Impact of a coastline-shape on sea-level distribution and change along the coast of Japan: A regional ocean model study

Zhaojun Liu, Shoshiro Minobe, Yoshi N. Sasaki

Graduate School of Science, Hokkaido University

1. Introduction

Sea-level rise is one of the most important oceanographic aspects of the global warming. In the recent IPCC-AR5 the upper-end estimate of global sea-level rise is 0.98 m at the end of the 21st century in the RCP8.5 scenario. However, sea-level rise will not be spatially uniform. The western North Pacific to the east of Japan is one of the regions where sea-level rise is predicted to be larger than the global mean in CMIP5 models.

The CMIP5 models, however, have coarse spatial resolution and inaccurate Japanese coastline, including artificially closed straits, and thus coastal sea-level distribution and its future change are likely to be inaccurate due to the wrong coastline.

In this study we conducted a series of numerical experiments in the western North Pacific using the Regional Ocean Modelling System (ROMS) aiming to examine the impact of a coastline-shape on sea-level distribution and change along the coast of Japan.

2. Model Setups and Methods

The model domain covers the North Pacific basin with a horizontal resolution of 1˚ and 30 vertical levels. At the surface, ROMS is forced by NCEP/NCAR winds, shortwave and longwave radiation, air temperature, air pressure, specific humidity and precipitation fields. Surface wind stress and net heat flux are computed using a bulk flux parameterization. The initial and boundary condition are determined by WOA2005. Fig.1 shows 3 model runs conducted in this study and the open/close condition of 3 main straits around Japan in each run. Because the Tsushima strait is opened in most of CMIP5 models, both 3 model runs opened the Tsushima strait. The model runs are performed in the period of 1970-2012, and last 20-years are analyzed.

3. Results

Closing the Soya or Tsugaru strait lowers the sea-level (about 0.15-0.1 m, as shown in Fig.2) from the south to east of Japan compared to when all straits are open. The sea-level along east coast of Japan is particularly affected by the Tsugaru strait. Fig. 3 show that closing any Soya and Tsugaru strait make the Kuroshio Extension southward shift, and the shift degree is larger in the case of close Tsugaru.

Low sea-level in the subpolar gyre affects the east coast of Japan through the coastally trapped waves, when any strait is closed. The climate models in which the strait is closed may underestimate the sea-level in east of Japan compared with the models in which the strait is all open. As one of the world's most densely populated coastal areas, high representative of sea-level change for western North Pacific are essential. Hence, dynamical downscaling of future sea-level change in the western North Pacific is necessary.

Table 1. List for model runs.

Experiment	Strait		
	Tsushima	Tsugaru	Soya
Open all	open	open	open
Close Tsugaru	open	**close**	open
Close Soya	open	open	**close**

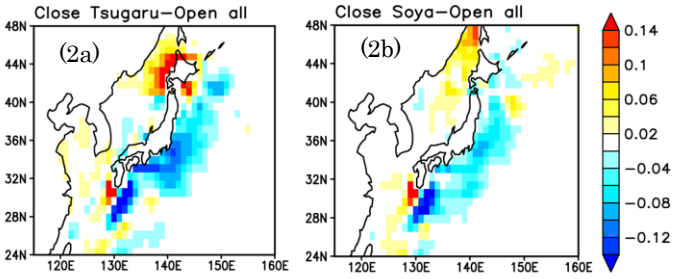

Fig. 2a, 2b: The sea-level anomaly differences between Close Tsugaru and Open all, Close Soya and Open all respectively.

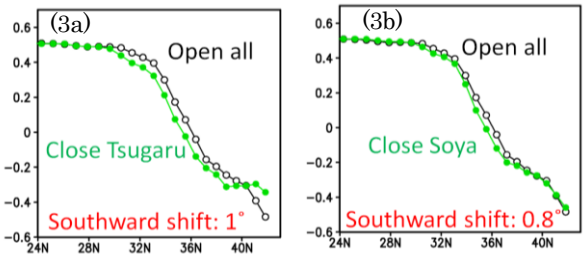

Fig. 3: Mean SSH (m) along 143 E for the case of Open all, Close Tsugaru (3a) and Close Soya (3b).