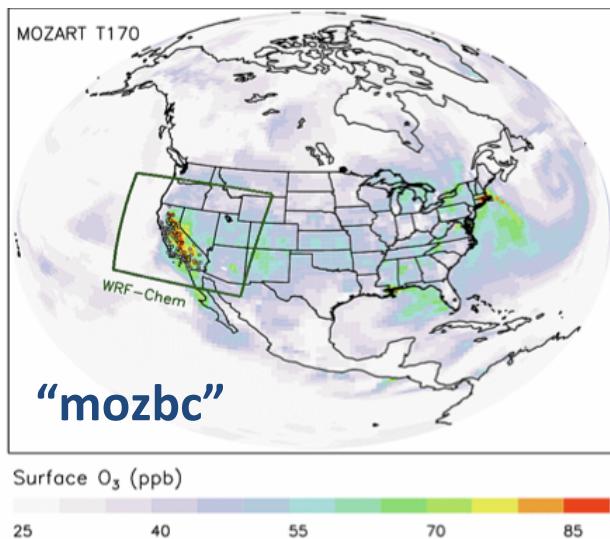


Chemical Boundary Conditions, MEGAN and FINN in WRF-Chem

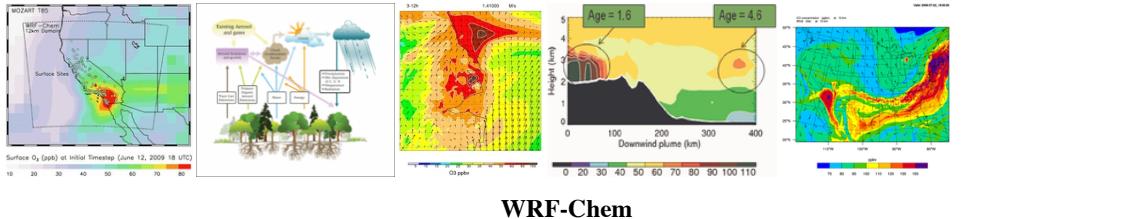


- Biogenic Emissions
“megan_bio_emiss”
- Fire Emissions
“fire_emis”



Gabriele Pfister, Stacy Walters, Christine Wiedinmyer, Alex Guenther, Mary Barth, Louisa Emmons, Tiffany Duhl

Preprocessors available from: www.acd.ucar.edu



WRF-Chem is the Weather Research and Forecasting (WRF) model coupled with Chemistry. The model simulates the emission, transport, mixing, and chemical transformation of trace gases and aerosols simultaneously with the meteorology. The model is used for investigation of regional-scale air quality, field program analysis, and cloud-scale interactions between clouds and chemistry.

The development of WRF-Chem is a collaborative effort among the community. NOAA/ESRL scientists are the leaders and caretakers of the code. The [Official WRF-Chem web page](#) is located at the NOAA web site. Our model development is closely linked with both NOAA/ESRL and DOE/PNNL efforts. Description of [PNNL WRF-Chem model](#) development is located at the PNNL web site as well as the [PNNL Aerosol Modeling Testbed](#).

Use the [MOZART Download](#) page to retrieve MOZART-4 model results.

Information on running WRF-Chem with the MOZART chemical mechanism can be found in the [MOZCART User's Guide](#).

Processors Available to the Community:

NEW (November 2011): Preprocessors have been updated to work for lat/lon projections in addition to Lambert, Mercator and Polar. The mozbc tool has been updated to enable time interpolation.

mozbc

NCAR/ACD has developed a program to create time-varying chemical boundary conditions for WRF-Chem from MOZART-4 output. For questions about running mozbc please contact: Stacy Walters (stacy@ucar.edu), Mary Barth (barthm@ucar.edu), or Gabriele Pfister (pfister@ucar.edu). To obtain mozbc, see the [Download](#) section below.

bio_emiss

Bio_emiss is a pre-processor for creating MEGAN input for WRF-Chem. To obtain bio_emiss, see the [Download](#) section below.

preprocessor tools

Pre-processor tools for running WRF-Chem / MOZCART. See the [Download](#) section below.

