

WACCM-X Tutorial

CEDAR 2025

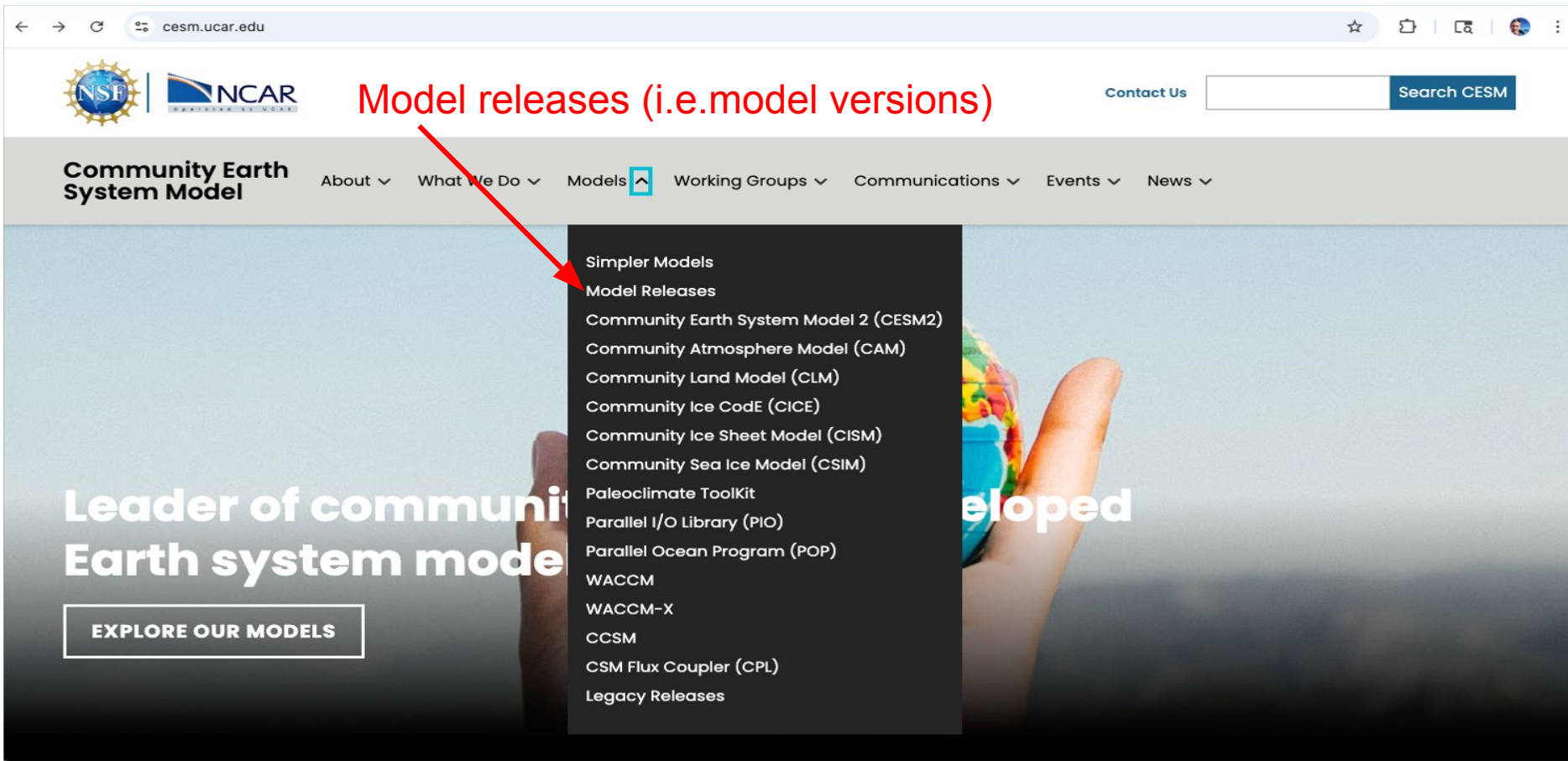


Overview

- Downloading model source code
- Creating a case directory
- Case setup, build, and run
- Contents of directories
- Modifying case settings
- Description, access, and viewing model output
- Documentation and help



CESM Web Page: <http://www.cesm.ucar.edu>



The screenshot shows the CESM web page with the URL <http://www.cesm.ucar.edu> in the browser address bar. The page features the NSF and NCAR logos, a 'Contact Us' link, and a search bar labeled 'Search CESM'. The main navigation bar includes links for 'About', 'What We Do', 'Models', 'Working Groups', 'Communications', 'Events', and 'News'. The 'Models' link is highlighted with a blue square, and a red arrow points to the 'Model Releases' option in the dropdown menu. The dropdown menu lists various models and tools, including 'Simpler Models', 'Model Releases', 'Community Earth System Model 2 (CESM2)', 'Community Atmosphere Model (CAM)', 'Community Land Model (CLM)', 'Community Ice Code (CICE)', 'Community Ice Sheet Model (CISM)', 'Community Sea Ice Model (CSIM)', 'Paleoclimate Toolkit', 'Parallel I/O Library (PIO)', 'Parallel Ocean Program (POP)', 'WACCM', 'WACCM-X', 'CCSM', 'CSM Flux Coupler (CPL)', and 'Legacy Releases'. The background of the page features a hand holding a globe and the text 'Leader of community Earth system models' and 'developed'.

Model releases (i.e.model versions)

Community Earth System Model

About ▾ What We Do ▾ Models ▾ Working Groups ▾ Communications ▾ Events ▾ News ▾

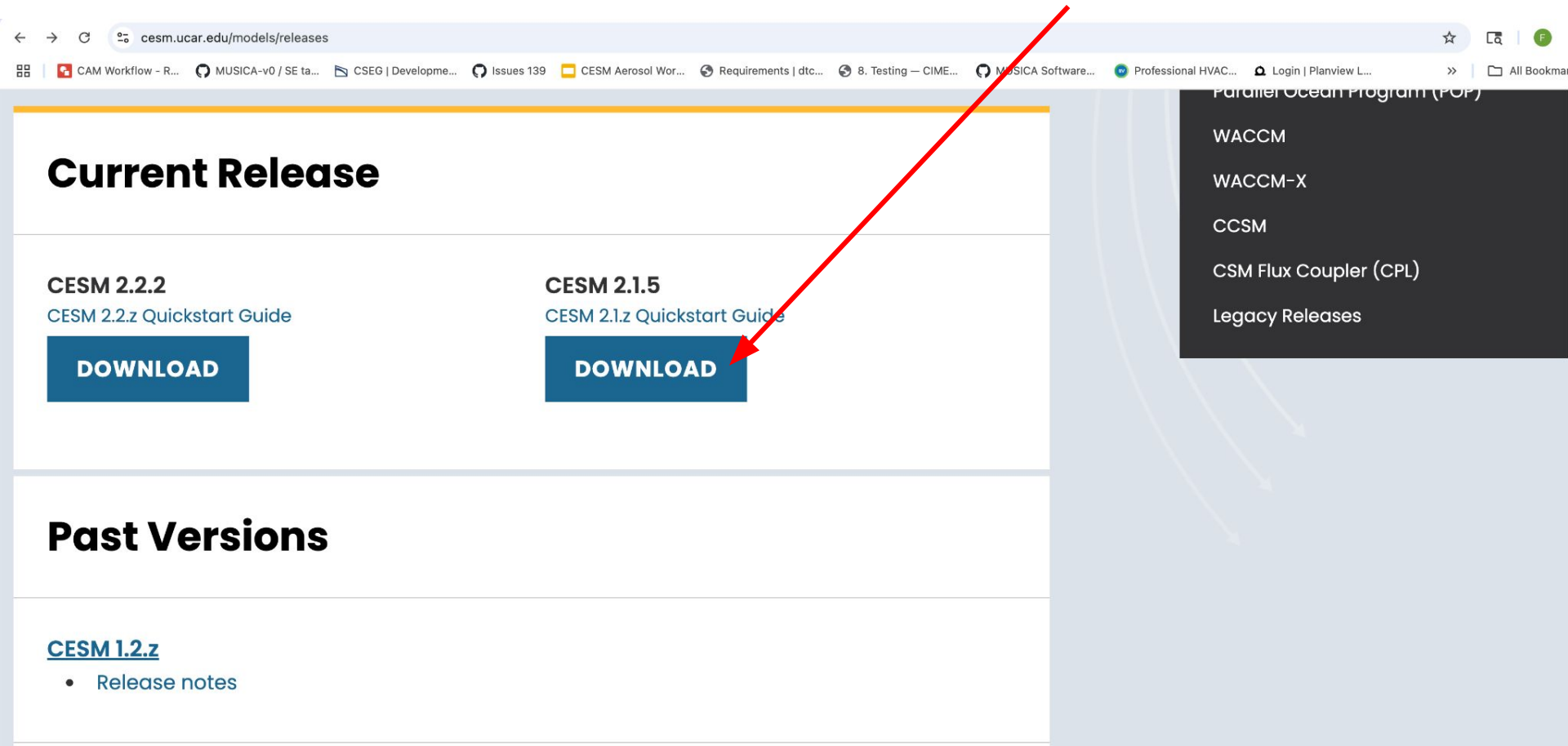
Leader of community Earth system models

EXPLORE OUR MODELS

Model Releases

- Simpler Models
- Model Releases
- Community Earth System Model 2 (CESM2)
- Community Atmosphere Model (CAM)
- Community Land Model (CLM)
- Community Ice Code (CICE)
- Community Ice Sheet Model (CISM)
- Community Sea Ice Model (CSIM)
- Paleoclimate Toolkit
- Parallel I/O Library (PIO)
- Parallel Ocean Program (POP)
- WACCM
- WACCM-X
- CCSM
- CSM Flux Coupler (CPL)
- Legacy Releases

Latest supported release – CESM2.1.5



The screenshot shows the CESM releases page at cesm.ucar.edu/models/releases. The page is divided into two main sections: "Current Release" and "Past Versions".

Current Release

CESM 2.2.2	CESM 2.1.5
CESM 2.2.z Quickstart Guide	CESM 2.1.z Quickstart Guide
DOWNLOAD	DOWNLOAD

Past Versions

- [CESM 1.2.z](#)
 - [Release notes](#)

A red arrow points from the top right towards the "DOWNLOAD" button for CESM 2.1.5. On the right side of the page, there is a dark sidebar with a list of links: "Partner Ocean Program (POP)", "WACCM", "WACCM-X", "CCSM", "CSM Flux Coupler (CPL)", and "Legacy Releases".

CESM github repository



ESCOMP / CESM

Type / to search

<> Code Issues 32 Pull requests 4 Discussions Actions Projects Wiki Security 4 Insights



CESM

Public

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release-cesm2.1.5

37 Branches

363 Tags

Go to file

<> Code



fischer-ncar Update for cesm2.1.5-rc.01

7a6c5b0 · 2 years ago

566 Commits

.github	Initial commit.	8 years ago
cime_config	Update for cesm2.1.5-rc.01	2 years ago
doc	More minor edits	4 years ago
manageExternals	Merge commit '4c715bb9b87e098a1692def6c0...	2 years ago
.gitignore	update rst source with links to http://www.cesm...	7 years ago
ChangeLog	Update for cesm2.1.5-rc.01	2 years ago
ChangeLog_template	Initial commit	8 years ago

About

The Community Earth System Model

www.cesm.ucar.edu/

climate

climate-model

ncar

Readme

View license

Code of conduct

Activity

Custom properties

375 stars

33 watching

See the README



← → ↻ github.com/escomp/cesm 🔍 ☆ 📄 | 📁 All Bookmarks

📖 README 📄 Code of conduct 📄 License ✎ ☰

The Community Earth System Model

See the CESM web site for documentation and information:

<http://www.cesm.ucar.edu>

The CESM Quickstart Guide is available at:

<http://escomp.github.io/cesm>

This repository provides tools for managing the external components that make up a CESM tag - alpha, beta and release. CESM tag creation should be coordinated through CSEG at NCAR.

This repository is also connected to slack at <http://cesm2.slack.com>

Contents

- [1 Software requirements](#)
 - [1.1 Software requirements for installing, building and running CESM](#)
 - [1.2 Details on Fortran compiler versions](#)
 - [1.3 More details on porting CESM](#)
- [2 Obtaining the full model code and associated scripting infrastructure](#)

Deployments 41

✓ [github-pages](#) 2 years ago

[+ 40 deployments](#)

Languages

Python 97.1% Shell 1.6% Other 1.3%

Download and Basics

Download from github

```
> git clone https://github.com/ESCOMP/CESM.git -b cesm2.1.5 cesm2.1.5  
> cd cesm2.1.5  
> manageExternals/checkoutExternals
```

Not covered here for unsupported machines (.e.g. derecho)

- Porting
- Create input data root directory

Basic steps for running

- Create case
- Invoke case.setup, case.build
- Submit the run ...



Download listing of CESM

```
> cd cesm2.1.5
> ls -l
ChangeLog
ChangeLog_template
cime
cime_config
components
describe_version
doc
Externals.cfg
LICENSE.txt
manageExternals
README.rst
```

Scripts for creating case, etc.
under cime

Model source code under
components



Components listing

```
> cd components
```

```
> ls -l
```

```
cam
```

```
cice
```

```
cism
```

```
clm
```

```
mosart
```

```
pop
```

```
rtm
```

```
ww3
```

Community Atmosphere Model

Community Sea Ice Model

Community Ice Sheet model

Community Land Model

Model for Scale Adaptive River Transport

Parallel Ocean Program

River Transport Model

WaveWatch3

```
> cd cam/src
```

```
> ls -l
```

```
advection
```

```
chemistry
```

```
control
```

```
cpl
```

```
dynamics
```

```
ionosphere
```

```
physics
```

```
unit_drivers
```

```
utils
```



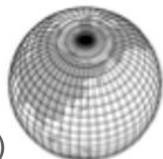
Create a new case



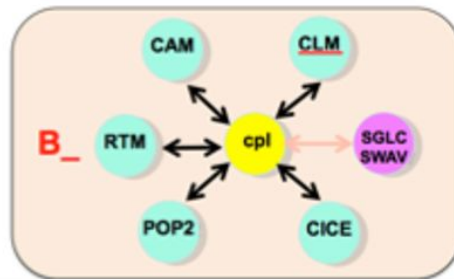
In the **cime/scripts** directory, **create_newcase** is the tool that generates a new model case.

create_newcase requires **3 arguments**:

Which resolution?



Which model configuration ?
Which set of components ?



Supported WACCM-X resolutions:

- f19_f19_mg17 (2-degree)
- f09_f09_mg17 (1-degree)

```
> ./create_newcase --res f19_f19_mg17 --compset FXHIST --case /glade/work/fvitt/cesm/cases/fe21.FXHIST.f19.t001
> ./create_newcase --help
```

What is a compset?



“**FXHIST**” is an example of a component set, or “compset”, which defines the configuration of the CESM component models: atmosphere, land, ocean, sea ice, and land ice.

All WACCM-X components use non-interactive data models for ocean and sea ice, and do not include interactive land ice. Such compsets all begin with the letter “F”.

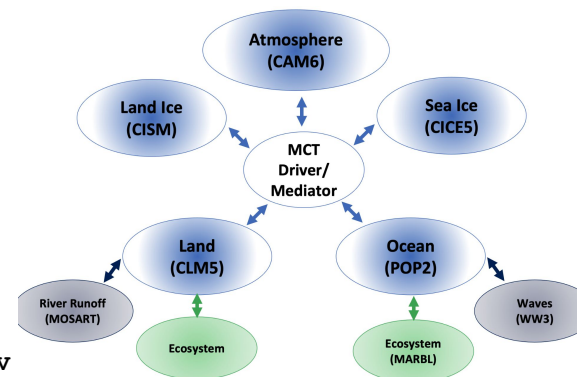
To list available WACCM-X compsets, under `cime/scripts` enter:

```
> ./query_config --compsets | grep %WXIE
```

Short name

Long name

FX2000	: 2000_CAM40%WXIE_CLM40%SP_CICE%PRES_DOCN%DOM_RTM_SGLC_SWAV
FXHIST	: HIST_CAM40%WXIE_CLM40%SP_CICE%PRES_DOCN%DOM_RTM_SGLC_SWAV
FXmadHIST	: HIST_CAM40%WXIED_CLM40%SP_CICE%PRES_DOCN%DOM_RTM_SGLC_SWAV
FXSD	: HIST_CAM40%WXIE%SDYN_CLM40%SP_CICE%PRES_DOCN%DOM_RTM_SGLC_SWAV
FXmadSD	: HIST_CAM40%WXIED%SDYN_CLM40%SP_CICE%PRES_DOCN%DOM_RTM_SGLC_SWAV

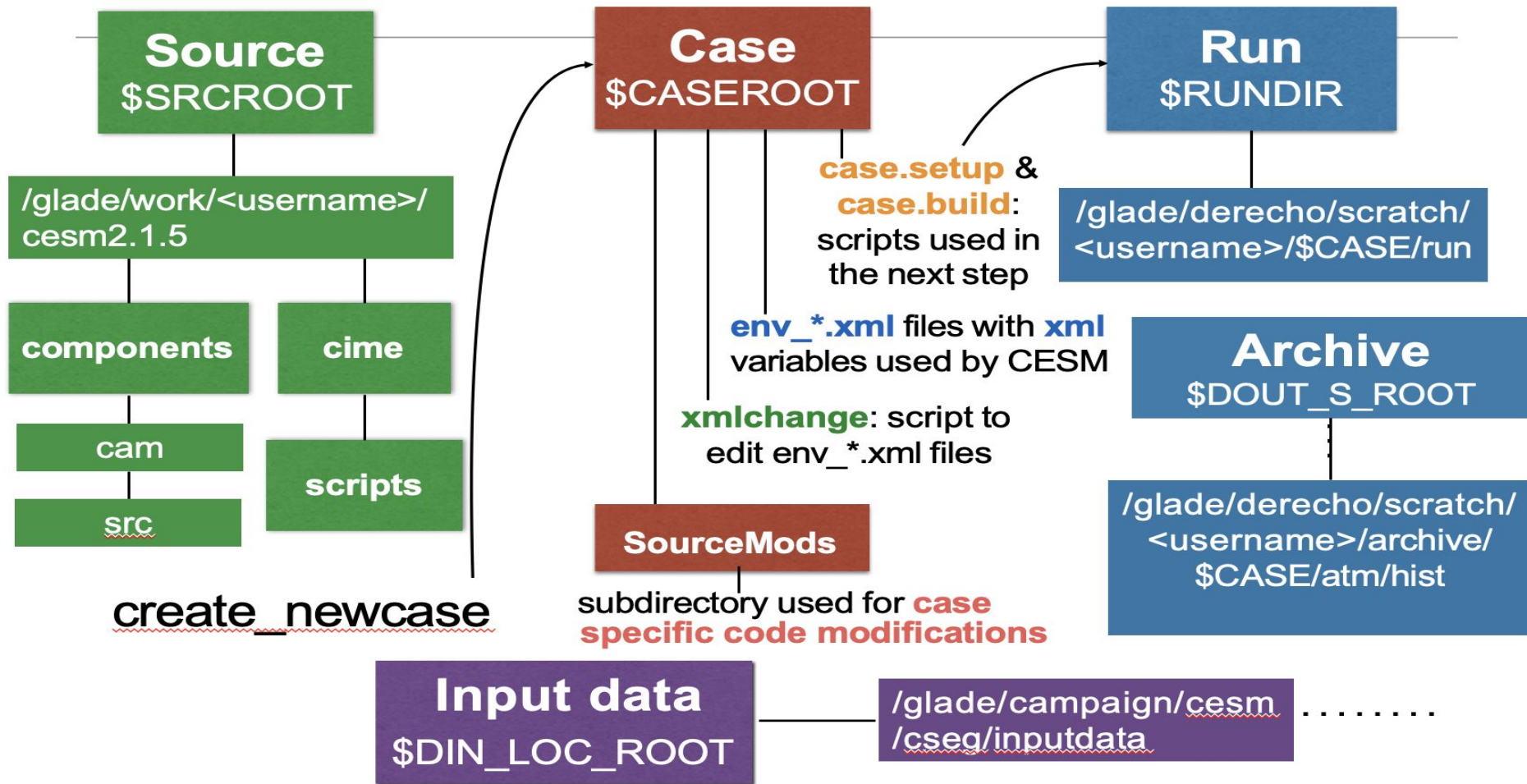


WACCM-X Compsets



FX2000	Perpetual year 2000 emissions forcings	Middle atmosphere WACCM chemistry
FXHIST	Transient emissions forcings	Middle atmosphere WACCM chemistry
FXmadHIST	Transient emissions forcings	Middle atmosphere chemistry plus D-region ion chemistry
FXSD	Transient emissions forcings Nudged to MERRA meteorology	Middle atmosphere WACCM chemistry
FXmadSD	Transient emissions forcings Nudged to MERRA meteorology	Middle atmosphere chemistry plus D-region ion chemistry

Directory Structure of Model Source and Created Case, Run, Archive, and Input Data



Compiling: Setup and Build (Derecho)

After creating your case, go to the case directory:



```
> cd /glade/work/fvitt/cesm/cases/fe21.FXHIST.f19.t001
```

Setup the case:

```
> ./case.setup
```

Build the case:

```
> ./case.build
```

Problems? Try:

```
> ./case.setup --reset  
> ./case.build --clean-all  
> ./case.build
```

Running: Submit and Checking Output (Derecho)

After compiling and building the case, submit the job:

```
> ./case.submit
```

Check the run in the queue:

```
> qstat -u fvitt
```

Check run directory while running::

```
> ls /glade/derecho/scratch/fvitt/fe21.FXHIST.f19.t001/run
```

Check archive directory after run completes::

```
> ls /glade/derecho/scratch/fvitt/archive/fe21.FXHIST.f19.t001/atm/hist
```

Problems? Log files in run directory can help : cesm*log*, atm*log*, cpl*log*



After running
out-of-the-box,
can make
changes to run
configuration

XML Files (build and run control variables)

There are multiple `env_*.xml` files in the `$CASEROOT` directory:

- `env_archive.xml`: specifies rules for short term archive script `case.st_archive`
- `env_batch.xml`: specifies batch specific settings used in `case.submit` script
- `env_build.xml`: specifies build information used in the `case.build` script
- `env_case.xml`: set by `create_newcase` and cannot be modified
- `env_mach_pes.xml`: specifies PE layout on NCAR HPC for components and used by `case.run` script
- `env_mach_specific.xml`: specifies machine specific information used in `case.build` script
- `env_run.xml`: sets run time information (such as length of run, number of submissions, ...)

Use `xmlquery` tool to see settings

```
>./xmlquery --partial STOP --full
```

Use `xmlchange` to change settings:

```
>./xmlchange $CONTINUE_RUN="TRUE"
```



Component processor usage (or layout)

```
> ./pelayout
```

Comp	NTASKS	NTHRDS	ROOTPE	PSTRIDE
------	--------	--------	--------	---------

CPL :	1536/	1;	0	1
-------	-------	----	---	---

ATM :	1536/	1;	0	1
-------	-------	----	---	---

LND :	1536/	1;	0	1
-------	-------	----	---	---

ICE :	1536/	1;	0	1
-------	-------	----	---	---

OCN :	1536/	1;	0	1
-------	-------	----	---	---

ROF :	1536/	1;	0	1
-------	-------	----	---	---

GLC :	1536/	1;	0	1
-------	-------	----	---	---

WAV :	1536/	1;	0	1
-------	-------	----	---	---

ESP :	1536/	1;	0	1
-------	-------	----	---	---

ESMF_AWARE_THREADING is False

ROOTPE is with respect to 128.0 tasks per node

To change number of MPI tasks:

```
> ./xmlchange NTASKS=-10
```

Negative value indicates number of compute nodes



Modifying Model Settings In user_nl_cam File

CaseDocs/atm_in file has current settings which can be modified in user_nl_cam

```
> less $CASEROOT/CaseDocs/atm_in
```

Output fields:

Search for “MASTER FIELD LIST” in atm log file output in archive directory

```
> less /glade/derecho/scratch/fvitt/archive/fe21.FXHIST.f19.t001/logs/atm*log*
```

Modified by setting “fincl” namelist variables

```
fincl2= 'Z3', 'T', 'Tion', 'TElec', 'e', 'U', 'V', 'OMEGA', 'UI', 'VI',  
'WI', 'EDens', 'ElecColDens', 'PHIM2D', 'PS', 'EDYN_ZIGM11_PED',  
'EDYN_ZIGM2_HAL', 'ED1', 'ED2', 'O', 'O2', 'H', 'NO',  
'TTGW', 'UTGW_TOTAL', 'DTCOND', 'QRS', 'QRL', 'QNO'
```

Output frequency, times per file, averaged or instantaneous

```
nhtfrq = 0, -3 , -24, -24, -120, -24  
mfilt = 1, 8, 7, 7, 10, 365  
avgflag_pertape= 'A', 'I', 'I', 'A', 'A', 'A'
```



Characteristics of WACCM-X Output netCDF History Files

- **netCDF:** self-describing binary data format used for primary CESM output
- **History files:** WACCM-X output is written to several output streams, each with a particular frequency and averaging characteristic which can be modified in the `user_nl_cam` file
 - **h0:** monthly averages
 - `f.e22.FXSD.f09_f09_mg17.001.cam.h0.2000-01.nc` (January 2000)
 - `f.e22.FXSD.f09_f09_mg17.001.cam.h0.2000-02.nc` (February 2000)
 - **h1:** 3-hourly instantaneous
 - `f.e22.FXSD.f09_f09_mg17.001.cam.h1.2000-01-01-00000.nc` (January 1, 2000)
 - `f.e22.FXSD.f09_f09_mg17.001.cam.h1.2000-01-02-00000.nc` (January 2, 2000)
 - **h2:** daily instantaneous
 - **h3:** daily averages
 - **h4:** 10-day average tidal coefficients
 - **h6:** daily averages, zonal mean circulation diagnostics



WACCM-X Output on Globus (1)

- WACCM-X output is available Globus website globus.org
- Three collections of WACCM-X output from 2000 through 2024
- 1 degree horizontal resolution historical (FXHIST) simulation output
- 1 (f09) and 2 (f19) degree horizontal resolution specified dynamics (FXSD) simulation output
- Updated regularly
- If new to Globus, go to <https://www.globusid.org/create> to sign up
- Log in, choose “File Manager” tab on left then in “Collection”, search for “WACCM-X 2.2” (next slide)



WACCM-X Output on Globus (2)



app.globus.org/file-manager/collections



File Manager - Collection Search



FILE MANAGER



ACTIVITY



COLLECTIONS



GROUPS



FLOWS



COMPUTE



TIMERS



CONSOLE



SETTINGS

Collection

WACCM-X 2.2



Cancel

☐ Search All Collections ?



WACCM-X 2.2 1 degree FXHIST Year 2000 to Present

Guest Collection (GCS) on NCAR Campaign Storage

Owner: edefbccb-49c6-44bb-ba45-73fbb48d2834@clients.auth.globus.org

Domain: g-8f4d92.7a577b.6fbd.data.globus.org

Description: WACCM-X version 2.2 output from 1 degree FXHIST simulation



WACCM-X 2.2 1 degree FXSD Year 2000 to Present

Guest Collection (GCS) on NCAR GLADE

Owner: joemci@identity.7a577b.6fbd.data.globus.org

Domain: g-9c4556.7a577b.6fbd.data.globus.org

Description: Simulations results from the Whole Atmosphere Community Climate Model - eXtended (WACCM-X) from the year 2000 to the present. 3-hourly, daily 0 UT, daily average, and monthly output.



WACCM-X 2.2 2 degree FXSD Year 2000 to Present

Guest Collection (GCS) on NCAR Campaign Storage

Owner: joemci@identity.7a577b.6fbd.data.globus.org

Domain: g-e322d1.7a577b.6fbd.data.globus.org

Description: Output history files from WACCM-X 2.2 2 degree Specified Dynamics simulations starting in the year 2000 and updated regularly to the present



University Allocations

<https://arc.ucar.edu/docs> - Left side bar “Getting Started” > “Allocations” > University Allocations”

The table below summarizes the HPC resource limits for each type of allocation. For Small, Exploratory, and Classroom projects, the amounts shown assume use of only Derecho or Derecho GPU. For requests to use both parts of Derecho, proportionally smaller limits apply—e.g., up to half the Derecho limit and half the Derecho GPU limit can be requested together.

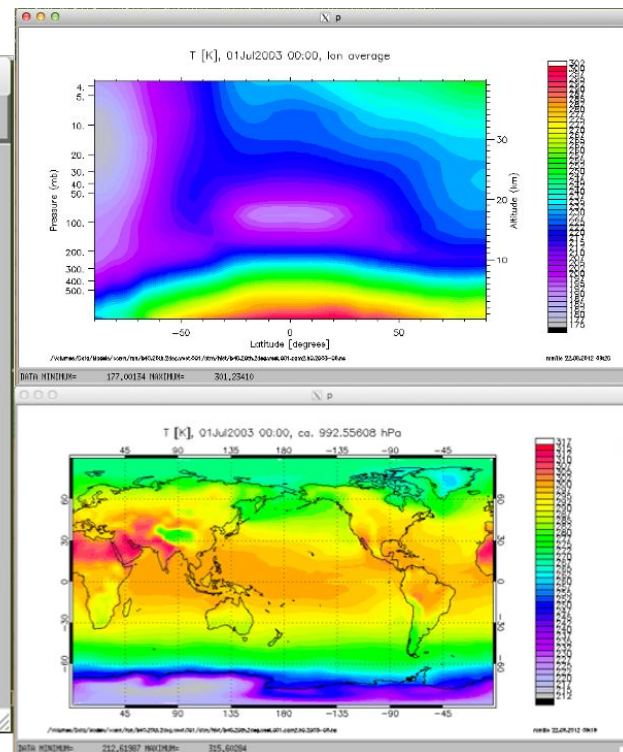
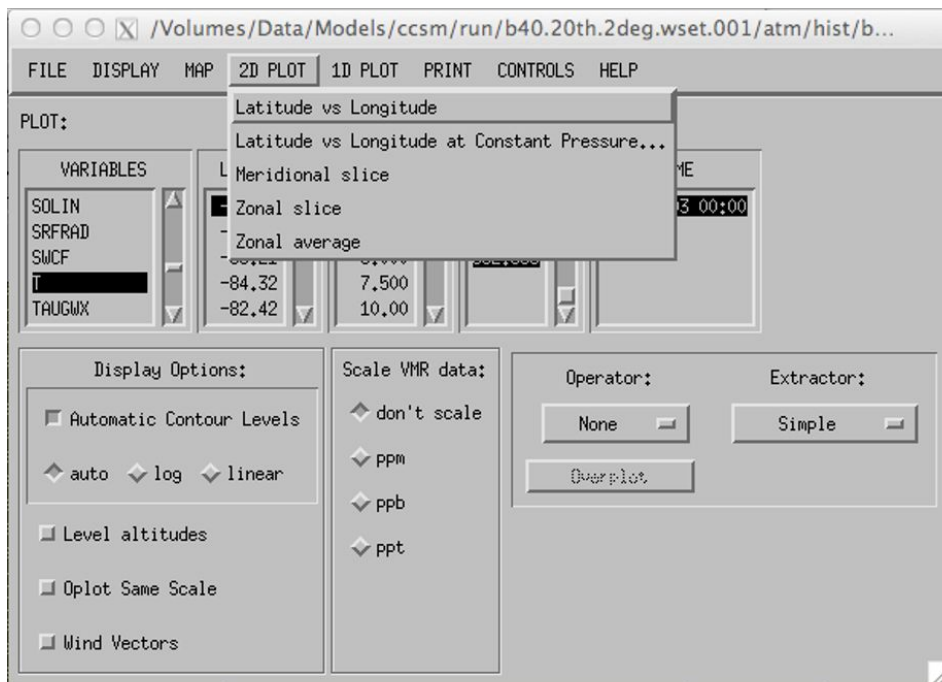
Allocation request	Initial HPC limit*	Supplement HPC limit	Frequency	Funding eligibility
Large	No upper limit (subject to availability)	No upper limit (subject to availability)	Semi-annual panel review	NSF award required
Small	Derecho: 1 million core-hours Derecho GPU: 2,500 GPU-hours	Derecho: 1 million core-hours Derecho GPU: 2,500 GPU-hours	Continuous	NSF award required
Exploratory & Classroom	Derecho: 500,000 core-hours Derecho GPU: 1,500 GPU-hours	Derecho: 500,000 core-hours Derecho GPU: 1,500 GPU-hours	Continuous	No external funding award
Data Analysis	n/a (Casper only)	n/a (Casper only)	Continuous	Any funding source

Submitting Your Request. For all types of university allocations, including any subsequent extension or supplement requests, requests should be submitted via the [ARC portal’s Allocations section](#). If you have questions about these options, please contact us via the [Research Computing help](#) desk.

Quick view of WACCM-X output



GEOV is an IDL-based viewer for geophysical history files



Quick view of WACCM-X output: GEOV



GEOV can be downloaded from github:

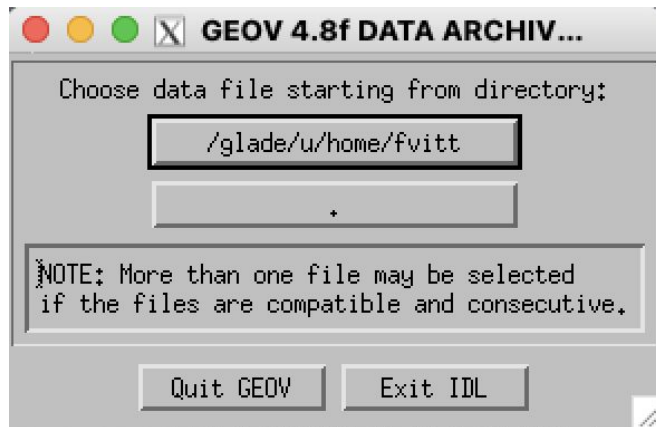
```
> git clone https://github.com/NCAR/GEOV.git
```

Can append GEOV path to `idl_path`:

```
idl_path = expand_path('+/location/GEOV')
```

On NCAR machines (.e.g., casper or derecho)

```
> module load idl  
> export IDL_STARTUP=~fvitt/idl_startup  
> idl geov
```



Resources



Quick Start

<https://escomp.github.io/CESM/versions/master/html/index.html>

Online Tutorial

<https://ncar.github.io/CESM-Tutorial/README.html>

CESM Discuss Forums (get help)

<https://bb.cgd.ucar.edu/cesm/>