GENERAL INFORMATION OF LONG-RANGE FORECASTS IN KOREA METEOROLOGICAL ADMINISTRATION

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1. System run schedule and forecast ranges

KMA produces three types of long-range weather forecasts: 1-month, 3-month (seasonal), and 6-month forecast (experimental). The 1-month forecasts are issued three times a month and include temperature, precipitation, and air pressure pattern for the next 30 days. The 3-month forecasts which are produced at monthly basis include the trends of temperature, precipitation including special seasonal events such as Asian dust, Typhoon and Changma for the next 3 months. The 6-month forecast is issued two times a year(May and November). The system run schedule and products are listed in Table 1.

Table 1. Basic properties of system run schedule and products

	1-month forecast	3-month forecast	6-month forecast
Issue Date	· 3rd , 13th, and 23rd day of each month	· 23rd day of each month	· 23rd day of May and Nov.
Spatial resolution	2.5° × 2.5°		-
Spatial coverage	Global		-
Lead time	About 3 weeks		-
Output type	Images		-
Forecast type	Three type categories : above, below and near normal The anomalies are based on model climatology obtained from a 24 year database(1979 to 2002).		
Contents	· 10-day mean temperature and precipitation · 30-day mean temperature and precipitation	· 1-month mean temperature and precipitation · 3-month mean temperature and precipitation *1 *Asian dust outlook* *2 *Typhoon outlook* *3 *Changma outlook*	· 1-month mean temperature and precipitation (Jun. to Nov./Dec. to May)
Forecast area	Temperature : whole Korea Precipitation : whole Korea	Temperature : whole Korea Precipitation : whole Korea	Temperature : whole Korea Precipitation : whole Korea

*[1] *Asian dust outlook* is issued in late February including frequency and density of Asian dust expected to affect Korea for the upcoming Spring.
*[2] *Typhoon outlook* is issued in late May and Aug. regarding number of Typhoon expected to affect Korea for the upcoming Summer and Fall.
*[3] *Changma outlook* is issued in late May regarding or duration and intensity of Changma .

2. Extended range forecasts (10 days to 30 days)

For the extended range forecast system, KMA has been operating global climate model with predicted sea surface temperature (2-Tier system). To predict the global sea surface temperature as a boundary condition for the 2-tier system, the global ocean forecasting system has been developed as a combined system of dynamical and statistical models. The global long-range forecasting system, using global climate models, is also being developed, and the SMIP2/HFP-type climatology for each model is produced for removing model bias and improving predictability. Detailed information about the model climatology is given in Table 2. The official products of extended range forecasts are 3-categorical forecasts of temperature and precipitation over Korea (see Table 1).

Table 2. Description of SMIP2/HFP Experiment

SMIP2/HFP Experiment		
Experiment design		24-year integration(1979-2002) 4-month integration for each case
Ensemble member		20 ensemble members
Initial member		00 & 12Z of 10 days for each case
Initial condition	Atmosphere	NCEP/NCAR reanalysis(U,V,T,q,Ps)
	Land surface	Climatology
Boundary condition	SST and sea ice	Predicted SST using dynamical and statistical prediction model
	Etc.	Same as SMIP2

2.1 Global Climate Model

The operational extended forecasts system is based on the global spectral model, GDAPS (Global Data Assimilation and Prediction System) with horizontal resolution of T106 and 21 vertical levels of hybrid sigma-pressure coordinate. For the Ensemble forecasts, we utilize 20 ensemble members by lagged average method with about 15-day forecast lead-time (see Table 2). Detailed model description is summarized in Table 3.

Table 3. Detailed description for global climate model

		GDAPS (Operational model)
Major Physics	Cloud Convection	Kuo (1974)
	Land Surface & PBL	SiB; Yamada-Meller (1982)
	Radiation	Lacis & Hansen (1974) for SW, Roger & Walshaw (1966); Glodman & Kyle (1968); Houghton (1977) for LW
	Large scale condensation	Kanamitsu et al.(1883)
Dynamics		Three-dimensional global spectral model with hydrostatic primitive equations Hybrid sigma-pressure coordinate Semi-implicit method
Resolution		T106L21
Ensemble size		20 members
Sea Surface Temperature		Predicted SST anomaly
Land Surface Initial Condition		Observed Climatology
Model Climatology		SMIP2/HFP simulation (1979 to 2005)
Forecast range		1-month forecast 3-month forecast 6-month forecast

2.2 Global sea surface temperature forecasting system

The El Nino prediction system (Kang and Kug, 2000) is based on the intermediate ocean and statistical atmosphere model. The ocean model differs from the Cane and Zebiak (1987) model in the parameterization of subsurface temperature and the basic state. The statistical atmosphere model is developed based on the singular value decomposition (SVD) of wind stress and SST.

To reduce the uncertainty of initial field on the ENSO model, the breeding technique is applied. In the case of an ideal experiment, it works for better predictability, while for our El Nino prediction model, its effect is not so clear because it has weak nonlineality. Therefore, it shows some possibilities to contribute the improvement of predictability for the complicated future ENSO prediction using coupled GCM.

In order to improve the western Pacific SST prediction, KMA introduced the heat flux formula and vertical mixing parameterization to the ocean model. The initialization of the model is done by combining observed SST and wind stress. Wind stress is calculated by using the 925hPa wind of NCEP/NCAR reanalysis data. The method with calculated wind stress for initialization has a better forecast skill than that with FSU wind stress in recent predictions (Kug et al., 2001). In addition, the present prediction is attended with random noise considered weather noise, and generates many sets of prediction. Our approach for random noise is similar to Kirtman and Schopf (1998).

Then, to correct the systemic error in the prediction model, the statistical model is also applied. The used Coupled Pattern Projection Model (CPPM, Lee and Kang 2003) is a kind of pointwise regression model, and the main idea of the model is to generate realization of predictions from projections of covariance patterns between the large-scale predictor field and regional predictions onto large-scale predictor field at the target year. By applying this model to the dynamic model results and compositing the results from both the dynamical and statistical models, the predictability over the tropical Pacific is improved than before.

To predict the whole global SST, a statistical global SST prediction system is being developed by combining Coupled Pattern Projection Model (CPPM), Lagged Linear Regression Method (LLRM), El Nino prediction model, and persistence method. In the tropical Pacific, predictions produced by El Nino prediction model are used, and in other regions the best results between CPPM, LLRM, and persistence are used. The LLRM is one of the point wise statistical model based on the lag relationship between the global SST and ENSO index and the optimal lag is selected by the hindcast process in the model. This is developed to determine predict the Indian SST prediction. Using this global ocean forecasting system, the boundary conditions for the global climate model are also produced.

3. Long range forecasts (30 days up to two years)

The long range forecast system is the same as the extended range forecast system described in section 1 except the forecast range. The official products of extended range forecasts are 3-categorical forecasts of temperature and precipitation over Korea for the upcoming 3 months (see Table 1).

For the long range forecasts, we also utilize the multi model ensemble (MME) technique which has been developed and operated by APEC Climate Center (APCC). The APCC collects the historical and real-time forecast data of 15 different models from 8 countries and constructs the automatic MME input data producing system. The APCC has developed various MME techniques for deterministic and probabilistic seasonal predictions. For deterministic forecast, three kinds of linear MME techniques are used, namely biased and unbiased simple composite, weighted combination of multi-models based on SVD, and MME with statistical corrections. For probabilistic forecast, three tercile ranges are determined by ranking method based on the percentage of ensemble members from all the participating models in those three categories. Moreover, regional MME system version MME I-IV has been developed for Asian Monsoon region.

4. References

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