

# ***Interactive comment on “Is dark carbon fixation relevant for oceanic primary production estimates?” by Federico Baltar and Gerhard J. Herndl***

## **Anonymous Referee #1**

Received and published: 19 July 2019

### General comments

The manuscript mentioned above by Baltar & Herndl estimates the importance of dark carbon fixation (e.g. chemoautotrophic production plus anaerobic reactions) in carbon budgets in the ocean. Authors use a novel approach to interpret routinely measured data, such as dark bottle incubations used for primary production estimations, to calculate dark carbon fixation rates. Interestingly the two datasets studied show a) that dark carbon fixation estimates are equal to 2.5 -22% of the phototrophic carbon fixation, b) there is a seasonal effect on the ratio of dark and light carbon fixation, especially for one site and, c) nitrification accounts for only a minor proportion (2-9%) of the total

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dark carbon fixation. These results are of relevance because they clearly show that dark carbon fixation in the euphotic layer can substantially increase the PP estimates. This estimated dark carbon fixation corresponds to a production of 1.2 to 11 Pg C y<sup>-1</sup> which scales well with the carbon respiration fluxes reported for ocean sediments and the dark ocean. Thus dark carbon fixation rates should be considered in future carbon budget studies of the ocean. Furthermore, the fact that nitrification plays a minor role in carbon cycling in the euphotic ocean suggests that the major sources of dark carbon fixation are unknown and deserve further study. In general, I find the manuscript well prepared and related work is well credited. To my knowledge, the methodology used is sound and I find no reason to doubt the interpretations of the data. I therefore recommend publication of the manuscript with minor corrections.

#### Specific comment

The results indicate that nitrification explains less than 10% of the total dark production. The Authors thus state that other chemoautotrophic processes (different from nitrification) and heterotrophic processes (anaplerotic reactions) should account for the remaining 90%. Assuming anaplerotic reactions account for 30% of this dark carbon fixation (line 72), then more than half of the activity remains un-assigned to a specific process. I ask the Authors to briefly discuss or present a specific hypothesis as to which other autotrophic processes may be involved, or suggest methods that can be used to unravel the sources of this unknown dark carbon fixation activity.

#### Technical corrections

Abstract: Choose one term throughout the text for consistency: “dark carbon fixation”, “dark DIC fixation” or “dark CO<sub>2</sub> fixation”.

Line 59: text states “citation on light sensitivity” please include reference

Line 114: please state actual maximum value instead of “>2.5”

Line 118” tendency detectable towards” change wording

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line 122: replace “sigma-t” with “density ( $\sigma_t$ )” ; after “[...] same period” add “Fig. 2).”

Line 123: change “(Fig 2)” to “(Fig 2C)”.

Line 123-125: When explaining the seasonality observed at Bats for the dark to light carbon fixation ratio the Authors mention a deepening of the deep chlorophyll maximum but do not explicitly describe how this affects the calculated ratio. I ask the Authors to rephrase these sentences so that the readers can clearly understand the connexion that is currently implied in the text.

Line 136-149: include a reference to Table 1 to guide the reader through the calculations

Line 138: change “[...] by (Yool et al., 2007)” for “[...] by Yool et al. (2007)”

Line 139-140: state the  $\text{NH}_4^+$  values taken from Segura-Noguera MM et al 2014 and Lipschultz 2001 to estimate nitrification either in the text or in table 1.

Line 141: Dore & Karl are written twice. Correct reference

Line 156: “during over the diel cycle” please correct wording

Line 158-159: add a reference to Table 1

Line 163: add citation for the concept that nitrification is reduced in light

Figure 1: keep the same range for the ratio for both plots, from 0 to 3, so that the colour scheme is the same.

Figure 2: remove names from plots (upper right corner) or write correctly (not Temp but Temperature)

Table 1: last column “% of dark DIC fixation from other chemolithoautotrophic and anaplerotic processes to total PP” is not explained or referred to in the text for either site. Please erase from table. Change “chemolithoautotrophy” for “chemoautotrophy”

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