CMIP6 Model Documentation

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Documentation Contents

1 Key Properties

Sea Ice key properties

1.1 Model

Name of seaice model used.

1.1.1 Model Overview

Overview of sea ice model.

Spec. ID: cmip6.seaice.key_properties.model.model_overview

Is Required ? TRUE

Enter TEXT value:

1.1.2 Model Name

Name of sea ice model code (e.g. CICE 4.2, LIM 2.1, etc.)

Spec. ID: cmip6.seaice.key_properties.model.model_name

Is Required ? TRUE

Enter TEXT value:

1.2 Variables

List of prognostic variable in the sea ice model.

1.2.1 Prognostic

List of prognostic variables in the sea ice component.

Spec. ID: cmip6.seaice.key_properties.variables.prognostic

Is Required ? TRUE

Select value(s):

- ☐ 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 Seawater Properties

Properties of seawater relevant to sea ice

1.3.1 Ocean Freezing Point

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

Spec. ID: cmip6.seaice.key_properties.seawater_properties.ocean_freezing_point

Is Required ? TRUE

Select value:

- ☐ TEOS-10 - Thermodynamic equation of seawater 2010
- ☐ Constant - Constant value of seawater freezing point is used.
- ☐ Other - please specify:

1.3.2 Ocean Freezing Point Value

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

Spec. ID: cmip6.seaice.key_properties.seawater_properties.ocean_freezing_point_value

Is Required ? FALSE

Enter FLOAT value:

1.4 Resolution

Resolution of the sea ice grid

1.4.1 Name

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

Spec. ID: cmip6.seaice.key_properties.resolution.name

Is Required ? TRUE

Enter TEXT value:

1.4.2 Canonical Horizontal Resolution

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

Spec. ID: cmip6.seaice.key_properties.resolution.canonical_horizontal_resolution

Is Required ? TRUE

Enter TEXT value:

1.4.3 Number Of Horizontal Gridpoints

Total number of horizontal (XY) points (or degrees of freedom) on computational grid.

Spec. ID: cmip6.seaice.key_properties.resolution.number_of_horizontal_gridpoints

Is Required ? TRUE

Enter INTEGER value:

1.5 Tuning Applied

Tuning applied to sea ice model component

1.5.1 Description

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.

Spec. ID: cmip6.seaice.key_properties.tuning_applied.description

Is Required ? TRUE

Enter TEXT value:

1.5.2 Target

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

Spec. ID: cmip6.seaice.key_properties.tuning_applied.target

Is Required ? TRUE

Enter TEXT value:

1.5.3 Simulations

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

Spec. ID: cmip6.seaice.key_properties.tuning_applied.simulations

Is Required ? TRUE

Enter TEXT value:

1.5.4 Metrics Used

List any observed metrics used in tuning model/parameters

Spec. ID: cmip6.seaice.key_properties.tuning_applied.metrics_used

Is Required ? TRUE

Enter TEXT value:

1.5.5 Variables

Which variables were changed during the tuning processxxx?

Spec. ID: cmip6.seaice.key_properties.tuning_applied.variables

Is Required ? FALSE

Enter TEXT value:

1.6 Key Parameter Values

Values of key parameters

1.6.1 Typical Parameters

What values were specificed for the following parameters if usedxxx?

Spec. ID: cmip6.seaice.key_properties.key_parameter_values.typical_parameters

Is Required ? FALSE

Select value(s):

- ☐ Ice strength (P*) in units of N m-2
- ☐ Snow conductivity (ks) in units of W m-1 K-1
- ☐ Minimum thickness of ice created in leads (h0) in units of m
- ☐ Other - please specify:

1.6.2 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

Spec. ID: cmip6.seaice.key_properties.key_parameter_values.additional_parameters

Is Required ? FALSE

Enter TEXT value(s):

1.7 Assumptions

Assumptions made in the sea ice model

1.7.1 Description

*General overview description of any *key* assumptions made in this model.*

Spec. ID: cmip6.seaice.key_properties.assumptions.description

Is Required ? TRUE

Enter TEXT value(s):

1.7.2 On Diagnostic Variables

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

Spec. ID: cmip6.seaice.key_properties.assumptions.on_diagnostic_variables

Is Required ? TRUE

Enter TEXT value(s):

1.7.3 Missing Processes

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

Spec. ID: cmip6.seaice.key_properties.assumptions.missing_processes

Is Required ? TRUE

Enter TEXT value(s):

1.8 Conservation

Conservation in the sea ice component

1.8.1 Description

Provide a general description of conservation methodology.

