WRF Nesting: Set Up and Run

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Outline

- General comments
- Nest namelist options
- Running WRF with nests
  - NMM case: one-way nesting
  - ARW case: two-way nesting
  - ARW moving nest
  - ARW one-way nesting
- Summary

Before You Run ..

- Make sure you have selected nest compiled options and appropriate executables are created in **`WRFV2/main/`** directory:

  For ARW:
  - **`ideal.exe`**
  - **`real.exe`**
  - **`wrf.exe`**
  - **`ndown.exe`**

  For NMM:
  - **`real_nmm.exe`**
  - **`wrf.exe`**

- If you are running a real-data case, be sure that files for *nest* domains from WPS are generated:
  - **`met_em.d0*.<date>`**, for ARW or
  - **`met_nmm.d01.<date>`**, **`geo_nmm.102.nc ..`** for NMM

Steps to Run (same as before)

1. cd to *run/* or one of the *test case* directories
2. Link or copy WPS output files to the directory for real-data cases
3. Edit *namelist.input* file for the appropriate grid and times of the case
4. Run initialization program (*real.exe*, or *real_nmm.exe*) as in the single domain case
5. Run model executable, *wrf.exe*

All in the namelist…

- Nearly all controls for a nested run can be achieved by editing the namelist file.
- Look at nest specific namelist options

Important to note:

- Key variable: **`max_dom`** must be set to >= 2
- Need to pay attention to multi-column namelists

Nest namelist Options

&time_control

```
run_days            = 0,
run_hours           = 24,
run_minutes         = 0,
run_seconds         = 0,
start_year          = 2000, 2000, 2000,
start_month         = 01,   01,   01,
start_day           = 24,   24,   24,
start_hour          = 12,   12,   12,
start_minute        = 00,   00,   00,
start_second        = 00,   00,   00,
end_year            = 2000, 2000, 2000,
end_month           = 01,   01,   01,
end_day             = 25,   25,   25,
end_hour            = 12,   12,   12,
end_minute          = 00,   00,   00,
end_second          = 00,   00,   00,
interval_seconds    = 21600
```

domain 1 option

These controls the start and end times of the nests. They can be different from the parent domain, but must fit in the time window of the parent domain

&time_control

```
interval_seconds     = 21600
history_interval     = 180,  60,   60,
frame_per_outfile    = 1000, 1000, 1000,
restart_interval     = 360,
```

History files may be split into multiple pieces

- History files are written separately for each domains
- History intervals may be different for different domains
- restart files are also written one per domain

&time_control

ARW only

```
input_from_file  = .true., .true., .true.,
fine_input_stream   = 0, 2, 2,
```

Specify what fields to use in nest input: they can be all (0), or data specified in I/O stream 2 in Regsitry (2). Useful for nest start at a later time.

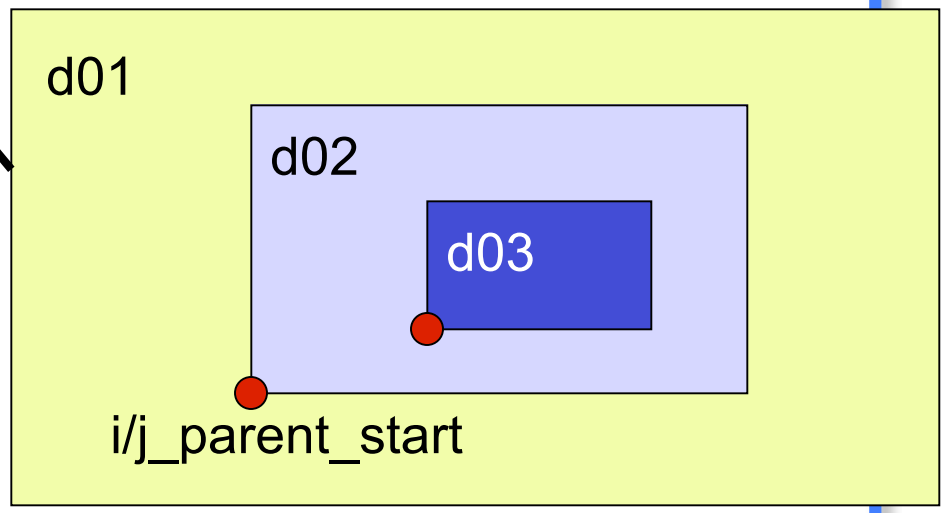
Whether to produce in *real* and use nest wrfinput files. This is usually the case for real-data runs. For idealized nest runs, set it to .false. .

