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REGIONAL ASPECTS OF THE WWW COMPONENTS AND SUPPORT FUNCTIONS, INCLUDING REPORTS BY THE RAPPORTEURS/CO-ORDINATORS

Data-Processing and Forecasting Systems (DPFS)

(Submitted by the Secretariat)

Summary and purpose of document

This document provides information on the status of the Data-Processing and Forecasting Systems in RA II, based on information available at the Secretariat, and recalls relevant statements from CBS Ext.(06) and Congress XV.

ACTION PROPOSED

The group is invited to take note of the information provided in this document, discuss the noted issues, together with the report of the Rapporteur on GDPS matters, and develop any appropriate recommendations.

References:

1. Abridged Final Report with Resolutions and Recommendations of the Extraordinary Session 2006 of the Commission for Basic Systems (WMO-No. 1017);
2. Provisional Report with Resolutions from the Fifteenth Congress, Geneva, 7-25 May 2007.

Global Data-Processing and Forecasting Systems in RA II

Status of GDPFS

1. GDPFS centres in the Region continued to enhance and improve their forecasting systems and computer facilities. In 2007, eighteen of the thirty-five Members of Region II are running NWP systems. Six Members (China, India, Japan, Republic of Korea, Russia and Thailand) run global models, and four (China, Japan, Republic of Korea and Russia) also run an ensemble prediction system in operational mode, and these four Members use also EPS for extended and long-range forecasting. Eighteen Members use regional models for operation (detailed information is provided in the Appendix). Nevertheless, it is important to note that there is still a wide technological gap in Region II among Members in terms of capacity to access, process and use the models output for application to weather forecasting, and moreover to implement and operate an NWP forecasting system, although substantial progress have been observed during the years. The transfer of technology from advanced centres to developing centres is still a priority issue in the Region. In that aspect, one can note that training courses were organized by China (several courses related to NWP), by the Republic of Korea (co-sponsoring of ASEAN-ROK - 10 participants from 5 RA II countries, and co-sponsoring of GEO) and also by WMO (use of EPS products in Shanghai in April 2005 at the kind invitation of China - 35 participants from RA II countries).

2. The three RSMCs designated for the provision of transport model products in case of nuclear emergencies (Beijing, Obninsk and Tokyo) have implemented the regional and global arrangements for the provision, upon request, of specialized transport / dispersion / deposition information in accordance with Appendices I.3 and II.7 to the Manual on the GDPS. Tokyo is also a Volcanic Ash Advisory Centre and provides ash clouds trajectories and dispersion forecast for aviation. It is important to recall that the last WMO Fifteenth Congress supported extending the programme to include response to non-nuclear incidents or hazards, such as chemical incidents, smoke from large fires, gas and ash emissions from volcanic eruptions, or other airborne hazards.

3. The two RSMCs designated for tropical cyclone forecasting: New-Delhi and Tokyo run Typhoon Track Models. Ensemble global models show that they can be used by providing useful tropical cyclone forecast tracks and strike probabilities. .

Developments

NWP

4. The NWP systems of Members have been still expanding during the last few years. The diminution in cost of computer power, thanks to the used of cluster techniques, has enabled the increase in resolution of all NWP systems. The number of Members running a regional model increased from seven in 1997 to sixteen in 2004 and eighteen in 2007. The horizontal resolution of models has been enhanced constantly over the last few years. Since some products of global models with 25 km resolution are now available, Limited Area Model (LAM) should have at least a higher resolution to be potentially useful. Five centres run non-hydrostatic models. Improvement of data assimilation is still performed. Two centres are using operationally 4-D VAR data assimilation system, three centres use 3 D-VAR, but work for the development of 4 D-VAR system. The last WMO Congress stressed the importance of NWP in developing countries to enabling them to implement and maintain reliable and effective routine forecasting and severe weather warning programmes through enhanced availability and use of NWP products and delivery of timely and authoritative forecasts and early warnings, thereby contributing to reducing the risk of disasters from natural hazards. Congress also recommended that Centres running global NWP models facilitate the acquisition of boundary conditions required by NMCs to enable them to run Limited Area Models matching their operational requirements. Congress also emphasized the need for NWP Centres (e.g., RSMCs) to disseminate their products to NMHSs of countries covered by their models' domains and to work in consultation with NMHSs to further develop and propagate the benefits of NWP systems into neighboring regions. Congress also endorsed the organizing concept of a "consortium" of participating Centres; Members should systematically consider using this approach to share expertise, knowledge and resources, building upon a common regional

NWP model to accelerate progress in improvements of the model and the use of products, in a sustainable way.

EPS and probabilistic forecasting

5. The development and improvement of ensemble forecasting has continued and among the four centres running EPS system, some are running more than one system for different ranges. It is also the main method to perform long-range forecasting. Given the large amount of NWP and EPS output products, Members need more capability than ever before to deal with post-processing. Most Members rely on direct output from leading NWP and EPS centres. It is recalled that the last WMO Congress encouraged EPS-producing centres to provide to Members access to as many as possible of their EPS products relevant to severe weather forecasting such as probabilistic charts of meteorological parameters, "EPS-grams" (time series) of EPS outputs, or indices such as the "Extreme Forecast Index (EFI)" developed at ECMWF. Congress had expressed appreciation for the provision of location-specific products such as the EPSgrams by ECMWF to WMO Members. Congress encouraged Members to use these products and requested them to provide feedback to the producing centres.

6. Since the ensemble prediction outputs and long-range products are available on the WEB, the instruction for the interpretation of the product and associated standard verification scores are recommended to be provided along with the products. EPS outputs are mostly used at the producing centre, and still only few products are available to other Members in the region. The EPS products from other regions (for instance, ECMWF; NCEP, NOGAPS) can also be used in the region mostly through Internet. The needs and requirements for the education and training are high for the promotion and application of EPS. Particularly, the users of ensemble prediction system have to be well aware of the value of probability forecasts for the risk management. The education need to be focused in part on the interpretation of probabilistic forecasts for the high impact weather.

Severe weather forecasting

7. The last WMO Congress noted with satisfaction the significant development and progress of the Severe Weather Forecasting Demonstration Project (SWFDP) implemented in the south-eastern region of Africa in 2006, focusing on heavy precipitation and strong winds, and involving 3 global products centres (ECMWF, Met Office UK, NCEP (USA)), 2 RSMCs and 5 NMCs. The participating NMHSs have recognized and appreciated the support from the global and regional centres. This experiment demonstrated the importance of a well coordinated cascading process for RSMCs to provide appropriate products to NMHS, for severe weather risk and warnings. The role of the RSMCs is revitalised in such project. In RA II, RSMCs should perform these tasks as these are part of the functions normally expected from them as defined in the GDPFS Manual. It was emphasized that while warnings are improved from more effective use of all supporting data and data-processing and forecasting systems, the international exchange of warning information, especially among neighbouring countries increases the benefits to the safety and security of populations. Congress, noting the importance of accurate and timely severe weather warnings for Members, recommended that the concept of SWFDP be expanded and implemented throughout other Regions of WMO especially in developing countries.

Long-range Forecasting

8. Noting that Cg-XIV had agreed that a reliable operational global long-range forecasting (LRF) system should include three types of centres: Global Producing Centres of Long-range Forecasts (GPC), Regional Climate Centres (RCC) and National Meteorological Centres (NMC), Congress appreciated that CBS-Ext.(06) (Seoul, November 2006)) recognized nine official GPCs, including Beijing, Tokyo and Seoul. Moscow has also expressed officially its intention to request recognition as GPC. GPCs have to meet a set of requirements, including an agreed minimum list of global LRF products. Congress requested these products be made available to as many RCCs and NMCs as possible for the purpose of enabling them to perform their tasks. Congress requested collaboration between CBS and CCl to develop the minimum set of functions and services required of RCCs, in order to support their official designation and inclusion in the GDPFS Manual (Global Aspects, Volume I). As well, ongoing coordination is required to ensure that operational products from the GPCs meet the requirements for seasonal forecasting services

provided by RCCs and NMHSs. The Working Group is invited to consider the recognition of RCCs in RA II and make appropriate recommendations for that purpose. Congress also noted that some RCCs/NMCs would need assistance for training users (or other trainers), and requested GPCs to identify and provide suitable experts for interpretation and use of GPC LRF products, verification techniques (e.g. local verification of RCC-generated products and applications).

9. Given the anticipated improvements in skill of LRF by using a multi-model ensembles (MME) approach, the last Congress agreed that some GPCs of LRF could serve as collectors of global LRF data to build MMEs, and requested standards for MME products be developed. Congress noted that GPC Seoul and GPC Washington have agreed to explore the use of MME for LRF. A workshop on WMO/KMA GPC Workshop on Lead Center for Long-range Forecast Multi-Model Ensemble will take place, at the kind invitation and support of Republic of Korea, in Busan from 18 to 20 September 2007. This workshop will focus on refinement and clarification of the functions of Lead Centre for LRF MME with particular emphasis on: standardization of data, formats and access/distribution of LRF MME products and reporting of progress of GPCs and Lead Centre activities.

Training and Capacity Building

10. The Working Group should consider the needs for training in RA II. Use of NWP and EPS products and probabilistic forecasting is certainly a priority, especially with a view to help disaster reduction. Facilities and opportunities with distance-training such as the COMET (USA) programme, EUMETCal modules, and the WMO Space Programme's Virtual Laboratory High Profile Training Event concept should be considered. The last WMO Congress encouraged the Secretariat to organize various NWP training and capacity building initiatives into a WMO coordinated strategy. Events organized or co-sponsored by the Secretariat should be coordinated, as much as possible, with initiatives coming directly from NMHSs (in particular those with RSMCs) or other agencies, that were or could be opened to participants from other NMHSs (and in particular from neighboring NMCs).

APPENDIX

STATUS OF RA II RSMCs AND NMCs RELATIVE TO NUMERICAL MODELS *(2005, 2006 or 2007 information)* (last update 06/08/07)

GM = Global Model
LAM = Limited Area Model
Perturbation technique for ensemble prediction systems: SV = Singular Vectors, BGM = Breeding of Growing Modes, LAF = Lagged Average Forecasts, StoP = Stochastic Physics, OP = Observation Perturbations, ETKF = Ensemble Transform Kalman Filter

							DISSEMINATION		
CENTRE	***STATUS***	***MODELS***	***RESOL.***	***LEVELS***	***RANGE***	***Boundary***	***GTS***	***SAT.***	***SPECIAL***
ABU DHABI	NMC	LAM (NCEP-ETA)	0.3°	42	72 h	GFS (NCEP)			
		LAM (NCEP-ETA-non-hydrostatic)	0.09°	42	72 h	GFS (NCEP)			
		LAM (HRM)				GME (DWD)			
BANGKOK	NMC	GM (Unified UKMO)	100 km	19	168 h				
		LAM (South East Asia)	48 km	19	72 h	GM			
		LAM (Thailand Model)	17 km	31	48 h	SE Asia			
		WRF	?	?	?	GFS (NCEP)			
HANOI	NMC	LAM (ETA)	22 km	?	48 h				
		LAM (HRM)	14 km	31	48 h	GFS (NCEP)			
HONG-KONG	NMC	LAM-(ORSM) 3 D-VAR	60 km	36	72 h	GSM (Japan-JMA)			
		MPI-ORSM 4D-VAR	20 km	40	42 h	GSM (Japan-JMA)			
		NHM – non-hydrostatic – Wind RADAR data assimilated	5 km	45	12 h	LAM (ORSM)			
KARACHI	NMCs	LAM (HRM)	28 km	40	72 h	GME (DWD)			
MACAO	NMC	LAM	54/18 km	22	60 h				
MUSCAT	NMC	LAM (ORM28)	28 km	40	78 h	GME (Offenbach)			
		LAM (ORM07)	7 km	40	78 h	GME (Offenbach)			
PYONGYANG	NMC	Hemispheric Model (HM)	T42	14	96 h				
		LAM –Regional Spectral Model	100 km	14	48 h				
		LAM	50 km	18	24 h				

SEOUL	NMC	GM (GDAPS) 3D-VAR	T426	L40	240 h				
		LAM (RDAPS)	30 km	33	66 h	GDAPS			
		LAM (RDAPS nested) non-hydrostatic	10 km	33	24 h	RDAPS			
		LAM (RDAPS nested) non-hydrostatic	5 km	33	24 h	RDAPS			
		Typhoon (DBAR)	0.356 °	1	72 h	GDAPS			
		GM (GBEPS) Ens. 16 LAF coupled, members, BGM	T213	L40	10 days				
		GM Ens. 20 members, BGM, 2 tier system	T106	L21	1 month, 3 months 6 months				
TEHRAN	NMC	LAM (MM5)	30 km	23	102 h				
ULAANBATAR	NMC	LAM (MM5)	80 km	35	48 h				
NCMRWF -INDIA	Special Centre	GM	T80	L18	5 days				
		LAM	50 km	18	5 days				
BEIJING	Geo. and Transport Model (T.M.) RSMC	GM (3 D-VAR)	T639	L60	10 days		GTS	SAT	
		LAM-(GRAPES)	30 km	31	48 h	GM			
		GM-(MTTP). Typhoon Track	T213	L31	120 h				
		LAM (NMC-MM5) nested, D.A. = nudging method, non-hydrsostatic?	27/9/3 km	36	48 h				
		LAM Ens. 15 members, BGM	35 km	35	36 h				
		GM Ens. 15 members BGM	T213	L31	10 days				
		AGCM/OGCM	T106	L19	30 days				
		GM Ens. 32 members 16 SV, 16 LAF coupled, Ocean: GT63L30	T63	L16	1 month				
		GM Ens. 8 members LAF coupled	T63	L16	Season				
JEDDAH	Geo. RSMC	LAM (HRM)	48 km	48	48 h	GME (DWD)			
KHABAROVSK	Geo. RSMC	LAM	50 km	15	48 h				
NOVOSIBIRSK	Geo. RSMC	LAM (Sib- SRHMS)	50 km	15	48 h				
TASHKENT	Geo. RSMC								

NEW DELHI	Geo. and T.C. RSMC	full access to GM (NCMRWF)					GTS		
		LAM (LAFS) 3-DVAR	0.75°	16	48 h	NCMRWF			
		For TC: Quasi-Lagrangian model 3 D-VAR	40 km	16	36 h				
TOKYO	Geo.- T.M. and T.C. RSMC	GM (GSM0305) 4D-VAR	T319	40	216 h		GTS		special
		GM Ens. 51 members BGM	T159	40	9 days				
		GM Ens. 50 members, 25 BGM and 25 members LAF on 2 days	T159	40	34 days				
		GM Ens. 31 members, SV; 2 tiers for SST	T63	40	7 months				
		LAM (RSM0404) 4D-VAR	20 km	40	51 h	GSM			
		LAM (MSM0603) 4 D-VAR, non-hydrostatic	5 km	50	15 h	RSM			
		GM Coupled (AGCM/OGCM) Ens. 31 members, SV	T42	40	18 months				
		Typhoon (TYM0306)	24 km	25	84 h	GSM			

- COMPUTERS USED FOR DATA PROCESSING AT RSMCs AND NMCs -

REGION II

CENTRE	*MAINFRAME (number cruncher)*	*SECONDARY COMPUTER(S)*	*WORK STATIONS*
ABU DHABI		PC Clusters	PCs
BANGKOK	IBM RS/6000SP 12.96 GFlops	2 RS 6000 595	WKs
HANOI		PC Cluster	
HONG-KONG	IBP p630 cluster (16 processors) 76.8 GFlops, IBM p690 (20 processors) 88GFlops, IBM RS/6000 SP (44 processors) 66 GFlops	CRAY SV1-1A (16 processors), SGI Origin 2000, 2 SUN E450, 2 SGI O2	WSs
KARACHI		GRID RAK HP	PCs
OMAN	SUN E4500 12 processors and E4504 processors		
PYONGYANG		Pentium III	PC/AT – PS/2
SEOUL	CRAY X1E-3/192-L (15.75 TFlops), 2 CRAY X1-3/192-L (635 GFlops) NEC SX-5/28M2, SX-4/2A	HP V2500 (48PE)	SUN 2000
TEHRAN	2 PC Cluster Systems 8 and 32 Nodes	IBM 370 (2x 4381)	PCs
ULAANBATAR		PC Cluster System	MICRO VAX 3400
NCMRWF-INDIA	CRAY XMP/216		DEC Alpha WSs, SUN Ultra Sparc II WSs, SGI ORIGIN 200 and O2 WSs
BEIJING	IBM CLUSTER 1600 (20 TFLOPS) IBM SP RS6000 NH1 SP (71 GFLOPS)	IBM SP2/32	WSs
JEDDAH		CDC CYBER 962 – 2 CDC 910	3 SG – 4 VAX – 3 CDC
KHABAROVSK		XEON-2, COMPAREX, COMPLEX GIS Meteo	PC Pentium IV, PCs
NOVOSIBIRSK	CRAY EL	XEON-2	PCs
TASHKENT		HP 9000	PCs
NEW DELHI	CDC CYBER 2000U	SGI ORIGIN 200, 2CDC 4680	2 VAX 11/730, WS: 4 CYBER 910-485, VAX 3400, 5 Pentium II
TOKYO	HITACHI SR11000/K1 E1/80 nodes	3 HITACHI 8000	HITACHIs