ESCAP/WMO Typhoon Committee

FORTY-SIXTH SESSION

10 - 13 FEBRUARY 2014

BANGKOK, THAILAND

FOR PARTICIPANTS ONLY

WRD/TC.46/7.1
28 January 2014

ENGLISH ONLY

REPORT OF WGM

(submitted by Chair of WGM)

Action Proposed

The Committee is invited:

(a) To take note of the Members activities and major progress and issues in meteorology component in 2013 as reported by Members at the 8th IWS (http://www.typhooncommittee.org/8IWS_2TRCG/Members.html);
(b) To review the WGM activities in 2013 and planned activities in 2014 and beyond
(c) To endorse the WGM recommendations

APPENDIX I: Summary Report of WGM Parallel Meeting at the 8th IWS
APPENDIX II: Project Proposal of "Experiment on Typhoon Intensity Change in Coastal Area (EXOTICA)"

2013 ANNUAL REPORT 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.) 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 Tropical Cyclone Programme (TCP) of WMO and Typhoon Committee Secretariat (TCS), and the absolute sincere cooperation of all Members, WGM has successfully completed the tasks in 2013 with the significant outcomes as follow:

- WGM has completed all the action plans (include 10 AOPs, 3 POPs and 3 PPs) which were endorsed at the 45th session;
- The second assessment report on the impacts of climate change on tropical cyclones has been published in February 2013 and it is available on the TCS website (http://www.typhooncommittee.org/documents-tc-publications/). The two papers related to the second assessment report published in the Journal of ***Tropical Cyclone Research and Review***, were cited three times in Chapter 14 of IPCC AR5 (Climate change 2013: The physical science basis, the WGI report).
- With the support of all Members, the editorial office together with WGM has successfully published the journal ***Tropical Cyclone Research and Review*** **(Vol.2, No.1-4)** under the name of Typhoon Committee in 2013.
- WGM has provided help in the WMO Landfall Typhoon Forecast Demonstration Project (LTFDP) and NW Pacific Tropical Cyclones Ensemble track Forecast Project (NWP-TCEFP) concerning related Members. Both projects have been put into service of Members from 2010, and have been extended to 2015.

- WGM has drafted the proposal of the field experiment - Experiment on Typhoon Intensity Change in the Coastal Area (EXOTICA) based on the recommendation at the 45th TC Session. The revised draft proposal will soon be sent to the AWG members for discussion and further inputs from Members during the 46th TC Session.

2. Membership

2.1 The current composition and focal point members list of WGM are:

Chair	Mr. Lei Xiaotu (China)
Vice Chair	Mr. Nathaniel Servando (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) Ms. Kaisorn Thanthathep (Lao PDR) Mr. Wong Chan Seng (Macao, China) Ms. Che Gayah Ismail (Malaysia) Mr. Renito B. Paciente (Phillippines) Dr. Se-Won Kim (Rep. of Korea) Mr. Lesley Choo (Singapore) Dr. Songkran Agsorn (Thailand) Mr. Bill Ward (USA) Mr. Vo Van Hoa (Viet Nam)

2.2 Experts from other working groups of TC, TCP/WMO, TCS, RSMC-Tokyo, JTWC and others have also provided assistances to accomplish the tasks of WGM in 2013, namely the 45th session of TC, the two WMO demonstration projects, SSOP workshop in Bangkok of Thailand, attachment training on QPE/QPF in Tokyo, radar expert mission to Thailand, visiting editor to TCRR editor office (Shanghai).

3. WGM activities and progress of action plans in 2013

With the assistances of TCP/WMO and TCS and the strong support from all Members, WGM has successfully completed the action plans in 2013, which were endorsed at the 45th Session. The WGM activities and the progress of all action items in 2013 are reported in the Appendix I – Summary Report of the WGM Parallel Meeting at the 8th IWS. The complete table of the 2013 action plans (AOPs, POPs and PPs) and its implementation status are listed

in Annex I of the Summary Report.

After the 45th TC Session in 2013, WGM has been carrying out many activities that involve the cooperation among Members as well as other TC WGs and international organizations, which includes:

- The coordination meeting with CMA and WMO/WWRP/WGTMR on Typhoon Experiment (EXOTICA) held in Beijing in March, to revise the draft proposal of the project.
- AWG small meeting and SSOP workshop, held in Bangkok of Thailand on 8-9 May. The Typhoon Experiment project proposal was introduced to the AWG members.
- 8th WGDRR Workshop held at Seoul of Republic of Korea in May in which TCS meteorologist made a presentation on the Typhoon Experiment on this occasion. WGDRR members were invited to provide further input to the proposal.
- Coordinate with STI and National Meteorology Center (NMC) of CMA and National Typhoon Center (NTC) of Korea Meteorological Administration (KMA) to organize the 6th China-Korea joint workshop on the tropical cyclones, held in Shanghai and Beijing of China on 26-28 May 2013.
- Coordinate with STI of CMA and HKO to organize the training workshop on Dvorak technique, held in Shanghai from 28 to 30 May 2013.
- Coordinate with KMA to conduct a training course on TAPS, held at KMA in May. Three forecasters from Vietnam, Philippines and Thailand participated the training.
- Coordinate with RSMC Tokyo to organize the Annual Attachment Training, conducting the training of storm surge and QPE/QPF, held at RSMC Tokyo in July. Two experts from Cambodia and Thailand attended the Attachment Training.
- Participate and coordinate with PAGASA to organize the in-country pilot workshop on Synergized Standard Operating Procedures (SSOP) for coastal multi-hazards early warning system, held in Quezon City of Philippines on 3-4 October.
- Coordinate with HKO to organize the training on QPE/QPF and nowcasting of severe weather in SWIRLS (HKO's operational nowcasting system), conducted from 21 October to 1 November.
- Coordinate with JMA and TMD to hold a technical meeting at JMA on 25-28 November among the radar experts from both organizations to follow up on the progress of the project on the Development of Regional Radar Network.
- Coordinate with STI of CMA and TCS to edit and publish the Typhoon Committee Journal "*Tropical Cyclone Research and Review*", No.1-4 of Vol.2.

4. Conclusions and proposed action plans for 2014

On the basis of the information provided by Members and the respective coordinator of the action plans and based on the discussion during the Meeting, the following conclusions were

reached:

a. Members made important progress in the implementation of the TC Strategic Plan during the year 2013.
b. Members made significant progress during 2013 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. Successful completion of the WGM action plans in 2013.
d. The inputs from the beneficiary Members of the SSOP project contributed significantly to the implementation of the SSOP.
e. The role of the ensemble prediction products in tropical cyclone forecasts for effective warning is increasing through the effective tools provided in the WMO-TCEFP web page.
f. JMA has made significant progress in the research on TC genesis prediction skills. The results of the comparison of the Brier Scores of ECMWF, JMA, NCEP and UKMO with the climatology for Day1-Day3, Day3-Day7 and Day7-Day14 indicated that all EPS successfully predicts genesis events with a lead-time of five days over the investigated period from July to October in 2009 to 2012 by using TIGGE data.
g. Forecasts of tropical cyclone tracks from six global models during 2010-2012 were assessed by STI/CMA to study the current capability of track forecast guidance over the western North Pacific. It is concluded that certain improvements have been made for the six global models in their prediction accuracy and stability in the past three years.
h. The performance of the South China Sea Typhoon Model (TRAMS) has been improving in 2013. For example, the genesis of UTOR is predicted 30 hours before named, and the 24h, 48h and 72h track forecast error are 43km, 67km and 135km.
i. Significant progress has been made on the construction of web-based portal system for the typhoon seasonal prediction system hosted by KMA.
j. Significant progress has been made on the improvement of severe weather forecasting and interaction with the user communities of the participating Members through the implementation of the SWFDP-SeA web portal hosted by National Hydro-

Meteorological Services of Viet Nam.

k. With the technical assistances from JMA, TMD has made significant progress on the project of the Development of Regional Radar Network according to the roadmap.

l. The in-depth QPE/QPF training organized with the Typhoon Committee Research Fellowship Scheme was much appreciated by the participants from the UFRM pilot cities. Follow-on technical assistance to participating Members on the adaptation of the QPE/QPF technique is necessary.

m. The expansion of the forecasting region of the storm surge model (the region now cover 95-160°E in longitude and 0-46°N in latitude) and its improvement as well as the addition of the stations from Members for storm surge time series forecasting services will further contribute to the early warning capabilities of storm surge in the TC Region.

n. There are needs from Members to continue the transfer of technology and knowledge of the Typhoon Information System (TAPS) among Members as well as the assistances to implement the system.

o. Higher priority should be put to developing Members of the Committee as the target of the RSMC attachment training to reduce widening gaps between the developed and developing members; and the needs of developing Members for training opportunities to enhance their capacity in the storm surge forecasting should be considered as well.

p. The web-based typhoon forum could be very useful in terms of providing a convenient platform for both forecasters and researchers with more registered users from the Members.

q. The publication of the Typhoon Committee Journal "Tropical Cyclone Research and Review" plays an important role in providing an effective way to exchange the knowledge and the latest progress in tropical cyclone research, forecasting technique and warning system as well as to enhance the visibility of Typhoon Committee.

r. The digitization of CI numbers from different warning centers is in progress. The exchange of best-track datasets including digitized CI numbers and conduct cyclone by cyclone analysis of CI numbers will be useful to narrow down the differences between warning centers on tropical cyclone intensity assessment.

s. With the significant advances in observations and numerical prediction modelling of typhoon, there has been significant improvement in typhoon track forecast while no significant progress has been made in typhoon intensity forecast. Therefore, strengthening coordination of observations, cooperative efforts on research, and integrating the resources to carry out scientific experiments around common scientific issues and operational objectives, with the focus on the intensity changes of offshore and landfalling tropical cyclones, is very important.

t. Based on the discussion on the action plans for 2014 and according to the new structure of the action plans, it was also concluded that:

   i. AOP item 1 – 7 and 9 in 2013 will be continued in 2014.

   ii. Rename 2013 AOP item 8 as "Training attachment to HKO on QPE/QPF" and to be included in 2014 as AOP 11. 2013 AOP item 10 will be included in the POPs as new POP item 4 in 2014. POP item 1 – 3 in 2013 will be continued in 2014.

   iii. To move the 2013 PP item 1 "Assessment report on the impact of climate change on tropical cyclone in TC region" to AOPs as AOP item 8 in 2014.

   iv. Establish the new AOP item 10 of "Contribution for the Experiment on Typhoon Intensity Change in Coastal Area (EXOTICA) in order to support the implementation of this experiment. The project of High Resolution Typhoon Model (HRTM) will be undertaken as the new PP item 1 in 2014.

   v. PP 2 – 3 will be continued in 2014.

   vi. The total budget proposed by WGM, which was adjusted at the AWG meeting after the 8th IWS, for undertaking the actions plans (AOPs, POPs and PPs) in 2014 is **USD15000**. In addition, the budget of USD11000 will be allocated for the support of the next Integrated Workshop. Thus the total budget for WGM for year 2014 is **USD26000**. The financial support of USD5000 for AOP item 10 will be allocated through the "Special funding request", considering the necessity to hold a meeting in early 2014 with the participation of the concerned Members and experts for preparing the implementation of this project, and no extra WGM budget can be made available for this purpose.

5. Future Directions and Strategies

a. Intensify the field campaign on tropical cyclone in TC region and jointly carry out special scientific experiment on the difficult (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 capability 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 tech**n**iques 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*.

6. Recommendations

a. To endorse the WGM project proposal of "Experiment on Typhoon Intensity Change in Coastal Area (EXOTICA) as shown in Appendix II, and to encourage the active participation of the Members.
b. To establish the expert team on the impact of climatic change on tropical cyclone in TC region; and to carry out a preliminary review on the latest research development on the impacts of climate change on tropical cyclones to identify key areas that needed to be addressed in the 3rd Assessment.
c. To encourage Members, in particular the SSOP beneficiary Members to collaborate with the SSOP project.
d. To request RSMC Tokyo to provide storm surge time series forecasts if so requested by Members, and to enhance training contents on storm surge forecasts during the annual TC attachment training responding to requests from Members.
e. To request Members to provide tidal data archive to RSMC Tokyo for verification of the said storm surge time series forecasts and further improvement of the storm surge model.

f. To further improve QPE/QPF techniques of Members and request RSMC Tokyo to conduct QPE/QPF training during annual TC attachment training.
g. To request RSMC Tokyo to explore possible ways to enhance guidance on tropical cyclone ensemble forecasts over the western North Pacific for Members including those of the SWFDP-SeA, based on the success of NWP-TCEFP in order to further promote the operational use of such ensemble guidance.
h. To request RSMC Tokyo to further examine TC genesis prediction skills to identify potential of its operational use in the future.
i. To request KMA to further improve the typhoon information processing system (TAPS of KMA) project; and to collaborate with the Typhoon Committee Research Fellowship Scheme to provide training for the typhoon forecasters on the use of TAPS as well as to provide follow-on technical assistance on the implementation of TAPS as requested by Members.
j. To promote the web-based typhoon forum among members and to encourage more forecasters and researchers from Members to register to the forum.
k. To request TMD to apply radar composite technique provided by JMA to the nationwide radar network in Thailand and to conduct preliminary works on the application of QPE techniques with technical assistance of JMA. To request TMD and JMA to hold a technical meeting to identify a way forward on the submission of a progress report by TMD.
l. To request STI/CMA to carry out post-season verification and reliability analysis on the operational forecast of tropical cyclones and to further improve the evaluation system for tropical cyclone forecast with special attention on genesis and ensemble forecast in conjunction with WMO-TLFDP.
m. To request STI/CMA to further improve the editorial procedures of the TC Journal *Topical Cyclone Research and Review.*
n. To request WMO and ESCAP to promote the TC Journal *Topical Cyclone Research and Review* and to encourage Members to submit articles to the Journal.
o. To collaborate with TC Research Fellowship Scheme to provide QPE/QPF training to Member.
p. To request CMA to further improve the numerical prediction system TRAMS model of the project of *Improvement of South China Sea Typhoon Forecast* as well as to provide more related products through its website.
q. To request KMA to further develop the techniques of typhoon seasonal prediction as well as to improve the web portal web page to provide the products of typhoon seasonal prediction to Members.

r. To request National Hydro-Meteorological Service of Viet Nam to further improve the SWFDP-SeA portal web page to include more products.
s. To request STI/CMA to carry out the preliminary study on the High Resolution Tropical Cyclone Model (HTCM).
t. To continue the study on the methodology to compare the best track datasets based on the recommendations of the best track consolidation meeting with the consideration on the progress of digitization of CI numbers in hardcopy.
u. To exchange best-track datasets including digitized CI numbers for the period 2004-2013 by the end of June 2014. To conduct cyclone-by-cyclone comparison analysis of CI numbers with preliminary report of findings, if digitization of CI numbers of the said period are completed.
v. To continue the work of the Taskforce on TC Intensity Analysis for upgrading TD.
w. To request WMO to publish the 2014 edition of TOM on the Tropical Cyclone Programme (TCP) Website by March 2014.
x. To endorse the action plans (including the 11 AOPs, 4 POPs and 3 PPs) as listed in Annex II of the Appendix – Summary report of the WGM Parallel Meeting at the 8th IWS, which summarizes the above recommendations with additional action items.
y. To endorse the WGM budget proposal which is included in the budget proposal to be submitted by AWG for TC's approval under Agenda Item 13.4.
z. To appoint Mr. Tsukasa Fujita (Japan) as the TOM Rapporteur.
aa. To re-appoint Dr. Lei Xiaotu (China) and Ms. Che Gayah Ismail (Malaysia) as respective Chairperson and Vice-Chairperson of WGM and appoint Dr. Vicente Malano (Philippines) as the Vice-Chairperson.

APPENDIX I

Summary Report of the WGM Parallel Meeting
8th Integrated Workshop
Macao, China
5 December 2013

1. The WGM Parallel Meeting of the 8th Integrated Workshop was held on 5 December 2013, which was attended by 30 participants from 12 Members (Cambodia; China; DPR Korea; Hong Kong, China; Japan; Lao PDR; Macao, China; Malaysia; Philippines; Republic of Korea; Thailand and Viet Nam). Representatives from TCS and WMO and Project Manager/Technical Adviser of SSOP also attended the Meeting.

2. Members Reports (WGM Component) were presented during the parallel morning session on Day 2 of the 2nd TRCG Forum. 13 Members presented their Members report during this parallel session. The Meeting took note of the presentations of the Members' Reports and appreciated the Members' efforts in improving the tropical cyclone forecast accuracy, knowledge and technique transfer, information sharing, training and research coordination and various support extended to the Committee. The Members' Reports of 2013 are posted on the TC website.

3. At the 7th IWS held in Nanjing, China, WGM Chair proposed to restructure the table of Annual Operating Plans, namely the inclusion of 2 additional tables, which are the Perennial Operating Projects (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.

4. With the help of Tropical Cyclone Programme (TCP) of WMO and Typhoon Committee Secretariat (TCS), and the absolute sincere cooperation of all Members, WGM has successfully completed the tasks in 2013 with the significant outcomes as follow:

- WGM has fulfilled all the plans (include 10 AOPs, 3 POPs and 3 PPs) which were endorsed at the 45th session;
- The second assessment report on the impacts of climate change on tropical cyclones has been published in February 2013 and it is available on the TCS website (http://www.typhooncommittee.org/documents-tc-publications/). The two papers related to the second assessment report published in the Journal of ***Tropical Cyclone Research and Review***, were cited three times in Chapter 14 of IPCC AR5 (Climate change 2013: The physical science basis, the WGI report).
- With the support of all Members, the editorial office together with WGM has been successfully published the journal ***Tropical Cyclone Research and Review*** **(Vol.2, No.1-4)** under the name of Typhoon Committee since 2013.

- WGM has provided help in the WMO Landfall Typhoon Forecast Demonstration Project (LTFDP) and NW Pacific Tropical Cyclones Ensemble track Forecast Project (NWP-TCEFP) concerning related Members. Both projects have been put into service of Members from 2010, and have been extended to 2015.
- WGM has drafted the proposal of the field experiment - Experiment on Typhoon Intensity Change in the Coastal Area (EXOTICA) based on the recommendation at the 45th TC Session. The revised draft proposal will soon be sent to the AWG members for confirmation and further inputs from Members during the 46th TC Session.

5. Progress of WGM action plans (AOPs, POPs and PPs) in 2013

The Meeting reviewed the progress and the results of the AOPs, POPs and PPs since the 45th TC Session as presented by the respective coordinators of each project. The tables of WGM AOP 2013 Implementation status including the actions and the implementation status are listed in Annex I.

5.1 AOP1 – Contribution to SSOP

- As one of the three pilot countries (Philippines, Bangladesh, and Pakistan), Philippines participated at the SSOP Workshop held in Bangkok on 8-9 May on collecting and exchanging the performance status of coastal multi-hazard EWS in TC and PTC Members' countries at high risk.
- Coordinated with PAGASA to organize the in-country piloting workshop on Synergized Standard Operating Procedures (SSOP) for coastal multi-hazards early warning system, held in Quezon City of Philippines on 3-4 October, to identify Standard Operating Procedures (SOP) best practices, gaps and needs, recommendations, and an action plan to meet the needs of the Philippines and of the project for the other 12 beneficiary countries involved.
- PAGASA has an existing tropical cyclone SOP, but has no existing SOP for storm surge. Several of the PAGASA staff have been trained and are running the NOAH model. But there are many questions on how to use these data, how to disseminate, and what role it will play.
- There are sufficient numbers of sea level monitoring stations among PHIVOLCS, NAMRIA and PAGASA, but no existing mechanism for data sharing.
- PAGASA now has MOUs/MOAs with the media and disaster services and has good SOPs concerning urban flooding, heavy rain, and segmentation.
- SSOP Project Manager informed the Meeting that the 7 beneficiary TC Members of SSOP have provided the input for the SSOP project.

5.2 AOP2 – Enhanced use of Ensemble Forecast

- The results of the questionnaires addressed to the Members on the utility of the TCEFP website had found that most of the Members use the TIGGE ensemble TC tack products operationally.
- No addition of elements such as surface wind and precipitation on the TCEFP website. It will be carried out should corresponding EPS data be provided by data providers, for instance, with the development of extended CXML in the future.

- TC genesis prediction skills over a forecast length of 2 weeks was investigated by MRI/JMA using TIGGE data for the period from July to October in 2009 to 2012 as reported at TRCG Forum 2013. The Brier Scores of ECMWF, JMA, NCEP and UKMO in comparison with the climatology for Day1-Day3, Day3-Day7 and Day7-Day14 were presented and the results indicated all EPS successfully predicts genesis events with a lead time of five days.
- TCEFP has been extended to 2015 to further examine the potential for operational TC generation prediction by using EPS.

5.3 AOP3 – Verification of tropical cyclone operational forecast

- Forecasts of tropical cyclone tracks from six global models during 2010 and 2012 were assessed to study the current capability of track forecast guidance over the western North Pacific. It is concluded that certain improvements have been made for the six global models in their prediction accuracy and stability in the past three years. An analysis of the regional distribution of position errors showed that a high-latitude region, low-latitude region (which covers mostly the tropical cyclone genesis region) and the South China Sea are the three main areas within which large errors tend to concentrate. Binned analyses demonstrate the heavy reliance of forecast errors upon the initial characteristics of a tropical cyclone or its environmental conditions, including initial intensity, size, and vertical wind shear. The paper is published in *Tropical Cyclone Research and Review*, 2013, 2(3): 149-158.
- A new measure (the Track Forecast Integral Deviation, TFID) for the verification of tropical cyclone track forecasts is proposed, based on the mathematical consideration that a "good" forecast has a small distance to the observed track not only at zero-order but also at higher orders. It is suggested that such a measure is superior to the widely used position error (PE) in terms of reflecting the accuracy of the whole track instead of just one position. TFID was calculated for the track forecasts from the ECMWF-IFS during 2010–2012 as an experimental application and a comparison with PE showed that TFID can work as a good supplement to the PE in discriminating good or bad track forecasts.
- A number of comments were provided to the authors of the WMO document "Verification of tropical cyclone forecasts", with specially attention given to increase the visibility of related efforts in the western North Pacific region, such as the summary report "Operational Tropical Cyclone Forecast Verification Practice in the Western North Pacific Region" published by *Tropical Cyclone Research and Review* in 2012, which was a joint effort of all Typhoon Committee Members.
- Shanghai Typhoon Institute hosted a two-month visit of Ms Yen Lethihai from Viet Nam as jointly funded by the Typhoon Committee and Shanghai Typhoon Institute. Ms Yen implemented GFDL vortex tracker in Typhoon Forecast Evaluation and Assessment System (TFEAS), which can now provide tropical cyclone genesis products in real time based on CMA-T639 gridded output.

5.4 AOP4 – Improvement of South China Sea typhoon forecast

- The performance of TRAMS has improving continued in 2013. For example, the

genesis of UTOR is predicted 30 hours before named, and the 24h, 48h and 72h track forecast error are 43km, 67km and 135km.

- Based on the experiment data for the north area of South China Sea, a new parameterization scheme for turbulent transport of momentum in boundary layer was established. A two-way coupling mechanism is added into SAS scheme in TRAMS, the different drag coefficient (Cd) used in shallow or depth (far than 200km from land) sea area. The case study for typhoon Magi showed the new scheme could reduce the track error about 30km and 6 m/s of intensity forecast in shallow area during 48hr.
- 120 hours forecast for track and intensity were released from TRAMS, and a new version of this model with high resolution (9km) was tested in 2013.

5.5 AOP5 – Development of typhoon seasonal prediction system

- The current climate index condition, which is related with typhoon seasonal activity, will be included in the web-based typhoon seasonal prediction portal system.
- The ENSO, Arctic Oscillation (AO), Antarctic Oscillation (AAO), Pacific Decadal Oscillation (PDO), East Indian Ocean SST Anomaly (EIO SSTA) will be the major components for climate monitoring.
- As stated in 2012 AOP11 progress report, the typhoon seasonal forecast for 2013 summer is made from the consensus of three models from NTC/KMA, ECMWF, IRI, TSR, and the climate monitoring indexes. The result is listed on the currently building portal page of NTC/KMA.
- The conceptual design for the validation page of portal system for previous year prediction is under construction.
- The web-based typhoon seasonal prediction portal system will be linked to English page of National Typhoon Center homepage (http://typ.kma.go.kr/eng) and open to registered users of Typhoon Committee member countries at the end of year 2014.

5.6 AOP6- Improvement of severe weather forecasting and interaction with user communities

- The SWFDP-SeA webpage (http://www.swfdp-sea.com.vn) is operational now and there are a lot of products in available on the portal (username: swfdp-sea and password: RA2 - in case sensitive) for SeA NHMSs of Lao PDR, Cambodia and Thailand.
- The more products are operationally provided through the SWFDP-SeA portal, such as: Daily severe weather forecasting guidance for short range (1-2 days) and Medium range (3-5 days); Global deterministic and ensemble NWP products of NCEP, JMA, DWD, US Navy and CMC; Regional ensemble EPS of NHMS of Vietnam (SREPS for short range, LEPS for 3-5 days range and NAEFS for 5-10 days range); IR1 and VIS image of MTSAT; SCAT; GSMAP (Satellite based on rainfall) and storm track (forecast the very-short range motion of convective cloud based on MTSAT-2 data).
- The product for AMV and tropical cyclone track and intensity forecast is under-developed.

- The portal is real-time 24/7 and a team has established to maintain the portal in order to ensure all products are available. Recently two more countries (Myanmar and Philippines) requested to access the portal and utilize the products.

5.7 AOP7 – Development of regional radar network

- The source codes have been developed by TMD for conversion from UF format to GRIB2 format and beam blockage application to simulating beam height for each azimuth degree of each elevation on the topography of SRTM 250 meter resolution.
- A technical meeting for TMD radar staff was held at JMA from 25-28 November 2013. Two experts from TMD participated at the technical meeting to discuss the progress and to follow up on the training of producing a radar composite map on its own. TMD radar staff also acquired basic of the QPE technique in the technical meeting. TMD expressed its appreciation to JMA's technical assistances in the Meeting.

5.8 AOP8 – QPE/QPF for UFRM

- HKO offered a research fellowship to TMD (UFRM participating Member), with funding support from TCTF. The two-month attachment (21 Oct to 20 Dec 2013) arranged with research topic entitled "Development of location-specific severe weather nowcast techniques" was conducted.
- Two-week training for the research fellow on QPE/QPF and nowcasting of severe weather in SWIRLS (HKO's operational nowcasting system) conducted from 21 Oct to 1 Nov. One HKO-supported research fellow from the National Hydro-Meteorological Service of Vietnam (UFRM Member) and two self-funded meteorologists from the Macao Meteorological and Geophysical Bureau also participated in the training workshop.
- The technology transfer exercise to adapt SWIRLS for use in the Philippines and Malaysia continued. Further testing and evaluation was underway at MMD and PAGASA.

5.9 AOP9 – Storm surge watch scheme

- From 3 June 2013, JMA extends the forecasting region of the storm surge model and adds seven stations for storm surge time-series forecasting services. All products can be found on the JMA Numerical Typhoon Prediction website (https://tynwp-web.kishou.go.jp).
- The extended region covers 95-160°E in longitude and 0-46°N in latitude since June 2013, which includes the Mariana Islands and most of the Caroline Islands. This extension supports issuances of early warnings and directly helps users in the extension area to access to the predictions.
- The 7 new forecasting points in Thailand (Chumphon) and RoK (Boryeong, Busan, Incheon, Jeju, Mokpo and Sokcho) have been added responding to their requests since June 2013. Other 30 points in USA (1), The Philippines (9) and Vietnam (20) will be added in next year.
- Storm surge time series charts and tide level at more stations, if so requested and the station name, position, and hourly tidal observation data of the stations provide by

Members, will be developed and provided on the website by JMA.

5.10 AOP10 – Transfer of the technology of the Typhoon Analysis and Prediction System (TAPS)

- For effective support of TAPS operation of Vietnam, Vietnam made a request of additional data support from Korea Meteorological Administration (KMA) is being utilized.
- A new TAPS data supporting system server replaced the old one to provide TAPS-related data to Vietnam (Jun 2013).
- The construction of the webpage to support Vietnam and linkage to TAPS was implemented and tested on the system stability (Oct 2013).
- The dispatch of experts to Vietnam on Nov 2012 for the TAPS data supporting system and the construction of computer environment.
- In collaboration with the Typhoon Committee Research Fellowship Scheme and with the generous support from KMA, three operational forecasters from PAGASA, NCHMF of Viet Nam and TMD participated in the training at NTC/KMA from 1 May to 30 June 2013 with the training and research on optimizing typhoon forecast using TAPS and on the development of method of typhoon intensity and track forecast using model ensemble as well as other essential techniques.

5.11 POP1 – Improvement of QPE/QPF and storm surge technique for TC Members

- RSMC-Tokyo has conducted the year's attachment training from 17 to 26 July 2013, with funding support from TCTF and WMO. Two trainees from Cambodia and Thailand participated in the training, which includes the training on storm surge model and QPE/QPF. Evaluation reports by the participants were submitted to WMO/TCP.
- The Meeting noted the needs of the consideration of the 46th TC Session that higher priority may be put to developing Members of the Committee as the target of the RSMC attachment training to reduce widening gaps between the developed and developing Members. It further noted the needs of developing Members for training opportunities to enhance their capacity in storm surge forecasting.
- It noted that RSMC Tokyo, in consultation with TRCG, would consider the possibility to increase training opportunities, particularly targeting developing Members vulnerable to TC disasters, responding to the said needs.

5.12 POP2 – Web-based typhoon forum

- The web-based typhoon forum (http://www.typhoon.gov.cn/en/bbs) acts as a very convenient platform for forecasters and scientists to discuss typhoon-related topics online. Up to October 2013, there are 65 users coming from 11 Members in the forum.
- The discussions in this forum seemingly became less active in 2013 likely due to the job change of some of the registered users. To improve the forum further, it is taking into consideration that more researchers and specialists from universities and institutes to be encouraged to register as users of the forum, and to add more new topic sessions which the users are interested in 2014.

- It was suggested to consider the incorporation of the information from the social media applications in the Forum.

5.13 POP3 - Tropical Cyclone Research and Review

- As at the end of December 2013, 8 issues (No.1-4 of Vol.1 and No.1-4 of Vol.2) consist of 65 articles have been published. Not only WGs and TC Members, but also famous scientists worldwide have submitted their research paper to this journal. Each issue has been sent to each TC Members, WMO, universities and institutions and is also available on-line in the journal website.
- The journal is attracting more and more attention. As at the end of Decmeber 2013, the full texts were downloaded more than 26000 times, and averagely, each article was downloaded 410 times. And totally about 90 countries, including most of all TC Members, to download the journal's paper via the journal's website.
- Two invited experts, Dr. Jae Hyun Shim and Dr. Chi Hun Lee, from NDMI of Republic of Korea acted as visiting editor visited the editorial office in Shanghai for one week (2-8 September). One expert's financial support from the TCTF, other by ROK.
- More than 4 nominees from ROK, Thailand, Vietnam and Philippines applied for the visiting editor in 2013. It is planned to invite an expert to be the visiting editor for each issue.
- A special meeting with the head of Science Index Citation (SCI) center, aiming on *Tropical Cyclone Research and Review* to become SCI journal was held in Beijing in May. The head of SCI center expressed the appreciation to the themes, articles and layout of the journal, and encouraged the editorial office to continue sending the next 3 issues to them. If things going well, we'll be informed of the results by the end of this year.

5.14 PP1 – Assessment report on the impact of climate change on tropical cyclone in TC region

- The two papers, on our assessment of tropical cyclone climate change, published in the Journal of *Tropical Cyclone Research and Review* were cited three times by the IPCC AR5 in Chapter 14 (Climate change: The physical science basis, the WGI report).
- Some studies have been carried out on relevant issues. As suggested by expert team members of the 2nd Assessment Report, the 3rd Assessment Report on the impact of climate change on tropical cyclone in TC region will be carried out later upon the publication of more research papers on climate changes for the assessment.
- Some of the WGM members as well as the 2 expert team members of the 2nd Assessment Report participated in the Panel Discussion on the topic of "Establishment of mechanisms for building up homogeneous data sets for assessment of long term trends related to tropical cyclones patterns and activity" on Day 3 of the TRCG Forum in which the participants had the opportunity to discuss this project. It was suggested in the discussion to carry out a preliminary review on the latest research development on the impacts of climate change on tropical cyclones to identify key areas that needed to be addressed in the 3rd Assessment Report. During the discussion it was noted that climate researchers are interested in

the study on long term trends of the TC induced rainfall rate and extreme rainfall using high temporal resolution rainfall (e.g. hourly) data from weather stations of the Typhoon Committee Members. In addition, the following issues were considered needed to be addressed: (a) Standardized data analysis methods and definitions are not available; (b) Differences in best track data from various warning centers; (c) TC to ET transition (mid-latitude); and (d) Analysis of depressions after landfall (low latitude), especially for some Members that only infrequently experience TC landfalls.

5.15 PP2 – Harmonization of tropical cyclone intensity analysis

- Progress in digitization of CI numbers: CMA from 2008-2012, HKO from 2007-2011, RSMC Tokyo from 2004-2013, and JTWC 2004-2013.
- CMA CI-number data for season 2008–2012 was shared with JMA, HKO and JTWC. A website (http://tcdata.typhoon.gov.cn/en/index.html) was set up to share the CMA best track and CI-number data.
- The history of CMA's work on tropical cyclone best track data was overviewed, and a paper (Ying, M., W. Zhang, H. Yu, X. Lu, J. Feng, Y. Fan, Y. Zhu, and D. Chen, 2013: An overview of the China Meteorological Administration tropical cyclone database. *J. Atmos. Oceanic Technol*., doi: 10.1175/JTECH-D-12-00119.1) on technical details of the CMA TC data will soon be published.
- Agreed the completion of digitization of CI numbers from 2004 to 2013 to exchange best-track datasets including digitized CI numbers for the period 2004-2013 by the end of June 2014.
- Also agreed to conduct cyclone-by-cyclone comparison analysis of CI numbers with preliminary report of findings, if digitization completed.
- During the said Panel Discussion, progress of this project and the RSMC Tokyo initiative of reanalysis of CI numbers were shared with the participants. The participants noted that it is expected from climate communities (a) to narrow down the differences between warning centers on tropical cyclone intensity assessment and (b) to explore ways to bridge the difference in tropical cyclone intensity pre and post 1987 periods (for climate trend analysis). It was also informed the recent progress carried out by RSMC Tokyo on the re-analysis of satellite assessment of CI numbers back to 1981 and WGM on the exchange of historical CI records.

5.16 PP3 – Harmonization of timing of upgrade of TD to TS by various centers

- Task conducted by Taskforce:
  (i) Collecting the intensity data (2007-2011) from members;
  (ii) Comparing the data from different centers to ascertain the issue/problems in which 9 discrepancy cases between CMA and RSMC Tokyo during 2007-2011 were identified.
- The Taskforce will continue with the following actions as planned to:
  (i) Identify the reasons behind the discrepancies, specifically the timing of upgrading from TD to TS in each of 9 discrepancy cases between CMA and RSMC Tokyo during 2007-2011;
  (ii) Devise measures to remove/reduce the discrepancies in future based on the

findings from the above investigation, discuss the pros and cons of the proposed measures and reach a consensus on the way forward;

(iii) Make recommendations to WGM at 9th IWS in 2014.

6. The Meeting reviewed the proposal of Experiment on Typhoon Intensity Change in the Coastal Area (EXOTICA) based on the recommendation at the 45th TC Session as submitted by Chair of WGM. As WGM members has expressed concerns that more time is needed to review the proposal, it was agreed that the proposal to circulate again to members for comments and further input. After gathering inputs from members, the revised proposal will be submitted to the 46th TC Session.

7. Conclusions and the proposed action plans for 2014

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

- Members made important progress in the implementation of the TC Strategic Plan during the year 2013.
- Members made significant progress during 2013 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.
- Successful completion of the WGM action plans in 2013.
- Based on the discussion on the action plans for 2014 and beyond, it was concluded that:
  vii. AOP item 1 – 7 and 9 in 2013 will be continued in 2014.
  viii. Rename 2013 AOP item 8 as "Training attachment to HKO on QPE/QPF" and to be included in 2014 as AOP 11. 2013 AOP item 10 will be included in the POPs as new POP item 4 in 2014. POP item 1 – 3 in 2013 will be continued in 2014.
  ix. To move the 2013 PP item 1 "Assessment report on the impact of climate change on tropical cyclone in TC region" to AOPs as AOP item 8 in 2014.
  x. Establish the new AOP item 10 of "Contribution for the Experiment on Typhoon Intensity Change in Coastal Area (EXOTICA) in order to support the implementation of this experiment. After gathering comments and inputs from WGM member, the actions of this AOP will be revised (if necessary) before the 46th Session.
  xi. The project of High Resolution Typhoon Model (HRTM) will be undertaken as the new PP item 1 in 2014.
  xii. PP 2 – 3 will be continued in 2014.

- The total budget proposed by WGM, which was adjusted at the AWG meeting after the 8th IWS, for undertaking the actions plans (AOPs, POPs and PPs) in 2014 is **USD15000**. In addition, the budget of USD11000 was allocated for the support of the next Integrated Workshop. Thus the total budget for WGM for year 2014 is **USD26000**. The financial support of USD5000 for AOP item 10 will be allocated through the "Special funding request".

- The complete WGM 2014 action plans (AOPs, POPs and PPs) including the actions, the success indicators, coordinators and budget are listed in Annex II. The Meeting recommended that the proposed WGM 2014 action plans (subject to some follow-up revisions) to be endorsed at the 46th Session.

Annex I

Status of Perennial Operating Projects (POPs) in 2013 (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	Completed-Yes or No?
KRA 1 KRA 2 KRA 4 /SG4 (a)	1	Improvement of QPE/QPF and storm surge techniques for TC Members	(q) To collaborate with TRCG to conduct the yearly RSMC Tokyo Attachment Training for operational forecaster from TC Members including the training of storm surge model and QPE/QPF.	TRCG	1st -4th	JMA, WMO	Submission of the evaluation report	/	/	Tsukasa Fujita (JMA)	Yes
KRA 6 / SG 6b and SG 6c	2	Web-based typhoon forum	(a) To run routinely (b) Opening for scientists and operational forecasters upon Member's request (nominated by Members)	WGs	1st -4th	CMA Members	Submission of the progress report	/	/	Li qingqing (CMA)	Yes
KRA 1 - 6	3	Tropical Cyclone Research and Review	(a) To publish the journal quarterly in 2013 (b) Improvement of the editorial procedure (includes inviting the visiting editor) (c) Application of online ISSN	AWG, WGs	1st -4th	CMA, TCS Members	Progress report	US$3,000	TCTF	Ms. Wang Dongliang & Zhou Xiao (CMA)	Yes

Status of Annual Operating Projects (AOPs) in 2013 (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	Completed-Yes or No?
KRA 1 KRA 2 KRA 4	1	Contribution to SSOP	(a) To collect current status of Members' SOP for multi-hazard early warning (MEW) for coastal region (b) To convey the above outcomes to SSOP project for the implementation of SSOP	WGH WGDRR TRCG	1st -4th	TCS, Members, ESCAP WMO PTC ADRC	(a) Report of the collection of current status of Members' SOP for MEW for coastal region	TBD	SSOP Budget	Renito Paciente (PAGASA)	(a) Yes (Philippines and SSOP beneficiary Members only) (b) Yes
KRA 1 KRA 2 KRA 6 /SG 6b and 6c	2	Enhanced use of ensemble forecast	(a) To get feedback from Members for improvement of the TCEFP through WMO's questionnaire and SWFDP in Southeast Asia (b) To investigate tropical cyclogenesis prediction in the western North Pacific on medium-range timescales using the TIGGE data and on intraseasonal timescales using the JMA 1-month EPS conjunction with WMO-TCEFP	/	1st -4th	JMA	(a) Improvement of the web site responding to the feedback considering the provided data and feedback from SWFDP, if available (b) Investigate the TC genesis prediction over the western North Pacific during the 2009 and 2010 seasons using the TIGGE and JMA EPS data, and report the results	/	/	Tsukasa Fujita (JMA)	(a) No (to be postponed to include the addition of elements and to improve ensemble forecast products through past questionnaires in 2014) (b) 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	Completed-Yes or No?
KRA 1 KRA 2 KRA 6 / SG 6b and 6c	3	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 further improve the evaluation system for tropical cyclone forecast, with special attention on genesis forecast conjunction with WMO-TLFDP (to be included in the TC Fellowship Scheme) (c) To offer fellowship for training on (b)	AWG, TRCG	1st -4th	CMA, KMA, HKO, RSMC Tokyo Members	(a) Submission of the post-season verification report (b) Progress report on the improvement of evaluation system for tropical cyclone forecast	US$5,000	TCTF	Ms. Yu Hui (STI/CMA)	(a) Yes (b) Yes. 2 months Fellowship was offered to Vietnamese participant
KRA 1 KRA 2 KRA 6	4	Improvement of South China Sea typhoon forecast	(a) Further improvement of TRAMS model (b) Provide more products relate to typhoon assess through website	/	1st -4th	CMA, Viet Nam, PAGASA, MMD	Submission of the report on the assessment of model and website	/	/	Chen Zitong (CMA)	Yes
KRA 1 KRA 2 KRA 6	5	Development of typhoon seasonal prediction system	(a) To further develop the techniques of typhoon seasonal prediction (b) To establish the semi-operational web-based portal to provide the products of typhoon seasonal prediction for TC Members	/	1st -4th	KMA Members	Submission of the report on assessment of seasonal prediction models	/	/	Sangwook Park (KMA)	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	Completed-Yes or No?
KRA 1 KRA 2 KRA 6	6	Improvement of severe weather forecasting and interaction with user communities	(a) Semi-operation of SWFDP-SeA portal webpage (b) Provide more products in real time such as Daily Severe Weather Forecasting Guidance, thunderstorm index forecasting map, AMV, ASCAT, tropical cyclone track and intensity forecast, nowcasting for rainfall and storm, and Medium Weather Guidance (c) Investigate interpretation of EPS products as well as its NWP guidance (d) Coordinate real-time 24/7 communications among the participating centres in the region of the project (to maintain a list of 24/7 contact information; telephone, fax, e-mail)	WGH, WGDRR, TRCG	2nd-4th	Viet Nam, Cambodia, Lao, Thailand, WMO	Progress report	/	/	Vo Van HOA NHMS of Viet Nam	(a) Yes (b) Partly (c) Yes (d) Yes
	7	Development of regional radar network	(a) Development of source codes for conversion from UF format to GRIB2 format, as well as ones for production of EILS with the technical support from JMA (b) Specialized	TRCG	(a) 4th (b) 4th (c) 4th	TMD, JMA	Submission of the progress report, including a detailed schedule for the establishment of the radar composite map	US $5000	TCTF	Patchara Petvirojchai (TMD) Tsukasa Fujita (JMA) Derek Leong (TCS)	(a) Yes (b) Yes (c) 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	Completed-Yes or No?
			attachment training for TMD radar staff or an expert mission to TMD to complete the action (a) upon receipt of the progress report from TMD (c) To make the preparation studies on developing the composite map for the coverage of Thailand as well as utilizing QPE techniques by TMD								
KRA 1 KRA 2 KRA 4 / SG4a	8	QPE/QPF for UFRM	(a) To collaborate with TC Fellowship scheme to provide QPE/QPF training to TC Members participating in the UFRM pilot projects upon a request (b) To provide follow-on technical assistance to MMD and PAGASA on the adaptation of HKO's SWIRLS (c) Upon availability of budget, QPE/QPF workshop to be hosted by MMD	WGH WGDRR TRCG	(a) 2nd - 4th (b) 1st-2nd	RSMC Tokyo HKO, CMA	(a) & (b) Conduct of training and subsequent evaluation of the training	US$5,000	TCTF	Tsukasa Fujita (JMA) ST Chan (HKO)	(a) Yes (b) Yes (c) No (workshop postponed due to budget and no strong request from Members)
KRA 1 KRA 2 KRA 4 /SG4 (a)	9	Storm surge watch scheme	(a) To develop the storm surge model for expansion of the region (b) To provide storm surge time series charts at more than one point if so requested by Members	WGH TRCG	1st-4th	JMA	Submission of the progress report	/	/	Tsukasa Fujita (JMA)	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	Completed-Yes or No?
KRA 1 KRA 2 KRA 6 /SG 6b and 6c	10	Transfer of the Technology of the Typhoon Analysis and Prediction System (TAPS)	(a) To construct data server for operating the TAPS (b) To upgrade the user-compatible version of the TAPS (c) To train the typhoon forecasters on the use of the TAPS upon Member's request	TRCG	(a) 2nd – 3rd (b) 2nd – 4th (c) 2nd – 4th	KMA Members	Submission of the progress report	US $3,000	TCTF	Jiyoung Kim (KMA)	Yes

Status of Preliminary Projects (PPs) in 2013 (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	Completed -Yes or No
KRA 1 KRA 2 KRA 4	1	Assessment report on the impact of climate change on tropical cyclone in TC region	(a) To carry out the preliminary studies, on the impact of climate change on tropical cyclone, especially on the unusual behavior of tropical cyclone in the TC region (b) To prepare the AOP for drafting the 3rd assessment report upon the results of the preliminary studies (it'll be issued before IPCC AR6 in 2016)	WGH WGDRR TRCG	1st – 4th	HKO/China, CMA, USA, JMA, KMA, Macao/China (coordinator) Members	Submission of the progress report	/	/	Wong Chan Seng (Macao/ China)	(a) Yes (b) No. To be carried out in 2014.
KRA 1 KRA 2 KRA 4 /SG4 (a)	2	Harmonization of Tropical cyclone intensity analysis	Based on the recommendation of the best track consolidation meeting, continue to study the methodology to compare the best track datasets with the consideration on the progress of digitization of CI numbers in hard copy	/	1st – 4th	JMA, CMA, HKO	Submission of the progress report	/	/	Tsukasa Fujita (JMA)	Yes (partly)
KRA 1 KRA 2 KRA 4 /SG4 (a)	3	Harmonization of timing of upgrade of TD to TS by various warning centers	To continue with the work of the Taskforce on TC Intensity Analysis for Upgrading TD	/	1st – 4th	Taskforce on TC Intensity Analysis for Upgrading TD	Submission of the progress report	/	/	ST Chan (HKO)	Yes (partly)

Annex II

WGM-Perennial Operating Projects (POPs) in 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 /SG4 (a)	1	Improvement of QPE/QPF and storm surge techniques for TC Members	(a) To collaborate with TRCG to conduct the yearly RSMC Tokyo Attachment Training for operational forecaster from TC Members including the training of storm surge model and QPE/QPF.	TRCG	1st -4th	JMA, WMO	Submission of the evaluation report	/	/	Tsukasa Fujita (JMA)	Continued
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	1st -4th	CMA Members	Submission of the progress report	/	/	Zen Zhihua (CMA)	Continued
KRA 1 - 6	3	Tropical Cyclone Research and Review	(a) To publish the journal quarterly in 2014 (b) Improvement of the editorial procedure (includes inviting 2-3 visiting editors)	AWG, WGs	1st -4th	CMA, TCS Members	Submission of the progress report	US$5,000	TCTF	Ms. Wang Dongliang & Zhou Xiao (CMA)	Continued
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	1st–4th	KMA Members	Submission of the progress report	US$3,000	TCTF	KiRyong Kang (KMA)	Moved from AOP 10

WGM-Annual Operating Projects (AOPs) in 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	1	Contribution to the development of SSOP Manual and SSOP Training	(a) To review and comment on the SSOP Manual and related Documents (b) To review and provide input into planned SSOP Training	WGH WGDRR TRCG	1st -4th	TCS, Members, ESCAP WMO PTC ADRC ADPC ABU	(b) Seven beneficiary Members provide comments on SSOP Manual and related Documents (All Members are encouraged to provide comments) (c) Seven beneficiary members provide comments on planned SSOP training (All Members are encouraged to provide comments)	/	SSOP Budget	Project Manager, Steering Committee, Task Team, Renito Paciente (PAGASA)	Continued
KRA 1 KRA 2 KRA 6 /SG 6b and 6c	2	Enhanced use of ensemble forecast	(a) To explore ways to improve the ensemble forecast products on the website, responding to identified needs through the past questionnaires by WWRP/TCP and GIFS-TIGGE WG. (b) To further examine TC generation prediction skills to identify potential for its operational use in the future.	/	1st -4th	JMA	(a) Report possible ways to improve the ensemble forecast products. (b) Identify potential for TC generation prediction skills using TIGGE data	/	/	Tsukasa Fujita (JMA)	Continued

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	3	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 further improve the evaluation system for tropical cyclone forecast, with special attention on genesis and ensemble forecast conjunction with WMO-TLFDP (to be included in the TC Fellowship Scheme) (c) To offer fellowship for training on (b)	AWG, TRCG	1st -4th	CMA, KMA, HKO, RSMC Tokyo, 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)	Continued
KRA 1 KRA 2 KRA 6	4	Improvement of South China Sea typhoon forecast	(a) Further improvement of TRAMS model and products (b) Provide TRAMS-9km products relate to typhoon assess through website	/	1st -4th	CMA, Viet Nam, PAGASA, MMD	Submission of the report on the assessment of model and website	/	/	Chen Zitong (CMA)	Continued
KRA 1 KRA 2 KRA 6	5	Development of typhoon seasonal prediction system	(a) To further develop the techniques of typhoon seasonal prediction (b) To establish the semi-operational web-based portal to provide the products of typhoon seasonal prediction for TC Members	/	1st -4th	KMA Members	Submission of the report on assessment of seasonal prediction models	/	/	KiRyong Kang (KMA)	Continued

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	6	Improvement of severe weather forecasting and interaction with user communities	(a) Provide the motion of observed precipitation areas up to 3 hours ahead (1 hour cycle) using Semi-Lagrangian advection scheme in combination with satellite data (b) Provide tropical cyclone track and intensity and severe weather forecasting charts based on NWP model (c) Coordinate with WMO-TLFDP and "Web-based Typhoon Forum" project to provide the verification product and add the "Forecast Forum" tool in SWFDP-SeA website. (d) Set up FTP server to share raw data between Vietnam and others.	WGH, WGDRR, TRCG	2nd-4th	Viet Nam, Cambodia, Lao, Thailand, China, RSMC Tokyo	Progress report	/	/	Vo Van HOA NHMS of Viet Nam	Continued
KRA 1 KRA 2	7	Development of regional radar network	(a) Application of the radar composite techniques provided by JMA to the nationwide radar network in Thailand by TMD with technical assistance of JMA (b) Preliminary works on application of QPE techniques by TMD with technical assistance of JMA (c) Submission of a	TRCG	1st – 4th	TMD, JMA	(a) & (b) Submission of the progress report by TMD	US$4,000	TCTF	Patchara Petvirojchai (TMD) Tsukasa Fujita (JMA) Derek Leong (TCS)	Continued

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
			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								
KRA 1 KRA 2 KRA 4	8	Assessment report on the impact of climate change on tropical cyclone in TC region	(a) Establish the expert team and start the AOP on the 3rd assessment report in 2014. (b) Carry out a preliminary review on the latest research development on the impacts of climate change on tropical cyclones to identify key areas that need to be pushed forward in the research activities of TC Members and addressed in the 3rd Assessment (e.g. TC induced extreme rainfall, storm surge risk, data homogeneity, etc). (c) Proposed the outline and schedule of the 3rd Assessment Report based on the preliminary review.	WGH WGDRR TRCG	1st – 4th	HKO/China, CMA, USA, JMA, KMA, Macao/China (coordinator) Members	Submission of the progress report	/	/	Wong Chan Seng (Macao/ China)	Moved from PP1 of 2013

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)	9	Storm surge watch scheme	(a) To provide storm surge time series forecasts at several stations of Guam, the Philippines, and Viet Nam. Further addition will be considered if so requested by Members. (b) To conduct verification of time series forecasts at the stations to be added.	WGH TRCG	1st- 4th	JMA	(a) Develop storm surge time series charts at more than one point if so requested by Members (b) Report of verification results of time series forecasts at stations where feasible	/	/	Tsukasa Fujita (JMA)	Continued
KRA 1 KRA 2 KRA 6	10	Contribution for the Experiment on Typhoon Intensity Change in Coastal Area (EXOTICA)	(a) To hold a small meeting for preparing the implementation (field campaign in 2014) 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	1st – 4th	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)	New

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/SG 4a	11	Training attachment to HKO on QPE/QPF	(a) To collaborate with TC Fellowship scheme to provide QPE/QPF training to one TC Member	TRCG, WGH	2nd – 4th	HKO	Submission of the progress report			WK Wong (HKO)	New

WGM-Preliminary Projects (PPs) in 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 6	1	High resolution tropical cyclone model (HTCM)	(a) Coordinate with WMO-TLFDP, comparison of (semi-) operational typhoon model (HWRF and GRAPES-TCM) (b) Practicability and pilot study on the high resolution (≤ 3km) typhoon model development.	/	1st – 4th	CMA, Members WMO	Submission of the progress report	/	/	Chan Baode (STI/CMA)	New
KRA 1 KRA 2 KRA 4 /SG4 (a)	2	Harmonization of Tropical cyclone intensity analysis	(a) Exchange best-track datasets including digitized CI numbers for the period 2004-2013 by the end of June 2014. (b) Conduct cyclone by cyclone comparison analysis of CI numbers with preliminary report of findings, if digitization completed	/	1st – 4th	JMA, CMA, HKO	Submission of the progress report	/	/	Tsukasa Fujita (JMA)	Continued
KRA 1 KRA 2 KRA 4 /SG4 (a)	3	Harmonization of timing of upgrade of TD to TS by various warning centers	(a) Devise measures to remove/reduce the discrepancies in future based on the findings from the investigation on the discrepancy cases identified on the data (2007-2011) (b) Discuss the pros and cons of the proposed measures and reach a consensus on the way forward; (c) Make recommendations to WGM at 9th IWS	/	1st – 4th	Taskforce on TC Intensity Analysis for Upgrading TD	Submission of the progress report	/	/	ST Chan (HKO)	Continued

APPENDIX II

UNESCAP/WMO Typhoon Committee

Experiment on Typhoon Intensity Change in Coastal Area (EXOTICA)

Working Group on Meteorology (WGM) of UNESCAP/WMO Typhoon Committee

January 30, 2014

Experiment on Typhoon Intensity Change in Coastal Area (EXOTICA)

Experiment on Typhoon Intensity Change in Coastal Area (EXOTICA)

5. 1. Background

During the 45th Session of the UNESCAP/WMO Typhoon Committee (TC), held in Hong Kong, China from 29 January to 1 February 2013, the Working Group on Meteorology (WGM) proposed a regional field experiment to be implemented with the cooperation and joint efforts of the TC Members. Similar in scale to the “SPECTRUM-90” Typhoon Research Experiment, this experiment will focus on resolving the difficulties of operational typhoon forecasting and identifying the key scientific issues of tropical cyclone related disaster prevention and mitigation. The proposed project's concept was generally well received by TC Members.

Text from the 45th Session's final report, paragraph 45.t, reads: "*In conjunction with other WGs and TRCG, to take the lead in designing and formulating a tropical cyclone field experiment within the region, in particular by making use of the available opportunity in collaborating with the Southern China Monsoon Rainfall Experiment (SCMREX) planned by the WGTMR of WMO for implementation in 2013 (spin-up phase) and 2014 (field phase), and hold a small expert meeting to draft the proposal if necessary*". The committee concurred with the WGH recommendations that WGM, in conjunction with two other working groups (WGM and WGDRR) as well as TRCG, and in cooperation with the WMO demonstration project “South China Monsoon Rainfall Experiment (SCMREX)” which is led and implemented by the China Meteorological Administration (CMA), to design and formulate a proposal to be submitted to the Committee for its endorsement in the 46th Session.

Soon after the 45th Session, the WGM Chair drafted the project proposal (first draft). In March 2013, former TC Chair JIAO Meiyan (Deputy Administrator of CMA), at the request of the current TC Chair, organized a thematic symposium with the participation of the WGM Chair (LEI Xiaotu, Director of Shanghai Typhoon Institute of CMA), the Chief Scientist of SCMREX (LUO Yali, the professor of Chinese Academy of Meteorological Sciences) and the WMO/WGTMR Chair (DUAN Yihong, President of Chinese Academy of Meteorological Sciences). The proposal (first draft) was then submitted to TRCG Chair (AWG member) for feedback.

Based on discussions during the symposium and recommendations from the AWG, the proposal was then revised into a second draft, which was submitted for discussion at the AWG Meeting in Bangkok on May 10, 2013. The following changes were suggested and implemented:

a) To enhance the content of the logistical arrangements for project implementation, funding support, cooperation arrangements with SCMREX specific projects, as well as the relationship with existing operating plans, contributions and participation of Members in projects.

b) To establish the joint implementation of projects under the Typhoon Committee as a cross-team project, in which three TC Working Groups are to be involved in addition to Members, and which translates into additional hydrological and disaster risk reduction research.

c) To widely consult the Members and working groups. It was decided that the AWG Chair (Edwin LAI, Assistant Director of the Hong Kong Observatory) and TCS (Derek LEONG, TCS meteorologist) should draft a one-page project brief intended to introduce the project and to consult the 8th WGDRR Workshop in May and the WGH Workshop in November.

d) To implement this project step by step, in considering its complexity. After the proposed amendments at the AWG meeting and the input from WGDRR and WGH meetings in 2013, the project draft would be revised a second time and then submitted to the 8th Integrated Workshop (IWS) for discussion and further input and advice.

Based on the input from AWG meeting, WGDRR and WGH workshop in 2013, the proposal was then revised again into the third draft, which was submitted for discussion at the 8th IWS in Macao, China on December 2-7, 2013. Based on the proposed amendments at the WGM parallel meeting during 8th IWS and the input after the meeting from Japan Meteorology Agency (JMA) and Hong Kong Observatory (HKO), the proposal was then revised a third time into the fourth draft, which was submitted for endorsement at the 46th session of ESCAP/WMO Typhoon Committee in Bangkok, Thailand on February 10-13, 2014.

6. 2. Project fundamentals

2.1 Difficulties in typhoon intensity forecasting during operation

With the significant advances in observations and numerical prediction modeling of typhoon, there has been significant improvement in typhoon track forecast. The current 48-hour track forecast error incidence is equivalent to the 24-hour forecast

error incidence 15 years ago; in other words, the accuracy for the typhoon track forecasts has been improved (advanced) approximately one day in 15 years. However, no significant progress has been made in typhoon intensity forecast. In recent decades, the intensity forecasts of numerical prediction models still remain challenging, which may not yet fully meet the need in operation, while operational forecasting of typhoon intensity still mainly relies on statistical methods.

2.2 Frequent occurrences of abnormal intensity changes of offshore and landfalling typhoon before and after landfall

The typhoon intensity changes appear to have considerable volatility before and after landfall, which causes difficulties in deploying typhoon disaster prevention and mitigation measures. In contrast to open sea, where sea conditions are more uniform, the near-coast and landfalling typhoons are affected by the variation in sea depth, leading to more complicated sea and atmosphere interactions. In addition, the complex surface conditions of the coastal terrain and islands acting upon the sea-land-atmosphere interactions make intensity variations more uncertain. In fact, the lack of early warnings or excessive warnings is not uncommon during actual operation. It happens frequently in cases of rapid development and enhancement of a near-coast (South China Sea) tropical depression into a tropical storm, and before landfall. Due to the proximity of near-coast tropical cyclones to shore (usually 6-12 hours before landfall), the early warning and disaster management procedures may not have been in full operation or may be at a low alert level. Disaster management agencies thus do not have enough time to prepare and react, potentially causing significant casualties and economic damage.

Conversely, the lower estimation of TC intensities as the result of expected weakening of the tropical cyclones when moving north to high latitude areas may result in insufficient disaster response by those agencies due to underestimation of TC disasters. It frequently occurs that TCs re-intensify due to their evolution or re-entering the sea, which in turn leads to major disasters as a result of premature termination of the disaster management procedures. Therefore, improving the skills of forecasting the intensity change of offshore and landfalling tropical cyclones is extremely important for effective TC warnings.

2.3 Mechanisms of typhoon intensity changes and key forecasting techniques

The intensity analysis and the intensity changes of offshore typhoons (especially in the South China Sea) before and after landfall is not only the urgent problem in

operational forecasting. In recent years, WMO has been actively promoting international cooperation on identifying mechanisms behind typhoon intensity changes, organizing several related events and activities. WMO/WWRP has held two Typhoon Landfalling Process International Workshop, one Tropical Cyclone Abnormal Changes International Seminar, and one Tropical Cyclone Sudden Changes International High-level Forum. In addition, WMO established 2 demonstration projects: Typhoon Landfall Forecast Demonstration Project (TLFDP) and Tropical Cyclone Ensemble Forecast Project (TCEFP). Since 2008, the Typhoon Committee has attached special importance to the issue of tropical cyclone intensity analysis. WGM has put an effort to analyze the effect of different wind speed averaging periods (1-minute, 2-minute and 10-minute) on the accuracy of typhoon intensity analysis and the publication of the first and second assessment reports on the influence of climate change on tropical cyclones in the Typhoon Committee region. In addition, WGM established a taskforce to study the issue of upgrading a tropical depression into a tropical storm in the western North Pacific in a timely manner. These efforts of WGM have yielded some successful outcomes. In recent years, the Typhoon Committee Members have also devoted more efforts in near-coast and landfalling typhoon research, such as: the implementation of China's National Key Basic Research Program (973) – “Abnormal changes of typhoon before and after landfalling and its mechanism", the National Natural Science Foundation of China program – “The research on the multi-scale dynamic mechanism of the typhoon structure and intensity changes over the Taiwan Strait", the implementation of reconnaissance flights by Hong Kong, China, the regional radar composite map led by TMD with the support from JMA, and the TPARC scientific experiment organized and implemented by the USA and Japan. However, there is clearly more room for data exchange and experience sharing among Members and in implementing respective projects. In addition, the goals of the existing international cooperation research projects are relatively dispersed, with less support to improve typhoon intensity forecasting techniques as compared to “SPECTRUM90”.

Furthermore, in Typhoon Committee region, the core issue that impedes more in-depth analysis and improvements in forecasting capabilities is the lack of observations of intensity changes of tropical cyclones. Since the USA has stopped the reconnaissance flights in 1987, the primary technique for TC intensity analysis widely used by operational TC centres is the Dvorak technique. The tropical cyclone intensity estimated in warnings may vary across different Centers due to the subjectivity of the Dvorak technique. In recent years, though on-board microwave sensors in satellites have

gained wide application, they still cannot provide a significant improvement in this situation.

Therefore, strengthening coordination of observations, cooperative efforts on research, and integrating the resources to carry out scientific experiments around common scientific issues and operational objectives, with the focus on the intensity changes of offshore and landfalling tropical cyclones, is very important. It is thus essential to develop and implement a scientific experiment to forecast intensity changes in the Typhoon Committee region.

7. 3. Experimental objectives

To conduct field campaigns on the intensity and the structural characteristics of the target offshore and landfalling tropical cyclones by employing integrated aircraft dropsonde, vehicle/boat on-board GPS automatic sounding, offshore and island gradient tower observation, and novel tropical cyclone observation techniques such as rocket dropsonde, to retrieve such parameters as wind-temp vertical profile, cloud walls, dimensional scale of the tropical cyclones, sea surface temperature, and air-sea flux. It is planned to observe 3 – 5 target tropical cyclones per year.

To conduct demonstration research on the utilization of the synergized field observation data with the aim of deepening the understanding of the mechanism of intensity changes of offshore and landfalling tropical cyclones; to improve key techniques of intensity analysis and the regional tropical cyclone prediction model; to enhance the performance of tropical cyclone intensity forecasts from NWP models; to develop a more reliable storm surge model for the coastal cities in the Asia Pacific region; and to develop the flooding and associated risk assessment techniques and systems for the inland flood plains.

8. 4. Project-related scientific issues

The project will focus on intensity changes of offshore and landfalling tropical cyclones from June to October, 2014 to 2017, specifically targeting the following four scientific issues:

4.1 The effect of the offshore, non-uniform, and complex underlying surface on the boundary layer wind field structure

The non-uniformity of the underlying surface is the most important factor causing the boundary layer horizontal wind field asymmetric distribution and non-uniform vertical wind shear of offshore tropical cyclones, as well as difficulties in intensity analysis. The monsoon climate, complex geographic distribution of offshore islands, depth of warm waters, oceanic salinity, structure of ocean currents, and offshore sea-land-atmosphere interactions may exert significant influence on the structure of the tropical cyclones as well as their intensity changes, in particular abrupt and rapid intensity change, the genesis and development of tropical cyclones, as well as dissipation.

This project will fully utilize the field experiment observation data to reveal offshore tropical cyclones' wind field structures in the Asia Pacific region, in particular the conversion relationship of mean wind speed sampling at different heights and times. The observation data will be used in tandem with the numerical simulation experiment and the dynamic diagnosis to analyze the effect of the offshore non-uniform complex underlying surface on the structure of boundary layer wind field structure and its evolution characteristics as well as the effect on intensity analysis.

4.2 The accuracy of predicting intensity changes of tropical cyclones in the Asia Pacific region

The second scientific issue is on the effects of the complexity of the underlying surface, subtropical high, westerly trough, ITCZ and the oceanic mesoscale vortex position and its random oscillations on the modulation of the intensity changes of the tropical cyclones and thus the credibility of the prognoses of the current numerical model.

4.3 The effect of intensity changes of tropical cyclones on tidal level and flooding in the flood plains of the Asia Pacific region

In the Asia Pacific region, the specific characteristics of the continental shelf and ocean current conditions have significant influence on storm surges in the Asia Pacific coastal region brought by super typhoons and offshore/landfalling typhoons undergoing rapid intensity changes. Changes in the structure and intensity of typhoons will also bring about enhanced precipitation and re-distribution of the intense precipitation, which will in turn lead to severe flooding in the river delta area and inland flood plains.

4.4 The effect of intensity changes on the magnitudes of disasters caused by typhoons in the Asia Pacific region

The vulnerability of the Asia Pacific region to the effect of typhoons is significant. Under the current operational capacity in TC intensity forecast, it sometimes occurs that the warning of rapidly intensify/weakening TCs before landfalling is not done in a timely manner. Hence it could lead to insufficient responses to potentially devastating events.

9. 5. Main research content

Field campaign of offshore and landfalling typhoons in the Asia Pacific Region: Using meteorological and hydrological observations, the disaster information network of the Typhoon Committee Members, and with the deployment of advanced observation techniques to design an observation program, which is suitable for this region and covers field observation of 3-5 target typhoon per year.

Application of synergized field campaign data in the demonstration research project: Includes research on the techniques of operational typhoon intensity analysis, research on offshore and landfalling typhoons' intensity change mechanism, inter-comparison of the numerical prediction models on forecasting intensity changes, the effects of intensity changes of tropical cyclones on storm surge, flood forecasting of landfalling typhoons, and the effect of intensity changes on disaster impact.

10. 6. Target typhoon's observation

6.1 Observation period

The observation period is planned to cover the period from June to October, the peak tropical cyclone activity period, of 2014 – 2017 in the Asia Pacific Region.

6.2 Observation region

In the Asia Pacific region, the two observation regions will be the South China Sea and the East Asian Sea:

- The “South China Sea Observation Region” will cover the area of the South China Sea, the coastal area of Guangdong, Guangxi, and Hainan provinces, Hong Kong, Macao, the Philippines, and Vietnam. This observation region will have some overlapping area with SCMREX. The focus of the experiment in this observation region will be on the genesis and rapid intensity changes (including both the rapid intensification and dissipation) of a TC in the months of June-October, and the TC-induced storm surge and impacts.
- The “East Asian Sea Observation Region” will cover China (Fujian, Zhejiang, and

Shanghai provinces), Taiwan, Japan, Republic of Korea, and Democratic Republic of Korea. The focus of the experiment in this observation region will be on the dissipation and extratropical transition of TC and the sudden weakening of the intensity of the typhoons in the months from July to October and the induced storm surge and impacts.

6.3 Observation parameters

These include the WMO conventional observational network and, during the observation period of the target typhoon, enhanced with conventional observation of the atmosphere such as weather radar and satellite surveillance, upper air sounding, and ARGO buoy observation. In addition, the following non-conventional observational techniques will also be employed:

- **Enhanced satellite observations:** JMA, CMA (FY2, FY3)
- **Enhanced upper-air observations:** JMA, CMA
- **The aircraft observations**: Upper-air observations of the inner-core structure of tropical cyclones over northern part of the South China Sea could be available by using dropsondes and data probe on a fixed-wing aircraft from Hong Kong, China. The unmanned aerial vehicle (UAV) developed by China is another means to make the low altitude observation of the wind field and boundary layer of the inner core of typhoons.

- **Rocket launch through the target typhoon:** Improved rocket drop sounding to observe the target typhoons in the East Asian Sea and South China Sea observation regions in order to collect the vertical profile of the wind, temperature, and humidity around the center of the typhoons.

- **Wind chasing/mobile vehicle sounding:** Making use of the vehicles from STI/CMA and TC Members, equipped with mobile observation systems (e.g. microware radiometer, wind profiler, and GPS sounding), to make mobile observations of the target offshore or lanfalling typhoons, to collect the essential meteorological parameters under the various underlying surface conditions.

- **Offshore gradient tower observation:** Using the gradient observation towers set up on the coast and the offshore islands within the observation regions to carry out the gradient observation to collect the near surface (about 100m altitude) wind, vertical profiles of temperature and humidity as well as the

essential oceanic parameters from sea surface to bottom.

- **Buoy observation:** Using the satellite-linked buoy(s) to carry out buoy observation, with the aim to obtaining the essential atmospheric and oceanic parameters under typhoon conditions (including the air-sea flux).

- **Wind profiling radar and ground-based GPS/MET water vapor remote monitoring station:** Making use of the wind profiling radar of the SCMREX field experiment (5-beam antenna array) to make observations on horizontal wind speed and direction, vertical winds, and atmospheric refractive index at different altitudes, as well as using the related equipment of SCMREX to observe atmospheric water vapor column quantity.

- **Water level observation and disaster assessment:** Selecting 1-2 pilot coastal cities and a pilot flood plain within the field observation region for flood observation, which will mainly rely on the hydrological observation network of TC members to observe the water level of the rivers on course with the passage of the target typhoons, which induced storm surge or inundation. In response to devastating typhoons, together with affected Members, to carry out disaster assessment as well as identifying the relationship between the distribution of intense precipitation and the disaster.

6.4 Data sharing:

Establishing a project website to present the progress of this project and to enable access to a distributive database, which collects all the intense and non-conventional observation data of the target typhoons, in order to facilitate and promote data sharing. All observation data of target typhoons collected in the field campaigns of this project will be shared with all participating Members, and only be used in the demonstrating research of this project. More details on the mechanism for data sharing will be discussed among participating Members.

11. 7. Demonstration of the integrated application of the field observation data of the target typhoons in research

Research on key techniques of operational typhoon intensity analysis: To develop the objective analysis of wind speed and direction based on the multi-source observation and typhoon intensity analysis techniques. To provide technical support for

the improvement of operation in locating typhoons.

Research on intensity change mechanisms of offshore and landfalling typhoons: To reveal the structural changes of the typhoons and the offshore ocean-air interaction and to analyze factors contributing to genesis and dissipation, intensification and weakening of tropical cyclones.

Research on the offshore and landfalling typhoon numerical prediction model via inter-comparison studies: To compare the performance of NWP models in the prediction of the intensity of offshore and landfalling typhoons; to investigate the impact of field observations on the performance of NWP models; and to conduct research on the improvement of physical parameterization in NWP model intensity forecasts based on the observations of vortex structure and boundary layer characteristics.

Research on the effect of intensity changes on storm surge and the flood forecasting of landfalling typhoons: To evaluate and improve the storm surge and the inundation models of the pilot coastal cities, and the inland flooding model.

Research on the effect of the intensity changes on typhoon disasters: To analyze the typhoon disaster risk vulnerability in the Asia Pacific Region, in particular analysis of the sensitivity and vulnerability to super typhoons and weak TCs with intense precipitation, rapid intensity/weakening TCs, as well as the relationship between the total estimated precipitation and the damages caused.

12. 8. Implementation of the project and safeguard measures

8.1 Organizational structure

a) Scientific Steering Committee: The Scientific Steering Committee (SSC) will be established to provide guidance on the design and implementation of this field experiment. SSC will comprise the renowned typhoon experts. All the members of the SSC are will be nominated by the AWG of Typhoon Committee. The ToRs of SSC:

- Providing overall guidance and advice on the project activities
- Reviewing the status, scope of work and performance of the different project implementation teams
- Regular monitoring and evaluation of the project activities and

- Fulfill other functions as emerging needs are identified.

b) Organizing Committee: The Organizing Committee(OC) will be established to direct the implementation of this project, and to coordinate TC Members and working groups in their project activities. OC will comprised the AWG members and the chief representatives of the participating Members of Typhoon Committee.

c) Chief Scientists and Research Groups: One or two chief and vice-chief scientists, nominated by OC, under the guidance of the SSC and led by the OC, will be responsible for the implementation of the project and the work planning of the OC. In addition, five research groups (RGs) will be established: "Field Observation", "Research on Mechanism", "Model Comparison", "Inundation Early Warning" and "Disaster Assessment". These five groups will be responsible for carrying out the respective research. Members of each group will comprise the experts nominated by participating Members of Typhoon Committee and will be led by the Chief of the Research Group.
    - Field campaign: Led by WGM of Typhoon Committee, in cooperation with WGH and WGDRR, to be tasked with the operation of the observations in the two experimental regions.
    - Research on Mechanism and Model Comparison: Led by WGM and to be tasked with research on key techniques in typhoon intensity analysis, impact of observation in data assimilation of NWP models for TC intensity analysis and forecasting, the mechanism behind the intensity changes of the offshore and landfalling typhoons, the comparison of the NWP models on offshore and landfalling typhoons intensity changes, and the development of physical parametrization in NWP models to improve TC intensity forecasts.
    - Inundation Early Warning and Disaster Assessment: Led by WGH and WGDRR of Typhoon Committee, to be tasked with research on the effect of the intensity changes of typhoons on the storm surge and the flood forecasting of the landfalling typhoons, as well as studying the effect of the intensity changes of the typhoons on disaster impact.

8.2 Contributions from TC members

a) Management participation: Each Members' responsible person in charge of the Typhoon Committee's affairs will be the OC member, who will

participate in the organization of this project and coordinate the members' domestic activities related to this project (promotion, linkage with existing projects, and resource mobilization).

b) Establishing appropriate domestic projects: As per the assigned task, members are advised to set up corresponding domestic projects in order to facilitate project implementation.

c) Participation in field observation of the target typhoons: To implement meteorological and hydrological observation of typhoons, to organize domestic observation, and to select appropriate experts to participate in other members' observations during the passage of the target typhoons.

d) Participation in the application of the observed data research demonstration project: Members will select meteorologists, hydrologists and DRR experts to participate in the five research groups and to carry out the corresponding research.

8.3 Logistics and funding support

a) Funding field observation: Participating Members will be responsible for funding the operational costs and the acquisition of the equipment required for the intense and non-conventional observation of the target typhoons.

b) Funding research demonstration research: WGM, WGH and WGDRR of Typhoon Committee will establish the appropriate AOPs to link with this project and to allocate TCTF funding support for relevant activities. Members should consider inviting experts from TC Members to carry out research via their fellowship scheme.

c) Funding the meeting of the Scientific Steering Committee and Organizing Committee: Allocation from the TCS and AWG budget and funding support from WMO, will fund the meeting of the SSC, OC and the principal scientists, while contributions from the TRCG budget will cover travel expenses for the chiefs of the 5 research groups to attend the IWS.

d) Logistics: TCS will be responsible for the correspondence and logistics of the SSC

and OC, the coordination of the TC Members and WGM, WGH and WGDRR, as well as providing assistance on the logistics of the implementation of this project.

8.4 International cooperation

a) Cooperation among Members: This project will enhance cooperation among TC Members and the collaborating Typhoon Committee Working Groups through its implementation, and will also promote linkage between the Members' research activities and the Typhoon Committee's.

b) Cooperation with WMO demonstration project: The project will work closely with WMO SCMREX in conducting joint observation in the South China Sea Observation Region. Data and research outcomes will be shared between these two projects. The outcome of this project will also be shared to TC Members and other regions through the two WMO demonstration projects: "Typhoon Landfall Forecast Demonstration Project (WMO-TLFDP)" And "Tropical Cyclone Ensemble Forecast Project (WMO-TCEFP)".

c) Cooperation with international organizations: This project will promote cooperation between the Typhoon Committee and ESCAP in the area of disaster risk reduction, and close cooperation is expected with PTC through ESCAP. Further cooperation with WMO/TCP and WMO/WWRP will be made during research in observation technique and numerical simulation and evaluation, and with the WMO/WWRP/WGTRM typhoon panel in relation to the work on the mechanisms behind the intensity changes of typhoons.

d) Application for the WMO Demonstration Project: This will be made based on the design and the goal of this project taking into consideration the focus of important research works of TC Members, WMO/TCP and WMO/WWRP. The target is to make parts of this project as the WMO demonstration projects, such as "Typhoon Intensity Forecasting Demonstration Project (FDP)", "Typhoon numerical model comparison research demonstration project (RDP)" and "Typhoon Catastrophic Risk Assessment and Prevention technique research demonstration project (RDP)".

13. 9. Project planning and implementation schedule

The planning of this project was initiated soon after the 45th Typhoon Committee

Session, and the project is scheduled to be implemented from 2014 to 2017. The detailed schedule is as follows:

a) 2013: Drafting the proposal, preliminary testing of the observation systems (UAVs, and rocket sounding), and conducting a study overview to identify project issues.
b) 2014: Finalizing the project proposal for submission to the 46th Typhoon Committee Session for endorsement. Piloting (Spin-up) the field campaigns (include trial target observations for 1-2 tropical cyclones and testing of instruments, data communication etc.)
c) 2015-2016: Implementing the field campaigns for 3-5 target typhoons each year from June to October.
d) 2014-2017: Joint scientific demonstration research. Consolidating the outcomes of the project and submitting the project summary report to the Typhoon Committee Session in 2018.