10 April 2017

Subject: Revision of MS No.: bg-2016-476

Dear Associate editor,

We would like to thank both reviewers for their thorough revision of the manuscript. Many of the issues raised improved the coherence and cohesiveness of the manuscript.

Regarding the comments concerning the statistical analyses of reviewer 1, Prof. Dr. Pierre Legendre corroborated and elaborated the replies already given on Biogeosciences Discussions Forum.

Please find below our detailed replies to the reviewers' queries, the changes made to the manuscript (with line references of the revised manuscript) and a marked-up manuscript version,

Sincerely,

Daphne Cuvelier

Referee 1

General comments: The paper by Cuvelier et al. is an interesting study that uses time series analyses, conducted concurrently at two different hydrothermal vent settings in two different oceans. It is a unique study that deserves attention and it is good to see such work being done. However, there are some important scientific issues that need to be addressed. A major finding of the paper is that patterns in temperature and tubeworm behavior were seen at both the Pacific (NEP) and Atlantic (MAR) sites that correspond to 6 hour time intervals, which the authors conclude is linked to tidal patterns. Additionally, they note that the same effect is seen 6 hours apart between the two sites which is a product of the time difference between the two sites.

The 6 hour periodicity might be present, however, the link to tidal patterns is not sufficiently developed. There is no data on the tidal rhythms or whether the increases or decreases in tubeworm appearances or temperature values correspond to specific events of the local tidal patterns. In order to come to the conclusion that the periodicity seen in this study is indeed linked to the tides, tidal data needs to be examined and presented within the context of the results of this study.

Data on local tidal patterns and how they correspond with the rhythms found in temperature was indirectly included by means of pressure in supplementary figure S3. Potential mechanisms causing tide-related variability in hydrothermal fluids include the modulation of seafloor and hydrostatic pressure fields by ocean tides, modulation of horizontal bottom currents by tides and solid earth tide deformations (Schultz and Elderfield, 1997; Davis and Becker, 1999). Though the modulation of temperature by tides at several hydrothermal vents on the Juan de Fuca Ridge is thought to be mostly indirect through bottom currents (Tivey et al., 2002). A paragraph on what is known for local tidal patterns at our 2 sites of interest in section 4.3 is added in L599-613. Multiple day periodicities present in the temperature data were already linked to local oceanographic patterns from the literature in the discussion e.g. L623-627.

A sentence on three mechanisms explaining tide-related variability (i.e. the modulation of seafloor and hydrostatic pressure fields by ocean tides, modulation of horizontal bottom currents by tides and solid Earth tide deformations (Schultz and Elderfield, 1997; Davis and Becker, 1999)) was added in L593-596 as well.

It appears from the results, that by and large, not a lot of changes overall were seen. The mussel and shrimp densities at MAR and the pycnogonid densities are the only ones that show an increase over time. This brings up a number of issues and considerations that ought to be treated in the discussion of the paper. For example, one major issue is the spatial extent: the areas analyzed are very small and the authors should include a discussion of the spatial scales at which appreciable changes in the megafaunal community can be observed. In the cases of the increases in densities of taxa, it is surprising that the discussion includes no references to successional patterns. The authors do mention that the mussels represent a climax community at shallow Atlantic vent sites, but there is no discussion of recruitment or colonization as being possible explanations for the observed increases in densities. And, the overall stability is not discussed very well either. Though there is a brief reference to differences in the level of dynamism in vent communities being possibly linked to spreading rates, this is not discussed very much despite stability being one of the major findings.

With this manuscript we intended to focus on the comparison between the two sites rather than on the high local spatial variation observed at each hydrothermal vent site. Using the same reasoning, we limited ourselves in the large ecological implications and extrapolations for successional patterns since we are aware that the FOV is rather small and shows only a single assemblage, while hydrothermal

edifices are inhabited by mosaics of different faunal assemblages. These issues were more thoroughly explored in Cuvelier et al 2014 and Sarrazin et al 2014 and therefore were not mentioned as such in the current manuscript, though references to these papers were used. Our long-term experience with imagery data (from Sarrazin et al. 1997 up to now) have shown that the spatial scale of observation we are using in our observatories is sufficient to observe changes in composition and abundance of visible taxa. For example, a study by Cuvelier et al. (2011) showed that on the Atlantic Eiffel Tower edifice, the overall percentage of biological colonization and mussel coverage were stable on a decadal scale but that on shorter time scales as well as on smaller spatial scales, significant differences in microbial cover and individual assemblage coverage and distribution were observed.

However, taking into account that the current manuscript should be able to stand alone as an independent study as well, we addressed the issues raised by the reviewer by adding a section on the spatial variation issues and hence limitation of extrapolations at the beginning 4.1. of the discussion linked with observed stability (L405-416).

Regarding the lack of discussion on colonisation and recruitment, 23 days in one single year is a rather short window in time to be able to observe colonisation and recruitment, even when continuous recruitment is assumed. Also, it is important to bear in mind that new recruits are small and inconspicuous and can go easily unnoticed, especially when using image analysis. Recently, succession has been observed at the NEP observatory over a period of ~one year, with the formation of a small flange, colonised by *Paralvinella sulfincola* and followed by the rest of the community (unpublished data, see Sarrazin et al. 1997 for successional patterns). A short note on the fact that 23 days appears too short to allow observation of succession patterns was added to the manuscript (L550).

The writing itself needs considerable improvement. First, it should be read by a native English speaker since there are a number of grammatical errors and sentences that appear to be lost in translation.

We have thoroughly checked the manuscript for errors also taking into account the comments of the second reviewer, whom specifically pointed out the sentences that were poorly written. These were changed accordingly. We think that this approach considerably improved he manuscript.

Secondly, the discussion, particularly the part with reference to the different taxa is written as a list of short, highly abbreviated paragraphs. This needs to be improved upon, restructured and rewritten so that a cohesive story is presented as opposed to a list of short comments. For example, paragraphs should not end with a new thought or idea such as line 432, on page 12 which states 'Both species were considered predators or scavengers.' This is an important aspect to the biology of the snails discussed within this paragraph, without a doubt, but it is something that should be expanded upon, and should not be the final, concluding sentence of a paragraph that up to that point has not made any mention of trophic relationships or feeding biology. As it stands now, this part of the discussion reads basically like bullet points instead of a cohesive discussion.

This part was kept succinct on purpose, in order to avoid an extensive discussion which would appear more like a review than a research paper. Since this was an issue both reviewers touched upon, sections 4.1.2 and 4.1.3. were slightly restructured, though main lay-out was kept, and paragraphs were elaborated into a more cohesive text, mentioning relevant ecological interactions.

E.g. from section 4.1.2: "Many of the free-living polynoid species are known as active predators (Desbruyères et al., 2006) moving rather swiftly across the FOV looking for prey and were even observed attacking extended tubeworm plumes at NEP (Cuvelier et al., 2014). Free-living MAR scale worms were preponderantly associated with bare substratum, while those quantified for NEP were only those observed on top or within the tubeworm bush. They were also visible on the bare substratum

surrounding the tubeworm bush but this area was not taken into account during this study. While there was a difference in substratum association between polynoids as observed by the two observatories, all individuals seemed to be rather territorial (see Cuvelier at al., 2014). On the MAR, one individual appeared to repeatedly return to one single area within the FOV after excursions. Such behaviour might be indicative of topographic memory and homing behaviour. "

Specific comments:

Introduction:

In the key questions in the last paragraph: the first question is 'are tidal rhythms discernible in both vent settings?' It would be better to perhaps say 'are rhythms discernible in both vent settings that correspond to tidal patterns?' Since making the actual connection between the patterns seen in this study and tides is beyond the scope of the study.

We changed the first question to: "Are rhythms discernible in both hydrothermal settings?" since we searched for rhythms and one of the main results was the correspondence to the tides.

The introduction should include some background about the major faunal groups and community structure at the two study sites. This is presented currently in the Methods section and certainly more details can be presented there, but the Introduction should also contain this information because understanding the settings is important contextual information.

We added that the shallow (<2300m) MAR has a visual predominance of *Bathymodiolus* mussel that there is a *Ridgeia* tubeworms predominance in the North-East Pacific (L57-58). However, since the current paper already counts 17 pages of text (figures, tables and references not included) we do not want to repeat the same information both in introduction and methodology.

Methods and Results: A number of key methodological information is missing. Though it is mentioned that the MAR observatory was positioned to face the Eiffel Tower edi- fice, no such information is given about the NEP observatory, such as whether it is also facing a chimney structure or not. If it is also placed facing a chimney structure, then this should be clearly stated early on in the manuscript, because chimney communities differ from areas of diffuse flow (and even host different morphotypes of Ridgeia tubeworms) which would mean that this study is examining chimneys on vents from two different oceans, which is very specific.

This information was present in L76-77 for NEP in the first version of the manuscript.

We added a little bit more information in the revised manuscript for both deployment sites, see L75-76 for MAR and L78-79for NEP.

It is not mentioned, but clear from the photos, that the camera is positioned facing forward. In this case, there has to be clear details on how the spatial extent of the field of view was calculated. This is very important information and I am surprised that it has been left out. Other details about the imagery is also missing, for example, since video cameras were used, I assume that video stills were taken at the appropriate time points and those video stills were analyzed and used for marking the animals (in which software?), but these details are not present in the manuscript.

A section clarifying these methodological details has been added to 2.3 Short temporal analysis, see L127-134.

I think that it is inappropriate to use tubeworm abundances or tubeworm densities since in reality, what was counted where the extended plumes. Throughout the text, this should be changed to visible plumes or extended plumes, etc. and not tubeworm density.

This was already specified in L149-150 of the methodology section in the first version of the manuscript. This issue was addressed by adding a sentence stating that "from here on tubeworms visibly outside of their tubes will be referred to as tubeworm densities" (L163-164).

In general, density should not be used at all. In both cases, the surface filmed and analyzed is considerably less than 1 m2 which means that all the density numbers are extrapolations and I don't think that is appropriate. Since within a site, the same area is filmed and examined for all 23 days and time points, the use of numbers of individuals instead of extrapolated densities would be more appropriate.

We chose to work with densities in order to use relative values as a standardisation. Moreover, within the NEP time series, the zoom changed twice. Even though it was a minor change, the surface of the FOV changed and thus densities were preferred in order to allow comparisons amongst the images of the NEP alone (see Cuvelier et al., 2014 PlosOne).

When comparing MAR and NEP, the difference in surface filmed and analysed (see Table 2) was quite large, hence densities were used to mitigate the sample size which in this case is the FOV. This is also why we used the percentage coverage instead of area covered in square cm or m. Finally, the use of densities and % are the only way to allow comparison with other data series.

Similarly, for microbial mats, use area coverage instead of percentage of area (and was percentage and density calculated based on filmed area or analyzed area?)

All densities and coverages were calculated for the analysed area (hence the name choice, this is explained more clearly in the added methodology paragraph mentioned above), other areas were not taken into account as stated in L140-141, this also applies to the microbial mats.

There is no explanation as to why areas of microbial mats were examined at 12 hour intervals and not at 6 hour intervals like the fauna.

Variation observed in microbial mat coverage was rather low at a 12h frequency, which was why we decided to not increase its resolution. The chosen resolution is sufficient to observe coverage changes.

Due to the difference in depths and ambient temperatures between the two study sites, raw temperatures should not be used at all. Instead, rescaled temperatures (raw temperature – ambient temperature) should be used and presented. The authors even say that there is a 2 degree difference in ambient temperatures between the sites and they say that even when this is taken into account, the NEP temperature recordings have a higher mean and maximum temperature. However, that does not mean that the distributions are necessarily different. A simple t test should be done to test if they are significantly different or not. The temperature data shown, for example, in Figure 5 seems to indicate that they are not significantly different since they appear to basically differ by about 2 degrees, which is the difference in ambient temperature between the two sites.

The differences between raw and rescaled values are presented in Table 4 + L296-301 and discussed in L585-587 and are clearly visible in figure 5. In fact, differences are so large that there is no need to use a test of significance to see the difference. A reference to Fig. 5 in the legend of Table 4 was added.

t-tests compares the means of the two time series analysed. t-tests were significant for all combinations (T602-T603, T602-MAR and T603-MAR) at $p<0.05$ for the rescaled values. However, when looking at the boxplots the differences in variance in the time series are significantly less distinct. Since we were more interested in the variations over time, instead of the mere differences between NEP and MAR, an ANOVA seemed more appropriate. This test analysed if the variance occurring within a time series is larger (not significant) or smaller (significant) than that observed between the two time series. Anova's revealed no significant differences between MAR and NEP rescaled values (T602 and T603) ($p>0.05$). These test results were incorporated in the manuscript (L299) and references to the large differences has been added (L296-301).

We opted to use the raw values for representation and analyses purposes because it represents the temperature the animals experience at the MAR and NEP. In addition, using raw or rescaled temperatures has no impact on the identification of rhythms or lags between the two sites.

In case one would calculate the amount of hydrothermal fluids based on the temperature, it would be better to use rescaled temperature for comparison. To resume, raw temperature = temperature experienced by the organisms, rescaled temperature = proxy of the hydrothermal input.

The other major issue I have with the manuscript in its current form is the use of statistical tests. Some of them are not quite appropriate and others can be tweaked.

I am not convinced it is appropriate to use a linear regression model to state if changes in densities over the 23 day period were significant or not. The independent variable is time, which is actually specific time points. It is important to have Figure 3 to show the trends, but fitting a line to these data and using that to say the changes are significant or not is, I believe, incorrect. The buccinid density graph really illustrates this, where the densities increased, then decreased and then increased again. That clearly does not mean that overall, in the study time period, buccinid densities showed a decrease, or should be represented by a downward sloping best fit line (as it is in the paper).

The reviewer is wrong in presuming that the use of regression models is incorrect. Linear regression is widely used to identify trends in data (linear or not), and taking the residuals of these regressions is the most usual way used nowadays to detrend the data.
Reference: Legendre & Legendre "Numerical ecology" (2012), Section 12.2 "Trend extraction and numerical filters". In particular, p. 726: "The most usual approach for estimating trends is the analytical method. It consists in fitting a regression model to the whole series, using the least squares approach or some other method."

Hence regression lines were kept, even those computed for presence-absence data. Testing the slope of a OLS regression line is the same as the test of the Pearson correlation coefficient calculated between a quantitative variable (time) and a binary response variable (presence-absence of animals). The correlation coefficient is then called the point-biserial correlation coefficient and it is tested like any other Pearson correlation coefficient.
We would like to emphasise that these regressions are used to describe the trends observed for the timespan observed (23 days), not to extrapolate to larger time scales.

The differences in analyzed areas between the two study sites needs to be considered very carefully. I understand that the setup could not accomplish getting the same spatial extent for the fields of view, certainly, that would have been near impossible to achieve. However, when comparisons are made, for example, in the discussion about pycnogonid densities differing greatly between the two study sites, this difference in FOV extents needs to be kept in mind. In fact, it would be very difficult to

constrain whether differences in densities or numbers of a specific taxon between the two study sites is a real difference or due to sampling artifacts. Therefore, such discussions need to be treated very cautiously.

Indeed, it is impossible to accomplish similar surfaces covered by both modules. The TEMPO and TEMPO-mini modules are deployed before they are connected and activated. Once in place and connections (wireless or cabled) established, images are checked and small changes can be done by zooming in or by nudging the module or the camera with an ROV arm to slightly alter the FOV.

That is why, in order to compare differences between the 2 sites, without bias of the surface analysed and filmed, we used densities. Based on the knowledge existing for the taxa present at the two vent fields as discussed in section 4.1., we tried to describe the bigger picture by elaborating on the role of the taxa within the edifice community. For example, the pycnogonids at the 2 study sites do present a different behaviour, i.e. clustering at NEP vs. single individuals visible at the edge of the mussel assemblage. Snails are also far more abundant on the NEP than on the MAR. We conveyed these differences between similar taxa in the different oceans more clearly in section 4.1.

There are some inconsistencies in terms of what was analyzed. For example, anemones are mentioned in the text, but are not in Table 2 which lists all the animals analyzed. Similarly, in the results (lines 229), mention is made of ophiuroids, which are not mentioned anywhere else before. And line 232 talks about a fish, which is also mentioned in Table 2, but was actually not seen in the stills, but in other video footage, which means, it was seen at other time points. Discussion of trends seen outside the time points relevant to this study should be discussed separately because it is has the potential to introduce bias (large, flashy fauna are easily seen and focused on). Limpets are mentioned and it is also said that they were not quantified (understandably so, because they are very small and numerous), but they are not shown in Figure 2.

Anemone densities did not change over time (L251-252) and were thus not assessed on a 6h frequency which is why they were initially left out of the Table. However, we followed the reviewer's advice and added them in Table 2. We agree on the fact that the ophiuroids should be mentioned earlier on in the manuscript (L156) and they have been added to the table as well.

Observation of *Cataetyx* fish were more easily visible on the video sequences (moving imagery). On stills, they were difficult to observe due to shading and position within the FOV (more towards the back – in the background area of Fig. 2): If we would adjust brightness and contrast and different colour levels etc., the fish would be visible on the 6h frequency screen stills as well. Their behaviour is discussed separately as a visiting species.

Appearance of other fauna on other time points are limited to Zoarcidae and Majidae at the NEP. These were not present on the 6h frequency screen stills and were thus not included in the analyses and figures and do not introduce bias. The mention of these taxa was linked with another comment addressed by the reviewer and we introduced them all in the methodology section, hence this was altered accordingly in the revised manuscript (in text and table 2).

Organisms shown in Figure 2 were those quantified alongside features necessary for interpretation (as mentioned in the legend). Limpets were thus not shown in figure 2. They are present as several strands that are fairly easily to locate, but there are also quite some individuals scattered across the tubeworm bush which makes it nearly impossible to add them to Fig. 2.

In general, the results and the discussion appear to have three major themes that should be dealt with in separate sections. The first is spatial trends and associations between taxa within each study site,

the second is comparisons between the two sites and the third is temporal trends. These are often intermixed and the paper would benefit by having them discussed separately. There will be some overlap between them, but currently, the results and discussion comes off as being very patchy and leaping from one point to another, without complete development of each point. Splitting into different sections might help to make the paper more cohesive.

In our opinion, the discussion features two themes: comparison between sites at any given time (1) and over time (2). The spatial part is less important. We propose changing the subtitles in the discussion to make it more coherent to the results, as follows:

Discussion
4.1. Faunal assemblages => Comparison in faunal composition
4.2. Behavioural rhythms and variations => Short term variations and rhythms in fauna and environment
4.3. Environmental rhythms and conditions => Long term environmental variations and rhythms
4.4. Limitations

The discussion was modified accordingly.

I suggest adding two figures or analyses: first, in addition to figure 3, which shows densities plotted for the different time points, the authors could benefit by having a similar figure, but with difference in numbers from the previous time point (6 hours) on the x axis instead of numbers.

Figure 3 has the 6h frequency on the x-axis, we realised that the label of the X-axis was not shown in the figure but this has been added. We also changed the legend of the figure as to convey this point more clearly. In our opinion, the addition of the figure suggested by the reviewer will show the same data be it in a different way and would thus be redundant.

Secondly, I strongly suggest having a figure with tubeworm appearances (and anything else that shows the 6 hour pattern) vs. temperature. And in fact, regression models could be applied to these and it would strengthen your case that temperature can be used to predict tubeworm behavior.

While an interesting figure and approach, the suggestion made by the reviewer would have fit better in the already published paper on the hourly NEP analyses (Cuvelier et al., 2014). This type of figure has no temporal component which is the main scope of our study and was, since the current manuscript already features 9 figure and 3 supplementary figures, left out for now.

The discussion about the same taxon inhabiting bare substrate at one site but not at the other is very problematic, because the FOV for NEP does not include bare substrate at all. In fact, the caption for Figure 2 even lists bare substrate as being an MAR only feature. If bare substrate is not present in the images of NEP, then it is not possible to say that NEP taxa that are seen on bare substrate at MAR are not seen on bare substrate at NEP.

