CMIP6 Model Documentation

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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

GFDL LM3/LM3V (Shevliakova et al., 2009)

1.1.1.2 Keywords *

Keywords associated with land model code

Enter COMMA SEPARATED list:

1.1.1.3 Overview *

Overview of land model.

Enter TEXT:

1.1.1.4 Description *

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

Enter TEXT:

1.1.1.5 Land Atmosphere Flux Exchanges

Fluxes exchanged with the atmopshere.

Select MULTIPLE options:

- ☐ 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)

Enter TEXT:

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)

Enter TEXT:

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

Enter TEXT:

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)

Enter TEXT:

1.2.1.2 Water

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

Enter TEXT:

1.2.1.3 Carbon

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

Enter TEXT:

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?

Select either TRUE or FALSE:

☐ True ☐ False

1.3.1.2 Time Step *

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

Enter INTEGER value:

1.3.1.3 Timestepping Method *

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

Enter TEXT:

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.

Enter TEXT:

1.4.1.3 Code Languages

Code language(s).

Enter COMMA SEPARATED list:

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.

Enter TEXT:

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)

Enter TEXT:

2.2.1.2 Matches Atmosphere Grid *

Does the horizontal grid match the atmosphere?

Select either TRUE or FALSE:

☐ 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)

Enter TEXT:

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.

Enter TEXT:

3.1.1.3 Heat Water Coupling *

Describe the coupling between heat and water in the soil

Enter TEXT:

3.1.1.4 Number Of Soil layers *

The number of soil layers

Enter INTEGER value:

3.1.1.5 Prognostic Variables *

List the prognostic variables of the soil scheme

Enter COMMA SEPARATED list:

3.2.1 Soil Map

Key properties of the land surface soil map

3.2.1.1 Description *

General description of soil map

Enter TEXT:

3.2.1.2 Structure

Describe the soil structure map

Soil type prescibed at each grid point

3.2.1.3 Texture

Describe the soil texture map

Soil type prescibed at each grid point

3.2.1.4 Organic Matter

Describe the soil organic matter map

Enter TEXT:

3.2.1.5 Albedo

Describe the soil albedo map

Bare soil albedo prescibed at each grid point

3.2.1.6 Water Table

Describe the soil water table map, if any

Dynamic

3.2.1.7 Continuously Varying Soil Depth *

Does the soil properties vary continuously with depth?

Select either TRUE or FALSE:

☐ True ☐ False

3.2.1.8 Soil Depth

Describe the soil depth map

Enter TEXT:

3.3.1 Snow Free Albedo

Snow free albedo

3.3.1.1 Prognostic *

Is snow free albedo prognostic?

Select either TRUE or FALSE:

☐ 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

2

3.4.1 Hydrology

Key properties of the soil hydrology

3.4.1.1 Description *

General description of the soil hydrological model

Enter TEXT:

3.4.1.2 Time Step *

Time step of river soil hydrology in seconds

Enter INTEGER value:

3.4.1.3 Tiling

Describe the soil hydrology tiling, if any.

Enter TEXT:

3.4.1.4 Vertical Discretisation *

Describe the typical vertical discretisation

Enter TEXT:

3.4.1.5 Number Of Ground Water Layers *

The number of soil layers that may contain water

20

3.4.1.6 Lateral Connectivity *

Describe the lateral connectivity between tiles

Select MULTIPLE options:

- ☐ 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

20

3.4.2.2 Ice Storage Method *

Describe the method of ice storage

Basic thermodynamics

3.4.2.3 Permafrost *

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

Enter TEXT:

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

Enter TEXT:

3.4.3.2 Types

Different types of runoff represented by the land surface model

Select MULTIPLE options:

- ☐ 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

Enter TEXT:

3.5.1.2 Time Step *

Time step of soil heat scheme in seconds

Enter INTEGER value:

3.5.1.3 Tiling

Describe the soil heat treatment tiling, if any.

Enter TEXT:

3.5.1.4 Vertical Discretisation *

Describe the typical vertical discretisation

Enter TEXT:

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.

Enter TEXT:

4.1.1.3 Tiling

Describe the snow tiling, if any.

Enter TEXT:

4.1.1.4 Number Of Snow Layers *

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

5

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

Select SINGLE option:

- ☐ 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

Enter COMMA SEPARATED list:

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.

Enter TEXT:

5.1.1.2 Overview

Overview of land surface vegetation in land model.

Enter TEXT:

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?

Select either TRUE or FALSE:

☐ True ☐ False

5.1.1.5 Tiling

Describe the vegetation tiling, if any.

Enter TEXT:

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

Select MULTIPLE options:

- ☐ 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)

Enter TEXT:

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

Enter TEXT:

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

Enter TEXT:

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

Enter TEXT:

5.1.1.18 Biogeography *

Treatment of vegetation biogeography

Select SINGLE option:

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

5.1.1.19 Biogeography Description

General description of the treatment of vegetation biogeography

Enter TEXT:

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

Enter TEXT:

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.

Enter TEXT:

6.1.1.3 Tiling

Describe the energy balance tiling, if any.

Enter TEXT:

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)

1

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.

Enter TEXT:

7.1.1.2 Overview

Overview of land surface carbon cycle in land model.

Enter TEXT:

7.1.1.3 Tiling

Describe the carbon cycle tiling, if any.

Enter TEXT:

7.1.1.4 Time Step *

Time step of carbon cycle in seconds

Enter INTEGER value:

7.1.1.5 Anthropogenic Carbon

Describe the treament of the anthropogenic carbon pool

Select MULTIPLE options:

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

7.1.1.6 Prognostic Variables *

List the prognostic variables of the carbon scheme

Enter COMMA SEPARATED list:

7.2.1 Vegetation

Vegetation treatment in carbon cycle

7.2.1.1 Number Of Carbon Pools *

Enter the number of carbon pools used

5

7.2.1.2 Carbon Pools

List the carbon pools used

Leaves, storage, fine roots, sapwood, heartwood

7.2.1.3 Forest Stand Dynamics

Describe the treatment of forest stand dyanmics

Enter TEXT:

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.)

Enter TEXT:

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

Enter TEXT:

7.2.3.2 Growth Respiration

Describe the general method used for growth respiration

Enter TEXT:

7.2.4 Allocation

Allocation treatment in carbon cycle

7.2.4.1 Method *

Describe the general principle behind the allocation scheme

Enter TEXT:

7.2.4.2 Allocation Bins *

Specify distinct carbon bins used in allocation

- ☐ 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

Enter TEXT:

7.2.6 Mortality

Vegetation mortality treatment in carbon cycle

7.2.6.1 Method *

Describe the general principle behind the mortality scheme

Enter TEXT:

7.3.1 Litter

Litter treatment in carbon cycle

7.3.1.1 Number Of Carbon Pools *

Enter the number of carbon pools used

Enter INTEGER value:

7.3.1.2 Carbon Pools

List the carbon pools used

Enter COMMA SEPARATED list:

7.3.1.3 Decomposition

List the decomposition methods used

Enter COMMA SEPARATED list:

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

Enter INTEGER value:

7.4.1.2 Carbon Pools

List the carbon pools used

Fast and slow-respiring soil carbon

7.4.1.3 Decomposition

List the decomposition methods used

Enter COMMA SEPARATED list:

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?

Select either TRUE or FALSE:

☐ True ☐ False

7.5.1.2 Emitted Greenhouse Gases

List the GHGs emitted

Carbon dioxide

7.5.1.3 Decomposition

List the decomposition methods used

Enter COMMA SEPARATED list:

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.

Enter TEXT:

8.1.1.2 Overview

Overview of land surface nitrogen cycle in land model.

Enter TEXT:

8.1.1.3 Tiling

Describe the notrogen cycle tiling, if any.

Enter TEXT:

8.1.1.4 Time Step *

Time step of nitrogen cycle in seconds

Enter INTEGER value:

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

1

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?

- ☒ 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?

- ☐ 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

- ☐ 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?

☒ 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

☐ 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?

☒ True ☐ False

10.2.1.2 Albedo *

Describe the treatment of lake albedo

☐ Prognostic

☐ Diagnostic

☐ Other - please specify:

10.2.1.3 Dynamics *

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

☐ No lake dynamics

☐ Vertical

☐ Horizontal

☐ Other - please specify:

10.2.1.4 Dynamic Lake Extent *

Is a dynamic lake extent scheme included?

☒ True ☐ False

10.2.1.5 Endorheic Basins *

Basins not flowing to ocean included?

☒ True ☐ False

10.3.1 Wetlands

Welands treatment

10.3.1.1 Description

Describe the treatment of wetlands, if any

Enter TEXT: