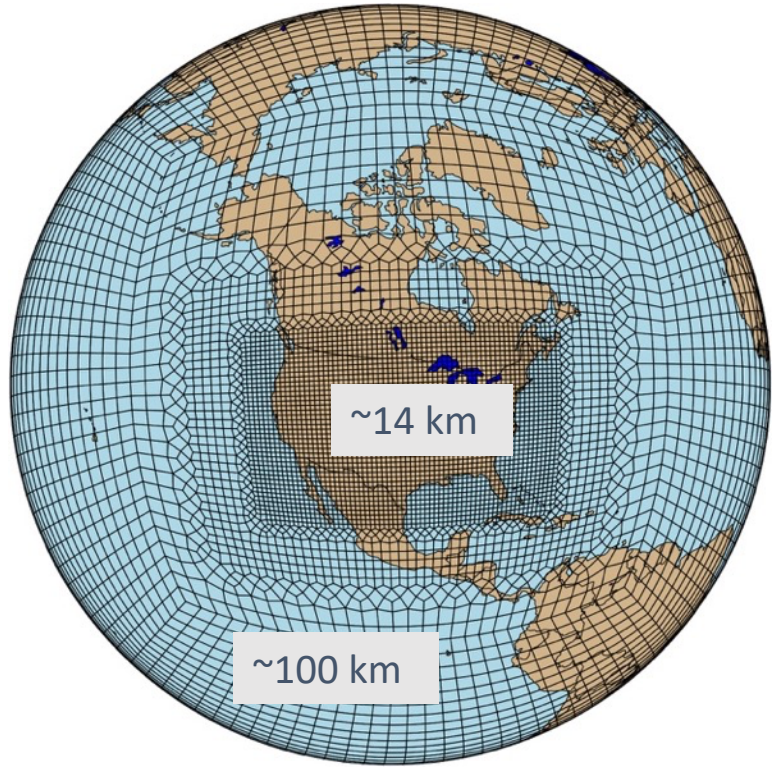
Tools to regrid emissions for MUSICA-V0

Emissions for CAM-chem-SE-RR(conus)

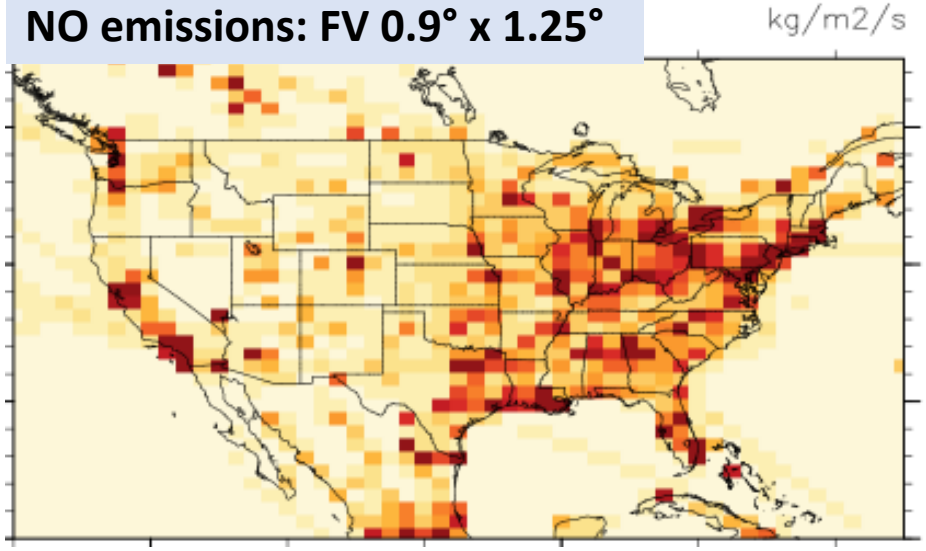
CESM will interpolate input emissions files to the model grid, but this does not conserve mass

Emissions files (anthropogenic, fires, ocean, etc.) must be conservatively regridded ahead of time

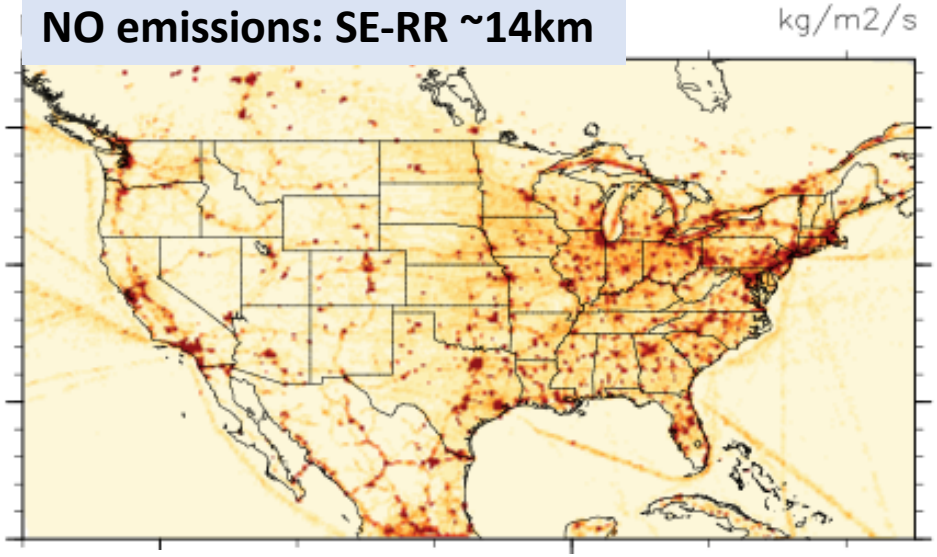
{hopefully in the not-too-distant future CESM will include conservative regridding and this step will be obsolete}

