Numerical weather forecast and digital forecast at KMA

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1 Overview of KMA's NWP system

Korea Meteorological Administration (KMA) has been operating global and regional NWP models since 1989. The main issues in KMA weather forecast are to produce seamless forecast from very-short range to seasonal scale and to issue more user-oriented quantitative forecast. Under the frame of seamless forecast, KMA operates global (T426L40), global ensemble (T213L40, 17members), and climate (T106L21, 20 members) models for the medium- and long-range forecasts. KMA produces 3 types of long-range forecasts: 1-month, 3-month (seasonal), and 6-month forecast.

To address the second issue KMA has been developing 'digital forecast', a post-processing procedure using numerical weather forecast and model output statistics. Digital forecast aims to deliver quantitative and detailed weather information in space and time. It has been semi-operationally tested since 2005 up to 2 days forecast, and further development is on going to extend its forecast range to a medium-range. Overall flows of NWP are illustrated in Fig. 1.

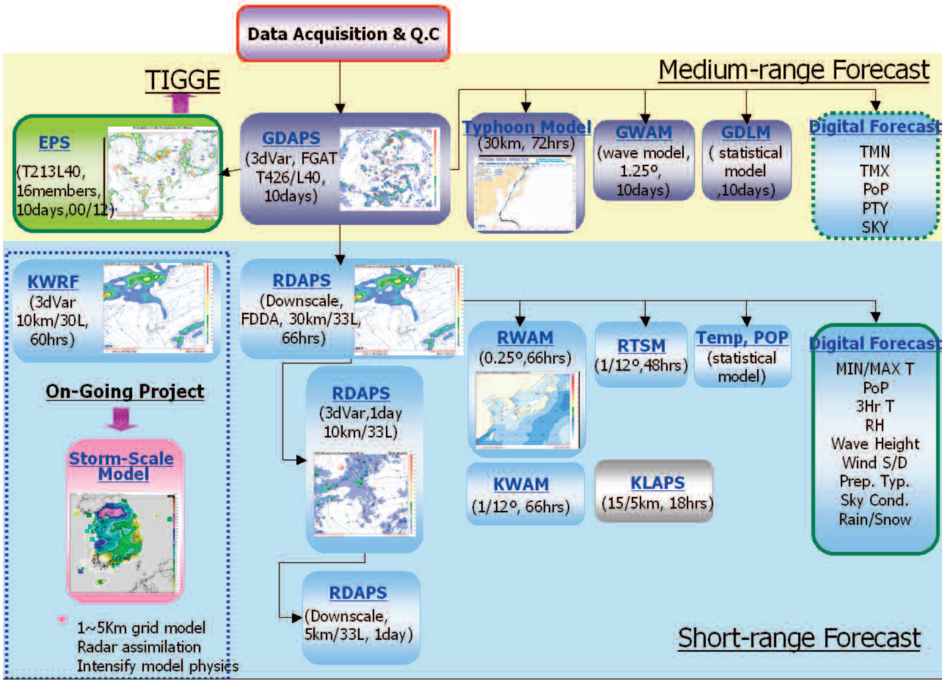

Fig. 1 Schematic diagram of KMA's NWP system for short and medium range forecast.

2 Medium-range forecast: EPS

The global ensemble prediction system (EPS), based on breeding method with global model (T106L21) was made operational in 2001. As the horizontal and vertical resolution of the operational global forecast model was enhanced from T213L30 to T426L40 in December 2005, high-resolution global ensemble prediction system (T213L40) was constructed and was made operational in June 2006.

An ensemble of 16 members is obtained using a rotated bred vector method, i.e. apply factor rotation after 12-hours of initial growing of perturbation and then foster perturbation for another 12-hours. Global EPS runs twice a day up to 10 days at 00 and 12 UTC to support weekly forecast. A post-processing using a decaying average bias estimation method (Bo Cui, 2000) has been introduced to the operation since 30 July 2007.

KMA participates in the WMO THORPEX TIGGE program and provides global ensemble products to the TIGGE archive centers since December 2006 (in operational mode since December 2007), and the standard verification scores of EPS will be regularly exchanged through the EPS verification web-site hosted by JMA. The main characteristics and changes of the global EPS is summarized in the table 1.

Operation period	2001.3.1 ~	2003.11.1 ~	2006.7.-
Data assimilation	2dOI → 3dOI	3dOI → 3dVar	3dVar
Model	GDAPS T106L21	GDAPS T106L30	GDAPS T213L40
Vertical resolution	21 levels	30 levels	40 levels
Perturbation method	Breeding	Breeding + Factor Rotation	Breeding + Factor Rotation
Target area (BV)	Global	Northern Hemisphere	Northern Hemisphere
Run per days	1 (12UTC)	1 (12UTC)	2 (00, 12UTC)
Lead time	10 days	8 days	10 days
Ensemble members	16 (16 members + 1 control)		(16+1)*2 members

Table 1. Main characteristics and changes of the global EPS at KMA.

3 Multi-model test using TIGGE ensemble

Ten operational weather forecasting centers producing daily global ensemble forecasts have agreed to deliver in near-real-time a selection of forecast data to the TIGGE data archives at CMA, ECMWF and NCAR. This is offered to the scientific community as a new resource for research and education. As of Feb 2008 all the providers are sending their ensemble forecasts to the archive centers in operational mode, with initial dates varying from Autumn 2006 to Autumn 2007. The archive length is therefore longer than one year for some centers.

Several sets of multi-model tests has been performed using available data from centers with long data period to see the impact of the way combining ensembles and possible gains from it. Fig.2 shows a preliminary result. Combining ensembles from ECMWF and UKMO together gives a slight gain over ECMWF over Northern Hemisphere in the forecast of 500 hPa geopotential height. But it produces much more gain over tropics, where two ensembles skill is not high. The gain becomes higher when bias-correction to the original ensemble is applied.

Through this preliminary test the value of TIGGE data in the predictability study and other research field has been proved. Users are encouraged to explore the TIGGE data.

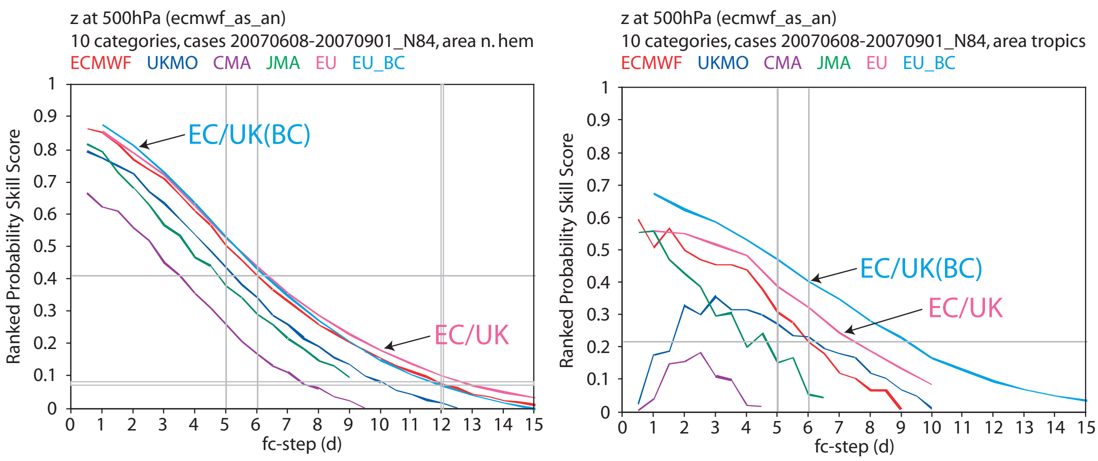

Fig. 2 Ranked probability skill score for Z500 over (a) NH and (b) tropics. Solid lines are for the single ensemble systems (ECMWF: red, UKMO: blue, CMA: purple, JMA: green) and dashed lines are for the combined ensembles (combined EC and UKMO: magenta, and bias-corrected combined EC and UKMO: cyan line), with biases estimated using a 30-day training period.

4 Digital Forecast

A survey about people's opinion on KMA's service showed that there was a strong demand for detailed and quantitative meteorological services. Public do not want weather information at a weather station, but at their house. They felt the use of meteorological data is too difficult. Private sector requires easy handling data to reproduce new application information, too. NWP output is used by only very limited area. This is one of important barrier to develop application information.

KMA has developed a Digital Forecast System (DFS) to address these demands, aiming a detailed and quantitative forecast in various formats, which is easy to apply. Fig.3 shows the changes in weather forecast by introducing digital forecast. DFS is consists of 4 main components (Fig. 4). First global/regional atmospheric and wave models produce NWP output, and then together with observation these NWP products are interpreted using MOS and PPM. Using these guidance forecasters edit the temporal and spatial distribution using GEM (Graphical Editing Module). These modified forecast and observations archived in the DFS DB and used for verification and WEM (WEb service Module).

The short-range digital forecast has been in semi-operation since Oct 2005. It provides quantitative forecast for 12 weather forecast elements every three hours out to 48 hours based on village-scale. Efforts are put on the improvement of the forecast skill before operation.

KMA is also developing a medium-range digital forecast system using output from the global model up to 10 days.

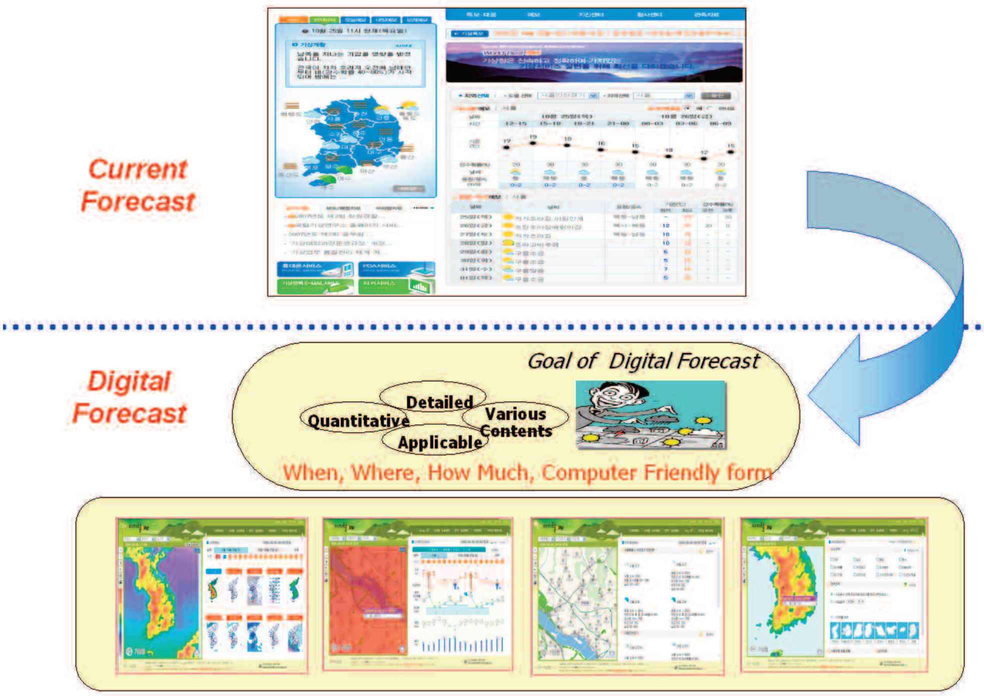

Fig. 3 The changes in weather forecast by introducing digital forecast.

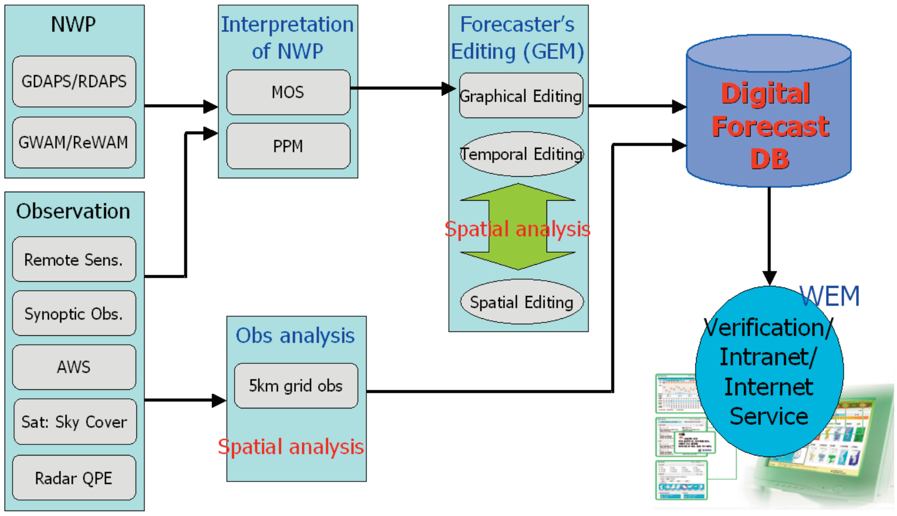

Fig. 4 Schematic structure of digital forecast.

Acknowledgements

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