Real Data Initialization

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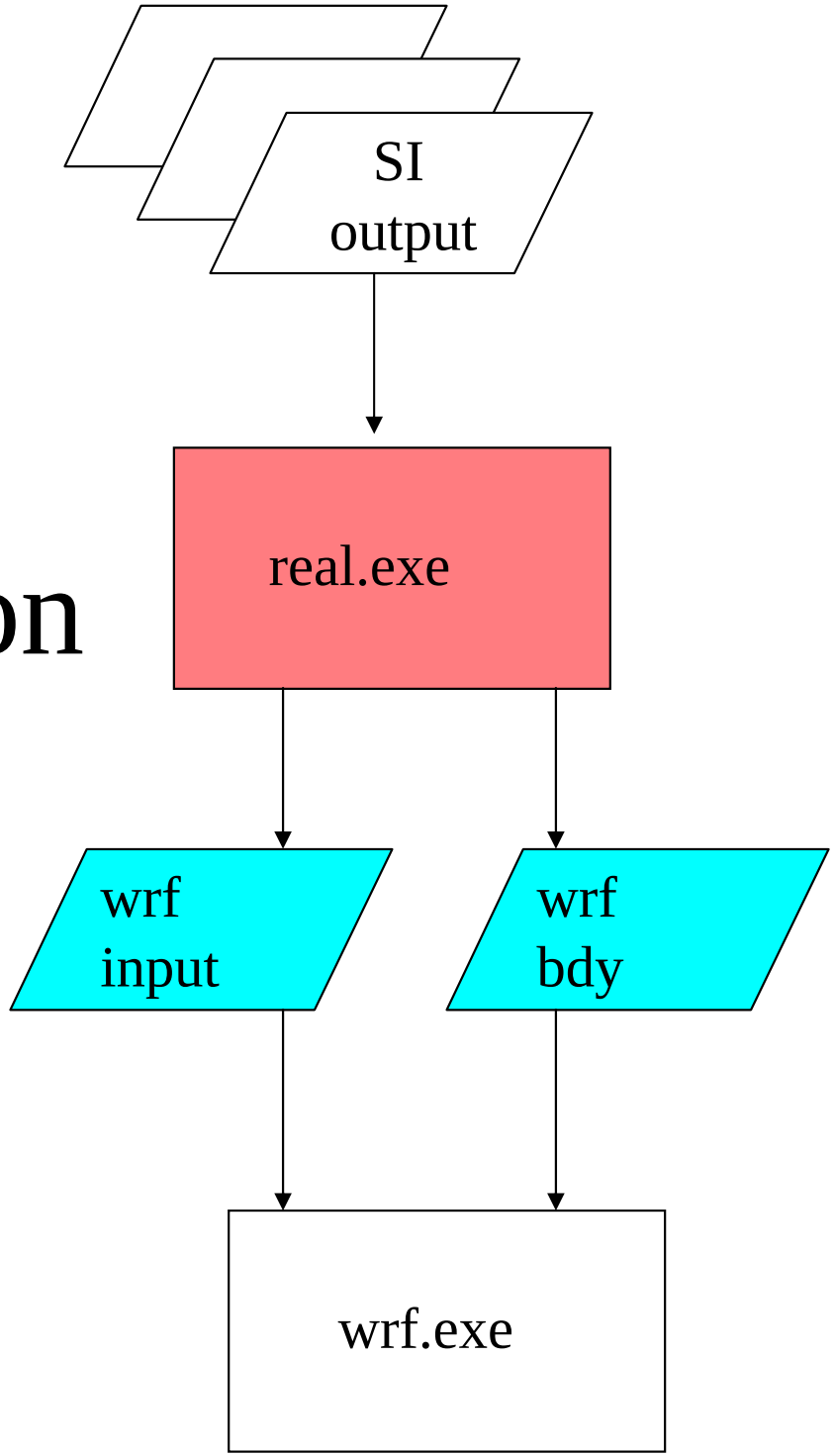


