Dear Editor

We thank the two reviewers for their comments. Both reviewers appear to be positive. Their comments aimed to clarify some aspects of the context of the work, and some aspects of the methods. We have tried to comply with all the requests. We provide hereafter explanations and additional information, that can be used for the revised version, or that can remain available in the Discussion archive.

Specifically,

Reviewer 1 requested:

1. a clarification of the relationship between Mean Low Water (MLW), which indicates the upper level of coral survival, and the ADT anomaly (Figure 3 of the initial manuscript). The reviewer said "*However, the upper level of coral survival before this event is not quantitatively discussed, but only described as Mean Low Water (MLW). MLW which limit the coral survival before the event should be quantitatively shown in the time series ADT in Figure 3, and then the mortality of the upper 15cm of corals should be defined in sea level changes*".

Response: The request can not be fulfilled since we do not have precise measurements of Mean Low Water level for Bunaken. For this, data from a pressure sensor are ideally needed. Instead, tide gauge data could be used, but tide-gauge data are scarce in Indonesia. Fortunately there are two tide-gauges in the north of Sulawesi in the city of Bitung, east of Bunaken, by latitude 1.430N and longitude 125.200E on the other side of Sulawesi compared to Bunaken, our study site. Thus, while tide-gauge data are available in the region, they are not exactly on Bunaken, but can help visualize the range of conditions found in Bunaken.

Bitung data can be retrieved from the Sea Level Center in Hawaii (SLCH), specifically at http://uhslc.soest.hawaii.edu/thredds/uhslc_quality_daily.html?dataset=RQD033A
The Sea Surface Height (SSH) provided is referenced, for Bitung, against a GPS station located at Bako (http://www.igs.org/igsnetwork/network_by_site.php?site=bako) which is itself referenced against the WGS84 ellipsoid. Hence, raw Bitung SSH do not represent absolute depth above the Bitung seafloor. SLCH provides high quality data (available till early 2015) that have been controlled for most outliers and errors, and lower quality data that includes the most recent coverage, included our period of interest (2015-2016).

We include below a graph showing from the available Bitung data the daily mean sea level (that can be compared to sea level as provided by altimetry), and the daily lowest level (not directly measured by altimetry) (Fig. 1). This graph only aims to show what was likely happening in Bunaken before El Niño in terms of range of sea level variations due to normal tide fluctuations. The daily lower value exhibits a ~40-cm variation from neap tide to spring tide. The limit of coral survival is species dependent, but close to the mean of the daily lowest level (blue curve). If this mean is changing through time, the limit of mortality also changes dynamically. Using the mean low level for the entire period of data coverage could be misleading to characterize the situation for a precise period. In 2014, and 2015, we witnessed during spring tide conditions *Porites* corals that had the upper part of the colonies well above the sea level, and without signs of mortality (see Picture 1). Hence, the upper limit of coral survival is somewhere around 20 cm above the spring tide lowest level for the end of the period shown on the graph below.

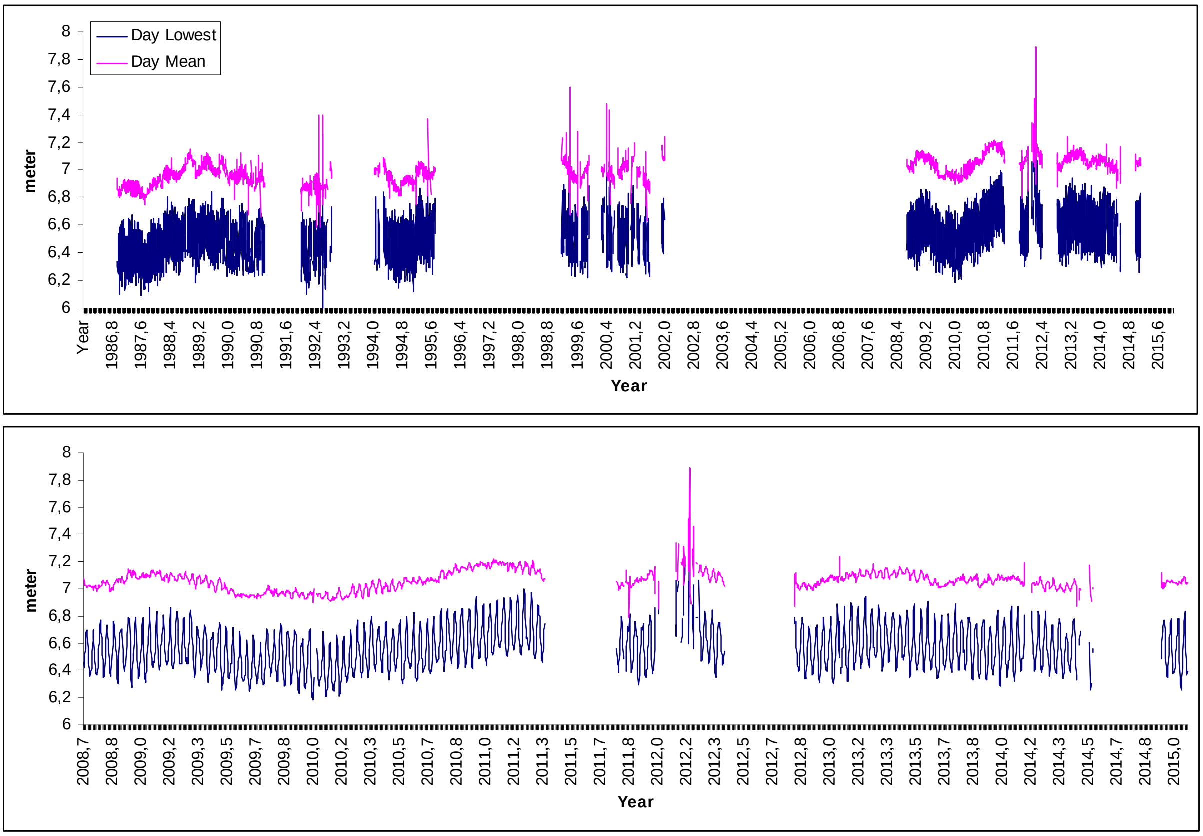


Figure 1 : Available data from the Bitung (east North Sulawesi) tide-gauge referenced against Bako GPS station. On top, the entire available data, from 1986 till 2015. Bottom, a close-up of the 2008-2015 period.

Picture 1: Reef flat close to lowest spring tide the 15th May 2014. The upper part of *Porites* colonies are fine and can obviously accommodate these conditions for few hours per month. The limit of growth is higher (~20 cm) than the lowest spring tide limit. This picture is from the same location as the Figure 1 on the manuscript, taken from a lower angle.

Therefore, the ~15cm fall that we observed on altimetry data around Bunaken and on most of east Indonesia changed for a short time (of several weeks) the lowest levels, and these changes lasted long enough so that coral tissues were damaged by too much UV and air exposure. This fall shifted during few weeks in August-September 2015 the mean low level close to the pre-El Niño lowest levels shown in the Figure 1 above.

The request "*the mortality of the upper 15cm of corals should be defined in sea level changes*" is unclear. Not all corals have a 15cm band of tissue mortality, as it depends on the depth of the coral. See the new photographs that we have added in response to Reviewer 2 (Picture 2). We hope that the above graph and discussion replies to this comment.

2. an explanation on how the extent of the mortality was mapped. Reviewer 1 said: "*Figure 2 shows coral mortality area spatially. To obtain spatial distribution of coral mortality, the authors states that "reef flats were visually surveyed and recent mortality was recorded. Geographic coordinates of the presence of mortality were compiled to map its extent". However, it seems to me the area was not only mapped by field survey, but also by remote sensing. If so, the authors should describe how remote sensing was applied to map the mortality area.*"

Response: Indeed, the map of mortality (Figure 2, middle, of the submitted paper) is created using a pre-existing habitat map from remote sensing (described in Ampou 2016, a PhD thesis recently defended 6th December 2016). Our survey was done for all coral habitats along the reef. If we recorded mortality for that habitat, we flagged the corresponding polygon in the map as a mortality area. Hence, the yellow mask in Figure 2 is the mask corresponding to all mapped habitats where mortality was found, but mortality itself is not inferred from remote sensing.
We have clarified this in the new Material and Methods section.

3. further discussion related to reconstruction of sea level using micro-atolls. The reviewer said "*Further discussion of this point referring to reconstruction of tectonic sea level change by coral microatolls would extend viewpoint of this paper*. »

Response: Indeed, there is a common ground between our observations and the use of coral to reconstruct sea level. Reconstructions of paleo-sea level, whether it is induced by tectonic relative sea level change or not, is a science that takes advantage of the shape of modern or fossil micro-atolls. We now briefly point out this aspect in the Introduction. However, we stress out that our study is clearly not about reconstructing sea levels using dead corals. Rather, we explain coral mortality using sea level data.

4. comparison of tide gauge data and altimetry sea level data. The reviewer said: "*The authors reconstruct sea level changes by satellite remote sensing. Reliable sea level history is obtained by tidal gauge. The remote sensing reconstruction should be compared with tide gauge data in this area.*"

Response: We show below publicly available sea level data from the aforementioned Bitung tide-gauge (low quality data to include the end of 2015 and 2016 period) to show the agreement between altimetry data and tide gauges (Fig. 2). The Bitung SSH data and the Sea Level altimetry data are comparable because we show the anomalies relative to the mean for the same period of concurrent measurement.
Altimetry data are extracted from the AVISO server: http://misgw-sltac.vlandata.cls.fr:45080/thredds/dodsC/dataset-duacs-rep-global-merged-allsat-msla-l4

These are interpolated data, from various altimetry missions. The selected retrieved location is the closest available from Bitung (1.375N and longitude 125.125E). Data are available without interruption since 1993.

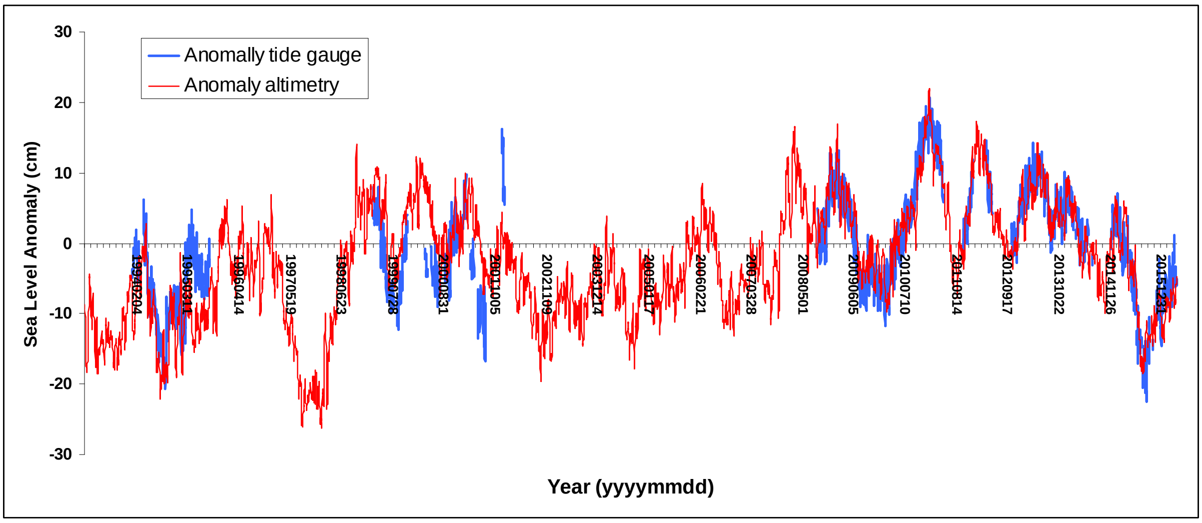


Figure 2: Sea level anomalies measured by the Bitung tide gauge station, and by altimetry (AVISO data server. Note the gaps in the tide gauge time-series. The anomaly was computed for both data sets by taking into account only the periods concurrently monitored by both types of measurements.

The good correlation (Pearson r=0.83) and the agreement in anomalies confirm that altimetry data are perfectly suitable to monitor sea level variation close to a coast. This confirms the value of using altimetry observations even without other local source of sea level data, as in Bunaken, to identify the cause of coral mortality (sea level fall).

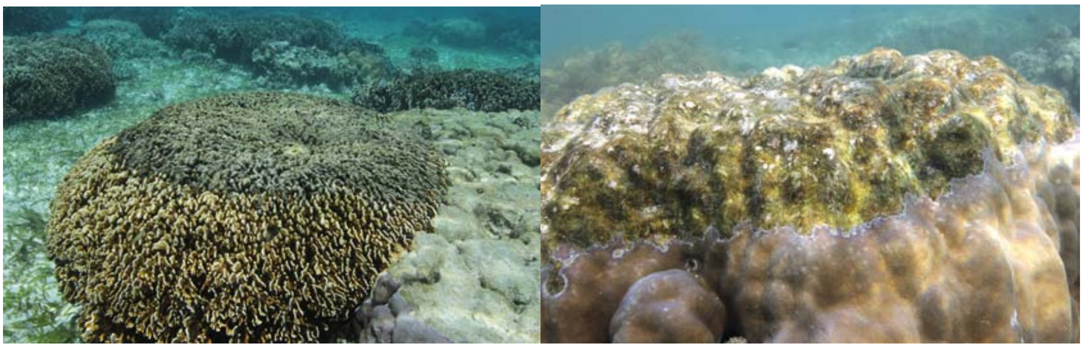
Reviewer 2 suggests:

5. to emphasize the paradox between our observations and the fact that one of the three main climate change threats for coral reefs is sea level rise.

Response: this can be now done at the beginning of the new Discussion. The following sentence will be added: "*Geological records and present-time observation have demonstrated that sea level variation is a driver of coral community changes. Sea level rise can have antagonistic effects: on the one hand, it can provide new growing space for corals. On the other hand, higher depth may enhance wave propagation in areas that were previously sheltered and increase coral physical breakage. If sea level rise is fast, corals may not keep up and the reef may be drowning relative to the new sea level. As such, sea level rise is seen as one of the three main climate change threats for coral reefs*"

6. enhancing the color plate with close-up of mortality on colonies.

Response: we have modified the color plate Figure 1 to include the two following close-up pictures with clear banding due to tissue mortality, for a *Heliopora* colony (Picture 2, left) and for a *Porites* colony (right). More information has also been provided on the Figure 1 caption.



Picture 2: Bands of dead tissue as seen in February 2016. Left: *Heliopora coerula* colony; right: A *Porites lutea* colony.

7. adding the number of colonies surveyed for each transect and station

Response: The information we have provided is the percentage of mortality found on all colonies on the transects, but we did not keep the information on how many colonies were measured. Photographs of the transects are available but they do not cover the entire transects. The number of colonies on 20m long transect is however high since coral cover was high. We estimate the number of colonies ranged between 10 and 30 per transect, depending on the size of the colonies. This estimation has been provided in the new caption of the Figure 2.

8. reorganize the map. The reviewer said: "*Figure 2 could do with a line drawing of that bit of the N Sulawesi coast to better present the geographic setting for the false colour map of the Bunaken reef. Make the present map of all Indonesia an inset to the N Sulawesi map*. »

Response: The Figure 2 has been re-organized as suggested.

9. suggest some additional references

Response: while we did not cite the 2 references provided by the Reviewer, we have previously included similar references to illustrate the same facts, including references by Brown et al. on Phuket reefs. However, we have now added the 2 suggested references.

In addition, Reviewer 2 provided edits on the draft itself, for English corrections that were all kept, if the initial text was not removed to accommodate the comments above.

END.