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**Biogeosciences Discussions**

# *Interactive comment on* "Nitrogen uptake by phytoplankton in the Atlantic sector of the Southern Ocean during late austral summer" *by* W. R. Joubert et al.

**W. R. Joubert et al.**

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Specific comments

Introduction: A more detailed presentation of the principle and the meaning of estimates based on nutrient-uptake and on 234Th deficit would be highly appreciated. Response: Introduction modified with a more detailed description of the Nitrogen uptake and 234Th deficit methods used in the manuscript.

Methods: Fig. 1: please provide a larger map showing the general position of the studied area. Response: Increased the font size of figure axes, updated the caption and indicated the position of South Africa on the map.



Are surface temperature and salinity data presented in Fig. 2 derived from a thermosalinometer measuring surface data in continuous? It is not mentioned in the method description. Response: Method description updated. "Onboard thermosalinograph data were collected in continuous mode and validated with daily water sampling followed by on-board analysis." was added to the section 2.2 in the manuscript. The figure caption was updated accordingly.

In the Result section (e.g. page 4929 l. 22) the depth of the mixed layer is cited, please describe how you identified the mixed layer depth. Response: "Mixed layer depths were determined using the temperature criteria (Temperature difference < 0.2oC from the surface reference value described by deBoyer-Montegue et al (2004)," were added to the methods section 2.2. Mixed layer depths at each sampling station were added to Table 1.

For the same reason, as the depth corresponding to 1% light is indicated, describe how was light availability measured. Was there a PAR sensor associated to the CTD? Response: An underwater PAR sensor was attached to the underway CTD to determine the irradiance levels with depth in the water column, see section 2.6. Furthermore, the irradiance levels were added to Table 1.

Nitrogen uptake: it is written that tracer additions were approximately 10% of ambient nutrient concentrations; however, from the concentration of the inoculum it seems that 15NH4 additions were greater than 10% in most cases. Was the amount inoculated constant or was it modified during the cruise according to the expected natural concentration? Response: Inoculum was kept constant throughout the cruise, resulting in ammonium inoculums concentrations of greater than 10%. Section 2.6 is updated accordingly.

Was new production in mmol C m-2 d-1 calculated from NO3 uptake using the in situ C:N ratio? It is written in the caption of Fig. 7, but it should be briefly mentioned also in the Methods section. Response: Methods section 2.7 is updated to include the

description of new production calculated from the NO3 uptake results and in situ C:N ratios.

A list of abbreviations used in the paper could facilitate the reading and understanding of the text. Please note that APF has not been defined. Response: A list of abbreviations added to the manuscript as Table 1. Typographic error APF was corrected to PF as the abbreviation for Polar Front throughout the manuscript.

Results: Fig. 3: please improve the quality as labels are not easy to read. White dotted lines are shown in Fig.3, but their meaning is not described in the caption. You could add: "lines as in Fig. 1." SaccF and SBdy, cited in the result description (p.4926 l. 4-6) are not clearly defined in the figure (Fig. 3) (see previous comment). Response: Figure 3 were divided into 3 separate figures instead of 2 as in the original manuscript. Fontsize of figure axes and labels were increased and the frontal positions are described in the captions.

Page 4924-4925 l. 20-24; l. 1-3 silicate concentrations in STZ and SAZ seem similar, however from the comments in the results it seems that the SAZ is more depleted. Response: Depleted Si(OH)4 concentrations for both STZ and SAZ were similar, and the cut-off concentration for both regions subsequently described as < 2 $\mu$mol l-1 for depleted concentrations in these regions. Manuscript updated accordingly.

Both absolute nitrogen uptake (N) and specific uptake (VN) are presented, however, unless a more in depth consideration on the significance of the two variables and on the spatial variability of N and of VN are presented, one of the two figures (Fig. 5 or Fig.6) can be removed, without losing information. Response: Figure 5 is removed and only Figure 6 is displayed, relabelled and discussed.

Discussion: Variations in nitrogen uptake dynamics are ascribed to several environmental parameters such as nutrient availability, mixed layer depth, light availability andiron concentration. However, some of these parameters (mixed layer depth, light availability, iron concentration) are not presented in tables or figures. I suggest to in-



sert in Table 1 the depth of the mixed layer and the depth of 1% light penetration, or to superimpose a line on Fig. 3. Response: We added the light penetration and mixed layer depths to Table 1. Caption of Table 1 is also updated. Iron concentrations was collected during the cruise and are referenced from Chever et al. 2010.

Has iron concentration been measured during the cruise or its role is derived from the literature? Page 4928 l. 25: why "alleviation of iron stress"? Are there any data on iron concentration during the cruise available? Response: Yes, Iron concentrations collected during the cruise are referenced from Chever et al. 2010.

Page 4929: some areas in the Southern Ocean are either Silicate or Nitrate limited (see e.g. Goeyens et al, 2000 Nutrient depletions in the Ross Sea and their relation with pigment stocks. Journal of Marine Systems). From your data, it seems that SAZ and PFZ are Silicate limited. Could this sustain the planktonic size structure? Response: Silicate limitation mainly affects diatom growth. Low chl-a pigment concentrations were observed in the PFZ, corresponding to depleted silicate concentrations. The discussion is updated to highlight the possible limitation of diatom production due to low silicate concentrations in this regions.

A more extensive discussion on the meaning of estimates based on nutrient-uptake and on 234Th deficit would help to better understand the importance of the comparison. Response: Section 4.3 updated to have a more extensive discussion on comparison between the two estimates.

The relevance of the results obtained should be better highlighted by giving more attention to the comparison with data from other regions of the Southern Ocean (Table 2), in order to understand the role of the studied region to biological CO2 uptake and export. In particular, as results are presented for different hydrographic regions, it is expected to recognise which region may contribute more to export production and for what reason. This important information does not appear clearly from the discussion and conclusion and should be better emphasized. Response: The discussion is up-

dated to better emphasise and highlight the comparison with other datasets as well as the relevance of this dataset.

Conclusions: Some conclusions seem not to be supported by data, but rather based on the literature (page 4932 l.7). Response: Conclusions section is modified and based on observations from the results obtained.

References: Page 4937 l.15 and p.4939 l. 2: I do not think that an article “in preparation” could be cited Response: The articles in preparation will form part of the Bonus Goodhope Special issue for which the current manuscript is submitted.

Technical corrections: Some typographic errors (p. 4932 l. 8) Page 4941 l. 1 Table 1:Caption Page 4951 Fig. 6: In caption specific uptake per hour (V, h-1) on Y axis per day V d-1. Response: Caption of Table 1 corrected to read: “List of data at each sampling station during the BGH cruise (MLD, sample depth, chl-a, $\mu$g l-1; POC and PON, $\mu$mol l-1; nutrients, $\mu$mol l-1; N, nmol l-1 d-1). The five sample depths at each station represent, with increasing depth, the 100%, 50%, 25%, 10% and 1% light depths.” Caption of Figure 6 corrected to (V, d-1).

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Interactive comment on Biogeosciences Discuss., 8, 4917, 2011.



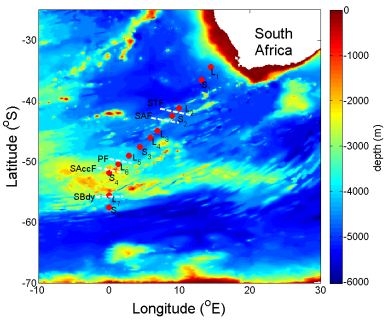


**Fig. 1.** Figure 1. Cruise track during the Bonus Goodhope 2008 campaign in the Atlantic Southern Ocean.

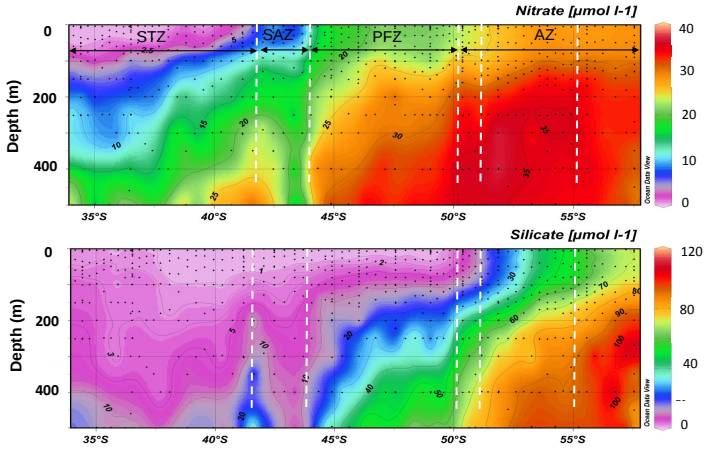


Figure 3 a, b. Profiles of $NO_3$ and $Si(OH)_4$ in the upper 500 m along the Bonus Goodhope Cruise track (taken from LeMoinge et al., 2011). It shows increasing surface nutrient concentrations with increasing latitude. Frontal positions are indicated by the white vertical dotted lines.

**Fig. 2.** Figure 3a,b: Profiles of NO3 and Si(OH)4 in the upper 500 m along the Bonus Goodhope Cruise track



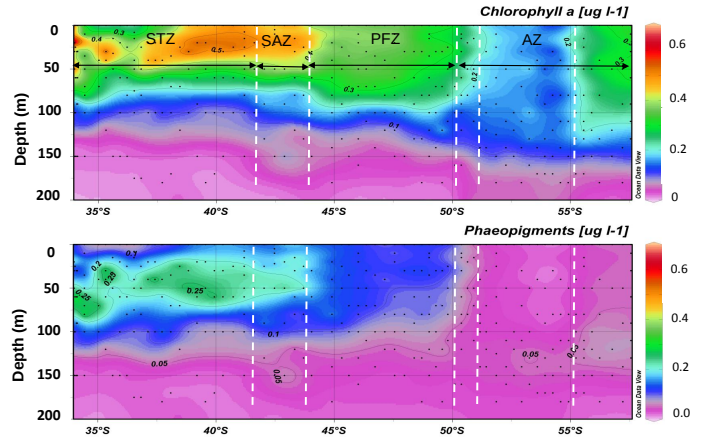


Figure 3 c, d (cont.). Profiles of chlorophyll-a and phaeopigments in the upper 200 m of the water column along the Bonus-Goodhope cruise track (Taken from Beker et al, 2011). Elevated pigment concentrations were observed in equatorward of the Subtropical Front. Frontal positions are indicated by the white vertical dotted lines.

**Fig. 3.** Figure 3c,d: Profiles of chlorophyll-a and phaeopigments in the upper 200 m of the water column along the Bonus-Goodhope cruise track