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Stanislav Martyanov, Vladimir Ryabchenko

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Bottom sediment resuspension in the easternmost Gulf of Finland in the Baltic Sea: a case study based on three-dimensional modeling

Stanislav Martyanov, Vladimir Ryabchenko*

The St.-Petersburg Branch of the P.P. Shirshov Institute of Oceanology, Russian Academy of Sciences, 30, 1 Liniya, Vasilievskiy Ostrov, 199053, St.-Petersburg, Russia

martyanov.sd@gmail.com

vla-ryabchenko@yandex.ru

*Corresponding author. Tel.: +7 812 3282729; fax: +7 812 3285759.

Abstract

A three-dimensional model of the Neva Bay, located in the eastern part of the Baltic Sea, was used to simulate the bottom sediment resuspension. The model takes into account the non-linear interaction of current-related and wave-related bed shear stress, sediment cohesion and packing effects, variable fall velocity of suspended particles due to hindered settling and flocculation, and also the influence of suspended particles upon the total stratification of the water column. Three main types of sediments in the Neva Bay were considered: gravel, sand and silt. The model SWAN was used to calculate the characteristics of wind waves. Satellite data was used to calibrate and validate the model. The present study has revealed that for the Neva Bay it is necessary to consider both current-related and wave-related bed shear stresses and spatial distribution of sediments, and also that taking into account the influence of suspended particles upon the total stratification in the Neva Bay leads to the damping of vertical turbulent mixing. The results have demonstrated that the model correctly simulates the patterns of high-turbidity events in the Neva Bay. Model runs for ice-free periods of 2004, 2008 and 2013 years have shown that significant sediment resuspension happened along the whole coastline from the town of Sestroretsk to the estuary of the Neva River and at the river sand bars during strong west and south-west winds. Sediment resuspension occurred most intensively during autumn months, with the peak of intensity being observed in November.