Review of MS by Elina Miettunen et al.
Transport dynamics in a complex coastal archipelago

The MS is aimed to study the currents and volume transports of water in the Archipelago Sea using results from the high-resolution (0.25 nautical miles) 3D NEMO ocean model. From the same model experiments, results about the neighboring Åland Sea have been published by Westerlund et al. (2022). Model results in the Archipelago Sea are validated with acceptable results by the observations of temperature, salinity and currents using the data from the archives. Results part of the MS present (chapter 4) statistics of modelled currents in relation to winds, using mainly directional "roses", and (chapter 5) time series of monthly mean volume transports across the selected 3 west-east transects. In particular, the study reveals that currents are steered by the geometry of the islands and straits and the bottom topography. Net transport in the upper 20 m layer was southward. Monthly volume transport had maximum southward direction in spring and northward direction in autumn and winter. Thus, the study and its results are generally interesting and could be published.

In the following, I elaborate the background in order to give recommendations how the MS might be made more significant and interesting.

A. The modelling results of the Archipelago Sea with a grid step of 0.25 nautical miles have been published earlier by Tuomi et al. (2018) and Miettunen et al. (2020). They used the 3D COHERENS model. Present MS should also reference to the earlier model. It should be interesting to know is there an improvement from COHERENS to NEMO. Oceanographic results of the two earlier studies are referenced in the Introduction. In my understanding, the oceanographic results of present MS does not go much beyond these earlier studies. Perhaps this feeling is subjective and fed by massive use of the term "complex" (15 cases vs 2 and 6 cases in earlier studies). Authors are encouraged to look how to include more oceanography and reduce information-poor terms/formulations like "complex" and "resolution" (26 cases).
B. The study reveals steering of currents along closely spaced isobaths in straits, channels and trenches. This issue of topographically constrained currents is generally known and could be more presented and discussed, including more references to the theoretical studies and observations in nearby Baltic regions. Is the role of islands to guide the flow, without significant frictional slow-down?
C. Complementary to the current roses in Figs. 4-5, it should be interesting to see (seasonally?) mean current maps (perhaps together with persistency contours).
D. Section of volume transports is interesting, but more information on water budget, transect areas and forcing factors could be presented. (a) Time series of monthly mean transports as shown in Fig. 7 are similar on surface and intermediated layers. Nevertheless, they are also similar on different transects, with correlation above 0.9 (I made this check). This indicates large-scale forcing of volume transport. (b) Forcing of volume transports has been discussed but not evaluated. Ambjörn and Gidhagen (1979) have concluded: "Main driving force on the net current, when the vertical stratification is weak, is the surface slope along the channel. Local acceleration and bottom friction are also important." This can be directly evaluated from the monthly mean model results. It should also be interesting to know what wind stress projections (to what angle) cause sea level slopes across the Archipelago Sea favoring northward or southward flows. For example, SE and NNW winds in 2014 created larger volume transports than in other years; was it related to the larger sea level slopes?
E. The MS emphasizes further need to increase the resolution. How many details are reasonable? Thousands of islands are making already some statistical entity. For example, flows in the porous media (e.g. Pratt, L.J. and Spall, M.A., 2003. A porous-medium theory for barotropic flow through ridges and archipelagos. Journal of physical oceanography, 33(12), pp.2702-2718.) can be modelled without counting each individual grain and/or pore. (Consider also Darcy law).

F. The title of MS is too general for the present content. Archipelago dynamics in general oceanographic sense is not presented and discussed. References to the other archipelago sea studies focus mainly on technical details, such as model setup, need for higher model resolution and more dense monitoring network. I recommend to rephrase the title.

I include also some minor remarks.

1) The term “high-resolution” (counted 11 times) could be specified.
2) The term “area” is used as a synonym for “region”. It could be useful to present and discuss actual geometrical areas of the transects, hypsographic curves of the regions etc.
3) Line 4: It has to be specified what NEMO is, even in the abstract (an oceanographic model?)
4) Lines 40-44 say that “situations where substances are transported through the Archipelago Sea occur rarely” and “there is constant exchange of water”. How water exchange occurs without transport of substances? The role of salt exchange is not figured out, although there should be long-term salt flux based on the Knudsen formulae.
5) Lines 78-79: open boundary data were taken from the Baltic Sea Physical Reanalysis Product. This data set has daily mean values for currents, temperature and salinity. How the boundary values with periods shorter than a day were taken into account? The reader could be interested to understand the main features without reading Westerlund et al. (2022).
6) Line 87: “temperature, salinity and currents are saved as 6 h averages” is nearly able to cover the daily cycle. How shorter period processes like 14-hour inertial oscillations, sea level variations can be taken into account? // Considered in the discussion, lines 273-276 but could be brought in earlier, in the methods.
7) Lines 128-129: “The model grid is too shallow to reproduce halocline in this area. However, this does not affect our study of currents and transports, as we focus on the shallower archipelago areas with no halocline.” It should be better justified. For example, presenting the fraction of halocline-covered area to the area of whole transect.
8) Lines 306-307: the statement “Archipelago Sea as a buffer zone between the Baltic Proper and the Bothnian Sea” needs explanation. It cannot be directly deduced from the synchronous monthly mean transports presented in Fig. 7. Regarding spreading of tracers, indeed Miettunen et al. (2020) have shown by integration of Lagrangian transport that “only a small percentage of the particles released in the southern and northern parts of the model area entered the middle and inner archipelagos.” Perhaps the flow speed corresponding to monthly mean transport is so small that water cannot be transported through the all sections during a month. Distance between northern and southern transects is about 85 km, there should be the speed 3.3 cm/s to cover such distance.
9) Lines 307-308: there is a statement “The transport dynamics in the Archipelago Sea are complicated so that no single transect can be chosen to represent the transport through the whole area.” On the other hand, Fig. 7 shows that monthly transports across the three sections are similar. There seems to be some controversy; please explain in the revised text.
10) Figures 4 and 5 could be combined together as (a) and (b) since their only difference is in the selection of layer: uppermost 5 m vs bottommost 5 m.
11) Figures 3 and 6 are very similar and contain repeated information. Perhaps to keep only one figure.
12) Net transport in Fig. 8 is the same as already presented in Fig. 7. Please try to avoid duplication.
13) Figures 8 and 9 contain the same information, only for the two different transects. By such presentation, comparison of transports is not straightforward. Please consider some other reader-friendly presentation.

I recommend an editorial revision of the MS.