Title

Dilution characteristics of riverine input contaminants in the Seto Inland Sea

Members' names and affiliations

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Aim

This project aims to carry out cooperative research with Prof. Guo Xinyu of Ehime University on the dilution characteristics of riverine contaminants in the Seto Inland Sea (SIS) and their controlling factors. At the same time, I am trying to establish a physical-biological coupled model in the SIS.

Procedure

I showed the recent studies about "Dilution characteristics of riverine input contaminants in the Seto Inland Sea", Then I tried to construct a three-dimensional low trophic-level ecosystem model in the Seto Inland Sea, and helped a student to study how to establish ecological models and analysis model results. During the period, I discussed the problems encountered in research and further research plan.

Results

(1) Dilution characteristics of riverine input contaminants in the Seto Inland Sea

Based on a hydrodynamic model (Model domain was shown in Fig. 1) which can well reproduce the seasonal variations in temperature and salinity of SIS. We first explored the spatial and temporal variations of concentrations of conservative contaminant and non-conservative contaminants (using antibiotics as an example), and then investigated the mechanisms controlling contaminant concentration in the SIS.

For conservative contaminant, when riverine input contaminant concentration was 100, the annual mean of C_v in the entire SIS was 1.64, showing a high value of 2.03 in July and a low value of 1.39 in January (Fig. 2a). The annual mean of C_a was 4.03, which was more than twice the annual mean of C_v. For C_v, the high value occurred in Harima-

Nada, Osaka Bay, and the Bisan Strait with an annual mean of 4.58, 3.87, and 3.84, respectively (Fig. 2b). The annual mean of C_v were 2.18, 1.97, and 1.86 in Hiuchi-Nada, Suo-Nada, and Hiroshima Bay (Fig. 2b), respectively. Low value of C_v was found in the Kii Channel, Iyo-Nada, and the Bungo Channel with an annual mean value of 1.57, 1.11, and 0.42, respectively (Fig. 2b).

Conservative contaminant exhibited a vertically mixed pattern with low concentration in winter and a vertically varying pattern with high concentration in summer (Fig. 3). Non-conservative contaminant showed a similar spatial distribution with the conservative contaminant. As the half-life period of non-conservative contaminant decreased, the contaminant concentration decreased following power functions. These were useful information for environmental management to set standards for contaminants to protect the health of the aquatic ecosystem of the SIS.

The roles played by surface wind velocity, air-sea heat flux and river discharge were confirmed with a series of numerical experiments (Fig. 4). The seasonal cycle of air-sea heat flux was responsible for seasonal variations of contaminant concentrations in the whole water column by influencing horizontal current and vertical stratification. The surface wind velocity, which induced sea surface current, played a vital role affecting surface contaminant concentration.

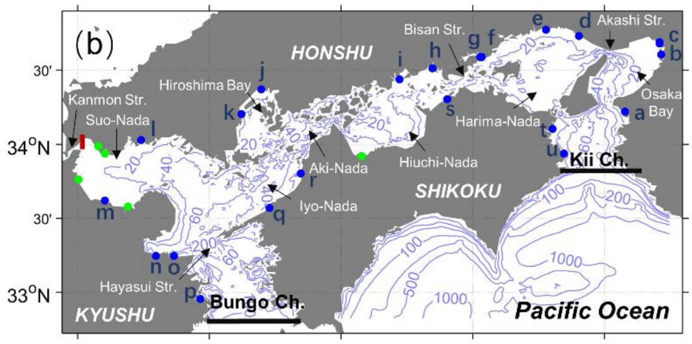

Fig. 1. Bathymetry (m) of the SIS and model domain. The solid black lines in (b) indicate the Bungo Channel and Kii Channel, which are the southern boundaries of the hydrodynamic model. The red solid line running in a northwest direction in (b) is the Kanmon Strait, which is closed in the model. The blue solid circles with lower case letters a to u along the coast in (b) are the locations of 21 major rivers around SIS.

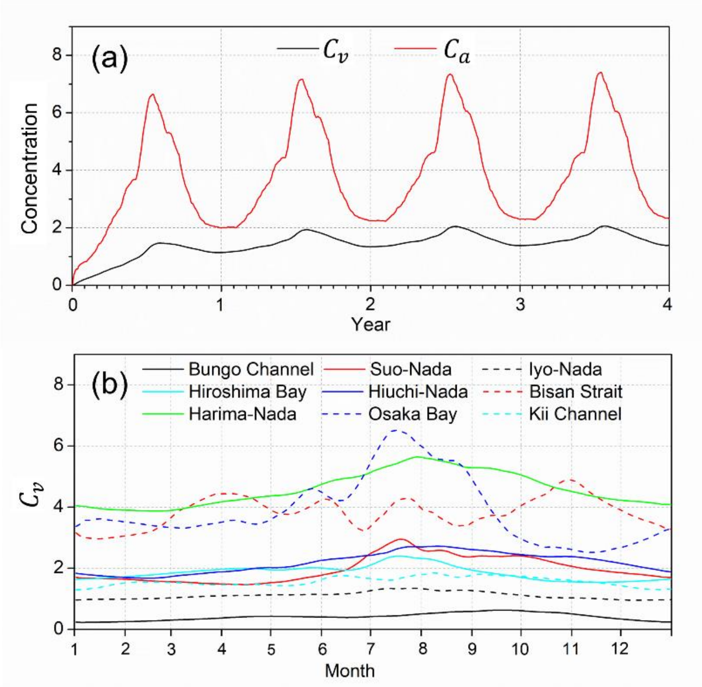

Fig. 2 Time series of (a) 15-day running mean of C_v and C_a over the entire SIS of case Control in four computational years. (b) is 7-day running mean of C_v in selected sub-regions in the fourth year. C_v is the volume-averaged concentration in the SIS, C_a is the area-averaged surface concentration in the SIS.

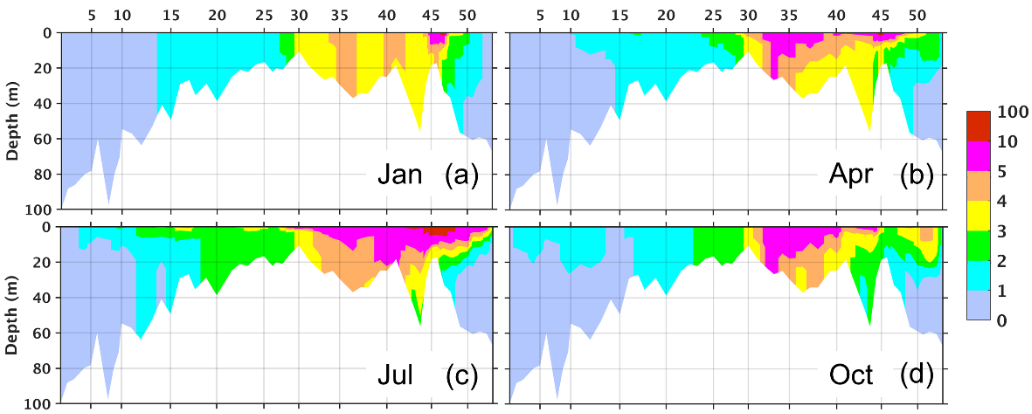

Fig. 3 Vertical distributions of contaminant concentrations in case Control along the transection of SIS in (a) January, (b) April, (c) July and (d) October. The numbers of stations correspond to numbers from 1 to 50 of the transection.

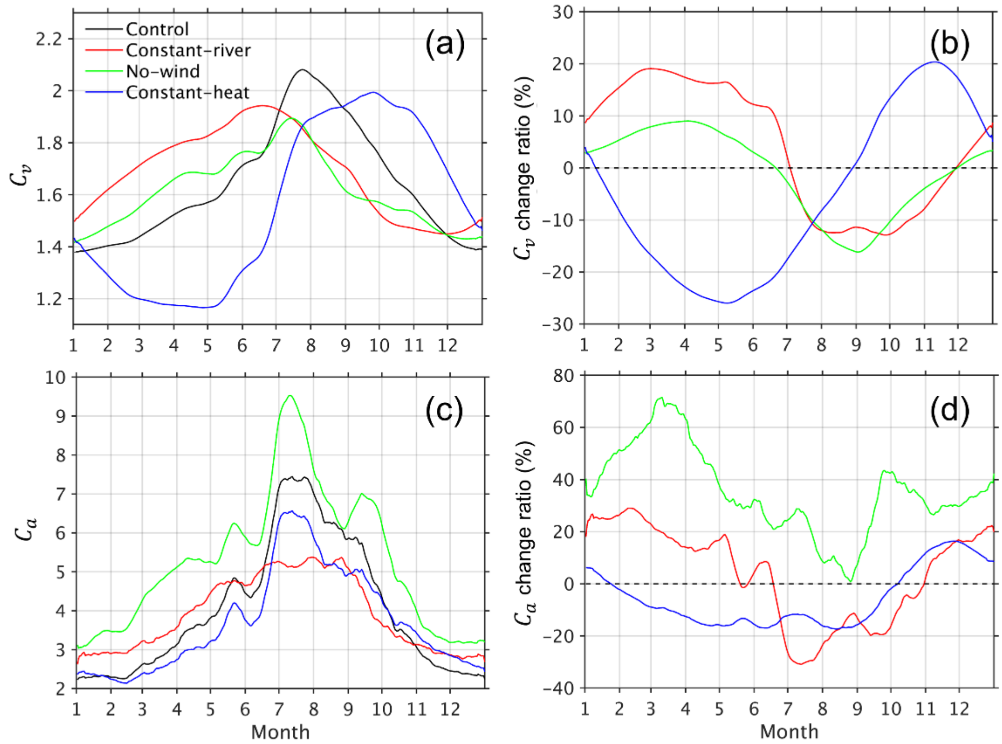

Fig. 4 Time series of 7-day running mean of (a) C_v in the numerical experiments and (b) their change ratios with respect to case Control. (c) and (d) are the same as (a) and (b), but for C_a.

(2) construct a three-dimensional low trophic-level ecosystem model in the Seto Inland Sea

based on a simple NPZD biogeochemical model and a 3-D hydrodynamical ocean model in the Seto Inland Sea (SIS) (Chang et al, 2009), I tried to couple the hydrodynamic-biogeochemical module on line to address the ecosystem change in the SIS. I have written the biogeochemical codes coupled with hydrodynamic module, and it also need to verify the feasibility of code through ideal experiment. At the same time, I prepared input data for biogeochemical model from observations, literatures and other materials, including riverine input nutrients of 21 major rivers around the SIS, nutrients input from the Bungo Channel and Kii Channel and benthic nutrients flux.

Publication/conference presentation

Publication:

Zhu J, Guo X, Shi J, et al. Dilution characteristics of riverine input contaminants in the Seto Inland Sea[J]. Marine pollution bulletin, 2019, 141: 91-103.

Oral presentation:

Title: Dilution characteristics of riverine input contaminants in the Seto Inland Sea and

development of a NPDZ type biogeochemical model for the Seto Inland Sea
Lecturer: Junying Zhu
Time: February 15, 2019
Location: Ehime University

Perspectives in future

We will carry out further research with Prof. Guo Xinyu on the following subjects:

1. The interannual variations of the cold water mass in Iyo-Nada.
2. The influence factors of seasonal warming range of cold water mass.
3. The physical-biological coupled model.