

ESCAP/WMO Typhoon Committee
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USA

FOR PARTICIPANTS ONLY
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ENGLISH ONLY

**WORKING GROUP ON METEOROLOGY ACTIVITIES
ANNUAL REPORT 2015**

(Item 8 of Tentative Program for TC 48th 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 2015 as reported by Members at the 10th IWS
- (b) Review the activities of WGM conducted in 2015
- (c) Approve the recommendations and planned activities of WGM for 2016 and beyond.

APPENDICES:

- I. DRAFT TEXT FOR INCLUSION AT SESSION REPORT
- II. Report on activities of Working Group on Meteorology (WGM) of TC in 2015
- III. Summary Report of WGM Parallel Meeting at the 10th 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 2015 as reported by Members at the 10th 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 the outcomes of the parallel session of the WGM on 27-28 October 2015 (**Appendix III**). With the help of WMO/TCP and TCS, and the sincere cooperation of all Members, WGM has successfully completed the tasks in 2015 with the significant outcomes as follows:

- a. WGM has completed all the action plans (include 4 POPs, 9 AOPs and 3 PPs), which were endorsed at the 47th session.
- b. The expert team (include 6 experts from TC Members) for the 3rd Assessment Report on the impact of climate change on tropical cyclone in TC region was established in 2014 and a provisional outline of the 3rd Assessment Report was drafted. The 3rd Assessment Report is planned to be published in 2017 or 2018.
- c. CMA has conducted a rocket dropsonding for Typhoon Mujigae in October 2015. The rocket travelled 200 km towards the centre of the typhoon and 4 dropsondes were deployed. Data were received and analyzed.
- d. The digitization of CI numbers for the period of 2004-2013 was completed and the best-track datasets including CI numbers of CMA, HKO, JTWC, and RSMC Tokyo were exchanged in June 2014. Most of the Dvorak Analysis of these four Centres were reasonably consistent, proving the credibility of the technique, but there were discrepancies in some of the cases.

4. The Committee further noted the following WGM activities in 2015:

- a. The first Organization Committee (OC) meeting for EXOTICCA (previously as EXOTICA) was held in Shanghai on 9 October 2015. Establishment of various committees and the corresponding terms of reference were discussed, with summaries on the progress by CMA, HKO and JMA. A technical lecture by USA on the current progress of the field campaign on hurricane intensity change in USA was also delivered.
- b. The technology transfer of Typhoon Analysis and Prediction System (TAPS) was conducted for two Members in 2015:
 - Lao PDR, 12-13 October 2015 and
 - Thailand, 14-16 October 2015

Two experts from KMA met the Members to train the typhoon forecasters on the use of TAPS and provide follow-on technical assistance to the Members on the implementation of TAPS. The mission was completed successfully and reported in

- the 10th Integrated Workshop in Kuala Lumpur.
- c. A research fellowship scheme was offered by Shanghai Typhoon Institute (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-TLFD's web site. The fellowship was offered to DPRK between 26 October and 25 November 2015.
 - d. The Roving Seminar 2015 was held in Lao PDR on 4-6 November 2015 with the support of Department of Meteorology and Hydrology and the topic was "Flash Flood and Landslides". It was the first time that Members from Panel on Tropical Cyclones (PTC) were invited to the Seminar and there was a total of 22 participants from Bangladesh, Cambodia, China, Myanmar, Pakistan, Philippines, Lao PDR, Sri Lanka and Thailand. The lecturers came from China, Japan and Republic of Korea and the Seminar was warmly appreciated by the participants.
 - e. The technical meeting on radar composite map project was held in Thailand between 30 November and 4 December 2015. The project applied JMA's quality management technique using statistical method to each of TMD's radar to develop source codes of radar data calibration for QPE by TMD with the assistance of JMA. The technical meeting was a follow up with the progress and to identify a way forward.
 - f. Experts from USA and Vietnam were invited by Shanghai Typhoon Institute (STI) on 6-11 December 2015 and 21-25 December 2015, respectively to improve the influence of the 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.
 - g. The WMO International Training Workshop for Tropical Cyclone Forecasting and Warning was held in the WMO RTC Training Center in Nanjing on 7-11 December 2015 for TC Members. 34 participants from China, DPRK, Republic of Korea, Lao PDR, Malaysia, Philippines, Thailand and Vietnam attended the workshop. 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:

5. On the basis of the information provided by Members and the respective coordinator of the AOPs (refer to **Annex I of Appendix III**) and on the discussion during the session, the following conclusions were reached:
- a. WGM action plans in 2015 were successfully completed.
 - b. Members made important progress in the implementation of the TC Strategic Plan during the year 2015.
 - c. Members made significant progress during 2015 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 Shanghai Typhoon Institute of

- CMA acted as a convenient platform for forecasters and scientists to discuss typhoon-related topics online.
- f. 12 issues of the Tropical Cyclone Research and Review (TCRR) Journal have been published since 2012 with more than 50,000 downloads from the website. Two visiting editors from USA and Vietnam, respectively were invited to the editorial office in November 2015 to provide guidance of improving the editorial procedures, reviewing articles and inviting articles.
 - g. The National Typhoon Center (NTC) of KMA was invited to conduct a follow-on technical assistance to the Department of Meteorology and Hydrology (DMH) of Lao, PDR on the Typhoon Analysis and Prediction System (TAPS) in October 2015. At the same time a training to Thai Meteorology Department (TMD) of Thailand on the use of TAPS was also conducted.
 - h. RSMC Tokyo relaunched the Numerical Typhoon Prediction (NTP) website in May 2015 to provide a variety of TC products including ensemble TC track guidance of ECMWF, NCEP and JMA.
 - i. Forecasts of tropical cyclone track and intensity from operational forecast agencies and deterministic NWP models in 2014 were evaluated. A remarkable progress has been made for track forecast but it remained a challenge for intensity forecast. A one-month fellowship scheme was offered to Mr. SONG Yong Choi and Mr. PAK Sang Il from DRPK to implement the tropical cyclone genesis products in real-time based on ECMWF-IFS gridded output in Typhoon Forecast Evaluation and Assessment System (TFEAS).
 - j. The performance of the high-resolution version of South China Sea Typhoon Model (TRAMS-9km) for Typhoon Soudelor in 2015 was impressive, with 24- and 48-hour average forecast errors of 56km and 70km, respectively which were smaller than JMA, ECMWF and T639.
 - 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.
 - l. A technical meeting was held in November/December 2015 between TMD and JMA experts in Thailand for discussing technical support for applying the QC and QPE techniques in the regional radar network, as well as training for TMD radar experts.
 - m. The expert term for the 3rd Assessment Report on the impact of climate change on tropical cyclones in TC region has drafted a provisional outline of the Report. The Report was planned to be published in 2017 or 2018.
 - n. The storm surge prediction system developed by JMA continued to run and a request from Malaysia was received. Storm surge prediction time series at several stations in Malaysia would be provided early next year.
 - o. The first Organization Committee (OC) meeting for EXOTICCA (previously as EXOTICA) was held in October 2015. 2 aircraft observations for Typhoon Linfa in July 2015 were conducted by HKO, and a rocket dropsonding for Typhoon Mujigae in October 2015 was conducted by CMA in which 4 dropsondes were deployed.
 - p. RSMC Tokyo developed a zero draft of the tropical cyclone forecasting competency based on the version developed by the Hurricane Committee.
 - q. The high-resolution tropical cyclone model based on Global/Regional Assimilation and Prediction System (GRAPES-TCM) could be further improved. The project will be merged with EXOTICCA in 2016.

- r. Digitization of CI numbers for the harmonization of tropical cyclone intensity analysis has been completed and best-track datasets between CMA, HKO, JTWC and RSMC Tokyo were exchanged. The overall CI numbers analyzed by the four Centres using the Dvorak Analysis were reasonably consistent (within 0.5 or less), proving the creditability of the technique.
- s. Observation Areas in the South China Sea including Nansha Observation Area, Xisha Observation Area and Hainan Observation Area were set up to estimate tropical cyclone intensity using various Wind-Pressure Relationship (WPR). The average estimation error for the MSLP was 6.4hPa.
- t. Based on the discussion on the action plans for 2016 and according to the new structure of the action plans, it was also concluded that:
 - i. POP1-4 will continue in 2016.
 - ii. AOP1, 3-9 will continue in 2016.
 - iii. AOP2, Verification of Tropical Cyclone Operational Forecast, will be moved to POP5.
 - iv. PP1, High Resolution Tropical Cyclone Model Based on GRAPES, will be merged with AOP8 (EXOTICCA).
 - v. PP2 will continue in 2016.
 - vi. The budget proposed by WGM, which was also concurred at the AWG meeting after the 10th IWS, for undertaking the action plans (POPs, AOPs and PPs) in 2016 was US\$17,000. Another budget of US\$10,000 was allocated for the support of WGM attendance at the next Integrated Workshop, thus the total budget for WGM in 2016 would be US\$27,000. In addition, a budget of US\$10,000 was proposed through the “Special Funding Request” for financial support on AOP8 EXOTICCA workshop (US\$5,000) and POP3 TCRR editorial board meeting (US\$5,000).

Recommendations of WGM

6. On the basis of the outcomes of the WGM parallel session at the 10th IWS in Kuala Lumpur, Malaysia and subsequent discussion, the WGM made the following recommendations:

- a. To request KMA to further develop the techniques of typhoon seasonal prediction, and to provide the products of typhoon seasonal prediction for TC Members.
- b. To request STI/CMA to attract more users from wider fields into the forum, to open new topic sessions which users are interested in, to encourage forecasters and scientists to participate in the discussion, and to make the forum serve as an exchange platform of real-time observations and link the forum to TC website and tropical-storms email group.
- c. To request CMA to attract more contributions from TC Members and WMO Members, to improve the editorial procedure and apply for online ISSN, and to host an editorial board meeting in Shanghai in May-June 2016.
- d. 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.
- e. To request JMA to provide ensemble TC genesis guidance if necessary NWP data are available, and to examine the potential of global ensemble models for TC intensity forecast guidance using TIGGE datasets.
- f. To request CMA to continue post-season verification and reliability analysis on

- the operational forecasts of tropical cyclones and report to Committee Session, 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, with special attention on genesis and ensemble forecast in conjunction with WMO-TLFDP (to be included in the TC Fellowship Scheme).
- g. To request CMA to further improve the TRAMS-9km model, to provide new products through website, and to further improve the real-time verification system for TRAMS.
 - h. To request NHMS of Vietnam to collaborate with RSMC Tokyo to release tropical cyclone guidance products over Southeast Asia, to update Himawari-8 images and storm-tracking products on SWFDP webpage, and to extend forecasting domain of regional NWP model to cover the east sea of the Philippines.
 - i. To request TMD and MMD to increase the number of radars used for the operational radar composite map, to apply radar calibration techniques for QPE with technical assistance from JMA, to experiment test of radar data sharing between JMA, TMD and MMD, and to submit a progress report by TMD. Upon the submission of the report, to hold a follow-up technical meeting at JMA or TMD to identify a way forward.
 - j. To request SMG to collaborate with the expert term for further literature review and discussion, especially for non-English papers, and to write the first draft of the 3rd Assessment Report in Oct-Dec 2016/2017.
 - k. To request JMA to provide multiple scenarios of storm surge predictions and ensemble one-week ocean wave predictions to TC Members from 2016 typhoon season, and to add storm surge time series prediction points if so requested by Members, and to verify storm surge predictions if tidal data during storm surge events are available.
 - l. To request STI/CMA to hold a workshop on typhoon intensity change forecast in conjunction with WMO-TLFDP, to implement the field campaign collaboration among participating Members, and to demonstrate research on tropical cyclone intensity change in conjunction with WMO-TLFDP by using target typhoon data from field campaign (to be included in the TC Fellowship Scheme).
 - m. To request JMA to circulate and update the zero draft of tropical cyclone forecasting competency based on input/feedbacks from WGM Members and discussion at the 8th RSMC/TCWC coordination meeting, and to finalize the draft if so agreed by WGM Members.
 - n. To request JMA to circulate summary of the tropical cyclone CI-number comparison study to CMA, HKO and JTWC for their feedback, and to finalize and report the summary.
 - o. To request CMA to continue to develop the tropical cyclone intensity estimate method with better use of surface observations, and develop a reliable Wind-Pressure-Relationship.
 - p. To endorse the action plans in 2016 (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 10th IWS which summarizes the above recommendations with additional action items.
 - q. To endorse the WGM budget request which is included in the budget proposal to be submitted by AWG.

Appendix II

Report on activities of Working Group on Meteorology (WGM) of TC in 2015

2015 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 implement 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 2015:

- (a) WGM has fulfilled all the plans (include 4 POPs, 9 AOPs and 3 PPs) which endorsed at the 47th Session.
- (b) WGM has promoted the development of the new techniques on the generation prediction and seasonal prediction based on ensemble forecast and TIGGE data, and promoted the development of the high-resolution tropical cyclone model. All of them have achieved initial success.
- (c) The digitization of CI numbers for the period of 2004-2013 was completed and the best-track datasets including CI numbers of CMA, HKO, JTWC, and RSMC Tokyo were

exchanged in June 2014. Most of the Dvorak Analysis of these four Centres were reasonably consistent, proving the credibility of the technique, but there were discrepancies in some of the cases.

- (d) The expert team (include 6 experts from TC Members) for the 3rd Assessment Report on the impact of climate change on tropical cyclone in TC region was established in 2014 and a provisional outline of the 3rd Assessment Report was drafted. The 3rd Assessment Report in planned to be published in 2017 or 2018.
- (e) WGM has provided help for WMO demonstration project (WMO-TLFDP and TCEFP) and TC cross cutting project (EXOTICCA) concerning related Members. CMA conducted a rocket dropsonding for Typhoon Mujigae in October 2015. The rocket travelled 200 km towards the centre of the typhoon and 4 dropsondes were deployed. Data were received and analyzed.

2. Membership

2.1 After the 47th TC Session, the composition and focal point members list of WGM are:

Chair	Mr. Lei Xiaotu (China)
Vice Chair	Dr. Natehaniel Servan do (The 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. Tsukasa Fujita (Japan) Mr. Vanhdy Douangmala (Lao PDR) Mr. Leong Weng Kun, Ivan (Macao, China) Mr. Renito B. Paciente (Phillippines) Mr. Se-Won Kim (Rep. of Korea) Dr. Felicia Shaw (Singapore) Dr. Songkran Agsorn (Thailand) Mr. Bill Ward (USA) Mr. Vo Van Hoa (Viet Nam)
Secretary of Mete.	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 2015, endorsed at the 47th 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, as well as visiting editors to TCRR editorial office (Shanghai) and the fellowships.

3. The progress of WGM's plans in 2015

With the assistances of TCP/WMO and TCS and the strong support from all Members, WGM has successfully completed the action plans in 2015, which were endorsed at the 47th Session. The WGM activities and the progress of all action items in 2015 are reported in the [Appendix III – Summary Report of the WGM Parallel Meeting at the 10th IWS](#). The complete table of the 2015 action plans (POPs, AOPs and PPs) and its implementation status are listed in [Annex I](#) of the Summary Report.

After the 47th TC Session in 2015, WGM has been carrying out many activities that involve the cooperation among Members as well as other TC WGs and international organizations, which includes:

- Coordinate with KMA to conduct a training course (technology transfer) on Typhoon Analysis and Prediction System (TAPS) for two Members in 2015 (Lao PDR, 12-13 October 2015 and Thailand, 14-16 October 2015).
- Coordinate with JMA and TMD to organize the technical meeting on radar composite map project, held in Thailand between 30 November and 4 December 2015. The project applied JMA's quality management technique using statistical method to each of TMD's radar to develop source codes of radar data calibration for QPE by TMD with the assistance of JMA. The technical meeting was a follow up with the progress and to identify a way forward.
- Coordinate with STI/CMA to invite two experts from USA and Vietnam to visit the editorial office in STI as the Journal visiting editor of Tropical Cyclone Research and Review (TCRR) on 6-11 December 2015 and 21-25 December 2015, respectively to improve the influence of 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.
- Coordinate with Lao PDR to organize the Roving Seminar 2015, held in Lao PDR on 4-6 November 2015 with the support of Department of Meteorology and Hydrology and the topic was "Flash Flood and Landslides". It was the first time that Members from Panel on Tropical Cyclones (PTC) were invited to the Seminar and there were a total of 22 participants from Bangladesh, Cambodia, China, Myanmar, Pakistan, Philippines, Lao PDR, Sri Lanka and Thailand. The lecturers came from China, Japan and Republic of Korea and the Seminar was warmly appreciated by the participants.
- Coordinate with STI/CMA, HKO, TCS, TCP/WMO and WWRP/TCP to organize the first Organization Committee (OC) meeting for EXOTICCA (previously as EXOTICA) was held in Shanghai on 9 October 2015.
- Coordinate with STI/CMA and National Typhoon Center (NTC) of KMA to organized the 8th China-Korea joint workshop on the tropical cyclones, held in Shanghai and Beijing of China on 18-20 May 2015.
- Coordinate with STI/CMA to conduct a research fellowship on tropical cyclone genesis

forecast technique, held at STI from October to November 2015. Two experts from DPRK participated at the research fellowship.

- Coordinate with WMO/TCP and WMO Regional Training Center (RTC) of Nanjing to conduct a WMO International Training Workshop on Tropical Cyclone Forecasting and Warning, held in the WMO RTC Training Center in Nanjing on 7-11 December 2015 for TC Members. 34 participants from China, DPRK, Republic of Korea, Lao PDR, Malaysia, Philippines, Thailand and Vietnam attended the workshop.

4. Conclusions and proposed action plans for 2016

On the basis of the information provided by Members and the respective coordinator of the action plans and based on the discussion during the 10th IWS, the following conclusions were reached:

- a. WGM action plans in 2015 were successfully completed.
- b. Members made important progress in the implementation of the TC Strategic Plan during the year 2015.
- c. Members made significant progress during 2015 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 acted as a convenient platform for forecasters and scientists to discuss typhoon-related topics online.
- f. 12 issues of the TCRR have been published since 2012 with more than 50,000 downloads from the website. Two visiting editors from USA and Vietnam, respectively were invited to the editorial office in November 2015 to provide guidance of improving the editorial procedures, reviewing articles and inviting articles.
- g. The NTC of KMA was invited to conduct a follow-on technical assistance to the Department of Meteorology and Hydrology (DMH) of Lao, PDR on the TAPS in October 2015. At the same time a training to TMD of Thailand on the use of TAPS was also conducted.
- h. RSMC Tokyo relaunched the Numerical Typhoon Prediction (NTP) website in May 2015 to provide a variety of TC products including ensemble TC track guidance of ECMWF, NCEP and JMA.
- i. Forecasts of tropical cyclone track and intensity from operational forecast agencies and deterministic NWP models in 2014 were evaluated. A remarkable progress has been made for track forecast but it remained a challenge for intensity forecast. A one-month fellowship scheme was offered to Mr. SONG Yong Choi and Mr. PAK Sang Il from DRPK to implement the tropical cyclone genesis products in real-time based on ECMWF-IFS gridded output in Typhoon Forecast Evaluation and Assessment System (TFEAS).

- j. The performance of the high-resolution version of South China Sea Typhoon Model (TRAMS-9km) for Typhoon Soudelor in 2015 was impressive, with 24- and 48-hour average forecast errors of 56km and 70km, respectively which were smaller than JMA, ECMWF and T639.
- 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.
- l. A technical meeting was held in November/December 2015 between TMD and JMA experts in Thailand for discussing technical support for applying the QC and QPE techniques in the regional radar network, as well as training for TMD radar experts.
- m. The expert term for the 3rd Assessment Report on the impact of climate change on tropical cyclones in TC region has drafted a provisional outline of the Report. The Report was planned to be published in 2017 or 2018.
- n. The storm surge prediction system developed by JMA continued to run and a request from Malaysia was received. Storm surge prediction time series at several stations in Malaysia would be provided early next year.
- o. The first Organization Committee (OC) meeting for EXOTICCA (previously as EXOTICA) was held in October 2015. 2 aircraft observations for Typhoon Linfa in July 2015 were conducted by HKO, and a rocket dropsonding for Typhoon Mujigae in October 2015 was conducted by CMA in which 4 dropsondes were deployed.
- p. RSMC Tokyo developed a zero draft of the tropical cyclone forecasting competency based on the version developed by the Hurricane Committee.
- q. The high-resolution tropical cyclone model based on Global/Regional Assimilation and Prediction System (GRAPES-TCM) could be further improved. The project will be merged with EXOTICCA in 2016.
- r. Digitization of CI numbers for the harmonization of tropical cyclone intensity analysis has been completed and best-track datasets between CMA, HKO, JTWC and RSMC Tokyo were exchanged. The overall CI numbers analyzed by the four Centres using the Dvorak Analysis were reasonably consistent (within 0.5 or less), proving the creditability of the technique.
- s. Forecasts of tropical cyclone tracks from operational forecast agencies and deterministic NWP models in 2015 were assessed by STI/CMA. A remarkable progress has been made by TC Members over last 6 years in the subjective and NWP track forecast. The subjective track errors at 24 hours are less than 100 km in 2015. The accuracy of subjective intensity forecast has not made any progress over recent years. The intensity forecast skill for both global and regional models were almost stagnating for the last 6 years. To make an accurate intensity forecast is still a challenge work for both subjective and objective methods.
- t. Observation Areas in the South China Sea including Nansha Observation Area, Xisha Observation Area and Hainan Observation Area were set up to estimate tropical cyclone intensity using various Wind-Pressure Relationship (WPR). The average estimation error for the MSLP was 6.4hPa. Exchange of more observational data (e.g. buoy, island station and oil rig data over the South China Sea), along with metadata, and the all

available observational data used in operational analysis for tropical cyclone track and intensity, encouraged.

- u. Based on the discussion during the 10th IWS on the action plans for 2016 and according to the new structure of the action plans, it was also concluded that:
 - i. POP1-4 will continue in 2016.
 - ii. AOP1, 3-9 will continue in 2016.
 - iii. AOP2, Verification of Tropical Cyclone Operational Forecast, will be moved to POP5.
 - iv. PP1, High Resolution Tropical Cyclone Model Based on GRAPES, will be merged with AOP8 (EXOTICCA).
 - v. PP2 will continue in 2016.
 - vi. The budget proposed by WGM, which was also concurred at the AWG meeting after the 10th IWS, for undertaking the action plans (POPs, AOPs and PPs) in 2016 was US\$17,000. Another budget of US\$10,000 was allocated for the support of WGM attendance at the next Integrated Workshop, thus the total budget for WGM in 2016 would be US\$27,000. In addition, a budget of US\$10,000 was proposed through the “Special Funding Request” for financial support on AOP8 EXOTICCA workshop (US\$5,000) and POP3 TCRR editorial board meeting (US\$5,000).

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 10th IWS in Kuala Lumpur, Malaysia and subsequent discussion, the WGM made the following recommendations:

- a. To request RSMC Tokyo and the WMO Regional Training Center Nanjing (the same of Training Center of Typhoon Committee) 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 attract more users from wider fields into the forum, to open new topic sessions which users are interested in, to encourage forecasters and scientists to participate in the discussion, and to make the forum serve as an exchange platform of real-time information (extra observations data, forecast products, pictures, video etc.) and link the forum to TC website and tropical-storms email group.
- d. To request CMA and TCS to attract more contributions from TC Members and WMO Members, to further improve the editorial procedures of the TC Journal *Tropical Cyclone Research and Review (TCRR)*, and to host an editorial board meeting in Shanghai in 2016.
- 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 RSMC Tokyo to provide ensemble TC genesis guidance if necessary NWP data are available, and to examine the potential of global ensemble models for TC intensity forecast guidance using TIGGE datasets.
- g. To request CMA to continue post-season verification and reliability analysis on the operational forecasts of tropical cyclones and report to Committee Session, 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).
- h. To request CMA to further improve the TRAMS-9km model, to provide new products through website.
- i. To request NHMS of Vietnam to collaborate with RSMC Tokyo to release tropical cyclone guidance products over Southeast Asia, to update Himawari-8 images and storm-tracking products on SWFDP webpage, and to extend forecasting domain of regional NWP model to cover the east sea of the Philippines.
- j. To request TMD and MMD to increase the number of radars used for the operational radar composite map, to apply radar calibration techniques for QPE with technical assistance from JMA, to submit a progress report by TMD, and to hold a follow-up technical meeting at JMA or TMD to identify a way forward.
- k. To request SMG to collaborate with the expert term for further literature review and discussion, especially for non-English papers, and to write the first draft of the 3rd Assessment Report in Oct-Dec 2016/2017.
- l. To request JMA to provide multiple scenarios of storm surge predictions and ensemble one-week ocean wave predictions to TC Members from 2016 typhoon season, and to add storm surge time series prediction points if so requested by Members, and to verify storm surge predictions if tidal data during storm surge events are available.
- 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 circulate and update the zero draft of tropical cyclone forecasting competency based on input/feedbacks from Members and discussion at the 8th RSMC/TCWC coordination meeting, and to finalize the draft.
- o. To request RSMC Tokyo to circulate summary of the tropical cyclone CI-number comparison study to CMA, JMA, HKO and JTWC for their feedback, and to finalize and report the summary.
- p. To endorse the action plans in 2016 (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 10th IWS**, which summarizes the above recommendations with additional action items.
- q. To endorse the WGM budget request which is included in the budget proposal which to be submitted by AWG.

Appendix III

Summary Report of WGM Parallel Meeting at the 10th IWS

Summary Report on the WGM Parallel Meeting
10th Integrated Workshop
Kuala Lumpur, Malaysia
27 – 28 October 2015

1. Background

- The WGM Parallel Meeting of the 10th Integrated Workshop (IWS) was held on 27 – 28 October 2015 in Berjaya Times Square Hotel, which was attended by 38 participants from 12 UNESCAP/WMO Typhoon Committee (TC) Members (China; DPR Korea; Hong Kong, China; Japan; Lao PDR; Macao, China; Malaysia; Philippines; Republic of Korea; Thailand, United States of America and Viet Nam). Representatives from TCS, AWG and WMO/TCP 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 progress of Members on meteorological component, the progress of POPs, AOPs and PPs in 2015, then followed by the discussion on the priority plans for 2016 including the new project proposals and the associated budget for each action plan.

3. Progress of WGM action plans (POPs, AOPs and PPs) in 2015

- The Meeting reviewed the progress and the results of all the priority plans (include 4 POPs, 9 AOPs and 3 PPs) since the 47th TC Session as well as the action plans in 2016 presented by the respective coordinators, which were reported as shown in bullet 3.1 to 3.16. The Implementation status of WGM Action plans in 2015 including the actions and the completion status; and the action plans in 2016 are listed in [Annex I](#) and [Annex II](#) respectively.

3.1 POP1: Development of typhoon seasonal prediction system

- In 2015, KMA issued the typhoon seasonal outlook information for summer and fall season in the Northwestern Pacific Area.
- The information includes the number of typhoon genesis and track pattern, and users can also find other information about the prediction results on the website (<http://gtaps.kma.go.kr/TSP/index.php>).
- KMA keeps issuing this kind of seasonal outlook information to support the TC Members.
- Plans for 2016:
 - i) To further develop the techniques of typhoon seasonal prediction;
 - ii) To provide the products of typhoon seasonal prediction for TC Members.

3.2 POP2: Web-based typhoon forum

- The web-based typhoon forum (<http://www.typhoon.gov.cn/en/bbs>) has run routinely by Shanghai Typhoon Institute of CMA since 2012, and acts as a very convenient platform for forecasters and scientists to discuss typhoon-related topics online.
- Current structure of the forum:
 - i) TC real-time information and forecast (<http://172.21.3.142>, WMO-TLFDP <http://tlfdp.typhoon.gov.cn>);
 - ii) History case (<http://10.228.2.54>);
 - iii) Forecast verification (<http://172.21.3.142>, WMO-TLFDP <http://tlfdp.typhoon.gov.cn>).
- Up to October 2015, there are 65 users coming from 11 Members in the forum.
- Plans for 2016:
 - i) To attract more users from wider fields into the forum, open for public (meteorologist);
 - ii) To open new topic sessions which the users are interested in;
 - iii) To encourage forecasters and scientists to participate in discussing on typhoon issues;
 - iv) To make this forum serve as an exchange platform of real-time observations of typhoons, link it to TC website and Tropical-storms (email) group.

3.3 POP3: Tropical Cyclone Research and Review (TCRR)

- As at October 2015, 12 issues of the Journal have been published since its launch (in 2012), which comprised 85 articles submitted by authors from 13 countries and regions. More than 50,000 downloads (compared to 36,500 before 2015) were recorded which reflected that the recognition of the Journal was increasing.

- Two visiting editors from the USA and Vietnam were invited to the editorial office in November 2015 to provide guidance of improving the editorial procedures, reviewing articles as well as inviting articles to be submitted to the Journal.
- Plans for 2016:
 - i) To attract more contributions from TC Members and WMO Members;
 - ii) To improve of editorial procedure;
 - iii) To apply for of online ISSN;
 - iv) To host an editorial board meeting in Shanghai, China in May-June 2016.

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

- The National Typhoon Center (NTC) of KMA was invited to conduct a follow-on technical assistance to the Department of Meteorology and Hydrology (DMH) in Lao PDR on 12-13 October 2015 and a training on the use of TAPS for Thai Meteorological Department (TMD) on 14-16 October 2015, respectively.
- The training included typhoon forecasting procedure; installation of TAPS; user educations; demonstration on typhoon forecast using TAPS. Both the follow-on technical assistance and training were successful.
- Plans for 2016:
 - i) To continue the project for Members interested in the system;
 - ii) To increase the budget to allow for two Members in a year.

3.5 AOP1: Enhanced use of ensemble forecast

- RSMC Tokyo relaunched the Numerical Typhoon Prediction (NTP) website in May 2015 and has provided a variety of TC products including ensemble TC track guidance of ECMWF, NCEP and JMA.
- ECMWF agreed that RSMC Tokyo provides ensemble TC genesis probability of ECMWF to the Members through the NTP website. Ensemble TC genesis probability of other centers such as NCEP and UKMO may be provided if necessary data are available.
- Multi-center grand ensemble (MCGE) for TC genesis prediction was examined. In most of the basins, the operational global medium-range ensembles are capable of providing skillful guidance of TC activity forecasts with a forecast lead time extending into week 2.
- The MCGEs have more skill (larger BSS) than the best single-model ensemble, which is generally the ECMWF ensemble for most time windows and in most TC basins.
- Plans for 2016:
 - i) To provide ensemble TC genesis guidance if necessary NWP data are available;

ii) To examine the potential of global ensemble models for TC intensity forecast guidance using TIGGE datasets.

3.6 AOP2: Verification of tropical cyclone operational forecast

- Forecasts of tropical cyclone tracks from operational forecast agencies and deterministic NWP models in 2014 were evaluated and the results were reported to the 47th Session of Typhoon Committee.
- An alternative approach to examining the average errors is to consider the distributions of errors. Box plots are used to summarize the annual distribution of errors in forecasts from 2010 to 2014 for each global model.
- One obvious characteristic is the stepped decrease in the values of each quantile were made at every lead time level from 2010 to 2014, especially for ECMWF-IFS, NCEP-GFS and UKMO-MetUM models.
- For track forecast, a remarkable progress has been made by Typhoon Committee Members over last 4 years in the subjective track forecast work. Most members' subjective track errors at 24 hours are under 100km from 2013.
- However, to make an accurate intensity forecast is still a challenge work for both subjective and objective methods. The accuracy of intensity forecast for subjective did not have any progress over last 10 years, and the intensity forecast errors from models are much larger compare to subjective methods at each lead time levels.
- STI/CMA hosted a two-month visit of Mr. Boothum Tanglumlead from Thailand, as jointly funded by the Typhoon Committee and STI/CMA. Mr. Boothum evaluated the tropical cyclone genesis products in real time based on CMA-T639 and NCEP-GFS gridded output.
- STI/CMA funded and hosted a one-month visit of Mr. SONG Yong Chol and Mr. PAK Sang Il from DPRK. They implemented the tropical cyclone genesis products in real time based on ECMWF-IFS gridded output in Typhoon Forecast Evaluation and Assessment System (TFEAS).
- Plan for 2016:
 - i) The item will be moved to POP5 in 2016;
 - ii) To continue the post-season verification and reliability analyses on the operational forecast of tropical cyclones and report to Committee session;
 - iii) To continue providing real time verification information on track and intensity forecast through WMO-TLFDP website;
 - iv) 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).

3.7 AOP3: Improvement of South China Sea typhoon forecast

- TRAMS covers the range of 0.8-50.5oN, 81.6-160.8oE. The horizontal grid interval is 0.36o, and the model is divided into 55 layers in the vertical. The model provides 120-h typhoon track and intensity forecasts since January 2014.
- The higher resolution version: TRAMS-9km, which is movable nested in TRAMS, is developed based on the typhoon location. The number of nested domain of TRAMS-9km could automatic follow the number of the typhoon, as well as the domain center for parameters setup and statistic data generating following each typhoon center location.
- Frequency of forecast for TRAMS-9km is 4 times a day with location (lat/long), central pressure, maximum tangential winds every 6 hours up to 168 hours.
- The performance of TRAMS-9km in Typhoon Soudelor in 2015 was impressive, with an average error of 56km for 24-hour forecast and 70km for 48-hour forecast, which was smaller than JMA, ECMWF and T639.
- Plans for 2016:
 - i) To further improve TRAMS model dynamic and physics;
 - ii) To provide new products through website;
 - iii) To further improve the real-time verification system for TRAMS.

3.8 AOP4: Progress in implementing RFSC - Ha Noi of SWFDP for South-East Asia

- Key functions of RFSC Ha Noi:
 - i) Implementing protected www.swfdp-sea.com.vn website (username: swfdp-sea; pass: RA2);
 - ii) Sharing global and regional NWP products (including both deterministic and ensemble);
 - iii) Sharing observations over the Southeast Asia domain: satellite data, satellite based products;
 - iv) Issuing 1-5 days guidance for heavy rainfall and strong wind areas based on NWP products.
- Global NWP forecast products:
 - i) Deterministic: GSM (JMA); GME (DWD); NAVGEM (US Navy); GEM (CMC); GFS (NCEP);
 - ii) Ensemble: NAEFS (21 members of GEFS);
- Regional NWP (ensemble) forecast products:
 - i) SREPS: Short range EPS (1-3 days) based on running HRM, WRF-ARW, and WRF-NMM models with 5 difference global models for boundary conditions (GME, GEM, GFS, GSM, NAVGEM), 15kmx15km;
 - ii) LEPS: Limited area EPS (3-5 days) based on running HRM model with boundary conditions from 21 members of GEFS, 22kmx22km.

- Guidance products:
 - i) One of the main purposes of SWFDP-SeA is to provide the guidance (summarizing the NWP products) up to 5 days related to severe weather phenomena;
 - ii) The NHMs can use the SWFDP-SeA guidance to enhance their forecasts;
 - iii) Two kind of guidance products: The short range guidance: from 1 to 2 days; The medium range guidance: from 3 to 5 days
 - iv) Criteria are used: Heavy precipitation: > 50mm/24hrs & > 100mm/24hrs; Strong Winds: > 30 Knots (over land and Sea) > 50 Knots (over Sea)
- Plans for 2016:
 - i) For guidance products:
 - Collaborating with RMSC Tokyo to release the suitable guidance in case of having tropical storm or tropical cyclone over the Southeast Asia domain;
 - Collaborating with experts from NHMS in SeA to enhance the knowledge of forecast experiences over different countries;
 - Verification for the guidance every day to enhance the skill of the forecasters in SWFDP-SeA RFSC Hanoi team;
 - Fully updating Himawari-8 images after receiving Himawari-cast at the end of 2015;
 - Collaborating with JAXA for updating GSMaP and the nowcasting of GSMap upto 3h;
 - 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.
 - ii) For regional NWP system:
 - Extending regional model running domain covering the east sea of Philippines;
 - Replacing the SREPS and LEPS systems by 1 system for 5 days ensemble regional forecast with data assimilation (WRF/COSMO/NHM-JMA with ensemble assimilation methods (Kalman Filter));
 - Implementing deterministic regional modeling system based on WRF/COSMO model with finer resolution (2 - 5 km);
 - Verification for the regional NWP products.

3.9 AOP5: Development of regional radar network

- TMD applied the radar composite with lowest level intensity (EIL) techniques provided by JMA to the nationwide radar network for 19 radars selected with technical assistance of JMA. The images and composite data are disseminating on the TMD website and intranet.
- Preliminary works on application of QPE techniques by TMD with technical assistance of JMA. The QPE with the First Calibration Factor with 1090 rain gauge data. The First Calibration Factor from calibration method does not consider neighbourhood radar data. To improve calibration factor with considered the neighbourhood radar data and to determine where is "common detection region" between two radars.
- A technical meeting was held between TMD and JMA experts from 30 November to 4

December 2015 in Thailand to discuss the issue on the technical support for applying the QC and QPE techniques as well as conducting training for TMD radar experts.

- Plans for 2016:
 - i) To increase in a number of TMD radar sites, including dual-polarization weather radars, used for the operational radar composite map with JMA's quality management technique;
 - ii) To apply radar calibration techniques for QPE by TMD with technical assistance of JMA;
 - iii) To perform experimental test of radar data sharing among Members involved;
 - iv) Submission of a progress report by TMD on item i) and ii). Upon the receipt of the report, hold a follow-up technical meeting at JMA or TMD to identify a way forward.

3.10 AOP6: Assessment report on the impact of climate change on tropical cyclone in TC region

- The expert team for the 3rd Assessment Report was established in 2014 with the following members:
 - i) Ming Ying (Shanghai Typhoon Institute/ CMA)
 - ii) Thomas R. Knutson (Geophysical Fluid Dynamics Laboratory/NOAA)
 - iii) Toshiyuki Nakaegawa (Japan Meteorological Administration)
 - iv) Tsz-Cheung Lee (Hong Kong Observatory)
 - v) Yun Wontae (Korea Meteorological Administration)
 - vi) Wong Chan Seng (Macao Meteorological and Geophysical Bureau) as the expert team coordinator
- An FTP site has been set up to share all reference papers available. Over 80 publications are collected on the site.
- A provisional outline of 3rd Assessment Report was drafted. The 3rd Assessment Report is planned to be published in 2017 or 2018.
- Plan for 2016 and beyond:
 - i) 2016: Literature review and discussion; Search for some non-English papers (in Chinese, Japanese or Korean) published in national journals;
 - ii) Oct-Dec 2016 and 2017: Write the first draft of the 3rd Assessment Report; Hold the expert symposium;
 - iii) Oct-Dec 2017 and 2018: Complete the first draft and solicit opinions on the IWS meeting;
 - iv) 2018 (Before IPCC AR6 in 2019 or 2020): Revise and publish the 3rd Assessment Report.

3.11 AOP7: Storm surge watch scheme

- In 2014 RSMC Tokyo added 41 stations; USA(1), The Philippines(9) from June, Viet Nam(20), Hong Kong China(5), Republic of Korea(5) in September. It also added one more station in the Philippines in October. The graphical representation has also been improved to make the products more user friendly since September 2014. All products can be found on the JMA Numerical Typhoon Prediction website (<https://tynwp-web.kishou.go.jp>).
- No stations were added in 2015. A request from Malaysia was received. Storm surge time-series prediction at several stations in Malaysia are to be added early next year.
- Currently one deterministic storm surge prediction based on TC advisory using GSM prediction. Additional five storm surge predictions based on five TC track scenarios derived from the cluster analysis (k-mean clustering) from 25 members of TEPS prediction. TC intensity scenarios are based on those in TC advisory.
- JMA plans to issue one-week ocean wave predictions in the second quarter of 2016. The product will be available to the Members for the aid of early warning.
- No requests were received from the Members for conducting verification of time series forecasts during past storm surge events.
- Plans in 2016:
 - i) To provide multiple scenarios of storm surge predictions and ensemble one-week ocean wave predictions to TC Members from TY season in 2016;
 - ii) To add storm surge time series prediction points if so requested by Members;
 - iii) To verify storm surge predictions if tidal data during storm surge events are available.

3.12 AOP8: Contribution for the Experiment on Typhoon Intensity Change in Coastal Area (EXOTICCA)

- The first Organization Committee (OC) meeting for EXOTICCA was held in Shanghai on 9 October 2015. Establishment of various committees and the corresponding terms of reference were discussed, with summaries on the progress by CMA, HKO and JMA. A technical lecture by USA on the current progress of the field campaign on hurricane intensity change in USA was also delivered. A web site has been set up in TC website: <http://www.typhooncommittee.org/EXOTICA>.
- The HKO conducted 2 aircraft observations for Typhoon Linfa in July 2015 and Mujigae in October 2015.
- The CMA conducted a UAV observation for Typhoon Chan-hom in July 2015 and a rocket drop-sounding for Typhoon Mujigae in October 2015. The rocket was launched at the southeast coast of Hainan and travelled 200 km towards Typhoon Mujigae and 4 drop-sondes were deployed at 11 km height.
- Plans in 2016:
 - i) To hold a workshop typhoon intensity change forecast (May-June. Or Sep.-Oct., 2016,

Shanghai) conjunction with WMO-TLFDP;

ii) To implement the field campaign collaboration among participating Members by using aircraft drop-sonde, mobile GPS radio-sonde and rocket drop-sonde;

iii) Demonstration research on tropical cyclone intensity change conjunction with WMO-TLFDP by using target typhoon data from the field campaign (to be included in the TC Fellowship Scheme).

3.13 AOP9: Development of tropical cyclone forecasting competency

- At the 66th WMO Executive Council, it was reiterated the need to develop the tropical cyclone forecaster competencies to ensure the quality of tropical cyclone forecasting services and to meet the users' requirements. The Council stressed the need for, and urged the Secretariat to support development of TC forecasting competencies in other tropical cyclone basins by regional tropical cyclone committees under the initiative of the RSMCs. As supplementary information for reference, the tropical cyclone forecasting competency being developed by the Hurricane Committee is available at http://www.wmo.int/pages/prog/www/tcp/HC-36_docplan.html.
- RSMC Tokyo developed a zero draft to outline the TC forecasting competency with the following areas:
 - i) Analyze broad scale environment and determine TC position, intensity and structure;
 - ii) Forecast TC track, intensity and structure;
 - iii) Access and interpret TC products and services;
 - iv) Determine potential weather impacts on at-risk areas;
 - v) Formulate policy and issue TC products;
 - vi) Communicate relevant TC information to internal and external stakeholders.
- Plans in 2016:
 - i) To circulate and update the zero draft TC competency based on input/feedbacks from WGM Members and discussion at the 8th RSMC/TCWC coordination meeting;
 - ii) To finalize the draft if so agreed by WGM Members.

3.14 PP1: High resolution tropical cyclone model based on GRAPES (G-TCM)

- The GRAPES (Global/Regional Assimilation and Prediction System) was developed during 2003-2008 by CMA, which includes variational data assimilation (3DVAR), full compressible non-hydrostatic dynamic core with semi-implicit and semi-Lagrangian discretization scheme, modularized model physics package. STI implemented a BDA scheme into the GRAPES, known as GRAPES-TCM (GRAPES-Tropical Cyclone Model) and put into operational forecast since 2007.
- Coordinate with WMO-TLFDP, comparison of (semi-) operational typhoon model (HWRF and GRAPES-TCM)
- Coordinate with EXOTICCA, Practicability and pilot study on the high resolution (\leq

3km) typhoon model development.

- Verifications using data in 2014 supported the research and further improvement can be achieved by more detailed adjustment of the model.
- Plans in 2016:
 - i) The item will be merged and combined with AOP8.

3.15 PP2: Harmonization of tropical cyclone intensity analysis

- Digitization of CI numbers for the period of 2004-2013 was completed and the best-track datasets including CI numbers of CMA, HKO, JTWC, and RSMC Tokyo were exchanged in June 2014 as scheduled.
- The number of named TCs in their datasets are different.
- CMA used Simplified Dvorak technique until 2012, while the other three centers have used conventional Dvorak technique.
- Overall, most of Dvorak analysis of these four Centers are reasonably consistent (0.5 or less), proving the credibility of the Dvorak technique.
- Major Reasons for large discrepancies:
 - i) Different interpretation during rapid intensification (Final T-number Constraints);
 - ii) Erroneous Interpretation of Cloud Patterns (Embedded Center Pattern);
 - iii) Different interpretation of peak CI numbers before weakening and/or Landfall rules (CI-number Rules);
 - iv) Minor difference in Dvorak parameters of Eye Patterns.
- Plans in 2016:
 - i) To circulate summary of the CI-number comparison study to CMA, HKO, JTWC for their feedback;
 - ii) To finalize and report the summary.

3.16 PP3: Observations to support tropical cyclone intensity estimation in the South China Sea

- On average, each year there are 3.7 TCs are generated in the South China Sea (SCS), and 6.7 TCs moved from the western North Pacific(WNP).
- Based on classical Dvorak technique, most TCs can be given a numeric CI index, which contribute to TCs' final MSLP and VMAX. Variances in TCs' final intensity are still exist on condition that different wind-pressure relationships (WPR) and experimental CI determinant.
- Observation system in SCS: Nansha Observation Area, Xisha Observation Area, Hainan Observation Area, et.al.
- Using estimated MSLP and Wind-Pressure Relationship (WPR), an estimated wind speed can be given correspondingly. However, the perfect WPR is still uncertain and need to be rebuilt by using reasonable method and data.
- On average, the total estimation error for MSLP is 6.4hPa for all analyzed cases.

- Plans in 2016:
 - i) To continue to develop the method to better use surface observation for TCs intensity estimation;
 - ii) A reliable WPR is important to intensity estimation;
 - iii) It is necessary to use surface or other observation and fusion technique for estimating a TC intensity when it is approaching to coastal;
 - iv) Advanced integrated method with satellite inversed data (Ascat / TBB / AMSU /..), and radar data as well , more asymmetric structure can be involved.

4. Conclusions and the proposed action plans for 2016

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. 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 2015.
- b. Members have made important progress in the implementation of the TC Strategic Plan during the year 2015.
- c. Members made significant progress during 2015 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. Based on the discussion on the action plans for 2016 during the 10th IWS, it was concluded to adopt the action plans as follows:
 - i) POP1-4 will continue in 2016;
 - ii) AOP2 will be moved to POP5;
 - iii) AOP1, 3-9 will continue in 2016;
 - iv) PP1 will be merged with AOP8;
 - v) PP2 will continue in 2016.
- e. The budget proposed by WGM, which was also concurred at the AWG meeting after the 10th IWS, for undertaking the actions plans (AOPs, POPs and PPs) in 2016 was US\$17000. In addition, a budget of US\$10000 was allocated for the support of WGM attendance at the next Integrated Workshop, thus the total budget for WGM for year 2016 would be US\$27000. In addition, a budget of US\$10000 was proposed through the “Special Funding Request” for financial support on EXOTICA workshop (US\$5000) and TCRR editorial board meeting (US\$5000).
- f. The complete WGM 2016 action plans (AOPs, POPs and PPs) including the actions, the success indicators, coordinators and budget is listed in Annex II.

5. Recommendations

The Committee to take note of the outcomes of the WGM Parallel Meeting at the 10th IWS and to endorse the proposed WGM 2016 action plans and the associated budget (subject to some

follow-up revisions) at the 48th Session.

6. Closing

The Chair of WGM expressed his thankfulness to all the participants for their interactions and input during the Meeting as well as the assistances of Mr. Renito B. PACIENTE, Mr. Ambun DINDANG 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 2015 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 28 October 2015.

Annex I:

Status of Perennial Operating Projects (POPs) in 2015 (WGM)

SP's KRA and SG	Objective Number	Objective	Action	Other WG's involved	Expected Quarter Completed	Other Organizations Involved	Success Indicators	Funding Required	Funding Sources	Coordinator	Status of Completion
KRA 1 KRA 2 KRA 6	1	Development of typhoon seasonal prediction system	(a) To further develop the techniques of typhoon seasonal prediction (b) To establish the web-based system to provide the products of typhoon seasonal prediction for TC Members.	/	1 st -4 th	KMA Members	Submission of the progress report	/	/	KiRyong Kang (KMA)	YES
KRA 6 / SG 6b and SG 6c	2	Web-based typhoon forum	(a) To run routinely (b) Upgrade the Forum and opening for scientists and operational forecasters upon request.	WGs	1 st -4 th	CMA Members	Submission of the progress report	/	/	Zen Zhihua (CMA)	YES
KRA 1 - 6	3	Tropical Cyclone Research and Review	(a) To publish the journal quarterly in 2015 (b) Improvement of the editorial procedure and enhance the Journal's recognition (includes inviting 2-3 visiting editor)	AWG, WGs	1 st -4 th	CMA, TCS Members	Submission of the Progress report	US\$5,000	TCTF	Ms. Wang Dongliang & Zhou Xiao (CMA)	YES
KRA 1 KRA 2 KRA 6 / SG 6b and 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	TRCG	1 st -4 th	KMA Members	Submission of the progress report	US\$4,000	TCTF	KiRyong Kang (KMA)	YES

Status of Annual Operating Projects (AOPs) in 2015 (WGM)

SP's KRA and SG	Objective Number	Objective	Action	Other WG's involved	Expected Quarter Completed	Other Organizations Involved	Success Indicators	Funding Required	Funding Sources	Coordinator	Status of Completion
KRA 1 KRA 2 KRA 6/SG 6b and 6c	1	Enhanced use of ensemble forecast	(a) To prepare for provision of ensemble TC track guidance of ECMWF, UKMO, NCEP, and JMA through the Numerical Typhoon Prediction Website if necessary NWP data are provided. (b) To examine a multi-center grand ensemble (MCGE) for TC generation prediction.	/	1 st -4 th	JMA	(a) Submission of the progress report. (b) Summarize verification results of TC generation prediction skills using TIGGE data and potential for its operational use	/	/	Tsukasa Fujita (JMA)	YES
KRA 1 KRA 2 KRA 6/SG 6b and 6c	2	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-TLFDP website (c) To further improve the evaluation system for tropical cyclone forecast, with special attention on genesis and ensemble forecast conjunction with WMO-TLFDP (d) To offer fellowship for training on (b)	AWG, TRCG	1 st -4 th	CMA, Members PTC	(a) & (b) Submission of the post-season verification report (c) & (d) Progress report on the improvement of evaluation system for tropical cyclone forecast and Fellowship	US\$3,000	TCTF	Ms. Yu Hui (CMA)	YES
KRA 1 KRA 2 KRA 6	3	Improvement of South China Sea typhoon forecast	(a) Further improvement of TRAMS-9km model (b) Provide TRAMS-9km products related to typhoon assess through website	/	1 st -4 th	CMA, Viet Nam, PAGASA, MMD	Submission of the report on the assessment of model and website	/	/	Chen Zitong (CMA)	YES

SP's KRA and SG	Objective Number	Objective	Action	Other WG's involved	Expected Quarter Completed	Other Organizations Involved	Success Indicators	Funding Required	Funding Sources	Coordinator	Status of Completion
KRA 1 KRA 2 KRA 6	4	Improvement of severe weather forecasting and interaction with user communities	(a) Further develop the web portal with the providence of more products for Member (b) Hosting the SWFDP-SeA website at IDC (c) Establish a FTP Server at NCHMF.	WGH, WGDRR , TRCG	2 nd -4 th	Viet Nam, Cambodia Lao PDR Thailand WMO	Progress report	/	/	Vo Van HOA NHMS of Viet Nam	YES
KRA 1 KRA 2	5	Development of regional radar network	(a) Application of JMA's quality management technique using statistical method to each of the TMD radar (b) Development of source codes of radar data calibration for QPE by TMD with technical assistance of JMA (c) Submission of a progress report by TMD. On receipt of the report, holding a technical meeting at JMA or TMD to follow up with the progress and to identify a way forward	TRCG	1 st - 4 th	TMD, JMA	(a) & (b) Submission of the progress report by TMD	US\$4,000	TCTF	Patchara Petvirojchai (TMD) Tsukasa Fujita (JMA) Derek Leong (TCS)	YES
KRA 1 KRA 2 KRA 4 / SG4a	6	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 results emerged (c) Collect data of progress of work (d) Make a draft of outline	WGH WGDRR TRCG	1 st - 4 th	HKO CMA, USA JMA, KMA, Macao Members	Submission of the progress report	/	/	Wong Chan Seng (Macao /China)	YES

SP's KRA and SG	Objective Number	Objective	Action	Other WG's involved	Expected Quarter Completed	Other Organizations Involved	Success Indicators	Funding Required	Funding Sources	Coordinator	Status of Completion
KRA 1 KRA 2 KRA 4 /SG4 (a)	7	Storm surge watch scheme	(a) To provide storm surge time series forecasts at more than one point if so requested by Members. (b) To prepare for provision of multiple scenarios of storm surge forecasts to TC Members. (c) To conduct verification of time series forecasts if tidal data during past storm surge events are provided by Members.	WGH TRCG	1 st - 4 th	JMA	(a) Develop storm surge time series charts at more than one point if so requested by Members. (b) Report progress of multiple scenarios of storm surge forecasts (c) Report the verification results, if any.	/	/	Tsukasa Fujita (JMA)	YES
KRA 1 KRA 2 KRA 6 /SG 6b and 6c	8	Contribution for the Experiment on Typhoon Intensity Change in Coastal Area (EXOTICCA)	(a) To hold the OC meeting for preparing the implementation (field campaign in 2015) of the experiment (b) To test the field campaign by using aircraft (un/manned) drop-sounds, mobile GPS rise-sound and rocket drop-sound. (c) Demonstration research on tropical cyclone intensity change by using target typhoon data from the field campaign (to be included in the TC Fellowship Scheme).	AWG	1 st – 4 th	CMA, HKO Members	(a) To report the outcomes of the meeting to the Organizing Committee (b) Carry out the field campaigns and gather the special observation data of 1-2 target typhoon (c) Submission of the progress report	US\$5,000	To be funded through "Special Funding Request" and not included in the WGM budget	LEI Xiaotu (CMA) WK Wong (HKO)	YES
KRA 1 KRA 2 KRA 4	9	Development of tropical cyclone forecasting competency	To develop an outline of tropical cyclone forecasting competency	TRCG	1 st -4 th	RSMC Tokyo and Honolulu, TC Members that are interested in this project	Submission of the outline and progress report	/	/	Tsukasa Fujita (RSMC Tokyo) Raymond Tanabe (RSMC Honolulu)	YES

Status of Preliminary Projects (PPs) in 2015 (WGM)

SP's KRA and SG	Objective Number	Objective	Action	Other WG's involved	Expected Quarter Completed	Other Organizations Involved	Success Indicators	Funding Required	Funding Sources	Coordinator	Remarks
KRA 1 KRA 2 KRA 4	1	High resolution tropical cyclone model based on GRAPES (G-TCM)	(a) Coordinate with WMO-TLFDP, comparison of (semi-) operational typhoon model (HWRF and GRAPES-TCM) (b) Coordinate with EXOTICA, Practicability and pilot study on the high resolution ($\leq 3\text{km}$) typhoon model development.	/	1 st – 4 th	CMA, Members WMO	Submission of the progress report	/	/	Chan Baode (STI/CM A)	YES
KRA 1 KRA 2 KRA 4 /SG4 (a)	2	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.	/	1 st – 4 th	JMA, CMA, HKO	Submission of the progress report	/	/	Tsukasa Fujita (JMA)	YES
KRA 1 KRA 2 KRA 4 /SG4 (a)	3	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.	TRCG	1 st -4 th	CMA Members that are interested in this project	Submission of the progress report	/	/	Qian Chuanhai (CMA)	YES

Annex II:

WGM-Perennial Operating Projects (POPs) in 2016

SP's KRA and SG	Objective Number	Objective	Action	Other WG's involved	Expected Quarter Completed	Other Organizations Involved	Success Indicators	Funding Required	Funding Sources	Coordinator	Remarks
KRA 1 KRA 2 KRA 6	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	/	1 st -4 th	KMA Members	Submission of the progress report	/	/	KiRyong Kang (KMA)	Continued (2015 -)
KRA 6 / SG 6b and 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	WGs	1 st -4 th	TCS, CMA Members	Submission of the progress report	/	/	Clarence FONG (TCS) & Zen Zhihua (CMA)	Continued (2013 -)
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	AWG, WGs	1 st -4 th	CMA, TCS Members	Submission of the progress report	US\$5,000 (plus US\$5,000 special funding for editorial board meeting)	TCTF and Special Funding Request	Ms. Wang Dongliang & Zhou Xiao (CMA)	Continued (2013 -)
KRA 1 KRA 2 KRA 6 /SG 6b and 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	TRCG	1 st -4 th	KMA Members	Submission of the progress report	US\$5,000	TCTF	KiRyong Kang (KMA)	Continued (2014 -)

KRA 1 KRA 2 KRA 6 / SG 6b and 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-TLFDP website (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)	AWG, TRCG	1 st -4 th	CMA, Members	(a) Submission of the post-season verification report (b) Progress report on the improvement of evaluation system for tropical cyclone forecast	US\$3,000	TCTF	Ms. Yu Hui (CMA)	Moved from AOP2_2015
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WGM-Annual Operating Projects (AOPs) in 2016

SP's KRA and SG	Objective Number	Objective	Action	Other WG's involved	Expected Quarter Completed	Other Organizations Involved	Success Indicators	Funding Required	Funding Sources	Coordinator	Remarks
KRA 1 KRA 2 KRA 6 / SG 6b and 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..	/	1 st -4 th	JMA	(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.	/	/	Tsukasa Fujita (JMA)	Continued (2011 -)

SP's KRA and SG	Objective Number	Objective	Action	Other WG's involved	Expected Quarter Completed	Other Organizations Involved	Success Indicators	Funding Required	Funding Sources	Coordinator	Remarks
KRA 1 KRA 2 KRA 6	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	/	1 st -4 th	CMA, Viet Nam, PAGASA, MMD	Submission of the report on the assessment of model and website	/	/	Chen Zitong (CMA)	Continued (2012 -)
KRA 1 KRA 2 KRA 6	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 images on SWFDP webpage (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 (e) Extending forecasting domain of regional NWP model in order to cover the east sea of Philippines	WGH, WGD RR, TRCG	3 rd -4 th	Viet Nam, Cambodia, Lao PDR, Thailand, Philippines, RSMC Tokyo	Progress report	/	/	Vo Van HOA, Duc TIEN NHMS of Viet Nam	Continued (2011 -)

SP's KRA and SG	Objective Number	Objective	Action	Other WG's involved	Expected Quarter Completed	Other Organizations Involved	Success Indicators	Funding Required	Funding Sources	Coordinator	Remarks
KRA 1 KRA 2	4	Development of regional radar network	(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. (b) Application of radar data calibration techniques for QPE by TMD with technical assistance of JMA. (c) Experimental test of radar data sharing among JMA, TMD, and MMD. (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.	TRCG	1 st – 4 th	TMD, MMD and JMA	(a) & (b) Submission of the progress report (c) Submission of the progress report by involved countries	US\$4,000	TCTF	Lucia Enggong (MMD) Patchara Petvirojchai (TMD) Tsukasa Fujita (JMA)	Continued (2011 -)
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	WGH WGDRR TRCG	1 st – 4 th	HKO/China, CMA, USA, JMA, KMA, Macao/China (coordinator) Members	Submission of the progress report	/	/	Wong Chan Seng (Macao/China)	Continued (2014-2017)

SP's KRA and SG	Objective Number	Objective	Action	Other WG's involved	Expected Quarter Completed	Other Organizations Involved	Success Indicators	Funding Required	Funding Sources	Coordinator	Remarks
KRA 1 KRA 2 KRA 4 /SG4 (a)	6	Storm surge watch scheme	<p>(a) To provide multiple scenarios of storm surge predictions and ensemble one-week ocean wave predictions to TC Members from TY season in 2016.</p> <p>(b) To add storm surge time series prediction points if so requested by Members.</p> <p>(c) To verify storm surge predictions if tidal data during storm surge events are available.</p>	WGH TRCG	1 st - 4 th	JMA	<p>(a) Provide multiple scenarios of storm surge predictions and ensemble one-week ocean wave predictions.</p> <p>(b) Add stations for storm surge time series if so requested by Members.</p> <p>(c) Report verification results if tidal data during storm surge events are provided.</p>	/	/	Tsukasa Fujita (JMA)	Continued (2012-)
KRA 1 KRA 2 KRA 6	7	Contribution for the Experiment on Typhoon Intensity Change in Coastal Area (EXOTICCA)	<p>(a) To implement the field campaign collaboration among participating Members by using aircraft drop-sondes, mobile GPS radio-sondes and rocket drop-sondes.</p> <p>(b) Demonstration research on tropical cyclone intensity change conjunction with WMO-TLFDP (to be included in the TC Fellowship Scheme).</p>	AWG	1 st – 4 th	CMA, HKO, Participant Members (KMA, TMD)	<p>(a) Carry out the field campaigns and gather the special observation data of 1-2 target typhoon</p> <p>(b) Submission of the progress report</p>	US\$5,000 (special funding)	Special Funding Request	LEI Xiaotu (CMA) WK Wong (HKO)	Continued (2014-)

SP's KRA and SG	Objective Number	Objective	Action	Other WG's involved	Expected Quarter Completed	Other Organizations Involved	Success Indicators	Funding Required	Funding Sources	Coordinator	Remarks
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.	TRCG	1 st -4 th	RSMC Tokyo and Honolulu, TC Members that are interested in this project	Report an updated TC competency	/	/	Tsukasa Fujita (RSMC Tokyo) Raymond Tanabe (RSMC Honolulu)	Continued (2015-)

WGM-Preliminary Projects (PPs) in 2016

SP's KRA and SG	Objective Number	Objective	Action	Other WG's involved	Expected Quarter Completed	Other Organizations Involved	Success Indicators	Funding Required	Funding Sources	Coordinator	Remarks
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.	/	1 st – 4 th	JMA, CMA, HKO	Submission of the progress report	/	/	Tsukasa Fujita (JMA)	Continued (2013-)
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.	TRCG	1 st -4 th	CMA Members that are interested in this project	Submission of the progress report	/	/	Qian Chuanhai (CMA)	Continued (2015-)