Chemical Boundary Conditions with WRF-Chem

Steven Peckham

Boundary Conditions

- Purpose: Understand what WRF-Chem uses for chemical boundary conditions

- Allow to user to make an educated choice for lateral boundary conditions

Default Chemical BCs

- have_bcs_chem = .false.

- WRF-Chem uses idealized chemical profile generated from the NALROM simulation (see WRF-Chem User's Guide & code for more details)
  - North America summer
  - Limited number of chemical species
  - Originally developed for lower troposphere ozone forecast

Boundary Conditions

- Consider:
  - Does one really need to specify chemical boundar conditions?
  - How long until the lateral boundary conditions impact the domain solution?

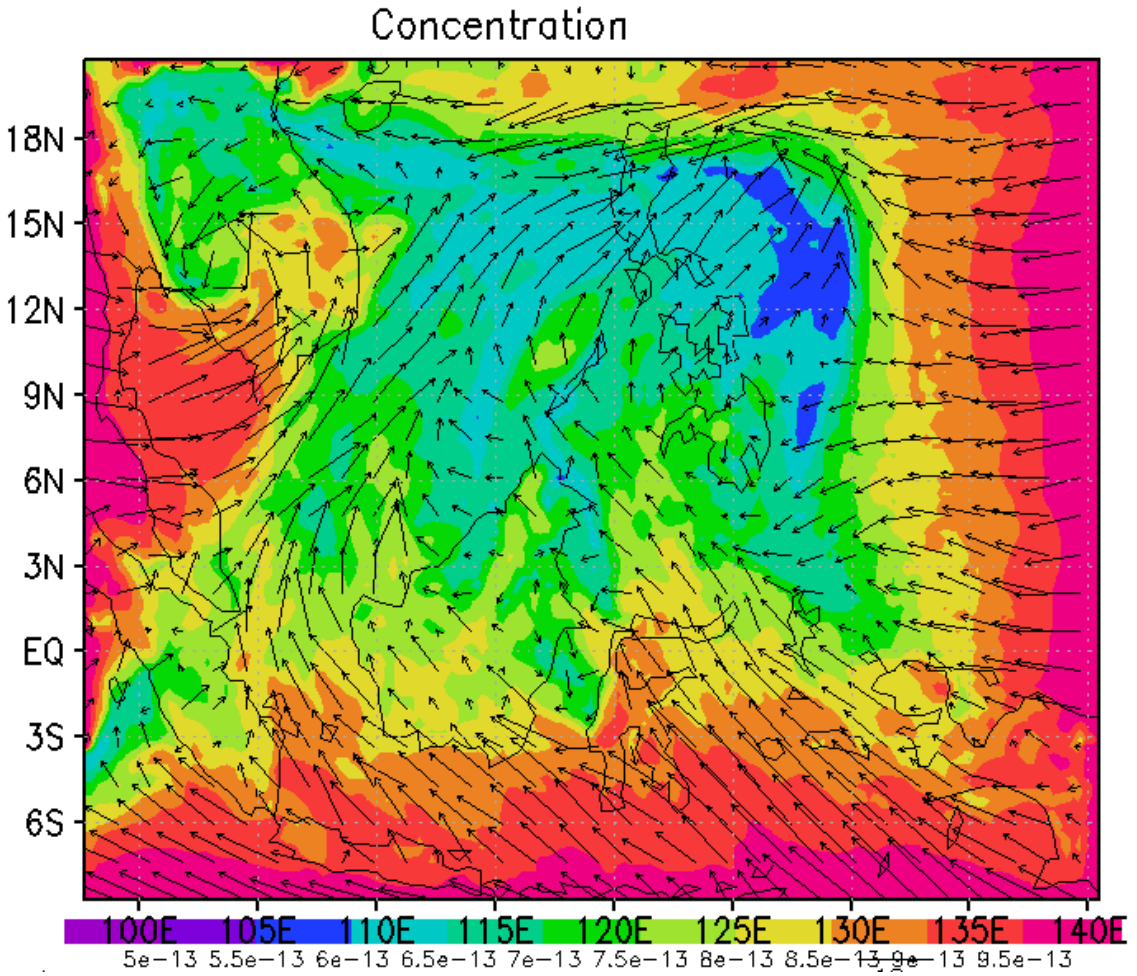
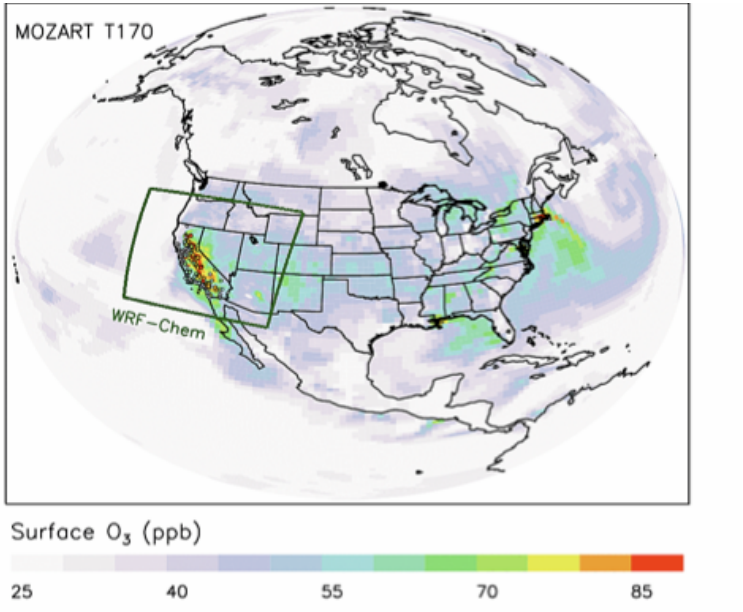


