We thank the referees who have made excellent work in going through the details of our submitted MS and made very constructive remarks and corrections. Our detailed step-by-step responses to each of the Referee #1 comments or questions are given below.

We have revised the MS, with the following main points.

- The main points of the EOF reconstruction and the found modes were presented too briefly, relying mainly on the reference Elken et al. (2019). In the revised MS, additional important issues have been included in the compact form (hopefully not repeating the already published MS).
- Justification for the large-scale EOF DA method, in comparison with other well-known DA methods, has been refined.
- Data transformations between the fine and coarse grids have been more carefully presented.
- Unfortunately, the issue of observational errors has not been included in the initial MS. It is now included in the revised MS.
- Presentation of DA validation has been reformulated and discussed in more details.
- Possibilities of the method regarding operational forecast (with assimilating only the past data) have been discussed.

Suggested technical corrections have been included as well.

Anonymous Referee #1

Received and published: 8 July 2020

Comments and questions in bold
Response by the authors in normal
Line and Figure numbers taken from first submission

The paper describes Data Assimilation experiments over a regional configuration of the NE Baltic Sea using the HBM model. The assimilated data are sparse observations of SST and SSS coming from different datasets. The analysis is a simple and classical method based on a linear regression using EOFs which are built from free simulation and no observation error are used in the analysis. A coarse grid is used to perform this analysis for physical and numerical reasons but also due to weak quantity of observation. The model is restarted using a simple nudging on SST and SSS. The results are relatively good even if the simulations with assimilation are very short in time so the stability and robustness of the results are not sure. The paper is very easy to read and the results are presented using figures of good quality. My remarks are very minor and the paper could well fit into Ocean Science Discussion. Consequently, I would suggest a minor revision with only technical corrections.

1 Major comments (S=Section, P=Page, l=Line)
S.2.4, l.34-35: The authors should spatially smooth (using for instance a shapiro filter or other) the model variable psi_m before estimating (psi_m-psi_o) in order to remove "noise" in the nudging. With the present formulation, the implemented nudging tends to artificially "kill" the little scale of the model.

Reconstruction psi_o is made on the coarse grid and transfer to the fine grid is smooth, using bilinear interpolation. Adding a smooth field to the fine-scale model results indeed damps the small-scale motions. In the first experiments, we used 10x10 grid points average filter (not the Shapiro filter) to find the coarse grid values from fine grid results, and applied a bilinear filter to find the deviations from the coarse grid. Those deviations were frozen during the given DA time step. After modifying

the coarse grid fields using observational reconstruction, these deviations were added to the result in order to obtain a fine grid analysis field.

In our study area, meso- and small-scale features are in a continuous generation and damping balance, therefore damping by relaxation to the smooth observation fields does not smooth out the fine grid variability, as can be seen from Figs. 4 and 5. Therefore, we used the simplest approach in the feasibility study.

We have added explanations on the damping problem into the revised MS. The paragraph on lines 220-222 has been replaced to:

"In practical calculations, SST and SSS observational data were reconstructed on the coarser 5' N $\times$ 10' E grid and interpolated/extrapolated by bilinear procedure to the finer 0.5' N $\times$ 1' E model grid. Such simple transition of data from coarse to finer grid includes smoothing, since ψ^o lacks the details that are present on the finer grid. We have tested that the effect of added smoothing is smaller than the physical diffusion. In our study area, generation of meso- and small-scale features is of high intensity; therefore relaxation to the smooth observation fields does not apparently damp the fine grid variability. The approach of using two grids with different resolutions is justified by irregular distribution of observations; reliable estimation is possible only for large-scale patterns of SST and SSS fields; the computationally more efficient coarser grid resolves these patterns with enough details."

2 Other Comments (S=Section, P=Page, l=Line)
S.2.3, l.185: "that that" should be "that". The word "that" is written two times.

Corrected.

S.3.2.4, l.408: "Golberg" should be "Golbeck".

Corrected.

References: the reference for Liu should be timely ordered.

Unfortunately, it seems that this remark cannot be accepted since the manuscript preparation guidelines https://www.ocean-science.net/for_authors/manuscript_preparation.html say: If there is more than one work by the same first author, their papers are listed in the following order: (1) single author papers (first author), followed by (2) co-author papers (first author and second author), and finally (3) team papers (first author et al.).