Running MUSICAv0 – Nanjing grid

MUSICA: MUlti-Scale Infrastructure for Chemistry and Aerosols

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September 2024

The steps to run MUSICAv0 is very similar to the steps to run CAM-chem and CESM.

In this part, we will run a case (MUSICAv0 with Nanjing grid) that has been **already set up** for this class.
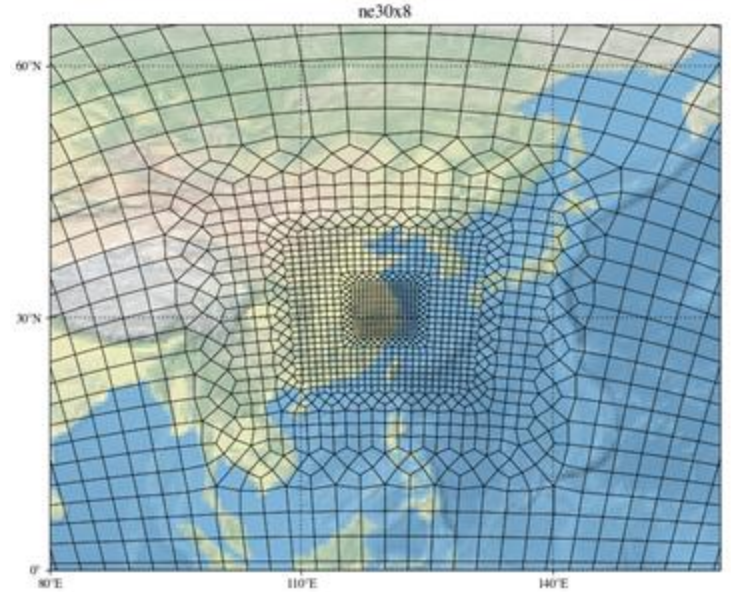
Tomorrow you will learn how to set up your own grid.
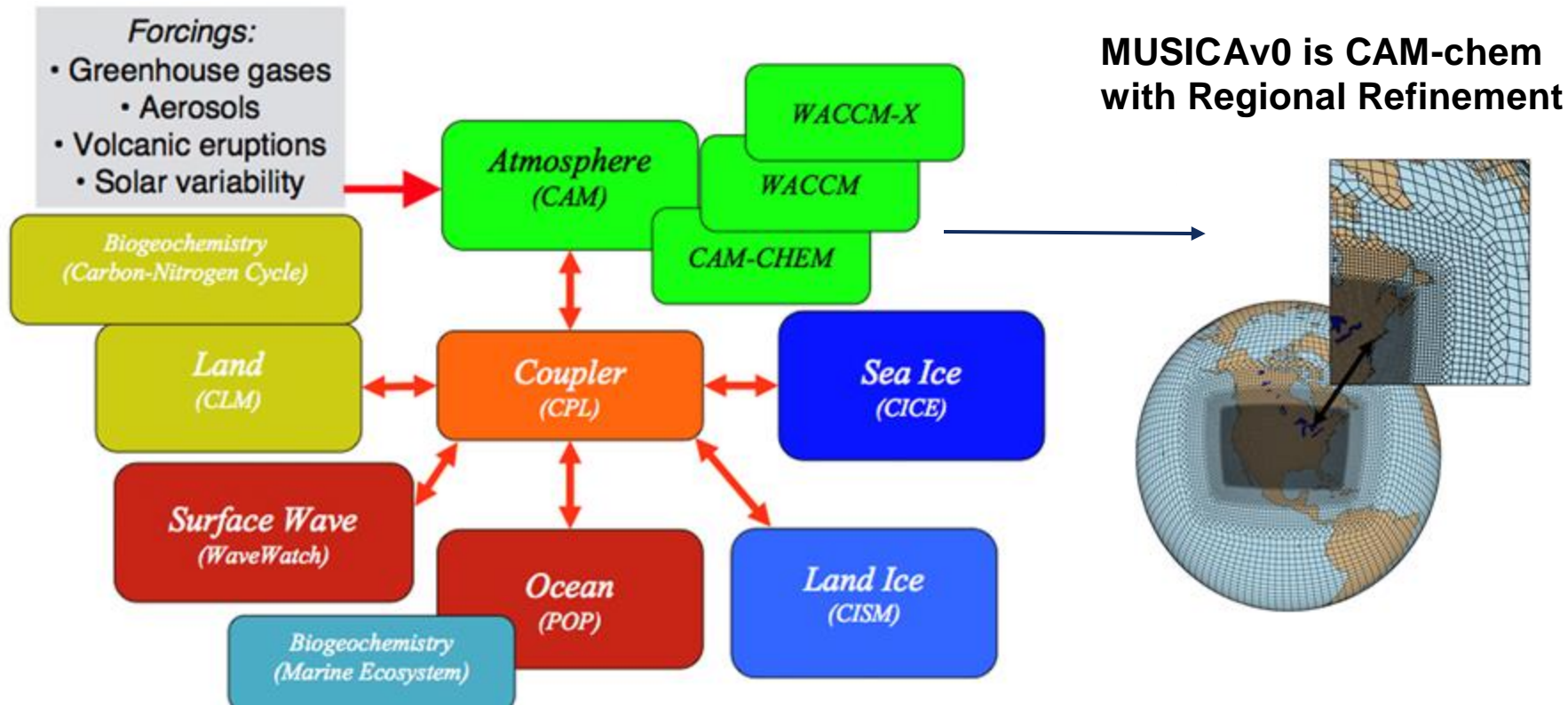
STEP-BY-STEP instruction: https://wiki.ucar.edu/display/MUSICA/Custom+Grid+in+CESM3

Info about more regionally refined grids: https://wiki.ucar.edu/display/MUSICA/Available+Grids
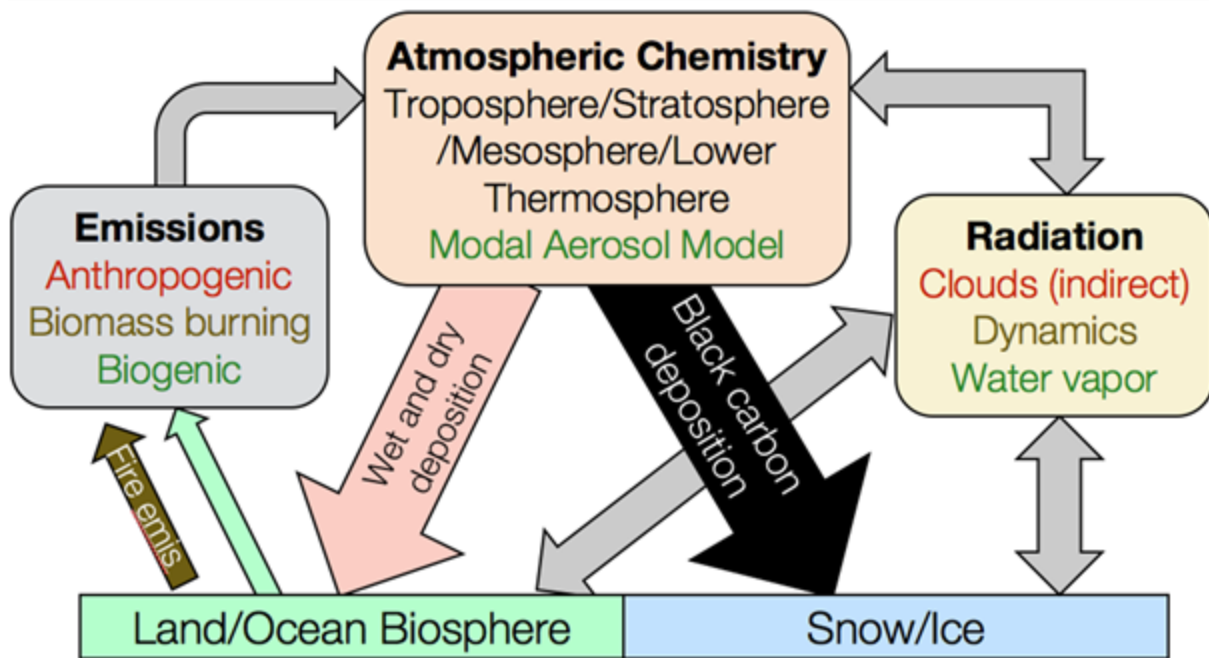
Overview

- Setting up the MUSICAv0 Nanjing grid run

- Modifying model start date (year, month)
  - Updating initial conditions for land and atmosphere

- Modifying the output and emissions of the run

ne30x8

CESM components and MUSICAv0

Forcings:
- Greenhouse gases
- Aerosols
- Volcanic eruptions
- Solar variability

MUSICAv0 is CAM-chem with Regional Refinement

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CESM components and MUSICAv0

- CAM-chem and MUSICAv0 are comprehensive Earth-System Models, including various processes and coupling.

- Component sets (**compsets**) have been produced for the community to easily perform simulations that are scientifically validated.

- Default MUSICAv0 configuration uses meteorological reanalysis to **nudge** winds and temperature.

CESM components and MUSICAv0

Nudging is used when the aim of simulations is to reproduce the meteorology as close to reality as possible.

We can choose to nudge different parameters (U, V, T, Q, PS) from the model to **reanalysis data (e.g., MERRA-2)** for a set time range.

- CAM-chem and MUSICAv0 are comprehensive Earth-System Models, including various processes and coupling.

- Component sets (**compsets**) have been produced for the community to easily perform simulations that are scientifically validated.

- Default MUSICAv0 configuration uses meteorological reanalysis to nudge winds and temperature.

Download CESM source code

MUSICAv0 is a configuration of CESM available in CESM since version 2.2.

If you will be running CESM on your own computer, please check the hardware, OS and software requirements in the CESM2 documentation: https://escomp.github.io/CESM/release-cesm2/introduction.html

Get your own copy of the source code (also see CESM2 download instructions https://escomp.github.io/CESM/release-cesm2/downloading_cesm.html):

Go to your work directory

```
git clone https://github.com/ESCOMP/CESM.git cesm3_0_beta01

cd cesm3_0_beta01

git checkout cesm3_0_beta01

./bin/git-fleximod update                              (takes a few minutes)
```

`cesm3_0_beta01` should be a directory in your home or work directory (not scratch).
This directory is referred to as **$CESM_ROOT.**

Add an entry

Add an entry for your new ESMF mesh file in **$CESM_ROOT**/ccs_config/component_grids_nuopc.xml
 vi **ccs_config/component_grids_nuopc.xml**
(Scroll down to end of CAM/SE mesh section, just before CAM/MPAS)
add:

 <domain name="ne0np4.Nanjing.ne30x8">

   <nx>60482</nx> <ny>1</ny>

   <mesh>/glade/work/emmons/tutorial_Nanjing/ne0np4.Nanjing.ne30x8/grids/Nanjing_ne30x8_np4_MESH.nc</mesh>

   <desc>ne0np4.Nanjing.ne30x8 is a Spectral Elem 1-deg grid with a 1/8 deg refined region over east China:</desc>

   <support>Test support only</support>

 </domain>

:wq (to save and quit vi)

Add a grid alias entry

Add a grid alias entry in $CESM_ROOT/ccs_config/modelgrid_aliases_nuopc.xml

Scroll down to end of VR-CESM grids with CAM-SE section.

add:

```
<model_grid alias="ne0Nanjingne30x8_ne0Nanjingne30x8_mt12" not_compset="_POP">
  <grid name="atm">ne0np4.Nanjing.ne30x8</grid>
  <grid name="lnd">ne0np4.Nanjing.ne30x8</grid>
  <grid name="ocnice">ne0np4.Nanjing.ne30x8</grid>
  <mask>tx0.1v3</mask>
</model_grid>
```

Note the "grid name" must match the "domain name" in component_grids_nuopc.xml.

:wq

Set up an "out of the box" CAM-chem run

- **Create your new case in your case directory: case_dir**

Go to the $CESM_ROOT directory.

`cd cime/scripts`

```
General command to create a new CESM case:

  ./create_newcase --case <your_path/$CASENAME> --res $RESOLUTION --compset $COMPSET --
project <$PROJECT_NUMBER> --run-unsupported

Here please do:
```

./create_newcase --case **YOUR_CASE_DIRECTORY/YOUR_CASE_NAME** --res ne0Nanjingne30x8_ne0Nanjingne30x8_mt12 --compset FCnudged --run-unsupported --project NACD0028 --pecount 2048

```
For example, my case is:
```

./create_newcase --case /glade/work/wenfut/MUSICAv0_Nanjing_tutorial_demo3 --res ne0Nanjingne30x8_ne0Nanjingne30x8_mt12 --compset FCnudged --run-unsupported --project NACD0028 --pecount 2048

See https://ncar.github.io/CESM-Tutorial/notebooks/basics/cesm_workflow/create_newcase.html

Resolution

- To see available support resolutions:

    $CESM_ROOT/cime/scripts/query_config --grids --long

f09_f09_mg17: 0.9x1.25
CONUS: ne30x8 over US, ne30 rest of globe

- Some combinations of compsets and resolution will work, though not scientifically validated: require **--run-unsupported** in ./create_newcase command

"Compset" – Component Set

- $CESM_ROOT/cime/scripts/query_config --compsets

Component set specifies component models, forcing scenarios and physics options for those models

compset naming convention

Each model compset can be specified by its alias or long name.

Example of equivalent alias and long name:

- alias: B1850
- long name = 1850_CAM60_CLM50%BGC_CICE_POP2%ECO_MOSART_CISM2%NOEVOLVE_WW3_BGC%BDRD

time   atm   lnd   ice   ocn   river   glacier   wave   BGC scenario

Compsets

F* = free-running with data ocean (specified SSTs)
B* = fully coupled (active ocean model)
Both use active land model

FHIST: CAM, free-running with specified SST, default emissions for 1750-2015

FCHIST: CAM-chem (32L), MOZART-TS1 chemistry, free-running
FC2000climo: cyclical 2000 simulation with 1995-2005 average emissions
FCnudged: CAM-chem (32L), MOZART-TS1 chemistry, nudged to meteorology reanalysis

FWHIST: WACCM (70L), MOZART-TSMLT1 chemistry, free-running,

Set up the MUSICAv0 run

- **Set up, build and submit your run**

`cd `**YOUR_CASE_DIRECTORY/YOUR_CASE_NAME**

`./case.setup`

Before build the MUSICAv0 run

Add these to the atmosphere namelist – user_nl_cam

`vi user_nl_cam`

ncdata = '/glade/work/emmons/tutorial_Nanjing/ne0np4.Nanjing.ne30x8/inic/cami-mam4_0000-01-01_ne0np4.Nanjing.ne30x8_L32_c240809.nc'
bnd_topo = '/glade/work/emmons/tutorial_Nanjing/ne0np4.Nanjing.ne30x8/topo/Nanjing_ne30x8_gmted2010_modis_bedmachine_nc3000_Laplace0100_noleak_20240810.nc'
drydep_srf_file = '/glade/work/emmons/tutorial_Nanjing/ne0np4.Nanjing.ne30x8/atmsrf/atmsrf_ne0np4.Nanjing.ne30x8_240809.nc'
se_refined_mesh = .true.
se_mesh_file = '/glade/work/emmons/tutorial_Nanjing/ne0np4.Nanjing.ne30x8/grids/Nanjing_ne30x8_EXODUS.nc'

inithist = 'DAILY'
Mfilt = 1
Nhtfrq = -24

Before build the MUSICAv0 run

Set the timestep based on recommended value in:

https://github.com/ESMCI/Community_Mesh_Generation_Toolkit/blob/master/VRM_tools/Docs/CAM-tsteps-inic-for-newgrids_v0.pdf

./xmlchange ATM_NCPL=384

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Before build the MUSICAv0 run

Add to land namelist – user_nl_clm:

`vi user_nl_clm`

fsurdat = '/glade/work/emmons/tutorial_Nanjing/ne0np4.Nanjing.ne30x8/land/surfdata_Nanjing_ne30x8_SSP3-7.0_1979_78pfts_c240809.nc'

flanduse_timeseries = '/glade/work/emmons/tutorial_Nanjing/ne0np4.Nanjing.ne30x8/land/landuse.timeseries_Nanjing_ne30x8_SSP3-7.0_1979-2026_78pfts_c240809.nc'

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Before build the MUSICAv0 run

Add the override flag in your individual case directory to ensure CTSM (the land model) doesn't error out due to an unsupported grid:

`./xmlchange --append CLM_BLDNML_OPTS="-no-chk_res"`

CTSM: Community Terrestrial Systems **Model (new version of CLM)**

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Build the MUSICAv0 run

`./preview_namelists`

On your own supercomputer, to build the case you only need to run
./case.build

Here on the NCAR supercomputer, "qcmd -A projectID" is required

qcmd -A NACD0028 -- ./case.build

Wait for it to finish build. This may take up to 30 minutes

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Specifying output

3. Check / modify your setup

Check your namelist settings after changing your user_nl_cam, user_nl_clm files and modify if needed

Paste and modify changes into your **user_nl_cam** file

`./preview_namelists`

`view CaseDocs/atm_in (DO NOT CHANGE atm_in!!! Only change user_nl_cam!)`

```
 Output:
 •    fincl1,    fincl2 etc… includes desired output variables
 •    mfilt          = 1,1,1,4,24
 •    nhtfrq         = 0,0,-24,-6,-1
 •    interpolate_output         = .true.,.false.,.false.,.true.,.false.
```

mfilt: number of time stamps in output file; nhfrq: time stamp (0: monthly; -X: X hours; X: X time steps

Also avgflag_pertape = 'A' or 'I' - average or instantaneous for each file.

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Specifying output, emissions etc

3. Check / modify your setup

Check your namelist settings after changing your user_nl_cam, user_nl_clm files and modify if needed

Paste and modify changes into your user_nl_cam file

`>./preview_namelists`

`>view CaseDocs/atm_in`

- `ncdata`: Initial Condition file
- `flbc_file`: lower boundary conditions (greenhouse gases and CFCs) (check date range)

  Nudging variables (make sure they cover the period you want to run)

- `nudge_beg_day, nudge_beg_month, nudge_beg_year`
- `nudge_end_day, nudge_end_month, nudge_end_year`
- `nudge_tcoef         = 0.25, nudge_ucoef         = 0.25, nudge_vcoef         = 0.25`

  Emissions:

- `srf_emis_specifier, ext_frc_specifier`

  Output:

- `fincl1,   fincl2 etc… includes desired output variables`
- `mfilt         = 1,1,1,4,24`
- `nhtfrq        = 0,0,-24,-6,-1`
- `interpolate_output          = .true.,.false.,.false.,.true.,.false.`

mfilt: number of time stamps in output file; nhfrq: time stamp (0: monthly; -X: X hours; X: X time steps

Also avgflag_pertape = 'A' or 'I' - average or instantaneous for each file.

Run the MUSICAv0 run

Set up to run only a 2 days from 2010-01-01

./xmlchange RUN_STARTDATE="2010-01-01"

./xmlchange STOP_N="2"

./xmlchange STOP_OPTION="ndays"

./xmlchange walltime="01:00:00"

./case.submit

- **Check your model run**

```
qstat -u <username>      -> status of your run
qdel  <run_number>       -> delete a run
```

After the model run finished

- **Check your model output and other files in your run directory**

`cd /glade/derecho/scratch/YOUR_user_NAME/YOUR_CASE_NAME/run`

Note: the default setup will produce a 5-day model run.

- **After your run finished: check your archive (/glade/scratch/<username>/archive/<casename>)**

Output:

`ls /glade/derecho/scratch/YOUR_user_NAME/archive/YOUR_CASE_NAME/atm/hist`

Restart and log files:

`ls /glade/derecho/scratch/YOUR_user_NAME/archive/YOUR_CASE_NAME/rest/`

`ls /glade/derecho/scratch/YOUR_user_NAME/archive/YOUR_CASE_NAME/logs`

See https://wiki.ucar.edu/display/camchem/Run+CAM-Chem+on+Cheyenne for more information

If you have only monthly mean output in your run, and only run for less than a month, you will have a "*rh0*" file with the partial month average.

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Plotting and Postprocessing

After the successful model run you want to look at the output.

Please see previous tutorial on
> How to use MUSICAv0 output, 12 November 2021
> https://www2.acom.ucar.edu/workshop/musica-tutorial-2021

Producing timeseries after you run (if desired), see:

https://wiki.ucar.edu/display/camchem/CAM-chem+automated+diagnostics

Resources

MUSICA wiki page: https://wiki.ucar.edu/display/MUSICA/MUSICA+Home

CAM-chem wiki page: https://wiki.ucar.edu/display/camchem/Home

CESM2 website: https://www.cesm.ucar.edu/models/cesm2/

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

CESM Forum: https://bb.cgd.ucar.edu/cesm/forums/cam-chem.154/

CESM for Containers and Cloud platforms:

https://bb.cgd.ucar.edu/cesm/forums/containers-cloud-platforms.162/

Additional information

Modifying model start date (year, month) - 1

1. Change your start date (and length of your run)

You can use xml command or go to env_run.xml file to edit

2. Update your initial condition (IC) file for the atmosphere and land (available for 2010-2020)
- Requires interpolating the atmospheric ne30 IC file to the CONUS model grid
- A land file for the CONUS grid exists for different months

3. Checking your run:
- Make sure your nudging variables and emissions and lower boundary conditions cover the desired time period
- Make sure your sea-surface temperature files cover the desired time period
  (currently till 2021)

Modifying model start date (year, month) - 2

1. Change your start date (in your case directory)

*xml files (those help you to modify the details of your run, setup, etc.)

- **env_run.xml:** change start date, duration of the run, and restart files (see below)
- **env_workflow.xml**: change "`JOB_QUEUE`" (`premium, regular, economy`)

"`JOB_WALLCLOCK_TIME`" (`maximum "12:00:00"`)

To change your start date: after a successful run of 5 days, you can also start a longer run

```
>./xmlchange RUN_STARTDATE=$run_start
>./xmlchange STOP_OPTION=$stop_option
>./xmlchange STOP_N=$stop_n
>./xmlchange CONTINUE_RUN=TRUE  (continue run where you stopped if you have restart files)
```

```
RUN_STARTDATE has format YYYY-MM-DD.
STOP_OPTION has many options including ndays, nmonths, or nyears (see env_run.xml for more options).
STOP_N will stop after the specified number of STOP_OPTION increments. For example the default values will stop simulations after 5 days.
```

Also consider changing the restart file frequency

```
>./xmlchange REST_OPTION=$stop_n
>./xmlchange REST_N=$stop_n
```

Modifying model start date (year, month) - 3

2. Update your initial condition (IC) file for the atmosphere and land

2.1. Interpolate IC files for the atmosphere (in your home directory):
```
>cd
>git clone https://github.com/NCAR/IPT
>cd Initial_conditions and modify regrid_all_spectral_data_conus.ncl
```

- modify your destination directory and file name where your regrid file will be written to
  ```
  regrid_dir   = "<your_VRM_Files>/<your_grid>/inic/"   (e.g., /glade/scratch/$USER/inic/)
  regrid_fname = regrid_dir + src_fname+"_<your_grid>.nc   (your_grid: ne0CONUSne30x8)
  ```

- modify the date of the initial condition file you want to regrid (change YYYY-MM)
  ```
  ; USER CHANGES
  ; Change to the starting date you need.
  src_dir   = "/glade/p/acom/MUSICA/init/ne30_ne30/"
  src_fname = "f.e22.FCnudged.ne30_ne30_mg17.release-
  ```
  cesm2.2.0_spinup.2010_2020.001.cam.i.**<restart_date>**-01-00000.nc"

To run with CESM, the file has to be then converted to a cdf5 format

```
>nccopy -k cdf5 oldfile newfile
```

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Modifying model start date (year, month) - 4

2. Update your initial condition (IC) file for the atmosphere and land

Initial condition files are changed in the user_nl_cam and user_nl_clm files

2.2. Add the new atmospheric IC file to the user_nl_cam namelist

edit **user_nl_cam** and add your new initial conditions file:

```
! Users should add all user specific namelist changes below in the form of
! namelist_var = new_namelist_value
!add nc_data file
ncdata          = 'regrid_dir + src_fname+"_<your_grid>.cdf5.nc'
```

Note: If you run a case that starts between 2012 and Jan 2014, you can also use initial condition files from the existing output: `/glade/p/acom/MUSICA/init/ne0CONUSne30x8/atm`

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2. Update your initial condition (IC) file for the atmosphere and land

Initial condition files are changed in the user_nl_cam and user_nl_clm files

2.3. Add land IC file to the user_nl_cam namelist

edit **user_nl_clm** and add your new initial conditions file:

```
finidat  = '/glade/p/acom/MUSICA/init/ne0CONUSne30x8/lnd/<land_ic_file>.nc'
use_init_interp = .true.
```

Find land restart files for different months (2012 and 2013) here:
/glade/p/acom/MUSICA/init/ne0CONUSne30x8/lnd/

Note: Land IC files don't have to match **the specific year but should match the month you want to run**. If you want to simulate a different year where no restart files exist, in that case you have to add:
use_init_interp = .true.

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Run a branch run from available restart files

MUSICAv0 CONUS community runs are available from Jan 2012- Dec 2013. You can run a branch from monthly restart files between 2012 and 2013 and compare your results with the existing output (e.g, for 2015-01-01)

1. **Create your new case in your case directory (see Slide 8)**
2. **Modify your case to become a branch run in your case directory (change env_run.xml)**

```
>./xmlchange RUN_TYPE=branch
>./xmlchange RUN_REFCASE=f.e22.FCcotagsNudged.ne0CONUSne30x8.cesm220.2012-01
>./xmlchange RUN_REFDATE=$branch_start
>./xmlchange RUN_STARTDATE=$branch_start
```

1. **Set up your case first**

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

1. **Copy restart files to your run directory**

```
>cd /glade/scratch/<username>/run
>cp
/glade/p/acom/MUSICA/restart/ne0CONUSne30x8/f.e22.FCcotagsNudged.ne0CONUSne30x8.cesm220.2012-
01//YYYY-MM-DD/* .
```

1. **Build and start your run (as described on Slide 8)**

Meteorological Data and Emissions

- **MERRA2 meteorological analysis have been interpolated to the CONUS grid for the 32-level CAM-chem model between the years 2012-2020**

  `/glade/p/acom/MUSICA/met_data/MERRA2_ne0CONUS30x8_L32/`

  If you need to process other years, please find more information here:

  https://wiki.ucar.edu/display/MUSICA/Regridding+meteorological+data

- **Different Emissions are available and can be interpolated to your grid.**

  https://wiki.ucar.edu/display/MUSICA/Available+Input+Datasets

  More details on emission inventories can be found at

  https://wiki.ucar.edu/display/camchem/Emission+Inventories

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