Verification at the DTC

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Overview

• Use of NCEP verification system
• Enhancements
  • Confidence Intervals
  • Model differences
• Development of Model Evaluation Tools (MET)
• Implementation of MET for DTC research
• Collaboration with HWT, HMT
• Future plans
Staff

Many staff members from NOAA GSD and NCAR RAL / DTC have contributed to the DTC verification efforts.
Use of NCEP verification system

- Matches up forecasts with observations.
- Computes a variety of traditional verification statistics.
- Accumulates forecasts over time.
- Lead time analysis.
Confidence and Model Differences

• Model comparisons difficult without confidence information.
• Since models compared on same cases, make use of pair-wise nature of the comparisons.
• Develop confidence on differences in statistics between two models.
Verification research

Statistical inference

- Traditionally, most verification scores have been reported with no information about uncertainty
  - Uncertainty is related to sampling variability, observation measurement error, representativeness
- Often, selection of models has been based on very small differences in scores; small samples
- Confidence intervals and significance tests provide information about uncertainty; allow more informed decision making
- Challenges:
  - Non-normal statistics
  - Spatial and temporal correlation
  - Observation uncertainty
  - Encouraging appropriate application of confidence intervals and significance tests
  - Practical significance vs. Statistical significance
Development of Model Evaluation Tools (MET)

• Started with NCEP verification system as baseline.
• Additional statistics
• Probabilistic forecast verification
• Confidence intervals
• Neighborhood methods
• Object-based verification (MODE)
• Intensity scale verification via wavelets
• Documentation, web site, email help.
MODE example

24-h precip forecast

Precip analysis

MODE quantitative results indicate forecast is good slightly displaced too intense

In contrast:

POD = 0.40
FAR = 0.56
CSI = 0.27
### What do the various methods measure?

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Traditional</th>
<th>Feature-based</th>
<th>Neighborhood</th>
<th>Scale</th>
<th>Field Deformation</th>
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<td>Indirectly</td>
<td>Indirectly</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Location errors</td>
<td>No</td>
<td>Yes</td>
<td>Indirectly</td>
<td>Indirectly</td>
<td>Yes</td>
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<tr>
<td>Intensity errors</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>No</td>
<td>No</td>
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<tr>
<td>Hits, etc.</td>
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<td>Yes</td>
<td>Yes</td>
<td>Indirectly</td>
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</table>
MET connections to the community

**Goals:**
Incorporate state-of-the-art methods contributed by the modeling, research, operational, and verification communities

**Examples:**
- Intensity-scale approach
- Neighborhood methods
- Graphical techniques

**Outreach**
- Collaborations with HWT, HMT
- Town Hall meetings at AMS, NCAR
  - International verification experts + NWP experts + DTC staff
  - Guidance on methods and approaches to be included
- Spatial method intercomparison project (ICP)
- DTC Visitor Program
  - M. Baldwin: Verification testbed
  - B. Casati: Intensity-scale approach
- Demonstrations
MET usage

• Initial release of MET July 2007.
• Over 300 registered users.
• Will be implemented to verify WRF for DTC tests this year.
• HWT spring experiment usage, 2008 and 2009.
• HMT usage expected beginning this fall.
Focus: Evaluate radar assimilation impact

Models and Obs:

- CAPS 4 km WRF-ARW with and without radar assimilation
- NOAA High Resolution Rapid Refresh (HRRR) grids for Vortex 2
- NMQ Q2 QPE and Composite Reflectivity

Displays:

- MET real-time evaluation at DTC
- Graphical results displayed on web-interface

DTC Participation:

- On-site participation for 5 weeks anticipated.
HMT Collaboration

- Verification is an initial, important area of collaboration

- Near-term goal: Implement and demonstrate existing capabilities
  - Event-based precipitation verification (varying thresholds)
  - MET traditional and spatial verification methods
  - Enhance tools to provide HMT-relevant information

- Longer-term goals: Enhance current capabilities
  - Observation uncertainty
  - Spatial verification methods for ensemble forecasts
  - Identify and implement capabilities needed for southeast region
Future Plans

- **MET**
  - More data formats.
  - Database and display.
  - Ensemble forecast methods.
  - Cloud verification.

- **DTC verification team**
  - Research new verification methods.
  - Promote use of MET.
  - Collaborate with WRF community.
Conclusions

- Verification is an essential component of the DTC mission.
- Verification is treated both as an independent scientific discipline and as a service.
- Collaborations can take advantage of either or both.