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

FOR PARTICIPANTS ONLY
WRD/TC.51/9.4
18 February 2019

ENGLISH ONLY

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;

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

(c) endorse the future plans of TRCG as outlined in Section 6 and Annexes VII and IX of the APPENDIX B.

APPENDICES :
A : Draft text for inclusion at Session Report
B : TRCG Annual Report 2018

APPENDIX A
DRAFT TEXT FOR INCLUSION IN THE SESSION REPORT

9.4. Training and Research Coordination Group

The Committee took note of the progress made in training and research activities as presented in the TRCG Report 2018 (Appendix ???)

The Committee noted the successful completion of the Technical Conference (TECO) in conjunction with the 50th Session of the Typhoon Committee (TC50) in February 2018 and expressed its gratitude to Viet Nam Meteorological and Hydrological Administration for hosting the TECO in Hanoi and the contribution of speakers in the event.

The Committee expressed its appreciation to the Meteorological Service Singapore for hosting the Roving Seminar 2018 in Singapore and the support of resource persons by China, Hong Kong, China, and Japan.

The Committee thanked China, Hong Kong, China and Republic of Korea for hosting research fellowship programs in 2018.

The Committee took note of the successful completion of the RSMC Tokyo Training Attachment of five forecasters from TC and PTC Members, including Macao, China, Malaysia and the Philippines of the Typhoon Committee as well as two forecasters in the Panel on Tropical Cyclone, and thanked Japan and WMO TCP for continuously supporting this capacity-building initiative.

The Committee expressed its appreciation to China for offering the Typhoon Forecaster Training for seven forecasters from TC and PTC including Thailand, Viet Nam, Malaysia, Lao PDR, Bangladesh and Sri Lanka.

The Committee appreciated TRCG's inputs in support of training and research activities in connection with TC's cross-cutting projects.

RECOMMENDATIONS of TRCG:

On the basis of the conclusions reached by the deliberation of Members, the TRCG made the following recommendations :

a. To request Members to confirm their respective focal points as members of TRCG and update the list of resource persons as appropriate.

b. To endorse the priority training and research areas as proposed in TRCG Report 2018.

c. To endorse the proposal of increasing the number of Typhoon Committee trainees for the RSMC Tokyo Training Attachment from 3 to 4, starting from 2019, with the same cost-sharing scheme for WMO TCP and TCTF to cover the additional ticket and lump sum respectively.

d. To endorse the TRCG AOP 2019 including the hosting of the roving seminar under the support of TCTF and other budget requests which are included in the budget proposal to be submitted by AWG.

APPENDIX B
TRAINING & RESEARCH COORDINATION GROUP (TRCG)
Annual Report 2018

T C Lee (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) coordinating training and research programmes, including activities in support of cross-cutting initiatives and other collaboration programmes among Members such as twinning and mentoring arrangement, aimed at improving the technical capacity and capability of Members to better serve the people in the region;

(d) evaluating the effectiveness of training and research activities undertaken by TRCG, and providing support to other working groups in performing such evaluation; and

(e) recommending to the Committee priority areas and long-term plans for cooperation in research and training in support of the targets and various KRAs of the Committee's Strategic Plan.

2. Membership

2.1 The composition and members list of TRCG (as at 31 October 2018) are:

Chair: Dr. T C LEE (Hong Kong, China)
Vice Chair: Dr. Namyoung Kang (Republic of Korea)
Members: Mr. So Im Monichoth (Cambodia)
             Mr. QIAN Chuanhai (China)
             Mr. Kang Bom Jin (DPR Korea)

Dr. Hisaki Eito (Japan)
Dr. Mayphou Mahachaleun (Lao PDR)
Mr. IAN Vai Kei, Brian (Macao, China)
Mr. Ambun Dindang (Malaysia)
Dr. Bonifacio G. Pajuelas (Philippines)
Ms Patricia Ee (Singapore)
Ms. Patchara Petvirojchai (Thailand)
Mr. Dinh Thai Hung (Viet Nam)

3. Major TRCG Activities in 2018

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.   With the kind support of TCS, a new Roving Seminar webpage has been set up in the Typhoon Committee website.   The Roving Seminar webpage collects reports, photos and presentation material of past roving seminars (since 2006) for future reference and knowledge sharing.

3.2   The Typhoon Committee Roving Seminar 2018 was successfully held on 20-22 November 2018 in Singapore.   The seminar was kindly hosted by the Meteorological Service Singapore.   The theme of this seminar is on "Application of Remote Sensing Technologies", which includes the following three topics:

Topic A -   Advances in satellite missions and product applications in the Typhoon Committee region
Himawari satellite system–Mr. Koji YAMASHITA, Meteorological Satellite Center, Japan Meteorological Agency, Japan
Fengyun satellite system–Dr Xiang FANG, National Satellite Meteorological Center, China Meteorological Administration, China

Topic B -   Tropical cyclone analysis using microwave satellite imagery
Dr Xiang FANG, National Satellite Meteorological Center, China Meteorological Administration, China

Topic C -   Radar applications in tropical cyclone and extreme weather monitoring and nowcasting
Mr Ray KONG, Hong Kong Observatory, Hong Kong, China

3.3   The Seminar was attended by 12 participants from Cambodia (2); Hong Kong, China (1); Lao PDR (1); Macao, China (1); Malaysia (2); Philippines (1); Singapore (2) and Thailand (2). Three resource persons came from China, Hong Kong and Japan and two representatives came from Typhoon Committee Secretariat (TCS).   The participants were appreciative of the three resource persons for their useful advice on relevant topics shared during their presentations.   Most participants indicated that they had gained knowledge on the latest remote sensing technologies and expressed interest in applying the technologies in their daily operations. A summary report of the seminar can be found in Annex II.

Technical Conference of Typhoon Committee

3.4   To celebrate the 50th anniversary of the Typhoon Committee in 2018, Typhoon Committee decided in its 49th Session to organize a Technical Conference (TECO) in conjunction with the 50th Session of the Typhoon Committee (TC50) in Viet Nam in 2018. With the kind support of Viet Nam Meteorological and Hydrological Administration, the TECO was successfully held on 26-27 February 2018 in Ha Noi, Viet Nam.   The TECO was attended by over 70 participants, including keynote speakers, experts from Typhoon Committee Members and WMO Members.   The main theme of the TECO was "Embracing new technologies and knowledge to meet the challenges in the new era of tropical cyclone forecasting" and there were three key topics under the main theme, namely :

(i)   Moving towards impact-based forecasts and risk-based warnings
(ii)   Embracing new technologies and research findings
(iii)   Facing the challenges arising from climate change and rising sea level

Nine Keynote Speakers from China, Hong Kong, China, Japan, Republic of Korea, United States and Viet Nam were invited to share their knowledge/research findings and discuss issues related to the three topics under the main theme.   The TECO aims to serve as a platform to foster knowledge sharing and cross-cutting collaboration between the operational and research communities amongst National Meteorological and Hydrological Services, international operational and research institutes and academia under the main theme and key topics.   The summary report of the 2-day TC50 TECO is included in Annex III.

Forecasters' Training Attachment

3.5   The RSMC-Tokyo Attachment Training in 2018 was held at JMA Headquarters from 15 to 26 October 2018.   Three forecasters from Macao, China, Malaysia and the Philippines of the Typhoon Committee as well as two forecasters in the Panel on Tropical Cyclone attended the training.   The contents of the training included:

(i)   The satellite analysis and viewer program (SATAID)
(ii) Tropical cyclone analysis (Dvorak technique)
(iii) Interpretation of microwave imagery
(iv) Tropical cyclone forecasting
(v)   Storm surge forecasting
(vi) Public Weather Service

This year, lectures and exercises on tropical cyclone forecasting were expanded considering the importance of TC forecast competency.   In addition, this training course also places great importance on lectures and exercises on public weather service that included setting of warning criteria using quantitative precipitation estimation and forecasting techniques and evaluation of forecast skills to enhance capacity in developing and implementing effective warning system in collaboration with disaster risk reduction partners.

