

ID: W2208506062

TITLE: The seasonal sea-ice zone in the glacial Southern Ocean as a carbon sink

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ABSTRACT:

Reduced surface-deep ocean exchange and enhanced nutrient consumption by phytoplankton in the Southern Ocean have been linked to lower glacial atmospheric CO₂. However, identification of the biological and physical conditions involved and the related processes remains incomplete. Here we specify Southern Ocean surface-subsurface contrasts using a new tool, the combined oxygen and silicon isotope measurement of diatom and radiolarian opal, in combination with numerical simulations. Our data do not indicate a permanent glacial halocline related to melt water from icebergs. Corroborated by numerical simulations, we find that glacial surface stratification was variable and linked to seasonal sea-ice changes. During glacial spring-summer, the mixed layer was relatively shallow, while deeper mixing occurred during fall-winter, allowing for surface-ocean refueling with nutrients from the deep reservoir, which was potentially richer in nutrients than today. This generated specific carbon and opal export regimes turning the glacial seasonal sea-ice zone into a carbon sink.

SOURCE: Nature communications

PDF URL: <https://www.nature.com/articles/ncomms9136.pdf>

CITED BY COUNT: 60

PUBLICATION YEAR: 2015

TYPE: article

CONCEPTS: ['Glacial period', 'Oceanography', 'Geology', 'Sea ice', 'Sink (geography)', 'Mixed layer', 'Phytoplankton', 'Deep sea', 'Environmental science', 'Nutrient', 'Paleontology', 'Ecology', 'Cartography', 'Biology', 'Geography']