6.4 El Niño Forecast Model

An El Niño forecast model has been operated since July 1998. The model is a coupled ocean-atmosphere general circulation model. The atmospheric component and flux adjustment method were improved in July 2003. Frequency of the forecast model integration was increased from twice a month to every 5 days in June 2005. The model is introduced briefly below.

6.4.1 Model and performance

JMA operates a coupled ocean-atmosphere model for the prediction of El Niño and the Southern Oscillation (ENSO). The oceanic part of this model is identical to the ocean general circulation model (OGCM) used for the ODAS (see 6.3). The atmospheric component is a lower resolution version of the global spectral model (GSM0103) which JMA used for the operational numerical weather prediction until 2003 (JMA, 2002).

The coupling takes place every 24 hours, the ocean model giving the sea surface temperature (SST) to the atmospheric model, and the atmospheric model providing the daily mean heat and momentum flux to the ocean model. The fresh water flux is not given, and the salinity in the ocean is restored to the climatology at higher latitudes and deep layers. When coupled, the simulated fields would approach the model climate state, which is substantially different from the average state of the real ocean and atmosphere. In order to suppress this climate drift, the adjustment is made to both the heat flux and wind stress. The adjustment amounts for the ocean model and the atmospheric one were estimated separately for each initial month and lead time as the difference between the model flux and the observation based flux. The ocean and atmospheric models were integrated separately for 17 months to estimate model flux biases from 150 initials between April 1986 and July 1992. The ocean model was integrated with the observation based momentum and heat fluxes as forcing the model SSTs to the observed ones. The atmospheric model was integrated

Atmospheric Component	Basic equation	Primitive
	Domain	Global
	Resolution	T42, 40 vertical levels
	Cumulus Convection	Prognostic Arakawa-Schubert scheme
	Land surface process	Simple Biosphere (SiB)
	Planetary boundary layer	Mellor & Yamada Level 2
Oceanic Component	Basic equation	Primitive, rigid rid
	Domain	Global except the Arctic Ocean
	Resolution	2.5° (lon) x 2.0° (lat), (2.5° (lon) x 0.5° (lat) near equator) 20 vertical levels
	Vertical diffusion	Mellor & Yamada Level 2.5
Coupling	Frequency	Every 24 hours
	Flux correction	Both for momentum and heat flux

Table 6.4.1 Specifications of the El Niño Forecast Model

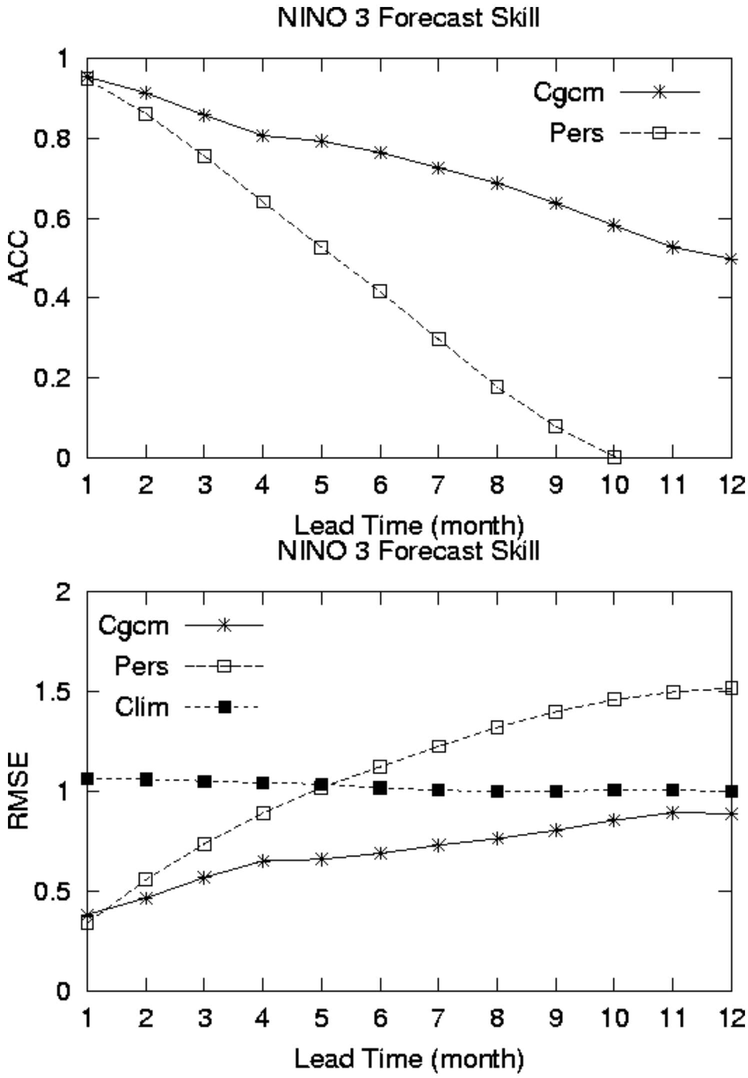

Fig. 6.4.1 The performance of the El Niño Forecast Model in anomaly correlation (upper) and root mean square error (lower) in the period from 1988 to 1999. Asterisk, open square and solid square denote the model forecast, persistence forecast and climatological forecast respectively.

with observed SSTs. The observation based momentum flux is the wind stress calculated from JMA global atmospheric analysis using the bulk formulae and the observation based heat flux is evaluated from ECMWF 15-year Re-analysis data provided by ECMWF. The specifications of the model are summarized in Table 6.4.1.

The atmospheric initial conditions are taken from the JMA global atmospheric analyses, and the ocean initial conditions are from the ODAS. The model is run every 5 days and the output is used for the six month outlook of the ocean and atmospheric conditions in the equatorial Pacific.

Figure 6.4.1 shows the performance of the model in terms of the anomaly correlations and root mean square errors (RMSE) of the NINO.3 (5°N-5°S, 150°W-90°W) sea surface temperature anomalies for 141 hindcast experiments from 1988 to 1999. The anomaly correlations of persistence, and the RMSEs of persistence and climatology are shown for reference. The anomaly correlation for six months lead time is nearly 0.8 and that for a lead time of twelve month is around 0.5. The RMSE against the climatological forecast and the persistence forecast shows that the model is skillful for the lead time from two to twelve months compared to climatology and persistence.

6.4.2 Products

Based on the model prediction, JMA issues the outlook of ENSO for six months in "Monthly El Niño Monitoring Report". Figure 6.4.2 is a sample chart that is attached to the report. This figure indicates a time series of the monthly sea surface temperature (SST) deviation for NINO.3 region. The thick line with closed circles shows the

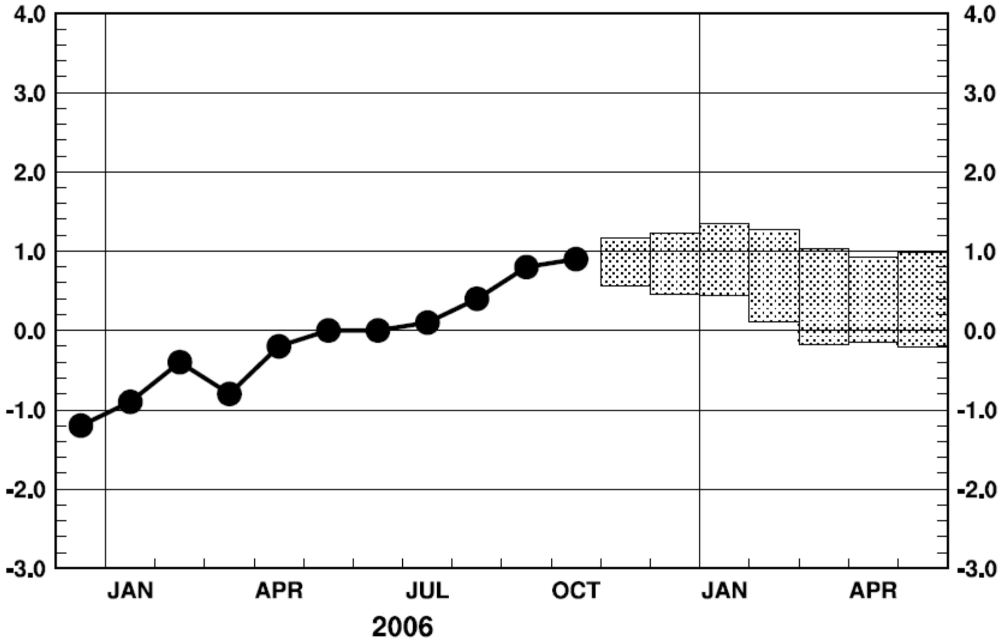

Fig. 6.4.2 ENSO outlook by the Model Output Statistics applied to the output of the El Niño Forecast Model. See the text for explanation.

observed SST deviation available at the time of the issuance, and the boxes show the prediction which is based on an average of latest twelve forecast members from which systematic biases are subtracted. The boxes indicate the range within which the SST deviation is predicted to fall with the probability of 70%. This chart is available through JMA's Distributed Data Base (http://ddb.kishou.go.jp).

6.4.3 Future plan

JMA plans to replace the El Niño forecast model with new one having higher oceanic and atmospheric resolutions in March 2008. The atmospheric part of the model is a lower resolution version (TL96L40) of the global atmospheric model now in operation for the numerical weather prediction (see 4.2). To improve the feature of heat, momentum and fresh water fluxes at the sea surface, several physical parameterizations in the model are changed from the operational one. The oceanic part of the model is identical to the new OGCM described in the future plan of ODAS (see 6.3).

Reference

Japan Meteorological Agency, 2002: Outline of the operational numerical weather prediction at the Japan Meteorological Agency. *Appendix to WMO numerical weather prediction progress report* 157pp.