Bare substratum is visible surrounding the tubeworm bush at NEP, however, quantifying the animals present on this type of substratum proved impossible due to its increased distance from the camera. It was called background in figure 2 because there were also patches of microbial cover and individual *Ridgeia* tubeworms visible, hence not classifying as bare substratum *per se*. Some general observations could be made see example of polynoids in L458-459. A more adequate definition of the term background ("background were areas that were not assessed because of increased distance to the camera's focal point and associated light emission and were therefore not included in the surface calculations"), clarifying this issue, is included in the methodology section (L138-139) and the legend of Fig. 2.

In the discussion, certain taxa names are introduced for the first time, e.g., Bythograei dae, Bythitidae, and Majidae. These names do not appear in the Introduction or Methods, even when the animals are being introduced and they do not appear in Table 2 which lists the animals studied. The manuscript would benefit by keeping reference names for taxa consistent throughout the manuscript.

See comment above addressing these issues: we accept the need for consistency in naming taxa throughout the manuscript and introducing them all in the methodology section, hence this was altered accordingly in the revised manuscript (in text and table 2).

The first part of section 4.2, ie, the discussion about mussel valve openings is problematic. By opening valves, do the authors mean that one of the siphons are visible and extended or simply open? Mussels filter water through their inherent and exhalant siphons and fully opened valves are generally only seen in sick or dead individuals. Therefore simply talking about mussels valve openings does not seem appropriate, or should be explained further.

Yes, mussels with open valves are those with siphons showing, this change has been made (L536 + 538).

I do not know what software was used to mark and count the animals, but if the animals were physically marked, then it might be a good idea to examine the extended tubeworms more closely to see if there is periodicity in appearances among individuals.

See comment above addressing the lack of methodological details of the image analysis and the paragraph added to section 2.3. Individuals were marked manually in Photoshop on screen still templates (L128).

For examples, are half the worms extending out of their plumes at a certain time while the other half remain in their tubes and at the next interval, do you see the retracted ones extended and the extended ones retracted, or is it random in who is retracted or extended at any time point?

Visible *R. piscesae* densities, i.e. individuals outside their tubes, based on an hourly analysis frequency ranged from 1038 to 8980 ind/m2, adding up to 8.5– 78.6% of the total tubes that constituted the filmed tubeworm bush (Cuvelier et al., 2014). Applying these numbers to the 6h frequency analysed here, this adds up to 11-70% of the entire tubeworm bush. However, these numbers do not take into account possibly dead tubeworms or empty tubes.

We agree that it would be very interesting to monitor individual tubeworms and their extension/retraction rhythms. Individual annotation and follow/up needs to be done manually, since their relative positioning in the FOV changes due to small changes in the zoom during the time period, which represents a huge time-consuming effort.

A separate project was initiated to try and automate the analysis of extension/retraction behaviour of individual tubeworms. This resulted in a preliminary paper (Aron et al., 2013), that aimed at identifying the tubeworm openings, which would then, in a subsequent step, be marked as open (retracted tubeworm) and closed (extended tubeworm). Only a limited number of individuals could be detected automatically.

Aron M., Cuvelier D., Aguzzi J., Costa C., Doya C., Sarrazin J, Sarradin P-M (2013). Preliminary results on automated video-imaging for the study of behavioural rhythms of tubeworms from the tempo-mini ecological module (Neptune, Canada). Instrumentation Viewpoint, (15), 35-37.

When talking about periodicity of the more mobile animals like pyconoginids and snails, etc., it is important to keep in mind the time and spatial scales: Currently, I don't think it has been shown conclusively that the observed periodicity is real periodicity and not the result of mobile animals moving in and out of a small area of focus at their own individual paces.

We agree that it is not conclusively shown, since there are no significant periodicities or links with environmental variables, only indications as such. Their link with tidal periodicities would indeed depend more on their mobility, in the sense that they can move into an area when local conditions are favourable, e.g. when a region is temporary (not) exposed to fluid flow due to tidal currents. Lelièvre et al. (2017) showed that macrofaunal abundances on top of a NEP tubeworm bush decrease in less favourable conditions (low temperature, high oxygen saturation) causing the organisms to remain deeper within the bush for protection from currents and predation.

The presence of pycnogonids over time within the NEP FOV is fairly restricted to a particular region (see Cuvelier et al., 2014 PlosOne). Few organisms were seen wandering around beyond this patch. Individuals that move around at larger distances are a large minority vs. those present at the specific spot (few individuals vs. >20), hence the periodicity observed is influenced by the less mobile "resident" individuals.

For the snails, however, no distinct region was occupied even though the species occurring a NEP tends to show more of a clustering behaviour (Martell et al, 2015) while those at MAR are more single occurrences. Buccinids are far more abundant at NEP than the bucciniform Turridae at MAR, making it nearly impossible to deduce any periodicities for the latter.

Though there is information on and a discussion of the CHEMINI system for measuring iron, no discussion or mention is made of sulfide. This is a very big gap in the discussion since sulfide is the fuel for the chemosynthesis based animals, and also a determinant of other animal distributions due to its toxicity. I understand that there was so sulfide sensor and therefore real sulfide measurements were not possible. However, temperature, oxygen and iron are correlated with sulfide and can be used as a proxy to a certain extent for sulfide. Even if real concentrations of sulfide are not included, sulfide itself should be discussed because it is the source of energy in this system and one of the main reasons why tubeworms extend out of their tubes.

As mentioned by this reviewer, the CHEMINI system can also be used to detect total dissolved sulphide. However, the CHEMINI used for the determination of total dissolved sulphide was not chosen for a long term deployment because the standards are not stable for a long period.

The current manuscript is very results oriented and therefore discussion of sulphide was not included, since it was not measured. With regard to its influence on the fauna, we chose to refer to the generic use of fluid or nutrients as such throughout the manuscript (and more specifically in 4.2.) instead of specifying sulphide concentrations or any associated metals. Temperature, Fe and Sulphide can be used as proxies for one another since they are positively correlated. This is now mentioned in the discussion section.

Temperature is a proxy of hydrothermal fluid input, not only of sulphide and Fe concentrations (added in L582-583). However, it is yet impossible to decorrelate the role of each chemical compound, hence we can only discuss the input of O2 with cold seawater vs. the inputs linked to the fluids, i.e. those involving the provision of reduced compounds necessary for chemosynthesis and of potentially toxic compounds such as metals, sulphides and radionuclides.

Regarding the influence of sulphide on tubeworm behaviour, the following sentences were added in section 4.2. “Emergence/retraction movements of siboglinid tubeworms were proposed to be a thermoregulatory behaviour or suggested to be governed by oxygen or sulphide requirements (Tunnicliffe et al., 1990, Chevaldonné et al., 1991) or tolerance to toxic compounds (sulphides, metals, etc.). Changing hydrothermal inputs (high sulphide concentrations/high temperature) and oxygen concentrations could thus regulate tubeworm appearances, reflecting the tidal patterns of these environmental variables.” (L445-449).

Technical corrections:

Please proofread for corrections to English grammar and sentence constructions.
See comment addressed above.

Figure 1: The inset pictures are very small, and I think, the ones showing the FOVs are not necessary here, since they are presented in Figure 2. A better figure would be the map and the instrumentation. If the authors do decide to include the pictures of the FOVs, please make sure that the caption states clearly what all the images are. Currently, the caption does not explain what the smaller pictures are.

Generally, figures are rather small and of fairly low resolution because of their inclusion in the pdf. Separately provided figures of a revised document will be bigger in size and of better resolution. However, we tried to improve our figures following the reviewer’s comments. Figure 1 now contains a bit more information on the observatories while the FOV/sample images are included in figure 2. The legends were edited accordingly.

Figure 2: In addition to the sketches with the animals and substrates interpreted, one sample image in its original form, without interpretations drawn in, needs to be included as well for each site. Ideally, instead of a composite sketch, just one sample image should be presented, with and without the interpretations drawn in (and a reference can be made to Table 2 for a comprehensive list of animals seen at the two sites). This provides the opportunity to see what is being analyzed. These images also need scale bars. And, the white arrow that is mentioned in the caption, which is supposed to be pointing to the fluid exit, is not in the figure. Additionally, there is no mention whatsoever, of ‘mussel background’ anywhere in the text but it is drawn in in this figure.

Sample images from Figure 1 have now been included in Figure 2 taking into account the comments of both reviewer’s 1 and 2. This facilitates interpretation and enhances readability of the scale. Legends have been changed accordingly.

Figure 4: The x axis is labeled incorrectly on the figure: it states ‘hours’, but the scale bar reads 0 to 40, but it should read 0 to 552 if it is hours. The caption reads that the x axis contains periods of 12 hours and this makes more sense, since 552 hours would equal to 46 12 hour periods. Secondly, as mentioned before, real areas should be used instead of percent areas. In fact, this is a reason why using percent cover is inappropriate: since the MAR FOV is much larger than the NEP FOV, the use of percent cover gives a very different view, namely that much more of the NEP is covered in microbial mats than at MAR. This is not necessarily true, it just so happens that the area in question at the NEP site is much smaller and a similarly sized microbial mat there gives the impression of being much larger because the overall study area is much smaller.

The label of the x-axis was corrected. The comment on real surface vs. percentage coverage was addressed previously with as main argument that percentages are relative values which allow comparison and tend to mitigate the sample size which in this case is the FOV.

Figure 7: what are the dashed lines?

The dashed lines indicate the point of statistical significance (here at ACF=0.8, with $p<0.05$) values between these lines and zero are not statistically significant, while those above and below the lines (towards one and minus one) are significant. This has been added to the legend.

Figure 8: The caption should mention why there is a box drawn in the graph for NEP Fe.

The legend now includes the following sentence: "Inset box in Fe graph for NEP shows variation occurring during the first 3-4 months in more detail."

Table 1: remove coordinates and write out the full form of latitude and longitude. The last line, for turbidity has a '/' for NEP, this should be changed to N/A.

Ok

Table 2: In number of images, please spell out that 93 is the total, and 9 or 5 are the number of images that are missing, or could not be recorded. However, given that in both cases, video stills were taken, is it not possible to take an image just before or just after the specific time in question?
Gaps means that the video sequence was non-existent due to several possible reasons. A definition for a gap in our time series has now been defined as: "The gaps in the recordings were failed recordings (due to observatory black-out or instrument failure) or unusable video sequences (empty files, black or unfocused videos)" and has been included in the Methodology section/2.3.1.image analysis at L133-134.

For surfaces, perhaps cms might be more appropriate since they are both much smaller than 1 m2. Surface analyzed: it says to refer to Fig X, please change to refer to the correct figure in question. The listing of taxa in this table needs to be more consistent. For example, if you put a descriptive category in the left column ('engineering species') then similar descriptive terms should be used for the others (mobile predators, scavengers, etc.). Basically, the same general type of information should be in the same column, instead of having a descriptor in one row and class or phylum names in the others. In the second and third columns, the order should be consistent. For example, you start with phylum (Mollusca), then family (Mytilidae), followed by common name in parentheses and the next line has the species name, which is a good format to follow. Similarly, for NEP, it should then read Annelida, Siboglinidae (tubeworms) and the species name on the next line. So, next, should be Annelida, Polynoidae (scaleworms) and then multiple species on the next line. With M. fortunata, these higher categories and common names are left out (and / should not be used to indicate not available). Finally, since anemones are also present and discussed, they should be included in this table as well.

These changes have been carried out. See Table 2 of the revised manuscript.

Table 4: As mentioned before, conduct a statistical test on the distributions of the rescaled temperature values to see if they are significantly different or not and include the results in this table

See t-test and comment above

Referee 2

Although the technology and methods used are still relatively new (and exciting), I found the authors neglected discussing vent ecology/animal physiology (i.e. mechanisms driving the patterns) to focus

on methods and data collected. The data aligns with the scope of BG, but the text requires work addressing specific interactions. This paper is an important stepping stone to better understanding the deep-sea hydrothermal vent environments. Although the findings are not exactly conclusive, there is valuable information presented here, about the tools and apparent (and lack of apparent) environmental and ecological temporal patterns. In general, I found the manuscript was well written, and the language used to be fluent and precise. That said, inconsistencies in formatting were very evident –this was distracting and, at times, outright confusing. The figures and tables also require work.

Valorising this reviewer's comment, as well as taking reviewer 1's comments into account, paragraphs in sections 4.1 and 4.2 are reorganised, though main lay-out is withheld, and more relevant information on the animals discussed was added. Links with their physiology are included when linked with environment, e.g. L436-438, L443-447. Overall, less significant interactions were observed than revealed by higher frequency analyses (e.g. Cuvelier et al. 2014, PlosOne).

SPECIFIC COMMENTS

Title and abstract. I found both to be slightly misleading. The majority of the study results yielded no evidence of rhythms. This lack of evidence is still a result and it warrants discussion (e.g. Why aren't the majority of vent animals influenced by tidal rhythms?).

In our experience, it is rather the opposite: the fact that tidal rhythms are present at deep-sea sites tends to surprise people, hence the more descriptive title. We decided to keep the same title as we do observe rhythms in both biotic and abiotic factors. More specifically, rhythms were found in one taxon at MAR (polynoids) and two (tubeworms and buccinids) at NEP (see L240-241 and L261-263 respectively). Rhythms in temperature were revealed at both sites (L369-378).

L. 55. ". . .exact same time span and resolution, have been analysed." Not sure I would say "exact": with the differences in gaps, sizes of images, and data collection durations (at times, continuous vs. punctuated). The first two paragraphs of section "2.3.1. Imagery analysis" are to the contrary.

The word exact was removed.

L. 88. Was the lighting different for the different sites? Were the lights on for different durations? Discuss the effect of any variability in artificial light at the sites.

Lights were on continuously in the period analysed for the NEP (see Table 1, 23 days), contrastingly at the MAR where lights powered on with the same frequency as imagery recording (every 6 hours). This was added in section 2.2. (L96-97) and briefly touched upon in the discussion (L528-530 + 681-682).

L. 122. Add text about the analysis of microbial mats and the anhydrite (in Fig. 2). Is there any mineralogical work to support the identification of anhydrite (could it have been sulphur precipitate)? How was the white encrusting mineral ("anhydrite") resolved to be different from the white encrusting bacterial mats?

Movement in bacterial filaments allowed to distinguish between microbial mats and encrusted minerals. It is very likely that there are encrusted bacterial mats within the "anhydrite" patch, though due to the colour similarity these were impossible to differentiate and quantify. Unfortunately, we do not have mineralogical work to support the identification of anhydrite. Therefore, we changed anhydrite in the legend of Fig. 2 to "white substratum" and added "possibly anhydrite with encrusted microbial mats" in the legend text.

L. 124. Explain the "gaps". Why are there gaps in the data?

Definition of gap has been added (L133-134): “The gaps in the recordings were failed recordings (due to observatory black-out or instrument failure) or unusable video sequences (empty files, black or unfocused videos).”

L. 127. What was the resolution of the images from the different sites (sub-centimeter)? Were the resolutions actually comparable? Were the cameras/image sizes/distances from substrate the same?

The same camera was used in both ecological modules in 2011, namely Axis Q1755.

Distances to the assemblage filmed tend to differ due to module location and proximity to the hydrothermal faunal assemblage and surface size of imagery recorded is thus different. Size of imagery recorded differed slightly, which was reflected in the size of the screen stills taken from the video sequences, which were 1920x1080 pixels for NEP and 1440x1080 pixels for MAR. However, surface filmed differs from the surface analysed see Table 2 (surface filmed: ~0.3802 m² for MAR, ~0.0661 m² for NEP; surface analysed: ~0.322 m² for MAR and ~0.0355 m² for NEP) and Fig. 2.

L. 132. "Sketch" suggests artistic, may be better to refer to it as a "map" (i.e. it is a single photo with overlays representing max. occurrences...). How was this map created? Add information regarding the program and method used.

Sketch has been changed to maps both in text and legends. These maps and the overlays were created in Photoshop, the merge of all images was done with ImgLEP programme (publication in prep), a software developed at Ifremer for (semi-)automated image analyses.

L. 138. Does “Fig. 1” show this? This figure and its caption don’t indicate as much.

Fig. 1. contained a sample image as filmed by each observatory, hence the reference. Both Fig. 1 and 2 have been altered (Fig. 2 contains now the sample images and Fig. 1 features more information on the observatory lay-out) and references to figures in the text we altered accordingly.

L. 223-225. and Fig. S1. Confusing. Consider removing at least the “days” from the text? As it reads now, the sentence references a Fig. with an x-axis in periods (which equal 6 hours), 18 hr periods, hours, days, and hours in multiples of 18. This is too much. Also, consider changing “*” to “x”.

The days were removed and “*” has been changed to “x”.

L. 247. I don’t see how Fig. 2 demonstrates this point: it’s a 2D schematic with no information about the substrate below the mobile fauna.

Figure reference has been removed.

L. 399. Add a sentence describing the diversities.

The following sentences were added in L423-429: “When comparing samples, an overall higher diversity was observed in the Pacific when compared to Atlantic hydrothermal vent ecosystems, with species richness being positively correlated with spreading rate, associated distance between vent fields and longevity of vents (Juniper and Tunnicliffe, 1997; Van Dover and Doerries, 2005). Nevertheless, such observations remain subject to how well a certain locality is studied and if all faunal size fractions (meiofauna to megafauna) are included in assessing diversity (e.g. Sarrazin et al., 2015). Diversity estimates represent one of the main limitations of imagery analysis which is limited to quantifying and correctly identifying (assessing) mega-and macrofauna (~mm).”

L. 423. The assumption is the same individual is returning every time? Can you really say this?

Caution is needed to identify recurring animals as being the same individual between images. Though, here it appears to be the case. It is quite a recognisable animal (a large golden-coloured polynoid) which is not observed very often on imagery at the Eiffel Tower edifice. The size and number of scales seems to confirm that it is the same animal.

L. 425. And so?

The paragraphs for this section were restructured and succinct information on ecological interactions has been added. In this particular case, following sentence was added: "Many of the free-living polynoid species are known as active predators (Desbruyères et al., 2006) moving rather swiftly across the FOV looking for prey and were even observed attacking extended tubeworm plumes at NEP (Cuvelier et al., 2014)." (L454-456)

L. 435. What is the "very distinct spatial distribution in NEP"?

This was a reference to the heat maps published in Cuvelier et al 204. The reference has been added. (L476).

L. 442-443. Unclear what the authors are saying here.

This sentence was rephrased to: "While being an abundant taxon with a localised clustering behaviour at the NEP site, it is scarce and vagrant at the MAR. Their niche occupation at the studied sites is likely to differ thus causing the discrepancies observed." (L485-487)

L. 487. How fast do mussels move? Did you expect to see a difference at a frequency of 6 hrs?

Species of *Bathymodiolus* have been observed moving 0.74cm per hour (Govenar et al., 2004). Hence, if they would start to move, we should be able to observe them moving away between 2 consecutive images or videos (6h apart) since the distance they could cover in 6 hours amounts to ~5cm and the distance from the mussel bed to the edges of the FOV equals 15-20 cm. Here we observed mostly mussel repositioning, no large distances (cm's) were covered.

L. 594. At vents or everywhere?

This sentence applied to our study, so we added "at hydrothermal vents".

L. 607. Review Lau back-arc basin hydrothermal vent studies linking faunal variations with environmental gradients.

Contrastingly to the works carried out in the Lau back-arc basin by Podowski et al. (2009) and Sen et al. (2013, 2014), where multiple measurements allow for extrapolations across a mapped surface and more successfully link environmental gradients to faunal presences, our study relies on single point measurements. These single-point measurements make establishing direct links between faunal variation across the FOV and environmental variables hard, despite the high resolution of data available. Spatial variation in environmental gradients is high as illustrated by the Lau back-arc basin hydrothermal vent studies and even when examining relatively small surfaces as is the case here. For instance, at the Grotto edifice at NEP, next to the TEMPO-mini deployment, temperature arrays (strings of loggers) in two areas of ca. 30x50 cm on the faunal assemblages demonstrate the high spatial variation at cm-scale both in fauna and temperature (Lee et al., 2015). We realise that this statement might have come across as an over-generalisation. This was clarified in the text (L672-676).

Discussion and Conclusion: Explicitly offer at least one mechanism to connect the influence of the tides and temperature, and the influence of tides and the pattern observed in tubeworm appearance.

The influence of tides on the temperature regimes has been discussed in L615-627. Temperature variability at hydrothermal vent on the Juan de Fuca Ridge was shown to correlate with the variability of the current speed and direction (more so than with ocean tidal pressure) (Tivey et al. 2002). Consistent with the main orientation of the ridge and the topography of Grotto, temperature and oxygen saturation in the tubeworm's environment were shown to be strongly and significantly influenced by the northern and southern horizontal bottom tidal currents (along the valley axis) (Lelièvre et al. 2017). Potential mechanisms causing tide-related variability in hydrothermal fluids include the modulation of seafloor and hydrostatic pressure fields by ocean tides, modulation of horizontal bottom currents by tides and solid earth tide deformations (Schultz and Elderfield, 1997; Davis and Becker, 1999).

A section was added on modulation of temperature by tides in section 4.3 (L593-613).

More information on extension/retraction in tubeworms and possible links with environment was added in lines 445-449.

Discussion and Conclusion: Do the authors believe the tides change the overall temperature of a vent, or just the outflow directionality of the fluid at the point location of the probe?

Based on personal observations on imagery, the fluid flow changes direction when currents are strong, no longer (temporary) bathing an assemblage in fluid flow. A negative (though not significant) correlation was observed between fluid flux and current speed at MAR (Sarrazin et al., 2014). Lelièvre et al. (2017) observed evident changes in environmental conditions with alternation between 'clear' seawater and shimmering fluids characteristics of diffuse venting at NEP. In our opinion, the overall temperature of a vent does not change but the fluids get redirected following the currents and locally perceptions might change since a probe may be only periodically exposed to the expelled fluid.

Similarly, methane seepage was shown to be modulated by periods of enhanced bottom currents associated with diurnal shelf waves, internal semidiurnal tides, and also wind-generated near-inertial motions (Thomsen et al 2012).

Discussion and Conclusion: Were all the tubeworms alive? If not, what effect could this have had on the ecological patterns observed/not observed?

No, it is very likely that several tubeworms tubes were "empty" or no longer containing live individuals. Visible tubeworm densities ranged between 11-70% of the entire tubeworm bush at the time points analysed. This will have no influence on the temporal patterns revealed, such as the tidal pattern. It could play a role in the spatial interpretation, e.g. dead tubeworm areas can be characterised by presence of certain organisms or a lack of associated organisms and thus be an indication of a changed microhabitat.

TECHNICAL COMMENTS

L. 56-60. Rewrite "Key questions" sections so that the sentences are grammatically correct. For example, ". . .put forward are: (i) are tidal. . ." and "the most? And finally, (iv) do . . .".

ok

At times, I found the writing was too informal for a scientific manuscript. I was not happy with the (repetitive) use of “vs.”, “on one hand. . .on the other”, and “and/or”, and [L. 422] "...individuals appeared very attached..." The tense of the manuscript jumps around sometimes. For example, L. 134-135. There are many inconsistencies in the text formatting: *“Hours” was written as “hours”, “hr”, and “h”, with a space or with no space between the number and the shorthand “hr” or “h”. This inconsistency was even more confusing because the UTC time was also reported using “h” (again, with either a space or no space between the number and the “h”) or UTC was reported with “AM” or with no units. *In-text citations are inconsistently formatted: “et al.,” is often missing a comma; both “and” and “” are used for 2 author papers; multi-paper citations were not always listed chronologically [L. 406]; author’s initials included [L. 164]; and missing a comma after authors [L. 186] *Values with units are reported with and without spaces. For example, m vs. m. *The shorthand for “Figure” is written with and without punctuation, within the text and the figure captions (i.e. “Fig.” and “Fig”). *Section numbers are written with and without “.” at the end (in the section titles, as well as when referred to in the text). *“Oxygen” or “oxygen”. *Text jumps between “iron” and “Fe” in same paragraph. *Formatting the title of a subsection varied between: title in the text (e.g. L. 253 and title on a separate line (e.g. L. 341); indented or not; followed by a long/short/bolded/no dash. *Mean and stdev written: ± units, ± units, and ± units. *Within the same paragraph, reporting a date range changes from "date to date" and "date - date". *The Reference section requires some attention. For example, "Year" vs. "(Years)"; ending the authors list with a ","; inconsistent formatting of the volume number, issue number, and page text; inconsistent spacing; inconsistent punctuation; different color text [L. 839-840]?; etc.

All periods are now referred to as “h”. TC times are listed as 06.00 UTC to avoid confusion with the analysing frequency or significant periods. The manuscript was checked thoroughly to remove such cases and other inconsistencies. Extra attention was given to the tenses used.

L. 165-166. Insert space

ok

L. 177. Remove “()”.

ok

L. 198-200. Poorly written. Rewrite sentence.

Sentence was changed to: “No specific correlations between faunal densities and environmental variables were presented. The high spatial variation occurring at hydrothermal vents proved difficult to capture with the experimental settings from the 2011 deployments. The probes at NEP were placed at a distance from the filmed assemblage and the relatively large surface filmed at MAR decreased the representativeness of single point measurements. The measurements made were considered more representative of an overall variability but not necessarily at the scale of individuals.” (L212-216).

L. 237. Change “featuring” to “with”.

We changed it to “there were 5 gaps in the imagery dataset” as it conveyed the point more clearly (L254).

L. 272-273. (as one example) Watch the p-value sig. figs.; at times, they vary within the same sentence. Personal preference: never report $p = 0$ (or in this example, “0.00”), report it as $p < 0.001$.

P-values have been checked and changed accordingly.

L. 305. Reference Fig. 5 somewhere in the paragraph.

Ok

General: Write out values less than 10 (e.g. 9 months –> nine months)

Ok

L. 339. Repetitive.

This was omitted.

L. 344. Use "...was already.." or "...as well", but not both.

We deleted “as well”.

L. 430. Correct. "...abundant on to areas..."

Corrected

L. 432. Correct. "...both species [are] considered..."

Corrected

L. 474. "...feeding [activity]..."?

Corrected

L. 494. Open bracket with no closing bracket.

Corrected

L. 496. Delete "Until now", because it still has not been established.

Corrected

L. 508. "...by a [longer] study..."

Corrected

L. 510. "...as they [become] more..."

Corrected

L. 522. "...in a single taxon..."

Corrected

L. 545. "...for both [temperature] probes..."

Added

L. 567. "...were close to..."

Corrected

L. 572. "...Tunnicliffe et al., 1997)."

Corrected

L. 614. What is meant by "harshness"?

The harshness of the local environment or rather the extreme environmental conditions and gradients. We changed the sentence to “Biotic interactions are at play as well. While these can be observed thanks to the remote observatory set-up, long-term high resolution data need to be assessed (Matabos et al., 2015)” as it appeared more relevant to our study (L678-679).

L. 617. "...and [piloting] skills..."?

Added

L. 629. "This is [likely] due..."?

Accepted

L. 635. Capitalize "automated".

ok

Do they "need" to, or would it be helpful?

In any scenario, it would be helpful. However, if we want to increase the resolution and duration of analysis (and deployments), automated tools are needed because of the time-consuming character of imagery analysis. There is only so much a person can do in a certain amount of time. In order to reflect this issue, we changed the sentence to: “(Semi-) Automated tools should be developed for specific taxa and settings to assist in assessing faunal abundances on in images.”

Suggestion: "faunal abundances [in] images."

ok

Figures (in general):

Consider

(i) standardizing graph formatting throughout the manuscript,

Fig. 4 was the only graph that stood out and was made consistent with the formatting of the other graphs

(ii) removing repetitive information in graph titles (e.g., Fig. 6: use the probe name only vs. "T-MAR for imagery duration - hourly average"; that information is in the caption),

Changes were carried out.

(iii) clean up the axis ticks, labelling, and titles, and (iv) move footnotes (denoted by an asterisks, "*") at the end of a Fig. caption.

Changes were carried out.

Fig.1. This figure is missing some key information. The text for the scale bars is too small. Why is there text and colour bars in the lower right-hand corner of the NEP bottom inset? Label Canada and/or USA? Label the oceans? In the caption, explain or refer to the 4 insets. What are we looking at here? Consider providing larger photos? Add punctuation for "Fig. 1." and "Matabos et al.".

The sample images featuring the scale bars have been added to Fig. 2, thus increasing readability (see inserted figure below). Fig. 1 and legend have been changed accordingly including more information on the observatories.

Fig. 2. Is it necessary to retain some transparency (the key colours really do not match the colours overlaid as semi-transparent)? Change to "Microbial [c]over" (in key). Why is the text "Ifremer" in the bottom right corner and why is it coloured in as "Pycnogonida" (in yellow)? The hatching in the MAR image (for "Mussel background" is difficult to resolve. Add punctuation for "Fig. 2.". Move footnote to the end of the caption?

The semi-transparent colours allow the reader to see what is underneath and could facilitate interpretation.

The Ifremer text is part of the watermark on the images recorded, as is Neptune Canada written before it. Since an original sample image has been added to this figure, we hope it is clear that it indeed is part of a watermark and not a pycnogonid patch.

Fig. 3. Graphs and text are grainy. Consider deleting "densities" from the 10 individual titles (repetitive), and just list the taxa. Reduce the number of x-axis ticks (I can't tell which line is associated to the values listed). Add y-axis title. The Crab graph is missing the number "10" on the y-axis. Shorten the number format of the y-axis for the MAR Pyncognoid and Shrimp graphs (i.e. 0, 1, 2... vs. 0.0, 1.0, 2.0...). Mention "23 days" in the caption. Change to "...with an "*"" OR "*Taxa with significant trends."

Resolution of the original graphs which will be submitted separately is better than those in the pdf of the manuscript. Axes, labels and (sub)titles have been changed. Instead of reducing the number of ticks, we chose to elongate those ticks that correspond to the numbers below.

Fig. 4. When printing in black and white, it is impossible to tell the difference between light blue and light gray. In Fig. 5, NEP is black and MAR is light gray (which can be distinguished in black and white print). To standardize the figures, and for printing purposes, consider changing NEP to black and MAR to gray for Fig. 4. Consider rewriting caption and/or changing the x-axis title. I'm not sure what the value is supposed to be, hours or periods? Reorganize so the sentence doesn't start with "

We agree and changed the colours of the graph to correspond to the other graphs.

Fig. 5. To save space, consider adding a 2nd axis to the temperature graph (to display both NEP probe temperatures, instead of repeating the MAR data. Remove "shortterm" for graph titles? If not, change to "NTU short-[t]erm". Is it necessary to repeat the same key for 3 of the 4 graphs? Although this is not the only time the figures include stacked graphs, this is the only time the x-axis is included.

Separate graphs were maintained for the 2 NEP temperature probes, since incorporating them into one would overlap the NEP temperature time-series and thus decrease readability of the figure. Other changes have been carried out.

Fig. 6. Shorten the y-axis labels to represent a count of the days (e.g., day "1", "2"..."23" vs. "2011-10-07", "2011-10-08"...). Add titles for the x- and y-axis (e.g., "day" and "hour"). Indicate somewhere in the figure or caption: temperature in ◦C.

The comment on changing the dates to count of days is opposite to what was proposed for Fig. S3. We opted to stick with the dates because they allow a reference to the time series investigated

Other changes have been carried out.

Fig. 7. More information is required for the caption. Are there gray and black vertical lines (appear to be)? If so, what do they represent? What are the 2 blue dashed horizontal lines on each graph? Change "X-axis" and "Y-axis" to "x-axis" and y-axis (to be consistent with text).

Vertical lines are all in the same colour. The horizontal blue dashed lines indicate the point of statistical significance (here ACF=0.8, with p<0.05), with the lines above towards 1 and below towards minus 1 being significant (this was added to the figure legend).

Fig. 8. Label and mention: one graph is MAR and the other is NEP. Change text and vector lines to black (vs. blue). Difficult to read the text on the graph, increase the size? Define RDA? There is a noticeable difference in the size and quality of text in the left and right graphs. Standardize?

Changes have been carried out.

Fig. 9. Is the x-axis in hours? Include "Temperature (◦C)", not just "◦C" for y-axis. Remove redundancy in the graph titles and consider adding this information to the figure captions, e.g. "...over six and nine months".

Changes have been carried out.

Fig. 10. Confused again by the x-axis title and the caption. This data is for a one-week period equalling 200 hours, but the x-axis title is "Period", not "Hours", and plus, 1 week = 168 hours. Please clarify. Change the lines to black (no need to be coloured red).

Lines are rendered in black.

Fig. S1. Include the information for the white vs. black symbols. Why change the x-axis intervals? If each period = 6 hrs, and there are 45 periods, the graph represents 270 hrs or 11.25 days. Include this easy to understand temporal reference (and why this length of time)? Change the lines to black (no need to be coloured red).

Information on the black squares was added (Black squares indicate periods significant at the 5% level.). X-axis interval changed because the time series for fauna is recorded at a 6h frequency while the temperature time-series as presented in Fig. 10 was recorded on an hourly frequency. This is mentioned in the figure legend as (1 period on x-axis=6h).

The periodograms have a maximum length of n/2 with n being the length of the time series analysed. For fauna this is thus 23 days/2. Length of the time series was added to the legend.

Lines are rendered in black.

Fig. S2. Similar concerns to Fig. S1. Why change the x-axis intervals? Remove the repetition of the x-axis title (i.e. only include "Period" once). Change the lines to black (no need to be coloured red).

See reply above. X-axis label was only included once.

Fig. S3. Change to "...(a) MAR and (b) NEP...". Are the "random" data consecutive? Yes

Why not report the specific month and year (even if it was selected randomly)? In analogy to what was decided for Fig. 6. We chose to add the specific dates to the random time series.

Use the same style quotation marks at start and end of the quote -or in this case, consider not using quotation marks at all. Many of the same comments and concerns as expressed for Fig. 6.

Tables (in general):

Consider

(i) reducing the number of lines (vertical and horizontal) for each table,

(ii) removing repetitive information (e.g. "2011-2012"),

(iii) condensing the area of each table (there is often a lot of blank space between rows),

(iv) use either "Table :" or "Table .", but be consistent, and

(iv) move footnotes (denoted by an asterisks, "*") below a Table.

Changes have been carried out.

Table 1. "[o]xygen". "[T]wice". Use "NA" instead of "/" (or define "/"). Be consistent, "min" or "min.". If minutes = "min", seconds could = "sec". As in the text, include "at" when listing the sample times (e.g., at 2h, 6h...UTC). Be consistent with apostrophe symbols for the coordinates (styles change between MAR and NEP). Explain/include row title for "Wireless" and "Cabled".

Changes have been carried out.

Table 2. Move footnote to below table (or at least the end of the caption). "[A]re visiting...". Fix: "see fig. X"? Reverse how the gap range is reported ("9 to 93 gaps" and "5 to 93 gaps")?For surface filmed and surface analyzed, be consistent with sig. figs. and with the information provided (why list the ca. dimensions 2 out of 4 times?). Reported frequency as "6hr" and "12 h" in the same table (use a consistent format). Check citation formatting (missing punctuation). Use "NA" instead of "/" (or define "/"). The lines of this table are bolded, why?

Gaps have been defined in the text and the legend (see comment above) and equal 9 for MAR and 5 for NEP. 93 is the amount of images theoretically present in our 23-day time series at a 6h frequency. They have been included as follows: “93 total with 9 gaps”. Other changes have been carried out.

Table 3. n = ? (photos?) Missing "h" after "553" twice. Add a space to "(2 days)".

n=number of images, other changes have been carried out.

Table 4. Include "◦C" in the table caption and remove it from each record. "[S]tdev"?

Changes have been carried out.

Biological and environmental rhythms in (dark) deep-sea hydrothermal ecosystems

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Abstract

During 2011, two deep-sea observatories focusing on hydrothermal vent ecology were up and running in the Atlantic (Eiffel Tower, Lucky Strike vent field) and the North-East Pacific Ocean (NEP) (Grotto, Main Endeavour field). Both ecological modules recorded imagery and environmental variables jointly for a time span of 23 days (7-30 October 2011) and environmental variables for up to 9 months (October 2011 ~~to -~ June 2012). Community dynamics were assessed based on imagery analysis and rhythms in temporal variation for both fauna and environment were revealed. Tidal rhythms were found to be at play in the two settings and were most visible in temperature and tubeworm appearances (at NEP). A ~6-hour lag in tidal rhythm occurrence was observed between Pacific and Atlantic hydrothermal vents which corresponds to the geographical distance and time delay between the two sites.

1. Introduction

All over our planet, animals are influenced by day- and night-cycles. Entrainment occurs when rhythmic physiological or behavioural events in animals match the periods and phase of an environmental oscillation, e.g. circadian rhythms to light-dark cycles. In marine populations such cycles are evident in the photic zone (Naylor 1985). However, more recently similar cycles have become apparent in deep-sea organisms and populations as well, at depths where light does not penetrate. At these greater depths, fluctuations in light intensity are likely to be replaced by changes in hydrodynamic conditions (Aguzzi et al., 2010). Several studies reveal the presence of tidal cycles in environmental variables (such as currents, fluid emission, temperature) in the deep sea, particularly at hydrothermal vents (e.g. Tivey et al., 2002; Thomsen et al., 2012; Barreyre et al., 2014; Sarrazin et al., 2014; Lelièvre et al., 2017) and the influence of tides on the deep-sea organisms ~~was already~~has been previously inferred. In meantime, an actual tidal rhythm has been revealed in visible faunal densities and appearance rate for inhabitants of various deep-sea chemosynthetic environments (e.g. a semi-diurnal tidal component in buccinids at cold seeps (Aguzzi et al., 2010) and semi-diurnal and diurnal tidal components in siboglinids (Tunnicliffe et al., 1990;

Cuvelier et al., 2014)). Presumably, though difficult to statistically demonstrate, the deep-sea organisms respond to or reflect ~~or respond to~~ the changing surrounding environmental conditions, which are modulated by hydrodynamic processes including the tides.

Despite the growing realisation that tidal influences are indeed at play in the deep ocean, it remains hard to actually reveal these patterns because of the isolation of the ecosystem and the limited access to the longer time-series. The use of deep-sea observatories, which have been deployed recently in various seas and oceans (see Puillat et al., 2012 for an overview) brings out new insights into the dynamics of these remote habitats. First ecological analyses based on deep-sea observatories have been published (Juniper et al., 2013; Matabos et al., 2014; 2015; Cuvelier et al., 2014; Sarrazin et al., 2014; Lelièvre et al., 2017), and many more works are in progress.

The current observatory-based study allows a unique comparison of hydrothermal vent community dynamics between two different oceans featuring a different seafloor spreading rate. Data originating from the deep-sea observatories on the slow-spreading Mid-Atlantic Ridge (MoMAR, now EMSO-Açores) and on the faster-spreading Juan de Fuca Ridge (North-East Pacific, NEPTUNE, now called Ocean Networks Canada (ONC)), featuring the ~~exact~~ same time span and resolution, have been analysed. ~~Whilst t~~The two oceans are characterised by different vent fauna, with a visual predominance of *Bathymodiolus* mussel in the shallower (<2300m) Atlantic and *Ridgeia* tubeworms in the North-East Pacific, but they do share higher taxonomic groups. ~~Key questions put forward are~~Following key questions are put forward: (i) Are there ~~tidal~~ rhythms discernible in both hydrothermal settings? (ii) Is there a lag/time difference in community dynamics and environmental variables observed between the two oceans? (iii) Which environmental variables influence community dynamics ~~the most~~? and finally (iv) Do the shared taxa occupy similar microhabitats and possible niches in each ocean? Answering these questions will provide new insights in understanding local vent community dynamics and will enlighten us on similarities and differences between oceanic ridges and oceans. In order to do this, a dual approach was wielded, assessing a short-term comparison between fauna and environment (23 days) and a longer-term comparison of environmental variables (9 months) featuring the same observation window at both study sites.

2. Material and Methods

2.1. Observatories and study sites

Two similar ecological observatory modules, called TEMPO and TEMPO-mini were deployed in two different oceans in 2011 (Fig. 1). The first one (TEMPO) was part of the EMSO-Azores observatory (http://www.emso-fr.org/EMSO-Azores) and was deployed on the Lucky Strike vent field on the Mid-Atlantic (MAR) Ridge, south of the Azores. The wireless EMSO-Azores observatory consists of two main hubs, positioned east and west of the central lava lake that is characteristic of the Lucky Strike vent field. The eastern hub (Seamon East, Blandin et al., 2010) focuses on hydrothermal vent ecology and hosts the TEMPO module. TEMPO 2011 was positioned at 1694 m depth at the southern base of ~~the~~ a large 11m high hydrothermally active edifice called Eiffel Tower ~~edifice at 1694 m depth~~. Its counterpart, TEMPO-mini, was implemented on the region-scaled cabled network NEPTUNE (http://www.oceannetworks.ca/) in the North-East Pacific (NEP), as part of the Endeavour instrument node. It was deployed at a depth of 2168m on a small 5m high platform on the north slope of the Grotto hydrothermal vent, a

10m high active edifice at Main Endeavour Field (MEF).~~It was deployed at the Grotto hydrothermal vent at a depth of 2168 m at Main Endeavour Field (MEF).~~ Both modules were equipped with a video camera (Axis Q1755;), temperature probes, a CHEMINI Fe analyser (Vuillemin et al., 2009) and an optode measuring temperature and oxygen. An additional instrument measuring turbidity was deployed in the vicinity of the TEMPO module in 2011 (Table 1). The biggest discrepancy between both modules was the energy provision, with the Atlantic one (TEMPO) being autonomous and battery-dependent (wireless), and the North-East Pacific one (TEMPO-mini) being connected to a cabled network. Detailed descriptions of both modules can be found in Sarrazin et al. (2007~~;~~, 2014) for TEMPO and Auffret et al. (2009) and Cuvelier et al. (2014) for TEMPO-mini.

Henceforth, the Atlantic set-up (TEMPO on MoMAR/EMSO-Azores) will be referred to as MAR, and the North-East Pacific (TEMPO-mini on NEPTUNE/ONC) set-up as NEP (Fig. 1).

2.2. Data collection and recordings

Data collected consisted of video imagery recordings, temperature measurements, iron and oxygen concentrations, and turbidity measurements (the latter for MAR only) (Table 1), which were recorded jointly for the period 7-30 October 2011. Differences in recording resolutions were mainly due to different observatory set-ups and more particularly due to the cabled or wireless network characteristics and their inherent energy limitations (continuous power vs. battery dependence). Lights were powered on with the same frequency as the imagery recording (every 6h) at MAR, contrastingly to NEP where lights were on continuously during the period analysed (23 days). On NEP, TEMPO-mini was equipped with a thermistor array of which two probes (T602 and T603) were deployed on an assemblage most similar to the one filmed (see Cuvelier et al., 2014). Therefore, only those two probes were used in the comparison to the MAR temperature data, which was recorded directly on the filmed assemblage.

Iron (from here on referred to as Fe) concentrations ~~(Fe)~~ were measured on top of the assemblage and within the field of view (FOV) on the MAR (Laës-Huon et al., 2015; Sarradin et al., 2015) and below the FOV on the NEP. An *in situ* calibration was performed at NEP, analysing 2 Fe standards a day of 20 and 60 µmol/l; no such calibration took place at the MAR. At NEP, sampling frequency was changed from twice (30 September ~~2011 to~~ 18 October 2011) to once a day (19 October 2011 ~~to~~ 31 January 2012) due to rapidly decreasing reagents. Fe concentrations were analysed for the longer-term and used to explore the differences between the observatory settings.

Closer examination of data recorded by the optode revealed some inconsistencies between the measured temperature and the O_2 concentrations. As the O_2 concentrations were corrected by the temperature, a difference in the response time between the temperature and oxygen sensor within the same instrument was presumed. This lag could not be quantified, making comparisons with other observations impossible. Oxygen concentrations measured were thus merely used as illustration to compare the differences between the two hydrothermal settings.

Turbidity was only measured at the MAR observatory in Nephelometric Turbidity Units (NTU), which were straightforward in their interpretation, i.e. the higher the more turbid. The sensor ~~is~~ was not calibrated as such ~~as~~

since its response ~~depends~~ depended on the particle size, which was unknown. Hence it only provided information on the relative turbidity (and peaks) of the environment.

2.3. Short-term temporal analyses

A unique subset of comparable data, allowing a joint assessment of ~~faunal densities and links with the~~fauna and environment, was available for the time period 7-30 October 2011 for both observatories. The image analysis period was limited because of data availability, which in this case was restricted by the imagery recordings from NEP~~, spanning 23 days~~ (see Cuvelier et al., 2014).

2.3.1. Imagery analysis

The variations occurring in the faunal assemblages in the two hydrothermal vent settings were analysed for 23 days ~~with a 6h frequency (at 0h, 6h, 12h, 18h UTC)~~. For this period, a screen still was taken every 6 hours at 00.00, 06.00, 12.00, 18.00 UTC. For each site, these screen-stills were used as a template in Photoshop© to map and count faunal abundances. Faunal densities were quantified at a 6h frequency, while the microbial coverage was assessed every 12h. To pursue the latter, the microbial cover was marked in white and the rest of the image rendered in black. Using the "magic wand tool" of the ImageJ image analysis software (Rasband, 2012), the surface covered by microorganisms was quantified and converted to percentages. Due to gaps in the data recordings different numbers of images were analysed for MAR and NEP (Table 2). These gaps were failed recordings (due to observatory black-out or instrument failure) or unusable video sequences (empty files, black or unfocused videos).

The surface filmed by each observatory was different (Table 2), which is why densities (individuals/m^2) were used instead of abundances. In each setting, there was also a discrepancy between the surface filmed and that analysed (Table 2, Fig. 2). Some surfaces ~~were~~ not taken into account because of their increased distance to the camera, ~~and~~ the focal point and associated light emission (referred to as 'background'), or due to the probe positioning within the FOV, making it impossible to quantify the fauna. These surfaces ~~we~~are marked in black and white on the ~~sketch~~ map in Fig. 2 and were not included in the analysed surface calculations. Both ~~sketches~~ maps were made based on a composed image, i.e. a merge of all images analysed, hence showing the most recurrent species distributions. For MAR, main shrimp cluster/distribution was confirmed using Matabos et al. (2015). For NEP, heat maps from Cuvelier et al. (2014) were used to confirm and localise mobile fauna. This ~~does~~ did not mean that the mobile fauna ~~does~~ did not venture elsewhere, but it showed an average distribution.

The Atlantic and Pacific oceans feature distinct hydrothermal vent fauna and while they do share several higher-level taxa, most species are different for the two oceans (Fig. 1 and 2). The main visible species and engineering taxon present for the 'shallower' (<2300m) ~~MAR~~ Mid-Alantic vents is a mytilid (*Bathymodiolus azoricus*) versus a siboglinid tubeworm for the NEP (*Ridgeia piscesae*). The second most characteristic Atlantic taxon is the *Mirocaris fortunata* alvinocaridid shrimp (Desbruyères et al., 2001; Cuvelier et al., 2009). Contrastingly, no hydrothermal shrimp are present at NEP vents, but associated visible fauna consisted of Buccinidae (Gastropoda), Polynoidae (Polychaeta) and Pycnogonida (containing the family Ammotheidae) (Cuvelier et al., 2014; Table 2,

Fig. 2). The latter two taxa ~~were~~ are also present at the shallower MAR sites be it in lower abundances and represented by different genera and species, as well as a bucciniform gastropod (Turridae family)~~, be it in lower abundances and represented by different genera and species~~. In the Atlantic ~~field of view~~FOV, a small patch of anemones (Actiniaria) was visible below the probe as well as single occurrences of Ophiuroidea. Visiting fish species consisted of *Cateatyx laticeps* (Bythitidae) and *Pachycara* sp. (Zoarcidae) at MAR and NEP respectively. *Segonzacia mesatlantica* (Bythograeidae) crabs were abundant at MAR while Majid spider crabs could be occasionally observed at NEP.

Overall, imagery analysis was limited to the ~~abundance~~ density assessment of the visible species (Cuvelier et al., 2012). In this perspective, tubeworm densities corresponded to the number of visible tubeworms, i.e. those that had their branchial plumes out of their tube at the moment of the image analysis. From here on, tubeworms visibly outside of their tubes will be referred to as tubeworm densities. Stacked limpets were visible on the NEP imagery but were impossible to assess quantitatively due to their small size and piling (Cuvelier et al., 2014). ~~Coverage of microbial mats was analysed on a 12h frequency at both sites.~~

2.3.2. Environmental data

An active fluid exit was visible on the images of the MAR, but not on the NEP recordings. The probe measuring the MAR environmental variables was positioned next to this fluid exit in the FOV, whilst the different probes of NEP (multiple probes measuring different environmental variables, see *in situ* observatory set-up in Cuvelier et al., 2014) were deployed below the FOV. The frequencies with which the environmental variables were recorded ~~are~~ were listed in Table 1. Due to the large variability and steep gradients in environmental conditions observed ~~at~~ in the hydrothermal vent ecosystems, the temperature variables used in the analyses were averaged per hour to reduce noise and variance. ~~For those variables used as explanatory variable (temperature and turbidity) in the joint analyses with the available faunal densities, every 6th h value was taken (corresponding with the 6h frequency at 0h, 6h, 12h and 18h UTC).~~ Only probes T602-T603 from NEP were used for comparison with MAR. The R package hydroTSM (Zambrano-Bigiarini ~~M.~~, 2012) was used to create an overview of the variations of hourly temperature values during imagery duration. For those variables used as explanatory variable (temperature and turbidity) in the joint analyses with the available faunal densities, every 6thh value was taken (corresponding with the 6h frequency at 00.00, 06.00, 12.00 and 18.00 UTC).

Fe was only sampled with a 12h or 24h frequency, hence limiting its use as an explanatory variable for the higher resolution faunal dynamics.

2.3.3. Statistical analyses

Multivariate regression trees (MRT, De'ath, 2002) were computed on Hellinger-transformed faunal densities. This analysis is a partitioning method of the species density matrix of each observatory, constrained by time. It grouped consistent temporal observations and thus identified groups with similar faunal composition that ~~are~~ were adjacent in time; these groups ~~are~~ were called "temporal split groups" from here on. Each split ~~is~~ was chosen to maximise the among-group sum-of-squares and the number of split groups ~~is~~ was decided upon by choosing the tree with the lowest cross-validation error; that tree ~~has~~ had the best predictive power. For this type of analysis, the

observations ~~do~~ did not need to be equi-spaced, as long as the constraining variable reflects the sampling time (Legendre and~~&~~ Legendre, 2012). The MRT partition was then subjected to a search for indicator taxa (IndVal analysis, Dufrêne ~~&~~ and Legendre, 1997; function multipatt~~()~~ in R package Indicspecies (De Caceres ~~&~~ and Legendre, 2009)). The IndVal index ~~combines~~ combined a measure of taxon specificity with a measure of fidelity to a group and thus ~~reveals~~ revealed which taxon was significantly more or less abundant in the group before than after the split. Its significance ~~is~~ was assessed *a posteriori* through a permutation test (Borcard et al., 2011). The observed temporally consistent groups were delineated by colour-codes within a Redundancy Analysis (RDA) ordination plot; RDA's were carried out on the Hellinger transformed faunal densities and environmental variables to visualise the possible influence of the environmental constraints on the temporal groups found in the faunal density matrices. Environmental variables were subject to forward selection (packfor package in R, Dray, 2009), revealing those explaining most of the variation in faunal densities (α=5%).

Rhythms and periodicities in faunal densities and environmental variables were examined with Whittaker-Robinson (WR) periodograms (Legendre, 2012). These WR periodograms were computed on the faunal densities, with a 6h resolution, and on the environmental variables with an hourly resolution (see 2.4). Prior to these analyses, stationarity was implemented by detrending time series when necessary. Time series were folded into Buys-Ballot tables with periods of 2 to a maximum of n/2 observations. The WR amplitude statistic was the standard deviation of the means of the columns of the Buys-Ballot table. Missing values were taken into account and filled in by NA values (''Not Available'').

In order to establish differences or similarities in the variations observed in temperature data from MAR and NEP, cross-correlations were carried out on the hourly temperature data for imagery duration (n=553). Cross-correlations could not be carried out between faunal and environmental variables, because the time series were relatively short and they contained gaps, an irregularity which cross-correlations cannot take into account.

No specific correlations between faunal densities and environmental variables were presented. The high spatial variation occurring at hydrothermal vents proved difficult to capture with the experimental settings from the 2011 deployments. The probes at NEP were placed at a distance from the filmed assemblage and the relatively large surface filmed at MAR decreased the representativeness of single point measurements. The measurements made were considered more representative of an overall variability but not necessarily at the scale of individuals. ~~No specific correlations between faunal densities and environmental variables were presented since to the high spatial variation and the locality of NEP probes on the one hand and the relatively large surface filmed in the MAR setting on the other considerably decreased representativeness.~~ Structuring strength and tendencies of environmental variables in faunal composition were deduced from ordinations.

2.4. Long-term temporal analyses

For the time period 29 September 2011 to 19 June 2012, environmental data spanning 9 months ~~featuring~~ of temperature and ~~iron~~ Fe were available for compared analyses, turbidity was only available for the MAR. The oxygen time series revealed the issues explained previously (see 2.2)~~, hence they~~ and were not subject to temporal

analyses but the differences in concentrations measured between the two observatory locations were addressed. Faunal densities could not be assessed on the longer term due to the lack of regular imagery recordings for MAR and NEP but also changes in zoom and subsequently image quality for the NEP. Long-term time series analyses in the form of WR periodograms were carried out on the hourly data for temperature and turbidity, and daily/12h (NEP/MAR respectively) frequency for Fe to allow comparison between MAR and NEP. See section 2.3.3 for details on the periodogram analyses.

3. Results

3.1. Short-term variability

3.1.1. Fauna

MAR – In total, 84 images were analysed from the TEMPO module; there were 9 gaps in the imagery data series (Table 2). The most abundant visible species were *Bathymodiolus azoricus* mussels and *Mirocaris fortunata* shrimp, the numbers of the other taxa (crabs, polynoids, bucciniform gastropods, pycnogonids) being an order of magnitude smaller (hundreds vs. single occurrences, for densities see Fig. 3.). An overall significant increase in mussel and shrimp densities was observed (R^2=0.68, p ~~-value~~<0.001 and R^2=0.32, p ~~-value~~<0.001 respectively, Fig. 3). Conversely, a significant negative trend was observed for the bucciniform gastropods (R^2=0.19, p-value<0.001, Fig. 3). For the other taxa, no significant trends in densities were observed. Trends were removed prior to periodogram analyses, which revealed no significant rhythms in mussels, shrimp, crabs and bucciniform gastropods. Only for polynoid scale worms, a significant 18 h period was observed, followed by significant periods at 90 h (~~3.75 days or~~ 5~~*~~x18 h), 186 h (~~7.75 days or~~ ~10~~*~~x18 h) and 204 h (~~8.5 days or~~ ~11~~*~~x18 h) (Fig. S1). Polynoids were mostly found on bare substratum though they ventured on the mussel bed occasionally. In fact, 92% of the observations were associated with bare substratum vs. 8% observations on the mussel bed. One large individual occupied the exact same area in 61% of all images analysed (Fig. 2). Bucciniform gastropods were observed on the bare rock in the foreground further away from the fluid exit (Fig. 2). Pycnogonids (7 observations) and the occasional ophiuroid (4 observations) were observed mostly at the edge or on top of the mussel bed, further away from fluid flow. *Segonzacia mesatlantica* crabs were mobile, some moving in the FOV, others appearing between the mussels. Their distribution was rather heterogeneous but mostly associated with the mussel beds and shrimp presence. A *Cataetyx laticeps* fish was observed 5 times within the analysed time series – mostly in the background and not interacting actively with the other organisms. Its presence was only discernible based on the video footage (and not on the screen stills). The small patch of anemones observed below the probe featured 33 individuals. No changes were documented over time for this taxon.

NEP – 88 images were analysed from the TEMPO-mini module; there were 5 gaps in the imagery dataset ~~featuring 5 gaps~~ (Table 2). *Ridgeia piscesae* tubeworms were the most abundant taxon assessed on imagery, adding up to several hundred visible (outside their tubes) individuals and with their tubes providing a secondary surface for the other organisms to occupy. Thus, several dozens of pycnogonids, up to a dozen of polynoids and a couple of buccinids were present on the tubeworm bush (for densities see Fig. 3.). The strings of stacked limpets were not quantified. Only pycnogonid densities showed a significant positive temporal trend (R^2=0.23, p ~~-value~~<0.001, Fig. 3). For the other taxa, no significant trends were observed. Periodogram analyses carried out on the faunal densities

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with a 6h period revealed a distinct 12h frequency and harmonics for tubeworms, a single 12h period (i.e. no harmonics) and 222h (9.25 days) for polynoids (Fig. S2). Buccinids also showed some significant frequencies at 174h (7.25 days) and 204-228h (~8.8 days, Fig. S2), while none were observed for pycnogonids. ~~All associated species (except for visiting fish) were found on the tubeworm bush surface (see Fig. 2).~~ Pycnogonids showed distinct clustering behaviour and spatial segregation which were also observed~~, be it to a lesser extent,~~ for the other taxa (buccinids and polynoids), be it to a lesser extent. ~~8~~ Eight visits of a *Pachycara* sp. (Zoarcidae) were documented, during which the fish was present next to the tubeworm bush and sometimes hiding underneath it. No specific behaviour of the fish interfering with the fauna of the tubeworm bush was documented.

Temporal split groups - Different adjacent temporal groups were identified for MAR and NEP based on changes in faunal composition and densities over time through Multivariate Regression Trees (MRT). Five temporal groups were delineated for NEP and MAR (Table 3) though they were partitioned differently over time. Most groups could be considered rather similar in time span for the two locations. For the MAR, the highest variance was described by the split separating <195h and ≥195h. This coincided with an increase in shrimp and mussel densities and decrease in gastropods and crab densities (Fig. 3), which were shown to be significantly indicative for different split groups post-195h. Shrimp were found to be most indicative for the ≥321h group (IndVal=0.47, p≤~~=~~0.~~037~~05) and bucciniform gastropods for the ≥195h ~~-~~<321h group (IndVal =0.78, p≤0.001~~=0.0002~~). *Bathymodiolus* mussels were indicative for the <51h group (IndVal =0.45, p~~=~~≤0.~~042~~05) featuring the lowest densities for the studied time series. Contrastingly for the NEP, splits coincided with the chronology and tubeworm densities were significantly indicative for the <45h group (IndVal =0.46, p≤0.001~~=0.001~~). Pycnogonids and buccinids were both indicative of ≥504h (IndVal=0.51, p≤0.001~~=0.0001~~ and IndVal=0.52, p≤0.001~~=0.0013~~ respectively). The temporal split groups (Table 3) were delineated onto the faunal variation graphs (Fig. 3) and used to colour-code groups in the ordinations (see 3.1.3) in order to investigate how individual taxa and environmental conditions coincide with and influence the temporal inconsistencies represented by the MRT groups.

Microbial Cover - Despite the large difference in percentage of the image covered by microbial mats between MAR (1.34—2.76%) and NEP (25.11—37.02%), both showed a decline during the period analysed (Fig. 4). The observed trends were significantly negative for both sites. For the MAR, this decline ~~resulted in~~corresponded to a significant negative correlation between microbial cover and mussel densities (r=-0.67, p~~=0.00~~≤0.001) ~~on the one hand~~ and shrimp densities ~~on the other~~ (r=-0.53, p≤0.001~~=0.0004~~). For the NEP, no significant correlations between microbial cover and other taxa were revealed.

3.1.2. Environmental data

Environmental data analysis presented in this section is a short-term analysis, spanning 23 days corresponding to the imagery duration.

Temperature - Generally, higher temperatures were recorded at the MAR (Fig. 5). Mean temperatures at MAR were significantly higher than maxima recorded by probes T602 and T603 at NEP (Fig. 5, Table 4), coinciding with higher ambient seawater temperatures for the MAR (~4°C) than for NEP (~2°C). Even when rescaling to

ambient temperature, minimum temperatures measured on the MAR were still higher than those of the NEP. However, maximum and mean temperatures no longer stood out (but remained significantly different at $p<0.05$) and were even lower than those measured by probes T602 and T603 in the NEP (Table 4). Standard deviations and variance were maintained and were consistently higher at NEP, but not significantly different.

The hourly temperature recordings showed noticeable cycles of higher and lower temperatures specifically in T602 and T603 (~~which are~~ visible as red and blue colours in Fig. 6 respectively). When such (more or less) coherent bands of lower and higher values are observed in tidal pressure heat-maps, it shows the cyclical nature of the tides. Hence, alongside the tidal rhythms revealed by the periodogram analyses, a tidal cyclicity was recognisable in the temperature recordings of the NEP. Patterns were less clear for the MAR temperature data. Information on pressure data from the same localities and correspondence to the temperature measurements was included as appendix/supplementary material (Fig. S3).

In order to investigate how the temperature time series from the two oceans related to one another, cross-correlations were carried out on the hourly temperature values (Fig. 7). Generally, positive autocorrelations were more pronounced, meaning that the two series were in phase. Maximum autocorrelation was reached at lag +5 h when comparing MAR to T602 with the MAR time series leading, and a +5 to +6 h lag between MAR and T603. Most of the dominant cross-correlations occurred between lags +4 and +7, with tapering occurring in both directions from that peak. This ~~corresponds~~ corresponded to the time difference of ~6h between MAR and NEP locations, calculated as follows: 24*degrees (difference in longitude)/360. Maximum negative autocorrelations were observed at lags –14 and +11 for NEP T602 and MAR and between lags +10 and +13 for NEP T603 and MAR. The difference between the maxima (and minima) closely corresponded to the tidal cycle (~6h).

Fe – There ~~is~~ was a lag of 6 hours' time difference in the Fe-recordings carried out in the NEP being measured at 6.00 and ~~18h~~ 18.00 UTC and on the MAR at ~~12h~~ 12.00 and ~~0h~~ 00.00 UTC. Fe on the MAR was recorded twice a day (in 4 cycles) during the analysed imagery period. Concentrations ranged from 0.41 µmol/l to 1.62 µmol/l with a mean of 0.81±0.28 µmol/l. A non-significant ($p=\geq 0.4$~~79~~) positive trend was observed but no significant relationships between fauna, microbial cover and Fe were revealed. Fe measurements at NEP were limited to 7 days at a frequency of one measurement a day (Fig. 5). Consequently, its use as an explanatory variable for faunal variations was limited and no patterns were revealed. Values ranged from 2.07 to 2.99 µmol/l, which were higher than those observed on the MAR but also showed less variation.

Turbidity – Turbidity measurements (NTU) were restricted to the MAR observatory and a non-significant positive trend was observed during imagery duration. A large peak was noticeable at ~400 h (around 23 October 2011) though it was not reflected in any of the other environmental variables or community dynamics (Fig. 5).

3.1.3. Fauna-environment interaction

MAR - Environmental variables incorporated in the ordination analyses did not distinguish significantly between faunal densities or the temporal split groups found in the faunal composition (Fig. 8). The first axis was

~~significantly more~~most important for the MAR RDA (83.76%), hence attributing a higher importance to the horizontal spreading, but was not significant. This separation corresponded mostly with the separation of *Mirocaris* and *Bathymodiolus*. NTU seemed to have a distinct impact on separating the images from one temporal split group (from 51h to ~~-15~~95h), though there was no clear signal in NTU values at that time. Overall, for the MAR, no distinct relationship between a specific taxon and measured environmental variables was revealed.

NEP - The first axis of the NEP RDA was significant at $p<0.005$ and~~also~~ explained most of the variance (98.2%) represented by the ordination plot (Fig. 8). This coincided with a separation in the plot between Pycnogonida, Polynoidae and Buccinidae that pooled apart from the tubeworms. This lateral separation in taxa coincided with the strong correlation between tubeworm densities (appearances) and the T602 and T603 temperature measurements. Only T603 was significant at $p<0.05$. Temporal split groups were vertically aligned in the plot and tended to overlap, with tubeworms being more indicative for <45h group (as corroborated by the "multipatt indval" analysis). No clear influence from the environmental variables on the separation in temporal split groups could be revealed.

3.2. Long-term variability

Long-term variations in environmental conditions from both observatories spanning 9 months were investigated. As for the short-term analysis, ~~T~~the long-term time series analysed was limited by the shortest deployment period for which both observatories were up and running at the same time~~. Long-term analysis~~ and was thus restricted by the TEMPO-mini observatory (NEP)~~, whose deployment spanned ~ 9 months (29 September 2011 – 20 June 2012)~~.

Temperature -

The continuous MAR temperature time series showed temperature variations between 4.48 and 10.91°C, with a mean of 5.54 ~~±~~ 0.71 °C (Fig. 9). A significant negative trend in temperature values was observed over the 9-month period~~. This negative~~; a trend ~~was~~ already visible in the short-term analyses ~~as well~~. The NEP temperature values recorded during this period by T602 and T603 were comprised between 2.23°C and 5.43°C, with a mean of 3.78 ~~±~~ 0.54°C. T602 showed a significant negative trend ($p<0.001$) while T603 showed a significant positive trend ($p<0.001$) over the longer term. Trends were removed and periodogram analysis was carried out on the residuals for periods of 2 to n/2 (3168 h ~ 4.5 months), 2 to 800 h (~1 month), and 1 week periods (2 to 200 h). Regardless of the time-span, diurnal and semi-diurnal periods and their harmonics were the main significant frequencies discerned. No clear or distinct significant hebdomadal (weekly) or infradian (multiple days) cycles were encountered. Therefore, in order to facilitate interpretation, only the periodograms with periods of 2 to 200 h ~~are~~ were presented (Fig. 10).

A significant period at 12h was revealed for the MAR and NEP T602 probes, but not for T603. For T603, a peak was present at T=12h but it was not significant; however, harmonics of that peak at 25, 37, 50 and 74, 75h (etc.) were significant. A significant 25h period was thus observed for both NEP probes (T602 and T603). Recurrent harmonics of both semi-diurnal (12h) and diurnal (25h) frequencies were identifiable throughout the temperature time series, more so for NEP time series than for MAR, which agree well with the tidal cycle (12h 25 min and 24h

50 min) (Fig. 10). A distinct 6.25-day period (at 150h) with a high amplitude was revealed for the T602 and T603 probes (Fig. 10). Such a peak was ~~recognizable~~ recognisable for the MAR as well, though it was not significant. A peak at 174h (7.25 days) was significant for all three probes (MAR ~~&~~ and NEP). The corresponding significant periods between MAR and NEP were thus 12h, 37h, 87h, 112h and 174h though some were less pronounced depending on the ocean.

Fe -

A negative almost significant trend (p~~=~~>0.05~~3~~) was observed for 6 months of data (30 Sept 2011 ~~-to-~~ 29 March 2012) from the MAR featuring two Fe measurements a day (at 00.00 and 12.00 UTC) (Fig. 9). Minimum and maximum concentrations were 0.25 and 2.61 µmol/l respectively with a mean ~~at~~ of 0.98 ~~±~~ 0.43 µmol/l, which was lower than the averaged concentrations of the other deployment years (with 2.12 ~~±~~ 2.66 µmol/l averaged over 2006, 2010-2011, 2012-2013 and 2013-2014). Periodogram analyses revealed a peak at 108h (4.5 days) and a more pronounced one at 180h (7.5 days), but none of these were significant. For the NEP, a time series of one Fe measurement a day (at 6.00 ~~AM~~ UTC), consisting out of 4 sampling cycles, spanning >4 months was analysed (20 October 2011 – 26 March 2012). The last 49 days (31 January ~~2012~~ – 26 March 2012) ~~days~~ were omitted due to artefacts visible in Fig. 9, which was due to the reagents running ~~down~~low. Periodogram analysis of these ~3 months of data revealed no significant periods either. Fe concentrations ranged from a minimum of 0.67 µmol/l to a maximum of 5.45 µmol/l; with mean values at 2.40 ~~±~~ 1.03 µmol/l. Mean values approached the maximum values measured by the MAR observatory, similar to what was observed in the short-term analyses.

Oxygen -

Due to the unresolved issues with the optodes and the oxygen concentrations measured (see section 2.2), ~~the absolute values were taken into account, however~~only the differences in overall concentration were used to describe the differences between the two sites. For the MAR, measurements ranged from 170.54 to 251.66 µmol/l with a mean of 230.62 ~~±~~ 16.98 µmol/l. The NEP featured distinctly lower concentrations, ranging from 23.67 µmol/l to 77.26 µmol/l with a mean of 63.42 ~~±~~ 7.15 µmol/l. Here as well, there seemed to be more variability at the NEP than at the MAR.

Turbidity -

Turbidity was only measured at the MAR observatory and showed several large peaks further along in the long-term time series (e.g. during end February 2012 and May to June 2012) (Fig. 9), however none of these observations translated themselves in the other environmental variables. There was a significant positive trend for NTU over 9 months ($p<0.001$) but no significant periods were revealed by the periodogram analyses.

4. Discussion

4.1. Comparison in faunal composition~~Faunal assemblages~~

The two observatories filmed one single assemblage over time in a limited FOV, whereas hydrothermal edifices are characteristically inhabited by mosaics of different faunal assemblages, spatially distributed according to local environmental conditions and microhabitats (e.g. Sarrazin et al., 1997; Cuvelier et al., 2009; 2011a, Sarrazin et al.,

2015); patterns are enhanced by high local variability in environmental variables at centimetre scales and steep physico-chemical gradients (Sarrazin et al., 1999; Le Bris et al., 2006). The two different study sites also feature different spreading rates, which may influence community dynamics at vents by creating less habitat stability in higher spreading rate settings (Tunnicliffe and Juniper 1991; Shank et al., 1998). While relative stability in faunal composition has been observed on a number of edifices, even reaching decadal-scale stability at some (e.g. Eiffel Tower), smaller scale variations, both in space and time, do occur (Cuvelier et al., 2011b). Hence, the variations in faunal densities observed during this study may not apply to the hydrothermal edifice as a whole; the presence of rhythms in the organisms and in temperature, even though observed on a smaller surface, are likely to apply for the entire hydrothermal structure.

Vent fauna hosted by the two study sites are quite different. While there are similarities at higher taxonomic levels, e.g. classes and families, there is only one correspondence on genus level (*Sericosura* sp., Pycnogonida) and none on species level between both sites. A higher number of visible taxa were identified on MAR images when compared to NEP (8 vs. 6, respectively, not taking into account microbial cover or visiting fish species). This observation does not imply that the MAR is more diverse than the NEP since imagery only gives a partial overview of the actual diversity (Cuvelier et al., 2012). When comparing samples, an overall higher diversity was observed in the Pacific than in the Atlantic hydrothermal vent ecosystems, with species richness being positively correlated with spreading rate, associated distance between vent fields and longevity of vents (Juniper and Tunnicliffe, 1997; Van Dover and Doerries, 2005). Nevertheless, such observations remain subject to how well a certain locality is studied and if all faunal size fractions (meiofauna to megafauna) are included in assessing diversity (e.g. Sarrazin et al., 2015). Diversity estimates represent one of the main limitations of imagery analysis which is limited to quantifying and correctly identifying (assessing) mega-and macrofauna (~mm). In the subsequent sections temporal variations and behaviour (rhythms) of the separate taxa and their implications for possible microhabitat and niche occupation will be discussed.

4.1.1. Engineering species

MAR – *Bathymodiolus azoricus* mussels visually dominate the shallow water (<2300m) vents along the MAR and appear to be a climax community, being present for a few decades on the same edifices within the Lucky Strike vent field (Cuvelier et al., 2011b). They form dense faunal assemblages in relatively low temperature microhabitats (~~Cuvelier et al., 2011a;~~ De Busserolles et al., 2009; Cuvelier et al., 2011a). A spatial segregation in mussel sizes is observed with a decrease in size with increasing distance from hydrothermal input and corresponding thermal gradient showing diet changes with mussel size categories (Husson et al., 2016). Contrastingly to what has been described by Sarrazin et al. (2014), no significant interactions between mussels and other organisms ~~could be revealed~~were observed based on the 6h frequency analysed here.

NEP – Tubeworms of the species *Ridgeia piscesae* ~~were~~ are the main visible constituents of the filmed assemblage and a secondary surface for the associated fauna assessed here. Their appearance rate showed a strong relationship with the temperature recorded by probes T602 and T603 (Cuvelier et al., 2014 and this study), contrastingly to the other taxa. Emergence/retraction movements of siboglinid tubeworms were proposed to be a thermoregulatory behaviour or suggested to be governed by oxygen or sulphide requirements (Tunnicliffe et al., 1990, Chevaldonné

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et al., 1991) or tolerance to toxic compounds (sulphides, metals, etc.). Changing hydrothermal inputs (high sulphide concentrations/high temperature) and oxygen concentrations could thus regulate tubeworm appearances, reflecting the tidal patterns of these environmental variables. Whilst interactions between tubeworms and other taxa were not significantly quantifiable on the current 6h frequency of image analyses, they have been observed and described for the hourly frequency (Cuvelier et al., 2014).

4.1.2. Shared taxonomic groups

Polynoidae – Many of the free-living polynoid species are known as active predators (Desbruyères et al., 2006) moving rather swiftly across the FOV looking for prey and were even observed attacking extended tubeworm plumes at NEP (Cuvelier et al., 2014). Free-living MAR scale worms were preponderantly associated with bare substratum, while those quantified for NEP were only those observed on top or within the tubeworm bush. They were also visible on the bare substratum surrounding the tubeworm bush but this area ~~that~~ was not taken into account during this study. While there was a difference in substratum association between polynoids as observed by the two observatories, all individuals seemed to be rather territorial (see Cuvelier at al., 2014). On the MAR, one individual appeared ~~very attached to one single area within the FOV, returning to it~~ repeatedly return to one single area within the FOV after excursions. Such behaviour might be indicative of topographic memory and homing behaviour. The Atlantic commensal polynoid *Branchiplynoe seepensis* can occasionally be observed outside of the mussel shells (Sarrazin et al., 2014), wherein it normally resides, but not on the image sequence analysed here.~~Many of the free-living polynoid species are known as active predators (Desbruyères et al., 2006).~~

Gastropoda – Buccinid (NEP) and bucciniform (MAR) gastropods appeared more related to less active environments. Both species are considered predators or scavengers (Desbruyères et al., 2006; Martell et al., 2015). Within the MAR setting, snails (*Phymorhynchus* sp.) were present in very low abundances (1 or 2 individuals at most) and were positioned on bare rock with no fluid flow. In the NEP setting, whelks (*Buccinum thermophilum*) were generally more abundant on ~~to~~ areas inhabited by vent animals. No correlation with emerging fluid temperatures was observed nor was a substratum preference revealed (Martell et al., 2015). ~~Numbers~~ Abundances observed within the FOV tended to vary from 1 to 6 individuals, while they were shown to congregate in groups of 5 or more individuals at MEF (Martell et al., 2015). ~~Both species were considered predators or scavengers (Desbruyères et al., 2006; Martell et al., 2015).~~

Pycnogonida – Sea spiders showed a very distinct spatial distribution ~~in~~ at NEP featuring a localised clustering behaviour (see heat maps published in Cuvelier et al., 2014), whilst their presence on the MAR was occasional. MAR pycnogonid individuals were only observed visiting the edge of the mussel bed which was further away from the fluid exit.~~At the latter, individuals were observed visiting the edge of the mussel bed, further away from venting.~~ A large difference in pycnogonid densities was observed between the two sites as well, with a ratio of 1/250 MAR vs. NEP. Increased activity and aggregations of more than 5 individuals (and increased intra-species contact) at NEP were linked to conditions of high temperature-low oxygen saturation (Lelièvre et al., 2017). Interestingly, these organisms all belong to the same genus, namely *Sericosura*. The species known for the Lucky strike vent field (MAR) is *Sericosura heteroscela* while there are multiple species (within the same genus) for the

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Main Endeavour Field (NEP) among which *Sericosura verenae*. All *Sericosura* species from the Ammotheidae family known so far appear to be mostly obligate inhabitants of hydrothermal vents or other chemosynthetic environments (Bamber, 2009). While being an abundant taxon with a localised clustering behaviour at the NEP site, it is scarce and vagrant at the MAR. Their microhabitat and niche occupation at the studied sites is likely to differ, causing the discrepancies observed. ~~Based on their abundance or scarcity in the study sites, their local niche occupation is likely to explain the discrepancy in densities observed between the studied sites.~~

Microbial cover – This is a generic term used to refer to the microbial mats colonising various surfaces in the vent environment without assuming similar microbial composition. While no significant relationships were revealed between microbial cover and fauna for NEP in the current study, a significant negative correlation was observed for this site between pycnogonids and microbial cover based on the same imagery analysed with a higher frequency (4h instead of 12h), which was attributed to pycnogonid grazing (Cuvelier et al., 2014). For MAR, significant negative correlations existed between microbial coverage and mussels ~~on one hand~~and microbial coverage and shrimp ~~on the other~~. For the mussels, this could be due to scattering and repositioning of individual mussels: as mussel reposition on top of the microbial mats, they decrease the visible and assessable microbial coverage. The negative relationship between shrimp and microbial cover could be caused by the shrimp grazing on microorganisms (Gebruk et al., 2000; Colaço et al., 2002; Matabos et al., 2015).

4.1.3. Regional taxa

MAR

Alvinocaridid shrimp – The hydrothermal shrimp observed by the MAR observatory mostly belong to the *Mirocaris fortunata* species. On the images analysed, they were most abundant in the main axe of flux. Matabos et al. (2015) quantified this to about 60% of the shrimp abundances (to 69cm of an emission), confirming previous distributional patterns of shrimp being indicative of fluid exits and characteristic for warmer microhabitats (Cuvelier et al., 2009, 2011a; Sarrazin et al., 2015). Their thermal resistance and tolerance corroborates this pattern (Shillito et al., 2006). Because their distribution is linked to the presence of fluid exits and flow, a significant positive correlation between shrimp and temperature would be expected. To date however, such a relationship could not be designated, not in this study or in previous studies based on data from the deep-sea observatories (Sarrazin et al., 2014; Matabos et al., 2015), though Sarrazin et al. (2014) did show a significant positive correlation between *Mirocaris fortunata* abundances and vent fluid flux.

Bythograeidae (Decapoda) – *Segonzacia mesatlantica* crabs were mostly associated with the mussel beds and anhydrites, as where the shrimp (Matabos et al., 2015). Some interactions between crabs and shrimp were observed mostly resulting in shrimp fleeing. Possible significance of these interactions (mostly territorial in nature) were described in more detail by Matabos et al. (2015).

Bythitidae (Osteichthyes) - The fish *Cataetyx laticeps* was frequently observed at the base of the Eiffel Tower edifice within the Lucky Strike vent field (Cuvelier et al., 2009). No feeding ~~action~~ on the benthic hydrothermal fauna was observed during the 6h frequency image analyses.

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NEP

Majidae (Decapoda) - Contrastingly to the 1h frequency observations (Cuvelier et al., 2014), no spider crabs were observed visiting the filmed assemblage on a 6h frequency imagery analyses. Whilst this majid spider crab is known as a major predator at hydrothermal vents, no such actions were recorded by ~~the~~ our observatory module.

Zoarcidae (Osteichthyes) – Similarly ~~as for~~to *Cataetyx* fish on the MAR, no visible activities of feeding or predation of *Pachycara* sp. eelpouts were observed on the NEP. Cuvelier et al. (2014) proposed that the eelpouts (and fish in general) may be more sensitive to the effects of lights but this hypothesis, based on behavioural observations, could not be confirmed in the present study due to the low-resolution observation frequency.

4.2. Short term variations and rhythms in fauna and environment~~Behavioural rhythms and variations~~

When looking at the engineering taxa for each ocean, a clear diurnal rhythm was observed in visible (i.e. out of their tubes) tubeworms (NEP), while there was a lack of temporal rhythms in mussel densities (MAR). However, taking in to account the characteristics of both chemosynthetic taxa, counts of mussels with open valves and extended siphons ~~openings~~ instead of densities should be used for comparison to tubeworms outside their tube. This difference in assessment could account for the lack of temporal periodicities at the MAR, where mussel valve openings or visible siphons were impossible to quantify due to the larger distance between the observatory and the filmed assemblage. Different causes might trigger a mussel to open his valve or a tubeworm to come out of its tube and these can be either attributed to an external trigger (e.g. retraction or closure after possible predation actions (for tubeworms: Cuvelier et al., 2014; for mussels: Sarrazin et al., 2014)) or to their physiology (need for nutrients or saturation). ~~Until now, n~~No significant links have yet been established between fluid flow and open mussel valves (Sarrazin et al., 2014) but some indications of tidal rhythmicity were visible (Matabos et al., unpublished data). No consistent statistically significant link between fluid flow and tubeworm appearance has been revealed to date either (Cuvelier et al., 2014), although ~~they showed~~ a steady significant semi-diurnal tidal rhythm over time was observed. The niche occupation and role within the ecological succession over time of mussels and tubeworms are very different for the two oceans. In Pacific monitoring studies, tubeworms ~~were~~ are out-competed by mytilid mussels when hydrothermal flux start~~ed~~ to wane (Hessler et al., 1985; Shank et al., 1998; Lutz et al., 2008; Nees et al., 2008), while the latter appear to represent a climax community in the more stable Atlantic <2300m (Cuvelier et al., 2011b). Nevertheless, 23 days appears too short to allow observation of succession patterns.

Next to the engineering species, only a few other taxa showed significant periodicities in densities over time, namely polynoids for MAR and NEP, and buccinids for NEP. The lack of significant periodicities in MAR shrimp was corroborated by a ~~more~~ long-term study by Matabos et al. (2015). Both polynoids and buccinids displayed multiple day periodicities instead of tidal cycles, which could be mostly reduced to harmonics of tidal cycles that become more visible further along in the time series as they ~~get~~ become more pronounced over time. For both taxa, the multiple day periodicities ~~revealed~~ approached those visible in Fe, i.e. 4.5 and 7.5 days (though non-significant) and besides an apparent preference for lower temperatures, there were no significant links with

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temperature (as corroborated by Lelièvre et al. (2017) for the polynoids). ~~More~~ Additional~~thorough and~~ high resolution investigations will be necessary to corroborate or validate these observations. Overall, the reasons for the lack of periodicities in fauna can be twofold: either the taxon in question is unevenly represented in low abundances and therefore too heterogeneous (rendering any statistical test difficult which was the case for MAR crabs and pycnogonids) or the recording/analysing frequency does not allow discerning of significant periods. The shortest period to be resolved is twice the interval between the observations of a time series. Hence, caution is needed when interpreting patterns as the recording and~~/or~~ analysing frequency influences observations. ~~Moreover~~A previous~~, it was shown previously in a~~ higher resolution study (hourly frequencies) already showed that depending on the frequencies investigated the type of relationships (significance, positive or negative) between the taxa might change (Cuvelier et al., 2014).

While certain environmental variables might explain a large amount of variation occurring in a single ~~or specific~~ taxon (e.g. NEP tubeworm appearances and temperature from probes T602 and T603), a wider variety of environmental variables measured at multiple sampling points ~~in~~ across the FOV in a resolution similar or higher than the imagery analyses frequency should be considered in order to explain and comprehend the whole of community dynamics. This was also illustrated with the temporal split groups identified in community composition constrained by time, where the predictive power of the split groups was rather low and groupings could not be corroborated with changes in the environmental variables. Split groups were ~~which were q~~quite similar for the larger groups (those with higher n) with ~~split groups~~those at the MAR occurring 6 hours later than those at the NEP. A slower pace in significant detectable changes in overall faunal composition in the Atlantic vs. the NE Pacific could be explanatory. For instance, difference in spreading rate was shown to be directly proportional to different rates of change in community dynamics between slow-spreading MAR and faster-spreading NEP (Cuvelier et al., 2011b). ~~However, for now, the predictive power of the split groups was rather low and groupings could not be corroborated with changes in the environmental variables.~~

4.3. Long term environmental variations and rhythms~~Environmental rhythms and conditions~~

At hydrothermal vents, temperature is a proxy of sulphide and Fe concentrations and most importantly of the hydrothermal vent input. Highest minimum temperatures were recorded at the MAR where the probe was positioned closer to a visible fluid exit, whereas NEP temperatures were ~~the most~~more variable and displayed broadest ranges. It is important to bear in mind that ambient seawater temperature at 1700m on the MAR is higher than that at 2200m depth in the NEP (4°C vs. 2°C respectively). When taking this into account and rescaling the temperature values, mean and maximum temperatures were highest at NEP. Highest positive and significant autocorrelation values indicated a ~5-6h lag between MAR and NEP, with MAR leading. Interestingly, the hour difference between the two sites corresponds to ~6 hours as well. The geographical distance separating the two localities does thus not only allow to quantify the time difference between two sites but also the delay in the tidal rhythms observed between the two.

Tidal rhythms were discernible in both NEP and MAR temperature series. Potential mechanisms causing tide-related variability in hydrothermal fluids included the modulation of seafloor and hydrostatic pressure fields by ocean tides, modulation of horizontal bottom currents by tides and solid earth tide deformations (Schultz and Elderfield, 1997; Davis and Becker, 1999). For NEP, diurnal periods at ~25 h were discerned for both temperature probes (T602 and T603). Significant semi-diurnal periods were also found in T602, though for T603 they could only be identified based on their harmonics. ~~Similarly, t~~The MAR temperature time series also had a distinguishable semi-diurnal component. Tidal rhythms observed in the temperature time series for NEP and MAR were concordant with observed tidal signals for the respective regions. For instance, in the North-East Pacific, measured tides in the Barkley Canyon, another instrumented node from ONC closer to shore, were mixed semidiurnal/diurnal at 870m depth (Juniper et al., 2013). In the same canyon, periods of enhanced bottom currents associated with diurnal shelf waves, internal semidiurnal tides, and also wind-generated near-inertial motions were shown to modulate methane seepage (Thomsen et al., 2012). While, temperature variability at hydrothermal vents at Cleft Segment on the Juan de Fuca Ridge was shown to greatly diminish when current directions did not shift in direction with the tides, it was suggested that the modulation of temperature by tides was only indirect, through the modulation of horizontal bottom currents (Tivey et al., 2002). These horizontal bottom currents showed 12.4h tidal periodicity which was also found in the temperature time series of the aforementioned article as well as in our NEP temperature time series. Consistent with the main orientation of the ridge and the topography of Grotto, temperature and oxygen saturation at the NEP deployment site were shown to be strongly and significantly influenced by the northern and southern horizontal bottom tidal currents (along the valley axis) (Lelièvre et al. 2017). Patterns in temperature variation of the MAR time series corresponded to the tidal signal observed in the Lucky Strike vent field at 25h and to the semi-diurnal tidal oscillation at 12h30 (Khripounoff et al., 2000; 2008).

Between oceans, ~~there are~~ differences ~~in the observation of~~were observed in tidal rhythms ~~based on the~~of high (>200°C) and low (<10°C) temperature records. For the NEP, the tidal influence ~~appears~~ appeared to wane in high temperature records making tidal signals less clear or even non-existent (Tivey et al., 2002; Hautala et al., 2012). While for the MAR the semi-diurnal variability in the high temperature records was shown to be more significant and to be more coherent with pressure than those observed in low-temperature (Barreyre et al., 2014). Unfortunately, we cannot corroborate this with the current study as only low-temperature time series were recorded by both ecological observatories. Even though we revealed some similarities in the rhythms of MAR and NEP low temperature series collected for the same period, there ~~are~~ were indications~~,~~ that local hydrography ~~controlling tides~~ and associated bottom-currents play a major role on the temporal variability of diffuse outflow and vent discharges (Barreyre et al., 2014, Lee et al., 2015). Clear peaks in temperature variables were noticeable at ~6-7 days in MAR and NEP. We do not know what caused this period to be significant. In comparison, ~~A~~at Cleft Segment more southwards on the Juan de Fuca Ridge (NEP), Tivey et al. (2002) found 4-5 day broadband peaks in temperature from diffuse flow as well as high-temperature vents which were thought to be storm-induced from the sea-surface.

~~Fe (iron) –~~ Fe is commonly used as a proxy for vent fluid composition. Higher Fe concentrations would thus be expected where temperatures were higher, in this case at MAR (vs. NEP). However, the opposite was observed here. ~~Moreover, t~~The Fe concentrations reported here for the MAR ~~in 2011~~ were lower than the Fe concentrations

from other deployment years at the same site (Laes-Huon et al., unpublished data). The 2011 concentrations recorded at the MAR were ~~really~~ close to the detection limit of the CHEMINI instrument (0.3 µmol/l). Additionally, the MAR system was not calibrated *in situ*, contrastingly to the NEP, which could have generated a lower accuracy in the calculated concentrations, though question remains if such large discrepancies can be explained by this feature alone. The location of the sample inlet and the high spatial variation occurring at hydrothermal vents might contribute to the patterns observed. The values observed at NEP~~, on the other hand,~~ were in the same order of magnitude as those reported for the Flow site also on the Juan de Fuca Ridge (i.e. 0 to 25 µmol/l, Tunnicliffe et al., ~~(~~1997~~)~~). No significant periods (based on 12h or 24h recording frequency) were found at the sites for the duration of the deployment, although some indications of 4.5 and 7.5 day periodicities could be observed at the MAR and 3.8 day cycles for Fe concentrations were detected in the same sampling area for 2012-2013 (~~Laës~~Laes-Huon et al., in press). For the North East Pacific, 4 day oscillations in currents near seamounts along the crest of the Juan de Fuca Ridge were observed (Cannon and Thomson, 1996), however, these were not visible in the Fe time series at NEP, although 4.5 day periodicities were visible in buccinids and polynoids (Cuvelier et al., 2014). Hence, there were some indications of multiple day periodicities, but these findings need to be corroborated, preferably by using a higher sampling frequency.

Turbidity ~~(~~—NTU) levels observed showed several large peaks over time. Particle flux at Lucky Strike combines both large and small diameter particles which have different settling velocity (Khripounoff et al., 2000). Kripounoff et al. (2008) showed an increased particle flux in April that reached a maximum end May (2002). These do not correspond to the peaks observed here (in this study peaks were most pronounced at the end of October, February to March and May to July) but turbidity peak occurrences tend to differ between years and seasons. Due to seasonal peaks, longer time series will be needed to reveal recurrent patterns.

Generally, multiple day periodicities ~~are~~ were harder to reveal as many of them can be reduced to harmonics of the tidal cycles. In this perspective, the long(er)-term environmental variable analyses were considered more robust due to increased number of data points. Nevertheless, there is not much we can currently say on multiple day or hebdomadal cycles observed in the time series presented here.

4.4. Limitations

Overall~~,~~ at hydrothermal vents, it remains hard to establish relationships among the environmental variables measured *in situ*. Ratios of temperature to chemical concentrations are not constant, and can vary between sites (Le Bris et al., 2006; Luther et al., 2012). There is also the issue of high variance (and noise) in environmental variable time series as well as that of a possible delay in appearance of certain peaks, which makes it difficult to unravel patterns. Such a delay between environmental variable recordings might exclude the ability of unravelling/exposing correlations. The example for Fe and temperature recordings, where a delay of 1 to 5 min precluded a direct correlation for each sample point, was presented by Laes-Huon et al. (2016).

Caution is needed when programming the recording frequencies of imagery and environmental variables. Despite being mainly restricted by battery life (wireless observatories), light usage (wired observatories) or quantity of reagents (both), a 6h analysing frequency might not be the most representative to assess faunal variations and links with the environment. Indicative of this are the differences observed when analysing different frequencies as briefly touched upon in Cuvelier et al. (2014) and comparing them with those presented here. It still proves difficult at hydrothermal vents to link faunal variations with ~~the~~single-point environmental variables measured *in situ*. This can ~~either be due~~be attributed to the high spatial and temporal variation of the environmental gradients compared to the larger FOV assessed ~~or due to~~and to the recording frequencies or complexity of *in situ* measurements with corrections to be applied and possible delays. Temperature still seems the best proxy for faunal variations, however not all faunal presence~~s~~/absence~~s~~, abundances or the entirety of community dynamics can be explained solely by temperature. ~~Biotic interactions are at play as well, which can be observed thanks to the remote observatory set-up granting us access to long-term high resolution data, but these may change as well according to local environmental conditions, gradients and harshness (Mullineaux et al 2003).~~Biotic interactions are at play as well. While these can be observed thanks to the remote observatory set-up, long-term high resolution data need to be assessed (Matabos et al., 2015).

The influence of the lights on the fauna was hard to discern during this study, though supposedly fish presence would be more impacted when compared to invertebrate fauna (Aguzzi et al., 2010; Cuvelier et al., 2014).

Deployment of probes has also proven to be a predicament. While more accessible sites tend to be preferred and selected, deployment setting, accessibility, underwater conditions (e.g. currents), ROV manoeuvrability and piloting skills also influence the final observatory set-up.

5. Conclusions

Influence of the tides is visible in both settings, most clearly in temperature variables and in tubeworms appearances. The geographical distance separating the two localities ~~was~~ is shown to not only quantify the time difference between two sites but also the delay in the tidal rhythms observed in temperature values (which is at a ~6h lag) between the MAR and NEP. Temporal split groups in community composition are rather similar between both settings, though the 6h delay is visible as well. Shared taxa comprised one genus (*Sericosura*), one family (Polynoidae) and one class (a buccinid and a bucciniform Gastropoda) and based on their relative abundance and behaviour, they seem to occupy different niches at the different hydrothermal vents. Nevertheless, it remains complicated to unravel links with environment and to discern which environmental variable is the most influential or explanatory. To date, temperature remains the most explanatory, though it cannot explain the entirety of community dynamics. This is ~~mainly~~ likely due to the high spatial variation at hydrothermal vents and the single point measurements done by the ~~temperature~~ environmental probes. ~~There thus remains a~~A persistent need remains for more complementary and representative data, measured at frequencies similar or higher than the imagery recordings and ~~measured~~ at multiple points in the FOV. Recording frequencies are crucial: a 6h recording frequency might not be good enough to represent the *in situ* reality. Also the implementations of instruments that do not imply complex tools but allow the assessment of additional environmental variables (e.g. current meters)

could be a way forward. (Semi-) ~~automated~~ Automated tools ~~need to~~should be developed for specific taxa and settings to assist in assessing faunal abundances ~~on~~ in images.

Acknowledgments

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Figures

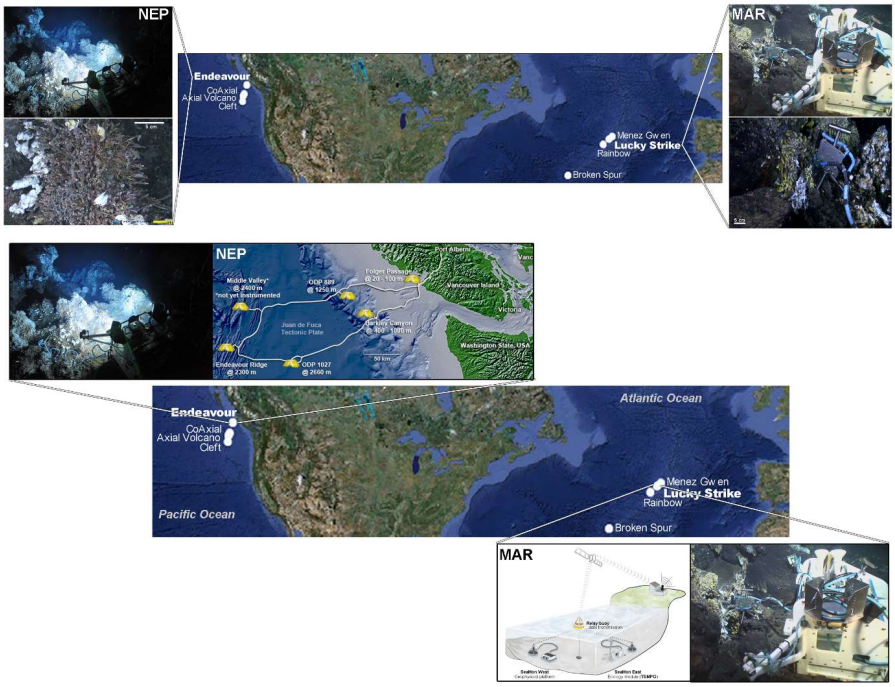


Fig. 1 Location of the two study-sites in the Atlantic and the Pacific Ocean, along with some other well-known vent fields for reference purposes. The NEP inset (top) shows the location of the different instrumented nodes of Ocean Networks Canada at the right and the TEMPO-mini ecological module deployed at Main Endeavour Field on the Juan de Fuca Ridge (NEP). The MAR inset (bottom) represents a sketch of the Atlantic observatory (EMSO-Açores) at Lucky Strike vent field on the left and the TEMPO ecological module on the right. For more details of the exact location of the observatories within the hydrothermal vent fields see Matabos et al. (2015) for MAR and Cuvelier et al. (2014) for NEP. ~~Location of the two study-sites along with some other well-known vent fields for reference purposes. TEMPO is located at the Lucky Strike vent field on the MAR, whilst TEMPO-mini is at Main Endeavour Field on the Juan de Fuca Ridge (NEP). For more details of the exact location of the observatories within the hydrothermal vent fields see Matabos et al (2015) for MAR and Cuvelier et al. (2014) for NEP.~~

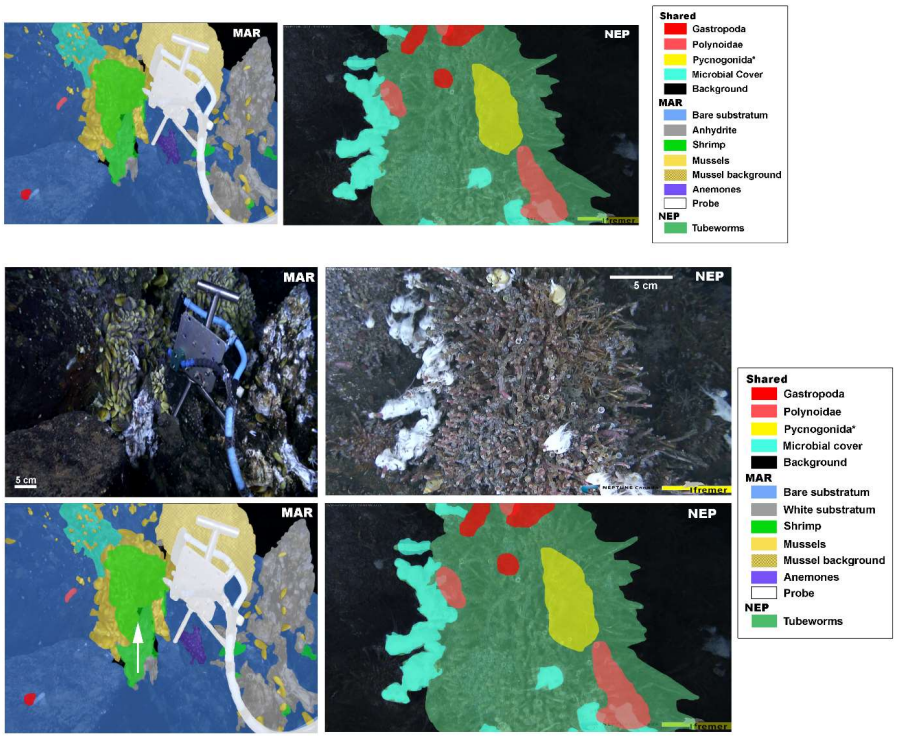
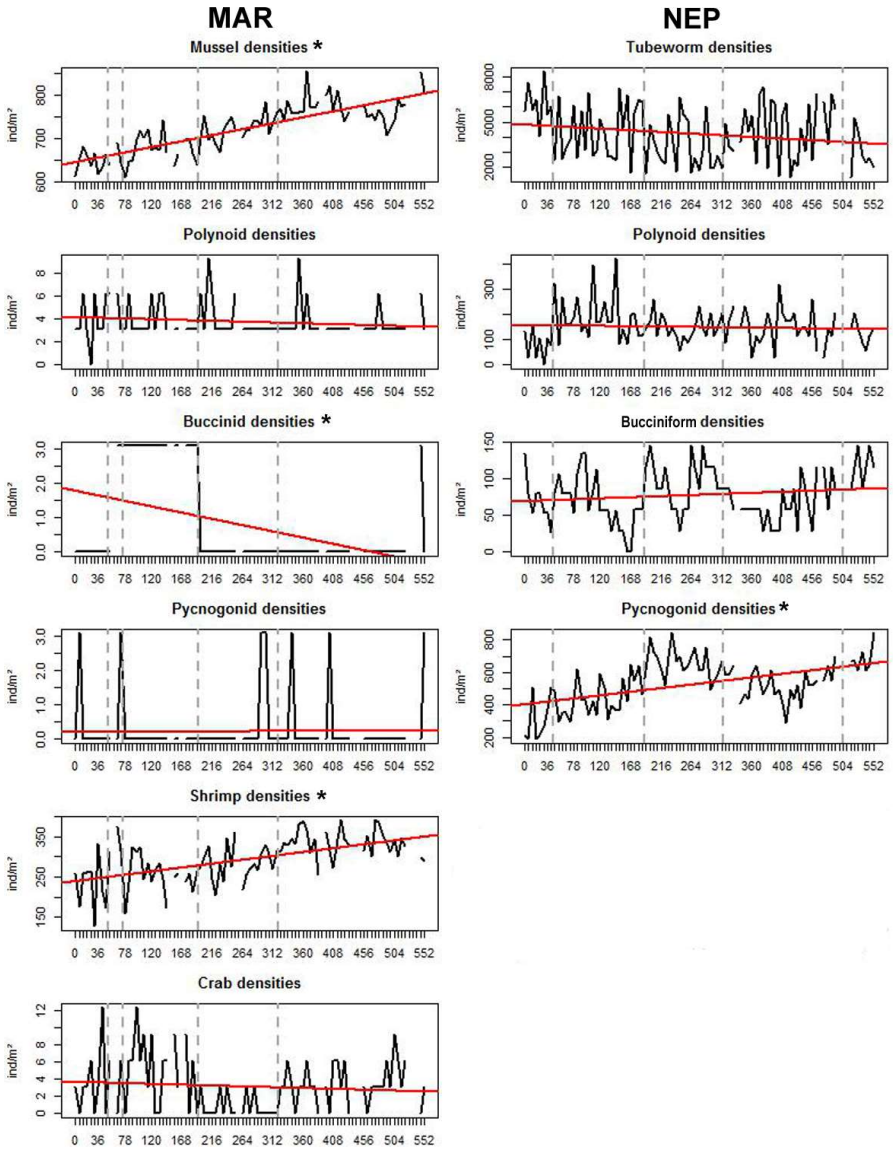


Fig. 2. Sample image recorded by the ecological observatory modules for MAR and NEP (top) and a map of the fields of view (FOV) featuring the various taxa assessed (bottom). Taxa or other features that are shared between the two observatories share the same colour codes. Gastropoda applies to Buccinidae for NEP and bucciniform Turridae on MAR. White substratum is possibly anhydrite with encrusted microbial mats. 'Mussel background', 'background' and 'probe' were areas that were not assessed. The white arrow represents the fluid flow exit and direction. No visible emission was observed on NEP. Visiting fish and crab species were not included (Table 2). Crab presence on MAR tends to correspond predominantly to shrimp distribution (Matabos et al., 2015). Surfaces filmed and analysed are listed in Table 2. '*' is a shared taxon but not visible on MAR sample image or map due to the scarce presence and low densities. ~~Sketch of the fields of view (FOV) as recorded by the ecological observatory modules for MAR and NEP with all features assessed. Taxa or other features that are shared between the two have the same colour codes. Gastropoda applies to Buccinidae for NEP and bucciniform Turridae on MAR. '*' is a shared taxon but not visible on MAR due to the scarce presence and low densities. 'Mussel background', 'background' and 'probe' were not included in the surface calculations. The white arrow represents the fluid flow exit and direction. No visible emission was observed on NEP. Visiting fish and crab species were not included (Table 2). Crab presence on MAR tends to correspond predominantly to shrimp distribution (Matabos et al., 2015).'*' is a shared taxon but not visible on MAR due to the scarce presence and low densities.~~


MAR
NEP
Mussel densities *
Tubeworm densities
Polynoid densities
Polynoid densities
Buccinid densities *
Bucciniform densities
Pycnogonid densities
Pycnogonid densities *
Shrimp densities *
Crab densities
ind/m²
0 36 78 120 168 216 264 312 360 408 456 504 552

1046

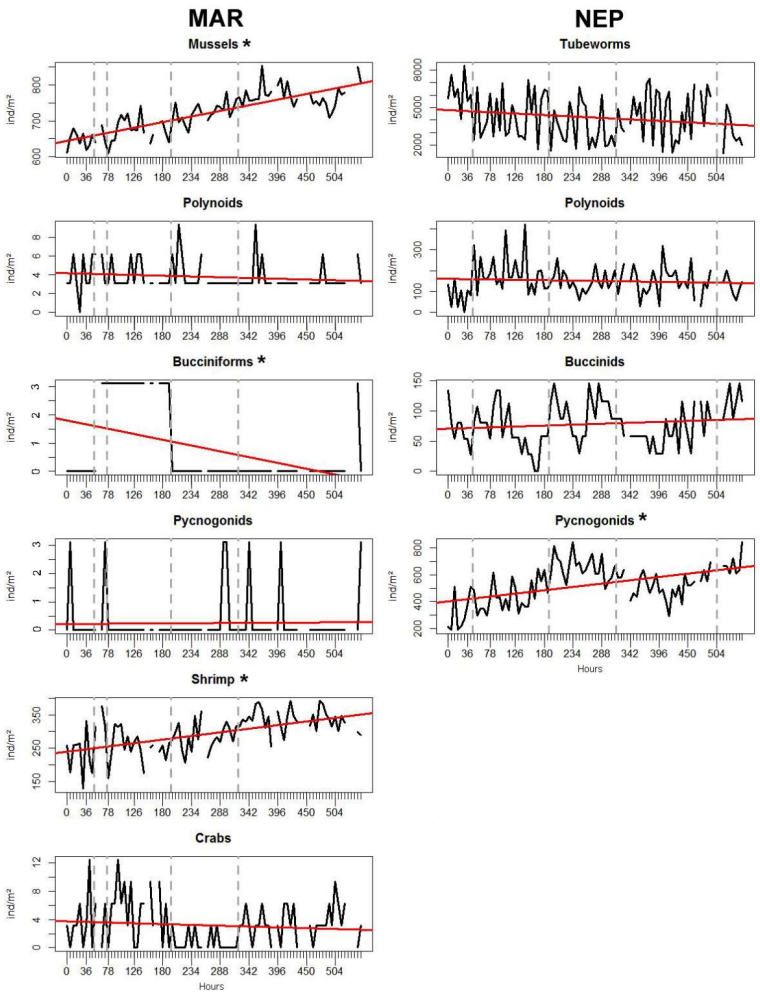


Fig. 3. Temporal variations in faunal densities for MAR and NEP along with trend lines (in red) and MRT temporal groups (grey vertical dotted ~~bars~~lines), x-axis ~~are hours,~~show the sampling frequency every 6h. Taxa with significant trends (p<0.05) are marked with an *.

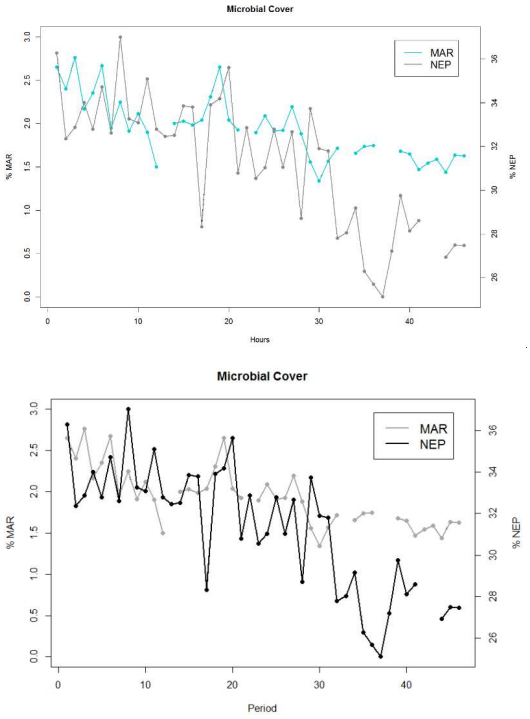


Fig. 4. % Microbial cover every 12h, for the imagery period analysed. X-axis contains periods, 1 period=12h

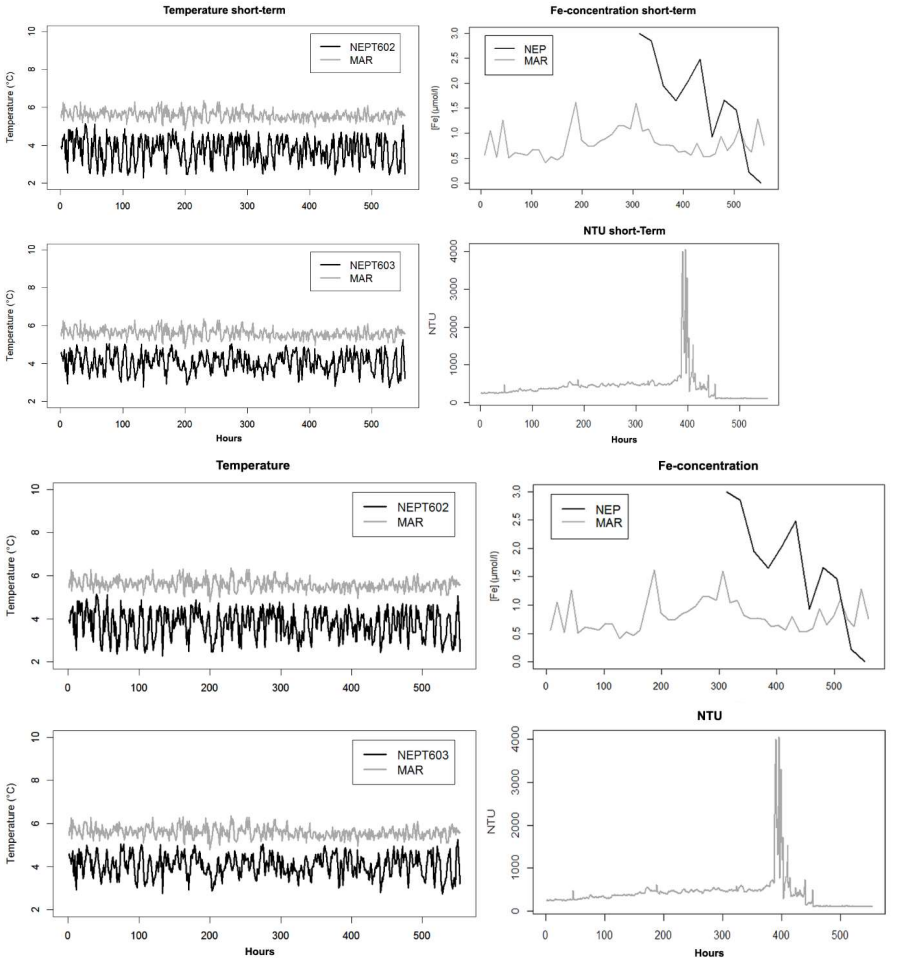


Fig. 5. Short term ~~E~~environmental variables (23 days) averaged per hour during the imagery analysis period. Variables measured at both deployment sites are presented in the same graphic (temperature and Fe). Fe has a daily frequency for the MAR but a 12h frequency for the NEP and recording times differ. NTU (Turbidity) was only available for the MAR.

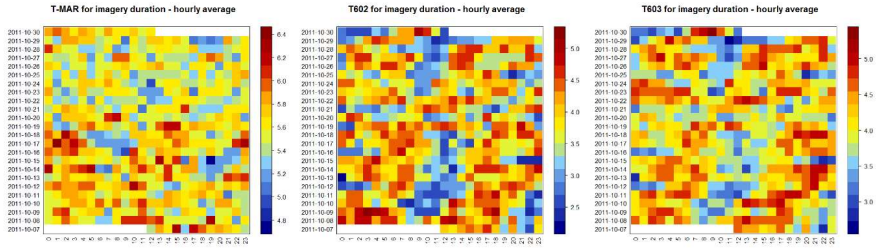


Fig. 6. Hourly temperature values (°C) for T602 and T603 probes from NEP and the MAR temperature probe. Red are higher temperatures while blue are lowest temperatures. Dates correspond to the duration of the imagery analyses (23 days).

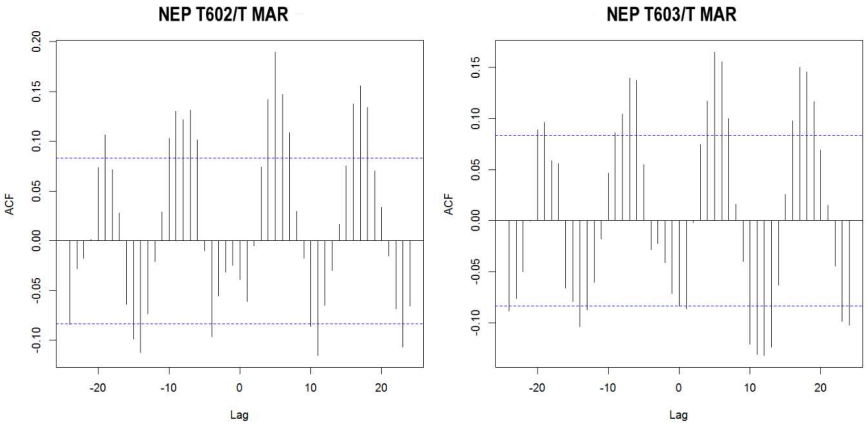
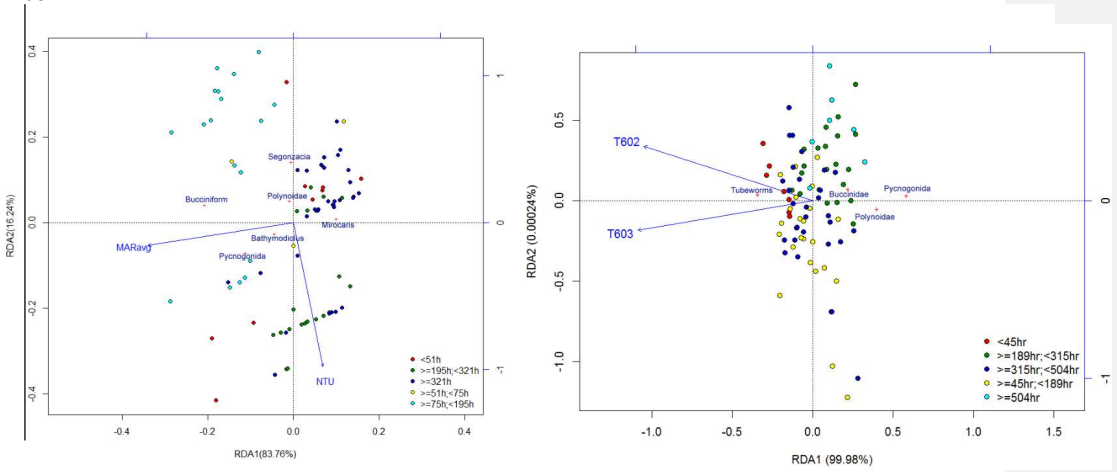


Fig. 7. Cross correlations of the hourly temperature values. ACF=autocorrelation function on ~~Y~~y-axis, 1 lag equals 1 hour on ~~X~~x-axis. Comparisons are made between the MAR probe (T MAR) and T602 (NEP T602) on left side and MAR (T MAR) and T603 (NEP T603) on the right. The horizontal dashed lines indicate the point of statistical significance at ACF=0.8, with the lines above towards 1 and below towards minus 1 being significant.



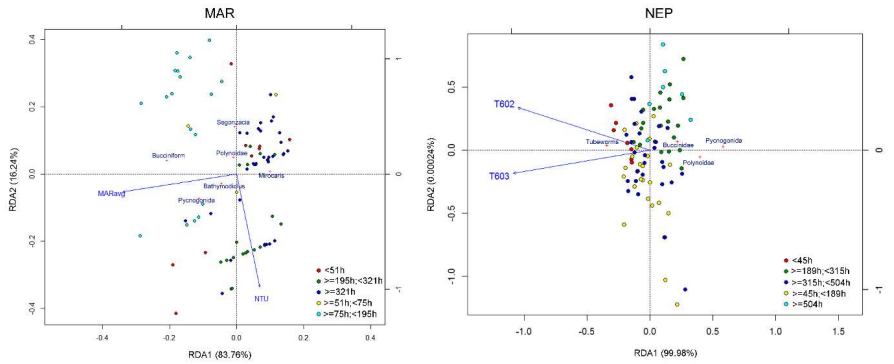


Fig. 8. Redundancy Analysis (RDA) ordinations featuring Hellinger transformed faunal densities and ~~standardised e~~environmental variables both at a 6h frequency. MARavg is the temperature time-series from the MAR and NTU is turbidity. T602 and T603 were the NEP temperature probes. Temporal splits groups were colour-coded in the ordination plots.

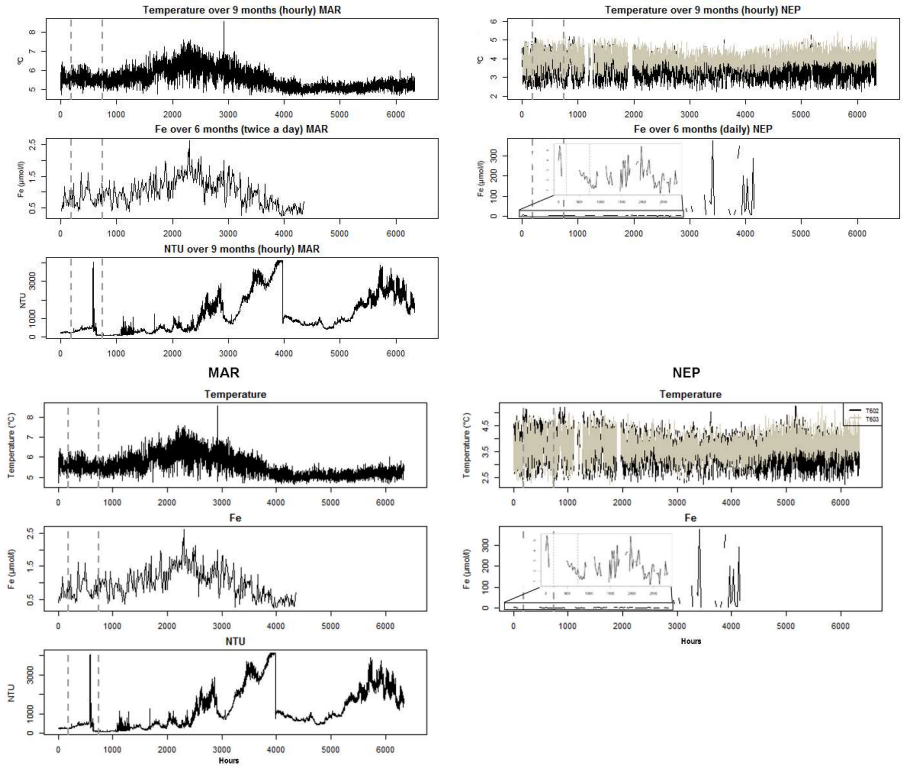
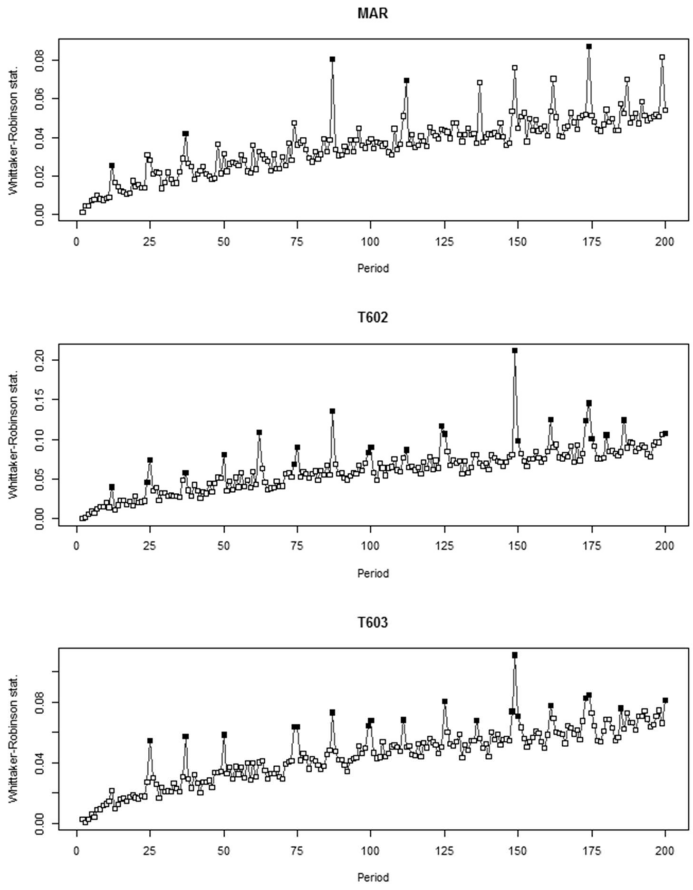


Fig. 9. Long-term environmental variable overview~~, spanning 9 months~~. Temperature time-series at MAR and NEP represent hourly temperature data spanning 9 months. Fe was recorded during 6 months, twice a day at MAR and daily at NEP. Dotted vertical lines delineate the period for which the images have been analysed. Inset box in Fe graph for NEP shows variation occurring during the first 4 months in more detail.


MAR
Whittaker-Robinson stat.
0.00
0.02
0.04
0.06
0.08
0
25
50
75
100
125
150
175
200
Period
T602
Whittaker-Robinson stat.
0.00
0.05
0.10
0.15
0.20
0
25
50
75
100
125
150
175
200
Period
T603
Whittaker-Robinson stat.
0.00
0.04
0.08
0
25
50
75
100
125
150
175
200
Period

1110

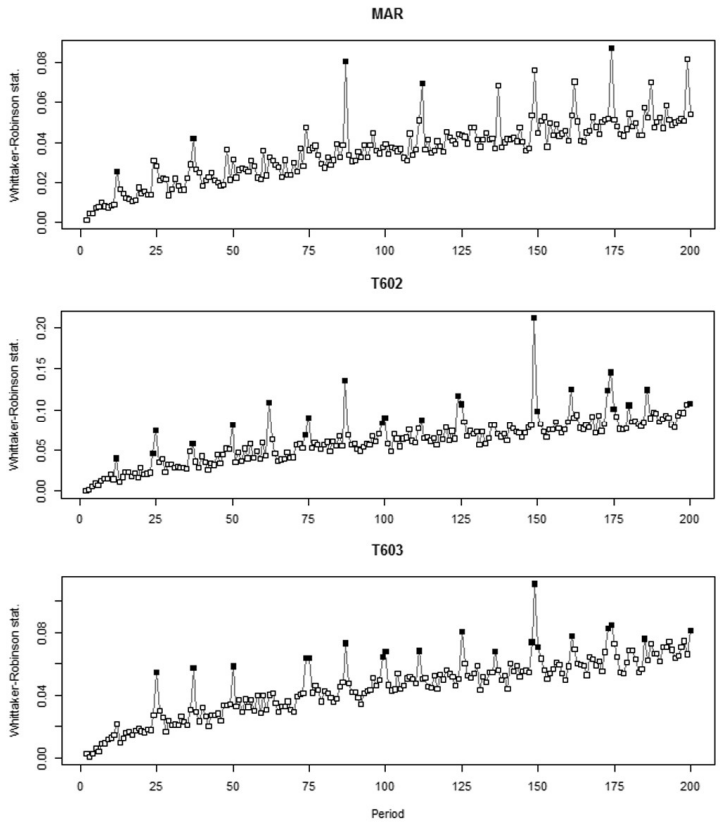


Fig. 10. Periodogram analyses of ~9 months of hourly temperature measurements for MAR and NEP (T602 and T603) represented as a one-week period (equalling 200h). Black squares indicate periods significant at the 5% level.

Appendix/Supplementary figures

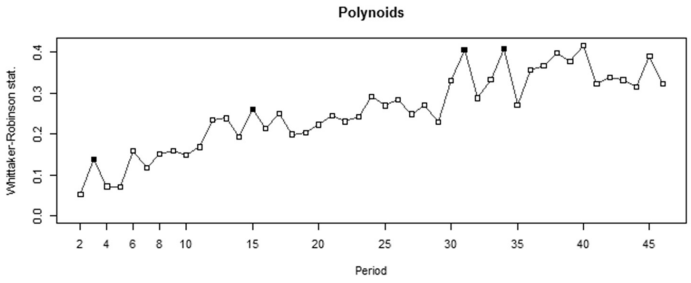
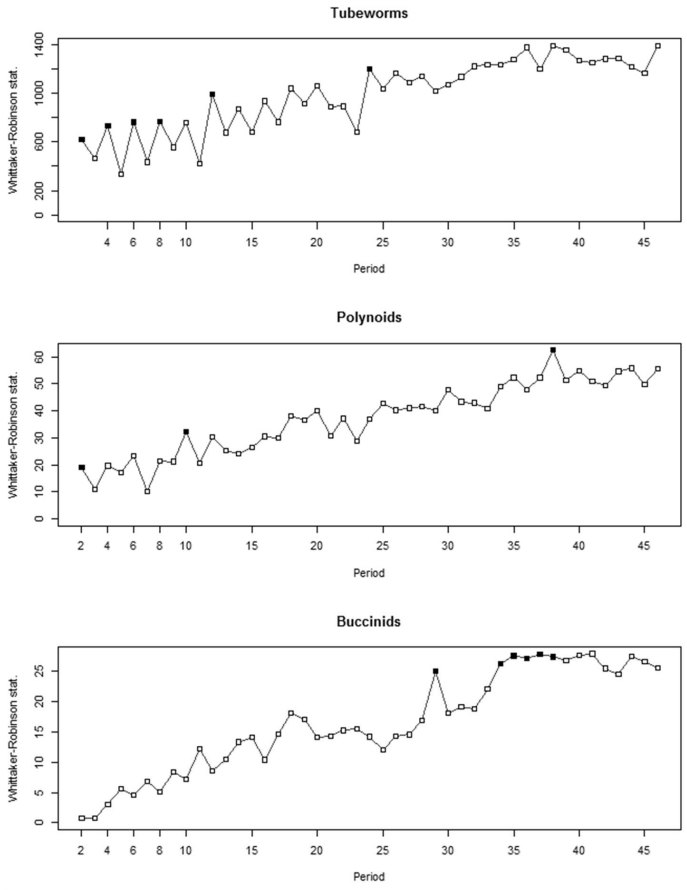


Fig. S1. MAR faunal periodogram on polynoid densities with a 6h frequency (1 period on x-axis=6h) of 23 days, all other taxa had no significant periodicities and were thus not shown. Black squares indicate periods significant at the 5% level.


Tubeworms
Whittaker-Robinson stat.
0
200
600
1000
1400
4
6
8
10
15
20
25
30
35
40
45
Period
Polynoids
Whittaker-Robinson stat.
0
10
20
30
40
50
60
2
4
6
8
10
15
20
25
30
35
40
45
Period
Buccinids
Whittaker-Robinson stat.
0
5
10
15
20
25
2
4
6
8
10
15
20
25
30
35
40
45
Period

1122

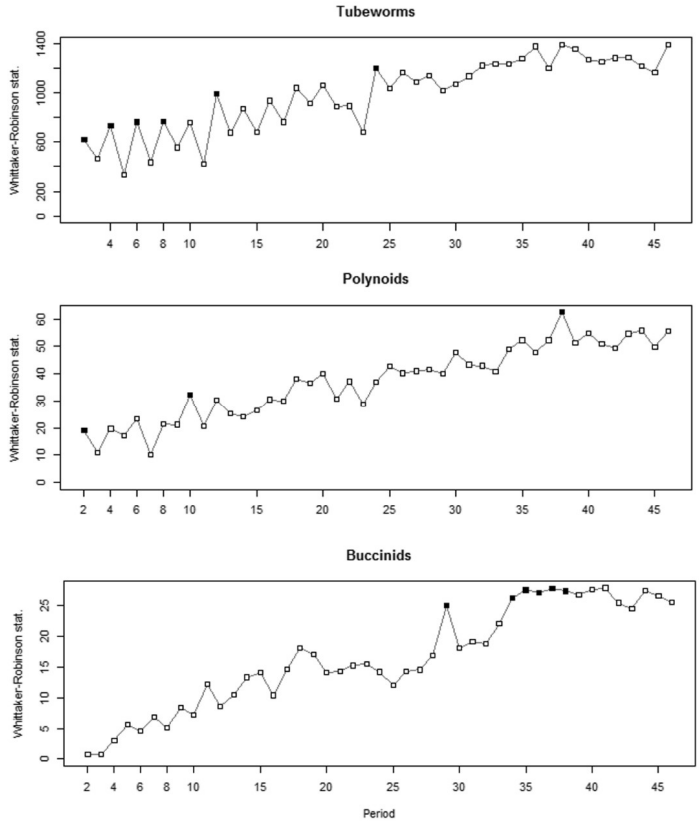


Fig. S2. NEP Faunal periodograms of 23 days featuring significant periodicities. Taxa presented are tubeworm, polynoid and buccinid densities with a 6h frequency for the MAR (1 period on x-axis=6h), pycnogonids showed no significant periodicities and were not shown. Black squares indicate periods significant at the 5% level.

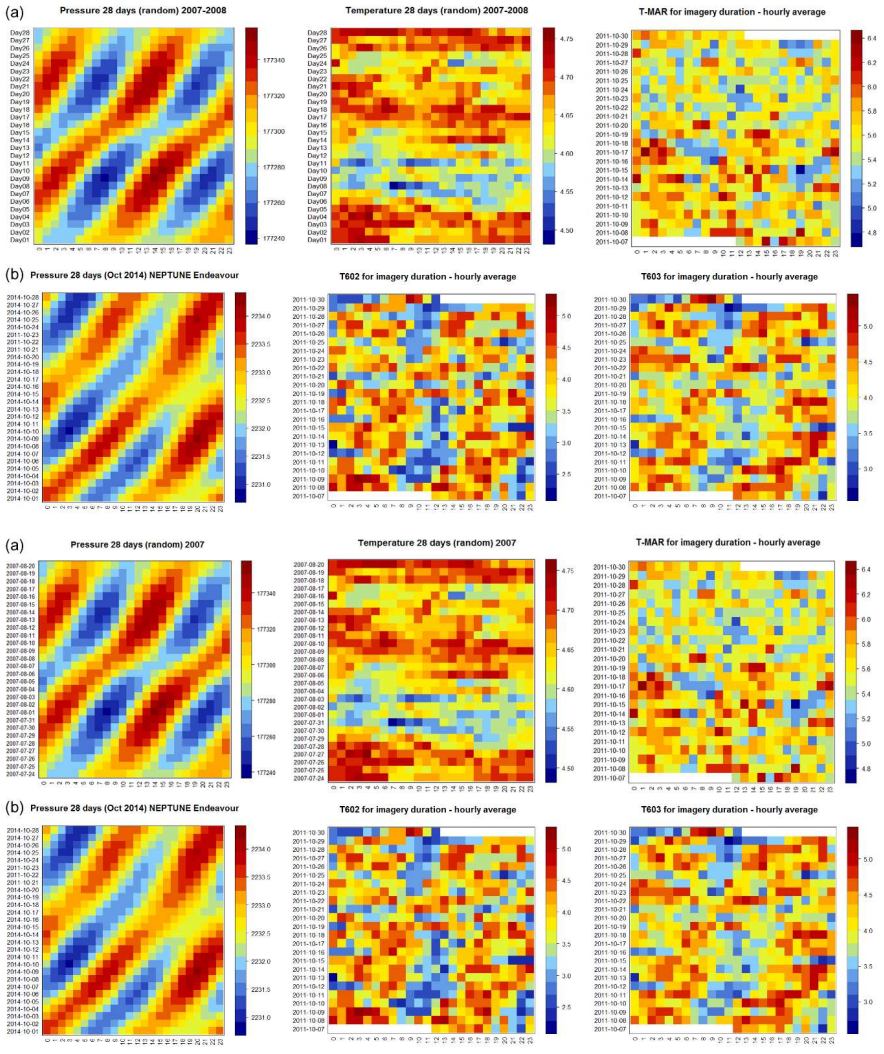


Fig. S3. Comparison of cyclicity in pressure data and temperature for (a) MAR ~~(a)~~ and (b) NEP ~~(b)~~ Red are higher values while blue are lowest values. Pressure data for MAR originates from 2007-2008 and was recorded at Seamon West of the EMSO-Azores observatory and represents a random 28 day (lunar) period (data courtesy of Valerie Ballu) . Pressure data for NEP were downloaded from ONC Portal from the BPR (NRCan Bottom Pressure Recorder deployed at MEF/Endeavour) ("Ocean Networks Canada Data Archive http://www.oceannetworks.ca, Total Pressure data from 1-29 Oct 2014, University of Victoria, Canada, Downloaded on 16 Jun 2015"). A random selection of 28 days in October 2014 is presented here (no earlier data were available).

Tables

Table 1: Overview of the location, data recorded and the recording resolutions of all variables of the two observatories on the NEP and MAR. ~~*limited usefulness due to issues related to correctly calculate the oxygen concentrations.~~

Energy provision	**TEMPO MoMAR/EMSO-Açores (MAR)** **Batteries (Wireless)**	**TEMPO-mini NEPTUNE (NEP)** **Cabled**
-	~~2011-2012~~	~~2011-2012~~
Coordinates Lat Coordinates Long	N 37° 17.3321' W 32° 16.5334'	N 47°56.9574' W 129°05.8998'
Depth	1694 m	2168 m
Imagery	4 min~~.~~ every 6h ~~hrs~~ (at 0.00, 6.00, 12.00, 18.00 ~~0h, 6h, 12h, 18h~~ UTC)	Continuous for ~23 days followed by 30 min every ~~4hrs~~ 4h (at 2.00, 6.00, 10.00, 14.00, 18.00 , 22.00~~2h, 6h, 10h, 14h, 18h , 22h~~ UTC)
Temperature	1 measurement every 5-min	1 measurement every 30 ~~seconds~~sec
Optode (~~Oxygen~~ oxygen + temperature) *	1 measurement every 15-min	1 measurement every 15-min
Chemini Fe	Ttwice a day	Ttwice a day/daily
Turbidity (NTU)	1 measurement every 15-min	N/A

***limited usefulness due to issues related to correctly calculate the oxygen concentrations.**

Table 2: Overview of the characteristics of the images analysed such as surface covered and taxa assessed within the FOV. ~~* are visiting predators.~~ The analysed surface on the MAR is about 10 times larger than that on the NEP. Gaps are failed or unusable video recordings.

	TEMPO MoMAR (MAR) ~~**2011-2012**~~	**TEMPO-mini NEPTUNE (NEP)** ~~**2011-2012**~~
# Images (6h~~r~~ frequency)	84 (93 total- with 9 gaps)	88 (93 total- with 5 gaps)
Surface filmed	~0.3802-m² (ca. 52.8 x 72-cm)	~0.0661-m²
Surface analysed (see fig. 2)	~0.322-m²	~0.0355-m² (ca. 20 x 18-cm)
Taxon densities		
Annelida		
Siboglinidae	NA	*Ridgeia piscesae*
Polynoidae	Multiple species (Desbruyères et al., 2006)	Multiple species (Cuvelier et al., 2014)
Arthropoda		
Alvinocarididae	*Mirocaris fortunata*	NA
Bythograeidae	*Segonzacia mesatlantica*	NA
Majidae	NA	*Macroregonia macrochira* *
Pycnogonida		
Ammotheidae	*Sericosura heteroscela*	Among others: *Sericosura verenae*
Cnidaria		
Actiniaria	Anemones sp.	NA
Echinodermata		
Ophiuroidea	Ophiuroid sp.	NA
Mollusca		
Buccinidae	NA	*Buccinum thermophilum*
Limpets (Lepetodrilidae, Provannidae etc.)	NA	Multiple species
Mytilidae	*Bathymodiolus azoricus*	NA
Turridae	*Phymorynchus* sp. (bucciniform)	NA
Pisces		
Bythitidae	*Cataetyx laticeps**	NA
Zoarcidae	NA	*Pachycara* sp.*
Surface coverage	% Microbial mats (12 h frequency)	% Microbial mats (12 h frequency)

*** Are visiting predators.**

Table 3. Temporal split groups for MAR and NEP based on MRT analysis. n=number of images

MAR		NEP		Timespan
<51h	n=9	< 45 h	n=8	~ 2 days
≥ 51 h, <75 h	n=3	≥ 45h, < 189 h	n=24	> 2 days, < 8 days (spanning ca. 6 days)
≥ 75h, < 195 h	n=18			
≥ 195 h, < 321h	n=20	≥ 189 h, < 315 h	n=21	>8 days, < ~ 13 days (spanning ca. 5 days)
≥ 321 h – 553h	n=34	≥ 315 h, < 504 h	n=28	> ~13 days, <21 days for NEP (spanning ~8 days) > ~13 days, 23 days (10 days for MAR)
		≥ 504 h – 553h	n=7	> 21 days till end of recordings (~ 2 days)

Table 4. Mean, maximum and minimum temperatures as measured by the probes and, for comparison purposes rescaled to ambient seawater temperature (highlighted in grey). See Fig. 5 for significant differences in raw temperature values. Variance and standard-deviations are presented as well. Bold values represent highest values which tend to change if rescaled to ambient seawater temperature or not.

	Mean (°C)		Max (°C)		Min (°C)		Var	~~stdev~~Stdev
MAR	**5.59 °C**	1.59°C	**6.36 °C**	2.36°C	**4.79 °C**	**0.79°C**	0.066	0.258
NEPT602	3.76°C	1.76°C	5.14 °C	3.14°C	2.28 °C	0.28°C	0.259	**0.645**
NEPT603	4.07 °C	**2.07°C**	5.27 °C	**3.27°C**	2.73 °C	0.73°C	**0.416**	0.509