

Interactive comment on “Satellite observations of new phytoplankton blooms in the Maud Rise Polynya, Southern Ocean” by Babula Jena and Anilkumar Narayana Pillai

Babula Jena and Anilkumar Narayana Pillai

bjena@ncpor.res.in

Received and published: 9 February 2020

Reviewer's suggestion 1: General comments: The authors reported phytoplankton blooms in the Maud Rise Polynya, Southern Ocean, which was unseen earlier in spring seasons from entire records of ocean color satellite data acquisition. On the basis of satellite data from CZCS, SeaWiFS, MODIS, and VIIRS they showed the bloom appeared for the first time in the satellite records since 1978. The linkage between the observed bloom and the oceanic pCO₂ condition were studied using Argo data. The low pCO₂ values in the polynya was possibly due to the presence of chl-a bloom with high NPP, which has potential to drive CO₂ fluxes from the atmosphere to the

C1

ocean. The observed biological pumping process in the polynya could play an important role for lowering the atmospheric CO₂ through transferring of atmospheric CO₂ to the ocean. I would suggest the authors to revise the manuscript according to the following comments.

Authors: Thanks for your insightful comments and we will revise the manuscript accordingly.

Reviewer's suggestion 2: Specific comments: Authors have shown the upwelling of high saline and warm water leads to melting sea-ice. While the conclusions are supported by the evidence, do the early loss of sea ice cover should lead to the warming of mixed layer through radiative heating particularly increase of shortwave radiation in the ocean surface in spring period? So the authors are suggested to look into any unusual enhancement of shortwave radiation in the polynya region during the study period compared to the long-term prevailed condition?? Any satellite or reanalysis/modeling product is adequate for this analysis.

Authors: As per the suggestion, we have analyzed the shortwave radiation for looking into any unusual enhancement of values in the polynya region. We computed the anomaly of shortwave radiation in September-November 2017 from the long-term mean of 1979-2015. Analysis indicated record highest gain of shortwave radiation in the polynya region during September-November 2017, considering the 38-year time series starting from 1979 through 2016 (Figure. S9). The observed anomalous gain is possibly due to the early loss of sea ice cover. The results will be included in the revised version. Thank you so much for your suggestion that has helped to improve the quality of the manuscript

Reviewer's suggestion 3: Even though some of the works are now included by the authors for the analysis of mixed layer warming (comments from other reviewers) on the Maud Rise, the shortwave heat input in absence of ice cover is crucial. Yet the manuscript is structured superbly with scientific understanding and hard to find tech-

C2

nical flaws. Some data are known to have uncertainty in the polar waters specifically remote sensing based primary productivity (level-4) viz. vgpm, eppey-vgpm, cbpm models, that lacking validation with ship measurements. But the uncertainties in remote sensing methods are apparently quantified by the authors using in-situ NPP estimated using ^{13}C tracer from the Indian scientific expedition to the polar waters.

Authors: We do agree that the shortwave heat input in the polynya is crucial, and therefore the analysis has been carried out as per your suggestion (Figure. S9). In fact, in-situ net primary production (NPP) observations are rarely available for the Southern Ocean. The main source of NPP data for the Southern Ocean is the ocean-colour-based models widely used in the scientific community. We evaluated the performance of these models by comparing with the in-situ NPP estimated using ^{13}C tracer during the Indian scientific expeditions to the Southern Ocean.

Other minor comments: Reviewer's suggestion 4: Line 15: Make expansion of 'MODIS'

Authors: We will expand as Aqua-Moderate Resolution Imaging Spectroradiometer.

Reviewer's suggestion 5: Line 140: It should be 'covered by the sea-ice'

Authors: We will correct it.

Reviewer's suggestion 6: Line 170: Describe about the white contours in figure 2.

Authors: We will describe about the white contours as bathymetry in figures 2.

Reviewer's suggestion 7: Line 230: Are there any studies that quantifies carbon fixation by prymnesiophytes (*Phaeocystis antarctica*) and diatoms in Antarctica sea ice?

Authors: As per our knowledge, there is no comprehensive study that quantifies carbon fixation by prymnesiophytes (*Phaeocystis antarctica*) and diatoms in the Antarctica sea ice.

Reviewer's suggestion 8: Line 230: Diffuse attenuation coefficient at 490 may be included here (see the comments from the other author) and discuss in the text.

C3

Authors: We will discuss about the diffuse attenuation coefficient in the appropriate place.

Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2019-282>, 2019.

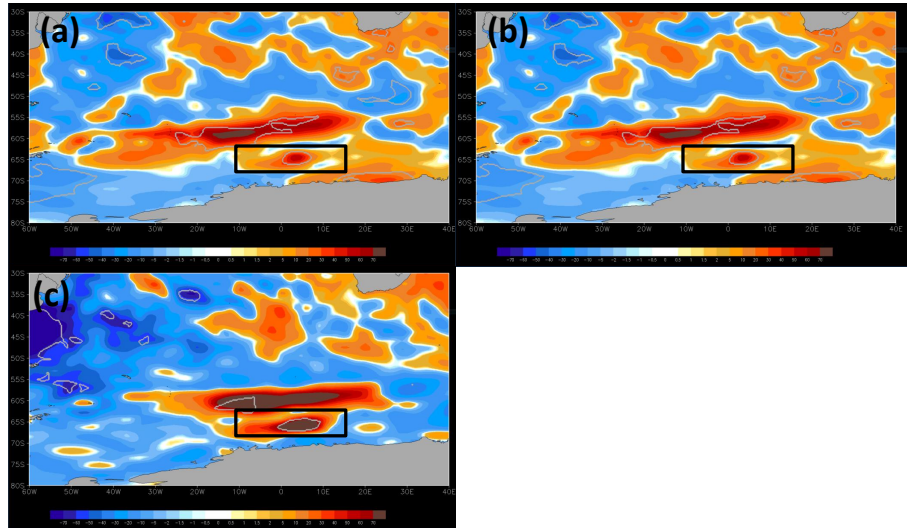


Figure S9. Monthly anomalies of shortwave radiation for (a) September, (b) October, and (c) November 2017 in the Maud Rise polynya (black rectangles). The anomalies were computed relative to a 38-year climatology (1979-2016). The regions within grey polylines shows the record level shortwave radiation in 2017 that lies outside of shortwave radiation values from 1979 to 2016.

Fig. 1.