Image credit: Surga Pamugkas

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



www.acd.ucar.edu/wrf-chem/

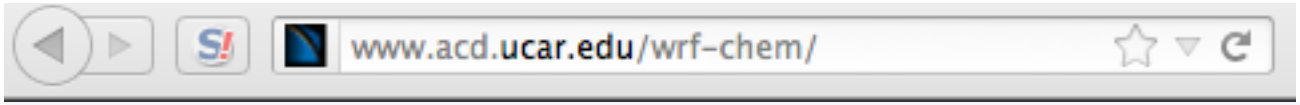
mozbc

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), Mary Barth (barthm at ucar . edu), or Gabriele Pfister (pfister at 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)



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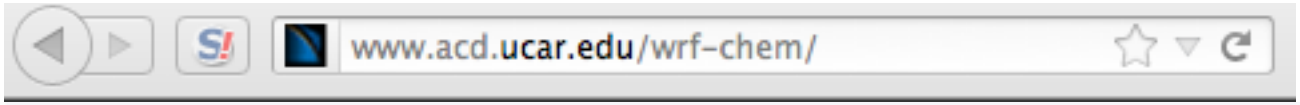
Chemical Boundary Conditions

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`



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Chemical Boundary Conditions

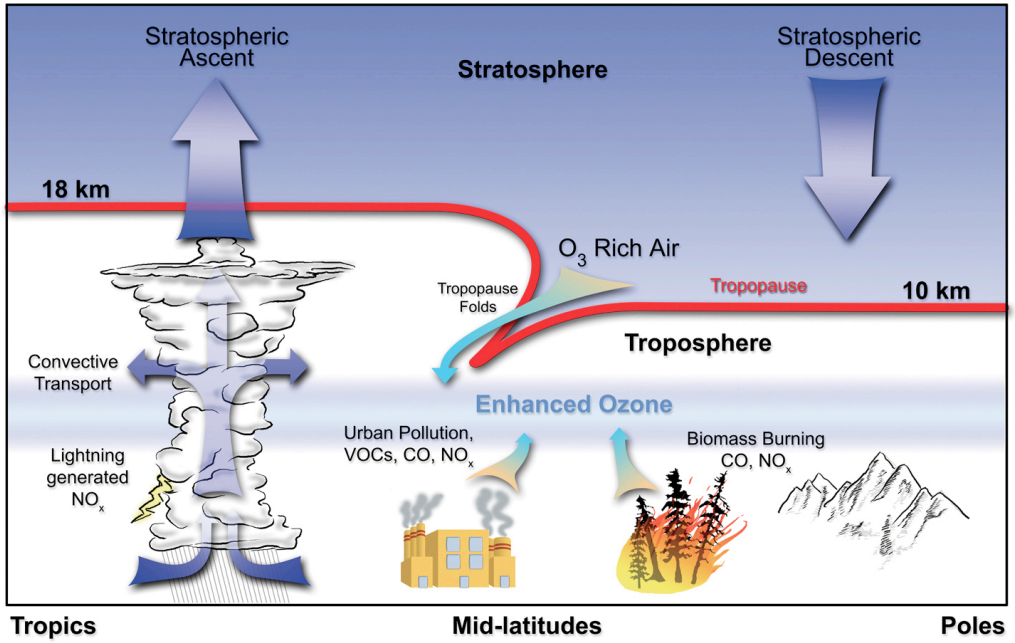
Example namelist file for mozbc:

```
&control

do_bc   = .true.                                   defines if BC are set  (default: .false.)
do_ic    = .true.                                  defines if IC are set  (default: .false.)
domain = 2                                         number of domains to work on (default: 1);
                                                   e.g. d=2 sets BC for d01 and IC for d01 and d02

dir_wrf   = '/ptmp/me/WRF_chem/'          path to WRF-Chem files (met_em*, wrfinp*, wrfbdy*)
dir_moz = '/ptmp/me/MOZBC/'               path to MOZART/CAM-Chem input files
fn_moz  = 'h0001.nc'                 initial MOZART/CAM-Chem file; mozbc increments filenames,
                                                   filenames must be of the form
prefix<nnn>.nc
