Chemical Boundary Conditions with WRF-Chem

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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 boundary conditions?
  - How long until the lateral boundary conditions impact the domain solution?
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

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 \textit{wrfinput} \textit{d<domain>} and \textit{wrfbdy} \textit{d<domain>} with global model output (run after \texttt{real.exe} and before \texttt{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

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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
Chemical Boundary Conditions

Example namelist file for mozbc:

```plaintext
&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$_3$ 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"
```
Emissions Tutorial Exercises for WRF-CHEM Version 3.5


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.