CMIP6 Model Documentation

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Documentation Contents

1 Key Properties

Key properties of the aerosol model

1.1.1 Top level properties

Key properties of the aerosol model

1.1.1.1 Name *

Name of aerosol model code

CanESM2 aerosol scheme

1.1.1.2 Keywords *

Keywords associated with aerosol model code

Enter COMMA SEPARATED list:

1.1.1.3 Overview *

Overview of aerosol model.

Prognostic, single-moment bulk scheme for sulphate, organic carbon, black carbon, sea salt, and mineral dust (online). Emissions for sulphur dioxide and organic and black carbon according to CMIP5. References: Lohmann, U., K. von Salzen, N. McFarlane, H. G. Leighton, and J. Feichter, 1999, Tropospheric sulphur cycle in the Canadian general circulation model, J. Geophys. Res., 104, 26,833-26,858; Croft, B., U. Lohmann, and K. von Salzen, 2005, Black carbon ageing in the Canadian Centre for Climate modelling and analysis atmospheric general circulation model, Atmos. Chem. Phys., 5, 1931-1949.

1.1.1.4 Scheme Scope *

Atmospheric domains covered by the aerosol model

- ☒ Troposphere
- ☒ Stratosphere
- ☐ Mesosphere
- ☐ Whole atmosphere
- ☐ Other - please specify:

1.1.1.5 Basic Approximations *

Basic approximations made in the aerosol model

Single-moment (mass), bulk

1.1.1.6 Prognostic Variables Form *

Prognostic variables in the aerosol model

- ☒ 3D mass/volume ratio for aerosols
- ☐ 3D number concentration for aerosols
- ☐ Other - please specify:

1.1.1.7 Number Of Tracers *

Number of tracers in the aerosol model

9

1.1.1.8 Family Approach *

Are aerosol calculations generalized into families of species?

☒ True ☐ False

1.2.1 Software Properties

Software properties of aerosol code

1.2.1.1 Repository

Location of code for this component.

Enter TEXT:

1.2.1.2 Code Version

Code version identifier.

Enter TEXT:

1.2.1.3 Code Languages

Code language(s).

Enter COMMA SEPARATED list:

1.3.1 Timestep Framework

Physical properties of seawater in ocean

1.3.1.1 Method *

Mathematical method deployed to solve the time evolution of the prognostic variables

- ☒ Uses atmospheric chemistry time stepping
- ☐ Specific timestepping (operator splitting)

- ☐ Specific timestepping (integrated)
- ☐ Other - please specify:

1.3.1.2 Split Operator Advection Timestep

Timestep for aerosol advection (in seconds)

Enter INTEGER value:

1.3.1.3 Split Operator Physical Timestep

Timestep for aerosol physics (in seconds).

Enter INTEGER value:

1.3.1.4 Integrated Timestep *

Timestep for the aerosol model (in seconds)

Enter INTEGER value:

1.3.1.5 Integrated Scheme Type *

Specify the type of timestep scheme

Select SINGLE option:

- ☐ Explicit
- ☐ Implicit
- ☐ Semi-implicit
- ☐ Semi-analytic
- ☐ Impact solver
- ☐ Back Euler
- ☐ Newton Raphson
- ☐ Rosenbrock
- ☐ Other - please specify:

1.4.1 Meteorological Forcings

1.4.1.1 Variables 3D

Three dimensional forcing variables, e.g. U, V, W, T, Q, P, conventive mass flux

Enter COMMA SEPARATED list:

1.4.1.2 Variables 2D

Two dimensional forcing variables, e.g. land-sea mask definition

Enter COMMA SEPARATED list:

1.4.1.3 Frequency

Frequency with which meteorological forcings are applied (in seconds).

Enter INTEGER value:

1.5.1 Resolution

Resolution in the aerosol model grid

1.5.1.1 Name *

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

Enter TEXT:

1.5.1.2 Canonical Horizontal Resolution

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

Enter TEXT:

1.5.1.3 Number Of Horizontal Gridpoints

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

Enter INTEGER value:

1.5.1.4 Number Of Vertical Levels

Number of vertical levels resolved on computational grid.

Enter INTEGER value:

1.5.1.5 Is Adaptive Grid *

Set to true if the grid resolution changes during execution.

Select either TRUE or FALSE:

☐ True ☐ False

1.6.1 Tuning Applied

Tuning methodology for aerosol model

1.6.1.1 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.

Enter TEXT:

1.6.1.2 Global Mean Metrics Used

List of metrics of the global mean state used in tuning model/component

Enter COMMA SEPARATED list:

1.6.1.3 Regional Metrics Used

List of metrics of regional mean state used in tuning model/component

Enter COMMA SEPARATED list:

1.6.1.4 Trend Metrics Used

List observed trend metrics used in tuning model/component

Enter COMMA SEPARATED list:

2 Grid

Aerosol grid

2.1.1 Top level properties

Aerosol grid

2.1.1.1 Name

Name of grid in aerosol model.

Enter TEXT:

2.1.1.2 Overview

Overview of grid in aerosol model.

Enter TEXT:

2.1.1.3 Matches Atmosphere Grid *

Does the atmospheric aerosol grid match the atmosphere grid?

Select either TRUE or FALSE:

☐ True ☐ False

2.2.1 Resolution

Resolution in the atmospheric aerosol grid

2.2.1.1 Name *

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

Enter TEXT:

2.2.1.2 Canonical Horizontal Resolution

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

Enter TEXT:

2.2.1.3 Number Of Horizontal Gridpoints

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

Enter INTEGER value:

2.2.1.4 Number Of Vertical Levels

Number of vertical levels resolved on computational grid.

Enter INTEGER value:

2.2.1.5 Is Adaptive Grid *

Set to true if grid resolution changes during execution.

Select either TRUE or FALSE:

☐ True ☐ False

3 Transport

Aerosol transport

3.1.1 Top level properties

Aerosol transport

3.1.1.1 Name

Commonly used name for the transport in aerosol model.

Enter TEXT:

3.1.1.2 Overview

Overview of aerosol transport in aerosol model.

Enter TEXT:

3.1.1.3 Scheme *

Method for aerosol transport modelling

Select SINGLE option:

- ☐ Uses atmospheric chemistry transport scheme
- ☐ Specific transport scheme (eulerian)
- ☐ Specific transport scheme (semi-lagrangian)
- ☐ Specific transport scheme (eulerian and semi-lagrangian)
- ☐ Specific transport scheme (lagrangian)

3.1.1.4 Mass Conservation Scheme *

Methods used to ensure mass conservation.

Select MULTIPLE options:

- ☐ Uses atmospheric chemistry transport scheme
- ☐ Mass adjustment
- ☐ Concentrations positivity
- ☐ Gradients monotonicity
- ☐ Other - please specify:

3.1.1.5 Convention *

Transport by convention

Select MULTIPLE options:

- ☐ Uses atmospheric chemistry transport scheme
- ☐ Convective fluxes connected to tracers
- ☐ Vertical velocities connected to tracers
- ☐ Other - please specify:

4 Emissions

Atmospheric aerosol emissions

4.1.1 Top level properties

Atmospheric aerosol emissions

4.1.1.1 Name

Commonly used name for the emissions in aerosol model.

Enter TEXT:

4.1.1.2 Overview

Overview of atmospheric aerosol emissions in aerosol model.

Enter TEXT:

4.1.1.3 Method *

Method used to define aerosol species (several methods allowed because the different species may not use the same method).

Select MULTIPLE options:

- ☐ None
- ☐ Prescribed (climatology)
- ☐ Prescribed CMIP6
- ☐ Prescribed above surface
- ☐ Interactive
- ☐ Interactive above surface
- ☐ Other - please specify:

4.1.1.4 Sources

Sources of the aerosol species are taken into account in the emissions scheme

Select MULTIPLE options:

- ☐ Vegetation
- ☐ Volcanos
- ☐ Bare ground
- ☐ Sea surface
- ☐ Lightning

- ☐ Fires
- ☐ Aircraft
- ☐ Anthropogenic
- ☐ Other - please specify:

4.1.1.5 Prescribed Climatology

Specify the climatology type for aerosol emissions

Select SINGLE option:

- ☐ Constant
- ☐ Interannual
- ☐ Annual
- ☐ Monthly
- ☐ Daily

4.1.1.6 Prescribed Climatology Emitted Species

List of aerosol species emitted and prescribed via a climatology

Enter COMMA SEPARATED list:

4.1.1.7 Prescribed Spatially Uniform Emitted Species

List of aerosol species emitted and prescribed as spatially uniform

Enter COMMA SEPARATED list:

4.1.1.8 Interactive Emitted Species

List of aerosol species emitted and specified via an interactive method

Enter COMMA SEPARATED list:

4.1.1.9 Other Emitted Species

List of aerosol species emitted and specified via an "other method"

Enter COMMA SEPARATED list:

4.1.1.10 Other Method Characteristics

Characteristics of the "other method" used for aerosol emissions

Enter TEXT:

5 Concentrations

Atmospheric aerosol concentrations

5.1.1 Top level properties

Atmospheric aerosol concentrations

5.1.1.1 Name

Commonly used name for the concentrations in aerosol model.

Enter TEXT:

5.1.1.2 Overview

Overview of atmospheric aerosol concentrations in aerosol model.

Enter TEXT:

5.1.1.3 Prescribed Lower Boundary

List of species prescribed at the lower boundary.

Enter COMMA SEPARATED list:

5.1.1.4 Prescribed Upper Boundary

List of species prescribed at the upper boundary.

Enter COMMA SEPARATED list:

5.1.1.5 Prescribed Fields Mmr

List of species prescribed as mass mixing ratios.

Enter COMMA SEPARATED list:

5.1.1.6 Prescribed Fields Aod Plus Ccn

List of species prescribed as AOD plus CCNs.

Enter COMMA SEPARATED list:

6 Optical Radiative Properties

Aerosol optical and radiative properties

6.1.1 Top level properties

Aerosol optical and radiative properties

6.1.1.1 Name

Commonly used name for the optical radiative properties in aerosol model.

Enter TEXT:

6.1.1.2 Overview

Overview of aerosol optical and radiative properties in aerosol model.

Enter TEXT:

6.2.1 Absorption

Absortion properties in aerosol scheme

6.2.1.1 Black Carbon

Absorption mass coefficient of black carbon at 550nm (if non-absorbing enter 0)

Enter FLOAT value:

6.2.1.2 Dust

Absorption mass coefficient of dust at 550nm (if non-absorbing enter 0)

Enter FLOAT value:

6.2.1.3 Organics

Absorption mass coefficient of organics at 550nm (if non-absorbing enter 0)

Enter FLOAT value:

6.3.1 Mixtures

6.3.1.1 External *

Is there external mixing with respect to chemical composition?

Select either TRUE or FALSE:

☐ True ☐ False

6.3.1.2 Internal *

Is there internal mixing with respect to chemical composition?

Select either TRUE or FALSE:

☐ True ☐ False

6.3.1.3 Mixing Rule

If there is internal mixing with respect to chemical composition then indicate the mixing rule

Enter TEXT:

6.4.1 Impact Of H2o

The impact of H2O on aerosols

6.4.1.1 Size *

Does H2O impact size?

Select either TRUE or FALSE:

☐ True ☐ False

6.4.1.2 Internal Mixture *

Does H2O impact aerosol internal mixture?

Select either TRUE or FALSE:

☐ True ☐ False

6.4.1.3 External Mixture *

Does H2O impact aerosol external mixture?

Select either TRUE or FALSE:

☐ True ☐ False

6.5.1 Radiative Scheme

Radiative scheme for aerosol

6.5.1.1 Overview *

Overview of radiative scheme

Enter TEXT:

6.5.1.2 Shortwave Bands *

Number of shortwave bands

Enter INTEGER value:

6.5.1.3 Longwave Bands *

Number of longwave bands

Enter INTEGER value:

6.6.1 Cloud Interactions

Aerosol-cloud interactions

6.6.1.1 Overview *

Overview of aerosol-cloud interactions

Enter TEXT:

6.6.1.2 Twomey *

Is the Twomey effect included?

Select either TRUE or FALSE:

☐ True ☐ False

6.6.1.3 Twomey Minimum Ccn

If the Twomey effect is included, then what is the minimum CCN number?

Enter INTEGER value:

6.6.1.4 Drizzle *

Does the scheme affect drizzle?

Select either TRUE or FALSE:

☐ True ☐ False

6.6.1.5 Cloud Lifetime *

Does the scheme affect cloud lifetime?

Select either TRUE or FALSE:

☐ True ☐ False

6.6.1.6 Longwave Bands *

Number of longwave bands

Enter INTEGER value:

7 Model

Aerosol model

7.1.1 Top level properties

Aerosol model

7.1.1.1 Name

Commonly used name for the model in aerosol model.

Enter TEXT:

7.1.1.2 Overview *

Overview of atmospheric aerosol model

Enter TEXT:

7.1.1.3 Processes *

Processes included in the aerosol model.

- ☒ Dry deposition
- ☒ Sedimentation
- ☒ Wet deposition (impaction scavenging)
- ☒ Wet deposition (nucleation scavenging)
- ☐ Coagulation
- ☒ Oxidation (gas phase)
- ☒ Oxidation (in cloud)
- ☐ Condensation
- ☒ Ageing
- ☐ Advection (horizontal)
- ☐ Advection (vertical)
- ☐ Heterogeneous chemistry
- ☐ Nucleation

7.1.1.4 Coupling

Other model components coupled to the aerosol model

- ☒ Radiation

- ☐ Land surface
- ☐ Heterogeneous chemistry
- ☒ Clouds
- ☐ Ocean
- ☐ Cryosphere
- ☐ Gas phase chemistry
- ☐ Other - please specify:

7.1.1.5 Gas Phase Precursors *

Gas phase aerosol precursors.

- ☒ DMS
- ☒ SO2
- ☐ Ammonia
- ☐ Iodine
- ☐ Terpene
- ☐ Isoprene
- ☐ VOC
- ☐ NOx
- ☐ Other - please specify:

7.1.1.6 Scheme Type *

Type(s) of aerosol scheme used by the aerosol model (potentially multiple: some species may be covered by one type of aerosol scheme and other species covered by another type).

- ☒ Bulk
- ☐ Modal
- ☐ Bin
- ☐ Other - please specify:

7.1.1.7 Bulk Scheme Species *

Species covered by the bulk scheme.

Select MULTIPLE options:

- ☐ Sulphate
- ☐ Nitrate

- ☐ Sea salt
- ☐ Dust
- ☐ Ice
- ☐ Organic
- ☐ Black carbon / soot
- ☐ SOA (secondary organic aerosols)
- ☐ POM (particulate organic matter)
- ☐ Polar stratospheric ice
- ☐ NAT (Nitric acid trihydrate)
- ☐ NAD (Nitric acid dihydrate)
- ☐ STS (supercooled ternary solution aerosol particule)
- ☐ Other - please specify: