Comment Responses

Dear Referees and Editorial Team,

We have previously provided detailed point-by-point responses to each of the comments, and have explained the changes made at your request.

Therefore, we will now simply indicate the line numbers or pages corresponding with the modified portions of text for each comment. To ease your review of the changes, we will reference locations from the track-changes version of the manuscript.

In addition to comment-specific changes, a brief overview of general modifications to the manuscript is as follows:

- General grammatical corrections throughout the paper
- Additional references in Section 3.1 for the paragraphs discussing fluvial and pluvial mechanisms, to match that of the coastal paragraph
- Refinement of precursor events and environmental conditions explanations in Section 3.3
- Minor further clarification of methodology details in Section 4 and addition of a PRISMA flow diagram (Table A1, Appendix)
- Greater development and clarification of hybrid modelling perspectives and approaches (Section 6.5.3)
- Additional suggestions and references added to Recommendations 1-5 (Section 7)
- Substantial further development of Section 6.4 on Climate Change

- Updated the literature database
    - We have removed 3 invalid papers that conflict with scoping criteria, and have added a further 11 papers that were missed during the initial literature search. The literature database now contains 279 papers.
    - All analysis, statistical metrics, figures, and tables have been recalculated and reproduced. These changes can be seen in the Results and Discussion (Sections 5/6) as well as supplementary tables (Appendix).

Regards,

Joshua Green on behalf of all authors

Referee #1

Dear Referee,

Thank you for the comments and valuable feedback. Please find the attached document addressing each of your points and highlighting any corresponding modifications. We believe these changes greatly enhance the paper.

Regards,

Joshua Green on behalf of all authors

1) Figure 1 (a–b): very simple schematics is shown contributing pluvial and fluvial floods. The contribution from groundwater/baseflow in runoff generations are not shown. Also, there is no schematics for runoff generation mechanisms, such as Hortonian overland flow and the saturation excess overland flow that potentially controls runoff mechanisms.

In this review we consider pluvial, fluvial, and coastal flood processes as the three main drivers of flooding in coastal and estuarine environments; around which we have structured the introductory section. While groundwater/baseflow certainly plays a role, we assigned it to the category of 'other drivers' detailed in Section 3.2. The schematic diagram in Figure 1 is only intended to include the three main drivers (as introduced on page 5) and an example of their compound interaction.

Figure 1 has not been changed for the reasons previously discussed.

2) Lines 143–148: All these examples show cases from the US. The review should have global coverage, including low-latitude and developing countries that are more vulnerable to such natural hazards due to low adaptive capabilities.

We assure the referee that this review does have global synthesis, and in numerous places (particularly Section 6.1) address flooding in low-latitude and developing regions. As an example, in the introduction (Section 1) we mention several recent devastating storm-induced compound flood events and event series that impacted developing countries, namely 2019 East Africa Tropical Cyclone Idai (Madagascar, Mozambique, Zimbabwe, and Malawi) as well as the 2019 Pacific Typhoon Season (East and Southeast Asia). Section 6.1 discusses hotspots and spatiotemporal patterns related to compound flooding for a number of low-latitude and developing regions, including southeast Africa as well as south, southeast, and east Asia.

The sentences referenced (lines 143-148) come in the middle of the introduction (Section 1) in which we highlight the growing public awareness of compound flood events in recent years. Here we chose to use Hurricane Harvey as an example of compound flooding due to its global recognizability with readers, the event's particular role in shifting perspective towards compound events, and finally the large volume of compound flood research dedicated to this particular event should the reader wish to look at additional literature. Only one example was provided here, and thus all the references were for this event, which so happens to be in the US.

This section has not been changed for the reasons previously discussed.

3) Lines 158-163: Guan et al. (2023) have presented a synthesis paper on compound pluvial- fluvial model and highlighted the importance of including damage models for risk management.

Thank you very much for bringing this paper to our attention. We have included this paper in the introduction (Section 1) where we discuss any existing review-style literature on compound flooding.

The paper Guan et al. 2023 has been referenced on lines 156-159.

4) Lines 257-259: A multivariate storm event with peak and volume also qualifies for compound event as they are tied together with dependence framework. Refer to Leonard et al. (2014) for details.

