Operational Impact of the QPF Component of the 2011 Spring Experiment

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Motivation

Flooding is a leading cause of weather-related deaths

"Improvements in QPF and mesoscale rainfall prediction need to be a top NWS research and training priority."

2009 SE US Flood Service Assessment
Motivation

“Warm season quantitative precipitation forecasts are, certifiably, the poorest performance area of forecast systems worldwide.”

Fritsch and Carbone (2004)
2011 HWT Spring Experiment
May 9 – June 10, 2011

• 3 components
  – Severe
  – Convective initiation
  – QPF

• ~80 participants representing operations, research, and academia
QPF Component

- GOAL: Document the strengths and limitations of the high resolution model guidance for QPF and determine how to best use experimental and operational data in a complementary manner

- Daily Activities
  - Probabilistic 6 hr QPFs
    - Valid 00Z, 06Z, and 12Z
    - 0.50” and 1.0” thresholds
    - Indicate highest possible amount within any 1.0” area
  - Forecast discussion
  - Subjective evaluation of experimental forecasts and model performance
## Experimental Model Guidance

<table>
<thead>
<tr>
<th>Provider</th>
<th>Model</th>
<th>Delta X</th>
<th>Notes</th>
<th>Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAPS</td>
<td>WRF/ARPS 24 member ensemble</td>
<td>4 km</td>
<td>Multi-model, multi-physics, multi-IC ensemble system with radar assimilation</td>
<td>SSEF</td>
</tr>
<tr>
<td>SPC</td>
<td>WRF/NMMB 7 member ensemble</td>
<td>4 km</td>
<td>Combination of available high resolution deterministic runs</td>
<td>SSEO</td>
</tr>
<tr>
<td>EMC</td>
<td>NMMB</td>
<td>4 km and 12 km</td>
<td>Pre-implementation version of the NAM</td>
<td>NMMB</td>
</tr>
<tr>
<td>NSSL</td>
<td>WRF-ARW</td>
<td>4 km</td>
<td>NAM initial and boundary conditions</td>
<td>NSSL WRF-ARW</td>
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<td>EMC</td>
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<td>NCEP HRW-NMM</td>
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<tr>
<td>EMC</td>
<td>WRF-ARW</td>
<td>5.1 km</td>
<td>NAM initial and boundary conditions</td>
<td>NCEP HRW-ARW</td>
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<tr>
<td>GSD</td>
<td>HRRR</td>
<td>3 km</td>
<td>Hourly updating with radar assimilation</td>
<td>HRRR</td>
</tr>
<tr>
<td>MDL</td>
<td>HRMOS</td>
<td>4 km</td>
<td>GFS-based statistical regression</td>
<td>HRMOS</td>
</tr>
</tbody>
</table>
Experimental Ensemble Products

Probability matched mean—combines the spatial pattern of the ensemble mean QPF with the frequency distribution of the rainfall rates (Ebert 2001)

Bias corrected mean—running 14 day bias correction applied to 6hr QPF

Ensemble maximum—Maximum from any member

Neighborhood probabilities—probability of an event occurring in the vicinity of a point

Spaghetti plots—contours outlining a selected precipitation amount
Forecast Valid 06Z 24 May 2011

6hr NSSLQ2 QPE valid 06Z 24 May 2011

4 km NMMB 6 hr QPF (30 hr forecast)
Results—Deterministic Models

Subjective Verification

2011 HWT Spring Experiment
Deterministic High Resolution Model Performance Compared to the NAM

<table>
<thead>
<tr>
<th>Models</th>
<th>Percentage Improved Guidance</th>
<th>Percentage Worse Guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCEP NMMB nest</td>
<td>31/56</td>
<td>2/56</td>
</tr>
<tr>
<td>NSSL WRF-ARW</td>
<td>30/67</td>
<td>5/67</td>
</tr>
<tr>
<td>NCEP HRW-NMM</td>
<td>25/69</td>
<td>12/69</td>
</tr>
</tbody>
</table>

DTC Objective Verification

HWT 2011 SE – Deterministic High Resolution Model Performance Compared to NAM

- NCEP NMMB nest
- NSSL WRF-ARW
- NCEP HRW-NMM
- NAM
- NCEP NMMB

0.50” threshold
Forecast Valid 06Z 9 June 2011

6hr NSSLQ2 QPE valid 06Z 9 June 2011

SREF mean 6 hr QPF (33 hr forecast)
Forecast Valid 06Z 9 June 2011

6hr NSSLQ2 QPE valid 06Z 9 June 2011

SSEF mean 6 hr QPF (30 hr forecast)
Forecast Valid 06Z 9 June 2011

6hr NSSLQ2 QPE valid 06Z 9 June 2011

SSEO mean 6 hr QPF (30 hr forecast)
Results—Ensembles

Subjective Verification

2011 HWT Spring Experiment
High Resolution Ensemble Performance Compared to the SREF

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<tr>
<th>Models</th>
<th>Percentage Improved Guidance</th>
<th>Percentage Worse Guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSEO</td>
<td>42/68</td>
<td>9/68</td>
</tr>
<tr>
<td>SREF</td>
<td>37/69</td>
<td>14/69</td>
</tr>
</tbody>
</table>

DTC Objective Verification

HWT 2011 SE – High Resolution Ensemble Performance Compared to SREF

Domain: DAILY, Event Equalizer: CN, Threshold 0.5" Evaluation Provided by DTC

0.50" threshold
Forecast Valid 00Z 12 May 2011

SSEF probability of exceeding 0.50”/6 hr (24 hr forecast)

SSEO probability of exceeding 0.50”/6 hr (24 hr forecast)
2011 HWT Spring Experiment
Ability to Capture 0.50"/6hr Rainfall Events

Percentage

<table>
<thead>
<tr>
<th>Model</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSEF</td>
<td>47/61</td>
<td>14/61</td>
</tr>
<tr>
<td>SSEO</td>
<td>28/64</td>
<td>36/64</td>
</tr>
<tr>
<td>SREF</td>
<td>49/64</td>
<td>49/64</td>
</tr>
</tbody>
</table>

HWT-EFP 2011 Spring Experiment - Reliability Diagrams

- SREF Prob (32 km)
- CAPS Nbrhd Prob (4km)
- CAPS Prob (4km)
- SSEO Prob (4km)

Forecasted Probability of Accum. Precip > 12.7mm

Observed vs. Forecasted Probability

Reliability"

Results—Ensembles
Operational Impact

• Small membership “poor man’s” ensembles can provide valuable forecast guidance
  – Can be run in real time at an operational center

• Spaghetti plots are a useful way to display information from multiple high resolution models on one display
Operational Impact

• Builds confidence in the use of high resolution models and ensembles
Conclusions and Future Work

- Participating in the HWT Spring Experiment has had a positive impact on HPC operations
  - Forecasters exposed to cutting edge research
  - Participation in testbed activities considered a reward

- SSEO performance demonstrates that a small membership “poor man’s” ensemble can provide useful QPF guidance
  - SSEO available at HPC

- Displays such as spaghetti plots can be used to condense information from multiple sources into a single visualization

- Working with NSSL to develop the Intense Precipitation/Flash Flooding (IPFF) supplement to the HWT