

Peer Review Report

Review Report on How earth system models can inform key dimensions of marine food security in the Alaskan Arctic

Original Research, Earth Sci. Syst. Soc.

Reviewer: Nadja Steiner

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EVALUATION

Q 1 Please summarize the main findings of the study.

The paper is generally well written. While I generally support the approach to link ESMs with potential changes in ecosystems and food security in order to inform both communities and policy makers on what they might have to expect in the future, I have major concerns with the way the article describes what the ESM(s) can do. This is extremely important to do correctly to ensure there are no misunderstandings, inadequate use of modelling tools and consequently mistrust by communities and policy makers (see detailed comments below). In particular the discussion and presentation does not clearly differentiate between ESMs and other types of models when describing links to food security and access to resources, and some figures directly compare real years with ESM years. I recommend publication only with major changes in the set-up and writing of the article as well as some of the evaluations.

Q 2 Please highlight the limitations and strengths.

Strength : general concept to use ESMs to identify climate change impacts on food security through access and food availability

limitations - clear information on what ESMs can do and cannot do is missing

- limitations of earth system models in terms of representing actual years not brought out
- info on uncertainty/multi-model approaches missing
- clear distinction between regional scale hindcast and predictive models and ESMs is not provided
- as is the take home message regarding ESMs and food security could easily be misinterpreted and lead to inadequate use of model tools and consequent development of mistrust in model tools in communities and policy makers.

Q 3 Please comment on the methods, results and data interpretation. If there are any objective errors, or if the conclusions are not supported, you should detail your concerns.

see Q2

coupled ESM model years and observational years cannot be directly compared.

Q 4 Check List

Is the English language of sufficient quality?

Yes.

Is the quality of the figures and tables satisfactory?

Yes.

Does the reference list cover the relevant literature adequately and in an unbiased manner?

No.

Are the statistical methods valid and correctly applied? (e.g. sample size, choice of test)

No.

If relevant, are the methods sufficiently documented to allow replication studies?

Yes.

Are the data underlying the study available in either the article, supplement, or deposited in a repository? (Sequence/expression data, protein/molecule characterizations, annotations, and taxonomy data are required to be deposited in public repositories prior to publication)

Yes.

Does the study adhere to ethical standards including ethics committee approval and consent procedure?

Not Applicable.

If relevant, have standard biosecurity and institutional safety procedures been adhered to?

Not Applicable.

Q 5 Please provide your detailed review report to the editor and authors (including any comments on the Q4 Check List):

Line 169/170 “understanding ocean–ecosystem–climate connections (Popova et al., 2012; Clement Kinney et al., 2020; Jeffery et al., 2020; Gibson et al., 2020; Gibson et al., 2022) – Note Popova and Clement–Kinney are not ESM evaluation – Popova ocean only, Clement–Kinney –RASM. Either remove or expand text accordingly)

Table 1 – The metrics and connections are very vague. While this may be acceptable to make general statements on potential future changes on ecosystems and food security it is too inaccurate to inform the communities on how their food sources maybe affected. There are a lot more details to consider requiring direct input from the communities. It needs to be made really clear on what can be provided and what not (see notes below).

Line 496...Gas prices are important and extremely relevant, they need to be matched with estimates of disposable income (example of loss of income due to seal–pelt sales following the seal ban). Eventhough the communities may rely primarily on subsistence, they still need to purchase the gas.

Line 480–501 & Fig 7, Productivity discussion discusses individual years of obs and model in a way suggestive of them being comparable. As this is a fully coupled model, individual years do not correspond with real years. It is extremely important to make these distinctions and adequately communicate the difference both to policy makers and affected communities. If this is not done, any mismatch can be seen as a reason to distrust models in general. Policy makers may use the model to determine harvesting limits assuming they are for a specific year. These things have happened before and led to major distrusts in anything containing the word “modelling”, see also L534/535 – “whether conditions in a given year” – a coupled ESM does not have that capacity! – it can identify however if there is a noticeable trend.

I suggest instead to talk about long–term trends and something like occurrences within a decade or better 20–30 year period, e.g. within each period so many years are below/above average etc.... (as is done in Golaz et al 2019 evaluation of the model)

It can still be discussed if the response is the same for various ranges around a community compared to basins.

L540–545 This is a bit of a mixed bag thrown together without much discussion. As a reader I would interpret as the authors would like to present a tool to help understand food security issues, but then indicate that its actually not helpful because all those other things. ..

I would suggest to describe at the beginning of the paper what are the components contributing to food security and indicate which of those components the model can assess (Bennet et al 2018 may potentially be of interest, <https://doi.org/10.1016/j.marpol.2017.10.023>).

L566/567 "If appropriately validated, these relatively inexpensive model products could eventually be used in conjunction with the observational maps provided by SIKU"

This is a big IF !!! there is a lot that can be done with higher resolution ice-ocean-bgc models that are forced by actual observed (reanalysis) data sets (and possibly/hopefully in operational prediction mode) in terms of linking changes in environmental conditions to detailed species and community impacts. But the title and intro indicates this is an evaluation of the use of ESMs. The authors indicate operational prediction models in the follow up of discussing model output from ESMs. ESM output does not have the capacity to be used to identify where travel is safe or not. There are lives at stake, hence the distinction needs to come out very clearly!

The next paragraph 571-589 actually starts to go into this discussion/argumentation and there is valuable content in there, but I would highly recommend to clearly state what different models and model modes exist and what each can do. While all those models may have the same core /code lines, it needs to be made clear enough so end-users use the right product for the right purpose. (I.e., ESMs give longterm trends, estimations of # per decade of lower or higher than average, while higher resolution models with reanalysis forcing (hindcasts) can provide indications on how actual community experiences were linked to environmental conditions, high-res prediction models can guide short-term future harvesting activities etc. (those will very unlikely be global). I am sure the authors, at least the modellers, are aware of all this but it does not come out clearly in the text. Most of this information is somewhere in the discussion section, but it needs to be more clearly structured to ensure it will not be misinterpreted.

Since this paper focuses on ESMS (title/abstract) the use of the ESM output should be highlighted (e.g., I suggest moving section 591-594 ahead to emphasize the use of ESMs), then there could be sections indicating how ESMs/ESM evaluations can help for the development and/or application of hindcasts and predictions.

L571 and elsewhere please use projection/projecting for climate projections and predictions/predicting for short-term predictions (a further distinction to help avoid confusion).

L 620 The authors present one model, indicating bgc is relatively complete in E3SM... It is unclear how to interpret "relatively complete". Please make note that ESMs still show very large biases for both historical and projection runs, particularly for biogeochemical variables. It needs to be highlighted that an individual model representation may not be adequate to make acceptable projections for a specific region and policy makers as well as communities may have to look at multi-model means instead. (maybe add a note on uncertainty ?).

The authors indicate E3SM represent phytoplankton biomass with reasonable skill - at which time and spatial scale??? Is it community-relevant?. The authors switch in the same paragraph to talking about "the models". It needs to be clear that this is a general statement about ESMs (see note on models above) (would be clearer if a multi-model discussion, see above, would be included).

L 640-641 reference Steiner et al 2019 (<https://doi.org/10.3389/fmars.2019.00179>) might be relevant.

Regarding Q4 - references are generally good, but could potentially be broadened to non-Alaska work, not a requirement, just a thought.

QUALITY ASSESSMENT

Q 6 → Originality	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q 7 → Rigor	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q 8 → Significance to the field	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Q 9 Interest to a general audience

Q 10 Quality of the writing

Q 11 Overall quality of the study