

Review of “Expanding the global coverage of gross primary production and net community production measurements using BGC-Argo floats” by Izett et al.,

**General comment:** This manuscript aims to provide an overview of available estimates of gross primary production (GPP) and net community production (NCP) obtained from the analysis of BGC-Argo float data. The manuscript starts with a detailed description of the assumptions driving GPP and NCP measurements based on float data, intertwined with a description of some of the existing studies reporting such productivity estimates for different ocean regions (and globally). In the second part of this manuscript (section 3 onwards), the authors further review available NCP estimates for OSP, and conduct their own novel analysis to derive global GPP estimates. Overall, I believe there is a lot of useful information compiled in this work, but the different sections of the manuscript feel disconnected from one another. Moreover, regarding the review of NCP estimates, the authors omit several studies that have inferred respiration rates in the mesopelagic layer from float data and have been used to obtain NCP estimates in the Southern Ocean. My initial recommendation is to divide the present manuscript into two separate works, dealing with GPP and NCP, separately. At this stage, I find the work related on GPP to be potentially more robust than that on NCP. Please see more detailed comments below:

**Specific comments:**

The introductory section is quite complete and provides a good description of the main productivity estimates that one can find in the literature (PP, GPP, NPP, NCP, etc.). For the most part, I like Figure 1, but I do not quite understand the second set of lines below the grey line indicating “autotrophic”. I would recommend simplifying panel (a) by removing the last three lines.

Figure 2d does not make sense to me given the large deployment of floats and profiles made available through the SOCCOM program. Based on this panel, it seems as if the Southern Ocean is one of the least sampled regions in terms of BGC-Argo profiles, which is not the case. I have attached below a map from the GO-BGC website showing that the Southern Ocean is the region with the largest quantity of floats (and thus BGC profiles) (<https://www.go-bgc.org/array-status#locations>). Is Figure 2d perhaps yielding a misleading picture based on the way the data was binned? Furthermore, Figure 2d seems to be inconsistent with Figure 6a, where the largest number of profiles is indeed observed in the Southern Ocean.

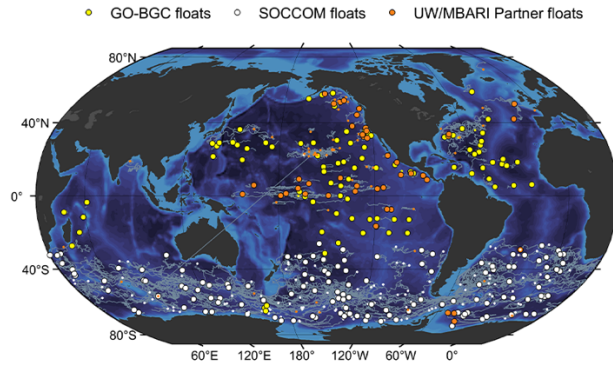


Figure from Go-BGC Map Room: <https://www.go-bgc.org/array-status#locations>

Section 2 provides a good description of the rationale behind the derivation of productivity rates based on tracer budgets and observations. However, community respiration (CR) should be preceded by a negative sign in all the equations where it is present (Eq 1, 2). In most cases, for budgets that include the effect of photosynthesis and respiration on tracers, respiration should always have the opposite sign to that of productivity/photosynthesis, as these chemical redox reactions “flow” in opposite directions.

Near line 115 “...are driven by daytime net autotrophic production ( $GPP + CR$ )”. Net autotrophic production is  $NPP (GPP - AR)$ .

Near line 125 “ $NCP (i.e., GPP + CR)$ ”. Should be  $GPP - CR$ .

Near line 160 “...derived from particle backscatter ( $bbp$ ) or beam attenuation ( $c_p$ , typically at 660 nm) measurements (both  $m^{-1}$ ) using regional (e.g., Loisel et al., 2011; Cetinić et al., 2012) or global (e.g., Graff et al., 2015) algorithms.”. The Graff et al, 2015 algorithm is not global, it is based on samples from an Atlantic Meridional Transect (AMT-22) and a subsection the Equatorial Pacific.

Section 2.1 is well documented and informative, but it has similar sign-problems in eq 5.3 (loss processes should be negative, as in eq. 5.1), and eq. 6 (again CR should be negative). This same correction applies for Figure 3, under assumptions, “ $GPP + CR$ ” should be corrected to “ $GPP - CR$ ”.

Section 2.2 for NCP. As this manuscript aims to provide a complete overview of all float-based NCP estimates/methods available, it should also include those applied to the mesopelagic layer, mostly conducted in the Southern Ocean to infer respiration rates, and thereby NCP, from oxygen drawdown:

- Martz, Todd R., Johnson, Kenneth S., Riser, Stephen C., (2008), Ocean metabolism observed with oxygen sensors on profiling floats in the South Pacific, *Limnology and Oceanography*, 53, doi: 10.4319/lo.2008.53.5\_part\_2.2094.

- Hennon, T. D., Riser, S. C., and Mecking, S. (2016), Profiling float-based observations of net respiration beneath the mixed layer, *Global Biogeochem. Cycles*, 30, 920– 932, doi:[10.1002/2016GB005380](https://doi.org/10.1002/2016GB005380).
- Arteaga, L. A., Pahlw, M., Bushinsky, S. M., & Sarmiento, J. L. (2019). Nutrient controls on export production in the Southern Ocean. *Global Biogeochemical Cycles*, 33, 942– 956. <https://doi.org/10.1029/2019GB006236>
- Su, J., Schallenberg, C., Rohr, T., Strutton, P. G., & Phillips, H. E. (2022). New estimates of Southern Ocean annual net community production revealed by BGC-Argo floats. *Geophysical Research Letters*, 49, e2021GL097372. <https://doi.org/10.1029/2021GL097372>

Section 3 suggest that examples of GPP and NCP will be showed at local and global scales. However, a local/regional example is shown for only NCP, and a global example is shown for only GPP. These GPP and NCP analyses seem therefore disconnected between them and from the previous sections of the manuscript.

Near line 400 “ *Float-based NCP studies are somewhat more numerous than GPP studies (Table A2) but are similarly limited in their 400 geographic extent. NCP has been well-studied around Ocean Station Papa (OSP; 50°N, 145°W) in the subarctic NE Pacific (sect. 3.1.1), and only a handful of localized studies have occurred elsewhere, such as in the S. China Sea (Huang et al., 2018) and the NW Atlantic (Alkire et al., 2014; Yang et al., 2021) (Fig. 2c).* “. This is incorrect, as it omits the Southern Ocean studies mentioned above.

Section 3.1.1. I think this analysis would be better presented in a manuscript dedicated exclusively to NCP or productivity fluxes at OSP. This way, the methodology could be better explained and expanded in a section of its own.

Section 3.2. Again, this section hints at the presentation of global NCP and GPP estimates, but results are presented only for GPP. This type of inconsistency could be addressed by having separate manuscripts on GPP and NCP.

Near line 475: “ *No studies to date have estimated global NCP from floats. Johnson et al. (2017) (Southern Ocean), Yang et al. (2019), and 475 Emerson and Yang (2022) (both Subtropical Ocean) have, however, provided extensive assessments of (A)NCP from a compilation of multiple floats. Johnson et al. (2017) used BGC-Argo data to characterize ANCP in the Southern Ocean by compiling NO<sub>3</sub><sup>-</sup> data from 24 floats deployed between 2009 and 2016. Similarly, Yang et al. (2019) and Emerson et al. (2022) compiled O<sub>2</sub> data from multiple floats to estimate ANCP in the North and South Hemisphere Subtropical Ocean.*”. Again, the studies listed above also used a compilation of floats to infer NCP in large regions of the Southern Ocean and should be referenced here.

Near line 490 “*Our calculations, we extend the work of ..*”. This sentence needs correction.

Near line 505 “ *There is generally good agreement between float O<sub>2</sub>- and bbp-based GPP and between the float estimates and independent GOP estimates derived from bottle sampling (Fig. 6b,c)*”. Also line 555 “*Float-based GPP estimates have been shown to compare well with independent data, and well between O<sub>2</sub>- and POC-based estimates (see our global GPP case study, sect. 3.2, also Johnson and Bif, 2021; Stoer and Fennel, 2022).*” I do not agree with these statements. On the contrary, I see a considerably disagreement between the zonally-averaged estimates presented in Figure 6b. From here on, most of the subsequent analyses are based on the premise of an agreement between independent GPP estimates, which is not supported by the presented analysis. The design and focus of the GPP and NCP analyses presented in section 3 do not seem to converge well together within one single manuscript. Therefore, I would strongly recommend having two different works for each topic. Overall, the review and novel analyses conducted with respect to GPP seem to be more mature than those for NCP. Perhaps the authors could consider approaching the topic of float-based GPP estimates first in a more concise manner.