# WRF
# *Runtime Options (namelists)*

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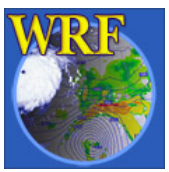
*NCAR/ESSL/MMM*



# Fortran namelist

- Fortran 90 namelist is used to configure a run without recompiling the code
- Fortran 90 namelist has very specific format, so edit with care:

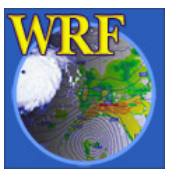
  **`&namelist-record`** - start

  **`/`** - end

- As a general rule:

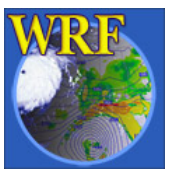
  Multiple columns: domain dependent

  Single column: value valid for all domains



# Notes on the Lecture

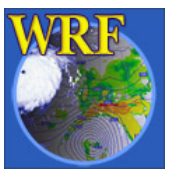
- Many options are available for both ARW and NMM
- Some options are only applicable to a particular solver,  we will try to indicate them where applicable
- When program **`real`** is mentioned, it refers to both **`real.exe`** and **`real_nmm.exe`**



# namelist.input

Eight namelist records:

- **&time_control**
- **&domains**
- **&physics**
- **&dynamics**
- **&bdy_control**
- **&namelist_quilt**
- **&fdda**
- **&grib2**



# &time_control

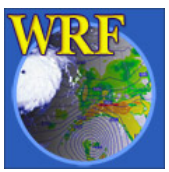
Run time control:

`run_days,run_hours, run_minutes, run_seconds` (**`wrf`**, coarse grid only)

`start_year, start_day, start_hour, start_minute, start_second, end_year, end_day, end_hour, end_minute, end_second` (**`real`** and **`wrf`**, esp. for nest)

Input data interval (and LBC file interval):

`interval_seconds` (**`real`** and **`ndown`** only)



# &time_control

Output control:

**history_interval:** output frequency in minutes

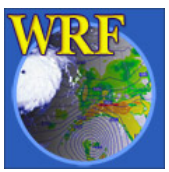
**frame_per_outfile:** output times per file

**restart:** whether this is a restart run

**restart_interval:** how often to write restart file

**io_form_history/restart/initial/boundary:**

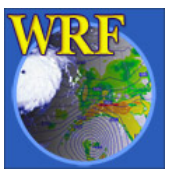
IO format (mostly set to 2 for netCDF; Other options: 1 – binary; 4 – PHDF5; 5 – GriB 1; 10 - GriB 2)



# &time_control

For a restart run in ARW, set:

```
start_year, start_day, start_hour,
  start_minute, start_second, end_year
restart = .true.
io_form_restart = 2
io_form_restart = 102
```
- write/read in patch size



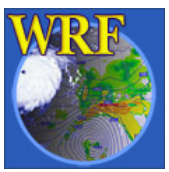
# &time_control

For a restart run in NMM, set:

```
start_year, start_day, start_hour,
  start_minute, start_second, end_year
restart = .true.
```

`tstart` = **6** - hours at restart time

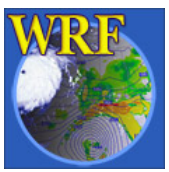
`io_form_restart` = **2**



# Sample of registry.io_boilerplate

Example 1: time control

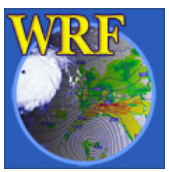
```
rconfig integer history_interval_mo namelist,time_control
   max_domains 0 h "history_interval_mo" "" "MONTHS"
rconfig integer history_interval_d namelist,time_control
   max_domains 0 h "history_interval_d" "" "DAYS"
rconfig integer history_interval_h namelist,time_control
   max_domains 0 h "history_interval_h" "" "HOURS"
rconfig integer history_interval_m namelist,time_control
   max_domains 0 h "history_interval_m" "" "MINUTES"
rconfig integer history_interval_s namelist,time_control
   max_domains 0 h "history_interval_s" "" "SECONDS"
```



# Sample of registry.io_boilerplate

Example 2: time control

```
rconfig integer history_begin_y namelist,time_control max_domains 0
   h "history_begin_y" "" "YEARS from start of run"
rconfig integer history_begin_mo namelist,time_control max_domains
   0 h "history_begin_mo" "" "MONTHS from start of run"
rconfig integer history_begin_d namelist,time_control max_domains 0
   h "history_begin_d" "" "DAYS from start of run"
rconfig integer history_begin_h namelist,time_control max_domains 0
   h "history_begin_h" "" "HOURS from start of run"
```