Real-Data Init - ARW

- Necessary steps to build IC/BC
- Files before and after
- Balancing and Initialization
- Program Flow
- Test Case

Necessary Steps to Build IC/BC

- Build real.exe and wrf.exe (ndown.exe is for free)
- Fix namelist with run-time options
- Link/copy SI output into correct run directory
- Run real.exe (can be serial or DM parallel for large memory cases)

Build real.exe and wrf.exe

- Get zip'ed tar file (Unix only) from WRF download (**http://wrf-model.org**) page, select USERS on main page
- Unzip and untar file
- **cd WRFV2**
- **./configure** (option 1 is usually for serial builds, watch options for nesting!)
- **./compile em_real**

Fix namelist with run-time options **`time_control`**

```
run_days                            = 0,
run_hours                           = 12,
run_minutes                         = 0,
run_seconds                         = 0,
```

Controls coarse grid if present (non-zero), else the end_* variables are used

WRF only

Fix namelist with run-time options

time_control

```
start_year                          = 2000, 2000, 2000,
start_month                         = 01,   01,   01,
start_day                           = 24,   24,   24,
start_hour                          = 12,   12,   12,
end_year                            = 2000, 2000, 2000,
end_month                           = 01,   01,   01,
end_day                             = 25,   25,   25,
end_hour                            = 12,   12,   12,
```

Controls start time for all domains, and end of all domains except coarse (only if run_* is zero does end_* affect CG)

real.exe uses first column only, multidomain runs imply multiple real.exe runs

Fix namelist with run-time options
time_control

```
interval_seconds      = 21600
input_from_file       = .t.  ,.f.  ,.f.,
history_interval      = 180,  60,   60,
frames_per_outfile    = 1000, 1000, 1000,
```

Default unit for history interval is minutes

Frames => how many time periods inside each file

Real.exe only uses interval_seconds to find SI files, and as lateral BC interval

Fix namelist with run-time options **`domains`**

```
time_step                = 180,
time_step_fract_num      = 0,
time_step_fract_den      = 1,
max_dom                  = 1,
```

Default unit for time step seconds (CG only)

Max_dom is total number of domains to be run during forecast

WRF only

Fix namelist with run-time options

domains

```
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,
```

“s_” start, always 1, “e_” end, max extent of u,v,w

“we” west-east, left-right, “sn” south-north

“vert” vertical dimension

real.exe uses first column only

Fix namelist with run-time options **`domains`**

```
dx                  = 30000, 10000,  3333,
dy                  = 30000, 10000,  3333,
```