We agree that a multivariate storm may be considered as a compound event according to Leonard et al. (2014) as its components would exhibit dependence.

The lines referenced (257-259) are within the paragraph of Section 2 discussing the definition from the IPCC SREX (Seneviratne et al., 2012). Here we emphasize the aspect of 'event clustering' as this is explicitly stated in the IPCC definition (unlike Leonard et al. 2014).

The following paragraph (lines 268-277) addresses Leonard et al. (2014) within which we do discuss the requirement of dependence. An example 'non-compound event' is given involving independent atmospheric river rainfall and snow-melt induced river discharge. At your request, we will also provide a 'compound event' example' (according to Leonard et al. 2014) using a multivariate storm event involving dependent variables (line 275).

An additional example of compounding has been provided as previously stated (lines 280-281).

5) Line 320: its seasonal shifts rather than 'weather seasons'.

We have modified this sentence as advised.

See line 327.

6) Line 323: Fluvial flooding also depends on topography, urbanization controlling runoff and infiltration mechanisms due to impervious surfaces, soil texture and structures, catchment size.

Yes, we agree that topography and urbanization play an important role in controlling runoff and infiltration. We believe that the later mentioned properties have already been captured in the text, with land cover addressing 'impervious surfaces', soil type covering 'soil texture and structure', and the existing mention of catchment size.

We have now added in 'topography' and have changed 'soil type' to 'soil properties' to encapsulate all relevant soil characteristics.

See lines 329-331.

7) Lines 330-339: Infiltration excess process - mostly results due to limited hydraulic capacity of drainage systems, which act as a weir or orifices, depending on the water depth surrounding the system. The urban flood duration depends on capacities of drainage systems, infiltration capacities of soil and evaporation of catchment & runoff volume. Refer to Mark et al., (2004).

We recognize that further citations could be provided for this paragraph. We have referenced Mark et al. (2004) and Bronstert et al. (2023), as well as further developed the discussion of rainfall-related saturation excess and infiltration excess.

The paragraph on pluvial flooding (pg. 19) has been modified as previously stated (lines 339-344).

8) Line 362: Groundwater flooding, ‘a temporary rise’.

Flooding from groundwater can occur on a range of timescales. While groundwater flooding certainly has the potential to be a short-term process, water table levels may change seasonally over the span of several months. In many glacially-fed watersheds, groundwater rises for several months in the spring and only lower in the subsequent fall (e.g. glacial/coastal British Columbia, Melone 1985). Furthermore, given the ever-changing climate we cannot be certain that groundwater levels in a region will always return to previous levels. We do not feel that it is appropriate to suggest that groundwater flooding in general is ‘temporary’.

This sentense has not been changed for the reasons previously discussed.

9) Line 396: The role of catchment wetness for flood generation process was shown for a large tropical (Ganguli et al., 2019) and mid-latitude (Merz et al., 2018) catchments.

We have now included Ganguli et al. (2019) in this section.

The paper Ganguli et al., 2019 is now referenced in the sentence on temp/heat-flood interactions (lines 408-410).

10) Lines 397-400: Here relative humidity plays a role. Extreme dry heat beyond certain temperature often leads to moisture limitations/drying, leading to dry spell. Refer to Fig. 2 in Ganguli and Merz (2024).

We have now mentioned the role of relative humidity and increased precipitable atmospheric water.

The sentence on temp/heat-flood interactions has been further developed (lines 412-415).

11) Lines 400-402: Wildfire often triggers landslides due to changes in mechanical properties of the

soil --> debris flows and flash floods. The complete event chain should be described. Refer to (Belongia et al., 2023; Monga and Ganguli, 2024).

Yes, we agree that wildfire often create conditions that are highly susceptible to landslide events (in addition to flooding). This is in fact mentioned in parts of Table 1 (De Ruiter et al. 2020; Gill and Malamud 2014).

We have cited Belongia et al., 2023; however do not feel that Monga and Ganguli, 2024 is appropriate given the scope of this section. We fully recognize the relationship between fires and landslides, however feel that this deviates too greatly from the flooding focus of this paper. There is no clear boundary at which point a flood becomes a debris flow and vice versa, and this review does not address the relationship between flooding and landslides. We do not wish to distract too greatly from the main topic of the review and therefore will not be discussing landslides.

