## **ANSWERS TO THE REVIWER COMMENTS:**

Journal: BG Title: Southwestern Tropical Atlantic coral growth response to atmospheric circulation changes induced by ozone depletion in Antarctica Author(s): H. Evangelista et al. MS No.: bg-2015-218 MS Type: Ideas and perspectives Iteration: Minor Revision

## Suggestions for revision or reasons for rejection (will be published if the paper is accepted for final publication)

The first contribution of this paper presents data on coral growth rates from the Abrolhos Islands along the east coast of Brazil and correlates them with SST anomaly data from the same region. The second contribution of the paper is exploring correlations among SST values for the region and potential drivers of those SST anomalies. In effect, the coral data don't have much at all to do with the climate data, so it's almost as if there are two very distinct papers here. I will comment on each one in turn.

In the first part of the paper, we learn that coral growth responds negatively to increasing temperature, but this pattern has already been noted in the literature many times. However, the absence of such a pattern has also been noted. There is no fundamental advance in our understanding of coral growth in this paper, other than another example of a negative correlation between SST anomaly and coral growth. This part of the paper would have benefited greatly from some discussion of the contrasting reports of the relationship between coral growth and SST found in the literature and potential reasons why the Brazilian corals show such a trend. I found the treatment of this aspect of the work to be superficial.

AUTHORS: With respect the relation of coral growth and SST, in fact investigations in several parts of the tropics and sub-tropics have been conducted, but never at the Southwestern Atlantic. Corals and reef environments at that region are relatively rare and corals there present a high endemism aspect. Considering the fact that the coral reef environments at the Southern Atlantic play an important ecological service, especially at Abrolhos site, understand their future in a changing climate is somewhat relevant.

In the second part of the paper the authors run through a series of arguments, invoking high correlations, to link the SST signal from the Brazilian coast with regional and global oceanographic and atmospheric patterns. The arguments, although logically consistent, do not seem to rest in any way on the coral growth patterns, but rather the SST patterns, so I fail to see how these two aspects of the paper are related. **AUTHORS: In our opinion, the two parts are absolutely linked, since the coral growth response is the end point of a process that is, following our arguments, trigged in Antarctica/Southern Ocean. See comments bellow.** 

Specific comments:

L69. What is `proper coral growth'? AUTHORS: For clarification we have changed the sentence:

**Original :** "~95% of global reefs will be under pressure from thermal stress and that only 15% will remain in areas of adequate aragonite saturation for proper coral growth (Burke, 2011)."

**Revised :** "approximately 95% of global reefs will be under pressure from thermal stress and that only 15% will remain in areas of adequate aragonite saturation that are considered ideal for coral development (Burke, 2011)."

L99. Change to 'a substantial'. **AUTHORS: we made the change** 

L109. You assert here that you 'combined measurements of coral growth rate and climate-oceanography modeled data' but the growth rate data were only correlated with SST anomaly data. **AUTHORS: We agree that the terminology "combined" maybe not appropriated. We have changed the sentence to better fit the objective:**  **Original :** "Considering that warming of surface waters may have implications over coral metabolism and health, potentially compromising the sustainability of coral reefs, we here combined measurements of coral growth rate and climate-oceanography modeled data to investigate wind driven impacts in costal environments, especially over the highly sensitive coral communities living in Abrolhos National Park of Brazil"

**Revised :** "Considering that a warming in surface waters has been detected at the Southwestern Atlantic since the 70's decade and such elevation may have implications over coral metabolism and health, potentially compromising the sustainability of coral reefs, we here compared time series of coral growth rate and climate-oceanography modeled data to investigate impacts in costal environments, especially over the highly sensitive coral communities living in Abrolhos National Park of Brazil"

L123-128. Seems odd to refer to Figure 2 here, especially since you haven't yet referenced Figure 1. **AUTHORS: The reviewer is correct and we removed that from L123-128, since it is already cited ahead in the text.** 

L135 Digitized, not 'digitalized'. **AUTHORS: we made the change.** 

L145 Shows, not 'show'. **AUTHORS: we made the change.** 

L159. Beginning, not 'begging'. **AUTHORS: we made the change.** 

L162-163. If you want the work to have broader appeal I would provide a succinct summary of what a 'reanalysis' of the NCEP-NCAR data is and who conducted it and how. By the way, I don't think these acronyms are ever spelled out – which they should be at least upon first usage in the text. **AUTHORS: We have inserted the following sentence:** 

"The NCEP/NCAR Reanalysis Project is a joint project between the National Centers for Environmental Prediction and the National Center for Atmospheric Research (NCAR). It uses a state-of-the-art analysis/forecast system to perform data assimilation using past data from 1948 to the present. Its latest products have time coverage of 4 times daily while data from 1948-1957 are presented in the regular (non-Gaussian) gridded data format".

Additionally we have cited in the Acknowledgments the web address of NCEP/NCAR Reanalysis where database was accessed.

L169. Add `corals' after Atlantic. Check reference parentheses. **AUTHORS: We made that.** 

L179. You state that coral growth is 'quote coincident' with SST anomaly for Abrolhos, but it would be better if you regressed coral growth on SST and provided a statistical test for this.

AUTHORS: First, we opted in focusing in the timing the parameters SST, coral growth, Ozone and others change pattern from positive to negative and vise-versa. We prefer not to use the correlation because from one side we have a z-score for corals of different species, so it represents a general response, and the SST do not refers to an *in situ* measurement, it is derived from model. Therefore, our interpretation is based on the trends considering these uncertainties. Several works use correlations but in different situations and different time scales (e.g. Cantin et at., 2010). Second, we changed the terminology "quite coincident" and changed the sentence to :

**Original** : "Figure 2d indicates that the decline in coral growth is quite coincident with SST anomaly for Abrolhos, Figure 2e, from negative to positive above average."

**Revised :** "Figure 2d indicates that the decline in coral growth follows the SST anomaly, Figure 2e, inversely for Abrolhos site. A temporal difference exists at the time when patterns change from positive to negative phases and vise-versa; nevertheless it is within the uncertainties of the modeled SST and z-score of growth rate. Also, slops of linear trends of SST and coral growth also differ, being steeper for SST."

L188. Should be concomitant 'with' not 'to'. **AUTHORS: we made the change.** 

L188-89. This assertion needs to be substantiated with an analysis. Can the 'zonal wind changes' be regressed with SST anomaly or coral growth?

AUTHORS: Again we based our finding in the timing the processes take part. And from this we constructed a model to link Ozone depletion in Antarctica to tropical coral growth in the Atlantic. Correlations were made solely when really necessary. In resume, the sequence we made was: (1) westerly winds increased around Antarctica since the 70's. Several authors attribute that to the positive phase of SAM enhanced by the ozone depletion. Our compilation at Figure 3a corroborate that; (2) we postulated it would impact wind structure at the tropical Atlantic (in this case, a correlation study demonstrated it is real, Figure 3c); (3) zonal winds acting against the western continental shelf at the Southern Atlantic would transport warmer surface waters and pileup waters in the coast, resulting in increasing SST; (4) therefore increasing SST is related to ozone depletion area evolution (in this case, a correlation study demonstrated it is real, Figure 4); (5) coral growth rates seems to respond SST trends (Figure 2).

L189. Should be Fig 3a, not 2a. **AUTHORS: we corrected that.** 

L230. You mention tropical Brazilian coast experienced increased zonal winds since 1979, so why are anomalies negative in Fig. 3e?

AUTHORS: We have revised the sentence. The correct is that the tropical Brazilian coast experienced zonal winds changes in direction since 1979. The signal of the anomaly depicts the zonal wind direction (from East to west and vise versa) as indicated in the Figure 3e. We made this correction.

L253. `...a significant parameterization' doesn't make sense to me. **AUTHORS: We changed the sentence:** 

Original : "In addition, the PDO is a significant parametrization when considering the 1970's climate shift".

**Revised :** "In addition, the interdecadal (PDO) is a significant climate variability mode when considering the 1970's climate shift being its magnitude unprecedented high since mid-20th century."

L264. You say r-Pearson values between SST and ozone at the Brazilian site are +0.6 to +0.7, but Fig 5 shows them to be negative. Did you mean SST and PDO values shown in Fig 4? AUTHORS: Correct number of the figure showing the correlation between SST and Ozone is Figure 4. We corrected that in the text. At Abrolhos site/Brazil values are between +0.6 and +0.7 according to that figure.

L284-85. This should be stated the other way around: 'Records of coral growth anomaly for Abrolhos site/Brazil evidenced changes (from positive to negative growth rate anomaly) were highly correlated to SST increases at coral living sites which in turn were concomitant with ozone area evolution'. **AUTHORS: We kindly thank the reviewer for the suggested that was implemented in the revised text.** 

Figures

Fig 1. The gray box on the left panel is distracting – is that a data point or is that just to tell us that the other filled boxes are from the CS1 sample? I would remove this. Also the black box at year 1915 on the right panel is also confusing – what is this all about?

AUTHORS: We have revised Figure 1 accordingly. The black box refers to a peace of the coral removed from the core additionally for U/Th dating tests. Do not have any mean. We see it is just a small detail. Follows below new Figure 1 and legend.



**Figure 1** - Comparison of chronologies obtained from X-ray radiography, named stratigraphy, and U/Th dating for a coral core of *Siderastrea stellate* (CS1) from Abrolhos National Park/Brazil. Error bars refer to 3 sd.

Fig. 2. Panels should be shown in reverse order as to how they are not – panel a at the top and panel e at the bottom.

AUTHORS: We have revised Figure 1 accordingly. Follows bellow new Figure 2 and legend.



**Figure 2 -** (a) SST anomaly for Abrolhos National Park/Brazil based on NCEP-NCAR reanalysis; (b) *z*-score for sample P1 (c), sample Abrolhos/UFBA (d) and sample CS1 (e).

Figure 3. Why the red box in Fig 3b? it obscures the underlying signal at the Abrolhos – can you make the box not filled in? For Fig 3d, what is the significance of the blue shading? Caption for 3a should start 'zonal wind changes around...'

AUTHORS: We have removed the box in Figure 3b, it is unnecessary. The blue shading was also removed from Figure 3d. We have changed the caption of 3a. Bellow, the revised figure 3 and the corresponding legend.



**Figure 3 -** Calculations based on NCEP-NCAR reanalysis for : (a) the zonal winds changes around Antarctica before and after 1979, previously published in 2013 (Cataldo *et al.* 2013); (b) sea level pressure difference (also before and after 1979, but with emphasis to the Southern Atlantic); (c) correlation of wind stress and the ozone depletion area (arrow lengths correspond to r-Pearson values); (d) ozone depletion area; and (e) the zonal wind anomalies calculated to Abrolhos site.

Fig. 5a. Again, the filled in black box depicting Abrolhos obscures underlying data – use an open symbol. **AUTHORS: We changed that. Bellow, the revised figure 5 and the corresponding legend.** 



**Figure 5 -** (a) Correlation map (SST x PDO) and; (b) PDO (Pacific Decadal Oscillation) anomaly time series. : Abrolhos region.