CMIP6 Model Documentation

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Documentation Contents

1 Key Properties

Sea Ice key properties

1.1.1 Top level properties

Sea Ice key properties

1.1.1.1 Name *

Name of seaice model code

Global Experimental Leads and sea ice for ATmosphere and Ocean

1.1.1.2 Keywords *

Keywords associated with seaice model code

Enter COMMA SEPARATED list:

1.1.1.3 Overview *

Overview of seaice model.

Enter TEXT:

1.2.1 Variables

List of prognostic variable in the sea ice model.

1.2.1.1 Prognostic *

Select all prognostic variables in the sea ice component.

- ☐ Sea ice temperature
- ☐ Sea ice concentration
- ☐ Sea ice thickness
- ☐ Sea ice volume per grid cell area
- ☐ Sea ice u-velocity
- ☐ Sea ice v-velocity
- ☐ Sea ice enthalpy
- ☐ Internal ice stress
- ☐ Salinity
- ☐ Snow temperature - Snow on ice temperature
- ☐ Snow depth - Snow on ice thickness

☐ Other - please specify:

1.3.1 Seawater Properties

Properties of seawater relevant to sea ice

1.3.1.1 Ocean Freezing Point *

What is the equation used to compute the freezing point (in deg C) of seawater, as a function of salinity and pressure?

Select SINGLE option:

☐ TEOS-10 - Thermodynamic equation of seawater 2010.

☐ Constant - Constant value of seawater freezing point is used.

☐ Other - please specify:

1.3.1.2 Ocean Freezing Point Value

If using a constant seawater freezing point, specify this value.

Enter FLOAT value:

1.4.1 Resolution

Resolution of the sea ice grid

1.4.1.1 Name *

This is a string usually used by the modelling group to describe the resolution of this grid e.g. N512L180, T512L70, ORCA025 etc.

Enter TEXT:

1.4.1.2 Canonical Horizontal Resolution *

Expression quoted for gross comparisons of resolution, eg. 50km or 0.1 degrees etc.

Enter TEXT:

1.4.1.3 Number Of Horizontal Gridpoints *

What are the total number of horizontal (XY) points (or degrees of freedom) on computational grid?

Enter INTEGER value:

1.5.1 Tuning Applied

Tuning applied to sea ice model component

1.5.1.1 Description *

Provide a general overview description of tuning: explain and motivate the main targets and metrics retained. Document the relative weight given to climate performance metrics versus process oriented metrics, and on the possible conflicts with parameterization level tuning. In particular describe any struggle with a parameter value that required pushing it to its limits to solve a particular model deficiency.

Enter TEXT:

1.5.1.2 Target *

What was the aim of tuning, e.g. correct sea ice minima, correct seasonal cycle?

Enter TEXT:

1.5.1.3 Simulations *

Which simulations had tuning applied, e.g. all, not historical, only pi-control?

Enter COMMA SEPARATED list:

1.5.1.4 Metrics Used *

List any observed metrics used in tuning model/parameters

Enter COMMA SEPARATED list:

1.5.1.5 Variables

Which (if any) variables were changed during the tuning process?

Enter COMMA SEPARATED list:

1.6.1 Key Parameter Values

Values of key parameters

1.6.1.1 Ice Strength

Ice strength (P) in units of N m-2*

Enter FLOAT value:

1.6.1.2 Snow Conductivity

Snow conductivity (ks) in units of W m-1 K-1

Enter FLOAT value:

1.6.1.3 Ice Thickness In Leads

Minimum thickness of ice created in leads (h0) in units of m

Enter FLOAT value:

1.6.1.4 Additional Parameters

If you have any additional paramterised values that you have used (e.g. minimum open water fraction or bare ice albedo), please provide them here as a comma separated list in the form parameter1: value1, parameter2: value2, etc.

Enter COMMA SEPARATED list:

1.7.1 Assumptions

Assumptions made in the sea ice model

1.7.1.1 Description *

*Provide a general overview description of any *key* assumptions made in this model.*

Enter TEXT:

1.7.1.2 On Diagnostic Variables *

Note any assumptions that specifically affect the CMIP6 diagnostic sea ice variables.

Enter COMMA SEPARATED list:

1.7.1.3 Missing Processes *

*List any *key* processes missing in this model configuration? Provide full details where this affects the CMIP6 diagnostic sea ice variables?*

Enter COMMA SEPARATED list:

1.8.1 Conservation

Conservation in the sea ice component

1.8.1.1 Description *

Provide a general description of conservation methodology.

Enter TEXT:

1.8.1.2 Properties *

Which properties conserved in sea ice by the numerical schemes?

