

RE: REVIEW, “THE APPLICATIONS OF UFS-COASTAL ....” SUN, TURUNCOGLU, JISAN, YU, ZHANG, LEMMEN, ABDOLALI, WORTHEN, TSAY, HADDAD, VELISSARIOU, CASSALHO, MANI, DANESHVAR, BANIHASHEMI, SALIMI-TARAZOUJ, SMITH, MYERS, MOGHIMI

*In their manuscript “The applications of UFS-Coastal v1.0.0b01: wave-current coupling of SCHISM and WAVEWATCH III,” the authors Sun et al. describe the extension of a coupled modeling framework to include coastal ocean models. It is shown that one component model SCHISM and the wave model WW3 can reproduce the waves and water levels during an offshore hurricane.*

*It is our recommendation that this manuscript requires major revisions. (It is noted that this review was completed by an invited reviewer and a team of graduate students, as a learning exercise in how to review an academic journal manuscript. Our review is longer and more-detailed than normal because it includes input from the team.)*

*UFS-Coastal is a significant achievement; it will ease the use of coastal ocean models for research and operations. However, this manuscript does not describe sufficiently its novel capabilities. In the methods sections, there is too much description of the individual components and too little description of the coupling mechanics, especially details about what quantities are passed and how. In the results section, the experiments demonstrate the coupling for only one of the four coastal ocean models, and the findings are similar to previous studies. The manuscript will be improved with a major revision to focus on and demonstrate the coupling framework.*

**Reply:** We thank the reviewer and the review team for their careful and detailed evaluation of the manuscript. We appreciate their recognition of the value of UFS-Coastal and agree that the original manuscript did not place sufficient emphasis on the coupling framework and its mechanics. In response, we have substantially revised the manuscript to more clearly describe the UFS-Coastal framework, including the component interfaces, exchanged fields, coupling architecture, workflow, and regression testing. We have also clarified the role of the individual model-component descriptions within the overall framework and expanded the discussion of how the components interact through CMEPS and model-specific NUOPC component caps. In addition, we now clearly distinguish the general capabilities of the UFS-Coastal framework from the SCHISM-WW3 configuration demonstrated in the Duck, NC application. The manuscript title has been revised accordingly to better reflect this scope: **“UFS-Coastal v1.0: description of a flexible coupled modeling framework for coastal ocean, wave, and sea-ice applications.”**

*The following major comments can be considered for a revised manuscript:*

*– Can the authors clarify the reasoning behind the ordering of the models when they are listed or presented? The ordering is inconsistent across instances in the manuscript (with examples below), and it is never justified. A clarification will be helpful, especially if it can align with how the models are used within NOAA. Then suggest to be consistent across all instances:*

- Lines 58–66: Presumably SCHISM is first because it is a focus of the demonstration in this study, but what is the reasoning behind the ordering of the other models?*
- Line 99, lines 104–105, lines 300 and 302, and line 340: Almost alphabetical?*
- Section 2.2: Almost alphabetical?*
- Line 482: SCHISM returns to the front?*
- Figure 1: New ordering?*

**Reply:** We agree that the ordering of the four coastal ocean models was inconsistent in the original manuscript. We have standardized the order throughout the revised manuscript and Fig. 1 as **ADCIRC**,

**FVCOM, SCHISM, and ROMS.** This ordering groups the three unstructured-grid coastal models first, with ADCIRC, FVCOM, and SCHISM listed alphabetically by acronym, followed by the structured-grid model ROMS. The ordering is used only for consistency and does not imply a ranking or priority among the models. SCHISM is identified separately where appropriate because it is the coastal ocean model used in the demonstration presented in Section 3.

*– Section 2 should describe the details of the UFS-Coastal component models and their coupling. This section is challenging to write, because (a) if it is too detailed with technical information, then the manuscript should rather be a white paper or technical report, and (b) if it is too high-level with conceptual descriptions, then it is not useful to readers to understand the mechanics of the system. To this reviewer, this section misses the mark to the latter direction. Too much of this section is spent on describing the components and referencing to existing studies, and too little is spent on describing the details of their coupling within UFS-Coastal. The authors should be encouraged to revise – the manuscript has the potential to be a significant contribution if this section is written well.*

**Reply:** We agree that the coupling mechanics were not described in sufficient detail in the original manuscript. In the revised manuscript, we have expanded Section 2 to more clearly describe how the coastal ocean components are connected to CMEPS, how exchanged fields are defined through model-specific NUOPC component caps, and how the coupling configuration depends on the selected component models. We have also clarified the specific exchanged fields and coupling interval for the SCHISM-WW3 configurations demonstrated in this study. In addition, we have revised the manuscript to distinguish the general UFS-Coastal coupling framework from the particular SCHISM-WW3 implementation used in the Duck, NC experiments.

*The following comments are specific but not comprehensive:*

*– What information is passed between models? A detailed summary for all models is needed. Presumably the passed information is different, depending on whether the models are 2D or 3D? For coupling from a 3D circulation model to the wave model, what currents are passed – surface, depth-averaged, or something else? It is likely that all of the coastal ocean models can accept surface pressures and wind stresses from the atmospheric models, but which can also accept heat fluxes and precipitation? Which models can accept the radiation stresses, and which can accept the vortex forces? This passing of information is maybe the most essential part of the coupling, but it is not described sufficiently in the present manuscript.*

**Reply:** We agree that the original manuscript did not sufficiently clarify that the exchanged fields and coupling functionality are model-specific. We have revised Section 2 to explain that each coastal ocean model interfaces with CMEPS through a model-specific NUOPC component cap and that the corresponding import and export fields are defined in version-specific YAML field dictionaries distributed with the UFS-Coastal source code. These dictionaries provide the detailed implemented field lists for each component.

We have also clarified that the current coupling functionality is not identical among ADCIRC, FVCOM, SCHISM, and ROMS. The detailed wave-current coupling implementation described in this manuscript is primarily associated with SCHISM-WW3. Sections 2.3.1 and 2.3.2 now identify the specific fields exchanged for the Longuet-Higgins and 3-D vortex configurations, including the surface and depth-averaged current fields where applicable. We further clarify that the 3-D vortex coupling is currently implemented for SCHISM-WW3 and is not presently supported by the other coastal ocean components.

Because the available field lists are component- and version-specific and are maintained directly in the source-code YAML dictionaries, we refer readers to those dictionaries for the complete field-by-field definitions rather than duplicating an evolving implementation list in the manuscript.

*– How is information passed between models? Lines 140–145 claim that information can be transferred with “a range of temporal and spatial interpolation methods”, but no other details are provided. What spatial interpolation techniques are used? Do they differ for various models or information? Is there an attempt to interpolate in a ‘conservative’ way – for example, if the waves are computed on a finer mesh and the wave forces are focused in a specific region, then is their peak retained when interpolating to the circulation model, or is it smoothed over the coarser mesh? In time, how often is information passed between models, and does the coupling interval differ for various models or information? These details are also essential, but they are lacking in the present manuscript.*

**Reply:** We agree that the original description of spatial and temporal field exchange was too general. We have revised Section 2 to clarify that CMEPS manages field transfer using the mapping method specified for the source and destination component grids and that coupling intervals are configurable for individual coupled configurations. For the Duck, NC SCHISM-WW3 experiments, we have added the specific implementation details in Section 3.2.3. SCHISM and WW3 use the same unstructured computational mesh, and their field exchange uses the CMEPS redistribution (redist) mapping rather than spatial interpolation between different horizontal grids. Thus, conservative versus non-conservative interpolation between meshes of different resolutions is not involved in these experiments. We also now state explicitly that a coupling interval of 300 s was used for the two-way SCHISM-WW3 exchange in both Cases 4 and 5.

*– How are the coupled models implemented in an HPC environment? This reviewer would guess that different models are assigned to different sets of CPUs, and then the coupler manages the passing of information between the component models. If this is correct, then how many CPUs are needed for each model? Does it differ between models, i.e. presumably the 3D models are more expensive than the 2D models? How many CPUs are assigned for the atmospheric, wave, and ice models? What is the overhead of the coupling, i.e. how much time is spent in interpolating between components? These details are also essential, but they are also lacking.*

**Reply:** We agree that the computational configuration should be described more clearly. However, processor allocation in UFS-Coastal is not fixed at the framework level. The number of MPI tasks assigned to each active component is specified for a particular application and depends on the component models, domain size, grid resolution, physics options, and HPC platform. We have revised Section 2 to clarify that these resource allocations are case-specific rather than general computational requirements of UFS-Coastal.

For the Duck, NC coupled experiments, SCHISM was run with 192 MPI tasks and WW3 with 900 MPI tasks and CDEPS with 8 MPI tasks. No active atmospheric or sea-ice model was used; atmospheric forcing was prescribed through CDEPS. We have added these case-specific processor allocations to Section 3.2.3.

We did not separately profile the computational overhead associated specifically with CMEPS field exchange in these experiments. Therefore, we do not report a coupling-overhead percentage. Such overhead is expected to depend on the component layout, grid configuration, mapping method, and HPC platform, and a systematic performance analysis is beyond the scope of the present framework-description and demonstration study.

– Section 2.1: These subsections contain background on CDEPS/CMEPS, WW3, and CICE. This background is nice, but much of it is duplicated from other studies. Can these subsections be shortened and focused on how they support the specific development of UFS-Coastal in the present study? For example, in Section 2.1.2, the first three paragraphs are a description of WW3 and its recent advancements, which are impressive but documented in other studies (with references here) – can this subsection be shortened and focused on how WW3 interacts with the other models inside the coupling of UFS-Coastal? Similar comments for Section 2.1.1 about CDEPS/CMEPS and Section 2.1.3 about CICE.

**Reply:** We appreciate this suggestion. In the revised manuscript, however, we have retained the background descriptions of CDEPS/CMEPS, WW3, and CICE because the scope of the manuscript has been revised to describe the broader UFS-Coastal framework rather than focusing only on the SCHISM-WW3 coupling application. The manuscript title has accordingly been changed to “**UFS-Coastal v1.0: description of a flexible coupled modeling framework for coastal ocean, wave, and sea-ice applications.**” Within this framework-oriented scope, brief descriptions of the major UFS components are important for documenting the structure and capabilities of UFS-Coastal.

Rather than substantially shortening these subsections, we have revised their framing to more clearly explain their specific roles within UFS-Coastal and their interactions with the coastal ocean components. In particular, Section 2.1.1 now places greater emphasis on how CDEPS provides prescribed forcing and how CMEPS manages component coupling and field exchange; Section 2.1.2 clarifies the role of WW3 in wave-current coupling; and Section 2.1.3 clarifies the role of CICE within the broader coupled framework. Detailed SCHISM-WW3 exchange mechanisms are then described separately in Sections 2.3.1 and 2.3.2.

– Section 2.2: Suggest to introduce these four models with subsections of equal length and referencing. As it is, the subsections are less detailed for ADCIRC (8 lines), FVCOM (6 lines), and ROMS (7 lines), and more detailed for SCHISM (13 lines), even though the content is similar about model capabilities and typical applications. Suggest to either lengthen the other three subsections or shorten the SCHISM subsection.

**Reply:** We agree that the descriptions of the four coastal ocean components should be more balanced. Because the revised manuscript is intended to describe the broader UFS-Coastal framework, we have retained the existing SCHISM description and expanded the ADCIRC, FVCOM, and ROMS subsections so that the four components are presented with a more consistent level of detail and structure. Specifically, we added information on ADCIRC’s variable-resolution unstructured-grid and wetting-drying capabilities, FVCOM’s terrain-following vertical coordinate, unstructured-grid refinement, and depth-resolving estuarine applications, and ROMS’s structured-grid, terrain-following formulation and representation of three-dimensional shelf circulation and vertical mixing. We also revised the end of Section 2.2 to clarify the complementary roles of the four coastal ocean components within UFS-Coastal. The subsections are not intended to be identical in length, but they now follow a more consistent structure and level of detail.

– Section 2.2: The SCHISM subsection includes one reference within the past 10 years, but the other model subsections have only references that are more than 10 years old. All of these models have received continuous development and application during that timeframe. Can the authors include more-recent references for each model?

**Reply:** We agree. We have retained the foundational references for each coastal ocean model and added more recent references to reflect their continued development and application. Specifically, we added Pringle et al. (2021) for recent ADCIRC development and global storm-tide applications, Li and Chen (2022) for a recent coupled FVCOM application, and López et al. (2020) for a recent ROMS-based

regional coastal circulation application. The SCHISM subsection already includes the recent study of Zhang et al. (2024). These references complement the original model-development citations and provide a more up-to-date representation of the continued use and development of all four coastal ocean models.

*– Section 2.3: This is a nice background of the radiation-stress and vortex-force methods for momentum transfer from the wave model to the circulation model. But this background could be shortened and referenced to previous studies. Also, SCHISM is the only model mentioned under the vortex-force method, but wasn't that method introduced first for ROMS?*

**Reply:** We appreciate this comment. Because the revised manuscript is framed as a description of the broader UFS-Coastal framework. Rather than removing the background needed for the framework description, we revised Section 2.3 to more clearly distinguish previous methodological developments from their implementation in UFS-Coastal and to emphasize the component exchanges specific to the present framework.

We also agree that the historical development of the vortex-force approach should be described more clearly. The revised Section 2.3.2 now notes that the underlying wave-current interaction framework was developed by McWilliams et al. (2004), that a three-dimensional vortex-force formulation was subsequently implemented in ROMS by Uchiyama et al. (2010), and that Kumar et al. (2012) further implemented and evaluated the approach in the ROMS-SWAN configuration of COAWST. We then clarify that, within the current UFS-Coastal implementation, the 3-D vortex-force configuration described here is implemented for SCHISM-WW3.

*– Section 2.4: This subsection seems to be closest to providing details about the coupling. But it is not clear to this reviewer which parts are existing technologies, and which parts were developed for UFS-Coastal and this study. Can this be clarified? Also, can Subsection 2.4.2 be expanded to describe the workflow with more description of Figure 1 or something similar?*

**Reply:** We agree that the original manuscript did not clearly distinguish the pre-existing infrastructure from the developments made specifically for UFS-Coastal. We have revised Section 2.4 to make this distinction more explicit. UFS-Coastal builds on existing infrastructure and model components, including ESMF/NUOPC, CMEPS, CDEPS, WW3, CICE, uwtools, Rocoto, Jenkins, and GitHub Actions. However, the development of UFS-Coastal involved not only integrating the four coastal ocean models through model-specific NUOPC component caps, but also modifying WW3 and CICE as needed for their integration within the UFS-Coastal framework. Additional developments include defining component interfaces and exchanged fields, implementing the supported coastal ocean-wave coupling configurations, and developing coastal-specific workflow and regression-test configurations.

We have also expanded Section 2.4.2 to describe the workflow from user configuration through coupled execution, including configuration generation, input staging, HPC execution, component initialization, field exchange through CMEPS, prescribed forcing through CDEPS, and output collection. Figure 1 is retained as a high-level architecture diagram, while the expanded text provides the more detailed workflow description requested by the reviewer.

*– The demonstration of the UFS-Coastal capabilities does not show the performance of all model components, and its findings are repetitive of studies outside of this coupled framework. The authors should be encouraged to redesign the numerical experiments to demonstrate a novel capability of UFS-Coastal and teach the reader about its mechanics.*

**Reply:** We appreciate this comment and agree that the original manuscript overstated the extent to which the Duck, NC experiments demonstrated the complete UFS-Coastal system. The current framework

includes multiple coastal ocean components, but their coupling functionality is model specific, and the most complete wave-current coupling implementation demonstrated here is the SCHISM-WW3 configuration. We therefore did not redesign the Duck experiment as a four-model intercomparison, because such an experiment would not represent the present implementation status of the different coastal ocean components on an equivalent basis.

The revised manuscript now includes an additional large-domain Bering Sea application to broaden the framework demonstration beyond the Duck SCHISM-WW3 case. The new section presents both SCHISM-WW3 and SCHISM-CICE configurations, illustrating coastal ocean-wave and coastal ocean-sea-ice coupling within UFS-Coastal. The simultaneous SCHISM-WW3-CICE configuration is identified as an ongoing development and is not presented as a fully evaluated capability.

We have also revised the scope and framing of the manuscript to make clear that its primary contribution is the UFS-Coastal coupled modeling framework and its implementation, rather than a new comparison of wave-current interaction formulations. The manuscript title has been changed to “UFS-Coastal v1.0: description of a flexible coupled modeling framework for coastal ocean, wave, and sea-ice applications.” The Duck, NC experiments are now presented as an illustrative demonstration of one supported SCHISM-WW3 configuration rather than as a comprehensive validation of all UFS-Coastal component models.

We have also revised Section 3 to emphasize the mechanics of this implementation, including prescribed forcing through CDEPS, component interfaces through NUOPC caps, the fields exchanged between SCHISM and WW3, the CMEPS. We now explicitly acknowledge that the Longuet-Higgins and 3-D vortex-force formulations have been investigated in previous studies; their use here is intended to demonstrate how different wave-current coupling formulations are implemented and exercised within the common UFS-Coastal framework rather than to claim a new wave-current interaction methodology.

*– Lines 392–400: Why is there only a demonstration of SCHISM in this study? Why not show results for the other three models for this same test case? There needs to be a justification for showing only SCHISM. Why do the authors expect SCHISM to be representative of the overall performance of UFS-Coastal?*

**Reply:** We agree that the reason for focusing on SCHISM was not sufficiently explained in the original manuscript. We do not assume that SCHISM is representative of the scientific performance of ADCIRC, FVCOM, or ROMS. The coupling functionality currently implemented within UFS-Coastal is model specific and is not identical among the four coastal ocean components.

We selected SCHISM for the Duck, NC demonstration because SCHISM currently provides the most complete wave-current coupling implementation within UFS-Coastal for the configurations considered here, including both the Longuet-Higgins radiation-stress and 3-D vortex-force approaches. The 3-D vortex-force configuration has not yet been implemented for the other three coastal ocean components within UFS-Coastal. Therefore, applying all four coastal ocean models to the same Duck case would not constitute a like-for-like comparison of equivalent UFS-Coastal coupling configurations.

We have revised Section 3.1 to make this rationale explicit and to clarify that the Duck experiments are intended to demonstrate the mechanics and execution of one supported UFS-Coastal configuration, rather than to evaluate or represent the performance of all four coastal ocean models.

*– Section 3.2.1: It is not clear to this reviewer that these test cases (ATM+WW3) are a demonstration of a novel capability in this study. Was WW3 already part of UFS? If so, then these test cases are demonstrating an existing capability, and not anything novel to this study. If not (i.e. if WW3 was not already part of UFS), then the earlier sections of this manuscript need to be revised to emphasize that*

*WW3 was also added in this development of UFS-Coastal. For example, lines 58–59 describe only the extension to include the coastal ocean models.*

**Reply:** We agree with the reviewer that WW3 was already an existing component of UFS-WM and that the ATM+WW3 cases should not be interpreted as demonstrating the introduction of a new wave-model capability in UFS-Coastal. We have revised Section 3.2.1 accordingly. Cases 1 and 2 are now described as baseline wave-only configurations that establish the WW3 response to prescribed forcing and provide a reference for comparison with the subsequent SCHISM-WW3 coupled cases.

We have also revised the earlier description of UFS-Coastal to clarify the development history. UFS-Coastal extends UFS-WM by integrating the four coastal ocean models into the UFS coupling infrastructure, while also adapting existing UFS-WM components, including WW3 and CICE, for regional coastal applications. Thus, WW3 itself was not newly added to UFS, although modifications were made to support its use within the UFS-Coastal framework.

The novelty of the present work therefore does not lie in the standalone ATM+WW3 configuration, but in the broader UFS-Coastal integration and in the coupled configurations that connect the coastal ocean components with WW3 through the common CMEPS-based framework.

*– Sections 3.2.1 and 3.2.3: How does WW3 handle the boundaries of the model domain? Are waves from another source (observation, another wave model) applied as boundary conditions? In Figure 4, the comparison is excellent at the 26m sensor near the open boundary, which suggests that wave information is specified as boundary conditions, but this reviewer cannot find where this is discussed in the manuscript.*

**Reply:** We agree that the WW3 wave boundary conditions were not sufficiently described in the original manuscript. We have revised Sections 3.2.1 and 3.2.3 to clarify that observed directional wave spectra from the FRF\_waverider-26m station were prescribed as the offshore boundary condition for WW3 in Cases 1, 2, 4, and 5.

