Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

ACG07-13 会場:201B 時間:5 月 27 日 14:15-14:30

Sediment Flux Separation on Interface Layer between River and Ocean Induced by Abukuma River Mouth Inflow

Sediment Flux Separation on Interface Layer between River and Ocean Induced by Abukuma River Mouth Inflow

Troselj Josko[1*] ; 山敷 庸亮 [2] ; 寶 馨 [3]
TROSELJ, Josko[1*] ; YAMASHIKI, Yosuke[2] ; TAKARA, Kaoru[3]

[1]Kyoto University, Graduate School of Engineering, [2]Kyoto University, Graduate School of Advanced Integrated Studies in Human Survivability, [3]Kyoto University, Disaster Prevention Research Institute
[1]Kyoto University, Graduate School of Engineering, [2]Kyoto University, Graduate School of Advanced Integrated Studies in Human Survivability, [3]Kyoto University, Disaster Prevention Research Institute

1. Introduction

The contamination of the land surface by radioactive fallout in the vicinity around the Fukushima Daiichi Nuclear Power Plant (FDNPP) is of much concern. While direct inputs of radionuclides from FDNPP to coastal waters have been estimated and modeled, less is known about the flux of radionuclides to the coastal zone derived from radioactive runoff into the river basin networks (Yamashiki et al., 2014) and about fate of the sediments during and after their transportation into the ocean.

2. Objective and motivation

The objective of this study is to give more detailed insight into fate of sediment particles when they approach the interface layer between river and ocean in order to better understand mechanisms of transportation of pollutants in estuaries. The study site is estuary zone affected by river inflow and associated sediment transportation from the Abukuma river basin in Japan.

The particular motivation for the study was unexpected vertical distribution of turbidity (Yamashiki et al., 2013), which showed turbidity peaks 500 meters from the river mouth towards the ocean at depths that correspond to middle water column of the river, while freshwater inflow at those depths was not simultaneously observed.

3. Methods

We used a general ocean circulation model MSSG with incompressible Navier-Stokes governing equations to solve the flow field. The turbulent-sediment transporting flow was nested separately together with MSSG model outputs, with finding relations between the two phase flows by using dimensional analysis similitude approach.

As our major intention was to consider influence of fluvial inflow towards the ocean, we manipulated with various boundary conditions mostly from the river side and briefly from the ocean, in order to find oceanic response to diverse fluvial conditions. Major emphasis was put on hydrodynamic processes during various rising limb stages of extreme fluvial discharge events.

4. Discussions

We found that relative relations among local bathymetry conditions, river inflow forcing and tidal ranges specific for the Abukuma river mouth contribute to strong vertical density stratification within the estuary zone and to occurrence of salt wedge, especially for moderate to higher discharges.

Unsteady flow conditions occurring during the rising limb stage of an extreme event are forcing the internal interfacial shear layer to become thinner and sharper up to the stage when we can describe it with similar physical similitude that is used for solving bottom boundary layers. Thus, the proposed new approach might be named as interface boundary layer (IBL) between two fluids. The biggest advantage of using the approach is proposed mechanism of linking it from the hydrodynamic phase flow towards suspended sediment transport phase.

Our assumption is that freshwater flow separation which is occurring within the laminar regime IBL may cause initial laminar inertia, while the flow separation occurring within the turbulent regime IBL may cause initial turbulent spinning and drag crisis applied to sediment particles. Thus, the particles from turbulent IBL would dissipate much of its velocity magnitude due to drag crisis caused by the separation, and would change tendency of its direction from upwards to downwards and from trajectory to spinning. The IBL flow regime transition would initially put part of particles into suspended state within the near-shore zone at middle water column depths, before being further influenced by ocean currents.

References

1. Yamashiki, Y., Onda, Y., Smith, H., G., Blake, W., H, Wakahara, T., Igarashi, Y., Matsuura, Y., Yoshimura, K., Initial flux of sediment-associated radiocesium to the ocean from the largest river impacted by Fukushima Daiichi Nuclear Power Plant,

Scientific Reports, 2014
2. Yamashiki, Y., Pratama, A., Yamazaki, H., Ishid, M., Niwa, Y., Field obervation on physical characteristics of Abukuma river estuary in Sendai bay, 2013 (unpublished)

キーワード: internal interfacial shear layer, sediment flux separation, river inflow, rising limb, oceanic response
Keywords: internal interfacial shear layer, sediment flux separation, river inflow, rising limb, oceanic response