An improvement of model performance in according high resolution in the coastal area

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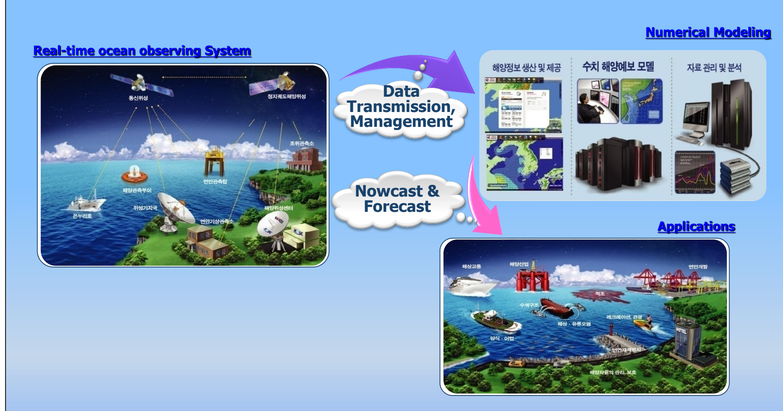
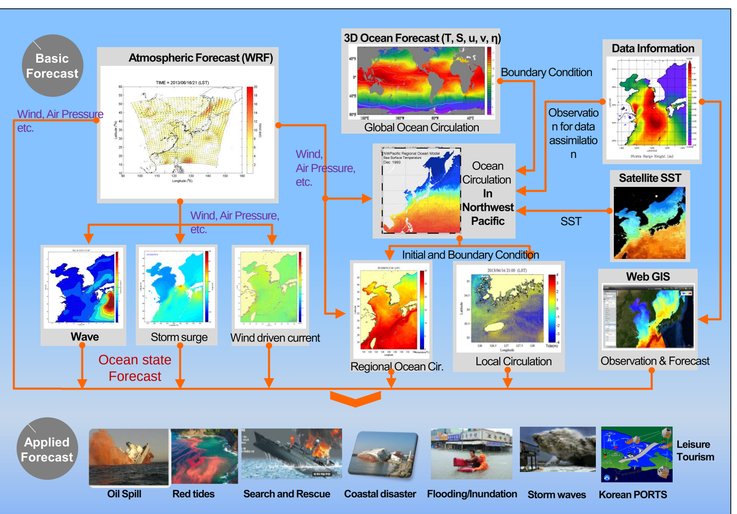
Abstract

The current systems in the south coast of Korea are complex and relatively strong due to combination of geological features and tidal effects. Even though it is not a very wide area, the flow patterns of eastern side and the western side are quite different. In the west part of the south coast of Korea where has strong tidal currents, the current speed of which is more than 3 m/s during spring tides, on the other hand, the southeast coast has relatively weak tidal current but Tsushima Current, a branch of the Kuroshio and flowing northeastward, affects constantly. So, it is very difficult to predict the currents in the south coast of Korea. Korea Institute of Ocean Science and Technology (KIOST) has been conducting the KOOS (Korea Operational Oceanographic System) project since 2009, including a three-dimensional circulation prediction system that calculates tidal and oceanic effects around the Korean peninsula. This project has consistently studied the improvement of coastal model accuracy, and has considered the criteria resolution for the prediction system. For the precise model predictions, the high-resolution grid would be better if other conditions are the same. However, the higher grids require more computational resources and time. An appropriate grid size is therefore needed to allow for both accuracy and efficiency.

Introduction

1) KOOS (Korea Operational Oceanographic System)





◆ Korea Institute of Ocean Science and Technology (KIOST) has been conducting the KOOS (Korea Operational Oceanographic System) project since 2009, including a three-dimensional circulation prediction system that calculates tidal and oceanic effects around the Korean peninsula.

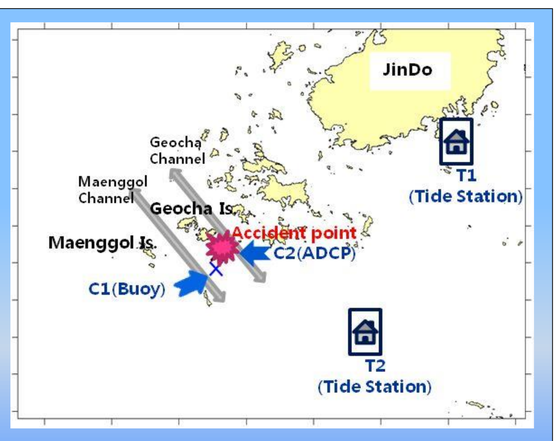
2) Sewol accident and Maenggol Channel

At 8:48 am on April 16, 2014 sunk in the Maenggol Channel near Jindo island, South Korea. This area has strong and unpredictable currents with maximum current speed is 3.49 m/s and the water depth is about 45 m.

Methods

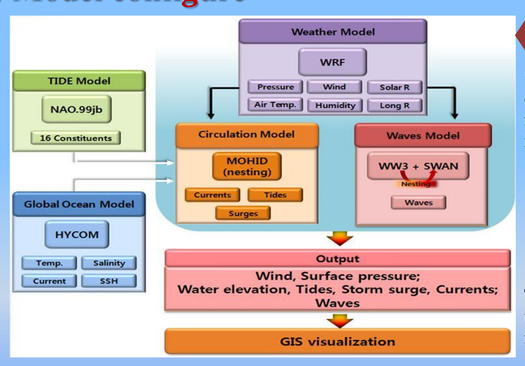
1) Observation

The water elevation and current data by KIOST, KMA1), and KHOA2) are used for observation current patterns in the accident region and validation the model. Right figure show the study area and observation points. The red star marks the accident point and station C2, the blue 'x' indicates station C1, house markers indicate tidal stations, and gray arrows are the two channels in this area

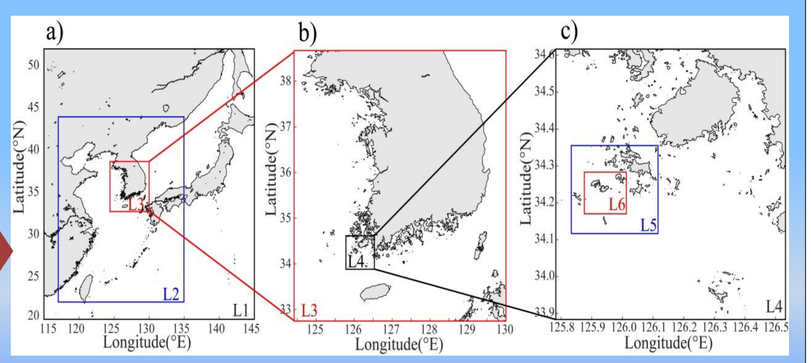


1) Korea Meteorological Administration/ 2) Korea Hydrographic and Oceanographic Administration

2) Model configure



Schematic of the coastal ocean forecasting system in KOOS

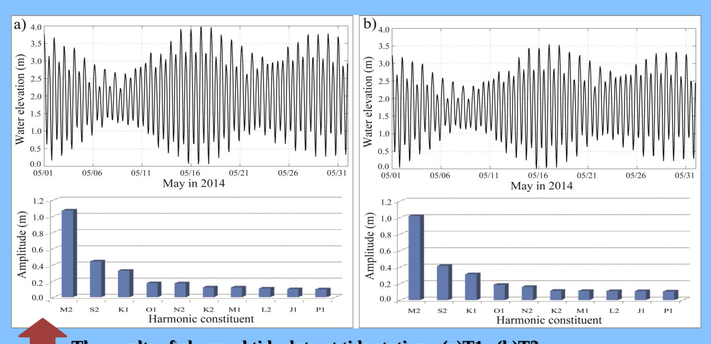


The grid system of the coastal ocean forecasting system

The high-resolution 72 hours ocean forecasting system is operated twice a day up. In this study, the computation was employed using minimum grid size of 1/1620 ° (66 m) through six steps nesting system, because resolution may have an important role in simulating tidal currents in the study area.

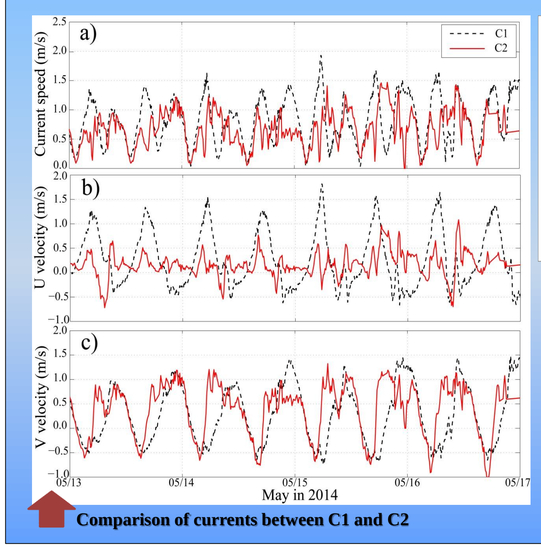
Results

1) Observation results

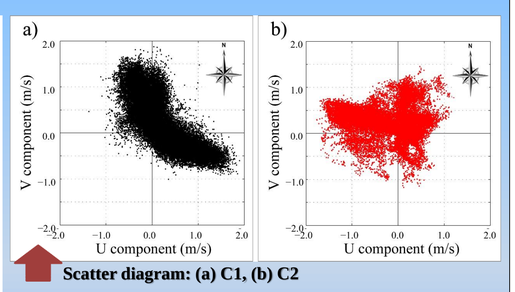


The results of observed tide data at tide stations (a)T1 , (b)T2

The maximum tidal range at T1 and T2 is about 3.5-4.0 m, and strong semi-diurnal tidal effects are evident at these points. By analyzing the harmonic constant of the tide, the summation of the amplitudes of the four major tidal components approximately 2.0 m.



Comparison of currents between C1 and C2

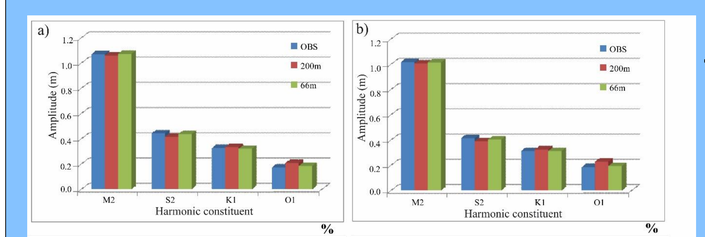


Scatter diagram: (a) C1, (b) C2

The currents include tidal currents, oceanic currents, and wind-driven currents. The maximum current speeds were 2.0 m/s and 1.5 m/s, respectively, with the tide turning approximately four times per day. The distance between the two stations is within 2 km, but current patterns vary significantly.

2) Model results

The model results for amplitude showed accuracy of 95% at both T1 and T2. And in current field results, the currents are almost similar during the flood tide, but during the ebb tide vorticity appears near station C2.



