

ESCAP/WMO Typhoon Committee
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Yokohama
Japan

FOR PARTICIPANTS ONLY
WRD/TC.49/8.1
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ENGLISH ONLY

**WORKING GROUP ON METEOROLOGY ACTIVITIES
ANNUAL REPORT 2016**

(Item 8 of Tentative Program for TC 49th Session)

(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 2016 as reported by Members at the 11th IWS
- (b) Review the activities of WGM conducted in 2016
- (c) Approve the recommendations and planned activities of WGM for 2017 and beyond.

APPENDICES:

- I. DRAFT TEXT FOR INCLUSION AT SESSION REPORT
- II. Report on activities of Working Group on Meteorology (WGM) in 2016
- III. Summary Report of WGM Parallel Meeting at the 11th IWS

APPENDIX I

DRAFT TEXT FOR INCLUSION AT SESSION REPORT

8.1 Meteorological Component

1. The Committee took note of the Members' activities and major progress and issues in Meteorological Component in 2016 as reported by Members at the 11th 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 the 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 11th IWS on 25-26 October 2016 (**Appendix III**). With the help of WMO/TCP and TCS, and the sincere cooperation of all Members, WGM has successfully completed the tasks in 2016 with significant outcomes as follows:
 - a. WGM has fulfilled all the plans (including 5 POPs, 8 AOPs and 2 PPs) which were endorsed at the 48th Session.
 - b. RSMC Tokyo provided a variety of tropical cyclone products including ensemble tropical cyclone track guidance of ECMWF, NCEP and JMA, and ensemble tropical cyclone genesis guidance. Two- and five-day prediction maps were included in the NTP web site from June 2016.
 - c. RSMC Tokyo drafted the final report for harmonization of tropical cyclone intensity analysis and circulated to CMA, HKO, JTWC for their feedback. A list of recommendations was provided and TC Members were encouraged to follow with their own efforts and/or through collaborative efforts under TC.
 - d. Literature review (including non-English papers) and discussion for the 3rd Assessment Report on the impact of climate change on tropical cyclones in TC region were carried out by the Members in 2016. A survey and an expert symposium will be held in 2017.
 - e. WGM has provided help for WMO demonstration project (WMO-TLFDP and UPDRAFT) and TC cross-cutting project (EXOTICCA). Field campaigns were carried out by STI/CMA and HKO for selected tropical cyclones, and with coordination from HRD, STI/CMA finished the experimental study on the preliminary evaluation of the first rocket-deployed dropsonde observation in STY Mujigae (2015).
4. The Committee further noted the following WGM activities in 2016:
 - a. A joint workshop for EXOTICCA and WMO-TLFDP was held in Shanghai on 21 October 2016 on the target data using in-structure analysis and typhoon numerical model. Data policy for field observation was also discussed.
 - b. A technology transfer of Typhoon Analysis and Prediction System (TAPS) was conducted by NTC/KMA for PAGASA, Philippines between 13-14 October 2016. The technology transfer included three lectures and practice classes which showed the typhoon forecast process and structure of TAPS.
 - c. A research fellowship scheme was offered by STI on tropical cyclone genesis forecast

technique. The objectives of the research were to develop techniques for tropical cyclone genesis forecast and implement them in STI's objective typhoon forecast system, and provide the forecast products to Members through WMO-TLFDP's web site. The fellowship was offered to DPRK in November 2016.

- d. A technical meeting on radar composite map project was held in Japan between JMA and TMD experts from 29 November to 2 December 2016 to discuss issues on the project such as quality management, algorithm for developing QPE product and further utilization and sharing of radar data.
- e. Experts from USA and Thailand were invited by STI in October 2016 to improve the influence of the TC Journal *Tropical Cyclone Research and Review (TCRR)* by providing guidance on editorial procedures, seeking and encouraging submission of articles from Members as well as international institutions, and accelerating publicity and promotional activities about the Journal. The first editorial board meeting was held in Shanghai on 21 October 2016.
- f. The WMO international training course on tropical cyclone was held in the WMO Regional Training Center (RTC) in Nanjing between 21 November and 2 December 2016. The workshop was to assist Members in their efforts to improve operational tropical cyclone forecast and warning through providing training and knowledge updates to its forecasters.

Conclusions of WGM:

On the basis of the information provided by Members and the respective coordinator of the action plans and based on the discussion during the 11th IWS, the following conclusions were reached:

- a. WGM action plans in 2016 were successfully completed.
- b. Members made important progress in the implementation of the TC Strategic Plan during the year 2016.
- c. Members made significant progress during 2016 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.
- d. Seasonal outlook information for number of typhoon genesis and track pattern issued by the KMA continued to be useful to TC Members.
- e. The web-based typhoon forum maintained by STI/CMA would be migrated to TCS web site to attract more TC Members, forecasters, scientists as well as the public.
- f. Up to September 2016, 14 issues of the TC Journal *Tropical Cyclone Research and Review (TCRR)* have been published (since 2012) with more than 79,000 downloads from the website. Two visiting editors from USA and Thailand were invited to STI in October 2016 to provide guidance of improving the editorial procedures, reviewing articles and inviting articles, and the first editorial board meeting was held in Shanghai on 21 October 2016.
- g. The NTC/KMA conducted another technology transfer of TAPS to PAGASA in the Philippines between 13-14 October 2016. During the visit, introduction and demonstration of TAPS as well as installation of the system on forecaster's computers were carried out.
- h. Performance of tropical cyclone track and intensity forecasts from operational forecast agencies and deterministic NWP models in 2015 was evaluated by STI. Real-time

verifications on track and intensity forecasts were provided routinely through WMO-TLFDP website. STI/CMA hosted the TLFDP-III project meeting in Shanghai between 20-21 October 2016 with coordination of WMO, and a two-month research fellowship was offered to two experts from DPRK between October and November 2016.

- i. RSMC Tokyo relaunched the Numerical Typhoon Prediction (NTP) website in May 2015 and provided a variety of tropical cyclone products including ensemble tropical track guidance of ECMWF, NCEP and JMA. Multiple-center grand-ensemble (MCGE) for tropical cyclone prediction was examined and two- and five-day prediction maps were included in the NTP web site from June 2016.
- j. The New Generation of TRAMS (NG-TRAMS), which included a 3-D reference atmosphere scheme and the coupling of dynamic and physical processes, was developed by CMA in 2016.
- k. The website of RFSC-Ha Noi of SWFDP for Southeast Asia continued to improve and provide global and regional (ensemble) NWP forecast products as well as guidance products. The domain of the regional models will be extended to cover Philippines and Myanmar.
- l. A technical meeting on the development of regional radar network was held in Japan between JMA and TMD experts to discuss issues on quality management, algorithm for developing QPE product and further utilization as well as sharing of radar data.
- m. Literature review (including non-English papers) and discussion for the 3rd Assessment Report on the impact of climate change on tropical cyclones in TC region were carried out by the Members in 2016. A survey and an expert symposium will be held in 2017.
- n. The storm surge prediction system developed by JMA continued and more stations were added. Maximum storm surge forecast for up to 6 scenarios (official forecast plus 5 scenarios from Typhoon EPS model) were provided in 2016.
- o. For EXOTICCA, STI carried out the field campaign on 3 target typhoons – Meranti (1614), Megi (1617) and Sarika (1621) in East China coastal area together with Zhejiang and Fujian Meteorology Service, while HKO carried out the field campaign on tropical depression on 26 July, typhoon NIDA on 1 August, low pressure area on 16 August, and the TS Dianmu on 18 August. With coordination from HRD, STI/CMA finished the experimental study on the preliminary evaluation of the first rocket-deployed dropsonde observation in STY Mujigae (2015).
- p. RSMC Tokyo drafted and updated the zero draft of the tropical cyclone forecasting competency based on the input and feedback from WGM Members. Members were also invited to nominate a focal point, preferably a tropical cyclone forecaster, for this project.
- q. RSMC Tokyo drafted the final report for harmonization of tropical cyclone intensity analysis and circulated to CMA, HKO, JTWC for their feedback. A list of recommendations was provided and TC Members were encouraged to follow with their own efforts and/or through collaborative efforts under TC.
- r. The quality of observation data and spatial distribution from Nansha Observation Area, Xisha Observation Area and Hainan Observation Area of China were assessed and re-processed. A new method was developed to estimate the intensity of tropical cyclones over central SCS and make landfall in the southern part of China and the performance was compared to using the Dvorak technique and satellite data.

- s. Based on the discussion during the 11th IWS on the action plans for 2017, and according to the new structure of the action plans, it was concluded that:
 - i. The POP items 1-5 will continue in 2017.
 - ii. The AOP items 1-8 will continue in 2017.
 - iii. The PP item 1 will be closed in 2017.
 - iv. The PP item 2 will continue in 2017 as item 1.
 - v. A new PP item 2, Collaborative Discussion (CoDi) platform on tropical cyclone (TC) analysis and forecast organized by CMA and HKO, will be established in 2017.
 - vi. The total budget proposed by WGM, which was also concurred at the AWG meeting after the 11th IWS, for undertaking the actions plans (AOPs, POPs and PPs) in 2017 was US\$21000. The financial support of US\$5000 for EXOTICCA OC meeting (workshop) and US\$5000 for TCRR expert team meeting will be allocated through the “Special funding request”.

Recommendations of WGM

On the basis of the outcomes of the WGM Parallel Session at the 11th IWS and subsequent discussion, the WGM made the following recommendations:

- a. To request RSMC Tokyo and the WMO Regional Training Center (RTC) of Nanjing to continue the collaboration with TRCG and WGM to conduct the annual training for operational forecaster from TC Members.
- b. To request KMA to further develop the techniques of typhoon seasonal prediction, and to provide the products of typhoon seasonal prediction for TC Members.
- c. To request CMA and TCS to invite TC Members to assign staff as moderators of the web-based typhoon forum, to announce the forum in TCS Facebook page to attract the public to join the forum, and to make the forum serve as an exchange platform of real-time information (extra observations data, forecast products, pictures, video etc.).
- d. To request CMA and TCS to call for more contributions to the TC Journal *Tropical Cyclone Research and Review (TCRR)* from TC Members and Working Groups. The contributions can include technical summaries and operation innovations, research results associated with Strategic Plan and AOP (and POP), and other research results and summaries.
- e. To request KMA to train the typhoon forecasters of TC Members on the use of TAPS upon request, and provide follow-on technical assistance on the implementation of TAPS.
- f. To request CMA to continue post-season verification and reliability analysis on the operational forecasts of tropical cyclones, to provide real-time verification on tropical cyclone track and intensity through WMO-TLFDP website, and to further improve the evaluation system for tropical cyclone forecast in conjunction with WMO-TLFDP (to be included in the TC Fellowship Scheme).
- g. To request RSMC Tokyo to provide tropical cyclone genesis guidance of other global ensembles if necessary NWP data are available.
- h. To request CMA to increase model products and enhance the application of TRAMS, and to further improve the forecasting ability of TRAMS, especially for the intensity and precipitation forecasting.
- i. To request NHMS of Vietnam to provide tropical cyclone track, intensity and severe weather

- forecasting charts based on global and regional NWP models, to extend forecast domain of regional NWP models to cover the east sea of Philippines and Myanmar.
- j. To request TMD to update quality control techniques applied to TMD and MMD radar network, to introduce the calibration process for QPE into operation of TMD radar with assistance of JMA, to continue experimental test of radar data sharing among JMA, TMD and MMD, and to share the experiences of the test with the RA II WIGOS radar project in southeast Asia.
 - k. To request SMG to collaborate with TCS to conduct a survey on tropical cyclone impacts in TC region, and to organize an expert meeting in 2017.
 - l. To request JMA to provide astronomical tide estimate for stations in which the information is not available, to add storm surge time series to prediction points on the request of TC Members, and to verify storm surge predictions.
 - m. To request CMA and HKO to implement the EXOTICCA field campaign collaboration among participating Members, to demonstrate research on tropical cyclone intensity change in conjunction with WMO-TLFDP (to be included in the TC Fellowship Scheme).
 - n. To request RSMC Tokyo to set up a task team to review and finalize the draft tropical cyclone forecast competency, and to organize a task team meeting if funds are available.
 - o. To request CMA to develop wind structure estimation method based on available surface observations.
 - p. To endorse the action plans in 2017 (including 5 POPs, 8 AOPs and 2 PPs) as listed in **Annex II of Appendix I – Summary Report for the WGM Parallel Meeting at the 11th IWS**, which summarizes the above recommendations with additional action items.
 - q. To endorse the WGM budget request included in the budget proposal to be submitted by AWG for TC's approval.
 - r. To re-appoint Dr. Lei Xiaotu (China) as the Chair of WGM, Dr. Vincente B. Malano (Philippines) and Ms. Che Gayah Ismail (Malaysia) as Vice-chair of WGM.

Appendix II

Report on activities of Working Group on Meteorology (WGM) of TC in 2016

2016 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.

1.2 With the help of ESCAP, Tropical Cyclone Program (TCP) of WMO and Typhoon Committee Secretariat (TCS), the absolute sincerity cooperation of all Members, and the effective work of focal points, WGM has successfully finished all the following tasks in 2016:

- (a) WGM has fulfilled all the plans (including 5 POPs, 8 AOPs and 2 PPs) which were endorsed at the 48th Session.
- (b) RSMC Tokyo provided a variety of tropical cyclone products including ensemble tropical cyclone track guidance of ECMWF, NCEP and JMA, and ensemble tropical cyclone genesis guidance. Two- and five-day prediction maps were included in the NTP web site from June 2016.
- (c) RSMC Tokyo drafted the final report for harmonization of tropical cyclone intensity analysis and circulated to CMA, HKO, JTWC for their feedback. A list of recommendations was provided and TC Members are encouraged to follow with their own efforts and/or through collaborative efforts under TC.

- (d) Literature review (including non-English papers) and discussion for the 3rd Assessment Report on the impact of climate change on tropical cyclones in TC region were carried out by the Members in 2016. A survey and an expert symposium will be held in 2017.
- (e) WGM has provided help for WMO demonstration project (WMO-TLFDP and UPDRAFT) and TC cross-cutting project (EXOTICCA). Field campaigns were carried out by STI/CMA and HKO for selected tropical cyclones, and with coordination from HRD, STI/CMA finished the experimental study on the preliminary evaluation of the first rocket-deployed dropsonde observation in STY Mujigae (2015).

2. Membership

2.1 After the 48th TC Session, the composition and focal point members list of WGM are:

Chair	Dr. Lei Xiaotu (China)
Vice Chair	Dr. Vicente Malano (Philippines) Ms. Che Gayah Ismail (Malaysia)
Members	Ms. Peou Phalla (Cambodia) Mr. Ryu Ki Ryol (DPR Korea) Mr. C.M. Cheng (Hong Kong, China) Mr. Chiashi Muroi (Japan) Mr. Vanhdy Douangmala (Lao PDR) Mr. Lao Ieng Wai (Macao, China) Mr. Renito B. Paciente (Philippines) Dr. Nam-young Kang (Rep. of Korea) Ms. Patricia Ee (Singapore) Dr. Songkran Agsorn (Thailand) Mr. Raymond Tanabe (USA) Mr. Vo Van Hoa (Viet Nam)
TCS Meteorologist	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 2016, endorsed at the 48th session of TC, the two WMO demonstration projects, attachment training in RSMC Tokyo, HKO and RTC-Nanjing technical meeting among the radar experts of TMD and JMA in JMA Headquarters, fist editorial board meeting of TCRR, as well as visiting editors to TCRR editorial office (Shanghai) and the fellowships.

3. The progress of WGM's plans in 2016

With the assistances of TCP/WMO and TCS and the strong support from all Members, WGM has

successfully completed the action plans in 2016, which were endorsed at the 48th Session. The WGM activities and the progress of all action items in 2016 are reported in the [Appendix I – Summary Report of the WGM Parallel Meeting at the 11th IWS](#). The complete table of the 2016 action plans (POPs, AOPs and PPs) and its implementation status are listed in [Annex I](#) of the Summary Report.

After the 48th TC Session in 2016, 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 TCS to improve the TC website and set up a new portal site (<http://www.typhooncommittee.org/member-products.html>) to share forecast products and information as proposed by AWG and to serve as a platform for the Members and provide better support.
- Coordinated with TRCG to host 2016 research fellowships. Up to now, three experts visited NTC/KMA to attend the training course on TAPS operations between 1-14 May, 2016. One expert visited HKO as the research fellow to undertake the research on tropical cyclone size climatology from October to December 2016. And two experts (Mr. Pak and Mr. Kim) from DPRK will visit STI as the research fellow to undertake the research project “tropical cyclone genesis forecast technique” of STI fellowship offer in November.
- Coordinated with CMA to host a training programme on typhoon monitoring analysis and NWP, four experts (one from Viet Nam, one from Thailand and two from DPRK) visited NMC/CMA and to attend the training between 10-19 October, 2016.
- Coordinated with WMO/TCP and WMO Regional Training Center (RTC) of Nanjing to host the international training course on tropical cyclone from 21 November to 2 December, 2016. The course topic is “improving operational forecast to mitigate tropical cyclone hazards”
- Coordinated with NTC/KMA and STI/CMA to organize the 9th China-Korea joint workshop on the tropical cyclones, held in Republic of Korea between 16-20 May, 2016.
- Coordinated with STI/CMA to edit and publish the Typhoon Committee Journal *Tropical Cyclone Research and Review*, No. 1-3 of Vol. 4.

4. Conclusions and proposed action plans for 2017

On the basis of the information provided by Members and the respective coordinator of the action plans and based on the discussion during the 11th IWS, the following conclusions were reached:

- a. WGM action plans in 2016 were successfully completed.
- b. Members made important progress in the implementation of the TC Strategic Plan during the year 2016.
- c. Members made significant progress during 2016 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.
- d. Seasonal outlook information for number of typhoon genesis and track pattern issued by the KMA continued to be useful to TC Members.

- e. The web-based typhoon forum maintained by STI/CMA would be migrated to TCS web site to attract more TC Members, forecasters, scientists as well as the public.
- f. Up to September 2016, 14 issues of the TC Journal *Tropical Cyclone Research and Review (TCRR)* have been published (since 2012) with more than 79,000 downloads from the website. Two visiting editors from USA and Thailand were invited to STI in October 2016 to provide guidance of improving the editorial procedures, reviewing articles and inviting articles, and the first editorial board meeting was held in Shanghai on 21 October 2016.
- g. The NTC/KMA conducted another technology transfer of TAPS to PAGASA in the Philippines between 13-14 October 2016. During the visit, introduction and demonstration of TAPS as well as installation of the system on forecaster's computers were carried out.
- h. Performance of tropical cyclone track and intensity forecasts from operational forecast agencies and deterministic NWP models in 2015 was evaluated by STI. Real-time verifications on track and intensity forecasts are provided routinely through WMO-TLFDP website. STI/CMA hosted the TLFDP-III project meeting in Shanghai between 20-21 October 2016 with coordination of WMO, and a two-month research fellowship was offered to two experts from DPRKA between October and November 2016.
- i. RSMC Tokyo relaunched the Numerical Typhoon Prediction (NTP) website in May 2015 and provided a variety of tropical cyclone products including ensemble tropical track guidance of ECMWF, NCEP and JMA. Multiple-center grand-ensemble (MCGE) for tropical cyclone prediction was examined and two-day and five-day prediction maps were included in the NTP web site from June 2016.
- j. The New Generation of TRAMS (NG-TRAMS), which includes a 3-D reference atmosphere scheme and the coupling of dynamic and physical processes, was developed by CMA in 2016.
- k. The website of RFSC-Ha Noi of SWFDP for Southeast Asia continued to improve and provide global and regional (ensemble) NWP forecast products as well as guidance products. The domain of the regional models will be extended to cover Philippines and Myanmar.
- l. A technical meeting on the development of regional radar network was held in November/December 2016 in Japan between JMA and TMD experts in Thailand to discuss issues on quality management, algorithm for developing QPE product and further utilization as well as sharing of radar data.
- m. Literature review (including non-English papers) and discussion for the 3rd Assessment Report on the impact of climate change on tropical cyclones in TC region were carried out by the Members in 2016. A survey and an expert symposium will be held in 2017.
- n. The storm surge prediction system developed by JMA continued to run and more stations were added. Maximum storm surge forecast for up to 6 scenarios (official forecast plus 5 scenarios from Typhoon EPS model) were provided in 2016.
- o. For EXOTICCA, STI carried out the field campaign on 3 target typhoons – Meranti (1614), Megi (1617) and Sarika (1621) in East China coastal area together with Zhejiang and Fujian Meteorology Service, while HKO carried out the field campaign on monsoon depression on 26 May, tropical depression on 26 July, typhoon NIDA on 1 August, low pressure area on 16 August, and the TS Dianmu on 18 August. With coordination from HRD, STI/CMA finished the experimental study on the preliminary evaluation of the first rocket-deployed dropsonde

- observation in STY Mujigae (2015).
- p. RSMC Tokyo drafted and updated the zero draft of the tropical cyclone forecasting competency based on the input and feedback from WGM Members. Members were also invited to nominate a focal point, preferably a tropical cyclone forecaster, for this project.
 - q. RSMC Tokyo drafted the final report for harmonization of tropical cyclone intensity analysis and circulated to CMA, HKO, JTWC for their feedback. A list of recommendations was provided and TC Members are encouraged to follow with their own efforts and/or through collaborative efforts under TC.
 - r. The quality of observation data and spatial distribution from Nansha Observation Area, Xisha Observation Area and Hainan Observation Area of China were assessed and re-processed. A new method was developed to estimate the intensity of tropical cyclones over central SCS and make landfall in the southern part of China or northeastern part of Viet Nam and the performance was compared to using the Dvorak technique and satellite data.
 - s. Based on the discussion on the action plans for 2017 during the 11th IWS, it was concluded to adopt the action plans as follows:
 - i. The POP items 1-5 will continue in 2017.
 - ii. The AOP items 1-8 will continue in 2017.
 - iii. The PP item 1 will be closed in 2017.
 - iv. The PP item 2 will continue in 2017 as item 1.
 - v. A new PP item 2, Collaborative Discussion (CoDi) platform on tropical cyclone (TC) analysis and forecast organized by CMA and HKO, will be established in 2017.
 - t. The total budget proposed by WGM, which was also concurred at the AWG meeting after the 11th IWS, for undertaking the actions plans (AOPs, POPs and PPs) in 2017 was US\$21000. The financial support of US\$5000 for EXOTICCA OC meeting (workshop), and US\$5000 for TCRR expert team meeting will be allocated through the “Special funding request”.

5. Future Directions and Strategies

- a. Intensify the field campaign on tropical cyclone in TC region, jointly carry out a special scientific experiment on the difficulty (hard to forecast) but important issues. For example, the structure and intensity changes of tropical cyclone in the coast area and landfall in TC region.
- b. Develop high resolution typhoon model and reinforce the forecast ability of intensity, wind (gale) and quantitative precipitation.
- c. Reinforce the research of techniques for medium and long range forecasting of TC, evaluate and recommend the short-term climate prediction techniques of TC.
- d. Strengthen the cooperation with WGH and WGDRR towards evaluation of TC impact and risk management.
- e. Enhance the collaboration with TRCG towards the exchange of latest developments and techniques related to tropical cyclone research and operational forecast, as well as the effectiveness of typhoon early warning system.
- f. Improve the quality and influence of the TC journal Tropical Cyclone Research and Review (TCRR).

6. Recommendations

On the basis of the outcomes of the WGM parallel session at the 11th IWS in Cebu, Philippines and subsequent discussion, the WGM made the following recommendations:

- a. To request RSMC Tokyo and the WMO Regional Training Center (RTC) of Nanjing to continue the collaboration with TRCG and WGM to conduct the annual training for operational forecaster from TC Members.
- b. To request KMA to further develop the techniques of typhoon seasonal prediction, and to provide the products of typhoon seasonal prediction for TC Members.
- c. To request CMA and TCS to invite TC Members to assign staff as moderators of the web-based typhoon forum, to announce the forum in TCS Facebook page to attract the public to join the forum, and to make the forum serve as an exchange platform of real-time information (extra observations data, forecast products, pictures, video etc.).
- d. To request CMA to call for more contributions to the TC Journal *Tropical Cyclone Research and Review (TCRR)* from TC Members and Working Groups. The contributions can include technical summaries and operation innovations, research results associated with Strategic Plan and AOP, and other research results and summaries.
- e. To request KMA to train the typhoon forecasters of TC Members on the use of TAPS upon request, and provide follow-on technical assistance on the implementation of TAPS.
- f. To request CMA to continue post-season verification and reliability analysis on the operational forecasts of tropical cyclones, to provide real-time verification on tropical cyclone track and intensity through WMO-TLFDP website, and to further improve the evaluation system for tropical cyclone forecast in conjunction with WMO-TLFDP (to be included in the TC Fellowship Scheme).
- g. To request RSMC Tokyo to provide tropical cyclone genesis guidance of other global ensembles if necessary NWP data are available.
- h. To request CMA to increase model products and enhance the application of TRAMS, and to further improve the forecasting ability of TRAMS, especially for the intensity and precipitation forecasting.
- i. To request NHMS of Vietnam to provide tropical cyclone track, intensity and severe weather forecasting charts based on global and regional NWP models, to extend forecast domain of regional NWP models to cover the east sea of Philippines and Myanmar.
- j. To request TMD to update quality control techniques applied to TMD and MMD radar network, to introduce the calibration process for QPE into operation of TMD radar with assistance of JMA, to continue experimental test of radar data sharing among JMA, TMD and MMD, and to share the experiences of the test with the RA II WIGOS radar project in southeast Asia.
- k. To request SMG to collaborate with TCS to conduct a survey on tropical cyclone impacts in TC region, and to organize an expert meeting in 2017.
- l. To request JMA to provide astronomical tide estimate for stations in which the information is not available, to add storm surge time series to prediction points on the request of TC

- Members, and to verify storm surge predictions.
- m. To request CMA and HKO to implement the EXOTICCA field campaign collaboration among participating Members, to demonstrate research on tropical cyclone intensity change in conjunction with WMO-TLFDP (to be included in the TC Fellowship Scheme).
 - n. To request RSMC Tokyo to set up a task team to review and finalize the draft tropical cyclone forecast competency, and to organize a task team meeting if funds are available.
 - o. To request CMA to develop wind structure estimation method based on available surface observations.
 - p. To endorse the action plans in 2017 (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 11th IWS**, which summarizes the above recommendations with additional action items.
 - q. To endorse the WGM budget request included in the budget proposal to be submitted by AWG for TC's approval.
 - r. To re-appoint Dr. Lei Xiaotu (China) as the Chair of WGM, Dr. Vincente B. Malano (Philippines) and Ms. Che Gayah Ismail (Malaysia) as Vice-chair of WGM.

Appendix III

Summary Report of WGM Parallel Meeting at the 11th IWS

Summary report on the WGM parallel meeting of 11th integrated workshop

Cebu, the Philippines

25-26 October 2016

1. Background

- The WGM Parallel Meeting of the 11th Integrated Workshop (IWS) was held on 25–26 October 2016 in Waterfront Cebu City Hotel and Casino, Cebu of the Philippines, which was attended by 33 participants from 14 UNESCAP/WMO Typhoon Committee (TC) Members (Cambodia; China; DPR Korea; Hong Kong, China; Japan; Lao PDR; Macao, China; Malaysia; Philippines; Republic of Korea; Singapore; Thailand, United States of America and Viet Nam). Representatives from TCS, AWG, WMO/TCP and UNESCAP also attended the Meeting.
- 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.

2. Organization of the Meeting

- The Meeting firstly reviewed the progresses of Members on meteorological component, the progresses of POPs, AOPs and PPs in 2016, then followed by the discussions on the priority plans for 2017 including the new project proposals and the associated budget for each action plan.

3. Progress of Members on meteorological component in 2016

- The Meeting reviewed the progress of Members on meteorological component since the 48th TC Session in 2016 presented by the respective focal points.
- Members have made important progress in the implementation of the TC Strategic Plan during the year 2016.
- Members made significant progress during 2016 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.

- Coordinated with TCS to improve the TC website and set up a new portal site (<http://www.typhooncommittee.org/member-products.html>) to share forecast products and information as proposed by AWG and to serve as a platform for the Members and provide better support.
- Coordinated with TRCG to host 2016 research fellowships. So far, three experts visited NTC/KMA to attend the training course on TAPS operations between 1-14 May, 2016. One expert visited HKO as the research fellow to undertake the research on tropical cyclone size climatology from October to December 2016. And two experts (Mr. Pak and Mr. Kim) from DPRK will visit STI as the research fellow to undertake the research project “tropical cyclone genesis forecast technique” of STI fellowship offer in November.
- CMA coordinated with TRCG to host a training programme on typhoon monitoring analysis and NWP, four experts (one from Viet Nam, one from Thailand and two from DPRK) visited NMC/CMA and attended the training between 10-19 October, 2016.
- STI/CMA coordinated with WMO Regional Training Center (RTC) of Nanjing to host the international training course on tropical cyclone from 21 November to 2 December, 2016. The course topic is “Improving operational forecast to mitigate tropical cyclone hazards”
- NTC/KMA coordinated with STI/CMA to organize the 9th China-Korea joint workshop on the tropical cyclones, held in Republic of Korea during 16-20 May, 2016.
- STI/CMA coordinated with TCS to edit and publish the Typhoon Committee Journal “Tropical Cyclone Research and Review”, No. 1-3 of Vol. 4.
- RSMC Tokyo coordinated with TRCC, TCS, and WMO secretariat to host the 16th Typhoon Committee Attachment Training course at the RSMC Tokyo — Typhoon Center from 15 to 26 August 2016.

4. Progress of WGM action plans (POPs, AOPs and PPs) in 2016

- The Meeting reviewed the progress and the results of all the priority plans (including 5 POPs, 8 AOPs and 2 PPs) since the 48th TC Session as well as the action plans in 2016 presented by the respective coordinators, which were reported as shown in bullet 4.1 to 4.15 (including new AOPs and PPs). The Implementation status of WGM Action plans in 2016 including the actions and the completion status; and the action plans in 2017 are listed in **Annex I and Annex II** respectively.

4.1 POP1: Development of typhoon seasonal prediction system

- KMA has provided the seasonal typhoon activity prediction results for the summer and fall of 2016 through the website for TC members. (<http://gtaps.kma.go.kr/TSP/index.php>). The information about the number of typhoon genesis and track pattern is produced based on the results of three types of models: multi-regression model, global dynamical model, and hybrid model of statistical and dynamical methods. Users can find a variety of information about the tropical seasonal prediction on the website, including prediction products, model information, model verification, and climate monitoring.
- The summer typhoon activity outlook was issued in 30 May. According to the summer outlook, 7-10 typhoons would be generated in the Northwest Pacific and passage frequency would be above normal over east of the Philippines and China, and below normal in the South China Sea. The fall typhoon activity outlook was issued on 25 August. According to the fall outlook, 8-12 typhoons would be generated in the Northwest Pacific and passage frequency would be above normal over east of Japan and below normal over east of Philippines and China.

4.2 POP2: Web-based typhoon forum

- STI/CMA has run the web-based typhoon forum (<http://www.typhoon.gov.cn/en/bbs>) routinely.
- As a convenient platform for forecasters and scientists to discuss typhoon-related topics online, additional information such as tropical cyclone real-time information, forecast and its verification, similar historical cases, and seasonal prediction products are available in the Forum by linking to WMO-TLFDP (<http://tlfdp.typhoon.gov.cn>) and POP1 website (<http://typ.kma.go.kr/eng>).
- Up to September 2016, there are 65 users from 11 Members in the forum.
- STI/CMA coordinated with TCS and invited Mr. Clarence Fong, the meteorological expert of TCS, to visit STI in April 2016 to prepare for migrating the forum to TC website and linking with operational websites of Members, in order to expand the information contained in the Forum as well as encourage more scientists and forecasters to join the Forum.

4.3 POP3: Tropical Cyclone Research and Review (TCRR)

- With coordination from TCS, the editorial office of TCRR and Shanghai Typhoon Institute (STI) of China Meteorological Administration (CMA) continue to make effort to maintain and update the TCRR website, and send hard copies of the Journal to TC Members, WMO and related research institutes.
- Up to September 2016, 14 issues (hard copies and online versions) of the Journal have been published since its launch (in 2012), which comprise 92 articles submitted

by authors from Typhoon Committee Members and non-Members, including Australia, India, Oman, Germany and Russia. More and more experts voluntarily submit their contributions to the Journal.

- The TCRR editorial office has made their effort in promoting the Journal, which includes posting publication news on Tropical-storms mailing list and distributing brochures and compact discs while attending international meetings. According to TCRR official web (<http://tcrr.typhoon.gov.cn>) statistics, our readers spread over 100 countries and regions. More than 79,000 downloads were recorded with an average of 775 for each article, which reflected that the Journal was getting more recognition. Statistics shows that the journal is attracting attention from a wide range of readers and the Journal is under the process of Science Citation Index application.
- Two visiting editors from the University of Hawaii USA (Dr. Yi-Leng Chen) and Thailand (Mr. KamolPronasakhanaSakolnakhon) were invited to visit the editorial office in STI in October 2016 to provide guidance of improving the editorial procedures, reviewing articles as well as inviting articles to be submitted to the Journal.
- 11 new editors accepted our invitation, including Frank Marks (the director of HRD), Robert Rogers, Peter Black, Jun Zhang, Jong-Dao Jou, Zhemin Tan, Peter Otto, Kevin Cheung, Shishir K. Dube, U.C. Mohanty and M.Mohapatra.
- The first editorial board meeting was held in Shanghai China on 21 October, 2016. During the meeting the following issues were addressed: a) How to catch up with the publishing schedule; b) Lack of contributions; c) Encourage forecasters, disaster managers, and researchers to submit articles to TCRR; d) Request TC members to collect articles for TCRR, particularly encourage forecasters to write short articles and communications on interesting events related to tropical cyclone; and e) Encourage publication of short notes (one to two pages) and interesting pictures.

4.4 POP4: Transfer of the Technology of the Typhoon Analysis and Prediction System (TAPS)

- Since 2011, NTC/KMA has been transferring technology of TAPS (including training course for typhoon forecasters) to TC Members who requested support for the operational forecasting of tropical cyclones. In 2016, NTC/KMA carried out another technology transfer to the staff of PAGASA in the Philippines from 13 to 14 October, 2016. The technology transfer included three lectures and practice classes which showed the typhoon forecast process and structure of TAPS.
- During the visit, KMA staff introduced TAPS and other related programs such as TAPS data supporting system, and helped the staff install TAPS on each computer and perform demonstration of typhoon forecasts using TAPS.

4.5 POP5: Verification of tropical cyclone operational forecast

- Forecasts in 2015 for tropical cyclone track, intensity and genesis from operational forecast agencies, deterministic subjective NWP models and ensemble systems were evaluated and the results were reported in the 48th Session of Typhoon Committee (TC) in February 2016.
- Real-time verifications on track and intensity forecasts are provided routinely through WMO-TLFDP website.
- Comments were submitted to the authors of the WMO document “Verification of tropical cyclone forecasts” (by JWGFVR), with special attention given to increase the visibility of related efforts in the western North Pacific region. This document has been published and is available on the website of the WMO (http://www.wmo.int/pages/prog/arep/wwrp/new/documents/WWRP2009-1_web_C_D.pdf).
- With coordination from WMO (TCP and WWRP), STI/CMA hosts the TLFDP-III project meeting and joint workshop of TFLDP and UPDRAFT project in Shanghai during 20-21 October, 2016.
- STI/CMA will host a two-month research fellowship between October and November 2016 for two experts from DPRK, as jointly funded by TC and STI/CMA.

4.6 AOP1: Enhanced use of ensemble forecast

- RSMC Tokyo began providing two- and five-day Tropical Cyclone Activity Prediction Maps using the ECMWF and UKMO ensembles at the Numerical Typhoon Prediction (NTP) website in June 2016. The products are updated twice a day and show the probability that TCs that exist and/or generate during the above-mentioned forecast time windows (within a 300-km distance from a certain location). The probability is calculated based on each ensemble and a combination of the two ensembles (i.e., multi-model grand ensemble).
- Note that ensemble TC tracking data are provided from each NWP Center and that the TC tracking algorithms differ by the Centers.
- To explore the potential of TC intensity prediction using ensembles, the Coupled Hurricane Intensity Prediction System (CHIPS), which is a simplified axisymmetric TC model combined with a 1D ocean model using TC surrounding parameters including SST and vertical wind shear as its input data, was tested. Through a verification study using the TIGGE archive for a period from 2012 to 2014, the consensus (ensemble mean) of the multiple CHIPS predictions is found to provide

better forecast skills than that of single model-based predictions in general. However the ensemble means of CHIPS do not necessarily predict TC intensity change well and the ensemble spreads do not well capture uncertainty of TC intensity predictions.

4.7 AOP2: Improvement of South China Sea typhoon forecast

- The New Generation of TRAMS (NG-TRAMS), which includes a 3-D reference atmosphere scheme and the coupling of dynamic and physical processes, was developed by CMA in 2016.
- The 24-, 48- and 72-hour track error of NG-TRMAS were 66, 128 and 224 km, respectively.
- CMA carried out a field-comprehensive observation experiment on super typhoon Nida upon landing from July 31 to August 3, 2016 with the coordination of Guangdong Meteorological Bureau, Chinese Academy of Meteorological Sciences, Nanjing University and Guangzhou Institute of Tropical and Marine Meteorology.

4.8 AOP3: Implementing Roles of RFSC Ha Noi in SE Asia

- RSFC Ha Noi continues its functions in 2016, including: 1) Implementing SWFDP-SeA website; 2) Sharing global and regional NWP products (both deterministic and ensemble); 3) Sharing observations over the Southeast Asia domain, including satellite data and satellite-based products; and 4) Issuing operational 1-5 day guidance for heavy rainfall and strong wind.
- Further plans: 1) Extend the regional model running domain to cover the Philippines and Myanmar; 2) Implement the deterministic regional modelling system based on WRF/COSMO model with finer resolution (2-5 km); 3) Perform verification for the regional NWP products; and 4) Join AOP2 (Improvement of South China Sea typhoon forecast) and AOP4 (Development of regional radar network) if possible.

4.9 AOP4: Development of regional radar network

- Thai Meteorological Department (TMD) reported its progress of development of nationwide radar composite map using the JMA's quality control technique. In addition, a technical meeting between TMD and JMA was held in November to discuss remaining technical issues related to quality control as well as application of the JMA's QPE algorithm and the plan in 2017. It also recognized the need for future expansion of this project to Members of interest such as Viet Nam, the Philippines, and Lao P.D.R.
- Radar data exchange experiment was conducted in 2016 among MMD, TMD and JMA in accordance with the agreed data policies. Joint RA II/RA V WIGOS radar

data projects will be developed based on the current RA II/RA V projects led by Malaysia and Thailand. The regional WIGOS implementation plan will be discussed in the 16th Session of RA II (February 2017).

4.10 AOP5: Assessment report on the impact of climate change on tropical cyclone in TC region

- Members carried out literature review and discussion for papers, including non-English papers. Each Member would be responsible for writing some chapters in the 3rd assessment report.
- A survey will be conducted on tropical cyclone impacts in Typhoon Committee region in 2017.
- An expert symposium will be held in October-December 2017.

4.11 AOP6: Storm surge watch scheme

- RSMC Tokyo began providing, in addition to a storm surge prediction based on TC official forecast, those of five different TC scenarios derived from Typhoon EPS (TEPS) 25 members. In addition, maximum storm surges among the above 6 scenarios during the entire forecast period are provided.
- 17 stations in Malaysia were added for time series chart on 26 Jan 2016. In addition, the storm surge model began running daily on an experimental basis on 28 Jan 2016, to support the provision of predictions for storm surges generated by monsoon winds or extra-tropical cyclones.
- RSMC Tokyo began providing week-range wave forecasts on 27 August 2016. The new products are based on the output of a global Wave Ensemble System (WENS), which covers most of the globe and has a 1.25-degree grid resolution. It runs once a day at 12 UTC and predicts ocean wave conditions up to 264 hours ahead with 27 members.
- Annual verification results of the storm surge products are to be regularly published in Annual Report on Activities of the RSMC Tokyo. Verification in 2015 were conducted at stations where tide observations are available in University of Hawaii Sea Level Center (UHSLC) database. Members are encouraged to provide tidal observations during storm surge events for verification of the storm surge predictions.

4.12 AOP7: Contribution for the Experiment on Typhoon Intensity Change in Coastal Area (EXOTICCA)

- The 2016 kickoff meeting of EXOTICCA-China was held in Beijing on May 31. During this meeting, CMA organized all the participants of China to discuss the details of 2016 field experiment. The topics included experiment chart, scientific objective, experiment area, observation instruments and experiment funding.
- EXOTICCA-2016 contains two experiment areas (South/East China Sea). STI carried out the field campaign on 3 target typhoons – Meranti (1614), Megi (1617) and Sarika (1621) in East China coastal area together with Zhejiang and Fujian Meteorology Service.
- HKO conducted reconnaissance flights over the South China Sea in 2016 for a monsoon depression on 26 May, tropical depression on 26 July, Typhoon Nida (1604) on 1 Aug, a low-pressure area on 16 Aug and Tropical Storm Dianmu (1608) on 18 Aug. Trial of the new dropsonde measurement system using a new jet aircraft was conducted for Typhoon Megi on 27 Sept 2016.
- In coordination with HRD, STI/CMA finished the experimental study on the preliminary evaluation of the first rocket-deployed dropsonde observation in STY Mujigae (2015), the article would be submitted soon.
- The demonstration research on the target typhoon (Mujigae) intensity change analysis using the cooperative experimental observation data by STI/CMA in collaboration with HKO and WMO TLFDP was in progress.
- A joint workshop with WMO TLFDP and UPDRAFT was held in Shanghai on 21 Oct 2016 to discuss the coordination amongst the three Projects including the data collection, data policy and research development of NWP models in TC intensity and rainfall forecasts.
- The Terms and Conditions of EXOTICCA for participating members was revised and submitted for discussion during the 11th IWS of TC.

4.13 AOP8: Development of tropical cyclone forecasting competency

- RSMC Tokyo explained that TC forecast competency is essential for 1) defining what is required to do the job, 2) developing the most appropriate training and 3) demonstrating forecasters can do the job.
- RSMCs Honolulu and Tokyo prepared and circulated the draft version of Tropical Cyclone Forecast Competency in the Typhoon Committee Region.
- To facilitate this process, the meeting discussed and agreed that the proposal of RSMCs Tokyo and Honolulu that a task team meeting is to be organized, in 2017, 1)

to review the competency for its finalization, and 2) to discuss how to utilize this competency for capacity developments (e.g. training) in the region.

4.14 PP1: Harmonization of tropical cyclone intensity analysis

- RSMC Tokyo reported that, on 19 October 2016, the draft final report of this project was circulated to CMA, HKO, and JTWC for their feedback by 30 November. The draft is to be finalized by the end of 2016 for submission to the session of the Typhoon Committee.
- The Center also explained that identified major causes of discrepancies in CI numbers among the Centers were 1) Final T-number constraints during rapid intensification, 2) Current Intensity Number Rules (Landfall Rules), 3) Erroneous interpretation and/or measurements of Dvorak parameters, and 4) Difference in measurements of Dvorak parameters for eye patterns. A set of recommendations included in the draft was explained by RSMC Tokyo and TC Members were encouraged to follow them with their own efforts and/or through collaborative efforts under TC.
- The project completed its mission and is to be closed.

4.15 PP2: Available data used in operational tropical cyclone analysis

- The available surface observations in the South China Sea (SCS) were investigated, including the Xisha and Nansha islands automatic weather stations (AWS), offshore islands AWS, oil platforms, buoys and shipboard AWS meteorological data.
- The quality of those observation data and spatial distribution were assessed, and then a re-processing method is developed to uniform and rectify original data which might include location migrations and altitude discrepancies.
- A new method is developed to estimate the intensity of those TCs that entering the middle part of the SCS and make a landfall in the southern part of China or north-eastern part of Vietnam. Besides traditional Dvorak technique based on meteorological satellite data, that method could be served as an objective and non-routine estimation which leads to reliable intensity analysis. An evaluation and errors distribution are given compared to the CMA best tracks data. Using such method, the intensity of tropical cyclone KIJIRA is estimated. The results show that both of estimated VMAX and MSLP of KIJIRA based on observation data are stronger than subjective and objective analyses using Dvorak technique and satellite data.
- Cases study manifests the value of such ocean-based observations in operational

intensity and structure analysis.

5. Conclusions and the proposed action plans for 2017

On the basis of the information provided by Members and the respective coordinators of the action plans and based on the discussions during the Meeting, the following conclusions were reached:

- a. Members have made important progress in the implementation of the TC Strategic Plan during the year 2016.
- b. Members made significant progress during 2016 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 2016.
- d. Based on the discussion on the action plans for 2017 during the 11th IWS, it was concluded to adopt the action plans as follows:
 - i. The POP items 1-5 will continue in 2017.
 - ii. The AOP items 1-8 will continue in 2017.
 - iii. The PP item 1 will be closed in 2017.
 - iv. The PP item 2 will continue in 2017 as item 1.
 - v. A new PP item 2, collaborative discussion platform on tropical cyclone analysis and forecast, will be established in 2017.
- e. The total budget proposed by WGM, which was also concurred at the AWG meeting after the 11th IWS, for undertaking the actions plans (AOPs, POPs and PPs) in 2017 was US\$21000. The financial support of US\$5000 for EXOTICCA OC meeting (workshop), and US\$5000 for TCR expert team meeting will be allocated through the “Special funding request”.
- f. The complete WGM 2017 action plans (AOPs, POPs and PPs) including the actions, the success indicators, coordinators and budget is listed in [Annex II](#).

6. Recommendations

The Committee took note of the outcomes of the WGM Parallel Meeting at the 11th IWS and to endorse the proposed WGM 2017 action plans and the associated budget (subject to some follow-up revisions) at the 49th Session.

7. Closing

The Chair of WGM, Dr. Lei xiaotu, expressed his thankfulness to all the participants for their interactions and input during the Meeting as well as the assistances of Mr. Vicente Malano, Mr. Herzon G. Koro and Mr. Clarence Fong to chair the part of the Meeting. He also thanked all the coordinators for their significant efforts to implement the action plans in 2016

as well as the collaboration all the WGM focal points. In addition, thanks also expressed to the Members for their support of the WGM actions and the offer of the Fellowship to the TC Members.

With no other business, the Meeting closed at 12:30 on 26 October 2016.

Annex I:

Status of Perennial Operating Plans (POPs) of WGM in 2016

SP's KRA & SG	No.	Objective	Action	Success Indicators	Funding (Req. & S.)	Organizer	Participants	Coordinator	Status of Completion
KRA1 KRA2 KRA6	1	Development of typhoon seasonal prediction system	(a) To further develop the techniques of typhoon seasonal prediction (b) To provide the products of typhoon seasonal prediction for TC Members	Submission of the progress report	/	KMA	/	Nam-Young Kang (KMA)	YES
KRA 6 SG 6b SG 6c	2	Web-based typhoon forum	(a) To run routinely (b) Upgrade the forum and open for public (meteorologists) upon request (c) Link to TC website and operational website of Members	Submission of the progress report	/	TCS, CMA	Members	Clarence Fong (TCS) Lu Xiaoping(CMA)	YES
KRA 1 - 6	3	Tropical Cyclone Research and Review	(a) To publish the journal quarterly in 2016 (b) Improvement of the editorial procedure and the journal's influence (includes inviting 2-3 visiting editors) (c) Enlarge the editorial board and hold a editorial board meeting	Submission of the progress report	\$5,000 (plus \$5,000 special funding for editorial board meeting)	CMA	Members	Wang Dongliang, Zhou Xiao (CMA)	YES
KRA 1 KRA 2 KRA 6 SG 6b SG 6c	4	Transfer of the Technology of the Typhoon Analysis and Prediction System (TAPS)	(a) To train the typhoon forecasters on the use of the TAPS upon Member's request (b) To provide follow-on technical assistance to Members on the implementation of TAPS	Submission of the progress report	US\$5,000	KMA	Members	Nam-Young Kang (KMA)	YES
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 in Committee Session (b) To provide the real time verification information on track and intensity forecast through WMO-TLFD website	(a) Submission of the post-season verification report (b)Progress report on the improvement of evaluation system	US\$3,000	CMA	HKO Members	Yu Hui (CMA)	YES

			(c) To further improve the evaluation system for tropical cyclone forecast and conjunction with WMO-TLFDP (to be included in the TC Fellowship Scheme) (d) To offer fellowship for training on (b	for tropical cyclone forecast					
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Status of Annual Operating Plans (AOPs) of WGM in 2016

SP's KRA & SG	No.	Objective	Action	Success Indicators	Funding (Req. & S.)	Organizer	Participants	Coordinator	Status of Completion
KRA 1 KRA 2 KRA 6 SG 6b SG 6c	1	Enhanced use of ensemble forecast	(a) To provide ensemble TC genesis guidance if necessary NWP data are available. (b) To examine the potential of global ensemble models for TC intensity forecast guidance using TIGGE datasets..	(a) Provide ensemble TC genesis guidance if necessary NWP data are available. (b) Report progress of developments of TC intensity forecast guidance using TIGGE datasets.	/	JMA	/	Chiashi Muroi (JMA)	YES
KRA1 KRA2 KRA6	2	Improvement of South China Sea typhoon forecast	(a) Further improvement of TRAMS-9km model (b) Provide TRAMS-9km products relate to typhoon assess through website	Submission of the report on the assessment of model and website	/	CMA	Viet Nam, PAGASA, MMD	Chen Zitong (CMA)	YES
KRA1 KRA2 KRA6	3	Implementing roles of RFSC-Ha Noi in SWFDP for South East Asia	(a) Providing tropical cyclone track and intensity and severe weather forecasting charts based on available global and regional NWP models (b) Collaborating with RMSC Tokyo to release the suitable guidance in case of TC activity over the SouthEast Asia domain (c) Fully updating Himawari-8	Progress report	/	Viet Nam	Cambodia, Lao PDR, Thailand, Philippines, RSMC-Tokyo	Vo Van HOA (Duc TIEN NHMS of Viet Nam)	YES

SP's KRA & SG	No.	Objective	Action	Success Indicators	Funding (Req. & S.)	Organizer	Participants	Coordinator	Status of Completion
			<p>images on SWFDp webpage</p> <p>(d) Updating storm-tracking products based on: i) new satellite products and testing the very short range warning capabilities of this product and ii) improving convective detection with JMA's algorithms</p> <p>(e) Extending forecasting domain of regional NWP model in order to cover the east sea of Philippines</p>						
KRA1 KRA2	4	Development of regional radar network	<p>(a) Increase in a number of TMD radar sites, including dual-polarization weather radars, used for the operational radar composite map with the JMA's quality management technique.</p> <p>(b) Application of radar data calibration techniques for QPE by TMD with technical assistance of JMA.</p> <p>(c) Experimental test of radar data sharing among JMA, TMD, and MMD.</p> <p>(d) Submission of a progress report by TMD (item a, b). Upon the receipt of the report, holding a follow-up technical meeting at JMA or TMD to identify a way forward.</p>	<p>(a) & (b) Submission of the progress report</p> <p>(c) Submission of the progress report by involved countries</p>	US\$4,000	TMD	MMD, JMA	<p>Lucia Enggong (MMD)</p> <p>Patchara Petvirojchai (TMD)</p> <p>Chiashi Muroi (JMA)</p>	YES

SP's KRA & SG	No.	Objective	Action	Success Indicators	Funding (Req. & S.)	Organizer	Participants	Coordinator	Status of Completion
KRA 1 KRA 2 KRA 4	5	Assessment report on the impact of climate change on tropical cyclone in TC region	(a) Accumulate findings from CMIP5 results and Event Attribution (EA) studies (b) Summarize and assess related research emerges (c) Collect data of progress of work (d) Make a draft of outline	Submission of the progress report	/	Macao (China)	CMA, HKO, USA, JMA, KMA	Lao Wai Ieng (SMG)	YES
KRA 1 KRA 2 KRA 4 SG4(a)	6	Storm surge watch scheme	(a) To provide multiple scenarios of storm surge predictions and ensemble one-week ocean wave predictions to TC Members from TY season in 2016. (b) To add storm surge time series prediction points if so requested by Members. (c) To verify storm surge predictions if tidal data during storm surge events are available.	(a) Provide multiple scenarios of storm surge predictions and ensemble one-week ocean wave predictions. (b) Add stations for storm surge time series if so requested by Members. (c) Report verification results if tidal data during storm surge events are provided.	/	JMA	/	Chiashi Muroi (JMA)	YES
KRA1 KRA2 KRA6	7	Contribution for the Experiment on Typhoon Intensity Change in Coastal Area (EXOTICCA)	(a) To implement the field campaign collaboration among participating Members by using aircraft drop-sondes, mobile GPS radio-sondes and rocket drop-sondes. (b) Demonstration research on tropical cyclone intensity change conjunction with WMO-TLFDP (to be included in the TC Fellowship Scheme).	(a) Carry out the field campaigns and gather the special observation data of 1-2 target typhoon (b) Submission of the progress report	US\$5,000 (special funding)	CMA, HKO	Participant Members (KMA, TM D)	LEI Xiaotu (CMA) Wai-Kin Wong (HKO)	YES

SP's KRA & SG	No.	Objective	Action	Success Indicators	Funding (Req. & S.)	Organizer	Participants	Coordinator	Status of Completion
KRA 1 KRA 2 KRA 4	8	Development of tropical cyclone forecasting competency	(a) To circulate and update the zero draft TC competency based on inputs/feedbacks from WGM Members and discussion at the 8th RSMC/TCWC coordination meeting. (b) To finalize the draft if so agreed by WGM Members.	Report an updated TC competency	/	RSMC-To kyo, RSMC-H onolulu	Members (interested in this project)	Chiashi Muroi (RSMC-Tokyo) Raymond Tanabe (RSMC-Honolulu)	YES

Status of Preliminary Projects (PPs) of WGM in 2016

SP's KRA & SG	No.	Objective	Action	Success Indicators	Funding (Req. & S.)	Organizer	Participants	Coordinator	Status of Completion
KRA 1 KRA 2 KRA 4 SG4(a)	1	Harmonization of Tropical cyclone intensity analysis	(a) Continue cyclone by cyclone comparison analysis of CI numbers. (b) Identify reasons for CI number differences between CMA, HKO, JTWC, and RSMC Tokyo.	Submission of the progress report	/	JMA	CMA, HKO	Chiashi Muroi (JMA)	YES
KRA 1 KRA 2 KRA 4 SG4(a)	2	Available data used in operational tropical cyclone analysis	(a) To investigate the available data in TC region (b) To assess the quality of the available data and try to develop the techniques to use them in operational tropical cyclone (intensity and track) analysis.	Submission of the progress report	/	CMA	Members (interested in this project)	Qian Chuanhai (CMA)	YES

Annex II:

Perennial Operating Plans (POPs) of WGM in 2017

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	/	Nam-Young Kang (KMA)	Continued (2015-)
KRA 6 SG 6b SG 6c	2	Web-based typhoon forum	(a) To run routinely (b) Upgrade the forum and open for public (meteorologists) upon request (c) Link to TC website and operational website of Members	Submission of the progress report	/	TCS, CMA	Members	Clarence Fong (TCS) Lu Xiaqing(CMA)	Continued (2013-)
KRA 1 - 6	3	Tropical Cyclone Research and Review	(a) To publish the journal quarterly in 2016 and 2017 (b) Improvement of the editorial procedure and the journal's influence (includes inviting 2-3 visiting editors)	Submission of the progress report	US\$5,000	CMA	Members	Wang Dongliang, 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	Nam-Young Kang (KMA)	Continued (2014 -)
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 in Committee Session (b) To provide the real time verification information on track and intensity forecast through WMO-TLFD website (c) To further improve the evaluation system for tropical cyclone	(a) Submission of the post-season verification report for TC Session (b)Progress report on the improvement of evaluation	US\$3,000	CMA, HKO	Members	Yu Hui (CMA), Sai-Tick Chan (HKO)	Continued (2015 -)

			forecast and conjunction with WMO-TLFD (to be included in the TC Fellowship Scheme) (d) To offer fellowship for training on (b	system for tropical cyclone forecast					
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Annual Operating Plans (AOPs) of WGM in 2017

SP's KRA & SG	No.	Objective	Action	Success Indicators	Funding (Req. & S.)	Organizer	Participants	Coordinator	Status of Completion
KRA 1 KRA 2 KRA 6 /SG 6b and 6c	1	Enhanced use of ensemble forecast	(a) To verify skills of ensemble TC track and genesis guidance. (b) To provide TC genesis guidance of other global ensembles if necessary NWP data are available.	Provide verification results.	/	JMA	/	Chiashi Muroi (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 performance report of model	/	CMA	Viet Nam, PAGASA, MMD	Chen Zitong (CMA)	Continued (2012 -)
KRA1 KRA2 KRA6	3	Implementing roles of RFSC-Ha Noi in SWFDP for South East Asia	(a) Providing tropical cyclone track and intensity and severe weather forecasting charts based on available global and regional NWP models (b) Collaborating with RMSC Tokyo to release the suitable guidance in case of TC activity over the SouthEast Asia domain (c) Extending forecasting domain of regional NWP model in order to cover the east sea of Philippines and Myanmar if have enough computing resources	Progress report	/	Viet Nam	Cambodia, Lao PDR, Thailand, Philippines, RSMC-Tokyo	Vo Van HOA (Duc TIEN NHMS of Viet Nam)	Continued (2011 -)

SP's KRA & SG	No.	Objective	Action	Success Indicators	Funding (Req. & S.)	Organizer	Participants	Coordinator	Status of Completion
			(d) Providing verification of track and intensity forecast derived from available global and regional NWP models						
KRA1 KRA2	4	Development of regional radar network	<p>(a) To update quality control techniques applied to MMD and TMD radar networks to improve their quality of radar composites.</p> <p>(b) To introduce the calibration process for QPE into operation of TMD radar network with technical assistance of JMA.</p> <p>(c) To continue experimental test of radar data sharing among JMA, TMD, and MMD, and to share the experiences of the test with the RA II WIGOS radar project in Southeast Asia.</p> <p>(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.</p>	Submission of the progress report by involved Members	US\$6,000	TMD	MMD, JMA(Lao PDR, Viet Nam, Philippines to be confirmed)	Ambun Dindang (MMD) Patchara Petvirojchai (TMD) Chiashi Muroi (JMA)	Continued (2011 -)
KRA 1 KRA 2 KRA 4	5	Assessment report on the impact of climate change on tropical cyclone in TC region	<p>(a) Conduct a survey on tropical cyclone impacts in Typhoon Committee region.</p> <p>(b) Organize an expert meeting.</p>	Submission of the progress report	/	Macao (China)	CMA, HKO, USA, JMA, KMA	Lao Wai Ieng (SMG)	Continued (2014-)

SP's KRA & SG	No.	Objective	Action	Success Indicators	Funding (Req. & S.)	Organizer	Participants	Coordinator	Status of Completion
KRA 1 KRA 2 KRA 4 /SG4(a)	6	Storm surge watch scheme	(a) To provide astronomical tide estimated by a ocean model to all the stations where astronomical tide is currently not available. (b) To add storm surge time series prediction points if so requested by Members. (c) To verify storm surge predictions.	(a) &(b) submit progress reports. (c) Report verification results.	/	JMA	/	Chiashi Muroi (JMA)	Continued (2012-)
KRA1 KRA2 KRA6	7	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. (b) Demonstration research on tropical cyclone intensity change conjunction with WMO-TLFDP (to be included in the TC Fellowship Scheme).	(a) Carry out the field campaigns and gather the special observation data of 1-2 target typhoon (b) Submission of the progress report	US\$5,000 (special funding)	CMA, HKO	Participant Members (KMA,TMD)	LEI Xiaotu (CMA) WONG Wai-Kin (HKO)	Continued (2014-)
KRA 1 KRA 2 KRA 4	8	Development of tropical cyclone forecasting competency	(a) To set up a Task Team to review and finalized the draft TC forecast competency. (b) To hold a Task Team meeting if funds are available.	(a) & (b) submit a progress report		RSMC-Tokyo, RSMC-Honolulu	Members (interested in this project)	Chiashi Muroi (RSMC Tokyo) Raymond Tanabe (RSMC Honolulu)	Continued (2015-)

Preliminary Projects (PPs) of WGM in 2017

SP's KRA & SG	No.	Objective	Action	Success Indicators	Funding (Req. & S.)	Organizer	Participants	Coordinator	Status of Completion
KRA 1 KRA 2 KRA 4 SG4(a)	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)	Qian Chuanhai (CMA)	Continued (2015-)
KRA 4 KRA 6 SG6(a)	2	Collaborative Discussion (CoDi) platform on tropical cyclone (TC) analysis and forecast	(a) To set up a mailing list and web-based discussion platform to facilitate real-time exchange of information and assessments on tropical cyclone analysis and forecast among the forecasters and/or TC experts in Members. (b) To serve as a web-based knowledge portal containing resources on post-season analysis of TC and the best practices in TC analysis and forecast techniques, applications of satellites and enhanced observations for intensity estimation.	Submission of the progress report	/	CMA HKO	Members interested in this project	QIAN Chuanhai (CMA) WONG Wai-Kin (HKO)	To commence in 2017