National Report

a. China – NMEFC

Background

The primary functions of the National Marine Environmental Forecasting Center (NMEFC) are marine environmental forecasting, marine disaster forecasting and warning, and operational management. Over the past 50 years, the NMEFC has published numerous marine forecasting products regarding ocean waves, storm surges, tsunamis, red tides, sea ice, ocean currents, sea temperature and El Niño patterns. Since 2014, the NMEFC has started to develop state-of-art ocean forecasting systems using NEMO for global and ROMS for regional to upgrade the current operational forecasting systems. Those systems have been in operational phase since September 2016. After more than one-year operational running, a series of compared results have been done with IVTT class4 methods. An atmosphere-ocean coupled typhoon forecast system has been in operational phase since May 2015.

1. Input data

The atmospheric forcing data sets in global and North Pacific models include the global forecasting system (GFS) 1/4 degree data of NCEP Final Analysis, 1/8 degree data from ECMWF and 1/4 degree data of GRAPES system from CMA (China Meteorological Administration). Fields of 6-hourly pressure at 10m, air temperature at 2m, and wind speed at 10m, downward long-wave and short-wave radiation, and specific humidity at 2m are input into the global model.

The atmospheric data forcing the Northwest Pacific and Bohai Sea systems are taken from a regional atmospheric model outputs using WRF.

2. Data serving

The NMEFC systems provide temperature, salinity and currents forecasting products. The figures of the forecasting system outputs can be freely accessed from the NMEFC's website, while the data sets are only available within the NMEFC.

3. Models

The model in global ocean forecast system is NEMO (NEMO 3.6), with spatial resolutions around 2~9 km on average, which is developed by The National Center for Scientific Research (CNRS), The Euro-Mediterranean Center on Climate Change (CMCC), Mercator Ocean, Met Office. It is a framework of ocean related engines, namely OPA for the ocean dynamics and thermodynamics (blue ocean), LIM for the sea-ice dynamics and thermodynamics (white ocean), TOP for the on/offline oceanic tracers transport and PISCES for the biogeochemical processes (green ocean). It is intended to be a flexible tool for studying the ocean and its interactions with the other components of the earth climate system (atmosphere, sea-ice, biogeochemical tracers) over a wide range of space and time scales.

The operational oceanography currents forecasting systems for the Bohai Sea, China Seas, Northwest Pacific and North Indian are all developed using ROMS (Regional Ocean Model Systems), with spatial resolutions around 3~5 km on average. ROMS is a free-surface, hydrostatic, primitive equations ocean model that uses stretched, terrain-following coordinates in the vertical and orthogonal curvilinear coordinates in the horizontal. It is isopycnal in the

open stratified ocean, but smoothly reverts to a terrain-following coordinate in shallow coastal regions, and to z-level coordinates in the mixed layer and/or unstratified seas. This year, the model of China Seas has been modified with model version (from v3.5 to v3.7), topography, atmospheric forcing, tide input, runoff, open boundary and data assimilation. A new version Northwest Pacific model with 1/36° horizontal resolution also has been used for opertional running.

The operational atmosphere-ocean coupled typhoon forecast system for the Northwest Pacific is based on the atmosphere model WRF, ocean model ROMS and wave model SWAN. The three component models with the same horizontal resolution of 15km communicate via the model coupling toolkit (MCT). The SST is passed from ROMS to WRF, while sea surface stresses (τ) and heat fluxes are passed from WRF to ROMS. WRF provides winds at 10 m above the sea surface to SWAN, on the other hand, receives significant wave height, average wavelength and relative peak period from SWAN and uses these wave values to compute an enhanced sea surface roughness. This year, ROMS has been improved with wave influence parameterization and its data assimilation scheme.

4. Assimilation methods

In the NEMO global forecast system, LESTKF scheme is used to assimilate satellite remote sensing of sea level anomaly (SLA), satellite remote sensing of sea surface temperature (SST) and temperature/salinity (T/S) profiles from the Array for Real-time Geostrophic Oceanography (ARGO) floats. Through adjusted with a historical relationship between surface and abysmal sea to update deep sea results of temperature and salinity, vertical structure of T/S profiles perform well.

The Northwest Pacific system and Bohai Sea systems use nudging, OI and 3Dvar methods.

In 2012, Ensemble Optimal Interpolation data assimilation scheme has been developed within the framework of ROMS. This assimilation systems demonstrate the capability of assimilate a variety of observations simultaneously, including along-track sea level anomaly (TSLA), satellite Sea Surface Temperatures (SST), Temperature/Salinity (T/S) profiles from Argo floats and other platforms.

In 2015, 3Dvar data assimilation method has been used in the operational forecasting of the Northwest Pacific system. Multi-source observations, such as SST and T/S from floats, have been assimilated into the model.

This year, EnOI scheme has been modified with coast boundary to improved SST. The T/S profiles from China Argo floats has been assimilated into the model based on 3DVar method.

5. Assimilation products and dissemination

See the data serving section above.

6. Systems

All the ocean forecast systems have been running daily at the National Environmental Forecasting Center (NMEFC). They provide the products of temperature, salinity, currents, and sea surface height.

7. Observations - Links to (Argo, GHRSST, etc.)

Till this year, China Argo Real-time data Center have arrayed 98 floats in Northwest Pacific and the Indian Ocean. This year, two deep sea ARVOR Argo floats have been arrayed in Northwest Pacific.

8. Internal metrics and intercomparison plans

We have the compared with SLA, SST and T/S profiles with GODAE IVTT Class4 method, include Bias, RMSE, AC and regional comparison. Sea current as a new variable joined Class4 and also compared well with TOGA data sets.

We have a long-time collaboration plan with Korea ocean forecasting system, Yellow sea and East China sea is the main domain we focus on.

For the cooperation with Italia, there has been the international and academic exchange. The model improvement and circulation results will be comprised in the Adriatic Sea and the East China Sea regions to evaluate the operational models.

9. Targeted Users and envisioned external metrics

It provides ocean environmental products for the users who are involved in the task in Global for safety or other purposes. It also provides boundary conditions for coastal regional models.

10. Reanalysis activities

The tropical reanalysis system provides monthly products of temperature and salinity. Global reanalysis system has been set-up by National Marine Data and Information Service with horizontal resolution is 1/12 degree.

11. Computing resources

The computer system at the NMEFC is comprised of high-performance Lenovo Clusters, Sunway 3000A computer workstation and PCs, which guarantee that oceanic numerical forecast models running smoothly, and the Float Top is 350 billion times.

12. Consolidation phase and transition to operational system (activities)

By using VSAT satellite communication, Internet, and computer automatic distribution methods, the computer system can transfer oceanic monitor data and forecast products in real time.

For the model validation and verification, the model output is compared with the in-situ data and satellite data, especially with the union data from IVTT.

13. GODAE OceanView related achievements and measures of success

Our global operational forecasting products have been uploaded the GODAE OceanView IVTT special data management system, NMEFC is one of the comparison member of IVTT.

System information overview

System name	Global ocean forecasting system
Ocean Models	
OGCM	NEMO
Domain	global

Horizontal resolution	1/12°
Vertical sampling	75 levels with 20 levels in upper 200m
Atmospheric Forcing	GFS 6-hourly and ECMWF
Assimilation characteristics	
Assimilation Scheme	LESTKF
SST	OSTIA SST
SSH	sea level anomaly from CLS
Other	T/S profiles from Argo floats
System Set-ups	
Forecast range	7 days
Update frequency	daily
Hindcast length	1 Day
System website links	
General information	N/A
Technical description	N/A
Viewing service	http://www.nmefc.cn/hailiu/quanqiu.aspx

System name	
Ocean Models	
OGCM	ROMS
Domain	Northwest Pacific
Horizontal resolution	1/20° (1/36°)
Vertical sampling	30 σ-levels (36σ-levels)
Atmospheric Forcing	6-hourly surface fluxes from NMEFCWRF / NCEP GFS / CFSR
Assimilation characteristics	
Assimilation Scheme	EnOI for SLA, 3DVar for SST and T/S profiles
SST	SST from MGDSST or OSTIA
SSH	Gridded sea level anomaly.

T/S	T/S profiles from Argo floats
Other	
System Set-ups	
Forecast range	7 Days
Update frequency	Daily
Hindcast length	1 Day
System website links	
General information	
Technical description	
Viewing service	http://www.nmefc.cn/hailiu/xibeitaipingyang.aspx

System name	
Ocean Models	
OGCM	ROMS
Domain	Bohai Sea, Yellow Sea and East China Sea
Horizontal resolution	1/30°
Vertical sampling	30 σ-levels
Atmospheric Forcing	6-hourly surface fluxes from NMEFC WRF / NCEP GFS / NCEP CFSR
Assimilation characteristics	
Assimilation Scheme	EnOI for SST
SST	MGDSST
SSH	
Other	
System Set-ups	
Forecast range	5 Days
Update frequency	Daily
Hindcast length	1 Day
System website links	
General information	

Technical description	
Viewing service	http://www.nmefc.cn/hailiu/huangdonghai.aspx

System name	
Ocean Models	
OGCM	ROMS
Domain	South China Sea
Horizontal resolution	1/30°
Vertical sampling	36 σ-levels
Atmospheric Forcing	6-hourly surface fluxes from NMEFC WRF / NCEP GFS / NCEP CFSR
Assimilation characteristics	
Assimilation Scheme	EnOI for SST and SLA
SST	SST from MGDSST or OSTIA
SSH	Gridded sea level anomaly
Other	
System Set-ups	
Forecast range	5 Days
Update frequency	Daily
Hindcast length	1 Day
System website links	
General information	
Technical description	
Viewing service	http://www.nmefc.cn/hailiu/nanhai.aspx

System name	
Ocean Models	
OGCM	ROMS
Domain	Bohai Sea
Horizontal resolution	1/60°
Vertical sampling	30 σ-levels

Atmospheric Forcing	6-hourly surface fluxes from NMEFC WRF / NCEP GFS / NCEP CFSR
Assimilation characteristics	
Assimilation Scheme	Nudging for SST
SST	SST from MGDSST or OSTIA
Other	
System Set-ups	
Forecast range	5 Days
Update frequency	Daily
Hindcast length	1 Day
System website links	
General information	
Technical description	
Viewing service	http://www.nmefc.cn/hailiu/bohai.aspx

System name	
Ocean Models	
OGCM	ROMS
Domain	North Indian Ocean
Horizontal resolution	1/12°
Vertical sampling	30 σ-levels
Atmospheric Forcing	6-hourly surface fluxes from NCEP GFS / CFSR
Assimilation characteristics	
Assimilation Scheme	EnOI for SLA and SST
SST	SST from MGDSST or OSTIA
SSH	Gridded sea level anomaly.
Other	
System Set-ups	
Forecast range	5 Days
Update frequency	Daily

Hindcast length	1 Day
System website links	
General information	
Technical description	
Viewing service	http://www.nmefc.cn/hailiu/yinduyang.aspx

System name	**The atmosphere-ocean coupled typhoon forecast system**
Ocean Models	
OGCM	ROMS
Domain	Northwest Pacific
Horizontal resolution	15km
Vertical sampling	40 σ-levels
Atmospheric Forcing	Sea surface stresses and heat fluxes from WRF results / CFSR
Assimilation characteristics	
Assimilation Scheme	EnOI
SST	OISST
SSH	Along-track sea level anomaly from CLS, includingJason-2/3, Altika, Cryosat-2, Sentinel-3a data.
Other	Argo T/S profile
System Set-ups	
Forecast range	5 Days
Update frequency	Twice daily
Hindcast length	
System website links	
General information	