Review of the Chinese Operational Ocean Forecasting System

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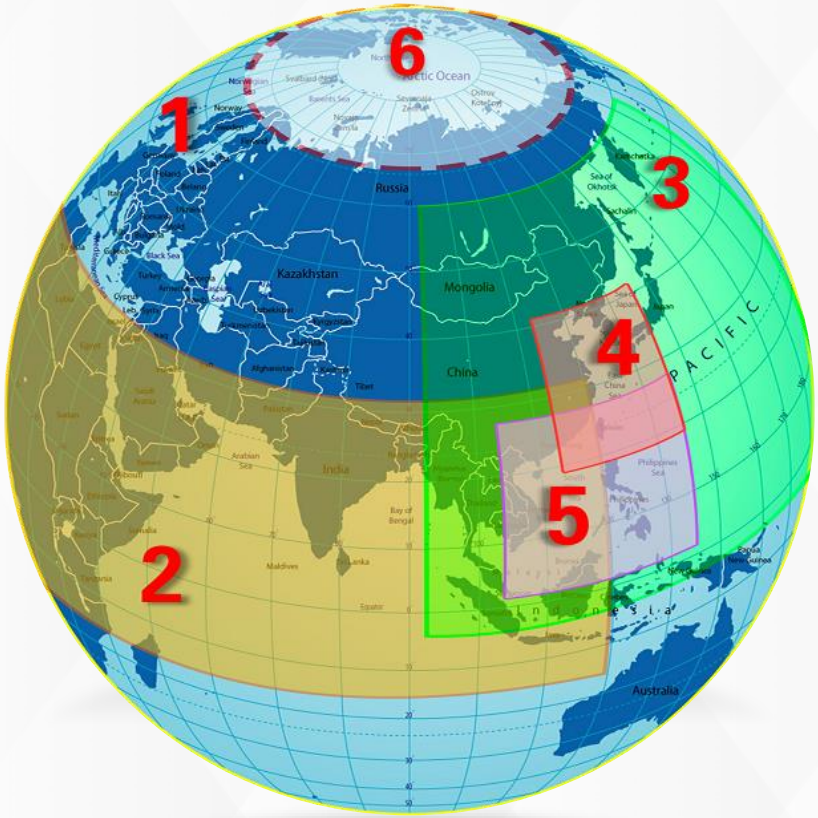
Contents

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

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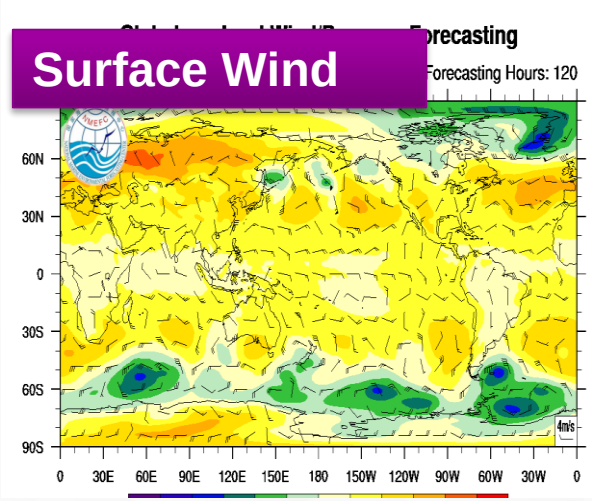
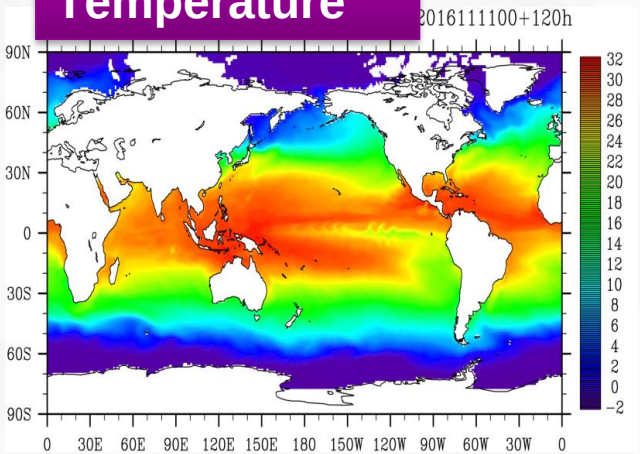
Achievements

Global Forecast Products of CGOFS

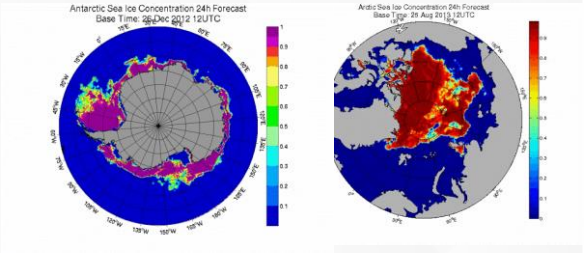
Surface Wind



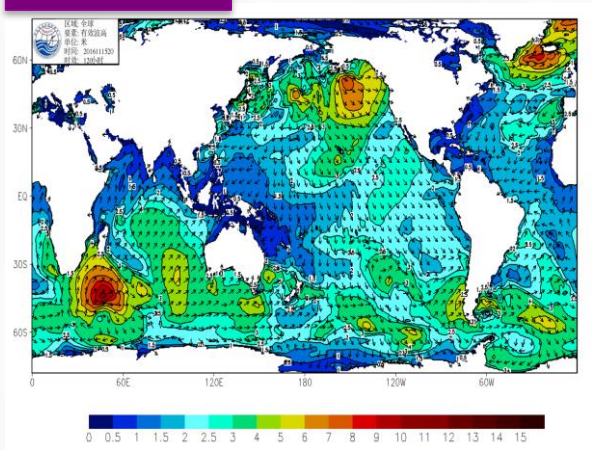
Temperature



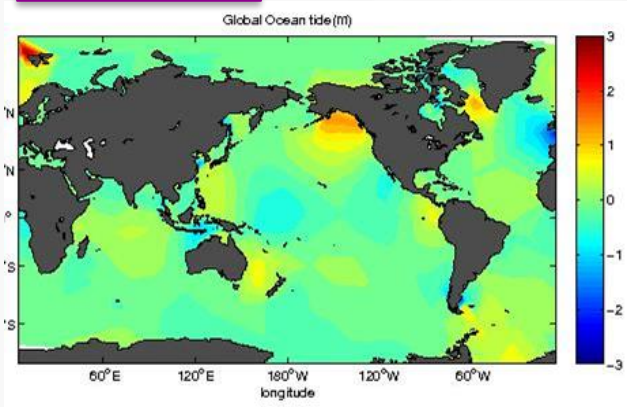
Polar ice



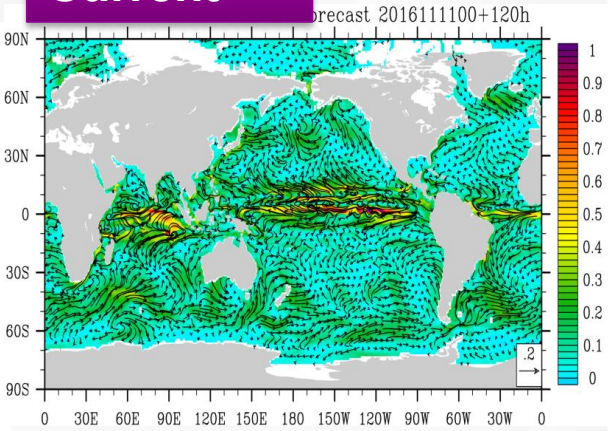
Wave



Tide

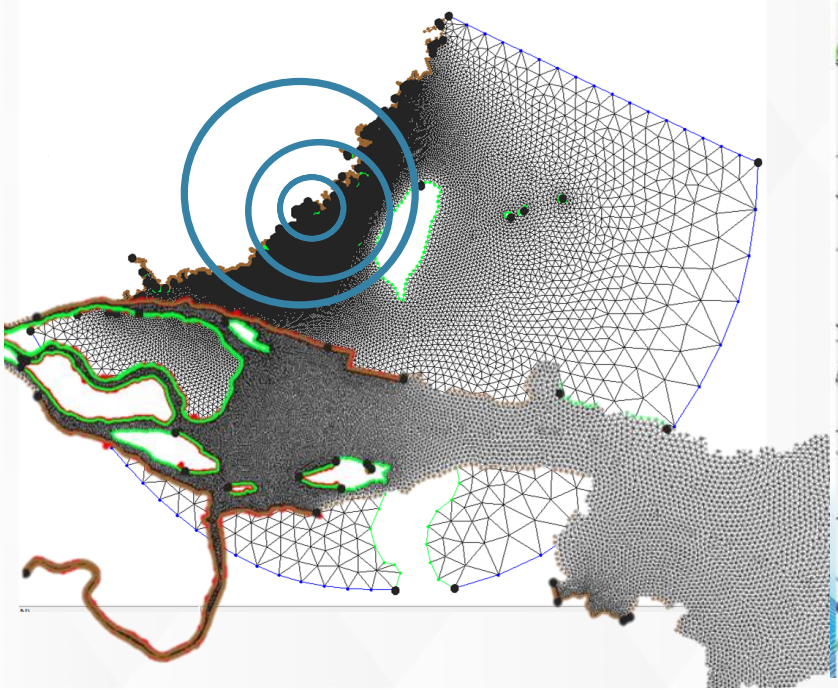


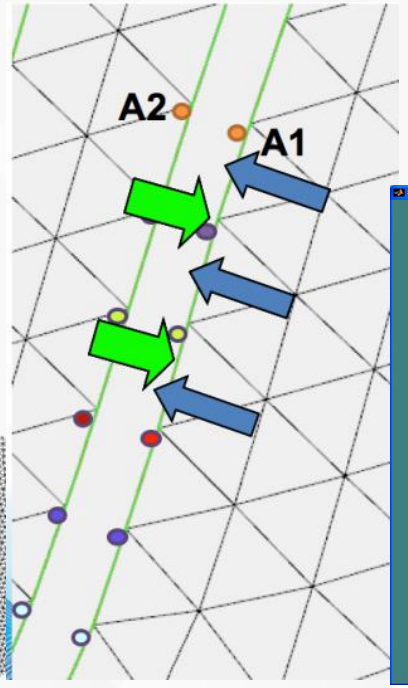
Current



Refined Forecasts in China Coastal Zone

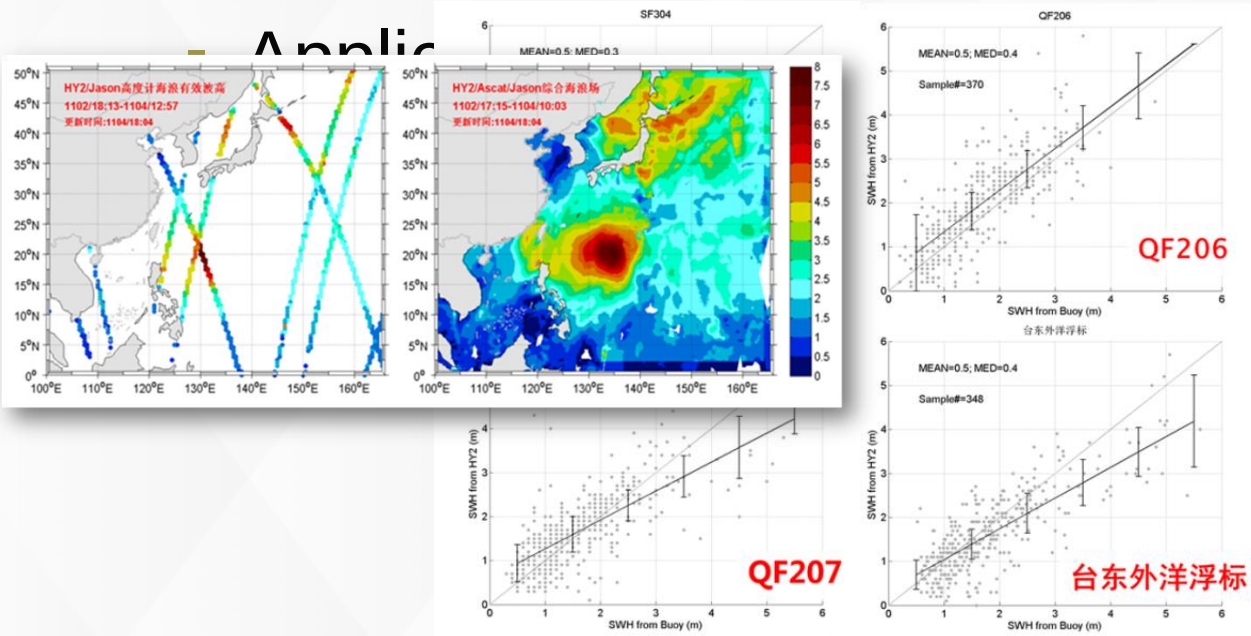
- Storm Surge
  - Resolution ~ 50 m, dam resolved
  - Waves offshore and flood considered
  - Application in Fujian, zhejiang ….

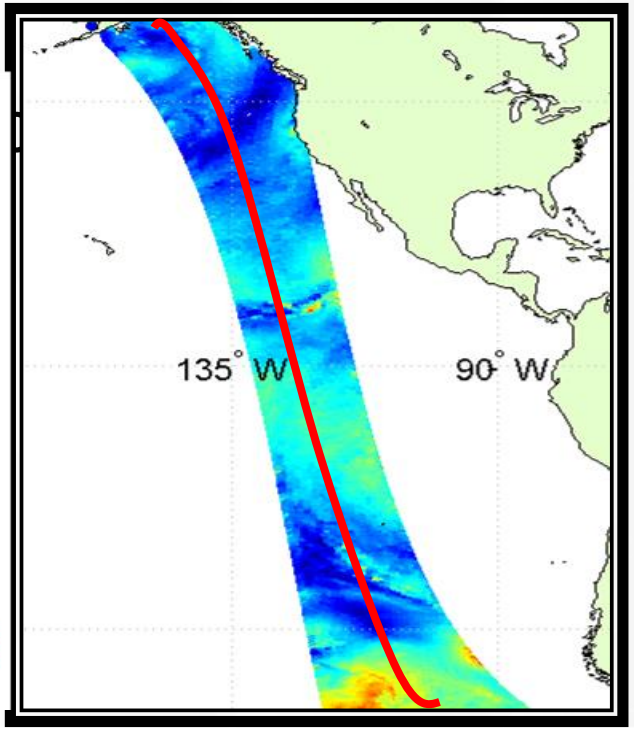




Refined Forecasts in China Coastal Zone

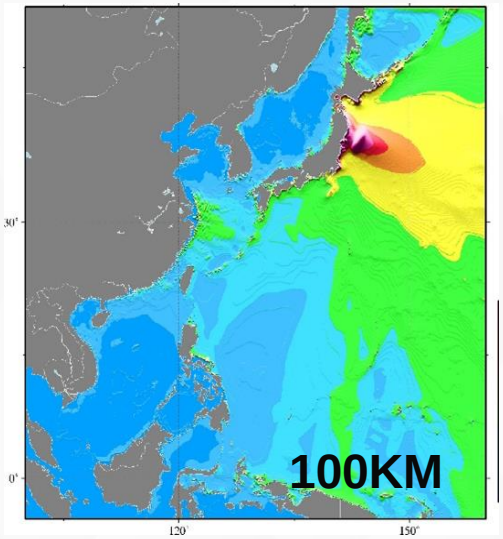
- Data assimilation on Waves
  - Combine radar altimeter(wave) and microwave scatter (wind) = narrow wave band + validated wide wave band derived from wind.
  - Applic

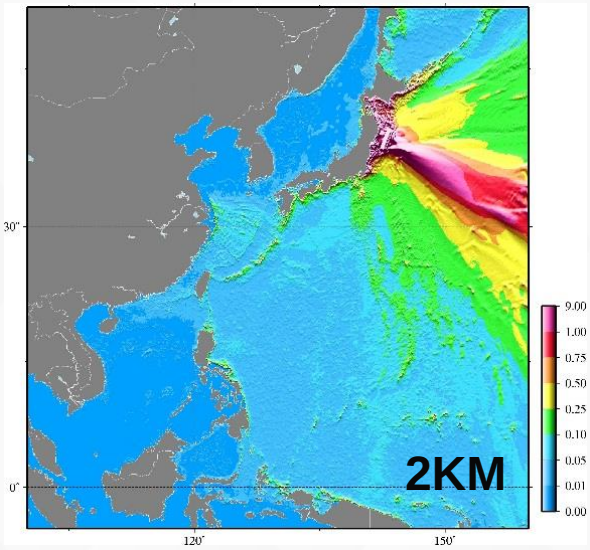


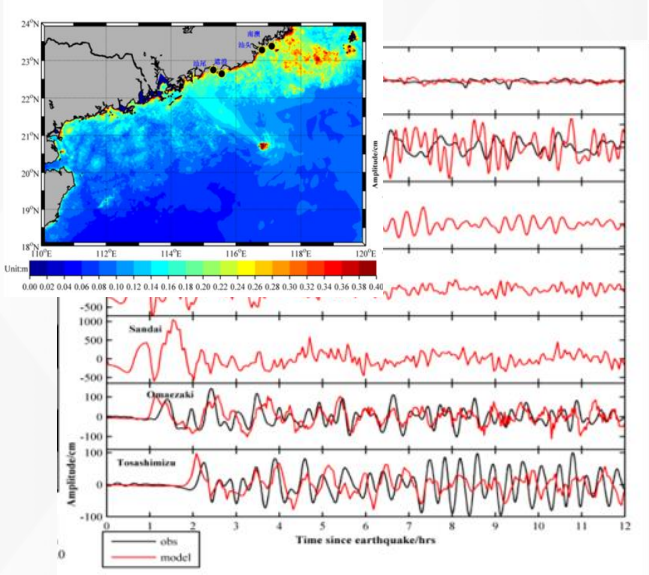


Refined Forecasts in China Coastal Zone

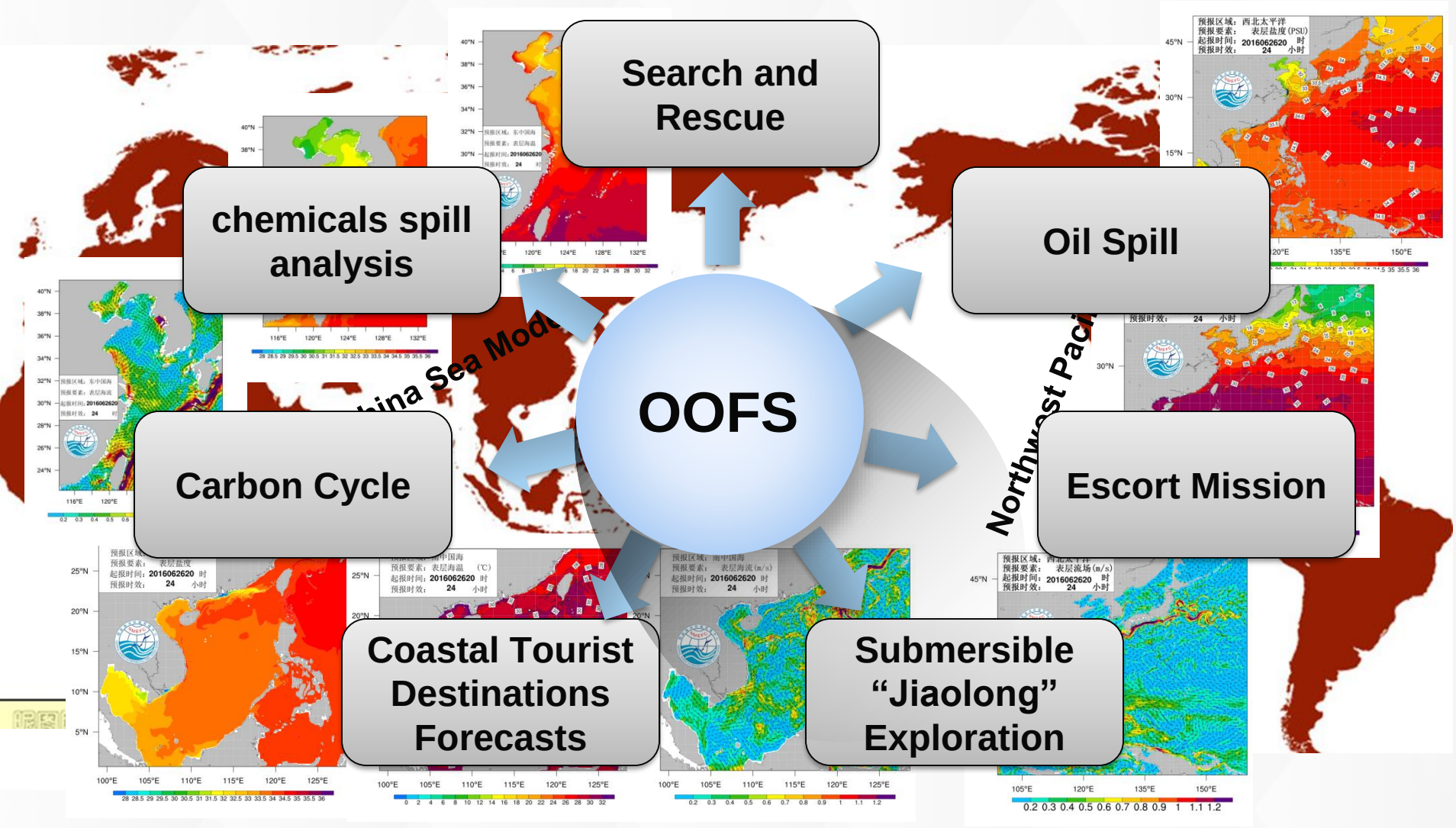
- Tsunami Warning
  - High resolution operational system.
  - High performance parallel tsunami model.
    - More than 20 times faster than previous version.
    - Release Warning within 2~5min all over Pacific and SCS





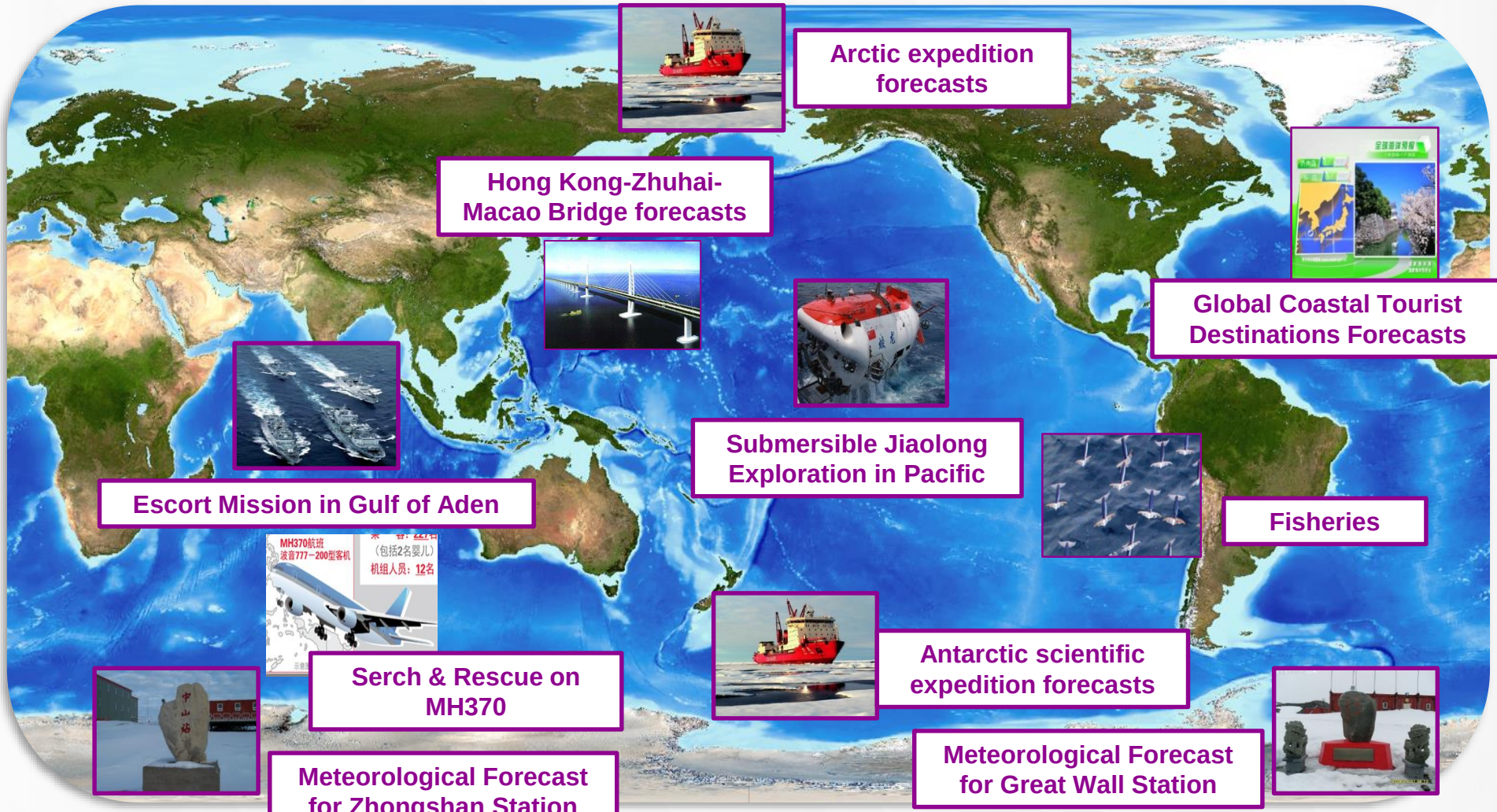


Ocean Services



South China Sea Model

Application: Global Forecasting Service



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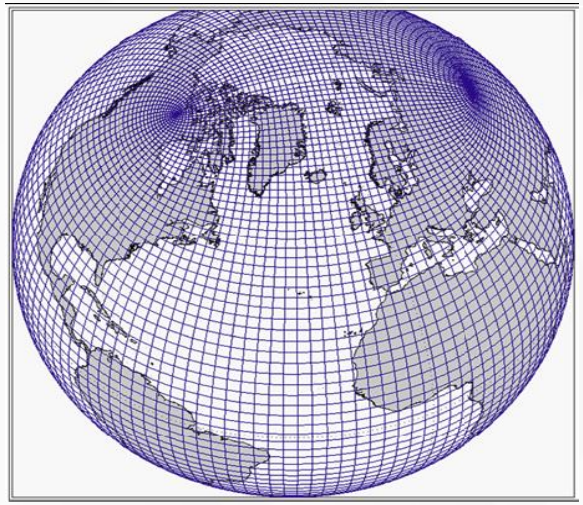
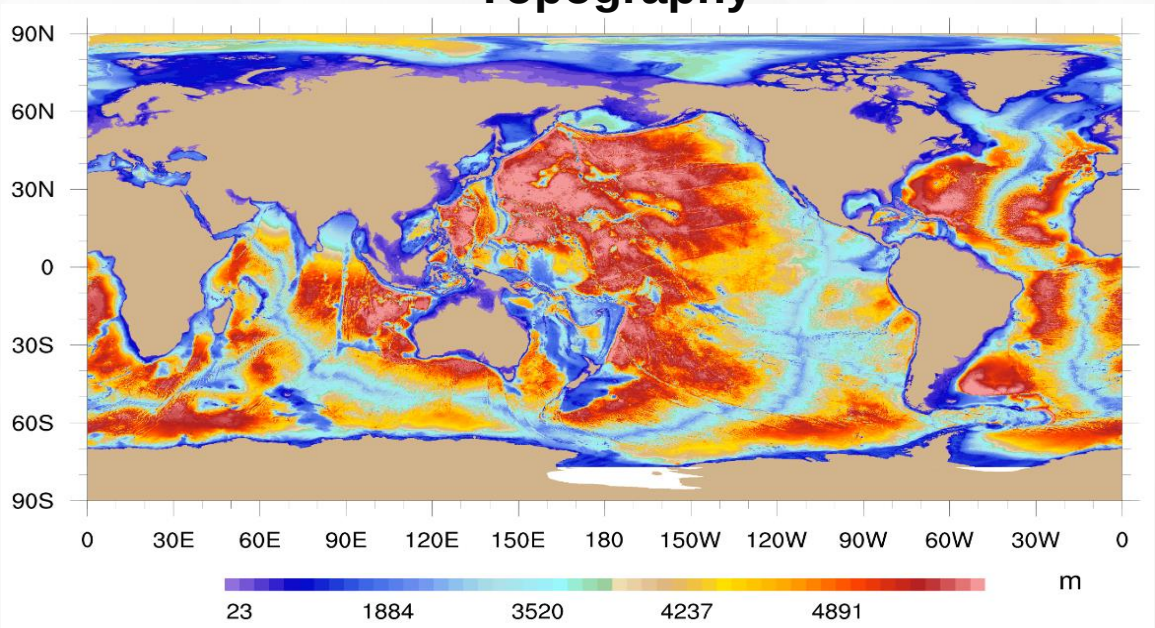
Update of the Forecasting Systems

Second generation global ocean numerical forecast system-NEMO 3.6 (2015-2017-2025)

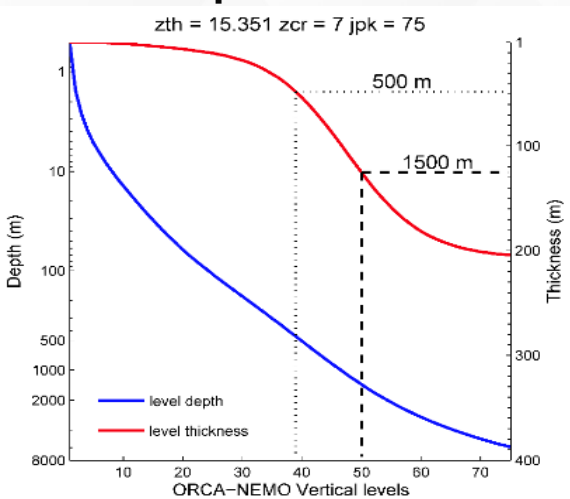
Horizontal grid



Topography



Levels depth and thickness



Code --NEMO3.6 + LIM3

Grid-- ORCA tripolar grid (Madec and Imbard [1996])

Horizontal resolution

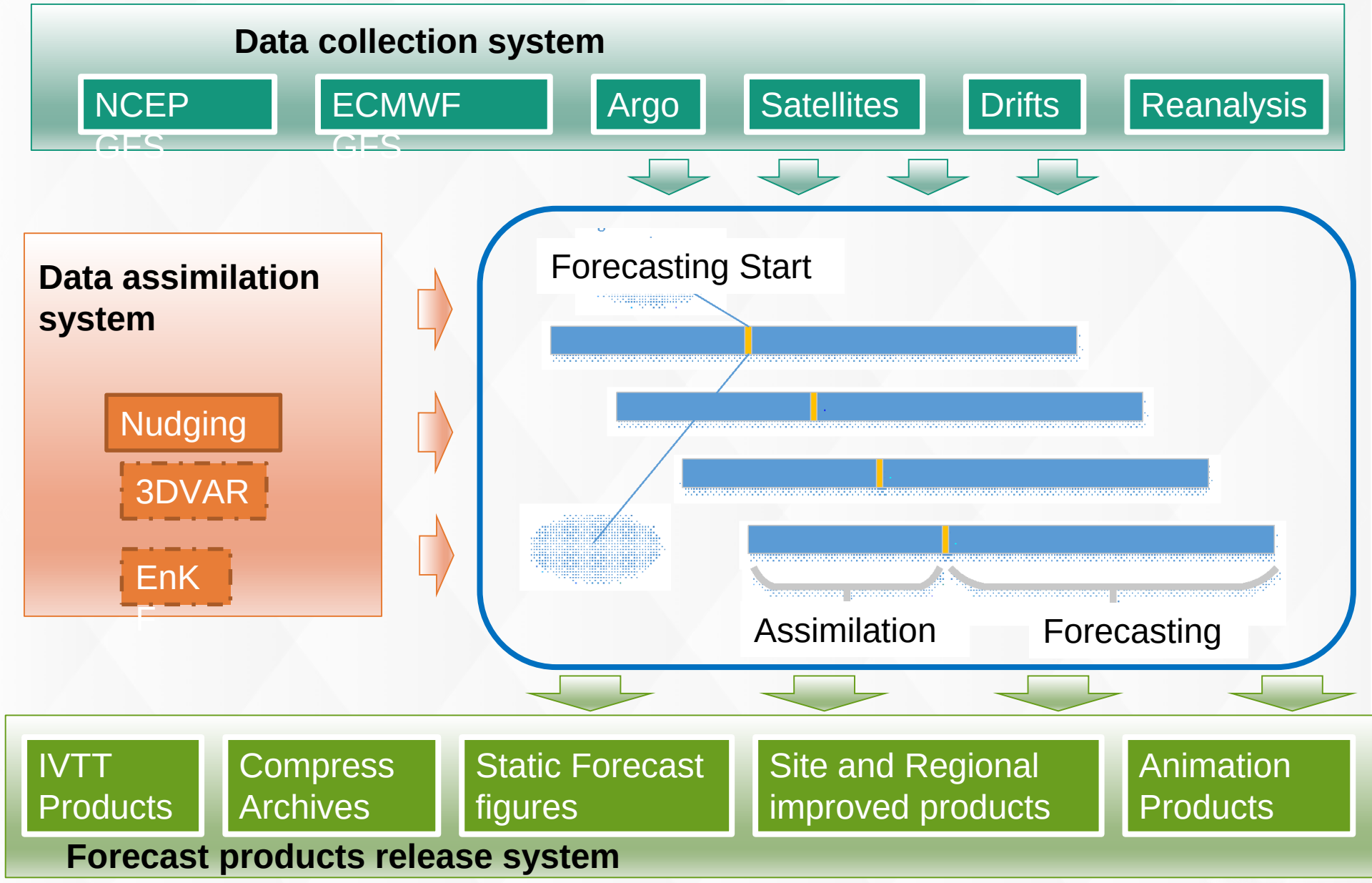
– 4322 x 3059 horizontal grid points

– 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, 0-6000m

Forecasting System Design



Main parameters configuration

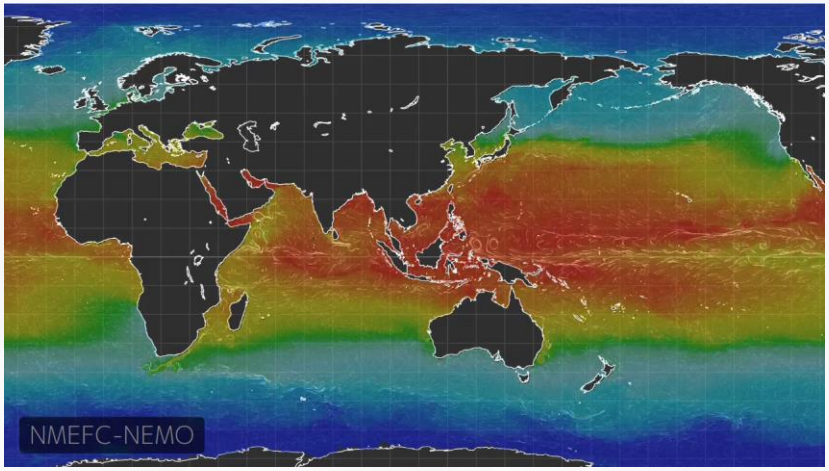
Work on Tianhe II Cluster with 2000 cores
z-coordinate with partial step
Filtered free surface (Roullet and Madec [2000])
Modified TKE turbulent closure model based on a prognostic equation for the turbulent kinetic energy (Madec et al. [1998])
Rotated laplacian operator for lateral diffusion on tracer (Guilyardi et al. [2001]) (125 m^2/s)
Iso-level bilaplacian operator for lateral diffusion on Momentum (1.25e10 m^4/s)

Guilyardi, E., G. Madec, and L. Terray, 2001 : The role of lateral ocean physics in the upper ocean thermal balance of a coupled ocean-atmosphere gcm. Clim. Dyn., 17 (8), 589–599.
Madec, G. and M. Imbard, 1996 : A global ocean mesh to overcome the north pole singularity. Clim. Dyn., 12, 381–388.
Madec, G., P. Delecluse, M. Imbard, and C. Levy, 1998 : Opa 8 ocean general circulation model - reference manual. Tech. rep., LODYC/IPSL Note 11.
Roullet, G. and G. Madec, 2000 : salt conservation, free surface, and varying levels : a new formulation for ocean general circulation models. J. Geophys. Res, 105, 23,927–23,942.

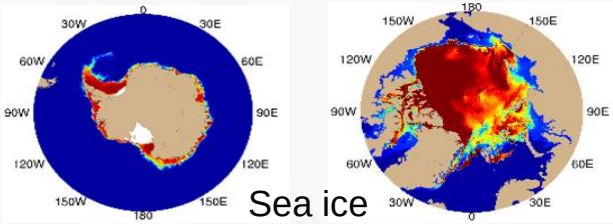
Diversification products

Products part one:
GODAE-IVTT standard products
Class 1：gridded model output
Class 2：time series of specified locations and sections
Class 3：transport through sections and other quantities
Class 4：metrics of forecast capability

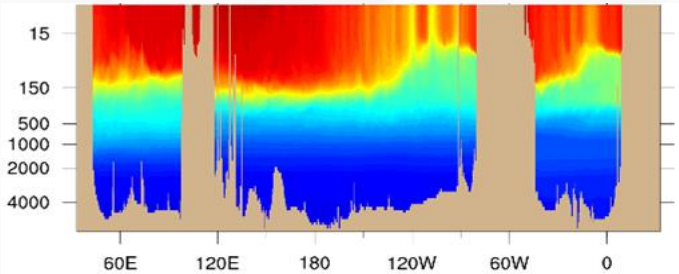
Products part three：Animation products



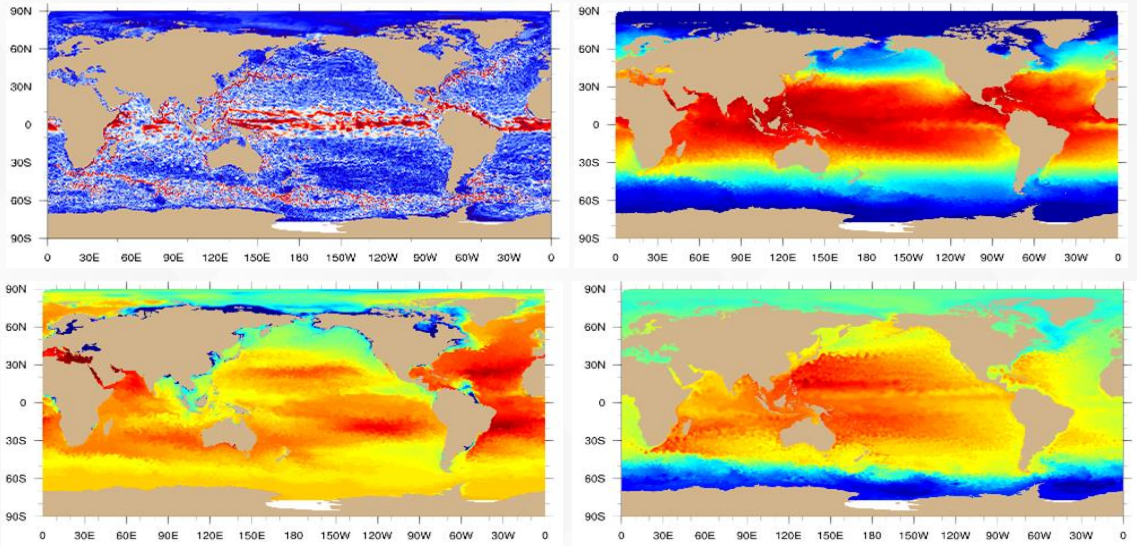
Products pat two：Conventional static visualization products



Sea ice

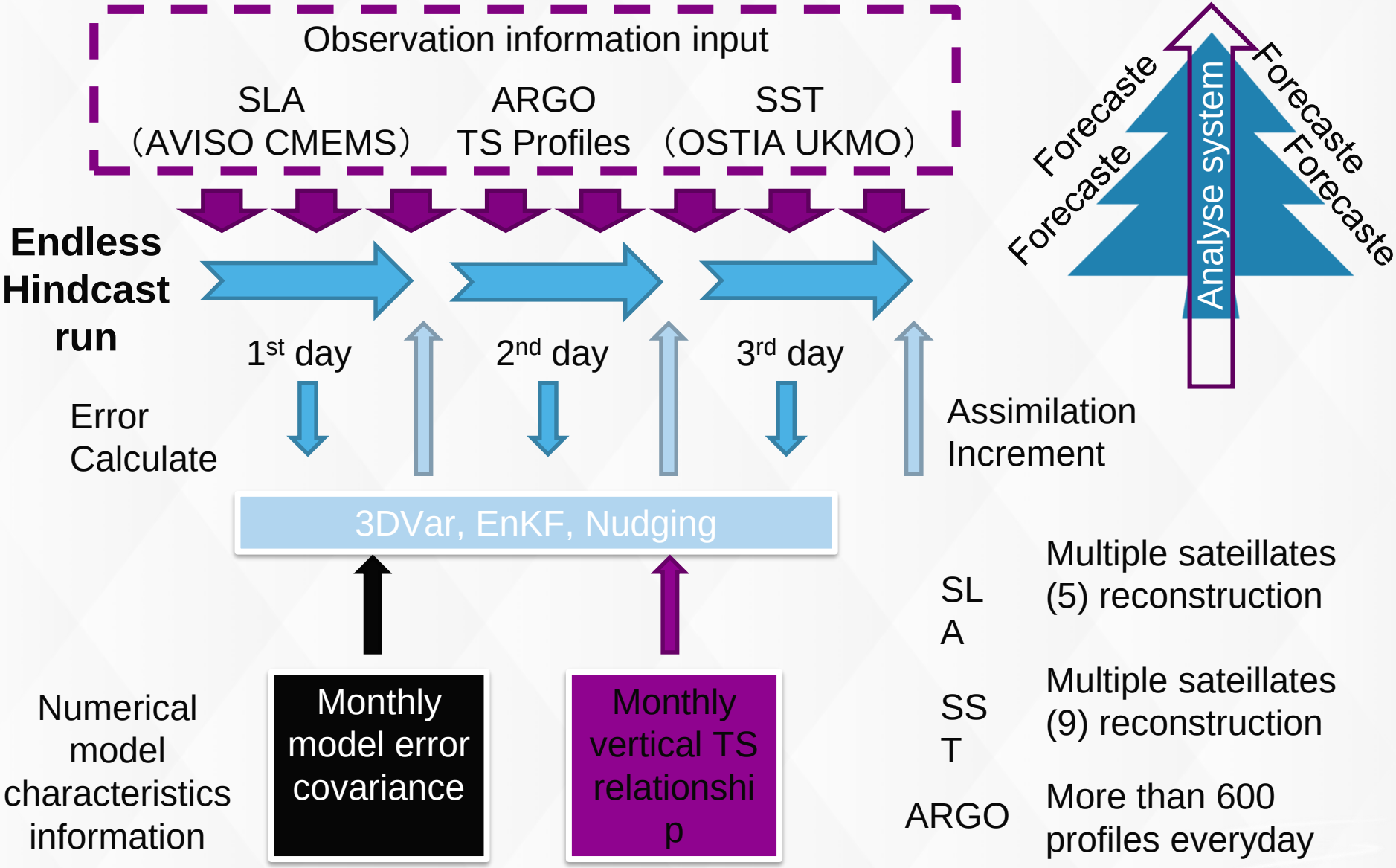


Vertical profile



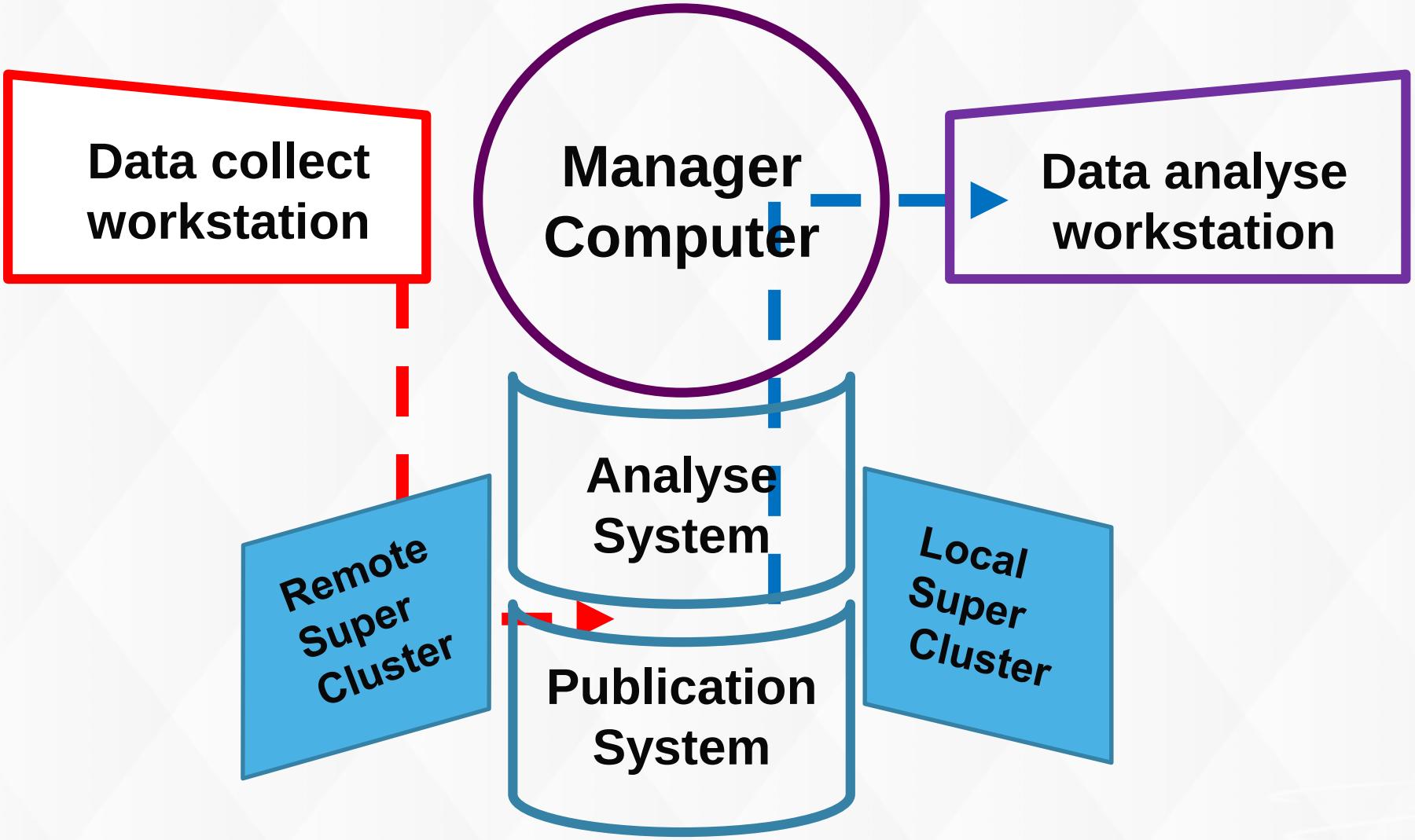
Temperature, salt, current, and SSH

Efficient Data Assimilation System



Distributed system

Safety, Efficient, Robust



Statistics improve system

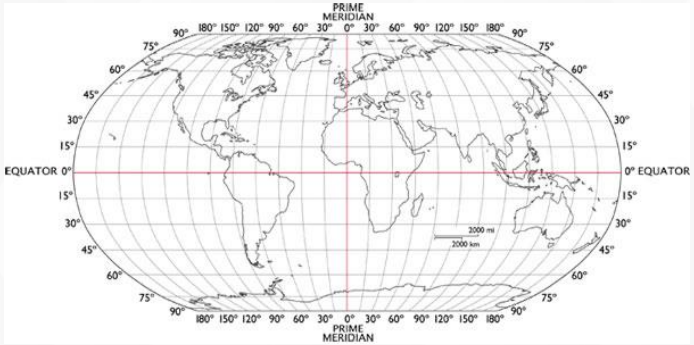
History Forecast

F_60 F_59 F_58 F_2 F_1

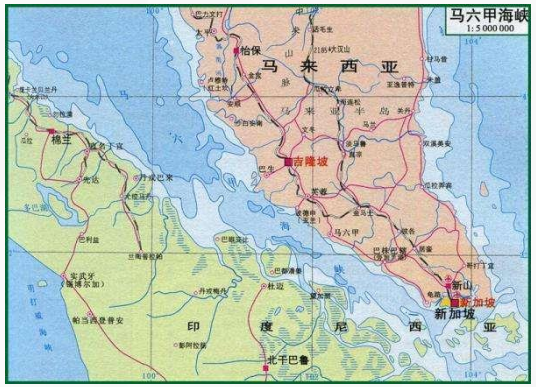
History Observation

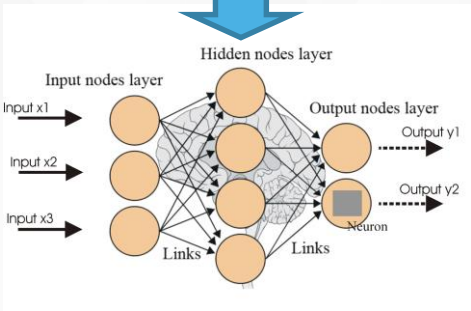
O_60 O_59 O_58 O_2 O_1

Global Grid Mapping

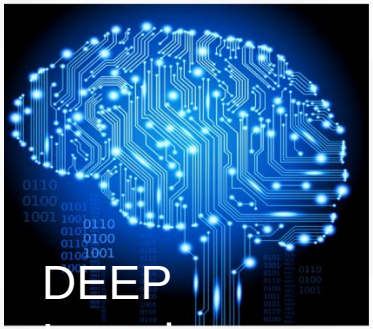


Regional and site bias relationship build



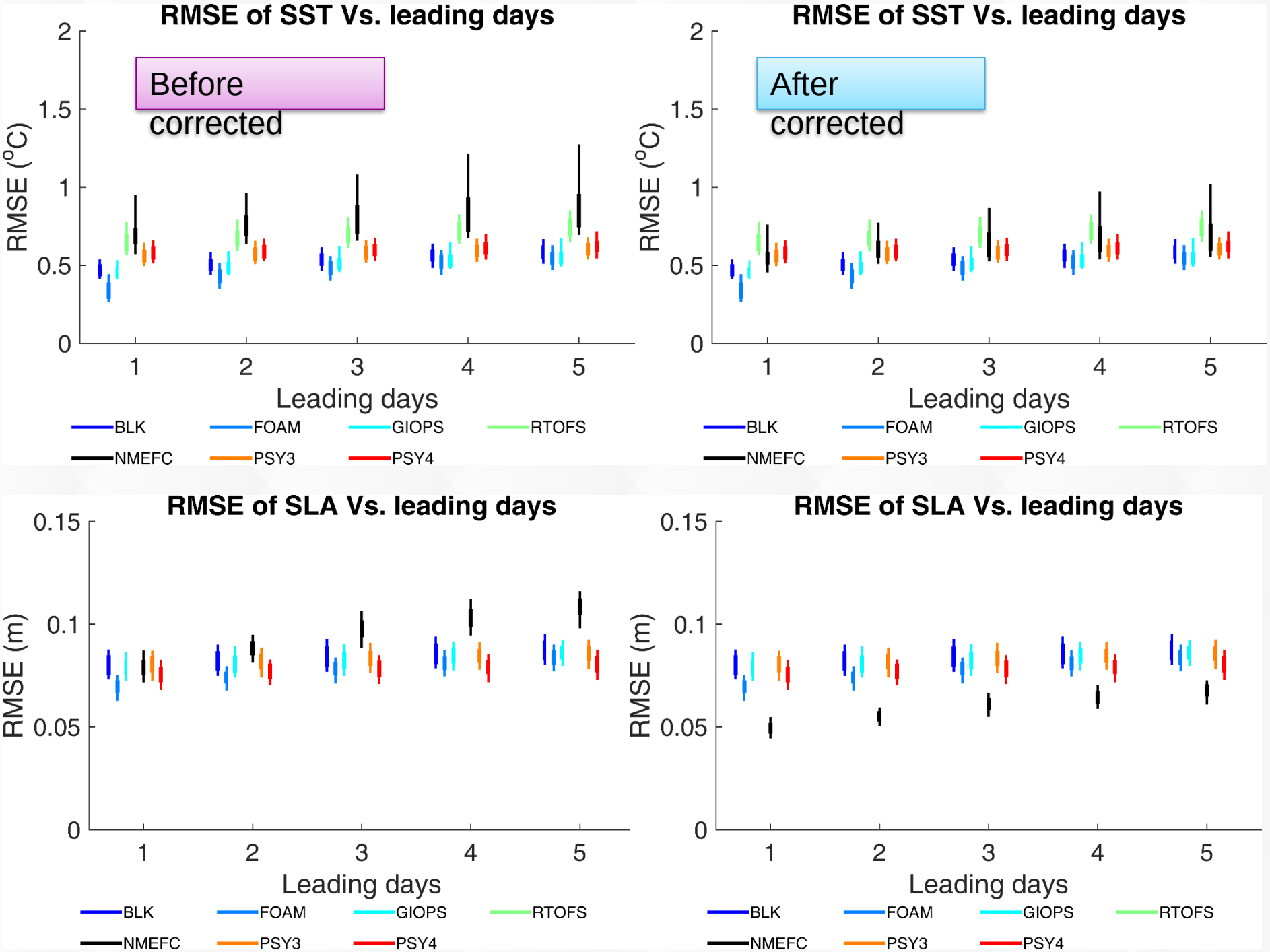


Artificial Neural Netw



Learning

Improved Forecasting Products


RMSE of SST Vs. leading days
Before corrected
RMSE (°C)
Leading days
RMSE of SST Vs. leading days
After corrected
RMSE (°C)
Leading days
RMSE of SLA Vs. leading days
RMSE (m)
Leading days
RMSE of SLA Vs. leading days
RMSE (m)
Leading days
BLK
FOAM
GIOPS
RTOFS
NMEFC
PSY3
PSY4

04

Foreseen challenges

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

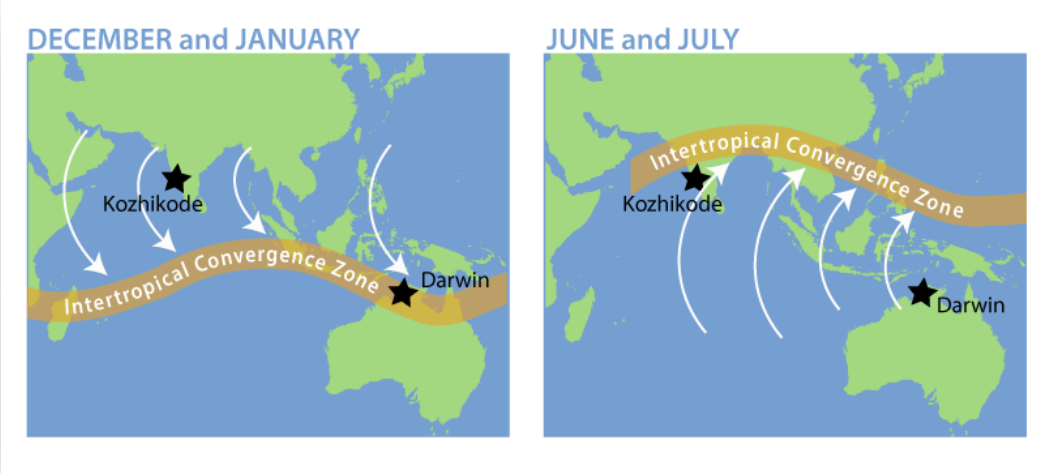
User requirements

- 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

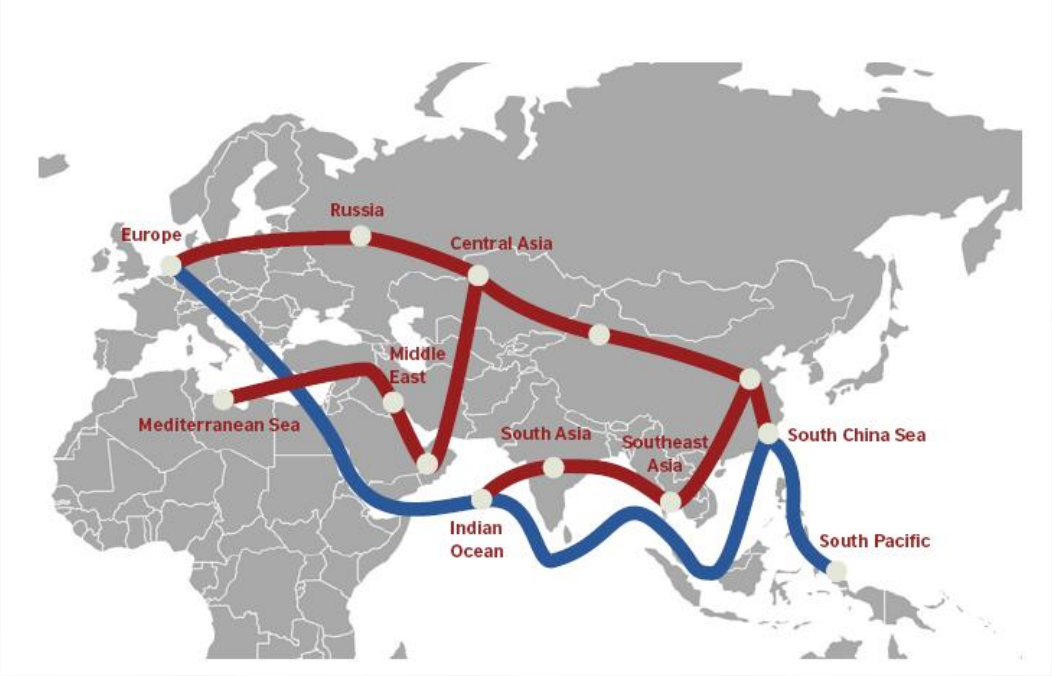
The monsoon system directly control China's drought and floods



Future perspective of China

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**

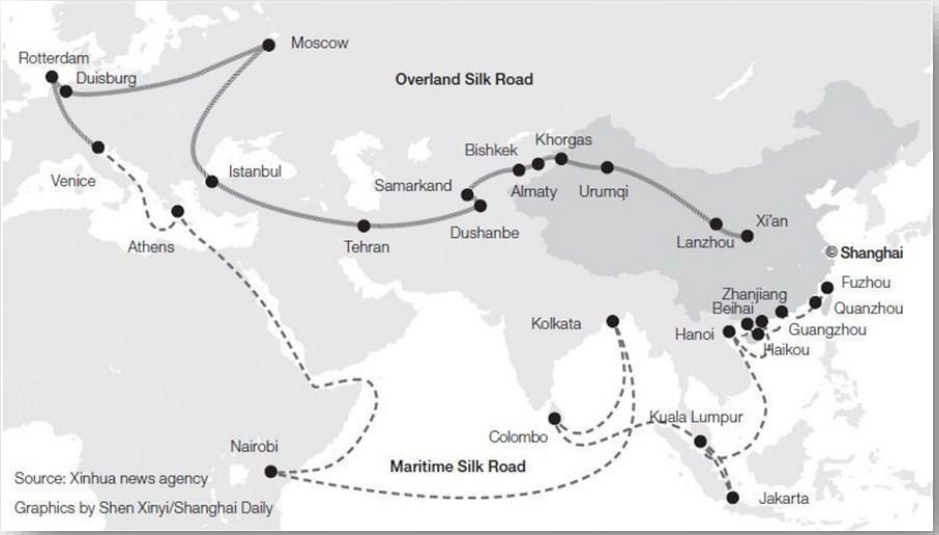
  - Coastal China—South China Sea—Indian Ocean—Europe
  - Coastal China—South China Sea—South Pacific

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.**



05

Outlook

Outlook

1. Develop the Marine Observation Network and Operational Oceanography Capability
   - development of global/coastal ocean forecast systems; data assimilation
   - intercomparison and validation ; observing system
   - climate change and prediction

2. Provide services for the countries along the 21st century Maritime Silk Road

Thank You !