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ACTIVITIES OF THE RSMC TOKYO - TYPHOON CENTER
IN 2010

(Item 5 of the Provisional Agenda)

Submitted by the RSMC Tokyo - Typhoon Center

Activities of the RSMC Tokyo - Typhoon Center in 2010

1. Provision of RSMC Products

The RSMC Tokyo - Typhoon Center (referred to here below as *the* Center) provides Typhoon Committee (TYC) Members with a range of products related to tropical cyclones in the western North Pacific and the South China Sea through the GTS and the AFTN. Table 1 shows the total numbers of products issued by the Center in 2010.

2. Track Forecasts

Operational track forecasts for the 14 TCs that reached TS intensity or higher in 2010 were verified against the Center's analysis data. Figure 1 shows the annual mean position errors of 24-hour (from 1982), 48-hour (from 1988), 72-hour (from 1997), 96-hour and 120-hour (from 2009) forecasts. The errors for the year were 105 km (122 km in 2009), 206 km (216 km), 332 km (312 km), 400 km (415 km) and 457 km (528 km) for 24-, 48-, 72-, 96- and 120-hour forecasts, respectively. The annual mean position errors up to 120-hour forecasts except for 72 hours in 2010 were improved (Table 2, Figure 1). Track forecasts were especially difficult for Kompas (1007), which gained speed and turned in a few days after it upgraded to typhoon (TY) intensity. The mean hitting ratios of probability circles* for 24-, 48-, 72-, 96- and 120-hour forecasts were 76% (69% in 2009), 65% (70%), 61% (70%), 74% (76%) and 77% (79%), respectively (Table 3).

* Probability circle: a circular area within which a TC is expected to be located with a probability of 70% at each forecast time, indicating the uncertainty of a forecast

3. Intensity Forecasts

Table 4 gives the root mean square errors (RMSEs) of 24-, 48- and 72-hour intensity forecasts for the 14 TCs of 2010. The annual mean RMSEs for central pressure forecasts were 12.2 hPa (13.1 hPa in 2009), 17.4 hPa (20.1 hPa) and 22.6 hPa (22.6 hPa) for 24-, 48- and 72-hour forecasts, respectively, while those of maximum wind speed forecasts for 24-, 48- and 72-hour forecasts were 5.8 m/s (6.4 m/s in 2009), 7.4 m/s (8.7 m/s) and 9.8 m/s (9.5 m/s), respectively. Intensity forecasts were particularly difficult for TCs that developed rapidly, such as Megi (1013) (50 hPa development in 24 hours).

4. RSMC Data Serving System

The Center operates the RSMC Data Serving System (RSMC-DSS) to provide TYC Members with

NWP products such as GPs and observational data through the Internet. The RSMC-DSS was being used by nine TYC Members as of the end of 2010. The products and data provided through this system are listed in Table 5. RSMC-DSS has provided TDCF (Table-driven Code Form) observational data types such as SYNOP BUFR since July 2010. It will continue to provide TAC and TDCF observational data in parallel until further notice.

5. JMA Numerical Typhoon Prediction (NTP) website

Since October 2004, the Center has officially operated a Numerical Typhoon Prediction (NTP) website in cooperation with eight NWP centers: BoM (Australia), MSC (Canada), CMA (China), ECMWF, DWD (Germany), KMA (Republic of Korea), UKMO (UK) and NCEP (US). The NTP website provides predictions of tropical cyclone tracks derived from models of major NWP centers in order to assist the NMHSs of TYC Members in their tropical cyclone forecasting and warning services. The website is available only to registered organizations, including the NMHSs of TYC Members and participating NWP centers. Ten TYC Members other than Japan had accessed the website as of the end of 2010. The site's main content is as follows:

- 1) Predictions of tropical cyclone tracks, in table and chart format, from participating NWP centers together with predictions by the Japan Meteorological Agency (JMA). Ensemble mean prediction with any combination of products is also available.
- 2) NWP model products, in chart format, from participating NWP centers
- 3) Results of satellite image analysis (early-stage Dvorak analysis and regular Dvorak analysis)

Distribution maps and time-series charts of storm surges will be provided on this website.

