Reply to referees Ver 25.5.2018

Referee 2, I. Vuorinen
Received and published: 3 May 2018

RC2_1: 1General comments:
The paper presents first time digitized and quality assured oceanographic data from the Northern Baltic proper in (semi) open sea conditions. Temporal range of the data is impressive, starting in 1881. Spatially the data is from one spot, which lies somewhat mid-way between open sea and coastal conditions, also between the Bay of Bothnia and the Gulf of Finland. Approach and methods are basic, which is okay for this type of paper (presentation of a new, significant data set).

The authors thank for the support for publishing this paper.

RC2_2:The discussion could be somewhat more extensive (see below in specific comments). Presentation of figures and tables is appropriate (with some exceptions which are commented below), and English is mostly okay. I suggest below some places where wording should be reconsidered.

I suggest publication with minor corrections.

Specific comments
RC2_2: Title: One hundred years of atmospheric and marine observations at Utö Island, the Baltic Sea. -There are several islands with that name in the Baltic. I know of one in Sweden and two in Finland. Consider adding the coordinates, the country, or other information in the title in order to avoid mixing at least with the Utö in the Stockholm archipelago.

We agree with the comment especially with the possible confusion to Swedish island Utö and changed the title to “One hundred years of atmospheric and marine observations at Finnish Utö Island in the Baltic Sea”

RC2_3: Abstract: I like the last sentence. It points out a possible tipping into a new phase. This idea should be discussed more thoroughly, considering a possible breakpoint, its temporal location and affecting mechanisms.

Our aim in this paper was to show the long tradition of observations at Utö, a station that will be even more important multi-scientific observation site in the future. We wanted to give background for the future studies by showing some trends and by quantifying changes that can be seen from those observations. In addition to that, we pointed out some potentials of our data sets. We agree that the datasets raise interesting questions, that should be studied further. However, such analyzes would need e.g. support from climate and hydrodynamic models.

RC2_4: I agree, that would be obligatorily speculative, but as at present this idea seems to be the only one outcome suggested by authors, it would be important to ponder it more deeply. I miss other conclusive sentences, such as what would be the best, or more appropriate way (instead of just assuming a linear model) to analyze the evidently non-linear change over time which is seen in many parameters, such as in the salinity. I agree that the linear analysis should be the one to start with, but I also expect the authors to show capability to go further. Seeing abrupt changes like temperature since the 1980s and salinity at Utö makes me look for possible explanations and coincidences. You could suggest a way forward, and the use of e.g. breakpoint equations in coming analyses, with other, non-linear, models.

We are using dynamical linear models (DLM) in the analysis, which does not correspond to traditional linear trend fitting. The trend estimated is not just a straight line but a function taking account the changes of the variables in time. See e.g. nice tutorial by Marko Laine in http://helios.fmi.fi/~lainema/dlm/dlmtut.html . DLM is actually a state-space model capable to model univariate or multivariate time series also in presence of non-stationarity, structural changes and irregular patterns.

RC2_5: Page 2 lines 10-12, you aim the paper to "analyse these time series in order to get information on typical atmospheric and marine conditions", but reading the paper makes me think that several less typical phenomena are shown, such as a rapid increase of salinity, or a decrease and disappearance of the ice cover and a subsequent suggestion of a shift of balance in the climate of Utö into a new phase. So I suggest rewording these lines, for the reader not expect too much of "just typical" happenings being observed.

We have now improved the introduction and better described the aims of the paper. Please see also replies to Referee 1

RC2_6: Line 31, you give the coordinates and write about the observation site and about the Island. Are these coordinates for the midpoint of the Island or the lighthouse or coordinates for atmospheric observations? Compare to page 4, line 33, where you give coordinates for the oceanographic sampling point.

Coordinates for all measurement site on Utö island and surrounding sea areas added to the caption of (new figure) A2 in the appendix.

RC2_7: Page 3, the map should have two panels, one showing the location in the Baltic sea (the present one) and another to show local bottom topography, depth etc.

A new figure A2 added to the paper.

RC2_8: Page 4, line 1, "with permanent pilots living on the island for generations" this is repetition of the information of the first part of the sentence, and, besides, "pilots living for generations" sounds improbable. Remove the sentence.

Corrected

RC2_9: Line 5, you write that: especially the deep samples may be considered to represent conditions of the Baltic Proper. On the other hand you write (page 9, line 1-2): we do not see any permanent halocline (and comment that possible cause to the halocline missing could be mixing due to currents.) These two statements are contradictory, first one is by Ahlnäs in 1961. Have the circumstances changed between then and now? Lack of the deep halocline also puts the sampling station oceanographically more to the Bothnian Bay side than on the Northern Baltic Sea. Could you comment on that?

This is a good point, please see the detailed reply to comments by Referee 1. This discussion is also now reflected in the paper.

RC2_10: Line 7. I do not accept the phrase about biological characteristics. First: there is no information included in writing that "biological characteristics are typical for the outer archipelago" as this is anyway the basic assumption. Secondly, this kind of basic assumption is not valid for this location as biological characteristics point out to a eutrophic environment. Since the 1980′ s the cyanobacterial blooms have been observed in this area, but before that the area, as the whole Northern Baltic Proper was considered to be an oligotrophic environment. Same rapid change from oligotrophy to eutrophy is seen in, for example, in Secchi disc readings in the Gulf of Finland during the 1900. Please give appropriate information on biological change over at least the last decades, as you do for the sea ice in the next sentence.

We decided to remove the comment on typical biological characteristics None of the authors is a marine biologist / limnologist and we do not feel competent to discuss the biological characteristics on scientific level. We have a publication focusing on biological aspects in preparations and we will include better description of local ecosystem in that paper,

RC2_11: Page 6, lines 32-33, you write that you investigated the annual average temperatures against the NAO indices in Fig 3., but that figure only shows the NAO history, while temperatures are given in the Fig. 2. You also claim finding, for individual years, lower temperatures connected to highest negative NAO values, but in Fig. 2 there are no temperature values given for individual years at all. You refer also to Fig. 2 having lowest temperature values (5 year periods) in around 1980, while this period (1980) in the NAO figures just show mid values of the index. What are "highest negative NAO values" anyway? Are they just lowest values of the index, or something else? Rewrite this part.

Please see the comments to the referee 1 above. We improved the text for this part.

RC2_12: Page 7, line 9 and 12, you write about manual observations, you should write about visual observations.

We added word visual and put word "manual" in parenthesis. This is terminological issue, we normally call man-made observations "manual" and machine-made "automatic".

RC2_13: Page 8, line 3, you mention not to have found significant changes in wind speed. Okay, but my personal observation from Utö station when comparing wind observations before and after the 1970s was that there was a substantial reduction of completely calm days (see attached figure which is based in Finnish Meteorological Institute observations at the Island of Utö)). So the overall windiness has increased anyway. As you suggest, more analyses are needed. You could try and include also the data on calm days.

We calculated histogram of wind speed and directions (Fig. R5) for different periods and found no significant changes in wind directions or wind speeds. We do not have data prior to 1960 properly quality assured yet, so unfortunately it is not possible to see any longer term changes.

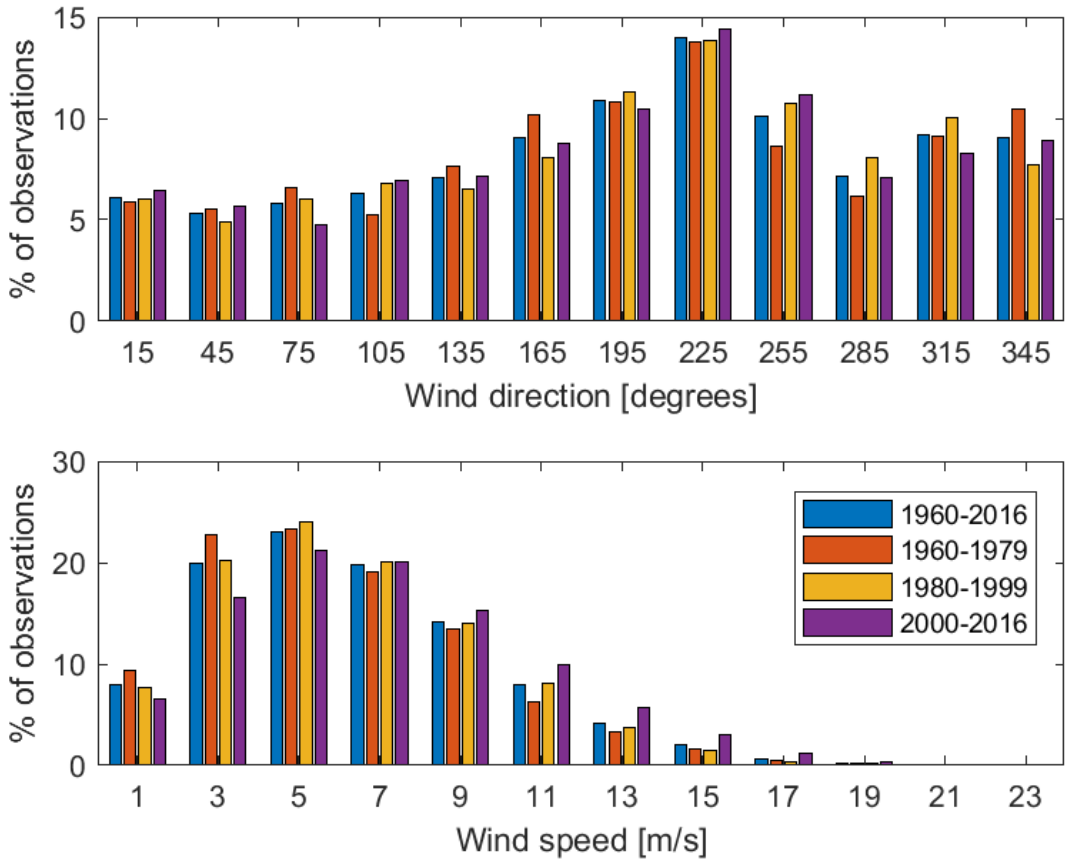

Figure R5: Histogram of wind directions and speeds for the period 1960-2016 and three shorter periods, 1960-1979, 1980-1999 and 2000-2016.

RC2_13: Page 9, line 4-5, remove the sentence: As our focus is..” and start directly from: We decided to... Lines 14-15 you write that: “the surface temperature follows the ... .atmospheric temperatures Fig. 2) ... with a rapid increase in 1980s, which is okay and correct, but then you write that: “and a warmer period from 1930 until 1960s” which, however is not seen at all in the Fig 2 which you refer to. Rewrite that part.

Beginning of the sentence removed. We do feel that there is a period with higher temperatures during this period, ~1930-1960 and it is visible in the top panel of Fig. 2

RC2_14: Page 13, line 10, “reduces the lowest temperatures” sounds strange. Consider rewording.

.. since open sea is a large source of latent heat, which leads to higher atmospheric temperatures than when the sea is ice covered

RC2_15: Typos: page 9, line 4 reads: one hundred year, should read one hundred years. Please also note the supplement to this comment:

Corrected