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# ACTIVITIES OF THE RSMC TOKYO - TYPHOON CENTER IN 2013

(Submitted by the RSMC Tokyo - Typhoon Center)

**Action Proposed**

The Committee is invited to review the activities of the RSMC Tokyo - Typhoon Center in 2013.

# Activities of the RSMC Tokyo - Typhoon Center in 2013

## 1. Provision of RSMC Products

The RSMC Tokyo - Typhoon Center (hereinafter referred to 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 number of products issued by the Center in 2013.

## 2. Track Forecasts

Operational track forecasts for 31 Tropical Cyclones (TCs) that reached Tropical Storm (TS) intensity or higher in 2013 were verified against the Center's analysis data. Figure 1 shows the time series of the annual mean position errors of 24-hour (from 1982), 48-hour (from 1989), 72-hour (from 1997), 96-hour and 120-hour (from 2009) forecasts. The errors of the year are 91 km (106 km in 2012), 149 km (200 km), 215 km (291 km), 336 km (413 km) and 480 km (527 km) for 24-, 48-, 72-, 96- and 120-hour forecasts, respectively (Table 2). The mean hitting ratios of probability circles* for 24-, 48-, 72-, 96- and 120-hour forecasts are 82% (76% in 2012), 82% (71%), 84% (75%), 81% (72%) and 75% (75%), respectively (Table 3). Track forecasts were especially difficult for Yagi (1303), for which both the mean position errors and hitting ratios were much worse than annual mean.

## 3. Intensity Forecasts

Table 4 gives the mean errors and root mean square errors (RMSEs) of 24-, 48- and 72-hour central pressure (Table 4a) and maximum sustained wind forecasts (Table 4b) for 31 TCs of 2013. The annual mean RMSEs for central pressure forecasts are 13.6 hPa (12.8 hPa in 2012), 21.4 hPa (17.5 hPa) and 23.7 hPa (20.2 hPa) for 24-, 48- and 72-hour forecasts, respectively, while those of maximum wind speed forecasts for 24-, 48- and 72-hour forecasts are 6.4 m/s (5.7 m/s in 2012), 9.4 m/s (7.5 m/s) and 10.4 m/s (9.6 m/s), respectively. Intensity forecasts were particularly difficult for TCs that developed rapidly, such as Lekima (1328) whose central pressure decreased by 70 hPa in 24 hours on 22 October.

## 4. Objective Tropical Cyclone Satellite Analysis

The Center has developed the objective method, Cloud Grid Information objective Dvorak analysis (CLOUD), to analyze TC intensities. CLOUD utilizes Cloud Grid Information (CGI) developed by JMA – an objective cloud product derived using satellite images from MTSAT and Numerical Weather Prediction outputs to identify convective cloud areas; details of CLOUD were published in the RSMC Technical Review in March 2013 (http://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/techrev.htm). CLOUD verification was performed with 1,944 cases to which the RSMC applied Early Dvorak and Dvorak Analysis from 2011 to August 2013. The results showed that 1,683 cases (87%) had T-number differences of 0.5 or less in the best Dvorak analysis conducted by the RSMC, whereas 261 cases (13%) had differences of 1.0 or greater. These results demonstrate that CLOUD T-numbers are as accurate as their manual counterparts and can be used as final T-numbers except in cases of: 1) CGI identification of convective cloud areas significantly different from manually identified ones; 2) low concentration of convective cloud areas around a TC center; 3) shear patterns; or 4) rapid intensification. These shortcomings of CLOUD can be overcome by adopting manually determined PT (Pattern T) or MET (Model Expected T-number) data as appropriate. CLOUD has been used operationally at the Center since January 2014.

## 5. Numerical Typhoon Prediction (NTP) website

Since October 2004, the Center has officially operated the 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 the

major NWP centers and TC related products 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. Fourteen organs from 7 TYC Members other than Japan accessed the website in 2013. The main contents of this site are as follows:

1) Predictions of tropical cyclone tracks, in table and chart format, from nine major NWP centers including JMA. Ensemble mean prediction with any combination of those centers is also available.
2) NWP model products, in chart format, from the NWP centers
3) Results of satellite image analysis (EDA and Dvorak analysis)
4) Storm surge distribution maps, storm surge time series charts of points for TYC Members

**6. Regional storm surge watch scheme suitable for the TYC region**

In response to the results of the survey in 2009, the Center has been providing distribution maps since 1 June 2011 and time-series charts of storm surges since 5 June 2012 on the NTP website. It has further enhanced the storm surge forecasts for TYC Members since 3 June, 2013, in line with recommendations included in the Annual Operating Plan 2013 of the TYC Working Group on Meteorology. The forecasting region has been extended to almost twice as large as the previous one, including the Mariana Islands and most of the Caroline Islands. It not only helps Members in the extended area to issue local warnings and advisories for storm surges, but also enables TYC Members to understand the general characteristics of forthcoming storm surges, thereby supporting the issuance of early warnings. In addition, seven stations at Chumphon (Thailand), Boryeong, Busan, Incheon, Jeju, Mokpo and Sokcho (Republic of Korea) were added for storm surge time-series forecasting services. As of the end of Dec. 2013, the Center has received the requests from Members for the provision of storm surge time-series forecasts at 30 stations (U.S.A.: 1 station, the Philippines: 9 stations, Vietnam: 20 stations). It is preparing to add those stations in response to requests from TYC Members in due course. This service is implemented within the framework of the WMO Storm Surge Watch Scheme (SSWS). The real-time storm surge forecasts are provided on NTP website (https://tynwp-web.kishou.go.jp/) when one or more typhoons are present in the region. The details of the model and the verification results of the model are shown in the Technical Review published in 2012 (http://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/techrev/text14-2.pdf).

**7. Contribution to the WMO western North Pacific Tropical Cyclone Ensemble Forecast (NWP-TCTEF) Project**

Tropical Cyclone Ensemble Forecast Information Home Page (NWP-TCEFP Home page) was launched by JMA in 2010 for the purpose of providing guidance of tropical cyclone forecasts in near real-time for TYC Members, using the TIGGE (THORPEX Interactive Grand Global Ensemble) Cyclone XML (CXML) data, under the joint project of World Weather Research Program (WWRP) and Tropical Cyclone Program (TCP), western North Pacific Tropical Cyclone Ensemble Forecast Project (NWP-TCEFP). This web page provides deterministic and ensemble TC track forecasts, and strike probability maps based on ensemble TC track forecasts. The effectiveness of EPS for TC operational forecasts was confirmed by the questionnaire sent to TYC Members from WMO in December 2011 and 2012. In line with AOP 2013, the NWP-TCEFP performed evaluation of cyclogenesis prediction over the western North Pacific on medium-range timescales for TCs generated between July and October in the period from 2009 to 2012 using ensemble predictions from ECMWF, JMA, NCEP and UKMO. The results indicate all ensemble systems successfully predicted TC genesis events with a lead time of at least five days. For further evaluation of tropical cyclogenesis predictability over the western North Pacific on up to medium-range timescales, NWP-TCEFP has been extended to 2015 at Sixteenth Session of the Commission for Atmospheric Sciences (CAS-16) in November 2013.

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

The Center participates in a sub-regional project in Southeast Asia (SWFDP-SeA) as the Regional Center for Tropical Cyclone / Typhoon Forecasting Support to provide typhoon related products. The Center has been involved with SWFDP-SeA since its development in 2010. In 2013, the Center dispatched two experts as lecturers to the joint training workshop of SWFDP-SeA and the subproject in South Asia (Bay of Bengal) held from 8 to 19 April 2013 in Macao, China. One more expert of the Center also gave a webinar (a lecture using a tele-communication tool) to the said joint training workshop. The Center is planning to provide guidance on tropical cyclone ensemble forecast over the western North Pacific in real time to TYC Members including those of SWFDP-SeA, based on the success of NWP-TCEFP, in order to further promote the operational use of such ensemble guidance. CAS welcomed, at its 16th Session, with appreciation this initiative of the Center and encouraged timely and sustainable dissemination of forecasts of ensemble prediction systems by NMCs operating global ensemble prediction systems to support such initiative.

**9. Tropical Cyclone Satellite Re-analysis**

Responding to the discussions of the Seventh WMO International Workshop on Tropical Cyclones (IWTC-VII La Reunion, France, 15-20, November 2010), and the 2nd international IBTrACS Workshop (Honolulu, Hawaii, 11-13 April 2011) held in conjunction with the WMO sponsored International Workshop on Satellite Analysis of Tropical Cyclones (IWSATC) (Honolulu, Hawaii, 13-16 April 2011), the Center started tropical cyclone satellite re-analysis in 2012 for the period from 1981 to confirm and improve the quality of the Current Intensity (CI) number in the satellite TC analysis. Re-analysis over the period from 1987 to 1996 is being implemented to be completed by the end of 2014.

**10. Tropical cyclone advisories in Common Alert Protocol (CAP)**

The Common Alert Protocol (CAP) is an international standard format for emergency alerting and public warning. After the sixteenth World Meteorological Congress (Geneva, June 2011) endorsed the implementation of the CAP as a joint collaborative effort between Public Weather Services Programme and the WIS, and the TYC documented in the 44th session (Hangzhou, February 2012) that "Standardization and harmonization of Members' practice to promote effective warnings", the Center started to develop experimental CAP profiles for TC advisories and has begun experimental service since November 2012. The experimental CAP messages are served in an Atom feed (sometimes called as RSS). Recipient centers can retrieve updates by polling (periodically accessing) the feed at http://www.data.jma.go.jp/fcd/yoho/cap-rsmctk/atom.xml. The latest and sample tropical cyclone advisories in CAP format have been posted at the JMA website http://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/RSMC_HP.htm.

**11. Radar composite map for the UFRM pilot city in Thailand**

Development of Regional Radar Network was endorsed as a project of the Working Group of Meteorology. An expert mission by the team from the Center, Kyoto University and the Typhoon Committee Secretariat visited Thailand in 2011 to investigate the capacity of the Thai Meteorological Department (TMD) for the development of radar composite maps covering the entire Thailand. In November 2012, the Center organized a training course to provide radar composite techniques to the TMD experts. In 2013, in accordance with the outcome of this training, TMD worked on the development of quality-assured radar echo intensity data on the lowest level at one radar site. A follow-up technical meeting was held in Tokyo from 25 to 28 November 2013 to develop radar composite maps of four radar sites (Krabi, Chumphon, Phuket, and Sathing Phra), with particular focus on the transfer of techniques for creation of elevation angle composite tables. TMD is developing nationwide composite maps with the transferred technique with continued assistance of the Center in 2014. A preliminary study on application of QPE technique is also planned.

**12. Tropical cyclone advisories for SIGMET in graphical format**

As indicated in the Manual of Aeronautical Meteorological Practice (Doc 8896), the information on TCs in graphical format provided by TCAC Tokyo is shown in the JMA website (http://www.jma.go.jp/en/typh/). In addition, the progress of development of graphical Tropical cyclone advisories (TCAs) based on the techniques utilizing the cloud grid information for the analysis of existing CB areas, according to MODEL TCG in the Appendix 1 of ICAO Annex 3, was reported at 17th meeting of the Meteorology sub-group (MET SG/17) of APANPIRG held in Bangkok, Thailand, in May 2013. The graphical TCAs will be issued in a few years.

**13. Himawari-8/9 - Japan's next generation of geostationary meteorological satellites**

JMA has operated a series of satellites at around 140 degrees east for more than 35 years since its launch of the first meteorological satellite in 1977. The currently operational MTSAT-2 is backed up by MTSAT-1R in stand-by orbit. In 2014, JMA plans to launch Himawari-8 which will start its operation in 2015 replacing MTSAT-2. Himawari-9 will also be launched in 2016. Both satellites will be located at around 140 degrees east, and will continue to observe the East Asia and Western Pacific regions for a period of 15 years. Himawari-8/9 will have 16 channels. Three of these will be visible channels corresponding to red, green and blue to enable the creation of true-color images. Observation frequency will also be enhanced, with full-disk imagery obtained every 10 minutes. In addition, rapid scanning will be conducted in several regions, one of which will be for targeted observation of tropical cyclones. JMA expects this rapid scanning to be especially useful for East Asian and Western Pacific countries. Since Himawari-8/9 will not carry a device for direct dissemination, all imagery from the satellites will be distributed via the Internet. For Members with limited Internet access, JMA will also disseminate a primary set of imagery for operational meteorological services via a commercial telecommunication satellite, and tentatively plans to begin this service in 2015 in parallel with the direct dissemination of imagery from MTSAT-2 via MTSAT-1R which will be terminated after the successful transition to Himawari-8. In the spring of 2014, detailed information including equipment needed to receive imagery via a telecommunication satellite will be released.

**14. Publications**

The Center published one paper, "Cloud Grid Information Objective Dvorak Analysis (CLOUD) at the RSMC Tokyo - Typhoon Center" as its Technical Review No. 15 in March 2013, and Annual Report on the Activities of the RSMC Tokyo - Typhoon Center in 2012 in December 2013. They are available on the Center's website at http://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/RSMC_HP.htm.

**15. Training**

Two forecasters from Cambodia and Thailand visited the Center from 17 to 26 July 2013 to participate in the 13th TYC Attachment Training. The details of the training were posted at the JMA website (http://www.jma.go.jp/jma/en/photogallery/RSMC_training_201307.html).

**16. Implementation Plans**

Table 5 shows the implementation plans of the Center for the period from 2013 to 2017.

Table 1 Monthly and annual total numbers of products issued by the RSMC Tokyo - Typhoon Center in 2013

| Product | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **IUCC10** | 40 | 14 | 0 | 0 | 0 | 114 | 97 | 196 | 238 | 376 | 122 | 0 | 1197 |
| **WTPQ20-25** | 45 | 19 | 0 | 0 | 0 | 139 | 121 | 277 | 309 | 420 | 153 | 0 | 1483 |
| **WTPQ30-35** | 10 | 5 | 0 | 0 | 0 | 31 | 31 | 69 | 76 | 103 | 39 | 0 | 364 |
| **WTPQ50-55** | 5 | 0 | 0 | 0 | 0 | 21 | 18 | 63 | 56 | 110 | 27 | 0 | 300 |
| **FXPQ20-25** | 44 | 18 | 0 | 0 | 0 | 136 | 118 | 270 | 304 | 412 | 150 | 0 | 1452 |
| **FKPQ30-35** | 22 | 9 | 0 | 0 | 0 | 68 | 59 | 135 | 152 | 206 | 75 | 0 | 726 |
| **AXPQ20** | 3 | 0 | 1 | 0 | 0 | 0 | 4 | 4 | 3 | 9 | 7 | 2 | 33 |