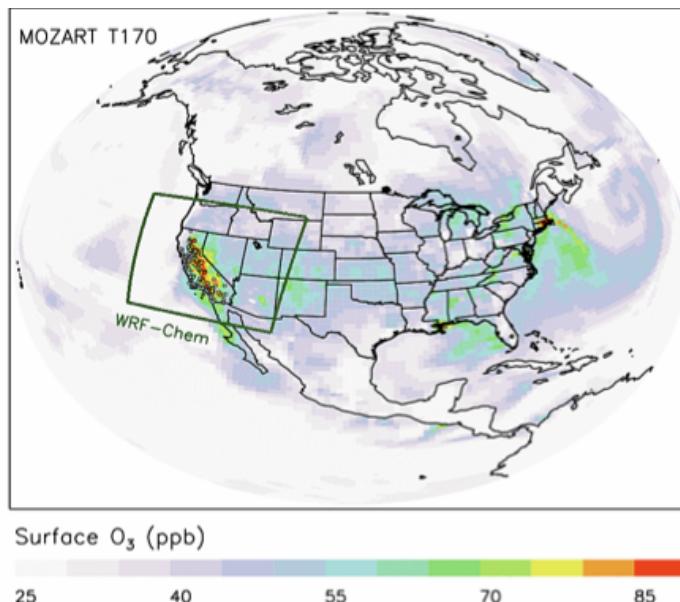
Download

- Preprocessors are in FORTRAN
- README details compilation and execution
- Require netcdf libraries; work on Portland Group or IBM fortran 90 compilers
- Domain information derived from wrfinput_d<domain>

Chemical Boundary Conditions

mozbc – set chemical initial and lateral boundary conditions

- chemical initial and boundary conditions are needed to account for initial concentrations and inflow/background concentrations



◀ ▶ S! www.acd.ucar.edu/wrf-chem/ ⌂ ⌃ ⌁

mozbc

NCAR/ACD has developed a program to create time-varying chemical boundary conditions for WRF-Chem from MOZART-4 output. For questions about running mozbc please contact: Stacy Walters ([stacy at ucar . edu](mailto:stacy@ucar.edu)), Mary Barth ([barthm at ucar . edu](mailto:barthm@ucar.edu)), or Gabriele Pfister ([pfister at ucar . edu](mailto:pfister@ucar.edu)). To obtain mozbc, see the **Download** section below.

Chemical Boundary Conditions

mozbc – set chemical initial and lateral boundary conditions

- fills the chemical fields in *wrfinput_d<domain>* and *wrfbdy_d<domain>* with global model output (run after real.exe and before wrf.exe)
- set-up for MOZART-4 and CAM-Chem global model output
- controlled by namelist file (e.g. define species mapping; mappings available for MOZART to RACM, RADM, CBMZ, MADE/Sorgam, MOZAIC, GOCART)
- Interpolation in time and space
- global MOZART-4 output for past years and forecasts available on Web (<http://web3.acd.ucar.edu/wrf-chem/mozart.shtml>)



mozbc

NCAR/ACD has developed a program to create time-varying chemical boundary conditions for WRF-Chem from MOZART-4 output. For questions about running mozbc please contact: Stacy Walters ([stacy at ucar . edu](mailto:stacy@ucar.edu)), Mary Barth ([barthm at ucar . edu](mailto:barthm@ucar.edu)), or Gabriele Pfister ([pfister at ucar . edu](mailto:pfister@ucar.edu)). To obtain mozbc, see the **Download** section below.

Chemical Boundary Conditions

mozbc – set chemical initial and lateral boundary conditions

- *mozbc* operates on the most common map projections in WRF (Lambert, Mercator, Polar, Lat/Lon)
- To compile: *make_mozbc* -> will create the executable *mozbc*
- Package includes example namelist files (“*mozbc.inp*”)
- To run: *mozbc < mozbc.inp > mozbc.out*
- to enable chemical IC and BC when running WRF-Chem set in *namelist.input*: *have_bcs_chem = .true*



mozbc

NCAR/ACD has developed a program to create time-varying chemical boundary conditions for WRF-Chem from MOZART-4 output. For questions about running *mozbc* please contact: Stacy Walters ([stacy at ucar . edu](mailto:stacy@ucar.edu)), Mary Barth ([barthm at ucar . edu](mailto:barthm@ucar.edu)), or Gabriele Pfister ([pfister at ucar . edu](mailto:pfister@ucar.edu)). To obtain *mozbc*, see the **Download** section below.

Chemical Boundary Conditions

Example namelist file for mozbc:

```
&control
```

```
do_bc = .true.
```

```
do_ic = .true.
```

```
domain = 2
```

```
dir_wrf = '/ptmp/me/WRF_chem/'
```

```
dir_moz = '/ptmp/me/MOZBC/'
```

```
fn_moz = 'h0001.nc'
```

defines if BC are set (default: .false.)

defines if IC are set (default: .false.)

number of domains to work on (default: 1);

e.g. d=2 sets BC for d01 and IC for d01 and d02

path to WRF-Chem files (met_em, wrfinp*, wrfbdy*)*

path to MOZART/CAM-Chem input files

initial MOZART/CAM-Chem file; mozbc increments filenames, filenames must be of the form prefix<nnn>.nc

suffix string for MOZART/CAM-Chem variables (default: '_VMR_inst')

prefix string for the WRF meterological files (default: 'met_em')

{standard WRF names: met_em.d<nn>.<yyyy-mm-dd_hh:mm:ss>.nc }

suffix string for the WRF meterological files (default: 'nc')

separator character for WRF meterological files (default: '.')

```
moz_var_suffix = '_VMR_avrg'
```

```
met_file_prefix = 'met_em'
```

```
met_file_suffix = '.nc'
```

```
met_file_separator = '.'
```

```
spc_map = 'o3 -> O3', 'o -> O', 'o1d_cb4 -> O1D', 'n2o -> N2O', 'no -> NO',
```

```
...
```

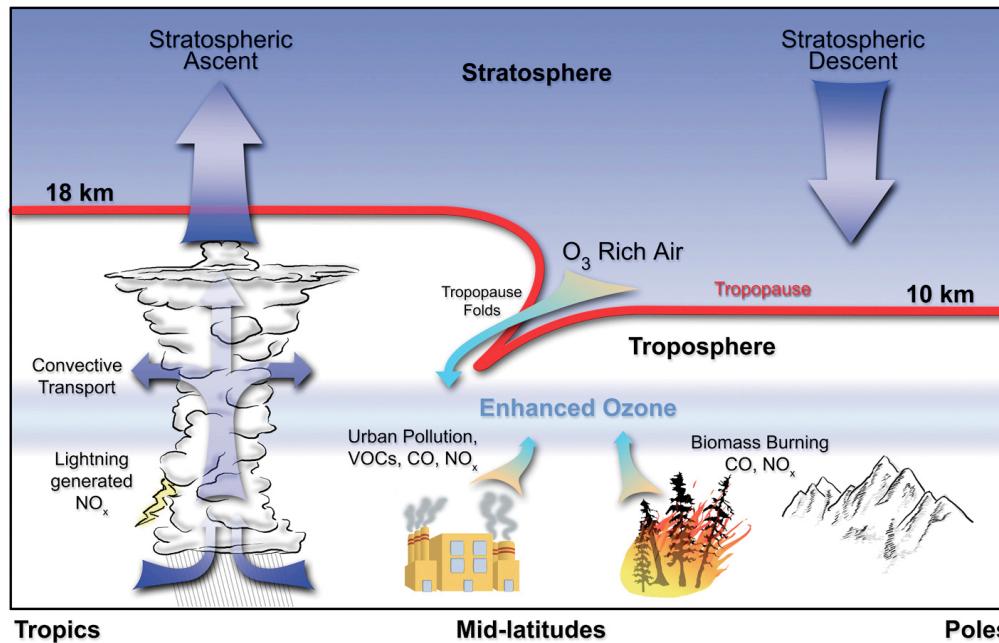
```
'DUST_4 -> .2348*[DUST3]+.5869*[DUST4];1.e9', 'DUST_5 -> .5869*[DUST4];1.e9'
```

```
/
```

Chemical Boundary Conditions

ubc - upper chemical boundary conditions

- WRF-Chem does not have a stratosphere – possible issues when looking at UTLS, STE influence or comparing to satellite products (e.g. trop. O₃ retrievals)



Chemical Boundary Conditions

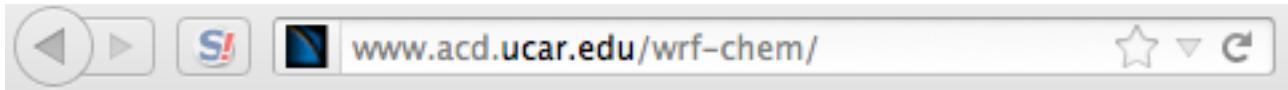
ubc - upper chemical boundary conditions

- $O_3, NO, NO_2, HNO_3, CH_4, CO, N_2O, N_2O_5$ are set to climatology above certain pressure level and relaxed to tropopause level below (pressure level can be set by user)
- Same scheme as used in MOZART-4 and CAM-Chem
- Climatologies for present and future available on Website
- namelist.input (&chem):

```
have_bcs_upper      = .true.
```

```
fixed_upper_bc      = 50.
```

```
fixed_ubc_inname    = "ubvals_b40.20th.track1_1996-2005.nc"
```



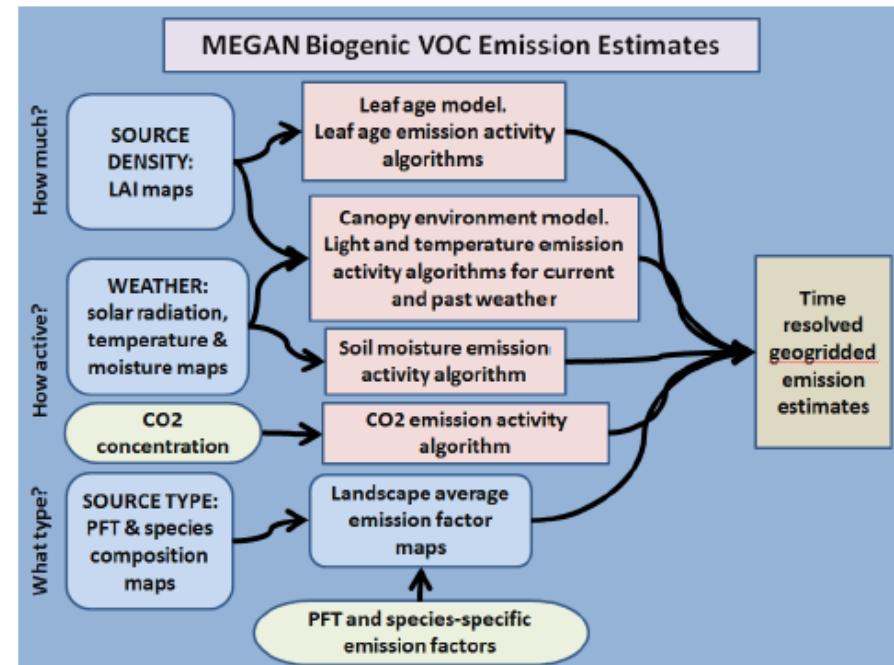
Upper Boundary Conditions

Download input files for running WRF-Chem V3.3.1 with Chemical Upper Boundary Conditions: [UBC_inputs.tar](#)

MEGAN online biogenic emissions

Model of Emissions of Gases and Aerosols from Nature

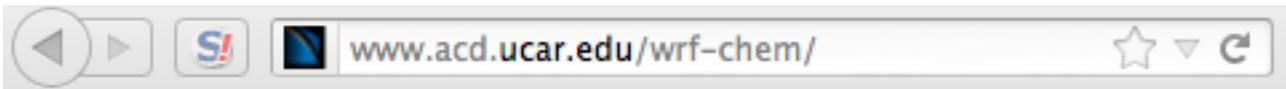
- Estimate emissions of VOCs, NOx and CO from vegetation
- Driving variables include landcover, LAI, weather, and atmospheric chemical composition
- Reference: *Guenther et al.*, GMD 2012 (for MEGAN v2.1)
- Note: as of current land cover used in MEGAN differs from that used within WRF-Chem
- Planned:
 - Update to latest MEGAN current version in WRF-Chem: 2.04
 - link to WRF-Chem land cover/CLM



from Guenther et al., 2012

MEGAN preprocessor

- Static input fields needed to run with online MEGAN biogenic emissions: *Isoprene Emissions Factors, past/current conditions (monthly LAI, solar radiation & temperature), Fractional coverage of broadleaf and needleleaf trees, shrubs and herbaceous*
- Compatible with MOZART, CBMZ, RADM, RACM, SAPRC (see module_data_mgn2mech.F for species mapping)
- Download source code (megan_bio_emiss.tar) and global input data (megan.data.tar.gz)
- `megan_bio_emiss` is a single cpu code, which:
 - ✓ reads global MEGAN input data
 - ✓ maps them on the WRF-Chem domain
 - ✓ creates `wrfbiochemi_d<domain>` file



[bio_emiss](#)

Bio_emiss is a pre-processor for creating MEGAN input for WRF-Chem. To obtain bio_emiss, see the **Download** section below.

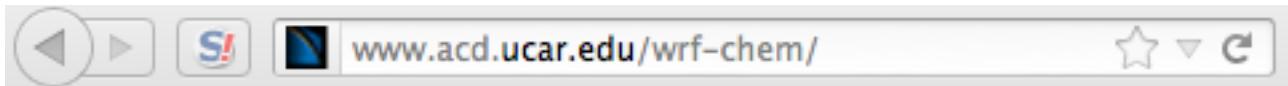
MEGAN preprocessor

- To compile:
make_util megan_bio_emis - creates the executable *megan_bio_emiss*
- *megan_bio_emiss* is controlled by a namelist file
e.g. “*megan_bio_emiss.inp*”

```
&control
domains = 3,
start_lai_mnth = 4,
end_lai_mnth  = 6,
wrf_dir  = '/home/me/megan/wrf_files',
megan_dir = '/home/me/megan/30sec'
/
```

creates wrfbiochemi_dnn for three domains (default: 1)
starting month for the monthly LAI (default: 1)
ending month for the monthly LAI (default: 12)
path to wrfinput_dnn (default: current)
path to MEGAN input files (default: current)

- To run : *megan_bio_emiss < megan_bio_emiss.inp > megan_bio_emiss.out*

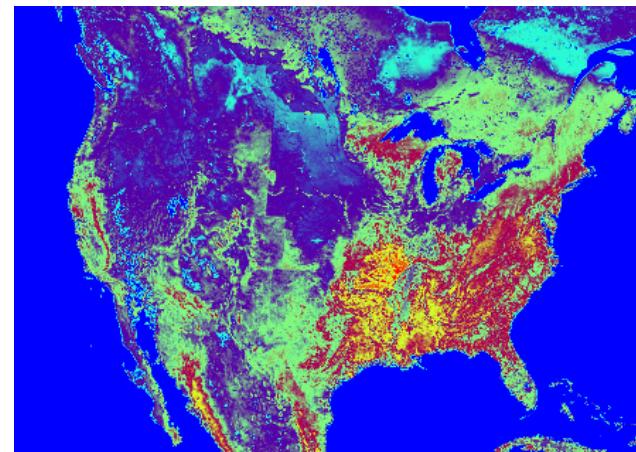


Running WRF-Chem with MEGAN

- WRF-Chem output variables: EBIO_<species>, ...
- namelist.input:

```
&time_control  
  (activate settings only either during real.exe or initial wrf.exe)  
    auxinput6_interval_h      = 24  
    auxinput6_inname          = 'wrfbiochemi_d01' ,  
    io_form_auxinput6         = 2 ,
```

```
&chem  
  bio emiss opt = 3  
  bioemdt = your choice (minutes)  
  ne_area = # chemical species
```



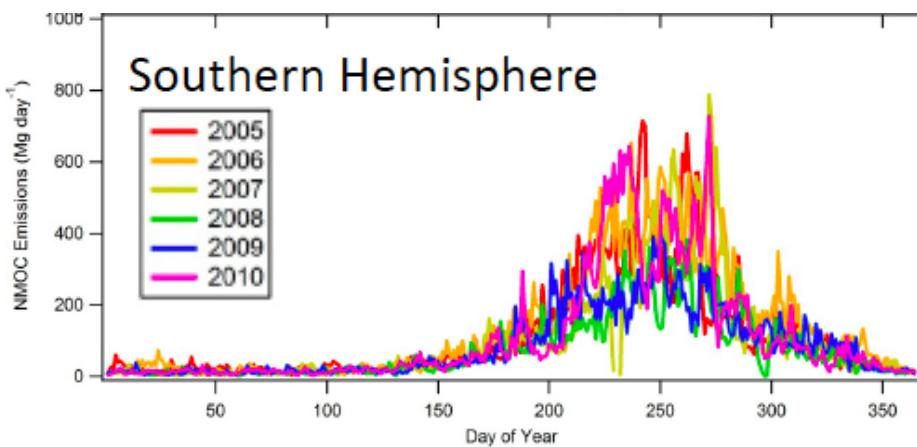
EBIO_ISO, 20 July 2008 21 UTC

FINN Fire Emissions

- FINN: Fire INventory from NCAR (Wiedinmyer et al., GMD, 2011)
- Daily, 1 km resolution, global estimates of the trace gas and particle emissions from open burning of biomass
- Uses satellite observations of active fires and land cover, together with emission factors and estimated fuel loadings

FINN combines:

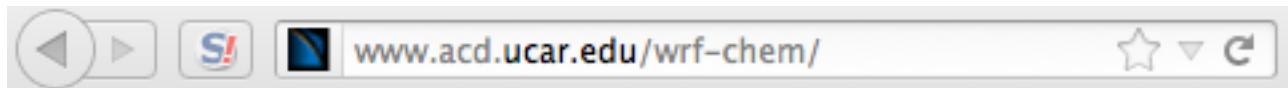
- MODIS Fire Detections
- MODIS Vegetation Continuous Field and Land Cover Type
- Emission Factors: Akagi et al., ACP, 2011
- Speciation of VOC for MOZART-4, SAPRC-99, GEOS-Chem



Daily NMVOC Emissions
(from Wiedinmyer et al., 2011)

FINN Fire Emissions Preprocessor

- create WRF-Chem ready fire emissions from FINN inventory -
`wrffirechemi_d<domain>_<date>` for use with online plume rise
(can also be merged into wrfchemi files)
note: fire_emis also works to create global emission files for MOZART-4/CAM-Chem
- Works for different chemical schemes (namelist controlled)
- WRAP diurnal emission profile applied
- Processor and FINN inputs available on Web
- FINN inputs in MOZART-4, SAPRC99, and GEOS-Chem speciation



[Fire_Emis](#)

Fortran based preprocessor for creating fire emission inputs for WRF-Chem when running with plumerise and also for creating fire emission inputs for the MOZART-4 and CAM-Chem global models. The fire emissions inventory is based on the Fire Inventory from NCAR (FINN). Both software (`fire_emis.tgz`) and required FINN input data sets are available at the [download page](#).

