Ocean forecasting information and its social benefits in China

Liying Wan and Xiaolei Yi
Structure of Chinese Forecast Organization

National Center
- National Marine Environmental forecasting Center

Regional Center
- North Marine Environmental forecasting Center
- East Marine Environmental forecasting Center
- South Marine Environmental forecasting Center

Province Center
- Liaoning
- Heibei
- Shandong
- More than 11 provinces
- Dalian
- Qinhuangdao
- Yantai
- More than 20 cities

City Center
Outline

- Introduction of NMEFC
- Status of marine forecasting and pre-warning
- Cases of Social benefits
- Summary and future
Overview

• NMEFC, Chinese national center for ocean forecasting

• Affiliated with the Ministry of Natural Resources that receives financial support from the Chinese government

• Over 300 scientists and engineers

• Authorized by the State Council Academic Degrees Committee of Physical Oceanography and Meteorology to grant Master’s degrees

• Leading authority that specializes in marine environmental and disaster forecasting and warning systems, scientific research, and consulting services

• Actively engaged in partnerships with international scientists and agencies
Established as the Marine Hydro-meteorological Forecasting General Observatory

Marine weather and wave forecast (China sea)
Sea ice forecast (Bohai sea)
Tropical cyclone storm surge forecast
Extra-tropical storm surge forecast
Sea temperature forecast (East China sea)

Renamed as the National Marine Environmental Forecasting Center

Release forecasts to public by radio and TV
El Niño forecast
Numerical temperature-salinity-currents and ocean wave forecasting systems for the China Sea and Northwest Pacific Ocean
Red tides forecast
tour and beach environment forecast
Tsunami forecast

Tsunami Warning Center of SOA
Chinese Global Operational Oceanography Forecasting System (CGOF S)

IOC/UNESCO South China Sea Tsunami Advisory Center (SCSTAC) starts to be trial-operational

1965
1966-1976
1983
1986-2010
2013
2018

History
Real-time data receiving system

**Coastal observing stations**
more than 20 key marine stations, including 109 observing points (till now):
Temperature, Salinity, Tide, Wave, Wind, Marine chemistry…

**Buoys**
25 large-size buoys for meteorology and wave height, temp.,
2 offshore small-size buoys;
2 Deep-sea Moorings;
4 offshore bottom-mounted moorings;
2 tsunami buoys.

**Radars**
5 Ground wave Radar for current, wave field;
2 X-band Marine Radar for wave field;
1 Radar Ice Sounder for Sea ice regime, thickness.

**International sources**
GTS
Agro
High Performance Computation Systems

- Sunway Cluster
- IBM Cluster

- Peak Performance ~ 350 TFlops
- Online Storage ~ 400 TB
- Supporting ~ 100 numerical forecast systems
To keep the operational video consultation

Provide the guide of different video consultation setup

Provide the skill training

More than 300 times video conference

Covered all the coastal region
Release to public

Operating maintenance a lot of News Clients, like Daily Headlines, Webchat and so on.

- more than 430 papers and videos;
- more than 2 millions pageviews of Daily Headlines, 3 millions pageviews of Netease News;
- more than 200 thousands pageviews of top news;
- more than 180 thousands of top video.
Release to public

Central Media
CCTV
China National Radio
China Radio International

7 programs in CCTV, CETV, Phoenix Satellite TV and the Travel Channel
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products

marine Environmental forecast

marine disaster pre-warning

marine weather

emergency forecast

temperature

current

storm surge

wave

tsunami

sea ice

oil spill

search and rescue

current

Touring

hhuge wave

storm surge

tsunami

red tide

oil spill

sea ice
We hope we could

01. Integrated systems
   from global to coast

02. Refined techniques
   high resolution, more accuracy

03. Diversified elements
   temperature, salinity, wave height, eddy, mix layer thickness and so on

04. Customized services
   optimal ship route, optimal work window

05. Self-dependent innovation
   marginal sea model, storm surge model
Status of Operational Oceanography in NMEFC

Chinese Global operational Oceanography Forecasting System (CGOFS v1.0) and extended forecast system

Global Oceanography Forecasts:
- Level 1: Global Ocean
- Level 2:
  - Northwest Pacific and Indian Ocean
- Level 3:
  - Bo-Yellow-East China Sea and South China Sea
- Level 4: Polar Region

Refined forecasts:
- China Coastal Zone

Ecological Forecasts:
- Level 1: Northwest Pacific
- Level 2: East and South China sea

Climate Prediction:
- Level 1: Global
- Level 2: Asia & Northwest Pacific
# Detailed of Systems

<table>
<thead>
<tr>
<th></th>
<th>Global</th>
<th>Indian Ocean</th>
<th>Northwestern Pacific</th>
<th>East/South China Sea</th>
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<tbody>
<tr>
<td>Resolution</td>
<td>$1^\circ/4$, 50 levels</td>
<td>$1^\circ/12$, 20 levels</td>
<td>$1^\circ/20$, 22 levels</td>
<td>$1^\circ/30$, 30(36) levels</td>
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<tr>
<td>Model</td>
<td>MOM4</td>
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<td>ROMSv3.5</td>
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<td>Atmospheric forcing</td>
<td>CGOFS-Wind</td>
<td></td>
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<td>NMEFC-WRF</td>
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<td>Assimilation scheme</td>
<td>3DVar</td>
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<tr>
<td>Data assimilated</td>
<td>RTGSST, SSH, Argo T/S</td>
<td>MGDSST SSH</td>
<td>MGDSST SSH</td>
<td>MGDSST/MGDSST, SSH, Argo T/S</td>
</tr>
<tr>
<td>Product</td>
<td>Temperature, current (surface, 20m, 50m, 100m, 200m, 500m, 1000m, profiles)</td>
<td></td>
<td></td>
<td>120hr</td>
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<tr>
<td>Forecast range</td>
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</tr>
</tbody>
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Air-Sea Coupled system for Typhoon

- harmonious physics processes
- synchronous forecast both atmosphere and ocean

WRF + ROMS + SWAN

Initial location of Typhoon

more accuracy of typhoon intensity change
We hope we could

**Integrated systems**
from global to coast

01

**Refined techniques**
high resolution, more accuracy

02

**Diversificated elements**
temperature, salinity, wave height, eddy, mix layer thickness and so on

03

**Customized services**
optimal ship route, optimal work window

04

**Self-dependent innovation**
marginal sea model, storm surge model

05
Storm Surge

- High resolution storm surge numerical forecasting system
- Storm surge and Wave Overflow numerical forecasting system (SWOFS)
- Storm surge and Wave Floodpain numerical forecasting system (SWIFS)
- Risk evaluation and regionalization of storm surge disaster
Ocean Wave

A. Unstructured refine ocean wave numerical forecasting system in coastal regions

B. Visualization of wave forecasting products

C. Analysis of the centennial recurrence period
Tsunami

- Quantified tsunami pre-warning data set
- Timed and refined tsunami numerical forecasting system
- Risk evaluation and regionalization of Tsunami

IOC/UNESCO South China Sea Tsunami Advisory Center (SCSTAC) starts to be trial-operational in 2018
We hope we could

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01 02
03 04
05
Ecological Forecasts

A. Ocean carbon cycle forecast in NWP & China Seas
B. Jellyfish blooms in East China Sea
C. Red tide numerical warning
D. Hypoxia area numerical simulating
E. Marine Ecosystem numerical forecast system in NWP, ECS, SCS
Oil Spill and Pollutant

01 Forcing by wind, temperature, salinity, wave and current

02 Input time, place, oil mass and discharge value and so on

03 Ensemble diffusion models
Search and Rescue

- Marine Dynamic Forecast
- Calculate drift speed
- Calculate drift path
- Visually display
- Forecast products

- high resolution forecast of wind and current

- NMEFCSAR model
- LEEWAY model

- four order lagrange drift path model

- visualization

- drift path and search area of wrecked target
Climate prediction

- Time scale from monthly to annual
- El niño dynamic and statistic prediction
- Ensemble prediction of different models
Diagnostic products

- Eddy
- Ocean front
- Indian Ocean
- Regional
- Coastal
We hope we could:

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   from global to coast

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Safe construction of Hong Kong-Zhuhai-Macao Bridge

- observation
- forecasting
- channel
- foundation trench
- weather
- wave
- current

- before one month
- before 5 days
- before 1 day
- Construct

- select time window
- decide time window
- confirm time window
- insitu garantee
Sea Ice

- High resolution Sea Ice numerical forecasting system in Bohai Sea and north of Yellow Sea
- Sea ice vibration forecasting system near oil platforms
- New techniques like Sea ice discrete element method and so on.
We hope we could

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**Customized services**
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**Self-dependent innovation**
marginal sea model, storm surge model
A Non-hydrostatic coordinates model has been built in China Seas, non-hydrostatic parameter MTYPE=4

Marginal sea model test case in SCS
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Services to Government

- Gulf of Aden Escort Guarantee
- Radioactive material monitoring in West Pacific
- MH370 search safety
- Weather forecast in Zhongshan Station
- Weather forecast in Great Wall Station
- Antarctic Expedition
- Test guarantee of “Jiaolong” deep diving device
Services to Society

- February to July, 2017
- First time mining of Gas hydrate in SCS
- Optimal time window
- Wind, wave, current, temperature, density and internal wave
Services to People

- Started from June, 2012;
- Ship monitoring, statistical analysis and website display;
- Leading time 72 hours;
- Wind, wave, temperature and so on.
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System structure update

• 3 levels to 2 levels

• More focus on marine ecological system

• Customized services improvement
Two innovative development projects

• Intelligentalize
  include intelligent gridding forecasting products, nowcast AI prewarning products and coastal basic forecasting products

• Independent development
  New self-dependendted models include storm surge, ocean wave, circulation, climate, Tsunami
Thank you for attention!

www.nmefc.cn