Review of the Chinese Operational Ocean Forecasting System

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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
Achievements
Global Forecast Products of CGOFS
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
Ocean Services

- Search and Rescue
  - Chemicals spill analysis
- Oil Spill
- Escort Mission
- Carbon Cycle
- Coastal Tourist Destinations Forecasts
- Submersible “Jiaolong” Exploration

South China Sea Model
Application: Global Forecasting Service

- Hong Kong-Zhuhai-Macao Bridge forecasts
- Escort Mission in Gulf of Aden
- Serch & Rescue on MH370
- Meteorological Forecast for Zhongshan Station
- Submersible Jiaolong Exploration in Pacific
- Antarctic scientific expedition forecasts
- Meteorological Forecast for Great Wall Station
- Arctic expedition forecasts
- Global Coastal Tourist Destinations Forecasts
- Fisheries
Update of the Forecasting Systems
Second generation global ocean numerical forecast system-NEMO 3.6 (2015-2017-2025)

2. Horizontal grid

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
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)

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 two: Conventional static visualization products

Sea ice

Vertical profile

Temperature, salt, current, and SSH

Products part three: Animation products
Efficient Data Assimilation System

- Observation information input
  - SLA (AVISO CMEMS)
  - ARGO TS Profiles
  - SST (OSTIA UKMO)

Endless Hindcast run

1st day
2nd day
3rd day

Error Calculate

3DVar, EnKF, Nudging

- Assimilation Increment
- Forecast
- Analyse system

Monthly model error covariance

Monthly vertical TS relationship

Numerical model characteristics information

Multiple sateillites (5) reconstruction

SLA

Multiple sateillites (9) reconstruction

SS

ARGO

More than 600 profiles everyday
Distributed system

Safety, Efficient, Robust

Manager Computer

Data collect workstation

Remote Super Cluster

Analyse System

Local Super Cluster

Publication System

Data analyse workstation
Statistics improve system

Global Grid Mapping

Regional and site bias relationship build

Improved Forecasting Products
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.
“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.

- **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
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