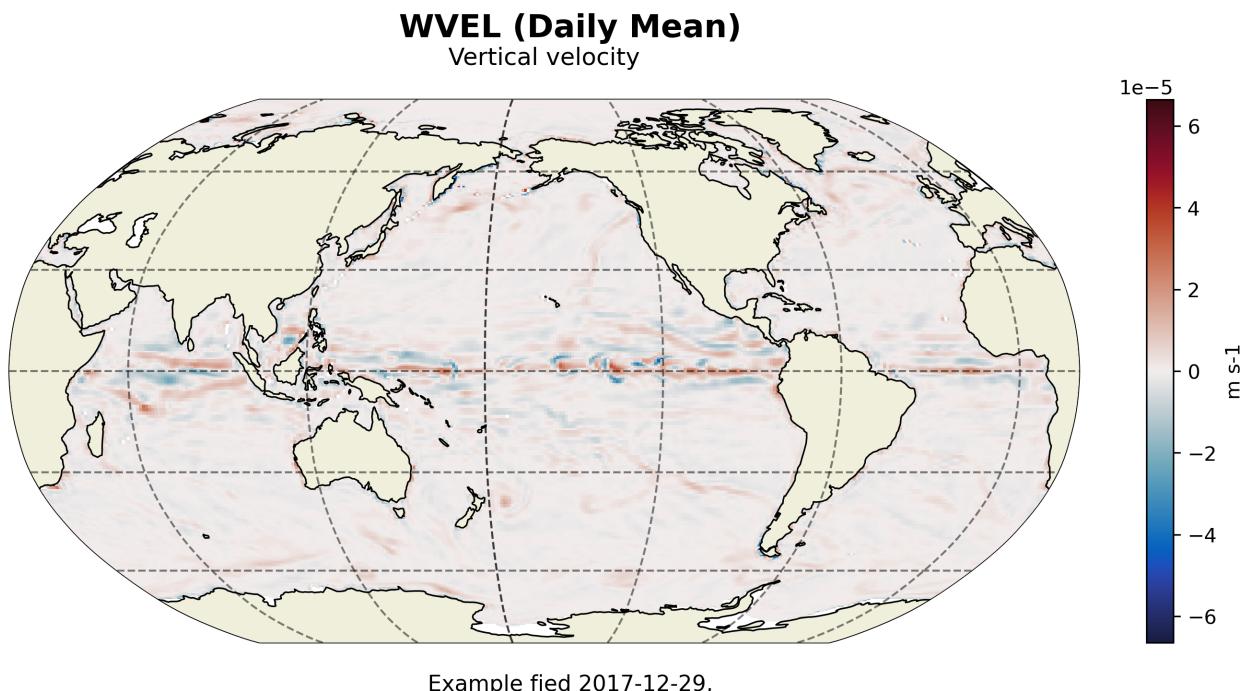


**Figure 165: Dataset: OCEAN\_VELOCITY Variable: NVEL**

### 21.11.3 Latlon Variable WVEL

**Table 21.57: CDL description of OCEAN\_VELOCITY's WVEL variable**

Storage Type	Variable Name	Description	Unit
float32	WVEL	Vertical velocity	m s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 166: Dataset: OCEAN\_VELOCITY Variable: WVEL**

## 21.12 Latlon NetCDF SEA\_ICE\_CONC\_THICKNESS

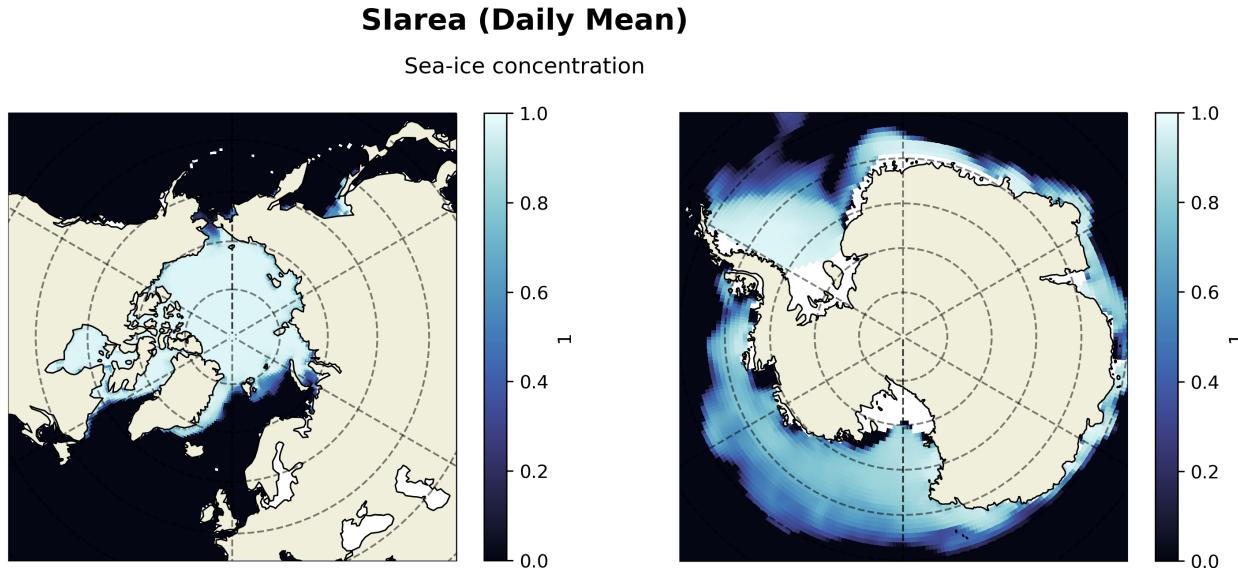
Table 21.58: Variables in the dataset SEA\_ICE\_CONC\_THICKNESS

Dataset:	SEA_ICE_CONC_THICKNESS
Field:	Slarea
Field:	Slheff
Field:	Slhsnow
Field:	slceLoad

### 21.12.1 Latlon Variable Slarea

**Table 21.59: CDL description of SEA\_ICE\_CONC\_THICKNESS's Slarea variable**

Storage Type	Variable Name	Description	Unit
float32	Slarea	Sea-ice concentration	1
<b>CDL Description</b>			
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			
<b>Comments</b>			
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. <a href="https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html">https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html</a> . 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. <a href="https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html">https://cfconventions.org/Data/cf-standard-names/73/build/cf-standard-name-table.html</a>			

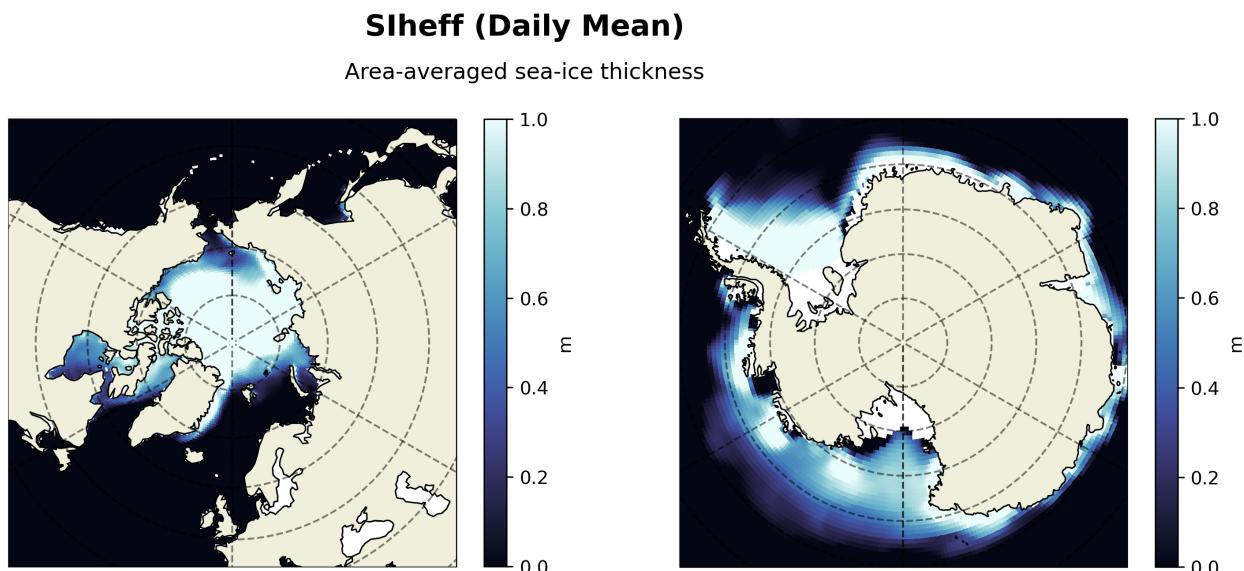


**Figure 167: Dataset: SEA\_ICE\_CONC\_THICKNESS Variable: Slarea**

### 21.12.2 Latlon Variable Slheff

**Table 21.60: CDL description of SEA\_ICE\_CONC\_THICKNESS's Slheff variable**

Storage Type	Variable Name	Description	Unit
float32	Slheff	Area-averaged sea-ice thickness	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 Slheff/Slarea			

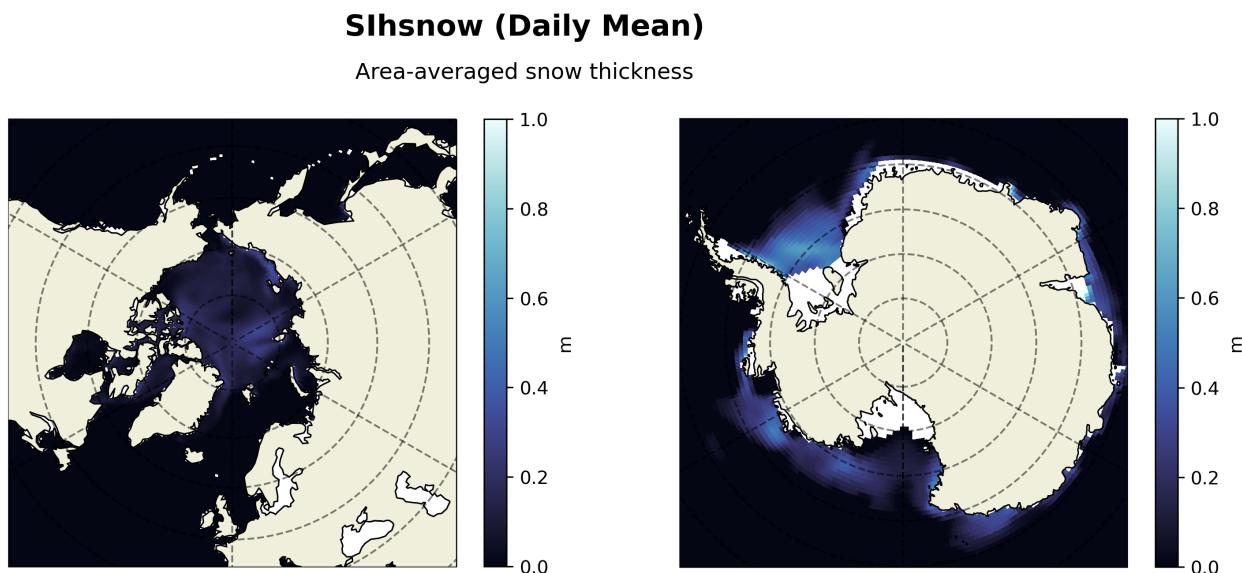


**Figure 168: Dataset: SEA\_ICE\_CONC\_THICKNESS Variable: Slheff**

### 21.12.3 Latlon Variable Slhsnow

**Table 21.61: CDL description of SEA\_ICE\_CONC\_THICKNESS's Slhsnow variable**

Storage Type	Variable Name	Description	Unit
float32	Slhsnow	Area-averaged snow thickness	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 Slhsnow/Slarea			



**Figure 169: Dataset: SEA\_ICE\_CONC\_THICKNESS Variable: Slhsnow**

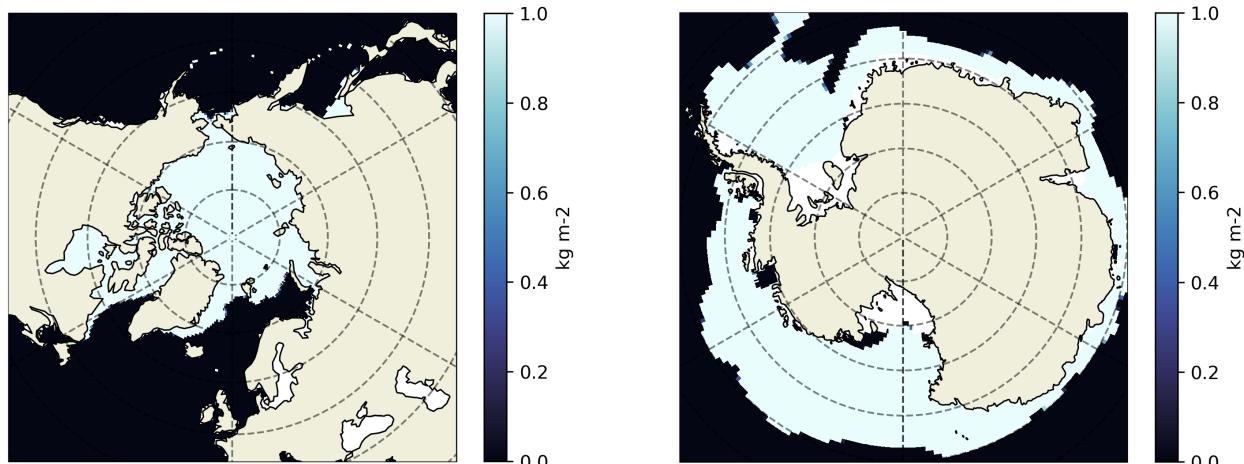
#### 21.12.4 Latlon Variable slceLoad

**Table 21.62: CDL description of SEA\_ICE\_CONC\_THICKNESS's slceLoad variable**

Storage Type	Variable Name	Description	Unit
float32	slceLoad	Average sea-ice and snow mass per unit area	kg m <sup>-2</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
Total mass of sea-ice and snow in a model grid cell averaged over model grid cell area. Note: slceLoad 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.			

#### slceLoad (Daily Mean)

Average sea-ice and snow mass per unit area



Example file 2017-12-29,  
SEA\_ICE\_CONC\_THICKNESS\_day\_mean\_2017-12-29\_ECCO\_V4r4\_latlon\_0p50deg.nc

**Figure 170: Dataset: SEA\_ICE\_CONC\_THICKNESS Variable: slceLoad**

## 21.13 Latlon NetCDF SEA\_ICE\_VELOCITY

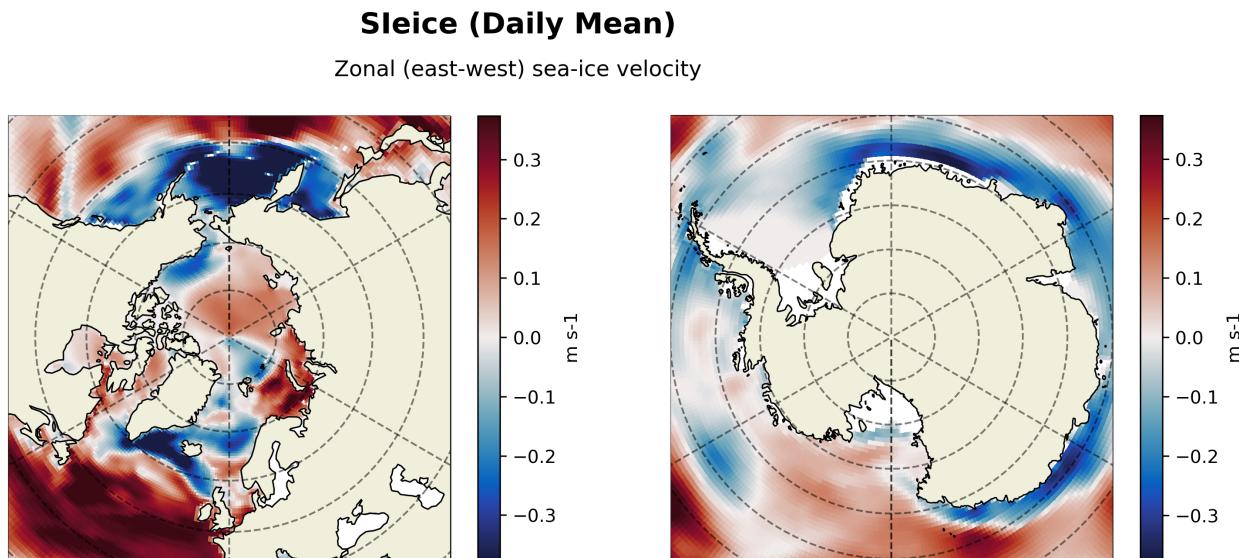
**Table 21.63: Variables in the dataset SEA\_ICE\_VELOCITY**

Dataset:	<b>SEA_ICE_VELOCITY</b>
Field:	Sleice
Field:	Slnice

### 21.13.1 Latlon Variable Sleice

**Table 21.64: CDL description of SEA\_ICE\_VELOCITY's Sleice variable**

Storage Type	Variable Name	Description	Unit
float32	Sleice	Zonal (east-west) sea-ice velocity	m s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
Zonal (east-west) component of sea-ice velocity. Note: mask with Slarea to remove nonzero values where ice is absent. Sleice is calculated by interpolating the model's x and y components of sea-ice velocity (Sluice and Slvice) to tracer cell centers and then finding the zonal component of the interpolated vectors. It is NOT recommended to use Sluice and Slvice for sea-ice volume budget calculations because interpolating Sluice and Slvice 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.			



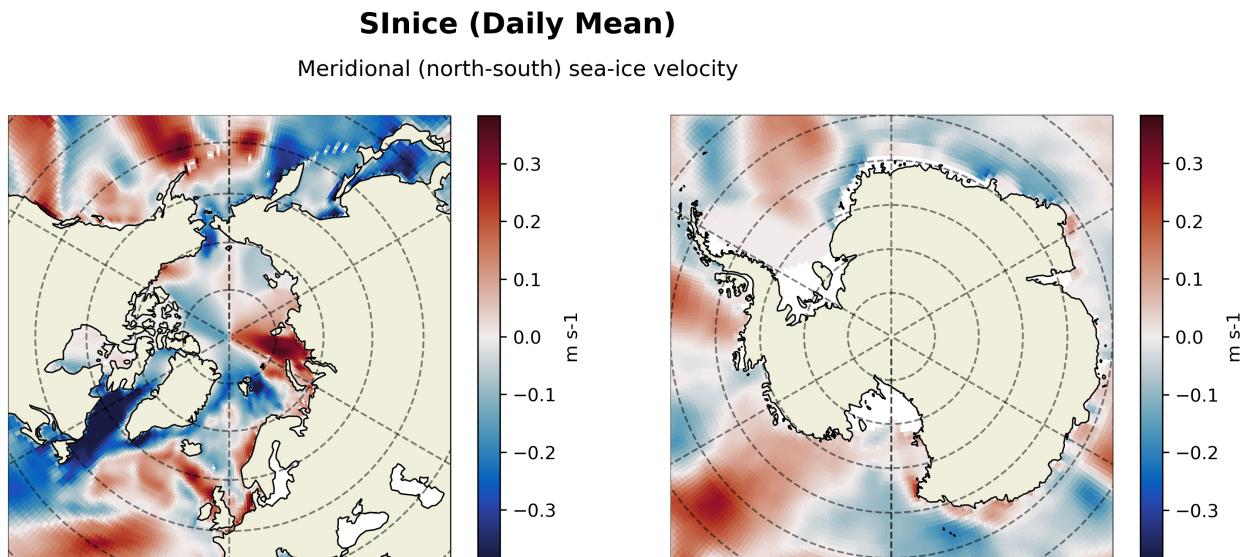
Example file 2017-12-29,  
SEA\_ICE\_VELOCITY\_day\_mean\_2017-12-29\_ECCO\_V4r4\_latlon\_0p50deg.nc

**Figure 171: Dataset: SEA\_ICE\_VELOCITY Variable: Sleice**

### 21.13.2 Latlon Variable Slnice

**Table 21.65: CDL description of SEA\_ICE\_VELOCITY's Slnice variable**

Storage Type	Variable Name	Description	Unit
float32	Slnice	Meridional (north-south) sea-ice velocity	m s <sup>-1</sup>
<b>CDL Description</b>			
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			
<b>Comments</b>			
Meridional (north-south) component of sea-ice velocity. Note: mask with Slarea to remove nonzero values where ice is absent. Slnice is calculated by interpolating the model's x and y components of sea-ice velocity (Sluice and Slvce) to tracer cell centers and then finding the meridional component of the interpolated vectors. It is NOT recommended to use Sluice and Slvce for sea-ice volume budget calculations because interpolating Sluice and Slvce 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.			