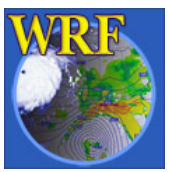


# &time_control

Nest input control: (ARW only)

**`input_from_file`**: whether one would create and use wrfinput_d0n (n>1) as input.

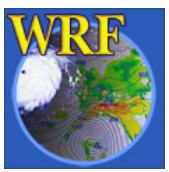
**`fine_input_stream`**: how nest domain input is used: = 0 – all input used; = 2 – only static input and masked fields are used - this option allows a nest to start at a later time.



# &time_control

Debug option:

**`debug_level`**: values from 0 – 500 give increasing amount of prints



# &time_control

If SI is used:

For ARW:

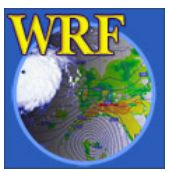
**auxinput1_inname =**

"wrf_real_input_em.d<*domain*>.<*date*>"

For NMM:

**auxinput1_inname =**

"wrf_real_input_nmm.d<*domain*>.<*date*>"



# &domains

Domain dimension control:

- **s_we:** always set to 1 (**s**: start; **we**: west-east)
- **e_we:** domain grid dimension in x direction (staggered; **e**: end)
- **s_sn:** always set to 1 (**sn**: south-north)
- **e_sn:** domain grid dimension in y direction (staggered)
- **s_vert:** always set to 1 (**vert**: vertical)
- **e_vert:** domain dimension in z (full η levels, staggered)
- **dx, dy:** grid distance in meters for ARW (dx = dy), and in degrees for NMM (dx ~ dy)
- **ztop:** only used in idealized case to set model top

# &domains

Program **`real`** only:

must specify:

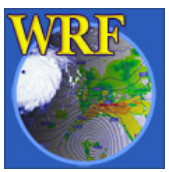
**`num_metgrid_level`**: number of incoming data levels (use ncdump -h to find out)

optional:

**`force_sfc_in_vinterp`**: number of levels to use surface data, default is 1

**`eta_levels`**: ranges from 1 to 0; if not provided, **`real.exe`** will compute the levels

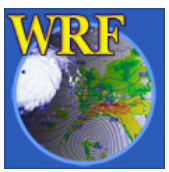
**`p_top_requested`** : pressure top, default is 50 mb



# &domains

Program **`real`** only, optional:

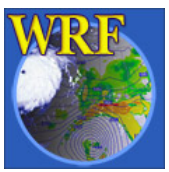
**`ptsgm`**: pressure value at which NMM vertical coordinate transitions from sigma-p to isobaric



# &domains

Program **`real`** only, optional:

- **`interp_type`**: in pressure or log pressure
- **`lagrange_order`**: linear or quadratic
- **`lowest_lev_from_sfc`**: logical, whether surface data is used to fill the lowest model level values
- **`zap_close_levels`**: delta p where a (non-surface) pressure level is removed in vertical interpolation



# &domains

Time step control:

**time_step:** integer,

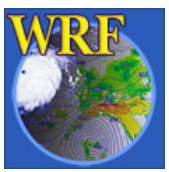
typically 6*dx (where dx is in km) for ARW, and 3*dx for NMM

**time_step_fract_num :** integer numerator value for fractional time step

**time_step_fract_den:** integer denominator for fractional time step

Example: if one would specify a time step of 15.5 sec, set

```
time_step = 15
time_step_fract_num = 1
time_step_fract_den = 2
```



# &domains

Nest control:

**max_dom:** how many domains to run

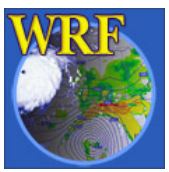
**grid_id, parent_id:** domain identifier

**i_parent_start, j_parent_start:** starting indices of a nest domain in its parent domain coordinate

**parent_grid_ratio, parent_time_step_ratio:** parent-nest grid and time-step ratios; integer only. Any interger for ARW, 3 for NMM.

**feedback = 0, 1** (ARW only)

**smooth_option = 0, 1 or 2** (ARW only)



# &domains

Moving nest control (ARW only): (*special compile options required*)

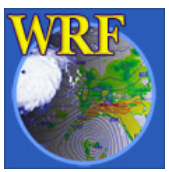
Two options available:

- specified move: only one grid cell move at a time

  **`num_moves, move_id, move_interval, move_cd_x, move_cd_y`**

- automatic move: use a vortex-following algorithm, applicable for hurricane tracking

  **`vortex_interval`** (default 15 min)
  **`max_vortex_speed`** (default 40 m/s)
  **`corral_dist`** (default 8 coarse grid cells)



# &physics

Seven major physics categories:

**mp_physics: 0,1,2,3,4,5,6,8,98,99**

**ra_lw_physics: 0,1,3,99**

**ra_sw_physics: 0,1,2,3,99**

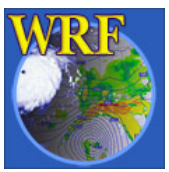
**sf_sfclay_physics: 0,1,2**

**sf_surface_physics: 0,1,2,3,99** (set before running **real** or **ideal**, need to match with **num_soil_layers** variable)

ucm_call = 0,1

**bl_pbl_physics: 0,1,2,99**

**cu_physics: 0,1,2,3,99**



# &physics

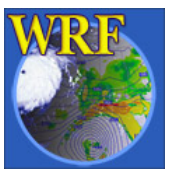
Physics call time control:

- **radt:** minutes between radiation calls (e.g. 10 min for 10 km grid, set same values for all domains)
- **bldt:** minutes between surface and PBL calls (set to 0 for ARW)
- **cudt:** minutes between cumulus scheme calls (5 min for ARW)

Negative moisture variable control:

- **mp_zero_out**: 0, 1, or 2 (set to 0 for NMM)
- **mp_zero_out_thresh**: 1E-8

* We recommend to use positive-definite advection scheme instead (see later)



# &physics

Other useful ones:

**surface_input_source:** whether to use WPS/SI landuse and soil cat data, or from GriB file (used in **real**)

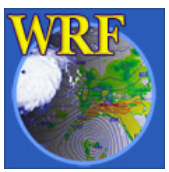
**num_soil_layers:** different values for different **sf_surface_physics** options (set before running **real** or **ideal**

Sea-ice temperature control (ARW only):

**seaice_threashold:** 271 K (default); grid changed to seaice when temperature falls below this value

$CO_2$ transmission function for GFDL radiation option:

**co2tf:** Whether to read $CO_2$ data from pre-generated file. = 0 for NMM, = 1 for ARW



# &physics

Lower boundary update control: allow SST and vegetation fraction to be updated during a model run (ARW only):

**`sst_update:`** 0 – no SST update

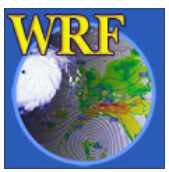
1 – update SST

Set before running **`real`**, and this will create an additional output: wrflowinp_d01

To use the file in **`wrf`**, in **`&time_control`**, add

**`auxinput5_inname`** = "wrflowinp_d01"

**`auxinput5_interval`** = 360



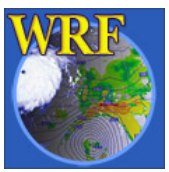
# &physics

Sensitivity tests:

- **`isfflx`**: 0, or 1 - switch off fluxes
- **`icloud`**: 0, or 1 - cloud effect on radiation

Grell-Devenyi cumulus scheme control:

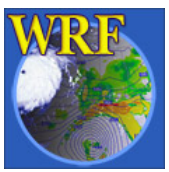
- **`maxiens, maxens, maxens2, maxens3`**:
  ensemble member dimensions for multiple closures and multiple parameter controls. Leave them as they are.



# &physics

Well tested options for NMM:

```
mp_physics: 5
ra_lw_physics: 99
ra_sw_physics: 99
sf_sfclay_physics: 2
sf_surface_physics: 99
   num_soil_layers = 4
bl_pbl_physics: 2
cu_physics: 2
```

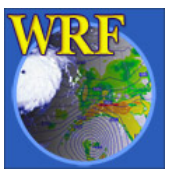


# &physics

Physics call control in NMM:

**nphs**: number of time steps between calls to PBL/turbulence and microphysics. It is usually configured to be equivalent to 3 minutes

