Response to Reviewer 2

River effects on sea-level rise in the

Río de la Plata during the past century

by Christopher G. Piecuch

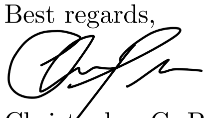
*****Reviewer's comments in black*****

*****Author's responses in red*****

Dear Reviewer 2,

Thank you for your comments on my manuscript. They made the paper stronger, clearer, and more precise. I revised the manuscript based on your reviews, and point-by-point responses follow below. Thank you for your time and consideration.

Best regards,



Christopher G. Piecuch

Reviewer 2—

General comments: The manuscript displays the role of the streamflow in the sea level variability especially at long-term trends in the Río de la Plata estuary. To fulfill the objective, annual data from tide gauges and stream gauges are analyzed. The main results indicate that the streamflow is not negligible in the sea level variability and in the long-term trend, except in the south of the river mouth. The river effect increases from the lower estuary to the upper estuary, explaining almost the 60% of the sea level variance. To corroborate that the streamflow is responsible of a percentage of the sea level trend, the author developed a theoretical model finding a coherence between the simulated/predicted data and the observations

The work presented is a hot topic from the climate change point of view. To understand the forcings of the sea level rate in coastal and regional areas is extremely important to prevent and mitigate the consequences. The work also contributes to the analysis of unexplored region compared with other part of the world. Most of the studies in the Río de la Plata estuary were focused on the analysis of the plume dynamics from synoptic to interannual temporal scales using models (e.g: Meccia et al., 2009; Dinapoli et al., 2021; Bodnariuk et al., 2021) and satellite data (e.g., Saraceno et al. 2014). Only a few works showed the sea level rate, however, the causes of the trends were not fully investigated.

Regarding the presentation quality, the manuscript is well-written and well organized. The figures and tables represent the results written.

I thank the reviewer for their positive review. Below they will find responses to all their comments.

Specific comments:

R2.CA Title: I suggest adding “Estuary” after “Plata”

I will add the word “Estuary” to the revised title.

R2.CB 3. Results: Taking advantage of a long sea level record, I suggest studying the acceleration of the sea level rate and the possible relationship with the streamflow, especially in Buenos Aires. The bibliography cited in the manuscript indicates that the sea level is increasing, however, the analysis of a possible acceleration has not been published in the study region.

This comment relates to **R2.CC** and **R2.CD** below. I agree that the length of the time series motivates a more detailed investigation as a function of timescale. For that reason, the revised paper includes a coherence analysis that quantifies the relationship between streamflow and sea level as a function of frequency band (see response to **R2.CD** below). However, estimating sea-level acceleration from tide-gauge data is nontrivial, and results can depend sensitively on time period (Haigh et al., 2014) and acceleration model (Bos et al., 2014; Visser et al., 2015). A meaningful, robust quantification of sea-level acceleration requires an analysis beyond the scope of this study, and is deferred to dedicated future investigations.

R2.CC Pag. 4, line 119: see comment on Conclusions

See my response to **R2.CD** immediately below.

R2.CD 5.Conclusions Pag. 11, line 290: The author mentioned that the river effects on sea level are apparent at multidecadal and centennial periods. However, I did not find convincing evidence on the paper. There is a discussion based on bibliography about the ENSO signal, the author calculated the correlation between ENSO index and in situ data, and the standard deviation of the streamflow but I was expected a spectral analysis (e.g., wavelet) to asseverate that other signals are also important. For example, it would be interesting to analyze the cross wavelet transform between streamflow and sea level measurements. Regarding the ENSO as an interannual variability, Bodnariuk et al. (2021b) analyzed the effect of SAM (Southern Annular Mode) on the Río de la Plata using a reanalysis model (35-years). The influence of SAM on the sea level was also studied in a wider region including the Mar del Plata tide gauge location (Bodnariuk et al., 2021a; Lago et al., 2021).

To address the reviewer’s concern, the revised manuscript includes a coherence analysis quantifying the relation between streamflow and sea level as a function of timescale, which includes the following new text at the end of section 3

- *Streamflow is significantly coherent with sea level at Buenos Aires across most time periods and frequency bands resolved by the data, and with sea level at Montevideo for particular periods and frequencies (e.g., decadal scales generally, interannual scales during the 1990s and 2000s), but mostly incoherent with Mar del Plata sea level (Figure 8).*

and new Figure 8. However, since the paper focuses mainly on sea-level physics, and since previous studies have explored the relationships between streamflow

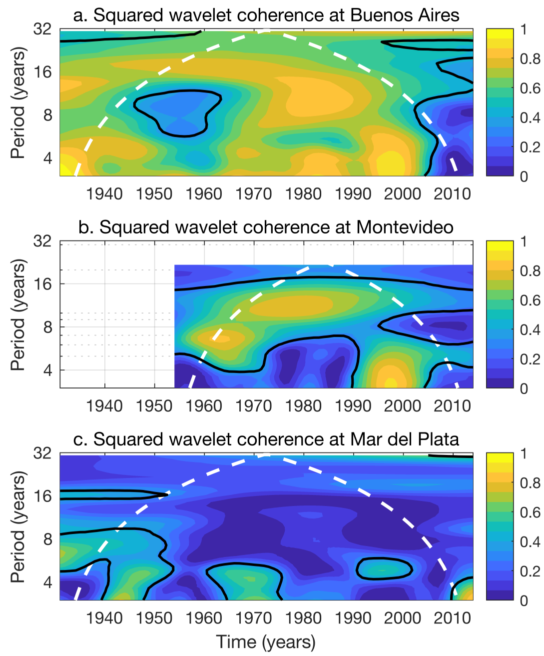


Figure 8: *Magnitude-squared wavelet coherence between streamflow and sea level at* **(a.)** *Buenos Aires,* **(b.)** *Montevideo, and* **(c.)** *Mar del Plata. Solid black lines identify where values are significant at the 68% confidence level and white dashed lines mark the cone of influence. Statistical significance is determined from 1 000 simulations with phase-scrambled versions of the observational data (Theiler et al., 1992). Values are based on the analytic Morlet wavelet.*

or sea level and large-scale climate, I haven't pursued a more detailed analysis of correlations between streamflow, sea level, and climate modes other than ENSO, as it would be tangential to the paper's primary focus.

Technical corrections:

R2.CE Replace "Section 4.a" and "4.b" with "4.2" and "4.3"

Thanks for catching the typos. They've been corrected in the revision.

R2.CF Figure 3 caption: the colors of the thick lines of Río de la Plata, Río Paraná and Río Uruguay do not match with the legend of the time series.

The thick lines match the legend labels. The thick blue, red, and yellow lines are the streamflow from the Río de la Plata, Río Paraná at Timbúes, and Río Uruguay composite as described in the text and identified in the legend.

R2.CG Figure 4 caption: the line styles of the time series do not match with the legend.

Line styles match the legend and no changes to the figure are needed. Note that, when data from only one gauge record is available, the virtual-station record (thin solid) is identical to and sits on top of the record from the gauge with data (thick dashed or thin solid dotted).

References

- Bos, M. S., et al., 2014, https://doi.org/10.1093/gji/ggt481.
- Grinsted, A., et al., 2004, https://doi.org/10.5194/npg-11-561-2004.
- Haigh, I. D., et al., 2014, https://doi.org/10.1038/ncomms4635.
- Theiler, J., et al., 1992, https://doi.org/10.1016/0167-2789(92)90102-S.
- Visser, H., et al., 2015, https://doi.org/10.1002/2015JC010716.