Review of the manuscript "A volumetric census of the Barents Sea in a changing climate", by Watelet et al.

This paper presents a novel temperature and salinity datasets that is presented on a regular grid for the Barents Sea, which are "constructed" from the available datasets. It also presents basic analysis of the thermohaline trends that are showing the state of the Barents Sea. The manuscript is well written and is easy to follow. For these reasons, I think that presented manuscript has a potential for the publication in the ESSD. However, I have some concerns regarding the manuscript, especially when it comes to the description of the used methods to "construct" the maps of temperature and salinity. In the manuscript, the Authors mention the DIVA software package, however I am missing the details on the used methods and the existing data. My other main concern is the coverage (in space and time) of the used thermohaline data, as well as for the final gridded maps, that were not clearly described in the manuscript, and for which I think that is important for the reader to understand your choice of analysis that are limited to seasons, years and/or regions.

Altogether, I recommend this manuscript for the publication after the major revisions.

The main concerns from my side are:

1. In the manuscript, I find that Section 2 is poorly described, which could lead the readers to miss the important details of the used data. You could provide a Figure of the Barents Sea with the locations of the used *in situ* data, and others. Are these data measured regularly (for instance on a monthly basis)? In addition, the Authors could also provide the references for the WOD13 data, PINRO CTD data and the NPI data.

2. The description of the method could include more details. Aside from the DIVA package, you mentioned several techniques that you used to create the gridded data with the estimated error fields, however, I am missing the details of the methods. For instance, until now I have never heard of the "clever poor man's method", and I couldn't get access to a reference paper. You could provide additional information about the used methods, since this is the main work of your manuscript.
3. Also, just by reading the Sections 3, I find it a bit confusing, which is a bit disappointing, considering that this Section is containing the main core of your paper. First of all, you should make it clear for the readers what are the input data and what are the resulting gridded maps. Similar to my previous comment, I am missing the description of the datasets. What is the coverage of the original datasets, and what is for the resulting gridded maps (in space and time)? Are the resulting maps on a monthly basis? In L57: you mention that "the ODV spreadsheets were vertically interpolated onto 23 depths…", however, I am missing the information on how the spreadsheets were constructed. Do they contain only the original data, and if so, what does one spreadsheet represent and how many data does it contain? Also, you mentioned that you performed the analysis on four seasons (L67), and that you constructed the data for these analysis by using an 11-year windows (for which I am not sure whether you averaged only the corresponding seasons during these 11 years, or the whole year). At this point, I was not sure whether this analysis is performed on the data that are showed in the T-S diagrams? I have to admit, I was bit confused reading this Section, so my suggestion is to rewrite it in a form that is more precise, and providing more details on the used methods, including the methods used for estimation of the errors.
4. Regarding the basic analysis of the gridded thermohaline fields, I find these Sections too descriptive. You should provide numbers when making statements, i.e. whenever you use phrases such as "increase", "decrease", "trend", etc., you should a give a value by "how much". Some examples are given bellow in the detailed comments

Minor detailed comments and suggestions:

Figures:

1. Most of the Figures are lacking the descriptions. Each of the Figure should contain detailed description of what it is showing. For instance, in Fig.2 and 3 it is not clear for me what the time-step for the data is. On Fig. 4 and 5, you should provide explanation for the values on the colorbar. On Fig. 7 should be mentioned which type of data is shown.
2. In Fig6a the y-axis: "Averaged relative temperature error" or "Averaged relative error for temperature". Same for the salinity (Fig6b)

L15 and elsewhere: I don't understand the usage of BS acronym. However, if you chose it, you should be more punctilious while using it. In this line you mention "Barents Sea", without the acronym, and you introduce it in the L16. Throughout the manuscript you are sometimes using "Barents Sea", and sometimes "BS". This should be corrected also at the Figure 1. Same comment applies for all the other used acronyms.

L17: use the apostrophes when mentioning Atlantification. As far as I know, this is not a name for a physical process, even though the readers do understand the meaning of the phrase.

L18: what are the "both physical conditions"? Perhaps you can exclude "such as", since it implies that there are more than two

L18 and 19: as well as on biological and marine ecosystem

L30: varies between seasons and years, especially during winter and spring

L31: … or concentrated at fixed sections.

L32: … sea surface temperature, and recently sea surface salinity

L33: Don't use "E.g." at the beginning of the sentence. Instead you could say "For example,…"

L34: … the Arctic that shows temperature increase for the period... What was the increase?

L35: … between the two periods: 1979-1995 and 1996-2012.

L36: …property changes,

L36: I find the phrase "in situ" differently written at several places. Sometimes it is "in situ", and sometimes is "in-situ". Try to be consistent when using phrases. I found in many places written in curves "*in situ*"

L36 and 37: … often have disadvantages of…. and/or time (sometimes it could be both)

L37 and 38: Please rephrase the sentence, it doesn't sound grammatically correct.

L39 and 40: Does the seasonal temporal resolution mean a 4-month averages? You should be more concise here, as well as in Section 3 (See my comment 3 in the main concerns)

L40: "based on all available observations". Does this also include satellite data? It is not that clear in the Section 2.

L53: … in situ data using a Variational…

L63 to 65: To which data are you referring here, original or the ones already interpolated on the 23 layers? It is not easy to follow this Section. At this point I am understanding that the Fig 2 and 3 are showing the interpolated data. However, L104 suggests that these Figures show original measurements. I find it a bit confusing.

L67: You should define the periods for the 4-month averages, just to be more precise. Later on, you use “autumn”, and you never defined that season. Even though it is self-clear, I find it better to be as much as precise as possible when writing a scientific paper. My suggestion “November to January (autumn), etc.”

L96: from the mid-2000s. Also, to what period do you refer when saying “than previously”?

L97: Why is the reason of choosing these exact 5-years periods? Also, could you give an exact number of the data used in the analysis?

L100: Why didn’t you include year 2016 for the estimation of the error fields?

L102 and 103: The relative error field averaged through all the layers for each variable and season is shown in Fig. 6

L105: there is no need to say “only when considering the whole BS”, since this is the only analysis that is considering the whole BS.

L106: Volumetric T-S changes for both periods were carried out by summing all the pixels falling inside the T-S classes … having a step of …

L106: Does the data only correspond to the autumn data? You should also mention this in the description of the Fig. 7

L112 to 113: You should mention that this increase implies only to autumn. Also, this is a good example of descriptive sentence. You should provide averages: “the increase in temperature and salinity is clear, by XX C and XX PSU in average”

L115: In Section 3 u stated that the reference fields were defined by an 11-year window, and here you say that you used a 10-year window. Please provide additional explanation.

L117 to 119: … weighted by the layer… for periods 1994-1998 and 2006-2010. It is clear that the error is much lower on the T-S classes showing larger changes, which are … This strengthens the reliability of the observed autumn T-S changes in the BS.

L122: Rephrase the sentence and correct the grammar

L125 to 127: If the errors are not shown, you need to state so

L127. This advantage allows us to analyze all the seasons at the MRA, in contrast to the whole BS. Here we focus on the periods: 1965-2015 for the temperature and 1970-2010 for the salinity. Also, add a sentence as an explanation of using these periods.

L128: You state that the years 1996-1997 is having a lack of data for the temperature at the MRA, which is showing the lowest errors. However, those two years are within the 5-years period that you used in the analysis of the previous Section, where you showed an increase in temperature. At this point, I am not convinced in the reliability of the previous analysis, and even more I still don’t understand the choice of those 5-year periods for that analysis. Could you please explain?

Subsection 6.2: Why did you choose to show vertical seasonal thermohaline profiles, all in one plot? The figures are a bit “messy”, showing all seasons, and it is not that clear to depict the trends. Instead of the profiles, you could show surface plots with the estimated trends for three different averaged layers (0-50, 50-300, and 300 to bottom). Other choice could be (a), (b), (c), and (d) for the profiles, where you could separate 4 seasons.

L131: I don’t understand the point of this sentence. You should remove it.

L132 to 134: I also find this descriptive. What is the averaged values for the temperature increase? Also for the salinity, “unambiguous raise between the 90s and the 2000s”, how much? … “similarly to the observation made for the whole BS”, I am missing a reference here.

Subsection 6.3.: Provide additional information on how you estimated the volume of water? What exactly are the Figures 12, 13 and 14 showing? Once again, I find this paragraph too descriptive. When using phrases such as “increase”, “decrease”, “trend”, etc. you should a give a value by “how much”.

L139: I don’t understand the phrase “classes” in this sentence. Define the “classes”.

L139: The calculations…

L145: … similarly to the conclusions made in Section 6.2.

Fig 12, 13 and 14: Are the diagrams showing the sums of the volumes in a whole seasons? You should state that in the description of the Figures

L146: … at the MRA…

L151: Define “reference period”

L152: In the Formula (1), OHC is dependent on the density changes, which is dependent on both temperature and salinity changes. How could you estimate OHC value for the period outside 1970-2010? Even in the L149 you stated that t and s are between 1970-2010. Could you please explain?

L154: Is the correlation significant? From the Figure 15a, it clearly is, but it is better to add it in the sentence as well.

L155: … at the BSO

L161: In Fig. 15b changes in the EFWC …

L163 and 164: To which threshold do you refer? The sentence on the choice of the significance tests should be stated before.

L165: Is the correlation significant? If yes, could you give a sentence in explanation on why the correlation is negative, similar to the one you gave for the OHC and temperature positive correlation? Also, it would be interesting to know what caused an extreme salinity decrease during the late 1970s and early 1980s, evident in both EFWC increase (Fig15b) and in the percentage of the total volume (Fig13). Are there any references for that?

L170: Rephrase the sentence

L171 and 172: “The results are consistent with the recent “Atlantification” processes at the BS already observed in the previous studies, i.e. warmer and more saline BS, even though our analysis only includes autumn when considering the whole BS”. Also, I am missing a references for the previous studies

L172 to 175: Concentrating on the MRA in the BS allowed us to analyze longer period (1965-2015) with all seasons included. The analyses showed similar results to the ones made for the whole BS, showing an overall positive temperature and salinity trend (with numbers!), while … cancelling effects of both temperature and salinity increase.

L176 and 177: …these conclusions as they show positive and negative trend, respectively, during the period 1965-2016. I am a bit concerned here. As I stated before in my comments, I find this period suspicious. Moreover, EFWC was estimated only for the period 1970-2010. In addition, I don’t think that EFWC trend is significant, since R2 is only around 12%.