Notes:

| | |
|---|---|
| IUCC10 RJTD | SAREP (BUFR format) |
| WTPQ20-25 RJTD | RSMC Tropical Cyclone Advisory |
| WTPQ30-35 RJTD | RSMC Prognostic Reasoning |
| WTPQ50-55 RJTD | RSMC Tropical Cyclone Advisory for five-day track forecast |
| FXPQ20-25 RJTD | RSMC Guidance for Forecast |
| FKPQ30-35 RJTD | Tropical Cyclone Advisory for SIGMET |
| AXPQ20 RJTD | RSMC Tropical Cyclone Best Track |

Table 2 Mean position errors of track forecasts for the TCs in 2013

| Tropical Cyclone | | | 24-hour Forecast | | | | 48-hour Forecast | | | | 72-hour Forecast | | | | 96-hour Forecast | | | | 120-hour Forecast | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 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 (%) |
| STS | Sonamu | (1301) | 67 | 41 | 14 | 37 | 96 | 49 | 10 | 22 | 105 | 38 | 6 | 13 | 180 | 1 | 2 | - | - | - | 0 | - |
| TS | Shanshan | (1302) | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TS | Yagi | (1303) | 177 | 57 | 11 | 80 | 406 | 55 | 7 | 125 | 491 | 72 | 3 | 70 | - | - | 0 | - | - | - | 0 | - |
| TS | Leepi | (1304) | 93 | 37 | 8 | 41 | 118 | 89 | 4 | 52 | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TS | Bebinca | (1305) | 155 | 86 | 10 | 47 | 236 | 142 | 5 | 35 | 352 | 0 | 1 | - | - | - | 0 | - | - | - | 0 | - |
| STS | Rumbia | (1306) | 150 | 64 | 12 | 81 | 311 | 98 | 8 | 109 | 422 | 56 | 4 | 116 | - | - | 0 | - | - | - | 0 | - |
| TY | Soulik | (1307) | 46 | 37 | 20 | 48 | 60 | 33 | 16 | 29 | 83 | 32 | 12 | 43 | 148 | 68 | 8 | 46 | 258 | 28 | 4 | 35 |
| TS | Cimaron | (1308) | 148 | 83 | 3 | 23 | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| STS | Jebi | (1309) | 77 | 20 | 10 | 39 | 114 | 26 | 6 | 31 | 175 | 40 | 2 | - | - | - | 0 | - | - | - | 0 | - |
| TS | Mangkhut | (1310) | 129 | 4 | 2 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TY | Utor | (1311) | 97 | 64 | 19 | 53 | 194 | 111 | 15 | 46 | 286 | 185 | 11 | 50 | 312 | 199 | 7 | 33 | 363 | 63 | 3 | 25 |
| STS | Trami | (1312) | 108 | 50 | 15 | 30 | 133 | 80 | 11 | 18 | 112 | 50 | 7 | 7 | 179 | 50 | 3 | 8 | - | - | 0 | - |
| STS | Pewa | (1313) | 112 | 66 | 22 | 60 | 181 | 94 | 18 | 42 | 307 | 126 | 14 | 45 | 447 | 121 | 10 | 50 | 734 | 255 | 6 | 118 |
| TS | Unala | (1314) | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| STS | Kong-rey | (1315) | 60 | 25 | 11 | 39 | 147 | 39 | 7 | 64 | 216 | 96 | 3 | 11 | - | - | 0 | - | - | - | 0 | - |
| TS | Yutu | (1316) | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| STS | Toraji | (1317) | 139 | 82 | 5 | 183 | 393 | 0 | 1 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TY | Man-yi | (1318) | 100 | 102 | 10 | 20 | 130 | 67 | 6 | 8 | 274 | 8 | 2 | - | - | - | 0 | - | - | - | 0 | - |
| TY | Usagi | (1319) | 98 | 71 | 22 | 56 | 135 | 110 | 18 | 31 | 194 | 108 | 14 | 22 | 235 | 65 | 10 | 19 | 185 | 108 | 6 | 12 |
| STS | Pabuk | (1320) | 66 | 30 | 19 | 26 | 83 | 37 | 15 | 17 | 198 | 89 | 11 | 33 | 406 | 228 | 7 | 42 | 461 | 206 | 3 | 43 |
| TY | Wutip | (1321) | 81 | 42 | 11 | 35 | 199 | 100 | 7 | 36 | 507 | 89 | 3 | 232 | - | - | 0 | - | - | - | 0 | - |
| TS | Sepat | (1322) | 56 | 19 | 7 | 15 | 100 | 16 | 3 | 10 | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TY | Fitow | (1323) | 61 | 37 | 22 | 48 | 85 | 39 | 18 | 23 | 139 | 43 | 14 | 26 | 328 | 108 | 10 | 64 | 588 | 128 | 6 | 76 |
| TY | Danas | (1324) | 81 | 54 | 15 | 29 | 125 | 65 | 11 | 19 | 270 | 121 | 7 | 22 | 758 | 18 | 3 | 92 | - | - | 0 | - |
| TY | Nari | (1325) | 80 | 38 | 21 | 52 | 162 | 74 | 17 | 45 | 181 | 74 | 13 | 33 | 231 | 112 | 9 | 48 | 268 | 57 | 5 | 31 |
| TY | Wipha | (1326) | 76 | 21 | 19 | 29 | 167 | 76 | 15 | 36 | 299 | 95 | 10 | 39 | 594 | 148 | 6 | 44 | 1149 | 34 | 2 | 43 |
| TY | Francisco | (1327) | 68 | 47 | 36 | 29 | 88 | 32 | 31 | 18 | 136 | 62 | 27 | 22 | 256 | 96 | 23 | 41 | 388 | 118 | 19 | 39 |
| TY | Lekima | (1328) | 85 | 46 | 19 | 20 | 142 | 83 | 15 | 16 | 150 | 80 | 11 | 12 | 395 | 91 | 7 | 41 | 971 | 67 | 3 | 81 |
| TY | Krosa | (1329) | 96 | 52 | 18 | 61 | 199 | 73 | 14 | 53 | 308 | 79 | 10 | 44 | 449 | 58 | 6 | 35 | 610 | 34 | 2 | - |
| TY | Haiyan | (1330) | 120 | 62 | 25 | 67 | 192 | 98 | 21 | 44 | 273 | 111 | 17 | 50 | 401 | 162 | 13 | 47 | 550 | 154 | 9 | 46 |
| TS | Podul | (1331) | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| Annual Mean (Total) | | | 91 | 61 | 406 | 41 | 149 | 101 | 299 | 31 | 215 | 131 | 202 | 30 | 336 | 177 | 124 | 41 | 480 | 258 | 68 | 42 |

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 TCs in 2013

| 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) |
| STS | Sonamu | (1301) | 100 | 14 | 141 | 100 | 10 | 250 | 100 | 6 | 352 | 100 | 2 | 370 | - | 0 | - |
| TS | Shanshan | (1302) | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| TS | Yagi | (1303) | 27 | 11 | 157 | 0 | 7 | 296 | 33 | 3 | 426 | - | 0 | - | - | 0 | - |
| TS | Leepi | (1304) | 100 | 8 | 174 | 100 | 4 | 352 | - | 0 | - | - | 0 | - | - | 0 | - |
| TS | Bebinca | (1305) | 40 | 10 | 139 | 60 | 5 | 204 | 0 | 1 | 296 | - | 0 | - | - | 0 | - |
| STS | Rumbia | (1306) | 50 | 12 | 139 | 25 | 8 | 252 | 25 | 4 | 389 | - | 0 | - | - | 0 | - |
| TY | Soulik | (1307) | 95 | 20 | 138 | 100 | 16 | 256 | 100 | 12 | 378 | 100 | 8 | 509 | 100 | 4 | 695 |
| TS | Cimaron | (1308) | 33 | 3 | 130 | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| STS | Jebi | (1309) | 100 | 10 | 132 | 100 | 6 | 204 | 100 | 2 | 343 | - | 0 | - | - | 0 | - |
| TS | Mangkhut | (1310) | 100 | 2 | 139 | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| TY | Utor | (1311) | 63 | 19 | 133 | 73 | 15 | 222 | 73 | 11 | 313 | 71 | 7 | 487 | 100 | 3 | 695 |
| STS | Trami | (1312) | 73 | 15 | 142 | 82 | 11 | 219 | 100 | 7 | 362 | 100 | 3 | 469 | - | 0 | - |
| STS | Pewa | (1313) | 73 | 22 | 134 | 67 | 18 | 235 | 57 | 14 | 329 | 80 | 10 | 489 | 50 | 6 | 671 |
| TS | Unala | (1314) | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| STS | Kong-rey | (1315) | 100 | 11 | 147 | 100 | 7 | 257 | 67 | 3 | 333 | - | 0 | - | - | 0 | - |
| TS | Yutu | (1316) | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| STS | Toraji | (1317) | 60 | 5 | 157 | 0 | 1 | 296 | - | 0 | - | - | 0 | - | - | 0 | - |
| TY | Man-yi | (1318) | 80 | 10 | 143 | 83 | 6 | 287 | 100 | 2 | 463 | - | 0 | - | - | 0 | - |
| TY | Usagi | (1319) | 82 | 22 | 130 | 78 | 18 | 210 | 79 | 14 | 296 | 100 | 10 | 430 | 100 | 6 | 556 |
| STS | Pabuk | (1320) | 95 | 19 | 138 | 100 | 15 | 251 | 91 | 11 | 347 | 57 | 7 | 476 | 67 | 3 | 648 |
| TY | Wutip | (1321) | 82 | 11 | 131 | 57 | 7 | 204 | 0 | 3 | 296 | - | 0 | - | - | 0 | - |
| TS | Sepat | (1322) | 100 | 7 | 147 | 100 | 3 | 333 | - | 0 | - | - | 0 | - | - | 0 | - |
| TY | Fitow | (1323) | 91 | 22 | 132 | 100 | 18 | 219 | 100 | 14 | 340 | 100 | 10 | 583 | 100 | 6 | 826 |
| TY | Danas | (1324) | 87 | 15 | 143 | 91 | 11 | 273 | 86 | 7 | 400 | 0 | 3 | 494 | - | 0 | - |
| TY | Nari | (1325) | 90 | 21 | 131 | 71 | 17 | 217 | 92 | 13 | 332 | 100 | 9 | 461 | 100 | 5 | 556 |
| TY | Wipha | (1326) | 100 | 19 | 146 | 93 | 15 | 252 | 80 | 10 | 372 | 33 | 6 | 482 | 0 | 2 | 695 |
| TY | Francisco | (1327) | 97 | 36 | 141 | 100 | 31 | 229 | 100 | 27 | 329 | 100 | 23 | 494 | 95 | 19 | 599 |
| TY | Lekima | (1328) | 89 | 19 | 151 | 87 | 15 | 279 | 100 | 11 | 409 | 86 | 7 | 519 | 0 | 3 | 695 |
| TY | Krosa | (1329) | 78 | 18 | 144 | 57 | 14 | 243 | 70 | 10 | 350 | 50 | 6 | 444 | 0 | 2 | 556 |
| TY | Haiyan | (1330) | 64 | 25 | 138 | 81 | 21 | 259 | 82 | 17 | 389 | 62 | 13 | 444 | 44 | 9 | 556 |
| TS | Podul | (1331) | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Annual Mean (Total) | | | 82 | 406 | 140 | 82 | 299 | 243 | 84 | 202 | 351 | 81 | 124 | 483 | 75 | 68 | 630 |

Table 4 Root mean square errors and mean errors of central pressure (4a: left) and maximum sustained wind (4b: right) forecasts for the TCs in 2013

| Tropical Cyclone | | | 24-hour Forecast | | | 48-hour Forecast | | | 72-hour Forecast | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Error (hPa) | RMSE (hPa) | Num. | Error (hPa) | RMSE (hPa) | Num. | Error (hPa) | RMSE (hPa) | Num. |
| STS | Sonamu | (1301) | 1.0 | 1.9 | 14 | 3.4 | 4.2 | 10 | 1.3 | 4.2 | 6 |
| TS | Shanshan | (1302) | - | - | 0 | - | - | 0 | - | - | 0 |
| TS | Yagi | (1303) | -4.5 | 5.6 | 11 | -7.3 | 9.1 | 7 | -9.3 | 10.1 | 3 |
| TS | Leepi | (1304) | -2.7 | 3.2 | 8 | -5.0 | 5.1 | 4 | - | - | 0 |
| TS | Bebinca | (1305) | 3.4 | 4.2 | 10 | 2.0 | 2.4 | 5 | 2.0 | 2.0 | 1 |
| STS | Rumbia | (1306) | 1.0 | 3.7 | 12 | 2.5 | 5.5 | 8 | -0.7 | 4.0 | 4 |
| TY | Soulik | (1307) | -2.5 | 19.2 | 20 | -2.7 | 26.4 | 16 | -14.9 | 28.9 | 12 |
| TS | Cimaron | (1308) | -2.7 | 2.8 | 3 | - | - | 0 | - | - | 0 |
| STS | Jebi | (1309) | -0.5 | 1.6 | 10 | 4.0 | 4.6 | 6 | 2.5 | 3.5 | 2 |
| TS | Mangkhut | (1310) | 1.0 | 1.4 | 2 | - | - | 0 | - | - | 0 |
| TY | Utor | (1311) | -8.9 | 19.0 | 19 | -15.5 | 26.8 | 15 | -24.6 | 31.3 | 11 |
| STS | Trami | (1312) | 4.9 | 7.8 | 15 | 8.0 | 8.6 | 11 | 9.9 | 12.8 | 7 |
| STS | Pewa | (1313) | -8.7 | 10.2 | 22 | -14.0 | 16.7 | 18 | -16.4 | 19.9 | 14 |
| TS | Unala | (1314) | - | - | 0 | - | - | 0 | - | - | 0 |
| STS | Kong-rey | (1315) | -8.8 | 12.4 | 11 | -10.0 | 14.7 | 7 | -19.3 | 21.9 | 3 |
| TS | Yutu | (1316) | - | - | 0 | - | - | 0 | - | - | 0 |
| STS | Toraji | (1317) | 6.4 | 6.8 | 5 | 5.0 | 5.0 | 1 | - | - | 0 |
| TY | Man-yi | (1318) | 1.0 | 5.5 | 10 | 5.0 | 8.7 | 6 | 0.0 | 5.0 | 2 |
| TY | Usagi | (1319) | 8.2 | 19.6 | 22 | 17.5 | 33.0 | 18 | 21.4 | 35.1 | 14 |
| STS | Pabuk | (1320) | -0.3 | 3.0 | 19 | -2.0 | 3.7 | 15 | -5.0 | 5.4 | 11 |
| TY | Wutip | (1321) | 4.5 | 12.0 | 11 | 4.7 | 20.7 | 7 | 5.3 | 15.2 | 3 |
| TS | Sepat | (1322) | 2.9 | 3.2 | 7 | 5.3 | 5.4 | 3 | - | - | 0 |
| TY | Fitow | (1323) | -5.3 | 7.6 | 22 | -9.8 | 11.1 | 18 | -12.2 | 13.4 | 14 |
| TY | Danas | (1324) | 6.5 | 19.2 | 15 | 24.5 | 30.9 | 11 | 22.9 | 32.6 | 7 |
| TY | Nari | (1325) | -3.0 | 9.8 | 21 | -8.4 | 17.9 | 17 | -8.6 | 20.2 | 13 |
| TY | Wipha | (1326) | 4.1 | 12.0 | 19 | 11.0 | 16.5 | 15 | 10.5 | 15.6 | 10 |
| TY | Francisco | (1327) | 1.7 | 12.5 | 36 | -1.8 | 18.0 | 31 | -5.7 | 16.6 | 27 |
| TY | Lekima | (1328) | 16.7 | 23.9 | 19 | 28.7 | 38.2 | 15 | 25.0 | 35.4 | 11 |
| TY | Krosa | (1329) | -9.1 | 11.6 | 18 | -12.4 | 16.9 | 14 | -18.1 | 24.2 | 10 |
| TY | Haiyan | (1330) | -1.9 | 23.6 | 25 | 6.7 | 34.6 | 21 | 6.2 | 35.4 | 17 |
| TS | Podul | (1331) | - | - | 0 | - | - | 0 | - | - | 0 |
| Annual Mean (Total) | | | 0.0 | 13.6 | 406 | 1.1 | 21.4 | 299 | -2.0 | 23.7 | 202 |

| Tropical Cyclone | | | 24-hour Forecast | | | 48-hour Forecast | | | 72-hour Forecast | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Error (m/s) | RMSE (m/s) | Num. | Error (m/s) | RMSE (m/s) | Num. | Error (m/s) | RMSE (m/s) | Num. |
| STS | Sonamu | (1301) | -2.2 | 2.6 | 14 | -6.4 | 8.7 | 10 | -6.9 | 10.5 | 6 |
| TS | Shanshan | (1302) | - | - | 0 | - | - | 0 | - | - | 0 |
| TS | Yagi | (1303) | 3.3 | 3.8 | 11 | 4.4 | 5.5 | 7 | 6.0 | 6.5 | 3 |
| TS | Leepi | (1304) | 1.9 | 2.2 | 8 | 3.9 | 4.1 | 4 | - | - | 0 |
| TS | Bebinca | (1305) | -2.8 | 5.9 | 10 | 0.0 | 0.0 | 5 | -18.0 | 18.0 | 1 |
| STS | Rumbia | (1306) | -0.9 | 2.3 | 12 | -1.3 | 3.4 | 8 | 0.6 | 2.9 | 4 |
| TY | Soulik | (1307) | -0.6 | 8.6 | 20 | -1.9 | 11.1 | 16 | 5.1 | 11.7 | 12 |
| TS | Cimaron | (1308) | 0.9 | 1.5 | 3 | - | - | 0 | - | - | 0 |
| STS | Jebi | (1309) | 0.5 | 2.8 | 10 | -1.3 | 2.3 | 6 | 0.0 | 2.6 | 2 |
| TS | Mangkhut | (1310) | 0.0 | 0.0 | 2 | - | - | 0 | - | - | 0 |
| TY | Utor | (1311) | 2.8 | 9.0 | 19 | 6.9 | 11.9 | 15 | 10.5 | 13.6 | 11 |
| STS | Trami | (1312) | -1.4 | 4.9 | 15 | -1.4 | 1.9 | 11 | -0.4 | 3.5 | 7 |
| STS | Pewa | (1313) | 5.4 | 6.6 | 22 | 8.1 | 10.1 | 18 | 8.6 | 11.1 | 14 |
| TS | Unala | (1314) | - | - | 0 | - | - | 0 | - | - | 0 |
| STS | Kong-rey | (1315) | 6.5 | 8.9 | 11 | 6.6 | 9.5 | 7 | 12.0 | 13.1 | 3 |
| TS | Yutu | (1316) | - | - | 0 | - | - | 0 | - | - | 0 |
| STS | Toraji | (1317) | -3.6 | 3.8 | 5 | -2.6 | 2.6 | 1 | - | - | 0 |
| TY | Man-yi | (1318) | 0.3 | 2.7 | 10 | -1.3 | 3.5 | 6 | 0.0 | 2.6 | 2 |
| TY | Usagi | (1319) | -2.3 | 8.6 | 22 | -5.6 | 13.2 | 18 | -5.9 | 13.2 | 14 |
| STS | Pabuk | (1320) | 1.2 | 2.8 | 19 | 2.9 | 4.6 | 15 | 5.1 | 6.2 | 11 |
| TY | Wutip | (1321) | -0.9 | 6.1 | 11 | -0.7 | 9.3 | 7 | -2.6 | 8.0 | 3 |
| TS | Sepat | (1322) | 0.0 | 1.9 | 7 | -1.7 | 2.1 | 3 | - | - | 0 |
| TY | Fitow | (1323) | 2.0 | 3.3 | 22 | 3.6 | 4.7 | 18 | 4.2 | 5.1 | 14 |
| TY | Danas | (1324) | -1.0 | 8.7 | 15 | -9.4 | 12.5 | 11 | -8.5 | 13.6 | 7 |
| TY | Nari | (1325) | -1.1 | 6.4 | 21 | 1.8 | 9.3 | 17 | 1.6 | 9.9 | 13 |
| TY | Wipha | (1326) | -1.2 | 5.2 | 19 | -2.1 | 5.6 | 15 | -0.3 | 4.5 | 10 |
| TY | Francisco | (1327) | 0.0 | 5.8 | 36 | 1.6 | 7.7 | 31 | 3.9 | 8.3 | 27 |
| TY | Lekima | (1328) | -6.5 | 8.9 | 19 | -10.1 | 14.5 | 15 | -8.9 | 12.6 | 11 |
| TY | Krosa | (1329) | 1.9 | 6.7 | 18 | 2.8 | 8.0 | 14 | 4.6 | 10.1 | 10 |
| TY | Haiyan | (1330) | 0.4 | 9.5 | 25 | -2.4 | 14.6 | 21 | -2.0 | 15.2 | 17 |
| TS | Podul | (1331) | - | - | 0 | - | - | 0 | - | - | 0 |
| Annual Mean (Total) | | | 0.1 | 6.4 | 406 | -0.1 | 9.4 | 299 | 1.5 | 10.4 | 202 |

Table 5 Implementation Plans of the RSMC Tokyo - Typhoon Center (2013 - 2017)

| PRODUCT | 2013 | 2014 | 2015 | 2016 | 2017 | REMARKS |
|---|---|---|---|---|---|---|
| **Satellite Observation** | | | | | | |
| MTSAT HRIT | ——— | ——— | ——— | | | All observed cloud images (full or half-disk) |
| MTSAT LRIT | ——— | ——— | ——— | | | 24 times/day (full-disk)<br>44 times/day (polar-stereo East Asia) |
| Himawari-8 imagery | | | ——— | ——— | ——— | |
| Cloud motion wind (BUFR) | ——— | ——— | ——— | ——— | ——— | 24 times/day |
| **Analysis** | | | | | | |
| RSMC Tropical Cyclone Advisory | ——— | ——— | ——— | ——— | ——— | 8 times/day |
| SAREP (for tropical cyclones, BUFR) | ——— | ——— | ——— | ——— | ——— | 8 times/day Position of cloud sytem center, etc.<br>4 times/day Dvorak intensity |
| Numerical Typhoon Website<br>satellite image analysis for tropical cyclones | ——— | ——— | ——— | ——— | ——— | 4 times/day<br>early stage Dvorak analysis & regular Dvorak analysis |
| Sea Surface Temperature | ——— | ——— | ——— | ——— | ——— | |
| Objective analysis<br>pressure pattern, etc | ——— | ——— | ——— | ——— | ——— | |
| satellite Tropical Cyclone intensity | | ——— | ——— | ——— | ——— | |
| **Forecast** | | | | | | |
| RSMC Tropical Cyclone Advisory | ——— | ——— | ——— | ——— | ——— | 4 times/day up to 120 hrs ahead<br>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)<br>4 times/day up to 132 hrs ahead (TEPS) |
| NWP products<br>pressure pattern, etc | ——— | ——— | ——— | ——— | ——— | |
| Numerical Typhoon Prediction Website<br>tracks and prediction fields, etc | ——— | ——— | ——— | ——— | ——— | mostly updated 2 times/day<br>4 times/day up to 132 hrs ahead (TEPS)<br>Storm surge forecasts over extended area and storm surge time series for more stations have been provided since 2013 |
| Experimental CAP Tropical Cyclone Advisory | ——— | ——— | ——— | ——— | ——— | |
| **Others** | | | | | | |
| RSMC Tropical Cyclone Best Track | ——— | ——— | ——— | ——— | ——— | |
| Annual Report | ——— | ——— | ——— | ——— | ——— | Publication |
| Technical Review | ····· | ····· | ····· | ····· | ····· | Publication (as necessary) |
| Tropical Cyclone Reanalysis | ——— | ——— | ——— | ——— | ——— | |

| SUPPORTING ACTIVITY | 2013 | 2014 | 2015 | 2016 | 2017 | REMARKS |
|---|---|---|---|---|---|---|
| Data archive | ——— | ——— | ——— | ——— | ——— | |
| Monitoring of data exchange | ——— | ——— | ——— | ——— | ——— | |
| Dissemination of products | ——— | ——— | ——— | ——— | ——— | Upgraded to WIS GISC Tokyo in 2011 |

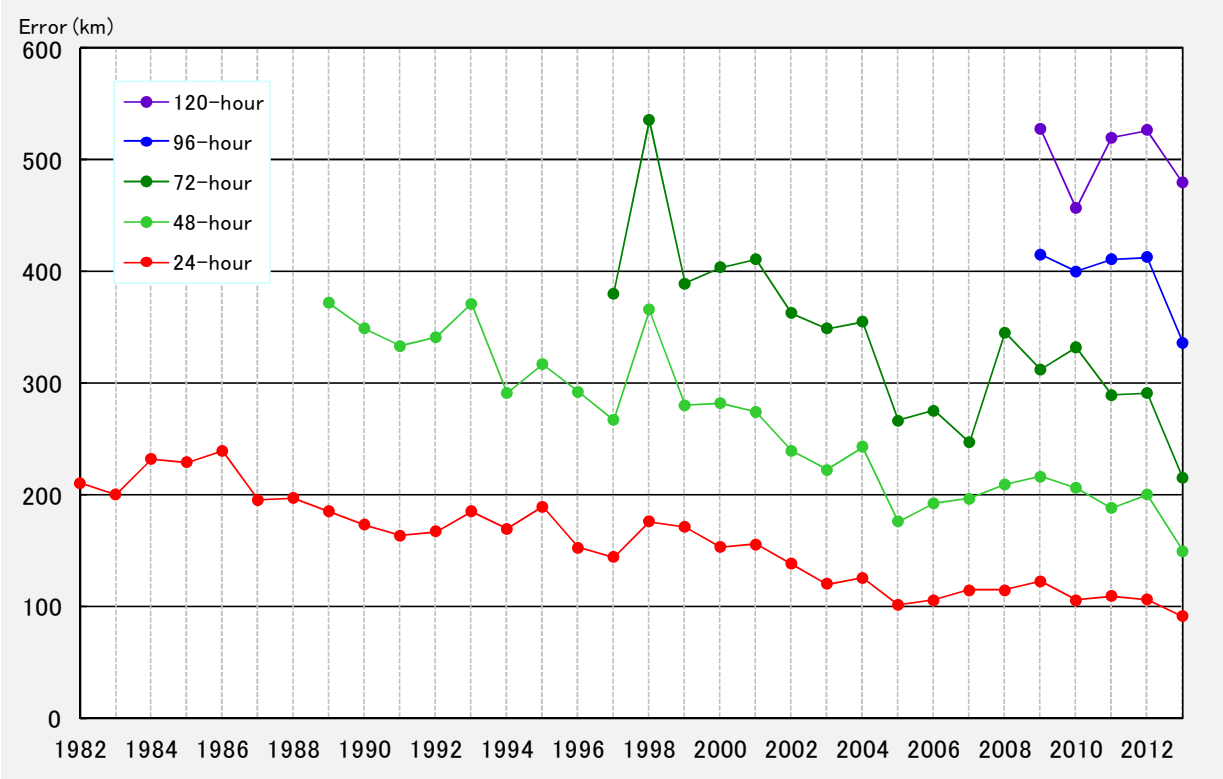



Figure 1 Annual mean position errors of track forecasts
Vertical axis:  position error (km), Horizontal axis: year

Appendix

*ESCAP/WMO Typhoon Committee - 46th session, Bangkok, Thailand*

# Progress Report

# for

# North Western Pacific

# Tropical Cyclone Ensemble Forecast Project

10 February 2014

World Weather Research Programme
Tropical Cyclone Programme

World Meteorological Organization

## 1. Introduction

The North Western Pacific Tropical Cyclone Ensemble Forecast Project (NWP-TCEFP) is a joint project by the World Meteorological Organization (WMO) Tropical Cyclone Programme (TCP) and the World Weather Research Programme (WWRP) with the aim to explore the utility of ensemble forecast products based on the Observing System Research and Predictability Experiment (THORPEX) Interactive Grand Global Ensemble (TIGGE) Cyclone XML (CXML) data and to promote such products for operational TC forecasting. The project has launched as a 5-year project in 2009, following a suggestion at the 42nd session of the Economic and Social Commission for Asia and the Pacific (ESCAP)/WMO Typhoon Committee (Singapore, 25-29 January 2010).

The Japan Meteorological Agency is a leading center of this project and has set out and maintained a password-protected website to provide TC ensemble forecasting products on a near real-time basis. The products have been utilized by the ESCAP/WMO Typhoon Committee Members since the establishment of the website. Moreover they have been used by operational forecasters in the Severe Weather Forecast Demonstration Project (SWFDP) in Southeast Asia. Progress of the project to date is summarized in this report.

## 2. Questionnaire surveys

In order to investigate the utility of the NWP-TCEFP website, questionnaire surveys were conducted by the WMO TCP/WWRP and also by the WMO Global Interactive Forecast System (GIFS)-TIGGE Working Group, respectivley. The responses confirmed that the ESCAP/WMO Typhoon Committee Members have constantly accessed the website and recognized the usefulness of the ensemble products available on the website. The surveys also identified the Members' requests for more timely and sustainable provision of such ensemble guidance and the needs for training.

For the future possible improvements of the website, the survey results confirmed that there was a lot of interest in forecasting strong winds and heavy precipitation.

The questionnaire sent to the ESCAP/WMO Typhoon Committee Members is shown in **Annex I**, and the main results of the 2012 and 2013 questionnaires are shown in **Annex II**.

## 3. Plan of action for 2014 and beyond

In line with the Annual Operating Plan (AOP) of the Working Group on Meteorology (WGM) of the ESCAP/WMO Typhoon Committee for 2013, the NWP-TCEFP performed

evaluation of tropical cyclogenesis prediction over the western North Pacific on medium-range timescales. The project has been extended to 2015, at the 16th session of the Commission for Atmospheric Sciences (CAS)/WMO (Turkey, 20-26 November 2013), for the investigation of tropical cyclogenesis prediction over the North Western Pacific on medium-range timescales.

The CAS/WMO noted at the 16th session that RSMC Tokyo - Typhoon Centre was planning to provide TC ensemble guidance over the North Western Pacific in real time to the ESCAP/WMO Members, following the success of the NWP-TCEFP, in order to further promote the operational use of such ensemble guidance. The Commission welcomed with appreciation this initiative of RSMC Tokyo - Typhoon Centre and encouraged timely and sustainable dissemination of forecasts by NMCs operating global ensemble prediction systems to support such initiative.

**Progress to date**

2009/12 Initial development of the project plan, including the Web development

2010/04 The first release of the Web site for the Project

2010/07 Minor update of the Web site

- "real time" page was implemented.
- "Readme" page was updated.
- Several issues remained, such as "introduction" page is not included, spotty map for strike probability

2010/10 Major update of the Web site

- "all center" ensemble track page was implemented
- EPSgram-like strike probability plot for some cities was implemented

2010/10 WMO sent the letter to PRs of the Typhoon Committee Members on the Project and Web page

2010/11 Presentation of the Web site at the IWTC-6 in La Reunion

2011/08 Presentation of the Web site at the THORPEX GIFS/TIGGE WG meeting in Geneva

2011/12 TCS sent the questionnaire to the TC Members on the Web site

2012/01 TCS received the replies of the questionnaire from 13 TC Members. WMO presented the questionnaire results at the 44th session of ESCAP/WMO Typhoon Committee held in Hangzhou, China.

2012/07 The GIFS/TIGGE WG sent the questionnaire to representatives of several forecast offices that are participating in SWFDP, or are likely to become involved in the future.

2012/12 The GIFS/TIGGE WG received the replies of the questionnaire from 13 forecast offices.

2012/12 TCS sent the questionnaire to the TC Members on the Web site

2013/01 TCS received the replies of the questionnaire from 12 TC Members.

2013/12 Progress of the NWP-TCEFP including preliminary results on evaluation of tropical cyclogenesis prediction were presented in the 8th IWS/2nd TRCG Forum in Macao, China.

Annex I

# Questionnaire

*About*

*WMO North-western Pacific Tropical Cyclone Ensemble Forecast Project*

**Date** : _____

**Country** : _____

1. **Project homepage (http://tparc.mri-jma.go.jp/cyclone)**

### 1.1 Users

What are the main users in your National Meteorological Hydrological Service (NMHS)?

( ) Forecast section

( ) Research section

( ) Others ( )

### 1.2 Frequency of visit to the Project homepage

How often does your NMHS visit this homepage?

( ) always when a tropical cyclone exists

( ) always when a tropical cyclone is approaching my country

( ) sometimes when a tropical cyclone exists

( ) sometimes when a tropical cyclone is approaching my country

( ) only occasionally

( ) have not visited the Homepage

### 1.3 Pages of most frequent visit (choose up to 3)

Ensemble

( ) all centers – tracks

( ) all centers – strike probability plots

( ) all centers – strike probability plots at certain times

( ) all centers – time series of strike probability at certain city

( ) individual centers – tracks

( ) individual centers – strike probability plots

( ) individual centers – strike probability plots at certain times

( ) individual centers – time series of strike probability at certain city

Deterministic

( ) all centers – tracks

None

( )

**1.4 Usability of the homepage**

( ) Very useful

( ) Useful

( ) Partly useful

( ) Not so useful

( ) Not useful at all

**1.5 Comments on the homepage**

Please comment, if any, on the homepage such as possible improvements, new products and future expectations.

| |
|---|
| |

**2. Ensemble forecast in general**

**2.1 Do you use ensemble forecast products from any other sources for TC forecasting?**

( ) Yes

( ) No

( ) No, but plan to use in the future.

**2.2 If yes, please specify the sources.**

| |
|---|
| |

**2.3 Do you think ensemble forecast improves the TC forecast performance?**

( ) Yes

( ) Uncertain

( ) No

( ) No, but probably yes in the future.

**2.4 Do you find any difficulties in using ensemble forecast?**

( ) Yes

( ) No

**2.5 If yes, please choose the reason.**

( ) Training is necessary to use ensemble forecast

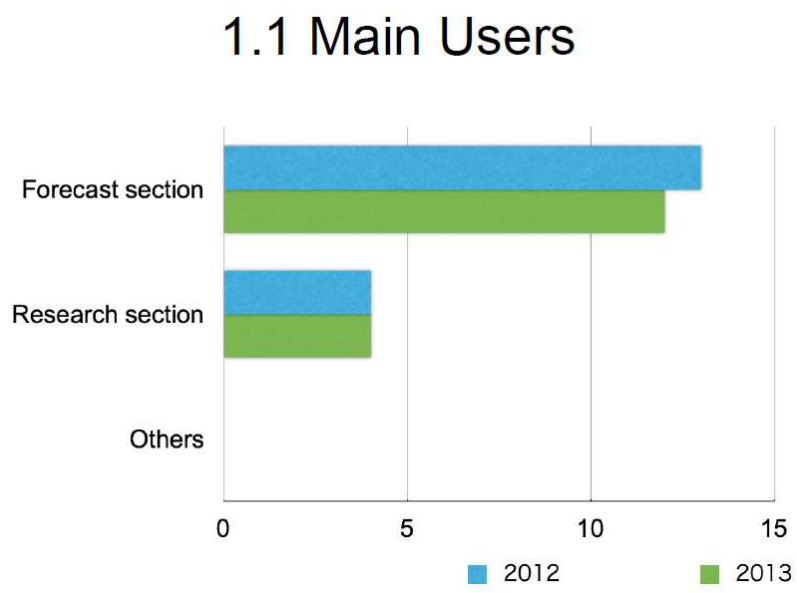
( ) Facilities are not enough (PCs, etc.)

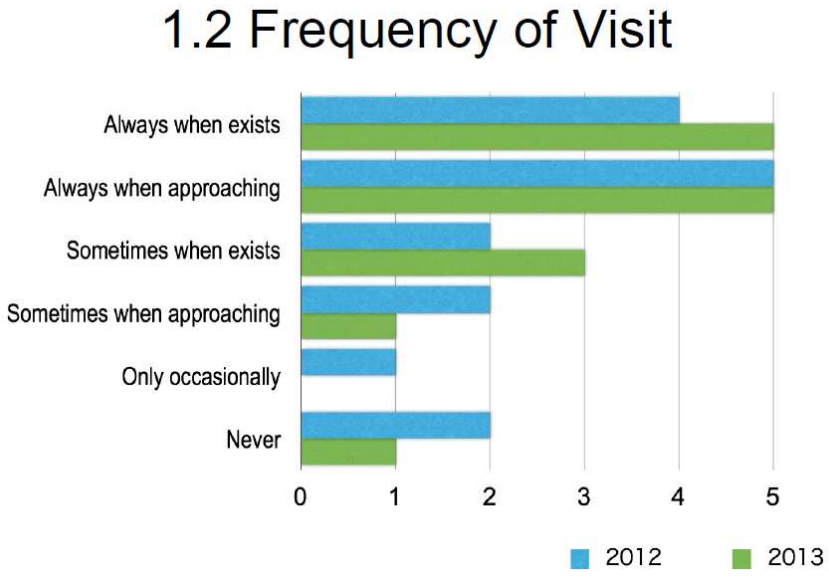
( ) Internet communication is not good

( ) Others ( )

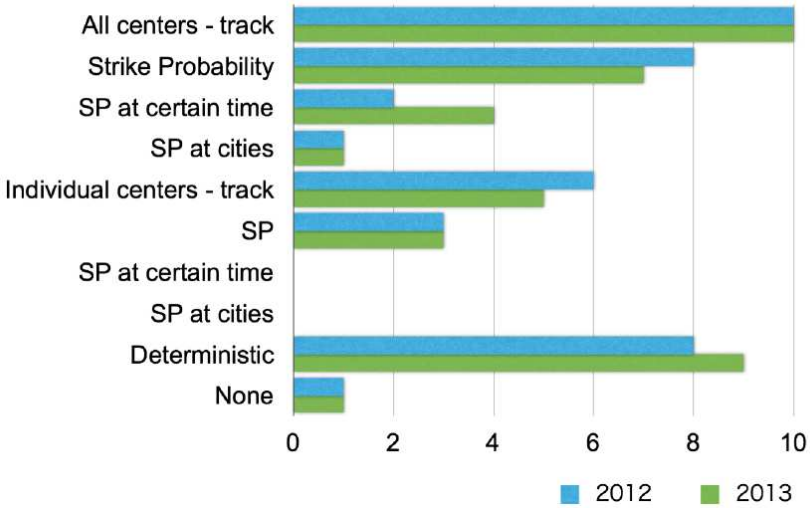
**Main results of the questionnaire surveys**

## I Summary of the responses

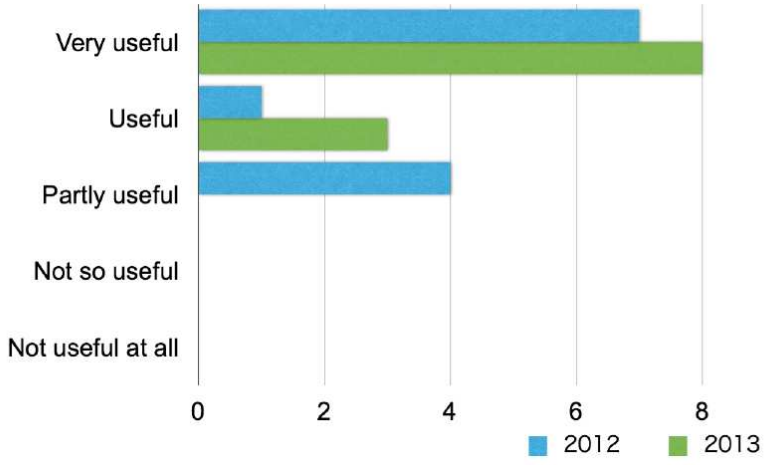


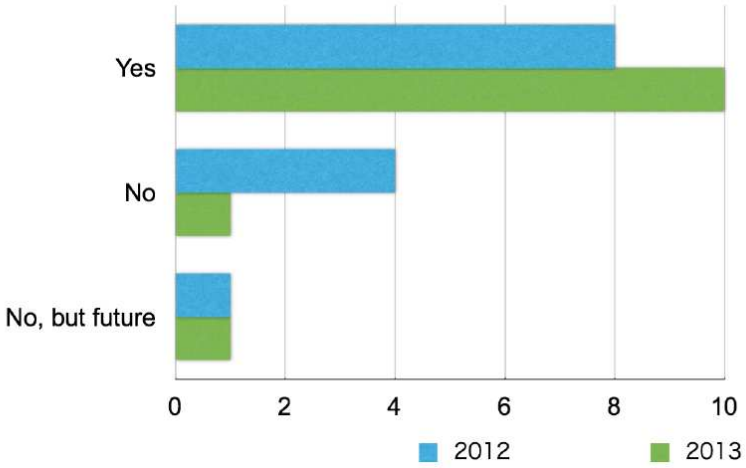
## 1.3 Pages of visit




## 1.4 Usability



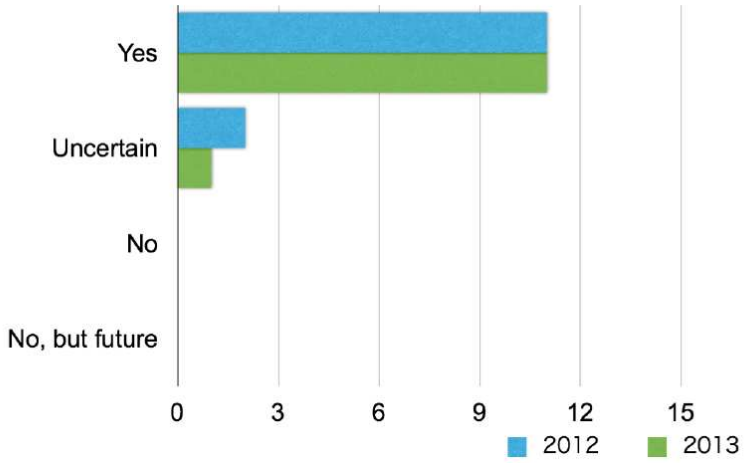
## 2.1 Other Ensemble Data



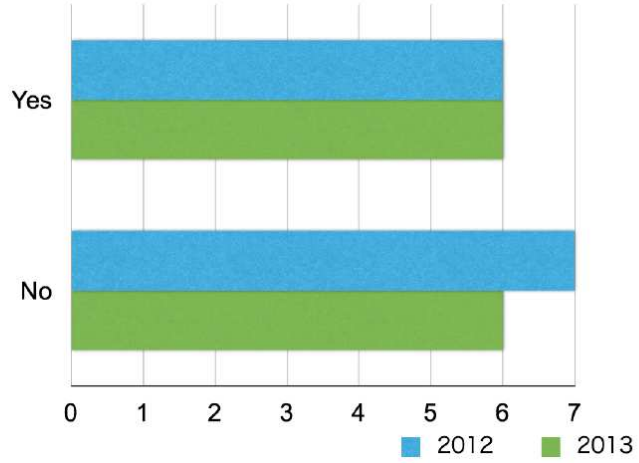

## 2.2 Ensemble Data Sources

ECMWF
JMA
WMO TLFDP
KMA
US Navy
CMA
NCEP/EMC
Cyclone XML Page
TIGGE
Viet Nam EPS

## 2.3 En FCST Improve TC FCST?




## 2.4 Difficulties in using En FCST



# 2.5 Reason for Difficulties