Spec. ID: cmip6.seaice.key_properties.conservation.description

Is Required ? TRUE

Enter TEXT value:

1.8.2 Properties

Properties conserved in sea ice by the numerical schemes.

Spec. ID: cmip6.seaice.key_properties.conservation.properties

Is Required ? TRUE

Select value(s):

☐ Energy

☐ Mass

☐ Salt

☐ Other - please specify:

1.8.3 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

Spec. ID: cmip6.seaice.key_properties.conservation.budget

Is Required ? TRUE

Enter TEXT value:

1.8.4 Was Flux Correction Used

Does conservation involved flux correctionxxx?

Spec. ID: cmip6.seaice.key_properties.conservation.was_flux_correction_used

Is Required ? TRUE

Select value:

☐ True ☐ False

1.8.5 Corrected Conserved Prognostic Variables

*List any variables which are conserved by *more* than the numerical scheme alone.*

Spec. ID: cmip6.seaice.key_properties.conservation.corrected_conserved_prognostic_variables

Is Required ? TRUE

Enter TEXT value:

2 Grid

Sea Ice grid

2.1 Horizontal

Sea ice discretisation in the horizontal

2.1.1 Grid

Grid on which sea ice is horizontal discretisedxxx?

Spec. ID: cmip6.seaice.grid.discretisation.horizontal.grid

Is Required ? TRUE

Select value:

- ☐ 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 Grid Type

What is the type of sea ice gridxxx?

Spec. ID: cmip6.seaice.grid.discretisation.horizontal.grid_type

Is Required ? TRUE

Select value:

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

2.1.3 Scheme

What is the advection schemexxx?

Spec. ID: cmip6.seaice.grid.discretisation.horizontal.scheme

Is Required ? TRUE

Select value:

- ☐ Finite differences
- ☐ Finite elements

☐ Finite volumes

☐ Other - please specify:

2.1.4 Thermodynamics Time Step

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

Spec. ID: cmip6.seaice.grid.discretisation.horizontal.thermodynamics_time_step

Is Required ? TRUE

Enter INTEGER value:

2.1.5 Dynamics Time Step

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

Spec. ID: cmip6.seaice.grid.discretisation.horizontal.dynamics_time_step

Is Required ? TRUE

Enter INTEGER value:

2.1.6 Additional Details

Specify any additional horizontal discretisation details.

Spec. ID: cmip6.seaice.grid.discretisation.horizontal.additional_details

Is Required ? FALSE

Enter TEXT value:

2.2 Vertical

Sea ice vertical properties

2.2.1 Layering

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

Spec. ID: cmip6.seaice.grid.discretisation.vertical.layering

Is Required ? TRUE

Select value(s):

☐ 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:

2.2.2 Number Of Layers

If using multi-layers specify how many.

Spec. ID: cmip6.seaice.grid.discretisation.vertical.number_of_layers

Is Required ? TRUE

Enter INTEGER value:

2.2.3 Additional Details

Specify any additional vertical grid details.

Spec. ID: cmip6.seaice.grid.discretisation.vertical.additional_details

Is Required ? FALSE

Enter TEXT value:

2.3 Seaice Categories

What method is used to represent sea ice categories ?

2.3.1 Has Mulitple Categories

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

Spec. ID: cmip6.seaice.grid.seaice_categories.has_mulitple_categories

Is Required ? TRUE

Select value:

☐ True ☐ False

2.3.2 Number Of Categories

If using sea ice categories specify how many.

Spec. ID: cmip6.seaice.grid.seaice_categories.number_of_categories

Is Required ? TRUE

Enter INTEGER value:

2.3.3 Category Limits

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

Spec. ID: cmip6.seaice.grid.seaice_categories.category_limits

Is Required ? TRUE

Enter TEXT value:

2.3.4 Ice Thickness Distribution Scheme

Describe the sea ice thickness distribution scheme

Spec. ID: cmip6.seaice.grid.seaice_categories.ice_thickness_distribution_scheme

Is Required ? TRUE

Enter TEXT value:

2.3.5 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.

Spec. ID: cmip6.seaice.grid.seaice_categories.other

Is Required ? FALSE

Enter TEXT value:

2.4 Snow On Seaice

Snow on sea ice details

2.4.1 Has Snow On Ice

Is snow on ice represented in this modelxxx?

Spec. ID: cmip6.seaice.grid.snow_on_seaice.has_snow_on_ice

Is Required ? TRUE

Select value:

☐ True ☐ False

2.4.2 Number Of Snow Levels

Number of vertical levels of snow on icexxx?

Spec. ID: cmip6.seaice.grid.snow_on_seaice.number_of_snow_levels

Is Required ? TRUE

Enter INTEGER value:

2.4.3 Snow Fraction

Describe how the snow fraction on sea ice is determined

Spec. ID: cmip6.seaice.grid.snow_on_seaice.snow_fraction

Is Required ? TRUE

Enter TEXT value:

2.4.4 Additional Details

Specify any additional details related to snow on ice.

Spec. ID: cmip6.seaice.grid.snow_on_seaice.additional_details

Is Required ? FALSE

Enter TEXT value:

3 Dynamics

Sea Ice Dynamics

3.1 Dynamics

Sea Ice Dynamics

3.1.1 Horizontal Transport

What is the method of horizontal advection of sea icexxx?

Spec. ID: cmip6.seaice.dynamics.horizontal_transport

Is Required ? TRUE

Select value:

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

3.1.2 Transport In Thickness Space

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

Spec. ID: cmip6.seaice.dynamics.transport_in_thickness_space

Is Required ? TRUE

Select value:

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

3.1.3 Ice Strength Formulation

Which method of sea ice strength formulation is usedxxx?

Spec. ID: cmip6.seaice.dynamics.ice_strength_formulation

Is Required ? TRUE

Select value:

- ☐ Hibler 1979
- ☐ Rothrock 1975

☐ Other - please specify:

3.1.4 Redistribution

Which processes can redistribute sea ice (including thickness)xxx?

Spec. ID: cmip6.seaice.dynamics.redistribution

Is Required ? TRUE

Select value(s):

☐ Rafting

☐ Ridging

☐ Other - please specify:

3.1.5 Rheology

Rheology, what is the ice deformation formulationxxx?

Spec. ID: cmip6.seaice.dynamics.rheology

Is Required ? TRUE

Select value:

☐ 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 Energy

Processes related to energy in sea ice thermodynamics

4.1.1 Enthalpy Formulation

What is the energy formulationxxx?

Spec. ID: cmip6.seaice.thermodynamics.energy.enthalpy_formulation

Is Required ? TRUE

Select value:

- ☐ 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:

4.1.2 Thermal Conductivity

What type of thermal conductivity is usedxxx?

Spec. ID: cmip6.seaice.thermodynamics.energy.thermal_conductivity

Is Required ? TRUE

Select value:

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

4.1.3 Heat Diffusion

What is the method of heat diffusionxxx?

Spec. ID: cmip6.seaice.thermodynamics.energy.heat_diffusion

Is Required ? TRUE

Select value:

- ☐ Conduction fluxes
- ☐ Conduction and radiation heat fluxes

☐ Conduction, radiation and latent heat transport

☐ Other - please specify:

4.1.4 Basal Heat Flux

Method by which basal ocean heat flux is handledxxx?

Spec. ID: cmip6.seaice.thermodynamics.energy.basal_heat_flux

Is Required ? TRUE

Select value:

☐ 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:

4.1.5 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.

Spec. ID: cmip6.seaice.thermodynamics.energy.fixed_salinity_value

Is Required ? FALSE

Enter FLOAT value:

4.1.6 Heat Content Of Precipitation

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

Spec. ID: cmip6.seaice.thermodynamics.energy.heat_content_of_precipitation

Is Required ? TRUE

Enter TEXT value:

4.1.7 Precipitation Effects On Salinity

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

Spec. ID: cmip6.seaice.thermodynamics.energy.precipitation_effects_on_salinity

Is Required ? FALSE

Enter TEXT value:

4.2 Mass

Processes related to mass in sea ice thermodynamics

4.2.1 New Ice Formation

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

Spec. ID: cmip6.seaice.thermodynamics.mass.new_ice_formation

Is Required ? TRUE

Enter TEXT value:

4.2.2 Ice Vertical Growth And Melt

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

Spec. ID: cmip6.seaice.thermodynamics.mass.ice_vertical_growth_and_melt

Is Required ? TRUE

Enter TEXT value:

4.2.3 Ice Lateral Melting

What is the method of sea ice lateral meltingxxx?

Spec. ID: cmip6.seaice.thermodynamics.mass.ice_lateral_melting

Is Required ? TRUE

Select value:

☐ Floe-size dependent (Bitz et al 2001)

☐ Virtual thin ice melting (for single-category)

☐ Other - please specify:

4.2.4 Ice Surface Sublimation

Describe the method that governs sea ice surface sublimation.

Spec. ID: cmip6.seaice.thermodynamics.mass.ice_surface_sublimation

Is Required ? TRUE

Enter TEXT value:

4.2.5 Frazil Ice

Describe the method of frazil ice formation.

Spec. ID: cmip6.seaice.thermodynamics.mass.frazil_ice

Is Required ? TRUE

Enter TEXT value:

4.3 Salt

Processes related to salt in sea ice thermodynamics.

4.3.1 Has Multiple Sea Ice Salinities

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

Spec. ID: cmip6.seaice.thermodynamics.salt.has_multiple_sea_ice_salinities

Is Required ? TRUE

Select value:

☐ True ☐ False

4.3.2 Sea Ice Salinity Thermal Impacts

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

Spec. ID: cmip6.seaice.thermodynamics.salt.sea_ice_salinity_thermal_impacts

Is Required ? TRUE

Select value:

☐ True ☐ False

4.4 Mass Transport

Mass transport of salt

4.4.1 Salinity Type

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

Spec. ID: cmip6.seaice.thermodynamics.salt.mass_transport.salinity_type

Is Required ? TRUE

Select value:

☐ Constant

☐ Prescribed salinity profile

☐ Prognostic salinity profile

☐ Other - please specify:

4.4.2 Constant Salinity Value

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

Spec. ID: cmip6.seaice.thermodynamics.salt.mass_transport.constant_salinity_value

Is Required ? FALSE

Enter FLOAT value:

4.4.3 Additional Details

Describe the salinity profile used.

Spec. ID: cmip6.seaice.thermodynamics.salt.mass_transport.additional_details

Is Required ? FALSE

Enter TEXT value:

4.5 Thermodynamics

Salt thermodynamics

4.5.1 Salinity Type

How is salinity determined in the thermodynamic calculationxxx?

Spec. ID: cmip6.seaice.thermodynamics.salt.thermodynamics.salinity_type

Is Required ? TRUE

Select value:

☐ Constant

☐ Prescribed salinity profile

☐ Prognostic salinity profile

☐ Other - please specify:

4.5.2 Constant Salinity Value

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

Spec. ID: cmip6.seaice.thermodynamics.salt.thermodynamics.constant_salinity_value

Is Required ? FALSE

Enter FLOAT value:

4.5.3 Additional Details

Describe the salinity profile used.

Spec. ID: cmip6.seaice.thermodynamics.salt.thermodynamics.additional_details

Is Required ? FALSE

Enter TEXT value:

4.6 Ice Thickness Distribution

Ice thickness distribution details.

4.6.1 Representation

How is the sea ice thickness distribution representedxxx?

Spec. ID: cmip6.seaice.thermodynamics.ice_thickness_distribution.representation

Is Required ? TRUE

Select value:

☐ Explicit

☐ Virtual (enhancement of thermal conductivity, thin ice melting)

☐ Other - please specify:

4.7 Ice Floe Size Distribution

Ice floe-size distribution details.

4.7.1 Representation

How is the sea ice floe-size representedxxx?

Spec. ID: cmip6.seaice.thermodynamics.ice_floe_size_distribution.representation

Is Required ? TRUE

Select value:

☐ Explicit

☐ Parameterised

☐ Other - please specify:

4.7.2 Additional Details

Please provide further details on any parameterisation of floe-size.

Spec. ID: cmip6.seaice.thermodynamics.ice_floe_size_distribution.additional_details

Is Required ? FALSE

Enter TEXT value:

4.8 Melt Ponds

Characteristics of melt ponds.

4.8.1 Are Included

Are melt ponds included in the sea ice modelxxx?

Spec. ID: cmip6.seaice.thermodynamics.melt_ponds.are_included

Is Required ? TRUE

Select value:

☐ True ☐ False

4.8.2 Formulation

What method of melt pond formulation is usedxxx?

Spec. ID: cmip6.seaice.thermodynamics.melt_ponds.formulation

Is Required ? TRUE

Select value:

☐ Flocco and Feltham (2010)

☐ Level-ice melt ponds

☐ Other - please specify:

4.8.3 Impacts

What do melt ponds have an impact onxxx?

Spec. ID: cmip6.seaice.thermodynamics.melt_ponds.impacts

Is Required ? TRUE

Select value(s):

☐ Albedo

☐ Freshwater

☐ Heat

☐ Other - please specify:

4.9 Snow Processes

Thermodynamic processes in snow on sea ice

4.9.1 Has Snow Aging

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

Spec. ID: cmip6.seaice.thermodynamics.snow_processes.has_snow_aging

Is Required ? TRUE

Select value:

☐ True ☐ False

4.9.2 Snow Aging Scheme

Describe the snow aging scheme.

Spec. ID: cmip6.seaice.thermodynamics.snow_processes.snow_aging_scheme

Is Required ? FALSE

Enter TEXT value:

4.9.3 Has Snow Ice Formation

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

Spec. ID: cmip6.seaice.thermodynamics.snow_processes.has_snow_ice_formation

Is Required ? TRUE

Select value:

☐ True ☐ False

4.9.4 Snow Ice Formation Scheme

Describe the snow ice formation scheme.

Spec. ID: cmip6.seaice.thermodynamics.snow_processes.snow_ice_formation_scheme

Is Required ? FALSE

Enter TEXT value:

4.9.5 Redistribution

What is the impact of ridging on snow coverxxx?

Spec. ID: cmip6.seaice.thermodynamics.snow_processes.redistribution

Is Required ? TRUE

Enter TEXT value:

4.9.6 Heat Diffusion

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

Spec. ID: cmip6.seaice.thermodynamics.snow_processes.heat_diffusion

Is Required ? TRUE

Select value:

☐ Single-layered heat diffusion

☐ Multi-layered heat diffusion

☐ Other - please specify:

5 Radiative Processes

Sea Ice Radiative Processes

5.1 Radiative Processes

Sea Ice Radiative Processes

5.1.1 Surface Albedo

Method used to handle surface albedo.

Spec. ID: cmip6.seaice.radiative_processes.surface_albedo

Is Required ? TRUE

Select value:

☐ Delta-Eddington

☐ Parameterized - Sea ice albedo is parameterized

☐ Multi-band albedo - Albedo value has a spectral dependence

☐ Other - please specify:

5.1.2 Ice Radiation Transmission

Method by which solar radiation through sea ice is handled.

Spec. ID: cmip6.seaice.radiative_processes.ice_radiation_transmission

Is Required ? TRUE

Select value(s):

☐ Delta-Eddington

☐ Exponential attenuation

☐ Ice radiation transmission per category - Radiation transmission through ice is different for each sea ice category

☐ Other - please specify: