

# CMIP6 Model Documentation

<b>Institute:</b>	BNU
<b>Model:</b>	BNU-ESM-1-1
<b>Topic:</b>	Aerosol
<b>Doc. Generated:</b>	2018-02-12
<b>Doc. Seeded From:</b>	N/A
<b>Specialization Version:</b>	0.2.0
<b>Further Info:</b>	<a href="https://es-doc.org/cmip6">https://es-doc.org/cmip6</a> <a href="https://specializations.es-doc.org/cmip6">https://specializations.es-doc.org/cmip6</a>

# Documentation Contents

<b>1</b>	<b>Key Properties</b>	<b>1</b>
1.1	Key Properties . . . . .	1
1.2	Software Properties . . . . .	2
1.3	Timestep Framework . . . . .	3
1.4	Meteorological Forcings . . . . .	4
1.5	Resolution . . . . .	5
1.6	Tuning Applied . . . . .	6
<b>2</b>	<b>Grid</b>	<b>7</b>
<b>3</b>	<b>Transport</b>	<b>8</b>
3.1	Transport . . . . .	8
<b>4</b>	<b>Emissions</b>	<b>10</b>
4.1	Emissions . . . . .	10
<b>5</b>	<b>Concentrations</b>	<b>13</b>
5.1	Concentrations . . . . .	13
<b>6</b>	<b>Optical Radiative Properties</b>	<b>14</b>
6.1	Optical Radiative Properties . . . . .	14
6.2	Absorption . . . . .	14
6.3	Mixtures . . . . .	14
6.4	Impact Of H2o . . . . .	15
6.5	Radiative Scheme . . . . .	16
6.6	Cloud Interactions . . . . .	16
<b>7</b>	<b>Model</b>	<b>18</b>
7.1	Model . . . . .	18

# 1 Key Properties

*Key properties of the aerosol model*

## 1.1 Key Properties

*Key properties of the aerosol model*

### 1.1.1 Model Overview

*Overview of aerosol model.*

**Spec. ID:** cmip6.aerosol.key\_\_properties.model\_\_overview

**Is Required ?** TRUE

**Enter TEXT value:**

### 1.1.2 Model Name

*Name of aerosol model code*

**Spec. ID:** cmip6.aerosol.key\_\_properties.model\_\_name

**Is Required ?** TRUE

**Enter TEXT value:**

### 1.1.3 Scheme Scope

*Atmospheric domains covered by the aerosol model*

**Spec. ID:** cmip6.aerosol.key\_\_properties.scheme\_\_scope

**Is Required ?** TRUE

**Select value(s):**

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

### 1.1.4 Basic Approximations

*Basic approximations made in the aerosol model*

**Spec. ID:** cmip6.aerosol.key\_\_properties.basic\_\_approximations

**Is Required ?** TRUE

**Enter TEXT value:**

### 1.1.5 Prognostic Variables Form

*Prognostic variables in the aerosol model*

**Spec. ID:** cmip6.aerosol.key\_\_properties.prognostic\_\_variables\_\_form

**Is Required ?** TRUE

**Select value(s):**

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

### 1.1.6 Number Of Tracers

*Number of tracers in the aerosol model*

**Spec. ID:** cmip6.aerosol.key\_\_properties.number\_of\_\_tracers

**Is Required ?** TRUE

**Enter INTEGER value:**

### 1.1.7 Family Approach

*Are aerosol calculations generalized into families of species:xxx?*

**Spec. ID:** cmip6.aerosol.key\_\_properties.family\_\_approach

**Is Required ?** TRUE

**Select value:**

- ☐ True
- ☐ False

## 1.2 Software Properties

*Software properties of aerosol code*

### 1.2.1 Repository

*Location of code for this component.*

**Spec. ID:** cmip6.aerosol.key\_\_properties.software\_\_properties.repository

**Is Required ?** FALSE

**Enter TEXT value:**

### 1.2.2 Code Version

*Code version identifier.*

**Spec. ID:** cmip6.aerosol.key\_\_properties.software\_\_properties.code\_\_version

**Is Required ?** FALSE

**Enter TEXT value:**

### 1.2.3 Code Languages

*Code language(s).*

**Spec. ID:** cmip6.aerosol.key\_properties.software\_properties.code\_languages

**Is Required ?** FALSE

**Enter TEXT value(s):**

## 1.3 Timestep Framework

*Physical properties of seawater in ocean*

### 1.3.1 Method

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

**Spec. ID:** cmip6.aerosol.key\_properties.timestep\_framework.method

**Is Required ?** TRUE

**Select value:**

- ☐ Uses atmospheric chemistry time stepping
- ☐ Specific timestepping (operator splitting)
- ☐ Specific timestepping (integrated)
- ☐ Other - please specify:

### 1.3.2 Split Operator Advection Timestep

*Timestep for aerosol advection (in seconds)*

**Spec. ID:** cmip6.aerosol.key\_properties.timestep\_framework.split\_operator\_advection\_timestep

**Is Required ?** FALSE

**Enter INTEGER value:**

### 1.3.3 Split Operator Physical Timestep

*Timestep for aerosol physics (in seconds).*

**Spec. ID:** cmip6.aerosol.key\_properties.timestep\_framework.split\_operator\_physical\_timestep

**Is Required ?** FALSE

**Enter INTEGER value:**

### 1.3.4 Integrated Timestep

*Timestep for the aerosol model (in seconds)*

**Spec. ID:** cmip6.aerosol.key\_properties.timestep\_framework.integrated\_timestep

**Is Required ?** TRUE

**Enter INTEGER value:**

### 1.3.5 Integrated Scheme Type

*Specify the type of timestep scheme*

**Spec. ID:** cmip6.aerosol.key\_properties.timestep\_framework.integrated\_scheme\_type

**Is Required ?** TRUE

**Select value:**

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

## 1.4 Meteorological Forcings

### 1.4.1 Variables 3D

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

**Spec. ID:** cmip6.aerosol.key\_properties.meteorological\_forcings.variables\_3d

**Is Required ?** FALSE

**Enter TEXT value:**

### 1.4.2 Variables 2D

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

**Spec. ID:** cmip6.aerosol.key\_properties.meteorological\_forcings.variables\_2d

**Is Required ?** FALSE

**Enter TEXT value:**

### 1.4.3 Frequency

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

**Spec. ID:** cmip6.aerosol.key\_\_properties.meteorological\_forcings.frequency

**Is Required ?** FALSE

**Enter INTEGER value:**

## 1.5 Resolution

*Resolution in the aerosol model grid*

### 1.5.1 Name

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

**Spec. ID:** cmip6.aerosol.key\_\_properties.resolution.name

**Is Required ?** TRUE

**Enter TEXT value:**

### 1.5.2 Canonical Horizontal Resolution

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

**Spec. ID:** cmip6.aerosol.key\_\_properties.resolution.canonical\_horizontal\_resolution

**Is Required ?** FALSE

**Enter TEXT value:**

### 1.5.3 Number Of Horizontal Gridpoints

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

**Spec. ID:** cmip6.aerosol.key\_\_properties.resolution.number\_of\_horizontal\_gridpoints

**Is Required ?** FALSE

**Enter INTEGER value:**

### 1.5.4 Number Of Vertical Levels

*Number of vertical levels resolved on computational grid.*

**Spec. ID:** cmip6.aerosol.key\_\_properties.resolution.number\_of\_vertical\_levels

**Is Required ?** FALSE

**Enter INTEGER value:**

### 1.5.5 Is Adaptive Grid

*Default is False. Set true if grid resolution changes during execution.*

**Spec. ID:** cmip6.aerosol.key\_\_properties.resolution.is\_adaptive\_grid

**Is Required ?** FALSE

**Select value:**

☐ True ☐ False

## 1.6 Tuning Applied

*Tuning methodology for aerosol model*

### 1.6.1 Description

*General overview description of tuning: explain and motivate the main targets and metrics retained. and 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 and with a parameter value that required pushing it to its limits to solve a particular model deficiency.*

**Spec. ID:** cmip6.aerosol.key\_properties.tuning\_applied.description

**Is Required ?** TRUE

**Enter TEXT value:**

### 1.6.2 Global Mean Metrics Used

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

**Spec. ID:** cmip6.aerosol.key\_properties.tuning\_applied.global\_mean\_metrics\_used

**Is Required ?** FALSE

**Enter TEXT value(s):**

### 1.6.3 Regional Metrics Used

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

**Spec. ID:** cmip6.aerosol.key\_properties.tuning\_applied.regional\_metrics\_used

**Is Required ?** FALSE

**Enter TEXT value(s):**

### 1.6.4 Trend Metrics Used

*List observed trend metrics used in tuning model/component*

**Spec. ID:** cmip6.aerosol.key\_properties.tuning\_applied.trend\_metrics\_used

**Is Required ?** FALSE

**Enter TEXT value(s):**



## **2 Grid**

*Aerosol grid*

## 3 Transport

### *Aerosol transport*

## 3.1 Transport

### *Aerosol transport*

#### 3.1.1 Overview

*Overview of transport in atmospheric aerosol model*

**Spec. ID:** cmip6.aerosol.transport.overview

**Is Required ?** TRUE

**Enter TEXT value:**

#### 3.1.2 Scheme

*Method for aerosol transport modeling*

**Spec. ID:** cmip6.aerosol.transport.scheme

**Is Required ?** TRUE

**Select value:**

- ☐ 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)

#### 3.1.3 Mass Conservation Scheme

*Method used to ensure mass conservation.*

**Spec. ID:** cmip6.aerosol.transport.mass\_conservation\_scheme

**Is Required ?** TRUE

**Select value(s):**

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

### 3.1.4 Convention

*Transport by convention*

**Spec. ID:** cmip6.aerosol.transport.convention

**Is Required ?** TRUE

**Select value(s):**

- ☐ 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 Emissions

##### *Atmospheric aerosol emissions*

##### 4.1.1 Overview

*Overview of emissions in atmospheric aerosol model*

**Spec. ID:** cmip6.aerosol.emissions.overview

**Is Required ?** TRUE

**Enter TEXT value:**

##### 4.1.2 Method

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

**Spec. ID:** cmip6.aerosol.emissions.method

**Is Required ?** TRUE

**Select value(s):**

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

##### 4.1.3 Sources

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

**Spec. ID:** cmip6.aerosol.emissions.sources

**Is Required ?** FALSE

**Select value(s):**

- ☐ Vegetation
- ☐ Volcanos
- ☐ Bare ground

- ☐ Sea surface
- ☐ Lightning
- ☐ Fires
- ☐ Aircraft
- ☐ Anthropogenic
- ☐ Other - please specify:

#### 4.1.4 Prescribed Climatology

*Specify the climatology type for aerosol emissions*

**Spec. ID:** cmip6.aerosol.emissions.prescribed\_climatology

**Is Required ?** FALSE

**Select value:**

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

#### 4.1.5 Prescribed Climatology Emitted Species

*List of aerosol species emitted and prescribed via a climatology*

**Spec. ID:** cmip6.aerosol.emissions.prescribed\_climatology\_emitted\_species

**Is Required ?** FALSE

**Enter TEXT value:**

#### 4.1.6 Prescribed Spatially Uniform Emitted Species

*List of aerosol species emitted and prescribed as spatially uniform*

**Spec. ID:** cmip6.aerosol.emissions.prescribed\_spatially\_uniform\_emitted\_species

**Is Required ?** FALSE

**Enter TEXT value:**

#### 4.1.7 Interactive Emitted Species

*List of aerosol species emitted and specified via an interactive method*

**Spec. ID:** cmip6.aerosol.emissions.interactive\_emitted\_species

**Is Required ?** FALSE

**Enter TEXT value:**

#### **4.1.8 Other Emitted Species**

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

**Spec. ID:** cmip6.aerosol.emissions.other\_emitted\_species

**Is Required ?** FALSE

**Enter TEXT value:**

#### **4.1.9 Other Method Characteristics**

*Characteristics of the other method used for aerosol emissions*

**Spec. ID:** cmip6.aerosol.emissions.other\_method\_characteristics

**Is Required ?** FALSE

**Enter TEXT value:**

## 5 Concentrations

*Atmospheric aerosol concentrations*

### 5.1 Concentrations

*Atmospheric aerosol concentrations*

#### 5.1.1 Overview

*Overview of concentrations in atmospheric aerosol model*

**Spec. ID:** cmip6.aerosol.concentrations.overview

**Is Required ?** TRUE

**Enter TEXT value:**

#### 5.1.2 Prescribed Lower Boundary

*List of species prescribed at the lower boundary.*

**Spec. ID:** cmip6.aerosol.concentrations.prescribed\_lower\_boundary

**Is Required ?** FALSE

**Enter TEXT value:**

#### 5.1.3 Prescribed Upper Boundary

*List of species prescribed at the upper boundary.*

**Spec. ID:** cmip6.aerosol.concentrations.prescribed\_upper\_boundary

**Is Required ?** FALSE

**Enter TEXT value:**

#### 5.1.4 Prescribed Fields Mmr

*List of species prescribed as mass mixing ratios.*

**Spec. ID:** cmip6.aerosol.concentrations.prescribed\_fields\_mmr

**Is Required ?** FALSE

**Enter TEXT value:**

#### 5.1.5 Prescribed Fields Mmr

*List of species prescribed as AOD plus CCNs.*

**Spec. ID:** cmip6.aerosol.concentrations.prescribed\_fields\_mmr

**Is Required ?** FALSE

**Enter TEXT value:**

## 6 Optical Radiative Properties

*Aerosol optical and radiative properties*

### 6.1 Optical Radiative Properties

*Aerosol optical and radiative properties*

#### 6.1.1 Overview

*Overview of optical and radiative properties*

**Spec. ID:** cmip6.aerosol.optical\_radiative\_properties.overview

**Is Required ?** TRUE

**Enter TEXT value:**

### 6.2 Absorption

*Absorption properties in aerosol scheme*

#### 6.2.1 Black Carbon

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

**Spec. ID:** cmip6.aerosol.optical\_radiative\_properties.absorption.black\_carbon

**Is Required ?** FALSE

**Enter FLOAT value:**

#### 6.2.2 Dust

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

**Spec. ID:** cmip6.aerosol.optical\_radiative\_properties.absorption.dust

**Is Required ?** FALSE

**Enter FLOAT value:**

#### 6.2.3 Organics

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

**Spec. ID:** cmip6.aerosol.optical\_radiative\_properties.absorption.organics

**Is Required ?** FALSE

**Enter FLOAT value:**

### 6.3 Mixtures



### 6.3.1 External

*Is there external mixing with respect to chemical compositionxxx?*

**Spec. ID:** cmip6.aerosol.optical\_radiative\_properties.mixtures.external

**Is Required ?** TRUE

**Select value:**

☐ True ☐ False

### 6.3.2 Internal

*Is there internal mixing with respect to chemical compositionxxx?*

**Spec. ID:** cmip6.aerosol.optical\_radiative\_properties.mixtures.internal

**Is Required ?** TRUE

**Select value:**

☐ True ☐ False

### 6.3.3 Mixing Rule

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

**Spec. ID:** cmip6.aerosol.optical\_radiative\_properties.mixtures.mixing\_rule

**Is Required ?** FALSE

**Enter TEXT value:**

## 6.4 Impact Of H2o

### 6.4.1 Size

*Does H2O impact sizexxx?*

**Spec. ID:** cmip6.aerosol.optical\_radiative\_properties.impact\_of\_h2o.size

**Is Required ?** TRUE

**Select value:**

☐ True ☐ False

### 6.4.2 Internal Mixture

*Does H2O impact internal mixturexxx?*

**Spec. ID:** cmip6.aerosol.optical\_radiative\_properties.impact\_of\_h2o.internal\_mixture

**Is Required ?** TRUE

Select value:

☐ True ☐ False

## 6.5 Radiative Scheme

*Radiative scheme for aerosol*

### 6.5.1 Overview

*Overview of radiative scheme*

**Spec. ID:** cmip6.aerosol.optical\_radiative\_properties.radiative\_scheme.overview

**Is Required ?** TRUE

**Enter TEXT value:**

### 6.5.2 Shortwave Bands

*Number of shortwave bands*

**Spec. ID:** cmip6.aerosol.optical\_radiative\_properties.radiative\_scheme.shortwave\_bands

**Is Required ?** TRUE

**Enter INTEGER value:**

### 6.5.3 Longwave Bands

*Number of longwave bands*

**Spec. ID:** cmip6.aerosol.optical\_radiative\_properties.radiative\_scheme.longwave\_bands

**Is Required ?** TRUE

**Enter INTEGER value:**

## 6.6 Cloud Interactions

*Aerosol-cloud interactions*

### 6.6.1 Overview

*Overview of aerosol-cloud interactions*

**Spec. ID:** cmip6.aerosol.optical\_radiative\_properties.cloud\_interactions.overview

**Is Required ?** TRUE

**Enter TEXT value:**

### 6.6.2 Twomey

*Is the Twomey effect includedxxx?*

**Spec. ID:** cmip6.aerosol.optical\_radiative\_properties.cloud\_interactions.twomey

**Is Required ?** TRUE

**Select value:**

☐ True ☐ False

### 6.6.3 Twomey Minimum Ccn

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

**Spec. ID:** cmip6.aerosol.optical\_radiative\_properties.cloud\_interactions.twomey\_minimum\_ccn

**Is Required ?** FALSE

**Enter INTEGER value:**

### 6.6.4 Drizzle

*Does the scheme affect drizzlexxx?*

**Spec. ID:** cmip6.aerosol.optical\_radiative\_properties.cloud\_interactions.drizzle

**Is Required ?** TRUE

**Select value:**

☐ True ☐ False

### 6.6.5 Cloud Lifetime

*Does the scheme affect cloud lifetimexxx?*

**Spec. ID:** cmip6.aerosol.optical\_radiative\_properties.cloud\_interactions.cloud\_lifetime

**Is Required ?** TRUE

**Select value:**

☐ True ☐ False

### 6.6.6 Longwave Bands

*Number of longwave bands*

**Spec. ID:** cmip6.aerosol.optical\_radiative\_properties.cloud\_interactions.longwave\_bands

**Is Required ?** TRUE

**Enter INTEGER value:**

## 7 Model

*Aerosol model*

### 7.1 Model

*Aerosol model*

#### 7.1.1 Overview

*Overview of atmospheric aerosol model*

**Spec. ID:** cmip6.aerosol.model.overview

**Is Required ?** TRUE

**Enter TEXT value:**

#### 7.1.2 Processes

*Processes included in the Aerosol model.*

**Spec. ID:** cmip6.aerosol.model.processes

**Is Required ?** TRUE

**Select value(s):**

- ☐ 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

### 7.1.3 Coupling

*Other model components coupled to the Aerosol model*

**Spec. ID:** cmip6.aerosol.model.coupling

**Is Required ?** FALSE

**Select value(s):**

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

### 7.1.4 Gas Phase Precursors

*List of gas phase aerosol precursors.*

**Spec. ID:** cmip6.aerosol.model.gas\_phase\_precursors

**Is Required ?** TRUE

**Select value(s):**

- ☐ DMS
- ☐ SO<sub>2</sub>
- ☐ Ammonia
- ☐ Iodine
- ☐ Terpene
- ☐ Isoprene
- ☐ VOC
- ☐ NO<sub>x</sub>
- ☐ Other - please specify:

### 7.1.5 Scheme Type

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

**Spec. ID:** cmip6.aerosol.model.scheme\_type

**Is Required ?** TRUE

**Select value(s):**

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

### 7.1.6 Bulk Scheme Species

*List of species covered by the bulk scheme.*

**Spec. ID:** cmip6.aerosol.model.bulk\_scheme\_species

**Is Required ?** TRUE

**Select value(s):**

- ☐ 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: