【SⅡ-2】

Comprehensive Studies on Oceanic Transport, Environmental Risk, and Advanced Monitoring of Marine Plastic Debris

ISOBE Atsuhiko
Kyushu University
6-1 Kasuga-koen Kasuga-Shi, Fukuoka, 816-8580, JAPAN
E-mail: aisobe@riam.kyushu-u.ac.jp

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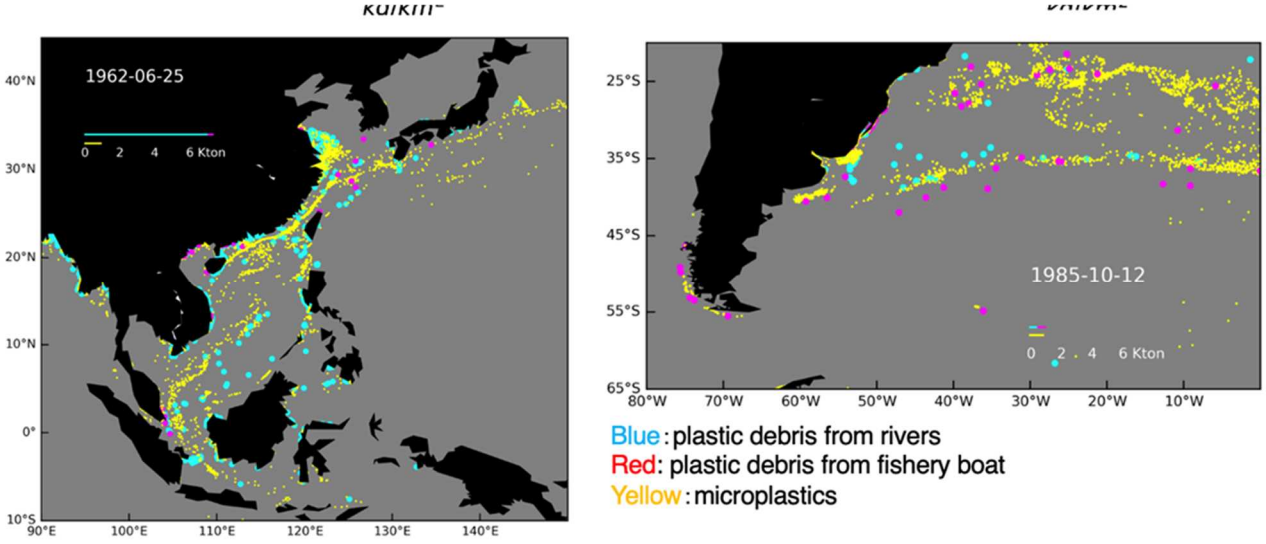
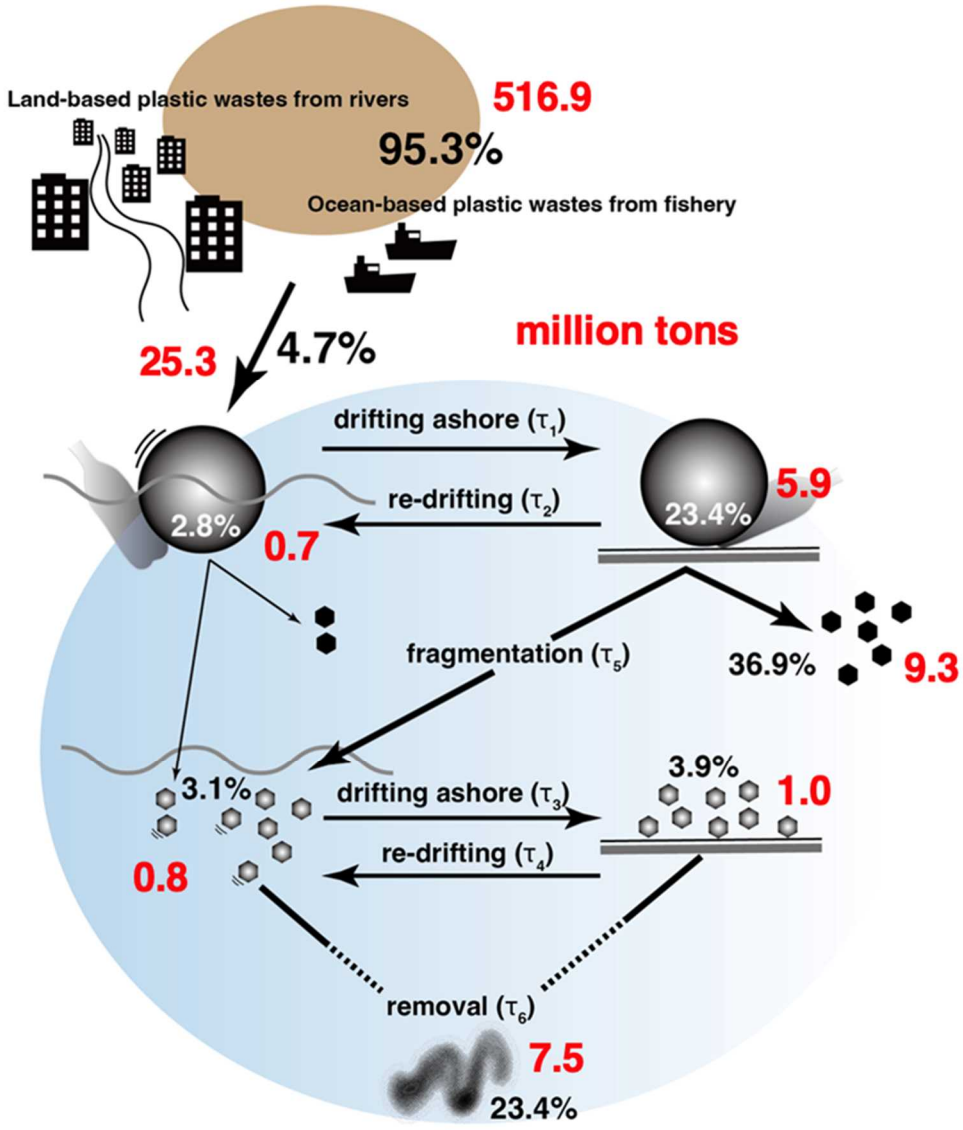
A total of 8,218 pelagic microplastic samples from the world's oceans were synthesized to create a dataset available for public use. Using the dataset for validation, a budget for ocean-plastic mass was estimated based on a combination of numerical particle tracking and linear mass-balance models. Of worldwide macroplastic emissions over the period 1961–2017, 23.4% of ocean plastics have wound up as macroplastics strewn currently on beaches. Meanwhile, 66.7% of ocean plastics have been removed from the upper ocean and beaches through sedimentation in deep oceans or fragmentation into tiny plastic fragments unmonitorable under current observation frameworks. The sedimentation processes were also investigated using a sediment trap and sediment cores sampled from the actual ocean.

When *medaka* fish were exposed to microplastics (MPs) (2, 20, 200 μm), MPs ingested by the *medaka* were eliminated from their bodies except 2μm MP. No effect was observed in survival and reproduction of *medaka* and *artemia*, but some gene expression levels were changed in the *medaka* intestine and *artemia* whole body. Ubiquitous occurrence of hydrophobic chemicals such as polychlorinated biphenyls as well as sporadic occurrence of high concentrations of additives in neuston and beach MPs were revealed. *Medaka* were exposed to anthracene and/or MP. The results showed that PE-MPs may act as a vector for concentrating and transferring anthracene to *medaka* upon ingestion. It was revealed that benthic invertebrates that ingested MPs accumulated chemical compounds such as PCBs and additives associated with MPs, and that these were transferred to benthic fish through the consumption of prey invertebrates that had consumed MPs.

We developed a method for collecting fine MPs distributed on the sea surface to a depth of 800 m using a multiple open/close net and a deep-sea pump, as well as a pretreatment process for the collected specimens and an efficient microscopic Fourier transform infrared operation method for detecting fine MPs. Furthermore, we clarified the effectiveness of coumarin as a fluorescence index in detection using the optical characteristics of MPs, with a detection method based on polarization parameters of MPs suggested to be effective for detecting MPs in water. In addition, we developed an automatic MP detection method to clarify particulate or fibrous materials and measure the number and length of MPs. We proposed and developed a method for estimating marine plastic debris volumes on beaches by combining unmanned aerial vehicle surveys and image processing based on deep learning.



Particle tracking model representing plastic debris
and microplastic motion in 60's Asia and 80's South Atlantic



Fate of ocean plastics uncovered in this project