WRF-ARW Research to Operations Update: The Rapid-Refresh (RAP) version 4, High-Resolution Rapid Refresh (HRRR) version 3 and Convection-Allowing Ensemble Prediction

13 June 2017

Curtis Alexander, Steve Weygandt, Stan Benjamin, David Dowell, Ming Hu, Tanya Smirnova, Joseph Olson, Jaymes Kenyon, Georg Grell, Eric James, Haidao Lin, Terra Ladwig, John Brown, Trevor Alcott and Isidora Jankov

NOAA/ESRL/GLOBAL SYSTEMS DIVISION
RAP/HRRR: Hourly-Updating Weather Forecast Suite

13-km Rapid Refresh (RAPv4) – to 39h (Feb 2018)
Initial & Lateral Boundary Conditions

3-km High-Resolution Rapid Refresh (HRRRv3) – to 36h (Feb 2018)
Initial & Lateral Boundary Conditions

750-m HRRR nest Scale-aware Physics Testing (ongoing)

3-km High-Resolution Time Lagged Ensemble (HRRR-TLE)

3-km High-Resolution Smoke (VIIRS fire data)

3-km High-Resolution Rapid Refresh Alaska, Hawaii and Puerto Rico Testing (HRRR-AK, HRRR-HI, HRRR-PR) Experimental (ongoing)

3-km Storm-Scale Ensemble Analysis and Forecast (HRRRE) 55% CONUS HRRR Experimental (ongoing)
### RAP/HRRR Implementation History

#### Operational Implementations

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>01 May 2012</td>
<td>RAPv1: Adoption of GSI, WRF-ARW and unified post</td>
<td>Enabled use of community-developed software</td>
</tr>
<tr>
<td>25 Feb 2014</td>
<td>RAPv2: Hybrid EnKF-3DVar data assimilation</td>
<td>Significant improvement in upper-air forecasts</td>
</tr>
<tr>
<td>30 Sep 2014</td>
<td>HRRRv1: 3-km Radar DA in WRF-ARW</td>
<td>Significant improvement in convective forecasts</td>
</tr>
<tr>
<td>23 Aug 2016</td>
<td>RAPv3/HRRRv2: Aerosol Thompson MP, improvements to MYNN PBL, RUC LSM, RRTMG Rad, Grell-Freitas cumulus</td>
<td>Significant improvement in surface forecasts</td>
</tr>
</tbody>
</table>

#### Extended Forecast Lengths

<table>
<thead>
<tr>
<th>Model</th>
<th>Cycle</th>
<th>Original Length</th>
<th>New Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAP</td>
<td>03z, 09z, 15z, 21z</td>
<td>21 hrs</td>
<td>39 hrs</td>
</tr>
<tr>
<td>RAP</td>
<td>All other hourly cycles</td>
<td>21 hrs</td>
<td></td>
</tr>
<tr>
<td>HRRR</td>
<td>00z, 06z, 12z, 18z</td>
<td>18 hrs</td>
<td>36 hrs</td>
</tr>
<tr>
<td>HRRR</td>
<td>All other hourly cycles</td>
<td>18 hrs</td>
<td></td>
</tr>
</tbody>
</table>

#### OCONUS Domains

- **HRRR-Alaska:**
  - Every 3 hrs to 18 hrs
  - Every 6 hrs to 36 hrs
- **HRRR-Hawaii:** ??

---

**18th WRF Workshop** • **RAP/HRRR Implementations**

13 June 2017 • 2
RAP/HRRR: Hourly-Updating Weather Forecast Suite

13-km Rapid Refresh (RAPv4) – to 39h (Feb 2018)

3-km High-Resolution Rapid Refresh (HRRRv3) – to 36h (Feb 2018)

Initial & Lateral Boundary Conditions

750-m HRRR nest Scale-ware Physics Testing (ongoing)

3-km High-Resolution Time Lagged Ensemble (HRRR-TLE)

3-km HRRR-Smoke (VIIRS fire data)

3-km High-Resolution Rapid Refresh Alaska, Hawaii and Puerto Rico Testing (HRRR-AK, HRRR-HI, HRRR-PR) Experimental (ongoing)

3-km Storm-Scale Ensemble Analysis and Forecast (HRRRE) 55% CONUS HRRR Experimental (ongoing)
<table>
<thead>
<tr>
<th>Model</th>
<th>Data Assimilation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RAPv4 (13 km)</strong></td>
<td><strong>WRF-ARW v3.8.1+ incl. physics changes</strong>&lt;br&gt;<strong>Physics changes (12 changes):</strong>&lt;br&gt;Thompson microphysics – improved upper-level clouds&lt;br&gt;GF Convective update – more optimal precip bias&lt;br&gt;MYNN PBL update – better sub-grid clouds, meso env&lt;br&gt;LSM update – 15” MODIS data – better lower boundary&lt;br&gt;Refined roughness lengths over various land use types&lt;br&gt;<strong>Numerics changes (3 changes):</strong>&lt;br&gt;Improved terrain (cell avg) – better winds /turbulence&lt;br&gt;Hybrid vertical coordinate from NCAR – better meso env&lt;br&gt;Full geometric diffusion – better winds/temp in terrain</td>
</tr>
<tr>
<td><strong>HRRRv3 (3 km)</strong></td>
<td><strong>WRF-ARW v3.8.1+ incl. physics changes</strong>&lt;br&gt;<strong>Physics changes (12 changes):</strong>&lt;br&gt;Thompson microphysics – improved upper-level clouds&lt;br&gt;MYNN PBL update – better sub-grid clouds, meso env&lt;br&gt;LSM update – 15” MODIS data – better lower boundary&lt;br&gt;Refined roughness lengths over various land use types&lt;br&gt;Gravity wave drag (RAP and HRRR) – better winds&lt;br&gt;<strong>Numerics changes (2 changes):</strong>&lt;br&gt;Hybrid vertical coordinate from NCAR – better meso env&lt;br&gt;Full geometric diffusion – better winds/temp in terrain</td>
</tr>
</tbody>
</table>
## Operational RAPv3/HRRRv2

<table>
<thead>
<tr>
<th>Model</th>
<th>Run at:</th>
<th>Domain</th>
<th>Grid Points</th>
<th>Grid Spacing</th>
<th>Vertical Levels</th>
<th>Vertical Coordinate</th>
<th>Pressure Top</th>
<th>Boundary Conditions</th>
<th>Initialized</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAP</td>
<td>GSD, NCO</td>
<td>North America</td>
<td>953 x 834</td>
<td>13 km</td>
<td>50</td>
<td>Sigma</td>
<td>10 mb</td>
<td>GFS</td>
<td>Hourly (cycled)</td>
</tr>
<tr>
<td>HRRR</td>
<td>GSD, NCO</td>
<td>CONUS</td>
<td>1799 x 1059</td>
<td>3 km</td>
<td>50</td>
<td>Sigma</td>
<td>20 mb</td>
<td>RAP</td>
<td>Hourly (pre-forecast hour cycle)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model</th>
<th>Version</th>
<th>Assimilation</th>
<th>Radar DA</th>
<th>Radiation LW/SW</th>
<th>Microphysics</th>
<th>Cumulus Param</th>
<th>PBL</th>
<th>LSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAP</td>
<td>WRF-ARW v3.6+</td>
<td>GSI Hybrid Ensemble to 0.75</td>
<td>13-km DFI</td>
<td>RRTMG/RRTMG</td>
<td>Thompson Aerosol v3.6</td>
<td>GF + Shallow</td>
<td>MYNN v3.6</td>
<td>RUC v3.6</td>
</tr>
<tr>
<td>HRRR</td>
<td>WRF-ARW v3.6+</td>
<td>GSI Hybrid Ensemble to 0.75</td>
<td>3-km 15-min LH</td>
<td>RRTMG/RRTMG</td>
<td>Thompson Aerosol v3.6</td>
<td>None</td>
<td>MYNN v3.6</td>
<td>RUC v3.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model</th>
<th>Horiz/Vert Advection</th>
<th>Scalar Advection</th>
<th>Upper-Level Damping</th>
<th>Diffusion Option</th>
<th>6th Order Diffusion</th>
<th>SW Radiation Update</th>
<th>Land Use</th>
<th>MP Tend Limit</th>
<th>Time-Step</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAP</td>
<td>5th/5th</td>
<td>Positive-Definite</td>
<td>w-Rayleigh 0.2</td>
<td>Simple (1)</td>
<td>Yes 0.12</td>
<td>20 min</td>
<td>MODIS Seasonal</td>
<td>0.01 K/s</td>
<td>60 s</td>
</tr>
<tr>
<td>HRRR</td>
<td>5th/5th</td>
<td>Positive-Definite</td>
<td>w-Rayleigh 0.2</td>
<td>Simple (1)</td>
<td>Yes 0.25</td>
<td>15 min with SW-dt</td>
<td>MODIS Seasonal</td>
<td>0.07 K/s</td>
<td>20 s</td>
</tr>
</tbody>
</table>
# RAPv4/HRRRv3 Summary of Changes

