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

Thanks to the reviewers' comments, we have adjusted the parameterization of the dispersion coefficient. Therefore, we would like to respond to your questions again, including an updated answer that takes these changes into account. We appreciate your feedback.

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;

Thanks to the reviewers' comments, we reviewed and adjusted the transport model to use a higher, more realistic constant diffusion coefficient without introducing instabilities into the model. In the revised version, based on Bowden (1983), we defined the most appropriate horizontal dispersion coefficient, taking into account the mean depth and tidal amplitude. This calculation was performed for all campaigns included in the analysis to ensure the use of a constant dispersion value appropriate for the system. The results indicate that the maximum constant dispersion based on velocity and depth is 150 m^2/s (this has also been added and explained in detail in the revised version of the article). In addition, a sensitivity analysis was performed with different dispersion coefficients to optimize this parameter as much as possible. It was found that a dispersion value higher than 200 m^2/s leads to numerical instabilities in the system.

Based on Bowden (1983), the effective horizontal dispersion coefficient can be calculated as $K_X = U^2 H^2 / 30 * K_z$, where *U* is the maximum tidal velocity, *H* is the mean channel depth, and *Kz* is the vertical eddy dispersion coefficient, assumed to be constant. In our case, we used *Kz*=0.01, as proposed by Bowden (1983).

Campaign	**U (ms^{-1})**	**K_x m^2s^{-1}**
MG1	0,85	143
MG2	0,88	154
MG3	0,88	153
MG4	0,80	127

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; Siles-Ajamil et al., 2019; Biemond et al., 2024). This choice not only maintains the stability of the model, avoiding numerical instabilities, also ensures that the results are consistent with theoretical expectations and experimental observations.

Regarding the use of a 2D model, although we have not explicitly applied a 2D model to the Guadalquivir estuary, we have analyzed its analytical solution. This approach allows us to observe that the differences in velocity in the longitudinal direction of the estuary are not significantly different from those obtained with the 1D version.

In Figure R1, we present the analytical solution for a channel-cross section using a 2D model that includes the channel width and a parabolic depth variation that approximates the change in depth from the lateral boundaries to the center of the channel. For comparison, we also include the 1D solution for the same channel (length = 5 km, width = 525 m, 2-day simulation) with an average depth of 6.7 m.

As shown, there are differences at the lateral boundaries, within the first 100 m on either side of the channel. However, the oscillations are not significant, and the velocities are very similar across most of the channel width. This shows that the behavior is generally homogeneous, validating the 1D solution. This conclusion is confirmed by the average velocities obtained for each solution at different times (Table R1), where the differences between the average velocities of the two models are minimal.

It is true that using the 1D solution slightly underestimates the velocity in the center of the channel and slightly overestimates it at the boundaries. However, these discrepancies do not affect the results, as the model has been shown in Sirviente et al. (2023) to reproduce the observations with high reliability.

This reinforces the idea that the use of a 2D model does not provide a substantial improvement over the 1D model.

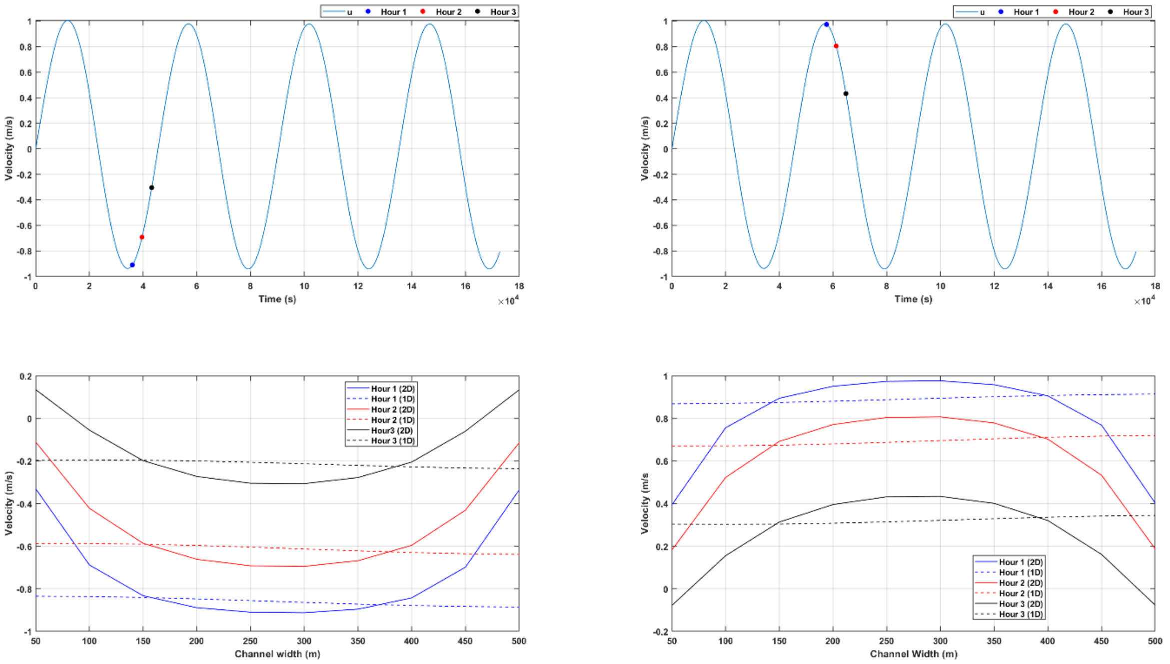

Figure R1. The top panels display the time series of the longitudinal velocity (uu) for section 20 of the channel. Colored markers highlight the three consecutive hours analyzed in the bottom panels. The bottom panels compare the velocity profiles obtained from the 2D model (solid lines) with those from the 1D model (dashed lines) at the selected times, illustrating the differences across the channel width.

Table R1. Average Velocity in Section 20 of the Idealized Channel for 2D and 1D Simulations Over a 6-Hour Period (3 Hours of Flood Tide and 3 Hours of Ebb Tide)

	u average 2D (ms^{-1})	*u average 1D* (ms^{-1})
Flood Hour 1	-0.75	-0.86
Flood Hour 2	-0.52	-0.61
Flood Hour 3	-0.16	-0.21
Ebb Hour 1	0.82	0.89
Ebb Hour 2	0.62	0.69
Ebb Hour 3	0.26	0.32

We appreciate the reviewer's suggestion and will take it into account for future work.

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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. This approach also demonstrates the necessity of including this anthropogenic factor in simulations to accurately reproduce the real behavior of the system.

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 "saline intrusion" instead, as it better describes the area of the estuary where high salinity is present due to tidal influence.

We have change it in the new version of the manuscript.