CMIP6 Model Documentation

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Documentation Contents

1 Key Properties

Key properties of the model

1.1.1 Top level properties

Key properties of the model

1.1.1.1 Name *

Name of coupled model

MIROC6

1.1.1.2 Keywords *

Keywords associated with coupled model

CCSR-AGCM, SPRINTARS, COCO, MATSIRO, atmosphere, aerosol, sea-ice ocean, land surface

1.1.1.3 Overview *

Top level overview of coupled model

MIROC6 is a physical climate model mainly composed of three sub-models: atmosphere, land, and sea ice-ocean. The atmospheric model is based on the CCSR-NIES atmospheric general circulation model. The horizontal resolution is a T85 spectral truncation that is an approximately 1.4 grid interval for both latitude and longitude. The vertical grid coordinate is a hybrid -p coordinate. The model top is placed at 0.004 hPa, and there are 81 vertical levels. The Spectral Radiation-Transport Model for Aerosol Species (SPRINTARS) is used as an aerosol module for MIROC6 to predict the mass mixing ratios of the main tropospheric aerosols. By coupling the radiation and cloud-precipitation schemes, SPRINTARS calculates not only the aerosol transport processes but also the aerosol-radiation and aerosol-cloud interactions.The land surface model is based on Minimal Advanced Treatments of Surface Interaction and Runoff (MATSIRO), which includes a river routing model based on a kinematic wave flow equation and a lake module where one-dimensional thermal diffusion and mass conservation are considered. The horizontal resolution of the land surface model is the same as that of the atmopheric component. There are a three-layers snow and a six-layers soil down to a 14 m depth.The sea ice-ocean model is based on the CCSR Ocean Component model (COCO). The tripolar horizontal coordinate system is adopted, and the longitudinal grid spacing is 1 and the meridional grid spacing varies from about 0.5 near the equator to 1 in the mid-latitudes. There are 62 vertical levels in a hybrid -z coordinate system. A coupler system calculates heat and freshwater fluxes between the sub-models in order to ensure that all fluxes are conserved within machine precision and then exchanges the fluxes among the sub-models. No flux adjustments are used in MIROC6.

1.2.1 Flux Correction

Flux correction properties of the model

1.2.1.1 Details *

Describe if/how flux corrections are applied in the model

No flux corrections are applied in this model.

1.3.1 Genealogy

Genealogy and history of the model

1.3.1.1 Year Released *

Year the model was released

2018

1.3.1.2 CMIP3 Parent

CMIP3 parent if any

MIROC3m

1.3.1.3 CMIP5 Parent

CMIP5 parent if any

MIROC5

1.3.1.4 CMIP5 Differences

Briefly summarize the differences between this model and its CMIP5 parent, if applicable

Major changes from MIROC5, which was our official model for the CMIP5, to MIROC6 are mainly done in the atmospheric component. These include implementation of a parameterization of shallow convective processes, the higher model top and vertical resolution in the stratosphere. The ocean and land-surface components have been also updated in terms of the horizontal grid coordinate system and higher vertical resolution in the former, and parameterizations for sub-grid scale snow distribution and wet lands due to snow-melting water in the latter.

1.3.1.5 Previous Name

Previously known as

MIROC5

1.4.1 Software Properties

Software properties of model

1.4.1.1 Repository

Location of code for this component.

Shared repository on a server at Japan Agency for Marine-Earth Science and Technology

1.4.1.2 Code Version

Code version identifier.

Fe6402342aec

1.4.1.3 Code Languages

Code language(s).

Basically FORTRAN77 but partially FORTRAN90 and C

1.4.1.4 Components Structure

Describe how model realms are structured into independent software components (coupled via a coupler) and internal software components.

The atmoshperic component and the ocean component are executed separately with a multiprogram-multiple data application. Note that a executable binary of the land surface component is included that of the atmospheric component. These submodels are coupled with time interval of 1 hour.

1.4.1.5 Coupler

Overarching coupling framework for model.

- ☐ OASIS - The OASIS coupler - prior to OASIS-MCT
- ☐ OASIS3-MCT - The MCT variant of the OASIS coupler
- ☐ ESMF - Vanilla Earth System Modelling Framework
- ☐ NUOPC - National Unified Operational Prediction Capability variant of ESMF
- ☐ Bespoke - Customised coupler developed for this model
- ☐ Unknown - It is not known what/if-a coupler is used
- ☐ None - No coupler is used
- ☐ Other - please specify:

1.5.1 Coupling

1.5.1.1 Atmosphere Double Flux *

Is the atmosphere passing a double flux to the ocean and sea ice (as opposed to a single one)?

☒ True ☐ False

1.5.1.2 Atmosphere Fluxes Calculation Grid

Where are the air-sea fluxes calculated

- ☐ Atmosphere grid
- ☐ Ocean grid
- ☒ Specific coupler grid
- ☐ Other - please specify:

1.5.1.3 Atmosphere Relative Winds *

Are relative or absolute winds used to compute the flux? I.e. do ocean surface currents enter the wind stress calculation?

☒ True ☐ False

1.6.1 Tuning Applied

Tuning methodology for model

1.6.1.1 Description *

General overview description of tuning: explain and motivate the main targets and metrics/diagnostics retained. Document the relative weight given to climate performance metrics/diagnostics versus process oriented metrics/diagnostics, 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.

In the first model tuning step, climatology, seasonal progression, and internal climate variability in the tropical coupled system are tuned in order that departures from observations or reanalysis datasets are reduced. Specifically, parameters of reference height for cumulus precipitation, efficiency of the cumulus entrainment of surrounding environment and maximum cumulus updraft velocity at the cumulus base are used to tune strength of the equatorial trade wind, climatological position and intensity of the Inter-Tropical Convergence Zone and South Pacific Convergence Zone, and interannual variability of El-Nio/Southern Oscillation. Summertime precipitation in the western tropical Pacific and characteristic of tropical intraseasonal oscillations are tuned by using the parameter for shallow convection describing the partitioning of turbulent kinetic energy between horizontal and vertical motions at the sub-cloud layer inversion. Next, the wintertime mid-latitude westerly jets and the stationary waves in the troposphere are tuned using the parameters of the orographic gravity wave drag and the hyper diffusion of momentum. The parameters of the hyper diffusion and the non-orographic gravity wave drag are also used when tuning stratospheric circulations of the polar vortex and Quasi Biennial Oscilation. Finally, the radiation budget at the TOA is tuned, primarily using the parameters for the auto-conversion process so that excess downward radiation can be minimized and maintained closer to 0.0 Wm-2. In addition, parameter tuning for the total radiative forcing associated with aerosol-radiation and aerosol-cloud interactions is done. In order that the total radiative forcing can be closer to the estimate of -0.9 Wm-2 (IPCC, 2013; negative value indicates cooling), parameters of cloud microphysics and the aerosol transport module, such as timescale for cloud droplet nucleation, in-cloud properties of aerosol removal by precipitation, and minimum threshold of number concentration of cloud droplets, are perturbed. To determine a suitable parameter set, several pairs of a present-day run under the anthropogenic aerosol emissions at the year 2000 and a pre-industrial run are conducted. A pair of the present and preindustrial runs has exactly the same parameters, and differences of tropospheric radiations between two runs are considered as anthropogenic radiative forcing.

1.6.1.2 Global Mean Metrics Used

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

TOA radiation budget, radiative forcing, sea ice area

1.6.1.3 Regional Metrics Used

List of regional metrics/diagnostics of mean state (e.g THC, AABW, regional means etc) used in tuning model/component

Tropical precipiation, mid-latitude jets, ENSO amplitude, THC

1.6.1.4 Trend Metrics Used

List observed trend metrics/diagnostics used in tuning model/component (such as 20th century)

HadCRU

1.6.1.5 Energy Balance *

Describe how energy balance was obtained in the full system: in the various components independently or at the components coupling stage?

The radiation budget at the TOA is tuned at the components coupling state.

1.6.1.6 Fresh Water Balance *

Describe how fresh_water balance was obtained in the full system: in the various components independently or at the components coupling stage?

Any tuninigs were done for fresh water balance.

1.6.2 Heat

Global heat convervation properties of the model

1.6.2.1 Global *

Describe if/how heat is conserved globally

Atmospheric heat is not conserved perffectly. The heat energy inconsistency is due to that internal energy associated with precipitation, water vapor and river runoff is not taken account in the atmospheric and land surface component in MIROC6.

1.6.2.2 Atmos Ocean Interface

Describe if/how heat is conserved at the atmosphere/ocean coupling interface

Heat flux is conserved during coupling procedures.

1.6.2.3 Atmos Land Interface *

Describe if/how heat is conserved at the atmosphere/land coupling interface

Heat flux is conserved during coupling procedures.

1.6.2.4 Atmos Sea-ice Interface

Describe if/how heat is conserved at the atmosphere/sea-ice coupling interface

Heat flux is conserved during coupling procedures.

1.6.2.5 Ocean Seaice Interface

Describe if/how heat is conserved at the ocean/sea-ice coupling interface

Heat is conserved during coupling procedures.

1.6.2.6 Land Ocean Interface

Describe if/how heat is conserved at the land/ocean coupling interface

Temperature of river water is not considered thus there is no heat exchange between the land and the ocean.

1.6.3 Fresh Water

Global fresh water convervation properties of the model

1.6.3.1 Global *

Describe if/how fresh_water is conserved globally

Freshwater and salt are conserved.

1.6.3.2 Atmos Ocean Interface

Describe if/how fresh_water is conserved at the atmosphere/ocean coupling interface

Freshwater flux is conserved during coupling procedures.

1.6.3.3 Atmos Land Interface *

Describe if/how fresh water is conserved at the atmosphere/land coupling interface

Freshwater flux is conserved during coupling procedures.

1.6.3.4 Atmos Sea-ice Interface

Describe if/how fresh water is conserved at the atmosphere/sea-ice coupling interface

Freshwater flux is conserved during coupling procedures.

1.6.3.5 Ocean Seaice Interface

Describe if/how fresh water is conserved at the ocean/sea-ice coupling interface

Freshwater flux is conserved during coupling procedures.

1.6.3.6 Runoff

Describe how runoff is distributed and conserved

Enter TEXT:

1.6.3.7 Iceberg Calving

Describe if/how iceberg calving is modeled and conserved

NA

1.6.3.8 Endoreic Basins

Describe if/how endoreic basins (no ocean access) are treated

Enter TEXT:

1.6.3.9 Snow Accumulation

Describe how snow accumulation over land and over sea-ice is treated

Enter TEXT:

1.6.4 Salt

Global salt convervation properties of the model

1.6.4.1 Ocean Seaice Interface

Describe if/how salt is conserved at the ocean/sea-ice coupling interface

Salt is conserved during coupling procedures.

1.6.5 Momentum

Global momentum convervation properties of the model

1.6.5.1 Details

Describe if/how momentum is conserved in the model

Enter TEXT:

2 Radiative Forcings

Radiative forcings of the model for historical and scenario (aka Table 12.1 IPCC AR5)

2.1.1 Top level properties

Radiative forcings of the model for historical and scenario (aka Table 12.1 IPCC AR5)

2.1.1.1 Name

Commonly used name for the radiative forcings in toplevel model.

MSTRNX

2.1.1.2 Overview

Overview of radiative forcings of the model for historical and scenario (aka table 12.1 ipcc ar5) in toplevel model.

Greenhouse gases: CO2, CH4, N2O, Trop O3, Strat O3 Aerosols: SO4, BC, OC, dust, volcanic, sea salt, land use, solar Cloud albedo efffect : YES Cloud lifetime effect: YES

2.1.2 CO2

Carbon dioxide forcing

2.1.2.1 Provision *

How this forcing agent is provided (e.g. via concentrations, emission precursors, prognostically derived, etc.)

☐ N/A - Not applicable - forcing agent is not included

☐ M - Emissions and concentrations determined by the model state rather than externally prescribed

☐ Y - Prescribed concentrations, distributions or time series data

☐ E - Concentrations calculated interactively driven by prescribed emissions or precursor emissions

☐ ES - Surface emissions (and 3-D concentrations away from the surface) derived via the model from the prescribed surface concentration

☐ C - Fixed prescribed climatology of concentrations with no year-to-year variability

☐ Other - please specify:

2.1.2.2 Additional Information

Additional information relating to the provision and implementation of this forcing agent (e.g. citations, use of non-standard datasets, explaining how multiple provisions are used, etc.).

Enter TEXT:

2.1.3 CH4

Methane forcing

2.1.3.1 Provision *

How this forcing agent is provided (e.g. via concentrations, emission precursors, prognostically derived, etc.)

☐ N/A - Not applicable - forcing agent is not included

☐ M - Emissions and concentrations determined by the model state rather than externally prescribed

☐ Y - Prescribed concentrations, distributions or time series data

☐ E - Concentrations calculated interactively driven by prescribed emissions or precursor emissions

☐ ES - Surface emissions (and 3-D concentrations away from the surface) derived via the model from the prescribed surface concentration

☐ C - Fixed prescribed climatology of concentrations with no year-to-year variability

☐ Other - please specify:

2.1.3.2 Additional Information

Additional information relating to the provision and implementation of this forcing agent (e.g. citations, use of non-standard datasets, explaining how multiple provisions are used, etc.).

Enter TEXT:

2.1.4 N2O

Nitrous oxide forcing

2.1.4.1 Provision *

How this forcing agent is provided (e.g. via concentrations, emission precursors, prognostically derived, etc.)

☐ N/A - Not applicable - forcing agent is not included

☐ M - Emissions and concentrations determined by the model state rather than externally prescribed

☐ Y - Prescribed concentrations, distributions or time series data

☐ E - Concentrations calculated interactively driven by prescribed emissions or precursor emissions

☐ ES - Surface emissions (and 3-D concentrations away from the surface) derived via the model from the prescribed surface concentration

☐ C - Fixed prescribed climatology of concentrations with no year-to-year variability

☐ Other - please specify:

2.1.4.2 Additional Information

Additional information relating to the provision and implementation of this forcing agent (e.g. citations, use of non-standard datasets, explaining how multiple provisions are used, etc.).

Enter TEXT:

2.1.5 Tropospheric O3

Troposheric ozone forcing

2.1.5.1 Provision *

How this forcing agent is provided (e.g. via concentrations, emission precursors, prognostically derived, etc.)

☐ N/A - Not applicable - forcing agent is not included

☐ M - Emissions and concentrations determined by the model state rather than externally prescribed

☐ Y - Prescribed concentrations, distributions or time series data

☐ E - Concentrations calculated interactively driven by prescribed emissions or precursor emissions

☐ ES - Surface emissions (and 3-D concentrations away from the surface) derived via the model from the prescribed surface concentration

☐ C - Fixed prescribed climatology of concentrations with no year-to-year variability

☐ Other - please specify:

2.1.5.2 Additional Information

Additional information relating to the provision and implementation of this forcing agent (e.g. citations, use of non-standard datasets, explaining how multiple provisions are used, etc.).

Enter TEXT:

2.1.6 Stratospheric O3

Stratospheric ozone forcing

2.1.6.1 Provision *

How this forcing agent is provided (e.g. via concentrations, emission precursors, prognostically derived, etc.)

☐ N/A - Not applicable - forcing agent is not included

☐ M - Emissions and concentrations determined by the model state rather than externally prescribed

☐ Y - Prescribed concentrations, distributions or time series data

☐ E - Concentrations calculated interactively driven by prescribed emissions or precursor emissions

☐ ES - Surface emissions (and 3-D concentrations away from the surface) derived via the model from the prescribed surface concentration

☐ C - Fixed prescribed climatology of concentrations with no year-to-year variability

☐ Other - please specify:

2.1.6.2 Additional Information

Additional information relating to the provision and implementation of this forcing agent (e.g. citations, use of non-standard datasets, explaining how multiple provisions are used, etc.).

Enter TEXT:

2.1.7 CFC

Ozone-depleting and non-ozone-depleting fluorinated gases forcing

2.1.7.1 Provision *

How this forcing agent is provided (e.g. via concentrations, emission precursors, prognostically derived, etc.)

☐ N/A - Not applicable - forcing agent is not included

☐ M - Emissions and concentrations determined by the model state rather than externally prescribed

☐ Y - Prescribed concentrations, distributions or time series data

☐ E - Concentrations calculated interactively driven by prescribed emissions or precursor emissions

☐ ES - Surface emissions (and 3-D concentrations away from the surface) derived via the model from the prescribed surface concentration

☐ C - Fixed prescribed climatology of concentrations with no year-to-year variability

☐ Other - please specify:

2.1.7.2 Equivalence Concentration *

Details of any equivalence concentrations used

☐ N/A - Not applicabale (CFCs not included or emissions and concentrations determined by the model state)

☐ Option 1 - CFCs, including CFC-12, are provided as actual concentrations

☐ Option 2 - CFC-12 is provided as actual concentrations and any other gases are provided as an equivalence concentration of CFC-11

☐ Option 3 - Ozone depleting gases, including CFC-12, are provided as an equivalence concentration of CFC-12 and all other fluorinated gases are provided as an equivalence concentration of HFC-134a

☐ Other - please specify:

2.1.7.3 Additional Information

Additional information relating to the provision and implementation of this forcing agent (e.g. citations, use of non-standard datasets, explaining how multiple provisions are used, etc.).

Enter TEXT:

2.1.8 SO4

SO4 aerosol forcing

2.1.8.1 Provision *

How this forcing agent is provided (e.g. via concentrations, emission precursors, prognostically derived, etc.)

☐ N/A - Not applicable - forcing agent is not included

☐ M - Emissions and concentrations determined by the model state rather than externally prescribed

☐ Y - Prescribed concentrations, distributions or time series data

☐ E - Concentrations calculated interactively driven by prescribed emissions or precursor emissions

☐ ES - Surface emissions (and 3-D concentrations away from the surface) derived via the model from the prescribed surface concentration

☐ C - Fixed prescribed climatology of concentrations with no year-to-year variability

☐ Other - please specify:

2.1.8.2 Additional Information

Additional information relating to the provision and implementation of this forcing agent (e.g. citations, use of non-standard datasets, explaining how multiple provisions are used, etc.).

DMS emission is diagnosed, and SO2 emission derived from biomass burning is prescribed.

2.1.9 Black Carbon

Black carbon aerosol forcing

2.1.9.1 Provision *

How this forcing agent is provided (e.g. via concentrations, emission precursors, prognostically derived, etc.)

☐ N/A - Not applicable - forcing agent is not included

☐ M - Emissions and concentrations determined by the model state rather than externally prescribed

☐ Y - Prescribed concentrations, distributions or time series data

☐ E - Concentrations calculated interactively driven by prescribed emissions or precursor emissions

☐ ES - Surface emissions (and 3-D concentrations away from the surface) derived via the model from the prescribed surface concentration

☐ C - Fixed prescribed climatology of concentrations with no year-to-year variability

☐ Other - please specify:

2.1.9.2 Additional Information

Additional information relating to the provision and implementation of this forcing agent (e.g. citations, use of non-standard datasets, explaining how multiple provisions are used, etc.).

Enter TEXT:

2.1.10 Organic Carbon

Organic carbon aerosol forcing

2.1.10.1 Provision *

How this forcing agent is provided (e.g. via concentrations, emission precursors, prognostically derived, etc.)

☐ N/A - Not applicable - forcing agent is not included

☐ M - Emissions and concentrations determined by the model state rather than externally prescribed

☐ Y - Prescribed concentrations, distributions or time series data

☐ E - Concentrations calculated interactively driven by prescribed emissions or precursor emissions

☐ ES - Surface emissions (and 3-D concentrations away from the surface) derived via the model from the prescribed surface concentration

☐ C - Fixed prescribed climatology of concentrations with no year-to-year variability

☐ Other - please specify:

2.1.10.2 Additional Information

Additional information relating to the provision and implementation of this forcing agent (e.g. citations, use of non-standard datasets, explaining how multiple provisions are used, etc.).

Enter TEXT:

2.1.11 Nitrate

Nitrate forcing

2.1.11.1 Provision *

How this forcing agent is provided (e.g. via concentrations, emission precursors, prognostically derived, etc.)

☐ N/A - Not applicable - forcing agent is not included

☐ M - Emissions and concentrations determined by the model state rather than externally prescribed

☐ Y - Prescribed concentrations, distributions or time series data

☐ E - Concentrations calculated interactively driven by prescribed emissions or precursor emissions

☐ ES - Surface emissions (and 3-D concentrations away from the surface) derived via the model from the prescribed surface concentration

☐ C - Fixed prescribed climatology of concentrations with no year-to-year variability

☐ Other - please specify:

2.1.11.2 Additional Information

Additional information relating to the provision and implementation of this forcing agent (e.g. citations, use of non-standard datasets, explaining how multiple provisions are used, etc.).

Enter TEXT:

2.1.12 Cloud Albedo Effect

Cloud albedo effect forcing (RFaci)

2.1.12.1 Provision *

How this forcing agent is provided (e.g. via concentrations, emission precursors, prognostically derived, etc.)

☐ N/A - Not applicable - forcing agent is not included

☐ M - Emissions and concentrations determined by the model state rather than externally prescribed

☐ Y - Prescribed concentrations, distributions or time series data

☐ E - Concentrations calculated interactively driven by prescribed emissions or precursor emissions

☐ ES - Surface emissions (and 3-D concentrations away from the surface) derived via the model from the prescribed surface concentration

☐ C - Fixed prescribed climatology of concentrations with no year-to-year variability

☐ Other - please specify:

2.1.12.2 Aerosol Effect On Ice Clouds *

Radiative effects of aerosols on ice clouds are represented?

☒ True ☐ False

2.1.12.3 Additional Information

Additional information relating to the provision and implementation of this forcing agent (e.g. citations, use of non-standard datasets, explaining how multiple provisions are used, etc.).

Enter TEXT:

2.1.13 Cloud Lifetime Effect

Cloud lifetime effect forcing (ERFaci)

2.1.13.1 Provision *

How this forcing agent is provided (e.g. via concentrations, emission precursors, prognostically derived, etc.)

☐ N/A - Not applicable - forcing agent is not included

☐ M - Emissions and concentrations determined by the model state rather than externally prescribed

☐ Y - Prescribed concentrations, distributions or time series data

☐ E - Concentrations calculated interactively driven by prescribed emissions or precursor emissions

☐ ES - Surface emissions (and 3-D concentrations away from the surface) derived via the model from the prescribed surface concentration

☐ C - Fixed prescribed climatology of concentrations with no year-to-year variability

☐ Other - please specify:

2.1.13.2 Aerosol Effect On Ice Clouds *

Radiative effects of aerosols on ice clouds are represented?

☒ True ☐ False

2.1.13.3 RFaci From Sulfate Only *

Radiative forcing from aerosol cloud interactions from sulfate aerosol only?

☐ True ☒ False

2.1.13.4 Additional Information

Additional information relating to the provision and implementation of this forcing agent (e.g. citations, use of non-standard datasets, explaining how multiple provisions are used, etc.).

Enter TEXT:

2.1.14 Dust

Dust forcing

2.1.14.1 Provision *

How this forcing agent is provided (e.g. via concentrations, emission precursors, prognostically derived, etc.)

☐ N/A - Not applicable - forcing agent is not included

☐ M - Emissions and concentrations determined by the model state rather than externally prescribed

☐ Y - Prescribed concentrations, distributions or time series data

☐ E - Concentrations calculated interactively driven by prescribed emissions or precursor emissions

☐ ES - Surface emissions (and 3-D concentrations away from the surface) derived via the model from the prescribed surface concentration

☐ C - Fixed prescribed climatology of concentrations with no year-to-year variability

☐ Other - please specify:

2.1.14.2 Additional Information

Additional information relating to the provision and implementation of this forcing agent (e.g. citations, use of non-standard datasets, explaining how multiple provisions are used, etc.).

Enter TEXT:

2.1.15 Tropospheric Volcanic

Tropospheric volcanic forcing

2.1.15.1 Provision *

How this forcing agent is provided (e.g. via concentrations, emission precursors, prognostically derived, etc.)

☐ N/A - Not applicable - forcing agent is not included

☐ M - Emissions and concentrations determined by the model state rather than externally prescribed

☐ Y - Prescribed concentrations, distributions or time series data

☐ E - Concentrations calculated interactively driven by prescribed emissions or precursor emissions

☐ ES - Surface emissions (and 3-D concentrations away from the surface) derived via the model from the prescribed surface concentration

☐ C - Fixed prescribed climatology of concentrations with no year-to-year variability

☐ Other - please specify:

2.1.15.2 Historical Explosive Volcanic Aerosol Implementation *

How explosive volcanic aerosol is implemented in historical simulations

Select SINGLE option:

☐ Type A - Explosive volcanic aerosol returns rapidly to zero (or near-zero) background.

☐ Type B - Explosive volcanic aerosol returns rapidly to constant (average volcano)

☐ Type C - Explosive volcanic aerosol returns slowly (over several decades) to constant (average volcano) background.

☐ Type D - Explosive volcanic aerosol set to zero

☐ Type E - Explosive volcanic aerosol set to constant (average volcano) background

☐ Other - please specify:

2.1.15.3 Future Explosive Volcanic Aerosol Implementation *

How explosive volcanic aerosol is implemented in future simulations

Select SINGLE option:

☐ Type A - Explosive volcanic aerosol returns rapidly to zero (or near-zero) background.

☐ Type B - Explosive volcanic aerosol returns rapidly to constant (average volcano)

☐ Type C - Explosive volcanic aerosol returns slowly (over several decades) to constant (average volcano) background.

☐ Type D - Explosive volcanic aerosol set to zero

☐ Type E - Explosive volcanic aerosol set to constant (average volcano) background

☐ Other - please specify:

2.1.15.4 Additional Information

Additional information relating to the provision and implementation of this forcing agent (e.g. citations, use of non-standard datasets, explaining how multiple provisions are used, etc.).

Enter TEXT:

2.1.16 Stratospheric Volcanic

Stratospheric volcanic forcing

2.1.16.1 Provision *

How this forcing agent is provided (e.g. via concentrations, emission precursors, prognostically derived, etc.)

Select MULTIPLE options:

☐ N/A - Not applicable - forcing agent is not included

☐ M - Emissions and concentrations determined by the model state rather than externally prescribed

☐ Y - Prescribed concentrations, distributions or time series data

☐ E - Concentrations calculated interactively driven by prescribed emissions or precursor emissions

☐ ES - Surface emissions (and 3-D concentrations away from the surface) derived via the model from the prescribed surface concentration

☐ C - Fixed prescribed climatology of concentrations with no year-to-year variability

☐ Other - please specify:

2.1.16.2 Historical Explosive Volcanic Aerosol Implementation *

How explosive volcanic aerosol is implemented in historical simulations

Select SINGLE option:

☐ Type A - Explosive volcanic aerosol returns rapidly to zero (or near-zero) background.

☐ Type B - Explosive volcanic aerosol returns rapidly to constant (average volcano)

☐ Type C - Explosive volcanic aerosol returns slowly (over several decades) to constant (average volcano) background.

☐ Type D - Explosive volcanic aerosol set to zero

☐ Type E - Explosive volcanic aerosol set to constant (average volcano) background

☐ Other - please specify:

2.1.16.3 Future Explosive Volcanic Aerosol Implementation *

How explosive volcanic aerosol is implemented in future simulations

Select SINGLE option:

☐ Type A - Explosive volcanic aerosol returns rapidly to zero (or near-zero) background.

☐ Type B - Explosive volcanic aerosol returns rapidly to constant (average volcano)

☐ Type C - Explosive volcanic aerosol returns slowly (over several decades) to constant (average volcano) background.

☐ Type D - Explosive volcanic aerosol set to zero

☐ Type E - Explosive volcanic aerosol set to constant (average volcano) background

☐ Other - please specify:

2.1.16.4 Additional Information

Additional information relating to the provision and implementation of this forcing agent (e.g. citations, use of non-standard datasets, explaining how multiple provisions are used, etc.).

Enter TEXT:

2.1.17 Sea Salt

Sea salt forcing

2.1.17.1 Provision *

How this forcing agent is provided (e.g. via concentrations, emission precursors, prognostically derived, etc.)

Select MULTIPLE options:

☐ N/A - Not applicable - forcing agent is not included

☐ M - Emissions and concentrations determined by the model state rather than externally prescribed

☐ Y - Prescribed concentrations, distributions or time series data

☐ E - Concentrations calculated interactively driven by prescribed emissions or precursor emissions

☐ ES - Surface emissions (and 3-D concentrations away from the surface) derived via the model from the prescribed surface concentration

☐ C - Fixed prescribed climatology of concentrations with no year-to-year variability

☐ Other - please specify:

2.1.17.2 Additional Information

Additional information relating to the provision and implementation of this forcing agent (e.g. citations, use of non-standard datasets, explaining how multiple provisions are used, etc.).

Enter TEXT:

2.1.18 Land Use

Land use forcing

2.1.18.1 Provision *

How this forcing agent is provided (e.g. via concentrations, emission precursors, prognostically derived, etc.)

Select MULTIPLE options:

- [ ] N/A - Not applicable - forcing agent is not included
- [ ] M - Emissions and concentrations determined by the model state rather than externally prescribed
- [ ] Y - Prescribed concentrations, distributions or time series data
- [ ] E - Concentrations calculated interactively driven by prescribed emissions or precursor emissions
- [ ] ES - Surface emissions (and 3-D concentrations away from the surface) derived via the model from the prescribed surface concentration
- [ ] C - Fixed prescribed climatology of concentrations with no year-to-year variability
- [ ] Other - please specify:

2.1.18.2 Crop Change Only *

Land use change represented via crop change only?

Select either TRUE or FALSE:

- [ ] True
- [ ] False

2.1.18.3 Additional Information

Additional information relating to the provision and implementation of this forcing agent (e.g. citations, use of non-standard datasets, explaining how multiple provisions are used, etc.).

Enter TEXT:

2.1.19 Solar

Solar forcing

2.1.19.1 Provision *

How solar forcing is provided

Select MULTIPLE options:

- [ ] N/A - Not applicable - solar forcing is not included
- [ ] Irradiance - Solar irradiance forcing
- [ ] Proton - Proton pathway to solar forcing
- [ ] Electron - Electron pathway to solar forcing
- [ ] Cosmic ray - Cosmic ray pathway to solar forcing
- [ ] Other - please specify:

2.1.19.2 Additional Information

Additional information relating to the provision and implementation of this forcing agent (e.g. citations, use of non-standard datasets, explaining how multiple provisions are used, etc.).

Enter TEXT: