Progress Report on the Global Data Processing and Forecasting System in 2005

Korea Meteorological Administration
Republic of Korea

1. Summary of highlights

In 2005, the main changes to the global and regional versions of the numerical prediction suites were the followings:

25th May Sea surface wind data retrieved from the QuikSCAT satellite is assimilated in the Global Data Assimilation and Prediction System (GDAPS). The Planetary Boundary Layer(PBL) operator is applied to interpolate model first guess to the observation level.

1st August Humidity profile is retrieved from the MTSAT-1R using HUMSAT like approach and the profile is assimilated in the GDPAS.

30th November New supercomputer Cray X1E was completely installed.

1st December The GDAPS improved its resolution from T213L30 to T426L40 owing to the complete installation new super computer Cray X1E at KMA .

1st December The outer loop resolution of GDAPS is improved from T213L30 to T426L40 and the inner loop is also improved from T63L30 to T106L40. The climatologic constraint of zonal averaged vorticity is applied in the cost function formulation to keep better zonal wind climatology at the lower stratosphere of the tropics.

2. Equipment in use at the KMA

The supercomputer Cray X1E-3/192-L is dedicated for the operation of the short, medium and long-range numerical weather prediction including climate simulation.

💻 Supercomputer: Cray X1E-3/192-L

-Peak Performance：15.7 T Flops

-Memory ：4.96T bytes

- Single CPU performance: 18.08G flops

-Direct Attached Storage ：62T bytes

-SAN Disk : 20Tbytes

3. Data and products from GTS in use

More than 5,000 synoptic observations, and various asynoptic observations, including satellite retrieval data, are used daily in the GDAPS. Table 1 presents the types and numbers of the observation that are available from the GTS. The pre-processing procedures such as data acquisition, quality control and decoding, are fully automated. The percentage of data used in data assimilation means the rate of final data used in assimilation to total input data (the percentage of data used in data assimilation in 2004 report showed the rate of the data after 1st QC to total input data).

Table 1. The types and numbers of observations received through GTS, and the percentage of data used in global data assimilation for 24 hours in 2005.

	Data type	Number of data/day	% used in assimilation
1	SYNOP/ SHIP	42,500	49
2	BUOY	7,782	84
3	TEMP/ PILOT	1,759	91
4	AIREP/ AMDAR/ACARS	219,102	8
5	SATEM	29,289	39
6	SATOB	20,341	87
7	ATOVS	108,347	18
8	AWS	5,518	57
9	PAOB	400	100
10	Wind profiler	332	36

4. Data input system

Fully automated system

5. Quality control system

Various real-time quality control checks are performed for each observation received from GTS.

6. Monitoring of the observing system

Most of observations are monitored in terms of availability and quality.

7. Forecasting System

7.1 System run schedule and forecast ranges

The GDAPS for 10-day projection runs at 00 UTC and 12 UTC with 2.5-hour data cutoff. The 84-hour projection is used for short-range weather forecasts, weekly forecast and for the provision of lateral boundary condition for the two high-resolution (10km and 5km with 33 layers) regional models. The RDAPS runs twice a day (00 and 12 UTC) for 48-hour forecasts. Four typhoon track forecasts are obtained from DBAR, RDAPS, GDAPS (T426/L40), and EPS when typhoon appears in Western Pacific. In addition, there are two types of applied models; Wave models for wave height and direction on both global and regional domain, and two statistical models of Perfect Prog Method (PPM) and Kalman Filter (KF) method for probability of precipitation and max/min temperature, respectively.

KMA produces three types of long-range weather forecasts: 1-month, 3-month (seasonal), and 6-month forecast. 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 forecast 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 2.

Table 2. Long range forecasting 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.
Forecast type	Three type categories : above, below and near normal The anomalies are based on model's climatologies obtained from a 27 year database(1979 to 2005).		
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 .

7.2 Medium-range forecasting system

7.2.1 Data assimilation, objective analysis and initialization

The global analysis is prepared with the 6-hour update cycle. A 6-hour forecast from the previous run provides a first guess for the next analysis. If a typhoon exists in the Western Pacific, a typhoon bogus profile is calculated and the profiles are assimilated in 3dVar as an observation with observation error which is determined statistically. The best fits of analysis are made with the 3dVar system.

The moisture profile is selected based on the cloud information derived from MTSAT-1R imaginary data and the profile is assimilated in 3dVar. The direct assimilation of ATOVS radiance data (level 1D type) is embedded in the 3dVar system to refine the temperature and moisture field especially over the ocean and stratosphere. The wind profiler data that was newly operated at four locations over the Korean peninsula is merged to the wind profiler data over the Japan and the U.S.A. The wind profiler data are also assimilated to correct the wind background over the globe. Sea surface wind data retrieved from the QuikSCAT satellite is assimilated using the PBL operator that is based on the MRF PBL method. The assimilation of QuikSCAT reduces the bias of typhoon track forecast and improves GDPAS performance in the Southern Hemisphere and the Tropics.

A Non-linear Normal Mode Initialization (NNMI) with full physics is performed to suppress the amplitude of high-frequency gravity waves. The high frequency component is filtered out for each spherical harmonic component in the five greatest vertical modes that exceed the critical frequency. Machenhauer's iterative scheme is used for determining the non-linear balanced solution.

The analysis resolution of global 3dVar is increased in accordance with the improvement of model resolution. The outer loop increase its resolution from T213L30 to T426L40 and the inner loop is also improved from T63L30 to T106L40. The analysis top becomes higher from 10 to 0.4 hPa. Increased resolution can produce detailed analysis structures and acquire more stable performance. However, increased vertical resolution simulates unrealistically strong zonal wind at the lower stratosphere in the Tropics. The climatologic constraint of zonal averaged vorticity is applied in the cost function formulation and GDPAS can produce realistic zonal wind climatology at the lower stratosphere in the Tropics.

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7.2.2 Model

Dynamics	
Basic equation	Primitive equations in sigma- pressure hybrid vertical coordinate
Numerics	Spectral representation of horizontal variables with triangular truncation of T426, corresponding to a Gaussian grid size of 0.28125 degrees or 30km
Domain	Global
Levels	40 vertical levels ranging from surface to 10 hPa
Time integration	Eulerian semi-implicit scheme

Physics	
Horizontal diffusion	Second order Laplacian, and Rayleigh friction
Moist processes	Kuo scheme, large-scale condensation, and shallow convection scheme
Radiation	Long wave radiation calculated every three hours Short wave radiation calculated every hour

Gravity wave drag	Long waves (wavelength>100km) Short waves (wavelength 10km)
PBL processes	Non-local diffusion scheme and similarity theory for surface layer
Land surface	Simple biosphere model
Surface state	NCEP daily SST anomaly added to monthly changing climatological SST Climatological values are used for the soil moisture, snow depth, roughness length and albedo

7.2.3 Numerical weather prediction products

NWP products are automatically generated from NWP systems of KMA. Various model outputs, including the potential vorticity at isentropic surface, are available in both graphic and imagery form. Those products are also disseminated to the end users through intranet of KMA or Internet (http://www.kma.go.kr/eng/wis/wis04_nwp01.jsp).

. A statistical model with KF produces 3-hourly temperature forecasts including the maximum and minimum temperature for 61 domestic stations up to 48 ~ 84 hours in advance. 10 days maximum and minimum temperatures are also provided by the KF method. The Probability of Precipitation (PoP) for 12 hour forecast of four sets up to 2 days are derived with PPM

7.2.4 Operational techniques for application of NWP products

The 6-hour forecast of GDAPS is used for the first guess in the analyses of regional model and the steering flow of typhoon model. The surface winds predicted by GDAPS and RDAPS are used as an input for the global and regional wave model. The wind field predicted by GDAPS is also used as an input for the trajectory model of yellow sand.

7.2.5 Ensemble prediction system

An ensemble prediction system (EPS), based on breeding method with global model (T106/L30), has been operational since Mar. 2001. An ensemble of 16 members is obtained from the sequence of 6-hour breeding cycle. The EPS runs once a day up to 8 days at 12 UTC to support weekly forecast. The probability of gust and precipitation by EPS can be accessed at KMA homepage (http://www.kma.go.kr/eng/wis/wis04_nwp04.jsp). The standard verification scores of EPS will be regularly exchanged through the JMA.

7.3 Short-range forecasting system

Assimilation	Four-dimensional Data Assimilation with nudging
First guess	GDAPS previous 6-hour prognosis
Observations	SYNOP, TEMP, PILOT, ACARS, SATEM, and SATOB with 12 hour interval Radar data for 10km grid spacing with 3-hour interval AWS for 10km and 5km grid spacing with 3-hour interval
Method	3 Dimension Optimal Interpolation/3dVar (10 km)
Variables	Wind, geopotential height, and relative humidity
Vertical levels	33 model sigma levels

Dynamics	
Grids	Triply nested domain (30km for 171 x 191, 10km for 160 x 178 and 5km for 141 x 141 gird points)
Numerics	Primitive equations based on the non- hydrostatic frame
Vertical resolution	33 layers with the model top of 50 hPa
Boundary condition	Time and inflow/ outflow dependent relaxation
Boundary update Frequency	30km : 12-hour interval by GDAPS forecasts 10km : 3- hour interval by 30km forecasts 5km : 3- hour interval by 10km forecasts
Time integration	48 hours for 30km mesh, and 24 hours for both 10km and 5km meshes

Physics	
Horizontal Diffusion	Fourth order diffusion
Precipitation physics	Explicit moisture scheme
Deep convection	New Kain-Fritch only for 30 km and 10km grid spacing
Planetary layer	Non-local boundary layer
Surface physics	5-layer soil model for ground temperature
Radiation	Simple cloud scheme

7.4 Specialized numerical predictions

Ocean wave prediction system

Two numerical wave models are currently on operation: Global WAve Model (GoWAM) and Regional WAve Model (ReWAM). Both models are adopted from the 3rd generation WAM model cycle 4 (developed by WAMDI group). Table 3 shows the description of wave models.

Table 3. The operational wave models at KMA

	GoWAM	ReWAM
Source Code	WAM model cycle 4	WAM model cycle 4
Coordinate	Spherical coordinate	Spherical coordinate
Spatial Domain	70°S-70°N	20°N-50°N, 115°E-150°E
Spatial Resolution (Dim.)	1.25° (288 by 113)	0.25° (141 by 121)
Spectral Resolution	25 frequency 24 direction	25 frequency 24 direction
Integration Time Step	720 second	360 second
Lead Time	240 hour (12UTC)	48 hour (00/12UTC)
Elapsed Time	12 minute	2.5 minute
Initial Condition	Previous 24 hour forecast	Previous 12 hour forecast
Sea Surface Wind Input	GDAPS 12-hour interval	RDAPS 3-hour interval

Typhoon track prediction system

Typhoon track forecasts are provided from four different models, the Double Fourier Series BARotropic typhoon prediction model (DBAR), GDAPS (T213/L30), RDAPS (30km grid spacing), and EPS. As a typhoon model at KMA, the Barotropic Adaptive grid Typhoon System (BATS) was replaced by DBAR in 2004. The DBAR is based on the continuous dynamic grid adaptation technique with the innermost grid spacing of 0.3 degrees. This model is specially designed to run with high resolution grids within little computational load. It runs four times a day by 6-hour interval.

Double Fourier Series Barotropic Typhoon Prediction Model (DBAR)

Input Data	GDAPS analysis and prognosis
Vortex Bogusing And Initialization	Geophysical Fluid Dynamics Laboratory (GFDL) bogussing
Dynamics	Spectral method using Double Fourier Series
Basic equation	Shallow water equations on the latitude-longitude coordinate
Horizontal representation	Grid distance of 0.356°

Domain	1024 x 512
Products	Central position (lat./lon.) every 6 hours up to 72 hours in advance.

7.5 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 4. The official products of extended range forecasts are 3-categorical forecasts of temperature and precipitation over Korea (see Table 2).

Table 4. Description of SMIP2/HFP Experiment

SMIP2/HFP Experiment		
Experiment design		27-year integration(1979-2005) 4-month integration for each case
Ensemble member		20 ensemble members
Initial member		00, 06, 12 & 18Z of 5 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

7.5.1 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 4). Detailed model description is summarized in Table 5.

Table 5. Detailed description for global climate model

<table>
<tr><td></td><td></td><td>GDAPS(Operational model)</td></tr>
<tr><td rowspan="5">Major Physics</td><td>Cloud Convection</td><td>Kuo (1974)</td></tr>
<tr><td>Land Surface & PBL</td><td>SiB;
Yamada-Meller (1982)</td></tr>
<tr><td>Radiation</td><td>Lacis & Hansen (1974) for SW,
Roger & Walshaw (1966);
Glodman & Kyle (1968);
Houghton (1977) for LW</td></tr>
<tr><td>Large scale condensation</td><td>Kanamitsu et al.(1883)</td></tr>
<tr><td colspan="2">Dynamics</td><td>Three-dimensional global spectral model with hydrostatic primitive equations
Hybrid sigma-pressure coordinate
Semi-implicit method</td></tr>
<tr><td colspan="2">Resolution</td><td>T106L21</td></tr>
<tr><td colspan="2">Ensemble size</td><td>20 members</td></tr>
<tr><td colspan="2">Sea Surface Temperature</td><td>Predicted SST anomaly</td></tr>
<tr><td colspan="2">Land Surface Initial Condition</td><td>Observed Climatology</td></tr>
<tr><td colspan="2">Model Climatology</td><td>SMIP2/HFP simulation (1979 to 2005)</td></tr>
<tr><td colspan="2">Forecast range</td><td>1-month forecast
3-month forecast
6-month forecast</td></tr>
</table>

7.5.1 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.

7.6 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 7.5 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 2).

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 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.

8. Verification of prognostic products

The summary of annual verification statistics for GDAPS is calculated by comparing the model forecast to the analysis and radiosonde observation (see Table 6.1 and 6.2). Table 7.1 to 7.5 present detailed monthly verification statistics for GDAPS, by comparing the model forecast to the analysis.

Table 6.1. RMSE verification of KMA's global model (GDAPS) against the analysis in 2005.

Statistic	Area.	T+24 hr	T+72 hr	T+120 hr
Z500	Northern Hemisphere	17.56	43.10	70.49
Z500	Southern Hemisphere	26.26	59.83	89.86
V250	Northern Hemisphere	6.37	12.91	18.46
V250	Southern Hemisphere	7.29	14.90	20.30
V250	Tropics	6.19	10.34	12.18
V850	Tropics	3.13	4.91	5.71

Table 6.2. RMSE verification of KMA's global model (GDAPS) against observation in 2005.

Statistic	Area.	T+24 hr	T+72 hr	T+120 hr
Z500(geopotential height)	North America	18.71	46.95	66.23
Z500	Europe	17.13	42.20	77.70
Z500	Asia	18.86	34.84	49.76
Z500	Australia/ New Zealand	19.94	40.41	65.73
V250(wind)	North America	8.40	16.35	20.63
V250	Europe	7.18	14.00	21.63
V250	Asia	8.02	12.32	15.80

Statistic	Area.	T+24 hr	T+72 hr	T+120 hr
V250	Australia/ New Zealand	8.95	14.22	19.26
V250	Tropics	8.34	10.22	11.77
V850	Tropics	4.85	5.62	6.30

Table 7.1. Monthly mean RMSE of 500 hPa geopotential height forecast (m) in Northern Hemisphere (GDAPS verification against analysis).

FCST	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
24H	20.70	19.32	18.41	17.15	15.40	15.67	15.25	14.45	15.62	19.02	20.98	18.69	17.56
72H	54.16	49.15	45.50	42.88	38.03	37.20	33.98	33.12	35.81	48.58	51.35	47.46	43.10
120H	88.83	82.75	77.88	70.79	65.38	59.17	52.80	52.44	57.76	76.55	83.26	78.28	70.49

Table 7.2. Monthly mean RMSE of 500 hPa geopotential height forecast (m) in Southern Hemisphere (GDAPS verification against analysis).

FCST	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
24H	23.76	22.14	24.50	24.87	26.45	28.82	28.22	28.07	29.20	23.18	31.72	24.13	26.26
72H	51.29	49.52	55.72	57.96	61.77	67.24	67.88	68.04	65.67	51.37	66.18	55.37	59.83
120H	75.94	72.94	83.21	90.98	99.91	102.91	100.80	103.94	97.41	79.60	90.04	80.58	89.86

Table 7.3. Monthly mean RMSE of 250 hPa wind forecast (m/s) in Northern Hemisphere (GDAPS verification against analysis).

FCST	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
24H	7.01	6.58	6.69	6.41	6.15	6.10	6.02	5.91	5.91	6.11	7.11	6.4	6.37
72H	14.17	13.03	12.67	12.39	12.32	12.43	11.96	12.02	12.21	14.73	13.97	13.03	12.91
120H	20.26	18.69	18.29	17.76	17.81	17.43	16.49	16.98	17.49	21.61	19.97	18.73	18.46

Table 7.4. Monthly mean RMSE of 250 hPa wind forecast (m/s) in Southern Hemisphere (GDAPS verification against analysis).

FCST	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
24H	7.12	6.38	7.40	7.36	7.53	7.73	7.58	7.35	7.62	6.27	8.54	6.55	7.29
72H	13.80	13.84	14.82	14.90	15.28	15.61	15.63	15.06	15.28	14.01	15.85	14.66	14.90
120H	19.07	18.84	20.00	21.14	22.14	21.14	21.74	20.95	20.99	17.30	20.57	19.67	20.30

Table 7.5. Monthly mean RMSE of 250 hPa wind forecast (m/s) in Tropic (GDAPS verification against analysis).

FCST	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
24H	6.52	6.40	6.34	6.38	6.02	5.93	6.09	6.15	6.03	5.81	6.73	5.82	6.19
72H	11.00	11.09	10.34	10.83	9.97	9.99	10.08	10.25	10.39	9.12	11.15	9.86	10.34
120H	12.79	12.99	11.87	12.65	12.05	11.77	11.73	12.05	11.97	11.63	12.82	11.81	12.18

The seasonal forecasts are verified in terms of global and regional (i.e. East Asia) anomaly correlation of precipitation and 850 hPa temperatures during spring (MAM). The anomaly correlations of the seasonal mean fields for the hindcast experiment period of 1979-2005 are listed in the Table 8.

Table 8. Anomaly correlation of temperature at 850 hPa and precipitation.

	GDAPS (1979-2005, MAM)	
	P	T
Global	0.061	0.215
East Asia	0.165	0.261

9. Plans for the future

9.1 Development of the GDPFS

Owing to operation of high resolution global model GDAPS (T426L40), KMA will improve the resolution of EPS from T106L30 to T213L40 in 2006. The EPS will run twice a day for 10 day forecast at 00UTC and 12UTC in 2006. As the new generation regional model at KMA, Weather Research and Forecast (WRF) of 10km grid spacing for 75 hour forecast will be under test in 2006.

The number of asynoptic data assimilated in the 3dVar system will intensively be increased in 2006. The WV channel TBB data observed by geostationary satellite and the MODIS polar winds will be assimilated in 3dVar. The global coverage ATOVS level 1C data and local direct readout ATOVS data will be merged and directly assimilated in 3dVar. Further tuning for bias correction will be followed to improve the impact of ATOVS data on GDAPS. As a first step to incorporate the time dependency of observation increment in analysis, the First Guess Appropriate Time (FGAT) technique will be introduced in the 3dVar system. The 3dVar for global and regional analysis will be merged into a unified 3dVar. The unified 3dVar shares the observation operators and other possible transform operators for global and regional application to shorten the developing period of assimilating newly observed data. The vertical decouple of background error is done by the empirical orthogonal function and physical decouple is done by unbalanced velocity potential, unbalance temperature, unbalanced surface pressure to the stream function. However for the horizontal decoupling of the background error, regional application uses recursive filter while the global application uses wave decoupling because spectral global model is in operation at KMA.

In ocean wave prediction system, GoWAM will run twice a day at 00 and 12 UTC for 240 hour forecast and ReWAM will extend lead time from 48 hours to 66 hours operationally in 2006. On semi-operational mode, ReWAM will run in 1/12° spatial resolution with WAVEWATCH III source code and CoWAM (Coastal WAve Model) runs in 6 coastal domains along the Korean peninsular with 1/120° spatial resolution over 24 hours lead time. ReWAM4DM (ReWAM for Digital Medium-range) will also run in 1/4° spatial resolution over 252 hours lead time on semi-operational mode in 2006.

KMA will continue to cooperate with universities and research institutes to improve the operational long range forecast (LRF) system. The future systems under research and development include 12-month forecast system and seasonal/annual typhoon forecast system. The 12-month forecast system will be based on the global SST prediction & 2-Tier LRF system, coupled GCM (1-Tier system) and statistical downscaling. The seasonal/annual typhoon forecast system will be based on the dynamical and statistical methods. These systems are being developed for operational use in 2007.

10. References

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