Press Releases

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JAMSTEC
Meteorological Research Institute

Arctic Sea CO_2 Uptake Accounts for 10% of Total in World's Oceans

Overview
A new study successfully quantified the air-sea CO_2 fluxes in the Arctic Ocean and its adjacent seas (Fig. 1). As a result, CO_2 uptake in the Arctic Ocean is estimated to be 10% of the total in the entire ocean, while the Arctic Ocean accounts for only 3% of the world's ocean surface area. This study project was led by Dr. Sayaka Yasunaka from the Institute of Arctic Climate and Environment Research (IACE) at the Japan Agency for Marine-Earth Science and Technology (JAMSTEC: Asahiko Taira, President) in collaboration with an international team of scientists including Meteorological Research Institute of Japan Meteorological Agency, and the U.S. National Oceanic and Atmospheric Administration.

So far, spatial and temporal distributions of CO_2 flux in the Arctic Ocean and its adjacent seas have not been well understood due to insufficient data coverage in the heterogeneous area. To address this issue, scientists applied a self-organizing map technique, which is a kind of neural network, to estimate monthly air–sea CO_2 fluxes in the Arctic Ocean and its adjacent seas for 18 years from January 1997 to December 2014. These results revealed that annual Arctic Ocean CO_2 uptake is 180±130 TgC (1 TgC = 10^{12} g of carbon = 1 million tons of carbon). In addition, their successful quantification of air-sea CO_2 flux in the area also found large spatial and temporal variability (Figs. 2, 3, and 4).

Accurate estimation of the global CO_2 budgets is indispensable for prediction of global warming. These study results will not only contribute to it but also provide a clue to understand ocean acidification resulted from CO_2 dissolved in the ocean, which has been giving serious impacts on the Arctic Ocean.

This study was carried out as part of the Arctic Challenge for Sustainability (ArCS) Project by the Ministry of Education, Culture, Sports, Science and Technology's subsidiary project.

The above results have been published in *Biogeosciences* on March 22, 2018 (JST).

Title: Arctic Ocean CO_2 uptake: an improved multi-year estimate of the air–sea CO_2 flux incorporating chlorophyll-a concentrations
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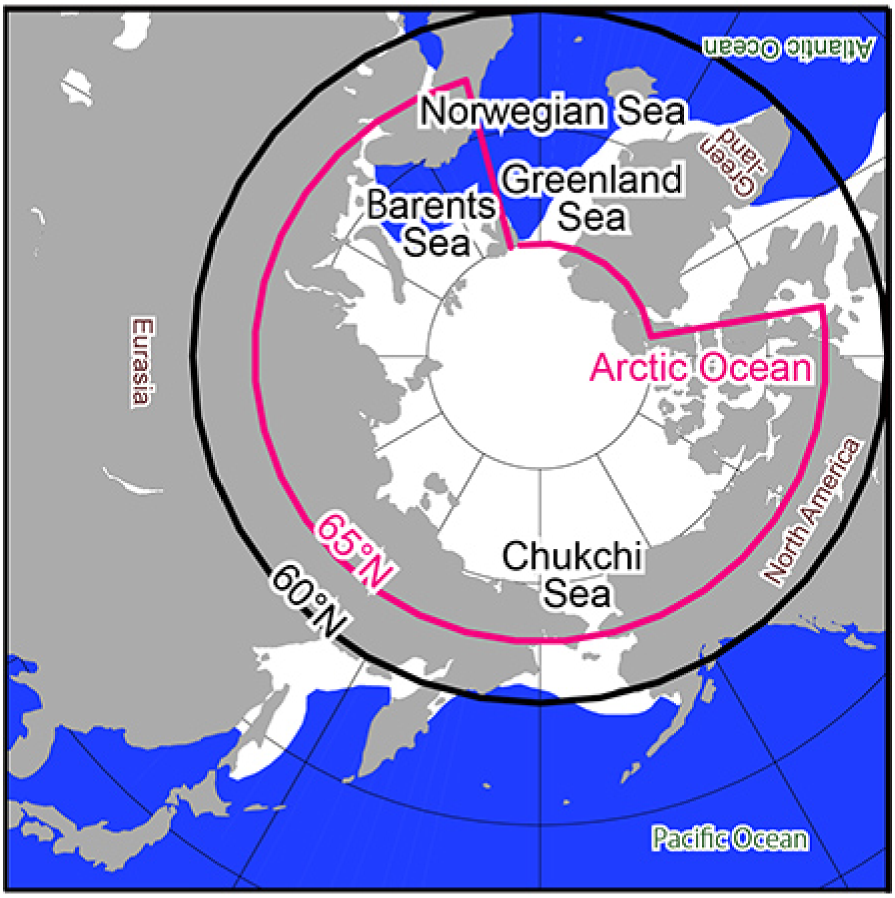

Figure 1. Map of the Arctic Ocean and its adjacent seas. An area for the mapping is north of 60°N. The Arctic Ocean is defined as a region enclosed by a magenta line. White area shows the 18-year annual mean sea ice concentration of 15% or more.

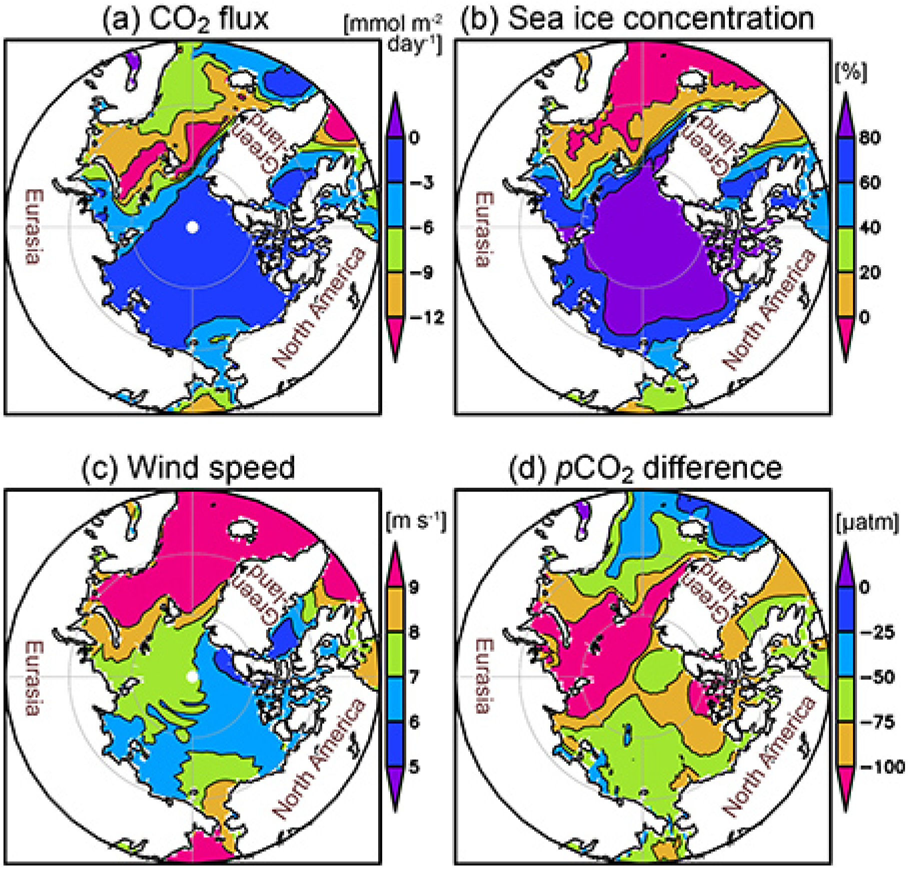

Figure 2. Eighteen-year annual means of (a) CO_2 flux (negative values indicate flux into the ocean), (b) sea ice concentration, (c) wind speed, and (d) CO_2 partial pressure difference between the ocean and the atmosphere (negative values indicate lower partial pressure of CO_2 in the ocean than in the atmosphere). Lower sea ice concentration, stronger wind, and larger CO_2 partial pressure difference relate to greater CO_2 flux.

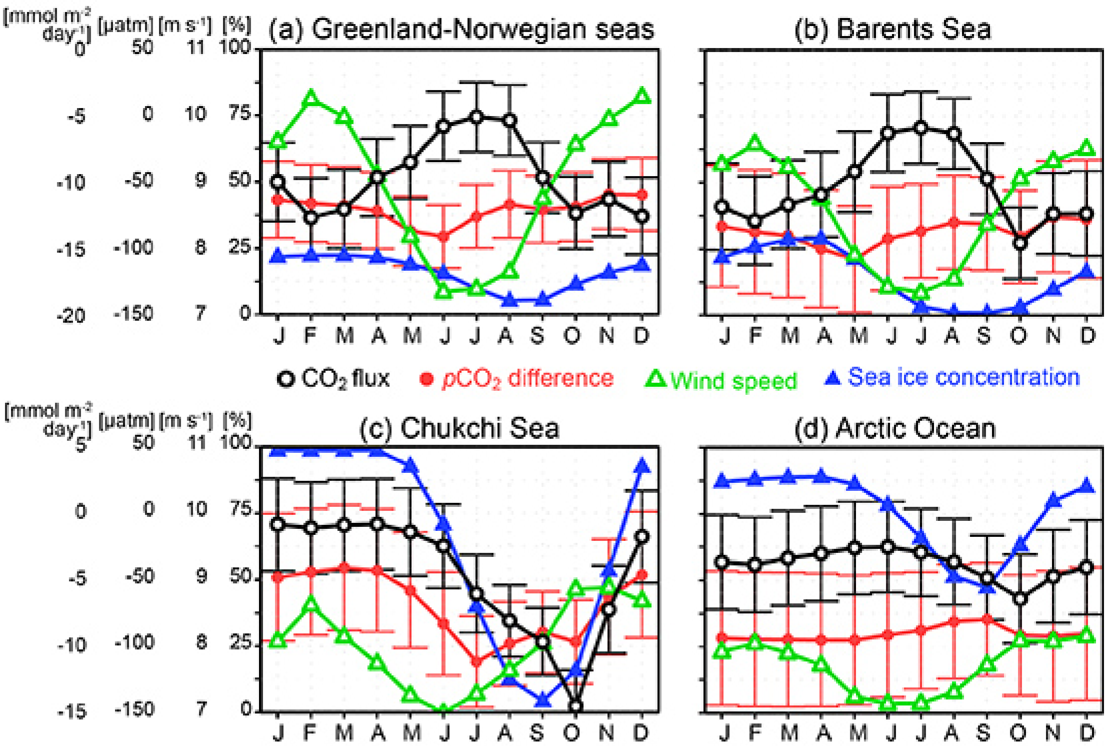

Figure 3. Seasonal change of CO_2 flux (black), CO_2 partial pressure difference between the ocean and the atmosphere (red), wind speed (green), and sea ice concentration

(blue), averaged over (a) the Greenland and Norwegian seas, (b) the Barents Sea, (c) the Chukchi Sea, and (d) the Arctic Ocean. Error bars indicate the uncertainty.

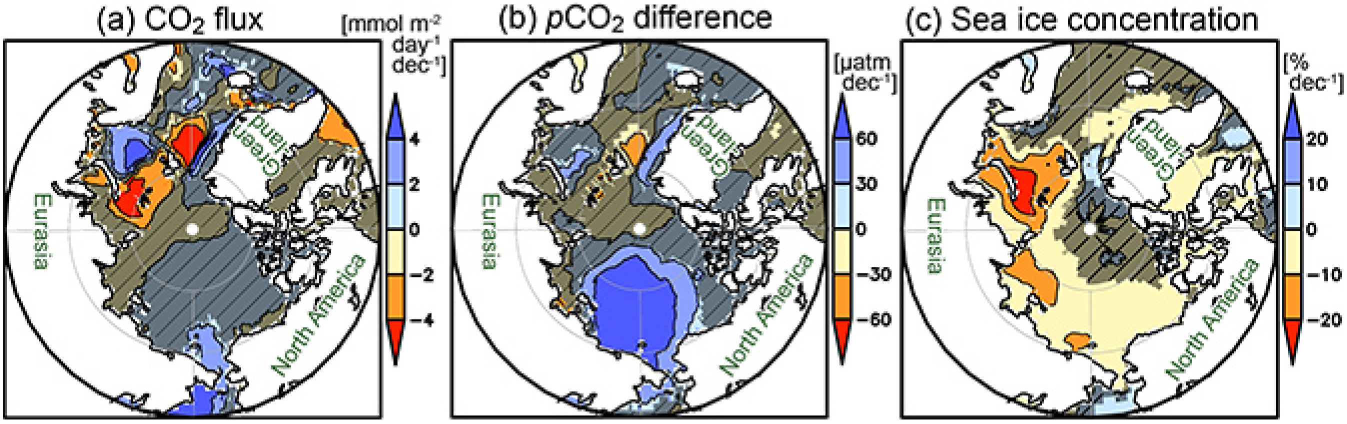

Figure 4. Long-term trends in (a) CO_2 flux (positive values indicate decrease in ocean uptake, negative values indicate increase in ocean uptake), (b) CO_2 partial pressure difference between the ocean and the atmosphere (positive values indicate a higher increase in partial pressure of CO_2 in the ocean than in the atmosphere, and therefore a decrease in the absolute difference of CO_2 partial pressure between the ocean and the atmosphere), and (c) sea ice concentration (negative values indicate decrease in sea ice). Larger CO_2 partial pressure difference and lower sea ice extent relate to greater CO_2 flux.

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