Detail response to Reviewer Prof. Lucien Montaggioni

In the following letter, each comment by Prof. Montaggioni in black is followed by our replies in red.

Reef workers know from empirically supported data that the decrease in coral calcification and reef accretion in the next future might result in a decrease in the ability of reef-crest and reef flat zones to reduce wave energy and to maintain coastal protection. The present paper by Hongo and associates has the merit of quantifying the responses of a given reef (Melekeok reef, Palau Islands) to the expected rise in sea level and intensification of typhoon activity during the next decades, according to three RCP scenarios. I agree with the authors regarding the remarkable building power of corymbose acroporids that make up upper fore-reef, reef-crest and outer-reef flats in most high-energy reef environments. The fact that that *Acropora* forms belonging to robusta group are amongst the most robust branching corals and corals with the highest vertical growth rates in the considered domain suggests that the relevant reefs would be able to compensate for significant changes in sea level and typhoon strength.

We are grateful to you that you review. We are happy to know that you agree with our statement of an importance of corymbose *Acropora* as a reef builder at a high wave energy condition.

By contrast, I am skeptical about the capacity of arborescent acroporids typified by gracile branching colonies to resist higher water energy; I guess the relevant reef-crest zones will suffer from storm surges of increasing strength. I particularly appreciate the section dealing with an estimation of future reef production rate; the presented data provide a robust estimate of the growth potentiality of the acroporid facies.

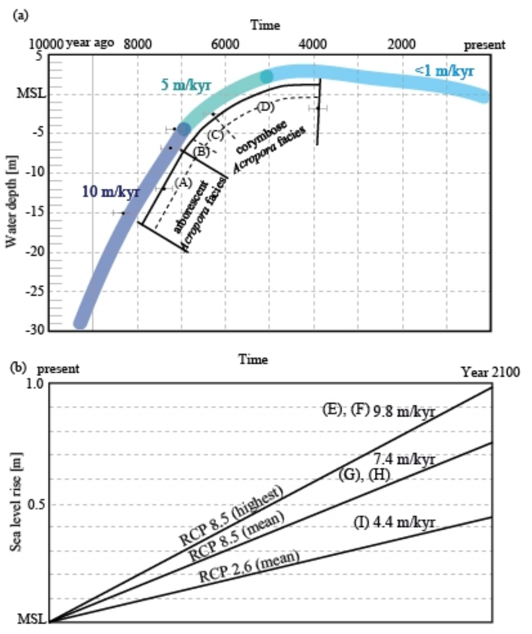
Thank you for giving the comment. This was not fully explained in the original manuscript. We also believe that arborescent *Acropora* will less contribute to reef formation by 2100 because of the corals are overturned and broken under the high wave energy conditions (a few meter of water depth). Thus, we estimate a reef production rate for corymbose *Acropora* by 2100, based on the analysis of reef drillcore and future sea-level rise. Consequently, we clearly describe in discussion, as follows.

In Section 4.2:

[According to the analysis of drillcore in this study, a corymbose *Acropora* facies at a high-wave energy condition in water depths less than 7 m and an arborescent *Acropora* facies at a low- to moderate- wave conditions in water depths less than 20 m contributed to the Holocene reef in the Palau Islands (Kayanne et al., 2002; Hongo and Kayanne, 2011). The maximum future SLR is predicted to +0.98 m by 2100 (Church et al., 2013). This implies that arborescent *Acropora* corals will probably be overturned and broken by high wave energy in shallow water depths, and so will not contribute to upward reef formation at the reef crest by 2100. In contrast, corymbose corals at the study site will contribute to reef formation by 2100, in response to future SLR. Although the dominant corals at Melekeok reef have yet to be documented, the corymbose *Acropora* facies on reef crests in the Palau Islands is generally composed of *A. digitifera*, *Acropora hyacinthus*, and *Acropora humilis* (Kayanne et al., 2002; Yukihira et al., 2007). These coral types are highly resistant to wave action at water depths of 0–7 m, and their preferred habitat (good light penetration and high oxygen concentrations) enables vigorous upward growth.]

In this context, we add the detail information about cormybose *Acropora* facies and arboresent *Acropora* facies into Method.
In Section 2.3:
[The corymbose *Acropora* facies is characterized by corals by corymbose and tabular *Acropora* (e.g., *Acropora digitifera*). These corals are found on distinct reef crests and upper reef slopes in Palau Islands (Kayanne et al., 2002; Yukihira et al., 2007). The zone is generally characterized by high-energy waves in water depths less than 7 m (Hongo and Kayanne, 2011). The arborescent *Acropora* facies is characterized by corals by arborescent *Acropora* (e.g., *Acropora muricata/ intermedia* complex). These corals occupy the inner reef slope and leeward reef slope at water depths of less than 20 m in Palau Islands and other reefs in the present-day Pacific Ocean (Montaggioni, 2005; Yukihira et al., 2007). These corals are interpreted to inhabit a low- to moderate- energy wave conditions (Hongo and Kayanne, 2011).]

In this context, to well understand, we revised Figure 6 because of the graph was very small.



(c)

Rate of Holocene SLR	Rate of reef prodcution ($kg\ CaCO_3/m^2/y$) arborescent *Acropora* facies	corymbose *Acropora* facies
10 m/kyr	(A) 2.4–26.7	(B) 14.2
5 m/kyr	—	(C) 1.3
<1 m/kyr	—	(D) 0.3

(d)

Rate of future SLR	Rate of potential reef prodcution ($kg\ CaCO_3/m^2/y$) arborescent *Acropora* facies	corymbose *Acropora* facies
9.8 m/kyr	(E) 7.1	(F) 5.8
7.4 m/kyr	(G) 5.3	(H) 4.4
4.4 m/kyr	—	(I) 2.6

Revised Figure 6

However, I am surprised to see that there would have no significant upward reef growth in response to changes (increase) in the water level (WLs) (page 9, lines15-16). And I do not see how porous framework with high permeability degree could prevent upward accretion. Examples from the literature reveal that the highest vertical reef growth rates relate to porous branching corals, especially robust branching ones. It would be interesting to assess the role of massid coral forms (e.g.poritids, faviids) in reef resistance to increasing wave energy, since a number of reef fronts in the Indo-Pacific province are dominantly composed of such builders.

Thank you for giving the comment. Our original manuscript was unclear. If the reef has no porosity, sea water will not permeate through the reef. But we know that a reef framework has a wide range of porosities from low (where internal cavities have been infilled with marine cements) to high (e.g., a reef framework is mainly composed of branching corals) (Hopley, 2011 Encyclopedia of Modern Coral Reefs). In this study, we assumed 10 % of porosity of reef structure for our wave/water level simulation. This means that a reef framework contributes to reducing wave height due to a 3D structure, but sea water permeates through the reef framework due to porosity. Consequently, our result indicates that upward reef growth reduces incoming wave heights, but there is no significant change of water level at reef between a degraded reef and a healthy reef by 2100. Moreover, the reviewer is interested in a role of reef framework by massive corals in reducing wave heights and water level. We are also interested in the question, but we assume that the study reef will be composed of corymbose *Acropora* corals. Therefore, the estimation is beyond our research in this manuscript. In a revised manuscript, we clearly describe as follows:

In Section 4.2:

[Our results indicate that there is no significant change in WL_s between a degraded reef and a healthy reef. This can be explained by the nature of coral reefs, which are porous structures characterized by a high degree of water permeability. A reef framework has a wide range of porosities from low (where internal cavities have been infilled with marine cements) to high (e.g., a reef framework is mainly composed of branching corals) (Hopley, 2011). In this study, mean porosity of reef framework is estimated as 10 %. This means that sea water permeates through the reef due to porosity, even if the reef is characterized by three dimensional structures.]

Additionally, we add the following into the Method:

In Section 2.2:

[We used 10 % of porosity for predicting vertical reef growth.]