ESCAP/WMO Typhoon Committee
Fifty-first Session
26 February – 1 March 2019
Guangzhou, China

FOR PARTICIPANTS ONLY
WRD/TC.51/9.1
21 February 2019

ENGLISH ONLY

WORKING GROUP ON METEOROLOGY ACTIVITIES ANNUAL REPORT 2018

(submitted by WGM Chair)

ACTION PROPOSED:

The Committee is invited to:

(a) Take note of the Members activities and major progress and issues in meteorology component in 2018 as reported by Members at the 13th IWS.
(b) Review the activities of WGM conducted in 2018.
(c) Approve the recommendations and planned activities of WGM for 2019 and beyond.

APPENDICES:

I. DRAFT TEXT FOR INCLUSION AT SESSION REPORT
II. Report on activities of Working Group on Meteorology (WGM) in 2018
III. Summary Report of WGM Parallel Meeting at the 13th IWS

APPENDIX I
DRAFT TEXT FOR INCLUSION IN THE SESSION REPORT

9.1 Meteorological Component

1. The Committee took note of the Member's activities and major progress and issues in Meteorological Component in 2018 as reported by Members at the 13th IWS.
2. The Committee reviewed the activities of Members in implementing the TC Strategic Plan and its annual operating plan in relation to Meteorological Component during past year, details of which are presented in **Appendix II**.
3. The Committee took note of the outcomes of the WGM Parallel Session at the 13th IWS on 5-9 November 2018 (**Appendix III**). With the assistances of TCP/WMO and TCS and the strong support from all Members, WGM has successfully completed the tasks in 2018 with significant outcomes as follows:

    a. WGM has fulfilled all the action plans (5 POPs, 6 AOPs and 2 PPs) in 2018, which were endorsed at the 50th Session.
    b. After the 50th TC Session in 2018, WGM has been carrying out many activities that involve the cooperation among Members as well as other TC WGs and international organizations, which include:

        i. Coordinated with the Shanghai Typhoon Institute (STI) to organize the first WGM Meeting in Shanghai on 9 July 2018.
        ii. Coordinated with KMA for holding a technology transfer of Typhoon Operation System (TOS) from 8 to 12 October 2018. The Members involved are Lao PDR and Thailand.
        iii. Coordinated with JMA for the RSMC Tokyo Attachment Training from 15 to 26 October 2018 with three forecasters from Macao, China; Malaysia and Philippines and two forecasters from Panel on Tropical Cyclones.
        iv. Coordinated with JMA for holding a technical meeting on regional radar network from 22 to 26 October 2018 with participants from Lao PDR Malaysia, Thailand and Viet Nam.
        v. Coordinated with JMA for holding a technical meeting on utilization of Himawari-8/9 products from 22 to 25 October 2018 with participants from Malaysia.
        vi. Coordinated with CMA for the International Training Course on Typhoon Monitoring and Forecast from 10 to 19 December 2018.
        vii. Coordinated with TRCG to host the 2018 research fellowships which include the following:
            - The National Typhoon Center (NTC) of KMA provided a training and

research programme on Typhoon Operation System (TOS) and analysis of satellite and radar data from 23 April to 4 May 2018. Five participants from China, Malaysia, Philippines, Thailand and Viet Nam participated in the programme.

- STI of CMA offered the fellowship on "Benefit Evaluation of Typhoon Disaster Prevention and Preparedness" to a forecaster from Malaysia from 2 May to 1 June 2018. The objective of the fellowship is introducing the techniques for evaluating the benefits of improving the accuracy of track and intensity forecast to improve the disaster prevention and preparation to the Members.
- The Hong Kong Observatory (HKO) offered the fellowship on "Short-term Rainfall Forecast for Tropical Cyclone Using Himawari-8 Data and NWP Model Products" from 3 January to 1 March 2019. A forecaster from Viet Nam participated in the fellowship. The project aimed at developing rainfall estimate and short-term forecast products for tropical cyclones based on Himawari-8 data as well as forecasts from NWP models and ensemble prediction system.
- The fellowship for the Visiting Editor for Tropical Cyclone Research and Review offered by STI will be conducted in February 2019.

Conclusions of WGM

On the basis of the information provided by Members and the respective coordinator of the actions plan and based on the discussion during the 13th IWS, the following conclusions were reached:

a. Members have made important progress in the implementation of the TC Strategic Plan during the year 2018.
b. Members made significant progress during 2018 in tropical cyclone monitoring and communication systems, data assimilation and numerical weather prediction systems, tropical cyclone forecast-aiding systems, and scientific understanding of tropical cyclone activities.
c. With the help of Tropical Cyclone Programme (TCP) of WMO and Typhoon Committee Secretariat (TCS), and the absolute sincere cooperation of all Members and the effective efforts of the WGM focal points, WGM has successfully completed the tasks in 2018.
d. Experts from other working groups of TC, WMO/TCP, TCS, RSMC-Tokyo, JTWC, etc. have also provided assistances to accomplish the tasks of WGM over 2018, namely the two WMO demonstration projects (TLFDP and TCEFP), visiting editor to TCRR editorial office (Shanghai) and research fellowships.

e. The 1st WGM meeting was held in Shanghai China on July 9, 2018 (**Annex III of Appendix III**). Major results of the meeting were reported during the WGM parallel session in the 13th IWS. WGM confirmed that it will maintain the existing chairperson with vice-chairpersons system (i.e., will not switch to co-chair), and proposed that Dr. Lei Xiaotu from China to continue to serve as chairperson in next two years. The vice-chairpersons will be Mr. Alui Bahari from Malaysia and Dr. Vicente B. Malano from the Philippines.
f. Based on the discussion on the action plans for 2019 during the 13th IWS, it was concluded to adopt the action plans as follows:
    i. The POP item 1-5 and AOP item 1-6 will be continued in 2019.
    ii. The PP2 item will be continued and moved to AOP7 in 2019.
    iii. The PP1 item will be continued and moved to AOP8 in 2019.
    iv. Establish 2 new PP item 1-2 in 2019.
g. The total budget proposed by WGM, which was concurred at the AWG meeting during the 13th IWS, for undertaking the actions plans (AOPs, POPs and PPs) in 2019 is US$36,500. In addition, special budget of US$15,000 will be allocated for publication of TCAR3 report, contribution for EXOTICCA-II and RaINS.
h. The complete WGM 2019 action plans (AOPs, POPs and PPs) including the actions, the success indicators, coordinators and budget are listed in **Annex II of Appendix III**.