moz_var_suffix  = '_VMR_avrg'     suffix string for MOZART/CAM-Chem variables (default: '_VMR_inst')
met_file_prefix  =  'met_em'      prefix string for the WRF meterological files (default: 'met_em')
                                                   {standard WRF names:
met_em.d<nn>.<yyyy-mm-dd_hh:mm:ss>.nc }
met_file_suffix   = '.nc'              suffix string for the WRF meterological files (default:'nc')
met_file_separator  = '.'              separator character for WRF meterological files (default: '.')

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. O_3 re



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Upper Boundary Conditions

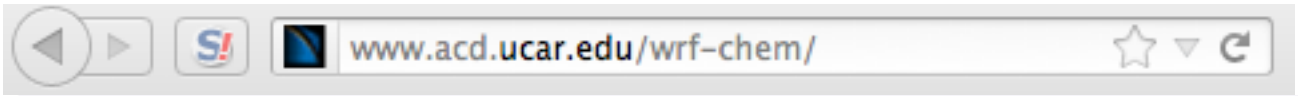
Download input files for running WRF-Chem V3.3.1 with Chemical Upper Boundary Conditions: UBC_inputs.tar

Chemical Boundary Conditions

ubc - **upper** chemical boundary conditions

- *o3,no,no2,hno3,ch4,co,n2o, n2o5* 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"
```



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WRF-Chem Emissions Tutorial

Emissions Tutorial Exercises for WRF-CHEM Version 3.5

Exercise 1: Building and using a global emissions data in a WRF-Chem simulation.

Exercise 2: Building and including biogenic emissions when running a WRF-Chem simulation.

Exercise 6: Using the mozbc utility and the MOZART global chemistry model data to construct improved initial and lateral boundary conditions.