

Development of a high-resolution Japanese coastal ocean model toward operational monitoring and forecasting



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1 Introduction

Japan Meteorological Agency (JMA) plans to launch a next-generation operational monitoring and forecasting system of the coastal seas. We have been developing a Japanese coastal ocean model for its platform.

Fig.1 Model region and topography.

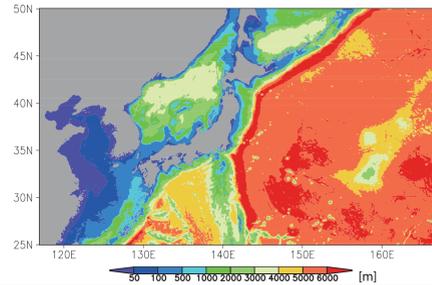
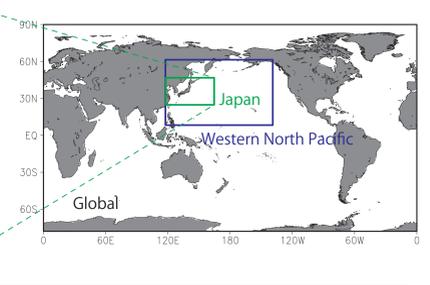


Fig.2 Nesting regions.



2 Model and experiment

2.1 Model

The model is a general circulation model designed to represent coastal processes.

Numerical model:

Meteorological Research Institute Community Ocean Model (MRI.COM)

- the primitive equations
- free-surface z-sigma hybrid coordinate
- hydrostatic and Boussinesq approximations

Region: 117E-167E, 25N-50N (Fig.1)

Horizontal resolution: 1/33 x 1/50 (~2 km)

five times finer than the current JMA ocean model

Vertical resolution: 4-600m (50 levels)

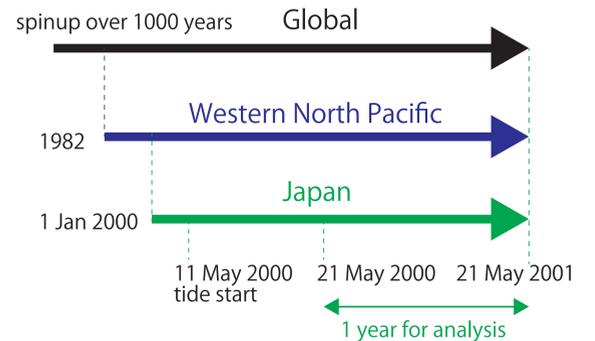
Downscaling: two-stage two-way online nesting

Global - Western North Pacific - Japan (Fig.2)

Schemes:

- New tide scheme (main 8 constituents)
- Generic Length Scale vertical mixing (suited for bottom boundary mixing)
- Smagorinsky-like biharmonic viscosity
- Category ice model

2.2 Test experiment



Surface forcing: Interannual CORE2 dataset (with river discharge)

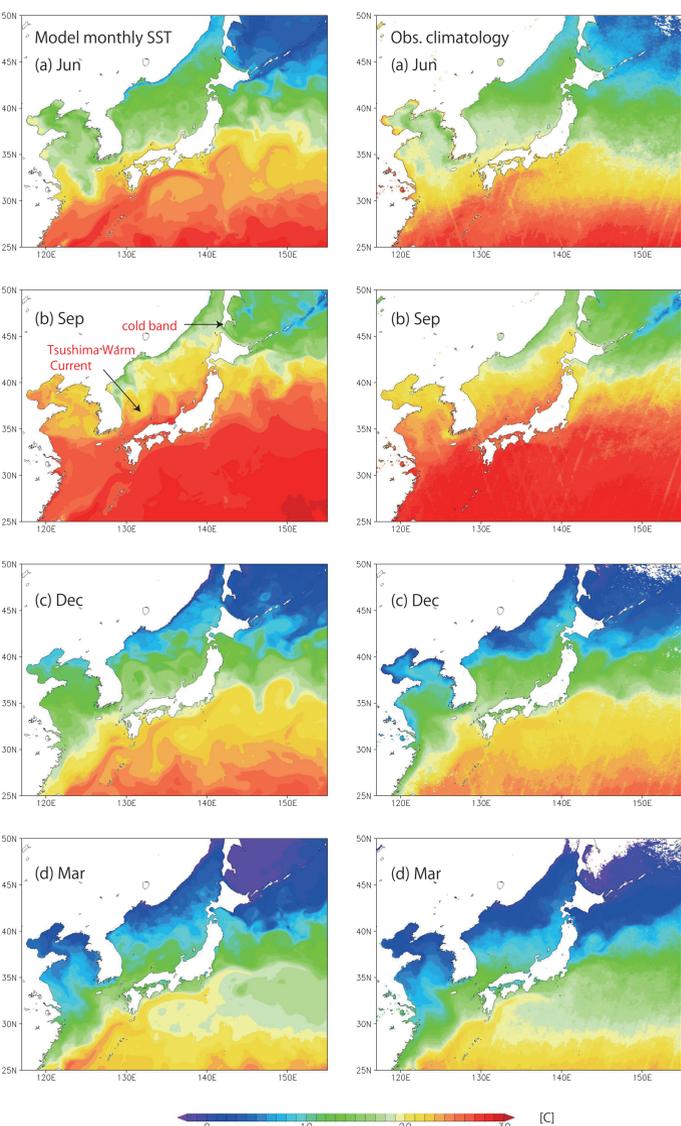
3 Results

3.1 Overview of seasonal variation

Seasonal evolution of the sea surface temperature (SST) distribution was reproduced fairly in a realistic fashion (Figs. 3 and 4).

Fig.3 Monthly mean SST in (a) June, (b) September, (c) December and (d) March.

Fig.4 Same as Fig.3 but for observational climatology, based on the MODIS satellite dataset of 3 years (2009-2011). (courtesy of JAXA)



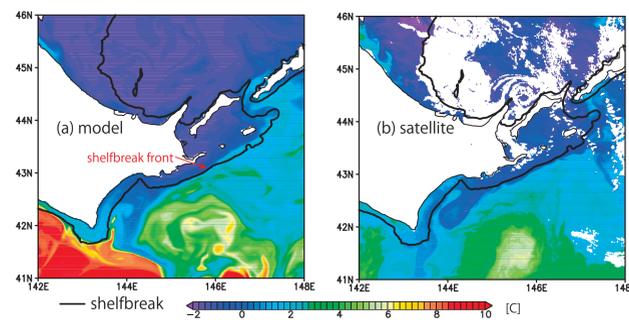
3.2 Snapshots of coastal areas

Coastal phenomena with a scale of 10 km appeared realistically in the model.

Doto area in winter:

A sharp shelfbreak front between the Coastal Oyashio Water originated in the Okhotsk Sea ($T < 1$ C) and the Oyashio Water offshore ($T > 1$ C).

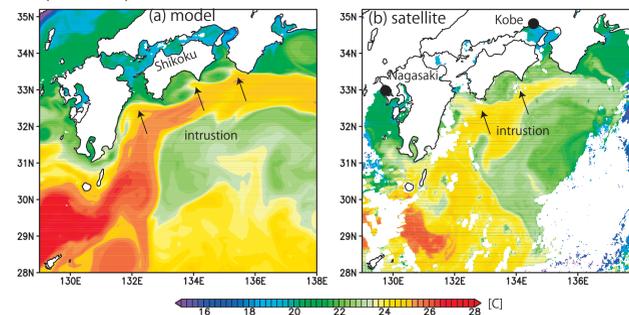
Fig.5 Winter SST in the Doto area of (a) the model (11 Mar 2000) and (b) a MODIS satellite snapshot (22 Feb 2011). The black lines indicate shelfbreak (150-m isobath).



South of Shikoku in summer:

Intrusion of the warm Kuroshio water into coastal seas in the shape of eddies (so called *Kyūcho*).

Fig.6 Summer SST south of Shikoku of (a) the model (11 Jun 2000) and (b) MODIS (6 Jun 2009).



3.3 Coastal sea surface heights

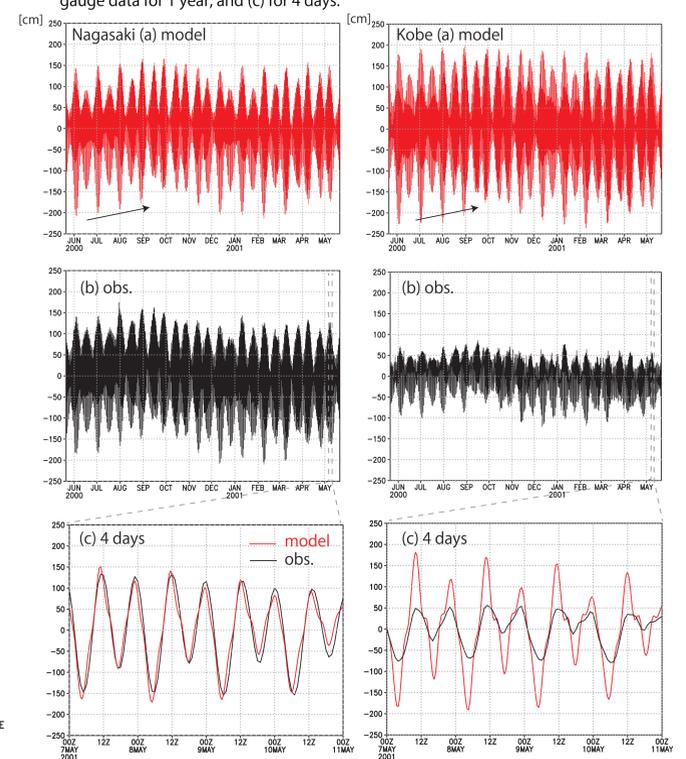
Tides were introduced explicitly into the model, using our own tide scheme (paper in preparation).

At many locations, sea surface heights agreed well with coastal tide gauge data (Fig. 7) as for tidal phase and amplitude, spring and neap tides, and seasonal change (increase in September).

But, reproducibility tended to decrease in inland seas (Fig. 8).

Fig.7 SSH variation at the station Nagasaki in (a) the model and (b) the tide gauge data for 1 year, and (c) for 4 days.

Fig.8 Same as Fig. 7 but for the station Kobe.



4 Conclusions

A 1-year experiment using our developing model simulated the Japanese coastal seas realistically to some extent such as

- overview of SST seasonal variation
- some coastal processes with a scale of 10 km
- tidal heights

Future issues

- validation of various coastal processes
- development of data assimilation system

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Our model site (in Japanese):

http://researchmap.jp/keisakamoto/MRICOM_jpn/