Development of a prediction model for long-term impacts of multi-locked new polymers on the marine environment

Presenter : Hirofumi Hinata（Ehime University）
PM： Dr. ITO Kohzo
Graduate School of Frontier Sciences, The University of Tokyo
Implementing organizations : The University of Tokyo, Mitsubishi Chemical Corporation, Bridgestone Corporation, Teijin Limited, Kureha Corporation, Kyushu University, Nagoya University, Yamagata University, Research Institute of Innovative Technology for the Earth (RITE), National Institute of Advanced Industrial Science and Technology (AIST), Ehime University, Tokyo Institute of Technology

Ehime University, Graduate school of science and engineering,
Hirofumi Hinata

E4bc「Development of a prediction model for long-term impacts of multi-locked new polymers on the marine environment」

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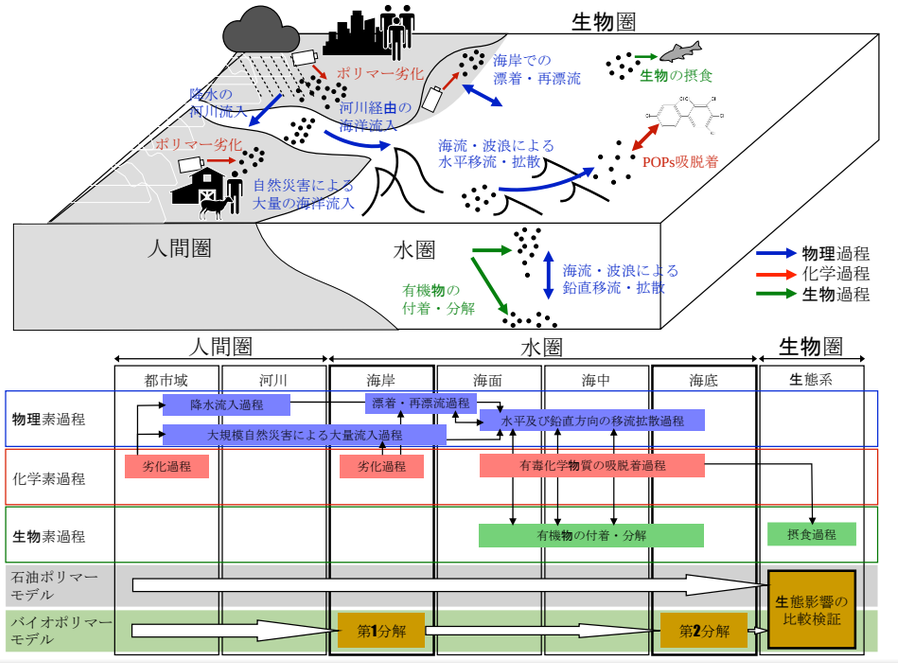
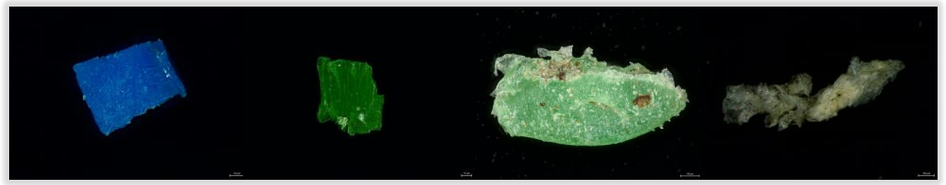
1) To develop a prediction model for long-term impacts of new polymers on the marine environment consisting of physical, chemical and biological models.
2) To understand the standing stocks in the marine reservoirs, such as water columns, beaches, bottom sediments, marine biota, and fluxes between them with the integrated model.
3) To comprehend the polymer behaviors in the marine environment and assess the impacts based on an input-output system approach.

Researches start with the Seto Inland Sea and then extend to the North Pacific.





