National Report – Republic of Korea

KHOA (KOOFS) /KIOST (KOOS)

Background

National demands for the ocean forecasting systems in the Republic of Korea have increased, due to the need to support economic activity and national safety including search and rescue, maritime defense, fisheries, coastal management and development, leisure activities and marine transportation. Further, accurate ocean forecasting is regarded as a key element in improving regional weather and climate forecasting. Various marine extreme events, such as storm surges; ocean heatwaves; water dilutions; plus maritime accidents, occur each year in the coastal area of Korea, often resulting in casualties and economic losses.

In terms of the production of data to support these activities, two major Korean institutes operate ocean forecasting systems: the Korea Hydrographic and Oceanographic Agency (KHOA); and the Korea Institute of Ocean Science and Technology (KIOST). Since 2012, KHOA has operated the Korea Ocean Observing and Forecasting System (KOOFS), which comprises four nested ocean models (regional, sub-regional, coastal areas and port areas) and a nested regional atmospheric model, with horizontal resolutions of 4 km and 20 km. Every day, the regional and sub-regional models generate 7 day forecasting data and the rest of the models produces 72 hr forecasting data. Its 'regional' ocean model domain covers the north pacific region at a horizontal resolution of 25 km. 'Sub-regional' ocean model domains cover the Yellow and East China Seas (YES); and the East Sea; both at a 3 km horizontal resolutions. The 'coastal sea' ocean model domains cover the west coast; and south coast regions of Korea, at horizontal resoultions of around 1 to 1.5 km. The 'port' ocean model domains cover major port areas at 0.1 to 0.5 km horizontal resoultions. In 2020 the Ulleungdo-Dokdo sub-coastal model, with a horizontal resoultion of ~300 m, was established. This sub-coastal model is nested through an off-line technique within the Ulleungdo coastal model, which has a horizontal resoultion of 1 km.

The regional and subregional ocean models, and the regional atmospheric model, are integrated in conjuction with a data assimilation system. In addition, since 2015 KHOA has operated the Korea Ocean Modelling Validation System (KOMVAS), to evaluate daily model prediction results. That is, the forecast data are compared with real time observation records from tidal observation stations, ocean buoys and HF-radars: these comprisons have revealed root-mean-square-errors (RMSEs) in sea-level height and water temperature of <0.3 cm and <1.5°C, respectively. Cost functions (CF) concerning the forecast skill and predictability are also calculated.

Since 2014, the other major ocean forcasting institute, KIOST, has been developing an ocean circulation prediction system for the Northwest Pacific, called the Ocean Predictability Experiment for Marine environments (OPEM). Since March 2017, KIOST has employed OPEM to generate ≤10 day marine forecasts from each Wednesday, supplying these data to relevant stakeholder agencies in Korea.

In addition, KIOST has also established the 'Coastal KOOS (Korea Operational Oceanographic System)' model, with a horizontal resolution of 300 m. The background to establishing Coastal KOOS was as follows: the marine geographical characteristics of Korean Peninsula pose challenging numerical modelling conditions in terms of the accuracy and computing efficiency. Maximum tides along the west coast, the eastern side of the Yellow Sea, range up to 10 m. The south coast features complex coastlines, many islands, and is under the influence of both tides and ocean currents. The east coast, in the East Sea, has relatively simpler coastlines, almost negligible tides (ranges of a few tens of centimeters), and steep depth changes, mostly with no continental shelf. Hence Coastal KOOS needed to operate at a spatial high-resolution in order to provide reliable ocean forecasting products for Korean coasts. Even with its 300 m horizontal resolution and huge computing times, the accuracy of Coastal KOOS is inadequate around small islands and in narrow channel features. To overcome this issue, a triangular unstructured grid ocean forecasting system is under development.

1. Input data

1.1. KHOA's KOOFS

- KOOFS uses 1-hourly atmospheric forcing data sets, derived from a Weather Research and Forecasting (WRF) Model based regional operational atmospheric prediction system (KHOA_WRF).
- Initial and surface boundary conditions for KHOA_WRF are taken from global forecasting data provided by the National Centers for Environmental Prediction's (NCEP's) Global Forecast System (GFS) Model, and the Unified Model (UM) from the Korea Meteorological Administration (KMA).
- The observation data for the data assimilation stage is sourced from Group for High Resolution Sea Surface Temperature (GHRSST) OSTIA (Operational Sea surface Temperature and Ice Analysis) satellite SST data; the KODC (Korea Oceanographic Data Center); the GTSPP (Global Temperature and Salinity Profile Program); and the KOON (Korea Ocean Observing Network) data. KOON is operated by KHOA and consists of tidal observation stations; ocean stations; ocean buoys; surface current stations; and three ocean research stations (Ieodo; Shinan Gageocho; and Ongjin Socheongcho).
- Quality control procedures for the observation data involve detecting missing mandatory information, duplicates, remaining outliers (spikes, out of scale data etc.), and attaching a quality flag.

