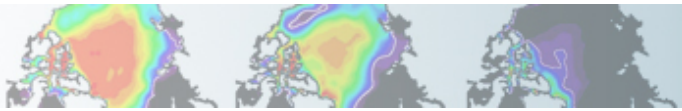


Namelist and Code Modifications

Part 1: Namelist Modifications

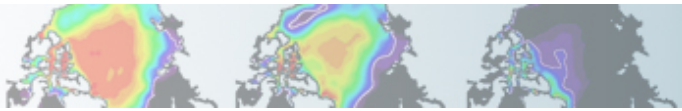
Part 2: Code Modifications

Part 3: Exercises and Quiz

Cecile Hannay, CAM Science Liaison
Atmospheric Modeling and Predictability Section
Climate and Global Dynamics Division

“I can only show you the door. You're the one that has to walk through it”

(The Matrix, 1999)



Part 1: Namelist Modifications

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- review the "CESM flow" and how to make namelist changes,

- see where to find documentation for namelist variables

- as an illustration, we will customize the output history files to get high frequency output

Review: The 4 commands to run CESM

Set of commands to build and run the model on ”cheyenne”

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# if you use tcsh shell
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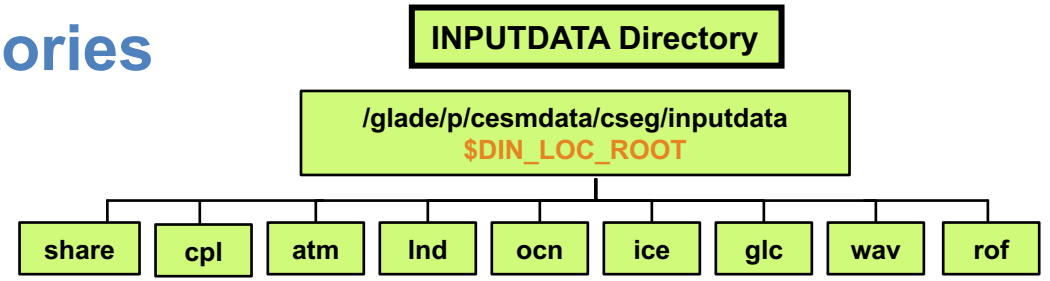
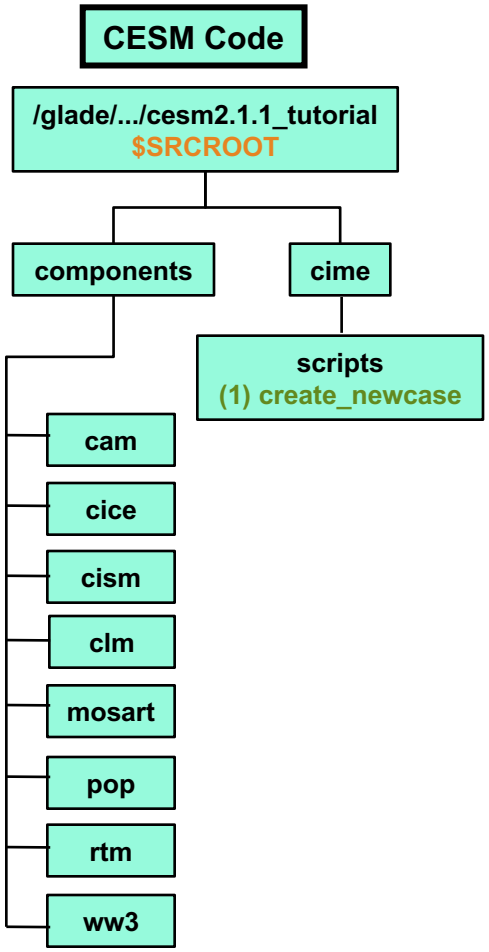
For tutorial only

"qcmd" is for Cheyenne only

Overview of CESM directories before create_newcase



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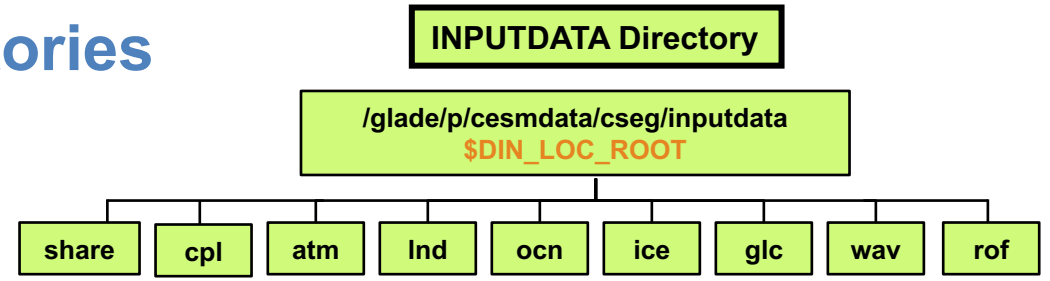

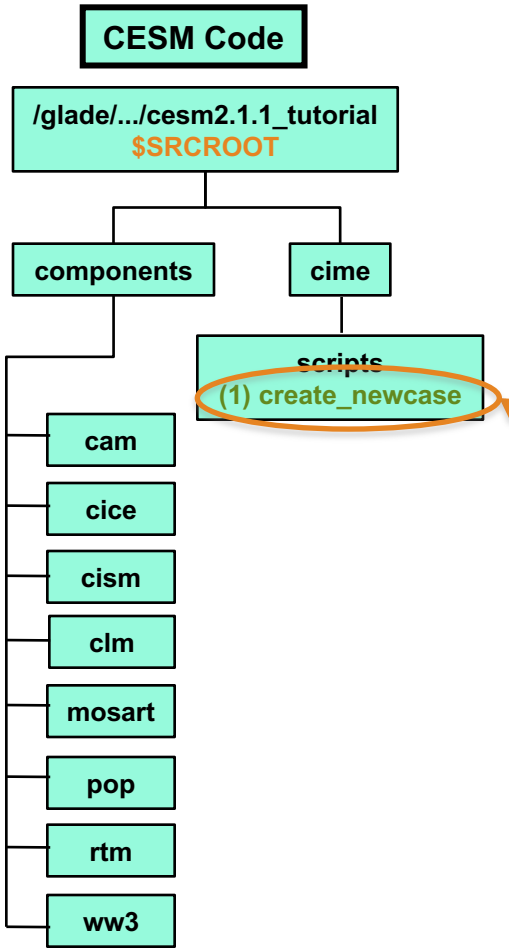


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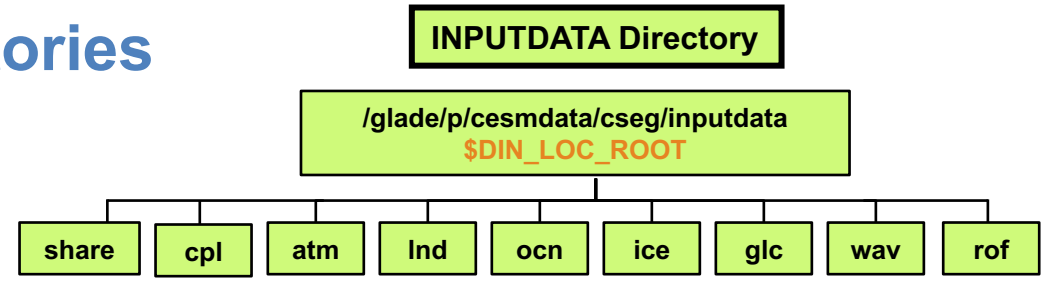

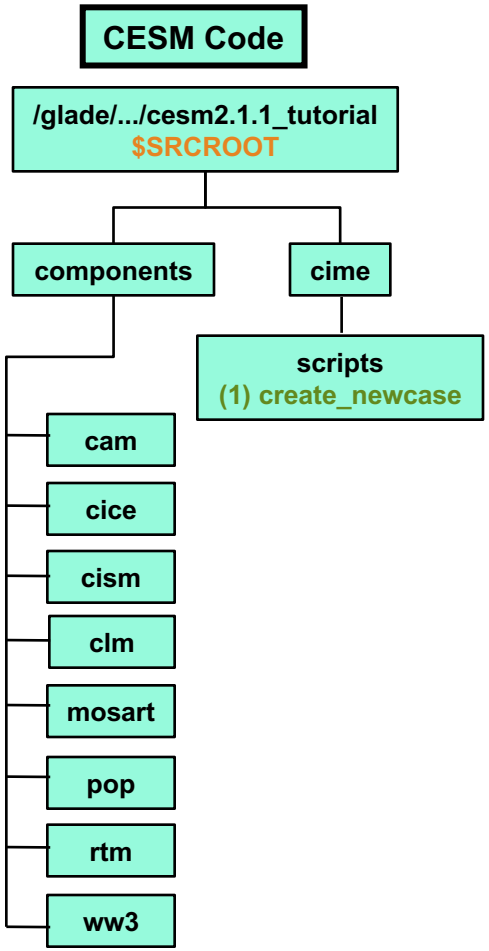

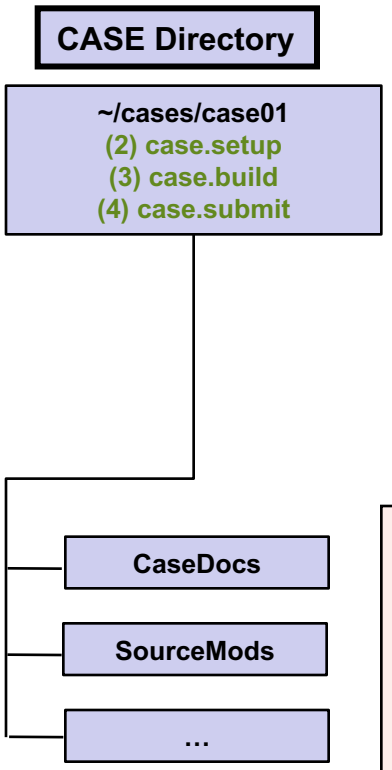

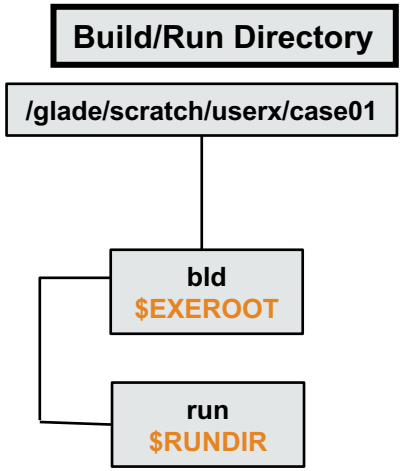


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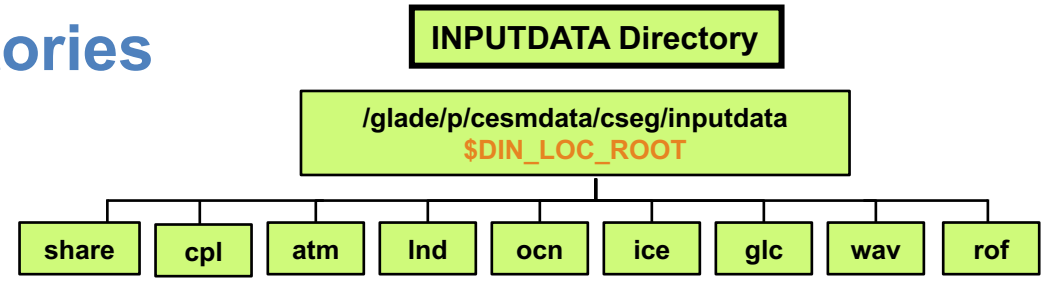
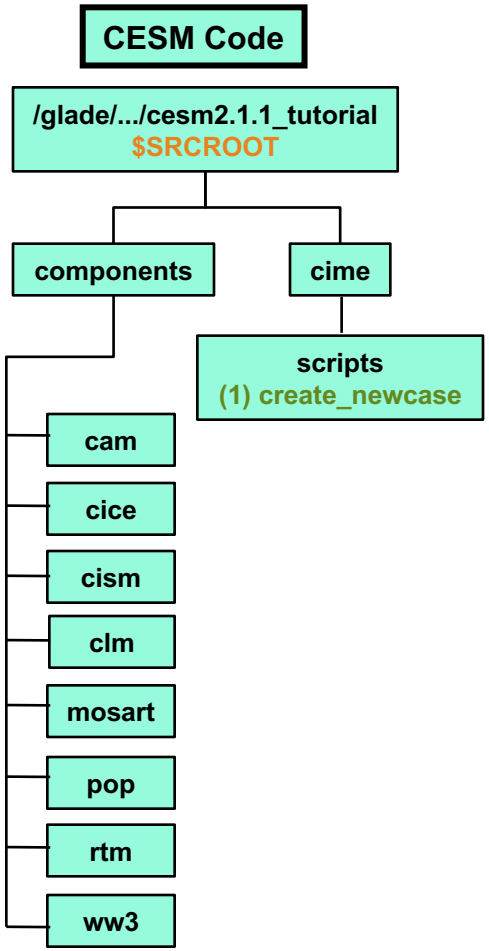
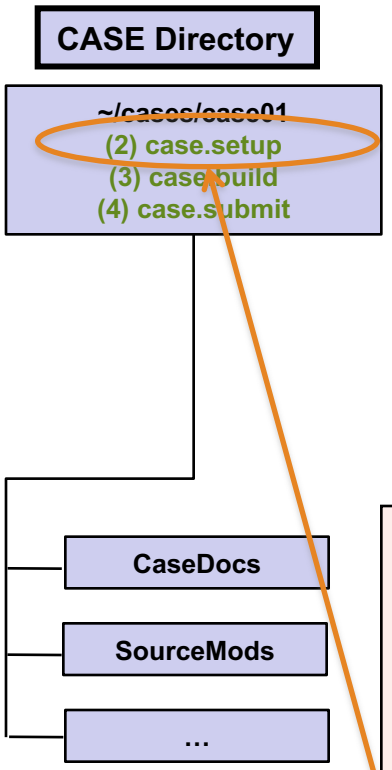
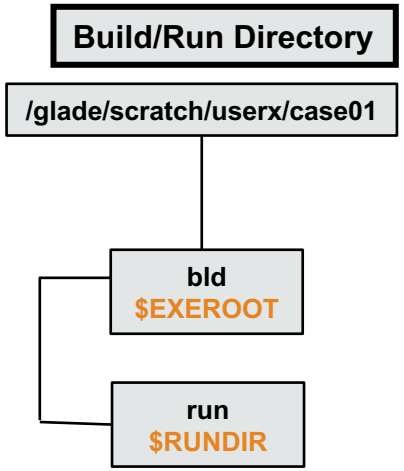
Overview of CESM directories + 4 CESM commands







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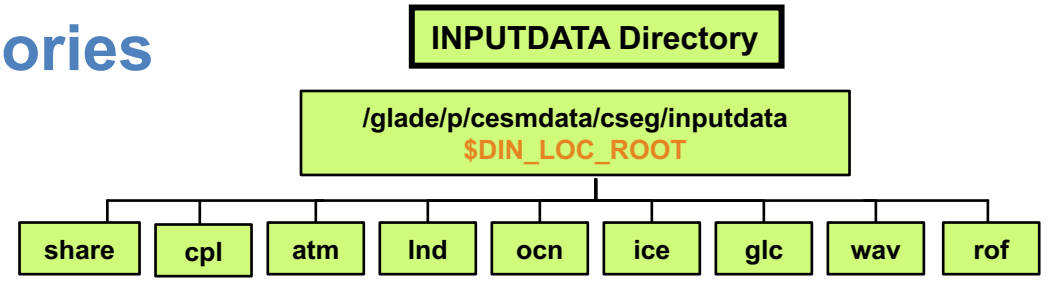

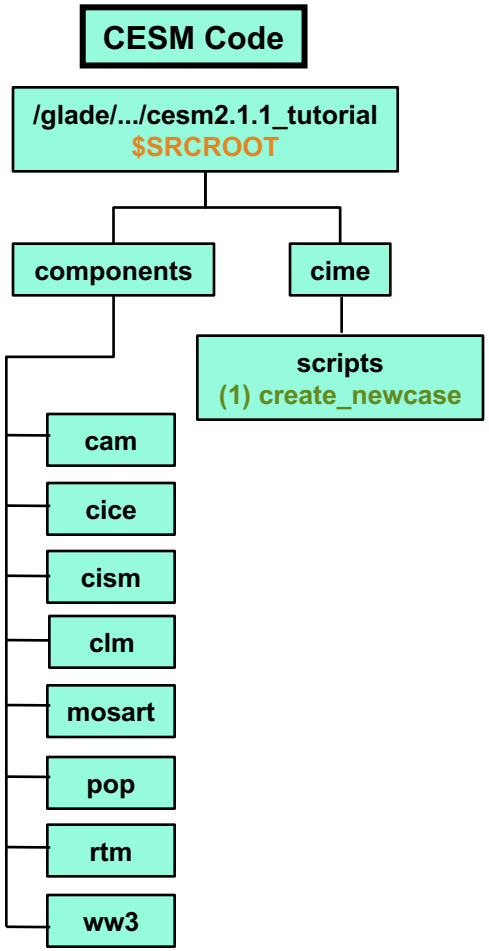

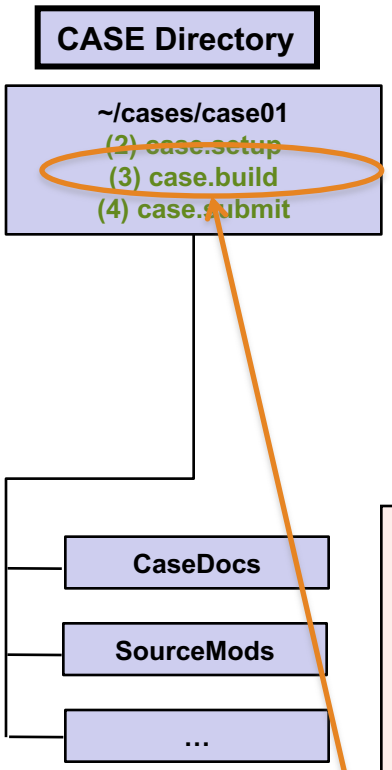

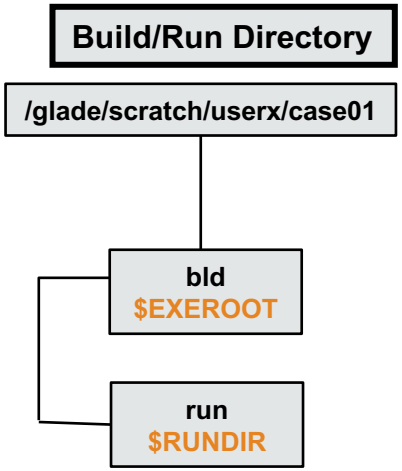


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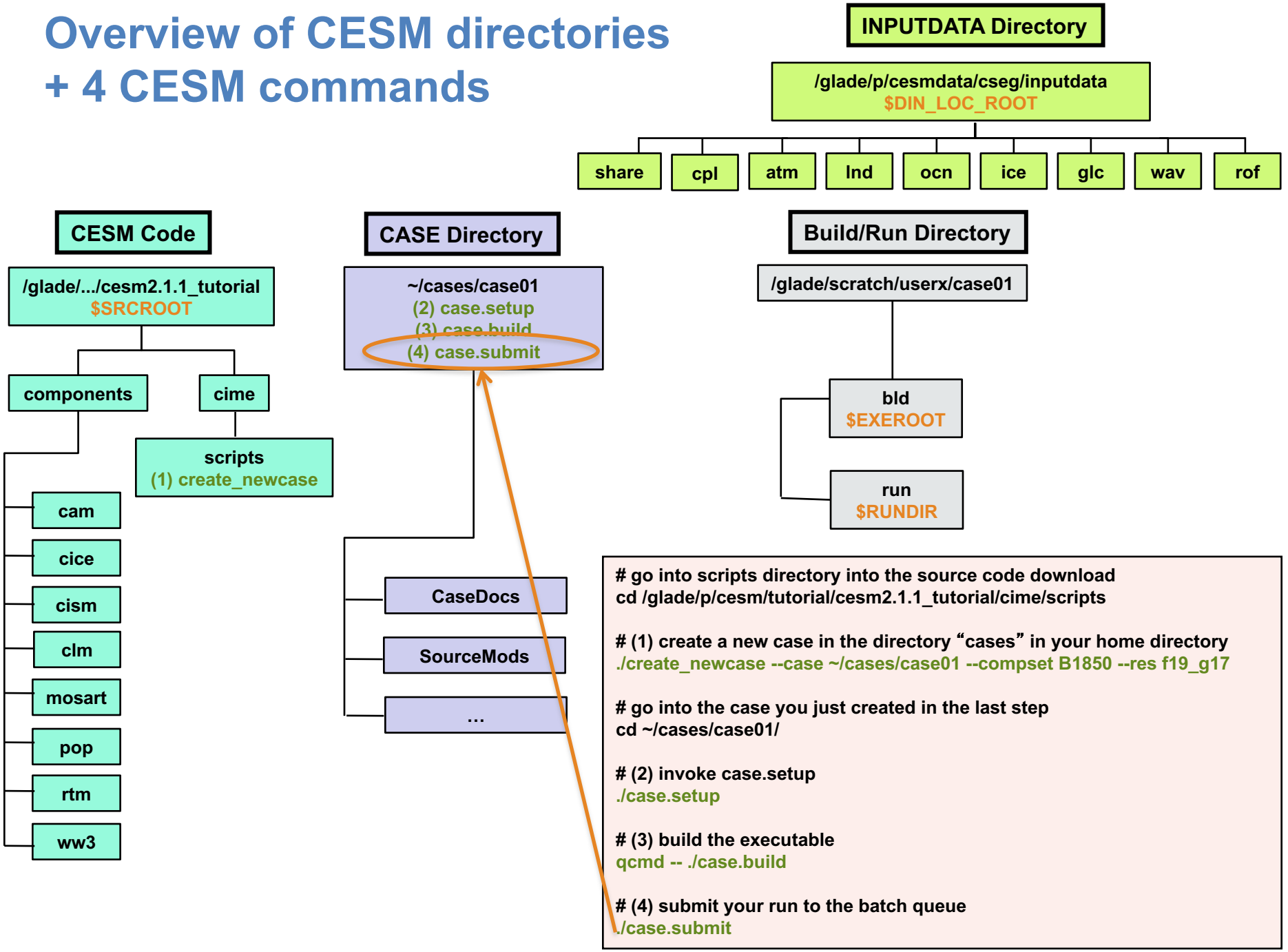

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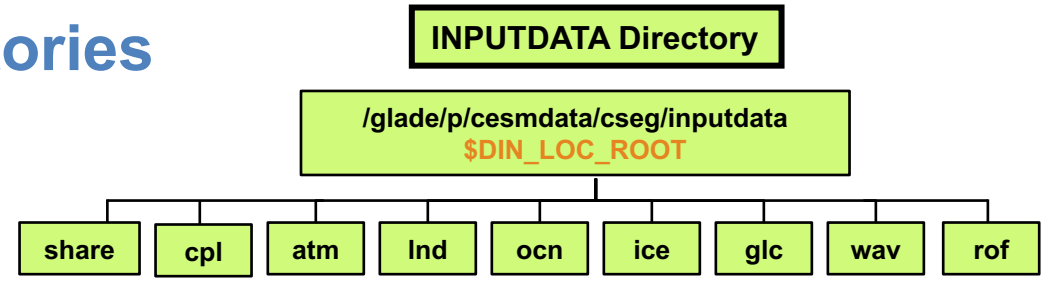

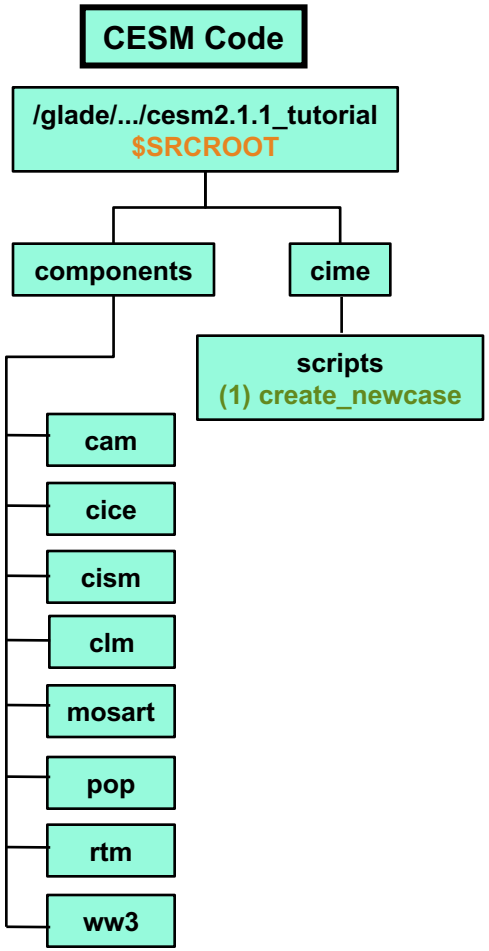

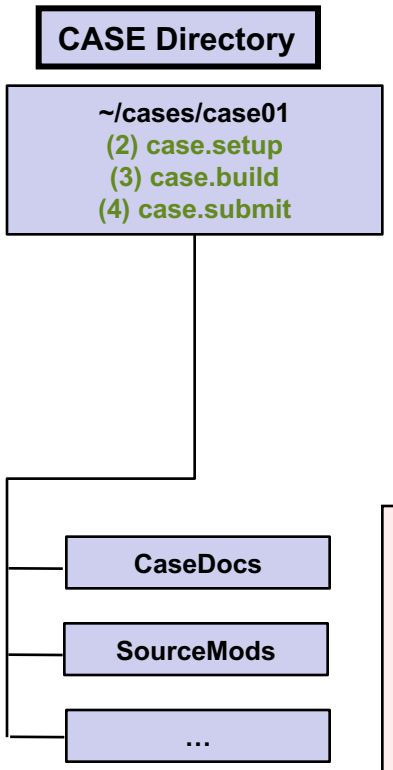

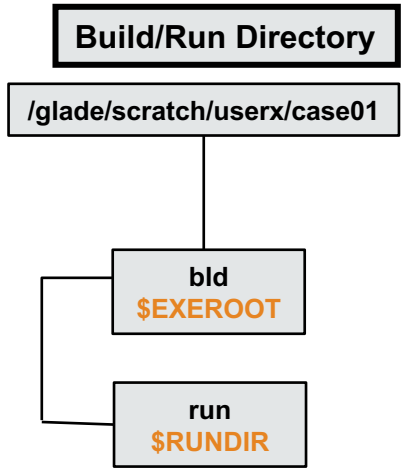


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This is when you can modify the namelists

Overview of CESM directories + 4 CESM commands

INPUTDATA Directory

/glade/p/cesmdata/cseg/inputdata
$DIN_LOC_ROOT

share | cpl | atm | lnd | ocn | ice | glc | wav | rof

CESM Code

/glade/.../cesm2.1.1_tutorial
$SRCROOT

components | cime

scripts
(1) create_newcase

cam
cice
cism
clm
mosart
pop
rtm
ww3

CASE Directory

~/cases/case01
(2) case.setup
(3) case.build
(4) case.submit
user_nl_cam
user_nl_cice
user_nl_cism
user_nl_clm
user_nl_cpl
user_nl_mosart
user_nl_pop
user_nl_ww

case.setup creates namelist modification files user_nl_xxx
this is where you modify your namelists

CaseDocs
atm_in
cism_in
drv_flds_in
drv_in
ice_in
lnd_in
mosart_in
pop_in
wav_in

CaseDocs contains copy of the namelists for reference only

(should not be edited)

SourceMods

...

Build/Run Directory

/glade/scratch/userx/case01

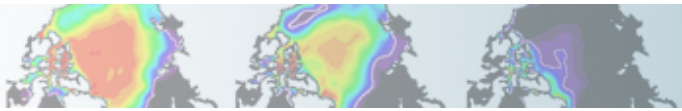
bld
$EXEROOT

run
$RUNDIR
atm_in
cism_in
drv_flds_in
drv_in
ice_in
lnd_in
mosart_in
pop_in
wav_in

The build script creates namelists in the run directory

This is used by the model at runtime

(should not be edited)



Part 1: Namelist Modifications

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- review the "CESM flow" and how to make namelist changes,

- see where to find documentation for namelist variables

- as an illustration, we will customize the output history files to get high frequency output

Where to find info about namelists ?

http://www.cesm.ucar.edu/models/cesm2

In "Prognostic Components" or in "Components Configuration Settings", you can find information about namelist variables in:
"Component Fortran Namelist settings"

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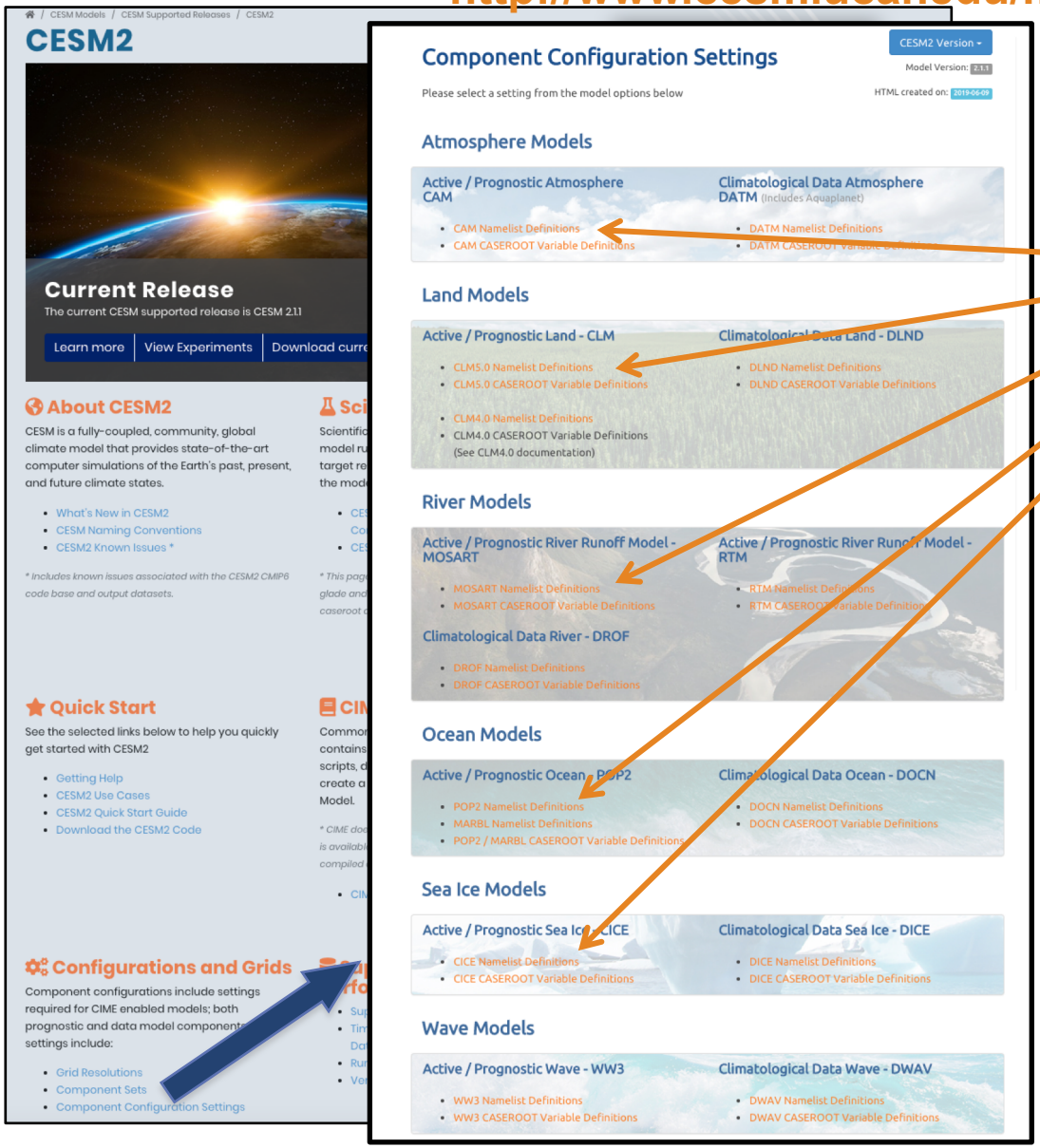

Namelist definitions for every component

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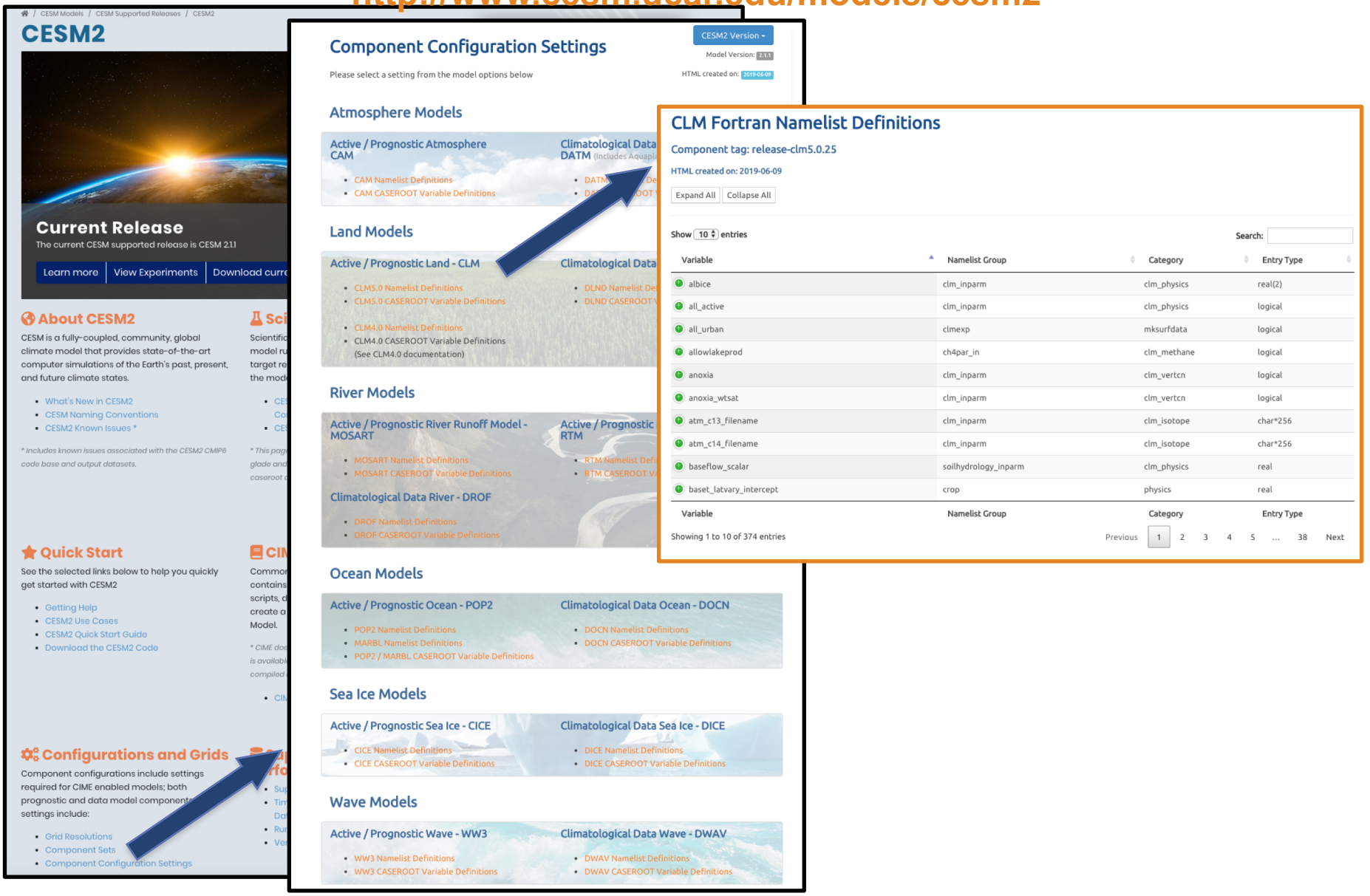

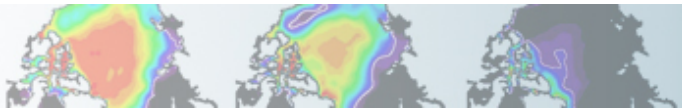

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Let's change the output frequency in CAM**

By default, CESM outputs monthly average history files but you can output at other frequency.

For instance: to change the output frequency of a CAM history file from monthly average to daily average,
we use the namelist variable: *nhtfrq=-24*

***** In this tutorial, examples will be coming from the atmospheric model. Concepts are transferable to other model components.***

Customizing CAM history files

In this section, we will cover:

- **how to change the output frequency**
- **how to output extra variables**
- **how to output extra history files**
- **how to control the number of time samples written to a history file**

This can be achieved with 3 namelist variables:

- ***nhtfrq*: sets the output frequency**
- ***fincl*: add variables to the history file**
- ***mfilt*: maximum number of time samples written to a history file**

Customizing CAM history files: nhtfrq

The default history file from CAM is a monthly average.

We can change the output frequency with the namelist variable *nhtfrq*

If nhtfrq=0, the file will be a monthly average
If nhtfrq>0, frequency is input as number of timesteps.

If nhtfrq<0, frequency is input as number of hours.

For instance to change the history file from monthly average to daily average, we set the namelist variable:
nhtfrq = -24

Customizing CAM history files: mfilt

To control the number of time samples in the history file, we can use the variable *mfilt*

For instance, to specify that we want 10 time samples on each history file, we set the namelist variable:

mfilt = 10

For instance, if we output daily data for a 1 year run:

nhtfrq = -24
mfilt = 365 ***=> 1 history file with 365 time samples***

nhtfrq = -24
mfilt = 1 ***=> 365 history files with 1 time sample***

NB: we cannot change mfilt for monthly frequency. For monthly frequency, mfilt = 1

Customizing CAM history files: fincl

You can output up to 10 history files: "h0", "h1", …, "h9".

The file "h0" contains the default variables (in the code: "call add_default"). This includes the variables necessary for the AMWG package.

For the files "h1" to "h9", the user has to specify the variables to output.

To control the list of fields in the history files we can use the namelist variables

h0	*h1*	…	*h9*
fincl1	*fincl2*	…	*fincl10*

For instance, the line:

fincl1 = 'PRECT'

is used to add the field *'PRECT'* to the file "h0"

Customizing CAM history files: fincl

Using a ":" following a field gives the averaging flag for the output field.

Valid flags are:

- **A ==> Average**
- **B ==> GMT 00:00:00 average**
- **I ==> Instantaneous**
- **M ==> Minimum**
- **X ==> Maximum**
- **L ==> Local-time**
- **S ==> Standard deviation**

For instance, the line:

fincl1 = 'PRECT:M'

is used to add the minimum of 'PREC' to the file "h0"

Example of customizing history files

For instance, what happen if we set:

fincl2 = 'T:I','Q:I','U:I','V:I'
nhtfrq = 0, -3
mfilt = 1, 8

In addition to the monthly history file "h0",
we output the file "h1"
with instantaneous values of T, Q, U, V every 3 hour
We have 8 time samples in each h1 file (we create a new file every day)

NB: If you plan to run the AMWG diagnostic package, it is recommended to leave the "h0" file untouched and to add extra history files

Outputting high frequency data in other components

Here is a few variables to control output frequency of land, ice and ocean

CLM

hist_nhtfrq: output frequency of the history file

hist_mfilt: number of samples on each history file

hist_fincl: adding variables and auxiliary history files

Example

user_nl_clm to output 4 extra history files with daily, six-hourly, hourly, and every time-step values of TG and TV (leaving the primary history files as monthly):

hist_fincl2 = 'TG', 'TV'
hist_fincl3 = 'TG', 'TV'
hist_fincl4 = 'TG', 'TV'
hist_fincl5 = 'TG', 'TV'
hist_nhtfrq = 0, -24, -6, -1, 1

http://www.cesm.ucar.edu/models/cesm2/settings/current/clm5_0_nml.html

Outputting high frequency data in other components

CICE

histfreq: Frequency of output written to history files ('1', 'm', 'd', 'y', …)

histfreq_n: Frequency history data is written to history files

hist_avg: if false => instantaneous values

if true => time-averages

Example

user_nl_cice to output an extra history file with daily values (leaving the primary history file as monthly):

histfreq = 'm','d','x','x','x'

histfreq_n = 1,1,1,1,1

See: http://www.cesm.ucar.edu/models/cesm2/settings/current/cice_nml.html

Outputting high frequency data in other components

POP2

tavg_freq = frequency at which the model fields are written

tavg_freq_opt = units of time for 'tavg_freq' ('nmonth', 'nhour', 'once',…)

tavg_file_freq = frequency at which the model files are written

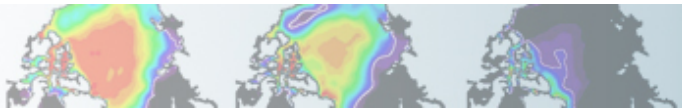
tavg_file_freq_opt = units of time for 'tavg_file_freq' ('nmonth', 'nhour', …)

http://www.cesm.ucar.edu/models/cesm2namelists/pop2_nml.html

For instance, to output a timeseries of daily averages bundled into a monthly file:

```
tavg_freq_opt = 'nday'
tavg_freq = 1
tavg_file_freq_opt = 'nmonth'
tavg_file_freq = 1
```

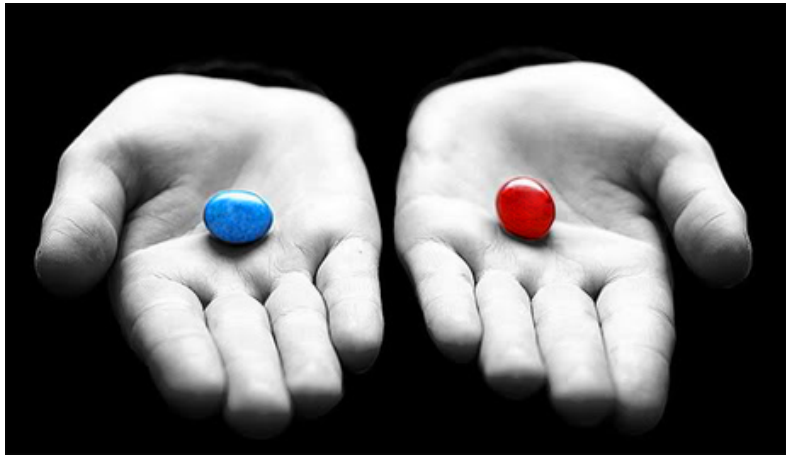
Changing tavg_nml variables is non standard
Do not modify these variables directly in user_nl_pop2
Use the workaround explained in user_nl_pop2



Part 2: Code Modification

In this section, we will learn how to do simple code modifications such adding a new variable

Your choice: The Red Pill or the Blue Pill



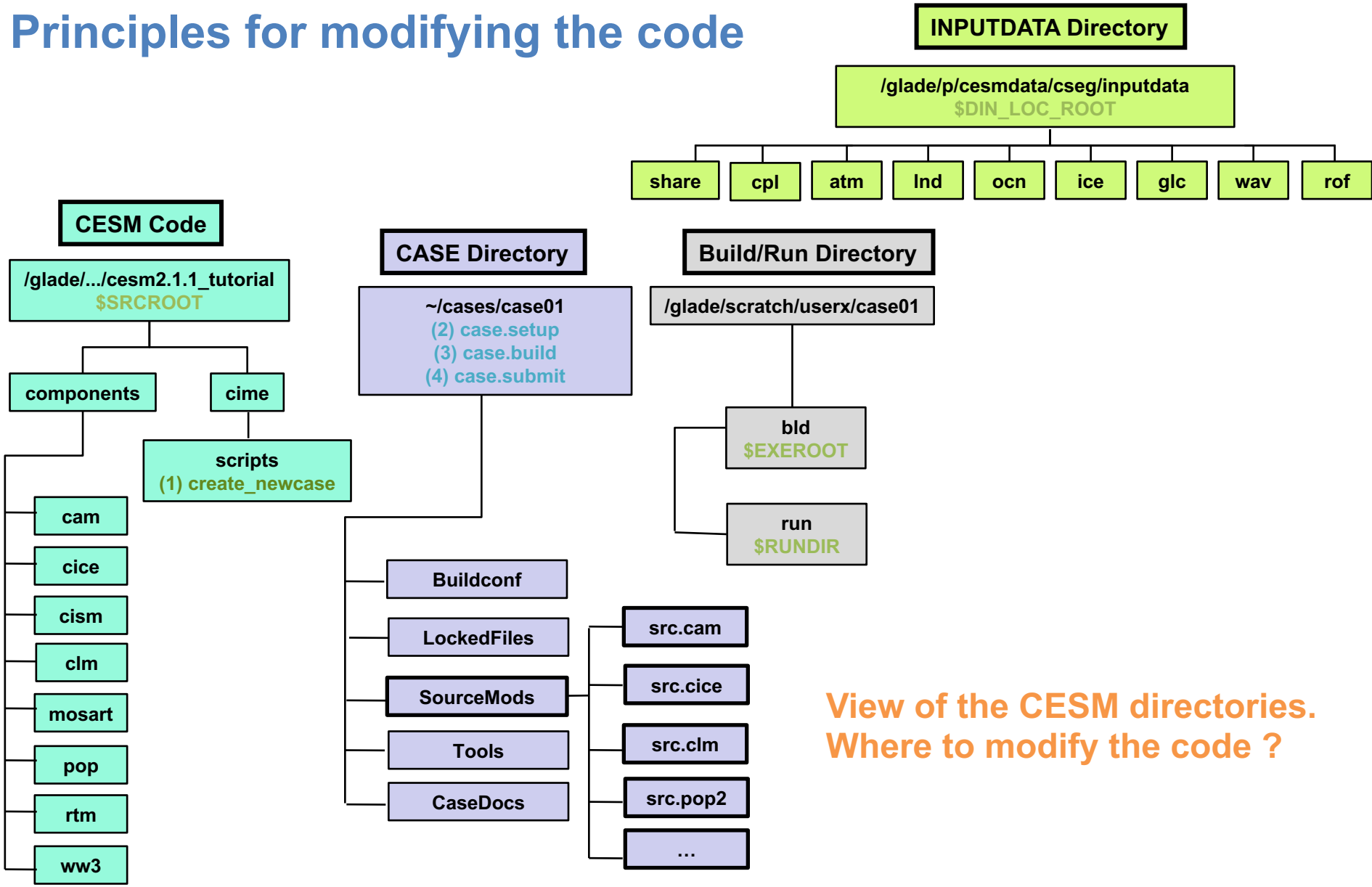
The Matrix (1999): Neo, the **main character is offered the choice between a red pill and a blue pill.**

-The blue pill would allow him to remain in the Matrix (a fictional computer-generated world)

-The red pill would lead to his "escape" from the Matrix into the real world and embracing the sometimes painful truth of reality.

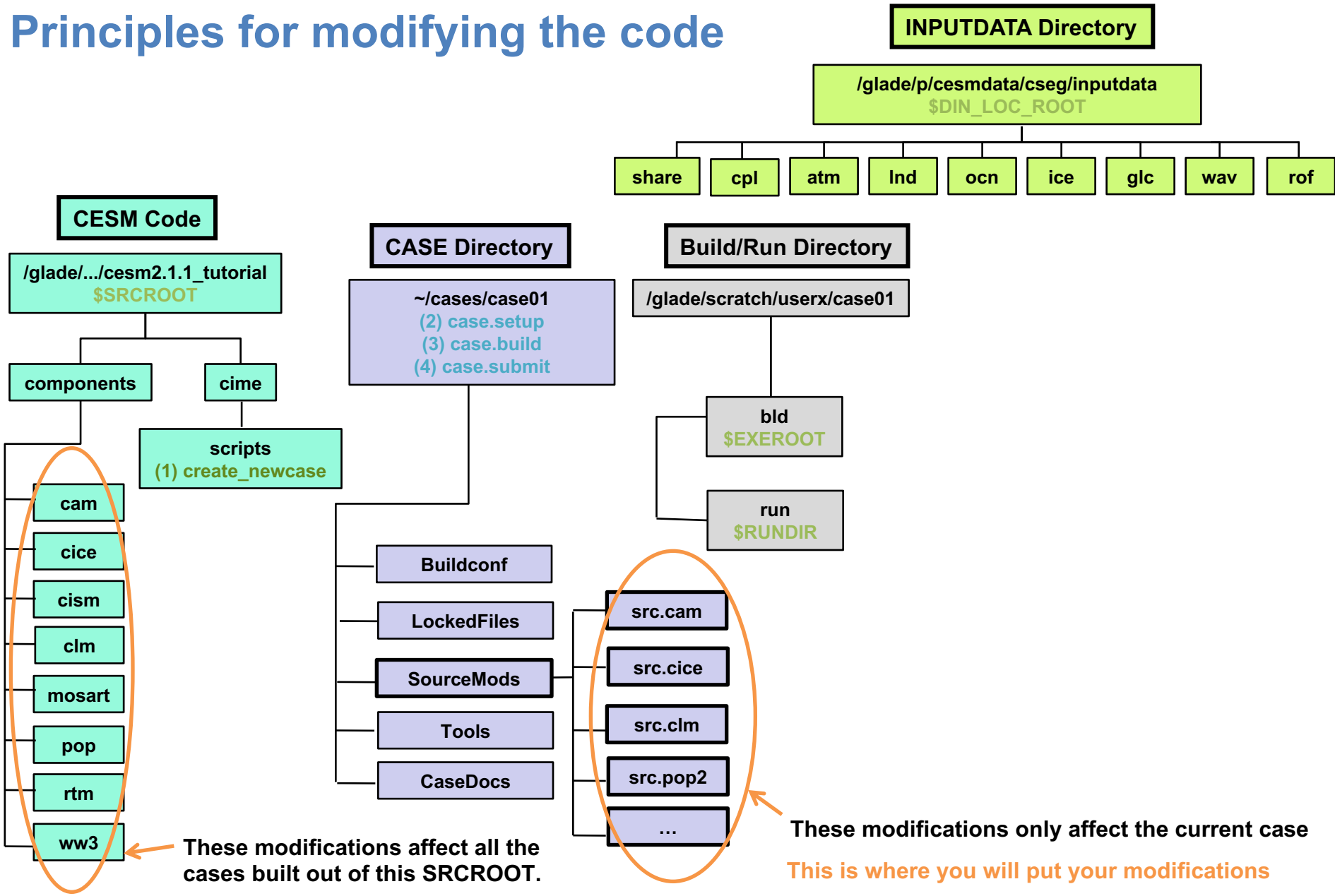
Courtesy: Andrew Gettelman

Principles for modifying the code



View of the CESM directories.
Where to modify the code ?

Principles for modifying the code



Principles for modifying the code

INPUTDATA Directory

/glade/p/cesmdata/cseg/inputdata
$DIN_LOC_ROOT

share | cpl | atm | lnd | ocn | ice | glc | wav | rof

CESM Code

/glade/.../cesm2.1.1_tutorial
$SRCROOT

components | cime

cam
cice
cism
clm
mosart
pop
rtm
ww3

scripts
(1) create_newcase

These modifications affect all the cases built out of this SRCROOT.

CASE Directory

~/cases/case01
(2) case.setup
(3) case.build
(4) case.submit

Buildconf
LockedFiles
SourceMods
Tools
CaseDocs

src.cam
src.cice
src.clm
src.pop2
…

These modifications only affect the current case

This is where you will put your modifications

Build/Run Directory

/glade/scratch/userx/case01

bld
$EXEROOT

run
$RUNDIR

```
# go into scripts directory
cd
/glade/p/cesm/tutorial/cesm2.1.1_tutorial/cime/scripts

# (1) create a new case
./create_newcase --case ~/cases/case01 --compset B1850 --res f19_g17

# go into the case you just created in the last step
cd ~/cases/case01/

# (2) invoke case.setup
./case.setup
```

Make your source mods

```
# (3) build the executable
qcmd -- ./case.build

# (4) submit your run to the batch queue
./case.submit
```


Modifying a subroutine

Steps to modify the code:

- **Find the subroutine you want to modify**

- **Copy this subroutine in SourceMods**

- **Make your mods**

- **Compile and run the model**

Output an extra variable

- **One common thing you may want to do is to add code to output a new variable**

- **For instance, CAM has a field to output the temperature at 500 mbar (T500) but not at 750mb.**
Let's add a field to output the temperature at 750 mbar (T750)

This can be done by a succession of calls:

call addfld ('T750', …) → **Add a field to master field list**

call add_default ('T750',…) → **Add this field to "h0" by default (optional)**

call outfld('T750', …) → **Collect values for this field and write to history file**

Syntax: addfld

addfld = Add a field to master field list

Field name

Units

Number of vertical levels:
single level :1
multi-level: pver or pverp

Averaging flag:
A = average
I = instantaneous

```
subroutine addfld (fname, units, numlev, avgflag, &
     long_name, decomp_type, [Optional arguments])
```

Field full name

Decomposition type (phys_decomp or dyn_decomp)

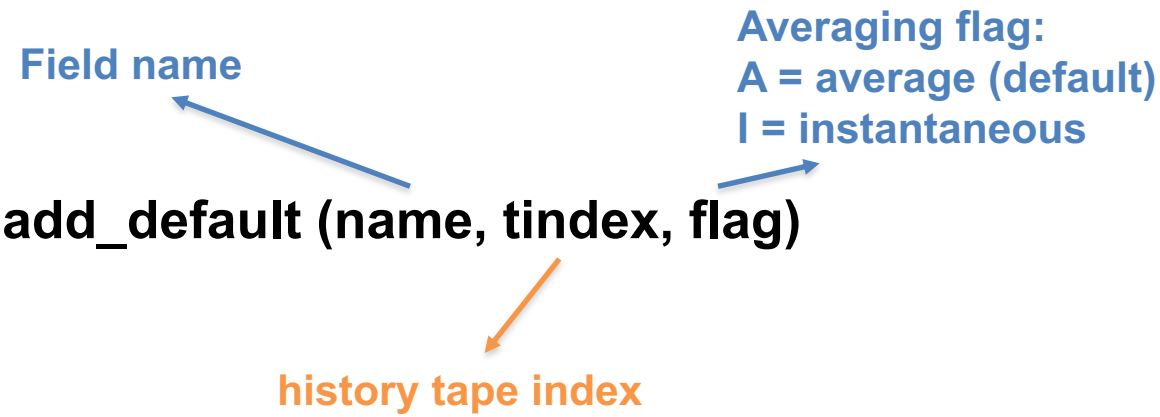
There are several optional arguments (not covered here. See documentation for more information about optional arguments)

Example:

call addfld ('T500', 'K',1,'A','Temperature at 500 mbar pressure surface', phys_decomp)

Syntax: add_default

add_default = Add a field to the list of default fields on history file

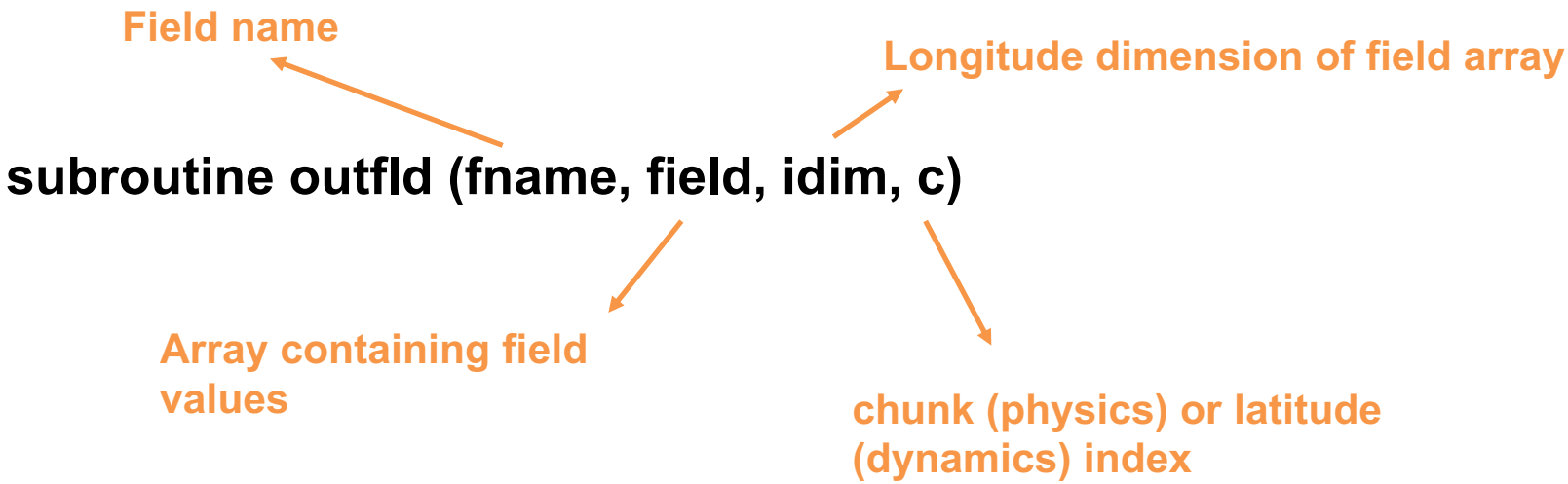


Example:

call add_default ('CLOUD ', 1, ' ')

Syntax: outfld

outfld = accumulate (or take min, max, etc. as appropriate) input field into its history buffer for appropriate tapes

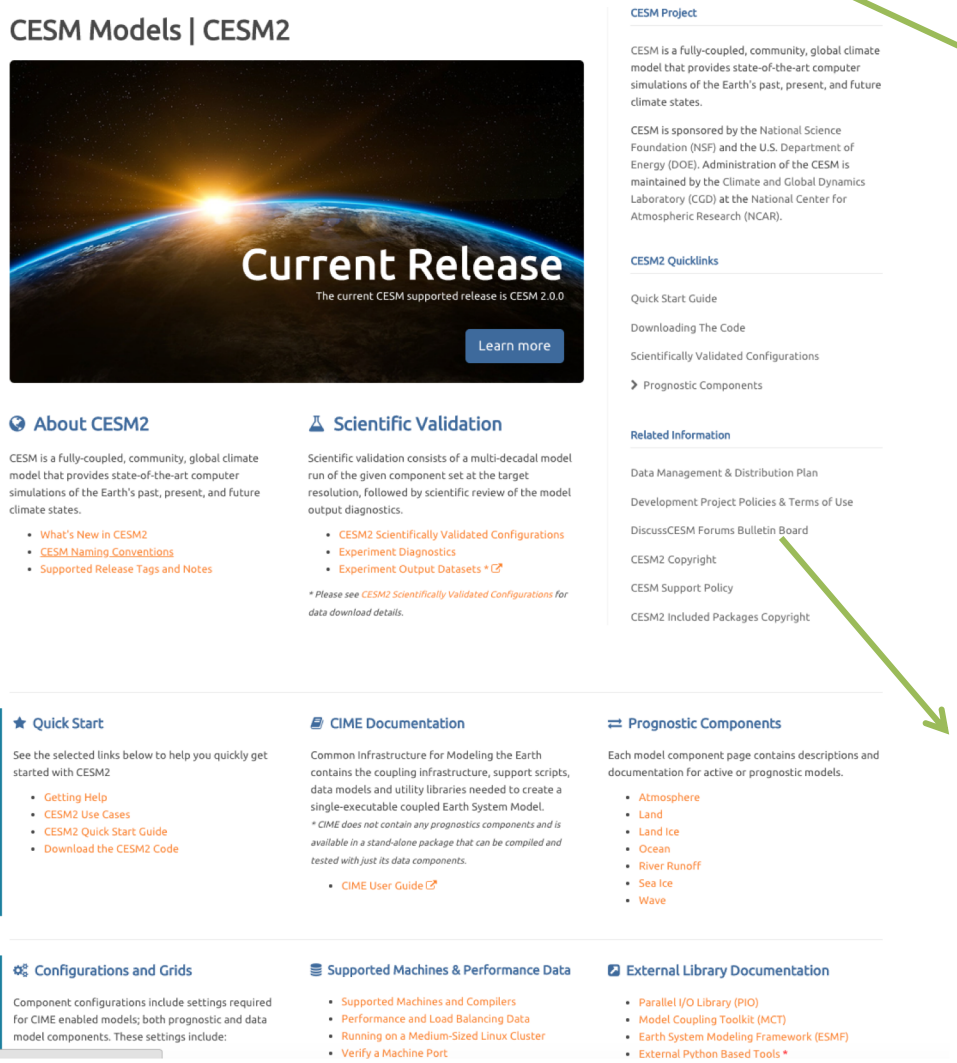


Example:

call outfld('CLOUD', cld, pcols, lchnk)

Where to find help ?

http://www.cesm.ucar.edu/models/cesm2



CESM Models | CESM2

Current Release

The current CESM supported release is CESM 2.0.0

Learn more

About CESM2

CESM is a fully-coupled, community, global climate model that provides state-of-the-art computer simulations of the Earth's past, present, and future climate states.

- What's New in CESM2
- CESM Naming Conventions
- Supported Release Tags and Notes

Scientific Validation

Scientific validation consists of a multi-decadal model run of the given component set at the target resolution, followed by scientific review of the model output diagnostics.

- CESM2 Scientifically Validated Configurations
- Experiment Diagnostics
- Experiment Output Datasets *

* Please see CESM2 Scientifically Validated Configurations for data download details.

CESM Project

CESM is a fully-coupled, community, global climate model that provides state-of-the-art computer simulations of the Earth's past, present, and future climate states.

CESM is sponsored by the National Science Foundation (NSF) and the U.S. Department of Energy (DOE). Administration of the CESM is maintained by the Climate and Global Dynamics Laboratory (CGD) at the National Center for Atmospheric Research (NCAR).

CESM2 Quicklinks

Quick Start Guide

Downloading The Code

Scientifically Validated Configurations

Prognostic Components

Related Information

Data Management & Distribution Plan

Development Project Policies & Terms of Use

DiscussCESM Forums Bulletin Board

CESM2 Copyright

CESM Support Policy

CESM2 Included Packages Copyright

Quick Start

See the selected links below to help you quickly get started with CESM2

- Getting Help
- CESM2 Use Cases
- CESM2 Quick Start Guide
- Download the CESM2 Code

CIME Documentation

Common Infrastructure for Modeling the Earth contains the coupling infrastructure, support scripts, data models and utility libraries needed to create a single-executable coupled Earth System Model.

* CIME does not contain any prognostics components and is available in a stand-alone package that can be compiled and tested with just its data components.

- CIME User Guide

Prognostic Components

Each model component page contains descriptions and documentation for active or prognostic models.

- Atmosphere
- Land
- Land Ice
- Ocean
- River Runoff
- Sea Ice
- Wave

Configurations and Grids

Component configurations include settings required for CIME enabled models; both prognostic and data model components. These settings include:

Supported Machines & Performance Data

- Supported Machines and Compilers
- Performance and Load Balancing Data
- Running on a Medium-Sized Linux Cluster
- Verify a Machine Port

External Library Documentation

- Parallel I/O Library (PIO)
- Model Coupling Toolkit (MCT)
- Earth System Modeling Framework (ESMF)
- External Python Based Tools *

CESM webpage is a gold mine for model documentation

If you cannot find an answer in the model documentation, post your question on the CESM Bulletin Board

Exercise Overview

- Exercise 1: Namelist modification
  Customize your history output
- Exercise 2: Namelist + Code modification
  Add a new output field to the code
- Exercise 3: Change a tuning parameter

Exercise 1: Customizing history files

Create a case called “b1850_high_freq” using the compset B1850 at f19_g17 resolution.

Set the run length to 1 month.

In addition to the monthly history file “h0”, output:
- “h1” file with instantaneous values of T, Q, U and V every 24 hour.
- “h2” file with time-average values of T, Q, U and V every 3 hour.

Set your namelist so that you output:
- a single h1 file with all the daily output for the month.
- multiple h2 file, one for every day of the month.

It means you will have one h1 file with 31 timesteps and you will have thirty-one h2 files with 8 timesteps each).

(Hint: - Use namelist variables: *nhtfrq, mfilt, fincl.* Look at the online documentation for these variables)

Exercise 1: Check your solution

When your run is completed,

(1) Check that your archive directory contains the files:

h0 files	`b1850_high_freq.cam.h0.0001-01.nc`
h1 files	`b1850_high_freq.cam.h0.0001-01.nc`

h2 files	`b1850_high_freq.cam.h2.0001-01-01-00000.nc`
	`b1850_high_freq.cam.h2.0001-01-02-00000.nc`
	`...`
	`b1850_high_freq.cam.h2.0001-02-01-00000.nc`

(2) Compare the contents of the h1 and h2 files using “ncdump”.

```
ncdump –h b1850_high_freq.cam.h1.0001-01-01-00000.nc
ncdump –h b1850_high_freq.cam.h2.0001-01-01-00000.nc
```

Look at the variables attributes. What is the difference between the 2 files ?

(3) Check the number of timesteps in the h1 and the h2 files.
Look at the sizes of the files.

Exercise 2: Add an output field

Create a case called “b1850_T750” using the compset B1850 at f19_g17 resolution.
Add an output field for the temperature at 750 mbar.
Output daily values of T750 and T500 in the “h1” history file.
Set the namelist to output a single h1 for the run.
Make a 1-month run.

Hint:

- Use T500 as a template for your changes.
- Find the subroutine containing T500 using grep –r T500 *

Check your solution

When the run is completed,

- check the field T750 and T500 are in the file h1
- create a file with the difference between T750-T500 (*)
- look at the difference with ncview.

(*) For instance, you can use ncap2

```
ncap2 -s 'T750_minus_T500=T750-T500' b1850_T750.cam.h1.0001-01-01-00000.nc  T750-T500.nc
```


Exercise 3: Modify a parameter, dcs

In the tuning lecture, we talked about the parameter dcs:

http://www.cesm.ucar.edu/events/tutorials/2019/files/Specialized-hannay.pdf

Create a case called “b1850_dcs” using the compset B1850 at f19_g17 resolution.
Locate the parameter Dcs and change from the default value:

micro_mg_dcs = 500.D-6 to micro_mg_dcs = 250.D-6
Make a 1-month run.

Hint: The trick is going to locate where is micro_mg_dcs

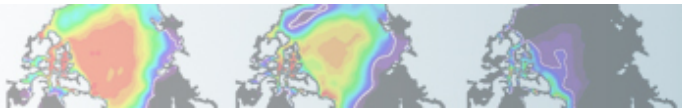
Compare to the first run: b1850_high_freq.

You can use ncdiff and ncview to look at the difference between the 2 runs.

```
ncdiff /glade/scratch/$user/archive/b1850_dcs/atm/hist/b1850_dcs.cam.h0.0001-01.nc
/glade/scratch/$user/archive/b1850_high_freq/atm/hist/b1850_high_freq.cam.h0.0001-01.nc
diff.nc
```

```
ncview diff.nc
```

How does this affect the LWCF ?



Quizzes

At the end of the practical, please go to the online course and take the quiz.
http://www.cesm.ucar.edu/events/tutorials/2019/quizzes.html

To answer the questions, you can use documentation, ask questions to others or to the helper. Indeed you are strongly encouraged to do all the above. This is the way you will use CESM in the future.

How are you graded ? You can take the quizzes as many times as you want, I only retain your highest score. But please try to understand your mistakes.

If you cannot complete the quiz by the end of the practical session, you have until August 17 to complete the quizzes. If you get a perfect score, you will get a certificate of awesomeness.

“Special prize” for those who get a perfect score before Friday morning!!!

Solutions to the exercises

At the request of previous year students, I am providing the solution.

My own recommendation:

DON'T LOOK AT THE SOLUTIONS DURING THE LAB !!!

I believe:

- You will only learn if you try the exercises by yourself.
- You will only learn if you do mistakes.
- Copy/paste will teach you little, indeed.
- Your best bet is to try, do mistakes, ask your neighbor, interact with each others, look at the documentation, try to understand what is wrong...

But this is my own opinion, and I am too old to believe I know the Truth.
So do what is best for you. Go to the next page at your own risk 😉

If you are sure you want to continue, click on the button...

Solution to exercise 1

Point to the prebuilt code (These instructions are for tcsh shell. If you use another shell, modify accordingly)

```
setenv CESM_BLD_TEMPLATE /glade/p/cesm/tutorial/templates/cesm2.1.1_b1850/bld
```

Create a new case

```
cd /glade/p/cesm/tutorial/cesm2.1.1_tutorial/cime/scripts
./create_newcase --case ~/cases/b1850_high_freq --compset B1850 --res f19_g17
```

Case setup

```
cd ~/cases/b1850_high_freq
./case.setup
```

Edit the user_nl_cam and add the lines:

```
 nhtfrq = 0, -24, -3
 mfilt = 1, 31, 8
 fincl2 = 'T:I','Q:I','U:I','V:I'
 fincl3 = 'T','Q','U','V'
```

Change run length

```
./xmlchange STOP_N=1,STOP_OPTION=nmonths
```

Build and submit

```
qcmd -- ./case.build
./case.submit
```


Solution to exercise 1

When your run is completed

(1) Check that your archive directory:

```
cd /glade/scratch/$user/archive/b1850_high_freq/atm/hist
ls
```

(2) Compare the contents of the h1 and h2 files using “ncdump”.
Look at the variables attributes. What is the difference between the 2 files ?

ncdump –h b1850_high_freq.cam.h1.0001-01-01-00000.nc	ncdump –h b1850_high_freq.cam.h2.0001-01-01-00000.nc
time = UNLIMITED ; // (31 currently) float Q(time, lev, lat, lon) ; Q:mdims = 1 ; Q:units = "kg/kg" ; Q:long_name = "Specific humidity" ; float T(time, lev, lat, lon) ; T:mdims = 1 ; T:units = "K" ; T:long_name = "Temperature" ; float U(time, lev, lat, lon) ; U:mdims = 1 ; U:units = "m/s" ; U:long_name = "Zonal wind" ; float V(time, lev, lat, lon) ; V:mdims = 1 ; V:units = "m/s" ; V:long_name = "Meridional wind" ;	time = UNLIMITED ; // (8 currently) float Q(time, lev, lat, lon) ; Q:mdims = 1 ; Q:units = "kg/kg" ; Q:long_name = "Specific humidity" ; Q:cell_methods = "time: mean" ; float T(time, lev, lat, lon) ; T:mdims = 1 ; T:units = "K" ; T:long_name = "Temperature" ; T:cell_methods = "time: mean" ; float U(time, lev, lat, lon) ; U:mdims = 1 ; U:units = "m/s" ; U:long_name = "Zonal wind" ; U:cell_methods = "time: mean" ; float V(time, lev, lat, lon) ; V:mdims = 1 ; V:units = "m/s" ; V:long_name = "Meridional wind" ; V:cell_methods = "time: mean" ;

Solution to exercise 1

(3) Check the number of timesteps in the h1 and the h2 files.

Look at the sizes of the files.

h1 => 31 timestep. In the netcdf file, time = UNLIMITED ; // (31 currently)
h2 => 8 timesteps. See in the netcdf file, time = UNLIMITED ; // (8 currently)

Check size of the files

```
du –ks –h /glade/scratch/$user/archive/b1850_high_freq/atm/hist
```

234M b1850_high_freq.cam.h0.0001-01.nc

210M b1850_high_freq.cam.h1.0001-01-01-00000.nc
7.0M b1850_high_freq.cam.h1.0001-02-01-00000.nc

55M b1850_high_freq.cam.h2.0001-01-01-00000.nc
55M b1850_high_freq.cam.h2.0001-01-02-00000.nc
...
55M b1850_high_freq.cam.h2.0001-01-31-00000.nc
7.0M b1850_high_freq.cam.h2.0001-02-01-00000.nc

The February files are smaller because there is only 1 timestep

Solution to exercise 2

Point to the prebuilt code (These instructions are for tcsh shell. If you use another shell, modify accordingly)

```
setenv CESM_BLD_TEMPLATE /glade/p/cesm/tutorial/templates/cesm2.1.1_b1850/bld
```

Create a new case

```
cd /glade/p/cesm/tutorial/cesm2.1.1_tutorial/cime/scripts
./create_newcase --case ~/cases/b1850_T750--compset B1850 --res f19_g17
```

Case setup

```
cd ~/cases/b1850_T750
./case.setup
```

Locate the file where T500 is computed and copy it SourceMods/sc

```
cp /glade/p/cesm/tutorial/cesm2.1.1_tutorial/components/cam/src/physics/cam/cam_diagnostics.F90
SourceMods/src.cam
```

Edit the file SourceMods/src.cam/cam_diagnostics.F90 and add the lines:

```
  !++ add a variable for T750
  call addfld ('T750',       horiz_only,  'A', 'K','Temperature at 750 mbar pressure surface')

  !++ add a variable for T750
     if (hist_fld_active('T750')) then
       call vertinterp(ncol, pcols, pver, state%pmid, 75000._r8, state%t, p_surf, &
           extrapolate='T', ps=state%ps, phis=state%phis)
       call outfld('T750    ', p_surf, pcols, lchnk )
     end if
```


Solution to exercise 2

Edit the user_nl_cam and add the lines:

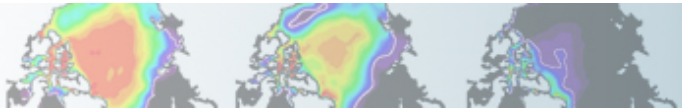
```
 nhtfrq = 0, -24
 mfilt = 1, 31
 fincl2 = 'T750', 'T500'
```

Change run length

```
./xmlchange STOP_N=1,STOP_OPTION=nmonths
```

Build and submit

```
qcmd -- ./case.build
./case.submit
```

Solution to exercise 2

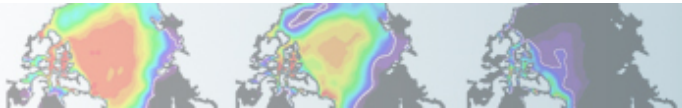
Check your solution

When the run is completed,

- check the field T750 and T500 are in the file h1

```
cd /glade/scratch/$user/archive/b1850_T750/atm/hist/
ncdump -h b1850_T750.cam.h1.0001-01-01-00000.nc
```

```
float T500(time, lat, lon) ;
        T500:units = "K" ;
        T500:long_name = "Temperature at 500 mbar pressure surface" ;
        T500:cell_methods = "time: mean" ;
 float T750(time, lat, lon) ;
        T750:units = "K" ;
        T750:long_name = "Temperature at 750 mbar pressure surface" ;
        T750:cell_methods = "time: mean" ;
```

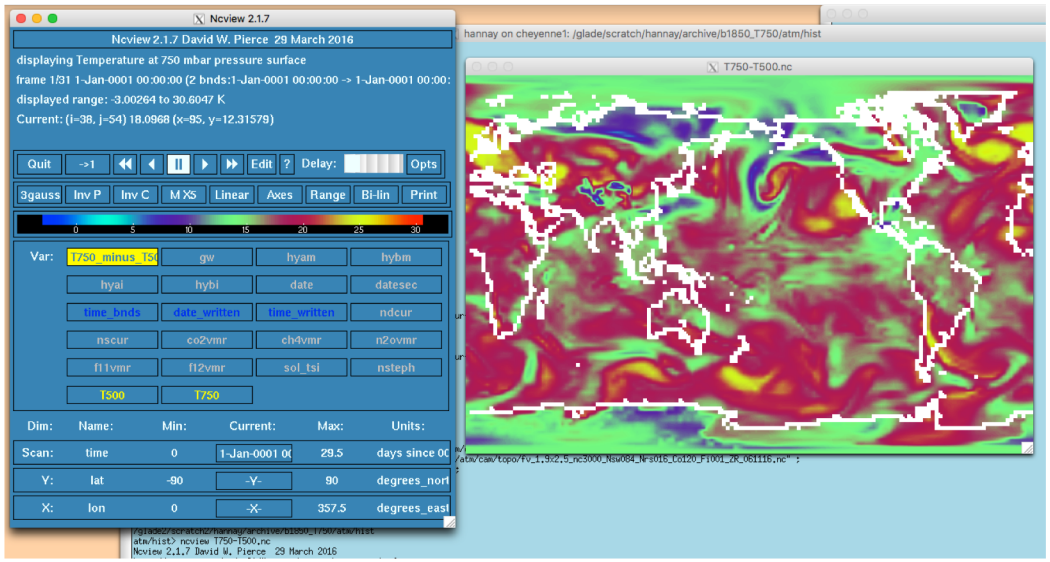
Solution to exercise 2

create a file with the difference between T750-T500

```
cd /glade/scratch/$user/archive/b1850_T750/atm/hist/
ncap2 -s 'T750_minus_T500=T750-T500' b1850_T750.cam.h1.0001-01-01-00000.nc  T750-T500.nc
```

look at the difference between T750-T500 with ncview.

```
cd /glade/scratch/$user/archive/b1850_T750/atm/hist/
ncview T750-T500.nc
```



Solution to exercise 3

Point to the prebuilt code (These instructions are for tcsh shell. If you use another shell, modify accordingly)

```
setenv CESM_BLD_TEMPLATE /glade/p/cesm/tutorial/templates/cesm2.1.1_b1850/bld
```

Create a new case

```
cd /glade/p/cesm/tutorial/cesm2.1.1_tutorial/cime/scripts
./create_newcase --case ~/cases/b1850_dcs --compset B1850 --res f19_g17
```

Case setup

```
cd ~/cases/b1850_dcs
./case.setup
```

Edit user_nl_cam

```
cd ~/cases/b1850_dcs
```

Replace `micro_mg_dcs = 500.D-6` by `micro_mg_dcs = 200.D-6`

Change run length

```
./xmlchange STOP_N=1,STOP_OPTION=nmonths
```

Build and submit

```
qcmd -- ./case.build
./case.submit
```


Solution to exercise 3

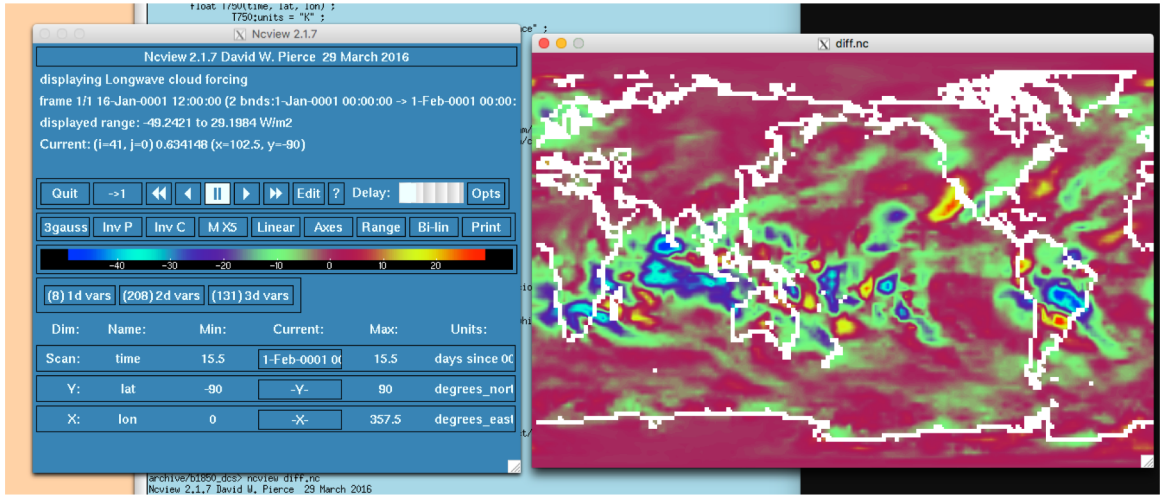
create a file with the difference between LWCF

Compare to the first run: b1850_high_freq.
You can use ncdiff and ncview to look at the difference between the 2 runs.

```
cd /glade/scratch/$user/archive/b1850_dcs
ncdiff /glade/scratch/$user/archive/b1850_dcs/atm/hist/b1850_dcs.cam.h0.0001-01.nc
/glade/scratch/$user/archive/b1850_high_freq/atm/hist/b1850_high_freq.cam.h0.0001-01.nc
diff.nc

ncview diff.nc
```

How does this affect the LWCF ?



This affect the tropics where LWCF is large

1-month run is too short to look at results

Where to find stuff ?

http://www.cesm.ucar.edu/events/tutorials/2019/

Tutorial Details

- **Dates**: 05 - 09 August 2019
- **Location**: NCAR Mesa Lab, Boulder, CO [More info]
- **Registration**: *Closed 08 March 2019

Tutorial Links

- **Agenda**: View the agenda in pdf format
- **Announcement**: Information about the event and how to apply to the tutorial
- **Prerequisites**: Please complete the following activities to ensure you are prepared for the tutorial
- **Coursework**: View the sciences presentations and the labs exercices.
- **Quizzes**: Access your daily quiz.
- **Visitor Wireless**: How to access the UCAR Visitor Wireless

Thursday, August 8

Lectures

Topic: Ocean Modeling II
Speaker: Peter Gent — Slides | Videos

Topic: Ocean Biogeochemistry
Speaker: Keith Lindsay — Slides | Videos

Topic: Sea Ice Modeling
Speaker: Alice DuVivier — Slides | Videos

Meet a Scientist

Topic: Sign up to meet one of our CESM Scientists — Scientist bios

Specialized Talk

Topic: Simpler Models
Speaker: Isla Simpson — Slides | Videos

Practical

Topic: Namelist and Code Modificatioms
Speaker: Cecile Hannay — Overview | Exercises | Videos

Lab overview (these slides)

Exercises/Solutions

2019 CESM Tutorial: Daily Quizzes

One-time registration/enrollment

To gain access to your daily quiz, you need to either use your existing account or create an account on the COMETMetEd website and then enroll in "CESMTut_2019". This is a one-time painless process.

Directions for those without existing accounts on COMET/MetEd (meted.ucar.edu)

1. Go to https://www.meted.ucar.edu
2. Click "Sign Up" located to the left the "Sign In" button.
3. Provide all required information and then click "Create Account" at the bottom of the page.
4. Go to https://courses.comet.ucar.edu/course/view.php?id=226
5. Scroll to the bottom of the Enrollment options page. Enter the enrollment key "CESMTut_2019" (without quotes), then click the "Enroll Me" button.
6. You should see the CESM Tutorial welcome message, and you will receive an email to confirm your enrollment.

Directions for those with existing accounts on COMET/MetEd (meted.ucar.edu)

1. Go to https://courses.comet.ucar.edu/course/view.php?id=226
2. Log on to the MetEd website.
3. Scroll to the bottom of the Enrollment options page. Enter the enrollment key "CESMTut_2019" (without quotes), then click the "Enroll Me" button.
4. You should see the CESM Tutorial welcome message, and you will receive an email to confirm your enrollment.

Daily quizzes

Once you have enrolled, follow the "Quiz Link" below to access your daily quiz.

Quiz Link: https://courses.comet.ucar.edu/course/view.php?id=226

Feel free to take the quiz anytime during the lab session or even after the lab session. For instance, you can take the quiz while you are waiting for the model to compile or your run to complete. However, please refrain from taking the quiz before your daily lab session. We might need to modify the quiz just before the lab session, and we would need to erase your attempts.

The goal of the quizzes is to challenge your knowledge and to create a learning experience. You can take the quiz as many times as you want. During the quiz: Feel to talk to your neighbor, to ask questions to your instructor, to look into the documentation.

Good luck ! And don't forget to have fun.