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Prediction system for long-term MP behaviors and their adverse effects on the marine eco-system

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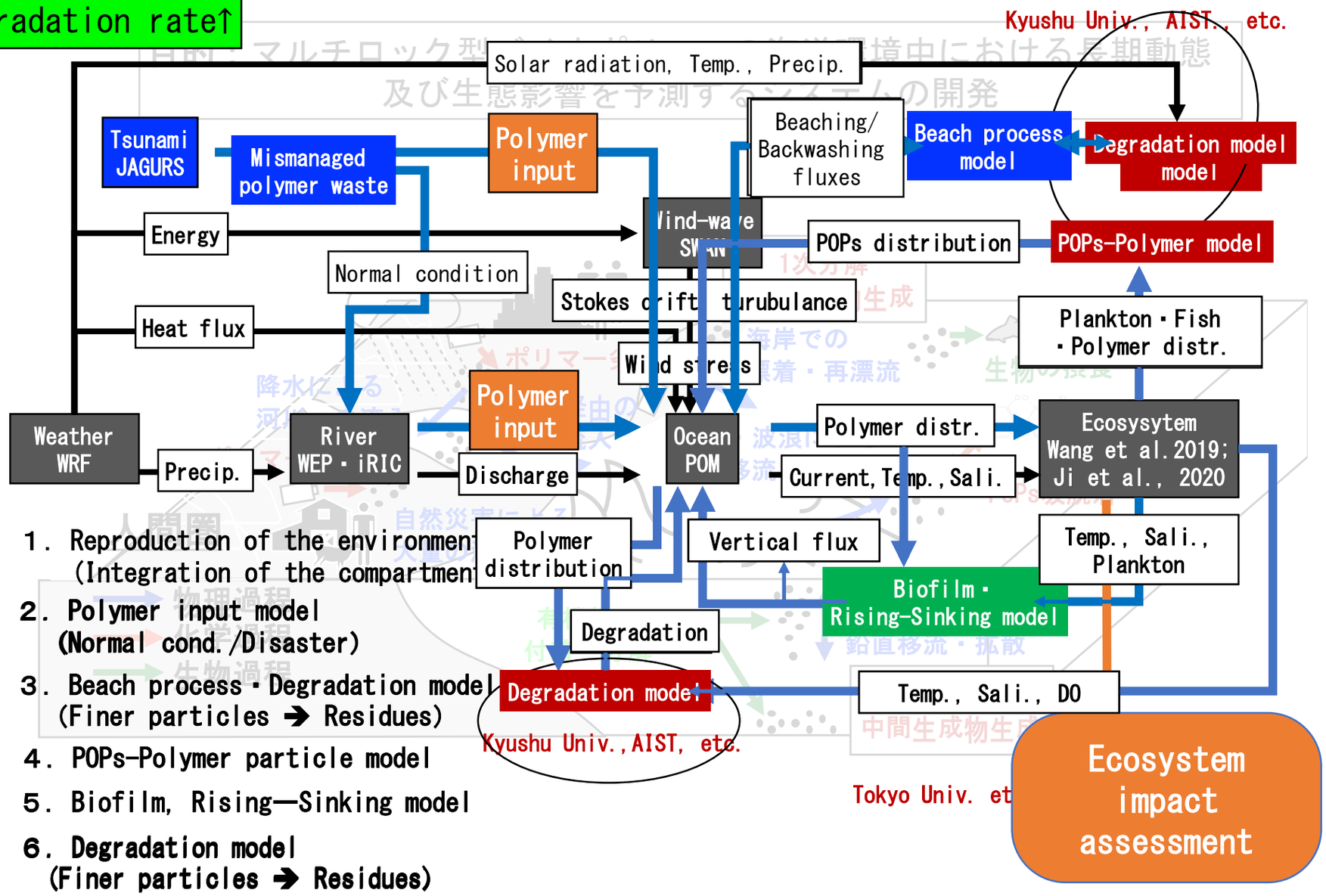
New polymer
Degradation rate↑