Select MULTIPLE options:

- ☐ Energy
- ☐ Mass
- ☐ Salt
- ☐ Other - please specify:

1.8.1.3 Budget *

For each conserved property, specify the output variables which close the related budgets. as a comma separated list. For example: Conserved property, variable1, variable2, variable3

Enter COMMA SEPARATED list:

1.8.1.4 Was Flux Correction Used *

Does conservation involved flux correction?

Select either TRUE or FALSE:

☐ True ☐ False

1.8.1.5 Corrected Conserved Prognostic Variables

*List any variables which are conserved by *more* than the numerical scheme alone (e.g. has correction applied).*

Enter COMMA SEPARATED list:

2 Grid

Sea Ice grid

2.1.1 Top level properties

Sea Ice grid

2.1.1.1 Name

Name of grid in seaice model.

Enter TEXT:

2.1.1.2 Overview

Overview of grid in seaice model.

Enter TEXT:

2.1.2 Horizontal

Sea ice discretisation in the horizontal

2.1.2.1 Grid *

On which grid is the sea ice horizontal discretisation?

- ☐ Ocean grid - Sea ice is horizontally discretised on the ocean grid.
- ☐ Atmosphere Grid - Sea ice is horizontally discretised on the atmospheric grid.
- ☐ Own Grid - Sea ice is horizontally discretised on its own independent grid.
- ☐ Other - please specify:

2.1.2.2 Grid Type *

What is the structure type of the sea ice grid?

Select SINGLE option:

- ☐ Structured grid
- ☐ Unstructured grid
- ☐ Adaptive grid - Computational grid changes during the run
- ☐ Other - please specify:

2.1.2.3 Scheme *

What is the horizontal discretization (advection) scheme?

Select SINGLE option:

- ☐ Finite differences
- ☐ Finite elements
- ☐ Finite volumes
- ☐ Other - please specify:

2.1.2.4 Thermodynamics Time Step *

What is the time step in the sea ice model thermodynamic component in seconds.

86400

2.1.2.5 Dynamics Time Step *

What is the time step in the sea ice model dynamic component in seconds.

21600

2.1.2.6 Additional Details

Specify any additional horizontal discretisation details.

Enter TEXT:

2.1.3 Vertical

Sea ice vertical properties

2.1.3.1 Layering *

What type of sea ice vertical layers are implemented for purposes of thermodynamic calculations?

- ☐ Zero-layer - Simulation has no internal ice thermodynamics.
- ☐ Two-layers - Simulation uses two layers (i.e. one ice and one snow layer).
- ☐ Multi-layers - Simulation uses more than two layers.
- ☐ Other - please specify:

2.1.3.2 Number Of Layers *

If using multi-layers specify how many.

Enter INTEGER value:

2.1.3.3 Additional Details

Specify any additional vertical grid details.

Enter TEXT:

2.2.1 Seaice Categories

What method is used to represent sea ice categories?

2.2.1.1 Has Mulitple Categories *

Set to true if the sea ice model has multiple sea ice categories.

Select either TRUE or FALSE:

☐ True ☐ False

2.2.1.2 Number Of Categories *

If using sea ice categories specify how many.

Enter INTEGER value:

2.2.1.3 Category Limits *

If using sea ice categories specify each of the category limits.

Enter COMMA SEPARATED list:

2.2.1.4 Ice Thickness Distribution *

Describe the sea ice thickness distribution.

Enter TEXT:

2.2.1.5 Other

If the sea ice model does not use sea ice categories specify any additional details. For example models that paramterise the ice thickness distribution ITD (i.e there is no explicit ITD) but there is assumed distribution and fluxes are computed accordingly.

Enter TEXT:

2.3.1 Snow On Seaice

Snow on sea ice details

2.3.1.1 Has Snow On Ice *

Is snow on ice represented in this model?

Select either TRUE or FALSE:

☐ True ☐ False

2.3.1.2 Number Of Snow Levels *

Number of vertical levels of snow on ice?

Enter INTEGER value:

2.3.1.3 Snow Fraction *

Describe how the snow fraction on sea ice is determined.

Enter TEXT:

2.3.1.4 Additional Details

Specify any additional details related to snow on ice.

Enter TEXT:

3 Dynamics

Sea Ice Dynamics

3.1.1 Top level properties

Sea Ice Dynamics

3.1.1.1 Name

Commonly used name for the dynamics in seaice model.

Enter TEXT:

3.1.1.2 Overview

Overview of sea ice dynamics in seaice model.

Enter TEXT:

3.1.1.3 Horizontal Transport *

What is the method of horizontal advection of sea ice?

Select SINGLE option:

- ☐ Incremental Re-mapping - (including Semi-Lagrangian)
- ☐ Prather
- ☐ Eulerian
- ☐ Other - please specify:

3.1.1.4 Transport In Thickness Space *

What is the method of sea ice transport in thickness space (i.e. in thickness categories)?

- ☐ Incremental Re-mapping - (including Semi-Lagrangian)
- ☐ Prather
- ☐ Eulerian
- ☐ Other - please specify:

3.1.1.5 Ice Strength Formulation *

Which method of sea ice strength formulation is used?

- ☐ Hibler 1979
- ☐ Rothrock 1975
- ☐ Other - please specify:

3.1.1.6 Redistribution *

Which processes can redistribute sea ice (including thickness)?

- ☐ Rafting
- ☒ Ridging
- ☐ Other - please specify:

3.1.1.7 Rheology *

Rheology, what is the ice deformation formulation?

Select SINGLE option:

- ☐ Free-drift
- ☐ Mohr-Coloumb
- ☐ Visco-plastic - VP
- ☐ Elastic-visco-plastic - EVP
- ☐ Elastic-anisotropic-plastic
- ☐ Granular
- ☐ Other - please specify:

4 Thermodynamics

Sea Ice Thermodynamics

4.1.1 Top level properties

Sea Ice Thermodynamics

4.1.1.1 Name

Commonly used name for the thermodynamics in seaice model.

Enter TEXT:

4.1.1.2 Overview

Overview of sea ice thermodynamics in seaice model.

To account for the presence of melting ponds, the surface albedo of melting sea ice is set to 0.56 in Gelato5.

4.2.1 Energy

Processes related to energy in sea ice thermodynamics.

4.2.1.1 Enthalpy Formulation *

What is the energy formulation?

Select SINGLE option:

- ☐ Pure ice latent heat (Semtner 0-layer)
- ☐ Pure ice latent and sensible heat
- ☐ Pure ice latent and sensible heat + brine heat reservoir (Semtner 3-layer)
- ☐ Pure ice latent and sensible heat + explicit brine inclusions (Bitz and Lipscomb)
- ☐ Other - please specify:

4.2.1.2 Thermal Conductivity *

What type of thermal conductivity is used?

Select SINGLE option:

- ☐ Pure ice
- ☐ Saline ice
- ☐ Other - please specify:

4.2.1.3 Heat Diffusion *

What is the method of heat diffusion?

- ☐ Conduction fluxes
- ☐ Conduction and radiation heat fluxes
- ☐ Conduction, radiation and latent heat transport
- ☐ Other - please specify:

4.2.1.4 Basal Heat Flux *

Method by which basal ocean heat flux is handled?

- ☐ Heat Reservoir - Brine inclusions treated as a heat reservoir.
- ☐ Thermal Fixed Salinity - Thermal properties depend on S-T (with fixed salinity).
- ☐ Thermal Varying Salinity - Thermal properties depend on S-T (with varying salinity.
- ☐ Other - please specify:

4.2.1.5 Fixed Salinity Value

If you have selected Thermal properties depend on S-T (with fixed salinity), supply fixed salinity value for each sea ice layer.

Enter FLOAT value:

4.2.1.6 Heat Content Of Precipitation *

Describe the method by which the heat content of precipitation is handled.

Enter TEXT:

4.2.1.7 Precipitation Effects On Salinity

If precipitation (freshwater) that falls on sea ice affects the ocean surface salinity please provide further details.

Enter TEXT:

4.3.1 Mass

Processes related to mass in sea ice thermodynamics.

4.3.1.1 New Ice Formation *

Describe the method by which new sea ice is formed in open water.

Brine entrapment as new ice forms is a function of the ice growth rate (Cox and Weeks, 1988)

4.3.1.2 Ice Vertical Growth And Melt *

Describe the method that governs the vertical growth and melt of sea ice.

Enter TEXT:

4.3.1.3 Ice Lateral Melting *

What is the method of sea ice lateral melting?

Select SINGLE option:

- ☐ Floe-size dependent (Bitz et al 2001)
- ☐ Virtual thin ice melting (for single-category)
- ☐ Other - please specify:

4.3.1.4 Ice Surface Sublimation *

Describe the method that governs sea ice surface sublimation.

Enter TEXT:

4.3.1.5 Frazil Ice *

Describe the method of frazil ice formation.

Enter TEXT:

4.4.1 Salt

Processes related to salt in sea ice thermodynamics.

4.4.1.1 Has Multiple Sea Ice Salinities *

Does the sea ice model use two different salinities: one for thermodynamic calculations; and one for the salt budget?

Select either TRUE or FALSE:

☐ True ☐ False

4.4.1.2 Sea Ice Salinity Thermal Impacts *

Does sea ice salinity impact the thermal properties of sea ice?

Select either TRUE or FALSE:

☐ True ☐ False

4.4.2 Mass Transport

Mass transport of salt.

4.4.2.1 Salinity Type *

How is salinity determined in the mass transport of salt calculation?

Select SINGLE option:

- ☐ Constant
- ☐ Prescribed salinity profile
- ☐ Prognostic salinity profile
- ☐ Other - please specify:

4.4.2.2 Constant Salinity Value

If using a constant salinity value specify this value in PSU?

Enter FLOAT value:

4.4.2.3 Additional Details

Describe the salinity profile used.

Enter TEXT:

4.4.3 Thermodynamics

Salt thermodynamics

4.4.3.1 Salinity Type *

How is salinity determined in the thermodynamic calculation?

Select SINGLE option:

- ☐ Constant
- ☐ Prescribed salinity profile
- ☐ Prognostic salinity profile
- ☐ Other - please specify:

4.4.3.2 Constant Salinity Value

If using a constant salinity value specify this value in PSU?

Enter FLOAT value:

4.4.3.3 Additional Details

Describe the salinity profile used.

Enter TEXT:

4.5.1 Ice Thickness Distribution

Ice thickness distribution details.

4.5.1.1 Representation *

How is the sea ice thickness distribution represented?

Select SINGLE option:

- ☐ Explicit
- ☐ Virtual (enhancement of thermal conductivity, thin ice melting)
- ☐ Other - please specify:

4.6.1 Ice Floe Size Distribution

Ice floe-size distribution details.

4.6.1.1 Representation *

How is the sea ice floe-size represented?

Select SINGLE option:

- ☐ Explicit
- ☐ Parameterised
- ☐ Other - please specify:

4.6.1.2 Additional Details

Provide further details on any parameterisation of floe-size.

Enter TEXT:

4.7.1 Melt Ponds

Characteristics of melt ponds.

4.7.1.1 Are Included *

Are melt ponds included in the sea ice model?

Select either TRUE or FALSE:

☐ True ☐ False

4.7.1.2 Formulation *

What method of melt pond formulation is used?

- ☐ Flocco and Feltham (2010)
- ☐ Level-ice melt ponds
- ☐ Other - please specify:

4.7.1.3 Impacts *

What do melt ponds have an impact on?

Select MULTIPLE options:

- ☐ Albedo
- ☐ Freshwater
- ☐ Heat
- ☐ Other - please specify:

4.8.1 Snow Processes

Thermodynamic processes in snow on sea ice

4.8.1.1 Has Snow Aging *

Set to True if the sea ice model has a snow aging scheme.

Select either TRUE or FALSE:

☐ True ☐ False

4.8.1.2 Snow Aging Scheme

Describe the snow aging scheme.

Enter TEXT:

4.8.1.3 Has Snow Ice Formation *

Set to True if the sea ice model has snow ice formation.

Select either TRUE or FALSE:

☐ True ☐ False

4.8.1.4 Snow Ice Formation Scheme

Describe the snow ice formation scheme.

Enter TEXT:

4.8.1.5 Redistribution *

What is the impact of ridging on snow cover?

Snow-aging, Snow-ice

4.8.1.6 Heat Diffusion *

What is the heat diffusion through snow methodology in sea ice thermodynamics?

Select SINGLE option:

- ☐ Single-layered heat diffusion
- ☐ Multi-layered heat diffusion
- ☐ Other - please specify:

5 Radiative Processes

Sea Ice Radiative Processes

5.1.1 Top level properties

Sea Ice Radiative Processes

5.1.1.1 Name

Commonly used name for the radiative processes in seaice model.

Enter TEXT:

5.1.1.2 Overview

Overview of sea ice radiative processes in seaice model.

Enter TEXT:

5.1.1.3 Surface Albedo *

Method used to handle surface albedo?

- ☐ Delta-Eddington
- ☐ Parameterized - Sea ice albedo is parameterized.
- ☐ Multi-band albedo - Albedo value has a spectral dependence.
- ☐ Other - please specify:

5.1.1.4 Ice Radiation Transmission *

Method by which solar radiation through sea ice is handled?

Select MULTIPLE options:

- ☐ Delta-Eddington
- ☐ Exponential attenuation
- ☐ Ice radiation transmission per category - Radiation transmission through ice is different for each sea ice category.
- ☐ Other - please specify: