Role of sea ice biogeochemistry in air-ice-ocean exchange of climatically important gases (CO₂ and DMS) in the Arctic: Preliminary results of coupled sea ice-ocean physical-biogeochemical model simulations

HAKASE HAYASHIDA¹, ERIC MORTENSON¹, ADAM MONAHAN¹, NADIA STEINER²,³, MARIOLAINÉ BLAIS⁴, MATTHEW GALE³, VIRGINIE GALINDO⁵, MICHEL GOSSELIN⁶, MARGAUX GOURDAL⁷, XIANMIN HU⁸, MAURICE LEVASSEUR⁷, & CHRISTOPHER JOHN MUNDY⁸

¹School of Earth and Ocean Sciences, University of Victoria, Victoria, British Columbia, Canada
²Canadian Centre for Climate Modelling and Analysis, Environment Canada, Victoria, British Columbia, Canada
³Institute of Ocean Sciences, Fisheries and Oceans Canada, Sidney, British Columbia, Canada
⁴Institut des sciences de la mer de Rimouski, Université du Québec à Rimouski, Rimouski, Quebec, Canada
⁵Port of Dover, Dover, Kent, United Kingdom
⁶Centre for Earth Observation Science, Faculty of Environment, Earth and Resources, University of Manitoba, Winnipeg, Manitoba, Canada
⁷Département de biologie, Québec-Océan, Université Laval, Québec, Québec, Canada
⁸Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, Alberta, Canada

Traditionally, sea ice was considered to act as a barrier for gas exchange between the atmosphere and the ocean. However, recent field work has indicated that sea ice could play an active role in atmosphere-snow-ice-ocean gas flux. Furthermore, biological processes within sea ice can contribute substantially to the biogeochemical cycling in polar marine environments. To address the role of sea ice biogeochemistry in air-ice-ocean exchange of climatically important gases (carbon dioxide and dimethylsulfide (DMS)) in the Arctic under present and future climates, we have developed a biogeochemical model that simulates the lower-trophic level polar marine ecosystem and associated carbon and sulfur cycles. The model has been tested in 1-D and successfully reproduced the observed variability of chlorophyll a, carbon, and dimethylsulfonpropionate. We are currently implementing the biogeochemical model developed in 1-D to an existing coupled 3-D pan-Arctic sea ice-ocean physical-biogeochemical model. We plan to discuss the preliminary results of model simulations including: simulated CO₂ and DMS fluxes, spatio-temporal variability, model-data comparison, parameter sensitivity analysis, and contribution of sea ice biogeochemistry to these fluxes.