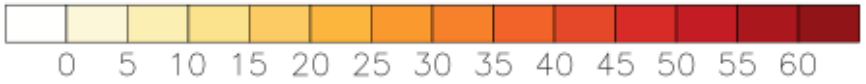


NO emissions: FV 0.9° x 1.25°



NO emissions: SE-RR ~14km





Original emissions files

Some possible emissions inventories are listed at:

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

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

- Start with a grid finer than the model grid, if possible
- CAMS anthropogenic emissions are provided at 0.1° x 0.1°
- CMIP6 original files are at 0.5°
- FINN fire emissions are at 1km x 1km resolution
- QFED original files are available at 0.1° and 0.25°, but our current script regrids 0.9°x 1.25° files that are already in MOZART species created with FINN emission factors
- NEI (US EPA) emissions are at 4 km or point sources
- In addition to regridding, additional transformations are needed to create CESM/MOZART species (CAMS, CMIP6)

Separate programs are available for each inventory

- Programs are available on github:

https://github.com/NCAR/IPT/ -> Emissions

- More explanation is provided on the MUSICA wiki page:

https://wiki.ucar.edu/display/MUSICA/Regridding+emissions

NCL routines to regrid regular lat-lon grids

- Earth System Modeling Framework (ESMF) regridding functions are used in NCL: https://www.ncl.ucar.edu/Applications/ESMF.shtml

- Separate routines for CAMS, CMIP6, QFED because input files are different (e.g., multiple sectors as separate variables or another dimension in emissions array)

- All use generally same procedure: calculate weights to map original grid to new grid, then conservatively regrid emissions

CAMS anthropogenic emissions

https://wiki.ucar.edu/display/MUSICA/Regridding+emissions

Original 0.1° resolution files for 2000-2019 are on cheyenne in: /glade/p/acom/acom-climate/tilmes/emis/download/

Scripts: https://github.com/NCAR/IPT/tree/master/Emissions/CAMS_Anthropogenic

Step 1: Regrid original files to new grid with ncl.
This processes all files in srcPath and keeps original CAMS species.

Regrid_fv2se_cams_anthro.ncl

Edit ncl program for paths, resolution, etc

Step 2: Transform species to CESM compounds, convert emissions to molecules/cm2/s, create aerosol number files, SOA precursors, etc.

rename_cams_anthro_se.ncl

Edit file for paths, resolution, etc.

Run on casper

```
>execdav --mem 50G
>ncl Regrid_fv2se_cams_anthro.ncl
>ncl rename_cams_anthro_se.ncl
```

```
; Directory to read grid definitions (can use this dir)
 grid_dir ="/glade/work/tilmes/refgrids/"

 ; Directory to write new grid weights (change to your directory)
 wght_dir ="/glade/scratch/emmons/emis/Grid_Weights/"

 ; Type of interpolation
 interp   = "conserve"

 ; Resolution of original file (for weight filename)
 ingrid   = "0.1x0.1"

 ; Resolution of new grid
 outgrid   = "ne30np4"     ;SE
 ;outgrid   = "ne30pg3"    ;SE-CSLAM
 ;outgrid  = "conus_30_x8"  ;refined region

 ; Directory of original emissions files - all files will be processed
 ;srcPath = "/glade/p/acom/acom-climate/tilmes/emis/download/"
 srcPath = "/glade/scratch/emmons/emis/cams/"

 ; Directory for new files
 dstPath = "/glade/scratch/emmons/emis/cams_ne30np4/"
```

Fortran programs for special cases

FINN emissions

- Provided as text files with emissions for each fire
- Instructions on MUSICA wiki: https://wiki.ucar.edu/display/MUSICA/Grid+FINN
- FINN regridding program and readme: https://github.com/NCAR/IPT/tree/master/Emissions/Fire/FINN

EPA/NEI (U.S. Anthro) emissions

- Combination of grids and point sources
- Fortran program (written by Stacy Walters) combines all types, applies vertical distribution for power plant sources, …

Verify results

Before running model with new emissions, it is highly recommended to:

- Calculate totals
- Plot maps