Seasonal variations of the partial pressure of CO_2 in surface water and quantitative assessment of its drivers in the Pacific Sector of the Arctic Ocean from winter to summer

Manami Tozawa[1], Daiki Nomura[1,2,3], Mariko Hatta[4], Amane Fujiwara[4], Sayaka Yasunaka[5], Akihiko Murata[4]

[1]*Faculty/Graduate School of Fisheries Sciences, Hokkaido University,*

[2]*Field Science Center for Northern Biosphere, Hokkaido University,*

[3]*Arctic Research Center, Hokkaido University,*

[4]*Japan Agency for Marine-Earth Science and Technology (JAMSTEC),*

[5]*Graduate School of Science, Tohoku University*

To comprehend the variations in the partial pressure of CO_2 (pCO_2) in the surface water in the Arctic Ocean and to identify its drivers, we conducted biogeochemical observation in the Pacific Sector from September to October 2021. The pCO_2 in surface water was undersaturated with respect to the atmosphere, indicating a CO_2 sink for the atmosphere in the study area. We estimated the surface water pCO_2 under sea ice in winter to be 363±14 µatm based on the water temperature, dissolved inorganic carbon, and total alkalinity at the winter water layer (175−220 m). Then, we also evaluated the variations of pCO_2 (δpCO_2) by temperature, freshwater inflow, and biological activity to assess the drivers determining pCO_2 quantitatively from winter to summer. In the area south of 70˚N, although a dramatical increase of the sea surface temperature from winter toward summer had the potential to increase pCO_2 and then should have led to the CO_2 supersaturation with respect to the atmosphere, the freshwater inflow and the biological activity reduced the pCO_2, and led the CO_2 undersaturation with respect to the atmosphere. In the northern part of the observation area (>72˚N), pCO_2 was lower than the value in the atmosphere due to a slight seasonal variation in sea surface temperature and significant freshwater inflow reducing pCO_2 in surface water as the result of the dilution effect. Furthermore, the freshwater origins (sea ice meltwater and snow meltwater) were identified using stable oxygen isotopic ratio and salinity, and it suggested that the impact on pCO_2 would vary depending on the freshwater source.

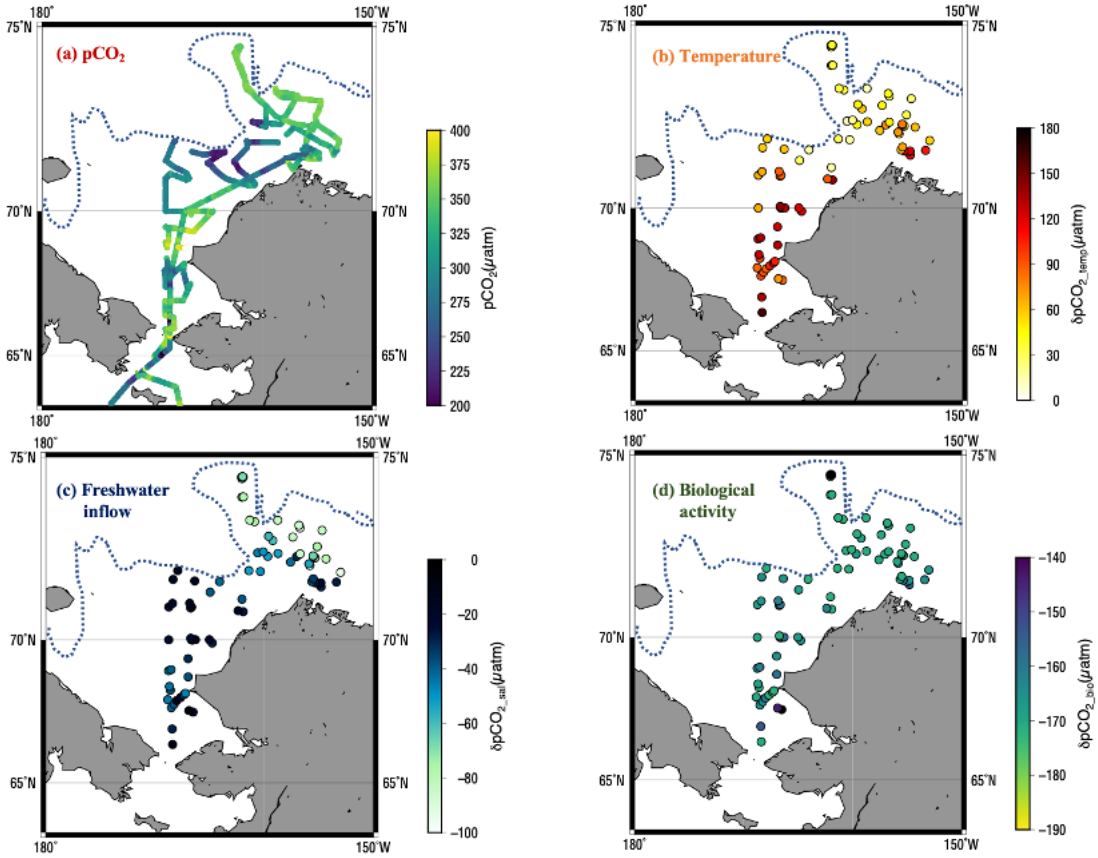

Figure 1. (a) Spatial distribution of pCO_2 in summer, (b) δpCO_2 by temperature, (c) δpCO_2 by freshwater inflow, and (d) δpCO_2 by biological activity