Operational ocean observation and forecasting services in China

Hui WANG
National Marine Environmental Forecasting Center (NMEFC), Beijing, China
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Outlines

1. Marine Observing System in China

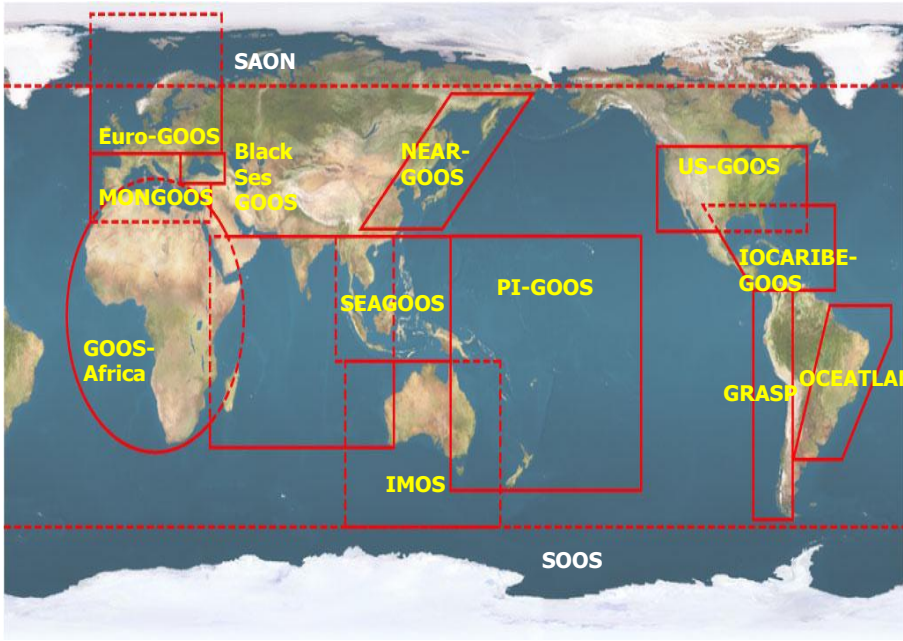
2. Marine Environment Forecasting and Disaster Warning Service

3. Perspective of China-EU collaboration

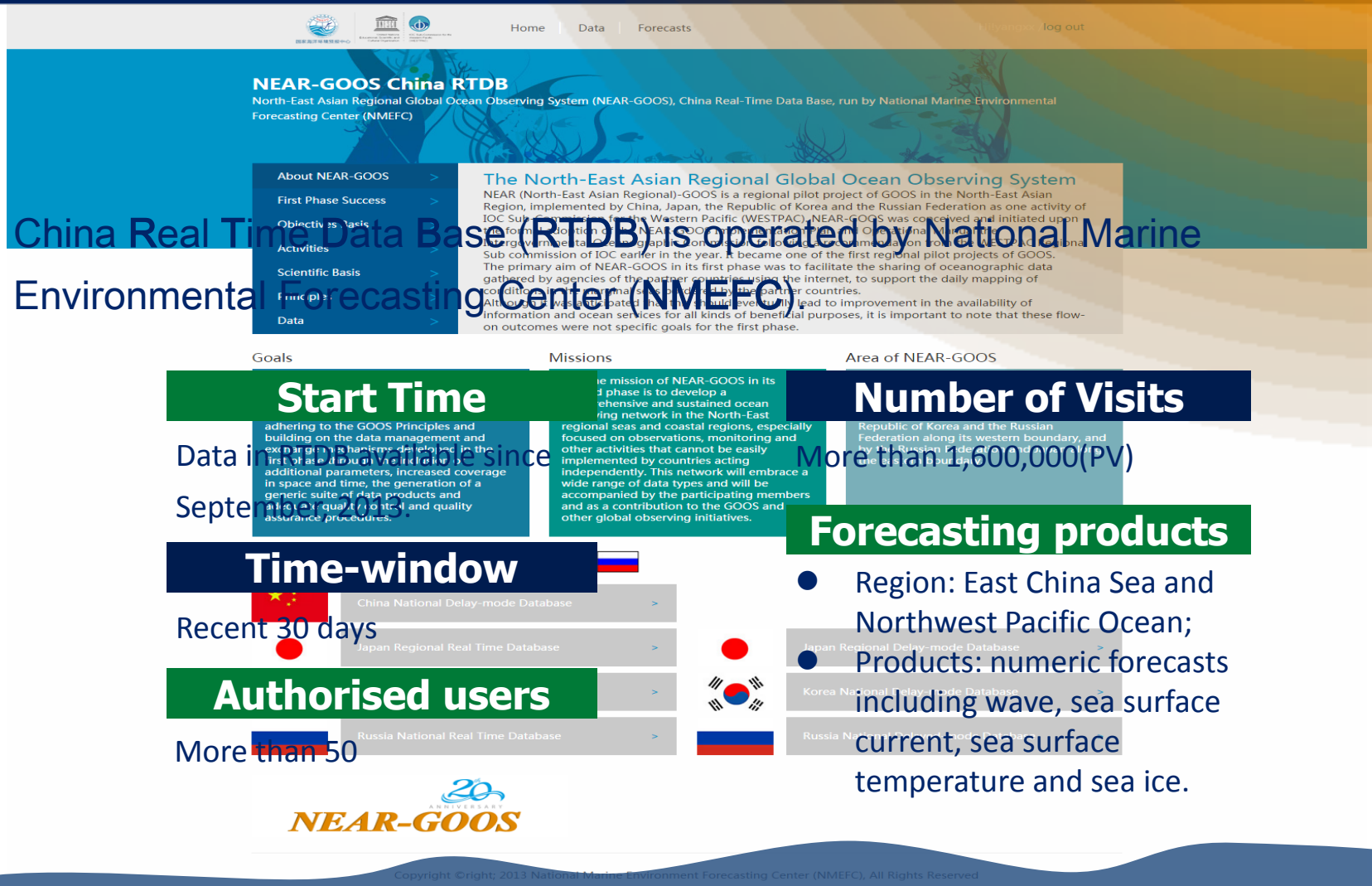
GOOS

GOOS Work Plan

- Improve the **Strategic Mapping** as **vision** for implementation of GOOS
- **Framework for Ocean Observing** processes
  - –Scientific oversight, network implementation and coordination, data management, evaluation
- Improving the **capacity** of **GOOS Regional Alliances**
- Energize and modernize GOOS through **Projects**
- Develop **communications**



General Status of China RTDB for NEAR-GOOS



China Real Time Data Base (RTDB) is operated by National Marine Environmental Forecasting Center (NMEFC).

Start Time

Data in RTDB available since September 2013.

Number of Visits

More than 1,600,000(PV)

Time-window

Recent 30 days

Authorised users

More than 50

Forecasting products

- Region: East China Sea and Northwest Pacific Ocean;
- Products: numeric forecasts including wave, sea surface current, sea surface temperature and sea ice.

General Status of China RTDB for NEAR-GOOS

Station database

Station Data

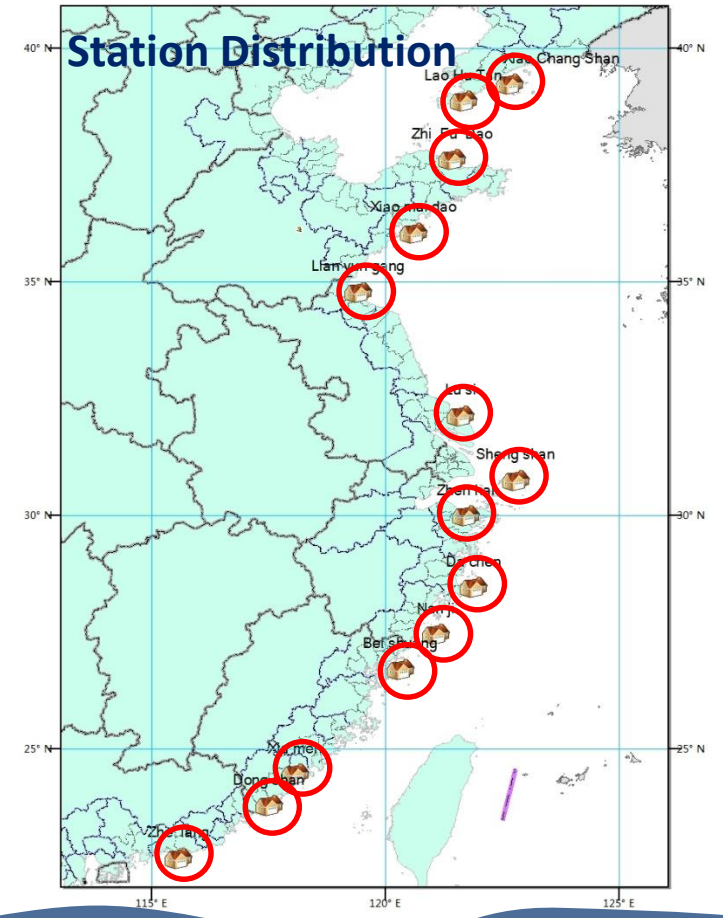
- ✓ 14 stations of SOA

Buoy Data

- ✓ 1 buoy of SOA

VOS Data

- ✓ Regional voluntary observation ship



GTS

“GTS” is acquired in real time through fiber networks that is established by National Marine Environment Forecasting Center and National Meteorological Information Center ．The NMEFC broadcasts information via VSAT

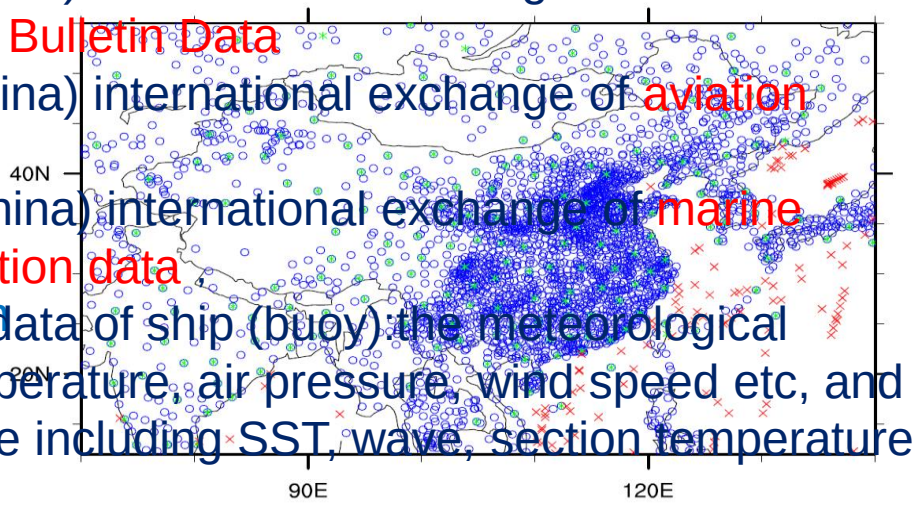
- Countries (including China) international exchange of observation data of upper air and surface
- Countries (including China) international exchange of Surface Meteorological Monthly Bulletin Data
- Countries (including China) international exchange of aviation observation data
- Countries (excluding China) international exchange of marine meteorological observation data ，
  Marine meteorological data of ship (buoy): the meteorological elements including temperature, air pressure, wind speed etc, and the marine elements include including SST, wave, section temperature, salinity and current etc.
- Facsimile chart and various alerts （Cyclone, typhoon, tsunami）

Distribution of GTS data in China

o：Surface weather observation

*：Radiosonde observation

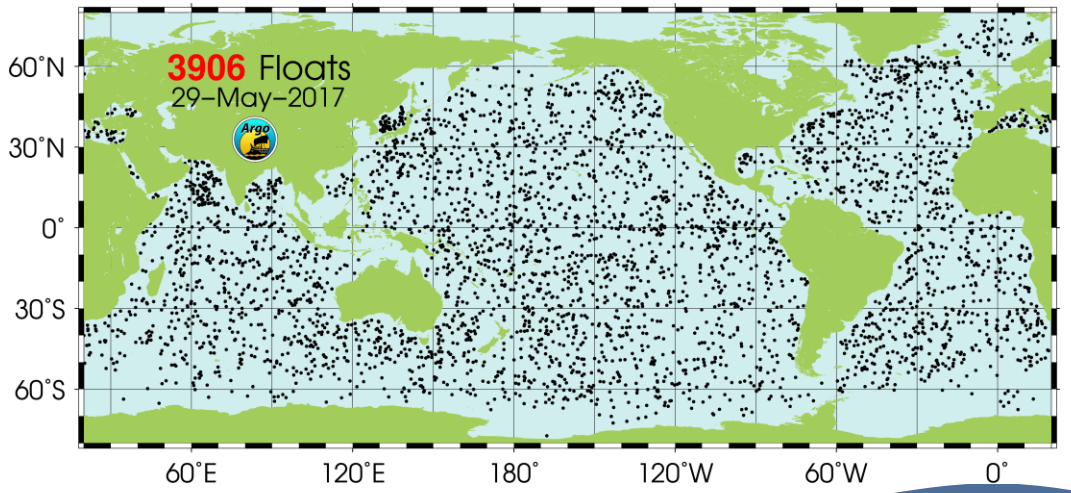
x：Volunteer ship and buoy observation

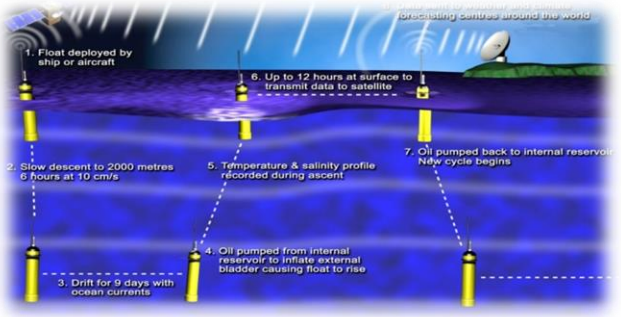


Global : ARGO

• Since 1998 more than 3000 Argo buoys have been deployed in the world oceans, measuring temperature and salinity profile more than 2000 meters deep.

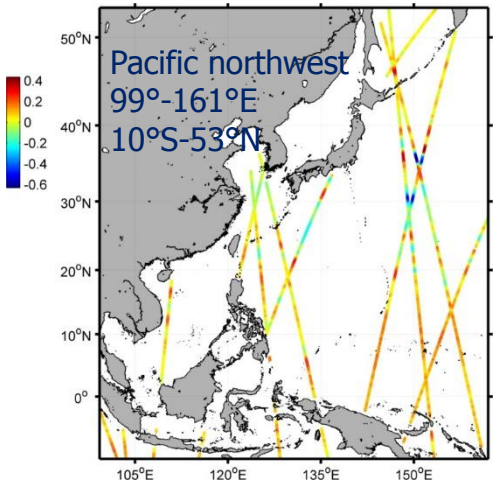
• China has participated in the Argo program, so far 376 profiling floats have been laid （According to The China Argo Center）

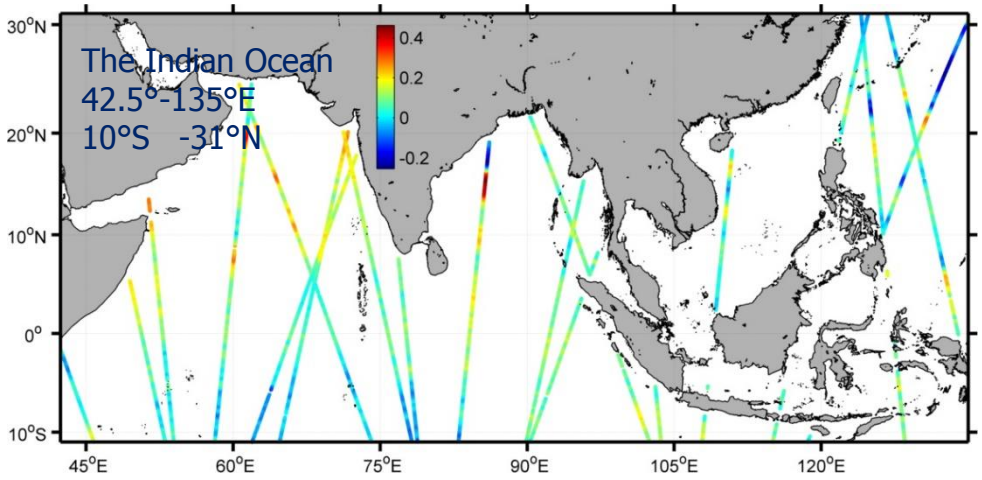




Satellite remote sensing data

Our forecasting Center has obtained CLS satellite data since 2010, covering the Pacific northwest and the India ocean, with a resolution of 7 km



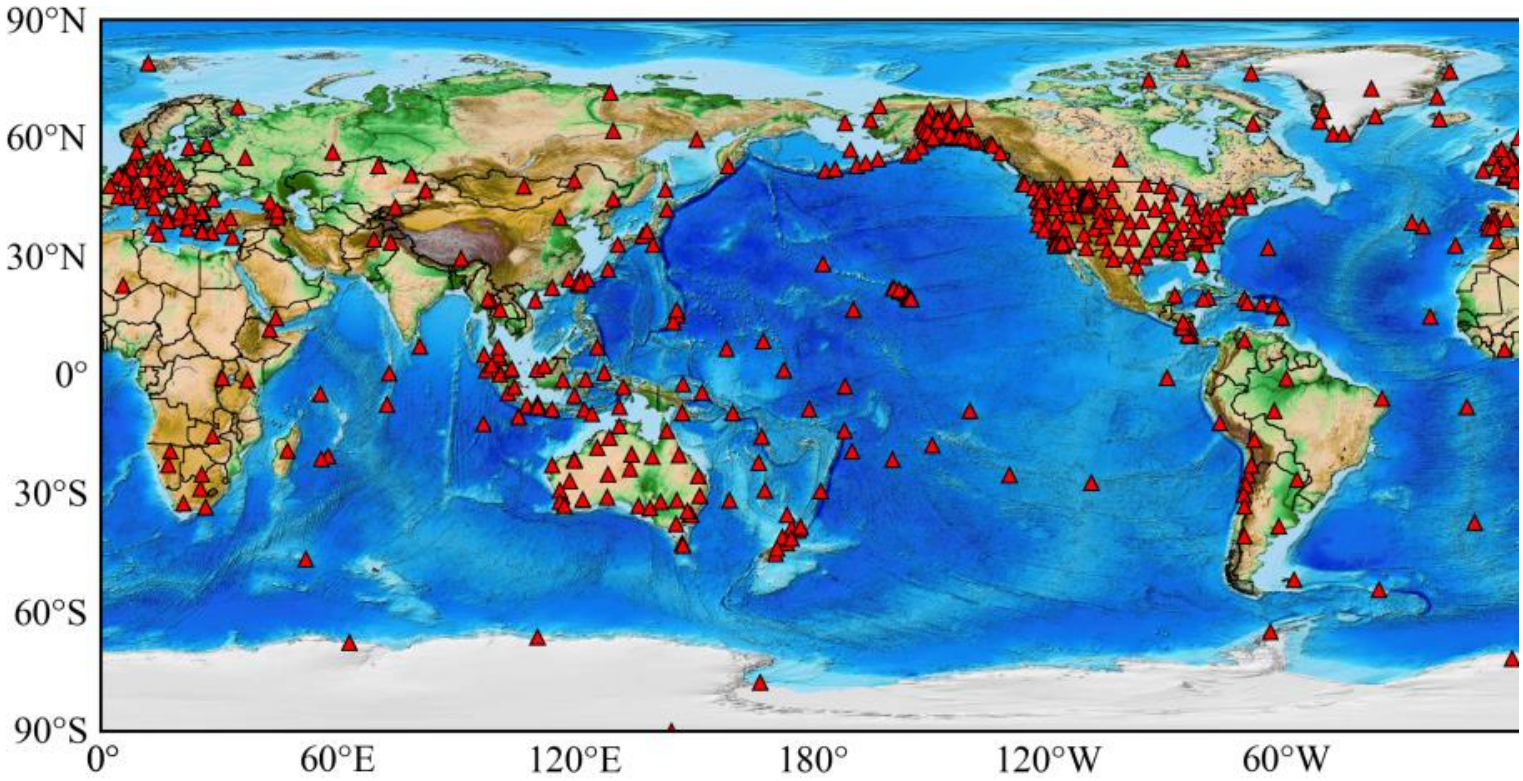


Date in Figure ：May 22, 2017

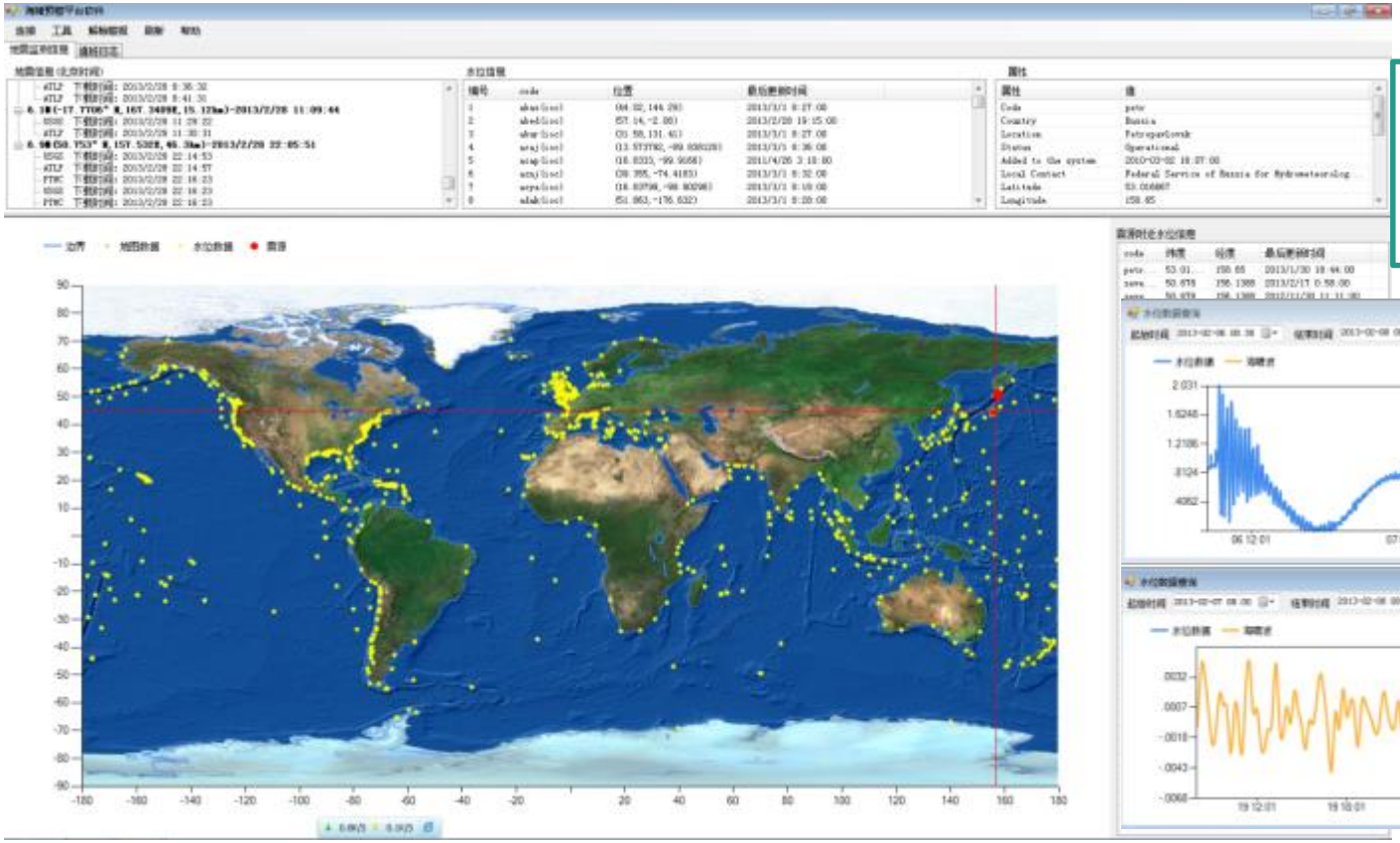
Sea level anomaly data along the rail

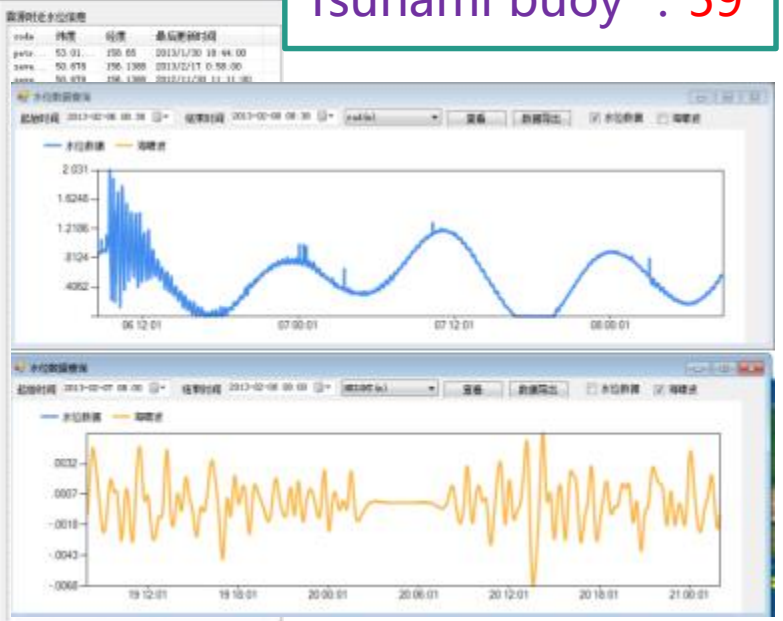
Global ： Global Seismic Networks （GSN）

- Obtain 540 global seismic network data in real time through the Internet



Global : IOC-GLOSS Global Sea Level Observing System





Tidal stations : 853

Tsunami buoy : 59

Marine environment observation of SOA

Real-time observation
Real-time transmission
Real-time monitoring

At present :

Ocean Station : 155

Buoy +3m buoy : 69

Ground wave radar : 7 groups

X-band Rada : 25

Hydrological data : 57sites

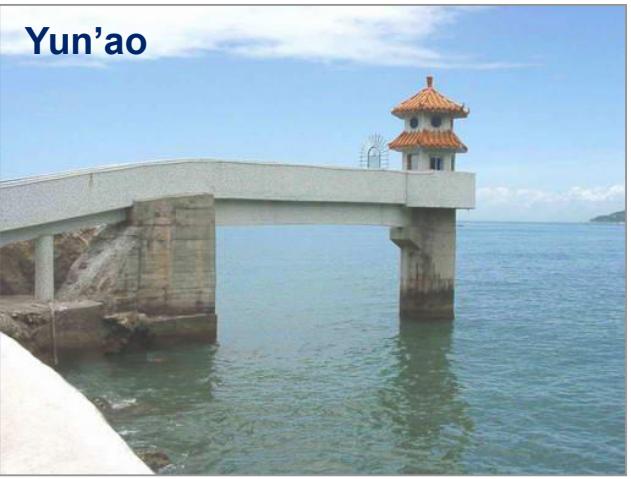
Seismic Station : 79 , 25 of the Seismic Stations belong to SOA the others sharing with Seismological Burea

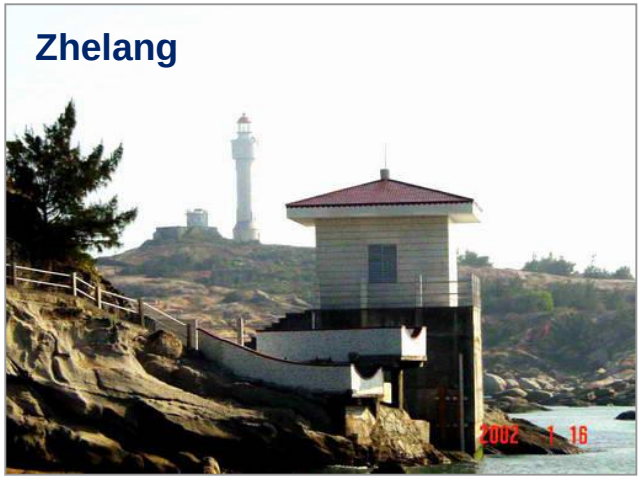
Shared real-time data with Chinese Academy of Sciences, Ministry of Water Resources, Seismological Burea etc.

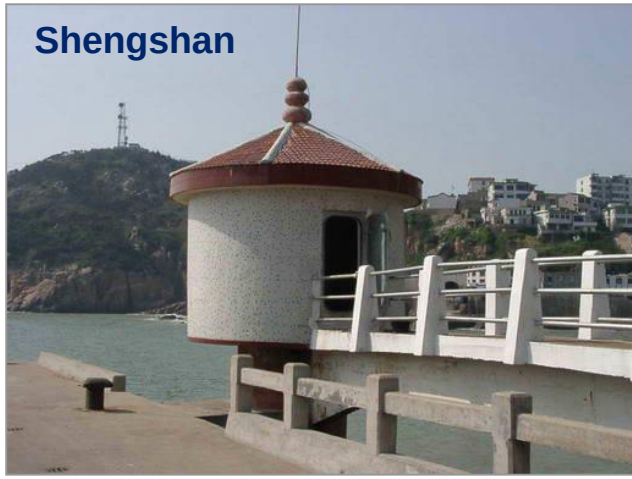
- The onshore data is real-time transmission Mainly through the line and VSAT
- The offshore data via satellite implement real-time transmission
- The onshore data basically actualize real-time transmission and monitoring in minute-timescale

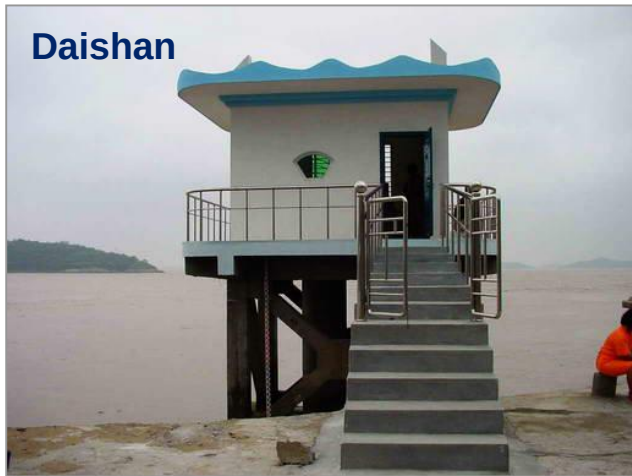
Marine Observation: Coastal observing stations

Real-time monitoring of seawater temperature, salinity, tide, wave, GPS, meteorology, marine chemistry, etc





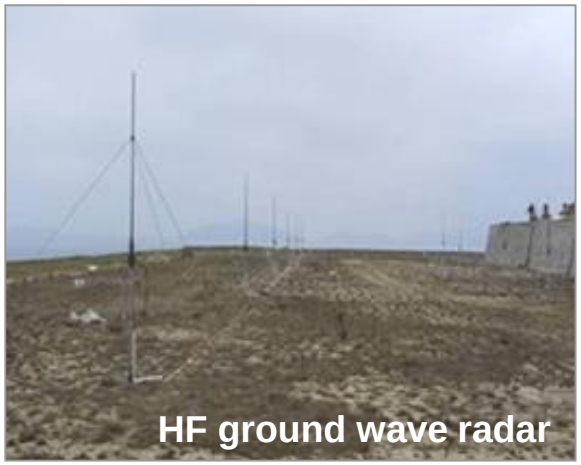


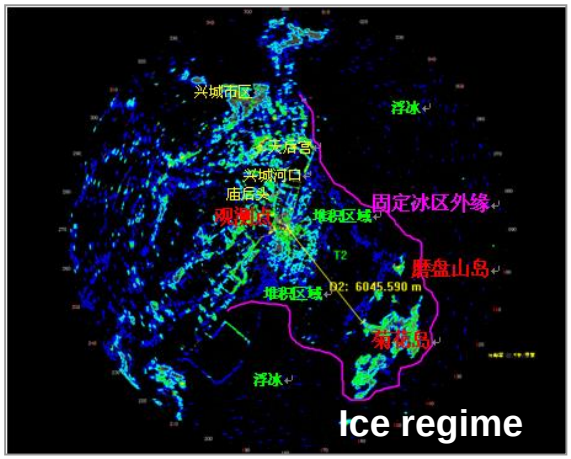


Marine Observation: Radars

Variety of radars for sea ice monitoring, wave observation, ocean surface current, etc..


Wave radar

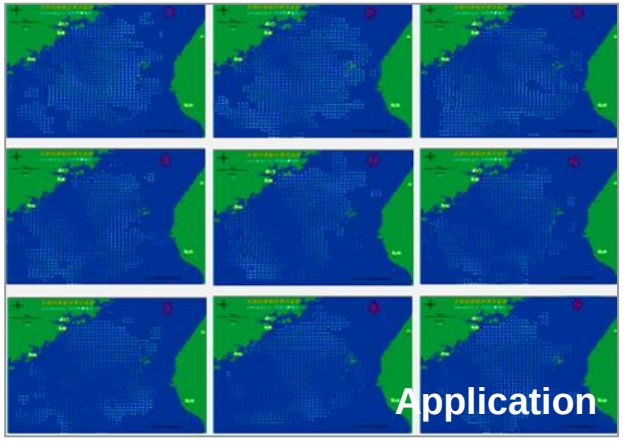

HF ground wave radar



Ice regime

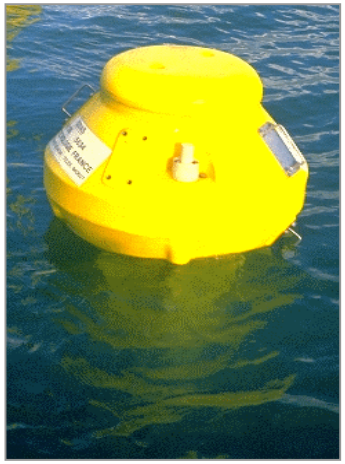

Longhai radar station


Dongshan radar station


Application

Marine Observation: Buoys

Variety of buoys for meteorological parameter, current, wave, temp., tsunami monitoring, etc..



Marine Observation: Ship Observations

- **Operational ship observations**
  - **Voluntary Observation Ships**
    - Commercial ships, fishing vessels
  - **Marine Section Observations**
    - Official research vessels of SOA
- **Scientific expedition ships**
  - **Antarctic and Arctic exploration:** ***Xuelong***
  - **World wide ocean expedition:** ***Ocean No. 1***
  - **……**

Marine Observation: Remote Sensing

CMS areoplanes are used for sea ice, red tide, oil spill monitoring, and emergency surveillance.

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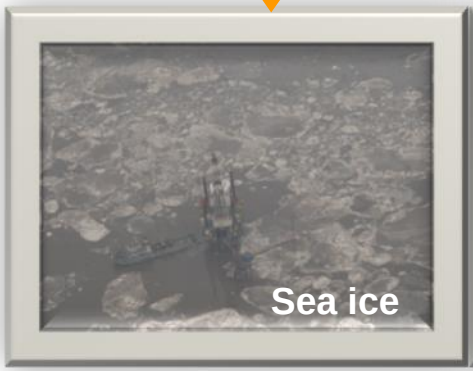
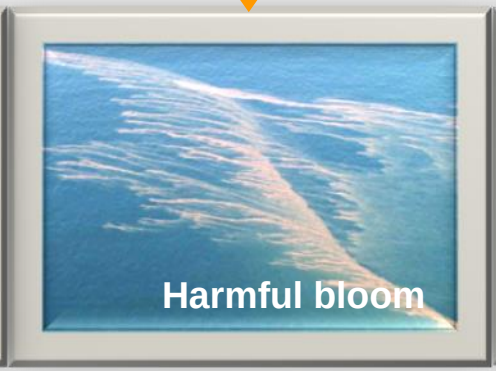
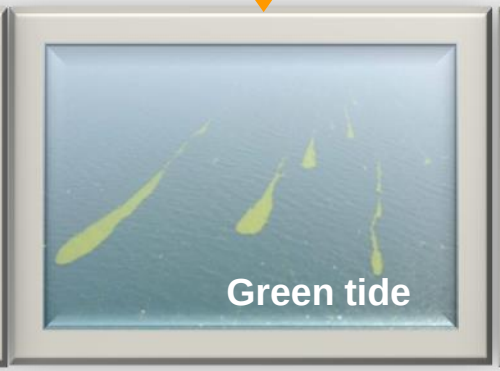
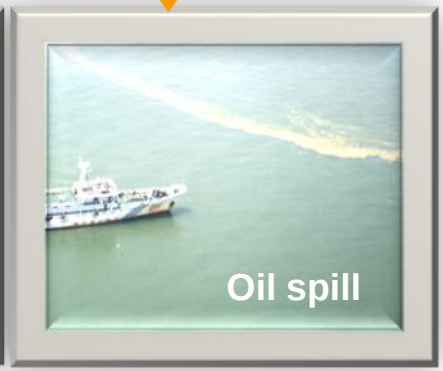
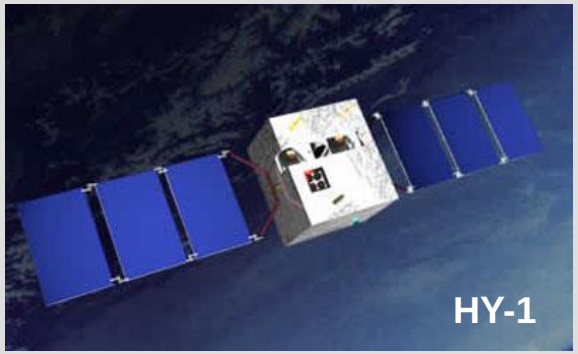