Example file 2017-12-29,  
SEA\_ICE\_VELOCITY\_day\_mean\_2017-12-29\_ECCO\_V4r4\_latlon\_0p50deg.nc

**Figure 172: Dataset: SEA\_ICE\_VELOCITY Variable: Slnice**

## 21.14 Latlon NetCDF SEA\_SURFACE\_HEIGHT

Table 21.66: Variables in the dataset SEA\_SURFACE\_HEIGHT

Dataset:	SEA_SURFACE_HEIGHT
Field:	SSH
Field:	SSHIBC
Field:	SSHNOIBC

### 21.14.1 Latlon Variable SSH

Table 21.67: CDL description of SEA\_SURFACE\_HEIGHT's SSH variable

Storage Type	Variable Name	Description	Unit
float32	SSH	Dynamic sea surface height anomaly	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
Dynamic sea surface height anomaly above the geoid, suitable for comparisons with altimetry sea surface height data products that apply the inverse barometer (IB) correction. Note: SSH is calculated by correcting model sea level anomaly ETAN for three effects: a) global mean steric sea level changes related to density changes in the Boussinesq volume-conserving model (Greatbatch correction, see sterGloH), b) the inverted barometer (IB) effect (see SSHIBC) and c) sea level displacement due to sea-ice and snow pressure loading (see slceLoad). 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.			

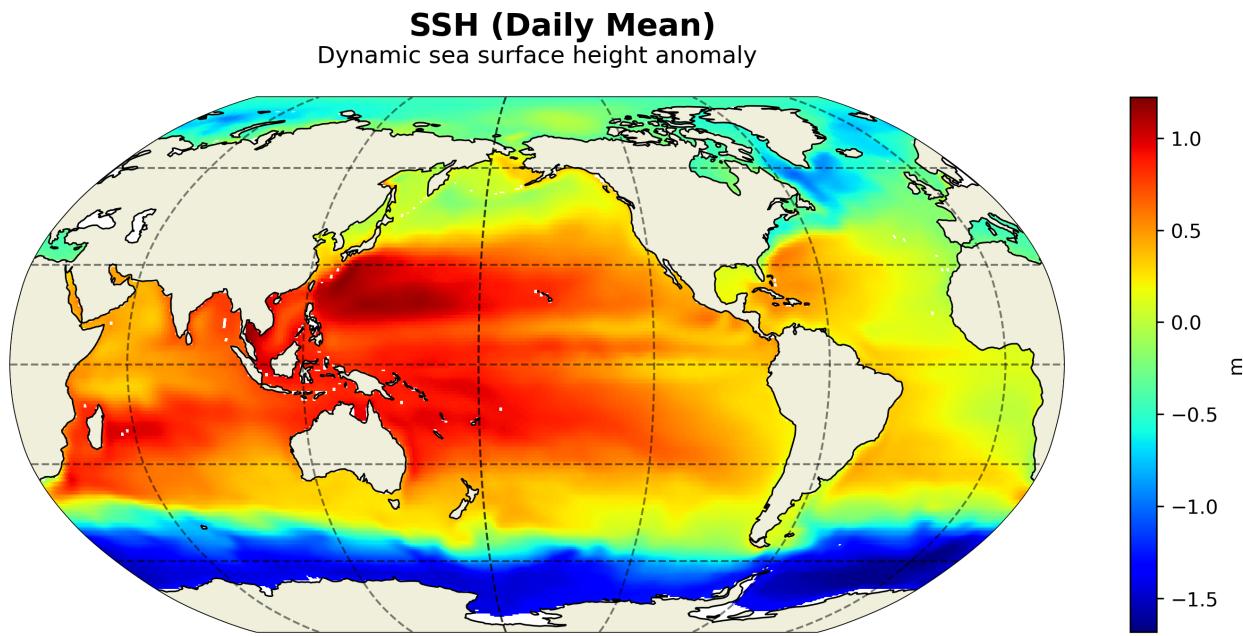


Figure 173: Dataset: SEA\_SURFACE\_HEIGHT Variable: SSH

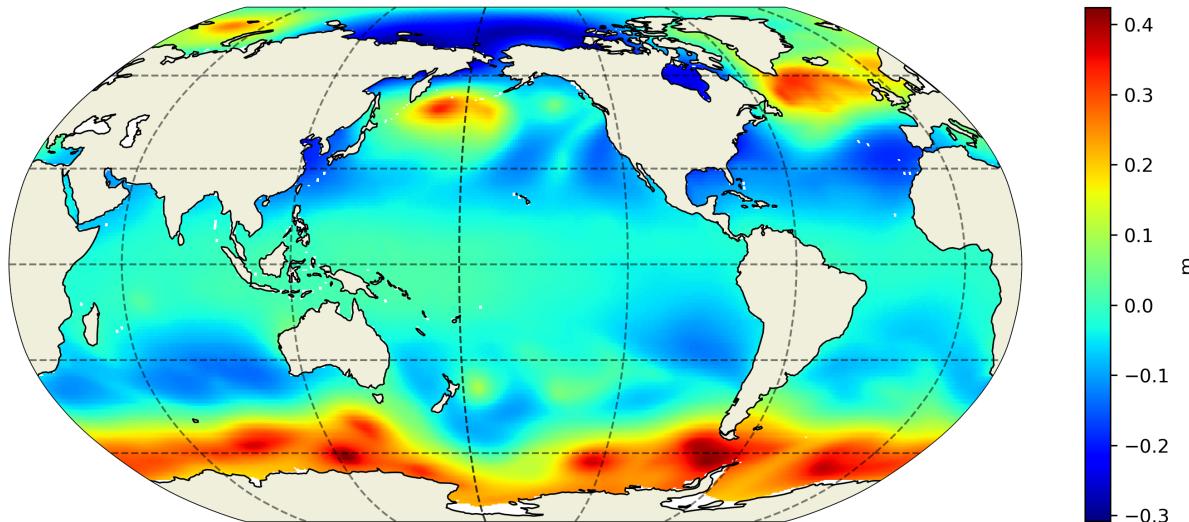
## 21.14.2 Latlon Variable SSHIBC

**Table 21.68: CDL description of SEA\_SURFACE\_HEIGHT's SSHIBC variable**

Storage Type	Variable Name	Description	Unit
float32	SSHIBC	The inverted barometer (IB) correction to sea surface height due to atmospheric pressure loading	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
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: $\text{SSH} = \text{SSHNOIBC} - \text{SSHIBC}$ . 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.			

### SSHIBC (Daily Mean)

The inverted barometer (IB) correction to sea surface height due to atmospheric pressure loading



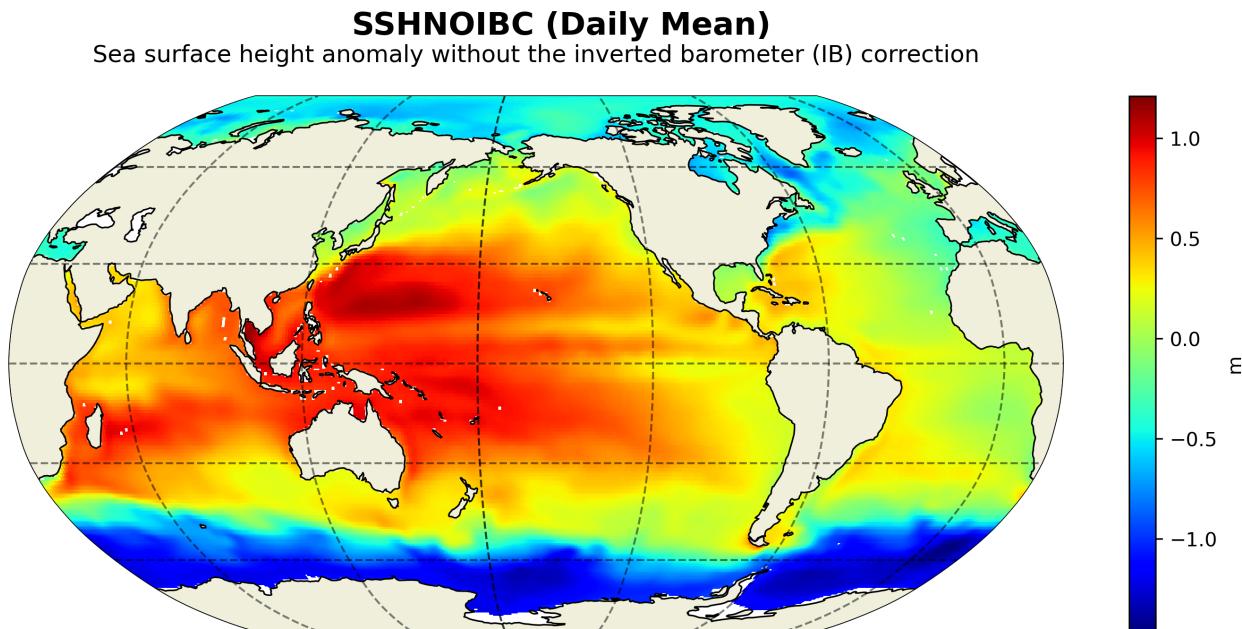
Example file 2017-12-29,  
SEA\_SURFACE\_HEIGHT\_day\_mean\_2017-12-29\_ECCO\_V4r4\_latlon\_0p50deg.nc

**Figure 174: Dataset: SEA\_SURFACE\_HEIGHT Variable: SSHIBC**

### 21.14.3 Latlon Variable SSHNOIBC

**Table 21.69: CDL description of SEA\_SURFACE\_HEIGHT's SSHNOIBC variable**

Storage Type	Variable Name	Description	Unit
float32	SSHNOIBC	Sea surface height anomaly without the inverted barometer (IB) correction	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
Sea surface height anomaly above the geoid without the inverse barometer (IB) correction, suitable for comparisons with altimetry sea surface height data products that do NOT apply the inverse barometer (IB) correction. Note: SSHNOIBC is calculated by correcting model sea level anomaly ETAN for two effects: a) global mean steric sea level changes related to density changes in the Boussinesq volume-conserving model (Greatbatch correction, see sterGloH), b) sea level displacement due to sea-ice and snow pressure loading (see slceLoad). 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.			



Example file 2017-12-29,  
SEA\_SURFACE\_HEIGHT\_day\_mean\_2017-12-29\_ECCO\_V4r4\_latlon\_0p50deg.nc

**Figure 175: Dataset: SEA\_SURFACE\_HEIGHT Variable: SSHNOIBC**

## 22 1-D Dataset Groupings

### 22.1 Overview of the 1-D Dataset Groupings

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## 22.2 1D NetCDF GLOBAL\_MEAN\_ATM\_SURFACE\_PRES

Table 22.1: Variables in the dataset GLOBAL\_MEAN\_ATM\_SURFACE\_PRES

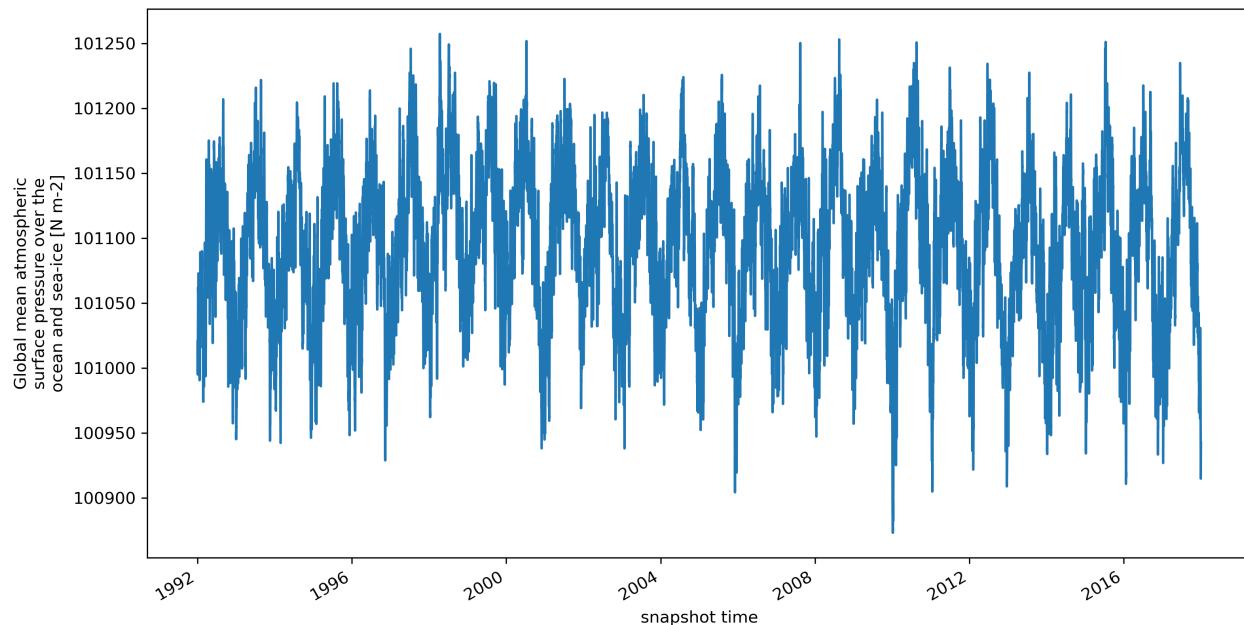
Dataset:	GLOBAL_MEAN_ATM_SURFACE_PRES
Field:	Pa_global

## 22.2.1 1D Variable Pa\_global

**Table 22.2: CDL description of GLOBAL\_MEAN\_ATM\_SURFACE\_PRES's Pa\_global variable**

Storage Type	Variable Name	Description	Unit
float64	Pa_global	Global mean atmospheric surface pressure over the ocean and sea-ice	N m-2
<b>CDL Description</b>			
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			
<b>Comments</b>			
N/A			

### Global mean atmospheric surface pressure over the ocean and sea-ice



Example file: GLOBAL\_MEAN\_ATM\_SURFACE\_PRES\_snap\_ECCO\_V4r4\_1D.nc

**Figure 176: Dataset: GLOBAL\_MEAN\_ATM\_SURFACE\_PRES Variable: Pa\_global**

## 22.3 1D NetCDF GLOBAL\_MEAN\_SEA\_LEVEL

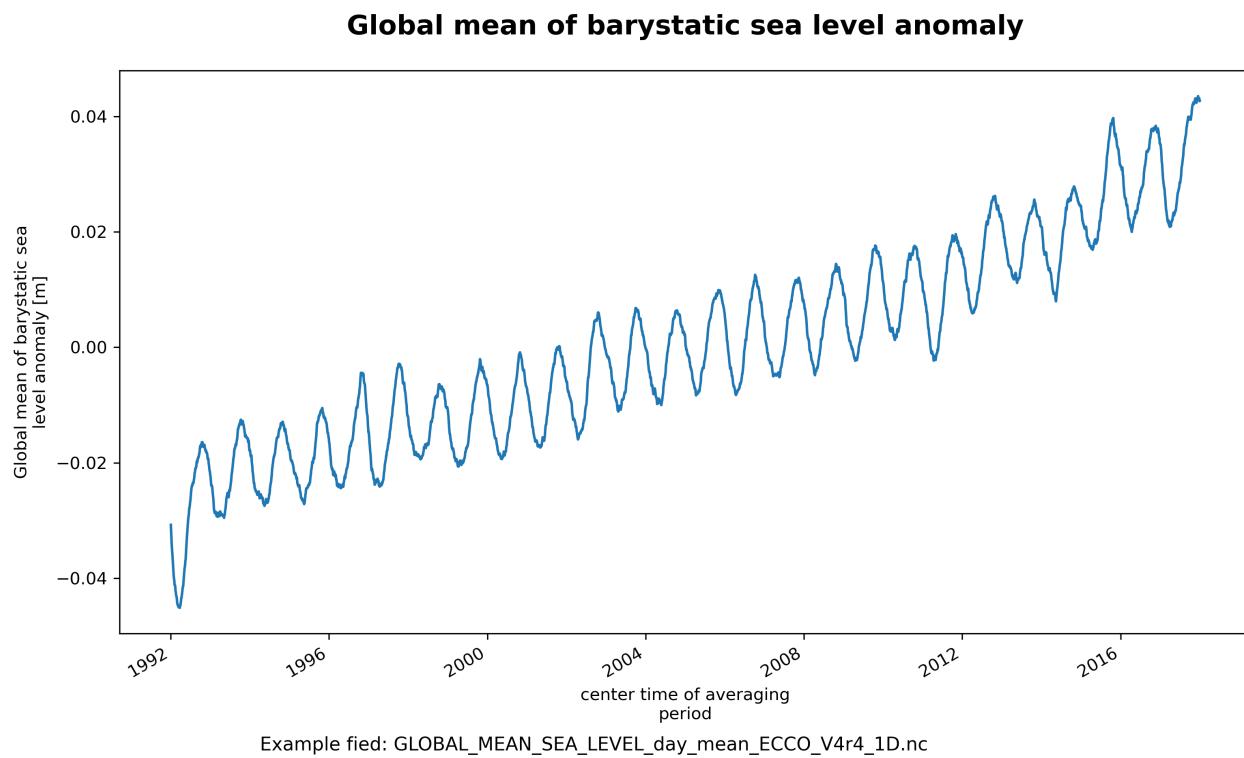
**Table 22.3: Variables in the dataset GLOBAL\_MEAN\_SEA\_LEVEL**

Dataset:	<b>GLOBAL_MEAN_SEA_LEVEL</b>
Field:	global_mean_barystatic_sea_level_anomaly
Field:	global_mean_sea_level_anomaly
Field:	global_mean_sterodynamic_sea_level_anomaly

### 22.3.1 1D Variable global\_mean\_barystatic\_sea\_level\_anomaly

**Table 22.4: CDL description of GLOBAL\_MEAN\_SEA\_LEVEL's global\_mean\_barystatic\_sea\_level\_anomaly variable**

Storage Type	Variable Name	Description	Unit
float32	global_mean_barystatic_sea_level_anomaly	Global mean of barystatic sea level anomaly	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
Global mean barystatic sea level anomaly due to changes in total ocean mass. Note: ECCOv4 uses a volume-conserving Boussinesq formulation of the MITgcm with a free-surface boundary condition with real freshwater flux forcing. Changes in ocean mass due to evaporation, precipitation, runoff, and sea-ice growth/melt are reflected in model sea level. However, as a consequence of the 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			