6. Migration of SAREP and RADOB to BUFR

The Center started disseminating SAREP in BUFR format via the GTS in November 2005 and

RADOB in BUFR format in September 2006 in response to the WMO migration plan. As agreed by TYC Members at the 41st session (Chiang Mai, 2009), the Center stopped providing alphanumeric SAREP and RADOB data at the end of 2010. In order to assist SAREP users in their TC monitoring and forecasting, the Center started in June 2009 to post the results of not only regular Dvorak analysis as included in SAREP reports but also those of early-stage Dvorak analysis on the NTP website.

7. Implementation of Amendment 75 to ICAO Annex 3 concerning Tropical cyclone advisories for SIGMET

Tropical cyclone (TC) advisories for SIGMET (FKPQ30-55 RJTD) issued by the Center (TCAC Tokyo) has been changed according to the implementation of Amendment 75 since Nov. 2010. Identification of unnamed cyclones; the term “ NIL” was replaced by “ NN” .

8. Switchover of MTSAT Meteorological Mission

On 1 July 2010, JMA switched over imaging satellite operations to the Multi-functional Transport Satellite-2 (MTSAT-2, also known as Himawari-7), which is located at 145 degrees east, from MTSAT-1R (Himawari-6), which is located at 140 degrees east and now operates as an in-orbit stand-by for MTSAT-2.

9. Regional storm surge watch scheme suitable for the TYC region

Following the recommendation of the WGM at the 41st session of the TYC (Chiang Mai, 2009), the Center distributed a survey in June 2009, and 12 TYC Members had responded as of the end of 2009. The survey' s aim is to collect information on the present status of TYC Members in using storm surge models in order to develop future plan for the establishment of a regional storm surge watch scheme suitable for the TYC region. After reviewing the survey responses, the Center

decided to provide TYC Members with distribution maps and time-series charts of storm surges. For this purpose, 7 TYC Members provided the Center with bathymetric data of their surrounding areas together with sea level data from past measurements. With the data, the Center has developed the prototype of storm surge model suitable for TYC region and is verifying the results of the model. From 2011 typhoon season, the Center plans to provide storm surge distribution maps through its NTP website. From 2012 typhoon season, the Center plans to provide storm surge time series charts at one point for each TYC Member (forecasting points to be increased in due course). Storm surge trainings will be conducted during the annual TYC attachment training at the Center from 2011.

10. Quantitative Precipitation Estimation and Forecast (QPE/QPF) techniques

Information on the techniques and the use of QPE/QPF was shared among TYC Members in 2010 at

- " TYPHOON COMMITTEE Integrated Workshop on Urban Flood Risk Management in a Changing Climate: Sustainable and Adaptation Challenges" at Macao in September
- " Third WMO International Conference On Quantitative Precipitation Estimation And Quantitative Precipitation Forecasting and Hydrology" at Nanjing in October, and
- " Workshop on Space Application to Reduce Water-related Disaster Risk in Asia" at Bangkok in December.

Information from TYC Members on use of QPE and QPF was corrected through questionnaire by TCS. The results were shared during the Integrated Workshop in Macao and are summarized at the 43rd session. QPE/QPF trainings will be conducted during the annual TC attachment training at the Center from 2011 and QPE/QPF workshop will be held in 2011. The QPE/QPF techniques of JMA will be published in the Technical Review.

11. Publications

The Center published *Technical Review No. 12* in March 2010 and *Annual Report on the Activities of the RSMC Tokyo - Typhoon Center in 2009* in December 2010. These are also available on the Center' s website at http://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/RSMC_HP.htm.

12. Training

Two forecasters from Hong Kong and Singapore visited the Center from 21 to 30 July 2010 to participate in annual on-the-job training for typhoon operations. During the two weeks of training,

they experienced the operational procedures of the Center in the analysis and forecasting of tropical cyclones. Storm surge and QPE/QPF trainings will be conducted during the training from 2011.

13. The Severe Weather Forecasting Demonstration Project (SWFDP) in South-east Asia

The SWFDP is designed as a series of regional subprojects whose scope is to test the usefulness of NWP products produced by global and regional meteorological centres, with the goal of improving severe weather forecasting services in countries where sophisticated model outputs are currently not used. The Center is designated as the Regional Centre for Tropical Cyclone / Typhoon Forecasting Support to provide typhoon related products.

