**Biogeosciences
Discussions**

Interactive comment on "Direct observations of diel biological CO$_2$ fixation in the oceans" *by* H. Thomas et al.

H. Thomas et al.

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We are grateful for the reviewer comments, which helped improve the manuscript significant. We have chosen to acknowledge this accordingly.

Referee 1: This paper focuses on the analysis of the diurnal variability of oceanic CO2 partial pressure (pCO2) measured by a CARIOCA sensor on the Scotian Shelf. It is based on a long time series of pCO2 already published by Shadwick et al.2011. Given the very few time series of pCO2 sampling the diurnal cycle, only a few studies appeared recently about pCO2 diurnal cycle. Hence the description of the pCO2 diurnal cycle in this particular region is original. However, its interpretation is misleading and the paper does not focus on this particular region. The paper refers only to biological processes whereas it is expected that the diurnal variation of the stratification in the

mixed layer plays also a role. The contributions of the biological activity plus diurnal stratification on pCO2 diurnal variation as observed by surface CARIOCA sensors has been first described in Boutin and Merlivat (GRL 2009) and more recently (including O2 measurements) in Lefèvre and Merlivat, GBC, 2012. None of these papers is referred in the manuscript. Because of the daily stratification and the nightime mixing, the increase of DIC during nightime cannot be simply interpretated as the result of the respiration process (p2159) : it is also due to surface depletion of DIC by biological activity during the day at the particular depth where the CARIOCA sensor is and to nightime mixing of surface waters with deeper waters less depleted in DIC. This leads Boutin and Merlivat 2009 to propose to estimate NCP from the day-to-day decrease of DIC at the end of the night when the DIC in the mixed layer is homogeneized. With respect to previous studies already cited, the SeaHorse vertical profiles, could probably help monitoring the development of diurnal T and S stratification. Conclusions about grazing and transitional metabolic rates are premature given the unknown effect of vertical mixing not taken into account in this study.

Response:

Thank you very much for this question, pointing to an important process. We agree that both papers are relevant for our paper, and we apologize to have overlooked them. We now have referred to both papers and added a figure (Fig. 2b) and a section to the text, investigating this effect. We can show that at our station there is no significant diel cycle in mixed layer depth, which would cause such an effect. This obviously is different at longer, seasonal timescales, where DIC entrainment from the subsurface water plays an important role in autumn, as argued by Shadwick et al. (2011, Mar. Chem). Furthermore, we have broadened our discussion of recent findings substantially, including a consideration of the above mentioned publications.

Referee 1: Detailed comments: Title: 'in the oceans' is too vague; as already mentioned, other studies in the Southern Ocean and in the tropical Atlantic have already studied the diurnal cycle of pCO2

Response:

We have adapted the title accordingly.

Referee 1: Section 2: recall the depth of CARIOCA sensor and the depths sampled by the Sea- Horse

Response:

The following details have been added: "...we combined the CARIOCA data with observations from the SeaHorse, an autonomous profiler (Greenan et al., 2004, 2008), which records water column profiles of temperature, salinity, photosynthetically available radiation (PAR), and downwelling irradiance (Ed(λ)) between depths of 3-80 m."

Referee 1: Section 3: -p2158: It would be better to define pCO2,obs, pCO2,temp, pCO2bio using equations. They should appear in section 2. Fig 3: what is the meaning of ' they are independent'? -p2159: the way NCP and GPP are computed should be described in section 2 but again the way they are derived is too simplistic

Response: We have introduced define pCO2,obs, pCO2,temp, pCO2bio as suggested in the methods section, as well as the computations of NCP and GPP. Also we have added the requested section on the role of MLD in governing pCO2 a diel time scales, such that NCP and GPP are sufficiently robust now.

Referee 1: Figures: the Figures are difficult to read (too small). Figure 2: why plotting the temporal evolution of the coherence as a function of SST? Wouldn't be better as a function of time?

Response: The size of the figures appears to be an editorial issue, which we shall bring to the attention, if the paper should be in production. Thank you very much for this hint. We have chosen monthly bins and a dependence on SST within these bins, since SST is the relevant variable here, and not time. As we argue the diel cycles in pCO2 can only be observed during the rise in SST, which of course can be attributed to a certain time, as we did by using monthly bins.

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