ENSO Simulations in the North American Multi-Model Ensemble: A First Look

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ENSO Impacts

- Strong influence on the seasonal P and T patterns around the globe and over the U.S.
- Improved P and T forecast skill in climate models can be attributed to the known impacts of ENSO signals.
ENSO Prediction

Questions:

• Can climate models predict the onset of ENSO events?
• If ENSO is in progress, can climate models adequately predict its impacts on P and T patterns?
NMME is an experimental multi-model seasonal forecasting system consisting of coupled climate models from U.S. modeling centers and Canadian Meteorological Centre, aimed at improving intraseasonal to interannual prediction capability.

- The multi-model ensemble approach has proven effective at quantifying prediction uncertainty due to uncertainty in model formulation, and has proven to produce better forecast quality (on average) than any single model ensemble.

- CTB NMME documents:
  http://www.cpc.ncep.noaa.gov/products/ctb/nmme/

- CPC NMME forecasts:
  http://www.cpc.ncep.noaa.gov/products/NMME/
<table>
<thead>
<tr>
<th>Model</th>
<th>Hindcast Period</th>
<th>No. of Member</th>
<th>Arrangement of Members</th>
<th>Lead (months)</th>
<th>Model Resolution: Atmosphere</th>
<th>Model Resolution: Ocean</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCEP-CFSv2</td>
<td>1982-2010</td>
<td>24</td>
<td>4 members (0,6,12,18Z) every 5th day</td>
<td>0-9</td>
<td>T126L64</td>
<td>MOM4 L40 0.25 deg Eq</td>
<td>Saha et al. (2014)</td>
</tr>
<tr>
<td>GFDL-CM2.1</td>
<td>1982-2010</td>
<td>10</td>
<td>All 1st of the month 0Z</td>
<td>0-11</td>
<td>2x2.5deg L24</td>
<td>MOM4 L50 0.30 deg Eq</td>
<td>Zhang et al. (2007)</td>
</tr>
<tr>
<td>CMC1-CanCM3</td>
<td>1981-2010</td>
<td>10</td>
<td>All 1st of the month 0Z</td>
<td>0-11</td>
<td>CanAM3 T63L31</td>
<td>CanOM4 L40 0.94 deg Eq</td>
<td>Merryfield et al. (2013)</td>
</tr>
<tr>
<td>CMC2-CanCM4</td>
<td>1981-2010</td>
<td>10</td>
<td>All 1st of the month 0Z</td>
<td>0-11</td>
<td>CanAM4 T63L35</td>
<td>CanOM4 L40 0.94 deg Eq</td>
<td>Merryfield et al. (2013)</td>
</tr>
<tr>
<td>NCAR-CCSM3</td>
<td>1982-2010</td>
<td>6</td>
<td>All 1st of the month</td>
<td>0-11</td>
<td>T85L26</td>
<td>POP L40 0.3 deg Eq</td>
<td>Kirtman and Min (2009)</td>
</tr>
<tr>
<td>NASA-GEOS5</td>
<td>1981-2010</td>
<td>11</td>
<td>4 members every 5th days; 7 members on the last day of the previous month</td>
<td>0-9</td>
<td>1x1.25deg L72</td>
<td>MOM4 L40 1/4 deg at Eq</td>
<td>Rienecker et al. (2008)</td>
</tr>
</tbody>
</table>
ENSO Composites

- The ENSO composite analysis is conducted using the 1982-2010 hindcasts from each of the six models in NMME.
- Composite years are selected based on the historical Ocean Nino Index (ONI).
- If the seasonal ONI just prior to the date the forecasts were initiated indicates a warm or cold ENSO episode, the forecasts are selected for the composite analysis.
- The composites apply to monthly mean conditions in November, December, January, February, and March, respectively, as well as to the five-month aggregates (NDJFM) resembling the winter conditions.
- The NMME composites are the equally weighted mean of the six models’ composites.
### Selected years used in the ENSO composite analysis

<table>
<thead>
<tr>
<th>Month</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENSO</td>
<td>Warm</td>
<td>Cold</td>
<td>Warm</td>
<td>Cold</td>
<td>Warm</td>
</tr>
<tr>
<td>Years</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total No. of years</td>
<td>8</td>
<td>7</td>
<td>10</td>
<td>9</td>
<td>10</td>
</tr>
</tbody>
</table>
El Nino Winter Patterns (Global)

Observations:

- NDJFM

Tanom:

- Warm
- Wet
- Dry & Warm

Panom:

- Warm
- Wet
- Dry
- Cool

NMME Forecasts:

- Warm
- Wet
- Dry
El Nino Tanom Composites (Global)

El Nino Composite for Ensemble Tanom Lead-1 Forecasts

a) Nov forecasts (IC: 100100)
b) Dec forecasts (IC: 110100)
c) Jan forecasts (IC: 120100)
d) Feb forecasts (IC: 010100)
e) Mar forecasts (IC: 020100)
f) NDJFM forecasts (5-month average)

El Nino Composite for Tanom Observations

c) Jan
b) Dec
d) Feb
e) Mar
f) NDJFM (5-month average)
El Nino Panom Composites (Global)

El Nino Composite for Ensemble Panom Lead-1 Forecasts

a) Nov forecasts (IC: 100100)

El Nino Composite for Panom Observations

a) Nov

b) Dec forecasts (IC: 110100)

b) Dec

c) Jan forecasts (IC: 120100)

c) Jan

d) Feb forecasts (IC: 010100)

d) Feb

e) Mar forecasts (IC: 020100)

e) Mar

f) NDJFM forecasts (5-month average)

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La Nina Winter Patterns (Global)
La Nina Panom Composites (Global)

La Nina Composite for Ensemble Panom Lead-1 Forecasts

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b) Dec forecasts (IC: 110100)

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c) Jan

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El Nino Winter Patterns (US)
El Nino Panom NDJFM Composites (US)

NMME

Obs

CFSv2

CMC1

CMC2

GFDL

NASA

NCAR
La Nina Winter Patterns (US)

La Nina Composite for Tanom NDJFM Observations

La Nina Composite for NMME Tanom NDJFM Forecasts

Tanom

Obs

NMME

Panom
La Nina Tanom NDJFM Composites (US)

NMME

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CMC1

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GFDL

NASA

NCAR
La Nina Panom NDJFM Composites (US)

NMME

Obs

CFSv2

CMC1

CMC2

GFDL

NASA

NCAR
Summary

• NMME simulate ENSO P patterns well during wintertime. All models are reasonably good.
• There are discrepancies between the model and observed composites for T anomaly over the U.S.
• The T differences are dominated by the large discrepancies in NASA, GFDL, and CMC2 models.
• The T differences are sensitive to how global warming is simulated in these models (a different topic).
• Model T composites do not capture the seasonal evolution over Asia for both El Nino and La Nina events.
• Further investigation is underway.
Thank you and questions

NMME ENSO webpage:

http://www.cpc.ncep.noaa.gov/products/NMME/enso/

Contact: lichuan.chen@noaa.gov
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El Nino Composite for Ensemble Tanom Lead-1 Forecasts

La Nina Composite for Ensemble Tanom Lead-1 Forecasts

El Nino

La Nina
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