

***Interactive comment on* “Environmental factors influencing cold-water coral ecosystems in the oxygen minimum zones on the Angolan and Namibian margins” by Ulrike Hanz et al.**

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We thank the reviewer for the efforts and input provided. We carefully went through all the comments and suggestions and have adjusted the manuscript accordingly. Below we provide a description of the adjustments made, addressing the reviewers remarks. Kind regards,

Ulrike Hanz (corresponding author)

Anonymous Referee #2 Received and published: 24 July 2019 This paper, according to the title, is about environmental factors influencing cold-water coral ecosystems

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in the oxygen minimum zones on the Angolan and Namibian margins. It describes results from a cruise off the southwest coast of the continent of Africa carried out in 2016. Specifically the cruise targeted two areas where previous work has suggested the presence of cold-water coral reef structures, one off the coast of Namibia and one further north off the coast of Angola. At each of the 2 sites landers were deployed, and across each site transects of CTD casts were made. There are numerous problems with the manuscript as it is written, many of which could easily be rectified. The first is that the paper is not really about cold-water coral ecosystems. The structures sampled in the Namibian sector are home to a deep water assemblage which just happens to have grown on the relict remains of a cold-water reef that died thousands of years ago. It could just have easily grown on emerging bed-rock, an oil platform or a relatively recent wreck. While what was found may be informative about hard-substrate dwelling assemblages, it tells us nothing about cold-water corals.

We agree that the ecosystem on the Namibian margin is not a cold-water coral ecosystem. We have emphasized in the text that it is a deep-water assemblage of sponges and bryozoans that is growing on cold-water coral remains, which grows in extremely low oxygen concentrations. We also have adapted the title of the manuscript.

The findings from the Angolan sector, on the other hand, do contain information relevant to our knowledge about cold-water corals, specifically extending our knowledge about the environmental envelope within which reefs may be able to survive, with some limited evidence for mechanisms which may assist their survival. Overall the question that the manuscript raises is why there are no living corals off Namibia, given that the conditions off Angola are not highly different and all the factors that apparently mitigate low oxygen there, such as abundant high quality food and tidal excursions replenishing depleted oxygen, are also present off Namibia where they support a different assemblage. Much of the manuscript is unfocussed and over-detailed. It reads like a cruise report. A large proportion of the information given is presented in formats that are difficult to digest and are ultimately irrelevant in the context of the paper. We do not

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need to know that 2 landers were deployed but only the data from one is used here, for example.

We have shortened the Materials and Method section and went through the manuscript to remove unnecessary information.

Samples for particulates and photo-pigments may have been collected from the CTDs, but there is no evidence analyses of these samples are used in the manuscript.

We have removed this from the manuscript, see comment above.

And so on. Several pages of text could be replaced by a table and/or as supplementary material, allowing the reader to focus on the portions of the data and interpretation that are directly relevant to the subject of the paper, namely factors influencing deep-water hard-substratum assemblages and supporting their survival in zones of reduced oxygen availability.

Specific comments:

P2 L35 Barotropic not barotrophic Changed.

P2 L37-39 Dead coral mounds are not CWCs, so a complete rewrite with consistent nomenclature is recommended It was changed in all relevant sections of the manuscript.

P2 L45 'Compensate' should be followed by 'for' We have added "for".

P3 L54 et seq. Spacing among references is needed A spacing was added to all relevant references.

P3 L72 If aragonite saturation is important why is it not mentioned in the rest of the manuscript, and why was it not measured in this study? In this study, we did not focus on the aragonite saturation even though it is an important factor. It is expected to not be a limiting factor in the Atlantic at these depths.

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P3 L77 If a specific density envelope is important why is it not mentioned in the rest of the manuscript, and why was it not measured? The appearance of CWCs in relation to the density envelope has been added to the discussion (L640-642).

P5 L114-118 Are key parameters influencing CWC growth and therefore mound development really the focus of this investigation? What do the surveys from Namibia tell us about CWC growth? There are no living CWCs there. What are the new insights into susceptibility? The focus of this manuscript is on benthic communities growing on coral mounds in oxygen depleted environments. We agree with the reviewer that the communities on the Namibian margin are no CWC ecosystems. We adapted the manuscript accordingly (see comment above).

P5 L127 All acronyms (here OMZ) should be defined on first occurrence in the manuscript. OMZ was defined in L110.

P6 L152-P7 L166 There were no CWCs at the Namibian site, only dead rubble with limited deep-water hard-bottom assemblages. We have changed the description of the benthic community to avoid confusion.

P8 L180-190 Important records and details of the biological communities were recorded, begging the question why more was not made of this data in the paper. Many fish species were recorded in the Angolan reefs, which presumably aren't all OMZ specialists. This was unfortunately not the focus of this manuscript, whereas we do agree that this information is very interesting. These data will be part of other manuscripts.

P9 et seq. Methods and results. We do not need complete details of everything that was done on the cruise, the cruise report is already referenced, we only need the sampling and analysis details for the variables of relevance to this paper. Much could be done to condense text into a table or SI, to considerably shorten and focus the manuscript. We do agree with the reviewer. We have shortened the text to only focus on relevant information.

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P10 L240 Why was turbidity data only collected from Angola, and were the data used? Unfortunately, no turbidity data were collected on the Namibian margin, due to technical issues with the sensor on the CTD. The data is shown in Figure 7.

P10 L274 What instrument was used to analyse the absorption spectrum etc? A Waters Acquity UPLC system was used (was added to material and methods L289)

P11 L284-285 'unsinf' - ? Why were the data mean and trends removed? The tidal analysis outcome will not change in respect of significant constituents or their amplitudes whether or not the means and trends are within the input data.

P12 L294 Why was 'SASSW' not discussed in the section describing water masses earlier? SCAW should presumably be SACW. The definition of SACW belongs in that section, not in the results. A short description of SASSW and AAIW was added (L 153-159) and the definition of SACW was moved to section 2.1.1. (L143-144)

P12 L297 Temperature differences must not be confused with actual temperatures. The -1.3 and -0.2 here are differences but they are reported as a values. This is a problem throughout the manuscript. AAIW was not mentioned in the section on water masses, and should have been. We agree that this might be confusing. Temperature differences are now reported as Δ values. AAIW is now mentioned in section 2.1.1. (L157-159).

P12 L305 et seq. Why DOconc and not simply DO, or even DO₂? Abbreviations should be defined on first use. The definition was added.

P13 L321 Table 1 is only metadata. A table of actual data would be helpful and reduce the need for a lot of text. An additional table with values from the lander deployments at the Angolan and Namibian margin was added (Table 2).

P13 L324 et seq. Are the r values Spearman rank correlations? What is the justification for this approach? Are values truly independent? Would a more multivariate approach not have been more appropriate? Why do correlations between temperature and DO

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switch from negative to positive? Spearman rank correlations were used because they show a general statistical correlation of two variables (water characteristics). Oxygen concentrations, for example, are not independent of temperature, whereas these dependencies are not strongly influencing the outcome since we were not investigating underlying causes for the correlations. Correlations did not switch from negative to positive. Both datasets from Angola come from two separate deployments in two separate depths and therefore show to separate correlations. We have indicated this more clearly in Fig 7.

P14 L331 It is unclear to this non-expert what several of the variables in Table 2 actually are/mean. I removed the polarization ratio. Other variables are explained in the table caption.

P14 L333 'whereafter', not 'where after' Changed.

P14 L327-341 Does this section not simply describe what is well known about the forces (e.g. along-shore winds) driving upwelling along this coast? Why is what is known not reviewed or discussed in more detail in this manuscript? It is reviewed in section 4.1.

P14 L342-347 Isn't this the key (and only really relevant) result? More should be made of it. Is the method appropriate for calculating such incursions? It would, of course, be much nicer to be able to capture these incursions with for example a mooring comprising the whole water column, but unfortunately, we did not use a mooring in this case. Our method is the best method we can use with the available data. We are aware that this is an estimation.

P16 L356-372 Was CTD data not used? Not used in this manuscript. (Changed in the method section, L265- 268).

P16 L374 The figure encapsulates all that we need to know about POM inputs, so the text should describe what it shows and the authors are encouraged to leave out much

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of the irrelevant details elsewhere in the manuscript. The figure also combines details from both sites. The authors could shorten the manuscript by producing combined sections comparing and contrasting the sites, rather than describing the 2 sites separately. We have changed the result section according to the recommendation made.

P16 L386 What is this surface water layer – a river plume? Should it not be described in the section about hydrography? This is now described in section 2.1.1. (L156-157).

P18 L408 Should this not read ‘from the shallowest to the deepest’? Some of this section is confusing. The paragraph was changed to remove eventual confusion.

P19 L425 What does ‘ $p < 0.01$, deep’ mean? It means that the correlation of turbidity and oxygen concentration during the deep deployment is significant. We changed the description to make it more clear (L403ff).

P19 L427-430 This is the result of relevance and should be focused on. It is focused on in section 4.4 and Figure 9. We have tried to stress the importance slightly more by adapting the text in section 4.4.

P21 L438 Would lower TOC and N in deeper waters not be expected? Could some of this text not be replaced with a figure, or is it repeating what is already in the figure? Yes, it is expected. It is a description of what is shown in Figure 8.

P21 L454 I do not accept that what was observed off Namibia can be regarded as a CWC. We have made the changes throughout the whole manuscript, see also response above.

P21 L461 Who says seasonality has a major impact? Reference(s)? A better review and incorporation of what is known about this coast needs to be included in the manuscript. Relevant references were added to section 4.1.

P21 L465 If the measurements made in this study are not the relevant ones, what is the point of the whole manuscript? These are the first records of environmental factors in these two specific areas. These data provide valuable insight into daily environmental

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fluctuations even though it is a short term record. Main outcome is that the boundaries previously described on oxygen tolerance need to be adapted. Indeed the data only provides a snapshot in time and ranges can be even larger. However, this does not devalue the measurements. We still measured the lowest ever recorded oxygen concentrations for *L. pertusa*.

P22 L468 What is ESACW? This wasn't mentioned before. ESACW was mentioned in L140.

P22 L470 'a temporal' not 'an temporal' Changed.

P22 L472-477 References are needed for all the statements in this paragraph (and elsewhere in the manuscript). References were added.

P22 L484 Some of this paragraph belongs in the results. Specific values were removed.

P22 L495 How can the authors, based on limited cruise data, possibly determine what determines the absence of living CWCs from the Namibian margin? We can not determine what determines the absence of living CWCs but we can hypothesize since it is accepted that environmental conditions changed at the same time with the CWCs disappearance (Tamborrino et al. accepted)

P23 L517 'Namibian' not 'Angolan'? Yes, Corrected.

P23 L518 DO is an input to habitat suitability modelling, not an output, surely? It is only an input. Corrected.

P23 L524 Not 'limits3' Corrected.

P24 L530-539 The conclusion appears to be drawn that increased food availability compensates for decreased oxygen or higher temperature. Is it not the case that increased food in the water column is actually one of the main causes of decreased oxygen availability in these regions? This doesn't seem to be mentioned anywhere. We agree with the reviewer and have adapted the text accordingly (L639ff).

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P24 L551 What does 'loss of energy which and associated increased energy demand like' mean? It should be 'loss of energy with an associated increased energy demand'. Corrected.

P24 L555 'an' before 'energy (food) availability' unnecessary. 'An' was removed.

P25 L563 If high quality food is available off Namibia but there are no living corals how can it be concluded that the presence of the SPOM promotes and/or supports coral growth? It can not be concluded for CWCs at the Namibian margin. It can only be suggested for the benthic fauna which is associated with the dead cold-water coral framework since it still survives in otherwise stressful conditions.

P25 L579 'leading to' not 'leads to' Corrected.

P25 L581-584 Some of this information belongs in the results section. Information was removed from this section.

P25 L585 Why does terrestrial POM constitute a less suitable food source, and who says so (references)? Because terrestrial matter includes carbon-rich polymeric material (cellulose, hemicellulose and lignin) which cannot easily be taken up by marine organisms (Hedges and Oades, 1997). A reference and explanation were added (L587-589).

P25 L589 Delivery rates of SPOM were not measured, only the presence of POM with speculation as to its source(s). True, the presence of SPOM was meant, corrected.

P26 L592 What is the source of this fresh POM? It is directly sinking as well as advected organic matter from the surface ocean. Explanation added (L700-701).

P26 L595 'fact that' not 'fact, that's' Corrected.

P26 L603 How are these currents likely to be responsible for the delivery of fresh SPOM from the surface productive zone? Currents lead to mixing of the water layers, which allows material from the surface water layer to sink down to the mound sites. An

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explanation was added to the manuscript (712ff)

P26 L610 I do not understand how the nepheloid layer is formed by bottom erosion due to the intensification of near-bottom water movements, which is indicated by maxima of the buoyancy frequency N^2 in 225 and 300 m depth. Explain and provide evidence. The interaction of internal waves with the margin topography will intensify currents and therefore mixing. These internal waves can move on density gradients which are indicated by buoyancy frequency maxima. The manuscript was changed and a better explanation was added.

P27 L622 et seq. The examples of ecological roles of CWCs are not applicable in OMZs. The benthic communities on the cold-water coral rubble were meant. We have changed the text.

P27 L626-627 CWCs are sometimes able to cope with low oxygen levels (there are none off Namibia). This is due to the fact that oxygen levels are too low at the Namibian margin.

The line numbers refer to the track changes document.

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