3.6   To promote the Typhoon Committee's regional cooperation and enhance Members' typhoon monitoring and early warning capability, the China Meteorological Administration organized the Typhoon Forecaster Training Programme on 10-19 December 2019. The 10-day training course covered rich contents, including the latest developments in the areas of satellite imagery based tropical cyclone and marine weather analysis, quantitative precipitation forecast, severe weather forecast, sea wave and storm surge forecast, in addition to DVORAK practices and operations. Professor Mark A. Lander was invited to participate in the training course as one of the tutors.   Seven trainees including five from the Typhoon Committee (Thailand, Viet Nam, Malaysia, and Lao PDR) and two from the Panel on Tropical Cyclone (Bangladesh and Sri Landa) attended the training.

Research Fellowship Scheme

3.7   The Research Fellowships are 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 the opportunity for visiting fellows to work closely with experienced scientists at the host centre, providing an avenue 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.

3.8   In 2018, fellowships were offered by China, Hong Kong, China and Republic of Korea.   Information of the latest projects under the scheme, as well as a summary of previous fellowships awarded, can be found in Annex IV.   Publications and papers published in

connection with the scheme are listed in Annex V.

(a) KMA Fellowships

The NTC/KMA hosted the Typhoon Research Fellowship Program from 23 April to 4 May 2018. This program was joined by five participants from the Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA), the Vietnam National Center for Hydro-Meteorological Forecasting (NCHMF), the Thailand Meteorological Department (TMD), the China Meteorological Administration (CMA), and the Malaysian Meteorological Department (MMD).   The participants made their presentations and joined in a practice session on tropical cyclone analysis and forecast using Typhoon Operation System (TOS) and a session on analysis of satellite and radar data.   They were also given the opportunity to visit the KMA headquarters in Seoul and the National Meteorological Satellite Center (NMSC) in Jincheon in the middle part of the Korean Peninsula.

(b) STI Fellowship

The Shanghai Typhoon Institute offered the fellowship on "Benefit evaluation of Typhoon disaster prevention and preparedness" to a forecaster from Malaysia from 2 May to 1 June 2018.   The objective of the fellowship is to introduce the techniques for evaluating the benefits of improving the accuracy of track and intensity forecast to improve the disaster prevention and preparation to the Members.   The project analyzed the impact of landfall point of tropical cyclone and its associated storm surge over coastal region of China to the Direct Economic Loss and the benefit evaluation model.   More than 230 questionnaires have been collected among TC members to evaluate the benefit of typhoon forecast and service.

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

(c) HKO Fellowship
HKO offered the fellowship on a topic entitled "Short-term Rainfall Forecast for Tropical Cyclone Using Himawari-8 Data and NWP Model Products" in 2018.   Ms Thu Hang Nguyen, forecaster of the National Centre for Hydro-Meteorological Service (NHMS), Vietnam participated in the fellowship and was attached to the HKO from 3 January to 1 March 2019. The project aimed at developing rainfall estimate and short-term forecast products for tropical cyclones based on Himawari-8 data as well as forecasts from NWP models and ensemble prediction system.

Development of tropical cyclone forecaster competency

3.9   The final draft of the Tropical Cyclone Forecast Competency was approved by the Committee during the 50th Session.   The competency framework includes requirements for dedicated and specialized TC forecasters at TC forecast agencies (Category 1) and those for general forecasters providing TC forecast services based on information provided by the parent RSMC or other agencies (Category 2).   The approved Competency will be included into TOM and may be updated as needed.

Other training activities

3.10   Training Workshop for Typhoon Committee Community Weather Station Project (iCoWIN) 2018 was successfully held in Hong Kong, China on 5-7 November 2018.   The training aims to enhance Members' capacities in setting up community weather stations for raising public awareness on weather and climate change and promote the use of new communication technology to facilitate sharing of weather information among community. Two participants from Republic of Korea and Thailand attended the training workshop.

4.   Resource Support for Research and Training

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

4.2   The Pacific International Training Desk (PITD), funded by the USA National Weather Service as part of the US contribution to the WMO Voluntary Cooperation Program (VCP), and is now managed by the Telecommunications and Social Informatics (TASI) Research Program at the University of Hawaii. The PITD provides one-on-one basic weather forecast training with an emphasis on the tropics. The training program is focused on operational forecasting to enable its participants to prepare and disseminate locally-produced meteorological, hydrologic and climate products for their home countries. There are four components to the training: 1) eLearning Prerequisite Course, a15-hour course implemented through the use of e-learning modules; 2) On-Site Training Program, a 4-week long, instructor-led on-site training programme carried out at the US Weather Forecast Offices in Honolulu and Guam (this is the first year that training was conducted on Guam); 3) Communications Training, a training on the use of communication systems; and 4) Advanced In-Island workshops on severe weather event topics. Priority is given to Regional Association V (RA V) of the World Meteorological Organization (WMO). However, subject to space availability, Typhoon Committee Members may also apply.

5.   Prioritization of Training and Research Areas

5.1   Based on the discussion during the 3rd TRCG Meeting held in conjunction with the 12th Integrated Workshop (IWS) in Jeju on 31 October – 1 November 2017.   The priority and need for training and research activities have been reviewed and updated as follows:

(A) Meteorology

Monitoring

- (a)   application of Dvorak and microwave satellite image analysis techniques;
- (b)   application of radar-based analysis/products for landfalling tropical cyclones and monsoon depressions;
- (c)   application of new observation technologies (such as aircraft reconnaissance, weather buoys, automatic weather network and mobile observations) in tropical cyclone monitoring and forecasting;

Forecasting and warning

- (a)   development of tropical cyclone structure and intensity forecasting techniques such as rapid intensification and wind structure;
- (b)   application of ensembles of guidance from global and regional dynamical models, ensemble prediction systems, conceptual models, statistical models and systematic knowledge-based approach;
- (c)   use of high resolution numerical models with advanced data assimilation techniques;
- (d)   rainfall forecasting: development of nowcasting and very short range forecasting techniques, and understanding of interaction between tropical cyclones and monsoon;
- (e)   development of probability forecasting and extended outlook; ;
- (f)   development of impact-based forecast and risk-based warnings;
- (g)   better understanding of wave, storm surge and marine forecasting;

(B) Meteorology and Hydrology

- (h)   application of meteorological and hydrological information for forecasting of river flooding and urban flash flood;
- *(i)*   geological hazards associated with heavy rain and tropical cyclones such as flash flood, mudslides and landslides;

(C)   Meteorology and DRR

(j)   development of technical procedures to quantify forecast uncertainties and to convert probabilistic information into effective warnings;

(k)   development of decision-making tools for DRR purpose, including the integration of forecast information with GIS and the use of automated information processing systems;

(l)   making use of new communication technology;

(m)   community response and outreach effort for mitigation of the societal impact caused by disasters.

