CC1: 'Comment on egusphere-2024-2451', Wenping Gong, 19 Aug 2024 reply

1.The dispersion coefficient D was defined as a constant in your simulations, it seems not be justified as it should vary with tidal strength and bathymetry and geometry of the estuary;

The dispersion coefficient D was modeled as a constant in this study for several reasons, as outlined below. Primarily, the simplicity of a constant value ensures numerical stability and facilitates the interpretation of results. This selection of a constant diffusion coefficient is based on the assumption that lateral dispersion is homogeneous and that strong currents will induce vertical mixing, thereby rendering advection the dominant process in the behavior of the salinity intrusion. Considering an along-channel current velocity gradient of ΔU=0.5 m in a distance of L=25000 m and an unrealistic high value for D=10.0 m^2/s yields a Péclet number, Pe=(ΔU.L)/D=1250 (largely exceeding 1) which is indicating that advective transport clearly dominates over diffusive transport.

Furthermore, given the lack of comprehensive data on the coefficient's variability across the estuary, it was determined that a constant value would be an adequate representation of the general conditions. Finally, model validation with observational data has demonstrated that employing a constant coefficient is an effective method for accurately reproducing the essential characteristics of the system, thereby supporting this approach within the context of the present study. Furthermore, numerous studies in the literature have demonstrated that models with a constant dispersion coefficient are capable of accurately reproducing salinity distributions (e.g., Lewis and Uncles, 2003; Brockway et al., 2006; Gay and O'Donnell, 2007, 2009; Xu et al., 2019).

Brockway, R., Bowers, D., Hoguane, A., Dove, V., and Vassele, V.: A note on salt intrusion in funnel–shaped estuaries: Application to the Incomati estuary, Mozambique, Estuar. Coastal Shelf S., 66, 1–5. https://doi.org/10.1016/j.ecss.2005.07.014, 2006.

Gay, P. and O'Donnell, J.: A simple advection–dispersion model for the salt distribution in linearly tapered estuaries, J. Geophys. Res., 112, C07021. https://doi.org/10.1029/2006JC003840, 2007.

Gay, P. and O'Donnell, J.: Comparison of the salinity structure of the Chesapeake Bay, the Delaware Bay and Long Island Sound using a linearly tapered advection–dispersion model, Estuaries Coasts, 32, 68–87. https://doi.org/10.1007/s12237-008-9101-4, 2009.

Lewis, R. E. and Uncles, R. J.: Factors affecting longitudinal dispersion in estuaries of different scale, Ocean Dynam., 53, 197–207. https://doi.org/10.1007/s10236-003-0030-2, 2003.

Xu, Y., Hoitink, A. J. F., Zheng, J., Kästner, K., and Zhang, W.: Analytical model captures intratidal variation in salinity in a convergent, well-mixed estuary, Hydrology and Earth System Sciences, 23, 4309–4322. https://doi.org/10.5194/hess-23-4309-2019, 2019.

2. The specification of withdrawl amount of freshwater along the estuary is not justified. Not sure if it can be determined from observation data or from other statistical data.

Thank you for your comment. With regard to the withdrawal values, these were established through empirical means during the calibration process. In this coastal area, the available information is scarce and imprecise due to the prevalence of unregulated withdrawals. This makes it challenging to obtain accurate data on the withdrawals occurring in the estuary, as both the locations and the volume of water withdrawn are unknown. The data provided by the authorities is insufficient for the purposes of this study, as it offers values at the basin level rather than for the specific estuary area targeted by this study. Accordingly, we have calculated this factor through a comprehensive calibration process, using a distinct factor for each time period and selecting the factor that yielded the most accurate simulation in line with the observations. Therefore, we present these experimentally derived approximate coefficients, which are accepted when validating simulations against observations. In fact, the use of this approach provides the more remarkable result, in the sense that it has allowed to demonstrate the necessity of incorporate this anthropogenic contribution in the hydrodynamical simulations as a necessary process to accurately reproduce the actual behavior of the saline intrusion in the estuary.

3. The terminology of "salt wedge" is confusing, as you mentioned that the estuary is well-mixed and your salt transport equation is based on the assumption of well-mixed estuary.

Thank you for your comment. Indeed, in well-mixed estuaries like this one, the term "salt wedge" may not be the most accurate. We will use the term "salinity intrusion" or “saline front” accordingly to the vertically mixed character of the estuary. We have changed it in the new version of the manuscript.

Lines (12,15,76,89,97,99,105,110,215,287,300,305,308,311,313,320,330,332,339,343,352,359,360,369,382,387,396,400,404,410,424,438,440,452,454,458,460,464)