

# CESM2 Tutorial: Basic Modifications

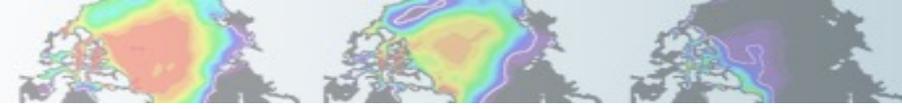
Hui Li

August, 2022



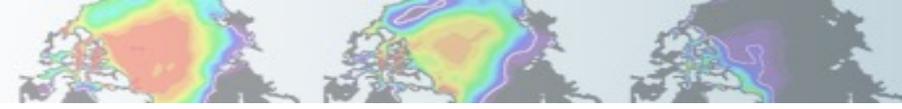
U.S. DEPARTMENT OF  
**ENERGY**

Office of  
Science



# Outline

- **Review of the basic workflow**
- **Model control files and basic modification**
  - env\*.xml files
  - namelist files
- **Exercises**



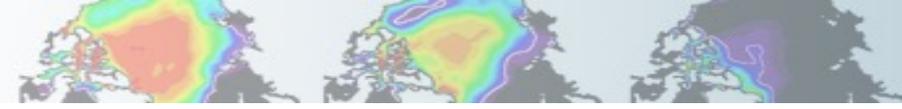
## CESM2 Tutorial: Basic Modifications:

**Review**

1. We will use the CESM code located locally on Cheyenne, no need to checkout or download any input data.
2. We will run with resolution f19\_g17: (atm/lnd = FV 1.9x2.5 ocn/ice=gx1v7)
3. Default scripts will **automatically** be configured for you using the code/script base prepared uniquely for this tutorial. You do not need to specify a project number today. (You may need to do this after the tutorial)!

***Tutorial Code and script base:***

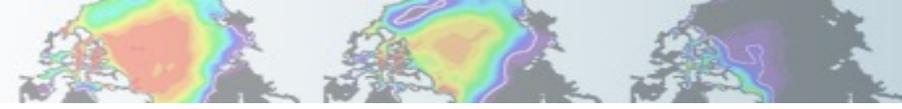
***/glade/p/cesm/tutorial/cesm2.1\_tutorial2022/cime/scripts***



## CESM2 Tutorial: Basic Modifications:

**Review**

1. Log into Cheyenne
2. Execute `create_newcase`
3. Execute `case.setup`
4. Compile model and position files (`case.build`)
5. Run model (`case.submit`)



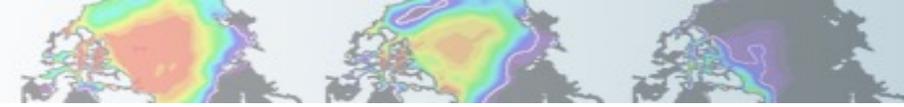
**This tutorial contains step by step instructions applicable to  
CESM2**

**<http://www.cesm.ucar.edu/models/cesm2/>**

**Quick Start Guide**

**<https://escomp.github.io/CESM/release-cesm2/>**

**For older releases, please see past tutorials.**



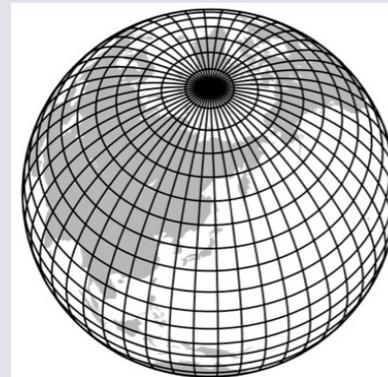
# CESM2 Tutorial: Basic Modifications: **Review:** **Creating a new case**

What is the casename?



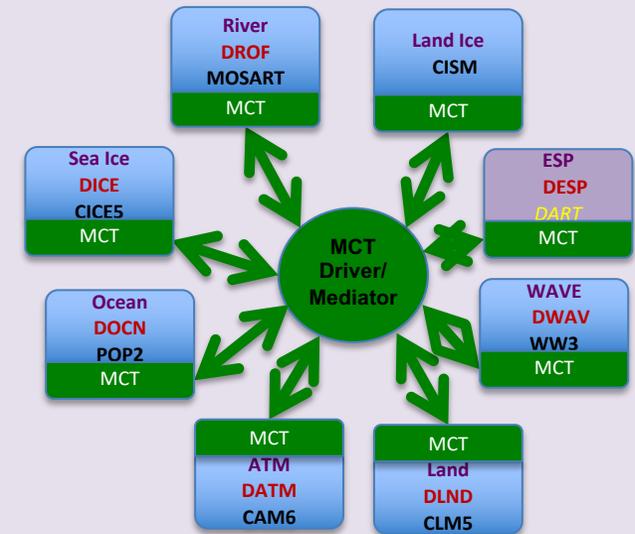
~/cases/b.day1.0

Which resolution?

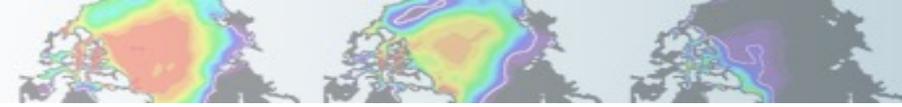


**f19\_g17**  
(FV 2deg coupled to gx1 ocean)

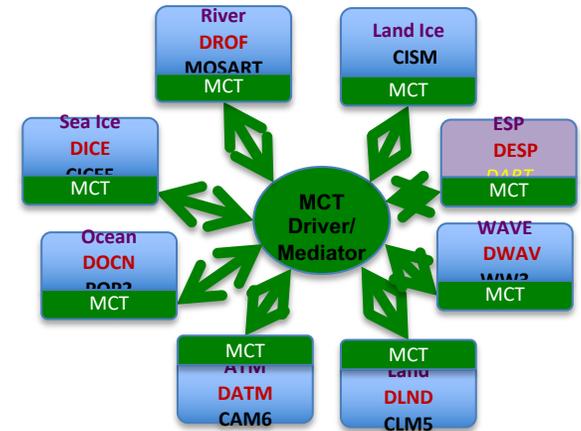
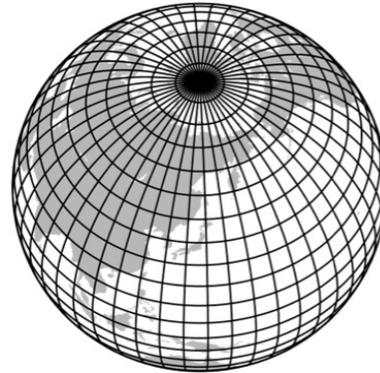
Which model configuration?  
Which set of components?



**B1850**



## CESM2 Tutorial: Basic Modifications: **Review:** **Creating a new case**

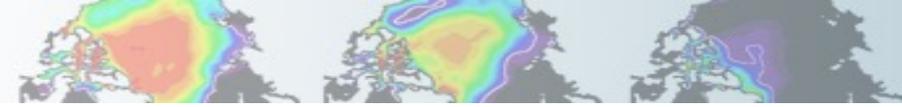


`create_newcase --case ~/cases/b.day1.0 --res f19_g17 --compset B1850 -- project UESM0011`

`create_newcase --help` (full list of arguments)

**Tutorial-only: You don't need to use the "-- project" argument**

The tutorial project number is UESM0011, but this is set by default for you during the tutorial months. Later, you will need to run the model using the project number for your home institution's computer allocation, depending on where you are running the model.



## CESM2 Tutorial: Basic Modifications: **Review:** **Documentation**

### Grid naming convention

<http://www.cesm.ucar.edu/models/cesm2/cesm/grids.html>

#### Grids Table

Show  entries

Show All

Hide All

Search:

##### Alias



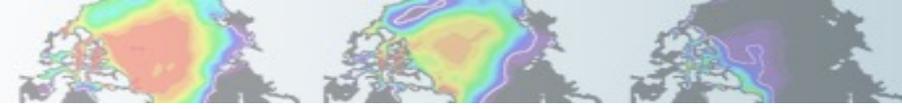
- f19\_f19\_mg16 (only for compsets that are not \_POP)
- f19\_f19\_mg17 (only for compsets that are not \_POP)
- f19\_f19\_mnull (only for compsets that are \_DOCN%SAQUAP|DOCN%DAQUAP)
- f19\_g16
- f19\_g16\_gl4 (only for compsets that are \_CISM)
- f19\_g16\_gl5 (only for compsets that are \_CISM)
- f19\_g16\_r01
- f19\_g16\_rx1 (only for compsets that are \_DROF)
- f19\_g17

##### Details

```
non-default grids are: atm:1.9x2.5  lnd:1.9x2.5  ocnice:gx1v7
mask is: gx1v7
```

```
1.9x2.5 is FV 2-deg grid: with domain file(s):
domain.lnd.fv1.9x2.5_gx1v6.090206.nc (only for mask: gx1v6 grid match: atm|lnd)
domain.ocn.1.9x2.5_gx1v6_090403.nc (only for mask: gx1v6 grid match: ocnice)
domain.lnd.fv1.9x2.5_gx1v7.181205.nc (only for mask: gx1v7 grid match: atm|lnd)
domain.ocn.fv1.9x2.5_gx1v7.181205.nc (only for mask: gx1v7 grid match: ocnice)
domain.aqua.fv1.9x2.5.nc (only for mask: null grid match: ocnice)
```

```
gx1v7 is displaced Greenland pole 1-deg grid with Caspian as a land feature: with domain file(s):
$DIN_LOC_ROOT/share/domains/domain.ocn.gx1v7.151008.nc (only for grid match: atm|lnd)
$DIN_LOC_ROOT/share/domains/domain.ocn.gx1v7.151008.nc (only for grid match: ocnice)
```



# CESM2 Tutorial: Basic Modifications: **Review:** **Documentation**

## Compset naming convention

<http://www.cesm.ucar.edu/models/cesm2/config/compsets.html>

### Component Set Definitions (compset)

Reference: [CIME Model Component Sets Documentation](#)

Grid Resolutions: [CESM2 Grid Resolution Definitions](#)

**Support Levels:**

**Defined** - The component set is defined but has not been tested.

**Tested** - The defined component set has been tested with a scientifically supported grid resolution.

**Scientific** - The tested component set has been **validated scientifically**.

CESM2 Version ▾

Model Version: **CESM2.1.1**

HTML created on: **2019-06-09**

---

Show  entries

Search:

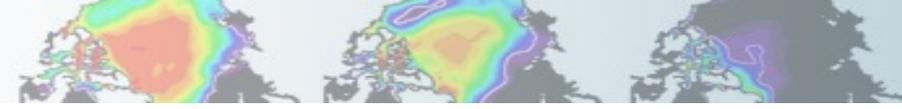
Alias	Long name	Defined By	Support Level
B1850	1850_CAM60_CLM50%BGC-CROP_CICE_POP2%ECO%ABIO-DIC_MOSART_CISM2%NOEVOLVE_WW3_BGC%BDRD	allactive	Scientific / Tested

**Scientifically Supported Grids**

- o f09\_g17\_gl4
- o f09\_g17

---

Details	Value	Description
<b>Initialization Time</b>	1850	1850: Pre-Industrial; 2000 present day: Additional initialization times defined by components.
<b>Atmosphere</b>	CAM60	CAM cam6 physics:
<b>Land</b>	CLM50%BGC-CROP	clm5.0:BGC (vert. resol. CN and methane) with prognostic crop:
<b>Sea-Ice</b>	CICE	Sea ICE (cice) model version 5
<b>Ocean</b>	POP2%ECO%ABIO-DIC	POP2 EcosystemAbiotic DIC/DIC14
<b>River runoff</b>	MOSART	MOSART: MOdel for Scale Adaptive River Transport
<b>Land Ice</b>	CISM2%NOEVOLVE	cism2 (default, higher-order, can run in parallel):cism ice evolution turned off (this is the standard configuration unless you're explicitly interested in ice evolution):
<b>Wave</b>	WW3	Wave Watch
<b>Ocean Biogeochemistry</b>	BGC%BDRD	BGC CO2=diag, rad CO2=diag:



## CESM2 Tutorial: Basic Modifications: **Review:** **Creating a new case**

Create and configure an out-of-the-box case (set of scripts) called “b.day2.0” on Cheyenne using FV 2deg atm/Ind coupled to 1deg ocean/ice and compset B1850. Review steps but do not build or run.

1. Change directories, (“cd”) to tutorial code base scripts directory (on slide 3).
2. Create initial scripts. (We will use the same “cases” subdirectory as day1 exercises).
3. “cd” to your casedir.
4. Setup your case.
5. Explore your directories



## CESM2 Tutorial: Basic Modifications: **Review:** **Creating a new case**

Create and configure an out-of-the-box case (set of scripts) called “b.day2.0” on cheyenne using f19\_g17 and compset B1850. Review steps but do not build or run.

1. `cd /glade/p/cesm/tutorial/cesm2.1_tutorial2022/cime/scripts`
2. `./create_newcase --case ~/cases/b.day2.0 --res f19_g17 --compset B1850`
3. `cd ~/cases/b.day2.0`
4. `./case.setup`
5. *What are the next steps if you were to compile and run?*



## CESM2 Tutorial: Basic Modifications: **Review:** **Creating a new case**

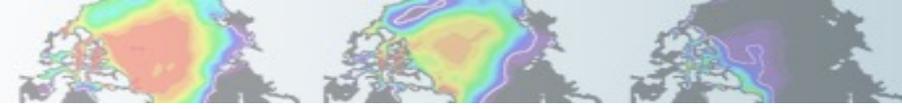
Create and configure an out-of-the-box case (set of scripts) called “b.day2.0” on cheyenne using f19\_g17 and compset B1850. Review steps but do not build or run.

1. `cd /glade/p/cesm/tutorial/cesm2.1_tutorial2022`/cime/scripts`
2. `./create_newcase --case ~/cases/b.day2.0 --res f19_g17 --compset B1850`
3. `cd ~/cases/b.day2.0`
4. `./case.setup`
5. *What are the next steps if you were to compile and run?*

`qcmd -A UESM0011 -- ./case.build`

`./case.submit`

- **The value for the account number, UESM0011, is for the tutorial only.**
- **Remember “qcmd” is for Cheyenne ONLY, don’t forget the “- - “!**



## CESM2 Tutorial: Basic Modifications: **Review: Queues and Jobs**

### On Cheyenne

1. Checking jobs:

Type

***qstat -u <username>***

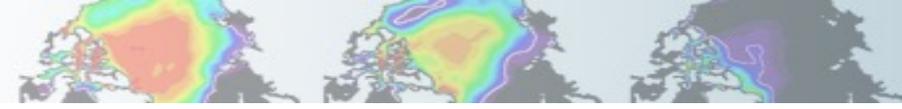
or

***qstat*** (shows everyone in the queue)

2. Killing jobs:

a. Type *qstat* to find your JOBID

b. Type ***qdel <JOBID>***, example: *qdel 1243081.chadmin1*

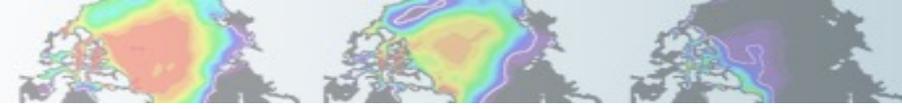


## CESM2 Tutorial: Basic Modifications: **Review: Documentation files**

In your case directory, in addition to your scripts, you will find automatically generated **documentation** files.

1. **README.case file:** information on your compset, grid, and physics modes
2. **CaseDocs/:** namelist configurations for you components (do not modify)
3. **software\_environment.txt:** software information
4. **CaseStatus:** documents your xmlchange commands, builds, submissions, and completions (including errors) with timestamps.

***README.case*, we highly recommend YOU document any changes you make to the default scripts. It is YOUR paper trail and opportunity to list modifications. CaseStatus will automatically list changes using the “xmlchange” tool, but that is it.**



## CESM2 Tutorial: Basic Modifications: **Review: create\_clone**

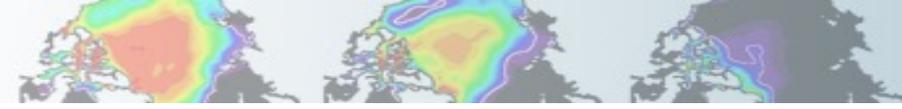
The **create\_clone** utility creates an **EXACT** copy of a previously created case.

The `create_clone` utility is very handy when the user wishes to run a slightly modified version of a previous experiment.

- a. Invoke `create_clone` to create an exact copy of an old case by typing the following on the command line from your script base directory (slide 2) :

```
create_clone --case <new case> --clone <case to clone>
```

- b. Implement desired modifications before building and running . (We will learn numerous way to modify the scripts during this presentation).
- c. Edit and DOCUMENT changes in README.case



## CESM2 Tutorial: Basic Modifications: **Review create\_clone**

Edit and DOCUMENT changes in README.case.

Otherwise your README.case file will look exactly like your original case and it will be much harder to backtrack your methods when troubleshooting.

**CAVEATS for CREATE\_CLONE: you need to use....**

- 1) same model tag**
- 2) same machine**
- 3) same compset**
- 4) same resolution**
- 5) same run-type** (slide 25)



## CESM2 Tutorial: Basic Modifications: **Model control files**

We control how we compile and run the model with *env\_\*.xml* files.

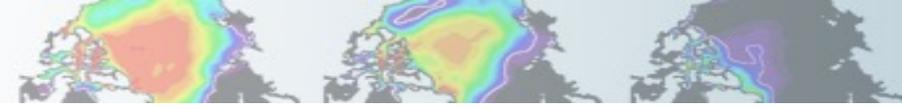
These files are created with *create\_newcase*.

We modify *env\_run.xml* according to our experimental design. We will practice this in the coming exercises.

We control what we ask of the model components with namelist files, *user\_nl\_<model>*.

These files are created after *case.setup* is invoked.

We modify the model component namelists according to our experimental design. We will practice some basic examples here, and more complex examples on Thursday.



## CESM2 Tutorial: Basic Modifications: **Editing Methods/Tools**

### Recommended:

#### Editing:

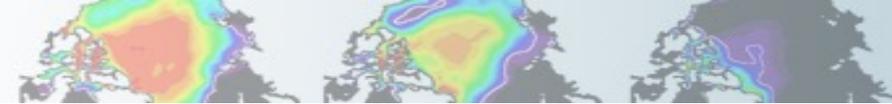
When modifying “xml” files, we highly recommend using the tool, **xmlchange**. However, the user is free to use her/his editor of choice, i.e. **vi or emacs**.

#### Searching:

To find xml variables in your case directory, we recommend using the tool **xmlquery**. Note: You need to be in your case directory to execute these commands.

For help, type `./xmlchange --help`

type `./xmlquery --help`



## CESM2 Tutorial: Basic Modifications: **Editing Methods/Tools**

### Example 1. Using xmlchange

If you want to manually resubmit an initial case that previously had a RESUBMIT value of 0, (i.e. you did not initially resubmit the run), edit `env_run.xml` via the `xmlchange` tool by typing on the command line:

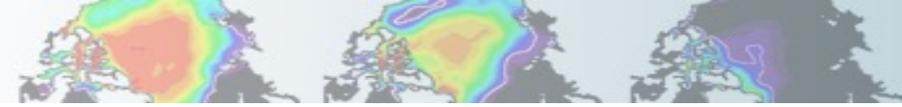
```
./xmlchange CONTINUE_RUN=TRUE
```

### Example 2. Using Subgroups and finding variables

For changing variables in env files that have multiple instances, we recommend you use `xmlquery` to find the default values, then the Subgroup functionality in `xmlchange` to specify which instance you want to change.

To change the default WALLCLOCK time from 20 minutes to 1 hour for the short term archiver subgroup, i.e. `<group id="case.st_archive">`, type the following on the command line:

```
./xmlquery JOB_WALLCLOCK_TIME  
./xmlchange --subgroup case.st_archive JOB_WALLCLOCK_TIME=01:00:00
```

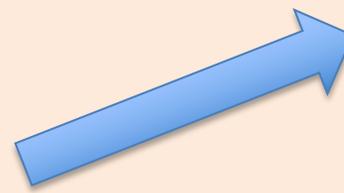


## CESM2 Tutorial: Basic Modifications: **Namelist variables**

Namelist variables can be changed using:

**user\_nl\_<model>** (e.g. user\_nl\_cam, user\_nl\_pop, etc )

For a complete list of namelists, please see the on-line documentation for each component model. (More on this later)...



Example: Namelist for the atmosphere model (CAM):

[http://www.cesm.ucar.edu/models/cesm2/settings/current/cam\\_nml.html](http://www.cesm.ucar.edu/models/cesm2/settings/current/cam_nml.html)

CAM6.0 Fortran Namelist Definitions

Component tag: cam\_cesm2\_0\_rel\_02  
HTML created on: 2018-06-02

Expand All Collapse All

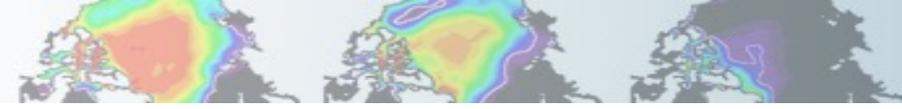
Show 25 entries

Search: find

Variable	Namelist Group	Category	Entry Type
find3lonlat	cam_history_nl	history	char*128(1000)
Valid Values [Any Char]			
Possible Default Values			
Description and out-of-the-box Default			
Same as find3lonlat, but for 9th history file.			
chem_sums	species_sums_nl	cam_chem	char*256(200)
chem_sums	rxn_rate_diags_nl	cam_chem	char*256(200)
sethist_freq	satellite_options_nl	history	char*256(1000)
scan_valtax_freq	scan_nl	scan	char*256(1000)
chem_sums	species_sums_nl	cam_chem	char*256(200)

Showing 26 to 31 of 31 entries (filtered from 865 total entries)

Previous 1 2 Next



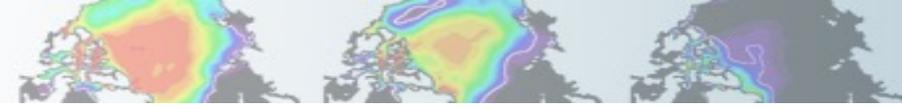
## CESM2 Tutorial: Basic Modifications: Runtime variables: **env\_run.xml**

Runtime variables can be changed in `env_run.xml` *at any point* during the run and control the mechanics of the run, i.e length, resubmits, and archiving.

Common variables to change include

1. **RESUBMIT** → sets the number of times to resubmit the run
2. **STOP\_OPTION** → sets the run length time interval type, i.e. nmonths, ndays, nyears or a specific date
3. **STOP\_N** → sets the number of intervals (set by `STOP_OPTION`) to run the model during the specified wallclock time. Wallclock time is set in your `env_workflow.xml` file and is a measure of the actual time.

**STOP\_OPTION** and **STOP\_N** control the length of the run per computer job submission. A typical simulation is comprised of many job submissions. (You can only stay in the computer queue for a specified time. This queue time limit is often shorter than the desired simulation length.)



## CESM2 Tutorial: Basic Modifications: Runtime variables:

### env\_run.xml

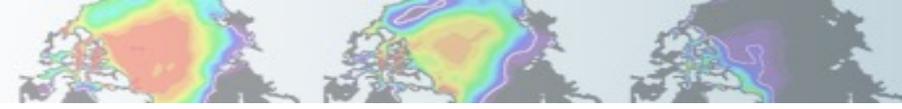
1. **RESUBMIT** → sets the number of times to resubmit the run
2. **STOP\_OPTION** → nmonths, ndays, nyears or a specific date
3. **STOP\_N** → sets the number of intervals (set by STOP\_OPTION) to run

### Question:

The tutorial version of FV ~2deg\_gx1 CESM on Cheyenne simulates ~10 model years per wallclock day.

Maximum wallclock request is 12 hours.

If you want to run 100 years, what values should be set for STOP\_OPTION, STOP\_N, and RESUBMIT?



## CESM2 Tutorial: Basic Modifications: Runtime variables

### `env_run.xml`

Question:

If you want to run 100 years, what values should be set for `STOP_OPTION`, `STOP_N`, and `RESUBMIT`?

Answer:

Assume 2 jobs submissions per day, (2 12-hr jobs).

Model runs 10yrs/day, so  $10/2 = 5$  model years per job submission.

**`STOP_OPTION = nyears`, `STOP_N = 5` , `RESUBMIT = 19`**

Initial run of 5yrs + (19 resubmits \* 5 years per job) = 100 years



## CESM2 Tutorial: Basic Modifications: Runtime variables

### env\_run.xml

env\_run.xml continued... example common runtime variables that we change include:

4. **CONTINUE\_RUN** → if TRUE, implies a CONTINUE run.

Note: if RESUBMIT is > 0 and it is an initial run (i.e. CONTINUE\_RUN=FALSE), CONTINUE\_RUN will automatically update to TRUE upon completion of initial run.

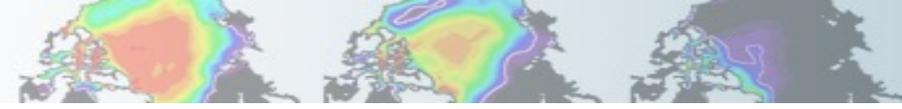
5. **INFO\_DEBUG** → sets level of stdout (standard out) print statements. If debugging, a higher value may be set.

6. **DOUT\_S** → turns on short-term archiving. DOUT\_S is TRUE by default.

7. **HIST\_OPTION** → coupler ("driver") history file specification. Note: All other model components specify history file information within the model component namelists!

8. **CCSM\_CO2\_PPMV** → CO<sub>2</sub> value to be propagated to POP and CLM (if CO<sub>2</sub> is constant).

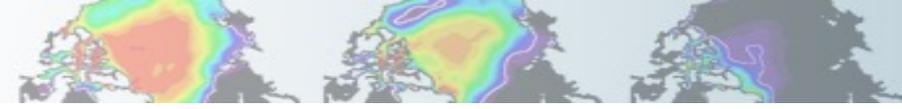
Take some time to review all other env\_run.xml settings....



## CESM2 Tutorial: Basic Modifications: Run-TYPE variables: **env\_run.xml**

Run-type variables define type of run (startup, hybrid, branch) and physical controls (namelist parameters).  
Sample variables specified in this file include:

1. **RUN\_TYPE** → startup, hybrid, branch
2. **RUN\_REFCASE** → if branch/hybrid, case name you are starting from
3. **RUN\_REFDATE** → if branch/hybrid, date stamp of reference case you are starting from
4. **GET\_REFCASE** → default = TRUE; for TRUE, data needs to be pre-staged in executable directory (this is different from previous versions of CESM).



## CESM2 Tutorial: Basic Modifications: Run-TYPE variables

### `env_run.xml`

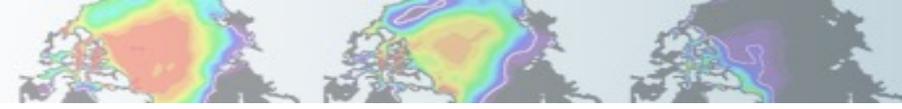
**CESM has three “types” of initial runs:**

STARTUP: All model components are initialized from basic default initial conditions. The coupler does NOT need an initial file.

HYBRID:

- The atmosphere is initialized from initial condition files generated by a user-specified CESM simulation
- The land, runoff, ocean and ice are initialized from restart files generated by a user-specified CESM simulation.
- No coupler file is needed
- Initial conditions and restart files use the same reference case and reference date.

BRANCH: All model components are initialized from restart files generated by a user-specified CESM simulation.

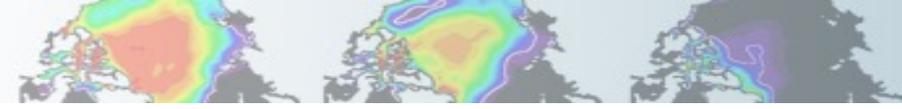


## CESM2 Tutorial: Basic Modifications: Run-TYPE variables: Branch vs Hybrid

Branch and hybrid runs are useful if you have an experiment which only slightly differs from your control, but you want to make a slight modification, add history output, or start your simulation from a CESM spun-up initial state and maintaining an exact restart (which mimics what the model would do if it had kept running in the original setup).

**Use a hybrid run:** for most applications where you do NOT need bit for bit restart. You CAN specify a new start date for your model run.

**Use branch run:** only for applications which require exact restart. You CANNOT specify a new start date for your model run. It will be assigned by the reference case (RUN\_REFDATE). **(Example, if you want to change the history output stream mid-run, you will need to branch).**



## CESM2 Tutorial: Basic Modifications: Run-TYPE variables

### `env_run.xml`

What is the “CONTINUE\_RUN”?

Remember our runtime variables example?

Question:

If you want to run 100 years, what values should be set for STOP\_OPTION, STOP\_N, and RESUBMIT?

**Answer:**

**Assume 2 jobs submissions per day, (2 12-hr jobs).**

**Model runs 10yrs/day, so  $10/2 = 5$  model years per job submission.**

**STOP\_OPTION = nyears, STOP\_N = 5 , RESUBMIT = 19**

**Initial run of 5yrs + (19 resubmits \* 5 years per job) = 100 years**

After the run has been initialized (either startup, hybrid, branch), this is just the 1<sup>st</sup> submission. You need to tell the model to continue after running after the first 5 years. You do this by setting CONTINUE\_RUN = TRUE.

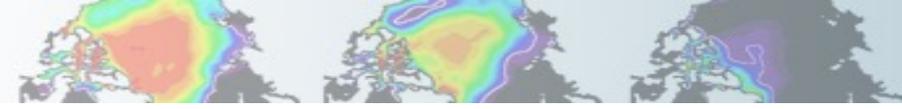


## CESM2 Tutorial: Basic Modifications: Run-TYPE variables

### env\_run.xml

**What is “CONTINUE\_RUN”?** It controls whether the model is initialized (FALSE), or continues a run (TRUE).

- Initial run-types (startup, branch, hybrid) are applied at initialization, i.e. the first submission into the queue.
- The model knows it is an initialization because CONTINUE\_RUN = FALSE
- If you are continuing a run (2<sup>nd</sup>, 3<sup>rd</sup>, etc., submission into the queue), CONTINUE\_RUN should be TRUE.
- If RESUBMIT > 0, your scripts will automatically change CONTINUE\_RUN = TRUE after completion of the first submission for all subsequent submissions into the queue.
- If you only want to test your run (recommended if just starting), submit your initial job with CONTINUE\_RUN = FALSE and your RUN\_TYPE to (startup, branch or hybrid). Check your run. If OK, use xmlchange to change CONTINUE\_RUN = TRUE, RESUBMITS = (number of resubmissions), and carry on running the model.



## CESM2 Tutorial: Basic Modifications: Run-TYPE variables

### env\_run.xml

#### What is “CONTINUE\_RUN”?

Question:

If you want to run 100 years, what values should be set for STOP\_OPTION, STOP\_N, and RESUBMIT?

**Answer:**

**Assume 2 jobs submissions per day, (2 12-hr jobs).**

**Model runs 10yrs/day, so  $10/2 = 5$  model years per job submission.**

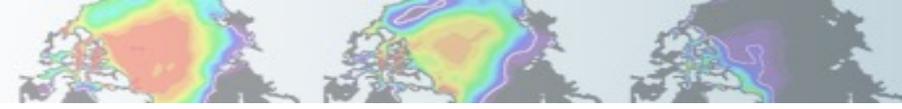
**STOP\_OPTION = nyears, STOP\_N = 5 , RESUBMIT = 19**

**Initial run of 5yrs + (19 resubmits \* 5 years per job) = 100 years**

**Initial run/submission of 5 years:**

**Next run/submission of 5 years:**

**2nd run/submission of 5 years:**



## CESM2 Tutorial: Basic Modifications: Run-TYPE variables

### **env\_run.xml**

### What is “CONTINUE\_RUN”?

Question:

If you want to run 100 years, what values should be set for STOP\_OPTION, STOP\_N, and RESUBMIT?

**Answer:**

**Assume 2 jobs submissions per day, (2 12-hr jobs).**

**Model runs 10yrs/day, so  $10/2 = 5$  model years per job submission.**

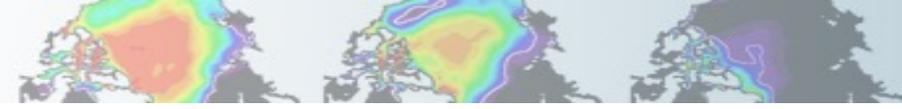
**STOP\_OPTION = nyears, STOP\_N = 5 , RESUBMIT = 19**

**Initial run of 5yrs + (19 resubmits \* 5 years per job) = 100 years**

**Initial run/submission of 5 years:** RUN\_TYPE = startup, CONTINUE\_RUN = FALSE, RESUBMIT =19

**Next run/submission of 5 years:**

**2nd run/submission of 5 years:**



## CESM2 Tutorial: Basic Modifications: Run-TYPE variables

### env\_run.xml

#### What is “CONTINUE\_RUN”?

##### Question:

If you want to run 100 years, what values should be set for STOP\_OPTION, STOP\_N, and RESUBMIT?

##### Answer:

Assume 2 jobs submissions per day, (2 12-hr jobs).

Model runs 10yrs/day, so  $10/2 = 5$  model years per job submission.

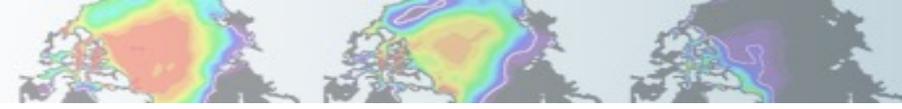
STOP\_OPTION = nyears, STOP\_N = 5 , RESUBMIT = 19

Initial run of 5yrs + (19 resubmits \* 5 years per job) = 100 years

**Initial run/submission of 5 years:** RUN\_TYPE = startup, CONTINUE\_RUN = FALSE, RESUBMIT =19

**Next run/submission of 5 years:** Run\_TYPE (doesn't change, but maintained for documentation, CONTINUE\_RUN = TRUE (automatically changed after initial run because RESUBMITS > 0, RESUMBIT = 18)

**2nd run/submission of 5 years:**



## CESM2 Tutorial: Basic Modifications: Run-TYPE variables

### env\_run.xml

#### What is “CONTINUE\_RUN”?

##### Question:

If you want to run 100 years, what values should be set for STOP\_OPTION, STOP\_N, and RESUBMIT?

##### Answer:

Assume 2 jobs submissions per day, (2 12-hr jobs).

Model runs 10yrs/day, so  $10/2 = 5$  model years per job submission.

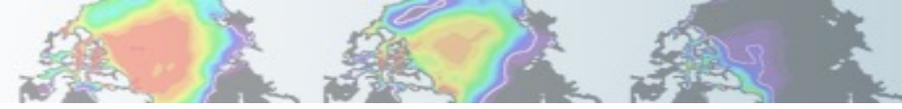
STOP\_OPTION = nyears, STOP\_N = 5 , RESUBMIT = 19

Initial run of 5yrs + (19 resubmits \* 5 years per job) = 100 years

**Initial run/submission of 5 years:** RUN\_TYPE = startup, CONTINUE\_RUN = FALSE, RESUBMIT =19

**Next run/submission of 5 years:** Run\_TYPE (doesn't change, but maintained for documentation, CONTINUE\_RUN = TRUE (automatically changed after initial run because RESUBMITS > 0, RESUMBIT = 18)

**2nd run/submission of 5 years:** same as above, except resubmits are now 17



## CESM2 Tutorial: Basic Modifications: `env_run.xml`

**EXERCISE.1.PART1:** Create a new fully coupled **startup** case from 1850 conditions and increase the amount of standard-output produced by the model. We will use pre-compiled code for tutorial purposes. (You will need to fully compile when you are home). Run 1 month.

**Focus: Get comfortable using xmlchange**

**See the end of the presentation (slide 57) for explicit instructions for each exercise!**

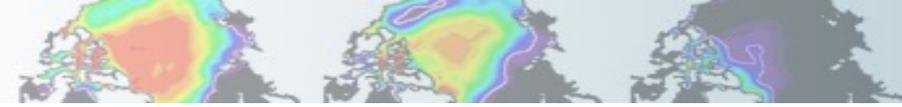


## CESM2 Tutorial: Basic Modifications: `env_run.xml` PART 2

**EXERCISE.1.PART2: Complete only \*after\* PART1 has finished running.** Expand Exercise 1 to produce a total of 38 months. You have already run 1 month. Continue with exercises 2-5 while you wait (depending on the queues, it could take 5-7 hours to complete). This data can be used for the Practical Session *Diagnostics and Output*.

**Focus: Get comfortable using xmlchange, create data for Diagnostics out Output lab**

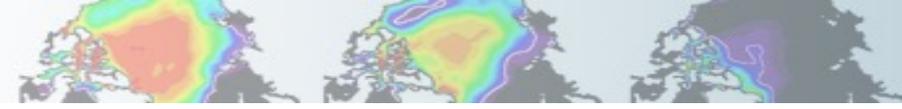
**See the end of the presentation (slide 57) for explicit instructions for each exercise!**



## CESM1 Tutorial: Basic Modifications: Ex1: Example README.case

```
shields — ssh -Y shields@cheyenne.ucar.edu — 154x54
2018-07-26 15:26:33: ./create_newcase --case /glade/u/home/shields/cases/b.day2.1 --res f19_g17 --compset B1850 --project P93300014
-----
2018-07-26 15:26:33: Compset longname is 1850_CAM60_CLM50%BGC-CROP_CICE_POP2%ECO_MOSART_CISM2%NOEVOLVE_WW3_BGC%BDRD
-----
2018-07-26 15:26:33: Compset specification file is /gpfs/fs1/p/cesm/tutorial/cesm2.0.0_tutorial/cime_config/config_compsets.xml
-----
2018-07-26 15:26:33: Pes      specification file is /gpfs/fs1/p/cesm/tutorial/cesm2.0.0_tutorial/cime_config/config_pes.xml
-----
2018-07-26 15:26:33: Forcing is 1850
-----
2018-07-26 15:26:33: Component CPL is Biogeochemistry intercomponent  with diagnostic CO2
-----
2018-07-26 15:26:33: Using None coupler instances
-----
2018-07-26 15:26:33: Component ATM is CAM cam6 physics:
-----
2018-07-26 15:26:33: ATM_GRID is 1.9x2.5
-----
2018-07-26 15:26:33: Component LND is clm5.0:BGC (vert. resol. CN and methane) with prognostic crop:
-----
2018-07-26 15:26:33: LND_GRID is 1.9x2.5
-----
2018-07-26 15:26:33: Component ICE is Sea ICE (cice) model version 5
-----
2018-07-26 15:26:33: ICE_GRID is gxlv7
-----
2018-07-26 15:26:33: Component OCN is POP2 Ecosystem
-----
2018-07-26 15:26:33: OCN_GRID is gxlv7
-----
2018-07-26 15:26:33: Component ROF is MOSART: MODEL for Scale Adaptive River Transport
-----
2018-07-26 15:26:33: ROF_GRID is r05
-----
2018-07-26 15:26:33: Component GLC is cism2 (default, higher-order, can run in parallel):cism ice evolution turned off (this is the standard configuration
unless you're explicitly interested in ice evolution):
-----
2018-07-26 15:26:33: GLC_GRID is gland4
-----
2018-07-26 15:26:33: Component WAV is Wave Watch
-----
2018-07-26 15:26:33: WAV_GRID is ww3a
-----
2018-07-26 15:26:33: ESP_GRID is None
-----
----- User Modifications -----
This is a test case for the CESM2 tutorial
~
~
"README.case" 50L, 2857C
```

Note: your xmlchange commands are recorded in CaseStatus



## CESM2 Tutorial: Basic Modifications: Namelist variables: **user\_nl\_<model>**

- Not all changes can be made in env\_run.xml.

- **user\_nl\_<model>** files appear in the case directory after ./case.setup has been invoked), i.e.

user\_nl\_cam ↔ atmosphere

user\_nl\_cice ↔ sea ice

user\_nl\_cism ↔ land ice

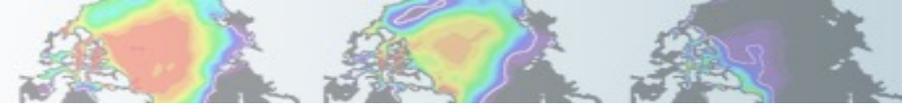
user\_nl\_clm ↔ land

user\_nl\_cpl ↔ coupler (driver)

user\_nl\_mosart ↔ river runoff

user\_nl\_pop ↔ ocean

user\_nl\_ww ↔ wave (ocean)



## CESM2 Tutorial: Basic Modifications: Namelist tool: **preview\_namelists**

- Insert namelist syntax for desired variable change into the appropriate file. To find the proper syntax and see all default namelist values, use **preview\_namelists** to create the resolved namelists the model will use at runtime in your run directory (i.e. /glade/scratch/<user>/<case>/run/ ).

- In your case directory, type **./preview\_namelists**

- cd to your run directory and view \*\_in files:

user_nl_cam	modifies	atm_in
user_nl_cice	modifies	ice_in
user_nl_cism	modifies	cism_in
user_nl_clm	modifies	lnd_in
user_nl_cpl	modifies	drv_in
user_nl_mosart	modifies	mosart_in
user_nl_pop	modifies	pop_in
user_nl_ww	modifies	wav_in

## CESM2 Tutorial: Basic Modifications: Namelist tool: **preview\_namelist**

Example: Decrease timestep in the ocean model by increasing dt\_count from 24 steps per day to 48 steps per day.

1. Edit (vi or emacs) user\_nl\_pop
2. Insert correct syntax as a new line at the end of the comment section in the form of:  
*namelist\_var = new\_namelist\_value*

i.e.,

```
dt_count = 48
```

3. Invoke *preview\_namelist* again to verify change in your run directory and update the documentation pop\_in file in CaseDocs.

Note: POP2 is now coupling every hour, rather than once per day (as in CESM1.2), so choice of dt\_count is restricted to multiples of 24. CESM2 POP2 documentation is under construction, for syntax, see the CESM1.2 webpage, however, consult the bulletin board for further details on changing POP timestep.

[http://www.cesm.ucar.edu/models/cesm1.2/pop2/doc/faq/#nml\\_general\\_change\\_dt](http://www.cesm.ucar.edu/models/cesm1.2/pop2/doc/faq/#nml_general_change_dt)

[https://ncar.github.io/POP/doc/build/html/users\\_guide/index.html](https://ncar.github.io/POP/doc/build/html/users_guide/index.html)

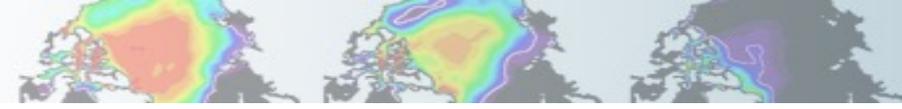


## CESM2 Tutorial: Basic Modifications: **Exercise 2**

**EXERCISE.2: BRANCH** from the end of EXERCISE 1 and double CO<sub>2</sub> for atmosphere and ocean. Double methane for the atmosphere. Include an initial file as output data. Run 1 month. Restart 1 month. Check your resolved namelists in your run directory.

**Focus:** Learn about Branch runs, practice xmlchange, get comfortable making namelist changes in `user_nl_<model>`

**See the end of the presentation (slide 60) for explicit instructions for each exercise!**



## CESM2 Tutorial: Basic Modifications: **env\_run.xml vs. user\_nl\_<model>**

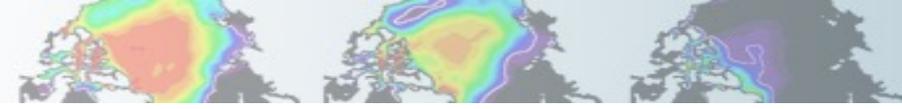
What method is best for changes?

**env\_run.xml:**

- Run\_type specification (startup, hybrid, branch)
- Runtime variables (stop\_option, resubmits, etc.)
- CO2 changes for land and ocean

**user\_nl\_<model>:**

- Swapping out a default inputdata set for a home-grown dataset
- Namelist changes for component models



## CESM2 Tutorial: Basic Modifications: `env_run.xml` vs. `user_nl_<model>`

At runtime, the scripts will automatically re-populate your resolved namelists based on `env_run` and the `user_nl_<model>` files, however, it is always good to document and check your changes BEFORE runtime.

**Always check your resolved `*_in` files (run directory, i.e. `/glade/scratch`) to make sure your changes have been applied.**



## CESM2 Tutorial: Basic Modifications: **Physics Time Step Changes**

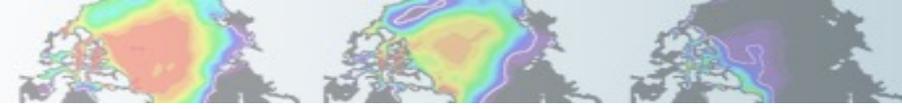
### Where and When to Change Time Steps

When the model crashes due to large, temporary instabilities, one method to overcome the problem is to change the time step.

This is typically done in either the atmosphere or ocean components.

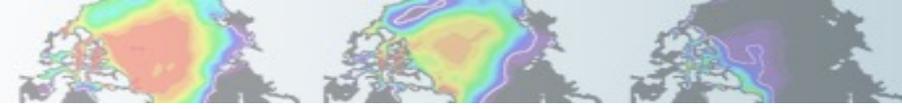
CAM/CLM: ATM\_NCPL in env\_run.xml.

POP: dt\_count in POP namelist. Edit and change the user\_nl\_pop file. (see slide 39).



## CESM2 Tutorial: Basic Modifications: **Physics Time Step Changes**

- 1. CAM6 time step** is set by **ATM\_NCPL** in `env_run.xml` and specifies the number of **coupling intervals per day** between the atmosphere/land and the coupled system. Based on `ATM_NCPL`, the scripts will automatically compute the time step for the atmosphere and land and populate the namelist files accordingly.
- 2. CLM5 time step** = CAM6 time step; this is automatically set with the CAM time step via `ATM_NCPL`. You cannot set this separately.
- 3. POP2 time step** is changed in the `user_nl_pop` file and is based on `OCN_NCPL` (found in `env_run.xml`), `dt_count`, and `dt_option`. The default `dt_option` is `steps_per_day`.
- 4. CICE5 time step** is set by the coupling interval variable `ICE_NCPL` found in `env_run.xml`. Note that `ICE_NCPL = ATM_NCPL`.

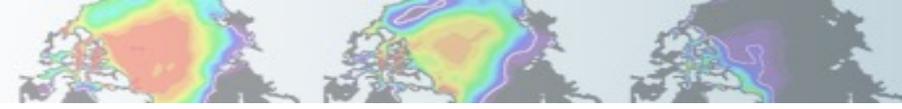


## CESM2 Tutorial: Basic Modifications: **More Exercises**

**EXERCISE.3: Hybrid** start a fully coupled for Pre-Industrial conditions. Use restart and initial files from EXERCISE 2. Change your orbital parameters to use condition from the 1600 AD and change the physics time step in the atmosphere and land to 1200 seconds (default is 1800). (Note: this is an exercise and does not represent any historical period). Run 5 days (default).

**Focus:** Learn about Hybrid runs, practice xmlchange, practice making namelist changes in user\_nl\_<model>

**See the end of the presentation (slide 63) for explicit instructions for each exercise!**

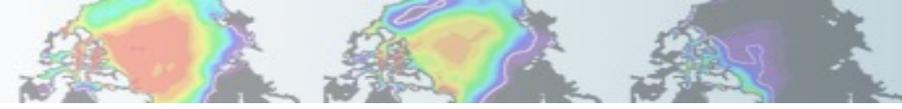


## CESM2 Tutorial: Basic Modifications: **More Exercises**

**EXERCISE.4:** Clone case from EXERCISE.3. Instead of specifying orbital year, assign individual parameters (eccentricity=0, obliquity=23., and precession=0.) Include new modification to use a different short wave absorption parameterization in POP called “jerlov”. Turn off the Urban parameterization in CLM. Run 5 days (default). ( Note: The default shortwave absorption parameterization is geography-specific and called “chlorophyll”. “Jerlov” is typically used for paleoclimate simulations where the geography is different from present day).

**Focus:** Learn about Cloned cases, practice xmlchange, practice making namelist changes in user\_nl\_<model>

**See the end of the presentation (slide 65) for explicit instructions for each exercise!**



## CESM2 Tutorial: Basic Modifications: **More Exercises**

### **EXERCISE 5: On your own... no explicit instructions!**

Continue EXERCISE.4 (restart) but reduce the snow albedoes in the ice model by half. (This is done in `user_nl_cice`). You do not need to recompile. Use the restart files that are already in the run directory and run 5 more days.

**Focus: Figuring out line by line instructions on your own!**

**See the end of the presentation (slide 66) for hints!**



## CESM2 Tutorial: Basic Modifications: **Bottom Line**

**What user-modified files are actually used at runtime?**

`./case.setup` (or `./preview_namelists`)  $\longrightarrow$  `$RUNDIR/atm_in`  
`$RUNDIR/lnd_in`  
`$RUNDIR/pop_in`  
`$RUNDIR/ice_in`  
`$RUNDIR/drv_in`

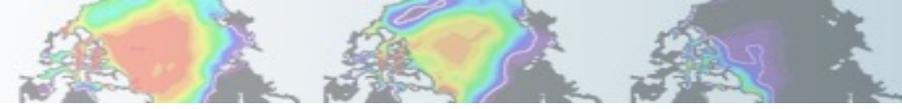
**Bottom Line: User modifications should be implemented in the `env_run.xml` or the `user_nl_<model>` files.**

**What files are for documentation purposes?**

`Buildconf/*.input_data_list`, `software_environment.txt`

`CaseDocs`, `CaseStatus`, `LockedFiles`, `README.case`

Note: `Buildconf/*conf` directories are created after `case.setup`. The user does NOT need to touch these files.



## CESM2 Tutorial: Basic Modifications: **env\_batch.xml**

**env\_workflow.xml** is where you can change the CESM2 default values related to job batch submissions.

After the tutorial when you are running at your home institution, you may want to change the default queues, wallclock time, or control the project number after you have set up a case.

**Wallclock time:** `<entry id="JOB_WALLCLOCK_TIME" value="12:00:00">`  
note: use subgroup `<group id="case.run">`

**Job queue:** `<entry id="JOB_QUEUE" value="regular">`

**Project number:** `<entry id="PROJECT" value="UESM0009">`

**Charge Account:** `<entry id="CHARGE_ACCOUNT" value="UESM0009">`

*To find your total wallclock time after running, either check timing file or your standard output file (i.e, b.day2.run.onnnnnnn) in your case directory.*



## CESM2 Tutorial: Basic Modifications: **Log Files**

### Log Files:

During model execution:



After model completion:



atm.log.jobid.yyddmm-nnnnnn.gz

cesm.log.jobid.yyddmm-nnnnnn.gz

cpl.log.jobid.yyddmm-nnnnnn.gz

glc.log.jobid.yyddmm-nnnnnn.gz

ice.log.jobid.yyddmm-nnnnnn.gz

lnd.log.jobid.yyddmm-nnnnnn.gz

ocn.log.jobid.yyddmm-nnnnnn.gz

rof.log.jobid.yyddmm-nnnnnn.gz

wav.log.jobid.yyddmm-nnnnnn.gz

### Model runtime standard output

\$RUNDIR/\*

Short term archive space

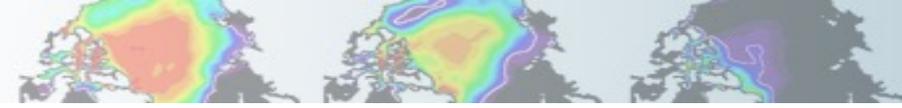
.../archive/<case>logs/\*

Files are gzipped after model completion.

Restore by typing *gunzip <logfile>*.

yyddmm = year, month, day

nnnnnn = time id stamp



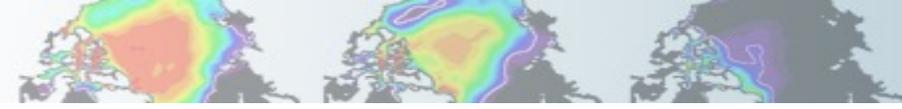
## CESM2 Tutorial: Basic Modifications: **Other Tips**

### **CHECK** your resolved namelists!

- Before you submit your job, it is always good to double check your \$RUNDIR/<model>\_in namelist files. These are the files the model will actually use at runtime and are based on your env\_run.xml and user\_nl\_<model> files.
- Verify that the model is using what you think it is using!

### **DOCUMENT** everything you do!

- A paper trail of your procedures and thoughts is good scientific practice. The README.case file is the perfect place to write notes. You will thank yourself months (years) later, when you are trying to figure out what you did oh-so-long ago!



## CESM2 Tutorial: Basic Modifications: **Post Run Tips**

### Check logs

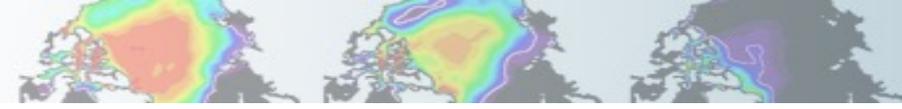
- Check your log files to make sure there are no hidden problems and to verify the model is running smoothly and as you expect. The log files may also help you verify your modifications were included in your run.

### Check output

- Check your history files. It is a good idea to run a small test sample of your experiment before launching your full production run. For example, if you want to run a 500 year control with various modifications, first run 10 years. Check the history output files and verify the model is running as you designed before continuing with the full 500 years. It is always best to find errors early, rather than later, in the run.

### Check timings

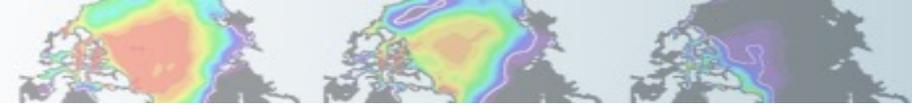
- Check your timings. After model completion, a timing subdirectory will be placed in your scripts directory. Check the timings after several job completions to verify that the model is running efficiently and as expected. Double check your timings with the CESM default timings for your specific model resolution and machine. Default timings for CESM2 can be found at:  
<https://csegweb.cgd.ucar.edu/timing/cgi-bin/timings.cgi>



## CESM2 Tutorial: Basic Modifications: **HELP!**

### Finding Help...

1. Documentation: <http://www.cesm.ucar.edu/models/cesm2/>
2. DiscussCESM: <https://bb.cgd.ucar.edu/cesm/>

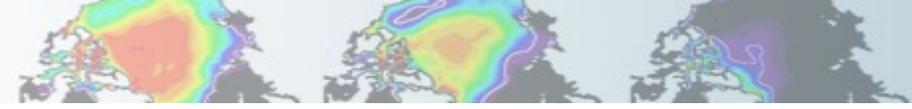


## CESM2 Tutorial: Basic Modifications

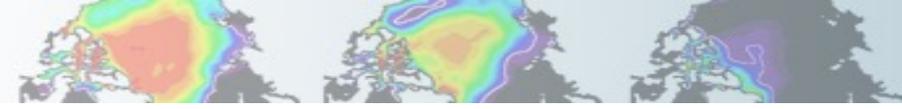


**Have Fun!!!**





# Exercises



## CESM2 Tutorial: Basic Modifications: **Review:** **Creating a new case**

EXERCISE 0: Create and configure an out-of-the-box case (set of scripts) called “b.day2.0” on cheyenne using f19\_g17 and compset B1850. Review steps but do not build or run.

1. `cd /glade/p/cesm/tutorial/cesm2.1_tutorial2022/cime/scripts`
2. `./create_newcase --case ~/cases/b.day2.0 --res f19_g17 --compset B1850`
3. `cd ~/cases/b.day2.0`
4. `./case.setup`
5. *Look at your case directory and understand what each file does.*
6. *Look at your scratch space and understand what each file does.*



## CESM2 Tutorial: Basic Modifications: **env\_run.xml**

**EXERCISE.1.PART1:** Create a new fully coupled startup case from 1850 conditions and increase the amount of standard-output produced by the model. Run 1 month. ***Tutorial-only instruction are noted (+). Hint: Do NOT cut and paste, the syntax translation does not always work.***

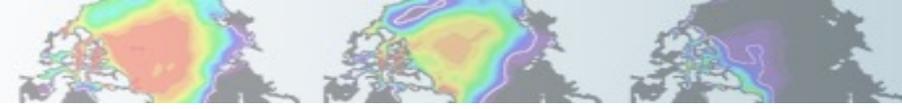
1. from scripts directory, create your case scripts:

```
./create_newcase --case ~/cases/b.day2.1 --res f19_g17 --compset B1850
```

2. from case directory, change your runtime variables:

```
./xmlchange INFO_DEBUG=2,STOP_N=1,STOP_OPTION=nmonths
```

```
./xmlchange JOB_WALLCLOCK_TIME=2:00:00
```



## CESM2 Tutorial: Basic Modifications: **env\_run.xml**

### EXERCISE.1.PART1 continued:

3. Manually update your README.case file to document your changes (Hint: type “history” on the command line and you will see all command line modifications you have made).
4. `./case.setup`
5. `qcmd -- ./case.build` (`qcmd` is used on Cheyenne only)
6. `./case.submit`

Review log files to familiarize yourself with standard out. Start looking at your history files. Check your CaseDocs/\*\_in files. Were your changes applied?



## CESM2 Tutorial: Basic Modifications: `env_run.xml` PART 2

**Set up PART 2 ONLY after EXERCISE 1 is complete.**

Assuming your b.day2.1 exercise ran successfully.....

Expand Exercise 1 to produce a total of 38 months. You have already run 1 month. Continue with exercises 2-5 will you wait (depending on the queues, it could take 5-7 hours). This data can be used for the Practical Session *Diagnostics and Output*.

**In `env_run.xml`:**

1. Set `CONTINUE_RUN` to "TRUE"
2. Keep `STOP_OPTION` set to "nmonths"
3. Set `STOP_N` to "37"
4. Set `INFO_DEBUG` to 1
5. Change wallclock time to allow runs the max allowed wallclock on Cheyenne (**do NOT cut and paste**)  
`./xmlchange --subgroup case.run JOB_WALLCLOCK_TIME=12:00:00`  
`./xmlchange --subgroup case.st_archive JOB_WALLCLOCK_TIME=6:00:00`
6. Submit (`./case.submit`) from your b.day2.1 case directory

## CESM2 Tutorial: Basic Modifications: **Exercise 2**

**EXERCISE.2: BRANCH** from the end of EXERCISE 1 and double CO<sub>2</sub> for atmosphere and ocean. Double methane for the atmosphere. Include an initial file as output data. Run 1 month. Restart 1 month. Check your resolved namelists in your run directory.

1. `./create_newcase --case ~/cases/b.day2.2 --res f19_g17 --compset B1850`
2. `cd ~/cases/b.day2.2`
3. `./xmlchange RUN_TYPE=branch,RUN_REFCASE=b.day2.1,RUN_REFDATE=0001-02-01,CLM_NAMELIST_OPTS=' ',  
GET_REFCASE=FALSE,STOP_OPTION=nmonths,STOP_N=1,RESUBMIT=1,CCSM_CO2_PPMV=569.4, JOB_WALLCLOCK_TIME=02:00:00`
4. `./case.setup`
5. Place a copy your restart files from your bday2.1 short term archive space to your bday2.2 run directory.  
`cp /glade/scratch/$LOGNAME/archive/b.day2.1/rest/0001-02-01-00000/* (space) /glade/scratch/$LOGNAME/b.day2.2/run/`

Notes and Hints: No spaces between arguments; `CCSM_CO2_PPMV` changes ocean only, `CLM_NAMELIST_OPTS` needs to be set to blank for branch runs. To find variables applied to reference cases (Branch and Hybrid runs), use `./xmlquery -p REF`.

**CESM2 Tutorial: Basic Modifications: Exercise 2****EXERCISE.2: continued**

6. `./preview_namelists`

7. Check CaseDocs/atm\_in for co2vmr syntax (and see default values). Add the following lines to user\_nl\_cam:

`co2vmr = 569.4e-6`

`ch4vmr = 1583.2e-9`

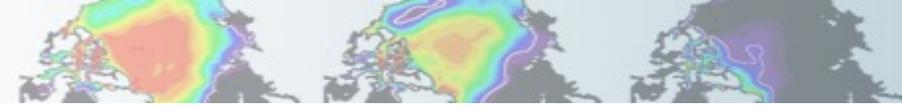
`inithist = 'MONTHLY'` (copy and paste won't work)

8. `./preview_namelists` (check atm\_in and pop\_in to make sure your changes were implemented)

9. `qcmd -- ./case.build`

**CESM2 Tutorial: Basic Modifications: Exercise 2****EXERCISE.2: continued**

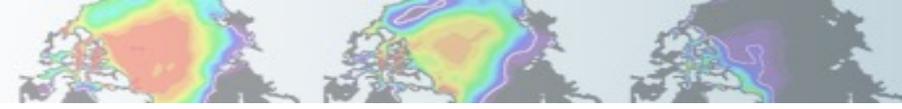
10. `./case.submit`
11. Review queues and log files. Where are your logs files (where are they)? How fast does the first month run (timing files are in the case directory and the run directory)? Was the second month resubmitted? What is the value of "CONTINUE\_RUN" initially? (Check before the model finishes the first month). What is the value after resubmission? Read the `env_run.xml` documentation for explanation! (Hint: see "RESUBMIT\_SETS\_CONTINUE\_RUN").
12. After the job completes, go to the short term archive space and explore.



## CESM2 Tutorial: Basic Modifications: **More Exercises**

**EXERCISE.3: Hybrid** start a fully coupled for Pre-Industrial conditions. Use restart and initial files from EXERCISE 2. Change your orbital parameters to use condition from the 1600 AD and change the physics time step in the atmosphere and land to 1200 seconds (default is 1800). (Note: this is an exercise and does not represent any historical period). Run 5 days (default).

1. `./create_newcase --case ~/cases/b.day2.3 --res f19_g17 --compset B1850`
2. `cd ~/cases/b.day2.3`
3. `./xmlchange RUN_TYPE=hybrid,RUN_REFCASE=b.day2.2,RUN_REFDATE=0001-03-01,GET_REFCASE=FALSE,ATM_NCPL=72,  
JOB_WALLCLOCK_TIME=2:00:00`  
(Why is ATM\_NCPL = 72, do the math).
4. `./case.setup`
5. Position your initial (atmosphere) and restart (all other components) data.  
`cp /glade/scratch/$LOGNAME/archive/b.day2.2/rest/0001-03-01-00000/* (space) /glade/scratch/$LOGNAME/b.day2.3/run/.`



## CESM2 Tutorial: Basic Modifications: **More Exercises**

### EXERCISE.3: Continued:

6. `./preview_namelists`

(What is the difference between the cam initial files in this Exercise versus the branch files in Exercise 2?

Hint: Check `ncl_data` and `cam_branch_file` in `atm_in`).

7. Edit `user_nl_cpl`, after comments, add line: `orb_ityear=1600`

(Hint, check `drv_in` for syntax, what is the default value)?

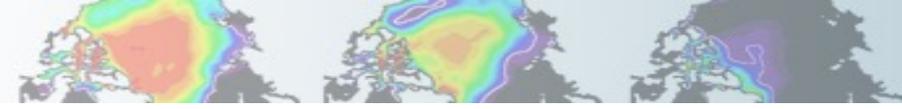
Update `README.case`

8. Optional: `./preview_namelists` (What is the value of `orb_ityear` in `drv_in` now)?

9. `qcmd -- ./case.build`

10. `./case.submit`

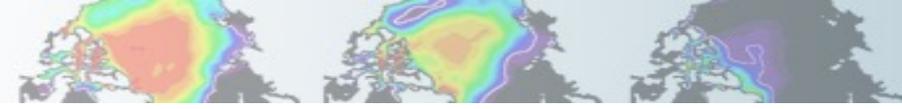
11. Check logs files. The coupler log file should confirm your orbital changes.



## CESM2 Tutorial: Basic Modifications: **More Exercises**

**EXERCISE.4:** Clone case from EXERCISE.3. Instead of specifying orbital year, assign individual parameters (eccentricity=0, obliquity=23., and precession=0.) Include new modification to use a different short wave absorption parameterization in POP called “jerlov”. Turn off the Urban parameterization in CLM. Run 5 days (default). ( Note: The default shortwave absorption parameterization is geography-specific and called “chlorophyll”. “Jerlov” is typically used for paleoclimate simulations where the geography is different from present day).

1. `./create_clone --case ~/cases/b.day2.4 --clone ~/cases/b.day2.3`
2. Edit `user_nl_cpl` and change the following:
  - a. Remove `orb_ityear`
  - b. Add `orb_mode = 'fixed_parameters'`
  - c. Add `orb_eccen = 0.`
  - d. Add `orb_mvlp = 0.`
  - e. Add `orb_obliq = 23.`
3. `./xmlchange JOB_WALLCLOCK_TIME=2:00:00`



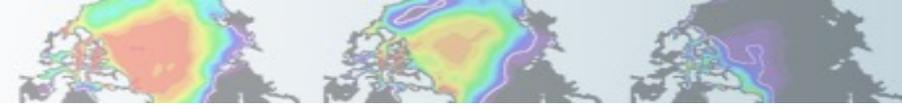
## CESM2 Tutorial: Basic Modifications: **More Exercises**

### EXERCISE.4: continued

4. Edit user\_nl\_pop and add: `sw_absorption_type = 'jerlov'`
5. Edit user\_nl\_clm and add: `urban_hac = 'OFF'`
6. Update your README.case file to document your changes.
7. `./case.setup`
8. `cp /glade/scratch/$LOGNAME/archive/b.day2.2/rest/0001-03-01-00000/* (space) /glade/scratch/$LOGNAME/b.day2.4/run/`
9. `./preview_namelists`

Because you cloned this case you already had your user\_nl\_<model> file in your case case directory, but you have changed them and therefore need to invoke preview\_namelist to update your CaseDocs.

10. `qcmd -- ./case.build`
11. `./case.submit`
12. If you want, you can start to look at the history output. Only the ocn will have daily output to view, the default is monthly for most model components. (Use ncview). To use ncview, you will need to type “module load ncview” on your command line. Where is the short term history output located? Go back to earlier exercises to explore monthly history files.
13. Compare b.day2.4 ocn history data to b.day2.3 data. (Use ncdiff). To use ncdiff, you will need to type “module load nco” on your command line.



## CESM2 Tutorial: Basic Modifications: **More Exercises**

### EXERCISE 5: On your own...

Continue EXERCISE.4 (restart) but reduce the snow albedoes in the icemodel by half. (This is done in `user_nl_ice`). You do not need to recompile. Use the restart files that are already in the run directory and run 5 more days.

Know what you are changing. Look up information on namelist variables in the documentation.

[https://cesmcice.readthedocs.io/en/latest/users\\_guide/ice\\_nml\\_var.html?highlight=albedos](https://cesmcice.readthedocs.io/en/latest/users_guide/ice_nml_var.html?highlight=albedos)

Be sure to update your README.case file to keep track of your changes. The model will run regardless of whether or not you remember to include all of your changes. Check your resolved namelist files (`$RUNDIR/<model>_in` files) to make sure all changes are included. If you like, resubmit and continue the run for 1 more month, experiment with other namelist variables changes, and compare history files.