ESCAP/WMO Typhoon Committee

WRD/TC.44/7.1

FORTY-FOURTH SESSION

HANGZHOU, CHINA

AGENDA ITEM 7

6 – 11 FEBRUARY 2012

Original: ENGLISH

TRAINING & RESEARCH COORDINATION GROUP (TRCG)

(submitted by TRCG Chair)

Summary and Purpose of Document**:**

This document reviews past activities, progress and future plans of TRCG.

Action Proposed

The Committee is invited to:

(a) note the major activities and development progress of TRCG as summarized in the APPENDIX;

(b) endorse the training and research priority areas as outlined in Section 5 of the APPENDIX;
and

(c) endorse the future plans of TRCG as outlined in Section 6, Annex XII and Annex XIII of the APPENDIX.

APPENDIX: TRCG Annual Report 2011

APPENDIX

TRAINING & RESEARCH COORDINATION GROUP (TRCG)
ANNUAL REPORT 2011

Edwin S.T. Lai (TRCG Chair)
Hong Kong, China

1. Introduction

1.1 According to the Terms of Reference, TRCG is to promote research and training activities on various aspects of tropical cyclone analysis and forecasting, including assessment of tropical cyclones' impacts on Members' socio-economic development processes, and to encourage cooperation of efforts among Members. Towards this end, TRCG is expected to assist in: (a) identifying scientific and technical problems in the analysis and forecasting of tropical cyclones and their impacts on water resources and measures for disaster prevention and preparedness; (b) facilitating the exchange of experience and knowledge on the latest development and techniques related to the above problems; (c) initiating activities and programmes aimed at improving the technical capacity and capability of Members to better serve the people in the region; and (d) recommending to the Committee priority areas and long-term plans for cooperation in research and training in support of the various KRAs of the Committee's Strategic Plan.

2. Membership

2.1 The composition and members list of TRCG are:

Chair: Mr. Edwin S.T. LAI (Hong Kong, China)

Vice Chair: Mr. Roger EDSON (USA)

Members: Ms. Seth VANNARETH (Cambodia)
Mr. XU Yinglong (China)
Mr. KANG Bom Jin (DPR Korea)
Ms. Naoko KITABATAKE (Japan)
Mr. Bounteum SYSOUPHANTHAVONG (Lao PDR)
Mr. LEONG Weng Kun Ivan (Macao, China)
Dr. Wan Azli WAN HASSAN (Malaysia)
Dr. Carina G. LAO (Philippines)

Dr. Ki-Ho CHANG (Republic of Korea)
Mr. Chien Wan THAM (Singapore)
Mr. Sampan THAIKRUAWAN (Thailand)
Mr. NGUYEN Dai Khanh (Viet Nam)

3. Major TRCG Activities in 2011

Roving Seminar / Visiting Lecturers Programme

3.1 Roving seminars have been arranged for capacity building purposes on both research and operational aspects. Knowledgeable experts travel to Members' countries and deliver lectures focused on subjects of current interest to operational centers. A record of all roving seminars previously organized can be found in Annex I.

3.2 The Typhoon Committee Roving Seminar 2011 was successfully held on 20 - 23 September in Petaling Jaya, Malaysia. The Seminar was hosted by the Malaysian Meteorological Department, Ministry of Science, Technology and Innovation, Malaysia. The selected theme was on "Heavy Rain and Flood Hazards associated with Landfalling Tropical Cyclones" with the following three sub-topics:

Topic A: Overview of QPE/QPF techniques and hydrological applications
Topic B: Review of QPE/QPF operational systems and application to tropical cyclone
rainfall forecasting
Topic C: Cause, assessment and management of flood hazards associated with landfalling
tropical cyclones and heavy rain

3.3 The Seminar was attended by 35 participants from Malaysia (13); China (6); Philippines (5); Thailand (3); Laos PDR (2); Viet Nam (2); Cambodia (1); Hong Kong, China (1); Macao, China (1) and Singapore (1). In the evaluation process, the participants warmly appreciated the effort made by the resource persons to provide new ideas and insight on the topics discussed. About half of the participants felt that skills and knowledge learnt would lead to operational benefits in their services within the next five years. A summary report of the seminar can be found in Annex II.

Forecasters' Training Attachment

3.4 Two forecasters, Ms. Sinthaly Chanthana (from Lao PDR) and Ms. Lai Un Man (from Macao, China) visited JMA headquarters from 20 to 29 July 2011 to participate in the 11th Typhoon Committee Attachment Training. The contents of the training included:

1. Satellite Analysis and Viewer Program (SATAID)
2. Tropical Cyclone Analysis (Dvorak technique)
3. Tropical Cyclone Forecast
4. Storm Surge
5. Quantitative Precipitation Estimation (QPE) and Forecast (QPF)

Research Fellowship Scheme

3.5 The Research Fellowships have been awarded to Members to promote joint research through the exchange of visiting scientists on a short-term basis with voluntary funding and logistic support by host Members. One of the merits of the scheme is that the visiting fellow has a chance to work closely with experienced scientists at the host centre, providing an opportunity to transfer knowledge and latest research findings to operational applications. The scheme has worked well on the basis of bilateral cooperation mutually agreed between the host and the applicant.

3.6 In 2011, fellowships were offered by China; Hong Kong, China; and Republic of Korea. Details of the latest projects under the scheme, as well as a summary of previous fellowships awarded, can be found in Annex III. Reports or papers since published in connection with the scheme are listed in Annex IV.

UFRM Guidelines

3.7 In the drafting of the UFRM Guidelines, TRCG Chair has provided his input in writing up the chapter on training and research.

4. Recent Research and Training Activities of Members

4.1 A wide range of research activities was undertaken by Members. Highlights of major projects and achievement as provided by individual Members can be found in Annex V– X.

4.2 Resource persons or contact points on specialized research subjects provided by some Members are tabulated for reference in Annex XI.

4.3 The Pacific Desk programme is operated by the USA National Weather Service and the training is provided in Honolulu, Hawaii. Six times each year, two interns from the same country or neighboring ones spend six weeks in Honolulu for basic forecaster training involving satellite interpretation, numerical model analysis, use of observations, general climatology of the interns' area, and other practical aspects of operational forecasting. Each intern is given a PC for use during the training, and then the PC is shipped to his or her affiliated meteorological service back home for further use in a sustained effort of capacity building. Funds have been secured to train six forecasters in 2012. Details have yet to be finalized, but WMO Region V and the Typhoon Committee Secretariat will be kept informed regarding the distribution of announcements for nominations.

5. Prioritization of Training and Research Areas

5.1 Taking into consideration comments made by the resource persons in the Roving Seminar 2011, the list of priority research topics is re-established as follows:

(A) Meteorology

(a) rainfall forecasting: development of nowcasting and very short range forecasting

techniques, and understanding of interaction between tropical cyclones and monsoon;

(b) application of Dvorak and microwave satellite image analysis techniques;
(c) application of radar-based analysis/products for landfalling tropical cyclones;
(d) application of ensembles of guidance from dynamical models, conceptual models, statistical models and systematic knowledge-based approach;
(e) use of high resolution numerical models with advanced data assimilation techniques;
(f) better understanding of TC-related issues across different spatial and time scales, from mesoscale and synoptic analysis for track prediction, to climatological impact arising from El Nino/La Nina and global warming/climate change;

(B) Meteorology and Hydrology

(g) application of meteorological information for forecasting of river flooding and urban flash flood;
(h) better understanding of wave, storm surge and marine forecasting;

(C) Meteorology and DPP

(i) development of technical procedures to quantify forecast uncertainties and to convert probabilistic information into effective warnings; and
(j) development of decision-making tools for DPP purpose, including the integration of forecast information with GIS and the use of automated information processing systems.

5.2 In view of the devastating impact of tropical cyclones that affected Members in recent years, attention should also be given to capacity-building in the following aspects:

(1) understanding and assessment of rain-induced geological hazards such as landslides and mudflow;
(2) forecasting and warning systems for better coastal protection from hazards such as storm surge, river delta inundation and urban flooding; and
(3) effective communication of warning messages to stakeholders, DPP users and communities at risk.

6. Future Directions and Strategies

6.1 Following the latest TRCG work plan (Annex XII), TRCG will try to set up more follow-up activities in support of training/research topics covered in roving seminars and integrated / ad hoc workshops; e.g. through more purposely planned research fellowship projects. AOP for 2011 and the associated budget can be found in Annex XIII.

6.2 TRCG will continue to support plans to have more cross-cutting training and research initiatives with the hydrological and DPP components, including the organization of joint meetings/activities such as UFRM. Members are also encouraged to promote such initiatives through proactive involvement of respective hydrological and DPP counterparts in their countries.

Annex I

Summary of Roving Seminars

Year	Dates	Venue	Topic	Lecturers
2003	20 – 21 Oct	Seoul	Interpretation of Typhoon Forecasts and Analyses	Dr. H-J Kwon Mr. Nobutaka Mannoji
	22 – 24 Oct	Hong Kong	Interpretation of Satellite Data and Use of Radar Data in Operational Tropical Cyclone Forecasting	Dr. Mark Lander Dr. P.W. Li Dr. B.-J. Sohn
	27 – 29 Oct	Shanghai	Interpretation of Satellite Data and Use of Radar Data in Operational Tropical Cyclone Forecasting	Dr. Mark Lander Dr. P.W. Li
2004	22 – 24 Nov	Beijing	Operational Application of Multi-model Ensemble Typhoon Forecasts	Prof. Johnny C.L. Chan Mr. Nobutaka Mannoji
	25 – 27 Nov	Kuala Lumpur	Operational Application of Multi-Model Ensemble Typhoon Forecasts	Prof. Johnny C.L. Chan Mr. Nobutaka Mannoji
2006	4 – 7 Sep	Ha Noi	Tropical Cyclone Motion and Intensity, and Principles of Dvorak Method	Prof. Johnny C.L. Chan Mr. Joe Courtney Dr. B.-J. Kim
2007	5 – 8 Sep	Manila	Satellite and Radar Analysis Techniques, and Tropical Cyclone Interaction w ith Monsoon Systems	Mr. Roger Edson Mr. Bart Hagemeyer Dr. Tetsuo Nakazawa
2009	16 – 19 Nov	Nanjing	Forecasting of High-impact Weather associated with Tropical Cyclones, and Formulation and Communication of Warning Messages	Mr. S.T. Chan Mr. Chip Guard Mr. Sam Muchemi
2010	30 Nov – 3 Dec	Ubon Ratchathani	Tropical Cyclone Genesis and Large Scale Interaction	Mr. S.M. Lee Prof. Zhang Qinghong Dr. Mark Lander
2011	20 – 23 Sep	Petaling Jaya	Heavy Rain and Flood Hazards associated with Landfalling Tropical Cyclones	Dr. Siriluk Chumchean Mr. H.Y. Yeung Prof. Chen Charng-Ning

Annex II

SUMMARY OF TYPHOON COMMITTEE ROVING SEMINAR 2011
(Petaling Jaya, Malaysia, 20 - 23 September 2011)

I. Organization

1. The Typhoon Committee Roving Seminar (TCRS) 2011: Heavy Rain and Flood Hazards associated with Landfalling Tropical Cyclones was successfully held on 20 - 23 September 2011 in Petaling Jaya, Malaysia. The Seminar was organized by the ESCAP/WMO Typhoon Committee and hosted by the Malaysian Meteorological Department, Ministry of Science, Technology and Innovation, Malaysia.

2. The Seminar was attended by 35 participants from Malaysia (13); China (6); Philippines (5); Thailand (3); Laos PDR (2); Viet Nam (2); Cambodia (1); Hong Kong, China (1); Macao, China (1) and Singapore (1). The three resource persons came from Hong Kong, China; Singapore and Thailand, along with one representative from the Typhoon Committee Secretariat.

II. Opening

1. The TCRS 2011 was officiated by Mr. Alui Bahari, Deputy Director General (Application), Malaysian Meteorological Department on behalf of the Secretary-General, Ministry of Science, Technology and Innovation, Malaysia.

2. Mr. Alui Bahari delivered the opening speech, expressing appreciation to the ESCAP/WMO Typhoon Committee for giving Malaysia the opportunity to host such an important seminar on tropical cyclones.

3. Mr. Derek Leong, Meteorologist of the Typhoon Committee, delivered the opening message addressing the significance of the Seminar and also expressing his sincere appreciation to the Ministry of Science, Technology and Innovation, Malaysian Meteorological Department as well as the resource persons.

III. Seminar Programme

1. Dr. Siriluk Chumchean of Mahanakorn University of Technology, Thailand, presented Topic A on "Overview of QPE/QPF techniques and hydrological applications".

2. Mr. H. Y. Yeung of Hong Kong Observatory presented Topic B on "Review of QPE/QPF operational systems and application to tropical cyclone rainfall forecasting".

3. Prof. Chen Charng-Ning of Nanyang Technological University, Singapore, presented Topic C on "Cause, assessment and management of flood hazards associated with landfalling tropical cyclones and heavy rain".

4. A technical visit to the Control Center of Stormwater Management And Road Tunnel (SMART) was arranged by the Malaysian Meteorological Department on 22 September.

5. After a brief wrap-up discussion, the seminar was closed before lunch on 23 September. Some participants took the opportunity to visit the Malaysian Meteorological Department's Weather Forecasting Center in the afternoon.

IV. Proposals and Recommendations

1. The participants warmly appreciated the effort made by the resource persons to provide new ideas and insight on the topics discussed.

2. About half of the participants felt that skills and knowledge learnt would lead to operational benefits in their services within the next five years. However, there were also some who failed to see any foreseeable opportunities to make progress.

3. Suggestions from the resource persons for future reference: (a) selection of participants with relevant background and experience to facilitate the training process; (b) capacity building in radar data processing; (c) QPE/QPF applications in support of nowcasting and flash flood forecasting; (d) impact of climate change on extreme rainfall.

V. Closing

1. The resource persons and participants expressed their gratitude and appreciation to the Malaysian Meteorological Department for the successful hosting of the Roving Seminar and for their warm hospitality.

2. Dr. Yap Kok Seng, Director General of Malaysian Meteorological Department delivered his closing remarks and, accompanied by Mr. Derek Leong, presented the certificates of attendance to the participants.

3. The TCRS 2011 was officially closed on 23 September 2011.

Annex III

Summary of Awarded Research Fellowships

Subject	Fellow	Host	Period
Analysis of evolution of landfalling tropical cyclones with a view to developing forecast guidance for wind and rain	Mr. XUE, Jianjun (China)	Hong Kong Observatory	1 Feb – 31 Mar. 2001
TC track forecasting with use of super-ensemble	Dr. PENG, Taoyong (China)	Korea Meteorological Administration	15 Jun – 15 Nov 2001
Near real-time analysis of the wind structure of tropical cyclones	Dr. Nathaniel T. SERVANDO (Philippines)	Hong Kong Observatory	5 May – 4 Jul 2002
Numerical modelling on typhoon intensity change	Miss YU, Hui (China)	Kongju National University and Korea Meteorological Administration	15 Jul –15 Sep 2002
Tropical cyclone track forecasting method	Dr. KANG, Bom Jin Dr. KIM, Tae Jin (DPR Korea)	Shanghai Typhoon Institute	Feb – Mar 2001 Oct – Nov 2002
Analyses on the responses of extratropical transition of tropical cyclone to its environment	Dr. Vicente B. MALANO (Philippines)	Korea Meteorological Administration	Jun – Aug 2004
Effect of tropical cyclone bogussing on model analysis and forecasts	Ms. WANG, Dongliang (China)	Hong Kong Observatory	11 Oct – 10 Dec 2004
Evaluation of the model performance in typhoon prediction in the high-resolution global model	Ms. Sugunyanee YAVINCHAN (Thailand)	Kongju National University and Korea Meteorological Administration	1 Aug – 30 Oct 2005

(T426L40)			
Impact study of Moisture Data on TC forecasting in South China Sea and Western North Pacific	Dr. Vicente B. MALANO (Philippines)	Hong Kong Observatory	20 Sep – 19 Nov 2005
Using ensemble prediction system (EPS) information in tropical cyclone forecasting	Ms. CHEN, Peiyan (China)	Hong Kong Observatory	13 Oct – 12 Dec 2006
Numerical simulation of Typhoon RUSA with a very high resolution mesoscale model, and calibration of intensity of typhoon with Kalman filtering	Mr. HOA, Vo Van (Viet Nam)	Korea Meteorological Administration	Jun – Aug 2006
Use of EPS information in TC forecasting	Mr. NGUYEN, Dang Quang (Viet Nam)	Hong Kong Observatory	15 Sep – 14 Nov 2007
Seasonality of Tropical Cyclone Activities over the Western North Pacific	Ms. YING, Ming	Korea Meteorological Administration	22 Sep – 20 Dec 2008
Study of high resolution non-hydrostatic model in prediction of landfalling tropical cyclones	Mr. Santi SUMDIN (Thailand)	Hong Kong Observatory	20 Oct – 19 Dec 2008
Tropical cyclone bogus in NHM and its impact on forecast track and intensity	Mr. QU, Anxiang (China)	Hong Kong Observatory	29 Oct – 28 Dec 2009
Typhoon Vortex Initialization Scheme and typhoon Ensemble Forecast Techniques	Ms. NGUYEN Thi Minh Phuong (Viet Nam) Mr. Chatchai CHAIYASAEN (Thailand)	National Meteorological Center, China Meteorological Administration	Early Dec 2009 – Early Feb 2010

Improvement of typhoon analysis and forecast with KMA's TAPS	Mr. TRAN Quang Nang (Viet Nam)	Korea Meteorological Administration	1 Sep – 27 Nov 2010
Study on the tropical cyclone genesis in the northwestern Pacific	Mr. Kamol Promasakha Na SAKOLNAKHON (Thailand)	Korea Meteorological Administration	1 Sep – 27 Nov 2010
Typhoon Information Processing System	Mr. NGUYEN Manh Linh (Viet Nam) and Ms. Kamolrat SARINGKARNPHASIT (Thailand)	National Meteorological Center, China Meteorological Administration	8 Oct – 8 Dec 2010
Can the extreme rainfall associated with Typhoon Morakot (0908) happen in Hong Kong?	Mr. HUANG, Yiwu (China)	Hong Kong Observatory	29 Oct – 28 Dec 2010
Improvement of typhoon analysis and forecast with KMA's TAPS	Mr. Jori J. LOIZ (Philippines)	Korea Meteorological Administration	Sep – Nov 2011
Improvement of typhoon analysis and forecast with KMA's TAPS	Mr. Chukiat THAIJARATSATIAN (Thailand)	Korea Meteorological Administration	Sep 2011
Implementation of Tropical Cyclone Intensity Forecast in the Tropical Cyclone Information Processing System (TIPS) of the Hong Kong Observatory	Mr. Nursalleh K. CHANG (Malaysia)	Hong Kong Observatory	24 Oct – 23 Dec 2011
Improvement of Prediction Method for the Rapid Intensification of Tropical Cyclones in the South China Sea	Dr. Sukrit KIRTSAENG (Thailand)	National Meteorological Center, China Meteorological Administration	2 Nov – 29 Dec 2011
Application of Numerical Ensemble Prediction in the Forecasting of Typhoon Sharp Turning Tracks	Mr. Raymond C. ORDINARIO (Philippines)	National Meteorological Center, China Meteorological Administration	14Nov 2011 – 13 Jan 2012

Annex IV

TRCG Publications / Papers

Xue, J.J., 2002: Structural and Diagnostic Analyses of Landfalling Tropical Cyclones near Hong Kong in 1999 and 2000. Typhoon Committee Annual Review 2001, pp. 153-161

Servando, N.T., P.W. Li and E.S.T. Lai, 2003: Near Real-time Analysis of the Wind Structure of Tropical Cyclones. Typhoon Committee Annual Review 2002 (in CD form)

Peng, T.-Y., H.-J. Kwon, W.-J. Lee, and J.-H. Lim, 2005: A systematic approach to tropical cyclone track. *The International Journal of Systems & Cybernetics.* **34**, 681-693.

Wang, D.L., W.K. Wong and E.S.T. Lai, 2005: A Study on Tropical Cyclone Bogussing Strategies in NWP Model Analysis and Forecast. Typhoon Committee Annual Review 2004.

Yu, Hui and H. Joe Kwon, 2005: Effect of TC–Trough Interaction on the Intensity Change of Two Typhoons. *Weather and Forecasting.* **20**, 199–211.

Malano, V.B., W.K. Wong and E.S.T. Lai 2006: Effect of Moisture Data to the Numerical Simulation of Tropical Cyclone in the Western North Pacific. Typhoon Committee Annual Review 2005, pp. 242 – 251.

Chen, P.Y. and S.T. Chan, 2009: Use of the JMA Ensemble Prediction System for Tropical Cyclone Intensity Forecasting. Typhoon Committee Annual Review 2008, pp. 276-285.

Nguyen, D.Q. and S.T. Chan, 2009: Study on Application of Ensemble Prediction System Information in Tropical Cyclone Track Forecasting. Typhoon Committee Annual Review 2008, pp. 286-291.

Chan, S.T. and Y. Huang, 2012: Can the Extreme Rainfall Associated with Typhoon Morakot (2009) Happen in Hong Kong? Tropical Cyclone Research and Review (submitted).