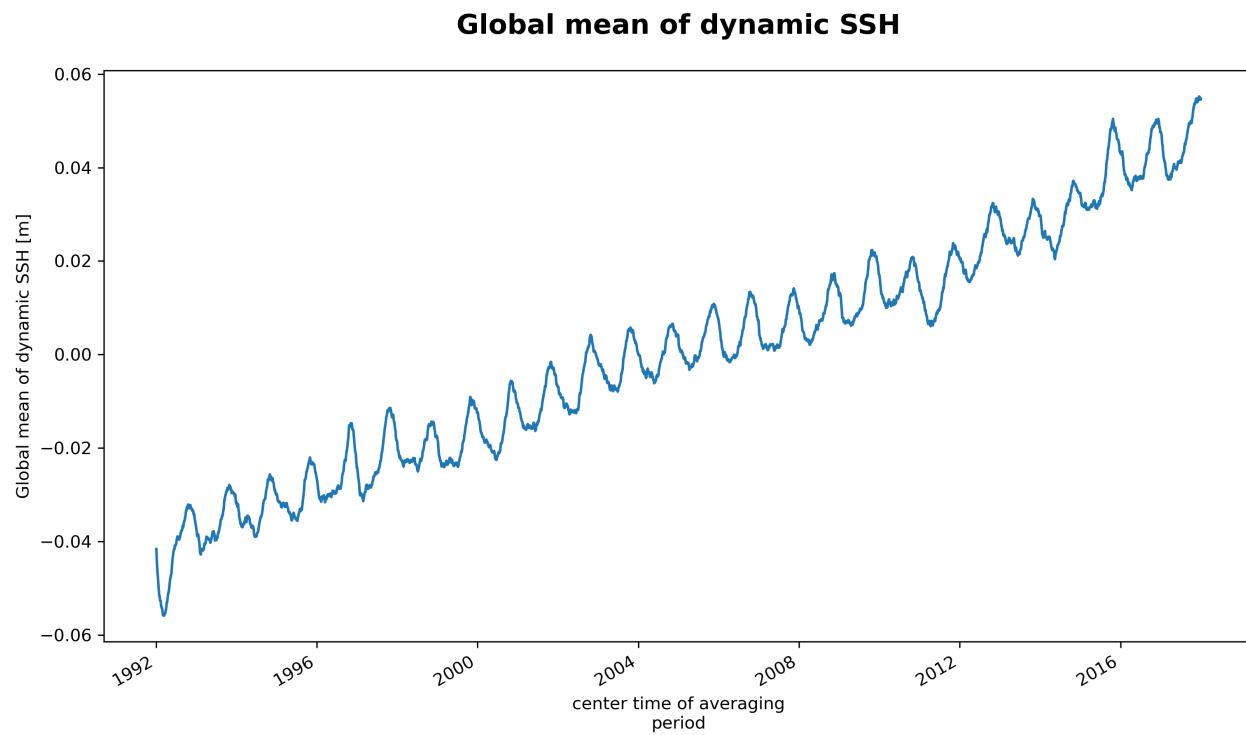


**Figure 177: Dataset: GLOBAL\_MEAN\_SEA\_LEVEL Variable: global\_mean\_barystatic\_sea\_level\_anomaly**

### 22.3.2 1D Variable global\_mean\_sea\_level\_anomaly

**Table 22.5: CDL description of GLOBAL\_MEAN\_SEA\_LEVEL's global\_mean\_sea\_level\_anomaly variable**

Storage Type	Variable Name	Description	Unit
float32	global_mean_sea_level_anomaly	Global mean of dynamic SSH	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
Global mean of dynamic sea level anomaly, equivalent to global mean sea level change. Note: ECCOv4 uses a volume-conserving Boussinesq formulation of the MITgcm with a free-surface boundary condition with real freshwater flux forcing. Changes in ocean mass due to evaporation, precipitation, runoff, and sea-ice growth/melt are reflected in model sea level. However, as a consequence of the 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			

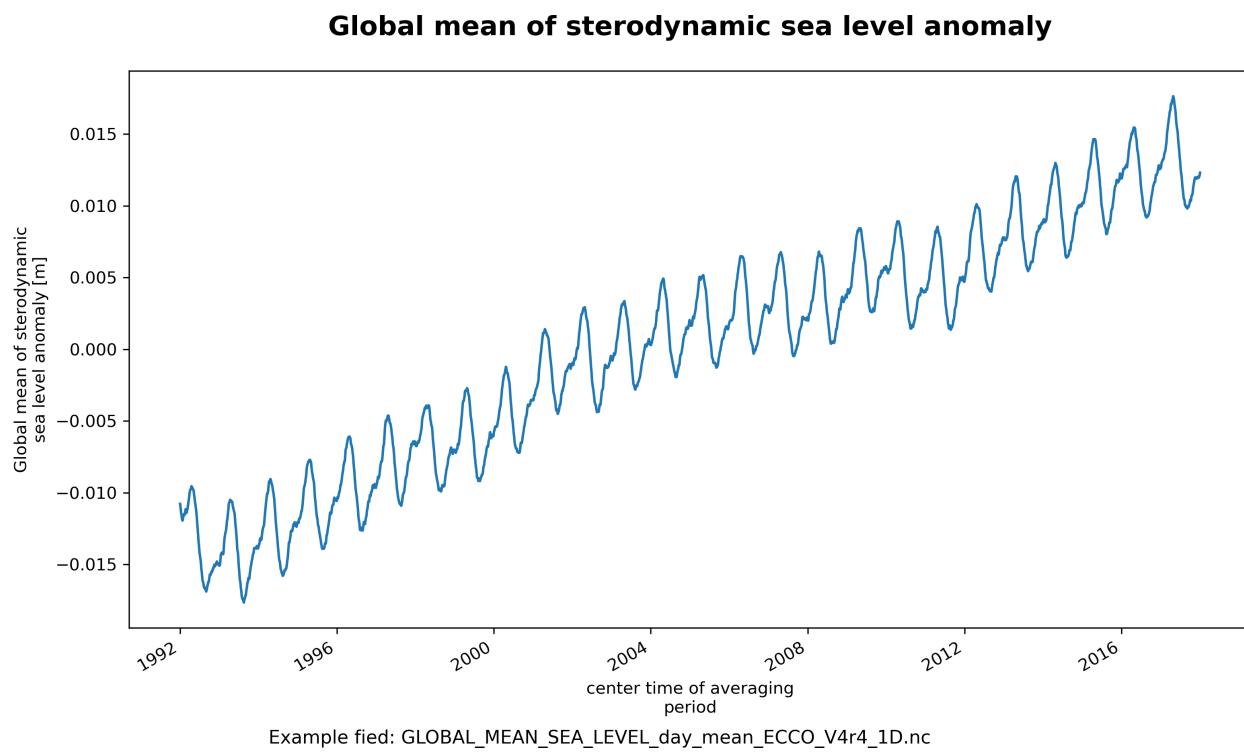


**Figure 178: Dataset: GLOBAL\_MEAN\_SEA\_LEVEL Variable: global\_mean\_sea\_level\_anomaly**

### 22.3.3 1D Variable global\_mean\_sterodynamic\_sea\_level\_anomaly

**Table 22.6: CDL description of GLOBAL\_MEAN\_SEA\_LEVEL's global\_mean\_sterodynamic\_sea\_level\_anomaly variable**

Storage Type	Variable Name	Description	Unit
float64	global_mean_sterodynamic_sea_level_anomaly	Global mean of sterodynamic sea level anomaly	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
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 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			



**Figure 179:** Dataset: **GLOBAL\_MEAN\_SEA\_LEVEL** Variable: **global\_mean\_sterodynamic\_sea\_level\_anomaly**

## 22.4 1D NetCDF SBO\_CORE\_PRODUCTS

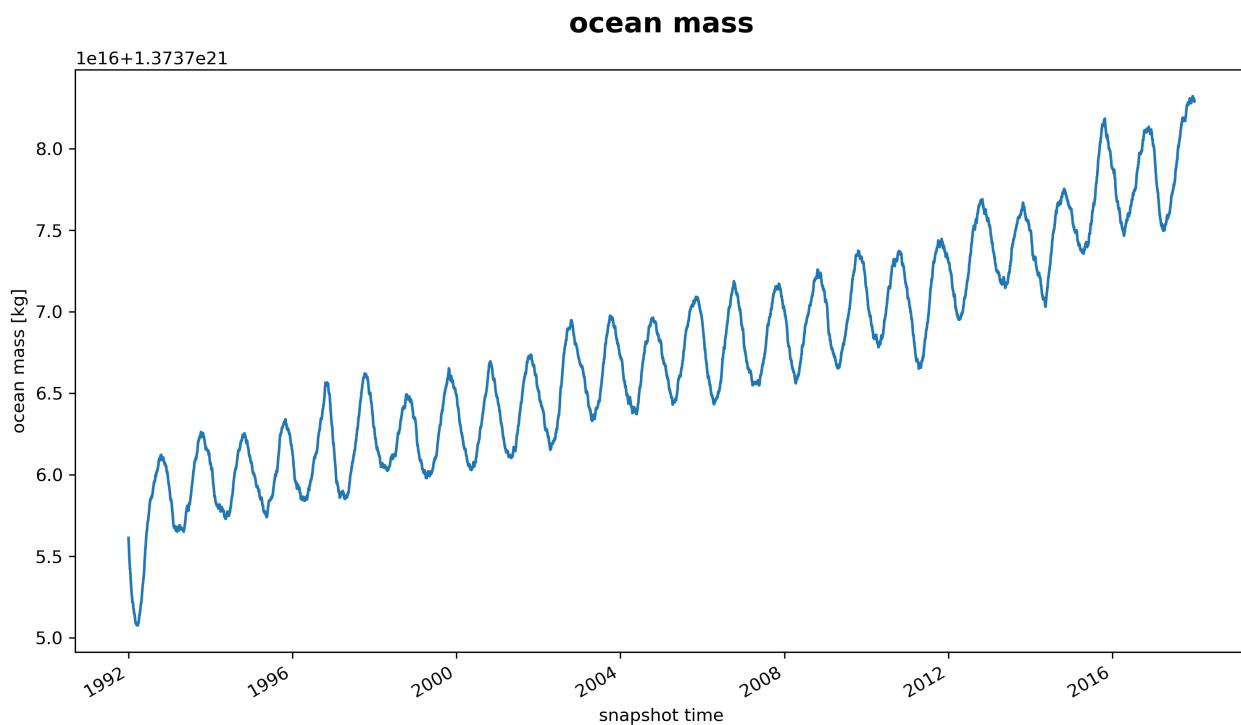
Table 22.7: Variables in the dataset SBO\_CORE\_PRODUCTS

Dataset:	SBO_CORE_PRODUCTS
Field:	xoamc
Field:	yoamc
Field:	zoamc
Field:	xoamp
Field:	yoamp
Field:	zoamp
Field:	mass
Field:	xcom
Field:	ycom
Field:	zcom
Field:	sboarea
Field:	xoamc_si
Field:	yoamc_si
Field:	zoamc_si
Field:	mass_si
Field:	xoamp_fw
Field:	yoamp_fw
Field:	zoamp_fw
Field:	mass_fw
Field:	xcom_fw
Field:	ycom_fw
Field:	zcom_fw
Field:	mass_gc
Field:	xoamp_dsl
Field:	yoamp_dsl
Field:	zoamp_dsl

#### 22.4.1 1D Variable mass

**Table 22.8: CDL description of SBO\_CORE\_PRODUCTS's mass variable**

Storage Type	Variable Name	Description	Unit
float64	mass	ocean mass	kg
<b>CDL Description</b>			
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			
<b>Comments</b>			
N/A			



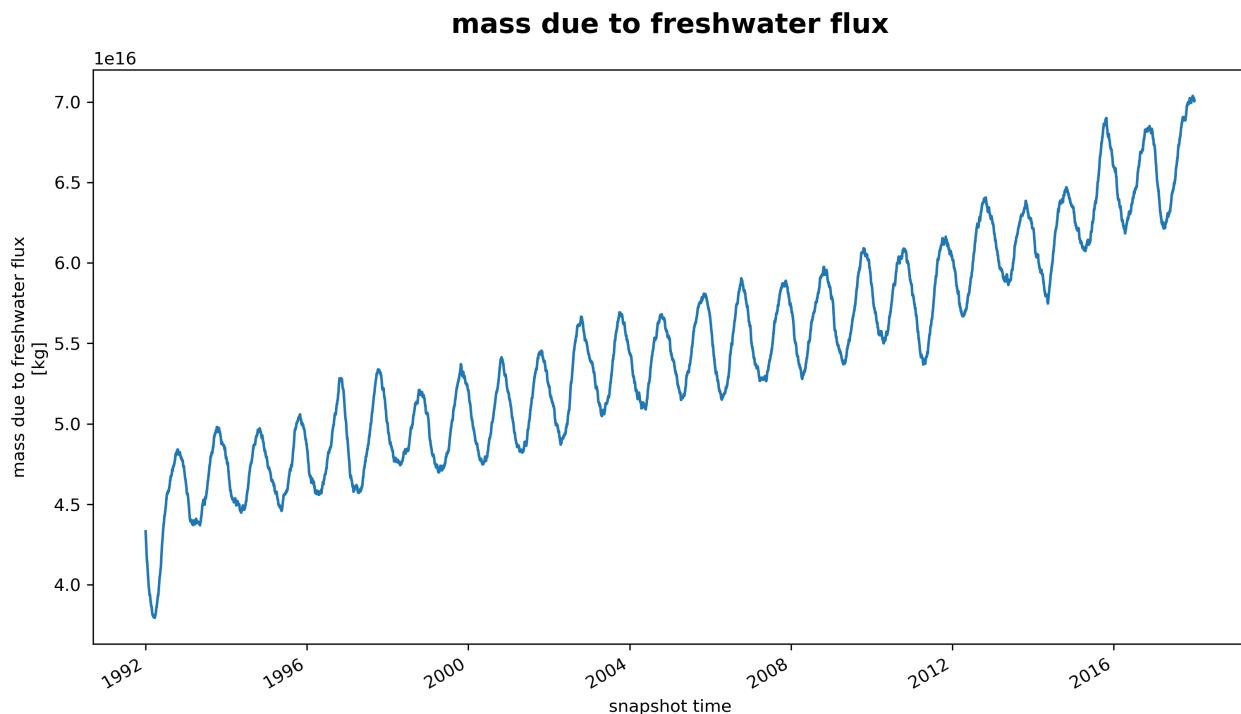
Example fied: SBO\_CORE\_PRODUCTS\_snap\_ECCO\_V4r4\_1D.nc

**Figure 180: Dataset: SBO\_CORE\_PRODUCTS Variable: mass**

## 22.4.2 1D Variable mass\_fw

**Table 22.9: CDL description of SBO\_CORE\_PRODUCTS's mass\_fw variable**

Storage Type	Variable Name	Description	Unit
float64	mass_fw	mass due to freshwater flux	kg
<b>CDL Description</b>			
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			
<b>Comments</b>			
N/A			

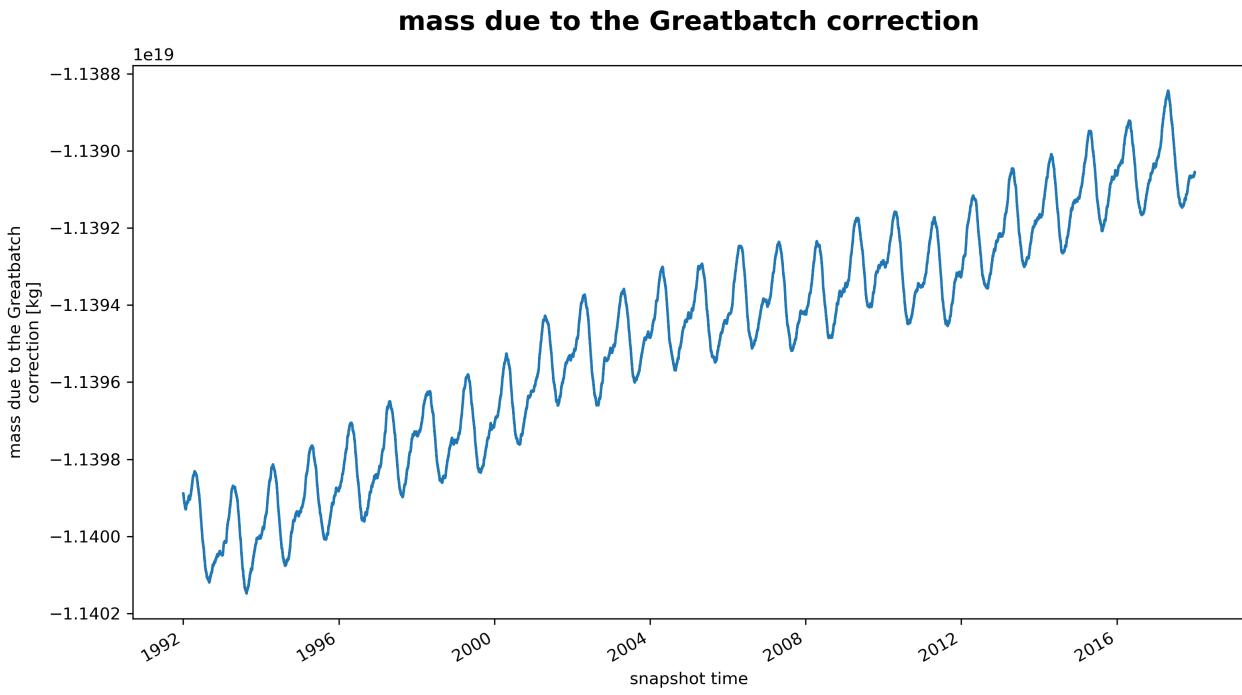


**Figure 181: Dataset: SBO\_CORE\_PRODUCTS Variable: mass\_fw**

### 22.4.3 1D Variable mass\_gc

**Table 22.10: CDL description of SBO\_CORE\_PRODUCTS's mass\_gc variable**

Storage Type	Variable Name	Description	Unit
float64	mass_gc	mass due to the Greatbatch correction	kg
<b>CDL Description</b>			
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			
<b>Comments</b>			
N/A			

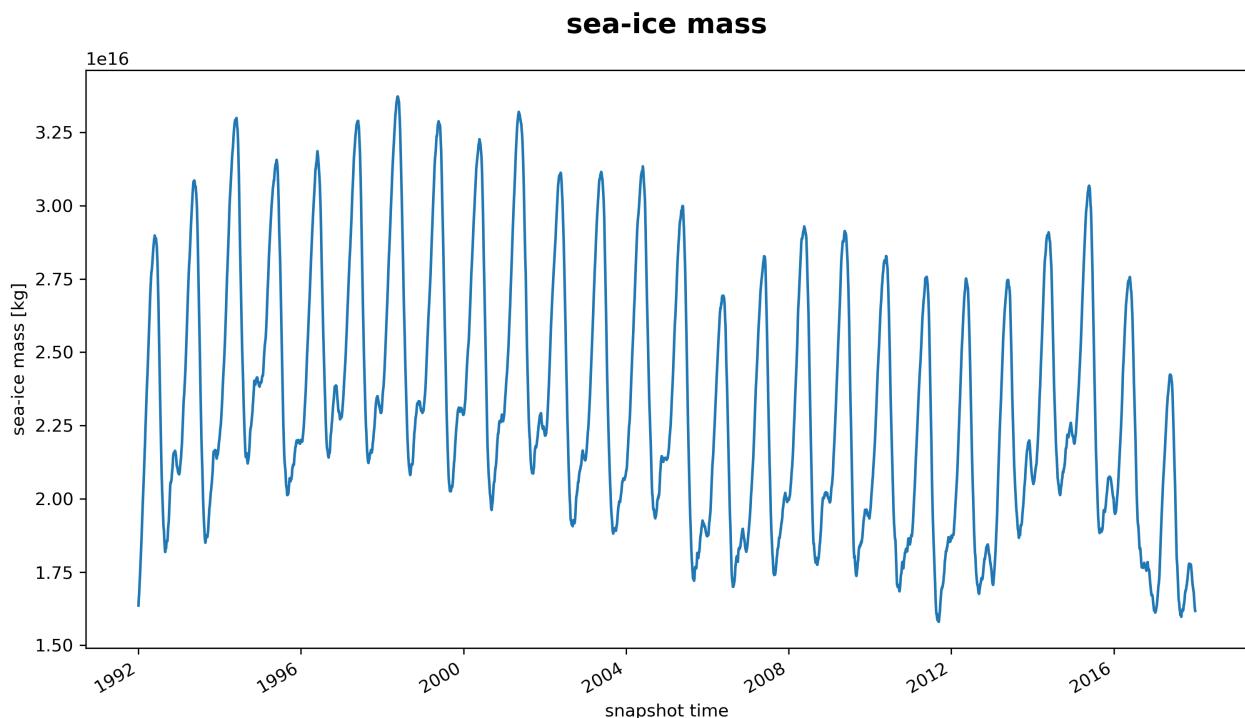


**Figure 182: Dataset: SBO\_CORE\_PRODUCTS Variable: mass\_gc**

#### 22.4.4 1D Variable mass\_si

**Table 22.11: CDL description of SBO\_CORE\_PRODUCTS's mass\_si variable**

Storage Type	Variable Name	Description	Unit
float64	mass_si	sea-ice mass	kg
<b>CDL Description</b>			
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			
<b>Comments</b>			
N/A			