Recommendations of WGM

a. To request KMA to continue provide seasonal typhoon outlook information for TC Members with further development in the techniques.
b. To request CMA to encourage TC Members to nominate contact to join the Collaborative Discussion (CoDi) Forum and participate for trial during typhoon season.
c. To request STI to publish the TCRR Journal on a quarterly basis in 2019, and to improve the editorial procedure and Journal's influence.
d. To request KMA to continue provide technology transfer of the TOS for interested Members, and to provide technical support and new modules to existing Members already with the system.
e. To request STI to continue the evaluation of performance of tropical cyclone forecast in western North Pacific in 2019, and to provide real-time verification in WMO-TLFDP website.
f. To request JMA to further develop tropical cyclone genesis guidance using early Dvorak Analysis (EDA) and global ensemble.
g. To request JMA to improve probability-circle radii in TC track forecasts using ensembles from multiple NWP centers and verify the new radii with tropical cyclone track data in 2019.

h. To request CMA to continue improving the TRAMS (Tropical Region Atmospheric Model System) and provide forecast products to Members.
i. To request JMA to further refine quality control techniques applied to MMD, TMD and VNMHA radar networks, and MMD and TMD's QPE calibration using rain-gauges.
j. To request JMA to continue the experimental regional radar composite data exchange and share the progress with RA II/V WIGOS radar project in Southeast Asia for expansion of the experiment.
k. To request JMA to hold follow-up technical meetings upon receipt of progress reports from TMD, MMD and VNMHA, and compose a user's guide among JMA, MMD and TMD.
l. To request SMG to redistribute the survey form to acquire a more comprehensive survey result for evaluating the impacts of tropical cyclones in Typhoon Committee Region.
m. To request SMG to publish the third assessment report by the end of 2019.
n. To request JMA to provide astronomical tide estimated by global ocean tide solution to stations where astronomical tide is not available.
o. To request JMA to add storm surge time series prediction upon request from Members.
p. To request JMA to publish verification results of storm surge predictions.
q. To request JMA to encourage Members to provide complete hourly tidal data of at least one year and sea level observations during storm surge events for improving the prediction and verification.
r. To request JMA to commence a joint development with MMD for RDCA global coefficient with Himawari 8/9 products and to perform testing.
s. To request JMA to host a meeting between JMA and MMD in late 2019 to exchange views and opinions on RDCA global coefficient.
t. To request JMA to provide initial supports for development of RDCA by MSS and VNMHA.
u. To request STI and HKO to continue field campaign, and to collect and share the field observation and research data.
v. To request STI and HKO to continue demonstration research on tropical cyclone intensity change in conjunction with WMO-TLFDP.
w. To request CMA to use radar data to evaluate the quality of surface observations, and to develop wind structure estimation based on available surface observations.
x. To request MMD and HKO to integrate radar data, blend data with NWP data, and perform verification of RaINS/SWIRL.
y. To request JMA to support AOP7 of WGH through providing knowledge on JMA's NWP model and instructions for the use of NWP products that are available via DIAS, and through sharing experiences on awareness raising to both local governments

and public including the appropriate use of products.

z. To endorse the proposed action plans in 2019 (including 5 POPs, 8 AOPs and 2 PPs) as listed in **Annex II of Appendix III – Summary Report for the WGM Parallel Meeting at the 13th IWS**, which summarizes the above recommendations with additional action items.

aa. To endorse the WGM budget request included in the budget proposal to be submitted by AWG for TC's approval.

Appendix II
Report on activities of Working Group on Meteorology (WGM) of TC in 2018

2018 ANNUAL REPORT OF WGM
(Submitted by Chair of WGM)

1. Introduction

1.1 According to the terms of reference, Working Group on Meteorology (WGM) is to promote cooperation among the Members of Typhoon Committee (TC) in the implementation of activities under the Meteorological Component of the Committee's Strategic Plan with the aim to support the socio-economic development process and enhance cooperation among the Members in all the three components. (Training and Research are incorporated as part of these three components.) Towards this end, the WGM is expected to advise and assist the Committee in:

(a) Identifying priority issues and areas of cooperation in the Meteorological Component;
(b) Promoting and facilitating the exchange of experiences and knowledge on latest developments and techniques related to the above issues and areas;
(c) Coordinating and implementing priority activities and programmes of the Committee aiming at strengthening capacity of the Members in meteorology;
(d) Mobilizing resources to carry out priority activities of the Committee related to the meteorological Component;
(e) Reporting overall progress in the implementation of the meteorology component of the Strategic Plan;
(f) Recommending to the Committee priority areas, programmes and activities for cooperation in meteorological research by related experts of the Members.

2. Membership

2.1 After the 50th TC Session, the composition and focal point members list of WGM are:

Chair	Dr. Lei Xiaotu (China)
Vice Chair	Dr. Vicente B. Malano (Philippines) Mr. Alui Bahari (Malaysia)
Members	Ms. Peou Phalla (Cambodia) Mr. Ryu Ki Ryol (DPR Korea) Mr. C.M. Cheng (Hong Kong, China) Dr. Hisaki Eito (Japan) Mr. Vanhdy Douangmala (Lao PDR) Mr. Wong Chan Seng (Macao, China) Mr. Renito B. Paciente (Philippines) Dr. Cha Eun Jeong (Rep. of Korea) Ms. Patricia Ee (Singapore) Mr. Surapong Sapara (Thailand) Mr. Christopher Brenchley (USA) Mr. Vo Van Hoa (Viet Nam)
TCS Meteorologist	Mr. Clarence Fong

2.2 Experts from other working groups of TC, TCP/WMO, WWRP/WMO, TCS, RSMC-Tokyo, JTWC, etc. have also provided assistances to accomplish the tasks of WGM over 2018, endorsed at the 50th session of TC. These include RSMC Tokyo attachment training and technical meetings for regional radar network and utilization of Himawari-8/9 products in JMA, research fellowships offered by CMA, HKO, KMA and STI, visiting editors to TCRR editorial office and first WGM Annual Meeting in STI.

3. The progress of WGM's plans in 2018

With the assistances of TCP/WMO and TCS and the strong support from all Members, WGM has successfully completed the action plans (5 POPs, 6 AOPs and 2 PPs) in 2018, which were endorsed at the 50th Session. The WGM activities and the progress of all action items in 2018 are reported in the **Appendix III – Summary Report of the WGM Parallel Meeting at the 13th IWS**. The complete table of the 2018 action plans and its implementation status are listed in **Annex I** of the Summary Report.

After the 50th TC Session in 2017, WGM has been carrying out many activities that involve the cooperation among Members as well as other TC WGs and international organizations, which includes:

- Coordinated with STI to organize the first WGM Annual Meeting in Shanghai on 9 July 2018.
- Coordinated with KMA for holding a technology transfer of Typhoon Operation System (TOS) from 8 to 12 October 2018. The Members involved are Lao PDR and Thailand.
- Coordinated with JMA for the RSMC Tokyo Attachment Training from 15 to 26 October 2018 with three forecasters from Macao, China; Malaysia and Philippines as well as two forecasters from Panel on Tropical Cyclones.
- Coordinated with JMA for holding a technical meeting on regional radar network from 22 to 26 October 2018 with participants from Lao PDR, Malaysia, Thailand and Viet Nam.
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- Coordinated with TRCG to host the 2018 research fellowships which include the following:
  (i) The National Typhoon Center (NTC) of KMA provided a training and research programme on Typhoon Operation System (TOS) and analysis of satellite and radar data from 23 April to 4 May 2018. Five participants from China, Malaysia, Philippines, Thailand and Viet Nam participated in the programme.
  (ii) The Shanghai Typhoon Institute (STI) of CMA offered the fellowship on "Benefit Evaluation of Typhoon Disaster Prevention and Preparedness" to a forecaster from Malaysia from 2 May to 1 June 2018. The objective of the fellowship is introducing the techniques for evaluating the benefits of improving the accuracy of track and intensity forecast to improve the disaster prevention and preparation to the Members.
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  (iv) The fellowship for the Visiting Editor for Tropical Cyclone Research and Review offered by STI will be conducted in February 2019.
- WGM has drafted the proposal on the ESCAP/WMO Typhoon Committee

Research Center (**Annex I of Appendix II**).

4. Conclusions

a. Members have made important progress in the implementation of the TC Strategic Plan during the year 2018.
b. Members made significant progress during 2018 in tropical cyclone monitoring and communication systems, data assimilation and numerical weather prediction systems, tropical cyclone forecast-aiding systems, and scientific understanding of tropical cyclone activities.
c. With the help of Tropical Cyclone Programme (TCP) of WMO and Typhoon Committee Secretariat (TCS), and the absolute sincere cooperation of all Members and the effective efforts of the WGM focal points, WGM has successfully completed the tasks in 2018.
d. Experts from other working groups of TC, WMO/TCP, TCS, RSMC-Tokyo, JTWC, etc. have also provided assistances to accomplish the tasks of WGM over 2018, namely the two WMO demonstration projects (TLFDP and TCEFP), visiting editor to TCRR editorial office (Shanghai) and research fellowships.
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5. Recommendations

a. To request KMA to continue provide seasonal typhoon outlook information for TC Members with further development in the techniques.
b. To request CMA to encourage TC Members to nominate contact to join the Collaborative Discussion (CoDi) Forum and participate for trial during typhoon season.
c. To request STI to publish the TCRR Journal on a quarterly basis in 2019, and to improve the editorial procedure and Journal's influence.
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the prediction and verification.

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s. To request JMA to host a meeting between JMA and MMD in late 2019 to exchange views and opinions on RDCA global coefficient.
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v. To request STI and HKO to continue demonstration research on tropical cyclone intensity change in conjunction with WMO-TLFDP.
w. To request CMA to use radar data to evaluate the quality of surface observations, and to develop wind structure estimation based on available surface observations.
x. To request MMD and HKO to integrate radar data, blend data with NWP data, and perform verification of RaINS/SWIRL.
y. To request JMA to support AOP7 of WGH through providing knowledge on JMA's NWP model and instructions for the use of NWP products that are available via DIAS, and through sharing experiences on the awareness raising to both local governments and public including the appropriate use of products.
z. To endorse the proposed action plans in 2019 (including 5 POPs, 8 AOPs and 2 PPs) as listed in **Annex II of Appendix III – Summary Report for the WGM Parallel Meeting at the 13th IWS**, which summarizes the above recommendations with additional action items.
aa. To endorse the WGM budget request included in the budget proposal to be submitted by AWG for TC's approval.

Annex I

Proposal of ESCAP/WMO Typhoon Committee Research Center

Tuesday, 28 February, 2019
Guangzhou, China

ESCAP/WMO Typhoon Committee Research Center

1. Background

Since its establishment in 1968, ESCAP/WMO Typhoon Committee has been endeavored to strengthen the technical cooperation on disaster prevention and mitigation among Members, to intensify the technical exchanges on typhoon-related disaster risk reduction, project cooperation, joint research and personnel training, and to share the experience and results of the disaster prevention.

The western North Pacific is the most active tropical cyclone region in the world. It is also the only basin which has tropical cyclone activities all year round. In recent years, unusual tropical cyclones with sudden track changes, rapid intensification as well as record-breaking super typhoons occur every typhoon season which caused great damages. It is not uncommon that all numerical weather prediction models have failed to forecast or their forecast errors far exceed average errors (e.g. 24-hr track error reached to 200km, even 300km).

There's limitation time for operational personnel to do research analysis. On the other hand, it is hard for researchers to learn specific technical difficulties in practice timely. Therefore, it is crucial to set up a joint typhoon monitoring forecast technique platform between scientists, operational forecasters and Members to carry out collaboration research on sustainable operational application.

2. Aims and Scopes

The aims of the proposed center are:

- To set up a joint typhoon monitoring forecast technique platform between scientists, operational forecasters and Members in order to guide more scientists to typhoon mitigation related theoretical research and cooperation with operational forecasters to develop the key operational techniques;
- To enhance TC members' capability of tropical cyclone operational forecast and scientific research;
- To promote science and technology exchange among the TC Members as well as the international community in meteorology, hydrology and disaster risk reduction;
- To expand influence of the Typhoon Committee in areas of typhoon research among the international meteorological community.

The scope of the proposed center covers the followings:

- To conduct typhoon scientific experiment research;
- To carry out theoretical research on unusual phenomenon of typhoon

track, intensity, structure, wind and rain, and so on;

- To conduct research on typhoon operational forecast techniques and verification methods;
- To develop hazard risk analysis techniques of typhoon;
- To develop benefit evaluation techniques of typhoon disaster risk reduction.

3. Organizational Structure

3.1 International Scientific Steering Committee (ISSC)

The ISSC consists of Typhoon Committee Advisory Working Group experts and world renowned typhoon experts. The main task is:

- To submit the strategic plan and annual work plan to the center for its consideration
- To provide guidance to the implementation of projects
- To offer suggestions to the international key research project's chief
- To publicize the center

3.2 Director of the center

The director will be internationally recruited (expert from Typhoon Committee preferred).

3.3 Staff of the center

- Permanent Staff: support and assist research projects
- Temporary Staff: members from research projects, visiting scholars and foreign students.

3.4 Branch of the center

- Research Supporting Division: provide basic research support
- Project Management Division: organize and evaluate the research projects and manage the research fund

4. Budget

- The center is suggested to be co-established and funded by China Meteorological Administration and Shanghai Municipal Government. Research fund and operation expense are proposed to be offered by Shanghai Municipal Government. Basic research condition expense will be borne by China Meteorological Administration (Shanghai Typhoon

Institute).

- Financial support from social organization and enterprises.

5. Proposed timeline:

Phase I: January, 2019 - March, 2019

- Draft proposal of the center and submit to Typhoon Committee.

Phase II：March, 2019 - October, 2019

- Improve the proposal and submit during 14th IWS.

Phase III：November, 2019 – December, 2020

- Further improve the proposal and submit during 52th TC Session;
- Complete the preparation of the center, officially launch the establishment and design the 1st trust fund program guidance.

Appendix III
Progress Report of Working Group on Meteorology (WGM) of TC in 2018

ESCAP/WMO Typhoon Committee
13th Integrated Workshop
5-9 November 2018
Chiang Mai, Thailand

WORKING GROUP ON METEOROLOGY ACTIVITIES
PROGRESS REPORT 2018

(Submitted by WGM Chair)

ACTION PROPOSED:

The Committee is invited to:

(a) Take note of the Members activities and major progress and issues in meteorology component in 2018 as reported

(b) Review the implementations of all WGM activities conducted in 2018

(c) Approve the recommendations and planned activities of WGM for 2019 and beyond.

ANNEXES:

I. Implementation status of WGM plans in 2018
II. Proposal plans of WGM activities in 2019
III. Summary report of First WGM Meeting in 2018

2018 PROGRESS REPORT OF WGM

(Submitted by Chair of WGM
for TC 13th IWS, Chiang Mai, Thailand 5-9 November 2018)

1. Background

- After the 50th TC Session, the composition and focal point members list of WGM are:

Chair	Dr. Lei Xiaotu (China)
Vice Chair	Dr. Vicente B. Malano (Philippines) Mr. Alui Bahari (Malaysia)
Members	Ms. Phalla Peou (Cambodia) Mr. Ryu Ki Ryol (DPR Korea) Dr. C.M. Cheng (Hong Kong, China) Dr. Hisaki Eito (Japan) Mr. Vanhdy Douangmala (Lao PDR) Mr. Wong Chan Seng (Macao, China) Mr. Renito B. Paciente (Phillippines) Dr. Cha Eun Jeong (Rep. of Korea) Ms. Patricia Ee (Singapore) Mr. Surapong Sarapa (Thailand) Mr. Christopher Brenchley (USA) Mr. Vo Van Hoa (Viet Nam)
Secretary of Mete.	Mr. Clarence Fong

- At the 7th IWS held in Nanjing, China, WGM Chair proposed to restructure the table of Annual Operating Plans (AOPs), namely the inclusion of 2 additional tables, which are the Perennial Operating Plans (POPs) and Preliminary Projects (PPs), and was adopted by WGM. POPs are referring to the WGM activities that will be carried out repeatedly in the following years while the PPs referring to the projects of which preliminary studies needed to be undertaken by WGM.
- The action plans in 2018 (including 5 POPs, 6 AOPs and 2 PPs) have been endorsed by 50th TC Session.

2. Progress of WGM action plans (POPs, AOPs and PPs) in 2018

- The progress and the results of all the priority plans (include 5 POPs, 6 AOPs and 2 PPs) since the 50th TC Session as well as the action plans in 2018

submitted by the respective coordinators, which were reported as shown in bullet 2.1 to 2.13.

- The Implementation status of WGM Action plans in 2018 including the actions and the completion status; and the action plans in 2019 are listed in **Annex I** and **Annex II** respectively.

2.1 POP1: Development of typhoon seasonal prediction system

- In 2018, the KMA provided TC members with seasonal outlooks for western North Pacific typhoons on the website (http://gtaps.kma.go.kr/TSP/index.php). The seasonal outlooks for summer and fall have been issued in late May and late August, respectively.
- In the fall (Sep-Nov) seasonal outlook, 9-12 tropical cyclones (Lifetime Maximum Wind Speed ≥ 17m/s) were forecasted to occur. Storm frequency would be above normal in the eastern sea of Taiwan and southern Sea of Japan, and below normal in the South China Sea.
- The techniques of typhoon seasonal prediction of KMA were reported at the IWTC-9 by Dr. Phil Klotzbach, a rapporteur. This report that summarizes the seasonal tropical cyclone forecasting of the several forecasting groups has been submitted to the TCRR and is under review.

2.2 POP2: Web-based typhoon forum and CoDi platform

- To encourage TC Members and TCS to nominate contact to get the account and password.
- To encourage interested Members to join for trial during typhoon season.
- To run routinely.

2.3 POP3: Tropical Cyclone Research and Review

- Since its launch in February 2012, 27 issues of *Tropical Cyclone Research and Review* (TCRR) were published, covering the topics of tropical cyclone (TC) intensity and structure, TC climatology, review of TC in history, operational TC forecast verification, TC induced storm surge, flood or wave, and risk management etc. Authors come from 13 different countries and regions, two-thirds of them are international authors. We insist on strict peer-review process to ensure the quality of our journal, and two-thirds of the reviewers are also overseas experts. All of the published papers are available freely from the website. Readers spread over 110 Countries, the most are from the US,

accounting for 50%. The full-text download capacity from January to September exceeded 38000 times, which was 58 percent over the same period of last year.

- Two visiting editors from Thailand and Viet Nam, respectively, were invited to the Editorial Office located in Shanghai Typhoon Institute for one week, with the support from Typhoon Committee. They sent more than 100 invitation letters for contribution to the potential authors, submitted 2 articles/abstracts, and reviewed 4 manuscripts during their stay.

- To celebrate the Typhoon Committee's 50th Anniversary, TCRR published special issues in 2018. Up to now, 3 issues with 17 articles were published. Thanks to the great support from the world's famous typhoon experts, including Russell Elsberry, Robert Rogers, Kevin Cheung, Nadao Kohno, Marie-Dominique Leroux, and Peter Otto etc., the second special issue gave valuable summaries and reviews based on the WMO IWTCLP-4.

- In February, one staff of the editorial office attended the Technical Conference (TECO) and 50th Session of TC, and the first issue was displayed in the Exhibition of Members' Achievement. Our staff also attended the EGU General Assembly 2018 held in Austria to publicize TCRR, together with the world's famous Publishers, like the Cambridge University Press, Oxford University Press, Springer Nature, and Wiley.

- Currently, TCRR has been included in two databases, one is the China National Knowledge Infrastructure, and the other is the Emerging Sources Citation Index (ESCI), which is like SCI, owned by the Clarivate Analytics. ESCI includes high-quality, peer-reviewed publications representing both regional importance and emerging scientific fields not well-covered in more established journals.

- At present, to be included in the Science Direct database is in progress. After that, TCRR will share this database with Elsevier's 2500 journals, 12000 books and 11000 medias.

2.4 POP4: Transfer of the Technology of the Typhoon Operation System (TOS)

- The NTC/KMA carried out the Typhoon Operation System (TOS) technology transfer to the Department of Meteorology and Hydrology (DMH) of Lao PDR and the Thai Meteorological Department (TMD) from October 8 to 12, 2018.
- Transfer of the Technology of the Typhoon Operation System (TOS) will be

continued at Member's request. Interested Members could send the request to the KMA for planning the work.

2.5 POP5: Verification of tropical cyclone operational forecast

- Forecasts of tropical cyclone tracks and intensity from deterministic guidance and ensemble systems in 2017 were evaluated and the results were reported to the 50th session of Typhoon Committee (TC). Part of the work has been submitted to Tropical Cyclone Research and Review (TCRR).

- Providing real time verification on track and intensity forecasts through WMO-TLFDP website. New verification products have been added, such as ensemble probability ellipse, probability of TC precipitation.

- Joint workshop of TLFDP & UPDRAFT & EXOTICCA has been meeting in Shanghai to discuss the project progress and future plan form July 9th to 11th, 2018.

2.6 AOP1: Enhanced use of ensemble forecast

- RSMC Tokyo has added ensemble results of JMA and NCEP for TC activity prediction map on NTP website, and Multi Center Grand Ensemble (MCGE) from the four centers is also available on the website now. Therefore, the item (a) in the Action Plan 2018 (To provide verification results of ensemble TC activity predictions from four NWP centers and multi-center grand ensemble (MCGE)) has been completed.

- As for the item (b), development with combination of EDA results and GEPs of ECMWF, UKMO, NCEP and JMA has been in progress. JMA conducted a verification of TC genesis against the ratio of ensemble members predicting sustained TC-like vortex with data from TS1701 to TY1825. JMA will continue working on tuning for higher hit rate.

2.7 AOP2: Improve the performances and impacts of South China Sea typhoon model

- Impact of model vertical resolution on typhoon forecast. Numerical simulations of the super typhoon 'Hato' in 2017 have been performed using models with 65, 95, and 125 vertical levels. Result shows that, as vertical resolution increases, short-term lead time forecast is significantly improved, which is used to more eastward. More than that, higher vertical resolution also improves intensity forecast, with the model of 125 levels performing the best.

The further batch test of multiple South China Sea typhoons verifies that increasing model vertical resolution has positive impact on typhoon forecast.

- Technique upgrade and preliminary assessment. Except for upgrading model resolution, techniques in the operational typhoon model have been fully upgraded, including: 1) Model initialization process is simplified, and initialization time is effectively shortened. 2) In dynamical core, second-order accurate vertical finite-difference scheme is adopted, and 3D reference scheme gets further improvement. 3) In physical process, major improvements are in cumulus convection scheme and boundary layer scheme. On top of that, radiation scheme is also updated.

