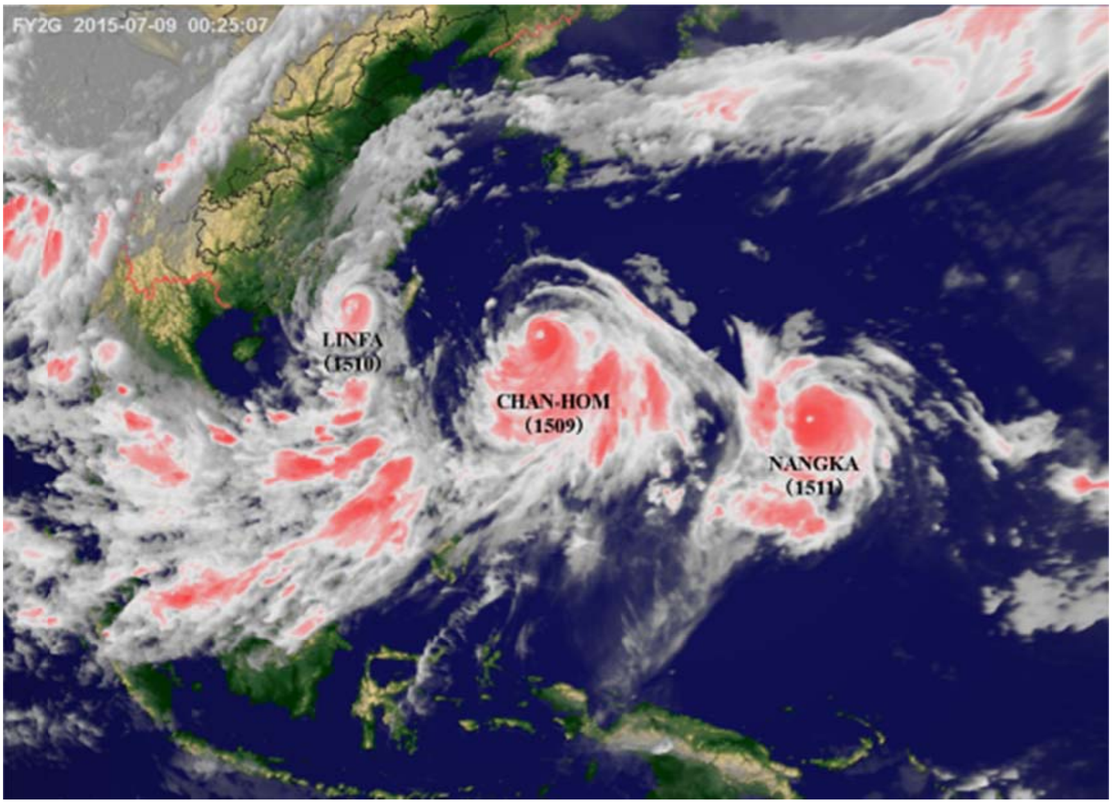
Member Report
(2015)

ESCAP/WMO Typhoon Committee

10th Integrated Workshop



China

Kuala Lumpur, Malaysia

26-29 October 2015

CONTENTS

I. Review of Tropical Cyclones Which Have Affected/Impacted Members Since the Previous Session

1.1 Meteorological and Hydrological Assessment

In the first half of 2015, the Central and Eastern Equatorial Pacific witnessed an abnormal warming trend in a central El Niño pattern. Under the influence of decadal warming trends, the Western Tropical Pacific has sustained a basically normal but slightly warmer trend. During January-March, the Walker circulation was enhanced over the equatorial region, compared with the previous months, which led to the abnormally high typhoon incidences in the first half of the year. In mid-summer, the Eastern Equatorial Pacific became warmed up rapidly, with the centre of warm water heading eastwards, in an eastern El Niño pattern. Meanwhile, the Western Tropical Pacific became abnormally colder, featured with a weakened Walker circulation that dampened convective activities over the Northwest Pacific. Additionally, MJO activities became surprisingly weakened, basically at phase 1 or phase 2, especially since late July, which attributed to the reduced typhoon genesis since mid-summer, especially in August.

During the period of 1 January to 15 October 2015, the Northwest Pacific and the South China Sea registered 25 tropical cyclones, including tropical storms, severe tropical storms, typhoons, severe typhoons and super typhoons (Figure 1.1). 6 of them made landfall over China's coastal areas (Figure 1.2), including KUJIRA (1508), CHAN-HOM (1509), LINFA (1510), SOUDELOR (1513), DUJUAN (1521) and MUJIGAE (1522).

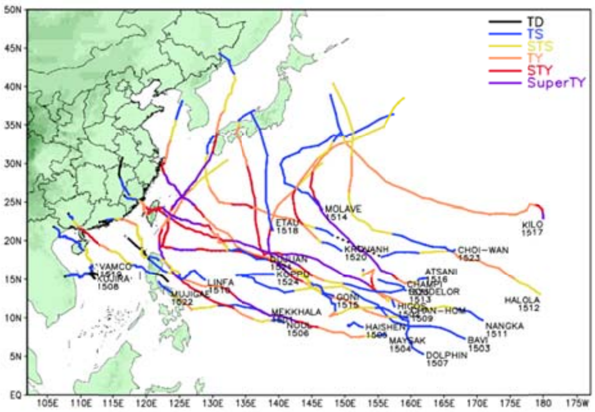


Fig. 1.1 Tracks of TCs over the western North Pacific and South China Sea from 1 Jan. to 15 Oct. 2015

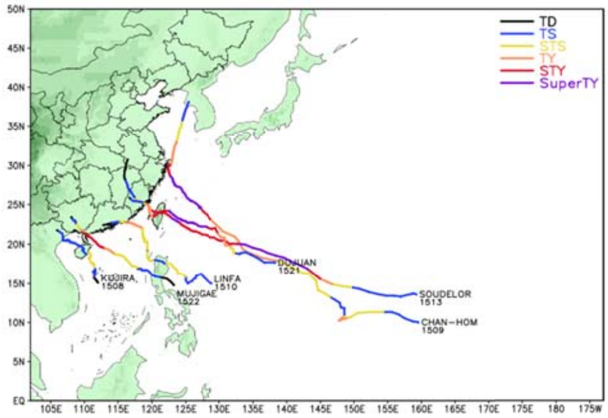


Fig. 1.2 Tracks of TCs that made Landfall over China from 1 Jan. to 15 Oct. 2015

1.1.1 Characteristics of the tropical cyclones in 2015

1) Increased number but reduced landfall

As of 15 October 2015, the Northwest Pacific and the South China Sea have registered 25 tropical cyclone genesis (Fig. 1.1 and Fig. 1.3), with 3.4 more genesis, compared with the historical average of 21.6 in the same period of 1949-2014 (the same below). A monthly comparison shows increased tropical cyclone activities during January to June, and reduced activities for August. Of the registered

25 tropical cyclones, six made landfall over China's coastal areas (Fig. 1.2 and Fig. 1.4), or 0.6 fewer, compared with the historical average of 6.6 incidences in the same period.

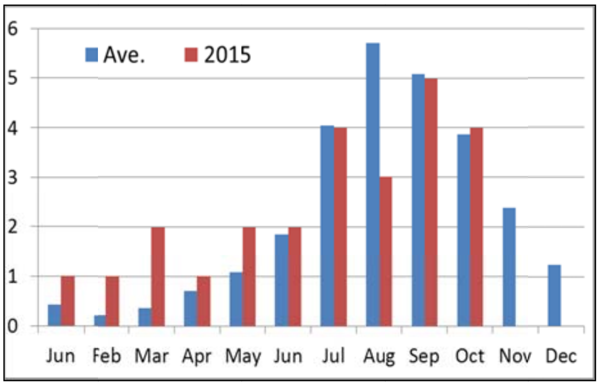


Fig. 1.3 Normal monthly TCs genesis compared with monthly TCs generated in 2015.

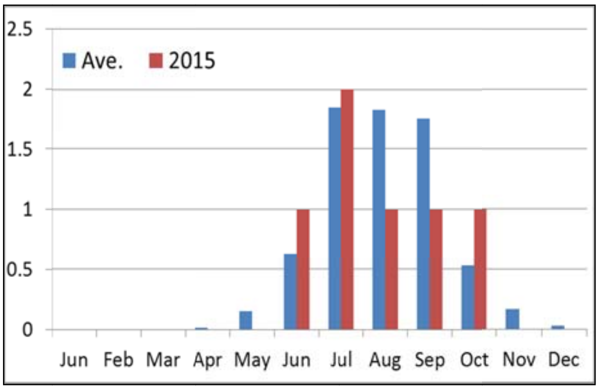


Fig. 1.4 Normal monthly landfall TCs compared with monthly TCs landed on China's coasts in 2015.

2) Noticeably enhanced strength

As of 15 October, the registered 25 tropical cyclones enjoyed an averaged peak strength of 44.5 m/s, significantly enhanced than the historical average of 39.1 m/s. Among them, 10 tropical cyclones became super typhoons, impressively higher than the historical average of 3.7 for the same period.

3) More easterly origins

Generally, tropical cyclones generate over the three areas of the Northwest Pacific and the South China Sea: 1) the northern part of South China Sea; 2) the sea east of the Philippines; and 3) the sea nearing the Mariana Islands. In this year, both the northern part of South China Sea and the sea east of the Philippines reported significantly reduced tropical cyclone incidences. Most tropical cyclones were generated on the water in the vicinity of the Mariana Islands or further east (Figure 1.5). In addition, this year had 13 registered tropical cyclones to the east of 150ºE, or 52.0% of the total tropical cyclones occurred in 2015. However, the multi-year average of the same period shows only 4.0 tropical cyclones to the east of 150ºE, or 18.4% of the total.

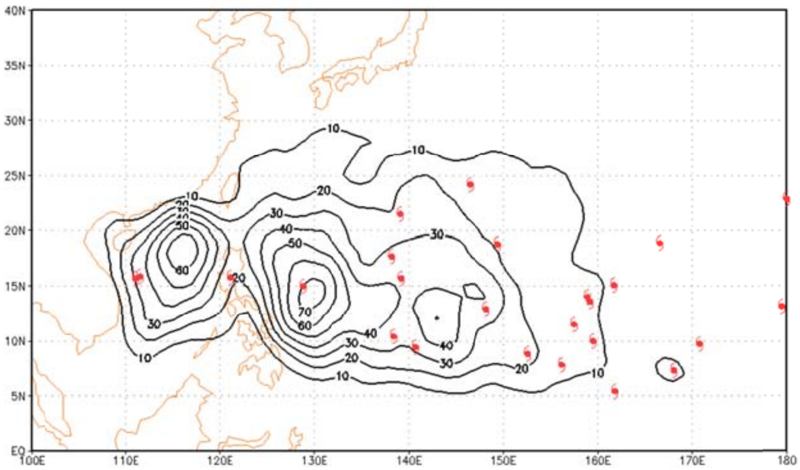


Fig. 1.5 Distribution of TC-generating Source Density in the western North Pacific and South China Sea (Unit: digit/πR^2, R=250km) Compared with TC genesis locations during 1 Jan. to 15 Oct. 2015.

4) Longer life cycle

The registered 25 tropical cyclones in this year had an averaged life about 7 days, or 2 days more compared with the multi-year average of around 5 days.

5) Higher landing intensity

The 6 tropical cyclones that made landfall over China this year had an averaged intensity up to 41 m/s, significantly enhanced compared with the multi-year average of 32.8 m/s.

1.1.2 Operational Forecast

During the period of 2011-2015, China Meteorological Administration (CMA) has sustained a steadily descending trend for typhoon track forecast errors. As of 15 October 2015, the 24h-120h typhoon track forecast errors were 66 km, 116 km, 174 km, 238 km and 329 km, respectively, lower than the multi-year averages.

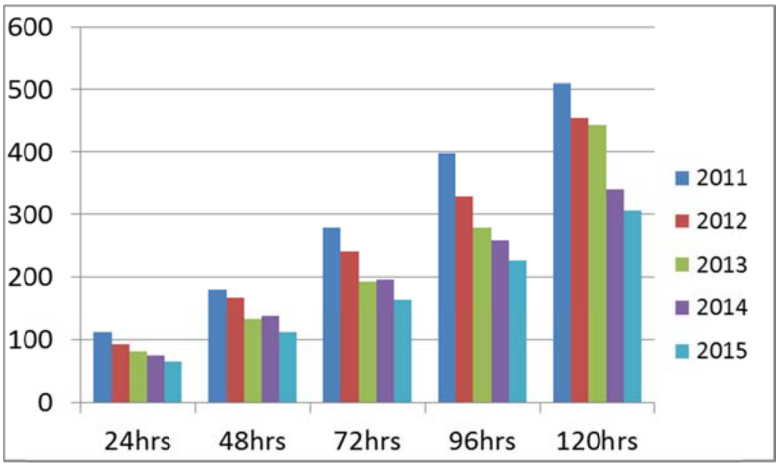


Fig. 1.6 CMA official TC track forecast errors between 2011 and 2015

1.1.3 Characteristics of major typhoon-induced rainfall that affected China in 2015

In this year, a range of typhoons, including KUJIRA (1508), CHAN-HOM (1509), LINFA (1510), SOUDELOR (1513), GONI (1015), VAMCO (1519), DUJUAN (1521) and MUJIGAE (1522), brought heavy rainfall to China and unleashed severe flooding. They are featured with the following consequences:

1) More affected areas with heavier rainfall. In this year, typhoon had affected 13 provinces or municipalities. Hydrological statistics shows that typhoon SOUDELOR brought 871 mm of rainfall to the Dongkenglin Reservoir of Wenzhou, Zhejiang Province, with a maximum 24-hour rainfall up to 692 mm, an exception that may appear only once every 100 years. Zhayang, part of Ningde, Fujian, reported 685 mm of rainfall brought by typhoon, or 50% of the annual rainfall in the locality.

2) Concentrated heavy flooding and endangered river water levels. A number of provinces, including Zhejiang, Fujian, Guangdong and Jiangsu, reported flash floods that endangered the water levels of some 50 rivers in the localities. 6 of them exceeded the maximum warning levels, and 3 others registered the second largest flooding. Some 20 coastal tidal wave stations reported the high tides exceeding the warning levels. The Baiyantang Tidal Wave Station in Fujian claimed the third highest

tidal wave since 1955.

1.1.4 Tropical cyclones effected or landed on China

1) Severe tropical storm KUJIRA (No. 1508)

Tropical storm KUJIRA developed at 0300 UTC of 21 June over the central water of South China Sea. It made its way northwestward, and became a severe tropical storm at 1500 UTC of 21 June. It landed on Wanning, Hainan Province at 1050 UTC of 22 June, with a near-centre wind up to 25 m/s and a minimum central pressure of 982 hPa. After landfall, KUJIRA swept northwestward and crossed Hainan Province with a steadily weakened intensity. It entered the east part of the Beibu Gulf at 0100 UTC of 23 June, heading west-northwestward, and made landfall over northern Vietnam at 0340 UTC of 24 June. It became weakened, and vanished in the northern part of Vietnam.

KUJIRA was the first tropical cyclone that made landfall over China in 2015. It appeared one week earlier than the multi-year average. Under the influence of KUJIRA, levels 8-10 of wind force hit the eastern and southern coastal areas of Hainan Province, and the central and western part of Guangdong Province. The Xisha Islets of Hainan Province reported winds up to levels 11-12. During 21-25 June, the central and southern part of Hainan, the coastal areas of Guangdong, the western and southern part of Guangxi, and the eastern part of Yunnan claimed a combined precipitation of 100-200 mm, with the southern part of Hainan and the southwest part of Guangxi at 250-392 mm. 81 water reservoirs in Hainan reported an increased water retaining volume by 106 million cubic meters.

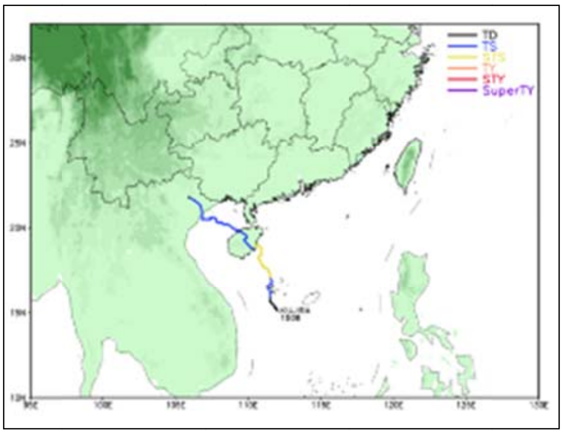


Fig. 1.7a Track of KUJIRA.

Fig. 1.7b FY3B image at 0610 UTC of 22 June.

2) Super Typhoon CHAN-HOM (No. 1509)

Tropical storm CHAN-HOM generated over the western North Pacific at 1200 UTC of 30 June. It moved westward, and became a northwest-bound typhoon at 1800 UTC of 2 July. It was developed in a twist-and-turn manner, and upgraded to a super typhoon at 1500 UTC of 9 July. It became weakened on the journey approaching the northern coasts of Zhejiang Province. CHAN-HOM made landfall at Zhujiajian, a coastal town of Zhoushan, Zhejiang Province at 0840 UTC of 9 July, with a maximum winds of 45 m/s near the centre and a minimum central pressure of 955 hPa. It makes the strongest typhoon that has landed on Zhejiang in July since 1949. After landing, CHAN-HOM moved north-northeastward, and was downgraded to a tropical storm over the eastern water of the Yellow Sea at 1000 UTC of 12 July. It landed over the west coast of North Korea at 1550 UTC of 12 July, and later died down in the northern part of Korean Peninsula.

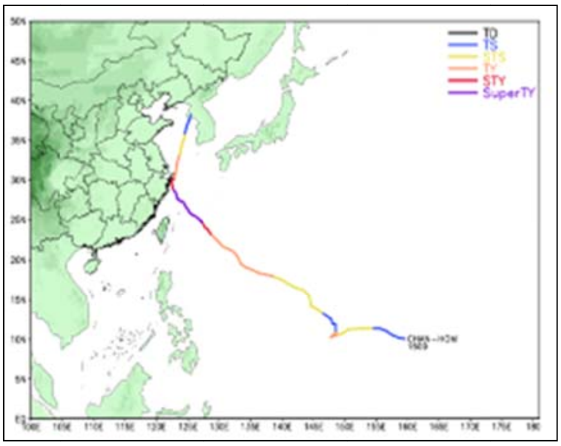


Fig. 1.8a Track of CHAN-HOM**.**

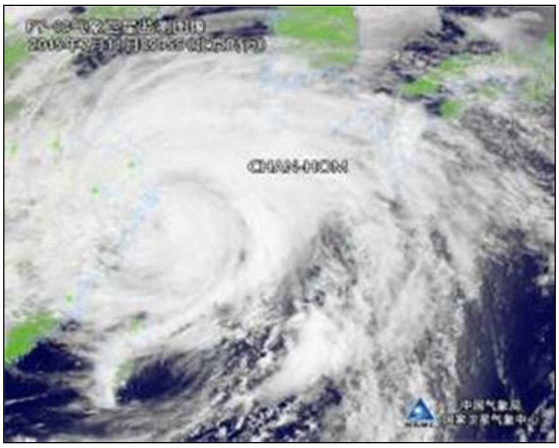


Fig. 1.8b FY3C image at 0355 UTC of 11 July.

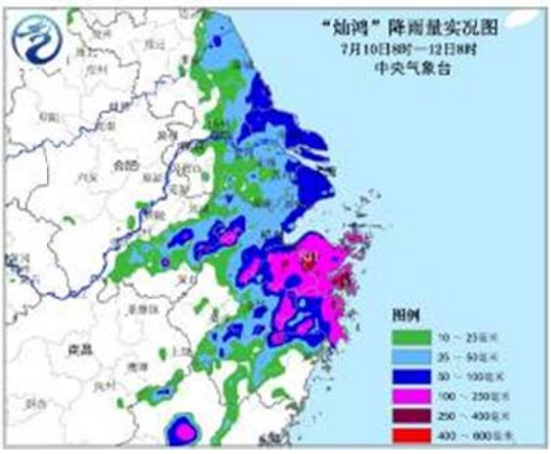


Fig. 1.8c Distribution of CHAN-HOM induced rainfall (0000 UTC 10 July-0000 UTC 12 July)

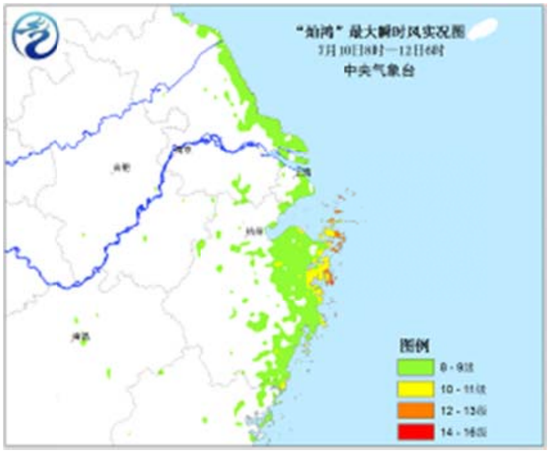


Fig. 1.8d Maximum Gust of CHAN-HOM (0000 UTC 10 July- 2200 UTC 11 July)

Figs. 1.8e Hazards of CHAN-HOM

Figs. 1.8f Hazards of CHAN-HOM

Under the influence of CHAN-HOM, a number of areas, including the eastern part of Zhejiang, Shanghai, the eastern part of Jiangsu, and the southern part of Anhui, reported 50-140 mm of rainfall from 0800UTC 10 July to 0800UTC 12 July. The northeastern part of Zhejiang and Huangshan Mountain area of Anhui reported a rainfall up to 150-280 mm, with Shaoxing and Ningbo, part of

Zhejiang Province, having a heavy downpour up to 300-400 mm, and Yuyao, Ninghai and Xiangshan, also part of Zhejiang, reporting an extreme rainfall up to 420-531 mm. Meanwhile, the coasts and islets of Zhejiang, the coastal areas of Shanghai, and the southeastern coasts of Jiangsu reported strong gusts up to levels 10-12, and Zhoushan/Xiangshan levels 13-16. Of them, Kechonggang of Dinghai, Zhejiang had reported winds up to 53 m/s, Shipu of Xiangshan 49.3 m/s, and Mayi of Zhouzhan 47.9 m/s. The heavy downpour induced a range of waterlogging incidences in Xiangshan County and Ninghai County of Ningbo City, Zhejiang Province. 11 rivers in Zhejiang had severe flooding that exceeded the maximum warning level by 1.91 m. In addition, 16 tidal wave stations in the coasts of Jiangsu, Shanghai, Zhejiang and Fujian reported the exceeding of warning levels, with the largest exceeding by 0.66m.

3) Typhoon LINFA (No. 1510)

Tropical storm LINFA was generated to the east of the Philippines at 1200UTC of 2 July. It was slowly moving west-northwestward, and became a severe tropical storm at 2100UTC of 3 July. LINFA made landfall over the northeast coast of Luzon at 2100UTC of 4 July, and was downgraded to a tropical storm. It entered the northeastern part of the South China Sea on 5 July, heading northward with a steadily enhanced strength. LINFA became a typhoon at 1200UTC of 8 July, moving west-northwestward heading for the eastern coasts of Guangdong Province. It landed on Jiadong town, Lufeng city in Guangdong Province, at 1200UTC of 9 July, with a near-centre maximum wind speeds up to 30 m/s and a minimum central pressure of 970hPa. After landfall, LINFA made a westbound movement, with a rapidly weakened strength. It vanished in the western part of Guangdong in the afternoon of 9 July.

Affected by LINFA, the eastern coastal cities and counties of Guangdong Province reported levels 9-12 of sustained wind force with gust of levels 14-15 during 8~10 July. The anchored buoy in Shantou (120km offshore) registered an averaged wind speed up to 35.7 m/s and a gusty wind up to 47.8 m/s, with the highest tidal wave up to 12m. The Qishi Township of Huilai, Jieyang, reported a terrestrial gusty wind up to 47.5 m/s, and the Peiyang Township, Lufeng, an averaged terrestrial wind up to 34.3 m/s. During 8-10 July, a range of areas in Guangdong Province were hit by heavy downpour. The Baxiang Township of Fengshun, part of Meizhou, Guangdong, reported an exceptional downpour of 269.2 mm. Other areas reporting heavy rainfall included the Taimei Township of Boluo County, Huizhou at 212.1 mm, the Leiling Township of Chaonan, Shantou at 204 mm, the Ma'anshan Farm of Puning, Jieyang at 192.7 mm, and the Zhongxin Township of Zengcheng in Guangzhou at 192.6 mm.

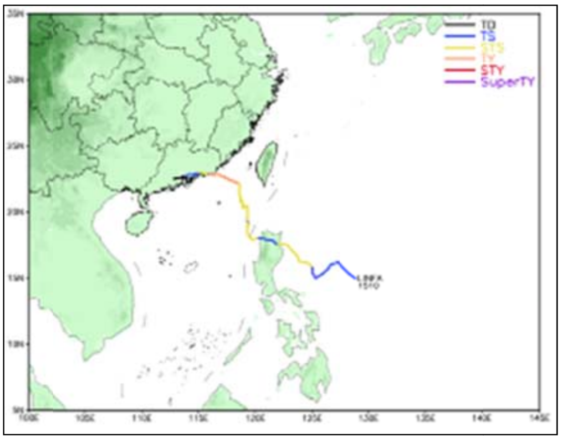


Fig. 1.9a Track of LINFA

Fig. 1.9b FY3C image at 0235 UTC of 9 July.

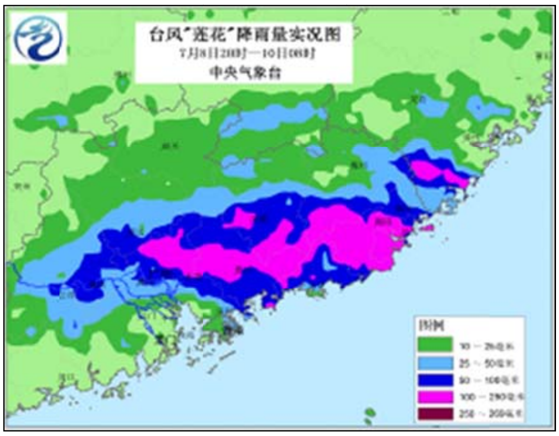


Fig. 1.9c Distribution of LINFA induced rainfall.
(1200 UTC 8 July-0000 UTC 10 July)

Fig. 1.9d Hazards of LINFA

4) Super Typhoon SOUDELOR (No. 1513)

Tropical storm SOUDELOR was formed over the western North Pacific at 1200UTC of 30 July. It moved west-northwestward with a steadily enhanced intensity. It became a typhoon at 0600UTC of 2 August, and was upgraded to a super typhoon at 0600UTC of 3 August. It became slowly weakened when approaching the east coasts of Taiwan. It made landfall over Hualien County, Taiwan at 2040UTC of 7 August, with a near-centre strength up to 48 m/s and a minimum central pressure of 940hPa. After landing, SOUDELOR headed southwestward across central Taiwan, and became a typhoon over the Taiwan Straits. It then turned north-northwest, approaching the central coasts of Fujian Province. It made landfall over Putian, Fujian Province at 1410UTC of 8 August, with a near-centre wind speed up to 38 m/s and a minimum central pressure of 970 hPa. After landing, SOUDELOR made a rapidly weakened journey across four provinces, including Fujian, Jiangxi, Anhui and Jiangsu, and ended up over the Yellow Sea.

SOUDELOR made the widest impacted areas over China in 2015, covering Taiwan, Guangdong, Fujian, Zhejiang, Shanghai, Jiangxi, Hunan, Hubei, Henan, Anhui and Jiangsu provinces. Under the influence of SOUDELOR, Taiwan, Zhejiang, Fujian, the northern and eastern part of Jiangxi, the central and southern part of Anhui, and the central and southern part of Jiangsu reported heavy rainfall. Most part of Taiwan witnessed a heavy downpour of 200-400 mm, with the southern and northern part at 500-700 mm and some localities at 800-1300 mm. Meanwhile, the eastern and southern part of Zhejiang, the northeastern part of Fujian, the central part of Jiangsu and the northern part of Jiangxi had a rainfall of 350-600 mm, with some localities at 650-806 mm. Three counties in Zhejiang, including Taishun, Wencheng and Pingyang, claimed an exceptional daily downpour of 300-500 mm that may appear only once every 100-120 years. Other areas reporting heavy rainfall include the Dongkengling Water Reservoir of Wencheng in Wenzhou, Zhejiang at 871 mm, Zhayang of Ningde in Fujian at 685 mm, Guling of Lushan in Jiujiang, Jiangxi at 474 mm, Dafeng of Yancheng in Jiangsu at 363 mm, and the Fuziling Water Reservoir of Lu'an in Anhui at 329 mm. 43 small rivers in Fujian, Zhejiang, Jiangxi and Jiangsu Provinces witnessed flash flooding that exceeded the warning levels. Meanwhile, the central and northern part of Taiwan reported winds up to levels 10-14, with the Pengjia Islets of Keelung, the Orchid Islands of eastern Taiwan and Wuci of central Taiwan and Suao having gusty winds of levels 16-17. The eastern coasts of Fujian, the central and southern coasts of Zhejiang, and a coastal belt from Putian to Xiapu of Fujian also had winds up to levels 10-15, with some localities of Putian reaching 53 m/s. In addition, 7 tidal wave stations in Zhejiang and Fujian reported water levels exceeding the warning line. For example, the Baiyantang Tidal Wave Station in Fujian claimed the third highest tidal wave since 1955.

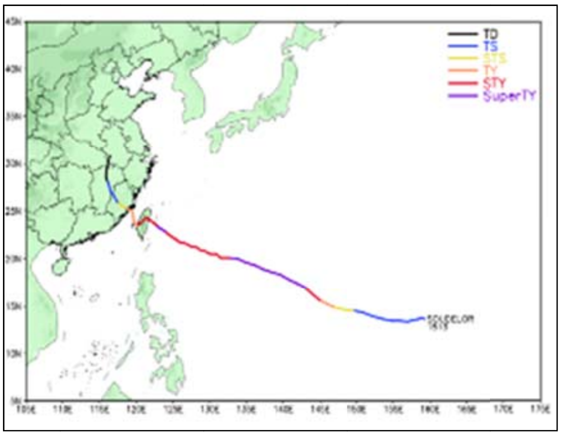


Fig. 1.10a Track of SOUDELOR.

Fig. 1.10b FY3C image at 0355 UTC of 7 August.

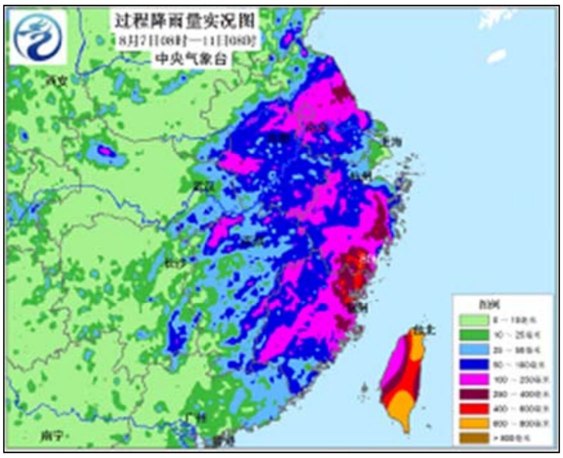


Fig. 1.10c Distribution of SOUDELOR induced rainfall (0000 UTC 7 August - 0000 UTC 11 August)

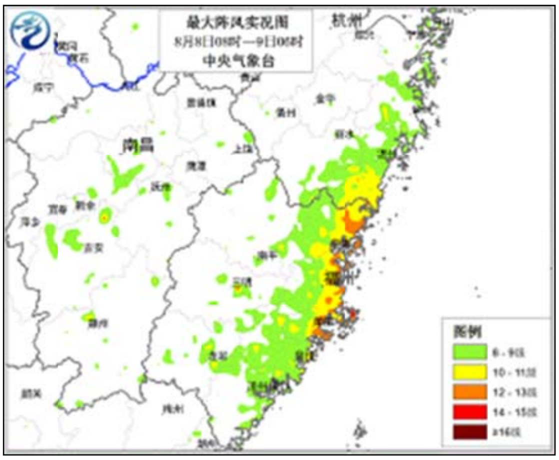


Fig. 1.10d Maximum Gust of SOUDELOR. (0000 UTC 8 August - 2200 UTC 8 August)

Figs.1.10e Hazards of SOUDELOR.

Figs.1.10f Hazards of SOUDELOR.

5) Super Typhoon GONI (No. 1515)

Tropical storm GONI was formed east of the Philippines at 1800UTC of 14 August (UTC). It headed north-northwestward with a steadily enhanced intensity. It became a typhoon at 1800UTC of 16 August, and was upgraded to a super typhoon at 0000UTC of 17 August. GONI was downgraded to a severe typhoon at 1200UTC of 17 August, when approaching the water northwest of the Guam Island. GONI headed for the water northeast of Luzon at 1200UTC of 19 August, where it became a super typhoon, before downgraded to a severe typhoon. Thereafter, GONI entered the water east of Taiwan with an enhanced intensity. It became a super typhoon again over the water northeast of Taiwan in the evening of 23 August, heading for the eastern water of the East China Sea. It approached the southwestern coasts of Japan, and made landfall on the west coasts of Japan's Kyushu at 1840UTC of 24 August, with a near-centre wind speed up to 50 m/s and a minimum central pressure of 940 hPa. After that, GONI headed for the Sea of Japan through the Island of Kyushu, and became a tropical storm at 1200UTC of 26 August. It took landing on the coasts of Vladivostok at 1900UTC of 26 August. After landing, GONI turned northwest, and entered the southeastern part of Heilongjiang Province at 2200UTC of 26 August. It later became an extratropical cyclone in Heilongjiang.

Under the influence of GONI and its peripheral cloud system, a number of areas, including eastern Taiwan, Jiangsu, Zhejiang and Shanghai, reported heavy downpour during 21-23 August. Wanxiang of Pudong in Shanghai, Rudong of Nantong in Jiangsu and Zhenhai of Ningbo in Zhejiang registered a combined rainfall of 337 mm, 257 mm and 154 mm, respectively. During 26-28 August, the southeastern part of Heilongjiang and the eastern part of Jilin had a heavy rainfall of 50-80 mm, with Baishishan of Jiaohe in Jilin reaching 109 mm. Affected by heavy rainfall, 15 small and medium sized rivers in Zhejiang and Heilongjiang reported heavy flooding that exceeded the warning levels, with the largest exceeding by 0.64 m. 57 large water reservoirs in Heilongjiang, Jilin and Liaoning reported an increased volume by 160 million cubic meters.

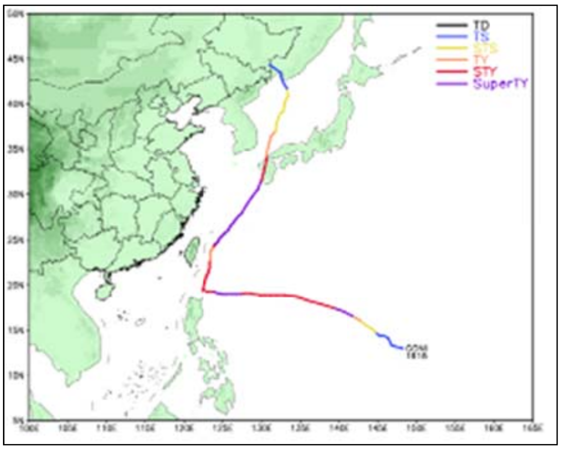


Fig. 1.11a Track of GONI.

Fig.1.11b FY3B image at 0515 UTC of 18 August.

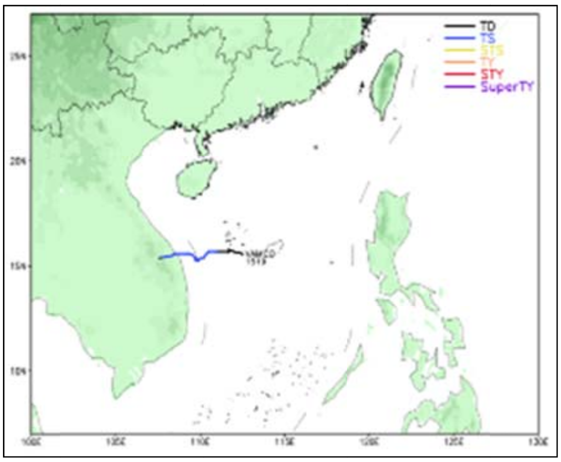
Figs.1.11c Hazards of GONI.

Figs.1.11d Hazards of GONI.

6) Tropical Storm VAMCO (No. 1519)

Tropical storm VAMCO was generated over the central part of the South China Sea at 1800UTC of 13 September. It made a westbound movement, gradually approaching the central coasts of Vietnam. It landed on the coasts of Quang Nam of Vietnam at 1350UTC of 14 September. After landing, VAMCO lost its strength gradually, and vanished in the Indochina Peninsular on 15 September.

Under the combined influence of VAMCO and cold air, the central and eastern part of Hainan Island and the southern part of Leizhou Peninsula, Guangdong had 100-200 mm of rainfall during 14-16 September. Haikou, Qiongshan and Wenchang in Hainan Province reported a heavy downpour of 280-497 mm. Other areas reporting heavy rainfall include Xinzhong of Wanning in Hainan at 401 mm, and Houtang of Zhanjiang in Guangdong at 230 mm. Affected by heavy rainfall, major rivers in Hainan, including the Wanquan River and the Nandu River, reported a slightly raised water level. 10 large water reservoirs in the province collected some 168 million cubic meters of rainwater.



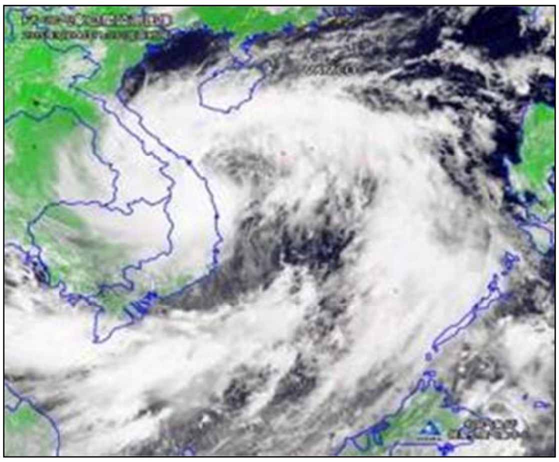


Fig. 1.12a Track of VAMCO. **Fig.1.12b** FY3C image at 0320 UTC of 14 September

Figs.1.12c Hazards of VAMCO. **Figs.1.12d** Hazards of VAMCO.

7) Super Typhoon DUJUAN (No. 1521)

Tropical storm DUJUAN was generated over the Northwest Pacific at 1800UTC of 22 September. It headed north-northwestward with an increasingly enhanced strength. It became a severe tropical storm at 1200UTC of 24 September, and was upgraded to a typhoon at 0900UTC of 25 September. It became a severe typhoon at 0600UTC of 26 September, and was further geared up to a super typhoon at 2100UTC of 26 September. It was downgraded to a severe typhoon when approaching the eastern coasts of Taiwan at 0900UTC of 28 September. DUJUAN made landfall over Yilan, Taiwan at 0950UTC of 28 September, with a near-centre wind speed up to 48 m/s and a minimum central pressure of 982 hPa. After landing, DUJUAN swept west across Taiwan Province, and entered the Taiwan Straits, where it turned northwestward approaching the central coasts of Fujian Province. DUJUAN made landfall over Putian, Fujian at 0050UTC of 29 September, with a near-centre wind speed up to 33 m/s and a minimum central pressure of 975 hPa. After landing, it moved west-northwestward, with a rapidly weakened intensity. It became a tropical depression over Fujian at 0900UTC of 29 September.

DUJUAN brought strong winds and heavy downpour to Taiwan, Zhejiang and Fujian. During 28-30 September, the northeast and southern part of Zhejiang and the eastern part of Fujian reported a rainfall of 100-200 mm, with Ningbo of Zhejiang, and Fuzhou/Putian of Fujian at 250-441 mm. Ningbo of

Zhejiang, in particular, had a daily rainfall over 200 mm, with Zhenhai County up to 314 mm. Meanwhile, the central and northern part of Taiwan received a rainfall of 250-400 mm, with Taipei, Taoyuan and Hualien exceeding 500 mm. Additionally, the southern part of Zhejiang and the eastern coasts of Fujian reported gusts of levels 10-12, with some localities of Fuzhou/Putian being hit by levels 13-14. The Niushan Island of Pingtan in Fujian registered winds up to 45.9 m/s. The attack of DUJUAN was coincided with the appearance of astronomical tides. Consequentially, 36 tidal wave stations in Fujian, Zhejiang and Shanghai reported the exceeding of warning levels by 0.03-1.18 m, with the Shima Tidal Wave Station in Longhai and the Baiyantang Tidal Wave Station in Changle of Fujian exceeding the warning level by 0.12 m and 0.24 m, respectively. The Jiuzhen Tidal Wave Station in Zhangpu of Fujian claimed a record tidal level. Raised tidal waves resulted in coastal flooding and urban waterlogging in many places in Fujian, including Xiamen, Putian, Fuding, Quanzhou, Aojiankou, among others. In Zhejiang Province, both Ningbo and Fenghua reported heavy urban waterlogging, and Wenzhou local landslides. DUJUAN also caused the delay of flights and trains in some parts of Fujian and Zhejiang.

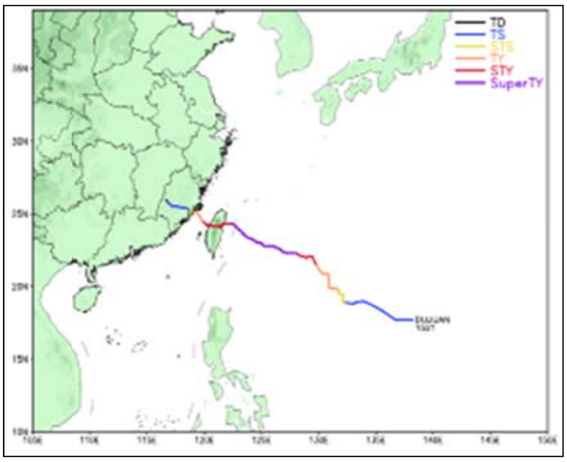


Fig. 1.13a Track of DUJUAN.

Fig.1.13b FY3B image at 0630 UTC of 29 September.

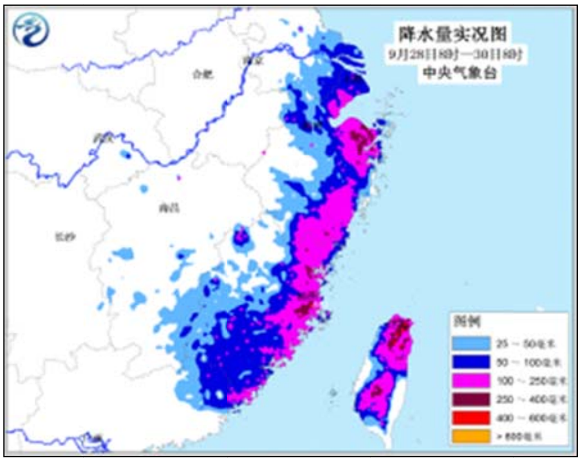


Fig. 1.13c Distribution of DUJUAN induced rainfall (0000 UTC 28 September - 0000 UTC 30 September)

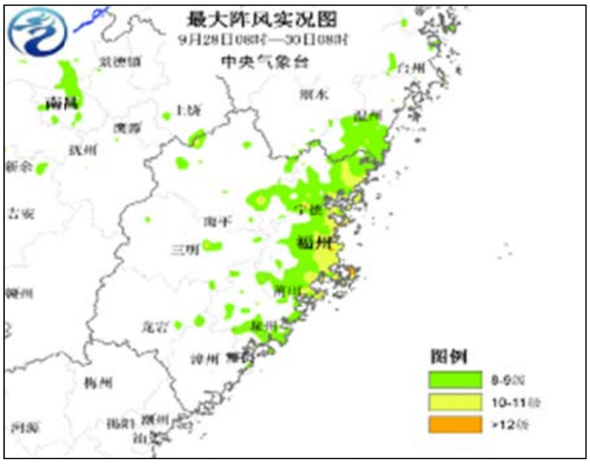


Fig. 1.13d Maximum Gust of DUJUAN (0000 UTC 28 September - 0000 UTC 30 September)

Figs.1.13e Hazards of DUJUAN.

Figs.1.13f Hazards of DUJUAN.

8) Super Typhoon MUGIGAE (No. 1522)

MUJIGAE formed as a tropical storm at 1800UTC on 1 October above Luzon. MUJIGAE headed northwestward, and entered the eastern water of the South China Sea on 2 October with an increasingly enhanced strength. It was upgraded to a severe tropical storm at 1200UTC of 2 October, and further to a typhoon at 0600UTC of 3 October. It became a severe typhoon at 1500UTC of 3 October, when approaching the western coasts of Guangdong Province. MUJIGAE made landfall on the coasts of Potou District, part of Zhanjiang City, Guangdong, with a near-centre wind speed up to 50 m/s and a minimum central pressure of 940 hPa. After landing, MUJIGAE headed northwestward, with a rapidly weakened strength. It became a tropical depression at 0600UTC of 5 October.

Typhoon MUJIGAE is of the following four features: (1) rapid intensification. After entering the eastern water of the South China Sea, MUJIGAE geared up fast to become a typhoon, and then a severe typhoon between afternoon and evening of 3 October. It took landing on 4 October with the strength of severe typhoon; (2) enhanced strength at landing and even with the record strength of the typhoon landed over China in October since 1949. MUJIGAE made landfall on China having the strength of severe typhoon, with a near-centre wind speed up to 50 m/s and a minimum central pressure of 940 hPa, a record strength of a landing typhoon on China in October since 1949. ; (3) strong winds and heavy rainfall for Guangdong, Guangxi and other provinces. the central and western part of Guangdong, the central and eastern part of Guangxi, the northeastern part and the southern coasts of Hainan, and the southwestern part of Hunan reported a combined rainfall of 100-250 mm during 3-6 October. During the same period, some localities in the central and western part of Guangdong and the eastern part of Guangxi received a heavy downpour up to 260-500 mm, with Yangchun of Guangdong and Jinxiu of Guangxi at 510-557 mm. The southwestern part and coastal areas of Guangdong, the northern coasts of Hainan, and the southern coasts of Guangxi experienced gusts of levels 9-11 gusts, and the southwestern coasts of Guangdong levels 13-17. The Huguang Township of Mazhang District in Zhanjiang City, Guangdong registered a gust up to 67.2 m/s; and (4) casualties caused by the tornados triggered by the peripheral cloud bands. MUJIGAE's peripheral spiral cloud bands brought tornados to Shunde and Foshan of Guangdong and Panyu of Guangzhou in the afternoon of 4 October, which

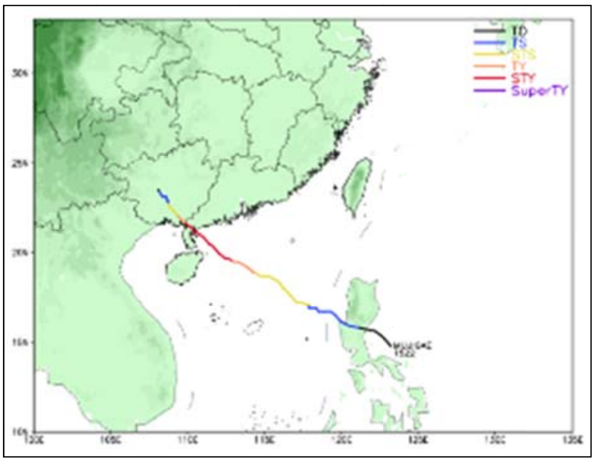


Fig. 1.14a Track of MUJIGAE.

Fig. 1.14b FY3B image at 0655 UTC of 4 October.

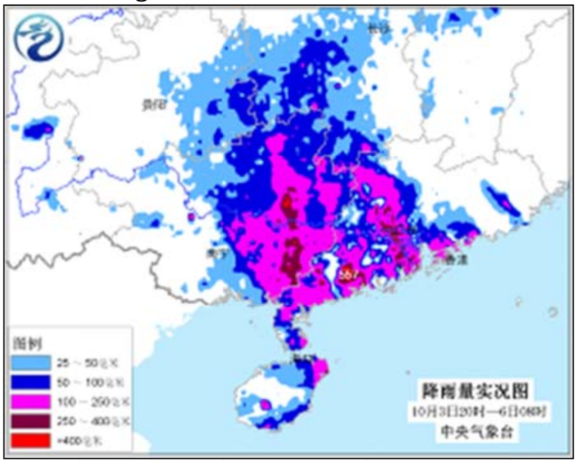


Fig. 1.14c Distribution of MUJIGAE induced rainfall. (1200 UTC 3 October- 0000 UTC 6 October.)

Fig. 1.14d Hazards of MUJIGAE

Figs. 1.14e Hazards of MUJIGAE.

Figs. 1.14f Hazards of MUJIGAE.

led to the blackouts in the northern part of Panyu District and Haizhu District. In addition, 6 coastal tidal wave stations in Guangdong and Hainan registered the exceeding of warning levels by 0.01-0.37 m. The Bomao Station in Zhanjian of Guangdong claimed an exceptional high tidal level that would appear only once a decade. On 7 October, the large and medium-sized water reservoirs in Guangdong, Guangxi and Hainan Provinces reported an increased water retaining volume by 800 million cubic meters, compared with that of 2 October. Of them, Guangdong saw an increase by 394 million cubic meters, Guangxi 326 million cubic meters, and Hainan 81 million cubic meters.

1.2 Socio-Economic Assessment

As of 15 October 2015, 8 tropical cyclones had affected China, and 6 of them made landfall. Typhoon MUJIGAE is the strongest typhoon landed on China in 2015. Of the six typhoons, SOUDELOR claimed the most affected population, death toll, missing person, emergency aiding population, damaged home, and MUJIGAE claimed the most direct economic loss.

According to preliminary statistics, typhoon-induced disasters have affected 23.5861 million people in 13 provinces or municipalities, with 63 people dead, 10 missing, 3.598 million evacuated, 237,000 aided, 24,000 houses collapsed, 204,000 houses damaged to different extent, 1.6796 million hectares of croplands affected, of which 136.800 hectares of croplands claimed no yield, and a direct economic loss worth RMB 66.066 billion.

Table 1.1 Impacts and Disaster caused by Typhoons in 2015

TC Name & No.	Landing Site	Landing Date	Max. Wind Force Near TC Centre When Landing (unit: level)	Affected Province (municipality, AR)	Affected Population (1,000)	Death Tolls (person)	Direct Economic Loss (RMB billion)
KUJIRA (1508)	Hainan	6.22	10 (25 m/s)	Hainan and Yunnan	159.4	/	0.085
CHAN-HOM (1509)	Zhejiang	7.11	14 (45 m/s)	Heilongjiang, Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Shandong, Taiwan	3,907.9	/	9.838
LINFA (1510)	Guangdong	7.9	11 (30 m/s)	Fujian, Guangdong, Taiwan	2,034.0	1	1.742
SOUDELOR (1513)	Taiwan Fujian	8.7 8.8	15 (48 m/s) 13 (38 m/s)	Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Taiwan	8,241.2	45	24.627
GONI (1515)				Shanghai and Heilongjiang	103.1	/	0.204
VAMCO (1519)				Hainan	/	/	0.002
DUJUAN (1521)	Taiwan Fujian	9.28 9.29	15 (48 m/s) 12 (33 m/s)	Zhejiang, Fujian, Taiwan	1,626.9	/	2.536
MUJIGAE (1522)	Guangdong	10.4	15 (50 m/s)	Guangdong, Guangxi, Hainan	7,513.6	27	27.032
Total					23,586.1	73	66.066

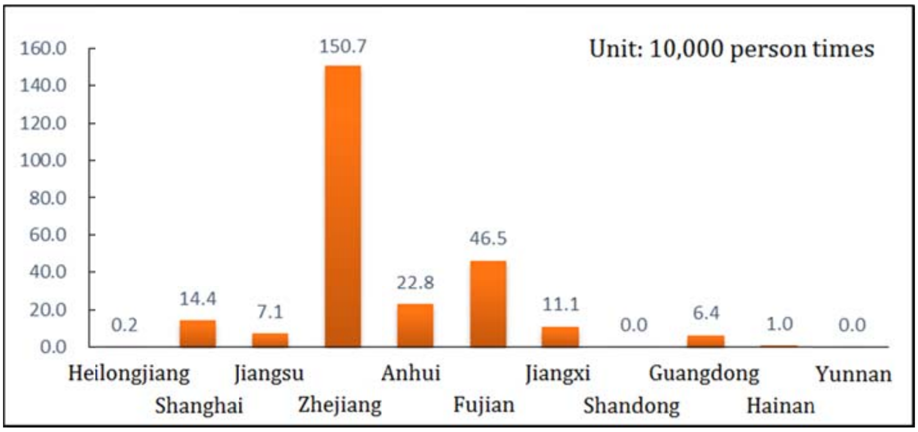


Fig.1.15 Statistics of evacuated people in emergency responses to potential typhoon-induced disasters in 2015

1.3 Regional Cooperation Assessment

1.3.1 International Symposium on High Impact Weather Research

An International Symposium on High Impact Weather, co-sponsored by the World Meteorological Organization (WMO) Commission for Atmospheric Sciences (CAS) World Weather Research Program (WWRP) Working Group on Tropical Meteorology Research, and the Chinese Academy of Meteorological Sciences State Key Laboratory for Severe Weather, and hosted by the Ningbo Municipal Meteorological Bureau, was held in Ningbo during 20-23 January 2015. Some 100 participants, from the United States, India, the Philippines, Bangladesh and Chinese meteorological departments, universities and research institutions, attended the meeting. The meeting discussed the latest research progresses made in the areas of tropical cyclones and southern monsoon heavy rainfall experiments. The event facilitated exchange and cooperation in the area of tropical cyclone research.

Fig. 1.16 International Symposium on High Impact Weather Research

1.3.2 8th China-Korea Workshop on Tropical Cyclones in Shanghai, 19-20 May 2015

The 8th China-Korea Workshop on Tropical Cyclones was held during 19-20 May 2015 in Shanghai, China. The workshop, co-sponsored by China Meteorological Administration (CMA) and Korea Meteorological Administration (KMA), was jointly hosted by Shanghai Meteorological Service and Shanghai Typhoon Institute (STI). The meeting discussed a range of issues, including tropical cyclone observation, numerical prediction techniques, tropical cyclone intensity and frequency, early warning, among others. Some 40 typhoon specialists from CMA, KMA, and renowned universities, including

Peking University, Nanjing University, Shanghai Jiaotong University, attended the meeting. The annual event facilitated the sharing of the latest progress achieved in tropical cyclone researches and operations between Republic of Korea and China. It enhanced bilateral cooperation on tropical cyclone forecasts.

Fig. 1.16 The 8th China-Korea Joint Workshop on Tropical Cyclones

1.3.3 International exchange on civil affairs

In 2015, China enhanced its exchange and cooperation with ASEAN countries in the area of disaster prevention and reduction, and has applied for four earmark projects. Chinese personnel participated in the 4th Disaster Relief Exercise organized under the ASEAN Regional Forum, and completed the desktop exercise and action assessment, in addition to resettlement exercise. China hosted a disaster management training course under the Istanbul Process, in an effort to promote exchange and cooperation between the Istanbul Process member countries in the area of disaster management. China completed the phase-II framework design of "Asian community comprehensive disaster management project" initiated by UK Department for International Development (DFID), and started the implementation. China launched an aid package feasibility study for the disaster prevention and reduction program in Bangladesh, and completed the site investigation along with a follow-up capacity-building proposal.

Fig. 1.17 Tabletop exercise participants at the 4th ASEAN Regional Forum.

1.3.4 Scholarship Programme of Typhoon Committee

According to the 2015 annual work plan of the Working Group on Meteorology – Verification of Tropical Cyclone Operational Forecast, research fellowships would be offered in the year. The fellowship will work on “Tropical Cyclone Genesis Forecast Techniques”. The two-month (October and November 2015) fellowships were offered by Shanghai Typhoon Institute (STI) with the support of TCTF. Typhoon Committee Members were invited to submit their nominations to the Typhoon Committee. Mr. Pak Sang Il and Mr. Ri Hak Il from the Democratic People’s Republic of Korea were chosen by STI to be part of the fellowship program.

II. Summary of Advances in Key Result Areas

2.1 Further improved objective typhoon track forecast methods and refined typhoon forecasting techniques

1）CMA has developed a multi-model correction method TYTEC, for typhoon track forecast. The method has been optimized for a better performance. Based on the ensemble forecasting experiments made in recent years, the weight of TYTEC was readjusted on different ensemble models for operational forecasts.

2）In 2015, the National Meteorological Centre paid more attention to the refined typhoon forecast products, including half-hour position and hourly track forecast. On the other hand, a dynamical interpretation method, TC-wind, was used to work on the wind field of the Grapes-TYM numerical model. The TC-wind technique is able to readjust the typhoon wind field derived from the model, based on the subjective track and intensity forecasts. It produces hourly wind field forecasts with a horizontal resolution of 10km.

3) In 2015, the National Meteorological Centre developed two new operational products for typhoon disaster impact assessment. Based on the major characteristics of previous typhoon disasters, a model to assess the destructive power of typhoon was developed by simulating a range of elements, including the speed and duration of typhoon winds and the characteristics of the disasters caused (Fig. 2.1 and 2.2). The destructive power of typhoon is marked by five levels, with Level-I referring to the extreme damage. Meanwhile, a comprehensive heavy rain disaster risk prediction model was developed through the simulation of rainfall intensity and associated environmental impacts. The two products will work for the following two conditions: (1) when a typhoon with level-12 or above strength is expected to make landfall on China within coming 72 hours, a destructive power prediction product will be released; and (2) when a typhoon is expected to induce heavy rainfall in Mainland China within coming 72 hours, a comprehensive heavy rain disaster risk prediction product will be released.

4) Chinese National Climate Centre Climate Projection Division used the CFSV2 data provided by NCEP/CFS (NCEP Climate Forecast System) to develop a method for monthly and seasonal objective typhoon forecasts. The two-year operational applications showed fine results of overall performance. The technique is desirable for enhancing the monthly and seasonal typhoon forecasting capability, though poor for extreme events forecasts. The monthly typhoon forecasts made using the technique in 2015 produced a range of trend forecasts consistent with the observed results in both June and July, though poor in August.

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

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

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

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2.2 Advancement on numerical typhoon modeling and data assimilation

1) GRAPES_TYM's resolution has been upgraded from 15km/L32 to 12km/L50, in an attempt to reduce the errors of typhoon track and intensity forecasts.

2) GSI-based high-resolution typhoon forecast system.

SHA-THRAPS (Shanghai-Tropical-Cyclone High-resolution Analysis and Prediction System) was put into quasi-operation in the year. The system is built on a 9km/3km nested WRF-ARW model, using a GSI (Grid point Statistical Interpolation) system to assimilate nonconventional data, such as satellite radiance. In addition to the traditional products on typhoon track/intensity and rainfall, SHA-THRAPS provides diversified TC inner-core forecast products, including refined wind/precipitation and 3D TC structure forecasts.

3) GSI-based ensemble data assimilation and forecasting system.

A three-dimensional ensemble-variation (3DVAR-EnKF) hybrid data assimilation system was developed, based on the GSI system. The WRF typhoon ensemble forecast model was built using NCEP-GEFS global ensemble forecasts as an ensemble background field. The system is designed to assimilate data in a more accurate manner, compared with the pure 3DVAR system, due to the nature of ensemble flow-dependent, which would result in a dynamically balanced initial field. Apart from deterministic forecasts, uncertainty prediction products have also been developed for TC hit probability, combined wind probability, precipitation probability, ensemble spread, among others.

4) Improved boundary layer and land-sea surface parameterization scheme for the South China Sea typhoon model. To enhance the capability of predicting a typhoon that has a twisted track, and to improve offshore typhoon forecasts and warning, Guangzhou Tropical Marine and Meteorological Institute of CMA has recently launched a number of studies. Taking LINFA's track forecast as an example. A plan that combines terrain parameters, SST variations and a new land surface scheme has noticeably improved LINFA's track forecast. In addition, when developing the land-sea surface parameterization module, researchers introduced a relatively simple sea surface parameterization scheme in the model to describe the air-sea interactions within the typhoon, making the sea surface temperature forecasts based on sea surface heat balance equation. The sea surface temperature forecasts would, in turn, improve the algorithms of sea surface sensible and latent heat flux, reducing the maritime track errors of severe typhoon forecasts. Meanwhile, the improved land surface scheme adds a soil moisture forecast on the basis of land surface heat balance scheme, which improves the track forecasts of offshore and weak South China Sea typhoons.

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

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

KRA =	1	2	3	4	5	6	7

Meteorology	√	√	√	√			
Hydrology							
DRR							
Training and research							
Resource mobilization or regional collaboration							

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2.3 Typhoon research progress

1) Chinese researchers analyzed the spatial and temporal distribution of rapidly intensified tropical cyclones over the South China Sea from 1979 to 2012. Showed that most rapidly intensified tropical cyclones occurred to the southeast of Hainan, or over the central of the South China Sea which is distant away from the continent. The ERA-Interim reanalysis data were used to develop a new threshold method for calculating environmental factors.

2) Study of the distributions of precipitation vary by TCs' intensity. The intensity of a landing typhoon would define the symmetric pattern of precipitation. However, intensity would impose no significant impact on the asymmetric precipitation. The maximum asymmetric precipitation would be on the wind shear or on the left side.

3) Study of land-sea difference effects the precipitation brought by a landing typhoon. An asymmetric distribution of precipitation brought by a landing typhoon would be subject to the impact of ambient vertical wind shear, due to the effect of strong vertical wind shear. In the presence of weak wind, land-sea difference would impose a significant impact on the asymmetric distribution of typhoon precipitation.

4) Horizontal transition of turbulent cascades at near-surface layer. The energy transfer between different scales, such as from a smaller scale to a larger one (upscale), or vice versa (downscale), may produce a profound impact on TC energy dynamics, due to the variation of available energy sources and sinks.

5) A comparative study of the asymmetric temperature and humidity structure of TC. The NCEP CFSR 0.5° reanalysis data and the Tokyo Typhoon Centre optimum track dataset were employed to synthesize and analyze the asymmetric and vertical non-uniform temperature and humidity structures over the western North Pacific and the South China Sea during 1979-2010.

6) An analysis was made to depict the characters of offshore typhoons that suddenly died down. A dynamic synthesized analysis and diagnosis of the features of large-scale circulations of an offshore typhoon is studied, and the differences between the typhoons over the East China Sea and the South China Sea were compared. Results showed that SST, VWS and DCC can be used to predict the time available for a suddenly decayed typhoon. For example, SST would indicate 36h, VWS 30-36h, and DCC 30h.

7) Study of the air-sea interactions under the influence of typhoon. The study led to the improvement of a numerical system and its application to the coupling of mesoscale atmospheric model, ocean circulation model and wave model. Researchers analyzed the impact of air-sea interaction on the variation of typhoon intensity and structure, in particular, the impact of sea wave on the variation of typhoon intensity and structure. Meanwhile, efforts have been made to improve the sea spray parameterization scheme, as it would improve the accuracy of typhoon strength forecast.

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

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

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

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2.4 Typhoon research project endorsed as part of National Key Basic Research Program

"Refined Landing Typhoon Structures: Observation, Forecasting and Impact Assessment", a project initiated by China Meteorological Administration Chinese Academy of Meteorological Sciences with Duan Yihong, a research fellow, as the chief scientist, was endorsed in 2015 as part of the National Key Basic Research Program (973). The project is designed to understand the structural variation of a landing typhoon based on field experiments, data integration, numerical experiments and theoretical analysis. It is supposed to produce innovative research findings of international influence, enhancing refined typhoon winds and rain forecast, providing evidence for decision-makers, and meeting the national and social needs for typhoon disaster prevention and reduction. The project is made up of six components: field experiments and associated analysis; multi-sourced data analysis theory and associated methods; refined structural variation of landing typhoon and associated mechanism; impact of refined landing typhoon structures on the intensity and distribution of winds and rain; key techniques for high-resolution numerical forecasting model; and methodologies applicable to typhoon disaster impact pre-assessment and assessment.

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

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

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

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2.5 Journal of Tropical Cyclone Research and Review

Up to date, the journal has published 90 papers contributed by authors from 13 countries or regions, including Typhoon Committee Members and non-Members. Two-thirds of the papers are authored by overseas researchers. More than two-thirds of the manuscripts were peer-reviewed by overseas reviewers. TCRR statistics show that the journal has attracted the readers from 100 countries or regions. As of July 2014, China took 48% of the reader population, the U.S. 29%, and the rest of the world 23%. Thanks to the operation of a new website (July 2014), the journal enjoys an increased reader population by 46% from the U.S., and 32% from China. As of December 2014, the full text download has been steadily increased to 36,500 in number, or 12,167 per year. The full text download in 2015 has reached 11,327 in number during January-July.

Shanghai Typhoon Institute plans to invite 1 or 2 visiting editors this year. TCRR is calling for contributions from all Members, including the review of tropical cyclone incidences, advance made in applied and basic tropical cyclone research and associated technological development. Meanwhile, the typhoon committee workshop participants are encouraged to submit their unpublished papers to the journal.

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

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

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

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2.6 Ocean observing system and associated experiments

1) Ocean observing system

China's national marine meteorological observation system has the following facilities in operation: 304 island-based or offshore platform-based automatic weather stations, 200 strong winds observing stations, 39 ship-based automatic weather stations, 33 anchored buoys, 26 weather radar, 10 radiosonde stations, 17 wind profilers, 75 GNSS/MET stations, 37 lightning stations, 6 ground wave radar stations and 2 storm surge stations.

2) Sea spray observation with the presence of typhoon

Under two-year preparation, the sea spray observing experiment with the presence of typhoon has achieved an impressive progress. During the period of June 22-23 2015, a range of instruments, including drop spectrometer and ultrasonic wind and temperature sensors, were employed to observe sea spray, high-frequency wind speed/direction and sea conditions with the presence of typhoon KUJIRA (No. 1508). The experiment has led to the first domestic collection of sea spray droplets, high-frequency wind speed/direction and sea surface condition data with the presence of typhoon (Fig. 2.3).

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

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

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

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2.7 FY-2G in official operation

After a successful launch, FY-2G was positioned at 99.5ºE above the equator on January 6, 2015. An in-orbit test team, set up by CMA, made a four-month test from January to May. The test period was coincided with an active typhoon period on the Southern Hemisphere. FY-2G was then employed to monitor a number of typhoons appeared on the Southern Hemisphere using the full-disk images within the visual range. Meanwhile, a quantitative synchronized comparison was made with Japan's MTSAT-2 on the same band. Analysis results show that the combined use of FY-2G and MTSAT-2 data at an interval of half an hour can realize the continuous monitoring of the evolution of deep convective low-temperature zone within the typhoon, suggesting that FY-2G and MTSAT-2 enjoy a similar radiation measurement capability. Comparing with MTSAT-2, FY-2G is desirable for brightness temperature observation, with an averaged bias better than -1.0K@200K. After the completion of in-orbit test, FY-2G was endorsed by CMA to be positioned at 105°E above the equator. It officially sat in for FY-2E on June 3, and became a primary satellite in operation. Thanks to an enhanced positioning accuracy, FY-2G played an important role in monitoring the typhoons formed during June-September 2015. It accurately positioned the four typhoons that made landfall on continental China during June-July, including KUJIRA, CHAN-HOM, LINFA, and SOUDELOR. It also repeatedly entered six-minute fast regional scanning mode upon emergency requests. It provided an important support for CMA Central Meteorological Observatory developing a new half-hour offshore typhoon positioning method.

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

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

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2.8 Advancement on CMACast and WIS

1) Satellite data broadcasting system，or CMACast, developed by China Meteorological Administration (CMA) is an important component of CMA’s national and international communication system. Built on a standard DVB-S2 platform, it was put into operation on June 2012. Some 2,700 provincial, prefectural and county-level meteorological departments are currently using the system to receive real-time meteorological data and products, making weather forecasts and providing meteorological services. Meanwhile, CMACast provides data broadcasting services to 184 non-meteorological department users and 26 WMO Member users at a rate of 70Mbps and in a daily volume exceeding 300GB. The data and products transmitted via CMACast include global observations and early warning, CMA’s T639 data forecast products, satellite products derived from FY2E/F/G and FY3B/C meteorological satellites, and EUMETSAT products. It works with MICAPS to enhance users’ applications of CMACast data.

2) CMA is an active participator and promoter of WIS implementation. In 2015, Beijing GISC and CMA's four DCPCs have been running smoothly, providing to Mongolia, Nepal, Pakistan, China Hong Kong, China Macao and other WMO Members in the Asia-Pacific region a range of products, including FY products, global monthly mean temperature and precipitation anomaly products, T213 ensemble forecast products, typhoon model ensemble forecast products, and other data discovery and access services. Beijing GISC and CMA's four DCPCs have released 133,500 entries of metadata to 102 registered users, in a daily data volume exceeding 875GB. In addition, CMA has since 2014 dispatched its technical experts to North Korea, Nepal, Myanmar, Kazakhstan and other WMO members, where they staged on-site CMACast, MICAPS and WIS related technical training, facilitating the implementation of WIS in Asian region.

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

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

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2.9 CMA's typhoon prevention strategy and action

1) Enhanced meteorological services for decision makers. In 2015, CMA instructed CMA Decision Making Meteorological Service Centre to release special significant meteorological information report and meteorological disaster warning service bulletin to the CPC Central Committee General Office, the State Council General Office and other relevant government agencies.

2) Warning service ready. CMA has released diversified timely information and warning on typhoon and heavy rainfall (Table 2.1). It also issued the warnings on geological disasters, waves, storm surges, power supply accidents, traffic accidents, and ship accidents because of strong winds to 29 early warning coordinating departments and relevant meteorological authorities at provincial, autonomous region and municipal levels, taking advantage of the national emergency warning information release system. It has provided early warning services to 200 million persons/times.

3) Meteorological service consultation. Nationwide weather consultation meeting held every day. After the consultation meeting, CMA would convene a meteorological service consultation meeting at national level, analyzing the impacts of typhoon and the service requirements of decision makers, the public, the professionals and science advocacy. It would ask departments concerned to prepare tailored service products under a unified caliber, strengthening internal results sharing and enhancing work efficiency. For example, based on the discussion at the consultation meeting, CMA organized the Science Advocacy Centre to prepare graphic products, and released it to a range of portals, including China Meteorological Science Advocacy Network, China Weather Network and other social media.

4) Timely survey and assessment. During the impact period of typhoon CHAN-HOM, CMA organized the National Meteorological Centre, the Public Service Centre and Zhejiang Meteorological Bureau to jointly assess the benefits brought by meteorological services, summarizing the experience on typhoon prevention and reduction.

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

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

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

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2.10 Typhoon disaster risk assessment

1) 16 provinces have been organized to work on typhoon disaster risk assessment and associated zoning, including technical guidelines for typhoon disaster risk assessment and zoning; strong winds risk assessment and zoning; storm surge risk assessment and zoning; urban waterlogging risk assessment and zoning; small and medium sized rivers risk assessment and zoning; and mountain flooding risk assessment and zoning.

2) Annual tropical cyclone disaster pre-assessment model. China has done little in assessing the annual or seasonal impact of tropical cyclone disasters, as current operations mainly focus on tropical cyclone frequency prediction. As a result, one is not in a position to assess the possible impact or disasters to be brought up by tropical cyclones in the coming year merely based on the frequency and numbers of tropical cyclones cited in the current year. To address the problem, Chinese researchers borrowed the YTCPI/STCPI indexes to mirror the potential annual or seasonal impact of tropical cyclones. They established a model to reflect the relationship between YTCPI/STCPI and disaster-caused losses, allowing researchers to foresee the YTCPI/STCPI index based on the precursor atmosphere-ocean circulation factors, and hence pre-assess the perspective of tropical cyclone disasters in the coming year.

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

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

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2.11 enhancing the capacity of typhoon disaster risk management

1) Disaster information reporting and releasing.

In 2015, the National Natural Disaster Management System was upgraded to perfect its functionalities (Figure 2.4). The upgrade makes disaster information collection and reporting at the village (community) and township levels possible, with an enhanced accuracy of disaster statistics. Up to date, 17 provinces have established disaster information collection and reporting networks at the village (community) and township levels, with a user population exceeding 20,000. Meanwhile, disasters related APPs have been developed for mobile collection and reporting at three levels (county, township and village), allowing users to send real-time disaster reports and images through the APPs on mobile phones (Figure 2.5). The Wechat version of "China Disaster Reduction" pushes daily real-time disaster and relief information to the public. It has now possessed some 3,400 public users, and released 184 issues of disaster and relief information (Figure 2.6).

2) State Oceanic Administration research project improves typhoon and storm surge disaster statistics.

In 2015, Chinese civil authorities, in collaboration with the State Oceanic Administration, completed a comparative study of typhoon and typhoon-storm surge disaster statistical indicators. The study defines the basic composition of typhoon and typhoon-storm surge disaster statistics, based on the analysis of historical statistics collected by both civil and oceanic departments. The study rolled out a disaster statistical indicator system and associated applicable methods that can be a reference for marine disaster statistics.

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

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

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2.12 Enhanced typhoon impact warning for reservoir rainwater retaining capability and improved soil moisture observation

1) In 2015, the Chinese Ministry of Water Resources Hydrology Bureau developed a forecast and early warning system for small and medium sized reservoirs rainwater retaining capability. Built on the consideration of water reservoir scheduling, the system is designed to calculate small and medium sized reservoirs rainwater retaining capability before the arrival of typhoon. It is able to compare the rainwater retaining capability and the predicted rainfall, so as to discharge in advance the water reservoir that has no enough room for the coming rainwater, ensuring the safety of the reservoir.

In addition, the Chinese Ministry of Water Resources Hydrology Bureau enhanced flood forecasts for the typhoon-affected areas. Hydrological departments at all levels in the affected areas released rolling hydrological forecasts, based on real-time rainfall and numerical weather forecasts. Hydrological forecasts were also sent to the regional and national flood control authorities for reference through a flood forecasts sharing mechanism. Up to date, hydrological departments in the typhoon-affected areas have released more than 1,000 real-time flood forecasts, effectively supported flood control decision making at all levels.

2) In 2015, the Chinese Ministry of Water Resources Hydrology Bureau enhanced the basic work of soil moisture observation and forecast. It released technical specifications for measuring the field capacity, a key parameter that has to be used in soil moisture calculation. It also staged nationwide on-site or online training events for the purpose. Meanwhile, some 1,000 soil moisture monitoring sites have been mobilized to measure the field capacity.

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

China has numerous small and medium sized water reservoirs that are extensively distributed. Each reservoir needs a flood forecast plan and a reservoir scheduling plan that would invite heavy workload.

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

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

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2.13 Urban real-time flooding forecast and dynamic risk mapping OSUFFIM

In 2015, thanks to the strong support of Sun Yat-sen University, “urban real-time flood forecast and dynamic risk mapping”, an Asia-Pacific Typhoon Committee AOP project (OSUFFIM) undertaken by the Chinese Ministry of Water Resources Hydrology Bureau, has won a grant offered by the Guangdong Provincial Science and Technology Department as an international cooperation project. The project has initially chosen China’s Dongguan and Thailand’s Hat Yai as pilot cities. The project will be implemented from August 2015 to July 2016.

The first "Asia-Pacific Urban Real Time Flood Forecast and Dynamic Risk Mapping System R&D" meeting, jointly sponsored by the Chinese Ministry of Water Resources Hydrology Bureau and Sun Yat-sen University, was held on 23 September 2015 in Guangzhou. Participants from the Typhoon Committee Secretariat, the Ministry of Water Resources Hydrology Bureau, Guangdong Provincial Science and Technology Department, Sun Yat-sen University, the Royal Irrigation Department of Thailand, and the two pilot cities attended the meeting.

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

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

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2.14 CMA's tropical cyclone forecast training events

In 2015, China Meteorological Administration Training Centre hosted a range of tropical cyclone training events. The training focused on the application of theoretical knowledge and new methods/materials in typhoon forecast, enhancing forecasters' application capabilities with a widened horizon of work, including

1) New generation weather radar work principle and products applications. The training course discussed hardware, principle of detection, and application of radar in weather analysis and forecast. Prof. Zhou Zhongdao of Taiwan University was invited to lecture on the application of Doppler radar in monitoring typhoon winds and rain.

2) Application of geostationary meteorological satellite data in weather analysis and forecast. The training course is designed to enable the trainees to understand the production principles and applications of diversified meteorological satellite products, and apply geostationary satellite imageries in typhoon analysis and forecasts.

3) Rotational training for the forecasters at prefectural and municipal levels. Forecasters attending the training event discussed and analyzed the typhoon cases they used to work on. The discussion deepened the understanding of weather forecasting system, allowing forecasters to share the applications of diversified data and information in typhoon forecast, so as to create a forecast indicator system tailored to the local situation and provide evidence for typhoon forecast.

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

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

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Appendix

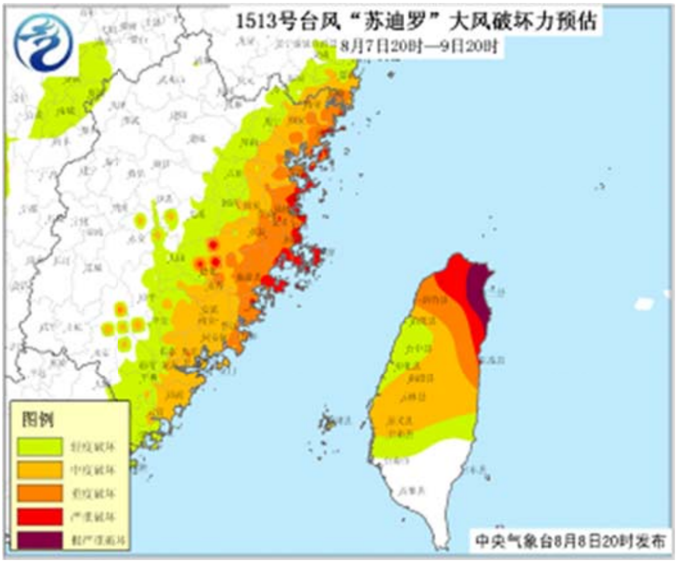

Fig.2.1. Predicted destructive power of typhoon SOUDELOR.

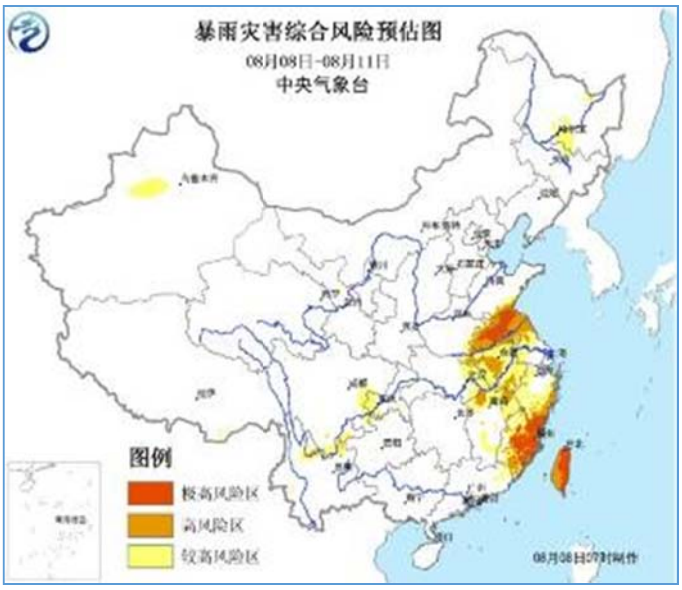

Fig. 2.2. Predicted heavy rainfall risk of typhoon SOUDELOR.

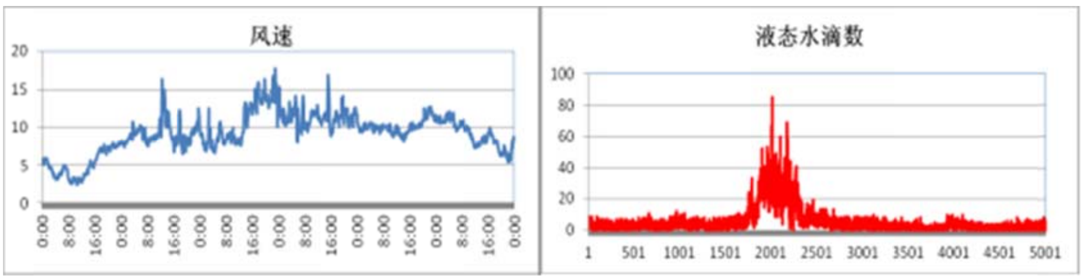

Fig. 2.3. Observed wind speed and sea spray during typhoon KUJIRA.

Fig. 2.5. Upgraded National Natural Disaster Management System

Fig. 2.5. National Natural Disaster Management System APP (village version)

Fig. 2.6. Natural Disaster MMS (left) and WeChat version of "China Disaster Reduction" (right)

Table 2.1. CMA Emergency Response and Typhoon Warning Service, 2015

TC No.	TC Name	Number of warnings issued	Emergency Response to Met. Disasters (typhoon) launched by CMA
1508	KUJIRA	11	Level-IV warning issued at 0830 of 22 June Level-IV warning dismissed at 0830 of 25 June
1509	CHAN-HOM	13	Level-III warning issued at 0830 of 7 July. Upgraded to Level-II at 0830 of 9 July. Further upgraded to Level-I at 0830 of 10 July. Level-I warning dismissed at 0830 of 12 July.
1510	LINFA	14	
1513	SOUDELOR	13	Level-III warning issued at 0830 of 6 August. Upgraded to Level-II at 0830 of 7 August. Downgraded to Level-IV at 0830 of 9 August. Level-IV warning dismissed at 0830 of 10 August.
1515	GONI	19	/
1519	VAMCO	4	/
1521	DUJUAN	11	Level-III warning issued at 0830 of 27 September Level-III warning dismissed at 0830 of 29 September
1522	MUJIGAE	11	Level-III warning issued at 0830 of 3 October Upgraded to Level-II at 0830 4 October Level-II warning dismissed at 1400 of 5 October