13. Implementation Plans

Table 6 shows the implementation plans of the Center for the period from 2010 to 2014. The

Center stopped providing alphanumeric SAREP data at the end of 2010.

Table 1 Monthly and annual total numbers of products issued by the RSMC Tokyo - Typhoon Center in 2010

Product	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
TCNA20	0	0	7	0	0	0	40	52	77	66	0	0	242
TCNA21	0	0	14	0	0	0	45	72	89	88	0	0	308
IJCC10	0	0	21	0	0	0	85	124	166	154	0	0	550
WTPQ20-25	0	0	28	0	0	0	88	139	168	178	0	0	601
WTPQ30-35	0	0	7	0	0	0	24	35	46	44	0	0	156
WTPQ50-55	0	0	4	0	0	0	20	28	32	50	0	0	134
FXPQ20-25	0	0	28	0	0	0	90	138	173	175	0	0	604
FKPQ30-35	0	0	14	0	0	0	45	72	88	87	1	0	307
AXPQ20	0	0	0	0	1	0	0	0	3	4	4	2	14

Notes:

TCNA20/21 RJ TD
IJCC10 RJ TD
WTPQ20-25 RJ TD
WTPQ30-35 RJ TD
WTPQ50-55 RJ TD
FXPQ20-25 RJ TD
FKPQ30-35 RJ TD
AXPQ20 RJ TD

SAREP (TACs)
SAREP (BUFR format)
RSMC Tropical Cyclone Advisory
RSMC Prognostic Reasoning
RSMC Tropical Cyclone Advisory for five-day track forecast
RSMC Guidance for Forecast
Tropical Cyclone Advisory for SIGMET
RSMC Tropical Cyclone Best Track

Table 2 Mean position errors of track forecasts for the 14 TCs in 2010

Tropical Cyclone			24-hour Forecast				48-hour Forecast				72-hour Forecast				96-hour Forecast				120-hour Forecast			
			Position Error & Number				Position Error & Number				Position Error & Number				Position Error & Number				Position Error & Number			
			Mean (km)	S.D. (km)	Num	EO/EP (%)	Mean (km)	S.D. (km)	Num	EO/EP (%)	Mean (km)	S.D. (km)	Num	EO/EP (%)	Mean (km)	S.D. (km)	Num	EO/EP (%)	Mean (km)	S.D. (km)	Num	EO/EP (%)
TS	OMAS	(1001)	179	29	2	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	CONSON	(1002)	144	67	20	104	283	95	16	90	400	67	12	98	526	67	8	75	609	13	4	97
TY	CHANTHU	(1003)	113	45	11	56	107	36	7	38	315	100	3	68	-	-	0	-	-	-	0	-
STS	DIANMU	(1004)	106	72	13	35	264	109	9	35	450	122	5	45	508	0	1	-	-	-	0	-
TS	MINDULLE	(1005)	74	25	4	145	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
STS	LIONROCK	(1006)	62	30	14	29	118	55	10	36	176	60	6	41	89	24	2	-	-	-	0	-
TY	KOMPASU	(1007)	149	54	12	41	371	136	8	47	780	61	4	67	-	-	0	-	-	-	0	-
TS	NAMTHEUN	(1008)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
STS	MALOU	(1009)	161	50	13	64	265	97	9	40	479	33	5	35	998	0	1	-	-	-	0	-
STS	MERANTI	(1010)	130	68	3	27	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	FANAPI	(1011)	58	43	17	30	77	45	13	17	151	77	9	15	365	98	5	24	743	0	1	-
TY	MALAKAS	(1012)	121	48	10	29	259	106	6	21	681	134	2	-	-	-	0	-	-	-	0	-
TY	MEGI	(1013)	75	37	37	41	150	60	33	32	229	62	29	26	319	101	25	23	386	124	21	27
TY	CHABA	(1014)	109	44	20	59	282	152	16	62	409	224	12	47	538	320	8	47	602	243	4	45
Annual Mean (Total)			105	59	176	47	206	127	127	40	332	189	87	37	400	208	50	31	457	175	30	32

Notes: S.D. means standard deviation of operational forecast errors.

Num. means numbers of forecasts.

