Uncertainties in Extend-Range Precipitation Forecasts: Model Biases or Predictability Limits

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• The CFSv2 skill is low in predicting the DJF precipitation anomalies over the US west coast.

• **Question:** Is the low skill in the CFSv2 due to the model biases or inherent predictability limits?
Analysis approach

• Assess the average skill for predicting DJF precipitation over the US west coast (wCoast) in seven models from the North American Multi-Model Ensemble (NMME), specifically,
  – How is CFSv2 skill compares to that in other models?

• Analyze the US west coast precipitation ENSO response in individual models for individual El Niño events, specifically,
  – To what extent the response in individual El Niño events differ from the composite, i.e. the sensitivity in response to the amplitude or to the flavors of ENSO SSTs?

• Analyze the precipitation ENSO response over the US southeast area (seCoast), where the skill is high, specifically,
  – Whether the SNR is also higher, and the consistency in responses is higher as well?
Data

• **Model data:**
  
  – 1-month-lead December-January-February (DJF) mean precipitation ensemble forecasts from seven dynamical climate forecast systems in the NMME (Kirtman et al. 2014);
  
  – 1982-2010 hindcasts and 2011-2016 real-time forecasts;

<table>
<thead>
<tr>
<th>Model</th>
<th>Ensemble size</th>
<th>Initial conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFSv2</td>
<td>24</td>
<td>00, 06, 12, 18UTC on Oct. 18, 23, and 28, and Nov. 2, 7, and 12</td>
</tr>
<tr>
<td>A</td>
<td>10</td>
<td>00UTC on Nov. 1</td>
</tr>
<tr>
<td>B</td>
<td>10</td>
<td>00UTC on Nov. 1</td>
</tr>
<tr>
<td>C</td>
<td>10</td>
<td>00UTC on Nov. 1</td>
</tr>
<tr>
<td>D</td>
<td>10</td>
<td>00UTC on Nov. 1</td>
</tr>
<tr>
<td>E</td>
<td>24</td>
<td>00UTC on Nov. 1</td>
</tr>
<tr>
<td>F</td>
<td>11</td>
<td>4 members every 5th day in Nov and 7 members on the last day of Oct.</td>
</tr>
</tbody>
</table>

• **Observation data:**

  – Precipitation: the CPC monthly precipitation reconstruction over land (PREC-L, Chen et al. 2002);

• Seasonal mean anomalies based on climatology of 1982-2010;
Validation of precipitation variability in model forecasts

- All models replicated the observed north-south variations in DJF precipitation climatology and its STDV, although there are differences in details.
- The ENSO linear signal in all models is similar to the typical ENSO signal patterns with negatives in north and positives in south.
- Differences in amplitude of linear responses across models.
- A stronger response does not necessarily lead to higher prediction skill.
The prediction skill across all the models is unanimously low. Further, the SNR is low for all models, and there is also a lack of correspondence between SNR and skill. No indication of low prediction skill in the CFSv2 is due to model biases; it is likely due to inherent noise in nature.
Precipitation response in individual models during individual El Niño events
Precipitation response during individual El Nino events

models

years
Consistency in the precipitation responses across El Niños

- Lower consistency in the observation due to contribution from noise;
- Good consistency in the NMME both over northern and southern areas;
- Different levels of consistency for different models, stronger consistency over the northern than southern;
- The consistency depends on the SNR in the models;
- High consistency in the response does not necessarily lead to high skill.
Consistency in the Precipitation responses across models during different El Niño events

- High consistency in the northern latitudes than over southern parts; but it does not result in higher skill there;
- No clear indication of definitive conclusions for the consistency across models;
- The model responses have different signs from the observed anomalies in most of events;
- May indicate the contributions from the large noise in observation (unpredictable).
• The consistency across different El Niños in model responses is high.
• The consistency across different models is high and improves as the El Niño amplitude gets stronger.
• The model responses has the same sign with the observed anomalies for moderate to strong events.
• All facts are consistent with higher skill.
Summary

• Low skill in CFSv2 for predicting seasonal mean precipitation along the US west coast was also found in predictions from other NMME models;

• Various analysis approaches point to a low SNR regime;

• For low SNR regions, it is hard to make inferences about higher order influence of ENSO (even with large datasets).