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Interactive comment on “Seasonality of sea ice controls interannual variability of summertime Ω_A at the ice shelf in the Eastern Weddell Sea – an ocean acidification sensitivity study” by A. Weeber et al.

Anonymous Referee #4

Received and published: 17 April 2015

This study makes use of underway sampling data collected in the Eastern Weddell Gyre spanning four years and a conceptual seawater density model to investigate seasonal to interannual variability in the aragonite saturation state (Ω_{arag}) and determine the physical and biological drivers for Ω_{arag} variability. The authors find that summertime sea-ice thaw, driven by changes in physical properties affecting the buoyancy flux, affects the availability of light and nutrient supply to the surface ocean, so that increased biological productivity is favored and thus Ω_{arag} increases. From this, they conclude that the main drivers for Ω_{arag} variability are the tim-

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ing and rate of the sea ice thaw, which directly affect phytoplankton blooms.

In summary, I think the topic of this manuscript is very interesting and relevant to the broader field of research on the Southern Ocean and believe the data to be of good quality and generally well presented in the figures. However, there are several points, referring mainly to the structure and presentation of the manuscript, that in my opinion need to be improved first before the manuscript can be submitted in its final form (see my general comments below). More specific, minor comments can be found after the general comments.

General comments:

- I found the title of the manuscript to be somewhat confusing. The title implies that it is the seasonality of sea ice that is the main driver for interannual variability in Omega_arag. However, in the introduction (P1656, L28/29), the authors state that they will investigate how interannual variability in the drivers of Omega_arag will influence the variability of the seasonal cycle of Omega_arag. Thus, a clear use of the terms “seasonal”, “interannual”, “intraseasonal”, and “intraannual” is essential for more clarity in the manuscript.

- I would strongly urge the authors to separate the results and discussion of the results. I am aware that this is a personal preference, but I found the results section to be too long and very difficult to follow. The authors introduce results from many other studies in the results section, so that I found it very difficult to clearly distinguish which results were produced for this study. Although I believe the authors have interesting results which are worth presenting, this would need to be done in a much more condensed way. In my opinion, the manuscript's structure and clarity would greatly benefit from presenting the results in a concise way (i.e., not mixing them with the discussion) and then, in a separate section, present a clear, to-the-point discussion of these results, where references are brought in to put the authors' results into context. The authors don't need to add any more information to the results and discussion – a simple re-

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structuring and condensing would be sufficient.

- I enjoyed reading Section 4 “Ecosystem implications” and Section 5 “Conclusions”, which I thought were the most well written parts of the manuscript. If the authors could manage to re-write the sections their results and discussion in a similarly concise fashion, then I believe the manuscript would be greatly improved.

- The manuscript should go through another couple of internal reviewing rounds, to improve the spelling, grammar and structure of the text, before it can be submitted in its final form. In general, the text could be shortened and condensed to be more flowing and coherent, which would greatly facilitate the reader’s comprehension of the text. There are numerous spelling mistakes, of which I will highlight just a few in the more specific comments below. I would urge the authors to do a more rigorous spell check during the next round of internal reviews.

- The abstract should be revisited after the manuscript has been improved. Currently, it does not significantly reflect the content of the manuscript, and it does not make it clear that the results of this study are based on observational data as well as on a conceptual model.

- Throughout the manuscript, it wasn’t clear to me what the authors meant by “seasonal phasing”. Do they refer to the timing of the maximum and minimum seasonal cycle? This should be made clearer to the reader.

Specific comments:

- P1654, L2: What is “its”?

- P1654, L3-4: The seasonal cycle and interannual variability of what variables within this ecosystem?

- P1654, L7: Drivers of what?

- P1654, L10: What does “optimal” mean here?

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- In general, I am missing a clear explanation in the introduction as to why this work is relevant and why it is important to investigate the connection between interannual and seasonal variability of Omega_arag. This is currently not clear to me from the introduction.
- P1655, L12: Where is this definition of the Revelle Factor from? Typically, the Revelle Factor is defined as $d(pCO_2)/d(DIC)*DIC/pCO_2$ (see Gruber and Sarmiento, 2006). Please provide a reference if this definition is indeed commonly used.
- P1655, L23: reductions in growth rates (be consistent with L22)
- P1656, L8: constraints, not constrains
- P1656, L11/12: I don't understand what the authors mean by "Taking seasonality into account. ...". Maybe they could explain in the introduction how seasonality affects the timing of future aragonite undersaturation events. This is also important in the light of their own study and should be properly introduced.
- P1656, L18: Define PAR.
- P1656, L17-22: These two sentences are somewhat repetitive.
- P1657: The authors mention towards the end of the introduction what they will be looking at in this study but don't provide any of their own results. I would like to see one to two sentences at the end of the introduction on their major results and findings, so as to guide the reader into the following text.
- Titles of Sections 2.2 and 2.3 are misspelled.
- P1657, L13: GPS device
- P1657, L15: Replace "Depth" with "depth"
- P1657, L119: Where is this reference density of 1027 kg m⁻³ from? How did the authors choose this value?

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- P1657, L20/21: I don't understand this sentence. What does the density (should be "rho" not "p") in parentheses refer to?
- P1658, L2: At what depths were the samples collected (vertical resolution)?
- P1658, L3-5: It isn't clear here where the additional 48 CTD profiles were measured. Are these the black dots in Fig. 1? Please make this clearer in the text and the caption of Fig. 1.
- P1658, L13: "by van Hoven". Please provide the correct citation.
- P1658, L13/14: How was the uncertainty in DIC and Alk computed?
- P1658, L18: How was Omega_arag calculated from DIC and Alk, using which formulation?
- P1659, L4: replace "were" with "where".
- P1659, L10: The uncertainties in DIC and Alk were mentioned previously, no need to mention them twice.
- P1659, L16: I assume the authors are referring to the RCP8.5 scenario, when they write "IPCC business-as-usual". Please specify.
- P1659, L24/25: I don't understand what is meant by "...using midnight as the daily time step". Please clarify.
- In general, the results section should be written in the present tense.
- P1660, L3-5: I don't understand what is meant by "...an equally strong interannual variability". Please provide numbers in the text for this interannual variability of the phasing and magnitude of Omega_arag.
- P1660, L5-10: This sentence should be part of the discussion, not merged with the results, as this is not part of the analysis done in this manuscript (see my general comment above).

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- P1661: The first paragraph should go into the introduction, in my opinion. This is what I was lacking from the introduction: a clear explanation as to why it is important to investigate interannual variability in Omega_arag.
- P1661, L20: What do the authors mean by intraseasonal? It seems that this is sometimes used instead of interannual. Please be consistent.
- P1661, L8-23: This whole paragraph mainly states results found in other studies (e.g., correlation between primary productivity and the magnitude and phasing of the summer increase in Omega_arag). However, the authors don't provide any quantification of their own results and just refer the reader to the figures. Furthermore, in Line21, how did the authors determine the two main drivers? What is their proposal based on? I find it very difficult to follow the authors' argumentation here.
- P1662, L27- P1663, L9: This paragraph doesn't belong here and should probably go into the introduction or into the methods.
- P1662: It was not clear to me when and where this model was used and which subsequent results were obtained by applying this model.
- Fig. 1: Caption: The regional bathymetry is not overlaid, but rather "underlaid". "and" missing: "CTD (red dots) and UCTD (green triangles)". In general, the phrasing of the caption is somewhat confusing. Please improve.
- Fig. 4: The grey lines showing the +/- 1 std are barely visible. A shading in a different color around the black line might be easier to see.

Interactive comment on Biogeosciences Discuss., 12, 1653, 2015.

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