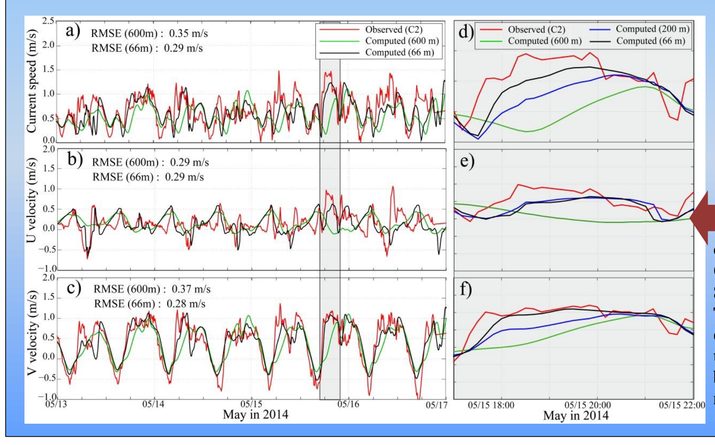
Const.	M2	S2	K1	O1
200m	98.9	94.0	102.3	110.3
60m	100.0	98.9	98.1	106.5
Dif.	-1.1	-4.9	4.2	3.8

%

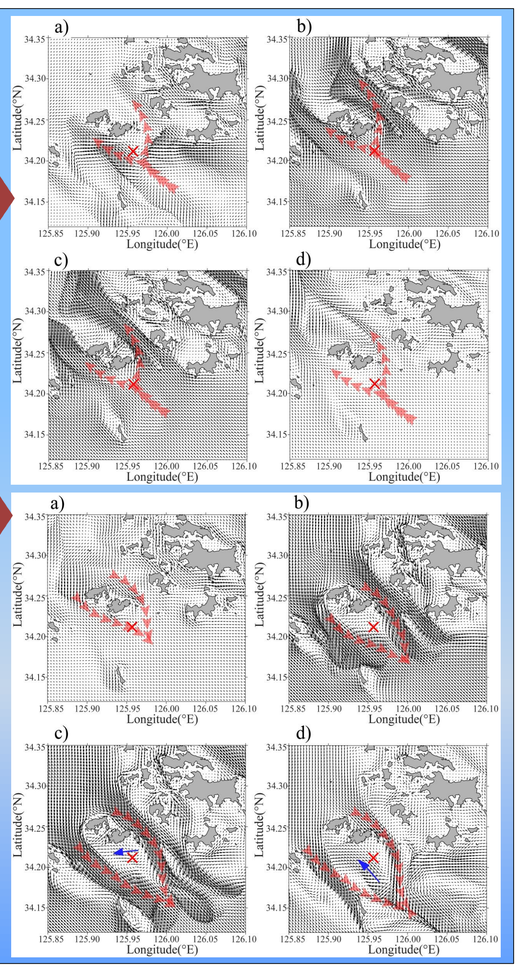
Const.	M2	S2	K1	O1
200m	98.9	94.2	103.7	113.0
60m	99.7	97.5	99.8	104.4
Dif.	-0.8	-3.3	3.9	8.6

%

Harmonic analysis results according to grid size of (a) T1, (b) T2



Comparison of observed current and predictions at C2 : (a) S, (b) U, (c) V, (d) S, (e) U, and (f) V . The red line : observed data, the green line : 600 m, the blue line : 200 m, the black line : 66 m grid size model result



The snapshots at flood tide :
(a) at the beginning,
(b) two hours after commencement
(c) three hours after commencement
(d) five hours after commencement

The snapshots at ebb tide :
(a) at the beginning,
(b) two hours after commencement
(c) three hours after commencement
(d) five hours after commencement

Discussion

For accurate prediction of conditions in the open ocean or on the coast, high-resolution numerical model computations, based on precise input data (including water depth) and using the latest schemes, are needed. In this study, we studied current patterns according to model grid sizes. As expected, study results indicated very good agreement with observed data when using the model with a higher-resolution grid. Good results were obtained when using a grid size of at least 100 m that considers the shape of the channel, the magnitude of current speed, the size of islands, and other such factors. But many vertical layers are not needed, because the difference in current speed between layers was not significant in the region.

Acknowledgements

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GODAE OceanView

5th GODAE OceanView Coastal Ocean and Shelf Seas Task Team (COSS-TT)
International Coordination Meeting (COSS-ICM5)