Review on paper "**Effects of lateral processes on the seasonal water stratification of the Gulf of Finland: 3-D NEMO-based model study**"

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General

This paper gives an overview of the NEMO based new configuration for the Gulf of Finland (GoF) with relatively high and low horizontal resolutions – 0.5 km and 2 km, respectively. The authors show the impact of higher resolution to the overall performance of the model system and speculate on impact of parameterization of convective processes to the thermocline.

To my mind, the topicality of the paper is high and the subject interesting to the readers of the Ocean Science journal. Increasing computer power makes it possible to run primitive equation hydrostatic models close to their applicable limit. In addition, recent studies for the ocean have shown the importance of the sub-mesoscale motions in the upper mixed layer, which can contribute significantly to the vertical transport through the thermocline. Obviously, these effects are also vital in the semi-enclosed seas like the Baltic. It is relevant to describe and analyze these small-scale features also by combining *in-situ* observations and modeling techniques. The present study provides another tool how to study small-scale processes and their importance in the Gulf of Finland.

In general the quality of the paper is satisfactory – general overview of the performed model tests with the setup description has been given, model results have been presented and also major conclusions brought out to the reader. However, there is major revision needed before this paper should be accepted for publication regarding the discussion and description of sub-mesoscale processes in the GoF. The discussion part at the moment is too shallow for scientific publication. According to the authors, the data coverage was not enough to outline the differences in behavior of the model results. Why not use longer simulations? In addition, one of the stated objectives of this paper was to give insight into the sub-mesoscale and basin-scale processes in the GoF. Although the upwelling is presented, there is not much about the sub-mesoscale processes. I would not consider parameterization of convective flows as sub-mesoscale processes, but instead some small-scale eddies and spots with large vorticity. The role of that kind of features to the vertical transport through the thermocline has not been discussed at all in this paper.

Specific comments and questions

Please include a separate figure with model domain shown in respect to the overall Baltic Sea and transect at 25.5E. The location of the boundary 23E could also be shown on that figure.

Several NEMO setups are being developed around the Baltic Sea whereas some of them have already being published. What might be the main differences between these two

setups (2 km and 0.5 km) and other published setups? For instance Hordoir et al 2013 and 2015.

According to Section 2.1, the model setups are using boundary conditions from HIROMB model at 23E. How reliable is the HIROMB model data at boundary?

Which versions of HIRLAM and HIROMB models (FMI or SMHI or …?) are being used and what is the temporal resolution of the atmospheric forcing and boundary conditions?

The authors show the impact of horizontal mixing schemes to the temperature. What is the impact of lateral parameterizations to the surface salinity and overall density gradient?

In Section 3.1, the authors speculate on validating stratification through comparison of simulated SST with the measurements from satellite. I do not agree. Satellite measured temperature describe only the thin layer of the surface water (measured by centi- or millimeters) and can easily produce overestimated values compared to the *in-situ* observations, when there has been no wind and constant heating from Sun. Obviously, the simulated temperatures can be lower as they describe the uppermost 1 m layer (the vertical resolution in this study) and we should not tune model quantitatively to match the satellite observations, but instead have qualitatively the same frontal structure with the satellite observations. Nevertheless what is more important is that we cannot tell anything about the depth of the thermocline (stratification) based on the surface measurements and therefore we cannot validate stratification from the surface observations.

Section 3.2, please show the location of east, west and central part profiles on separate figure.

Section 4: According to Fig. 5, the turbocline depth is clearly overestimated in the model experiments – the upper mixed layer in the observations is much shallower compared to the model experiments. Is it possible that the turbocline depth is also overestimated spatially in model experiments with higher resolution?

Section 5: The role of sub-mesoscale flows has not been sufficiently studied. There is nothing about the eddy induced transports between the coastal and open parts of the Gulf of Finland. What is the impact of increasing resolution to the overall off-shore water exchange?

The authors claim to have better results compared to previous numerical studies. Which numerical studies are being referred to? Test runs by authors or some published results by other groups? If latter, please give some references.

Minor remarks

Please correct p2404: “In Sect 2.1 the GLS…” with “In Sect 3.1 the GLS…”

Please correct p2404: “In Sect 2.2 we present …” with “In Sect 3.2 we present …”

Please replace “paten” of p2408 with “pattern”.

Please correct typo “turbolcline” on p2409.

Please replace “efficiacy” with “efficiency” on p2410.

Please indicate that Fig. 1 shows the results from the run with 0.5 km.

It would be better to keep same legend for profiles on Fig. 3 and Fig. 5 – grey observation, black solid line model 0.5 km and dashed black line model 2 km.

I would recommend proper English proof-reading for the authors.

References

Hordoir, R., Dieterich, C., Basu, C., Dietze, H., Meier, H.E.M. Freshwater outflow of the Baltic Sea and transport in the Norwegian current: A statistical correlation analysis based on a numerical experiment, Continental Shelf Research, Volume 64, 1 August 2013, Pages 1-9, ISSN 0278-4343, http://dx.doi.org/10.1016/j.csr.2013.05.006.

Hordoir, R., L. Axell, U. Loptien, H. Dietze, and I. Kuznetsov (2015), Influence of sea level rise on the dynamics of salt inflows in the Baltic Sea, J. Geophys. Res. Oceans, 120, doi:10.1002/2014JC010642