

Biogeosciences Discuss., author comment AC1
<https://doi.org/10.5194/bg-2021-90-AC1>, 2021
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Reply on CC1

Federica Maggioni et al.

Author comment on "The Bouraké semi-enclosed lagoon (New Caledonia) – a natural laboratory to study the lifelong adaptation of a coral reef ecosystem to extreme environmental conditions" by Federica Maggioni et al., Biogeosciences Discuss., <https://doi.org/10.5194/bg-2021-90-AC1>, 2021

The authors examine temporal and spatial variability in environmental conditions in a semi-enclosed mangrove lagoon in New Caledonia. Their results show that this system experiences extreme fluctuations in key environmental parameters mainly explained by tidal variations. I acknowledge the amount of work presented here that is especially useful and relevant to study the impact of temporal scale variability in ecosystems and its role in future global environmental change. However, this manuscript has substantial issues, and my main comment concerns the use of the literature. It is unfortunate that the authors fail to acknowledge important existing literature directly relevant to their study.

Response: We thank Dr. Dubuc for her time and her interest in our results. It is always difficult to mention all the relevant literature in an ms about essential issues such as climate change, coral reefs, environmental parameters, species distribution, etc. We had to make difficult choices to limit the number of citations (now already 110).

For instance, a large gap in their discussion concerns the explanation of why environmental conditions fluctuate in such way. Even if they acknowledge the role played by the mangrove forest in explaining the recorded variability, they mostly fail to provide a mechanistic explanation.

Response: Respectfully, the aim of this ms has not the pretension to provide a mechanistic explanation of the variability in the recorded environmental conditions as we reported in our conclusion (line 819). Our aim is clearly stated at the end of the introduction: we characterized the variability of multi environmental parameters and the distribution of primary benthic organisms living in Bouraké. Comparing our observations with the existing literature on the effect of ocean acidification, warming, and deoxygenation on corals, we were surprised by the presence of an abundant reef. We agreed with the previous finding by Camp et al. (2017) that Bouraké is a unique opportunity to investigate organisms 'response' and adaptation to extreme environments in a natural setting. Limiting our ms to the above-mentioned aims, we already provided a long and complex ms (42 pages; 11 figures; 2 tables + SI). We agree that this semi-enclosed lagoon within a mangrove forest, which has such a tide effect and is characterized by such environmental variability, is particular and of considerable interest. If we had to explain the mechanisms involved in such variability: i) the ms would become much more than 42 pages long; ii) our conclusions would be merely speculative since we would need dedicated physical and chemical measurements for each of the mechanisms

evocated. In addition, given the already complex nature of our article we felt it was too heavy to add these hypotheses and their discussion as well. However, more in-depth analyses of organic matter, its origin, and its effect on deoxygenation and pH are underway.

Intertidal areas, especially mangrove habitats, are well known to experience fluctuations in environmental parameters such as conditions described here. Please refer to key papers such as Alongi et al., 2004 and Dittmar et al., 2006 explaining the role of the large amount of organic matter in driving deoxygenation and acidification of water in productive environments such as mangrove areas. Also, please refer to Li et al., 2009; Bouillon et al., 2007; Gleeson et al., 2013; Call et al., 2015 for an explanation concerning the tidal pumping, a well-known mechanism responsible for deoxygenation and acidification during the ebbing tide. Therefore, their results are not surprising and expected for an area like this semi-enclosed mangrove lagoon.

Response: Likely we were not clear enough, and we will better clarify that this site is not a classic mangrove habitat, although within a mangrove forest. The difference here is the lack of a river, typical of most coastal mangrove habitats, and the site location, which is an arid geographical area. This is why a true coral reef thrives in such an environment, making this site unique. We are aware that environmental fluctuations characterize mangrove habitats. Most studies, including some cited above, are typical mangrove areas characterized by low salinity and high TDS concentrations, therefore not ideal for coral survival.

We agree that once we collect robust data to discuss the mechanisms involved in the environmental variability, we will cite the relevant literature that Dr. Dubuc suggested. We have great respect for colleagues and teams working on mangrove habitats, which is absolutely a complex topic because the physical and chemical mechanisms involved are multifaceted and interactions challenging to disentangle. We have a lot to learn from these studies, and with great humility, we will try to discuss in a future ms the complex interactions and chemical mechanisms of water with sediment, mangrove, etc.

Additionally, authors claim to have discovered this system which provides new means to study the future impact of climate change; however, this is not true, and previous works should be acknowledged. This site has indeed already received considerable attention starting as early as in 1988, regarding the environmental conditions (Komornicki, 1988; Thollot, 1992; Dubuc et al., 2019a) but also the benthic composition (Thollot, 1992) and fish assemblage composition (Komornicki, 1988; Thollot, 1992, Thollot et al., 1999; Dubuc et al., 2019b). These studies need to be acknowledged and the novelty of their own work considerably toned down.

Response: Respectfully, we have never mentioned in the ms that we have discovered this system. We recognize that previous studies such as some from our colleagues (e.g., Komornicki, Kulbicki and Thollot) reported data from the Bouraké lagoon, however: i) they investigated fish abundance and trophic structures; ii) they never described the benthic communities; iii) they did not measure any environmental parameter and its variability. Therefore, since our ms is not on fish but on the benthic organisms and environmental variability of Bouraké, it was not relevant to acknowledge these studies. We deleted the word "fish" we used one time only (L 784) to avoid any misunderstanding.

To the best of our knowledge, Camp et al. (2017), based on short-term observations, described for the first time the extreme environmental variability corals were exposed in Bouraké. Then, two years later, two studies from data collected in Bouraké were published: the first, described the fish assemblages and their migration from the border into the mangrove forest in relation to the tide (Dubuc et al. 2019 PlosOne); the second, reported the impact of dissolved oxygen variation (DO) on fish migration into the forest,

always in relation to the tide (Dubuc et al. 2019 BGS). Interestingly, the latter study reported eight days of DO data, which confirmed the oxygen fluctuation reported by Camp et al. (2017). For that, we are happy to cite this latter in the revised ms.

Other minor comments:

Authors mention that they have collected environmental data from YSI probes starting in February 2016; however, their time series start from October 2018 and there is no further mention of recordings during 2016. This issue should be addressed by either providing the data, or by correcting the start year if this is a mistake.

Response: We wrote L 133: "From March 2016 to December 2020 up to eight YSI 600 OMS-M, three Seabird SeaFET pH loggers, and four Hobo water..."). This general sentence was followed by the sampling design, which was divided for clarity in short-, medium-, and long-term measurements (L 140, 147, 149, respectively). We clearly described the frequency of measurements, the sensors used, and the duration of acquisitions. This was also reported in table and figure legends. However, we will double-check and eventually correct all sampling periods through the ms.

The manuscript could benefit from additional work to correct for language mistakes and clumsy phrasing, see below for a few examples:

Response: The ms has been already revised by a professional grammar checker, but we agree that it could benefit from additional work.

l.79: subject(ed)

Response: Done.

l.87: to understand better; to better understand

Response: Done.

l.94: were exposed 44 % of (the) time

Response: Done.

l.100: remain(s) unclear

Response: Done.

l.169: diel tide cycles: it can either be tidal or diel cycle one referring to a 24h cycle and the other referring to the tidal cycle of 12h observed in New Caledonia.

Response: We corrected with diel cycle, which means that sampling was performed from early morning to late afternoon.

l.125: the spring tidal cycle; simply say spring tides

Response: Done.

l.734: hypoxia is species-specific and cannot be determined by a single value. I suggest changing the wording.

Response: We changed in: L 734 "However, our study shows that the Bouraké system can reach conditions close to hypoxia for several coral species (< 3 mg L⁻¹; Fig. 4)".

735: The natural laboratory of Bouraké, where DO fluctuates with the tide, in combination with other environmental stressors, offers a perfect setting to test the practically unknown effects of deoxygenation and hypoxia thresholds in reef-building corals exposed to acid and hot conditions (Nelson and Altieri, 2019; Hughes et al., 2020). This sentence needs rewriting. I suggest deleting hypoxia thresholds.

Response: We deleted hypoxia thresholds.

l.739: Besides the hypothesis that environmental variability improves the metabolism of organisms, particularly their resilience to extreme conditions, a series of other physical and chemical parameters in the Bouraké lagoon may work in combination to offset or enhance these effects. This sentence is confusing.

Response: We changed with: "Besides the hypothesis that environmental variability improves the metabolism of organisms, particularly their resilience to extreme conditions, a series of other physical (e.g., current flow) and chemical parameters (e.g., organic matter) in the Bouraké lagoon may work in combination to offset or enhance these effects."