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Ocean Science
Discussions

Interactive comment on "Investigation of saline water intrusions into the Curonian Lagoon (Lithuania) and two-layer flow in the Klaipėda Strait using finite element hydrodynamic model" *by* P. Zemlys et al.

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Comment: - It is not mentioned if temperature was calculated. A quantitative analysis of the temperature contribution to stratification would be informative. This is necessary to verify the sentences on e.g. page 330 -331 or on page 337 where it is stated that stratification is strongest at the Klaipeda strait and that stratification depends mainly on freshwater discharge. How strong is summer stratification due to temperature? - Following the first point: How is the density in Eq. (1) and (2) calculated without temperature? Which density equation is used?

Response: Water temperature was calculated in the simulations by a radiational transfer model for heat at the sea surface coupled to the hydrodynamic model. The performance statistics for the model can be found in Table 1 given as supplement to this response. The density of sea-water was calculated in the model by the international UNESCO equation of state using water temperature, salinity and pressure as inputs. As suggested by the referee, we carried out a quantitative analysis of the water temperature contributions to stratifications in the Klaipeda Strait. It was estimated as the ratio between the thermal induced vertical density gradient (imposing the vertically averaged salinity) and the vertical density gradient determined by both water temperature and salinity. The results of this analysis showed that the vertical salinity gradient controls water stratification in the strait. The water temperature contribution to vertical stratification is on average less than 5%, with maximum values of about 20% in summer. In the revised manuscript we will provide more details on water temperature and density calculations and include some considerations about the relative role of both water temperature and salinity in determining water column stratification in the strait.

Comment: - Fig. 5C shows the water level inside the lagoon. Is there water elevation data available for validation, as e.g. in Ferrarin 2008? As said on page 332 wind and water level differences correlate well, validated water levels would support the performance and analysis of the model output.

Response: The model was successfully validated on water level, surface salinity and surface water temperature in one station in the Klaipeda Strait (Klaipeda) andthree stations inside the lagoon (Juodkrante, Nida and Vente) and one station in the Baltic Sea (Palanga, 25 km north of Klaipeda). Model performance is summarized in Table 1 given as supplement to this response. The table will also be included and commented in the revised version of the manuscript.

Comment: - Validation of stratification is based on four measurements distributed over the whole year. Is there more vertically resolved data available? An overview of available data for validation would be informative. Some comments on the quality of the boundary conditions would be good.

Response: Unfortunately, there are no more salinity profiles in this area and model results were compared mostly with surface observations (see response above). The Sea boundary was chosen far enough away from Klaipeda strait (70 km to the West and 50 km to the North from the Curonian Lagoon outlet) to minimize boundary effect to the water exchange between Lagoon and Sea in the model. One of the stations used for the model validation is located North of the Lagoon, about 25 km from the northern sea boundary. The model performance on this location is sensitive to the imposed boundary conditions. Results of the statistical analysis (see Table 1 given as supplement to this response) demonstrate that the imposed salinity and water temperature boundary conditions, obtained by the operational hydrodynamic model HIROMB, are good enough for the purpose of this study.

Comment: - Ferrarin et al. 2008 report a statistical analysis of salinity and water level for 4 different station distributed over the lagoon using a depth integrated model. Since the model in this paper resolves the baroclinic processes including the interaction between density driven flows and vertical mixing without having to be parameterized by a horizontal eddy diffusivity, model results should have been improved. Is this so?

Response: Though the study studies refer to different periods, we could state that using the 3D model and considering the open shelf in front of the Lagoon improved the results of the numerical simulations. The results of the statistical analysis of the numerical results obtained in this study is reported in Table 1 (see supplement to this response).

Comment: - The analysis of the “average relative magnitude” (Eq. 5) is not entire clear to me and the results based on the analysis are rather short. Please explain better or remove that part.

Response: Average relative magnitude is used to compare the volume ïňĆux magnitudes of opposite two-directional ïňĆows. The interpretation of its values is explained

on page 334 lines 6-9. It is important to know how much different are the opposite direction flows in case of two-directional flow and this consideration cannot be removed. We will improve the explanation in the revised manuscript.

Comment: - As discussed through the paper, salt flux into the lagoon is either barotropic or due to a two layer flow. On page 332 a correlation between water level difference and salt flux is calculated and briefly discussed. The discussion lacks the influence of the two layer flow. If a correlation between water level difference and salt flux during barotropic inflow events is made, the correlation is probably much higher, leading to the question how much salt is actually transport by which process? Barotropic transport seems to dominate, this could be quantitized.

Response: We thank the reviewer for this useful comment which helped us to clarify the role of barotropic transport on salt water intrusion. We estimated that more than 90 % of the total salt mass inflow to the lagoon is transported during barotropic inflow events. Therefore, we could state that barotropic processes, driven by water level variation along the strait, control the salinity water intrusion into the lagoon. We will report this result in the revised manuscript.

Comment: - It is often referred to a vertical integrated salinity but units are in promille, is vertically averaged salinity meant?

Response: Yes. “Vertically integrated” will be changed to “vertically-averaged” everywhere.

Comment: - Fig. 1 Add a scale

Response: The scale will be added in final version.

Comment: - Fig. 2 labels are not consistent

Response: Labels will be corrected in final version

Comment: - Fig. 3 units are missing or not consistent

Response: Units for the depth will be introduced in final version.

Comment: - Fig. 10 Add error for hb/H. Color scale between 0-0.1 and 0.1- 0.25 in Fig. 4D are hard to distinguish, this should be clearer.

Response: Error bar for hb/H will be included in final version of Fig. 10. Fig. 4D will be improved in final version.

Please also note the supplement to this comment:
http://www.ocean-sci-discuss.net/10/C242/2013/osd-10-C242-2013-supplement.pdf

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Interactive comment on Ocean Sci. Discuss., 10, 321, 2013.

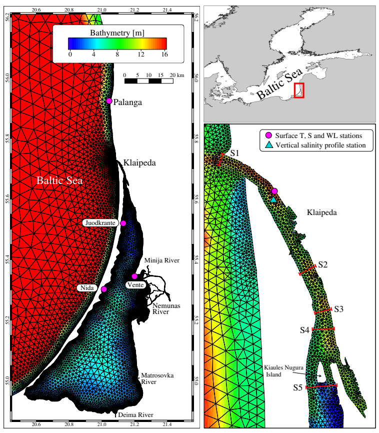

Figure 1: Computational finite element grid of the Curonian Lagoon and coastal area of the Baltic Sea with a zoom on the Klaipėda Strait. Red continuous lines mark the location of cross-sections (S1-S5) and the black dashed line marks the along-strait section. The magenta circle marks the location of the surface salinity continuous monitoring stations (Klaipėda harbour station is shown on the magnified part on the right) and the cyan triangle marks the location of the vertical salinity profile station.

Fig. 1. Revised figure 1