Annex V

Research and Training Activities in China Meteorological Administration (CMA)

1. Tropical Cyclone Information Display and Processing System (TIPS):

a) Improvement in operational tropical cyclone forecasting platform

The TIPS had been greatly improved in its usability and functionality during 2011. One main progress was the incorporation of probabilistic analysis and forecasting of the typhoon track based on TIGGE and the CMA ensemble forecasting system T213. Another new feature was the implementation of the consensus prediction method BLUE. The improved platform now provides functions of visualization of various observational data, interactive production and release of tropical cyclone forecasts and plotting of cyclone tracks, intensity, gale wind and rainfall. With the help of this platform forecasters will be more efficient in weather analysis and forecasting.

b) Integration with the real-time forecast error analysis system

A real-time forecast error analysis system had been developed by the National Meteorological Centre (NMC)/CMA and was first put into operation in the typhoon season of 2011. By making use of various methods, the system can estimate forecast errors not only for typhoon track and intensity, but also moving speed and direction, gale and rainfall. This system offers assessment for both subjective and objective products in real time.

c) Integration with a new searching system for tropical cyclones over the Western North Pacific and the South China Sea

In order to search similar historical tracks and backgrounds of the current tropical cyclone, a new searching system had been developed based on the CMA best track database. By inputting a key area or a time period, a series of similar synoptic features including track, intensity, source, gale, rainfall and circulation can be identified, and a summary analysis is generated

simultaneously. Another useful feature is the sorting of historical records based on given criteria.

2. Research progress on tropical cyclone related numerical models:

a) Improvement of nowcasting system based on radar observation assimilation

NMC has already developed an operational objective analysis system for tropical cyclone landfall using wind and precipitation retrievals from the new generation of weather radars and data assimilation techniques. This forecasting system can now provide 1-hour nowcasting and 24-hour track and intensity forecasts, as well as prediction of precipitation and gale wind. The spatial resolution is 10 km in the target domain. During the 2011 typhoon season, this system has performed impressively in the forecasting of tropical cyclone landfall.

b) Improvement of GRAPES_TYM Model System

Combined with typhoon bogus initialization, improved GRAPES_TYM Model has upgraded its physical progress and dynamical frame. Performance of the new version after these major advances was very much comparable to the old one. As an output from GRAPES_TYM Model, 10-minute wind speed has been used in gale wind forecast.

c) Operational forecasting trial of high resolution typhoon related gale wind and precipitation

In 2011, NMC began to produce and issue 6-hour maximum gale wind forecasting twice a day with a horizontal resolution of 0.1 degree. This series of product is based on numerical and nowcasting products from radar observation. Meanwhile, official track forecasts and historical analogue analysis would also be considered for subjective adjustment.

3. Training courses and international conferences in 2011:

Invited by WMO Regional Training Centre in Nanjing, Dr. Jing XU from NMC gave a lecture on “International Training Course on Multi Hazard Warning” in May and December2011. The lecture was mainly about early warnings on

landslides induced by typhoon heavy rainfall as well as the contributing factors to a landslide, such as terrain, steep slopes, geology, earthquakes, vegetation etc. Focusing on improving the ability of early landslides monitoring and warning, characteristics of typhoon-induced geologic hazards and a statistical module were presented using simple idealized rainfall patterns.

As an important international activity of WMO's World Weather Research Programme (WWRP)/Tropical Cyclone Programme (TCP), the international workshop on Tropical Cyclone Unusual Behaviour, hosted by NMC and State Key Laboratory of Severe Weather/China Academy of Meteorological Sciences, was held in Xiamen from 18 to 20 Oct 2011. The workshop aimed at bringing forecasters and researchers together to exchange empirical knowledge and research findings in topics which would help participants to have a better understanding of the rapid changes in various tropical cyclone phenomena. More than 40 participants from 16 countries took part in the workshop, and 27 speakers gave lectures during the workshop.

4. Typhoon Committee Research Fellowships offered in 2011:

Two Typhoon Committee Research Fellowships were awarded by NMC to Mr. Raymond C. Ordinario from Philippines on the topic "Application of Numerical Ensemble Prediction in the Forecasting of Typhoon Sharp Turning Tracks" and Dr. Sukrit KIRTSAENG from Thailand on the topic "Improvement of Prediction Method for the Rapid Intensification of Tropical Cyclones in the South China Sea".

Annex VI

Research and Training Activities in Hong Kong Observatory (HKO)

1. Research

The problem of occasional mis-identification of lee-lows over rugged terrain (such as Taiwan and Luzon) as the centres of tropical cyclone (TCs) by the vortex tracker on HKO's Non-Hydrostatic Model (Meso-NHM) was studied. The tracker was subsequently upgraded by taking into consideration 850 hPa vorticity apart from mean sea level pressure. The problem was fixed with the new tracker, and the dissemination via GTS of the Meso-NHM-based tropical cyclone forecast guidance bulletins commenced on 1 June 2011.

A real-time TC track verification tool was developed and put it into operation for the 2011 TC season. The tool helps the forecasters monitor the development of TC track biases by different models so that they can take that information into account when formulating their TC track forecasts.

At the invitation of the Chief Editor of the Typhoon Committee's Journal – "Tropical Cyclone Research and Review", HKO contributed a paper "A review on the long term variations of tropical cyclone activity in the Typhoon Committee Region" in August 2011 for its inauguration issue.

The findings from the simulation study of Typhoon Morakot in 2009 jointly conducted with a researcher from CMA under the Typhoon Committee Research Fellowship 2010 were summarized into a paper entitled "Can the extreme rainfall associated with Typhoon Morakot (0908) happen in Hong Kong?' and submitted to the "Tropical Cyclone Research and Review".

A study on the benefits from typhoons from the Hong Kong perspective has been conducted and the paper will be published in "Weather".

A study on probabilistic forecasting of high wind affecting Hong Kong during TCs using ECMWF EPS outputs was conducted. The technique developed successfully reduced the overall model biases according to the verification based on limited cases in 2011. Implementation of the technique for operational trial would be pursued upon further fine-tuning and testing.

RAPIDS, the Observatory's nowcast-NWP QPF blending system, was upgraded with the non-hydrostatic NWP model component enhanced from 5-km to 2-km resolution. Real-time verification results showed that due to improved QPF from the model, RAPIDS became generally more skillful than its predecessor.

For better rain gauge data quality control and rainfall analysis in support of

hydrological applications, a QPE technique based on radar-rain gauge co-Kriging was implemented and put under operational trial in 2011. The QC system was proved robust for both the rainfall cases during the trial and selected historical extreme events. The co-Kriging QPE provides in general a more realistic rainfall maps, especially over gauge-sparse areas.

A research project on the mesoscale characteristics of rainstorms commenced in 2011, and the historical rainstorms in Hong Kong directly or indirectly related to TCs during 1999-2010 were reviewed. The radar climatology and orographic enhancement of TC rainfall were among the themes of study. Preliminary findings indicated that the enhancements were significant with details dependent on the height of mountain, wind speed and wind direction. Application of the orographic enhancement factors to QPE/QPF will be further studied.

The Observatory, on a trial basis, historically carried out its first TC reconnaissance flight over the South China Sea for Typhoon Molave (0906) in July 2009. Further experimental flights were undertaken for Tropical Storm Haima (1104) and Typhoon Nesat (1117) in 2011. Wind, pressure, temperature and humidity measurements were recorded along the flight routes and were further processed for ingestion into the data assimilation system of the Observatory's Non-Hydrostatic Model. Positive impacts were obtained on the analysis of low-level winds and moisture around the TCs, as well as reduction of forecast track errors in the model simulation.

The Tropical Cyclone Information Display and Processing System (TIPS), the major system for TC forecast operations, was enhanced in 2011. Its storm surge forecast module was improved by ingesting TC forecast track of higher temporal resolution and fine-tuning the effect of other weather systems such as monsoon.

A new probabilistic product giving the closest approach of tropical cyclones from Hong Kong International Airport was developed based on ECMWF EPS outputs and put to trial use during the tropical cyclone season of 2011. The Kalman-filtering method for post-processing model wind speed forecast was being tested using past data. Generation of the probability of maximum wind speed and crosswind for the entire life cycle of tropical cyclone would also be explored.

A satellite convective cloud prediction system was developed to assist the forecaster in fine-tuning significant convection forecasts generated from NWP model outputs. The system produces forecast positions of deep convective cloud clusters at hourly intervals up to 12 hours ahead by using advection technique based on multi-grid optical flow method.

HKO recently utilized dynamical model data, for example, sea surface temperature and upper air circulation, provided by the Climate Prediction Center (CPC), NOAA, USA to investigate the forecast skill of a statistical-dynamical approach in predicting the TC activity affecting Hong Kong. Based on data from 1982-2009, the

statistical-dynamical approach was able to reduce the forecast error by 30% over the climatological forecast. Model outputs from other GPCs would be tried out and further study on the extraction of environment factors would be conducted with a view to improving the forecast skill.

HKO continued to support the Typhoon Committee's initiative in assessing the impacts of climate change on the tropical cyclone activities in the Typhoon Committee Region by providing a member of staff, Dr. T.C. Lee, to serve on the expert team of the 2nd Assessment Report.

2. Training

A meteorologist from HKO served as a resource person for the Typhoon Committee Roving Seminar 2011 held in Malaysia from 20-23 September 2011 to share with the participants his expertise and experience on operational quantitative precipitation forecast and its application to tropical cyclone conditions. Another officer from HKO also attended the Seminar as a trainee.

HKO and WMO jointly hosted a training workshop on forecasting and warning services for severe weather, including tropical cyclone, at the Observatory from 4 to 15 July 2011 under the Severe Weather Forecasting Demonstration Project (SWFDP) for Southeast Asia. Representatives from national meteorological services and disaster management authorities of five countries, namely Cambodia, Lao PDR, Philippines, Thailand and Viet Nam attended the workshop.

Annex VII

Research Activities in Japan Meteorological Agency (JMA)

1. Introduction of a Stochastic Physics Scheme for Representation of Model Uncertainties to JMA's Typhoon Ensemble Prediction System

Since February 2008, JMA has operated typhoon ensemble prediction system (TEPS). TEPS has been designed to improve track forecast targeting for tropical cyclones (TCs) in the RSMC Tokyo - Typhoon Center's area of responsibility within the framework of WMO. The forecast model of TEPS is a low-resolution version (TL319L60) of JMA Global Spectral Model (GSM) at T959L60. TEPS adopts a singular vector (SV) method to generate initial perturbations and calculates dry SV targeting for the mid-latitude area in the Center's area of responsibility. It also calculates moist SV targeting for TC surroundings where moist processes are critical.

A stochastic physics scheme based on Buizza *et al.* (1999) was introduced into TEPS in December 2010. It is the first scheme for representation of model uncertainties in TEPS and its formulation is based on random errors associated with parameterized physical processes. The introduction contributes to appropriate ensemble spread and improves the forecast skill over the tropics.

2. A Study on the Relative Benefits of Multi-Center Grand Ensemble for Tropical Cyclone Track Prediction in the Western North Pacific

Ensemble TC track predictions are examined using the TIGGE data from nine NWP centers. The main goal of this study is to investigate the relative benefits of multi-center grand ensemble (MCGE) over single model ensemble (SME) from both deterministic and probabilistic perspectives. Here, the SME corresponds to the EPS at each NWP center and the MCGE consists of all ensemble members of all or selected SMEs (maximum ensemble size is 248). Verified TCs are 58 TCs in the western North Pacific from 2008 to 2010.

In the verification of TC strike probability, the Brier skill score of MCGE is larger than that of the best SME, which is the ECMWF EPS, in the medium-range time scale. In addition, the reliability is found to be improved in the MCGE, especially in the high-probability range. Moreover, the MCGE reduces the missing area by about 1 / 10 compared with the best SME. In the verification of confidence information, the MCGE is found to be successful in extracting confidence information throughout the prediction times from 1 to 5 days. The relative benefit of MCGE over SME is seen in the cases where the ensemble spread is extremely small. In such cases, the position error of MCGE is generally smaller than that of the best SME, indicating that when multiple SMEs simultaneously predict the low

uncertainty, the confidence level increases and a chance to have a large position error decreases. In the verification of deterministic track predictions, the ensemble mean TC track prediction of MCGE by the ECMWF, JMA and UKMO EPSs is found to be slightly better in the 5-day prediction on average than that of the best SME, though the difference in the errors is not statistically significant.

3. Singular Vectors for Tropical Cyclone–Like Vortices in a Non-divergent Barotropic Framework

Singular vectors (SVs) are computed in a non-divergent barotropic framework in order to understand the basic properties of SVs that grow in the vicinity of tropical cyclones. First, the location of SVs, which is important in adaptive observations, is investigated. The location of SVs is found to be sensitive to the structure of initial axisymmetric vortices such as the maximum wind speed and radium of maximum wind and to the configurations of SV calculations such as the optimization time interval. Following this, a connection between SVs and tropical cyclone motions is investigated. For this purpose, SVs are computed on a β-plane where the initial axisymmetric vortices evolve (move) due to the beta-gyres. The results show that the initial 1st and 2nd SVs have an azimuthal wavenumber one structure. Note that an azimuthal wavenumber one structure leads to the displacement of a vortex. The linear combination of the initial 1st and 2nd SVs can displace a vortex toward any direction at the optimization time when they are used as ensemble initial perturbations. This result indicates the importance of using SVs with large singular values that result in the displacement of a vortex when creating ensemble initial perturbations or sensitivity analysis guidance.

4. Impacts of Diurnally-Varying Sea Surface Temperature and Wave-ocean Interaction on the Intensity Prediction of an Idealized Vortex and Typhoon Haitang (2005)

Impact of the ocean and wave-ocean interaction on the intensity prediction of an idealized vortex and Typhoon Haitang (2005) was studied using a coupled atmosphere-wave-ocean model. The idealized numerical experiments indicated that rapid intensification is affected by changes in surface roughness lengths at the early rapid intensification phase. At the late rapid-intensification phase, the intensification is affected by variation of SST including diurnally varying SST and noisy-varying SST. The numerical experiments for Haitang indicated that a difference of surface boundary schemes between Kondo (1975) and Louis *et al.* (1982) results in a difference of the dependencies of the momentum exchange coefficients on surface wind speed at a height of 10 m at very high winds exceeding 40 m s^{-1} when the function of wave steepness was used for estimating surface roughness lengths. The exchange coefficient for the momentum flux rapidly decreased when the scheme of Kondo (1975) was used, while it was maintained when that of Louis *et al.* (1982) was used.

5. The Thermohaline Responses to Typhoons Ma-on and Muifa in 2011 Observed by Three Iridium Profiling Floats

Three Iridium profiling floats observed daily thermohaline responses to successive passages of Typhoons Ma-on and Muifa around 20º-24ºN, 137ºE in 2011. The two typhoons induced remarkable sea-surface cooling by 2.6ºC-5.3ºC instantaneously after their passages, particularly on the right side of their tracks. Sub-surface salinity at a 4-m depth decreased by 0.55 where heavy precipitation accompanied by Ma-on occurred when the typhoon existed north of 20˚N. The trend of salinity decrease lasted the subsequent ten days. Freshened water reached nearly a 60-m depth after the passage of Muifa and it lasts for the following six days. In contrast, the salinity increased by 0.35-0.55 during the passage of Muifa when the typhoon existed south of 20˚N. The increase of salinity is mainly caused by vertical turbulent mixing on the right side of the track.

6. Climatology of Extratropical Transition of Tropical Cyclones in the Western North Pacific defined by Using Cyclone Phase Space

Tropical cyclones (TCs) in the western North Pacific from 1979 through 2004 are examined to present climatology of their extratropical transition (ET). Two parameters of the cyclone phase space (CPS) are calculated as indices of ET. The onset and the completion of ET are defined as the beginning of an increase in thermal asymmetry and the evolution from the warm- to the cold-core structure, respectively. Forty percent of all TCs are assumed to complete ET. The mean transition period from the ET onset until the ET completion is estimated to be about 18 hrs. Meridional fluctuation of the location of ET completion by season attains its peak in August, while the peak of the ET events occurs in September-October in respect of the ratio of the ET frequency to all TCs, the transition period, and intensity at the time of ET completion. These characteristics of ET affect the seasonal variation in the structure of landfalling TCs in Japan.

Annex VIII

Research Activities in Korea Meteorological Administration (KMA)

1. Development of English version of TAPS

A Korean version of TAPS (Typhoon Analysis and Prediction System) has been operationally used in KMA (Korea Meteorological Administration) for the typhoon forecast generated in western North Pacific. Its English version was developed for its worldwide use in 2011. The transfer of TAPS to Viet Nam will be completed within 2012. This tool helps to forecast typhoon track and central pressure more efficiently. The main functions of TAPS are to help forecasters to generate the warning messages including the typhoon intensity, track, the area of 15 m/s, 25 m/s winds, the area of 70% probability of typhoon on a map. In this system, it is possible to search historical typhoons in the selected region, to show the track forecasts of other countries (RSMC, JTWC, etc) and to display the current weather chart (850 hPa streamline , SST, 500 hPa height, etc.) and many model results simultaneously.

2. Seasonal Prediction Systems for Typhoon Genesis Frequency and Track Patterns

Three types of seasonal prediction systems are operated at National Typhoon Center (NTC)/KMA for typhoon genesis frequency and track pattern forecast. For each season, the three-month lead-time prediction is made one month prior to the target season. The seasonal prediction outputs consist of monthly statistics for total number of typhoon occurrence in western North Pacific (WNP) and possible threat to Korean peninsula among them, and the probability of each categorized track pattern. The three systems involve the NTC-COAPS system which is based on FSU/COAPS[1] 3D primitive equation global spectral model ensembles at a resolution of T126L27 (a Gaussian grid spacing of 0.94º), the NTC-KNU[2] system which is based on multiple linear regression model, and the NTC-SNU[3] system which is based on hybrid type of statistical-dynamical model. The official typhoon seasonal prediction information is decided by consensus from those three systems and disseminated to public as part of Climate Prediction Division's official seasonal forecast. The basic idea and operational processes about those three systems are described. The web-based monitoring system which summarizes the three systems result is under construction. The extension to seasonal forecasting of cyclone activity in Indian Ocean and southern hemisphere is also under consideration.

3. Typhoon Committee Training and Research Fellowship in 2011

[1] FSU/COAPS: Florida State University/ Center for Ocean-Atmospheric Prediction Studies
[2] KNU: Kongju National University
[3] SNU: Seoul National University

Participating in Training and Research Coordination Group (TRCG) Fellowship Program of the Typhoon Committee, NTC/KMA had trained 7 typhoon experts from other countries since 2010. This year, we offered the training program to one expert each from the Thailand Meteorological Department (TMD) during September to October and the Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA) from September to November. The two trainees were able to complete the course on typhoon forecasting process without language barriers by using the newly developed TAPS English version. In one month, the TMD trainee has obtained the basic method using the TAPS to forecast typhoons. In 2012, for more efficient technology transfer, this fellowship will start in May and to be completed in two or three months.

4. International Conferences in 2011

On 11-13 May 2011, in Seogwuipo, Republic of Korea, the NTC/KMA held the "International Workshop on Tropical Cyclone-Ocean Interaction in the Northwest Pacific" attended by 50 domestic and foreign experts on typhoon-ocean interaction from U.S. (NOAA, 4 research institutes and universities), Japan (Kyoto University), Taiwan (National Taiwan University) and Korea (8 research institutes including the Korea Ocean Research and Development Institute).

Participants made 35 presentations in 7 sessions (including poster session), sharing research information on observation, theories, and modeling for better understanding of the interaction between typhoon tracks and the western North Pacific Ocean conditions. There were intensive discussion on the dynamic process of atmosphere-ocean interaction and application of dynamic atmosphere-ocean coupling model. The 3rd workshop will be held in National Taiwan University.

Shanghai Typhoon Institute (STI) of CMA and National Typhoon Center (NTC) of KMA co-hosted the fourth joint workshop on tropical cyclones, which was held on 19 December 2011 in Shanghai, China. Thirteen papers were presented at the workshop on a wide range of topics such as boundary layer impact on tropical cyclone, dynamical or statistical seasonal prediction systems, initialization scheme for TC forecast model, typhoon information processing systems, assimilation of Doppler radar radial winds, long-term trend in typhoon climate, best-track generation from historical data, and satellite-based typhoon analysis. The participating organizations besides STI/CMA and NTC/KMA were Korea Meteorological Satellite Center, Chinese Academy of Meteorological Sciences, International Pacific Research Center at University of Hawaii, Key Laboratory for Mesoscale Weather at Nanjing University, Shanghai Center for Remote Sensing and Application, and Typhoon and Marine Weather Forecasting Center at CMA.

Annex IX

Research and training activities in
Department of Meteorology and Hydrology, Lao PDR

1. Training

Technical staff members from Department of Meteorology and Hydrology (DMH) attended the following training workshops:

1.1. Mrs. Sinthaly CHANTHANA attended the 10th Typhoon Operation Forecasting from 20 – 29 July 2011, at RSMC, TCC, Tokyo, Japan

1.2. Mrs. Sinthaly CHANTHANA and Mr. Sengduangduan PHOUTHANOXAY attended the roving seminar on "Heavy Rain and Flood Hazards Associated with Landfall Tropical Cyclone" from 20 to 23 September 2011 in Malaysia.

1.3. Mrs. Souvanny PHONEVILAY, Mrs. Bouangeun OUDOMCHIT, Mr. Somphanh VITHAYA and Mr. Bounteum SYSOUPHANTHAVONG attended the Integrated Workshop on "Damage Assessment Methodology and Pre-Assessment of Typhoon Landfall Impact" in Nha Trang, Vietnam, from 7 to 11 November 2011.

2. Numerical Weather Prediction development

DMH was developing the use of Weather Research and Forecasting (WRF) model for improving the weather forecasting and warning system in Lao PDR, and is currently simulating the rainfall estimates for downscaling.

3. Research

Under the Weather Forecasting and Aeronautical Division of DMH, two research studies were completed on WRF model simulation of rainfall during pre-monsoon, monsoon, tropical cyclones associated with monsoon, and post-monsoon.

Annex X

Research and Training Activities in Malaysian Meteorological Department (MMD)

1. Training

Officers from MMD attended the following meetings and workshops:

i) 43rd Typhoon Committee Session in Jeju, Republic of Korea on 17-21 January 2011;
ii) ACTS-WG Meeting and APEC Typhoon Symposium in Taipei, Taiwan on 9-14 April 2011;
iii) 1st Asia-Pacific Economic Cooperation (APEC) Research Center for Typhoon and Society (ACTS) Workshop in Cebu, Philippines on 25 - 27 May 2011; and
iv) Integrated Workshop: Damage Assessment Methodology and Pre-Assessment of Typhoon Landfall Impact in Nha Thrang, Vietnam on 7-11 November 2011.

2. NWP Development

The MMD has upgraded all its radars to Doppler radars to enhance the radar network coverage over Malaysia. The assimilation of the Doppler radar reflectivity into WRF and MM5 models is currently being performed to enhance the quantitative rainfall estimates associated with tropical cyclones. The Shanghai Typhoon Institute's Bogus Data Assimilation (BDA) scheme will be introduced into the MM5 model for typhoon bogussing. In future, the assimilation of Doppler radar radial wind data would be included to improve tropical cyclone track prediction.

3. Research

The Research Section in the Technical Development Division of MMD completed three research studies related to tropical cyclone activities as follows:

i) Impact of Tropical Cyclones in the West North Pacific and South China Sea on the Asian Monsoon Rainfall during Pre-monsoon, Monsoon and Post-monsoon Seasons;
ii) ENSO Events and Tropical Cyclones over the West Pacific Ocean 1945-2009; and
iii) Impact of Tropical Cyclones on Sabah Rainfall during Southwest Monsoon.

There is an ongoing research study related to "Storm Surge Modeling Results for Typhoon Vamei".

4. Typhoon Committee Roving Seminar 2011

The Typhoon Committee Roving Seminar 2011 (TCRS 2011) was organized and hosted by the MMD from 20 to 23 September 2011. The theme for TCRS 2011 was *Heavy Rain and Flood Hazards Associated with Landfalling Tropical Cyclones*. There are 22 international participants from China, Philippines, Hong Kong, Cambodia, Lao PDR, Macao, Singapore, Thailand and Viet Nam, 13 local participants from Malaysia, together with 3 resource persons from Hong Kong, Singapore and Thailand, and an ex officio from the Typhoon Committee Secretariat taking part in the seminar.

The participants were introduced to the QPE/QPF techniques and its applications during the seminar. The cause, assessment and management of flood hazards associated with landfalling tropical cyclones and heavy rain were also discussed. Generally the participants are satisfied with the organization of the seminar. They have improved their knowledge and enhanced their skills in forecasting heavy rain and floods due to landfalling tropical storms and have the opportunity to become familiarized with the Hong Kong Observatory's nowcasting system - "Short-range Warning of Intense Rainstorms in Localized Systems (SWIRLS)".

Annex XI

List of Resource Persons

Member	Specialties	Name	E-mail	Affiliation
(A) Data Assimilation				
China	TC vortex initialization	LIANG, Xudong	Liangxd@mail.typhoon.gov.cn	Shanghai Typhoon Institute
	TC intensity estimation by radar, satellite, SSMI and QuikScat	GAO, Shuanzhu ZHOU, Bing	gaosz1129@sina.com bingz@cma.gov.cn	National Meteorological Center
	Radar data quality control and assimilation scheme	GONG, Jiandong	gongjd@cma.gov.cn	National Meteorological Center
Hong Kong, China	TC data assimilation	W.K. WONG	wkwong@hko.gov.hk	Hong Kong Observatory
Japan	Satellite data analysis	Naotaka UEKIYO	n-uekiyo@mri-jma.go.jp	Meteorological Research Institute
	TC intensity estimation	Shunsuke HOSHINO	shoshino@mri-jma.go.jp	Meteorological Research Institute
	Data analysis related to extratropical transition	Naoko KITABATAKE	nkitabat@mri-jma.go.jp	Meteorological Research Institute

Member	Specialties	Name	E-mail	Affiliation
(A) Data Assimilation (cont'd)				
Republic of Korea	Typhoon bogussing	YOO, Hee Dong	hyoo@kma.go.kr	Korea Meteorological Administration
		KWON, H. Joe	hjkwon@kongju.ac.kr	Kongju National University
	Satellite data analysis	CHOI, Byoung-Choel	cbc123@korea.kr	Korea Meteorological Administration
	Radar data analysis	PARK, Jong Seo	jspark@kma.go.kr	Korea Meteorological Administration
USA (western North Pacific)	TC analysis, satellite interpretation, use of microwave imagery and scatterometer data	Tom LEE Peter BLACK Paul CHANG	Lee@nrlmry.navy.mil Peter.Black.ctr@nrlmry.navy.mil Paul.S.Chang@noaa.gov	NRL, Monterey, CA NRL, Monterey CA NOAA/NESDIS, Suitland MD
(B) Modelling				
China	Numerical schemes of TC model	DUAN, Yihong	duanyh@mail.typhoon.gov.cn	Shanghai Typhoon Institute
	TC model physics and bogussing schemes	MA, Suhong	mash@cma.gov.cn	National Meteorological Center
	Ensemble track forecasting	ZHOU, Xiaqiong	zhouxq@mail.typhoon.gov.cn	Shanghai Typhoon Institute
	Typhoon modelling	LIANG, Xudong	Liangxd@mail.typhoon.gov.cn	Shanghai Typhoon Institute

Member	Specialties	Name	E-mail	Affiliation
(B) Modelling (cont'd)				
Hong Kong, China	TC modelling and bogussing schemes	W.K. WONG	wkwong@hko.gov.hk	Hong Kong Observatory
Japan	Ensemble track forecasting	Munehiko YAMAGUCHI	myamagu@mri-jma.go.jp	Meteorological Research Institute
	TC-ocean interaction (incl. mixed-layer ocean and ocean surface wave modelling)	Akiyoshi WADA	awada@mri-jma.go.jp	Meteorological Research Institute
	Storm surge modelling	Nadao KOHNO	nkono@met.kishou.go.jp	Japan Meteorological Agency
Republic of Korea	Global NWP model tracks	PARK, Hoon	hoon@kma.go.kr	Korea Meteorological Administration
	Ensemble track forecasting	PARK, Hoon	hoon@kma.go.kr	Korea Meteorological Administration
	Typhoon modelling	PARK, Hoon	hoon@kma.go.kr	Korea Meteorological Administration
		KWON, H. Joe	hjkwon@kongju.ac.kr	Kongju National University
		HO, Chang Hoi	hoch@cpl.snu.ac.kr	Seoul National University

Member	Specialties	Name	E-mail	Affiliation
(B) Modelling (cont'd)				
USA (western North Pacific)	TC Modeling Extratropical Transition	Jim DOYLE Pat HARR	James.Doyle@nrlmry.navy.mil paharr@nps.edu	NRL, Monterey CA Naval Postgraduate School, Monterey CA
Viet Nam	Computational fluid dynamics and modelling	LE, Duc	leducvn@yahoo.com	National Hydro-Meteorological Service of Viet Nam
(C) Forecasting				
China	Track and intensity forecasting	LEI, Xiaotu	Leixt@mail.typhoon.gov.cn	Shanghai Typhoon Institute
	Long-range prediction of typhoon	XU, Ming	Xum@mail.typhoon.gov.cn	Shanghai Typhoon Institute
Hong Kong, China	TC climatology and best track analysis	W.H. LUI	whlui@hko.gov.hk	Hong Kong Observatory
	TC intensity, structure and landfall impact	S.T. Chan	stchan@hko.gov.hk	Hong Kong Observatory
	Long-range forecasting of TCs	S.M. LEE	smlee@hko.gov.hk	Hong Kong Observatory
	TC motion, intensity, size, modelling and seasonal prediction	Johnny C.L. CHAN	Johnny.Chan@cityu.edu.hk	City University of Hong Kong.

Member	Specialties	Name	E-mail	Affiliation
(C) Forecasting (cont'd)				
Republic of Korea	Track and intensity forecasting	PARK, Hoon	hoon@kma.go.kr	Korea Meteorological Administration
		KWON, H. Joe	hjkwon@kongju.ac.kr	Kongju National University
		HO, Chang Hoi	hoch@cpl.snu.ac.kr	Seoul National University
		SOHN, Byung-Ju	sohn@snu.ac.kr	Seoul National University
	Long-range prediction of typhoon	KWON, H. Joe	hjkwon@kongju.ac.kr	Kongju National University
		HO, Chang Hoi	hoch@cpl.snu.ac.kr	Seoul National University
Singapore	Seasonal prediction of typhoon	LIM, Tian Kuay	LIM_Tian_Kuay@nea.gov.sg	Meteorological Services Division, National Environment Agency
USA (western North Pacific)	TC analysis and forecasting, seasonal prediction, use of microwave imagery and scatterometer data, Dvorak technique	Mark LANDER Roger EDSON	mlander@uguam.uog.edu Roger.Edson@noaa.gov	University of Guam (WERI) National Weather Service, Forecast Office Guam
	Satellite data analysis, use of microwave imagery	Jeff HAWKINS	Jeff.Hawkins@nrlmry.navy.mil	Navy Research Laboratory, Monterey

Member	Specialties	Name	E-mail	Affiliation
(C) Forecasting (cont'd)				
USA (western North Pacific)	Satellite data analysis, use of microwave imagery, automated Dvorak Technique, AMSU	Chris VELDEN Derrick HERNDON	chris.velden@ssec.wisc.edu dherndon@ssec.wisc.edu	CIMSS, University of Wisconsin-Madison
	Satellite data analysis, use of microwave imagery, AMSU	John KNAFF	knaff@CIRA.colostate.edu	CIRA, Colorado State University
(D) Application				
Hong Kong, China	TC warning systems and operations	Edwin S.T. LAI	stlai@hko.gov.hk	Hong Kong Observatory
	TC information visualization and display systems	L.S. LEE	lslee@hko.gov.hk	Hong Kong Observatory
USA (western North Pacific)	TC warning and disaster preparedness, seasonal prediction, Dvorak technique	Chip GUARD	chip.guard@noaa.gov	NOAA National Weather Service Guam

Annex XII

TRCG Work Plans (2011 – 2013) – updated as at end of 2011

Year	Quarter	Typhoon Committee Activity	Training and Research Activities (*activities organized by parties other than TRCG)	Themes (if any) / Remarks
2011	Q1	TC-43 (Jeju)		
	Q2		Research Fellowship	Seasonal forecast; TC genesis; TIPS
	Q3		RSMC Tokyo attachment*	Attended by Macao and Lao PDR
			WMO Storm Surge Workshop (Macao)*	
			Research Fellowship	Seasonal forecast; TC genesis; TIPS
			Roving Seminar (Petaling Jaya)	Heavy rain and flooding associated with landfalling tropical cyclones
	Q4	Integrated Workshop (Nha Trang)	Research Fellowship	Seasonal forecast; TC genesis; TIPS
2012	Q1	TC-44 (Hangzhou)	UFRM Training Workshop (Macao)*	
	Q2		Research Fellowship	Urban/coastal flooding; TC QPF; TIPS
	Q3		RSMC Tokyo attachment*	To be attended by Viet Nam and Cambodia
			Research Fellowship	Urban/coastal flooding; TC QPF; TIPS
	Q4	Integrated Workshop	Roving Seminar	Damage assessment methodology and pre-evaluation (with WGDRR?)
			Research Fellowship	Urban/coastal flooding; TC QPF; TIPS
2013	Q1	TC-45		
	Q2		2nd TRCG Forum / Meeting	(theme to be confirmed)
	Q3		RSMC Tokyo attachment*	To be attended by Philippines and Thailand
			Research Fellowship	TC damage assessment methodology and pre-evaluation
	Q4	Integrated Workshop	Research Fellowship	TC damage assessment methodology and pre-evaluation

Annex XIII

Training and Research Coordination Group (TRCG) Annual Operating Plan 2012

Objective Number	*KRA / SG*	*Objective*	*Action*	*Other WGs Involved*	*TCS Responsibility*	*Expected Quarter Completed*	*Other Organizations Involved*	*Success Indicators*	*Funding Required*	*Funding Sources*
1	KRA 6 / SG 6b and 6c	To: (a) implement training initiatives in the priority operational and research areas as identified in the TRCG annual report; and (b) enhance Members' capability and capacity in the assessment of damage and pre-assessment of potential impact caused by landfalling TCs	Roving Seminar [with themes on damage assessment and pre-assessment methodology]	WGDRR	Provision of administrative and logistic support.	3rd or 4th	-	Feedback from evaluation forms to be completed by a target audience of about 30 people.	USD 14,000	TCTF
2	KRA 6 / SG 6b and 6c	To facilitate technology transfer (emphasis on QPF/QPE) among TC Members through research and development initiatives.	Research Fellowship	WGM	Provision of administrative and logistic support.	2nd - 4th	TC Members	Publication of research findings and development output in TCAR or other journals.	Fellowship offered by voluntary hosts.	TC Members
3	KRA 6 / SG 6b and 6c	To enhance TC Members' capacity and knowledge in operational tropical cyclone forecasting.	Attachment of two forecasters (Cambodia and Viet Nam) to RSMC Tokyo	nil	Provision of administrative and logistic support.	3rd	RSMC Tokyo, WMO	Assessment as given in RSMC Tokyo report.	USD 4,000	TCTF