Improved Telescopic Nesting for Hurricane Forecasting

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Telescoping Nesting: What and Why?

- Some areas are more important than others
- Some areas need higher resolution than others

Sample 27:9:3 Gustav Run

$\theta$ (K) at 650 mbar
2012 Upgrade: 3km Resolution

• Hurricanes need higher resolution:
  – Need <4km for satellite products
  – <5km to represent wind maximum
  – <5km for mesovortices, vorticity waves
  – <3km for resolved convection
  – <1km for vorticity sheets

• Cannot do 3km everywhere. Too expensive!
27:9:3 2012 Implementation

Problems Encountered

• Drastic improvement to track, improved structure, but *no improvement to intensity*

• Problems:
  – Domains did not properly follow storm
  – 3km domain too small
  – physics timestep too large
  – Convection scheme differences degrade synthetic satellite products.
27:9:3 Planned 2013 Implementation
Large Improvement

• Large 3km domain, smaller timesteps, better nest motion algorithm, improved nest-parent interpolation.
• and much more
Nest Motion Trouble
MSLP Tracking No Longer Reliable

- 3km can resolve mesolows, vorticity sheets
  - Stronger localized MSLP values
- Bad MSLP calculation method
  - Spurious MSLP over mountains
Nest Motion Solution
Membrane MSLP

\[ dP = -\rho gdz \]

• Re-express atmosphere as ocean world on pressure levels
• Extrapolate virtual temperature on pressure surfaces
• Smooth atmosphere
• Integrate to get \( P(z=0) \)
Nest Motion Solution
Nine Field Tracker

• MSLP alone is not enough
• Track nine thermodynamic and wind fields
  – Used in NCEP Tracker for storm track and intensity
  – Parallelized, modified for E grid rotated lat-lon
New Nest-Parent Interpolation
(also parent to nest)
Old Method: Two Step Interpolation

New Method: Single Step
New Nest-Parent Interpolation
(also parent to nest)

• Allows non-bulk microphysics
  – Tested with Thompson and WSM6 schemes
• Faster
• Improved upscale interpolation
Larger Domain, Smaller Timesteps

• 5x5 degree grid too small – go to 6x6 degree
  – 50% more gridpoints (expensive!)
  – Affordable on new Intel/Linux WCOSS machines.

• Smaller physics timesteps:
  – 27km: 180 sec -> 90 sec
  – 9km: 180 sec -> 90 sec
  – 3km: 180 sec -> 30 sec
Improved Synthetic Satellite Products
Work in Progress

- Convection scheme in 27km, 9km domain, but not 3km.
- Post includes convective rain when calculating synth. sat.
- Result: discontinuities in satellite products.
- Meso-SAS convection scheme (work in progress)
  - Degradation of intensity skill
  - Working on fixing this
Conclusion

• Improved telescopic nesting in planned next HWRF model:
  – Larger domain, smaller timesteps, better nest motion algorithm, new interpolation schemes
  – Drastic improvements to intensity skill

• Developing better convection scheme to fix satellite product issues.