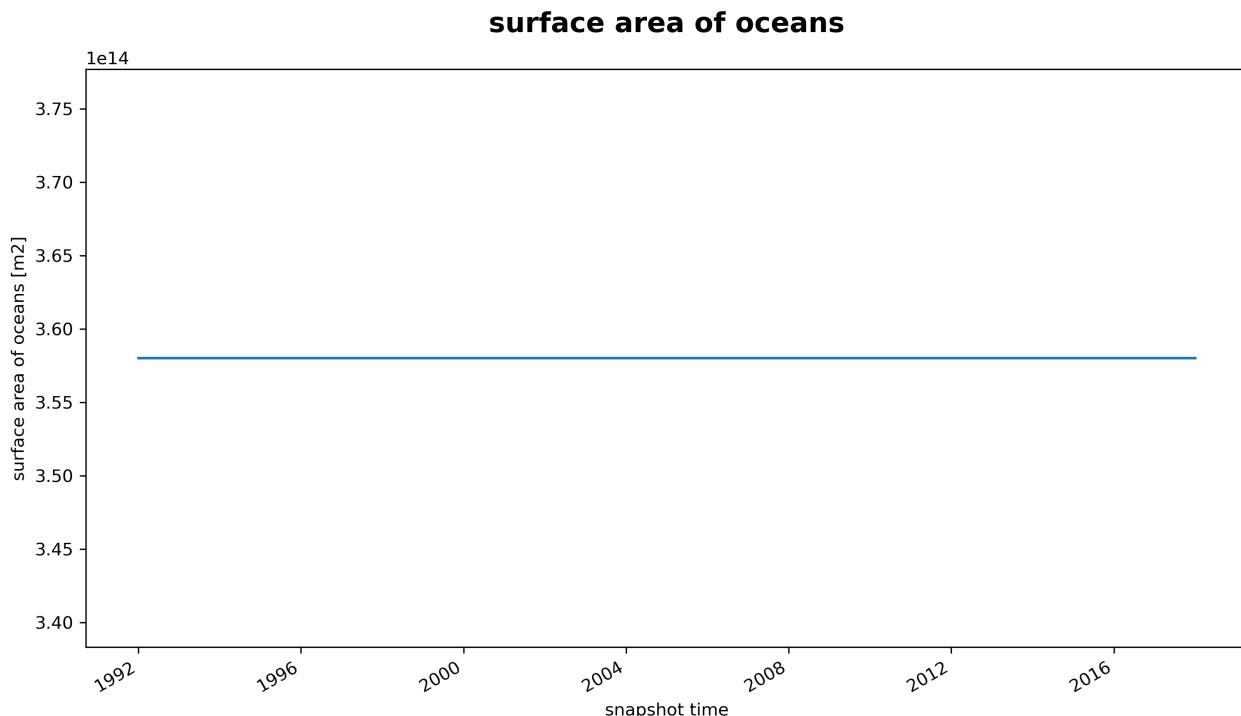


**Figure 183: Dataset: SBO\_CORE\_PRODUCTS Variable: mass\_si**

#### 22.4.5 1D Variable sboarea

Table 22.12: CDL description of SBO\_CORE\_PRODUCTS's sboarea variable

Storage Type	Variable Name	Description	Unit
float64	sboarea	surface area of oceans	m2
<b>CDL Description</b>			
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			
<b>Comments</b>			
Note: ocean surface area is constant but provided as time series for convenience			



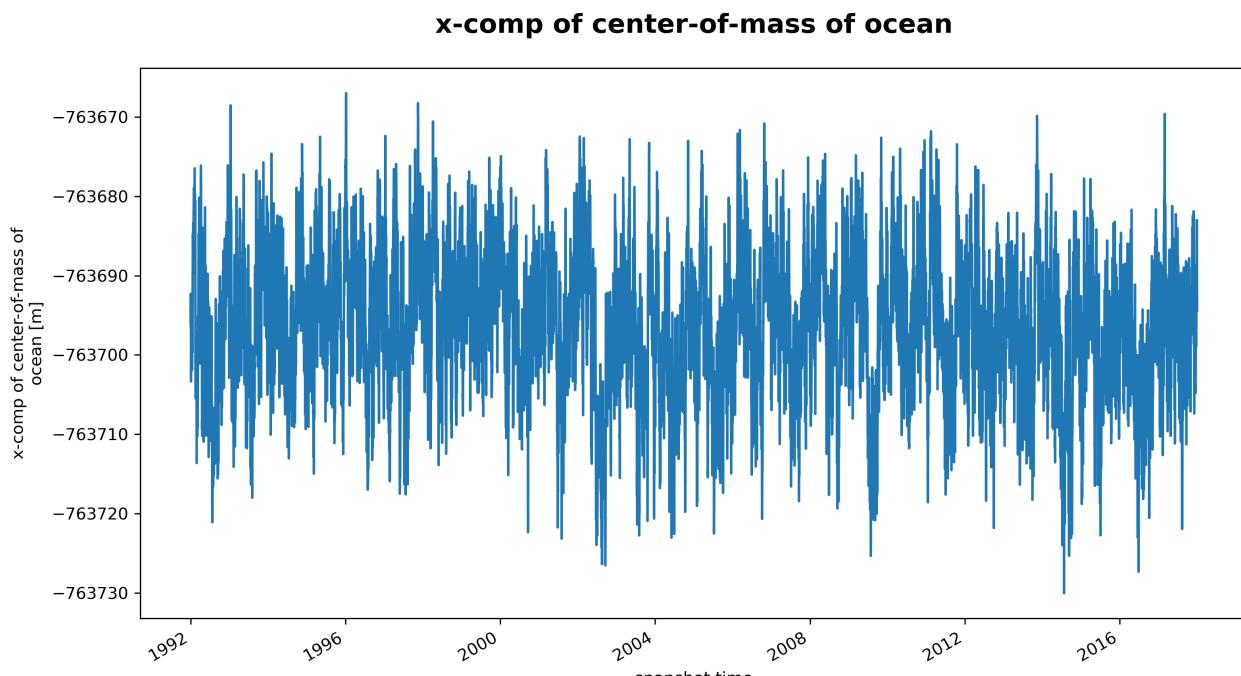
Example file: SBO\_CORE\_PRODUCTS\_snap\_ECCO\_V4r4\_1D.nc

Figure 184: Dataset: SBO\_CORE\_PRODUCTS Variable: sboarea

#### 22.4.6 1D Variable xcom

**Table 22.13: CDL description of SBO\_CORE\_PRODUCTS's xcom variable**

Storage Type	Variable Name	Description	Unit
float64	xcom	x-comp of center-of-mass of ocean	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
N/A			



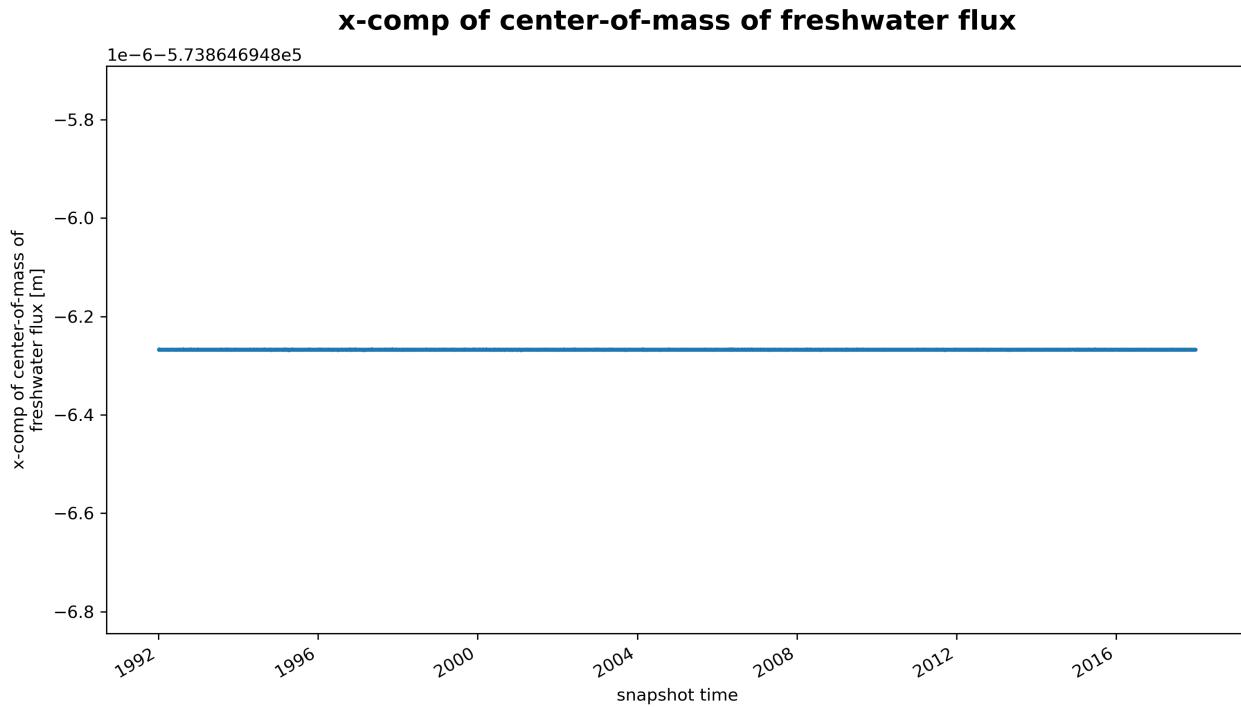
Example file: SBO\_CORE\_PRODUCTS\_snap\_ECCO\_V4r4\_1D.nc

**Figure 185: Dataset: SBO\_CORE\_PRODUCTS Variable: xcom**

#### 22.4.7 1D Variable xcom\_fw

**Table 22.14: CDL description of SBO\_CORE\_PRODUCTS's xcom\_fw variable**

Storage Type	Variable Name	Description	Unit
float64	xcom_fw	x-comp of center-of-mass of freshwater flux	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
N/A			



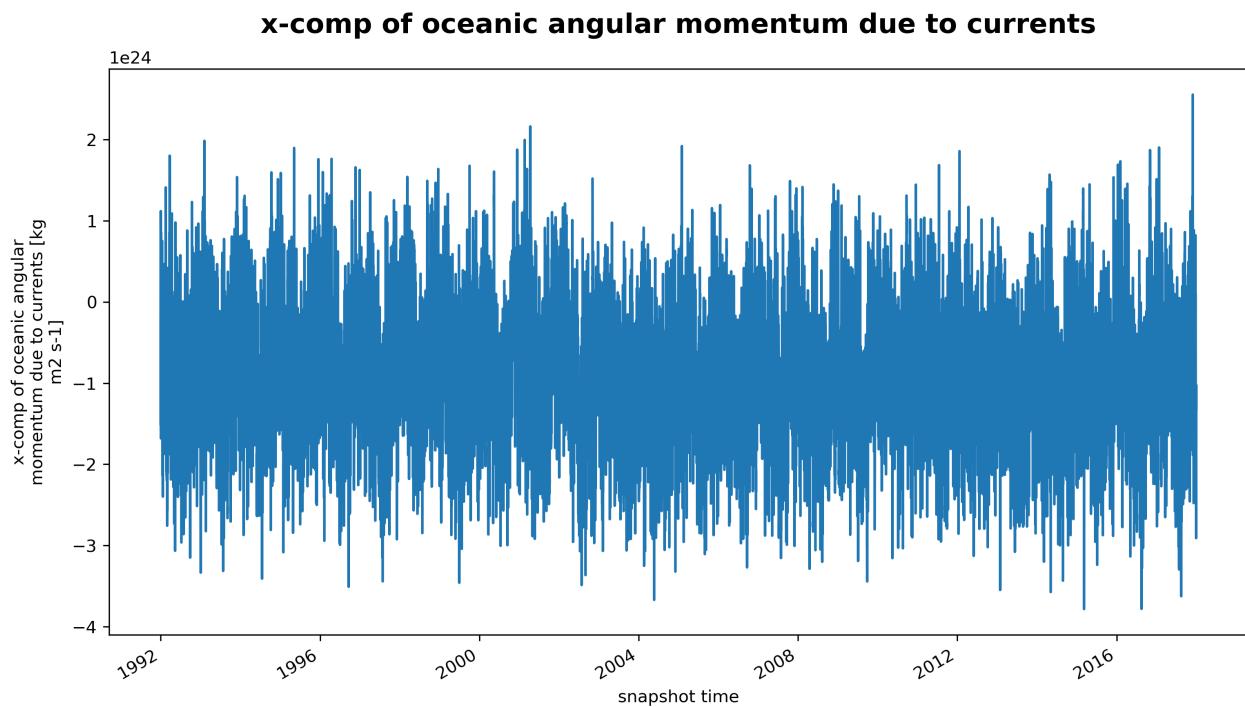
Example fied: SBO\_CORE\_PRODUCTS\_snap\_ECCO\_V4r4\_1D.nc

**Figure 186: Dataset: SBO\_CORE\_PRODUCTS Variable: xcom\_fw**

#### 22.4.8 1D Variable xoamc

**Table 22.15: CDL description of SBO\_CORE\_PRODUCTS's xoamc variable**

Storage Type	Variable Name	Description	Unit
float64	xoamc	x-comp of oceanic angular momentum due to currents	kg m <sup>2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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 m <sup>2</sup> s: 1			
xoamc: valid_min = : 3.783733447704127e+24			
xoamc: valid_max = 2.555331552045857e+24			
xoamc: coordinates = time			
<b>Comments</b>			
N/A			



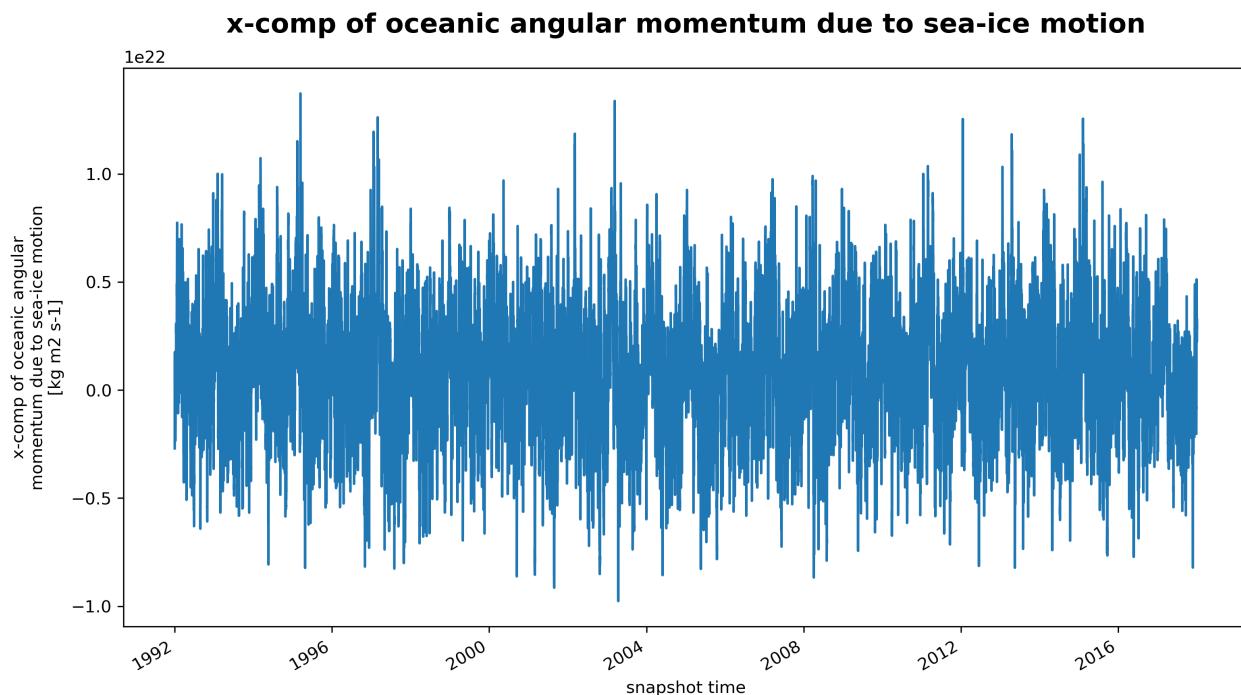
Example file: SBO\_CORE\_PRODUCTS\_snap\_ECCO\_V4r4\_1D.nc

**Figure 187: Dataset: SBO\_CORE\_PRODUCTS Variable: xoamc**

#### 22.4.9 1D Variable xoamc\_si

**Table 22.16: CDL description of SBO\_CORE\_PRODUCTS's xoamc\_si variable**

Storage Type	Variable Name	Description	Unit
float64	xoamc_si	x-comp of oceanic angular momentum due to sea-ice motion	kg m <sup>2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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 m <sup>2</sup> s: 1			
xoamc_si: valid_min = : 9.76342837969224e+21			
xoamc_si: valid_max = 1.3721188892065168e+22			
xoamc_si: coordinates = time			
<b>Comments</b>			
N/A			



