WRF Nesting

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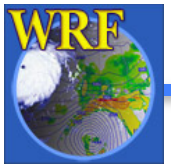
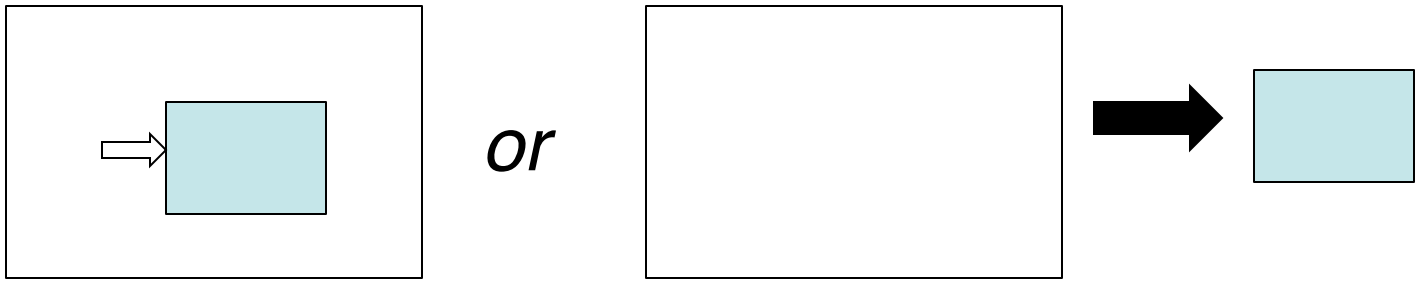


What is a nest simulation?

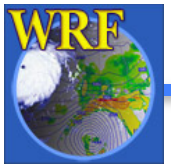
- A nest is a *finer-resolution* model run. It may be *embedded simultaneously* within a coarser-resolution (parent) model run, or *run independently* as a separate model forecast.



- The nest covers *a portion* of the parent domain, and is driven along its lateral boundaries by the parent domain.

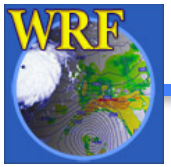
Why nesting?

- Large area of high resolution model run is too expensive: Finer details in terrain, landuse, land/water contrast, etc.
- Lateral boundary conditions from other sources are not adequate in time (*less frequent*) and space (may be *lack of vertical resolution*), and may not be consistent with WRF model
- No boundary conditions for microphysical variables and vertical motion
- Consider using the parent domain as a provider of LBCs for the nest

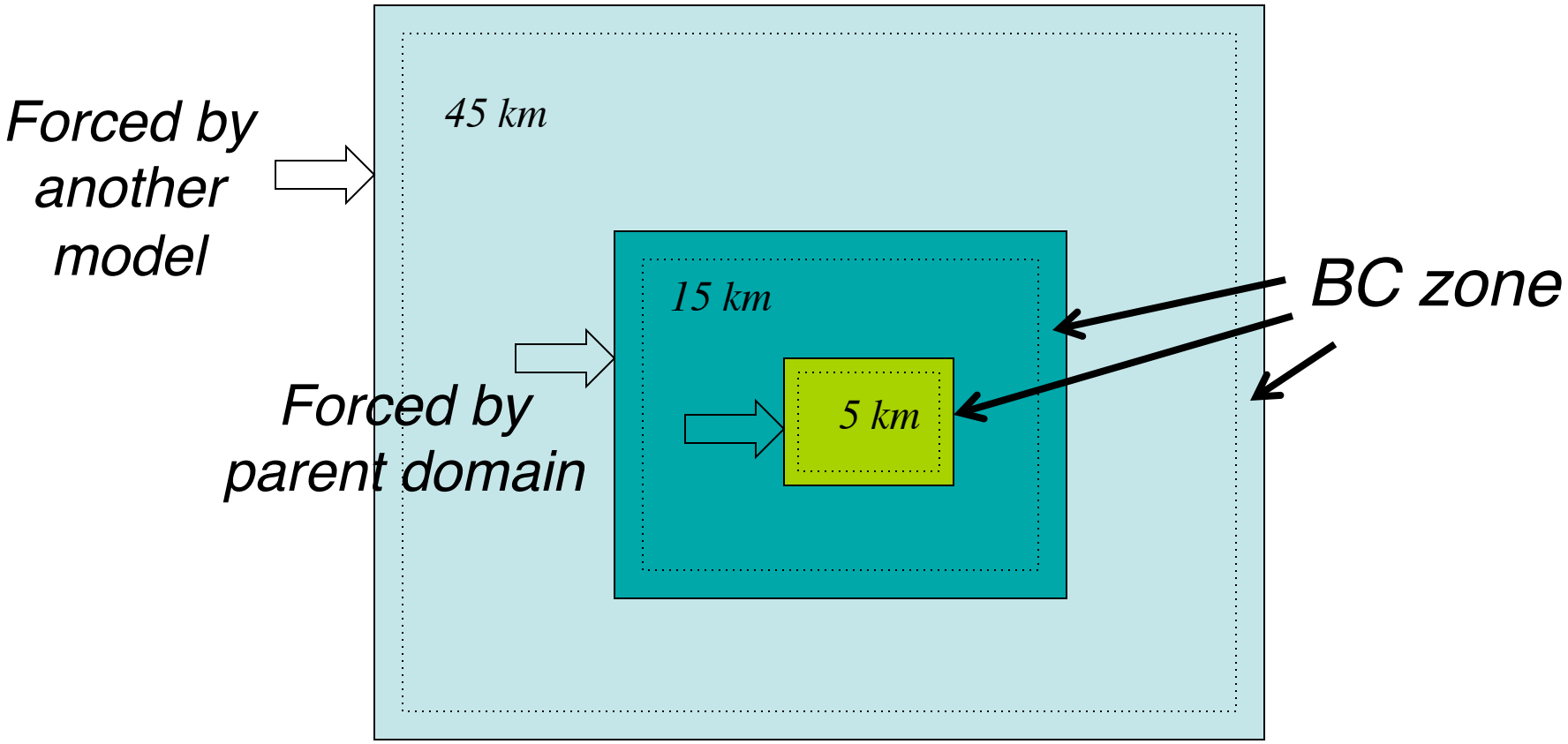


Why not nesting?

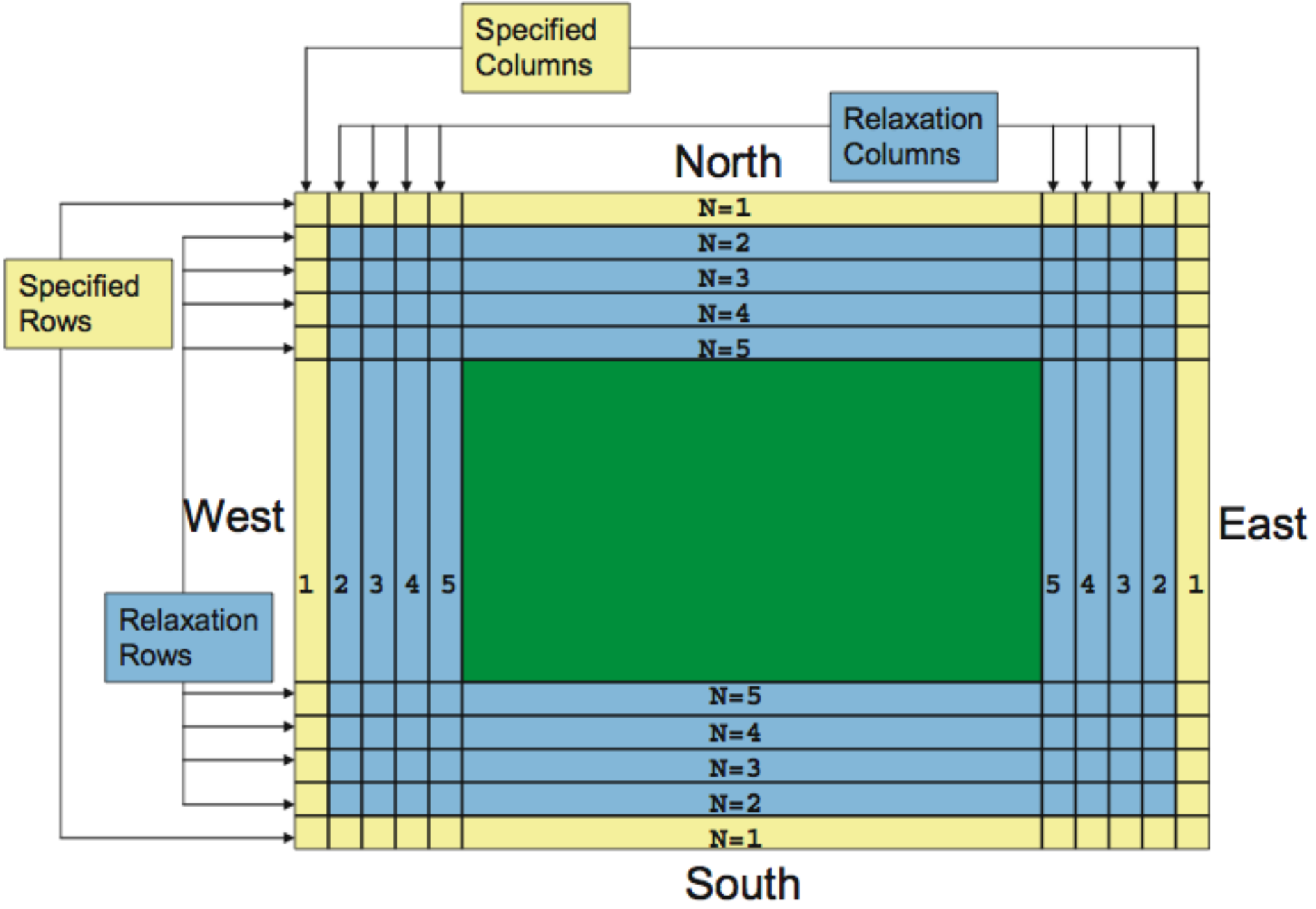
- However, there are advantages NOT to use a nested run:
  - Global model resolution is getting higher
  - Nest uses more memory
  - Need nest input (esp. for chem)
  - Have lateral boundaries on multiple domains
  - Solutions may not be smooth across nest domain boundaries



Nesting Illustration



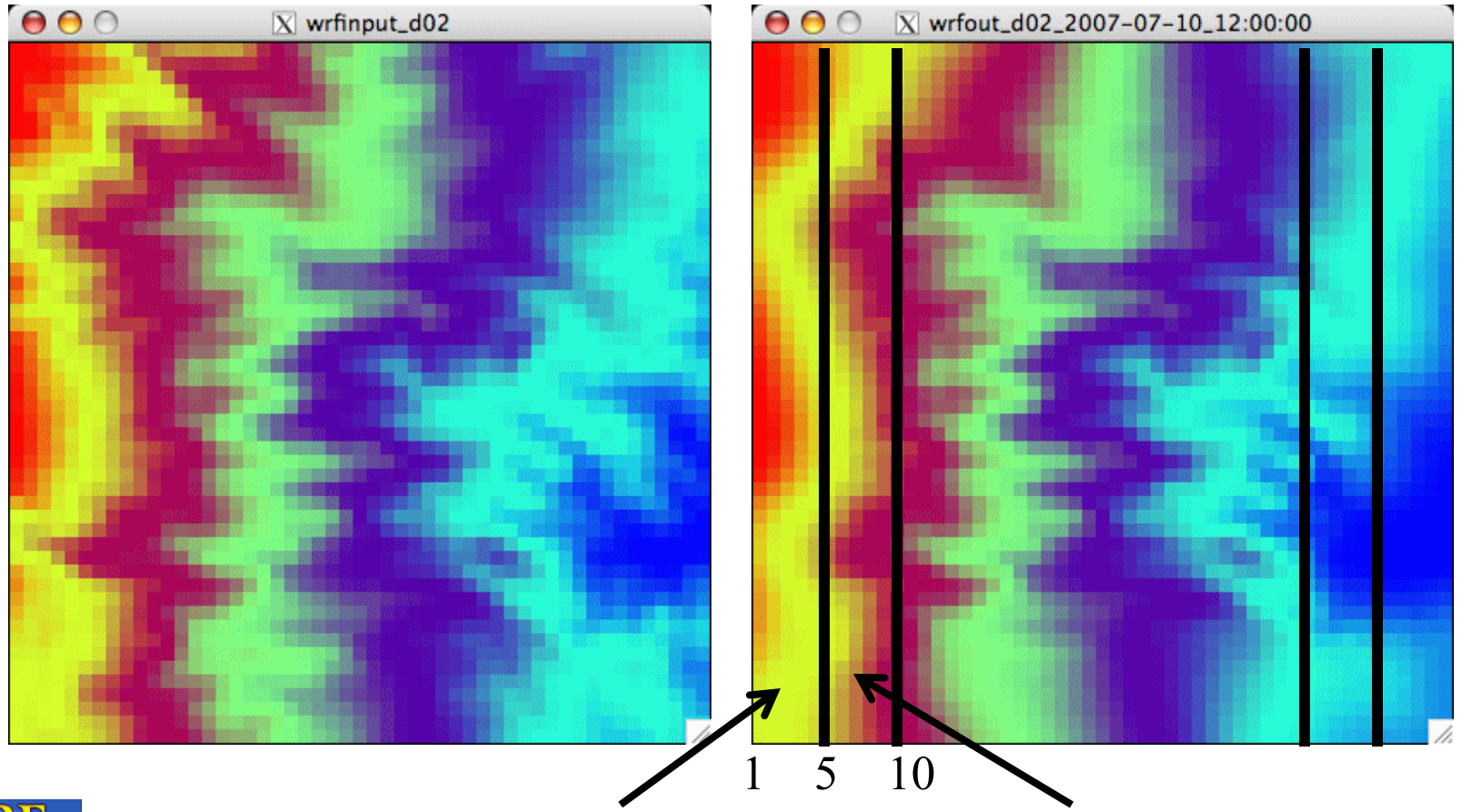
Real-Data Lateral Boundary Condition: Location of Specified and Relaxation Zones



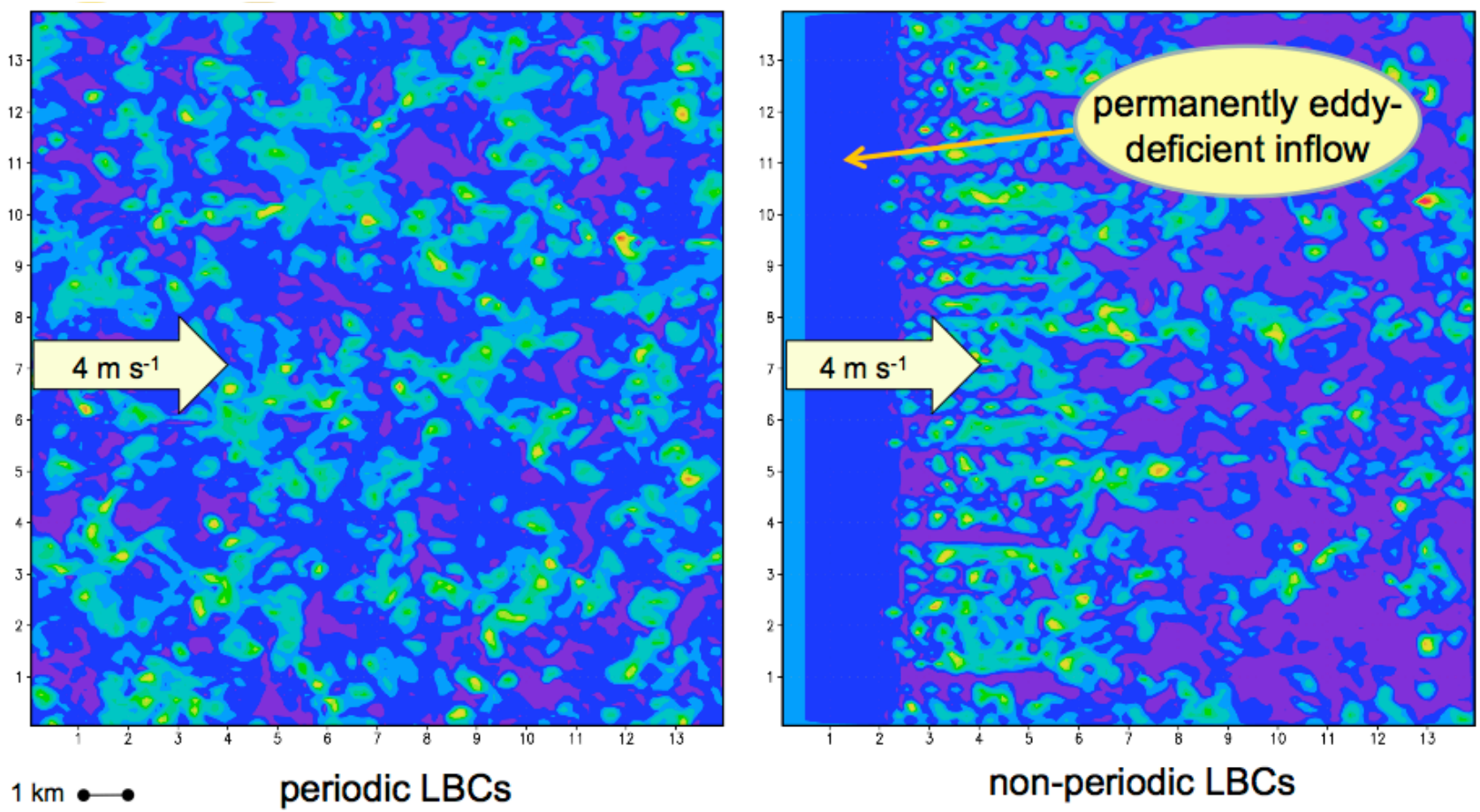
Nest Terrain Lateral Smoothing

wrfinput_d02

*wrfout_d02_**



Lateral Boundary Effect (*example*)

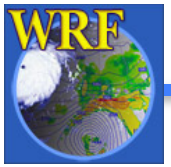


(Bryan and Fritsch, 2002)

Ways to do nesting

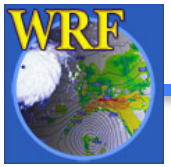
- Two-way nesting:
  - Common: run nest and parent domains in a single run, with two-way nesting
  - Same as above but no feedback – one-way
- One-way nesting via *ndown* program

Start by running *geogrid* for nested domains



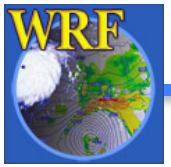
Nesting (Two-Way)

- Lateral boundary condition is provided by parent domain at every parent step
- Method is same as for outer domain (specified and relaxation zones)
- Additional fields include vertical motion and microphysics species
- Feedback: Interior of nest (1 row/ column in) overwrites overlapped parent area:
  - namelist option: *feedback = 1*



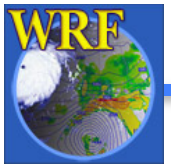
Nesting (Two-Way)

- Sequence
  - Parent domain runs a time-step to t+dt
  - Nest boundaries from beginning and end of time-step interpolated
  - Nest runs typically three steps (dt/3) using time-interpolated parent info at nest boundaries
  - After nest reaches t+dt, feedback overwrites parent in overlapped region
  - Repeat



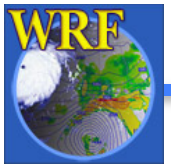
One-Way Nesting

- As two-way nesting but no feedback:
  - namelist option: *feedback = 0*
  - nest BC updated frequently – good
  - Solution in parent and nest may drift apart – bad

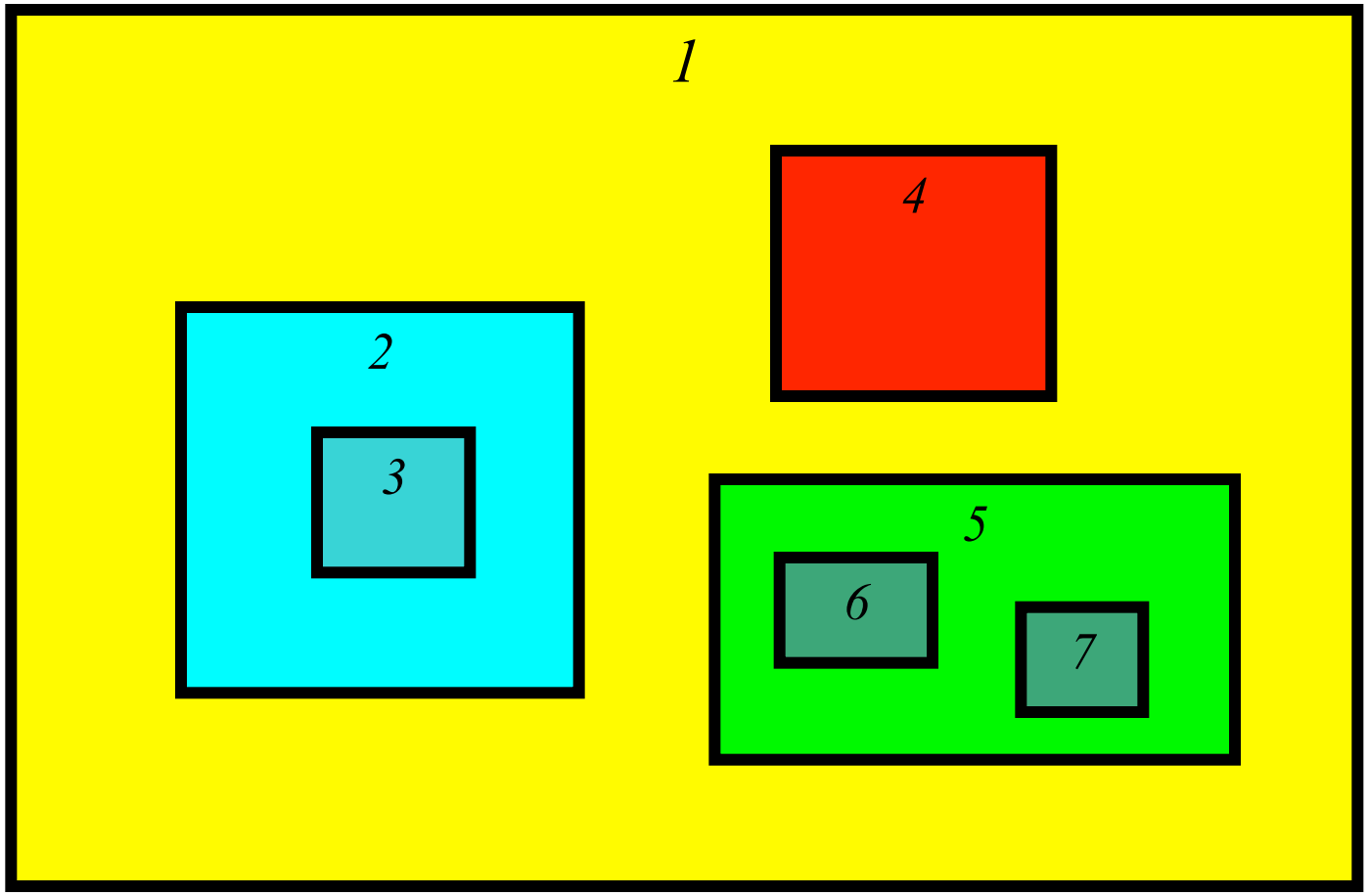


One-Way Nesting

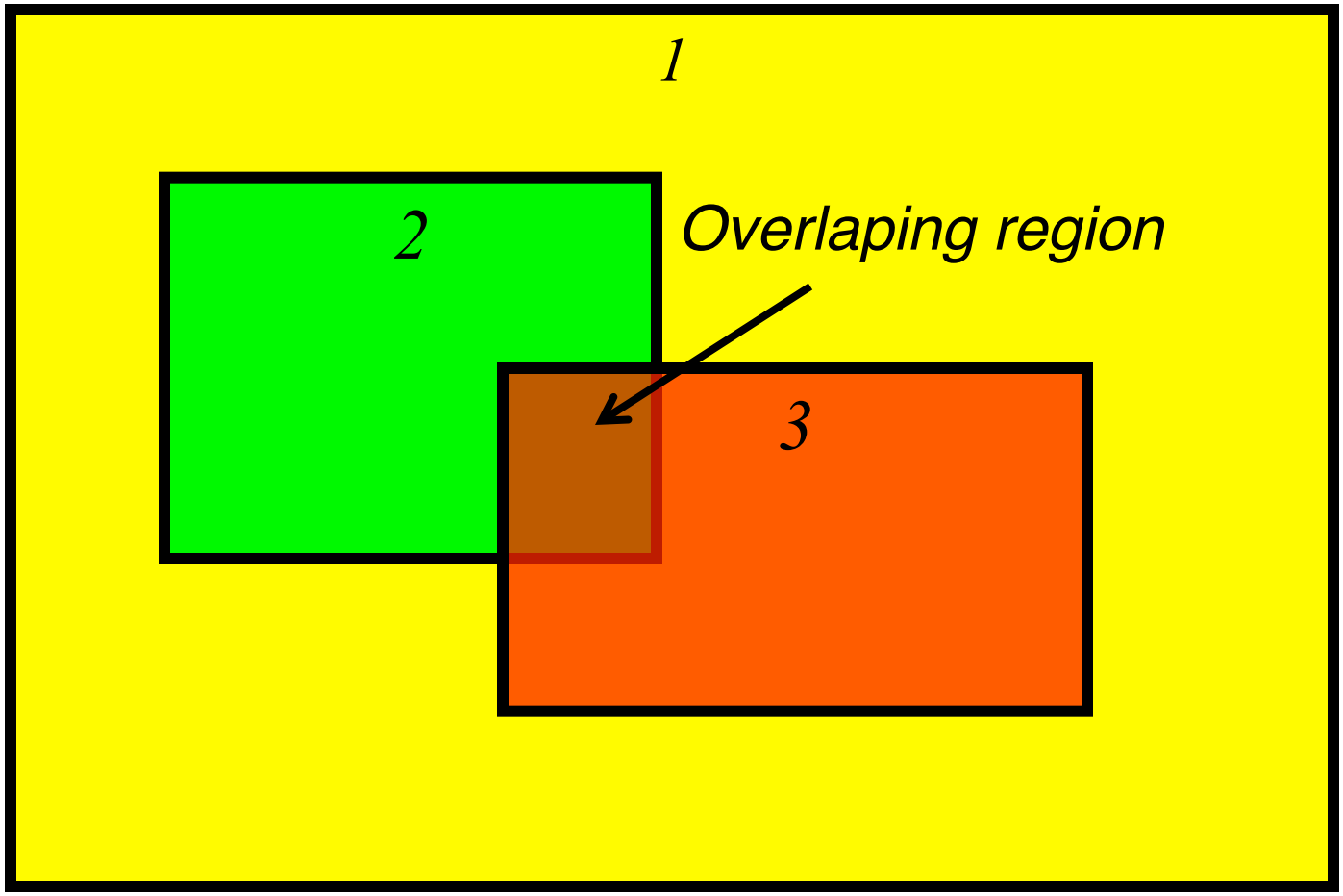
- Achieved with NDOWN program to take a previous WRF run output and provide nest boundary conditions at parent output frequency
  - Uses parent WRF run instead of analysis for initial and lateral boundary conditions
  - Like the parent domain, no vertical motion and microphysical variables in LBC
  - Take advantages of running your own model: output parent domain frequently for LBCs
  - May add more vertical levels



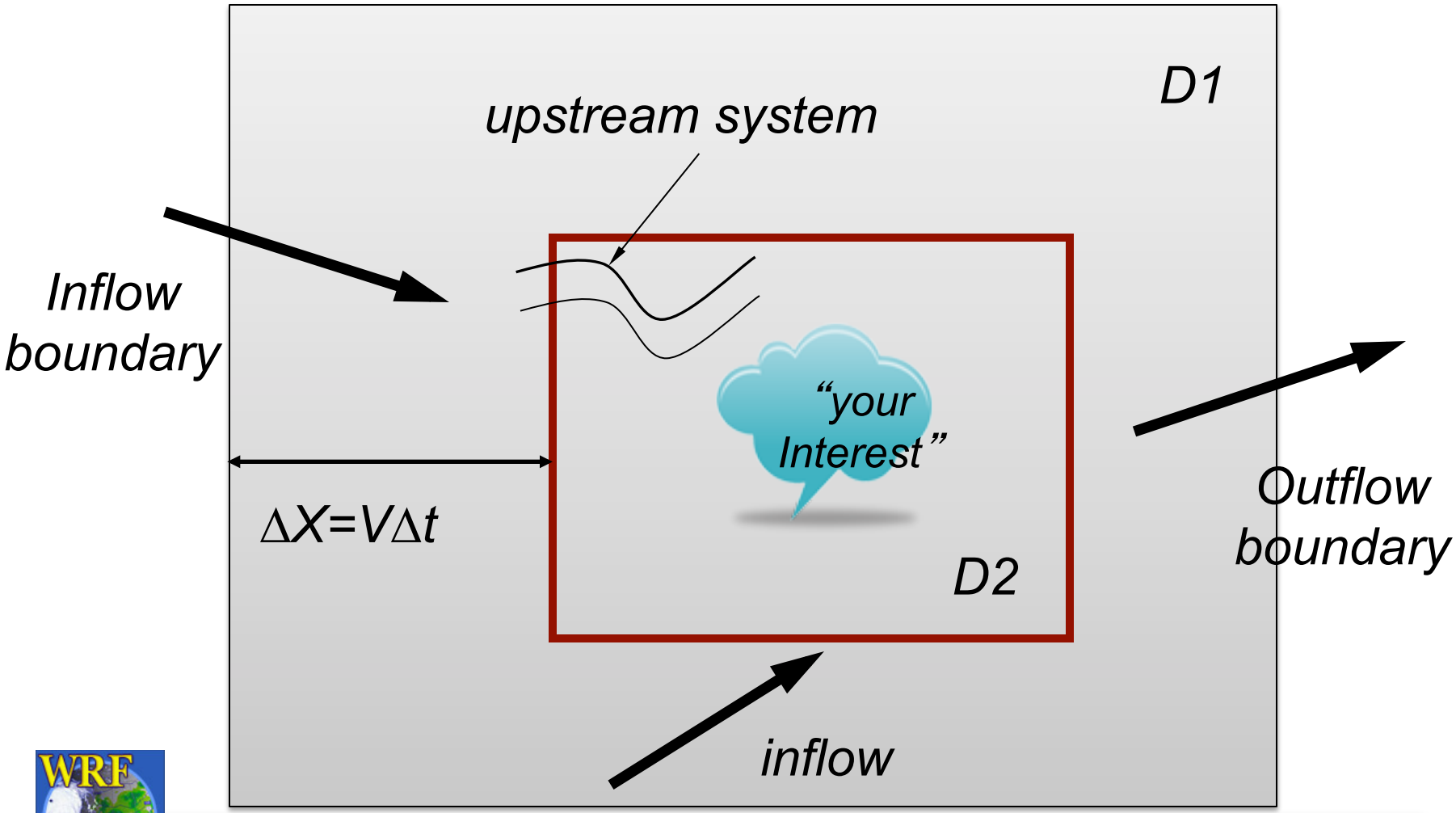
Nesting: OK



Nesting: Not OK

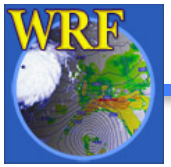


Placement of a nest

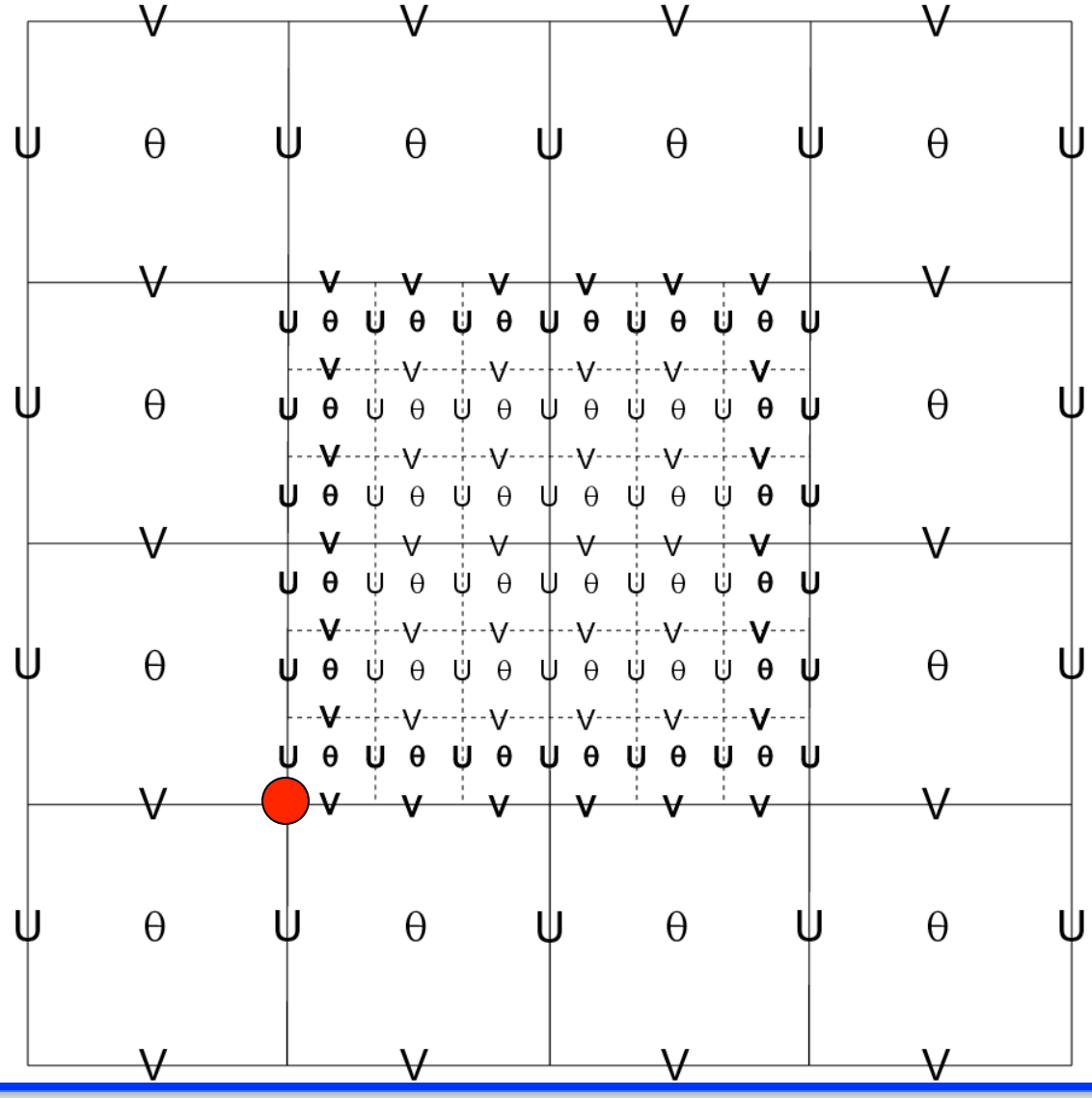


How to Setup Nested Runs?

