Operational Coastal Modeling System using ROMS

2014 ROMS User Workshop

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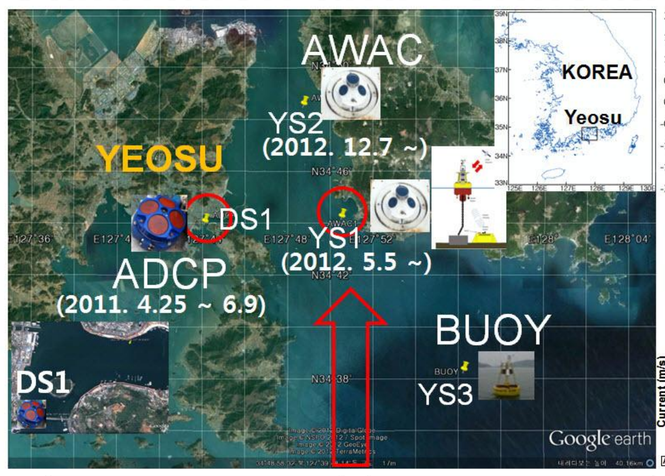
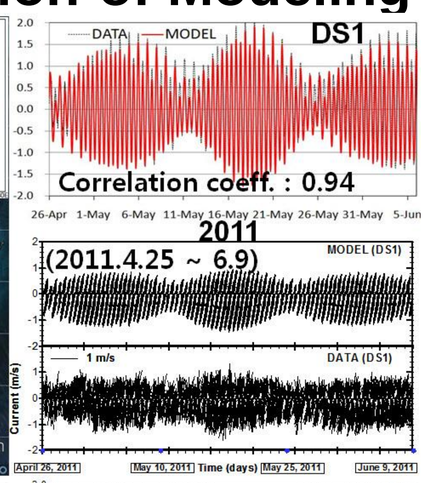
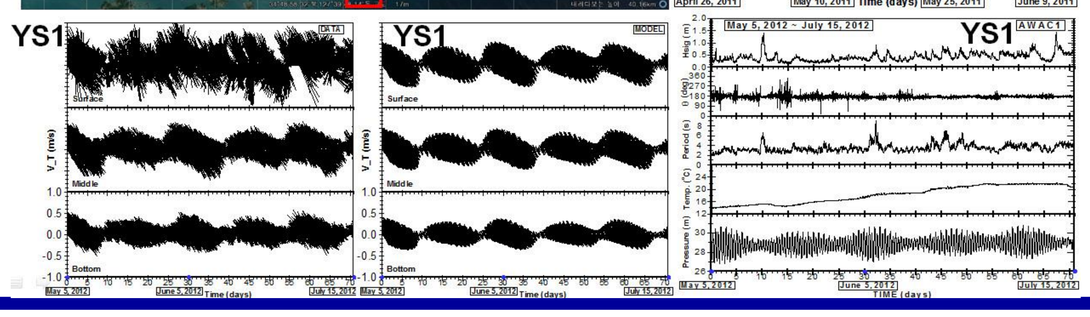
Abstract

We have developed a down-scaled high-resolution operational coastal modeling system for the coastal waters of Korea to support the major ports of Korea. For the operation of this system, we use a high-resolution coastal modeling system with 300 m grid size, for the western ports of Incheon and Gunsan, and southern ports of Yeosu, Masan, Busan, and Ulsan. The modeling system consists of operational coastal modeling and web-GIS modules. The modeling system uses a Regional Ocean Modeling System (ROMS), which is coupled with wave model SWAN using Model Coupling Toolkit (MCT), to exchange data fields between the ocean model ROMS and wave model SWAN. The wave-current coupled model ROMS-SWAN is internally nested with the Community Sediment Transport Modeling System (CSTMS), and is externally nested with the water quality model CE-QUAL-ICM. For the surface forcing, we use predicted results derived from an operational atmospheric model WRF, which has been operated for the East China Sea and East Sea. The open boundary condition of the coupled model ROMS-SWAN is nested with predicted results from an operational model coupled ROMS and SWAN, which is in operation for the East China Sea. For the tides at the open boundary of ROMS, we use 8 major tidal constituents with semi-diurnal tidal constituents (M2, S2, N2, K2) and diurnal tidal constituents (K1, O1, P1, O1) derived from the regional ocean tide model NAO.99jb with 5′ resolution. The system predicts hydrodynamic variables twice a day on a 72-hour basis, including sea surface elevation, currents, temperature, salinity, storm surge height, sediment transport and wave information, for the coastal waters of major ports in Korea. The hydrodynamic variables were calibrated with tidal surface elevation, and verified with current data observed by a bottom-mounted AWAC. To validate the predicted results, we use real-time monitoring data transferred from a buoy system with specially designed bottom-mounted AWAC, 1-h averaged surface currents measured by HF-Radar system, and suspended sediment concentration (SSC) and ocean current vector (OCV) obtained hourly, and derived from the Geostationary Ocean Color Imager (GOCI), the world's first geostationary ocean color satellite. The system will provide monitoring and predicted data to government port agencies and to the public, to support ship navigation and marine activity, and also to solve problems associated with coastal accidents, such as storm surge, inundation, wave-setup, oil-spills, and search and rescue, as part of the Korea Operational Oceanographic System (KOOS).

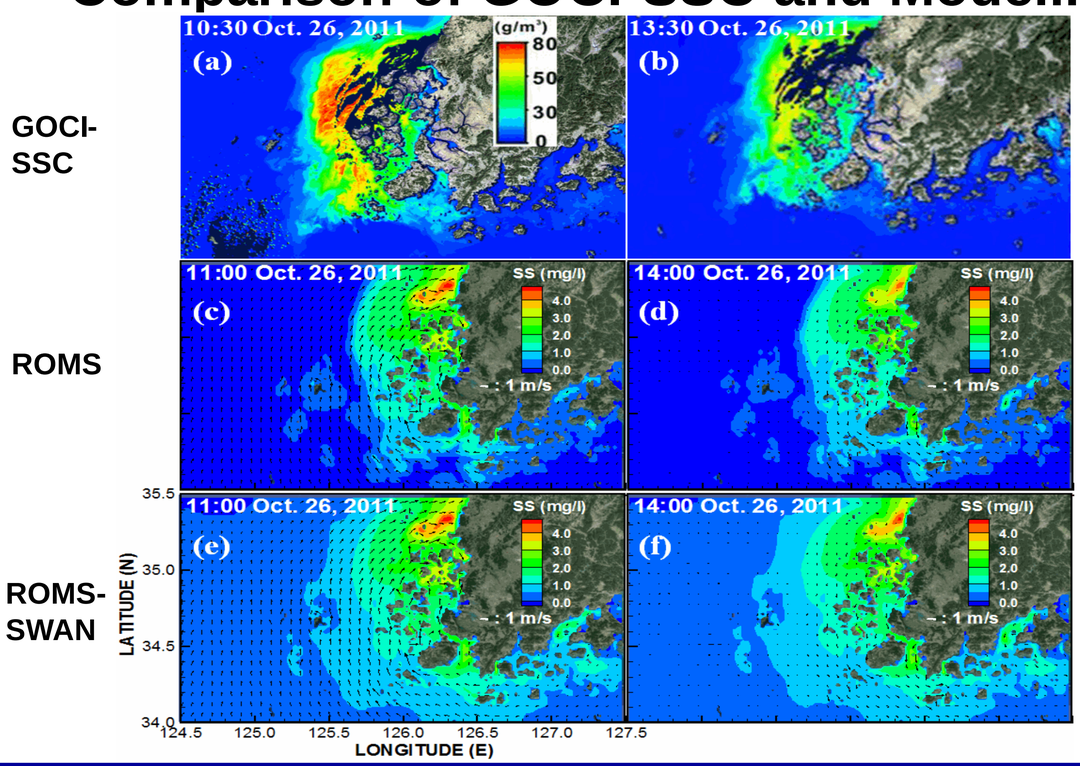
Calibration and Verification of Modeling



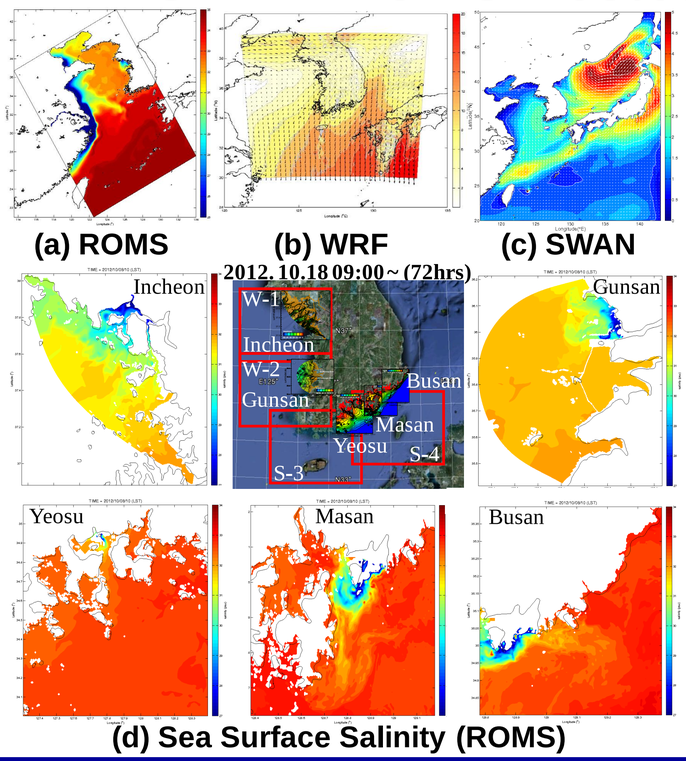




Comparison of GOCI-SSC and Modeling

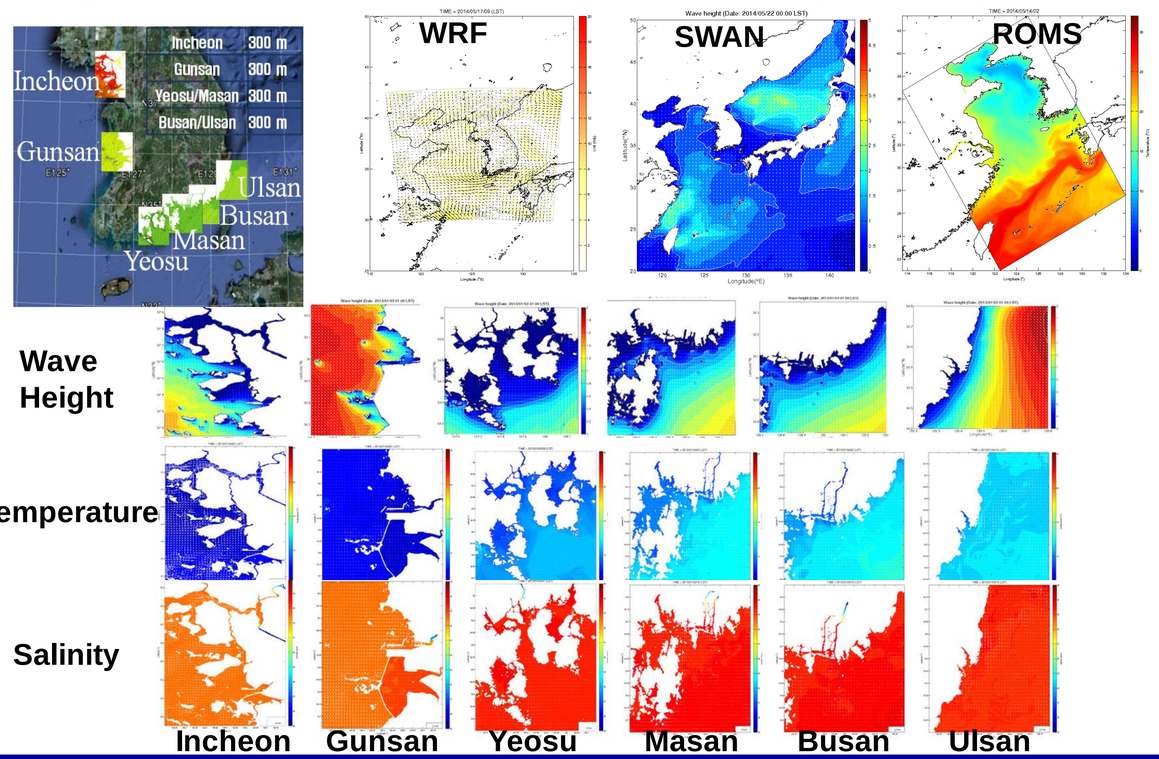


WRF-SWAN-ROMS Nested Modeling System

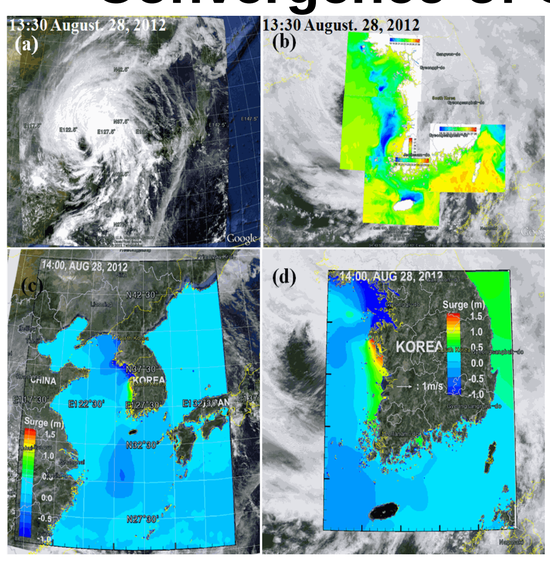


(a) Sea surface salinity,
(b) surface wind, and
(c) wave height simulated by operational model ROMS, WRF, and SWAN. (d) High-resolution sea surface salinity was predicted by the operational coastal modeling system, which is nested with ROMS, WRF and SWAN predicted results for ocean boundary condition, atmospheric surface forcing, and wave boundary condition.

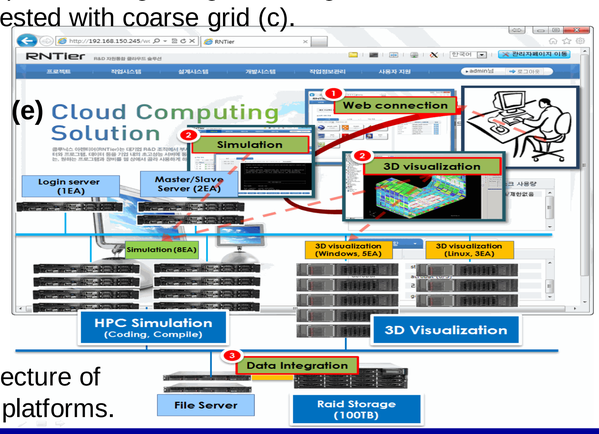
Integrated MAritime Prediction System(I-MAPS)



Convergence of GOCI and Model Data



(a) Map of the Typhoon Bolaven (2012) derived from GOCI image at 13:30 on August 28, 2012 (local time).
(b) Convergence of GOCI image of Typhoon Bolaven and model SST predicted by operational coastal modeling system when the Typhoon Bolaven approached at the west coast of Korea.
(c) Convergence of GOCI Bolaven cloud and storm surge height predicted by operational model ROMS for (c) the Yellow Sea and East Sea at 14:00 on August 28, 2012.
(d) Storm surge height with high-resolution coastal model nested with coarse grid (c).



(e) Schematic diagram of the core architecture of a cloud computing system for multiple platforms.

Conclusions

We have demonstrated forecasting performance of a high-resolution coastal modeling system, comparing with real-time monitoring data for the coastal waters of Korea especially for the major port, Yeosu. This operational coastal modeling system has been originally developed for the prediction system of coastal waters of Korea and used for the development of the Integrated-MAritime Prediction System (I-MAPS) supporting the operation of the major ports of Korea. The system uses a wave-current coupled model that is coupled with hydrodynamics, wave, sediment transport, and water quality modules. The high-resolution modeling system with a less than 300m grid size uses wave-current coupled model ROMS-SWAN that is nested with a coarse-grid operational ROMS, SWAN, and WRF for the East China Sea and a part of East Sea. The hydrodynamic variables, including sea surface elevation, currents, temperature, salinity, and waves are predicted twice a day on a 72-hour basis. To validate the operational model, we use real-time monitoring data, such as hydrodynamic observation by remote buoy, 1-hour-averaged surface currents observed by HF-radar system, SSC derived from GOCI satellite images. The hourly acquired GOCI-derived SSC data are also used for validation of the sediment transport model. The implemented wave-current interaction using ROMS-SWAN is found to effectively increase tidal modulation and sediment transport in the shallow waters. In summary, the predicted high-resolution wave and hydrodynamic results in a 72-hour base with real-time monitoring data are provided to government agencies and to the public to support maritime activities and ship navigation related to the operation of the major ports, and also solve pending problems associated with coastal disasters.

Acknowledgement

This research was supported by the project entitled "Development of Korea Operational Oceanographic System (KOOS II)" funded by the Ministry of Oceans and Fisheries, Korea as well as the project entitled "Functional improvement of the Korea Ocean Satellite Center" funded by the Korea Institute of Ocean Science & Technology (KIOST).