ESCAP/WMO Typhoon Committee
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ACTIVITIES OF THE RSMC TOKYO - TYPHOON CENTER IN 2021

(Submitted by the RSMC Tokyo - Typhoon Center)

ACTION REQUIRED:

The Committee is invited to review the activities of the RSMC Tokyo - Typhoon Center in 2021 and future plans.

APPENDIXES:

A) DRAFT TEXT FOR INCLUSION IN SESSION REPORT

B) RSMC Tokyo - Typhoon Center Activity Report 2021 and future plans

APPENDIX A:
DRAFT TEXT FOR INCLUSION IN THE SESSION REPORT

x.x Review of the activities of the Regional Specialized Meteorological Center (RSMC) Tokyo in 2021

1. The Committee noted with appreciation the review of RSMC advisories, products and operational activities and changes made in 2021. It noted the forecast verification results for 22 TCs that reached TS intensity or higher formed in 2021: the forecast track errors of the year of 87 km (74 km in 2020), 157 km (119 km), 225 km (176 km), 261 km (214 km) and 264 km (267 km) for 24-, 48-, 72-, 96- and 120-hour forecasts, respectively, the annual mean RMSEs for central pressure forecasts of 11.9 hPa (11.6 hPa), 15.9 hPa (15.0 hPa), 18.0 hPa (14.6 hPa), 19.0 hPa (13.9 hPa) and 17.9 hPa (13.0 hPa) for 24-, 48-, 72-, 96- and 120-hour forecasts, respectively, and those for maximum wind speed forecasts for 24-, 48-, 72-, 96- and 120-hour forecasts of 5.0 m/s (5.8 m/s), 6.5 m/s (7.0 m/s), 6.9 m/s (7.3 m/s), 7.6 m/s (7.2 m/s) and 8.2 m/s (6.8 m/s) respectively.

2. The Committee noted with appreciation the changes in RSMC advisories, products and operational/coordination activities made in 2021, especially the commencement of five-day 50-kt wind probability map provision for tropical depressions (TDs) expected to reach tropical storm (TS) intensity or higher within 24 hours and enhanced tropical cyclone verification.

3. The Committee noted with appreciation the operation of RSMC Tokyo's Numerical Typhoon Prediction (NTP) website, and noted changes made in 2021 as well as those planned for the near future.

4. The Committee noted with appreciation RSMC Tokyo's maintenance of a dedicated platform for enhanced communication between operational forecasters and RSMC-Tokyo, as well as the sharing of advance-notice updates. Full-scale operation of the platform was started during the 2021 typhoon season and at least 15 inquiries relating to tropical cyclones have been submitted, with related discussion helping to clarify TC status and forecasts.

5. The Committee noted with appreciation the contribution of RSMC Tokyo (which also serves as an ICAO Tropical Cyclone Advisory Centre (TCAC Tokyo)) to compliance with ICAO Standards and Recommended Practices (SARPs), addressing the provision of TCA information in text, graphical and IWXXM 3.0 formats via multi-platform channels such as the TCAC Tokyo website.

6. The Committee noted with appreciation the ongoing contribution of RSMC Tokyo to the regional Storm Surge Watch Scheme (SSWS), especially the provision of various products including storm surge forecast distribution maps, time-series charts for selected stations and multi-scenario storm surge predictions, as well as week-range probabilistic wave forecasts for significant wave heights and peak wave periods. The Committee again encouraged Members to make their sea level observation data available in order to support verification activity. The Committee was informed that SSWS products are scheduled to be upgraded in 2022.

7. The Committee noted with appreciation the continuous efforts and progress of RSMC Tokyo's development of tropical cyclone genesis guidance using early Dvorak Analysis and global ensemble.

8. The Committee was pleased to note the progress of the regional radar network development project, under which experimental exchange of radar composite data among Japan, Thailand and Malaysia started in 2016. The project has been expanded, and three more Members (Lao PDR, the Philippines and Viet Nam) joined in 2018. The Committee noted with appreciation the progress made on regional radar data exchanges, especially the creation of a sample regional composite map consisting of participating Members' radar data in 2021, and the Users Guide on Introduction and Utilization of Quantitative Precipitation Estimation (QPE) drafted by Thailand, Malaysia and Japan.

9. The Committee was pleased to note the activities of the project for enhancing the utilization of Himawari-8/9 products, under which technical support for developing Rapidly Developing Cumulus Area (RDCA) identification using Himawari-8/9 data is provided. The Committee noted with appreciation the ongoing discussion and support engaged in between experts from Malaysia and Japan. It also expressed appreciation for efforts made in an online technical meeting attended by experts from Singapore, Thailand and Viet Nam in February 2020, and JMA's consideration for progress, including another meeting in February 2022 to share information on RDCA detection techniques. The Committee also noted that HCAI (High-resolution Cloud Analysis Information) data and AMV-based Sea-surface Wind data are provided to NMHSs every 10 minutes.

10. The Committee noted with appreciation RSMC Tokyo's publication of its Technical Review No. 23 and the Annual Report on the Activities of the RSMC Tokyo Typhoon Center 2020 in April and December 2021, respectively.

11. The Committee was informed that RSMC Tokyo had started tropical cyclone satellite re-analysis in 2012 for the period from 1981 onward to enable evaluation and improvement regarding the quality of the Current Intensity (CI) number in satellite TC analysis. It also acknowledged that the Center has almost completed the reanalysis along with basic quality checking (QC) for the period from 1987 to 2016. In line with the need for additional QC, the Committee was also informed that RSMC Tokyo will share the whole dataset for the period from 1987 to 2016 with Members in 2022.

12. The Committee noted with appreciation that the operation of Himawari-8/9 geostationary meteorological satellites and further welcome the intention of RSMC Tokyo to continue providing Himawari products as well as technical support for using them. The Committee was informed that the switchover from Himawari-8 to -9 is scheduled to take place around December 2022.

13. The Committee noted with appreciation RSMC Tokyo's virtual hosting of the 20th Attachment Training session from 9 to 11 March 2021 with 44 attendees from seven Members (Hong Kong China, Macao China, Malaysia, the Philippines, the Republic of Korea, Singapore and Thailand) to support understanding of up-to-date public weather services as well as conventional TC monitoring, analysis and forecasting techniques. The Committee also noted with appreciation the hosting of the 21st course (11 – 13 January 2022) with 55 attendees from eight Members (China, Hong Kong China, Macao China, Malaysia, the Republic of Korea, the USA, Thailand and Viet Nam). The 2022 session included presentations on state-of-the-art TC analysis techniques by distinguished invited lectures and exercises on satellite image analysis. The course helped attendees to learn more about TCs for application in operational services.

14. The Committee noted for RSMC-Tokyo's regular monitoring of observation data exchanges in 2021 as per the Typhoon Committee Operational Manual's Meteorological Components (TOM), with results to be provided by March 2022. The Committee expressed appreciation to all Members providing special observation data to Committee Members in 2021, and further encouraged all Members to conduct additional observation as requested by TOM.

APPENDIX B:
RSMC Tokyo - Typhoon Center Activity Report 2021 and future plans

1. RSMC advisories, products and operational/coordination activities

The RSMC Tokyo - Typhoon Center provides the Typhoon Committee Members with a range of products related to tropical cyclones in the western North Pacific and the South China Sea through the Global Telecommunication System (GTS) of World Meteorological Organization (WMO) and the Aeronautical Fixed Telecommunication Network (AFTN). This section reviews RSMC advisories, products and operational activities in 2021 and summarizes changes and future plans.

1.1 Review of RSMC advisories, products and operational activities in 2021

Table 1 shows the total number of products issued by the Center in 2021.

✧ **Verification of track forecasts**

Operational track forecasts for 22 Tropical Cyclones (TCs) that reached Tropical Storm (TS) intensity or higher in 2021 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 87 km (74 km in 2020), 157 km (119 km), 225 km (176 km), 261 km (214 km) and 264 km (267 km) for 24-, 48-, 72-, 96- and 120-hour forecasts, respectively (Table 2).

✧ **Verification of track forecast probability circles**

RSMC Tokyo uses track forecast probability circles* to represent TC track forecast uncertainties. The mean hitting ratios of circles* for 24-, 48-, 72-, 96- and 120-hour forecasts throughout 2021 are 67% (74% in 2020), 72% (77%), 74% (83%), 86% (89%) and 93% (100%), respectively (Table 3).

* Track forecast probability circle: a circular area within which the center of a TC is expected to be located with a probability of 70% at each forecast time.

✧ **Verification of intensity forecasts**

Table 4a and 4b give the mean errors and root mean square errors (RMSEs) of 24-, 48-, 72-, 96- and 120-hour central pressure (Table 4a) and maximum sustained wind forecasts (Table 4b) for 22 TCs of 2021. The annual mean RMSEs for central pressure forecasts are 11.9 hPa (11.6 hPa in 2020), 15.9 hPa (15.0 hPa), 18.0 hPa (14.6 hPa), 19.0 hPa (13.9 hPa) and 17.9 hPa (13.0 hPa) for 24-, 48-, 72-, 96- and 120-hour forecasts, respectively, while those for maximum wind speed forecasts for 24-, 48-, 72-, 96- and 120-hour forecasts are 5.0 m/s (5.8 m/s in 2020), 6.5 m/s (7.0 m/s), 6.9 m/s (7.3 m/s), 7.6 m/s (7.2 m/s) and 8.2 m/s (6.8 m/s) respectively.

1.2 Changes in RSMC advisories, products and operational activities in 2021

✧ **Commencement of five-day storm wind probability maps for tropical depression (TD) expected to reach TS intensity within 24 hours**

In response to the September 2020 commencement of five-day track and intensity forecast provision for TDs expected to reach TS intensity within 24 hours, five-day storm wind probability maps were updated in December 2021. These are provided when named TCs or TDs expected to reach TS intensity are present (Figure 2).

✧ **Enhanced tropical cyclone verification**

The RSMC Tokyo – Typhoon Center conducts post-event analysis of tropical cyclones based on quality-assured observational data, publishing the results in its annual report. The 2020

report highlighted improvements including (i) timing of initial operational forecasts for named TCs, (ii) frequency distribution of 24- to 120-hour forecast position errors in the longitudinal/latitudinal and cross-track/along-track directions, and (iii) errors in track and intensity forecasts for named TCs, including periods when TDs are expected to reach TS intensity or higher within 24 hours.

✧ **Full operation of the TC communication platform**

The RSMC Tokyo – Typhoon Center's TC communication platform (developed and maintained by the Center since July 2019) supports enhanced communication between operational forecasters and the Center, as well as sharing of advance-notice updates. As of 2 November 2021, more than fifteen inquiries relating to tropical cyclones had been submitted via the platform, with related discussions helping to clarify TC status and forecasts.

1.3 Future plans for changes in RSMC advisories, products and operational activities

✧ **Upgrade of the storm surge watch scheme (SSWS) model and updating of related products on the NTP website (see also Section 3.1)**

In association with the upgrade of the SSWS model, SSWS products on the NTP website will be updated in summer 2022. The changes will include higher resolution for coastal areas, expansion of the forecast area, extension of the forecast range and addition of probabilistic products based on comprehensive use of whole ensemble members.

✧ **End of WTPQ20-25 RJTD distribution**

RSMC Tokyo has currently been providing advisories for both five-day and three-day forecasts with GTS headings of WTPQ50-55 RJTD and WTPQ20-25 RJTD, respectively, considering some users' system transition. WTPQ20-25 RJTD will be terminated in 2022.

2. Web-based RSMC TC Products

2.1 Numerical Typhoon Prediction (NTP) website

Since October 2004, RSMC Tokyo has operated the Numerical Typhoon Prediction (NTP) website (https://tynwp-web.kishou.go.jp/) as part of its contribution to the WMO/ESCAP Typhoon Committee. All the products of the NTP website are listed in Table 5. Changes made in 2021 and those planned in 2022 are as follows.

✧ **Commencement of five-day storm wind probability maps for tropical depression (TD) expected to reach TS intensity within 24 hours (see section 1.2)**

2.2 Tropical cyclone advisories for SIGMET in graphical format

In August 2015, as an ICAO TCAC, RSMC Tokyo started providing graphical tropical cyclone advisories (hereinafter referred to as TCG) according to MODEL TCG in Appendix 1 of ICAO Annex 3. In March 2016, it started providing the graphical tropical cyclone advisories using a new Himawari product identifying Cb associated with tropical cyclones potentially affecting aviation safety. TCG is being provided through the website where the specifications and text format advisories are also available (https://www.data.jma.go.jp/tca/data/index.html). This website is linked to the NTP website. Also, TCG is sent to WAFCs, so that they are transmitted through WIFS and Secure SADIS FTP. WMO AHLs of the bulletin are PZXE (01-06) RJTD.
TCG is issued, together with text advisories, when 1) a tropical cyclone with TS intensity or higher exists in the area of responsibility of RSMC Tokyo, or 2) a tropical cyclone is expected to reach TS intensity in the area within 24 hours. In the second case, gale force wind area is not to be presented in TCG.

In November 2020, TCAC Tokyo began providing tropical cyclone advisory messages with full ICAO SARP compliance, including IWXXM 3.0-formatted telegrams, via the TCAC Tokyo website.

2.3 Experimental version of TC advisory in CAP format

RSMC Tokyo has provided the experimental provision of TC advisory in CAP format at the website (https://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/RSMC_HP.htm) since 12 November 2012.

3. RSMC Tokyo-led activities

3.1 Regional storm surge watch scheme suitable for the Typhoon Committee region

Since 2011, RSMC Tokyo has been providing products to support storm surge prediction, within the framework of the Storm Surge Watch Scheme (SSWS), in response to the results of the survey conducted in 2009 after the devastating storm surge disaster caused by Cyclone Nargis in 2008 (Hasegawa et al. 2017).

Products include storm surge forecast distribution maps, time-series charts at selected stations, multi-scenario storm surge predictions and week-range wave forecasts based on JMA Wave Ensemble system (WENS). JMA's storm surge model runs four times a day, even when no TCs exist in the area of responsibility, for providing information on storm surges generated by monsoon winds or extra-tropical cyclones (see Annex B Table 6 for specifications). Multi-scenario storm surge predictions give predictions based on RSMC Tokyo TC advisory and five additional TC scenarios extracted from JMA's GEPS using cluster analysis. Maximum storm surges at each grid among the above six scenarios during the entire forecast period are also provided.

Stations for storm surge time-series predictions are increased upon requests from the Committee Members. As of January 2022, time-series storm surge predictions are provided to 78 stations; USA (1), the Philippines (10), Viet Nam (20), Hong Kong China (6), Macao China (1), Republic of Korea (11), Thailand (2), Malaysia (17), Cambodia (4) and Singapore (6). Time series of storm surge predictions are provided on top of astronomical tides for stations calculated from hourly tidal observational data for a few years that are provided by Members. In addition, since February 2019, for stations where those observational data are not available, astronomical tides and storm tides have also become available by adopting a global ocean tide solution (FES2014).

Annual verification results of the storm surge products have been regularly published in Annual Report on Activities of the RSMC Tokyo since 2015. Statistical verification is conducted for stations where sea level observations are available in University of Hawaii Sea Level Center (UHSLC) data base. The verification continues to be enhanced with results for high-impact storm surge cases, in addition to the statistical verification.

Week-range wave forecasts created using WENS are provided on the NTP website. WENS covers most of the global region and has a 0.5-degree grid resolution. It runs twice a day at 00 and 12 UTC and enables prediction of ocean wave conditions up to 264 hours ahead. RSMC Tokyo upgraded WENS in March 2021, increasing the number of ensemble members from 27 to 51 for better probabilistic wave forecasting.

RSMC Tokyo plans to upgrade the storm surge watch scheme model and update related products on the NTP storm surge forecast page in summer 2022. The new model incorporates the finite volume method (FVM) with an unstructured grid. Grid resolution around coastal regions will be increased from 2 minutes to 1.5 km, the model domain will be expanded to cover most of the RSMC's area of responsibility, the forecast range will be extended from 72 to 132 hours, and the number of multi-scenario predictions will be increased based on the use of whole GEPS members.

3.2 Enhanced use of ensemble forecasts

RSMC Tokyo works as part of the World Weather Research Program (WWRP), the Tropical Cyclone Program (TCP) and the North Western Pacific Tropical Cyclone Ensemble Forecast Project (NWP-TCEFP) to enhance operational use of ensemble forecasts by Committee Members. Such forecasts are currently used for:

- ✧ Provision of ensemble TC track guidance from ECMWF, NCEP, UKMO and JMA via the NTP website.
- ✧ Provision of two- and five-day tropical cyclone activity prediction (TCAP) maps displaying percentages of ensemble members in which TC-like vortices are represented within 300 km of a certain location during the relevant forecast time. Provision via the NTP website started in 2016, and accuracy improvement based on parameter-tuning was introduced in 2020 along with addition of climatological normal maps.
- ✧ Probability circles show the range into which the center of a TC is expected to move with 70% probability at each validation time. Since June 2019, the radius for all forecast times has been determined using the multiple ensemble method, which is solely premised on confidence levels based on cumulative ensemble spread calculated using ECMWF, NCEP and UKMO global EPSs in addition to GEPS.

GEPS upgrades were made in March 2021, with increased ensemble size (27 to 51) for forecasts with lead times up to 264 hours (Section 5.3).

3.3 Development of Regional Radar Network

Development of Regional Radar Network is a project of the Typhoon Committee's Working Group on Meteorology. Technical assistance provided via the project includes development of a domestic radar network, radar data quality control and application of composite as well as quantitative precipitation estimation (QPE) techniques to the nationwide radar network. As a result of activities conducted in collaboration with Thailand and Malaysia (such as participation in technical meetings and workshops), an experimental radar data exchange involving these nations and Japan was initiated in 2016. Hourly regional radar composite imagery based on the exchange data is available on the RSMC Tokyo NTP website at https://tynwp-web.kishou.go.jp/Analysis/Radar/index.html.

In 2018, Lao PDR, the Philippines and Viet Nam joined the project, and technical meetings were held at JMA headquarters in 2018 and 2019. Based on the 2019 meeting, a sample regional composite map consisting of participating Members' radar data was produced in 2021 to demonstrate the usefulness of regional radar data exchange. Members at an online technical meeting held in November 2021 reviewed project achievements and highlighted their current situations along with challenges in radar. The discussions underlined the significance of data exchanges within the regional radar network and engagement in technical collaboration. The Users Guide on Introduction and Utilization of Quantitative Precipitation Estimation (QPE) was also drafted by Thailand, Malaysia and Japan.

3.4 Enhancement of utilization of Himawari-8/9

The Enhancement of Utilization of Himawari-8/9 is a project of the Working Group of Meteorology of the Typhoon Committee. Technical assistance provided through this project includes developing Rapidly Developing Cumulus Area (RDCA) detection technique using Himawari-8/9 products. A technical meeting was held with experts from Malaysia at JMA headquarters in October 2018 to exchange information on recent progress and ideas for advanced products in the field, and technical support and communication between Malaysia and RSMC Tokyo has conducted via e-mails.

An online technical meeting was also held with Members from Singapore, Thailand and Viet Nam in February 2020 to give an outline of RDCA detection, including technical aspects and the wide range of usage and verification methods implemented. Members also considered potential RDCA applications and data suitable for verification. In 2021, Japan experts

considered future initiatives, including another meeting in February 2022, to promote the adoption of RDCA detection techniques.

The High-resolution Cloud Analysis Information (HCAI) satellite-derived product based on data from the Advanced Himawari Imager (AHI) units on the Himawari-8/-9 satellites includes information on cloud mask (including dust mask), snow and ice mask, cloud top height, cloud type and quality control. HCAI data are provided to National Meteorological and Hydrological Services (NMHSs) via the JMA Data Dissemination System (JDDS) every 10 minutes in addition to AMV-based Sea-surface Wind data.

3.5 Cross-cutting activities with ICHARM

Enhancement of disaster risk reduction against heavy rain in collaboration with an Annual Operating Plan (AOP) of the Working Group on Hydrology (WGH), led by ICHARM, is undertaken by RSMC Tokyo for the Working Group on the Meteorology (WGM) side. RSMC Tokyo has currently been providing various data of JMA's NWP model to ICHARM so that ICHARM can test the effectiveness and figure out which data to use for the project. In 2021, RSMC Tokyo provided one-month and three-month ensemble NWP model data.
Also in 2021, JMA contributed to International Flood Initiative (IFI) e-learning workshops for the Philippines in April and for Indonesia in October. IFI is a platform established via collaboration among various international and national governmental organizations. Experts from various disciplines and public-sector operators (e.g., government bodies, public organizations and media) were hosted at the "Effective Hazard Information and Public Awareness" presentation on JMA's latest disaster risk reduction efforts.
In addition, a number of favorable practices related to effective public awareness were adopted in 2021. By way of example, during a prolonged period of heavy rain caused by a stationary front over wide areas of Japan in August, JMA (a meteorological body) and the country's Ministry of Land, Infrastructure and Transportation (a hydrological body) held a joint press conference to call for early evacuation due to the possibility of flooding from large rivers based on rainfall forecasts, thereby providing a united authoritative front to the public.

4. Publications

4.1 Technical review

RSMC Tokyo published "Upgrades to JMA's Operational NWP High-resolution Global Model" as its Technical Review No. 23 in April 2021, which is available on the Center's website at:
https://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/techrev.htm.

4.2 Annual report on the activities of the RSMC Tokyo - Typhoon Center

RSMC Tokyo published Annual Report on the Activities of the RSMC Tokyo - Typhoon Center 2020 in December 2021, which is available on the Center's website at:
https://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/annualreport.html.

5. Other related activities

5.1 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), RSMC Tokyo 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 for the period from 1987 to 2016 has been completed, though it was figured out that the re-analysis from 1981 to 1986 is difficult to conduct with accuracy consistent with later events due to the inadequacy of available satellite imagery. Due to the need for additional quality checking, RSMC Tokyo plans to share the whole

dataset for the period from 1987 to 2016 with Members in 2022.

5.2 Himawari-8/9

The Himawari-8 geostationary meteorological satellite operated by JMA began operation at 02 UTC on 7 July 2015. Himawari-8 features significant improvements in terms of the number of observation bands, data capture periodicity and spatial resolution as compared to the previous generation. These enhancements are expected to support unprecedented prevention and mitigation of tropical cyclone-related disasters in the East Asia and Western Pacific regions. JMA runs two services for the provision of Himawari-8 imagery. One is the HimawariCast service, by which primary sets of imagery are disseminated for operational meteorological services via a communication satellite. The other is the HimawariCloud service, by which full sets of imagery are delivered to National Meteorological and Hydrological Services (NMHSs) via an Internet cloud service. In addition, JMA continuously provides Himawari-8 imagery in SATAID format via the WIS/GISC Tokyo server with its automatic downloader.

On 2 November 2016, Himawari-9 was launched as the follow-on satellite to Himawari-8. After a period of in-orbit testing, Himawari-9 began serving as back-up to Himawari-8 on 10 March 2017 and will continue in this role until the planned switchover around December 2022. This dual combination of new-generation satellites will support JMA's stable provision of continuous satellite observation data for the Asia-Oceania region until 2029.

The Advanced Himawari Imager (AHI) on board Himawari-8/9 is capable of frequent and flexible observation, providing Full-Disk images of the earth every 10 minutes and regional images with shorter periodicity. In regional monitoring, Target Area observation provides imagery covering an area of approximately 1,000 km x 1,000 km every 2.5 minutes with flexibility for location changes. This rapid observation provides superior insight for extreme events such as tropical cyclones and volcanic eruptions. One example of the use for tropical cyclones is ASWind, as described in Chapter 2.1, which is used operationally by RSMC Tokyo for sea surface winds estimation in the vicinity of tropical cyclones.

Since January 2018, JMA has launched an international service called HimawariRequest service, allowing NMHSs to request Target Area observations, within a framework of a WMO RA II (Asia) regional project in collaboration with WMO RA V (South-West Pacific) Members. As of the end of January 2021, JMA had taken registrations from 21 NMHSs in RA II and RA V and opened the service to the 18 whose preparations for request submission were complete. The service has been introduced upon requests to monitor tropical cyclones, volcanic ash from eruptions and forest fire. Further information on HimawariRequest, including a service description and registration form, is available on the JMA website at https://www.jma.go.jp/jma/jma-eng/satellite/HimawariRequest.html. JMA expects the service to support disaster risk reduction activities in the region based on the monitoring of tropical cyclones and other extreme events.

5.3 Updates to the operational global model

JMA upgraded its operational global NWP system in March 2021 to incorporate the enhanced vertical resolution (100 to 128) of the JMA Global Spectral Model (GSM), improved land surface analysis and an upgraded atmospheric data assimilation system. These improvements resulted in better forecasting, particularly for the Northern Hemisphere.
JMA upgraded its GEPS in March 2021 to incorporate the same model upgrades as in the GSM, an increased ensemble size (27 to 51) for forecasts with lead times up to 264 hours, and improved initial perturbations. The increased number of ensemble members improved the capture rate in tropical cyclone course prediction.

6. Typhoon Committee Attachment Training at RSMC Tokyo

The RSMC Tokyo – Typhoon Center has organized ESCAP/WMO Typhoon Committee Attachment Training courses every year since 2001 with the support of the WMO Tropical Cyclone Programme and the Typhoon Committee in order to advance the tropical cyclone (TC) analysis and forecasting capacity of Committee Members. Forecasters from Member countries of the Panel on Tropical Cyclones have also been hosted since 2015.

Due to COVID-19, RSMC Tokyo conducted the 20th Attachment Training course online from 9 to 11 March 2021, with 44 attendees from seven Members (Hong Kong China, Macao China, Malaysia, the Philippines, the Republic of Korea, Singapore and Thailand). The main purpose of the training was to support a solid understanding of up-to-date public weather services as well as conventional TC monitoring, analysis and forecasting based on the use of RSMC Tokyo products. Focus was also placed on the promotion of information sharing on the latest tropical cyclone activities conducted by attendees. RSMC New Delhi senior forecaster Ms. Sunitha Devi attended as a presenter.

The 21st course, also online, was held from 11 to 13 January 2022, with 55 attendees from eight Members (China, Hong Kong China, Macao China, Malaysia, the Republic of Korea, the USA, Thailand and Viet Nam). Improvements based on feedback from the 2021 course included the provision of hands-on training materials for self-study and scheduling for interactive exercises on satellite analysis techniques and Dvorak analysis. Prof. Hidenori Fudeyasu (a recognized expert in the field of tropical cyclones) of Yokohama National University provided interesting up-to-date information on multiscale interactions in TC formation. To clarify the purposes of the course, Tropical Cyclone Forecast Competency in the Typhoon Committee Region specifications from the Typhoon Committee Operational Manual (TOM) were highlighted, and the course was set as a Category 2 Unit.

7. Regular monitoring of exchange information

In accordance with the ESCAP/WMO Typhoon Committee Operational Manual (TOM), RSMC Tokyo monitors observational data exchanges twice a year. The state of 2021 exchanges are currently being assessed, with final monitoring results to be circulated by March 2022.

8. Implementation plan

Table 6 shows the implementation plan of the Center for the period from 2021 to 2025.

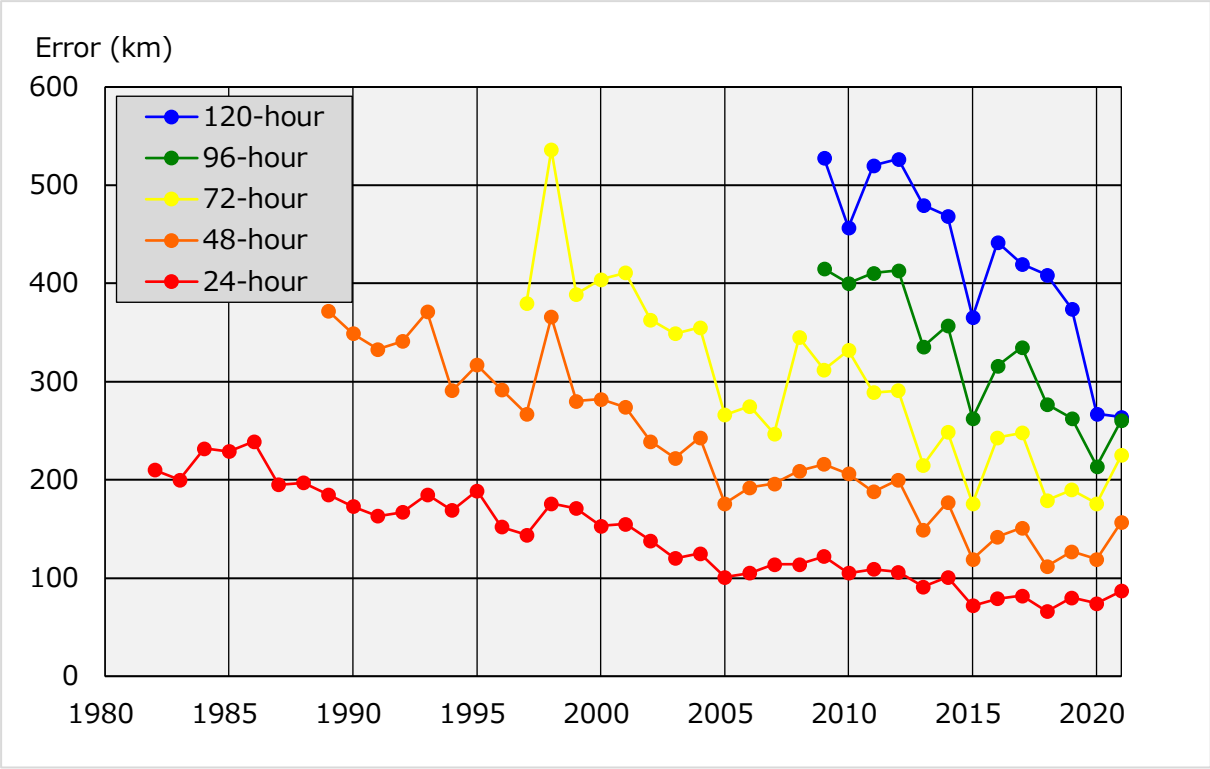

Figure 1 Annual mean position errors of track forecasts
Vertical axis: position error (km), Horizontal axis: year

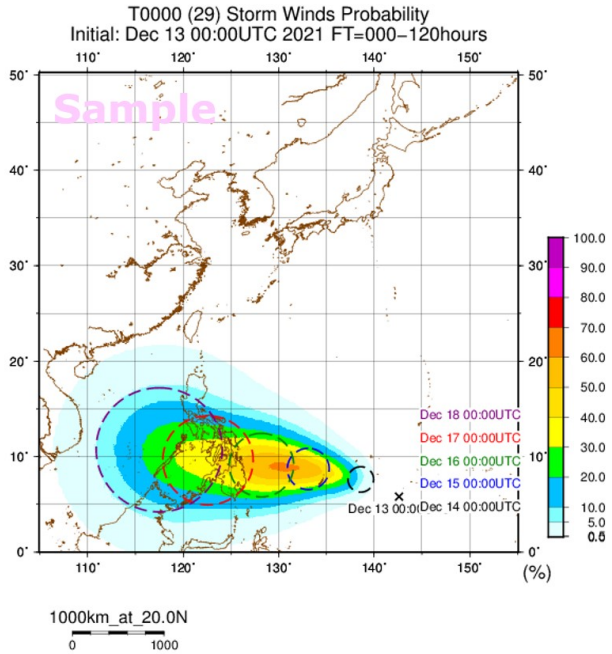

Figure 2 Five-day 50-kt wind probability map for tropical depressions (TDs) expected to reach tropical storm (TS) intensity or higher within 24 hours

A sample image for a tropical depression (TC2129) in December

Table 1 Monthly and annual total numbers of products issued by the RSMC Tokyo - Typhoon Center in 2021

Product	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
IUCC10	0	35	0	93	13	87	150	143	205	186	9	90	1011
WTPQ20-25	0	41	0	98	22	97	163	163	214	203	12	96	1109
WTPQ30-35	0	20	0	48	12	47	78	81	105	99	6	47	543
WTPQ50-55	0	41	0	98	22	97	163	163	214	203	12	96	1109
FXPQ20-25	0	20	0	48	11	47	79	79	105	99	6	47	541
FXPQ30-35	0	20	0	48	11	47	79	79	105	99	6	47	541
FKPQ30-35	0	20	0	49	11	47	80	80	106	99	6	47	545
AXPQ20	5	5	0	0	1	0	1	2	1	1	5	5	26

Notes:

IUCC10 RJTD	SAREP (BUFR format)
WTPQ20-25 RJTD	RSMC Tropical Cyclone Advisory for Three-day Forecasts
WTPQ30-35 RJTD	RSMC Prognostic Reasoning
WTPQ50-55 RJTD	RSMC Tropical Cyclone Advisory
FXPQ20-25 RJTD	RSMC Guidance for Forecast by Global Model
FXPQ30-35 RJTD	RSMC Guidance for Forecast by Global Ensemble Prediction System
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 2021

Tropical Cyclone			24-hour Forecast				48-hour Forecast				72-hour Forecast				96-hour Forecast				120-hour Forecast			
			Mean (km)	S.D. (km)	Num.	Impr. (%)	Mean (km)	S.D. (km)	Num.	Impr. (%)	Mean (km)	S.D. (km)	Num.	Impr. (%)	Mean (km)	S.D. (km)	Num.	Impr. (%)	Mean (km)	S.D. (km)	Num.	Impr. (%)
TS	Dujuan	(2101)	170	65	10	27	270	32	6	-4	382	13	2	11	-	-	0	-	-	-	0	-
TY	Surigae	(2102)	46	29	41	73	74	47	37	79	105	70	33	79	123	51	29	81	148	69	25	81
TS	Choi-wan	(2103)	145	63	18	37	359	64	9	16	497	81	6	22	553	130	3	30	-	-	0	-
TS	Koguma	(2104)	62	1	2	42	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Champi	(2105)	82	46	15	43	142	78	11	52	176	110	7	61	140	56	3	63	-	-	0	-
TY	In-fa	(2106)	44	19	37	69	92	42	33	74	176	65	29	68	275	118	25	56	380	195	21	49
TY	Cempaka	(2107)	41	25	9	52	70	50	5	55	326	0	1	-55	-	-	0	-	-	-	0	-
TS	Nepartak	(2108)	110	51	15	64	157	71	11	77	164	98	7	85	324	32	3	73	-	-	0	-
TS	Lupit	(2109)	183	167	16	12	485	350	11	-17	650	331	8	19	679	268	4	43	-	-	0	-
STS	Mirinae	(2110)	98	91	15	63	110	63	11	81	116	91	7	89	196	46	3	88	-	-	0	-
STS	Nida	(2111)	150	61	7	23	463	69	3	27	-	-	0	-	-	-	0	-	-	-	0	-
TS	Omais	(2112)	93	35	10	65	111	38	6	79	218	93	2	82	-	-	0	-	-	-	0	-
STS	Conson	(2113)	126	58	18	11	224	91	14	27	326	99	10	18	423	145	6	-8	479	152	2	-38
TY	Chanthu	(2114)	89	54	43	57	159	95	39	71	210	114	34	75	227	91	31	79	217	154	27	81
TS	Dianmu	(2115)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Mindulle	(2116)	46	27	30	54	59	24	26	74	86	42	22	78	103	59	18	79	139	68	14	72
TS	Lionrock	(2117)	50	28	6	56	82	26	2	71	-	-	0	-	-	-	0	-	-	-	0	-
STS	Kompasu	(2118)	67	44	22	56	69	41	18	85	110	64	14	88	172	90	10	88	209	131	6	88
STS	Namtheun	(2119)	169	125	24	0	438	253	20	-7	719	338	16	-26	914	328	10	-9	839	374	6	10
TY	Malou	(2120)	71	49	15	60	93	64	11	77	105	74	7	77	253	170	3	51	-	-	0	-
TY	Nyatoh	(2121)	73	67	12	69	129	68	8	84	345	73	4	79	-	-	0	-	-	-	0	-
TY	Rai	(2122)	53	27	26	68	72	31	22	78	115	71	18	81	178	77	14	80	261	67	10	75
Annual Mean (total)			87	77	391	51	157	165	303	62	225	227	227	66	261	239	162	68	264	225	111	71

Notes: S.D. means standard deviation of operational forecast errors.
Num. means numbers of forecasts.
Impr. indicates the ratios of position errors in operational forecasts to those in CLIPER predictions.

Table 3 Mean hitting ratios (%) and radii (km) of 70% probability circles issued for track forecasts for the TCs in 2021

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	Dujuan	(2101)	10	10	115	17	6	198	0	2	315	-	0	-	-	0	-
TY	Surigae	(2102)	90	41	85	86	37	151	94	33	235	100	29	344	100	25	477
TS	Choi-wan	(2103)	39	18	123	11	9	228	0	6	349	33	3	519	-	0	-
TS	Koguma	(2104)	100	2	130	-	0	-	-	0	-	-	0	-	-	0	-
TY	Champi	(2105)	73	15	93	73	11	177	86	7	280	100	3	426	-	0	-
TY	In-fa	(2106)	95	37	77	94	33	137	83	29	229	80	25	353	81	21	513
TY	Cempaka	(2107)	100	9	76	100	5	133	0	1	259	-	0	-	-	0	-
TS	Nepartak	(2108)	60	15	112	82	11	200	86	7	291	100	3	407	-	0	-
TS	Lupit	(2109)	38	16	123	36	11	227	25	8	338	25	4	491	-	0	-
STS	Mirinae	(2110)	67	15	85	73	11	159	100	7	275	100	3	407	-	0	-
STS	Nida	(2111)	29	7	90	0	3	139	-	0	-	-	0	-	-	0	-
TS	Omais	(2112)	60	10	97	100	6	208	100	2	315	-	0	-	-	0	-
STS	Conson	(2113)	33	18	102	36	14	179	30	10	285	67	6	435	50	2	556
TY	Chanthu	(2114)	53	43	88	59	39	161	59	34	270	90	31	401	100	27	568
TS	Dianmu	(2115)	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
TY	Mindulle	(2116)	83	30	75	96	26	133	100	22	227	100	18	335	100	14	501
TS	Lionrock	(2117)	100	6	102	100	2	204	-	0	-	-	0	-	-	0	-
STS	Kompasu	(2118)	68	22	104	100	18	197	100	14	303	100	10	459	100	6	667
STS	Namtheun	(2119)	38	24	106	20	20	208	19	16	329	20	10	482	50	6	667
TY	Malou	(2120)	80	15	87	82	11	175	100	7	296	100	3	482	-	0	-
TY	Nyatoh	(2121)	83	12	97	88	8	188	50	4	324	-	0	-	-	0	-
TY	Rai	(2122)	81	26	76	95	22	133	100	18	220	100	14	327	100	10	496
Annual Mean (total)			67	391	93	72	303	168	74	227	266	86	162	386	93	111	533

Table 4a Root mean square errors and mean errors of central pressure forecasts for the TCs in 2021

Tropical Cyclone			24-hour Forecast				48-hour Forecast				72-hour Forecast				96-hour Forecast				120-hour Forecast			
			Error (hPa)	RMSE (hPa)	Num.	Impr. (%)	Error (hPa)	RMSE (hPa)	Num.	Impr. (%)	Error (hPa)	RMSE (hPa)	Num.	Impr. (%)	Error (hPa)	RMSE (hPa)	Num.	Impr. (%)	Error (hPa)	RMSE (hPa)	Num.	Impr. (%)
TS	Dujuan	(2101)	-3.0	3.8	10	56	-9.0	9.1	6	26	-10.0	10.0	2	52	-	-	0	-	-	-	0	-
TY	Surigae	(2102)	5.7	15.2	41	-9	7.7	17.5	37	33	7.3	20.4	33	35	4.4	19.2	29	37	-0.6	12.7	25	49
TS	Choi-wan	(2103)	1.8	3.1	18	78	0.7	3.8	9	87	1.7	3.9	6	91	2.0	2.0	3	96	-	-	0	-
TS	Koguma	(2104)	-1.0	1.4	2	80	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Champi	(2105)	-3.1	8.7	15	13	-2.9	10.3	11	54	-3.1	5.8	7	81	-4.0	4.3	3	89	-	-	0	-
TY	In-fa	(2106)	-1.1	7.9	37	4	-1.3	9.6	33	18	2.0	7.9	29	41	10.9	12.0	25	22	15.7	18.1	21	-63
TY	Cempaka	(2107)	3.2	6.5	9	52	1.2	1.5	5	92	0.0	0.0	1	100	-	-	0	-	-	-	0	-
TS	Nepartak	(2108)	-1.5	3.7	15	4	-1.2	3.6	11	63	-1.0	2.8	7	81	4.7	4.8	3	77	-	-	0	-
TS	Lupit	(2109)	0.8	3.2	16	39	-0.2	4.6	11	61	-0.3	4.4	8	66	2.0	3.2	4	66	-	-	0	-
STS	Mirinae	(2110)	-2.1	5.7	15	-38	2.1	4.3	11	-20	4.0	5.4	7	-46	1.0	3.1	3	31	-	-	0	-
STS	Nida	(2111)	2.0	4.8	7	-30	5.3	5.7	3	-10	-	-	0	-	-	-	0	-	-	-	0	-
TS	Omais	(2112)	2.8	3.3	10	56	6.7	6.8	6	65	6.0	6.0	2	80	-	-	0	-	-	-	0	-
STS	Conson	(2113)	-3.8	6.5	18	52	-5.2	9.6	14	63	-1.6	4.6	10	86	-1.0	3.4	6	91	-1.5	7.6	2	80
TY	Chanthu	(2114)	5.7	17.0	43	-16	6.2	21.9	39	-16	2.7	24.8	34	-17	1.2	28.5	31	-26	-4.7	23.4	27	-57
TS	Dianmu	(2115)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Mindulle	(2116)	-10.7	20.9	30	-18	-14.0	26.8	26	-17	-16.1	27.0	22	-50	-19.2	20.8	18	-28	-13.2	14.3	14	24
TS	Lionrock	(2117)	-3.7	4.4	6	43	-7.0	7.1	2	65	-	-	0	-	-	-	0	-	-	-	0	-
STS	Kompasu	(2118)	0.2	3.8	22	65	3.6	7.1	18	57	4.6	6.7	14	63	3.8	8.6	10	55	-1.7	9.3	6	61
STS	Namtheun	(2119)	-1.5	2.9	24	69	-2.8	6.1	20	75	-2.1	8.2	16	76	-3.4	9.5	10	74	-2.2	7.6	6	80
TY	Malou	(2120)	-2.0	7.2	15	9	-12.3	13.9	11	-83	-14.3	15.1	7	-401	-16.7	17.3	3	-179	-	-	0	-
TY	Nyatoh	(2121)	16.3	21.2	12	19	24.6	26.8	8	1	32.5	38.2	4	-42	-	-	0	-	-	-	0	-
TY	Rai	(2122)	8.7	16.9	26	40	15.7	22.8	22	29	17.4	23.8	18	5	18.6	24.3	14	5	16.5	24.5	10	12
Annual Mean (total)			0.9	11.9	391	15	1.4	15.9	303	25	1.7	18.0	227	26	2.0	19.0	162	24	1.3	17.9	111	17

Impr. indicates the ratios of RMSEs of operational forecasts to those of SHIFOR predictions.

Table 4b Root mean square errors and mean errors of maximum sustained wind forecasts for the TCs in 2021

Tropical Cyclone			24-hour Forecast				48-hour Forecast				72-hour Forecast				96-hour Forecast				120-hour Forecast			
			Error (m/s)	RMSE (m/s)	Num.	Impr. (%)	Error (m/s)	RMSE (m/s)	Num.	Impr. (%)	Error (m/s)	RMSE (m/s)	Num.	Impr. (%)	Error (m/s)	RMSE (m/s)	Num.	Impr. (%)	Error (m/s)	RMSE (m/s)	Num.	Impr. (%)
TS	Dujuan	(2101)	1.3	2.2	10	30	6.4	6.7	6	-5	7.7	7.7	2	-5	-	-	0	-	-	-	0	-
TY	Surigae	(2102)	-1.0	5.7	41	24	-1.5	6.3	37	52	-0.9	7.0	33	59	1.1	7.3	29	60	3.0	6.0	25	64
TS	Choi-wan	(2103)	-1.7	3.3	18	3	-0.9	3.5	9	53	-2.6	3.9	6	60	-4.3	4.5	3	58	-	-	0	-
TS	Koguma	(2104)	2.6	2.6	2	-18	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Champi	(2105)	3.1	6.3	15	-32	3.3	8.3	11	-13	4.4	6.6	7	9	5.1	5.6	3	47	-	-	0	-
TY	In-fa	(2106)	0.5	3.6	37	31	0.9	4.3	33	53	-0.4	2.9	29	76	-3.5	4.2	25	68	-6.6	8.5	21	29
TY	Cempaka	(2107)	-5.4	7.9	9	19	-2.1	2.8	5	68	-2.6	2.6	1	38	-	-	0	-	-	-	0	-
TS	Nepartak	(2108)	0.7	1.6	15	-11	0.7	2.1	11	32	2.2	2.4	7	53	0.0	0.0	3	100	-	-	0	-
TS	Lupit	(2109)	-0.3	1.6	16	25	-0.5	3.3	11	-2	0.3	2.4	8	32	-0.6	1.3	4	28	-	-	0	-
STS	Mirinae	(2110)	0.2	2.0	15	23	-1.4	1.9	11	37	-2.2	2.7	7	-23	-0.9	1.5	3	21	-	-	0	-
STS	Nida	(2111)	-5.1	6.4	7	-65	-8.6	8.7	3	-50	-	-	0	-	-	-	0	-	-	-	0	-
TS	Omais	(2112)	-0.8	2.4	10	24	-3.0	3.2	6	58	-2.6	2.6	2	74	-	-	0	-	-	-	0	-
STS	Conson	(2113)	1.7	3.2	18	36	2.9	5.5	14	36	1.3	4.5	10	56	0.4	4.6	6	59	0.0	7.7	2	42
TY	Chanthu	(2114)	-2.0	7.4	43	-18	-1.5	8.8	39	1	-0.4	9.4	34	8	0.8	11.1	31	-8	3.1	10.7	27	-37
TS	Dianmu	(2115)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Mindulle	(2116)	3.5	7.3	30	-17	4.8	9.6	26	-0	6.1	9.6	22	5	7.3	7.5	18	23	6.2	6.4	14	41
TS	Lionrock	(2117)	2.6	2.6	6	-9	5.1	5.1	2	14	-	-	0	-	-	-	0	-	-	-	0	-
STS	Kompasu	(2118)	0.1	1.6	22	58	0.3	2.6	18	50	-0.6	2.5	14	55	-0.8	2.9	10	53	2.6	4.7	6	40
STS	Namtheun	(2119)	1.3	2.3	24	36	1.7	5.4	20	27	-0.8	6.7	16	34	-1.5	7.9	10	34	-3.4	7.1	6	38
TY	Malou	(2120)	1.7	3.1	15	23	4.7	5.4	11	15	5.5	5.8	7	28	6.9	7.0	3	-18	-	-	0	-
TY	Nyatoh	(2121)	-6.2	7.7	12	15	-9.6	10.3	8	21	-12.2	13.9	4	9	-	-	0	-	-	-	0	-
TY	Rai	(2122)	-2.8	6.1	26	30	-5.6	8.1	22	26	-6.9	8.5	18	22	-8.3	10.4	14	8	-6.7	9.3	10	35
Annual Mean (total)			-0.2	5.0	391	11	-0.1	6.5	303	27	-0.1	6.9	227	37	-0.1	7.6	162	38	0.3	8.2	111	33

Impr. indicates the ratios of RMSEs of operational forecasts to those of SHIFOR predictions.

Table 5 Products of RSMC Tokyo via the NTP website

Products	Frequency	Details
RSMC Advisories		
RSMC TC Advisory	At least 8 times/day	• RSMC Tokyo – Typhoon Center's TC analysis and forecasts up to 120-hours (linked to the JMA website at https://www.jma.go.jp/bosai/map.html#contents=typhoon&lang=en)
Storm Wind Probability Map	4 times/day	• Probabilistic forecast map for sustained wind upward of 50-kt for 1, 2, 3, 4 and 5 days ahead
Prognostic Reasoning	4 times/day	• RSMC Tokyo Tropical Cyclone Prognostic Reasoning (WTPQ3X)
Advance Notice		• Advance notice on TC status change from RSMC Tokyo – Typhoon Center *Supplemental information to RSMC advisories (It may not be provided in certain situations and should not be considered as an official RSMC advisory and/or its replacement)
Graphical TC Advisory	4 times/day	• Graphical TC Advisory including RSMC Tokyo – Typhoon Center's TC analysis, track and intensity forecasts up to 24-hours and horizontal extents of cumulonimbus cloud and cloud top height associated with TCs potentially affecting aviation safety (linked to the Tropical Cyclone Advisory Center Tokyo website at https://www.data.jma.go.jp/tca/data/index.html)
Remote Sensing		
Satellite Analysis	At least 4 times/day	• Results and historical logs of RSMC Tokyo – Typhoon Center's TC analysis conducted using satellite images (Conventional Dvorak analysis and Early-stage Dvorak analysis)
Satellite Imagery	Up to 142 times/day	• Satellite imagery of Himawari-8/9 (linked to the JMA website at https://www.jma.go.jp/bosai/map.html#contents=himawari&lang=en)
Satellite Microwave Products		• TC snapshot images • Warm-core-based TC intensity estimates • Weighted consensus TC intensity estimates made using Dvorak analysis and satellite microwave warm-core-based intensity estimates
Sea-surface AMV (ASWind)	Every 10 / 30 minutes	• AMV-based Sea-surface Wind in the vicinity of TC (linked to Meteorological Satellite Center's web site: https://www.jma.go.jp/jma/jma-eng/satellite/jdds.html)
Radar	Every hour	• Radar composite imagery of the Typhoon Committee Regional Radar Network
Atmospheric Circulation		
Weather Charts	4 times/day	• Weather maps for surface analysis, 24- and 48-hour forecasts (linked to the JMA website at https://www.jma.go.jp/bosai/weather_map/#lang=en)
NWP Multi Center Weather Charts	Twice/day	• Mean sea level pressure and 500 hPa Geopotential height (up to 168 hours) of deterministic NWP models from nine centers (BoM, CMA, CMC, DWD, ECMWF, KMA, NCEP, UKMO and JMA)
JMA GSM Analysis and Forecast	4 times/day	• Upper-air analysis and forecast data based on JMA-GSM - Streamlines at 850, 500 and 200 hPa - Divergence at 200 hPa - Velocity potential at 200 hPa - Vertical Velocity in Pressure Coordinate at 500 hPa - Dew Point Depression at 600 hPa - Curvature Vorticity at 850 hPa - Vertical wind shear between 200 and 850 hPa - Sea Level Pressure - Genesis Potential Index

MJO Phase Diagram	Daily	• MJO phase and amplitude diagram and MJO Hovmöller diagram (linked to the Tokyo Climate Center web site: https://ds.data.jma.go.jp/tcc/tcc/products/clisys/mjo/monitor.html https://ds.data.jma.go.jp/tcc/tcc/products/clisys/ASIA_TCC/mjo_cross.html)
Asian Monsoon Monitoring Indices	Daily, only during Apr. - Oct.	• Time series of vertical wind shear, OLR and other indices associated with SW Asian Monsoon (linked to the Tokyo Climate Center web site: https://ds.data.jma.go.jp/tcc/tcc/products/clisys/ASIA_TCC/monsoon_index.html)
Ocean Condition		
SST	Once/day	• Sea surface temperature and related differences from 24 hours ago
TCHP	Once/day	• Tropical cyclone heat potential and related differences from 24 hours ago
Numerical TC Prediction		
Track Bulletin	4 times/day	• RSMC Tokyo Tropical Cyclone Track Forecast Bulletin - Track forecast by GSM (FXPQ2X) - Track forecast by GEPS (FXPQ3X)
TC intensity (TIFS monitor)	4 times/day	• TIFS (Typhoon Intensity Forecast scheme based on SHIPS) Monitor
TC Track Prediction	4 times/day	• TC track prediction of deterministic NWP models from nine centers (BoM, CMA, CMC, DWD, ECMWF, KMA, NCEP, UKMO and JMA) and a related consensus • TC track prediction of EPS models from four centers (ECMWF, NCEP, UKMO and JMA)
TC Activity Prediction	Twice/day	• Two- and five-day TC activity prediction maps based on EPS models from four centers (ECMWF, NCEP, UKMO and JMA) and a related consensus
TC Verification	4 times/day	• Verification results of RSMC Tokyo's official forecasts as well as NWP model and guidance predictions
Marine Forecast		
Storm Surge Forecasts	4times/day	• Distribution maps of storm surge for RSMC Tokyo – Typhoon Center's TC track forecast and each of five TC track forecasts selected from GEPS ensemble members and maximum storm surge among these six TC track forecasts (up to 72 hours) • Time-series storm surge forecast charts for RSMC Tokyo – Typhoon Center's TC track forecast and each of five TC track forecasts selected from GEPS ensemble members (up to 72 hours)
Ocean Wave Forecasts	Twice/day	• Distribution maps for ensemble mean, maximum, probability of exceeding various thresholds and ensemble spread of wave height and period based on Wave Ensemble System (WENS) (up to 264 hours) • Time-series representations with box-and-whisker plots for wave height/period and probability of exceeding various wave height/period thresholds based on WENS (up to 264 hours)

Table 6 Implementation Plans of the RSMC Tokyo - Typhoon Center (2021 - 2025)

PRODUCT	2021	2022	2023	2024	2025	REMARKS
Satellite Observation						
Himawari- 8/9	———	———	———	———	———	Every 10 minutes (Full-disk) Every 2.5 minutes (Target area)
Cloud motion wind (BUFR)	———	———	———	———	———	24 times/day
RSMC TC Advisories / Bulletins						
RSMC Tropical Cyclone Advisory	———	———	———	———	———	8 times/day
SAREP (for tropical cyclones, BUFR)	———	———	———	———	———	8 times/day Position of cloud sytem center, 4 times/day Dvorak intensity
RSMC Prognostic Reasoning	———	———	———	———	———	4 times/day
Operational Remarks	———	———	———	———	———	
RSMC Guidance for Forecast	———	———	———	———	———	4 times/day up to 132 hrs (GSM and GEPS)
Web-based RSMC Advisories / Products						
Numerical Typhoon Prediction Website	———	———	———	———	———	
Graphical Tropical Cyclone Advisory	———	———	———	———	———	
Experimental CAP Tropical Cyclone Advisory	———	———	———	———	———	
Others						
RSMC Tropical Cyclone Best Track	———	———	———	———	———	
Annual Report	———	———	———	———	———	Publication
Technical Review	·····	·····	·····	·····	·····	Publication (as necessary)
Tropical Cyclone Reanalysis	———	———	———	———	———	
Communication platform	———	———	———	———	———	(Full operation started in 2021)

SUPPORTING ACTIVITY	2021	2022	2023	2024	2025	REMARKS
Attachment Training	———	———	———	———	———	The 22nd training course will be conducted in 2
Data archive	———	———	———	———	———	
Monitoring of data exchange	———	———	———	———	———	
Dissemination of products via GISC Tokyo	———	———	———	———	———	