1. Reproduction of the environment (Integration of the compartmen
2. Polymer input model (Normal cond./Disaster)
3. Beach process・Degradation model (Finer particles ➔ Residues)
4. POPs-Polymer particle model
5. Biofilm, Rising—Sinking model
6. Degradation model (Finer particles ➔ Residues)

1. **To understand the standing stocks in the reservoirs and fluxes between them with a Physical-Chemical-Biological model.**
2. **To comprehend the polymer behaviors in the marine environment with an input-output system approach.**
3. **Researches start with the Seto Inland Sea and then extend to the North Pacific.**

Key physical processes for understanding long-term impacts

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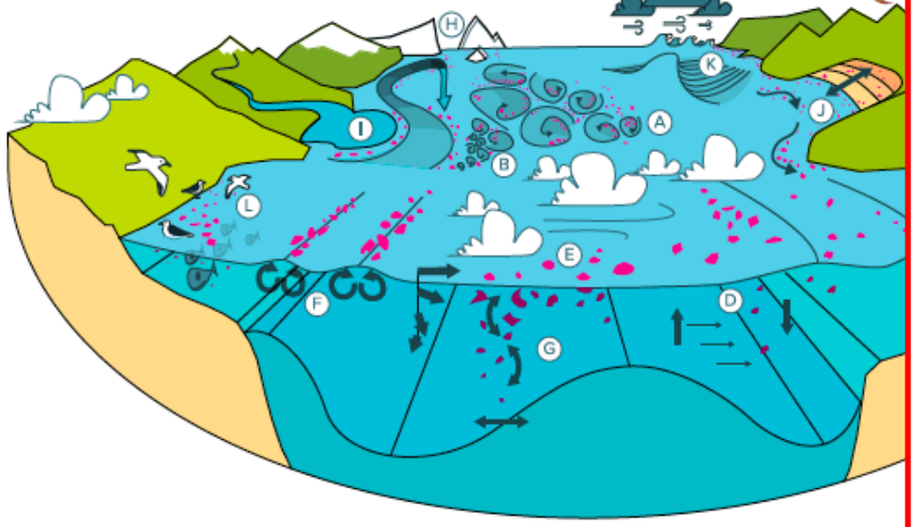
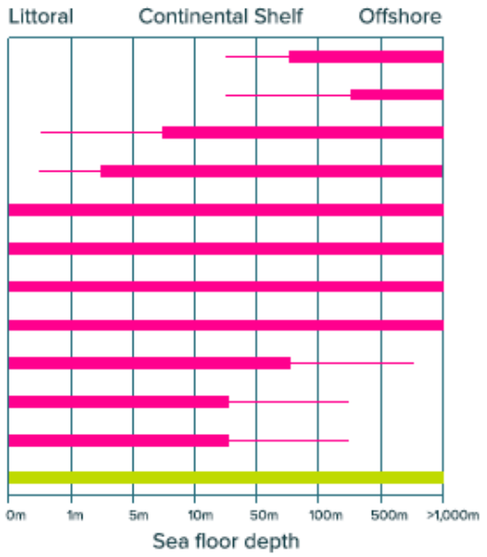
van Sebille et al., 2020





	PHYSICAL PROCESSES
A	Large-scale open ocean pro
B	Submesoscale open ocean processes
C	Open ocean Stokes drift
D	Internal tides
E	Direct wind transport (windage)
F	Langmuir circulation
G	Vertical mixing
H	Ice formation, melting and drift
I	River plumes and coastal fronts
J	Coastal currents, surface waves and beaching
K	Extreme events
L	*Transport by biology*

Figure 1. Schematic of the physical processes that affect the transport of plastic (pink items) in the ocean (top panel). The table (lower panel) identifies in which regions different processes are important. Thick pink lines in the table mean that the process is among the most important in that water depth, while thin pink lines mean that the process is only of secondary importance. Transport by organisms is not a physical process and therefore represented with a green line instead of a pink one.

+degradation
+resuspension

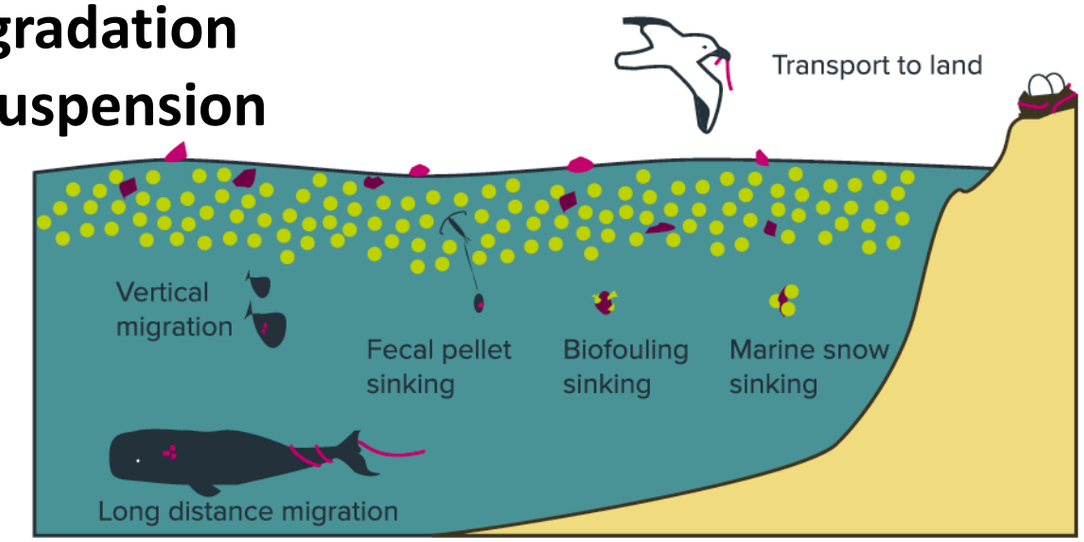
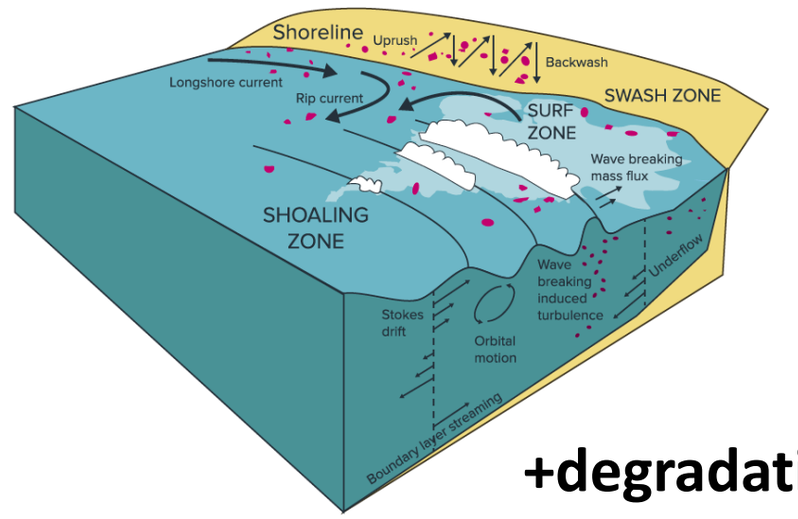


Figure 6. Schematic of the different transport processes by which organisms can affect movements of initially buoyant plastics. Green circles represent plankton.



+degradation

Figure 5. Schematic of the processes that transport plastics in the coastal zone. Adapted from figure 1.2 of van der Zanden (2016).

MP sedimentation history from 1940s -Understanding the past and predicting the future-

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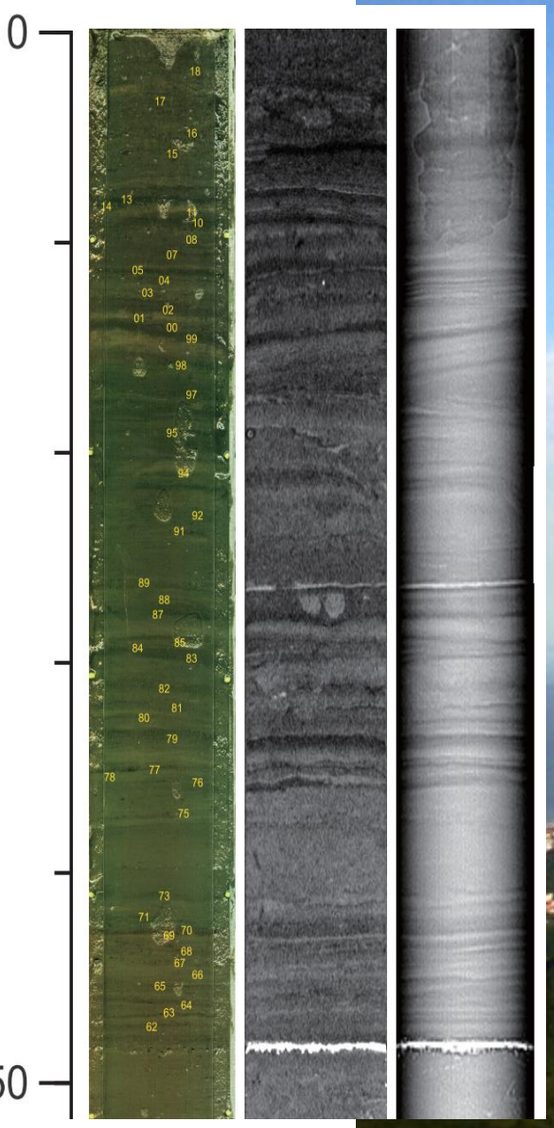
Beppu Bay bottom sediments：A high-resolution record medium for MP pollution history



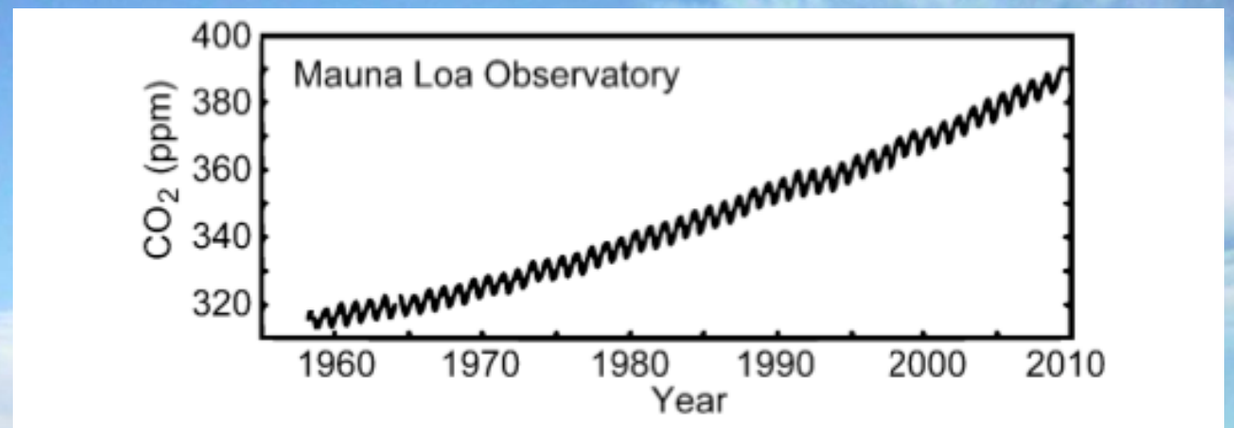
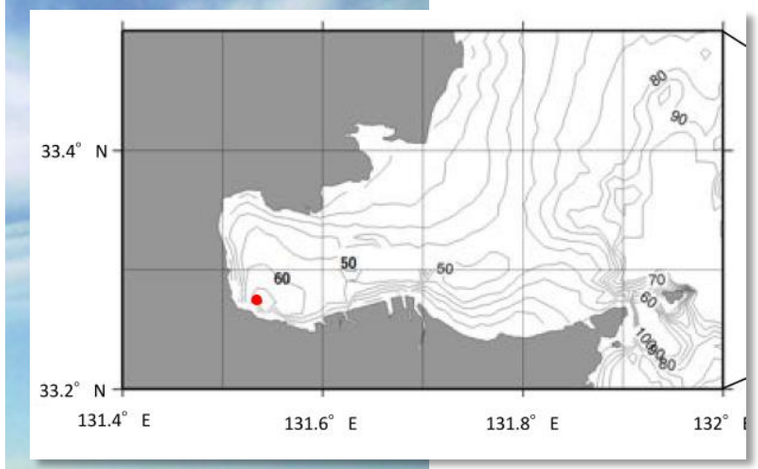
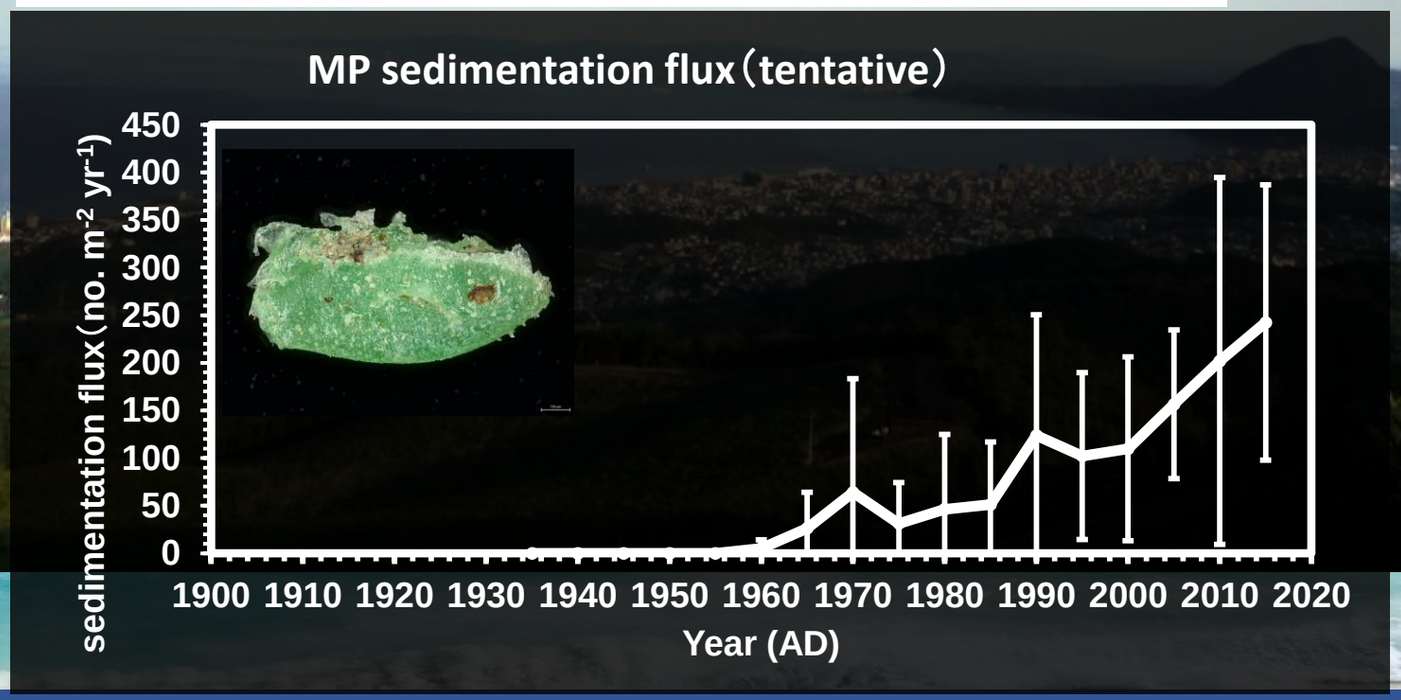
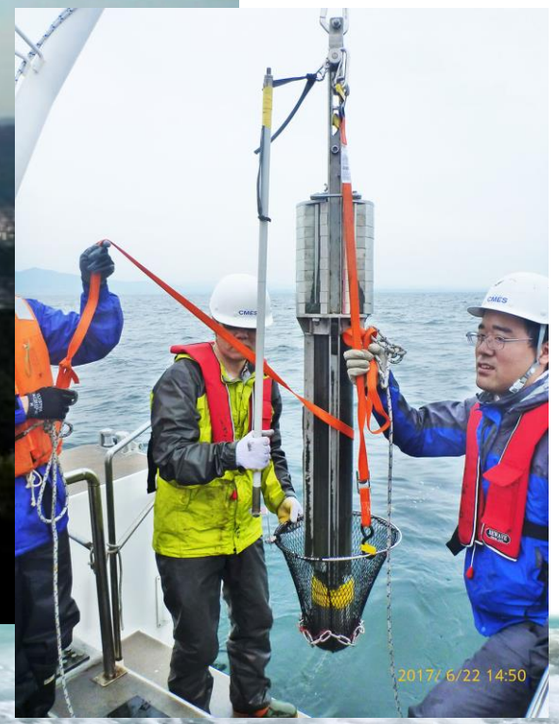


Figure 4. Keeling Curve: a half century of CO_2 data from Mauna Loa Observatory. Data from ref 7.

(Harris, 2010)







Beach process modeling
—Beach: A hot spot of MP production—

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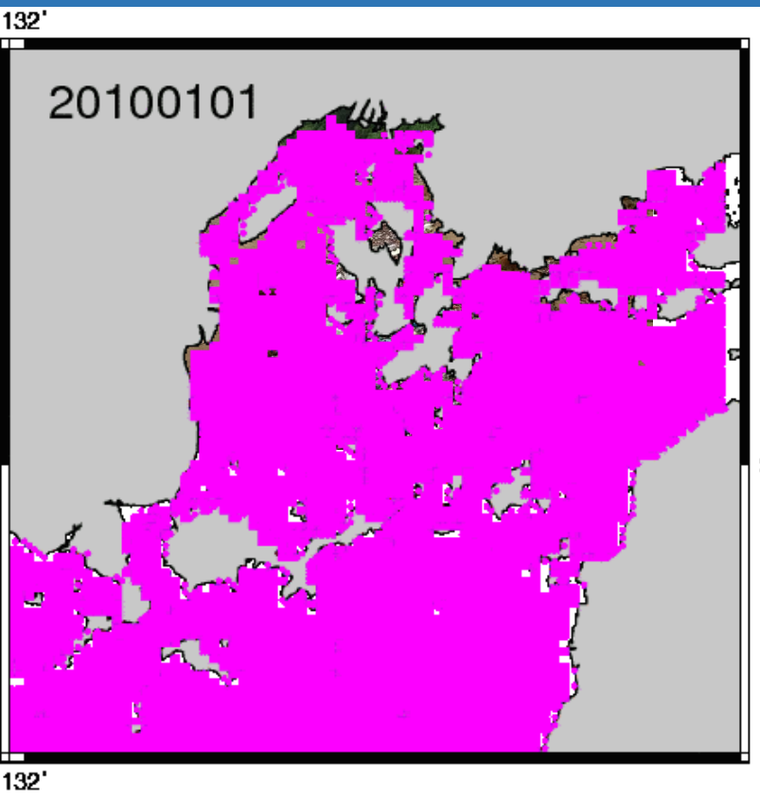
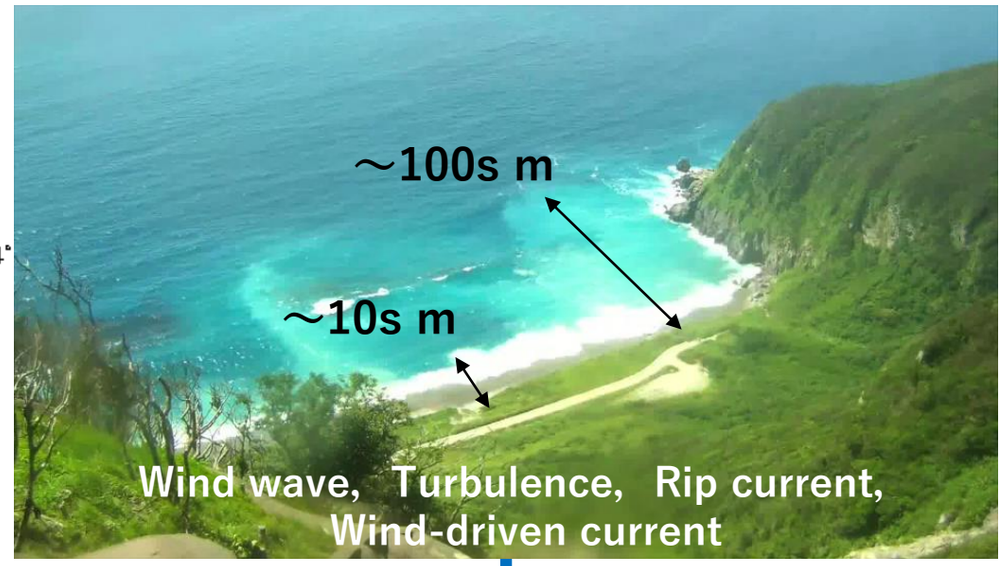
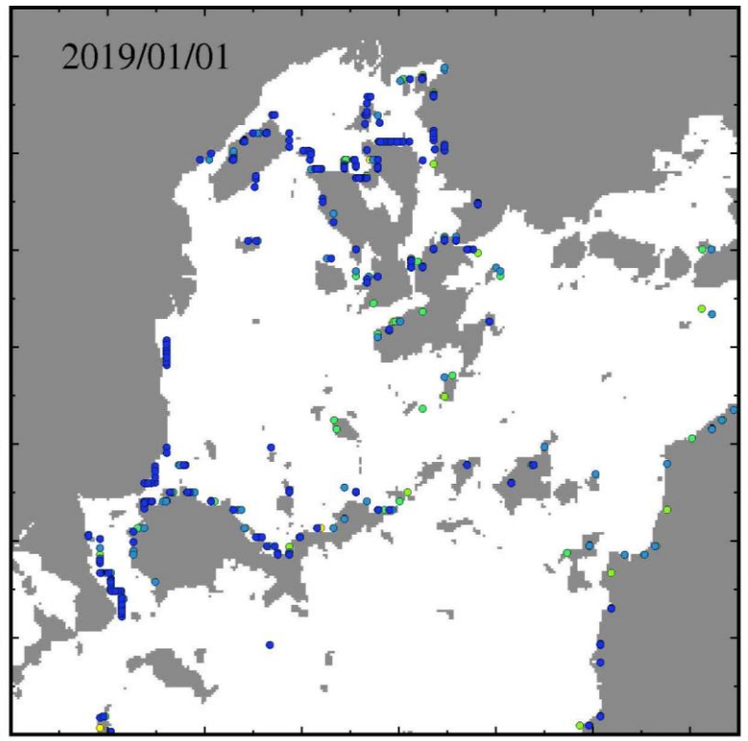


Beach process: beaching-backwashing





(Hinata et el., 2020a, b)

- **Diffusion coefficients**
  - Polymer➔Tracer
    - A & D
      Comp. cost
      Tracking add. info.
- **Probability**
  - Polymer➔Particle
    - A & D
      Comp. cost
      Tracking add. info.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