**ncnvc**: number of time steps between cumulus scheme calls; set equal to nphs

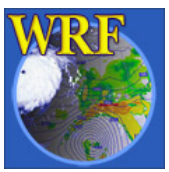


# &dynamics

dynamics options: *this is NOT a runtime option!*

**`dyn_opt = 1`**: for ARW

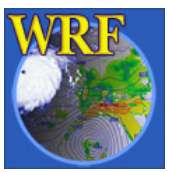
**`dyn_opt = 4`**: for NMM



# &dynamics

Diffusion/filter options (ARW only):

- **`diff_opt=1, km_opt=4:`** recommended for real data cases
- **`w_damping:`** real-time runs only, used to control excessive vertical motion
- **`damp_opt, zdamp, dampcoef:`** upper level damping controls. **`damp_opt = 1`** works for real-data cases, with **`dampcoef =`** 0.01 - 0.1

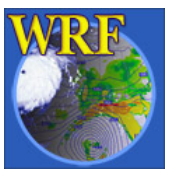


# &dynamics

Diffusion options (ARW only):

**`diff_6th_opt :`** 0, 1, or 2, 6th order numerical diffusion

**`diff_6th_factor:`** values ranges 0 - 1, with 1 corresponding to complete removal of 2 DX wave in one time step



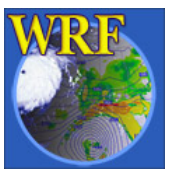
# &dynamics

Positive definite advection scheme (ARW only, recommended to use):

**pd_moist = .true.** or **.false.**

**pd_scalar = .true.** or **.false.**

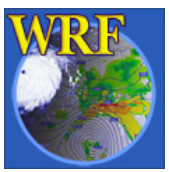
**pd_tke = .true.** or **.false.**



# &dynamics

Other filter options (ARW only):

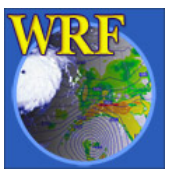
- **`smdiv`**: divergence damping control (~ 0.1)
- **`emdiv`**: external mode control (~ 0.01)
- **`epssm`**: coeff for vertically implicit off-centered acoustic step (~ 0.1)



# &dynamics

Base state parameter control: set before running **`real.exe`**: (ARW only)

- **`base_temp`**: default value is 290 K
- **`base_pres`**: default value is 100000 Pa
- **`base_lapse`**: default value is 50 K from 1000 to 400 mb

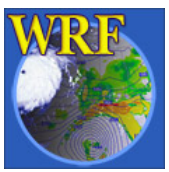


# &dynamics

Other options:

**`non_hydrostatic`**: set to false to enable hydrostatic option

**`time_step_sound`**: number of sound time steps in a model time step (ARW only, automatically computed if set to 0)



# &bdy_control

Idealized, ARW only

**Open_xs, open_xe**

**symmetric_xs, symmetric_xe**

**periodic_xs, periodic_xe**

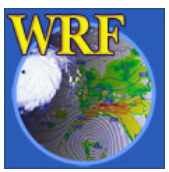
Real data application

**specified** (set before running **real**)

**spec_bdy_width**: = spec_zone + relax_zone
(= 1 for NMM)

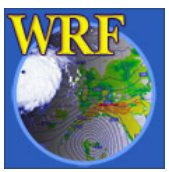
**spec_zone**: = 1 (should not change) (ARW only)

**relax_zone**: = 4 (can be varied) (ARW only)



# &grib2

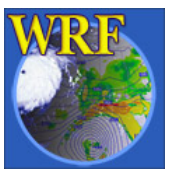
Control how GriB 2 files are written. Defaults available.



# &namelist_quilt

Parallel I/O control:

- **`nio_tasks_per_group (>0):`** allow IO to be done on separate processors. Performance improvement for large domain runs. A value of 2 to 4 works well.
- **`io_groups (>1):`** which I/O streams that the quilting applies.



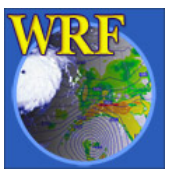
# Recommended

Start with the namelist or namelists in a particular test directory, and the values specified in them, and make modifications.

For example, for ARW, in **`test/em_real/`**, there are

**`namelist.input.jan00`** - 30 km case

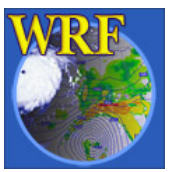
**`namelist.input.jun01`** - 10 km case



# Recommended

If you work with SI data, look for
**`test/em_real/namelist.input.si`**

If you would like to try grid nudging, look for
**`test/em_real/namelist.input.fdda_grid`**



# Recommended

If you work with NMM, look for
**`test/nmm_real/namelist.input`**