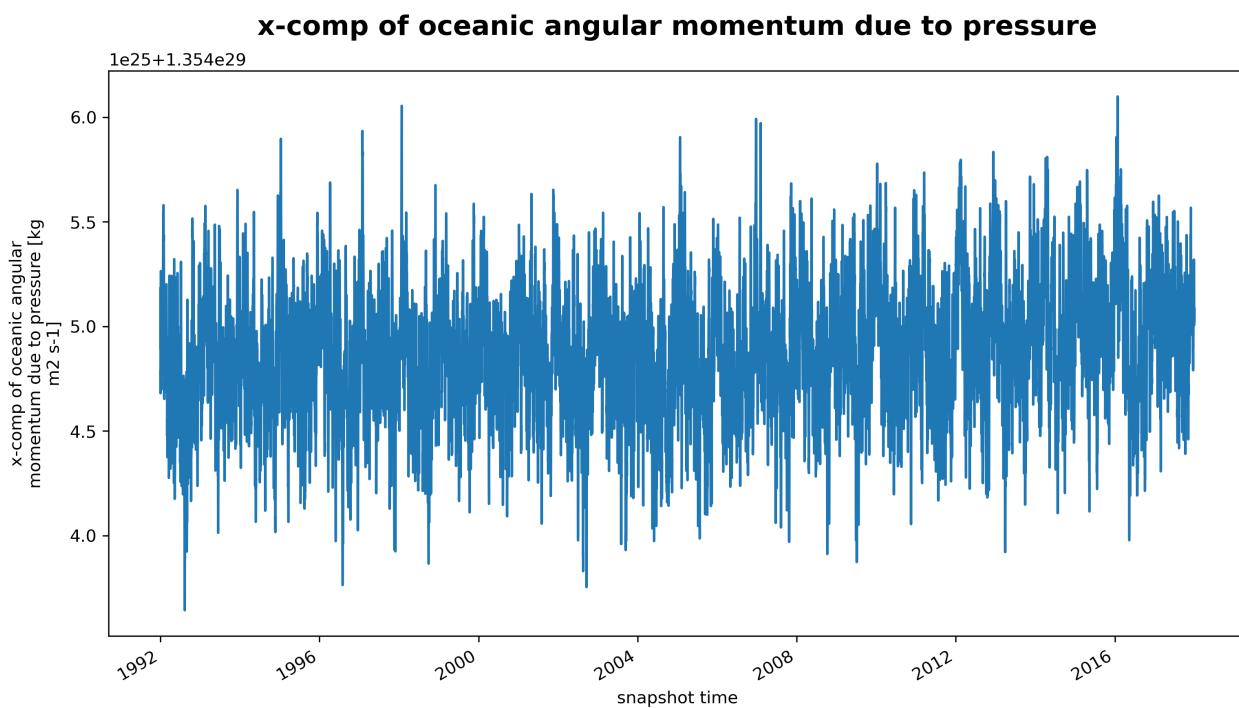
Example file: SBO\_CORE\_PRODUCTS\_snap\_ECCO\_V4r4\_1D.nc

**Figure 188: Dataset: SBO\_CORE\_PRODUCTS Variable: xoamc\_si**

#### 22.4.10 1D Variable xoamp

**Table 22.17: CDL description of SBO\_CORE\_PRODUCTS's xoamp variable**

Storage Type	Variable Name	Description	Unit
float64	xoamp	x-comp of oceanic angular momentum due to pressure	kg m <sup>2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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 m <sup>2</sup> s <sup>-1</sup>			
xoamp: valid_min = 1.3543642768158851e+29			
xoamp: valid_max = 1.3546098666231897e+29			
xoamp: coordinates = time			
<b>Comments</b>			
N/A			



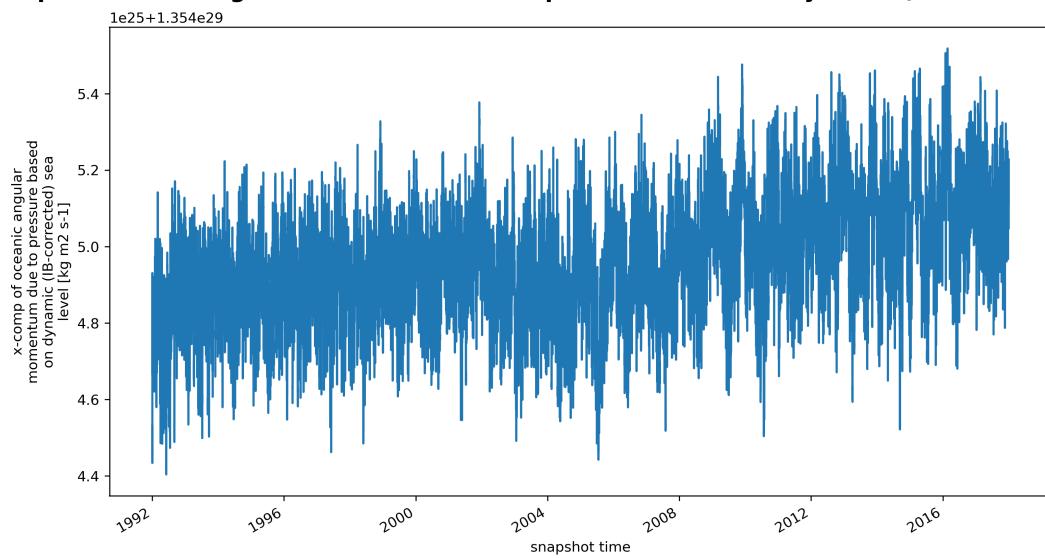
**Figure 189: Dataset: SBO\_CORE\_PRODUCTS Variable: xoamp**

#### 22.4.11 1D Variable xoamp\_dsl

**Table 22.18: CDL description of SBO\_CORE\_PRODUCTS's xoamp\_dsl variable**

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 <sup>2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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 m <sup>2</sup> s: 1			
xoamp_dsl: valid_min = 1.354440386439953e+29			
xoamp_dsl: valid_max = 1.3545518352698056e+29			
xoamp_dsl: coordinates = time			
<b>Comments</b>			
N/A			

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



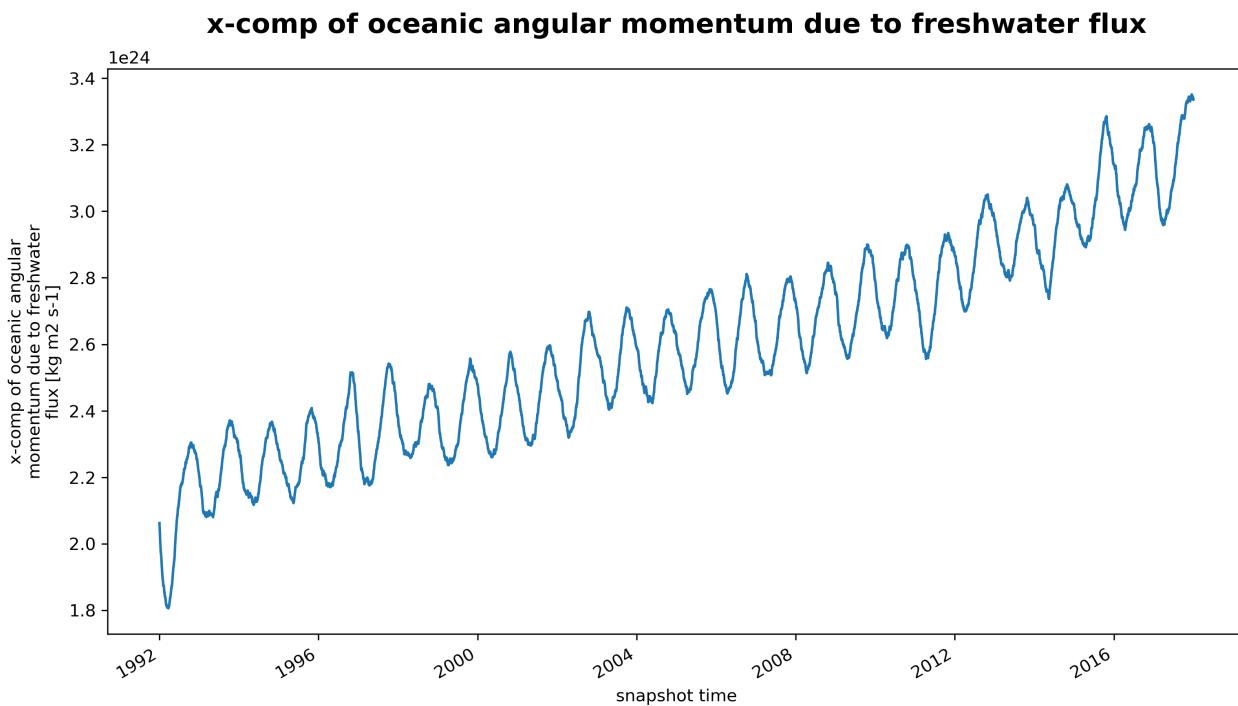
Example fied: SBO\_CORE\_PRODUCTS\_snap\_ECCO\_V4r4\_1D.nc

**Figure 190: Dataset: SBO\_CORE\_PRODUCTS Variable: xoamp\_dsl**

#### 22.4.12 1D Variable xoamp\_fw

**Table 22.19: CDL description of SBO\_CORE\_PRODUCTS's xoamp\_fw variable**

Storage Type	Variable Name	Description	Unit
float64	xoamp_fw	x-comp of oceanic angular momentum due to freshwater flux	kg m <sup>2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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 m <sup>2</sup> s <sup>-1</sup>			
xoamp_fw: valid_min = 1.805799644912138e+24			
xoamp_fw: valid_max = 3.351358892803656e+24			
xoamp_fw: coordinates = time			
<b>Comments</b>			
N/A			



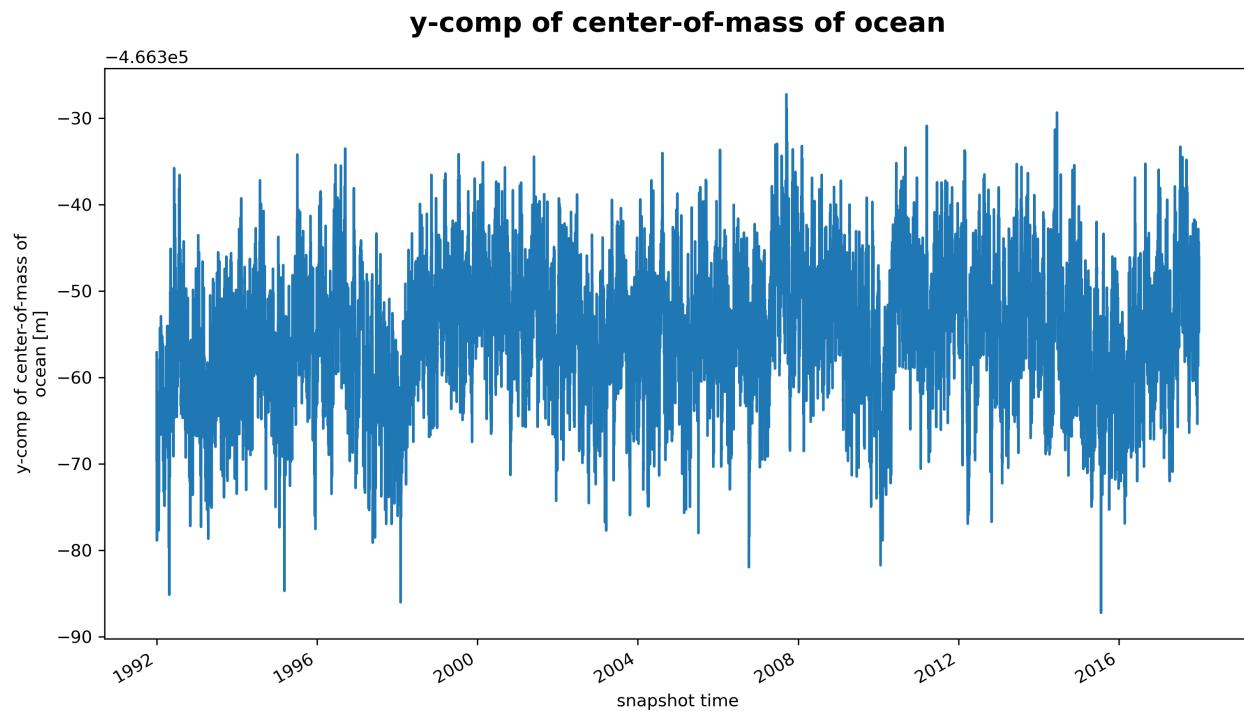
Example fied: SBO\_CORE\_PRODUCTS\_snap\_ECCO\_V4r4\_1D.nc

**Figure 191: Dataset: SBO\_CORE\_PRODUCTS Variable: xoamp\_fw**

#### 22.4.13 1D Variable ycom

**Table 22.20: CDL description of SBO\_CORE\_PRODUCTS's ycom variable**

Storage Type	Variable Name	Description	Unit
float64	ycom	y-comp of center-of-mass of ocean	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
N/A			



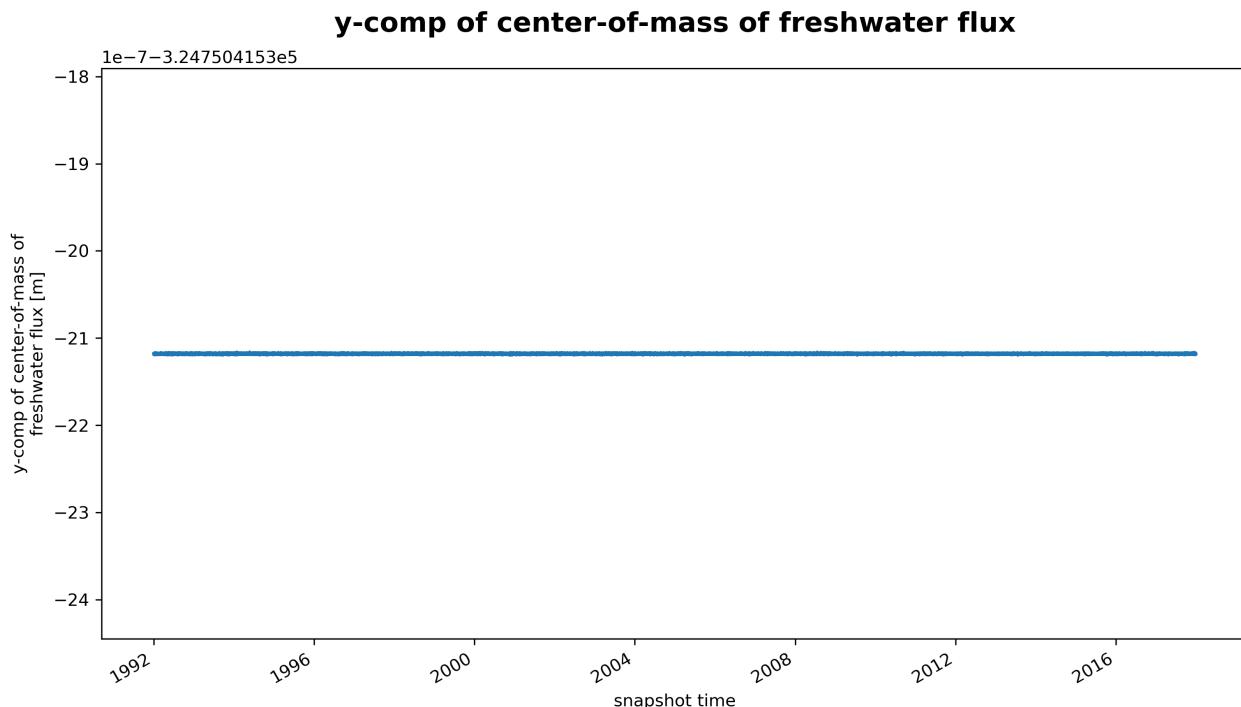
Example file: SBO\_CORE\_PRODUCTS\_snap\_ECCO\_V4r4\_1D.nc

**Figure 192: Dataset: SBO\_CORE\_PRODUCTS Variable: ycom**

#### 22.4.14 1D Variable ycom\_fw

**Table 22.21: CDL description of SBO\_CORE\_PRODUCTS's ycom\_fw variable**

Storage Type	Variable Name	Description	Unit
float64	ycom_fw	y-comp of center-of-mass of freshwater flux	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
N/A			



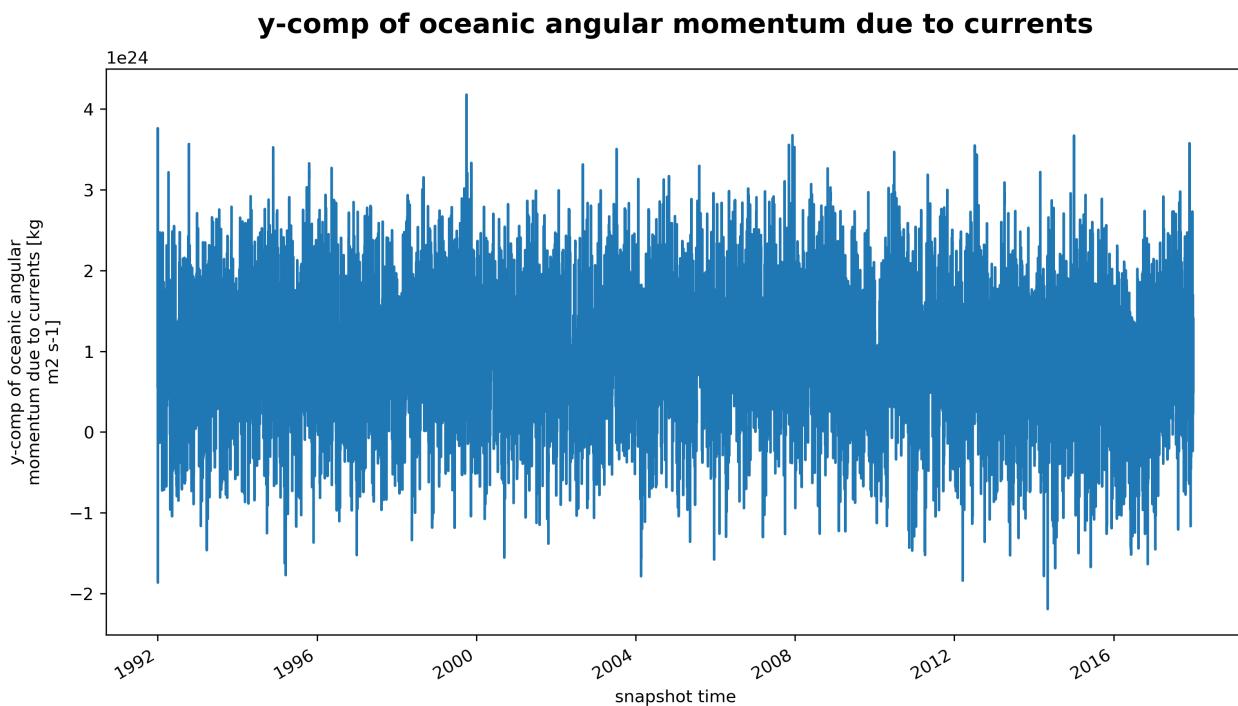
Example fied: SBO\_CORE\_PRODUCTS\_snap\_ECCO\_V4r4\_1D.nc

**Figure 193: Dataset: SBO\_CORE\_PRODUCTS Variable: ycom\_fw**

#### 22.4.15 1D Variable yoamc

**Table 22.22: CDL description of SBO\_CORE\_PRODUCTS's yoamc variable**

Storage Type	Variable Name	Description	Unit
float64	yoamc	y-comp of oceanic angular momentum due to currents	kg m <sup>2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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 m <sup>2</sup> s <sup>-1</sup>			
yoamc:valid_min = : 2.19249690136359e+24			
yoamc:valid_max = 4.179441018940977e+24			
yoamc:coordinates = time			
<b>Comments</b>			
N/A			