EO/EP indicates the ratio of EO (mean position error of operational forecasts) to EP (mean position error of forecasts by the persistency forecast).

Table 3 Mean hitting ratios (%) and radii (km) of 70% probability circles issued for track forecasts for the 14 TCs in 2010

Tropical Cyclone			24-hour Forecast			48-hour Forecast			72-hour Forecast			96-hour Forecast			120-hour Forecast		
			Ratio (%)	Num.	Radius (km)	Ratio (%)	Num.	Radius (km)	Ratio (%)	Num.	Radius (km)	Ratio (%)	Num.	Radius (km)	Ratio (%)	Num.	Radius (km)
TS	OMAS	(1001)	0	2	130	-	0	-	-	0	-	-	0	-	-	0	-
TY	CONSON	(1002)	40	20	132	12	16	204	8	12	296	25	8	463	50	4	625
TY	CHANTHU	(1003)	55	11	130	100	7	204	33	3	296	-	0	-	-	0	-
STS	DIANMU	(1004)	85	13	156	67	9	313	60	5	463	100	1	788	-	0	-
TS	MINDULLE	(1005)	100	4	130	-	0	-	-	0	-	-	0	-	-	0	-
STS	LIONROCK	(1006)	100	14	154	100	10	296	100	6	408	100	2	718	-	0	-
TY	KOMPASU	(1007)	42	12	144	25	8	280	0	4	408	-	0	-	-	0	-
TS	NAMTHEUN	(1008)	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
STS	MALOU	(1009)	46	13	151	44	9	280	0	5	385	0	1	519	-	0	-
STS	MERANTI	(1010)	100	3	164	-	0	-	-	0	-	-	0	-	-	0	-
TY	FANAPI	(1011)	94	17	142	100	13	224	100	9	307	80	5	445	0	1	556
TY	MALAKAS	(1012)	80	10	144	50	6	306	0	2	463	-	0	-	-	0	-
TY	MEGI	(1013)	97	37	141	85	33	232	93	29	351	96	25	448	86	21	567
TY	CHABA	(1014)	80	20	145	50	16	272	50	12	422	50	8	632	75	4	834
Annual Mean (Total)			76	176	143	65	127	252	61	87	364	74	50	498	77	30	610

Notes: Num. means numbers of forecasts.

Table 4 Root mean square errors (RMSEs) of intensity forecasts for the 14 TCs in 2010

Tropical Cyclone			24-hour Forecast			48-hour Forecast			72-hour Forecast		
			Central pressure	Maximum sustained wind	Num.	Central pressure	Maximum sustained wind	Num.	Central pressure	Maximum sustained wind	Num.
			(hPa)	(m/s)		(hPa)	(m/s)		(hPa)	(hPa)	
TS	OMAS	(1001)	3.2	2.6	2	-	-	0	-	-	0
TY	CONSON	(1002)	12.2	6.3	20	15.7	7.0	16	13.1	5.2	12
TY	CHANTHU	(1003)	6.2	5.0	11	6.5	6.1	7	9.7	4.2	3
STS	DIANMU	(1004)	7.2	4.3	13	4.6	3.0	9	2.5	3.3	5
TS	MINDULLE	(1005)	4.6	2.9	4	-	-	0	-	-	0
STS	LIONROCK	(1006)	4.2	2.3	14	5.4	3.3	10	7.9	4.6	6
TY	KOMPASU	(1007)	12.8	7.3	12	13.4	7.4	8	13.9	6.3	4
TS	NAMTHEUN	(1008)	-	-	0	-	-	0	-	-	0
STS	MALOU	(1009)	10.8	3.3	13	13.7	4.5	9	16.4	6.1	5
STS	MERANTI	(1010)	6.6	12.1	3	-	-	0	-	-	0
TY	FANAPI	(1011)	8.7	4.1	17	16.2	6.3	13	21.7	13.5	9
TY	MALAKAS	(1012)	7.4	3.6	10	10.0	3.3	6	3.5	0.0	2
TY	MEGI	(1013)	20.3	8.2	37	26.5	10.7	33	31.9	13.3	29
TY	CHABA	(1014)	7.6	4.5	20	14.7	6.5	16	21.5	8.2	12
Annual Mean (Total)			12.2	5.8	176	17.4	7.4	127	22.6	9.8	87

Notes: Num. means numbers of forecasts.

Table 5 List of GPV products and data provided with the RSMC Data Serving System

Model	GSM	GSM	GSM
Area and resolution	Whole globe, 1.25° × 1.25°	20°S– 60°N, 60°E– 160°W 1.25° × 1.25°	Whole globe, 2.5° × 2.5°
Levels and elements	10 hPa: Z, U, V, T 20 hPa: Z, U, V, T 30 hPa: Z, U, V, T 50 hPa: Z, U, V, T 70 hPa: Z, U, V, T 100 hPa: Z, U, V, T 150 hPa: Z, U, V, T 200 hPa: Z, U, V, T, ψ , χ 250 hPa: Z, U, V, T 300 hPa: Z, U, V, T, H, ω 400 hPa: Z, U, V, T, H, ω 500 hPa: Z, U, V, T, H, ω , ζ 600 hPa: Z, U, V, T, H, ω 700 hPa: Z, U, V, T, H, ω 850 hPa: Z, U, V, T, H, ω , ψ , χ X 925 hPa: Z, U, V, T, H, ω 1000 hPa: Z, U, V, T, H, ω Surface: P, U, V, T, H, R†	10 hPa: Z, U, V, T 20 hPa: Z, U, V, T 30 hPa: Z, U, V, T 50 hPa: Z, U, V, T 70 hPa: Z, U, V, T 100 hPa: Z, U, V, T 150 hPa: Z, U, V, T 200 hPa: Z [§] , U [§] , V [§] , T [§] , ψ , χ 250 hPa: Z, U, V, T 300 hPa: Z, U, V, T, D 400 hPa: Z, U, V, T, D 500 hPa: Z [§] , U [§] , V [§] , T [§] , D [§] , ζ 700 hPa: Z [§] , U [§] , V [§] , T [§] , D [§] , ω 850 hPa: Z [§] , U [§] , V [§] , T [§] , D [§] , ω , ψ , χ 925 hPa: Z, U, V, T, D, ω 1000 hPa: Z, U, V, T, D Surface: P [¶] , U [¶] , V [¶] , T [¶] , D [¶] , R [¶]	10 hPa: Z*, U*, V*, T* 20 hPa: Z*, U*, V*, T* 30 hPa: Z°, U°, V°, T° 50 hPa: Z°, U°, V°, T° 70 hPa: Z°, U°, V°, T° 100 hPa: Z°, U°, V°, T° 150 hPa: Z*, U*, V*, T* 200 hPa: Z, U, V, T 250 hPa: Z°, U°, V°, T° 300 hPa: Z, U, V, T, D*‡ 400 hPa: Z*, U*, V*, T*, D*‡ 500 hPa: Z, U, V, T, D*‡ 700 hPa: Z, U, V, T, D 850 hPa: Z, U, V, T, D 1000 hPa: Z, U*, V*, T*, D*‡ Surface: P, U, V, T, D‡, R†
Forecast hours	0– 84 (every 6 hours) and 96– 192 (every 12 hours) † Except analysis	0– 84 (every 6 hours) § 96– 192 (every 24 hours) are also available for 12 UTC Initial time. ¶ 0– 192 (every 6 hours)	0– 72 (every 24 hours); 96– 192 (every 24 hours) are also available for 12 UTC Initial time. ° 0– 120 for 12 UTC † Except analysis * Analysis only
Initial times	00, 06, 12, 18 UTC	00, 06, 12, 18 UTC	00, 12UTC ‡ 00 UTC only

Model	GSM	Mid-range EPS
Area and resolution	20°S– 60°N, 80°E– 200°E 2.5° × 2.5°	Whole globe, 2.5° × 2.5°
Levels and elements	100 hPa: Z, U, V, T 150 hPa: Z, U, V, T 200 hPa: Z, U, V, T 250 hPa: Z, U, V, T 300 hPa: Z, U, V, T 500 hPa: Z, U, V, T, D, ζ	250 hPa: μ U, σ U, μ V, σ V 500 hPa: μ Z, σ Z 850 hPa: μ U, σ U, μ V, σ V, μ T, σ T 1000 hPa: μ Z, σ Z Surface: μ P, σ P

	700 hPa: Z, U, V, T, D, ω 850 hPa: Z, U, V, T, D, ω Surface: P, U, V, T, D, R	
Forecast hours	0– 36 (every 6 hours), 48, 60 and 72	0– 192 (every 12 hours)
Initial times	00, 12 UTC	12 UTC

Notes: Z: geopotential height U: eastward wind V: northward wind
T: temperature D: dewpoint depression H: relative humidity
 ω : vertical velocity ζ : vorticity ψ : stream function
 χ : velocity potential P: sea level pressure R: rainfall

The prefixes μ and σ represent the average and standard deviation of ensemble prediction results respectively.

The symbols $^{\circ}$, $*$, \P , \S , \ddagger and \dagger indicate limitations on forecast hours or initial time as shown in the notes.

Table 5 (continued)

Data	Satellite products	Tropical cyclone Information	Wave data	Observational data
Contents/ Frequency (initial time)	<p>High density atmospheric motion vectors (BUFR)</p> <p>(a) MTSAT-2 (VIS, IR, WV)</p> <ul style="list-style-type: none"> 0-60N, 90E-170W: 00, 03, 06, 09, 12, 15, 18 and 21 UTC 60S-0, 90E-170W: 00, 06, 12 and 18 UTC <p>(b) METEOSAT-7 (VIS, IR, WV)</p> <p>VIS: every 1.5hours between 01:30 and 15:00 UTC</p> <p>IR, WV: every 1.5hours</p>	<p>Tropical cyclone related information (BUFR)</p> <ul style="list-style-type: none"> tropical cyclone analysis data <p>00, 06, 12 and 18 UTC</p>	<p>Global Wave Model (GRIB2)</p> <ul style="list-style-type: none"> significant wave height prevailing wave period wave direction <p>Forecast hours:</p> <p>0– 84 every 6 hours (00, 06 and 18UTC)</p> <p>0– 84 every 6 hours and 96-192 every 12 hours (12 UTC)</p>	<p>(a) Surface data (SYNOP, SHIP, BUOY)</p> <p>Mostly 4 times a day</p> <p>(b) Upper-air data (TEMP, parts A-D) (PILOT, parts A-D)</p> <p>Mostly twice a day</p>

Table 6 Implementation Plans of the RSMC Tokyo - Typhoon Center (2010-2014)

PRODUCT	2010	2011	2012	2013	2014	REMARKS
Satellite Observation						
MTSAT HRIT						All observed cloud images (full or half-disk)
MTSAT LRIT						{ 24 times/day (full-disk) 24 times/day (polar-stereo East Asia)
Cloud motion wind (BUFR)						{ 8 times/day (Northern Hemisphere) 4 times/day (Southern Hemisphere)
Analysis						
RSMC Tropical Cyclone Advisory						8 times/day
SAREP (for tropical cyclones, TACs)					{ 8 times/day Position of cloud system center, etc. 4 times/day Dvorak intensity
SAREP (for tropical cyclones, BUFR)						
Numerical Typhoon Website satellite image analysis for tropical cyclones						{ 4 times/day early stage Dvorak analysis & regular Dvorak analysis
Sea Surface Temperature Objective analysis pressure pattern, etc						
Forecast						
RSMC Tropical Cyclone Advisory						{ 4 times/day up to 120 hrs ahead 8 times/day up to 24 hrs ahead
RSMC Prognostic Reasoning						2 times/day
RSMC Guidance for Forecast						{ 4 times/day up to 84 hrs ahead (GSM) 4 times/day up to 132 hrs ahead (TEPS)
NWP products pressure pattern, etc						
Numerical Typhoon Prediction Website tracks and prediction fields, etc						{ mostly updated 2 times/day 4 times/day up to 132 hrs ahead (TEPS)
Others						
RSMC Tropical Cyclone Best Track Annual Report						Publication
Technical Review					Publication (as necessary)
SUPPORTING ACTIVITY	2010	2011	2012	2013	2014	REMARKS
Data archive						
Monitoring of data exchange						
Dissemination of products						RSMC Data Serving System

Figure 1 Annual mean position errors of track forecasts
Vertical axis: position error (km), Horizontal axis: year

