



EGUsphere, referee comment RC2  
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## **Comment on egusphere-2022-142**

Anonymous Referee #2

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Referee comment on "Modelling the impact of anthropogenic measures on saltwater intrusion in the Weser estuary" by Pia Kolb et al., EGU sphere,  
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The authors conducted a series of numerical experiments to investigate impact of historic engineering on salt intrusion in the Weser estuary. Their methods are valid, figures and tables are clear, some findings are interesting and useful.

My major concern about their paper is that the authors assume estuarine circulation (or vertical exchange flow) is the only landward salt transport process about the salt transport processes. In addition to vertical shear dispersion, tidal pumping can act as an important salt transport mechanism in well mixed estuaries (Wei et al., 2016), weakly stratified estuaries (Wei et al 2021) and partially mixed estuaries (Uncles et al 1985). Uncles et al. (1985) also pointed out importance of transverse shear dispersion in wide sections. The Weser estuary is relatively long (>120 km) with a tidal range of 2.8-4.1 m, it is very likely that tidal pumping plays a significant role in salt transport here. Lateral shear dispersion may be also important in the wide Outer Weser.

These additional processes might help to explain the difference in the relationship between salt intrusion length and river discharge in the Weser with that in the Hudson estuary found by Ralston and Geyer (2019), where the vertical shear dispersion due to gravitational circulation was assumed to dominate the landward salt transport. I suggest the authors systematically explore the dominant processes of salt transport in all experiments and attribute changes in responses of salt intrusion (if any) to those processes. This should also help increase the impact of their study, for example, by making their findings applicable to other estuaries dominated by similar processes.

Other comments:

Figure 1: can you show the bathymetry map of the Weser with topography data of 2012?

Line 140: how large are the horizontal mixing coefficients? Is it the same constant for all experiments?

Line 140-145. "UnTRIM<sup>2</sup> was coupled with the sediment transport model SediMorph (BAW, 2002) to calculate bottom roughness. For simplicity, we neglected sediment transport in this study". These two sentences seem contradictory.

Line 165: "the resolution of small-scale features such as bedforms in the different model topographies is not directly comparable." Can you show the bathymetry maps of different years as supplementary figures?

Line 255, "...with some variations among models." How different are the increased roughness in the lower Weser (landward side of Weser-km 55) across all experiments? How sensitive are salinity results to this increased roughness?

Line 250-260. Can you show the estimated form roughness for each experiment? How large is the simulated form roughness compared to the additionally increased roughness?

Figure 3: Model calibration with tidal range only, how about the tidal phase and tidal/residual currents? If exchange flow is the dominant salt transport process, it is essential to make sure the model reproduces the residual currents well. Right?

Line 285: intertidal --> intratidal

Line 294-295. The fact that salt intrusion increases with increasing tidal range also suggests tidal pumping as an important landward salt transport agent.

Figure 4. the ticks of the x-axis are not aligned with the labels.

Line 309: tide level --> tidal level

Line 319-321: salt intrusion length has already been defined on line 238-239.

Line 322-335: this part is more suitable for the Methods section.

Line 344-345: did salt transport mechanisms change from 1966 to 1981?

Line 353: "2012 – however, ..." --> 2012. However, ...

Line 373-374: Delete the content in the bracket as you have already defined brackish water zone.

Line 381: this sentence is misleading. You didn't include sediment transport or morphological evolution in the model, right?

Line 400: estuarine circulation is not the only important salt transport process for every estuary. See my major comment above.

Line 440-444: what about responses of salt intrusion length to tides? Did it change?

The paper is lengthy with quite some information repeated. I suggest the authors to remove repetitive and unnecessary contents to make the paper more concise.

#### References:

Uncles, R. J., Elliott, R. C. A., & Weston, S. A. (1985). Dispersion of salt and suspended sediment in a partly mixed estuary. *Estuaries*, 8(3), 256-269.

Wei, X., Schramkowski, G. P., & Schuttelaars, H. M. (2016). Salt dynamics in well-mixed estuaries: Importance of advection by tides. *Journal of Physical Oceanography*, 46(5), 1457-1475.

Wei, X., Schuttelaars, H. M., Williams, M. E., Brown, J. M., Thorne, P. D., & Amoudry, L. O. (2021). Unraveling interactions between asymmetric tidal turbulence, residual circulation, and salinity dynamics in short, periodically weakly stratified estuaries. *Journal of Physical Oceanography*, 51(5), 1395-1416.