

The manuscript "Projected impacts of climate change and ocean acidification on the global biogeography of planktonic foraminifera" by Tilla Roy et al. describes the effect of climate change, including ocean acidification (OA) on the distribution of the most abundant planktonic foraminiferal species. This is based on models results from an Earth system model incorporating temperature, food availability (plankton biomass) and light as the main drivers of foraminiferal biogeography. Results indicate shifts in foraminiferal abundance and diversity, depending on the region and or species to sometimes huge extents.

The research is original and provides interesting data to the community. The model setup is state of the art and data from the literature was incorporated appropriately. The presented data seems to be of appropriate quality. In a few cases the discussion of the data in relation to the already existing literature needs to be extended to give a fuller and more correct view, as indicated below. Also some of the statements and conclusions drawn are not correct. I strongly encourage the authors to carefully check the grammar and language, preferably by a professional. I would recommend publication of this manuscript after major revisions have been carried out. I wish the authors good luck with the revisions and remain available for further feedback and discussions.

Comments:

General:

- manuscript could be shortened in some cases to make it more concise
- Figure captions starting with "The". rephrase, e.g. Fig.6:"Zonally averaged changes...."
- wrong tense: e.g. l.279 under climate change shifts... polewards, in this case it should be rather "was shifted". This is the case in many more examples, I would highly recommend to consult a language editor
- the adjective of foraminifera is foraminiferal not foraminifer (e.g. caption of Fig.1)
- narrative order is sometimes confusing, eg. l. 88 -90 distinguishes spinose and nonspinose forams, however, the term spinose has been used earlier without introducing the term (l. 82). BGD has a broad audience, therefore explaining such terms is crucial (same goes for explaining OA, see comments below)
- some figures have stripes (eg 3a, b, 4a,c,d,5a,5c), please remove
- The abstract mentions: "changes in the marine carbon cycle would be expected...", however, this has not been discussed, also the potential effect remains questionable.

Comments according to sections:

Introduction:

- l.48: of past what? word missing.
- l.52: add citation
- l.63: explain what OA is and why reduction in carbonate production would decrease atmospheric CO₂ (broad audience of BGD).
- l.66: not depends but results from

l.71: rephrase sentence "Towards this end, in this study investigate present and future changes in the 3D distribution..." (?)
l.86: impact on, not of
l. 93: to reconstruct
l. 111: ";" should be after the bracket
l.117: change . with , after concentration
l.127: living not live
l.127: add citations
l.128: growth rate or growth? what is the unit of the growthrate? (um/ ug per day?)
l.139 what are the factors a and b?
Table 1: %P really in percent or as fraction?? eg. should 0.46 not really be 46%? (caption says percentage), is S_{nb} based on 250 ug or 250um individual (caption vs text l. 148)? references for the values?
l. 160/ 161: I understand that the number of foraminiferal species incorporated in the model needs to be limited, however, it would be interesting to see how high the discrepancy is between only using 8 species and the reality? A short comment on this, e.g. differentiated into the main regions of the model (tropics/ subtropics, etc and surface/ whole watercolumn) would be highly appreciated. (Maybe this can be achieved by comparison to MARGO database?)
l.166: sampling
l.171: "and calculate..." rephrase
l.171: explain Omega C here (l. 342 is too late in the document)
l. 182: replace the with that
l. 188: replace [] with ()
l.189: et al.
l. 202/ 203: it has been possible to reproduce foraminifera in the lab (benthic ones), see for instance **Toyofuku et al., 2008**, G3, 9, 5, Q05005, doi:10.1029/2007GC001772

and **deNoijer et al., 2009**, Biogeosciences, 6, 2669–2675, 2009

l. 203: the fact that planktics do not reproduce in the lab might not be the only fact allowing us to conclude that foraminifera behave differently in the lab. Lab experiemnts are always artificial and do never correspond to real live, however, it is all we have to manipulate certain parameters.
l. 210/211: please explain a bit more
l. 233: define RMSE
l. 232-235: I think other numbers need to be cited here (those of the present study only), e.g. abundance: the one of the here presented data is 3-24 based on the table, in l. 233 "3-25%" is mentioned, I assume 25 is from the Fraile study, same for RMSE
l.245 maybe put at different spot in manuscript, maybe more as a discussion, conclusion section, not as method?
l.245 five not 5

Results:

fig.4 add timeframe to "future change" (eg year 2100)
l. 283: the total abundance IS shifted to greater depths...
l.284: reference to Fig5a is not correct here
l.286: under climate change scenario: rephrase

Fig 4 could benefit if Fig. 4a and c were also showing the future scenarios, not only present day.

l.286: are the decreases in the tropics and increase in subpolar regions statistically significant? What are the estimated errors of the simulation & calculation of the Shannon diversity index?

Figure 6: While Abund And Rabund are correctly defined in both the materials section and the caption of Figure 6, it is not used elsewhere (not even in the respective axis labeling of Figure 6) and should therefore be omitted to avoid confusion.

Fig. 6: what exactly refers to surface?

l.301: verb is missing after N. dutertrei (decrease?)

l.304: "was accompanied by small increases"-> judging from Fig, 6c the decrease of 20% in N.pac is matched by the total increase of 20% in G.bull, N.inc, N.dut , therefore I would not say that generally species diversity is low, but that it seems that in the futures species diversity seems to increase in the higher lats (shift from N.pac to G.bull, N.inc, N.dut), also seen in fig. 5d.

l.310: Both,

Change order: Figure 8 before Figure 7, also change order in results section

l.320: "changes in nutrition rates" ? Please explain this, as I do not see how temperature would affect nutrition rate solely in such a way that abundance shift. I would more attribute this to the physiological optimum temperature for a give species.

Fig. 8: Please quickly comment about the general patterns of change in temperature and food observed, e.g. why is phytoplankton concentration in the Southern Ocean increasing in the future?

Fig.9: Why is the increase in habitat for O.uni, G.sacc, G.Siph and Grub not reflected in a relative increase in abundance? The negative impact of a decrease in habitat seems to be well reflected in a decrease in foraminiferal abundance, but not vice versa. This should be discussed in more detail in lines 417-421, as I find this interesting and puzzling. As stated in l. 415 it is generally expected that pelagic species should have the potential to escape to more favourable conditions, however, this study shows that while the more favourable conditions are predicted, abundance still drop (or do at least not benefit as much as would be expected).

Fig. 11: red contours hardly visible (exp. Fig11a). change colour scheme so to avoid reddish colours in the figure to enhance contrast

Fig. 11c) make clear in caption this is for the future, not present. In general the captions are sometimes too short. The more information is found in the figures, the better.

l.355 add citation

Discussion:

order should reflect that of results. rearrange (e. OA is last in results and first in discussion)
the addition of subheadings could increase readability

l.367: "which reduces foraminiferAL calcification rates" this statement is not correct in its current form, it is different for different species and also different studies have found different responses, see e.g. Keul et al . 2013 (Biogeosciences, 10, 6185–6198, 2013, www.biogeosciences.net/10/6185/2013/ doi:10.5194/bg-10-6185-2013) for an overview.

l. 368: can accelerate: only to a certain degree in a certain temperature window

l.371: add reference to respective figure

l.376: "are a response to higher atmospheric co2 concentrations" this statement in this general form is not true. On a physiological level, this might not be true for at least a few foraminifera, see for instance the study in Keul et al. 2013 where the disentanglement in the different C-system parameters allowed the conclusion that not the increase in CO2 but the reduction in CO3²⁻ causes the observed decrease in shell weights.

l.377: "is generally reduced at low carbonate ion concentrations" This is not true for all foraminifera (e.g. *C. gaudichaudii* in Hikami et al. 2011, see the discussion and references in Keul et al. 2013)

l.382: how is this assessed to be 20%?

l.385: omit are

l.386: and are thusly... (or better: consequently)

l.387: Omega =1 is the theoretical threshold, however, studies have found that foraminifera can thrive in waters with Omega <1, or can be also affected by waters >1. This fact should at least be shortly mentioned.

l.397: "magnitude and the sign of the slope"... this strongly contrast the earlier statement in l. 377 "calcification is generally reduced at lower carbonate concentration"....! (the statement in l. 377 is not correct, see earlier comments)

l.398: it does not only depend on how relationships were assessed, e.g. in laboratory cultures on the same species fundamental differences in the calcification response have been found (see eg. the discussion in Keul et al. 2013 on the differing calcification responses of *Marginopora* to OA in culture)

l. 416: add citation to Figure 9 (as a general comment, the discussion would be easier to navigate if comments such as 'we show" are backed up by the specific Figure references, also l. 422 ref. to fig. 6)

l.437: each species' preferred..

l.467: how would such a shift to deeper waters affect photosynthesis of symbionts and consequently foraminiferal growth?

Figures 9 and 10 seem a bit blurry

References:

Titles are capitalized in some

l. 643: odd paragraph

l.603: delete space after P in Pole

l.592 and l.526: "pp Page": check

l.579 and 523: issue and or page numbers seem to be missing

l.514: 275-&: check