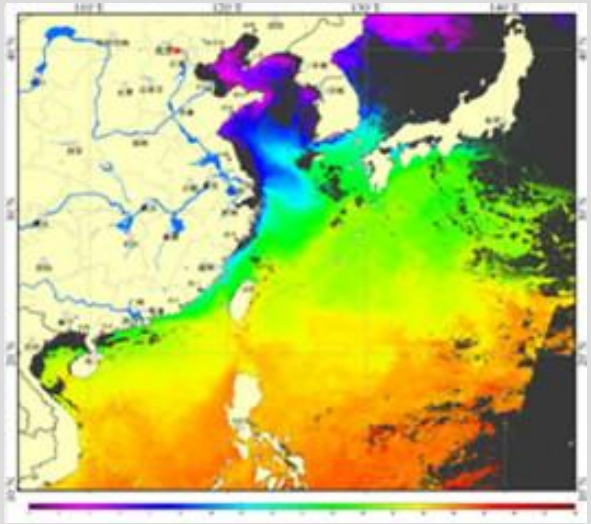


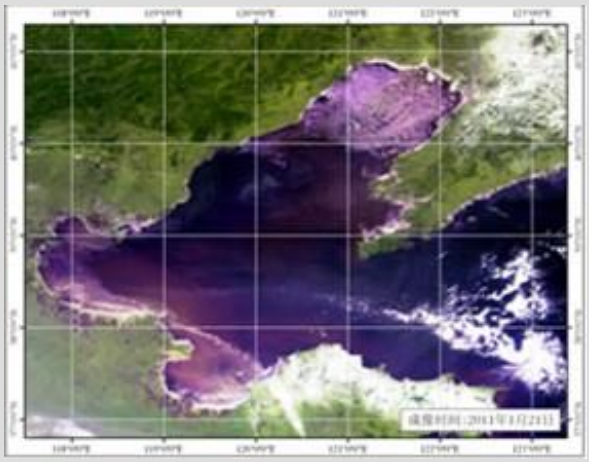
Marine Observation: Satellite



Data

Analysis



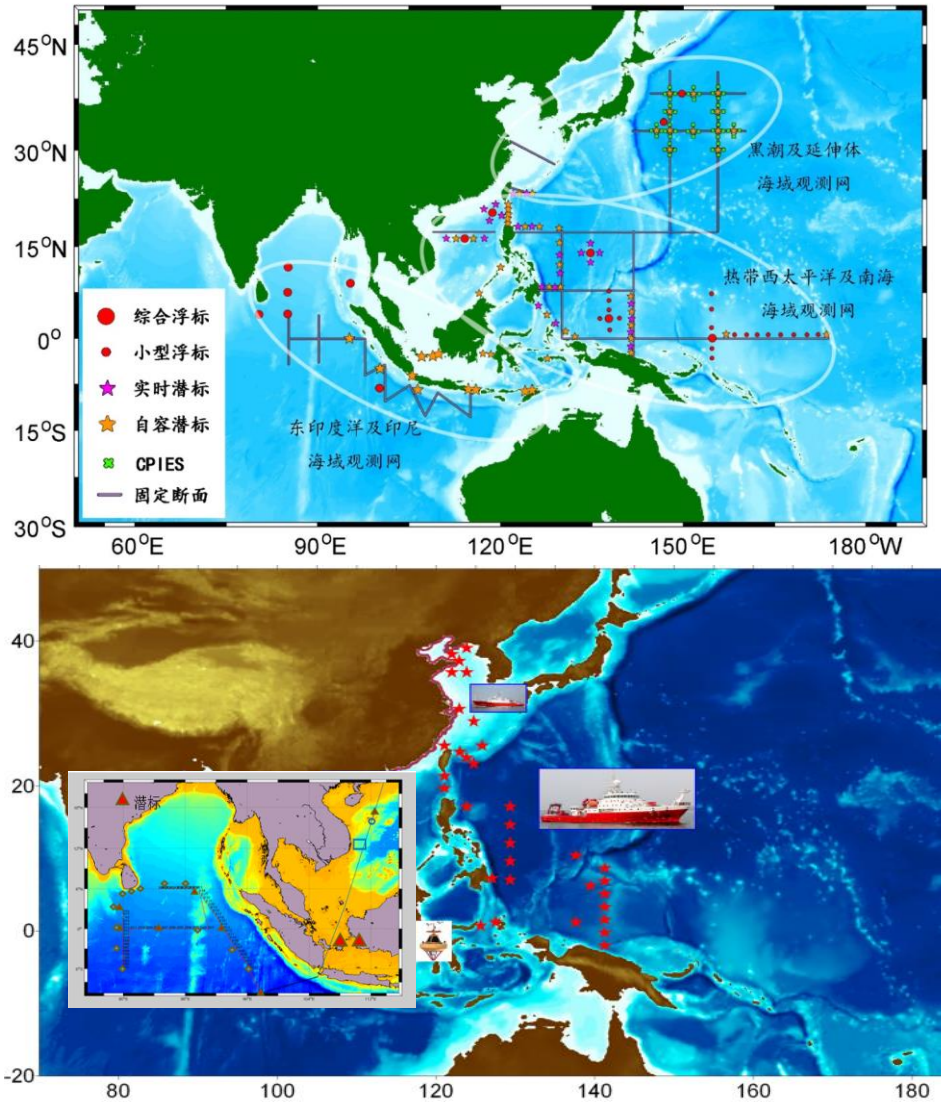


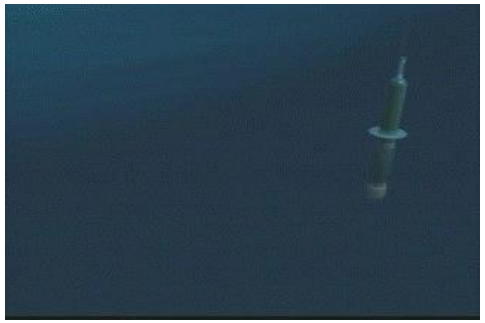
Satellite

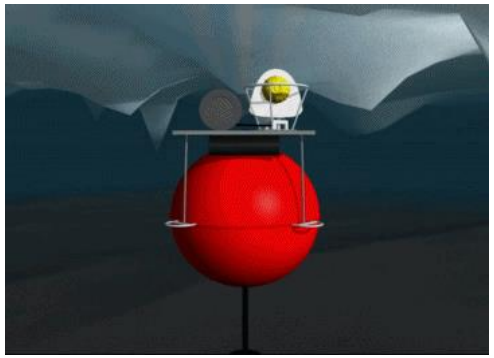
Ground station

Application

Global Integrated Observation System Program in China







Outlines

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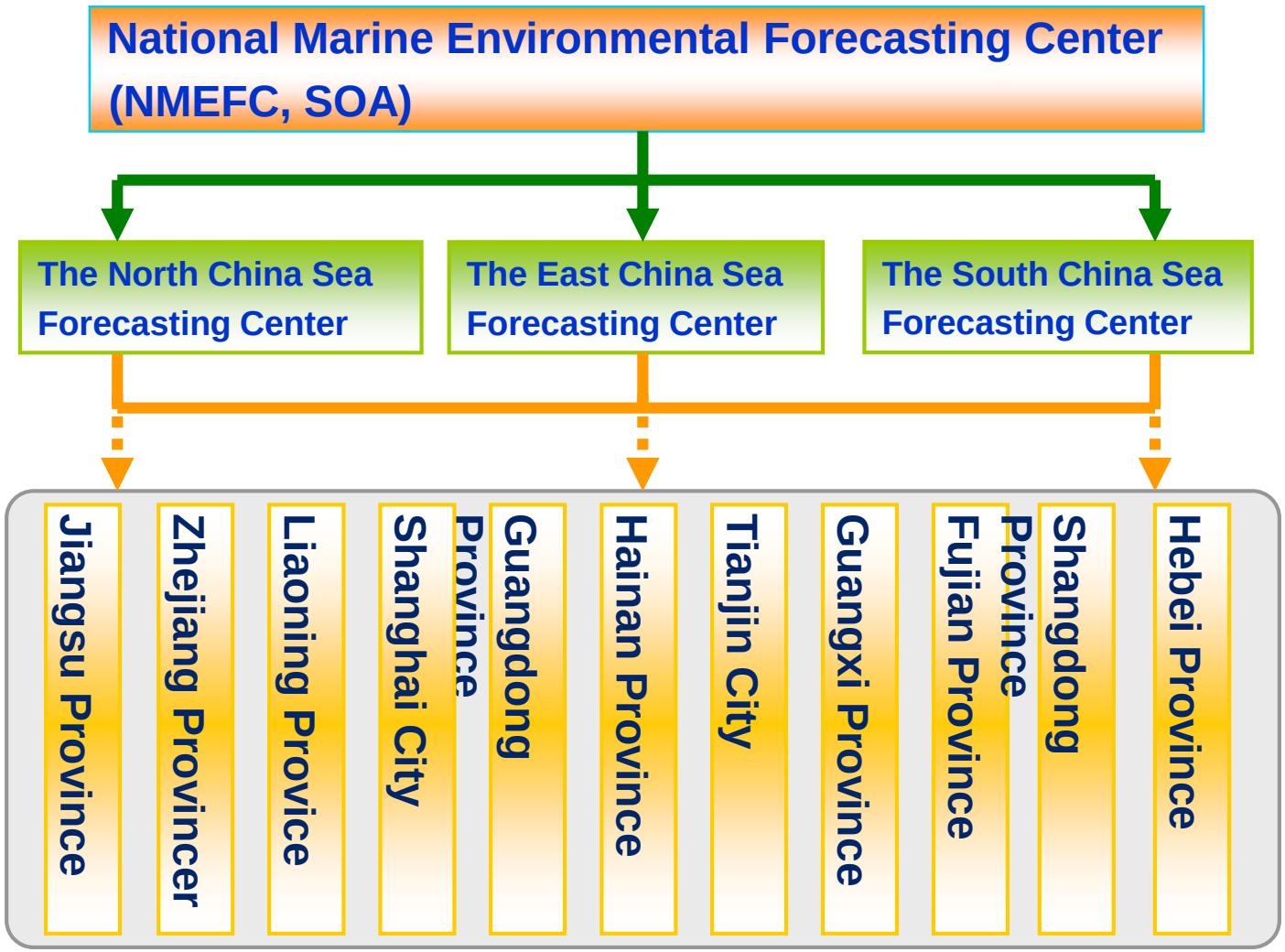
3. Perspective of China-EU collaboration

Marine Forecasting System: Organizational structure



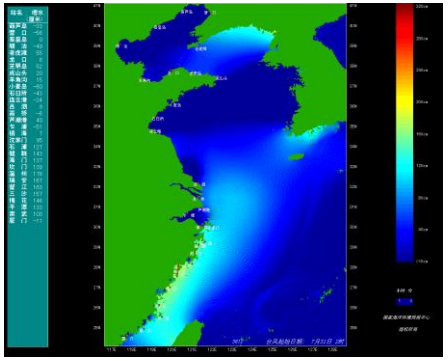
1 National Forecasting Centers

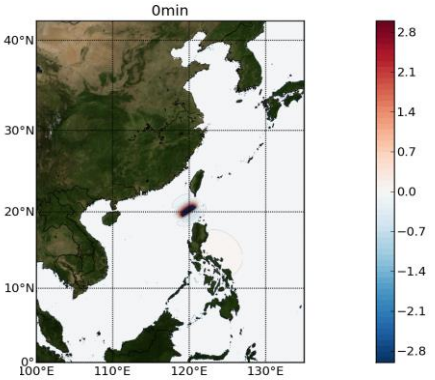
3 Regional Forecasting Centers

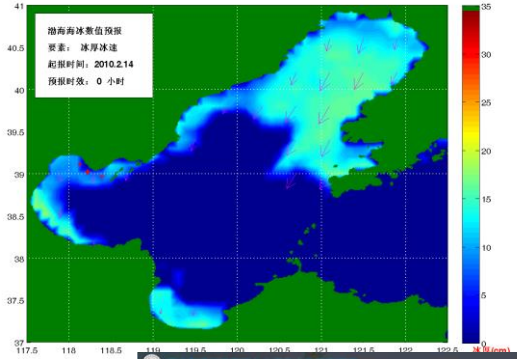
11 City-level Forecasting Centers

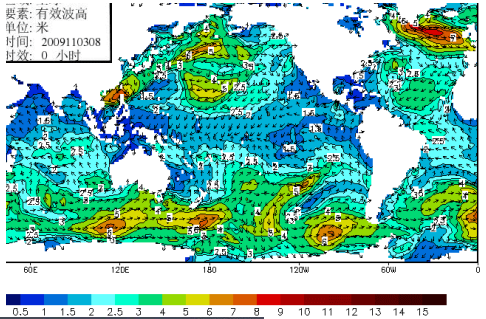
Marine forecasting services

- Ocean wave
- Storm surge
- Tsunami
- Sea ice
- Temperature and currents
- Forecasts for Search and Rescue
- Public forecasts
- For Fishery
- ENSO prediction & climate prediction
- Sea route forecasting for polar exploration



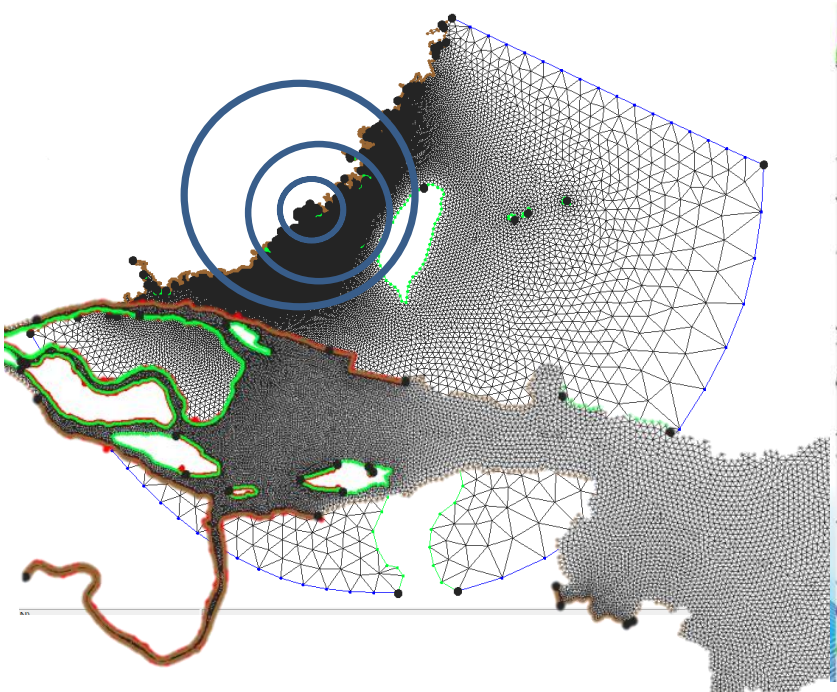


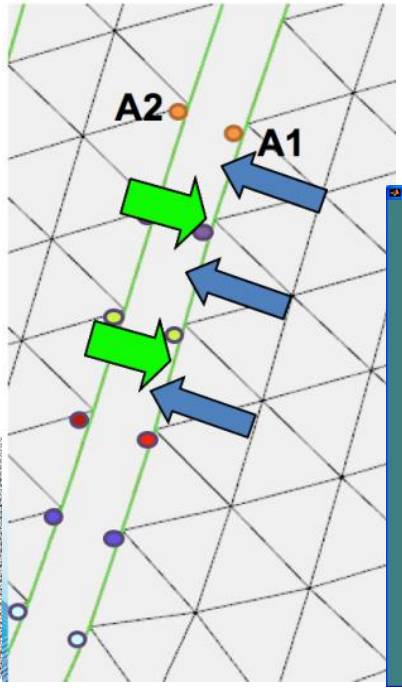




Refined Forecasts in China Coastal Zone

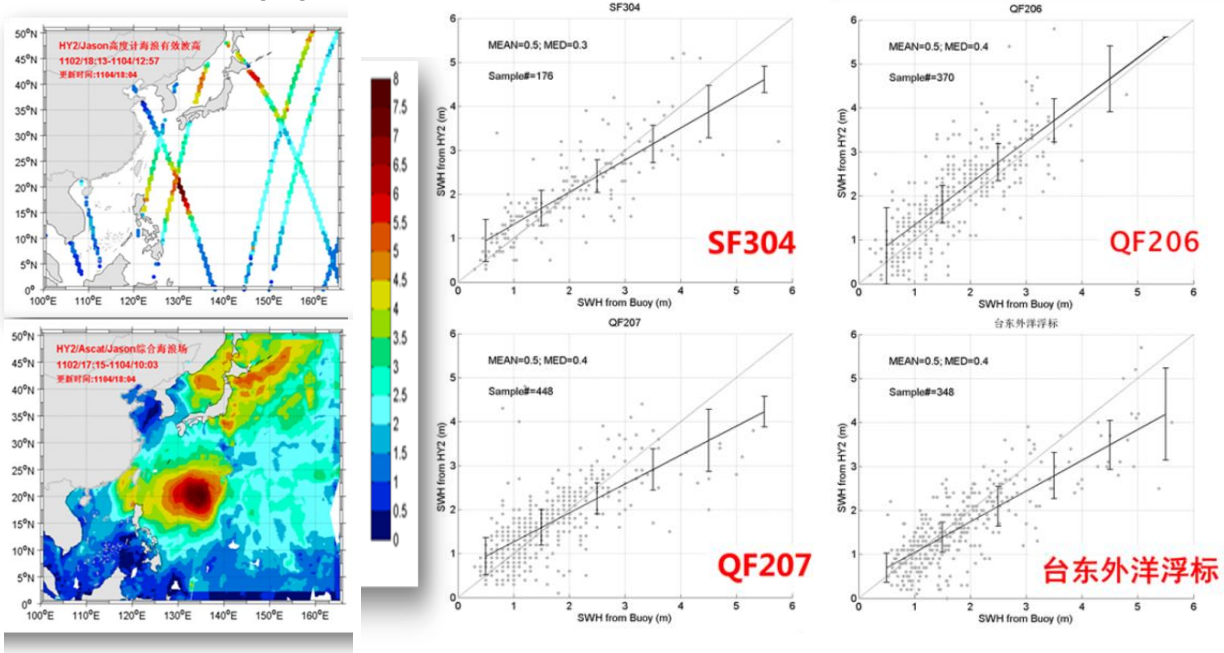
- Storm Surge
  - Resolution ~ 50 m, dam resolved
  - Waves offshore and flood considered
  - Application in Fujian, zhejiang ….

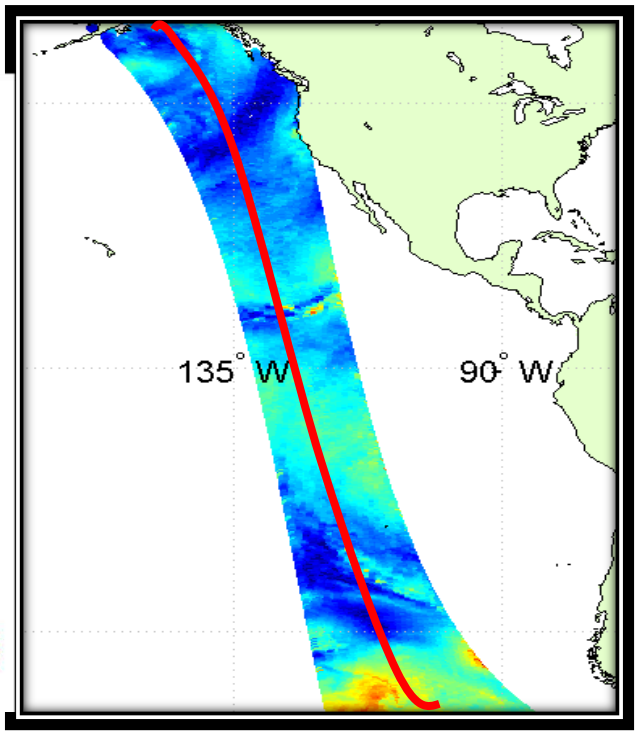




Refined Forecasts in China Coastal Zone

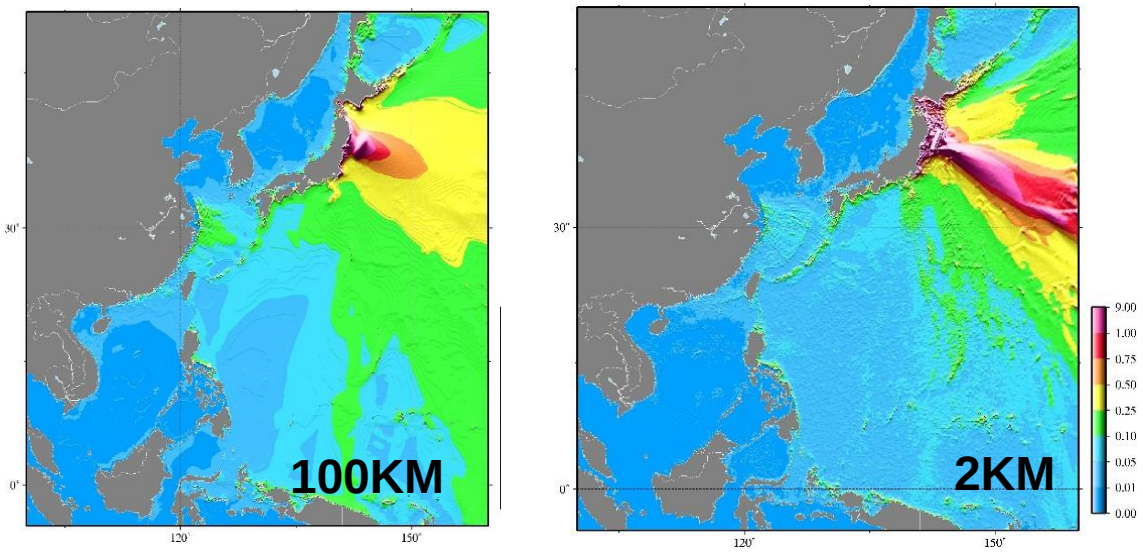
- Data assimilation on Waves
  - Combine radar altimeter(wave) and microwave scatter (wind) = narrow wave band + validated wide wave band derived from wind.
  - Application in Northwest Pacific

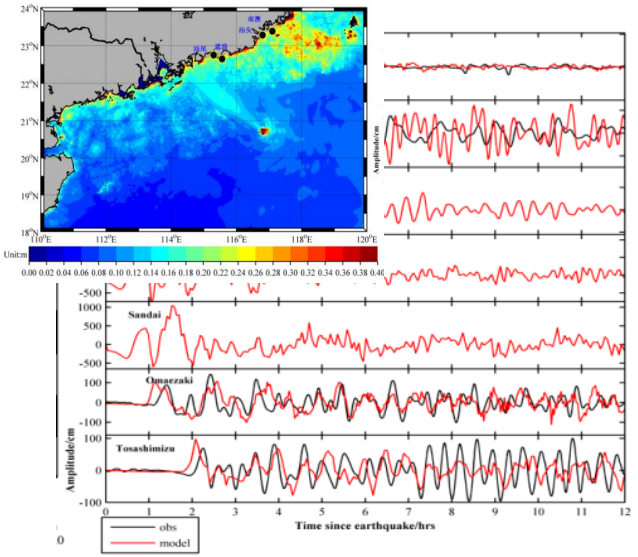




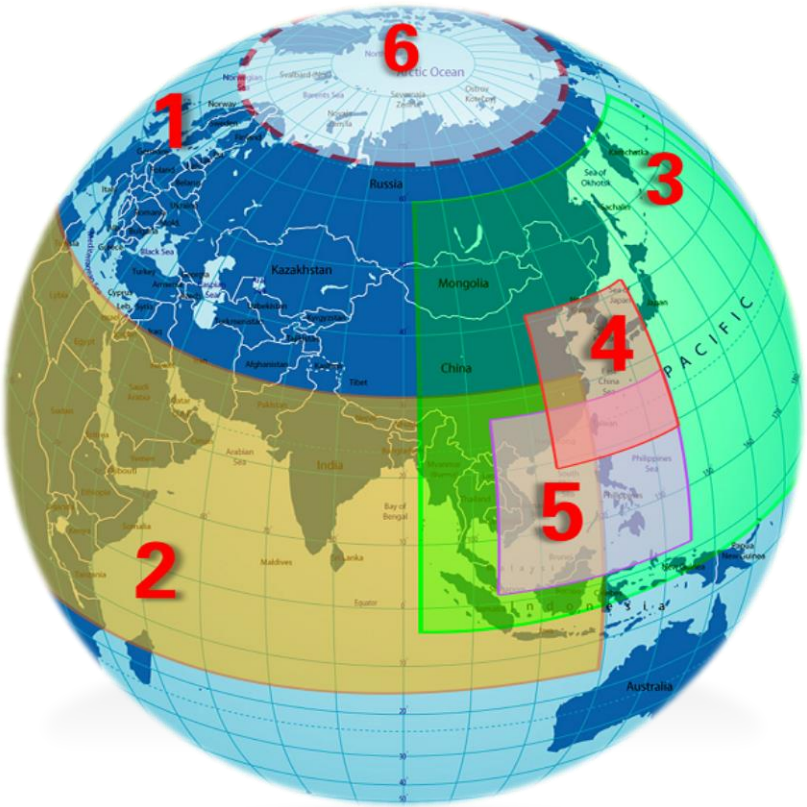
Refined Forecasts in China Coastal Zone

- Tsunami Warning
  - High resolution operational system.
  - High performance parallel tsunami model.
    - More than 20 times faster than previous version.
    - Release Warning within 2~5min all over Pacific and SCS





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

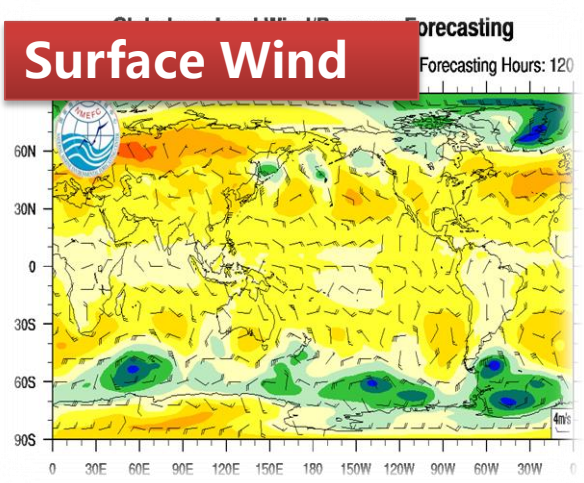
Climate Prediction:

Level 1: Global

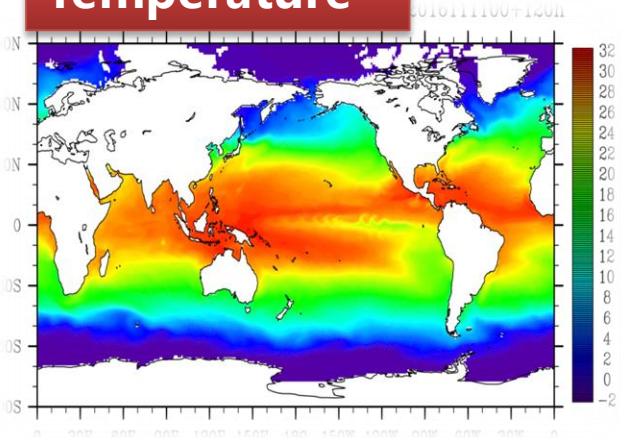
Level 2: Asia & Northwest Pacific

Global Forecast Products of CGOFS

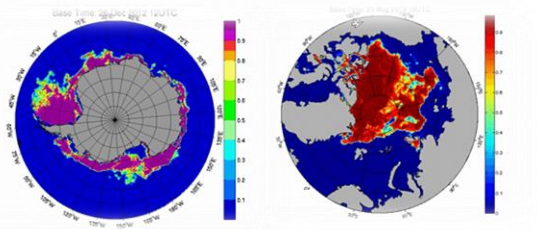
Surface Wind



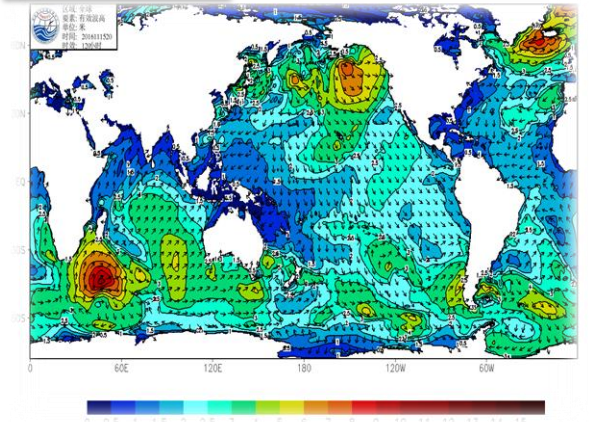
Temperature



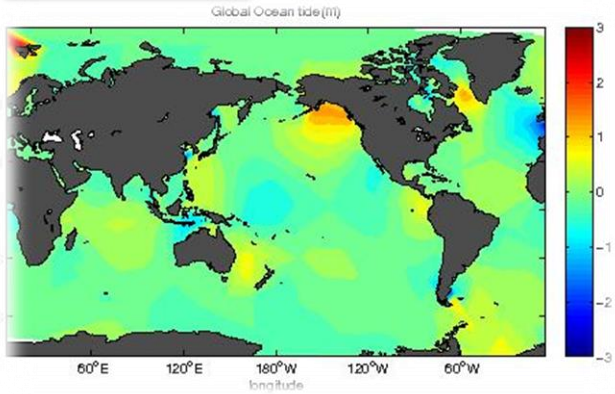
Polar ice



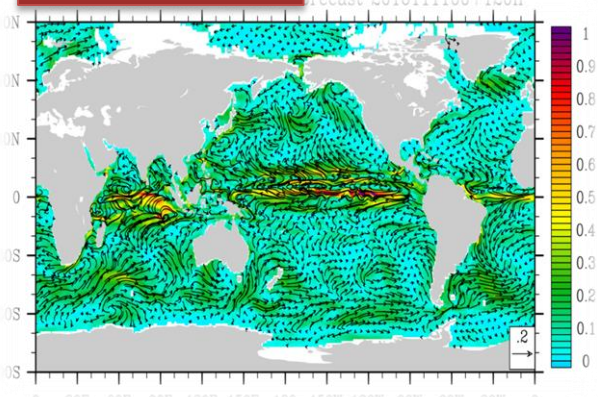
Wave



Tide



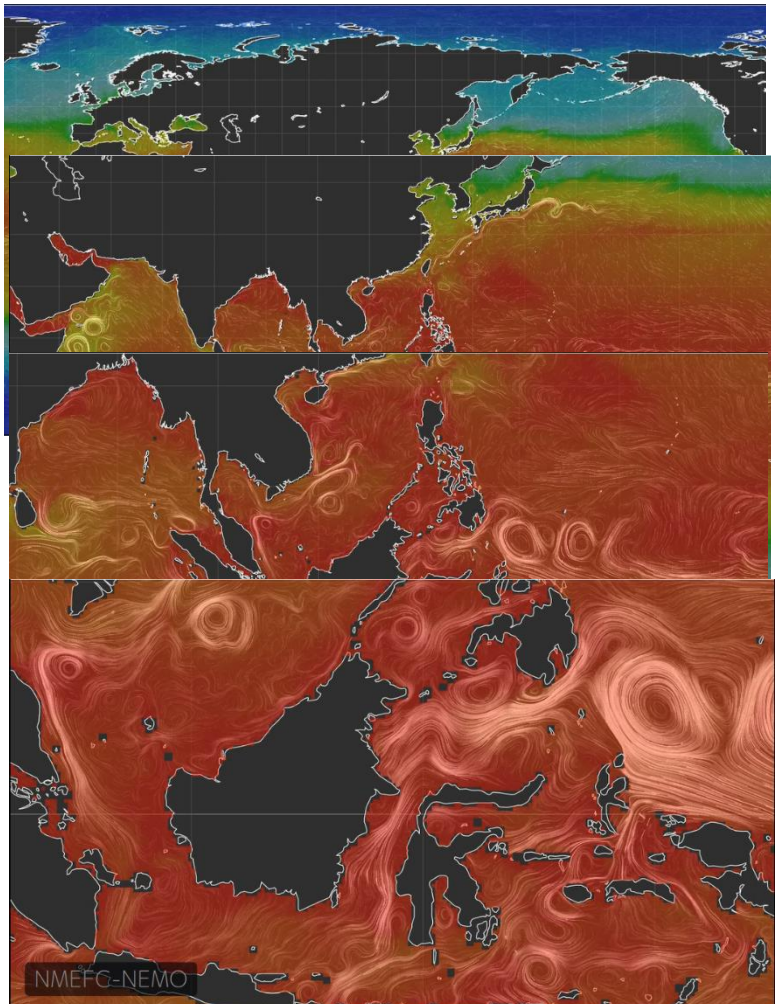
Current



Developing Progress

(1) Global 1/12° High Resolution Forecasting System

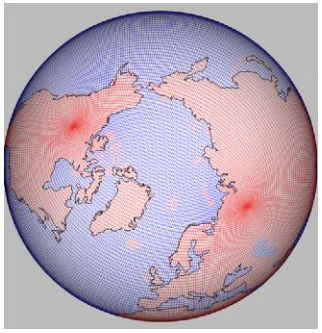
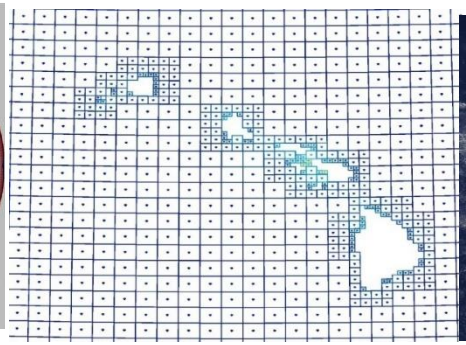
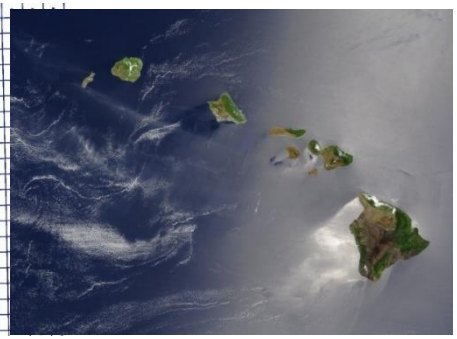
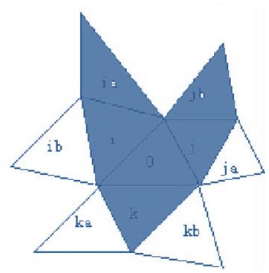
- **Code**
  -- NEMO v3.6
- **Grid**
  -- ORCA tri-polar grid, 1/12° at equator
  -- cyclic east-west and north fold with T-point pivot
- **Bathymetry and coordinate**
  -- from Mercator Ocean bathymetry_ORCA12_V3.5，provided by Romain Bourdalle Badie
- **Horizontal resolution**
  – 4322 x 3059 horizontal grid points
  – Grid spacing from 10 km at equator down to 3 km at high latitudes
- **Vertical grid**
  – 75 levels, with a resolution of 1m near the surface and 200m in the deep ocean，0-5900m

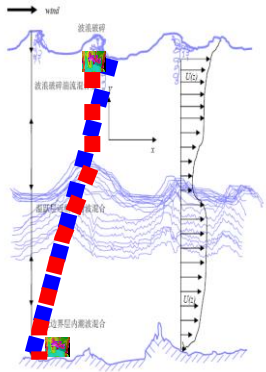


Developing Progress

(1) Global 1/12° High Resolution Forecasting System

- **Global Oceanography Forecast System v2.0**
  - Develop ocean mixing parameter **schemes** on internal oscillation, diurnal process and so on.
  - 10km global currents (LiCOM, FIO-COM,PCOM), wave (WWIII, UMWM), tide (Hohai, FVCOM) **multi-model** forecast system.

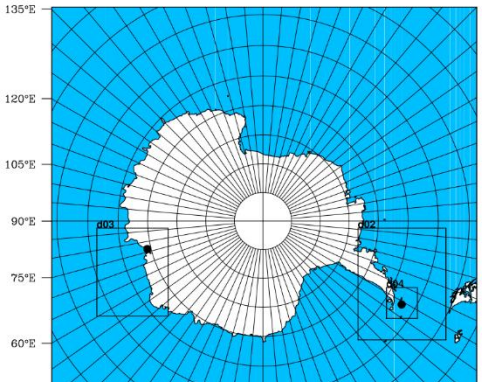







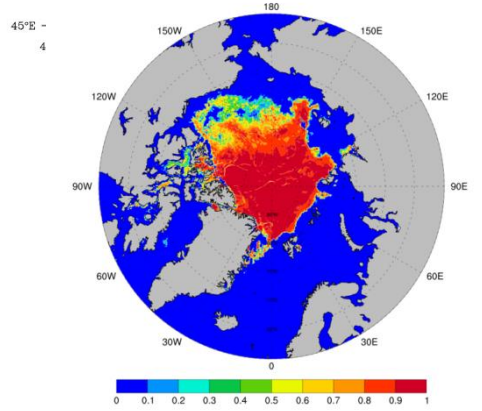
Developing Progress

(2) Polar forecasting service

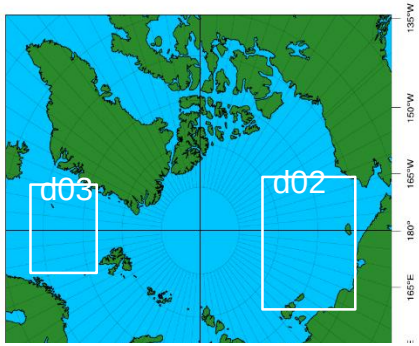
Arctic



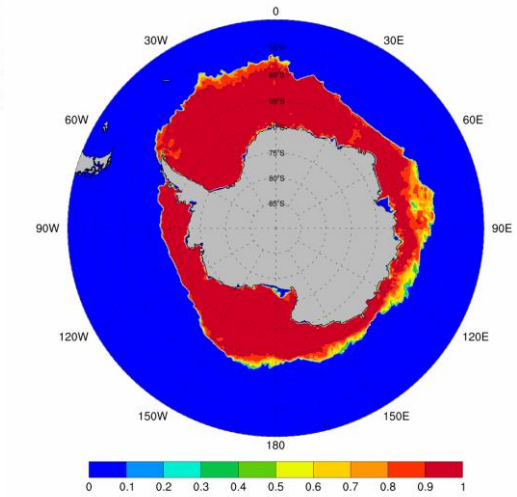
Arctic Sea Ice Concentration 72h Forecast Base Time 20150805



Antarctic



Antarctic Sea Ice Concentration 24h Forecast Base Time 20151120



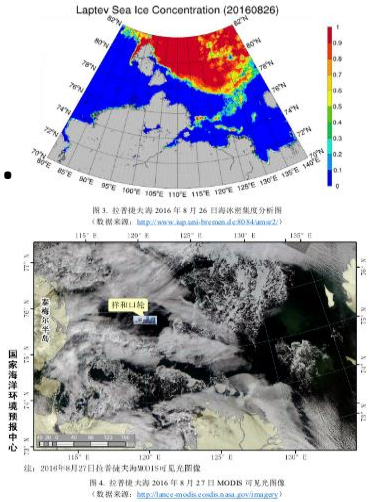
- ✓ Polar WRF model (30-10-3km)
- ✓ MITgcm ice-ocean model (4km)
- ✓ EnKF ice-ocean data assimilation (in research)

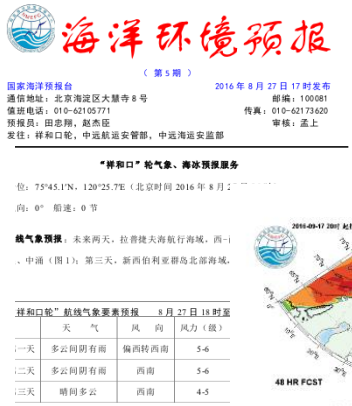
Developing Progress

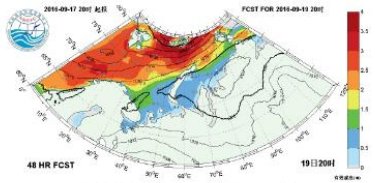
(2) Polar forecasting service

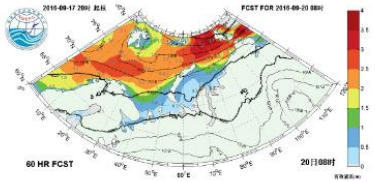
YONG SHENG- General Cargo Ship
2013, 1st experiment voyage cross Arctic.
2015, two-way navigating

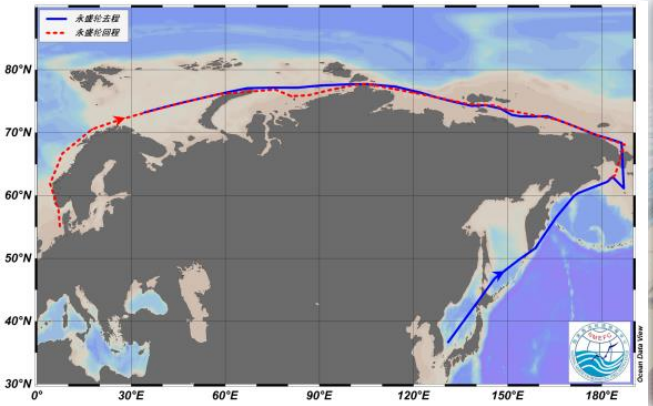
2016, 5 merchant ships cross Arctic









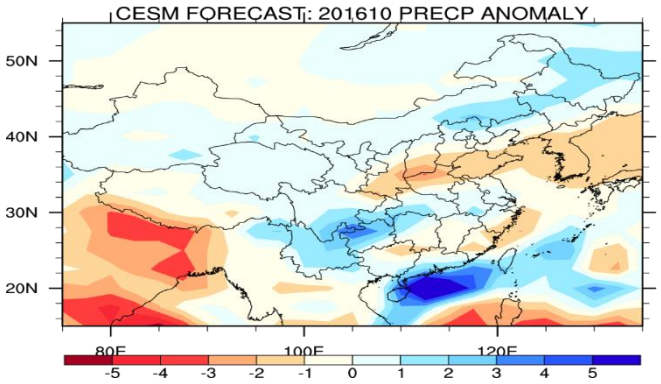


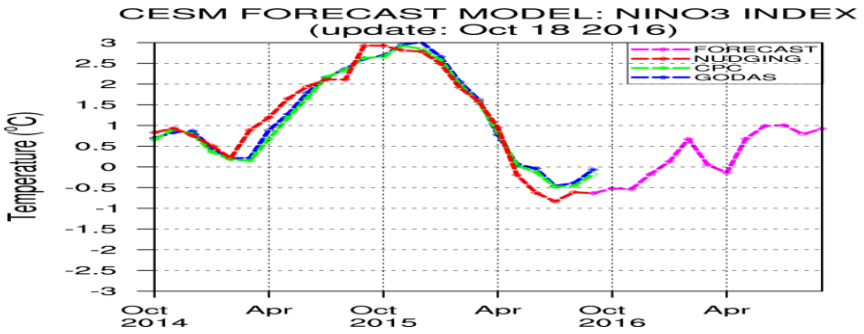
Developing Progress

(3) Climate Prediction

CESM coupled model

- forecast time： 12 months
- forecast range： global
- time resolution： monthly
- spatial resolution： 0.9×1.25_gx1v6



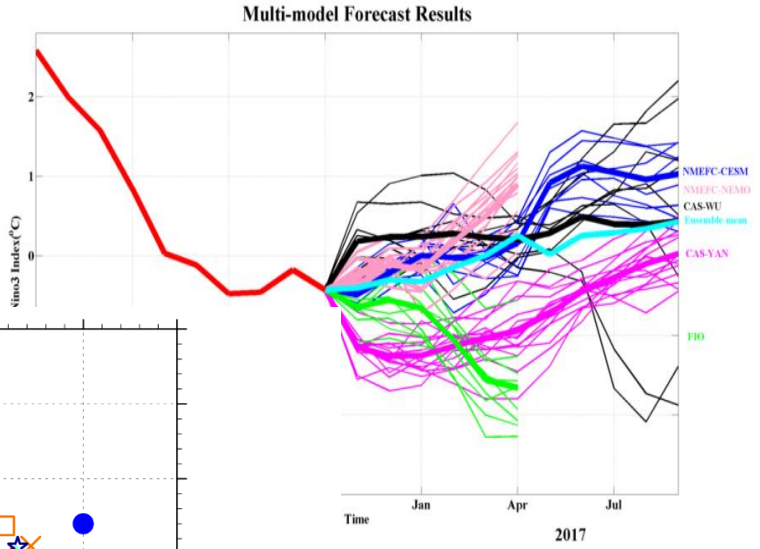


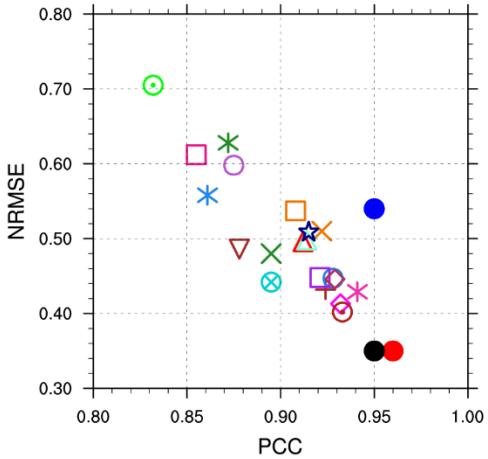
Developing Progress

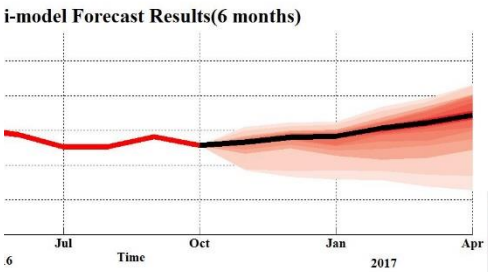
(3) Climate Prediction

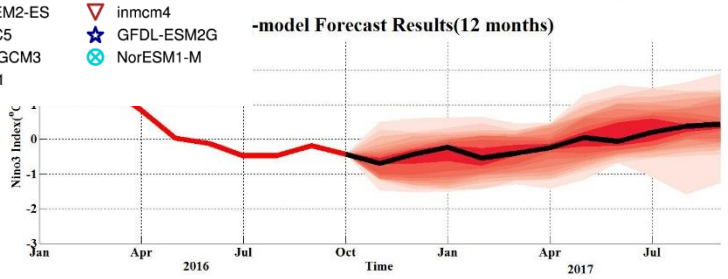
Ensemble Prediction

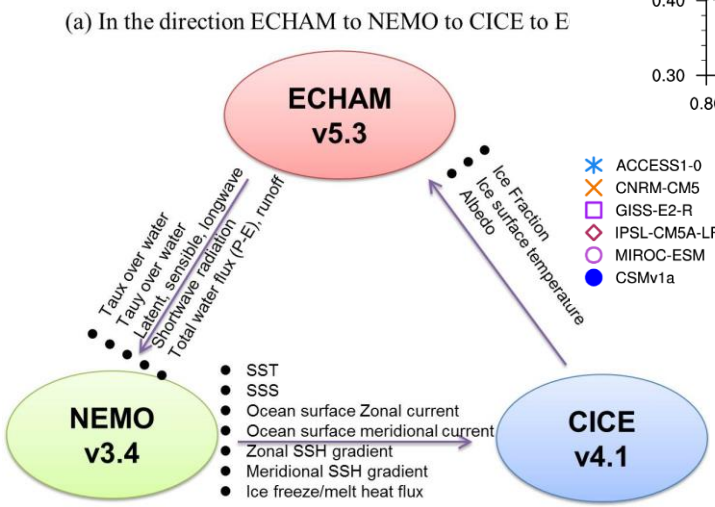
- Couple Models:
  - IAP-FGOALs
  - IAP-ICM
  - FIO-ESM
  - NUIST Model











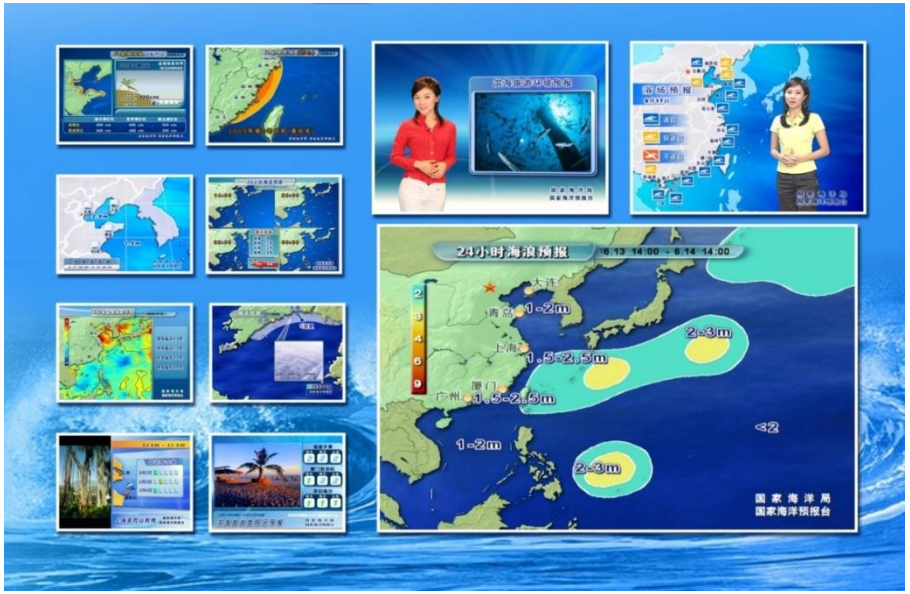
Release media for marine forecasts and warnings

Forecasting products are produced and disseminated to the public by:

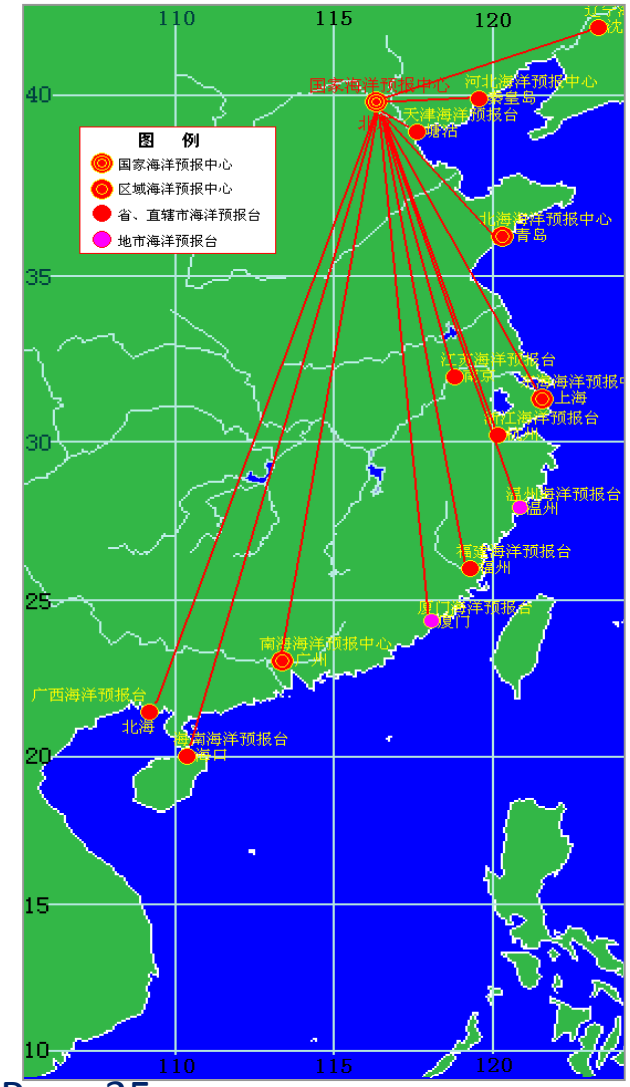
- **TV programs covering the national and regional TV channels (CCTV, et al.)**
- **Broadcasting programs (CCBS)**
- **Website**
- **Micro blog**
- **Newspaper**
- **LCD in the fishery ports or beach**

Forecasts and Warnings are disseminated to the governments and relative departments by:

- **Digital fax using parallel tech.**
- **Short messages**
- **Telephone**



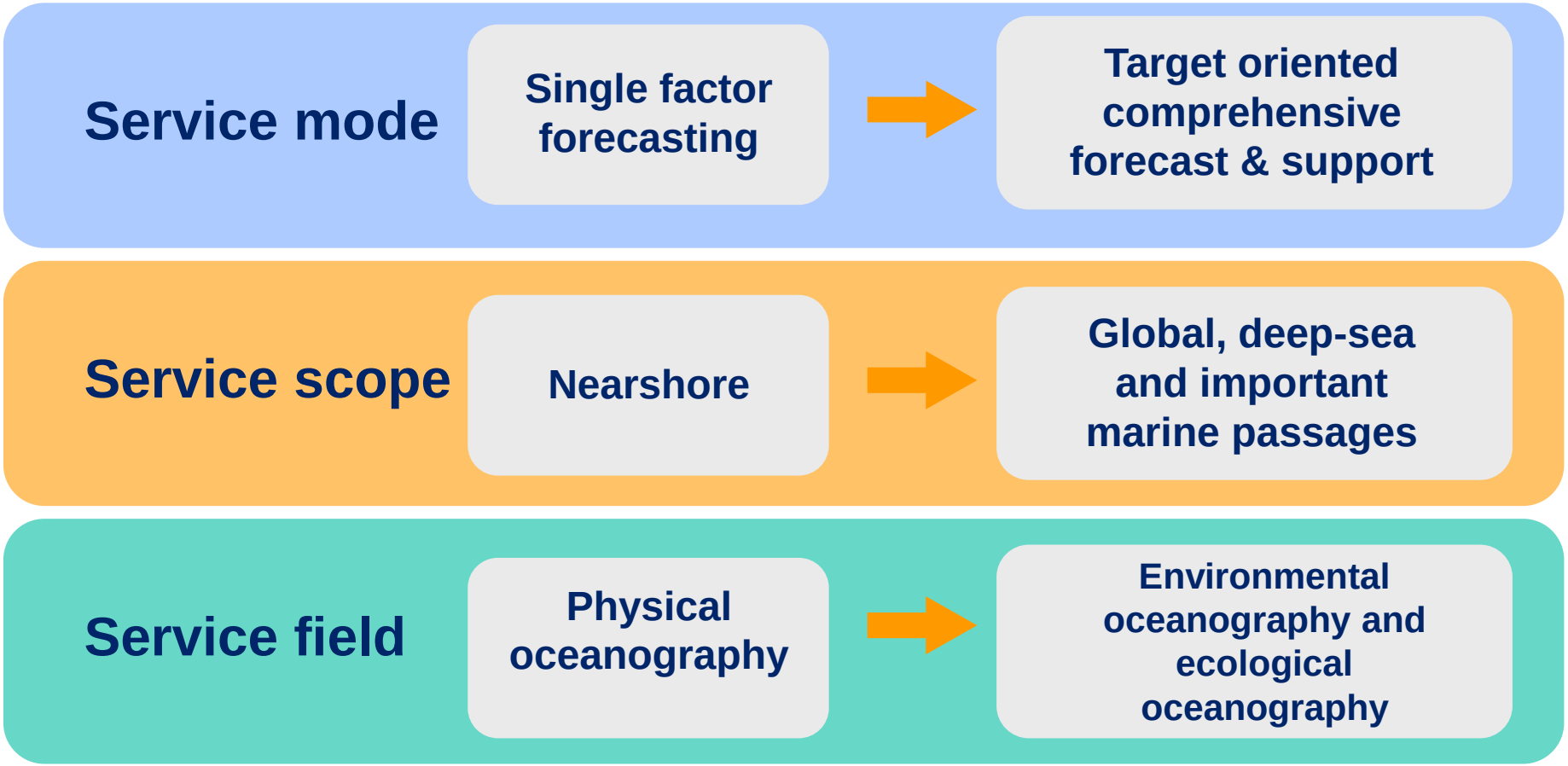
National Marine Forecasting Video Consultation System



- National marine forecasting center
- 3 regional forecasting centers
- 11 provincial marine forecasting centers
- Several city-level forecasting centers

are inter-connected to establish the National Marine Forecasting Video Consultation System

Future development prospect of marine forecasting work



Outlines

1. Marine Observing System in China

2. Marine Environment Forecasting and Disaster Warning Service

3. Perspective of China-EU collaboration

China-Italy cooperation

2009 — **Memorandum of Agreement**
1st China-Italy Collaboration Workshop
Bologna

2010 — **2nd Scientific Workshop**
Shanghai

2012 — **3rd China-Italy Collaboration Workshop**
Venice

2013 — **4th China-Italy Collaboration Workshop Memorandum of Agreement**
Guangzhou

2014 — **5th China-Italy Collaboration Workshop**
Lecce

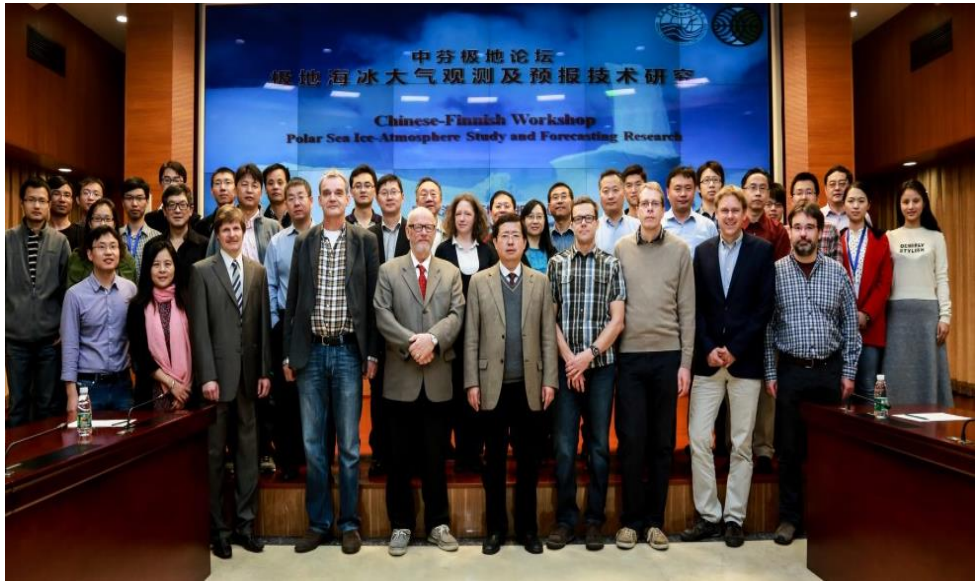
2015 — **6th China-Italy Collaboration Workshop**
Hangzhou

2017 — **7th China-Italy Collaboration Workshop**
Rome

cmcc INGV OGS 国家海洋局 STATE OCEANIC ADMINISTRATION NMEFC

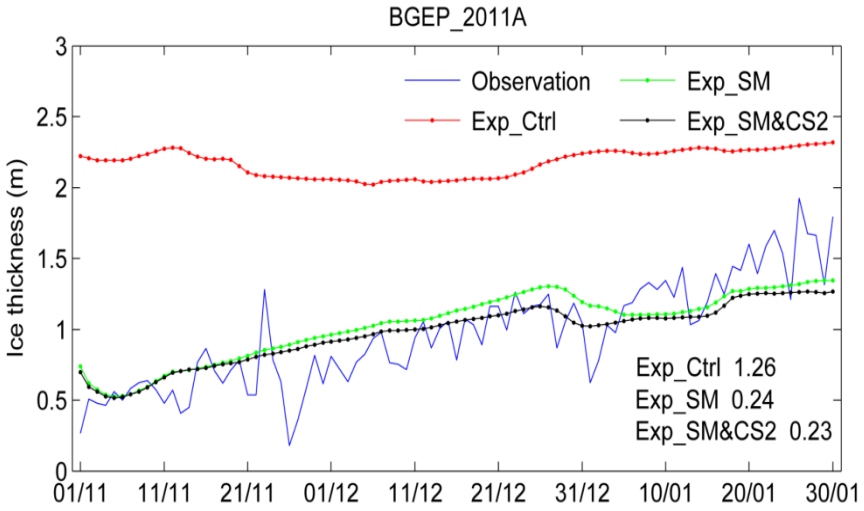
China-FMI/Finland Cooperation

- Joint research on sea ice since 1990s;
- Sea ice/weather observation and numerical modelling;
- Signed MoU on 2012, and will renew in June 2017;
- Two scientists are visiting in FMI;
- Chinese-Finnish joint polar prediction workshop (2012, 2014, 2017)



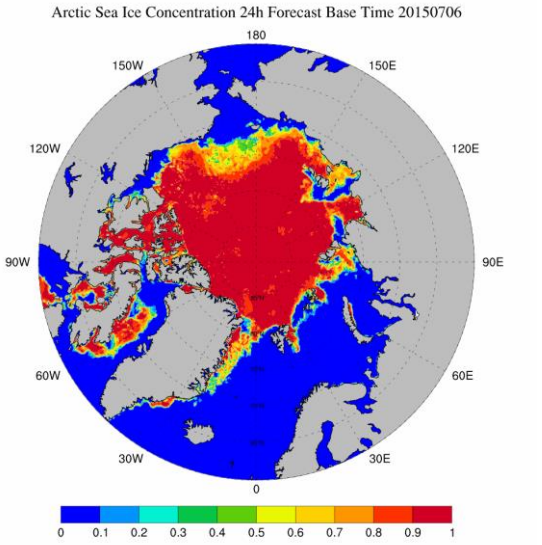
China-AWI/Germany Cooperation

- Joint research on sea ice-ocean data assimilation and forecast;
- Also cooperation in the framework of WMO Polar Prediction Project (PPP);
- Signed MoU on 2014;
- Regular bi-visiting between AWI and NMEFC;
- BMBF-SOA Project: A high resolution Arctic sea ice-ocean coupled modeling and forecasting system (2014-2017);
- DFG-NSFC 2017 Proposal: Ensemble based sea ice-ocean multivariate data assimilation: Towards a better Arctic sea ice prediction (IODAPP)

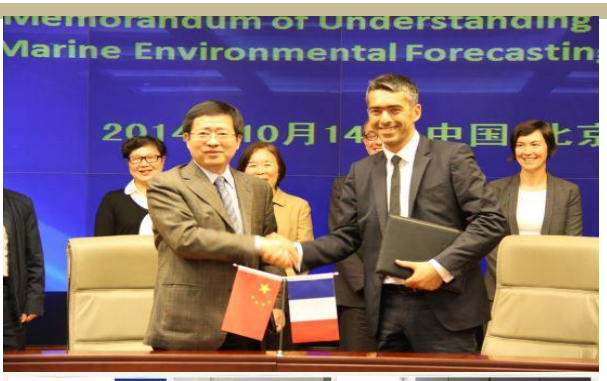


China-Norway Cooperation

- Joint research on sea ice-ocean numerical modelling and observations;
- Official Partner of EU project INTAROS – Integrated Arctic Observation System (2016-2021; Lead by NERSC Norway) ;
- Will sign MoU on polar prediction with Met Norway in November 2017;



China-France cooperation



Signing Ceremony For Memorandum of Understanding between NMEFC and Mercator Océan in October 2014. This opened the normalization of our bilateral international cooperation and talent exchange on operational oceanography for the South China Sea and global ocean.

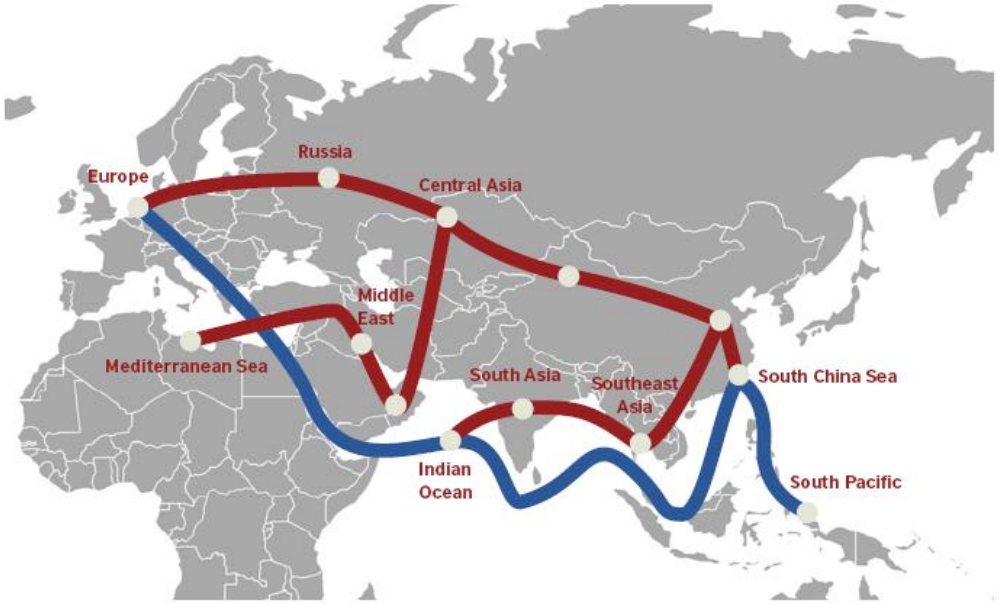
"The 1st French-China joint workshop on operational oceanography" is held in Toulouse in November 2015, mainly focusing on the development and application of ROMS-based high resolution numerical forecasting system in the South China Sea and a NEMO-based high resolution forecasting system in the global domain to discuss.

The 2nd China-France Joint Workshop on Operational Oceanography for the South China Sea will be held in Hangzhou China in June, 2017. It aims to improve the forecast service capacity and the quality of the numerical analysis and prediction for the regional sea and global ocean.

Future perspective of China-EU collaboration

National policy -- One Belt, One Road Initiative

"One Belt One Road" (OBOR) is an initiative, which was launched by President Xi Jinping in 2013, to focus on improving and creating new trading routes, links and business opportunities with China, passing through over 60 countries along the way, across Asia, Europe, the Middle East and Africa.



Silk Road Economic Belt

21st Century Maritime Silk Road

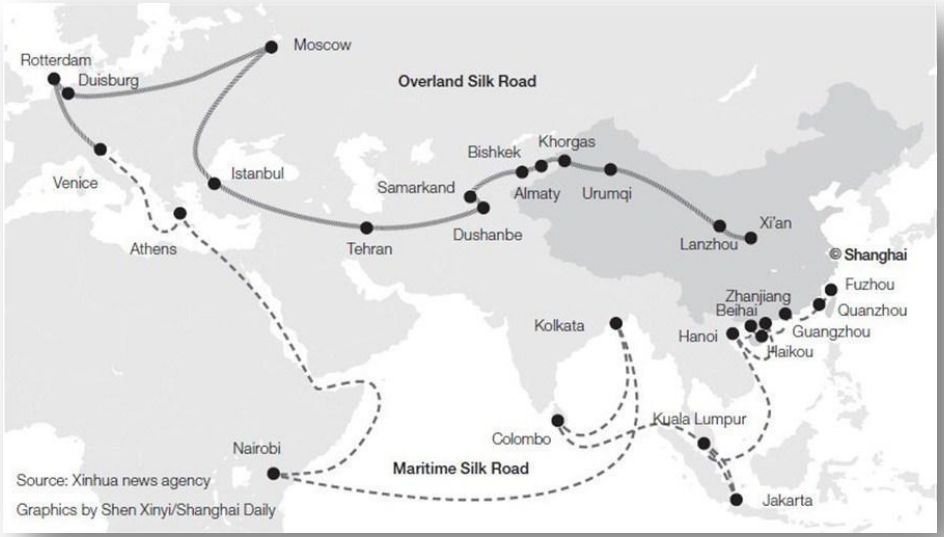
- **One Belt: The Silk Road Economic Belt**
  Enhancing and developing land routes:
  - Building a "Eurasian land ridge"
  - Developing a number of economic corridors
- **One Road: The 21st Century Maritime Silk Road**
  - o Coastal China—South China Sea—Indian Ocean—Europe
  - o Coastal China—South China Sea—South Pacific

Source: A role for UK companies in developing China's new initiative

21st Century Maritime Silk Road

The 21st-Century Maritime Silk Road – a sea route rather than a road

- runs west from China's east coast to Europe through the **South China Sea and the Indian Ocean, and east into the South Pacific.**
- The aim of the sea route is to build efficient transport routes between major ports in various countries, including the development of an economic corridor through the Indian Ocean, better connecting China with **South Asia, the Middle East, Africa and the Mediterranean**.

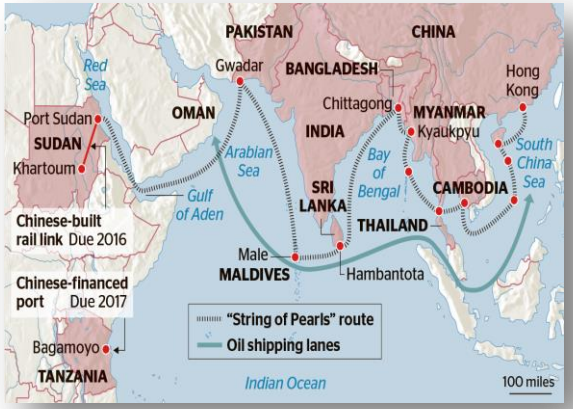


Challenges and Prospects for Marine Forecasting

- **Enhanced economic dynamism**
- **Geo-economics construct : trade and energy flows**
- **Dependence on sea lanes**
- **Economic prosperity intertwined with maritime affairs**
- **Geostrategic construct : region characterized by continental and maritime powers**
- **Regional waterways : strategic for merchant and naval shipping**

User requirements

- Fundamental **Marine environmental and disaster pre-warning and forecasting system** in China coastal area, Indian Ocean and Pacific Ocean and the Mediterranean
- **Special warning system** and platform construction for Marine transport, Shipping routes, oil and gas and fisheries



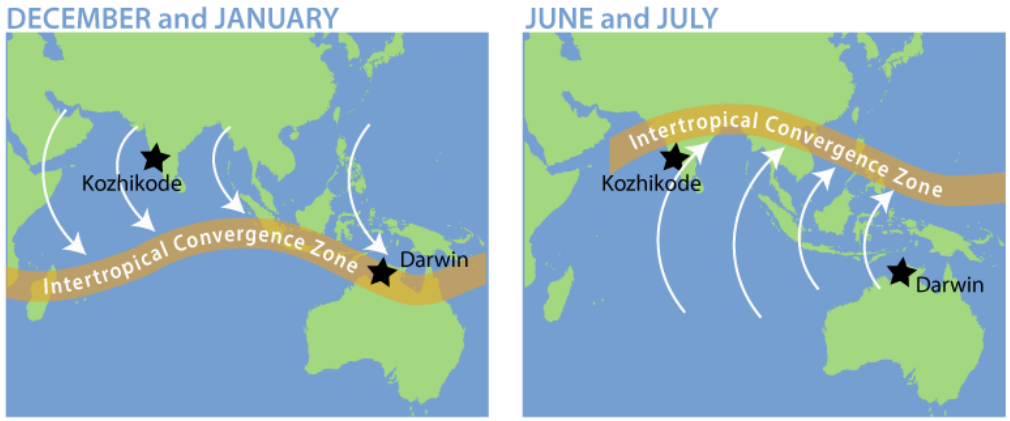
User requirements

- Marine environmental and marine weather forecasts for **stakeholders , important strait and channels**

The Straits of Malacca which connects the Pacific Ocean and the Indian Ocean is an important oceanic energy channel. It increases the importance to enhance our ability to protect the ocean, and to maintain the safety of important maritime energy transport corridors

- Study on **monsoon climate** and environmental change

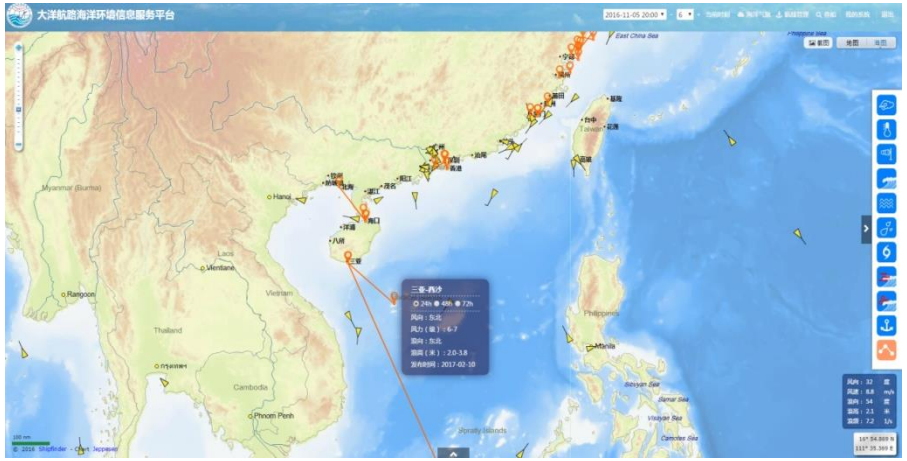
The monsoon system directly control China's drought and floods



“One Road” ocean forecasting capability

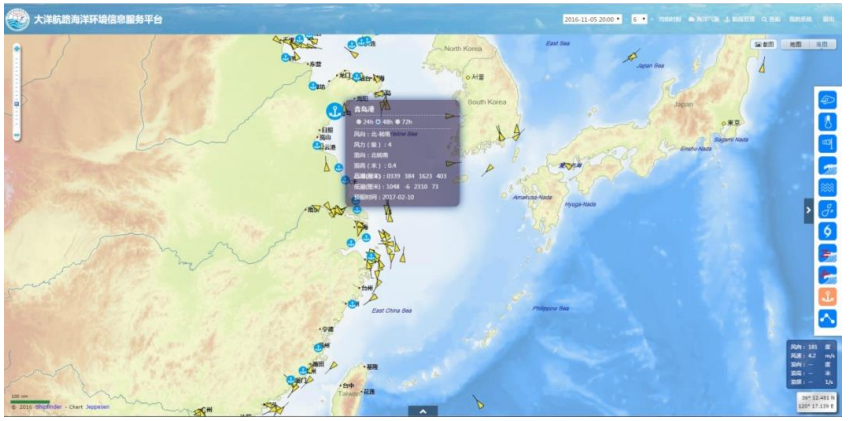
Maritime Silk Road Environmental Service System

covers 28 offshore routes and 40 important ports

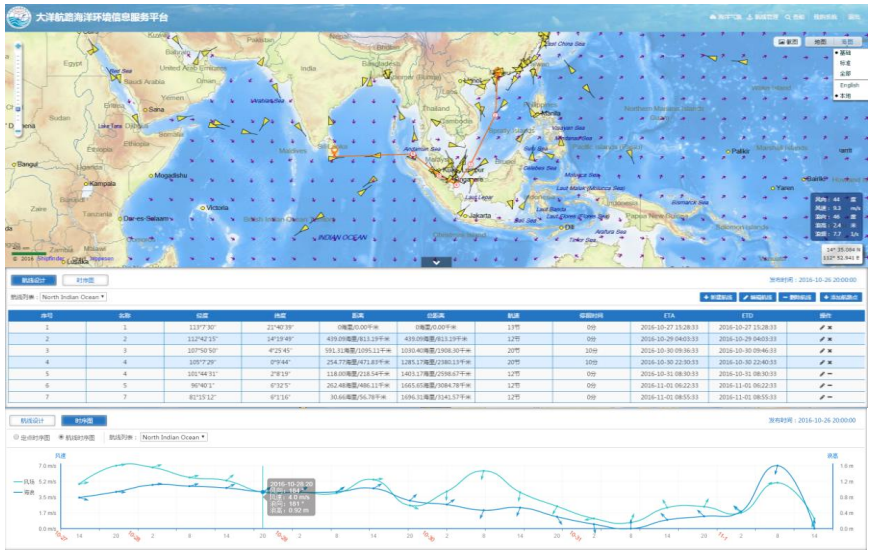


- Special service website is on-line trial operation in early January 2017
- realization of the domestic port, coastal route comprehensive forecast

- forecast variables : wind, wind direction, wave height, wave direction and tide.
- Forecast time: 24,48,72 hours

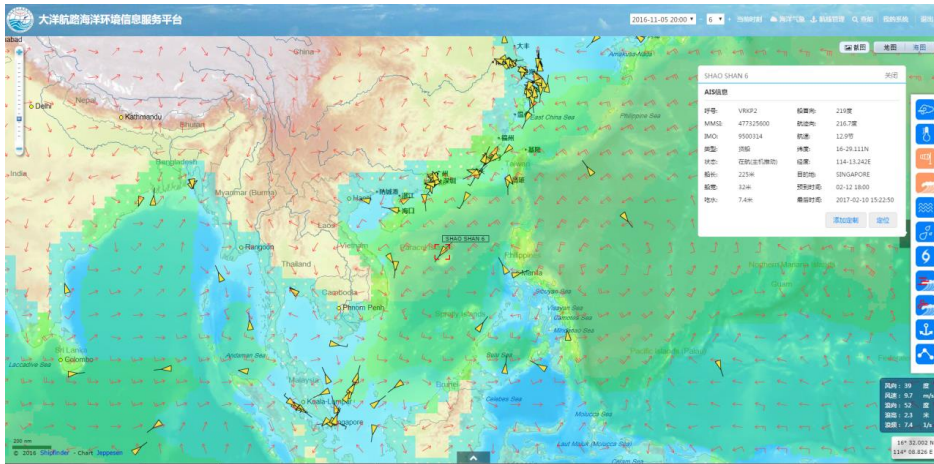


Functions of the Service System



- Real-time position dynamic overlay display function
- Plan route setting function
- Dynamic simulation of route trajectory function
- Generate the wind / wave element time evolution curve on the route

- C-map Electronic chart background map
- Wind, wave, current forecast field dynamic display function
- Wind and waves, tropical cyclone warning function



☐ Promote cooperation in the 21st century Maritime Silk Road

- Promote cooperation in providing marine environmental forecasting and marine disaster prevention and mitigation decision-making services for the countries along the 21st century Maritime Silk Road and provide technical support for national strategies.
- Carry out research on monsoon climate and environmental change.
- Develop marine emergency warning systems and products for important sea lanes, ports and stake areas.

Conclusion

Future research and cooperation priorities

1. Jointly develop the Marine Observation Network and Operational Oceanography Capability
   - . development of global/coastal ocean forecast systems
   - . intercomparison and validation ; observing system
   - . climate change and prediction
2. Provide services for the countries along the 21st century Maritime Silk Road

Thank You!

国家海洋环境预报中心

NMEFC，SOA，CHINA