WRF:
More Runtime Options

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July 2016

More options

- Some useful runtime options:
  - Vertical interpolation options
  - IO options
  - Base state parameters
  - Options for long simulations
  - Adaptive-time step
  - Digital filter
  - Global runs
  - Moving nest
  - TC options
  - Tracer / trajectory
  - Optional output
  - Stochastic kinetic-energy backscatter scheme (SKEB)
  - IO quilting
- Time series output (surface and profile)

namelist.input

general namelist records:

- `&time_control`
- `&domains`
- `&physics`
- `&dynamics`
- `&bdy_control`
- `&namelist_quilt`

specialized namelist records:

- `&dfi_control`
- `&fdda`
- `&grib2`
- `&scm`
- `&tc`
- `&noah_mp`

Look for these in **`examples.namelist`**

Vertical interpolation options (1)

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

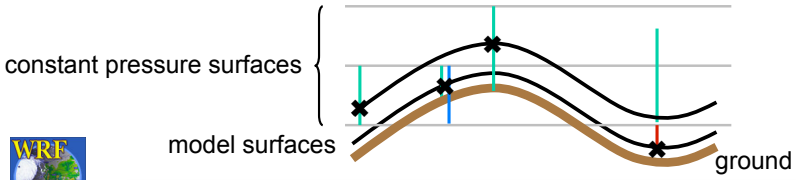
- `use_surface`: whether to use surface observations
- `use_levels_below_ground`: whether to use data below the ground
- `lowest_lev_from_sfc`: logical, whether surface data is used to fill the lowest model level values
- `force_sfc_in_vinterp`: number of levels to use surface data, default is 1
- `extrap_type`: how to do extrapolation: 1 - use 2 lowest levels; 2 - constant
- `t_extrap_type` : extrapolation option for temperature: 1 - isothermal; 2 - 6.5 K/km; 3 - adiabatic

Vertical interpolation options (2)

Program **real** for ARW only, optional:

- **interp_type:in** pressure or log pressure
- **lagrange_order:** linear or quadratic
- **zap_close_levels:** Δp where a non-surface pressure level is removed in vertical interpolation

related namelists: **examples.namelist**



IO Control (1)

History output control in **&time_control**

history_interval:	used often, unit in minutes
history_interval_h:	history output interval in hours
history_interval_s:	history output interval in seconds
history_begin_h:	history output beginning time in hours
history_begin_d:	history output beginning time in days

Look for listing in **Registry/ registry.io_boilerplate**

IO Control (2)

Optional history output in **&time_control**

1. Change Registry.EM and **recompile**:

```
state integer rainc ij misc 1 - h03 "RAINC" ""
  "ACCUMULATED TOTAL CUMULUS PRECIPITATION"
state integer rainnc ij misc 1 - h03 "RAINC" ""
  "ACCUMULATED TOTAL GRID SCALE PRECIPITATION"
```

2. Edit namelist.input to output these variables:

```
auxhist3_outname = "rainfall_d<domain>"
auxhist3_interval = 10, 10,
frames_per_auxhist3 = 1000, 1000,
io_form_auxhist3 = 2
```


IO Control (3)

Starting in V3.2, there is an alternative to add/remove additional output at **runtime** (state variables in Registry only)

1. new namelists in &time_control:

```
iofields_filename(max_dom) = 'my_output.txt',
ignore_iofields_warning = .true.
```

2. prepare a text file ('my_output.txt') to select io fields:

```
+:h:3:rainc,rainnc
```
← syntax in the file

3. set other namelists under **&time_control**:

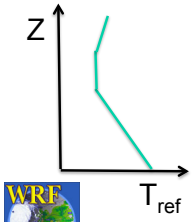
```
auxhist3_outname = "rainfall_d<domain>"
auxhist3_interval = 10, 10,
frames_per_auxhist3 = 1000, 1000,
io_form_auxhist3 = 2
```

See 'Run-Time IO' section in Chapter 5, User's Guide

Base State Parameters

The following could be varied:

`base_temp`	Base state surface temperature
`iso_temp`	Base state stratosphere temperature
`base_pres_strat`	Pressure at which the stratosphere temperature lapse rate changes (since 3.6.1)



Help to improve simulations when model top is higher than 20 km (~ 50 mb)

Options for long simulations (1)

Lower boundary update control: allow SST, seaice, monthly vegetation fraction, and albedo to be updated regularly during a model run:

`sst_update:` 0 – no update
1 – update all above fields

Set before running **`real.exe`**, and this will create additional output files: wrflowinp_d01, wrflowinp_d02, ..

Other namelists required in **`&time_control`**:

`auxinput4_inname` = "wrflowinp_d<domain>"
`auxinput4_interval` = 360, 360,
`io_form_auxinput4` = 2 (netCDF)

See 'Using sst_update Option' in Chapter 5, User's Guide

Options for long simulations (2)

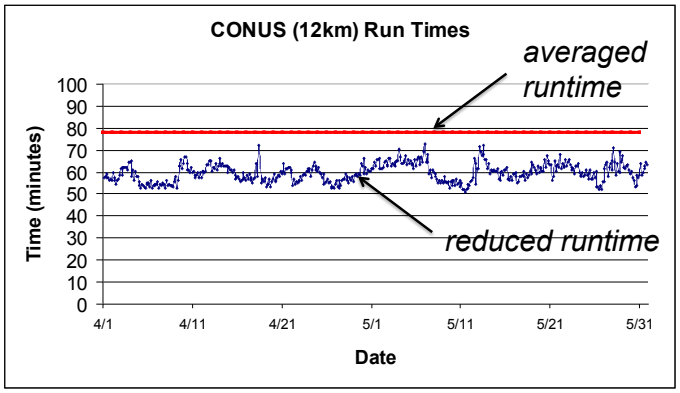
`sst_skin`	diurnal water temp update
`tmn_update`	deep soil temp update, used with lagday
`lagday`	averaging time in days
`bucket_mm`	bucket reset value for rainfall (e.g. **`rainc=i_rainc*bucket_mm+rainc`**)
`bucket_j`	bucket reset value for radiation fluxes
`spec_exp`	exponential multiplier for boundary zone ramping (set in *real*). Usually used with wider boundary zone

Adaptive time steps (1)

- Adaptive-time-step is a way to maximize the model time step while keeping the model numerically stable.
- New in V3. Good to use for real-time run.
- May not work in combination with other options.

Also see 'Using Adaptive Time Stepping' section in Chapter 5, UG

Adaptive time steps (2): an example



On average, forecasts finish in 60 min (50-73min) as compared to 79 min standard runtime

Adaptive time steps (3)

Namelist control: **`&domains`** * USE WITH CARE

`use_adaptive_time_step`	logical switch
`step_to_output_time`	whether to write at exact history output times
`target_cfl`	maximum cfl allowed (1.2)
`max_step_increase_pct`	percentage of time step increase each time; set to 5, 51, 51 (larger value for nest)
`starting_time_step`	in seconds; e.g. set to 4*DX
`max_time_step`	in seconds; e.g. set to 8*DX
`min_time_step`	in seconds; e.g. set to 4*DX

Digital filter initialization (1)

Digital filter initialization is a simple way to remove initial model imbalance:

- May be introduced by simple interpolation, different topography, or by objective analysis, or data assimilation
- It may generate spurious gravity waves in the early simulation hours, which could cause erroneous precipitation, numerical instability and degrade subsequent data assimilation
- Useful for short-range (1-6 h) forecast

Digital filter initialization (2)

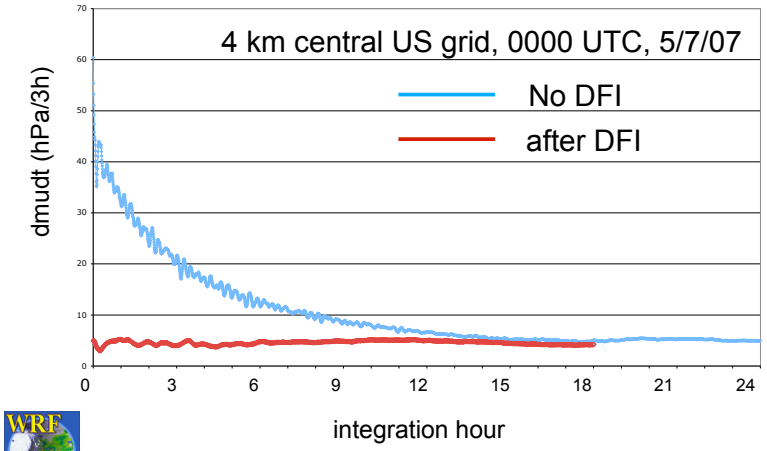
Using DFI

- can construct consistent model fields which do not exist in the initial conditions, e.g. vertical motion, cloud variables
- may reduce the spin-up problem in early simulation hours
- Useful if the first few hours of forecast is the interest

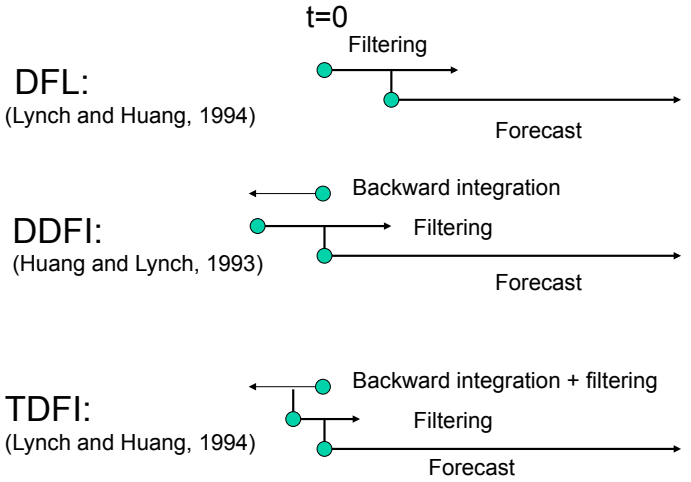
DFI is done after program **`real`**, or data-assimilation step, just before model integration

See 'Using Digital Filter Initialization', Chap 5, UG.

Digital filter initialization (3)



Digital filter initialization (4)



Digital filter inilialization (5)

Namelist control: **`&dfi`**

- `dfi_opt`: dfi options: 0: no DFI; 1: DFL; 2: DDFI; 3: TDFI (recommended)
- `dfi_nfilter`: filter options 0 - 8, recommended: 7
- `dfi_cutoff_seconds` : cutoff period
- `dfi_write_filtered_input` : whether to write filtered IC
- `dfi_bckstop_*` : stop time for backward integration
- `dfi_fwdstop_*` : stop time for forward integration

related namelists: **`examples.namelist`**

To get pressure tendency data, set `diag_print=1` or `2`

Global application

- Setup mostly done in WPS:
  - `map_proj = 'lat-lon'`
  - `e_we, e_sn:` **`geogrid`** will compute dx, dy
  - See template `'namelist.wps.global'`
- Requires only one-time period data
- In the model stage:
  - `fft_filter_lat`: default value is 45 degrees
  - Caution: some options do not work, or have not been tested with global domain. Start with template `'namelist.input.global'`

See 'Global Run' section, Chap 5, UG

Automatic moving nest options

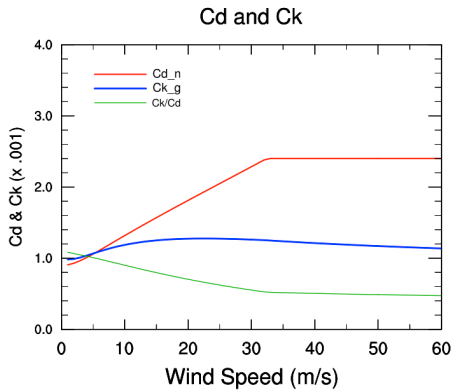
Tropical cyclone / typhoon / hurricane applications:

- **vortex_interval:** time interval when vortex location is estimated
- **max_vortex_speed:** used to compute the search radius for vortex location
- **corral_dist:** how far the vortex can move near the parent domain boundary (number of grids)
- **track_level:** e.g. 700 or 500 mb
- **time_to_move:** hold nests still until this time

See 'Moving Nested Run', Chap 5, UG

TC options (1)

isftcflx: alternative C_d (Donelan) and C_k (=2, Garratt) formulation for TC application



TC options (2)

sf_ocean_physics=1: simple ocean mixed layer

oml_hml0: initial ocean mixed layer depth

oml_gamma: lapse rate in deep water

The ocean mixed layer model can also be initialized with real-data, e.g. HYCOM. More info can be found at

http://www2.mmm.ucar.edu/wrf/users/hurricanes/wrf_ahw.html

TC options (3)

sf_ocean_physics = 2:

3D Price-Weller-Pinkel (PWP) ocean model based on Price et al. (1994). It has full ocean process (e.g. advection, pressure-gradient force, and mixing). It doesn't have ocean bathymetry (or ocean depth). Only simple initialization is provided in Version 3.5.

tracer option

Add the following in **&dynamics** to activate tracer option (default no. is 8: with array names **tr17_1, tr17_2, …, tr17_8**):

tracer_opt = 2,

One would need some way to initialize the tracer. A simple initialization can be found in program real (**dyn_em/module_initialize_real.F**)

trajectory option

Add the following in **&physics** to activate trajectory option:

traj_opt = 1,

And set the number of trajectories in **&domains**:

num_traj = 25, (default value)

Output: **traj_i(num_traj), traj_j, traj_k, traj_lat, traj_long**

To change initial launch points, edit code in initialization program **real.exe** (**dyn_em/module_initialize_real.F**)

Stochastic kinetic-energy backscatter scheme

This is a way to stochastically perturb forecasts.

stoch_force_opt: = 1, activate the scheme

nens: = N, an integer that controls the random number stream; a different integer will give a differently perturbed forecast

perturb_bdy: = 1, use SKEB pattern; = 2, use user-provided pattern (new in 3.5)

Also see 'Option to stochastically perturb forecasts' section in Chap 5, UG

Also see http://www.cgd.ucar.edu/~berner/skebs.html

Additional Output Option (1)

prec_acc_dt = 60.:

Output precipitation in a time interval (e.g. 60 min):

PREC_ACC_C, for convective rain

PREC_ACC_NC, for explicit rain

SNOW_ACC_NC, for explicit snow

(May not suitable for use in long runs)

Additional Output Option (2)

Since V3.4.1:

```
&diags
 p_lev_diag = 1.
 num_press_levels = 4,
 press_levels = 85000,70000,50000,20000
```

Output a few met fields on pressure levels :

U_PL, V_PL, S_PL, T_PL, TD_PL, RH_PL, GHT_PL,

Output goes to auxiliary stream 23, so need to set

`auxhist23_outname, io_form_auxhist23,`
`auxhist23_interval, frames_per_auxhist23`

Additional Output Option (3)

`output_diagnostics = 1:`

output max, min, time of max and min, mean value, standard deviation of the mean for 8 surface variables (T2, Q2, TSK, U10, V10, 10 m wind speed, RAINCV, and RAINNCV [time step rain])

`auxhist3_outname =“wrfxtrm_d<domain>_<date>”`
`io_form_auxhist3 = 2`
`auxhist3_interval = 1440, 1440,`
`frame_per_auxhist3 = 10, 10,`

Additional Output Option (4)

`nwp_diagnostics = 1:`

Output max 10 m wind speed, max helicity in 2 – 5 km layer, max w in updraft and downdraft below 400 mb, mean w in 2 – 5 km layer, and max column graupel in a time window between history output times.

