The JMA operational seasonal forecast system and applications

Shoji Hirahara¹, Yuhei Takaya¹, Satoko Matsueda¹, Tamaki Yasuda², and ITACS development team¹

¹ Tokyo Climate Center (TCC) / Climate Prediction Division, the Japan Meteorological Agency (JMA)
² Climate Research Department, the Meteorological Research Institute, Japan Meteorological Agency (MRI-JMA)
1. The JMA operational Seasonal Ensemble Prediction System (EPS)

2. “ITACS” : The *Interactive Tool for Analysis of the Climate System*
Current and *Next version* of the JMA operational Seasonal EPS

white-blue shades: sea ice concentration (Sep2007)
white dots: AGCM grids
rainbow shades: sea surface temperature

<table>
<thead>
<tr>
<th></th>
<th>JMA/MRI-CGCM1 (Feb. 2010 - )</th>
<th>JMA/MRI-CGCM2 (Feb. 2015? - )</th>
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</thead>
<tbody>
<tr>
<td><strong>Atmosphere</strong></td>
<td><em>TL95L40</em>, ~180km, Up to 0.4hPa</td>
<td><em>TL159L60</em>, ~110km, Up to 0.1hPa</td>
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<tr>
<td>(JMA –AGCM)</td>
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<td>Stochastic Tendency Perturbation</td>
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<td><strong>GHG forcing</strong> in the IPCC RCP4.5 scenario</td>
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<td><strong>Ocean</strong></td>
<td>1.0º (lon) x 0.3-1º (lat) L50</td>
<td>1.0º (lon) x 0.5º (lat), tripolar, L52</td>
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<td>(MRI.COM: Usui et al 2006, Tsujino et al 2010)</td>
<td><strong>Sea-ice climatology</strong></td>
<td><strong>Sea-ice dynamics</strong></td>
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<td><strong>Coupler</strong></td>
<td>1-hour coupling interval</td>
<td>1-hour coupling interval</td>
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<td>(Scup: Yoshimura and Yukimoto 2008)</td>
<td><em>Momentum and heat flux adjustment</em></td>
<td><em>No flux adjustment applied</em></td>
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Asian Summer Monsoon

- Improved representation of the Asian summer monsoon
- Higher horizontal resolution in AGCM
- Seasonal typhoon forecast
Sea ice model

- The sea ice model reasonably reproduces mean distribution of sea ice edges and year-to-year variability of sea ice area in the Arctic.
- The forecast skill is greater when initiated in the melting season and verified for the growing season (e.g. Chevallier and Salas-Melia 2012).
- The major source of forecast skill comes from the long-term decrease of sea ice area.
- This partly explains the model’s improved representation of the linear warming trend in 2m temperatures in the Arctic.

Fig. Mean positions of sea ice edge (15% level of SIC) in September at lead time of 5 months in the model (purple line) and in the analysis (green line, COBE-SST(Ishii et al. 2005)), and mean error of sea ice concentration (shades).

Fig. Analysed (black) and forecasted anomalies of sea ice extent (solid line) in September at lead times of 2 (red) and 5 months (green) and their trends (left, dash line).
We need an analysis tool that …

More and more components are being incorporated in climate models (sea ice, stratosphere, aerosols), enabling recent progress in operational forecast.

But still,

- model outputs need to be checked/corrected before used, based on:
  - model bias and forecast skill
  - estimated with the long-term hindcasts.

In checking these, an analysis tool would help which

- is easy enough for operational use
- includes ready-to-use datasets.
  - observation/analys + forecast/hindcast
“ITACS” : The Interactive Tool for Analysis of the Climate System

- A web-based data analyzer & visualizer
- Various datasets ready
- Results shareable via a URL
- Legacy Fortran/C codes + Ruby + JavaScript + GrADS
- Open to domestic researchers and NMHSs since 2009
  - 100+ users from 37 countries
User Interface

http://ds.data.jma.go.jp/tcc/tcc/
> click the “ITACS” logo

Dataset
(CLIMAT reports, atmospheric and ocean reanalysis, OLR, one-month forecasts, ...)

Area
(Lat/Lon/Vertical level)

Statistics period
time filter

Analysis method
(Regression, composite map, EOF, SVD, Fourier analysis, wavelet analysis)

Graphic option

Submit button

Submit button

Submit button
Examples

Wavelet Analysis on NINO 3.4 index

Regression Analysis between OLR and NINO.3 index with six months lag

Wave Activity Flux at 200hPa in DJF 2011-2012

Composite map of ocean subsurface temperature in recent years (2000-)

EOF Analysis on 500hPa Height in Jan.
The Advisory Panel on Extreme Climate Events (since 2007-)

Quick, coordinated analysis on the ongoing extreme climate event
Outlook for the event based on the latest operational forecast

The common infrastructure (a data server, analysis tools, and a simple user-interface) has played a big role in this framework.

“what kind of physical processes made the forecast good/bad for this event?”

Extremely cold winter in the East Asia (DJF 2011-2012)
ITACS is currently used when forecasters want to know statistical estimation based on observation/analysis to understand the accuracy of their forecasts. A technical infrastructure is desirable, that provides a more casual way to do analysis with observation/analysis and forecast/hindcasts to share knowledge on a model we use.

Next ITACS will include decades of hindcasts to improve the forecast system.
Summary

- The JMA seasonal EPS is to be upgraded in early 2015.
- ITACS will be upgraded soon to include the hindcasts for the current operational model.
- This kind of tools has been revealed to be useful in operational climate monitoring and forecasting.
- One way of boosting up operation-research cycle is a handy tool and easy access to observation/analysis and forecast including hindcast.
Thank you for your attention

Acknowledgement:
GrADS is kindly provided as an open source software by the Center for Ocean-Land-Atmosphere Studies (COLA), USA.
Available Datasets

- **CLIMAT** reports (stored at JMA since 1982)
- Atmospheric reanalysis, **JRA-25** (Onogi et al. 2007)
- Sea Surface Temperature, **COBE-SST** (Ishii et al. 2005)
- Ocean reanalysis, **MOVE** (Usui et al. 2006)
- The NOAA Interpolated **Outgoing Longwave Radiation** (Liebmann and Smith 1996)
- **Arbitrary time series** submitted online by users
- Ensemble forecasts of the JMA **One-Month EPS (ens. mean only)**
• Staratocumulus (Wood and Bretherton 2006)
• Cloud overwrap (Nagasawa, 2013)
• Sub-cloud model (Jacob and Siebesma 2003)
• Second-order moment advection (Prather 1986)
• Skin SST (Takaya et al 2010) etc.
• Sea ice (Smolarkiewicz 1984; Hunke and Lipscomb 2006)
• Stochastic Tendency Perturbation: Palmer et al 2009
Examples

- Latitude-Longitude Map
- Polar Stereographic Map
- Vertical Cross Section
- Time-Longitude Cross Section
- Time-Series Graph
Typhoon Forecast : 1998

Analysis

850-hPa Streamline & Rain (JJASO)

Forecast (ensemble)

850-hPa Streamline & Rain (JJASO)

TC Days Anomalies (days / Jun-Oct)

JMA/MRI-CGCM1

850-hPa Streamline & Rain (JJASO)

TC Days Anomalies (days / Jun-Oct)

cf.) Nakazawa (2001)