WRF:
More Runtime Options

Wei Wang

NCAR/NESL/MMM

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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:

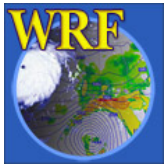
  `&namelist-record` - start

  `/` - end

- As a general rule:

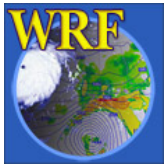
  Multiple columns: domain dependent

  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
  - options for long simulations
  - Adaptive-time step
  - Digital filter
  - Global runs
  - Moving nest
  - TC options
  - tracer
  - Stochastic kinetic-energy backscatter scheme (SKEB)
  - IO quilting
- Time series output



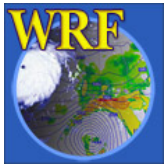
namelist.input

general namelist records:

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

specialized namelist records:

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

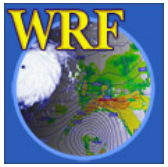


IO Control (1)

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)

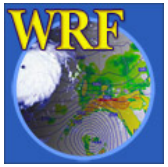
Optional history output in **`&time_control`**

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
io_form_auxhist3 = 2
```



IO Control (3)

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

1. new namelists in &time_control:

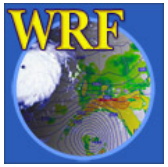
```
iofields_filename(max_dom) = 'my_output.txt',
ignore_iofields_warning
```

2. prepare text file ('`my_output.txt`') to define new io fields:

```
+:h:3:rainc,rainnc
```

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

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

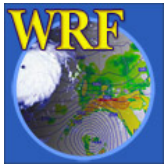


See 'Run-Time IO' section in Chapter 5, User's Guide

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

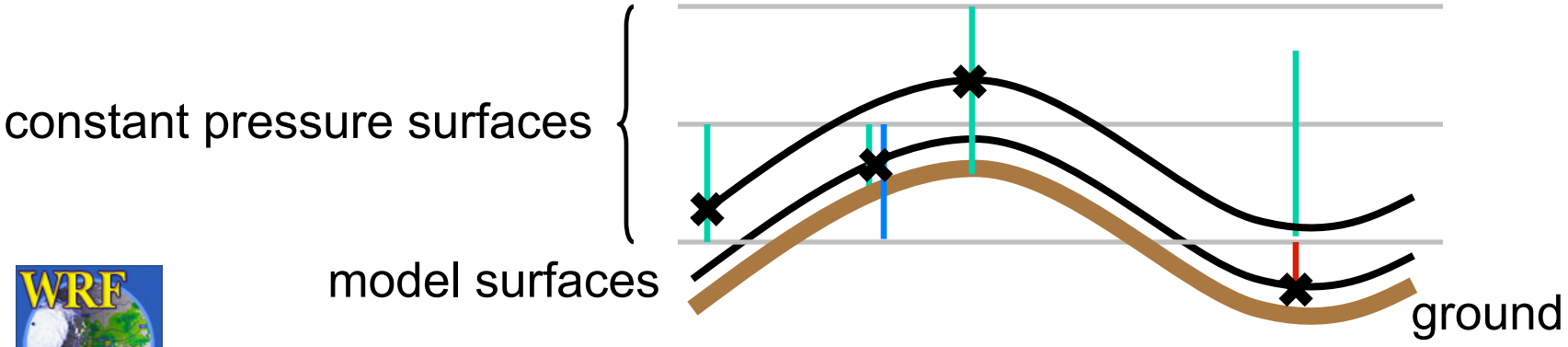


Vertical interpolation options (2)

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`**



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 SST update

1 – update SST

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

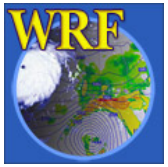
Other namelists required in **`&time_control`**:

`auxinput4_inname` = "wrflowinp_d<domain>"

`auxinput4_interval` = 360

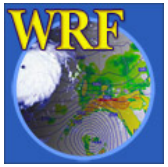
`io_form_auxinput4` = 2 (netCDF)

See 'Using sst_update Option' in Chapter 5, UG



Options for long simulations (2)

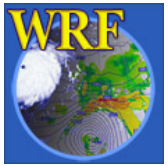
`sst_skin`	diurnal water temp update
`tmn_update`	deep soil temp update, used with lagday
`lagday`	averaging time
`bucket_mm`	bucket reset value for rainfall
`bucket_j`	bucket reset value for radiation fluxes
`spec_exp`	exponential multiplier for boundary zone ramping



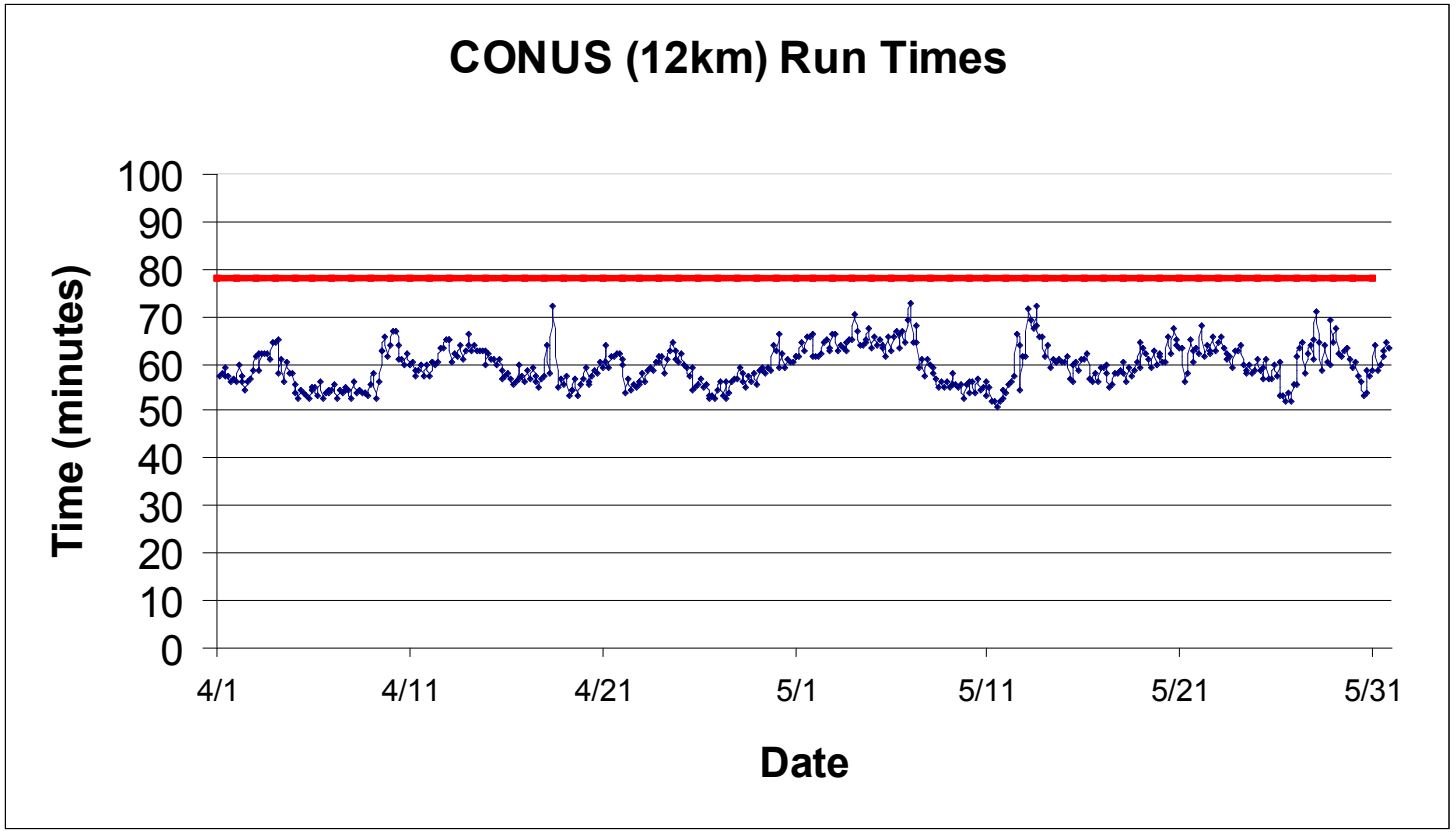
Adaptive time steps (1)

- 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
- 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

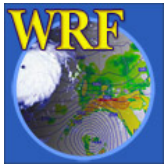


On average, forecasts finish in 60 min (50-73min) as compared to 79 min standard runtime

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

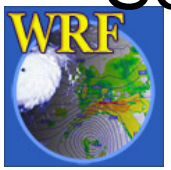
Digital filter initialization (2)

Using DFI

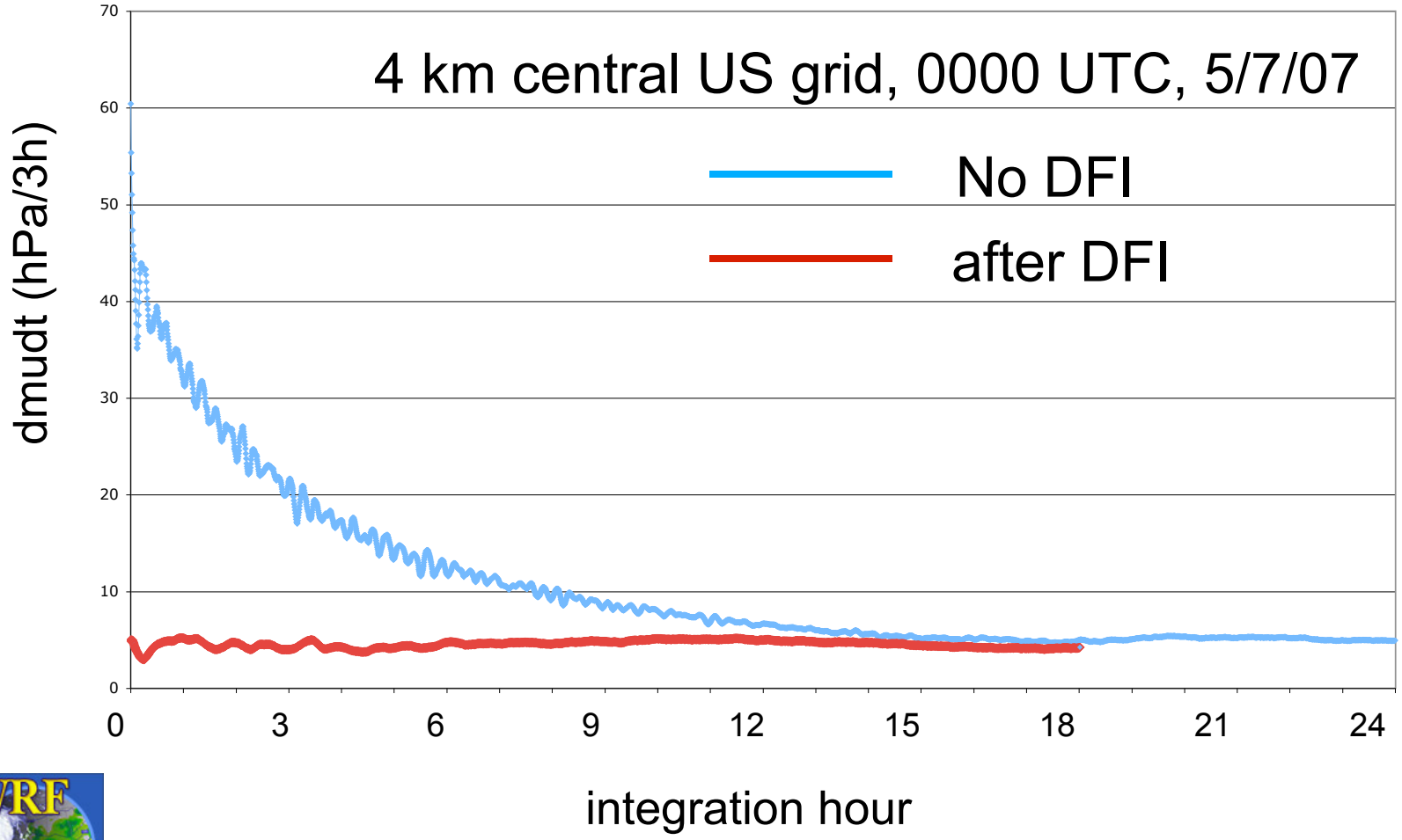
- can construct consistent model fields which do not exist in the initial conditions, e.g. vertical motion, cloud variables
- may reduce the spin-up problem in early simulation hours

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

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

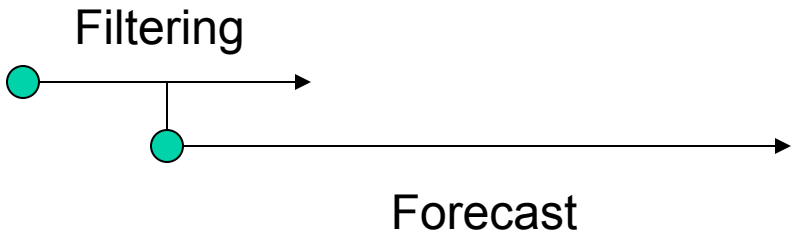


Digital filter initialization (3)

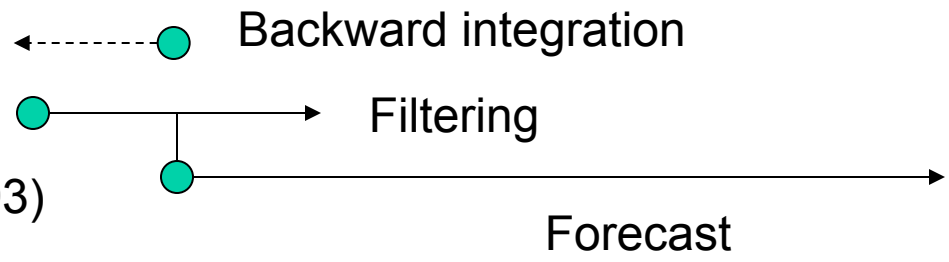


Digital filter initialization (4)

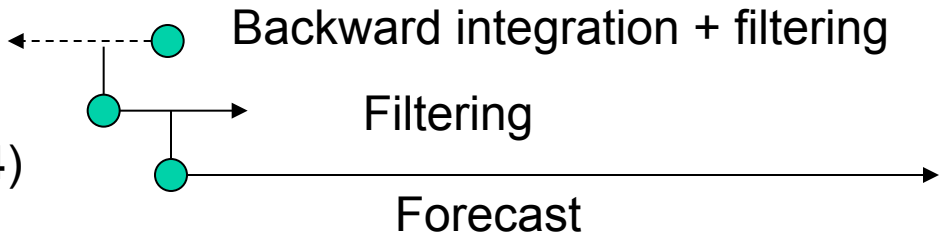
DFL:
(Lynch and Huang, 1994)



DDFI:
(Huang and Lynch, 1993)



TDFI:
(Lynch and Huang, 1994)

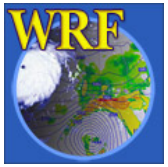


Digital filter inilialization (5)

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'`

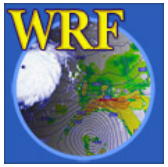
`e_we, e_sn:` **`geogrid`** will compute dx, dy

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'`

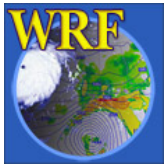


See 'Global Run' section, Chap 5, UG

Automatic moving nest options

Tropical cyclone / typhoon / hurricane applications:

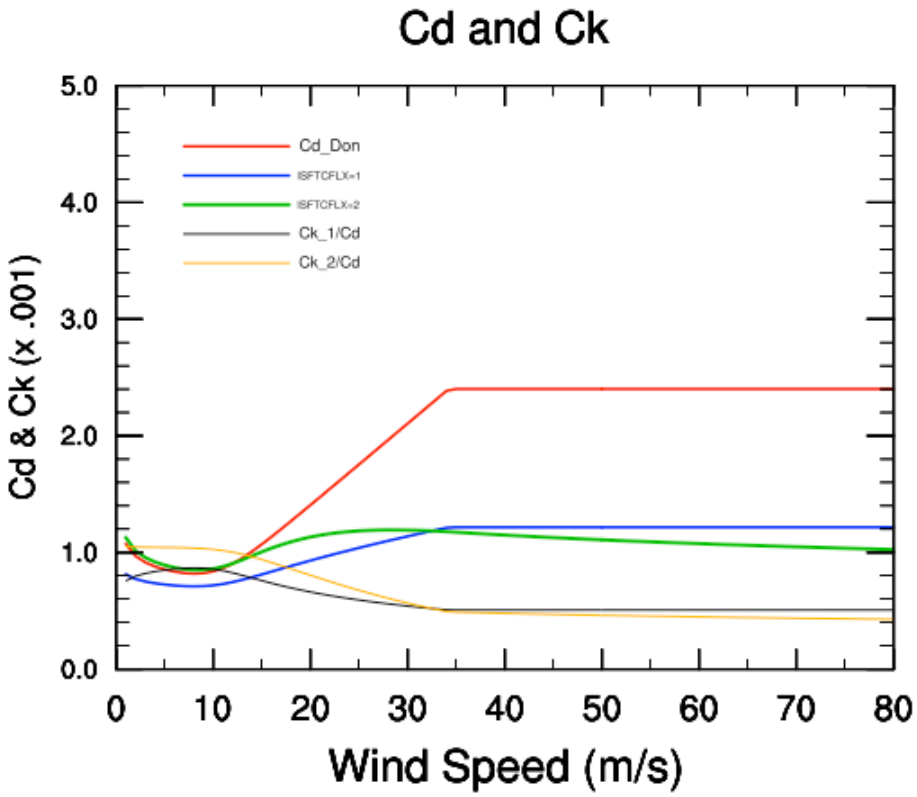
- **`vortex_interval:`** time interval when vortex location is estimated
- **`max_vortex_speed:`** used to compute the search radius for vortex location
- **`corral_dist:`** how far the vortex can move near the parent domain boundary (number of grids)
- **`track_level:`** e.g. 700 or 500 mb
- **`time_to_move:`**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



See 'Moving Nested Run', Chap 5, UG

TC options (1)

`isftcflx:` alternative C_d (Donelan) and C_k (=1, const z0q; =2, Garratt) formulation for TC application



TC options (2)

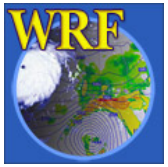
`omlcall:` simple ocean mixed layer

`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

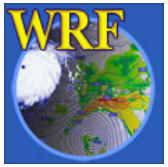
http://www.mmm.ucar.edu/wrf/users/hurricanes/wrf_ahw.html



tracer options

`tracer_opt:` = 2, activate tracers (default no. is 8)

One would need some way to initialize the tracer



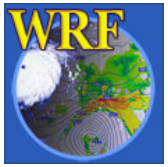
Stochastic kinetic-energy backscatter scheme

This is a way to stochastically perturb forecasts.

`stoch_force_opt:` = 1, activate the scheme

`nens:` = 1, an integer that controls the random number stream; a different integer will give a differently perturbed forecast

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



IO quilting: &namelist_quilt

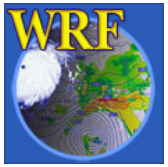
Parallel I/O control:

`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

Note that using p-netCDF is another way to improve IO



Time Series Output (1)

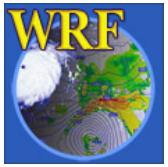
- It is a special output in text format with file name like

  ***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 (e.g. at weather station)

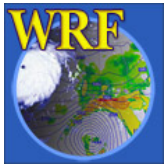


Time Series Output (2)

- 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
```

