WRF:
More Runtime Options

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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

More options

- Have covered basic, physics / diffusion options, and nudging options..
- More are introduced here:
  - IO options
  - Vertical interpolation options
  - SST update and other options for long simulations
  - Adaptive-time step
  - Digital filter
  - Global runs
  - Moving nest
  - TC options
  - IO quilting
- Time series output

namelist.input

general namelist records:

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

specialized namelist records:

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

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

Complete 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
frames_per_auxhist3 = 1000
```

Vertical interpolation options (1)

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

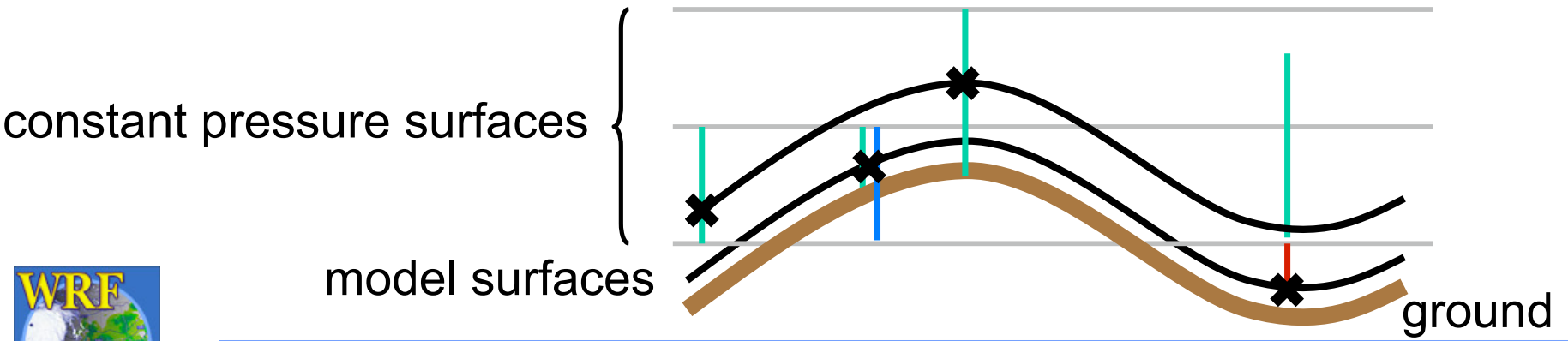
- **`use_surface`**: whether to use surface observations
- **`use_levels_below_ground`**: whether to use data below the ground
- **`lowest_lev_from_sfc`**: logical, whether surface data is used to fill the lowest model level values
- **`force_sfc_in_vinterp`**: number of levels to use surface data, default 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`**: delta p where a non-surface pressure level is removed in vertical interpolation