1.2. KIOST's KOOS

KOOS_OPEM

- In-situ profile data from Argo, the KODC (Korea Oceanographic Data Center), and various other sources are assimilated in this model. KODC data comes from NIFS (National Institute of Fisheries Science) and comprises serial observation data from the four marginal seas around the Korean Peninsula. In addition to Argo and KODC data, ocean profile data from various other sources is used, as extracted from the GTSPP.

- Quality control of the profile data is carried out as follows: (1) minimum and maximum temperature (T), salinity (S) and pressure values are checked; (2) instability is determined by checking temperature and salinity gradients; (3) density inversion testing is performed using the potential temperature and sigma theta. Data assimilation for the TS profile is performed once a week.

- The satellite-borne SST data for the data assimilation comprise National Oceanic and Atmospheric Administration (NOAA) Optimum Interpolation Sea Surface Temperature (OISST) V2 data (March 2017 - December 2017) and GHRSST Level 4 OSTIA Global Foundation Sea Surface Temperature Analysis (January 2018 - present). The SST data are subsampled by 0.25 degree intervals and assimilated once per day.
- The satellite-borne sea level anomaly data for the data assimilation are taken from the global gridded data of the AVISO. The sea level anomaly data are subsampled by 1 degree intervals and assimilated once a week.
- Surface Boundary Conditions (SBC) have been calculated by bulk formula using meteorological data supplied by the KMA (Korea Meteorological Administration) GDAPS (Global Data Assimilation and Prediction System) for real-time prediction since March 2017.
- Open Boundary Conditions (OBC) are obtained in the form of daily means from the CMEMS (Copernicus Marine Environment Monitoring Service) global analysis and forecasts (PSY4V3R1).

Coastal KOOS

- Coastal KOOS is forced by hourly atmospheric forcing from the KOOS_WRF (Weather Research and Forecasting) model.
- The initial and lateral boundary conditions for KOOS_WRF are derived from the NCEP GFS numerical weather prediction model, a 6-hourly forecast for the globe at 1.0° resolution.
- For tides, FES2014 data are used along the open boundaries. Other variables for the initial and open boundary conditions, such as temperature, salinity, currents, and sea level heights, are derived from KOOS_OPEM.
- Freshwater discharges are considered from 12 rivers, including five from China.

2. Data serving

2.1. KHOA's KOOFS

- KOOFS provides 3-day hourly forecast data for temperature; salinity; sea-level height; and currents. Figures and animations displaying the forecast data can be freely accessed through KHOA's websites: the Ocean Data in Grid Framework (http://www.khoa.go.kr/oceangrid/khoa/intro.do); and Port

Oceanographic Information System (POIS, http://www.khoa.go.kr/oceanmap/pois/intro.do).

- KHOA is concerned with understanding how to best provide prediction data to users. To avoid user confusion and encourage expansion in the use of its output data, KHOA made the grid based-display system and open API, thus enabling ready access to model outputs.

2.2. KIOST's KOOS

- KIOST does not have a website for the system. However, monitoring results for major variables, such as temperature and salinity in the Northwest Pacific, are shared internally once a week. KOOS is planning to open a website within this year.
- Results from the system are also provided to end users for academic activities, collaborative research and the media.
- After an agreement is signed between KIOST and users, the results are supplied to a designated SFTP server.
- Model data required for irregular uses can also be produced to suit user requirements, such as for specific variables, durations, time-intervals and horizontal areas.
- KIOST is now integrating the KIOST_OPEM to produce an ocean reanalysis in the Northwest Pacific from 1993 to 2018. The KIOST_OPEM for reanalysis is almost same to the operational KIOST_OPEM but the satellite-borne sea level anomaly from the AVISO is assimilated for the KIOST_OPEM reanalysis every 7 days. The KIOST_OPEM reanalysis will be released to the public upon completion.
- The products from Coastal KOOS will mainly be used by decision makers, and by researchers seeking simple data products to support research papers.
- Coastal KOOS products will be delivered via various methods and as efficiently as possible while meeting end-user needs, including via a SFTP server, texting, and as completed figures.
- In the newly built web server, prediction results can be displayed and compared with real-time observation data, while the forecasting data can be downloaded using OPeNDAP. A limited number of users can be logged in at any one time.

3. Models

3.1. KHOA's KOOFS

- KOOFS systems for the regional, sub-regional, coastal, sub-coastal and 9 port models are based on the ROMS (Regional Ocean Modelling System).
- The regional forecasting system is based on ROMS version 624, with a horizontal resolution of 25 km and 30 vertical sigma levels.
- The two sub-regional forecasting systems, for the Yellow and East China Seas; and the East Sea, are based on ROMS version 439, with a horizontal resolution of 3 km and 41 vertical sigma levels.

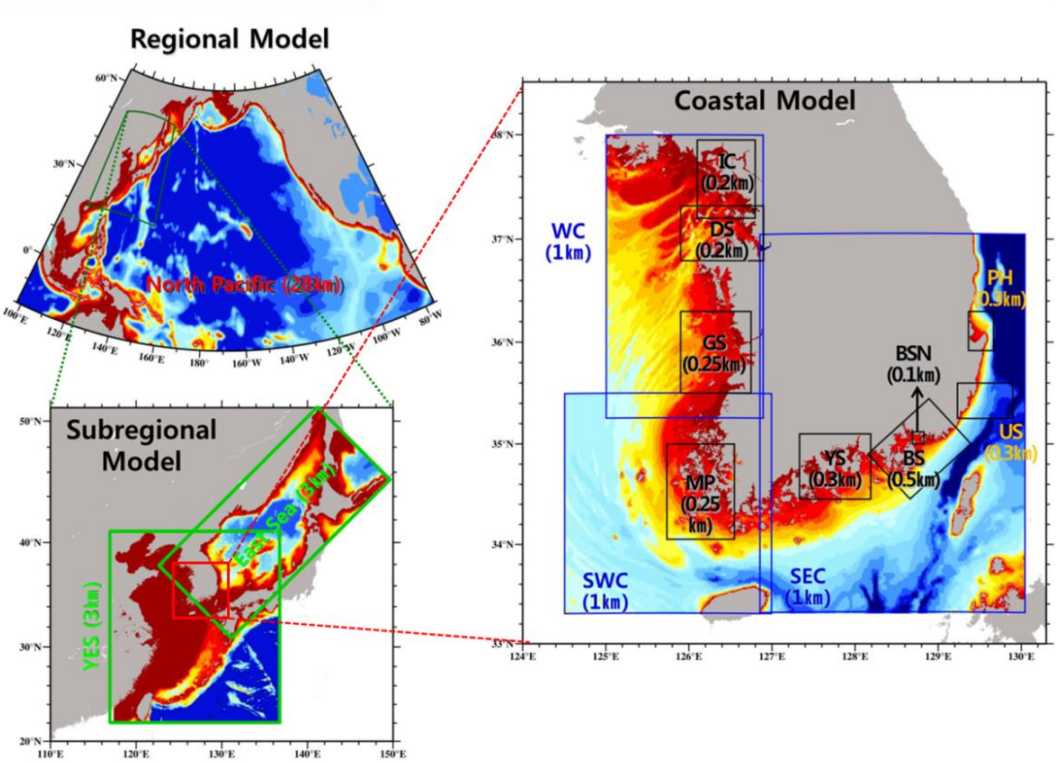

Figure 1. KHOA operational ocean forecasting model domains for the regional (North Pacific), two sub-regional (YES and East Sea), three coastal seas (WC, SWC, SEC) and 9 main port models.

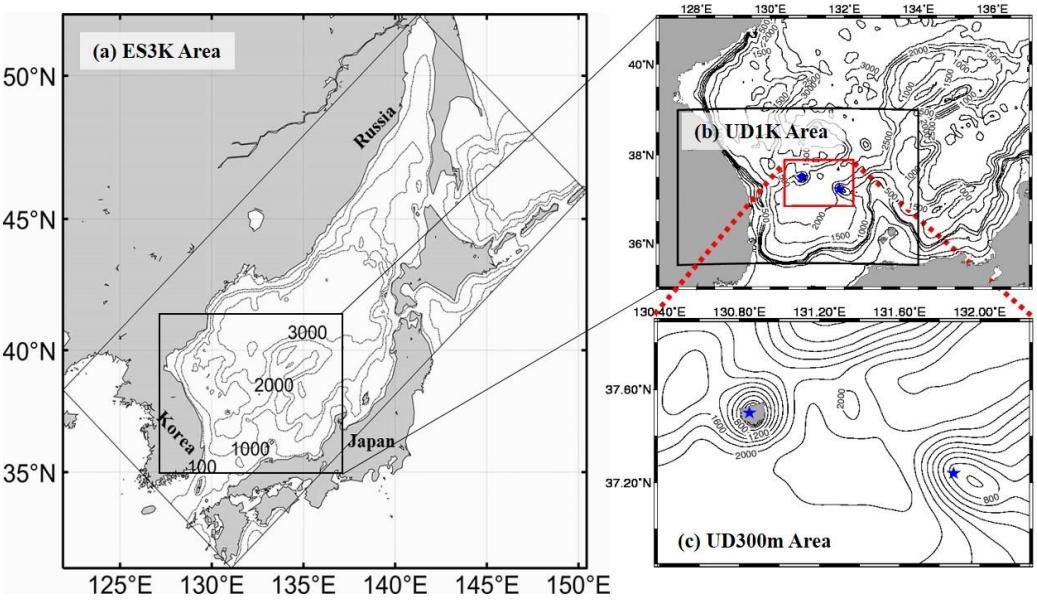

Figure 2. The model domains of the East Sea sub-regional model, the Ulleungdo coastal model and the Ulleungdo-Dokdo sub-coastal model, which are nested through an off-line technique.

- The coastal forecasting systems for the Ulleungdo and the west and south coast areas of Korea are based on ROMS version 439, with a horizontal resolution of 1 to 1.5 km and 41 vertical sigma levels.

- The 9 major port systems, for Incheon; Daesan; Gunsan; Gwangyang; Mokpo; Busan; New Busan; Ulsan; and Pohang Ports, are based on ROMS version 439, with a horizontal resolution of 0.1 to 0.5 km and 10 vertical sigma levels.
- The models are basically forced by momentum, water and heat fluxes interactively computed by bulk formulae using the 1-hour KHOA_WRF. Discharges from the Yangtze River and 17 rivers around the Bohai Sea and Yellow Sea are included as freshwater sources.
- Tidal forcing is applied along the open boundaries using 10 major tidal components in order to include the tidal mixing effect using NAO99jb.
- Vertical mixing is calculated by the M-Y scheme. Chapman, Flather, and clamped boundary conditions are used for free surface elevation, barotropic momentum, and baroclinic momentum.
- The bathymetries for 9 port regional models are generated using exclusive bathymetric survey data of KHOA, filtered using TIN (Triangulated Irregular Network) and Z-Tolerance.

3.2. KIOST's KOOS

KOOS_OPEM

- The KOOS_OPEM is the ocean prediction system based on the GFDL-MOM5 (Geophysical Dynamics Laboratory Modular Ocean Model 5). The domain of the numerical model covers the Northwest Pacific area (5 to 63°N, 99 to 170°E). The horizontal grid is the Arakawa B-grid system, with a resolution 1/24°. The vertical grid is the z-star coordinate system, with 51 layers.
- In order to improve KOOS_OPEM model performance regarding coastal currents and salinity outputs, runoff data is input from the Global River Discharge (RivDIS) version 1.1 data in the form of monthly climatology.
- The KOOS_OPEM does not simulate tides but rather applies a tidal mixing parameterization using the TOPEX/Poseidon Inverse Model TPXO.7.0 data.
- The OPEM is a regional ocean model, and requires OBC and SBC.

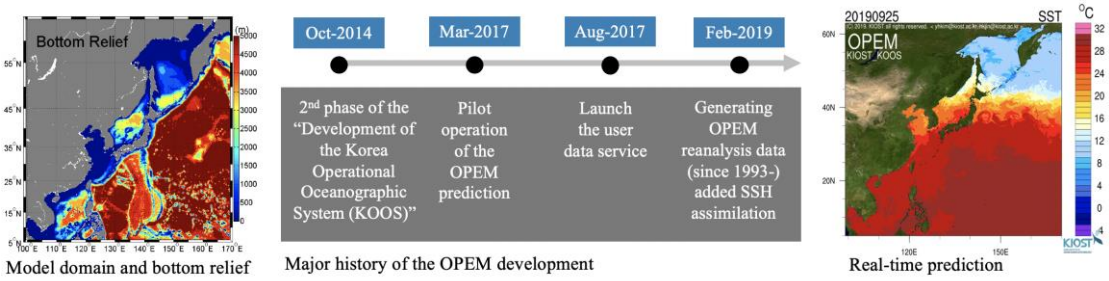

Figure 3. Model domain and bottom relief for KOOS_OPEM, a brief history of the development and its example of SST prediction.