dx, dy must be equal

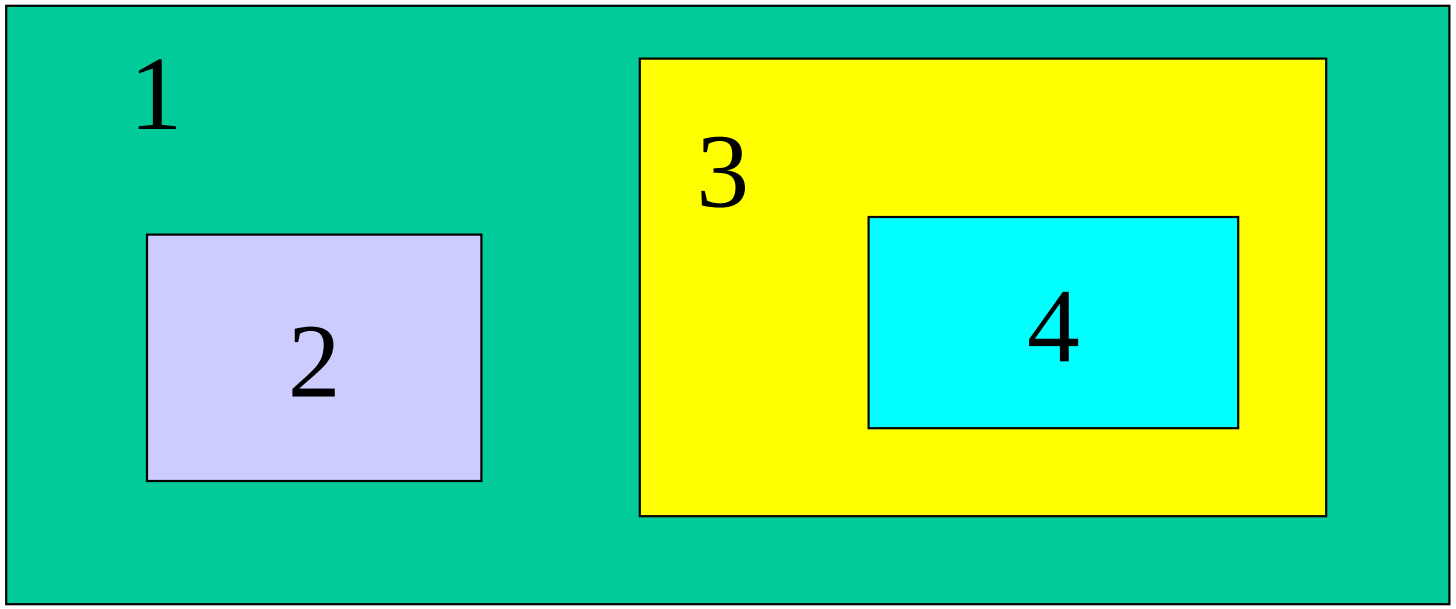
Unit is meters

real.exe uses first column only

Fix namelist with run-time options

domains

```
grid_id                 = 1,    2,    3,
parent_id               = 0,    1,    2,
```



real.exe uses first column only of grid_id

Fix namelist with run-time options **`domains`**

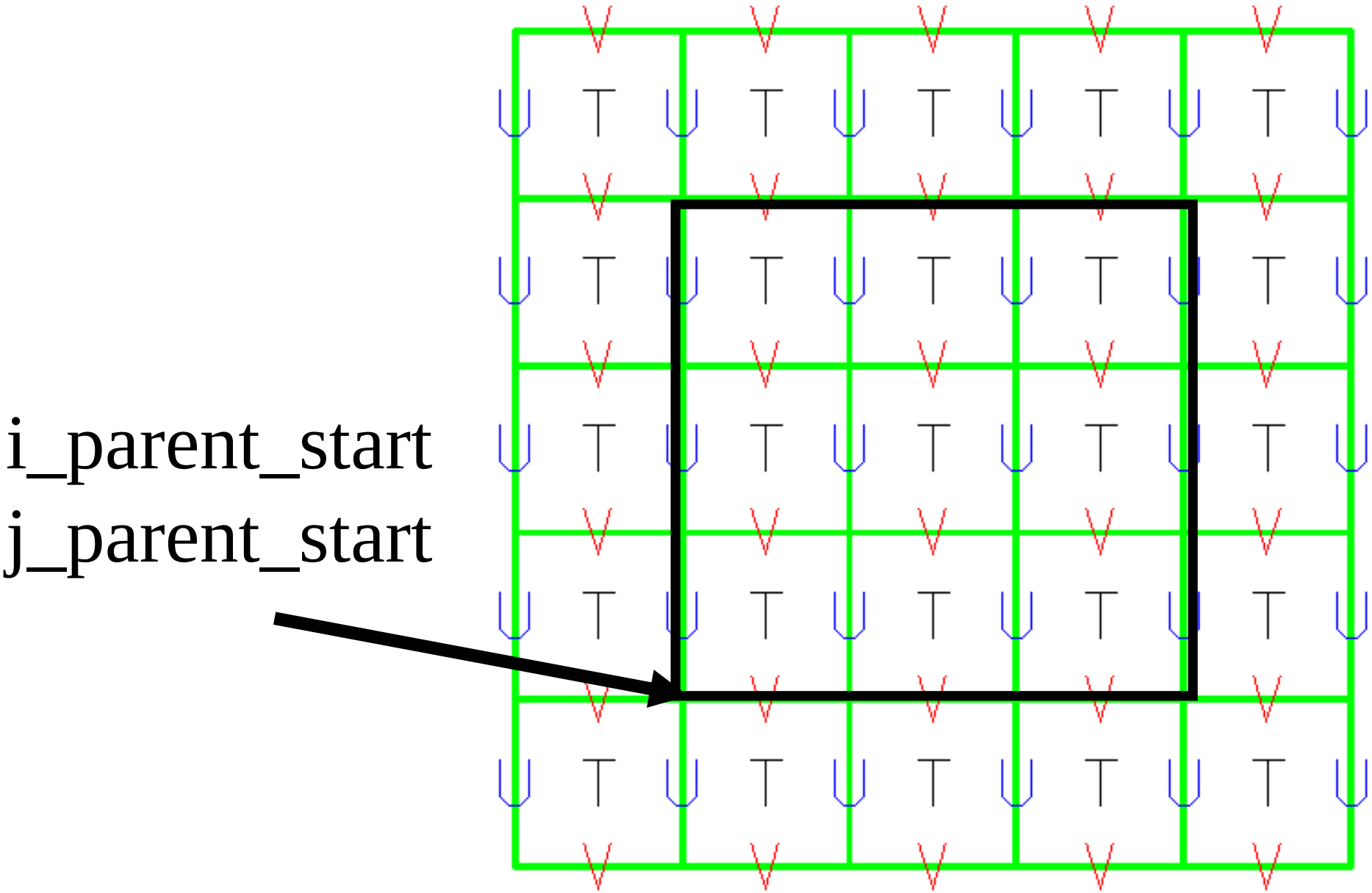
```
i_parent_start         = 0,    31,    30,
j_parent_start         = 0,    17,    30,
parent_grid_ratio      = 1,     3,     3,
parent_time_step_ratio = 1,     3,     3,
```