- In 2019, we will continue to: 1) the Development on typhoon initialization scheme. Considering error always existing in typhoon location and intensity in initial fields from global model, we develop a simple initialization technique to correct the initial intensity and location based on observation data. While the large-scale environment remains unchanged, typhoon location is displaced to the accurate location. And intensity correction is to adjust the TC vortex field based on maximum wind velocity and minimum pressure from observation. Preliminary test shows that the scheme is able to improve both path and intensity forecast within 48-hour forecast lead time. 2) Forecast system of new version of TRAMS. A new TRAMS model forecasting system will be set up in 2019, configuration of TRAMS are as follow: Horizontal res: 0.09* 0.09º; Lat: 0.8ºN - 50.57ºN; Lon: 81.6ºE - 160.89ºE; Vertical res: 95 layers; Iterative SISL scheme; 3D reference and A vertical difference scheme with second order accuracy; RRTMG radiation scheme; New shallow convection and Multi Scale SAS Scheme; New SMS land surface.

2.8 AOP3: Development of regional radar network

- A technical meeting was held at JMA from 22 to 26 October in 2018 to discuss how to expand the radar network in Southeast Asia.

- Experts from Lao PDR, Malaysia, Thailand and Vietnam attended the meeting. Experts from UAE also attended the meeting as observers to exchange information on the radar networks in Southeast and West Asia.

- The meeting agreed that the project needs to pursue both expansion of the network and technical development among its participants, and to this end, the current experimental radar data exchange should be joined by applicants at an early date while existing participants provide technical advice on QC to

the new ones.

2.9 AOP4: Assessment report on the impact of climate change on tropical cyclone in TC region

- Experts finished the first draft of the assessment report for the Expert Meeting.
- The Expert Meeting was held at SMG, Macao between 26-27 Nov in 2018 to discuss the contents and future plans of the project.
- One of the chapters in this Assessment Report is to assess the impacts of tropical cyclones in the Typhoon Committee Region. In order to acquire a more comprehensive survey result, TC members who missed to return the complete result will be invited to fill the survey form again.
- The third assessment is scheduled to be published by the end of 2019.

2.10 AOP5: Storm surge watch scheme

- Verification of storm surge prediction (multi-scenario prediction) in 2017 is being done for stations where sea level observations are available in University of Hawaii Sea Level Center (UHSLC) data base. The results have been published in the Annual Report of RSMC Tokyo 2017.
- At 27 stations out of 78 stations, storm tide is not plotted in time-series charts, since the harmonic constants of astronomical tides are not available for those stations. In order to calculate astronomical tides and storm tides for such stations, JMA is currently testing global ocean tide solutions (FES2014 and TPXO).

2.11 AOP6: Contribution for the Experiment on Typhoon Intensity Change in Coastal Area (EXOTICCA)

- The field campaign and the demonstration research were conducted by CMA and HKO in 2018. The demonstration research using the field campaign observation data are continue and focus on the study of intensity and structure change in coastal area typhoon.
- Trial of the low-level (below 650m) unmanned aerial vehicle (UAV) and the Autonomous Marine Weather Observation (A-MWO) were piloted by STI/CMA and IAP of China as well as the mobile monitoring system in East China coastal area in summer.
- Trial of the drop-sonde measurements system using a middle-level UAV was

prepared and will be piloted by STI/CMA in 2019.

- HKO conducted reconnaissance flights and the jet aircraft over the South China Sea in summer for the tropical cyclones, and continue in 2018.

- The 1st Project meeting of the WWRP projects, Typhoon Landfall Forecast Demonstration Project (TLFD and Understanding and Prediction of Rainfall Associated with Tropical Cyclones (UPDRAFT), and the Typhoon Committee Project of the Experiment on Typhoon Intensity Change in Coastal Area (EXOTICCA) was held in 10-11 July 2018 in Shanghai, China. WMO/WWRP and about 40 experts from China, Hong Kong China, and USA participated. Technical presentations about the latest technologies and experiments have been delivered by STI, IAP, BUAA, HKO and HRD as well as the progress report of EXOTICCA presented by STI and HKO.

- In the future, the field campaign for offshore and landfall typhoon will be carry out routine operational-like. The dynamic analysis (particularly the analysis/re-analysis for tropical cyclone intensity and structure) and modeling (with data assimilation in high-resolution typhoon model) for target typhoons will be conduct collaboration with Typhoon Committee Members through perennial operational project (POP) and its fellowships. The demonstration research will also be conduct by collaborating with WMO international demonstration, such as the WMO-TLFDP, UPDRAFT and High Impact weather (HIweather) projects.

2.13 PP1: Available data used in operational tropical cyclone analysis

- Use radar data to evaluate the quality of surface observations.
- Develop wind structure estimation method based on available surface observations.

2.14 PP2: Enhancing Utilization of Himawari 8/9 Products

- Technical meeting between JMA and MMD was held at JMA from 22 to 25 October in 2018. In the meeting, JMA and MMD shared progress, identified issues, provided technical advice and discussed the way forward including expansion of the project.

3. Conclusions and the proposed action plans for 2019

On the basis of the information provided by Members and the respective

coordinators of the action plans and based on the discussions during the Parallel Meeting, the following conclusions were reached:

a. Members have made important progress in the implementation of the TC Strategic Plan during the year 2018.
b. Members made significant progress during 2018 in tropical cyclone monitoring and communication systems, data assimilation and numerical weather prediction systems, tropical cyclone forecast-aiding systems, and scientific understanding of tropical cyclone activities
c. With the help of Tropical Cyclone Programme (TCP) of WMO and Typhoon Committee Secretariat (TCS), and the absolute sincere cooperation of all Members and the effective efforts of the WGM focal points, WGM has successfully completed the tasks in 2018.
d. Experts from other working groups of TC, WMO/TCP, TCS, RSMC-Tokyo, JTWC, etc. have also provided assistances to accomplish the tasks of WGM over 2018, namely the two WMO demonstration projects (TLFDP and TCEFP), TCRR editorial board meeting in Shanghai of China, visiting editor to TCRR editor office (Shanghai) and the fellowships.
e. The 1st WGM meeting was held in Shanghai China on July 9, 2018 (**Annex III**). The information and the major results were reported during the WGM parallel session, and the parallel session confirmed that WGM will maintain the existing chairperson with vice-chairpersons system (i.e., will not switch to co-chair), and proposed that Dr. Lei Xiaotu from China to continue to serve as chairperson in next two years. The vice-chairpersons will be Mr. Alui Bahari from Malaysia and Dr. Vicente B. Malano from the Philippines.
f. Based on the discussion on the action plans for 2019 during the 13th IWS, it was concluded to adopt the action plans as follows:
    i. The POP item 1-5 and AOP item 1-6 will be continued in 2019.
    ii. The PP2 item will be continued and moved to AOP7 in 2019.
    iii. The PP1 item will be continued and moved to AOP8 in 2019.
    iv. Establish 2 new PP item 1-2 in 2019.
g. The total budget proposed by WGM, which was concurred at the AWG meeting during the 13th IWS, for undertaking the actions plans (AOPs, POPs and PPs) in 2019 is US$36,500. In addition, special budget of US$15,000 will be allocated for publication of TCAR3 report, contribution for EXOTICCA-II and RaINS.
h. The complete WGM 2019 action plans (AOPs, POPs and PPs) including the actions, the success indicators, coordinators and budget are listed in **Annex II**.

Annex I

Status of Perennial Operating Plans (POPs) of WGM in 2018

No.	Objective	Action	Success Indicators	Funding (Req. & S.)	Organizer	Participants	Coordinator	Status of Completion
1	Development of typhoon seasonal prediction system	(a) To provide the products of typhoon seasonal prediction for TC Members (b) To further develop the techniques of typhoon seasonal prediction	Submission of the progress report	/	KMA	/	Dr. Nam-Young Kang (KMA)	Yes
2	Web-based typhoon forum and CoDi platform	(a) To encourage TC Members and TCS to nominate contact to get the account and password. (b) To encourage interested Members to join for trial during typhoon season. (c) To run routinely.	Submission of the progress report	/	CMA, HKO, TCS	Members	Mr. Qian Chuanhai (CMA) Mr. Wong Wai-Kin (HKO) Ms. Lu Xiaoqing (CMA)	In Progress
3	Tropical Cyclone Research and Review	(a) To publish the journal quarterly in 2018, includes the special issue for TC50. (b) Improvement of the editorial procedure and the journal's influence (includes inviting 2-3 visiting editors, and hold 3rd editorial board meeting)	Submission of the progress report	US$5,000	CMA	Members	Dr. Wang Dongliang,(CMA) Ms. Zhou Xiao (CMA)	Yes
4	Transfer of the Technology of the Typhoon Operation System (TOS)	(a) To train the typhoon forecasters on the use of the TOS upon Member's request (b) To provide follow-on technical assistance to Members on the implementation of TOS	Submission of the progress report	US$5,000	KMA	Members	Mr. Kim Dongjin (KMA)	Yes
5	Verification of tropical cyclone operational forecast	(a) To carry out post-season verification and reliability analyses on the operational forecast of tropical cyclones and report to Committee Session (b) To provide the real time verification information on track and intensity forecast through WMO-TLFDP website (c) To further improve the evaluation	(a) Submission of the post-season verification report for TC Session (b)Progress report on the	US$3,000	CMA, HKO	Members	Dr. Yu Hui (CMA), Mr. Wong Wai-Kin (HKO)	Yes

No.	Objective	Action	Success Indicators	Funding (Req. & S.)	Organizer	Participants	Coordinator	Status of Completion
		system for tropical cyclone forecast, with special attention on genesis and ensemble forecast in conjunction with WMO-TLFDP (to be included in the TC Fellowship Scheme)	improvement of evaluation system for tropical cyclone forecast					

Status of Annual Operating Plans (AOPs) of WGM in 2018

No.	Objective	Action	Success Indicators	Funding (Req. & S.)	Organizer	Participants	Coordinator	Status of Completion
1	Enhanced use of ensemble forecast	(a) To provide verification results of ensemble tropical cyclone activity predictions from four NWP centers and multi-center grand ensemble (MCGE). (b) To further develop tropical cyclone genesis guidance using early Dvorak Analysis (EDA) and global ensemble.	(a) Provide verification results. (b) Submit progress report	/	JMA	/	Dr. Hisaki Eito (JMA)	Yes
2	Improve the performances and impacts of South China Sea typhoon model	(a) Increase model products and enhancing the application of TRAMS (b) Further improving the forecasting ability of TRAMS, especially for the intensity and precipitation forecasting.	Submission of the assessment of performance report of model	/	CMA	Viet Nam, PAGASA, MMD	Dr. Chen Zitong (CMA)	Yes

No.	Objective	Action	Success Indicators	Funding (Req. & S.)	Organizer	Participants	Coordinator	Status of Completion
3	Development of regional radar network	(a) To further refine quality control techniques applied to MMD and TMD radar networks, including dual pol. radars, to improve their quality of radar composites (b) To implement and refine MMD and TMD's QPE calibration using rain-gauge with technical assistance of JMA. (c) To continue the experimental regional radar composite data exchange, and to share the progress with the RA II/V WIGOS radar project in Southeast Asia for its discussion on expansion of this experiment. (d) Submission of progress reports by TMD and MMD. Upon the receipt of the reports, holding follow-up technical meeting(s) to identify a way forward.	Submission of the progress report by involved Members	US$6,000	TMD, MMD, JMA	Lao PDR, Vie Nam, Philippines	Ms. Lucia Euggong (MMD) Ms. Patchara Petvirojchai (TMD) Dr. Hisaki Eito (JMA)	Yes
4	Assessment report on the impact of climate change on tropical cyclone in TC region	(a) Complete the first draft of the assessment report for Members' comment. (b) Organize an expert meeting (likely in Macao, China).	Submission of the progress report	US$7500	Macao (China)	CMA,HKO, USA, JMA, KMA	Mr. Ho Kuok-Hou (SMG)	Yes
5	Storm surge watch scheme	(a) To provide astronomical tide estimated by an ocean model to the stations where astronomical tide is not available. (b) To add storm surge time series prediction points if so requested by Members. (c) To publish verification results of storm surge predictions. (d) Request Members to provide complete hourly tidal data of at least one year to provide accurate astronomical tides at the stations. (e) Request Members to provide tidal	Submission of the progress report	/	JMA	/	Dr. Hisaki Eito (JMA)	Yes

No.	Objective	Action	Success Indicators	Funding (Req. & S.)	Organizer	Participants	Coordinator	Status of Completion
		observations during storm surge events for verification of storm surge predictions.						
6	Contribution for the Experiment on Typhoon Intensity Change in Coastal Area (EXOTICCA)	(a) To implement the field campaign collaboration among participating Members by using buoy, mobile GPS radiosonde, aircraft and rocket drop-sondes and so on. (b) Demonstration research on tropical cyclone intensity change and forecast in conjunction with WMO-TLFDP (to be included in the TC Fellowship Scheme). (a) To hold a joint workshop with WMO-TLFDP and HIWeather on the experiment of typhoon (likely in June in Shanghai).	(a) Carry out the field campaigns operationally. (b) Submission of the progress report	US$5,000 (special funding)	CMA, HKO	Participant Members	Dr. LEI Xiaotu (CMA) Mr. WONG Wai-Kin (HKO)	Yes

Status of Preliminary Projects (PPs) of WGM in 2018

No.	Objective	Action	Success Indicators	Funding (Req. & S.)	Organizer	Participants	Coordinator	Status of Completion
1	Available data used in operational tropical cyclone analysis	(a) Use radar data to evaluate the quality of surface observations. (b) Develop wind structure estimation method based on available surface observations.	Submission of the progress report	/	CMA	Members (interested in this project)	Mr. Qian Chuanhai (CMA)	Yes
2	Enhancing Utilization of Himawari 8/9 Products	(a) Review and verification of the RDCA product through test operation in MMD. (b) Improvement of the product through a technical meeting at JMA. (c) Drafting a progress report by MMD with assistance of JMA.	Submission of the progress report.	US$6,000	JMA	MMD, MSS, NHMS of Viet Nam	Ms. Lucia Euggong (MMD) Mr. Wong Songhan (MSS) Mr. Vo Van Hoa (NHMS of Viet Nam) Hisaki Eito (JMA)	Yes

Annex II

Proposal for the Perennial Operating Plans (POPs) of WGM in 2019

SP's KRA & SG	No.	Objective	Action	Success Indicators	Funding (Req. & S.)	Organizer	Participants	Coordinator	Remarks
KRA1 KRA2 KRA6	1	Development of typhoon seasonal prediction system	(a) To provide the products of typhoon seasonal prediction for TC Members (b) To further develop the techniques of typhoon seasonal prediction	Submission of the progress report	/	KMA	/	Dr. Nam-Young Kang (KMA)	Continued (2015-)
KRA 6 SG 6b SG 6c	2	Collaborative Discussion (CoDi) Forum on TC Analysis and Forecast	(a) To encourage TC Members and TCS to nominate contact to get the account and password. (b) To encourage interested Members to join for trial during typhoon season. (c) To run routinely.	Submission of the progress report	/	CMA, HKO, TCS	Members	Mr. Qian Chuanhai (CMA) Mr. Wong Wai-Kin (HKO) Ms. Lu Xiaoqing (CMA)	Continued (2018-)
KRA 1 - 6	3	Tropical Cyclone Research and Review	(a) To publish the journal quarterly in 2019, includes the special issue. (b) Improvement of the editorial procedure and the journal's influence (includes inviting 2-3 visiting editors, and hold 3rd editorial board meeting)	Submission of the progress report	US$5,000	CMA	Members	Dr. Wang Dongliang,(CMA) Ms. Zhou Xiao (CMA)	Continued (2013 -)
KRA 1 KRA 2 KRA 6 SG 6b SG 6c	4	Transfer of the Technology of the Typhoon Operation System (TOS)	(a) To train the typhoon forecasters on the use of the TOS upon Member's request (b) To provide follow-on technical assistance to Members on the implementation of TOS	Submission of the progress report	US$5,000	KMA	Members	Mr. Kim Dongjin (KMA)	Continued (2014 -)

SP's KRA & SG	No.	Objective	Action	Success Indicators	Funding (Req. & S.)	Organizer	Participants	Coordinator	Remarks
KRA1 KRA2 KRA6 SG 6b SG 6c	5	Verification of tropical cyclone operational forecast	(a) To carry out post-season verification and reliability analyses on the operational forecast of tropical cyclones and report to Committee Session (b) To provide the real time verification information on track and intensity forecast through WMO-TLFDP website (c) To further improve the evaluation system for tropical cyclone forecast, with special attention on genesis and ensemble forecast in conjunction with WMO-TLFDP (to be included in the TC Fellowship Scheme)	(a) Submission of the post-season verification report for TC Session (b)Progress report on the improvement of evaluation system for tropical cyclone forecast	US$5,000	CMA, HKO	Members	Dr. Yu Hui (CMA), Mr. Wong Wai-Kin (HKO)	Continued (2015 -)

Proposal for the Annual Operating Plans (AOPs) of WGM in 2019

SP's KRA &SG	No.	Objective	Action	Success Indicators	Funding (Req. & S.)	Organizer	Participants	Coordinator	Remarks
KRA 1 KRA 2 KRA 6 /SG 6b and 6c	1	Enhanced use of ensemble forecast	(a) To further develop tropical cyclone genesis guidance using early Dvorak Analysis (EDA) and global ensemble. (b) To improve probability-circle radii in TC track forecasts using ensembles from multiple NWP centers and verify the new radii with tropical cyclone track data in 2019	(a) Provide verification results. (b) Submit progress report	/	JMA	/	Dr. Hisaki Eito (JMA)	Continued (2011 -)
KRA1 KRA2 KRA6	2	Improve the performances and impacts of South China Sea typhoon model	(a) Increasing model products and enhancing the application of TRAMS (b) Further improving the forecasting ability of TRAMS, especially for the intensity and precipitation forecasting.	Submission of the assessment of performanc e report of model	/	CMA	Viet Nam, PAGASA, MMD	Dr. Chen Zitong (CMA)	Continued (2012 -)
KRA1 KRA2	3	Development of regional radar network	(a) To further refine quality control techniques applied to MMD and TMD radar networks, including dual pol. radars, to improve their quality of radar composites. (b) To implement and refine MMD and TMD's QPE calibration using rain-gauge with technical assistance of JMA. (c) To refine quality control techniques in VNMHA with technical assistance of JMA. (d) To support applicants to join the	Submission of the progress report by involved Members	US$8,000	TMD, MMD, JMA	Lao PDR, Viet Nam, Philippines	Ms. Lucia Euggong (MMD) Ms. Patchara Petvirojchai (TMD) Dr. Hisaki Eito (JMA)	Continued (2011 -)

SP's KRA &SG	No.	Objective	Action	Success Indicators	Funding (Req. & S.)	Organizer	Participants	Coordinator	Remarks
			experimental radar data exchange in the near future, and to share the progress with the RA II/V WIGOS radar project in Southeast Asia. (e) Submission of progress reports by TMD, MMD and VNMHA. Upon the receipt of the reports, holding follow-up technical meeting(s) to identify a way forward. (f) To compose a user's guide among JMA, MMD and TMD.						
KRA 1 KRA 2 KRA 4	4	Assessment report on the impact of climate change on tropical cyclone in TC region	(a) To redistribute the survey form to acquire a more comprehensive survey result for evaluating the impacts of tropical cyclones in Typhoon Committee Region. (b) To publish the third assessment report by the end of 2019.	Submission of the progress report	US$5,000	Macao (China)	CMA,HKO, USA, JMA, KMA	Mr. Ho Kuok Hou (SMG)	Continued (2014-)
KRA 1 KRA 2 KRA 4 /SG4(a)	5	Storm surge watch scheme	(a) To provide astronomical tide estimated by a global ocean tide solution to the stations where astronomical tide is not available, during the first quarter of 2019. (b) To add storm surge time series prediction points if requested by Members. (c) To publish verification results of storm surge predictions. (d) Request Members to provide complete hourly sea level data of at least one year to provide accurate astronomical tides at the stations. (e) Request Members to provide sea level observations during storm	Submission of the progress report	/	JMA	/	Dr. Hisaki Eito(JMA)	Continued (2012-)

SP's KRA &SG	No.	Objective	Action	Success Indicators	Funding (Req. & S.)	Organizer	Participants	Coordinator	Remarks
			surge events for verification of storm surge predictions.						
KRA1 KRA2 KRA6	6	Contribution for the Experiment on Typhoon Intensity Change in Coastal Area (EXOTICCA-II)	(a) To implement the field campaign collaboration among participating Members by using aircraft, airship, rocket drop-sondes etc. (b) To collect and share the field observation and research data (c) Demonstration research on tropical cyclone intensity change conjunction with WMO-TLFDP (to be included in the TC Fellowship Scheme).	Submission of the progress report	US$5,000 (special funding for 1-2 visiting research)	CMA, HKO	Participant Members (KMA,TMD)	Dr. LEI Xiaotu (CMA) Mr. WONG Wai-Kin (HKO)	Continued (2014-)
KRA 4 KRA 6 SG6(a)	7	Enhancing Utilization of Himawari 8/9 Products	(a) A joint development commences in 2019, for the coefficient generation applicable to the global RDCA. JMA prepares a draft document necessary for the RDCA global coefficient's specifications, and MMD reviews it. (b) A meeting is held between JMA and MMD in the late 2019 to exchange views and opinions. (c) RDCA Global coefficient development is done until the end of 2019. JMA provides a coefficient set to MMD. MMD tests it, and	Submission of the progress report.	US$9,000	JMA	MMD, MSS, TMD, VNMHA	Mr. Kohei Matsuda (JMA) Ms. Lucia Euggong (MMD) Mr. Wong Songhan (MSS) Ms. Patchara Petvirojchai (TMD) Mr. Vo Van Hoa (VNMHA)	Continued (2018-) Moved from PP2

SP's KRA &SG	No.	Objective	Action	Success Indicators	Funding (Req. & S.)	Organizer	Participants	Coordinator	Remarks
			sends the results to JMA. (d) JMA provides initial supports for development of RDCA by MSS and VNMHA.						
KRA 6 SG 6b SG 6c	8	Parallel analysis of satellite data in operational tropical cyclone monitoring (Available data used in operational tropical cyclone analysis)	(a) Use radar data to evaluate the quality of surface observations. (b) Develop wind structure estimation method based on available surface observations.	Submission of the progress report	US$4,500	CMA	Members interested in this project	Mr. Qian Chuanhai (CMA)	Continued

Proposal for the Preliminary Projects (PPs) of WGM in 2019

SP's KRA & SG	No.	Objective	Action	Success Indicators	Funding (Req. & S.)	Organizer	Participants	Coordinators	Status of Completion
KRA1 KRA2 KRA3	1	Radar nowcasting based on RaiNS/SWIRL	(a) Integrating radar data (b) Blending radar data with NWP data (c) Verification of RaINS/SWIRL (d) Preparation of progress report	Submission of the progress report	US$5,000	MMD HKO	TBC	Mr. Ambun Dindang (MMD), Mr. Yip Weng Sang (MMD) Mr. Wong Wai Kin (HKO)	New project
Cross-cutting project	2	Enhancement of disaster risk reduction against heavy rain in collaboration of AOP#7 of WGH	To support AOP7 of WGH through (a) providing knowledge on JMA's NWP model as well as instruction for the use of NWP products that are available via DIAS (b) sharing experiences on awareness raising to both local governments and public, including the appropriate use of products	Submission of the progress report	/	JMA	Philippines	Dr. Hisaki Eito (JMA)	New project

Annex III

ESCAP/WMO Typhoon Committee
Summary of the First Meeting of Working Group on Meteorology (WGM)

The first meeting of Working Group on Meteorology (WGM) of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP)/World Meteorological Organization (WMO) Typhoon Committee was successfully held in Shanghai on July 9, 2018. Here is the summary of the meeting:

1. Introduction

The Typhoon Committee consists of working groups on meteorology (WGM), hydrology (WGH), disaster risk and reduction (WGDRR), training and research coordination (TRCG) and advisory (AWG). In order to strengthen the communication among Members, prepare for collaboration in annual priority plans, the meeting was hosted by the Shanghai Typhoon Institute (STI) of CMA, chaired by WGM's current chairperson Dr. Lei Xiaotu from China and vice-chairpersons Mr. Ambun Dindang from Malaysia. Nearly 20 experts from 8 Members including China (International Cooperation Department, Typhoon and Marine Meteorological Forecast Center, Guangzhou Tropical Marine Meteorological Institute and Shanghai Typhoon Institute), Hong Kong, Macao, Japan, Laos PDR, Malaysia, South Korea and Thailand attended the meeting (for agenda and the list of participants, see Annex 1). Dr. Lei made a report on the progress of WGM's work in the past 10 years. The meeting reviewed the implementation of annual priority plans for this year, discussed the work focus of the next phase of WGM and Members reached a consensus.

2. Review of work progress in the past 10 years

The Typhoon Committee was established in 1968 and has been providing a platform for technical cooperation and exchange among Members since then. The WGM was established in 2004 and has made important contributions to the improvement in typhoon monitoring, forecasting and early warning in the region. In the past 10 years, an average of more than 10 annual priority plans have been set every year. During the period, rocket launching and sounding technologies have been developed for direct detection of typhoons, and forecast-based sensitive observations have become possible. Scientific experiments on typhoon intensity change were carried out, and researches on typhoon structure and intensity change were done based on multi-source observation data. This promoted the development of typhoon science and typhoon intensity analysis. In addition, there was significant development in high-resolution typhoon models and ensemble forecasts, and operational platforms were built for latest research results and technical training purposes. Typhoon forecast errors of Members have generally decreased by more than 30% compared to 10 years ago and 24-hour position

error has dropped to about 70km which aligns with the best standard worldwide. Seasonal typhoon forecasts and genesis forecasts have significantly extended the typhoon forecasting time in the region, which provided valuable lead-time for decision-making in disaster risk reduction. The assessment reports on climate change on typhoons and the launch of professional academic journals (Tropical Cyclone Research and Review) have greatly increased the international influence of the Committee.

3. Implementation of the annual priority plans for the current year

This year, WGM set up 15 annual priority plans (including 5 permanent POPs, 6 AOPs and 2 preparatory PPs). Representatives from 8 Members introduced the progress of WGM projects undertaken and participated by them. The Head of the Tokyo Typhoon Center (RSMC-Tokyo) introduced the latest technology progress of the center. Experts from the Hong Kong Observatory introduced the recent development and research work on tropical cyclone. Based on the presentations of the Members in the meeting, the progress of WGM priority plans this year was smooth.

4. Scientific experiment (EXOTICCA)

The meeting reviewed the progress of EXOTICCA since its establishment in 2014. Considering that China and Hong Kong of China will continue to conduct operational typhoon field observation experiments after the end of the first phase of EXOTICCA in 2018, it was proposed to change the AOP to POP (post-EXOTICCA, to be implemented by the Shanghai Typhoon Institute and Hong Kong Observatory) and introduce Members to the new typhoon detection equipment and results of shared observational experiments and related observation data. It was also proposed to invite Members to participate in the scholarship program (Fellowship) based on joint study of field observations which will be included in the fourth phase of the WMO Demonstration Project (TLFDP).

5. New proposals for WGM annual priority plan

The meeting encouraged Members to focus on the difficulties in the typhoon monitoring and forecasting, strengthen the research and development of new typhoon detection equipment, carry out high-resolution typhoon numerical models and key technology research, improve the application of ensemble forecast and seasonal forecast products, and strengthen cooperation and data sharing. During the meeting:

i) Experts from Malaysia proposed and introduced the basic idea of Radar integrated nowcasting system (RaINS).

ii) Based on the “7.6 Thailand Shipwreck Accident”, experts from China proposed the establishment of a regional typhoon and severe weather early warning information sharing system. The system will be a multilingual one to form a full coverage in the region. It is recommended that WGM to propose to the Committee

as a cross-cutting project.

iii) Experts from Thailand, Malaysia and Japan proposed to strengthen the sharing of radar and field observations and access the shared materials through the website of the Typhoon Committee Secretariat (TCS).

iv) Expert from Hong Kong, China proposed setting up a common platform for collection and sharing of operational and research data, in particular those used in the TLFDP, EXOTICA and UPDRAFT projects, among all Members.

v) Forecasters from China proposed the operational track and intensity forecasting errors and time bias in the TCs' landfall events, which reflect the combination between DRR and NMS services, and call for an upcoming future of impact-based forecast within the Typhoon Committee members.

6. Nomination of chairperson and vice-chairpersons

The meeting confirmed that WGM will maintain the existing chairperson with vice-chairpersons system (i.e., will not switch to co-chair), and proposed that Dr. Lei Xiaotu from China to continue to serve as chairperson in next two years. The vice-chairpersons will be Mr. Alui Bahari from Malaysia and an expert from the Philippines (TCS will contact the Philippines for nomination).

7. Date and venue for the second WGM meeting

The meeting accepted that Japan Meteorological Agency (JMA) will undertake the organization of the second WGM meeting. The meeting will be held in Japan in the middle of October 2019 tentatively. JMA will submit a plan including the specific time and place of the meeting and agenda of the meeting to the WGM meeting during the 13th IWS for consideration.