- Run *geogrid.exe* for all domains
  - geo_em.d01.nc, geo_em.d02.nc, ..
- Run *metgrid.exe* for all domains with first time period for nested domains:
  - met_em.d01.<date>, multiple time periods
  - met_em.d02.<date>, first time period only
- Run *real.exe* as if going to run two-way nest:
  - wrfinput_d01, wrfinput_d02
  - Rename wrfinput_d02 to wrfndi_d02 for ndown



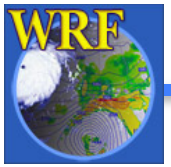
ARW Coarse Grid Staggering 3:1 Ratio



Starting Location I = 31, J = 17

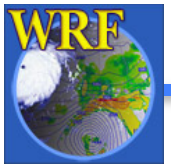
Notes on Nesting

- Use the same physics in all nests
  - An exception is convection parameterization, which may be turned off in a finer nest (< 5 km)
- For real-data, use odd nest ratio: 3 or 5
- Nest can use different model time-step ratio than grid-size ratio (to save computing time, for example):
  - Grid-size ratio is 3. e.g. 30/10 km
  - Nest time-step ratio can be 3, but it can also be 2 or 4



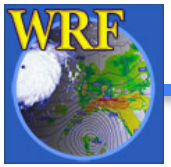
Notes on Nesting

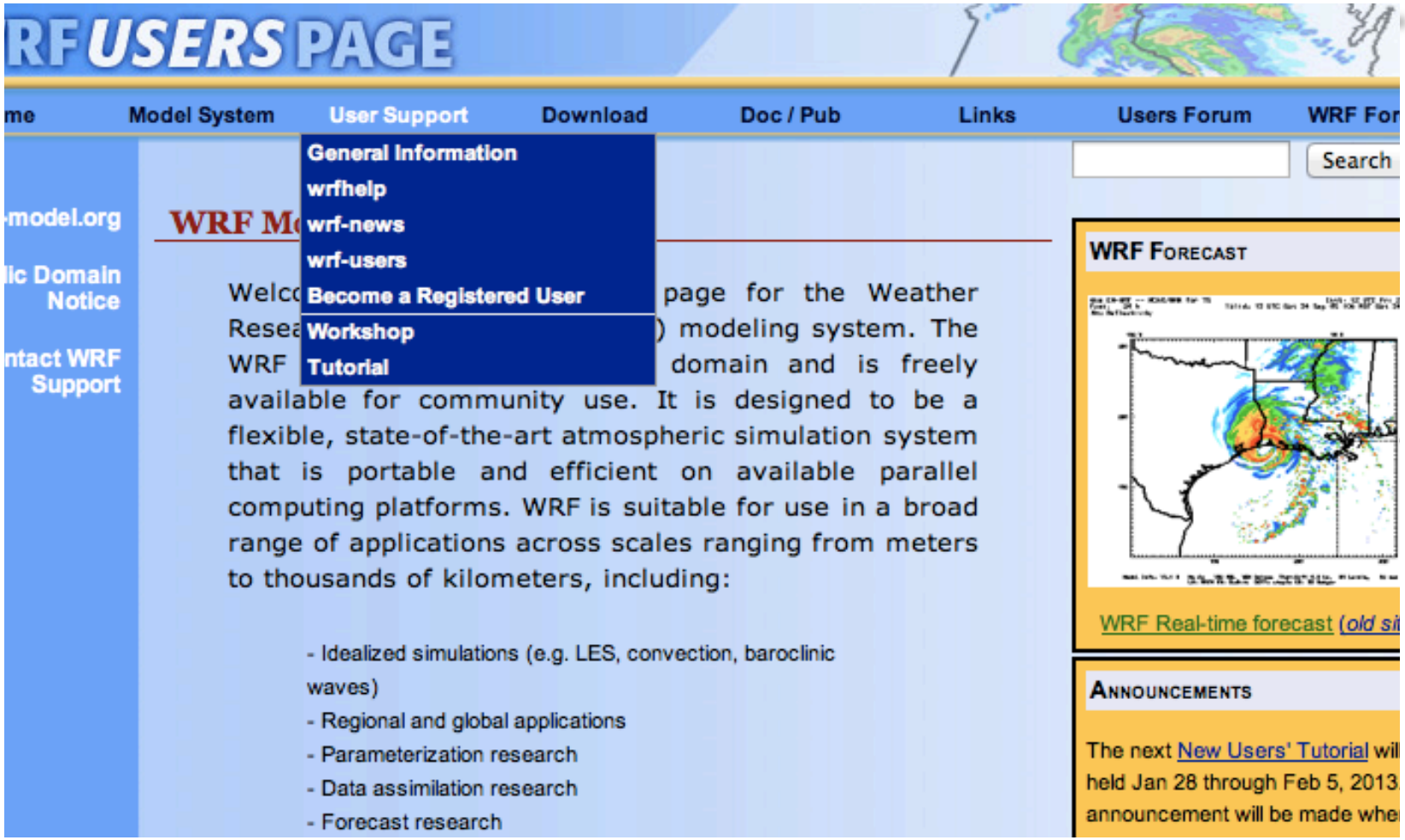
- No need to save on coarse domain:
  - If both domains have the same grid numbers, the coarse domain is only a ¼ of the total cost
- Don't use small nest (nest LBC effect)
- Place your nest away from parent domain boundary (parent domain LBC effect)
- Configure the nest with its parent domain – run *geogrid* as if you were to run a two-way nested run, even if you plan to run program *ndown.exe* – ensure your nest placement is correct



Resources

- User Web pages:
  - http://www.mmm.ucar.edu/wrf/users/
  - Online tutorial
  - Tutorial lecture slides
  - User's Guide, Chapter 5

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Announcements
The next New Users' Tutorial wil
held Jan 28 through Feb 5, 2013
announcement will be made whe