

Interactive comment on “Light availability modulates the effects of warming in a marine N₂ fixer” by Xiangqi Yi et al.

Anonymous Referee #1

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The authors investigated the combined effects of light and temperature on the growth, N₂ fixation and photosynthesis in the marine diazotroph, *Trichodesmium*. Light and temperature are two of the most environmental drivers for this species as for other marine primary producers. However, the combined effects of these two factors have surprisingly little been documented on *Trichodesmium*. This work fills such gap. The new finding from this work is that the thermal responses in *Trichodesmium* are strongly dependent on light exposures when grown under different light and temp levels. The parameters derived from the measurement are of significance in predicting the responses of *Trichodesmium* to ocean physical environmental changes associated with global changes. Generally, this work has been well performed and delivers a clear message, but some revisions are needed before being considered acceptable for publication at BG:

1. Line 65, “. . . where light intensity could be as low as 2 $\mu\text{mol quanta m}^{-2} \text{s}^{-1}$ ”. What’s the source of this number?

Response: We used the following equation to get this number:

$$E(d) = E_0 * \exp(-k * d)$$

E(d) is the light intensity ($\mu\text{mol quanta m}^{-2} \text{s}^{-1}$) at depth d(m); k is the light extinction coefficient; E₀ is the surface solar irradiance. We assumed that the water column was homogenous, extinction coefficient was 0.05 m^{-1} (common value reported for subtropical and tropical pelagic oceans (Olson et al., 2015)) and surface solar irradiance was 2000 $\mu\text{mol quanta m}^{-2} \text{s}^{-1}$.

In the revised manuscript, we will add references here which can directly give similar number.

2. Line 69, “. . . *Trichodesmium*’s N₂ fixation and growth,”. It’s better to delete “’s N₂ fixation and growth”.

Response: we will follow this suggestion.

3. Line 115 – 118. In the treatment “light-limiting, 31 oC”, the N₂ fixation rate under growth condition was obtained through an indirect and unusual way. I recommend that the authors should also take the N₂ fixation rate measured at >31oC into consideration (maybe use the average of this and that measured at 30 oC), although such modification may alter the Figure 1b, and require revision of related text.

Response: We will try this.

4. Line 122. “. . .Aliquots of 1.5 m . . .” should be “1.5 ml”.

Response: This will be corrected.

5. The authors should describe the statistical analysis techniques they used in the Material and methods. Although I can roughly deduce the used statistical techniques from the text in Results, the authors should explicitly present them, which will help readers evaluate their results and conclusions.

Response: This was a big mistake, and we will add the paragraphs describing how we analyze the data. Generally, we used the two-way ANOVA and Tukey test to determine the effects of light, temperature and interaction of light and temperature on the tested physiological traits, such as growth rate, effective photochemical efficiency, N₂ fixation rate (Figure 1) and parameters obtained through non-linear fitting (Table 1; Figure 2, 3, 4).

6. Figure 3. It seems that the selections of temperature gradients are different among different treatments, which is uncommon. Why? Will this affect the interpretation of the data?

Response: We found that the temperature was not homogeneous in the multi-zone chambers that were used to measure the response of N₂ fixation to acute temperature changes (Figure 3), so we used the actually measured temperatures rather than the pre-set temperatures. No, this should not be a problem.

7. Line 202-205. How did the authors get the numbers “>28% and 7%-20%”? The cited literatures do not provide such numbers.

Response: We got these numbers from the figures in the cited references (Figure 3 in Davis & McGillicuddy, 2006; Fig 8 and 10 in Olson et al., 2015), although they do not show up in the text.

8. Table 1. In the text, the light treatments were referred as “light limiting” and “light saturating”, but in this Table they were denoted as “LL” and “HL”. It will be better to keep them consistent.

Response: We will replace “LL” and “HL” with “light limiting” and “light saturating”.

9. Fig 3b. The temperature norm of N₂ fixation in the treatment “light-limiting, 31 oC” is quite different from those in other treatments, which deserves more discussion. However, authors didn’t put much attention on this phenomenon.

Response: We guess that the unusual performance in treatment “light-limiting, 31 °C” might be related to the nitrogenase damage which was induced by the high growth temperature and exacerbated by the light limitation. The quantity of the functional nitrogenase might be not enough to form the expected N₂ fixation peak. We will try to explain this phenomenon in the revised manuscript.

All in all, this work focused on a valuable but previously overlooked scientific topic and obtained some interesting results. If the authors can properly deal with the concerns listed above, I think it will be qualified to be published in BG.

Davis, C. S., & McGillicuddy, D. J. (2006). Transatlantic Abundance of the N₂-Fixing Colonial Cyanobacterium *Trichodesmium*. *Science*, 312(5779), 1517-1520. doi:10.1126/science.1123570

Olson, E. M., McGillicuddy, D. J., Flierl, G. R., et al. (2015). Mesoscale Eddies and *Trichodesmium* Spp. Distributions in the Southwestern North Atlantic. *Journal of Geophysical Research: Oceans*, 120(6), 4129-4150. doi:10.1002/2015JC010728