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



SST update for long simulations (1)

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

`sst_update:` 0 – no SST update

1 – update SST

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

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

`auxinput4_inname` = "wrflowinp_d<domain>"

`auxinput4_interval` = 360

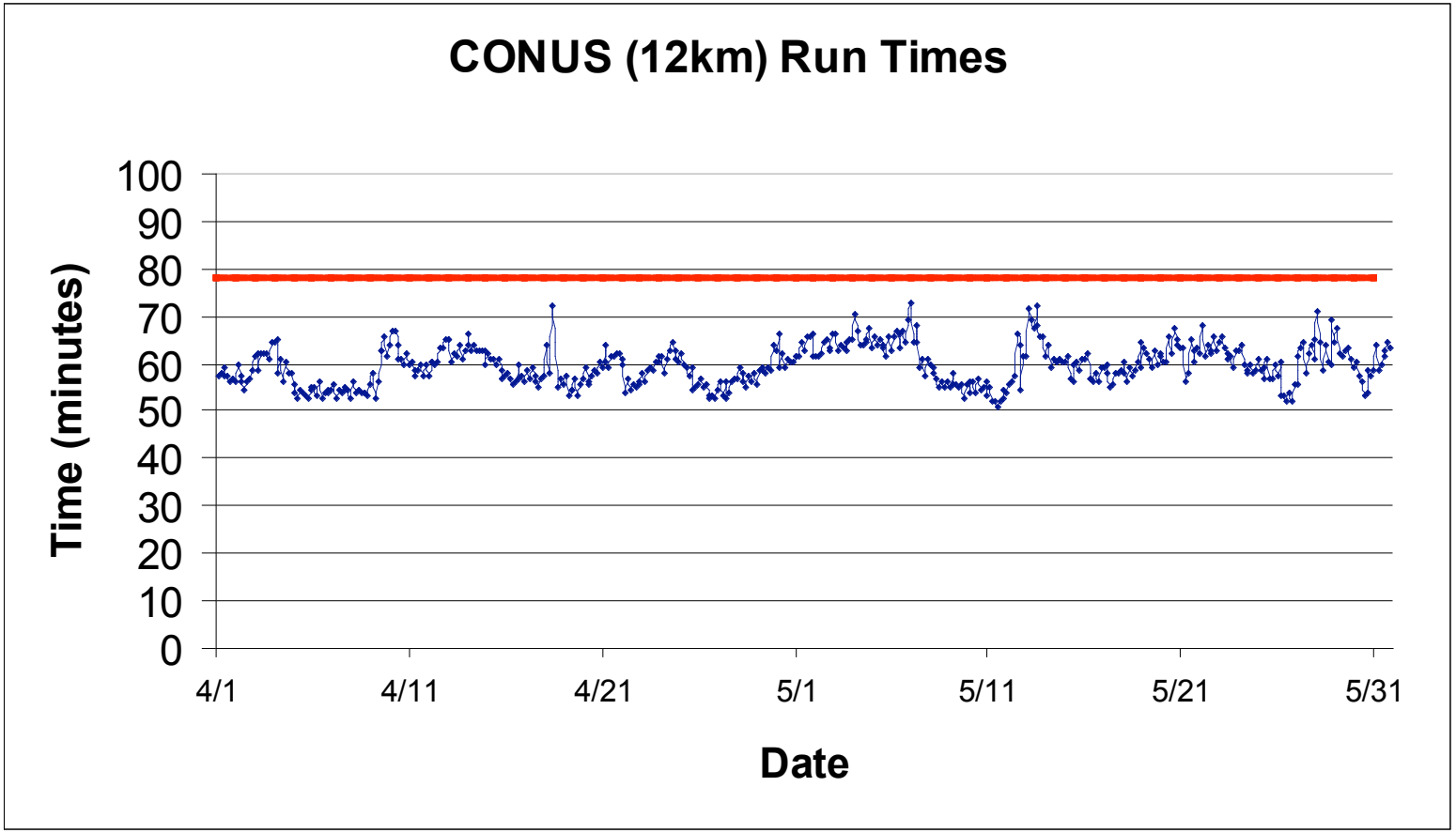
SST update for long simulations (2)

`sst_skin`	diurnal water temp update
`tmn_update`	deep soil temp update, used with lagday
`lagday`	averaging time
`bucket_mm`	bucket reset value for rainfall
`bucket_j`	bucket reset value for radiation fluxes
`spec_exp`	exponential multiplier for boundary zone ramping

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

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

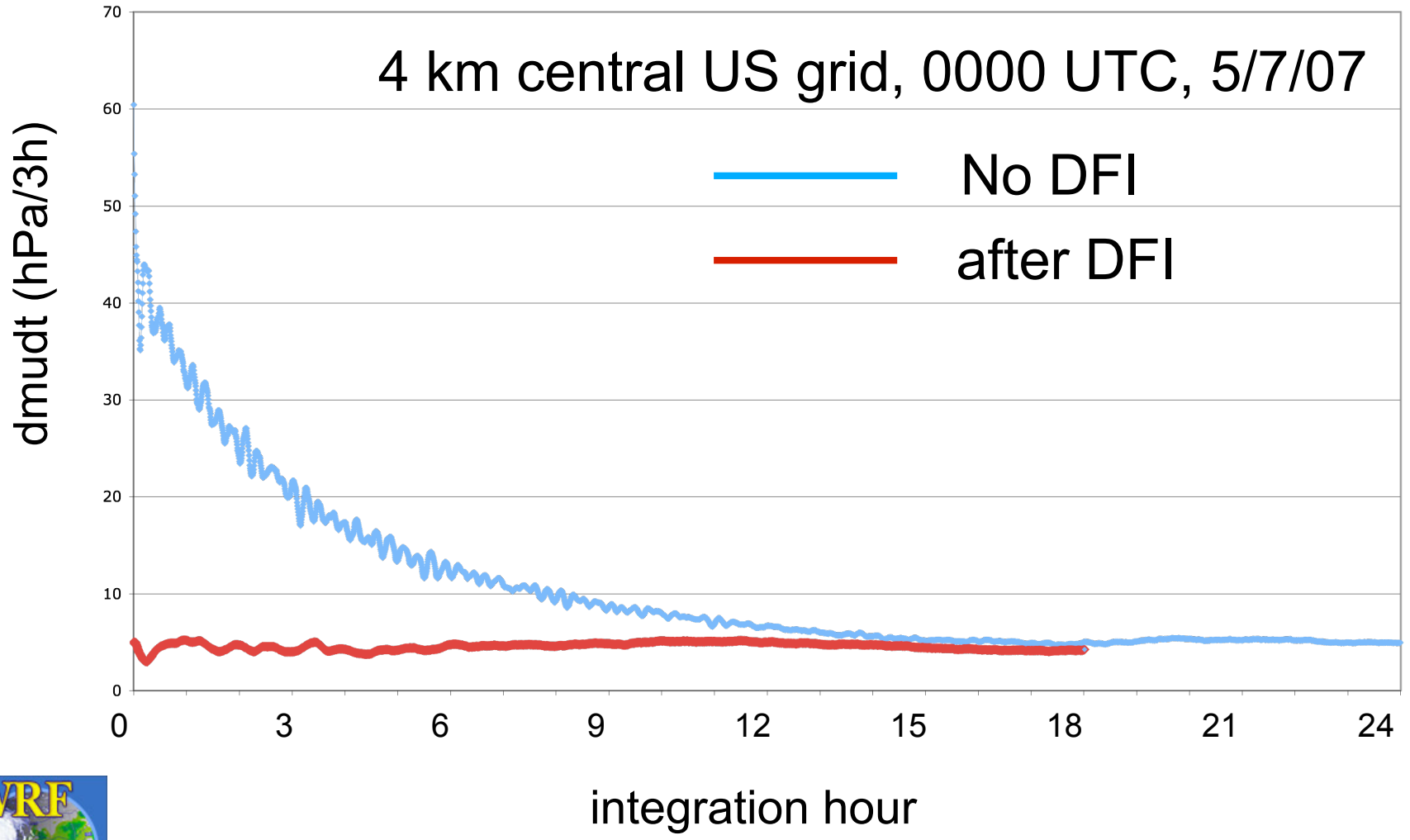
Digital filter initialization (2)

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

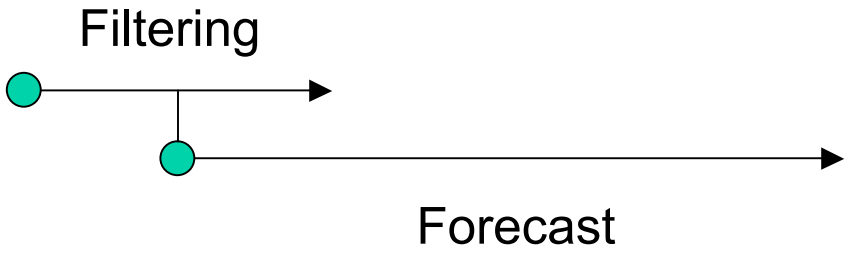
DFI is done after program **`real`**, or data-assimilation step, just before model integration

Digital filter initialization (3)

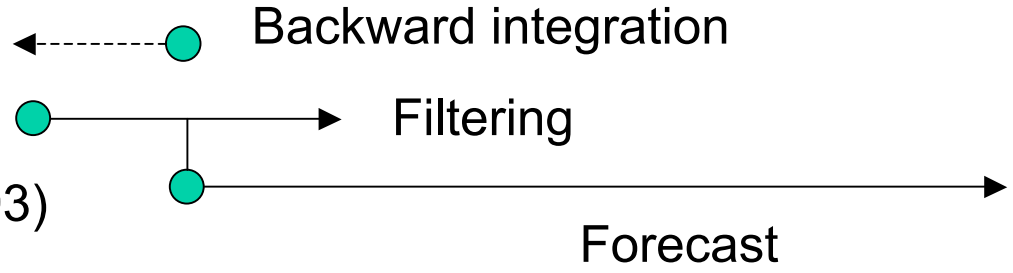


Digital filter initialization (4)

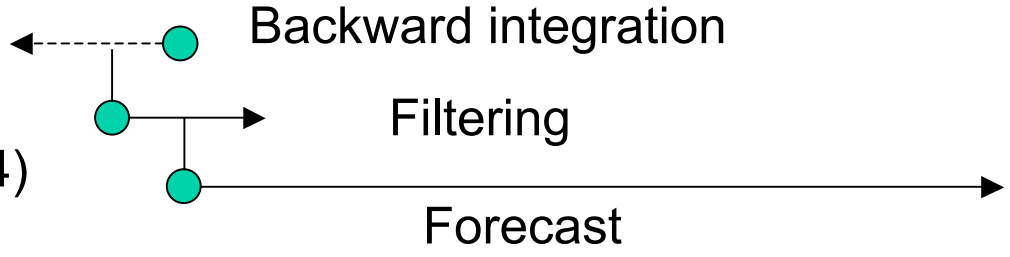
DFL:
(Lynch and Huang, 1994)



DDFI:
(Huang and Lynch, 1993)



TDFI:
(Lynch and Huang, 1994)



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`**

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'`

In the model stage:

`fft_filter_lat:` default value is 45 degrees

Caution: some options do not work, or have been tested with global domain. Start with template `'namelist.input.global'`

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

TC options

`isftcflx:` alternative C_d and C_k formulation for TC application

`omlcall:` simple ocean mixed layer

`oml_hml0:` initial ocean mixed layer depth

`oml_gamma:` lapse rate in deep water

Currently the ocean mixed layer model can only be used with slab model or **`sf_surface_physics = 1`**

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.

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, surface fluxes

- One file per location/weather station

Time Series Output (2)

- Not a namelist option
- 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 User's Guide, Chapter 5

Recommended

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

For special applications, 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 ARW Tech Note, and User's Guide.