



EGUsphere, referee comment RC1
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Comment on egusphere-2022-1364

Anonymous Referee #1

Referee comment on "Impact of deoxygenation and warming on global marine species in the 21st century" by Anne L. Morée et al., EGU sphere,
<https://doi.org/10.5194/egusphere-2022-1364-RC1>, 2023

General comments

I find this research using AGI to evaluate the effect of long-term warming and deoxygenation on contemporary habitat useful. It uses the AGI an index that represents the o₂ supply to demand ratio for maintenance activity. It is handy as it requires few data somewhat easily accessible. The authors show how this index can be used to assess species vulnerability to environmental changes using only species-specific biogeographic data of 47 species. An interesting point, is that the authors show that tendencies and mean changes alone (warming, deoxygenation and mean changes in AGI) do not suffice to predict species vulnerability within their present habitat, but rather the quantity of habitat volume close to AGI_{crit} as show by the CDF of the AGIs. They also show the high inter-species variability in terms habitat preferences and critical thresholds greatly influence the changes in viable habitat. Indeed the mean changes do not reflect species-specific changes in habitat viability. It is also very interesting to present the results by degrees of global warming.

A few improvements could be made to facilitate the reading of the results (see specific comments):

- More systematic presentation of the results
- Some methods of calculation are not given
- A bit more clarity is needed regarding the definition of some terms or choice of wording (e.g. habitat viability, potential habitat, AGI^{rel} vs. ΔAGI...). I suggest they all be defined in the method section.

Questions regarding the AGI need to be discussed.

Specific comments

In general, a more systematic presentation of results is need to ease the reading and further support the demonstration. In particular, a more systematic presentation of the figure (to facilitate the reading, so the reader doesn't have to go back and forth in the

main text. Also more consistency when choosing the warming level, scenario, etc. when presenting the figure in the main text. If you start presenting results for the levels of warming (Fig. 3 and 4) , please do so for the rest of the manuscript. Even with figures in the supplemental.

Abstract

Line 17-20: not clear, please rephrase.

Methods and data

- The choice of keeping a constant value for j_1 and j_2 across all species is indeed convenient and confers great value to the AGI and has been somewhat evaluated in the Clarke et al 2021 per comparison to the metabolic index. However, I still believe that sensitivity analysis to j_1 and j_2 would be useful to demonstrate the added power of the AGI since this index is quite sensitive to parameters j_1 and j_2 . Given the formula and the scale to which it is applied, I imagine AGI^{rel} at global scale will be only weakly affected by the choice of j_1 and j_2 . But for species species-specific AGI, it is less certain, in particular for species from equatorial and tropical areas. In particular, it will affect AGI_{crit} and so the changes in volume of viable habitat ($AGI > AGI_{crit}$) and possibly the slope of the CDF used to assess species vulnerability to changes in AGI, as you demonstrate that changes in viable habitat are species-dependant. So sensitivity analysis of AGI^{rel} and various AGI would be useful to demonstrate the degree of independence of the AGI to these parameters and would add great value to the results.
- As the AGI is comparable the metabolic index and given that it has recently been shown that it cannot be applied to certain species such as *D. gigas* or other species performing vertical migrations (Seibel & Birk, 2022), I wonder if the same limitations may apply to the AGI ? which case this type of species should be excluded from the study. Also it may need to be discussed in the manuscript.

Line 139 : which data ? O₂, T, salinity ?

Line 156 : please detail a bit more. You mean global mean SST reached by 2100 ?

Results

Line 174 : « habitat viability » suggests you refer to where $AGI > AGI_{crit}$, but you refer to AGI^{rel} . It can be confusing. AGI^{rel} would indicate « potential viable habitat » ?

Also, « AGI^{rel} reduction » is incorrect. AGI is either negative or positive reflecting a decrease or increase in AGI between t_0 and t_1 . Please rephrase.

Line 180-191 : A figure to show this would be better.

Line 201 : «A relative reduction in habitat viability [...] we expect a reduction in habitat viability ». Please rephrase. See comment above (line 174) relative to « habitat viability ».

Line 207 : Please detail somewhere how the contribution of po_2 and T to AGI and AGI^{rel} is

calculated.

Line 209 – 216 : Not clear what the difference is between the calculation method of the contribution of po2 and T is between line 208-210 and 212-216. For instance, « the AGI^{rel} due to T is -xx % for the epipelagic» (line 209) and « an average 87 % of AGI^{rel} is driven by... warming » (line 212). What is the difference between the two ? please detail calculation.

Figure 2 : please provide the same map as Fig. 2 (and C2) for 1.5 °C and 3°C to be consistent with the remainder of the paper.

Fig C3 caption : « AGI^{crit} as the minimum in-habitat AGI value, the 5th percentile, the 10th percentile, the 15th percentile and the 20 th percentile ». Word missing ?

Line 242-246 : in the text, changes in viable habitat are expressed in terms of habitat loss, but in the referenced figure (Fig. 3) changes in viable habitat are expressed in terms of remaining habitat. Please be consistent.

Line 256: please define "absolute loss".

Figure 3 : not clear how the different models/scenarios are represented or used for the calculation of changes in viability.

Fig. 5 : for which degree of warming ? Scenario ? Period of AGI ? Please precise in the figure caption. Also C4 is presented for a 3°C global warming. For the purpose of the demonstration, I understand that the chosen level is not determining, but consistency between figs within the same result section would be better to support the demonstration. Also distribution of AGI +/-.

Line 316: "The correspondent linear equation taken across all depth realms is $y = 7.31x - 0.10$." not useful.

Line 322: ΔAGI is $AGI(t1) - AGI(t0)$? please define.

Fig 6 : please provide same for 1.5 and 3 °C. Also, why only SSP5-8.5 ?

Line 336-337 : any hypothesis regarding those two species ?

Technical comments

Line 43 : ref Bopp et al. 2013 is about CMIP5

Line 139 : please specify « all data »

Line 201 : « reduction in AGI^{rel} », see comment above.

Line 204: « AGI^{rel} reduction » see comment above.

Line 229 : « decrease in AGI^{rel} », see comment above. See also line 231, 239

Line 240 : habitat volume is where $AGI > AGI^{crit}$? Please precise.

Line 291-296 : Please precise which period of the AGI is used for the PDF.

Line 302 : Only only

Line 303 : In An

Line 306 : indicates remove s