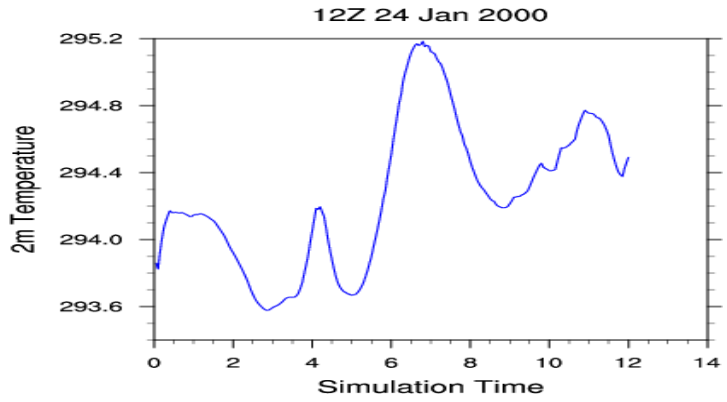
- This file provides a list of locations where you would like to output time series
- More information in **`run/README.tslist`** and 'Output Time Series' section, Chapter 5, UG



Time Series Output (3)

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
```



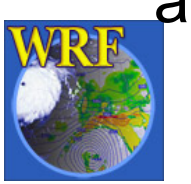
Recommended

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

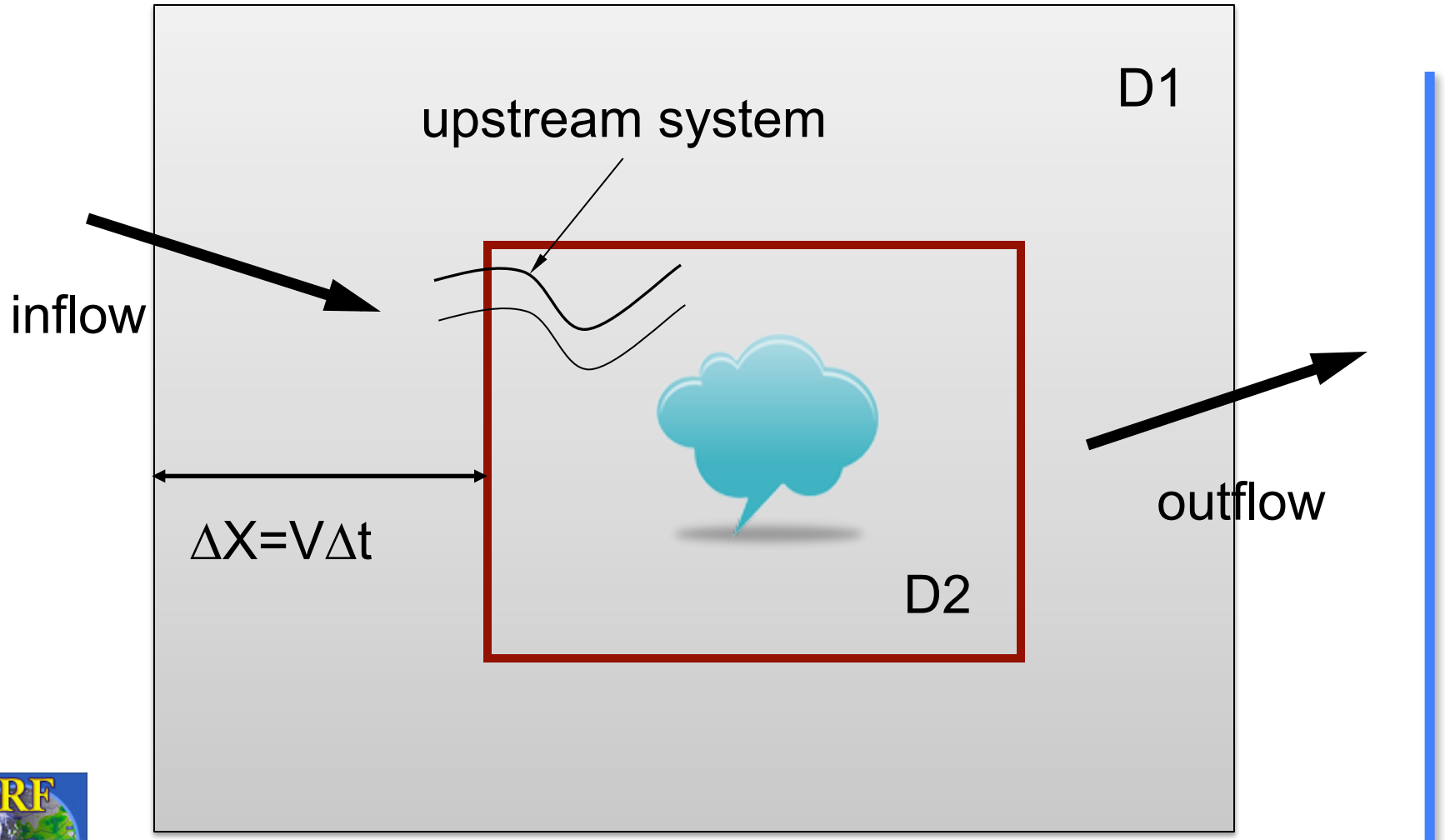
