Majority of spring bloom net community production in Southern Ocean seasonal sea ice zone occurs before sea ice retreat

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Introduction

Annual phytoplankton blooms are observed in the seasonal sea ice zone (SIZ) each spring.

Recent work using biogeochemical profiling floats with under ice capabilities have enabled annual observations of the SIZ, and indicate phytoplankton growth begins well before total sea ice retreat[1,2]

We investigate the biogeochemical impact of these blooms, and estimate how much net community production occurs during the under ice period when ocean color observations are unavailable.

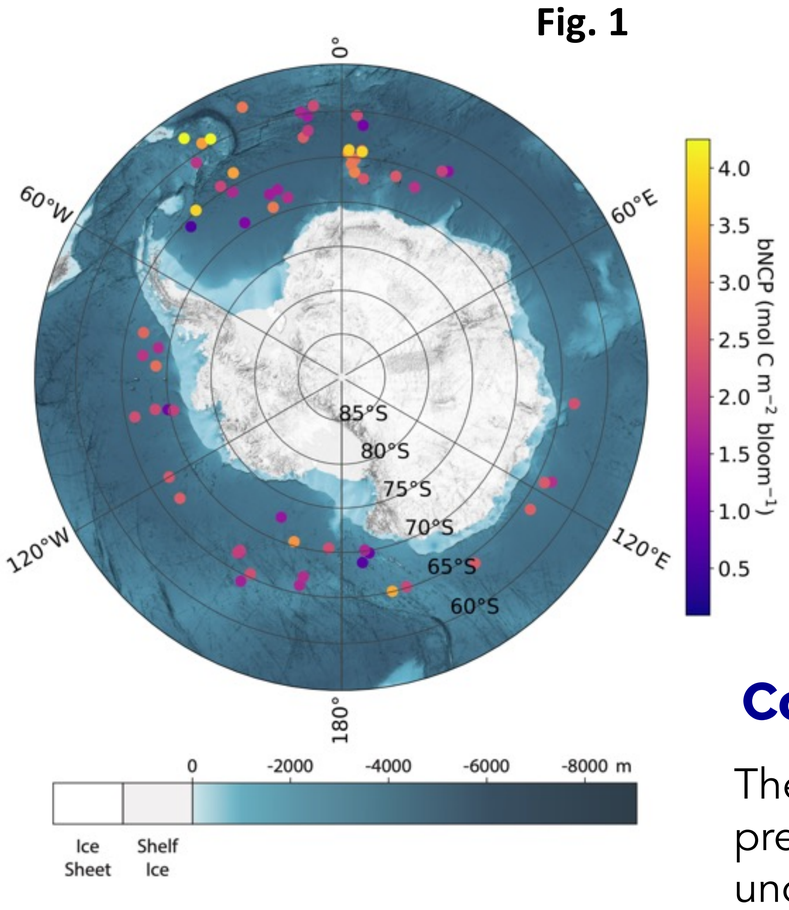
Methods

Use profiling float observations of Salinity, Temperature, Depth, Oxygen, Nitrate, and Particulate Backscatter obtained between 2015 and 2021 along with satellite derived sea ice concentration (SIC) and reanalysis derived surface solar radiation.

Identify when phytoplankton carbon (estimated from particulate backscatter) increase and nitrate drawdown occur in relation to seasonal changes in sea ice cover.

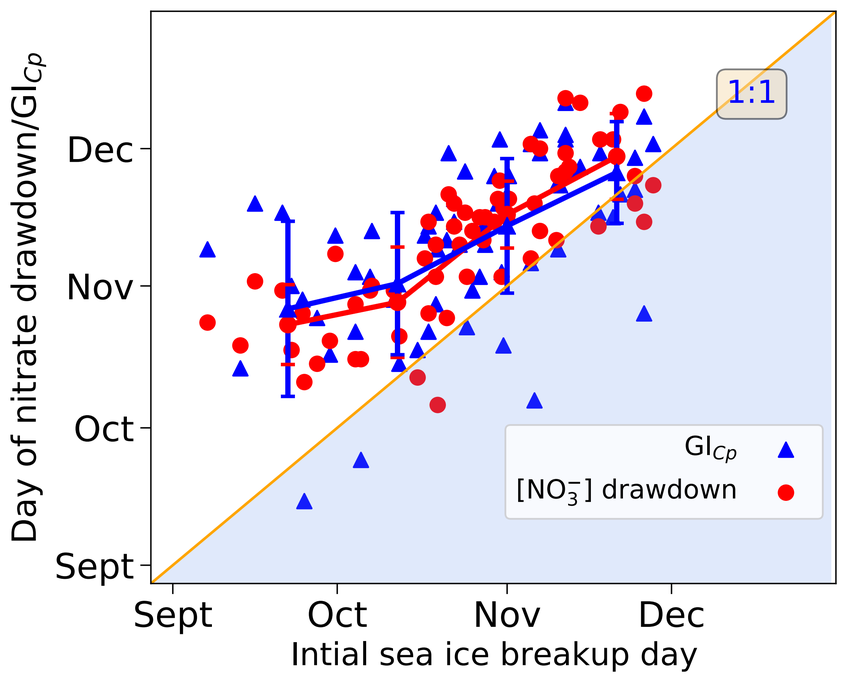
Estimate net community production during the phytoplankton bloom (bNCP) from seasonal change in Nitrate (vertically integrated to depth of the winter MLD).

Fig. 1



Results

Fig. 2



Initial sea ice breakup spurs increase in phytoplankton biomass and nutrient drawdown.

Fig2 : Phytoplankton carbon (C_p) increase **and** NO_3^- decrease **occur after initial sea ice breakup. This occurs while SIC is near complete** (>85%)

Majority (64%) of total NCP during the phytoplankton bloom occurs under partial sea ice cover (Fig 3). Higher daily NCP rates are found under partial sea ice than after sea ice retreat.

Higher bNCP is observed when sea ice breakup occurs earlier in the year (Fig 4). However, the amount of available light during the bloom is not significantly related to the magnitude of bNCP.

The highest estimates of bNCP (yellow dots Fig 1) occur near Maud rise and downstream of islands, which we hypothesize may be due to increased iron supply in these areas.

Fig. 3.

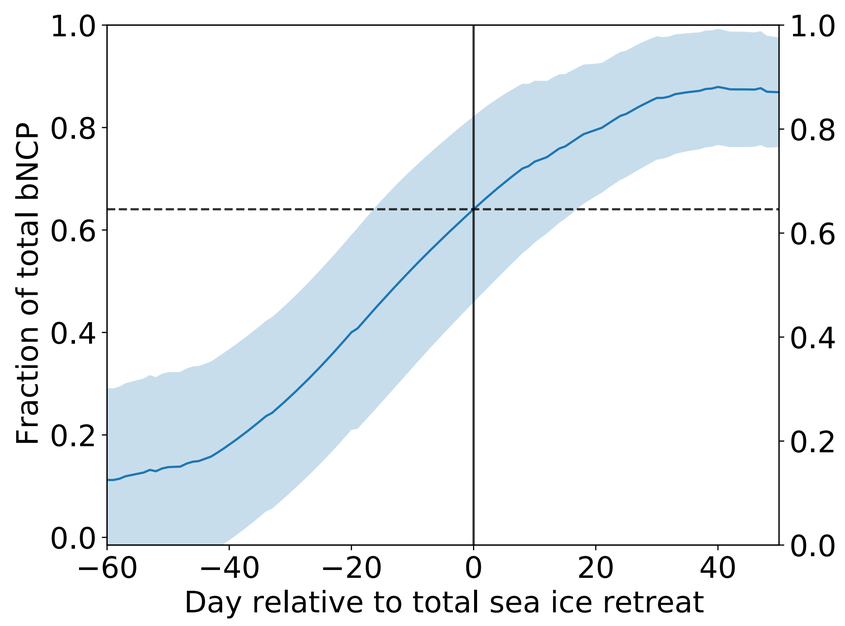
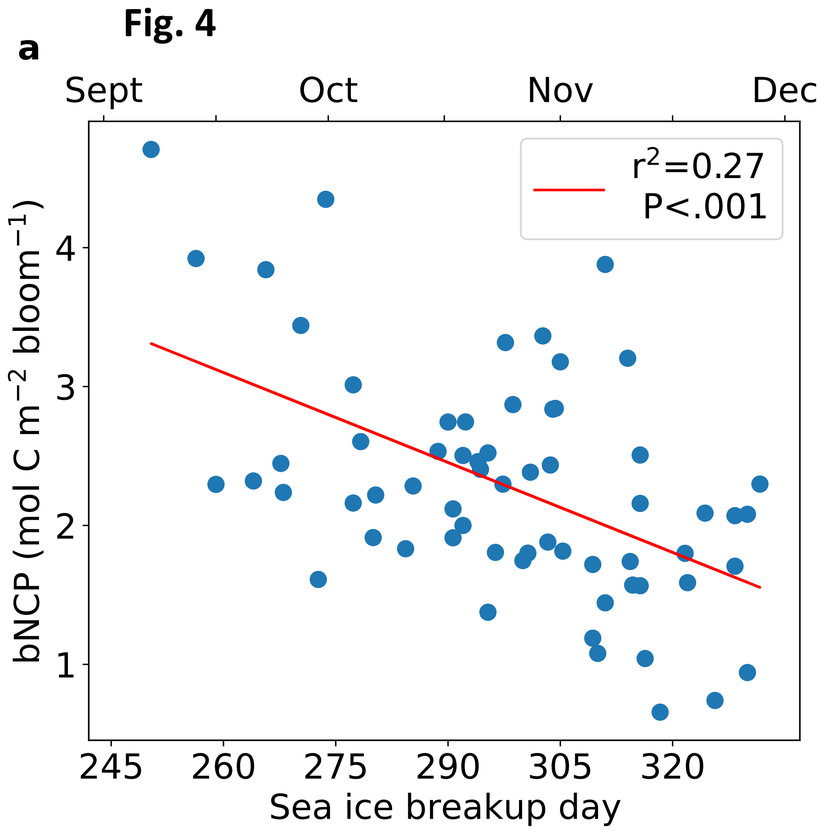


Fig. 4



Conclusions

The sea ice region may contribute more to total Southern Ocean production than previously estimated from satellite-derived ocean color observations that do not include under-ice production. Furthermore, our results indicate that future changes in sea ice will affect the timing and magnitude of SIZ phytoplankton blooms and biogeochemistry.

References

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