JMA’s Ensemble Prediction System for One-month and Seasonal Predictions

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  - Products on Tokyo Climate Center (TCC) web site

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  - Physics (cumulus parameterization, radiation)
  - Initial perturbation

- Future Plan
  - Introducing a CGCM into seasonal forecast
Outline of EPS

**One-month Forecast**
- \( T_L \): 1.125 deg \( \sim 110 \) km
- \( L40 \): model top = 0.4 hPa
- Ensemble size: 50
- I. Perturbation: BGM/LAF
- Frequency: **Once a week**
- Forecast period: 34 days
- Land: SiB
- SST: **Persisted anomaly**

**Seasonal Forecast**
- \( T_L \): 1.875 deg \( \sim 180 \) km
- \( L40 \): model top = 0.4 hPa
- Ensemble size: 51
- I. Perturbation: SV
- Frequency: **Once a month**
- Forecast period: 120/210 days
- Land: SiB
- SST: Prescribed using persisted anomaly, climatology and ENSO prediction by CGCM
Products on TCC web site

Tokyo Climate Center (TCC)


->”NWP Model Prediction”

One-month Forecast
28-day average
(1\textsuperscript{st}, 2\textsuperscript{nd}, 3\textsuperscript{rd} & 4\textsuperscript{th} weeks)
Elements: Z500, T850, Psea, VP200, RAIN, SF200, SF850, T2m, SST (persisted)

Three-month Forecast
Warm/Cold season (JJA/DJF) Forecast

Initial:
Products on TCC web site

- Experimental Probabilistic forecasts (three-month average)
- T2m, Precipitation

11th ECMWF workshop on Meteorological Operational Systems  
12-16 November 2007
Verification is also available on TCC web site operationally.

One-month forecast
28-day average
Initial:
27 Sep, 2007
Products on TCC web site

- Verification is also available on TCC web site operationally.

For Z500 during 2006/07 winter

<table>
<thead>
<tr>
<th>Event</th>
<th>Hit Rate (%)</th>
<th>False Alarm Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH</td>
<td>0.740</td>
<td>9-15 day</td>
</tr>
<tr>
<td>NH</td>
<td>0.789</td>
<td>2-29 day</td>
</tr>
</tbody>
</table>

(Anomaly>0)

One-month forecast
### Verification: Setting of Hindcast

<table>
<thead>
<tr>
<th><strong>One-month Forecast</strong></th>
<th><strong>Seasonal Forecast</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1982-2001 (20 years)</td>
<td>1984-2005 (22 years)</td>
</tr>
<tr>
<td>Initial date:</td>
<td>Initial date:</td>
</tr>
<tr>
<td>10(^{th}), 20(^{th}) and the end of each month</td>
<td>10(^{th}) of each month</td>
</tr>
<tr>
<td>Ensemble size: 5</td>
<td>Ensemble size: 11</td>
</tr>
</tbody>
</table>

- Initial condition: **JRA-25**
- SST: **COBE-SST** (Ishii et al. 2005)
  
  (ENSO prediction by JMA-CGCM is also used for hindcast of seasonal forecast)
- Data for verification: **JRA-25/J CDAS, ERA15-GANAL, ERA40, GPCP, CMAP**
Verification: One-month Forecast

- Anomaly Correlation: $Z_{500}$ over NH

![Bar chart showing anomaly correlation for different dates and initial dates.]

- Day 2-8: JUL = 0.9, JAN = 0.9
- Day 9-15: JUL = 0.4, JAN = 0.4
- Day 2-29: JUL = 0.5, JAN = 0.5

Initial date:
- JUL: 30 Jun
- JAN: 31 Dec
Verification: One-month Forecast

- ROC scores: Z500, Anom>0 over NH (from operational prediction; each season)

![Line graph showing the ROC scores for different time periods: 9-15 day, 16-29 day, 2-29 day, and the average from SPR/2001 to SUM/2007.](image)
Verification: Seasonal Forecast

- ROC for T2m / 3-month average
- Upper tercile / Northern Hemisphere / all season

![ROC for T2m / 3-month average](image)

<table>
<thead>
<tr>
<th>Lead</th>
<th>ROC Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-month</td>
<td>0.691</td>
</tr>
<tr>
<td>4-month</td>
<td>0.658</td>
</tr>
</tbody>
</table>
Verification: Seasonal Forecast

- ROC for Precipitation / 3-month average
  Upper tercile / Northern Hemisphere / all season

0.600

1-month lead

0.586

4-month lead
Recent Developments

- Cumulus parameterization
  - Trigger function (DCAPE)
- Radiation
  - Shortwave absorption by water vapor
  - Aerosol Climatology
- Initial Perturbation (BGM; for one-month forecast)
  - Extract growing mode associated with the instability of the MJO (Chikamoto et al. 2007)
- Implementation
  - One-month forecast : Mar. 2007~
  - Seasonal forecast : Sep. 2007~
Trigger Function (DCAPE)

- Incorporated a trigger function based on DCAPE (dynamic CAPE generation rate; Xie and Zhang 2000) into the cumulus parameterization.
- Convective precipitation occurs when DCAPE > 0.

\[
DCAPE = \frac{[\text{CAPE}(T^*, q^*) - \text{CAPE}(T, q)]}{\Delta t}
\]

\[
T^* = T + (\frac{\partial T}{\partial t})_{\text{adv}} \times \Delta t
\]

\[
q^* = q + (\frac{\partial q}{\partial t})_{\text{adv}} \times \Delta t
\]
Trigger Function (DCAPE)

- Trigger function is expected to suppress weak precipitation.
- The number of no precipitation days becomes closer to those of observation (GPCP-1DD) in tropics.

Distribution of the number of no precipitation days per month (July)
Shortwave Absorption by Water Vapor

- Shortwave absorption increases in troposphere.
- Low temperature bias seen in mid-latitude is reduced.

Zonal mean temperature error in JJA

11th ECMWF workshop on Meteorological Operational Systems 12-16 November 2007
Aerosol Climatology

- Use realistic aerosol distribution based on satellite observations with seasonal change.

Optical thickness associated with aerosol at 850hPa

OLD

NEW
Improvement in bias of clear-sky shortwave radiation flux at TOA over the ocean.

Difference of clear-sky shortwave radiation flux at TOA between model and observation (ERBE)
Growing mode associated with the instability of the MJO is able to be obtained selecting appropriate magnitudes of norm. (Chikamoto et al. 2007)

Velocity Potential at 200hPa
Initial perturbation (1st BV) on 26 Nov. 2003

Large scale mode (3.3%)
Convective mode (0.33%)
Initial Perturbation (BGM)

- Forecast skill around equator using the new initial perturbations is better than that using the old perturbations.

### Anomaly correlation [20°S-20°N]

#### Initial date: 21 Dec, 2006

50 members
In 2010, JMA plans to introduce a CGCM into seasonal forecast, which is a new version of JMA’s operational ENSO forecast model from Mar 2008.

<table>
<thead>
<tr>
<th>AGCM</th>
<th>J MA/ MRI Unified AGCM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tl95L40 (horizontal resolution ~ 180km)</td>
</tr>
<tr>
<td>OGCM</td>
<td>MRI.COM Ishikawa et al. (2005)</td>
</tr>
<tr>
<td></td>
<td>75S-75N, 0-360E</td>
</tr>
<tr>
<td></td>
<td>horizontal resolution: lon 1.0°, lat 0.3-1.0°</td>
</tr>
<tr>
<td></td>
<td>vertical resolution : 50 levels</td>
</tr>
<tr>
<td></td>
<td>(23 levels in the upper 200m)</td>
</tr>
<tr>
<td>Coupler</td>
<td>coupling interval : 1 hour</td>
</tr>
<tr>
<td></td>
<td>flux adjustment for heat and momentum flux</td>
</tr>
</tbody>
</table>
Forecast skill of SSTs with the new version of CGCM is better than that with the current CGCM for ENSO forecast.

*Period: 1979-2005
*1 member forecast started from the end of every month (NOT ensemble forecast)
Forecast Skill of Precipitation

- JMA/MRI-CGCM shows better skill than the current seasonal prediction model

ROC for Precipitation in JJA

*Period: 1984-2005 (22 years)
*10-member ensemble forecast started from the end of January

11th ECMWF workshop on Meteorological Operational Systems   12-16 November 2007
JMA/MRI-CGCM shows better skill than the current seasonal prediction model.

ROC for T2m in DJF

Four months lead
Upper tercile

*Period: 1984-2005 (22 years)
*10-member ensemble forecast started from the end of January
Summary

- JMA’s products and verifications for one-month and seasonal forecasts are available on TCC website.
  

- Developments for one-month and seasonal forecast models have been done to improve forecast skills.

- Future Plan: In 2010, JMA plans to introduce a CGCM into seasonal forecast.
Thanks!

“Harerun”, JMA’s mascot