Two additional papers (Bayazıt and Koç, 2022; Belongia et al., 2023) have been referenced in the sentence on fire-flood interactions (lines 415-418).

12) Lines 509-513: South Asia in general and India as an example, is underrepresented here. Although a few recent studies have been available recently. For example, (Ganguli et al., 2019; Ganguli and Merz, 2024; Khatun et al., 2022; Mohanty et al., 2020).

Yes, despite flooding being a paramount issue in the region, the systematic literature search only uncovered 8 papers on coastal compound flooding specific to South Asia (6 India, 2 Bangladesh, 0 Nepal, 0 Sri-Lanka). As of present, the vast majority of published compound flood literature focuses on the Global North. This a key finding of this review, and the limited geographic coverage of research is highlighted in Recommendation 2. As this review was limited to English-written literature, it is unknown if there is substantial published research on compound flooding in South Asia in the respective local languages.

Ganguli et al., 2019 – While this paper addresses flooding, it is not primarily about compound flooding and thus does not adhere to the literature selection methodology outlined in Section 4.

Ganguli and Merz, 2024 – As detailed in the Section 4 methodology, the synthesis and analysis component of the review only considers papers for the literature database up to the year 2022. As this paper was published in 2024 it is not considered within the scope of this review

Khatun et al. 2022 – This study is already included in the review analysis.

Mohanty et al., 2020 – This paper was missed during the literature search process. It has now been added to the literature database and the analysis figures and statistics have been recalculated and updated throughout the paper. Thank you for sharing.

We have now added the missed paper Mohanty et al., 2020 to the literature database. As stated previously, all of the analysis and figures have been updated. South Asia is addressed in the Asia portion of section 6.1 (lines 707-719).

13) Lines 518-520: A few journals were not included, which regularly publishes articles on

compound flooding, Geophys. Research letters, Earth's Future, Environmental Research Letters, NpJ Climate & Atmospheric Sciences.

For the sake of brevity, the referenced sentence only lists the top 5 most frequent journals. Geophysical Research Letters, Earth's Future, and Environmental Research Letters are in fact all noted in Figure 4. One paper from Nature Climate & Atmospheric Science (Ridder et al. 2022) was included in this paper, but not listed, as Figure 4 was limited to publication sources with at least 2 papers to ensure readability.

As explained, all of the main journals have been accounted for. Nothing requires changing.

14) From page 35: Line 627: Khatun et al. (2022) analyzed joint pluvial-fluvial compound flood extremes along the Mahanadi catchment, which is close to coast.

The line referenced (627) discusses pluvial-fluvial extremes in the 'North America' subsection of Section 6.1. We have instead correctly referenced Khatun et al. (2022) in the 'Asia' subsection following your suggestion in Comment 15.

This paper is referenced at lines 712-714.

15) Page 37: lines 679–688: pluvial–fluvial flood drivers are well established for Mahanadi River basin catchments (Ganguli et al., 2019; Khatun et al., 2022) and three geographically diverse flood-prone coastal catchments in western and eastern catchments of India (Mohanty et al., 2020).

We have included these references in the section discussing pluvial-fluvial findings. Furthermore, we have added several additional citations to papers focused on South Asia (Sampurno 2022, Pandey 2021, Ikeuchi 2017, Shahapure 2010, Vongvisessomjai and Rojanakamthorn 1989).

The additional papers have been referenced at lines 712-718 and 946-948

16) Line 836: … German dyke breach led to a compound inland pluvial – damming/…

Thank you for bringing this to our attention. This indeed appears to be a non-coastal paper as it focuses on interior central Germany. To ensure a consistent systematic review methodology, we have removed Thieken et al. (2022) from the literature database. Upon this finding, we have meticulously gone through the literature database and identified two addition papers (Mohor et al. 2020; Sui and Koehler 2001) that both focuses on compounding in interior/southern Germany. Thus we have removed three papers total.

As Thieken et al. (2022) and Mohor et al. (2020) were the two main examples of compounding involving damming/dam-failure, we have done considerable further literature searching and have identified two damming/dam-failure compound flooding papers that appropriately take place at the coast (Kim and Sanders 2016; Yang et al. 2021). These two papers have now been added to the literature database, and this paragraph of the review has been rewritten.

Following these changes, all the figures and literature database analysis have been recalculated and corrected throughout this review.

As stated previously, we have removed three papers () from the review due to incompatability with the scope criteria as outlined in Section 4. We have subsequently added in two new papers. Any references to the removed papers have been corrected throughout the paper. Modified lines include 570-571 and 868-875.

17) Page 44: Line 860: Lucey and Gallien (2022) showed that although annual maximum sampling is commonly used for characterizing multivariate events, annual maximum sampling may substantially underestimate marine water levels for extreme events.

We are unsure what the referee wishes us to address here. The referenced sentence (line 860) discusses the projected increased frequency of flood drivers due to climate change, while the referee's comment is about uncertainty associated with annual maximum sampling approaches.

As these two topics are unrelated, we wonder if the referee meant to address the Statistical Methodology Subsection (6.5.2) which mentions the use of maximum sampling. We have now discussed this finding in the appropriate section.

See lines 1083-1086.

18) Lines 872: Using a time-dependent statistical model on tide gauge data along U.S. and Pacific Basin coastlines, Sweet et al., (2024) showed that extreme coastal water level probability distributions shift on an annual basis, with shift higher & lower with tide cycles, climatic pattern & SLR. Likewise, Hague and Talke (2024) showed that changes in tidal amplitudes generally have a much larger impact on flood frequencies than equivalent share of changes in storm surge magnitudes.

We have added in several additional references and further developed discussions around climate-driven shifts in flood seasonality and the changing roles of individual coastal components.

Section 6.4 has been substantially further developed as stated above. Changes addressing the comment requests can be found at lines 925-943.

19) Line 880: … combination of heavy precipitation events, SLR, tidal cycles, and …

This sentence has been modified as advised.

See lines 963-966.

20) Line 978: Heinrich et al., (2023) analyzed the joint occurrence of extreme river discharge events and storm surges in northern and central Europe. Likewise, in line 988: to identify rivers that show a higher number of compound flood events than expected by pure chance, Heinrich et al. (2023) utilised a Monte Carlo approach.

Thank you for sharing these publications. As detailed in the Section 4 methodology, this review only considers papers for analysis and addition to the literature database up to the year 2022. As both of these papers were published in 2023, they are not considered within the scope of this review.

As previously explained, this section has not been changed.

21) Line 1002: at a standard significance level

This sentence has been modified as advised.

The modified sentence can be found at line 1091.

22) Lines 1002-1006: they can describe event coincidence analyses, including precursor coincidences.

We have added a few sentences on event coincidence analysis following the discussion of joint probability.

Coincidence analysis is now addressed on lines 1096-1100.

23) Line 1051: However, reanalysis records has their own limitations for not adequately capture several variables, such as specific humidity, windspeed and their directions, including extremes are often under-represented.

We have added further discussion, addressing the limitations of climate reanalysis and statistical event set generation.

We now discuss limitation of reanalysis records on lines 1153-1156.

24) Lines 1305 and beyond: recently, Feng et al. (2024) developed multi-scale coupling framework within the Energy Exascale Earth System Model (E3SM), integrating global atmosphere and land with interactively coupled river and ocean models using variable meshes to simulate tide and storm surges during the CF events.

Thank you for sharing this publication. As detailed in the Section 4 methodology, this review only considers papers for analysis and addition to the literature database up to the year 2022. As this paper was published in 2024 it is not considered within the scope of this review. However, there are two other appropriate compound flood publications that demonstrate the use of ocean-land-atmosphere coupled modelling systems that we will reference here (Saleh et al. 2017; Blanton et al. 2018).

See lines 1492-1494 and 1508-1509.

25) Page 64: Recommendation 5: they should discuss about an ensemble forecast systems, considering river-ocean interactions, including coastal backwater effects. Refer to my comment above.

We have briefly mentioned ensemble forecasting and ocean-land-atmosphere coupled modeling systems in the subsections for Recommendation 4 and 5.

Same as comment 24. See lines 1492-1494 and 1508-1509.

