CMIP6 Model Documentation

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Documentation Contents

1 Key Properties

Land surface key properties

1.1.1 Top level properties

Land surface key properties

1.1.1.1 Name *

Name of land model code

VISIT-e (Biogeochemistry) and MATSIRO6 (Physics and biophysics)

1.1.1.2 Keywords *

Keywords associated with land model code

Biogeochemistry, carbon cycle, nitrogen cycle, dry-matter-reproduction, Monsi-Saeki model, land-use change, land surface model, big leaf model, multi-layer snow scheme, TOPMODEL-based approach

1.1.1.3 Overview *

Overview of land model.

The model for land ecosystem/biogeochemistry component introduced into MIROC-ES2L is the Vegetation Integrative SImulator for Trace gases model extended for ESM (VISIT-e). This model simulates carbon and nitrogen dynamics on land interactively, with exchanging variables between the land physics and atmosphere component. LUC impact on biogeochemistry is simulated in this component, based on schemes that are newly designed for CMIP6 exercises. Minimal Advanced Treatments of Surface Interaction and Runoff (MATSIRO6) is a land model that consists of six soil layers, up to three snow layers, and a single canopy layer, and predicts the temperature and amount of water in the canopy, soil and snow. It is basically the same as the previous version of MATSIRO, but a physically-based parameterization of sub-grid snow distribution and a snow-derived wetland with consideration of sub-grid terrain complexity are incorporated.

1.1.1.4 Description *

General description of the processes modelled (e.g. dymanic vegation, prognostic albedo, etc.)

Land biogeochemistry: carbon cycle, nitrogen cycle, land-use change impact on biogeochemistry, agricultural treatment (harvesting, fertilizer, grazing pressure), N leaching into river-ocean, dynamics of leaf area index, geographically static vegetation distribution. Land physics and biophysics: surface energy balance, radiative transfer in canopy, stomatal resistance, canopy interception, snow hydrology, prognostic snow albedo, runoff generation, soil hydrology and soil temperature.

1.1.1.5 Land Atmosphere Flux Exchanges

Fluxes exchanged with the atmopshere.

- ☒ Water
- ☒ Energy
- ☒ Carbon
- ☒ Nitrogen

☐ Phospherous

☐ Other - please specify:

1.1.1.6 Atmospheric Coupling Treatment *

Describe the treatment of land surface coupling with the Atmosphere model component, which may be different for different quantities (e.g. dust: semi-implicit, water vapour: explicit)

Implicit

1.1.1.7 Land Cover *

Types of land cover defined in the land surface model

☒ Bare soil

☐ Urban

☒ Lake

☒ Land ice

☐ Lake ice

☒ Vegetated

☐ Other - please specify:

1.1.1.8 Land Cover Change

Describe how land cover change is managed (e.g. the use of net or gross transitions)

For biogeochemistry, gross transition between 5 LUC categories (see below) is considered; for physics, net transition between potential vegetation cover and cropland is considered.

1.1.1.9 Tiling *

Describe the general tiling procedure used in the land surface (if any). Include treatment of physiography, land/sea, (dynamic) vegetation coverage and orography/roughness

For biogeochemistry, grids are sub-divided into 5 types of tiles: primary vegetation, secondary vegetation, urban, crop, and pasture. Crop and pasture tiles furtherly have sub-categories (normal/N-fixing crop, and pasture/rangeland, respectively). For physics, each land grid has three tiles: potential vegetation, cropland, and lake. The potential vegetation and cropland tiles are divided into two areas with and without snow cover. The lake is also divided into ice-covered and open water areas. The land surface fluxes are calculated in each area and averaged, weighted by their fractions. The land/sea fraction is considered.

1.2.1 Conservation Properties

Convservation

1.2.1.1 Energy

Describe if/how energy is conserved globally and to what level (e.g. within X [units]/year)

Energy is conserved globally at land surface.

1.2.1.2 Water

Describe if/how water is conserved globally and to what level (e.g. within X [units]/year)

Water is conserved globally except for land ice grids.

1.2.1.3 Carbon

Describe if/how carbon is conserved globally and to what level (e.g. within X [units]/year)

Carbon is conserved globally except for land ice grids.

1.3.1 Timestepping Framework

Timestepping

1.3.1.1 Timestep Dependent On Atmosphere *

Is a time step dependent on the frequency of atmosphere coupling?

☒ True ☐ False

1.3.1.2 Time Step *

Overall timestep of land surface model (i.e. time between calls)

1

1.3.1.3 Timestepping Method *

General description of time stepping method and associated time step(s)

Variable atmosphere time step and 3600 seconds, and 1 day are used for flux calculation, land physics integration, and land biogeochemistry, respectively

1.4.1 Software Properties

Software properties of land surface code

1.4.1.1 Repository

Location of code for this component.

Enter TEXT:

1.4.1.2 Code Version

Code version identifier.

Abe2fa1221de

1.4.1.3 Code Languages

Code language(s).

C and FORTRAN

1.5.1 Tuning Applied

Tuning methodology for land component

1.5.1.1 Description *

General overview description of tuning (if any): explain and motivate the main targets and metrics retained. andDocument the relative weight given to climate performance metrics versus process oriented metrics, andand on the possible conflicts with parameterization level tuning. In particular describe any struggle andwith a parameter value that required pushing it to its limits to solve a particular model deficiency.

Enter TEXT:

2 Grid

Land surface grid

2.1.1 Top level properties

Land surface grid

2.1.1.1 Name

Name of grid in land model.

Enter TEXT:

2.1.1.2 Overview

Overview of grid in land model.

Atmosphere horizontal grid is used for the land models.

2.2.1 Horizontal

The horizontal grid in the land surface

2.2.1.1 Description *

Describe the general structure of the horizontal grid (not including any tiling)

Atmosphere horizontal grid is used.

2.2.1.2 Matches Atmosphere Grid *

Does the horizontal grid match the atmosphere?

☒ True ☐ False

2.3.1 Vertical

The vertical grid in the soil

2.3.1.1 Description *

Describe the general structure of the vertical grid in the soil (not including any tiling)

Soil has six layers with a thickness of 0.05, 0.2, 0.75, 1, 2, and 10 m for water and energy transfer.

2.3.1.2 Total Depth *

The total depth of the soil (in metres)

Enter INTEGER value:

3 Soil

Land surface soil

3.1.1 Top level properties

Land surface soil

3.1.1.1 Name

Commonly used name for the soil in land model.

Enter TEXT:

3.1.1.2 Overview

Overview of land surface soil in land model.

The soil parameterization includes soil hydrology, soil temperature prediction, and TOPMODEL-based runoff parameterization with six soil layers. The soil parameters depend on soil texture from ISLSCP I. For biogeochemistry, soil is structured as upper (0-10cm) and lower (10-200cm).

3.1.1.3 Heat Water Coupling *

Describe the coupling between heat and water in the soil

Heat and water is coupled through soil freeze and thaw processes.

3.1.1.4 Number Of Soil layers *

The number of soil layers

6

3.1.1.5 Prognostic Variables *

List the prognostic variables of the soil scheme

Soil temperature, Soil moisture, Soil ice content, litter and soil carbon, litter, humus, microbe, and inorganic nitrogen

3.2.1 Soil Map

Key properties of the land surface soil map

3.2.1.1 Description *

General description of soil map

The soil texture map based on ISLSCP Initiative I is used. For biogeochemistry, field capacity and bulkdensity refer to IGBP soil data, and HWSD is used for soil texture.

3.2.1.2 Structure

Describe the soil structure map

ISLSCP Initiative I (FAO, GISS, U. Arizona, NASA/GSFC); Global Gridded Surfaces of Selected Soil Characteristics (IGBP-DIS)

3.2.1.3 Texture

Describe the soil texture map

ISLSCP Initiative I (FAO, GISS, U. Arizona, NASA/GSFC); Wieder, W.R., J. Boehnert, G.B. Bonan, and M. Langseth. 2014. Regridded Harmonized World Soil Database v1.2. Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, USA. http://dx.doi.org/10.3334/ORNLDAAC/1247

3.2.1.4 Organic Matter

Describe the soil organic matter map

N/A

3.2.1.5 Albedo

Describe the soil albedo map

ISLSCP Initiative I (ERBE)

3.2.1.6 Water Table

Describe the soil water table map, if any

N/A. Water table is diagnosed in the model.

3.2.1.7 Continuously Varying Soil Depth *

Does the soil properties vary continuously with depth?

☐ True ☒ False

3.2.1.8 Soil Depth

Describe the soil depth map

N/A. Soil depth is constant.

3.3.1 Snow Free Albedo

Snow free albedo

3.3.1.1 Prognostic *

Is snow free albedo prognostic?

☒ True ☐ False

3.3.1.2 Functions

If prognostic, describe the dependancies on snow free albedo calculations

☐ Vegetation type

☐ Soil humidity

☒ Vegetation state

☐ Other - please specify:

3.3.1.3 Direct Diffuse

If prognostic, describe the distinction between direct and diffuse albedo

☒ Distinction between direct and diffuse albedo

☐ No distinction between direct and diffuse albedo

☐ Other - please specify:

3.3.1.4 Number Of Wavelength Bands

If prognostic, enter the number of wavelength bands used

3

3.4.1 Hydrology

Key properties of the soil hydrology

3.4.1.1 Description *

General description of the soil hydrological model

The unfrozen soil moisture is predicted by the Richards equation with hydraulic properies based on Clapp and Hornberger (1979).

3.4.1.2 Time Step *

Time step of river soil hydrology in seconds

180

3.4.1.3 Tiling

Describe the soil hydrology tiling, if any.

N/A

3.4.1.4 Vertical Discretisation *

Describe the typical vertical discretisation

Soil has six layers with a thickness of 0.05, 0.2, 0.75, 1, 2, and 10 m.

3.4.1.5 Number Of Ground Water Layers *

The number of soil layers that may contain water

6

3.4.1.6 Lateral Connectivity *

Describe the lateral connectivity between tiles

- ☐ Perfect connectivity - Common soil for multiple tiles
- ☐ Darcian flow - Darcian flow among hillslope tiles
- ☐ Other - please specify:

3.4.1.7 Method *

The hydrological dynamics scheme in the land surface model

- ☐ Bucket
- ☐ Force-restore
- ☐ Choisnel
- ☒ Explicit diffusion
- ☐ Other - please specify:

3.4.2 Freezing

Frozen soil treatment

3.4.2.1 Number Of Ground Ice Layers *

How many soil layers may contain ground ice

6

3.4.2.2 Ice Storage Method *

Describe the method of ice storage

Thermo dynamics

3.4.2.3 Permafrost *

Describe the treatment of permafrost, if any, within the land surface scheme

There is no specific treatment for permafrost. But near-surface permafrost is represented by soil freezing processes.

3.4.3 Drainage

Drainage treatment in the soil

3.4.3.1 Description *

General describe how drainage is included in the land surface scheme

Runoff is calculated following a simplified TOPMODEL.

3.4.3.2 Types

Different types of runoff represented by the land surface model

- ☐ Gravity drainage
- ☒ Horton mechanism
- ☒ Topmodel-based
- ☒ Dunne mechanism
- ☐ Lateral subsurface flow
- ☐ Baseflow from groundwater
- ☐ Other - please specify:

3.5.1 Heat Treatment

Soil heat treatment

3.5.1.1 Description *

General description of how heat treatment properties are defined

The soil temperature is predicted by a heat conduction equation with a zero heat flux at the bottom. The soil moisture freeze and thaw processes are included.

3.5.1.2 Time Step *

Time step of soil heat scheme in seconds

3600

3.5.1.3 Tiling

Describe the soil heat treatment tiling, if any.

Tiling corresponded to potential vegetation /cropland tiling.

3.5.1.4 Vertical Discretisation *

Describe the typical vertical discretisation

Soil has six layers with a thickness of 0.05, 0.2, 0.75, 1, 2, and 10 m.

3.5.1.5 Heat Storage *

Specify the method of heat storage

- ☐ Force-restore
- ☒ Explicit diffusion
- ☐ Other - please specify:

3.5.1.6 Processes *

Describe processes included in the treatment of soil heat

Select MULTIPLE options:

- ☐ Soil moisture freeze-thaw
- ☐ Coupling with snow temperature
- ☐ Other - please specify:

4 Snow

Land surface snow

4.1.1 Top level properties

Land surface snow

4.1.1.1 Name

Commonly used name for the snow in land model.

Enter TEXT:

4.1.1.2 Overview

Overview of land surface snow in land model.

The snow parameterization includes snow accumulation, snowmelt, and refreeze of snowmelt and rainfall with up to three snow layers. Snow temperature is calculated by a heat conduction equation. SSNOWD (Liston, 2004) snow cover fraction parameterization, which assumes a subgrid snow distribution function, is implemented.

4.1.1.3 Tiling

Describe the snow tiling, if any.

Tiling corresponded to potential vegetation/cropland tiling.

4.1.1.4 Number Of Snow Layers *

The number of snow levels used in the land surface scheme/model

3

4.1.1.5 Density *

Description of the treatment of snow density

- ☐ Prognostic
- ☒ Constant
- ☐ Other - please specify:

4.1.1.6 Water Equivalent *

Description of the treatment of the snow water equivalent

- ☒ Prognostic
- ☐ Diagnostic
- ☐ Other - please specify:

4.1.1.7 Heat Content *

Description of the treatment of the heat content of snow

- ☐ Prognostic
- ☒ Diagnostic
- ☐ Other - please specify:

4.1.1.8 Temperature *

Description of the treatment of snow temperature

- ☒ Prognostic
- ☐ Diagnostic
- ☐ Other - please specify:

4.1.1.9 Liquid Water Content *

Description of the treatment of snow liquid water

- ☐ Prognostic
- ☐ Diagnostic
- ☐ Other - please specify:

4.1.1.10 Snow Cover Fractions *

Specify cover fractions used in the surface snow scheme

- ☒ Ground snow fraction
- ☒ Vegetation snow fraction
- ☐ Other - please specify:

4.1.1.11 Processes *

Snow related processes in the land surface scheme

- ☒ Snow interception
- ☒ Snow melting
- ☒ Snow freezing
- ☐ Blowing snow
- ☐ Other - please specify:

4.1.1.12 Prognostic Variables *

List the prognostic variables of the snow scheme

Snow mass, Snow temperature, Snow albedo, Dust density in snow, Accumulated snow mass in the absence of any melt, Accumulated snow water-equivalent melt depth

4.2.1 Snow Albedo

Snow albedo

4.2.1.1 Type *

Describe the treatment of snow-covered land albedo

- ☒ Prognostic
- ☐ Prescribed
- ☐ Constant
- ☐ Other - please specify:

4.2.1.2 Functions

Describe the function types if prognostic snow albedo

Select MULTIPLE options:

- ☐ Vegetation type
- ☐ Snow age
- ☐ Snow density
- ☐ Snow grain type
- ☐ Aerosol deposition
- ☐ Other - please specify:

5 Vegetation

Land surface vegetation

5.1.1 Top level properties

Land surface vegetation

5.1.1.1 Name

Commonly used name for the vegetation in land model.

VISIT-e and MATSIRO6

5.1.1.2 Overview

Overview of land surface vegetation in land model.

Leaf area is simulated by the biogeochemical component. Stomatal Resistance from SiB2 based photosynthesis scheme is used to calculate transpiration. Canopy interception is considered.

5.1.1.3 Time Step *

Time step of vegetation scheme in seconds

Enter INTEGER value:

5.1.1.4 Dynamic Vegetation *

Is there dynamic evolution of vegetation?

☐ True ☒ False

5.1.1.5 Tiling

Describe the vegetation tiling, if any.

Physics: potential vegetaion cover and cropland Biogeochemistry: primary vegetation, secondary vegetation, urban, crop, and pasture

5.1.1.6 Vegetation Representation *

Vegetation classification used

☐ Vegetation types

☐ Biome types

☐ Other - please specify:

5.1.1.7 Vegetation Types

List of vegetation types in the classification, if any

- ☒ Broadleaf tree
- ☒ Needleleaf tree
- ☒ C3 grass
- ☒ C4 grass
- ☒ Vegetated
- ☐ Other - please specify:

5.1.1.8 Biome Types

List of biome types in the classification, if any

- ☒ Evergreen needleleaf forest
- ☒ Evergreen broadleaf forest
- ☒ Deciduous needleleaf forest
- ☒ Deciduous broadleaf forest
- ☒ Mixed forest
- ☐ Woodland
- ☒ Wooded grassland
- ☒ Closed shrubland
- ☐ Opne shrubland
- ☒ Grassland
- ☒ Cropland
- ☐ Wetlands
- ☐ Other - please specify:

5.1.1.9 Vegetation Time Variation *

How the vegetation fractions in each tile are varying with time

- ☒ Fixed (not varying)
- ☐ Prescribed (varying from files)
- ☐ Dynamical (varying from simulation)
- ☐ Other - please specify:

5.1.1.10 Vegetation Map

If vegetation fractions are not dynamically updated , describe the vegetation map used (common name and reference, if possible)

Watanabe_2010 and MODIS Land Cover Type product (MCD12Q1)

5.1.1.11 Interception *

Is vegetation interception of rainwater represented?

☒ True ☐ False

5.1.1.12 Phenology *

Treatment of vegetation phenology

☐ Prognostic

☐ Diagnostic (vegetation map)

☐ Other - please specify:

5.1.1.13 Phenology Description

General description of the treatment of vegetation phenology

Controlled by LAI phenology

5.1.1.14 Leaf Area Index *

Treatment of vegetation leaf area index

☐ Prescribed

☒ Prognostic

☐ Diagnostic

☐ Other - please specify:

5.1.1.15 Leaf Area Index Description

General description of the treatment of leaf area index

LAI and the phenology are controlled by the biogeochemical component.

5.1.1.16 Biomass *

Treatment of vegetation biomass

☒ Prognostic

☐ Diagnostic

☐ Other - please specify:

5.1.1.17 Biomass Description

General description of the treatment of vegetation biomass

Biomass is simulated by the biogeochemical component, but only used for biogeochemistry except for LAI dynamics.

5.1.1.18 Biogeography *

Treatment of vegetation biogeography

- ☐ Prognostic
- ☐ Diagnostic
- ☐ Other - please specify:

5.1.1.19 Biogeography Description

General description of the treatment of vegetation biogeography

Static vegetation distribution

5.1.1.20 Stomatal Resistance *

Specify what the vegetation stomatal resistance depends on

- ☒ Light
- ☒ Temperature
- ☒ Water availability
- ☒ CO2
- ☐ O3
- ☐ Other - please specify:

5.1.1.21 Stomatal Resistance Description

General description of the treatment of vegetation stomatal resistance

Stomatal resistance is calculated using a photosynthetic scheme after SiB2 (Selleres et al., 1996).

5.1.1.22 Prognostic Variables *

List the prognostic variables of the vegetation scheme

Enter COMMA SEPARATED list:

6 Energy Balance

Land surface energy balance

6.1.1 Top level properties

Land surface energy balance

6.1.1.1 Name

Commonly used name for the energy balance in land model.

Enter TEXT:

6.1.1.2 Overview

Overview of land surface energy balance in land model.

The surface energy balance is calculated by linearization of surface temperature equations for canopy and surface. The canopy albedo and transmissivity are calculated using simplified radiative transfer in canopy by Watanabe and Ohtani (1995). The bulk coefficients are estimated based on Watanabe (1994).

6.1.1.3 Tiling

Describe the energy balance tiling, if any.

The energy balance is calculated for snow-covered and snow-free surface of each tile.

6.1.1.4 Number Of Surface Temperatures *

The maximum number of distinct surface temperatures in a grid cell (for example, each subgrid tile may have its own temperature)

4

6.1.1.5 Evaporation *

Specify the formulation method for land surface evaporation, from soil and vegetation

- ☐ Alpha
- ☐ Beta
- ☐ Combined
- ☐ Monteith potential evaporation
- ☐ Other - please specify:

6.1.1.6 Processes *

Describe which processes are included in the energy balance scheme

Select MULTIPLE options:

- ☐ Transpiration

☐ Other - please specify:

7 Carbon Cycle

Land surface carbon cycle

7.1.1 Top level properties

Land surface carbon cycle

7.1.1.1 Name

Commonly used name for the carbon cycle in land model.

VISIT-e

7.1.1.2 Overview

Overview of land surface carbon cycle in land model.

The model for land ecosystem/biogeochemistry component introduced into MIROC-ES2L is the Vegetation Integrative SImulator for Trace gases model extended for ESM (VISIT-e). This model simulates carbon and nitrogen dynamics on land interactively, with exchanging variables between the land physics and atmosphere component. LUC impact on biogeochemistry is simulated in this component, based on schemes that are newly designed for CMIP6 exercises.

7.1.1.3 Tiling

Describe the carbon cycle tiling, if any.

Primary vegetation, secondary vegetation, urban, crop(normal crop and N-fixing crop), and pasture(pasture and rangeland).

7.1.1.4 Time Step *

Time step of carbon cycle in seconds

86400

7.1.1.5 Anthropogenic Carbon

Describe the treament of the anthropogenic carbon pool

- ☐ Grand slam protocol
- ☐ Residence time
- ☐ Decay time
- ☐ Other - please specify:

7.1.1.6 Prognostic Variables *

List the prognostic variables of the carbon scheme

Leaf, stem, root, foliage/stem/root litters, active/intermediate/passive humus, three anthoropogenic pools

7.2.1 Vegetation

Vegetation treatment in carbon cycle

7.2.1.1 Number Of Carbon Pools *

Enter the number of carbon pools used

3

7.2.1.2 Carbon Pools

List the carbon pools used

Leaf, stem, root for upper canopy and forest floor vegetations (prognostic); other diagnostic carbon pools

7.2.1.3 Forest Stand Dynamics

Describe the treatment of forest stand dyanmics

Treated as "big-leaf" model

7.2.2 Photosynthesis

Photosynthesis treatment in carbon cycle

7.2.2.1 Method

Describe the general method used for photosynthesis (e.g. type of photosynthesis, distinction between C3 and C4 grasses, Nitrogen depencence, etc.)

Based on Monsi-Saeki theory, and the photosynthetic capacity depends on leaf nitrogen concentration. Canopy photosynthesis is analytically integrated.

7.2.3 Autotrophic Respiration

Autotrophic respiration treatment in carbon cycle

7.2.3.1 Maintainance Respiration

Describe the general method used for maintainence respiration

Depends on: specific respiration rate, the size of each c pool, and air temperature with modified Q10 function.

7.2.3.2 Growth Respiration

Describe the general method used for growth respiration

Construction cost is proportional to biomass growth.

7.2.4 Allocation

Allocation treatment in carbon cycle

7.2.4.1 Method *

Describe the general principle behind the allocation scheme

The allocation of photosynthate between carbon pools in vegetation (leaf, stem, root) is dynamically regulated following phenological stages.

7.2.4.2 Allocation Bins *

Specify distinct carbon bins used in allocation

Select SINGLE option:

- ☐ Leaves + stems + roots
- ☐ Leaves + stems + roots (leafy + woody)
- ☐ Leaves + fine roots + coarse roots + stems
- ☐ Whole plant (no distinction)
- ☐ Other - please specify:

7.2.4.3 Allocation Fractions *

Describe how the fractions of allocation are calculated

- ☐ Fixed
- ☐ Function of vegetation type
- ☐ Function of plant allometry
- ☐ Explicitly calculated
- ☐ Other - please specify:

7.2.5 Phenology

Phenology treatment in carbon cycle

7.2.5.1 Method *

Describe the general principle behind the phenology scheme

Dependent on growing degree days and cumulative coldness for temperature-regulated plant categories, and land water condition for rain-regulated plant categories.

7.2.6 Mortality

Vegetation mortality treatment in carbon cycle

7.2.6.1 Method *

Describe the general principle behind the mortality scheme

Fixed mortality rate

7.3.1 Litter

Litter treatment in carbon cycle

7.3.1.1 Number Of Carbon Pools *

Enter the number of carbon pools used

3

7.3.1.2 Carbon Pools

List the carbon pools used

Leaf, stem, and root litters

7.3.1.3 Decomposition

List the decomposition methods used

Temperature dependency based on Lloyd and Taylor (1994) and soil moisture effect

7.3.1.4 Method

Describe the general method used

Enter TEXT:

7.4.1 Soil

Soil treatment in carbon cycle

7.4.1.1 Number Of Carbon Pools *

Enter the number of carbon pools used

3

7.4.1.2 Carbon Pools

List the carbon pools used

Active, intermediate, and passive humus

7.4.1.3 Decomposition

List the decomposition methods used

Temperature dependency based on Lloyd and Taylor (1994) and soil moisture effect

7.4.1.4 Method

Describe the general method used

Enter TEXT:

7.5.1 Permafrost Carbon

Permafrost carbon treatment in carbon cycle

7.5.1.1 Is Permafrost Included *

Is permafrost included?

☐ True ☒ False

7.5.1.2 Emitted Greenhouse Gases

List the GHGs emitted

CO2

7.5.1.3 Decomposition

List the decomposition methods used

Temperature dependency based on Lloyd and Taylor (1994) and soil moisture effect

7.5.1.4 Impact On Soil Properties

Describe the impact of permafrost on soil properties

Enter TEXT:

8 Nitrogen Cycle

Land surface nitrogen cycle

8.1.1 Top level properties

Land surface nitrogen cycle

8.1.1.1 Name

Commonly used name for the nitrogen cycle in land model.

VISIT-e

8.1.1.2 Overview

Overview of land surface nitrogen cycle in land model.

The model for land ecosystem/biogeochemistry component introduced into MIROC-ES2L is the Vegetation Integrative SImulator for Trace gases model extended for ESM (VISIT-e). This model simulates carbon and nitrogen dynamics on land interactively, with exchanging variables between the land physics and atmosphere component. LUC impact on biogeochemistry is simulated in this component, based on schemes that are newly designed for CMIP6 exercises.

8.1.1.3 Tiling

Describe the notrogen cycle tiling, if any.

Primary vegetation, secondary vegetation, urban, crop(normal crop and N-fixing crop), and pasture(pasture and rangeland). N fertilizer is applied to crop tile, and additional N fixing is included following areal fraction of N-fixing crop.

8.1.1.4 Time Step *

Time step of nitrogen cycle in seconds

86400

8.1.1.5 Prognostic Variables *

List the prognostic variables of the nitrogen scheme

Enter COMMA SEPARATED list:

9 River Routing

Land surface river routing

9.1.1 Top level properties

Land surface river routing

9.1.1.1 Name

Commonly used name for the river routing in land model.

Enter TEXT:

9.1.1.2 Overview

Overview of land surface river routing in land model.

Enter TEXT:

9.1.1.3 Tiling

Describe the river routing, if any.

Enter TEXT:

9.1.1.4 Time Step *

Time step of river routing scheme in seconds

Enter INTEGER value:

9.1.1.5 Grid Inherited From Land Surface *

Is the grid inherited from land surface?

Select either TRUE or FALSE:

☐ True ☐ False

9.1.1.6 Grid Description

General description of grid, if not inherited from land surface

Enter TEXT:

9.1.1.7 Number Of Reservoirs *

Enter the number of reservoirs

Enter INTEGER value:

9.1.1.8 Water Re Evaporation *

TODO

Select MULTIPLE options:

- ☐ Flood plains
- ☐ Irrigation
- ☐ Other - please specify:

9.1.1.9 Coupled To Atmosphere

Is river routing coupled to the atmosphere model component?

Select either TRUE or FALSE:

☐ True ☐ False

9.1.1.10 Coupled To Land

Describe the coupling between land and rivers

Enter TEXT:

9.1.1.11 Quantities Exchanged With Atmosphere

If couple to atmosphere, which quantities are exchanged between river routing and the atmosphere model components?

Select MULTIPLE options:

- ☐ Heat
- ☐ Water
- ☐ Tracers
- ☐ Other - please specify:

9.1.1.12 Basin Flow Direction Map *

What type of basin flow direction map is being used?

Select SINGLE option:

- ☐ Present day
- ☐ Adapted for other periods
- ☐ Other - please specify:

9.1.1.13 Flooding

Describe the representation of flooding, if any

Enter TEXT:

9.1.1.14 Prognostic Variables *

List the prognostic variables of the river routing

Enter COMMA SEPARATED list:

9.2.1 Oceanic Discharge

Oceanic discharge treatment in river routing

9.2.1.1 Discharge Type *

Specify how rivers are discharged to the ocean

Select SINGLE option:

- ☐ Direct (large rivers)
- ☐ Diffuse
- ☐ Other - please specify:

9.2.1.2 Quantities Transported *

Quantities that are exchanged from river-routing to the ocean model component

Select MULTIPLE options:

- ☐ Heat
- ☐ Water
- ☐ Tracers
- ☐ Other - please specify:

10 Lakes

Land surface lakes

10.1.1 Top level properties

Land surface lakes

10.1.1.1 Name

Commonly used name for the lakes in land model.

Enter TEXT:

10.1.1.2 Overview

Overview of land surface lakes in land model.

Enter TEXT:

10.1.1.3 Coupling With Rivers *

Are lakes coupled to the river routing model component?

Select either TRUE or FALSE:

☐ True ☐ False

10.1.1.4 Time Step *

Time step of lake scheme in seconds

Enter INTEGER value:

10.1.1.5 Quantities Exchanged With Rivers

If coupling with rivers, which quantities are exchanged between the lakes and rivers

Select MULTIPLE options:

☐ Heat

☐ Water

☐ Tracers

☐ Other - please specify:

10.1.1.6 Vertical Grid

Describe the vertical grid of lakes

Enter TEXT:

10.1.1.7 Prognostic Variables *

List the prognostic variables of the lake scheme

Enter COMMA SEPARATED list:

10.2.1 Method

Lakes treatment

10.2.1.1 Ice Treatment *

Is lake ice included?

Select either TRUE or FALSE:

☐ True ☐ False

10.2.1.2 Albedo *

Describe the treatment of lake albedo

Select SINGLE option:

☐ Prognostic

☐ Diagnostic

☐ Other - please specify:

10.2.1.3 Dynamics *

Which dynamics of lakes are treated? horizontal, vertical, etc.

Select MULTIPLE options:

☐ No lake dynamics

☐ Vertical

☐ Horizontal

☐ Other - please specify:

10.2.1.4 Dynamic Lake Extent *

Is a dynamic lake extent scheme included?

Select either TRUE or FALSE:

☐ True ☐ False

10.2.1.5 Endorheic Basins *

Basins not flowing to ocean included?

Select either TRUE or FALSE:

☐ True ☐ False

10.3.1 Wetlands

Welands treatment

10.3.1.1 Description

Describe the treatment of wetlands, if any

Enter TEXT: