Response to Reviewer 1

I am generally happy with the significant revisions the authors have made to this manuscript, especially in the additional supplementary materials. I have a few additional comments, after which I recommend publication.

Reply: We thank the reviewer for the comments and suggestions.

- Considering that the authors use a dynamic modeling framework including feedback to calculate alkalinity addition, I still would have preferred to see model bias corrections made as a part of the simulations. I appreciate the case the authors have made that UVic's biases fall within the range of those in other ocean models including biogeochemistry, but I think a bit more discussion is warranted of how, given the biases in UVic in particular, their results would be influenced by these biases. In the case of each region, do the authors expect that the amount of alkalinity addition required would be higher or lower if UVic we better at simulating surface chemistry and circulation? This would only require 2-3 additional sentences in the discussion.

Reply: The potential for bias corrections in our study regions is clearly limited by the lack of data in those particular regions (see figures S1, S2). Only pCO_2 and SST data are available to investigate the difference between model data and bias-corrected model data. A detailed description of our procedure has been given in the last paragraph of section 1 of the supplementary material (Page 3, line 1 to 18):

"We also estimated the potential impacts of model biases in simulated carbonate chemistry on our AOA model results. A rigorous bias-correction process would require observational DIC and TA data from our AOA regions, which is unfortunately not available based on published data sets such as GLODAP. However, in our AOA regions, observational pCO2 and SST are accessible. Variations in the oceanic buffer factor depend mainly on changes in oceanic pCO2 and the ratio of DIC to TA. A bias in pCO2 can thus induce a bias in the ocean buffer factor and the sea surface aragonite Ω change per unit alkalinity addition. To estimate this possible bias, we first use model generated values of pCO_2, TA, SST and sea surface salinity (SSS) to calculate a model-based sea surface aragonite Ω through CO2sys (Lewis and Wallace 1998, van Heuven *et al* 2009). Assuming TA and SSS are unbiased, we use observational pCO_2 and SST data to estimate a bias-corrected sea surface aragonite Ω through CO2sys, too (Table S1). This estimated bias-corrected sea surface aragonite Ω from GB and SC is 6% and 5% higher than the model-based aragonite Ω. Without (with) bias corrected values of pCO_2 and SST, the aragonite Ω increments per unit alkalinity addition (computed from the model results of the first year of AOA, see table S1)

amount to 4.15 (4.29) m^3/mol in GB, 3.37 (3.11) m^3/mol in CS and 3.39 (3.526) m^3/mol in SC. The estimated biases in omega translate into an uncertainty of required lime additions of roughly 3% more (GB), 7% less (CS) and 4% more (SC)."

We discuss this also in brief in the main text of the paper (page 12 line 28 to 33): "How well do our simulations reflect the real environmental conditions that coral reef ecosystems might experience during a high CO_2 climate scenario (control run) and AOA deployment? An estimate of potential impacts of model errors in simulated carbonate chemistry (table S1) suggests uncertainties in the calculated regionally averaged alkalinity requirements of less than 10%. This result indicates that the seawater chemistry simulated by UVic is acceptable for such an initial study of potential AOA. "

- The color scale in Figure 1 is not well chosen. The figure should be generated with a color scale that highlights distinctions in the realm of the authors' proposed threshold of omega=3. That is, it should be easy for the reader to tell the difference between waters with omega = 2.8 and omega = 3.2 just by sight.

Reply: We have changed the color scale of figure. 1 accordingly. In addition, pCO_2 fields and aragonite omega fields from preindustrial level and year 2020 are now shown. Coral reef locations are indicated as red spots.

- p16 l31: This sentence is very obtuse. I suggest a revision along the lines of "we acknowledge that they must be addressed in order to better understand how to best protect coral reefs from anthropogenic induced environmental change." --> "it is clear that protection of coral reefs will require a portfolio of management approaches to address all environmental stressors"

Reply: Thank you for the suggestion, we rearranged our structure a bit and this sentence has been deleted due to lack of justification from our results.

- p16 l47 "with [estimated] implementation costs" - there should be an "estimated" inserted here to emphasize the very preliminary nature of such cost estimates

Reply: This phrase has been changed as suggested (Page 16 line 15)

- p16 l57: The language here is also overconfident; revise along the lines of "and can be used to protect tropical coral reef ecosystem from it" -> "for the purpose of protecting tropical coral reef ecosystems" to remove the "can be used" which is premature given the scoping nature of this study

Reply: This sentence has been rewritten as suggested, and it states now at Page 16 line 20-22:

"This research shows that AOA has the potential to mitigate regional ocean acidification for the purpose of protecting tropical coral reef ecosystems."

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