Performance of Precipitation Forecasts from a Convection-Permitting Ensemble Relative to Operational Guidance over the Western United States

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MOTIVATION

- Convection-permitting ensemble modeling systems are required to capture the large spatial variability and quantify the inherent uncertainty of precipitation forecasts in areas of complex terrain
  - Ensemble modeling systems remain largely untested at convection-permitting grid spacings (4-km or less) over the western U.S
  - Experimental NCAR Ensemble (10 members at 3-km) serves as an ideal platform for QPF validation study of next generation NWP

OBJECTIVES

- Determine the advantages of QPF from a cloud-permitting ensemble forecast system over complex terrain in the western US
  - Deterministic: How well does a single member of the NCAR Ensemble predict characteristics of precipitation?
  - Probabilistic: What is the reliability and resolution of probabilistic QPF from all 10 members of the NCAR Ensemble?

MODEL DATA

<table>
<thead>
<tr>
<th>Model</th>
<th>Resolution</th>
<th>Convection Permitting?</th>
<th>Forecasts Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCAR Ensemble Ctrl. (Member 1)</td>
<td>3-km</td>
<td>Yes</td>
<td>Hours 12-36 from 00Z</td>
</tr>
<tr>
<td>HRRRv1</td>
<td>3-km</td>
<td>Yes</td>
<td>Hours 3-15 from 09Z and 21Z</td>
</tr>
<tr>
<td>NAM-4km</td>
<td>4-km</td>
<td>Yes</td>
<td>Hours 12-36 from 00Z</td>
</tr>
<tr>
<td>NAM-12km</td>
<td>12-km</td>
<td>No</td>
<td>Hours 12-36 from 00Z</td>
</tr>
<tr>
<td>GFS</td>
<td>0.5 (~28-km)</td>
<td>No</td>
<td>Hours 12-36 from 00Z</td>
</tr>
<tr>
<td>NCAR Ensemble (10 Members)</td>
<td>3-km</td>
<td>Yes</td>
<td>Hours 12-36 from 00Z</td>
</tr>
<tr>
<td>GEFS (20 Members)</td>
<td>1.0 (~55-km)</td>
<td>No</td>
<td>Hours 12-36 from 00Z</td>
</tr>
<tr>
<td>ECMWF Ensemble (50 members)</td>
<td>0.5 (~28-km)</td>
<td>No</td>
<td>Hours 12-36 from 00Z</td>
</tr>
</tbody>
</table>

Table 1: Models used in study. Red shading indicates single member, deterministic models. Blue shading indicates multi-member, ensemble models. All data from 2015/2016 cool season.

OBSERVATIONAL DATA

SNOTEL
- Located in upper elevations
- Long-term storage gauges that report hourly precip to one-tenth of an inch (2.54 mm)
- Daily (12Z to 12Z) precip used

PRISM
- PRISM Group at Oregon State University
- Used to reveal model climatology
- 4-km gridded daily (12Z to 12Z) precip data
- Uses point data, spatial data, and a digital elevation model

SUMMARY

- Short range QPF from a single member of a convection-permitting ensemble performs very well relative to operational NWP over the western US
  - NCAR Ensemble Control has strong bias (~1), moderate/high accuracy, modest ability capturing large events
  - HRRR performs similarly well, but has advantage of shorter range forecasts
- Short range QPF from a convection-permitting ensemble performs better compared to GEFS and ECMWF Ensemble over the western US

*See regional results on poster 1177

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