Modeling the influence of biogeochemical processes on microplastic transport in the Arctic ocean

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Abstract

Microplastic (MP) pollution of the marine environment is one of the most urgent global problems in recent years. Biogeochemical processes, such as biofouling, ingestion by zooplankton, transport with pellets significantly affect the physical properties of MP and its transport.
However, only limited number of modelling studies addressed the role of ecosystem processes in the transport of MP in the marine environment.
The aim of this work was to develop a numerical model for assessing changes in the concentration of MP in the marine environment under the influence of natural biogeochemical cycles in the conditions of the Arctic seas.
The work used the biogeochemical model OxyDep (E. V. Yakushev et al., 2011) which reproduces the seasonality of ecosystem. A developed new model named BioPlast (Berezina et. al. 2021) considers processes of MP degradation, biofouling, ingestion of particles by zooplankton and MP in detritus. OxyDep biogeochemical module and MP module BioPlast were coupled with the transport models using the FABM framework (Bruggeman & Bolding, 2014). The applied models describe the transformation of MP and reproduce in detail the effect of ecosystem and biogeochemical processes on the its vertical and horizontal transport, as well as on its burying in sediments. At the first stage, the 2DBP hydrophysical model (2D benthic-pelagic transport model), which considers the processes in the water column and bottom sediments together, was used. This allowed to show the seasonality in MP content in the water column. On the second stage, the 3D model ROMS (Regional Ocean Modeling System) with 20 km horizontal resolutiom was applied for the Arctic Ocean to study MP transport from river sources. First results show that MP is affected by biofouling in the areas of higher productivity (coastal zone, river mounths), while the impact of ingestion by zooplankton seems to be insignificant.

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