## Upcoming RAPv4/HRRRv3

<table>
<thead>
<tr>
<th>Model</th>
<th>Run at:</th>
<th>Domain</th>
<th>Grid Points</th>
<th>Grid Spacing</th>
<th>Vertical Levels</th>
<th>Vertical Coordinate</th>
<th>Pressure Top</th>
<th>Boundary Conditions</th>
<th>Initialized</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAP</td>
<td>GSD, NCO</td>
<td>North America</td>
<td>953 x 834</td>
<td>13 km</td>
<td>50</td>
<td>Sigma-Isob Hybrid</td>
<td>10 mb</td>
<td>GFS</td>
<td>Hrly (cycled)</td>
</tr>
<tr>
<td>HRRR</td>
<td>GSD, NCO</td>
<td>CONUS</td>
<td>1799 x 1059</td>
<td>3 km</td>
<td>50</td>
<td>Sigma-Isob Hybrid</td>
<td>20 mb</td>
<td>RAP</td>
<td>Hrly (pre-forecast hour cycle)</td>
</tr>
</tbody>
</table>

### Changed components for RAPv4/HRRRv3.

### Newer Model Version with hybrid vert coord

### More Ensemble Weight

### Advanced Physics Suite

### Seasonal Vegetation Fraction/Leaf Area Index

### No Change in CONUS Domains

## Changed components for RAPv4/HRRRv3.

### Newer Model Version with hybrid vert coord

### More Ensemble Weight

### Advanced Physics Suite

### Seasonal Vegetation Fraction/Leaf Area Index

## Model Run at: Domain

<table>
<thead>
<tr>
<th>Model</th>
<th>Version</th>
<th>Assimilation</th>
<th>Radar DA</th>
<th>Radiation LW/SW</th>
<th>Microphysics</th>
<th>Cumulus Param</th>
<th>PBL</th>
<th>LSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAP</td>
<td>WRF-ARW v3.8.1+</td>
<td>GSI Hybrid Ens to 0.85, better cloud</td>
<td>13-km DFI, 1/2 Strength</td>
<td>RRTMG/RRTMG</td>
<td>Thompson Aerosol v3.8.1</td>
<td>GF + Shallow</td>
<td>MYNN v3.8.1</td>
<td>RUC v3.8.1</td>
</tr>
<tr>
<td>HRRR</td>
<td>WRF-ARW v3.8.1+</td>
<td>GSI Hybrid Ens to 0.85, better cloud</td>
<td>3-km 15-min LH</td>
<td>RRTMG/RRTMG</td>
<td>Thompson Aerosol v3.8.1</td>
<td>None</td>
<td>MYNN v3.8.1</td>
<td>RUC v3.8.1</td>
</tr>
</tbody>
</table>

## Model Horiz/Vert Advection Scalar Advection Upper-Level Damping Diffusion Option 6th Order Diffusion SW Radiation Update Land Use MP Tend Limit Time-Step

<table>
<thead>
<tr>
<th>Model</th>
<th>Horiz/Vert Advection</th>
<th>Scalar Advection</th>
<th>Upper-Level Damping</th>
<th>Diffusion Option</th>
<th>6th Order Diffusion</th>
<th>SW Radiation Update</th>
<th>Land Use</th>
<th>MP Tend Limit</th>
<th>Time-Step</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAP</td>
<td>5th/5th</td>
<td>Positive-Definite</td>
<td>w-Rayleigh 0.2</td>
<td>Full (2)</td>
<td>Yes 0.12</td>
<td>20 min</td>
<td>MODIS Seasonal</td>
<td>0.01 K/s</td>
<td>60 s</td>
</tr>
<tr>
<td>HRRR</td>
<td>5th/5th</td>
<td>Positive-Definite</td>
<td>w-Rayleigh 0.2</td>
<td>Full (2)</td>
<td>Yes 0.25</td>
<td>15 min with SW-dt</td>
<td>MODIS Seasonal</td>
<td>0.07 K/s</td>
<td>20 s</td>
</tr>
</tbody>
</table>

### 18th WRF Workshop • RAPv4/HRRRv3 • 13 June 2017 • 6
New RAP/HRRR Vertical Coordinate

Hybrid coordinate

Terrain-following coordinate

VVEL (fill), POTL TEMP (black), PBL TOP (dash)

Less “Noise” in Hybrid
RAP RMSE Upper-Air Winter (Three Weeks Jan 2017)

**RAPv4**

**RAPv3 (ops)**

**RAPv4-RAPv3**

6 hr

**RAPv4** better

Full Tropospheric Improvements

12 hr

**RAPv4** better

18th WRF Workshop  ●  Upper-Air Verification  13 June 2017  ●  8
RAP BIAS Upper-Air Winter (Three Weeks Jan 2017)

RAPv4
RAPv3 (ops)
6 hr fcsts

00 UTC

Reduced RH Bias Aloft

12 UTC

18th WRF Workshop • Upper-Air Verification
RAP RMSE Upper-Air Summer (Three Weeks Jul 2016)

**RAPv4**
**RAPv3 (ops)**
**RAPv4-RAPv3**

6 hr

Full Tropospheric Improvements

12 hr

18th WRF Workshop • Upper-Air Verification
RAP BIAS Upper-Air Summer (Three Weeks Jul 2016)

**RAPv4**
**RAPv3 (ops)**
6 hr fcsts

**00 UTC**

**12 UTC**
RAP/HRRR Improved Subgrid Cloud Effects

SURFRAD/SOLRAD DSWRF 6hr Fcst Verification

- 7D MAE
- 7D BIAS

HRRrv3 better

- 3D MAE
- 3D BIAS

HRRrv3 better

Improved Bias

More Shortwave Attenuation

18th WRF Workshop • Radiation Verification 13 June 2017 • 12
RAP RMSE Surface Winter (Three Weeks Jan 2017)

RAPv4
RAPv3 (ops)
RAPv4-RAPv3

6 hr

Improved Diurnal T/T_d

12 hr
RAP BIAS Surface Winter (Three Weeks Jan 2017)

RAPv4
RAPv3 (ops)
12 hr fcsts

West US

East US

18th WRF Workshop • Surface Verification
13 June 2017 • 14
RAP RMSE Surface Summer (Three Weeks Jul 2016)

**RAPv4**

**RAPv3 (ops)**

**RAPv4-RAPv3**

6 hr

**Improved Daytime**

**T/T_d/Wind**

12 hr

18th WRF Workshop • Surface Verification 13 June 2017 • 15
RAP BIAS Surface Summer (Three Weeks Jul 2016)

**RAPv4**

**RAPv3 (ops)**

12 hr fcsts

West US

East US

18th WRF Workshop • Surface Verification 13 June 2017 • 16
RAP/HRRR Cloud Building w/Smaller Size Distribution

No qnr/qni specified

qnr/qni specified at large values (small sizes)

More low clouds retained

18th WRF Workshop ● Cloud Verification

13 June 2017 ● 17
RAP TSS Ceiling Winter (Three Weeks Jan 2017)

RAPv4
RAPv3 (ops)
RAPv4-RAPv3

More Skill During Cold/Cloudy Outbreak 6-11 Jan

6 hr

12 hr
RAP TSS Ceiling Summer (Three Weeks Jul 2016)

RAPv4
RAPv3 (ops)
RAPv4-RAPv3

6 hr
RAPv4 better

12 hr
RAPv4 better

Ceiling Verification
13 June 2017
RAP CSI/BIAS Precipitation Winter (Three Weeks Jan 2017)

- **CSI**
  - 40 km

- **BIAS**
  - 13 km

**More Optimal Bias**

18th WRF Workshop  ●  Precip Verification  ●  13 June 2017  ●  20
RAP CSI/BIAS Precipitation Summer (Three Weeks Jul 2016)

RAPv4
RAPv3 (ops)

CSI
40 km

BIAS
13 km

More
Optimal
Bias

1 hr
6 hr
12 hr
RAP/HRRR: Hourly-Updating Weather Forecast Suite

- **13-km Rapid Refresh (RAPv4)** – to 39h (Feb 2018)
- **3-km High-Resolution Rapid Refresh (HRRRv3)** – to 36h (Feb 2018)
- **Initial & Lateral Boundary Conditions**
- **750-m HRRR nest Scale-ware Physics Testing (ongoing)**
- **3-km High-Resolution Time Lagged Ensemble (HRRR-TLE)**
- **3-km HRRR-Smoke (VIIRS fire data)**
- **3-km High-Resolution Rapid Refresh Alaska, Hawaii and Puerto Rico Testing (HRRR-AK, HRRR-HI, HRRR-PR) Experimental (ongoing)**
- **3-km Storm-Scale Ensemble Analysis and Forecast (HRRRE) 55% CONUS HRRR Experimental (ongoing)**
HRRR Improved Convective Forecasts

Experimental HRRRv3 13 hr fcst
Valid 00 UTC 17 May 2017

Composite Reflectivity Observations
00 UTC 17 May 2017

Operational HRRRv2 13 hr fcst
Valid 00 UTC 17 May 2017

More Accurate Convection Along Weakly-Forced Dryline
HRRR CSI/BIAS Precipitation Spring (Three Weeks May 2017)

HRRRv3

HRRRv2 (ops)

CSI
40 km

BIAS
3 km

More
Optimal
Bias

Optimal
HRRR CSI/BIAS Reflectivity Spring (Three Weeks May 2017)

HRRRv3
HRRRv2 (ops)

CSI
40 km

BIAS
3 km

More
Optimal Bias

Optimal

Optimal

Optimal

18th WRF Workshop  •  Reflectivity Verification
13 June 2017  •  25
RAP/HRRR: Hourly-Updating Weather Forecast Suite

13-km Rapid Refresh (RAPv4) – to 39h (Feb 2018)

3-km High-Resolution Rapid Refresh (HRRRv3) – to 36h (Feb 2018)

Initial & Lateral Boundary Conditions

Initial & Lateral Boundary Conditions

3-km High-Resolution Time Lagged Ensemble (HRRR-TLE)

3-km Storm-Scale Ensemble Analysis and Forecast (HRRRE)
55% CONUS HRRR Experimental (ongoing)

55% CONUS HRRR
Experimental (ongoing)

3-km Storm-Scale
Ensemble Analysis and
Forecast (HRRRE)

3-km HRRR-Smoke (VIIRS fire data)

3-km High-Resolution
Rapid Refresh Alaska,
Hawaii and Puerto Rico
Testing (HRRR-AK,
HRRR-HI, HRRR-PR)
Experimental (ongoing)

13 June 2017

18th WRF Workshop • Overview
Ceiling (True Skill Score) HRRR-AK vs NAM-NEST-AK (two weeks)

NAM-AK
HRRR-AK

6 hr
HRRR better

12 hr
HRRR better

NAM-HRRR

3000'
1000'
500' (rare)

TSS for NAM-NEST_AH-HRRR_AK, AK rgn, 6h, 3000 ft
TSS for NAM-NEST_AH-HRRR_AK, AK rgn, 6h, 1000 ft
TSS for NAM-NEST_AH-HRRR_AK, AK rgn, 6h, 500 ft

TTS for HRRR-AK, AK rgn, 6h, 3000 ft
TTS for HRRR-AK, AK rgn, 6h, 1000 ft
TTS for HRRR-AK, AK rgn, 6h, 500 ft

18th WRF Workshop  •  HRRR-AK Ceiling
13 June 2017  •  27
Visibility (True Skill Score) HRRR-AK vs NAM-NEST-AK (two weeks)

NAM-AK
HRRR-AK

6 hr
HRRR better

12 hr
HRRR better

NAM-HRRR

10 mi

NAM
HRRR
better

04 06 08 10 12 14 16
2017-05

ZERO 10 Visibility

| TSS for NAM-AK, AK crns, 6h lead of 10 mi, vis (1 d avg) |
| TSS for NAM-NEST-AK, AK crns, 6h lead of 10 mi, vis (1 d avg) |
| TSS for NAM-HRRR-AK, AK crns, 6h lead of 10 mi, vis (1 d avg) |
| TSS for NAM-HRRR-AK, AK crns, 6h lead of 10 mi, vis (1 d avg) |

12 hr

NAM
HRRR
better

04 06 08 10 12 14 16
2017-05

ZERO 2 Visibility

| TSS for NAM-AK, AK crns, 12h lead of 10 mi, vis (1 d avg) |
| TSS for NAM-NEST-AK, AK crns, 12h lead of 10 mi, vis (1 d avg) |
| TSS for NAM-HRRR-AK, AK crns, 12h lead of 10 mi, vis (1 d avg) |
| TSS for NAM-HRRR-AK, AK crns, 12h lead of 10 mi, vis (1 d avg) |

1 mi (rare)

NAM
HRRR
better

04 06 08 10 12 14 16
2017-05

ZERO 3 Visibility

| TSS for NAM-AK, AK crns, 6h lead of 1 mi, vis (1 d avg) |
| TSS for NAM-NEST-AK, AK crns, 6h lead of 1 mi, vis (1 d avg) |
| TSS for NAM-HRRR-AK, AK crns, 6h lead of 1 mi, vis (1 d avg) |
| TSS for NAM-HRRR-AK, AK crns, 6h lead of 1 mi, vis (1 d avg) |

13 June 2017
18th WRF Workshop • HRRR-AK Visibility
RAP/HRRR: Hourly-Updating Weather Forecast Suite

13-km Rapid Refresh (RAPv4) – to 39h (Feb 2018)

3-km High-Resolution Rapid Refresh (HRRRv3) – to 36h (Feb 2018)

Initial & Lateral Boundary Conditions

750-m HRRR nest Scale-ware Physics Testing (ongoing)

3-km High-Resolution Time Lagged Ensemble (HRRR-TLE)

3-km HRRR-Smoke (VIIRS fire data)

3-km High-Resolution Rapid Refresh Alaska, Hawaii and Puerto Rico Testing (HRRR-AK, HRRR-HI, HRRR-PR) Experimental (ongoing)

3-km Storm-Scale Ensemble Analysis and Forecast (HRRRE) 55% CONUS HRRR Experimental (ongoing)
**HRRRE 2017 (01 March – 30 June 2017)**

- Single core (ARW)
- Ensemble DA (DART and GSI-EnKF)
- RAP mean + GDAS perturbations w/more inflation
- Conventional observations
  - Radar reflectivity observations
  - Stochastic physics
  - Cloud analysis
  - Soil adjustments
  - HRRR-TLE post-processing

### Assimilation & Forecast

<table>
<thead>
<tr>
<th>Assimilation</th>
<th>Forecast</th>
</tr>
</thead>
<tbody>
<tr>
<td>36 members</td>
<td>12z – Nine members to 18 hrs</td>
</tr>
<tr>
<td>1 hr cycling</td>
<td>15z – Nine members to 18 hrs</td>
</tr>
<tr>
<td>15 fcsts / day</td>
<td>18z – Nine members to 18 hrs</td>
</tr>
<tr>
<td>Start 09z day one</td>
<td>21z – Nine members to 18 hrs</td>
</tr>
<tr>
<td>End 00z day two</td>
<td>00z – Nine members to 36 hrs</td>
</tr>
</tbody>
</table>

**Proof-of-concept**

Real-time demonstration

With NSSL Experimental WoF System for ensembles “NEWS-e”

Real-Time Web Graphics

https://rapidrefresh.noaa.gov/hrrr/HRRRE

55% CONUS HRRR

Topography height meters MSL

MAX 4183.78
MIN 0.00

HGT_M

4000 3750 3500 3250 3000 2750 2500 2250 2000 1750 1500 1250 1000 750 500 250

18th WRF Workshop  •  HRRRE Design  •  13 June 2017  •  31
Isolated Supercell
00z 15 April 2017

More Accurate Convection with CAM Ensemble DA in 0-6 hrs

Deterministic HRRR 6-hr Forecast
RAP/HRRR: Hourly-Updating Weather Forecast Suite

13-km Rapid Refresh (RAPv4) – to 39h (Feb 2018)

3-km High-Resolution Rapid Refresh (HRRRv3) – to 36h (Feb 2018)

Initial & Lateral Boundary Conditions

3-km Storm-Scale Ensemble Analysis and Forecast (HRRRE) 55% CONUS HRRR Experimental (ongoing)

750-m HRRR nest Scale-ware Physics Testing (ongoing)

3-km High-Resolution Time Lagged Ensemble (HRRR-TLE)

3-km HRRR-Smoke (VIIRS fire data)