Parent start refers to lower left point in nest that overlaps with coarse domain

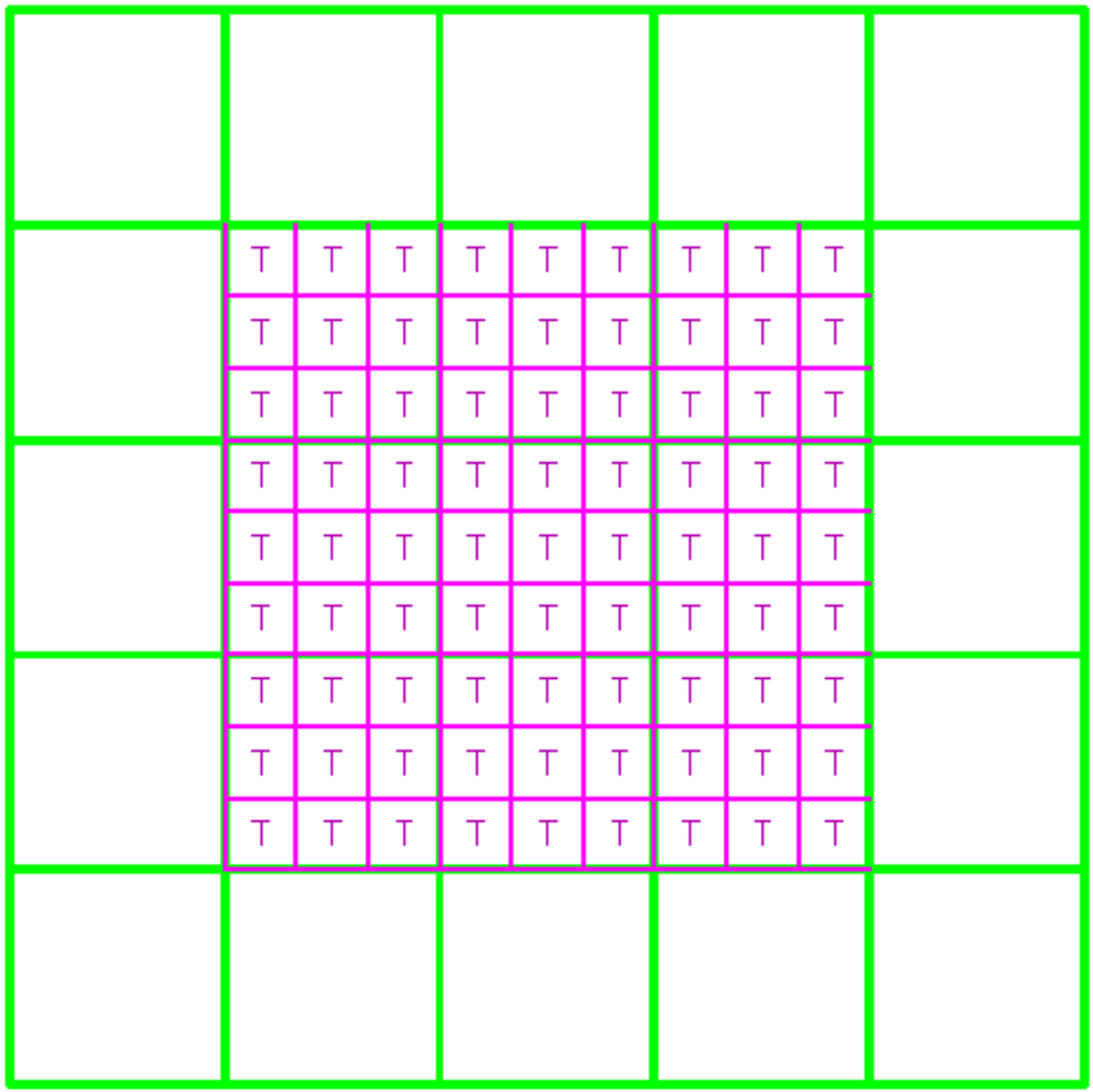
Grid and time ratios not tied to each other

WRF only

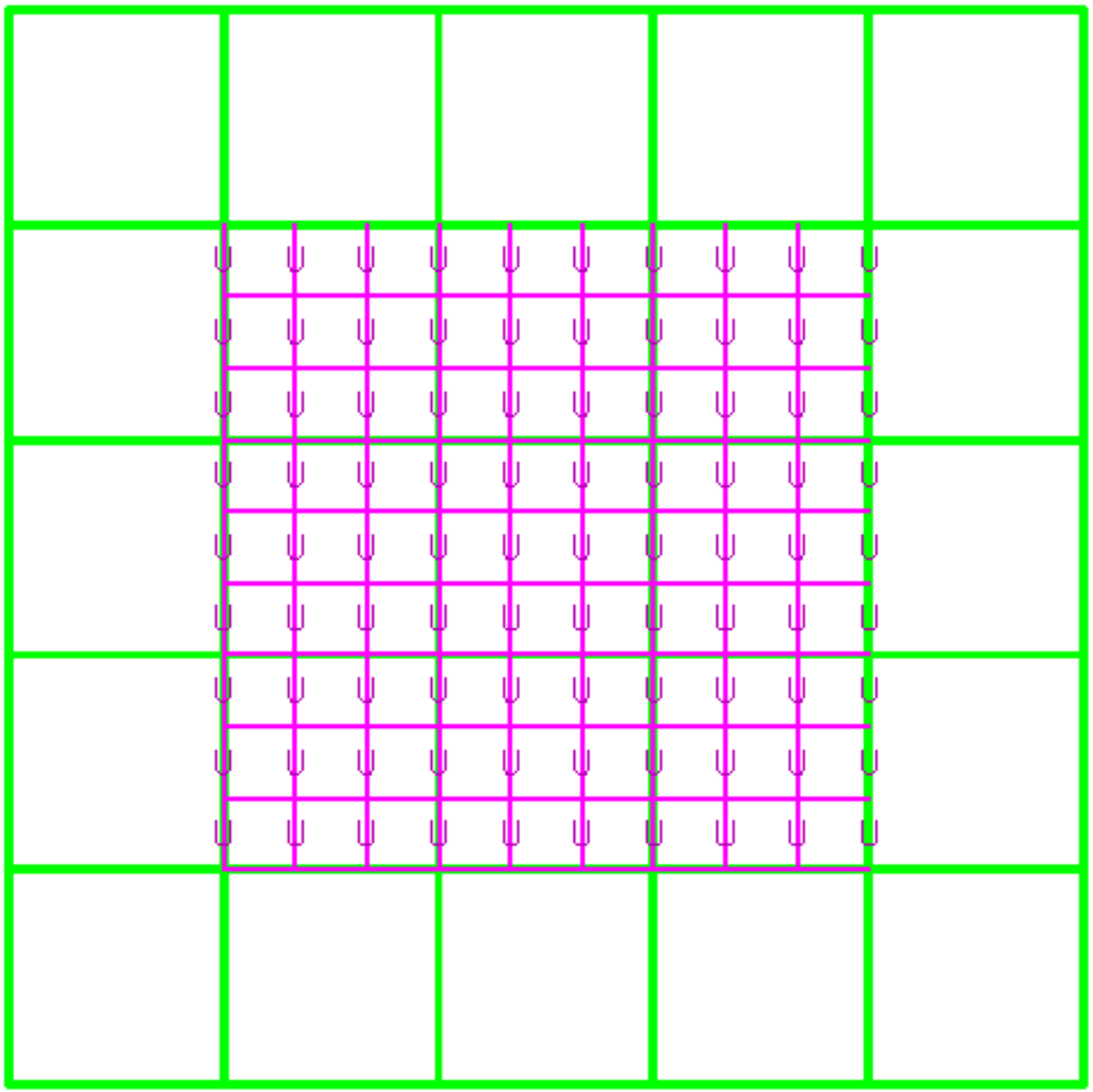
Coarse Grid Staggering



Fine Grid Staggering - Mass



Fine Grid Staggering - U



Fix namelist with run-time options **`domains`**

```
feedback                = 1,
smooth_option           = 0
```

Feedback options (1 point or cell/face average) defined in Registry for each variable, on/off switch provided in namelist

Smooth options are run-time:

- 0= no smoothing,
- 1= 1-2-1 smoother (2 directions),
- 2= smoother-desmoother

WRF only

Fix namelist with run-time options **physics**

```
sf_surface_physics   = 1,      1,      1,
num_soil_layers      = 5,
```

Or

```
sf_surface_physics   = 2,      2,      2,
num_soil_layers      = 4,
```

Or

```
sf_surface_physics   = 3,      3,      3,
num_soil_layers      = 6,
```

real.exe uses first column only, THIS MUST BE CONSISTENT WITH THE WRF RUN

Fix namelist with run-time options **`bdy_control`**

```
specified     = .true., .false.,.false.,
nested        = .false., .true., .true.,
```

Only the first domain is ever “specified”, all subsequent nested domains are “nested”

real.exe uses first column only

Link/copy SI output into correct directory

- **`cd ./WRFV2/test/em_real`**
- **`ln –s  \ $MOAD_DATAROOT/siprd/wrf_r* .`**
- One SI file required for each of the boundary times (as assumed from the “interval”)
- Minimum of 2 files required for a real-data forecast
- Only one domain at a time is permitted for real.exe

Run real.exe

- The real.exe, ndown.exe, wrf.exe are all able to run as distributed-memory parallel
- Serially:

```
./real.exe >&! foo.out
```

- Parallel:

```
mpirun –np n ./real.exe
poe ./real.exe
```

- Not much processing speed is gained by parallelizing real.exe, but you can run larger domains via aggregate memory

Run real.exe

- Did it work? Check the stdout file
- Serially:

  `tail foo.out`
- Parallel:

  `tail rsl.out.0000`
- Look for **`“SUCCESS COMPLETE REAL_EM INIT”`**

Files Before and After

- The input files required by real.exe are output from the SI, in netCDF
- The SI output files are usually linked into the real-data directory
- Times and dimensions are checked
- Physics options are infrequently impacted by SI output

```
ls $MOAD_DATAROOT/siprd/wrf_r*
```

Files Before and After

- Two output files are generated by the real.exe program: wrfinput_d01 and wrfbdy_d01
- Initial time in wrfinput is the initial time of the WRF forecast (from the namelist)

```
ncdump –v Times wrfinput_d01
```

- Time periods from wrfbdy file cover forecast period (reported time is at the beginning of the lateral boundary interval)
- Surface physics options are impacted by physics choices selected prior to running real.exe

Balancing and Initialization

- Mass coordinate is reference pressure based, surfaces move up and down in pressure space
- Reference state function of terrain elevation plus several constants
- Surface pressure => pressure => potential temperature => density => geopotential
- All balancing handled in ./WRFV2/dyn_em/module_initialize_real.F

Reference State

```
p_surf = p00 * EXP (-t00/a + ((t00/a)**2
  - 2.*g*ht(i,j)/a/r_d ) **0.5 )
```

p00 – ref sea level pressure (10^5 Pa, fixed)

a – lapse rate (50 K, fixed)

t00 – ref sea level temperature (290 K, variable)

ht – terrain elevation (m)

Reference State

```
pb(i,k,j) = znu(k)*(p_surf - p_top) + p_top
t_init(i,k,j) = (t00 + A*LOG(pb(i,k,j)/p00))
  *(p00/pb(i,k,j))**(r_d/cp) - t0
alb(i,k,j) = (r_d/p1000mb)*(t_init(i,k,j)+t0)
  *(pb(i,k,j)/p1000mb)**cvpm
```

Reference 3d pressure, potential temperature, inverse density (defined at mass points, half levels)

Reference State

```
mub(i,j) = p_surf - p_top

phb(i,k,j) = phb(i,k-1,j) - dnw(k-1)
  *mub(i,j)*alb(i,k-1,j)
```

Reference geopotential (full levels, k=1 defined as terrain*g)

Balancing

```
p(i,k,j) = p(i,k+1,j) - (mu_2(i,j)
  + qvf1*mub(i,j))/qvf2/rdn(k+1)
alt(i,k,j) = (r_d/p1000mb)*
  (t_2(i,k,j)+t0)*qvf*
  (((p(i,k,j)+pb(i,k,j))/p1000mb)
  **cvpm)
al(i,k,j) = alt(i,k,j) - alb(i,k,j)
```

- Integrate perturbation pressure, diagnose perturbation inverse density

Balancing

```
ph_2(i,k,j) = ph_2(i,k-1,j) - &
   dnw(k-1) * (
   (mub(i,j)+mu_2(i,j))*al(i,k-1,j) +
   mu_2(i,j)*alb(i,k-1,j) )
```

- Integrate perturbation geopotential

Initializing – Met 3D

- All moisture variables initialized automatically (only Qv on lateral boundaries for CG)
- No modifications to input horizontal velocity components (already rotated to the projection)
- Potential temperature has a constant (300 K) removed

Initializing – Soil/Surface

- Checks for consistent land/soil and various surface fields
- Soil temperatures interpolated from input values to requested levels
- Surface and soil temperatures adjusted due to differences in terrain elevation

Program Flow

- Code browser

Run Through Test Case

- Download
- Build
- Edit namelist
- Copy SI files for input
- Run
- Check if OK

(as close as possible, Klingon for *finis*)