EUROPEAN COMMISSION
JOINT RESEARCH CENTRE

14 September 2018,15:00 UTC

Tropical Cyclone MANGKHUT

Guam, Northern Mariana Islands, Philippines, China, Vietnam

MANGKHUT: GDACS Tropical Cyclone Red Alert
7 September 2018 - ongoing

UPDATE 1

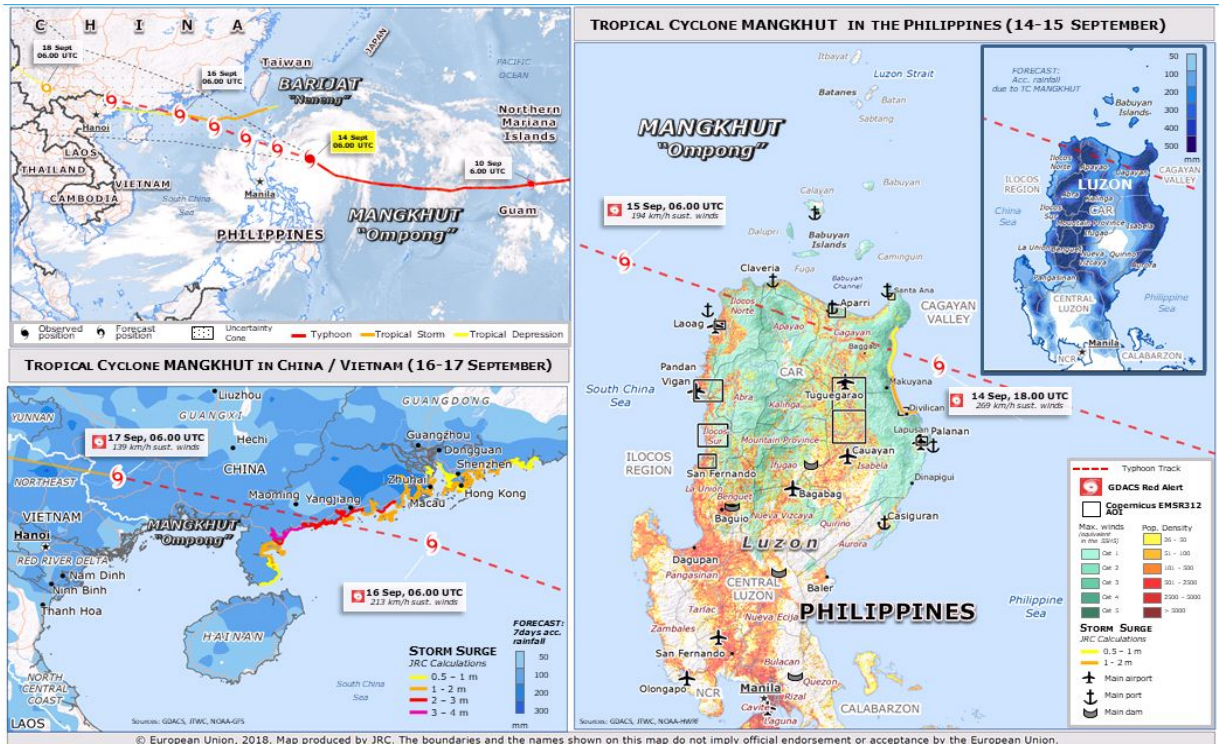

***Figure 1** - TC MANGKHUT in Guam, Northern Mariana Islands, Philippines, China, Vietnam (as of 14 Sep 2018, 06:00 UTC)*

1 Executive Summary

- Tropical Cyclone **MANGKHUT** (OMPONG in the Philippines) is currently approaching the northern Philippines as a very intense Typhoon. It is expected to reach the eastern coast of Cagayan Province on 14 September evening (UTC) with max. sustained winds up to **260-270 km/h** (equivalent to a **Category 5** in the Saffir Simpson Hurricane Scale).

- After the landfall in Philippines it is forecast to cross northern Luzon and start moving over the South China Sea, still as an intense Typhoon. It could reach the south-western coastal areas of Guangdong, near Yangjiang, west of Hong Kong / Macau on 16 September morning (UTC), still as a Typhoon (max. sustained winds up to **200 km/h**). In China, extreme high levels of storm surge are expected (more than **3.1 m**), in particular in the area of Zhanjiang.

- The Joint Research Centre (JRC) is following the event through the information automatically collected and analysed in the Global Disasters Alerts and Coordination System (GDACS). GDACS issued a **RED** alert on 7th September for potential disaster in the Philippines and in China.

- The Copernicus Emergency Response Mapping service was activated by ERCC on 14 September for several locations in the northern Philippines.

- This report is an update of the first report that has been issued on 12th September[1], and contains a situation update and a better identification of the possible consequences in China.

2 Situation Overview

2.1 Meteorological Situation

2.1.1 Tropical Cyclone MANGKHUT

- **CURRENT**: TC MANGHUT (named OMPONG in the Philippines) is moving towards northern Philippines. On 14 September at 06:00 UTC, its centre was located over the Philippine Sea, approx. 380 km south-east of Cagayan (northern Luzon) and it had max. sustained winds of 270 km/h (equivalent to a Category 5 in the Saffir Simpson Hurricane Scale, see Annex 2).
- **FORECAST** (as of 14 September, 06:00 UTC TC data): it is expected to reach the eastern coast of Cagayan Province on 14 September evening (UTC), as a very intense Typhoon with max. sustained winds up to **260-270 km/h**. After the landfall it is forecast to cross northern Luzon and start moving over the South China Sea, still as an intense Typhoon. It could reach the south-western coastal areas of Guangdong, near Yangjiang, west of Hong Kong / Macau on 16 September morning (UTC), still as a Typhoon (max. sustained winds up to 200 km/h), but the track/intensity **uncertainty** is still **high**. According to this forecast, very strong winds, heavy rains and storm surge could especially affect northern Philippines on 14-15 September, as well as Hong Kong, Macau and the south-western coastal areas of the province of Guangdong (China) on 16-17 September. Heavy rain could also affect southern and eastern Taiwan, Hainan and Guangxi (China) and northern Vietnam (see Section 2.2).

- **UNCERTAINTY**: There is still some uncertainty on the area of the landfall, some models provide a slightly different track (more to the south) with a possible landfall over northern Isabela province. The maximum sustained wind speed during the expected landfall has still a large

[1] http://portal.gdacs.org/GDACSDocuments/TC_MANGKHUT_.pdf

variability and it is between 170-280 km/h. Most of the models agrees on the landfall in Guangdong with max sustained winds between **140 and 200 km/h**.

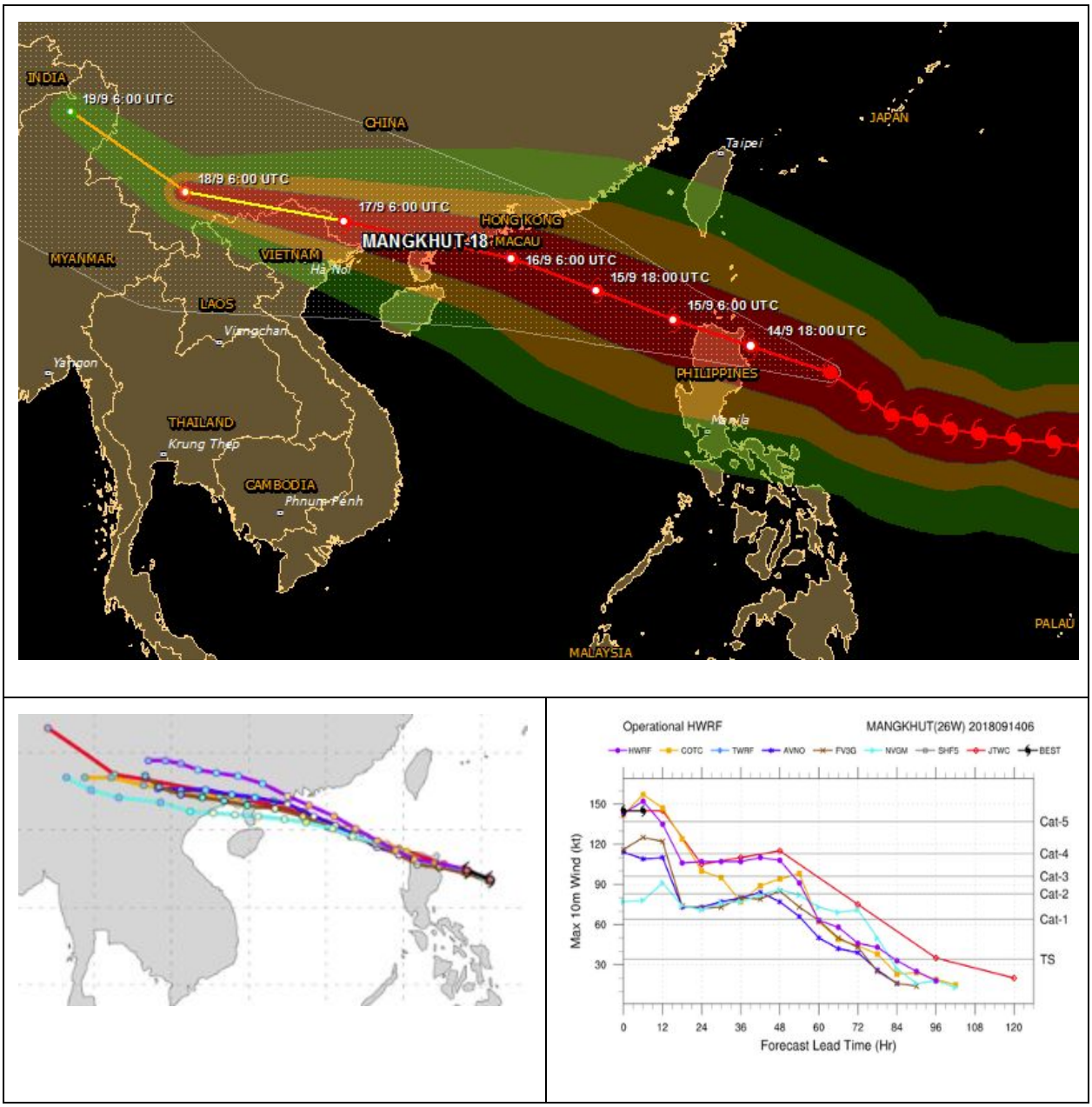

***Figure 2** - TC MANGKHUT uncertainty track/intensity (as of 14 Sep, 06:00 UTC). Sources: GDACS (TOP), NOAA-HWRF (BOTTOM)*

2.1.2 Warnings in effect

As of 14 September, 12:00 UTC, there are the following warnings in effect:

PHILIPPINES *(source: PAGASA)*

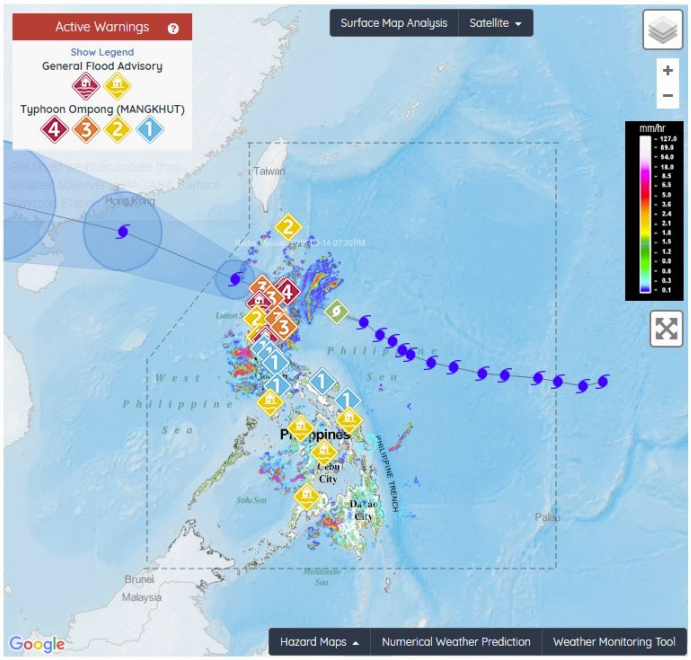

Figure 3 *- Latest Active Warnings page taken from PAGASA: http://bagong.pagasa.dost.gov.ph*

Tropical Cyclone Warning Signal no. (TCWS), as of 14 Sep, 17:00 local time (PAGASA)	
4	**Luzon: Cagayan, northern Isabela**
3	**Luzon:** Babuyan Group of Is., southern Isabela, Ilocos Norte, Ilocos Sur, Apayao, Abra, Kalinga, Mountain Province, Benguet, Ifugao, Nueva Vizcaya, Quirino, Northern Aurora
2	**Luzon:** Batanes, La Union, Pangasinan, Tarlac, Nueva Ecija, southern Aurora, northern Zambales
1	**Luzon:** Southern Zambales, Pampanga, Bulacan, Bataan, Rizal, Metro Manila, Cavite, Batangas, Laguna, Quezon incl. Polillo Is., Northern Occidental Mindoro incl. Lubang Is., Northern Oriental Mindoro, Masbate, Marinduque, Camarines Norte, Camarines Sur, Catanduanes, Albay, Sorsogon, Burias and Ticao Islands **Visayas:** Northern Samar

TAIWAN *(source: CWB)*

The warning in effect are reported in CWB figure below:

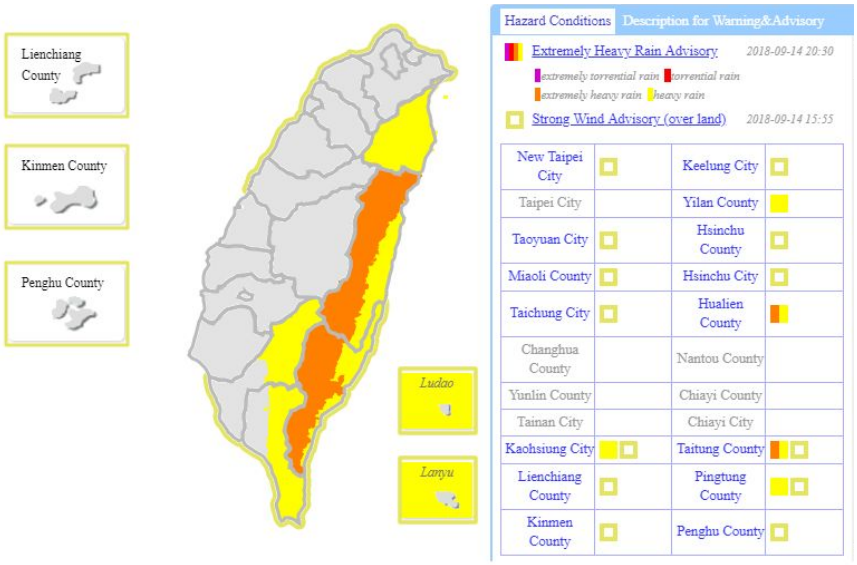

Figure 4 *- Latest Active Warnings page taken from Central Weather Bureau - CWB (source:* https://www.cwb.gov.tw/V7e/prevent/fifows/index.htm?)

HONG KONG (source: Hong Kong Observatory)
As of 14 Sep, 18:45 local time, there are no Tropical Cyclone Warning Signals in effect, but as reported in the Hong Kong Observatory: *"The Observatory will consider issuing the Standby Signal, No. 1 tonight. Members of the public should complete all precautionary measures as soon as possible."*

CHINA (source: China Meteorological Administration)
As reported in the China Meteorological Administration website: *"the CMA upgraded the emergency response to typhoon Mangkhut to the **level two**. It is required that the relevant meteorological sectors attached to CMA enter the emergency position immediately and put corresponding meteorological services in place. The potential affected areas such as Guangdong, Hainan and Guangxi are expected to sustain or adjust the emergency state according to local realities. The National Meteorological Center issued an **orange warning of typhoon** on 14 Sep at 6:00 p.m."*

VIETNAM (source: NCHMF: http://www.nchmf.gov.vn/web/en-US/104/102/12233/Default.aspx)

As reported in the National Centre for Hydro-Meteorological Forecasting website:

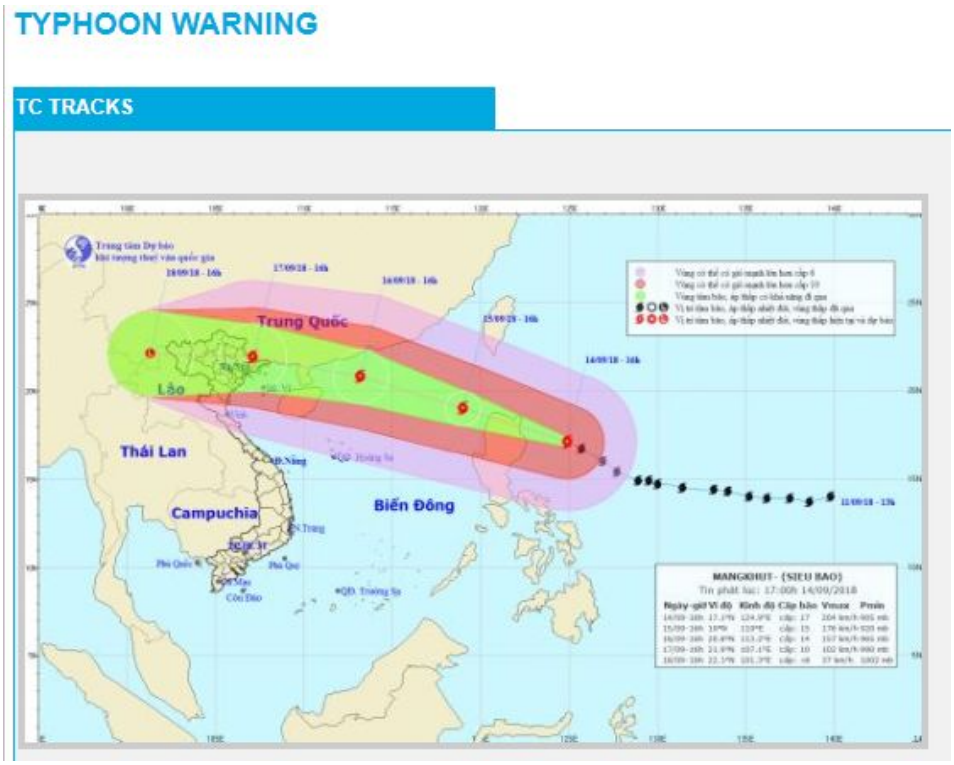

Figure 5 *- Latest Active Warnings page taken from the National Centre for Hydro-Meteorological Forecasting - NCHMF(source: http://www.nchmf.gov.vn/web/en-US/104/102/12233/Default.aspx)*

2.2 Impact Analysis of TC MANGKHUT

The possible impact of Typhoon MANGKHUT over the next few days in the potentially affected countries (**Philippines**, China, Vietnam) is shown below, while the impact of MANGKHUT in Guam and Northern Mariana Islands has been already included in the previous JRC Emergency Report.

NOTE: *TC MANGKUT has a forecasted track very similar to the one of TC HAIMA that affected the same area as an intense Typhoon on 19 Oct 2016, causing the death of 19 people and nearly 270,000 houses were destroyed, mostly in Cagayan and Isabela provinces (see Section 2.3).*

Wind

- **PHILIPPINES:** The center of MANGKHUT is expected to pass over northern Philippines on 14-15 September, as a very intense Typhoon with max. sustained winds of over 260-270 km/h (equivalent to a Category 5 in the SSHS, see Annex). Very strong winds (locally up to 270 km/h, with higher gusts) could affect Cagayan Province, including Babuyan islands, and Isabela provinces. Strong winds (>118 km/h) could also affect other provinces of northern Luzon (Philippines), see map below.

  Potentially most affected areas: **Cagayan Province (including Babuyan islands), Isabela, Apayao, Ilocos Norte**

Figure 6 *- FORECAST: max. winds in the northern Philippines (GDACS, NOAA-HWRF)*

- **CHINA (Taiwan):** the center of MANGKHUT is forecast to pass approx. 300-400 km south of southern Taiwan. Strong winds could affect the southern tip of Taiwan during its passage.

Potentially most affected areas: **Pingtung, Taitung, Kaohsiung** (southern Taiwan).

- **CHINA (Guangdong, Guangxi and Hainan Provinces, Hong Kong and Macau)**: Strong winds (locally up to 200 km/h, with higher gusts) could also affect south-western Guangdong, Hong Kong and Macau on 16-17 September, especially the area of **Yangjiang**. Tropical Storm winds could also affected the other areas of Guangdong, Hainan and Guangxi.

  Potentially most affected areas: south-western **Guangdong**, **Hong Kong** and **Macau,** southern **Guangxi, Hainan.**

  NOTE: South-western Guangdong and Hainan (China) and northern Vietnam have been recently affected by strong winds due to the passage of BARIJAT.

Rainfall

- **PHILIPPINES:** TC MANGKHUT is expected to produce very heavy rains (locally total acc. > 500 mm) over several areas of northern Luzon, in particular along the coast of Cagayan and Isabela provinces and in the mountain areas (see Figure 7). This amount of rainfall could cause landslides and flash floods. Heavy rain could also affect central Luzon. Moreover, according to PAGASA, MANGKHUT could also enhance the "Habagat" (Southwest Monsoon), causing occasional moderate to heavy rains over Visayas, while scattered light to moderate (at times heavy) rains over Palawan, Zamboanga Peninsula, Northern Mindanao and Caraga. The total rainfall accumulation forecast for the next 5 days (NOAA-HWRF, 14 Sep, 00:00 UTC) is shown in Figure 7.

  Potentially most affected areas: **Cagayan, including Babuyan islands, Isabela, Batanes, Aurora, Apayao, Ilocos Norte, Ilocos Sur, Abra, Kalinga, Benguet, Ifugao, Mountain Province, Nueva Vizcaya.**

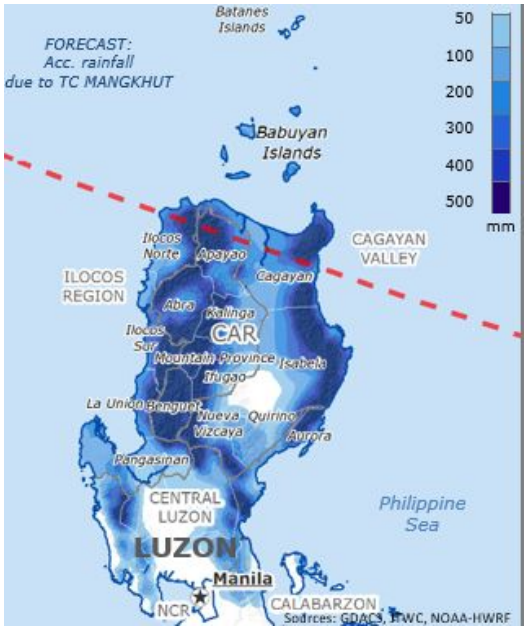

***Figure 7** - Total rainfall forecast for the next 5 days based on NOAA-HWRF (right panel)*

- **CHINA (Taiwan):** according to the last forecast, it is expected to produce heavy rainfall (over 300 mm) over southern and eastern Taiwan, especially on the mountain areas.

  Potentially most affected areas: **Pingtung, Taitung** (southern-eastern Taiwan)

- **CHINA (Guangdong, Guangxi and Hainan Provinces, Hong Kong and Macau)**: There is still some uncertainty on the possible forecast, however based on the last data available, heavy rain could affect these areas on 15-17 September (locally over 300 mm), with the risk of floods and flash floods. These areas have been recently affected by heavy rains, during the passage of BARIJAT.

Storm Surge

For a detailed analysis of the Storm surge please refer to chapter 3.1.

2.3 Humanitarian impact and Preparedness

Up to now no relevant humanitarian impact has been caused by the events, since the typhoon has not yet made landfall.

Philippines

The Philippines National Disaster Risk Reduction and Management Operation Center (NDRRMOC) raised his alert level to RED since 11th September 8:00AM (local time). Preparedness actions are ongoing in all the regions/provinces identified by the TC warning Signals. Pre-emptive evacuation is ongoing for **9,107 people**. 22 domestic flights have been cancelled. 4,000 passengers and hundreds of boats are stranded in the exposed ports.[2]

China

At 6:00 p.m. today, China Meteorological Administration (CMA) upgraded the emergency response to typhoon Mangkhut to the level two. It is required that the relevant meteorological sectors attached to CMA enter the emergency position immediately and put corresponding meteorological services in place. The potential affected areas such as Guangdong, Hainan and Guangxi are expected to sustain or adjust the emergency state according to local realities.[3]

Northern Mariana Islands

The U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) announced on September 10, 2018, and continuing, that federal emergency aid has been made available to the Commonwealth of Northern Mariana Islands to supplement Commonwealth and local response efforts due to the emergency conditions in the area affected by Typhoon Mangkhut.[4]

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[2] https://www.ndrrmc.gov.ph/attachments/article/3437/Sitrep_No_06_re_Preparedness_Measures_and_Effects_for_TY_OMPONG_IN_MANGKHUT_as_of_14SEP2018_0600H.pdf

[3] http://www.cma.gov.cn/en2014/news/News/201809/t20180914_477984.html

[4] https://www.fema.gov/news-release/2018/09/10/president-donald-j-trump-signs-emergency-declaration-northern-mariana

Guam

Several power outages were reported on Guam Island. No significant flooded areas have been detected by the Copernicus EMS trough radar image analysis, although some flooded area were reported by media (see previous report).

The population of the provinces/regions potentially affected of the countries potentially most affected by strong winds (Category 1 or higher strength, see SSHS), according to the last forecast available (GDACS), is shown in the table below. The area already affected of Guam and Northern Mariana Islands are also included.

Affected provinces

Region Province	Country	Population
Cagayan Valley	Philippines	2.3 million people
Southern Tagalog	Philippines	8.2 million people
Cordillera Administrative Region	Philippines	1.1 million people
Ilocos	Philippines	3.5 million people
Guangdong	China	69.6 million people
Hong Kong	China	5.8 million people
Macau	China	380000 people
Guangxi	China	46.8 million people
Quang Ninh	Viet Nam	910000 people
Lang Son	Viet Nam	680000 people
Cao Bang	Viet Nam	640000 people
Guam	Guam	140000 people
Bac Thai	Viet Nam	1.1 million people
Northern Mariana Is.	Northern Mariana Islands	60000 people

***Table 1** - Population of the potentially affected provinces (source:GDACS, 14 Sep, 06:00 UTC)*

***Figure 8** - Situation in the Municipality of Aparri in Cagayan on 14 Sep at 10 a.m..*

(credits:Mark Espiritu Reparejo's video via Facebook / MANILA BULLETIN) [5]

It could be noted that the current forecast of MANGKHUT is very similar for Philippines to **2016, HAIMA** (locally named LAWIN), from 14 Oct to 26 Oct (see image below). Significant changes for the track forecast in China.

TC HAIMA made landfall in Cagayan as a very intense Typhoon (equivalent to a Category 4 in the SSHS, with max. sustained winds of 210-220 km/h, GDACS (more intense forecast for MANGKHUT: Category 5, 260-270 km/h) and killed 19 people and nearly 270,000 houses were destroyed, mostly in Cagayan and Isabela provinces (see ECHO Daily Map of 20 Oct 2016 in Annex).

***Figure 9**- The current forecast track and intensity of TC MANGKHUT is very similar for Philippines to 2016 TC HAIMA.*

[5] https://news.mb.com.ph/2018/09/14/impact-of-typhoon-ompong-in-cagayan-caught-on-camera/

3 JRC contributions

In the period after the end of ARISTOTLE services and the beginning of the new 24h service that is being prepared, JRC supplies ERCC with a similar service during working hours.

The JRC provides updated information on TC MANGKHUT since 7th September for the ECHO Daily Flash reports, available at http://erccportal.jrc.ec.europa.eu/ECHO-Flash.

On 12th Sept JRC issued the first Emergency Report, announcing the risk for a severe event occurring in the Philippines. This is the updated report, compiled on request of ERCC.

In terms of operational systems the following ones have been activated:

- GDACS, Global Disasters Alerts and Coordination System
- *GLOFAS, Global Flood Awareness System (no new information respect to the first report)*
- Copernicus EMS, Emergency Mapping Service

3.1. GDACS System

The JRC is closely following TC **MANGKHUT** because of the strength and the possible impact. The present report was done at the request of the ERCC.

Event alert

- The event continued to remain **RED** alert due to strong winds in the Philippines. At the time of writing also the storm surge in China appears to be extremely high (more than 3 m).

- According to the latest bulletin (12 Sep, 06:00 UTC), the GDACS alert level is now **RED** (for high winds) for this event in Philippines and China with nearly 6 million people in Category 1 or higher (winds > 120 km/h) in Philippines and 42 million in China. The possible impact due to winds, rainfall and storm surge are shown below, while the automatic GDACS report for TC **MANGKHUT** can be found at this address:
  http://www.gdacs.org/report.aspx?name=MANGKHUT-18 .

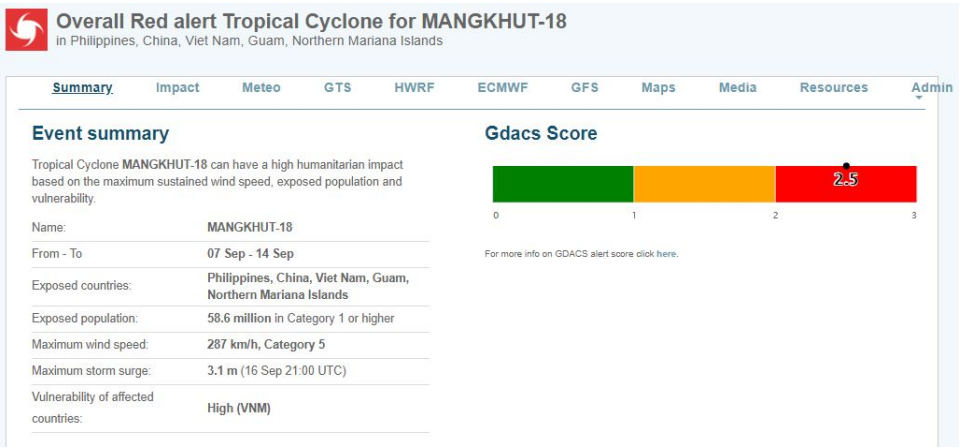

***Figure 10** - Automatic GDACS impact estimation for MANGKHUT (as of 14 Sep 2018, 06:00 UTC).*

Bulletin Timeline

Advisory	Alert color	Date (UTC)	Category	Wind speed	Population in Tropical Storm	Population in Cat.1 or higher	Location (lat, lon)
30		14 Sep 2018 06:00	Category 5	**269 km/h** (166 mph)	57.5 million people	3.7 million people	16.8, 125.6
30		14 Sep 2018 18:00	Category 5	**269 km/h** (166 mph)	64 million people	6.3 million people	17.8, 122.6
30		15 Sep 2018 06:00	Category 3	**194 km/h** (120 mph)	152.6 million people	1.7 million people	18.8, 119.7
30		15 Sep 2018 18:00	Category 3	**204 km/h** (126 mph)	156.8 million people	6 million people	19.9, 116.8
30		16 Sep 2018 06:00	Category 4	**213 km/h** (132 mph)	197.4 million people	42.7 million people	21.1, 113.6
30		17 Sep 2018 06:00	Category 1	**139 km/h** (86 mph)	80.5 million people	12.3 million people	22.5, 107.3
30		18 Sep 2018 06:00	Tropical storm	**65 km/h** (40 mph)	11.7 million people	no people	23.6, 101.3
30		19 Sep 2018 06:00	Tropical depression	**37 km/h** (23 mph)	no people	no people	26.6, 97

Figure 11 *- GDACS Alert for Tropical Cyclone MANGKHUT - Event Timeline, population affected, max. sustained winds (the Category is based on the Saffir-Simpson Hurricane Scale, see Annex), as of 14 Sep 2018, 06:00 UTC.*

Storm Surge Estimations

According to the JRC HyFlux2 storm surge calculation (using as input the data of the bulletin of 14 Sep 2018 06:00 UTC) and using the standard GDACS model, the areas potentially most affected are all along the China areas close to the landfall , with a maximum value

- **3.1 m** in Ma-hsien on 16 Sep. at 21:00

The impact of storm surge estimated by GDACS for Philippines indicates a maximum value of

- **0.8 m** in Catugaran on 14 Sep. at 22:00

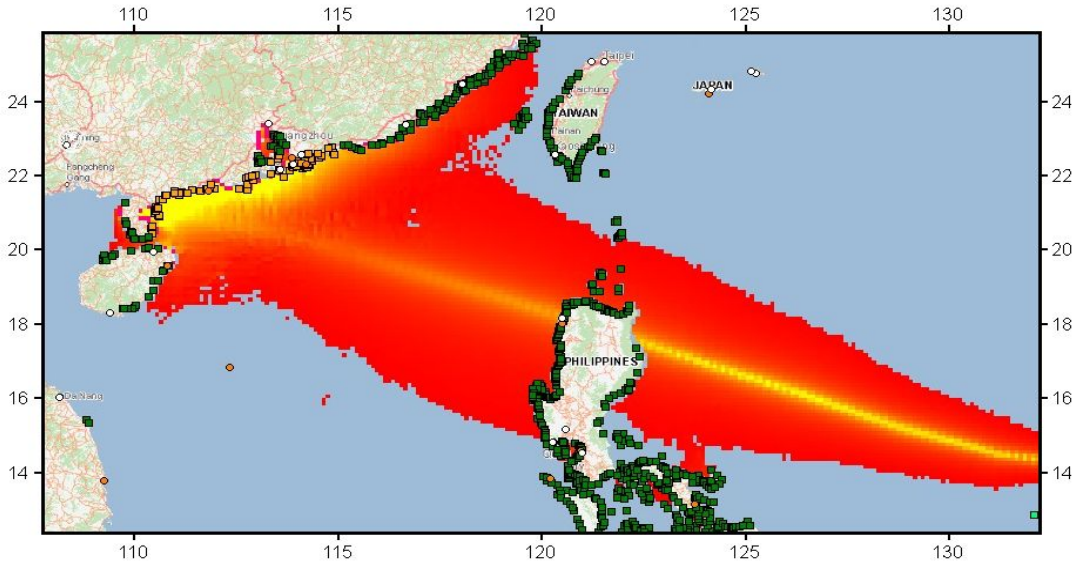

Figure 12 *- Storm surge over the track of MANGKHUT-18*

The list of locations for storm surge is shown below (Fig. 18).

Date	Name	Country	Alert	Storm surge height (m)
16 Sep 2018 21:00:00	Ma-hsieh	China		3.1m
16 Sep 2018 21:00:00	Badongxu	China		3.1m
16 Sep 2018 21:00:00	Baisha	China		2.9m
16 Sep 2018 21:00:00	Huangpo	China		2.9m
16 Sep 2018 21:00:00	Chiu-wu-ch'uan	China		2.9m
16 Sep 2018 21:00:00	Meilu	China		2.9m
16 Sep 2018 21:00:00	Hai-lu	China		2.9m
16 Sep 2018 21:00:00	Xingyou	China		2.8m
16 Sep 2018 20:00:00	Shaoyao	China		2.5m
16 Sep 2018 20:00:00	Magang	China		2.3m
16 Sep 2018 20:00:00	Ch'i-ching	China		2.3m
16 Sep 2018 20:00:00	Dianbai	China		2.3m
16 Sep 2018 18:00:00	Chengcun	China		2.2m
16 Sep 2018 19:00:00	Diancheng	China		2.2m
16 Sep 2018 18:00:00	Shangyang	China		2.1m

...

14 Sep 2018 22:00:00	Catuguran	Philippines		0.8m
14 Sep 2018 22:00:00	Linao	Philippines		0.8m
14 Sep 2018 22:00:00	Bisagu	Philippines		0.8m
14 Sep 2018 22:00:00	Aparri	Philippines		0.8m
14 Sep 2018 22:00:00	Alilinu	Philippines		0.8m

***Figure 13** - Reference locations for storm surge calculations for China using HyFlux2*

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The detailed impact for Storm Surge in the landfall area is shown in the Figure 19; the JRC/GDACS HyFlux2 calculation was used. This calculation was performed using the meteorological parameters of 14 Sep 6:00.

These values could still change due to the track/intensity uncertainty and do not include the possible effects on China because storm surge is calculated only for 3 days forecast.

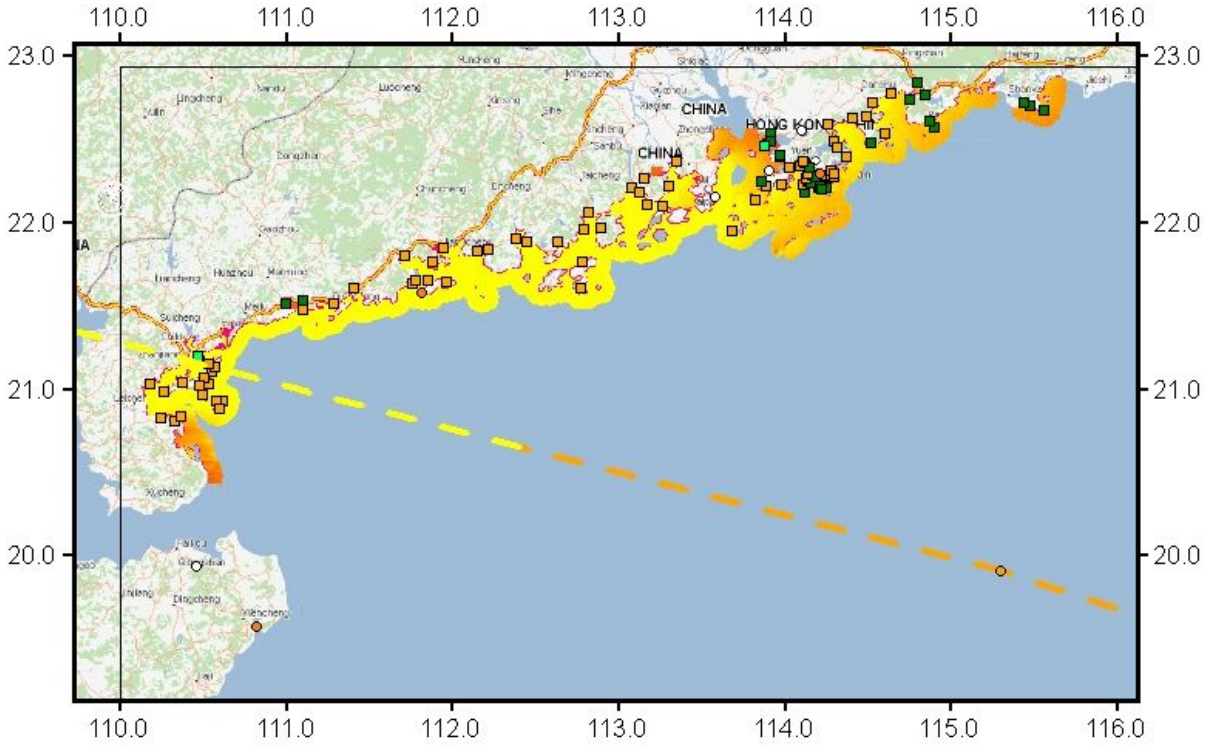


Figure 14 *- Storm surge impact in the China coast close to the landfall area and other northern areas affected*

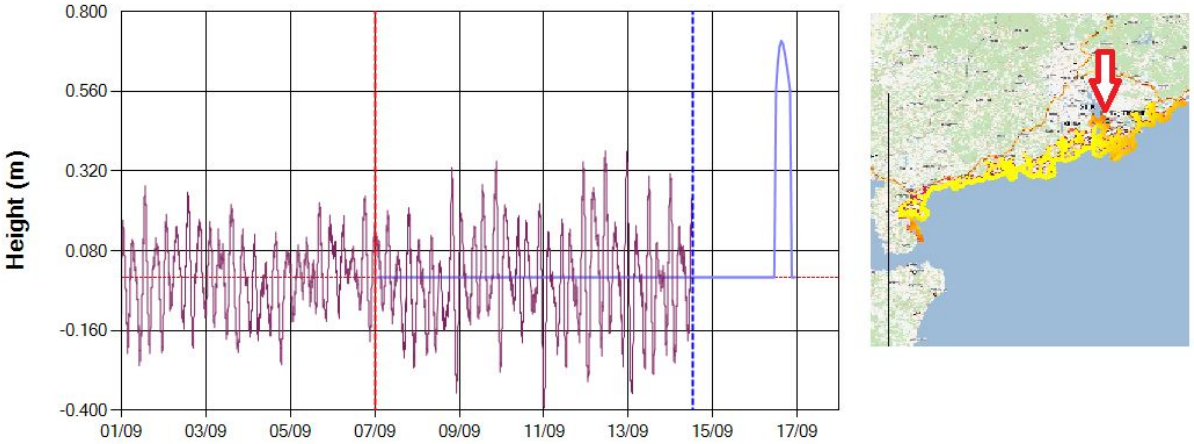


Figure 15*- Storm surge estimated in Shenzen, Hong Kong (China)*

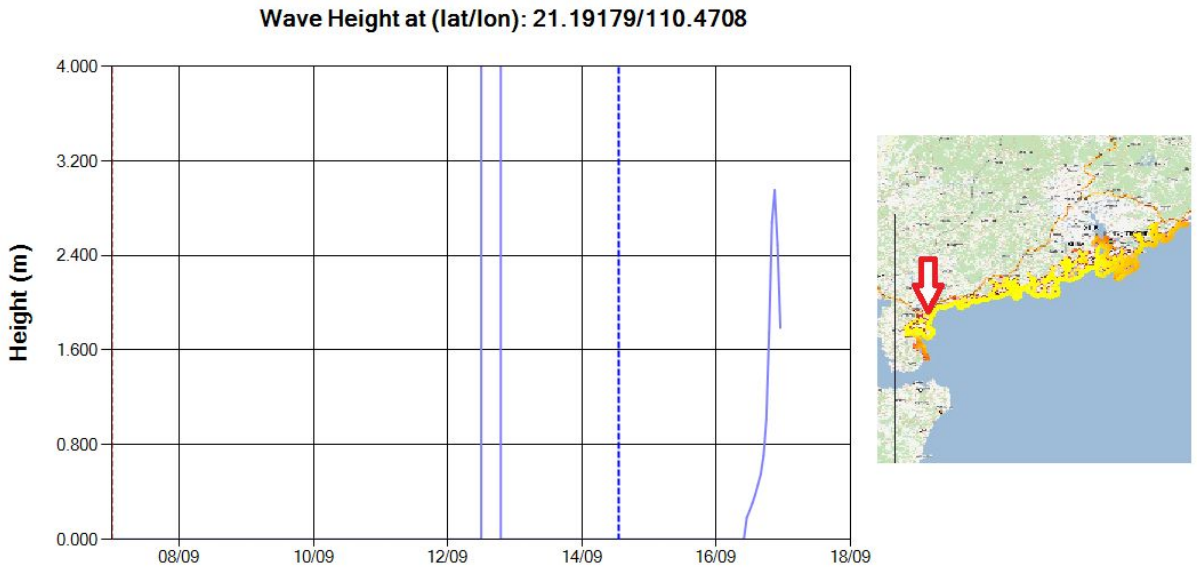


***Figure 16**- Storm surge estimated in Ma-hsien, (China), where the 3m maximum is estimated*

Note: *JRC storm surge calculations don't include wave, tide and river effects. It is important to note that in the area of a delta river, the storm surge may be higher. The torrential rains that may affect the mountains areas during the passage of a Tropical Cyclone may increase the river flow and its outflow could be blocked by the incoming storm surge. This could create floods in the surrounding areas of the cities close to a delta river.*

3.2. GLOFAS System

No differences respect to the first report.

3.3 Copernicus EMS activation

There are two activations for this TC: EMSR310 (see last report) and EMSR312.

There are no updates for EMSR310 since the last report.

On 14 September 08:19 UTC the ERCC activated the service (EMSR312) requesting pre- and post disaster maps for the areas shown in the figure below. This request was preceded by a pre-tasking request from ERCC on 13 September 16:09 UTC for areas over northern Luzon (for radar imagery).
Ten of the EMSR312 areas of interest are located on Luzon Island and one on Calayan Island, north of Luzon. Reference mapping is ongoing for all areas of interest. The production for the post-disaster maps will start on 15 September for six of the eleven areas of interest, and for these the analysis will focus on identifying flooded areas from the (pre-tasked) radar imagery (delineation maps). First results are expected in the early afternoon. Production for the remaining five areas will start not before 17 September as these will provide damage assessments requiring optical images (grading maps).

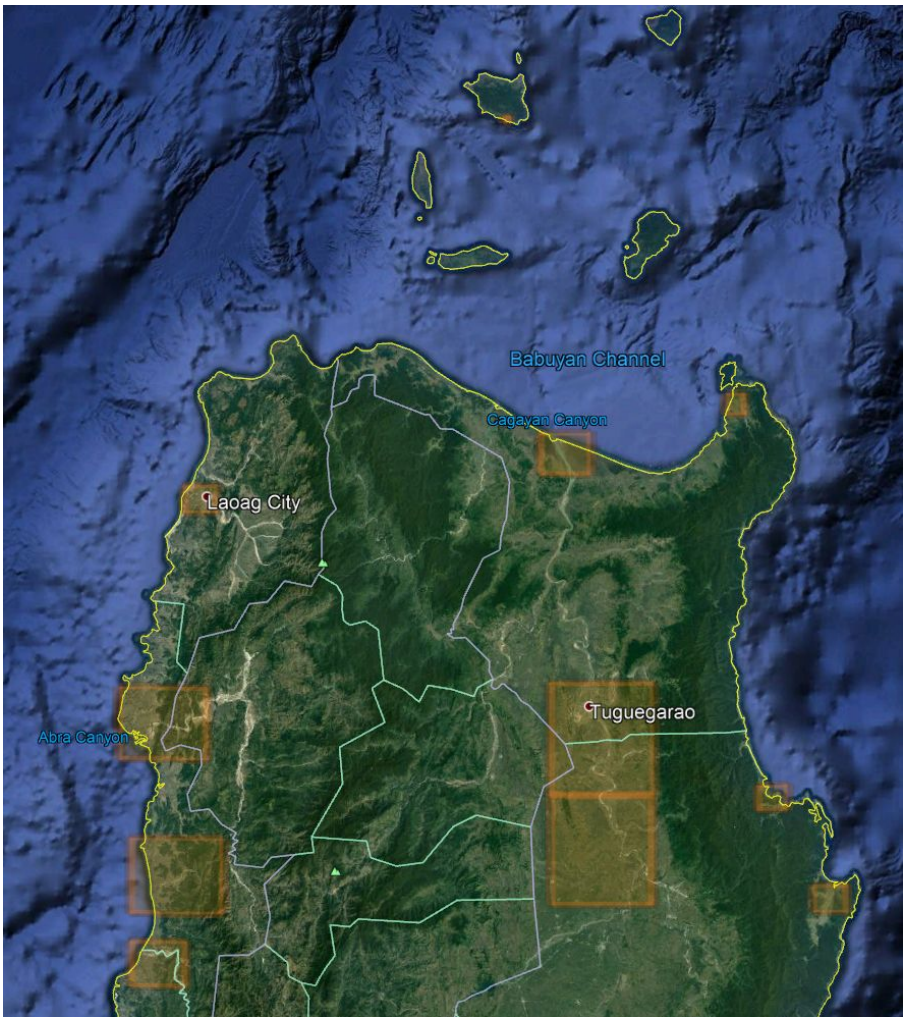


Figure 17 - *Areas of interest of EMSR312*

More and updated information is available at
http://emergency.copernicus.eu/mapping/list-of-components/EMSR312

4 Other information

4.1 Virtual OSOCC Activation

Virtual OSOCC opened a Discussion in the system, in view of a possible severity of the situation. A number of Relief teams have already provided their availability from Switzerland, Belgium, US and France. All teams are monitoring the situation.

Monitoring	Assessment	Swiss Humanitarian Aid	Switzerland	WASH Emergency shelter Medical (EMT maternal and child health)
Monitoring	Assessment	B-FAST	BELGIUM	Medical team (fix & mobile), Water Purification, USAR, OISS
Monitoring	Emergency Medical Team (EMT)	Massachusetts General Hospital Global Disaster Response	US	
Monitoring	USAR	FRA03	FRANCE	
Monitoring	USAR	Secouristes Sans Frontières	Franc	

4.2 International Charter for Space and Major Disasters

Not activated yet.

5 Expected Updates

The report will be updated if relevant changes will be identified.

6 References and contact points within JRC

Contact points within JRC: Disaster Risk Management Unit
- Alessandro Annunziato, alessandro.annunziato@ec.europa.eu (GDACS)
- Pamela Probst, pamela.probst@ec.europa.eu (GDACS Meteorologist)
- Chiara Proietti, chiara.proietti@ec.europa.eu (Humanitarian response)
- Thomas Petroliagkis, thomas.petroliagkis@ec.europa.eu (GDACS Meteorologist)
- Annett Wania, annett.wania@ec.europa.eu (Copernicus EMS activation)

- Ian Clark, ian.clark@ec.europa.eu
- Tom De Groeve, tom.de-groeve@ec.europa.eu

For updated information on the disaster, please consult the following web sites:

- GDACS: http://www.gdacs.org
- ERCC portal: http://erccportal.jrc.ec.europa.eu/
- Copernicus EMS: http://emergency.copernicus.eu/mapping/list-of-components/EMSR312
- National Meteorological service:
    - Guam: http://www.prh.noaa.gov/guam/
    - Northern Mariana Islands: https://www.weather.gov/prh/aboutGUM
    - Philippines: http://bagong.pagasa.dost.gov.ph/
    - Taiwan: https://www.jma.go.jp/jma/indexe.html
    - China: http://www.cma.gov.cn
    - Hong Kong: https://www.hko.gov.hk/contente.htm
    - Vietnam: http://www.nchmf.gov.vn
    - Japan: https://www.jma.go.jp/jma/indexe.html
- WMO Severe weather Information Centre: http://severe.worldweather.org/
- Regional Specialized Meteorological Centres (RSMCs) and Tropical Cyclone Warning Centres (TCWCs):
    - RSMC Tokyo-Typhoon Center / Japan Meteorological Agency: http://www.jma.go.jp/en/typh/
- NOAA-HWRF (Hurricane Weather Research and Forecasting system): http://www.emc.ncep.noaa.gov/gc_wmb/vxt/HWRF/index.php

- JRC Emergency Report

    - TC MANGKHUT-18 - JRC Emergency Report#1 http://portal.gdacs.org/GDACSDocuments/TC_MANGKHUT_.pdf
    - 2018 - NW Pacific Typhoons: Past events, current situation and seasonal forecast http://portal.gdacs.org/GDACSDocuments/015-NW%20Pacific%20Typhoons_update.pdf

Annex 1 - Detailed Map on the Tropical Cyclone

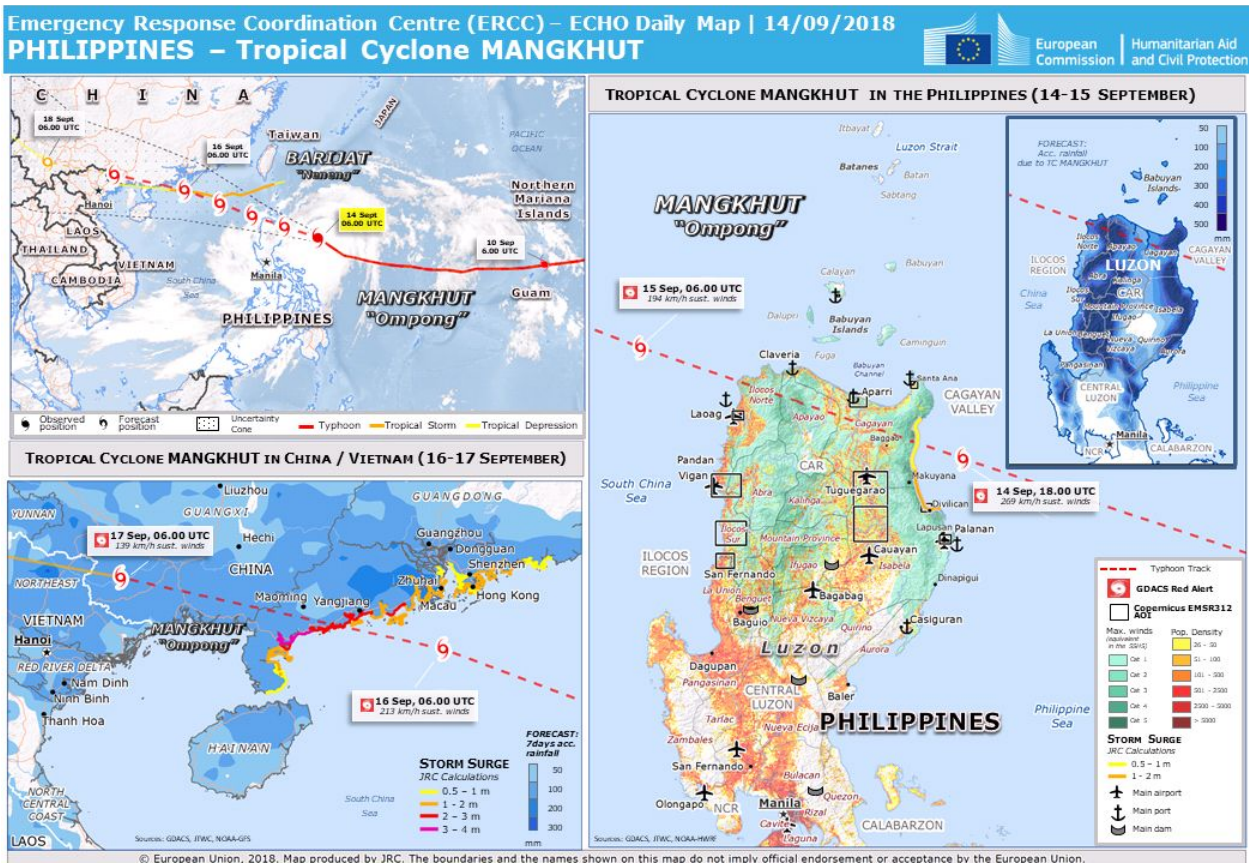


Figure A1.1. *- TC MANGKHUT in Guam and the Northern Mariana Islands (ECHO Daily Map of 14 Sep 2018)*

Annex 2 - GDACS Alerts

JRC is responsible for the operation of GDACS (Global Disaster Alerting Coordination System), that plays a major role in alerting the international community to humanitarian emergencies during natural disasters. The alerts of GDACS (Green, Orange, Red) are elaborated based on the severity of the event, the population involved and the vulnerability of the countries. GDACS also sends e-mail and SMS alerts to subscribed recipients. A detailed description of GDACS can be found in the GDACS Guidelines available at:
http://www.gdacs.org/Documents/GDACS%20Guidelines%202014_-_FINAL.PDF

GDACS ALERTS		
	**GREEN ALERT**	Moderate event, International Assistance not likely
	**ORANGE ALERT**	Potential local disasters, International Assistance might be required
	**RED ALERT**	Potentially severe disasters, International Assistance is expected to be required

Tropical Cyclones (TCs) are among the most dangerous natural disasters, causing every year extensive damage and deaths in several countries around the world. They have three destructive effects (strong wind, heavy rain and storm surge). GDACS includes the analysis of all TCs occurring worldwide.

TC information:
JRC set up an automatic routine that includes the TC bulletins produced by the National Oceanic and Atmospheric Administration (NOAA) and the Joint Typhoon Warning Center (JTWC) into a single database, covering all TC basins. This information is used in GDACS for the wind impact, and as input for the JRC storm surge system. JRC has recently developed new tools for the analysis of the TC impacts and included new sources (NOAA Hurricane Weather Research and Forecast - HWRF and Global Forecasting System - GFS, global high resolution model of the European Centre for Medium Weather Forecast -ECMWF).
→ NW Pacific: JTWC data

Wind
The GDACS alert levels for the TCs are based on the risk formula that includes:

- TC wind speed[6] (hazard)
- Population affected
- Vulnerability of the affected country

The equivalent Category based on the Saffir-Simpson Hurricane Wind Scale (SSHS), 1-min sustained winds, is also indicated in GDACS (see next page).
The overall alert for a Tropical Cyclone comes from **wind effects.**

[6] GDACS, JTWC, NOAA wind information based on 1-min sustained winds; other centers: 10-min average (see: https://www.wmo.int/pages/prog/www/tcp/documents/WMO_TD_1555_en.pdf)

Recently, in order to avoid too much false alerts or flip-flop effects due to the too early forecast and change of track direction or intensity, the alert level for forecast data with more than 3 days lead time is limited to Orange Alert, even if Red Alert is estimated.

Storm Surge

Storm surge is an abnormal rise of water above the predicted astronomical tides, generated by strong winds and by a drop in the atmospheric pressure. It was implemented in the HyFlux2 code, routinely used in GDACS to model inundation due to tsunami run-up.

The GDACS alert levels are based on the maximum storm surge height:

- Green: < 1.0 m;
- Orange: 1.0m - 3.0 m;
- Red: > 3.0 m.

It should be noted that the estimation of the sea level is strongly dependent on the initial data (wind velocity and direction). The sea level change according to each bulletin that was available.

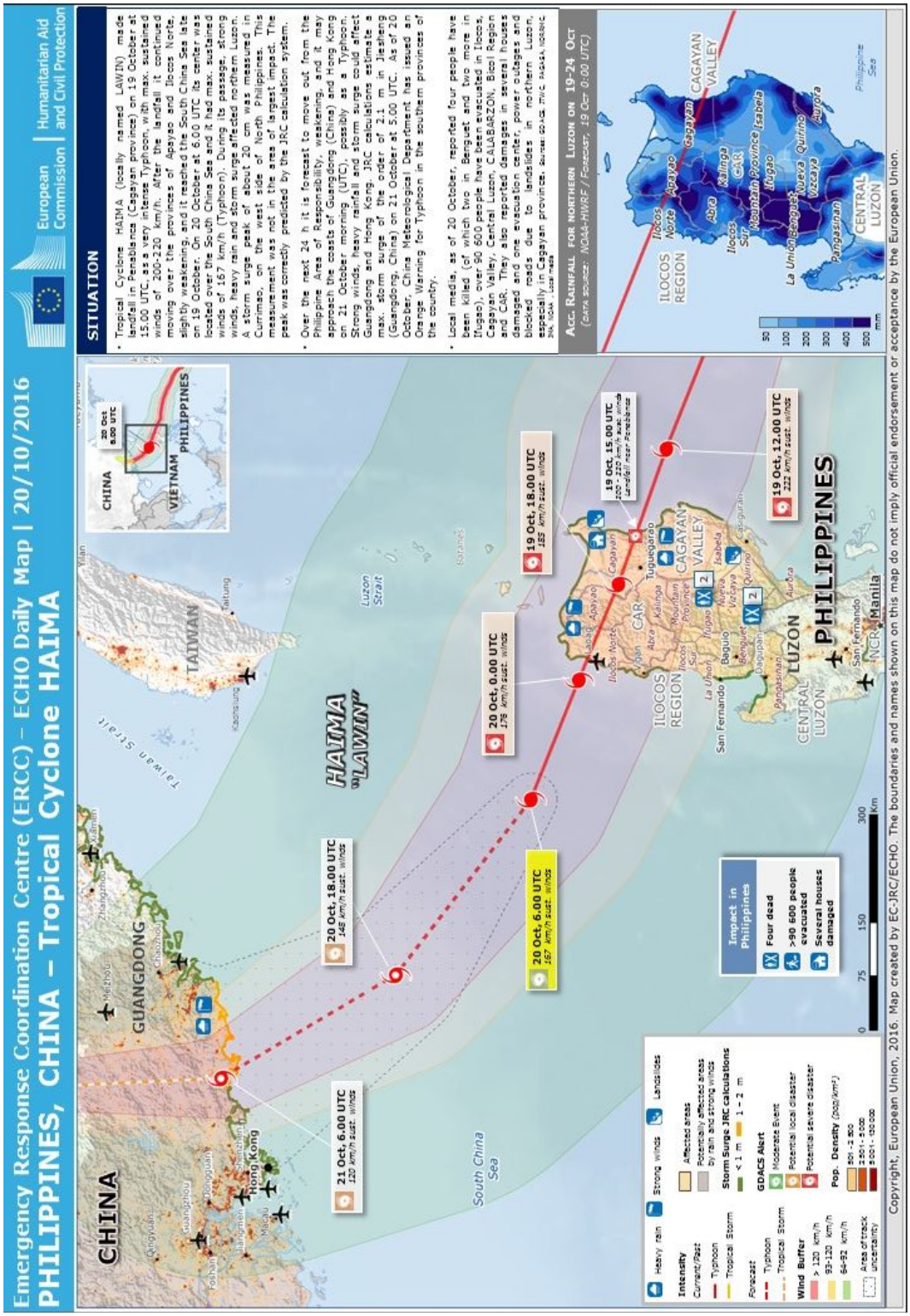
TC Classification used in GDACS

The equivalent Category based on the Saffir-Simpson Hurricane Wind Scale (SSHS) is also indicated in GDACS. The SSHS is the official scale used by NOAA-NHC for the North Atlantic TC basin and is a scale from 1 to 5, based on the hurricane's 1-min sustained wind speed and it estimates the potential property damage (see Table A2.1). Note: for the NW Pacific basin, the JMA uses the following classes: Tropical Depression, Tropical Storm, Severe Tropical Storm, Typhoon, based on 10-min average winds.

Saffir-Simpson Hurricane Wind Scale (SSHS), source NOAA-NHC		
Hurricane CATEGORY	**1-min sustained winds (km/h)**	**Types of Damage Due to Hurricane Winds**
Cat. 1	119 - 153	Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
Cat. 2	154 - 177	Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks
Cat. 3 *Major Hurricane*	178 - 208	Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes
Cat. 4 *Major Hurricane*	209 - 251	Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
Cat. 5 *Major Hurricane*	≥ 252	A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months

Table A2.1 -*TC Classification (Saffir-Simpson Hurricane Wind Scale), used in GDACS. (see NOAA-NHC: http://www.nhc.noaa.gov/aboutsshws.php)*

Annex 3 - 2016 TC HAIMA - ECHO Daily Map of 20 Oct 2016



Annex 4 - Weather forecasts for Specific Locations (Ensemble Meteograms)

Ensemble Meteograms contain information coming from both the deterministic singe model high-resolution (HRES) operational forecast and the Ensemble Prediction System (EPS) comprising 50 ensemble (ENS) members plus one (control forecast).

The horizontal resolution of the HRES is ~8 km whereas the resolution of ensemble members (and the control) is ~16 km. HRES is denoted by blue, whereas the control forecast (of the ensemble) is denoted by red colour.

The values of the ensemble are contained in a box plot type of diagram that graphically depicts groups of numerical data through their quartiles while maximum and minimum values are highlighted by whiskers.

The first panel of meteogram contains the total (low - medium & high) cloudiness in octas. The second panel refers to the total (convective and large-scale) precipitation utilising values estimated over 6-hour intervals. The third panel refers to the instantaneous (averaged over 10 minutes) wind speed values. The fourth panel refers to the temperature at 2 meters height.

All Meteograms are based on the latest run of ECMWF HRES and EPS initiated from 14 September 00 UTC (Analysis).

Points of References:

- Babuyan Islands - Philippines

- Tuguegarao - Philippines

- Baguio - Philippines

- Baggao - Philippines

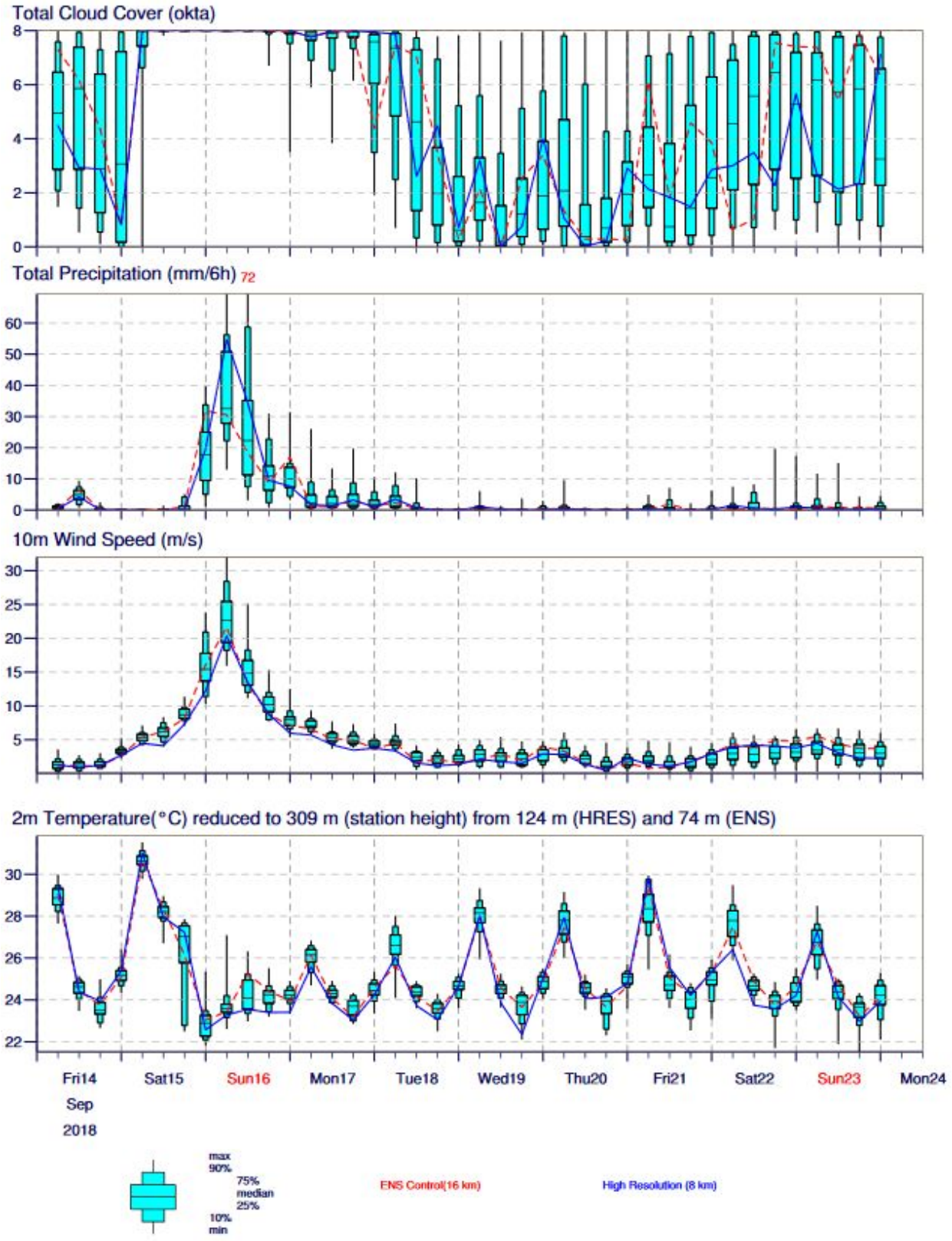
- Hong Kong - China

- Yangjiang - China

ENS Meteogram

Babuyan Islands 22.42°N 114.12°E (ENS land point) 309 m

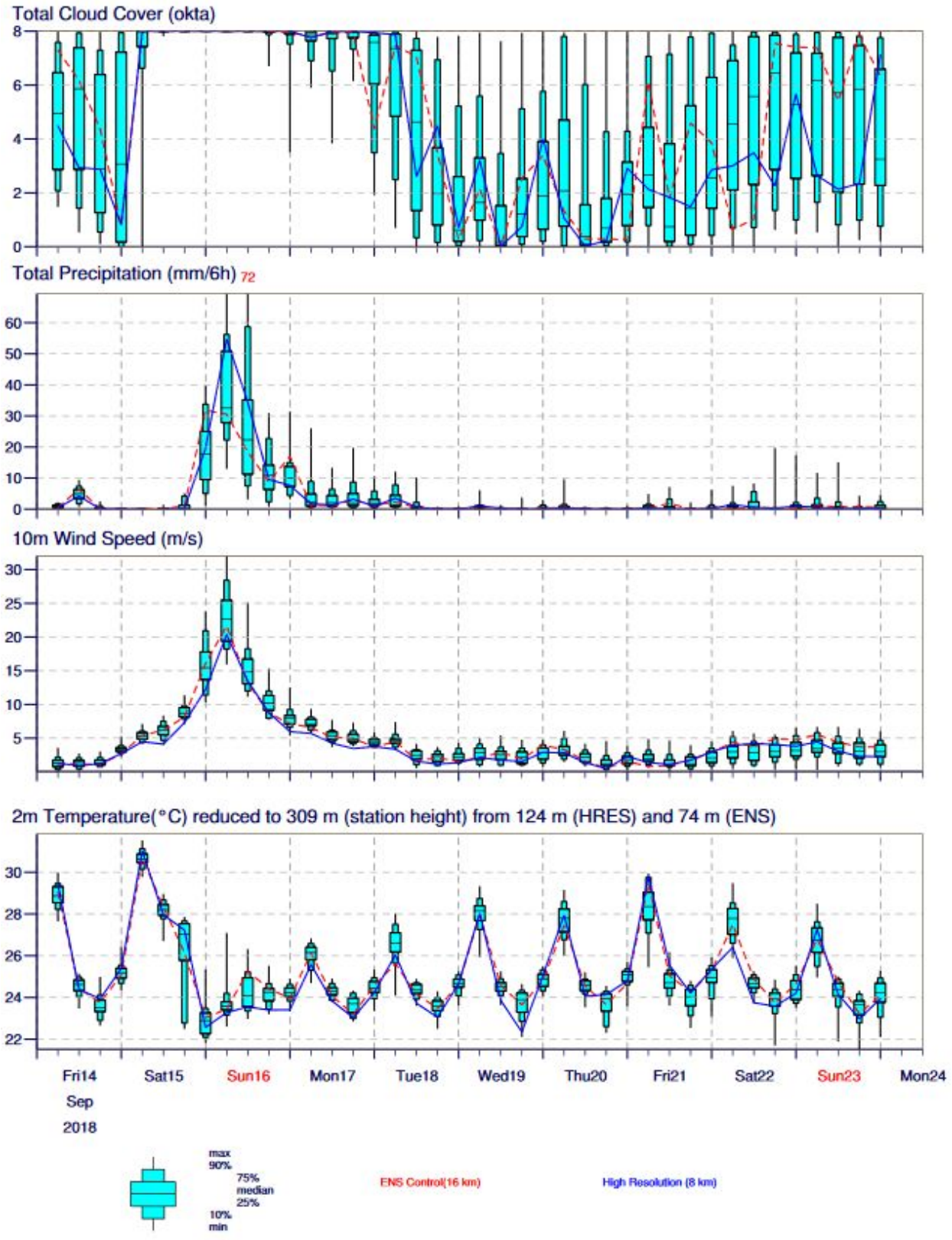
High Resolution Forecast and ENS Distribution Friday 14 September 2018 00 UTC



ENS Meteogram

Tuguegarao 22.42°N 114.12°E (ENS land point) 309 m

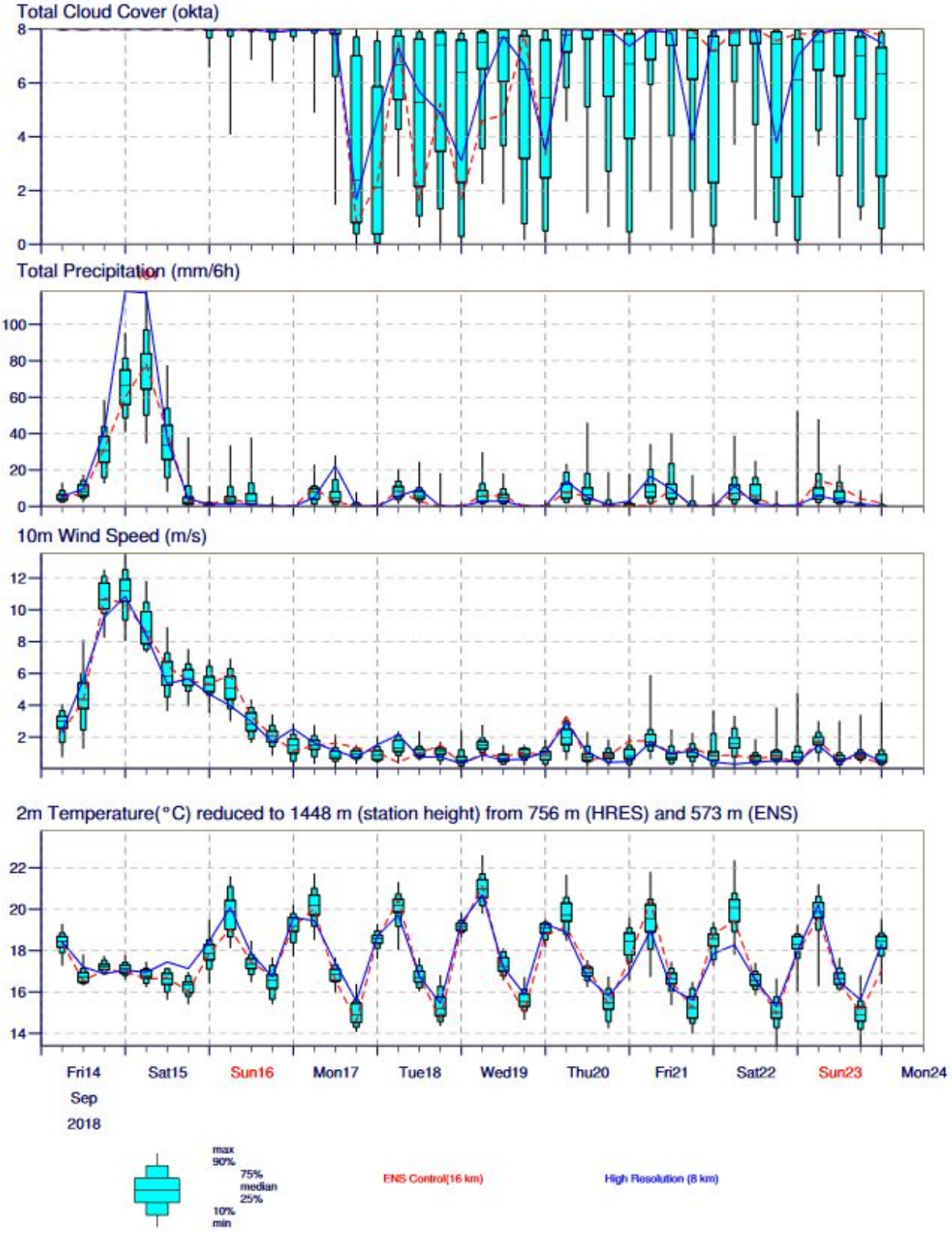
High Resolution Forecast and ENS Distribution Friday 14 September 2018 00 UTC



ENS Meteogram

Baguio, Philippines 16.38°N 120.51°E (ENS land point) 1448 m

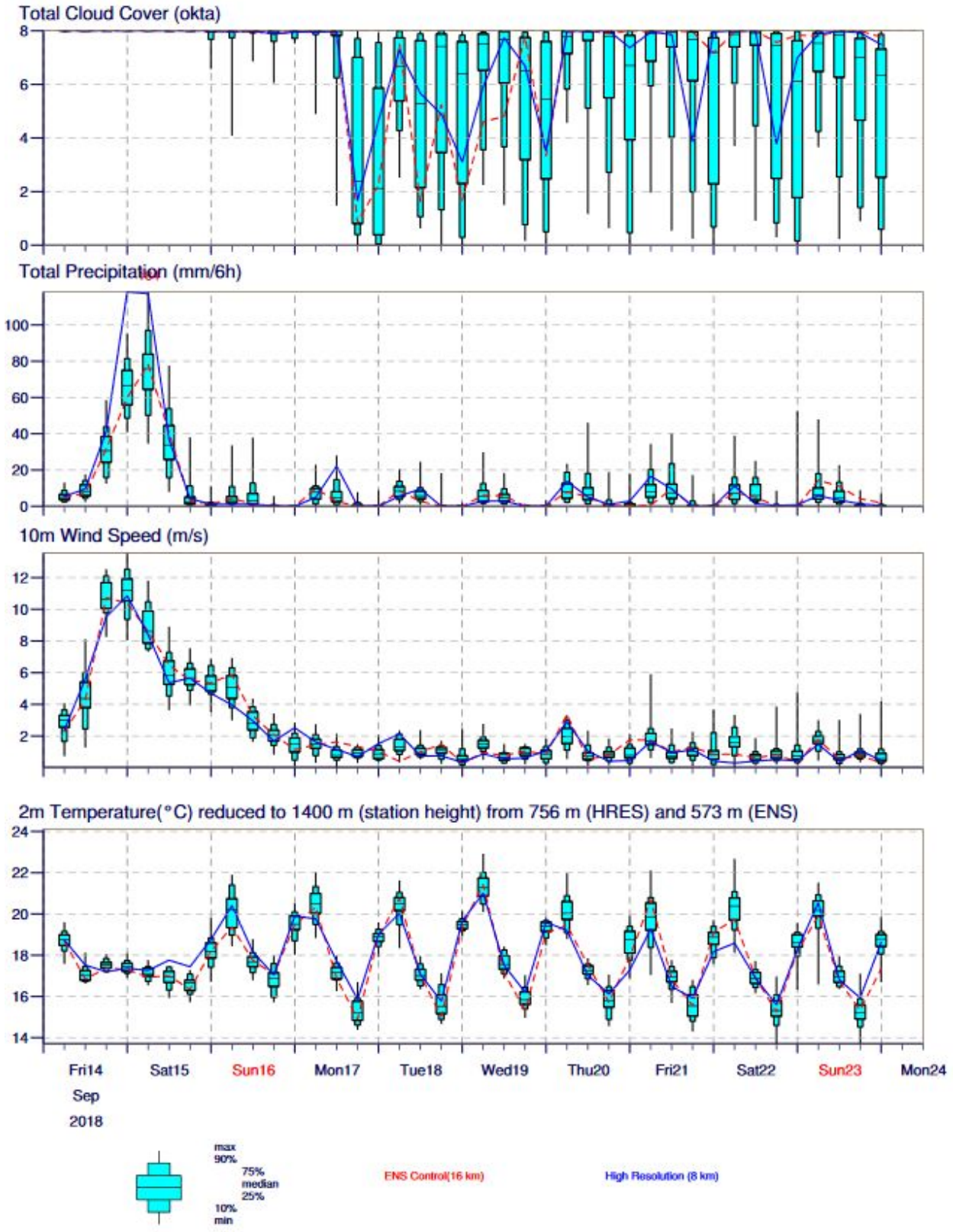
High Resolution Forecast and ENS Distribution Friday 14 September 2018 00 UTC



ENS Meteogram

Baggao 16.38°N 120.51°E (ENS land point) 1400 m

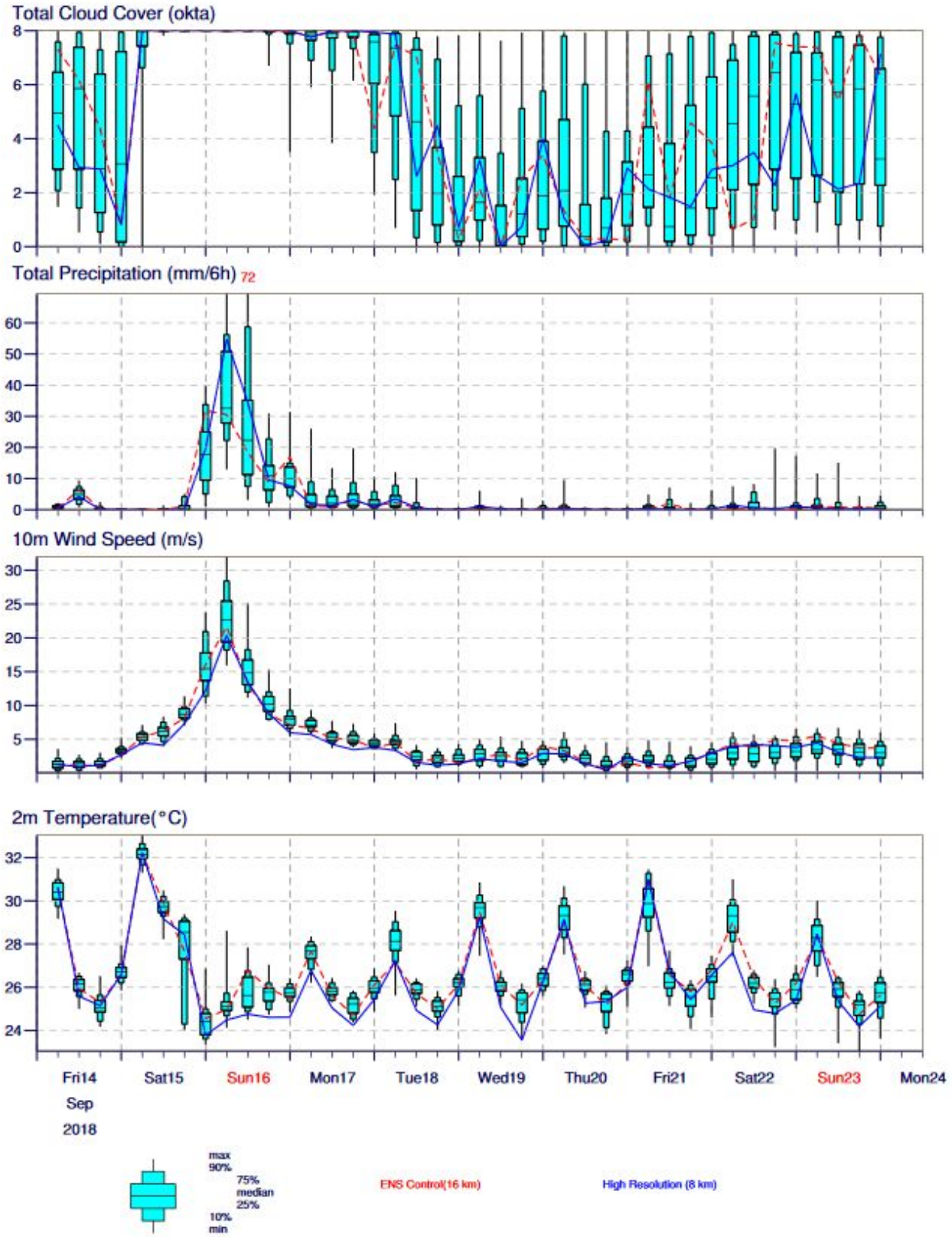
High Resolution Forecast and ENS Distribution Friday 14 September 2018 00 UTC



ENS Meteogram

Hong Kong, Hong Kong 22.42°N 114.12°E (ENS land point)

High Resolution Forecast and ENS Distribution Friday 14 September 2018 00 UTC



ENS Meteogram

Yangjiang 22.42°N 114.12°E (ENS land point) 309 m

High Resolution Forecast and ENS Distribution Friday 14 September 2018 00 UTC