We also agree that this explains the close agreement between the model and observations at the 26 m station in Fig. 4. Because observations from FRF\_waverider-26m are used directly as wave boundary forcing, this station is not an independent validation location. We have revised the discussion of Fig. 4 and its caption accordingly. The shallower FRF stations are used to assess how the modeled wave field transforms from the imposed offshore boundary conditions into the nearshore region.

*– Lines 434–435: “The rationale for comparing these two coupling approaches was to explicitly investigate the advantages of resolving vertical momentum exchanges and wave-induced turbulence ....” Lines 489–490: “A key contribution of this study was the explicit evaluation and comparison of two distinct wave-current interaction methodologies ....” This comparison has been done already, including in references cited in Section 2.3. The results are as expected, with the vortex-force method able to transfer momentum in a realistic way through the water column. Even if this finding was novel, it would not be a specific demonstration of the benefits of the model coupling within UFS-Coastal. Can the authors develop an experimental plan that demonstrates the novel capabilities of this new technology?*

**Reply:** We agree with the reviewer that the comparison between the Longuet-Higgins radiation-stress and 3-D vortex-force formulations is not, by itself, a novel scientific contribution. Both formulations have been developed and evaluated in previous studies, including those already cited in Section 2.3. We have therefore removed the statements identifying this comparison as a key contribution of the study and no longer interpret the Duck experiments as demonstrating the superiority of the vortex-force approach.

Rather than introducing a new physical comparison, we have revised the experimental presentation to emphasize the mechanics of UFS-Coastal. The existing cases are now presented as a progression from

prescribed forcing and individual-component configurations to two-way SCHISM-WW3 coupling. In the revised Section 3, we describe how forcing is supplied through CDEPS, how SCHISM and WW3 are connected through CMEPS.

*– Section 3.3: This section is a qualitative discussion of the results. It is claimed (lines 452–454) that the vortex coupling has better predictions, but the quantitative comparisons are relegated to Table 2. Can the quantitative*

**Reply:** We agree that the original Section 3.3 relied too heavily on qualitative descriptions and that the statement suggesting generally better predictions from the 3-D vortex configuration was not sufficiently supported by the quantitative statistics. We have substantially revised Section 3.3 to incorporate the bias and RMSE values from Table 2 directly into the discussion.

The revised text now shows that the relative performance of Cases 4 and 5 depends on both the wave variable and the observation location. For example, the mean Hs RMSE values are similar for Cases 4 and 5 (0.43 and 0.41 m, respectively), while Case 4 has lower Hs RMSE at the 6 m and 8 m stations and Case 5 has lower Hs RMSE at the 2 m station. Case 5 provides lower mean-period error, whereas Case 4 provides slightly lower directional RMSE. We have therefore removed the general statement that the 3-D vortex configuration produces better wave predictions and now describe the differences as variable- and station-dependent.

We also clarify that FRF\_waverider-26m supplies the observed directional spectra used as the WW3 offshore boundary forcing and is therefore not treated as an independent validation station. The discussion now places greater emphasis on the shallower observation sites when assessing modeled nearshore wave transformation.

*– This reviewer was expecting a discussion of the computational requirements for UFS- Coastal. How much time is required for each model component? How much time is spent in passing information between models? How much time is saved via the coupling in UFS-Coastal, relative to other coupling frameworks?*

**Reply:** We agree that the computational configuration should be described more clearly. We have added a discussion of computational resource allocation in Section 2.4.2 and the specific processor configuration used for the Duck, NC experiments in Section 3.2.3. UFS-Coastal does not prescribe a fixed processor count for individual components; resource allocation depends on the selected components, domain size, grid resolution, physics options, coupling configuration, and HPC platform. For the Duck, NC experiments, SCHISM was run using 192 MPI tasks and WW3 using 900 MPI tasks with 8 tasks for CDEPS on Hercules. No active atmospheric or sea-ice model was used in these experiments.

The computational cost associated specifically with CMEPS field exchange was not separately profiled in these experiments, so we do not report a coupling-overhead percentage. We now state this limitation explicitly.

We also did not conduct a controlled performance benchmark against other coupling frameworks. Such a comparison would require equivalent model configurations, grids, processor layouts, coupling intervals, and HPC platforms. We have therefore avoided making claims that UFS-Coastal provides a specific runtime saving relative to other coupling frameworks.

*The following minor comments can also be considered:*

*– Line 33 (“successfully”), line 43 (“accurately”), line 46 (“specifically”), line 53 (“originally”), line 53 (“explicitly”), line 57 (“specifically”), line 60 (“particularly”), line 65 (“extensively”), line 67*

