

Interactive comment on “Potential and limitations of finite element modelling in assessing structural integrity of coralline algae under future global change” by L. Melbourne et al.

Anonymous Referee #1

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Melbourne et al. present model simulations to assess the impact of elevated CO₂ on the structural integrity of rhodoliths. They build on the work by Ragazzola et al. 2012, using their data and extending their 2D simulations into 3D. 2D and 3D models that differ in their level of realism are compared. The results show a compartmentalized 3D model gives similar structural results (measured as von Mises stress and total strain energy) as a more complex model that is based on tomographic scan. They also confirm the model findings of Ragazzola et al., which noted that the structural changes observed by Ragazzola under elevated pCO₂ leads to weaker structures.

This manuscript covers two aspects. First, it presents an engineering approach to study the impact of structural changes on stability. Second, it assesses the role of model

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complexity and dimensionality on the simulation results. The introduction outlines the general issue nicely and the text is easy to follow. What is found is that 2D and 3D models produce somewhat comparable von Mises stress (a measure how easily the structure can break), but differ much more in the total strain energy. Comparing current and elevated CO₂ conditions, the von Mises stress increases about 2 to 3 fold, yet strain energy varies 2 vs. 15 fold for 3D and 2D simulations, respectively.

My main concern is that the work is a somewhat incremental addition to the literature. It relies extensively on the publication by Ragazzola et al. 2012, both with regard to the data and the general concept. While an expansion to more complex models is valuable, it largely reflects the findings of the 2 vs. 3D structural FE analyses from other fields as cited in the text.

I found the discussion of the factors not accounted for in the model quite useful (e.g. Mg content, proteins), but to have a larger impact on the readership of BGD, it would be helpful and necessary to expand on the environmental context of these simulations further. E.g., are the changes simulated environmentally significant? How does the load tested relate to typical stresses experienced in situ? I am not convinced that statements such as ‘we have confirmed previous results that future climate change will lead to a loss in the structural integrity of coralline algae’ are justified. Yes, the simulations here match the trends of published simulations, though the effect of increasing CO₂ is much less, in particular for the strain energy. But more importantly, there is no validation of simulation results of actual structural damage with field data, and it is not obvious that effects from other adaptations can be ruled out completely.

With the current focus on the simulations alone, it would also be helpful to provide more information on the modeling itself. There is no information given on what is calculated (governing equations or concise citations). Thus, a reader interested in the topic but not familiar with the analysis is not well served.