MEMBER REPORT
Hong Kong, China

ESCAP/WMO Typhoon Committee
13th Integrated Workshop
Chiang Mai, Thailand
5-9 November 2018

CONTENTS

I. Overview of tropical cyclones which have affected/impacted Member's area since the last Committee Session

1. Meteorological Assessment (highlighting forecasting issues/impacts)

Five tropical cyclones affected Hong Kong, China from 1 January to 30 October 2018 (tracks as shown in Figure 1): Tropical Storm Ewiniar (1804) in June, Tropical Strom Son-Tinh (1809) in July, Severe Tropical Storm Bebinca (1816) in August, Tropical Storm Barijat (1823) and Super Typhoon Mangkhut (1822) in quick succession over a 5-day period in mid-September.

The position errors of forecasts issued by the Hong Kong Observatory (HKO) for these five tropical cyclones are summarized in Table 1. The performance of tropical cyclone forecasts was generally satisfactory with the average errors within the "potential track area" (the probable area of tropical cyclone location with a probability above 70%).

Mangkhut necessitated the issuance of the highest tropical cyclone warning signal, the No.10 Hurricane Signal, for 10 hours in Hong Kong on 16 September 2018. This is the second longest duration of No. 10 Hurricane Signal in Hong Kong since 1946, just next to the record of 11 hours set by Typhoon York on 16 September 1999. Ewiniar, Son-Tinh, Bebinca and Barijat necessitated the issuance of the No. 3 Strong Wind Signal.

With an extensive circulation, the destructive storm to hurricane force winds of Mangkhut battered Hong Kong generally on 16 September. During the passage of Mangkhut, maximum 60-minute mean winds of 161 and 157 km/h were recorded respectively at Waglan Island and Cheung Chau, the outlying islands over the southern part of Hong Kong. Both are the second highest record of the corresponding stations, just lower than the record high of Ellen in 1983 and exceeding the records of other notorious typhoons in Hong Kong history such as Wanda (1962), Rose (1971) and Hope (1979). Maximum gust of 256 km/h was recorded at Tate's Cairn[1], ranking after Wanda (1962) and Ruby (1964) as the third highest for that station.

[1] Elevation of anemometer is 587 m

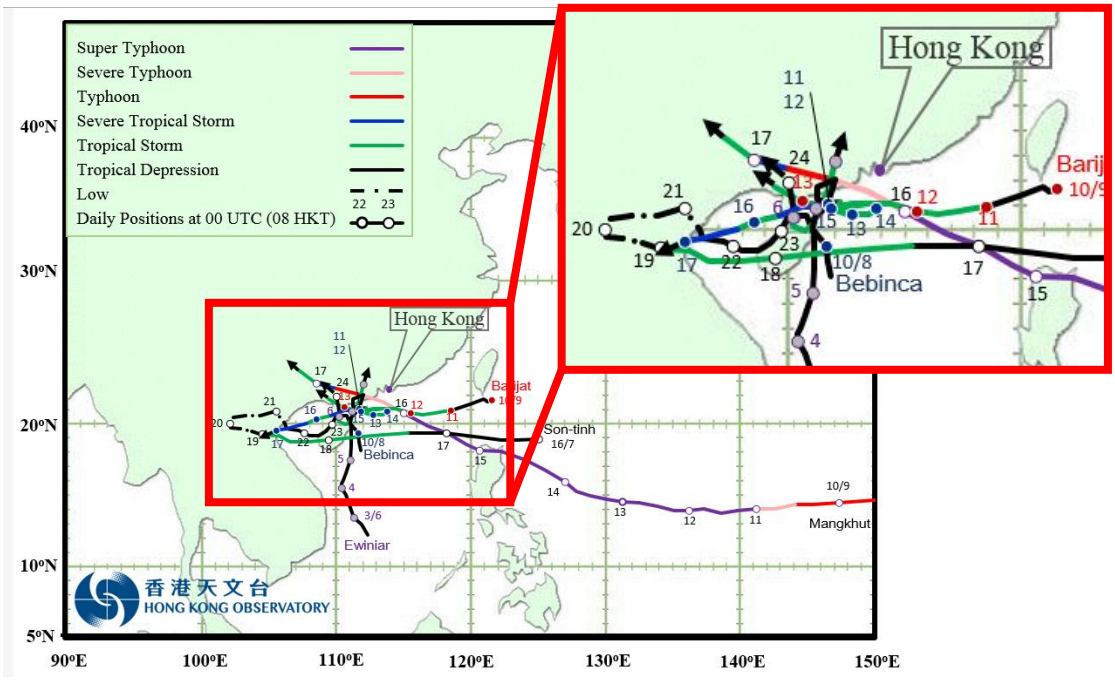

Figure 1 - Tracks of tropical cyclones that affected Hong Kong, China from 1 January to 31 October 2018.

	Position forecast error (km) (No. of cases)				
	24-hr	48-hr	72-hr	96-hr	120-hr
Ewiniar (1804)	86 (11)	120 (9)	208 (7)	246 (5)	376 (3)
Son-Tinh (1809)	54 (7)	139 (3)			
Bebinca (1816)	88 (13)	121 (12)	207 (11)	335 (9)	449 (7)
Barijat (1823)	35 (4)	76 (2)			
Mangkhut (1822)	39 (13)	73 (11)	111 (9)	147 (7)	199 (5)

Table 1 Performance summary of track forecasts issued by HKO at 00 UTC and 12 UTC as verified against HKO's warning track for the five tropical cyclones that affected Hong Kong, China from 1 January to 31 October 2018.

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

Although the date that Mangkhut hit Hong Kong fell on the day with relatively low astronomical tide level, the record-breaking storm surge induced by Mangkhut raised the water level in Hong Kong generally by more than 2 metres, leading to inundation of many low-lying areas along the coast of Hong Kong. The maximum storm surge (increase in water level) of 2.35 metres and 3.38 metres registered respectively at Quarry Bay inside the Victoria Harbour and the Tai Po Kau inside the Tolo Harbour on 16 September 2018 were the highest since instrumental records began at these stations[2]. The maximum water level at Quarry Bay reached 3.88 metres (above Chart Datum, same below), exceeding the 3.57 metres registered during the passage of Super Typhoon Hato in 2017, and only lower

[2] The instrumental records of Quarry Bay/North Point and Tai Po Kau began in 1954 and 1962 respectively.

than the record high of 3.96 metres set by Super Typhoon Wanda in 1962. A maximum water level of 4.69 metres was recorded at Tai Po Kau, also only lower than the record high of 5.03 metres set by Wanda.

In terms of rainfall, Ewiniar was the wettest tropical cyclone affecting Hong Kong by far in 2018. Ewiniar brought more than 250 millimetres of rainfall to Hong Kong, and the rainfall over some parts of the territory exceeded 400 millimetres. About 200 millimetres of rainfall was generally recorded over Hong Kong during the passage of Mangkhut. The rainfall associated with Bebinca was less than 150 millimetres, while the rainfall from Son-Tinh and Barijat were both less than 50 millimetres.

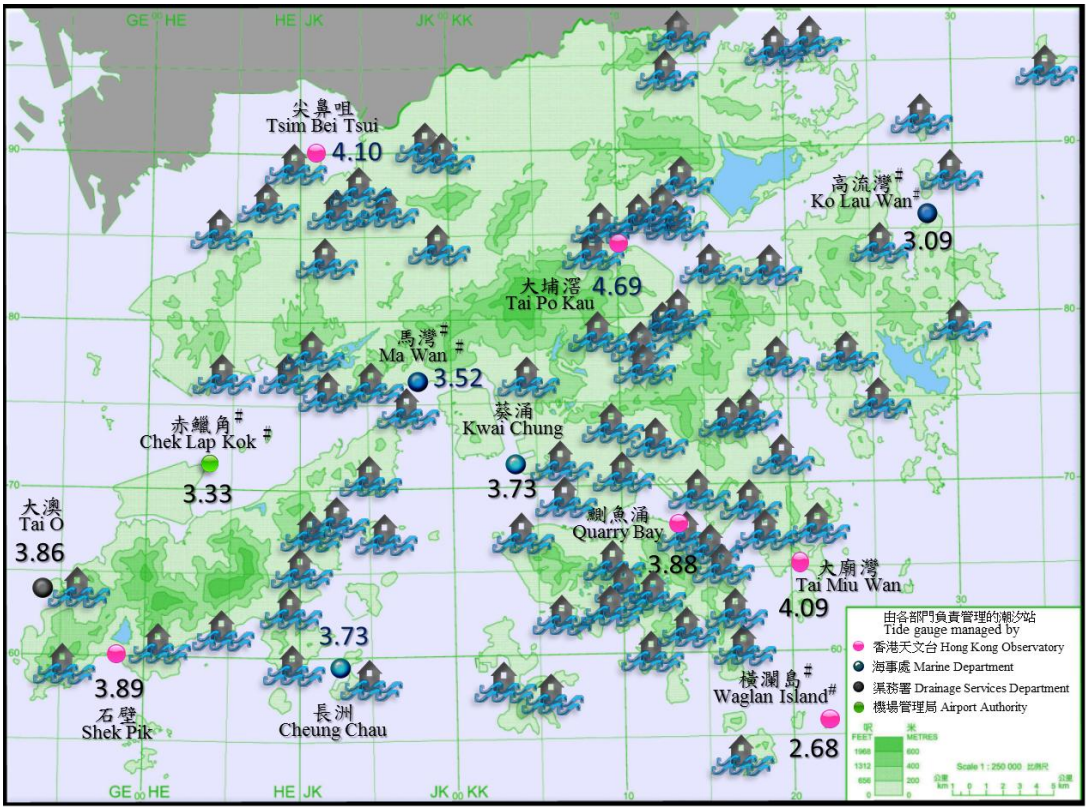

Figure 2 - The maximum sea level recorded at various tide stations in Hong Kong and flood reports (not exhaustive) from government departments, news and social media during the passage of Mangkhut on 16 September 2018.

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

The destructive winds, severe storm surge and squally heavy rain associated with Mangkhut ravaged the city on 16 September 2018, causing serious and extensive damages to Hong Kong. Preliminary reports indicated that there were serious flooding in many coastal and low-lying areas, substantial damages of coastal structures/buildings, more than 60,000 reports of fallen trees, at least 500 reports of smashed windows or glass curtain walls, and interruptions of water and power supply in various places (Figure 3). Hundreds of yachts, dinghies and boats of various sizes were lost, sunk or seriously damaged by the powerful waves. While 458 people were injured during the passage of Mangkhut, there was no fatality. Traffic and transportation services in Hong Kong were seriously affected on 16 and 17 September due to flooding, blocking of roads or railways by fallen trees and scaffoldings and damage of pier facilities. Around 900 flights were cancelled at the Hong Kong International Airport. Preliminary assessment by the insurance sector suggested that the economic losses caused by Mangkhut over the Pearl Delta region should be smaller than those caused by the Super Typhoon Hato (1713) due to the advance warming, early preparation and response days before the approach of Mangkhut.

Ewiniar, Son-Tinh, Bebinca and Barijat did not cause significant damage in Hong Kong.

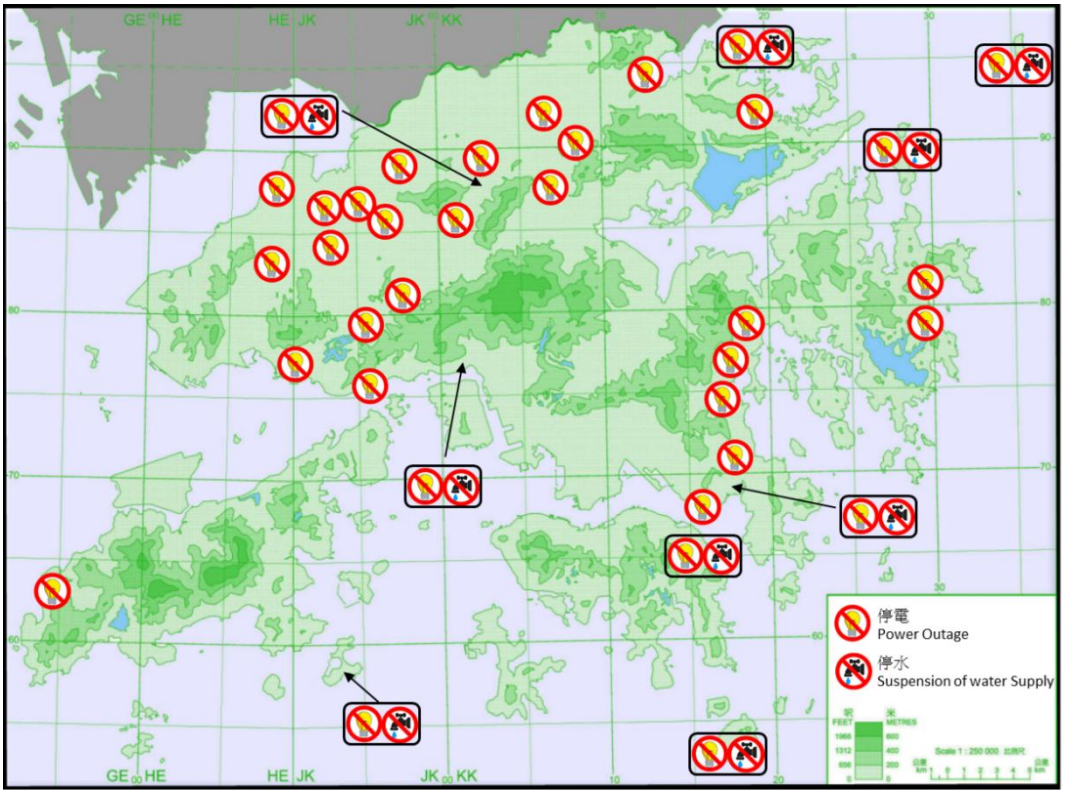

Figure 3 – Reports of interruption of power and water supply (not exhaustive) from news and social media during the passage of Mangkhut.

4. Regional Cooperation Assessment (highlighting regional cooperation success and challenges.

HKO signed a Memorandum of Understanding (MoU) with the World Meteorological Organization (WMO) on 2 October 2018 to further strengthen meteorological co-operation. Under the MoU, HKO will support the WMO's initiative in establishing the Global Multi-hazard Alert System (GMAS). In this connection, HKO has revamped the Severe Weather Information Centre website (SWIC 2.0) (https://severe.worldweather.wmo.int/v2) and is also updating the World Weather Information Service website to aggregate authoritative warning signals related to high-impact weather, water and climate events issued by official weather service organizations around the world. Decision makers of various organizations, including international and humanitarian agencies, can make use of the information on these websites to keep an overview of natural disasters on a global basis and take appropriate disaster risk reduction measures. Moreover, WMO has been awarded the Welfare Betterment Prize of the 2018 LUI Che Woo Prize – Prize for World Civilisation in recognition of their long term efforts in mitigating disaster losses related to extreme weather, climate and water events.

HKO also continued to operate the WMO Tropical Cyclone Forecaster Website (http://severe.worldweather.wmo.int/TCFW/) on behalf of WMO.

Figure 4 - The Director of HKO, Mr Shun Chi-ming (left), signed a Memorandum of Understanding with the Secretary-General of the WMO, Professor Petteri Taalas (right), to further strengthen meteorological co-operation.

II. Summary of Progress in Priorities supporting Key Result Areas

1. Tropical cyclone surveillance flights

Main text:

HKO, in collaboration with the Hong Kong Government Flying Service, continued to undertake dropsonde reconnaissance flights for tropical cyclones over the South China Sea in 2018. A total of seven missions were conducted up to October 2018 including that for an area of low pressure which subsequently developed into Ewiniar (4, 5 and 6 June), an area of low pressure (16 and 17 June), Barijat (12 September) and Mangkhut (15 September; see Figure 5).

In liaison with RSMC Tokyo, HKO dropsonde bulletins in BUFR format are disseminated through GTS on a near real-time basis.

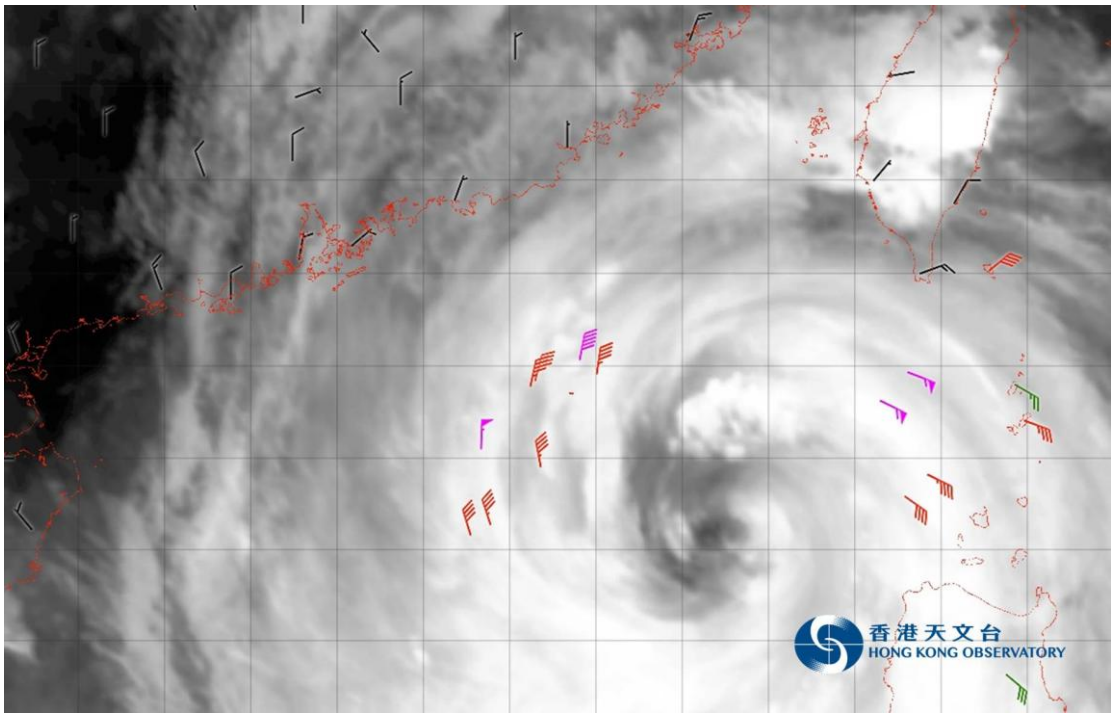

Figure 5 - Near-surface winds sampled within the circulation of Mangkhut on 15 September by dropsonde missions of HKO (northwest quadrant) and DOTSTAR (northeast quadrant) together with available GTS wind observations.

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

The assimilation of dropsonde observations into NWP models using advanced ensemble-based techniques would be studied. The possibility of extending the dropsonde reconnaissance flights into neighboring Flight Information Regions will be explored with the respective meteorological services in coordination with WMO

Priority Areas Addressed:

Meteorology

- Enhance the capacity to monitor and forecast typhoon activities particularly in genesis, intensity and structure change.
- Promote communication among typhoon operational forecast and research communities in Typhoon Committee region.

Contact Information:

Member: Hong Kong, China
Name of contact for this item: Mr K K Hon
Telephone: (852) 2926 8331
Email: kkhon@hko.gov.hk

2. Enhancement of meteorological observation over the South China Sea and Pacific

Main text:

To enhance meteorological observation over the sea during the tropical cyclone season, HKO continued to deploy drifting buoys under the Barometer Upgrade Scheme of the Global Drifter Programme (GDP) of the Data Buoy Cooperation Panel (DBCP) of JCOMM in 2018. With the assistance of Hong Kong voluntary observing ships, two buoys were deployed in the western North Pacific to the east of Luzon in May and June 2018 respectively, and other two were deployed in the South China Sea in July 2018 (Figure 6). This was the first attempt of HKO to deploy drifting buoys over the western North Pacific. Hourly observations of sea level pressure and sea surface temperature were transmitted to HKO via Iridium for onward dissemination on GTS. The data collected by the buoys proved to be very useful for the analysis of the location and intensity of the tropical cyclones during the year. In particular, one of the drifting buoys recorded the low pressure induced by Mangkhut over the seas off the western coast of Luzon on 15 September 2018 (Figure 7).

Figure 6 - Track of the drifting buoys since launch. ▲ denotes the last reported position.

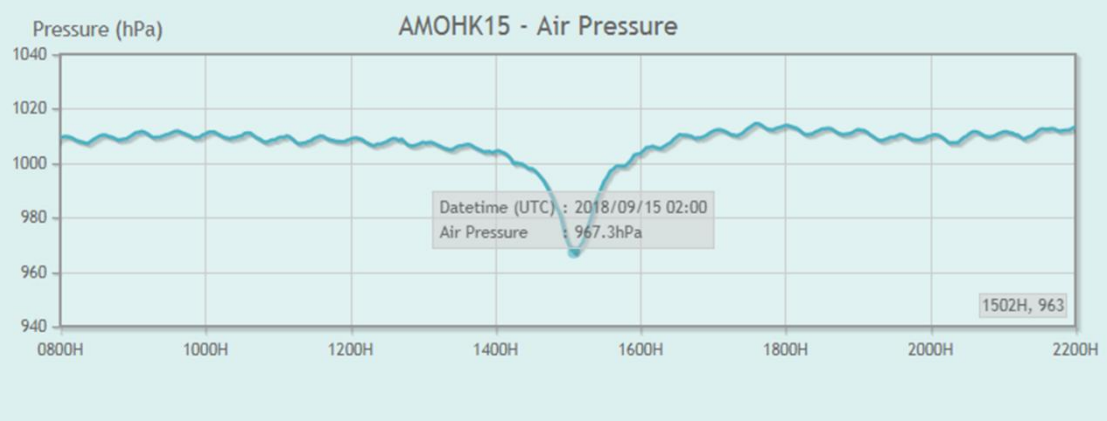

Figure 7 – The low pressure of Super Typhoon Mangkhut (1822) captured by Buoy "AMOHK15" (WMO ID: 2201568) over the seas off the western coast of Luzon on 15 September 2018.

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

HKO will continue to deploy more drifting buoys in the South China Sea and western North Pacific. Installation of automatic weather system (AWS) onboard vessels as an alternative way to enhance meteorological observation over the sea will also be considered.

Priority Areas Addressed:

Meteorology

- Enhance the capacity to monitor and forecast typhoon activities particularly in genesis, intensity and structure change.
- Promote communication among typhoon operational forecast and research communities in Typhoon Committee region.

Contact Information:

Member: Hong Kong, China
Name of contact for this item: Mr S T Chan
Telephone: (852) 2926 8451
Email: stchan@hko.gov.hk

3. Revamped website of Severe Weather Information Centre (SWIC 2.0)

Main text:

To support WMO's initiative of Global Multi-hazard Alert System (GMAS) in contribution to Sendai Framework for Disaster Risk Reduction, the SWIC website was revamped to aggregate and displays official weather warnings issued by over 60 NMHSs, which are coded in Common Alerting Protocol (CAP) format on a Geographical Information System (GIS) platform. The ISO 22324, guidelines for colour-coded alerts, is also adopted to provide visual effect on the severity of CAP alerts to aid searching on map. The beta version of SWIC 2.0 was launched jointly by HKO and WMO in Hong Kong on 2 October 2018. Members of the public and decision makers of various organizations, including international and humanitarian agencies, can make use of the information on the websites to keep an overview of natural disasters, including tropical cyclones, on a global basis and take appropriate disaster risk reduction measures.

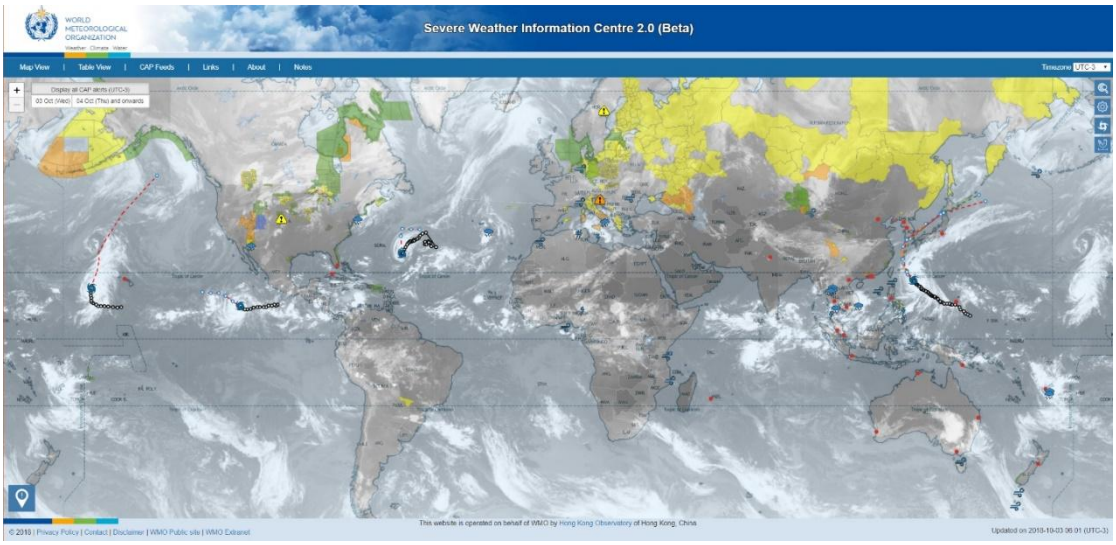

Figure 8 – Screen capture of the beta website of SWIC 2.0, displaying global authoritative weather warnings and information

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

The use of CAP format in coding weather warnings and alerts of WMO Members should be further promoted.

Priority Areas Addressed:

Integrated
- Enhance activities to develop impact-based forecasts and risk-based warning.
- Enhance collaborative activities with other regional/international frameworks/organizations, including TC and PTC cooperation mechanism.

Meteorology
- Promote communication among typhoon operational forecast and research communities in Typhoon Committee region.
- Enhance RSMC capacity to provide regional guidance including storm surge, responding to Member's needs.

Hydrology
- Enhance capacity in flood risk (hazard, inundation) information, mapping and its application.

DRR
- Promote international cooperation of DRR implementation project.

Contact Information:

Member: Hong Kong, China
Name of contact for this item: Mr Y C Cheng
Telephone: (852) 2926 8358
Email: yccheng@hko.gov.hk

4. Asian version of Global Multi-hazard Alert System (GMAS-Asia)

Main text:

To enhance visibility of NMHSs as the authoritative source of warnings at global, regional and national levels, and to facilitate the effective delivery of warning information to decision makers and the public, a pilot project jointly coordinated by HKO and CMA to enhance the capability of meteorological disaster risk reduction in RA II was approved at its 16th Session meeting in February 2017. In this connection, the Asian version of the Global Multi-hazard Alert System (GMAS-Asia) was developed and launched on 12 September 2018. The GMAS-Asia (https://gmas.asia) platform consists of a public facing portal aggregating and displaying official weather warnings in CAP format issued by NMHSs. It also has a restricted portal for exclusive use by NMHSs. The restricted portal provides advisory forecast and warning products, and features a chatroom to facilitate coordination between NMHSs' forecasters in cross boundary weather events.

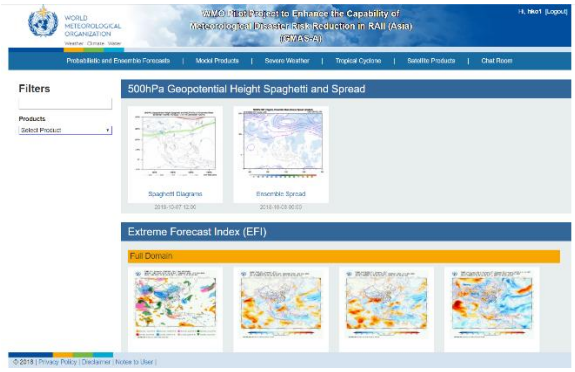

Figure 9 - Screen capture of the restricted portal of GMAS-Asia that provides advisory forecast and warning products

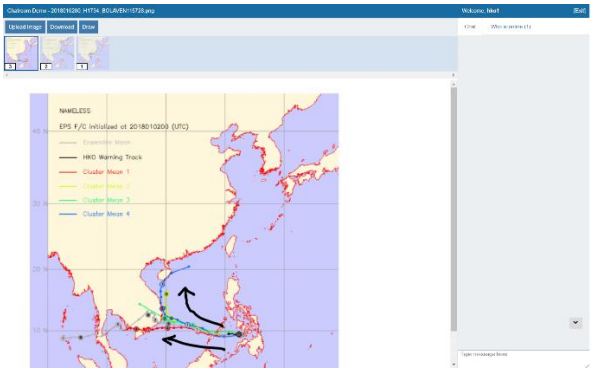

Figure 10 - Screen capture of the chatroom on the restricted portal of GMAS-Asia

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

The use of platform for sharing of advisory forecast and warning should be further promoted. The use of the Chatroom for coordination on cross-border weather events should be encouraged.

Priority Areas Addressed:

Integrated
- Enhance activities to develop impact-based forecasts and risk-based warning.
- Enhance collaborative activities with other regional/international frameworks/organizations, including TC and PTC cooperation mechanism.

Meteorology
- Promote communication among typhoon operational forecast and research communities in Typhoon Committee region.
- Enhance RSMC capacity to provide regional guidance including storm surge, responding to Member's needs.

Hydrology
- Enhance capacity in flood risk (hazard, inundation) information, mapping and its application.

DRR
- Promote international cooperation of DRR implementation project.

Contact Information:

Member: Hong Kong, China
Name of contact for this item: Mr Y C Cheng
Telephone: (852) 2926 8358
Email: yccheng@hko.gov.hk

5. Regional Specialized Meteorological Centre (RSMC) for Nowcasting

Main text:

HKO was designated by WMO as a Regional Specialized Meteorological Centre (RSMC) for Nowcasting in June 2018. A dedicated website to provide real-time rainfall nowcast and significant convection products has since been established (https://rsmc.hko.gov.hk/).

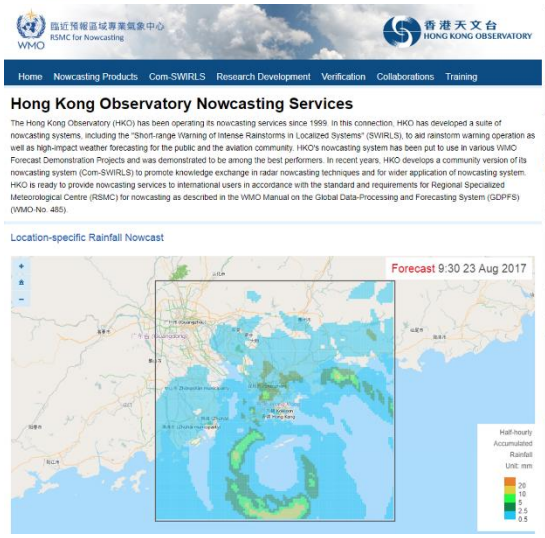

Figure 11 – Homepage of Hong Kong Observatory RSMC for Nowcasting

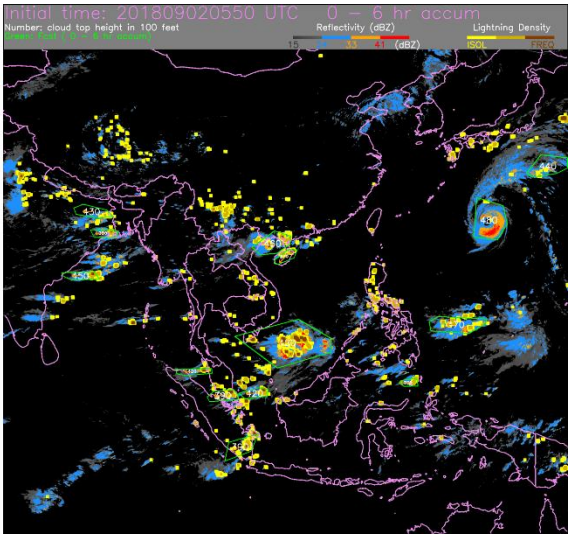

Figure 12 - 6-hour significant convection nowcast.

HKO has been sharing a community version of the SWIRLS nowcasting system (Com-SWIRLS) with NMHSs. Meteorological services in India, Malaysia, South Africa and Zhuhai, China have already adopted it for operational use, while those in Myanmar, Vietnam and the Philippines are actively exploring its application. Com-SWIRLS has been progressively enhanced with improved portability using virtual machine in open virtualization format (OVF), and software codes to ingest various radar data formats. In 2018, HKO continued to provide training and technical support on rainfall nowcast and Com-SWIRLS through a couple of training workshops for meteorologists from meteorological bureaux in China and through a VCP training workshop on aviation nowcasting.

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

RSMC for Nowcasting website provides a platform on nowcast information to meteorological and hydrological services in Asia. Exchanges on the nowcasting technology and data products would be further promoted. Training on nowcasting techniques and Com-SWIRLS will be organized.

Priority Areas Addressed:

Integrated

- Enhance activities to develop impact-based forecasts and risk-based warning.
- Enhance collaborative activities with other regional/international frameworks/organizations, including TC and PTC cooperation mechanism.

Meteorology

- Enhance and provide typhoon forecast guidance based on NWP including ensembles and weather radar related products, such as QPE/QPF.
- Enhance, in cooperation with TRCG, training activities in accordance with Typhoon Committee forecast competency, knowledge sharing, and exchange of latest development and new techniques.

Hydrology

- Enhance capacity in impact-based and community-based operational flood forecasting and early warning, including methodology research, hydrological modelling, and operation system development.
- Enhance capacity in advanced technology (including satellite data, GIS, RS, QPE/QPF, ensemble, parallel computing) utilization in typhoon-related flood forecasting and early warning, and hydrological modelling.

Contact Information:

Member: Hong Kong, China
Name of contact for this item: Mr W K Wong
Telephone: (852) 2926 8416
Email: wkwong@hko.gov.hk

6. Launching of Hong Kong Observatory Facebook page and Instagram platform to enhance communication with the public through social media

Main text:

HKO has launched its Facebook (FB) page and Instagram platforms on 23 March 2018 to strengthen public communication through social media, enhance public awareness on natural disaster prevention and response, and understanding on weather, climate and meteorological topics by means of photos, videos and computer animation (Figure 13). Within six months, the two platforms gained popularity with over 110,000 page likes and 120,000 followers on Facebook, and over 7000 followers on IG.

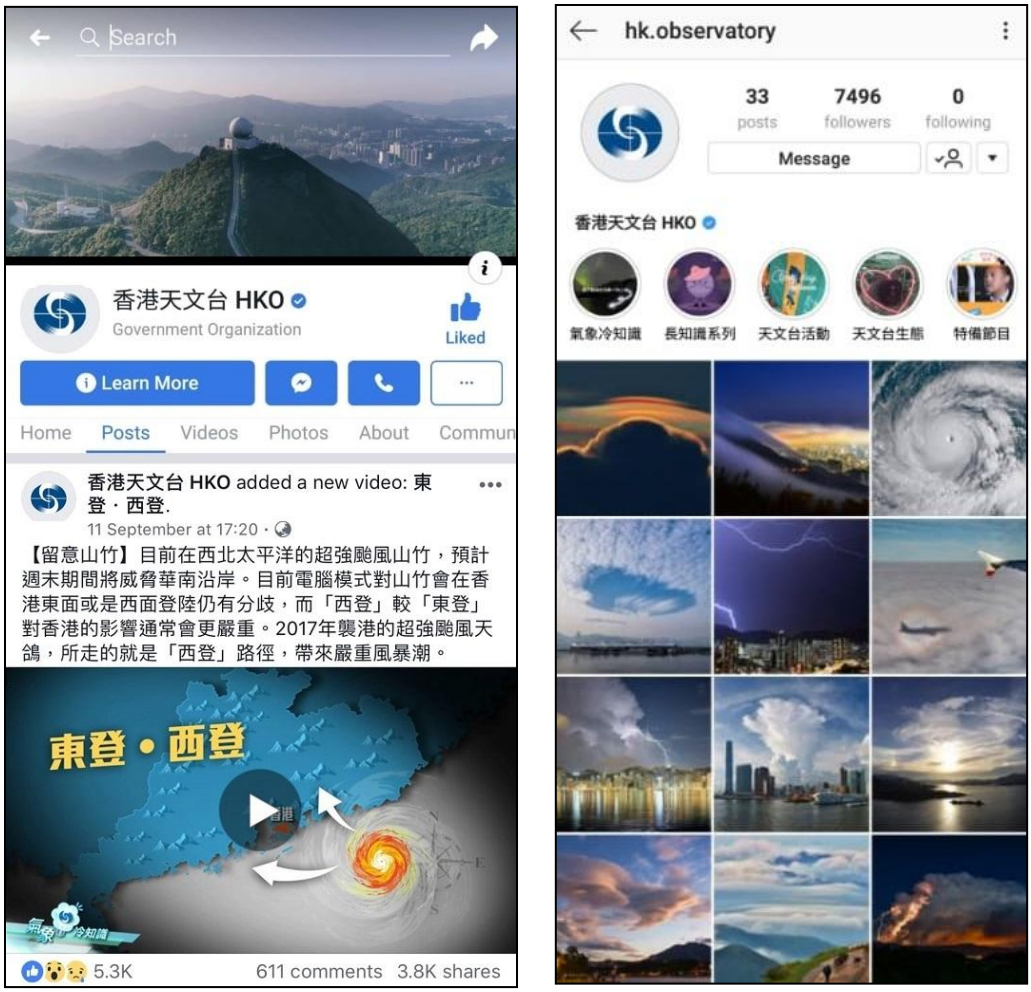

Figure 13 - HKO FB page (left) and Instagram (right) are well received by the public

An exemplary case of disaster risk reduction is the handling of Mangkhut, various educational videos, press briefing videos and infographic were posted on FB days before the passage of Mangkhut, to remind public about typhoon hazards and necessary measures that should be taken (Figure 14). During the passage of Mangkhut, the latest warning status, the actual and predicted increase in local sea level induced by storm surge, were posted on FB so as to alert the public the real-time devastating situation (Figure 15). Number of page likes and followers increased by more than 30,000 within a week due to Mangkhut. Photos and videos on impact and damages brought by Mangkhut were collected via crowdsourcing on FB platform, which

proved to be an effective means to collect disaster-related impact information. These photos/videos would also serve as useful archive for future study and public educational purpose.

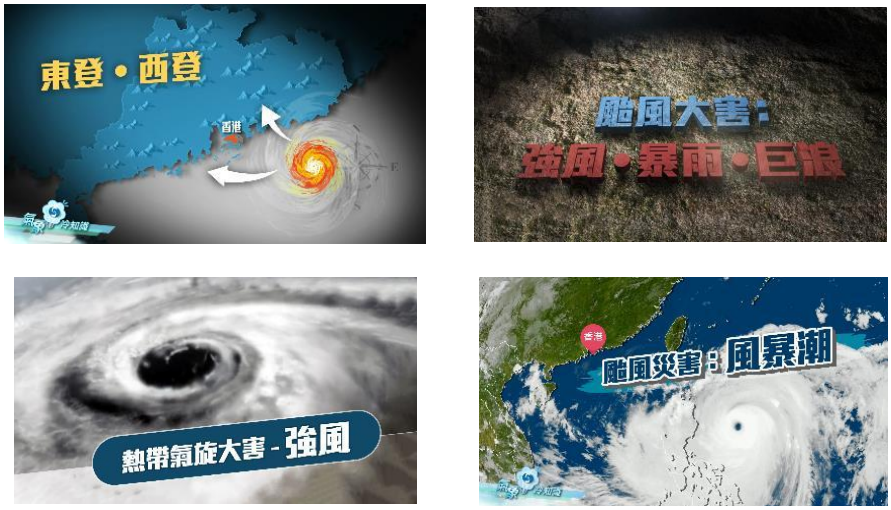

Figure 14 - Pre-produced educational videos with topics on typhoon related hazards (storm surge, high winds and waves) had been posted on HKO FB before the passage of Super Typhoon Mangkhut so as to remind the public on the potential threats from typhoon

Figure 15 - Press briefing on the latest warning status (left), the actual and predicted increase in local water level induced by storm surge (right) were posted on HKO FB so as to alert the public

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

Social media is increasingly important and popular in public communication. It is often peppered with views or rumours that spread quickly throughout the interconnected community rapidly, sometimes to the disadvantage of NMHSs. As such, it is critical for NMHSs to be present on social media platforms to provide authoritative weather information to rebut myths, clarify misconceptions, stop rumours spreading and deliver the correct messages in an effective way. This capability is in particular crucial during inclement weather when there are many rumours and misleading information.

Priority Areas Addressed:

DRR

- Share experience/know-how of DRR activities including legal and policy framework, community-based DRR activities, methodology to collect disaster-related information.
- Evaluate socio-economic benefits of disaster risk reduction for typhoon-related disasters.

Contact Information:

Member: Hong Kong, China
Name of contact for this item: Mr K L Lee
Telephone: (852) 2926 8345
Email: kllee@hko.gov.hk

7. Communication of information for strengthening resilience of communities against typhoon-related disasters

Main text:

As an annual event, HKO organized seminars for partner government departments and organizations in preparation for the typhoon season in 2018. HKO also participated in regular exercises and drills on disaster prevention and preparedness related to tropical cyclones. In particular, briefing sessions on emergency response plans were organized for local residents in low-lying areas vulnerable to storm surge. Moreover, on top of the original six flood-prone locations, based on experience gained during the passage of Super Typhoon Hato (1713), provision of storm surge alert for two more flood-prone locations was arranged in 2018 to facilitate the triggering of emergency response actions by relevant government departments and local residents.

Days before the arrival of Mangkhut (1822) in September 2018, HKO alerted the Hong Kong Government to the serious threat of the storm. Two inter-departmental meetings were subsequently held to review the preparedness of government departments for Mangkhut and discuss issues on response plans, monitoring and coordination, preventive measures, information flow and early warnings for the public.

Figure 16 – The inter-departmental meeting held on 12 September 2018 chaired by the Secretary for Security, reviewed the preparedness of government departments for handling Mangkhut

During the passage of Bebinca (1816) in August and Mangkhut in September 2018, local storm surge alerts were activated and appropriate precautions and responses were effectively undertaken by relevant government departments to mitigate the storm surge impacts and avoid casualties, particularly in the face of extreme and record-breaking storm surge generated during the passage of Mangkhut on 16 September 2018.

Figure 17 – HKO officer delivering a briefing on the operation of the storm surge alert system for local residents of Sham Tseng, a low-lying village vulnerable to storm surge, on 13 June 2018.

Figures 18 (a) and (b) - Response plans put into effective action at Tai O during the passage of Mangkhut in September 2018 (photos courtesy of Drainage Services Department)

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

HKO will collaborate with partner government departments in enhancing the storm surge alerting services to cover additional low-lying areas in Hong Kong. Moreover, HKO will continue to collaborate with communication and social science experts to enhance the effectiveness in communication with the media and the public on the impacts of tropical cyclones including storm surge, taking into account forecast uncertainties in extreme or high-impact weather situations. More community engagement opportunities will also be explored to enhance public preparedness and response in tropical cyclone situations.

Priority Areas Addressed:

Hydrology

- Enhance capacity in assessment and dealing with the impacts of climate change, urbanization and other human activities on typhoon-related flood disaster vulnerability and water resources availability.

DRR

- Share experience/know-how of DRR activities including legal and policy framework, community-based DRR activities, methodology to collect disaster-related information

Contact Information:

Member: Hong Kong, China
Name of contact for this item: Mr L S Lee
Telephone: (852) 2926 8371
Email: lslee@hko.gov.hk

8. New tropical cyclone track maps for the public

Main text:

To facilitate easy viewing of tropical cyclone tracks by members of the public and sharing of such information on social media platforms, a new and more visually appealing design of tropical cyclone forecast track map (fixed-area map version) was introduced on the Tropical Cyclone Track and Position webpage of HKO in August 2018.

The new design utilities a satellite basemap with enlarged spatial coverage. The new map also uses different colors to indicate the different intensities of tropical cyclone, such that important information on the forecast track is more easily comprehended at a glance (Figure 19).

Figure 19 – New tropical cyclone track map for Super Typhoon Mangkhut in September 2018.

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

Other ways to improve visualization of forecast tracks and impacts (such as high winds) of tropical cyclones for easy understanding by the general public will be explored.

Priority Areas Addressed:

Meteorology

- Enhance the capacity to monitor and forecast typhoon activities particularly in genesis, intensity and structure change.
- Enhance and provide typhoon forecast guidance based on NWP including ensembles and weather radar related products, such as QPE/QPF.

Contact Information:

Member: Hong Kong, China
Name of contact for this item: Mr H Y Yeung
Telephone: (852) 2926 8434
Email: hyyeung@hko.gov.hk

9. Extended outlook on tropical cyclone track probability

Main text:

An extended outlook on tropical cyclone (TC) movement in the next nine days, viz. the "Tropical Cyclone Track Probability Forecast", was launched to the public in August 2017 to provide assessment of the possible scenarios of TC movement within HKO's area of responsibility (7-36°N, 100-140°E). Well received by users, this product indicates the likely areas that may be affected by TCs in the next nine days. This enables users to better plan their activities and take precautionary measures.

The "Tropical Cyclone Track Probability Forecast" utilizes prognostic information extracted from several Ensemble Prediction Systems (EPS) of global NWP models. The probability information, coded in colour, represents the probability of tropical cyclone coming within 120 kilometres of a location on the map in the coming nine days.

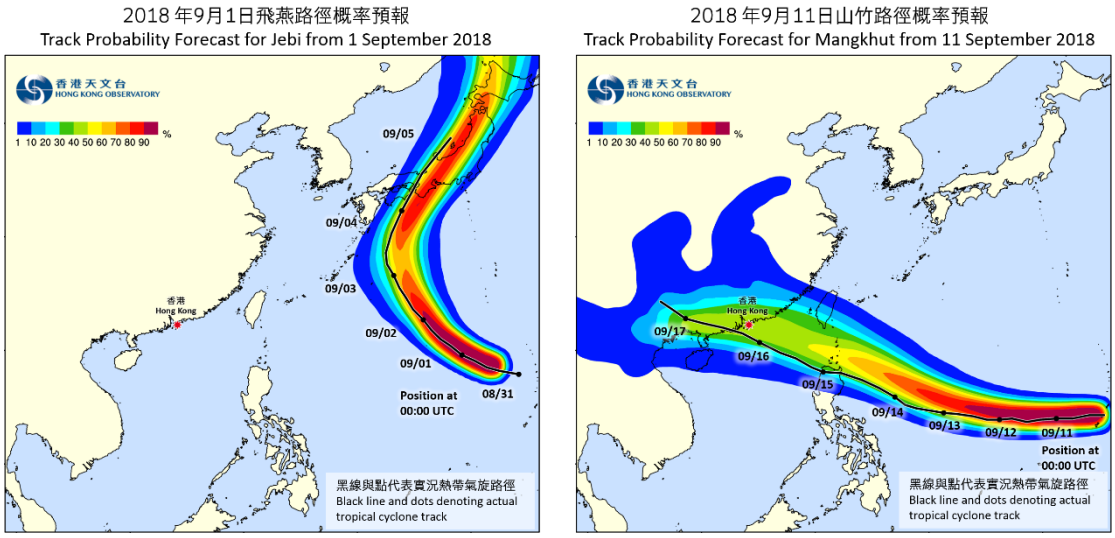

Figure 20 - Track probability forecasts for Jebi (1823) and Mangkhut (1826). HKO's analysis tracks of the tropical cyclones are plotted in black dots and lines.

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

Development of extended outlook for other elements such as wind, pressure and rainfall is underway to enhance the forecasting services on tropical cyclones and high-impact weather.

Regional collaboration on the development of probabilistic forecasts for tropical cyclone and post-processing techniques of EPSs and NWP models will be explored.

Priority Areas Addressed:

Integrated

- Enhance activities to develop impact-based forecasts and risk-based warning for tropical cyclones.

Meteorology

- Develop and enhance TC analysis and forecast technique from short- to long-term.
- Enhance and provide typhoon forecast guidance based on NWP including ensembles and weather radar related products, such as QPE/QPF.

Contact Information:

Member: Hong Kong, China
Name of contact for this item: Mr W K Wong
Telephone: (852) 2926 8416
Email: wkwong@hko.gov.hk

10. Enhancement of storm surge and sea states prediction

Main text:

HKO has been operating the SLOSH storm surge model, developed by the National Oceanic and Atmospheric Administration (NOAA) of USA to support its tropical cyclone warning operation since 1994. The model could predict the storm surge heights in Hong Kong induced by tropical cyclones, with input parameters including forecast positions, intensity and size of the storm extracted from the HKO's forecast track.

In 2018, the computational basin of the model was updated with the latest bathymetry data and high resolution LiDAR Data Elevation Model data for Hong Kong. Verification results indicated that the updated basin would bring general improvements to storm surge prediction such as in the case of Super Typhoon Mangkhut (1822) in 2018

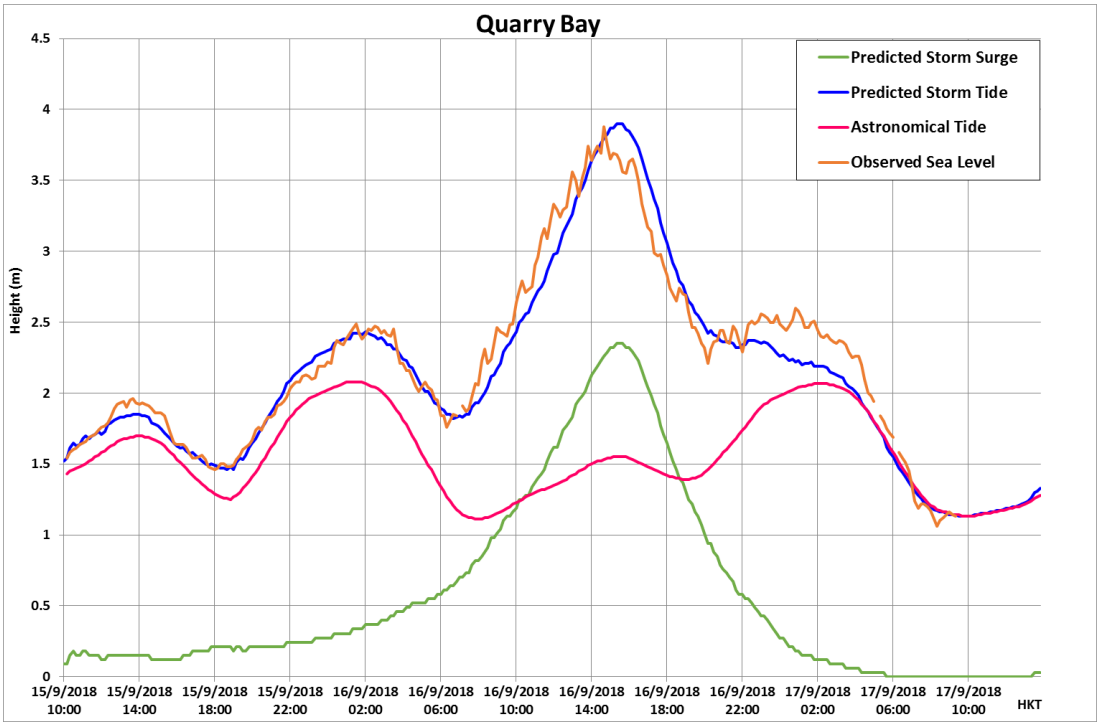

Figure 21 - Time series of predicted storm surge and storm tide, along with observed sea level and astronomical tide at Quarry Bay during the passage of Mangkhut 2018.

The operational numerical wave model WaveWatch III adapted from NOAA was upgraded with an extended forecast area covering the South China Sea, western North Pacific and North Indian Ocean. Coupling with a nearshore wave model SWAN, high-resolution wave products were also generated for the coastal waters of Hong Kong. Wave/Swell forecast products in 3-hour time steps up to 96 hours ahead to support sea state forecasting were made available for trial use by the forecasters at HKO.

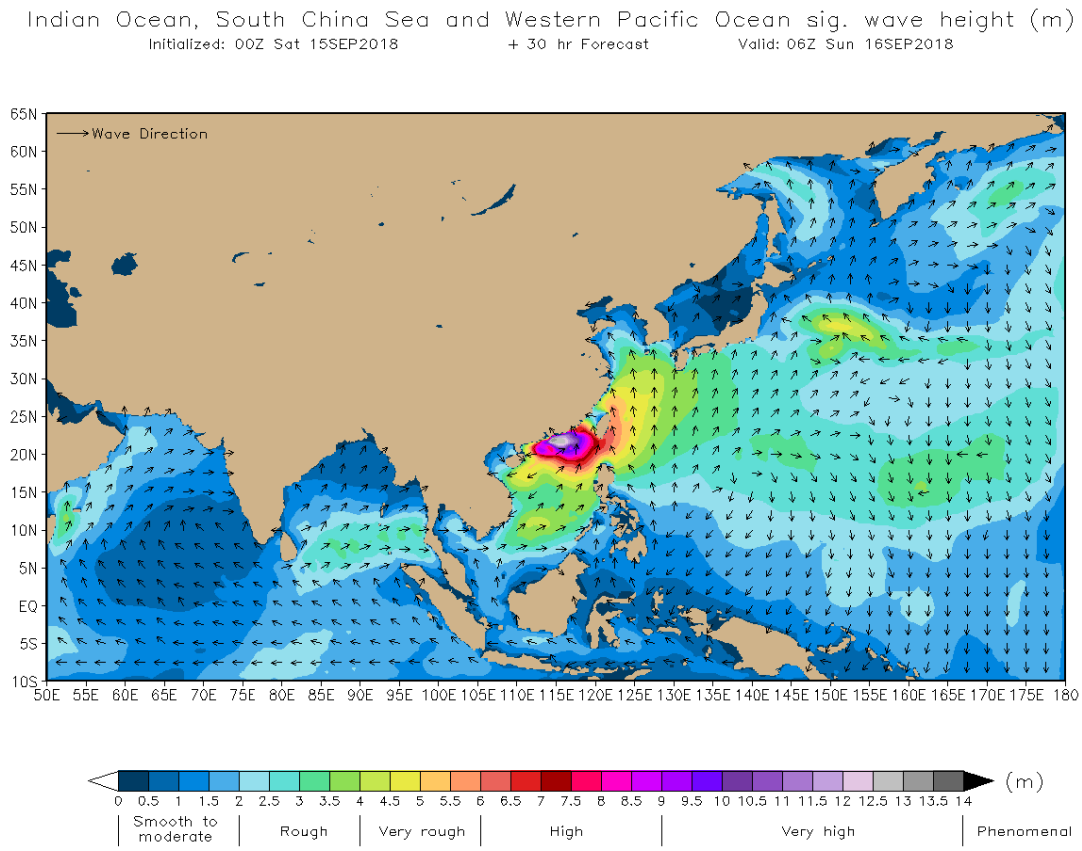

Figure 22 - Sea state prediction for Mangkhut (1822) generated by the upgraded wave model suite.

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

Based on a study on Super Typhoon Hato (1713) in 2017, it was found that for tropical cyclones passing in the vicinity of Hong Kong, the accuracy of storm surge prediction and the associated impact based on one single warning track would be highly sensitive to the distance of closest approach, storm size, as well as the translation speed of the storm. Alternative tracks constructed based on forecast uncertainties should be taken into account in the formulation of warnings and advisory messages. A probabilistic approach should also be considered to support risk assessment, and to allow the general public and stakeholders to take early and appropriate precautionary measures against the range of possible alternative scenarios.

Priority Areas Addressed:

<u>Meteorology</u>

- Enhance and provide typhoon forecast guidance based on NWP including ensembles and weather radar related products, such as QPE/QPF.

<u>Hydrology</u>

- Enhance capacity in impact-based and community-based operational flood forecasting and early warning, including methodology research, hydrological modelling, and operation system development.
- Enhance capacity in flood risk (hazard, inundation) information, mapping and its

application.

Contact Information:

Member: Hong Kong, China
Name of contact for this item: Mr S T Chan
Telephone: (852) 2926 8451
Email: stchan@hko.gov.hk

11. System and product development to support tropical cyclone operation

Main text:

To expand the range of NWP products in support of tropical cyclone forecast operation, prognostic charts of different parameters based on output from the Global Deterministic Prediction System (GDPS) of CMC and GRAPES-GFS model from CMA were sought and made available for forecasters' reference. In addition, tropical cyclone warning tracks from KMA have been added to HKO's Tropical Cyclone Information Processing System (TIPS), an integrated platform for use by forecasters in preparing tropical cyclone forecasts and warnings.

"Meteorological Data Display System" (MDDS), a GIS-powered data analysis and visualization system developed in-house at HKO, was enhanced with additional hydrological information from Drainage Services Department, a department of the Hong Kong Government responsible for drainage and sewage. The information is particularly useful for common situational awareness and decision-making on hydrological impacts. The system also displays impacts from tropical cyclones, including the reported locations of flooding, fallen trees and landslides (Figure 23).

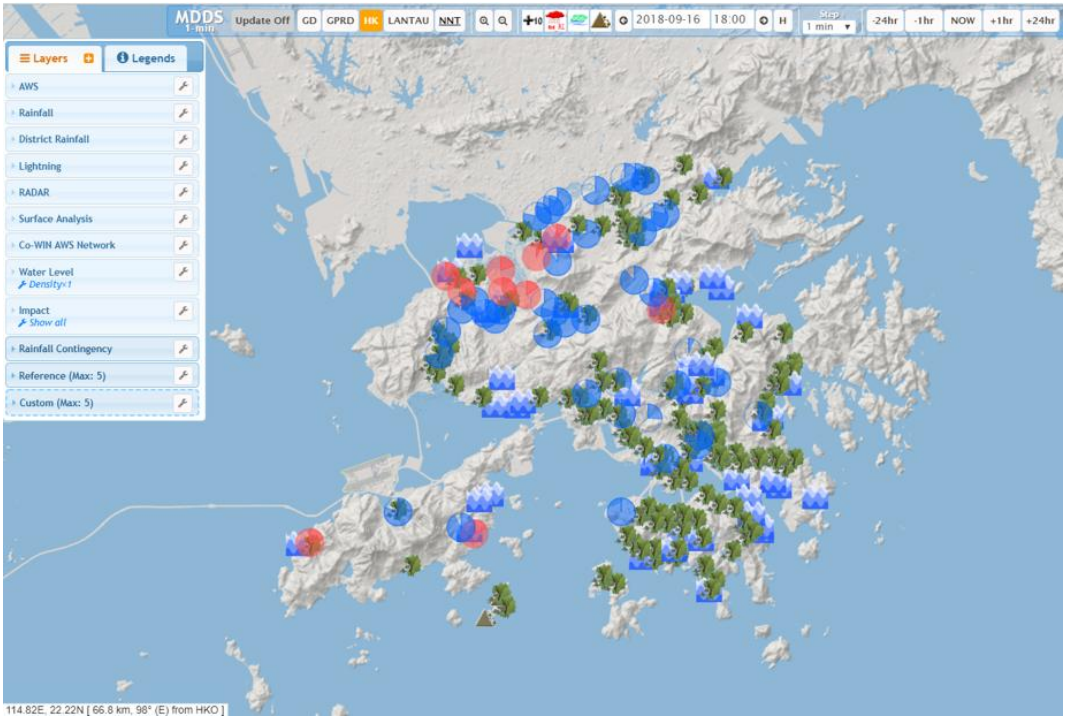

Figure 23 – MDDS display of hydrological information (as pie charts: red/blue colour refers to water level above/below alert thresholds), fallen tree ( ), landslide ( ) and flood ( ) reports (not exhaustive) in Hong Kong during the passage of Mangkhut on 16 September 2018.

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

Further studies and collaboration will be explored in crowdsourcing, more data from the public domain, social media platforms, other government departments, which will provide more useful information supporting impact-based weather forecasting and warning.

Priority Areas Addressed:

Meteorology

- Enhance the capacity to monitor and forecast typhoon activities particularly in genesis, intensity and structure change.
- Enhance and provide typhoon forecast guidance based on NWP including ensembles and weather radar related products, such as QPE/QPF.

Hydrology

- Enhance capacity in flood risk (hazard, inundation) information, mapping and its application.

DRR

- Share experience/know-how of DRR activities including legal and policy framework, community-based DRR activities, methodology to collect disaster-related information.

Contact Information:

Member: Hong Kong, China
Name of contact for this item: Dr C K Pan
Telephone: (852) 2926 8357
Email: ckpan@hko.gov.hk

12. Mesoscale 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, 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). Recently, the 200-m resolution Aviation Model (AVM) has been enhanced to provide full coverage over Hong Kong for providing hourly-updated urban-scale forecasts as well as aviation-specific products for the Hong Kong International Airport (HKIA).

Additionally, in support of regional prediction of aviation-impact weather under the Asian Aviation Meteorological Centre initiative, an extended-domain prediction system resolution has been set up to provide 10-km resolution, 48-hour forecasts over the region (20^0S – 60^0N, 45^0E – 160^0E; Fig. 1). Preliminary TC track performance in 2018 (mean positional error of about 60 km for T+24 and 110 km for T+48) is highly competitive with leading global and regional models.

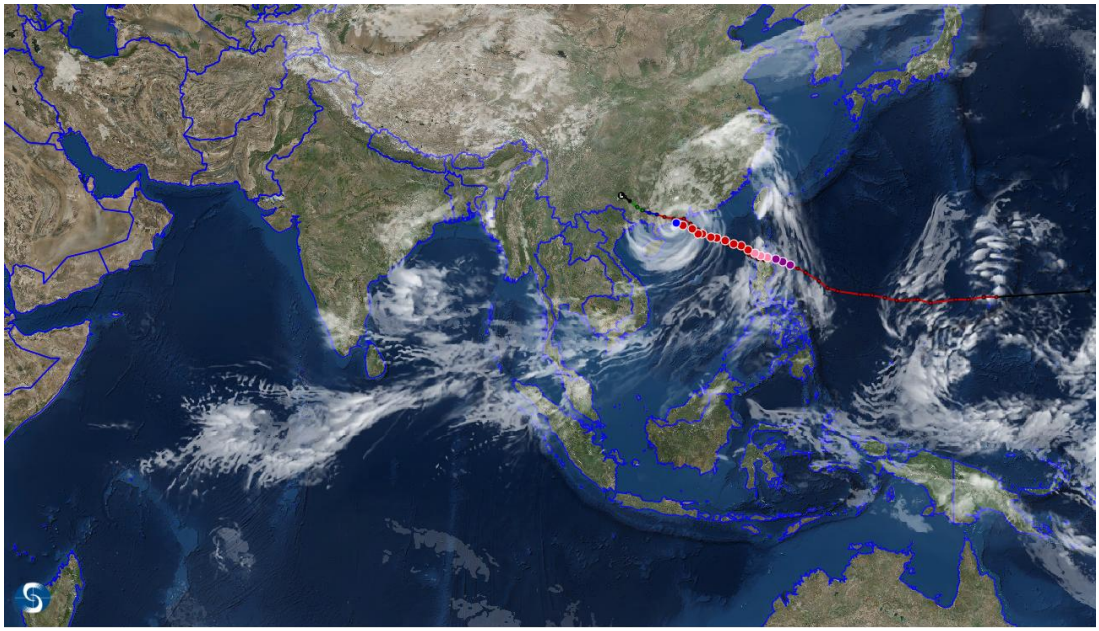

Figure 24 - Forecast (dots, thick; 48-hour forecasts initiated at 14 Sep 2018, 12 UTC) and actual (line with dots, light; whole life cycle) movement of Mangkhut by HKO's extended-domain prediction system overlaid on its simulated satellite imagery covering (20^0S – 60^0N, 45^0E – 160^0E).

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

Research and development of advanced assimilation techniques, especially for regional radar composites and new-generation satellite observations, would continue.

Regional exchange of model output products would be explored with a view to fostering closer collaboration.

Priority Areas Addressed:

Meteorology

- Develop and enhance typhoon analysis and forecast technique from short- to long-term.
- Enhance and provide typhoon forecast guidance based on NWP including ensembles and weather radar related products, such as QPE/QPF.

Contact Information:

Member: Hong Kong, China
Name of contact for this item: Mr K K Hon
Telephone: (852) 2926 8331
Email: kkhon@hko.gov.hk

13. 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 had exceeded 160 by end of September 2018.

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 120,000 weather reports/photos have been received from these two sources so far. In 2018, CWOS Facebook was used to crowd source photos and videos of impact of tropical cyclone Mangkhut. About 600 photos and over 50 videos were collected.

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. US and Lao participants attended the training workshop organized at the Hong Kong Observatory during 1-3 November 2017. US planned tentative installation of the station in December 2018 at Mt. Carmel in Chalan Kanoa, Saipan.

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

Two prototype microclimate stations have been developed in Hong Kong. It is planned that a network of microclimate stations, including those from Co-WIN, will be implemented for providing real-time weather data for use in urban climate studies and potential applications for smart city planning.

Priority Areas Addressed:

DRR

- Promote international cooperation of DRR implementation project
- Share experience/know-how of DRR activities including legal and policy framework, community-based DRR activities, methodology to collect disaster-related information

Contact Information:

Member: Hong Kong, China
Name of contact for this item: Mr K H Tam
Telephone: (852) 2926 8414
Email: khtam@hko.gov.hk

Appendix I - Priority Areas of Working Groups

WG	Priorities
Integrated	1. Enhance activities to develop impact-based forecasts and risk-based warning.
	2. Strengthen cross-cutting activities among working groups in the Committee.
	3. Enhance collaborative activities with other regional/international frameworks/organizations, including TC and PTC cooperation mechanism.
Met	4. Enhance the capacity to monitor and forecast typhoon activities particularly in genesis, intensity and structure change.
	5. Develop and enhance typhoon analysis and forecast technique from short- to long-term.
	6. Enhance and provide typhoon forecast guidance based on NWP including ensembles and weather radar related products, such as QPE/QPF.
	7. Promote communication among typhoon operational forecast and research communities in Typhoon Committee region.
	8. Strengthen the cooperation with WGH and WGDRR to develop impact-based forecast and risk-based warning.
	9. Enhance, in cooperation with TRCG, training activities in accordance with Typhoon Committee forecast competency, knowledge sharing, and exchange of latest development and new techniques.
	10. Enhance RSMC capacity to provide regional guidance including storm surge, responding to Member's needs.
Hydrology	11. Improve typhoon-related flood (including river flood, urban flood, mountainous flood, flash flood and storm surge, etc. the same below) monitoring data collection, quality control, transmission and processing.
	12. Enhance capacity in typhoon-related flood risk management (including dam operation), integrated water resources management and flood-water utilization.
	13. Enhance capacity in impact-based and community-based operational flood forecasting and early warning, including methodology research, hydrological modelling, and operation system development.
	14. Enhance capacity in flood risk (hazard, inundation) information, mapping and its application.
	15. Enhance capacity in assessment and dealing with the impacts of climate change, urbanization and other human activities on typhoon-related flood disaster vulnerability and water resources availability.
	16. Enhance capacity in advanced technology (including satellite data, GIS, RS, QPE/QPF, ensemble, parallel computing) utilization in

	typhoon-related flood forecasting and early warning, and hydrological modelling.
DRR	17. Provide reliable statistics of mortality and direct disaster economic loss caused by typhoon-related disasters for monitoring the targets of the Typhoon Committee.
	18. Enhance Members' disaster reduction techniques and management strategies.
	19. Evaluate socio-economic benefits of disaster risk reduction for typhoon-related disasters.
	20. Promote international cooperation of DRR implementation project.
	21. Share experience/know-how of DRR activities including legal and policy framework, community-based DRR activities, methodology to collect disaster-related information.