Reviewer 1:

This paper describes a long-term model simulation that investigates saltwater intrusion along almost the entirety of the United States East Coast over the course of a 20-year long simulation with remarkable spatial resolution using SCHISM. Overall, the paper demonstrates an impressive application of ocean modeling tools to multiple coastal ecosystems, allowing for novel regional comparisons that are not typically simultaneously simulated together with this level of detail. The methods described are appropriate for this task, and most of the model validation presented here supports the use of SCHISM for this application. However, many details could be elaborated upon a bit further, particularly in the discussion section which is quite light and could benefit from a reorganization of section titles with more comprehensive references to other literature and the figures presented in this paper. Some conclusions drawn in the discussion section are difficult for the reader to pick out from the presented results and some may be better supported by other results that are not shown (or are not shown in great detail).

Thank you for your constructive feedback. We have addressed your specific comments as outlined below and clarified the discussion section to more clearly connect the detailed results with broader interpretations.

Specific Comments:

Line 32: small typo, "… has been an effective tool…"

Typo is now fixed at line #32.

Line 116-122: Typos in "… Ocean Observing System…", "… Chesapeake Bay Program…", and "… data from the Neuse…"

Typos are now fixed at lines #128-133.

Line 170 (Figure 3): In panel b, are the light blue bars meant to show the annual mean discharge for each of these rivers? Could use a little more explanation in the caption or text.

Yes, the light blue bars are showing annual mean discharge. Explanation "Light blue bars in panel (b) represent the annual mean discharge for each of these estuaries" has been added to the caption now.

Line 217-219: I'm a little confused by the explanation of the model bias, which mostly just restates the definition of a bias? I'd also add that SCHISM appears to have higher variability on shorter timescales than DRBC observational data, although I'm not sure if this is just due to temporal sampling limitations of the upper saltwater limit?

Thank you for pointing this out. We agree that the initial presentation lacked clarity. In the revised manuscript, we have clarified that the higher apparent variability in SCHISM output, compared to the DRBC dataset (Fig. 9a), is mainly due to the 7-day averaged daily records provided by DRBC, which smooth out short-term fluctuations. We also added explanation about the relative high reliability of DRBC's upper versus low reliability of lower salt front estimates, and supported the model performance through direct comparison with salinity observations from a USGS station used in DRBC's framework (Fig. 9b).

We rephrase these explanations at lines #243-249.

Line 233-234: I don't find this degraded model skill in temperature in shallow tributaries that surprising, NARR tends to overestimate shortwave/longwave radiation and air temperatures in coastal water bodies when compared to observations and other reanalysis products like ERA5. I don't think that this warrants any major changes to the paper, but it's something that could be considered in the future.

Thank you for the suggestion! We will consider using other products like ERA5 for the future versions of NAAC. We have revised the text in lines #268-271.

Line 247-248: And the model appears to slightly overestimate current velocities at station 'cb1001'? I'd be curious to know if this overestimate and underestimate are temporally correlated or if the bias patterns are unique to the different stations.

Thank you for your thoughtful observation. We have reviewed the velocity comparisons at these stations and confirm a slight overestimation or underestimations in the modeled current magnitudes relative to observations. We found that the bias patterns are largely station-specific rather than temporally correlated. At 'cb0301', the overestimation is more prominent during ebb/flooding tides, whereas at other stations like 'cb3020', the model shows underestimation during similar periods. This station-dependent bias likely reflects local bathymetric complexities or grid resolution limitations, which we plan to improve as needed in future model updates. We have added a brief explanation of this analysis in the revised manuscript in lines #290-294.

Line 272-274: This sentence reads a little awkwardly, I believe that you are saying that water resources on the Delmarva peninsula are at risk from SWI?

This sentence has been rephrased to "One use of this model is to serve as an important supplement for the monitoring and prediction of SWI in the Delaware Bay and the surrounding

Delmarva region, which has been identified as highly vulnerable to SWI over recent decades" at line #319-320.

Line 275-278: Change "as not reached" to "has not reached" and suggest changing second half of sentence to, "… from DRBC may tend to be underestimated by interpolation constraints due to relatively few observational stations."

This sentence has been rephrased accordingly at line #322-324.

Line 282: Suggest rephrasing as "share a drainage source from the same…"

This sentence has been rephrased accordingly at line #327.

Line 289-290: Some awkward phrasing, also seems to suggest that Sanford et al. (1992) was focused on coastal carbon cycling? A better reference for the second clause of the sentence would be something like Najjar et al. (2022) - https://doi.org/10.1002/2017GB005790

We originally intended to cite Sanford et al. (1992) to highlight the importance of tidal flushing. Following your suggestion, we have now included the recommended citation related to carbon cycling. To improve clarity and avoid confusion, we have revised the sentence to read: "Tidal flushing plays a key role in exchanging water between coastal and estuarine zones, offering essential insights for studies on processes like coastal carbon cycling." The revised text is at lines #342-343.

Line 297-300: What figures is this point referencing? I assume a combination of Figures 3 and possibly 8? Same question for the remainder of the paragraph.

We now add a new Fig. 13 to further support this part of discussion. This figure shows tidal fluxes at major coastal water bodies and illustrates the impact of hurricane events on local water exchange patterns.

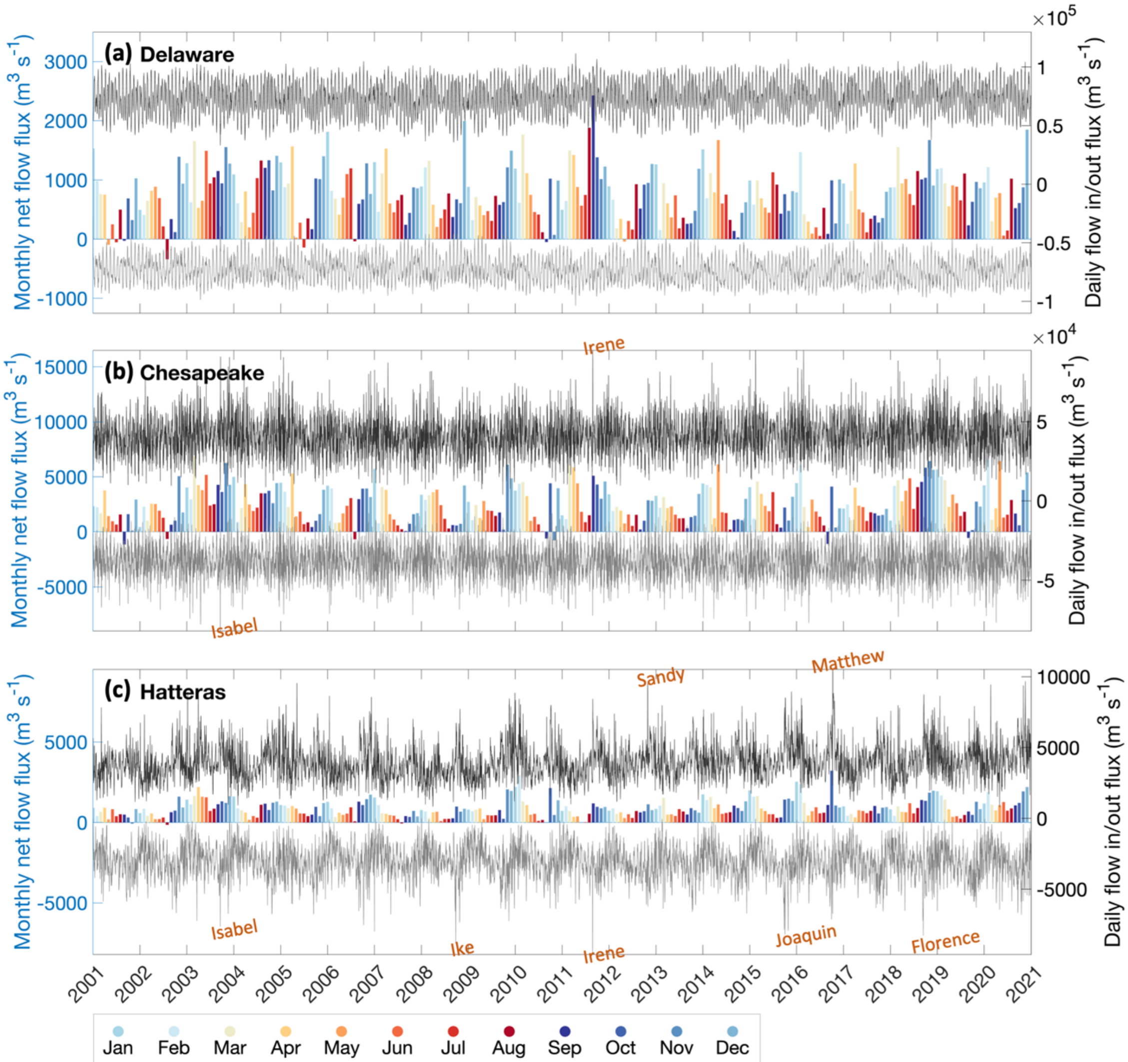

Figure 13: Tidal fluxes across the mouths of (a) Delaware Bay, (b) Chesapeake Bay, and (c) Hatteras Inlet at APES. Colored bars represent monthly net flow, while black and grey lines show daily inflow and outflow. Notable hurricanes are indicated along the timeline.

Line 305-314: To me it seems like this wetlands application of the model got significantly more description in the methodology section than is warranted by the relatively brief summary of the results presented here in the discussion section. If there is not much more to add, I would suggest potentially moving this paragraph to the results section or describe some additional implications of highly resolved wetlands processes here.

Thank you for the suggestion! In response to this comment and Reviewer 2's comments, we have re-organized this section to "Resolving tidal wetlands and their connectivity to shelf-scale processes" in order to better highlight tidal wetland application. While the original discussion primarily focused on model refinements within tidal wetland regions, we have now expanded the content by incorporating a tracer study to directly illustrate the connectivity between the coastal ocean and wetlands. This new tracer visualization is designed to represent generalized transport pathways, emphasizing how large-scale oceanic features—such as the Gulf Stream, Shelf break Jet, and Georges Bank Gyre—influence the movement and exchange of materials between small wetlands, estuaries, and neighboring marine systems. The detailed text can be found from lines #388-413.

Reviewer 2:

This paper describes a regional model with downscaling capabilities, such that the model resolves a large domain including the mid-Atlantic bight and Gulf of Maine, while also resolving a tidal wetland in detail. This 'seamless' approach is an important advancement in regional modeling, and mirrors recent work by the ICON team ('Seamless Integration of the Coastal Ocean in Global Marine Carbon Cycle Modeling' by Mathis et al., JAMES, 2022). I would recommend the authors acknowledge this related work. While I am very impressed with this effort, I think that there are some issues that need to be addressed and acknowledged (if not fixed) before this work can be published. My concerns are centered around model fidelity at the smallest and largest scales, and the connections between these scales, which I don't think has been adequately demonstrated.

Thanks for referring to the ICON work, we have acknowledged this work in introduction at lines #44-49.

Our response for the concerns centered around model fidelity is in the corresponding comments below. Overall, this study builds upon a substantial body of work demonstrating SCHISM's seamless capabilities across multiple spatial and temporal scales. Therefore, we streamlined some validation details in the manuscript to maintain clarity and conciseness.

First, at the smallest scales, I am worried that the large timestep reduces the model accuracy. The authors state "Notably, the model's scheme bypasses the constraints of the Courant-Friedrichs-Lewy condition (Zhang et al., 2016), allowing for the use of relatively large time steps even with high-resolution grids that capture detailed geomorphic features." Model stability is not the same as model accuracy, and running at timesteps greater than CFL prescribes can lead to model degradation, even if the model remains stable. The authors need to discuss the accuracy of their numerical schemes at the smallest scales, as these are what typically set the timestep.

