WRF-Chem V3.4.1: Nested Simulation Considerations

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Nested Chemistry Simulation: Best practices

• Be familiar with running a nested WRF simulation
  – Namelist settings
  – Methodology

• Start by making a nested run following NDOWN methodology for meteorology only

• Move on to 2-way interactive nested simulations using meteorology only
  – Considerations:
    • time step for each domain,
    • namelist settings – set for each nest or once for all domains,
    • domain sizes large enough for study of item of interest

• When a nested meteorology simulation works as expected, then move on to adding chemistry.
Nested Chemistry Simulation: Best Practices

• Start a nested chemistry run by using NDOWN
  – Need to generate emissions for nested domain
    • Use nested domain map information in prep_chem_sources
    • Can not simply interpolate emissions from mother domain to nest
      – Mass conservation issues
      – Emissions source issues (land/water location, point emissions shifted to wrong location, etc.)

• Confirm that the nested domain with chemistry produces the correct results

• If 1-way nested run is correct, then advance to 2-way interactive nested run.
  – No moving nests possible when using chemistry!
Nested Chemistry Simulation: ndown Methodology
ndown without chemistry

• Save wrf output files for coarse domain
• Get met files for domain and rename them to domain 1 files (met_em.d01....)
• Run real for domain 2 with all settings in the domain 1 column
• Rename files generated by real.exe
• Get wrfout files for coarse domain
• Set namelist.input for nested domain run.
  – Make sure that inverval_seconds is set for the update interval of the wrfout files
• Run ndown.exe
• Rename files input files for domain 2 to domain 1 and clean-up directory.
• Verify that wrfinput and wrfbdy are correct.
• Run domain 2 now as as if you are running a single domain.
nDown with chemistry

- Save wrf output files for coarse domain
- Get met files for domain and rename them to domain 1 files (met_em.d01....)
- Run real for domain 2 with all settings in the domain 1 column
- Rename files generated by real.exe
- Get wrfout files for coarse domain
- Set namelist.input for nested domain run.
  - Make sure that interval_seconds is set for the update interval of the wrfout files
- Build emissions for nested domain
- Run ndown.exe with namelist.input settings for chemistry turned on
- Rename files input files for domain 2 to domain 1 and clean-up directory.
- Verify that wrfinput and wrfbdy are correct.
- Run domain 2 now as as if you are running a single domain.
Nested Chemistry Simulation: prep_chem_sources Settings

• Building emissions with prep_chem_sources
  – Prep_chem_sources has nested domain settings in map projection calculation

• Grid mapping routines not as flexible as WRF mapping routine

• Make sure emissions map onto the nested domain
prep_chem_sources Settings for Nest

grid_type = 'lambert',

NGRIDS = 2,    ! Number of grids to run

NNXP = 41, 61, 86, 46,  ! Number of x grid points
NNYP = 41, 61, 74, 46,  ! Number of y grid points
NXTNEST = 0, 1, 2, 3,  ! Grid number which is the next coarser grid
DELTAX = 100000.,  ! X and Y grid spacing
DELTAY = 100000.,

! Nest ratios between this grid and the next coarser grid.
NSTRATX = 1, 5, 3, 4,  ! x-direction
NSTRATY = 1, 5, 3, 4,  ! y-direction

NINEST = 1, 10, 0, 0,  ! Grid point on the next coarser
NJNEST = 1, 10, 0, 0,  ! nest where the lower southwest
! corner of this nest will start.
! If NINEST or NJNEST = 0, use CENTLAT/LON
POLELAT = 35.,  ! If polar, latitude/longitude of pole point
POLELON = 25.,  ! If lambert/mercator, lat/lon of grid origin (x=y=0.) (ref_lat/ref_lon from namelist.wps)

CENTLAT = 35.0, 35.0, 27.5, 27.5,  ! (ref_lat/ref_lon from namelist.wps)
CENTLON = 25.0, 25.0, -80.5, -80.5,
Convert Emissions For Nest

• Link grid 2 output and grid 2 wrfinput to run convert_emiss (nested domain only)
• Set namelist.input for nested domain

```
max_dom = 1,
e_we = 61, 112, 94,
e_sn = 61, 97, 91,
e_vert = 35, 28, 28,
p_top_requested = 5000,
num_metgrid_levels = 27,
num_metgrid_soil_levels = 4,
dx = 20000, 10000, 3333.33,
dy = 20000, 10000, 3333.33,
```

• Run convert_emiss.exe for one domain – not capable of doing nested domains
• Verify the emissions are correct for the nested domain (land vs sea, cities, roads, etc.)
Nested Chemistry Simulation: Methodology

- Save wrf output files for coarse domain
- Get met files for domain and rename them to domain 1 files (met_em.d01....)
- Run real for domain 2 with all settings in the domain 1 column
- Rename files generated by real.exe
- Get wrfout files for coarse domain
- Set namelist.input for nested domain run.
  - Make sure that interval_seconds is set for the update interval of the wrfout files
- Build emissions for nested domain
- Run ndown.exe with namelist.input settings for chemistry turned on
- Rename files input files for domain 2 to domain 1 and clean-up directory.
- Verify that wrfinput and wrfbdy are correct.
- Run domain 2 now as as if you are running a single domain.
## Ndown namelist.input

### Namelist.input settings for ndown with chemistry

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>&amp;domains</td>
<td></td>
<td></td>
</tr>
<tr>
<td>max_dom</td>
<td>2</td>
<td>With or without chem</td>
</tr>
<tr>
<td>&amp;chem</td>
<td></td>
<td></td>
</tr>
<tr>
<td>kemit</td>
<td>1</td>
<td>Needed for chem input</td>
</tr>
<tr>
<td>chem_opt</td>
<td>11, 11</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bio_emiss_opt</td>
<td>2, 2</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>biomass_burn_opt</td>
<td>1, 1</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
IF( nested_grid%chem_opt .NE. 0 ) then
! Read the chemistry data from a previous wrf forecast (wrfout file)
! Generate chemistry data from a idealized vertical profile
if(nested_grid%biomass_burn_opt == BIOMASSB) THEN
  message = 'READING BIOMASS BURNING EMISSIONS DATA'
  CALL wrf_message ( message )
  CALL med_read_wrf_chem_emissopt3 ( nested_grid , config_flags)
end if

if(nested_grid%dust_opt == 1 .or. nested_grid%dmsemis_opt == 1 &
  .or. nested_grid%chem_opt == 300 .or. nested_grid%chem_opt ==
  301) then
  message = 'READING GOCART BG AND/OR DUST and DMS REF FIELDS'
  CALL wrf_message ( message )
  CALL med_read_wrf_chem_gocart_bg ( nested_grid , config_flags)
end if

if( nested_grid%bio_emiss_opt .eq. 2 )then
  message = 'READING BEIS3.11 EMISSIONS DATA'
  CALL wrf_message ( message )
  CALL med_read_wrf_chem_bioemiss ( nested_grid , config_flags)
else if( nested_grid%bio_emiss_opt == 3 ) THEN
  message = 'READING MEGAN 2 EMISSIONS DATA'
  CALL wrf_message ( message )
  CALL med_read_wrf_chem_bioemiss ( nested_grid , config_flags)
endif
ENDIF

Biomass burning

GOCART background

Biogenic emissions
Nested Chemistry Simulation:

WRF Methodology
Nested Chemistry Simulation: namelist.input settings

• Registry provides information as to possible nested run settings

| rconfig | real  | BIOEMDT | namelist,chem | max_domains | 0 | h | "BIOEMDT" | "" | ""
|---------|-------|---------|---------------|-------------|---|---|-----------|---|---------|
| rconfig | real  | PHOTDT  | namelist,chem | max_domains | 0 | h | "PHOTDT" | "" | ""
| rconfig | real  | CHEMDT  | namelist,chem | max_domains | 0 | h | "CHEMDT" | "" | "" »
| rconfig | real  | BIOEMDT  | namelist,chem | max_domains | 0 | h | "BIOEMDT" | "" | ""
| rconfig | real  | PHOTDT  | namelist,chem | max_domains | 0 | h | "PHOTDT" | "" | ""
| rconfig | real  | CHEMDT  | namelist,chem | max_domains | 0 | h | "CHEMDT" | "" | "" »
| rconfig | integer | ne_area | namelist,chem | 1 | 41 | irh | "ne_area" | "" | ""
| rconfig | integer | kemit | namelist,chem | 1 | 9 | irh | "kemit" | "" | ""
| rconfig | integer | nmegan | namelist,chem | 1 | 138 | irh | "nmegan" | "" | ""
| rconfig | integer | kemit_aircraft | namelist,chem | 1 | 1 | - | "kemit_aircraft" | "" | ""
| rconfig | integer | biomass_emiss_opt | namelist,chem | max_domains | 0 | rh | "biomass_emiss_opt" | "" | "" »

• Examine column 5 in registry.chem to determine which options are set for each domain
Nested Chemistry Simulation: namelist.input

- Namelist.input settings for chemistry

<table>
<thead>
<tr>
<th>Setting</th>
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</tr>
</thead>
<tbody>
<tr>
<td>kemit</td>
<td>1,</td>
</tr>
<tr>
<td>chem_opt</td>
<td>11, 6, 0</td>
</tr>
<tr>
<td>chemdt</td>
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</tr>
<tr>
<td>phot_opt</td>
<td>2, 3,</td>
</tr>
<tr>
<td>emiss_opt</td>
<td>5, 3,</td>
</tr>
<tr>
<td>chem_in_opt</td>
<td>0, 0,</td>
</tr>
<tr>
<td>gas_drydep_opt</td>
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<tr>
<td>aer_drydep_opt</td>
<td>1, 1,</td>
</tr>
<tr>
<td>bio_emiss_opt</td>
<td>1, 2,</td>
</tr>
<tr>
<td>gaschem_onoff</td>
<td>1, 0,</td>
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<tr>
<td>aerchem_onoff</td>
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<tr>
<td>chem_conv_tr</td>
<td>1, 1,</td>
</tr>
<tr>
<td>seas_opt</td>
<td>1,</td>
</tr>
</tbody>
</table>

- Can one change chemistry options between domains?
  - Will the namelist above work?
Nested Chemistry Simulation:

Questions?
Discussion

How large should mother domain (domain 1) be for a nested simulation? Nest likewise?

Need to consider:
- $U \sim O[10 \text{ m/s}] \Rightarrow \sim 40 \text{ km/h} \sim 500 \text{ km/d}$
- Mountain locations in domain, flow across mountains/gravity waves and reflection off top
- Recirculation of pollutants
- Available computing resources