Review of Anthropogenic pressures driving the salinity intrusion in the Guadalquivir Estuary: Insights from 1D Numerical Simulations by Sirviente et al.

The authors use ship-based observations and 1-D hydrodynamic model to analyze the impact of anthropogenic-driven freshwater withdrawal on the salt intrusion in the Guadalquivir Estuary. Model sensitivity experiments indicate that enhancing the freshwater flow and volume (mostly regulated by the dam) leads to a reduction in salt intrusion into the estuary. The study highlights the need to include the sink term associated with freshwater withdrawal from human activities in the model to accurately depict the observed salinity wedge in the estuary.

This is an interesting study and has implications for regulating domestic water use and understanding the impacts of salinity intrusion on the primary production and marine ecosystems. The manuscript is generally well written with good quality figures. However, the authors need to address the following concerns related to the methodology and analysis.

Major comments:

1. The study is based on assumptions which need to be clearly stated in section 2. Please mention how processes such as vertical mixing at the edge of the salinity front, which can significantly influence salinity distribution across the estuary, are accounted for in the model. Include a discussion of the vertical structure of the salt wedge and related citations in the Introduction. The model is validated using salinity data collected at 2 m depth. Salt intrusions could be happening at deeper depths, which seem to be unaccounted for in this study. Please justify.

2. Apart from the anthropogenic freshwater withdrawal, the sink term may also include uncertainties related to unaccounted processes such as drainage from marshes and crop lands, evaporation, vertical mixing etc. A strong justification on the attribution of sink term to anthropogenic effects has to be provided.

3. Fig. 1b shows that the channel is deep in the 15-25 km distance range, where the salt intrusions appear to be more pronounced (Figs. 5,6). It could be that the mixing induced by strong tidal currents at these depths result in increase in salinity, which is not related to freshwater withdrawal.

4. As noted by the other reviewers, there is confusion regarding the different terminology used for terms such as 'salt wedge' and 'salinity front'. Be consistent with the terminology and define a salt front/wedge. I guess it indicates the region where the lateral gradient in salinity is maximum. In Figs. 5,6 – Mark the location of maximum lateral change in salinity on each curve with a dot in respective color. It will be helpful for the readers to see the spatial variation in the salinity front in each model run.

5. Observation data from the cruises are gathered in different months, ranging between July-February each year. I'm assuming the anthropogenic water withdrawals do not vary much across these months. Please mention that in the data section.

Minor comments:

Authors mention mooring observations are used. Are MG1, MG2 and MG3 mooring locations or sampling points for ship? Are the mooring observations integrated with the ship-based data? It may be good to mark the moorings in Fig. 1 and mention the locations in the caption. The validation of model results using mooring observations is not shown. It may also be good to add a scatter plot between near-surface salinity from moorings and 2 m salinity from ship-based thermosalinograph data to see how they compare.

Fig.1c , y-axis label needs to be corrected to “width”

Line 37: Not sure what the word “positive” means in this context.

Lines 48 and 50: m3/s should be m^3/s. Superscript missing in the units in several other places. Please correct.

Fig. 4 – It is not clear if this model simulation includes sink term or not. Also, please mention in the caption what the contours represent. How does the salt intrusion differ during the spring and neap tidal cycles before and after including the sink term? It may be worth checking that.

Fig. 5 – Is this the model surface salinity plotted? Please mention the depth of salinity in the caption. Also, change the legend label in panels (b) and (d) to F +50% Q=18 m^3/s

Fig. 6 – Use the same y axis limits for panels (a) and (b).

Line 249-250: The November 2023 results are not shown in Fig. 2

Line 300: may have “an impact” on the salinity wedge penetration

Line 396: What is 2.5 psu difference? Is it the difference between the slopes of the two lines? Also, in what distance regime?

Line 446: through idealized model setup?