(D)   Other Cross Cutting Topics

(n)   better understanding of tropical cyclone related issues and impacts across different spatial and time scales, from mesoscale and synoptic analysis arising from El Nino/La Nina and global warming/climate change;

(o)   forecasting and warning systems for better coastal protection from multi-hazards such as storm surge, high winds, heavy rain, river delta inundation and urban flooding;

(p)   effective communication of warning messages to stakeholders, DRR users and communities at risk; and

(q)   utilization of big data, social media, crowdsourcing and artificial intelligence in tropical cyclone and weather monitoring, impact assessment, DRR and public education.

6.   Future Directions and Strategies

6.1   Following the new 4-year plan approved in the 50th Session of the Typhoon Committee (Annex VII), TRCG will continue to support plans to have more cross-cutting training and research initiatives in consultation with the meteorology, hydrology and DRR components.   Members are in turn encouraged to promote such initiatives through proactive involvement of the appropriate meteorological, hydrological and DRR personnel in their countries.

6.2   The current arrangement in RSMC Forecasters' Training Attachment operated smoothly in past few years and will generally be maintained in the next three years.   With a view to meeting the increasing needs of Members for participation in the RSMC Forecaster's Training Attachment, it is proposed that, starting from 2019, the number of Typhoon

Committee trainees for the Training to be increased from 3 to 4 with a corresponding TCTF budget request increasing from US7,500 to US10,000 and WMO TCP covering the additional ticket.

6.3   The possibility of involving hydrologists and DRR experts in RSMC Attachment Training, CMA Training Programme, and TC Research Fellowship Schemes could be explored by corresponding Members in the future.   Moreover, training and research opportunities will be explored in collaboration with WGM, WGH, WGDRR and WMO Training Centre in Nanjing as well as various interested Members as appropriate.

6.4   Review of the TRCG AOP 2018 can be found in Annex VIII and the proposed AOP 2019 is in Annex IX.

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 with 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
2012	30 Oct – 1 Nov	Seoul	Tropical Cyclone Damage Assessment and Impact Forecast	DRR experts from NDMI Ms. Xu Jing Mr. W.K. Wong

2014	3-5 Nov	Hong Kong	Warning communication	Mr. Chip Guard Mr. Ahmed Nadeem Ms. Sandy, M.K. Song Mr. K.L. Lee
2015	4-6 Nov	Lao PDR	Flash flood and landslides	Mr Yoshiki Nagai Prof Xu-dong Fu Dr Dong-ryul Lee
2016	15-17 Nov	Viet Nam	Storm Surge	Mr Nadao Kohno Mr Author Taylor Mr Dickson Lau
2018	20-22 Nov	Singapore	Application of Remote Sensing Technologies	Mr. Koji Yamashita Dr Xiang Fang Mr Ray Kong

SUMMARY OF TYPHOON COMMITTEE ROVING SEMINAR 2018
(Singapore, 20-22 November 2018)

I.   Organization

1.   The Typhoon Committee Roving Seminar (TCRS) 2018 with the theme on "Application of Remote Sensing Technologies" was successfully held on 20-22 November 2018 in Singapore. It was organized by ESCAP/WMO Typhoon Committee (TC) and hosted by the Meteorological Service Singapore (MSS) of Singapore.

2.   The Seminar was attended by 12 participants from Cambodia (2); Hong Kong, China (1); Lao PDR (1); Macao, China (1); Malaysia (2); Philippines (1); Singapore (2) and Thailand (2). Three resource persons came from China, Hong Kong and Japan and two representatives came from Typhoon Committee Secretariat (TCS).   The list of participants is given in Attachment A.

II.   Opening

1.   The TCRS 2018 was officiated by Meteorologist of TCS, Mr. Fong Chi Kong. He expressed his gratitude to MSS for hosting the Roving Seminar as it was one of the main activities of the TC which has been coordinated by the TRCG since 2003. He also expressed his gratitude to the resource persons for sharing valuable experience in remote sensing technologies among TC Members. As technologies advance social and economic loss due to tropical cyclones in TC region can be reduced.

III. Seminar Programme

1.   Mr. Koji Yamashita from Japan Meteorological Agency and Dr. Xiang Fang from China Meteorological Administration presented Topic A on "Advances in Satellite Missions and Product Applications in the Typhoon Committee Region".

2.   Dr. Xiang Fang also presented Topic B on "Tropical Cyclone Analysis using Microwave Satellite Imagery".

3.   Mr. Ray Kong from Hong Kong Observatory presented Topic C on "Radar applications in Tropical Cyclone and Extreme Weather Monitoring and Nowcasting".

4.   A technical visit to Central Forecast Office of Meteorological Service Singapore was conducted in the afternoon of 22 November 2018.

5.   The Roving Seminar Programme is given in Attachment B.

IV.   Proposals and Recommendations

1.   The participants gave a warm appreciation to the three resource persons for their presentations and useful advice on the relevant topics.

2.   During the wrap up discussion, most participants indicated that they gained knowledge on

the latest remote sensing technologies and expressed interest to apply the technologies in daily operations. The resource persons encouraged the participants to discuss with them for future assistance and collaboration. The Feedbacks and recommendations collated from the participants are summarized in Attachment C.

3. Suggestions from the resource persons and organizers for future reference:
   (a)   more communication and cooperation between satellite operators and users;
   (b)   more focus on the applications of remote sensing technologies;
   (c)   combination of GEO/LEO satellites and radar products.

V.   Closing

1. The resource persons and participants expressed their gratitude to MSS for hosting this seminar and for the warm hospitality.

2. Ms. Yap Chui Wah of MSS presented the attendance certificates to the participants.

3. The Roving Seminar closed on 22 November 2018.

List of Participants of the Typhoon Committee Roving Seminar 2018
(Singapore, 20-22 November 2018)

Members	Name of Participants
Cambodia	Mr. CHUON Sokun
	Mr. PHAN Sambath
Hong Kong, China	Mr. CHOY Shui-chung
Lao PDR	Mr. Phapasit KHAMPHOUMY
Macao, China	Mr. Hong Kei MUI
Malaysia	Mr. Mohd Hafizi MAT YASIN
	Ir. Rajaselvam s/o GOVINDARAJU
Philippines	Ms. Alexis R. RUIVIVAR
Singapore	Ms. HUAN Jia Yan
	Mr. NG Jin Zheng
Thailand	Dr. Kamol Promasakha na SAKOLNAKHON
	Miss Ornnicha PHANTHURAT

Resource persons	Dr. Xiang FANG
	Mr. Ray, Wai KONG
	Mr. Koji YAMASHITA
TCS	Mr. Chi Kong FONG
	Ms. Yeji SHIN

Typhoon Committee Roving Seminar 2018
Provisional Programme

Dates and Venue: 20 – 22 November 2018, Centre for Climate Research Singapore, Singapore

Main Theme: Application of Remote Sensing Technologies

Topic A – Advances in satellite missions and product applications in the Typhoon Committee region
Himawari satellite system–Mr. Koji YAMASHITA, Meteorological Satellite Center, Japan Meteorological Agency, Japan
Fengyun satellite system–Dr Xiang FANG, National Satellite Meteorological Center, China Meteorological Administration, China

Topic B – Tropical cyclone analysis using microwave satellite imagery
Dr Xiang FANG, National Satellite Meteorological Center, China Meteorological Administration, China

Topic C – Radar applications in tropical cyclone and extreme weather monitoring and nowcasting
Mr Ray KONG, Hong Kong Observatory, Hong Kong, China

Seminar Schedule:

		Day 1 (20 Nov, Tue)	Day 2 (21 Nov, Wed)	Day 3 (22 Nov, Thu)
A M	0900 – 1030	Registration & Opening Ceremony (0900 – 1000)	Lecture Topic A (Himawari – Part II)	Lecture Topic C (Part II)
	1030 – 1100	Tea Break (1000 – 1030 on Day 1)		
	1100 – 1200	Experience Sharing by Member Representatives[a] (1030 – 1200)	Lecture Topic A (Fengyun – Part II)	Wrap-up Discussion
		Lunch Break (1200 – 1330)		
P M	1330 – 1500	Lecture Topic A (Himawari – Part I)	Lecture Topic C (Part I)	Technical Visit (Central Forecast Office of Meteorological Service Singapore)
	1500 – 1530	Tea Break		
	1530 – 1700	Lecture Topic A (Fengyun – Part I)	Lecture Topic B (1530-1730)	

(a) One of the participants from each Member will be invited to represent his/her weather services to deliver a 10 to 15 minutes presentation regarding the application of remote sensing technologies of his/her Service.

