Response to comments from Anonymous Referee #2

The study looks into the structure and variability of the Arctic front in the Nordic Seas using satellite SST and wind data as well as an ocean reanalysis. There are some interesting aspects in this paper, but the study seems to touch (briefly) upon a number of questions that ones looses track of the main objective. Because of this, I do not recommend this study for publication in its present form. The main issues are listed below.

We thank the reviewer for the constructive comments. Below we provide point-to-point response of the major and general comments.

Major and general comments

- The singularity analysis is not well defined and is currently only descriptive without any mathematical formulations.

We agree. In the revised version of the manuscript we will provide descriptive details of the singularity analysis in the Appendix Section.

- It is mentioned that a positive (negative) singularity exponent provides information about regularity (irregularity). This does not add much to the understanding of the method unless you thoroughly explain it. Moreover, Figures 4-6 show exponents less than +0.3 in blue colours, but you discuss most of these results as they were strictly negative.

In the revised version of the manuscript, the methodology will be explained thoroughly.

Zero contour in the figures will be highlighted so that the readers can clearly recognize the negative singularity exponents. Results (newly drawn figures with zero contours highlighted) will be re-checked, and more care will be given in discussing the results. We thank the reviewer for pointing out this.

- What is the reason for these three atmospheric modes when the North Atlantic Oscillation is apparently the most important mode? Are the other modes and their explained variance even significant?

It is true that the North Atlantic Oscillation (NAO) is the most dominant atmospheric mode in the North Atlantic and Nordic Seas. However, it is also known that the location of the centers of the NAO dipole can be affected through the interplay with the East Atlantic (EAP) and the Scandinavian (SCAN) teleconnection patterns (Chafik et al., 2015). Even though the impact of NAO on the slope current is well-known, its impact on the front current and on the Arctic Front is not very clearly documented. One of the possible reasons may be the influence of the other 2 modes on the front current. This is the main reason why we tried to address the impact of all the 3 important climate modes on the Arctic Front in addition to impact of NAO. We agree that this needs to be made clear in the manuscript. We thank the reviewer for pointing this out. The updated version of the manuscript will include the above-mentioned points. The significance of the 2nd and 3rd modes will also be checked.

- The timescale of interest is not well defined; you show most of your results for summer and winter but the atmospheric indices you base your composite analysis on are in fact on monthly time scales. I cannot therefore reconcile the results presented in this study and this is a major issue.

We agree that there is confusion in the structure. The first part of the paper is devoted on the seasonal variation of the Arctic Front. Whereas the composite analysis is meant to show the variation related with different climate modes, for which the monthly time scales are the most relevant. We believe that these are two separate aspects and should not be mixed. But we agree that there is need to clarify the structure much better and will be done in the revised version of the manuscript. We thank that reviewer for pointing this out.

- Consider showing the significant regions for the composite analysis.

We will include significance in composite analysis.

- I do not see the difference between the Arctic Front and the Norwegian Atlantic Front Current? You talk about the former and make a sudden transition to the latter. What is the difference over the Mohn Ridge?

We agree that the reviewer has a valid point, since the Norwegian Atlantic Front Current (NwAFC) is a baroclinic current. However, we also have reasons for considering them separate over the Mohn Ridge. In our study the Arctic Front is defined as the region with the maximum in temperature gradient, one of the classical methods used to distinguish between two distinct water masses, in our case the Atlantic Water and the Arctic Waters. Our results show that the shift (spreading and narrowing) in the core (defined by the maximum speed) of the NwAFC associated with the variability in the atmospheric circulation, is further linked to the variability in the strength of the Arctic Front (Figure 12). In the revised version of the manuscript, a clarity on these issues will be provided, a sudden transition will be avoided, and the text will be revised by also considering the final comment made by the reviewer (relation with the paper by Orvik, 2004).

- The SST-wind relationship at the fronts in the Nordic Seas is interesting but rather descriptive and not convincing at this stage. This needs more careful investigation and needs to be mathematically formulated.

We agree that more quantitative work needs to be done in terms of SST and wind interaction. However, we believe that the qualitative agreement supports well enough the main goal of the manuscript (variability of the Arctic Front), and the SST-wind topic in itself has the potential to be a separate paper. However, we think that it should still be of interest to the readers to see the new results. In the revised version we will make sure that these results are not influencing the major conclusions of the study and in the discussion part we will also highlight the need for a detailed analysis of the wind-SST relationship over the Arctic Front. We believe that the inclusion of these results in this study will result in new studies focusing exclusively on the subject.

- Does the ocean reanalysis also assimilate the same satellite data you are using? If so, are the similarities you find surprising?

Yes, TOPAZ reanalysis assimilates measurements including along-track altimetry data, sea surface temperatures, sea ice concentrations and sea ice drift from satellites along with in-situ temperature and salinity profiles. Hence, we agree that the similarities are not surprising, although not warranted due to the residual errors of assimilation. But the intent is to show that the reanalysis data is able to reproduce the Arctic Front. This will be clearly mentioned in the revised version of the manuscript.

- Some of the texts in the results do not simply fit in there and should be removed or moved to the introduction (one of the many examples is in pp. 7, line 2-3 about seabirds. Another example is the discussion about mesoscale eddies, which I do not see how it fits in)

We agree. In the revised version, the discussion about the seabirds will be limited to the introduction part. However, note that the discussion on the mesoscale eddies is needed to explain the absence of the Arctic Front signature in the singularity exponent map over the northern Vøring Plateau. Please note that the discussion on the mesoscale eddies is supported by the supplementary Figure S2. More clarity will be provided in the revised version of the manuscript.

- There is quite some speculation in the first paragraph of page 8, which needs to be made more sound, especially in relation to the reduced gravity model of Orvik (2004). This is an important part of the paper.

We agree that the hypothesis we postulated needs to be better stated even though they are in-line with the results of Orvik (2004). This paragraph will be redrafted taking into accounts of the reviewer comment. We thank the reviewer.

Chafik, L., Nilsen, J. E. Ø., and Dangendorf, S.: Impact of North Atlantic Teleconnection Patterns on Northern European Sea Level. Journal of Marine Science and Engineering, 5, 43, 2017.

Orvik, K. A., 2004. The deepening of the Atlantic water in the Lofoten Basin of the Norwegian Sea, demonstrated by using an active reduced gravity model. Geophys. Res. Lett. 31, L01306, doi:10.1029/2003GL018687.