Press Releases

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JAMSTEC

Enhanced Role of Eddies in Arctic Marine Ecosystems
~ Sea Ice Reduction Creates Better Plankton Habitat ~

Dr. Eiji Watanabe and Dr. Jonaotaro Onodera, Research and Development (R&D) Center for Global Change (RCGC), the Japan Agency for Marine-Earth Science Technology (JAMSTEC: Asahiko Taira, President) detected a significant amount of sinking biological materials with particulate organic nitrogen under sea ice during early winter. It reveals an enhanced role of eddies in transporting nutrient-rich shelf water to the Arctic deep-sea basins with sea ice reduction in recent years. To obtain the results, a sediment trap mooring system (*1) was deployed in the Pacific Arctic for observation and an eddy-resolving coupled sea ice-ocean model (*2) with the Earth Simulator was used for simulation based on the observational findings.

The findings indicate that plankton habitats are expanding in the Arctic basin, where the sea ice cover is considered to have suppressed the biological productivity of phytoplankton, zooplankton, and fishes. It will also enable us to assess the impacts of future climate changes on marine ecosystems over the Arctic region.

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Title: Enhanced role of eddies in the Arctic marine biological pump

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*1　Sediment trap mooring system

Sediment traps are instruments used to measure the quantity of sinking particulate organic (and mineral) material in oceans. They are deployed at specific water depths using a mooring system with floats, cables, releasers and anchors. In this research, a year-long observation was conducted by replacing sampling bottles containing preservations every two weeks.

*2 Eddy-resolving coupled sea ice-ocean model
In the numerical models assessing sea ice and ocean circulation and thermal changes based on physical laws and empirical formulas, it is necessary to divide horizontal grids into small pieces to show relatively small-scale important phenomena such as eddies and coastal current. For the Arctic Ocean, a model with a 10-km or less grid size is regarded as “eddy-resolving”. If the target ocean area is the same, the higher resolution increases complexity in computation. For this reason, there are only a few examples of simulations with an “eddy-resolving model” for the Arctic Ocean. It is also very rare to couple it with marine ecosystem models. In this research, the JAMSTEC Earth Simulator made such a pioneering approach possible.

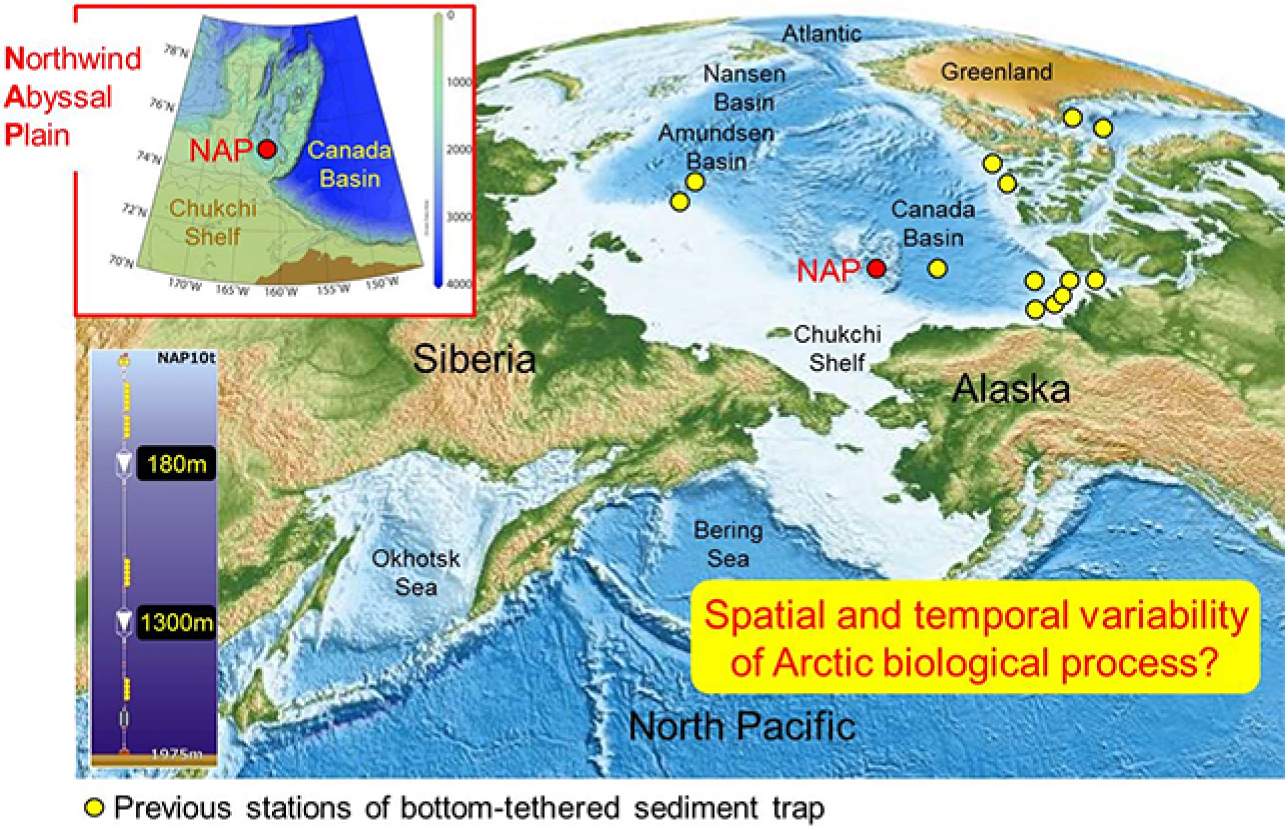

Figure 1: Topography map in the Arctic-subarctic regions. Red dots show the location of Station NAP, where our sediment trap has been deployed since October 2010.

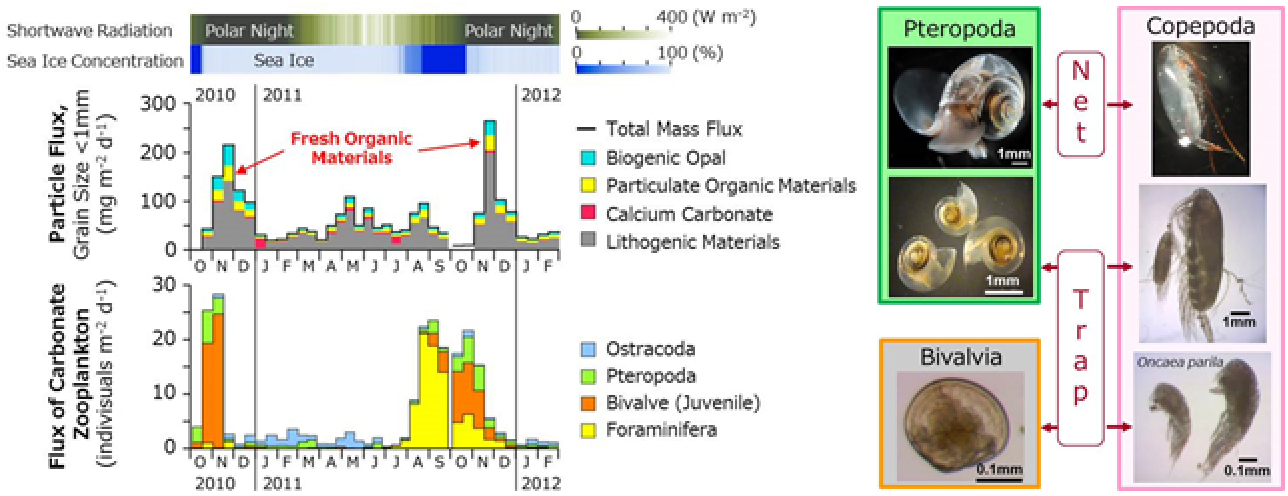

Figure 2: Trapped particles at Station NAP. (left) Flux time series from October 4, 2010 through March 1, 2012 of cumulative bulk component (mg m^{-2} per day) and carbonate shell bearing micro-zooplankton (individuals m^{-2} per day). Downward shortwave radiation at the surface of sea ice and ocean (after sea ice opening) (W m^{-2}) and sea ice concentration (%) shown above were obtained from the NCEP-CFSR dataset. (right) Microscope photographs of zooplankton samples captured by in-situ plankton nets and moored sediment trap measurements.

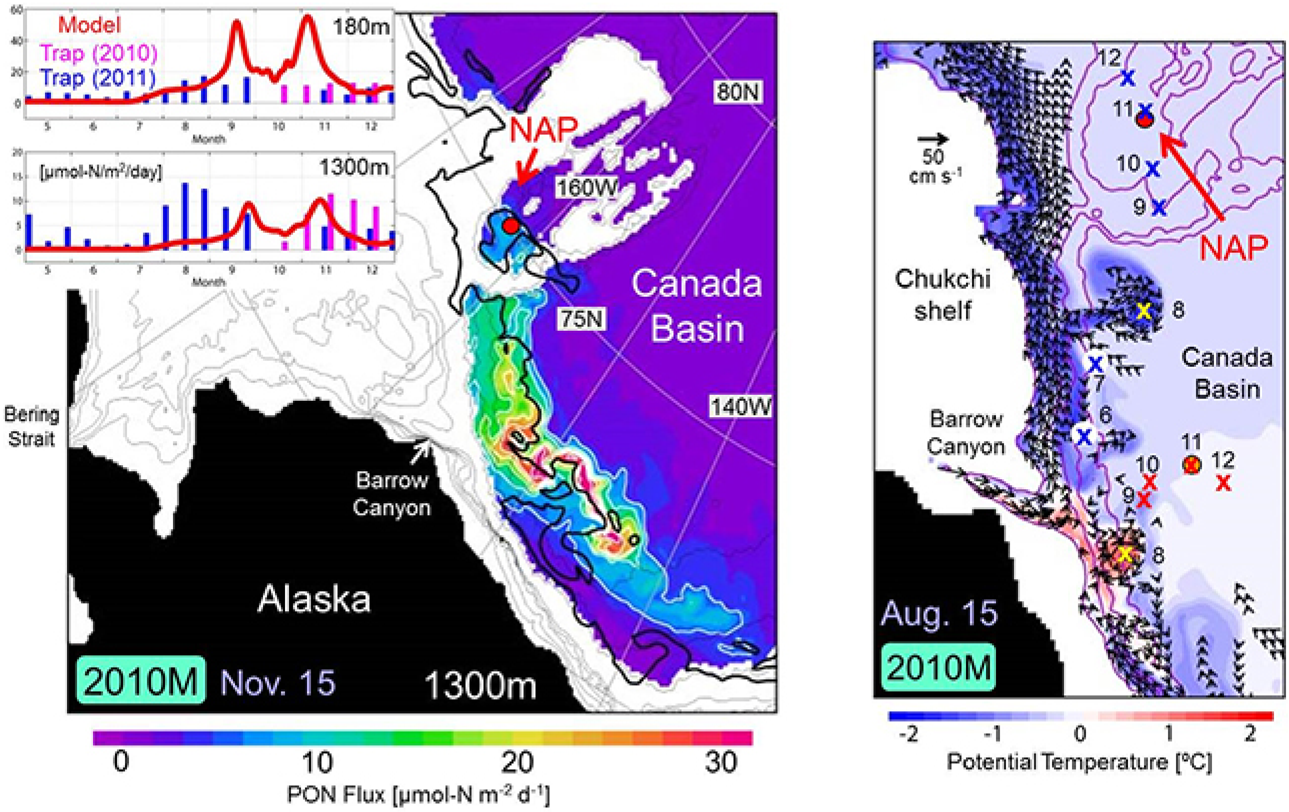

Figure 3: (left) Simulated flux of particulate organic nitrogen (PON). The spatial distribution on November 15 and the time series at Station NAP are shown. Black contours indicate the simulated edge of shelf bottom water tracer. (right) Pathway of shelf-break eddies. Simulated water temperature and ocean horizontal velocity at a 100 m depth on August 15 are shown.

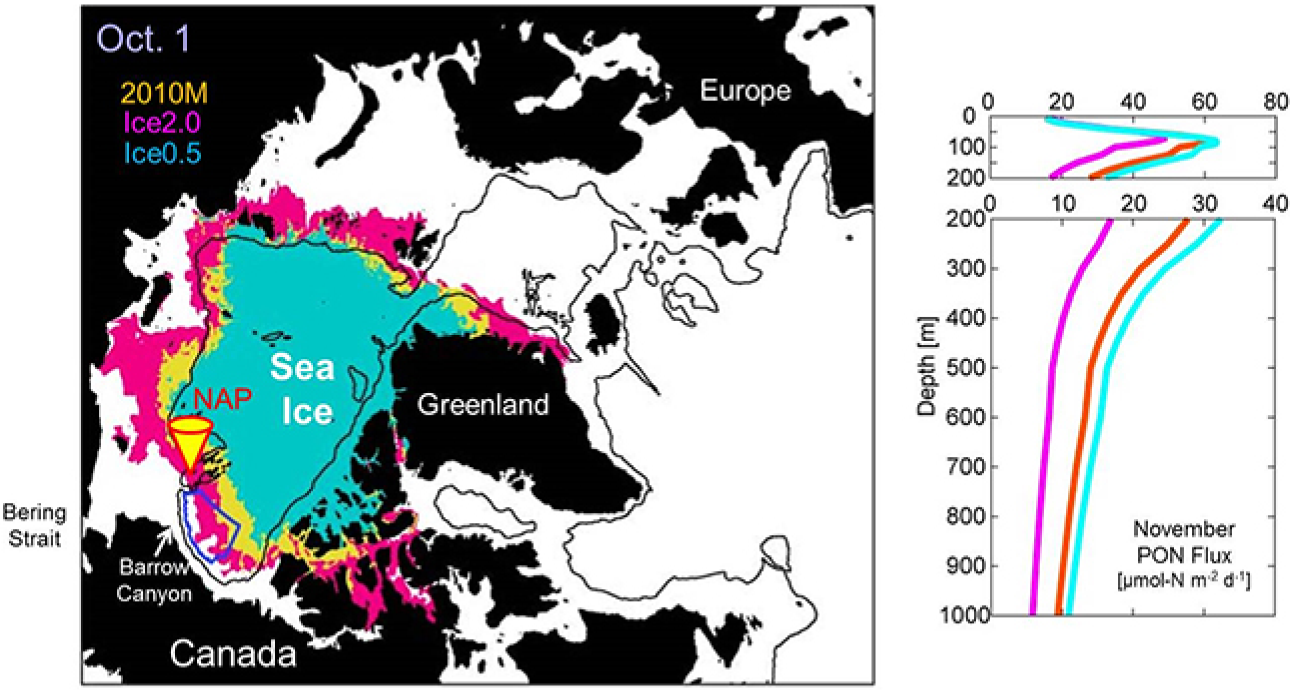

Figure 4: (left) Simulated sea ice distribution on October 1 in small, medium, and large ice volume cases. Black contours represent 1,000 m isobaths. The location of Station NAP is shown by a yellow cone. (right) Vertical profile of November mean PON flux in each case (μmol-N m^{-2} per day).

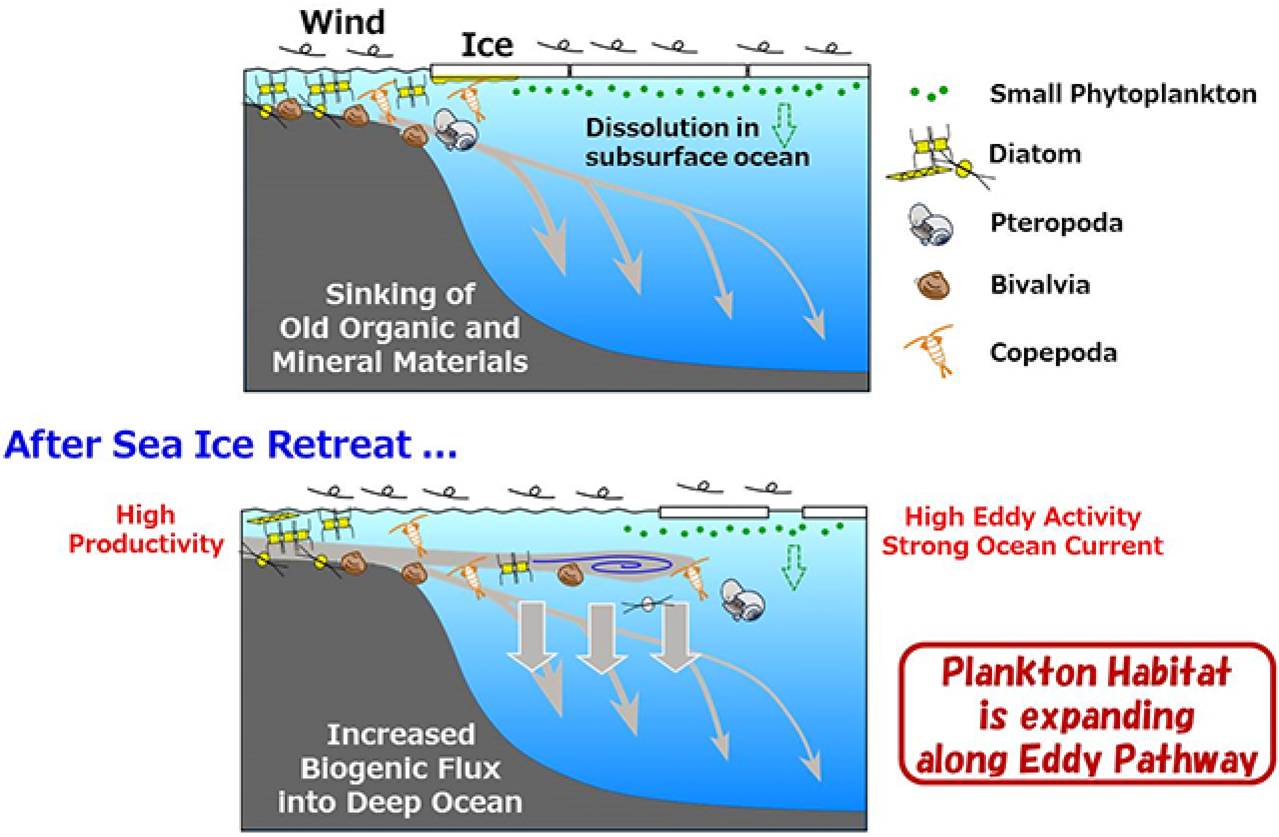

Figure 5: Schematic image of sea ice impact. Sea ice retreat causes high biological productivities on the (nutrient-rich) shelves and enhances eddy activity and ocean current in the deep basin area. As a result, plankton habitat is expanding along eddy pathway.

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