*(“dynamically”), line 97 (“closely”), line 98 (“originally”), line 111 (“specifically”), line 132 (“presently”), line 145 (“dynamically”), line 149 (“computationally”), line 150 (“seamlessly”), line 151 (“dynamically”), line 152 (“consistently”), line 153 (“flexibly”), line 153 (“globally”), line 154 (“fully”), line 160 (“efficiently”), line 161 (“locally”), line 163 (“explicitly”), line 165 (“notably”), line 166 (“directly”), line 172 (“strictly”), line 212 (“particularly”), line 213 (“extensively”), line 213 (“particularly”), line 220 (“commonly”), line 226 (“efficiently”), line 231 (“faithfully”), line 235 (“particularly”), line 240 (“commonly”), line 246 (“externally”), line 248 (“consistently”), line 256 (“fundamentally”), line 261 (“directly”), line 263 (“Consequently”), line 265 (“specifically”), line 266 (“accurately”), line 267 (“consistently”), line 269 (“predominantly”), line 272 (“explicitly”), line 274 (“solely”), line 280 (“internally”), line 286 (“particularly”), line 288 (“vertically”), line 296 (“regularly”), line 309 (“quickly”), line 326 (“systematically”), line 328 (“specifically”), line 328 (“nightly”), line 372 (“comprehensively”), line 373 (“Specifically”), line 379 (“sharply”), line 380 (“approximately”), line 383 (“specifically”), line 387 (“smoothly”), line 402 (“approximately”), line 403 (“roughly”), line 403 (“Observationally”), line 404 (“uniformly”), line 408 (“comprehensively”), line 409 (“incrementally”), and elsewhere (because this reviewer gave up after line 400): Suggest to remove adverbs in all instances. Adverbs are imprecise and thus not suitable for technical writing. Each of these adverbs can be removed without any change to the meaning of their sentences, and with a substantial streamlining of the writing. Suggest to do a careful scrub of all adverbs (by using a global search for words ending in -ly) in the manuscript.*

**Reply:** We thank the reviewer for this helpful suggestion. We agree that the manuscript overused intensifying adverbs, and we therefore performed the suggested manuscript-wide “-ly” review. The large majority of the flagged instances (e.g., “successfully”, “faithfully”, “comprehensively”, and “particularly”) were removed or rewritten, which has substantially tightened the prose and reduced subjective or promotional wording.

We retained a limited number of adverbs when they convey specific technical information that would otherwise be lost, such as numerical approximation, spatial treatment, test frequency, or methodological scope (e.g., “approximately”, “uniformly”, “nightly”, and “predominantly”). In several such cases, the wording was further revised to make the underlying technical meaning explicit rather than relying the adverb alone.

We believe these changes substantially improve the precision and readability of the revised manuscript.

*– Abstract: Several acronyms are used but not defined (e.g. the four coastal models).*

**Reply:** We thank the reviewer for noting this issue. We have revised the Abstract to reduce the use of undefined acronyms. Acronyms retained in the Abstract are now defined at first use. In particular, SCHISM is now introduced as the Semi-implicit Cross-scale Hydroscience Integrated System Model (SCHISM), and WW3 and CICE are also defined at first use. The other supported coastal ocean models are referred to generically in the Abstract and are introduced with their full names and acronyms in the Introduction.

*– Lines 24 and 25: The phrase “to address this need” is repeated. Also, the word ‘need’ is not used in the first sentence. Suggest to change to ‘address this requirement’ and use the phrase only once.*

*– Lines 25–26: “by disentangle extending” is awkward.*

**Reply:** We thank the reviewer for identifying this repetition. We revised the opening of the Abstract and removed the duplicated phrase. Rather than replacing “need” with “requirement” in both locations, we rewrote the sentences so that UFS-Coastal v1.0 is introduced directly and the motivation is stated only once.

- *The manuscript suffers from errors in typography and spelling.*
- *Spacing: There are instances where spacing is wrong, often near references:*
  - *Line 27: “byintegrating” needs a space between words.*
  - *Line 64: “modeling(Luettich” needs a space.*
  - *Line 96: “configurations(Moghim” needs a space.*
  - *Line 125: “(1)Atmospheric” needs a space.*
  - *Line 143: “CMEPS allows” has too many spaces?*
  - *Line 254: “formalism(Uchiyama” needs a space.*
  - *Line 261: “density(Moghim” needs a space.*
  - *Line 386: “profiles(Fig” needs a space.*
  - *Line 402: “WW3(Fig” needs a space.*
- *Spelling: There are instances of mis-spelled words:*
  - *Line 26: “CaostalApp” is mis-spelled.*
  - *Line 119: “compoents” is mis-spelled.*
  - *Line 143: “synchroning” is mis-spelled.*
- *Punctuation: There are instances of missing periods:*
  - *Lines 109 and 112: Need periods to end these sentences.*
  - *Line 406: Need period at end of sentence.*
  - *Line 27: “four different” can just be ‘four’.*

**Reply:** We thank the reviewer for the careful proofreading and for identifying these typographical and formatting issues. We corrected the noted misspellings, missing spaces around words and citations, and missing punctuation throughout the manuscript. We also performed an additional manuscript-wide proofreading pass to identify and correct similar issues in spelling, spacing, punctuation, citation formatting, figure and table references, and typographical consistency.

We also checked the apparent spacing issue noted around “CMEPS allows.” The manuscript source contains standard spacing at this location; the wider appearance in the PDF results from full text justification rather than an additional space in the source. No textual correction was required there.

Additional typographical and formatting inconsistencies identified during this broader review were also corrected in the revised manuscript.

- *Lines 39–42: This sentence has multiple claims about multiple physical processes. It would be better to support these claims with multiple references.*

**Reply:** We agree. The original sentence combined several distinct coastal processes while citing only a single reference. We have revised this paragraph by separating the different physical processes and adding process-specific references. Storm-surge generation and propagation are now supported by Westerink et al. (2008) and Hope et al. (2013); tidal and estuarine exchange and wetting-drying processes are supported by Chen et al. (2006), Zhang et al. (2016), and Deb et al. (2022); and nearshore wave transformation and wave-current interactions are supported by Newberger and Allen (2007), Kumar et al.

(2012), Moghimi et al. (2013), and Martins et al. (2022). We also revised the description of wave–current interactions to avoid the overly broad statement in the original text.

– *Line 40: Need a hyphen between “wave current”.*

– *Line 49: Should “earth” be capitalized?*

– *Line 49: Should “scale” be pluralized?*

**Reply:** We thank the reviewer, these are corrected.

– *Line 68 and elsewhere: The registered trademark symbol (R ) seems out of place in an academic manuscript. Presumably all of these models are released with licenses that include copyrights, so why not include a copyright symbol (c ) next to every model name and instance? Or better yet, suggest to omit these symbols.*

**Reply:** We agree. The registered trademark symbols associated with WAVEWATCH III have been removed throughout the manuscript. Model names are now presented consistently without trademark or copyright symbols.

– *Lines 170–171: WW3 was not the first wave model to use unstructured grids and a domain decomposition. Suggest to remove the term “major paradigm shift”.*

**Reply:** We have removed this phrase and revised the sentence to describe the implementation of the unstructured-mesh and domain-decomposition capabilities directly and factually.

– *Line 198: What is meant by the phrase “adding caps”? Is this short for capabilities?*

**Reply:** We thank the reviewer for pointing out that the term “caps” was not defined. Here, “caps” refers to the model-specific NUOPC component caps used in the UFS coupling architecture. These caps serve as the interfaces between the native coastal ocean models and CMEPS. In addition to providing the services required for component initialization, time advancement, and field exchange, each cap registers the model-specific grid representation, including whether the model uses a structured or unstructured grid, with the coupling framework. This information enables CMEPS to exchange and map fields among components using different grid structures and resolutions. We have revised the text to define the term “component cap” at first use and to clarify these functions.

– *Line 200: There is a reference to “[t]hese atmospheric fields”, but the previous sentences are about “caps” for the ocean models? This phrasing is awkward.*

**Reply:** We agree that the phrase “these atmospheric fields” was unclear because the preceding text discussed the NUOPC component caps rather than atmospheric forcing. We have revised this transition so that the functions of the component caps are described first, followed by a separate sentence that explicitly introduces prescribed atmospheric forcing and explains its ingestion through CDEPS and transfer through CMEPS.

– *Line 204: Should “radiation stress” be expanded to also include vortex forces?*

**Reply:** We agree that “radiation stress” was too specific in this general description of the coupling framework. We have revised the sentence to use the broader term “wave-derived forcing,” which covers both coupling formulations discussed in the manuscript. The revised sentence now reads: “This allows two-way wave-current coupling, in which wave-derived forcing influences coastal circulation and water levels, while evolving currents and water levels modify wave propagation, refraction, breaking, and dissipation.”

– *Line 214: Can a reference be added for HSOFS?*

**Reply:** We agree. We have added a reference to Vinogradov et al. (2020), which describes NOAA/NOS storm-surge operational forecast development, including HSOFS, at its first mention.

– *Line 242: “ROMS’ ” should rather be ‘ROMS’s’, because ROMS is an acronym and thus not plural already.*

**Reply:** Corrected.

– *Lines 294 (“UFS-Coastal”) and 338 (“the UFS-Coastal”): The use of the article “the” is inconsistent.*

**Reply:** We agree and have standardized the usage throughout the manuscript. “UFS-Coastal” is used without “the” when referring to the system by name, while “the” is retained in phrases such as “the UFS-Coastal framework” or “the UFS-Coastal modeling system.”

– *Line 295: Should “System” be plural?*

**Reply:** Yes. We now use “HPC systems” when referring generically to multiple computing platforms, while retaining official names and acronyms such as RDHPCS and WCOSS.

– *Line 315: This URL is different than the URL provided in line 91. What is the difference?*

**Reply:** The two URLs refer to different repositories. The first URL points to the CoastalApp repository discussed in the development history of UFS-Coastal, whereas the second points to the UFS-Coastal-App repository, which provides the workflow for configuring and running UFS-Coastal applications. We have revised the text at both locations to clarify the role of each repository.

– *Line 330: Should “either” be deleted?*

**Reply:** Corrected

– *Lines 418–419 and 459: What is the difference between a case (e.g. Case 1, line 419) and an experiment (e.g. Experiment #3, line 459)?*

**Reply:** We agree that the terminology was inconsistent. In the revised manuscript, we use “case” consistently to denote each of the five numerical configurations listed in Table 1 (Cases 1-5). The term “experiment” is used only in the general sense when referring collectively to the numerical demonstration. References such as “Experiment #3” have therefore been changed to “Case 3.”

– Line 444: “Fig. 4 demonstrated ....” is awkward, because it anthropomorphizes a figure. It is also dry, in that the text is only a description of what is shown in the figures. The authors should be encouraged to narrate the story told by the results and including supporting references to the figures as necessary.

**Reply:** We agree. We have substantially revised the Results section so that the scientific findings, rather than the figures themselves, are the subject of the discussion. Figure 5 (now) and Table 3 are now cited as supporting evidence for the results instead of being described sequentially. In particular, the revised text discusses the station-dependent effects of including water-level forcing, the remaining underestimation of significant wave height at the 6 and 8 m stations, and the different performance of the two coupled cases across wave height, period, and direction. We also removed broad statements such as “Fig. 4 demonstrated robust agreement” and avoided implying that one coupling formulation consistently outperforms the other across all wave variables.

The revised discussion therefore presents the Duck experiments as an illustration of model behavior under different forcing and coupling configurations rather than as evidence of uniformly improved predictive skill.

– Line 455: Should “was” be ‘were’ to agree with “comparisons”?

**Reply:** Corrected.

– Line 479: “systematic validation” is not accurate, as only one coastal model was used in the validation.

**Reply:** We agree. The phrase “systematic validation” overstated the scope of the study because the Duck application demonstrates only the SCHISM-WW3 configuration and does not validate all coastal-model options available within UFS-Coastal. We have removed this phrase and revised the manuscript consistently to distinguish framework description, regression verification, model demonstration, and observational validation. The Duck study is now described as an illustrative demonstration and evaluation of one supported SCHISM-WW3 configuration rather than as a systematic validation of the entire UFS-Coastal framework.

– Figure 1: It seems awkward to not show the four coastal ocean models on the same horizontal level in this figure. Why is ADCIRC placed above and to the side? Also, the ordering from left to right (SCHISM, ROMS, FVCOM, ADCIRC) does not match the ordering in other instances in the manuscript.

**Reply:** Figure 1 has been revised to place the four coastal ocean models at the same horizontal level and with the same visual hierarchy. Their left-to-right order has also been standardized as ADCIRC, FVCOM, SCHISM, and ROMS, consistent with the ordering used throughout the manuscript.

– Figure 1: The CDEPS box is not connected to anything else in this workflow. Can the figure be revised to show how CDEPS interacts with the other components?

**Reply:** Figure 1 has been revised to connect CDEPS to CMEPS and to show its role in providing prescribed external forcing to the coupled system. The corresponding text in Section 2.2 has also been clarified.

– Figure 1: This is a high-level description of the coupling, but it does not provide details about the mechanics of the coupling. These details are also sometimes missing in the main text. For example, two-way green arrows are used to show the communication between model components, but it is not clear

*what is communicated. What quantities are sent to SCHISM, and what quantities does it send back to the other components? Are the same quantities sent back and forth to ROMS? Or FVCOM or ADCIRC? If not, then can the differences be indicated in this workflow figure? Somewhere, either in this figure or in the main text, it will be good to include a summary of what quantities can be passed between each model component.*

**Reply:** We agree that the coupling mechanics were not sufficiently clear in the original manuscript. To keep Figure 1 readable as a high-level architecture diagram, we have added the detailed explanation to the main text rather than listing all exchanged fields in the figure. Section 2.2 now clarifies that the exchanged fields are defined by the model-specific NUOPC component caps and may differ among ADCIRC, FVCOM, SCHISM, and ROMS. It also summarizes the major categories of exchanged fields. Sections 2.3.1 and 2.3.2 have been clarified to identify the specific fields exchanged between SCHISM and WW3 for the Longuet-Higgins and 3D vortex coupling methods demonstrated in this study.

*– Figure 2: What are the units for the bathymetry scale?*

**Reply:** The bathymetry scale is in meters. We have revised the Figure 2 and its caption to state the unit explicitly.

*– Figure 3: It would be helpful to include the locations where these quantities were observed, either as a label in each sub-figure or in the figure caption. For example, are these the water levels from the FRF8m sensor?*

**Reply:** We agree. We have added a new table in Section 3.1 summarizing the locations and measured variables of the observation sites used in this study. The Figure 3 caption and the corresponding text have also been revised to identify the specific data source for each forcing variable, including FRF\_met\_wind for wind and FRF\_met\_barometer for atmospheric pressure.

*– Figure 6: It would be helpful to include the sign convention for the alongshore and cross-shore velocities. For the alongshore velocities, does a positive value indicate the velocity is directed into the page? For the cross-shore velocities, does a positive value indicate the velocity is directed to the right on the page?*

**Reply:** We have revised the Figure 6 caption to explicitly define the velocity sign conventions using the local coordinate system adopted in the analysis. Positive cross-shore and alongshore velocities correspond to bearings of 71.2° and 341.2° true, respectively.

*– Figure 6: What are the units of the axes? Where is this slice in the overall domain, e.g. where in Figure 1?*

**Reply:** Figure 7 has been revised to identify the horizontal distance in kilometers, the vertical coordinate in meters, and velocity in m/s. The caption now also specifies that the section extends from the shoreline to the FRF\_awac-6m station, whose location is shown in Fig. 3. We chose to describe the section location in the caption rather than add an additional transect line to Fig. 3, which would reduce the readability of the existing domain and observation-site information.

*– Table 1: The caption mentions six experiments, but only five are described in the table and main text.*

**Reply:** Thank you for pointing this out. The caption contained a typographical error. There are five numerical cases, not six, and the table caption has been corrected accordingly. We have also standardized the use of “Case” for these five model configurations throughout the manuscript.