FINN Fire Emissions Preprocessor

- To compile: *make_fire_emis*
- To run: *fire_emis <fire_emis.inp> fire_emis.out*
- Example namelist “*fire_emis.inp*” for MOZCART

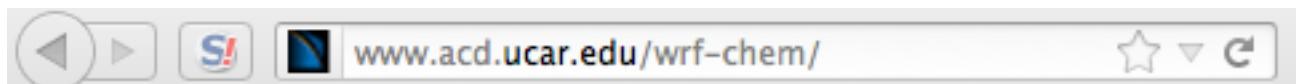
```
&control
domains      = 1,
fire_directory = '',
fire_filename = 'GLOB2012a MOZ4_07242012.txt',
wrf_directory = '',
start_date    = '2012-06-01',
end_date     = '2012-06-10',
diag_level   = 1,

wrf2fire_map =  'co -> CO', 'no -> NO', 'so2 -> SO2', 'bigalk -> BIGALK', 'bigene -> BIGENE', 'c2h4 -> C2H4',
                 'c2h5oh -> C2H5OH', 'c2h6 -> C2H6', 'c3h8 -> C3H8', 'c3h6 -> C3H6', 'ch2o -> CH2O',
                 'ch3cho -> CH3CHO', 'ch3coch3 -> CH3COCH3', 'ch3oh -> CH3OH', 'mek -> MEK',
                 'toluene -> TOLUENE', 'nh3 -> NH3', 'no2 -> NO2', 'open -> BIGALD', 'c10h16 -> C10H16',
                 'ch3cooh -> CH3COOH', 'cres -> CRESOL', 'glyald -> GLYALD', 'mgly -> CH3COCHO',
                 'gly -> CH3COCHO', 'acetol -> HYAC', 'isop -> ISOP', 'macr -> MACR', 'mvk -> MVK',
                 'oc -> 0.24*PM25 + 0.3*PM10;aerosol', 'bc -> 0.01*PM25 + 0.08*PM10;aerosol',
                 'pm10_raw -> PM10;aerosol', 'pm25_raw -> PM25;aerosol',
                 'sulf -> -0.01*PM25 + 0.02*PM10;aerosol',
                 'pm25 -> 0.36*PM25;aerosol', 'pm10 -> -0.61*PM25 + 0.61*PM10;aerosol'
/
```

FINN Fire Emissions Preprocessor

- Running WRF-Chem with FINN emissions and plumerise:

```
&time_control
    auxinput7_inname          = 'wrffirechemi_d<domain>_<date>',
    auxinput7_interval_m      = 60, 60, 60,
    io_form_auxinput7         = 2,
    frames_per_auxinput7      = 1, 1, 1,
&chem
    biomass_burn_opt          = your choice
    plumerisefire_frq         = your choice
    scale_fire_emiss           = .true.
```



Fire_Emis

Fortran based preprocessor for creating fire emission inputs for WRF-Chem when running with plumerise and also for creating fire emission inputs for the MOZART-4 and CAM-Chem global models. The fire emissions inventory is based on the Fire Inventory from NCAR (FINN). Both software (fire_emis.tgz) and required FINN input data sets are available at the [download page](#).

For Questions:

Gabriele Pfister *pfister@ucar.edu*

Stacy Walters *walters@ucar.edu*

Modifying output during runtime

- Create ASCII file, e.g. “**hist_io_mods_d01**”

```
# list of fields to remove/add from primary history output
+:h:0:ebu_co
+:h:0:E_CO
+:h:0:EBIO_ISO
-:h:0:hno3
```

- Add to *namelist.input*:

```
&time_control
  iofields_filename = 'hist_io_mods_d01'
```