

The ECCO Data Specification (ECCO) v4r4 User Guide

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

April 2025

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The ECCO Data Specification (EDS)

EDS Technical Specifications

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the ECCO Science Team 2025

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1 The ECCO Science Team 2025

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

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

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

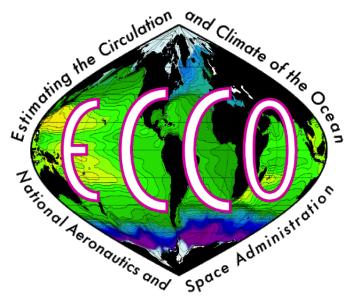
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JPL Jet Propulsion Laboratory

MIT Massachusetts Institute of Technology

aer Atmospheric and Environmental Research

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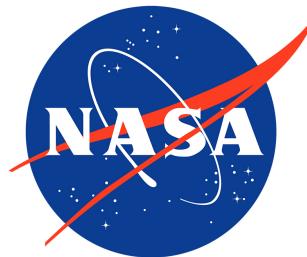
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2 Executive Summary

The ECCO Version 4 Release 4 (V4r4) products are comprehensive global ocean and sea-ice state estimates spanning from 1992 to 2018. These datasets are dynamically and kinematically consistent reconstructions of the three-dimensional, time-evolving ocean, sea-ice, and surface atmospheric states. They include a wide range of variables such as temperature, salinity, velocity, sea level anomalies, and fluxes (e.g., heat, freshwater, and salt). The data are available at daily, monthly, and instantaneous intervals on both the high-resolution LLC90 grid and a 0.5-degree interpolated grid. The datasets adhere to modern metadata standards and are formatted in netCDF-4 (and may be available in other data format such as Zarr data format) for accessibility via NASA's Earthdata Cloud infrastructure (PO.DAAC-NASA).

The key features of ECCO V4r4 include its ability to assimilate diverse observational datasets from satellites and in situ measurements using the MIT general circulation model (MITgcm). This allows for accurate representation of global ocean dynamics and climate processes. The release also introduces advanced cloud-native services for efficient data access and processing. These products are essential for studying ocean circulation, climate variability, sea-level changes, and freshwater fluxes on a global scale.

This user guide document first provides the scope and the key overall content of the present document, then an overview of ECCO data products (Level 4) followed by detailed technical specifications of dataset filename, file structure and supporting configuration. Finally, a full description of grid geometry, the coordinates and the data variables for both native lat-lon-cap 90 (llc90), latlon 0.5-degree and 1D datasets are provided with example of each of them.

3 Table of Contents

Contents

1 The ECCO Science Team 2025	4
2 Executive Summary	7
3 Table of Contents	8
4 Figures in this document	15
5 Tables in this document	18
6 Acryonyms and abbreviation list	25
7 Scope and Content of this Document	27
8 Overview of ECCO Data	28
8.1 Why trust ECCO?	28
8.2 Why Choose ECCO Over Alternatives?	28
9 ECCO Data Filenames and Supporting Conventions	30
9.1 General filename Structure	30
9.2 Examples	30
10 ECCO Data Product File Structure	31
10.1 Overview of the ECCO Data netCDF File Format	31
10.2 ECCO netCDF Global Attributes	31
10.3 ECCO Data netCDF Coordinates, Dimensions and Variables Attributes	34
10.4 ECCO Data netCDF Dimensions definition	35
10.5 ECCO Data netCDF Coordinates variable definition	35
10.6 Example of ECCO V4r4 netCDF latlon grid datasets	37
10.7 Example of ECCO V4r4 netCDF native llc90 grid datasets	39
10.8 Example of ECCO V4r4 netCDF for 1D data	43
11 Native lat-lon-cap 90 (llc90) Coordinates and Grid Geometry	44
11.1 Native coordinates GRID_GEOMETRY_ECCO	44
11.1.1 Overview	44
11.1.2 Native coordinates Variable: XC	46
11.1.3 Native coordinates Variable: YC	47
11.1.4 Native coordinates Variable: XG	48
11.1.5 Native coordinates Variable: YG	49
11.1.6 Native coordinates Variable: CS	50
11.1.7 Native coordinates Variable: SN	51
11.1.8 Native coordinates Variable: rA	52
11.1.9 Native coordinates Variable: dxG	53
11.1.10 Native coordinates Variable: dyG	54
11.1.11 Native coordinates Variable: Depth	55
11.1.12 Native coordinates Variable: rAz	56
11.1.13 Native coordinates Variable: dxC	57
11.1.14 Native coordinates Variable: dyC	58
11.1.15 Native coordinates Variable: rAw	59
11.1.16 Native coordinates Variable: rAs	60
11.1.17 Native coordinates Variable: hFacC	61

11.1.18 Native coordinates Variable: hFacW	62
11.1.19 Native coordinates Variable: hFacS	63
11.1.20 Native coordinates Variable: maskC	64
11.1.21 Native coordinates Variable: maskW	65
11.1.22 Native coordinates Variable: maskS	66
12 Native Dataset Groupings	67
12.1 Native dataset of ATM_SURFACE_TEMP_HUM_WIND_PRES	67
12.1.1 Overview	67
12.1.2 Native Variable: EXFaqh	68
12.1.3 Native Variable: EXFatemp	69
12.1.4 Native Variable: EXFpress	70
12.1.5 Native Variable: EXFuwind	71
12.1.6 Native Variable: EXFvwind	72
12.1.7 Native Variable: EXFwspee	73
12.2 Native dataset of OCEAN_3D_MIXING_COFFS	74
12.2.1 Overview	74
12.2.2 Native Variable: DIFFKR	75
12.2.3 Native Variable: KAPGM	76
12.2.4 Native Variable: KAPREDI	77
12.3 Native dataset of OCEAN_3D_MOMENTUM_TEND	77
12.3.1 Overview	77
12.3.2 Native Variable: Um_dPHdx	79
12.3.3 Native Variable: Vm_dPHdy	80
12.4 Native dataset of OCEAN_3D_SALINITY_FLUX	81
12.4.1 Overview	81
12.4.2 Native Variable: ADVr_SLT	82
12.4.3 Native Variable: ADVx_SLT	83
12.4.4 Native Variable: ADVy_SLT	85
12.4.5 Native Variable: DFrE_SLT	87
12.4.6 Native Variable: DFrI_SLT	89
12.4.7 Native Variable: DFxE_SLT	91
12.4.8 Native Variable: DFyE_SLT	93
12.4.9 Native Variable: oceSPnd	95
12.5 Native dataset of OCEAN_3D_TEMPERATURE_FLUX	96
12.5.1 Overview	96
12.5.2 Native Variable: ADVr_TH	97
12.5.3 Native Variable: ADVx_TH	98
12.5.4 Native Variable: ADVy_TH	100
12.5.5 Native Variable: DFrE_TH	102
12.5.6 Native Variable: DFrI_TH	104
12.5.7 Native Variable: DFxE_TH	106
12.5.8 Native Variable: DFyE_TH	107
12.6 Native dataset of OCEAN_3D_VOLUME_FLUX	108
12.6.1 Overview	108
12.6.2 Native Variable: UVELMASS	110
12.6.3 Native Variable: VVELMASS	112
12.6.4 Native Variable: WVELMASS	114
12.7 Native dataset of OCEAN_AND_ICE_SURFACE_FW_FLUX	115
12.7.1 Overview	115
12.7.2 Native Variable: EXFempmr	116
12.7.3 Native Variable: EXFevap	117
12.7.4 Native Variable: EXFpreci	118
12.7.5 Native Variable: EXFroff	119

12.7.6 Native Variable: SFLUX	120
12.7.7 Native Variable: SlacSubl	121
12.7.8 Native Variable: SlatmFW	122
12.7.9 Native Variable: SlfwThru	123
12.7.10 Native Variable: SlrsSubl	124
12.7.11 Native Variable: SlsnPrcp	125
12.7.12 Native Variable: oceFWflx	126
12.8 Native dataset of OCEAN_AND_ICE_SURFACE_HEAT_FLUX	127
12.8.1 Overview	127
12.8.2 Native Variable: EXFhl	128
12.8.3 Native Variable: EXFhs	129
12.8.4 Native Variable: EXFlwdn	130
12.8.5 Native Variable: EXFlwnet	131
12.8.6 Native Variable: EXFqnet	132
12.8.7 Native Variable: EXFswdn	133
12.8.8 Native Variable: EXFswnet	134
12.8.9 Native Variable: Slaaflux	135
12.8.10 Native Variable: SlatmQnt	136
12.8.11 Native Variable: TFLUX	137
12.8.12 Native Variable: oceQnet	138
12.8.13 Native Variable: oceQsw	140
12.9 Native dataset of OCEAN_AND_ICE_SURFACE_STRESS	141
12.9.1 Overview	141
12.9.2 Native Variable: EXFtaux	142
12.9.3 Native Variable: EXFtauy	143
12.9.4 Native Variable: oceTAUX	144
12.9.5 Native Variable: oceTAUY	146
12.10 Native dataset of OCEAN_BOLUS_STREAMFUNCTION	147
12.10.1 Overview	147
12.10.2 Native Variable: GM_PsiX	149
12.10.3 Native Variable: GM_PsiY	150
12.11 Native dataset of OCEAN_BOLUS_VELOCITY	151
12.11.1 Overview	151
12.11.2 Native Variable: UVELSTAR	152
12.11.3 Native Variable: VVELSTAR	153
12.11.4 Native Variable: WVELSTAR	154
12.12 Native dataset of OCEAN_BOTTOM_PRESSURE	155
12.12.1 Overview	155
12.12.2 Native Variable: OBP	156
12.12.3 Native Variable: OBPGMAP	158
12.12.4 Native Variable: PHIBOT	160
12.13 Native dataset of OCEAN_DENS_STRAT_PRESS	161
12.13.1 Overview	161
12.13.2 Native Variable: DRHODR	162
12.13.3 Native Variable: PHIHYD	163
12.13.4 Native Variable: PHIHYDcR	164
12.13.5 Native Variable: RHOAnoma	165
12.14 Native dataset of OCEAN_MIXED_LAYER_DEPTH	165
12.14.1 Overview	165
12.14.2 Native Variable: MXLDEPTH	167
12.15 Native dataset of OCEAN_TEMPERATURE_SALINITY	168
12.15.1 Overview	168
12.15.2 Native Variable: SALT	169
12.15.3 Native Variable: THETA	170

12.16 Native dataset of OCEAN_VELOCITY	171
12.16.1 Overview	171
12.16.2 Native Variable: UVEL	172
12.16.3 Native Variable: VVEL	173
12.16.4 Native Variable: WVEL	174
12.17 Native dataset of SEA_ICE_CONC_THICKNESS	175
12.17.1 Overview	175
12.17.2 Native Variable: Slarea	176
12.17.3 Native Variable: Slheff	177
12.17.4 Native Variable: Slhsnow	178
12.17.5 Native Variable: slceLoad	179
12.18 Native dataset of SEA_ICE_HORIZ_VOLUME_FLUX	179
12.18.1 Overview	179
12.18.2 Native Variable: ADVxHEFF	181
12.18.3 Native Variable: ADVxSNOW	182
12.18.4 Native Variable: ADVyHEFF	183
12.18.5 Native Variable: ADVySNOW	184
12.18.6 Native Variable: DFxEHEFF	185
12.18.7 Native Variable: DFxESNOW	186
12.18.8 Native Variable: DFyEHEFF	187
12.18.9 Native Variable: DFyESNOW	188
12.19 Native dataset of SEA_ICE_SALT_PLUME_FLUX	189
12.19.1 Overview	189
12.19.2 Native Variable: oceSPDep	190
12.19.3 Native Variable: oceSPflx	191
12.20 Native dataset of SEA_ICE_VELOCITY	191
12.20.1 Overview	191
12.20.2 Native Variable: Sluice	193
12.20.3 Native Variable: Slvice	194
12.21 Native dataset of SEA_SURFACE_HEIGHT	194
12.21.1 Overview	194
12.21.2 Native Variable: ETAN	196
12.21.3 Native Variable: SSH	197
12.21.4 Native Variable: SSHIBC	198
12.21.5 Native Variable: SSHNOIBC	199
13 Lat-Lon Coordinates and Grid Geometry	200
13.1 Latlon coordinates GRID_GEOMETRY_ECCO	200
13.1.1 Overview	200
13.1.2 Latlon coordinates Variable: hFacC	201
13.1.3 Latlon coordinates Variable: maskC	202
14 Latlon Dataset Groupings	203
14.1 Latlon dataset of ATM_SURFACE_TEMP_HUM_WIND_PRES	203
14.1.1 Overview	203
14.1.2 Latlon Variable: EXFaqh	204
14.1.3 Latlon Variable: EXFatemp	205
14.1.4 Latlon Variable: EXFewind	206
14.1.5 Latlon Variable: EXFnwind	207
14.1.6 Latlon Variable: EXFpress	208
14.1.7 Latlon Variable: EXFwspee	209
14.2 Latlon dataset of OCEAN_AND_ICE_SURFACE_FW_FLUX	209
14.2.1 Overview	209
14.2.2 Latlon Variable: EXFempmr	211

14.2.3 Latlon Variable: EXFevap	212
14.2.4 Latlon Variable: EXFpreci	213
14.2.5 Latlon Variable: EXFroff	214
14.2.6 Latlon Variable: SFLUX	215
14.2.7 Latlon Variable: SlacSubl	216
14.2.8 Latlon Variable: SlatmFW	217
14.2.9 Latlon Variable: SlfwThru	218
14.2.10 Latlon Variable: SlrsSubl	219
14.2.11 Latlon Variable: SlsnPrcp	220
14.2.12 Latlon Variable: oceFWflx	221
14.3 Latlon dataset of OCEAN_AND_ICE_SURFACE_HEAT_FLUX	221
14.3.1 Overview	221
14.3.2 Latlon Variable: EXFhl	223
14.3.3 Latlon Variable: EXFhs	224
14.3.4 Latlon Variable: EXFlwdn	225
14.3.5 Latlon Variable: EXFlwnet	226
14.3.6 Latlon Variable: EXFqnet	227
14.3.7 Latlon Variable: EXFswdn	228
14.3.8 Latlon Variable: EXFswnet	229
14.3.9 Latlon Variable: Slaaflux	230
14.3.10 Latlon Variable: SlatmQnt	231
14.3.11 Latlon Variable: TFLUX	232
14.3.12 Latlon Variable: oceQnet	233
14.3.13 Latlon Variable: oceQsw	234
14.4 Latlon dataset of OCEAN_AND_ICE_SURFACE_STRESS	234
14.4.1 Overview	234
14.4.2 Latlon Variable: EXFtaue	236
14.4.3 Latlon Variable: EXFtaun	237
14.4.4 Latlon Variable: oceTAUE	238
14.4.5 Latlon Variable: oceTAUN	239
14.5 Latlon dataset of OCEAN_BOLUS_VELOCITY	239
14.5.1 Overview	239
14.5.2 Latlon Variable: EVELSTAR	241
14.5.3 Latlon Variable: NVELSTAR	242
14.5.4 Latlon Variable: WVELSTAR	243
14.6 Latlon dataset of OCEAN_BOTTOM_PRESSURE	243
14.6.1 Overview	243
14.6.2 Latlon Variable: OBP	245
14.6.3 Latlon Variable: OBPGMAP	246
14.7 Latlon dataset of OCEAN_DENS_STRAT_PRESS	247
14.7.1 Overview	247
14.7.2 Latlon Variable: DRHODR	248
14.7.3 Latlon Variable: PHIHYD	249
14.7.4 Latlon Variable: RHOAnoma	250
14.8 Latlon dataset of OCEAN_MIXED_LAYER_DEPTH	250
14.8.1 Overview	250
14.8.2 Latlon Variable: MXLDEPTH	252
14.9 Latlon dataset of OCEAN_TEMPERATURE_SALINITY	252
14.9.1 Overview	252
14.9.2 Latlon Variable: SALT	254
14.9.3 Latlon Variable: THETA	255
14.10 Latlon dataset of OCEAN_VELOCITY	255
14.10.1 Overview	255
14.10.2 Latlon Variable: EVEL	257

14.10.3 Latlon Variable: NVEL	258
14.10.4 Latlon Variable: WVEL	259
14.11 Latlon dataset of SEA_ICE_CONC_THICKNESS	259
14.11.1 Overview	259
14.11.2 Latlon Variable: Slarea	261
14.11.3 Latlon Variable: Slheff	262
14.11.4 Latlon Variable: Slhsnow	263
14.11.5 Latlon Variable: slceLoad	264
14.12 Latlon dataset of SEA_ICE_VELOCITY	264
14.12.1 Overview	264
14.12.2 Latlon Variable: Sleice	266
14.12.3 Latlon Variable: Slnice	267
14.13 Latlon dataset of SEA_SURFACE_HEIGHT	267
14.13.1 Overview	267
14.13.2 Latlon Variable: SSH	269
14.13.3 Latlon Variable: SSHIBC	270
14.13.4 Latlon Variable: SSHNOIBC	271
15 1-D Dataset Groupings	272
15.1 1D dataset of GLOBAL_MEAN_ATM_SURFACE_PRES	272
15.1.1 Overview	272
15.1.2 1D Variable: Pa_global	273
15.2 1D dataset of GLOBAL_MEAN_SEA_LEVEL	273
15.2.1 Overview	273
15.2.2 1D Variable: global_mean_barystatic_sea_level_anomaly	275
15.2.3 1D Variable: global_mean_sea_level_anomaly	277
15.2.4 1D Variable: global_mean_sterodynamic_sea_level_anomaly	278
15.3 1D dataset of SBO_CORE_PRODUCTS	279
15.3.1 Overview	279
15.3.2 1D Variable: mass	281
15.3.3 1D Variable: mass_fw	282
15.3.4 1D Variable: mass_gc	283
15.3.5 1D Variable: mass_si	284
15.3.6 1D Variable: sboarea	285
15.3.7 1D Variable: xcom	286
15.3.8 1D Variable: xcom_fw	287
15.3.9 1D Variable: xoamc	288
15.3.10 1D Variable: xoamc_si	289
15.3.11 1D Variable: xoamp	290
15.3.12 1D Variable: xoamp_dsl	291
15.3.13 1D Variable: xoamp_fw	292
15.3.14 1D Variable: ycom	293
15.3.15 1D Variable: ycom_fw	294
15.3.16 1D Variable: yoamc	295
15.3.17 1D Variable: yoamc_si	296
15.3.18 1D Variable: yoamp	297
15.3.19 1D Variable: yoamp_dsl	298
15.3.20 1D Variable: yoamp_fw	299
15.3.21 1D Variable: zcom	300
15.3.22 1D Variable: zcom_fw	301
15.3.23 1D Variable: zoamc	302
15.3.24 1D Variable: zoamc_si	303
15.3.25 1D Variable: zoamp	304
15.3.26 1D Variable: zoamp_dsl	305

15.3.27 1D Variable: zoamp_fw 306

4 Figures in this document

List of Figures

1	Dataset: GRID_GEOMETRY_ECCO, Variable: XC	46
2	Dataset: GRID_GEOMETRY_ECCO, Variable: YC	47
3	Dataset: GRID_GEOMETRY_ECCO, Variable: XG	48
4	Dataset: GRID_GEOMETRY_ECCO, Variable: YG	49
5	Dataset: GRID_GEOMETRY_ECCO, Variable: CS	50
6	Dataset: GRID_GEOMETRY_ECCO, Variable: SN	51
7	Dataset: GRID_GEOMETRY_ECCO, Variable: rA	52
8	Dataset: GRID_GEOMETRY_ECCO, Variable: dxG	53
9	Dataset: GRID_GEOMETRY_ECCO, Variable: dyG	54
10	Dataset: GRID_GEOMETRY_ECCO, Variable: Depth	55
11	Dataset: GRID_GEOMETRY_ECCO, Variable: rAz	56
12	Dataset: GRID_GEOMETRY_ECCO, Variable: dxC	57
13	Dataset: GRID_GEOMETRY_ECCO, Variable: dyC	58
14	Dataset: GRID_GEOMETRY_ECCO, Variable: rAw	59
15	Dataset: GRID_GEOMETRY_ECCO, Variable: rAs	60
16	Dataset: GRID_GEOMETRY_ECCO, Variable: hFacC	61
17	Dataset: GRID_GEOMETRY_ECCO, Variable: hFacW	62
18	Dataset: GRID_GEOMETRY_ECCO, Variable: hFacS	63
19	Dataset: GRID_GEOMETRY_ECCO, Variable: maskC	64
20	Dataset: GRID_GEOMETRY_ECCO, Variable: maskW	65
21	Dataset: GRID_GEOMETRY_ECCO, Variable: maskS	66
22	Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFaqh	68
23	Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFatemp	69
24	Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFpress	70
25	Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFuwind	71
26	Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFvwind	72
27	Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFwspee	73
28	Dataset: OCEAN_3D_MIXING_COEFFS, Variable: DIFFKR	75
29	Dataset: OCEAN_3D_MIXING_COEFFS, Variable: KAPGM	76
30	Dataset: OCEAN_3D_MIXING_COEFFS, Variable: KAPREDI	77
31	Dataset: OCEAN_3D_MOMENTUM_TEND, Variable: Um_dPHdx	79
32	Dataset: OCEAN_3D_MOMENTUM_TEND, Variable: Vm_dPHdy	80
33	Dataset: OCEAN_3D_SALINITY_FLUX, Variable: ADVr_SLT	82
34	Dataset: OCEAN_3D_SALINITY_FLUX, Variable: ADVx_SLT	84
35	Dataset: OCEAN_3D_SALINITY_FLUX, Variable: ADVy_SLT	86
36	Dataset: OCEAN_3D_SALINITY_FLUX, Variable: DFrE_SLT	88
37	Dataset: OCEAN_3D_SALINITY_FLUX, Variable: DFrl_SLT	90
38	Dataset: OCEAN_3D_SALINITY_FLUX, Variable: DFxE_SLT	92
39	Dataset: OCEAN_3D_SALINITY_FLUX, Variable: DFyE_SLT	94
40	Dataset: OCEAN_3D_SALINITY_FLUX, Variable: oceSPnd	95
41	Dataset: OCEAN_3D_TEMPERATURE_FLUX, Variable: ADVr_TH	97
42	Dataset: OCEAN_3D_TEMPERATURE_FLUX, Variable: ADVx_TH	99
43	Dataset: OCEAN_3D_TEMPERATURE_FLUX, Variable: ADVy_TH	101
44	Dataset: OCEAN_3D_TEMPERATURE_FLUX, Variable: DFrE_TH	103
45	Dataset: OCEAN_3D_TEMPERATURE_FLUX, Variable: DFrl_TH	105
46	Dataset: OCEAN_3D_TEMPERATURE_FLUX, Variable: DFxE_TH	106
47	Dataset: OCEAN_3D_TEMPERATURE_FLUX, Variable: DFyE_TH	108
48	Dataset: OCEAN_3D_VOLUME_FLUX, Variable: UVELMASS	111

49	Dataset: OCEAN_3D_VOLUME_FLUX, Variable: VVELMASS	113
50	Dataset: OCEAN_3D_VOLUME_FLUX, Variable: WVELMASS	114
51	Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFempmr	116
52	Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFevap	117
53	Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFpreci	118
54	Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFroff	119
55	Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SFLUX	120
56	Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SlacSubl	121
57	Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SlatmFW	122
58	Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SlfwThru	123
59	Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SlrsSubl	124
60	Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SlsnPrcp	125
61	Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: oceFWflx	126
62	Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFhl	128
63	Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFhs	129
64	Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFlwdn	130
65	Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFlwnet	131
66	Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFqnet	132
67	Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFswdn	133
68	Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFswnet	134
69	Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: Slaflux	135
70	Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: SlatmQnt	136
71	Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: TFLUX	137
72	Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: oceQnet	139
73	Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: oceQsw	140
74	Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: EXFtaux	142
75	Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: EXFtauy	143
76	Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: oceTAUX	145
77	Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: oceTAUY	147
78	Dataset: OCEAN_BOLUS_STREAMFUNCTION, Variable: GM_PsiX	149
79	Dataset: OCEAN_BOLUS_STREAMFUNCTION, Variable: GM_PsiY	150
80	Dataset: OCEAN_BOLUS_VELOCITY, Variable: UVELSTAR	152
81	Dataset: OCEAN_BOLUS_VELOCITY, Variable: VVELSTAR	153
82	Dataset: OCEAN_BOLUS_VELOCITY, Variable: WVELSTAR	154
83	Dataset: OCEAN_BOTTOM_PRESSURE, Variable: OBP	157
84	Dataset: OCEAN_BOTTOM_PRESSURE, Variable: OBPGMAP	159
85	Dataset: OCEAN_BOTTOM_PRESSURE, Variable: PHIBOT	160
86	Dataset: OCEAN_DENS_STRAT_PRESS, Variable: DRHODR	162
87	Dataset: OCEAN_DENS_STRAT_PRESS, Variable: PHIHYD	163
88	Dataset: OCEAN_DENS_STRAT_PRESS, Variable: PHIHYDcR	164
89	Dataset: OCEAN_DENS_STRAT_PRESS, Variable: RHOAnoma	165
90	Dataset: OCEAN_MIXED_LAYER_DEPTH, Variable: MXLDEPTH	167
91	Dataset: OCEAN_TEMPERATURE_SALINITY, Variable: SALT	169
92	Dataset: OCEAN_TEMPERATURE_SALINITY, Variable: THETA	170
93	Dataset: OCEAN_VELOCITY, Variable: UVEL	172
94	Dataset: OCEAN_VELOCITY, Variable: VVEL	173
95	Dataset: OCEAN_VELOCITY, Variable: WVEL	174
96	Dataset: SEA_ICE_CONC_THICKNESS, Variable: Slarea	176
97	Dataset: SEA_ICE_CONC_THICKNESS, Variable: Slheff	177
98	Dataset: SEA_ICE_CONC_THICKNESS, Variable: Slhsnow	178
99	Dataset: SEA_ICE_CONC_THICKNESS, Variable: slceLoad	179
100	Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: ADVxHEFF	181
101	Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: ADVxSNOW	182
102	Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: ADVyHEFF	183

103	Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: ADVySNOW	184
104	Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: DFxEHEFF	185
105	Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: DFxESNOW	186
106	Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: DFyEHEFF	187
107	Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: DFyESNOW	188
108	Dataset: SEA_ICE_SALT_PLUME_FLUX, Variable: oceSPDep	190
109	Dataset: SEA_ICE_SALT_PLUME_FLUX, Variable: oceSPflx	191
110	Dataset: SEA_ICE_VELOCITY, Variable: Sluice	193
111	Dataset: SEA_ICE_VELOCITY, Variable: Slvice	194
112	Dataset: SEA_SURFACE_HEIGHT, Variable: ETAN	196
113	Dataset: SEA_SURFACE_HEIGHT, Variable: SSH	197
114	Dataset: SEA_SURFACE_HEIGHT, Variable: SSHIBC	198
115	Dataset: SEA_SURFACE_HEIGHT, Variable: SSHNOIBC	199
116	Dataset: GRID_GEOMETRY_ECCO, Variable: hFacC	201
117	Dataset: GRID_GEOMETRY_ECCO, Variable: maskC	202
118	Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFaqh	204
119	Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFatemp	205
120	Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFewind	206
121	Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFnwind	207
122	Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFpress	208
123	Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFwspee	209
124	Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFempmr	211
125	Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFevap	212
126	Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFpreci	213
127	Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFroff	214
128	Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SFLUX	215
129	Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SlacSubl	216
130	Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SlatmFW	217
131	Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SlfwThru	218
132	Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SlrsSubl	219
133	Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SlsnPrcp	220
134	Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: ocefWfllx	221
135	Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFhl	223
136	Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFhs	224
137	Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFlwdn	225
138	Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFlwnet	226
139	Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFqnet	227
140	Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFswdn	228
141	Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFswnet	229
142	Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: Slaflux	230
143	Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: SlatmQnt	231
144	Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: TFLUX	232
145	Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: oceQnet	233
146	Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: oceQsw	234
147	Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: EXFtaue	236
148	Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: EXFtaun	237
149	Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: oceTAUE	238
150	Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: oceTAUN	239
151	Dataset: OCEAN_BOLUS_VELOCITY, Variable: EVELSTAR	241
152	Dataset: OCEAN_BOLUS_VELOCITY, Variable: NVELSTAR	242
153	Dataset: OCEAN_BOLUS_VELOCITY, Variable: WVELSTAR	243
154	Dataset: OCEAN_BOTTOM_PRESSURE, Variable: OBP	245
155	Dataset: OCEAN_BOTTOM_PRESSURE, Variable: OBPGMAP	246
156	Dataset: OCEAN_DENS_STRAT_PRESS, Variable: DRHODR	248

157	Dataset: OCEAN_DENS_STRAT_PRESS, Variable: PHIHYD	249
158	Dataset: OCEAN_DENS_STRAT_PRESS, Variable: RHOAnoma	250
159	Dataset: OCEAN_MIXED_LAYER_DEPTH, Variable: MXLDEPTH	252
160	Dataset: OCEAN_TEMPERATURE_SALINITY, Variable: SALT	254
161	Dataset: OCEAN_TEMPERATURE_SALINITY, Variable: THETA	255
162	Dataset: OCEAN_VELOCITY, Variable: EVEL	257
163	Dataset: OCEAN_VELOCITY, Variable: NVEL	258
164	Dataset: OCEAN_VELOCITY, Variable: WVEL	259
165	Dataset: SEA_ICE_CONC_THICKNESS, Variable: Slarea	261
166	Dataset: SEA_ICE_CONC_THICKNESS, Variable: Slheff	262
167	Dataset: SEA_ICE_CONC_THICKNESS, Variable: Slhsnow	263
168	Dataset: SEA_ICE_CONC_THICKNESS, Variable: slceLoad	264
169	Dataset: SEA_ICE_VELOCITY, Variable: Sleice	266
170	Dataset: SEA_ICE_VELOCITY, Variable: Slnice	267
171	Dataset: SEA_SURFACE_HEIGHT, Variable: SSH	269
172	Dataset: SEA_SURFACE_HEIGHT, Variable: SSHIBC	270
173	Dataset: SEA_SURFACE_HEIGHT, Variable: SSHNOIBC	271
174	Dataset: GLOBAL_MEAN_ATM_SURFACE_PRES, Variable: Pa_global	273
175	Dataset: GLOBAL_MEAN_SEA_LEVEL, Variable: global_mean_barystatic_sea_level_anomaly	276
176	Dataset: GLOBAL_MEAN_SEA_LEVEL, Variable: global_mean_sea_level_anomaly	277
177	Dataset: GLOBAL_MEAN_SEA_LEVEL, Variable: global_mean_sterodynamic_sea_level_anomaly	279
178	Dataset: SBO_CORE_PRODUCTS, Variable: mass	281
179	Dataset: SBO_CORE_PRODUCTS, Variable: mass_fw	282
180	Dataset: SBO_CORE_PRODUCTS, Variable: mass_gc	283
181	Dataset: SBO_CORE_PRODUCTS, Variable: mass_si	284
182	Dataset: SBO_CORE_PRODUCTS, Variable: sboarea	285
183	Dataset: SBO_CORE_PRODUCTS, Variable: xcom	286
184	Dataset: SBO_CORE_PRODUCTS, Variable: xcom_fw	287
185	Dataset: SBO_CORE_PRODUCTS, Variable: xoamc	288
186	Dataset: SBO_CORE_PRODUCTS, Variable: xoamc_si	289
187	Dataset: SBO_CORE_PRODUCTS, Variable: xoamp	290
188	Dataset: SBO_CORE_PRODUCTS, Variable: xoamp_dsl	291
189	Dataset: SBO_CORE_PRODUCTS, Variable: xoamp_fw	292
190	Dataset: SBO_CORE_PRODUCTS, Variable: ycom	293
191	Dataset: SBO_CORE_PRODUCTS, Variable: ycom_fw	294
192	Dataset: SBO_CORE_PRODUCTS, Variable: yoamc	295
193	Dataset: SBO_CORE_PRODUCTS, Variable: yoamc_si	296
194	Dataset: SBO_CORE_PRODUCTS, Variable: yoamp	297
195	Dataset: SBO_CORE_PRODUCTS, Variable: yoamp_dsl	298
196	Dataset: SBO_CORE_PRODUCTS, Variable: yoamp_fw	299
197	Dataset: SBO_CORE_PRODUCTS, Variable: zcom	300
198	Dataset: SBO_CORE_PRODUCTS, Variable: zcom_fw	301
199	Dataset: SBO_CORE_PRODUCTS, Variable: zoamc	302
200	Dataset: SBO_CORE_PRODUCTS, Variable: zoamc_si	303
201	Dataset: SBO_CORE_PRODUCTS, Variable: zoamp	304
202	Dataset: SBO_CORE_PRODUCTS, Variable: zoamp_dsl	305
203	Dataset: SBO_CORE_PRODUCTS, Variable: zoamp_fw	306

5 Tables in this document

List of Tables

10.1	Global Attributes used in ECCO V4r4 data netCDF files	31
------	---	----

10.1	Global Attributes used in ECCO V4r4 data netCDF files	32
10.1	Global Attributes used in ECCO V4r4 data netCDF files	33
10.1	Global Attributes used in ECCO V4r4 data netCDF files	34
10.2	Coordinates, Dimensions and Variables Attributes used in ECCO V4r4 data netCDF files	34
10.2	Coordinates, Dimensions and Variables Attributes used in ECCO V4r4 data netCDF files	35
10.3	Dimensions used in used in ECCO V4r4 data netCDF files	35
10.4	Coordinates used in used in ECCO V4r4 data netCDF files	36
10.5	Example CDL description of latlon dataset	37
10.5	Example CDL description of latlon dataset	38
10.6	Example CDL description of native dataset	39
10.6	Example CDL description of native dataset	40
10.6	Example CDL description of native dataset	41
10.6	Example CDL description of native dataset	42
10.7	Example CDL description of 1D dataset	43
11.1	Coordinates and Variables in the dataset GRID_GEOMETRY_ECCO	44
11.1	Coordinates and Variables in the dataset GRID_GEOMETRY_ECCO	45
11.2	Attributes description of the variable 'XC' from GRID_GEOMETRY_ECCO's dataset.	46
11.3	Attributes description of the variable 'YC' from GRID_GEOMETRY_ECCO's dataset.	47
11.4	Attributes description of the variable 'XG' from GRID_GEOMETRY_ECCO's dataset.	48
11.5	Attributes description of the variable 'YG' from GRID_GEOMETRY_ECCO's dataset.	49
11.6	Attributes description of the variable 'CS' from GRID_GEOMETRY_ECCO's dataset.	50
11.7	Attributes description of the variable 'SN' from GRID_GEOMETRY_ECCO's dataset.	51
11.8	Attributes description of the variable 'rA' from GRID_GEOMETRY_ECCO's dataset.	52
11.9	Attributes description of the variable 'dxG' from GRID_GEOMETRY_ECCO's dataset.	53
11.10	Attributes description of the variable 'dyG' from GRID_GEOMETRY_ECCO's dataset.	54
11.11	Attributes description of the variable 'Depth' from GRID_GEOMETRY_ECCO's dataset.	55
11.12	Attributes description of the variable 'rAz' from GRID_GEOMETRY_ECCO's dataset.	56
11.13	Attributes description of the variable 'dxC' from GRID_GEOMETRY_ECCO's dataset.	57
11.14	Attributes description of the variable 'dyC' from GRID_GEOMETRY_ECCO's dataset.	58
11.15	Attributes description of the variable 'rAw' from GRID_GEOMETRY_ECCO's dataset.	59
11.16	Attributes description of the variable 'rAs' from GRID_GEOMETRY_ECCO's dataset.	60
11.17	Attributes description of the variable 'hFacC' from GRID_GEOMETRY_ECCO's dataset.	61
11.18	Attributes description of the variable 'hFacW' from GRID_GEOMETRY_ECCO's dataset.	62
11.19	Attributes description of the variable 'hFacS' from GRID_GEOMETRY_ECCO's dataset.	63
11.20	Attributes description of the variable 'maskC' from GRID_GEOMETRY_ECCO's dataset.	64
11.21	Attributes description of the variable 'maskW' from GRID_GEOMETRY_ECCO's dataset.	65
11.22	Attributes description of the variable 'maskS' from GRID_GEOMETRY_ECCO's dataset.	66
12.1	Coordinates and Variables in the dataset ATM_SURFACE_TEMP_HUM_WIND_PRES	67
12.2	Attributes description of the variable 'EXFaqh' from ATM_SURFACE_TEMP_HUM_WIND_PRES's dataset.	68
12.3	Attributes description of the variable 'EXFatemp' from ATM_SURFACE_TEMP_HUM_WIND_PRES's dataset.	69
12.4	Attributes description of the variable 'EXFpress' from ATM_SURFACE_TEMP_HUM_WIND_PRES's dataset.	70
12.5	Attributes description of the variable 'EXFuwind' from ATM_SURFACE_TEMP_HUM_WIND_PRES's dataset.	71
12.6	Attributes description of the variable 'EXFvwind' from ATM_SURFACE_TEMP_HUM_WIND_PRES's dataset.	72
12.7	Attributes description of the variable 'EXFwspee' from ATM_SURFACE_TEMP_HUM_WIND_PRES's dataset.	73
12.8	Coordinates and Variables in the dataset OCEAN_3D_MIXING_COEFFS_ECCO	74
12.9	Attributes description of the variable 'DIFFKR' from OCEAN_3D_MIXING_COEFFS's dataset.	75
12.10	Attributes description of the variable 'KAPGM' from OCEAN_3D_MIXING_COEFFS's dataset.	76
12.11	Attributes description of the variable 'KAPREDI' from OCEAN_3D_MIXING_COEFFS's dataset.	77

12.12 Coordinates and Variables in the dataset OCEAN_3D_MOMENTUM_TEND	78
12.13 Attributes description of the variable 'Um_dPHdx' from OCEAN_3D_MOMENTUM_TEND's dataset.	79
12.14 Attributes description of the variable 'Vm_dPHdy' from OCEAN_3D_MOMENTUM_TEND's dataset.	80
12.15 Coordinates and Variables in the dataset OCEAN_3D_SALINITY_FLUX	81
12.16 Attributes description of the variable 'ADVr_SLT' from OCEAN_3D_SALINITY_FLUX's dataset.	82
12.17 Attributes description of the variable 'ADVx_SLT' from OCEAN_3D_SALINITY_FLUX's dataset.	83
12.18 Attributes description of the variable 'ADVy_SLT' from OCEAN_3D_SALINITY_FLUX's dataset.	85
12.19 Attributes description of the variable 'DFrE_SLT' from OCEAN_3D_SALINITY_FLUX's dataset.	87
12.20 Attributes description of the variable 'DFrI_SLT' from OCEAN_3D_SALINITY_FLUX's dataset.	89
12.21 Attributes description of the variable 'DFxE_SLT' from OCEAN_3D_SALINITY_FLUX's dataset.	91
12.22 Attributes description of the variable 'DFyE_SLT' from OCEAN_3D_SALINITY_FLUX's dataset.	93
12.23 Attributes description of the variable 'oceSPtnd' from OCEAN_3D_SALINITY_FLUX's dataset.	95
12.24 Coordinates and Variables in the dataset OCEAN_3D_TEMPERATURE_FLUX	96
12.25 Attributes description of the variable 'ADVr_TH' from OCEAN_3D_TEMPERATURE_FLUX's dataset.	97
12.26 Attributes description of the variable 'ADVx_TH' from OCEAN_3D_TEMPERATURE_FLUX's dataset.	98
12.27 Attributes description of the variable 'ADVy_TH' from OCEAN_3D_TEMPERATURE_FLUX's dataset.	100
12.28 Attributes description of the variable 'DFrE_TH' from OCEAN_3D_TEMPERATURE_FLUX's dataset.	102
12.29 Attributes description of the variable 'DFrI_TH' from OCEAN_3D_TEMPERATURE_FLUX's dataset.	104
12.30 Attributes description of the variable 'DFxE_TH' from OCEAN_3D_TEMPERATURE_FLUX's dataset.	106
12.31 Attributes description of the variable 'DFyE_TH' from OCEAN_3D_TEMPERATURE_FLUX's dataset.	107
12.32 Coordinates and Variables in the dataset OCEAN_3D_VOLUME_FLUX	108
12.32 Coordinates and Variables in the dataset OCEAN_3D_VOLUME_FLUX	109
12.33 Attributes description of the variable 'UVELMASS' from OCEAN_3D_VOLUME_FLUX's dataset.	110
12.34 Attributes description of the variable 'VVELMASS' from OCEAN_3D_VOLUME_FLUX's dataset.	112
12.35 Attributes description of the variable 'WVELMASS' from OCEAN_3D_VOLUME_FLUX's dataset.	114
12.36 Coordinates and Variables in the dataset OCEAN_AND_ICE_SURFACE_FW_FLUX	115
12.37 Attributes description of the variable 'EXFempmr' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.	116
12.38 Attributes description of the variable 'EXFevap' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.	117
12.39 Attributes description of the variable 'EXFpreci' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.	118
12.40 Attributes description of the variable 'EXFroff' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.	119
12.41 Attributes description of the variable 'SFLUX' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.	120
12.42 Attributes description of the variable 'SlacSubl' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.	121
12.43 Attributes description of the variable 'SlatmFW' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.	122
12.44 Attributes description of the variable 'SIfwThru' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.	123
12.45 Attributes description of the variable 'SIsrsSubl' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.	124
12.46 Attributes description of the variable 'SIsnPrcp' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.	125
12.47 Attributes description of the variable 'oceFWflx' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.	126
12.48 Coordinates and Variables in the dataset OCEAN_AND_ICE_SURFACE_HEAT_FLUX	127
12.49 Attributes description of the variable 'EXFhl' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.	128
12.50 Attributes description of the variable 'EXFhs' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.	129
12.51 Attributes description of the variable 'EXFlwdn' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.	130

12.52 Attributes description of the variable 'EXFlwnet' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.	131
12.53 Attributes description of the variable 'EXFqnet' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.	132
12.54 Attributes description of the variable 'EXFswdn' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.	133
12.55 Attributes description of the variable 'EXFswnet' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.	134
12.56 Attributes description of the variable 'Slaaflux' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.	135
12.57 Attributes description of the variable 'SlatmQnt' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.	136
12.58 Attributes description of the variable 'TFLUX' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.	137
12.59 Attributes description of the variable 'oceQnet' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.	138
12.60 Attributes description of the variable 'oceQsw' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.	140
12.61 Coordinates and Variables in the dataset OCEAN_AND_ICE_SURFACE_STRESS	141
12.62 Attributes description of the variable 'EXFtaux' from OCEAN_AND_ICE_SURFACE_STRESS's dataset.	142
12.63 Attributes description of the variable 'EXFtauy' from OCEAN_AND_ICE_SURFACE_STRESS's dataset.	143
12.64 Attributes description of the variable 'oceTAUX' from OCEAN_AND_ICE_SURFACE_STRESS's dataset.	144
12.65 Attributes description of the variable 'oceTAUY' from OCEAN_AND_ICE_SURFACE_STRESS's dataset.	146
12.66 Coordinates and Variables in the dataset OCEAN_BOLUS_STREAMFUNCTION	147
12.66 Coordinates and Variables in the dataset OCEAN_BOLUS_STREAMFUNCTION	148
12.67 Attributes description of the variable 'GM_PsiX' from OCEAN_BOLUS_STREAMFUNCTION's dataset.	149
12.68 Attributes description of the variable 'GM_PsiY' from OCEAN_BOLUS_STREAMFUNCTION's dataset.	150
12.69 Coordinates and Variables in the dataset OCEAN_BOLUS_VELOCITY	151
12.70 Attributes description of the variable 'UVELSTAR' from OCEAN_BOLUS_VELOCITY's dataset.	152
12.71 Attributes description of the variable 'VVELSTAR' from OCEAN_BOLUS_VELOCITY's dataset.	153
12.72 Attributes description of the variable 'WVELSTAR' from OCEAN_BOLUS_VELOCITY's dataset.	154
12.73 Coordinates and Variables in the dataset OCEAN_BOTTOM_PRESSURE	155
12.74 Attributes description of the variable 'OBP' from OCEAN_BOTTOM_PRESSURE's dataset.	156
12.75 Attributes description of the variable 'OBPGMAP' from OCEAN_BOTTOM_PRESSURE's dataset.	158
12.76 Attributes description of the variable 'PHIBOT' from OCEAN_BOTTOM_PRESSURE's dataset.	160
12.77 Coordinates and Variables in the dataset OCEAN_DENS_STRAT_PRESS	161
12.78 Attributes description of the variable 'DRHODR' from OCEAN_DENS_STRAT_PRESS's dataset.	162
12.79 Attributes description of the variable 'PHIHYD' from OCEAN_DENS_STRAT_PRESS's dataset.	163
12.80 Attributes description of the variable 'PHIHYDcR' from OCEAN_DENS_STRAT_PRESS's dataset.	164
12.81 Attributes description of the variable 'RHOAnoma' from OCEAN_DENS_STRAT_PRESS's dataset.	165
12.82 Coordinates and Variables in the dataset OCEAN_MIXED_LAYER_DEPTH	166
12.83 Attributes description of the variable 'MXLDEPTH' from OCEAN_MIXED_LAYER_DEPTH's dataset.	167
12.84 Coordinates and Variables in the dataset OCEAN_TEMPERATURE_SALINITY	168
12.85 Attributes description of the variable 'SALT' from OCEAN_TEMPERATURE_SALINITY's dataset.	169
12.86 Attributes description of the variable 'THETA' from OCEAN_TEMPERATURE_SALINITY's dataset.	170
12.87 Coordinates and Variables in the dataset OCEAN_VELOCITY	171
12.88 Attributes description of the variable 'UVEL' from OCEAN_VELOCITY's dataset.	172
12.89 Attributes description of the variable 'VVEL' from OCEAN_VELOCITY's dataset.	173
12.90 Attributes description of the variable 'WVEL' from OCEAN_VELOCITY's dataset.	174
12.91 Coordinates and Variables in the dataset SEA_ICE_CONC_THICKNESS	175
12.92 Attributes description of the variable 'Slarea' from SEA_ICE_CONC_THICKNESS's dataset.	176
12.93 Attributes description of the variable 'Slheff' from SEA_ICE_CONC_THICKNESS's dataset.	177
12.94 Attributes description of the variable 'Slhsnow' from SEA_ICE_CONC_THICKNESS's dataset.	178
12.95 Attributes description of the variable 'SlceLoad' from SEA_ICE_CONC_THICKNESS's dataset.	179

12.96 Coordinates and Variables in the dataset SEA_ICE_HORIZ_VOLUME_FLUX	180
12.97 Attributes description of the variable 'ADVxHEFF' from SEA_ICE_HORIZ_VOLUME_FLUX's dataset.	181
12.98 Attributes description of the variable 'ADVxSNOW' from SEA_ICE_HORIZ_VOLUME_FLUX's dataset.	182
12.99 Attributes description of the variable 'ADVyHEFF' from SEA_ICE_HORIZ_VOLUME_FLUX's dataset.	183
12.100 Attributes description of the variable 'ADVySNOW' from SEA_ICE_HORIZ_VOLUME_FLUX's dataset.	184
12.101 Attributes description of the variable 'DFxEHEFF' from SEA_ICE_HORIZ_VOLUME_FLUX's dataset.	185
12.102 Attributes description of the variable 'DFxESNOW' from SEA_ICE_HORIZ_VOLUME_FLUX's dataset.	186
12.103 Attributes description of the variable 'DFyEHEFF' from SEA_ICE_HORIZ_VOLUME_FLUX's dataset.	187
12.104 Attributes description of the variable 'DFyESNOW' from SEA_ICE_HORIZ_VOLUME_FLUX's dataset.	188
12.105 Coordinates and Variables in the dataset SEA_ICE_SALT_PLUME_FLUX	189
12.106 Attributes description of the variable 'oceSPDep' from SEA_ICE_SALT_PLUME_FLUX's dataset.	190
12.107 Attributes description of the variable 'oceSPflx' from SEA_ICE_SALT_PLUME_FLUX's dataset.	191
12.108 Coordinates and Variables in the dataset SEA_ICE_VELOCITY	191
12.109 Coordinates and Variables in the dataset SEA_ICE_VELOCITY	192
12.109 Attributes description of the variable 'Sluice' from SEA_ICE_VELOCITY's dataset.	193
12.110 Attributes description of the variable 'Slvce' from SEA_ICE_VELOCITY's dataset.	194
12.111 Coordinates and Variables in the dataset SEA_SURFACE_HEIGHT	195
12.112 Attributes description of the variable 'ETAN' from SEA_SURFACE_HEIGHT's dataset.	196
12.113 Attributes description of the variable 'SSH' from SEA_SURFACE_HEIGHT's dataset.	197
12.114 Attributes description of the variable 'SSHIBC' from SEA_SURFACE_HEIGHT's dataset.	198
12.115 Attributes description of the variable 'SSHNOIBC' from SEA_SURFACE_HEIGHT's dataset.	199
13.1 Coordinates and Variables in the dataset GRID_GEOMETRY_ECCO	200
13.2 Attributes description of the variable 'hFacC' from GRID_GEOMETRY_ECCO's dataset.	201
13.3 Attributes description of the variable 'maskC' from GRID_GEOMETRY_ECCO's dataset.	202
14.1 Coordinates and Variables in the dataset ATM_SURFACE_TEMP_HUM_WIND_PRES	203
14.2 Attributes description of the variable 'EXFaqh' from ATM_SURFACE_TEMP_HUM_WIND_PRES's dataset.	204
14.3 Attributes description of the variable 'EXFatemp' from ATM_SURFACE_TEMP_HUM_WIND_PRES's dataset.	205
14.4 Attributes description of the variable 'EXFewind' from ATM_SURFACE_TEMP_HUM_WIND_PRES's dataset.	206
14.5 Attributes description of the variable 'EXFnwind' from ATM_SURFACE_TEMP_HUM_WIND_PRES's dataset.	207
14.6 Attributes description of the variable 'EXFpress' from ATM_SURFACE_TEMP_HUM_WIND_PRES's dataset.	208
14.7 Attributes description of the variable 'EXFwspee' from ATM_SURFACE_TEMP_HUM_WIND_PRES's dataset.	209
14.8 Coordinates and Variables in the dataset OCEAN_AND_ICE_SURFACE_FW_FLUX	210
14.9 Attributes description of the variable 'EXFempmr' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.	211
14.10 Attributes description of the variable 'EXFevap' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.	212
14.11 Attributes description of the variable 'EXFpreci' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.	213
14.12 Attributes description of the variable 'EXFroff' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.	214
14.13 Attributes description of the variable 'SFLUX' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.	215
14.14 Attributes description of the variable 'SlacSubl' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.	216
14.15 Attributes description of the variable 'SlatmFW' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.	217
14.16 Attributes description of the variable 'SIfwThru' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.	218
14.17 Attributes description of the variable 'SIsrsSubl' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.	219

14.18 Attributes description of the variable 'SIsnPrcp' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.	220
14.19 Attributes description of the variable 'oceFWflx' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.	221
14.20 Coordinates and Variables in the dataset OCEAN_AND_ICE_SURFACE_HEAT_FLUX	222
14.21 Attributes description of the variable 'EXFhl' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.	223
14.22 Attributes description of the variable 'EXFhs' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.	224
14.23 Attributes description of the variable 'EXFlwdn' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.	225
14.24 Attributes description of the variable 'EXFlwnet' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.	226
14.25 Attributes description of the variable 'EXFqnet' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.	227
14.26 Attributes description of the variable 'EXFswdn' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.	228
14.27 Attributes description of the variable 'EXFswnet' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.	229
14.28 Attributes description of the variable 'Slaaflux' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.	230
14.29 Attributes description of the variable 'SlatmQnt' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.	231
14.30 Attributes description of the variable 'TFLUX' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.	232
14.31 Attributes description of the variable 'oceQnet' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.	233
14.32 Attributes description of the variable 'oceQsw' from OCEAN_AND_ICE_SURFACE_HEAT_FLUX's dataset.	234
14.33 Coordinates and Variables in the dataset OCEAN_AND_ICE_SURFACE_STRESS	235
14.34 Attributes description of the variable 'EXFtaue' from OCEAN_AND_ICE_SURFACE_STRESS's dataset.	236
14.35 Attributes description of the variable 'EXFtauri' from OCEAN_AND_ICE_SURFACE_STRESS's dataset.	237
14.36 Attributes description of the variable 'oceTAUE' from OCEAN_AND_ICE_SURFACE_STRESS's dataset.	238
14.37 Attributes description of the variable 'oceTAUN' from OCEAN_AND_ICE_SURFACE_STRESS's dataset.	239
14.38 Coordinates and Variables in the dataset OCEAN_BOLUS_VELOCITY	240
14.39 Attributes description of the variable 'EVELSTAR' from OCEAN_BOLUS_VELOCITY's dataset.	241
14.40 Attributes description of the variable 'NVELSTAR' from OCEAN_BOLUS_VELOCITY's dataset.	242
14.41 Attributes description of the variable 'WVELSTAR' from OCEAN_BOLUS_VELOCITY's dataset.	243
14.42 Coordinates and Variables in the dataset OCEAN_BOTTOM_PRESSURE	244
14.43 Attributes description of the variable 'OBP' from OCEAN_BOTTOM_PRESSURE's dataset.	245
14.44 Attributes description of the variable 'OBPGMAP' from OCEAN_BOTTOM_PRESSURE's dataset.	246
14.45 Coordinates and Variables in the dataset OCEAN_DENS_STRAT_PRESS	247
14.46 Attributes description of the variable 'DRHODR' from OCEAN_DENS_STRAT_PRESS's dataset.	248
14.47 Attributes description of the variable 'PHIHYD' from OCEAN_DENS_STRAT_PRESS's dataset.	249
14.48 Attributes description of the variable 'RHOAnoma' from OCEAN_DENS_STRAT_PRESS's dataset.	250
14.49 Coordinates and Variables in the dataset OCEAN_MIXED_LAYER_DEPTH	250
14.49 Coordinates and Variables in the dataset OCEAN_MIXED_LAYER_DEPTH	251
14.50 Attributes description of the variable 'MXLDEPTH' from OCEAN_MIXED_LAYER_DEPTH's dataset.	252
14.51 Coordinates and Variables in the dataset OCEAN_TEMPERATURE_SALINITY	253
14.52 Attributes description of the variable 'SALT' from OCEAN_TEMPERATURE_SALINITY's dataset.	254
14.53 Attributes description of the variable 'THETA' from OCEAN_TEMPERATURE_SALINITY's dataset.	255
14.54 Coordinates and Variables in the dataset OCEAN_VELOCITY	256
14.55 Attributes description of the variable 'EVEL' from OCEAN_VELOCITY's dataset.	257
14.56 Attributes description of the variable 'NVEL' from OCEAN_VELOCITY's dataset.	258

14.57 Attributes description of the variable 'WVEL' from OCEAN_VELOCITY's dataset.	259
14.58 Coordinates and Variables in the dataset SEA_ICE_CONC_THICKNESS	260
14.59 Attributes description of the variable 'Slarea' from SEA_ICE_CONC_THICKNESS's dataset.	261
14.60 Attributes description of the variable 'Slheff' from SEA_ICE_CONC_THICKNESS's dataset.	262
14.61 Attributes description of the variable 'Slhsnow' from SEA_ICE_CONC_THICKNESS's dataset.	263
14.62 Attributes description of the variable 'SlceLoad' from SEA_ICE_CONC_THICKNESS's dataset.	264
14.63 Coordinates and Variables in the dataset SEA_ICE_VELOCITY	265
14.64 Attributes description of the variable 'Sleice' from SEA_ICE_VELOCITY's dataset.	266
14.65 Attributes description of the variable 'Slnice' from SEA_ICE_VELOCITY's dataset.	267
14.66 Coordinates and Variables in the dataset SEA_SURFACE_HEIGHT	268
14.67 Attributes description of the variable 'SSH' from SEA_SURFACE_HEIGHT's dataset.	269
14.68 Attributes description of the variable 'SSHIBC' from SEA_SURFACE_HEIGHT's dataset.	270
14.69 Attributes description of the variable 'SSHNOIBC' from SEA_SURFACE_HEIGHT's dataset.	271
15.1 Coordinates and Variables in the dataset GLOBAL_MEAN_ATM_SURFACE_PRES	272
15.2 Attributes description of the variable 'Pa_global' from GLOBAL_MEAN_ATM_SURFACE_PRES's dataset.	273
15.3 Coordinates and Variables in the dataset GLOBAL_MEAN_SEA_LEVEL	274
15.4 Attributes description of the variable 'global_mean_barystatic_sea_level_anomaly' from GLOBAL_MEAN_SEA_LEVEL's dataset.	275
15.5 Attributes description of the variable 'global_mean_sea_level_anomaly' from GLOBAL_MEAN_SEA_LEVEL's dataset.	277
15.6 Attributes description of the variable 'global_mean_sterodynamic_sea_level_anomaly' from GLOBAL_MEAN_SEA_LEVEL's dataset.	278
15.7 Coordinates and Variables in the dataset SBO_CORE_PRODUCTS	279
15.7 Coordinates and Variables in the dataset SBO_CORE_PRODUCTS	280
15.8 Attributes description of the variable 'mass' from SBO_CORE_PRODUCTS's dataset.	281
15.9 Attributes description of the variable 'mass_fw' from SBO_CORE_PRODUCTS's dataset.	282
15.10 Attributes description of the variable 'mass_gc' from SBO_CORE_PRODUCTS's dataset.	283
15.11 Attributes description of the variable 'mass_si' from SBO_CORE_PRODUCTS's dataset.	284
15.12 Attributes description of the variable 'sboarea' from SBO_CORE_PRODUCTS's dataset.	285
15.13 Attributes description of the variable 'xcom' from SBO_CORE_PRODUCTS's dataset.	286
15.14 Attributes description of the variable 'xcom_fw' from SBO_CORE_PRODUCTS's dataset.	287
15.15 Attributes description of the variable 'xoamc' from SBO_CORE_PRODUCTS's dataset.	288
15.16 Attributes description of the variable 'xoamc_si' from SBO_CORE_PRODUCTS's dataset.	289
15.17 Attributes description of the variable 'xoamp' from SBO_CORE_PRODUCTS's dataset.	290
15.18 Attributes description of the variable 'xoamp_dsl' from SBO_CORE_PRODUCTS's dataset.	291
15.19 Attributes description of the variable 'xoamp_fw' from SBO_CORE_PRODUCTS's dataset.	292
15.20 Attributes description of the variable 'ycom' from SBO_CORE_PRODUCTS's dataset.	293
15.21 Attributes description of the variable 'ycom_fw' from SBO_CORE_PRODUCTS's dataset.	294
15.22 Attributes description of the variable 'yoamc' from SBO_CORE_PRODUCTS's dataset.	295
15.23 Attributes description of the variable 'yoamc_si' from SBO_CORE_PRODUCTS's dataset.	296
15.24 Attributes description of the variable 'yoamp' from SBO_CORE_PRODUCTS's dataset.	297
15.25 Attributes description of the variable 'yoamp_dsl' from SBO_CORE_PRODUCTS's dataset.	298
15.26 Attributes description of the variable 'yoamp_fw' from SBO_CORE_PRODUCTS's dataset.	299
15.27 Attributes description of the variable 'zcom' from SBO_CORE_PRODUCTS's dataset.	300
15.28 Attributes description of the variable 'zcom_fw' from SBO_CORE_PRODUCTS's dataset.	301
15.29 Attributes description of the variable 'zoamc' from SBO_CORE_PRODUCTS's dataset.	302
15.30 Attributes description of the variable 'zoamc_si' from SBO_CORE_PRODUCTS's dataset.	303
15.31 Attributes description of the variable 'zoamp' from SBO_CORE_PRODUCTS's dataset.	304
15.32 Attributes description of the variable 'zoamp_dsl' from SBO_CORE_PRODUCTS's dataset.	305
15.33 Attributes description of the variable 'zoamp_fw' from SBO_CORE_PRODUCTS's dataset.	306

6 Acryonyms and abbreviation list

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

EVR	Extra-Vehicular Robotics
FAQ	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

7 Scope and Content of this Document

This document has been developed to provide guidance to ECCO V4r4 data users for easily navigating the list of available datasets. It offers an overview of the ECCO V4r4 datasets, including the data storage format, filename conventions, supporting metadata conventions, and the structure of data product files.

Descriptions are provided for NetCDF data files, including global attributes, dimensions, coordinates, and variable metadata. Additionally, detailed descriptions are included for each ECCO V4r4 dataset: the native Lat-Lon-Cap 90 (LLC90) grid, the regular 0.5-degree latitude-longitude grid, and the one-dimensional dataset. Grid geometry details are also provided for both the native LLC90 grid and the 0.5-degree latitude-longitude grid configurations. Illustrative figures accompany each section to enhance understanding.

8 Overview of ECCO Data

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

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

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

8.1 Why trust ECCO?

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

ECCO:

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

8.2 Why Choose ECCO Over Alternatives?

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

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

9 ECCO Data Filenames and Supporting Conventions

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

9.1 General filename Structure

For ECCO dataset product files:

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

For ECCO data geometry and grid files:

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

Keypoints	Description
ShortName:	Describes the dataset variable (e.g., SSH for sea surface height, TEMP_SALINITY for temperature and salinity).
TemporalResolution:	Indicates the time averaging or snapshot type (e.g., DAILY, MONTHLY, SNAP).
GridType :	Specifies the grid used (e.g., native_llc90 for the native ECCO grid or latlon_Op50deg for interpolated 0.5 °lat-lon grid). It can also be a specific information such as 1D to indication the one-dimentional dataset files over the full period of ECCO data availability.
Version:	Identifies the ECCO release version (e.g., V4r4).
Indicative Time:	Encodes the time period covered by the file (e.g., monthly files use YYYY-MM, daily files use YYYY-MM-DD)
File Type	netCDF or Zarr data format.

9.2 Examples

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

- ATM_SURFACE_TEMP_HUM_WIND_PRES_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc
- ATM_SURFACE_TEMP_HUM_WIND_PRES_day_mean_2017-12-29_ECCO_V4r4_latlon_Op50deg.nc

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

- SEA_SURFACE_HEIGHT_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

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

- GLOBAL_MEAN_ATM_SURFACE_PRES_snap_ECCO_V4r4_1D.nc

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

- GRID_GEOMETRY_ECCO_V4r4_latlon_Op50deg.nc

10 ECCO Data Product File Structure

10.1 Overview of the ECCO Data netCDF File Format

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

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

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

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

10.2 ECCO netCDF Global Attributes

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

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

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

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

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

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

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

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

uuid	string	A Universally Unique Identifier (UUID). Numerous, simple tools can be used to create a UUID, which is inserted as the value of this attribute. See http://en.wikipedia.org/wiki/Universally_Unique_Identifier for more information and tools.	ACDD
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10.3 ECCO Data netCDF Coordinates, Dimensions and Variables Attributes

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

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

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

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

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

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

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

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

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

10.5 ECCO Data netCDF Coordinates variable definition

The so-called non-dimension coordinates: i- are variables that (may) contain coordinate data, but are not a dimension coordinate; ii- they can be multidimensional and there is no relationship between the name of a non-

dimension coordinate and the name(s) of its dimension(s); iii- can be useful for indexing or plotting ... Table below provides a list of unique coordinates used in ECCO V4r4 data.

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

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

Regular latitude/logitude grids

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

Non-regular latitude/longitude grids

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

10.6 Example of ECCO V4r4 netCDF latlon grid datasets

Table 10.5: Example CDL description of latlon dataset

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

Table 10.5: Example CDL description of latlon dataset

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

10.7 Example of ECCO V4r4 netCDF native llc90 grid datasets

Table 10.6: Example CDL description of native dataset

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

Table 10.6: Example CDL description of native dataset

```

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

```

Table 10.6: Example CDL description of native dataset

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

Table 10.6: Example CDL description of native dataset

<pre> 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 top and bottom faces of tracer grid cell" </pre>
data variables
<pre> float32 DIFFKR (k, tile, j, i) DIFFKR:_FillValue = "9.969209968386869e+36" DIFFKR:coverage_content_type = "modelResult" DIFFKR:long_name = "Vertical diffusivity" DIFFKR:units = "m2 s-1" DIFFKR:comment = "Background vertical diffusion coefficient for temperature and salinity. Total vertical diffusivity includes background diffusivity plus contributions from the GGL90 vertical mixing and the Gent-McWilliams/Redi parameterizations. Note: DIFFKR is a model control variable and has been optimized from a spatially-invariant first-guess value of 1e-5 m2 s-1." DIFFKR:valid_min = "9.99999974752427e-07" DIFFKR:valid_max = "0.00018549950618762523" DIFFKR:coordinates = "Z XC YC" </pre>
<pre> float32 KAPGM (k, tile, j, i) KAPGM:_FillValue = "9.969209968386869e+36" KAPGM:coverage_content_type = "modelResult" KAPGM:long_name = "Gent-McWilliams diffusivity" KAPGM:units = "m2 s-1" KAPGM:comment = "Gent-McWilliams diffusivity coefficient as described in Gent and McWilliams (1990, JPO). Note: KAPGM is a model control variable and has been optimized from a spatially invariant first guess of 1e3 m2 s-1." KAPGM:valid_min = "100.0" KAPGM:valid_max = "10000.0" KAPGM:coordinates = "Z XC YC" </pre>
<pre> float32 KAPREDI (k, tile, j, i) KAPREDI:_FillValue = "9.969209968386869e+36" KAPREDI:coverage_content_type = "modelResult" KAPREDI:long_name = "Along-isopycnal diffusivity" KAPREDI:units = "m2 s-1" KAPREDI:comment = "Redi along-isopycnal diffusivity coefficient as described in Redi (1982, JPO). Note: KAPREDI is a model control variable and has been optimized from a spatially invariant first guess of 1e3 m2 s-1." KAPREDI:valid_min = "100.0" KAPREDI:valid_max = "10000.0" KAPREDI:coordinates = "Z XC YC" </pre>

10.8 Example of ECCO V4r4 netCDF for 1D data

Table 10.7: Example CDL description of 1D dataset

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

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

11.1 Native coordinates GRID_GEOMETRY_ECCO

11.1.1 Overview

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

Table 11.1: Coordinates and Variables in the dataset GRID_GEOMETRY_ECCO

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

Table 11.1: Coordinates and Variables in the dataset GRID_GEOMETRY_ECCO

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

11.1.2 Native coordinates Variable: XC

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

Storage Type	Variable Name	Description	Unit
float32	XC	Longitude of tracer grid cell center	degrees_east
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Nonuniform grid spacing			

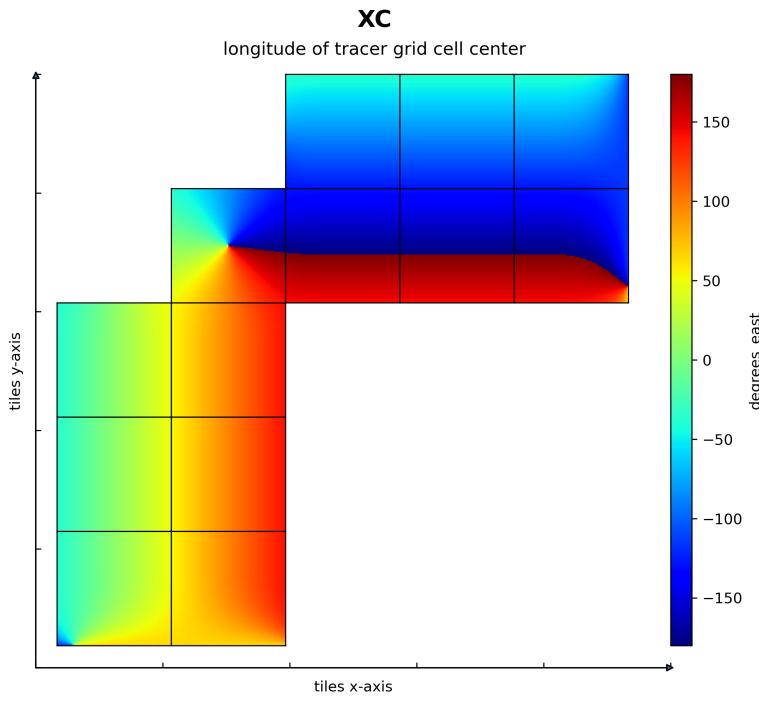


Figure 1: Dataset: GRID_GEOMETRY_ECCO, Variable: XC

11.1.3 Native coordinates Variable: YC

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

Storage Type	Variable Name	Description	Unit
float32	YC	Latitude of tracer grid cell center	degrees_north
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Nonuniform grid spacing			

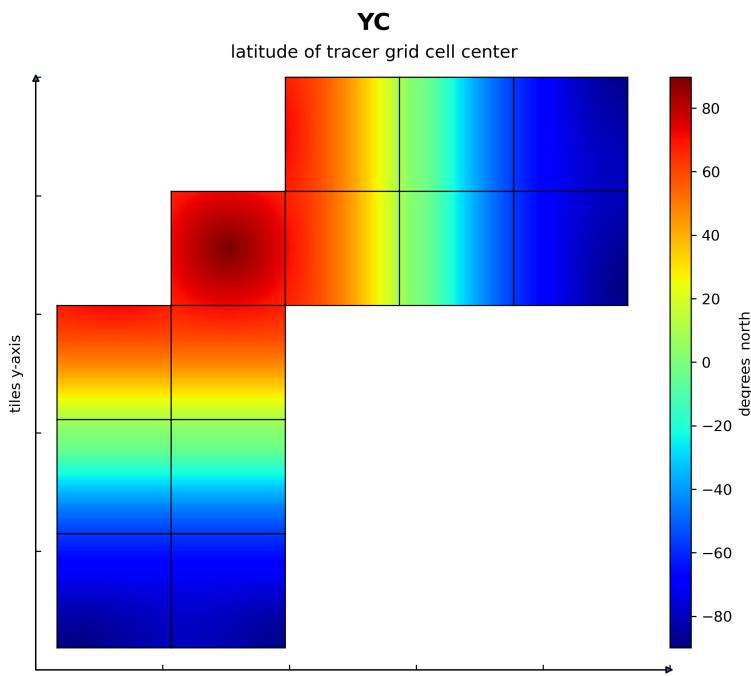


Figure 2: Dataset: GRID_GEOMETRY_ECCO, Variable: YC

11.1.4 Native coordinates Variable: XG

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

Storage Type	Variable Name	Description	Unit
float32	XG	Longitude of 'southwest' corner of tracer grid cell	degrees_east
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Nonuniform grid spacing. note: 'southwest' does not correspond to geographic orientation but is used for convenience to describe the computational grid. see mitgcm dcoumentation for details.			

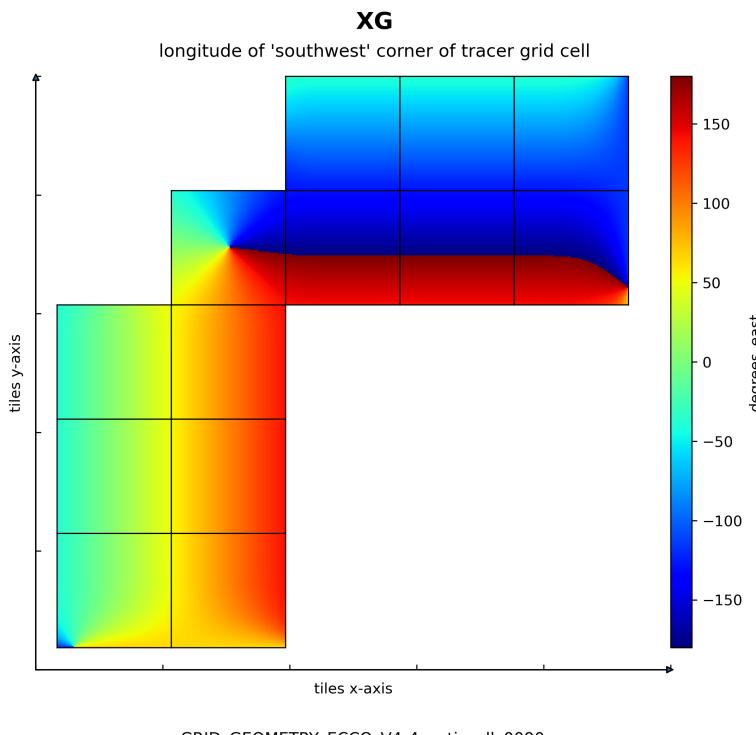


Figure 3: Dataset: GRID_GEOMETRY_ECCO, Variable: XG

11.1.5 Native coordinates Variable: YG

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

Storage Type	Variable Name	Description	Unit
float32	YG	Latitude of 'southwest' corner of tracer grid cell	degrees_north
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Nonuniform grid spacing. note: 'southwest' does not correspond to geographic orientation but is used for convenience to describe the computational grid. see mitgcm dcoumentation for details.			

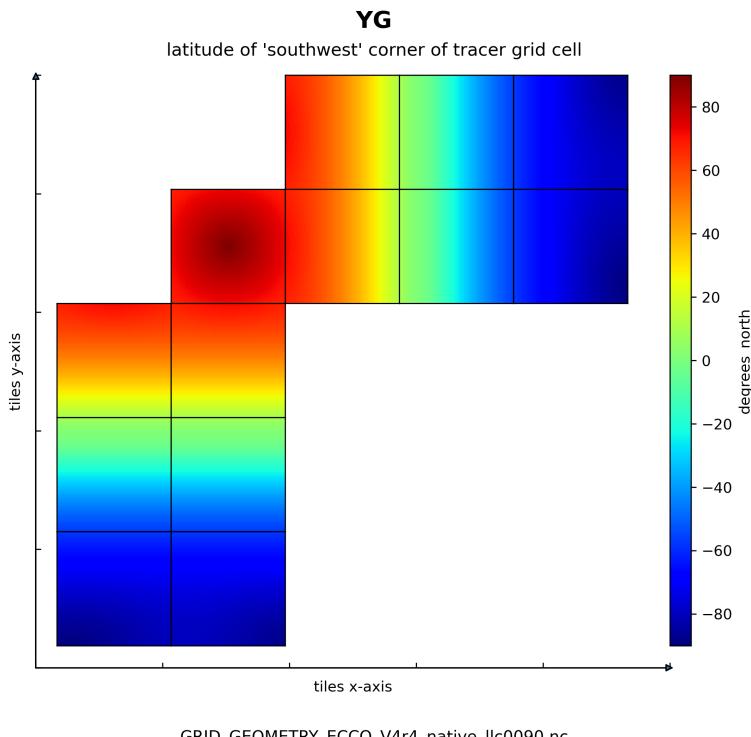
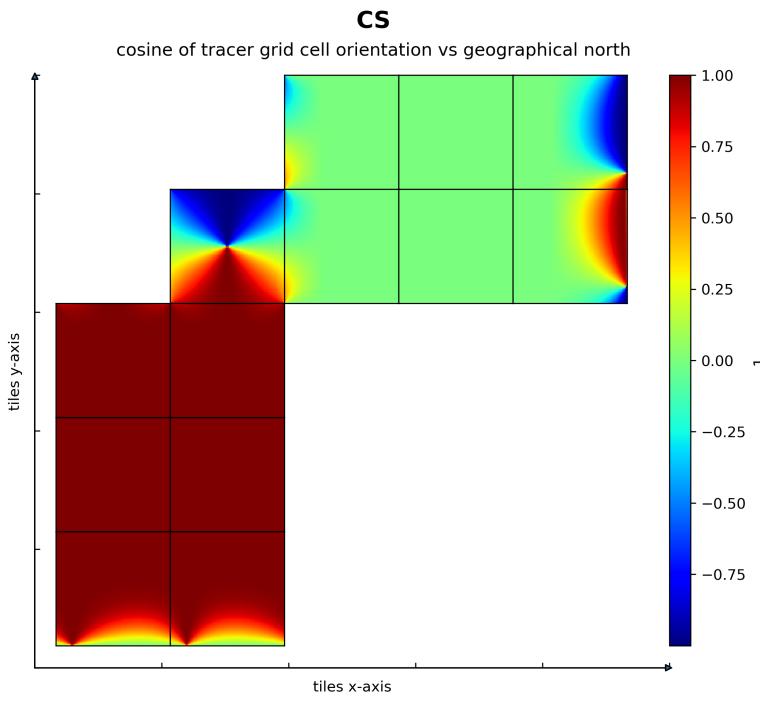


Figure 4: Dataset: GRID_GEOMETRY_ECCO, Variable: YG

11.1.6 Native coordinates Variable: CS

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

Storage Type	Variable Name	Description	Unit
float32	CS	Cosine of tracer grid cell orientation vs geographical north	1
Description of the variable in Common Data language (CDL)			
<pre>float32 CS(tile, j, i) CS: _FillValue = 9.96921e+36 CS: long_name = cosine of tracer grid cell orientation vs geographical north CS: units = 1 CS: coordinate = YC XC CS: coverage_content_type = modelResult CS: coordinates = YC XC</pre>			
Comments			
Cs and sn are required to calculate the geographic (meridional, zonal) components of vectors on the curvilinear model grid. note: for vector r with components r_x and r_y: r_{east} = cs r_x - sn r_y. r_{north} = sn r_x + cs r_y			



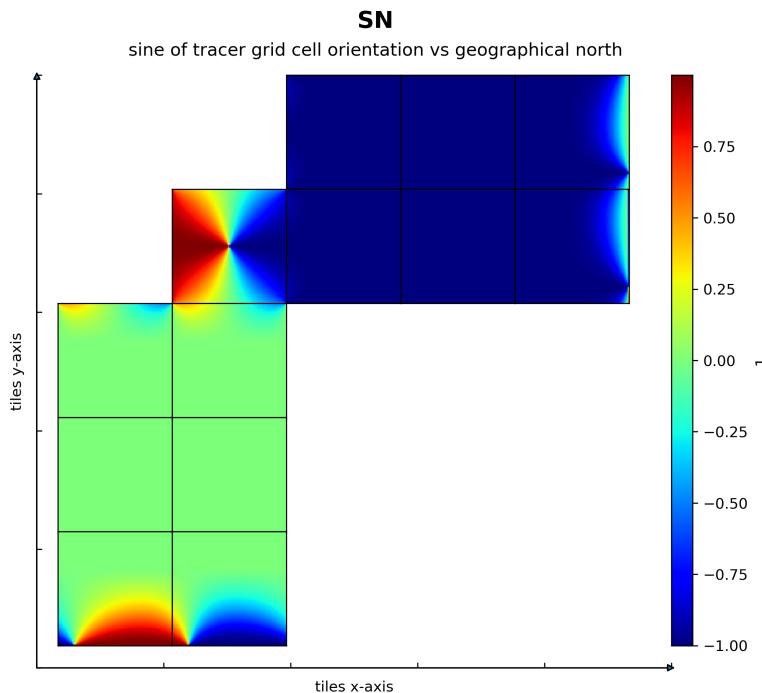
GRID_GEOMETRY_ECCO_V4r4_native_llc0090.nc

Figure 5: Dataset: GRID_GEOMETRY_ECCO, Variable: CS

11.1.7 Native coordinates Variable: SN

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

Storage Type	Variable Name	Description	Unit
float32	SN	Sine of tracer grid cell orientation vs geographical north	1
Description of the variable in Common Data language (CDL)			
<pre>float32 SN(tile, j, i) SN: _FillValue = 9.96921e+36 SN: long_name = sine of tracer grid cell orientation vs geographical north SN: units = 1 SN: coordinate = YC XC SN: coverage_content_type = modelResult SN: coordinates = YC XC</pre>			
Comments			
Cs and sn are required to calculate the geographic (meridional, zonal) components of vectors on the curvilinear model grid. note: for vector r with components r_x and r_y in local grid directions x and y, the geographical eastward component r_{east} = cs r_x - sn r_y. the geographical northward component r_{north} = sn r_x + cs r_y.			



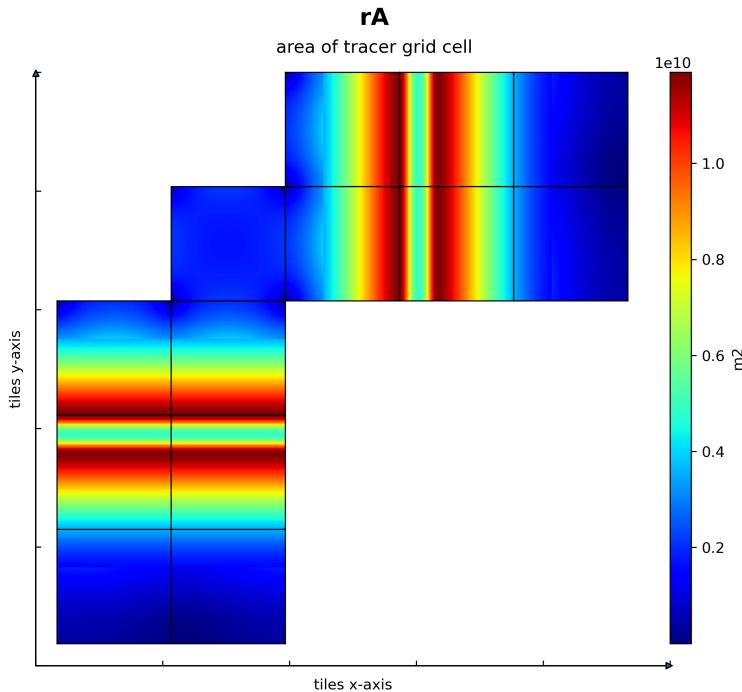
GRID_GEOMETRY_ECCO_V4r4_native_llc0090.nc

Figure 6: Dataset: GRID_GEOMETRY_ECCO, Variable: SN

11.1.8 Native coordinates Variable: rA

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

Storage Type	Variable Name	Description	Unit
float32	rA	Area of tracer grid cell	m ²
Description of the variable in Common Data language (CDL)			
	float32 rA(tile, j, i)		
	rA: _FillValue = 9.96921e+36		
	rA: long_name = area of tracer grid cell		
	rA: units = m ²		
	rA: coordinate = YC XC		
	rA: coverage_content_type = modelResult		
	rA: standard_name = cell_area		
	rA: coordinates = YC XC		
Comments			
N/a			



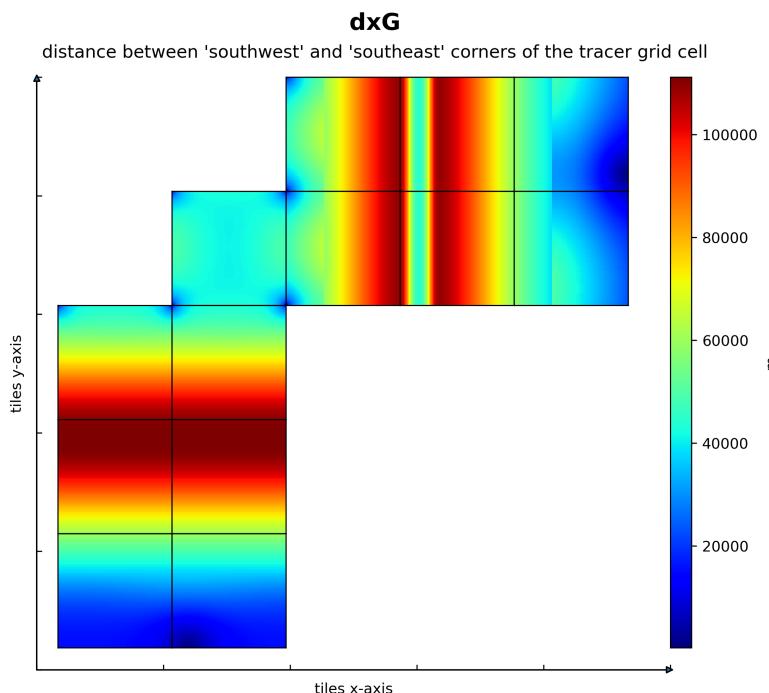
GRID_GEOMETRY_ECCO_V4r4_native_llc0090.nc

Figure 7: Dataset: GRID_GEOMETRY_ECCO, Variable: rA

11.1.9 Native coordinates Variable: dxG

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

Storage Type	Variable Name	Description	Unit
float32	dxG	Distance between 'southwest' and 'southeast' corners of the tracer grid cell	m
Description of the variable in Common Data language (CDL)			
<pre>float32 dxG(tile, j_g, i) dxG:_FillValue = 9.96921e+36 dxG:long_name = "distance between southwest and southeast corners of the tracer grid cell" dxG:units = m dxG:coordinate = YG XC dxG:coverage_content_type = modelResult</pre>			
Comments			
Alternatively, the length of 'south' side of tracer grid cell. note: 'south', 'southwest', and 'southeast' do not correspond to geographic orientation but are used for convenience to describe the computational grid. see mitgcm documentation for details.			



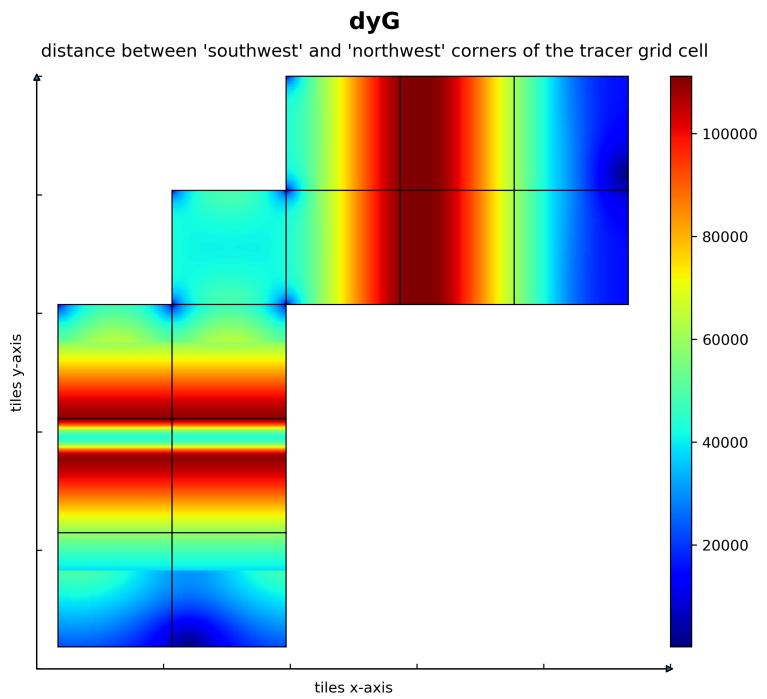
GRID_GEOMETRY_ECCO_V4r4_native_llc0090.nc

Figure 8: Dataset: GRID_GEOMETRY_ECCO, Variable: dxG

11.1.10 Native coordinates Variable: dyG

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

Storage Type	Variable Name	Description	Unit
float32	dyG	Distance between 'southwest' and 'northwest' corners of the tracer grid cell	m
Description of the variable in Common Data language (CDL)			
<pre>float32 dyG(tile, j, i_g) dyG:_FillValue = 9.96921e+36 dyG:_long_name = "distance between southwest and northwest corners of the tracer grid cell" dyG:_units = m dyG:_coordinate = YC XG dyG:_coverage_content_type = modelResult</pre>			
Comments			
Alternatively, the length of 'west' side of tracer grid cell. note: 'west', 'southwest', and 'northwest' do not correspond to geographic orientation but are used for convenience to describe the computational grid. see mitgcm documentation for details.			



GRID_GEOMETRY_ECCO_V4r4_native_llc0090.nc

Figure 9: Dataset: GRID_GEOMETRY_ECCO, Variable: dyG

11.1.11 Native coordinates Variable: Depth

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

Storage Type	Variable Name	Description	Unit
float32	Depth	Model seafloor depth below ocean surface at rest	m
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Model sea surface height (ssh) of Om corresponds to an ocean surface at rest relative to the geoid. depth corresponds to seafloor depth below geoid. note: the mitgcm used by ecco v4r4 implements 'partial cells' so the actual model seafloor depth may differ from the seafloor depth provided by the input bathymetry file.			

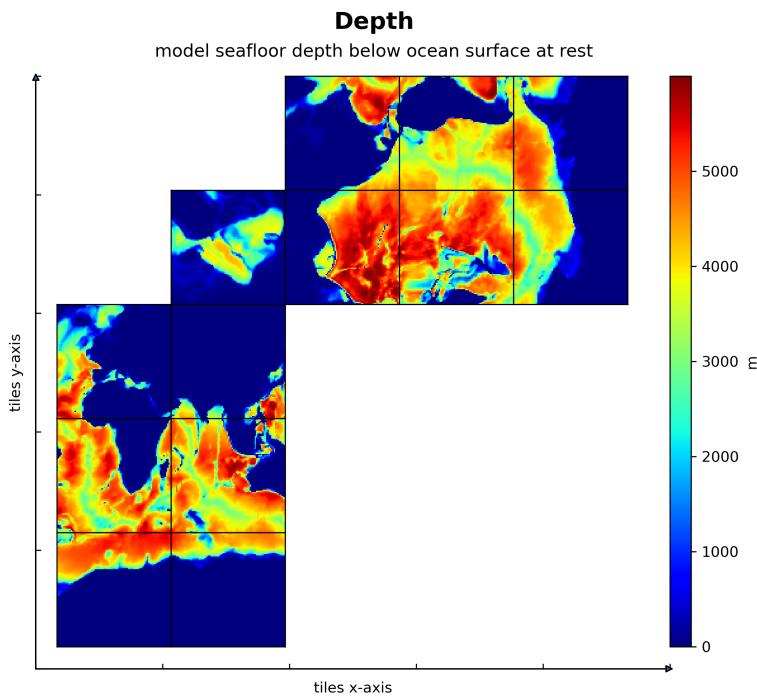
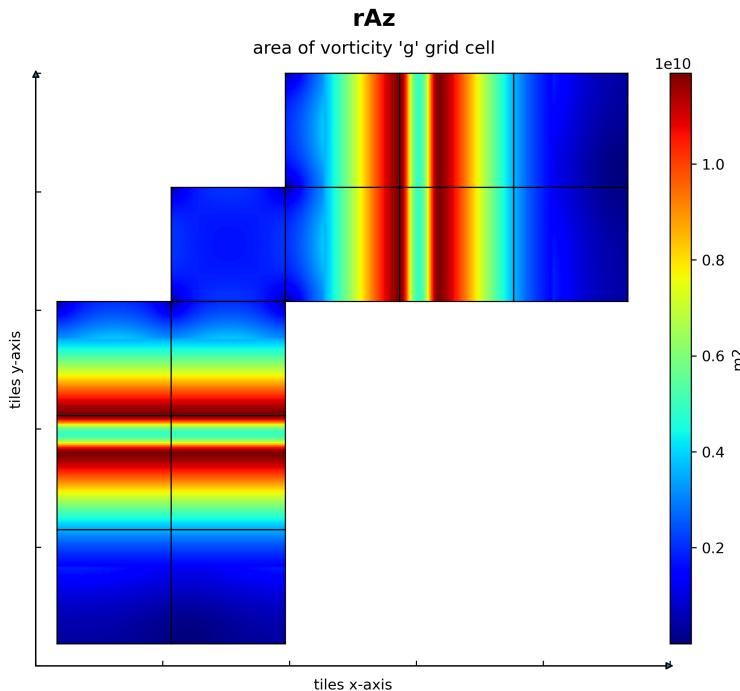


Figure 10: Dataset: GRID_GEOMETRY_ECCO, Variable: Depth

11.1.12 Native coordinates Variable: rAz

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

Storage Type	Variable Name	Description	Unit
float32	rAz	Area of vorticity 'g' grid cell	m ²
Description of the variable in Common Data language (CDL)			
	float32 rAz(tile, j_g, i_g)		
	rAz: _FillValue = 9.96921e+36		
	rAz: long_name = "area of vorticity g grid cell"		
	rAz: units = m2		
	rAz: coordinate = YG XG		
	rAz: coverage_content_type = modelResult		
	rAz: standard_name = cell_area		
	rAz: coordinates = YG XG		
Comments			
Vorticity cells are staggered in space relative to tracer cells, nominally situated on tracer cell corners. vorticity cell (i,j) is located at the 'southwest' corner of tracer grid cell (i, j). note: 'southwest' does not correspond to geographic orientation but is used for convenience to describe the computational grid. see mitgcm documentation for details.			



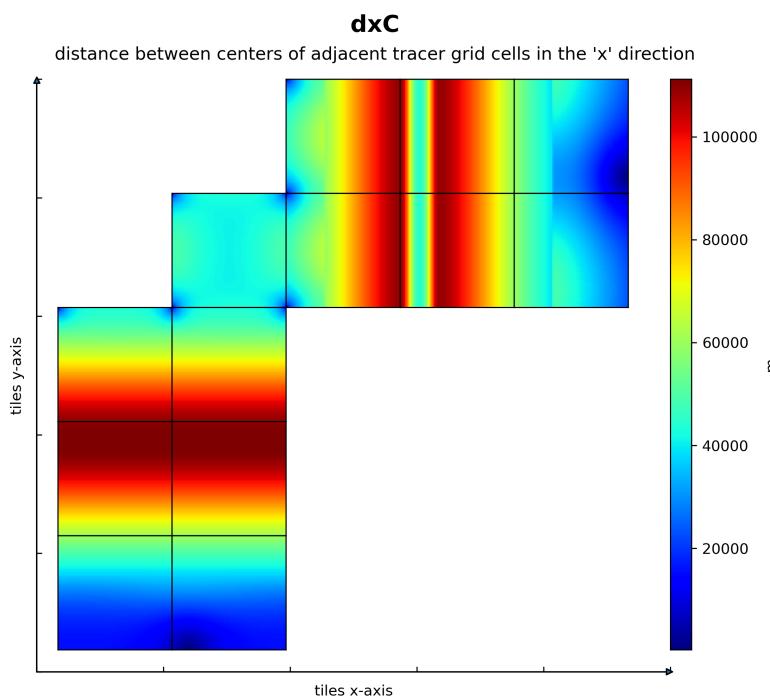
GRID_GEOMETRY_ECCO_V4r4_native_llc0090.nc

Figure 11: Dataset: GRID_GEOMETRY_ECCO, Variable: rAz

11.1.13 Native coordinates Variable: dxC

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

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



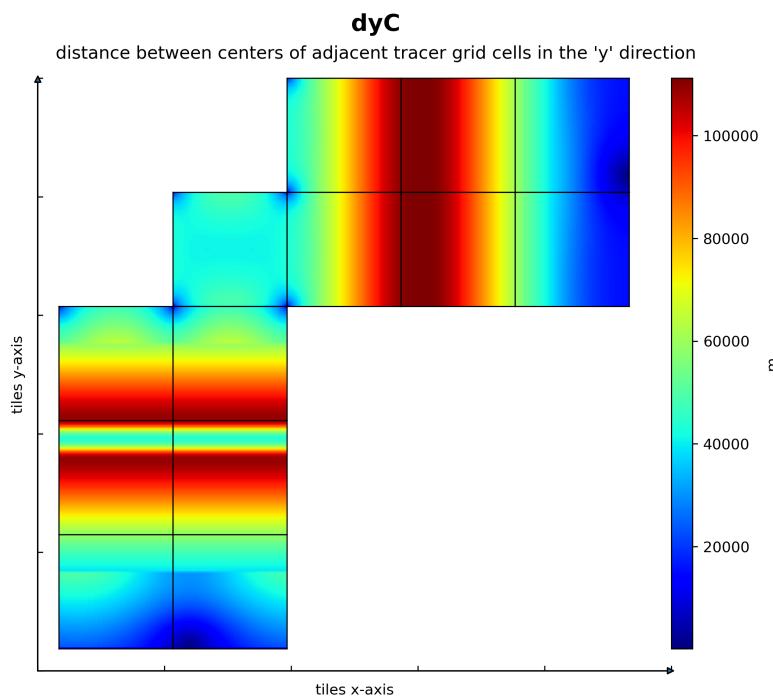
GRID_GEOMETRY_ECCO_V4r4_native_llc0090.nc

Figure 12: Dataset: GRID_GEOMETRY_ECCO, Variable: dxC

11.1.14 Native coordinates Variable: dyC

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

Storage Type	Variable Name	Description	Unit
float32	dyC	Distance between centers of adjacent tracer grid cells in the 'y' direction	m
Description of the variable in Common Data language (CDL)			
<pre>float32 dyC(tile, j_g, i) dyC:_FillValue = 9.96921e+36 dyC:_long_name = "distance between centers of adjacent tracer grid cells in the y direction" dyC:_units = m dyC:_coordinate = YG XC dyC:_coverage_content_type = modelResult</pre>			
Comments			
Alternatively, the length of 'east' side of vorticity grid cells. note: 'east' does not correspond to geographic orientation but is used for convenience to describe the computational grid. see mitgcm documentation for details.			



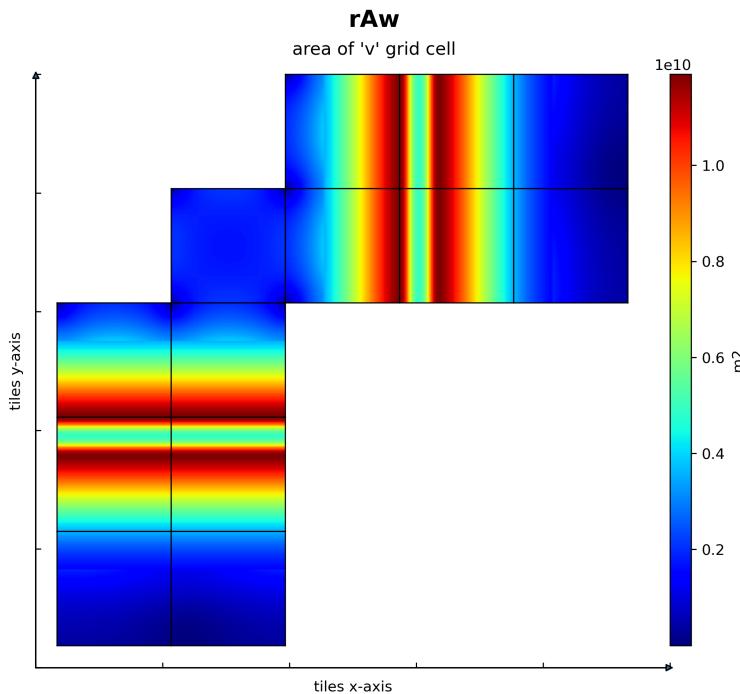
GRID_GEOMETRY_ECCO_V4r4_native_llc0090.nc

Figure 13: Dataset: GRID_GEOMETRY_ECCO, Variable: dyC

11.1.15 Native coordinates Variable: rAw

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

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



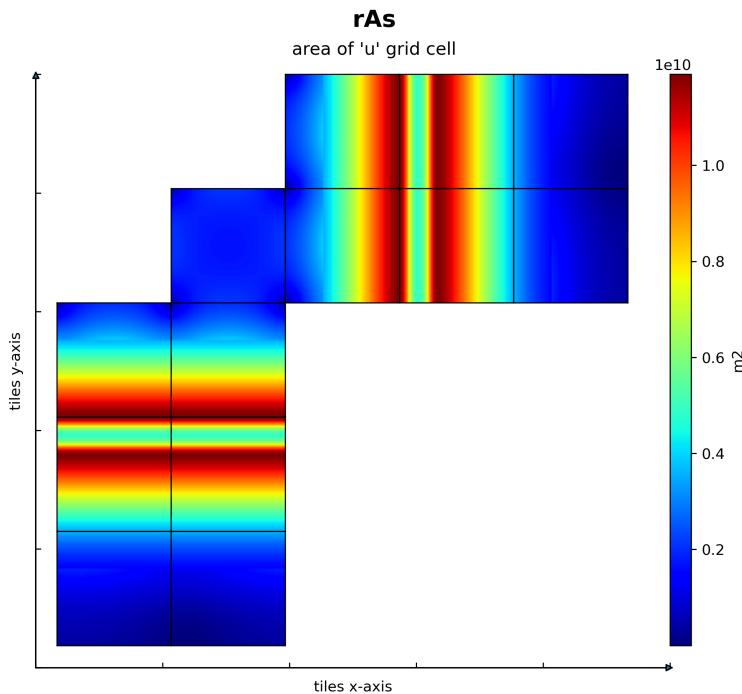
GRID_GEOMETRY_ECCO_V4r4_native_llc0090.nc

Figure 14: Dataset: GRID_GEOMETRY_ECCO, Variable: rAw

11.1.16 Native coordinates Variable: rAs

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

Storage Type	Variable Name	Description	Unit
float32	rAs	Area of 'u' grid cell	m ²
Description of the variable in Common Data language (CDL)			
	float32 rAs(tile, j_g, i)		
	rAs: _FillValue = 9.96921e+36		
	rAs: long_name = "area of u grid cell"		
	rAs: units = m2		
	rAs: coordinates = YG XC		
	rAs: coverage_content_type = modelResult		
	rAs: standard_name = cell_area		
Comments			
Model 'u' grid cells are staggered in space between adjacent tracer grid cells in the 'y' direction. 'u' grid cell (i,j) is situated at the 'south' edge of tracer grid cell (i, j). note: 'south' does not correspond to geographic orientation but is used for convenience to describe the computational grid. see mitgcm documentation for details.			



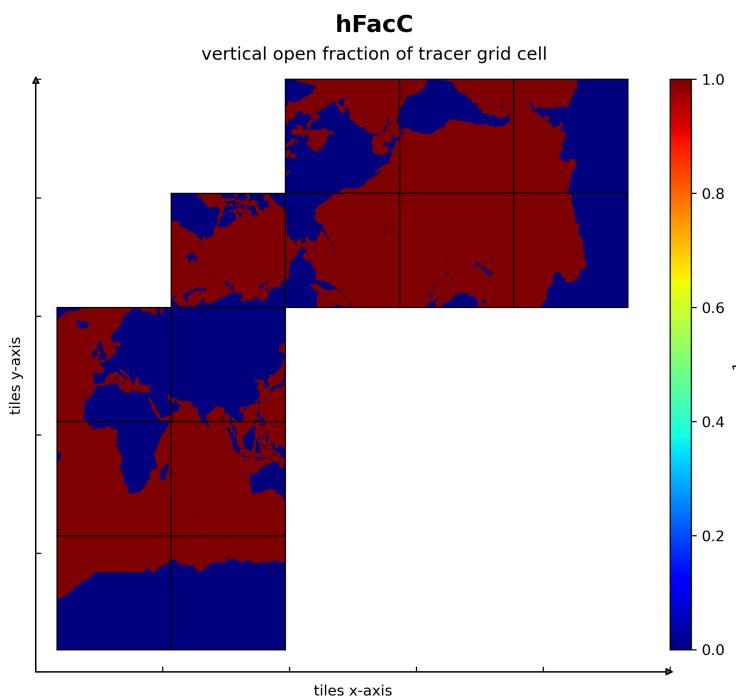
GRID_GEOMETRY_ECCO_V4r4_native_llc0090.nc

Figure 15: Dataset: GRID_GEOMETRY_ECCO, Variable: rAs

11.1.17 Native coordinates Variable: hFacC

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

Storage Type	Variable Name	Description	Unit
float32	hFacC	Vertical open fraction of tracer grid cell	1
Description of the variable in Common Data language (CDL)			
<pre>float32 hFacC(k, tile, j, i) hFacC: _FillValue = 9.96921e+36 hFacC: long_name = vertical open fraction of tracer grid cell hFacC: coverage_content_type = modelResult hFacC: units = 1 hFacC: coordinates = Z YC XC</pre>			
Comments			
Tracer grid cells may be fractionally closed in the vertical. the open vertical fraction is hfacc. the model allows for partially-filled cells to represent topographic variations more smoothly (hfacc < 1). completely closed (dry) tracer grid cells have hfacc = 0. note: the model z* coordinate system allows hfacc to vary through time. a time-invariant hfacc field is provided for reference.			



GRID_GEOMETRY_ECCO_V4r4_native_llc0090.nc

Figure 16: Dataset: GRID_GEOMETRY_ECCO, Variable: hFacC

11.1.18 Native coordinates Variable: hFacW

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

Storage Type	Variable Name	Description	Unit
float32	hFacW	Vertical open fraction of tracer grid cell 'west' face	1
Description of the variable in Common Data language (CDL)			
<pre>float32 hFacW(k, tile, j, i_g) hFacW: _FillValue = 9.96921e+36 hFacW: long_name = "vertical open fraction of tracer grid cell west face" hFacW: coverage_content_type = modelResult hFacW: units = 1 hFacW: coordinates = Z</pre>			
Comments			
<p>The 'west' face of tracer grid cells may be fractionally closed in the vertical. the open vertical fraction is hfacw. the model allows for partially-filled cells for smoother representation of seafloor topography. tracer grid cells adjacent in the 'x' direction that are partially closed in the vertical have hfacw < 1. the model z* coordinate system used by the model permits hfacc, and therefore hfacw, to vary through time. a time-invariant hfacw field is provided for reference. note: the term 'west' does not correspond to geographic orientation but is used for convenience to describe the computational grid. see mitgcm documentation for details.</p>			

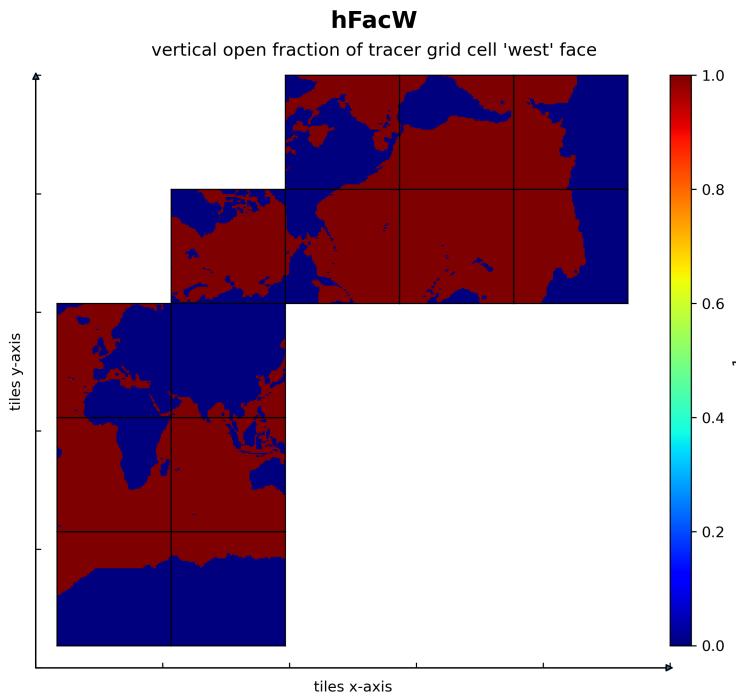


Figure 17: Dataset: GRID_GEOMETRY_ECCO, Variable: hFacW

11.1.19 Native coordinates Variable: hFacS

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

Storage Type	Variable Name	Description	Unit
float32	hFacS	Vertical open fraction of tracer grid cell 'south' face	1
Description of the variable in Common Data language (CDL)			
<pre>float32 hFacS(k, tile, j_g, i) hFacS: _FillValue = 9.96921e+36 hFacS: long_name = "vertical open fraction of tracer grid cell south face" hFacS: coverage_content_type = modelResult hFacS: units = 1 hFacS: coordinates = Z</pre>			
Comments			
<p>The 'south' face of tracer grid cells may be fractionally closed in the vertical. the open vertical fraction is hfacs. the model allows for partially-filled cells for smoother representation of seafloor topography. tracer grid cells adjacent in the 'y' direction that are partially closed in the vertical have hfacs < 1. the model z* coordinate system used by the model permits hfacc, and therefore hfacs, to vary through time. a time-invariant hfacs field is provided for reference. note: the term 'south' does not correspond to geographic orientation but is used for convenience to describe the computational grid. see mitgcm documentation for details.</p>			

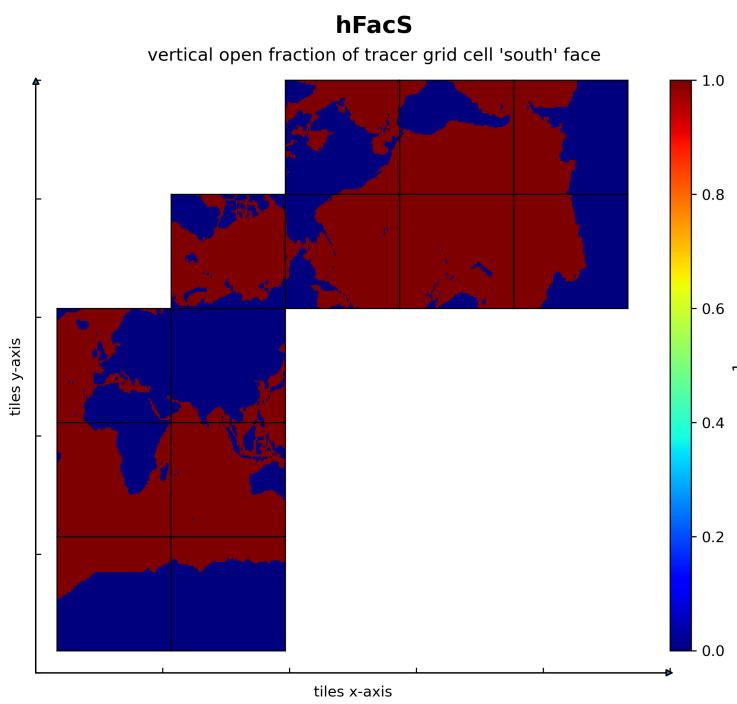


Figure 18: Dataset: GRID_GEOMETRY_ECCO, Variable: hFacS

11.1.20 Native coordinates Variable: maskC

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

Storage Type	Variable Name	Description	Unit
bool	maskC	Wet/dry boolean mask for tracer grid cell	N/A
Description of the variable in Common Data language (CDL)			
<pre>bool maskC(k, tile, j, i) maskC:_FillValue = 1 maskC:long_name = wet/dry boolean mask for tracer grid cell maskC:coverage_content_type = modelResult maskC:coordinates = Z YC XC</pre>			
Comments			
True for tracer grid cells with nonzero open vertical fraction ($hfacc > 0$), otherwise false. although $hfacc$ can vary though time, cells will never close if starting open and will never open if starting closed: $hfacc(i,j,k,t) > 0$ for all t , if $hfacc(i,j,k,t=0) > 0$ and $hfacc(i,j,k,t) = 0$ for all t , if $hfacc(i,j,k,t=0) = 0$. therefore, maskc is time invariant.			

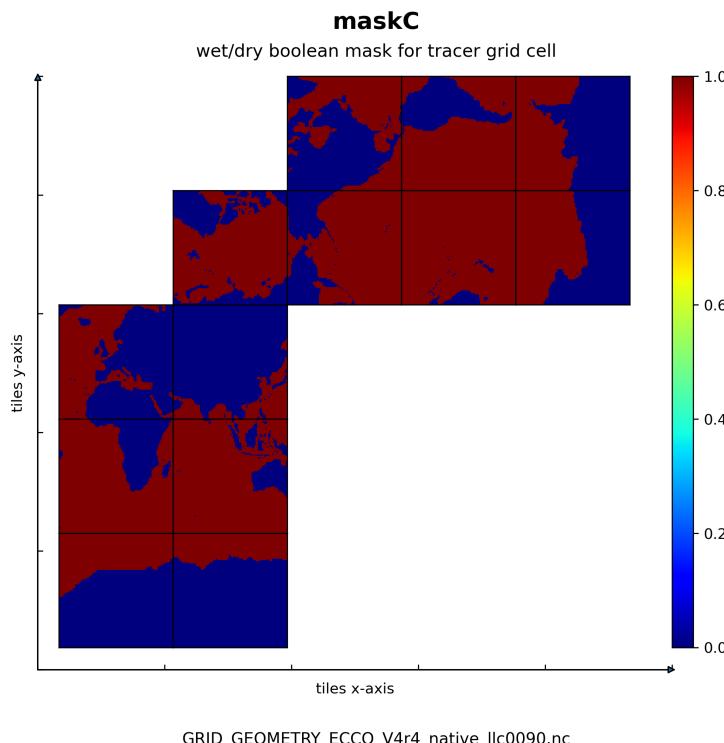


Figure 19: Dataset: GRID_GEOMETRY_ECCO, Variable: maskC

11.1.21 Native coordinates Variable: maskW

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

Storage Type	Variable Name	Description	Unit
bool	maskW	Wet/dry boolean mask for 'west' face of tracer grid cell	N/A
Description of the variable in Common Data language (CDL)			
<pre>bool maskW(k, tile, j, i_g) maskW:_FillValue = 1 maskW:long_name = "wet/dry boolean mask for west face of tracer grid cell" maskW:coverage_content_type = modelResult maskW:coordinates = Z</pre>			
Comments			
True for grid cells with nonzero open vertical fraction along their 'west' face ($hfacw > 0$), otherwise false. although $hfacw$ can vary though time, cells will never close if starting open and will never open if starting closed: $hfacw(i,j,k,t) > 0$ for all t , if $hfacw(i,j,k,t=0) = 0$ and $hfacw(i,j,k,t) = 0$ for all t , if $hfacw(i,j,k,t=0) = 0$. therefore, $maskw$ is time invariant. note:			

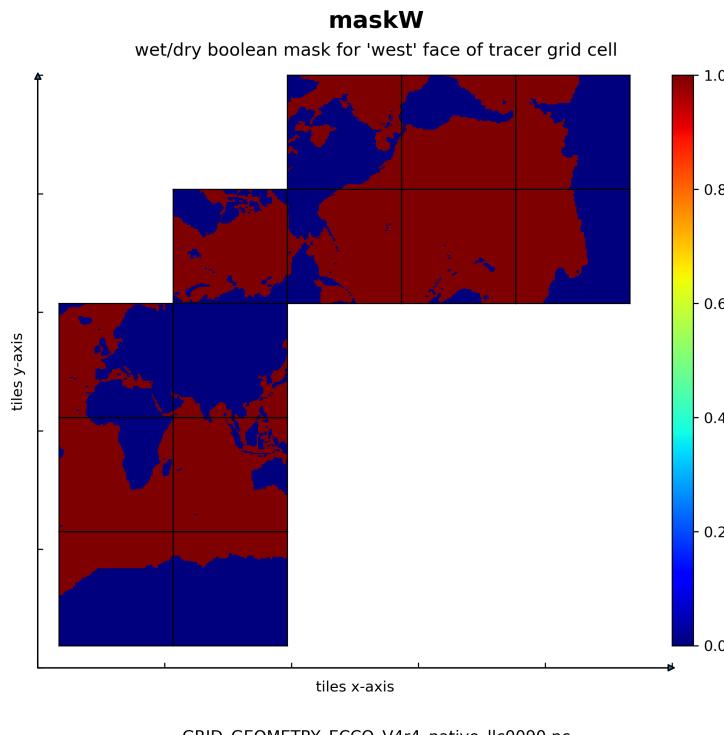


Figure 20: Dataset: GRID_GEOMETRY_ECCO, Variable: maskW

11.1.22 Native coordinates Variable: maskS

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

Storage Type	Variable Name	Description	Unit
bool	maskS	Wet/dry boolean mask for 'south' face of tracer grid cell	N/A
Description of the variable in Common Data language (CDL)			
<pre>bool maskS(k, tile, j_g, i) maskS:_FillValue = 1 maskS:long_name = "wet/dry boolean mask for south face of tracer grid cell" maskS:coverage_content_type = modelResult maskS:coordinates = Z</pre>			
Comments			
True for grid cells with nonzero open vertical fraction along their 'south' face ($hfacs > 0$), otherwise false. although $hfacs$ can vary though time, cells will never close if starting open and will never open if starting closed: $hfacs(i,j,k,t) > 0$ for all t , if $hfacs(i,j,k,t=0) = 0$ and $hfacs(i,j,k,t) = 0$ for all t , if $hfacs(i,j,k,t=0) = 0$. therefore, masks is time invariant. note:			

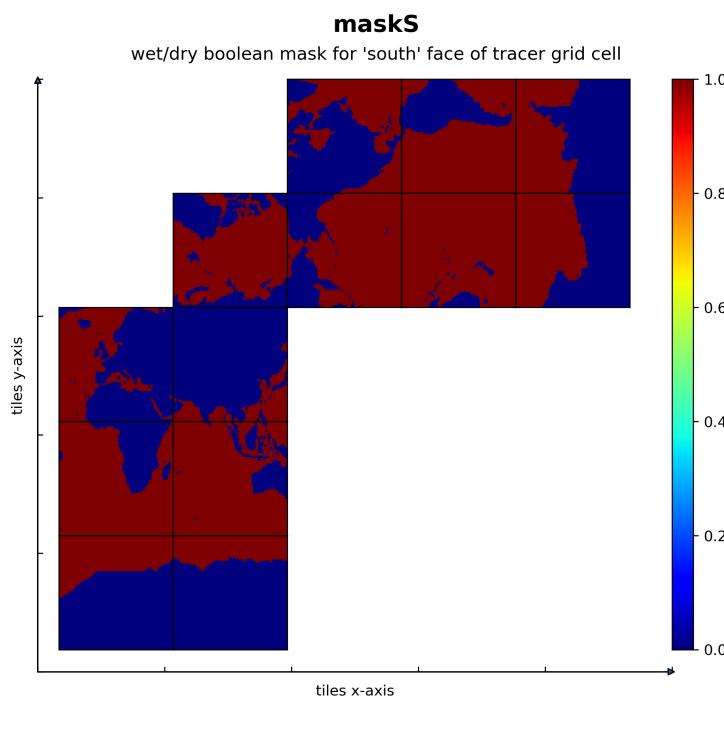


Figure 21: Dataset: GRID_GEOMETRY_ECCO, Variable: maskS

12 Native Dataset Groupings

12.1 Native dataset of ATM_SURFACE_TEMP_HUM_WIND_PRES

12.1.1 Overview

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

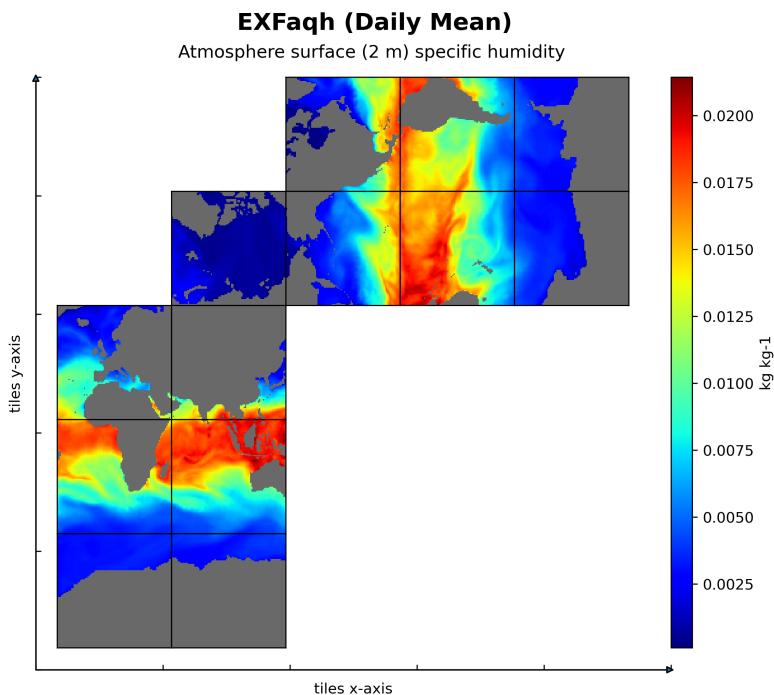
Table 12.1: Coordinates and Variables in the dataset ATM_SURFACE_TEMP_HUM_WIND_PRES

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

12.1.2 Native Variable: EXFaqh

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

Storage Type	Variable Name	Description	Unit
float32	EXFaqh	Atmosphere surface (2 m) specific humidity	kg kg ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 EXFaqh(time, tile, j, i) EXFaqh:_FillValue = 9.96921e+36 EXFaqh:long_name = Atmosphere surface (2 m) specific humidity EXFaqh:units = kg kg: 1 EXFaqh:coverage_content_type = modelResult EXFaqh:standard_name = surface_specific_humidity EXFaqh:coordinates = time XC YC EXFaqh:valid_min = : 0.0014020215021446347 EXFaqh:valid_max = 0.03014513850212097</pre>			
Comments			
Surface (2 m) specific humidity over open water. note: sum of era-interim surface specific humidity and the control adjustment from ocean state estimation.			



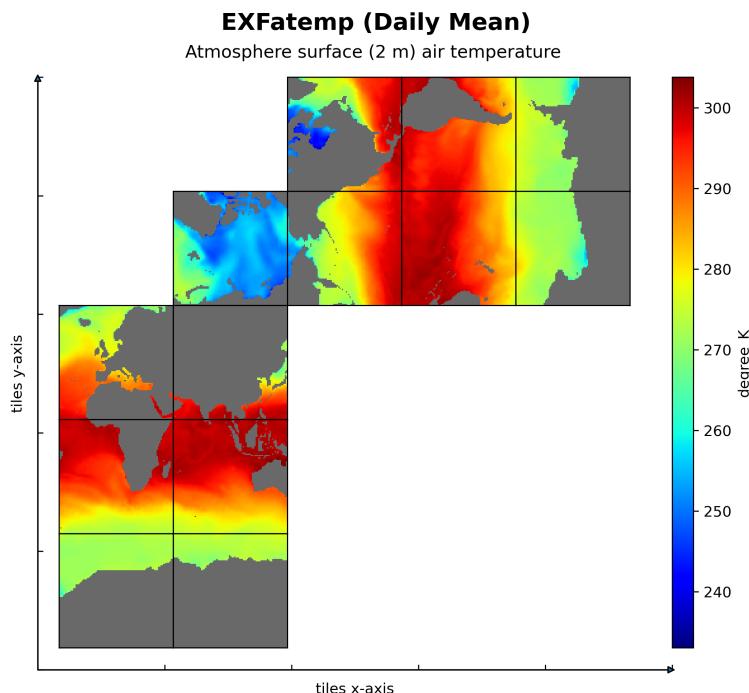
ATM_SURFACE_TEMP_HUM_WIND_PRES_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 22: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFaqh

12.1.3 Native Variable: EXFatemp

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

Storage Type	Variable Name	Description	Unit
float32	EXFatemp	Atmosphere surface (2 m) air temperature	degree_K
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Surface (2 m) air temperature over open water. note: sum of era-interim surface air temperature and the control adjustment from ocean state estimation.			



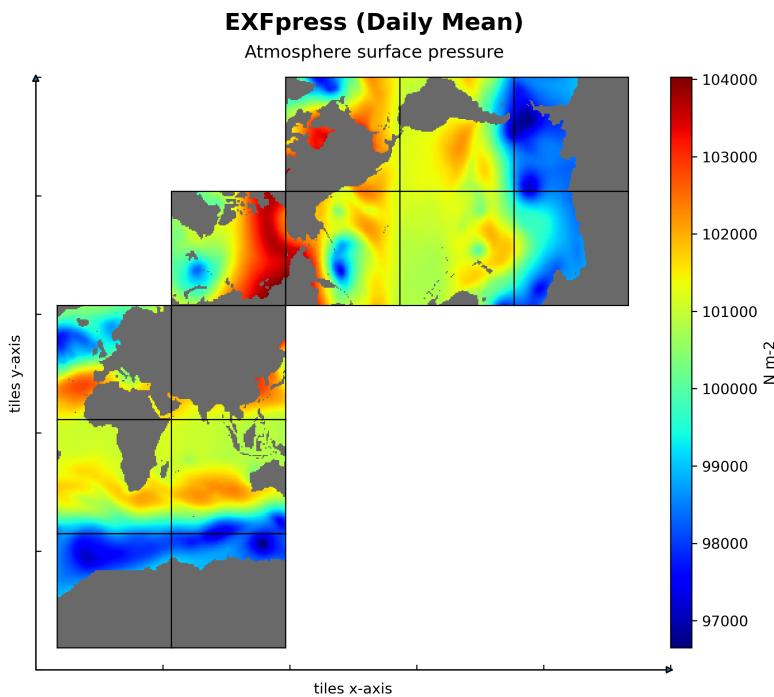
ATM_SURFACE_TEMP_HUM_WIND_PRES_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 23: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFatemp

12.1.4 Native Variable: EXFpress

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

Storage Type	Variable Name	Description	Unit
float32	EXFpress	Atmosphere surface pressure	N m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>float32 EXFpress(time, tile, j, i) EXFpress:_FillValue = 9.96921e+36 EXFpress:long_name = Atmosphere surface pressure EXFpress:units = N m: 2 EXFpress:coverage_content_type = modelResult EXFpress:standard_name = surface_air_pressure EXFpress:coordinates = time XC YC EXFpress:valid_min = 92044.171875 EXFpress:valid_max = 106314.7734375</pre>			
Comments			
Atmospheric pressure field at sea level. note: era-interim atmospheric pressure, with air tides removed using a variety of methods. not adjusted by the ocean state estimation.			



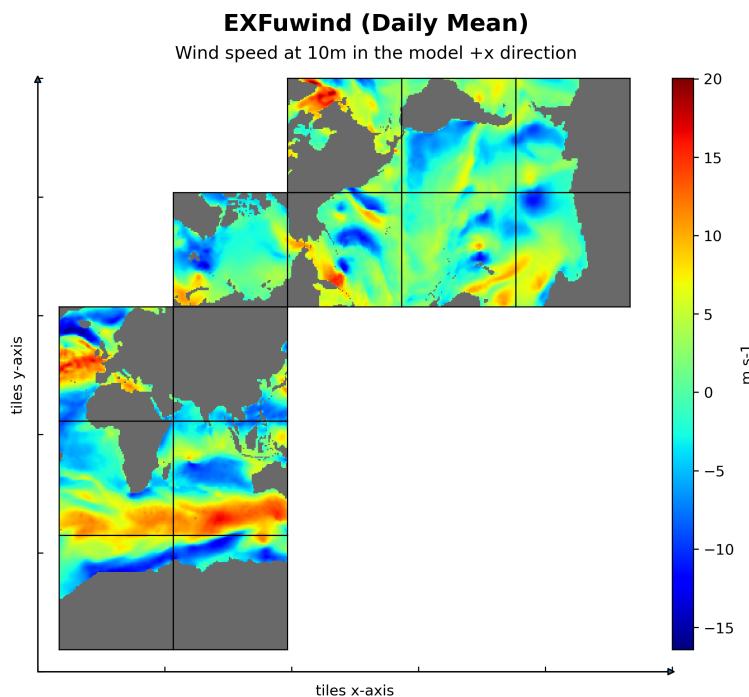
ATM_SURFACE_TEMP_HUM_WIND_PRES_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 24: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFpress

12.1.5 Native Variable: EXFuwind

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

Storage Type	Variable Name	Description	Unit
float32	EXFuwind	Wind speed at 10m in the model +x direction	m s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 EXFuwind(time, tile, j, i) EXFuwind:_FillValue = 9.96921e+36 EXFuwind:long_name = Wind speed at 10m in the model +x direction EXFuwind:units = m s: 1 EXFuwind:coverage_content_type = modelResult EXFuwind:standard_name = x_wind EXFuwind:coordinates = time XC YC EXFuwind:valid_min = : 34.528900146484375 EXFuwind:valid_max = 29.92486572265625</pre>			
Comments			
Wind speed at 10m in the +x direction at the tracer cell on the native model grid. note: ecco v4r4 is forced with wind stress (see exftaux) not vector winds converted to wind stress using bulk formulae. exfwind is calculated by converting wind stress to vector wind using bulk formulae.			



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: EXFuwind

12.1.6 Native Variable: EXFvwind

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

Storage Type	Variable Name	Description	Unit
float32	EXFvwind	Wind speed at 10m in the model +y direction	m s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 EXFvwind(time, tile, j, i) EXFvwind:_FillValue = 9.96921e+36 EXFvwind:long_name = Wind speed at 10m in the model +y direction EXFvwind:units = m s: 1 EXFvwind:coverage_content_type = modelResult EXFvwind:standard_name = y_wind EXFvwind:coordinates = time XC YC EXFvwind:valid_min = : 27.9254093170166 EXFvwind:valid_max = 45.065101623535156</pre>			
Comments			
Wind speed at 10m in the +y direction at the tracer cell on the native model grid. note: ecco v4r4 is forced with wind stress (see exftauy) not vector winds converted to wind stress using bulk formulae. exfvwind is calculated by converting wind stress to vector wind using bulk formulae.			

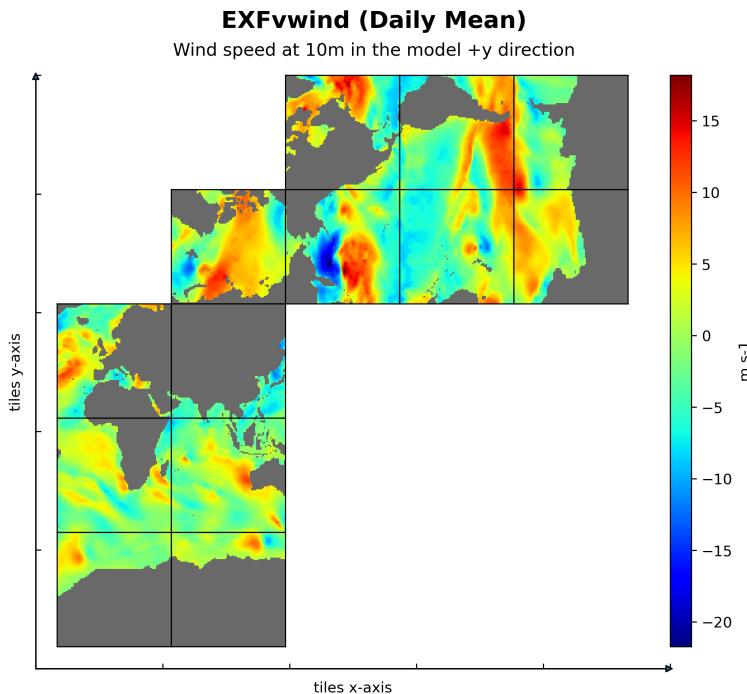
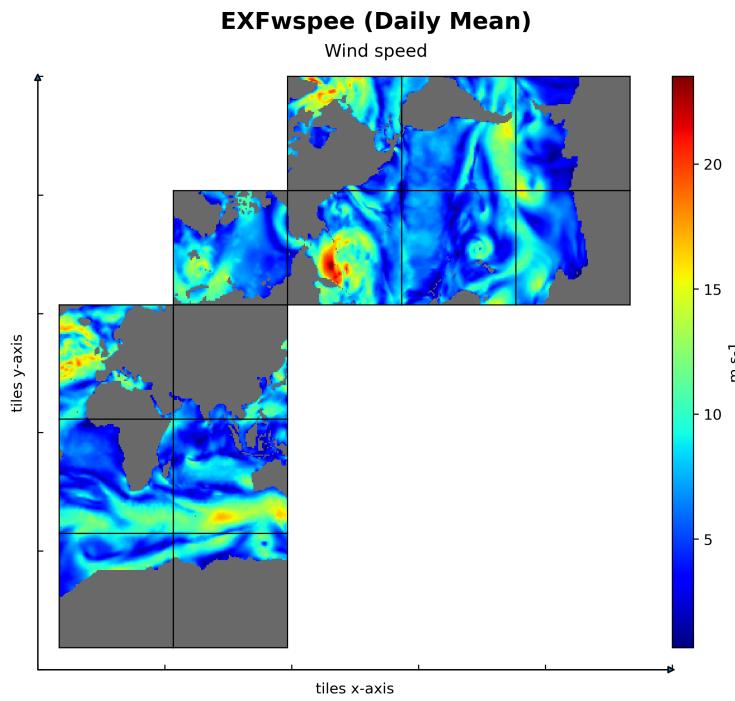


Figure 26: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFvwind

12.1.7 Native Variable: EXFwspee

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

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



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: EXFwspee

12.2 Native dataset of OCEAN_3D_MIXING_COEFFS

12.2.1 Overview

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

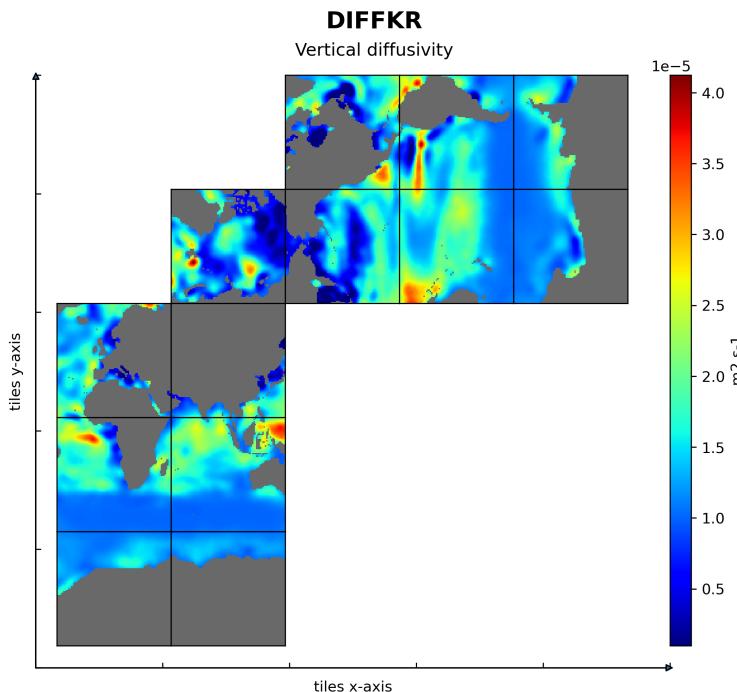
Table 12.8: Coordinates and Variables in the dataset OCEAN_3D_MIXING_COEFFS_ECCO

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

12.2.2 Native Variable: DIFFKR

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

Storage Type	Variable Name	Description	Unit
float32	DIFFKR	Vertical diffusivity	m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 DIFFKR(k, tile, j, i) DIFFKR: _FillValue = 9.96921e+36 DIFFKR: coverage_content_type = modelResult DIFFKR: long_name = Vertical diffusivity DIFFKR: units = m2 s: 1 DIFFKR: valid_min = 1e: 06 DIFFKR: valid_max = 0.0001854995 DIFFKR: coordinates = Z XC YC</pre>			
Comments			
Background vertical diffusion coefficient for temperature and salinity. total vertical diffusivity includes background diffusivity plus contributions from the ggl90 vertical mixing and the gent-mcwiliams/redi parameterizations. note: diffkr is a model control variable and has been optimized from a spatially-invariant first-guess value of 1e-5 m ² s ⁻¹ .			



OCEAN_3D_MIXING_COEFFS_ECCO_V4r4_native_llc0090.nc

Figure 28: Dataset: OCEAN_3D_MIXING_COEFFS, Variable: DIFFKR

12.2.3 Native Variable: KAPGM

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

Storage Type	Variable Name	Description	Unit
float32	KAPGM	Gent-mcwilliams diffusivity	m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 KAPGM(k, tile, j, i) KAPGM: _FillValue = 9.96921e+36 KAPGM: coverage_content_type = modelResult KAPGM: long_name = Gent: McWilliams diffusivity KAPGM: units = m2 s: 1 KAPGM: valid_min = 100.0 KAPGM: valid_max = 10000.0 KAPGM: coordinates = Z XC YC</pre>			
Comments			
Gent-mcwilliams diffusivity coefficient as described in gent and mcwilliams (1990, jpo). note: kapgm is a model control variable and has been optimized from a spatially invariant first guess of 1e3 m ² s ⁻¹ .			

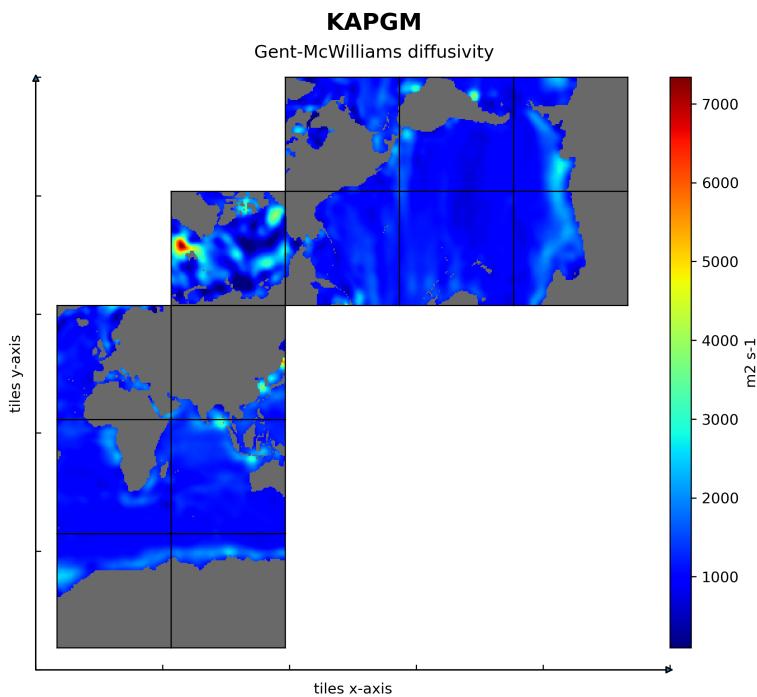


Figure 29: Dataset: OCEAN_3D_MIXING_COEFFS, Variable: KAPGM

12.2.4 Native Variable: KAPREDI

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

Storage Type	Variable Name	Description	Unit
float32	KAPREDI	Along-isopycnal diffusivity	m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 KAPREDI(k, tile, j, i) KAPREDI: _FillValue = 9.96921e+36 KAPREDI: coverage_content_type = modelResult KAPREDI: long_name = Along: isopycnal diffusivity KAPREDI: units = m2 s: 1 KAPREDI: valid_min = 100.0 KAPREDI: valid_max = 10000.0 KAPREDI: coordinates = Z XC YC</pre>			
Comments			
Redi along-isopycnal diffusivity coefficient as described in redi (1982, jpo). note: kapredi is a model control variable and has been optimized from a spatially invariant first guess of 1e3 m ² s ⁻¹ .			

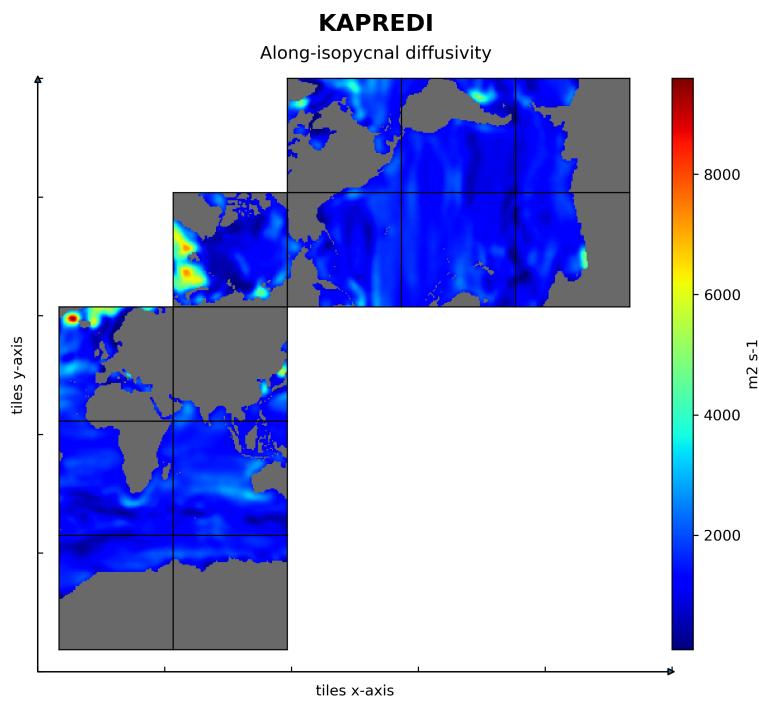


Figure 30: Dataset: OCEAN_3D_MIXING_COEFFS, Variable: KAPREDI

12.3 Native dataset of OCEAN_3D_MOMENTUM_TEND

12.3.1 Overview

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

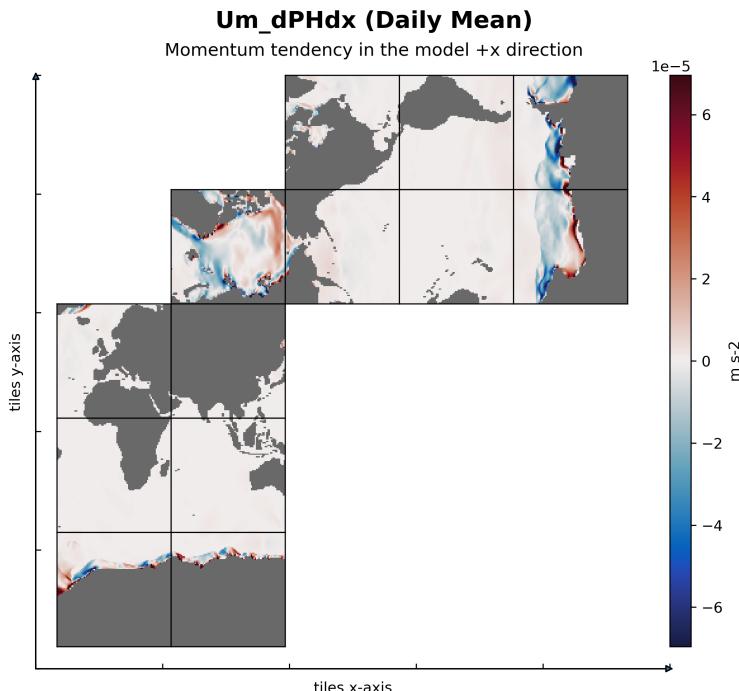
Table 12.12: Coordinates and Variables in the dataset OCEAN_3D_MOMENTUM_TEND

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

12.3.2 Native Variable: Um_dPHdx

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

Storage Type	Variable Name	Description	Unit
float32	Um_dPHdx	Momentum tendency in the model +x direction	m s ⁻²
Description of the variable in Common Data language (CDL)			
<pre>float32 Um_dPHdx(time, k, tile, j, i_g) Um_dPHdx:_FillValue = 9.96921e+36 Um_dPHdx:long_name = Momentum tendency in the model +x direction Um_dPHdx:units = m s: 2 Um_dPHdx:mate = Vm_dPHdy Um_dPHdx:coverage_content_type = modelResult Um_dPHdx:coordinates = time Z Um_dPHdx:valid_min = : 0.0010651482734829187 Um_dPHdx:valid_max = 0.0011411579325795174</pre>			
Comments			
Momentum tendency in the +x direction due to the hydrostatic pressure gradient at the 'u' face of the native model grid cell . note: the model +x direction does not necessarily correspond to the geographical east-west direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.			



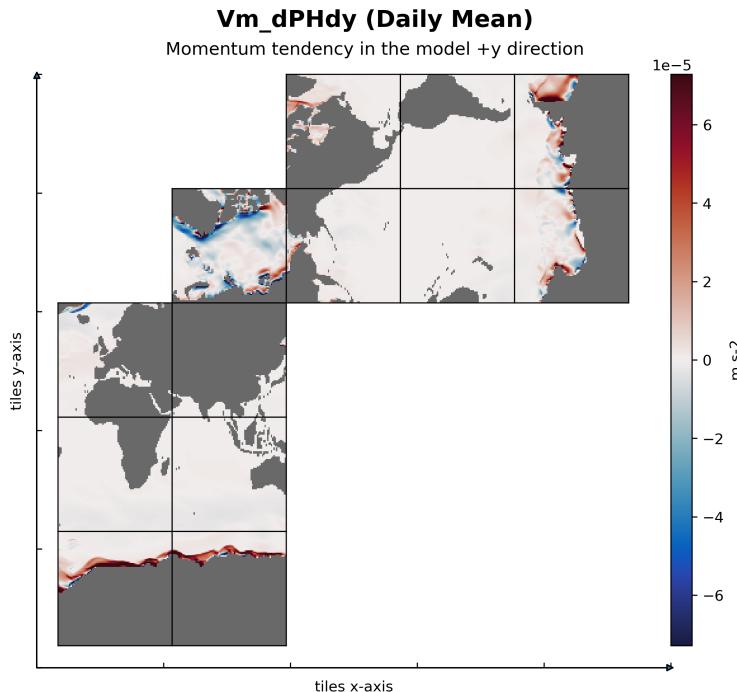
OCEAN_3D_MOMENTUM_TEND_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 31: Dataset: OCEAN_3D_MOMENTUM_TEND, Variable: Um_dPHdx

12.3.3 Native Variable: Vm_dPHdy

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

Storage Type	Variable Name	Description	Unit
float32	Vm_dPHdy	Momentum tendency in the model +y direction	m s ⁻²
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Momentum tendency in the +y direction due to the hydrostatic pressure gradient at the 'v' face of the native model grid cell . note: the model +y direction does not necessarily correspond to the geographical north-south direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.			



OCEAN_3D_MOMENTUM_TEND_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 32: Dataset: OCEAN_3D_MOMENTUM_TEND, Variable: Vm_dPHdy

12.4 Native dataset of OCEAN_3D_SALINITY_FLUX

12.4.1 Overview

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

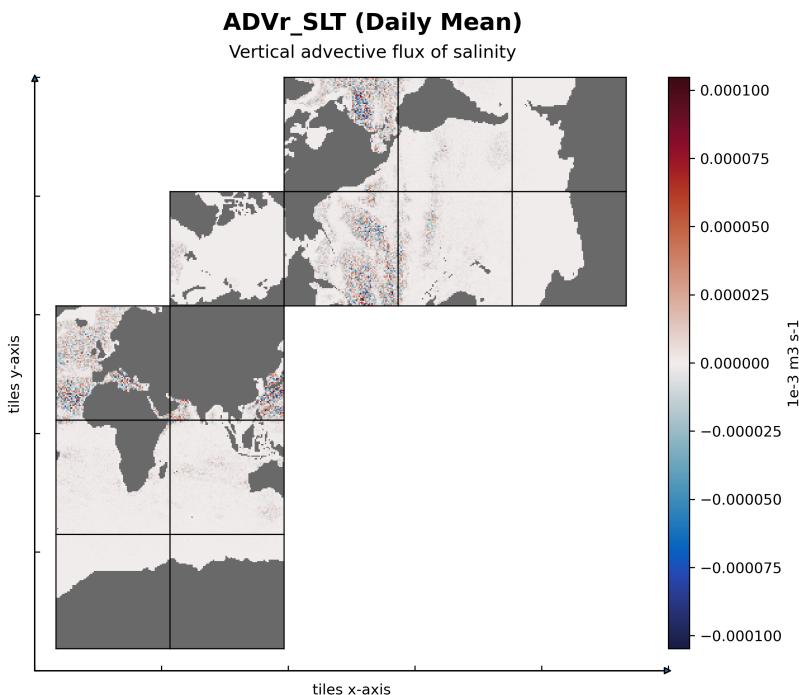
Table 12.15: Coordinates and Variables in the dataset OCEAN_3D_SALINITY_FLUX

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

12.4.2 Native Variable: ADVr_SLT

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

Storage Type	Variable Name	Description	Unit
float32	ADVr_SLT	Vertical advective flux of salinity	1e-3 m3 s-1
Description of the variable in Common Data language (CDL)			
<pre>float32 ADVr_SLT(time, k_l, tile, j, i) ADVr_SLT:_FillValue = 9.96921e+36 ADVr_SLT:long_name = Vertical advective flux of salinity ADVr_SLT:units = 1e: 3 m3 s: 1 ADVr_SLT:coverage_content_type = modelResult ADVr_SLT:direction = >0 decreases salinity (SALT) ADVr_SLT:coordinates = XC Z1 YC time ADVr_SLT:valid_min = : 324149856.0 ADVr_SLT:valid_max = 263294624.0</pre>			
Comments			
<p>Vertical advective flux of salinity (salt) in the +z direction through the top 'w' face of the tracer cell on the native model grid. note: in the arakawa-c grid, vertical flux quantities are staggered relative to the tracer cells with indexing such that +advr_slt(i,j,k_l) corresponds to upward +z fluxes through the top 'w' face of the tracer cell at (i,j,k). salinity defined using cf convention 'sea water salinity' is the salt content of sea water, often on the practical salinity scale of 1978. however, the unqualified term 'salinity' is generic and does not necessarily imply any particular method of calculation. the units of salinity are dimensionless and the units attribute should normally be given as 1e-3 or 0.001 i.e. parts per thousand. see https://cfconventions.org/data/cf-standard-names/73/build/cf-standard-name-table.html</p>			



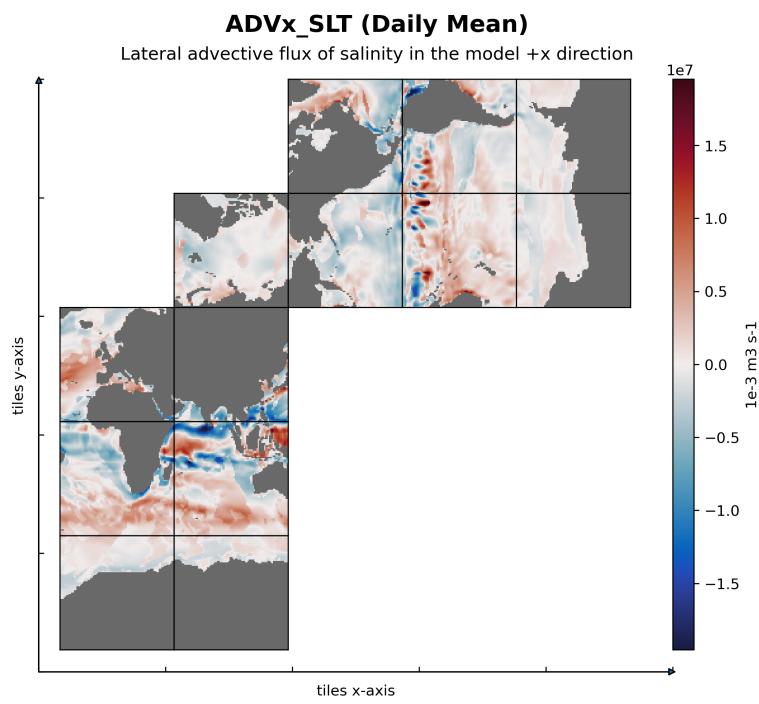
OCEAN_3D_SALINITY_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 33: Dataset: OCEAN_3D_SALINITY_FLUX, Variable: ADVr_SLT

12.4.3 Native Variable: ADVx_SLT

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

Storage Type	Variable Name	Description	Unit
float32	ADVx_SLT	Lateral advective flux of salinity in the model +x direction	1e-3 m3 s-1
Description of the variable in Common Data language (CDL)			
<pre>float32 ADVx_SLT(time, k, tile, j, i_g) ADVx_SLT: _FillValue = 9.96921e+36 ADVx_SLT: long_name = Lateral advective flux of salinity in the model +x direction ADVx_SLT: units = 1e: 3 m3 s: 1 ADVx_SLT: mate = ADVy_SLT ADVx_SLT: coverage_content_type = modelResult ADVx_SLT: direction = >0 increases salinity (SALT) ADVx_SLT: coordinates = Z time ADVx_SLT: valid_min = : 181830224.0 ADVx_SLT: valid_max = 260411296.0</pre>			
Comments			
<p>Lateral advective flux of salinity (salt) in the +x direction through the 'u' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +advx_slt(i_g,j,k) corresponds to +x fluxes through the 'u' face of the tracer cell at (i,j,k). also, the model +x direction does not necessarily correspond to the geographical east-west direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles. salinity defined using cf convention 'sea water salinity' is the salt content of sea water, often on the practical salinity scale of 1978. however, the unqualified term 'salinity' is generic and does not necessarily imply any particular method of calculation. the units of salinity are dimensionless and the units attribute should normally be given as 1e-3 or 0.001 i.e. parts per thousand' see https://cfconventions.org/data/cf-standard-names/73/build/cf-standard-name-table.html</p>			



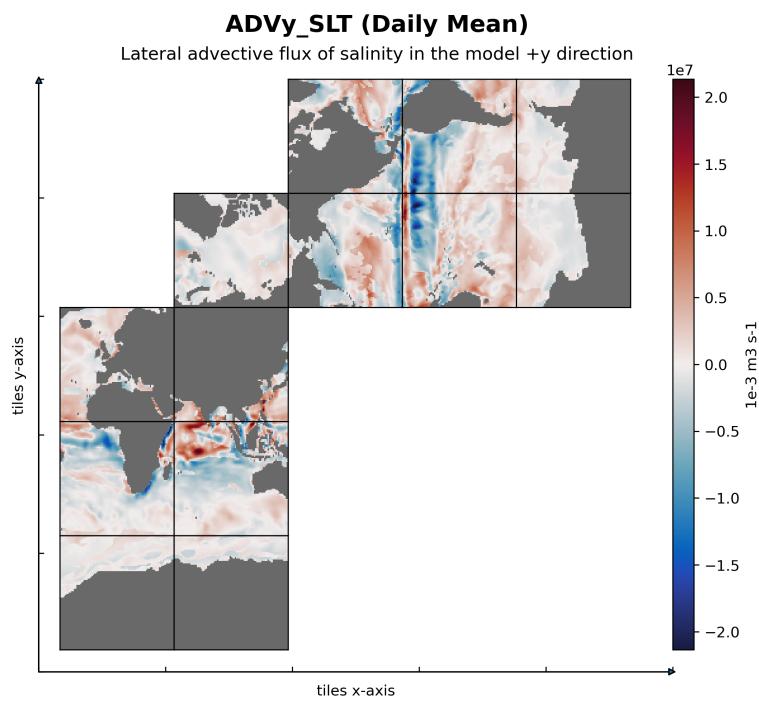
OCEAN_3D_SALINITY_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 34: Dataset: OCEAN_3D_SALINITY_FLUX, Variable: ADVx_SLT

12.4.4 Native Variable: ADVy_SLT

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

Storage Type	Variable Name	Description	Unit
float32	ADVy_SLT	Lateral advective flux of salinity in the model +y direction	1e-3 m3 s-1
Description of the variable in Common Data language (CDL)			
<pre>float32 ADVy_SLT(time, k, tile, j_g, i) ADVy_SLT: _FillValue = 9.96921e+36 ADVy_SLT: long_name = Lateral advective flux of salinity in the model +y direction ADVy_SLT: units = 1e: 3 m3 s: 1 ADVy_SLT: mate = ADVx_SLT ADVy_SLT: coverage_content_type = modelResult ADVy_SLT: direction = >0 increases salinity (SALT) ADVy_SLT: coordinates = Z time ADVy_SLT: valid_min = : 137905760.0 ADVy_SLT: valid_max = 164271664.0</pre>			
Comments			
<p>Lateral advective flux of salinity (salt) in the +y direction through the 'v' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +advy_slt(i,j,g,k) corresponds to +y fluxes through the 'v' face of the tracer cell at (i,j,k). also, the model +y direction does not necessarily correspond to the geographical north-south direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles. salinity defined using cf convention 'sea water salinity' is the salt content of sea water, often on the practical salinity scale of 1978. however, the unqualified term 'salinity' is generic and does not necessarily imply any particular method of calculation. the units of salinity are dimensionless and the units attribute should normally be given as 1e-3 or 0.001 i.e. parts per thousand.' see https://cfconventions.org/data/cf-standard-names/73/build/cf-standard-name-table.html</p>			



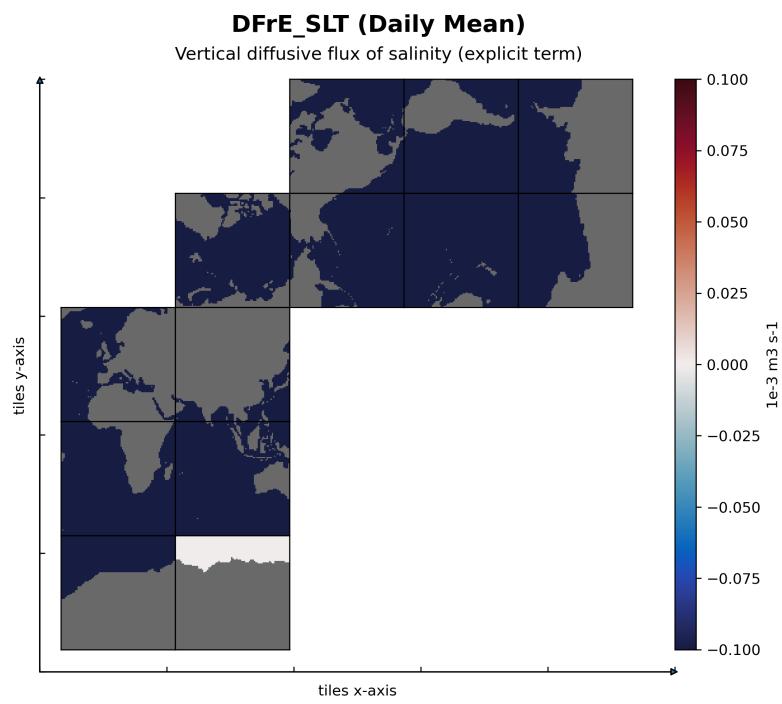
OCEAN_3D_SALINITY_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 35: Dataset: OCEAN_3D_SALINITY_FLUX, Variable: ADVy_SLT

12.4.5 Native Variable: DFrE_SLT

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

Storage Type	Variable Name	Description	Unit
float32	DFrE_SLT	Vertical diffusive flux of salinity (explicit term)	1e-3 m3 s-1
Description of the variable in Common Data language (CDL)			
<pre>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 Z1 YC time DFrE_SLT: valid_min = : 1074719.375 DFrE_SLT: valid_max = 471215.75</pre>			
Comments			
<p>The explicit term of the vertical diffusive flux of salinity (salt) in the +z direction through the top 'w' face of the tracer cell on the native model grid. in the ecco v4r4 model, an implicit scheme is used to calculate vertical diffusive tracer fluxes due to background diffusivity and the kwz component of the gm-redi tensor (vertical flux as a function of vertical gradient) while an explicit scheme is used to calculate the vertical diffusive fluxes from the kwx and kwy components of the gm-redi tensor (vertical flux as a function of horizontal gradient). both implicit and explicit components of vertical diffusive flux of salinity are provided. note: in the arakawa-c grid, vertical flux quantities are staggered relative to the tracer cells with indexing such that +dfre_slt(i,j,k_l) corresponds to upward +z fluxes through the top 'w' face of the tracer cell at (i,j,k). salinity defined using cf convention 'sea water salinity' is the salt content of sea water, often on the practical salinity scale of 1978. however, the unqualified term 'salinity' is generic and does not necessarily imply any particular method of calculation. the units of salinity are dimensionless and the units attribute should normally be given as 1e-3 or 0.001 i.e. parts per thousand.' see https://cfconventions.org/data/cf-standard-names/73/build/cf-standard-name-table.html</p>			



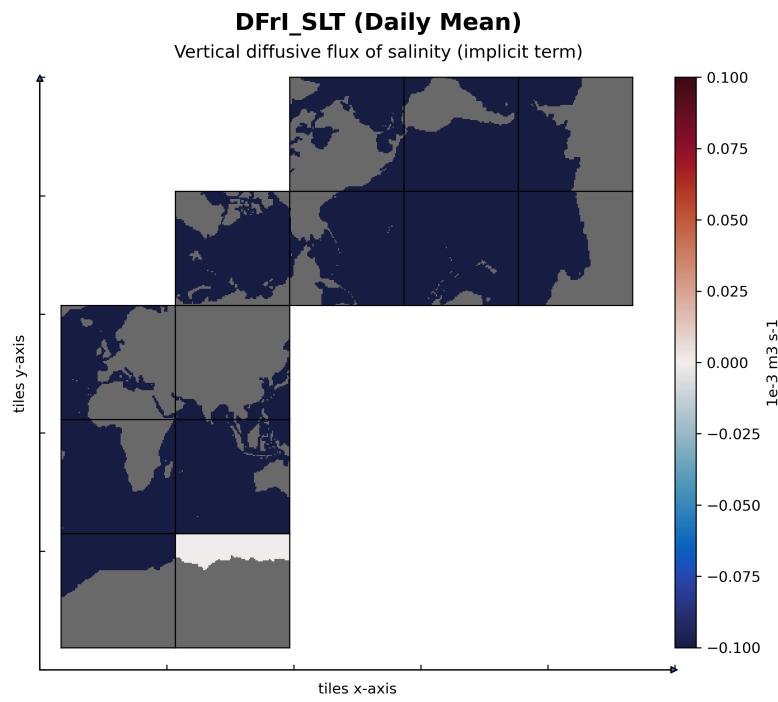
OCEAN_3D_SALINITY_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 36: Dataset: OCEAN_3D_SALINITY_FLUX, Variable: DFrE_SLT

12.4.6 Native Variable: DFrl_SLT

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

Storage Type	Variable Name	Description	Unit
float32	DFrl_SLT	Vertical diffusive flux of salinity (implicit term)	1e-3 m3 s-1
Description of the variable in Common Data language (CDL)			
<pre>float32 DFrl_SLT(time, k_l, tile, j, i) DFrl_SLT: _FillValue = 9.96921e+36 DFrl_SLT: long_name = Vertical diffusive flux of salinity (implicit term) DFrl_SLT: units = 1e: 3 m3 s: 1 DFrl_SLT: coverage_content_type = modelResult DFrl_SLT: direction = >0 decreases salinity (SALT) DFrl_SLT: coordinates = XC Z1 YC time DFrl_SLT: valid_min = : 30609048.0 DFrl_SLT: valid_max = 3197643.0</pre>			
Comments			
<p>The implicit term of the vertical diffusive flux of salinity (salt) in the +z direction through the top 'w' face of the tracer cell on the native model grid. in the ecco v4r4 model, an implicit scheme is used to calculate vertical diffusive tracer fluxes due to background diffusivity and the kwz component of the gm-redi tensor (vertical flux as a function of vertical gradient) while an explicit scheme is used to calculate the vertical diffusive fluxes from the kwx and kwy components of the gm-redi tensor (vertical flux as a function of horizontal gradient). both implicit and explicit components of vertical diffusive flux of salinity are provided. note: in the arakawa-c grid, vertical flux quantities are staggered relative to the tracer cells with indexing such that +dfri_slt(i,j,k_l) corresponds to upward +z fluxes through the top face 'w' of the tracer cell at (i,j,k). salinity defined using cf convention 'sea water salinity' is the salt content of sea water, often on the practical salinity scale of 1978. however, the unqualified term 'salinity' is generic and does not necessarily imply any particular method of calculation. the units of salinity are dimensionless and the units attribute should normally be given as 1e-3 or 0.001 i.e. parts per thousand.' see https://cfconventions.org/data/cf-standard-names/73/build/cf-standard-name-table.html</p>			



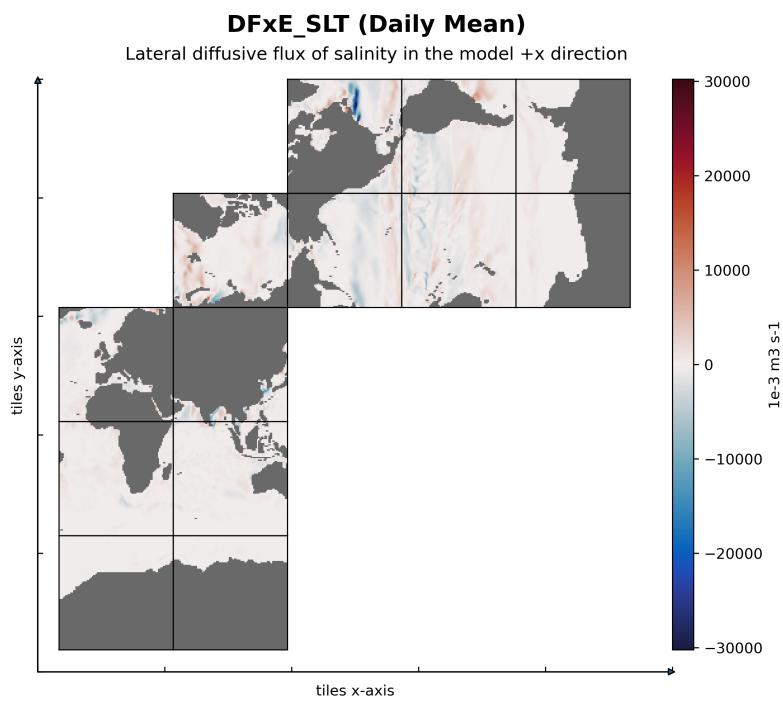
OCEAN_3D_SALINITY_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 37: Dataset: OCEAN_3D_SALINITY_FLUX, Variable: DFrl_SLT

12.4.7 Native Variable: DFxE_SLT

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

Storage Type	Variable Name	Description	Unit
float32	DFxE_SLT	Lateral diffusive flux of salinity in the model +x direction	1e-3 m3 s-1
Description of the variable in Common Data language (CDL)			
<pre>float32 DFxE_SLT(time, k, tile, j, i_g) DFxE_SLT: _FillValue = 9.96921e+36 DFxE_SLT: long_name = Lateral diffusive flux of salinity in the model +x direction DFxE_SLT: units = 1e: 3 m3 s: 1 DFxE_SLT: mate = DFyE_SLT DFxE_SLT: coverage_content_type = modelResult DFxE_SLT: direction = >0 increases salinity (SALT) DFxE_SLT: coordinates = Z time DFxE_SLT: valid_min = : 125908.03125 DFxE_SLT: valid_max = 192716.484375</pre>			
Comments			
<p>Lateral diffusive flux of salinity (salt) in the +x direction through the 'u' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +dfxe_slt(i_g,j,k) corresponds to +x fluxes through the 'u' face of the tracer cell at (i,j,k). also, the model +x direction does not necessarily correspond to the geographical east-west direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles. salinity defined using cf convention 'sea water salinity' is the salt content of sea water, often on the practical salinity scale of 1978. however, the unqualified term 'salinity' is generic and does not necessarily imply any particular method of calculation. the units of salinity are dimensionless and the units attribute should normally be given as 1e-3 or 0.001 i.e. parts per thousand' see https://cfconventions.org/data/cf-standard-names/73/build/cf-standard-name-table.html</p>			



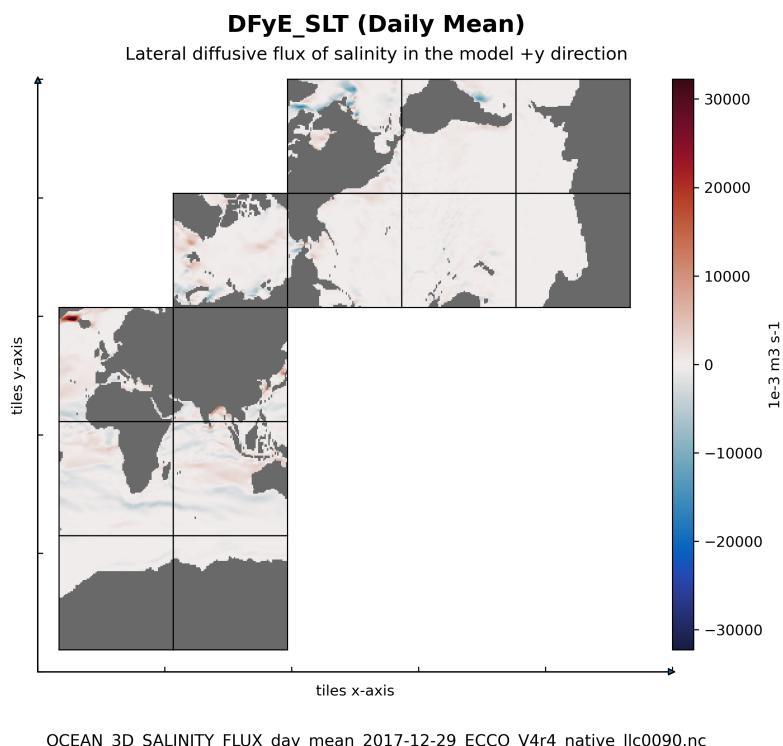
OCEAN_3D_SALINITY_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 38: Dataset: OCEAN_3D_SALINITY_FLUX, Variable: DFxE_SLT

12.4.8 Native Variable: DFyE_SLT

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

Storage Type	Variable Name	Description	Unit
float32	DFyE_SLT	Lateral diffusive flux of salinity in the model +y direction	1e-3 m3 s-1
Description of the variable in Common Data language (CDL)			
<pre>float32 DFyE_SLT(time, k, tile, j_g, i) DFyE_SLT: _FillValue = 9.96921e+36 DFyE_SLT: long_name = Lateral diffusive flux of salinity in the model +y direction DFyE_SLT: units = 1e: 3 m3 s: 1 DFyE_SLT: mate = DFxE_SLT DFyE_SLT: coverage_content_type = modelResult DFyE_SLT: direction = >0 increases salinity (SALT) DFyE_SLT: coordinates = Z time DFyE_SLT: valid_min = : 114959.2109375 DFyE_SLT: valid_max = 154227.140625</pre>			
Comments			
<p>Lateral diffusive flux of salinity (salt) in the +y direction through the 'v' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +dfye_slt(i,j_g,k) corresponds to +y fluxes through the 'V' face of the tracer cell at (i,j,k). also, the model +y direction does not necessarily correspond to the geographical north-south direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles. salinity defined using cf convention 'sea water salinity' is the salt content of sea water, often on the practical salinity scale of 1978. however, the unqualified term 'salinity' is generic and does not necessarily imply any particular method of calculation. the units of salinity are dimensionless and the units attribute should normally be given as 1e-3 or 0.001 i.e. parts per thousand.' see https://cfconventions.org/data/cf-standard-names/73/build/cf-standard-name-table.html</p>			



OCEAN_3D_SALINITY_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 39: Dataset: OCEAN_3D_SALINITY_FLUX, Variable: DFyE_SLT

12.4.9 Native Variable: oceSPtnd

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

Storage Type	Variable Name	Description	Unit
float32	oceSPtnd	Salt tendency due to the vertical transport of salt in high-salinity brine plumes	g m ⁻² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 oceSPtnd(time, k, tile, j, i) oceSPtnd: _FillValue = 9.96921e+36 oceSPtnd: long_name = Salt tendency due to the vertical transport of salt in high: salinity brine plumes oceSPtnd: units = g m: 2 s: 1 oceSPtnd: coverage_content_type = modelResult oceSPtnd: direction = >0 increases salinity (SALT) oceSPtnd: coordinates = XC Z YC time oceSPtnd: valid_min = 0.0 oceSPtnd: valid_max = 0.021119138225913048</pre>			
Comments			
Salt tendency due to the vertical transport of salt in high-salinity brine plumes. note: units are grams of salt per square meter per second, not salinity per square meter per second.			

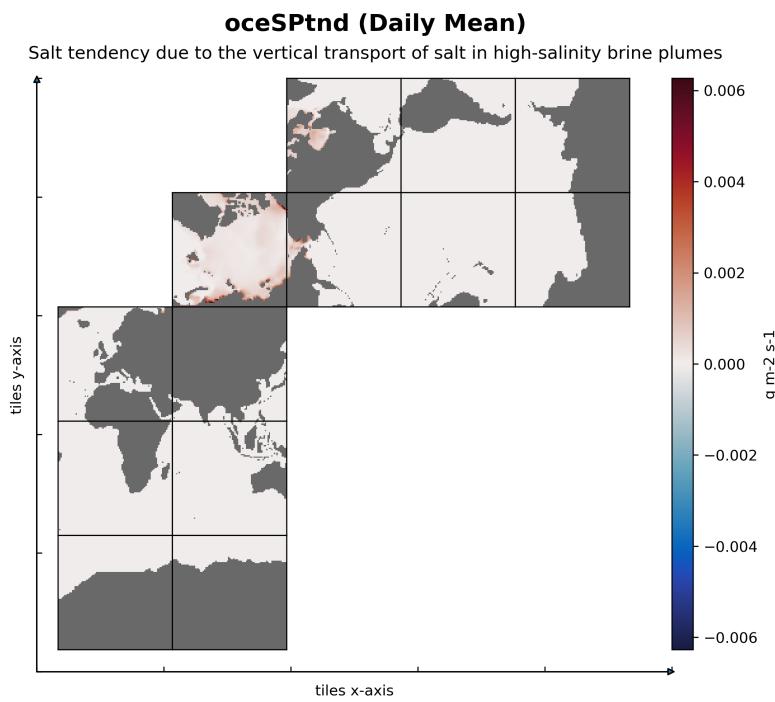


Figure 40: Dataset: OCEAN_3D_SALINITY_FLUX, Variable: oceSPtnd

12.5 Native dataset of OCEAN_3D_TEMPERATURE_FLUX

12.5.1 Overview

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

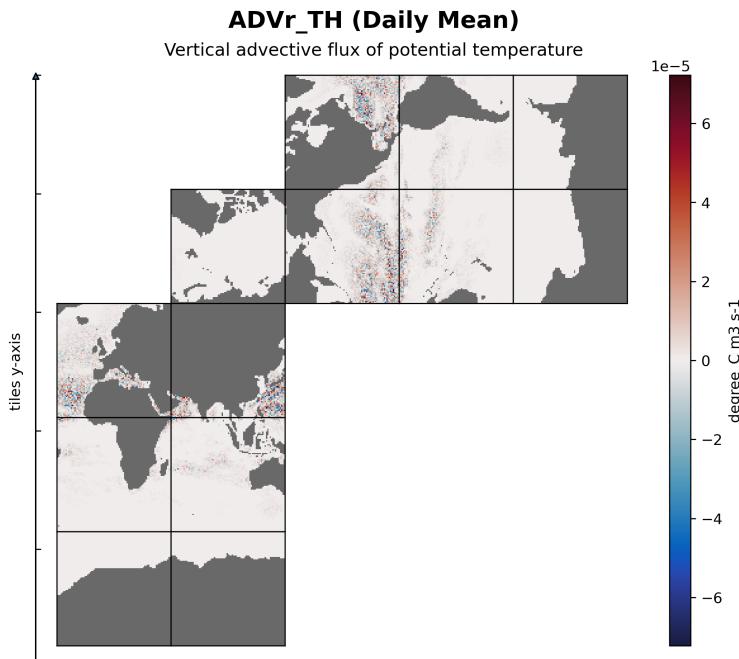
Table 12.24: Coordinates and Variables in the dataset OCEAN_3D_TEMPERATURE_FLUX

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

12.5.2 Native Variable: ADVr_TH

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

Storage Type	Variable Name	Description	Unit
float32	ADVr_TH	Vertical advective flux of potential temperature	degree_C m3 s-1
Description of the variable in Common Data language (CDL)			
<pre>float32 ADVr_TH(time, k_l, tile, j, i) ADVr_TH:_FillValue = 9.96921e+36 ADVr_TH: long_name = Vertical advective flux of potential temperature ADVr_TH: units = degree_C m3 s: 1 ADVr_TH: coverage_content_type = modelResult ADVr_TH: direction = >0 decreases potential temperature (THETA) ADVr_TH: coordinates = XC YC time Zl ADVr_TH: valid_min = : 125094904.0 ADVr_TH: valid_max = 179459344.0</pre>			
Comments			
Vertical advective flux of potential temperature (theta) in the +z direction through the top 'w' face of the tracer cell on the native model grid. note: in the arakawa-c grid, vertical flux quantities are staggered relative to the tracer cells with indexing such that +advr_th(i,j,k_l) corresponds to upward +z fluxes through the top 'w' face of the tracer cell at (i,j,k)			



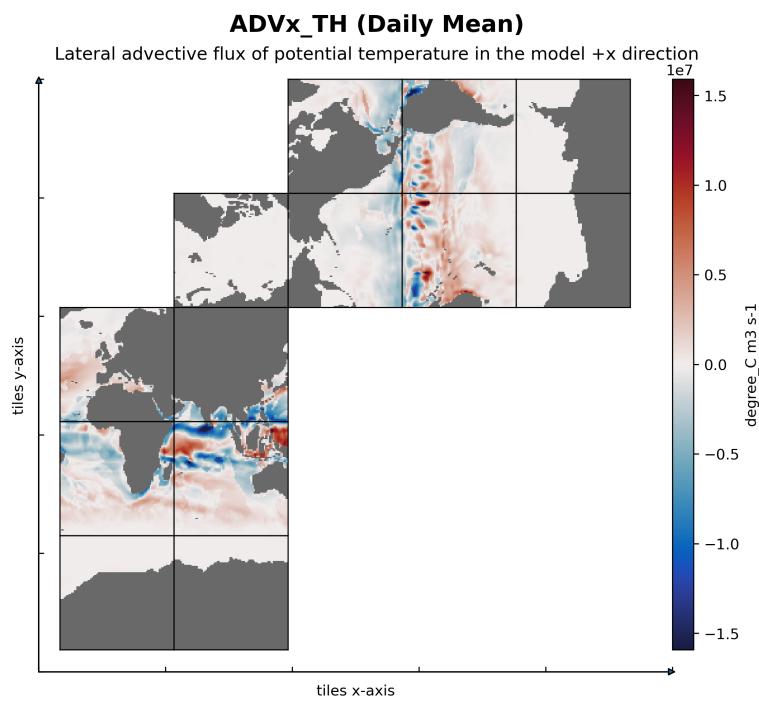
OCEAN_3D_TEMPERATURE_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 41: Dataset: OCEAN_3D_TEMPERATURE_FLUX, Variable: ADVr_TH

12.5.3 Native Variable: ADVx_TH

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

Storage Type	Variable Name	Description	Unit
float32	ADVx_TH	Lateral advective flux of potential temperature in the model +x direction	degree_C m3 s-1
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Lateral advective flux of potential temperature (theta) in the +x direction through the 'u' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +advx_th(i_g,j,k) corresponds to +x fluxes through the 'u' face of the tracer cell at (i,j,k). also, the model +x direction does not necessarily correspond to the geographical east-west direction because the x and y axes of the model's lat-lon-cap (llc) curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.			



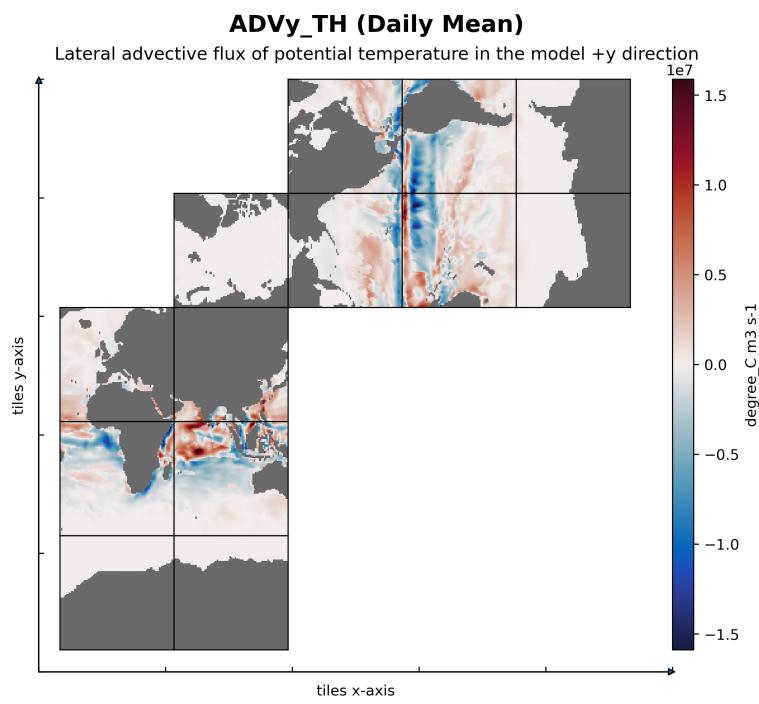
OCEAN_3D_TEMPERATURE_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 42: Dataset: OCEAN_3D_TEMPERATURE_FLUX, Variable: ADVx_TH

12.5.4 Native Variable: ADVy_TH

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

Storage Type	Variable Name	Description	Unit
float32	ADVy_TH	Lateral advective flux of potential temperature in the model +y direction	degree_C m3 s-1
Description of the variable in Common Data language (CDL)			
<pre>float32 ADVy_TH(time, k, tile, j_g, i) ADVy_TH: _FillValue = 9.96921e+36 ADVy_TH: long_name = Lateral advective flux of potential temperature in the model +y direction ADVy_TH: units = degree_C m3 s: 1 ADVy_TH: mate = ADVx_TH ADVy_TH: coverage_content_type = modelResult ADVy_TH: direction = >0 increases potential temperature (THETA) ADVy_TH: coordinates = time Z ADVy_TH: valid_min = : 43909120.0 ADVy_TH: valid_max = 56347884.0</pre>			
Comments			
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.			



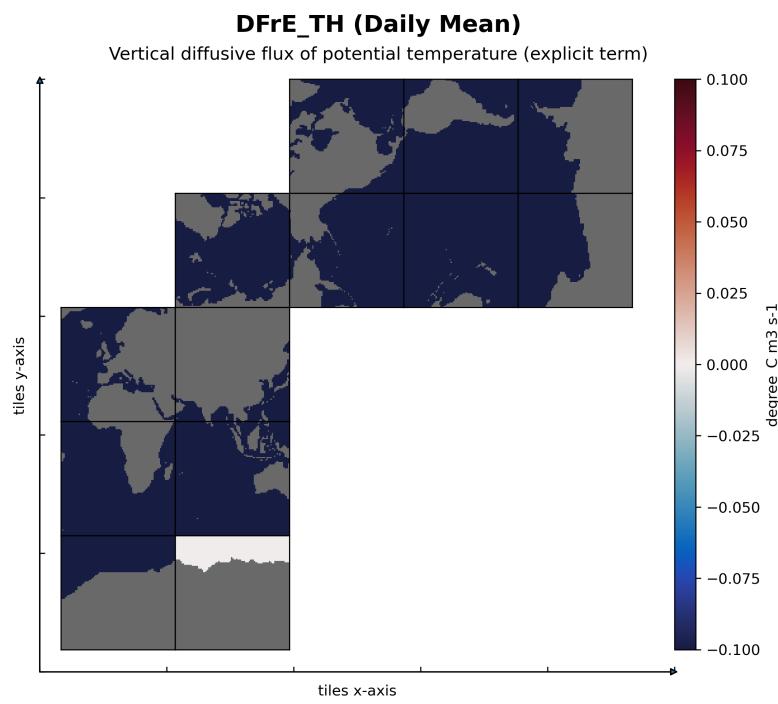
OCEAN_3D_TEMPERATURE_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 43: Dataset: OCEAN_3D_TEMPERATURE_FLUX, Variable: ADV_y_TH

12.5.5 Native Variable: DFrE_TH

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

Storage Type	Variable Name	Description	Unit
float32	DFrE_TH	Vertical diffusive flux of potential temperature (explicit term)	degree_C m3 s-1
Description of the variable in Common Data language (CDL)			
<pre>float32 DFrE_TH(time, k_l, tile, j, i) DFrE_TH: _FillValue = 9.96921e+36 DFrE_TH: long_name = Vertical diffusive flux of potential temperature (explicit term) DFrE_TH: units = degree_C m3 s: 1 DFrE_TH: coverage_content_type = modelResult DFrE_TH: direction = >0 decreases potential temperature (THETA) DFrE_TH: coordinates = XC YC time Zl DFrE_TH: valid_min = : 2632379.75 DFrE_TH: valid_max = 2659875.25</pre>			
Comments			
<p>The explicit term of the vertical diffusive flux of potential temperature (theta) in the +z direction through the top 'w' face of the tracer cell on the native model grid. in the ecco v4r4 model, an implicit scheme is used to calculate vertical diffusive tracer fluxes due to background diffusivity and the kwz component of the gm-redi tensor (vertical flux as a function of vertical gradient) while an explicit scheme is used to calculate the vertical diffusive fluxes from the kwx and kwy components of the gm-redi tensor (vertical flux as a function of horizontal gradient). both implicit and explicit components of vertical diffusive flux of potential temperature are provided. note: in the arakawa-c grid, vertical flux quantities are staggered relative to the tracer cells with indexing such that +dfre_th(i,j,k_l) corresponds to upward +z fluxes through the top 'w' face of the tracer cell at (i,j,k).</p>			



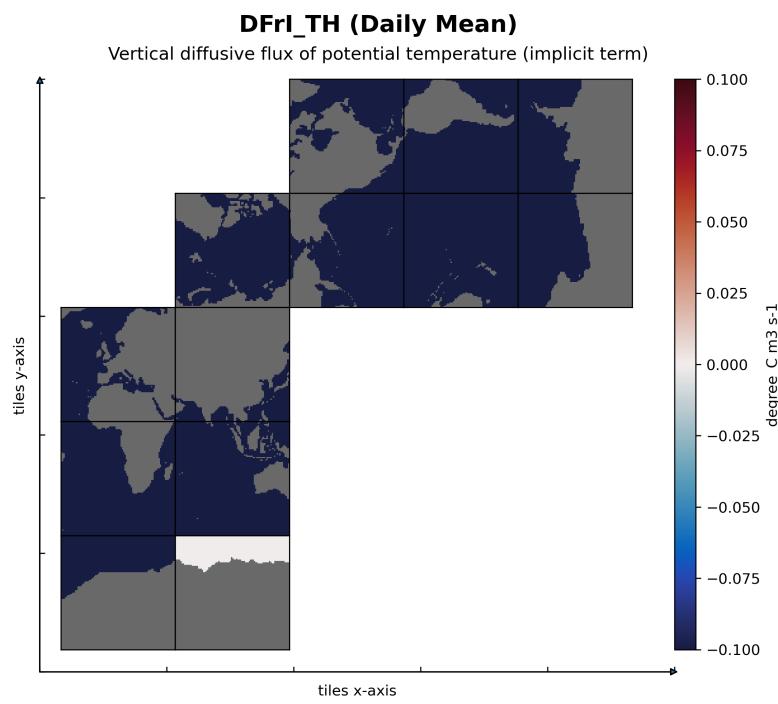
OCEAN_3D_TEMPERATURE_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 44: Dataset: OCEAN_3D_TEMPERATURE_FLUX, Variable: DFrE_TH

12.5.6 Native Variable: DFrl_TH

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

Storage Type	Variable Name	Description	Unit
float32	DFrl_TH	Vertical diffusive flux of potential temperature (implicit term)	degree_C m3 s-1
Description of the variable in Common Data language (CDL)			
<pre>float32 DFrl_TH(time, k_l, tile, j, i) DFrl_TH: _FillValue = 9.96921e+36 DFrl_TH: long_name = Vertical diffusive flux of potential temperature (implicit term) DFrl_TH: units = degree_C m3 s: 1 DFrl_TH: coverage_content_type = modelResult DFrl_TH: direction = >0 decreases potential temperature (THETA) DFrl_TH: coordinates = XC YC time Zl DFrl_TH: valid_min = : 104210688.0 DFrl_TH: valid_max = 23574302.0</pre>			
Comments			
<p>The implicit term of the vertical diffusive flux of potential temperature (theta) in the +z direction through the top 'w' face of the tracer cell on the native model grid. in the ecco v4r4 model, an implicit scheme is used to calculate vertical diffusive tracer fluxes due to background diffusivity and the kwz component of the gm-redi tensor (vertical flux as a function of vertical gradient) while an explicit scheme is used to calculate the vertical diffusive fluxes from the kwx and kwy components of the gm-redi tensor (vertical flux as a function of horizontal gradient). both implicit and explicit components of vertical diffusive flux of potential temperature are provided. note: in the arakawa-c grid, vertical flux quantities are staggered relative to the tracer cells with indexing such that +dfri_th(i,j,k_l) corresponds to upward +z fluxes through the top 'w' face of the tracer cell at (i,j,k)</p>			



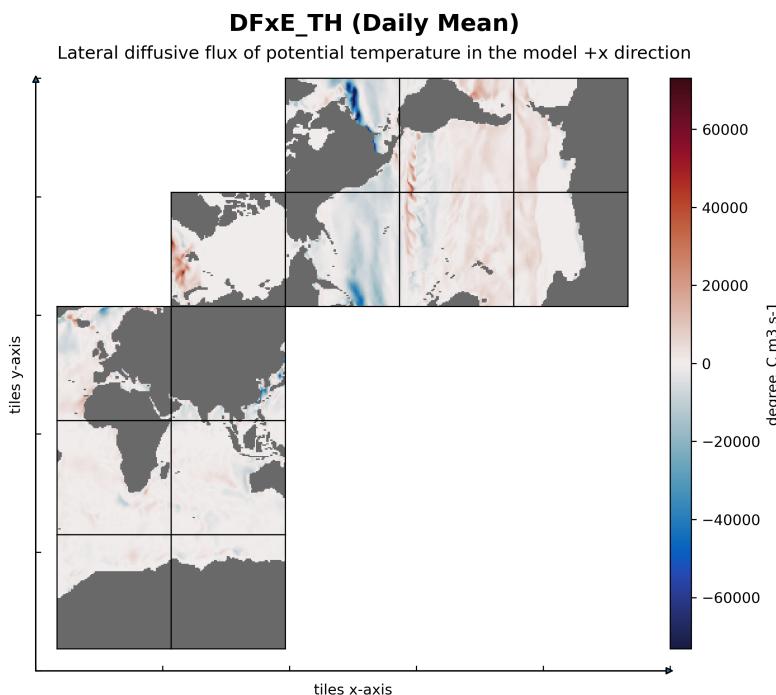
OCEAN_3D_TEMPERATURE_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 45: Dataset: OCEAN_3D_TEMPERATURE_FLUX, Variable: DFrl_TH

12.5.7 Native Variable: DFxE_TH

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

Storage Type	Variable Name	Description	Unit
float32	DFxE_TH	Lateral diffusive flux of potential temperature in the model +x direction	degree_C m3 s-1
Description of the variable in Common Data language (CDL)			
<pre>float32 DFxE_TH(time, k, tile, j, i_g) DFxE_TH:_FillValue = 9.96921e+36 DFxE_TH: long_name = Lateral diffusive flux of potential temperature in the model +x direction DFxE_TH: units = degree_C m3 s: 1 DFxE_TH: mate = DFyE_TH DFxE_TH: coverage_content_type = modelResult DFxE_TH: direction = >0 increases potential temperature (THETA) DFxE_TH: coordinates = time Z DFxE_TH: valid_min = : 582494.125 DFxE_TH: valid_max = 698695.75</pre>			
Comments			
Lateral diffusive flux of potential temperature (theta) in the +x direction through the 'u' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +dfxe_th(i_g,j,k) corresponds to +x fluxes through the 'u' face of the tracer cell at (i,j,k). also, the model +x direction does not necessarily correspond to the geographical east-west direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.			



OCEAN_3D_TEMPERATURE_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 46: Dataset: OCEAN_3D_TEMPERATURE_FLUX, Variable: DFxE_TH

12.5.8 Native Variable: DFyE_TH

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

Storage Type	Variable Name	Description	Unit
float32	DFyE_TH	Lateral diffusive flux of potential temperature in the model +y direction.	degree_C m3 s-1
Description of the variable in Common Data language (CDL)			
<pre>float32 DFyE_TH(time, k, tile, j_g, i) DFyE_TH: _FillValue = 9.96921e+36 DFyE_TH: long_name = Lateral diffusive flux of potential temperature in the model +y direction. DFyE_TH: units = degree_C m3 s: 1 DFyE_TH: mate = DFxE_TH DFyE_TH: coverage_content_type = modelResult DFyE_TH: direction = >0 increases potential temperature (THETA) DFyE_TH: coordinates = time Z DFyE_TH: valid_min = : 421044.78125 DFyE_TH: valid_max = 1053781.25</pre>			
Comments			
Lateral diffusive flux of potential temperature (theta) in the +y direction through the 'v' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +dfye_th(i,j_g,k) corresponds to +y fluxes through the 'v' face of the tracer cell at (i,j,k). also, the model +y direction does not necessarily correspond to the geographical north-south direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.			

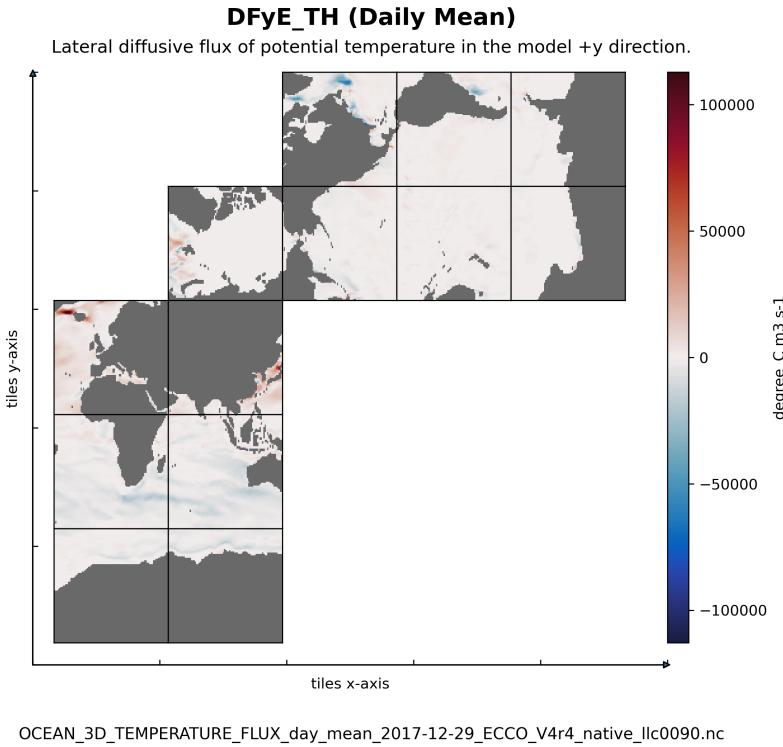


Figure 47: Dataset: OCEAN_3D_TEMPERATURE_FLUX, Variable: DFyE_TH

12.6 Native dataset of OCEAN_3D_VOLUME_FLUX

12.6.1 Overview

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

Table 12.32: Coordinates and Variables in the dataset OCEAN_3D_VOLUME_FLUX

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

Table 12.32: Coordinates and Variables in the dataset OCEAN_3D_VOLUME_FLUX

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

12.6.2 Native Variable: UVELMASS

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

Storage Type	Variable Name	Description	Unit
float32	UVELMASS	Horizontal velocity in the model +x direction per unit area of the grid cell 'u' face	m s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
<p>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</p>			

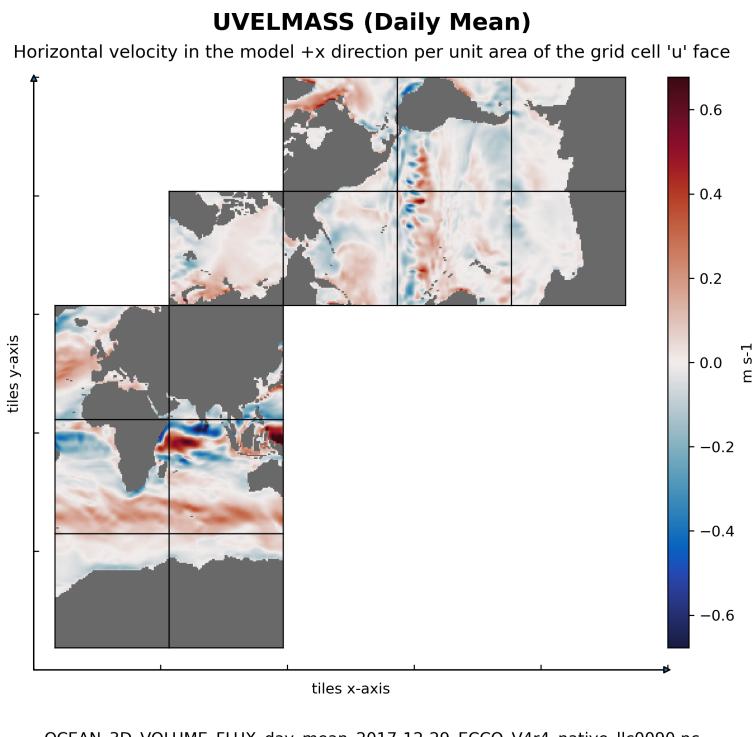
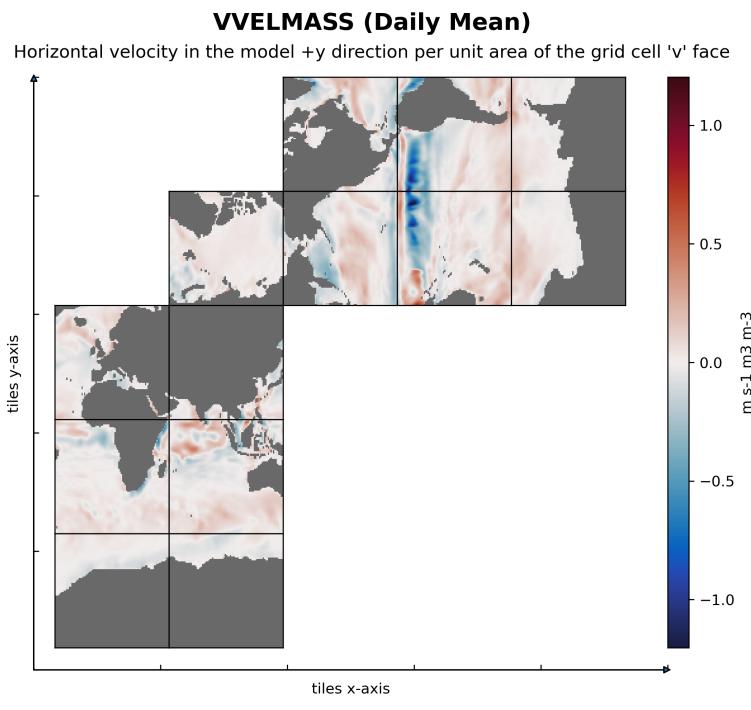


Figure 48: Dataset: OCEAN_3D_VOLUME_FLUX, Variable: UVELMASS

12.6.3 Native Variable: VVELMASS

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

Storage Type	Variable Name	Description	Unit
float32	VVELMASS	Horizontal velocity in the model +y direction per unit area of the grid cell 'v' face	m s-1 m3 m-3
Description of the variable in Common Data language (CDL)			
<pre>float32 VVELMASS(time, k, tile, j_g, i) VVELMASS: _FillValue = 9.96921e+36 VVELMASS: long_name = "Horizontal velocity in the model +y direction per unit area of the grid cell v face" VVELMASS: units = m s: 1 m3 m: 3 VVELMASS: mate = UVELMASS VVELMASS: coverage_content_type = modelResult VVELMASS: direction = >0 increases volume VVELMASS: coordinates = Z time VVELMASS: valid_min = : 1.7897182703018188 VVELMASS: valid_max = 1.9216758012771606</pre>			
Comments			
<p>Horizontal velocity in the model +y direction averaged over the area of the tracer grid cell 'v' face on the native model grid ('v' grid cell face area = drf dxg). accounts for partial cells (hfacs < 1) and for time-varying grid cell thickness (z* coordinate system). volume flux in +y = vvelmass drf dxg. note: in the arakawa-c grid, horizontal velocities are staggered relative to the tracer cells with indexing such that +vvelmass(i,j,k) corresponds to +y fluxes through the 'v' face of the tracer cell at (i,j,k). vvelmass can be used for volume flux calculations because it accounts for grid cell thicknesses variations in the +y direction (hfacs) with time (z* coordinate system). also, the model +y direction does not necessarily correspond to the geographical north-south direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles. see uvelmass and wvelmass.</p>			



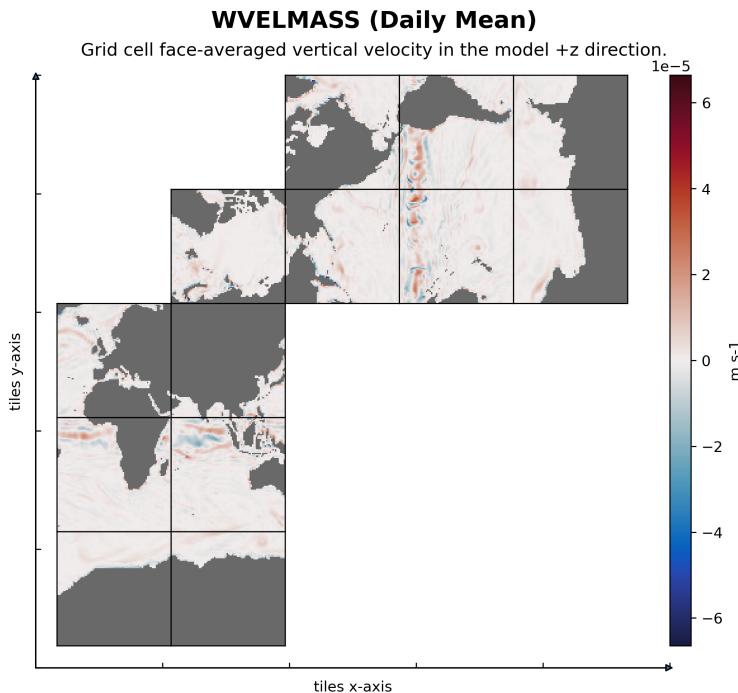
OCEAN_3D_VOLUME_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 49: Dataset: OCEAN_3D_VOLUME_FLUX, Variable: VVELMASS

12.6.4 Native Variable: WVELMASS

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

Storage Type	Variable Name	Description	Unit
float32	WVELMASS	Grid cell face-averaged vertical velocity in the model +z direction.	m s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 WVELMASS(time, k_l, tile, j, i) WVELMASS: _FillValue = 9.96921e+36 WVELMASS: long_name = Grid cell face: averaged vertical velocity in the model +z direction. WVELMASS: units = m s: 1 WVELMASS: coverage_content_type = modelResult WVELMASS: direction = >0 decreases volume WVELMASS: standard_name = upward_sea_water_velocity WVELMASS: coordinates = YC Z1 time XC WVELMASS: valid_min = : 0.0023150660563260317 WVELMASS: valid_max = 0.0016380994347855449</pre>			
Comments			
Vertical velocity in the +z direction at the top 'w' face of the tracer cell on the native model grid. volume flux in +z = wvelmass dra. note: in the arakawa-c grid, vertical velocities are staggered relative to the tracer cells with indexing such that +wvelmass(i,j,k) corresponds to upward +z motion through the top 'w' face of the tracer cell at (i,j,k). unlike uvelmass and vvelmass, wvelmass is not scaled by a time-varying open water fraction because the open water fraction of the 'w' face is always 1, thus wvelmass is identical to wvel.			



OCEAN_3D_VOLUME_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 50: Dataset: OCEAN_3D_VOLUME_FLUX, Variable: WVELMASS

12.7 Native dataset of OCEAN_AND_ICE_SURFACE_FW_FLUX

12.7.1 Overview

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

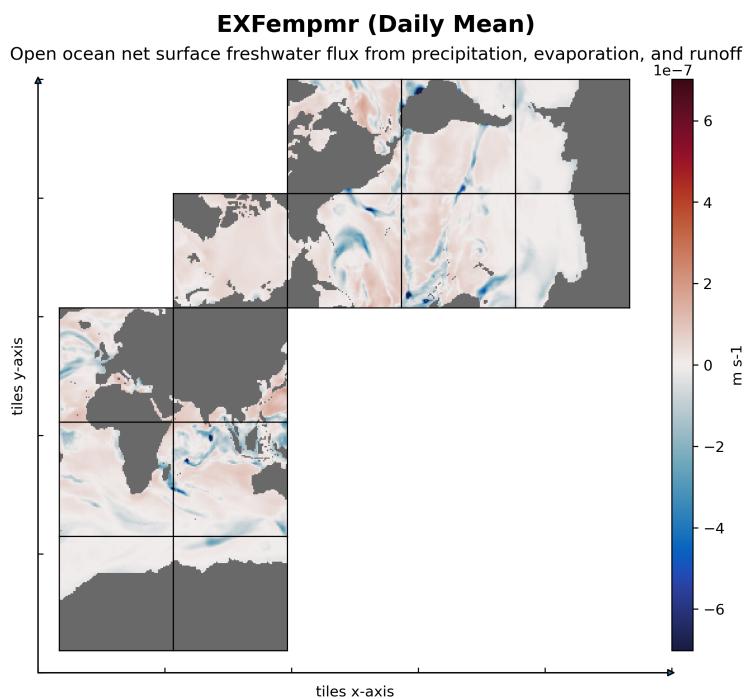
Table 12.36: Coordinates and Variables in the dataset OCEAN_AND_ICE_SURFACE_FW_FLUX

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

12.7.2 Native Variable: EXFempmr

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

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



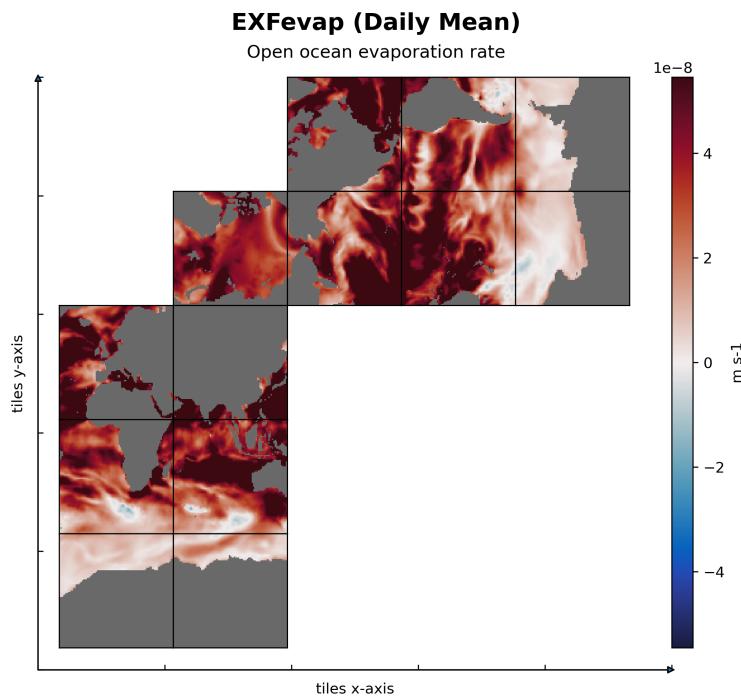
OCEAN_AND_ICE_SURFACE_FW_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 51: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFempmr

12.7.3 Native Variable: EXFevap

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

Storage Type	Variable Name	Description	Unit
float32	EXFevap	Open ocean evaporation rate	m s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Evaporation rate per unit area of open water (not covered by sea-ice). note: calculated using the bulk formula following large and yeager (2004) ncarr/tn-460+str.			



OCEAN_AND_ICE_SURFACE_FW_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 52: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFevap

12.7.4 Native Variable: EXFpreci

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

Storage Type	Variable Name	Description	Unit
float32	EXFpreci	Precipitation rate	m s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Precipitation rate. note: sum of era-interim precipitation and the control adjustment from ocean state estimation.			

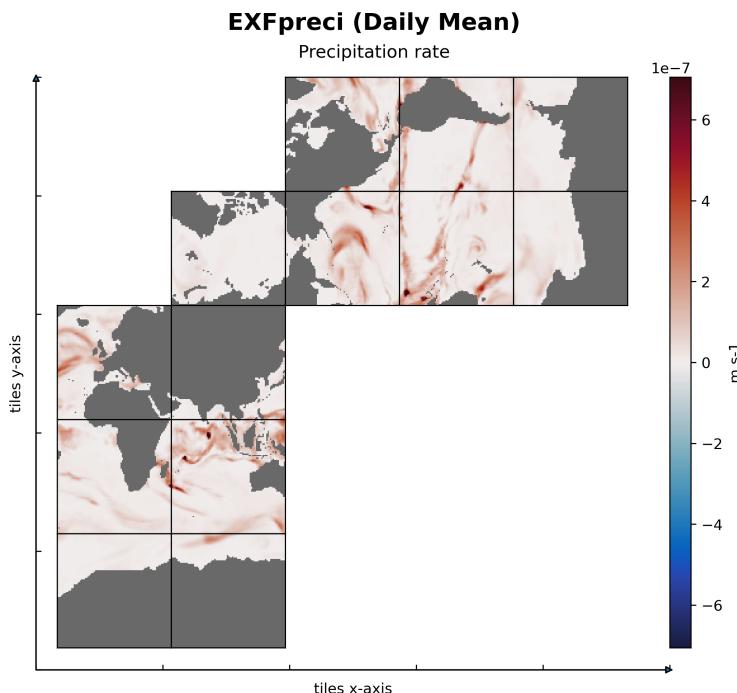
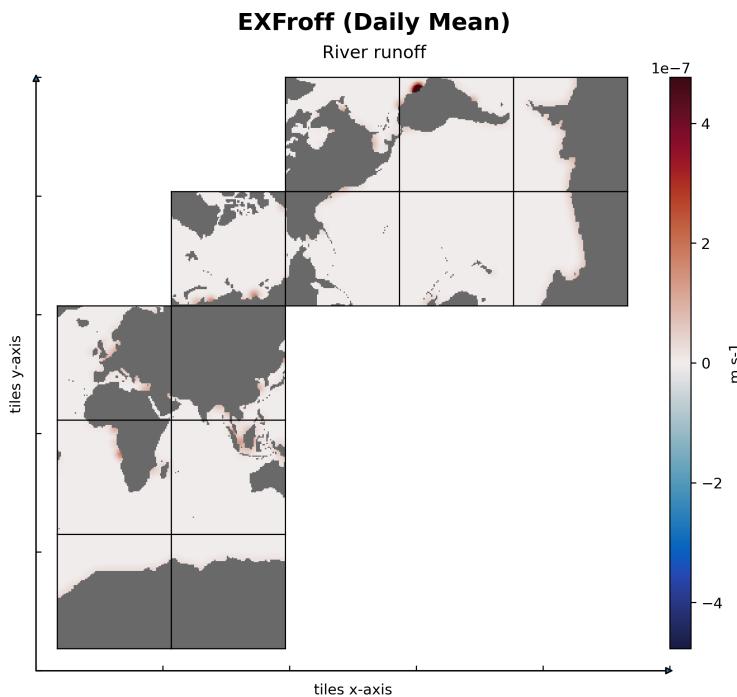


Figure 53: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFpreci

12.7.5 Native Variable: EXFroff

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

Storage Type	Variable Name	Description	Unit
float32	EXFroff	River runoff	m s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
River runoff freshwater flux. note: not adjusted by the optimization.			



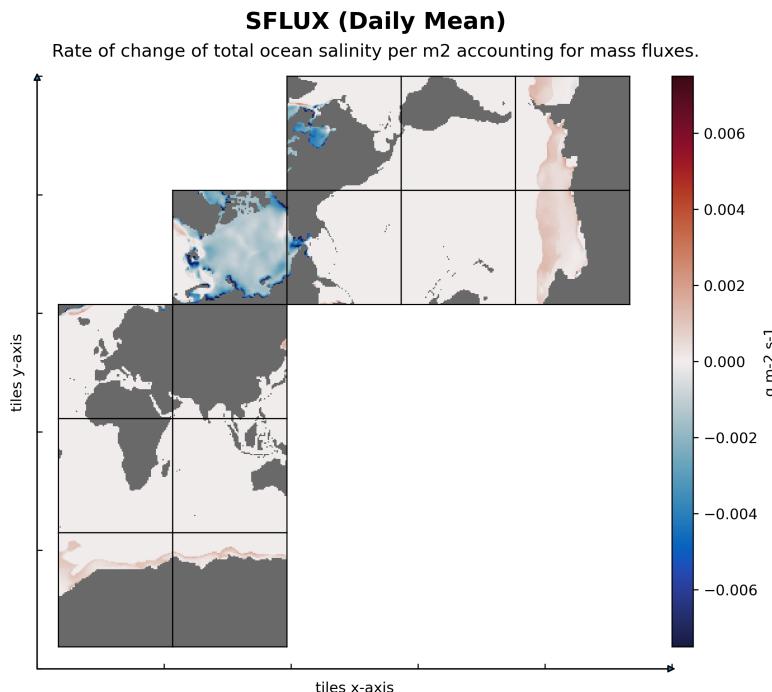
OCEAN_AND_ICE_SURFACE_FW_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 54: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFroff

12.7.6 Native Variable: SFLUX

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

Storage Type	Variable Name	Description	Unit
float32	SFLUX	Rate of change of total ocean salinity per m2 accounting for mass fluxes.	g m ⁻² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
The rate of change of total ocean salinity due to freshwater fluxes across the liquid surface and the addition or removal of mass. note: the global area integral of sflux matches the time-derivative of total ocean salinity (psu s ⁻¹). unlike ocefwflx, sflux includes the contribution to the total ocean salinity from changing ocean mass (e.g. from the addition or removal of freshwater in ocefwflx).			



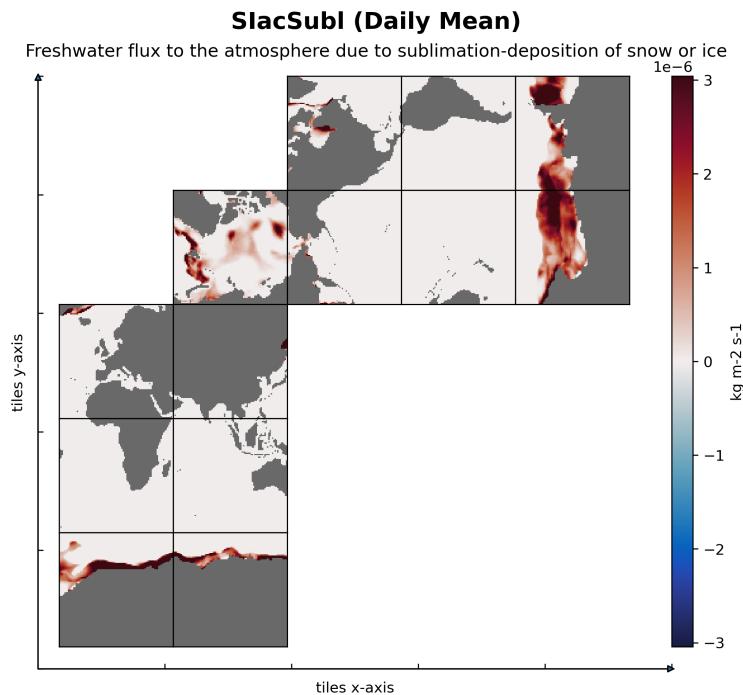
OCEAN_AND_ICE_SURFACE_FW_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 55: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SFLUX

12.7.7 Native Variable: SlacSubl

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

Storage Type	Variable Name	Description	Unit
float32	SlacSubl	Freshwater flux to the atmosphere due to sublimation-deposition of snow or ice	kg m ⁻² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 SIacSubl(time, tile, j, i) SIacSubl:_FillValue = 9.96921e+36 SIacSubl:long_name = Freshwater flux to the atmosphere due to sublimation: deposition of snow or ice SIacSubl:units = kg m: 2 s: 1 SIacSubl:coverage_content_type = modelResult SIacSubl:direction = >0 decreases snow or sea: ice thickness (HSNOW or HEFF) SIacSubl:standard_name = water_sublimation_flux SIacSubl:coordinates = YC XC time SIacSubl:valid_min = 0.0 SIacSubl:valid_max = 8.154580427799374e: 05</pre>			
Comments			
Freshwater flux to the atmosphere due to sublimation-deposition of snow or ice. positive values imply sublimation from ice/snow to vapor, negative values imply deposition from atmospheric moisture			



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: SlacSubl

12.7.8 Native Variable: SlatmFW

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

Storage Type	Variable Name	Description	Unit
float32	SlatmFW	Net freshwater flux into the open ocean, sea-ice, and snow	kg m ⁻² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 SIatmFW(time, tile, j, i) SIatmFW: _FillValue = 9.96921e+36 SIatmFW: long_name = Net freshwater flux into the open ocean sea: ice and snow SIatmFW: units = kg m: 2 s: 1 SIatmFW: coverage_content_type = modelResult SIatmFW: direction = >0 decreases salinity (SALT) SIatmFW: standard_name = surface_downward_water_flux SIatmFW: coordinates = YC XC time SIatmFW: valid_min = : 0.00043017856660299003 SIatmFW: valid_max = 0.008299433626234531</pre>			
Comments			
Net freshwater flux into the combined liquid ocean, sea-ice, and snow reservoirs from the atmosphere and runoff. note: freshwater fluxes between the liquid ocean and sea-ice or snow reservoirs do not contribute to siatmfw. siatmfw counts all fluxes to/from the atmosphere that change the total freshwater stored in the combined liquid ocean, sea-ice, and snow reservoirs.			

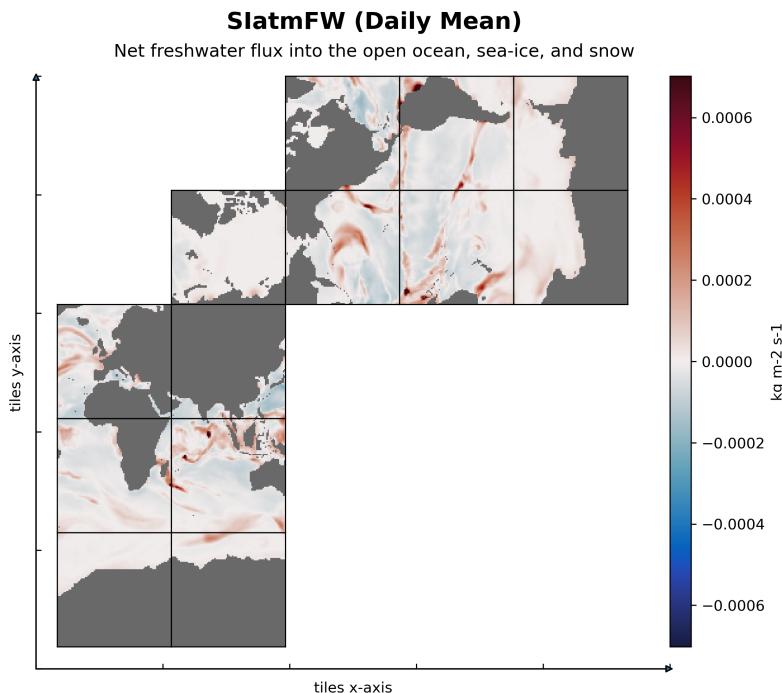
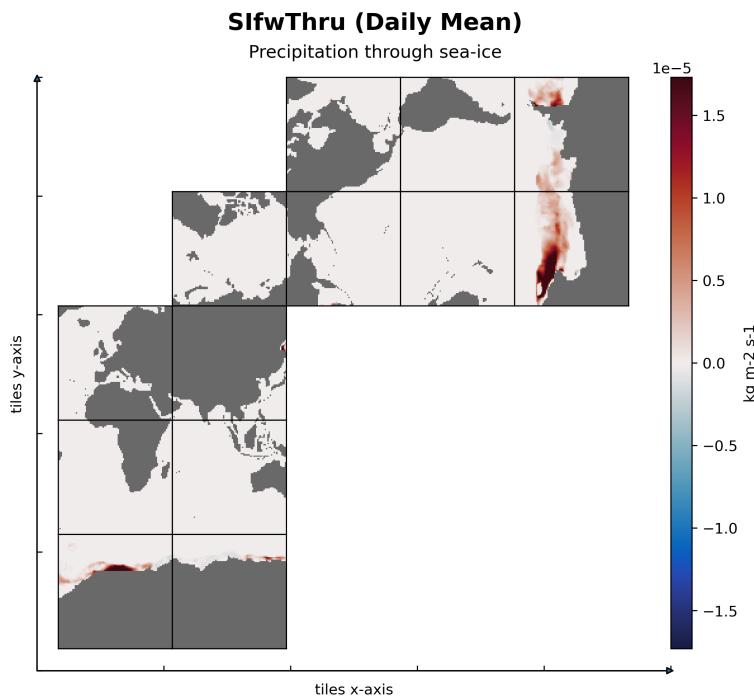


Figure 57: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SlatmFW

12.7.9 Native Variable: SIfwThru

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

Storage Type	Variable Name	Description	Unit
float32	SIfwThru	Precipitation through sea-ice	kg m ⁻² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Precipitation over sea-ice covered regions reaching ocean through sea-ice. note: precipitation over sea-ice covered regions that directly reaches ocean through the sea-ice. it is not due to melt of sea-ice/snow.			



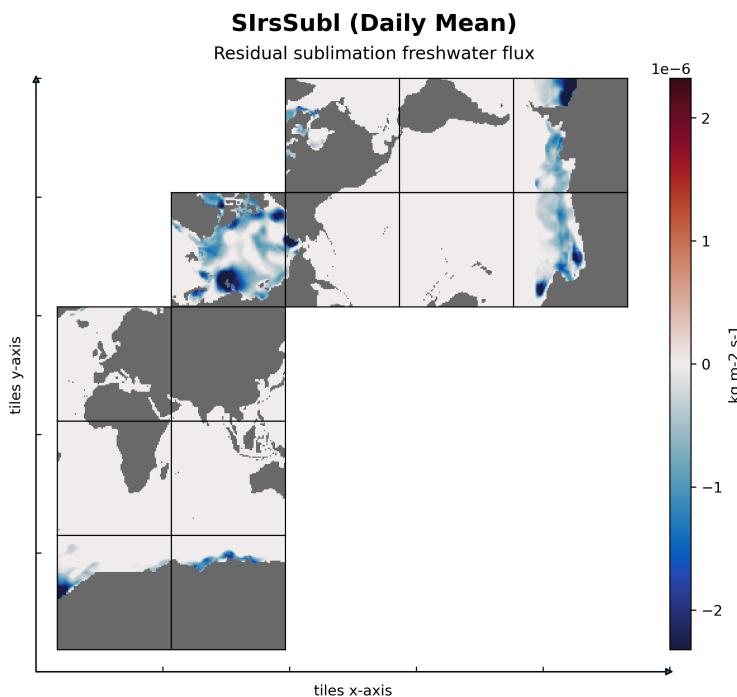
OCEAN_AND_ICE_SURFACE_FW_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 58: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SIfwThru

12.7.10 Native Variable: SIrsSubl

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

Storage Type	Variable Name	Description	Unit
float32	SIrsSubl	Residual sublimation freshwater flux	kg m ⁻² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 SIrsSubl(time, tile, j, i) SIrsSubl:_FillValue = 9.96921e+36 SIrsSubl:long_name = Residual sublimation freshwater flux SIrsSubl:units = kg m: 2 s: 1 SIrsSubl:coverage_content_type = modelResult SIrsSubl:direction = >0 decreases ocean volume SIrsSubl:coordinates = YC XC time SIrsSubl:valid_min = : 0.0001067528864950873 SIrsSubl:valid_max = 8.640533451398369e: 06</pre>			
Comments			
Residual freshwater flux by sublimation to remove water from or add water to ocean. when implied sublimation freshwater flux siacsabl is larger than available sea-ice/snow, sirssubl is positive and water is removed from ocean. note: freshwater flux by sublimation that is to remove water from the ocean when it is positive.			



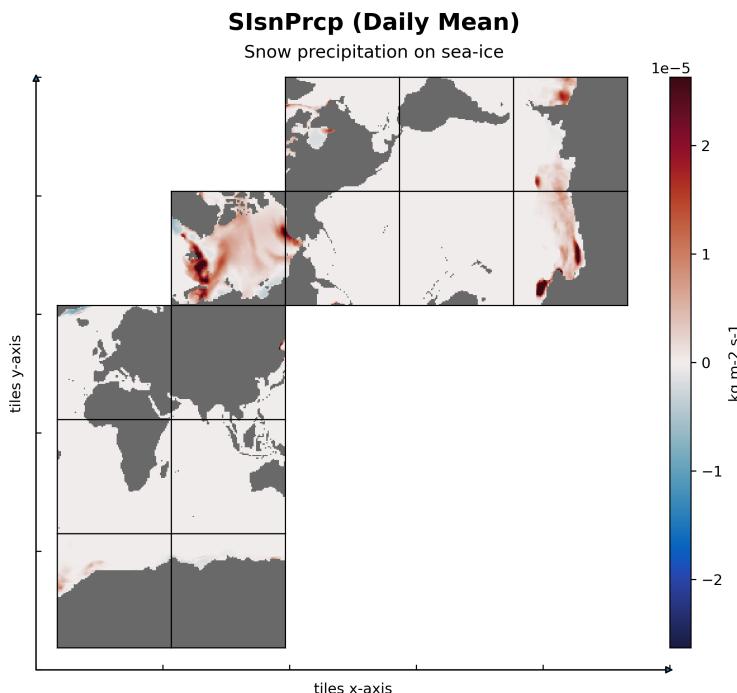
OCEAN_AND_ICE_SURFACE_FW_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 59: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SIrsSubl

12.7.11 Native Variable: SIsnPrcp

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

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



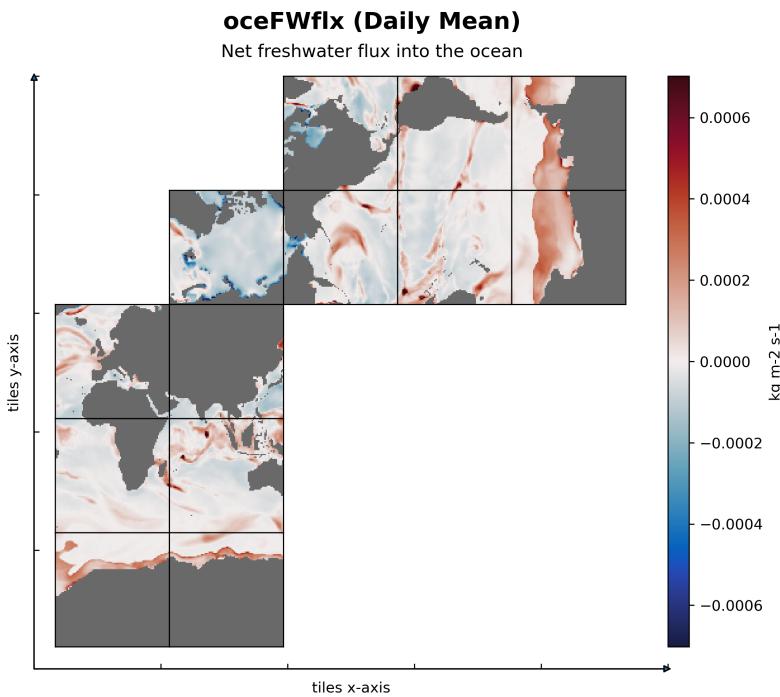
OCEAN_AND_ICE_SURFACE_FW_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 60: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SIsnPrcp

12.7.12 Native Variable: oceFWflx

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

Storage Type	Variable Name	Description	Unit
float32	oceFWflx	Net freshwater flux into the ocean	kg m ⁻² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 oceFWflx(time, tile, j, i) oceFWflx:_FillValue = 9.96921e+36 oceFWflx:long_name = Net freshwater flux into the ocean oceFWflx:units = kg m: 2 s: 1 oceFWflx:coverage_content_type = modelResult oceFWflx:direction = >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</pre>			
Comments			
Net freshwater flux into the ocean including contributions from runoff, evaporation, precipitation, and mass exchange with sea-ice due to melting and freezing and snow melting. note: ocefwmflux does not include freshwater fluxes between the atmosphere and sea-ice and snow. the variable 'siatmfw' accounts for freshwater fluxes out of the combined ocean+sea-ice+snow reservoir.			



OCEAN_AND_ICE_SURFACE_FW_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 61: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: oceFWflx

12.8 Native dataset of OCEAN_AND_ICE_SURFACE_HEAT_FLUX

12.8.1 Overview

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

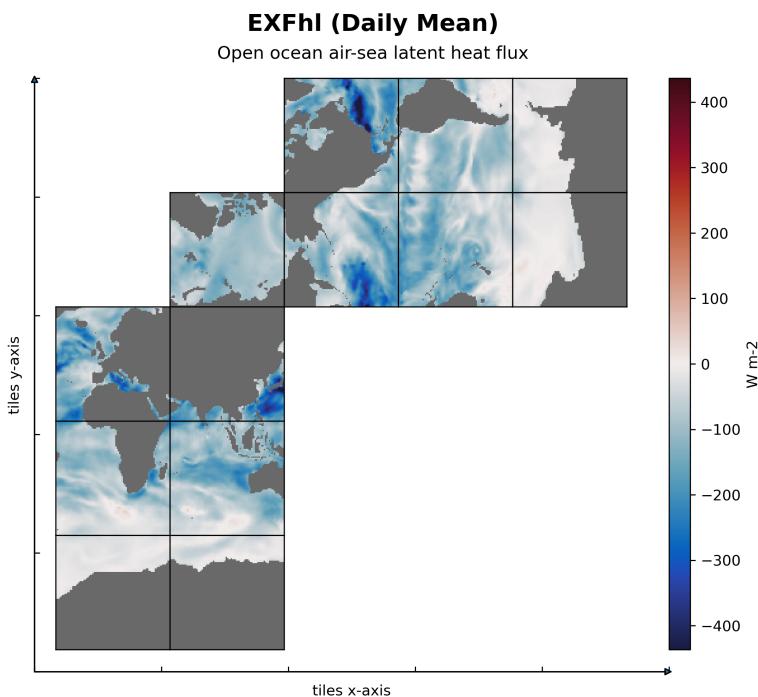
Table 12.48: Coordinates and Variables in the dataset OCEAN_AND_ICE_SURFACE_HEAT_FLUX

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

12.8.2 Native Variable: EXFhl

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

Storage Type	Variable Name	Description	Unit
float32	EXFhl	Open ocean air-sea latent heat flux	W m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>float32 EXFhl(time, tile, j, i) EXFhl: _FillValue = 9.96921e+36 EXFhl: long_name = Open ocean air: sea latent heat flux EXFhl: units = W m: 2 EXFhl: coverage_content_type = modelResult EXFhl: direction = >0 increases potential temperature (THETA) EXFhl: standard_name = surface_downward_latent_heat_flux EXFhl: coordinates = XC time YC EXFhl: valid_min = : 1772.513671875 EXFhl: valid_max = 273.9528503417969</pre>			
Comments			
Air-sea latent heat flux per unit area of open water (not covered by sea-ice). note: calculated from the bulk formula following large and yeager (2004) ncar/tn-460+str.			



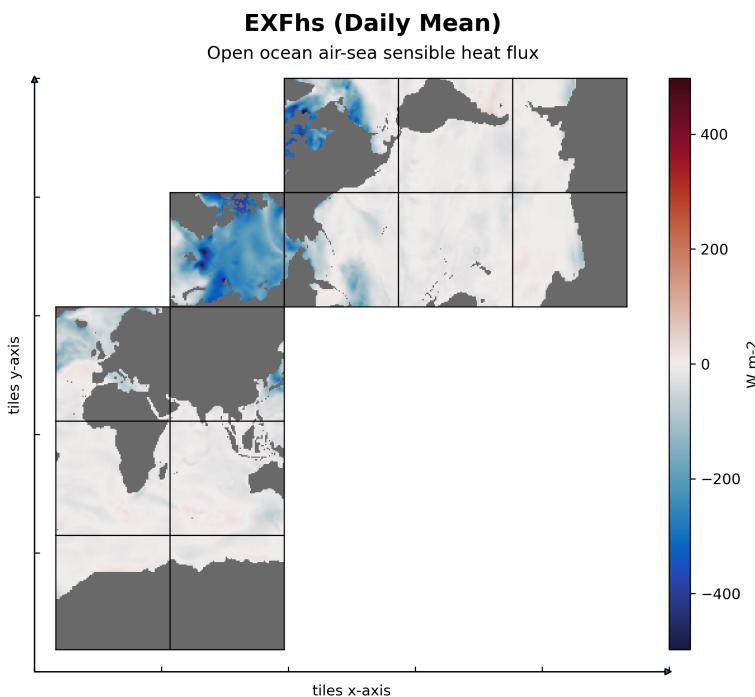
OCEAN_AND_ICE_SURFACE_HEAT_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 62: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFhl

12.8.3 Native Variable: EXFhs

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

Storage Type	Variable Name	Description	Unit
float32	EXFhs	Open ocean air-sea sensible heat flux	W m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Air-sea sensible heat flux per unit area of open water (not covered by sea-ice). note: calculated from the bulk formula following large and yeager (2004) ncar/tn-460+str.			



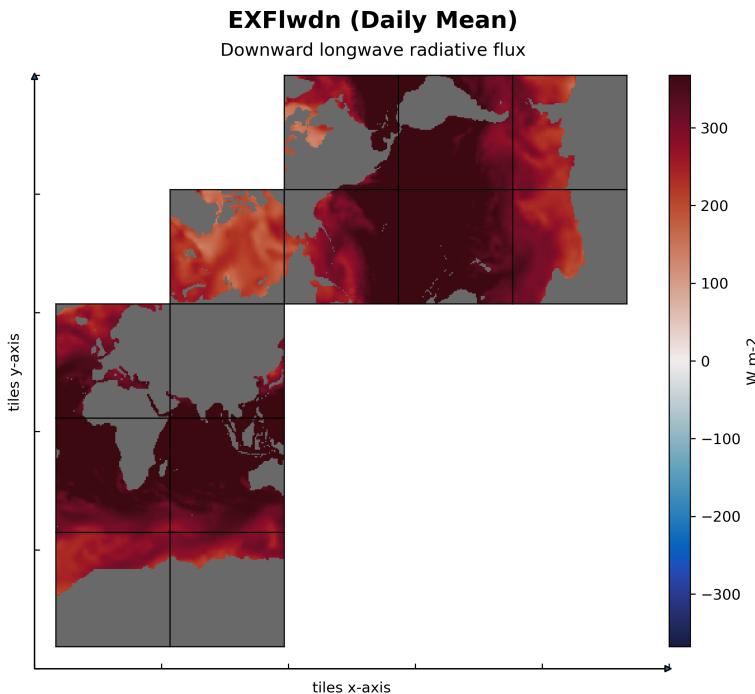
OCEAN_AND_ICE_SURFACE_HEAT_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 63: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFhs

12.8.4 Native Variable: EXFlwdn

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

Storage Type	Variable Name	Description	Unit
float32	EXFlwdn	Downward longwave radiative flux	W m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>float32 EXFlwdn(time, tile, j, i) EXFlwdn: _FillValue = 9.96921e+36 EXFlwdn: long_name = Downward longwave radiative flux EXFlwdn: units = W m: 2 EXFlwdn: coverage_content_type = modelResult EXFlwdn: direction = >0 increases potential temperature (THETA) EXFlwdn: standard_name = surface_downwelling_longwave_flux_in_air EXFlwdn: coordinates = XC time YC EXFlwdn: valid_min = 4.188045501708984 EXFlwdn: valid_max = 513.3919067382812</pre>			
Comments			
Downward longwave radiative flux. note: sum of era-interim downward longwave radiation and the control adjustment from ocean state estimation.			



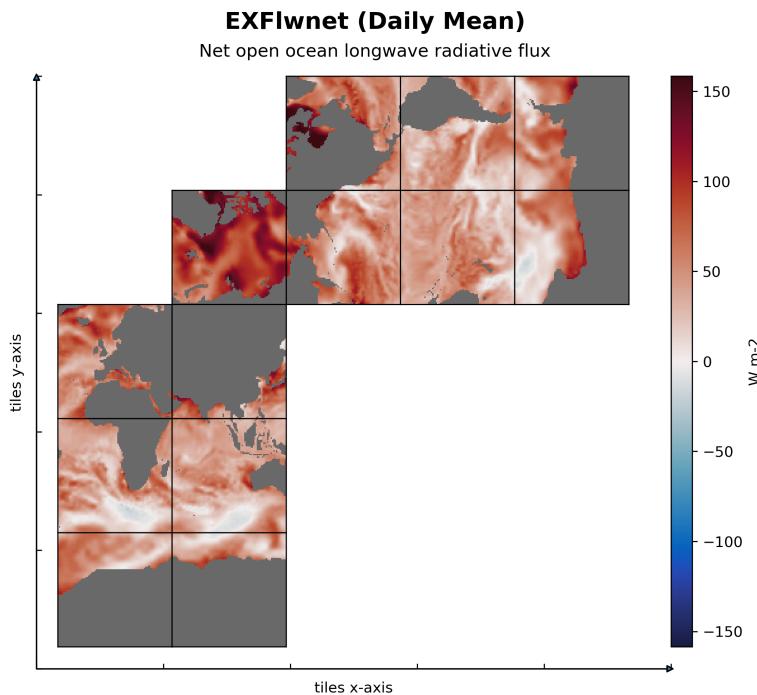
OCEAN_AND_ICE_SURFACE_HEAT_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 64: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFlwdn

12.8.5 Native Variable: EXFlwnet

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

Storage Type	Variable Name	Description	Unit
float32	EXFlwnet	Net open ocean longwave radiative flux	W m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Net longwave radiative flux per unit area of open water (not covered by sea-ice). note: net longwave radiation over open water calculated from downward longwave radiation (exflwdn) and upward longwave radiation from ocean and sea-ice thermal emission (stefan-boltzman law).			



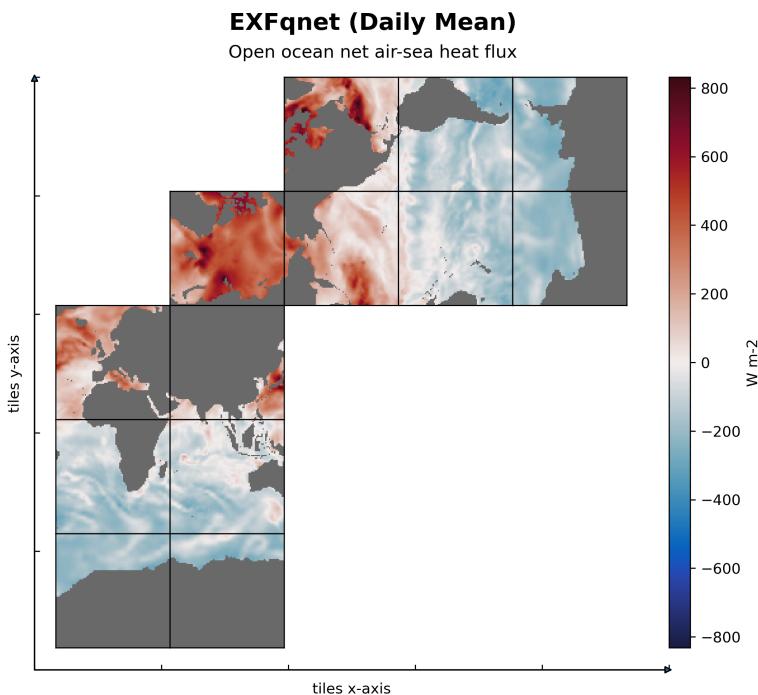
OCEAN_AND_ICE_SURFACE_HEAT_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 65: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFlwnet

12.8.6 Native Variable: EXFqnet

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

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



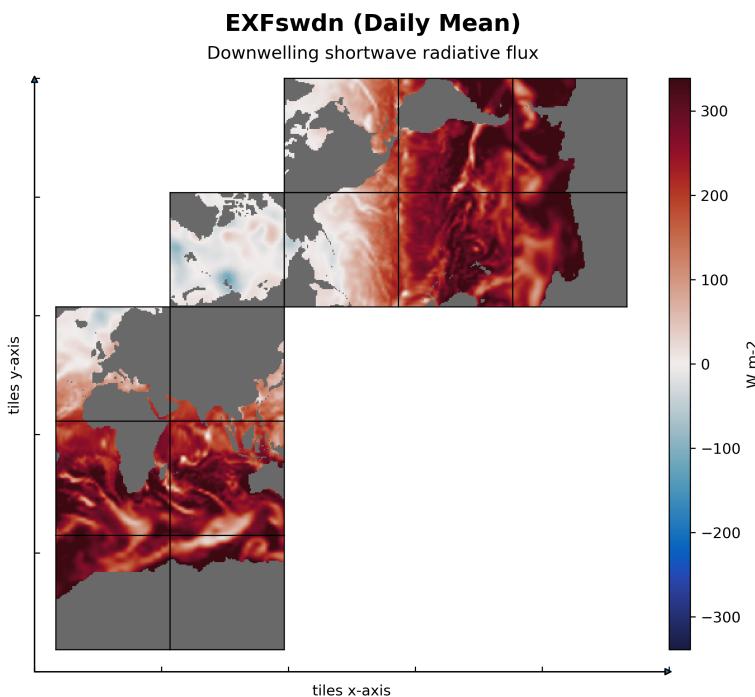
OCEAN_AND_ICE_SURFACE_HEAT_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 66: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFqnet

12.8.7 Native Variable: EXFswdn

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

Storage Type	Variable Name	Description	Unit
float32	EXFswdn	Downwelling shortwave radiative flux	W m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Downward shortwave radiative flux. note: sum of era-interim downward shortwave radiation and the control adjustment from ocean state estimation.			



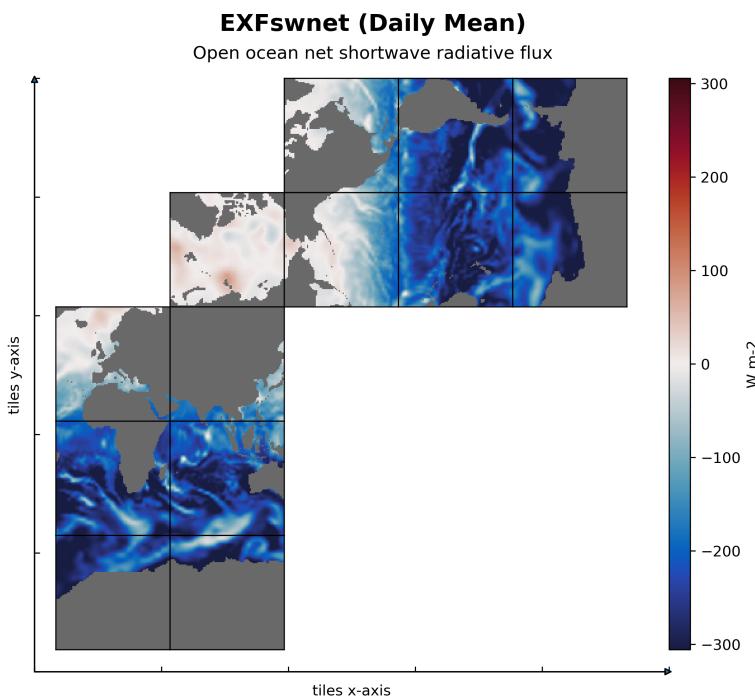
OCEAN_AND_ICE_SURFACE_HEAT_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 67: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFswdn

12.8.8 Native Variable: EXFswnet

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

Storage Type	Variable Name	Description	Unit
float32	EXFswnet	Open ocean net shortwave radiative flux	W m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Net shortwave radiative flux per unit area of open water (not covered by sea-ice). note: net shortwave radiation over open water calculated from downward shortwave flux (exfswdn) and ocean surface albedo.			



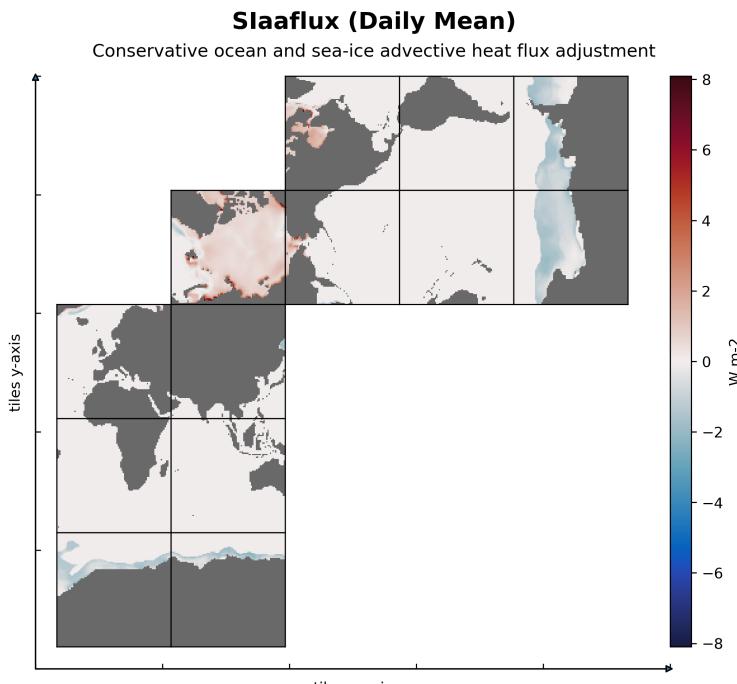
OCEAN_AND_ICE_SURFACE_HEAT_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 68: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFswnet

12.8.9 Native Variable: Slaaflux

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

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



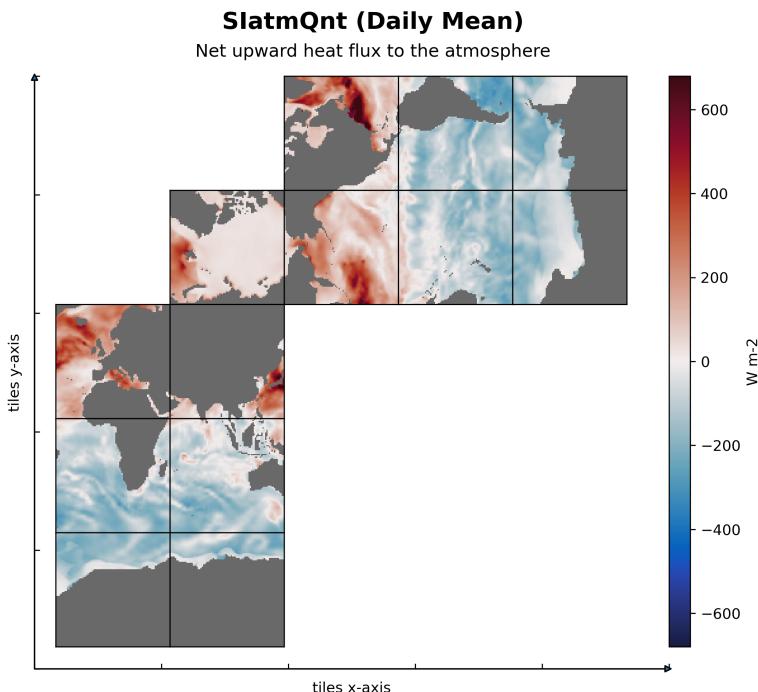
OCEAN_AND_ICE_SURFACE_HEAT_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 69: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: Slaaflux

12.8.10 Native Variable: SlatmQnt

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

Storage Type	Variable Name	Description	Unit
float32	SlatmQnt	Net upward heat flux to the atmosphere	W m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>float32 SIatmQnt(time, tile, j, i) SIatmQnt: _FillValue = 9.96921e+36 SIatmQnt: long_name = Net upward heat flux to the atmosphere SIatmQnt: units = W m: 2 SIatmQnt: coverage_content_type = modelResult SIatmQnt: direction = >0 upward decreases ocean temperature SIatmQnt: standard_name = surface_upward_heat_flux_in_air SIatmQnt: coordinates = XC time YC SIatmQnt: valid_min = : 756.0607299804688 SIatmQnt: valid_max = 1704.7703857421875</pre>			
Comments			
Net upward heat flux to the atmosphere across open water and sea-ice or snow surfaces. note: nonzero siatmqnt may not be associated with a change in ocean potential temperature due to sea-ice growth or melting. to calculate total ocean heat content changes use the variable tflux which also accounts for changing ocean mass (e.g. ocefwflx).			



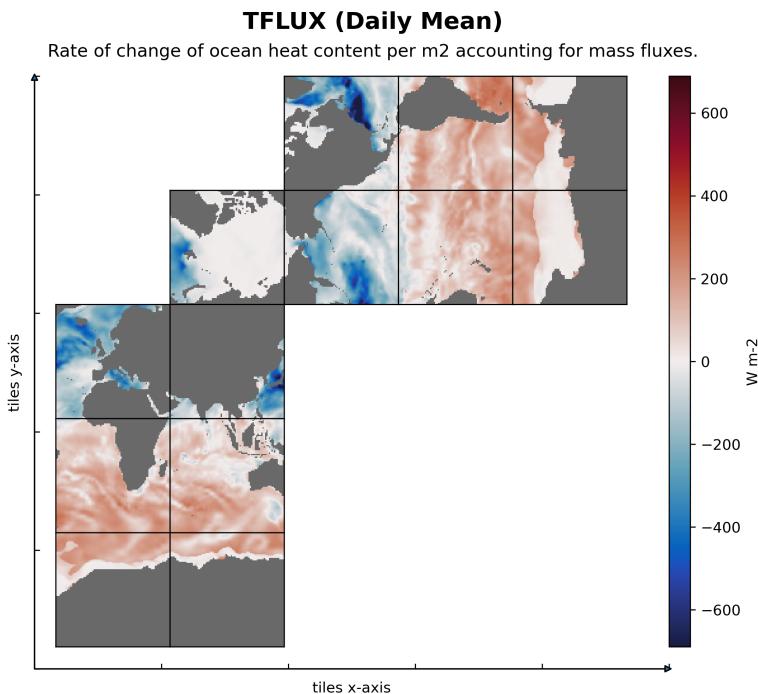
OCEAN_AND_ICE_SURFACE_HEAT_FLUX_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 70: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: SlatmQnt

12.8.11 Native Variable: TFLUX

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

Storage Type	Variable Name	Description	Unit
float32	TFLUX	Rate of change of ocean heat content per m2 accounting for mass fluxes.	W m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>float32 TFLUX(time, tile, j, i) TFLUX: _FillValue = 9.96921e+36 TFLUX: long_name = Rate of change of ocean heat content per m2 accounting for mass fluxes. TFLUX: units = W m: 2 TFLUX: coverage_content_type = modelResult TFLUX: direction = >0 increases potential temperature (THETA) TFLUX: coordinates = XC time YC TFLUX: valid_min = : 1713.51220703125 TFLUX: valid_max = 870.3130493164062</pre>			
Comments			
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 ocefwlx).			



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: TFLUX

12.8.12 Native Variable: oceQnet

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

Storage Type	Variable Name	Description	Unit
float32	oceQnet	Net heat flux into the ocean surface	W m-2
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
<p>Net heat flux into the ocean surface from all processes: air-sea turbulent and radiative fluxes and turbulent and conductive fluxes between the ocean and sea-ice and snow. note: oceqnet does not include the change in ocean heat content due to changing ocean mass (ocefwflx). mass fluxes from evaporation, precipitation, and runoff (exfempmr) happen at the same temperature as the ocean surface temperature. consequently, empmr does not change ocean surface temperature. conversely, mass fluxes due to sea-ice thickening/thinning and snow melt in the model are assumed to happen at a fixed Oc. consequently, mass fluxes due to phase changes between seawater and sea-ice and snow induce a heat flux when the ocean surface temperaure is not Oc. the variable tflux does include the change in ocean heat content due to changing ocean mass.</p>			

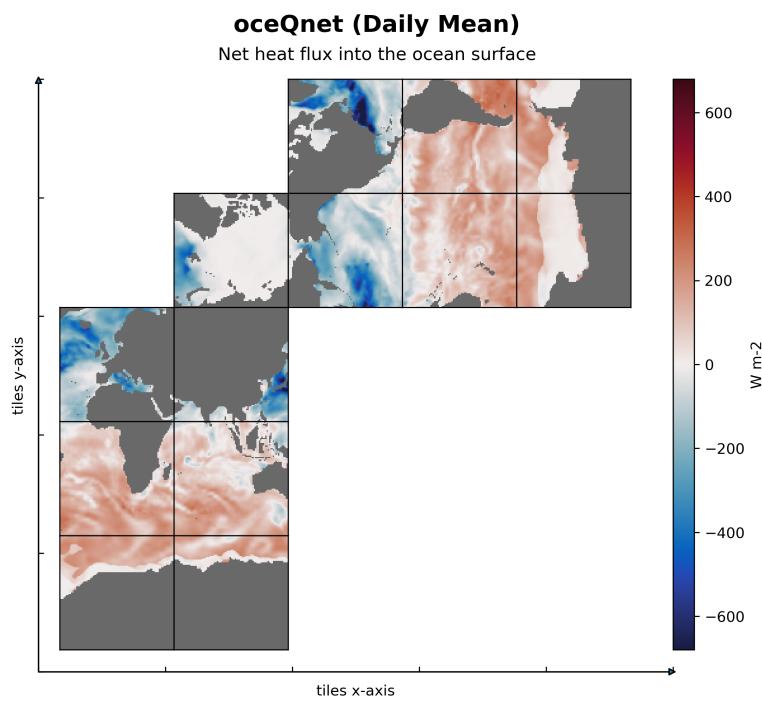
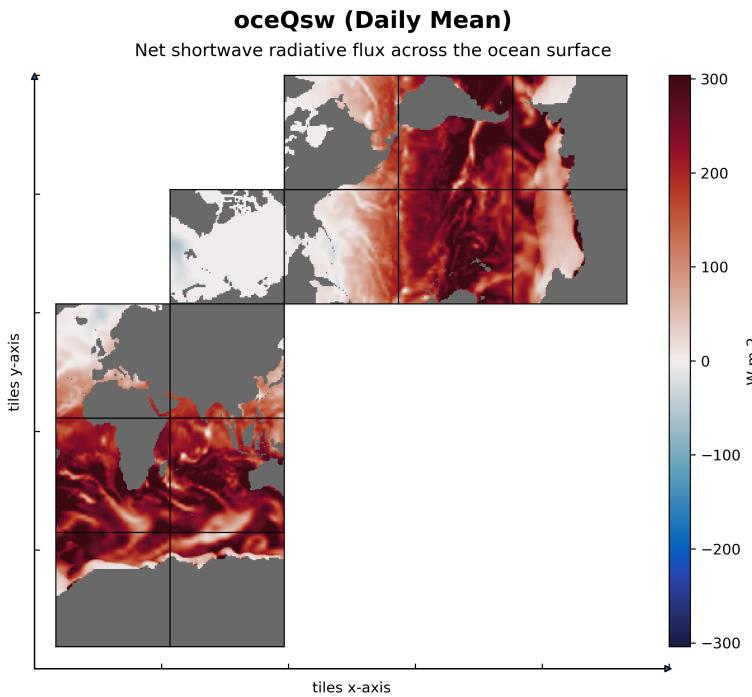


Figure 72: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: oceQnet

12.8.13 Native Variable: oceQsw

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

Storage Type	Variable Name	Description	Unit
float32	oceQsw	Net shortwave radiative flux across the ocean surface	W m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>float32 oceQsw(time, tile, j, i) oceQsw: _FillValue = 9.96921e+36 oceQsw: long_name = Net shortwave radiative flux across the ocean surface oceQsw: units = W m: 2 oceQsw: coverage_content_type = modelResult oceQsw: direction = >0 increases potential temperature (THETA) oceQsw: coordinates = XC time YC oceQsw: valid_min = : 134.39808654785156 oceQsw: valid_max = 655.6171264648438</pre>			
Comments			
Net shortwave radiative flux across the ocean surface. note: shortwave radiation penetrates below the surface grid cell.			



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: oceQsw

12.9 Native dataset of OCEAN_AND_ICE_SURFACE_STRESS

12.9.1 Overview

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

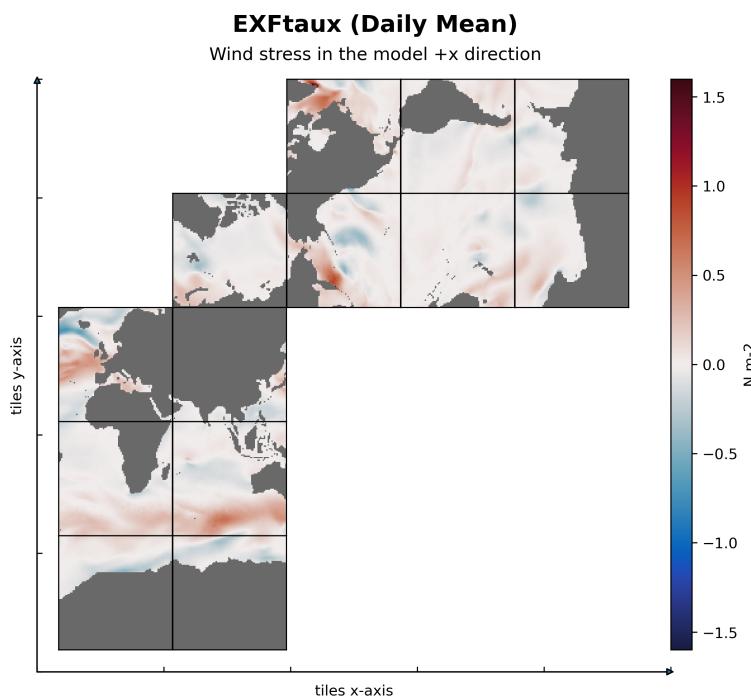
Table 12.61: Coordinates and Variables in the dataset OCEAN_AND_ICE_SURFACE_STRESS

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

12.9.2 Native Variable: EXFtaux

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

Storage Type	Variable Name	Description	Unit
float32	EXFtaux	Wind stress in the model +x direction	N m-2
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Wind stress in the +x direction at the tracer cell on the native model grid. note: exftaux is the stress applied to the ice-free ocean surface and sea-ice covered surface. when sea-ice is present, the total stress applied to the ocean surface in the +x direction is not exftaux, but a combination of exftaux wind stress in the open water fraction and a stress from sea-ice in the ice-covered fraction (see octaux). exftaux is the sum of era-interim stress and the control adjustment from ocean state estimation.			



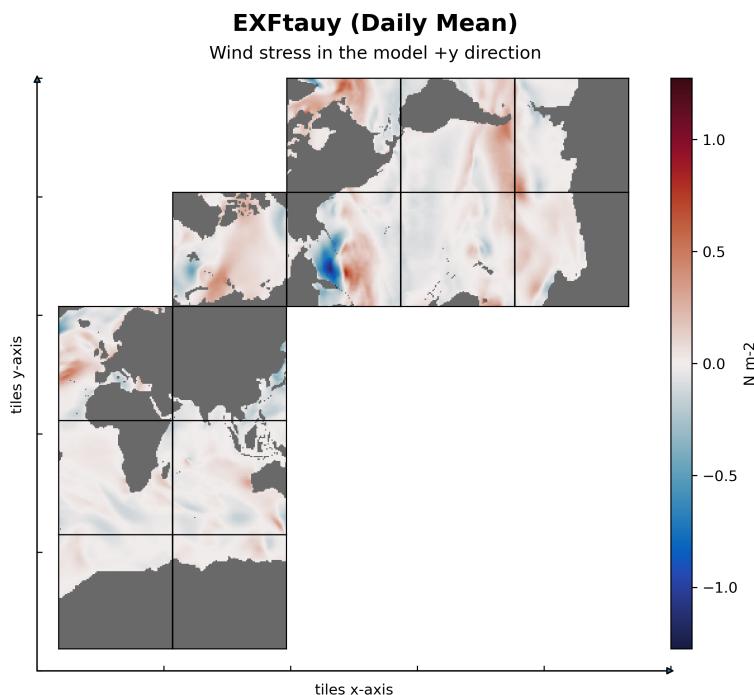
OCEAN AND ICE SURFACE STRESS day mean 2017-12-29 ECCO V4r4 native llc0090.nc

Figure 74: Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: EXFtaux

12.9.3 Native Variable: EXFtauy

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

Storage Type	Variable Name	Description	Unit
float32	EXFtauy	Wind stress in the model +y direction	N m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>float32 EXFtauy(time, tile, j, i) EXFtauy: _FillValue = 9.96921e+36 EXFtauy: long_name = Wind stress in the model +y direction EXFtauy: units = N m: 2 EXFtauy: coverage_content_type = modelResult EXFtauy: direction = >0 increases horizontal velocity in the +y direction (VVEL) EXFtauy: standard_name = surface_downward_y_stress EXFtauy: coordinates = time YC XC EXFtauy: valid_min = : 3.71972918510437 EXFtauy: valid_max = 3.7044837474823</pre>			
Comments			
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.			



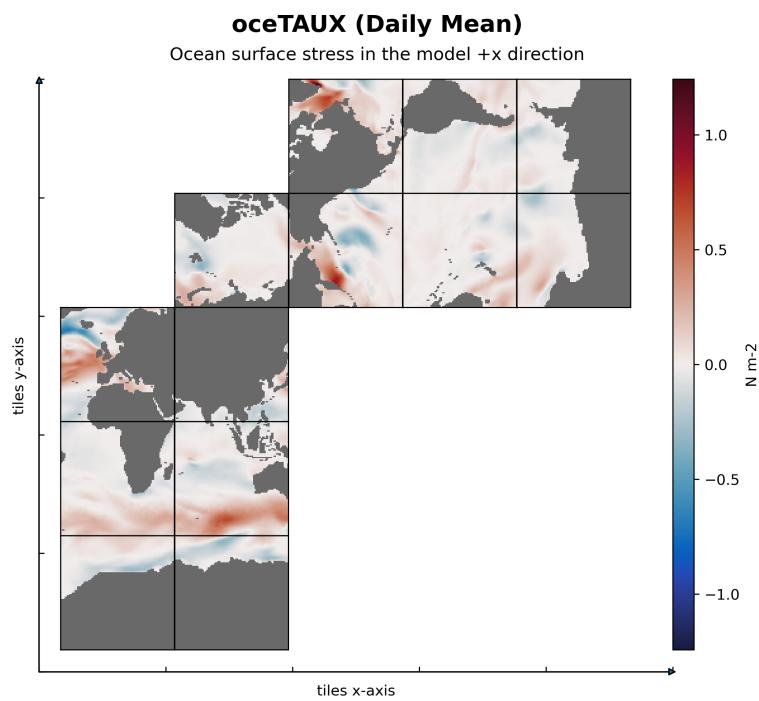
OCEAN_AND_ICE_SURFACE_STRESS_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 75: Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: EXFtauy

12.9.4 Native Variable: oceTAUX

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

Storage Type	Variable Name	Description	Unit
float32	oceTAUX	Ocean surface stress in the model +x direction	N m-2
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
<p>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.</p>			



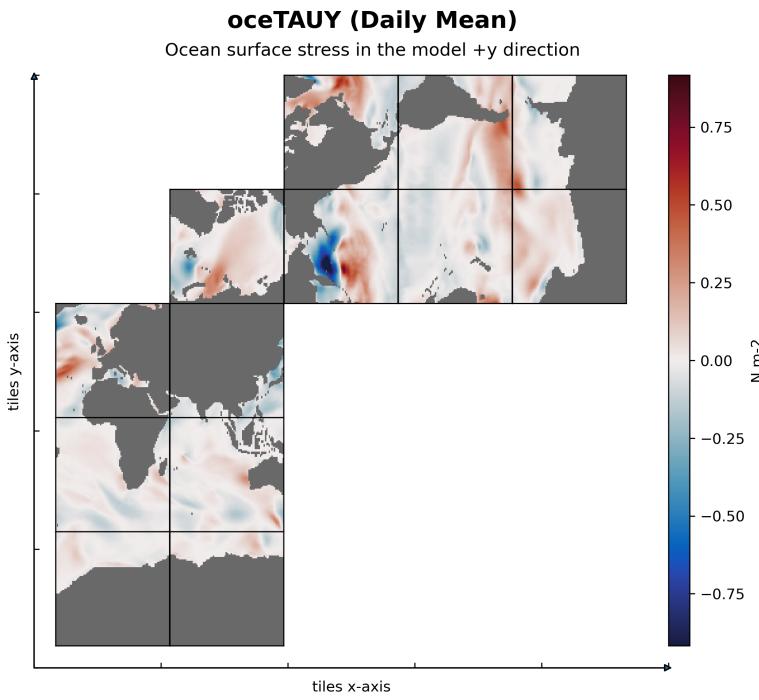
OCEAN_AND_ICE_SURFACE_STRESS_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 76: Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: oceTAUX

12.9.5 Native Variable: oceTAUY

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

Storage Type	Variable Name	Description	Unit
float32	oceTAUY	Ocean surface stress in the model +y direction	N m-2
Description of the variable in Common Data language (CDL)			
<pre>float32 oceTAUY(time, tile, j_g, i) oceTAUY: _FillValue = 9.96921e+36 oceTAUY: long_name = Ocean surface stress in the model +y direction oceTAUY: units = N m: 2 oceTAUY: mate = oceTAUX oceTAUY: coverage_content_type = modelResult oceTAUY: direction = >0 increases horizontal velocity in the +y direction (VVEL) oceTAUY: standard_name = downward_y_stress_at_sea_water_surface oceTAUY: coordinates = time oceTAUY: valid_min = : 2.0606131553649902 oceTAUY: valid_max = 1.9999693632125854</pre>			
Comments			
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.			



OCEAN_AND_ICE_SURFACE_STRESS_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 77: Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: oceTAUY

12.10 Native dataset of OCEAN_BOLUS_STREAMFUNCTION

12.10.1 Overview

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

Table 12.66: Coordinates and Variables in the dataset OCEAN_BOLUS_STREAMFUNCTION

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

Table 12.66: Coordinates and Variables in the dataset OCEAN_BOLUS_STREAMFUNCTION

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

12.10.2 Native Variable: GM_PsiX

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

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

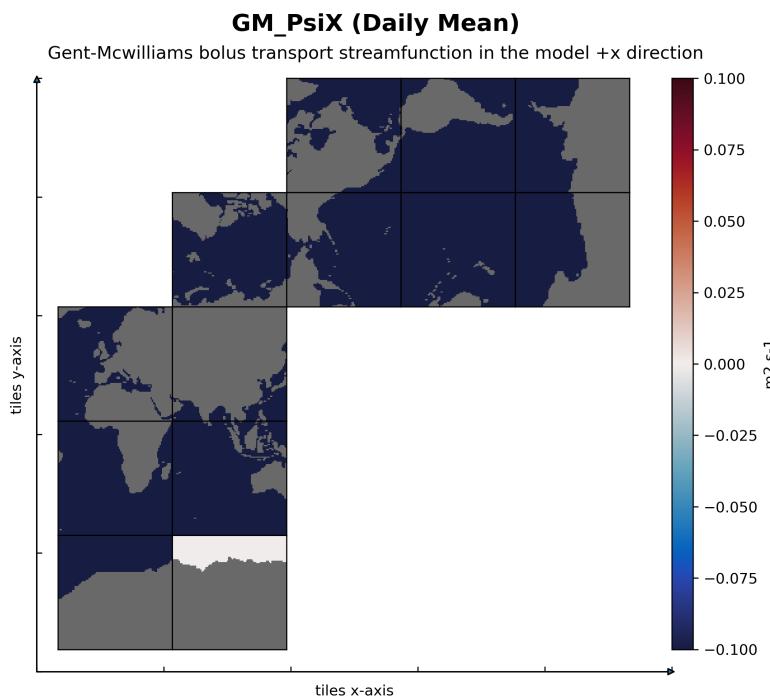


Figure 78: Dataset: OCEAN_BOLUS_STREAMFUNCTION, Variable: GM_PsiX

12.10.3 Native Variable: GM_PsiY

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

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

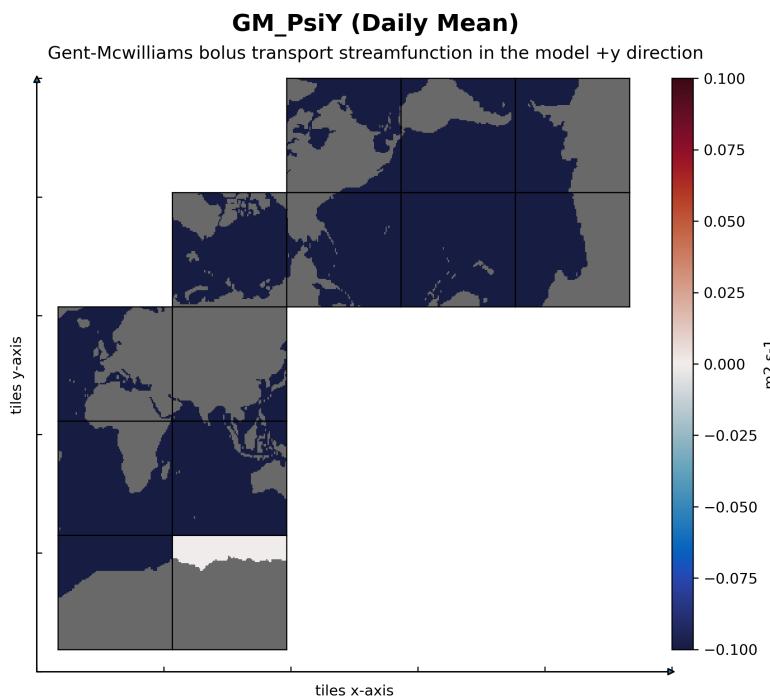


Figure 79: Dataset: OCEAN_BOLUS_STREAMFUNCTION, Variable: GM_PsiY

12.11 Native dataset of OCEAN_BOLUS_VELOCITY

12.11.1 Overview

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

Table 12.69: Coordinates and Variables in the dataset OCEAN_BOLUS_VELOCITY

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

12.11.2 Native Variable: UVELSTAR

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

Storage Type	Variable Name	Description	Unit
float32	UVELSTAR	Gent-mcwilliams velocity in the model +x direction scaled by time-varying grid cell thickness	m s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 UVELSTAR(time, k, tile, j, i_g) UVELSTAR:_FillValue = 9.96921e+36 UVELSTAR:long_name = Gent: McWilliams velocity in the model +x direction scaled by time: varying grid cell thickness UVELSTAR:units = m s: 1 UVELSTAR:mate = VVELSTAR UVELSTAR:coverage_content_type = modelResult UVELSTAR:standard_name = sea_water_x_velocity_due_to_parameterized_mesoscale_eddies UVELSTAR:coordinates = Z time UVELSTAR:valid_min = : 0.7960150241851807 UVELSTAR:valid_max = 0.7762293219566345</pre>			
Comments			
<p>Gent-mcwilliams horizontal velocity in the +x direction at the 'u' face of the tracer cell on the native model grid. note: uvelstar is not a model diagnostic but is calculated offline: uvelstar = -d/dz gm_psix. in the arakawa-c grid, horizontal velocities are staggered relative to the tracer cells with indexing such that +uvelstar(i_g,j,k) corresponds to +x tracer fluxes through the 'u' face of the tracer cell at (i,j,k). also, the model +x direction does not necessarily correspond to the geographical east-west direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles. see evelstar and nvelstar.</p>			

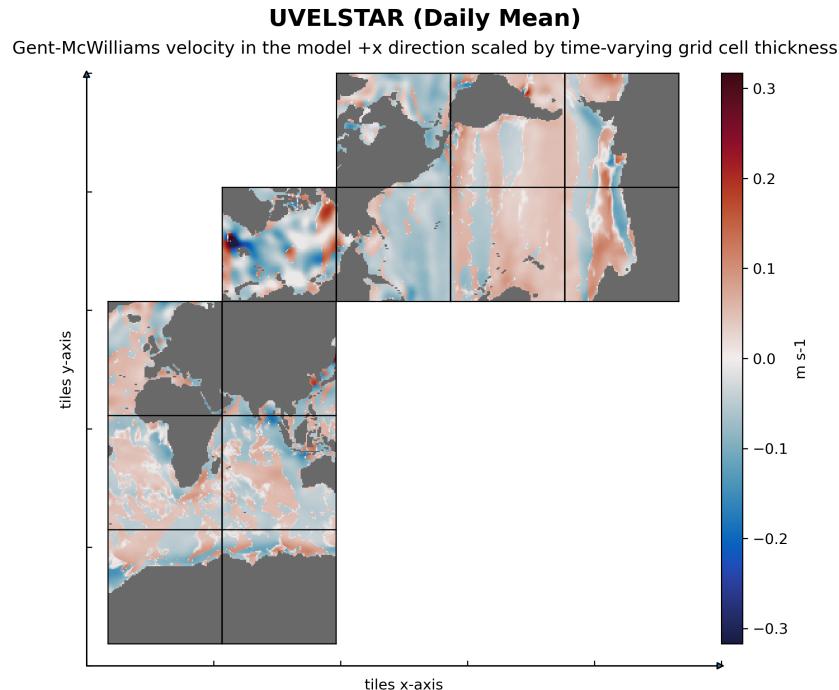


Figure 80: Dataset: OCEAN_BOLUS_VELOCITY, Variable: UVELSTAR

12.11.3 Native Variable: VVELSTAR

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

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

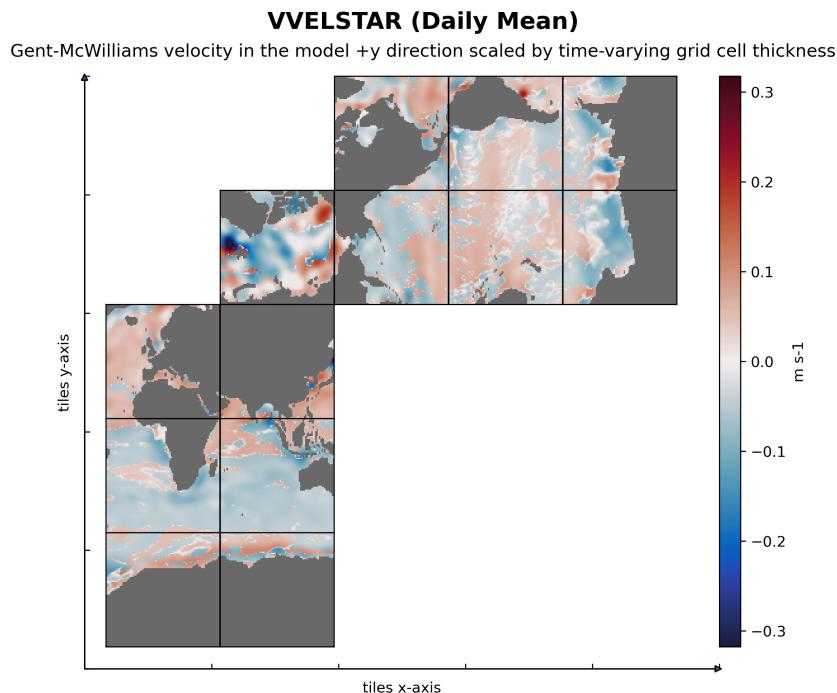


Figure 81: Dataset: OCEAN_BOLUS_VELOCITY, Variable: VVELSTAR

12.11.4 Native Variable: WVELSTAR

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

Storage Type	Variable Name	Description	Unit
float32	WVELSTAR	Gent-mcwilliams velocity in the model +z direction	m s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Gent-mcwilliams vertical bolus velocity in the +z direction at the top 'w' face of the tracer cell on the native model grid. note: in the arakawa-c grid, vertical velocities are staggered relative to the tracer cells with indexing such that +wvelstar(i,j,k_l) corresponds to upward +z motion through the top 'w' face of the tracer cell at (i,j,k).			

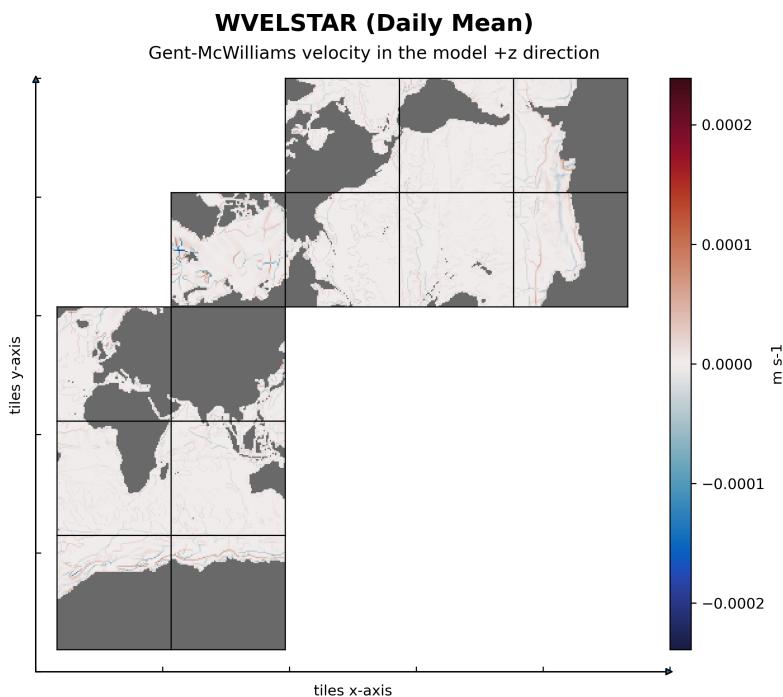


Figure 82: Dataset: OCEAN_BOLUS_VELOCITY, Variable: WVELSTAR

12.12 Native dataset of OCEAN_BOTTOM_PRESSURE

12.12.1 Overview

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

Table 12.73: Coordinates and Variables in the dataset OCEAN_BOTTOM_PRESSURE

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

12.12.2 Native Variable: OBP

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

Storage Type	Variable Name	Description	Unit
float32	OBP	Ocean bottom pressure given as equivalent water thickness	m
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
<p>Obp excludes the contribution from global mean atmospheric pressure and is therefore suitable for comparisons with grace data products. obp is calculated as follows. first, we calculate ocean hydrostatic bottom pressure anomaly, phibot, with phibot = p_b/rhoconst - gh(t), where p_b = model ocean hydrostatic bottom pressure, rho-const = reference density (1029 kg m⁻³), g is acceleration due to gravity (9.81 m s⁻²), and h(t) is model depth at time t. then, obp = phibot/g + corrections for i) global mean steric sea level changes related to density changes in the boussinesq volume-conserving model (greatbatch correction, see sterghlo) and ii) global mean atmospheric pressure variations. use obp for comparisons with ocean bottom pressure data products that have been corrected for global mean atmospheric pressure variations. grace data typically are corrected for global mean atmospheric pressure variations. in contrast, ocean bottom pressure gauge data typically are not corrected for global mean atmospheric pressure variations.</p>			

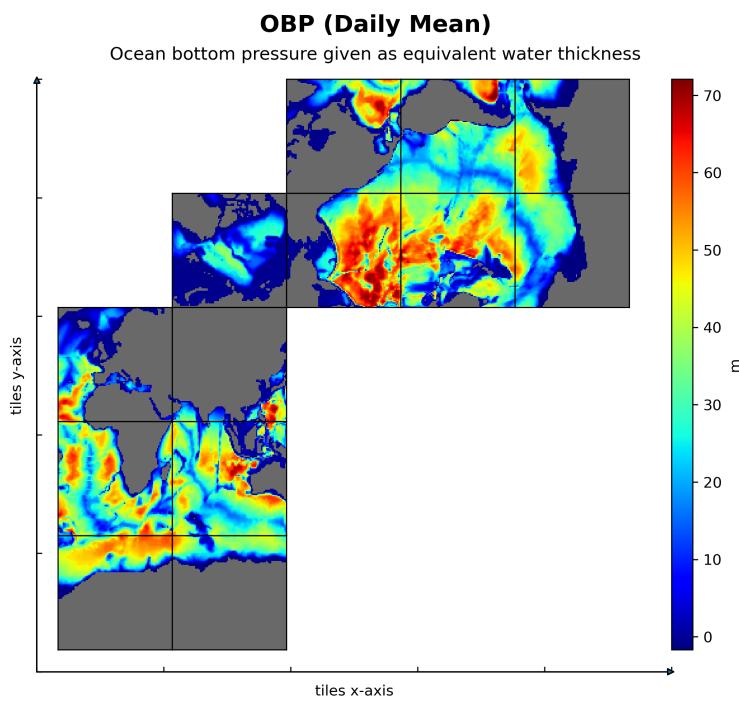


Figure 83: Dataset: OCEAN_BOTTOM_PRESSURE, Variable: OBP

12.12.3 Native Variable: OBPGMAP

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

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

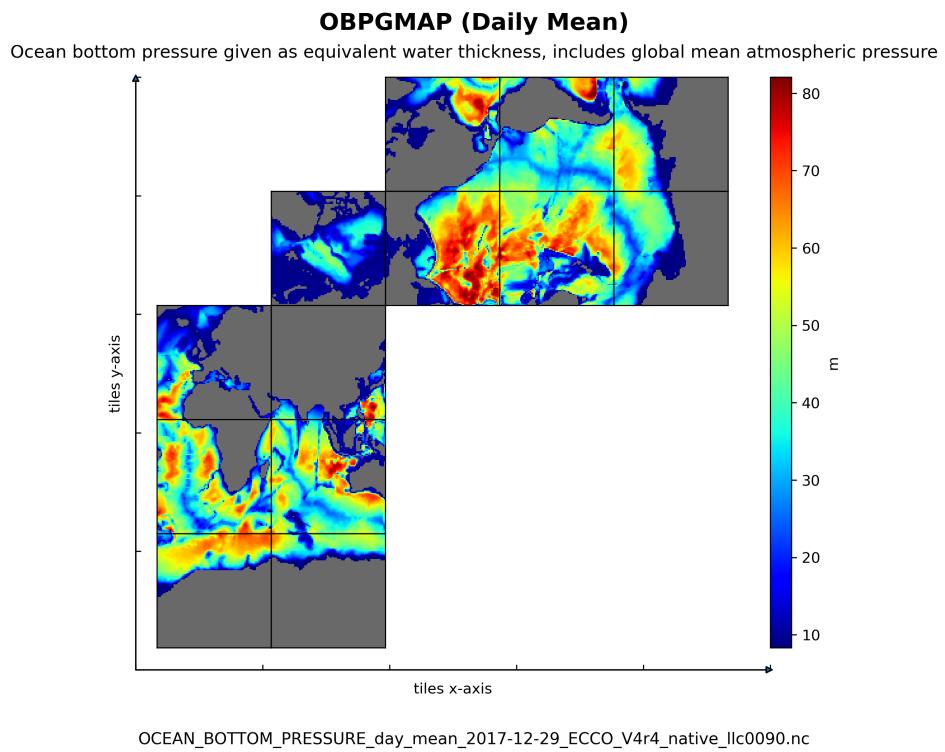
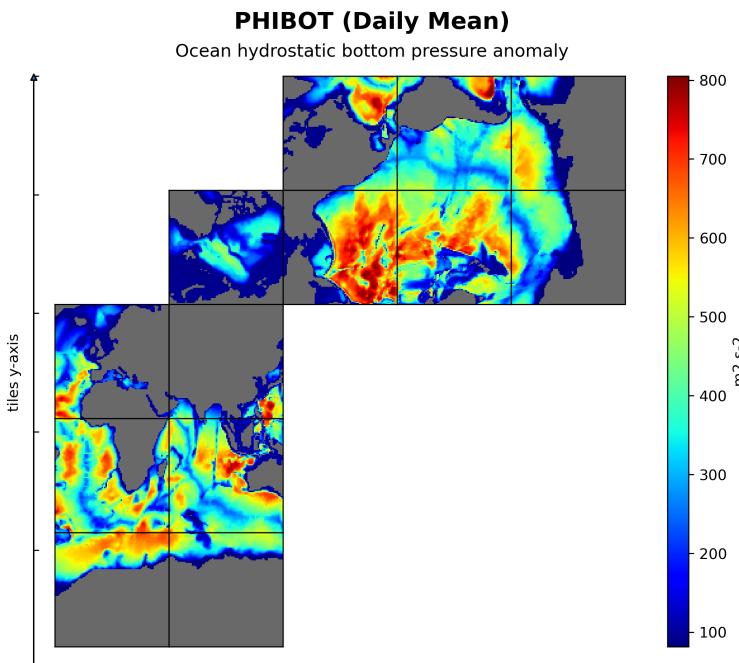


Figure 84: Dataset: OCEAN_BOTTOM_PRESSURE, Variable: OBPGMAP

12.12.4 Native Variable: PHIBOT

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

Storage Type	Variable Name	Description	Unit
float32	PHIBOT	Ocean hydrostatic bottom pressure anomaly	m2 s-2
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
<p>Phibot = $p_b / \rho_{\text{const}} - g h(t)$, where p_b = hydrostatic ocean bottom pressure, ρ_{const} = reference density (1029 kg m⁻³), g is acceleration due to gravity (9.81 m s⁻²), and $h(t)$ is model depth at time t. units: p_b: [kg m⁻¹ s⁻²], ρ_{const}: [kg m⁻³], g: [m s⁻²], $h(t)$: [m]. note: includes atmospheric pressure loading. phibot accounts for the model's time-varying grid cell thickness (z^* coordinate system). phibot is not corrected for global mean steric sea level changes related to density changes in the boussinesq volume-conserving model (greatbatch correction, see sterghoh), and therefore should not be used for comparisons with ocean bottom pressure data. instead, see obpgmap and obp.</p>			



OCEAN_BOTTOM_PRESSURE_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 85: Dataset: OCEAN_BOTTOM_PRESSURE, Variable: PHIBOT

12.13 Native dataset of OCEAN_DENS_STRAT_PRESS

12.13.1 Overview

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

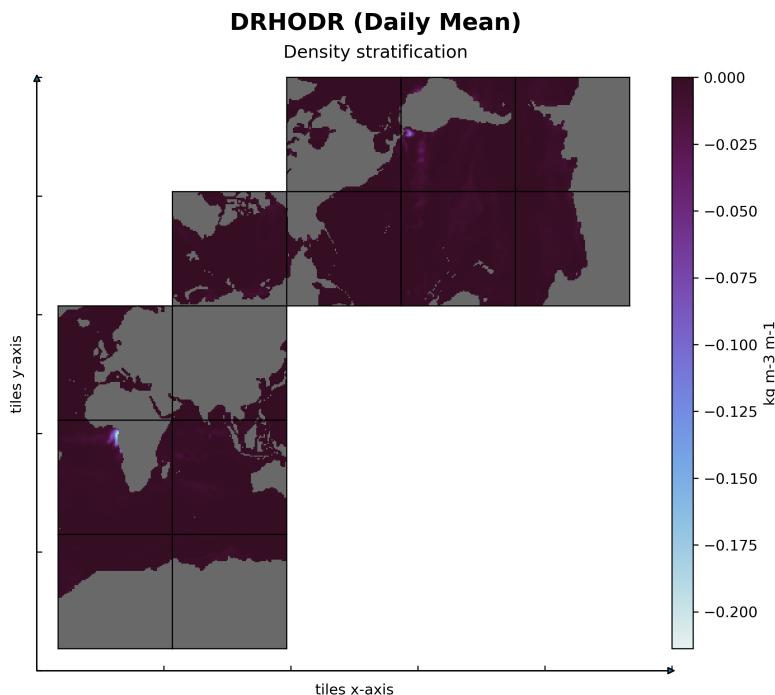
Table 12.77: Coordinates and Variables in the dataset OCEAN_DENS_STRAT_PRESS

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

12.13.2 Native Variable: DRHODR

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

Storage Type	Variable Name	Description	Unit
float32	DRHODR	Density stratification	kg m ⁻³ m ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 DRHODR(time, k_1, 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</pre>			
Comments			
Density stratification: d(sigma) d z-1. note: density computations are done with in-situ density. the vertical derivatives of in-situ density and locally-referenced potential density are identical the equation of state is a modified unesco formula by jackett and mcdougall (1995), which uses the model variable potential temperature as input assuming a horizontally and temporally constant pressure of \$p_0=-g h_{\{0\}} z\$.			



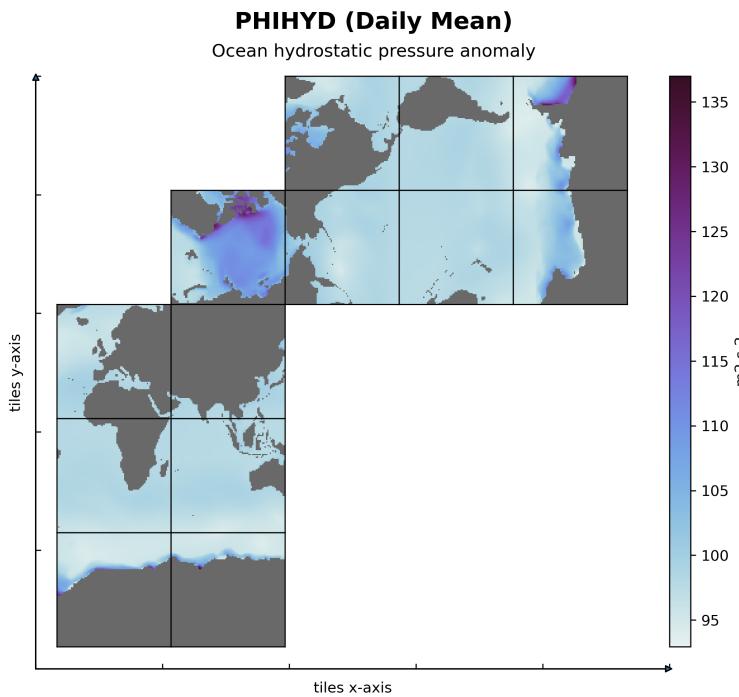
OCEAN_DENS_STRAT_PRESS_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 86: Dataset: OCEAN_DENS_STRAT_PRESS, Variable: DRHODR

12.13.3 Native Variable: PHIHYD

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

Storage Type	Variable Name	Description	Unit
float32	PHIHYD	Ocean hydrostatic pressure anomaly	m ² s ⁻²
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
<p>Phihyd = $p(k) / \rho_{\text{const}} - g z^*(k,t)$, where p = hydrostatic ocean pressure at depth level k, ρ_{const} = reference density (1029 kg m⁻³), g is acceleration due to gravity (9.81 m s⁻²), and $z^*(k,t)$ is model depth at level k and time t. units: p:[kg m⁻¹ s⁻²], ρ_{const}:[kg m⁻³], g:[m s⁻²], $h(t)$:[m]. note: includes atmospheric pressure loading. quantity referred to in some contexts as hydrostatic pressure anomaly. phibot accounts for the model's time-varying grid cell thickness (z^* coordinate system). see phihydr for hydrostatic pressure potential anomaly calculated using time-invariant grid cell thicknesses. phihyd is not corrected for global mean steric sea level changes related to density changes in the boussinesq volume-conserving model (greatbatch correction, see sterglo).</p>			



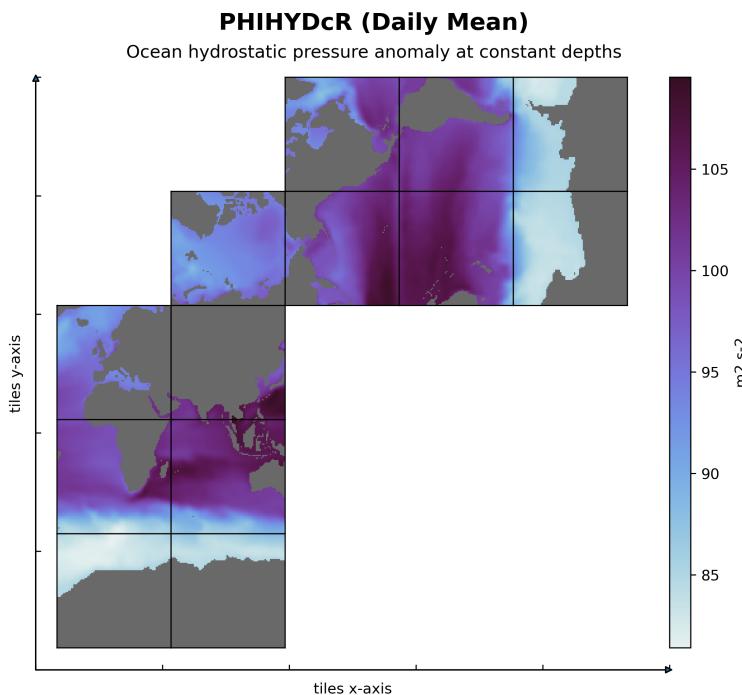
OCEAN_DENS_STRAT_PRESS_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 87: Dataset: OCEAN_DENS_STRAT_PRESS, Variable: PHIHYD

12.13.4 Native Variable: PHIHYDcR

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

Storage Type	Variable Name	Description	Unit
float32	PHIHYDcR	Ocean hydrostatic pressure anomaly at constant depths	m2 s-2
Description of the variable in Common Data language (CDL)			
<pre>float32 PHIHYDcR(time, k, tile, j, i) PHIHYDcR:_FillValue = 9.96921e+36 PHIHYDcR:long_name = Ocean hydrostatic pressure anomaly at constant depths PHIHYDcR:units = m2 s: 2 PHIHYDcR:coverage_content_type = modelResult PHIHYDcR:coordinates = YC Z XC time PHIHYDcR:valid_min = 73.08939361572266 PHIHYDcR:valid_max = 784.4268188476562</pre>			
Comments			
<p>Phihyd = $p(k) / \rho_{\text{const}} - g z(k,t)$, where p = hydrostatic ocean pressure at depth level k, ρ_{const} = reference density (1029 kg m^{-3}), g is acceleration due to gravity (9.81 m s^{-2}), and $z(k,t)$ is fixed model depth at level k. units: $p: [\text{kg m}^{-1} \text{s}^{-2}]$, $\rho_{\text{const}}: [\text{kg m}^{-3}]$, $g: [\text{m s}^{-2}]$, $h(t): [\text{m}]$. note: includes atmospheric pressure loading. quantity referred to in some contexts as hydrostatic pressure potential anomaly. phihydr is calculated with respect to the model's initial, time-invariant grid cell thicknesses. see phihyd for hydrostatic pressure anomaly calculated using model's time-variable grid cell thicknesses (z^* coordinate system). phihydr is not corrected for global mean steric sea level changes related to density changes in the boussinesq volume-conserving model (greatbatch correction, see stergho).</p>			



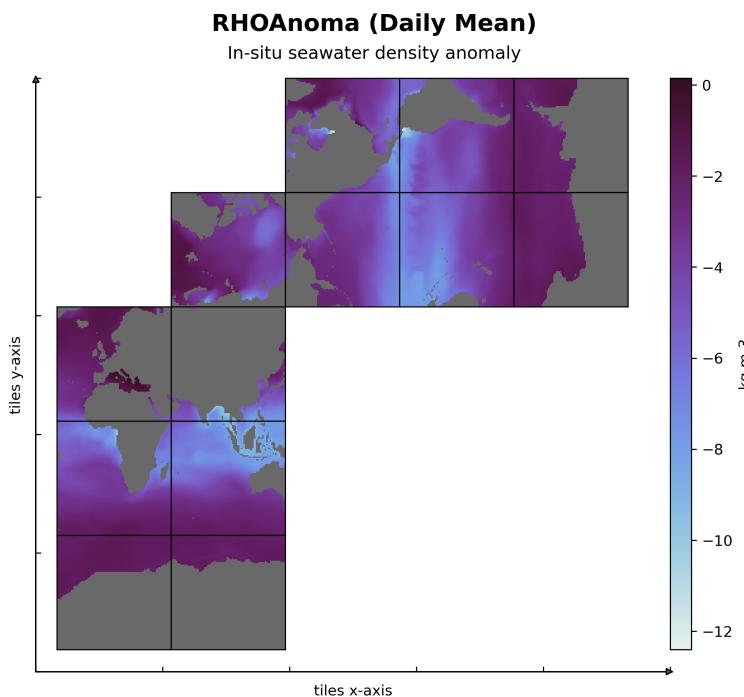
OCEAN_DENS_STRAT_PRESS_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 88: Dataset: OCEAN_DENS_STRAT_PRESS, Variable: PHIHYDcR

12.13.5 Native Variable: RHOAnoma

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

Storage Type	Variable Name	Description	Unit
float32	RHOAnoma	In-situ seawater density anomaly	kg m ⁻³
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
In-situ seawater density anomaly relative to the reference density, rhoconst. rhoconst = 1029 kg m ⁻³			



OCEAN_DENS_STRAT_PRESS_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 89: Dataset: OCEAN_DENS_STRAT_PRESS, Variable: RHOAnoma

12.14 Native dataset of OCEAN_MIXED_LAYER_DEPTH

12.14.1 Overview

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

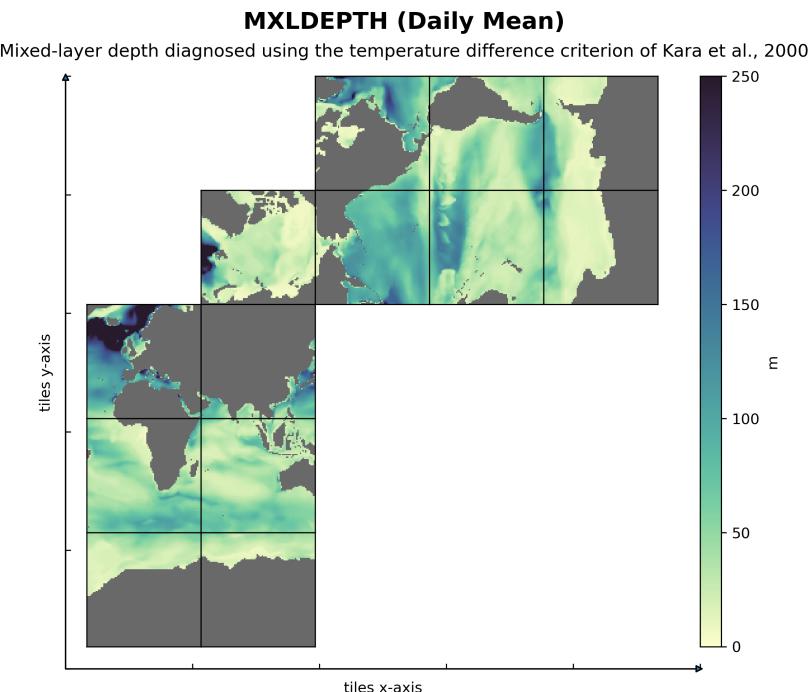
Table 12.82: Coordinates and Variables in the dataset OCEAN_MIXED_LAYER_DEPTH

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

12.14.2 Native Variable: MXLDEPTH

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

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



OCEAN_MIXED_LAYER_DEPTH_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 90: Dataset: OCEAN_MIXED_LAYER_DEPTH, Variable: MXLDEPTH

12.15 Native dataset of OCEAN_TEMPERATURE_SALINITY

12.15.1 Overview

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

Table 12.84: Coordinates and Variables in the dataset OCEAN_TEMPERATURE_SALINITY

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

12.15.2 Native Variable: SALT

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

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

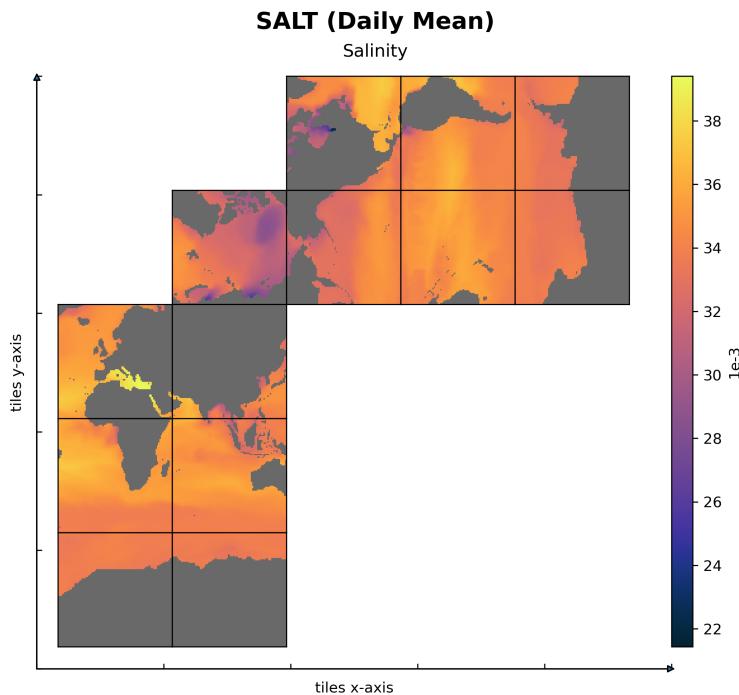


Figure 91: Dataset: OCEAN_TEMPERATURE_SALINITY, Variable: SALT

12.15.3 Native Variable: THETA

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

Storage Type	Variable Name	Description	Unit
float32	THETA	Potential temperature	degree_C
Description of the variable in Common Data language (CDL)			
	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		
Comments			
Sea water potential temperature is the temperature a parcel of sea water would have if moved adiabatically to sea level pressure. note: the equation of state is a modified unesco formula by jackett and mcdougall (1995), which uses the model variable potential temperature as input assuming a horizontally and temporally constant pressure of $\$p_0 = -g h o_{\{0\}} z\$$.			

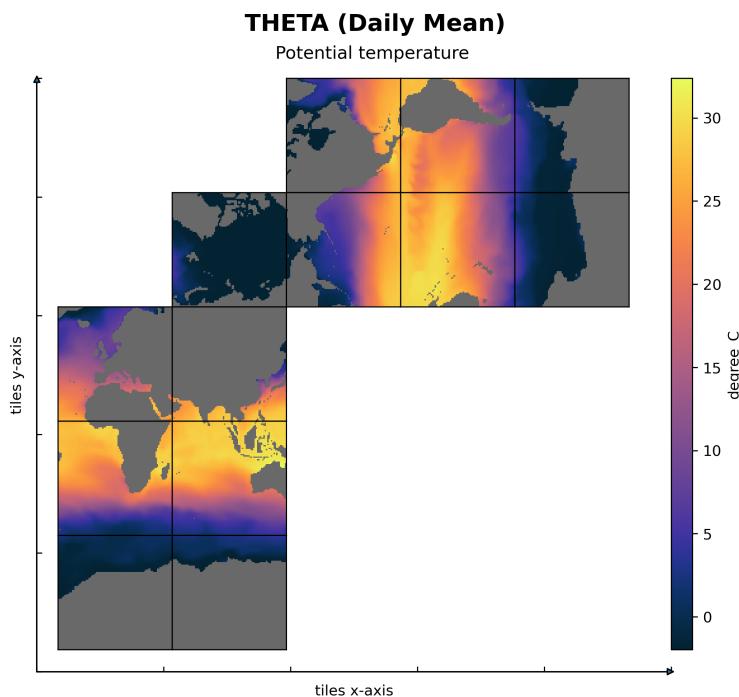


Figure 92: Dataset: OCEAN_TEMPERATURE_SALINITY, Variable: THETA

12.16 Native dataset of OCEAN_VELOCITY

12.16.1 Overview

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

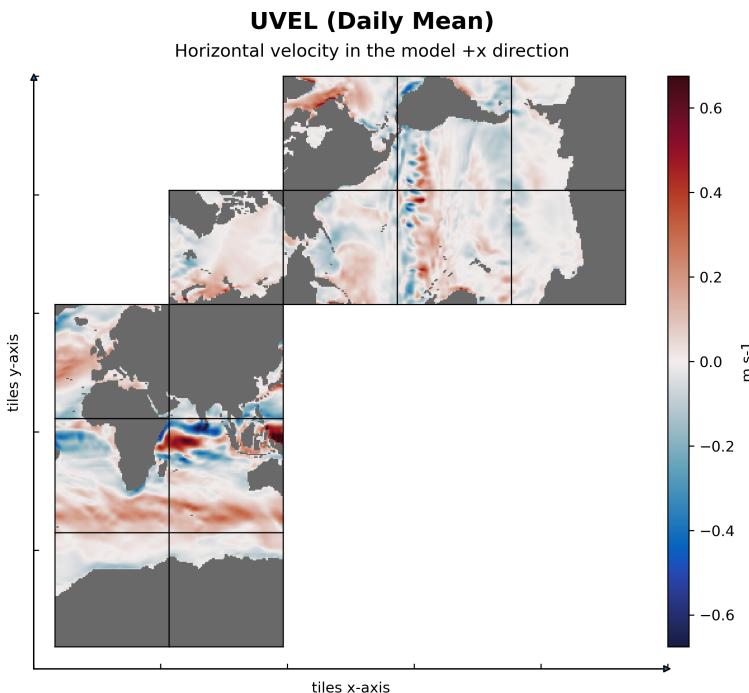
Table 12.87: Coordinates and Variables in the dataset OCEAN_VELOCITY

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

12.16.2 Native Variable: UVEL

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

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



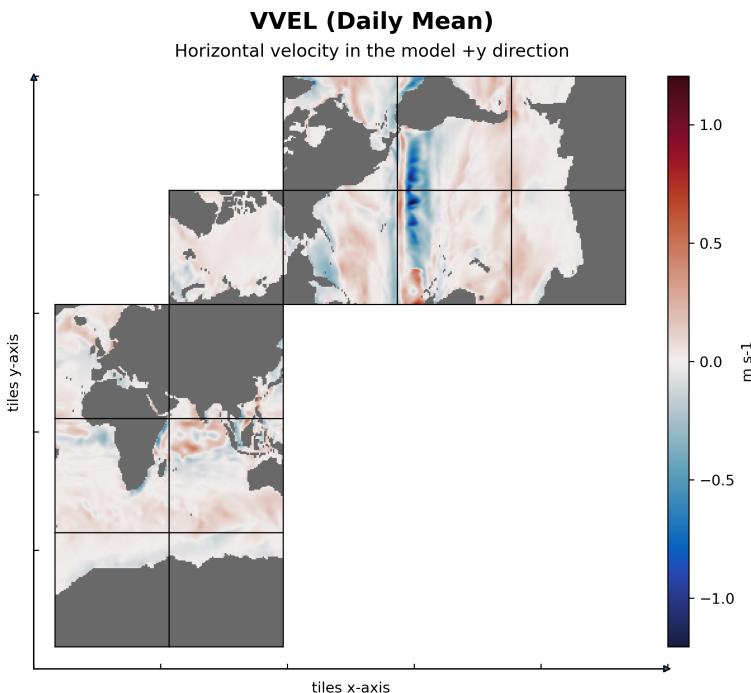
OCEAN_VELOCITY_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 93: Dataset: OCEAN_VELOCITY, Variable: UVEL

12.16.3 Native Variable: VVEL

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

Storage Type	Variable Name	Description	Unit
float32	VVEL	Horizontal velocity in the model +y direction	m s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 VVEL(time, k, tile, j_g, i) VVEL:_FillValue = 9.96921e+36 VVEL:long_name = Horizontal velocity in the model +y direction VVEL:units = m s: 1 VVEL:mate = UVEL VVEL:coverage_content_type = modelResult VVEL:direction = >0 increases volume VVEL:standard_name = sea_water_y_velocity VVEL:coordinates = Z time VVEL:valid_min = : 1.7877743244171143 VVEL:valid_max = 1.9089667797088623</pre>			
Comments			
<p>Horizontal velocity in the +y direction at the 'v' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal velocities are staggered relative to the tracer cells with indexing such that +vvel(i,j_g,k) corresponds to +y fluxes through the 'v' face of the tracer cell at (i,j,k). do not use vvel for volume flux calculations because the model's grid cell thicknesses vary with time (z* coordinates); use vvelmass instead. also, the model +y direction does not necessarily correspond to the geographical north-south direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles. see evel and nvel for zonal and meridional velocity.</p>			



OCEAN_VELOCITY_day_mean_2017-12-29_ECCO_V4r4_native_llc0090.nc

Figure 94: Dataset: OCEAN_VELOCITY, Variable: VVEL

12.16.4 Native Variable: WVEL

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

Storage Type	Variable Name	Description	Unit
float32	WVEL	Vertical velocity	m s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Vertical velocity in the +z direction at the top 'w' face of the tracer cell on the native model grid. note: in the arakawa-c grid, vertical velocities are staggered relative to the tracer cells with indexing such that +wvel(i,j,k_l) corresponds to upward +z motion through the top 'w' face of the tracer cell at (i,j,k). wvel is identical to wvelmass.			

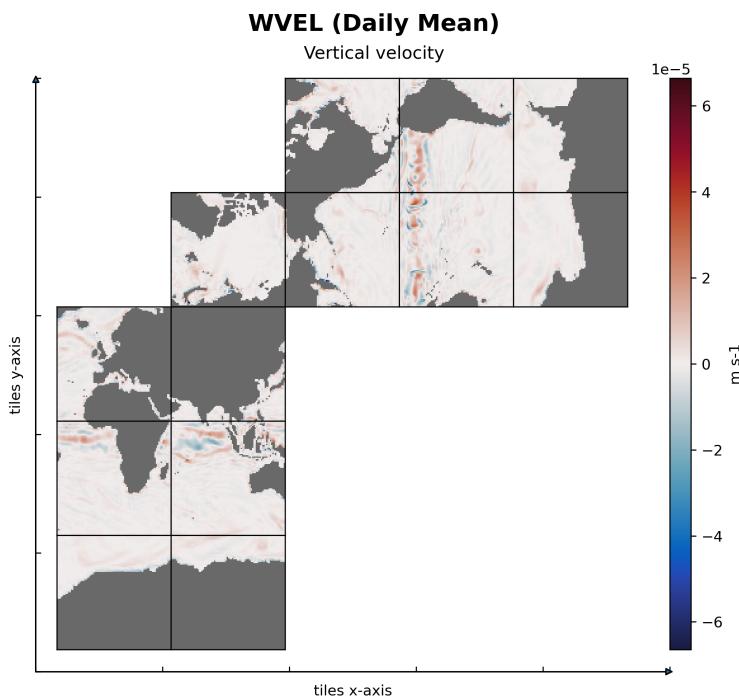


Figure 95: Dataset: OCEAN_VELOCITY, Variable: WVEL

12.17 Native dataset of SEA_ICE_CONC_THICKNESS

12.17.1 Overview

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

Table 12.91: Coordinates and Variables in the dataset SEA_ICE_CONC_THICKNESS

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

12.17.2 Native Variable: Slarea

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

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

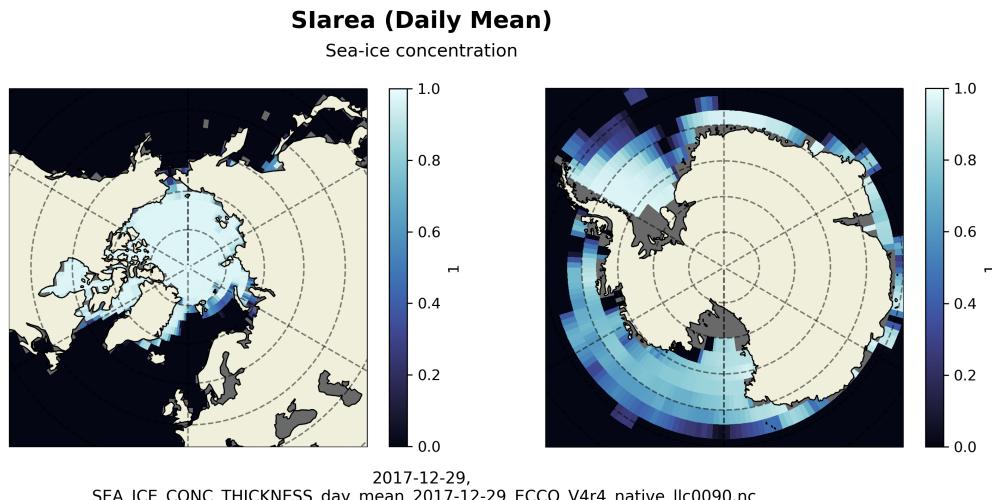


Figure 96: Dataset: SEA_ICE_CONC_THICKNESS, Variable: Slarea

12.17.3 Native Variable: SIheff

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

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

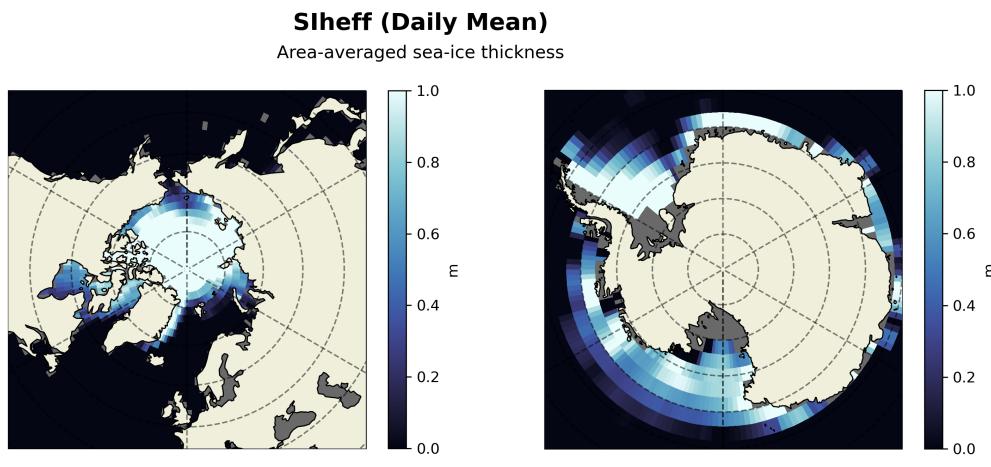


Figure 97: Dataset: SEA_ICE_CONC_THICKNESS, Variable: SIheff

12.17.4 Native Variable: SIhsnow

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

Storage Type	Variable Name	Description	Unit
float32	SIhsnow	Area-averaged snow thickness	m
Description of the variable in Common Data language (CDL)			
<pre>float32 SIhsnow(time, tile, j, i) SIhsnow: _FillValue = 9.96921e+36 SIhsnow: long_name = Area: averaged snow thickness SIhsnow: units = m SIhsnow: coverage_content_type = modelResult SIhsnow: standard_name = surface_snow_thickness SIhsnow: coordinates = time YC XC SIhsnow: valid_min = : 0.0004725505714304745 SIhsnow: valid_max = 2.7013046741485596</pre>			
Comments			
Snow thickness averaged over the entire model grid cell, including open water where snow thickness is zero. note: snow thickness over the ice-covered fraction of the grid cell is sihsnow/siarea			

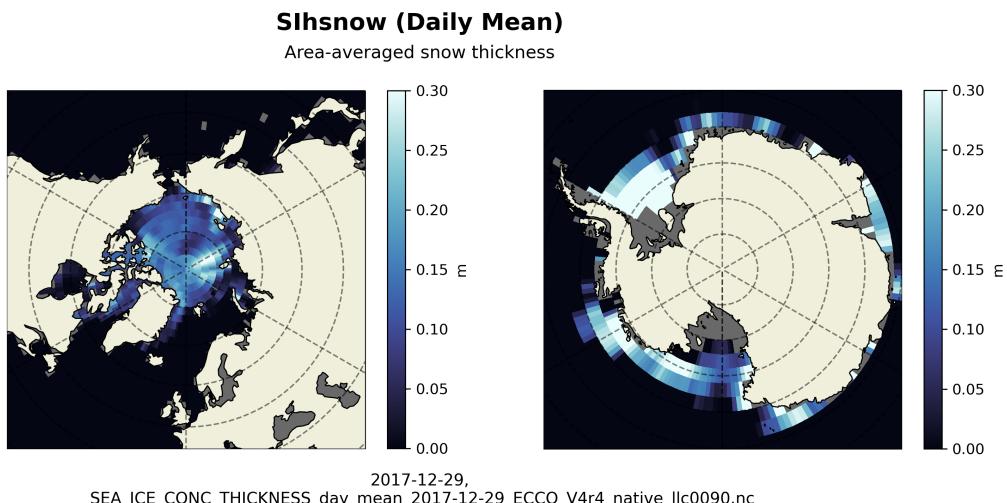


Figure 98: Dataset: SEA_ICE_CONC_THICKNESS, Variable: SIhsnow

12.17.5 Native Variable: slceLoad

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

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

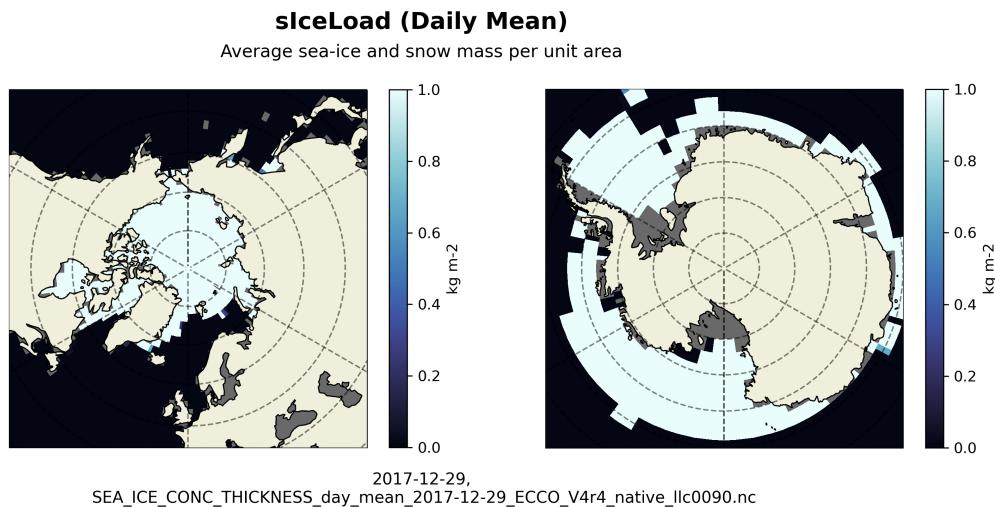


Figure 99: Dataset: SEA_ICE_CONC_THICKNESS, Variable: slceLoad

12.18 Native dataset of SEA_ICE_HORIZ_VOLUME_FLUX

12.18.1 Overview

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

Table 12.96: Coordinates and Variables in the dataset SEA_ICE_HORIZ_VOLUME_FLUX

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

12.18.2 Native Variable: ADVxHEFF

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

Storage Type	Variable Name	Description	Unit
float32	ADVxHEFF	Lateral advective flux of sea-ice thickness in the model +x direction	m ³ s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 ADVxHEFF(time, tile, j, i_g) ADVxHEFF:_FillValue = 9.96921e+36 ADVxHEFF:long_name = Lateral advective flux of sea: ice thickness in the model +x direction ADVxHEFF:units = m3 s: 1 ADVxHEFF:mate = ADVyHEFF ADVxHEFF:coverage_content_type = modelResult ADVxHEFF:direction = >0 increases mean sea: ice thickness (HEFF) ADVxHEFF:coordinates = time ADVxHEFF:valid_min = : 151912.28125 ADVxHEFF:valid_max = 107688.7578125</pre>			
Comments			
Lateral advective flux of grid cell mean sea-ice thickness (heff) in the +x direction through the 'u' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +advxheff(i_g,j) corresponds to +x fluxes through the 'u' face of the tracer cell at (i,j,k=0). also, the model +x direction does not necessarily correspond to the geographical east-west direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.			

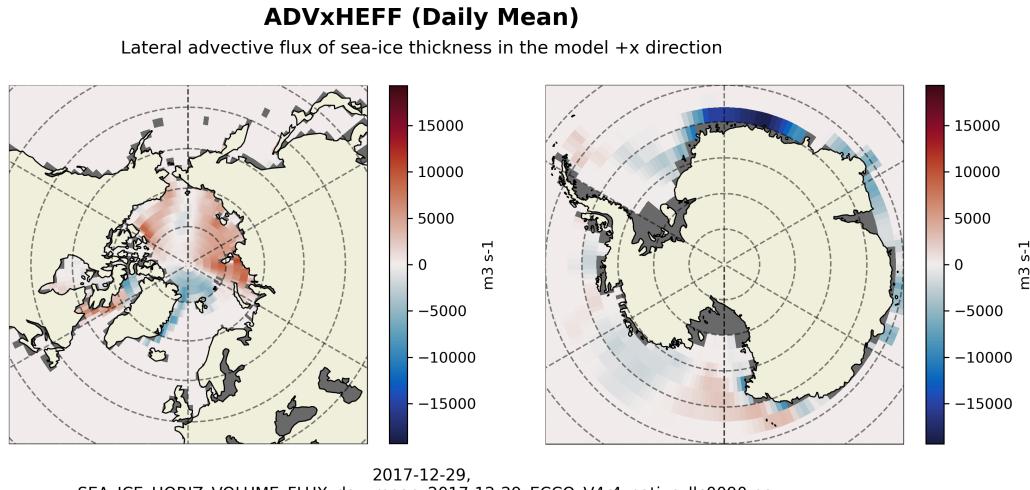


Figure 100: Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: ADVxHEFF

12.18.3 Native Variable: ADVxSNOW

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

Storage Type	Variable Name	Description	Unit
float32	ADVxSNOW	Lateral advective flux of snow thickness in the model +x direction	m ³ s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 ADVxSNOW(time, tile, j, i_g) ADVxSNOW: _FillValue = 9.96921e+36 ADVxSNOW: long_name = Lateral advective flux of snow thickness in the model +x direction ADVxSNOW: units = m3 s: 1 ADVxSNOW: mate = ADVySNOW ADVxSNOW: coverage_content_type = modelResult ADVxSNOW: direction = >0 increases mean snow thickness (HSNOW) ADVxSNOW: coordinates = time ADVxSNOW: valid_min = : 38343.0234375 ADVxSNOW: valid_max = 20385.103515625</pre>			
Comments			
Lateral advective flux of grid cell mean snow thickness (hsnow) in the +x direction through the 'u' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +advxsnow(i_g,j) corresponds to +x fluxes through the 'u' face of the tracer cell at (i,j,k=0). also, the model +x direction does not necessarily correspond to the geographical east-west direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.			

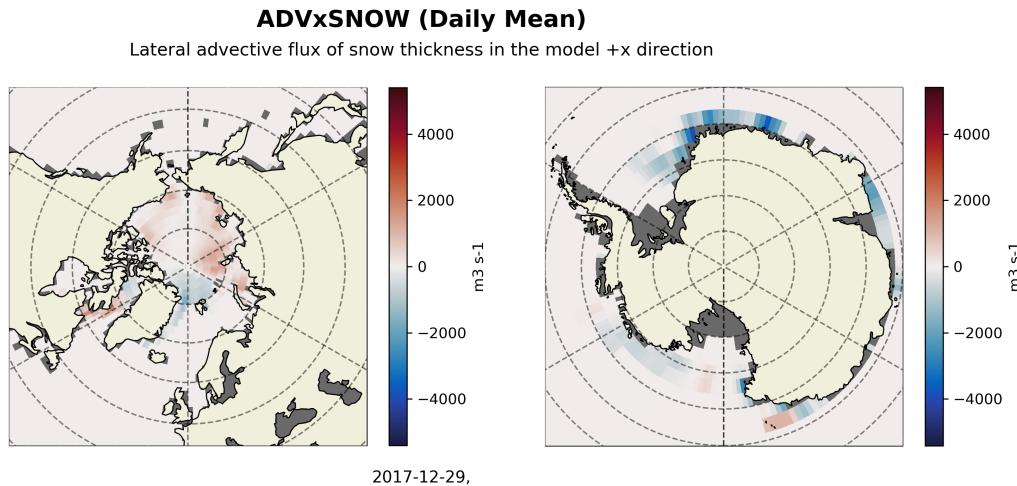


Figure 101: Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: ADVxSNOW

12.18.4 Native Variable: ADVyHEFF

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

Storage Type	Variable Name	Description	Unit
float32	ADVyHEFF	Lateral advective flux of sea-ice thickness in the model +y direction	m3 s-1
Description of the variable in Common Data language (CDL)			
<pre>float32 ADVyHEFF(time, tile, j_g, i) ADVyHEFF: _FillValue = 9.96921e+36 ADVyHEFF: long_name = Lateral advective flux of sea: ice thickness in the model +y direction ADVyHEFF: units = m3 s: 1 ADVyHEFF: mate = ADVxHEFF ADVyHEFF: coverage_content_type = modelResult ADVyHEFF: direction = >0 increases mean sea: ice thickness (HEFF) ADVyHEFF: coordinates = time ADVyHEFF: valid_min = : 95350.6328125 ADVyHEFF: valid_max = 115755.4375</pre>			
Comments			
Lateral advective flux of grid cell mean sea-ice thickness (heff) in the +y direction through the 'v' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +advyheff(i,j_g) corresponds to +y fluxes through the 'v' face of the tracer cell at (i,j,k=0). also, the model +y direction does not necessarily correspond to the geographical north-south direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.			

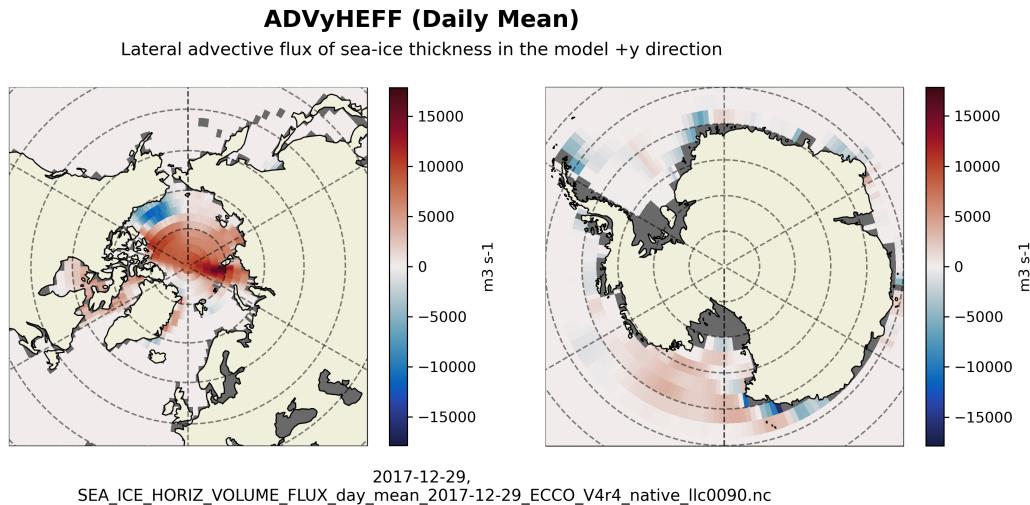


Figure 102: Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: ADVyHEFF

12.18.5 Native Variable: ADVySNOW

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

Storage Type	Variable Name	Description	Unit
float32	ADVySNOW	Lateral advective flux of snow thickness in the model +y direction	m3 s-1
Description of the variable in Common Data language (CDL)			
<pre>float32 ADVySNOW(time, tile, j_g, i) ADVySNOW: _FillValue = 9.96921e+36 ADVySNOW: long_name = Lateral advective flux of snow thickness in the model +y direction ADVySNOW: units = m3 s: 1 ADVySNOW: mate = ADVxSNOW ADVySNOW: coverage_content_type = modelResult ADVySNOW: direction = >0 increases mean snow thickness (HSNOW) ADVySNOW: coordinates = time ADVySNOW: valid_min = : 30630.552734375 ADVySNOW: valid_max = 27252.87890625</pre>			
Comments			
<p>Lateral advective flux of grid cell mean snow thickness (hsnow) in the +y direction through the 'V' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +advysnow(i,j_g) corresponds to +y fluxes through the 'V' face of the tracer cell at (i,j,k=0). also, the model +y direction does not necessarily correspond to the geographical north-south direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.</p>			

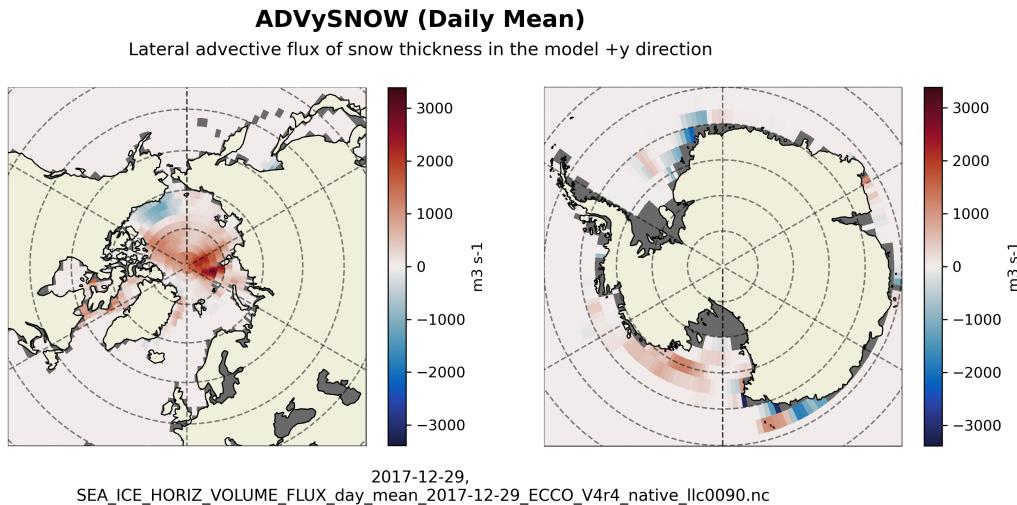


Figure 103: Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: ADVySNOW

12.18.6 Native Variable: DFxEHEFF

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

Storage Type	Variable Name	Description	Unit
float32	DFxEHEFF	Lateral diffusive flux of sea-ice thickness in the model +x direction.	m ³ s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 DFxEHEFF(time, tile, j, i_g) DFxEHEFF: _FillValue = 9.96921e+36 DFxEHEFF: long_name = Lateral diffusive flux of sea: ice thickness in the model +x direction. DFxEHEFF: units = m3 s: 1 DFxEHEFF: mate = DFyEHEFF DFxEHEFF: coverage_content_type = modelResult DFxEHEFF: direction = >0 increases mean sea: ice thickness (HEFF) DFxEHEFF: coordinates = time DFxEHEFF: valid_min = : 1444.172607421875 DFxEHEFF: valid_max = 2379.271240234375</pre>			
Comments			
Lateral diffusive flux of grid cell mean sea-ice thickness (heff) in the +x direction through the 'u' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +dfxeheff(i_g,j) corresponds to +x fluxes through the 'u' face of the tracer cell at (i,j,k=0). also, the model +x direction does not necessarily correspond to the geographical east-west direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.			

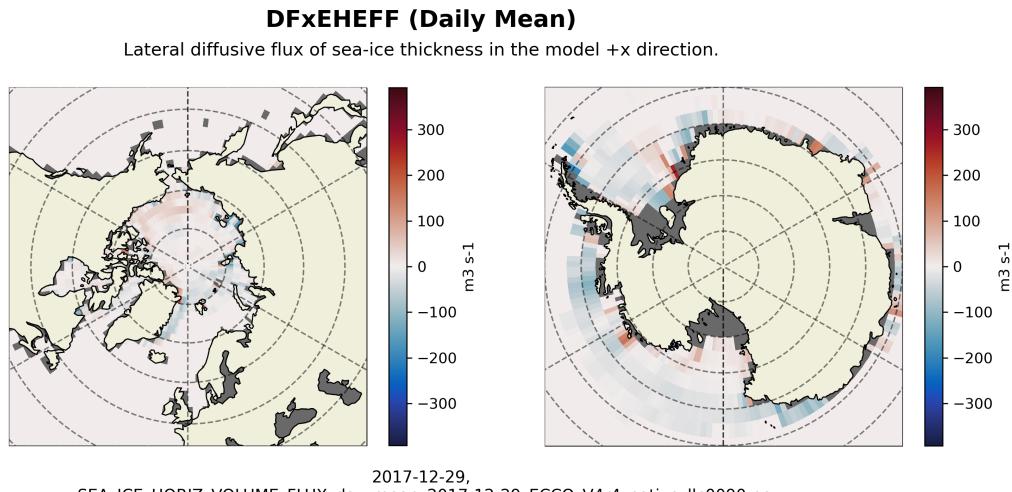


Figure 104: Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: DFxEHEFF

12.18.7 Native Variable: DFxESNOW

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

Storage Type	Variable Name	Description	Unit
float32	DFxESNOW	Lateral diffusive flux of snow thickness in the model +x direction	m ³ s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 DFxESNOW(time, tile, j, i_g) DFxESNOW:_FillValue = 9.96921e+36 DFxESNOW:long_name = Lateral diffusive flux of snow thickness in the model +x direction DFxESNOW:units = m3 s: 1 DFxESNOW:mate = DFyESNOW DFxESNOW:coverage_content_type = modelResult DFxESNOW:direction = >0 increases mean snow thickness (HSNOW) DFxESNOW:coordinates = time DFxESNOW:valid_min = : 448.1134948730469 DFxESNOW:valid_max = 440.94427490234375</pre>			
Comments			
Lateral diffusive flux of grid cell mean snow thickness (hsnow) in the +x direction through the 'u' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +dfxesnow(i_g,j) corresponds to +x fluxes through the 'u' face of the tracer cell at (i,j,k=0). also, the model +x direction does not necessarily correspond to the geographical east-west direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.			

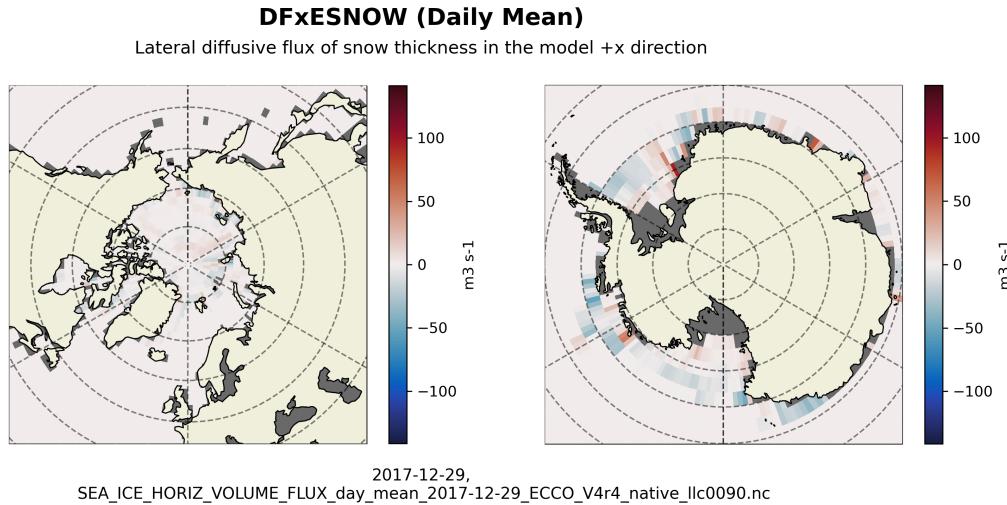


Figure 105: Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: DFxESNOW

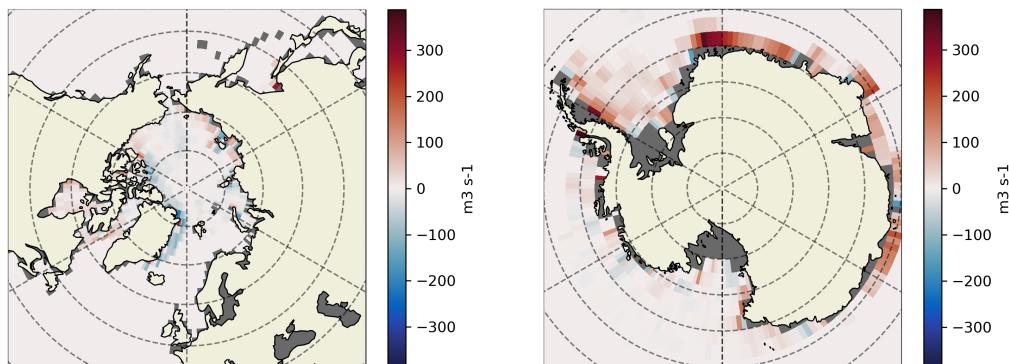
12.18.8 Native Variable: DFyEHEFF

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

Storage Type	Variable Name	Description	Unit
float32	DFyEHEFF	Lateral diffusive flux of sea-ice thickness in the model +y direction.	m ³ s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 DFyEHEFF(time, tile, j_g, i) DFyEHEFF: _FillValue = 9.96921e+36 DFyEHEFF: long_name = Lateral diffusive flux of sea: ice thickness in the model +y direction. DFyEHEFF: units = m3 s: 1 DFyEHEFF: mate = DFxEHEFF DFyEHEFF: coverage_content_type = modelResult DFyEHEFF: direction = >0 increases mean sea: ice thickness (HEFF) DFyEHEFF: coordinates = time DFyEHEFF: valid_min = : 3078.810791015625 DFyEHEFF: valid_max = 1614.6512451171875</pre>			
Comments			
Lateral diffusive flux of grid cell mean sea-ice thickness (heff) in the +y direction through the 'v' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +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.



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: DFyEHEFF

12.18.9 Native Variable: DFyESNOW

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

Storage Type	Variable Name	Description	Unit
float32	DFyESNOW	Lateral diffusive flux of snow thickness in the model +y direction	m ³ s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 DFyESNOW(time, tile, j_g, i) DFyESNOW: _FillValue = 9.96921e+36 DFyESNOW: long_name = Lateral diffusive flux of snow thickness in the model +y direction DFyESNOW: units = m3 s: 1 DFyESNOW: mate = DFxESNOW DFyESNOW: coverage_content_type = modelResult DFyESNOW: direction = >0 increases mean snow thickness (HSNOW) DFyESNOW: coordinates = time DFyESNOW: valid_min = : 662.0200805664062 DFyESNOW: valid_max = 411.7032470703125</pre>			
Comments			
Lateral diffusive flux of grid cell mean snow thickness (hsnow) in the +y direction through the 'v' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal flux quantities are staggered relative to the tracer cells with indexing such that +dfyesnow(i,j_g,k) corresponds to +y fluxes through the 'v' face of the tracer cell at (i,j,k=0). also, the model +y direction does not necessarily correspond to the geographical north-south direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.			

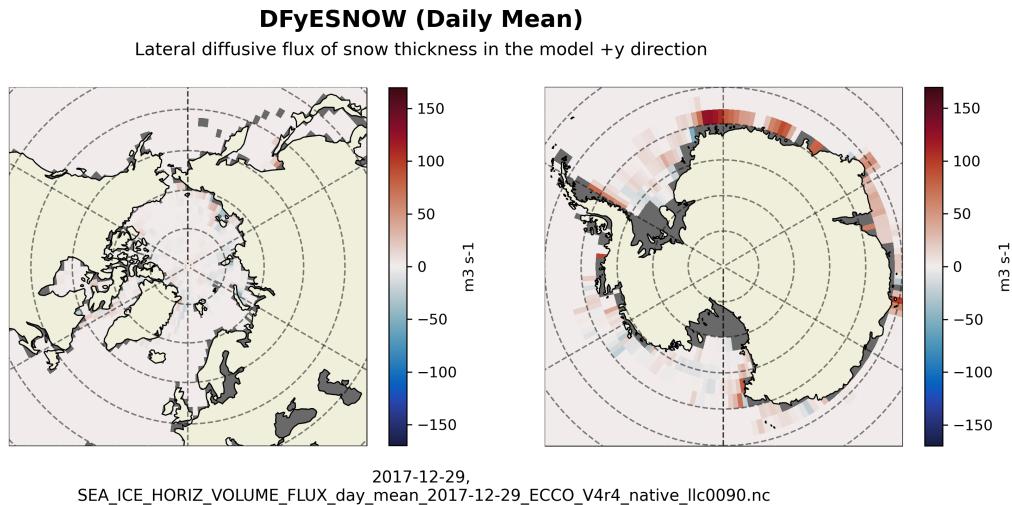


Figure 107: Dataset: SEA_ICE_HORIZ_VOLUME_FLUX, Variable: DFyESNOW

12.19 Native dataset of SEA_ICE_SALT_PLUME_FLUX

12.19.1 Overview

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

Table 12.105: Coordinates and Variables in the dataset SEA_ICE_SALT_PLUME_FLUX

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

12.19.2 Native Variable: oceSPDep

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

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

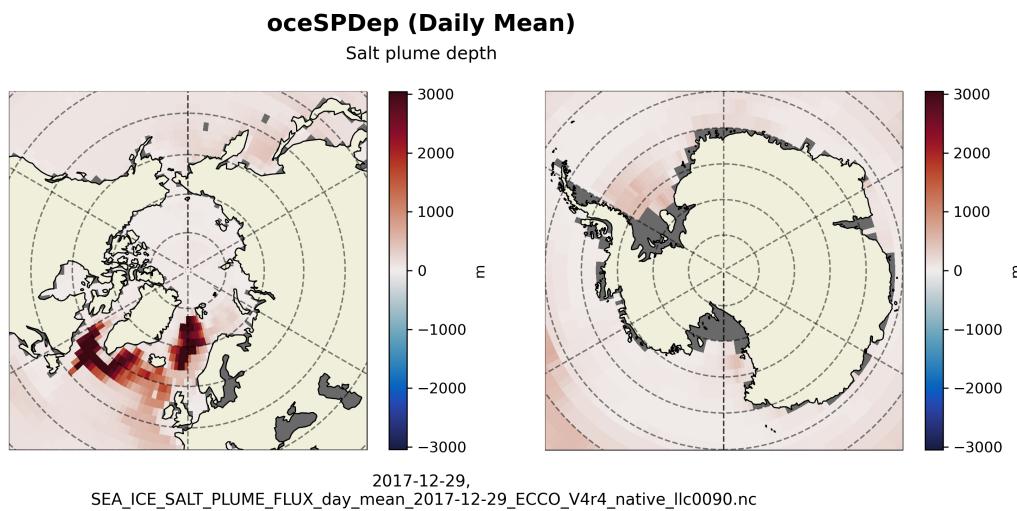


Figure 108: Dataset: SEA_ICE_SALT_PLUME_FLUX, Variable: oceSPDep

12.19.3 Native Variable: oceSPflx

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

Storage Type	Variable Name	Description	Unit
float32	oceSPflx	Net salt flux into the ocean due to brine rejection	g m ⁻² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 oceSPflx(time, tile, j, i) oceSPflx: _FillValue = 9.96921e+36 oceSPflx: long_name = Net salt flux into the ocean due to brine rejection oceSPflx: units = g m: 2 s: 1 oceSPflx: coverage_content_type = modelResult oceSPflx: direction = >0 increases salinity (SALT) oceSPflx: coordinates = time YC XC oceSPflx: valid_min = 0.0 oceSPflx: valid_max = 0.058169759809970856</pre>			
Comments			
Net salt flux into the ocean due to brine rejection during sea-ice formation. note: units are grams of salt per square meter per second, not salinity per square meter per second.			

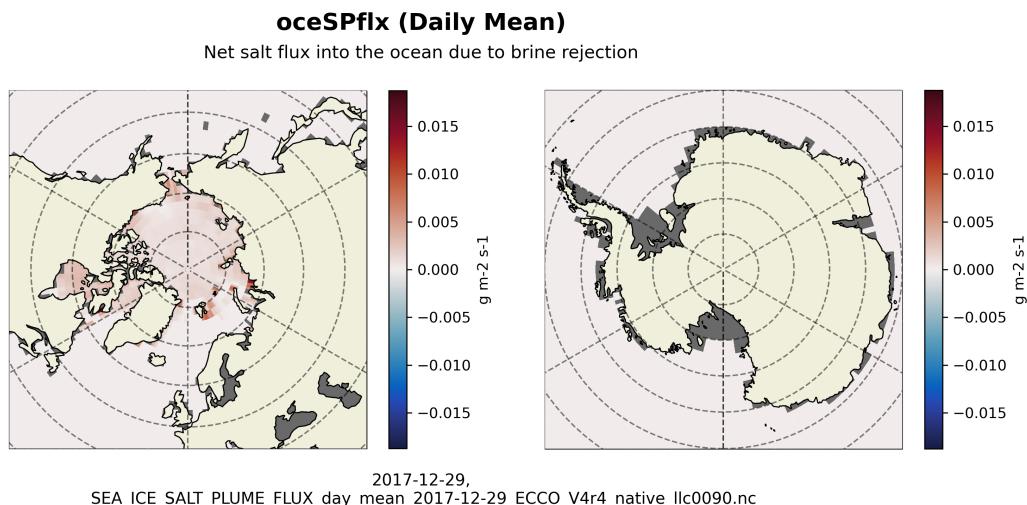


Figure 109: Dataset: SEA_ICE_SALT_PLUME_FLUX, Variable: oceSPflx

12.20 Native dataset of SEA_ICE_VELOCITY

12.20.1 Overview

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

Table 12.108: Coordinates and Variables in the dataset SEA_ICE_VELOCITY

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

Table 12.108: Coordinates and Variables in the dataset SEA_ICE_VELOCITY

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

12.20.2 Native Variable: Sluice

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

Storage Type	Variable Name	Description	Unit
float32	Sluice	Sea-ice velocity in the model +x direction	m s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 SIuice(time, tile, j, i_g) SIuice: _FillValue = 9.96921e+36 SIuice: long_name = Sea: ice velocity in the model +x direction SIuice: units = m s: 1 SIuice: mate = SIvice SIuice: coverage_content_type = modelResult SIuice: standard_name = sea_ice_x_velocity SIuice: coordinates = time SIuice: valid_min = : 0.4000000059604645 SIuice: valid_max = 0.4000000059604645</pre>			
Comments			
<p>Horizontal sea-ice velocity in the +x direction at the 'u' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal velocities are staggered relative to the tracer cells with indexing such that +siuice(i_g,j) corresponds to +x fluxes through the 'u' face of the tracer cell at (i,j,k=0). also, the model +x direction does not necessarily correspond to the geographical east-west direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.</p>			

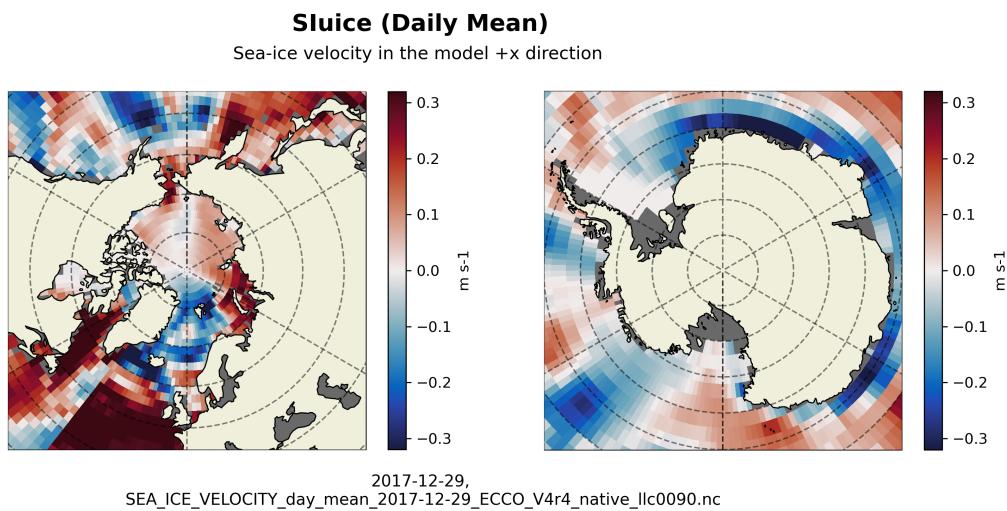


Figure 110: Dataset: SEA_ICE_VELOCITY, Variable: Sluice

12.20.3 Native Variable: Slvice

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

Storage Type	Variable Name	Description	Unit
float32	Slvice	Sea-ice velocity in the model +y direction	m s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 SIvice(time, tile, j_g, i) SIvice:_FillValue = 9.96921e+36 SIvice:long_name = Sea: ice velocity in the model +y direction SIvice:units = m s: 1 SIvice:mate = SIuice SIvice:coverage_content_type = modelResult SIvice:standard_name = sea_ice_y_velocity SIvice:coordinates = time SIvice:valid_min = : 0.4000000059604645 SIvice:valid_max = 0.4000000059604645</pre>			
Comments			
Horizontal sea-ice velocity in the +y direction at the 'v' face of the tracer cell on the native model grid. note: in the arakawa-c grid, horizontal velocities are staggered relative to the tracer cells with indexing such that +sivice(i,j_g) corresponds to +y fluxes through the 'v' face of the tracer cell at (i,j,k=0). also, the model +y direction does not necessarily correspond to the geographical north-south direction because the x and y axes of the model's curvilinear lat-lon-cap (llc) grid have arbitrary orientations which vary within and across tiles.			

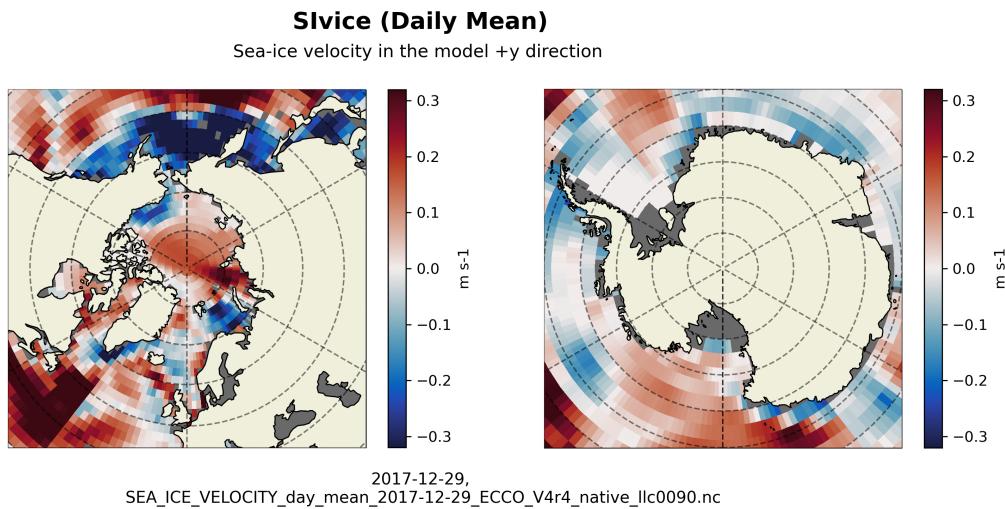


Figure 111: Dataset: SEA_ICE_VELOCITY, Variable: Slvice

12.21 Native dataset of SEA_SURFACE_HEIGHT

12.21.1 Overview

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

surface without the inverse barometer correction) - SSHIBC (inverse barometer correction). The inverted barometer correction accounts for variations in sea surface height due to atmospheric pressure variations. Note: ETAN is model sea level anomaly and should not be compared with satellite altimetry products, see SSH and ETAN for more details.

Table 12.111: Coordinates and Variables in the dataset SEA_SURFACE_HEIGHT

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

12.21.2 Native Variable: ETAN

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

Storage Type	Variable Name	Description	Unit
float32	ETAN	Model sea level anomaly	m
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
<p>Model sea level anomaly without corrections for global mean density (steric) changes, inverted barometer effect, or volume displacement due to submerged sea-ice and snow . note: etan should not be used for comparisons with altimetry data products because etan is not corrected for (a) global mean steric sea level changes related to density changes in the boussinesq volume-conserving model (greatbatch correction, see sterghoh) nor (b) sea level displacement due to submerged sea-ice and snow (see siceload). these corrections are made for the variables ssh and sshnoibc.</p>			

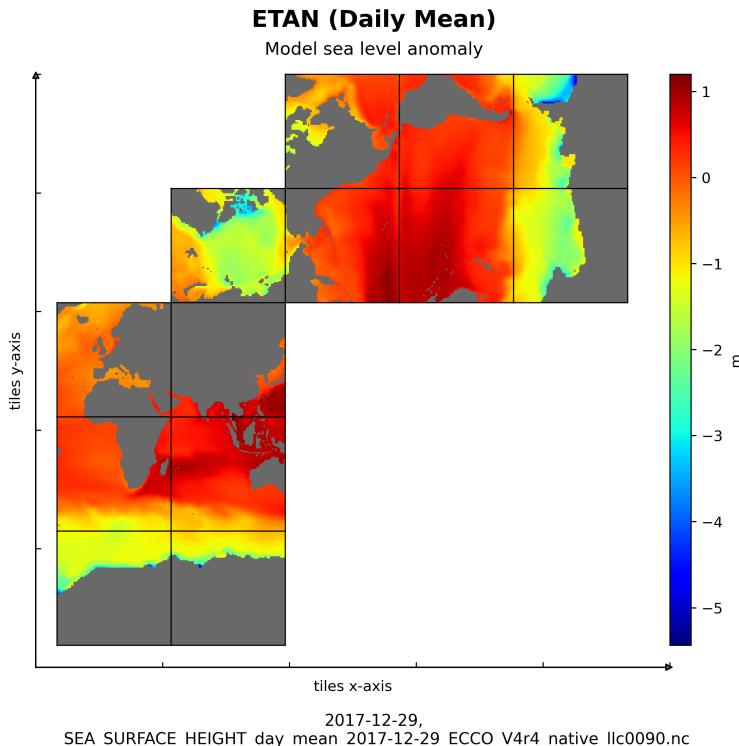


Figure 112: Dataset: SEA_SURFACE_HEIGHT, Variable: ETAN

12.21.3 Native Variable: SSH

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

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

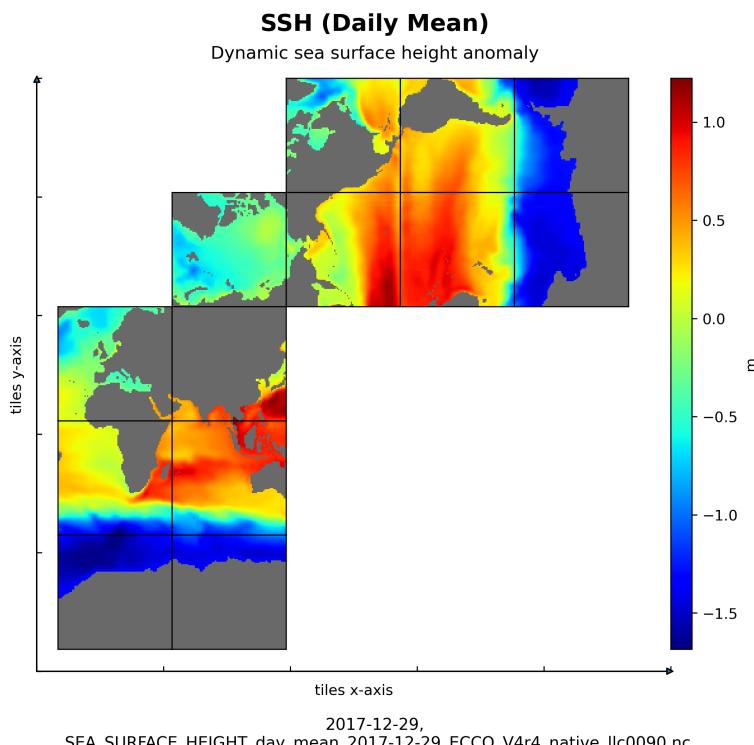


Figure 113: Dataset: SEA_SURFACE_HEIGHT, Variable: SSH

12.21.4 Native Variable: SSHIBC

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

Storage Type	Variable Name	Description	Unit
float32	SSHIBC	The inverted barometer (ib) correction to sea surface height due to atmospheric pressure loading	m
Description of the variable in Common Data language (CDL)			
<pre>float32 SSHIBC(time, tile, j, i) SSHIBC:_FillValue = 9.96921e+36 SSHIBC:long_name = The inverted barometer (IB) correction to sea surface height due to atmospheric pressure loading SSHIBC:units = m SSHIBC:coverage_content_type = modelResult SSHIBC:coordinates = YC time XC SSHIBC:valid_min = : 0.5228679180145264 SSHIBC:valid_max = 0.9044463634490967</pre>			
Comments			
Not an ssh itself, but a correction to model sea level anomaly (etan) required to account for the static part of sea surface displacement by atmosphere pressure loading: ssh = sshnoibc - sshibc. note: use ssh for model-data comparisons with altimetry data products that do apply the ib correction and sshnoibc for comparisons with altimetry data products that do not apply the ib correction.			

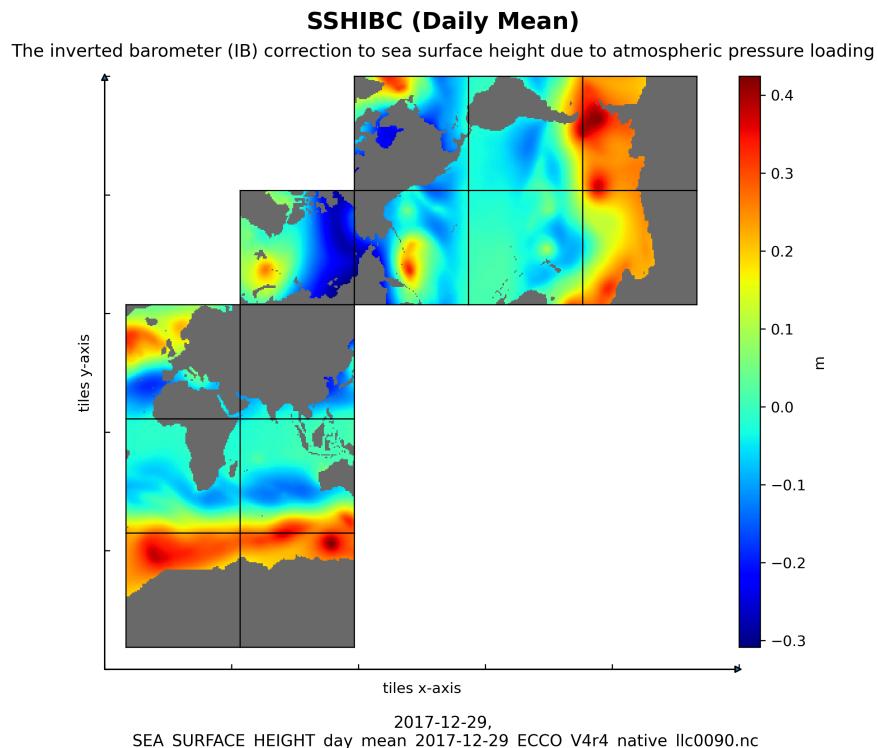


Figure 114: Dataset: SEA_SURFACE_HEIGHT, Variable: SSHIBC

12.21.5 Native Variable: SSHNOIBC

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

Storage Type	Variable Name	Description	Unit
float32	SSHNOIBC	Sea surface height anomaly without the inverted barometer (ib) correction	m
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
<p>Sea surface height anomaly above the geoid without the inverse barometer (ib) correction, suitable for comparisons with altimetry sea surface height data products that do not apply the inverse barometer (ib) correction. note: sshnoibc is calculated by correcting model sea level anomaly etan for two effects: a) global mean steric sea level changes related to density changes in the boussinesq volume-conserving model (greatbatch correction, see ster-glo), b) sea level displacement due to sea-ice and snow pressure loading (see siceload). in ecco version 4 release 4 the model is forced with atmospheric pressure loading. sshnoibc does not correct for the static part of the effect of atmosphere pressure loading on sea surface height (the so-called inverse barometer (ib) correction). use ssh for comparisons with altimetry data products that do apply the ib correction.</p>			

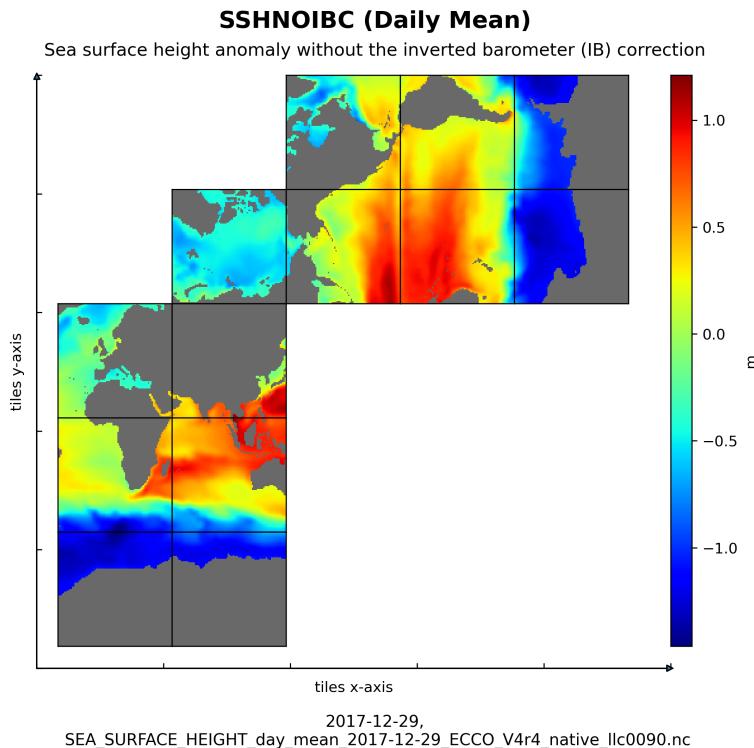


Figure 115: Dataset: SEA_SURFACE_HEIGHT, Variable: SSHNOIBC

13 Lat-Lon Coordinates and Grid Geometry

13.1 Latlon coordinates GRID_GEOMETRY_ECCO

13.1.1 Overview

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

Table 13.1: Coordinates and Variables in the dataset GRID_GEOMETRY_ECCO

Variables	Description of data variables	Unit
hFacC	Vertical open fraction of grid cell	1
Depth	Model seafloor depth below ocean surface at rest	m
area	Area of lat-lon grid cell	m ²
drF	Distance between the upper and lower interfaces of the model grid cell	m
maskC	Wet/dry boolean mask for grid cell	—none—
Coordinates	Description of data coordinates	Unit
Z	Depth of grid cell center	m
latitude	Latitude at grid cell center	degrees_north
longitude	Longitude at grid cell center	degrees_east
latitude_bnds	Latitudes of grid cell edges	—none—
longitude_bnds	Longitudes of grid cell edges	—none—
Z_bnds	Depths of grid cell upper and lower interfaces	—none—

13.1.2 Latlon coordinates Variable: hFacC

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

Storage Type	Variable Name	Description	Unit
float64	hFacC	Vertical open fraction of grid cell	1
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
<p>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.</p>			

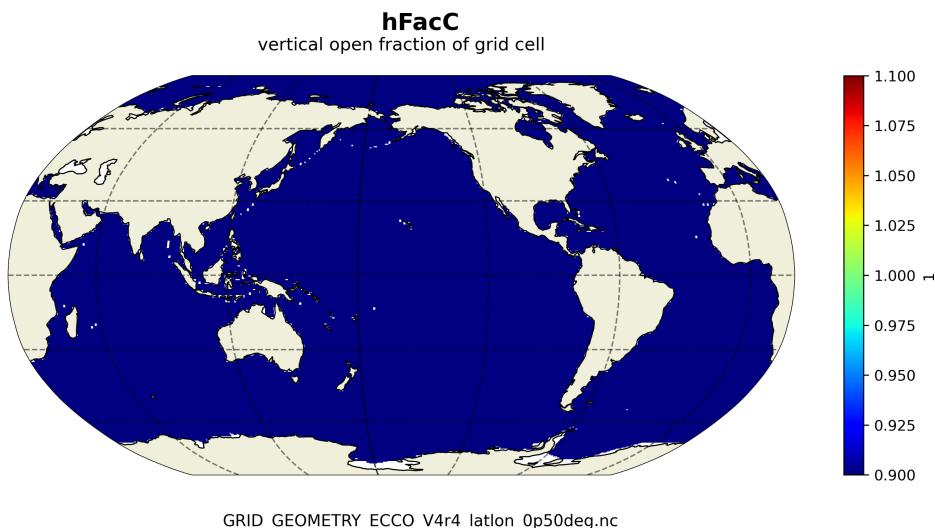


Figure 116: Dataset: GRID_GEOMETRY_ECCO, Variable: hFacC

13.1.3 Latlon coordinates Variable: maskC

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

Storage Type	Variable Name	Description	Unit
bool	maskC	Wet/dry boolean mask for grid cell	N/A
Description of the variable in Common Data language (CDL)			
bool maskC(Z, latitude, longitude) maskC: _FillValue = 1 maskC: coverage_content_type = modelResult maskC: long_name = wet/dry boolean mask for grid cell			
Comments			
True for grid cells with nonzero open vertical fraction ($hfacc > 0$), otherwise false.			

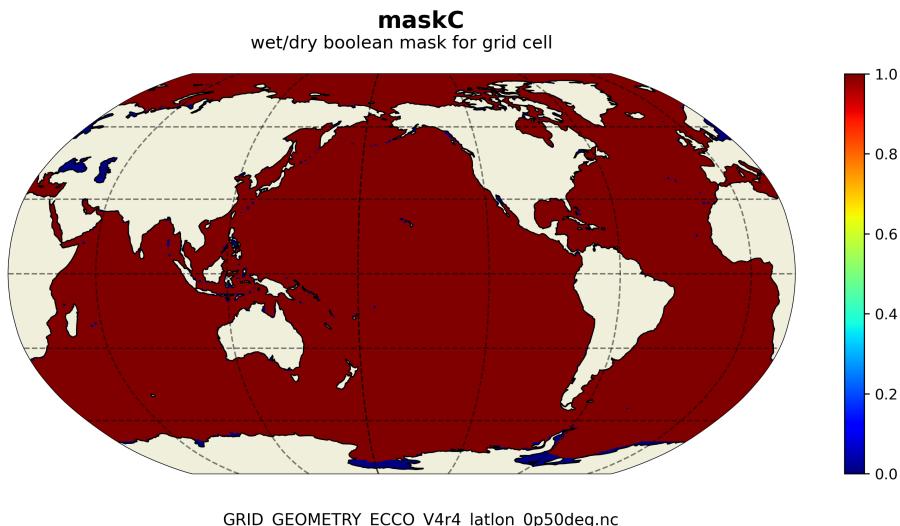


Figure 117: Dataset: GRID_GEOMETRY_ECCO, Variable: maskC

14 Latlon Dataset Groupings

14.1 Latlon dataset of ATM_SURFACE_TEMP_HUM_WIND_PRES

14.1.1 Overview

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

Table 14.1: Coordinates and Variables in the dataset ATM_SURFACE_TEMP_HUM_WIND_PRES

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

14.1.2 Latlon Variable: EXFaqh

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

Storage Type	Variable Name	Description	Unit
float32	EXFaqh	Atmosphere surface (2 m) specific humidity	kg kg ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 EXFaqh(time, latitude, longitude) EXFaqh:_FillValue = 9.96921e+36 EXFaqh:coverage_content_type = modelResult EXFaqh:long_name = Atmosphere surface (2 m) specific humidity EXFaqh:standard_name = surface_specific_humidity EXFaqh:units = kg kg: 1 EXFaqh:coordinates = time EXFaqh:valid_min = : 0.0014020215021446347 EXFaqh:valid_max = 0.03014513850212097</pre>			
Comments			
Surface (2 m) specific humidity over open water. note: sum of era-interim surface specific humidity and the control adjustment from ocean state estimation.			

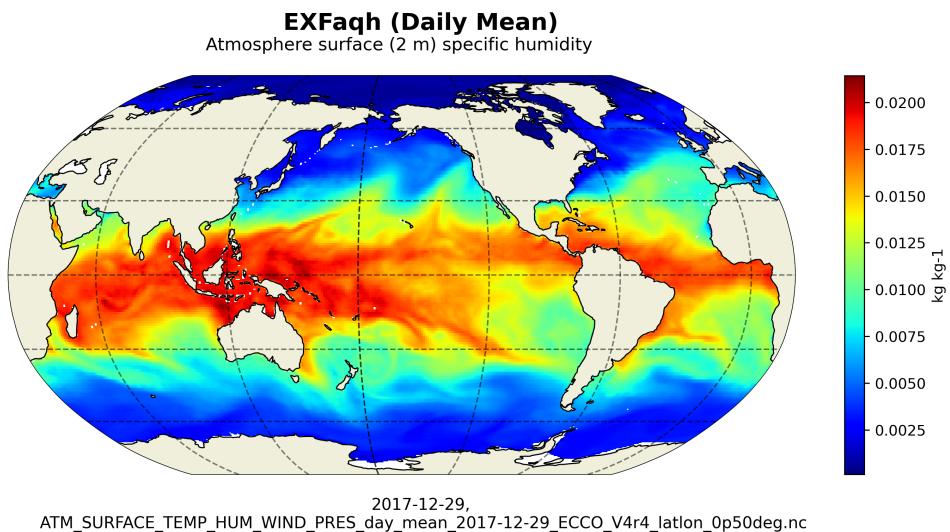


Figure 118: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFaqh

14.1.3 Latlon Variable: EXFatemp

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

Storage Type	Variable Name	Description	Unit
float32	EXFatemp	Atmosphere surface (2 m) air temperature	degree_K
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Surface (2 m) air temperature over open water. note: sum of era-interim surface air temperature and the control adjustment from ocean state estimation.			

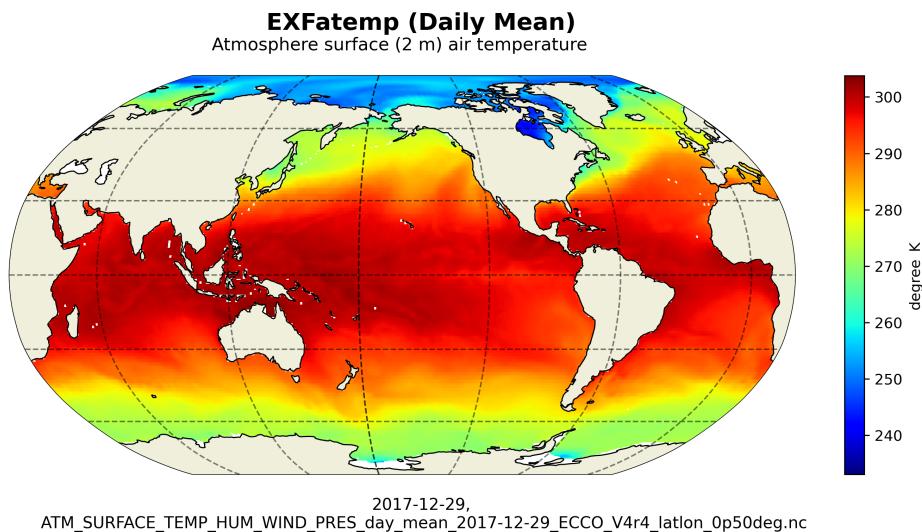


Figure 119: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFatemp

14.1.4 Latlon Variable: EXFewind

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

Storage Type	Variable Name	Description	Unit
float32	EXFewind	Zonal (east-west) wind speed	m s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Zonal (east-west) component of ocean surface wind. note: exfewind is calculated by interpolating the model's x and y components of wind velocity (exfuwind and exfvwind) to tracer cell centers and then finding the zonal component of the interpolated vectors. ecco v4r4 is forced with wind stress (see exftaux, exftauy), not vector winds + bulk formulae. exfewind is calculated by converting wind stress to vector wind using bulk formulae.			

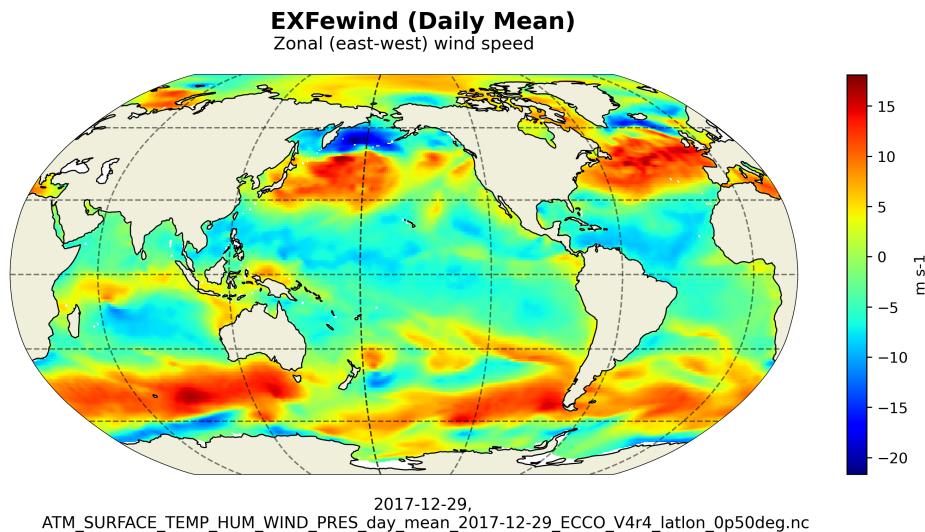


Figure 120: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFewind

14.1.5 Latlon Variable: EXFnwind

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

Storage Type	Variable Name	Description	Unit
float32	EXFnwind	Meridional (north-south) wind speed	m s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Meridional (north-south) component of ocean surface wind. note: exfnwind is calculated by interpolating the model's x and y components of wind velocity (exfuwind and exfvwind) to tracer cell centers and then finding the meridional component of the interpolated vectors. ecco v4r4 is forced with wind stress (see exftaux, exftauy), not vector winds + bulk formulae. exfnwind is calculated by converting wind stress to vector wind using bulk formulae.			

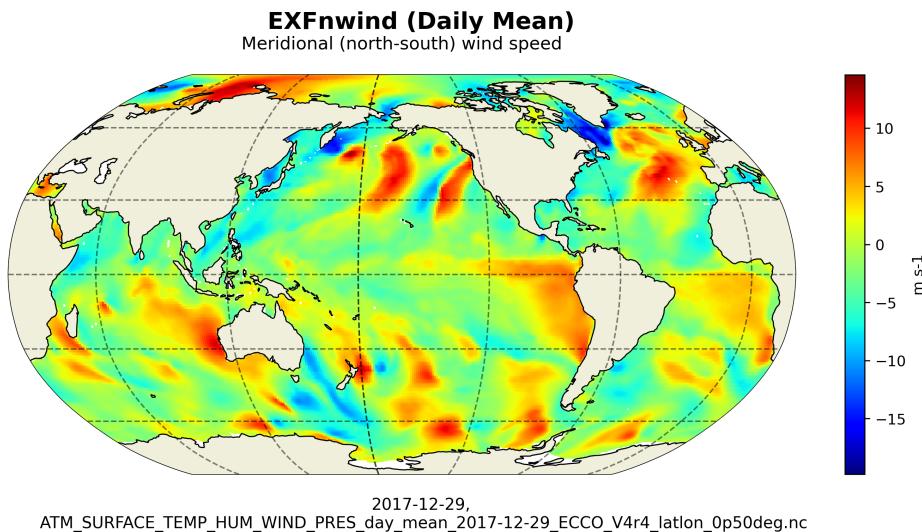


Figure 121: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFnwind

14.1.6 Latlon Variable: EXFpress

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

Storage Type	Variable Name	Description	Unit
float32	EXFpress	Atmosphere surface pressure	N m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Atmospheric pressure field at sea level. note: era-interim atmospheric pressure, with air tides removed using a variety of methods. not adjusted by the ocean state estimation.			

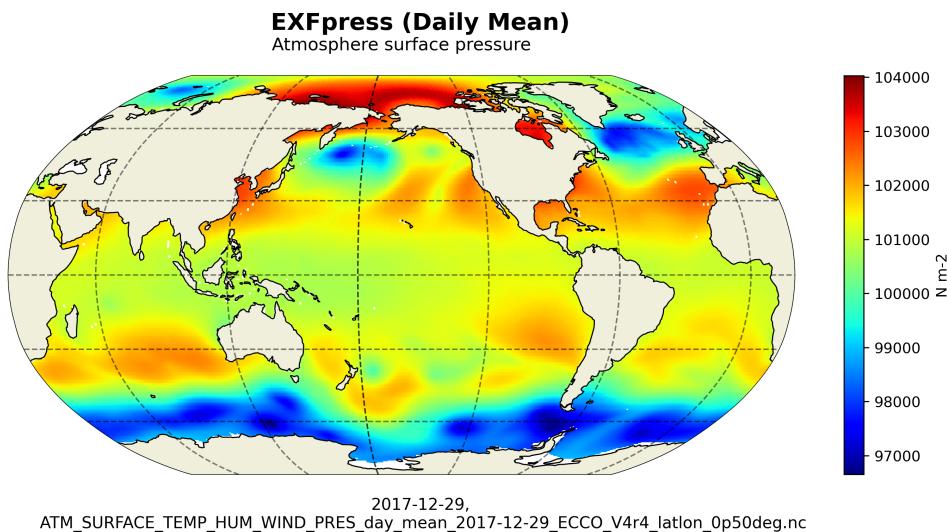


Figure 122: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFpress

14.1.7 Latlon Variable: EXFwspee

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

Storage Type	Variable Name	Description	Unit
float32	EXFwspee	Wind speed	m s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
10-m wind speed magnitude (>= 0) over open water. only used for the calculation of air-sea fluxes using bulk formulae. note: not adjusted by the ocean state estimation and not necesarily consistent with exfuwind and exfvwind because exfuwind and exfvwind are calculated from exftaux and exftauy using bulk formulae. exfwspee != sqrt(exfuwind**2 + exfvwind**2).			

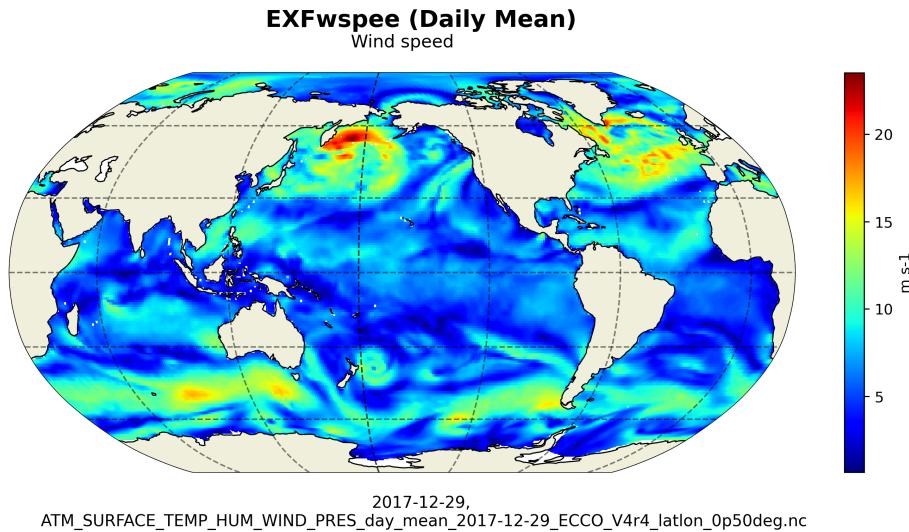


Figure 123: Dataset: ATM_SURFACE_TEMP_HUM_WIND_PRES, Variable: EXFwspee

14.2 Latlon dataset of OCEAN_AND_ICE_SURFACE_FW_FLUX

14.2.1 Overview

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

Table 14.8: Coordinates and Variables in the dataset OCEAN_AND_ICE_SURFACE_FW_FLUX

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

14.2.2 Latlon Variable: EXFempmr

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

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

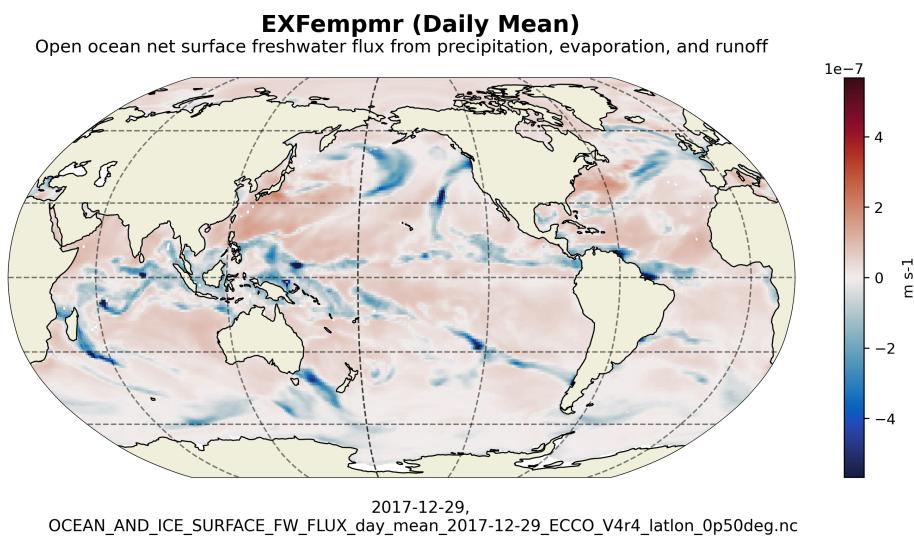


Figure 124: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFempmr

14.2.3 Latlon Variable: EXFevap

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

Storage Type	Variable Name	Description	Unit
float32	EXFevap	Open ocean evaporation rate	m s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Evaporation rate per unit area of open water (not covered by sea-ice). note: calculated using the bulk formula following large and yeager (2004) ncarr/tn-460+str.			

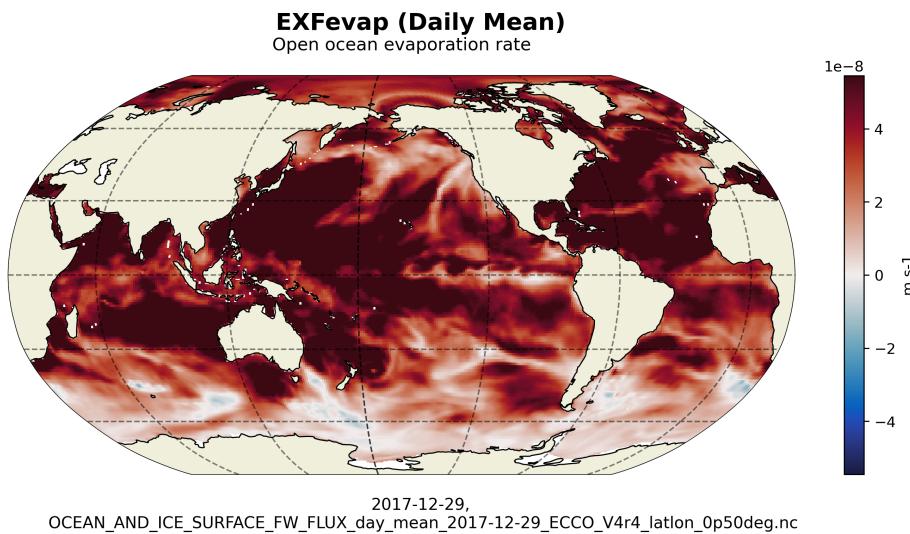


Figure 125: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFevap

14.2.4 Latlon Variable: EXFpreci

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

Storage Type	Variable Name	Description	Unit
float32	EXFpreci	Precipitation rate	m s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Precipitation rate. note: sum of era-interim precipitation and the control adjustment from ocean state estimation.			

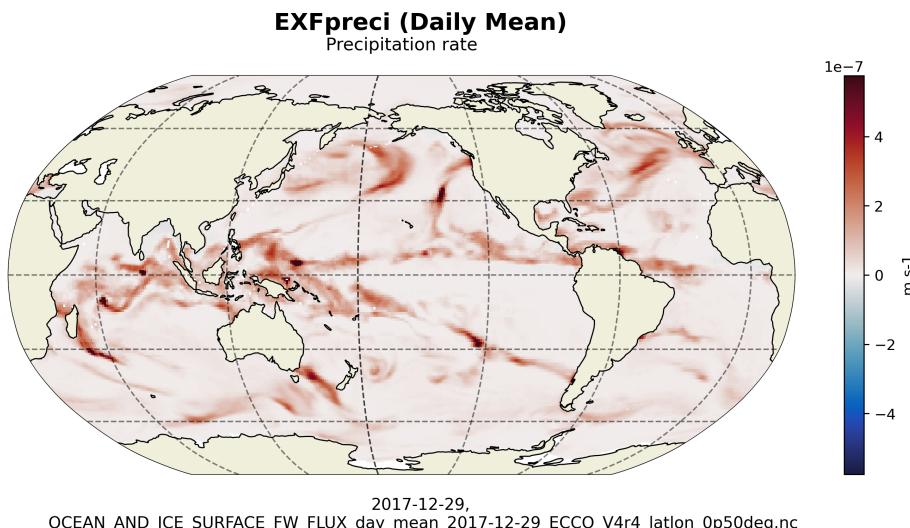


Figure 126: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFpreci

14.2.5 Latlon Variable: EXFroff

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

Storage Type	Variable Name	Description	Unit
float32	EXFroff	River runoff	m s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
River runoff freshwater flux. note: not adjusted by the optimization.			

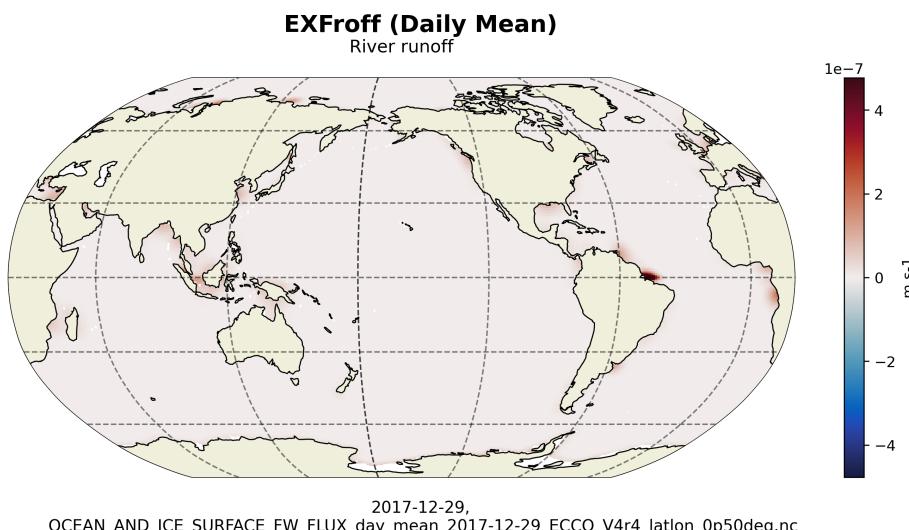


Figure 127: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: EXFroff

14.2.6 Latlon Variable: SFLUX

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

Storage Type	Variable Name	Description	Unit
float32	SFLUX	Rate of change of total ocean salinity per m2 accounting for mass fluxes.	g m ⁻² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
<p>The rate of change of total ocean salinity due to freshwater fluxes across the liquid surface and the addition or removal of mass. note: the global area integral of sflux matches the time-derivative of total ocean salinity (psu s⁻¹). unlike ocefwflx, sflux includes the contribution to the total ocean salinity from changing ocean mass (e.g. from the addition or removal of freshwater in ocefwflx).</p>			

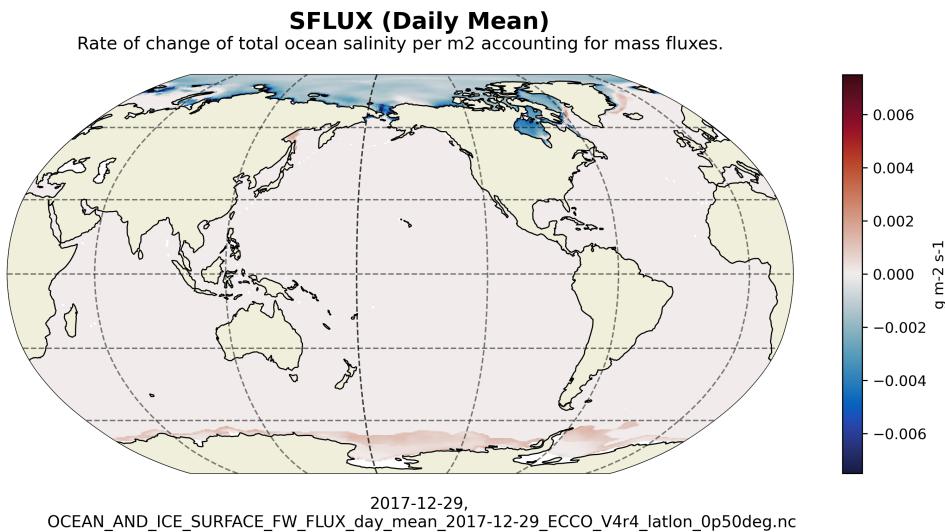


Figure 128: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SFLUX

14.2.7 Latlon Variable: SlacSubl

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

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

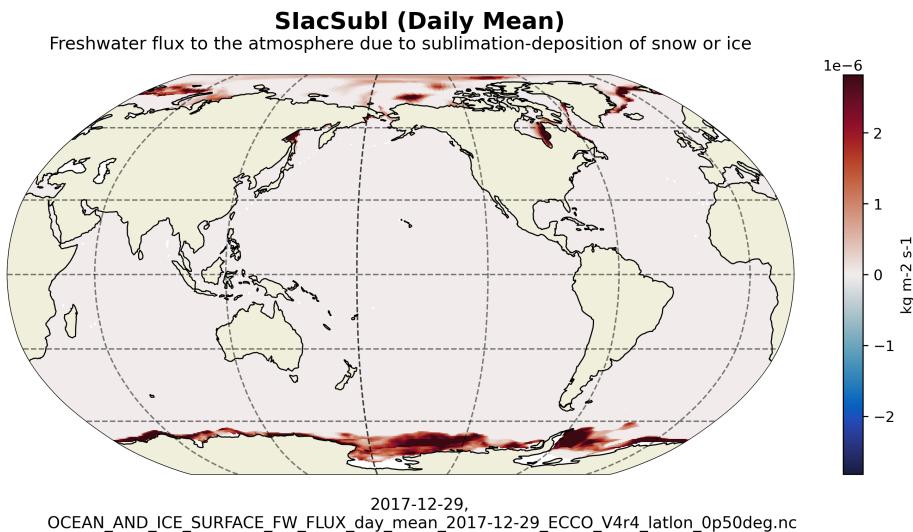


Figure 129: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SlacSubl

14.2.8 Latlon Variable: SlatmFW

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

Storage Type	Variable Name	Description	Unit
float32	SlatmFW	Net freshwater flux into the open ocean, sea-ice, and snow	kg m ⁻² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 SIatmFW(time, latitude, longitude) SIatmFW:_FillValue = 9.96921e+36 SIatmFW:coverage_content_type = modelResult SIatmFW:direction = >0 decreases salinity (SALT) SIatmFW:long_name = Net freshwater flux into the open ocean sea: ice and snow SIatmFW:standard_name = surface_downward_water_flux SIatmFW:units = kg m: 2 s: 1 SIatmFW:coordinates = time SIatmFW:valid_min = : 0.00043017856660299003 SIatmFW:valid_max = 0.008299433626234531</pre>			
Comments			
<p>Net freshwater flux into the combined liquid ocean, sea-ice, and snow reservoirs from the atmosphere and runoff. note: freshwater fluxes between the liquid ocean and sea-ice or snow reservoirs do not contribute to siatmfw. siatmfw counts all fluxes to/from the atmosphere that change the total freshwater stored in the combined liquid ocean, sea-ice, and snow reservoirs.</p>			

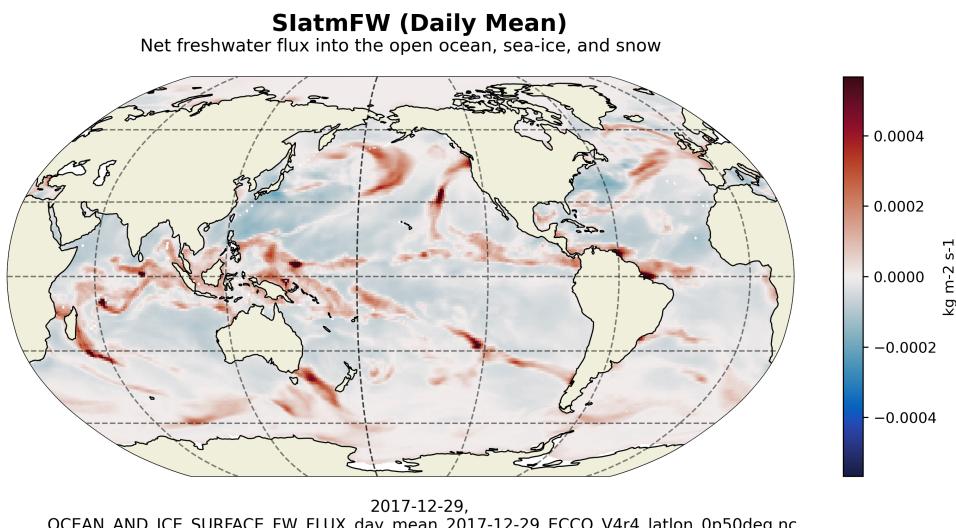


Figure 130: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SlatmFW

14.2.9 Latlon Variable: SI fw Thru

Table 14.16: Attributes description of the variable 'SI fw Thru' from OCEAN_AND_ICE_SURFACE_FW_FLUX's dataset.

Storage Type	Variable Name	Description	Unit
float32	SI fw Thru	Precipitation through sea-ice	kg m ⁻² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 SI fw Thru(time, latitude, longitude) SI fw Thru:_FillValue = 9.96921e+36 SI fw Thru:coverage_content_type = modelResult SI fw Thru:direction = >0 increases ocean volume SI fw Thru:long_name = Precipitation through sea-ice SI fw Thru:units = kg m: 2 s: 1 SI fw Thru:coordinates = time SI fw Thru:valid_min = : 1.695218452368863e: 05 SI fw Thru:valid_max = 0.0010632629273459315</pre>			
Comments			
Precipitation over sea-ice covered regions reaching ocean through sea-ice. note: precipitation over sea-ice covered regions that directly reaches ocean through the sea-ice. it is not due to melt of sea-ice/snow.			

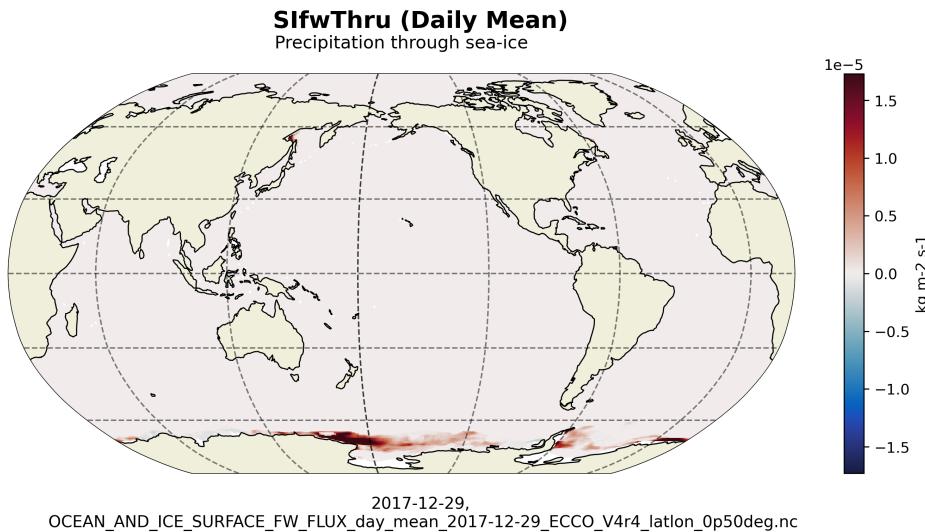


Figure 131: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SI fw Thru

14.2.10 Latlon Variable: SIrsSubl

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

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

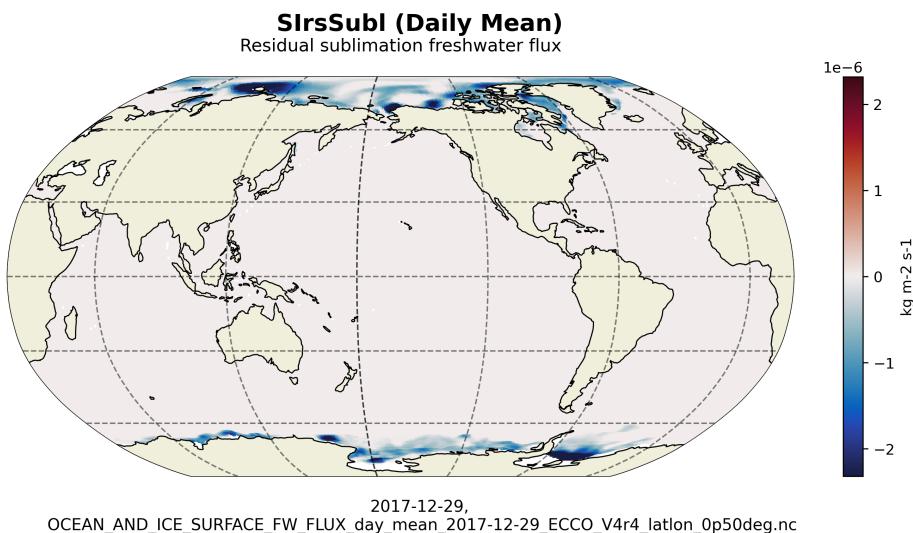


Figure 132: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SIrsSubl

14.2.11 Latlon Variable: SIsnPrcp

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

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

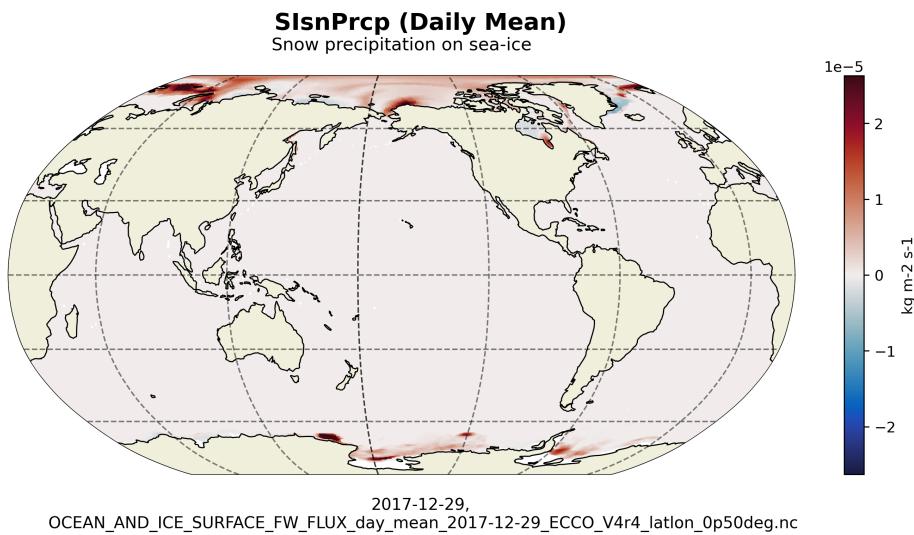


Figure 133: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: SIsnPrcp

14.2.12 Latlon Variable: oceFWflx

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

Storage Type	Variable Name	Description	Unit
float32	oceFWflx	Net freshwater flux into the ocean	kg m ⁻² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Net freshwater flux into the ocean including contributions from runoff, evaporation, precipitation, and mass exchange with sea-ice due to melting and freezing and snow melting. note: ocefwflux does not include freshwater fluxes between the atmosphere and sea-ice and snow. the variable 'siatmfw' accounts for freshwater fluxes out of the combined ocean+sea-ice+snow reservoir.			

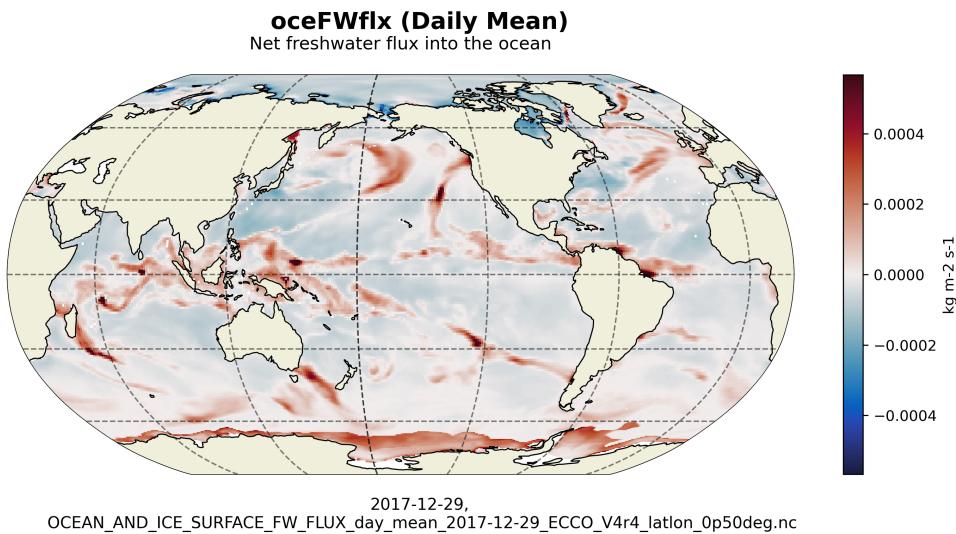


Figure 134: Dataset: OCEAN_AND_ICE_SURFACE_FW_FLUX, Variable: oceFWflx

14.3 Latlon dataset of OCEAN_AND_ICE_SURFACE_HEAT_FLUX

14.3.1 Overview

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

Table 14.20: Coordinates and Variables in the dataset OCEAN_AND_ICE_SURFACE_HEAT_FLUX

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

14.3.2 Latlon Variable: EXFhl

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

Storage Type	Variable Name	Description	Unit
float32	EXFhl	Open ocean air-sea latent heat flux	W m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Air-sea latent heat flux per unit area of open water (not covered by sea-ice). note: calculated from the bulk formula following large and yeager (2004) ncar/tn-460+str.			

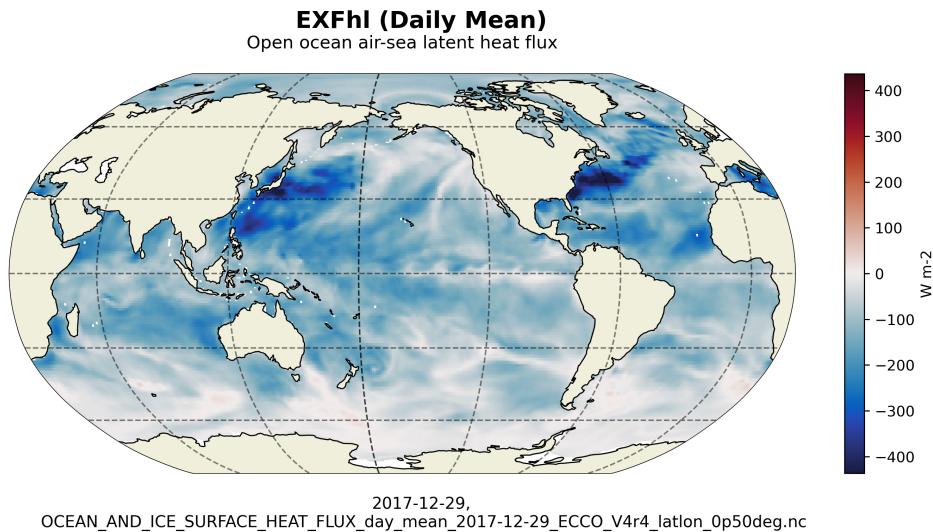


Figure 135: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFhl

14.3.3 Latlon Variable: EXFhs

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

Storage Type	Variable Name	Description	Unit
float32	EXFhs	Open ocean air-sea sensible heat flux	W m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Air-sea sensible heat flux per unit area of open water (not covered by sea-ice). note: calculated from the bulk formula following large and yeager (2004) ncar/tn-460+str.			

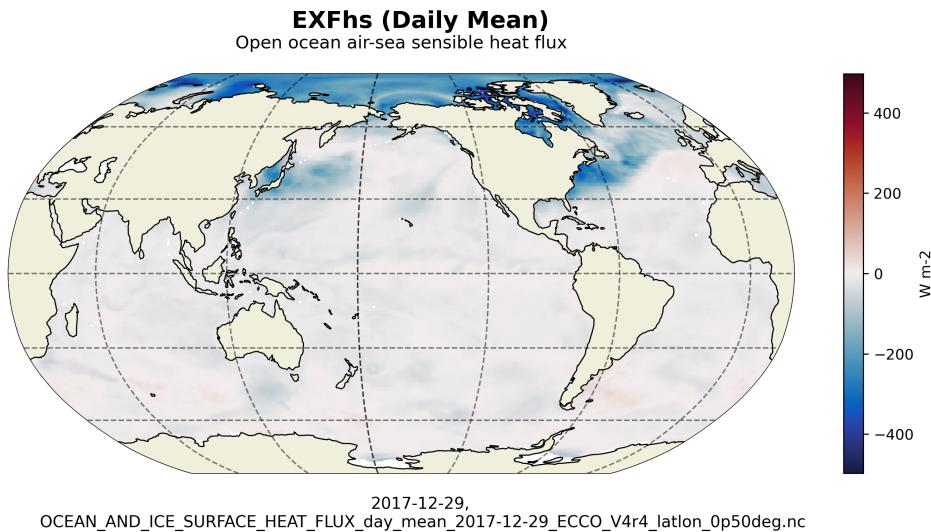


Figure 136: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFhs

14.3.4 Latlon Variable: EXFlwdn

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

Storage Type	Variable Name	Description	Unit
float32	EXFlwdn	Downward longwave radiative flux	W m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Downward longwave radiative flux. note: sum of era-interim downward longwave radiation and the control adjustment from ocean state estimation.			

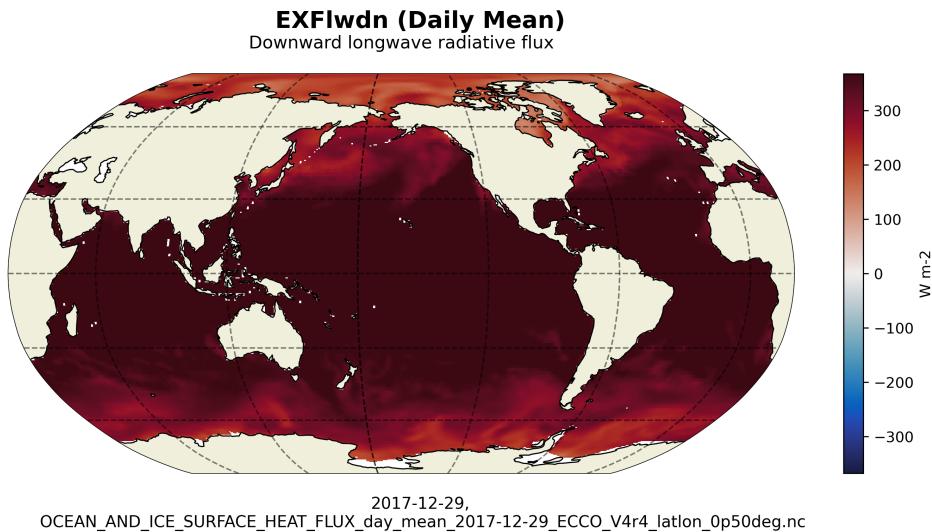


Figure 137: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFlwdn

14.3.5 Latlon Variable: EXFlwnet

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

Storage Type	Variable Name	Description	Unit
float32	EXFlwnet	Net open ocean longwave radiative flux	W m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Net longwave radiative flux per unit area of open water (not covered by sea-ice). note: net longwave radiation over open water calculated from downward longwave radiation (exflwdn) and upward longwave radiation from ocean and sea-ice thermal emission (stefan-boltzman law).			

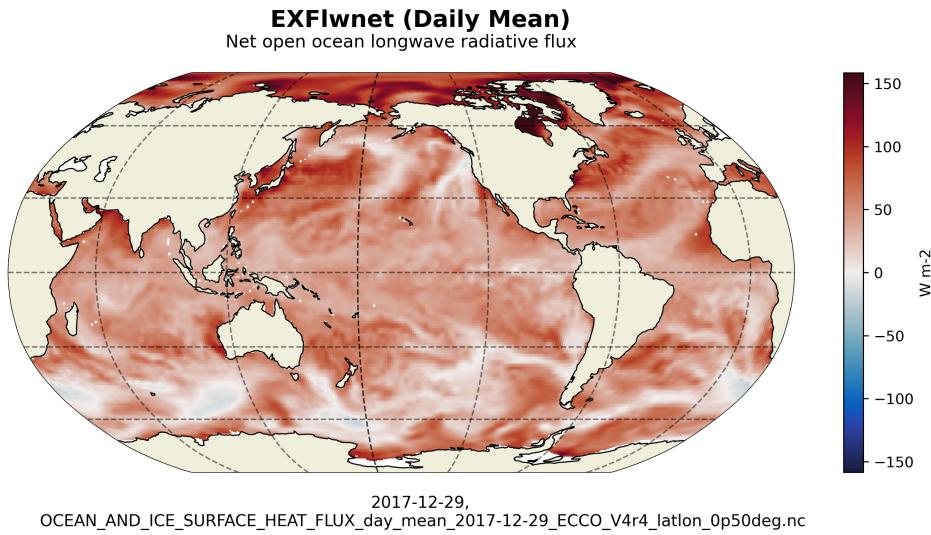


Figure 138: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFlwnet

14.3.6 Latlon Variable: EXFqnet

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

Storage Type	Variable Name	Description	Unit
float32	EXFqnet	Open ocean net air-sea heat flux	W m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Net air-sea heat flux (turbulent and radiative) per unit area of open water (not covered by sea-ice). note: net upward heat flux over open water, calculated as exflwnet+exfswnet-exflh-exfhs.			

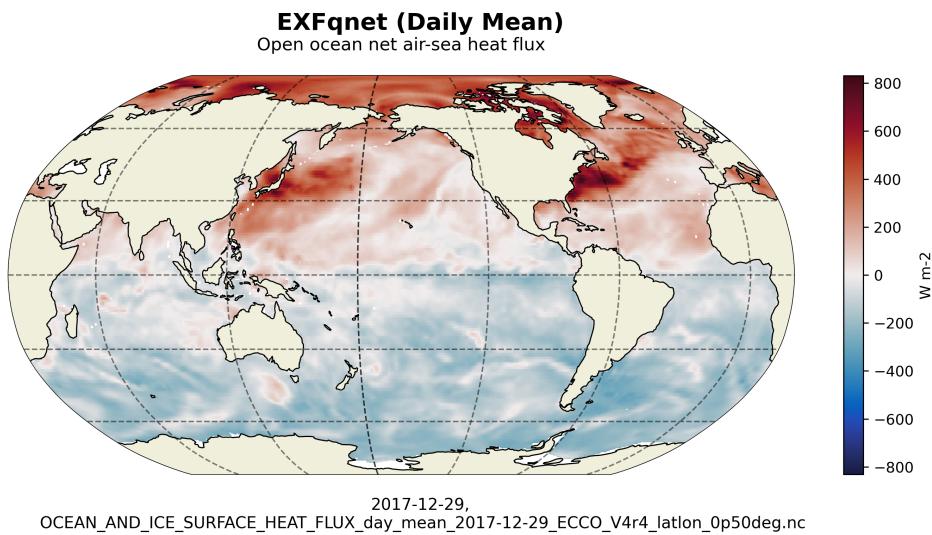


Figure 139: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFqnet

14.3.7 Latlon Variable: EXFswdn

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

Storage Type	Variable Name	Description	Unit
float32	EXFswdn	Downwelling shortwave radiative flux	W m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Downward shortwave radiative flux. note: sum of era-interim downward shortwave radiation and the control adjustment from ocean state estimation.			

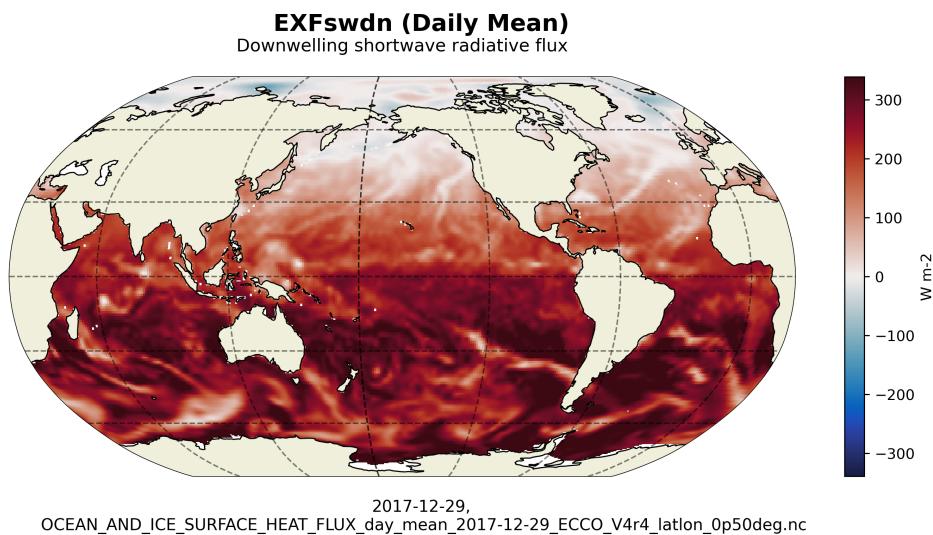


Figure 140: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFswdn

14.3.8 Latlon Variable: EXFswnet

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

Storage Type	Variable Name	Description	Unit
float32	EXFswnet	Open ocean net shortwave radiative flux	W m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Net shortwave radiative flux per unit area of open water (not covered by sea-ice). note: net shortwave radiation over open water calculated from downward shortwave flux (exfswdn) and ocean surface albedo.			

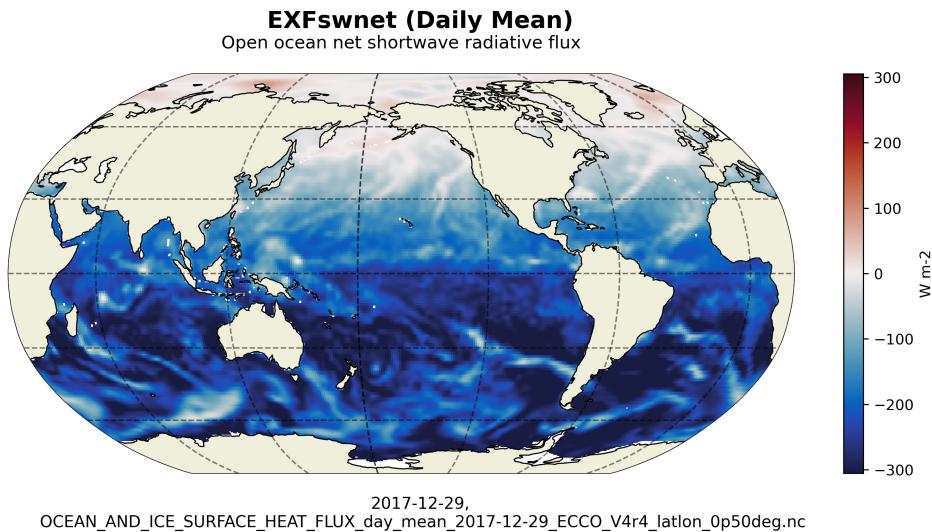


Figure 141: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: EXFswnet

14.3.9 Latlon Variable: Slaaflux

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

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

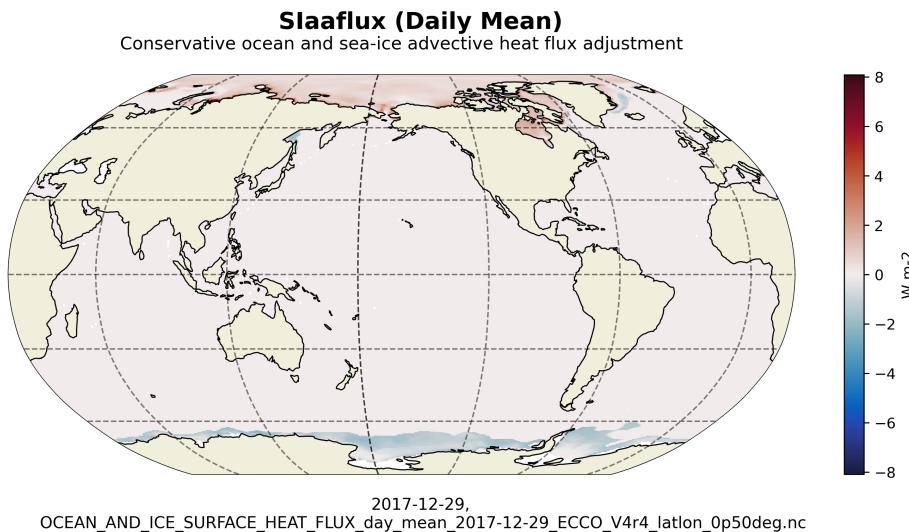


Figure 142: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: Slaaflux

14.3.10 Latlon Variable: SlatmQnt

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

Storage Type	Variable Name	Description	Unit
float32	SlatmQnt	Net upward heat flux to the atmosphere	W m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>float32 SIatmQnt(time, latitude, longitude) SIatmQnt: _FillValue = 9.96921e+36 SIatmQnt: coverage_content_type = modelResult SIatmQnt: direction = >0 upward decreases ocean temperature SIatmQnt: long_name = Net upward heat flux to the atmosphere SIatmQnt: standard_name = surface_upward_heat_flux_in_air SIatmQnt: units = W m: 2 SIatmQnt: coordinates = time SIatmQnt: valid_min = : 756.0607299804688 SIatmQnt: valid_max = 1704.7703857421875</pre>			
Comments			
Net upward heat flux to the atmosphere across open water and sea-ice or snow surfaces. note: nonzero siatmqnt may not be associated with a change in ocean potential temperature due to sea-ice growth or melting. to calculate total ocean heat content changes use the variable tflux which also accounts for changing ocean mass (e.g. ocefwflx).			

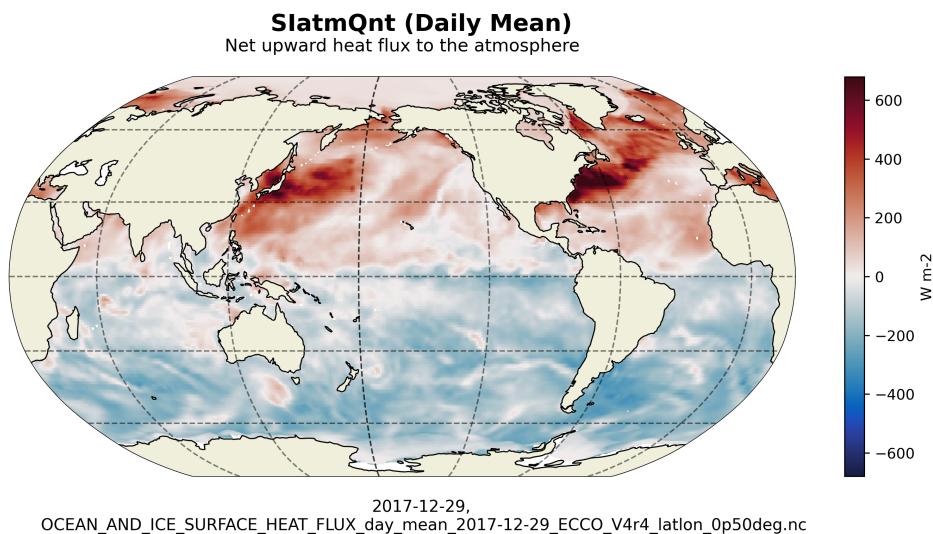


Figure 143: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: SlatmQnt

14.3.11 Latlon Variable: TFLUX

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

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

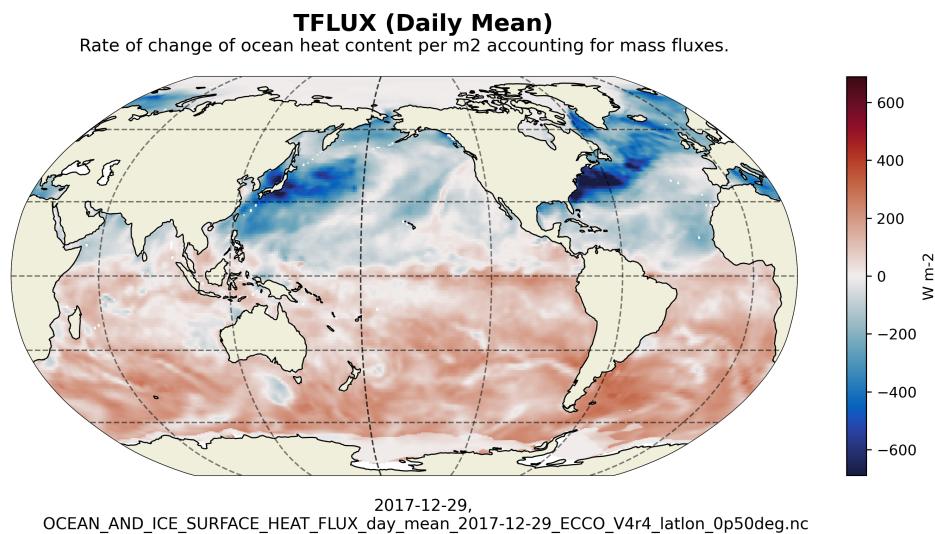


Figure 144: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: TFLUX

14.3.12 Latlon Variable: oceQnet

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

Storage Type	Variable Name	Description	Unit
float32	oceQnet	Net heat flux into the ocean surface	W m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
<p>Net heat flux into the ocean surface from all processes: air-sea turbulent and radiative fluxes and turbulent and conductive fluxes between the ocean and sea-ice and snow. note: oceqnet does not include the change in ocean heat content due to changing ocean mass (ocefwflx). mass fluxes from evaporation, precipitation, and runoff (exfempmr) happen at the same temperature as the ocean surface temperature. consequently, empmr does not change ocean surface temperature. conversely, mass fluxes due to sea-ice thickening/thinning and snow melt in the model are assumed to happen at a fixed Oc. consequently, mass fluxes due to phase changes between seawater and sea-ice and snow induce a heat flux when the ocean surface temperaure is not Oc. the variable tflux does include the change in ocean heat content due to changing ocean mass.</p>			

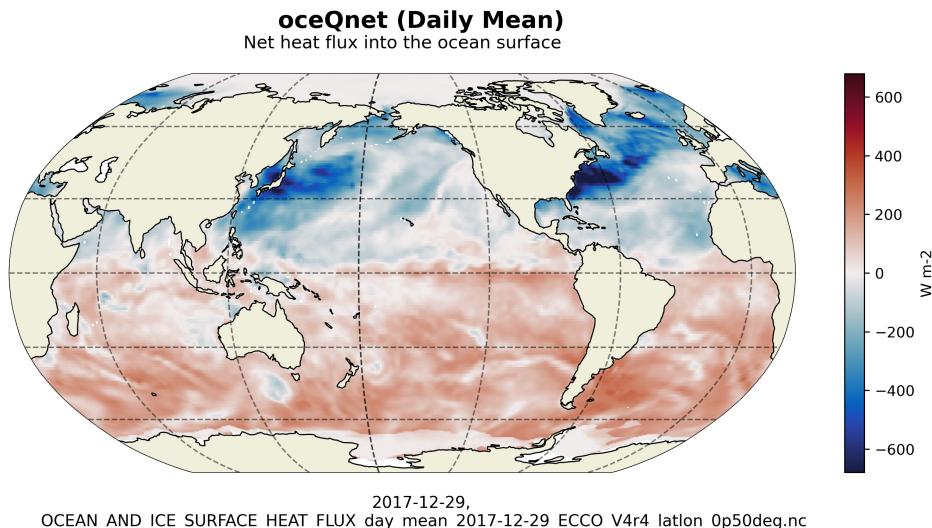


Figure 145: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: oceQnet

14.3.13 Latlon Variable: oceQsw

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

Storage Type	Variable Name	Description	Unit
float32	oceQsw	Net shortwave radiative flux across the ocean surface	W m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Net shortwave radiative flux across the ocean surface. note: shortwave radiation penetrates below the surface grid cell.			

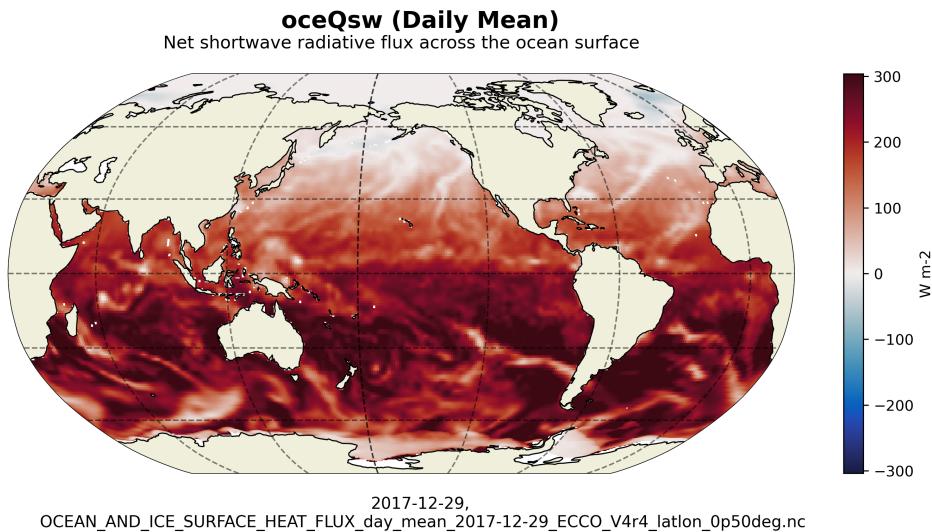


Figure 146: Dataset: OCEAN_AND_ICE_SURFACE_HEAT_FLUX, Variable: oceQsw

14.4 Latlon dataset of OCEAN_AND_ICE_SURFACE_STRESS

14.4.1 Overview

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

Table 14.33: Coordinates and Variables in the dataset OCEAN_AND_ICE_SURFACE_STRESS

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

14.4.2 Latlon Variable: EXFtaue

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

Storage Type	Variable Name	Description	Unit
float32	EXFtaue	Zonal (east-west) wind stress	N m-2
Description of the variable in Common Data language (CDL)			
<pre>float32 EXFtaue(time, latitude, longitude) EXFtaue:_FillValue = 9.96921e+36 EXFtaue:coverage_content_type = modelResult EXFtaue:direction = >0 increases eastward velocity (EVEL) EXFtaue:long_name = Zonal (east: west) wind stress EXFtaue:standard_name = surface_downward_eastward_stress EXFtaue:units = N m: 2 EXFtaue:coordinates = time EXFtaue:valid_min = : 3.1686902046203613 EXFtaue:valid_max = 3.284827709197998</pre>			
Comments			
<p>Zonal (east-west) component of wind stress. note: exftaue is the zonal wind stress applied to the ocean and sea-ice. when sea-ice is present, the total zonal stress applied to the ocean surface is not exftaue, but a combination of the wind stress in the open water fraction (exftaue) and a stress from sea-ice in the ice-covered fraction (see ocetaue). exftaue is calculated by interpolating the model's x and y components of wind stress (exftaux and exftauy) to tracer cell centers and then finding the zonal component of the interpolated vectors. it is not recommended to use exftaue and exftaun for momentum budget calculations because interpolating exftaux and exftauy from the model grid to the lat-lon grid introduces errors. for momentum fluxes to the ocean surface see ocetaux and ocetauy.</p>			

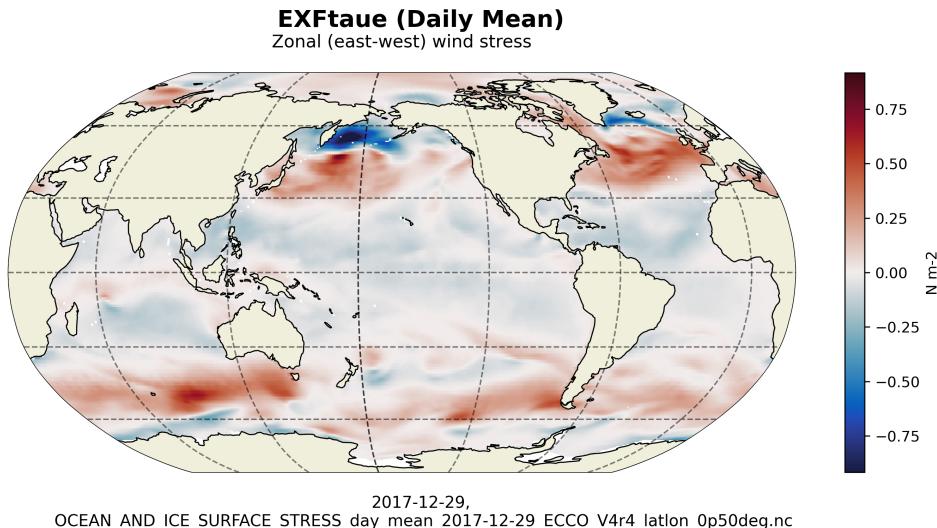


Figure 147: Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: EXFtaue

14.4.3 Latlon Variable: EXFtaun

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

Storage Type	Variable Name	Description	Unit
float32	EXFtaun	Meridional (north-south) wind stress	N m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>float32 EXFtaun(time, latitude, longitude) EXFtaun: _FillValue = 9.96921e+36 EXFtaun: coverage_content_type = modelResult EXFtaun: direction = >0 increases northward velocity (NVEL) EXFtaun: long_name = Meridional (north: south) wind stress EXFtaun: standard_name = surface_downward_northward_stress EXFtaun: units = N m: 2 EXFtaun: coordinates = time EXFtaun: valid_min = : 4.111213207244873 EXFtaun: valid_max = 6.878159523010254</pre>			
Comments			
<p>Meridional (north-south) component of wind stress. note: exftaun is the stress applied to the ocean and sea-ice. when sea-ice is present, the total meridional stress applied to the ocean surface is not exftaun, but a combination of the wind stress in the open water fraction (exftaun) and a stress from sea-ice in the ice-covered fraction (see ocetaun). exftaun is calculated by interpolating the model's x and y components of wind stress (exftaux and exftauy) to tracer cell centers and then determining the meridional component of the interpolated vectors. it is not recommended to use exftaue and exftaun for momentum budget calculations because interpolating exftaux and exftauy from the model grid to the lat-lon grid introduces errors. for momentum fluxes to the ocean surface see ocetaux and ocetauy.</p>			

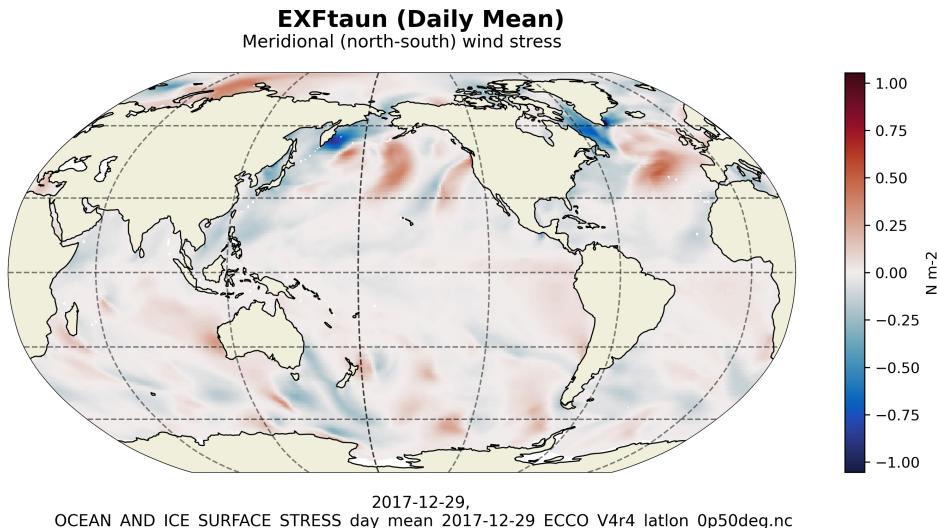


Figure 148: Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: EXFtaun

14.4.4 Latlon Variable: oceTAUE

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

Storage Type	Variable Name	Description	Unit
float32	oceTAUE	Zonal (east-west) ocean surface stress	N m-2
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Zonal (east-west) component of ocean surface stress due to wind and sea-ice. note: ocetaue is calculated by interpolating the model's x and y components of ocean surface stress (ocetaux and ocetauy) to tracer cell centers and then finding the zonal component of the interpolated vectors.			

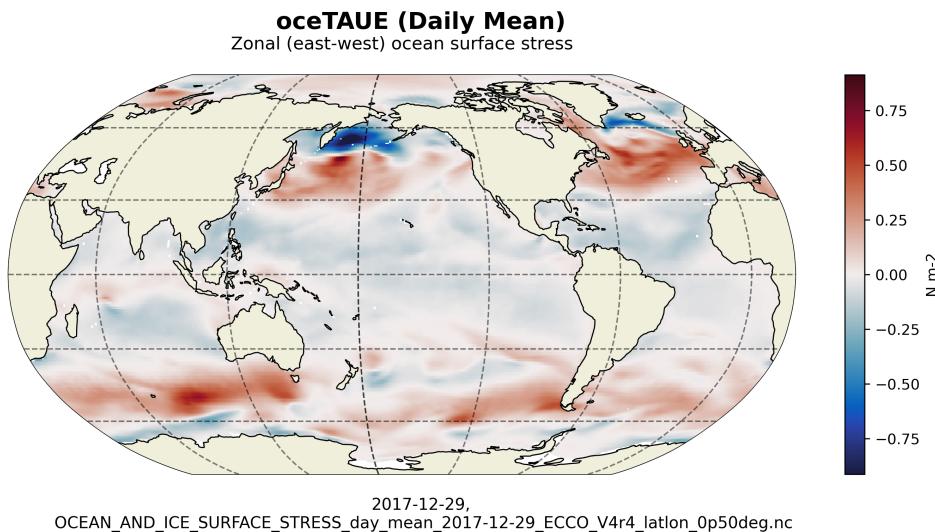


Figure 149: Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: oceTAUE

14.4.5 Latlon Variable: oceTAUN

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

Storage Type	Variable Name	Description	Unit
float32	oceTAUN	Meridional (north-south) ocean surface stress	N m ⁻²
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Meridional (north-south) component of ocean surface stress due to wind and sea-ice. note: ocetaun is calculated by interpolating the model's x and y components of ocean surface stress (ocetaux and octauy) to tracer cell centers and then finding the meridional component of the interpolated vectors.			

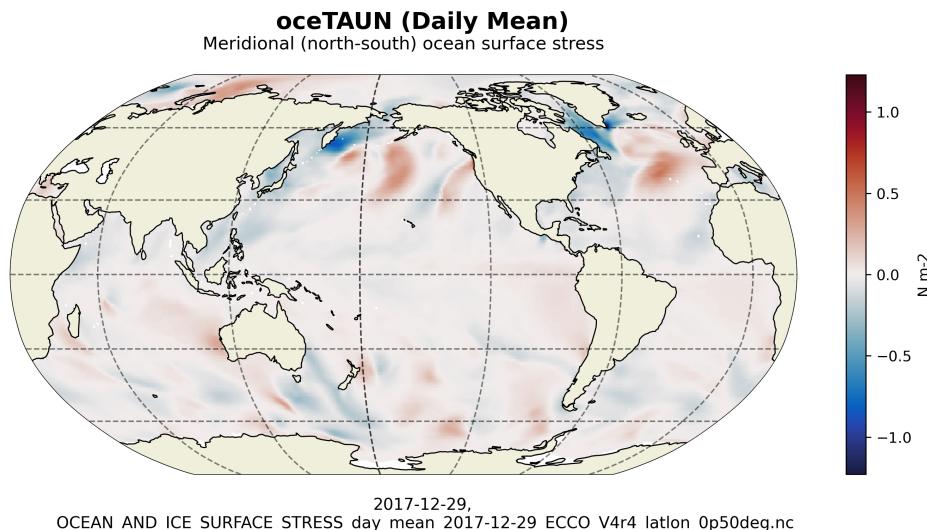


Figure 150: Dataset: OCEAN_AND_ICE_SURFACE_STRESS, Variable: oceTAUN

14.5 Latlon dataset of OCEAN_BOLUS_VELOCITY

14.5.1 Overview

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

Table 14.38: Coordinates and Variables in the dataset OCEAN_BOLUS_VELOCITY

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

14.5.2 Latlon Variable: EVELSTAR

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

Storage Type	Variable Name	Description	Unit
float32	EVELSTAR	Gent-mcwilliams zonal (east-west) bolus velocity	m s-1
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
<p>Zonal (east-west) component of the gent-mcwilliams bolus ocean velocity. note: evelstar is calculated by interpolating the model's x and y components of gm bolus ocean velocity (uvelstar and vvelstar) to tracer cell centers and then finding the zonal components of the interpolated vectors. one should take care when interpreting bolus velocities interpolated from the ecco native model grid because interpolating from the model grid to the lat-lon grid introduces errors. some closed buget calculations require bolus velocity terms on the native model grid.</p>			

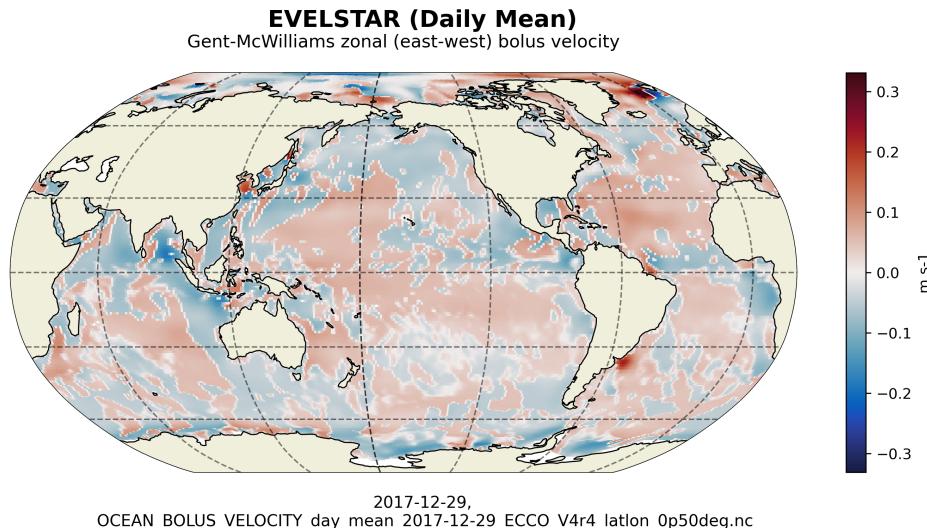


Figure 151: Dataset: OCEAN_BOLUS_VELOCITY, Variable: EVELSTAR

14.5.3 Latlon Variable: NVELSTAR

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

Storage Type	Variable Name	Description	Unit
float32	NVELSTAR	Gent-mcwilliams meridional (north-south) bolus velocity	m s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Meridional (north-south) component of the gent-mcwilliams bolus ocean velocity. note: nvelstar is calculated by interpolating the model's x and y components of gm bolus ocean velocity (uvelstar and vvelstar) to tracer cell centers and then finding the meridional components of the interpolated vectors. one should take care when interpreting bolus velocities interpolated from the ecco native model grid because interpolating from the model grid to the lat-lon grid introduces errors. some closed buget calculations require bolus velocity terms on the native model grid			

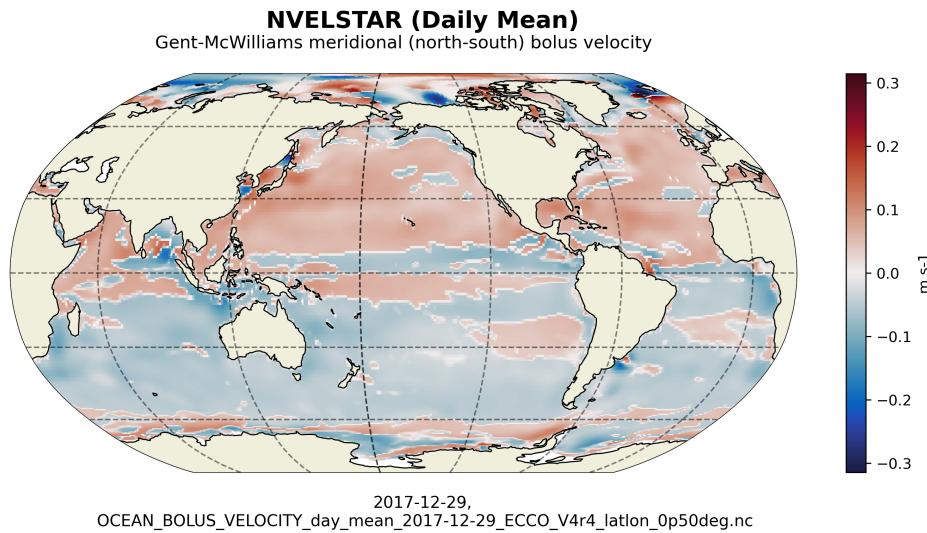


Figure 152: Dataset: OCEAN_BOLUS_VELOCITY, Variable: NVELSTAR

14.5.4 Latlon Variable: WVELSTAR

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

Storage Type	Variable Name	Description	Unit
float32	WVELSTAR	Gent-mcwilliams vertical bolus velocity	m s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Vertical component of the gent-mcwilliams bolus ocean velocity. note: in the arakawa-c grid used in ecco v4r4, vertical velocities are staggered relative to the tracer cell centers with values at the top and bottom faces of each grid cell.			

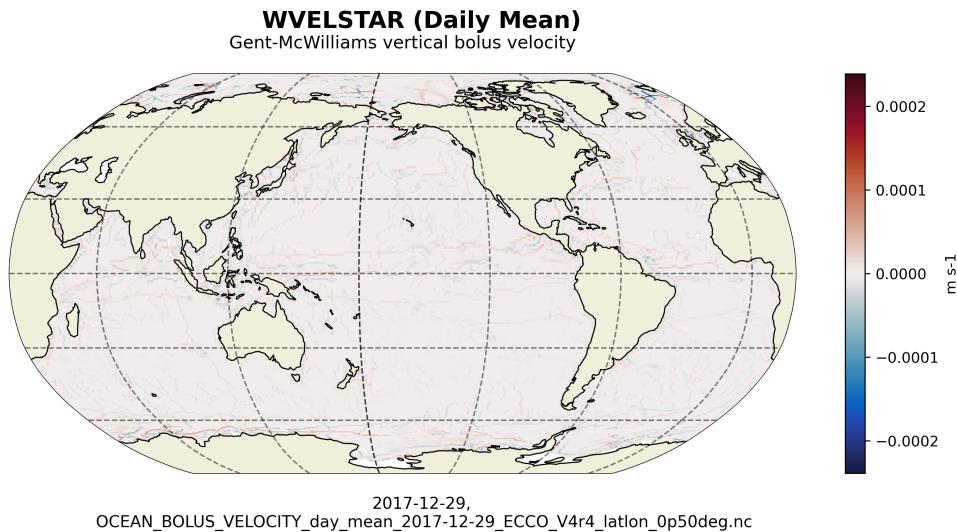


Figure 153: Dataset: OCEAN_BOLUS_VELOCITY, Variable: WVELSTAR

14.6 Latlon dataset of OCEAN_BOTTOM_PRESSURE

14.6.1 Overview

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

Table 14.42: Coordinates and Variables in the dataset OCEAN_BOTTOM_PRESSURE

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

14.6.2 Latlon Variable: OBP

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

Storage Type	Variable Name	Description	Unit
float32	OBP	Ocean bottom pressure given as equivalent water thickness	m
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
<p>Obp excludes the contribution from global mean atmospheric pressure and is therefore suitable for comparisons with grace data products. obp is calculated as follows. first, we calculate ocean hydrostatic bottom pressure anomaly, phibot, with phibot = p_b/rhoconst - gh(t), where p_b = model ocean hydrostatic bottom pressure, rhoconst = reference density (1029 kg m⁻³), g is acceleration due to gravity (9.81 m s⁻²), and h(t) is model depth at time t. then, obp = phibot/g + corrections for i) global mean steric sea level changes related to density changes in the boussinesq volume-conserving model (greatbatch correction, see sterghlo) and ii) global mean atmospheric pressure variations. use obp for comparisons with ocean bottom pressure data products that have been corrected for global mean atmospheric pressure variations. grace data typically are corrected for global mean atmospheric pressure variations. in contrast, ocean bottom pressure gauge data typically are not corrected for global mean atmospheric pressure variations.</p>			

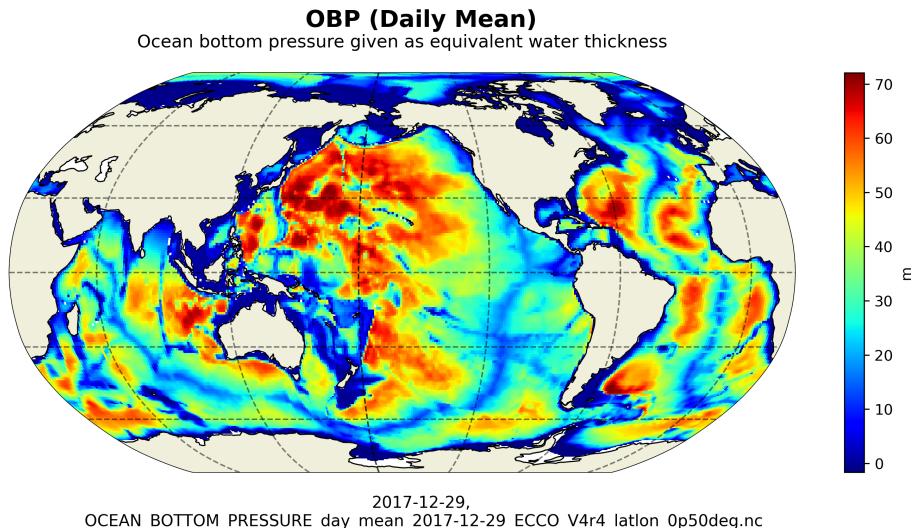


Figure 154: Dataset: OCEAN_BOTTOM_PRESSURE, Variable: OBP

14.6.3 Latlon Variable: OBPGMAP

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

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

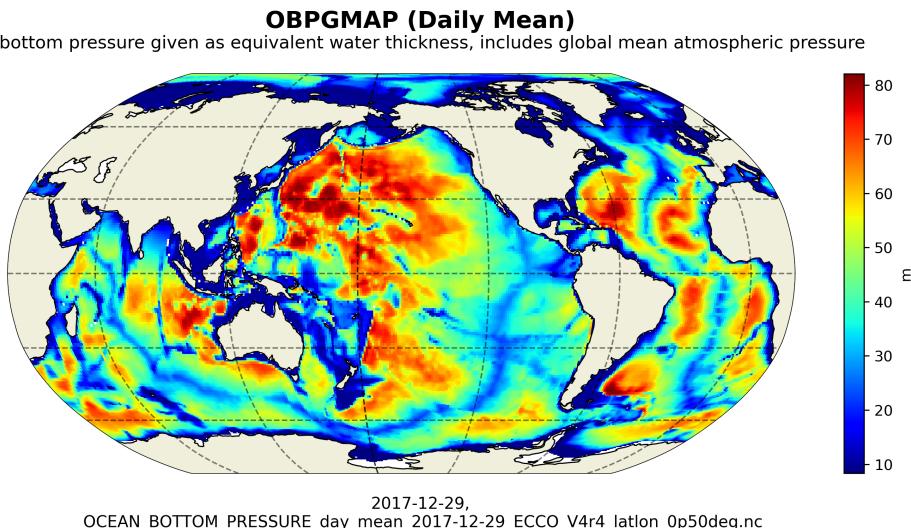


Figure 155: Dataset: OCEAN_BOTTOM_PRESSURE, Variable: OBPGMAP

14.7 Latlon dataset of OCEAN_DENS_STRAT_PRESS

14.7.1 Overview

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

Table 14.45: Coordinates and Variables in the dataset OCEAN_DENS_STRAT_PRESS

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

14.7.2 Latlon Variable: DRHODR

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

Storage Type	Variable Name	Description	Unit
float32	DRHODR	Density stratification	kg m ⁻³ m ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Density stratification: d(sigma) d z-1. note: density computations are done with in-situ density. the vertical derivatives of in-situ density and locally-referenced potential density are identical the equation of state is a modified unesco formula by jackett and mcdougall (1995), which uses the model variable potential temperature as input assuming a horizontally and temporally constant pressure of \$p_0=-g h_{\{0\}} z\$.			

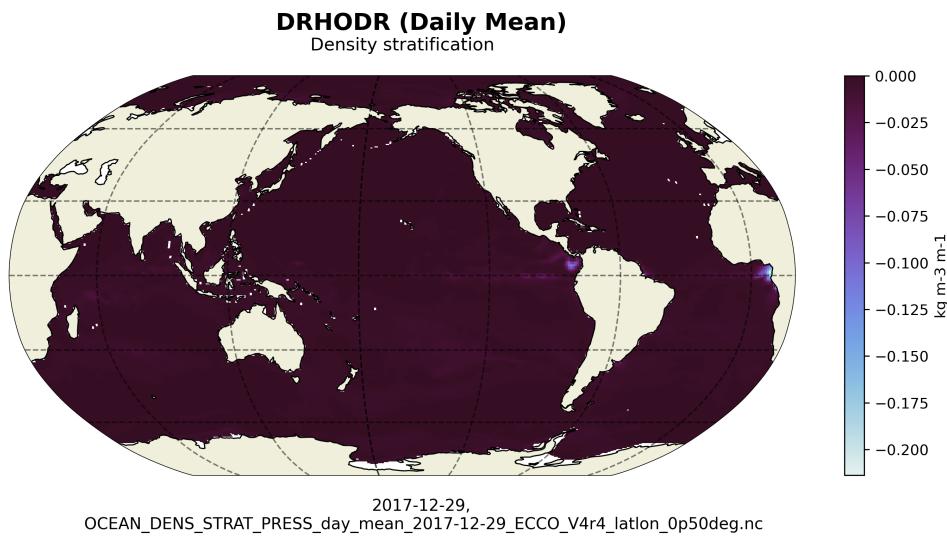


Figure 156: Dataset: OCEAN_DENS_STRAT_PRESS, Variable: DRHODR

14.7.3 Latlon Variable: PHIHYD

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

Storage Type	Variable Name	Description	Unit
float32	PHIHYD	Ocean hydrostatic pressure anomaly	m2 s-2
Description of the variable in Common Data language (CDL)			
<pre>float32 PHIHYD(time, Z, latitude, longitude) PHIHYD:_FillValue = 9.96921e+36 PHIHYD:coverage_content_type = modelResult PHIHYD:long_name = Ocean hydrostatic pressure anomaly PHIHYD:units = m2 s: 2 PHIHYD:coordinates = time Z PHIHYD:valid_min = 74.71473693847656 PHIHYD:valid_max = 783.9188232421875</pre>			
Comments			
<p>Phihyd = $p(k) / \rho_{\text{const}} - g z^*(k,t)$, where p = hydrostatic ocean pressure at depth level k, ρ_{const} = reference density (1029 kg m⁻³), g is acceleration due to gravity (9.81 m s⁻²), and $z^*(k,t)$ is model depth at level k and time t. units: p:[kg m⁻¹ s⁻²], ρ_{const}:[kg m⁻³], g:[m s⁻²], $h(t)$:[m]. note: includes atmospheric pressure loading. quantity referred to in some contexts as hydrostatic pressure anomaly. phibot accounts for the model's time-varying grid cell thickness (z^* coordinate system). see phihydr for hydrostatic pressure potential anomaly calculated using time-invariant grid cell thicknesses. phihyd is not corrected for global mean steric sea level changes related to density changes in the boussinesq volume-conserving model (greatbatch correction, see sterglo).</p>			

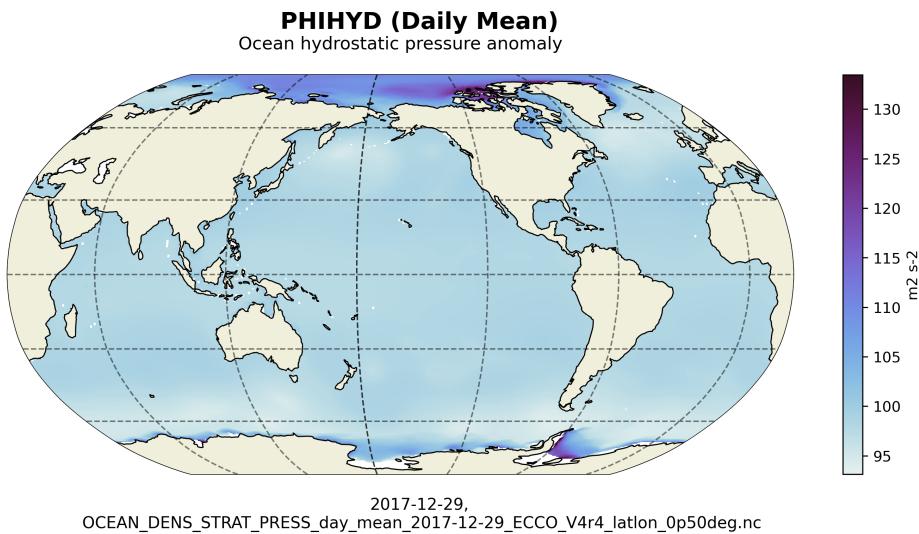


Figure 157: Dataset: OCEAN_DENS_STRAT_PRESS, Variable: PHIHYD

14.7.4 Latlon Variable: RHOAnoma

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

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

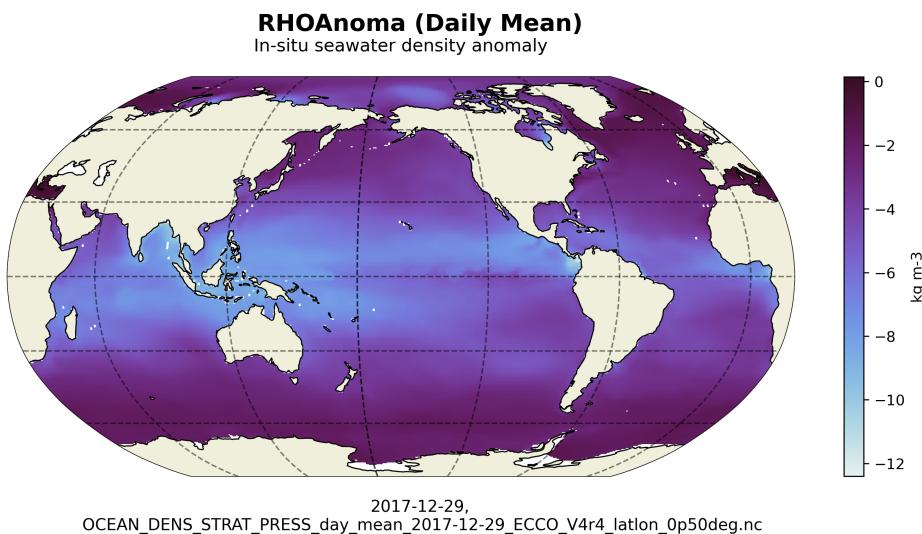


Figure 158: Dataset: OCEAN_DENS_STRAT_PRESS, Variable: RHOAnoma

14.8 Latlon dataset of OCEAN_MIXED_LAYER_DEPTH

14.8.1 Overview

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

Table 14.49: Coordinates and Variables in the dataset OCEAN_MIXED_LAYER_DEPTH

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

Table 14.49: Coordinates and Variables in the dataset OCEAN_MIXED_LAYER_DEPTH

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

14.8.2 Latlon Variable: MXLDEPTH

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

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

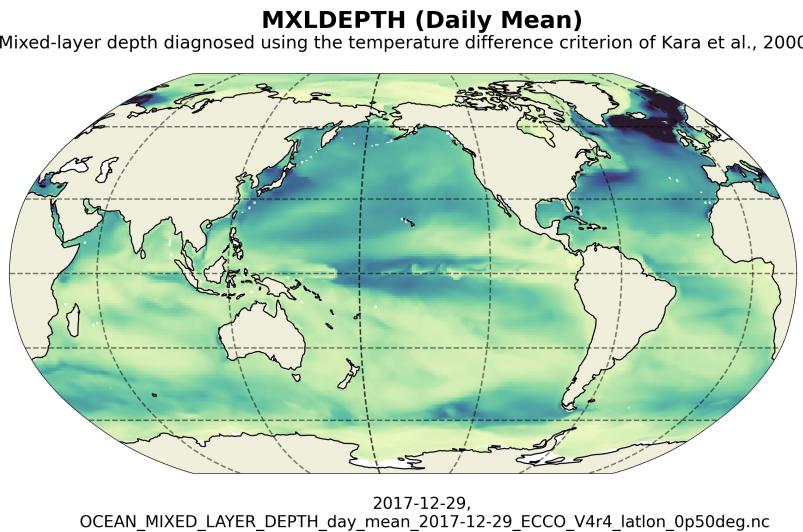


Figure 159: Dataset: OCEAN_MIXED_LAYER_DEPTH, Variable: MXLDEPTH

14.9 Latlon dataset of OCEAN_TEMPERATURE_SALINITY

14.9.1 Overview

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

daily-average and monthly-average time resolution.

Table 14.51: Coordinates and Variables in the dataset OCEAN_TEMPERATURE_SALINITY

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

14.9.2 Latlon Variable: SALT

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

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

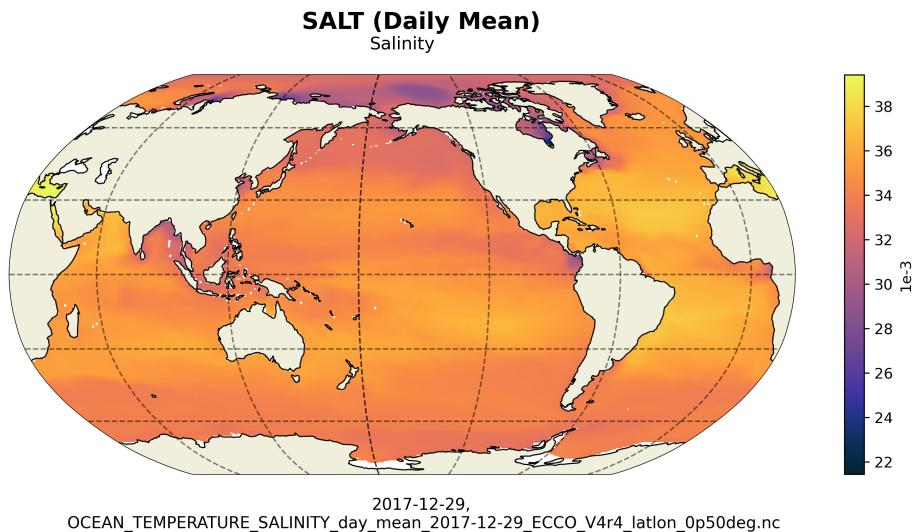


Figure 160: Dataset: OCEAN_TEMPERATURE_SALINITY, Variable: SALT

14.9.3 Latlon Variable: THETA

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

Storage Type	Variable Name	Description	Unit
float32	THETA	Potential temperature	degree_C
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Sea water potential temperature is the temperature a parcel of sea water would have if moved adiabatically to sea level pressure. note: the equation of state is a modified unesco formula by jackson and mcdougall (1995), which uses the model variable potential temperature as input assuming a horizontally and temporally constant pressure of $\$p_0 = -g \cdot h_0$.			

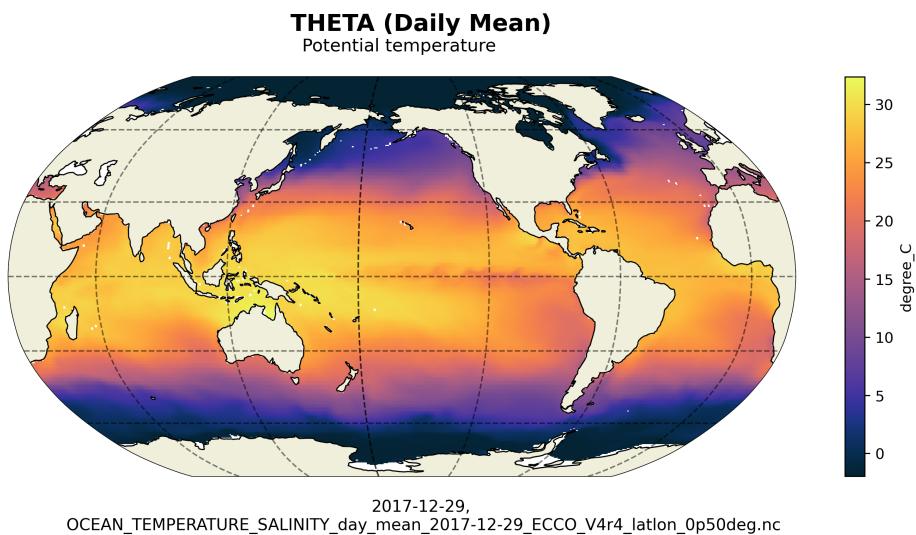


Figure 161: Dataset: OCEAN_TEMPERATURE_SALINITY, Variable: THETA

14.10 Latlon dataset of OCEAN_VELOCITY

14.10.1 Overview

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

Table 14.54: Coordinates and Variables in the dataset OCEAN_VELOCITY

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

14.10.2 Latlon Variable: EVEL

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

Storage Type	Variable Name	Description	Unit
float32	EVEL	Zonal (east-west) velocity	m s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
<p>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.</p>			

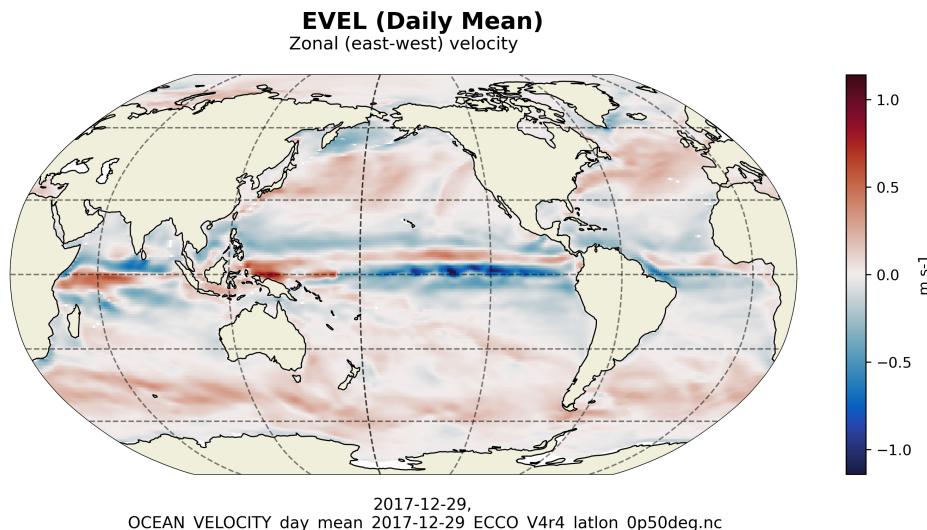


Figure 162: Dataset: OCEAN_VELOCITY, Variable: EVEL

14.10.3 Latlon Variable: NVEL

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

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

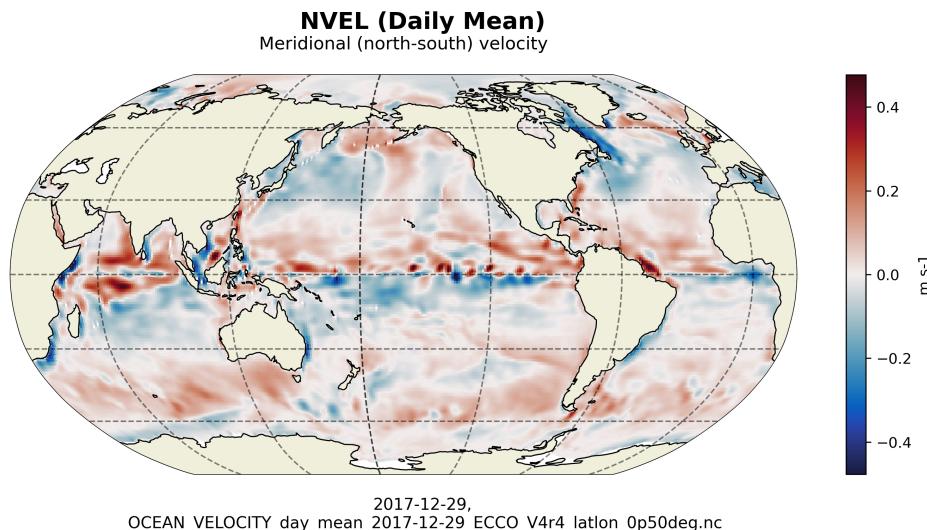


Figure 163: Dataset: OCEAN_VELOCITY, Variable: NVEL

14.10.4 Latlon Variable: WVEL

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

Storage Type	Variable Name	Description	Unit
float32	WVEL	Vertical velocity	m s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Vertical velocity in the +z direction at the top face of the grid cell. note: in the arakawa-c grid used in ecco v4r4, vertical velocities are staggered relative to the tracer cell centers with values at the top and bottom faces of each grid cell.			

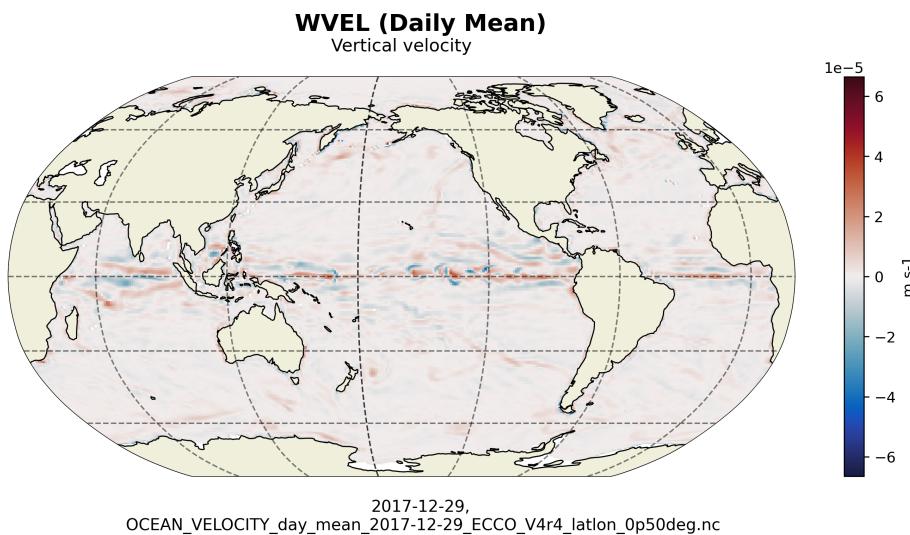


Figure 164: Dataset: OCEAN_VELOCITY, Variable: WVEL

14.11 Latlon dataset of SEA_ICE_CONC_THICKNESS

14.11.1 Overview

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

Table 14.58: Coordinates and Variables in the dataset SEA_ICE_CONC_THICKNESS

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

14.11.2 Latlon Variable: Slarea

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

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

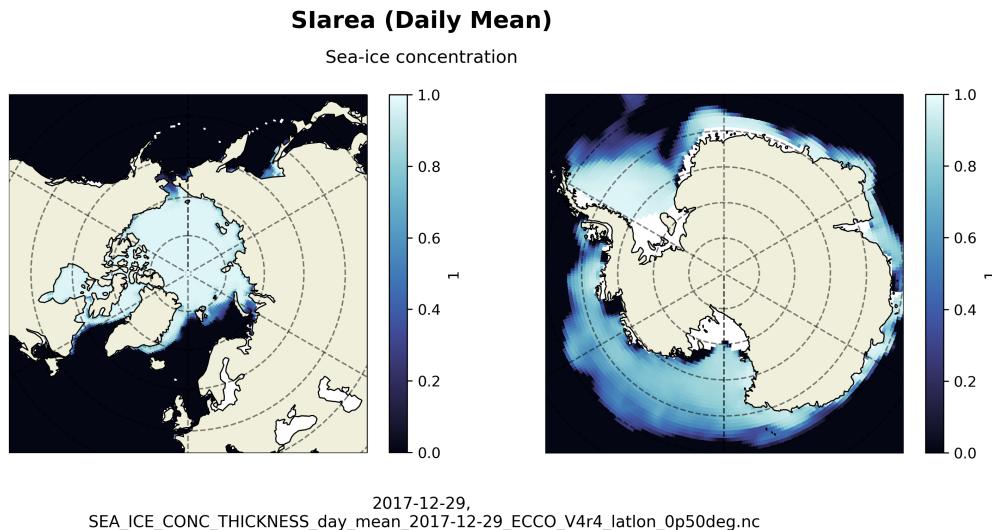


Figure 165: Dataset: SEA_ICE_CONC_THICKNESS, Variable: Slarea

14.11.3 Latlon Variable: SIheff

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

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

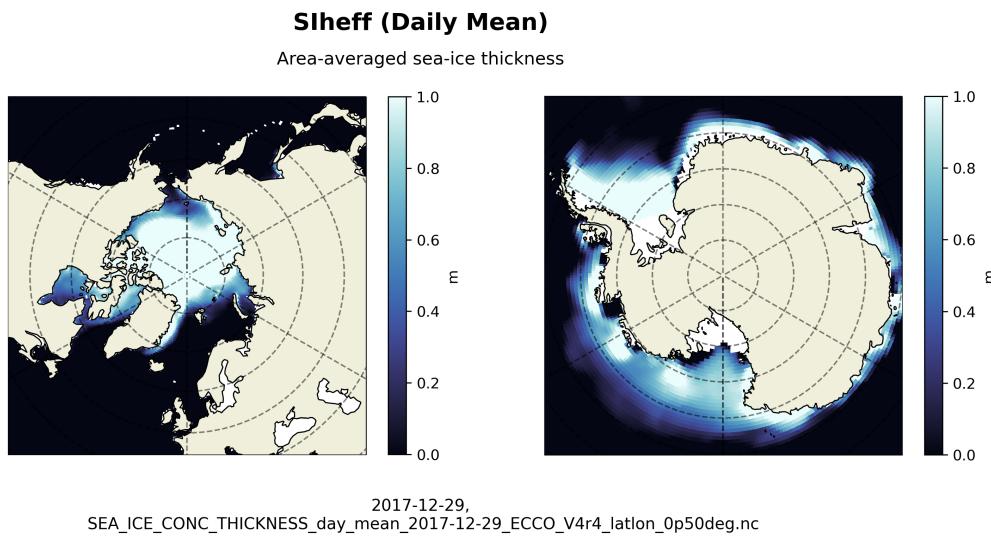


Figure 166: Dataset: SEA_ICE_CONC_THICKNESS, Variable: SIheff

14.11.4 Latlon Variable: SIhsnow

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

Storage Type	Variable Name	Description	Unit
float32	SIhsnow	Area-averaged snow thickness	m
Description of the variable in Common Data language (CDL)			
<pre>float32 SIhsnow(time, latitude, longitude) SIhsnow: _FillValue = 9.96921e+36 SIhsnow: coverage_content_type = modelResult SIhsnow: long_name = Area: averaged snow thickness SIhsnow: standard_name = surface_snow_thickness SIhsnow: units = m SIhsnow: coordinates = time SIhsnow: valid_min = : 0.0004725505714304745 SIhsnow: valid_max = 2.5671639442443848</pre>			
Comments			
Snow thickness averaged over the entire model grid cell, including open water where snow thickness is zero. note: snow thickness over the ice-covered fraction of the grid cell is sihsnow/siarea			

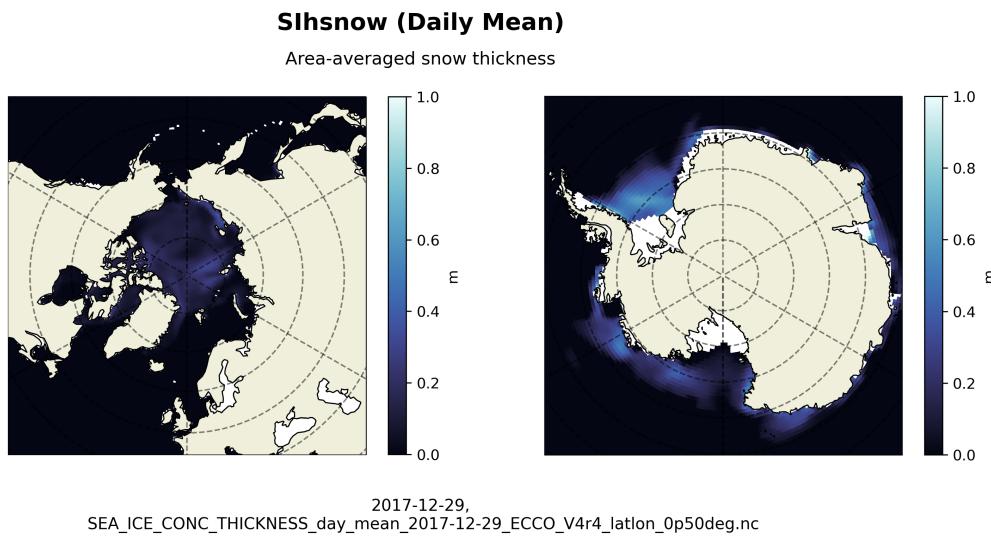


Figure 167: Dataset: SEA_ICE_CONC_THICKNESS, Variable: SIhsnow

14.11.5 Latlon Variable: slceLoad

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

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

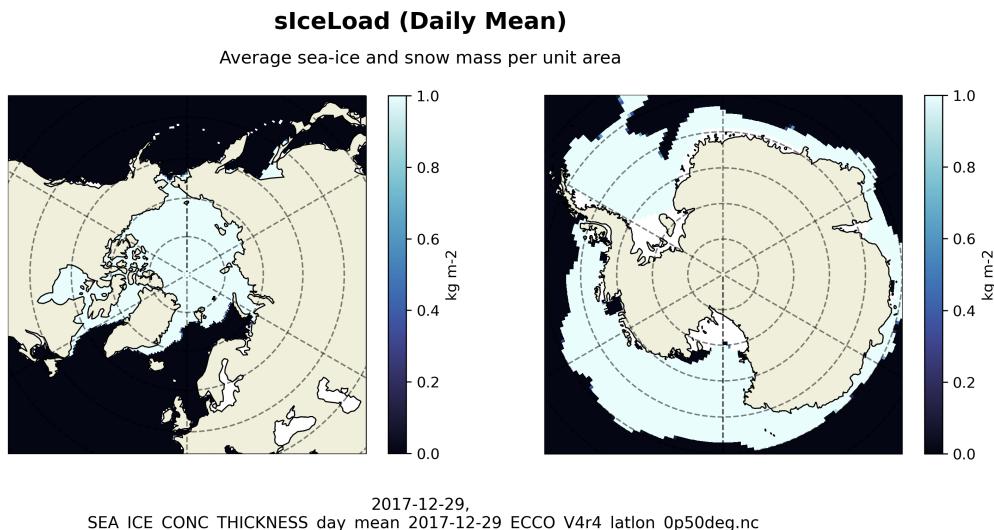


Figure 168: Dataset: SEA_ICE_CONC_THICKNESS, Variable: slceLoad

14.12 Latlon dataset of SEA_ICE_VELOCITY

14.12.1 Overview

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

Table 14.63: Coordinates and Variables in the dataset SEA_ICE_VELOCITY

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

14.12.2 Latlon Variable: Sleice

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

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

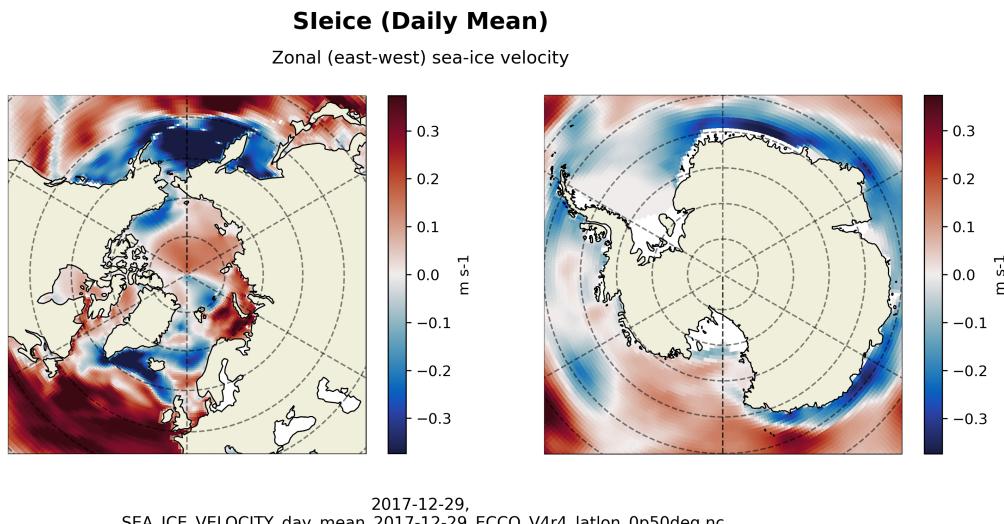


Figure 169: Dataset: SEA_ICE_VELOCITY, Variable: Sleice

14.12.3 Latlon Variable: SInice

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

Storage Type	Variable Name	Description	Unit
float32	SInice	Meridional (north-south) sea-ice velocity	m s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float32 SInice(time, latitude, longitude) SInice:_FillValue = 9.96921e+36 SInice:coverage_content_type = modelResult SInice:long_name = Meridional (north: south) sea: ice velocity SInice:standard_name = northward_sea_ice_velocity SInice:units = m s: 1 SInice:coordinates = time SInice:valid_min = : 0.5615208148956299 SInice:valid_max = 0.5656854510307312</pre>			
Comments			
Meridional (north-south) component of sea-ice velocity. note: mask with siarea to remove nonzero values where ice is absent. sInice is calculated by interpolating the model's x and y components of sea-ice velocity (siuice and sivice) to tracer cell centers and then finding the meridional component of the interpolated vectors. it is not recommended to use siuice and sivice for sea-ice volume budget calculations because interpolating siuice and sivice from the model grid to the lat-lon grid introduces errors. perform sea-ice mass budget calculations with advxheff, advyheff, dfxheff, and dfyheff on the native model grid.			

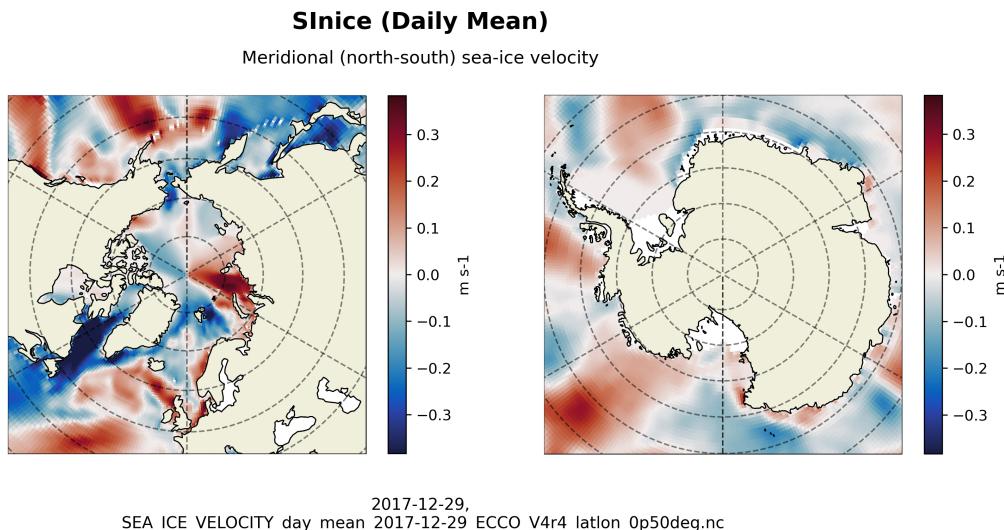


Figure 170: Dataset: SEA_ICE_VELOCITY, Variable: SInice

14.13 Latlon dataset of SEA_SURFACE_HEIGHT

14.13.1 Overview

This dataset provides 2D fields of dynamic sea surface height interpolated to a regular 0.5-degree grid from the ECCO Version 4 Release 4 (V4r4) ocean and sea-ice state estimate. The dataset is provided on daily-average and monthly-average time resolution. SSH (dynamic sea surface height) = SSHNOIBC (dynamic sea surface without

the inverse barometer correction) - SSHIBC (inverse barometer correction). The inverted barometer correction accounts for variations in sea surface height due to atmospheric pressure variations.

Table 14.66: Coordinates and Variables in the dataset SEA_SURFACE_HEIGHT

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

14.13.2 Latlon Variable: SSH

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

Storage Type	Variable Name	Description	Unit
float32	SSH	Dynamic sea surface height anomaly	m
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
<p>Dynamic sea surface height anomaly above the geoid, suitable for comparisons with altimetry sea surface height data products that apply the inverse barometer (ib) correction. note: ssh is calculated by correcting model sea level anomaly etan for three effects: a) global mean steric sea level changes related to density changes in the boussinesq volume-conserving model (greatbatch correction, see sterglo), b) the inverted barometer (ib) effect (see sshibc) and c) sea level displacement due to sea-ice and snow pressure loading (see siceload). ssh can be compared with the similarly-named ssh variable in previous ecco products that did not include atmospheric pressure loading (e.g., version 4 release 3). use sshnoibc for comparisons with altimetry data products that do not apply the ib correction.</p>			

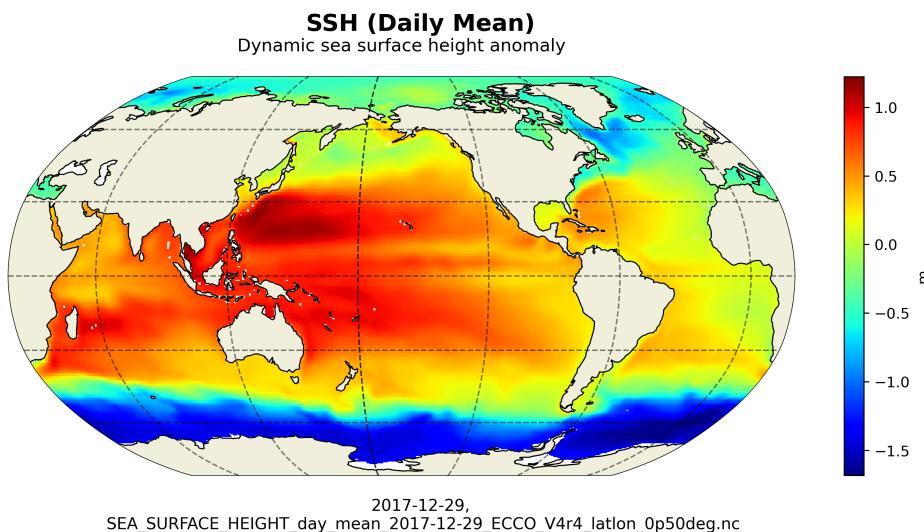


Figure 171: Dataset: SEA_SURFACE_HEIGHT, Variable: SSH

14.13.3 Latlon Variable: SSHIBC

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

Storage Type	Variable Name	Description	Unit
float32	SSHIBC	The inverted barometer (ib) correction to sea surface height due to atmospheric pressure loading	m
Description of the variable in Common Data language (CDL)			
<pre>float32 SSHIBC(time, latitude, longitude) SSHIBC:_FillValue = 9.96921e+36 SSHIBC:coverage_content_type = modelResult SSHIBC:long_name = The inverted barometer (IB) correction to sea surface height due to atmospheric pressure loading SSHIBC:units = m SSHIBC:coordinates = time SSHIBC:valid_min = : 0.5228679180145264 SSHIBC:valid_max = 0.8955588340759277</pre>			
Comments			
Not an ssh itself, but a correction to model sea level anomaly (etan) required to account for the static part of sea surface displacement by atmosphere pressure loading: ssh = sshnoibc - sshibc. note: use ssh for model-data comparisons with altimetry data products that do apply the ib correction and sshnoibc for comparisons with altimetry data products that do not apply the ib correction.			

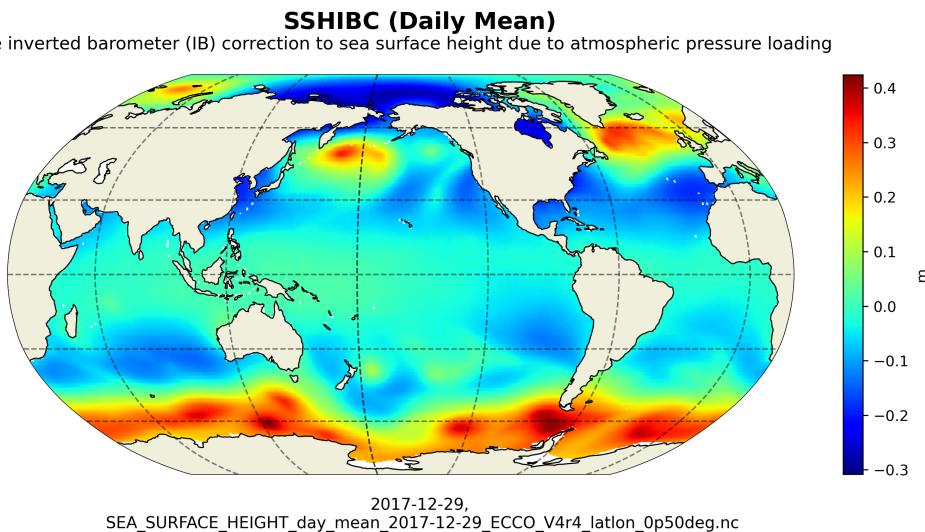


Figure 172: Dataset: SEA_SURFACE_HEIGHT, Variable: SSHIBC

14.13.4 Latlon Variable: SSHNOIBC

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

Storage Type	Variable Name	Description	Unit
float32	SSHNOIBC	Sea surface height anomaly without the inverted barometer (ib) correction	m
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
<p>Sea surface height anomaly above the geoid without the inverse barometer (ib) correction, suitable for comparisons with altimetry sea surface height data products that do not apply the inverse barometer (ib) correction. note: sshnoibc is calculated by correcting model sea level anomaly etan for two effects: a) global mean steric sea level changes related to density changes in the boussinesq volume-conserving model (greatbatch correction, see ster-glo), b) sea level displacement due to sea-ice and snow pressure loading (see siceload). in ecco version 4 release 4 the model is forced with atmospheric pressure loading. sshnoibc does not correct for the static part of the effect of atmosphere pressure loading on sea surface height (the so-called inverse barometer (ib) correction). use ssh for comparisons with altimetry data products that do apply the ib correction.</p>			

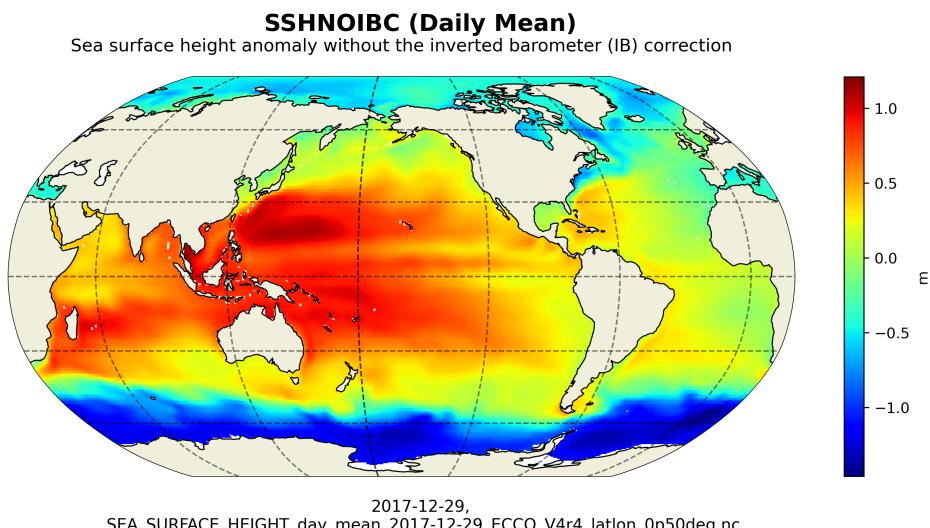


Figure 173: Dataset: SEA_SURFACE_HEIGHT, Variable: SSHNOIBC

15 1-D Dataset Groupings

15.1 1D dataset of GLOBAL_MEAN_ATM_SURFACE_PRES

15.1.1 Overview

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

Table 15.1: Coordinates and Variables in the dataset GLOBAL_MEAN_ATM_SURFACE_PRES

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

15.1.2 1D Variable: Pa_global

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

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

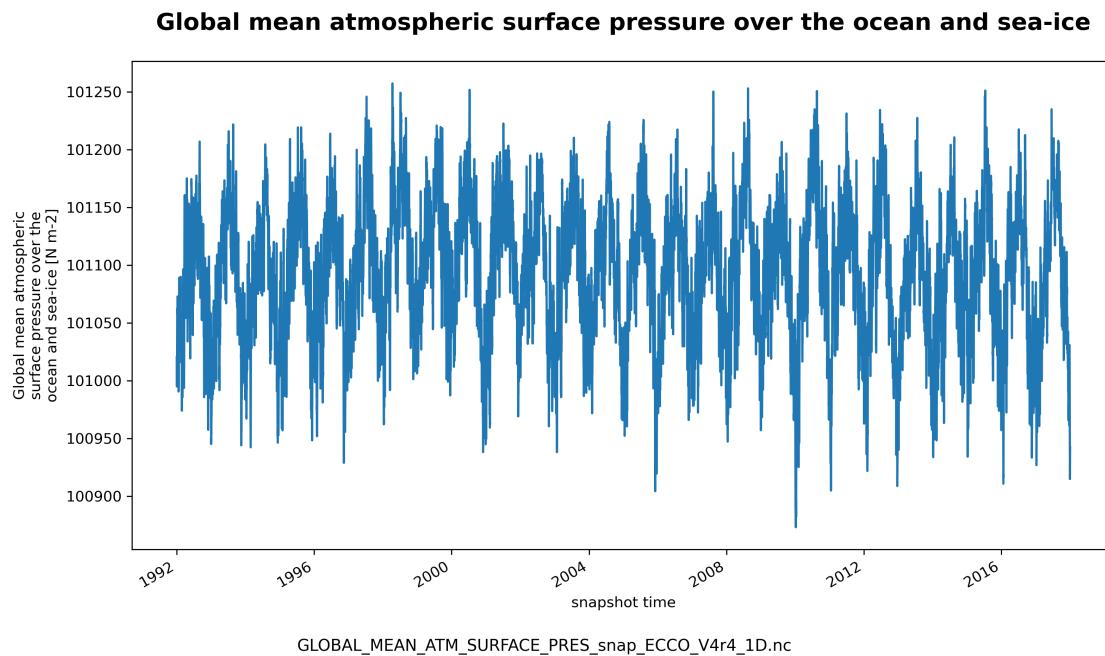


Figure 174: Dataset: GLOBAL_MEAN_ATM_SURFACE_PRES, Variable: Pa_global

15.2 1D dataset of GLOBAL_MEAN_SEA_LEVEL

15.2.1 Overview

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

average and monthly-average time resolution.

Table 15.3: Coordinates and Variables in the dataset GLOBAL_MEAN_SEA_LEVEL

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

15.2.2 1D Variable: global_mean_barystatic_sea_level_anomaly

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

Storage Type	Variable Name	Description	Unit
float32	global_mean_barystatic_sea_level_anomaly	Global mean of barystatic sea level anomaly	m
Description of the variable in Common Data language (CDL)			
<pre>float32 global_mean_barystatic_sea_level_anomaly(time) global_mean_barystatic_sea_level_anomaly: _FillValue = 9.96921e+36 global_mean_barystatic_sea_level_anomaly: coverage_content_type = modelResult global_mean_barystatic_sea_level_anomaly: long_name = Global mean of barystatic sea level anomaly global_mean_barystatic_sea_level_anomaly: standard_name = global_mean_barystatic_sea_level_anomaly: units = m global_mean_barystatic_sea_level_anomaly: valid_min = : 0.045110904 global_mean_barystatic_sea_level_anomaly: valid_max = 0.043493364 global_mean_barystatic_sea_level_anomaly: coordinates = time</pre>			
Comments			
<p>Global mean barystatic sea level anomaly due to changes in total ocean mass. note: eccv4 uses a volume-conserving boussinesq formulation of the mitgcm with a free-surface boundary condition with real freshwater flux forcing. changes in ocean mass due to evaporation, precipitation, runoff, and sea-ice growth/melt are reflected in model sea level. however, as a consequence of the boussinsq formulation, changes to seawater density due to net buoyancy fluxes (e.g., global mean surface heating/cooling) do not change model sea level anomaly (etan) via seawater expansion/contraction. changes in global ocean density therefore induce a spurious change in model ocean bottom pressure (phibot) via 'virtual mass fluxes'. the 'greatbatch correction' is a time varying, globally-uniform correction to account for changes in global mean density in boussinesq models. this correction is used to calculate dynamic sea surface height (ssh) and ocean bottom pressure (obp). importantly, there is no dynamical significance to the greatbatch correction but it is required to account for steric changes in global sea level. see greatbatch, 1994. j. of geophys. res. oceans, doi.org/10.1029/94jc00847</p>			

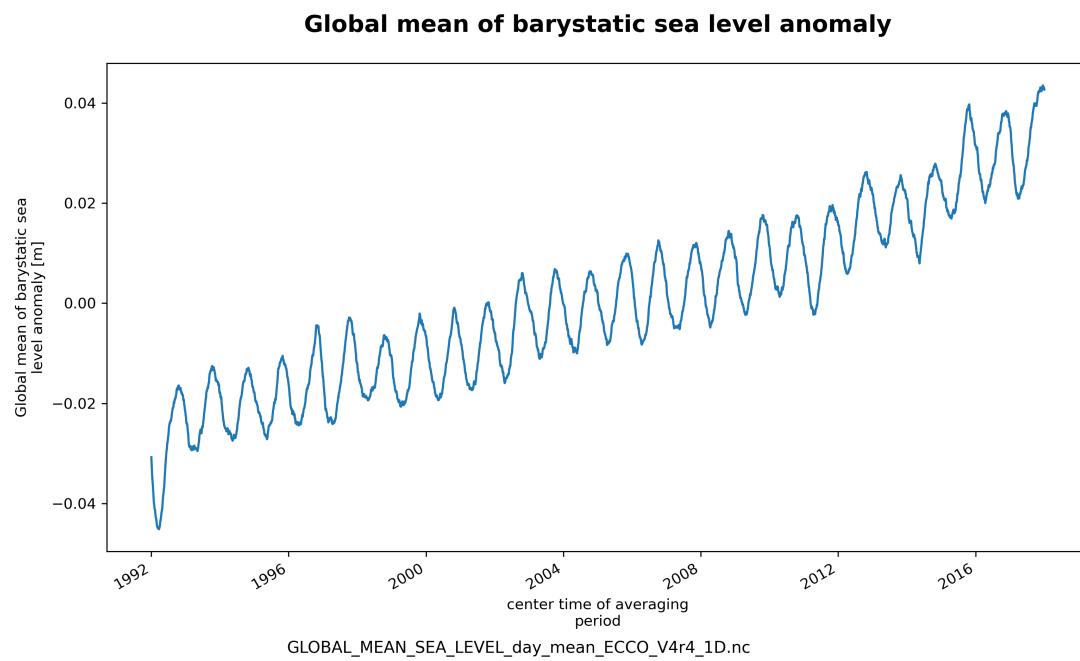


Figure 175: Dataset: GLOBAL_MEAN_SEA_LEVEL, Variable: global_mean_barystatic_sea_level_anomaly

15.2.3 1D Variable: global_mean_sea_level_anomaly

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

Storage Type	Variable Name	Description	Unit
float32	global_mean_sea_level_anomaly	Global mean of dynamic ssh	m
Description of the variable in Common Data language (CDL)			
<pre>float32 global_mean_sea_level_anomaly(time) global_mean_sea_level_anomaly: _FillValue = 9.96921e+36 global_mean_sea_level_anomaly: coverage_content_type = modelResult global_mean_sea_level_anomaly: long_name = Global mean of dynamic SSH global_mean_sea_level_anomaly: standard_name = global_mean_sea_level_anomaly: units = m global_mean_sea_level_anomaly: valid_min = : 0.055836163 global_mean_sea_level_anomaly: valid_max = 0.05520557 global_mean_sea_level_anomaly: coordinates = time</pre>			
Comments			
<p>Global mean of dynamic sea level anomaly, equivalent to global mean sea level change. note: 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</p>			

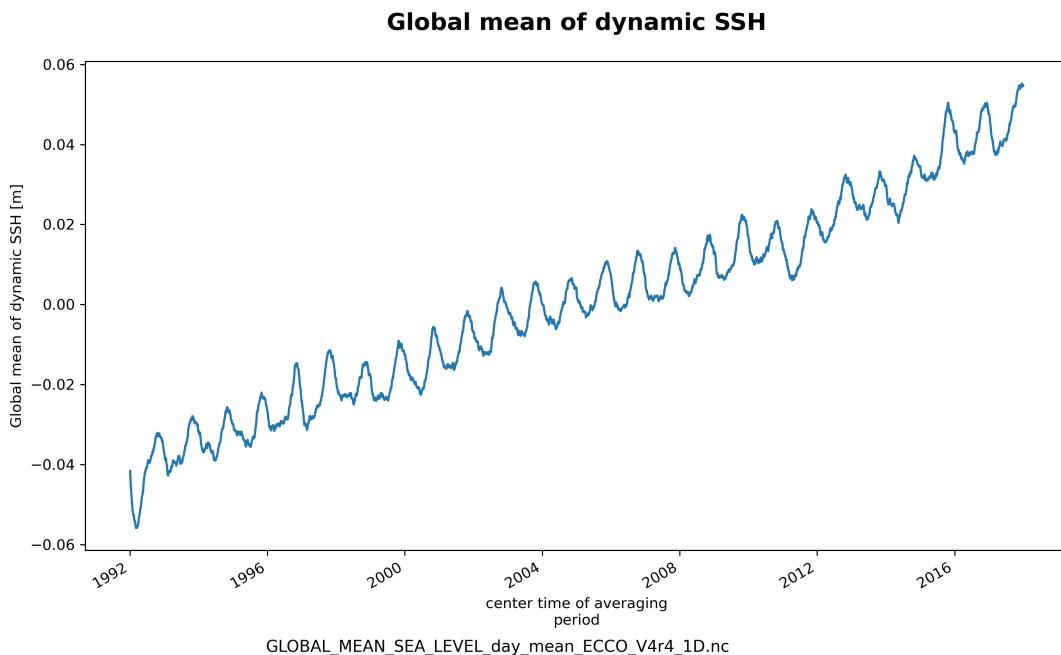


Figure 176: Dataset: GLOBAL_MEAN_SEA_LEVEL, Variable: global_mean_sea_level_anomaly

15.2.4 1D Variable: global_mean_sterodynamic_sea_level_anomaly

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

Storage Type	Variable Name	Description	Unit
float64	global_mean_sterodynamic_sea_level_anomaly	Global mean of sterodynamic sea level anomaly	m
Description of the variable in Common Data language (CDL)			
<pre>float64 global_mean_sterodynamic_sea_level_anomaly(time) global_mean_sterodynamic_sea_level_anomaly: _FillValue = 9.969209968386869e+36 global_mean_sterodynamic_sea_level_anomaly: coverage_content_type = modelResult global_mean_sterodynamic_sea_level_anomaly: long_name = Global mean of sterodynamic sea level anomaly global_mean_sterodynamic_sea_level_anomaly: standard_name = global_mean_sterodynamic_sea_level_anomaly: units = m global_mean_sterodynamic_sea_level_anomaly: valid_min = : 0.017658796143049296 global_mean_sterodynamic_sea_level_anomaly: valid_max = 0.017642477223663407 global_mean_sterodynamic_sea_level_anomaly: coordinates = time</pre>			
Comments			
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			

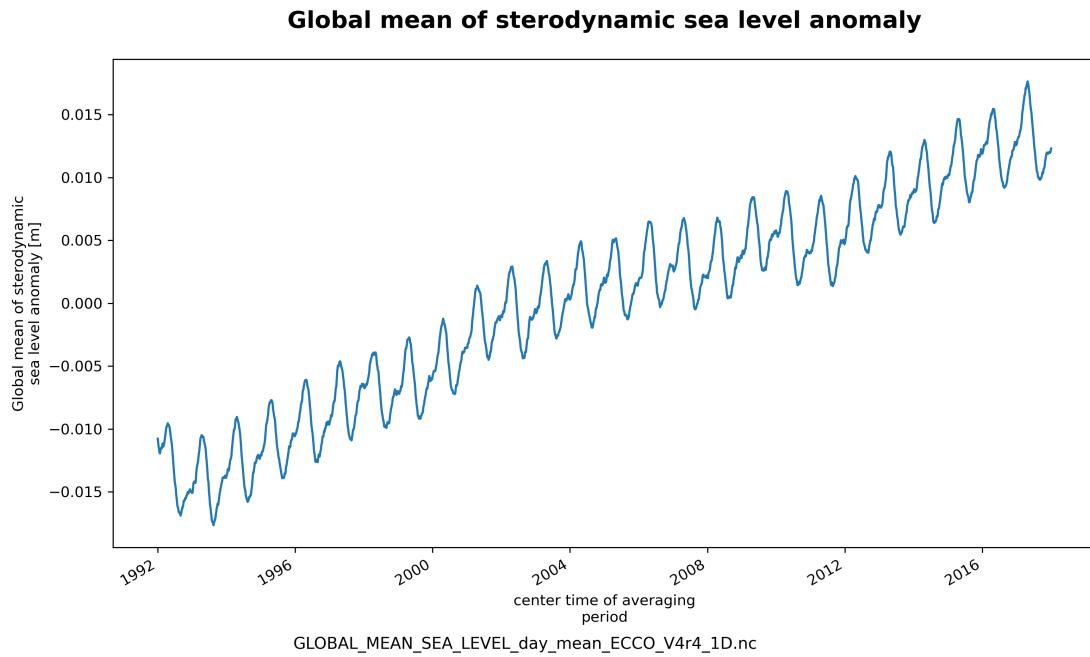


Figure 177: Dataset: GLOBAL_MEAN_SEA_LEVEL, Variable: global_mean_sterodynamic_sea_level_anomaly

15.3 1D dataset of SBO_CORE_PRODUCTS

15.3.1 Overview

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

Table 15.7: Coordinates and Variables in the dataset SBO_CORE_PRODUCTS

Variables	Description of data variables	Unit
xoamc	X-comp of oceanic angular momentum due to currents	kg m ² s ⁻¹
yoamc	Y-comp of oceanic angular momentum due to currents	kg m ² s ⁻¹
zoamc	Z-comp of oceanic angular momentum due to currents	kg m ² s ⁻¹
xoamp	X-comp of oceanic angular momentum due to pressure	kg m ² s ⁻¹
yoamp	Y-comp of oceanic angular momentum due to pressure	kg m ² s ⁻¹
zoamp	Z-comp of oceanic angular momentum due to pressure	kg m ² s ⁻¹
mass	Ocean mass	kg
xcom	X-comp of center-of-mass of ocean	m
ycom	Y-comp of center-of-mass of ocean	m
zcom	Z-comp of center-of-mass of ocean	m
sboarea	Surface area of oceans	m ²
xoamc_si	X-comp of oceanic angular momentum due to sea-ice motion	kg m ² s ⁻¹
yoamc_si	Y-comp of oceanic angular momentum due to sea-ice motion	kg m ² s ⁻¹
zoamc_si	Z-comp of oceanic angular momentum due to sea-ice motion	kg m ² s ⁻¹
mass_si	Sea-ice mass	kg

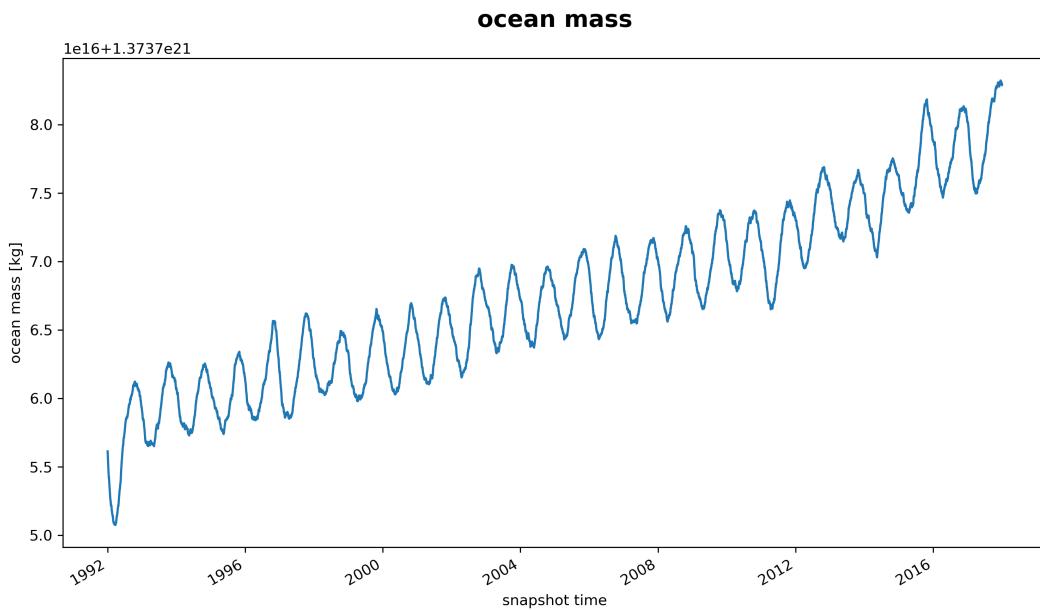
Table 15.7: Coordinates and Variables in the dataset SBO_CORE_PRODUCTS

	Description	Unit
xoamp_fw	X-comp of oceanic angular momentum due to freshwater flux	kg m ² s ⁻¹
yoamp_fw	Y-comp of oceanic angular momentum due to freshwater flux	kg m ² s ⁻¹
zoamp_fw	Z-comp of oceanic angular momentum due to freshwater flux	kg m ² s ⁻¹
mass_fw	Mass due to freshwater flux	kg
xcom_fw	X-comp of center-of-mass of freshwater flux	m
ycom_fw	Y-comp of center-of-mass of freshwater flux	m
zcom_fw	Z-comp of center-of-mass of freshwater flux	m
mass_gc	Mass due to the greatbatch correction	kg
xoamp_dsl	X-comp of oceanic angular momentum due to pressure based on dynamic (ib-corrected) sea level	kg m ² s ⁻¹
yoamp_dsl	Y-comp of oceanic angular momentum due to pressure based on dynamic (ib-corrected) sea level	kg m ² s ⁻¹
zoamp_dsl	Z-comp of oceanic angular momentum due to pressure based on dynamic (ib-corrected) sea level	kg m ² s ⁻¹
Coordinates	Description of data coordinates	Unit
time	Snapshot time	—none—

15.3.2 1D Variable: mass

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

Storage Type	Variable Name	Description	Unit
float64	mass	Ocean mass	kg
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
N/a			



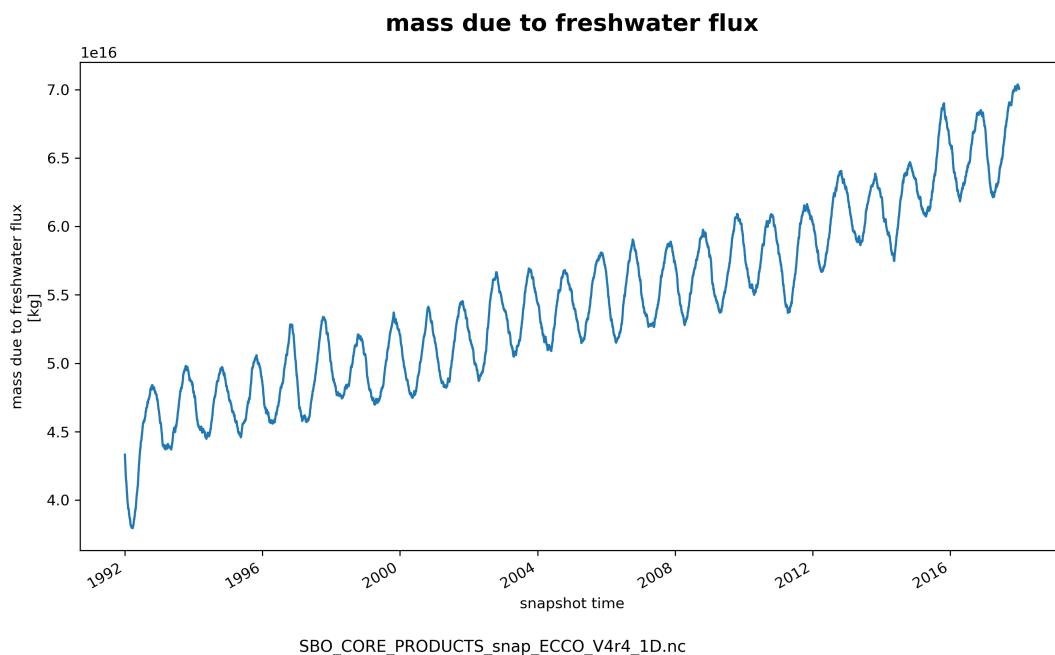
SBO_CORE_PRODUCTS_snap_ECCO_V4r4_1D.nc

Figure 178: Dataset: SBO_CORE_PRODUCTS, Variable: mass

15.3.3 1D Variable: mass_fw

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

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



SBO_CORE_PRODUCTS_snap_ECCO_V4r4_1D.nc

Figure 179: Dataset: SBO_CORE_PRODUCTS, Variable: mass_fw

15.3.4 1D Variable: mass_gc

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

Storage Type	Variable Name	Description	Unit
float64	mass_gc	Mass due to the greatbatch correction	kg
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
N/a			

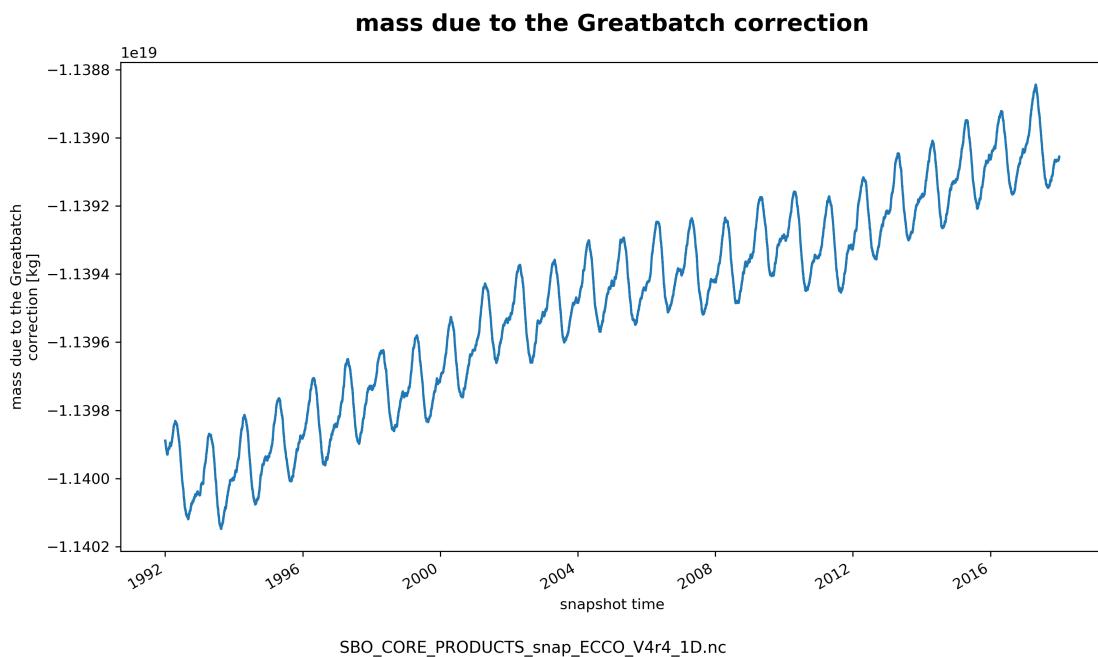


Figure 180: Dataset: SBO_CORE_PRODUCTS, Variable: mass_gc

15.3.5 1D Variable: mass_si

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

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

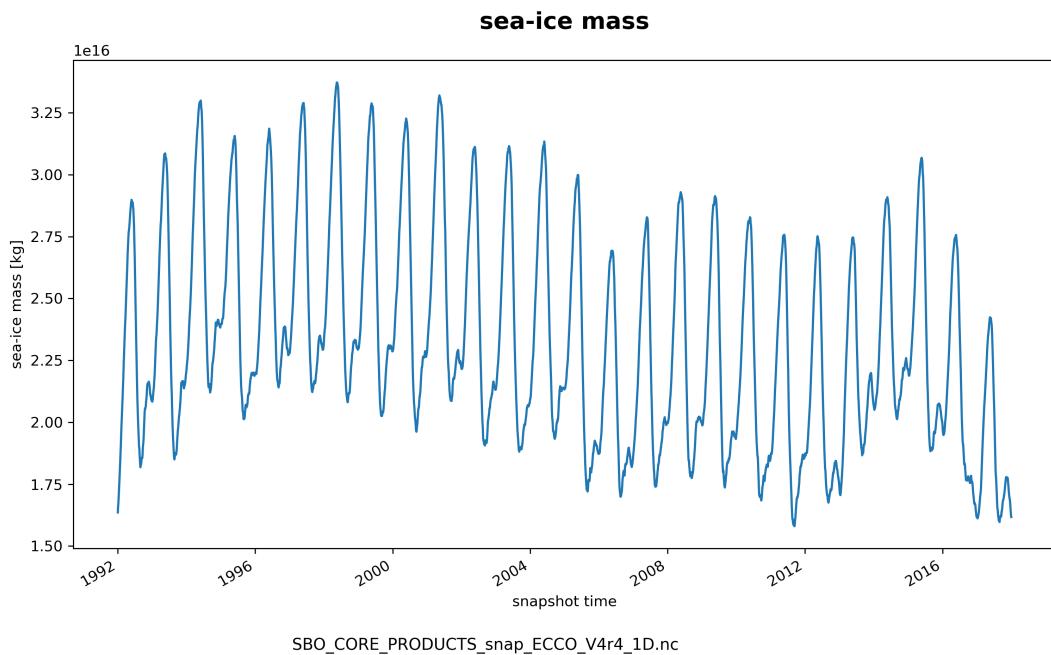


Figure 181: Dataset: SBO_CORE_PRODUCTS, Variable: mass_si

15.3.6 1D Variable: sboarea

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

Storage Type	Variable Name	Description	Unit
float64	sboarea	Surface area of oceans	m2
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
Note: ocean surface area is constant but provided as time series for convenience			

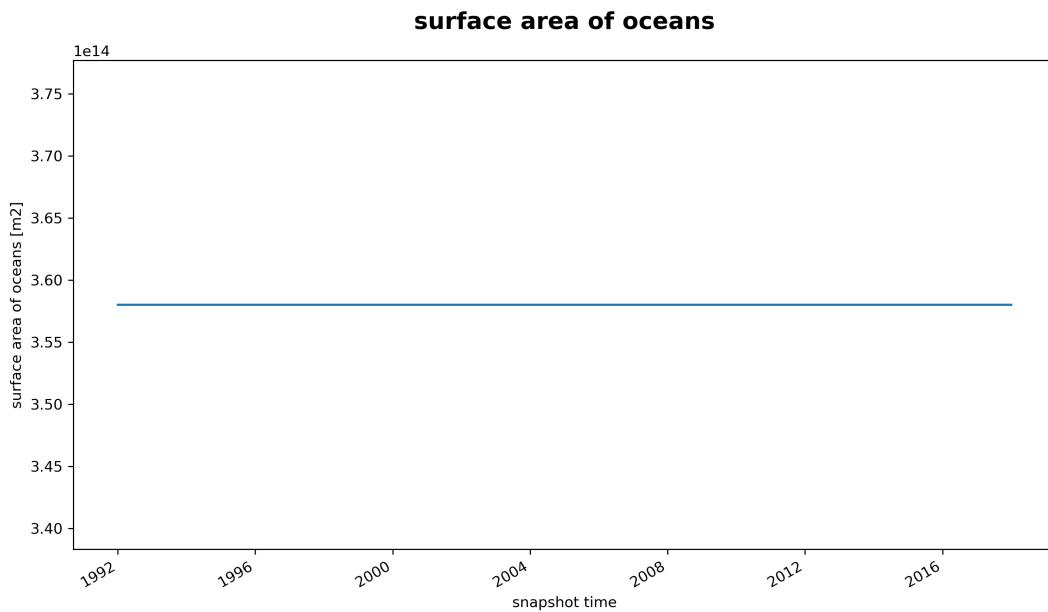


Figure 182: Dataset: SBO_CORE_PRODUCTS, Variable: sboarea

15.3.7 1D Variable: xcom

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

Storage Type	Variable Name	Description	Unit
float64	xcom	X-comp of center-of-mass of ocean	m
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
N/a			

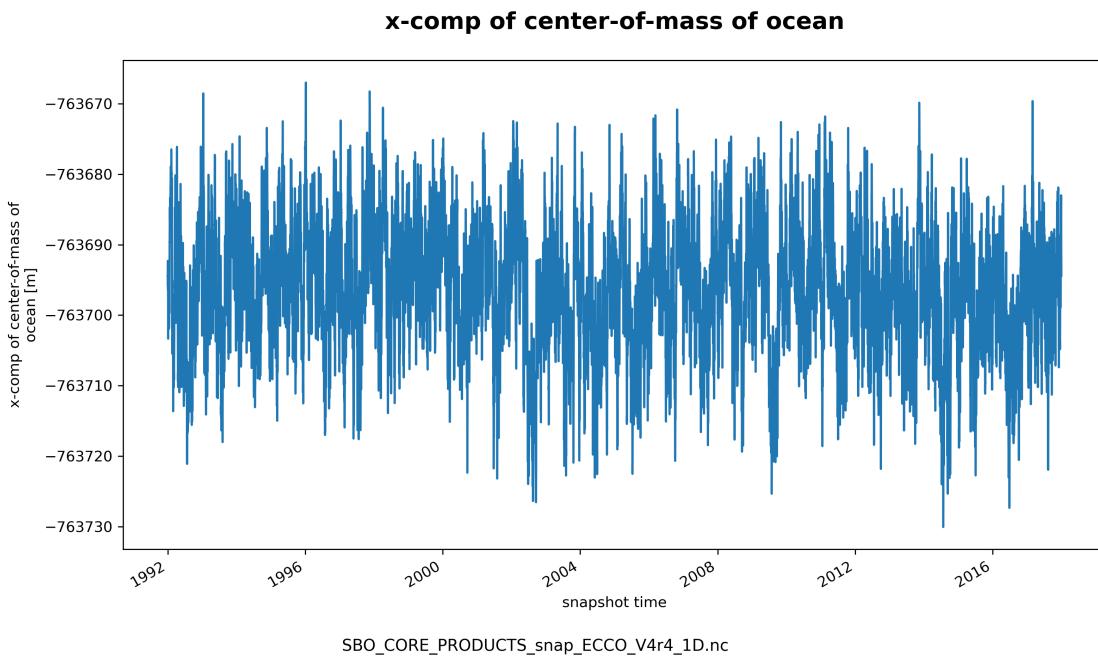
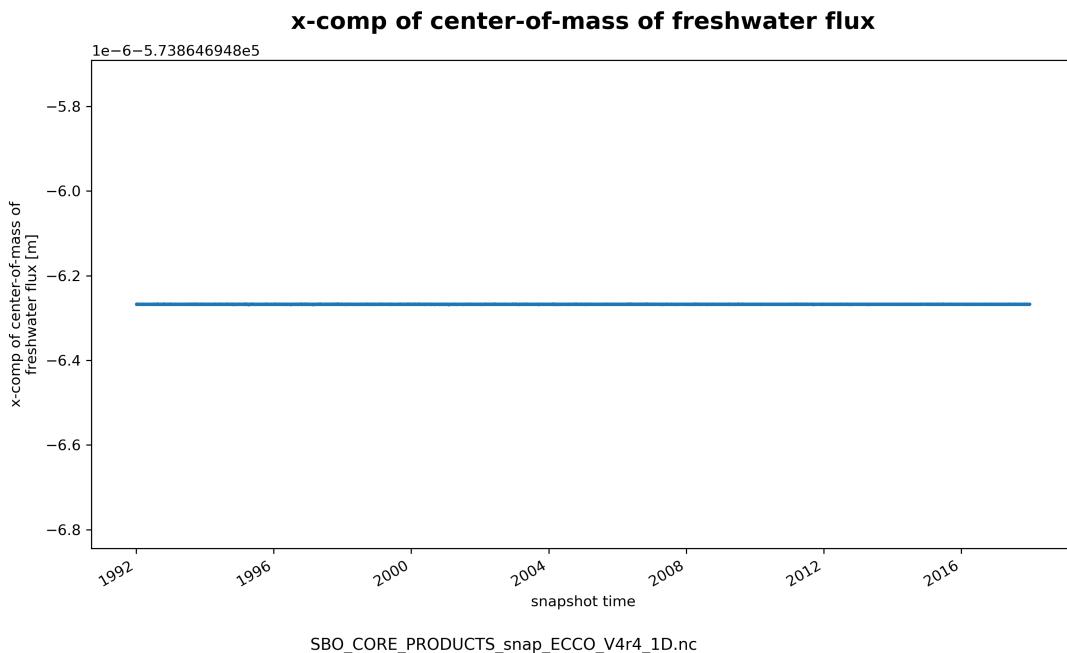


Figure 183: Dataset: SBO_CORE_PRODUCTS, Variable: xcom

15.3.8 1D Variable: xcom_fw

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

Storage Type	Variable Name	Description	Unit
float64	xcom_fw	X-comp of center-of-mass of freshwater flux	m
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
N/a			



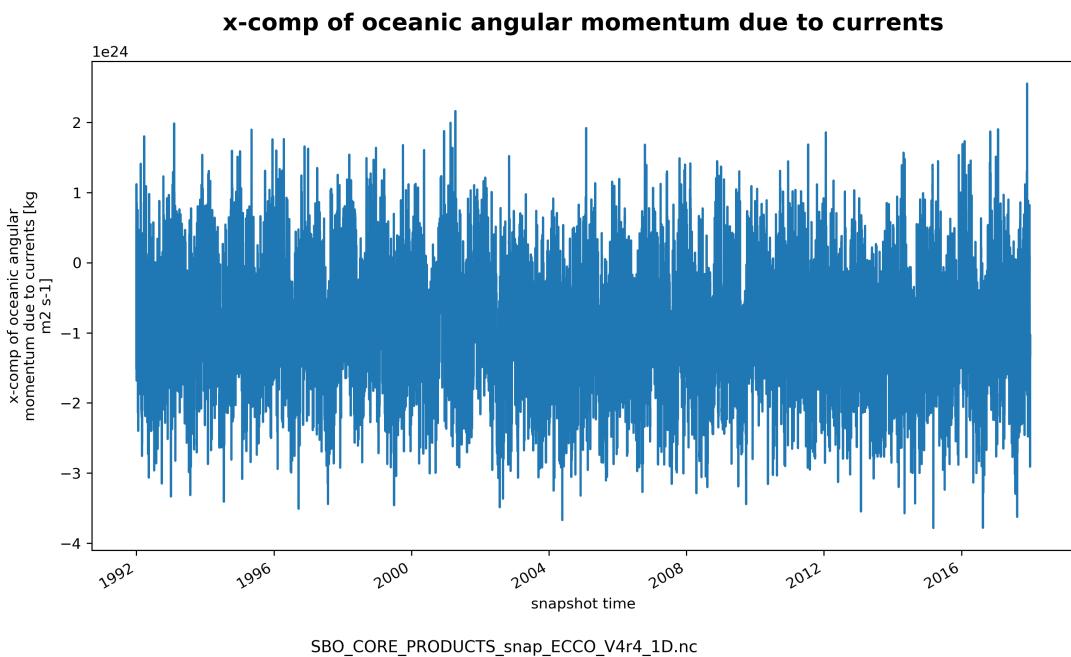
SBO_CORE_PRODUCTS_snap_ECCO_V4r4_1D.nc

Figure 184: Dataset: SBO_CORE_PRODUCTS, Variable: xcom_fw

15.3.9 1D Variable: xoamc

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

Storage Type	Variable Name	Description	Unit
float64	xoamc	X-comp of oceanic angular momentum due to currents	kg m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float64 xoamc(time) xoamc: _FillValue = 9.969209968386869e+36 xoamc: coverage_content_type = modelResult xoamc: long_name = x: comp of oceanic angular momentum due to currents xoamc: units = kg m² s: 1 xoamc: valid_min = : 3.783733447704127e+24 xoamc: valid_max = 2.555331552045857e+24 xoamc: coordinates = time</pre>			
Comments			
N/a			



SBO_CORE_PRODUCTS_snap_ECCO_V4r4_1D.nc

Figure 185: Dataset: SBO_CORE_PRODUCTS, Variable: xoamc

15.3.10 1D Variable: xoamc_si

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

Storage Type	Variable Name	Description	Unit
float64	xoamc_si	X-comp of oceanic angular momentum due to sea-ice motion	kg m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float64 xoamc_si(time) xoamc_si:_FillValue = 9.969209968386869e+36 xoamc_si:coverage_content_type = modelResult xoamc_si:long_name = x: comp of oceanic angular momentum due to sea- ice motion xoamc_si:units = kg m2 s: 1 xoamc_si:valid_min = : 9.76342837969224e+21 xoamc_si:valid_max = 1.3721188892065168e+22 xoamc_si:coordinates = time</pre>			
Comments			
N/a			

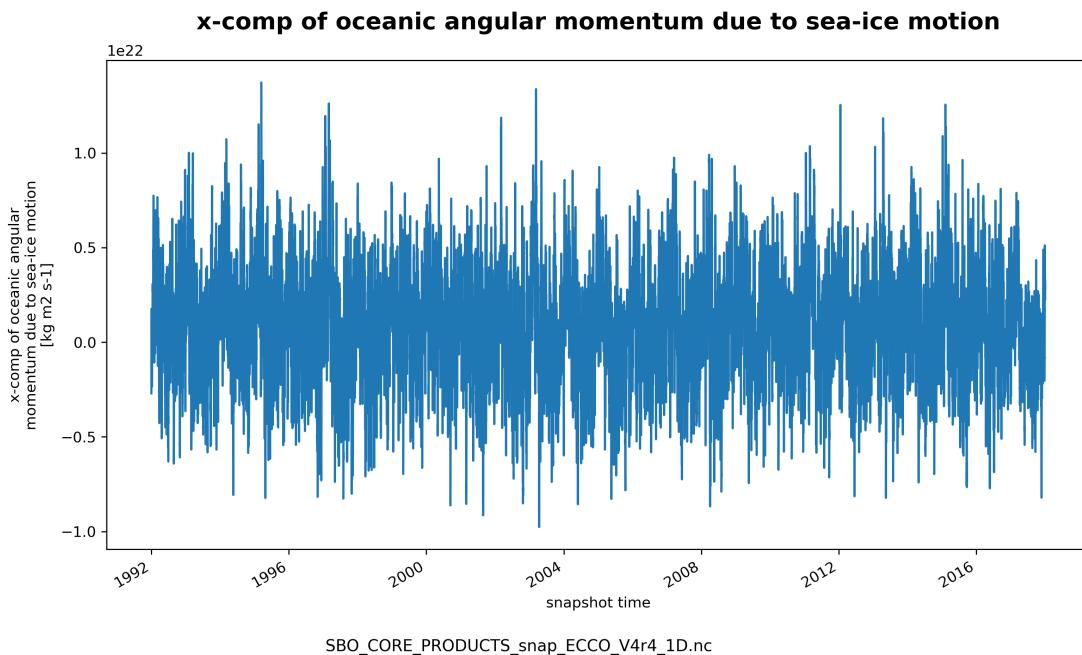


Figure 186: Dataset: SBO_CORE_PRODUCTS, Variable: xoamc_si

15.3.11 1D Variable: xoamp

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

Storage Type	Variable Name	Description	Unit
float64	xoamp	X-comp of oceanic angular momentum due to pressure	kg m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float64 xoamp(time) xoamp:_FillValue = 9.969209968386869e+36 xoamp:coverage_content_type = modelResult xoamp:long_name = x: comp of oceanic angular momentum due to pressure xoamp:units = kg m² s: 1 xoamp:valid_min = 1.3543642768158851e+29 xoamp:valid_max = 1.3546098666231897e+29 xoamp:coordinates = time</pre>			
Comments			
N/a			

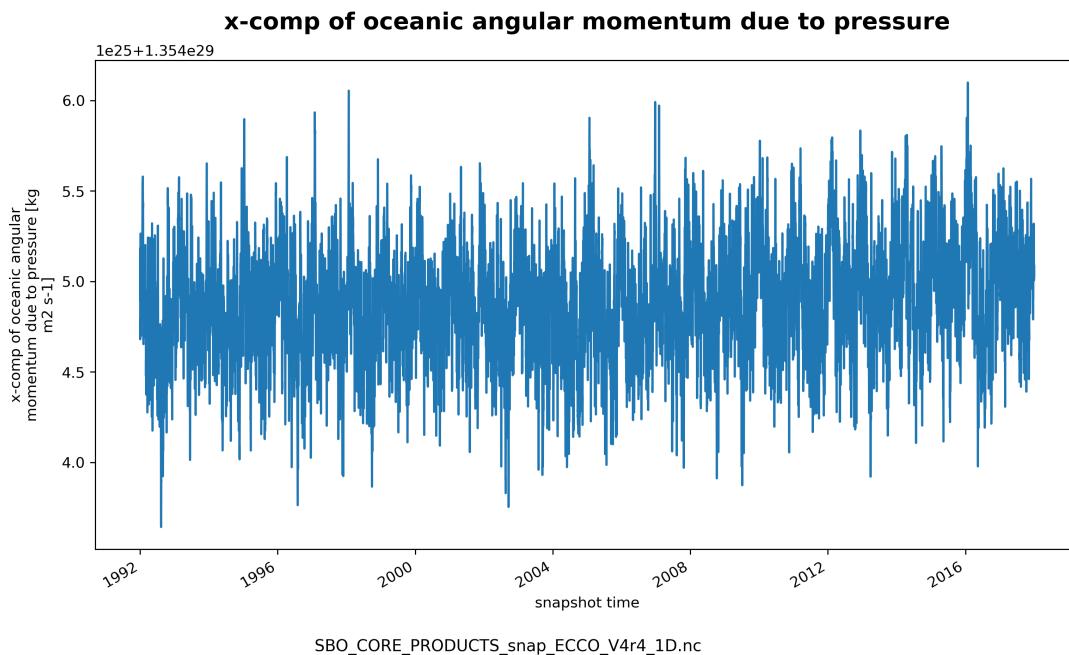


Figure 187: Dataset: SBO_CORE_PRODUCTS, Variable: xoamp

15.3.12 1D Variable: xoamp_dsl

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

Storage Type	Variable Name	Description	Unit
float64	xoamp_dsl	X-comp of oceanic angular momentum due to pressure based on dynamic (ib-corrected) sea level	kg m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float64 xoamp_dsl(time) xoamp_dsl:_FillValue = 9.969209968386869e+36 xoamp_dsl:coverage_content_type = modelResult xoamp_dsl:long_name = x: comp of oceanic angular momentum due to pressure based on dynamic (IB: corrected) sea level xoamp_dsl:units = kg m2 s: 1 xoamp_dsl:valid_min = 1.354440386439953e+29 xoamp_dsl:valid_max = 1.3545518352698056e+29 xoamp_dsl:coordinates = time</pre>			
Comments			
N/a			

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

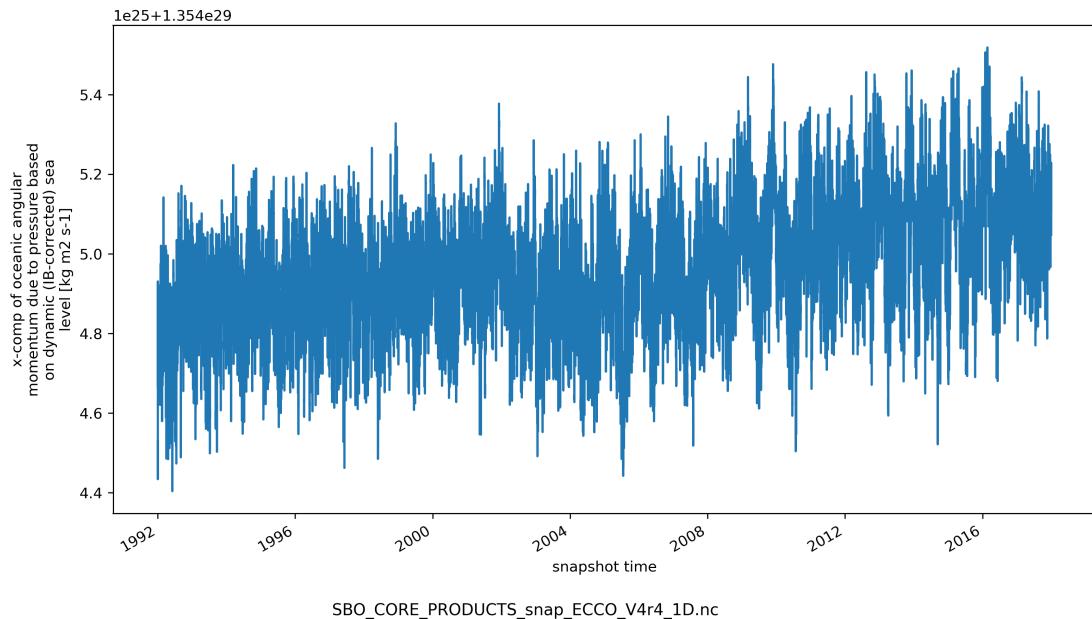


Figure 188: Dataset: SBO_CORE_PRODUCTS, Variable: xoamp_dsl

15.3.13 1D Variable: xoamp_fw

Table 15.19: Attributes description of the variable 'xoamp_fw' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	xoamp_fw	X-comp of oceanic angular momentum due to freshwater flux	kg m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float64 xoamp_fw(time) xoamp_fw:_FillValue = 9.969209968386869e+36 xoamp_fw:coverage_content_type = modelResult xoamp_fw:long_name = x: comp of oceanic angular momentum due to freshwater flux xoamp_fw:units = kg m² s: 1 xoamp_fw:valid_min = 1.805799644912138e+24 xoamp_fw:valid_max = 3.351358892803656e+24 xoamp_fw:coordinates = time</pre>			
Comments			
N/a			

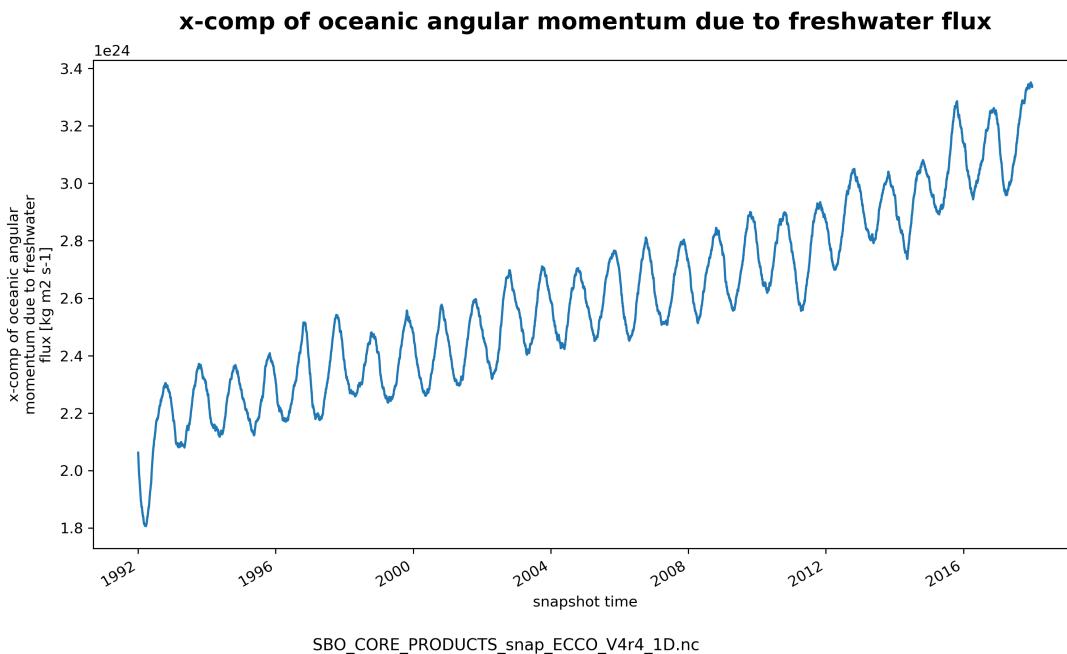


Figure 189: Dataset: SBO_CORE_PRODUCTS, Variable: xoamp_fw

15.3.14 1D Variable: ycom

Table 15.20: Attributes description of the variable 'ycom' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	ycom	Y-comp of center-of-mass of ocean	m
Description of the variable in Common Data language (CDL)			
	float64 ycom(time)		
<pre> 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 </pre>			
Comments			
N/a			

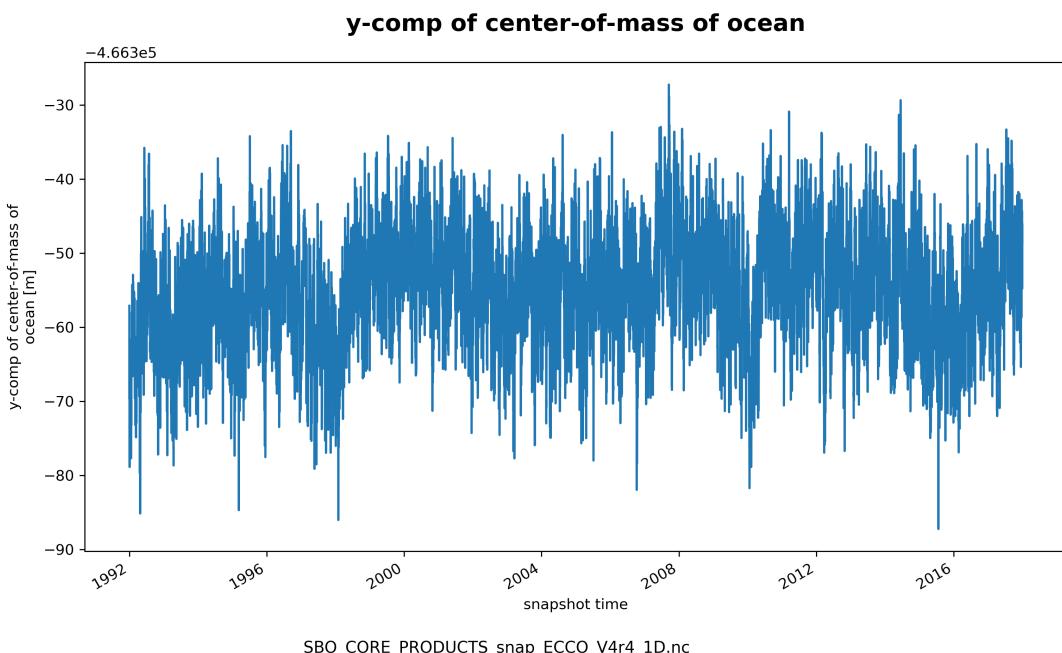


Figure 190: Dataset: SBO_CORE_PRODUCTS, Variable: ycom

15.3.15 1D Variable: ycom_fw

Table 15.21: Attributes description of the variable 'ycom_fw' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	ycom_fw	Y-comp of center-of-mass of freshwater flux	m
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
N/a			

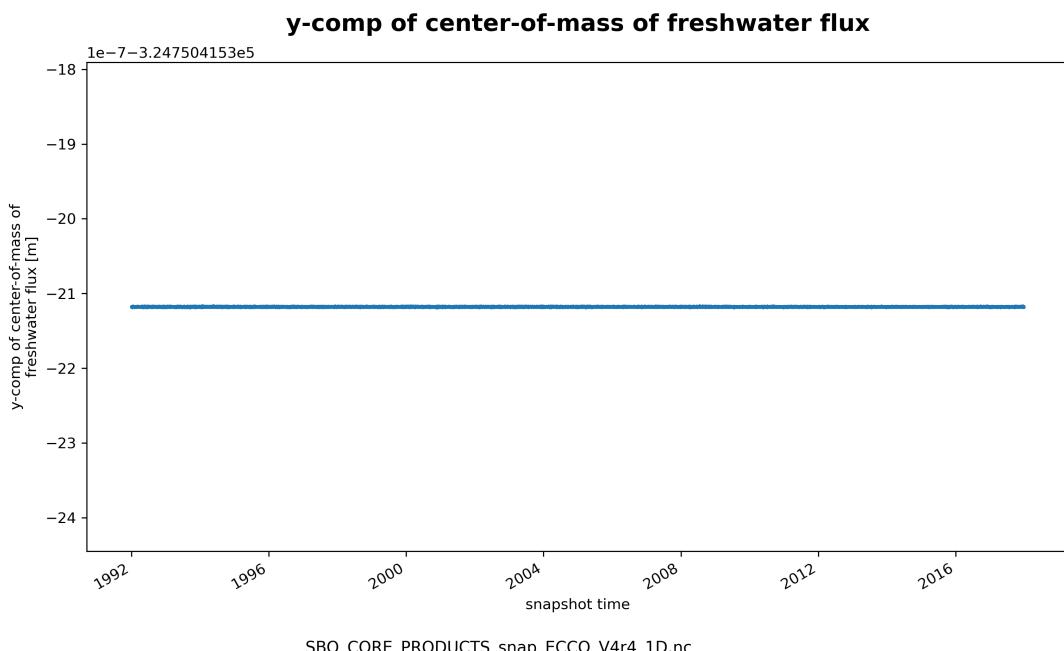


Figure 191: Dataset: SBO_CORE_PRODUCTS, Variable: ycom_fw

15.3.16 1D Variable: yoamc

Table 15.22: Attributes description of the variable 'yoamc' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	yoamc	Y-comp of oceanic angular momentum due to currents	kg m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float64 yoamc(time) yoamc:_FillValue = 9.969209968386869e+36 yoamc:coverage_content_type = modelResult yoamc:long_name = y: comp of oceanic angular momentum due to currents yoamc:units = kg m² s: 1 yoamc:valid_min = : 2.19249690136359e+24 yoamc:valid_max = 4.179441018940977e+24 yoamc:coordinates = time</pre>			
Comments			
N/a			

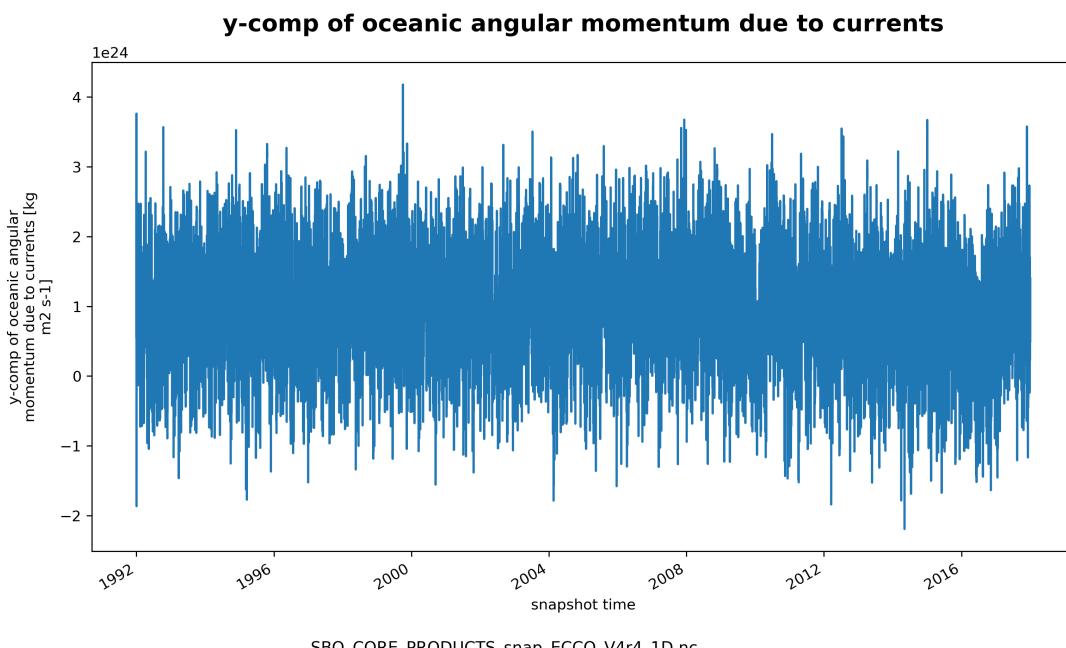


Figure 192: Dataset: SBO_CORE_PRODUCTS, Variable: yoamc

15.3.17 1D Variable: yoamc_si

Table 15.23: Attributes description of the variable 'yoamc_si' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	yoamc_si	Y-comp of oceanic angular momentum due to sea-ice motion	kg m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float64 yoamc_si(time) yoamc_si: _FillValue = 9.969209968386869e+36 yoamc_si: coverage_content_type = modelResult yoamc_si: long_name = y: comp of oceanic angular momentum due to sea- ice motion yoamc_si: units = kg m2 s: 1 yoamc_si: valid_min = : 1.176556337395274e+22 yoamc_si: valid_max = 1.6107851446370722e+22 yoamc_si: coordinates = time</pre>			
Comments			
N/a			

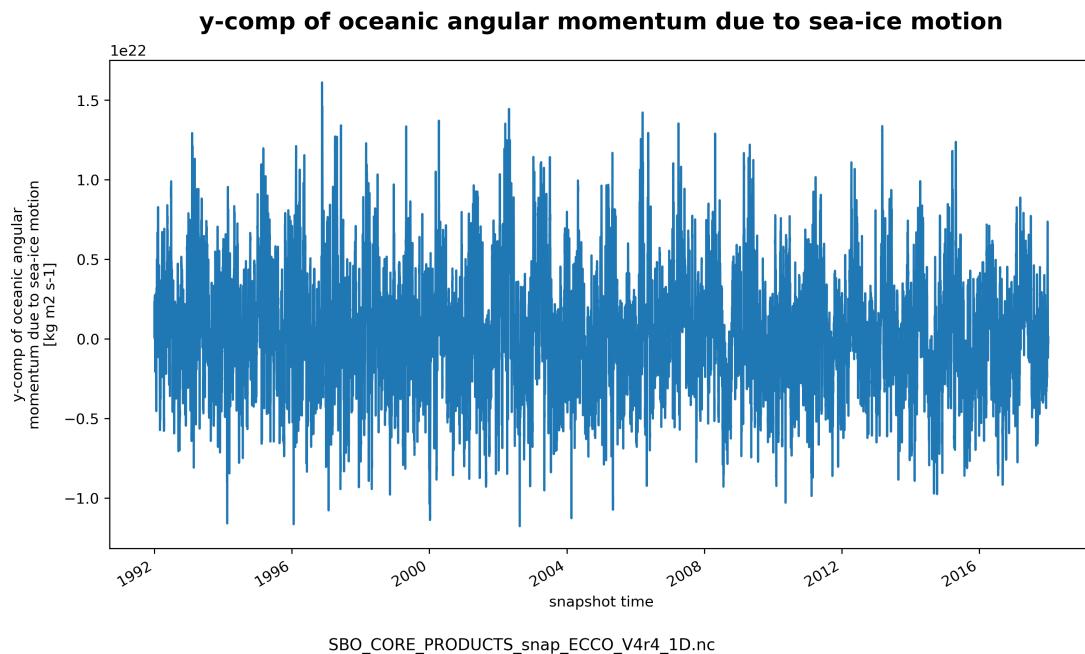


Figure 193: Dataset: SBO_CORE_PRODUCTS, Variable: yoamc_si

15.3.18 1D Variable: yoamp

Table 15.24: Attributes description of the variable 'yoamp' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	yoamp	Y-comp of oceanic angular momentum due to pressure	kg m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float64 yoamp(time) yoamp:_FillValue = 9.969209968386869e+36 yoamp:coverage_content_type = modelResult yoamp:long_name = y: comp of oceanic angular momentum due to pressure yoamp:units = kg m2 s: 1 yoamp:valid_min = 1.0476388397938864e+29 yoamp:valid_max = 1.0478581623131764e+29 yoamp:coordinates = time</pre>			
Comments			
N/a			

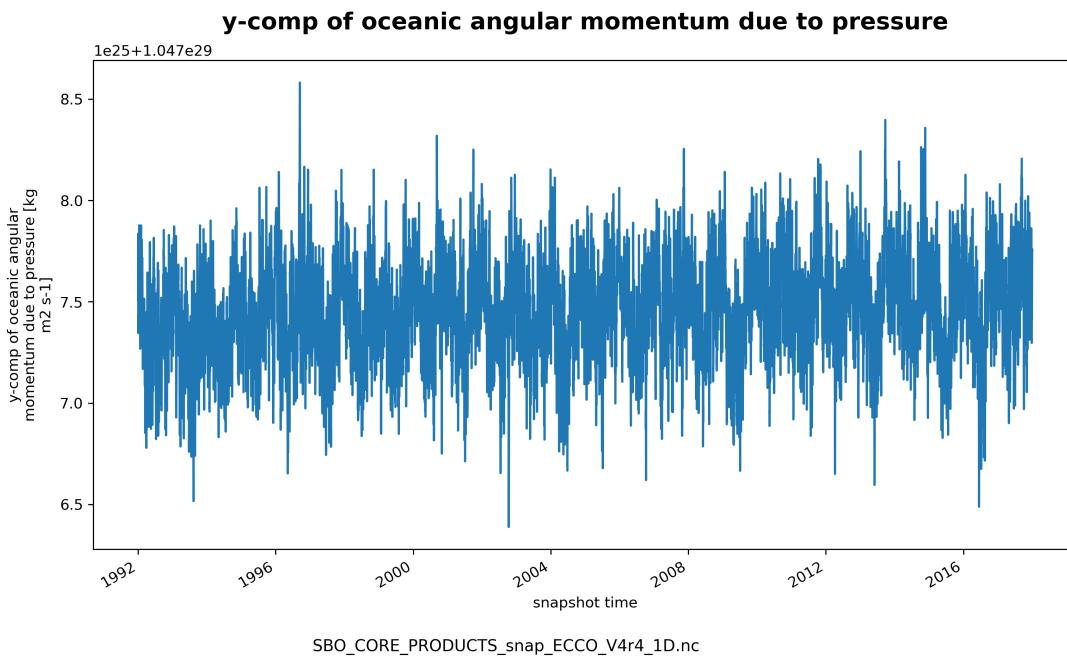


Figure 194: Dataset: SBO_CORE_PRODUCTS, Variable: yoamp

15.3.19 1D Variable: yoamp_dsl

Table 15.25: Attributes description of the variable 'yoamp_dsl' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	yoamp_dsl	Y-comp of oceanic angular momentum due to pressure based on dynamic (ib-corrected) sea level	kg m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float64 yoamp_dsl(time) yoamp_dsl:_FillValue = 9.969209968386869e+36 yoamp_dsl:coverage_content_type = modelResult yoamp_dsl:long_name = y: comp of oceanic angular momentum due to pressure based on dynamic (IB: corrected) sea level yoamp_dsl:units = kg m2 s: 1 yoamp_dsl:valid_min = 1.0476994334049981e+29 yoamp_dsl:valid_max = 1.0478187262074598e+29 yoamp_dsl:coordinates = time</pre>			
Comments			
N/a			

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

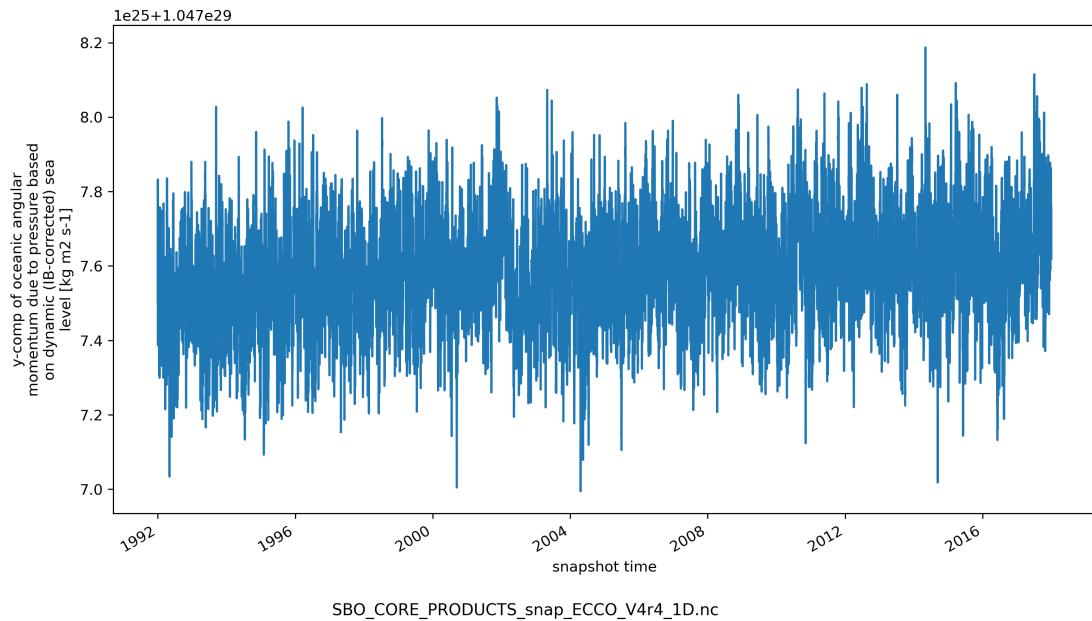


Figure 195: Dataset: SBO_CORE_PRODUCTS, Variable: yoamp_dsl

15.3.20 1D Variable: yoamp_fw

Table 15.26: Attributes description of the variable 'yoamp_fw' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	yoamp_fw	Y-comp of oceanic angular momentum due to freshwater flux	kg m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float64 yoamp_fw(time) yoamp_fw:_FillValue = 9.969209968386869e+36 yoamp_fw:coverage_content_type = modelResult yoamp_fw:long_name = y: comp of oceanic angular momentum due to freshwater flux yoamp_fw:units = kg m2 s: 1 yoamp_fw:valid_min = 2.6255410225894626e+24 yoamp_fw:valid_max = 4.872705717529432e+24 yoamp_fw:coordinates = time</pre>			
Comments			
N/a			

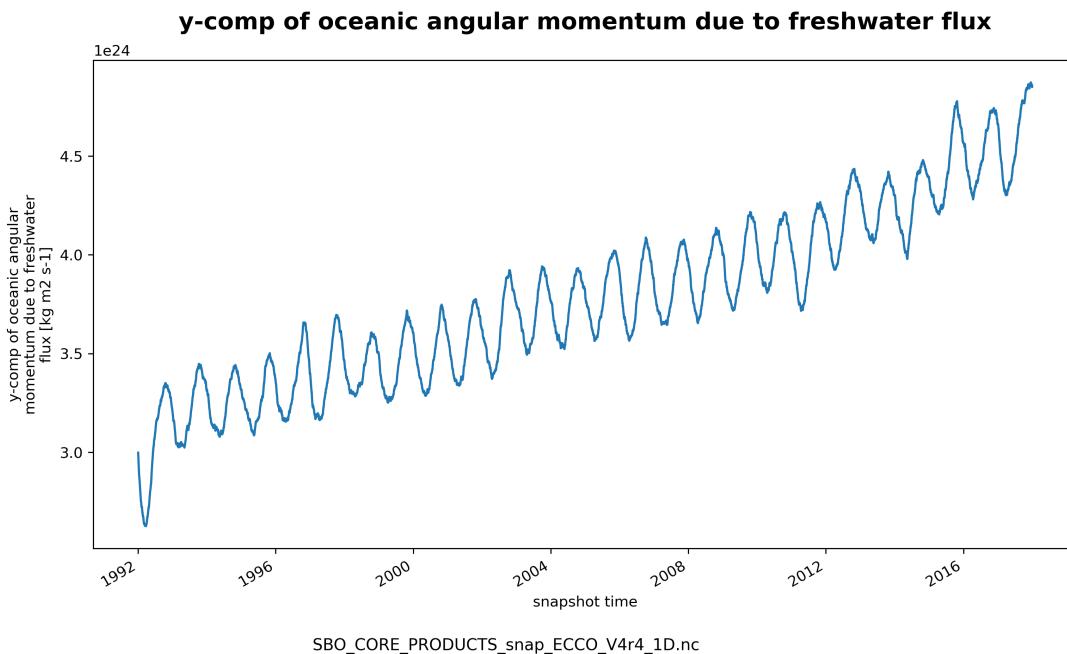


Figure 196: Dataset: SBO_CORE_PRODUCTS, Variable: yoamp_fw

15.3.21 1D Variable: zcom

Table 15.27: Attributes description of the variable 'zcom' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	zcom	Z-comp of center-of-mass of ocean	m
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
N/a			

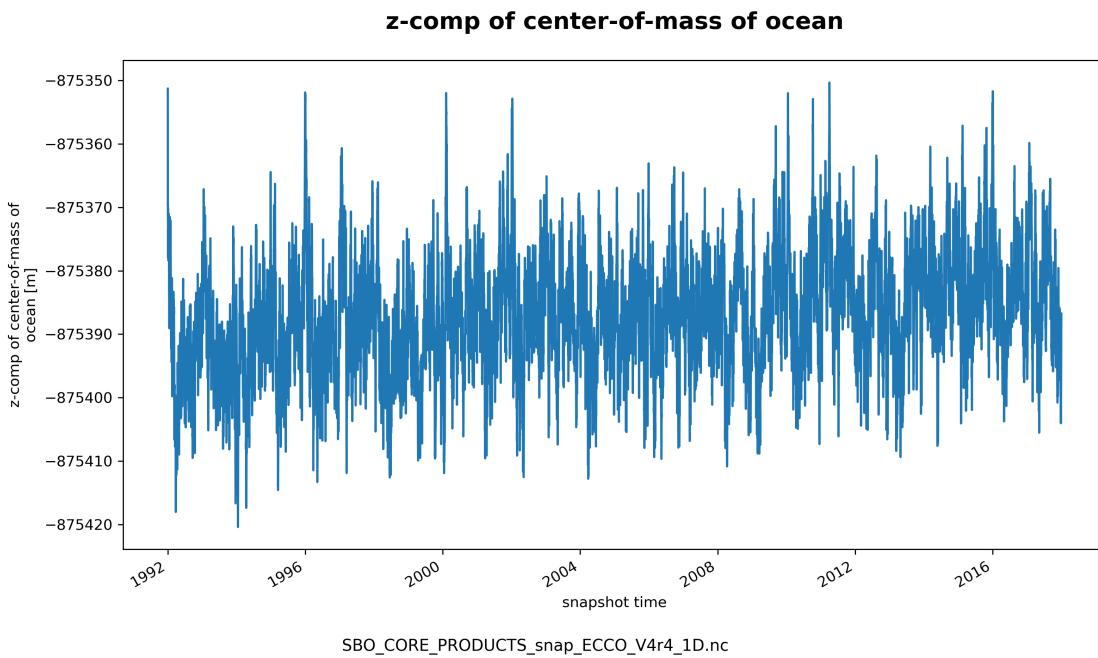
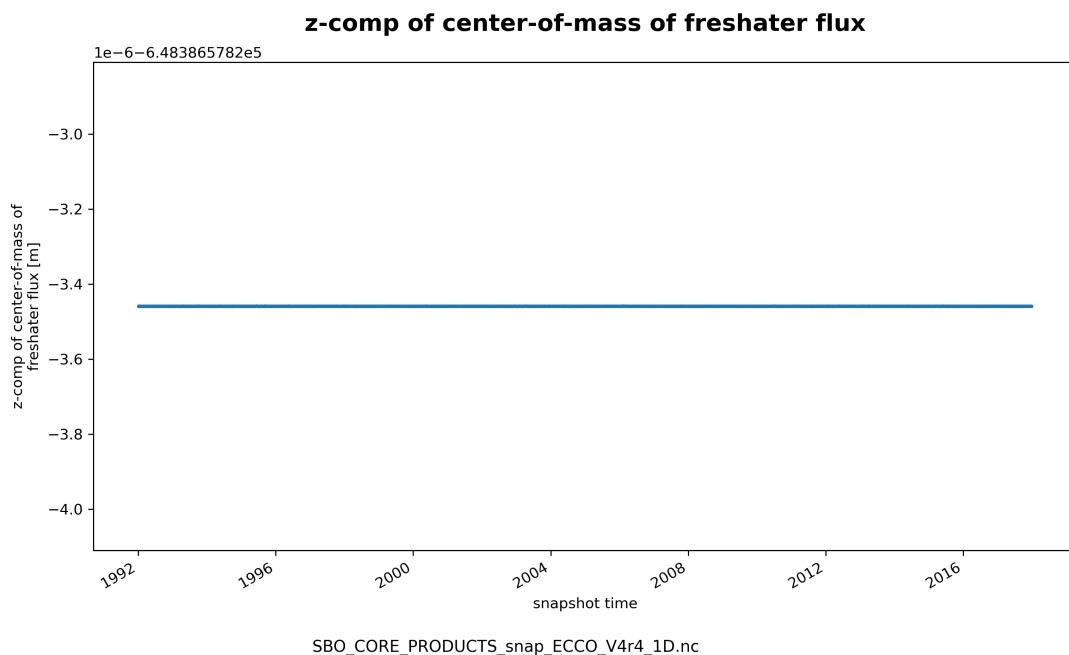


Figure 197: Dataset: SBO_CORE_PRODUCTS, Variable: zcom

15.3.22 1D Variable: zcom_fw

Table 15.28: Attributes description of the variable 'zcom_fw' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	zcom_fw	Z-comp of center-of-mass of freshater flux	m
Description of the variable in Common Data language (CDL)			
<pre>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</pre>			
Comments			
N/a			



SBO_CORE_PRODUCTS_snap_ECCO_V4r4_1D.nc

Figure 198: Dataset: SBO_CORE_PRODUCTS, Variable: zcom_fw

15.3.23 1D Variable: zoamc

Table 15.29: Attributes description of the variable 'zoamc' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	zoamc	Z-comp of oceanic angular momentum due to currents	kg m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float64 zoamc(time) zoamc: _FillValue = 9.969209968386869e+36 zoamc: coverage_content_type = modelResult zoamc: long_name = z: comp of oceanic angular momentum due to currents zoamc: units = kg m² s: 1 zoamc: valid_min = 7.331764457927521e+24 zoamc: valid_max = 2.207264300276968e+25 zoamc: coordinates = time</pre>			
Comments			
N/a			

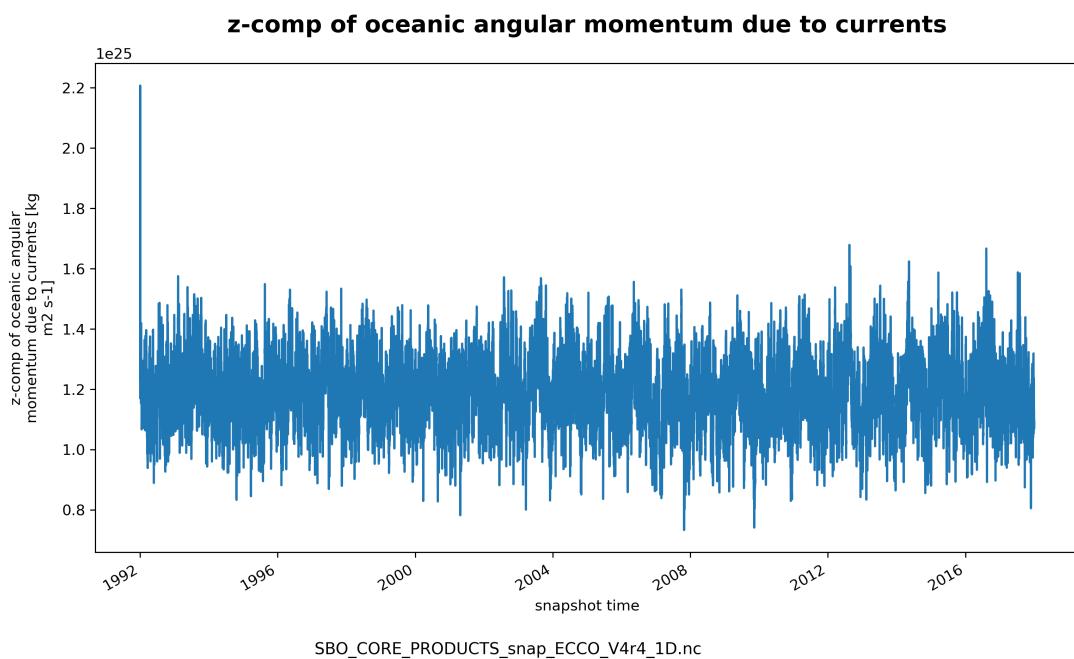


Figure 199: Dataset: SBO_CORE_PRODUCTS, Variable: zoamc

15.3.24 1D Variable: zoamc_si

Table 15.30: Attributes description of the variable 'zoamc_si' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	zoamc_si	Z-comp of oceanic angular momentum due to sea-ice motion	kg m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float64 zoamc_si(time) zoamc_si:_FillValue = 9.969209968386869e+36 zoamc_si:coverage_content_type = modelResult zoamc_si:long_name = z: comp of oceanic angular momentum due to sea- ice motion zoamc_si:units = kg m2 s: 1 zoamc_si:valid_min = : 5.909426721868294e+21 zoamc_si:valid_max = 5.930388258256482e+21 zoamc_si:coordinates = time</pre>			
Comments			
N/a			

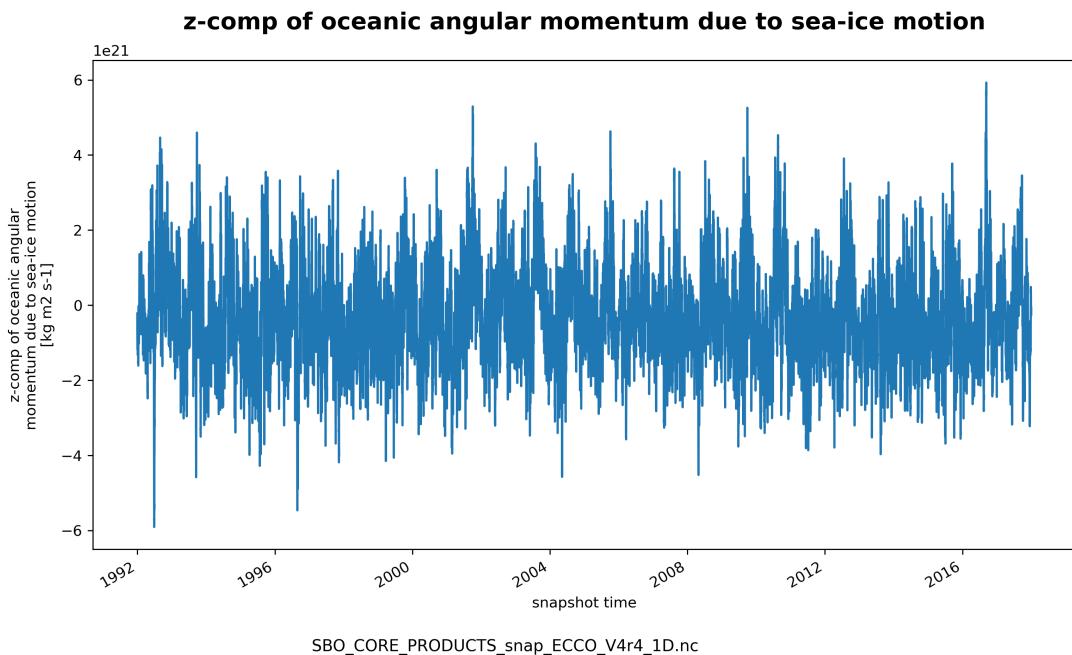
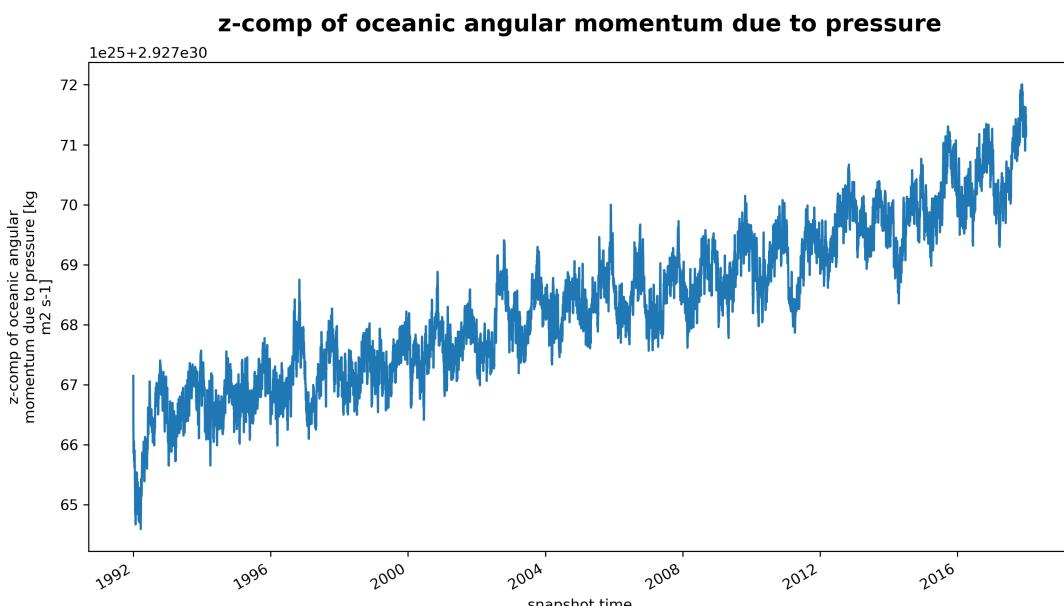


Figure 200: Dataset: SBO_CORE_PRODUCTS, Variable: zoamc_si

15.3.25 1D Variable: zoamp

Table 15.31: Attributes description of the variable 'zoamp' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	zoamp	Z-comp of oceanic angular momentum due to pressure	kg m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float64 zoamp(time) zoamp:_FillValue = 9.969209968386869e+36 zoamp:coverage_content_type = modelResult zoamp:long_name = z: comp of oceanic angular momentum due to pressure zoamp:units = kg m² s: 1 zoamp:valid_min = 2.927645942668479e+30 zoamp:valid_max = 2.9277200254389854e+30 zoamp:coordinates = time</pre>			
Comments			
N/a			



SBO_CORE_PRODUCTS_snap_ECCO_V4r4_1D.nc

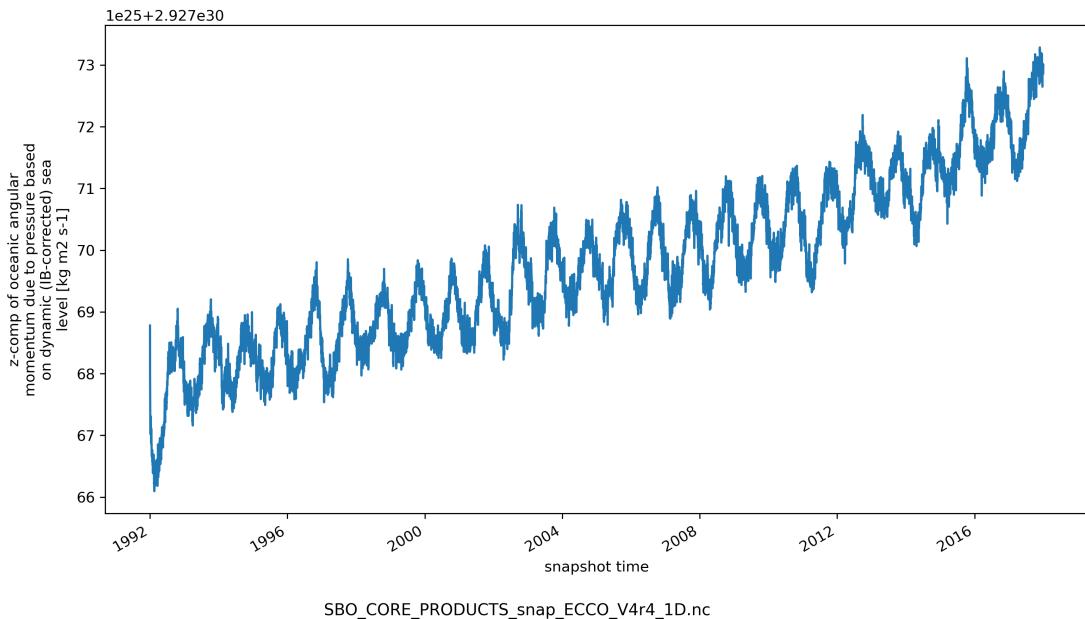
Figure 201: Dataset: SBO_CORE_PRODUCTS, Variable: zoamp

15.3.26 1D Variable: zoamp_dsl

Table 15.32: Attributes description of the variable 'zoamp_dsl' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	zoamp_dsl	Z-comp of oceanic angular momentum due to pressure based on dynamic (ib-corrected) sea level	kg m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float64 zoamp_dsl(time) zoamp_dsl:_FillValue = 9.969209968386869e+36 zoamp_dsl:coverage_content_type = modelResult zoamp_dsl:long_name = z: comp of oceanic angular momentum due to pressure based on dynamic (IB: corrected) sea level zoamp_dsl:units = kg m2 s: 1 zoamp_dsl:valid_min = 2.9276609546728614e+30 zoamp_dsl:valid_max = 2.9277328440911863e+30 zoamp_dsl:coordinates = time</pre>			
Comments			
N/a			

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



SBO_CORE_PRODUCTS_snap_ECCO_V4r4_1D.nc

Figure 202: Dataset: SBO_CORE_PRODUCTS, Variable: zoamp_dsl

15.3.27 1D Variable: zoamp_fw

Table 15.33: Attributes description of the variable 'zoamp_fw' from SBO_CORE_PRODUCTS's dataset.

Storage Type	Variable Name	Description	Unit
float64	zoamp_fw	Z-comp of oceanic angular momentum due to freshwater flux	kg m ² s ⁻¹
Description of the variable in Common Data language (CDL)			
<pre>float64 zoamp_fw(time) zoamp_fw:_FillValue = 9.969209968386869e+36 zoamp_fw:coverage_content_type = modelResult zoamp_fw:long_name = z: comp of oceanic angular momentum due to freshwater flux zoamp_fw:units = kg m² s: 1 zoamp_fw:valid_min = 7.774584605728723e+25 zoamp_fw:valid_max = 1.442874536478883e+26 zoamp_fw:coordinates = time</pre>			
Comments			
N/a			

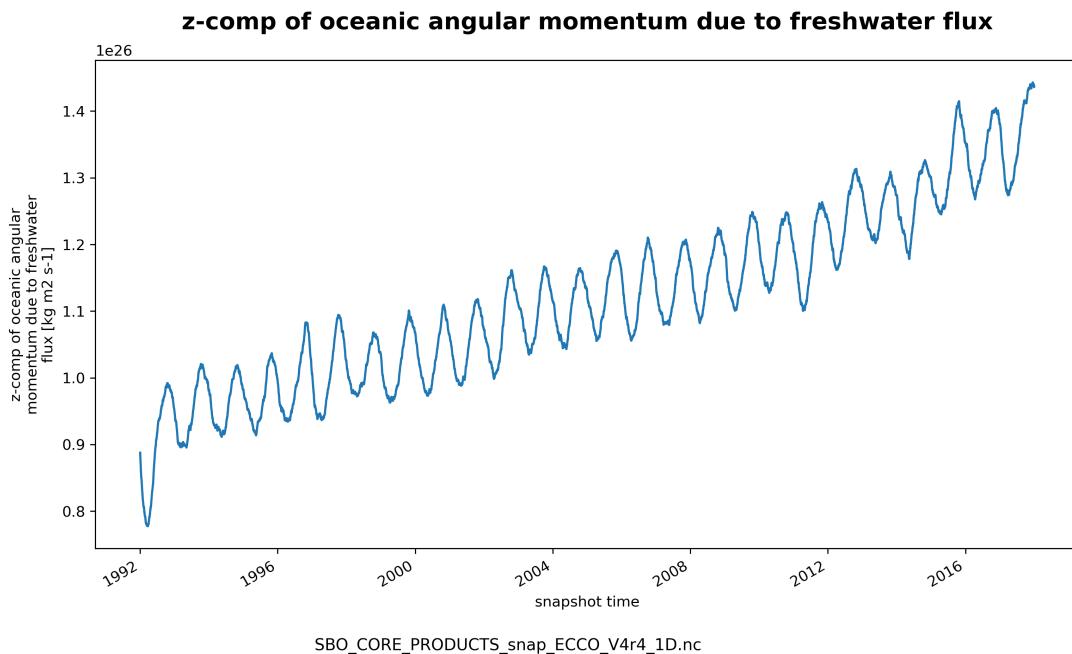


Figure 203: Dataset: SBO_CORE_PRODUCTS, Variable: zoamp_fw

How to find out more about ECCO:

A complete description of ECCO V4r4 together with all project documentation can be found at the following web spaces:

Main ECCO portal
ECCO History
ECCO data analysis tools
ECCO tutorial
ECCO Python tutorial
To contact ECCO team

<https://ecco-group.org/home.htm>
<https://ecco-group.org/about.htm>
<https://ecco-group.org/home.htm>
<http://ghrsst.nodc.noaa.gov>
<https://ecco-v4-python-tutorial.readthedocs.io/>
<https://ecco-group.org/contact.htm>

