CESM2 Tutorial: Basic Modifications

Christine A. Shields

Virtual Tutorial: July-August, 2021

NSF
NCAR
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH
U.S. DEPARTMENT OF ENERGY | Office of Science

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 specific a project number today. (You may need to do this after the tutorial)!

Tutorial Code and script base:

/glade/p/cesm/tutorial/cesm2.1_tutorial_2021/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/

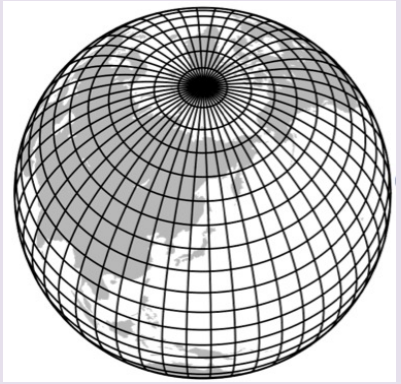
For older releases, please see past tutorials.

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

What is the casename?

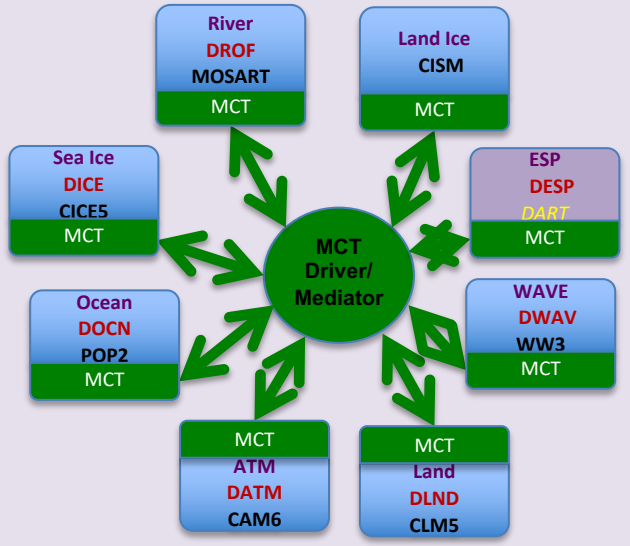
~/cases/b.day1.0

Which resolution?



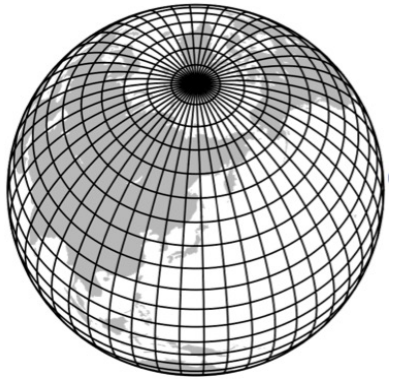
f19_g17
(FV 2deg coupled to gx1 ocean)

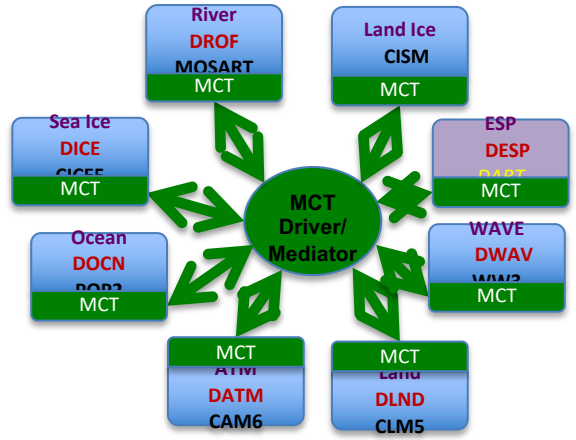
Which model configuration ?
Which set of components ?



B1850

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





create_newcase --case ~/cases/b.day1.0 --res f19_g17 --compset B1850 -- project UESM0009

create_newcase --help (full list of arguments)

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

The tutorial project number is UESM0009, 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 10 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)

CESM2 Version

Reference: CIME Model Component Sets Documentation

Model Version: CESM2.1.1

Grid Resolutions: CESM2 Grid Resolution Definitions

HTML created on: 2019-06-09

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.

Show 10 entries | Show All | Hide All | 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

- f09_g17_gl4
- f09_g17

Details

	Value	Description
Initialization Time	1850	1850: Pre-Industrial; 2000 present day: Additional initialization times defined by components.
Atmosphere	CAM60	CAM cam6 physics:
Land	CLM50%BGC-CROP	clm5.0:BGC (vert. resol. CN and methane) with prognostic crop:
Sea-Ice	CICE	Sea ICE (cice) model version 5
Ocean	POP2%ECO%ABIO-DIC	POP2 EcosystemAbiotic DIC/DIC14
River runoff	MOSART	MOSART: MOdel for Scale Adaptive River Transport
Land Ice	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):
Wave	WW3	Wave Watch
Ocean Biogeochemistry	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/lnd 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 2).
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_tutorial_2021/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_tutorial_2021/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 UESM0009 -- ./case.build

   ./case.submit

- ***The value for the account number, UESM0009, 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: README

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 usng 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

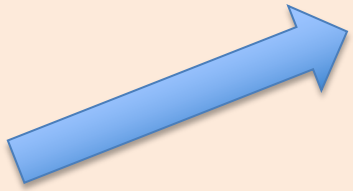
./xmlchange --subgroup case.st_archive JOB_WALLCLOCK_TIME=01:00:00

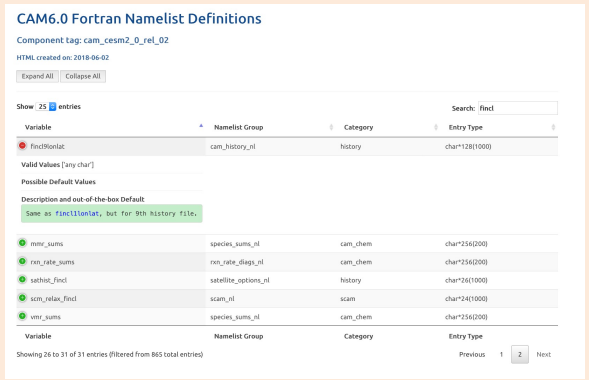
CESM2 Tutorial: Basic Modifications: Namelist variables

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

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 *.run 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_DBUG** → 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_2 value to be propagated to POP and CLM (if CO2 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) 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 " " , 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

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 1st 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 (2nd, 3rd, 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: 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: 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 56) 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 will 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 58) for explicit instructions for each exercise!

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

```
shields — ssh -Y shields@cheyenne.ucar.edu — 154×54
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 gx1v7
 ------------------------------------------------------
2018-07-26 15:26:33: Component OCN is POP2 Ecosystem
 ------------------------------------------------------
2018-07-26 15:26:33: OCN_GRID is gx1v7
 ------------------------------------------------------
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 Modications -----

This is a test case for the CESM2 tutorial

~
~
"README.case" 50L, 2857C                                                                                    48,43         All
```

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_namelists

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_namelists* 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
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_2 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 59) 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).

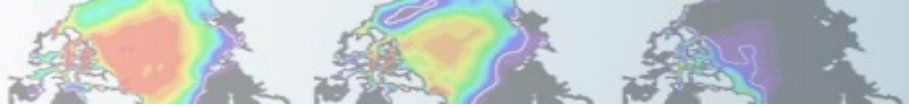
CESM2 Tutorial: Basic Modifications: Physics Time Step Changes

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.

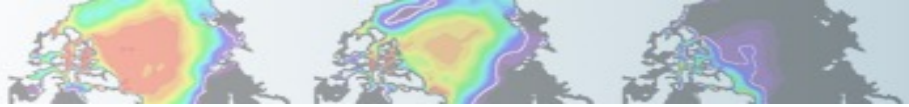


CESM2 Tutorial: Basic Modifications: More Exercises

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 62) 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 64) 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*) ⟶ $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.onnnnnn) in your case directory.

CESM2 Tutorial: Basic Modifications: Log Files

Log Files:

During model execution: → $RUNDIR/*

After model completion: → Short term archive space …/archive/<case>logs/*

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

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

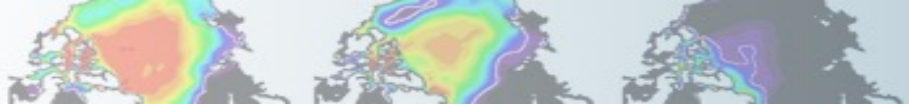
- Check your log files to make sure there are no hidden problems and to verify the model is running smoothly and as you expect. The log files may also help you verify your modifications were included in your run.

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!

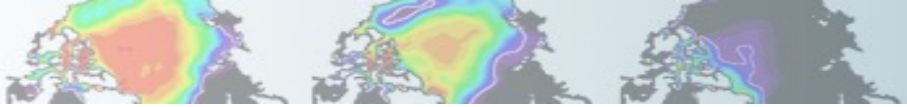
Finding Help…

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/cesm2.1.1_tutorial/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_DBUG=2,STOP_N=1,STOP_OPTION=nmonths
   ./xmlchange JOB_WALLCLOCK_TIME=2:00:00

Continued next page

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_DBUG* 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_2 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.*

Continued next page

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*

Continued next page

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/.

Continued next page

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 *ncdata* and cam_branch_file in atm_in).

7. Edit user_nl_cpl, after comments, add line: *orb_iyear=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_iyear 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_iyear*
   b. Add *orb_mode = 'fixed_parameters'*
   c. Add *orb_eccen = 0.*
   d. Add *orb_mvelp = 0.*
   e. Add *orb_obliq = 23.*
3. *./xmlchange JOB_WALLCLOCK_TIME=2:00:00*

Continued next page

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 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.

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

Be sure to update your README.case file to keep track of your changes. The model will run regardless of whether or not your 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.