EGU2020-1755, updated on 23 Sep 2020
https://doi.org/10.5194/egusphere-egu2020-1755
EGU General Assembly 2020

Timing and magnitude of Southern Ocean sea ice/carbon cycle feedbacks over the last eight glacial cycles

Karl Stein[1,2], Axel Timmermann[1,2], Eun Young Kwon[1,2], and Tobias Friedrich[3]
[1]Pusan National University, IBS Center for Climate Physics, Busan, South Korea (iccp.stein@gmail.com)
[2]Pusan National University, Busan, South Korea
[3]Department of Oceanography, University of Hawai'i at Manoa, Honolulu, HI, USA

The Southern Ocean (SO) played a prominent role in the exchange of carbon between ocean and atmosphere on glacial timescales through its regulation of deep ocean ventilation. Previous studies indicated that SO sea ice could dynamically link several processes of carbon sequestration, but these studies relied on models with simplified ocean and sea ice dynamics or snapshot simulations with general circulation models. Here we use a transient run of the LOVECLIM intermediate complexity climate model, covering the past eight glacial cycles, to investigate the orbital-scale dynamics of deep ocean ventilation changes due to SO sea ice. Cold climates increase sea ice cover, sea-ice export, and Antarctic Bottom Water formation, which are accompanied by increased SO upwelling, stronger poleward export of Circumpolar Deep Water, and a reduction of the atmospheric exposure time of surface waters by a factor of ten. Moreover, increased brine formation around Antarctica enhances deep ocean stratification, which could act to decrease vertical mixing by a factor of four compared to the current climate. The impact of the two mechanisms on carbon sequestration was then tested within a steady-state carbon cycle. The two mechanisms combined can reduce atmospheric carbon by 40 ppm, of which approximately 30 ppm is due to ocean stratification. Moreover, ocean stratification from increased SO sea ice production acts early within glacial cycles to amplify the carbon cycle response.

How to cite: Stein, K., Timmermann, A., Kwon, E. Y., and Friedrich, T.: Timing and magnitude of Southern Ocean sea ice/carbon cycle feedbacks over the last eight glacial cycles, EGU General Assembly 2020, Online, 4–8 May 2020, EGU2020-1755, https://doi.org/10.5194/egusphere-egu2020-1755, 2019