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Comment on egusphere-2022-700

Anonymous Referee #1

Referee comment on "River effects on sea-level rise in the Río de la Plata estuary during the past century" by Christopher G. Piecuch, EGUsphere, https://doi.org/10.5194/egusphere-2022-700-RC1, 2022

Review of "River effects on sea-level rise in the Río de la Plata during the past century" by C. Piecuch (OS 2022)

Summary:

This manuscript investigates the dynamic link between the variability of Rio de la Plata discharge and coastal sea level variability observed in the immediate vicinity of its outlet, primarily focusing on the long timescales. It starts with an in-depth analysis of the few long tide-gauge and streamwflow datasets available there, which reveal increasing trend of both the discharge and the coastal sea level over the past century. Then it proceeds with two idealized modeling frameworks that are derived in order to explain the observed co-existence of discharge and sea level trends, in a causal fashion. The first framework is essentially a one-dimensional barotropic frictional model, where the water-air interfacial slope is balanced by the bottom friction in the along-estuary direction. This framework is applied to the inner estuary, around Buenos Aires. The second framework is a more complex two-dimensional baroclinic framework, where the plume would induce a coastal jet of brackish water, in thermal wind balance with a sea level higher at the coast than further offshore, off the plume offshore edge. It is applied further downstream, around Montevideo. It is concluded that both these modelings results, although based on highly idealized assumptions, stand in very good agreement with the observed relationship between discharge trends and sea level trends, for both regions. Hence it is concluded that the link between Rio de la Plata discharge trend and sea level trend in these two regions is causal in nature.

General comments:

This study nicely tackles the long-lasting issue of long-term trends of sea level in estuarine ambients. It does so in a very relevant region, home of virtually the sole long-term observational records of the east coast of South America, itself in a very poorly observed basin as far as sea level is concerned: the southern Atlantic. The author makes clever use of the few observational records available, be it of streamflow or of coastal sea level. The approach is sound, and the results are convincing, in that the manuscript consistently backs its findings with statistical analyses. The merit of the study is to end up with a very simple conceptual framework that manages to explain the potentially complex and non-linear dynamics underlying the observed relationship between discharge and coastal sea level. This said, I am somewhat doubtful about the practical strategy of the author when it comes to test the validity of his two idealized frameworks against his observational findings, through the choice of numerical parameters of the required quantities (see my specific comment hereafter). I strongly encourage him to assess the relevance of his idealized models against one (or ideally several) OGCM outputs, typically considering the latest class of eddy-admitting CMIP6 historical runs. This would add considerable strength to the present manuscript. There are very concrete and practical implications of the findings reported here, as regards to the general understanding of the sea level budget and its closure over the southern Atlantic basin, as the observational databases available therein are deeply influenced by the handful of stations analyzed in the present manuscript.

Specific comments:

-l. 90: " To (...) reduce dimensionality": isn't there a more fundamental reason than just reducing dimensionality? Reducing the impact of observational errors, typically?

-l. 195: "As a mental model": an actual schematic would help the reader here.

-Table 4: shouldn't U be simply dictated by the geometry of the estuary at x=0, given the value of q observed? It is unclear what relevance the tidal current has in this steady-state model. Is the value chosen for H_0 some sort of optimum resulting from a tuning, so as to achieve best consistency of the prediction wrt to the result of the regression analysis based on observations?

-l. 254-256: " These theoretical estimates agree with the coefficient of (7.3±1.8)*10−6 m m−3 s and the streamflow-driven 255 sea-level trend of 0.71±0.35 mm yr−1 found earlier from regression analysis of observed streamflow and sea level at Buenos Aires": indeed, the values do agree very, very well. Hence it is needed here to get a feel of the

extent of ad-hoc tuning, implicit in the choice of parameters listed in table 4, so as to ensure this quasi-perfect match.

-l. 257-260: I have the same concern for the results of the Montevideo idealized model.

-l. 322: " Theories developed here may be helpful in this regard": indeed, nowadays there is a whole batch of centennial model outputs that became open for public use, several of which resolve -at least partly- the baroclinic Rossby radius of deformation at the latitude of Rio de la Plata. As part of CMIP6 for instance, multi-centennial historical simulations of the present climate as well as century-long projections have recently become commonly available (see e.g. Held et al 2019 https://doi.org/10.1029/2019MS001829, among many others). If indeed the two idealized dynamical balances proposed in the present study successfully explain the observed relationship between discharge variability and coastal sea level variability in the estuary at long timescales, this relationship should be captured by these long model simulations that have the full physics required to capture these, and much more (in particular that have realistic mixing schemes, and do not impose the idealized frontal structure of the plume density nor its linearly stratified density profile). These OGCMs have, with their 1/4° typical resolution in the ocean, the capability to resolve to a fairly large extent the thermal-wind balance invoked in the present idealized framework. I strongly encourage the author to consider at least one of this class of state-of-the-art model historical simulations, and to assess the relationship between Rio de la Plata discharge trend, along-shore equatorward coastal current trend slightly downstream of the outlet, and cross-shore sea level slope trend, at the long timescales of interest here. If the idealized framework presented in the present manuscript holds there as well, this would add considerable strength to the results reported here (as the conclusion would not depend in any fshion on the potentially subjective choices of parameters listed in Table 4). The encouraging results observed from altimetry call for such an independent assessment of the idealized framework.

Technical corrections:

-l. 48: centred

-fig3 caption: "thick black" line is not seen

-l. 149-150: it should be Sections 4.1, 4.2 and 4.3

-l. 249: should be sections 4.1 and 4.2