&domains

```
max_dom   = 3,
s_we      = 1,   1,   1,
e_we      = 74, 112,94,
s_sn      = 1,   1,   1,
e_sn      = 61, 97, 91,
s_vert    = 1,   1,   1,
e_vert    = 28, 28, 28,
grid_id          = 1,   2,   3,
parent_id        = 0,   1,   2,
i_parent_start = 0, 31, 30,
j_parent_start = 0, 17, 30,
```

Activate nests

Dimensions of all domains; same as in WPS.



&domains

ARW

```
dx = 30000, 10000, 3333.33,
dy = 30000, 10000, 3333.33,
parent_grid_ratio = 1, 3, 3,
parent_time_step_ratio = 1,3,3,
```

All 4 variables must be specified. *Grid ratio* can be any integer, and *time step ratio* can be different from grid ratio.

NMM

```
dx = 0.096290,
dy = 0.096011,
parent_grid_ratio = 1,
parent_time_step_ratio = 1,
```

Values in nest columns are ignored. Everything is defined by 1:3 ratio in the model.

&domains

ARW only

```
feedback        = 1,
smooth_option = 2,
```

When feedback is on, this option can be selected to smooth the area in the parent domain where nest is. Valid values are 0,1,2.

Whether nest will overwrite parent domain results. Setting feedback=0 ➔ 'one-way' nesting in a concurrent run.

&bdy_control

```
spec_bdy_width = 5,  (1 for NMM)
spec_zone      = 1,  (ARW only)
relax_zone     = 4,  (ARW only)
specified      = .T.,.F.,.F.,
nested         = .F.,.T.,.T.,
```

Boundary condition option for domain 1.

Boundary condition option for nests.

Other notes for namelists

- Use same physics options for all domains.
  - An exception is cumulus scheme. One may need to turn it off for a nest that has grid distance of a few kilometers.
- Also use same physics calling frequency (e.g. radt, cudt, etc.) in all domains.

Where do I start?

- Always start with a *namelist* template provided in a test case directory, whether it is a ideal case, ARW or NMM.
- Not all namelists are function of domains. If in doubt, check Registry.EM or Registry.NMM (look for string 'namelist').
- Use document to guide the modification of the namelist values:
  - run/README.namelist
  - User's Guide, Chapter 5

Running NMM Nested Case

Running WRF NMM Nested Cases

- Files available from WPS:

  met_nmm.d01.<date>

  geo_nmm.102.nc,..

- Link or copy WPS output files to the run directory:

```
cd test/nmm_real
ln -s ../../../WPS/met_nmm.*   .
ln -s ../../../WPS/geo_nmm.*   .
```

Running WRF NMM Nested Cases

- Edit **namelist.input** file for runtime options (set **max_dom >= 2** for a nest run)

- Run the real-data initialization program (MPI only):

  mpirun -n *N* ./real_nmm.exe

- Successfully running this program will create model initial and boundary files:

  wrfinput_d01

  wrfbdy_d01

  (geo_nmm.102.nc ← from geogrid)

Running WRF NMM Nested Cases

- Run the model executable by typing (MPI only):

  `mpirun -n N ./wrf.exe`

- Successfully running the model will create model *history* files, one for each domain:

  `wrfout_d01_2005-08-28_00:00:00`

  `wrfout_d02_2005-08-28_00:00:00`

  And *restart* file if selected:

  `wrfrst_d01_<date>, wrfrst_d02_<date>`

Running ARW Nested Case

Running ARW Nested Case

- If you have compiled the *em_real* case with nest option, you should have:

  `real.exe` - real data initialization program

  `wrf.exe` - model executable

  `ndown.exe` - program for doing one-way nesting

- These executables are linked to:

  `WRFV2/run`

  and

  `WRFV2/test/em_real`

➔ One can go to either directory to run.

Running WRF ARW Nested Cases

- Files available from WPS:

  met_em.d01.<*date*>

  met_em.d02.<*date*> ..

- Link or copy WPS output files to the run directory:

  cd test/*em_real*

  ln -s ../../../WPS/met_em.* .

