HI-RES RAPID REFRESH (HRRR)  
Initial Implementation V1.0.0  

Kickoff Planning Meeting  
June 16, 2014  

Presented by: Geoff Manikin  
Collaborators: Curtis Alexander, Stan Benjamin, Steve Weygandt, David Dowell, Eric James, Ming Hu, Tanya Smirnova, John Brown, Joe Olson, and the rest of the ESRL/GSD crew  
Jianbing Yang/Becky Cosgrove  NCO
Charter Overview

– This project is an NWS and NCEP Annual Operating Plan (AOP) milestone for Q4 FY2014

– Implementation scheduled for September 2014

– Hi-Res Rapid Refresh description
  • Used by SPC, AWC, WPC, FAA and others for details short-range forecasts, especially convective evolution
  • 24 cycles/day – each run out to 15 hours
  • No cycling
Rapid Refresh and **HRRR**

NOAA hourly updated models

13km Rapid Refresh (RAP) (mesoscale)
V2 in ops: 2/25/14

3km HRRR (storm-scale)

High-Resolution Rapid Refresh
Scheduled NCEP Implementation Q4 2014
HRRR Initialization from RAPv2

13 km RAP

GSI Hybrid
GSI HM Anx
Digital Filter
GSI HM Anx
Digital Filter
GSI HM Anx
Digital Filter

3 km HRRR

3-km Interp

1 hr pre-fcst

GSI 3D-VAR

15 hr fcst

1 hr fcst

1 hr fcst
Basic Overview

- Runs every hour (24/day)
- Uses previous hour’s RAP analysis interpolated from 13 km to 3 km to initiate pre-forecast period
- Uses previous hour’s RAP forecast for boundary conditions (01/13z HRRR use 2-hr old RAP due to 00/12z RAP having later start time)
- Runs a 1-hr spin-up forecast, using temperature tendencies obtained from processing radar data every 15 minutes to help properly initialize ongoing precipitation
- Runs a 3 km GSI after spin-up forecast to assimilate new data
- Model forecast is integrated out to 15 hours
- Full post-processing is done for every forecast hour; subset of fields is post-processed every 15 minutes
- Bufr output and gempak data generated for each forecast hour
Structure – Part 1: Before the Forecast

• Interpolation of RAP guess: 4 min
• Process radar data: 4 min
• Make boundary conditions: 13 min (not needed until free forecast)
• Process cloud data: < 1 min
• Generate temp. tendencies: 2.5-3 min
• 1-hr spinup forecast: 7 min
• GSI (analysis): 6-7 min

4 min + 3 min + 7 min + 6 min = 20 min
Structure – Part 2: Forecast and Products

• 15-hr model forecast: ~41 min
• Simultaneous hourly post-processing: 3 min each
• Simultaneous hourly wrfbufr: 1-2 min each
• Simultaneous subhourly post-processing: 2 min each
• Sounding post (bufr): 2 min
• Gempak: runs alongside post manager
RESOURCES – allocated 75 nodes

- Interpolation of RAP guess: 6 nodes
- Process radar data: 4 min: 4 nodes
- Make boundary conditions: 6 nodes
- Process cloud data: 1 node
- Generate temp. tendencies: 1 node
- 1-hr spinup forecast: 75 nodes
- GSI (analysis): 30 nodes

- 6 or 7 minute overlap between the spinup forecast and the boundary processing
- Hoping to speed up forecast job to be able to run with fewer nodes
- Makebc is divided into 3 parts (2 min, 3 min, 8 min); could break it up into 3 jobs and run most of final piece alongside the GSI
RESOURCES – allocated 75 nodes

- 15-hr model forecast: 70 nodes
- Simultaneous hourly post-processing: 2 nodes each
- Simultaneous hourly wrfbufr: 1 node each
- Simultaneous sub-hourly post-processing: 2 nodes each
- Sounding post (bufr): 1 node (shared)
- Gempak: 1 node (shared)

- Maximum overlap is 2 hourly post jobs, 2 subhourly post jobs, the gempak job, and 1 wrfbufr job for a system total of 80 nodes
- Hoping to speed up forecast job to be able to run with fewer nodes
- Could eliminate sub-hourly post-processing or bufr soundings but overall footprint for those is small
Resources

- Allocated 75 nodes
- Simultaneous hourly post-processing: 3 min each
- Simultaneous hourly wrfbufr: 1-2 min each
- Simultaneous subhourly post-processing: 2 min each
- Sounding post (bufr): 2 min
- Gempak: runs continuously waiting for files to become available: 42 min
DEPENDENCIES

UPSTREAM: RAP, RAP obs processing, RAP “early” 00/12z obs processing

DOWNSTREAM: RTMA (eventually), HRRRE-TL (eventually)

Upstream dependency requires following enhancements:

1. Need Phase 2 of ObsProc implemented
2. No changes to RAP needed

TIN: To be prepared and issued in late June
What Still Needs to Be Done

• NCO needs to put grib2 post into parallel and add in NDFD processing (need g2 template library fix)
• Need to give NCO changes to generate sub-hourly output
• Downscale NDFD 2.5 output
• Add backup capability for radar data
• Build in contingencies for missing RAP cycles
• Clean up grib2 labeling issues
• Add entries to gempak tables
• Set up alerts
• Make hpss decisions
• Make post-DFI RAP guess available for GSD comparison runs
DEVELOPMENT TESTING

- CONUS HRRR run at GSD for 4+ years
- Built at EMC Jan-April
- Using 2013 version except for bug fix to address cold bias over snow pack
- NCO parallel running stably and generating grib2 and bufr output for several weeks. gempak output for over a week

Recommended plan: run functional parallel for 30 days to assess stability (July)
  - will freeze code in terms of science changes but will likely be ironing out product issues

Recommended length of time for official evaluation parallel: 30 days (August)
  - frozen code
## PROPOSED EVALUATION TEAM

<table>
<thead>
<tr>
<th>Organization</th>
<th>Recommended</th>
<th>Optional (nice to have)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCEP Centers</td>
<td>EMC, NCO</td>
<td></td>
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<tr>
<td>NCEP Service Centers</td>
<td>WPC, SPC, AWC</td>
<td>OPC, TPC</td>
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<tr>
<td>NWS Region / WFO</td>
<td>ER, CR, SR, WR</td>
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<tr>
<td>Other NWS or NOAA components</td>
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<tr>
<td>External Customers / Collaborators</td>
<td>FAA</td>
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</table>
PRODUCTS

For each forecast hour (16), generate
- 3 km file with data on pressure levels  350 MB (each file)
- 3 km file with data on native levels  545 MB
- 3 km file with mostly 2-D (surface) data  82 MB
- 2.5 km NDFD file for AWIPS  96 MB
- bufr sounding file  22 MB  gempak file  210 MB

16.4 GB per cycle / 400 GB per day
  gempak files add 3.3 MB per cycle/ 80 GB per day

For every 15 minutes, generate
- 3 km file with very limited 2-D (surface) data  22 MB
- Time labels are in minutes
- Cat 15/30/45/60 past hour into a single file  75 MB

1.1 GB per cycle / 26.4 GB per day
<table>
<thead>
<tr>
<th>Disk Usage</th>
<th>Current Production</th>
<th>Expected New Production</th>
<th>Actual New Production</th>
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</thead>
<tbody>
<tr>
<td>IBM Disk</td>
<td>-</td>
<td>1.6 TB/day</td>
<td>-</td>
</tr>
<tr>
<td>IBM Tape</td>
<td>-</td>
<td>TDB</td>
<td>-</td>
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<tr>
<td>NCEP FTP Server</td>
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<td>425 GB/day</td>
<td>-</td>
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<tr>
<td>NWS FTP Server</td>
<td>-</td>
<td>Same?</td>
<td>-</td>
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</table>
• Original suggestion was to mimic RAP output and add in a few more parameters
• But is any value gained over the RAP showing upper level heights/winds/thicknesses/etc.. ?
• Should focus on 2-d “surface” fields and take advantage of the hi-resolution
• 15 minute output probably not an option?
• Break down by regions?
GSD HRRR Web Page
rapidrefresh.noaa.gov/HRRR/welcome.cgi
Hi-Resolution Rapid Refresh v1.0.0
Project Status as of 6/16/14

Project Information and Highlights

Lead: Geoff DiMego, Geoff Manikin EMC and Chris Magee, NCO

Scope:
1. Initial version of 3 km Hi-Res Rapid Refresh
2. Similar to RAP but allows explicit convection
3. Initialized from previous hour’s RAP analysis interpolated to 3 km. Radar data assimilated every 15 minutes to allow a one-hour “spinup” forecast, followed by a final 3 km GSI.
4. Output generated every 15 minutes of forecast

Expected Benefits:
1. Hourly hi-resolution forecasts of convective evolution and structure along with various parameters relevant to severe storm, aviation, and winter weather forecasting

Issues/Risks

Issues: Timing improved but still tight – no margin for error
Risks: Footprint on production machine still too large
Mitigation: working with IBM to optimize code and script settings

Scheduling

<table>
<thead>
<tr>
<th>Milestone (NCEP)</th>
<th>Date</th>
<th>Status</th>
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<tbody>
<tr>
<td>EMC testing complete/ EMC CCB approval</td>
<td>6/30/2014</td>
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<tr>
<td>Final code submitted to NCO</td>
<td>6/20/2014</td>
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<td>Technical Information Notice Issued</td>
<td>6/30/2014</td>
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<tr>
<td>CCB approve parallel data feed</td>
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<td>Parallel testing begun in NCO</td>
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<tr>
<td>IT testing begins</td>
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<td>IT testing ends</td>
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<td>Real time evaluation ends</td>
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<td>Downstream test begins</td>
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<td>Management Briefing</td>
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<td>Implementation</td>
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Finances

Associated Costs:

Funding Sources:

Management Attention Required
Potential Management Attention Needed
On Target