The Community Land Model

David Lawrence

Terrestrial Sciences Section

Climate and Global Dynamics Division

Community Earth System Model CESM

Search advanced

CESM1.0: CLM DOCUMENTATION

Introduction

The Community Land Model version 4.0 (CLM4.0.14) is the land model used in the CESM1.0.2 release. CLM4.0.14 is the latest in a series of land models developed through the CESM project. More information on the CLM project and access to previous CLM model versions and documentation can be found via the CLM Web Page.

Documentation

- CLM4.0.14 User's Guide [html] [pdf] (Last update: Feb/ 7/2011)
- What's new in the CESM1.0.2 release of CLM4? [html]
- What's new in the CESM1.0.1 release of CLM4? [html]
- What's new in the CESM1.0 release of CLM4? [html] [pdf]
- What's new in CLM4.0 relative to CLM3.5? [pdf]
- CLM4.0 Technical Note [pdf] (Last update: Jun/17/2010)
- CLM4.0 Urban Model Technical Note [pdf] (Last update: Jan/11/2011)
- CLM4.0.14 Code Reference Guide [html]
- CESM1.0 All active model code browser [html]

Model output and offline forcing data and diagnostic plots

- CLM4.0 offline control simulations: Diagnostic plots
- CLM4.0 offline control simulations: Model output data
- CLM4.0 offline control simulations: Model forcing data

CLM Post-Processing Utilities

- CLM Diagnostic Package: Code (via svn repository, registration required)
- CLM Diagnostic Package: User's Guide

References

- Oleson, K.W., D.M. Lawrence, G.B. Bonan, M.G. Flanner, E. Kluzek, P.J. Lawrence, S. Levis, S.C. Swenson, P.E. Thornton, A. Dai, M. Decker, R. Dickinson, J. Feddema, C.L. Heald, F. Hoffman, J.-F. Lamarque, N. Mahowald, G.-Y. Niu, T. Qian, J. Randerson, S. Running, K. Sakaguchi, A. Slater, R. Stockli, A. Wang, Z.-L. Yang, Xi. Zeng, and Xu. Zeng, 2010: Technical Description of version 4.0 of the Community Land Model (CLM). NCAR Technical Note NCAR/TN-478+STR, National Center for Atmospheric Research, Boulder, CO, 257 pp.
- Lawrence, D.M., K.W. Oleson, M.G. Flanner, P.E. Thornton, S.C. Swenson, P.J. Lawrence, X. Zeng, Z.-L. Yang, S. Levis, K. Sakaguchi, G.B. Bonan, and A.G. Slater, 2010: Parameterization improvements and functional and structural advances in version 4 of the Community Land Model. *Submitted to J. Adv. Model. Earth Sys.*.

The LMWG diagnostics package

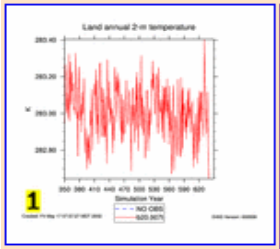
b40.1850.track1.1deg.006
and
b30.020.ES02

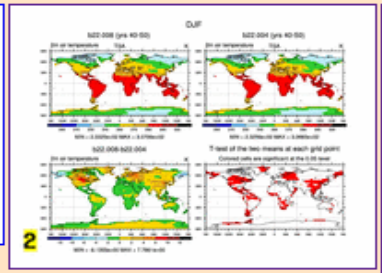
LND_DIAG Diagnostics Plots Source: /fis/cgd/tss/diag/lnd_diag4.1

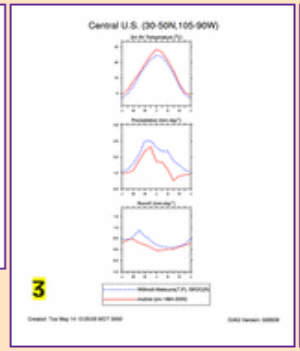
Set Description

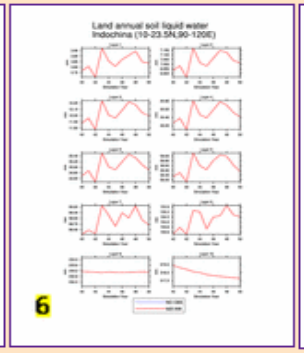
1 Line plots of annual trends in energy balance, soil water/ice and temperature, runoff, snow water/ice, photosynthesis
2 Horizontal contour plots of DJF, MAM, JJA, SON, and ANN means
3 Line plots of monthly climatology: regional air temperature, precipitation, runoff, snow depth, radiative fluxes, and turbulent fluxes
4 *(Inactive)* Vertical profiles at selected land raobs stations
5 Tables of annual means
6 Line plots of annual trends in regional soil water/ice and temperature, runoff, snow water/ice, photosynthesis
7 Line plots, tables, and maps of RTM river flow and discharge to oceans
8 *(Inactive)* Line and contour plots of Ocean/Land/Atmosphere CO2 exchange
9 *(Inactive)* Contour plots and statistics for precipitation and temperature. Statistics include DJF, JJA, and ANN biases, and RMSE, correlation and standar observations

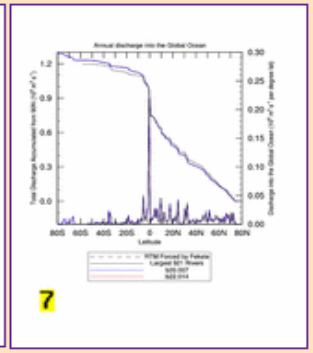
Click on Plot Type











Offline CLM Compsets

Compsets are shortcuts designed for specific cases… treat them as starting points for all cases

"I" compsets run the clm/datm and no ice/ocean models

Name	Short Name	Description
I_2000	I	CLM4SP, where SP = satellite phenology
I_1850 $aerosol_{dep}$	I1850	CLM4SP, single year corresp. to pfts, CO_2 ,
I_1948-2004	I4804	CLM4SP, year range corresp. to datm data only
I_1850-2000	I8520	CLM4SP, year range corresp. to transient data
I_2000_CN	ICN	CLM4CN, where CN = carbon-nitrogen model
I_1850_CN N_{dep}	I1850CN	CLM4CN, same comment as for the SP case +
I_1948-2004_CN	I4804CN	CLM4CN, same comment as for the SP case
I_1850-2000_CN	I8520CN	CLM4CN, same comment as for the SP case

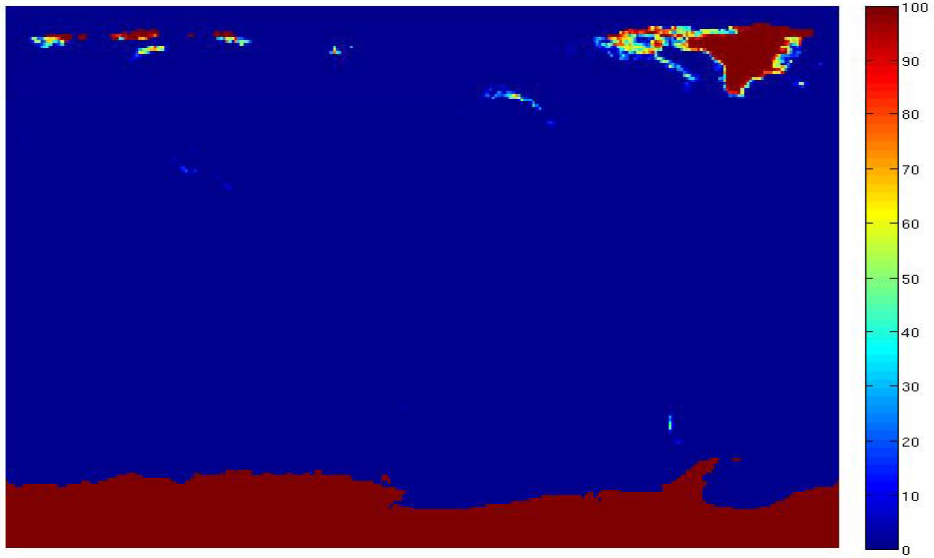
Differences between compsets => customizing a case

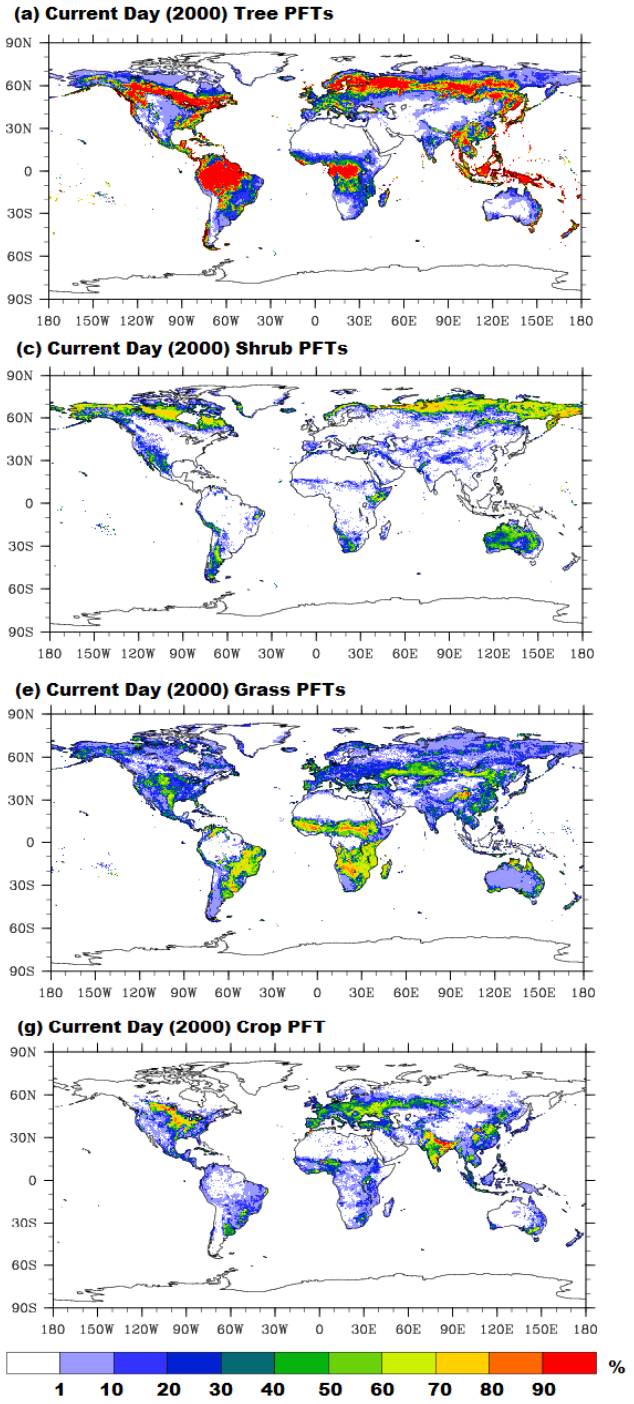
Tip: Create a case **with two different compsets** and see how **settings change automatically** for you. Use this information to understand how **you may also change settings manually** for the purposes of a case not explicitly supported by an existing compset.

Understanding and modifying input data

Learn what inputs the clm needs and what they look like

% glacier





CLM Namelist (excerpt) – Buildconf/clm.buildnml.csh

```
&clm_inparm
 co2_ppmv             = 284.7
 co2_type             = 'diagnostic'
 finidat      = '$DIN_LOC_ROOT/lnd/clm2/initdata/clmi.BCN_0051-01-01_48x96_gx3v7_simyr1850_c100303.nc
 fpftcon      = '$DIN_LOC_ROOT/lnd/clm2/pftdata/pft-physiology.c100226'
 frivinp_rtm     = '$DIN_LOC_ROOT/lnd/clm2/rtmdata/rdirc.05.061026'
 fsnowaging   = '$DIN_LOC_ROOT/lnd/clm2/snicardata/snicar_drdt_bst_fit_60_c070416.nc'
 fsnowoptics   = '$DIN_LOC_ROOT/lnd/clm2/snicardata/snicar_optics_5bnd_c090915.nc'
 fsurdat          = '$DIN_LOC_ROOT/lnd/clm2/surfdata/surfdata_48x96_simyr1850_c110114.nc'
 fpftdyn          = '$DIN_LOC_ROOT/lnd/clm2/surfdata/surfdata.pftdyn_48x96_hist_simyr1850-
2005_c110114.nc
 hist_mfilt           = 1
 hist_nhtfrq           = 0
 urban_hac             = 'ON_WASTEHEAT'

&ndepdyn_nml
 stream_fldfilename_ndep  = '$DIN_LOC_ROOT/lnd/clm2/ndepdata/fndep_clm_hist_simyr1849-
                                    2006_1.9x2.5_c100428.nc'
```

CAM or DATM Namelist

```
 aerodep_flx_file            = 'aerosoldep_monthly_1850_mean_1.9x2.5_c090421.nc
```


Spinning up CLM with Carbon-Nitrogen (CN)

Spin up CN (carbon stocks) from bare ground with CESM climate or observed climate

Step 1: B-case with high frequency compset; run for 30 years

Step 2: I-case with "-ad_spinup on" in CLM_CONFIG_OPTS; run 600 years; finidat=' '

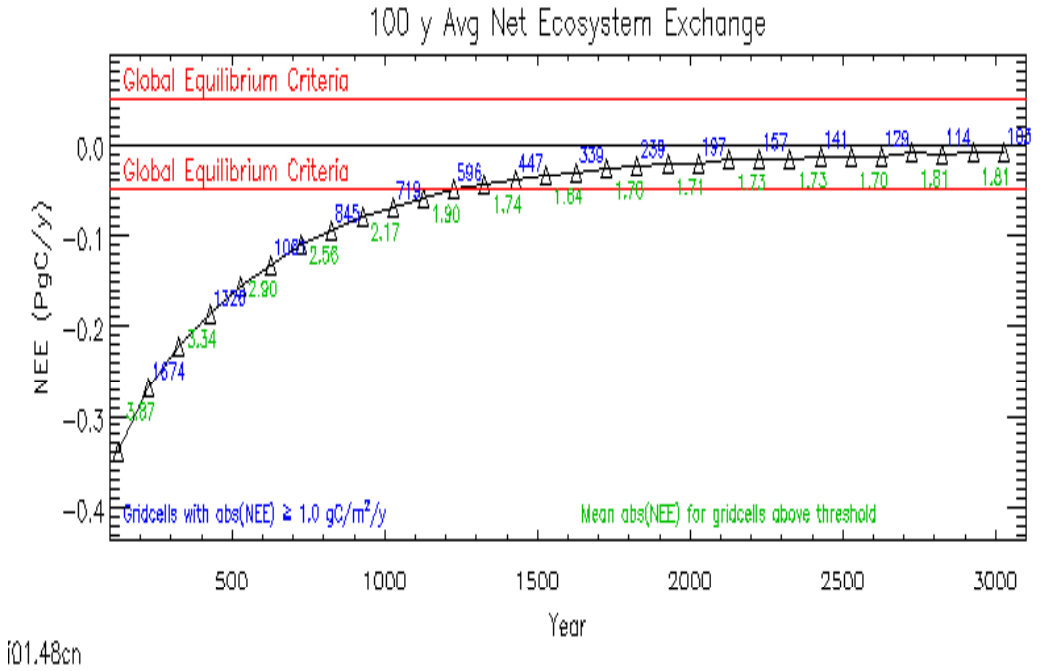
Step 3: I-case with "-exit_spinup on" in CLM_CONFIG_OPTS; 1 yr; finidat from step 2

Step 4: I-case with neither of the above options; run for >50 years; finidat from step 3

Comments:

Look for long-term average Net Ecosystem Exchange (NEE) near zero or Total Ecosystem Carbon (TOTECOSYSC) not drifting for successful spin-up

Initial file from step 4 may serve to start a CNDV (dynamic veg.) run



Exercise 1: Diagnosing an error

What do you do if the model crashes?

In this exercise, we are going to intentionally introduce a problem that will prevent the model from executing

1. Create a new case with the F_1850 compset at T31 resolution. Call it “case.crash” and then configure the case. Before you build it, make the following change to the clm namelist (Buildconf/clm.buildnml.csh)

fsurdat = '$DIN_LOC_ROOT/lnd/clm2/surfdata/surfdata_48x96_simyr1850_c090928.nc'

fsurdat = ‘/scratch1/dlawren/surfdata_48x96_simyr1850_nobaresoil_c110421.nc‘

2. Build and run the model. While you are waiting, take a look at some log files from simulations you ran previously. Note that while your simulation is running, log files can be found in your run directory. When the run finishes, log files are copied into ~/[casename]/logs

There are log files for each component, e.g. atm.log. and lnd.log.**

Exercise 1: Diagnosing an error

3. The model should not start running because of an inconsistency between the land surface dataset (fsurdat) and the initial condition (finidat) dataset. Look in the land log file to see if you see the following error:

Reading restart dataset

ERROR:: PFT weights are SIGNIFICANTLY different from the input finidat file and fsurdat file(s).

ERROR:: maximum difference is 0.999821867776252260 max allowed = 0.50000000000000010E-03

ERROR:: Run interpinic on your initial condition file to interpolate to the new surface dataset

4. One way to solve such a problem would be to use the CLM tool - interpinic (models/lnd/clm/tools). Interpinic interpolates clm initial condition files from one surface dataset to another.

Here, if you swap the fsurdat back to the original file, the model should run. Try it and look at the lnd log file again to see what a log file from a successfully completed run looks like.

5. Take a look at the two surface datasets and look at the variable PCT_PFT. Bare soil is pft=0 and C3 Grass is pft=13

Exercise 1: Solutions

Exercise 1: Change the surface dataset in the CLM namelist. Model will crash. Look at log files to identify the error. Fix the problem. Look at land surface datasets

1. Go the the scripts directory and create a new case

   create_newcase -case mycase.1850.crash -res T31_g37 -compset B_1850 -mach mapache

2. Go to the case directory, configure, and edit the CLM namelist file

   cd mycase.1850.crash

   configure -case

   cd Buildconf

   cp clm.buildnml.csh clm.buildnml.csh.bak

   vi clm.buildnml.csh edit so that fsurdat = '/scratch1/dlawren/surfdata_48x96_simyr1850_nobaresoil_c110421.nc'

3. Build and run the model and then look at the log files

   ./mycase.1850.crash.mapache.build

   ./mycase.1850.crash.mapache.submit

   cd /scratch1/CESM/mycase.1850.crash/run

   vi lnd.log. look for error message at end of file*

4. Go back and run with correct surface dataset (i.e., with surface dataset that is consistent with the initial conditions data)

   cp Buildconf/clm.buildnml.csh.bak Buildconf/clm.buildnml.csh

   ./mycase.1850.crash.mapache.build

   ./mycase.1850.mapache.submit

5. When run finishes, look at log file for a successful run to see the difference (note that log files are copied back to your case directory if a run finishes successfully

   cd logs

   gunzip –c lnd.log | more*

Exercise 2: Extra credit

1) Create two I compset cases (e.g. I2000) (mycase.I2000.control and mycase.I2000_mod)
   Remember that an I case is offline CLM forced with data atmosphere

2) For the control case, configure, build, and run for two months.

3) For the modified case, configure, and then make a copy of the pft-physiology file (see clm.buildnml.csh for location of original) in your case directory.
   Modify a parameter in the pft-physiology file after looking at the clm code that reads the file (pftvarcon.F90) to determine which parameter you're interested in changing (e.g. an albedo param)
   Note: Most input files are netCDF but the pft-physiology file in cesm1_0_2 is ascii (will be netCDF in next release)
   Edit clm.buildnml.csh to point to your modified pft-physiology file
   Build and run for two months

4) Compare history output for the two runs. Do you see differences?