

# CMIP6 Model Documentation

<b>Institute:</b>	CNRM-CERFACS
<b>Model:</b>	CNRM-ESM2-1-HR
<b>Topic:</b>	Atmosphere
<b>Doc. Generated:</b>	2018-02-15
<b>Doc. Seeded From:</b>	N/A
<b>Specialization Version:</b>	0.3.0
<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	Overview . . . . .	1
1.2	Resolution . . . . .	2
1.3	Timestepping . . . . .	3
1.4	Orography . . . . .	3
<b>2</b>	<b>Grid</b>	<b>5</b>
2.1	Discretisation . . . . .	5
2.2	Horizontal . . . . .	5
2.3	Vertical . . . . .	6
<b>3</b>	<b>Dynamical Core</b>	<b>8</b>
3.1	Dynamical Core . . . . .	8
3.2	Top Boundary . . . . .	9
3.3	Lateral Boundary . . . . .	10
3.4	Diffusion Horizontal . . . . .	10
3.5	Advection Tracers . . . . .	11
3.6	Advection Momentum . . . . .	12
<b>4</b>	<b>Radiation</b>	<b>15</b>
4.1	Radiation . . . . .	15
4.2	Shortwave Radiation . . . . .	15
4.3	Shortwave GHG . . . . .	17
4.4	Shortwave Cloud Ice . . . . .	19
4.5	Shortwave Cloud Liquid . . . . .	20
4.6	Shortwave Cloud Inhomogeneity . . . . .	21
4.7	Shortwave Aerosols . . . . .	22
4.8	Shortwave Gases . . . . .	23
4.9	Longwave Radiation . . . . .	23
4.10	Longwave GHG . . . . .	24
4.11	Longwave Cloud Ice . . . . .	27
4.12	Longwave Cloud Liquid . . . . .	28
4.13	Longwave Cloud Inhomogeneity . . . . .	29
4.14	Longwave Aerosols . . . . .	29
4.15	Longwave Gases . . . . .	30
<b>5</b>	<b>Turbulence Convection</b>	<b>32</b>
5.1	Turbulence Convection . . . . .	32
5.2	Boundary Layer Turbulence . . . . .	32
5.3	Deep Convection . . . . .	33
5.4	Shallow Convection . . . . .	35
<b>6</b>	<b>Microphysics Precipitation</b>	<b>37</b>
6.1	Microphysics Precipitation . . . . .	37
6.2	Large Scale Precipitation . . . . .	37
6.3	Large Scale Cloud Microphysics . . . . .	37

<b>7</b>	<b>Cloud Scheme</b>	<b>39</b>
7.1	Cloud Scheme . . . . .	39
7.2	Optical Cloud Properties . . . . .	41
7.3	Sub Grid Scale Water Distribution . . . . .	41
7.4	Sub Grid Scale Ice Distribution . . . . .	42
<b>8</b>	<b>Observation Simulation</b>	<b>44</b>
8.1	Observation Simulation . . . . .	44
8.2	Isscp Attributes . . . . .	44
8.3	Cosp Attributes . . . . .	45
8.4	Radar Inputs . . . . .	45
8.5	Lidar Inputs . . . . .	46
<b>9</b>	<b>Gravity Waves</b>	<b>48</b>
9.1	Gravity Waves . . . . .	48
9.2	Orographic Gravity Waves . . . . .	49
9.3	Non Orographic Gravity Waves . . . . .	50
<b>10</b>	<b>Solar</b>	<b>53</b>
10.1	Solar . . . . .	53
10.2	Solar Pathways . . . . .	53
10.3	Solar Constant . . . . .	53
10.4	Orbital Parameters . . . . .	54
10.5	Insolation Ozone . . . . .	55
<b>11</b>	<b>Volcanos</b>	<b>56</b>
11.1	Volcanos . . . . .	56
11.2	Volcanoes Treatment . . . . .	56

# 1 Key Properties

## *Atmosphere key properties*

### 1.1 Overview

#### *Top level key properties*

#### 1.1.1 Model Overview

##### *Overview of atmosphere model*

**Spec. ID:** cmip6.atmos.key\_properties.overview.model\_overview

**Is Required ?** TRUE

**Enter TEXT value:**

#### 1.1.2 Model Name

##### *Name of atmosphere model code (CAM 4.0, ARPEGE 3.2,...)*

**Spec. ID:** cmip6.atmos.key\_properties.overview.model\_name

**Is Required ?** TRUE

**Enter TEXT value:**

#### 1.1.3 Model Family

##### *Type of atmospheric model.*

**Spec. ID:** cmip6.atmos.key\_properties.overview.model\_family

**Is Required ?** TRUE

**Select value:**

- ☐ AGCM - Atmospheric General Circulation Model
- ☐ ARCM - Atmospheric Regional Climate Model
- ☐ Other - please specify:

#### 1.1.4 Basic Approximations

##### *Basic approximations made in the atmosphere.*

**Spec. ID:** cmip6.atmos.key\_properties.overview.basic\_approximations

**Is Required ?** TRUE

**Select value(s):**

- ☐ Primitive equations
- ☐ Non-hydrostatic

- ☐ Anelastic
- ☐ Boussinesq
- ☐ Hydrostatic
- ☐ Quasi-hydrostatic
- ☐ Other - please specify:

## 1.2 Resolution

*Characteristics of the model resolution*

### 1.2.1 Horizontal Resolution Name

*This is a string usually used by the modelling group to describe the resolution of the model grid, e.g. T42, N48.*

**Spec. ID:** cmip6.atmos.key\_properties.resolution.horizontal\_resolution\_name

**Is Required ?** TRUE

**Enter TEXT value:**

### 1.2.2 Canonical Horizontal Resolution

*Expression quoted for gross comparisons of resolution, e.g. 2.5 x 3.75 degrees lat-lon.*

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

**Is Required ?** TRUE

**Enter TEXT value:**

### 1.2.3 Range Horizontal Resolution

*Range of horizontal resolution with spatial details, eg. 1 deg (Equator) - 0.5 deg*

**Spec. ID:** cmip6.atmos.key\_properties.resolution.range\_horizontal\_resolution

**Is Required ?** TRUE

**Enter TEXT value:**

### 1.2.4 Number Of Vertical Levels

*Number of vertical levels resolved on the computational grid.*

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

**Is Required ?** TRUE

**Enter INTEGER value:**

### 1.2.5 High Top

*Does the atmosphere have a high-topxxx? High-Top atmospheres have a fully resolved stratosphere with a model top above the stratopause.*

**Spec. ID:** cmip6.atmos.key\_properties.resolution.high\_top

**Is Required ?** TRUE

**Select value:**

☐ True ☐ False

## 1.3 Timestepping

*Characteristics of the atmosphere model time stepping*

### 1.3.1 Timestep Dynamics

*Timestep for the dynamics, e.g. 30 min.*

**Spec. ID:** cmip6.atmos.key\_properties.timestepping.timestep\_dynamics

**Is Required ?** TRUE

**Enter TEXT value:**

### 1.3.2 Timestep Shortwave Radiative Transfer

*Timestep for the shortwave radiative transfer, e.g. 1.5 hours.*

**Spec. ID:** cmip6.atmos.key\_properties.timestepping.timestep\_shortwave\_radiative\_transfer

**Is Required ?** FALSE

**Enter TEXT value:**

### 1.3.3 Timestep Longwave Radiative Transfer

*Timestep for the longwave radiative transfer, e.g. 3 hours.*

**Spec. ID:** cmip6.atmos.key\_properties.timestepping.timestep\_longwave\_radiative\_transfer

**Is Required ?** FALSE

**Enter TEXT value:**

## 1.4 Orography

*Characteristics of the model orography*

### 1.4.1 Type

*Time adaptation of the orography.*

**Spec. ID:** cmip6.atmos.key\_properties.orography.type

**Is Required ?** TRUE

**Select value:**

☐ Present day

☐ Modified

### 1.4.2 Changes

*If the orography type is modified describe the time adaptation changes.*

**Spec. ID:** cmip6.atmos.key\_properties.orography.changes

**Is Required ?** TRUE

**Select value(s):**

- ☐ Related to ice sheets
- ☐ Related to tectonics
- ☐ Modified mean
- ☐ Modified variance if taken into account in model (cf gravity waves)

## 2 Grid

### *Atmosphere grid*

#### 2.1 Discretisation

##### *Atmosphere grid discretisation*

##### 2.1.1 Overview

*Overview description of grid discretisation in the atmosphere*

**Spec. ID:** cmip6.atmos.grid.discretisation.overview

**Is Required ?** TRUE

**Enter TEXT value:**

#### 2.2 Horizontal

##### *Atmosphere discretisation in the horizontal*

##### 2.2.1 Scheme Type

*Horizontal discretisation type*

**Spec. ID:** cmip6.atmos.grid.discretisation.horizontal.scheme\_type

**Is Required ?** TRUE

**Select value:**

- ☐ Spectral
- ☐ Fixed grid
- ☐ Other - please specify:

##### 2.2.2 Scheme Method

*Horizontal discretisation method*

**Spec. ID:** cmip6.atmos.grid.discretisation.horizontal.scheme\_method

**Is Required ?** TRUE

**Select value:**

- ☐ Finite elements
- ☐ Finite volumes
- ☐ Finite difference
- ☐ Centered finite difference



### 2.2.3 Scheme Order

*Horizontal discretisation function order*

**Spec. ID:** cmip6.atmos.grid.discretisation.horizontal.scheme\_order

**Is Required ?** TRUE

**Select value:**

- ☐ Second
- ☐ Third
- ☐ Fourth
- ☐ Other - please specify:

### 2.2.4 Horizontal Pole

*Horizontal discretisation pole singularity treatment*

**Spec. ID:** cmip6.atmos.grid.discretisation.horizontal.horizontal\_pole

**Is Required ?** FALSE

**Select value:**

- ☐ Filter
- ☐ Pole rotation
- ☐ Artificial island
- ☐ Other - please specify:

### 2.2.5 Grid Type

*Horizontal grid type*

**Spec. ID:** cmip6.atmos.grid.discretisation.horizontal.grid\_type

**Is Required ?** TRUE

**Select value:**

- ☐ Gaussian
- ☐ Latitude-Longitude
- ☐ Cubed-Sphere
- ☐ Icosahedral
- ☐ Other - please specify:

## 2.3 Vertical

*Atmosphere discretisation in the vertical*

### 2.3.1 Coordinate Type

*Type of vertical coordinate system*

**Spec. ID:** cmip6.atmos.grid.discretisation.vertical.coordinate\_\_type

**Is Required ?** TRUE

**Select value(s):**

- ☐ Isobaric - Vertical coordinate on pressure levels
- ☐ Sigma - Allows vertical coordinate to follow model terrain
- ☐ Hybrid sigma-pressure - Sigma system near terrain and isobaric above
- ☐ Hybrid pressure
- ☐ Vertically lagrangian
- ☐ Other - please specify:

## 3 Dynamical Core

*Characteristics of the dynamical core*

### 3.1 Dynamical Core

*Characteristics of the dynamical core*

#### 3.1.1 Overview

*Overview description of atmosphere dynamical core*

**Spec. ID:** cmip6.atmos.dynamical\_core.overview

**Is Required ?** TRUE

**Enter TEXT value:**

#### 3.1.2 Name

*Commonly used name for the dynamical core of the model.*

**Spec. ID:** cmip6.atmos.dynamical\_core.name

**Is Required ?** FALSE

**Enter TEXT value:**

#### 3.1.3 Timestepping Type

*Timestepping framework type*

**Spec. ID:** cmip6.atmos.dynamical\_core.timestepping\_type

**Is Required ?** TRUE

**Select value:**

- ☐ Adams-Bashforth
- ☐ Explicit
- ☐ Implicit
- ☐ Semi-implicit
- ☐ Leap frog
- ☐ Multi-step
- ☐ Runge Kutta fifth order
- ☐ Runge Kutta second order
- ☐ Runge Kutta third order
- ☐ Other - please specify:

### 3.1.4 Prognostic Variables

*List of the model prognostic variables*

**Spec. ID:** cmip6.atmos.dynamical\_core.prognostic\_variables

**Is Required ?** TRUE

**Select value(s):**

- ☐ Surface pressure
- ☐ Wind components
- ☐ Divergence/curl
- ☐ Temperature
- ☐ Potential temperature
- ☐ Total water
- ☐ Water vapour
- ☐ Water liquid
- ☐ Water ice
- ☐ Total water moments
- ☐ Clouds
- ☐ Radiation
- ☐ Other - please specify:

## 3.2 Top Boundary

*Type of boundary layer at the top of the model*

### 3.2.1 Top Boundary Condition

*Top boundary condition*

**Spec. ID:** cmip6.atmos.dynamical\_core.top\_boundary.top\_boundary\_condition

**Is Required ?** TRUE

**Select value:**

- ☐ Sponge layer
- ☐ Radiation boundary condition
- ☐ Other - please specify:

### 3.2.2 Top Heat

*Top boundary heat treatment*

**Spec. ID:** cmip6.atmos.dynamical\_core.top\_boundary.top\_heat

**Is Required ?** TRUE

**Enter TEXT value:**

### 3.2.3 Top Wind

*Top boundary wind treatment*

**Spec. ID:** cmip6.atmos.dynamical\_core.top\_boundary.top\_wind

**Is Required ?** TRUE

**Enter TEXT value:**

## 3.3 Lateral Boundary

*Type of lateral boundary condition (if the model is a regional model)*

### 3.3.1 Condition

*Type of lateral boundary condition*

**Spec. ID:** cmip6.atmos.dynamical\_core.lateral\_boundary.condition

**Is Required ?** FALSE

**Select value:**

- ☐ Sponge layer
- ☐ Radiation boundary condition
- ☐ Other - please specify:

## 3.4 Diffusion Horizontal

*Horizontal diffusion scheme*

### 3.4.1 Scheme Name

*Horizontal diffusion scheme name*

**Spec. ID:** cmip6.atmos.dynamical\_core.diffusion\_horizontal.scheme\_name

**Is Required ?** FALSE

**Enter TEXT value:**

### 3.4.2 Scheme Method

*Horizontal diffusion scheme method*

**Spec. ID:** cmip6.atmos.dynamical\_core.diffusion\_horizontal.scheme\_method

**Is Required ?** TRUE

**Select value:**

- ☐ Iterated Laplacian
- ☐ Bi-harmonic
- ☐ Other - please specify:

## 3.5 Advection Tracers

*Tracer advection scheme*

### 3.5.1 Scheme Name

*Tracer advection scheme name*

**Spec. ID:** cmip6.atmos.dynamical\_core.advection\_tracers.scheme\_name

**Is Required ?** FALSE

**Select value:**

- ☐ Heun
- ☐ Roe and VanLeer
- ☐ Roe and Superbee
- ☐ Prather
- ☐ UTOPIA
- ☐ Other - please specify:

### 3.5.2 Scheme Characteristics

*Tracer advection scheme characteristics*

**Spec. ID:** cmip6.atmos.dynamical\_core.advection\_tracers.scheme\_characteristics

**Is Required ?** TRUE

**Select value(s):**

- ☐ Eulerian
- ☐ Modified Euler
- ☐ Lagrangian

- ☐ Semi-Lagrangian
- ☐ Cubic semi-Lagrangian
- ☐ Quintic semi-Lagrangian
- ☐ Mass-conserving
- ☐ Finite volume
- ☐ Flux-corrected
- ☐ Linear
- ☐ Quadratic
- ☐ Quartic
- ☐ Other - please specify:

### 3.5.3 Conserved Quantities

*Tracer advection scheme conserved quantities*

**Spec. ID:** cmip6.atmos.dynamical\_core.advection\_tracers.conserved\_quantities

**Is Required ?** TRUE

**Select value(s):**

- ☐ Dry mass
- ☐ Tracer mass
- ☐ Other - please specify:

### 3.5.4 Conservation Method

*Tracer advection scheme conservation method*

**Spec. ID:** cmip6.atmos.dynamical\_core.advection\_tracers.conservaion\_method

**Is Required ?** TRUE

**Select value:**

- ☐ Conservation fixer
- ☐ Priestley algorithm
- ☐ Other - please specify:

## 3.6 Advection Momentum

*Momentum advection scheme*

### 3.6.1 Scheme Name

*Momentum advection schemes name*

**Spec. ID:** cmip6.atmos.dynamical\_core.advection\_momentum.scheme\_name

**Is Required ?** FALSE

**Select value:**

- ☐ VanLeer
- ☐ Janjic
- ☐ SUPG (Streamline Upwind Petrov-Galerkin)
- ☐ Other - please specify:

### 3.6.2 Scheme Characteristics

*Momentum advection scheme characteristics*

**Spec. ID:** cmip6.atmos.dynamical\_core.advection\_momentum.scheme\_characteristics

**Is Required ?** TRUE

**Select value(s):**

- ☐ 2nd order
- ☐ 4th order
- ☐ Cell-centred
- ☐ Staggered grid
- ☐ Semi-staggered grid
- ☐ Other - please specify:

### 3.6.3 Scheme Staggering Type

*Momentum advection scheme staggering type*

**Spec. ID:** cmip6.atmos.dynamical\_core.advection\_momentum.scheme\_staggering\_type

**Is Required ?** TRUE

**Select value:**

- ☐ Arakawa B-grid
- ☐ Arakawa C-grid
- ☐ Arakawa D-grid
- ☐ Arakawa E-grid
- ☐ Other - please specify:



### 3.6.4 Conserved Quantities

*Momentum advection scheme conserved quantities*

**Spec. ID:** cmip6.atmos.dynamical\_core.advection\_momentum.conserved\_quantities

**Is Required ?** TRUE

**Select value(s):**

- ☐ Angular momentum
- ☐ Horizontal momentum
- ☐ Enstrophy
- ☐ Mass
- ☐ Total energy
- ☐ Vorticity
- ☐ Other - please specify:

### 3.6.5 Conservation Method

*Momentum advection scheme conservation method*

**Spec. ID:** cmip6.atmos.dynamical\_core.advection\_momentum.conservation\_method

**Is Required ?** TRUE

**Select value:**

- ☐ Conservation fixer
- ☐ Other - please specify:

## 4 Radiation

*Characteristics of the atmosphere radiation process*

### 4.1 Radiation

*Characteristics of the atmosphere radiation process*

#### 4.1.1 Aerosols

*Aerosols whose radiative effect is taken into account in the atmosphere model*

**Spec. ID:** cmip6.atmos.radiation.aerosols

**Is Required ?** TRUE

**Select value(s):**

- ☐ Sulphate
- ☐ Nitrate
- ☐ Sea salt
- ☐ Dust
- ☐ Ice
- ☐ Organic
- ☐ BC (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 particle)
- ☐ Other - please specify:

### 4.2 Shortwave Radiation

*Properties of the shortwave radiation scheme*

#### 4.2.1 Overview

*Overview description of shortwave radiation in the atmosphere*

**Spec. ID:** cmip6.atmos.radiation.shortwave\_radiation.overview

**Is Required ?** TRUE

**Enter TEXT value:**

#### 4.2.2 Name

*Commonly used name for the shortwave radiation scheme*

**Spec. ID:** cmip6.atmos.radiation.shortwave\_radiation.name

**Is Required ?** FALSE

**Enter TEXT value:**

#### 4.2.3 Spectral Integration

*Shortwave radiation scheme spectral integration*

**Spec. ID:** cmip6.atmos.radiation.shortwave\_radiation.spectral\_integration

**Is Required ?** TRUE

**Select value:**

- ☐ Wide-band model
- ☐ Correlated-k
- ☐ Exponential sum fitting
- ☐ Other - please specify:

#### 4.2.4 Transport Calculation

*Shortwave radiation transport calculation methods*

**Spec. ID:** cmip6.atmos.radiation.shortwave\_radiation.transport\_calculation

**Is Required ?** TRUE

**Select value(s):**

- ☐ Two-stream
- ☐ Layer interaction
- ☐ Bulk - Highly parameterised methods that use bulk expressions
- ☐ Adaptive - Exploits spatial and temporal correlations in optical characteristics
- ☐ Multi-stream
- ☐ Other - please specify:

#### 4.2.5 Spectral Intervals

*Shortwave radiation scheme number of spectral intervals*

**Spec. ID:** cmip6.atmos.radiation.shortwave\_radiation.spectral\_intervals

**Is Required ?** TRUE

Enter INTEGER value:

## 4.3 Shortwave GHG

*Representation of greenhouse gases in the shortwave radiation scheme*

### 4.3.1 Greenhouse Gas Complexity

*Complexity of greenhouse gases whose shortwave radiative effects are taken into account in the atmosphere model*

**Spec. ID:** cmip6.atmos.radiation.shortwave\_ghg.greenhouse\_gas\_complexity

**Is Required ?** TRUE

**Select value(s):**

- ☐ CO2 - Carbon Dioxide
- ☐ CH4 - Methane
- ☐ N2O - Nitrous Oxide
- ☐ CFC-11 eq - Summarize the effect of non CO2, CH4, N2O and CFC-12 gases with an equivalence concentration of CFC-11
- ☐ CFC-12 eq - Summarize the radiative effect of the Ozone Depleting Substances, ODSs, with a CFC-12 equivalence concentration
- ☐ HFC-134a eq - Summarize the radiative effect of other fluorinated gases with a HFC-134a equivalence concentration
- ☐ Explicit ODSs - Explicit representation of Ozone Depleting Substances e.g. CFCs, HCFCs and Halons
- ☐ Explicit other fluorinated gases - Explicit representation of other fluorinated gases e.g. HFCs and PFCs
- ☐ O3
- ☐ H2O
- ☐ Other - please specify:

### 4.3.2 ODS

*Ozone depleting substances whose shortwave radiative effects are explicitly taken into account in the atmosphere model*

**Spec. ID:** cmip6.atmos.radiation.shortwave\_ghg.ods

**Is Required ?** FALSE

**Select value(s):**

- ☐ CFC-12 - CFC
- ☐ CFC-11 - CFC
- ☐ CFC-113 - CFC
- ☐ CFC-114 - CFC

- ☐ CFC-115 - CFC
- ☐ HCFC-22 - HCFC
- ☐ HCFC-141b - HCFC
- ☐ HCFC-142b - HCFC
- ☐ Halon-1211 - Halon
- ☐ Halon-1301 - Halon
- ☐ Halon-2402 - Halon
- ☐ Methyl chloroform - CH<sub>3</sub>CCl<sub>3</sub>
- ☐ Carbon tetrachloride - CCl<sub>4</sub>
- ☐ Methyl chloride - CH<sub>3</sub>Cl
- ☐ Methylene chloride - CH<sub>2</sub>Cl<sub>2</sub>
- ☐ Chloroform - CHCl<sub>3</sub>
- ☐ Methyl bromide - CH<sub>3</sub>Br
- ☐ Other - please specify:

#### 4.3.3 Other Flourinated Gases

*Other flourinated gases whose shortwave radiative effects are explicitly taken into account in the atmosphere model*

**Spec. ID:** cmip6.atmos.radiation.shortwave\_ghg.other\_flourinated\_gases

**Is Required ?** FALSE

**Select value(s):**

- ☐ HFC-134a - HFC
- ☐ HFC-23 - HFC
- ☐ HFC-32 - HFC
- ☐ HFC-125 - HFC
- ☐ HFC-143a - HFC
- ☐ HFC-152a - HFC
- ☐ HFC-227ea - HFC
- ☐ HFC-236fa - HFC
- ☐ HFC-245fa - HFC
- ☐ HFC-365mfc - HFC
- ☐ HFC-43-10mee - HFC

- ☐ CF4 - PFC
- ☐ C2F6 - PFC
- ☐ C3F8 - PFC
- ☐ C4F10 - PFC
- ☐ C5F12 - PFC
- ☐ C6F14 - PFC
- ☐ C7F16 - PFC
- ☐ C8F18 - PFC
- ☐ C-C4F8 - PFC
- ☐ NF3
- ☐ SF6
- ☐ SO2F2
- ☐ Other - please specify:

## 4.4 Shortwave Cloud Ice

*Shortwave radiative properties of ice crystals in clouds*

### 4.4.1 General Interactions

*General shortwave radiative interactions with cloud ice crystals*

**Spec. ID:** cmip6.atmos.radiation.shortwave\_cloud\_ice.general\_interactions

**Is Required ?** TRUE

**Select value(s):**

- ☐ Scattering
- ☐ Emission/absorption
- ☐ Other - please specify:

### 4.4.2 Physical Representation

*Physical representation of cloud ice crystals in the shortwave radiation scheme*

**Spec. ID:** cmip6.atmos.radiation.shortwave\_cloud\_ice.physical\_representation

**Is Required ?** TRUE

**Select value(s):**

- ☐ Bi-modal size distribution - Small mode diameters: a few tens of microns, large mode diameters: typically hundreds of microns

- ☐ Ensemble of ice crystals - Complex shapes represented with an ensemble of symmetric shapes
- ☐ Mean projected area - Randomly oriented irregular ice crystals present a greater mean projected area than spheres
- ☐ Ice water path - Integrated ice water path through the cloud kg m-2
- ☐ Crystal asymmetry
- ☐ Crystal aspect ratio
- ☐ Effective crystal radius
- ☐ Other - please specify:

#### 4.4.3 Optical Methods

*Optical methods applicable to cloud ice crystals in the shortwave radiation scheme*

**Spec. ID:** cmip6.atmos.radiation.shortwave\_cloud\_ice.optical\_methods

**Is Required ?** TRUE

**Select value(s):**

- ☐ T-matrix - For non-spherical particles
- ☐ Geometric optics - For non-spherical particles
- ☐ Finite difference time domain (FDTD) - For non-spherical particles
- ☐ Mie theory - For spherical particles
- ☐ Anomalous diffraction approximation
- ☐ Other - please specify:

### 4.5 Shortwave Cloud Liquid

*Shortwave radiative properties of liquid droplets in clouds*

#### 4.5.1 General Interactions

*General shortwave radiative interactions with cloud liquid droplets*

**Spec. ID:** cmip6.atmos.radiation.shortwave\_cloud\_liquid.general\_interactions

**Is Required ?** TRUE

**Select value(s):**

- ☐ Scattering
- ☐ Emission/absorption
- ☐ Other - please specify:

### 4.5.2 Physical Representation

*Physical representation of cloud liquid droplets in the shortwave radiation scheme*

**Spec. ID:** cmip6.atmos.radiation.shortwave\_cloud\_liquid.physical\_representation

**Is Required ?** TRUE

**Select value(s):**

- ☐ Cloud droplet number concentration - CDNC
- ☐ Effective cloud droplet radii
- ☐ Droplet size distribution
- ☐ Liquid water path - Integrated liquid water path through the cloud kg m-2
- ☐ Other - please specify:

### 4.5.3 Optical Methods

*Optical methods applicable to cloud liquid droplets in the shortwave radiation scheme*

**Spec. ID:** cmip6.atmos.radiation.shortwave\_cloud\_liquid.optical\_methods

**Is Required ?** TRUE

**Select value(s):**

- ☐ Geometric optics - For non-spherical particles
- ☐ Mie theory - For spherical particles
- ☐ Other - please specify:

## 4.6 Shortwave Cloud Inhomogeneity

*Cloud inhomogeneity in the shortwave radiation scheme*

### 4.6.1 Cloud Inhomogeneity

*Method for taking into account horizontal cloud inhomogeneity*

**Spec. ID:** cmip6.atmos.radiation.shortwave\_cloud\_inhomogeneity.cloud\_inhomogeneity

**Is Required ?** TRUE

**Select value:**

- ☐ Monte Carlo Independent Column Approximation - McICA
- ☐ Triplecloud - Regions of clear sky, optically thin cloud and optically thick cloud, Shonk et al 2010
- ☐ Analytic
- ☐ Other - please specify:



## 4.7 Shortwave Aerosols

*Shortwave radiative properties of aerosols*

### 4.7.1 General Interactions

*General shortwave radiative interactions with aerosols*

**Spec. ID:** cmip6.atmos.radiation.shortwave\_aerosols.general\_interactions

**Is Required ?** TRUE

**Select value(s):**

- ☐ Scattering
- ☐ Emission/absorption
- ☐ Other - please specify:

### 4.7.2 Physical Representation

*Physical representation of aerosols in the shortwave radiation scheme*

**Spec. ID:** cmip6.atmos.radiation.shortwave\_aerosols.physical\_representation

**Is Required ?** TRUE

**Select value(s):**

- ☐ Number concentration
- ☐ Effective radii
- ☐ Size distribution
- ☐ Asymmetry
- ☐ Aspect ratio
- ☐ Mixing state - For shortwave radiative interaction
- ☐ Other - please specify:

### 4.7.3 Optical Methods

*Optical methods applicable to aerosols in the shortwave radiation scheme*

**Spec. ID:** cmip6.atmos.radiation.shortwave\_aerosols.optical\_methods

**Is Required ?** TRUE

**Select value(s):**

- ☐ T-matrix - For non-spherical particles
- ☐ Geometric optics - For non-spherical particles
- ☐ Finite difference time domain (FDTD) - For non-spherical particles

- ☐ Mie theory - For spherical particles
- ☐ Anomalous diffraction approximation
- ☐ Other - please specify:

## 4.8 Shortwave Gases

*Shortwave radiative properties of gases*

### 4.8.1 General Interactions

*General shortwave radiative interactions with gases*

**Spec. ID:** cmip6.atmos.radiation.shortwave\_gases.general\_interactions

**Is Required ?** TRUE

**Select value(s):**

- ☐ Scattering
- ☐ Emission/absorption
- ☐ Other - please specify:

## 4.9 Longwave Radiation

*Properties of the longwave radiation scheme*

### 4.9.1 Overview

*Overview description of longwave radiation in the atmosphere*

**Spec. ID:** cmip6.atmos.radiation.longwave\_radiation.overview

**Is Required ?** TRUE

**Enter TEXT value:**

### 4.9.2 Name

*Commonly used name for the longwave radiation scheme.*

**Spec. ID:** cmip6.atmos.radiation.longwave\_radiation.name

**Is Required ?** FALSE

**Enter TEXT value:**

### 4.9.3 Spectral Integration

*Longwave radiation scheme spectral integration*

**Spec. ID:** cmip6.atmos.radiation.longwave\_radiation.spectral\_integration

**Is Required ?** TRUE

**Select value:**

- ☐ Wide-band model
- ☐ Correlated-k
- ☐ Exponential sum fitting
- ☐ Other - please specify:

#### 4.9.4 Transport Calculation

*Longwave radiation transport calculation methods*

**Spec. ID:** cmip6.atmos.radiation.longwave\_radiation.transport\_calculation

**Is Required ?** TRUE

**Select value(s):**

- ☐ Two-stream
- ☐ Layer interaction
- ☐ Bulk - Highly parameterised methods that use bulk expressions
- ☐ Adaptive - Exploits spatial and temporal correlations in optical characteristics
- ☐ Multi-stream
- ☐ Other - please specify:

#### 4.9.5 Spectral Intervals

*Longwave radiation scheme number of spectral intervals*

**Spec. ID:** cmip6.atmos.radiation.longwave\_radiation.spectral\_intervals

**Is Required ?** TRUE

**Enter INTEGER value:**

### 4.10 Longwave GHG

*Representation of greenhouse gases in the longwave radiation scheme*

#### 4.10.1 Greenhouse Gas Complexity

*Complexity of greenhouse gases whose longwave radiative effects are taken into account in the atmosphere model*

**Spec. ID:** cmip6.atmos.radiation.longwave\_ghg.greenhouse\_gas\_complexity

**Is Required ?** TRUE

**Select value(s):**

- ☐ CO2 - Carbon Dioxide

- ☐ CH4 - Methane
- ☐ N2O - Nitrous Oxide
- ☐ CFC-11 eq - Summarize the effect of non CO2, CH4, N2O and CFC-12 gases with an equivalence concentration of CFC-11
- ☐ CFC-12 eq - Summarize the radiative effect of the Ozone Depleting Substances, ODSs, with a CFC-12 equivalence concentration
- ☐ HFC-134a eq - Summarize the radiative effect of other fluorinated gases with a HFC-134a equivalence concentration
- ☐ Explicit ODSs - Explicit representation of Ozone Depleting Substances e.g. CFCs, HCFCs and Halons
- ☐ Explicit other fluorinated gases - Explicit representation of other fluorinated gases e.g. HFCs and PFCs
- ☐ O3
- ☐ H2O
- ☐ Other - please specify:

#### 4.10.2 ODS

*Ozone depleting substances whose longwave radiative effects are explicitly taken into account in the atmosphere model*

**Spec. ID:** cmip6.atmos.radiation.longwave\_ghg.ods

**Is Required ?** FALSE

**Select value(s):**

- ☐ CFC-12 - CFC
- ☐ CFC-11 - CFC
- ☐ CFC-113 - CFC
- ☐ CFC-114 - CFC
- ☐ CFC-115 - CFC
- ☐ HCFC-22 - HCFC
- ☐ HCFC-141b - HCFC
- ☐ HCFC-142b - HCFC
- ☐ Halon-1211 - Halon
- ☐ Halon-1301 - Halon
- ☐ Halon-2402 - Halon
- ☐ Methyl chloroform - CH3CCl3
- ☐ Carbon tetrachloride - CCl4

- ☐ Methyl chloride - CH<sub>3</sub>Cl
- ☐ Methylene chloride - CH<sub>2</sub>Cl<sub>2</sub>
- ☐ Chloroform - CHCl<sub>3</sub>
- ☐ Methyl bromide - CH<sub>3</sub>Br
- ☐ Other - please specify:

#### 4.10.3 Other Flourinated Gases

*Other flourinated gases whose longwave radiative effects are explicitly taken into account in the atmosphere model*

**Spec. ID:** cmip6.atmos.radiation.longwave\_ghg.other\_flourinated\_gases

**Is Required ?** FALSE

**Select value(s):**

- ☐ HFC-134a - HFC
- ☐ HFC-23 - HFC
- ☐ HFC-32 - HFC
- ☐ HFC-125 - HFC
- ☐ HFC-143a - HFC
- ☐ HFC-152a - HFC
- ☐ HFC-227ea - HFC
- ☐ HFC-236fa - HFC
- ☐ HFC-245fa - HFC
- ☐ HFC-365mfc - HFC
- ☐ HFC-43-10mee - HFC
- ☐ CF<sub>4</sub> - PFC
- ☐ C<sub>2</sub>F<sub>6</sub> - PFC
- ☐ C<sub>3</sub>F<sub>8</sub> - PFC
- ☐ C<sub>4</sub>F<sub>10</sub> - PFC
- ☐ C<sub>5</sub>F<sub>12</sub> - PFC
- ☐ C<sub>6</sub>F<sub>14</sub> - PFC
- ☐ C<sub>7</sub>F<sub>16</sub> - PFC
- ☐ C<sub>8</sub>F<sub>18</sub> - PFC
- ☐ C-C<sub>4</sub>F<sub>8</sub> - PFC

- ☐ NF3
- ☐ SF6
- ☐ SO2F2
- ☐ Other - please specify:

## 4.11 Longwave Cloud Ice

*Longwave radiative properties of ice crystals in clouds*

### 4.11.1 General Interactions

*General longwave radiative interactions with cloud ice crystals*

**Spec. ID:** cmip6.atmos.radiation.longwave\_cloud\_ice.general\_interactions

**Is Required ?** TRUE

**Select value(s):**

- ☐ Scattering
- ☐ Emission/absorption
- ☐ Other - please specify:

### 4.11.2 Physical Reprerentation

*Physical representation of cloud ice crystals in the longwave radiation scheme*

**Spec. ID:** cmip6.atmos.radiation.longwave\_cloud\_ice.physical\_reprentation

**Is Required ?** TRUE

**Select value(s):**

- ☐ Bi-modal size distribution - Small mode diameters: a few tens of microns, large mode diameters: typically hundreds of microns
- ☐ Ensemble of ice crystals - Complex shapes represented with an ensemble of symmetric shapes
- ☐ Mean projected area - Randomly oriented irregular ice crystals present a greater mean projected area than spheres
- ☐ Ice water path - Integrated ice water path through the cloud kg m-2
- ☐ Crystal asymmetry
- ☐ Crystal aspect ratio
- ☐ Effective crystal radius
- ☐ Other - please specify:

### 4.11.3 Optical Methods

*Optical methods applicable to cloud ice crystals in the longwave radiation scheme*

**Spec. ID:** cmip6.atmos.radiation.longwave\_cloud\_ice.optical\_methods

**Is Required ?** TRUE

**Select value(s):**

- ☐ T-matrix - For non-spherical particles
- ☐ Geometric optics - For non-spherical particles
- ☐ Finite difference time domain (FDTD) - For non-spherical particles
- ☐ Mie theory - For spherical particles
- ☐ Anomalous diffraction approximation
- ☐ Other - please specify:

## 4.12 Longwave Cloud Liquid

*Longwave radiative properties of liquid droplets in clouds*

### 4.12.1 General Interactions

*General longwave radiative interactions with cloud liquid droplets*

**Spec. ID:** cmip6.atmos.radiation.longwave\_cloud\_liquid.general\_interactions

**Is Required ?** TRUE

**Select value(s):**

- ☐ Scattering
- ☐ Emission/absorption
- ☐ Other - please specify:

### 4.12.2 Physical Representation

*Physical representation of cloud liquid droplets in the longwave radiation scheme*

**Spec. ID:** cmip6.atmos.radiation.longwave\_cloud\_liquid.physical\_representation

**Is Required ?** TRUE

**Select value(s):**

- ☐ Cloud droplet number concentration - CDNC
- ☐ Effective cloud droplet radii
- ☐ Droplet size distribution

- ☐ Liquid water path - Integrated liquid water path through the cloud kg m-2
- ☐ Other - please specify:

### 4.12.3 Optical Methods

*Optical methods applicable to cloud liquid droplets in the longwave radiation scheme*

**Spec. ID:** cmip6.atmos.radiation.longwave\_cloud\_liquid.optical\_methods

**Is Required ?** TRUE

**Select value(s):**

- ☐ Geometric optics - For non-spherical particles
- ☐ Mie theory - For spherical particles
- ☐ Other - please specify:

## 4.13 Longwave Cloud Inhomogeneity

*Cloud inhomogeneity in the longwave radiation scheme*

### 4.13.1 Cloud Inhomogeneity

*Method for taking into account horizontal cloud inhomogeneity*

**Spec. ID:** cmip6.atmos.radiation.longwave\_cloud\_inhomogeneity.cloud\_inhomogeneity

**Is Required ?** TRUE

**Select value:**

- ☐ Monte Carlo Independent Column Approximation - McICA
- ☐ Triplecloud - Regions of clear sky, optically thin cloud and optically thick cloud, Shonk et al 2010
- ☐ Analytic
- ☐ Other - please specify:

## 4.14 Longwave Aerosols

*Longwave radiative properties of aerosols*

### 4.14.1 General Interactions

*General longwave radiative interactions with aerosols*

**Spec. ID:** cmip6.atmos.radiation.longwave\_aerosols.general\_interactions

**Is Required ?** TRUE

**Select value(s):**



- ☐ Scattering
- ☐ Emission/absorption
- ☐ Other - please specify:

#### 4.14.2 Physical Representation

*Physical representation of aerosols in the longwave radiation scheme*

**Spec. ID:** cmip6.atmos.radiation.longwave\_aerosols.physical\_representation

**Is Required ?** TRUE

**Select value(s):**

- ☐ Number concentration
- ☐ Effective radii
- ☐ Size distribution
- ☐ Asymmetry
- ☐ Aspect ratio
- ☐ Mixing state - For shortwave radiative interaction
- ☐ Other - please specify:

#### 4.14.3 Optical Methods

*Optical methods applicable to aerosols in the longwave radiation scheme*

**Spec. ID:** cmip6.atmos.radiation.longwave\_aerosols.optical\_methods

**Is Required ?** TRUE

**Select value(s):**

- ☐ T-matrix - For non-spherical particles
- ☐ Geometric optics - For non-spherical particles
- ☐ Finite difference time domain (FDTD) - For non-spherical particles
- ☐ Mie theory - For spherical particles
- ☐ Anomalous diffraction approximation
- ☐ Other - please specify:

#### 4.15 Longwave Gases

*Longwave radiative properties of gases*

#### 4.15.1 General Interactions

*General longwave radiative interactions with gases*

**Spec. ID:** cmip6.atmos.radiation.longwave\_\_gases.general\_interactions

**Is Required ?** TRUE

**Select value(s):**

- ☐ Scattering
- ☐ Emission/absorption
- ☐ Other - please specify:

## 5 Turbulence Convection

*Atmosphere Convective Turbulence and Clouds*

### 5.1 Turbulence Convection

*Atmosphere Convective Turbulence and Clouds*

#### 5.1.1 Overview

*Overview description of atmosphere convection and turbulence*

**Spec. ID:** cmip6.atmos.turbulence\_convection.overview

**Is Required ?** TRUE

**Enter TEXT value:**

### 5.2 Boundary Layer Turbulence

*Properties of the boundary layer turbulence scheme*

#### 5.2.1 Scheme Name

*Boundary layer turbulence scheme name*

**Spec. ID:** cmip6.atmos.turbulence\_convection.boundary\_layer\_turbulence.scheme\_name

**Is Required ?** FALSE

**Select value:**

- ☐ Mellor-Yamada
- ☐ Holtslag-Boville
- ☐ EDMF - Combined Eddy Diffusivity Mass-Flux
- ☐ Other - please specify:

#### 5.2.2 Scheme Type

*Boundary layer turbulence scheme type*

**Spec. ID:** cmip6.atmos.turbulence\_convection.boundary\_layer\_turbulence.scheme\_type

**Is Required ?** TRUE

**Select value(s):**

- ☐ TKE prognostic
- ☐ TKE diagnostic
- ☐ TKE coupled with water
- ☐ Vertical profile of Kz

- ☐ Non-local diffusion
- ☐ Monin-Obukhov similarity
- ☐ Coastal Buddy Scheme - Separate components for coastal near surface winds over ocean and land
- ☐ Coupled with convection
- ☐ Coupled with gravity waves
- ☐ Depth capped at cloud base - Boundary layer capped at cloud base when convection is diagnosed
- ☐ Other - please specify:

### 5.2.3 Closure Order

*Boundary layer turbulence scheme closure order*

**Spec. ID:** cmip6.atmos.turbulence\_convection.boundary\_layer\_turbulence.closure\_order

**Is Required ?** TRUE

**Enter INTEGER value:**

### 5.2.4 Counter Gradient

*Uses boundary layer turbulence scheme counter gradient*

**Spec. ID:** cmip6.atmos.turbulence\_convection.boundary\_layer\_turbulence.counter\_gradient

**Is Required ?** TRUE

**Select value:**

- ☐ True      ☐ False

## 5.3 Deep Convection

*Properties of the deep convection scheme*

### 5.3.1 Scheme Name

*Deep convection scheme name*

**Spec. ID:** cmip6.atmos.turbulence\_convection.deep\_convection.scheme\_name

**Is Required ?** FALSE

**Enter TEXT value:**

### 5.3.2 Scheme Type

*Deep convection scheme type*

**Spec. ID:** cmip6.atmos.turbulence\_convection.deep\_convection.scheme\_type

**Is Required ?** TRUE

**Select value(s):**

- ☐ Mass-flux
- ☐ Adjustment
- ☐ Plume ensemble - Zhang-McFarlane
- ☐ Other - please specify:

### 5.3.3 Scheme Method

*Deep convection scheme method*

**Spec. ID:** cmip6.atmos.turbulence\_convection.deep\_convection.scheme\_method

**Is Required ?** TRUE

**Select value(s):**

- ☐ CAPE - Mass flux determined by CAPE, convectively available potential energy.
- ☐ Bulk - A bulk mass flux scheme is used
- ☐ Ensemble - Summation over an ensemble of convective clouds with differing characteristics
- ☐ CAPE/WFN based - CAPE-Cloud Work Function: Based on the quasi-equilibrium of the free troposphere
- ☐ TKE/CIN based - TKE-Convective Inhibition: Based on the quasi-equilibrium of the boundary layer
- ☐ Other - please specify:

### 5.3.4 Processes

*Physical processes taken into account in the parameterisation of deep convection*

**Spec. ID:** cmip6.atmos.turbulence\_convection.deep\_convection.processes

**Is Required ?** TRUE

**Select value(s):**

- ☐ Vertical momentum transport
- ☐ Convective momentum transport
- ☐ Entrainment
- ☐ Detrainment
- ☐ Penetrative convection
- ☐ Updrafts
- ☐ Downdrafts
- ☐ Radiative effect of anvils

- ☐ Re-evaporation of convective precipitation
- ☐ Other - please specify:

### 5.3.5 Microphysics

*Microphysics scheme for deep convection. Microphysical processes directly control the amount of detrainment of cloud hydrometeor and water vapor from updrafts*

**Spec. ID:** cmip6.atmos.turbulence\_convection.deep\_convection.microphysics

**Is Required ?** FALSE

**Select value(s):**

- ☐ Tuning parameter based
- ☐ Single moment
- ☐ Two moment
- ☐ Other - please specify:

## 5.4 Shallow Convection

*Properties of the shallow convection scheme*

### 5.4.1 Scheme Name

*Shallow convection scheme name*

**Spec. ID:** cmip6.atmos.turbulence\_convection.shallow\_convection.scheme\_name

**Is Required ?** FALSE

**Enter TEXT value:**

### 5.4.2 Scheme Type

*Shallow convection scheme type*

**Spec. ID:** cmip6.atmos.turbulence\_convection.shallow\_convection.scheme\_type

**Is Required ?** TRUE

**Select value(s):**

- ☐ Mass-flux
- ☐ Cumulus-capped boundary layer
- ☐ Other - please specify:

### 5.4.3 Scheme Method

*Shallow convection scheme method*

**Spec. ID:** cmip6.atmos.turbulence\_convection.shallow\_convection.scheme\_method

**Is Required ?** TRUE

**Select value:**

- ☐ Same as deep (unified)
- ☐ Included in boundary layer turbulence
- ☐ Separate diagnosis - Deep and Shallow convection schemes use different thermodynamic closure criteria

### 5.4.4 Processes

*Physical processes taken into account in the parameterisation of shallow convection*

**Spec. ID:** cmip6.atmos.turbulence\_convection.shallow\_convection.processes

**Is Required ?** TRUE

**Select value(s):**

- ☐ Convective momentum transport
- ☐ Entrainment
- ☐ Detrainment
- ☐ Penetrative convection
- ☐ Re-evaporation of convective precipitation
- ☐ Other - please specify:

### 5.4.5 Microphysics

*Microphysics scheme for shallow convection*

**Spec. ID:** cmip6.atmos.turbulence\_convection.shallow\_convection.microphysics

**Is Required ?** FALSE

**Select value(s):**

- ☐ Tuning parameter based
- ☐ Single moment
- ☐ Two moment
- ☐ Other - please specify:

## 6 Microphysics Precipitation

*Large Scale Cloud Microphysics and Precipitation*

### 6.1 Microphysics Precipitation

*Large Scale Cloud Microphysics and Precipitation*

#### 6.1.1 Overview

*Overview description of large scale cloud microphysics and precipitation*

**Spec. ID:** cmip6.atmos.microphysics\_\_precipitation.overview

**Is Required ?** TRUE

**Enter TEXT value:**

### 6.2 Large Scale Precipitation

*Properties of the large scale precipitation scheme*

#### 6.2.1 Scheme Name

*Commonly used name of the large scale precipitation parameterisation scheme*

**Spec. ID:** cmip6.atmos.microphysics\_\_precipitation.large\_scale\_\_precipitation.scheme\_name

**Is Required ?** FALSE

**Enter TEXT value:**

#### 6.2.2 Hydrometeors

*Precipitating hydrometeors taken into account in the large scale precipitation scheme*

**Spec. ID:** cmip6.atmos.microphysics\_\_precipitation.large\_scale\_\_precipitation.hydrometeors

**Is Required ?** TRUE

**Select value(s):**

- ☐ Liquid rain
- ☐ Snow
- ☐ Hail
- ☐ Graupel
- ☐ Other - please specify:

### 6.3 Large Scale Cloud Microphysics

*Properties of the large scale cloud microphysics scheme*



### 6.3.1 Scheme Name

*Commonly used name of the microphysics parameterisation scheme used for large scale clouds.*

**Spec. ID:** cmip6.atmos.microphysics\_precipitation.large\_scale\_cloud\_microphysics.scheme\_name

**Is Required ?** FALSE

**Enter TEXT value:**

### 6.3.2 Processes

*Large scale cloud microphysics processes*

**Spec. ID:** cmip6.atmos.microphysics\_precipitation.large\_scale\_cloud\_microphysics.processes

**Is Required ?** TRUE

**Select value(s):**

- ☐ Mixed phase
- ☐ Cloud droplets
- ☐ Cloud ice
- ☐ Ice nucleation
- ☐ Water vapour deposition
- ☐ Effect of raindrops
- ☐ Effect of snow
- ☐ Effect of graupel
- ☐ Other - please specify:

## 7 Cloud Scheme

*Characteristics of the cloud scheme*

### 7.1 Cloud Scheme

*Characteristics of the cloud scheme*

#### 7.1.1 Overview

*Overview description of the atmosphere cloud scheme*

**Spec. ID:** cmip6.atmos.cloud\_scheme.overview

**Is Required ?** TRUE

**Enter TEXT value:**

#### 7.1.2 Name

*Commonly used name for the cloud scheme*

**Spec. ID:** cmip6.atmos.cloud\_scheme.name

**Is Required ?** FALSE

**Enter TEXT value:**

#### 7.1.3 Atmos Coupling

*Atmosphere components that are linked to the cloud scheme*

**Spec. ID:** cmip6.atmos.cloud\_scheme.atmos\_coupling

**Is Required ?** FALSE

**Select value(s):**

- ☐ Atmosphere\_radiation
- ☐ Atmosphere\_microphysics\_precipitation
- ☐ Atmosphere\_turbulence\_convection
- ☐ Atmosphere\_gravity\_waves
- ☐ Atmosphere\_solar
- ☐ Atmosphere\_volcano
- ☐ Atmosphere\_cloud\_simulator

#### 7.1.4 Uses Separate Treatment

*Different cloud schemes for the different types of clouds (convective, stratiform and boundary layer)*

**Spec. ID:** cmip6.atmos.cloud\_scheme.uses\_separate\_treatment

**Is Required ?** TRUE

**Select value:**

☐ True ☐ False

### 7.1.5 Processes

*Processes included in the cloud scheme*

**Spec. ID:** cmip6.atmos.cloud\_scheme.processes

**Is Required ?** TRUE

**Select value(s):**

☐ Entrainment  
☐ Detrainment  
☐ Bulk cloud  
☐ Other - please specify:

### 7.1.6 Prognostic Scheme

*Is the cloud scheme a prognostic scheme?*

**Spec. ID:** cmip6.atmos.cloud\_scheme.prognostic\_scheme

**Is Required ?** TRUE

**Select value:**

☐ True ☐ False

### 7.1.7 Diagnostic Scheme

*Is the cloud scheme a diagnostic scheme?*

**Spec. ID:** cmip6.atmos.cloud\_scheme.diagnostic\_scheme

**Is Required ?** TRUE

**Select value:**

☐ True ☐ False

### 7.1.8 Prognostic Variables

*List the prognostic variables used by the cloud scheme, if applicable.*

**Spec. ID:** cmip6.atmos.cloud\_scheme.prognostic\_variables

**Is Required ?** FALSE

**Select value(s):**

- ☐ Cloud amount
- ☐ Liquid
- ☐ Ice
- ☐ Rain
- ☐ Snow
- ☐ Other - please specify:

## 7.2 Optical Cloud Properties

*Optical cloud properties*

### 7.2.1 Cloud Overlap Method

*Method for taking into account overlapping of cloud layers*

**Spec. ID:** cmip6.atmos.cloud\_scheme.optical\_cloud\_properties.cloud\_overlap\_method

**Is Required ?** FALSE

**Select value:**

- ☐ Random
- ☐ Maximum
- ☐ Maximum-random - Combination of maximum and random overlap between clouds
- ☐ Exponential
- ☐ Other - please specify:

### 7.2.2 Cloud Inhomogeneity

*Method for taking into account cloud inhomogeneity*

**Spec. ID:** cmip6.atmos.cloud\_scheme.optical\_cloud\_properties.cloud\_inhomogeneity

**Is Required ?** FALSE

**Enter TEXT value:**

## 7.3 Sub Grid Scale Water Distribution

*Sub-grid scale water distribution*

### 7.3.1 Type

*Sub-grid scale water distribution type*

**Spec. ID:** cmip6.atmos.cloud\_scheme.sub\_grid\_scale\_water\_distribution.type

**Is Required ?** TRUE

Select value:

- ☐ Prognostic  
☐ Diagnostic

### 7.3.2 Function Name

*Sub-grid scale water distribution function name*

**Spec. ID:** cmip6.atmos.cloud\_scheme.sub\_grid\_scale\_water\_distribution.function\_name

**Is Required ?** TRUE

**Enter TEXT value:**

### 7.3.3 Function Order

*Sub-grid scale water distribution function type*

**Spec. ID:** cmip6.atmos.cloud\_scheme.sub\_grid\_scale\_water\_distribution.function\_order

**Is Required ?** TRUE

**Enter INTEGER value:**

### 7.3.4 Convection Coupling

*Sub-grid scale water distribution coupling with convection*

**Spec. ID:** cmip6.atmos.cloud\_scheme.sub\_grid\_scale\_water\_distribution.convection\_coupling

**Is Required ?** TRUE

Select value(s):

- ☐ Coupled with deep  
☐ Coupled with shallow  
☐ Not coupled with convection

## 7.4 Sub Grid Scale Ice Distribution

*Sub-grid scale ice distribution*

### 7.4.1 Type

*Sub-grid scale ice distribution type*

**Spec. ID:** cmip6.atmos.cloud\_scheme.sub\_grid\_scale\_ice\_distribution.type

**Is Required ?** TRUE

Select value:

- ☐ Prognostic

☐ Diagnostic

#### 7.4.2 Function Name

*Sub-grid scale ice distribution function name*

**Spec. ID:** cmip6.atmos.cloud\_scheme.sub\_grid\_scale\_ice\_distribution.function\_name

**Is Required ?** TRUE

**Enter TEXT value:**

#### 7.4.3 Function Order

*Sub-grid scale ice distribution function type*

**Spec. ID:** cmip6.atmos.cloud\_scheme.sub\_grid\_scale\_ice\_distribution.function\_order

**Is Required ?** TRUE

**Enter INTEGER value:**

#### 7.4.4 Convection Coupling

*Sub-grid scale ice distribution coupling with convection*

**Spec. ID:** cmip6.atmos.cloud\_scheme.sub\_grid\_scale\_ice\_distribution.convection\_coupling

**Is Required ?** TRUE

**Select value(s):**

- ☐ Coupled with deep
- ☐ Coupled with shallow
- ☐ Not coupled with convection

## 8 Observation Simulation

*Characteristics of observation simulation*

### 8.1 Observation Simulation

*Characteristics of observation simulation*

#### 8.1.1 Overview

*Overview description of observation simulator characteristics*

**Spec. ID:** cmip6.atmos.observation\_simulation.overview

**Is Required ?** TRUE

**Enter TEXT value:**

### 8.2 Isscp Attributes

*ISSCP Characteristics*

#### 8.2.1 Top Height Estimation Method

*Cloud simulator ISSCP top height estimation methodUo*

**Spec. ID:** cmip6.atmos.observation\_simulation.isscp\_attributes.top\_height\_estimation\_method

**Is Required ?** TRUE

**Select value(s):**

- ☐ No adjustment
- ☐ IR brightness
- ☐ Visible optical depth
- ☐ Other - please specify:

#### 8.2.2 Top Height Direction

*Cloud simulator ISSCP top height direction*

**Spec. ID:** cmip6.atmos.observation\_simulation.isscp\_attributes.top\_height\_direction

**Is Required ?** TRUE

**Select value:**

- ☐ Lowest altitude level
- ☐ Highest altitude level
- ☐ Other - please specify:

## 8.3 Cosp Attributes

*CFMIP Observational Simulator Package attributes*

### 8.3.1 Run Configuration

*Cloud simulator COSP run configuration*

**Spec. ID:** cmip6.atmos.observation\_simulation.cosp\_attributes.run\_configuration

**Is Required ?** TRUE

**Select value:**

- ☐ Inline
- ☐ Offline
- ☐ Other - please specify:

### 8.3.2 Number Of Grid Points

*Cloud simulator COSP number of grid points*

**Spec. ID:** cmip6.atmos.observation\_simulation.cosp\_attributes.number\_of\_grid\_points

**Is Required ?** TRUE

**Enter INTEGER value:**

### 8.3.3 Number Of Sub Columns

*Cloud simulator COSP number of sub-columns used to simulate sub-grid variability*

**Spec. ID:** cmip6.atmos.observation\_simulation.cosp\_attributes.number\_of\_sub\_columns

**Is Required ?** TRUE

**Enter INTEGER value:**

### 8.3.4 Number Of Levels

*Cloud simulator COSP number of levels*

**Spec. ID:** cmip6.atmos.observation\_simulation.cosp\_attributes.number\_of\_levels

**Is Required ?** TRUE

**Enter INTEGER value:**

## 8.4 Radar Inputs

*Characteristics of the cloud radar simulator*

### 8.4.1 Frequency

*Cloud simulator radar frequency (Hz)*

**Spec. ID:** cmip6.atmos.observation\_simulation.radar\_inputs.frequency



**Is Required ?** TRUE

**Enter FLOAT value:**

### 8.4.2 Type

*Cloud simulator radar type*

**Spec. ID:** cmip6.atmos.observation\_simulation.radar\_inputs.type

**Is Required ?** TRUE

**Select value:**

- ☐ Surface
- ☐ Space borne
- ☐ Other - please specify:

### 8.4.3 Gas Absorption

*Cloud simulator radar uses gas absorption*

**Spec. ID:** cmip6.atmos.observation\_simulation.radar\_inputs.gas\_absorption

**Is Required ?** TRUE

**Select value:**

- ☐ True ☐ False

### 8.4.4 Effective Radius

*Cloud simulator radar uses effective radius*

**Spec. ID:** cmip6.atmos.observation\_simulation.radar\_inputs.effective\_radius

**Is Required ?** TRUE

**Select value:**

- ☐ True ☐ False

## 8.5 Lidar Inputs

*Characteristics of the cloud lidar simulator*

### 8.5.1 Ice Types

*Cloud simulator lidar ice type*

**Spec. ID:** cmip6.atmos.observation\_simulation.lidar\_inputs.ice\_types

**Is Required ?** TRUE

**Select value:**

- ☐ Ice spheres
- ☐ Ice non-spherical
- ☐ Other - please specify:

### 8.5.2 Overlap

*Cloud simulator lidar overlap*

**Spec. ID:** cmip6.atmos.observation\_simulation.lidar\_inputs.overlap

**Is Required ?** TRUE

**Select value(s):**

- ☐ Max
- ☐ Random
- ☐ Other - please specify:

## 9 Gravity Waves

*Characteristics of the parameterised gravity waves in the atmosphere, whether from orography or other sources.*

### 9.1 Gravity Waves

*Characteristics of the parameterised gravity waves in the atmosphere, whether from orography or other sources.*

#### 9.1.1 Overview

*Overview description of gravity wave parameterisation in the atmosphere*

**Spec. ID:** cmip6.atmos.gravity\_waves.overview

**Is Required ?** TRUE

**Enter TEXT value:**

#### 9.1.2 Sponge Layer

*Sponge layer in the upper levels in order to avoid gravity wave reflection at the top.*

**Spec. ID:** cmip6.atmos.gravity\_waves.sponge\_layer

**Is Required ?** TRUE

**Select value:**

- ☐ Rayleigh friction
- ☐ Diffusive sponge layer
- ☐ Other - please specify:

#### 9.1.3 Background

*Background wave distribution*

**Spec. ID:** cmip6.atmos.gravity\_waves.background

**Is Required ?** TRUE

**Select value:**

- ☐ Continuous spectrum
- ☐ Discrete spectrum
- ☐ Other - please specify:

#### 9.1.4 Subgrid Scale Orography

*Subgrid scale orography effects taken into account.*

**Spec. ID:** cmip6.atmos.gravity\_waves.subgrid\_scale\_orography

**Is Required ?** TRUE

**Select value(s):**

- ☐ Effect on drag
- ☐ Effect on lifting
- ☐ Enhanced topography - To enhance the generation of long waves in the atmosphere
- ☐ Other - please specify:

## 9.2 Orographic Gravity Waves

*Gravity waves generated due to the presence of orography*

### 9.2.1 Name

*Commonly used name for the orographic gravity wave scheme*

**Spec. ID:** cmip6.atmos.gravity\_waves.orographic\_gravity\_waves.name

**Is Required ?** FALSE

**Enter TEXT value:**

### 9.2.2 Source Mechanisms

*Orographic gravity wave source mechanisms*

**Spec. ID:** cmip6.atmos.gravity\_waves.orographic\_gravity\_waves.source\_mechanisms

**Is Required ?** TRUE

**Select value(s):**

- ☐ Linear mountain waves
- ☐ Hydraulic jump
- ☐ Envelope orography
- ☐ Low level flow blocking
- ☐ Statistical sub-grid scale variance
- ☐ Other - please specify:

### 9.2.3 Calculation Method

*Orographic gravity wave calculation method*

**Spec. ID:** cmip6.atmos.gravity\_waves.oro-graphic\_gravity\_waves.calculation\_method

**Is Required ?** TRUE

**Select value(s):**

- ☐ Non-linear calculation
- ☐ More than two cardinal directions
- ☐ Other - please specify:

### 9.2.4 Propagation Scheme

*Orographic gravity wave propagation scheme*

**Spec. ID:** cmip6.atmos.gravity\_waves.oro-graphic\_gravity\_waves.propagation\_scheme

**Is Required ?** TRUE

**Select value:**

- ☐ Linear theory
- ☐ Non-linear theory
- ☐ Includes boundary layer ducting
- ☐ Other - please specify:

### 9.2.5 Dissipation Scheme

*Orographic gravity wave dissipation scheme*

**Spec. ID:** cmip6.atmos.gravity\_waves.oro-graphic\_gravity\_waves.dissipation\_scheme

**Is Required ?** TRUE

**Select value:**

- ☐ Total wave
- ☐ Single wave
- ☐ Spectral
- ☐ Linear
- ☐ Wave saturation vs Richardson number
- ☐ Other - please specify:

## 9.3 Non Orographic Gravity Waves

*Gravity waves generated by non-orographic processes.*

### 9.3.1 Name

*Commonly used name for the non-orographic gravity wave scheme*

**Spec. ID:** cmip6.atmos.gravity\_waves.non\_orographic\_gravity\_waves.name

**Is Required ?** FALSE

**Enter TEXT value:**

### 9.3.2 Source Mechanisms

*Non-orographic gravity wave source mechanisms*

**Spec. ID:** cmip6.atmos.gravity\_waves.non\_orographic\_gravity\_waves.source\_mechanisms

**Is Required ?** TRUE

**Select value(s):**

- ☐ Convection
- ☐ Precipitation
- ☐ Background spectrum
- ☐ Other - please specify:

### 9.3.3 Calculation Method

*Non-orographic gravity wave calculation method*

**Spec. ID:** cmip6.atmos.gravity\_waves.non\_orographic\_gravity\_waves.calculation\_method

**Is Required ?** TRUE

**Select value(s):**

- ☐ Spatially dependent
- ☐ Temporally dependent

### 9.3.4 Propagation Scheme

*Non-orographic gravity wave propagation scheme*

**Spec. ID:** cmip6.atmos.gravity\_waves.non\_orographic\_gravity\_waves.propagation\_scheme

**Is Required ?** TRUE

**Select value:**

- ☐ Linear theory
- ☐ Non-linear theory
- ☐ Other - please specify:

### 9.3.5 Dissipation Scheme

*Non-orographic gravity wave dissipation scheme*

**Spec. ID:** cmip6.atmos.gravity\_waves.non\_orographic\_gravity\_waves.dissipation\_scheme

**Is Required ?** TRUE

**Select value:**

- ☐ Total wave
- ☐ Single wave
- ☐ Spectral
- ☐ Linear
- ☐ Wave saturation vs Richardson number
- ☐ Other - please specify:

## 10 Solar

*Top of atmosphere solar insolation characteristics*

### 10.1 Solar

*Top of atmosphere solar insolation characteristics*

#### 10.1.1 Overview

*Overview description of solar insolation of the atmosphere*

**Spec. ID:** cmip6.atmos.solar.overview

**Is Required ?** TRUE

**Enter TEXT value:**

### 10.2 Solar Pathways

*Pathways for solar forcing of the atmosphere*

#### 10.2.1 Pathways

*Pathways for the solar forcing of the atmosphere model domain*

**Spec. ID:** cmip6.atmos.solar.solar\_pathways.pathways

**Is Required ?** TRUE

**Select value(s):**

- ☐ SW radiation - Shortwave solar spectral irradiance.
- ☐ Precipitating energetic particles - Precipitating energetic particles from the sun (predominantly protons) and the magnetosphere (predominantly electrons) affect the ionization levels in the polar middle and upper atmosphere, leading to significant changes of the chemical composition
- ☐ Cosmic rays - Cosmic rays are the main source of ionization in the troposphere and lower stratosphere.
- ☐ Other - please specify:

### 10.3 Solar Constant

*Solar constant and top of atmosphere insolation characteristics*

#### 10.3.1 Type

*Time adaptation of the solar constant.*

**Spec. ID:** cmip6.atmos.solar.solar\_constant.type

**Is Required ?** TRUE

**Select value:**



- ☐ Fixed
- ☐ Transient

### 10.3.2 Fixed Value

*If the solar constant is fixed, enter the value of the solar constant ( $W\ m^{-2}$ ).*

**Spec. ID:** cmip6.atmos.solar.solar\_constant.fixed\_value

**Is Required ?** FALSE

**Enter FLOAT value:**

### 10.3.3 Transient Characteristics

*Solar constant transient characteristics ( $W\ m^{-2}$ )*

**Spec. ID:** cmip6.atmos.solar.solar\_constant.transient\_characteristics

**Is Required ?** TRUE

**Enter TEXT value:**

## 10.4 Orbital Parameters

*Orbital parameters and top of atmosphere insolation characteristics*

### 10.4.1 Type

*Time adaptation of orbital parameters*

**Spec. ID:** cmip6.atmos.solar.orbital\_parameters.type

**Is Required ?** TRUE

**Select value:**

- ☐ Fixed
- ☐ Transient

### 10.4.2 Fixed Reference Date

*Reference date for fixed orbital parameters (yyyy)*

**Spec. ID:** cmip6.atmos.solar.orbital\_parameters.fixed\_reference\_date

**Is Required ?** TRUE

**Enter INTEGER value:**

### 10.4.3 Transient Method

*Description of transient orbital parameters*

**Spec. ID:** cmip6.atmos.solar.orbital\_parameters.transient\_method

**Is Required ?** TRUE

**Enter TEXT value:**

#### 10.4.4 Computation Method

*Method used for computing orbital parameters.*

**Spec. ID:** cmip6.atmos.solar.orbital\_parameters.computation\_method

**Is Required ?** TRUE

**Select value:**

- ☐ Berger 1978
- ☐ Laskar 2004
- ☐ Other - please specify:

### 10.5 Insolation Ozone

*Impact of solar insolation on stratospheric ozone*

#### 10.5.1 Solar Ozone Impact

*Does top of atmosphere insolation impact on stratospheric ozone???*

**Spec. ID:** cmip6.atmos.solar.insolation\_ozone.solar\_ozone\_impact

**Is Required ?** TRUE

**Select value:**

- ☐ True      ☐ False

## 11 Volcanos

*Characteristics of the implementation of volcanoes*

### 11.1 Volcanos

*Characteristics of the implementation of volcanoes*

#### 11.1.1 Overview

*Overview description of the implementation of volcanic effects in the atmosphere*

**Spec. ID:** cmip6.atmos.volcanos.overview

**Is Required ?** TRUE

**Enter TEXT value:**

### 11.2 Volcanoes Treatment

*Treatment of volcanoes in the atmosphere*

#### 11.2.1 Volcanoes Implementation

*How volcanic effects are modeled in the atmosphere.*

**Spec. ID:** cmip6.atmos.volcanos.volcanoes\_treatment.volcanoes\_implementation

**Is Required ?** TRUE

**Select value:**

- ☐ High frequency solar constant anomaly
- ☐ Stratospheric aerosols optical thickness
- ☐ Other - please specify: