Multi-year estimate of the air-sea CO2 flux in the Arctic with the use of the chlorophyll-a concentration

*Sayaka Yasunaka[1], Eko Siswanto[1], Are Olsen[2,7], Mario Hoppema[3], Eiji Watanabe[1], Agneta Fransson[5], Melissa Chierici[4], Akihiko Murata[1], Naohiro Kosugi[6], Siv Kari Lauvset[7], Jeremy Mathis[8]

1. Japan Agency for Marine-Earth Science and Technology, 2. University of Bergen, 3. Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, 4. Institute of Marine Research, 5. Norwegian Polar Institute, 6. Meteorological Research Institute, 7. Bjerknes Centre for Climate Research, 8. NOAA Arctic Research Program

We examined the relationship between partial pressure of CO_2 in the surface water (pCO_{2w}) and chlorophyll-a concentration (Chl-a) in the Arctic. The relationship between pCO_{2w} and Chl-a is negative where Chl-a < 1 mg m^{-3}, but there is no significant relationship where Chl-a > 1 mg m^{-3}. In the Greenland/Norwegian Seas, a relationship between pCO_{2w} and Chl-a is strongly negative in spring and weakly negative in summer. Chl-a is higher in summer than in spring, while nutrient concentration is high in spring and low in summer there. A positive relationship between pCO_{2w} and Chl-a is found in the Barents Sea in summer when Chl-a values decline while pCO_{2w} remains at a relatively constant low level. In the Kara and East Siberian Seas and the Bering Strait, the relationships are positive because of high pCO_{2w} and Chl-a water in the coastal region.
We estimated monthly air–sea CO_2 flux in the Arctic north of 60°N from 1997 to 2014 by applying a self-organizing map technique with Chl-a, SST, SSS, SIC, xCO_{2a}, and geographical positions. The addition of Chl-a as a training parameter enables us to improve the estimate of pCO_{2w} through reproducing its decline in spring by biological production. A significant CO_2 uptake of 180 ±130 TgC yr^{-1} in the Arctic Ocean was obtained. This estimate has been much improved compared to a previous estimate thanks to the use of Chl-a, but to some extent also due to a higher number of CO_2 data.

Keywords: CO2 flux, Arctic, chlorophyll-a, SOCAT