Coastal KOOS

- Coastal KOOS utilizes atmospheric forcing from the KOOS_WRF model, with cycling three-dimensional variational data assimilation (3D-VAR).
- Coastal KOOS's hydrodynamic model is based on MOHID, which was developed by MARETEC (the Marine and Environmental Technology Research Center) at the Instituto Superior Tecnico (IST) of the University of Lisboa, Portugal.
- The Coastal KOOS nested grid systems comprises (a) L2, which covers from 117.50°E, 28.67°N to 132.50°E, 43.50°N, at a 1/48° horizontal grid resolution; and (b) L3, which covers from 124.50°E, 32.92°N to 130.13°E, 38.54°N, at a 1/288° horizontal grid resolution.
- There are 40 vertical layers, delineated by a hybrid coordinate system (8 σ-levels, and 32 z-levels).
- An unstructured coastal forecasting system is currently being developed, based on the TELEMAC model, and is destined to replace the finest Coastal KOOS domain (L3) once operational. Its minimum horizontal grid size is <20 m, and it employs 20 vertical layers delineated via a hybrid coordinate system (Z-star and Z-plane).

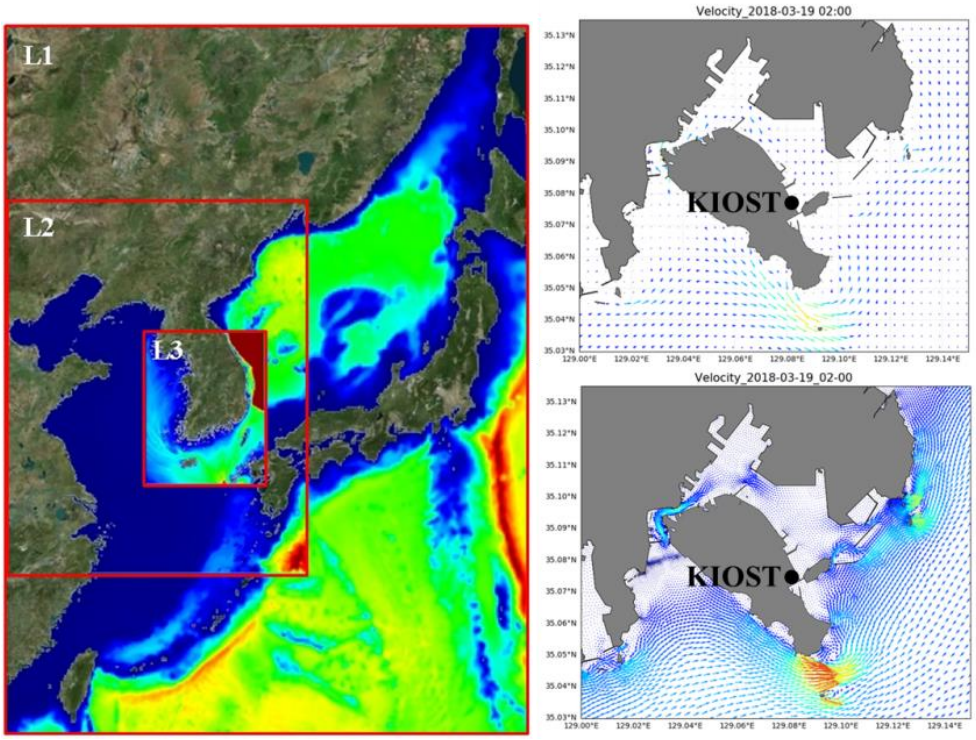

Figure 4. Coastal KOOS nested model domains (L2 and L3) and their bathymetry (left panel); and comparison of L3 surface current results in vicinity of KIOST's Busan campus produced using the MOHID model with its structured grid (upper right panel), and using TELEMAC and its unstructured grid (lower right panel).

4. Assimilation method

4.1. KHOA's KOOFS

- For the regional forecasting system (North Pacific), the 4DVAR scheme is used to assimilate satellite remote sensing of sea surface temperature (OSTIA), with a 7 day assimilation window.
- For the sub-regional forecasting systems (YES and East Sea), Ensemble Optimal Interpolation (EnOI) data assimilation methods are employed. This EnOI method has been developed and adapted by KHOA. The observation data use OSTIA satellite sea surface temperatures and GTSPP T/S profiles.

4.2. KIOST's KOOS

- The KIOST_OPEM operates an ocean data assimilation system which is based on the EnOI, and called DASK (the Data Assimilation System of KIOST) (Kim et al., 2015)*. This system also requires in-situ profile data and SST satellite data as inputs for data assimilation.
- The stationary ensemble members for DASK were constructed from a long-term historical run.
- The data assimilation for SST is performed once a day, while that for profiles is performed once a week. The time window is 7 days, and the decorrelation length scale is 150 km horizontally and 100 m vertically.

- KIOST has updated the DASK to assimilate the satellite-borne sea level anomaly. The DASK assimilates the pseudo profiles taken from the sea level anomaly by applying Cooper and Haines (1986)**. The sea level data assimilation of the DASK was not applied to the real-time forecast system yet but was applied to the reanalysis system.

*Y.H. Kim, C. Hwang, B.-J. Choi, 2015. An assessment of ocean climate reanalysis by the Data Assimilation System of KIOST from 1947 to 2012, Ocean Modeling, 91(1), 1-22.

**Cooper, M., Haines, K., 1996. Altimetric assimilation with water property conservation. J. Geophys. Res. 101 (C1), 1959–1977.

5. Systems (operational)

5.1. KHOA's KOOFS

- All KOOFS forecasting models are run every day, and produce 3-7 day long, hourly forecasting data for temperature, salinity, currents and sea-level heights. These data are uploaded through OPeNDAP.
- The regional model automatically performs 4DVAR data assimilation each Wednesday, while the two sub-regional models automatically carry out EnOI data assimilation every day.
- The East Sea sub-regional model (the parent model of the Ulleungdo-Dokdo sub-coastal model) performs its data assimilation using the ensemble Kalman filter.

- The number of ensembles comprises 30. Assimilation is conducted at weekly intervals, using SST and SSH satellite data, and GTSPP observation data collected by KHOA.

5.2. KIOST's KOOS

- The entire KIOST_OPEM system processes are carried out each Wednesday, including the collection of observation data, the generation of input data, and the automatic operation of both the data assimilation and prediction systems.
- Coastal KOOS is run every day, using automatically generated boundary input data derived from KIOST_OPEM, and produces 3-day long, hourly forecasting data.
- In addition, from the second half of 2020, all of the forecasting systems (e.g., weather, circulation, waves) have been generating 7-day test predictions. This involves the system generating hourly forecasting data every day, as in the previous system.

6. Link to observations (e.g. Argo, GHRSST, etc.)

6.1. KHOA's KOOFS

- This has not yet been fully planed, but KHOA is ready to provide the KOOFS results if requested.

6.2. KIOST's KOOS

- This has not yet been fully planned, but KIOST is ready to provide the KOOS results if requested.

7. Internal metrics and inter-comparison plans

7.1. KHOA's KOOFS

- KHOA has established the Korea Ocean Modelling Validation System (KOMVAS) to evaluate daily model prediction results since 2015. The prediciton data are compared with real time records observed from tidal observation stations, ocean buoys and HF-radars.

7.2.KIOST's KOOS

- This has not yet been fully planned, but KIOST is ready to provide the KOOS results if requested.

8. Targeted users and envisioned external metrics

8.1. KHOA's KOOFS

- KOOFS end users include fishermen, shipping agencies, ports and harbours, the Korean Navy and off-shore industries.

8.2. KIOST's KOOS

- KOOS product users include:
    - internal and external contributors who: (1) support observation activities by providing marine prediction information near the target area for temperature and current observations; and (2) provide OBC for other regional ocean models, or SBC for atmospheric models; and
    - intermediate and end users who: (1) support the marine information service by reworking the model data from the KOOS, and (2) use the basic output materials to support decision making processes when responding to and/or predicting potential marine disasters.

9. Reanalysis and Hindcasting activities

9.1. KHOA's KOOFS

- KHOA plans to produce a sub-regional ocean reanalysis (YES and East Sea) covering the years 1998 to 2017. Until 2018 KHOA has produced 3 year reanalysis from 2015 to 2017 through assimilating ocean observation data such as the sea surface height (SSH) anomaly, temperature and salinity profiles, and sea surface temperature (SST) using EnKF (Ensemble Kalman Filter).
- The reanalysis datasets are available form KOHA homepage

  (http://www.khoa.go.kr/koofs/kor/seawf/sea_wfreanal.do?menuNo=03&link=).

9.2. KIOST's KOOS

- The KIOST_OPEM system has generated ocean reanalysis data once a week since January 2015. Additionally KIOST plans to produce a long-term reanalysis data set covering the years 1993 to 2018 until early 2019, using the advanced data assimilation method.
- Reanalysis data are being produced using Coastal KOOS (in the L2 and L3 domains). The data are produced for each new year, with 15 years of reanalysis data available thus far.

10. Computing resources

10.1. KHOA's KOOFS

- Currently, the KOOFS systems are run on a Linux network of workstations with 87 *Intel* processor nodes, capable of 156 TFLOPS.
- The KOOFS systems run time is about 14 hours total.
- KOOFS system's required storage is about 110 GB per complete process cycle.

10.2. KIOST's KOOS

KOOS_OPEM

- The KOOS_OPEM internal computing resources comprise 34 *Intel* processor nodes, capable of 2.19 TFLOPS.
- The KOOS_OPEM run time is about 18 hours total, including a 12 hour DA run; 4 hour prediction run; and 2 hours of pre/post-processing.
- KOOS_OPEM's required storage is about 140 GB per complete process cycle.

Coastal KOOS

- The Coastal KOOS internal computing resources comprise 60 *Intel* processor nodes, capable of 70 TFLOPS.
- The Coastal KOOS running time is about 8 hours, including for the middle (L2) and fine (L3) domain runs.
- Coastal KOOS requires about 30 GB data storage per complete process cycle.

11. Consolidation phase and transition to operational systems (activities)

11.1. KHOA's KOOFS

- Every year KHOA works to improve the prediction accuracy of KOOFS through both model and data assimilation method improvements.

11.2. KIOST's KOOS

- Improved systems for assimilating the satellite-borne sea level data have been developed, and the prediction system that will apply this improved system is currently under construction.
- In the near future, the OBC for the KIOST_OPEM will be replaced by an in-house global prediction model (Global OPEM) under developing, based on the GFDL-MOM6 with 1/12°.

12. GODAE OceanPredict related achievements and measures of success

- Scientific delegates from KHOA and KIOST have participated in GODAE OceanPredict task team activities as members of COSS-TT, DA-TT and IV-TT.
- We believe that collaborating with GODAE OceanPredict is helpful for understanding the latest ocean research trends and for acquiring new ocean research skills. As such, this collaboration is foundational to the establishment of the KOOFS and the OPEM system.

System Information overview

System name	KOOFS (North Pacific)
Ocean Models	
OGCM	ROMS
Domain	North Pacific (NPACIFIC)
Horizontal resolution	0.25°
Vertical sampling	30 σ-levels
Atmospheric Forcing	NCEP GFS (NOAA)
Assimilation characteristics	
Assimilation Scheme	4DVAR
SST	OSTIA
SSH	
Other	
System Set-ups	
Forecast range	7 days
Update frequency	12-hourly
Hindcast length	
System website links	
General information	
Technical description	
Viewing service	

System name	KOOFS (YES)
Ocean Models	
OGCM	ROMS
Domain	The Yellow and East China Seas
Horizontal resolution	3 km
Vertical sampling	41 σ-levels
Atmospheric Forcing	hourly surface fluxes from WRF
Assimilation characteristics	
Assimilation Scheme	EnOI
SST	OSTIA, GTSPP
SSH	
Other	
System Set-ups	
Forecast range	7 days
Update frequency	12-hourly
Hindcast length	
System website links	
General information	
Technical description	
Viewing service	

System name	KOOFS (East Sea)
Ocean Models	
OGCM	ROMS
Domain	East Sea
Horizontal resolution	3 km
Vertical sampling	41 σ-levels
Atmospheric Forcing	hourly surface fluxes from WRF
Assimilation characteristics	
Assimilation Scheme	EnOI
SST	OSTIA, GTSPP
SSH	
Other	
System Set-ups	
Forecast range	7 days
Update frequency	Daily
Hindcast length	
System website links	
General information	
Technical description	
Viewing service	

System name	KOOFS (Korea Strait)
Ocean Models	
OGCM	ROMS
Domain	Korea Strait
Horizontal resolution	1.5 km
Vertical sampling	20 σ-levels
Atmospheric Forcing	hourly surface fluxes from WRF
Assimilation characteristics	
Assimilation Scheme	
SST	
SSH	
Other	
System Set-ups	
Forecast range	3 days
Update frequency	Daily
Hindcast length	
System website links	
General information	
Technical description	
Viewing service	

System name	KOOFS (West Coastal Zone Model)
Ocean Models	
OGCM	ROMS
Domain	West Coastal Zone of Korea
Horizontal resolution	1 km
Vertical sampling	30 σ-levels
Atmospheric Forcing	hourly surface fluxes from WRF
Assimilation characteristics	
Assimilation Scheme	
SST	
SSH	
Other	
System Set-ups	
Forecast range	3 days
Update frequency	Daily
Hindcast length	
System website links	
General information	
Technical description	
Viewing service	

System name	KOOFS (Southwest Coastal Zone Model)
Ocean Models	
OGCM	ROMS
Domain	Southwest coastal zone of Korea
Horizontal resolution	1 km
Vertical sampling	30 σ-levels
Atmospheric Forcing	hourly surface fluxes from WRF
Assimilation characteristics	
Assimilation Scheme	
SST	
SSH	
Other	
System Set-ups	
Forecast range	3 days
Update frequency	Daily
Hindcast length	
System website links	
General information	
Technical description	
Viewing service	

System name	KOOFS (Ulleungdo Coastal Model)
Ocean Models	
OGCM	ROMS
Domain	Ulleungdo of Korea
Horizontal resolution	1 km
Vertical sampling	41 σ-levels
Atmospheric Forcing	hourly surface fluxes from WRF
Assimilation characteristics	
Assimilation Scheme	
SST	
SSH	
Other	
System Set-ups	
Forecast range	3 days
Update frequency	Daily
Hindcast length	
System website links	
General information	
Technical description	
Viewing service	

System name	KOOFS (Ulleungdo-Dokdo sub-coastal model)
Ocean Models	
OGCM	ROMS
Domain	Ulleungdo & Dokdo of Korea
Horizontal resolution	0.3 km
Vertical sampling	41 σ-levels
Atmospheric Forcing	hourly surface fluxes from WRF
Assimilation characteristics	
Assimilation Scheme	
SST	
SSH	
Other	
System Set-ups	
Forecast range	3 days
Update frequency	Daily
Hindcast length	
System website links	
General information	
Technical description	
Viewing service	

System name	KOOS_OPEM
Ocean Models	
OGCM	GFDL-MOM5
Domain	Northwest Pacific
Horizontal resolution	1/24°
Vertical sampling	51 layers (z-star coordinate)
Atmospheric Forcing	6-hourly surface fluxes from ECMWF ERA INTERIM data (201501-201702) / KMA GDAPS (201703-)
Assimilation characteristics	
Assimilation Scheme	DASK (Kim et al., 2014) (based on the EnOI)
SST	NOAA OISST V2 data (201501-201712), and GHRSST Level4 OSTIA Global Foundation SST Analysis data (201801-)
SSH	AVISO-SLA global data
Other	In-situ profile from the Argo (201501-), KODC (201501-201604, temperature only) and GTSPP real-time data (201703-)
System Set-ups	
Forecast range	10 days
Update frequency	Weekly (once a week, in Wednesday since March 1st , 2017)
Hindcast length	1 day
System website links	
General information	
Technical description	
Viewing service	

System name	Coastal KOOS
Ocean Models	
OGCM	MOHID
Domain	Seas adjacent to the Korean Peninsula (L2 and L3)
Horizontal resolution	1/48° (L2) and 1/288° (L3)
Vertical sampling	40 layers (8 σ-levels and 32 z-levels)
Atmospheric Forcing	hourly surface fluxes from the WRF (Weather Research and Forecasting) model, with 3D-VAR cycling
Assimilation characteristics	
Assimilation Scheme	
SST	
SSH	
Other	
System Set-ups	
Forecast range	3 days
Update frequency	daily
Hindcast length	15 years
System website links	
General information	
Technical description	
Viewing service	Only available to contributors