Thank you for raising this important point regarding the distinction between numerical stability and model accuracy. SCHISM employs semi-implicit time-stepping schemes that allow the model to bypass the stringent Courant–Friedrichs–Lewy (CFL) constraints typically associated with explicit schemes (Zhang and Baptista, 2008; Zhang et al., 2016). In fact, SCHISM performs optimally at CFL numbers greater than 0.4—a reversal of traditional CFL constraints where CFL < 1 is required for stability (https://schism-dev.github.io/schism/master/getting-started/grid-generation.html). Specifically, SCHISM utilizes an Eulerian–Lagrangian Method (ELM) for momentum advection, which further alleviates numerical stability limitations. Larger time steps introduce temporal truncation errors, but they also reduce numerical diffusion in the ELM framework. On the other hand, excessively small time steps may degrade model skill due to overly low CFL values. Therefore, selecting the time step involves a careful balance between accuracy, computational efficiency, and robustness, particularly in baroclinic environments spanning shallow to deep waters.

For a fixed mesh, model accuracy has been shown to be well maintained for 3D simulations with timesteps ranging from 100 to 200 seconds (Zhang et al., 2016). The model skill at reproducing small-scale hydrodynamic processes has been demonstrated in prior applications, including wake formation near bridge pilings (Liu et al., 2018), hydraulic jumps (Zhang et al., 2020), and marsh-vegetation interactions (Zhang et al., 2019; Cai et al., 2023)—all of which employed similarly large timesteps from 100 to 200 seconds. These successes highlight SCHISM's effective balance between numerical dissipation (due to semi-implicit scheme) and numerical dispersion (Finite-Element Method). The Crank–Nicolson method, known for preserving wave propagation fidelity, further supports this balance.

The selected time step of 150 seconds for the NAAC (v1.0) configuration falls within validated range established through previous applications of SCHISM across U.S. East Coast estuaries and global domains (Ye et al., 2018; Ye et al., 2020; Cai et al., 2022; Cai et al., 2023; Zhang et al., 2023). This value has shown to be both stable and accurate at the grid resolution used in NAAC (v1.0).

We revised the manuscript accordingly to reflect this discussion at lines #153-161.

At the largest scales, it is not clear to me that the model reproduces large scale shelf features well. A single snapshot of the Gulf Stream surface currents is not sufficient evidence that the key features on the shelf are reproduced. This is important because it is the whole point of the 'seamless' downscaling approach -- that the larger scale (shelf) processes that influence the smaller scale (bay/wetland) processes are all reasonably reproduced.

At the largest scales, the model's capability in capturing shelf processes has been demonstrated through several closely related studies, including Cui et al. (2024) for shelf current dynamics, Huang et al. (2024) for shelf responses to hurricane events, and Park et al. (2024) for coastally trapped wave propagation along the U.S. Atlantic shelf. Specifically for this study, we now introduce a passive tracer experiment as shown in the next reply.

Finally, given this last point, it would be good to see some evidence that there is indeed a connection between the shelf and the wetlands. I would prefer to see some relationship in terms of tracers (temperature or salinity) rather than tidal flows that at least qualitatively demonstrates how shelf processes might influence the wetland region.

We agree that illustrating tracer transport helps clarify the linkage between large-scale and small-scale processes. Given that multiple SCHISM modeling papers have already shown shelf processes using temperature and salinity (e.g., Ye et al., 2020) and for the purpose of directly illustrate wetland-to-shelf transport pathways, here we employ a passive conservative tracer initialized in the marsh region as an additional diagnostic. This approach isolates physical transport mechanisms without interference from internal sources or sinks, providing clear evidence of shelf influence on the material transport sourced from a tidal wetland. We added Fig. 15: a log-scale plot showing the distribution of a passive tracer continuously released from a constant source at the wetlands in Plum Island Estuary. This tracer visualization illustrates the general transport pathways and highlights how oceanic processes (e.g., Gulf Stream, Shelf-break Jet and Georges Bank Gyre) influence the movement and exchange of materials from small wetlands and water bodies to adjacent regions. The text on this discussion can be found at lines #388-413.

