MEMBER REPORT

Hong Kong, China

ESCAP/WMO Typhoon Committee

11th Integrated Workshop

Cebu, Philippines

24 – 28 October 2016

CONTENTS

I. Overview of tropical cyclones which have affected/impacted Member's area in 2016

1. Meteorological Assessment (highlighting forecasting issues/impacts)

Six tropical cyclones affected Hong Kong, China from 1 January to 30 September 2016 (their tracks as shown in Figure 1 and position errors of forecasts issued by the Hong Kong Observatory (HKO) in Table 1): A tropical depression over the South China Sea in late-May, Severe Tropical Strom Mirinae (1603) in July, Typhoon Nida (1604) and Tropical Storm Dianmu (1608) in August, Super Typhoon Meranti (1614) and Severe Typhoon Megi (1617) in September. Nida necessitated the issuance of the Gale and Storm Signal in Hong Kong and the tropical depression over the South China Sea in late May and Dianmu necessitated the issuance of the Strong Wind Signal.

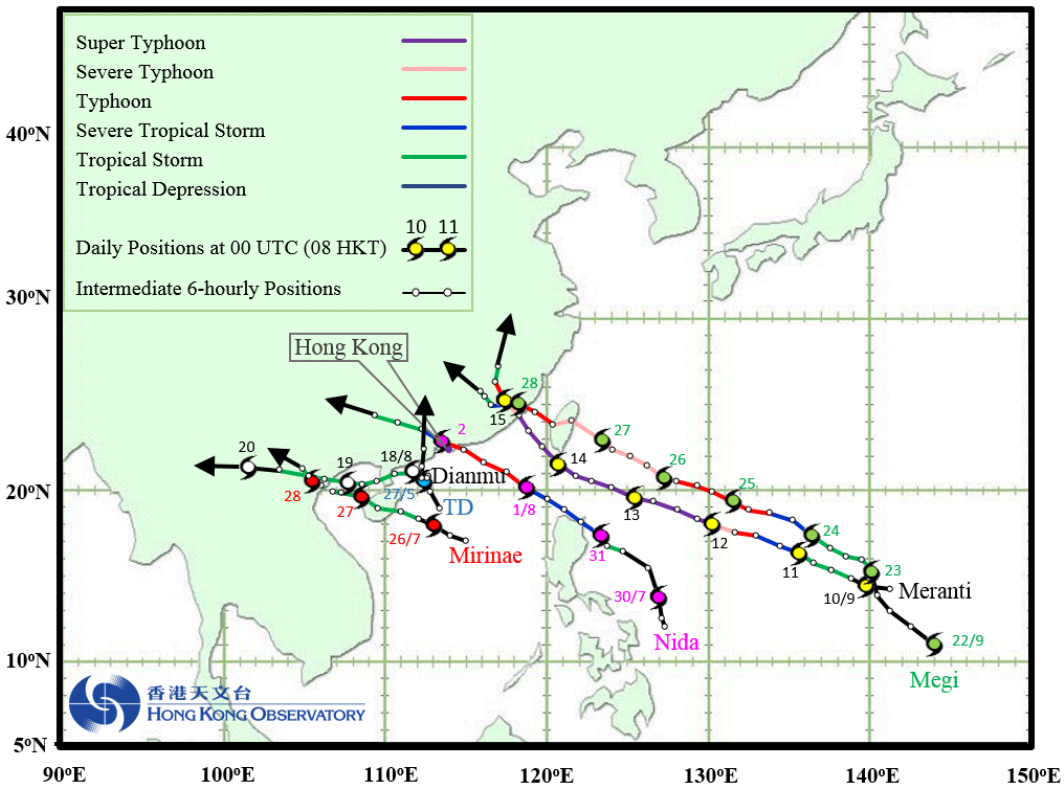

Figure 1 Tracks of tropical cyclones that affected Hong Kong, China from 1 January to 30 September 2016

Table 1 Performance summary of track forecast issued by HKO as verified against HKO's best track analysis for the six tropical cyclones that affected Hong Kong, China from 1 January to 30 September 2016

	Position forecast error (km) (No. of cases)				
	24-hr	48-hr	72-hr	96-hr	120-hr
T.D. in late-May	78 (1)				
Mirinae (1603)	61 (8)	138 (4)			
Nida (1604)	69 (13)	143 (9)	291 (5)	496 (1)	
Dianmu (1608)	61 (9)	69 (5)			
Meranti (1614)	68 (16)	151 (12)	207 (8)	200 (5)	321 (2)
Megi (1617)	70 (15)	108 (11)	151 (7)	178 (4)	205 (2)

The performance of tropical cyclone forecasts was generally satisfactory with the average errors well within the "potential track area" (the probable area of tropical cyclone location with a probability above 70%). In particular, for the potentially high-impact typhoon Nida which landed within 40 km of Hong Kong on 2 August, HKO successfully forecasted a landing to the east of Hong Kong which helped the community to take appropriate precautionary measures and responses.

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

Nida brought more than 100 mm of rainfall to most parts of Hong Kong during its passage. Storm surge triggered by Nida caused minor flooding and backflow of sea water in some low lying areas in Hong Kong.

Dianmu brought more than 50 mm of rainfall generally to Hong Kong.

The tropical depression in late May and Mirinae brought more than 10 mm of rainfall to some places of Hong Kong.

Meranti and Megi did not bring significant rainfall to Hong Kong.

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

At least 12 people were injured in Hong Kong during the passage of Nida. There were more than 400 reports of fallen trees, two reports of flooding, one report of landslide and many incidents of falling objects. About 300 hectares of farmland were affected.

The tropical depression in late May, Mirinae, Dianmu, Meranti and Megi did not cause significant damage in Hong Kong.

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

HKO actively participated in the International Best Track Archive for Climate Stewardship (IBTrACS) meeting held in conjunction with 2nd WMO International Workshop on Satellite Analysis of Tropical Cyclones (IWSATC-2) during 16-19 February 2016 in Hawaii, USA.

HKO continued to operate Severe Weather Information Centre (SWIC) (http://severe.worldweather.wmo.int/) and the WMO Tropical Cyclone Forecaster Website (http://severe.worldweather.wmo.int/TCFW/) on behalf of WMO.

TC Members' Report
Summary of Progress in KRAs

Title of item (1):
Tropical Cyclone Surveillance Flight

Main text:
Reconnaissance flights in collaboration with Government Flying Service (GFS) continued in 2016 to collect meteorological observations for tropical cyclones in the vicinity of Hong Kong.

A total of five missions were conducted in 2016 so far, including: a tropical depression (26 May); Mirinae (25 July); Nida (1 August); a broad area of low pressure (15 August) where Dianmu later developed (18 August). In particular, the circulation centres of Nida (then of typhoon intensity) and Dianmu (then of tropical storm intensity) were traversed, providing valuable observation data for accurately locating the storms as well as determining their intensity.

Meanwhile, a dropsonde system installed on board a new fixed-wing GFS aircraft commenced operation in September 2016 and the Observatory's first ever dropsonde mission was conducted on 27 September during the approach of Megi (Figure 2), making Hong Kong, China the first Typhoon Committee Member to conduct routine typhoon reconnaissance using GPS dropsonde over the South China Sea since the US Air Force suspended the operation of reconnaissance flights over the western North Pacific in 1987.

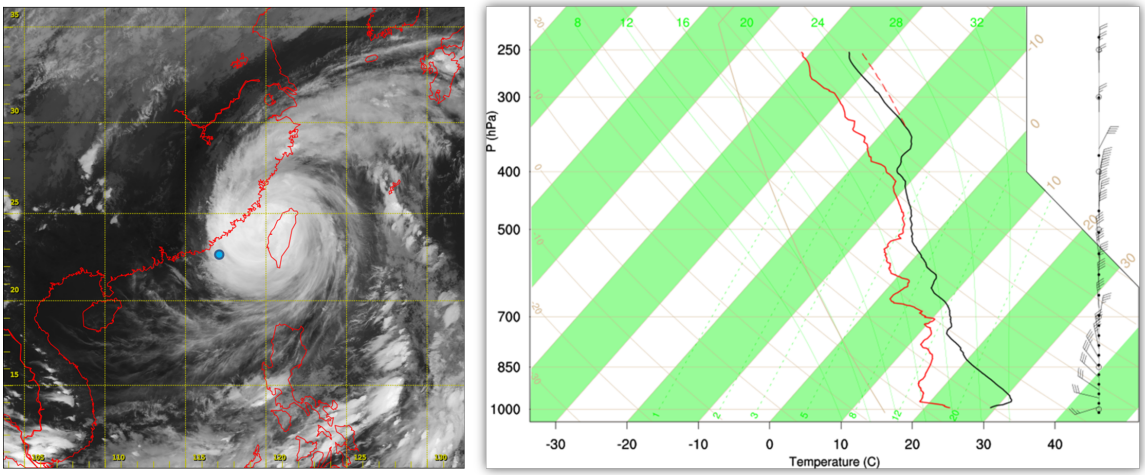

Figure 2 Vertical meteorological profile (right, including temperature, dew point and winds) sampled over the southwestern quadrant of Megi (left, drop location in blue) during the Observatory's first ever dropsonde mission on 27 September 2016.

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

The assimilation of dropsonde observations into NWP models using advanced ensemble-based techniques will be studied.

Operational exchange of reconnaissance flight data and dropsonde observations with international and regional agencies is under discussion and expected to commence in 2017.

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						✓	

Member: Hong Kong, China

Name of contact for this item: Mr K K Hon

Telephone: (852) 2926 8331

Email: kkhon@hko.gov.hk

TC Members' Report
Summary of Progress in KRAs

Title of item (2):
Enhancement of Meteorological Observations over the South China Sea

Main text:

Further to the trial deployment of a drifting buoy in the South China Sea west of Luzon in 2015, another five drifting buoys (Figure 3) were deployed into the data sparse region of the South China Sea in August and September 2016 with the help of one of the Hong Kong Voluntary Observing Ships. Under the Barometer Upgrade Scheme of the Global Drifter Programme of the Data Buoy Cooperation Panel of WMO JCOMM, hourly observations of sea-level pressure and sea temperature are transmitted to the GTS through US NOAA.

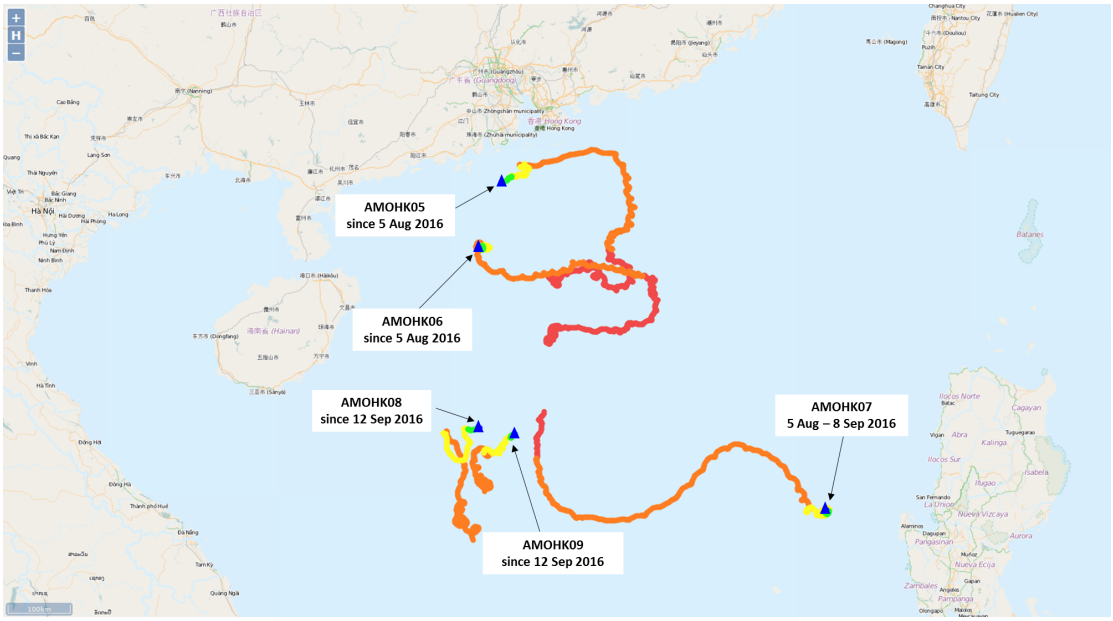

Figure 3 Tracks of the five drifting buoys since their deployment in the South China Sea. ▲ denotes their positions in early October except AMOHK07 which lost communication since 8 September 2016.

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

Continual support of the shipping companies would be essential for the deployment of drifting buoys, as deployment locations and schedules are often limited by the voyage routes of the Hong Kong Voluntary Observing Ships.

Experience in the deployment of drifting buoys since June 2015 indicates that vandalism to the buoys remains a challenge in the region.

The present drifting buoys deployed can only measure pressure and sea surface temperature. Pending the availability of more advanced versions of drifting buoys commercially, more weather elements may be measured in the future.

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						✓	

Member: Hong Kong, China

Name of contact for this item: Mr H Y Mok

Telephone: (852) 2926 8451

Email: hymok@hko.gov.hk

TC Members' Report
Summary of Progress in KRAs

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

Main text:

A newly commissioned dual-polarization S-band Doppler weather radar at Tate's Cairn enabled improved removal of non-meteorological echoes such as ground clutters and anomalous propagation, and also better hydro-classification such as hail identification.

A revamped satellite webpage was launched on the Internet to provide more frequent satellite pictures and also true colour satellite pictures using Himawari-8 data, and global mosaic with the inclusion of GOES and Meteosat satellite pictures for enhancing public awareness and preparedness on tropical cyclones.

New satellite products based on Himawari-8 data were implemented, enabling better identification of convection development areas and improving analysis of tropical cyclone structures, and they were found to be very useful in forecasting the onset of severe weather.

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

A disdrometer would be installed and used in a study of polarimetric parameters of dual-polarization Doppler weather radar. A study on improving radar QPE using these parameters would be conducted.

Data reception and processing facilities for FY4A satellite data would be acquired after launch of the new satellite. Application of the new data would be explored afterward.

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							

Member: Hong Kong, China

Name of contact for this item: Dr W T Wong

Telephone: (852) 2926 8430

Email: wtwong@hko.gov.hk

TC Members' Report
Summary of Progress in KRAs

Title of item (4):
Communication of Information for Strengthening Resilience of Communities to Typhoon-related Disasters

Main text:

Seminars were arranged on the preparedness for tropical cyclones for relevant government departments and organizations before the typhoon season in 2016. The Hong Kong Observatory also participated in regular exercises and drills on tropical cyclone disaster prevention and preparedness. Briefing sessions on emergency response plans were organized for local residents living in places vulnerable to flooding due to storm surge. During the passage of Typhoon Nida (1604) in August 2016, localized storm surge alerts were activated and appropriate precautions were taken by relevant government departments.

To facilitate early preparation for tropical cyclones, an email notification with the latest tropical cyclone track, local weather forecast as well as possible disruption to the operations of Hong Kong International Airport would be sent to the Airport Authority of Hong Kong automatically whenever a tropical cyclone forms within or enters the area bounded by 7-36N, 90-140E. Briefings are conducted for tropical cyclones with local impact as well as impact on other regional aerodromes with significant air traffic to and from Hong Kong.

An in-house commissioned training workshop on Public Communication and Media Handling in Difficult Situations was organised for HKO staff on 10 March 2016 to enhance participants' communication skills and their social and political sensitivities when handling media and public enquiries, especially in high-impact situations such as tropical cyclone cases. The workshop comprised lectures, past case studies and practicals with case simulations.

Identified opportunities/challenges, if any, for further development or collaboration:
Communication strategies and effective presentation skills in conveying key messages for triggering response actions, taking into account forecast uncertainties in extreme or high-impact weather situations, through different channels including new media would continue to be developed in collaboration with communication and social science experts of local universities or civil think tanks.

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							

Member: Hong Kong, China

Name of contact for this item: Mr L S Lee / Dr P W Li / Ms Queenie Lam

Telephone: (852) 2926 8371 / (852) 2926 8437 / (852) 2926 8441

Email: lslee@hko.gov.hk / pwli@hko.gov.hk / cclam@hko.gov.hk

TC Members' Report
Summary of Progress in KRAs

Title of item (5):
Meso-scale and High-resolution Regional Prediction Systems for Tropical Cyclones

Main text

A mesoscale numerical prediction suite, the Atmospheric Integrated Rapid-cycle (AIR) forecast system based on the Non-hydrostatic Model, provides forecasts over East Asia and the western North Pacific at 10-km resolution up to 72 hours ahead, 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). Meanwhile, the fine-scale Aviation Model (AVM) continues to provide hourly-updated aviation-specific forecasts for the Hong Kong International Airport at horizontal resolution down to 200 m.

In 2016, effort was undertaken to implement the Tiedtke convective parameterisation scheme in Meso-NHM with a view to improving tropical cyclone track forecast performance (Figure 4). Additionally, the Hong Kong Observatory has begun near real-time trial of a mesoscale ensemble prediction system to assist probabilistic assessment of tropical cyclone evolution with performance comparable to major global models over the South China Sea (Figure 5).

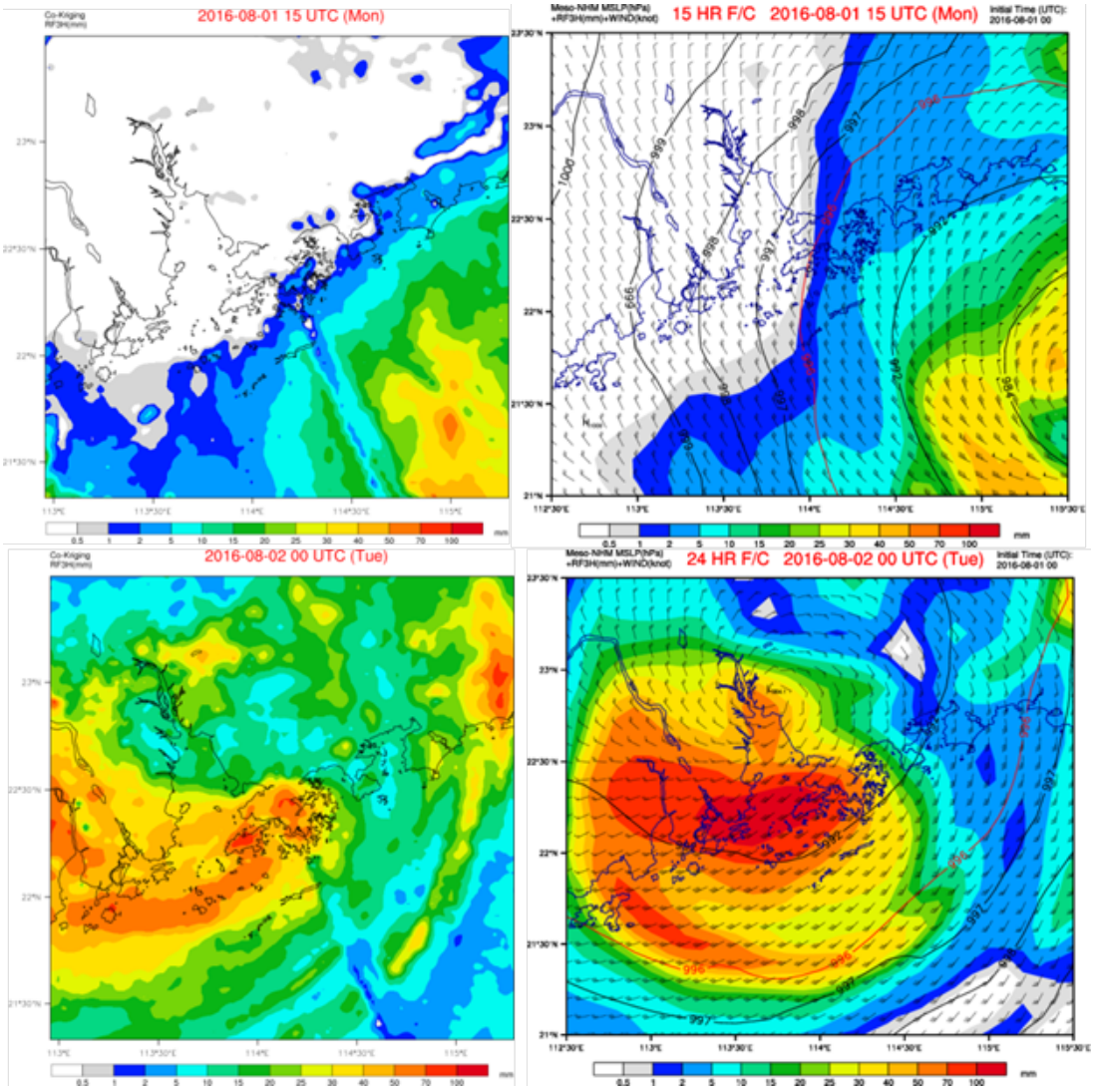

Figure 4 Comparison between estimated rainfall by co-Kriging (left) and short-term forecasts by Meso-NHM (right) during passage of Typhoon Nida.

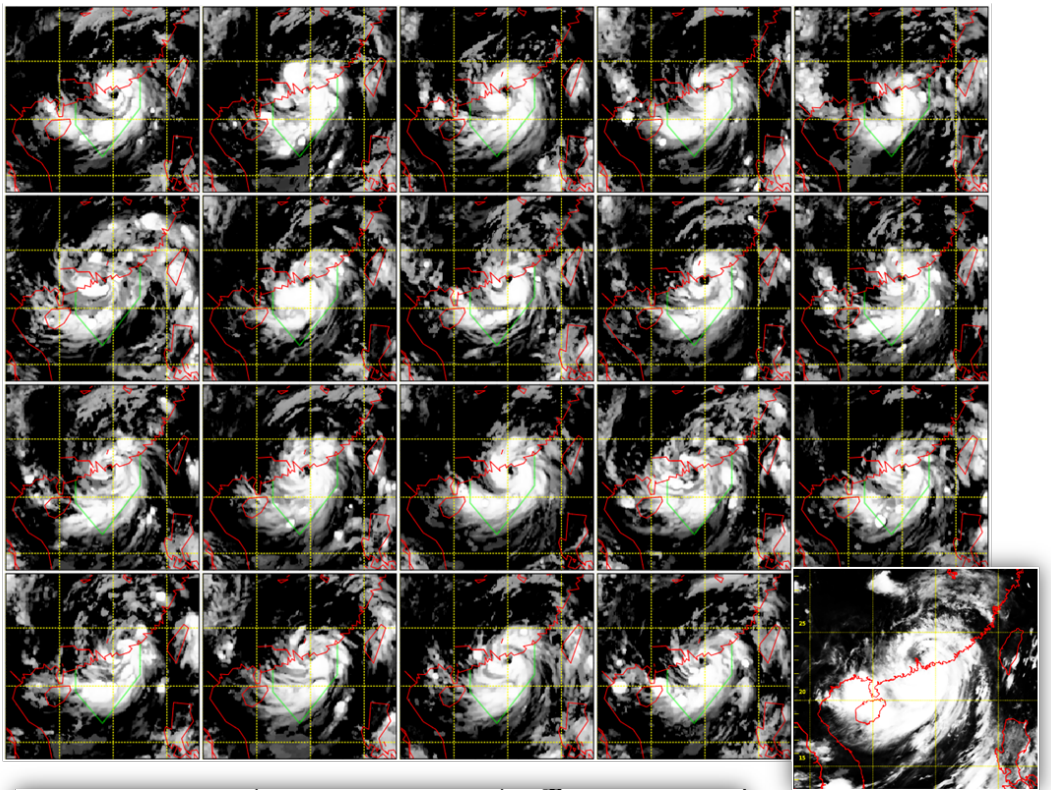

Figure 5 Stamp map of simulated satellite imagery by a mesoscale EPS against actual Himawari-8 observations of Typhoon Nida (bottom right).

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

Development on assimilation of remote-sensing observations, particularly satellite data, will continue in the coming years to further improve model performance.

Regional exchange of mesoscale model outputs with more meteorological agencies will be pursued with a view to fostering closer collaboration.

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						✓	

Member: Hong Kong, China

Name of contact for this item: Mr K K Hon

Telephone: (852) 2926 8331

Email: kkhon@hko.gov.hk

TC Members' Report
Summary of Progress in KRAs

Integrated Information Display System

Main text:

An Integrated Information Display System, comprising a video wall of about 5 metres wide and 2 metres high with touch-sensing feature, was installed in the Central Forecasting Office of the Hong Kong Observatory in early January 2016 to facilitate assimilation of weather information, enhance common situation awareness and support effective decision-making (Figure 6).

The System provides a large display area for simultaneous display of weather information in various formats, such as data listing, charts and multimedia graphics, from various sources and meteorological centres. It also provides the flexibility to depict all relevant information related to tropical cyclone and its associated hazards like winds, rainfall and storm surge, side by side for viewing at a glance, which is essential to understanding and assimilating diversified information. Real-time monitoring and display of news and social media postings on the integrated display further facilitates appreciation of the impact of tropical cyclones to the society. In addition, the touch-sensing feature of the System facilitates interactive and effective presentation of information. Under tropical cyclone situation, there will be additional manning in the Central Forecasting Office, including weather forecasters, media team responsible for communicating tropical cyclone forecasts and warnings to the public through mass media, and other supporting staff. The System enables them to carry out their duties effectively in a concerted manner, and thus improving the efficiency of communication and decision-making.

Figure 6 Integrated Information Display System

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

Installation of the Integrated Information Display System was completed successfully. More data and information will be integrated in various formats in innovative ways to make good use of the System in support of tropical cyclone monitoring and provision of forecasting and warning services.

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							

Member: Hong Kong, China

Name of contact for this item: Mr S W Li

Telephone: (852) 2926 3661

Email: swli@hko.gov.hk

TC Members' Report
Summary of Progress in KRAs

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

Main text:

Following the upgrade of various global NWP models, prognostic charts of different parameters with enhanced resolution, viz. 0.1 degree for European Centre for Medium Range Weather Forecasts (ECMWF) high-resolution model, 0.156 degree for UK Met Office (UKMO) Unified Model, and 0.117 degree for National Centers for Environmental Prediction (NCEP) Global Forecast System (GFS) were routinely generated for forecasters' reference in support of the tropical cyclone warning operation.

"Integrated Meteorological Information Display" (MET-GIS), a GIS-powered data analysis and visualization system developed in-house at the Hong Kong Observatory, was enhanced with a tool to incorporate the radar mosaic from the China Meteorological Administration (CMA). The radar mosaics are particularly useful for tracking tropical cyclones' movement and development across the Luzon Strait and the northern part of the South China Sea.

The "Operational Storm Surge Prediction System" was further enhanced in 2016, providing a range of predicted storm surges and storm tides covering the uncertainty of the operational forecast track of movement of a tropical cyclone.

A new information search system has recently been developed to enable forecasters and researchers to retrieve key information of historical tropical cyclones, using different prescribed criteria (such as month of genesis, maximum sustained winds, local tropical cyclone signals, maximum storm surge values, tropical cyclone related rainfall, etc.) and to display the tracks as well as other information of the selected tropical cyclones on MET-GIS. Based on the search results, the system also allows users to readily download the relevant information and data for further processing and analysis.

A statistical-dynamical forecast guidance on the rapid intensification (RI) of tropical cyclone has been implemented for trial operation. Using logistic regression and the naïve Bayes classifier techniques applied to predictors including: (a) NOAA tropical

cyclone heat potential; (b) the previous 12-hour intensity change and the current intensity, and (c) ECMWF model forecasts of 200 hPa divergence, 300-500 hPa relative humidity, 200-850 hPa vertical wind shear, the chances of RI in the next 48 hours are derived and found to out-perform the intensity estimates from direct NWP model output over the western North Pacific.

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

The historical tropical cyclone searching system will be further enhanced to include more historical tropical cyclone related data.

The performance of the statistical-dynamical forecast guidance on RI will be further evaluated using more tropical cyclone cases. The algorithm will be further refined to improve the skills of prediction, in particular over the South China Sea, by investigating predictors from satellite observations and other NWP model products.

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							

Member: Hong Kong, China

Name of contact for this item: Mr S T Chan / Mr C W Choy / Mr H Y Mok

Telephone: (852) 2926 8434 / (852) 2926 3665 / (852) 2926 8451

Email: stchan@hko.gov.hk / cwchoy@hko.gov.hk / hymok@hko.gov.hk

TC Members' Report
Summary of Progress in KRAs

Title of item (8):
Community Version of "Short-range Warning of Intense Rainstorms in Localized Systems" (SWIRLS)

Main text:

The Hong Kong Observatory made available the community version of SWIRLS (Com-SWIRLS) – a radar-based precipitation nowcasting system to interested National Meteorological and Hydrological Services in supporting capacity building on tropical cyclone rainfall nowcasting and related high-impact weather services. Com-SWIRLS was publicized through the WMO VCP training workshop on rainfall nowcasting hosted by the Hong Kong Observatory in December 2015, as well as during the WMO WWRP 4th International Symposium on Nowcasting and Very-short-range Forecast 2016 (WSN16) in July 2016 and the WMO "Workshop on the Implementation of New Numerical Weather Prediction (NWP) and Impact-based Forecast and Warning Techniques" in Myanmar in September 2016.

To date, Malaysian Meteorological Department and South Africa Weather Service have successfully adopted SWIRLS for nationwide operational use and for aviation nowcast research respectively. Zhuhai Meteorological Bureau, China Meteorological Administration has also put SWIRLS into operational use. Research fellows from Philippine Atmospheric Geophysical and Astronomical Services Administration, Thailand Meteorological Department, and the National Hydro-Meteorological Service, Vietnam have received attachment trainings to install and operate SWIRLS.

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

Com-SWIRLS will be enhanced to incorporate severe weather (e.g. thunderstorms, hails and gusts etc.) nowcasts. Research and development on the use of geostationary satellite products to improve the quantitative precipitation estimation and forecast are underway.

Training initiatives on Com-SWIRLS will be pursued to promote capacity building and regional co-operation.

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							

Member: Hong Kong, China

Name of contact for this item: Mr W K Wong / Mr W C Woo

Telephone: (852) 2926 8416 / (852) 2926 8453

Email: wkwong@hko.gov.hk / wcwoo@hko.gov.hk

TC Members' Report
Summary of Progress in KRAs

Title of item (9):
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 was over 150 by end of September 2016.

The "Community Weather Observing Scheme" (CWOS), an initiative of Co-WIN launched in 2011, also saw significant development in the past few years through the establishment of an open CWOS Facebook Group and the launch of a new CWOS website. More than 70,000 weather reports/photos have been received from these two sources so far. In 2016, the "Weather Observation Competition", for students to share weather photos and videos on the CWOS platform, continued to be held with encouraging participation. Furthermore, a series of talks covering the topics on "Weather and Photography for the Elderly", "Weather and Photography", "Sea of Clouds and Time-lapse Photography", "Weather and Outdoor Activities", etc. were also held in 2016, attracting hundreds of participants. Several activities were also held using the CWOS Facebook Group to invite members to contribute photos of different cloud types and optical phenomena for consideration by WMO CIMO's Task Team for updating the International Cloud Atlas.

Under a Typhoon Committee WGDRR initiative, the Hong Kong Observatory 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. DPR Korea and Thailand attended the training workshop organized at the Hong Kong Observatory during 2-5 November 2015.

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. The Hong Kong Observatory is coordinating with the Chinese University of Hong Kong to pursue projects to upgrade the community weather observing equipment as well as to revamp the Co-WIN webpage to facilitate reception, display and analysis of observation data from portable AWS.

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							

Member: Hong Kong, China

Name of contact for this item: Mr K H Tam

Telephone: (852) 2926 8414

Email: khtam@hko.gov.hk

TC Members' Report
Summary of Progress in KRAs

Title of item (10):
Public Education on Climate Change and Extreme Weather and Community Campaign on Disaster Resilience

Main text:

A roving exhibition on climate change was organised in collaboration with relevant local government departments and organisations as well as community partners under the "Science in the Public Service" campaign, led by the Hong Kong Observatory, to enhance the understanding of the public on the impacts of climate change, including the increased threat of extreme weather and storm surge brought by tropical cyclones in a warmer world with rising sea level.

The Hong Kong Observatory collaborated with Hong Kong Maritime Museum in arranging an exhibition of historical typhoon disasters during July to September 2016 to increase awareness and preparation of the public to high-impact typhoons and storm surge.

The Hong Kong Observatory coordinated with the Hong Kong Jockey Club Disaster Preparedness and Response Institute (HKJCDPRI) in the "Community Campaign on Disaster Resilience" and arranged a series of public educational activities that aimed to enhance public awareness on natural hazards as well as disaster resilience. In particular, "Multi-media Competition", which included "Mini-Film Production" targeting secondary school students and "Drawing Contest" for primary school children, was successfully organized through which awareness on typhoon hazards was enhanced in a creative manner (http://www.hkjcdpri.org.hk/multi-media-competition).

Identified opportunities/challenges, if any, for further development or collaboration: More educational materials would be prepared and activities organised to further enhance public preparedness and response. The Hong Kong Observatory will continue to explore community engagement opportunities on typhoon-related issues and topic

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							

Member:	Hong Kong, China	Name of contact for this item:	Ms Queenie Lam / Ms Sandy Song
Telephone:	(852) 2926 8441 / (852) 2926 8336	Email:	cclam@hko.gov.hk / mksong@hko.gov.hk