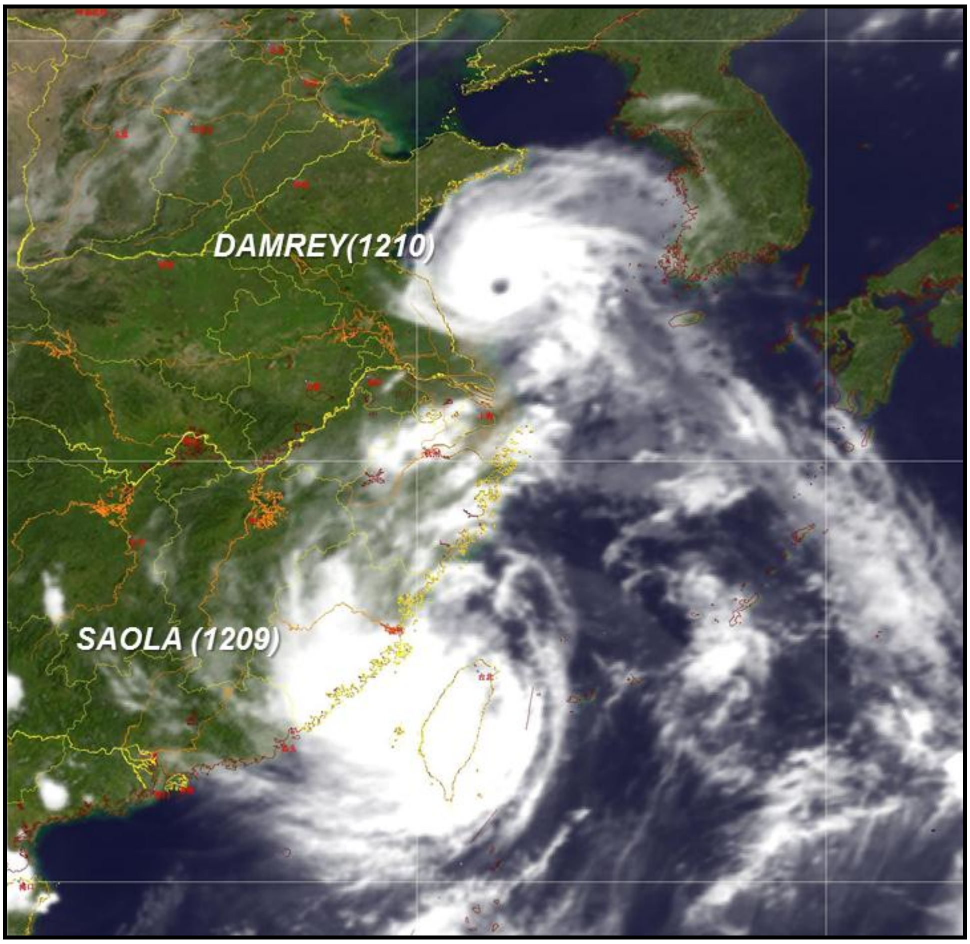
# MEMBER REPORT

(2012)

ESCAP/WMO Typhoon Committee



## China

# I. Overview of tropical cyclones which have affected/impacted Member's area in 2012

## 1.1 *Meteorological Assessment*

From 1 January to 31 October 2012, totally 23 tropical cyclones (including tropical storms, severe tropical storms, typhoons, severe typhoons and super typhoons) formed over the western North Pacific Ocean and the South China Sea (Fig1.1) and 7 of them made their landfalls on China's coastal areas (Fig1.2). They were severe tropical storm DOKSURI (1206), typhoon VICENTE (1208), severe typhoon SAOLA (1209), typhoon DAMREY (1210), severe typhoon HAIKUI (1211)， typhoon KAI-TAK (1213) and severe typhoon TEMBIN (1214).

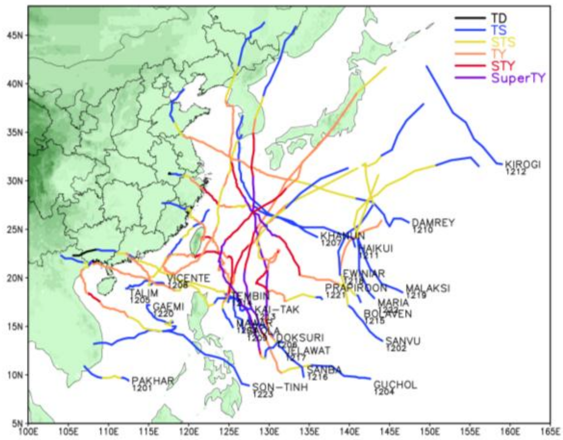


**Fig 1.1** Tracks of TCs over the western North Pacific and the South China Sea
(From 1 January to 31 October 2012)

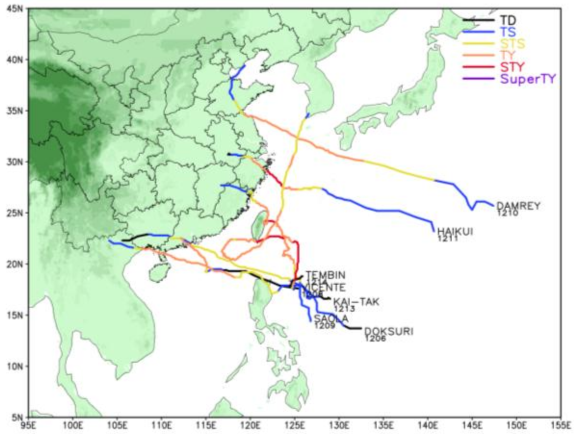


**Fig 1.2** Tracks of TCs that made landfall over China's coastal area
(From 1 January to 31 October 2012)

### *1.1.1 The Characteristics of tropical cyclones in 2012*

The characteristics of the tropical cyclones in 2012 are described as follows:

### *1) Stronger landing TCs than normal*

Until 31 October, 23 TCs formed over the Western North Pacific and the South China Sea. The total TC number is nearly the same as the average (22.9). Among those, 7 TCs made their landfall over China's coastal areas. The number of landing TC is slightly over historical average (6.6). Six of seven landing TCs made their landfalls in the form of typhoon or with higher intensity. Among them, Severe Typhoon SAOLA (1209), Severe Typhoon HAIKUI (1211) and Severe Typhoon TEMBIN (1214) made their landfalls with maximum surface wind speed around 42~45m/s. And the averaged intensity of all landing TCs is 38.1m/s, stronger than the average (31.4 m/s).

### *2) High frequency of landing activities in August*

In August, 5 TCs made their landfall over China's coastal areas (1209 SAOLA, 1210 DAMREY, 1211

HAIKUI, 1213 KAI-TAK and 1214 TEMBIN). This number also broke the historical record in August, just as the same month in 1994 and 1995. Particularly two tropical cyclones SAOLA and DAMREY made their landfalls on 2 August 2012 within only 10 hours in between, which was the earliest in record. Few days later, KAI-TAK made its landfall in Zhejiang Province. In one-week period, 3 TCs hit China's coastal areas.

### *3) Extensive areas affected by strong rainfall and winds*

In 2012, the coastal regions hit by TC landfalls extend from the Southeast to the Northeast part of China with a large spread of latitude. The TCs landing on the Southern China coast have higher frequency, while those landing on the Eastern China coast have strong intensity. DAMREY (1210) and BOLAVEN (1215) brought severe rainfall and gale winds in the north part of China, while normally only one tropical cyclone in every two years would impact that region in every two years. DAMREY (1210) became the strongest TC landing to the north of the Yangtze River since 1949.

There are 18 provinces/regions in China have been affected by strong rainfall related to TC landfalls. Among them, Liaoning province, the northeast part of Hebei Province, Zhejiang Province, Shanghai, and the south parts of Jiangsu and Anhui Provinces, and Guangdong and Guangxi Provinces have witnessed regional heavy rainfall. During the period of SAOLA (1209) affecting Taiwan Island, accumulated rainfall of 1786 mm has been observed in the Taiping Mountain in Yilan, Taiwan, China. During the period of Severe Typhoon HAIKUI (1211), strong winds related to TC landfalls affected coastal areas in Zhejiang Province in Aug 7-8. In those areas, gale winds above 12-level (Beaufort scale) lasted 33hr and 14-level lasted 24hr. The strong rainfalls and storm winds lasted for about one week by 3 TCs, which are SAOLA (1209), DAMREY (1210) and HAIKUI (1211) one after another.

### *4) Binary tropical cyclones (more than usual)*

There were much clearly more "binary typhoon" activities in 2012 than usual, and there were totally 10 individual typhoons that had formed into 5 binary typhoon processes, i.e. SAOLA and DAMREY; TEMBIN and BOLAVEN; JELAWAT and EWINIAR; MALIKSI and GAE MI; PRAPIROO and MARIA. Among them, SAOLA first landed on Hualien, Taiwan, China at 03:15 on August 2, and made its second landfall on Fuding, Fujian province at 06:50 on 3 August. DAMREY landed on Xiangshui County, Jiangsu Province at 21:30 on 2 August. DAMREY's landing time differed in less than 10 hours from the SAOLA's second landfall, breaking the record for the shortest interval of consecutive landing by two typhoons on China. TEMBIN first landed on Pingtung, Taiwan Province at 05:00 on 24 August, eventually on the Republic of Korea at 09:30 on 30 August. BOLAVEN first landed on PDRK and then entered Jilin and Heilongjiang provinces in China, bringing high winds and rainstorms to the East China coast, 3 provinces in the Northeast China and the Korean Peninsula.

### *5) Offshore intensification*

Among all TCs which either landed on or affected China in 2012, five typhoons were featured with offshore intensifications, and they were VICENTE (1208), DAMREY (1210), HAIKUI (1211), KAI-TAK (1213) and SON-TINH (1223) respectively. Specifically, VICENTE got intensified when it was approaching the coast of Midwest Guangdong, with its maximum wind near the centre increasing from Force 10 (25 m/s) up to Force 13 (40 m/s) before landing; DAMREY's extreme wind intensity at its centre reached 40 m/s after entering the Yellow Sea; HAIKUI became a strong typhoon 13 hours before its landfall, with its centre only 270 km from Xiangshan, Zhejiang province, and it reached the peak intensity with the maximum wind of Force 15 (48 m/s) near its centre just 4 hours before landing; KAI-TAK was only a severe tropical storm before it entered the 24-hour alerting line, but it reached the highest intensity of 40 m/s (Force 13) in its lifetime, when it was approaching to and landing on the west coast of the Guangdong Province; SON-TINH was intensified into a severe typhoon over sea about 100 km away from Sanya City, Hainan Province.

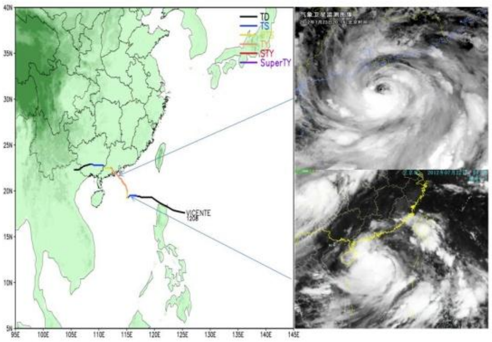


**Fig 1.3 (a)** Typhoon VICENTE (1208)
Upper right: 24 July; Lower right: 22 July

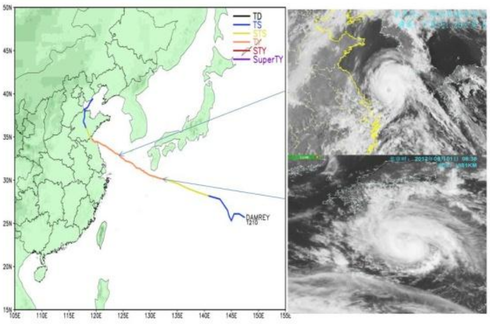


**Fig 1.3 (b)** Typhoon DAMREY (1210)
Upper right: 2 August; Lower right: 1 August

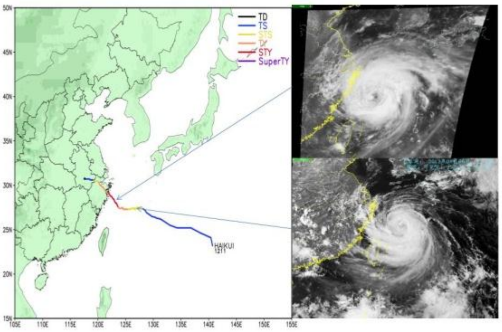


**Fig 1.3 (c)** Severe typhoon HAIKUI (1211)
Upper right: 7 August; Lower right: 6 August

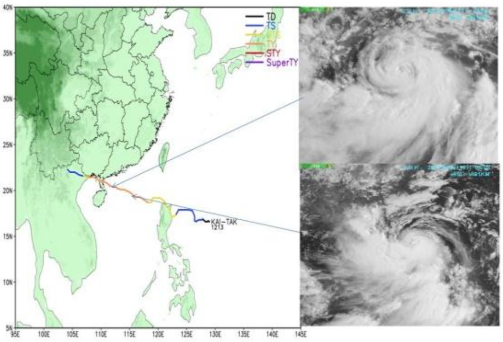


**Fig 1.3 (d)** Typhoon KAI-TAK (1213)
Upper right: 17 August; Lower right: 16 August

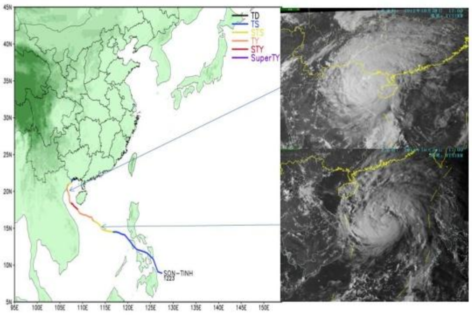


**Fig 1.3 (e)** Severe typhoon SON-TINH (1223)
Upper right: 28 Oct.; Lower right: 27 Oct.

### 1.1.2 Operational Forecast

From the perspective of TC track forecasts in the past 5 years, there is a tendency that the errors of the official typhoon track forecasts are decreasing year by year. In 2012, the deviations of 24-, 48- and 72-hour typhoon track forecasts were 93 km, 163 km and 232 km respectively, which were obviously less than the multi-year mean values, especially, the 24-hour forecast error was less than 100 km for the first time.

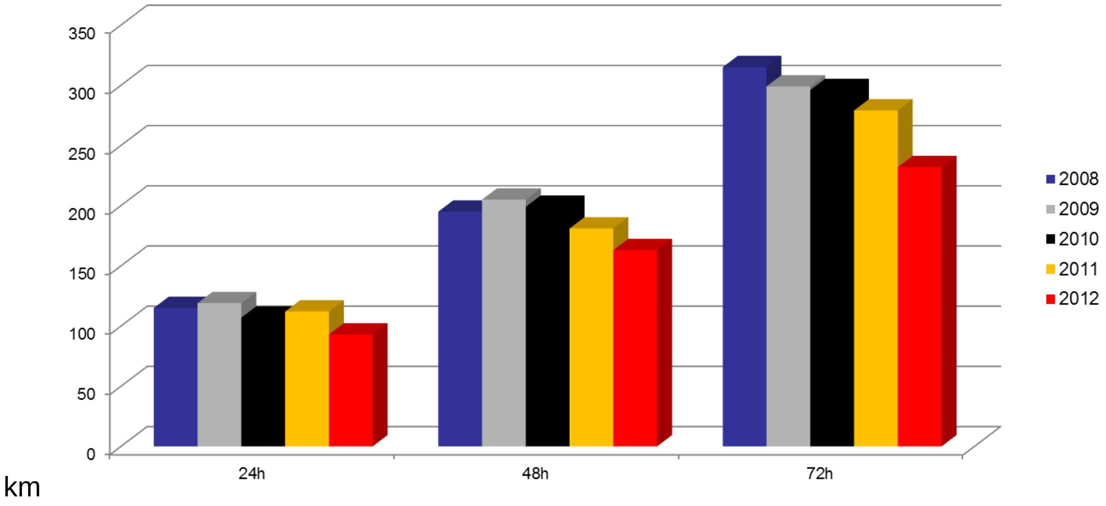


**Fig 1.4** CMA TC track forecast errors in the past 5 years

### 1.1.3 Narrative on Tropical Cyclones

#### *1) DOKSURI (1206)*

DOKSURI emerged as a tropical depression over the western North Pacific at 00:00 UTC 26 June 2012. It moved west-northwest afterwards. It developed into a tropical storm at 12:00 UTC 26 June. Then it turned to northwest. DOKSURI approached gradually to the coast of Guangdong Province, China. It landed on Zhuhai, Guangdong Province at 18:30 UTC 29 June with the maximum wind at 25m/s near its centre. After landfall, DOKSURI moved northwestwards with its intensity being weakened gradually. It became a tropical depression in Guangdong province, where it disappeared at 00:00 UTC 30 June. Its life was only 96 hours. DOKSURI is the first tropical cyclone landing on China in 2012. From 00:00 UTC 29 June to 00:00 UTC 30 June, Guangdong province, Guangxi Autonomous Region and Hainan province witnessed large-scale rainfall. The precipitation is 230 mm in Sanya, Hainan province.

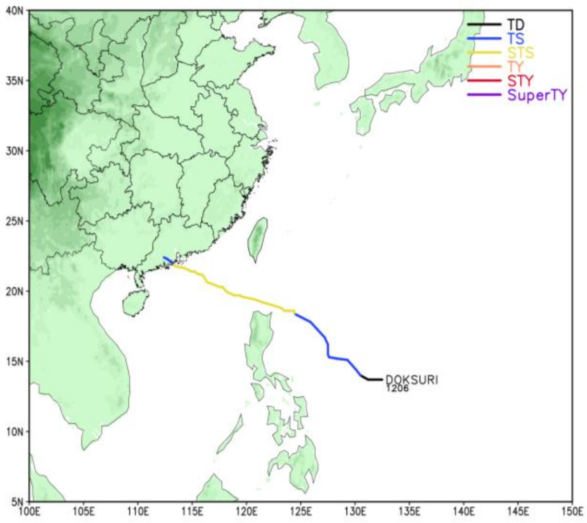


**Fig 1.5a:** Track of DOKSURI (1206)

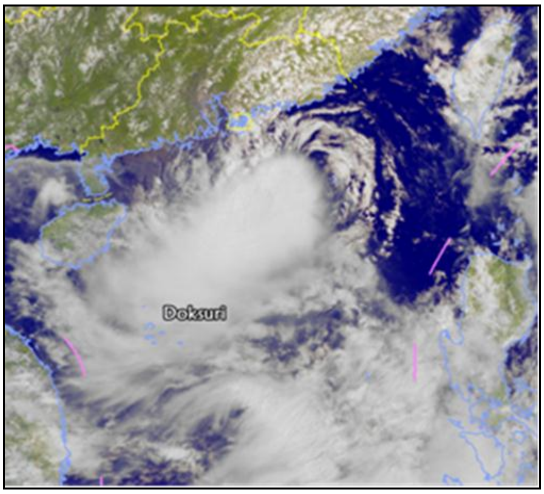


**Fig 1.5b:** FY-3B image at 05:45 UTC, 29 June

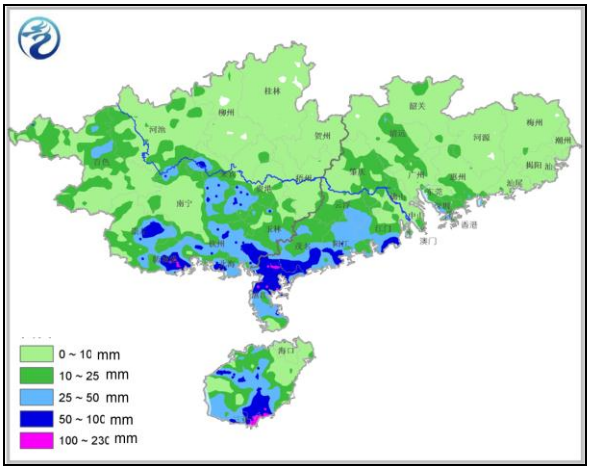


**Fig 1.5c:** Accumulative Precipitation of DOKSURI

(From 00:00 UTC 29 June to 00:00 UTC 30 June 2012)

### 2) *VICENTE (1208)*

It firstly turned out to be a tropical depression over the northeast offing of the Philippines at 00:00 UTC 20 July 2012. It moved west-northwest afterwards. VICENTE developed into a tropical storm over the northeastern part of South China Sea at 15:00 UTC 21 July. It intensified gradually and become a typhoon at 02:00 UTC 23 July. Then it approached gradually to the western coast in Guangdong Province, China. VICENTE intensified inshore. It landed on Taishan, Guangdong Province at 20:15 UTC 23 July with the maximum wind at 40m/s near its centre. After landfall, it turned gradually westwards and entered Guangxi Zhuang Autonomous Region, where it was weakened and became a tropical depression at 15:00 UTC on 24 July. At last, it disappeared over northern Vietnam at 06:00 UTC on 25 July. From 00:00 UTC on 23 July to 00:00 UTC on 27 July, large-scale rainfall emerged in Guangdong Province, Hainan, Fujian and Yunnan Provinces and Guangxi Autonomous Region.

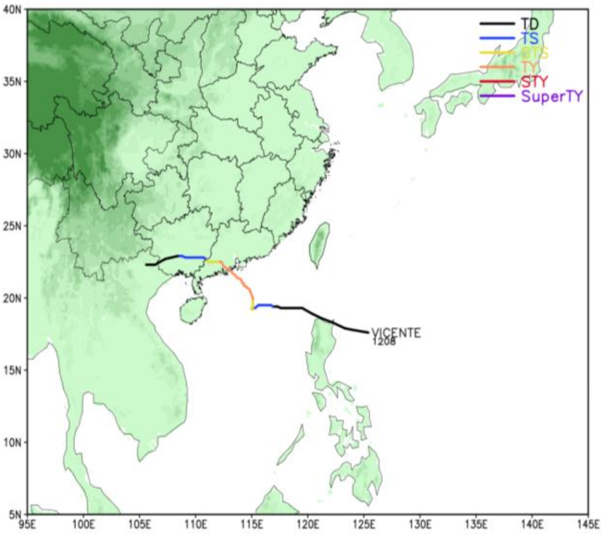


**Fig 1.6a:** Track of VICENTE (1208)

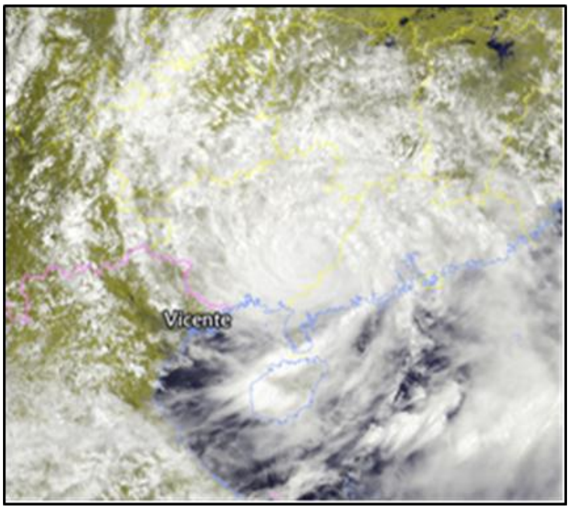


**Fig 1.6b:** FY-3B image at 06:20UTC 24 July

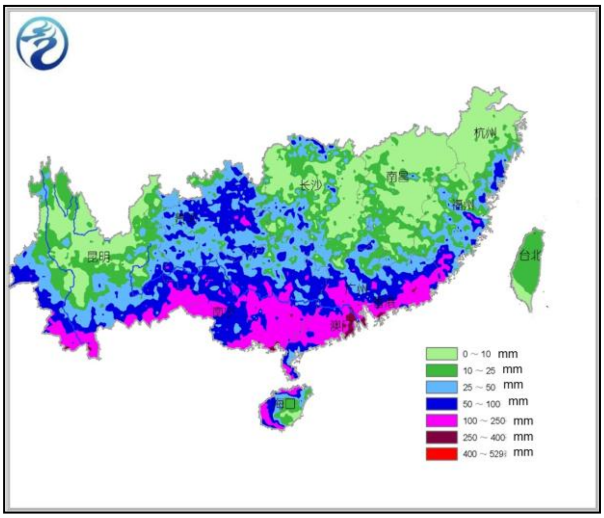


**Fig 1.6c:** Accumulative Precipitation of VICENTE

(From 00:00UTC 23 July to 00:00UTC 27 July 2012)

**Fig 1.6d:** A big tree damaged by VICENTE

### *3) SAOLA (1209)*

Tropical storm SAOLA was formed at 00:00 UTC on 28 July 2012 over the east offing of the Philippines. It moved north-northwest afterwards. Its intensity reached a typhoon category at 06:00 UTC on 30 July. It developed into a severe typhoon at 14:00 UTC 1 August. Then it turned to west-northwest. It approached gradually to the eastern coast of Taiwan, China. SAOLA landed on Hualien in Taiwan, China at 19:15 UTC 1 August with the maximum wind up to 42m/s near its centre. After the first landing, it changed its path to southwest, looped counter-clockwise, then it turned northwest. SAOLA gradually approached the northern coast of Fujian province and landed on Fuding, Fujian Province at 22:50 UTC 2 August, with the maximum wind at 25m/s near its centre. After landing, its intensity was weakened gradually. SAOLA entered Jiangxi Province at 11:00 UTC 3 August, where it became a tropical depression at 13:00 UTC 3 August. At last it disappeared at 15:00 UTC 3 August in Jiangxi province. SAOLA moved very slowly in its life.

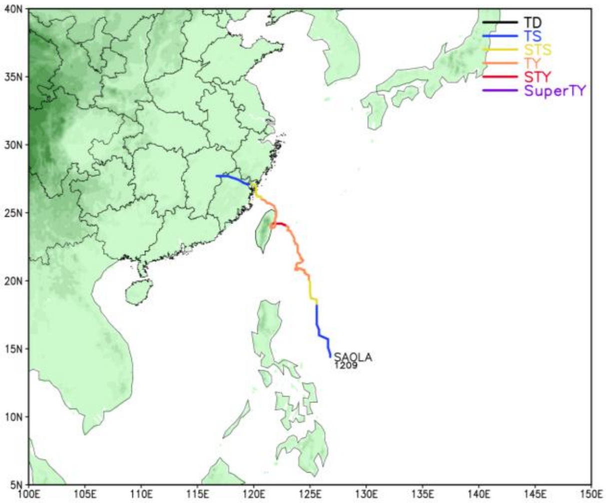


**Fig 1.7a:** Track of SAOLA (1209)

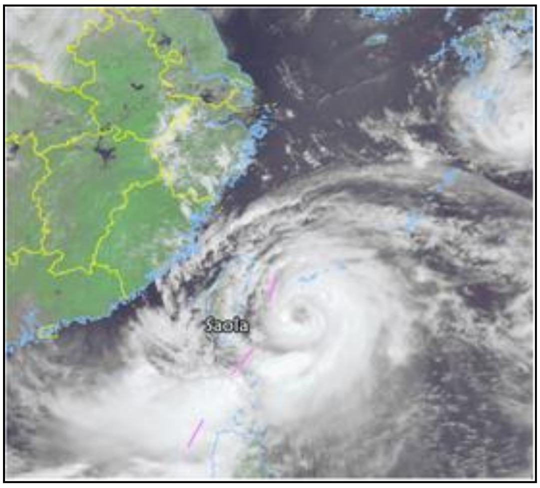


**Fig 1.7b:** FY-3A image at 02:20UTC
1 August

**Fig 1.7c:** A big billboard damaged by SAOLA

### *4) DAMREY (1210)*

Tropical storm DAMREY was formed at 12:00 UTC 28 July 2012 over the western North Pacific, and it moved west-northwest. Then it turned to move northwestwards. It intensified into a severe tropical storm at 00:00 UTC 31 July and a typhoon at 00:00 UTC 1 August respectively. Then it was gradually approaching the northern coast of Jiangsu Province, China, DAMREY landed on Xiangshui, Jiangsu Province at 13:30 UTC 2 August with the maximum wind at 35m/s near centre. After landfall, it turned north-northwest and entered Shandong Province, China. It was weakened and became a tropical storm at 01:00 UTC 3 August. Then it began to move north-northeast and entered Bohai Sea. DAMREY became a tropical depression over the northern part of Bohai Sea, where it disappeared at 03:00 UTC 4 August. DAMREY is the strongest typhoon that made landfall on the north part of the Changjiang River since 1949. The common effect of DAMREY and SAOLA, from 00:00 UTC 2 August to 00:00 UTC 5 August, Fujian, Zhejiang, Shandong, Hebei and Liaoning was represented by rainfall. The precipitation was 405 mm at Xiuyan, Liaoning Province.

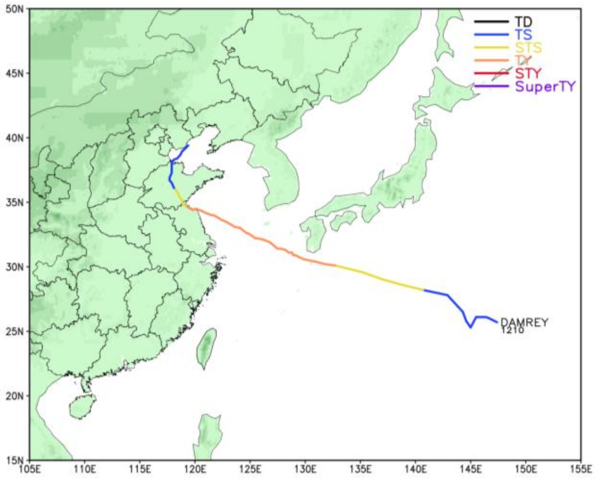


**Fig 1.8a:** Track of DAMREY (1210)

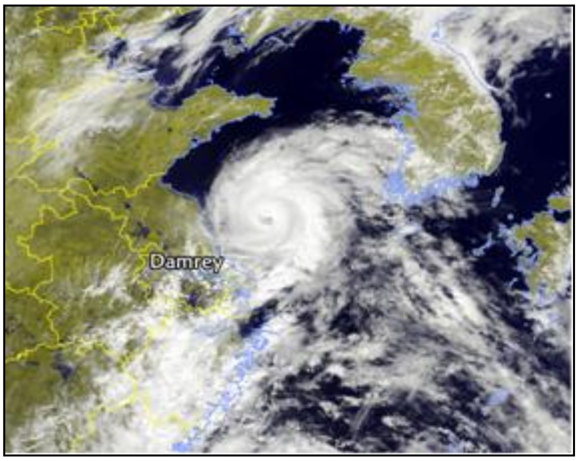


**Fig 1.8b:** FY-3B image at 05:20UTC 2 August

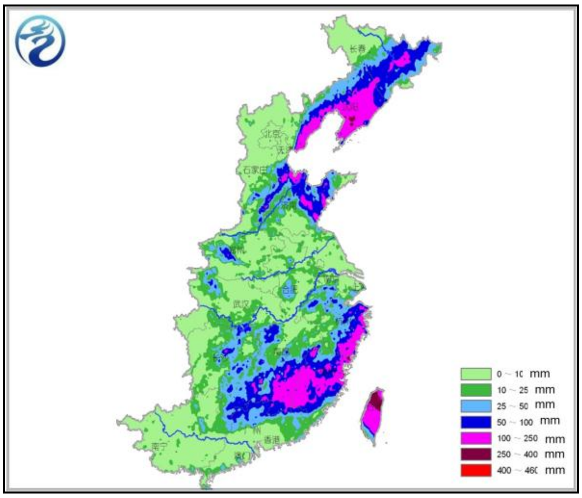


**Fig 1.8c:** Accumulative precipitation of SAOLA and DAMREY

(From 00:00UTC 2 August to 00:00UTC 5 August 2012)

**Fig 1.8d:** Some billboards damaged by DAMREY

### *5) HAIKUI (1211)*

The Tropical storm HAIKUI appeared at 00:00 UTC 3 August 2012 over the Northwestern Pacific. It moved west-northwest after its genesis. Its intensity increased into a severe typhoon category at 06:00 UTC 7 August. Then it turned northwest. HAIKUI gradually approached the northeastern coast of Zhejiang province, China. Later it landed on Xiangshan of Zhejiang Province at 19:20 UTC 7 August with the maximum wind up to 42m/s near its centre. After its landfall, it continued to move northwest with its intensity being reduced. Then it crossed Zhejiang province and entered Anhui province. HAIKUI became a tropical depression in Anhui province, where it disappeared at 15:00 UTC 9 August. After landfall, HAIKUI moved very slowly. It remained long time in land. HAIKUI is the strongest tropical cyclone that it landed on Mainland China. From 12:00 UTC, 6 August to 00:00 UTC, 11 August, Jiangsu Anhui and Jiangxi were affected with rainfall. The precipitation was 740.3 mm at Mt. Huangshan in Anhui Province.

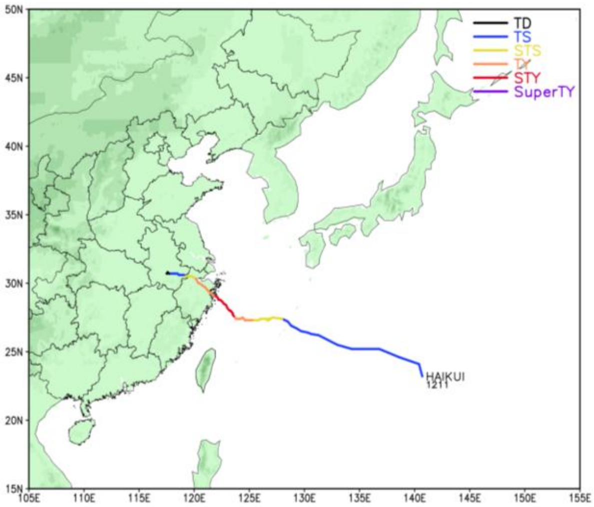


**Fig 1.9a** Track of HAIKUI (1211)

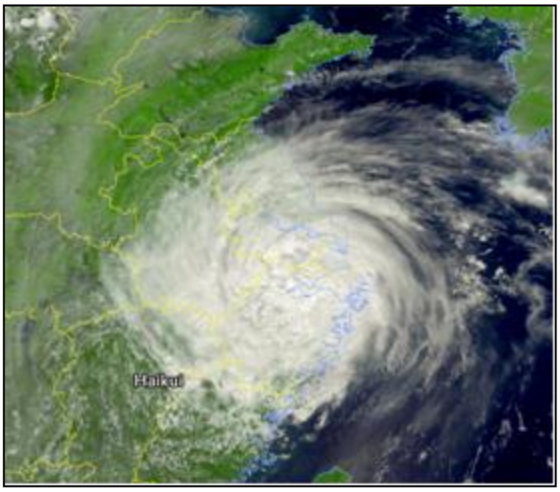


**Fig 1.9b** FY-3B image at 05:10UTC 8 August

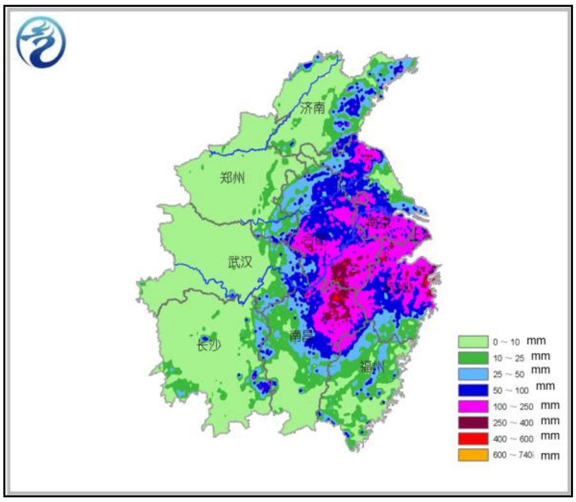


**Fig 1.9c:** Accumulative precipitation of HAIKUI **Fig 1.9d:** Ferris wheel destroyed by HAIKUI

(From 12:00UTC 6 August to 00:00UTC 11 August 2012)

### *6) KAI-TAK (1213)*

KAI-TAK emerged as a tropical depression over the east offing of Luzon, the Philippines at 12:00 UTC 12 August 2012. Moving west-northwest, it intensified into a tropical storm at 00:00 UTC 13 August. It intensified gradually and became a severe tropical storm at 15:00 UTC 14 August. Then it approached gradually to Luzon, the Philippines. KAI-TAK landed on the northeastern coast of Luzon on 14 August. Then it began to move northwest and entered South China Sea. As it was gradually approaching the western coast of Guangdong Province, it intensified into a typhoon inshore at 21:00 UTC 15 August. KAI-TAK landed again on Zhanjiang, Guangdong Province at 04:30 UTC 17August with the maximum wind reaching 38m/s near its centre. After landfall, KAI-TAK turned west-northwest and entered Beibu Gulf. It landed thirdly on the northern coast of Vietnam 17 August. It was weakened rapidly and became a tropical depression at 06:00 UTC 18 August. At last, it disappeared over northern Vietnam on 18 August. From 00:00 UTC 16 August to 00:00 UTC 19 August, rainfall emerged in Guangdong, Guangxi, Hainan and Yunnan. The accumulated precipitation was 631 mm in the Fangchenggang City, Fangchenggang (Guangxi Province).

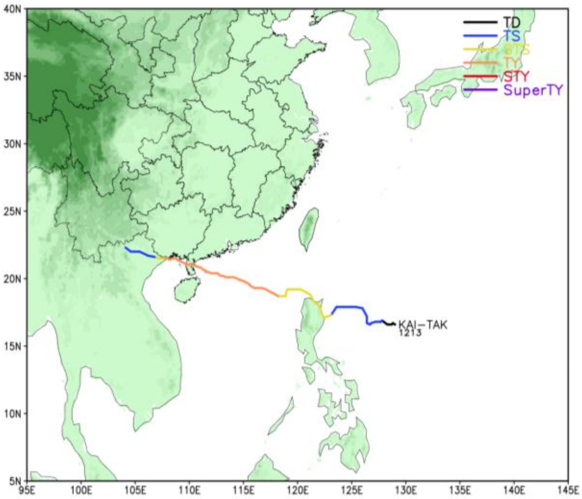


**Fig 1.10a:** Track of KAI-TAK (1213)

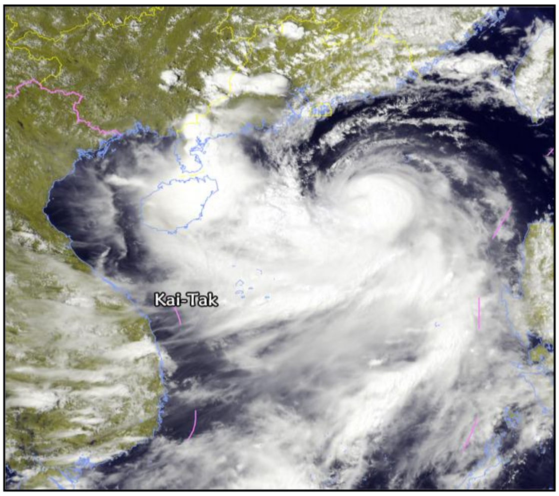


**Fig 1.10b:** FY-3B image at 06:00UTC 16 August

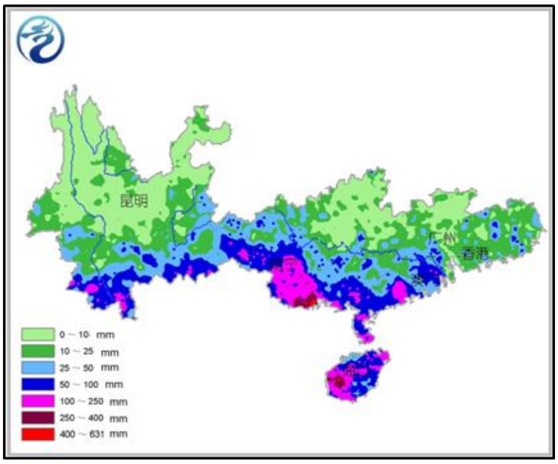


**Fig 1.10c:**Accumulative precipitation of KAI-TAK(From 00:00UTC 16 August to 00:00UTC 19 August 2012)

**Fig 1.10d:** Influence, KAI-TAK

### *7) TEMBIN (1214)*

TEMBIN initially turned out to be a tropical depression over the northeast offing of the Philippines at 06:00 UTC on 18 August 2012. It moved southwest afterwards. TEMBIN developed into a tropical storm at 00:00 UTC 19 August. It intensified gradually and became a severe tropical storm at 18:00 UTC 19 August. Then it turned to northwards. It intensified quickly into a severe typhoon at 06:00 UTC 20 August. TEMBIN approached gradually to the southern coast of Taiwan, China. It landed on Pingdong, Taiwan Province at 21:15 UTC 23 August, with the maximum wind up to 45m/s near its centre. After landfall, it moved westwards and entered the northeastern part of South China Sea. It suddenly changed its stable path westwards over the northeastern part of South China Sea, looped counter-clockwise, then it turned north-northeast with its intensity being weakened into a severe tropical storm at 12:00 UTC on 28 August. Then it entered East China Sea and Yellow sea. TEMBIN approached gradually to the southwestern coast of Korea Peninsula. It reduced to a tropical storm at 01:00 UTC on 30 August. It landed again on the southwestern coast of Korea Peninsula on 30 August. At last it faded away in Korea Peninsula at 06:00 UTC on 30 August.

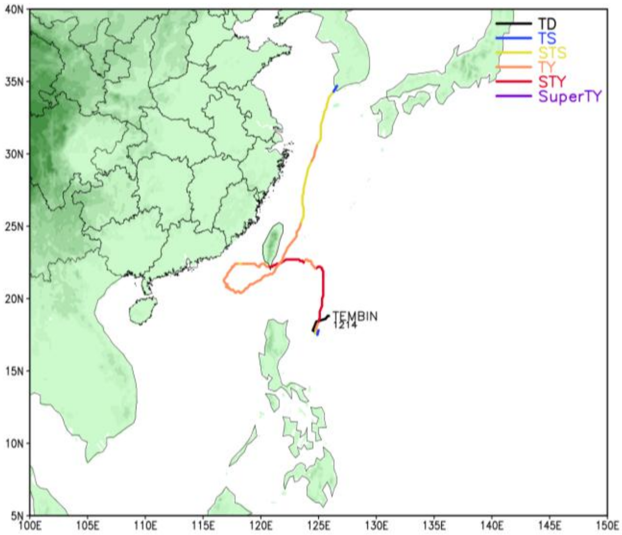


**Fig 1.11a:** Track of TEMBIN (1214)

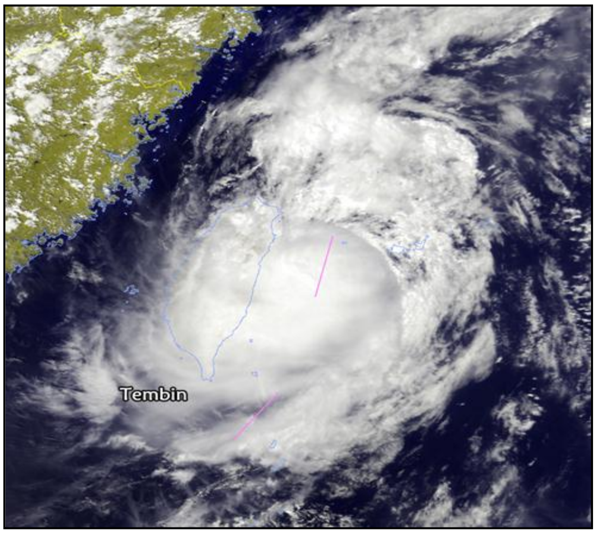


**Fig 1.11b:** FY-3B image at 05:35UTC 28 August 2012

**Fig 1.11c:** The street inundated by TEMBIN

Although super typhoon BOLAVEN(1215) did not make landfall over China, it really brought severe impacts to China.

### *8) BOLAVEN (1215)*

BOLAVEN firstly turned out to be a tropical depression over the western North Pacific at 00:00 UTC 20 August 2012. It moved west-northwest afterwards. BOLAVEN developed into a tropical storm at

06:00 UTC 20 August. It intensified gradually and became a severe typhoon at 18:00 UTC 23 August. Then it turned northwestwards. It intensified into a super typhoon at 09:00 UTC 25 August. Then it entered East China Sea. It turned north with its intensity being weakened into a typhoon at 14:00 UTC 27 August. Then it entered Yellow sea. BOLAVEN gradually approached the northwestern coast of Korea Peninsula. It was weakened to a severe tropical storm at 12:00 UTC 28 August. It landed on the northwestern coast of Korea Peninsula 28 August. After landfall, BOLAVEN turned north-northeast and entered Liaoning Province, China. Then it entered Heilongjiang Province, China. At last it disappeared at 09:00 UTC 29 August in Heilongjiang Province, China. Its life was 9 days. From 00:00 UTC 28 August to 23:00 UTC 28 August, large-scale Instantaneous gales emerged in Zhejiang, Jiangsu, Shandong, Liaoning, Jilin and Heilongjiang provinces. The instantaneous wind reached 38.2m/s at Zhuanghe of Liaoning province. From 00:00 UTC 27 August to 00:00 UTC 30 August, widespread rainfall occurred in Shandong, Liaoning, Jilin and Heilongjiang provinces. The precipitation was 207 mm at Benxi in Liaoning Province.

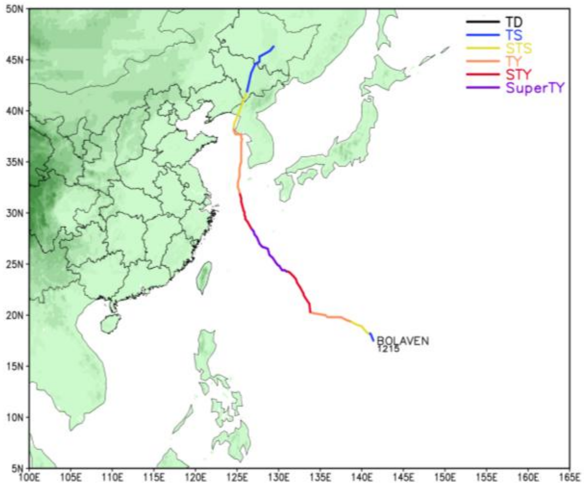


**Fig 1.12a:** Track of BOLAVEN (1215)

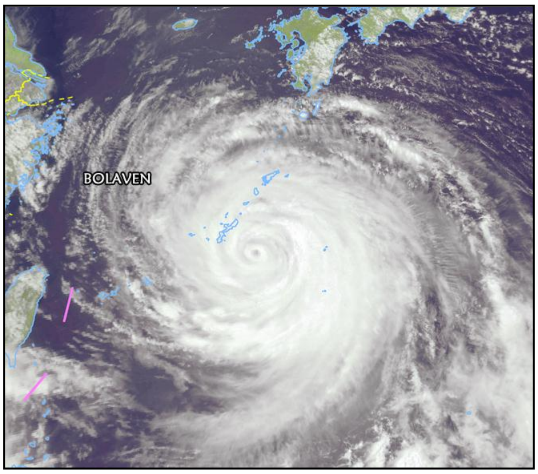


**Fig 1.12b:** FY-3B image at 04:35UTC August

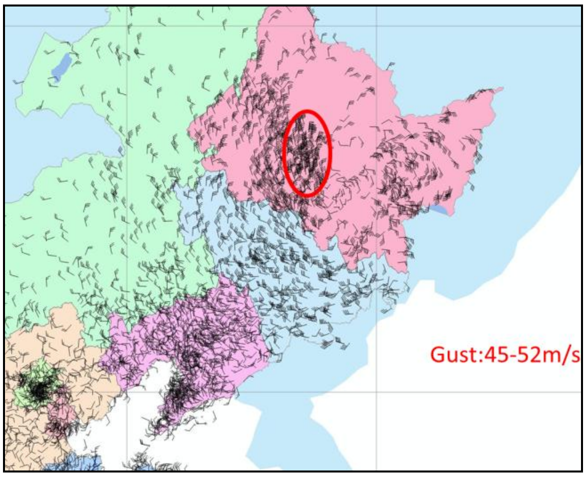


**Fig 1.12c:** Gust of BOLAVE

(03:00UTC 29 August 2012)

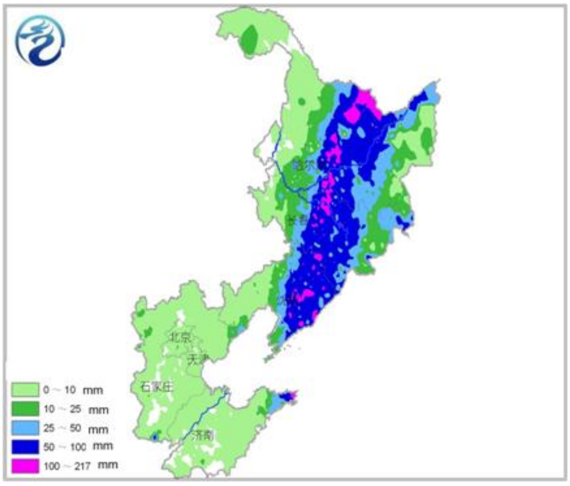


**Fig1.12d:** Accumulative precipitation of BOLAVEN

(From 00:00UTC 27 August to 00:00UTC)

### *1.2 Hydrological Assessment (highlighting water-related issues/impact)*

In 2012, in general, the precipitation was evenly distributed nationwide, but the precipitation in the Northern China was evidently more than usual, featuring earlier, more frequent and repeated occurrences of heavy rain with higher intensities in some localities. Compared with normal years, the precipitation increase ranged from 50% to 100% in Midwest Inner Mongolia, Western Gansu, Southern Xinjiang; and it was 20%~40% less than normal in Northwestern Henan, Southern Shanxi, and some areas in the Tibet. According to the statistical analyses by river basins, with only exception of the Huai River basin where the rainfall was 10% less than the normal value, all other river basins witnessed more rainfall than normal or close to it, especially in Zhejiang-Fujian region and Liaohe River basin where the rainfall increased by 20%. The short but high-intensity rainfalls occurred in Gansu, Guizhou, Sichuan, Beijing, Inner Mongolia, Ningxia, Xinjiang among others, among which the Min County in Gansu recorded the maximum hourly rainfall up to 65.4 mm in the first 10-day period in May, with a probability of reoccurrence beyond 1-in-100 year; and the Hebei Township in the Fangshan District of Beijing measured the daily rainfall of 541 mm on 21 July, approaching to the probability of 1-in-500 years.

There were frequent floods from small- and medium-sized rivers nationwide, and there were more than 350 rivers with water exceeding their warning levels and eventually causing inundations, 60 rivers being overwhelmed due to super-saturation, and 35 rivers meeting historical record-breaking floods. The main trunk of the Yangtze River had met 4 water-level peaks, with its Zhutuo River segment leading to an extensive record-breaking flood, with Cuntan River segment causing the largest flood since 1981. Totally, 3 water level peaks occurred in the main trunk of the Yellow River, and its upper and lower reaches met the largest flood since 1989. The Beiyun River segment in the Hai River basin witnessed the historical record-breaking flood. The Juma River, a branch of the Daqing River, caused the largest flood since 1963. Flood took place in the Taihu Lake region as its water level was beyond the warning line.

Overall, water was abundant in the major rivers across the country, and obviously there was more inflow water than usual in the upper reach of the Yellow River, whereas there was apparently less inflow water than usual in the Huai River and Songhua River. According to statistics of accumulated water inflows in 7 major rivers nationwide in comparison with same period in normal years, from January to September, with exceptions of the main trunk of the Huai River where inflow was 60%~70% less than normal, the Songhua River and Liao River where inflows were 10%~40% less than normal value, and Xijiang River where inflow was almost 20% less than normal, the rest 4 major rivers had more water inflows than normal or close to it. Specifically, the inflow of the upper reach of the Yellow River was increased by nearly 60%, those of the middle reach of the Yellow River and Yangtze River by more than 10%, and those of Xiangjiang River in Hunan and Ganjiang River in Jiangxi Province by 10%~30%.

The water storage in the large reservoirs reached a high level across the country, especially the situation was better than that in last year in the northern area. By 1 October, the total water storage in nationwide 422 reservoirs reached 214.77 billion cubic meters, 16.03 billion cubic meters more than that in the same period of 2011, increasing by 10%, compared with the same period of many years, it was increased by 35.43 billion cubic meters on average, accounting for 20%. According to the statistics based on 134 large reservoirs in the nine provinces (cities, districts) to the north of the Yellow River, the total amount of water was 49.84 billion cubic meters by 1 October, or 2.25 billion cubic meters more than that in early September, accounting for 10% more; it was increased by 7.33 billion cubic meters compared with that in the same period of 2011, accounting for 20% increase; compared with the same period of many years, it was increased by 7.33 billion cubic meters on average, increasing by 20%.

### *1.3 Socio-economic Assessment (highlighting socio-economic and DPP issues/impacts)*

Typhoons or tropical storms brought abundant precipitation to China, and abated the agricultural drought and impact of warm weather on Jiangnan (areas to the south of the Yangtze River) and the South China, and favored water storage in reservoirs. The violent gust, heavy rain and associated astronomical tides also brought about severe losses in the coastal areas in 2012. About twenty provinces have been impacted, because generation locations of typhoons are northern shift further than normal. Comparing with the economic losses caused by typhoons with those of the last 10 years, the economic losses from Jan. to Oct. 2012 were heavier.

In 2012 typhoon disasters affected 50,445,000 person-times in 18 provinces/autonomous regions /municipalities including Hebei, Liaoning, Jilin, Heilongjiang, Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Shandong, Henan, Hubei, Hunan, Guangdong, Guangxi, Hainan and Taiwan, claimed 78 lives, with 24 persons missing and 5,620,000 person-times being relocated, affecting 5,998,200 hectares of croplands, including 696,000 hectares of complete failure, and toppling 125,000 houses in which 246,000 were seriously damaged and 419,000 were moderately damaged, with a total direct economic loss of 113.73 billion RMB Yuan. Jilin, Heilongjiang, Hebei, Liaoning and Shandong among others in the North China, which are rarely affected by typhoons, suffered from serious damages and losses.

**Table 1.1** Impacts & losses by TCs in China in 2012

| **TC Name** (Number) | **Landing Date** | **Landing Place** | **Maximum Wind at landing** | **Affected Provinces** | **Affected People** (ten thousand) | **Death/ Missing People** | **Direct Economic Losses** (0.1 billion RMB Yuan ) |
|---|---|---|---|---|---|---|---|
| *Talim* (1205) | / | / | / | Fujian, Taiwan | 25 | 1 | 22.5 |
| *Doksuri* (1206) | 30 Jun | Zhuhai, Guangdong | 25m/s | Guangdong, Hainan | 0 | 0 | 0 |
| *Vicente* (1208) | 24 Jul | Taishan, Guangdong | 40m/s | Guangdong, Guangxi,Hainan, Fujian,Yunnan | 162.7 | 11 | 20.5 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Saola*<br>(1209) | 2 Aug | Hualian,Taiwan | 42m/s | Hualian,Taiwan | 1762.6 | 73 | 461.5 |
| | 3 Aug | Fuding, Fujian | 25m/s | Fujian,Jiangxi, Hubei, Hunan, | | | |
| *Damrey*<br>(1210) | 2 Aug | Xiangshui, Jiangsu | 35m/s | Jiangsu, Henan, Shandong,Zhejiang Hebei,Liaoning | | | |
| *Haikui*<br>(1211) | 8 Aug | Xiangshan, Zhejiang | 42m/s | Zhejiang, Anhui,Jiangxi, | 1438 | 6 | 370.9 |
| *Kai-Tak*<br>(1213) | 17 Aug | Zhanjiang, Guangdong | 38m/s | Guangdong, Guangxi,Hainan, Yunnan | 491.5 | 4 | 48.5 |
| *Tembin*<br>(1214) | 24 Aug | Pingdong, Taiwan | 45m/s | Taiwan | 977.0 | 0 | 198.2 |
| *Bolaven*<br>*(1215)* | / | / | / | Shandong,Liaoning, Jilin,Heilongjiang | | | |
| *Son-Tinh*<br>(1223) | / | / | / | Hainan, Guangxi | 187.7 | 7 | 15.2 |
| **Total** | | | | | 5044.5 | 102 | 1137.3 |

### *1.4 Regional Cooperation Assessment (highlighting regional cooperation successes and challenges)*

### *1) Training course on Dvorak technique*

Typhoon and Marine Weather Forecast Centre of CMA (TMWFC) held a training course on Dvorak technique from 22 to 29 February for young forecasters. The trainees were from TMWFC and researchers from Remote Sensing Department of NSMC and Shanghai Typhoon Institute. On the first half of the course, Dr. Xu Yinglong, the Chief Forecaster of NMC, gave an explanation on the process and rules of Dvorak technique in detail. On the second half of the course, Mr. Chan S.T., the senior scientific director of HKO, had been invited and given an introduction on the history of Dvorak technique and each detailed step of the technique documents and the present application situation of Dvorak technique in each tropical cyclone forecasting centre over the world. Besides, Mr. Chan shared many experiences in using Dvorak technique in HKO operational work. The trainees practiced Dvorak technique using previous TC cases under tutors' guidance.

**Fig 1.13** Forecasters and researchers in the Dvorak technique training course

***2) The roving seminar of TRCG***

The roving seminar 2012, endorsed by the Committee's Training and Research Coordination Group (TRCG), was held in Seoul from 30 October to 1 November in 2012. Dr. Xu Jing from the National Meteorological Centre of China Meteorological Administration to serve as a resource person for Topic B and to share with the participants her expertise and experience in the field of high impact weather and natural hazards induced by tropical cyclones.

**Fig 1.14** Dr. Xu took part in the seminar in Seoul

# II. Summary of progress in Key Result Areas

## 2.1 Progress on Key Result Area 1: Reduced Loss of Life from Typhoon-related Disasters.

### 2.1.1 Meteorological Achievements/Results

In 2012, totally 7 typhoons landed on China, six of which reached typhoon intensity. China Meteorological Administration initiated Meteorological Disaster Emergency Response plans respectively. Among these, the Category II emergency response was initiated for Vicente (1208), SAOLA (1209), DAMREY (1210) and KAI-TAK (1213). In response to typhoon HAIKUI (1211), China Meteorological Administration firstly initiated red warning in the past five years. Others, CMA issued Category III Emergency Responses respectively to address typhoon TEMBIN and BOLAVEN. The details were in following table.

**Table 2.1** CMA typhoon emergency response table in 2012

| **TC Name** (Number) | **Emergency Response Actions** | | **Landing Time/Date** |
|---|---|---|---|
| | **Category** | **Action Time** | |
| 1206 DOKSURI | III | 09:00 UTC, 29 Jun. | 2:30 UTC, 30 Jun. |
| 1208 VICENTES | III<br>II | 11:30 UTC, 22 Jul.<br>17:00 UTC, 23 Jul. | 4:15 UTC, 24 Jul. |
| 1209 SAOLA<br>1210 DAMREY | III<br>II<br>IV | 11:30 UTC, 31 Jul.<br>22:30 UTC, 1 Aug.<br>12:00 UTC, 3 Aug. | SAOLA 6:50 UTC, 3 Aug.<br>DAMREY 21:30 UTC, 2 Aug. |
| 1211 HAIKUI | III<br><br>II<br>I | 09:00 UTC, 6 Aug.<br>17:00 UTC, 8 Aug.<br>08:30 UTC, 7 Aug.<br>18:00 UTC, 7 Aug. | 03:20 UTC, 8 Aug. |
| 1213 KAI-TAK | IV<br>II | 10:00 UTC, 15 Aug.<br>09:00 UTC, 16 Aug. | 12:30 UTC, 17 Aug. |
| 1214 TEMBIN | III | 18:00 UTC, 22 Aug. | |

As typhoons SAOLA (1209) and DAMREY (1210) impacted the coastal area of east China, then typhoon HAIKUI (1211) approached. CMA had started the intensive observations of satellite, radar, and sounding to track the typhoon closely, the FY-2F meteorological satellite typhoon image was made every 6 minutes,126 times intensive observations from 20 sounding stations were carried out, which are located in 7 provinces/cities. The NMC of CMA had carried out intensive forecast consults in collaboration with Fujian, Zhejiang, Jiangsu and Shandong provincial meteorological services. The NMC/CMA issued red warning for typhoon in succession twice a day.

In response to typhoon HAIKUI (1211), CMA had initiated the category I emergency response plan on

August 7, which was the first time in the past five years, and sent workgroup to Shandong, Zhejiang and Shanghai to guide the meteorological service. Although typhoon BOLAVEN (1215) did not make landfall on China, but it still brought severe impact to the Northeast China after it landed on PDRK. CMA had initiated Category III emergency response at 18:00 UTC in 22 August, and Liaoning meteorological bureau had initiated category I emergency response at 8:00 UTC in 27 August. Liaoning, Jilin and Heilongjiang suffered severe storm flood disasters, which brought 15 billion RMB Yuan direct economic losses.

**Fig 2.1** Observers in Dachen Island in Zhejiang made observations in a harsh condition

**Fig 2.2** A large number of vessels orderly returned to harbor, Taizhou, Zhejiang Province

**Fig 2.3** On 28 August, Changchun City, Jilin Province, torrential rain and wind caused by Bolaven flooded some regions

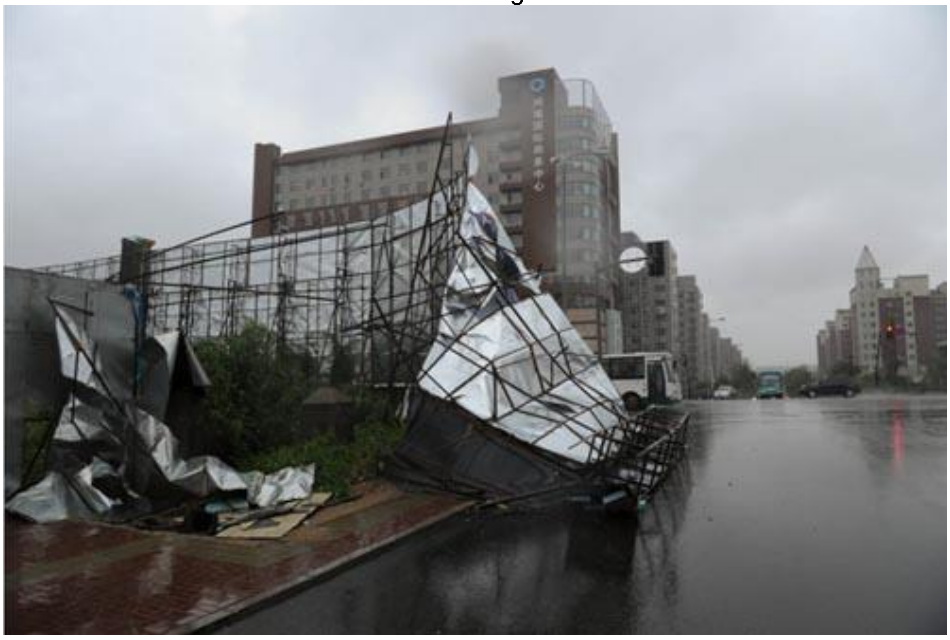


**Fig 2.4** High wind damaged a roadside billboard in Changchun City, Jilin Province

### *2.1.2 Hydrological Achievements/Results*

In 2012, the Bureau of Hydrology, MWR focused on the flood control and drought relief work, strengthened the construction of hydrological information and forecasting institutions, strengthened the efforts in hydrological monitoring and forecasting, and provided better hydrological services in flood control- and drought relief-oriented services; it enhanced efforts to upgrade its hydrological operational system, to refine the hydrological information processing, and to extend hydrological services and products; and it fully implemented the construction of hydrological monitoring system for medium- and small-sized rivers, further advanced the monitoring and early warning of flash floods and hydrological monitoring in emergency.

***1) Closely monitoring the Hydrology development, and making rolling prediction and forecasting to enhance the efforts on flood control and drought hydrological meteorological services***

The first is to strengthen the hydro-meteorological work shifts. During the Spring Festival, the hydro-meteorological personnel were arranged on duty every day, routine work shifts were arranged in March, and 24-hour work shifts were advanced in mid-May, monthly and ten-day Hydrological Overview Summary were added, apart from the issuing of the hydrological situation reports and forecasts as well as SMS 3 times per day. The second is to increase efforts on the preparation of the service materials. Up to now, totally 109 "Hydrological Situation Reports", 141 "Hydrological Bulletins", 38 "Hydrological Forecasts” have been issued, and over 100 comprehensive analysis materials have been submitted. The third is to timely submit the analysis on significant hydrological situations and forecasts. More than 10 analysis-based comments on rainfall and hydrological trend forecast have been reported since the beginning of 2012, meanwhile the real-time flood forecasts were released for more than 500 stations, to provide a scientific basis for the leaders of the Ministry of Water Resources and the National Disaster Prevention Office to make decision. The fourth is to expand the hydrological service contents. The information including soil moisture and water level of medium-sized reservoirs were collected in real time, to lay a good foundation for drought information services. The prediction and forecasting for 63 main control sections have been conducted, which were issued forecasts twice per day at 9:00 and 21:00 respectively.

***2) Improving the related hydrological meteorological operational systems, and providing the system platform in order to improve the level of hydrological meteorological consultation***

Based on ArcGIS platform developed in the phase-1 project of the State Flood Control and Drought Relief Command System, a new version of the Regime Consultation System has been developed, which has completed the system function of service platform and information platform. The system provide four categories of 14 hydrological products, featuring intuitive displays in both areas and specific points, automatic generation, active push, easy to operate and rapid access. The system has been put into operation during the flood control consultations of the National Disaster Prevention Office in flood season of 2012. The meteorological operational application system has been improved, initially completing software development of precipitation forecast products production, to get a trial run in the weather forecasting operation; to transform and standardize the rainfall map displaying color of numerical prediction product, and enable consistent forecasting precipitation figure showing consistent, which achieved good results in flood control consultation and publicity. In addition, the flash flood warning system, the flood forecasting system and the database maintenance management system have been improved, regimen consultation system has been tested, which provide technical support for the hydrological services in 2012.

***3) Strengthening the management of the information submission to conduct the integration of information source of small and medium-sized rivers, flash flood monitoring and early***

***warning***

In March, the National Disaster Prevention Office issued "Notice on Assigning the Task for Flood and Drought Reporting in 2012 ", which has identified 4500 stations reporting floods and droughts, 63 major rivers forecasting stations and 77 coastal typhoon forecasting stations, which should directly provide the central government with the water levels and rainfall situation, clearly specify the reporting items including elements and frequency, and ensure the successful reporting of floods and droughts.

Making use of the national hydrological information exchange system, the regime situation and rainfall information of small- and medium-sized rivers monitoring projects, and project construction of flash flood monitoring and warning system has been integrated, which enables the exchange of information between the Hydrological Services at ministerial, river basin, provincial, prefecture and city levels, and greatly improves the timeliness of flood reporting, and expanding the information content. Currently, the number of stations reporting to ministerial Hydrological Service has increased from 8500 stations to 39000 stations in 2012, among which 16,000 stations are for flash flood projects, 15,000 stations are for medium- and small-sized rivers projects, and 700 stations of medium-sized reservoirs.

### *2.1.3 Disaster Prevention and Preparedness Achievements/Results*

In 2012, the number of deaths and missing people caused by typhoon disaster was the sixth lowest since 2000, being at middle level compared with the same period in the history.

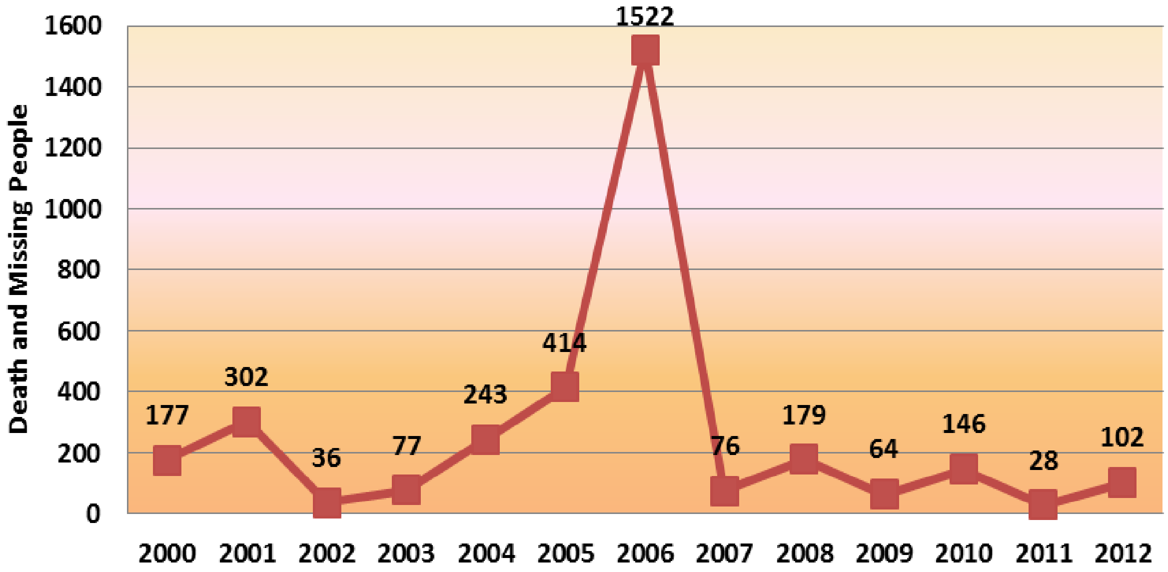


**Fig 2.5** Deaths and Missing People Caused by Typhoon Disaster from 2000 to 2012

#### *1) Timely Activated Early-warning Response System to Transfer People in Advance to Avoid Risks*

According to the typhoon track and landing forecasts provided by meteorological departments, local civil affairs departments at all levels can timely activate early-warning response system and made emergency transfer and relocation of 5,620,000 person-times, which effectively reduced casualties. At the central level, the China National Committee for Disaster Reduction and the Ministry of Civil Affairs activated early-warning response system for seven times and dispatched a number of working groups to inspect relief material reserves and shelters and guide local governments to cope with possible impacts of typhoon.

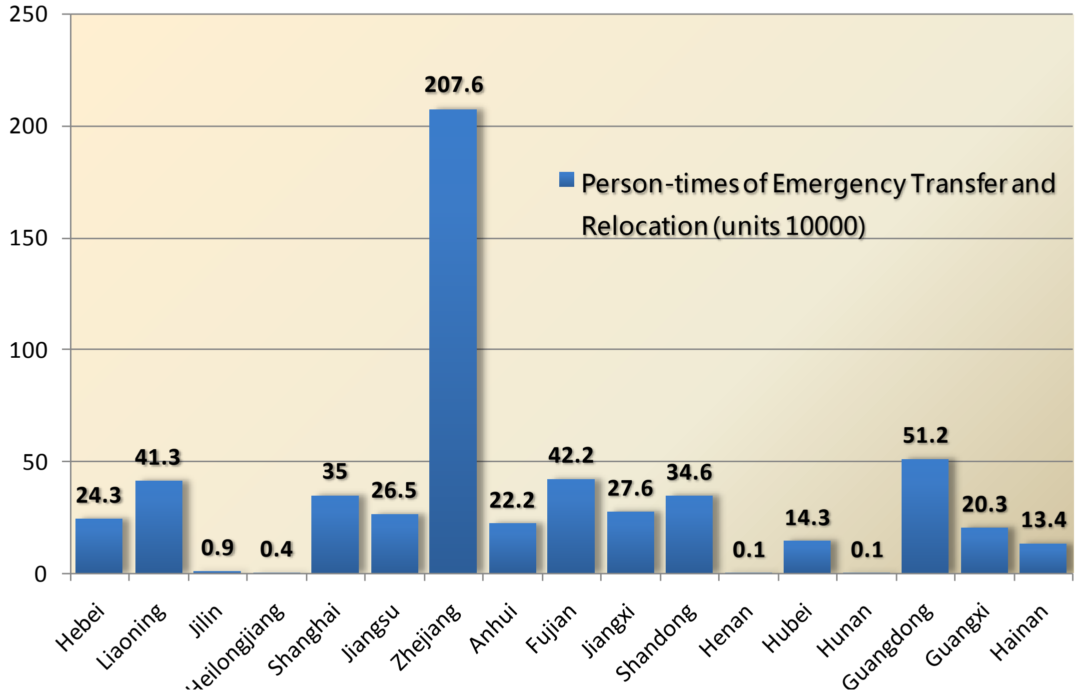


**Fig 2.6** Statistical Chart of Person-times of Emergency Transfer and Relocation in Provinces Affected by Typhoons in 2012

### *2) Promotion of the Normalization and Standardization of National Comprehensive Disaster Reduction Demonstration Community*

China focused on promoting the normalization and standardization of the construction of national comprehensive disaster reduction demonstration communities. China promulgated the industry standard *Standards for the Construction of National Comprehensive Disaster Reduction Demonstration Communities*, printed and distributed the *Interim Measures for the Administration of the Construction of National Comprehensive Disaster Reduction Demonstration Communities*, developed the “Application & Exhibition Management System of National Comprehensive Disaster Reduction Demonstration Community”, and standardized the construction of demonstration communities. According to the statistics, as of the end of September, the China National Committee for Disaster Reduction and the Ministry of Civil Affairs named 2,843 national comprehensive disaster reduction demonstration communities. China constantly improved grass-root capability of disaster reduction in urban and rural areas, raised the awareness of disaster prevention, preparedness and reduction of all people, gradually fostered a social awareness of disaster prevention, preparedness and gradually scored achievements.

### *3) Actively Planned Promotional and Education Activities Based on the Day of Disaster Prevention and Reduction*

In 2012, the Day of Disaster Prevention and Reduction were themed with “Carrying Forward the Culture of Disaster Prevention and Reduction and Raising the Awareness of Disaster Prevention and Reduction”. The China National Committee for Disaster Reduction timely distributed the *Notice Concerning Doing a Good Job in Related Work on the Day of Disaster Prevention and Reduction in 2012* to arrange various works related to the Day of Disaster Prevention and Reduction nationwide. According to incomplete statistics, during the Publicity Week of Disaster Prevention and Reduction 2012, a total of more than 20 million popular science books and publicity brochures on disaster prevention and reduction were distributed, over 3,000 lectures on disaster prevention and reduction were held and over 30,000 exercises were organized. The activities of the Day of Disaster Prevention and Reduction have gradually heightened the awareness of disaster prevention and reduction, steadily promoted the efforts on comprehensive disaster reduction of urban and rural communities, effectively facilitated community disaster risk and hidden danger inspection and control and constantly raised the awareness of disaster prevention and reduction among all people.

### *2.1.4 Research, Training, and Other Achievements/Results*

In the past year, National Climate Centre had promoted several researches to satisfy the need of seasonal prediction of typhoon, including climatic relationship between the track, intensity, genesis of tropical cyclones and large-scale circulations. Furthermore, we also had developed a seasonal dynamical downscale ensemble prediction system for Northwestern Pacific Ocean typhoon based on a WRF model.

### *1) The dynamic model of TC climate prediction and the climate prediction of WNP 2012 TC season*

The characteristics of the TC activities over the Western North Pacific (WNP) in 2011 were summarized. A dynamic climate model was developed for TC short term climate prediction. The preliminary tests were carried out. The prediction of TC activity over the WNP in 2012 was made in the spring. The results were the frequency would be below normal, the frequency of TCs landfall China would be around normal. The 2nd western North Pacific TC climate assessment report was completed.

### *2) The TC disaster estimations in 2012*

The disaster pre-estimation was made for every major TC impacting China in 2012. For those severe impacting TCs, the disaster risks were also analyzed.

### *2.1.5 Regional Cooperation Achievements/Results*

### *1) Cooperation with Malaysian Meteorological Department*

According to the cooperation agreement between the China Meteorological Administration (CMA) and the Malaysian Meteorological Department (MMD), Dr. Wan Maisarah and Muhamad Sofian from

MMD visited CMA for two-week visit from 2 to 15 September, mainly focusing on the numerical weather prediction post-processing and products interpretation and application. Taking lectures by CMA expert as the main form of this study and exchange, according to the learning needs of the Malaysian experts, the NWP Centre has carefully organized the entire learning process, arranging 10 experts from the field of NWP (including typhoon numerical forecasting), the server weather forecasting, MICAPS system, web pages production, weather graphics software, system software, and so on to give lectures.

**Fig 2.7** Two Malaysian experts visiting the National NWP Centre

**2) International Promotion of the 3rd version of MICAPS**

Up to now, MICAPS has been applied to 17 countries, and relevant trainings have been provided for their technicians. In 2012, MICAPS developers visited Mongolia, Pakistan and Laos among others for technical training and guidance. Meanwhile, training and guidance were also provided for technicians from DPRK and Malaysia, etc. At the International Training Course for Weather Forecasters, which was held in Nanjing in September 2012, training and guidance related to MICAPS application were provided for the forecasters from various countries.

**Fig 2.8** MICAPS developers trained for technicians from the Laos.

### *2.1.6 Identified Opportunities/Challenges for Future Achievements/Results*

The main hazard caused by tropical cyclones on land is gale and rainstorm. The influences of rainstorm are much severe than gale. By collecting hazard factors, hazard bearing body, and environment, the capacity of disaster prevention and reduction, and disaster information of tropical cyclones will be built. These data will be used to build assessment model of tropical cyclone disaster for the service of disaster assessment of tropical cyclones. We also plan to research the threshold conditions of rainstorm and gale to build the risk assessment model of tropical cyclone for the pre-disaster assessment service.

To satisfy the need of seasonal prediction of typhoon, Beijing Climate Centre will further develop a downscaling ensemble prediction system for Northwestern Pacific Ocean typhoon based on the seasonal ensemble prediction system.

## *2.2 Progress on Key Result Area 2: Minimized Typhoon-related Social and Economic Impacts.*

### *2.2.1 Meteorological Achievements/Results*

The tropical cyclone frequency prediction issued in the early of April 2012 was as follows: It is estimated that the tropical cyclones (the max. wind near the centre above 8 grade level) number would be from 22 to 24 in 2012 in the western North Pacific and the South China Sea, less than normal (26, average between 1981 and 2010), and more than that of 2011(total number 21). The number of landing tropical cyclones in China would be from 7 to 9, more than normal (7).The beginning landing date would be earlier than normal (28 June), the ending landing date later than normal (4 October).

The number of generated tropical cyclones was 23 in the western North Pacific and the South China Sea in 2012, near the same as normal(22.9). The number of landing tropical cyclones was 7, near normal. The beginning landing date of tropical cyclone in China was 29 June, later than normal; the ending landing date was 17 August, earlier than normal. The further analysis of large-scale circulation anomalies showed that, during the active period of tropical cyclone (July to September), sea surface temperatures were below or near normal over northwestern Pacific and above normal over the central and eastern equatorial Pacific, which were unfavorable to the development of tropical cyclone. Tropical cyclone activity was found to be related significantly to the variability of the monsoon trough, during July to September 2012, the location of monsoon trough was more westward and northward than normal, implied an inactive monsoon trough over the western North Pacific and the South China Sea. Meanwhile, the magnitude of the vertical zonal wind share was 4m/s-6m/s larger than normal over the western North Pacific, the larger wind share enhanced the divergence of heat and energy, which was also not conducive for development of tropical cyclone. Therefore, the occurrence number of tropical cyclone was less than normal in 2012.

When we reviewed the predictions results, we found the following predictors support our prediction:

- According to the inter-annual and decadal variation analysis, the number of generated tropical cyclones was less than normal in 2012, landing tropical cyclones in more than normal.
- According to the forecast of summer vertical wind shear index (weak) at troposphere and vortices at 850hPa by the numerical dynamic model, the number of generated tropical cyclones would be less than normal in 2012.
- Considering the relationship between the landing tropical cyclone and SLP in previous winter, the number of landing tropical cyclones would be more than normal in 2012.
- According to statistical analysis, when the western North Pacific subtropical high is strong in summer, landing tropical cyclones would be more than normal.

### *2.2.2 Hydrological Achievements/Results*

In the 42nd Session of the Typhoon Committee, the project “Urban Flood Risk Management (UFRM)” initiated and led by China was identified as a comprehensive cooperation project for the three working groups on meteorology, hydrology, and disaster risk prevention and mitigation, and planned to be completed in the first half of the 2013. Its demonstration cities include Shanghai (China), Anseong (Korea) and Yokohama (Japan). In addition, five pilot cities including Bangkok (Thailand), Manila (the Philippines), Hanoi (Viet Nam), Kuala Lumpur (Malaysia) and Guangzhou (China) actively engaged in the project activities. The expected results of the project include the preparation and publication of the Guidelines on Urban Flood Risk Management, provision for the pilot cities of technical support and operational capacity building in terms of weather and flood forecasts and urban flood risk mapping.

To actively and effectively make smooth progress of the project, and successfully complete the tasks undertaken by China on schedule, the Bureau of Hydrology (BOH) under the Ministry of Water Resources (MWR) organized a series of activities under the UFRM project in 2012.

### 1) Drafting Meeting on UFRM Guidelines

The Drafting Meeting on UFRM Guidelines was jointly held by the Bureau of Hydrology, Ministry of Water Resources and the Typhoon Committee and hosted by WMO Regional Training Centre Nanjing from 13-14 February 2012 in Nanjing. There were 14 participants from Typhoon Committee secretariat, China, Hong Kong (China), Japan, Korea and the Philippines. The meeting mainly focused on the first draft of UFRM Guidelines submitted by China, and defined the further points to be modified, milestones and timetable for the Guidelines, and the deadline for submission of the report. At present, the second draft of the Guidelines has been completed for discussion at the 7th Typhoon Committee Integrated Workshop.

**Fig 2.9** Meeting site

**Fig 2.10** Group photo of participants in the drafting meeting on UFRM guidelines

### *2) Urban Flood Risk Management Training Course*

The MWR Bureau of Hydrology and the Typhoon Committee jointly held the Urban Flood Risk Management Training Course in Guangzhou from 24-26 September 2012, with participants from Thailand, the Philippines, Viet Nam, Malaysia and China, representing five pilot cities of UFRM project respectively. The Typhoon Committee secretariat dispatched its hydrological experts for technical guidance. The 3-day training focused on the application of the Xin'anjiang model, urban flood risk mapping, and QPE/QPF techniques and products application.

### *2.2.3 Disaster Prevention and Preparedness Achievements/Results*

Compared with the same periods since 2000, the number of houses collapsed by typhoon disasters is decreased by 20.6% in 2012.

### *1) Initiated Emergency Response System Many Times to Effectively Carry out Disaster Relief Efforts*

To cope with such typhoons as Vicente, Saola, Damrey, Haikui and Kai-tak, the National Committee for Disaster Reduction and the Ministry of Civil Affairs successively initiated the National Natural Disaster Relief and Emergency Response System for four times, timely sent working groups to disaster-affected areas to assist and guide local governments in emergency relief efforts, and activity cooperated with the Ministry of Finance to arrange the distribution of disaster relief funds and materials from the central government. According to the statistics by the end of September, the Ministry of Civil Affairs and the Ministry of Finance arranged central disaster relief funds of 6.125 billion RMB in 59 batches, including 700 million RMB for typhoon disaster.

### *2) Timely Carried out Rapid Risk Evaluation on Typhoon Disaster*

China can determine the coverage (county-level administrative unit) and risk levels of typhoons by leveraging forecast data of typhoon track and in accordance with precipitation forecasts, data of typhoon losses in history, data of potential geological-disaster-prone areas, etc., and can estimate the possible losses to be caused by typhoons by drawing similar tracks in history. In 2012, China carried out seven evaluations on early-warning of typhoon disaster, each of which was completed within 5-8 hours on average. China has further strengthened its capability of rapid risk evaluation on typhoon disaster.

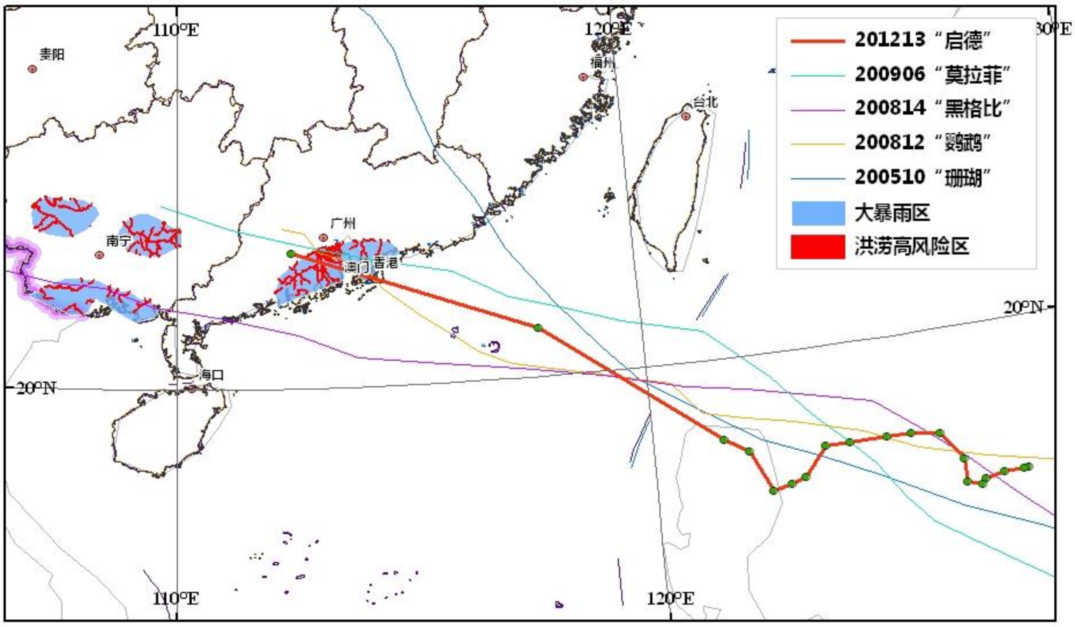


**Fig 2.11** Assessment of disaster risks caused by Kai-tak

### 3) Further buildup of volunteers for last-mile disaster information delivery and their training

In 2012, the Ministry of Civil Affairs has built up the teams of volunteers for disaster information delivery, and various local governments have also actively conducted trainings on volunteers for disaster information delivery. According to the statistics by the end of September, China has more than 630,000 volunteer disaster messengers and further strengthened the volunteer messenger teams at provincial, city, county, town and village levels.

### 4) Earnestly Implemented the Instructions of the Chinese Leaders to Enhance Organization and Leadership of Typhoon Prevention and Preparedness

In 2012, the State Flood Control and Drought Relief Headquarters held 6 video conferences to make arrangements according to 9 important instructions from the Chinese leaders on typhoon prevention and preparedness. The meteorological departments at all levels have established the leading groups on meteorological services chaired by their executives to ensure their presence at the forecasting desks, and strengthen interaction between higher and lower level departments and emergency consultation to timely initiate emergency response based on weather situations. From January to September, CMA initiated 10 emergency responses to major meteorological disasters (typhoons, rainstorms). When the impact of TC Haikui was felt, CMA initiated its first category-I emergency response over the past five years, and dispatched 5 working groups to supervise and guide the emergency response services at the grass root meteorological departments.

### *5) Strengthened Typhoon Monitoring and Warnings to Improve the Timeliness and Accuracy of forecasts and warnings*

In 2012, building on the modern meteorological operational reform and major projects construction, efforts were made to improve meteorological monitoring and forecasting services. The observing stations in disaster-prone areas were separated by 5 km, and the data was uploaded hourly and even 5 minutes in case of typhoon emergency response; the new generation weather radar transmits data and national and regional mosaics in real time every 6 minutes; when the impact of typhoon was being felt, CMA initiated upper air and satellite intensive observations, FY-2F provided monitoring imagery every 6 minutes which effectively improved typhoon location and intensity, and wind and precipitation forecasts. In 2012, the errors of 24-, 48- and 72-hour typhoon track forecasts by the Central Meteorological Office (CMO) were 94, 162 and 212 km respectively, decreasing by 18, 19 and 67 km respectively compared with 2011. When the impacts of such typhoons as Saola, Damrey and Haikui were being felt, CMA initiated satellite, radar and radiosonde intensive observations, including monitoring images from FY-2F every 6 minutes and 126 observations at 20 radiosonde stations in 7 provinces (municipalities), to ensure more frequent monitoring of typhoon movement in all weather and all aspects, in order to provide real-time and dynamic typhoon information for various sectors and the general public. CMO, together with provincial meteorological departments of Fujian, Zhejiang, Jiangsu and Shandong among others, conducted several decades of forecasting consultations, and provided 40 messages on the hourly location and intensity of Haikui. CMO also accurately forecasted the landfall time, location of the above three typhoons, and wind and rainfall influence caused by them, and issued 2 red typhoon warnings, which provided strong support for disaster prevention, preparedness and mitigation.

### *6) Enhanced meteorological services for decision-making in typhoon prevention and disaster relief.*

In 2012 when typhoons affected the country, China Meteorological Administration (CMA) submitted approximately 200 reports for decision making to CPC Central Committee, State Council, Ministry of Civil Affairs, Ministry of Land and Resources, Ministry of Transport, Ministry of Water Resources, National Tourism Administration, State Oceanic Administration, etc. About 3000 reports of this kind were also submitted to local governments and relevant departments by meteorological services at various levels in provinces such as Fujian, Jiangsu, Zhejiang, Guangdong, Hainan. When Haikui, Saola and Damrey affected China in the same period, China’s meteorological departments sent 2.25 million person-pieces of warning information to heads of governments and those in charge of emergencies. The meteorological departments also participated in typhoon response decision-making by providing suggestions to CPC committees and governments at all levels on evacuating people as well as relieving and preventing disasters.

### *7) Pre-evaluation of typhoon related disasters in 2012*

In 2012, National Meteorological Centre of CMA had carried out 4 typhoon disaster pre-evaluations with the accuracy of 60%. According to the pre-evaluation result for typhoons Saola and Damrey, their total economic losses would be 10 billion RMB or more and affected people would be ten millions or more, while the real losses and affected people were 46.1 billion RMB and 17.619 million. For severe typhoon Haikui, the pre-evaluation results showed especially severe typhoon disaster impacts with economic losses more than 10 billion RMB and affected people more than 10 million, while the real losses and affected people were 37.09 billion RMB and 14.38 million. The pre-evaluation results show consistent with the real disasters.

### *2.2.4 Research, Training, and Other Achievements/Results*

Using the related meteorological data and historical typhoon - storm disaster data, and the local social economy and human resource data, environment data, etc.. Careful analysis on the risk of hazard -formative factors, hazard-affected body, multiply disaster environment and typhoon - storm catastrophe comprehensive risk distribution in main affect region of Asian have been conducted. Through the project research, we established Asian typhoon - heavy rains comprehensive disaster index, and defined the grade standard of jumbo disasters above disasters level, formed risk assessment model about typhoon-storm, made relevant risk zoning maps, and mapped the typhoon-rainstorm risk zoning series project atlas, published 24 study papers or articles. We also developed a new meteorological element interpolation method, and applied to the intellectual property registration on the analysis of the typhoon-storm hazard -formative factors.

### *2.2.5 Regional Cooperation Achievements/Results*

Mr. Xue Jianjun, an expert from National Meteorological Centre of CMA, attended the 7th international workshop of Typhoon Committee Working Group on Disaster Risk Reduction (WGDRR) at Seoul, Korea on 30-31 May 2012. He presented a report entitled Typhoon disaster risk management in China. The report describes China typhoon disasters and disaster warning, emergency response, pointed out disaster early-warning and defense systems played effective roles obviously in typhoon preparedness in recent years, the personnel deaths reduced significantly. At the same time, Mr. Xue Jianjun raised some viewpoints such as uncertainties and sudden TC changes in direction and intensity in typhoon landing forecasts and associated wind and rainfall predictions, which should be taken into account in the typhoon disaster risk management. He also proposed that the risk mapping should consider such factors as climate change and economic and social development, recommended that the case analysis should be strengthened for major typhoon disaster-oriented services, and shared some efficient and effective experience.

### *2.2.6 Identified Opportunities/Challenges for Future Achievements/Results*

***NIL***

## *2.3 Progress on Key Result Area 3: Enhanced Beneficial Typhoon-related Effects for the Betterment of Quality of life.*

### *2.3.1 Meteorological Achievements/Results*

See 2.1.1 for KRA1

See 2.2.1 for KRA2

### *2.3.2 Hydrological Achievements/Results*

Regarding typhoon preparedness in 2012, through enhanced leadership, thoughtful deployments, scientific directives and clear-cut responsibilities, the State Flood Control and Drought Relief Headquarters made good preparations for possible typhoon- induced floods by replacing people under risks to safety and minimizing damages and losses. On condition that preparatory work was well done to prevent and reduce typhoon-induced disasters, based on effective and timely forecasts, the local governments took opportunities to increase water storages from typhoon rainfall for reservoirs and bonds in dry areas.

In 2012, on the basis of flood forecasting schemes for 77 sections of 66 rivers in 8 provinces in China's coastal regions, the MWR Hydrological Information and Forecasting Centre provided hydrological forecasts and early warnings for the regions that might be affected by landing typhoons. It also enhanced torrential rain forecasts/warnings for small- and medium-sized reservoirs and improved accuracy and quality of the hydrological forecasts. Such information not only minimized damages, but also provided effective guidance for coastal provinces in making full use of favorable rainfall from typhoons for drought relief and water storage. For example, during the landing of Typhoon Bolaven, on condition that public safety is ensured, the Heilongjiang, Jilin and Liaoning provinces, which had not enough water, increased water storages in large and medium-sized reservoirs. The water of big reservoirs was increased by 181 million cubic meters.

### *2.3.3 Disaster Prevention and Preparedness Achievements/Results*

See 2.1.3 for KRA1

See 2.2.3 for KRA2

### *2.3.4 Research, Training, and Other Achievements/Results*

See 2.1.4 for KRA1

See 2.2.4 for KRA2

### *2.3.5 Regional Cooperation Achievements/Results*

#### *1) Training Workshop on Operational Tropical Cyclone Forecast, in Shanghai, China in 12-14 June 2012 under WMO Typhoon Landfall Forecast Demonstration Project (TLFDP)*

The WMO-TLFDP Training Workshop on Tropical Cyclone Forecasting was held in Shanghai, China during 12-14 June 2012. More than 70 participants attended the meeting, including 16 lecturers from

7 institutions worldwide. The WMO-TLFDP is jointly supported by WMO World Weather Research Program (WWRP), Tropical Cyclone Program (TCP) and Public Weather Service Program (PWS). It is also an annual operating plan (AOP-Verification of Landfall Typhoon Forecast) of Typhoon Committee Working Group on Meteorology. This project made some progresses in the past two years. Real-time forecast products were collected; forecast products and its official website (http://tlfdp.typhoon.gov.cn) were disseminated; training courses were organized; verification techniques on TC forecast had been improved, etc. Through this workshop, a set of verification techniques was established and the project will be extended to 2015.

### 2) Launching of the inaugural issue of the Tropical Cyclone Research and Review

The first issue of the Tropical Cyclone Research and Review was launched during the 44th session. China Meteorological Administration, together with TCS, edits and publishes the Typhoon Committee science and technology journal quarterly from February 2012. This journal publishes research findings on basic theoretical and applied studies on tropical cyclones. It also publishes review and research on hydrology and disaster risk reduction related to tropical cyclones. Contributions are made via the website (http://mc03.manuscriptcentral.com/tcrr). Additional information is available at *http://tcrr.typhoon.gov.cn*

### 2.3.6 Identified Opportunities/Challenges for Future Achievements/Results

***NIL***

## 2.4 Progress on Key Result Area 4: Improved Typhoon-related Disaster Risk Management in Various Sectors.

### 2.4.1 Meteorological Achievements/Results

Through project of the Ministry of Science and Technology, the studies on typhoon risk assessment techniques and applications in Asia have achieved the following research findings:

China has put forward a classification standard for severe disasters including impacts of typhoon–induced storms. However, the typhoon-storm disasters differ from earthquakes and tsunamis, etc. The TC disaster frequency is higher, but its casualties are less relative to earthquakes and tsunami among others. It is not suitable to directly establish disaster categories from existing disaster research findings. Therefore, by using TC-related casualties and their direct economic loss as assessment factors, through analyses and plausible data quantification, the corresponding disaster index was established. Then, considering different economic development levels in Asia, a comprehensive typhoon disaster grading standard was proposed, which is more valuable in applications.

China has established a comprehensive risk assessment model for typhoon hazard, which takes into account "three factors", i.e. formative factors, hazard-affected bodies and multiple disaster environments. The typhoon-rainstorm hazard-formative factors generally include total precipitation, precipitation intensity per unit time, duration, rainfall coverage, etc. Hazard-affected body mainly includes three categories, i.e. population (population distribution, population structure and personnel quality), wealth (regional economic density, disaster-resistant buildings, disaster-resilient agriculture and aquaculture), and lifeline systems (transportation, communication, water and power supplies and people’s normal life). Multiple disaster environments mainly include terrain conditions, river distribution, vegetation coverage, land use conditions, geological conditions and soil types.

The risk mapping has been made for China and other parts of Asia, taking into account typhoon hazard formative factors: hazard-affected bodies and multiple disaster environments, and the comprehensive risk mapping is based on integrated analysis of the above three factors. The China regional risk mapping is found practical in applications.

In thematic researches, 24 academic papers have been written or published, and 8 master degree or graduate students have graduated. Through the project research, the scientific research personnel's enthusiasm and creativity in risk management have been fully mobilized, an innovative team of professionals on risk assessment has been basically set up, and some leading scientists in the field of comprehensive disaster risk research have played a solid role in meeting the China's targets for improving technical capabilities in comprehensive risk avoidance by 2020.

### *2.4.2 Hydrological Achievements/Results*

In aspect of typhoon disaster risk management, the Ministry of Water Resources initiated emergency response mechanism and took emergency measures based on the changing flood situations to ensure people’s safety.

On the afternoon of 1 August 2012, Bureau of Hydrology, Ministry of Water Resources convened a special emergency meeting and initiated the Category II emergency response plan against typhoons Saola (No. 9) and Damrey (No. 10). At the time when China faced serious flood threats as the two typhoons were approaching and likely to land on the eastern and northern coasts, bringing about great potential impacts on a dozen provinces. At the meeting, it was pointed out that the nation’s flood prevention was in a critical period and relevant departments must recognize the importance, urgency and complexity of the work. They were also charged with specific responsibilities to closely monitor typhoons, associated rainfall and floods, strengthen the duty system and the consultation mechanism, enhance the communication with relevant departments, to provide high-quality forecasts and early warnings, ensure the smooth operation of communications, networks, video conference systems, etc., go all out in making hydrological observations and predictions, and provide strong support to typhoon preparedness and flood combat. Immediately after the meeting, Bureau of Hydrology issued *Urgent Notice on Enhancing Hydrological Observation and Prediction*, which required the hydrological departments in relevant basins and provinces (autonomous regions, municipalities) to release timely and accurate information, strengthen the duty system and secure smooth information flow, improve prediction and forecasting for decision-making for people’s safety.

### 2.4.3 Disaster Prevention and Preparedness Achievements/Results

Since 2012, the Ministry of Civil Affairs has further advanced the buildup of volunteer teams for disaster information delivery, and local governments at various levels have also actively conducted training on the last-mile disaster messengers. According to the statistics by the end of September, China had more than 630,000 disaster messengers and further strengthened the volunteer disaster information delivery teams at provincial, city, county, town and village levels.

### 2.4.4 Research, Training, and Other Achievements/Results

***NIL***

### 2.4.5 Regional Cooperation Achievements/Results

***NIL***

### 2.4.6 Identified Opportunities/Challenges for Future Achievements/Results

***NIL***

## 2.5 Progress on Key Result Area 5: Strengthened Resilience of Communities to Typhoon-related Disasters.

### 2.5.1 Meteorological Achievements/Results

See 2.1.1 for KRA1

See 2.2.1 for KRA2

See 2.4.1 for KRA4

### 2.5.2 Hydrological Achievements/Results

***NIL***

### 2.5.3 Disaster Prevention and Preparedness Achievements/Results

China drafted the *Work Procedures on Usage of Civil Affair Administration Donated Disaster Relief Funds for Post-Disaster Reconstruction*, in order to improve the disaster relief donation management system. Besides, China reviewed the implementation of the *Natural Disaster Relief Work Regulations*, to accelerate the promulgation of related files by local governments. Moreover, according to the *Relief Procedure for Disaster Affected People in Winter and Spring* and the work plan, China carefully organized the winter and spring relief work across the country, to ensure the basic living for disaster affected people.

### 2.5.4 Research, Training, and Other Achievements/Results

***NIL***

### 2.5.5 Regional Cooperation Achievements/Results

***NIL***

### *2.5.6 Identified Opportunities/Challenges for Future Achievements/Results*

***NIL***

## *2.6 Progress on Key Result Area 6: Improved Capacity to Generate and Provide Accurate, Timely, and understandable Information on Typhoon-related Threats.*

### *2.6.1 Meteorological Achievements/Results*

#### *1) Improvement in Marine Observation System*

By June 2012, there were 139 marine automatic weather stations (including those in islands, ships and oil drilling rigs), 18 buoys and 34979 regional automatic weather stations across China. In the flood season, these instruments showed good performance in typhoon observations.

#### *2) Improvement in Radar Observing System*

Since 2012, 6 additional CINRAD radars have been set up on mainland China. They have further increased China's capability for monitoring typhoons along its southeast coasts, among others. They have contributed to the disastrous weather preparedness and reduction in many provinces.

#### *3) Improvement in Satellite Observation System*

- FY-2F geostationary satellite rapid range scanning plays important role in TCs detection and analysis.

A new geostationary satellite (FY-2F, the seventh of FY-2 series) was launched from the Xichang Satellite Launch Centre on 13 January 2012. FY-2F has more flexible and higher temporal resolution for specific regions to be scanned. Using FY-2F satellite data, the targeted TCs and convective weather systems can be tracked and monitored continuously. FY-2F provides the multi-temporal observations and in-orbit backup with FY-2D and FY-2E. Together, they will play an important role in natural disaster monitoring, prevention and preparedness.

Based on the satellite imagery which is used to determine TC centres, FY-2F cloud animations are very useful, especially for asymmetrical TC structures (e.g. DOKSURI). Because they have six minutes interval and can show more continuous TC structure evolutions. At the same time, a new improved calibration method was used in FY-2F infrared channels, which can make the brightness temperature and some retrieved products more reliable for TC applications. For example, TBB products reflect evolution of mesoscale TC internal convections and it is a useful tool for accurate TC intensity analysis by using DVORAK objective methods.

- Satellite Weather Analysis Platform (SWAP) application in TC forecasting, and progress in improving satellite demonstration and supportive capability.

Since 2012, Satellite Weather Analysis Platform (SWAP) has already been used for TC prediction in the National and Provincial Meteorological Services, including the National Meteorological Centre, Guangdong Province, Shanghai Municipality, and Zhejiang Province, etc. This platform provides a useful tool for all forecasters, and satellite data can be easily localized. It will become one of the important tools for TC prediction and relevant services work.

- Increased comprehensive applications of geostationary and polar orbiting satellites have improved applications.

FY-3B polar orbiting satellites has several advantages in monitoring TC internal thermal structure, raining band structure, heavy precipitation range and cloud asymmetrical structure, with MWTS (Microwave Temperature Sounder), MWHS (Microwave Humidity Sounder) and MWRI (Microwave Radiation Imager). While, using FY-2D/E/F geostationary satellite, some products like Quantitative Precipitation Estimation and Cloud Classification can be derived. In 2012, taking their respective advantages, new products were developed and applied to TC analyses.

- High temporal resolution mosaic imagery from several geostationary satellites has significant positive impacts on global TC monitoring.

Taking comprehensive use of the geostationary satellites of a number of countries, including Chinese FY-2 series, American GOES series, Europe MSG and Japanese MTSAT, a global imagery can be obtained in a 3-hour internal. The high temporal resolution mosaic imagery give forecasters more information including global TC genesis, development and evolution. In past observations, only the polar orbiting satellites or single geostationary satellite were used. Significant progress has been made in applications of multiple satellites. In 2012, numerous TCs have been captured, including Atlantic Ocean TCs (PAFAEL, NADINE, LESLIE, MICHAEL, ISAAC, ERNESTO), Eastern Pacific TCs (PAUL, MIRIAM, KRISTY, JOHN, HECTOR, FABIO, EMILIA, DANIEL), and Indian Ocean TCs (GIOVANNA, HILWA).

### 4) Improvement of Tele-Communication System

CMAcast, which is a newly established DVB-S2 standard satellite data broadcast system of CMA, has become its formal operation since 1 June 2012. The CMAcast is an integrated satellite data-broadcasting system in conformance to the DVB-S2 standard, substituting for the present satellite data-broadcasting systems (PCVSAT, DVB-S and FENGYUNcast) which already have 2400, 700 and 200 users respectively. The CMAcast is the major component of the national meteorological data dissemination system, continuously broadcasting the real-time observational data and products crucial for the weather forecasts and related services to more than 2500 users. It is also the most effective way to share the various meteorological data and products with the public user communities in China. At present, the daily broadcast data volume is more than 210 GB, including the territorial and international observation data, the CMA T639 NWP products, the satellite observation products of FY2D/E and FY3A/B, EUMETSAT satellite products, etc.

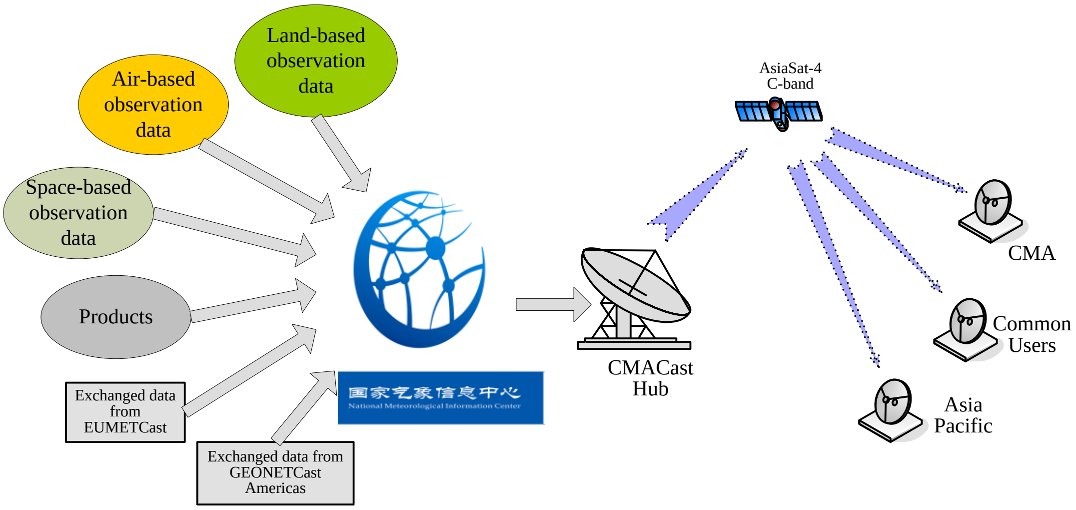


**Fig 2.12** The diagrammatic sketch of CMA Cast system

The CMACast system is also a major component of WMO IGDDS and GEONETCast systems. It substitutes the Regional GEONETCast Network Centre (GNC) for the FENGYUNCast, which was formerly integrated into GEONETCast in 2007 as the contribution of China to GEONETCast. The CMACast system, compared to the FENGYUNCast, provides higher bandwidth, many new data contents, as well as the improved user and data management mechanisms. The CMACast system has achieved the requirements so as to provide the full services within the framework of GEONETCast, plus the better ones to the users in Asia-Pacific Region.

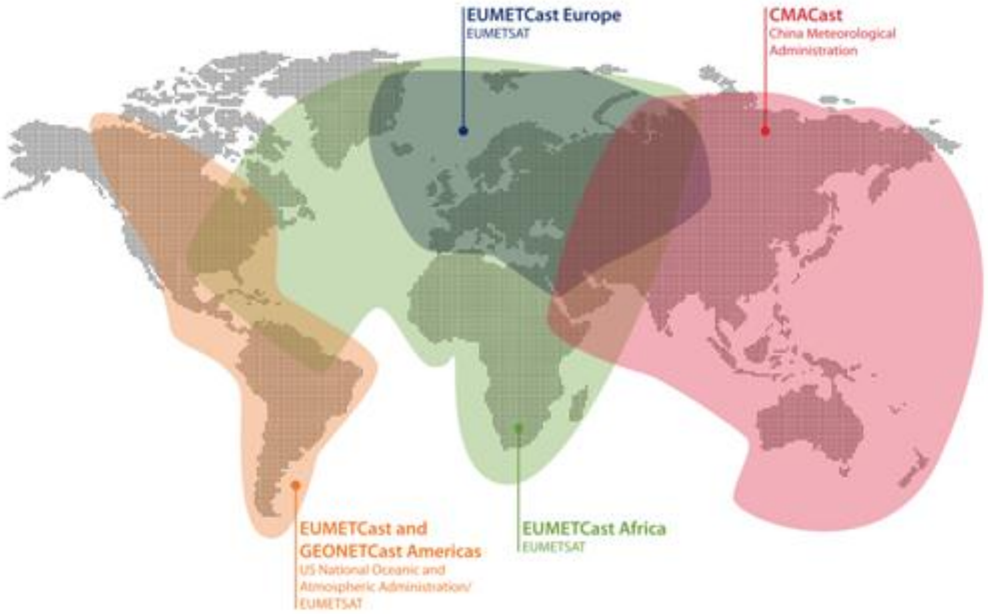


**Fig 2.13** The four meteorological information centres around the world

And, in addition to the National Meteorological Information Centre designated as GISC and RTH Beijing designated as DCPC at the 16th WMO Congress in 2011, CMA has 4 centres, which are

RCC Beijing, RSMC Beijing, RSMC-ERR Beijing and the National Meteorology Satellite Centre (NMSC) of CMA, were designated as DCPC at the 64th session of WMO Executive Council.

GISC Beijing becomes operational as from August 15, 2011. Apart from continuous provision of GTS data and service products, GISC Beijing provides an integrated web portal (http://wisportal.cma.gov.cn), through which information from WMO and other interoperable systems can be discovered and accessed. Currently, it maintains over 200,000 metadata records for meteorological observations and products, and supports the data discovery and subscription service for GTS data, CMA's NWP products and the satellite data of FY-2D/E, FY-3A/B, etc. And, the 4 DCPCs will initiate operation by the end of 2012.

### ***5) Development in GRAPES_TYM***

GRAPES-TYM passed the quasi-operational test in July of 2012. It is mainly used to forecast typhoon tracks, intensity, wind and rainfall brought about by typhoon in the western North Pacific and the South China Sea. This model runs twice per day when typhoon develops, with a forecast time validity of 72h. Its horizontal resolution is 0.15 degree and vertical resolution 31 layers. The track forecast of GRAPES-TYM is a slightly better than T213 Global Typhoon Track Prediction System, while its typhoon intensity and rainfall forecasts are significantly better than T213.

### ***6) Development in Guangzhou Tropical Cyclone models***

In 2012, the Guangzhou Tropical Cyclone Model (GZTCM) was running smoothly at the Guangzhou Institute of Tropical and Marine Meteorology under CMA. A non-hydrostatic semi-Lagrange model with a limited area, GZTCM has a horizontal resolution of 0.36 degree, 55 vertical layers (updated from the former version with 31 layers) and a time step of 200 seconds. With this model, 5-day conventional weather forecasts, 72-h typhoon track forecasts and 72-h typhoon intensity (pressure at TC centre) and high wind forecasts are issued. Assessments of real-time forecasts are made for reference in operational forecasts.

Due to the shortfalls in the former version of the GZTCM, work has been done on the processing techniques for the oceanic boundary layer, convection and underlying surface and related technical schemes have been upgraded, in an attempt of improving the model performance.

As shown in related observational and experimental studies, the drag coefficient Cd no longer satisfies the Charnok equation under the condition of strong winds. It is known in the analysis of the observations in offshore waters of the coast that Cd reduces significantly when local wind speed is larger than 25.2 m/s. The model marine area is divided into a domain of deep water, for which the Large and Pong equation is used and Cd decreases when wind speed is larger than 35 m/s, and a domain of shallow water, for which an equation that was determined using the observations was used and Cd reduces significantly when wind speed is larger than 25.2 m/s. The two equations were then applied in the GZTCM successfully. Take the typhoon Nanmadol as example. A comparative experiment was conducted that started on 00UTC 26 Oct, 2011. The results show that TC track forecasts have been improved, especially after the initial 24 hours. Besides, as Cd all reduces significantly in strong-wind condition and maximum wind speed at 10 m increases accordingly, the model tracks are found more realistic.

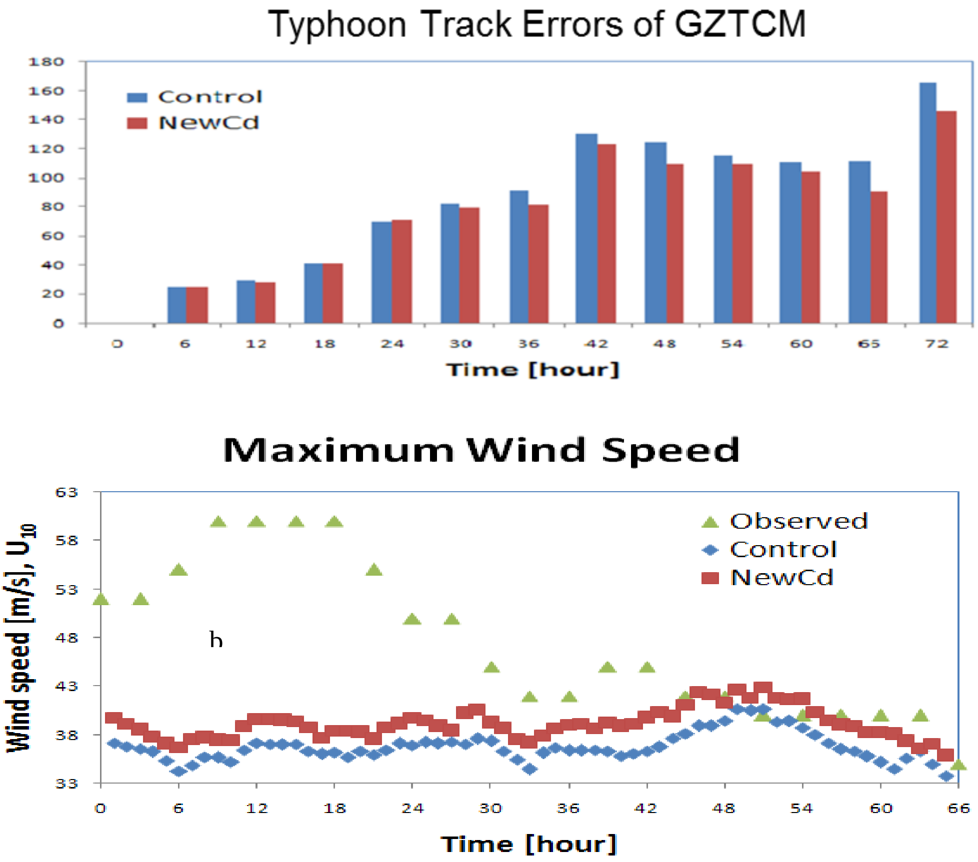


**Fig 2.14** Comparisons of the improved scheme and the original scheme (control):

a) Track forecast errors; b) Maximum wind speed forecast.

Comparisons the improved convective scheme (NSAS) with the original scheme (SAS) have shown the following improvements: (1) the convection prohibitive energy is defined as the function of cloud-base vertical velocity in the NSAS while being treated as a constant in the SAS; (2) the rate of entrainment was used as a constant in the SAS but as a value in NSAS that decreases with height and changes with relative humidity of ambient atmosphere at heights above cloud base. For the SAS scheme, updraft was being entrained out only at heights above cloud top while downdraft was being entrained out only heights below cloud base. For NSAS (new SAS) scheme, the entrainment took place between the cloud base and cloud top at a constant rate of entrainment; (3) the layer of dry air at the cloud base inhibits the triggering mechanism of convection is taken into account; (4) in NSAS, the mass flux at the cloud base has to meet the needs of local CFL criteria; (5) in SAS, the cloud-top height was randomly chosen at heights in which the buoyancy of the air parcel was zero, but in the NSAS, the cloud-top height was where the height where the air parcel was at a zero vertical velocity; (6) In NSAS, the effect of vertical wind shear in the convective system on the transportation of momentum was taken into consideration; and (7) in NSAS, the entrainment of cloud water and snow is taken into account. The new scheme showed better results, as shown in operational comparative experiments.

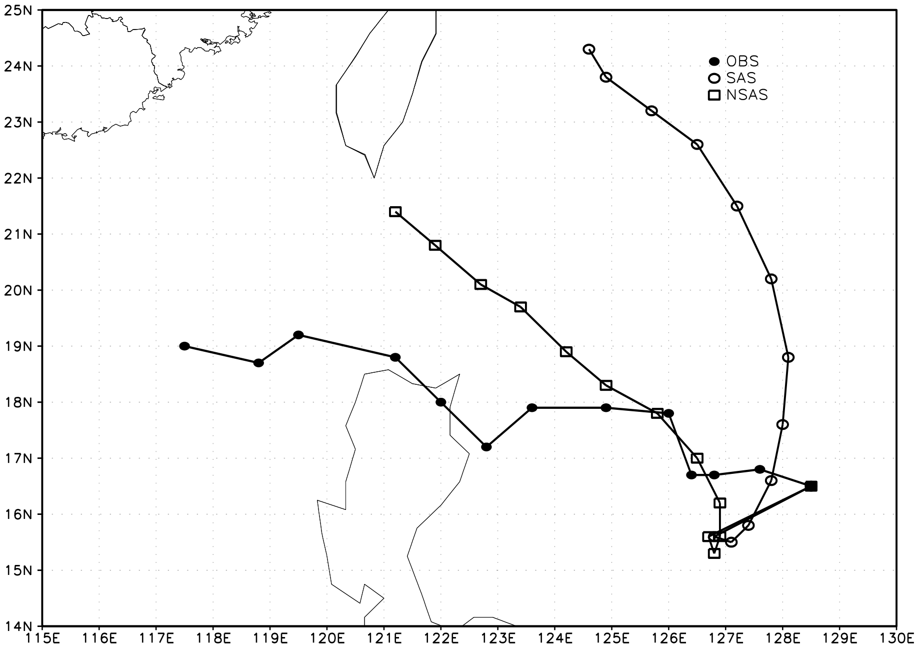


**Fig 2.15** The improved experiment for 72-h track forecast for Typhoon Kai-tak using NSAS (initialized at 00:00, August 13, 2012).

### *7) Improvement in the using of ensemble models*

In 2012, Typhoon and Marine Weather Forecast Centre of CMA (TMWFC) has conducted some research work in application of ensemble forecasts and product development. Based on multi-year experience in ensemble forecast applications, through analyses on TC track forecasts in recent years, an ensemble–based TC track rectifying approach has been developed, which has integrated the ensemble TC forecasts with operational TC positioning by the Central Forecasting Office/NMC. The TC track forecasts with this approach show less errors compared with subjective forecasts. The following chart shows the typhoon hindcast errors in 2011, in which the 24-hour ensemble forecast error is within 83 km, better than subjective forecasts made by experts and 48- and 72-hour forecasts also show encouraging performances. Therefore, this approach has certain reference values, which helps forecasters consider uncertainties in typhoon track forecasts by integrating various conditions, so as to make better quality forecasts.

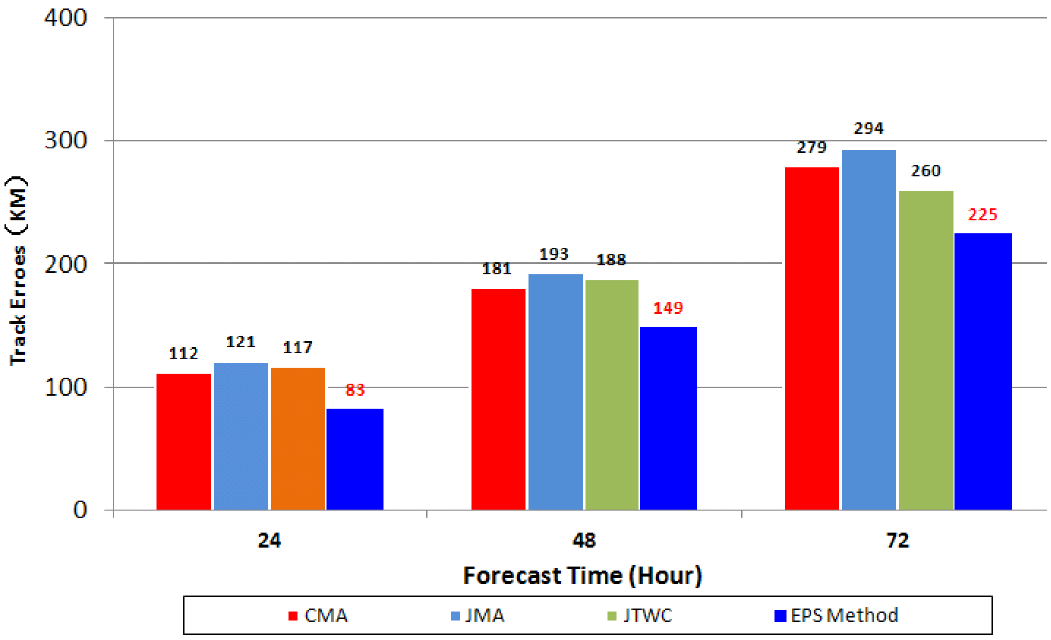


**Fig 2.16** The track forecast errors in 2011 including adj-ensemble method

### *2.6.2 Hydrological Achievements/Results*

***1) The hydrological prediction and forecast for the key medium-sized reservoirs and their rainstorm-resilience analysis have been organized, including hydrological warning and forecasting for the reservoirs in typhoon-affected regions.***

Based on studying and improving the air-land surface coupling technique for flood forecasts, the hydrological department proposed the technical theory and methodology in rainstorm resilient capacity of reservoirs, and collected flood-prone water levels and capacity curves and forecasting schemes for 19 reservoirs in river basins, provinces, municipalities and autonomous regions. Automatic rainstorm-resistant capacity forecasting and warning functions have been developed for 750 key medium-sized reservoirs based on China's flood forecasting system platform, and put in operation in video consultation on typhoon preparedness in 2012, providing the scientific basis for flood prevention and control in the medium- and small-sized reservoirs.

In typhoon service delivery, the Bureau of Hydrology under the Ministry of Water Resources had completed the flood forecasts for totally 77 sections of the 66 rivers in 8 typhoon-affected coastal provinces in 2012. In the potential typhoon affected regions, based on the real time rainfall, combining with the numerical weather predictions, the hydrological departments at various levels issued the rolling hydrological forecasts for the river and tidal stations, and uploaded them to the Hydrological Bureau of Ministry of Water Resources in a timely manner in accordance with the flood forecasting sharing mechanism. By the end of the flood season in 2012, the Hydrological Information Forecasting Centre of the Ministry of Water Resources had accumulated over 2000 real-time flood forecasts, the improved accuracy of flood forecasts in critical periods has provided a scientific basis for decision-making by the Ministry of Water Resources and the National Flood Prevention Office.

### *2) Hydrological warning signals and criteria as well as their release management have been prepared, and design and pre-development work of the flood early warning platform has been completed*

In order to standardize the flood warning release within the hydrology sector and through radio, television, newspapers, public networks and other news media, considering the needs for hydrological services in flood control and drought relief, the forecasting centre organized to prepare the *Standard for Hydrological Warning Signal*s and the *Regulation for Releasing Hydrological Warning Signals*, and convened expert workshops to solicit opinions from all parties. The national flood warning platform has designed, with the pre-development being completed.

关键字：

开始：2012-07-07

结束：2012-10-15

● 全部 ○ 洪水 ○ 枯水

● 全部 ○ 蓝色 ○ 黄色 ○ 橙色 ○ 红色

● 全部 ○ 预警中 ○ 人工解除 ○ 自动解除

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| 发布时间 | 发布单位 | 类型等级 | 状 态 |
|---|---|---|---|
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| 2012-9-12 16:03:49 | 水利部水文局 | 枯水蓝色 | 自动解除 |

**Fig 2.17** The major interface of the platform for sharing the hydrological early warning information nationwide

### *2.6.3 Disaster Prevention and Preparedness Achievements/Results*

### *1) Active reporting and releasing information on disaster impacts*

According to the revised *Natural Disaster Information Statistical System*, China has upgraded the National Natural Disaster Information Management System in 2012. According to the statistics by the end of September, the system had covered all provinces, prefecture-level cities and counties nationwide as well as all rural towns (residential districts) in Hebei, Jiangsu, Jiangxi, Hubei and Guangdong provinces, and engaged with more than 10,000 users in total. The system has greatly improved the timeliness, standardization and accuracy of disaster information statistics.

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**Fig 2.18** Interface of the National Natural Disaster Information Management System

### *2) Natural Disaster Information Mobile Newspaper has been officially launched*

To improve disaster information services, the Ministry of Civil Affairs officially issued the “Natural Disaster Information Mobile Newspaper” on 10 May 2012. The “Natural Disaster Information Mobile Newspaper” timely and visually reports the latest news in the form of MMS about natural disaster information and disaster relief on a daily basis to member units of the China National Committee for Disaster Reduction, the Ministry of Civil Affairs and the departments (bureaus) of civil affairs of various provinces (autonomous regions and municipalities directly under the central government), covering more than 1,000 subscribers.

### *3) Improved comprehensive disaster response capability by leveraging the project on satellite constellation for environment and disaster reduction*

In 2012, the National Disaster Reduction Centre of the Ministry of Civil Affairs has completed the trial operation and acceptance inspection of 10 subsystems of the project on satellite constellation for environment and disaster reduction, including operational management system software, database management platform development service, user service and information distribution subsystem, remote sensing data processing subsystem, disaster monitoring and early-warning subsystem, emergency response subsystem, disaster information assessment subsystem, decision making support subsystem, software assembly, and hardware assembly, and will launch the use of the subsystems. By leveraging the project on satellite constellation for environment and disaster reduction, the National Committee for Disaster Reduction will improve its comprehensive capabilities in disaster information acquisition, rapid assessment, early-warning response, comprehensive research and judgment, service launching, etc. for various natural disasters.

### *4) Actively carried out domestic exchanges and cooperation on disaster prevention, preparedness and reduction*

In April, the Ministry of Civil Affairs and the China Meteorological Administration jointly launched the *Disaster Reduction in China*, a weekly expert interview program broadcasted via China Weather TV for the first time, publicizing policies, technologies and knowledge on disaster prevention, preparedness and reduction to the general public. In May, the third National Comprehensive Disaster Prevention and Reduction and Sustainable Development Forum was held by the Expert Panel on the National Committee for Disaster Reduction and the National Disaster Reduction Centre in Beijing, further deepening domestic exchanges and discussions on the latest scientific research achievements and technologies in disaster prevention, preparedness and reduction. In May, the Ministry of Civil Affairs and PICC Property and Casualty Company Limited signed the Memorandum on Strengthening Strategic Cooperation in Disaster Prevention and Reduction to actively carry out cooperation in disaster risk evaluation, loss assessment, settlement of insurance claims and other business sectors.

### *2.6.4 Research, Training, and Other Achievements/Results*

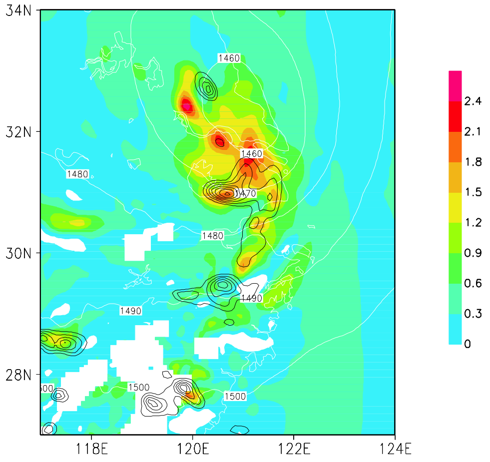
#### *1) Study on determining the extra-tropical transition (ET) onset and completion times of tropical cyclones*

Four methods for determining the extratropical transition (ET) onset and completion times of Typhoons Mindulle (2004) and Yagi (2006) were compared using four numerically-analyzed datasets. The open wave and scalar frontogenesis parameter methods failed to smoothly and consistently determine the ET completion from the four data sources, because some dependent factors associated these two methods highly impact on the results. Although the cyclone phase space technique succeeded in determining the ET onset and completion times, the ET onset and completion times of Yagi identified by this method exhibited large distinction across the datasets, agreeing with prior studies. The isentropic potential vorticity method was also able to identify the ET onset times of both Mindulle and Yagi using all the datasets, whereas the determined ET onset time of Yagi by such a method strikingly differed from that by the cyclone phase space technique, which may create forecast uncertainty.

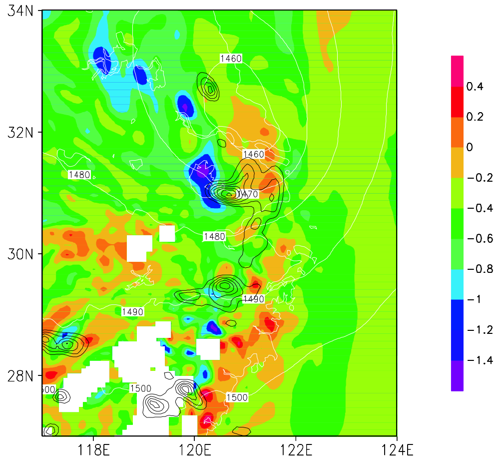
#### *2) Application of Generalized Convective Vorticity Vector in a Rainfall Process Caused by a Landing Tropical Depression*

A heavy rainfall caused by a landing tropical depression (TD) is studied via a numerical control experiment. It is found that contours of generalized equivalent potential temperature ($\theta^*$) are almost vertical with respect to horizontal surfaces near the TD centre and more densely distributed than those of equivalent potential temperature ($\theta e$). Because the atmosphere is non-uniformly saturated in reality, $\theta^*$ takes place of $\theta e$ in the definition of convective vorticity vector (CVV) so that a new vector, namely the generalized convective vorticity vector (CVV*), is applied in this study. Since CVV* could reflect both the secondary circulation and the variation of horizontal moist baroclinicity, the vertical integration of vertical component of CVV* can reflect the rainfall areas in the TD case better than potential vorticity (PV), moist potential vorticity (MPV), generalized moist potential vorticity (Pm), and CVV, with high-value area corresponding to heavy-rainfall area.

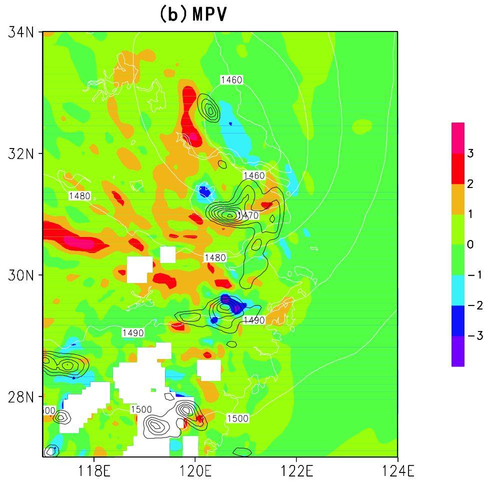
By carrying out a numerical sensitivity experiment on the effect of Hangzhou Bay, it is found that the CVV* becomes weaker than that in the control experiment, resulting in reduced rainfall. Further analyses show that the Hangzhou Bay provides good water vapor and surface latent and sensible heat fluxes to the TD system. Therefore, the bay is very important to mesoscale cloud clusters' genesis and development around the TD and the associated rainfall.



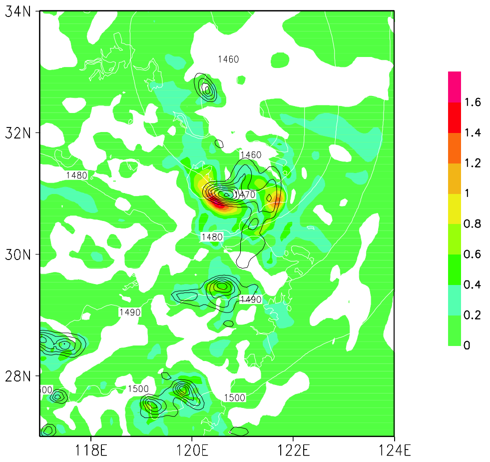
(a) PV



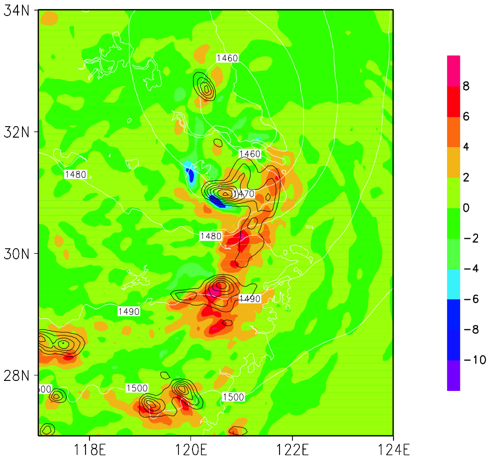
(b) MPV



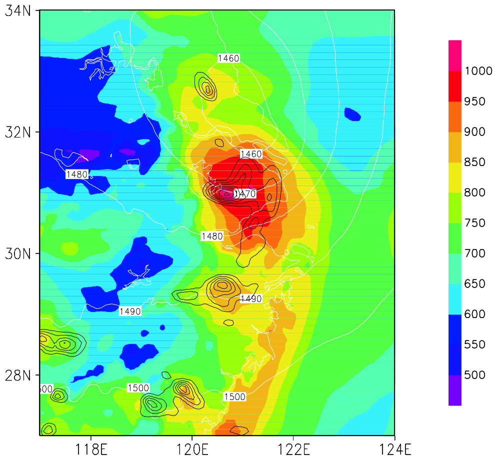
(c) Pm



(d) CVV



(e) CVV*



(f) Rh

**Fig 2.19** The rainfall and each physical quantity distributions.

(a), (b), (c), (d), (e) and (f) is for PV, MPV, Pm, CVV, CVV*, and Rh respectively.

### *3) An observational study on distribution of precipitation associated with landing tropical cyclones affecting China*

In order to provide an operational reference for tropical cyclone precipitation forecast, this study investigates the spatial distributions of precipitation associated with landing tropical cyclones (TCs) affecting China using Geostationary Meteorological Satellite 5 (GMS5)-TBB dataset. All named TCs formed over the western North Pacific that made direct landfall over China during the period of 2001-2009 are included in the study. Based on the GMS5-TBB data, this paper reveals that in general there are four types of distribution of precipitation related to landing TCs affecting China. (a) the South-West Type in which there is a precipitation maximum to the southwestern quadrant of TC; (b) the Symmetrical South Type in which the rainfall is more pronounced to the south side of TC in the inner core while there is a symmetrical rainfall distribution in the outer band region; (c) the South Type, in which the rainfall maxima is more pronounced to the south of TC; and (d) the North Type, in which the rainfall maxima is more pronounced to the north of TC. Analyses of the relationship between precipitation distributions and intensity of landing TCs show that for intensifying TCs, both the maximum and the coverage area of the precipitation in TCs increase with the increase of TC intensity over northern Jiangsu province and southern Taiwan Strait, while decreasing over Beibu Gulf and the sea area of Yangtze River estuary. For all TCs, the centre of the torrential rain in TC shifts toward the TC centre as the intensity of TC increases. This finding is consistent with many previous studies. The possible influences of storm motion and vertical wind shear on the observed precipitation asymmetries have also been examined. Results show that the environmental vertical wind shear is an important factor contributing to the large down-shear rainfall asymmetry, especially when a TC makes landfall on the southern and eastern China’s coast. These results are also consistent with previous observational and numerical studies.

### *4) Impact of sea spray on tropical cyclone structure and intensity change*

The effects of sea spray on tropical cyclone (TC) structure and intensity variation are evaluated through numerical simulations using an advanced sea-spray parameterization from the National Oceanic and Atmospheric Administration/Earth System Research Laboratory (NOAA/ESRL), which is incorporated in the idealized Advanced Research version of the Weather Research and Forecast (WRF-ARW) model. The effect of sea spray on TC boundary-layer structure is also analyzed. The results show that there is a significant increase in TC intensity when its boundary-layer wind includes the radial and tangential winds, their structure change, and the total surface wind speed change. Diagnosis of the vorticity budget shows that an increase of convergence in TC boundary layer enhances TC voritcity due to the dynamic effect of sea spay. The main kinematic effect of the friction velocity reduction by sea spray produces an increment of large-scale convergence in the TC boundary layer, while the radial and tangential winds significantly increase with an increment of the horizontal gradient maximum of the radial wind, resulting in a final increase in the simulated TC intensity. The surface enthalpy flux enlarges TC intensity and reduces storm structure change to some degree, which results in a secondary thermodynamic impact on TC intensification. Implications of the new interpretation of sea-spray effects on TC intensification are also discussed.

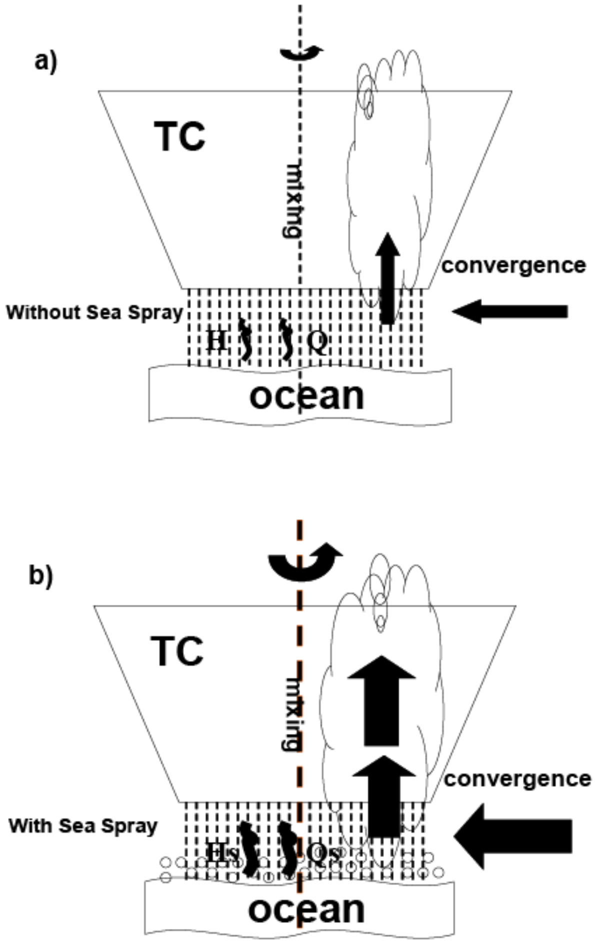


**Fig 2.20** Conceptual pattern about the effect without (a) and (b) with sea spray on the boundary layer of the simulated TC. Hs and Qs (H and Q) are the sensible heat and latent heat with (without) the effect of sea spray, respectively. The rotating vector stands for the relative vorticity.

### *5) Numerical simulation on re-intensification of tropical cyclone remnant re-entering the sea: A case study*

When Typhoon Toraji (2001) reached the Bohai Gulf in 1-2 August 2001, a heavy rain event occurred over Shandong Province in China along the Bohai Gulf. The advanced Weather Research and Forecast (WRF-ARW) model was used to explore possible effects of environmental factors, including effects of moisture transportation, upper-level trough interaction with potential vorticity anomalies, tropical cyclone (TC) remnant circulation, and TC boundary-layer process on the re-intensification of Typhoon Toraji, which re-entered the Bohai Gulf after having made a landfall. The National Centres for Environmental Prediction (NCEP) global final (FNL) analysis provided both the initial and lateral boundary conditions for the WRF-ARW model. The model was initialized at 1200 UTC on 31 July and integrated until 1200 UTC on 3 August 2001, during which Toraji remnant experienced the extratropical transition and re-intensification. Five numerical experiments were performed in the study, including one control and four sensitivity experiments. In the control experiment, the simulated typhoon had a track and intensity change similar to those observed. The results from three sensitivity experiments showed that the moisture transfer by a southwesterly lower-level jet, a low vortex to the northeast of China, and the presence of Typhoon Toraji all played important roles in simulated heavy rainfall over Shandong and remnant re-intensification over the sea, which are consistent with the observation. One of the tests illustrated that the local boundary layer forcing played a secondary role in the TC intensity change over the sea.

### *6) The use of shear gradient vortices in tropical cyclone heavy precipitation prediction: a high-resolution numerical case study.*

This study introduces a new dynamical quantity, shear gradient vorticity (SGV), which is defined as vertical wind shear multiplying the horizontal component of vorticity gradient, aiming to diagnose heavy precipitation induced by some strong convective weather systems. The vorticity gradient component can be used to study the collision or merging process between different vortexes or the deformation of a vortex with a sharp vorticity gradient. Vertical wind shear, another contributed component of SGV, always represents the environmental dynamical factor in meteorology. By the combined effect of the two components, overall, SGV can represent the interaction between the environmental wind shear and the evolution of vortexes with a large vorticity gradient. Other traditional vorticity-like dynamical quantities (such as helicity) have the limitation in the diagnosis of the convection, since they do not consider the vorticity gradient. From this perspective, SGV has the potential to diagnose some strong convective weather processes, such as Extratropical Transition (ET) of tropical cyclones and the evolution of multicell storms. The forecast performance of SGV for the numerical ET case of Typhoon Toraji (0108) has been evaluated. Compared with helicity, SGV has showed a greater advantage to forecast the distribution of heavy precipitation more accurately, especially in the frontal zone.

### *7) Development of a coupled atmosphere-sea wave model*

A coupled atmosphere-sea wave model system has been developed to evaluate the impact of sea surface roughness, sea spray and SST cooling on the changes in intensity and structure of tropical cyclone. The coupled model consists of mesoscale atmospheric model Global and Regional Assimilation and Prediction System (GRAPES), Estuarine Coastal Ocean Model with sediment transport (ECOMSED) and WAVEWATCH III (WW3). The coupling among model components is implemented by using Ocean Atmosphere Sea Ice Soil (OASIS) coupling software. The results show the effect of waves in increasing the sea surface roughness under moderate winds conditions and enhancing the heat flux between air and sea. Overall, the wave tends to increase the intensity of tropical cyclone. However, the air-sea interaction induced by the ocean model (SST cooling) weakens the intensity of tropical cyclone compared to the result of separate atmospheric model experiment.

### *8) New method for Typhoon targeted observation*

For typhoon occurred in the low latitude, it is more nonlinear compared with those middle latitude systems. So the conditional nonlinear optimal perturbation (CNOP) is one of the most effective approaches for the determination of typhoon sensitive area. How to choose the cost function when CNOP is applied to typhoon intensity and track forecast is investigated. The impacts of CNOP targeted observation on typhoon forecast, as well as the sensitivity of different variables and variables on different layers in the sensitive area are investigated. In addition, the results of observing simulation system experiments (OSSEs) are verified with real data through multiple typhoon cases. It shows that, for different typhoon, the sensitive area differs. The perturbation on variables in the sensitive area of initial field leads to significant variation of typhoon prediction.

### *9) An update of GRAPES Typhoon Numerical Model*

Some improvements have been made in the GRAPES typhoon numerical model and compared to the operational one (GRAPES-TCM), including an initial vortex scheme using the MC-3dvar technique, an improved convection parameterization scheme, an adjusted algorithm of the drag coefficient in the boundary layer parameterization scheme and increased horizontal resolution (from 25 km to 15 km).Preliminary verification on the updated model shows decreased error in typhoon track prediction in comparison to that of the GRAPES-TCM.

### *10) The sensitivity of Typhoon model forecast to the convective parameterization*

To better understand the influence of two convection parameterization schemes Kain-Fritsch (KF) and Betts-Miller-Janjic (BMJ) on typhoon prediction, the GRAPES-TCM is used to make sensitivity experiments for 44 typhoon cases. The experiment results show that the typhoon overall prediction with KF scheme is better than that with BMJ scheme. The advantage of BMJ scheme is the intensity prediction of strong Typhoon. The influence of the two schemes on the Typhoon track prediction has no obvious feature of differences. The influence of the two schemes on the typhoon intensity and precipitation prediction depends on the typhoon initial intensity. The difference of the predicted typhoon intensity with the two schemes is basically consistent with the difference of the predicted typhoon precipitation intensity with the two schemes.

### *11) Four stream radioactive transfer parameterization scheme*

Two-stream-approximation is widely used in radioactive transfer model in weather (typhoon) model. It is very accurate under clear sky conditions, with a relative error less than 1.5% for heating rate and flux. However, under cloudy conditions, cloud heating might been underestimated by as much as 12%. The incorrect cloud absorption could affect weather and climate model behavior as cloud top heating is crucial to cloud evolution. In particular, tropical cyclone is a sophisticated cloud system associated with deep convection. Therefore, to obtain the accurate results for cloud absorption of deep convection in typhoon cyclone, a more accurate scheme for radiation transfer parameterizations is required. Recently, an analytical method of four stream doubling–adding method was developed in Shanghai Typhoon Institute. The relative error of four stream doubling in heating rate and flux at cloud top layer could be less than 1%. The scheme is expected to be implemented in tropical cyclone numerical model to improve cloud-radiation interaction and tropical cyclone prediction.

### *12) The preliminary results of radar data assimilation with an EnKF for Typhoon forecast*

Taking into account a tropical cyclone's characteristic of highly rotational and axi-symmetric circulation, the ensemble Kalman Filter (EnKF) with flow-dependent background error covariance is more suitable for the TC initiation. To obtain more refined initial field, radar radial wind data was assimilated into an EnKF system. A case-study of Typhoon MORAKOT showed the positive results by directly assimilating the radar data.

### *13) Study on air-sea interaction under typhoon impact*

The research about air-sea interaction under typhoon influence is further developed in Shanghai Typhoon Institute. A numerical system is established by coupling the mesoscale atmospheric model, ocean circulation model and wave model. On this basis, numerical simulations are conducted to find the characteristics of marine elements, e.g. the upper ocean sea surface temperature and ocean currents, wave and wind stress under typhoon influence. The influence of air-sea interaction to the change of typhoon intensity is also analyzed.

To meet the demands of developing of marine meteorological service, China has developed an operational forecast system of global ocean waves with spatial resolution of 0.5*0.5 degree and forecasting period of 7 days. Additionally, a hydrologic numerical forecast system of Huangpu River in Shanghai is also established with high resolution of decade meters, and it can provide refined forecast products of sea level and ocean current, and provide reference to urban flood control Work in Shanghai, as an improvement it can also meet the demands of port area routine work of Shanghai International Port.

### *14) Study in the structure, track and intensity of tropical cyclones in CAMS (Chinese Academy of Meteorological Science)*

- Structure

Early researches indicate that 43% typhoons have a pre-squall line in front of typhoon. Formation of pre-squall line is closely related to an unstable stratification atmospheric structure and convergence area with high value of CAPE which is produced by typhoon. 14.7% typhoons will produce a remote cloud cluster and heavy precipitation (TRP). Observational and numerical simulation demonstrates that the occurrence of TRP is a result of the interaction between typhoon and a mid-latitude trough. The rain rate and distribution of TRP depend upon the moisture transport of typhoon and strength of the trough. Topographic effect plays an important role on rainfall increasing.

To study the characteristics of barotropic wave, the simulation data of mesoscale WRF model is applied to a barotropic shallow water equation. The results show that there are inertial-gravity waves which propagate counterclockwise and vortex Rossby waves in Typhoon Matsa. Those two kinds of waves have different structures and stabilities.

- Track

The northward turning of Typhoon Megi in 2009 is analyzed. The results show that the enhancement and eastward movement of Qinghai－Xizang High gave birth to the strengthening and development of upper-level westerly trough. Then the South China High which moved southward to the Indo-china peninsula hindered Megi from moving eastward. Meanwhile, southwest basic flow resulting from the cross-equatorial flow made a contribution to the northward turning of Megi.

- Intensity

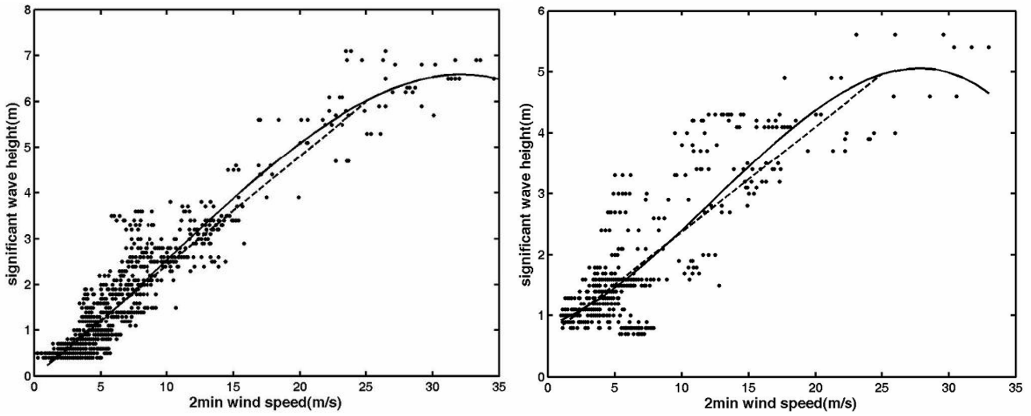
National Natural Science Foundation of China program (40730948) has studied the mechanism of intensity change for Landing Tropical Cyclones (LTC) which include those typhoons approaching land, moving across coast and reentering ocean from land. Offshore typhoons could increase its intensity from the binary typhoon interaction, upper level cold vortex overlapping and cold cloud area expanding. It could decrease its intensity due to not only stronger vertical wind shear but also reducing of the temperature difference between upper level and low layer air column. Typhoon over land will be dissipated by the land friction consuming, but 9.7% of them could revive and perhaps bring about heavier rainfall than its in landfall stage. Studies reveal that both ET process and monsoon surges drawn into the typhoon would be the major causes to reinvigorate the remnant of LTC. Mesoscale shear line (MSL) could be occurred within LTC which would reinvigorate the convective systems and increase rainfall. Numerical simulation indicate that the large scale inland water surface could alleviate the decaying rate of LTC and activate the mesoscale convection and rainfall.16% of LTC would reenter ocean and 45.8% of them could increase its intensity. Study shows that ET process, out flow divergence over the LTC, vorticity and moisture transport to the remnant and the decreasing of the surface friction would be the major mechanism for resuscitating of the remnant when it move into the Eastern coast. The high sea surface temperature is a major cause for the increasing of LTC when they entering the South China Sea.

Based on Potential Vorticity (PV) budget diagnosis, the causes of intensity evolution of severe typhoon Saomai are analyzed. The results show that the variations of vertical wind shear, vorticity and divergence around the centre of the typhoon affected the variation of its intensity significantly. The PV diagnosis shows that the condensation latent heat, vertical advection and horizontal advection played different influence on its intension and decaying.

### *15) Study in the characteristics of momentum exchange between the sea and land under conditions of varying wind speeds*

The observations from offshore sea surface profilers of a marine observation platform were to study the characteristics of momentum exchange between the sea and land under conditions of varying wind speeds. It was found that the friction velocity U* increases with the wind speed and the drag coefficient Cd and roughness length Z0 first decrease with the increase of U10 (U10≤6 m/s), within the range of U10<24 m/s and then strengthen with the increase of wind speed; when U10>24 m/s, U* shows a tendency of saturation and Z0 and Cd increase, after reaching the extreme value, with the growth of wind speed.

Figure 2.21 shows the relationship between the effective wave height and 2-min. wind speed at the height of 2m under the conditions of Typhoons Molave and Chanthu. As shown in the figure, the relationship was very good in the case of Chathu (with buoy measurements from Maoming) and the correlation coefficient could be as high as 0.8921 with polynomial fitting, but it was discrete for Molave (with buoy measurements from Shanwei) and the correlation coefficient was 0.7464, which was much smaller than that for Maoming. It suggests, to some extent, complicated relationships between the effective wave height and wind speed in the coastal region offshore.



a b

**Fig 2.21** Relationships between the effective wave height (m) and 2-min wind speed (m/s) under the condition (a). Maoming buoys (b). Shanwei buoys

#### *2.6.5 Regional Cooperation Achievements/Results*

#### *2.6.6 Identified Opportunities/Challenges for Future Achievements/Results*

### *2.7 Progress on Key Result Area 7: Enhanced Typhoon Committee's Effectiveness and International Collaboration.*

#### *2.7.1 Meteorological Achievements/Results*

**Fig 2.22** The first International Training Course of Weather Forecasters

The first International Training course for weather forecasters hosted by National Meteorological Centre was held in the Regional training Centre of Nanjing University of Information and Science Technology from 17 to 27 in September. There were eighteen forecasters from fifteen developing countries attended this ten day's training. During the training, fifteen experts from NMC gave course on weather forecasting system, synoptic analysis, typhoon and marine forecast, numerical forecast, Micaps system application and etc. The aim of this international training was to reinforce the operational application of MICAPS (developed by National Metrological Centre) in those eighteen supported countries. From this international training, the new achievements on the modern weather forecasting technique would be brought to the international world.

**Table 2.2** The topics in the international Training Course

| | Topics |
|---|---|
| ✧ | Briefing of the Weather Forecast Operations of National Meteorological Centre of CMA |
| ✧ | Communicating forecast uncertainty |
| ✧ | Medium-range Meteorology |
| ✧ | Monitoring of Climate Extremes |
| ✧ | Marine Weather Forecasting and Warning in CMA |
| ✧ | Operational Typhoon Analysis and Forecasts in CMA |
| ✧ | Recent Developments of Numerical Weather Prediction Systems in CMA |
| ✧ | MICAPS System |
| ✧ | Introduction to CMACast and its Data Catalogue& Interface between CMACast and Micaps |

- Severe Convective Weather Prediction Operations and Its Developments in CMA
- Monitoring of Strong Convective Weather and Nowcasting
- Meso-Scale Analysis and Forecasting on Strong Convective Weather
- Objective Methods on Severe Convective Weather Prediction
- Short-Rang Weather Forecast and Its Developments in CMA
- NWP Output Verification and Modification
- NWP Ensemble Products Application
- How to make a better QPF

### *2.7.2 Hydrological Achievements/Results*

#### *1) Organization of International Training Workshop on Urban Flood Risk Management by the Typhoon Committee*

In 23-27 September, the Hydrological Bureau of the Ministry of Water Resource and Typhoon Committee (TC) cosponsored the International Training Workshop on Urban Flood Risk Management (UFRM). The host of this activity is the Hydrological Bureau of the Guangdong Province. The meeting was attended by the hydro-meteorologists and scientists from the Typhoon Committee Secretariat, Hydrology Bureau of the Ministry of Water Resources, Guangdong Bureau of Hydrology and representatives from Malaysia, Philippine, Thailand and Vietnam. The meeting also invited experts from the Hohai University, Sun Yat-Sen University, China Institute of Water Resources and Hydropower Research to present the thematic reports and provide training.

The workshop focused on the Xinanjiang Model and its applications, the application of the products of hydrology-meteorology coupled Quantitative Precipitation Estimation and Quantitative Precipitation Forecast (QPE/QPF) and its techniques, the urban inundation risk mapping and urban flood warning and prediction models, etc. Meanwhile, the tour to Guangzhou project of urban flood prevention and system of flood warning was organized for the participants, who also exchanged their experiences and practices in the urban flood prevention in their own countries.

**Fig 2.23** A scene of the training workshop

**Fig 2.24** A presentation by an expert

**Fig2.25** Trainees attending the workshop

**Fig2.26** A group photo on completion of the training workshop

**Fig2.27** A group photo of the experts and scientists attending the workshop

### *2.7.3 Disaster Prevention and Preparedness Achievements/Results*

In 2012, China has actively participated in international cooperation focusing on disaster prevention, preparedness and reduction. The National Disaster Reduction Centre successively received visits and exchanges of experts and guests all over the world. The international organizations included the United Nations Children's Fund, the United Nations Development Programme as well as U.S., the Republic of Belarus, Finland and other countries, and actively participated in various international conferences and trainings held by the United Nations. Benefited from binary cooperation and exchanges, both China and other countries as well as international organizations have strengthened mutual understanding and shared experience and practices, which can build up solid foundation for further cooperation in the future.

### *2.7.4 Research, Training, and Other Achievements/Results*

***NIL***

### *2.7.5 Regional Cooperation Achievements/Results*

***NIL***

### *2.7.6 Identified Opportunities/Challenges for Future Achievements/Results*

***NIL***

## III. Resource Mobilization Activities

## IV. Update of Members' Working Groups representatives

### *1. Working Group on Meteorology*

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