TRCG ACTIVITIES EVALUATION FORM
Roving Seminar 2018
(Singapore, 20 – 22 Nov 2018)

**15 responses (out of 12 participants + 3 lecturers)
(not all questions answered by responders)**

Part A: Event Logistics

Expectation levels as indicated number of responders	Below expectation ☹		Met expectation 😐		Exceeded expectation 😊	
(P = participants; R = resource persons)	P	R	P	R	P	R
1. Overall administration/organization	0	0	3	0	9	3
2. Pre-event arrangement and liaison	0	0	1	0	9	3
3. Venue facilities	0	0	1	0	11	3
4. Informative announcements and instructions	0	0	2	0	10	3
5. Travel arrangements	0	0	1	0	9	3
6. Funding arrangements	0	0	3	0	7	3
7. Accommodation	0	0	4	1	6	2
8. Refreshments	0	0	4	0	8	3
9. Social events and visitors' information	0	0	8	0	3	3
10. Helpfulness and friendliness of organizers	0	0	0	0	12	3

Specific points for improvement, if any:

Make it longer, more harder training

Hands on activity

After seminar social activities/programmes

Dinner location together

Tourist spot visit for all

Can improve the coordination in getting the lunch ready

Wireless@sg was a little inconvenient for foreigners

Refreshments could also be improved

Part B: Technical Contents (from participants only)

A – Lectures by Mr. Koji YAMASHITA B – Lectures by Dr. Xiang FANG C – Lectures by Mr. Ray KONG	A	B	C
Interest in Topic (1 to 5 ; from disinterested to most interested)			
Topic Contents (1 to 5 ; from irrelevant to topic to most relevant)			
Topic Organization (1 to 5 ; from loosely structured to well-structured)			
Lecture/Workshop Presentation (1 to 5 ; from poor to excellent)			
Training or Practical Material (1 to 5 ; from ill-prepared to well-prepared)			
Language (1 to 5 ; from hard to understand to easy to follow)			
Effectiveness (1 to 5 ; from little understanding gained to much understanding gained)			

	A	B	C
Objectives and Scope (L = too narrow; M = just right; R = too wide)			
Emphasis (L = too theoretical; M = just right; R = too practical)			
Length (L = too short; M = just right; R = too long)			
Technical level (L = too elementary; M = just right; R = too difficult)			

Part C: Follow-ups

1. (For Lecturers) Any views on considerations in selecting future lecturers and participants?

   > - Suggest to invite more participants

2. What operational benefits (new ideas, skills or methodology) you think would be gained from your experience in the event?

   > - Many techniques to classify cloud types for satellites and many techniques for more accurate rain forecast
   > - New ideas in extreme weather monitoring, such as radar-derived wind products to look for convergence/divergence
   > - Get to know about more new information & products usage about remote sensing, which is useful for application in forecast work
   > - Integrated data to use
   > - More technical knowledge
   > - More ways of microwave satellite images for TC analysis
   > - Radar data interpretation
   > - Skills and methodologies in monitoring area forecasting may need satellite/radar technology
   > - Lots of experience gain can do a lot of think from satellite and radar can explore more

3. Any foreseeable opportunity for operational implementation of the above benefits?

   Answer: Yes, benefits likely to be felt in about
              (a) a couple of years or less   7
              (b) in 2 – 5 years   3
              (c) in 5 years or more   1
              (d) no foreseeable opportunity   1

4. (For Lecturers) Any views on future topics that may generally help to improve Members' capacity in remote sensing technologies?

   - More communication and cooperation between satellite operators and users
   - The lecture could focus move on the applications of remote sensing technologies

5. (For Lecturers) Any specific suggestions, assuming you have the opportunity to visit local forecasting offices, for host Member to enhance its capacity in remote sensing technologies?

   - Using for combining the products (GEO/LEO satellites and radar etc.)

The participants of the Roving Seminar taking a group photo at the Centre for Climate Research Singapore with the resource persons and representatives from Typhoon Committee Secretariat.

**Summary report of the Technical Conference of Typhoon Committee on
"Embracing new technologies and knowledge to meet the challenges
in the new era of tropical cyclone forecasting"
26-27 February 2018, Ha Noi, Viet Nam**

1. Background

Established in 1968, the ESCAP/WMO Typhoon Committee and its Members have been working together to enhance forecast and warning capability and coordinate the planning and implementation of disaster risk reduction measures to minimize the loss of life and material damage caused by tropical cyclones and related severe weather in the region. Over this half-century, benefiting from various technological advancements and the concerted efforts of the Typhoon Committee Members, there were significant improvements in tropical cyclone prediction and related warning services in the Typhoon Committee region.

To celebrate the 50th anniversary of the Typhoon Committee in 2018, Typhoon Committee decided in its 49th Session to organize a Technical Conference (TECO) in conjunction with the 50th Session of the Typhoon Committee (TC50) in Viet Nam in 2018. The main theme of the TECO was "Embracing new technologies and knowledge to meet the challenges in the new era of tropical cyclone forecasting" and there were three key topics under the main theme, namely :

(i)   Moving towards impact-based forecasts and risk-based warnings
(ii)   Embracing new technologies and research findings
(iii)   Facing the challenges arising from climate change and rising sea level

The TECO aims to serve as a platform to foster knowledge sharing and cross-cutting collaboration between the operational and research communities amongst National Meteorological and Hydrological Services, international operational and research institutes and academia under the main theme and key topics.

With the kind support of Viet Nam Meteorological and Hydrological Administration, the TECO was successfully held on 26-27 February 2018 in Ha Noi, Viet Nam. The TECO was attended by over 70 participants, including keynote speakers, experts from Typhoon Committee Members and WMO Members.

2. Opening

The TECO was officiated by Dr. Tran Hong Thai, Deputy Director General of NHMS, Viet Nam (now Viet Nam Meteorological and Hydrological Administration). In his opening speech, Dr. Tran highlighted the impacts of climate change and extreme weather on the Members of the Typhoon Committee and around the world. Dr. Tran also pointed out the importance of international support and collaborations on typhoon forecasting research activities with a view to improving forecasting quality in term of timing and accuracy. Dr. Tsz-cheung Lee, Chair of TRCG, Mr. Jixin Yu, Secretary of Typhoon Committee and Dr. Chung Kyu Park, Director of Regional Office for Asia and South-west Pacific, WMO also gave welcoming remarks in the opening session. In particular, Dr. Lee, on behalf of the TRCG, thanked the Government of Viet Nam and the NHMS of Viet Nam for supporting and hosting the TECO and appreciated the great effort of appreciation to the Local Organizing Committee and the colleagues of Typhoon Committee Secretariat in organizing the conference. He also emphasized that the advancement of various technologies and upsurge of Big Data and social media analytics would bring about both opportunities and challenges for meteorological services to further enhance their services in order to meet the emerging needs of various sectors in the society.

3. TECO programme

The TECO consisted of three sessions based on the three topics under the main theme. Each session included three keynote presentations by invited keynote speakers and a number of technical presentations nominated by Members. Overall, there were nine keynote speakers from China, Hong Kong, China, Japan, Republic of Korea, United States and Viet Nam and over 30 technical presentations from forecasters/researchers of Typhoon Committee regions and WMO Members.

Moreover, breakout group discussions and panel discussions were arranged on the second day afternoon to discuss the challenges and opportunities as well as future development related to the three topics and the main theme. Finally, Mr Raymond Tanabe, Chair of Advisory Working Group of Typhoon Committee concluded the discussions of the TECO and delivered the closing remark. The detailed programme of the TECO is given in Attachment I of the report.

4. Summary of discussion and recommendations

Key items/recommendations discussed during the breakout group discussions and panel discussions are concisely summarized below :

(i)   Impact-based Forecasts and Risk-based Warnings

-     It is important to collaborate/engage with cross-cutting stakeholders to develop impact-based forecast and warning services and identify suitable approaches to convey risk-level to users (e.g. color coded systems).

-     Involvement of social scientists / media experts in the design of forecasting and warning services are encouraged to ensure warning messages could be understandable and actionable to users.   Social media platform would also be an important communication channel in disseminating information and engaging the public.

-     Big data analytics is a useful tool to extract the relationship between weather and impact and collaborations with data scientists and domain experts are required.

-     The WMO Global Multi-Hazard Alert System (GMAS) being developed will be useful to increase sharing of warning and hazard products among Members.   Also, the development of platform for common situation awareness to share weather and impact information among forecasters and other stakeholders are also important.

(ii)   Embracing New Technologies and Research Findings

-     Improvement of physics algorithms for high resolution models in capturing storm movement and rapid intensification as well as land interactions for landfalling storms will be useful for precipitation, storm surge and inundation forecasts.

-     On the observational aspects, the extraction of useful information from high resolution observations and advance in geostationary satellite could help improve model performance.   To improve real-time tropical cyclone analysis, more sharing of high resolution analysis data from different satellites by various operational centers are encouraged.

-     Further improvement of the accuracy of tropical cyclone analysis is vital to model initialization and forecasts. It is suggested to enhance communication and sharing of data, tools and products among different operational centers.   Some future thrusts include probabilistic products and the utilization of AI tools and data analytics to extract more useful information from both high resolution models and high resolution measurements for development of better products.

(iii)   Challenges arising from climate change

-        On the meteorological aspects, further research on the response of tropical cyclone tracks and rainfall to global warming, environmental connection to rapid intensification, and probabilistic prediction for disaster reduction should be pursued.

-        Facing the increase trend of extreme rainfall events, enhancement of QPE by advanced satellite observations and sharing/combination of rainguage data from different organizations can help improve the effectiveness of hydrological warnings.

-        For disaster risk reduction, public education on climate change impacts is important for disaster reduction and promoting understanding of future risks.   Moreover, by incorporation of big data analytics and A.I. guidance could assist in formulating timely countermeasures / responses against potential storm disasters.

-        It is important to further enhance collaborations between meteorological, hydrological and DRR communities to achieve better disaster prevention, in particular on the worst scenario consideration and the risk of multi-hazard weather events.

5. Presentations and publications

All the keynote and technical presentations delivered during the TECO have been made available online in the Typhoon Committee website under the URL below :
http://www.typhooncommittee.org/tc50-teco/

Moreover, a number of papers related to the TECO presentations have been published in the Special Issue of the Tropical Cyclone Research and Review for the 50th Session of Typhoon Committee.

6. Participant responses and comments

Evaluation forms were distributed to participants after the event and the feedbacks and recommendations collated from the participants are summarized in Attachment II.

Generally speaking, the responses from the participants are positive and encouraging. Participants considered the event was successful. Most participants are very satisfactory with the logistic arrangements apart from one comment indicated that the Lilac meeting room may be a bit small.   The keynote and

technical presentations as well as discussions were useful for participants to understand the latest technology development and share research/operational experience in meteorological, hydrological and DRR aspects.

Group photo of the participants in the TECO on 26-27 February 2018 in Ha Noi, Viet Nam

Keynote speakers participated in the Panel Discussion Session of the TECO

Detailed programme of the TECO held on 26-27 February 2018
in Ha Noi, Viet Nam

Day 1 (26 February 2018)

Time	Event
08:00-08:30	**Registration**

08:30-09:15	**Opening Ceremony**
	• Opening speech and welcome remarks
	    - Dr. Tran Hong Thai, Deputy Director General, NHMS Viet Nam (Opening speech)
	    - Dr Tsz-cheung Lee, Chair of TRCG
	    - Mr. Jixin Yu, Secretary of the Typhoon Committee
	    - Dr Chung Kyu Park, Director of Regional Office for Asia and South-west Pacific, WMO
	• Group Photo

	Session 1 **Moving towards impact-based forecasts and risk-based warnings** *Chair by Mr Yoshiaki Takeuchi*
09:15-09:45	Keynote presentation #1 Managing Disaster Risk and Climate Extremes in Viet Nam to advance Climate Change Adaptation *by Prof. Tran Thuc, Viet Nam Panel on Climate Change, Viet Nam*
09:45-10:15	Keynote presentation #2 Impact-based Forecast and Risk Warning Induced by Typhoon Gale and Torrential Rainfall *by Dr Wei Li, China Meteorological Administration, China*
10:15-10:45	Keynote presentation #3 Planning of WMO Global Multi-hazard Alert System in relation to Tropical Cyclones *by Mr Y F Tong, Hong Kong Observatory, Hong Kong, China*
10:45-11:00	*Tea break*
11:00-12:40	Parallel Sessions
	Technical Presentations 1A-1 to 1A-5 *Chair by Dr Wei Li*
	Technical Presentations 1B-1 to 1B-5 *Chair by Mr Y F Tong*

12:40-14:00	*Lunch*
	Session 2 **Embracing new technologies and research findings** *Chair by Dr KANG Nam-young*
14:00-14:30	Keynote presentation #4 Advanced Technology Developed in Tropical Cyclone Observation, Analysis and Forecast *by Mr. Yoshiaki Takeuchi, Japan Meteorological Agency, Japan*
14:30-15:00	Keynote presentation #5 Advancing the State of the Art in Tropical Cyclone Modeling at NOAA's National Weather Service National Center for Environmental Prediction (NWS/NCEP) *by Dr. Avichal Mehra, NOAA National Weather Service, USA*
15:00-15 :30	Keynote presentation #6 Horizontal Transition of Turbulent Cascade in the Near-surface Layer of Tropical Cyclones *by Dr TANG Jie, Shanghai Typhoon Institute, China*
15:30-15:45	*Tea break*
15:45-18:00	Parallel Sessions
	Technical Presentations 2A-1 to 2A-6 *Chair by Dr. Avichal Mehra*
	Technical Presentations 2B-1 to 2B-6 *Chair by Dr TANG Jie*

Day 2 (27 February 2018)

Time	Event
	Session 3 **Facing the challenges arising from climate change and rising sea level** *Chair by Prof. Tran Thuc*
08:30-09:00	Keynote presentation #7 A review of the environmental connection to 2015 typhoon intensity *by Dr Nam-young KANG, National Typhoon Center, Republic of Korea*
09:00-09:30	Keynote presentation #8 High-resolution simulations and aircraft observations of typhoons for future typhoon disaster prevention *by Prof. Kazuhisa Tsuboki, Nagoya University, Japan*
09:30-10:00	Keynote presentation #9 Climate change vulnerability assessment and natural disaster management in the tropical area for sustainable development: case study of Vietnam *by Prof. Mai Trong Nhuan, Vietnam National University Key Lab of Geo-environment and Climate change response, Viet Nam*
10:00-10:15	*Tea break*
10:15-12:30	Parallel Sessions
	Technical Presentations 3A-1 to 3A-6 *Chair by Prof. Kazuhisa Tsuboki*
	Technical Presentations 3B-1 to 3B-6 *Chair by Prof Mai Trong Nhuan*
12:30-14:00	*Lunch*

Time	Event
14:00-15:30	**Parallel Sessions** **Break out group discussion** (Challenges and opportunities as well as future development)
	Group 1 – "Impact-based forecasts and risk-based warnings" *(Moderate by Mr YF Tong)*
	Group 2 – "Embracing new technologies and research findings" *(Moderate by Dr. Avichal Mehra)*
	Group 3 – "Challenges arising from climate change" *(Moderate by Dr Nam-young KANG)*
15:30-16:00	*Tea break*
16:00-17:00	**Panel discussion - 9 Keynote Speakers** *(Moderate by Mr Raymond Tanabe, USA, Chair of AWG)* Main theme : Embracing new technologies and knowledge to meet the challenges in the new era of tropical cyclone forecasting
17:00-17:30	**Closing remark** by Hydrometeorological Service of Vietnam

Summary of evaluation forms received for the TECO

Part A: Event Logistics

Expectation levels as indicated number of responders *(P = participants; R = resource persons)*	Below expectation ☹		Met expectation ☺		Exceeded expectation ☺	
	P	R	P	R	P	R
1. Overall administration/organization	0	0	8	8	18	18
2. Pre-event arrangement and liaison	0	0	10	10	16	16
3. Venue facilities	0	0	7	7	18	18
4. Informative announcements and instructions	1	1	6	6	19	19
5. Travel arrangements	1	1	3	3	15	15
6. Funding arrangements	0	0	3	3	7	7
7. Accommodation	1	1	4	4	15	15
8. Refreshments	0	0	7	7	13	13
9. Social events and visitors' information	0	0	3	3	9	9
10. Helpfulness and friendliness of organizers	0	0	3	3	22	22

Specific points for improvement, if any:

- The Lilac room is a bit small
- Should change the theme title 'Facing the Challenge ~~Climate Change' content of parallel session 3A
- Need more support to travel cost

Part B: Keynote Presentations

Session1 - Moving towards impact-based forecasts and risk-based warnings Session2 - Embracing new technologies and research findings Sesison3 – Facing the challenges arising from climate change and rising sea level	Session		
	1	2	3
How many presentation did you attend?			
Which presentation do you like the most			
Please rate the following for the whole session:			
Interest in Topic (1 to 5 ; from disinterested to most interested)			
Topic Contents (1 to 5 ; from irrelevant to topic to most relevant)			
Topic Organization (1 to 5 ; from loosely structured to well-structured)			
Presentation (1 to 5 ; from poor to excellent)			
Language (1 to 5 ; from hard to understand to easy to follow)			
Effectiveness (1 to 5 ; from little understanding gained to much understanding gained)			
Technical level (L = too elementary; M = just right; R = too difficult)			

Part C: Technical Presentations

Parallel Session 1A and 1B
(Day 1 - 26 February 2018, 11:00-12:40)

	1A	1B
How many presentation did you attend?		
Which presentation do you like the most		
Please rate the following for the whole session:		
Interest in Topic (1 to 5 ; from disinterested to most interested)		
Topic Contents (1 to 5 ; from irrelevant to topic to most relevant)		
Topic Organization (1 to 5 ; from loosely structured to well-structured)		
Presentation (1 to 5 ; from poor to excellent)		
Language (1 to 5 ; from hard to understand to easy to follow)		
Effectiveness (1 to 5 ; from little understanding gained to much understanding gained)		
Technical level (L = too elementary; M = just right; R = too difficult)		

Parallel Session 2A and 2B
(Day 1 – 26 February 2018, 15:45-18:00)

|	2A	2B
How many presentation did you attend?		
Which presentation do you like the most		
Please rate the following for the whole session:		
Interest in Topic (1 to 5 ; from disinterested to most interested)		
Topic Contents (1 to 5 ; from irrelevant to topic to most relevant)		
Topic Organization (1 to 5 ; from loosely structured to well-structured)		
Presentation (1 to 5 ; from poor to excellent)		
Language (1 to 5 ; from hard to understand to easy to follow)		
Effectiveness (1 to 5 ; from little understanding gained to much understanding gained)		
Technical level (L = too elementary; M = just right; R = too difficult)		

Parallel Session 3A and 3B
(Day 2- 27 February 2018, 10:15-12:30)

	3A	3B
How many presentation did you attend?		
Which presentation do you like the most		
Please rate the following for the whole session:		
Interest in Topic (1 to 5 ; from disinterested to most interested)		
Topic Contents (1 to 5 ; from irrelevant to topic to most relevant)		
Topic Organization (1 to 5 ; from loosely structured to well-structured)		
Presentation (1 to 5 ; from poor to excellent)		
Language (1 to 5 ; from hard to understand to easy to follow)		
Effectiveness (1 to 5 ; from little understanding gained to much understanding gained)		
Technical level (L = too elementary; M = just right; R = too difficult)		

Part D: Follow-ups

6. What operational benefits (new ideas, skills or methodology) you think would be gained from your attendance in the event?

    - More observations of typhoon are shown on the TECO. Forecasters should act more confidence in determining in the TCs intensity in the real-time operation
    - All of presentations are useful for my skill and experience
    - Some methods of disaster risk reduction
    - Disaster prevention and reduction of TC based on social investigation : Application of GIS and Big Data to assess TC impact
    - Applied for routine works
    - Bring operational information to our forecasters
    - Flight observations in boundary layer

7. Any foreseeable opportunity for operational implementation of the above benefits?

    Answer: Yes, benefits likely to be felt in about _____ year's time.
                    (a) a couple of years or less   1
                    (b) in 2 – 5 years   11
                    (c) in 5 years or more   4
                    (d) no foreseeable opportunity   3

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 (T426L40)	Ms. Sugunyanee YAVINCHAN (Thailand)	Kongju National University and Korea Meteorological Administration	1 Aug – 30 Oct 2005
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) and 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
Typhoon Analysis and Prediction System (TAPS), genesis and dissipation of tropical cyclones, and change of typhoon characteristics due to climate change	Mr. Renito B. PACIENTE (Philippines), Ms. Plaidao KHUMCHAIYAPHUM (Thailand) and Mr. Bounteum SYSOUPHANTHAVONG (Lao PDR)	Korea Meteorological Administration	May – June 2012
Enhancement of rainfall nowcast in tropical cyclone situation	Mr. Maqrun Fadzli Mohd Fahmi (Malaysia) and Mr. Michael S. Bala (Philippines)	Hong Kong Observatory	22 Oct – 21 Dec 2012
Optimizing typhoon forecast using Typhoon Analysis and Prediction System (TAPS), and research on intensity and track forecasts using model ensemble, correction of track forecast bias according to synoptic patterns, and analysis of synoptic features and typhoon model forecast errors in anomalous typhoon tracks.	Dr. Bonifacio Galt Pajulelas (Philippine) , Mr. Nguyen Huu Thanh (Vietnam), and Ms. Prapaporn Wongsaming (Thailand)	Korea Meteorological Administration	1 May – 30 June 2013
Development of location-specific severe weather nowcasting techniques.	Dr. Sukrit KIRTSAENG (Thailand)	Hong Kong Observatory	21 Oct – 20 Dec 2013
Optimizing typhoon forecast using Typhoon Analysis and Prediction System (TAPS) and separate researches (typhoon-mid latitude pressure system interaction, study on the typhoon recurvature and moving speed, and study on the relationship between the central pressure and maximum sustained winds for typhoon)	Ms. Bai Lina (China) Mr. Nguyen Tung Thanh (Vietnam) Mr. Juanito S. Galang (The Philippines)	Korea Meteorological Administration	1 May – 30 June 2014

Tropical Cyclone Genesis Forecast Technique	Mr. Boonthum Tanglumlead (Thailand)	Shanghai Typhoon Institute	1 Jul – 31 Aug 2014
The utilization of ECMWF products in detecting storm tracks over the North Western Pacific	Mr Pak Sang Il and Mr Song Yong Chol (DPR Korea)	Shanghai Typhoon Institute	1-30 Sept 2014
Nationwide Nowcast of Tropical Cyclone Rainfall	Mr Evan James K. Carlos (The Philippines)	Hong Kong Observatory	6 Oct – 5 Dec 2014
Optimizing typhoon forecast using Typhoon Analysis and Prediction System (TAPS), and research on typhoon monitoring, interpretation of satellite-based and radar images, typhoon track and intensity forecast and tropical depression or extra-tropical transition	Ms. Akhom THAMALANGSY (Lao PDR) Mr. Aldczar D. Aurelio (The Philippines), Mr. Jose Frivaldo, JR. (The Philippines), Mr. Somprat Srithagon (Thailand), and Ms. DO Thi Thanh Thuy (Viet Nam)	Korea Meteorological Administration	19 April - 2 May 2015
Tropical cyclone genesis forecast technique	Mr. Pak Sang Il (DPR Korea) Mr. Ri Hak Il (DPR Korea)	Shanghai Typhoon Institute	26 Oct - 25 Nov 2015
Visiting editor for Tropical Cyclone Research and Review (TCRR)	Dr Jason Sippel (USA) Dr Nguyen Dang Quang (Viet Nam)	Shanghai Typhoon Institute	6-13 Dec 2015 20-26 Dec 2015
Development of objective guidance on tropical cyclone genesis forecast using global models	Mr Wen FENG (China)	Hong Kong Observatory	Mid Nov 2015 – mid Jan 2016
Training for typhoon forecast - Typhoon genesis and analysis - Typhoon track and intensity forecast - TAPS* operations and products	Benison Jay N. Estareja(The Philippines) Boonthum Tanglumlead(Thailand) Narongpon Thongsang(Thailand)	Korea Meteorological Administration	1 May to 14 May 2016
Tropical cyclone genesis forecast technique	Mr. Pak Sang Il and Mr. Kim Kum Song (DPR Korea)	Shanghai Typhoon Institute	24 October to 23 November 2016
Visiting editor for Tropical Cyclone Research and Review (TCRR)	Mr. Kamol Promasakha na Sakolnakhon (Thailand) Dr. Chen Yi-Leng (USA)	Shanghai Typhoon Institute	17-21 October 2016

Tropical Cyclone Size Climatology	Mr Wei HONG (China)	Hong Kong Observatory	mid-Dec 2016 – 31 Jan 2017
Training for typhoon forecast - Typhoon genesis and analysis - Typhoon track and intensity forecast - TAPS* operations and products	Ms. Pensiri Trisataya and Ms. Chuanpit Ngernchalad (Thailand) Mr. Robert B. Badrina (The Philippines) Ms. Hoang Thi Mai (Viet Nam)	Korea Meteorological Administration	16-29 April 2017
Observational Study on Intensity and Structure of Offshore Typhoon for EXOTICCA	Mr. Jaral Yiemwech (Thailand) Ms. Khanh Hoa Bui Thi (Viet Nam)	Shanghai Typhoon Institute	September 2017
Benefit evaluation of Typhoon disaster prevention and preparedness	Mr. Nursalleh Chang (Malaysia)	Shanghai Typhoon Institute	September 2017
Visiting Editor for Tropical Cyclone Research and Review	Mr. Somkuan Tonjan (Thailand) Dr. Doan Quang Tri from (Viet Nam)	Shanghai Typhoon Institute	February 2018
Tropical Cyclone Precipitation Verification	No nomination was received	Shanghai Typhoon Institute	NA
Short-term Rainfall Forecast for Tropical Cyclone Using Himawari-8 Data and NWP Model Products	Applicant who was accepted for the fellowship withdrew from the offer	Hong Kong Observatory	NA
Benefit evaluation of Typhoon disaster prevention and preparedness	Mr Nursalleh K Chang (Malaysia)	Shanghai Typhoon Institute	2 May – 1 June 2018
Training for forecasters: - Tropical meteorology & climatology - Processing observed meteorological variables - Typhoon analysis and monitoring- - Producing typhoon information using TAPS and TOS - Seasonal typhoon prediction	Mr. Nuthakit Singhaphet, (Thailand) Mr. Tran Quang Nang, Typhoon (Viet Nam) Dr. Guanbo Zhou (China) Mr. Robb Prieto Gile (the Philippines) Mr. Wan Muhammad Hafiz Bin Husin, (Malaysia)	Korea Meteorological Administration	23 April to 4 May 2018
Short-term Rainfall Forecast for Tropical Cyclone Using Himawari-8 Data and NWP Model Products	Ms Nguyen Thu Hang (Viet Nam)	Hong Kong Observatory	3 Jan – 1 Mar 2019

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.

Wong W.K., S. Sumdin, and E.S.T Lai 2010: Development of Air-Sea Bulk Transfer Coefficients and Roughness Lengths in JMA Non-hydrostatic Model and Application in Prediction of an Intense Tropical Cyclone. Scientific Online Letters on the Atmosphere (SOLA), **6**, 65-68.

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, **1**, 1-15.

Chang, N.K., L.S. Lee and Y.S. Li, 2012: Comparison of Performance of Various Multiple-Model Ensemble Techniques in Forecasting Intensity of Tropical Cyclone.   Tropical Cyclone Research and Review, **1**, 353-360.

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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 assimilation	Kazumasa AONASHI	aonashi@mri-jma.go.jp	Meteorological Research Institute
	Satellite data assimilation	Kozo OKAMOTO	kokamoto@mri-jma.go.jp	Meteorological Research Institute
	Data assimilation	Toshiyuki ISHIBASHI	ishibasi@mri-jma.go.jp	Meteorological Research Institute

(A) Data Assimilation (cont'd)

Republic of Korea	Typhoon bogussing	JOO, Sang Won	swjoo@korea.kr	Korea Meteorological Administration
	Satellite data analysis	KIM, Ok Hee	koh@korea.kr	Korea Meteorological Administration
	Radar data analysis	JUNG, Sung Hwa	shjung95@korea.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
Hong Kong, China	TC modelling and bogussing schemes	W.K. WONG	wkwong@hko.gov.hk	Hong Kong Observatory

(B) Modelling (cont'd)

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
	TC modelling	Masahiro SAWADA	msawada@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	KIM, Yoon Jae	yoonjae@korea.kr	Korea Meteorological Administration
	Ensemble track forecasting	LEE, Seung Woo	redparis@korea.kr	Korea Meteorological Administration
	Typhoon modelling	JOO, Sang Won	swjoo@korea.kr	Korea Meteorological Administration
USA (western North Pacific)	TC Modeling Extratropical Transition TC Genesis Sub-Tropical Systems Structure	Jim DOYLE Pat HARR Jenni EVANS	James.Doyle@nrlmry.navy.mil paharr@nps.edu evans@meteo.psu.edu	NRL, Monterey CA Naval Postgraduate School, Monterey CA Pennsylvania State Univ
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	C.W. CHOY	cwchoy@hko.gov.hk	Hong Kong Observatory
	TC rainfall nowcasting	W.C. Woo	wcwoo@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.
Japan	Satellite data analysis, use of microwave imagery, AMSU	Ryo OYAMA	royama@mri-jma.go.jp	Meteorological Research Institute
	Doppler radar data analysis	Udai SHIMADA	ushimada@mri-jma.go.jp	Meteorological Research Institute
Republic of Korea	Track and intensity forecasting	KANG, Nam Young	kny@kma.go.kr	Korea Meteorological Administration
	Long-range prediction of typhoon			
Singapore	Seasonal prediction of typhoon	LIM, Tian Kuay	LIM_Tian_Kuay@nea.gov.sg	Meteorological Services Division, National Environment Agency

(C) Forecasting (cont'd)

USA (western North Pacific) 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	Jorel TORRES Dan LINDSEY	Jorel.Torres@colostate.edu Dan.Lindsey@colostate.edu	NOAA/NESDIS at CIRA, Colorado State University
	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	john.knaff@noaa.gov	NOAA/NESDIS at CIRA, Colorado State University
	Satellite-based rainfall estimates in TCs (eTRaP)	Bob KULIGOWSKI Shelden KUSSELSON	bob.kuligowski@noaa.gov sheldon.kusselson@noaa.gov	NOAA/NESDIS Suitland, Maryland

(D) Application

Hong Kong, China	TC warning systems and operations	L. S. Lee	lslee@hko.gov.hk	Hong Kong Observatory

	TC information visualization and display systems	S.T. CHAN	stchan@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

TRCG Work Plan (2018 – 2021)

Year	Quarter	Typhoon Committee Activity	Training and Research Activities (*activities organized by parties other than TRCG)	Themes (if any) / Remarks
2018	**Q1**	TC-50 TECO	Technical Conference (TECO) in conjunction with the TC50	Successfully held in Viet Nam
	Q2		Research Fellowship	KMA fellowship in April - May STI fellowship in May - June
	Q3			
	Q4	13th IWS (Chiang Mai, Thailand)	RSMC Tokyo attachment	Successfully held in Oct 2018
			Roving Seminar	Roving Seminar successfully held in Singapore in Nov 2018
			CMA Typhoon Forecaster Training Programme	CMA Typhoon Forecaster Training successfully held in Dec 2018
2019	**Q1**	TC-51	Research Fellowship	HKO fellowship in Jan-Mar 2019
	Q2		Research Fellowship (KMA)	TBC
	Q3		CMA Typhoon Forecaster Training Program	TBC
			Research Fellowship (STI/CMA)	TBC
	Q4	14th IWS (Guam, USA)	Research Fellowship (STI/CMA)	TBC
			RSMC Tokyo attachment	TBC
			Roving Seminar*	Proposed to be in China with theme on "QPE and QPF"
2020	**Q1**	TC-52		
	Q2		Research Fellowship	
	Q3		CMA Training Program	TBC
			Research Fellowship	
	Q4	15th IWS (TBC)	Research Fellowship	
			RSMC Tokyo attachment	TBC
			Roving Seminar*	Proposed to be in Vietnam with theme on "Impact-based forecasting"
2021	**Q1**	TC-53		
	Q2		Research Fellowship	
	Q3		CMA Training Program	TBC
			Research Fellowship	
	Q4	16th IWS (TBC)	Research Fellowship	
			RSMC Tokyo attachment	TBC
			TRCG Forum / 4th TRCG Meeting	Proposed to be held in conjunction with the 16th IWS

* The hosting venue of the roving seminar is still subject to the confirmation of the proposed hosting Member.

Review of Training and Research Coordination Group (TRCG) Annual Operating Plan 2018
Objective Number	KRA	Objective	Action	Other WGs Involved	TCS Responsibility	Expected Quarter Completed	Other Organizations Involved	Success Indicators	Funding Required	Funding Sources	Review and Target Met ? (Yes/No)
1	KRA 1-3	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	TC50 TECO in conjunction with the TC50	WGM, WGH and WGDRR	Provision of administrative and logistic support.	1st	-	Feedback and recommendations collected from the speakers and participants	USD 60,000[1]	TCTF	Yes
			Roving Seminar [Application of remote sensing technologies]	WGM, WGH and WGDRR	Provision of administrative and logistic support.	4th		Feedback from evaluation forms to be completed by a target audience of about 30 people.	USD 16,000	TCTF	Yes
2	KRA 1-3	To facilitate technology transfer among TC Members through research and development initiatives.	Research Fellowship	WGM, WGH and WGDRR	Provision of administrative and logistic support.	2nd - 4th	TC Members	Publication of research findings and development output in TCRR or other journals.	Fellowship offered by voluntary hosts.	TC Members	Yes
3	KRA 1-3	To enhance TC Members' capacity and knowledge in operational tropical cyclone forecasting.	Attachment of 3 forecasters from TC and 3 forecasters from PTC to RSMC Tokyo	nil	Provision of administrative and logistic support.	4th	RSMC Tokyo, WMO	Assessment as given in RSMC Tokyo report.	USD 7,500	TCTF	Yes
4	KRA 1-3	To enhance TC Members' capacity and knowledge in operational tropical cyclone forecasting.	Up to 4 forecasters from TC to CMA Forecaster Training	nil	Provision of administrative and logistic support.	3rd – 4th	CMA	Assessment as given in CMA report.	Participation will be supported by CMA	CMA	*Yes*

Remarks :
1.   Including estimated budget for the proposed TC50 TECO to be held in conjunction with TC50 in early 2018

				Training and Research Coordination Group (TRCG) Annual Operating Plan 2019						
Objective Number	KRA	Objective	Action	Other WGs Involved	TCS Responsibility	Expected Quarter Completed	Other Organizations Involved	Success Indicators	Funding Required	Funding Sources
1	KRA 1-3	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 [QPE and QPF]	WGM, WGH and WGDRR	Provision of administrative and logistic support.	4th	-	Feedback from evaluation forms to be completed by a target audience of about 30 people.	USD 16,000	TCTF
2	KRA 1-3	To facilitate technology transfer among TC Members through research and development initiatives.	Research Fellowship	WGM, WGH and WGDRR	Provision of administrative and logistic support.	2nd - 4th	TC Members	Publication of research findings and development output in TCRR or other journals.	Fellowship offered by voluntary hosts.	TC Members
3	KRA 1-3	To enhance TC Members' capacity and knowledge in operational tropical cyclone forecasting.	Attachment of 3 forecasters from TC and 3 forecasters from PTC to RSMC Tokyo	nil	Provision of administrative and logistic support.	4th	RSMC Tokyo, WMO	Assessment as given in RSMC Tokyo report.	USD 10,000[1]	TCTF
4	KRA1-3	To enhance TC Members' capacity and knowledge in operational tropical cyclone forecasting.	Up to 4 forecasters from TC to CMA Forecaster Training	nil	Provision of administrative and logistic support.	3rd – 4th	CMA	Assessment as given in CMA report.	Participation will be supported by CMA	CMA

Remarks :

1. Proposed to increase the budget of RSMC Training from US7,500 to US10,000 in order to increase the number of participants from 3 to 4.