Geophysical Research Abstracts
Vol. 21, EGU2019-5970, 2019
EGU General Assembly 2019

Developing parameterisation for secondary microplastics generation in the sea swash zone

Irina Chubarenko, Irina Efimova, Margarita Bagaeva, and Andrei Bagaev
Shirshov Institute of Oceanology, Atlantic Branch, Kaliningrad, Russian Federation (irina_chubarenko@mail.ru)

Prediction of transport and fate of any pollutant in marine environment requires information on the sources of the pollution. For microplastics (MPs, here – from 0.5 to 5 mm), the point sources (like cities, ports, etc.), and the distributed sources (mainly - the shorelines) are distinguished. We have analysed the effectiveness of mechanical fragmentation of plastic objects (or, the effectiveness of generation of secondary MPs) in the sea swash zone taking into account the type of the beach sediment (large and small pebbles, granules, and coarse sand), the wave energy, and the availability of plastics on the beach. Analysis is based on (i) principal analytical considerations, (ii) the results of two extensive sets of laboratory experiments carried out in rotating laboratory mixer that mimics mechanical fragmentation of plastic macro-samples (2 cm x 2 cm) into the micro-particles (0.5 – 5 mm), and (iii) the order-of-magnitude evaluations of the variability of other parameters for the exemplary case of the Baltic Sea shores. It is shown that, from general physical viewpoint, the effectiveness of the particular shore in mechanical fragmentation of plastic objects is proportional to the amount of plastics available for fragmentation, the type of the bottom sediments, and the incident wave energy (proportional to the significant wave height squared). Laboratory experiments indicate that, in general, the coarser is the sediment – the larger is the fraction of mass of the plastics, transferred by mixing into the category of MPs; this is valid for all the plastics used in the experiments, disregarding their sinking/floating behaviour. Evaluations show that the pebble beaches under the same external conditions are up to 100 times more effective in plastic fragmentation than the sandy beaches; in other words, the 1-km long coarse clastic beach and 100-km long sandy beach produce similar mass/number of MPs (from similar amount of plastics available for fragmentation, and under similar wave conditions). Natural variability of the significant wave height is even larger (especially at the oceanic coasts), while the amount of plastics available for fragmentation at the shores [of the Baltic Sea as for example] seems to be not as variable. The results prove that the clastic shores during stormy events are the most significant (and most probably the major) sources of secondary MPs in marine environment. The developed parameterization can be applied to various beaches and wave conditions, and used in numerical models of MPs transport after proper calibration of the coefficient of proportionality against local field data.