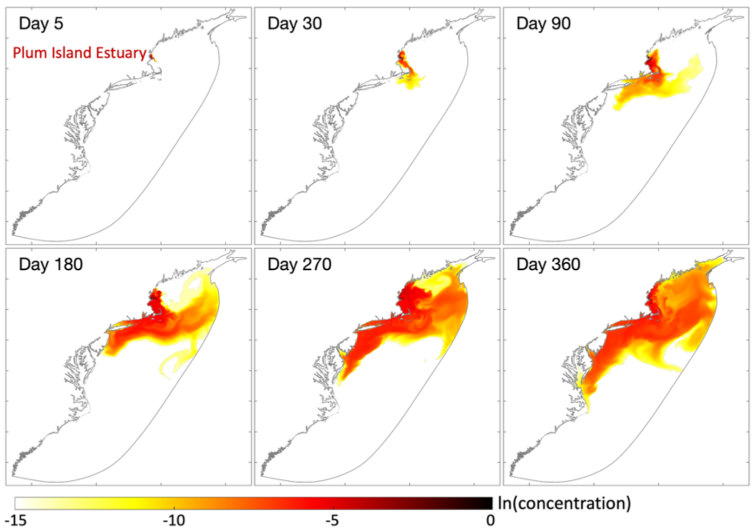

Figure 15: Log-scale plot showing the distribution of a passive tracer released continuously from a constant source of wetlands at Plum Island Estuary.

In summary, I'm very impressed by the model application development, but I am not yet convinced of its usefulness.

We appreciate your thoughtful feedback and hope the clarifications above help to address your concerns.

References

Cai, X., Shen, J., Zhang, Y.J., Qin, Q. and Linker, L., 2023. The roles of tidal marshes in the estuarine biochemical processes: A numerical modeling study. *Journal of Geophysical Research: Biogeosciences*, 128(2), p.e2022JG007066. doi: 10.1029/2022JG007066

Cai, X., Zhang, Y.J., Shen, J., Wang, H., Wang, Z., Qin, Q. and Ye, F., 2022. A numerical study of hypoxia in Chesapeake Bay using an unstructured grid model: Validation and sensitivity to bathymetry representation. *JAWRA Journal of the American Water Resources Association*, 58(6), pp.898-921. doi: 10.1111/1752-1688.12887

Cui, L., Ye, F., Zhang, Y.J., Yu, H., Wang, Z., Moghimi, S., Seroka, G., Riley, J., Pe'eri, S., Mani, S. and Myers, E., 2024. Total water level prediction at continental scale: Coastal ocean. *Ocean Modelling*, 192, p.102451. doi: 10.1016/j.ocemod.2024.102451

Huang, W., Ye, F., Zhang, Y.J., Du, J., Park, K., Yu, H.C. and Wang, Z., 2024. Hydrodynamic responses of estuarine bays along the Texas-Louisiana coast during Hurricane Harvey. *Ocean Modelling*, 187, p.102302. doi: 10.1016/j.ocemod.2023.102302

Liu, Z., Zhang, Y.J., Wang, H.V., Huang, H., Wang, Z., Ye, F. and Sisson, M., 2018. Impact of small-scale structures on estuarine circulation. *Ocean Dynamics*, 68(4), pp.509-533. doi: 10.1007/s10236-018-1148-6

Park, K., Di Lorenzo, E., Zhang, Y.J., Wang, H., Ezer, T. and Ye, F., 2024. Delayed coastal inundations caused by ocean dynamics post-Hurricane Matthew. *npj Climate and Atmospheric Science*, 7(1), p.5. doi: 10.1038/s41612-023-00549-2

Ye, F., Zhang, Y.J., Wang, H.V., Friedrichs, M.A., Irby, I.D., Alteljevich, E., Valle-Levinson, A., Wang, Z., Huang, H., Shen, J. and Du, J., 2018. A 3D unstructured-grid model for Chesapeake Bay: Importance of bathymetry. *Ocean Modelling*, 127, pp.16-39.doi: 10.1016/j.ocemod.2018.05.002

Ye, F., Zhang, Y.J., Yu, H., Sun, W., Moghimi, S., Myers, E., Nunez, K., Zhang, R., Wang, H.V., Roland, A. and Martins, K., 2020. Simulating storm surge and compound flooding events with a creek-to-ocean model: Importance of baroclinic effects. *Ocean Modelling*, 145, p.101526. doi: 10.1016/j.ocemod.2019.101526

Zhang, Y. and Baptista, A.M., 2008. SELFE: A semi-implicit Eulerian–Lagrangian finite-element model for cross-scale ocean circulation. *Ocean modelling*, 21(3-4), pp.71-96. doi: 10.1016/j.ocemod.2007.11.005

Zhang, Y.J., Fernandez-Montblanc, T., Pringle, W., Yu, H.C., Cui, L. and Moghimi, S., 2023. Global seamless tidal simulation using a 3D unstructured-grid model (SCHISM v5. 10.0). *Geoscientific Model Development*, 16(9), pp.2565-2581. doi: 10.5194/gmd-16-2565-2023

Zhang, Y.J., Gerdts, N., Ateljevich, E. and Nam, K., 2020. Simulating vegetation effects on flows in 3D using an unstructured grid model: model development and validation. *Ocean Dynamics*, 70(2), pp.213-230. doi: 10.1007/s10236-019-01333-8

Zhang, Y.J., Ye, F., Stanev, E.V. and Grashorn, S., 2016. Seamless cross-scale modeling with SCHISM. *Ocean Modelling*, 102, pp.64-81. doi: 10.1016/j.ocemod.2016.05.002

Zhang, Y.J., Ye, F., Yu, H., Sun, W., Moghimi, S., Myers, E., Nunez, K., Zhang, R., Wang, H., Roland, A. and Du, J., 2020. Simulating compound flooding events in a hurricane. *Ocean Dynamics*, 70(5), pp.621-640. doi: 10.1007/s10236-020-01351-x

Reviewer 3:

This manuscript is about the implementation of a modelling system based on SCHISM covering the Gulf of Maine, the Mid-Atlantic Bight, and much of the South-Atlantic Bight (SAB) along the North American Atlantic Coast. In this study, the authors conducted a 20-year simulation from 2001 to 2020, focusing on tidal elevation, salinity, temperature, and velocity. The system was evaluated by model-observation comparisons over the studied regions. For the first time, they extended a regional continental-scale ocean model to the tidal wetlands to include the compound flooding process. They also conducted a single-year simulation with comprehensive tidal marsh coverage for sensitivity analysis. The model lays a foundation for future applications and is worthy of publication. I suggest a major revision before publication.

Thank you for your thoughtful comments and suggestions to help improve our manuscript. We have carefully considered your feedback and incorporated the suggested revisions into the updated manuscript, along with a detailed point-by-point response to facilitate your evaluation.

The labels in Figure 1 are confusing, with repetitive labels of (b), (c), (d), (e), (g). I understand that the orange boxes are defining the regions covered by (b), (c), (d), (e) subplots. However, the way to present is confusing. I suggest you change the orange labels to the name of the regions, for example, change orange (b) to Gulf of Maine, orange (c) to Long Island Sound.

Thank you for the suggestion. Due to limited space in panel (a) for labeling coastal names—particularly since panel (c) spans a larger area than just Long Island Sound and panel (d) focuses only on part of the Mid-Atlantic coast—we have incorporated the suggested revisions into the subplots (b), (c), (d), and (e). We also explicitly denote the orange boxes in the figure caption.

P125: was used to validate creek and wetland simulations -> were used to validate creek and wetland simulations

We have fixed this error at line #136.

P235: The authors stated that "The model effectively represents the Gulf Stream, as indicated by sea surface temperature (not shown)". I am wondering why they are not showing the SST comparisons? It is important to demonstrate the representation of the Gulf Stream.

We agree that illustrating shelf-scale processes such as the Gulf Stream is important. Given that multiple SCHISM modeling papers have already shown the model's capability in capturing shelf processes, including Ye et al. (2020 for SST, Cui et al. (2024) for shelf current dynamics, Huang et al. (2024) for shelf responses to hurricane events, and Park et al. (2024) for coastally trapped wave propagation along the U.S. Specifically for this study, our focus is the linkage to shallow water systems and we now introduce a passive tracer experiment as a response to Riewer 2 to directly illustrate wetland-to-shelf transport pathways under the influence of the Gulf Stream and other shelf processes. Therefore, we streamlined some validation details in the manuscript to maintain clarity and conciseness.

For the currents comparison in Figure 10, a metric is needed for a quantitative comparison of both magnitude and direction.

We have added the RMSD values for velocity magnitude and directions across the region throughout the year at line #272-274.

P275: “by the salt front estimation data provided from DRBC (Fig. 10)”. It is referring to the wrong figure, since Figure 10 is not related to salt front.

We have fixed this error at line #321.

It is not clear how salt front distance is defined/calculated.

We now add this definition “distance from the bay mouth to the location where salinity drops below 0.5 PSU” at line # 240-241.

In section 4.1.2, the authors stated that “…modeled tidal flow fluxes at the gate or major inlets of the three significant waterbodies at mid-Atlantic – Delaware Bay, Chesapeake Bay, and the APES. While the net fluxes are always associated with the riverine discharge as denoted in Fig. 3, the flood and ebb tidal fluxes have distinct patterns among these three systems” However, this discussion lacks the detailed analysis one would expect from such a statement. The section provides no calculations, additional figures, or quantitative comparisons of these "distinct patterns." Without supporting data or deeper analysis, this discussion feels superficial and insufficient to warrant its own section.

We now add a new Fig. 13 to further support this part of discussion. This figure shows tidal fluxes at major coastal water bodies and illustrates the impact of hurricane events on local water exchange patterns.

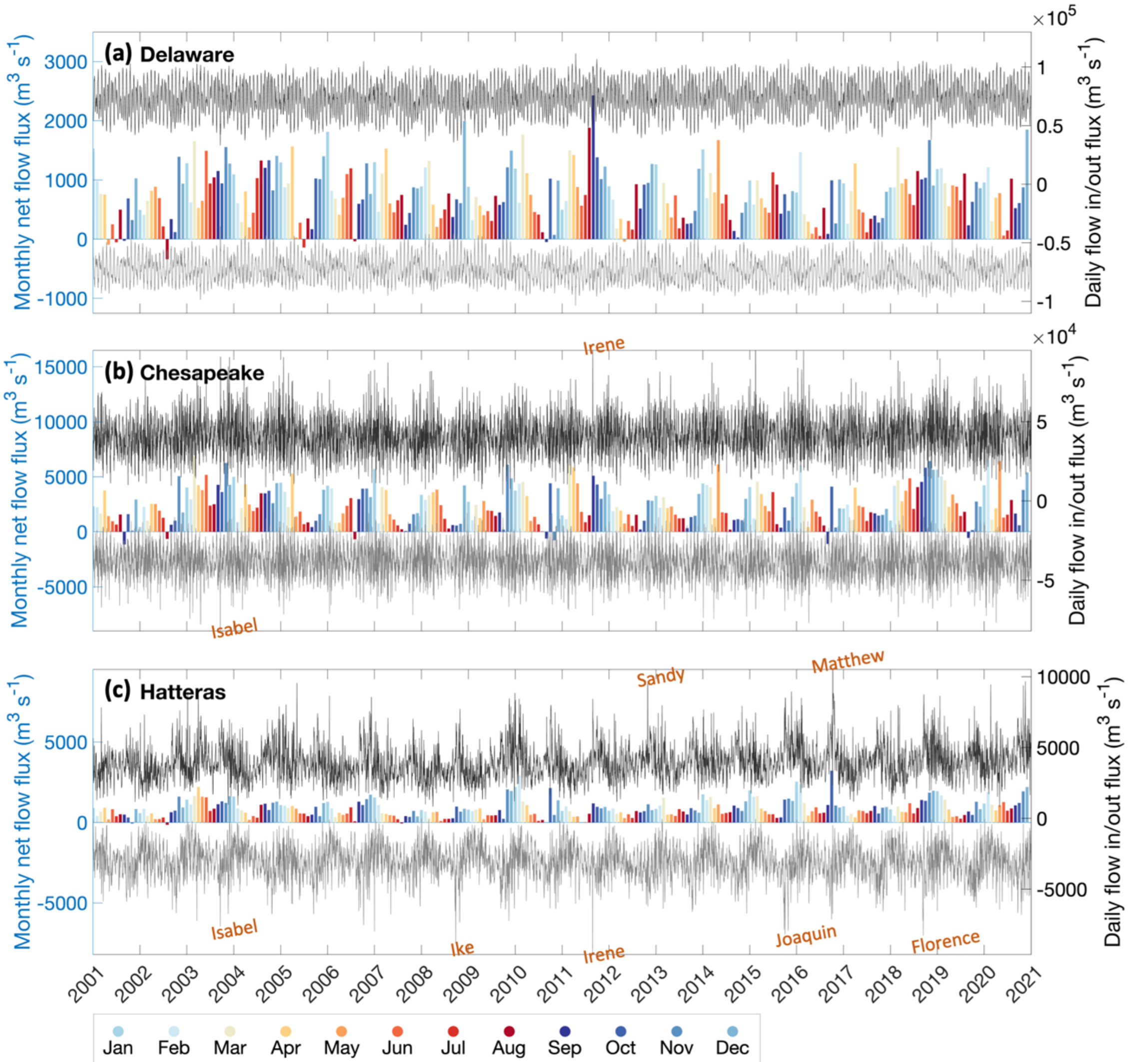

Figure 13: Tidal fluxes across the mouths of (a) Delaware Bay, (b) Chesapeake Bay, and (c) Hatteras Inlet at APES. Colored bars represent monthly net flow, while black and gray lines show daily inflow and outflow. Notable hurricanes are indicated along the timeline.

References

Cui, L., Ye, F., Zhang, Y.J., Yu, H., Wang, Z., Moghimi, S., Seroka, G., Riley, J., Pe'eri, S., Mani, S. and Myers, E., 2024. Total water level prediction at continental scale: Coastal ocean. *Ocean Modelling*, 192, p.102451. doi: 10.1016/j.ocemod.2024.102451

Huang, W., Ye, F., Zhang, Y.J., Du, J., Park, K., Yu, H.C. and Wang, Z., 2024. Hydrodynamic responses of estuarine bays along the Texas-Louisiana coast during Hurricane Harvey. *Ocean Modelling*, 187, p.102302. doi: 10.1016/j.ocemod.2023.102302

Park, K., Di Lorenzo, E., Zhang, Y.J., Wang, H., Ezer, T. and Ye, F., 2024. Delayed coastal inundations caused by ocean dynamics post-Hurricane Matthew. *npj Climate and Atmospheric Science*, 7(1), p.5. doi: 10.1038/s41612-023-00549-2

Ye, F., Zhang, Y.J., Yu, H., Sun, W., Moghimi, S., Myers, E., Nunez, K., Zhang, R., Wang, H.V., Roland, A. and Martins, K., 2020. Simulating storm surge and compound flooding events with a creek-to-ocean model: Importance of baroclinic effects. *Ocean Modelling*, 145, p.101526. doi: 10.1016/j.ocemod.2019.101526