prescribeSM Documentation

Release 0

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CHAPTER 1

Introduction

`prescribeSM_CESM_1.2.x` allows to prescribe `SOILLIQ` and `SOILICE` in CLM 4.0 for CESM 1.2.x.

The code is originally by Ruth Lorenz (with the help of Dave Lawrence) and has been adapted for CLM 4.0 and CESM 1.2.

1.1 Features

- Prescribe `SOILLIQ` (and `SOILICE`) (-> SM) in CLM 4.0
- Several methods to prescribe SM
- Prescribe SM globally or regionally
- Prescribe daily mean or monthly mean SM (linear interpolation in between)
- Conveniently define options via namelist

Usage

1. Run a reference simulation with CESM/ CLM, *output* `SOILLIQ` and `SOILICE` daily data.

2. Process the output, e.g. calculate a climatology.

3. *Convert* the *4D* output file to *3D*, if necessary.

4. *Add the necessary files and compile CESM.*

5. Create the *namelist* file, deciding what *method* to use to prescribe SM.

6. Run CESM with prescribed SM

Installation

Note: This guide only explains how to add the extended functionality to CLM and not how CESM can be installed.

3.1 Obtaining the Source Code

The source code must first be obtained from github: `git clone https://github.com/IACETH/prescribeSM_cesm_1.2.x.git`

3.2 Compilation

There is one additional source code file and a number of original CLM files were changed (see *Source Files*). The files need to go in to the `SourceMods` folder (`$CASEROOT/SourceMods/src.clm/`) before CESM is compiled.

Soil Moisture Data Set

This file defines the target values which are prescribed in CLM. It is a netCDF file and needs to have the variables `SOILICE` and `SOILLIQ` on it (even if you only prescribe `SOILLIQ`). The variables are not in the usual lat/ lon format (named *4D*) but in an indexed format (named *3D*). The data is obtained from a reference simulation of CLM. The file must have 365 (12) time steps on it to prescribe SM daily (monthly) data.

4.1 Obtain SM Data Set from CLM

CLM can directly output the needed *3D* soil moisture fields. Assume you want to output daily *4D* files in `history tape 2` and daily *3D* fields in `history tape 3`, you have to add the following lines to `user_nl_clm`:

```
# daily SM, lat, lon grid:
hist_fincl2 = 'SOILICE', 'SOILLIQ'
# daily SM, column form
hist_fincl3 = 'SOILLIQ','SOILICE'
hist_nhtfrq = 0, -24, -24
hist_mfilt = 1, 365, 365
# conversion to lat/ lon format?
hist_dov2xy = .true., .true., .false.
```

4.2 Convert 4D to 3D

If you only have the SM forcing file in *4D* format it is possible to convert it to a *3D* file. A small python script that shows how to do this is given in the repository: `clm_col_to_xy_example.py`.

It translates the lat/ lon information to index information. This requires one *3D* file with the used set up (create it as in *Obtain SM Data Set from CLM*).

4.3 Regional Forcing

- if you set SOILLIQ or SOILICE to -1 at a gridpoint/ level, `SOILLIQ` and `SOILICE` are calculated interactively at this point

- this can be used to prescribe SM only regionally

- or at certain depths only

> **Warning:** to prescribe SM only at certain time days of the year will only work if you use (1) daily data and (2) set

Namelist

PrescribeSM has its own namelist that is called `prescribe_SM_nl`. This namelist must go in the `run` directory of CESM. The location of the `run` directory is defined in `$CASEROOT/env_run.xml` under the entry "RUNDIR".

Note: an example namelist is given with the code

5.1 Namelist Options

pSMfile [string] path to the history file containing SOILLIQ and SOILICE

pSMtype [int] Defines how to prescribe SM, see *Methods to Prescribe Soil Moisture*.

monthly [bool] If `.false.` uses daily input. If `.true.` assumes monthly mean SM is provided.

interp_day [bool] If `.false.` uses the daily mean, if `.true.` linearly interpolates between daily mean. Applies only if daily input data is used (`monthly = .false.`).

levstart [int, optional] First level to prescribe SM, default = 1.

levstop [int, optional] Last level to prescribe SM, default = 10.

nudge [float between 0. and 1., optional] Nudging parameter. Not tested. Default = 1 (i.e. no nudging).

use_qdrai [bool, optional] Only for pSMtype 3. Do not use, default = `.true.`.

reservoir_capacity, float, optional Only for pSMtype 3. Do not use, default = 0.

Warning: if you set monthly=.true. but have a daily SM input file it will still work (uses the first 12 days as the months)

CHAPTER 6

Methods to Prescribe Soil Moisture

pSMtype = 1 Prescribe `SOILLIQ` and `SOILICE` at every time step (PRES_LIQ+ICE). Ignores gridcells/ levels where `SOILLIQ` or `SOILICE` is negative.

pSMtype = 2 Prescribe `SOILLIQ` if soil temperature is above freezing (PRES_LIQ). Prescribes `SOILLIQ + SOILICE` at every time step. Ignores gridcells/ levels where `SOILLIQ` is negative.

pSMtype = 3 Not tested, do not use. Prescribe `SOILLIQ` if soil temperature is above freezing (PRES_LIQ) and only if runoff (or potentially water in the reservoir is available). Does not remove water. Prescribes `SOILLIQ + SOILICE` at every time step.

pSMtype = 4 As pSMtype = 2 but does not remove water.

Additional Info

7.1 Source Files

The three changed source files are:

- `prescribeSoilMoistureMod.F90`
- `clm_driver.F90`
- `BalanceCheckMod.F90`

`prescribeSoilMoistureMod.F90`

The main file for prescribing soil moisture. Contains the following routines:

- prescribeSoilMoisture
- initPrescribeSoilMoisture
- interpSoilMoisture
- readSoilMoisture

`clm_driver.F90`

The subroutine prescribeSoilMoisture is called from the main program of CLM.

`BalanceCheckMod.F90`
Prescribing soil moisture violates the water and energy balance. Therefore these two checks have to be turned off.

7.2 Glossary

4D The usual file.

time x level x latitude x longitude

3D time x level x index

CHAPTER 8

Indices and tables

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Symbols