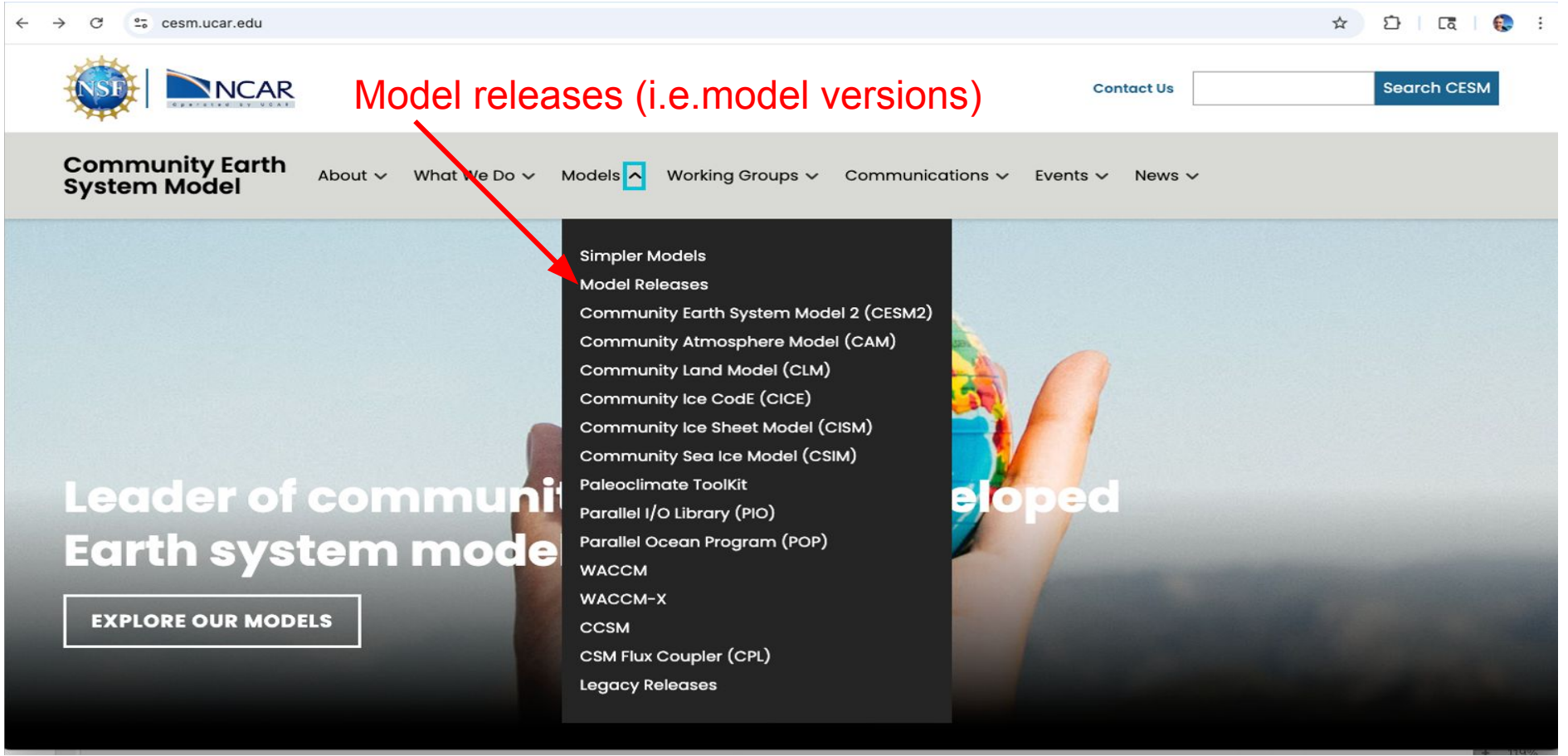
WACCM-X Tutorial

CEDAR 2025

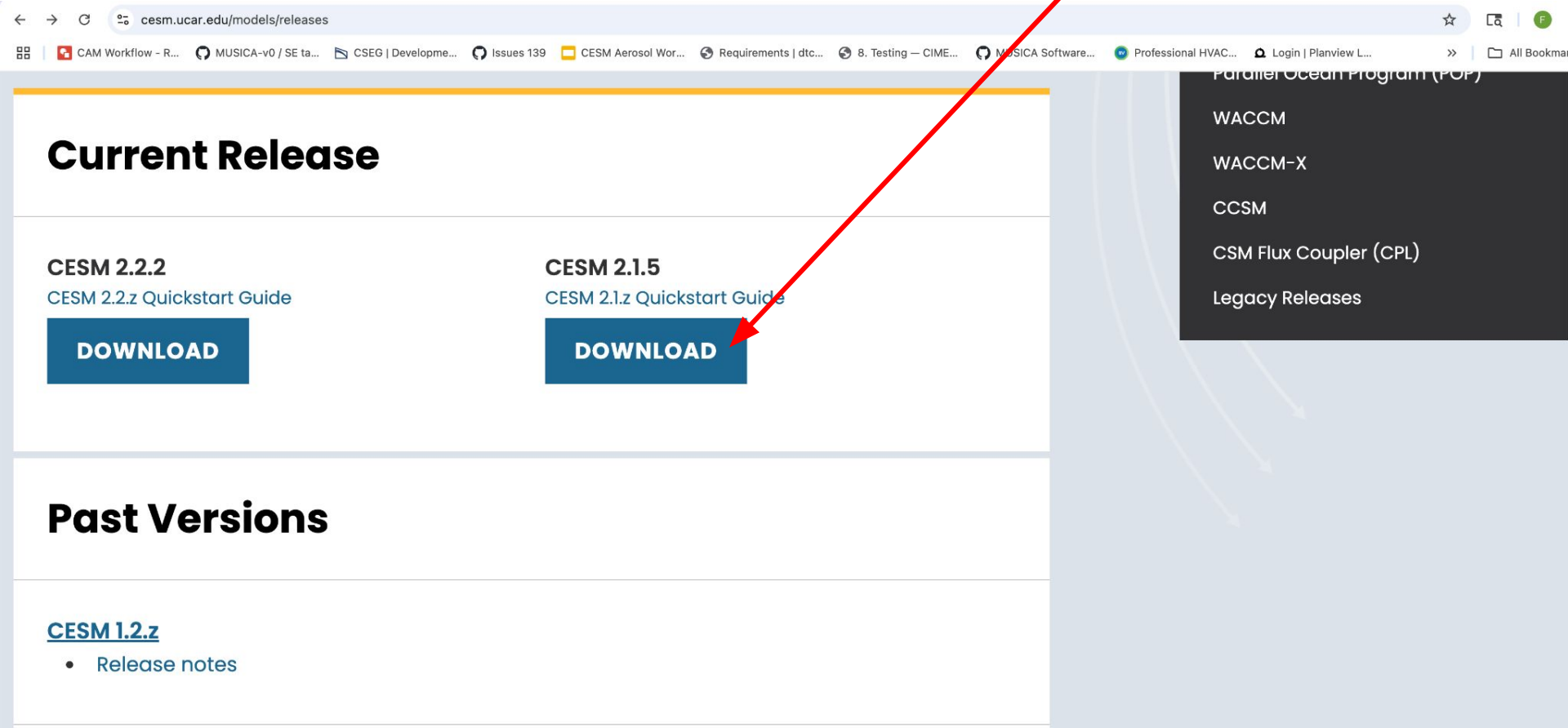
Overview

- 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

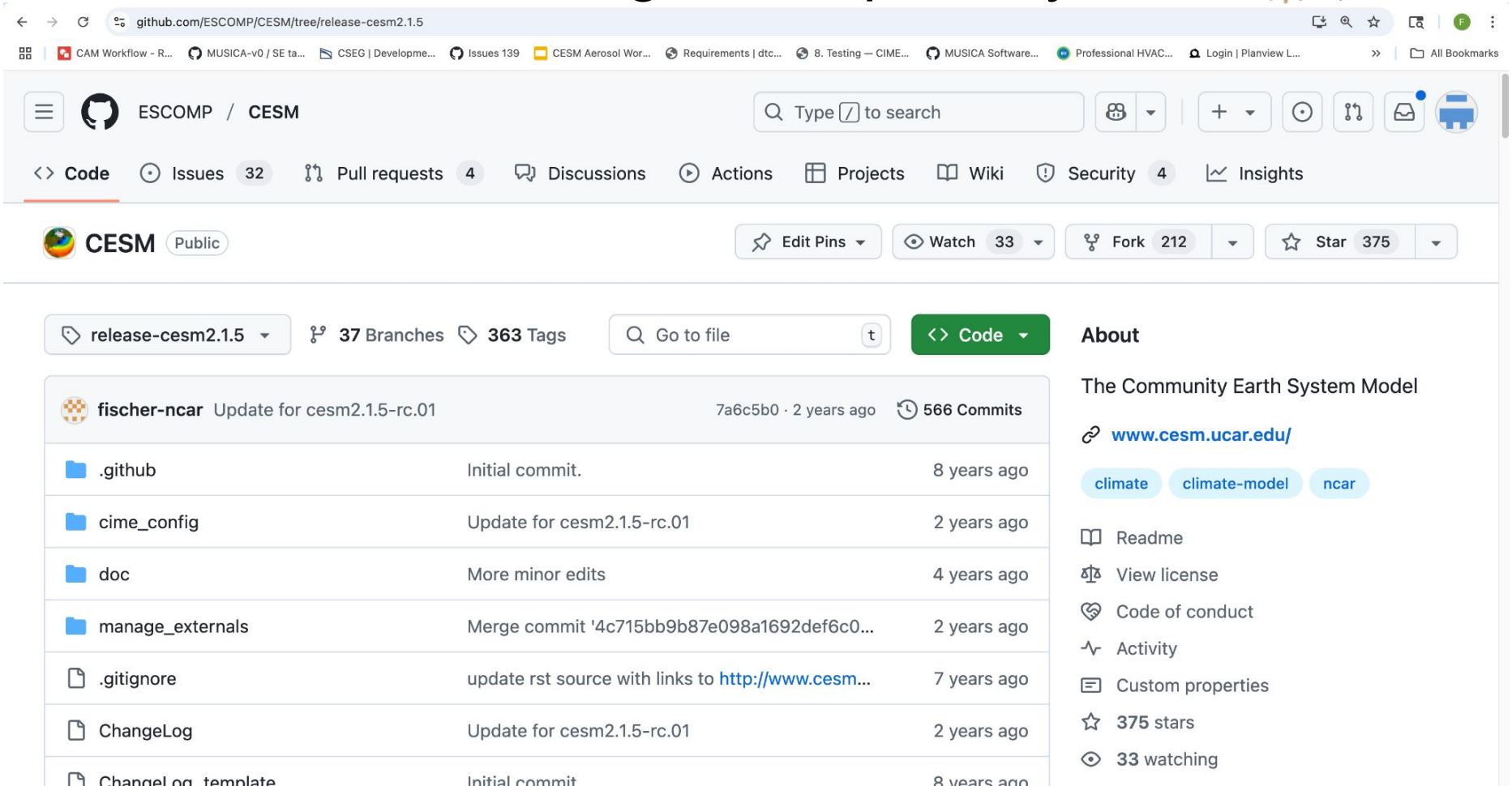
CESM Web Page: http://www.cesm.ucar.edu



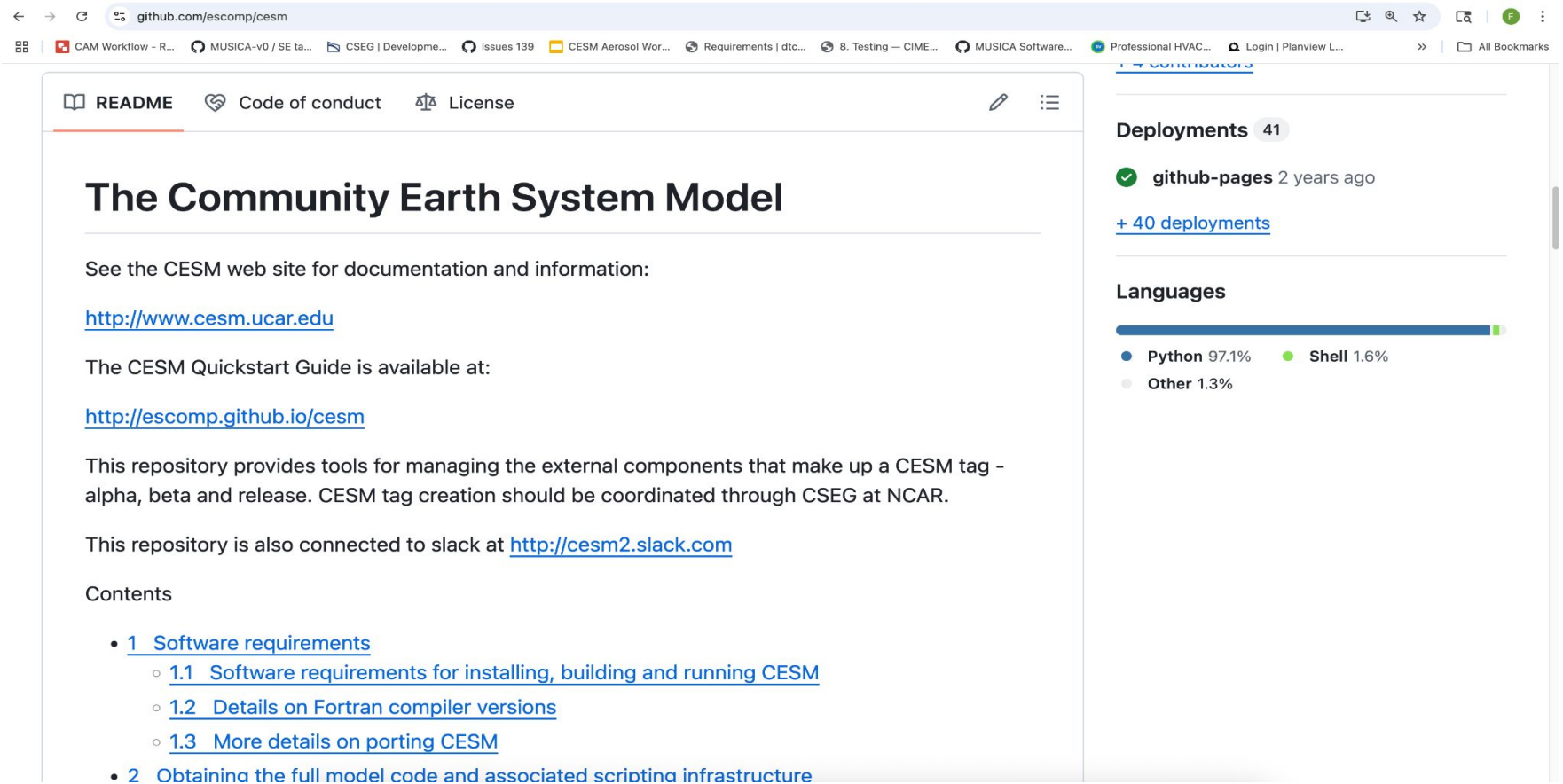
Latest supported release – CESM2.1.5



CESM github repository



See the README



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
> manage_externals/checkout_externals
```

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 -1
ChangeLog
ChangeLog_template
cime
cime_config
components
describe_version
doc
Externals.cfg
LICENSE.txt
manage_externals
README.rst
```

Scripts for creating case, etc. under cime

Model source code under components

Components listing

```
> cd components
> ls -1
cam
cice
cism
clm
mosart
pop
rtm
ww3
```

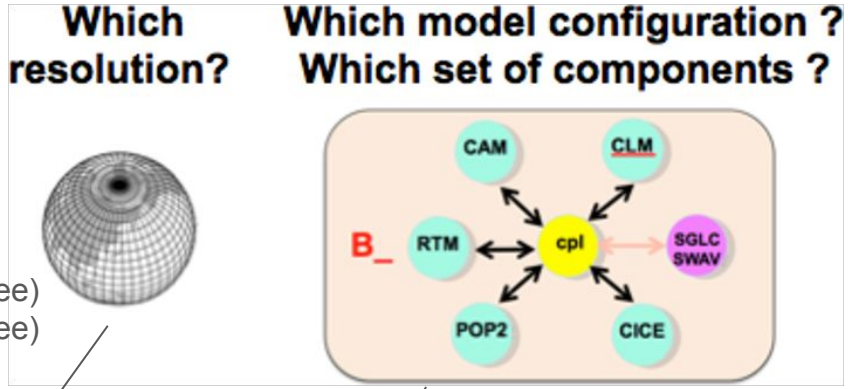
- **Community Atmosphere Model**
- Community Sea Ice Model
- Community Ice Sheet model
- Community Land Model
- Model for Scale Adaptive River Transport
- Parallel Ocean Program
- River Transport Model
- WaveWatch3

```
> cd cam/src
> ls -1
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**:



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?

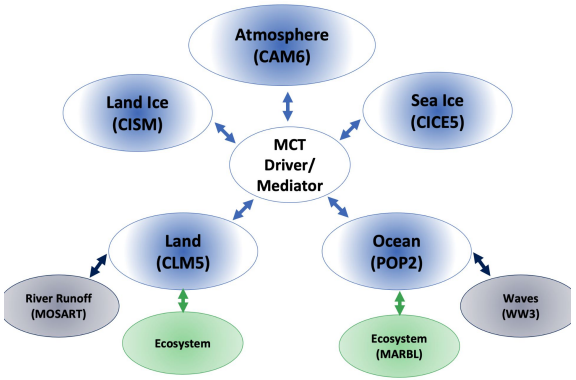
“FXHIST” is an example of a component set, or “compset”, which defines the configuration of the CESM component models: atmosphere, land, ocean, sea ice, and land ice.

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
```

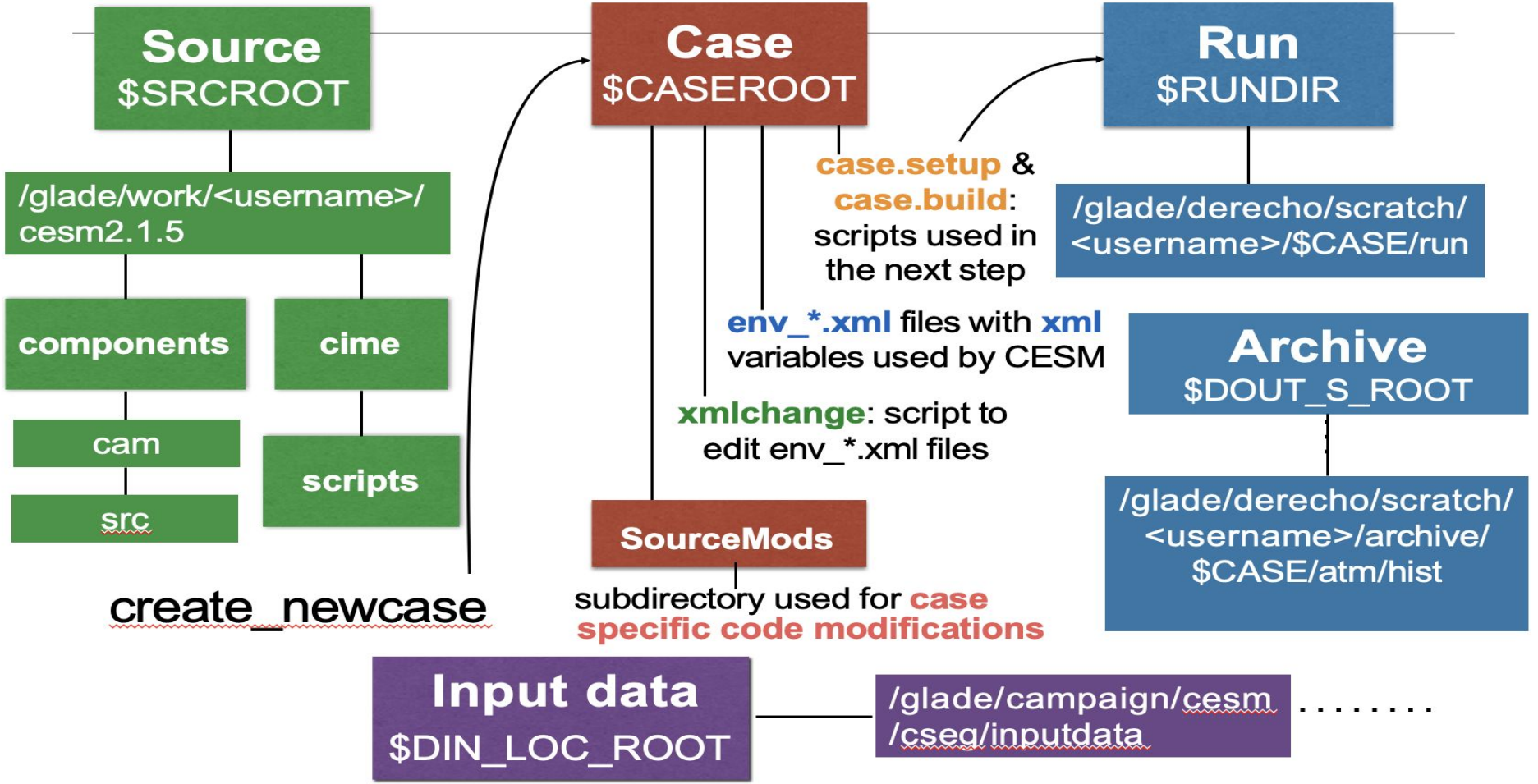
Short name	Long name
FX2000	: 2000_CAM40%WXIE_CLM40%SP_CICE%PRES_DOCN%DOM_RTM_SGLC_SWAV
FXHIST	: HIST_CAM40%WXIE_CLM40%SP_CICE%PRES_DOCN%DOM_RTM_SGLC_SWAV
FXmadHIST	: HIST_CAM40%WXIED_CLM40%SP_CICE%PRES_DOCN%DOM_RTM_SGLC_SWAV
FXSD	: HIST_CAM40%WXIE%SDYN_CLM40%SP_CICE%PRES_DOCN%DOM_RTM_SGLC_SWAV
FXmadSD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

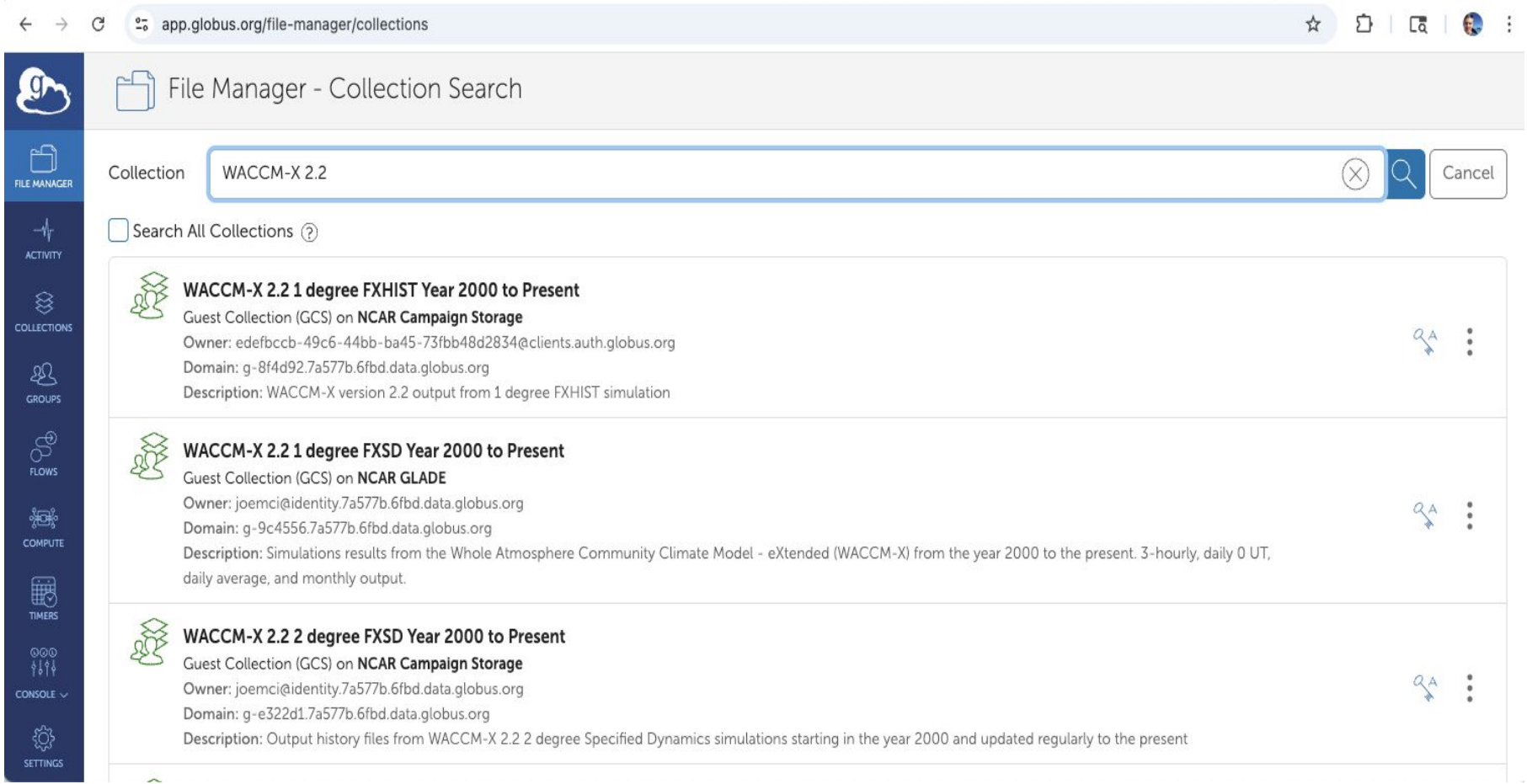
- **netCDF:** self-describing binary data format used for primary CESM output
- **History files:** WACCM-X output is written to several output streams, each with a particular frequency and averaging characteristic which can be modified in the user_nl_cam file

  - **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)



University Allocations

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

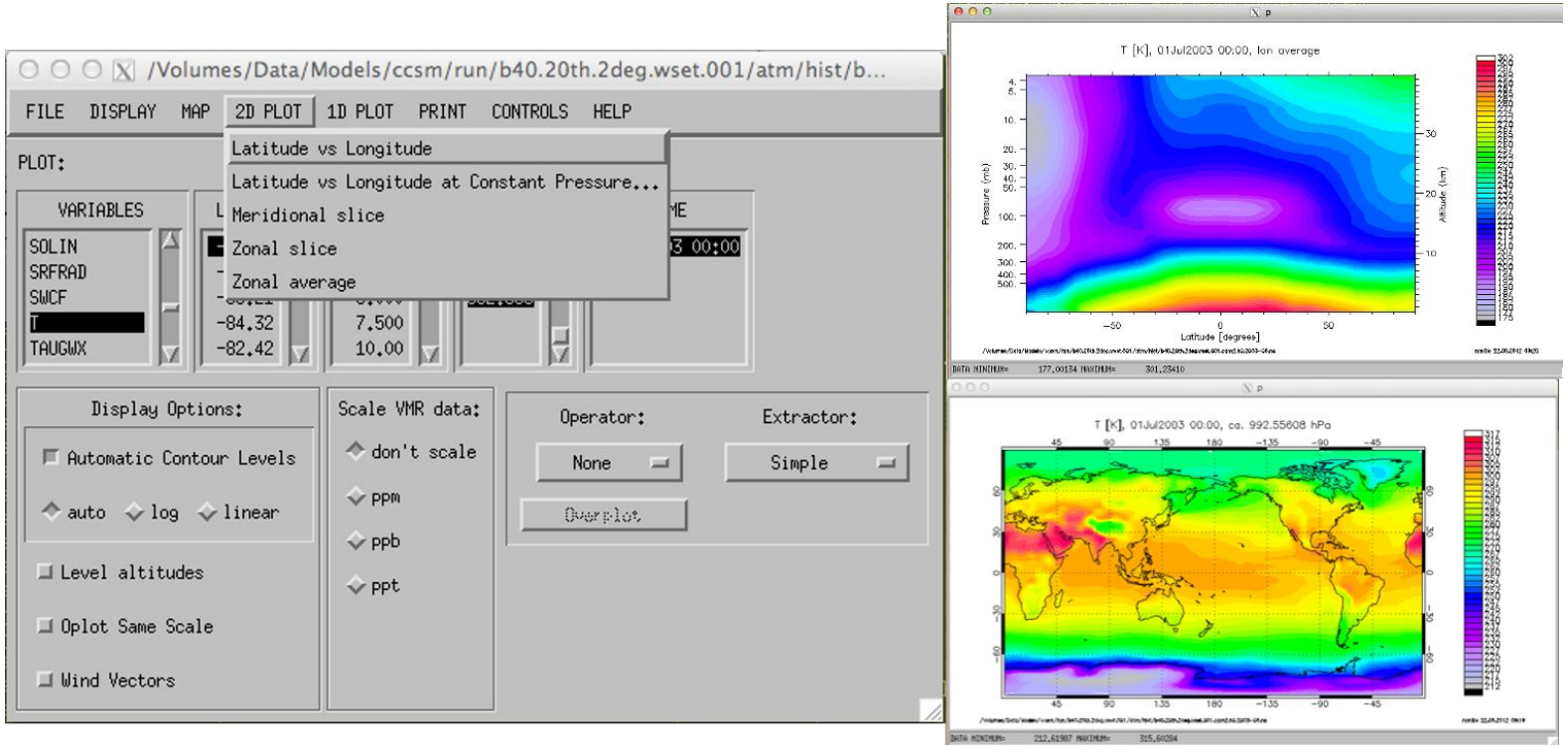
The table below summarizes the HPC resource limits for each type of allocation. For Small, Exploratory, and Classroom projects, the amounts shown assume use of only Derecho or Derecho GPU. For requests to use both parts of Derecho, proportionally smaller limits apply—e.g., up to half the Derecho limit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

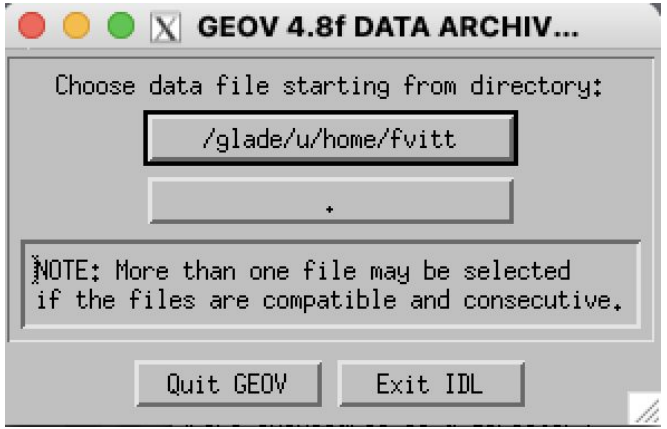
```
> git clone https://github.com/NCAR/GEOV.git
```

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/