Data goes to history file.

Additional Output Option (5)

`do_radar_ref = 1:`

Compute radar reflectivity using parameters used by different microphysics. Works for options mp_physics = 2,4,6,7,8,10,14,16. Option 9, NSSL mp also produce radar reflectivity output.

Data goes to history file.

Additional Output Option (6)

`do_avgflx_em = 1:`

output history-time-averaged, column-pressure-coupled u, v and w:
AVGFLX_RUM, AVGFLX_RVM, AVGFLX_RWM
– useful for driving downstream transport model

Additional Output Option (7) *(extra)*

`afwa_*_opt = 1:` (with sub-options)

output over 60 diagnostic variables to history file (for example, MSLP, precipitable water, cloud cover, etc.)

See Registry/registry.afwa for full listing.

Data goes to history as well as auxhist2 file.

IO quilting: &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):` number of I/O streams that the quilting applies.

See 'Using IO Quilting' section, Chap 5, UG

Other ways to improve IO: 1) p-netCDF; 2) use netCDF4 compression option; 3) use io_form_history=102 to output patches of data

Time Series Output (1)

- It is a special output in text format with file name like
  `prefix.d<domain>.TS`
- It outputs 14 surface variables at every time step:
  e.g. 10 m u/v, 2 m T/qv, precipitation, radiation fluxes, surface fluxes
- One file per location (e.g. at weather station), per domain

Time Series Output (2)

- It also outputs profiles of U, V, Th, Qv, PH (levels set by **max_ts_level**, default 15):

  ***prefix*.d<domain>.UU**

  ***prefix*.d<domain>.VV**

  ***prefix*.d<domain>.TH**

  ***prefix*.d<domain>.QV**

  ***prefix*.d<domain>.PH**

- One file per location (e.g. at weather station), per domain.

Time Series Output (3)

- Not a namelist option
- If output more than 5 locations, use namelist **max_ts_locs**
- Depends the presence of a file called '**tslist**' (a sample of the file is available in **WRFV3/run/**

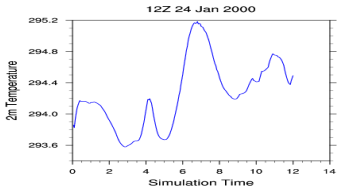
```
#-----------------------------------------------#
# 24 characters for name | pfx |  LAT  |   LON  |
#-----------------------------------------------#
Cape Hallett             hallt -72.330  170.250
McMurdo Station          mcm   -77.851  166.713
```

- This file provides a list of locations where you would like to output time series
- More information in **run/README.tslist** and 'Output Time Series' section, Chapter 5, UG

Time Series Output (4)

Content in `hallt.d01.TS`:

```
Cape Hallett                1  1 hallt ( 36.710, -79.000) (  41,  38)
   ( 36.600, -79.142)  159.6 meters
 1     0.050000     1   41    38     275.47397       0.00288
   3.52110      -2.34275   99988.76563     244.81276
 0.00000     -29.94841       4.09765     273.90295     278.20197
   0.00000       0.00000       0.00000
 1     0.100000     1   41    38     275.56287       0.00282
   3.14414      -2.05875   99956.98438     244.81276
 0.00000     -25.64095       4.18446     273.78323     278.18314
   0.00000       0.00000       0.00000
```



Recommended

Start with the namelist template in a particular test directory, and the options specified in the file, and make modifications.

Chapter 5 of ARW User's Guide, pages 5-33 – 5-35: examples for various applications.

For special applications in ARW, look for related namelists in the file *examples.namelist* in *test/em_real/* directory.

For more information on global extension, DFI and adaptive time step, read Tech Note, and User's Guide.