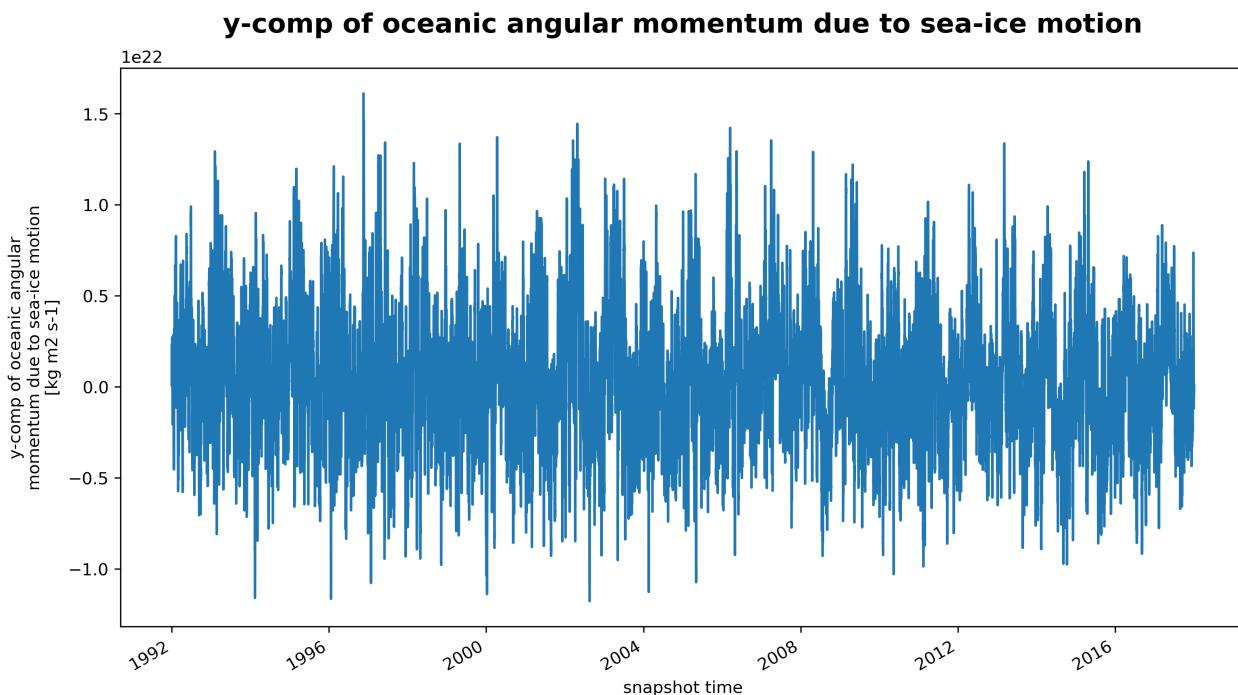


**Figure 194: Dataset: SBO\_CORE\_PRODUCTS Variable: yoamc**

#### 22.4.16 1D Variable yoamc\_si

**Table 22.23: CDL description of SBO\_CORE\_PRODUCTS's yoamc\_si variable**

Storage Type	Variable Name	Description	Unit
float64	yoamc_si	y-comp of oceanic angular momentum due to sea-ice motion	kg m <sup>2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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 m <sup>2</sup> s <sup>-1</sup>			
yoamc_si: valid_min = : 1.176556337395274e+22			
yoamc_si: valid_max = 1.6107851446370722e+22			
yoamc_si: coordinates = time			
<b>Comments</b>			
N/A			



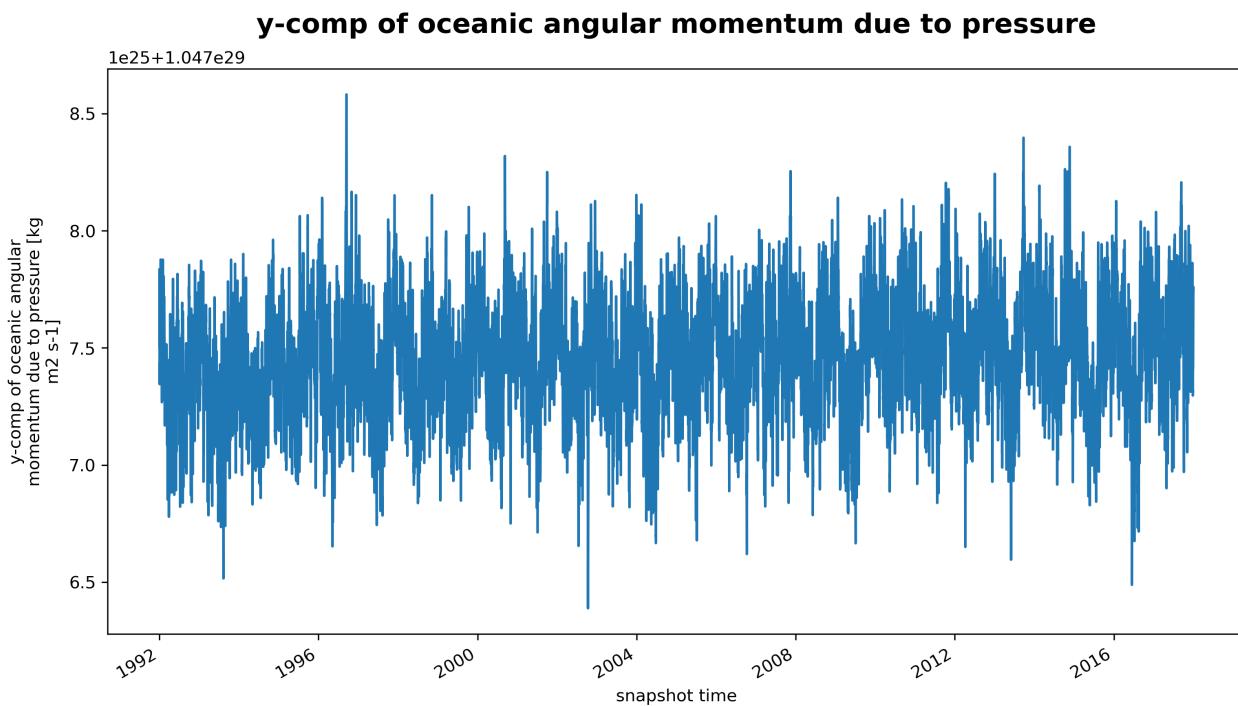
Example file: SBO\_CORE\_PRODUCTS\_snap\_ECCO\_V4r4\_1D.nc

**Figure 195: Dataset: SBO\_CORE\_PRODUCTS Variable: yoamc\_si**

#### 22.4.17 1D Variable yoamp

**Table 22.24: CDL description of SBO\_CORE\_PRODUCTS's yoamp variable**

Storage Type	Variable Name	Description	Unit
float64	yoamp	y-comp of oceanic angular momentum due to pressure	kg m <sup>2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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 m <sup>2</sup> s <sup>-1</sup>			
yoamp: valid_min = 1.0476388397938864e+29			
yoamp: valid_max = 1.0478581623131764e+29			
yoamp: coordinates = time			
<b>Comments</b>			
N/A			



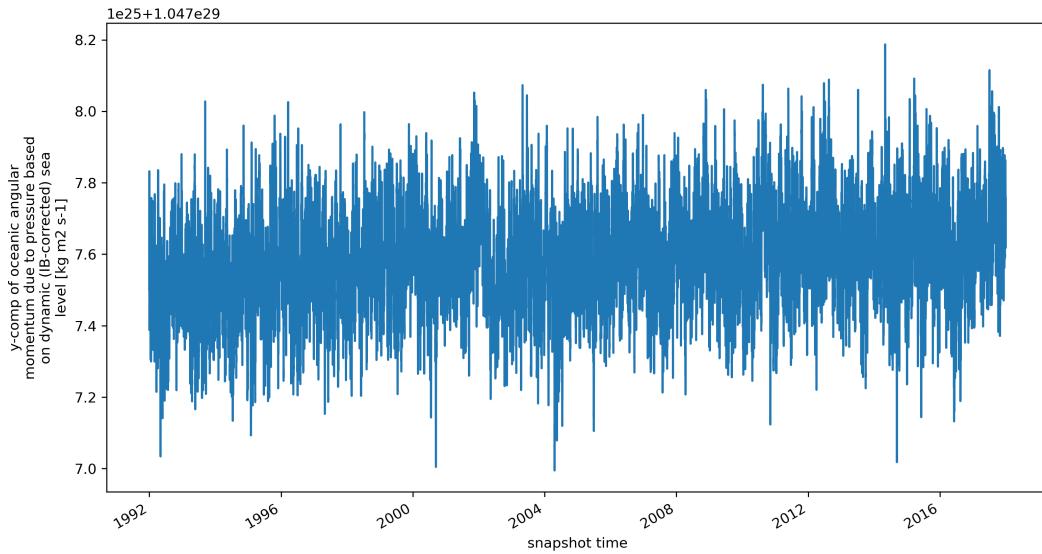
**Figure 196: Dataset: SBO\_CORE\_PRODUCTS Variable: yoamp**

#### 22.4.18 1D Variable yoamp\_dsl

**Table 22.25: CDL description of SBO\_CORE\_PRODUCTS's yoamp\_dsl variable**

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 <sup>2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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 m <sup>2</sup> s <sup>-1</sup>			
yoamp_dsl:valid_min = 1.0476994334049981e+29			
yoamp_dsl:valid_max = 1.0478187262074598e+29			
yoamp_dsl:coordinates = time			
<b>Comments</b>			
N/A			

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



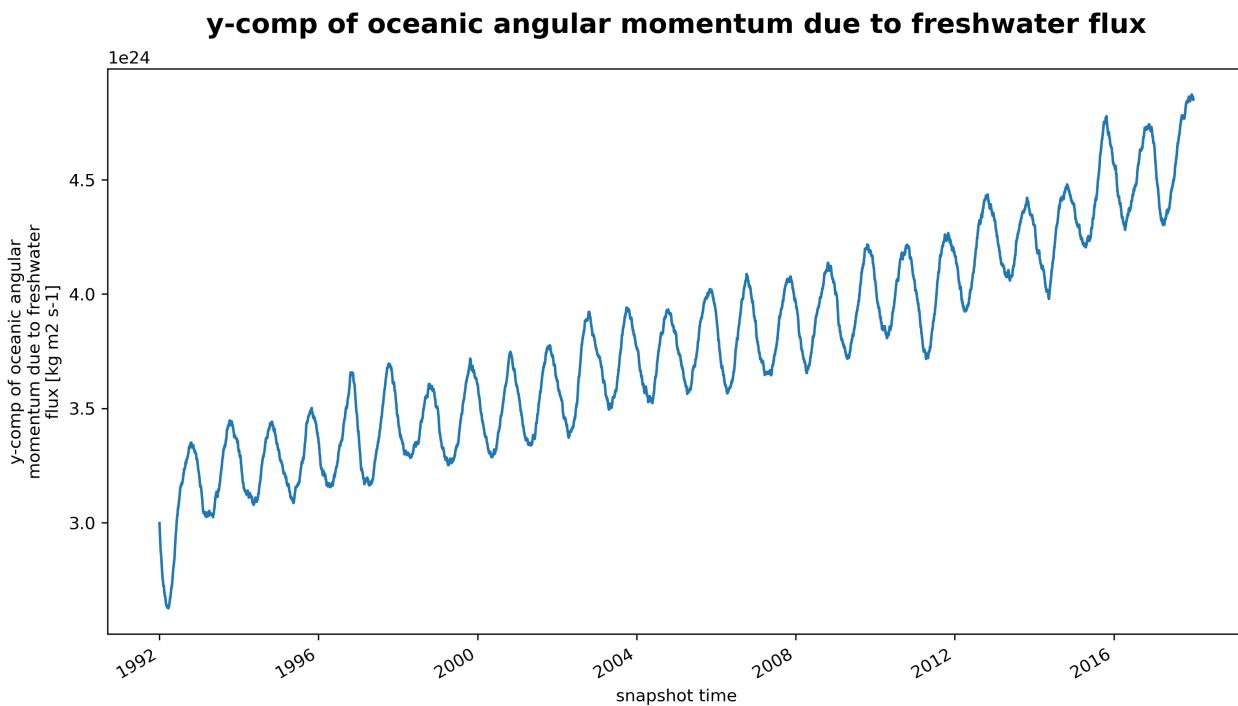
Example file: SBO\_CORE\_PRODUCTS\_snap\_ECCO\_V4r4\_1D.nc

**Figure 197: Dataset: SBO\_CORE\_PRODUCTS Variable: yoamp\_dsl**

#### 22.4.19 1D Variable yoamp\_fw

**Table 22.26: CDL description of SBO\_CORE\_PRODUCTS's yoamp\_fw variable**

Storage Type	Variable Name	Description	Unit
float64	yoamp_fw	y-comp of oceanic angular momentum due to freshwater flux	kg m <sup>2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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 m <sup>2</sup> s <sup>-1</sup>			
yoamp_fw: valid_min = 2.6255410225894626e+24			
yoamp_fw: valid_max = 4.872705717529432e+24			
yoamp_fw: coordinates = time			
<b>Comments</b>			
N/A			



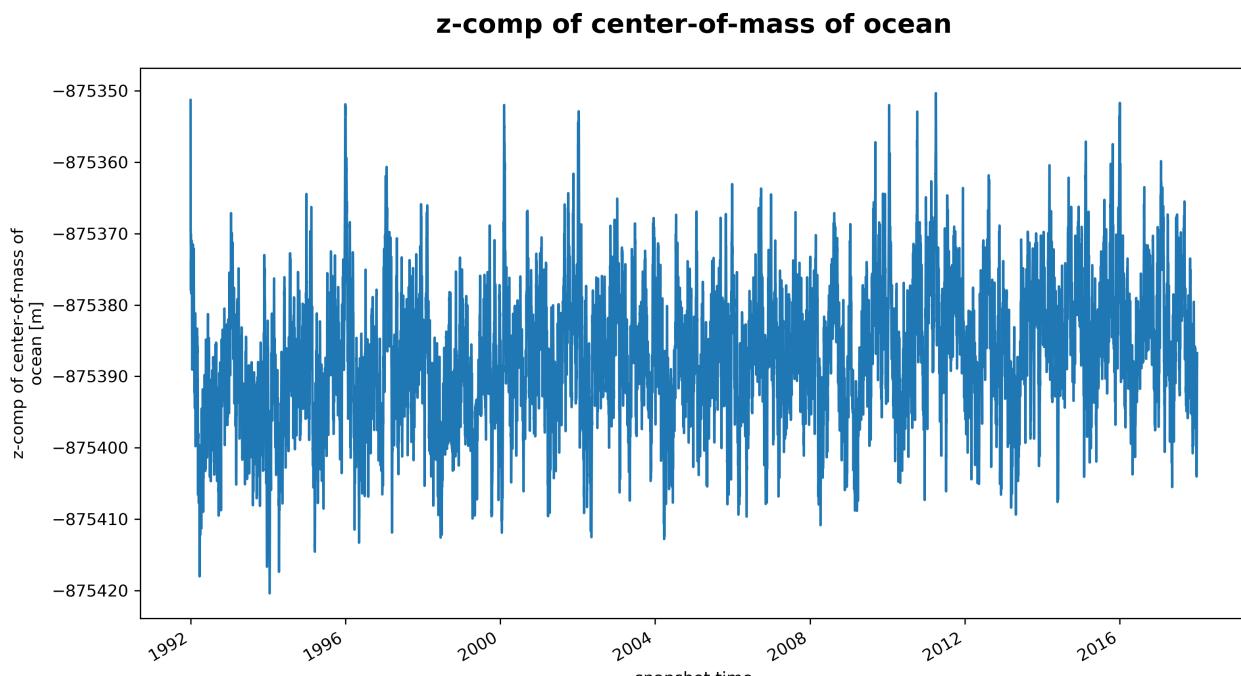
Example file: SBO\_CORE\_PRODUCTS\_snap\_ECCO\_V4r4\_1D.nc

**Figure 198: Dataset: SBO\_CORE\_PRODUCTS Variable: yoamp\_fw**

#### 22.4.20 1D Variable zcom

**Table 22.27: CDL description of SBO\_CORE\_PRODUCTS's zcom variable**

Storage Type	Variable Name	Description	Unit
float64	zcom	z-comp of center-of-mass of ocean	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
N/A			



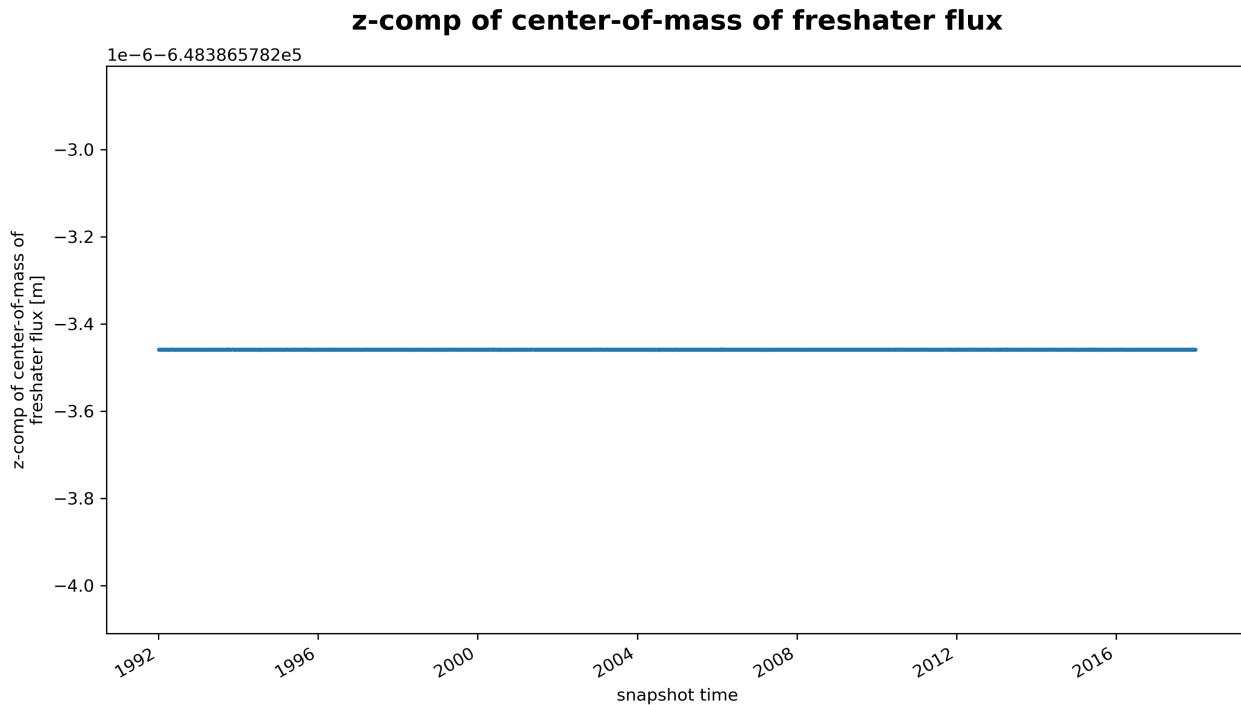
Example file: SBO\_CORE\_PRODUCTS\_snap\_ECCO\_V4r4\_1D.nc

**Figure 199: Dataset: SBO\_CORE\_PRODUCTS Variable: zcom**

#### 22.4.21 1D Variable zcom\_fw

**Table 22.28: CDL description of SBO\_CORE\_PRODUCTS's zcom\_fw variable**

Storage Type	Variable Name	Description	Unit
float64	zcom_fw	z-comp of center-of-mass of freshater flux	m
<b>CDL Description</b>			
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			
<b>Comments</b>			
N/A			



