MEMBER REPORT

ESCAP/WMO Typhoon Committee

10th Integrated Workshop

Hong Kong, China

Kuala Lumpur, Malaysia

26 – 29 October 2015

CONTENTS

I. Overview of tropical cyclones which have affected/impacted Member's area in 2015

1. Meteorological Assessment (highlighting forecasting issues/impacts)

Three tropical cyclones affected Hong Kong, China from January to 10 October 2015 (their tracks as shown in Figure 1 and position errors of forecasts issued by the Hong Kong Observatory (HKO) in Table 1): Tropical Storm Kujira (1508) in June, Typhoon Linfa (1510) in July and Severe Typhoon Mujigae (1522) in October. Linfa necessitated the issuance of the Gale and Storm Signal in Hong Kong on 9 July and Mujigae necessitated the issuance of the Strong Wind Signal No. 3 on 3 and 4 October.

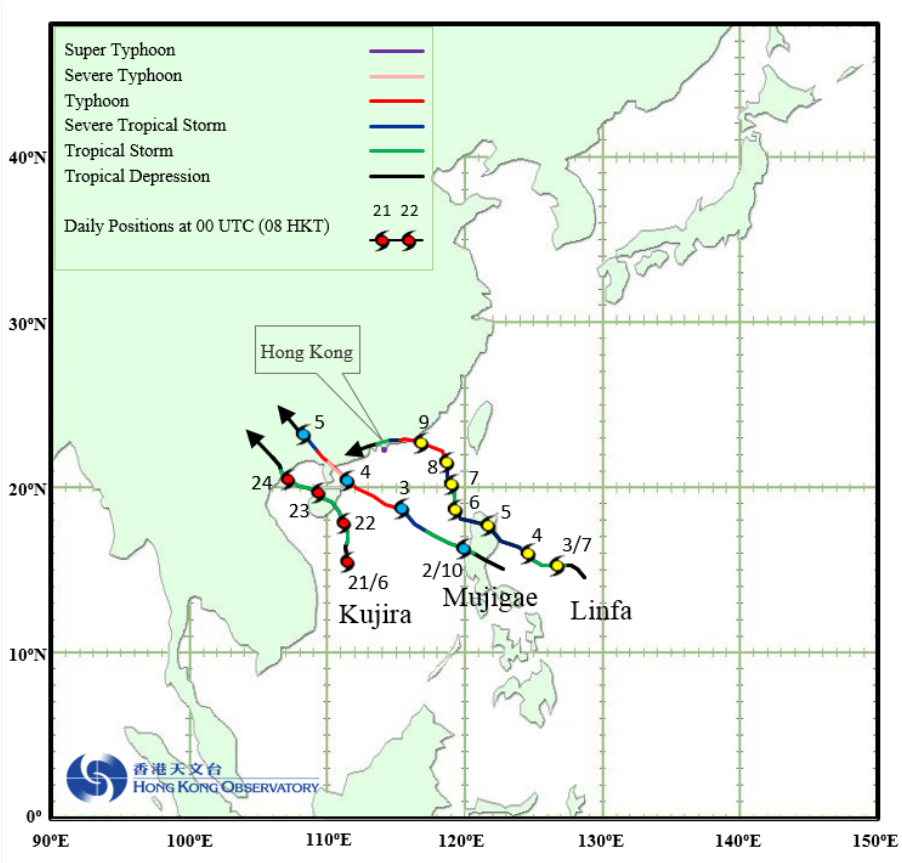

Figure 1 Tracks of tropical cyclones that affected Hong Kong, China from 1 January to 10 October 2015

Table 1 Performance summary of track forecast issued by HKO as verified against HKO's best track analysis for the three tropical cyclones that affected Hong Kong from 1 January to 10 October 2015

	Position forecast error (km)				
	24-hr	48-hr	72-hr	96-hr	120-hr
Kujira (1508)	92	198	346	490	*
Linfa (1510)	93	186	301	341	514
Mujigae (1522)@	55	93	163	#	#

* 120-hr forecast not available for Kujira as its life span was less than 120 hours

@ Figures based on provisional best track of Mujigae

\# 96-hr and 120-hr forecast not available for Mujigae as its life span was less than 96 hours

HKO extended its tropical cyclone forecast track from three days to five days starting from 2015 typhoon season. The service enhancement resulted from the improvement in the accuracy of HKO track forecasts in recent years, thanks to the continuous skill improvement of the NWP models.

The performance for 24 and 48-hr forecasts were satisfactory with the average error well within the "potential track area" (the probable area which the tropical cyclone will fall with a probability of 70%). However, relatively larger errors were evident for 72-hr to 120-hr forecasts for Kujira and Linfa. As position forecasts at 72-hr and beyond are very much model-dependent, the co-existence of both reliable and less reliable forecasts from different models requires research attention and careful interpretation in operational assessment.

2. Hydrological Assessment (highlighting water-related issues/impact)

Both Kujira and Linfa brought more than 100 mm of rainfall in total to many places of the Hong Kong during their passages.

Mujigae brought more than 150 mm of rainfall generally to Hong

Kong during its passage, and rainfall even exceeded 300 mm in some places.

3. Socio-Economic Assessment (highlighting socio-economic and DRR issues/impacts)

Both Kujira and Linfa did not cause significant damage in Hong Kong.

There were many reports of fallen trees and flooding during the passage of Mujigae. Traffic was disrupted in many places.

4. Regional Cooperation Assessment (highlighting regional cooperation successes and challenges)

HKO actively participated in the Eighth International Workshop on Tropical Cyclones (IWTC-VIII), held in conjunction with the Third International Workshop on Tropical Cyclone Landfall Processes (IWTCLP-III), in Jeju, Republic of Korea during 2 - 10 December 2014. The Director and an Assistant Director of HKO chaired the Recommendation Committee that deliberated on the recommendations for future forecasting studies and researches on tropical cyclones. Three other HKO experts provided input and served as rapporteurs in two working groups.

The WMO Tropical Cyclone Forecaster Website (http://severe.worldweather.wmo.int/TCFW/), operated by HKO on behalf of WMO, was enhanced with the inclusion of the updated Global Guide to Tropical Cyclone Forecasting and two new MetEd modules entitled "Forecasting Tropical Cyclone Storm Surge" and "Tropical Cyclone Forecast Uncertainty".

TC Members' Report
Summary of Progress in KRAs

Title of item (1):
Trial Studies to Enhance Meteorological Observations over the South China Sea

Main text:

In 2015, HKO joined hands with a shipping company to conduct trial studies in making use of the Hong Kong Voluntary Observing Ships (HKVOS) to enhance meteorological observation over the South China Sea.

During the trial studies, seven weather balloons carrying radiosondes were successively launched from a portable upper-air sounding system by HKO colleagues on board a HKVOS travelling from Hong Kong to Singapore to collect air temperature, humidity, wind direction and wind speed in the upper atmosphere over the South China Sea during 14 – 17 June (Figure 2).

On 26 June, a drifter buoy equipped with pressure and sea surface temperature sensors was deployed over the central part of the South China Sea near 16°N 115°E by the crew members on board another HKVOS. Carried along by ocean currents, the buoy made in-situ atmospheric pressure and sea surface temperature measurements over the data-sparse sea areas west of the Philippines and transmitted the data to HKO on an hourly basis via satellite (Figure 2). The buoy observations were transmitted to the GTS starting at 0600 UTC on 22 July.

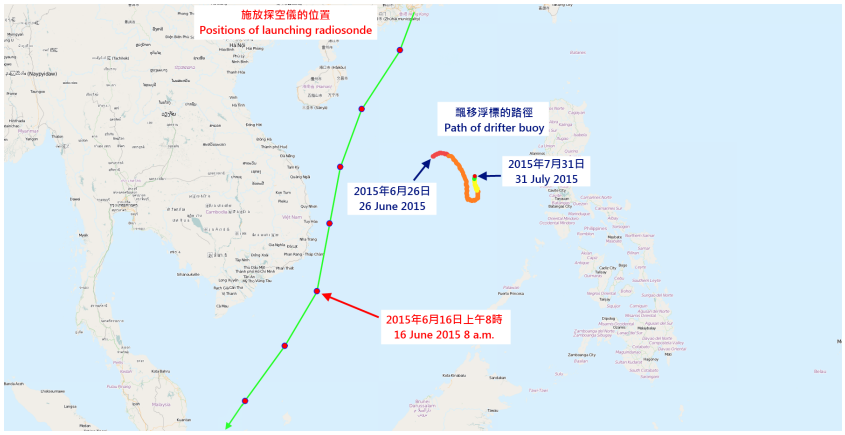

Figure 2 Positions of release of radiosondes and path of the drifter buoy under the trial studies to enhance the meteorological observations over the South China Sea

Identified opportunities/challenges, if any, for further development or collaboration:

The two aforementioned trials were the results of fruitful collaboration between HKO and the shipping community. The gathering of more meteorological data will support weather monitoring over the South China Sea and the surrounding areas, enhance the forecasting capability of tropical cyclones and contribute to navigation safety in the region. However, it is noted that vandalism to weather buoys over the ocean is of concern and thus the security of the drifter buoys is still a challenge to the meteorological community.

Summary Table of relevant KRAs and components:

KRA =	1	2	3	4	5	6	7
Meteorology	✓			✓		✓	✓
Hydrology							
DRR							
Training and research				✓		✓	
Resource mobilization or regional collaboration						✓	

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TC Members' Report
Summary of Progress in KRAs

Title of item (2):
Tropical Cyclone Surveillance Flight

Main text:

Reconnaissance flights in collaboration with the Hong Kong Government Flying Service (GFS) continued in 2015 to collect meteorological observations for tropical cyclones over the South China Sea. So far, a total of three flights were conducted for the TC season of 2015 including Maysak (5 and 6 April) and Linfa (9 July).

In particular, measurements made near the eye of Linfa before its landfall provided important reference in augmenting radar-based wind estimates (Figure 3). The resultant graphical visualization also played a key role in aiding the communication of forecast uncertainties to the general public.

Aircraft surveillance data provided valuable information on tropical cyclone location and wind distribution in the vicinity of the system, which were important for monitoring cyclone intensity as well as assessing impact on local weather.

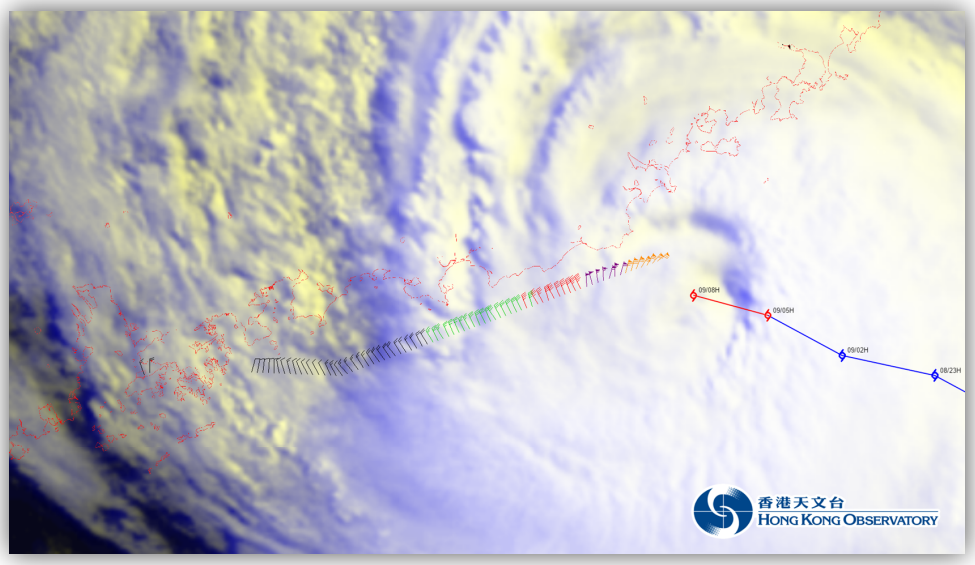

Figure 3 Wind observation data collected during the reconnaissance flight for Linfa overlaid on MTSAT false colour image at 0032 UTC on 9 July 2015.

Identified opportunities/challenges, if any, for further development or collaboration:

A dropsonde system capable of measuring vertical wind and temperature profiles within tropical cyclones is expected to commence operation in summer 2016 following the upgrade of GFS fixed-wing aircraft fleet.

Operational exchange of reconnaissance data (including future dropsonde output) with international and regional agencies is being pursued. The surveillance programme also opened opportunities for regional collaboration, including participation in the National Basic Research Program of China, and the WMO EXOTICA project.

Summary Table of relevant KRAs and components:

KRA =	1	2	3	4	5	6	7
Meteorology	✓	✓		✓		✓	
Hydrology							
DRR							
Training and research						✓	
Resource mobilization or regional collaboration						✓	

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TC Members' Report
Summary of Progress in KRAs

Title of item (3):
Radar and Satellite Observations of Tropical Cyclones

Main text:

A new dual-polarization S-band Doppler weather radar installed at Tate's Cairn started operation in April 2015. The radar would be used for monitoring tropical cyclones and also precipitation near Hong Kong. The dual-polarization capability will enable ready identification of hails and assessment of the reflectivity-rainfall relationship for the radar.

HKO started issuing satellite report (SAREP) in August 2015 based on the images of Himawari-8 satellite at enhanced resolution and higher update frequency. The SAREP was prepared based on the satellite image about 10 minutes before the synoptic hour and issued an hour later.

Identified opportunities/challenges, if any, for further development or collaboration:

A study on the relationship among polarimetric parameters, raindrop size distribution and rainfall rates for the radar will be conducted.

Summary Table of relevant KRAs and components:

KRA =	1	2	3	4	5	6	7
Meteorology						✓	
Hydrology						✓	
DRR						✓	
Training and research						✓	
Resource mobilization or regional collaboration							

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TC Members' Report
Summary of Progress in KRAs

Title of item (4):
5-day Tropical Cyclone Forecast Tracks from the Hong Kong Observatory

Main text:

HKO extended its tropical cyclone forecast track from three days to five days for the 2015 typhoon season. The service enhancement resulted from the improvement in the accuracy of HKO track forecasts in recent years, thanks to the continuous skill improvement of the NWP models. The position error for the 24-hour track forecasts issued by HKO dropped from around 150 km in 2003 to below 100 km from 2010 onwards (Figure 4). Based on objective verification, the accuracy of the recent Day-5 track forecasts was found to be comparable to that of the Day-3 track forecast first launched in 2003 (between 300 and 400 km).

Accompanying the enhancement, a new "Potential Track Area" was introduced to indicate the uncertainty of the track forecast (yellow shaded area in Figure 5). Based on historical error statistics, the uncertainty circles for 24-h, 48-h, 72-h, 96-h and 120-hour forecast positions were defined such that the tropical cyclone would fall within the circle at each forecast hour with a probability of about 70%. These revised uncertainty circles replaced the old uncertainty circles that were previously constructed using the mean position errors.

The Tropical Cyclone Warning bulletin (with abbreviated headings of "WTPQ20 VHHH" and "WTSS20 VHHH") and Subjective Forecast bulletin (with abbreviated headings of "FXPQ21 VHHH" and "FXSS21 VHHH") on exchange via GTS were also enhanced to include the extended track forecasts. The enhanced Tropical Cyclone Warning bulletin was also disseminated to the shipping community via NAVTEX (Navigational Telex).

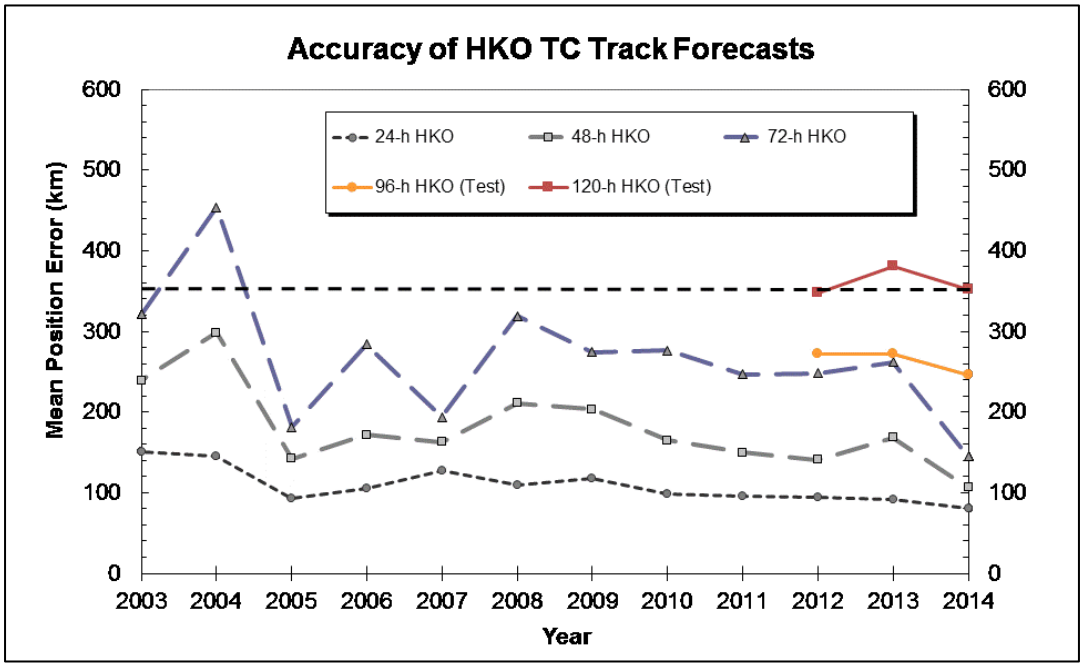

Figure 4 Mean position errors of HKO track forecasts during 2003 - 2014. Forecasts for 96 hours and 120 hours were obtained from a testing forecast dataset generated from the operational multi-model ensemble comprising the model runs of ECMWF, UKMO, NCEP and JMA as members

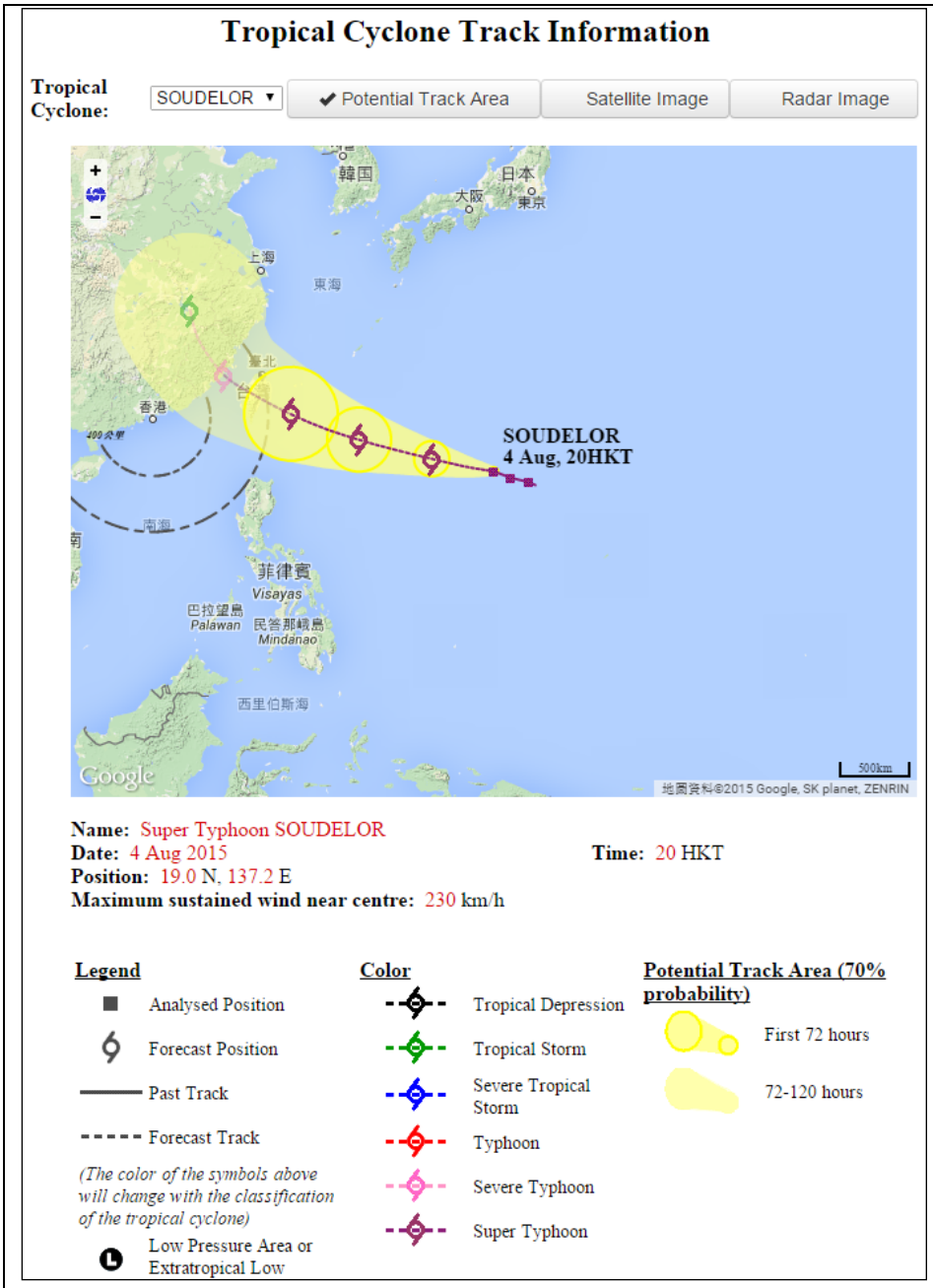

Figure 5 Tropical Cyclone Track Information webpage

Identified opportunities/challenges, if any, for further development or collaboration:

Inclusion of strong wind radii analysis information on the tropical cyclone track map for public will be further explored.

Summary Table of relevant KRAs and components:

KRA =	1	2	3	4	5	6	7
Meteorology	✓	✓		✓	✓	✓	
Hydrology							
DRR							
Training and research							
Resource mobilization or regional collaboration							

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TC Members' Report
Summary of Progress in KRAs

Title of item (5):
Communication of Information for Strengthening Resilience of Communities to Typhoon-related Disasters

Main text:

HKO continued to participate in regular exercises and drills on tropical cyclone disaster prevention and preparedness with relevant government departments and organizations. Briefing sessions on emergency response plans were organized for local residents living in places vulnerable to flooding due to storm surge. During the approach of Typhoon Linfa (1510) in July 2015, localized storm surge alerts were activated and appropriate precautions were taken by the relevant government departments.

A government-wide drill in preparation for possible storm surge was conducted at a flood-prone village named Tai O in May 2015 (Figure 6). Moreover, HKO enhanced the communication with the Drainage Services Department by providing advance notification on possible storm surge through mobile Short Message Service (SMS) to facilitate their setting up of flood protection barriers along the river wall at Tai O (Figure 7).

HKO continued to reach out to various sectors of the society, such as labour parties and associations and transport sector, to better understand their concerns and needs in respect of tropical cyclone information and warning services. Talks and visits to HKO were arranged for relevant government departments and public transport operators before the tropical cyclone season in 2015.

To better support operational planning at the Hong Kong International Airport (HKIA), special TC weather briefings were arranged for local airport operators and airlines on the forecast weather conditions to affect airports in the region. The briefings were well received by the local airport operators and airlines as potential air traffic disruption and delays would affect the operation of flights to and from HKIA.

Figure 6 Rescuing residents on a boat during a drill.

Figure 7 Drainage Services Department staff set up flood protection barriers along the river wall at Tai O to enhance its flood protection.

Identified opportunities/challenges, if any, for further development or collaboration:

HKO will keep in view of future needs for further service development and explore opportunities to collaborate with social scientists of local universities on warning communication strategies and public education aspects of Disaster Risk Reduction.

Summary Table of relevant KRAs and components [please tick boxes, can be more than one, as appropriate]:

KRA =	1	2	3	4	5	6	7
Meteorology	✓	✓		✓	✓		
Hydrology							
DRR							
Training and research							
Resource mobilization or regional collaboration							

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TC Members' Report
Summary of Progress in KRAs

Title of item (6):
Meso-scale and High-resolution Regional Prediction Systems for Tropical Cyclones

Main text

HKO operates a mesoscale numerical prediction suite, the Atmospheric Integrated Rapid-cycle (AIR) forecast system based on the Non-hydrostatic Model (NHM), providing forecasts over East Asia and the western North Pacific at 10-km resolution up to 72 hours ahead (Meso-NHM), as well as over southern China and the northern part of the South China Sea at 2-km resolution up to 15 hours ahead (RAPIDS-NHM).

In 2015, the extended domain configuration of the 10-km Meso-NHM (Figure 8) commenced operation following hardware upgrade and software testing. The new configuration is expected to bring further benefits to the prediction of tropical cyclone track and intensity as well as associated hazardous weather.

Additionally, the Aviation Model (AVM), a high-resolution numerical weather prediction system in support of aviation weather services at the Hong Kong International Airport (HKIA), commenced operation in late 2014. The outer AVM-PRD domain focuses on high-impact weather over the Pearl River Estuary region (Figure 9) at 600-m resolution while the inner AVM-HKA domain provides fine-scale aviation-specific forecasts for HKIA, including occurrence potential of windshear and turbulence, at 200 m resolution.

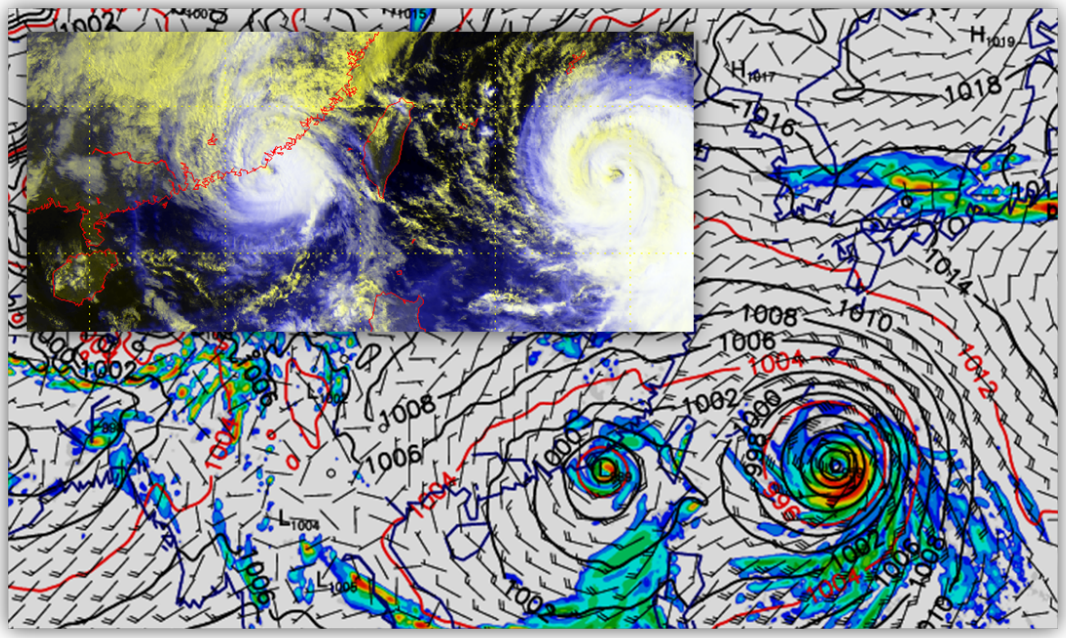

Figure 8 Linfa over the South China Sea and Chan-hom over the western North Pacific as observed by MTSAT (inset) and forecast by Meso-NHM.

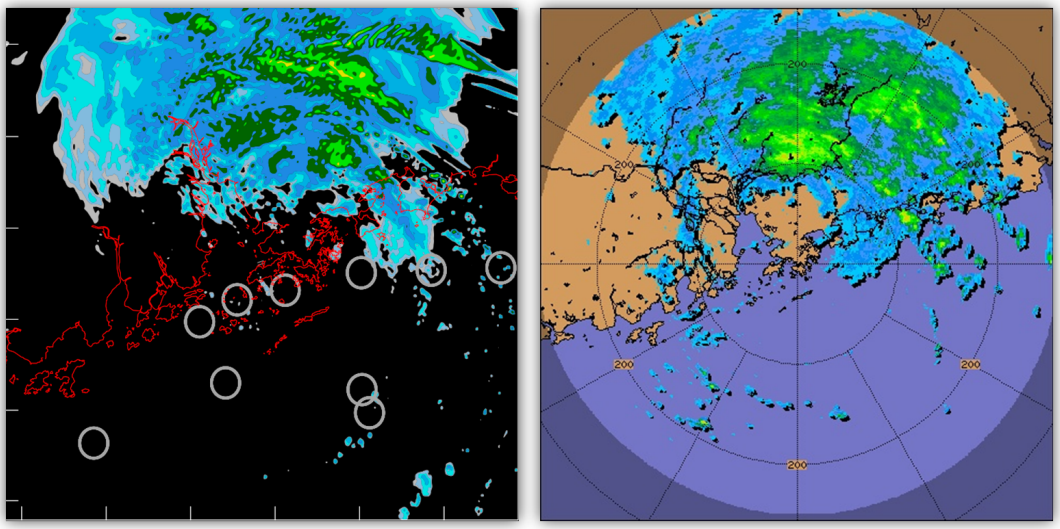

Figure 9 Observed weather radar return (right) and the corresponding high-resolution forecast by the AVM (left) during the passage of Linfa near Hong Kong, China.

Identified opportunities/challenges, if any, for further development or collaboration:

Upcoming development efforts would focus on assimilation of remote-sensing observations and fine-tuning of physical processes with a view to further improving model performance in severe weather, e.g. tropical cyclones and torrential rainfall.

Summary Table of relevant KRAs and components:

KRA =	1	2	3	4	5	6	7
Meteorology	✓	✓				✓	
Hydrology							
DRR							
Training and research						✓	
Resource mobilization or regional collaboration							

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TC Members' Report
Summary of Progress in KRAs

Title of item (7):
System and Product Development to Support Tropical Cyclone Operation

Main text:

0.25-degree gridded model output was made available by the National Centers for Environmental Prediction (NCEP) following the upgrade of its Global Forecast System (GFS) in January 2015. Based on the high resolution forecast data, prognostic charts of different parameters, time series and time cross plots, and forecast tephigrams at grid points near Hong Kong were routinely generated for forecasters' reference in predicting the evolution of weather as tropical cyclones approach.

The Integrated Meteorological Information Display (named MET-GIS), a GIS-enabled data analysis and visualization system, was enhanced to process the new atmospheric motion vector (AMV) products from JMA's Himawari-8 and KMA's COMS-1, and RapidScat wind products from the Ocean and Sea Ice Satellite Application (OSI SAF) of EUMESTAT, for conducting TC analysis.

TC track forecasts from the NCEP Operation Hurricane Weather Research and Forecast System (HWRF) were also made available on the Tropical Cyclone Information Display and Processing System (TIPS) for forecasters' reference.

Following the operational trial of the "Operational Storm Surge Prediction System" in 2014, in particular the experience gained during the passage of Typhoon Kalmaegi (1415) with exceptionally large storm size in September 2014, an enhancement of the user interface and implementation of tools for facilitating user input of appropriate storm size for better representation of cyclone structure in the SLOSH (Sea, Lake, and Overland Surges from Hurricane) storm surge prediction model was implemented in the 2015 TC season.

Identified opportunities/challenges, if any, for further development or collaboration:
A new project has been initiated to develop the next generation of TIPS built on a GIS-enabled platform.

Summary Table of relevant KRAs and components:

KRA =	1	2	3	4	5	6	7
Meteorology						✓	
Hydrology							
DRR							
Training and research							
Resource mobilization or regional collaboration							

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TC Members' Report
Summary of Progress in KRAs

Title of item (8):
Continual Development of the "Community Weather Information Network (Co-WIN)"

Main text:

The "Community Weather Information Network (Co-WIN)", established in 2007 in collaboration with the Hong Kong Polytechnic University, saw further expansion as more community weather stations were installed in schools and community organizations. The number of Co-WIN members has reached around 150.

In early 2015, a "Sea Level Measurement Device Design Competition" was organized for primary and secondary school students. The competition aroused students' awareness of the threats from sea level rise through participating in a series of talks and workshops. Furthermore, a train-the-trainer workshop on "Building a portable AWS for weather measurement in geography fieldwork" was jointly organized with local education authority in June for secondary school teachers from 35 schools.

The "Community Weather Observing Scheme" (CWOS), an initiative of Co-WIN launched in 2011, also saw significant development in the past couple of years through the establishment of an open CWOS Facebook Group and the launch of a new CWOS website. More than 20,000 weather reports/photos have been received from these two sources so far and some excellent weather photos were selected for the HKO calendars for 2015 and 2016. In early 2015, the second "Weather Observation and Investigative Study Competition" was organized to encourage students to develop an interest in weather observations through the sharing of weather photos and videos on the CWOS platform. Talks on the theme "Weather and Photography" and "Weather and Outdoor Activities" were also held in 2015, attracting hundreds of participants. The increasing popularity of CWOS and the experience gained through its development were brought to the attention of CIMO, supporting its work to update the International Cloud Atlas.

Identified opportunities/challenges, if any, for further development or collaboration:

Co-WIN and CWOS will be further developed to facilitate more participation at the community level through various mobile platforms and activities.

Under a Typhoon Committee WGDRR initiative, HKO led a project to promote the setting up of community weather stations among Typhoon Committee Members for raising public awareness on climate change and extreme weather. Viet Nam and Lao PDR attended the training workshop organized at HKO during 5-7 November 2014. Another training workshop would be held at HKO during 2-4 November 2015.

Summary Table of relevant KRAs and components:

KRA =	1	2	3	4	5	6	7
Meteorology							
Hydrology							
DRR					✓		
Training and research							
Resource mobilization or regional collaboration							

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TC Members' Report
Summary of Progress in KRAs

Title of item (9):
Community Version of "Short-range Warning of Intense Rainstorms in Localized Systems" (SWIRLS)

Main text:

With the experience gained in a number of collaboration projects conducted under the Typhoon Committee Research Fellowship scheme in recent years, HKO took the opportunity to enhance its nowcasting system, namely SWIRLS, to generate rainfall nowcast using radar, satellite and rain gauge data. A community version of SWIRLS was subsequently developed with a view to promoting knowledge exchange on rainfall nowcasting technique. This community version allows flexible configuration of spatial coverage and inputs of rain gauge, radar or satellite data to compute the quantitative precipitation estimate (QPE) and quantitative precipitation forecasts (QPF).

Identified opportunities/challenges, if any, for further development or collaboration:

The community version of SWIRLS would be made available to interested NMHSs to facilitate capacity building and regional co-operation on rainfall nowcasting techniques of TC related process. Its success would rely on the commitment and engagement of the participating NMHSs.

Summary Table of relevant KRAs and components:

KRA =	1	2	3	4	5	6	7
Meteorology						✓	✓
Hydrology						✓	✓
DRR							
Training and research							✓
Resource mobilization or regional collaboration							

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TC Members' Report
Summary of Progress in KRAs

Title of item (10):
Production of Videos to Enhance Public Awareness on Tropical Cyclone-related Hazards

Main text:

Under a project of Typhoon Committee WGDRR and led by HKO, a short educational video on hazards from tropical cyclones was produced to raise the public awareness of the threats from tropical cyclones. Through real-life visual images from typhoons in recent years, including Morakot, Utor and Haiyan, the video introduces four major threats caused by tropical cyclones, namely, strong winds, rainstorms, huge waves and storm surge.

The videos received worldwide support and were publicized in the international arena. They were premiered at the Third UN World Conference on Disaster Risk Reduction held in Sendai, Japan in March 2015, and have since been uploaded to the World Meteorological Organization (WMO) and Typhoon Committee websites.

Typhoon Committee website:
http://www.typhooncommittee.org/2015/03/19/tc-hazard-video/

WMO website:
https://www.youtube.com/watch?v=PV6cy1MXWxY

In Hong Kong, to promote public awareness on swells caused by tropical cyclones, HKO produced short video and radio clip as Announcements in the Public Interest (API) for broadcast on local TV and radio channels. The API illustrates the potential danger of swells caused by tropical cyclones and reminds the public to pay attention to forecast and warning messages. The video is also available at HKO's YouTube channel :
(https://www.youtube.com/watch?v=8NJUHduPnhE)

An API on the threats caused by thunderstorms, such as lightning, squall and hail, was also produced by HKO in May 2015.

Identified opportunities/challenges, if any, for further development or collaboration: HKO will continue to explore opportunities to produce educational videos to enhance public awareness on typhoon-related hazards and other severe weather threats.

Summary Table of relevant KRAs and components:

KRA =	1	2	3	4	5	6	7
Meteorology					✓		
Hydrology					✓		
DRR					✓		
Training and research							
Resource mobilization or regional collaboration							

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TC Members' Report
Summary of Progress in KRAs

Title of item (11):
Production of TV Documentary "Meteorology Series IV"

Main text:

"Meteorology Series IV" is a four-part TV documentary series jointly produced by HKO and Radio Television Hong Kong (RTHK) to raise public awareness of climate change and extreme weather events. The programme provides a fascinating insight into the increasing impact caused by climate change, including stunning images and footages of weather and climate hazards that have generated headlines over various parts of the world.

The four episodes with sub-themes on typhoons, cryosphere, flooding and water resources were broadcast through major TV networks in Hong Kong in April and May 2014. A web version of the documentary was also available for viewing on the internet, and can be watched online at programme.rthk.hk/rthk/tv/programme.php?name=tv/meteorology2014. DVDs of the "Meteorology Series IV" have been produced and distributed to schools and libraries in Hong Kong as well as to WMO Members in 2015.

"Meteorology Series IV" received both local and overseas recognitions. It was rated 8th among the 204 top-ranking Hong Kong television programmes in the "2014 TV Programme Appreciation Index Survey". The second episode, "Meltdown: Cryosphere under Pressure", won the prestigious Silver World Medal (Environment and Ecology category) at the international "2015 New York Festivals World's Best TV and Films".

Identified opportunities/challenges, if any, for further development or collaboration:

Project successfully completed.

Summary Table of relevant KRAs and components:

KRA =	1	2	3	4	5	6	7
Meteorology					✓		
Hydrology					✓		
DRR					✓		
Training and research							
Resource mobilization or regional collaboration							

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TC Members' Report
Summary of Progress in KRAs

Title of item (12):
Training Workshop on Crisis Communication

Main text:

An in-house Training Workshop on Crisis Communication was organized for HKO staff on 19 March 2015 to enhance participants' communication skills and sensitivities in the handling of crisis communication with the public, and to present messages and information effectively in bulletins and briefings using different communication channels, particularly in tropical cyclone situations.

Identified opportunities/challenges, if any, for further development or collaboration:

Effective ways to deliver authoritative forecasts and warnings, to communicate clear and useful impact-based messages to the public in tropical cyclone and other hazardous weather situations, and to convey different levels of forecast confidence and extent of uncertainties, would continue to be studied in collaboration with communication and social science experts.

Summary Table of relevant KRAs and components:

KRA =	1	2	3	4	5	6	7
Meteorology						✓	
Hydrology							
DRR						✓	
Training and research						✓	
Resource mobilization or regional collaboration							

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TC Members' Report
Summary of Progress in KRAs

Title of item (13):
Public Education on Tropical Cyclone

Main text:

Blog articles were published and online quiz games were launched to enhance public knowledge on tropical cyclones.

Briefings on General Weather Knowledge including a significant part on tropical cyclone and its impacts to airport operations were provided to local airport community.

Identified opportunities/challenges, if any, for further development or collaboration:

More educational materials on tropical cyclones would be prepared to further enhance public preparedness and response.

Summary Table of relevant KRAs and components:

KRA =	1	2	3	4	5	6	7
Meteorology					✓		
Hydrology							
DRR		✓		✓	✓		
Training and research							
Resource mobilization or regional collaboration							

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