For special applications in ARW, look for related namelists in the file *examples.namelist* in *test/em_real/* directory.

Chapter 5 of ARW User's Guide, pages 5-23 – 5-25: examples for various applications.

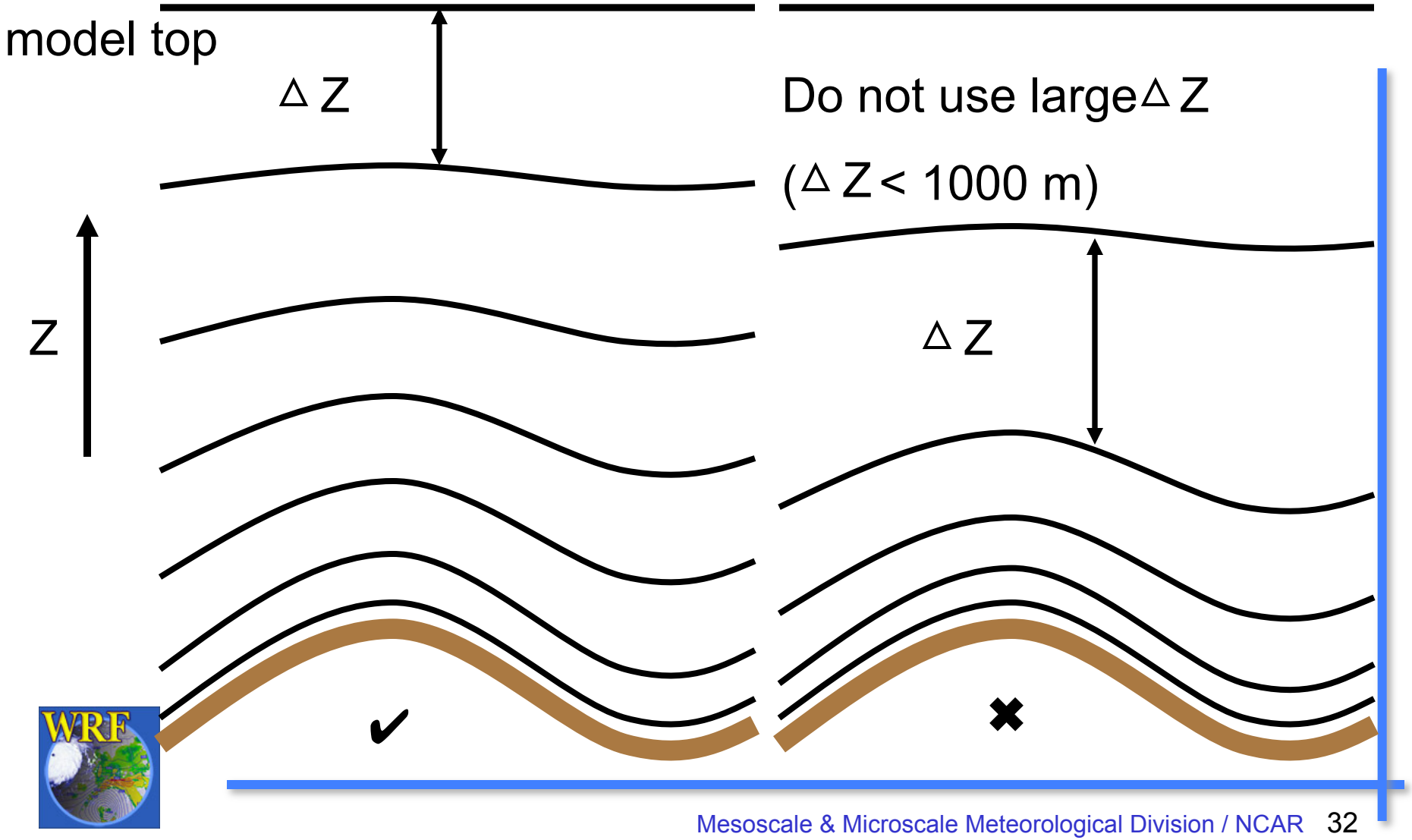
For more information on global extension, DFI and adaptive time step, read Tech Note, and User's Guide.



Note on Configuring Domains: Horizontal



Note on Configuring Domains: Vertical



Reference Book:

Numerical Weather and Climate Prediction, 2011. By Thomas Warner, Cambridge University Press.