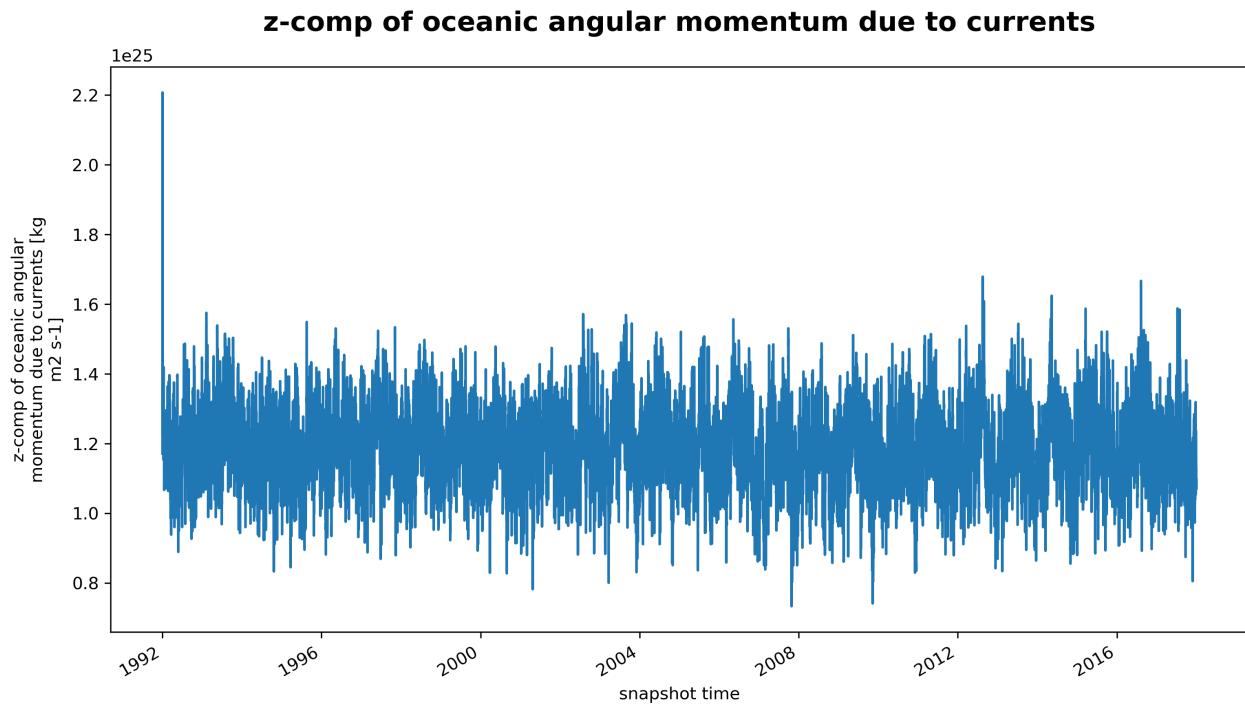
Example fied: SBO\_CORE\_PRODUCTS\_snap\_ECCO\_V4r4\_1D.nc

**Figure 200: Dataset: SBO\_CORE\_PRODUCTS Variable: zcom\_fw**

#### 22.4.22 1D Variable zoamc

**Table 22.29: CDL description of SBO\_CORE\_PRODUCTS's zoamc variable**

Storage Type	Variable Name	Description	Unit
float64	zoamc	z-comp of oceanic angular momentum due to currents	kg m <sup>2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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 <sup>2</sup> s: 1			
zoamc: valid_min = 7.331764457927521e+24			
zoamc: valid_max = 2.207264300276968e+25			
zoamc: coordinates = time			
<b>Comments</b>			
N/A			



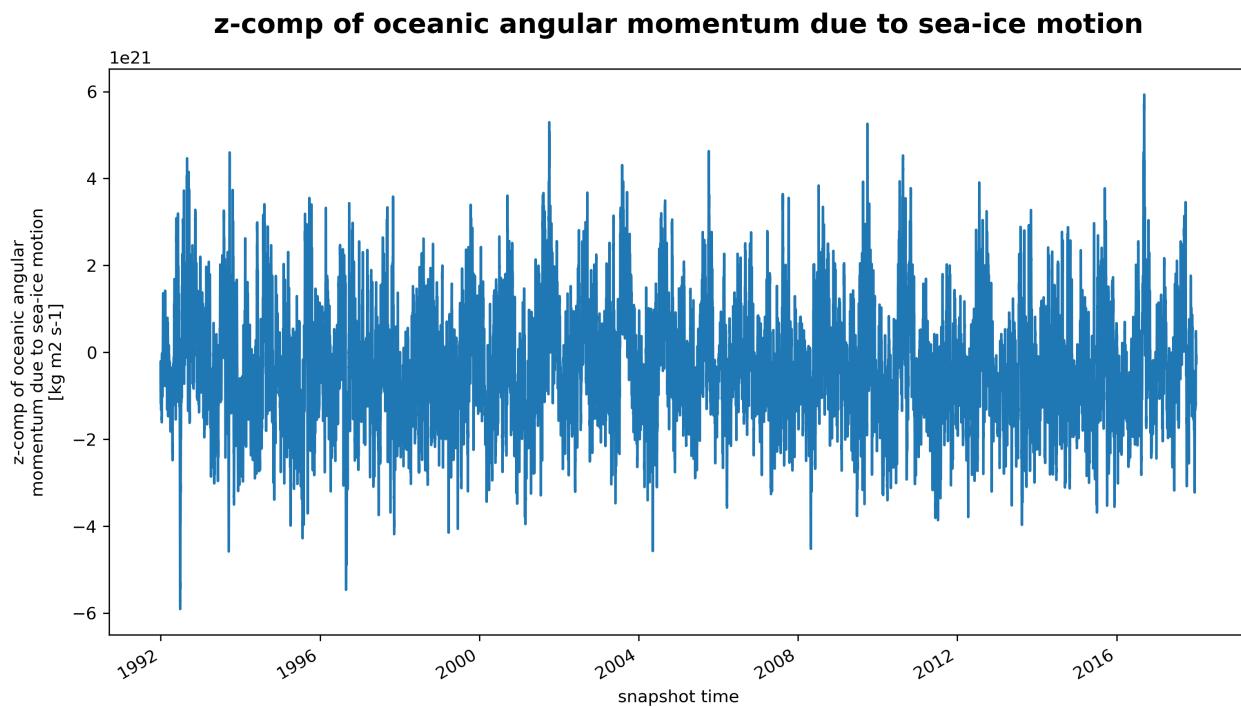
Example fied: SBO\_CORE\_PRODUCTS\_snap\_ECCO\_V4r4\_1D.nc

**Figure 201: Dataset: SBO\_CORE\_PRODUCTS Variable: zoamc**

#### 22.4.23 1D Variable zoamc\_si

**Table 22.30: CDL description of SBO\_CORE\_PRODUCTS's zoamc\_si variable**

Storage Type	Variable Name	Description	Unit
float64	zoamc_si	z-comp of oceanic angular momentum due to sea-ice motion	kg m <sup>2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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 m <sup>2</sup> s: 1			
zoamc_si: valid_min = : 5.909426721868294e+21			
zoamc_si: valid_max = 5.930388258256482e+21			
zoamc_si: coordinates = time			
<b>Comments</b>			
N/A			



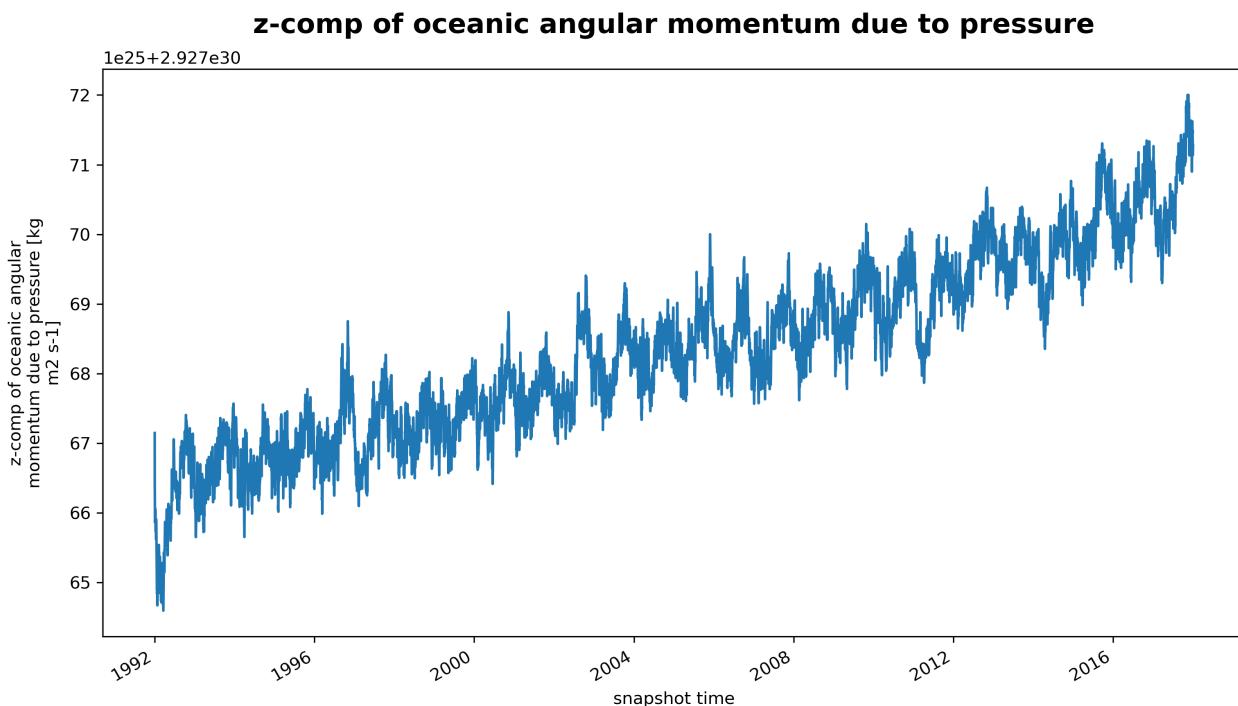
Example file: SBO\_CORE\_PRODUCTS\_snap\_ECCO\_V4r4\_1D.nc

**Figure 202: Dataset: SBO\_CORE\_PRODUCTS Variable: zoamc\_si**

#### 22.4.24 1D Variable zoamp

**Table 22.31: CDL description of SBO\_CORE\_PRODUCTS's zoamp variable**

Storage Type	Variable Name	Description	Unit
float64	zoamp	z-comp of oceanic angular momentum due to pressure	kg m <sup>2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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 m <sup>2</sup> s <sup>-1</sup>			
zoamp: valid_min = 2.927645942668479e+30			
zoamp: valid_max = 2.9277200254389854e+30			
zoamp: coordinates = time			
<b>Comments</b>			
N/A			



Example file: SBO\_CORE\_PRODUCTS\_snap\_ECCO\_V4r4\_1D.nc

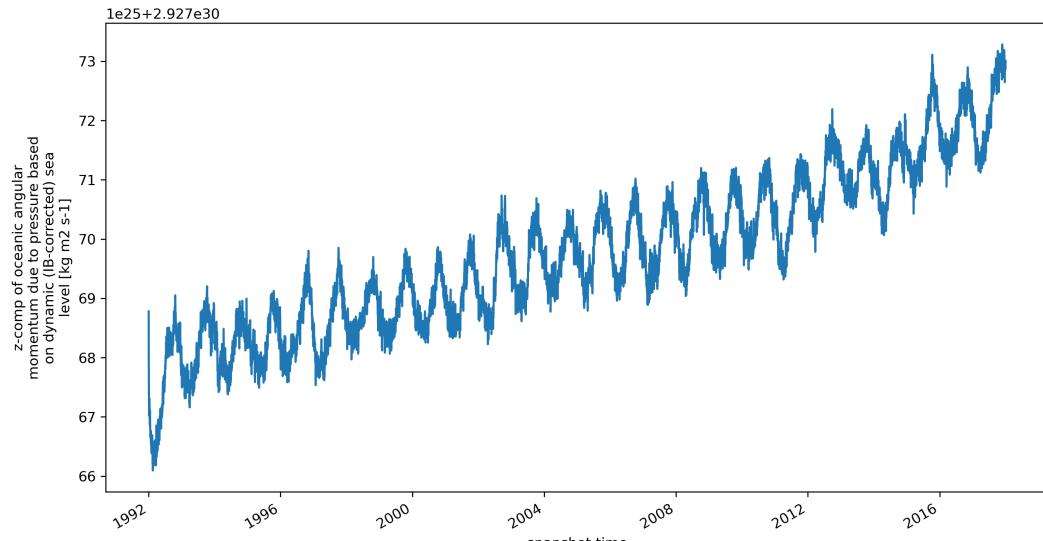
**Figure 203: Dataset: SBO\_CORE\_PRODUCTS Variable: zoamp**

#### 22.4.25 1D Variable zoamp\_dsl

**Table 22.32: CDL description of SBO\_CORE\_PRODUCTS's zoamp\_dsl variable**

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 <sup>2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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 <sup>2</sup> s: 1 zoamp_dsl:valid_min = 2.9276609546728614e+30 zoamp_dsl:valid_max = 2.9277328440911863e+30 zoamp_dsl:coordinates = time			
<b>Comments</b>			
N/A			

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



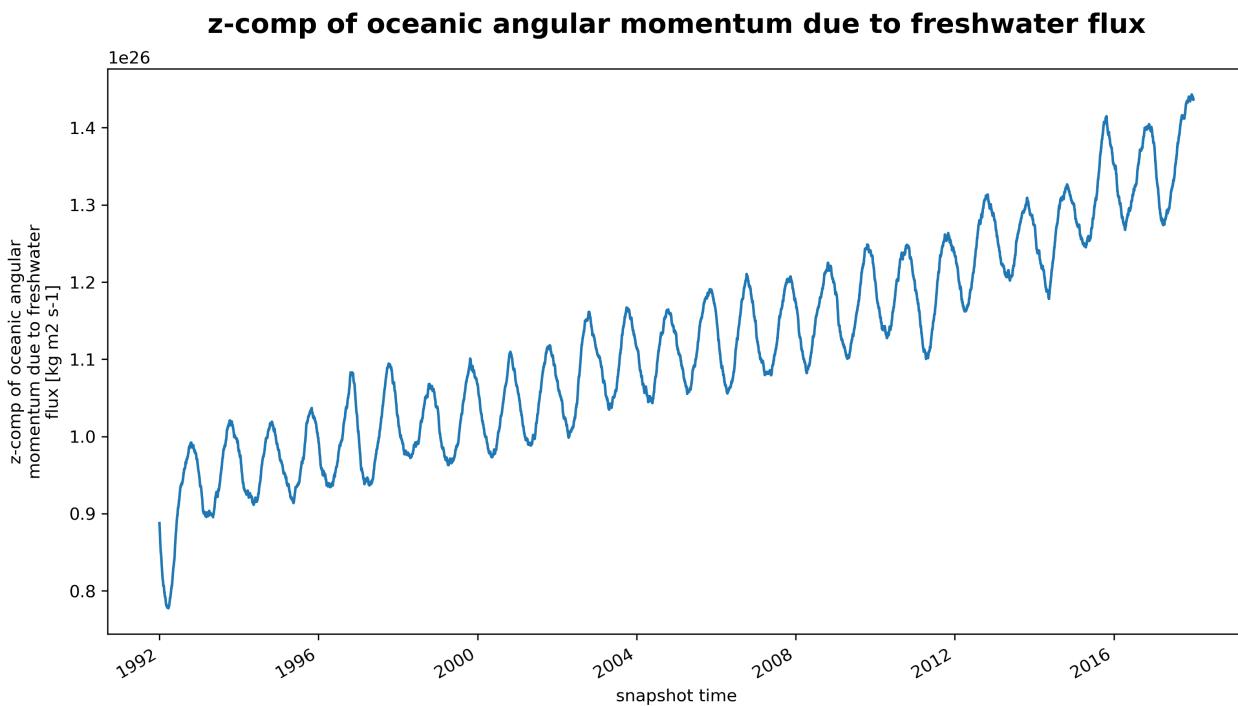
Example fied: SBO\_CORE\_PRODUCTS\_snap\_ECCO\_V4r4\_1D.nc

**Figure 204: Dataset: SBO\_CORE\_PRODUCTS Variable: zoamp\_dsl**

#### 22.4.26 1D Variable zoamp\_fw

**Table 22.33: CDL description of SBO\_CORE\_PRODUCTS's zoamp\_fw variable**

Storage Type	Variable Name	Description	Unit
float64	zoamp_fw	z-comp of oceanic angular momentum due to freshwater flux	kg m <sup>2</sup> s <sup>-1</sup>
<b>CDL Description</b>			
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 m <sup>2</sup> s <sup>-1</sup>			
zoamp_fw: valid_min = 7.774584605728723e+25			
zoamp_fw: valid_max = 1.442874536478883e+26			
zoamp_fw: coordinates = time			
<b>Comments</b>			
N/A			



Example fied: SBO\_CORE\_PRODUCTS\_snap\_ECCO\_V4r4\_1D.nc

**Figure 205: Dataset: SBO\_CORE\_PRODUCTS Variable: zoamp\_fw**

## 23 ECCO Metadata Specification

### 23.1 Overview Description of the ECCO Metadata Model

The GHRSST data are global collections compiled by scientists and data production systems in many countries, so the ISO 19115-2 International Geographic Metadata Standard (extensions for imagery and gridded data) has been adopted as the standard for GDS 2.0 metadata. This standard provides a structured way to manage not just the data usage and granule-level discovery metadata provided by the CF metadata in the GHRSST netCDF files, but also collection-level discovery, data quality, lineage, and other information needed for long-term stewardship and necessary metadata management. The GHRSST GDAC and LTSRF work with individual RDACs to create and maintain the collection-level ISO record for each of their datasets (one collection level record for each product line). The collection level record will be combined by the GDAC with metadata embedded in the netCDF-4 files preferred by the GDS 2.0. In the event that an RDAC chooses to produce netCDF-3 files instead of netCDF-4, they must also create a separate XML metadata record for each granule (following the GDS 1.6 specification detail in [RD-1]). RDACs will assist with maintaining the collection portion of the ISO metadata record and will update it on an as-needed basis. This approach ensures that for every L2P, L3, L4, or GMPE granule that is generated, appropriate ISO metadata can be registered at the GHRSST Master Metadata Repository (MMR) system. Details of this approach are provided in Section 13.3 after a brief description of the heritage GDS 1.0 metadata approach.

### 23.2 Evolution from the GHRSST GDS 1.0 Metadata Model

The GDS 1.6 specification metadata model ([RD-1]) contained three distinct metadata records. The Data Set Descriptions (DSD) included metadata that provided an overall description of a GHRSST product, including discovery and distribution. These metadata changed infrequently and were termed collection level metadata. The File Records (FR) contained metadata that describe a single data file or granule (traditionally called granule metadata). Finally there was also granule metadata captured in the CF attributes of a netCDF3 file. Under the new GDS 2.0 initial GHRSST 2.0 Metadata Model, all three types of metadata are leveraged into a single ISO-compliant metadata file as shown in Figure 13-2. Future revisions of the GDS 2.0 will incorporate more of the ISO metadata capabilities.

### 23.3 The ISO 19115-2 Metadata Model

The ISO metadata model is made up of a set of containers (also referred to as classes or objects) that contain metadata elements or other objects that, in turn, contain other elements or objects (see Figure 13-1 and Table 13-1). The root element is MI\_Metadata<sup>1</sup>. It contains twelve major classes that document various aspects of the resource (series or dataset) being described. The MD\_DataIdentification object contains other major classes that also describe various aspects of the dataset.

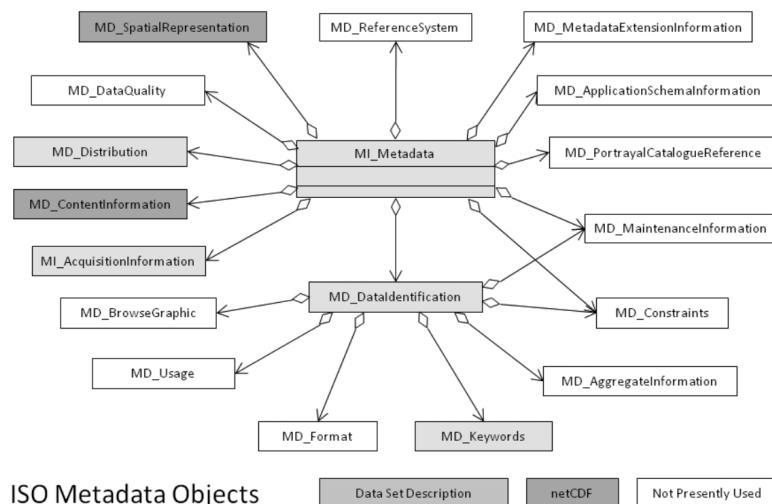


Figure 206: ISO Metadata Objects and their sources

<sup>1</sup>The ISO Standard for Geographic Data has two parts. ISO 19115 is the base standard. ISO 19115-2 includes 19115 and adds extensions for images and gridded data. We will use both parts in this model and refer to the standard used as 19115-2.

**Table 23.1: Major ISO Objects. Objects in use in the GHRSST metadata model are shaded in gray.**

ISO Object	Explanation
MI_Metadata	Root element that contains information about the metadata itself.
MI_AcquisitionInformation	Information about instruments, platforms, operations and other elements of data acquisition.
MD_ContentInformation	Information about the physical parameters and other attributes contained in a resource.
MD_Distribution	Information about who makes a resource available and how to get it.
MD_DataQuality	Information about the quality and lineage of a resource.
MD_SpatialRepresentation	Information about the geospatial representation of a resource.
MD_ReferenceSystem	Information about the spatial and temporal reference systems used in the resource.
MD_MetadataExtensionInformation	Information about user specified extensions to the metadata standard used to describe the resource.
MD_ApplicationSchemaInformation	Information about the application schema used to build a dataset (not presently used for GHRSST metadata).
MD_PortrayalCatalogueReference	Information identifying portrayal catalogues used for the resource (not presently used for GHRSST metadata).
MD_MaintenanceInformation	Information about maintenance of the metadata and the resource it describes.
MD_Constraints	Information about constraints on the use of the metadata and the resource it describes.
MD_DataIdentification	Information about constraints on the use of the metadata and the resource it describes.
MD_AggregateInformation	Information about groups that the resource belongs to.
MD_Keywords	Information about discipline, themes, locations, and times included in the resource.
MD_Format	Information about formats that the resource is available in.
MD_Usage	Information about how the resource has been used and identified limitations.
MD_BrowseGraphic	Information about graphical representations of the resource.

MI\_Metadata objects can be aggregated into several kinds of series that include metadata describing particular elements of the series, termed dataset metadata, as well as metadata describing the entire series (i.e. series or collection metadata). Unlike the GDS 1.0 Metadata Model, the ISO-based GDS 2.0 model combines both collection level and granule level metadata into a single XML file. The initial approach will be to extract and translate granule metadata from netCDF-4 CF attributes in conjunction with collection level metadata from existing GDS 1.0 compliant DSD records. In the case of a data producer providing a netCDF-3 granule, an additional FR metadata record **must** still be provided (see GDS 1.6 for details on the format of the FR metadata records). The flow of metadata production is described below in two scenarios:

#### Existing GDS 1.0 GHRSST products

1. Generate ISO collection level metadata from existing GDS 1.0 DSD records
2. Generate ISO granule level metadata from CF attributes embedded in a GDS 2.0 specification netCDF4 granule
3. Combine 1 and 2 into a complete GDS 2.0 ISO 19115-2 record
4. If the granule is GDS 1.0 netCDF3 format the RDAC must provide a File Record

#### GDS 2.0 GHRSST products

1. Use existing ISO collection level metadata. RDACs will provide the initial metadata record from a template.
2. Generate ISO granule level metadata from CF attributes embedded in a GDS 2.0 specification netCDF4 granule
3. Combine 1 and 2 into a complete GDS 2.0 ISO 19115-2 record

In both cases, the GDAC has the primary role to create the ISO metadata records in steps 1-3. A RDAC can also choose to do steps 1-3, or maintain only the collection level portion.

A diagram of the production approach is shown in Figure 13-2. The root element for the combined file is DS\_Series which includes dataset and series metadata. Dataset metadata will be constructed using metadata extracted from the netCDF-4 CF attributes (or a FR record if the file is in netCDF3 format). Series Metadata will be constructed with information from (initially) the DSD or the collection level portion of an existing GDS 2.0 specification ISO record.

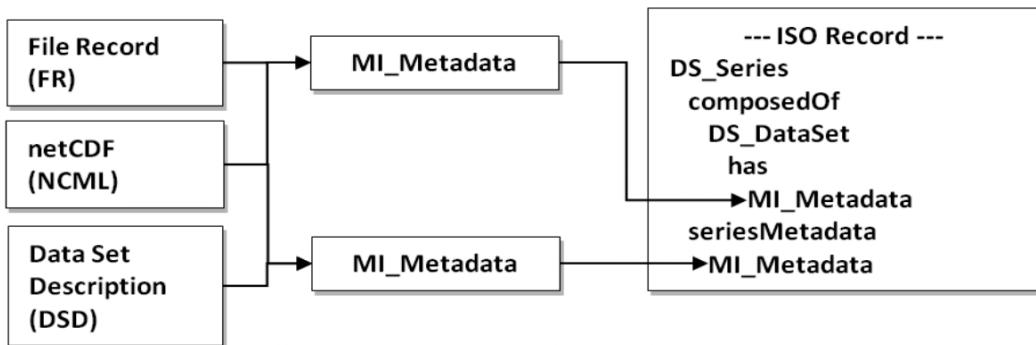


Figure 207: Initial GHSST Metadata Translation Approach to ISO record

To see the comprehensive details of the GHSST GDS 2.0 metadata model refer to the GDS 2.0 Metadata Specification documents and example at the GDAC (<http://ghsst.jpl.nasa.gov>).

## 24 GDS 2.0 Document Management Policy

The purpose of a GDS document management Policy is to establish the framework under which official records and documents of GHRSST are created and managed. It lists the responsibilities of key actors, and articulates the principles underpinning the processes outlined in the records and document management guidelines.

The **intent** of this Policy is to ensure that the GHRSST GPO, Science Team and actors working within GHRSST have the appropriate governance and supporting structure in place to enable them to manage their records and documents in a manner that is planned, controlled, monitored, recorded and audited, using an authorized system. This Policy states the key strategic and operational requirements for adequate recordkeeping and document management of the GDS to ensure that evidence, accountability and information about GHRSST activities are met.

The **scope** of this Policy is applicable to all people working in GHRSST and to all official records and documents, in any format and from any source. Examples include paper, electronic messages, digital documents and records, video, DVD, web-based content, plans, and maps. This Policy does not apply to public domain material.

### 24.1 GDS Document Management Definitions

<b>Document:</b>	Structured units of information recorded in any format and on any medium and managed as discrete units or objects. Some documents are records because they have participated in a business transaction, or were created to document such a transaction. Conversely, some documents are not records because they do not function as evidence of a business transaction.
<b>Email:</b>	The transmission of text messages and optional file attachments over a network.
<b>ERDMS:</b>	Electronic Records and Document Management System.
<b>Records:</b>	Information created, received, and maintained as evidence and information by an organization or person, in pursuance of legal obligations or in the transaction of business.
<b>Records Management:</b>	Field of management responsible for the efficient and systematic control of the creation, receipt, maintenance, use and disposition of records, including processes for capturing and maintaining evidence of and information about business activities and transactions in the form of records.

### 24.2 GDS Document Management Policy Statement

GDS records and documents created, received or used by GHRSST in the normal course of activities are the property of the GHRSST project, unless otherwise agreed. This includes reports compiled by external consultants commissioned by the GHRSST Project Office or Science Team.

GHRSST official records constitute its corporate memory, and as such are a vital asset for ongoing operations, and for providing evidence of activities and transactions. They assist the GPO and GHRSST Science Team in making better informed decisions and improving best practice by providing an accurate record of what has occurred before.

Thus GDS records are to be:

- managed in a consistent and structured manner;
- managed in accordance with best practice guidelines and procedures;
- stored in a secure manner;
- disposed of, or permanently archived appropriately;
- captured and registered using an authorized recordkeeping system

GHRSST GDS documents are to be

- created by authorized officers and managed by the GPO
- version controlled by authorized officers

### 24.3 GDS Document Management Policy Responsibility

The GHRSST Science Team is responsible for GDS Records Management and has delegated responsibility for records management to the GPO coordinator.

The Coordinator is accountable for providing assistance in the overall management of the GDS and documents, including:

- management of the GHRSST Document Management System (GHRSST Website document repository);
- providing assistance on the implementation and interpretation of the GDS Document Management;
- maintaining and developing GHRSST GDS document Management policy and promulgating this across GHRSST as a whole;
- identifying retention and disposal requirements for GHRSST records;
- providing training in GDS document management processes and the GHRSST website document repository

### 24.4 GHRSST GDS Recordkeeping and Document Management System

The GHRSST recordkeeping and document management system assists people working in GHRSST to capture records, protect their integrity and authenticity, provide access through time, dispose of records no longer required by GHRSST in the conduct of its activities, and ensure records of enduring value are retained. It also facilitates the creation, version control, and authority of official corporate documents.

The GHRSST recordkeeping and document management system is managed by the GPO which provides ongoing support, development and training, so that GHRSST community responsibilities are met.

The GHRSST authorized recordkeeping and document management system is the GHRSST Project Office Web site document library (<http://www.ghrsst.org>).

All GHRSST actors are to use <http://www.ghrsst.org> to ensure that:

- GDS official records and documents are routinely captured and subjected to the relevant retention and disposal policy;
- access to records and documents is managed according to authorized access and appropriate retention times regardless of international location;
- records and documents are protected from unauthorized alteration or deletion;
- documents are version controlled as required;
- there is one authoritative and primary source of information documenting GHRSST GDS decisions and actions.

All GHRSST actors who create, receive and keep records and documents as part of their GHRSST work, should do so in accordance with these policies, procedures and standards. GHRSST actors should not undertake disposal of records without the authority of the GPO – and only in accordance with authorized disposal schedules.

### 24.5 GDS Document location

1. An approved and complete version of the GDS shall be stored on the GHRSST web site (<http://www.ghrsst.org>) under the documents -> GDS -> operational section of the web site. This version shall be the Operational version of the GDS.
2. A development version of the GDS shall be stored on the GHRSST web site (<http://www.ghrsst.org>) under the documents -> GDS -> development section of the web site. This version shall be the development version of the GDS
3. An archive of all GDS documents shall be stored on the GHRSST web site (<http://www.ghrsst.org>) under the documents -> GDS -> archive section of the web site.
4. A single zip file containing all operational documents shall be available at the GHRSST web site

### 24.6 GDS Document Publication

1. The GHRSST Project Office is responsible for publication of GDS operational documents
2. A document BookCaptain is responsible for the publication of development GDS documents and shall inform the GHRSST project office when new documents have been published.

## 24.7 GDS Document formats

1. Operational GDS documents shall be stored as pdf documents.
2. Development GDS documents shall be stored as Microsoft word documents.
3. Both word and pdf documents shall be stored in the GDS archive.

## 24.8 GDS Document filing

1. Documents shall be numbered using the following nomenclature suffix to be appended at the end of a filename :

MM.mmm

where MM is the major revision e.g. 2 and mmm is a minor revision e.g. 019. for example, the following GDS filename is valid

GDS2.0\_TechnicalSpecifications\_rev02.001.doc

2. Following any change to a document, a new revision number shall be assigned to the document by the BookCaptain before publication.

## 24.9 Document retrieval

1. Free and open access to all GDS documents shall be provided by the GHRSST web page interface.

## 24.10 Document security

1. GDS documents stored within the GHRSST web page are backed up by the web hosting company every night.
2. An independent backup copy of all GDS documents shall be maintained by the GHRSST Project Office.

## 24.11 Retention and long term archive

1. GDS documents shall be retained in perpetuity within a stewardship facility.

## 24.12 Document workflow

1. Each GDS document shall be owned and administered by a document Book Captain.
2. A GDS BookCaptain is a central point of contact that is responsible for managing and maintaining the content of their GDS document
3. All revisions must be approved by a GDS document Book Captain.
4. All updates and revisions shall be entered into the Document change record.
5. A revised version of the GDS is passed to the GPO coordinator for registration and document management (revision control).
6. A revised version of the GDS is passed by the GPO to the GHRSST Data and Systems Technical Advisory Group (DAS-TAG) for review.
7. If required, the GPO may convene an external review Board to subject the revised GDS document to an independent peer review.
8. Proposed changes to the GDS, as provided by the DAS-TAG (and independent peer review if convened) are passed back to the Book Captains for implementation.
9. A final version of the GDS documents is passed back to the GPO.
10. A final version of the GDS is passed to the GHRSST Advisory council for approval.
11. The GPO publishes the GDS document on the GHRSST web site in the appropriate location of the GHRSST document library.

## 24.13 Document creation

1. The GHRSST Project Office, in collaboration with the GHRSST Science Team is responsible for the creation of new GDS documents.
2. The GHRSST Project Office may delegate the responsibility to create new documents to a member of the GHRSST Science Team.

# *How to find out more about GHRSST:*

A complete description of GHRSST together with all project documentation can be found at the following web spaces:

Main GHRSST portal

<https://www.ghrsst.org>

GHRSST GDAC (rolling archive)

<http://ghrsst.jpl.nasa.gov>

GHRSST LTSRF (Archive)

<http://ghrsst.nodc.noaa.gov>

GHRSST HRDDS (diagnostics)

<http://www.hrdds.net>

GHRSST MDB (validation)

<http://www.ifremer.fr/matchupdb>

GHRSST GMPE (L4 ensembles)

[http://ghrsst-pp.metoffice.com/pages/latest\analysis\sst\\\_monitor\daily\ens\index.html](http://ghrsst-pp.metoffice.com/pages/latest\analysis\sst\_monitor\daily\ens\index.html)

GHRSST data discovery

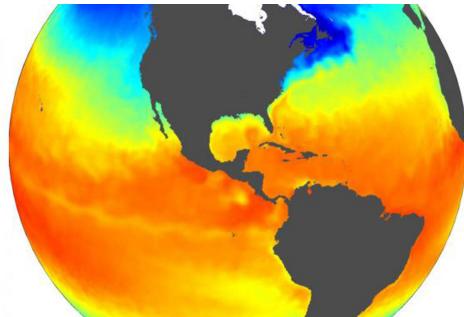
[http://ghrsst.jpl.nasa.gov/data\\\_search.html](http://ghrsst.jpl.nasa.gov/data\_search.html)

GHRSST data visualisation (EU)

<http://www.naiad.fr>

GHRSST data visualisation (USA)

<http://podaac-tools.jpl.nasa.gov/dataminer/>



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**Table 12.3: GHRSST Processing Level Conventions and Codes**

Level	<Processing Level> Code	Description
Level 0	LO	Unprocessed instrument and payload data at full resolution. GHRSST does not make recommendations regarding formats or content for data at this processing level.
Level 1A	L1A	Reconstructed unprocessed instrument data at full resolution, time referenced, and annotated with ancillary information, including radiometric and geometric calibration coefficients and geo-referencing parameters, computed and appended, but not applied, to LO data. GHRSST does not make recommendations regarding formats or content for data at this processing level.
Level 1B	L1B	Level 1A data that have been processed to sensor units. GHRSST does not currently make recommendations regarding formats or content for L1B data.
Level 2	Preprocessed L2P	Geophysical variables derived from Level 1 source data at the same resolution and location as the Level 1 data, typically in a satellite projection with geographic information. These data form the fundamental basis for higher-level GHRSST products and require ancillary data and uncertainty estimates.
Level 3	L3U L3C L3S	<p>Level 2 variables mapped on a defined grid with reduced requirements for ancillary data. Uncertainty estimates are still mandatory. Three types of L3 products are defined:</p> <ul style="list-style-type: none"> <li>• Un-collated (L3U): L2 data granules remapped to a space grid without combining any observations from overlapping orbits</li> <li>• Collated (L3C): observations combined from a single instrument into a space-time grid</li> <li>• Super-collated (L3S): observations combined from multiple instruments into a space-time grid.</li> </ul> <p>Note that L3 GHRSST products do not use analysis or interpolation procedures to fill gaps where no observations are available.</p>
Level 4	L4	Data sets created from the analysis of lower level data that result in gridded, gap-free products. SST data generated from multiple sources of satellite data using optimal interpolation are an example of L4 GHRSST products. GMPE products are a type of L4 dataset.
Note that within GHRSST, all L2P files require a full set of extensive ancillary data such as wind speeds and times of observation that are provided as dynamic flags that users can manipulate to filter data according to their own quality criteria.		

**Table 14.2: Regional Data Assembly Centre (RDAC) code table**

RDAC Code	GHRSSST RDAC Name
ABOM	Australian Bureau of Meteorology
CMC	Canadian Meteorological Centre
DMI	Danish Meteorological Institute
EUR	European RDAC
GOS	Gruppo di Oceanografia da Satellite
JPL	JPL Physical Oceanography Distributed Active Archive Center
JPL_OUROCEAN	JPL OurOcean Project
METNO	Norwegian Meteorological Institute
MYO	MyOcean
NAVO	Naval Oceanographic Office
NCDC	NOAA National Climatic Data Center
NEODAAS	NERC Observation Data Acquisition and Analysis Service
NOC	National Oceanography Centre, Southampton
NODC	NOAA National Oceanographic Data Center
OSDPD	NOAA Office of Satellite Data Processing and Distribution
OSISAF	EUMETSAT Ocean and Sea Ice Satellite Applications Facility
REMSS	Remote Sensing Systems, CA, USA
RSMAS	University of Miami, RSMAS
UKMO	UK Meteorological Office
UPA	United Kingdom Multi-Mission Processing and Archiving Facility
ESACCI	ESA SST Climate Change Initiative
JAXA	Japan Aerospace Exploration Agency
New codes	Please contact the GHRSSST international Project Office if you require new codes to be included in future revisions of the GDS.

**Table 14.3: GHRSST Processing Level Conventions and Codes**

Level	<Processing Level> Code	Description
Level 0	LO	Unprocessed instrument and payload data at full resolution. GHRSST does not make recommendations regarding formats or content for data at this processing level.
Level 1A	L1A	Reconstructed unprocessed instrument data at full resolution, time referenced, and annotated with ancillary information, including radiometric and geometric calibration coefficients and geo-referencing parameters, computed and appended, but not applied, to LO data. GHRSST does not make recommendations regarding formats or content for data at this processing level.
Level 1B	L1B	Level 1A data that have been processed to sensor units. GHRSST does not currently make recommendations regarding formats or content for L1B data.
Level 2	Preprocessed L2P	Geophysical variables derived from Level 1 source data at the same resolution and location as the Level 1 data, typically in a satellite projection with geographic information. These data form the fundamental basis for higher-level GHRSST products and require ancillary data and uncertainty estimates.
Level 3	L3U L3C L3S	<p>Level 2 variables mapped on a defined grid with reduced requirements for ancillary data. Uncertainty estimates are still mandatory. Three types of L3 products are defined:</p> <ul style="list-style-type: none"> <li>• Un-collated (L3U): L2 data granules remapped to a space grid without combining any observations from overlapping orbits</li> <li>• Collated (L3C): observations combined from a single instrument into a space-time grid</li> <li>• Super-collated (L3S): observations combined from multiple instruments into a space-time grid.</li> </ul> <p>Note that L3 GHRSST products do not use analysis or interpolation procedures to fill gaps where no observations are available.</p>
Level 4	L4	Data sets created from the analysis of lower level data that result in gridded, gap-free products. SST data generated from multiple sources of satellite data using optimal interpolation are an example of L4 GHRSST products. GMPE products are a type of L4 dataset.
Note that within GHRSST, all L2P files require a full set of extensive ancillary data such as wind speeds and times of observation that are provided as dynamic flags that users can manipulate to filter data according to their own quality criteria.		

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NOC	National Oceanography Centre, Southampton
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OSDPD	NOAA Office of Satellite Data Processing and Distribution
OSISAF	EUMETSAT Ocean and Sea Ice Satellite Applications Facility
REMSS	Remote Sensing Systems, CA, USA
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