Running WRF ARW Nested Cases

- Edit **`namelist.input`** file for runtime options (set **`max_dom >= 2`** in **`&domains`** for a nested run)

- Run the real-data initialization program:

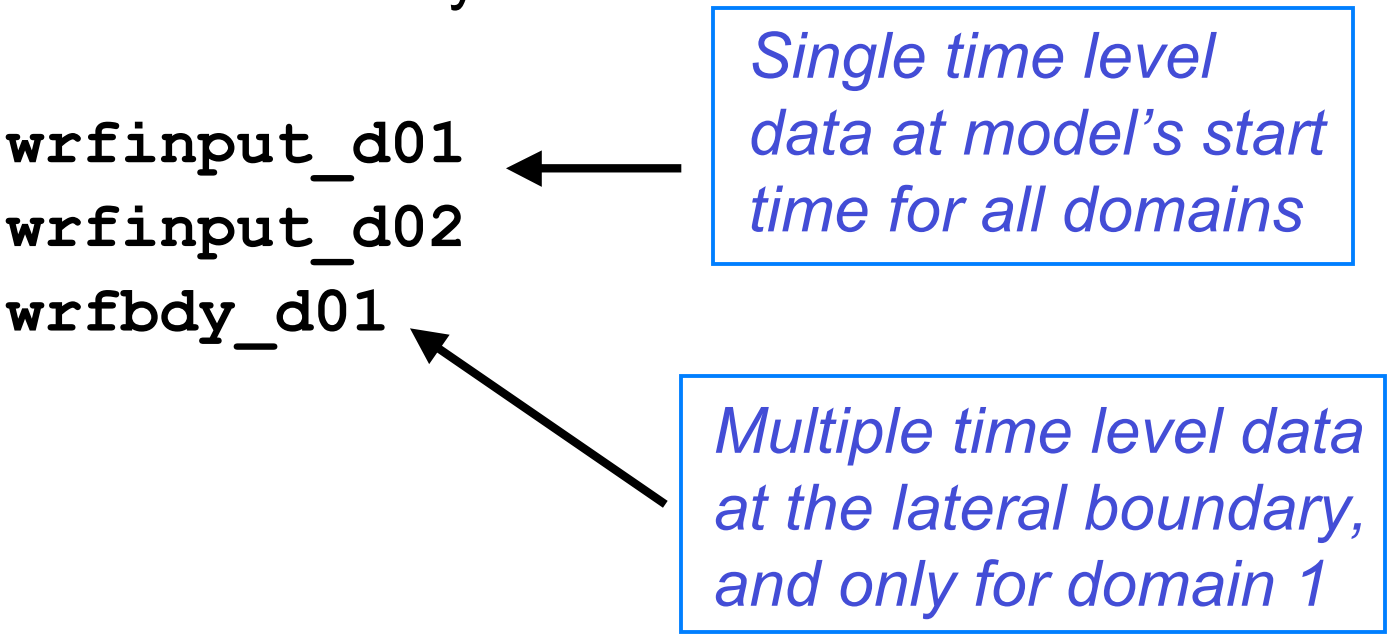
  `./real.exe`, if compiled serially / SMP, or

  `mpirun -n N ./real.exe`, for a MPI job

  where ***N*** is the number of processors requested

Running WRF ARW Nested Cases

- Successfully running this program will create model initial and boundary files:



Running WRF ARW Nested Cases

- Run the model executable by typing:

  `./wrf.exe >& wrf.out &`

  or

  `mpirun -n N ./wrf.exe &`

- Successfully running the model will create model *history* files, one for each domain:

  `wrfout_d01_2005-08-28_00:00:00`

  `wrfout_d02_2005-08-28_00:00:00`

  And *restart* file if selected:

  `wrfrst_d01_<date>, wrfrst_d02_<date>`

Moving Nest Case (ARW only)

- The main reason for using this option is to run the model economically.
- Must add additional compile options in **`configure.wrf`** file.
- Other options are controlled by the namelists.
- Can do specified move, and automatic vortex tracking (for tropical cyclone application).
- All nest domains can move.

Specified Moving Case

- In **`configure.wrf`** file, add **`-DMOVE_NEST`** to **`ARCHFLAGS`**

- Namelists in **`&domains`**:

  `num_moves, move_id, move_interval, move_cd_x, move_cd_y`

  ➔ only one grid cell move at a time

Automatic Moving Case

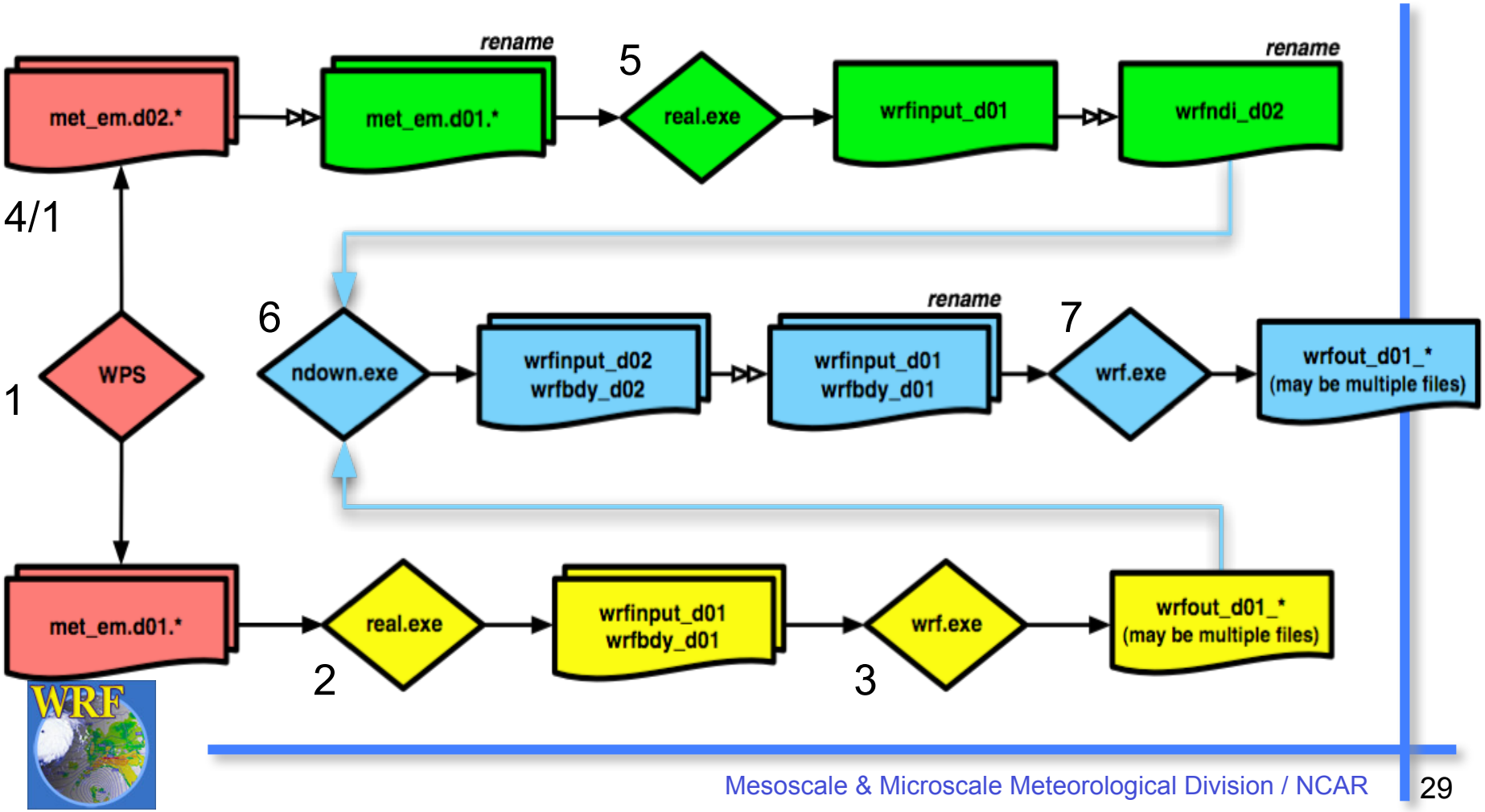
- Tropical cyclone applications only.
- Works better for well developed storms.
- In **`configure.wrf`** file, add
  `-DMOVE_NEST` and
  `-DVORTE_CENTER` to **`ARCHFLAGS`**
- Namelists in **`&domains`**:

  `vortex_interval` (default 15 min)

  `max_vortex_speed` (default 40 m/s)

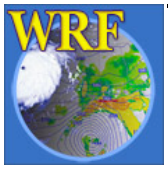
  `corral_dist` (default 8 coarse grid cells)

One-way Nesting: Two separate runs



Summary

- NMM:
  - one-way nesting in current version, two inputs. Two-way will be available in V3.
- ARW:
  - Two-way, without nest input files (**`input_from_file=.f.`**)
  - Two-way, with nest input files (**`input_from_file = .t.`**)
  - Two-way, with static nest input only (**`input_from_file=.t.`**, **`fine_input_stream = 2`**)
  - One-way, concurrent run (**`feedback = 0`**)
  - One-way, separate runs (treated like two single domain runs, with ***`ndown`***)
  - Two-way, specified moving nest run
  - Two-way, automatic vortex tracking run



References

- Information on compiling and running WRF with nests, and a more extensive list of namelist options and their definition / explanations can be found in the ARW and NMM User's Guide, Chapter 5
- Practice with online tutorial, and in the class.