Answer to reviewer 1

The revisions have improved the manuscript and I am satisfied with the responses to my previous review. I've noted a few technical details and edits that should be checked before final publication.
We thank the reviewer for the positive assessment of our revised manuscript. Please find our answers to all detailed comments below. We note that in addition to both reviewers' comments and upon suggestion by the editor, we have made some further minor edits to the title, the abstract and the main text so that the revised manuscript now includes a title for the new synthetic float capabilities ("LIGHT-bgcArgo"). Please see the track change document for an overview of these text modifications.

Line 75: insert period between "ocean" and "Yet".
Inserted as suggested.

Line 205: "only knowing the respective float's position on day 1 and 10 [...] of each 10-day period"; technically, if samples were taken exactly every 10 days, we would know the position on day 1 and day 11.
We thank the reviewer for pointing this out, which made us realize that there was a mistake in how we calculated the trajectory length from daily float positions. In the submitted manuscript, we had calculated the trajectory length between day 1 and 10, while it should of course be between day 1 and 11. We note that we had correctly calculated the trajectory from 10-daily sampling, and Figure 3 (trajectory-based velocity estimates) is thus not affected by this mistake. In the revised manuscript, we have corrected the text in section 3.2 to read "[…] on day 1 and 11 […]" and have updated Figure 5 accordingly. Further, while we have made minor additional adjustments to the text in section 3.2 to reflect the corrected calculation (see track-change document), the major take-away message of this section remains unchanged.

Section 3.3.1: Only a suggestion: this section calls the range between the maximum and minimum value during a year the "seasonal amplitude". I would call it the "seasonal range".
We thank the reviewer for this suggestion. We decided to stick to "seasonal amplitude" but have revised the starting sentence of section 3.3.1 to now read:

"Our first case study quantifies the synthetic float-derived amplitude of seasonal variations of physical and biogeochemical marine ecosystem stressors […]"

Line 341: "flaots" -> "floats"
Corrected.

Lines 384--385: I was confused what "float densities ranging from 2 to 28" means. Clarifying that this is the number of floats sampled from within the basin (I think) might help.
We have revised this sentence to now read:

"To obtain a statistically robust estimate of the mismatch, we subsample the 197 available synthetic floats in the subtropical Pacific 5000 times to float densities ranging from 2 to 28 in this subregion (corresponding to between 100 and 1200 floats globally)."

Figure 9a: the float estimates appear to have a higher mean value than the Eulerian values. Is this from a sampling bias in the floats?
Thanks for spotting this. We believe that this is at least in part due to the fact that all our synthetic floats currently sample at the same time of the day (midnight GMT), causing a slight

systematic discrepancy between the full-day average of the Eulerian model output and the synthetic float-based estimates.

Line 452: "by sampling every ten days, float-derived velocities are biased high"; this should say biased low.
Corrected.

Answer to reviewer 2

In the present manuscript, the authors use the Energy Exascale Earth System Model version 2 to retrieve vertical synthetic profiles of various physical and biogeochemical properties in order to assess uncertainties of the spatiotemporal retrieved by the current mission of the OneArgo program in the global ocean. After evaluating the method on 3D fields of physical parameters, velocity, and nitrate, authors present four case studies in which the synthetic profiles informs on potential uncertainties that current and/or future array of real floats encounter due to their sampling scheme and mission configuration.

Manuscript was really well presented and written, and I appreciated the effort put by the authors regarding the quality of redaction and the clarity of the Figures. I feel that this study provides an innovative way and tool to assess uncertainties for studies based on Argo floats measurements, and by extension, by any autonomous platforms. In my opinion, the manuscript is suitable for publication after minor revisions (cf detailed comments below).
We thank the reviewer for the positive assessment of our revised manuscript. Please find our answers to all detailed comments below. We note that in addition to both reviewers' comments and upon suggestion by the editor, we have made some further minor edits to the title, the abstract and the main text so that the revised manuscript now includes a title for the new synthetic float capabilities ("LIGHT-bgcArgo"). Please see the track change document for an overview of these text modifications.

l.15: It is not clear to me what the authors imply by "seasonal variability"? Do they mean: short-term variability in ecosystem stressors impact on the estimates of their seasonal cycle?
Yes, this is what we mean. To clarify, we have corrected this as suggested.

l.19 and 22: Maybe mention before and/or after presenting the 3 missions that they are part of the international OneArgo program (Roemmich et al., 2019), and mention "Core Argo" mission or array (l.19), and "BGC Argo" mission or array (l.22) for more clarity.
We have made the suggested changes and added the following sentence to the first paragraph of the introduction:

"All three arrays are part of the international "One Argo" program (Roemmich et al., 2019)."

Figure 1: Add "irradiance" (one of the six "core" variable of the BGC mission) on the list of parameters on the panel b.
Added as suggested.

Figure 2: I feel that it could be informative for the reader to see the distribution of the current fleet (BGC/core/Deep) on the map, in order to compare it with the synthetic floats distribution. I know that there is already a lot of information on this Figure, so this is up to the authors.
We appreciate this suggestion. We agree that it could be a nice addition to also show the Argo float distributions on the map, but we believe this would make the map too busy. The panels at

the top and on the right side of the map were included in this figure to specifically facilitate the comparison of the float distributions in Argo and in E3SM, and we hope this level of detail is sufficient for the majority of readers.

l.226-229: I would reo-order the presentation of the case study exemples so that they match the order in which they are described afterward in the manuscript.
We thank the reviewer for spotting this. While the order of the case studies did already correspond to the subsequent subsections, the references to the subsections given in the parentheses were incorrect. We fixed this in the revised manuscript.

Case 1: I agree with the fact that a 10-day sampling captures less variability over than a sub-10-days sampling scheme, but I would also suggest adding that the 10-days sampling might capture some "extreme" events that for example does not represent the average seasonal cycle, which can be important depending on the application.
We thank the reviewer for raising this point. In the revised manuscript, we have revised the first paragraph of section 3.3.1 to now read:

"Yet, given the floats' 10-day sampling cycle, it remains unclear to what extent these data capture extreme conditions which are not representative of the seasonal cycle. Further, the contribution of daily variability to float-derived estimates of seasonal variability remains unquantified."

l.333: I would not specify a temperature threshold, to remain "global" (the mentioned one is mostly used for the Southern Ocean, but other are used for other area of the global ocean, cf https://archimer.ifremer.fr/doc/00658/77029/).
We thank the reviewer for pointing this out. As suggested, we have taken out the mentioning of a specific temperature threshold. Further, we have added the suggested reference (André et al., 2020, DOI: 10.3389/fmars.2020.577446).

l.341: typo (end of the line): synthetic floats (instead of flaots).
Corrected.

Figure 8: I am not familiar with the sea ice concentration, but are there some units for the color scale?
Sea ice concentration represents the fraction of the respective grid cell that is covered by sea ice. As such, it can be presented as a non-dimensional property on a scale from 0 to 1 or be given in percent. To clarify, we show sea-ice concentration in percent in the revised Figure 8 of the manuscript and have modified the figure caption accordingly:

"Annual mean (left) and winter mean (June, July, August; right) sea-ice concentration in percent in each grid cell of E3SMv2 averaged over 2012-2017."

l. 375: I would mention the international BGC-Argo program/mission/array and not exclusively the US contribution (through GO-BGC), as other countries contribute to the program worldwide… Here is a link for a map with the implementation of the international BGC program https://maps.biogeochemical-argo.com/bgcargo/.
We have added the suggested link. The sentence now reads:

"Similar advances are expected in other regions (e.g., Cornec et al., 2021) as more biogeochemical floats are deployed globally (see https://www.go-bgc.org/array-status and https://maps.biogeochemical-argo.com/bgcargo/; last access June 28, 2024)."

In the different cases study, it is unclear why the authors mention 1200 floats, when the goal of the OneArgo program regarding the BGC floats operational fleet size is 1000 floats. Could the authors explicit this choice?
While the reviewer is of course correct that 1000 is the target number for BGC floats, the target number for Deep Argo is 1200 (see, e.g., https://argo.ucsd.edu/oneargo/). Acknowledging that it is still unclear how many of these floats should (ideally) be equipped with biogeochemical sensors, we have decided to report our results for a float density up to 1200 floats globally to encompass both Argo programs. Additionally, we note that for our last case study, substantial uncertainty in capturing phytoplankton bloom phenology remains even at a global BGC float density of 1200.

Fig. 9: Typo in the y axis of panels f and g: phytoplankton bloom peak (instead of phtoplankton)
Corrected.

Conclusion: I feel that the authors should emphasize more the utility of the modeled synthetic profiles for further applications using Argo data. The authors remind the results of the examples of applications, but I feel that they should generalize more the conclusion and focus rather on the applications potential of this approach, that could be use to help constraining uncertainties in future Argo studies (e.g., to constrain lateral advection of water masses in 1-D framework BGC approaches, gas exchanges estimations, etc…), as well as maybe be a potential tool to identify locations of interest for ongoing and future float deployments in the framework of the OneArgo program.
We have added the following sentence to the conclusion section:

"For example, the synthetic float capabilities could be used to i) assess uncertainties in deriving biogeochemical fluxes such as air-sea CO_2 exchange or net community production from float-based observations, ii) assess uncertainties in mapping float-based observations or derived quantities to global, gridded datasets arising from, e.g., float distributions, sampling frequency, or sensor inaccuracies including drift, or iii) inform future float deployment strategies as part of the One Argo program."