CLM5.0 Tutorial: Changing Model Setup

Jackie Shuman & Katie Dagon
Lecture/Intro

- Review Practical 1
- Why change model setup?

Practical

- Checkout a Local Branch on Git
- Changing Model Setup
  1) Component sets
  2) Namelist files
  3) Parameter changes
- Data Analysis with Jupyter Notebook
Review Practical 1: Create & run an out-of-the-box simulation

First, a one-time step to create a directory to store your experiment cases:
mkdir ~/clm_tutorial_cases

Then, navigate to the scripts directory in the source code directory:
cd /glade/u/home/$USER/clm5.0_2019tutorial/cime/scripts

(1) create a new case

Type this command line:
./create_newcase --case ~/clm_tutorial_cases/I1850CLM50_001 --res f19_g17 --compset I1850Clm50Sp

(2) invoke case.setup

Then, navigate to your case directory:
cd ~/clm_tutorial_cases/I1850CLM50_001
Type this command line:
./case.setup

(3) build the executable

Type this command line:
qcmd -- ./case.build

(4) submit your run to the batch queue

Type this command line:
./case.submit
**Review CLM Directory Structure**

**CESM Source Code**

/glade/u/home/<username>/clm5.0_2019tutorial/

$SRCCROOT

**components**

**cism**

**rtm**

**mosart**

**scripts**

create_newcase

**CASE Directory**

~/clm_tutorial_cases/l1850CLM50_001

$CASEROOT
case.setup
case.build
case.submit
user_nl_xxx

**Build/Run Directory**

/glade/scratch/<username>/
l1850CLM50_001

$EXEROOT

**build**

atm

Ind

ocn

ice

glc

wav

lib

run

$SRUNDIR

**CESM data**

/glade/p/cesm/cseg/inputdata

$DIN_LOC_ROOT

**share**

**cpl**

**atm**

**Ind**

**ocn**

**ice**

**glc**

**wav**

**rof**
Review: Queues and Jobs

On Cheyenne

Checking jobs:
  a. Type `qstat <username>`

Killing jobs:
  a. Use `qstat` to find your <JOBID>
  b. Type `qdel <JOBID>`
Why change model setup?

• Investigate differences between preindustrial and present-day climates
  ➢ *Change the compset* to use year 2000 forcing data instead of 1850

• Study changes happening over higher frequency time periods
  ➢ *Change the output frequency* to save daily data instead of monthly averages

• Calculate sensitivity of a parameter representing land surface processes
  ➢ *Change the parameter value* for a specified process
3 Types of Basic Modifications

1. Component Sets
2. Namelist files
3. Parameter changes
In the scripts directory, `create_newcase` generates a new case. `create_newcase` requires 3 arguments:

- **--case**: What is the casename?
- **--res**: Which resolution?
- **--compset**: Which model configuration? Which set of components?
Changing compsets lets you run different experiments

Some component options:

- Year (1850, 2000, transient, etc.)
- Data atmosphere (GSWP3, CRUNCEP, CPLHIST3HrWx)
- Model options (SP [satellite phenology], BGC [biogeochemistry], FATES*)
- RCP scenarios

SP means that the phenology is prescribed based on remote sensing data. BGC/FATES means that the phenology is prognostic based on model-calculated climatology. FATES also includes size structure with disturbance and competition.

*FATES (Functionally Assembled Terrestrial Ecosystem Simulator) model option must also be specified with a namelist parameter: use_fates=.true.
List of component sets are available on the CESM website

Component sets website: http://www.cesm.ucar.edu/models/cesm2/config/compsets.html
3 Types of Basic Modifications

1. Component Sets

2. Namelist files

3. Parameter changes
Name lists in CLM Directory Structure

**CASE Directory**

```
~/clm_tutorial_cases/I1850CLM50_001
$CASEROOT
  case.setup
  user_nl_cism
  user_nl_clm
  user_nl_cpl
  user_nl_datm
  user_nl_mosart
  case.build
  case.submit
```

**Build/Run Directory**

```
/glade/scratch/<username>/I1850CLM50_001
$EXEROOT
```

- **case.setup** creates namelist modification files `user_nl_xxx`
  - This is where namelist files are modified

- **case.build** creates namelists in the run directory

**Case Docs**

- Contains copies of the namelists for reference only (should not be edited)
Modifying Namelist files

• Compset choice sets up initial namelists

• `user_nl_clm` modifies namelist file `Ind_in`

    **Important:** Don’t modify the namelist file (`Ind_in`) directly. Make changes in `user_nl_clm`.

• Website for CLM5.0 namelist variables:
  [http://www.cesm.ucar.edu/models/cesm2/settings/current/clm5_0_nml.html](http://www.cesm.ucar.edu/models/cesm2/settings/current/clm5_0_nml.html)

** Some namelist variables can also be changed in `env_run.xml` file
Website for CLM5.0 namelist variables:
http://www.cesm.ucar.edu/models/cesm2/settings/current/clm5_0_nml.html

<table>
<thead>
<tr>
<th>Variable</th>
<th>Namelist Group</th>
<th>Category</th>
<th>Entry Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>albice</td>
<td>clm_inparm</td>
<td>clm_physics</td>
<td>real(2)</td>
</tr>
<tr>
<td>all_active</td>
<td>clm_inparm</td>
<td>clm_physics</td>
<td>logical</td>
</tr>
<tr>
<td>all_urban</td>
<td>clmexp</td>
<td>mksurfdta</td>
<td>logical</td>
</tr>
<tr>
<td>allowlakeprod</td>
<td>ch4par_in</td>
<td>clm_methane</td>
<td>logical</td>
</tr>
<tr>
<td>anoxia</td>
<td>clm_inparm</td>
<td>clm_vertcn</td>
<td>logical</td>
</tr>
<tr>
<td>anoxia_wtsat</td>
<td>clm_inparm</td>
<td>clm_vertcn</td>
<td>logical</td>
</tr>
<tr>
<td>atm_c13_filename</td>
<td>clm_inparm</td>
<td>clm_isotope</td>
<td>char*256</td>
</tr>
<tr>
<td>atm_c14_filename</td>
<td>clm_inparm</td>
<td>clm_isotope</td>
<td>char*256</td>
</tr>
<tr>
<td>baseflow_scalar</td>
<td>soilhydrology_inparm</td>
<td>clm_physics</td>
<td>real</td>
</tr>
<tr>
<td>baset_latvary_intercept</td>
<td>crop</td>
<td>physics</td>
<td>real</td>
</tr>
<tr>
<td>baset_latvary_slope</td>
<td>crop</td>
<td>physics</td>
<td>real</td>
</tr>
<tr>
<td>baset_mapping</td>
<td>crop</td>
<td>physics</td>
<td>char*20</td>
</tr>
<tr>
<td>bgc_mode</td>
<td>default_settings</td>
<td>default_settings</td>
<td>char*5</td>
</tr>
<tr>
<td>borealpeatfire_c</td>
<td>lifire_inparm</td>
<td>clm_physics</td>
<td>real</td>
</tr>
<tr>
<td>br_root</td>
<td>cnmresp_inparm</td>
<td>clm_physics</td>
<td>real</td>
</tr>
</tbody>
</table>
3 Types of Basic Modifications

1. Component Sets

2. Namelist files

3. Parameter changes
Parameter changes

• Parameters exist to represent physical processes in the model
• To test sensitivity and quantify uncertainties, we can try out different parameter values
• We’ll be looking at PFT-dependent parameters, which live in their own netcdf file. (Other parameters are set using the namelist.)
Parameters in CLM Directory Structure

The default parameter file lives in this directory.

In the practical, you will copy this file and modify it to change a parameter value.
Structure of parameter file

Navigate to parameter data directory:

```
cd /glade/p/cesm/cseg/inputdata/lnd/clm2/paramdata
```

Use ncview to look at parameter file:

```
ncview clm5_params.c171117.nc
```

Click on 1d or 2d vars to get a list of PFT-dependent parameters

Select “medlynslope” from the 1d list to look at the different values of this parameter for each PFT

ncview will plot the different values of medlynslope
Today’s Practical:
3 Types of Basic Modifications

1. Change Component Set
2. Modify Namelist file
3. Change a Parameter

Questions?
Start Practical Here
Use git to checkout a local branch

Navigate into your clm code directory
`cd ~/clm5.0_2019tutorial`
Check your branch. *What branch are you on now?*
`git branch -v`
Create local branch
`git checkout -b <username_tutorial>`
Check again. *Are you on the new branch?*
`git branch -v`

➢ This is your “active branch” and all work should be done in this branch.
Today’s Exercises:
3 Types of Basic Modifications

1. Change Component Set
   Create and build simulation for year 2000

2. Modify Namelist file

3. Change a Parameter
Exercise 2.1: Change Compset
Create and build simulation for year 2000
Exercise 2.1: Change Compset
Create and build simulation for year 2000

`create_newcase` requires 3 arguments

- What is the casename?
- Which resolution?
- Which model configuration? Which set of components?

```
--case
--res
--compset
```

Now we’ll change the compset
Navigate to the scripts directory in the source code directory:
cd /glade/u/home/$USER/clm5.0_2019tutorial/cime/scripts

./query_config -h
This will show a help message with information and options for the command

List compsets specific to clm:
./query_config --compsets clm

TO DO: Identify and copy name of component set for year 2000 with GSWP3 atmosphere using CLM5 and Satellite Phenology
CLM component sets:

List compsets specific to clm:

```
./query_config --compsets clm
```

Compset Alias:
- Short name for component set
  CLM only = “I” Alias compsets

Compset Long Name:
- Year
- Data atmosphere (GSWP3, CRUNCEP, etc.)
- Model options (SP [satellite phenology], BGC [biogeochemistry])
Exercise 2.1: Change Compset
Create and build simulation for year 2000

Navigate to the scripts directory in the source code directory:
```
cd /glade/u/home/$USER/clm5.0_2019tutorial/cime/scripts
```

(1) create a new case
Type this command line
```
./create_newcase --case ~/clm_tutorial_cases/I2000CLM50_001 --res f19_g17 --compset I2000Clm50Sp --project UCGD0004
```

(2) invoke case.setup

NOTE: you can use compset <alias> or <long name> here

(3) build the executable

(4) submit your run to the batch queue
Exercise 2.1: Change Compset
Create and build simulation for year 2000

Navigate to the scripts directory in the source code directory:
```
cd /glade/u/home/$USER/clm5.0_2019tutorial/cime/scripts
```

(1) create a new case

Type this command line
```
./create_newcase --case ~/clm_tutorial_cases/I2000CLM50_001 --res f19_g17 --compset I2000Clm50Sp --project UCGD0004
```

(2) invoke case.setup

Navigate to the case directory
```
cd ~/clm_tutorial_cases/I2000CLM50_001
```
Type this command line
```
./case.setup
```

(3) build the executable

Type this command line:
```
qcmd -q R4231039 -- ./case.build
```

Type this command line:
```
./xmlchange STOP_OPTION=nyears
./xmlchange JOB_WALLCLOCK_TIME=1:00:00
./xmlchange PROJECT=UCGD0004
```

After step 3, update to run for 5 years, reduce wall clock time, and specify Project code

(4) submit your run to the batch queue
Exercise 2.1: Change Compset
Create and build simulation for year 2000

Navigate to the scripts directory in the source code directory:
```
cd /glade/u/home/$USER/clm5.0_2019tutorial/cime/scripts
```

(1) create a new case

Type this command line
```
./create_newcase --case ~/clm_tutorial_cases/I2000CLM50_001 --res f19_g17 --compset I2000Clm50Sp --project UCGD0004
```

(2) invoke case.setup

Navigate to the case directory
```
cd ~/clm_tutorial_cases/I2000CLM50_001
```
Type this command line
```
./case.setup
```

(3) build the executable

Type this command line:
```
qcmd -q R4231039 -- ./case.build
```

Type this command line:
```
./xmlquery STOP_OPTION
./xmlquery STOP_N
```

Confirm you are running for 5 years, then submit case

(4) submit your run to the batch queue

Type this command line:
```
./case.submit
```
Today’s Exercises:
3 Types of Basic Modifications

1. Change Component Set

2. Modify Namelist file
   Changing data record frequency with a new case

3. Change a Parameter
Modifying Namelist files

• Not all changes can be made with ./xmlchange
• Additional changes made using namelist files: user_nl_<model>
• user_nl_<model> files created in the case directory after ./case.setup

user_nl_cism & ice (cism_in)

user_nl_datm & atmosphere (datm_in)

user_nl_clm & land (lnd_in)

user_nl_cpl & coupler (driver; drv_in)

user_nl_mosart & river transport (mosart_in)
Namelist in CLM Directory Structure

### CASE Directory

```
~/clm_tutorial_cases/l2000CLM50_001
~/$CASEROOT
  case.setup
  user_nl_cism
  user_nl_clm
  user_nl_cpl
  user_nl_datm
  user_nl_mosart
  case.build
  case.submit
```

- **case.setup** creates namelist modification files `user_nl_xxx`
- This is where namelist files are modified

### Build/Run Directory

```
/glade/scratch/<username>/l2000CLM50_001
~/$EXEROOT
```

- **Run** `$RUNDIR`
  - `cism_in`
  - `datm_in`
  - `drv_flds_in`
  - `drv_in`
  - `lnd_in`
  - `mosart_in`

### SourceMods

- `LockedFiles`
- `Buildconf`
- `Tools`
- `SourceMods`
- `Case Docs`

### CaseDocs

- `cism_in`
- `datm_in`
- `drv_flds_in`
- `drv_in`
- `lnd_in`
- `mosart_in`

- **CaseDocs** contains copies of the namelists for reference only (should not be edited)

- **case.build** creates namelists in the run directory
Looking at Namelist Files

Note: These files tell the input datasets and model options that your simulation is set up to use. Do not change these xxx_in files directly. If changes are necessary, modify the user_nl_xxx files.

Open and view the Ind_in file using one of these options

Option 1

- navigate to the CaseDocs directory inside you case directory
  
  \texttt{cd \textasciitilde/clm\_tutorial\_cases/I2000CLM50\_001/CaseDocs}

- Open \texttt{Ind\_in} with text editor of your choice (VI, emacs, etc)
  
  \texttt{emacs Ind\_in}

Option 2

- navigate to the run directory
  
  \texttt{cd /glade/scratch/\$USER/I2000CLM50\_001/run}

- Open \texttt{Ind\_in} with text editor of your choice (VI, emacs, etc)
  
  \texttt{emacs Ind\_in}

Reminder: Do not change these files directly. If changes are necessary, modify the user_nl_xxx files.
Beginning of the `lnx_in` file

```plaintext
beginning of the lnx_in file
```
Beginning of the `Ind_in` file

```
clm_inparm
albIce = 0.50,0.30
co2 ppmv = 387.0
co2_type = 'constant'
create_crop_landunit = .true.
dtime = 1800
fatmIndfc = '/glade/p/cesmdata/cseg/inputdata/share/domains/domain.1nd_fv1.9x2.5_gx1v7.170518.nc'
findat = '/glade/p/cesmdata/cseg/inputdata/nd/clm2/initdata_map/clm1.2000_clm500gcCrop.2011-01-01.1.9x2.5_gx1v7_gl4_simyr2000_c180715.nc'
fsnowaging = '/glade/p/cesmdata/cseg/inputdata/nd/clm2/snicardata/snicar_drdrtd_bst_fit_68_c070416.nc'
fsnowoptics = '/glade/p/cesmdata/cseg/inputdata/nd/clm2/snicardata/snicar_optics_bnd_c090915.nc'
fsurdat = '/glade/p/cesmdata/cseg/inputdata/nd/clm2/surfdata_map/surfdata_1.9x2.5_16pfts_Irrig_CMIP5_simyr2000_c170824.nc'
gl_do_dnglacier = .true.
glc_snow_persistence_max_days = 0
h2osno_max = 10000.0
int_snow_max = 2000.
irrigate = .true.
maxpatch_glcmec = 10
maxpatch_pft = 17
melt_glcmec = 10.0d00
nlevsno = 12
nsegspc = 35
paramfile = '/glade/p/cesmdata/cseg/inputdata/nd/clm2/paramdata/clm5_params.c171117.nc'
run_zero_weight_urban = .false.
soil_layerstruct = '20SL_8.5m'
spinup_state = 0
use_bedrock = .true.
use_century_decomp = .false.
use_cn = .false.
use_crop = .false.
use_dynroot = .false.
use_fates = .false.
use_fertilizer = .false.
use_fun = .false.
use_grainproduct = .false.
use_hydrstres = .true.
use_init_interp = .true.
use_lai_streams = .false.
use_lch4 = .false.
use_luna = .true.
use_nitrif_denitrif = .false.
use_vertsoilc = .false.
```
Exercise 2.2: Modify Namelist
Changing data record frequency with a new case

Navigate to the scripts directory in the source code directory:
```
cd /glade/u/home/$USER/clm5.0_2019tutorial/cime/scripts
```

(1) create a new case

Type this command line
```
./create_newcase --case ~/clm_tutorial_cases/I2000CLM50_002 --res f19_g17 --compset I2000Clm50Sp --project UCGD0004
```

(2) invoke case.setup

Create a new case for exercise 2.2

(3) build the executable

(4) submit your run to the batch queue
Exercise 2.2: Modify Namelist
Changing data record frequency with a new case

Type this command line:
```
./create_newcase --case ~/clm_tutorial_cases/I2000CLM50_002 --res f19_g17 --compset I2000Clm50Sp --project UCGD0004
```

(1) create a new case

Navigate to the scripts directory in the source code directory:
```
cd /glade/u/home/$USER/clm5.0_2019tutorial/cime/scripts
```
(2) invoke case.setup

Navigate to the case directory
```
cd ~/clm_tutorial_cases/I2000CLM50_002
```
Type this command line:
```
./case.setup
```
(3) build the executable

Type this command line:
```
qcmd -q R4231039 -- ./case.build
```
Type this command line:
```
./xmlchange STOP_OPTION=nyears
./xmlchange STOP_N=2
./xmlchange JOB_WALLCLOCK_TIME=1:00:00
./xmlchange PROJECT=UCGD0004
```
After step 3, update to run for 2 years, reduce wall clock time, and specify Project code

(4) submit your run to the batch queue
Exercise 2.2: Modify Namelist
Changing data record frequency with a new case

Navigate to the scripts directory in the source code directory:
cd /glade/u/home/$USER/clm5.0_2019tutorial/cime/scripts

(1) create a new case

Type this command line:
./create_newcase --case ~/clm_tutorial_cases/I2000CLM50_002 --res f19_g17 --compset I2000Clm50Sp --project UCGD0004

(2) invoke case.setup

Navigate to the case directory
cd ~/clm_tutorial_cases/I2000CLM50_002
Type this command line:
./case.setup

(3) build the executable

Type this command line:
qcmd -q R4231039 -- ./case.build

After xmlchanges, modify the namelist before submit

(4) submit your run to the batch queue
Example Modification: user_nl_clm

Changing the frequency of model output

**hist_mfilt**: Number of samples within a file

**Default** is 1

Setting value to 12 would put 12 records into a single file
**Example Modification: user_nl_clm**

Changing the frequency of model output

**hist_mfilt:** Number of samples within a file

**Default** is 1

Setting value to 12 would put 12 records into a single file

**hist_nhtfrq:** Frequency that data are recorded and written to a file

**Default** is 0; means that output is recorded every month (monthly averages)

**Positive Values** represent number of model timesteps (half-hourly) for output record

Ex: 48 means output is recorded every day (daily averages)

**Negative Values** represent absolute value in hours for output record

Ex: -1 means output is recorded hourly; -24 means output is recorded daily

* Both hist_mfilt & hist_nhtfrq must be integers
What values of `hist_mfilt` and `hist_nhtfrq` will produce:

• Daily output?

AND

• 1 year of output in each history file?

TO DO: Identify the values needed for these two namelist settings in order to update `user_nl_clm`. 
Exercise 2.2: Modify Namelist
Changing data record frequency with a new case

Navigate to the Case directory

cd ~/clm_tutorial_cases/I2000CLM50_002

Open user_nl_clm with text editor of your choice (VI, emacs, etc)

emacs user_nl_clm

Add this text to the bottom of the file:

hist_mfilt=365
hist_nhtfrq=-24

These changes will produce daily output with each year written to a separate file.

This changes the default settings, as used in the I1850 and I2000_001 case, from monthly output with each month written to a separate file.
Exercise 2.2: Modify Namelist
Changing data record frequency with a new case

Navigate to the scripts directory in the source code directory:
```bash
cd /glade/u/home/$USER/clm5.0_2019tutorial/cime/scripts
```

(1) create a new case

Type this command line:
```bash
./create_newcase --case ~/clm_tutorial_cases/I2000CLM50_002 --res f19_g17 --compset I2000Clm50Sp --project UCGD0004
```

(2) invoke case.setup

Navigate to the case directory:
```bash
cd ~/clm_tutorial_cases/I2000CLM50_002
```
Type this command line:
```bash
./case.setup
```

(3) build the executable

Type this command line:
```bash
qcmd -q R4210171 -- ./case.build
```

After modifying namelist, submit the case:

(4) submit your run to the batch queue

Type this command line:
```bash
./case.submit
```

Note: The case.submit script will automatically update and check the namelists. If you want to update and check your namelists before submitting, you can also run `./preview_namelists` from your case directory.
Today’s Exercises:
3 Types of Basic Modifications

1. Change Component Set

2. Modify Namelist file

3. Change a Parameter
   Altering medlynslope to change stomatal conductance
Medlynslope parameter

This parameter represents the slope of the stomatal conductance – photosynthesis relationship

From the CLM5 Documentation:

\[
g_s = g_o + 1.6(1 + \frac{g_1}{\sqrt{D}}) \frac{A_n}{c_s/P_{atm}}
\]

- stomatal conductance
- medlynslope
- photosynthesis

Medlyn et al. (2011)
Exercise 2.3: Update a Parameter
Altering medlynslope to change stomatal conductance
Exercise 2.3: Update a Parameter
Altering medlynslope to change stomatal conductance

Navigate to the scripts directory in the source code directory:

cd /glade/u/home/$USER/clm5.0_2019tutorial/cime/scripts

(1) create a new case
Type this command line
./create_newcase --case ~/clm_tutorial_cases/I2000CLM50_003 --res f19_g17 --compset I2000Clm50Sp --project UC0004

(2) invoke case.setup

(3) build the executable

(4) submit your run to the batch queue
Exercise 2.3: Update a parameter
Set up and build new case to run for 5 years

1. create a new case

Type this command line
./create_newcase --case ~/clm_tutorial_cases/I2000CLM50_003 --res f19_g17 --compset I2000Clm50Sp --project UCGD0004

2. invoke case.setup

Navigate to the case directory
cd ~/clm_tutorial_cases/I2000CLM50_003
Type this command line
./case.setup

3. build the executable

Type this command line:
qcmd -q R4231039 -- ./case.build
Type this command line:
./xmlchange STOP_OPTION=nyears
./xmlchange JOB_WALLCLOCK_TIME=1:00:00
./xmlchange PROJECT=UCGD0004

After step 3, update to run for 5 years, reduce wall clock time, and specify Project code

4. submit your run to the batch queue
Exercise 2.3: Update a Parameter
Altering medlynslope to change stomatal conductance

Navigate to the scripts directory in the source code directory:
```bash
cd /glade/u/home/$USER/clm5.0_2019tutorial/cime/scripts
```

(1) create a new case

Type this command line
```bash
./create_newcase --case ~/clm_tutorial_cases/I2000CLM50_003 --res f19_g17 --compset I2000Clm50Sp --project UCGD0004
```

(2) invoke case.setup

Navigate to the case directory
```bash
cd ~/clm_tutorial_cases/I2000CLM50_003
```
Type this command line
```bash
./case.setup
```

(3) build the executable

Type this command line:
```bash
qcmd -q R4231039 -- ./case.build
```

After xmlchanges, update the parameter file before you submit

(4) submit your run to the batch queue
Exercise 2.3: Update a Parameter
Altering medlynslope to change stomatal conductance

Navigate to the CaseDocs inside your Case directory
`cd ~/clm_tutorial_cases/I2000CLM50_003/CaseDocs`

Open `Ind_in` with text editor of your choice (VI, emacs, etc)
`emacs Ind_in`

In `Ind_in` find path for `paramfile` and copy this file to your case directory
`cp <paramfile> ~/clm_tutorial_cases/I2000CLM50_003/`
`cd ~/clm_tutorial_cases/I2000CLM50_003`

Next: We’ll present 2 options for modifying this file, but ask that everyone follow option 1 for this exercise
Exercise 2.3: Update a Parameter
Altering medlynslope to change stomatal conductance

**Option 1: netCDF Operators**

*Load the NCO operators*

```
module load nco
```


```
ncap2 -s "medlynslope=medlynslope*0.9" clm5_params.c171117.nc <new_param_file_name>
```

The parameter we want to change is called “medlynslope”

We will decrease all the values of this parameter by 10%

Create a new file name for this modified file (include .nc file extension, for example `new_file.nc`)
Exercise 2.3: Update a Parameter

Altering medlynslope to change stomatal conductance

Option 1: netCDF Operators

Load the NCO operators

module load nco

Modify copy of parameter file using netCDF Operators or NCO (http://nco.sourceforge.net/)
ncap2 -s "medlynslope=medlynslope*0.9" clm5_params.c171117.nc <new_param_file_name>

Then, set new path for paramfile in user_nl_clm

Navigate to the Case directory

cd ~/clm_tutorial_cases/I2000CLM50_003

Open user_nl_clm with text editor of your choice (VI, emacs, etc)

dmacs user_nl_clm

Add this text to the bottom of user_nl_clm (filling in brackets as appropriate):

paramfile = '/glade/u/home/$USER/clm_tutorial_cases/I2000CLM50_003/<new_param_file_name>"
Exercise 2.3: Update a Parameter
Altering medlynslope to change stomatal conductance

Option 2: ncdump and ncgen

Navigate to the CaseDocs inside your Case directory

cd ~/clm_tutorial_cases/I2000CLM50_003/CaseDocs

Open *Ind_in* with text editor of your choice (VI, emacs, etc)

```bash
evens 1nd_in
```

In *Ind_in* find path for *paramfile* and copy file to your case directory

```bash
cp <paramfile> ~/clm_tutorial_cases/I2000CLM50_003/.
cd ~/clm_tutorial_cases/I2000CLM50_003
```

Create a cdl file and open with a text editor

Then, update “medlynslope” by replacing with a new value

```bash
ncdump clm5_params.c171117.nc > clm5_temp.cdl
evens clm5_temp.cdl
```

**NOTE:** For updating a whole set of PFT parameter values, such as this, using NCO commands are less error prone. ncdump and ncgen are useful for smaller changes. We present the syntax here, but you do not need to modify these by hand, since you did this in option 1 with an NCO command.
Exercise 2.3: Update a Parameter
Altering medlynslope to change stomatal conductance

**Option 2: ncdump and ncgen**

Navigate to the CaseDocs inside your Case directory
```
cd ~/clm_tutorial_cases/I2000CLM50_003/CaseDocs
```

Open `lnd_in` with text editor of your choice (VI, emacs, etc)
```
emacs lnd_in
```

In `lnd_in` find path for `paramfile` and copy file to your case directory
```
cp <paramfile> ~/clm_tutorial_cases/I2000CLM50_003/.
cd ~/clm_tutorial_cases/I2000CLM50_003
```

Create a cdl file and open with a text editor
```
Then, update “medlynslope” by replacing with a new value
ncdump clm5_params.c171117.nc > clm5_temp.cdl
emacs clm5_temp.cdl
```

Create a new nc file from your edited cdl file
```
ncgen -o clm5_medlynless10.nc clm5_temp.cdl
```

Set new path for `paramfile` in `user_nl_clm`
```
Add this text to the bottom of the file:
paramfile = '/glade/u/home/$USER/clm_tutorial_cases/I2000CLM50_003/clm5_medlynless10.nc'
```

Reminder: you are not making changes here, you made these modifications with Option 1.
Exercise 2.3: Update a Parameter
Altering medlynslope to change stomatal conductance

Navigate to the scripts directory in the source code directory:

```
cd /glade/u/home/$USER/clm5.0_2019tutorial/cime/scripts
```

(1) create a new case

Type this command line:

```
./create_newcase --case ~/clm_tutorial_cases/I2000CLM50_003 --res f19_g17 --compset I2000Clm50Sp --project UCGD0004
```

(2) invoke case.setup

Navigate to the case directory

```
cd ~/I2000CLM50_003
```

Type this command line:

```
./case.setup
```

(3) build the executable

Type this command line:

```
qcmd -q R4231039 -- ./case.build
```

After updating parameter file submit the case

(4) submit your run to the batch queue

Type this command line:

```
./case.submit
```
Lecture/Intro

• Review Practical 1
• Why change model setup?

Practical

• Checkout a Local Branch on Git
• Changing Model Setup
  1) Component sets
  2) Namelist files
  3) Parameter changes
• Data Analysis with Jupyter Notebook
Basic Analysis using Jupyter Lab

Using a web browser, navigate to this website:

http://jupyterhub.ucar.edu/ch

Log into the website using your cheyenne log in credentials: your username and yubikey (as the password).

This will navigate to a webpage with “Spawner Options”. You’ll need to enter today’s Reservation number and the JupyterHub project number and then click “Spawn”

Enter today’s Reservation number here: R4231039

Enter Project number here: UCGD0004
Basic Analysis using Jupyter Lab

This will take you a new page that will allow you to explore the CLM output using code we developed in Jupyter Lab. On the left, navigate to the “notebooks” directory, and then click on “Practical2”. This will bring up the lab, with sections of code and comments on the left. Run through the exercises here. You can use the ▶ on the navigation bar or use the keyboard commands “shift” + “return” to run each cell.
Using the Jupyter notebook, you will analyze CLM output from all three exercises. (Don’t worry if your simulations haven’t finished, we provide the output for you.)

• Exercise 2.1
  • Look at the difference between this simulation with year 2000 compset, and Day 1 practical simulation with year 1850 compset.

• Exercise 2.2
  • Look at a timeseries of daily output from this simulation compared to a timeseries of monthly output from Exercise 2.1.

• Exercise 2.3
  • Look at the difference between this simulation with medlynslope decrease, and the simulation from Exercise 2.1 with the default parameter value.
Now **YOU** know how to run and modify CLM!

Use these **3 basic modifications** to run a variety of simulations.

1. Component Sets
2. Namelist files
3. Parameter changes

*Congratulations on learning these new skills! Tomorrow, you will learn about tracking bugs and coding best practices.*
Documenting Your Changes: README files

In your case directory, you will find automatically generated documentation files.

**README.case file**: detailed information on your compset and resolution, including whether your configuration has science support.

**Best Practice**: In the **README.case file**, we highly recommend YOU document any changes you make to the default scripts. It is YOUR paper trail and opportunity to list modifications.
Bonus Exercises: Test Your Knowledge

1) Set up a 2-degree CLM5.0-BGC simulation for 2000 and run for 1 month with daily history files.

2) Set up a 2-degree CLM5.0-BGC historical simulation and run for 5 years with monthly history files.

3) Set up a 1-degree CLM5.0-BGC 1850 simulation and run for 1 year with monthly history files.