Marine early warning system at NMEFC

Dr. Benxia Li
National Marine Environmental Forecasting Center
Ministry of Natural Resources of P.R.C.
Outlines

- Overview
- Marine calamity warning process
- Operational storm surge forecasting system
- Operational wave forecasting system
- Outlook
North-west Pacific is the region where global typhoon is most active, suffering from more easily super-strong typhoon, and about 30% typhoons originate here.
Because China is adjacent to North-west Pacific, China seas suffer from serious marine calamity, such as storm surge, and huge waves.
Overview

Direct economic losses due to marine calamities

According to data from 《Bulletin of China Marine Disaster》， since 1989, annually economic losses due to marine disaster is about 100 million China-Yuan, about 200 people are lost or die from marine calamities each year.

The total death due to marine calamities
When tropical, extratropical cyclones or strong cold weather are expected to influence the China’s seas

Issuing pre-warning message 72 hours in advance

Issuing warning products in 24 hours ahead of time

Broadcast  Television  Internet  Fax  MMS

An example of warning product

Four grades of warning
✓ Red warning
✓ Orange warning
✓ Yellow warning
✓ Blue warning

Nationwide Emergency meeting
Marine observation stations and buoys in China Seas

- 194 marine stations
- 43 buoys
- 2 marine satellites (HY-1, HY-2)
Operational storm surge forecasting system
China’s Typhoon Storm Surge Forecasting System (CTS)

System Characteristics:

◆ Developed by NMEFC, run operationally in 2003;
◆ Base on spherical coordinates semi-implicit finite difference; grid resolution reached 2’
◆ ensemble forecast -- accounting for the uncertainty of typhoon forecast in moving speed and central track
China’s extra-tropical storm surge forecasting system (CES)

System Characteristics:
◆ Developed by NMEFC, run operationally in 2004;
◆ Computing area including Bohai sea and Yellow Sea
◆ grid Resolution reached 6’
◆ Driven by WRF model and run twice per day Automatically

System Characteristics:
◆ Developed by NMEFC, run operationally in 2004;
◆ Computing area including Bohai sea and Yellow Sea
◆ grid Resolution reached 6’
◆ Driven by WRF model and run twice per day Automatically
Storm surge overtopping barrier forecasting system

System Characteristics:

◆ Based on unstructured mesh and Using FEA method.

◆ High–resolution topography and water depth data, the height and structure of barrier

◆ including astronomical tide, storm surges, coastal wave and wave run-up in the front of barrier.

◆ less than 15min simulating 3 days storm surge in HPCs

◆ run operationally in NMEFC
Storm surge around the world

The bay of Bengal is an important node of “The Belt and Road initiative” and affected by storm surge seriously.

<table>
<thead>
<tr>
<th>Year</th>
<th>Date</th>
<th>Wind &amp; surge</th>
<th>Affected region</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>12-13,November</td>
<td>W=222km/h, s=5.5m</td>
<td>Khulna-Chittagong</td>
<td>300,000</td>
</tr>
<tr>
<td>1971</td>
<td>28-30,November</td>
<td>W=110km/h, s=1.0m</td>
<td>Sunderban</td>
<td>11,000</td>
</tr>
<tr>
<td>1985</td>
<td>24-25,May</td>
<td>W=154km/h, s=3.2m</td>
<td>Noakhali-Cox’s Bazar</td>
<td>11,069</td>
</tr>
<tr>
<td>1988</td>
<td>29,November</td>
<td>W=160km/h, s=3.5m</td>
<td>Sunderban</td>
<td>5,708</td>
</tr>
<tr>
<td>1991</td>
<td>29,April</td>
<td>w=236km/h, s=5.8m</td>
<td>Patuakhali-Cox’s Bazar</td>
<td>14,500</td>
</tr>
<tr>
<td>2008</td>
<td>2,May</td>
<td>w=215km/h</td>
<td>Myanmar</td>
<td>138,000</td>
</tr>
</tbody>
</table>
Storm surge forecasting system in the bay of Bengal
Operational wave forecasting system
China Operational Wave Forecasting System

Global
Regional
China seas
Parameters setting of operational wave forecasting system

- **Resolution**
  - Global: 1/3° × 1/3°
  - Indian Ocean: 1/6° × 1/6
  - North-West Pacific: 1/10° × 1/10°
  - China seas: 1/30° × 1/30°

- **Forecasting products**
  - SWH, Peak wave period, mean wave direction

- **Forecasting duration**
  - 72-120 hours

- **Wave model**
  - Global, Indian, North-west Pacific: NWW3
  - China seas: SWAN

- **Forcing wind**
  - NCEP/GFS, WRF, Grapes

- **Data assimilation**
  - HY-2 satellite altimeter SWH using optimal interpolation
Wave forecasting products

**SWH, T, and Wave direction**

**3D simulation of SWH**

**Mean wave steepness**

**BFI about freak waves**

**Time series of SWH at a certain point**
Outlook

- Forecasting and warning of extreme sea state
- Coastal process forecast: wave run-up, wave overtopping, flooding
- More precise storm surge forecast, such as including urban sewerage system, recognizing city streets
- Application of artificial intelligence (AI) technique in marine forecasting and warning
Thank you for your attention

lbx@nmefc.cn
http://www.nmefc.cn