26) Table A.1 include recent references and as stated earlier in general Asia and Australia are under-represented in their write-up. Whole focus is on either US and Europe.

We are excluding more recent publications as the scope of this review paper was limited to the year 2022. Section 4 of this paper details the methodology used for literature search and literature database paper selection. While it would be nice to have included 2023/2024, this is sadly not feasible given the substantial amount of resources that would be required and the limited time constraints of the authors. We hope the reviewer can understand the need to maintain a consistent methodology. Note that this review does reference general papers published in 2023 for the purpose of supporting arguments, however none of these papers are part of the analysis or included in the compound flood literature database.

We assure the referee that there is considerable discussion on Asia and Australia throughout the review and considered in analysis. Nonetheless, we have gone through and provided a few more examples in several places. As of present, the vast majority of published compound flood literature focus on the Global North. This a key finding of this review, and the limited geographic coverage of research is highlighted in Recommendation 2. This review does not seek to emphasize any geographic region over another, and merely aims to provide an understanding of the current state of research.

We have added a select few additional references representing regions of Asia. There are primarily seen throughout the Asia portion of section 6.1 (lines 707-719), as well as section 6.4 (lines 927-929 and 946-948) discussing climate change.

Referee #2

Dear Dr. Moftakhari,

Thank you for the comments and valuable feedback. Please find the attached document addressing each of your points and highlighting any corresponding modifications. We believe these changes greatly enhance the paper.

Regards,

Joshua Green on behalf of all authors

1) L113-115 and 301-312: in various points throughout the article, authors have referred to the fluvial, pluvial, coastal, groundwater, damming/dam failure, and Tsunami sources of flooding as drivers, and in L115 they refer to these as sources. To me, here and in the previous literature, this is one of the unclear points that needs further thought and agreement. To my understanding, these six items are basically the sources or the components of a compound flooding events that are driven by drivers like hydro-meteorological forcing. I think this is a point that authors could put more thought and come up with a good selection that helps the community of CCF to use a homogeneous language in distinguishing between sources/components and drivers.

Thank you for this question. Throughout the paper we use the term 'driver' as to be the direct mechanism that causes the flooding. Yes, the use of 'source' on L115 may be misleading as multiple drivers can have a shared source, for example fluvial and groundwater flooding can both originate from a 'glacial melt' source.

As you say, some might interpret 'source' to be the hydrometeorological forcings that lead to the drivers. For our purposes, we consider these as separate hydrometeorological 'modulators' that shape the occurrence and characteristics of the flood driver. To avoid confusion, we have changed this sentence to use 'driver' as has otherwise been used all throughout the paper.

We have change the wording of line 115.

2) L240-248: better to be consistent with the direct quotations in various points of the article. i.e. here L240-242 with single quotation mark, and in L244-248 with double quotation mark and italic font.

We agree and have removed the quotation from the first instance on L240-242 to remain consistent.

We have corrected the punctuation. See lines 247-249.

3) L315: large volumes of "excessive rainfall and snowmelt"... this way is more clear

We have modified this sentence as advised.

See line 326.

4) L326: I'd replace "rapid heavy rainfall" with "intense rainfall". The term intense encompass both depth (heavy) and time (rapid) characteristics of a rainstorm.

We have modified this sentence as advised.

See line 339.

5) L376: I'd replace "reservoirs" with "control infrastructure" as not all the examples (levees/dykes) are suitable to be called water reservoirs.

We have modified this sentence as advised.

See lines 393-394.

6) L391: abnormally high or elevated soil moisture conditions?

We have modified this sentence to provide greater clarity.

We have reworded this sentence at lines 409-411.

7) L396-400: Prolonged drought and wildfire yield in vegetation loss that in turn promotes reduced roughness against flood water movement so more intense flooding. Also, the loosened soil after wildfire favors mudflows that are significantly more destructive than freshwater flooding.

We have modified this sentence to provide greater clarity.

A sentence discussing the interactions of drought, fire, and heat on flooding has now been included (lines 421-423).

8) L403: being close to the end of 2024, and given the fact highlighted in L493-495 and Figure 2 that the CCF literature is growing exponentially, I am curious why 2023 is excluded?

This was a highly demanding and detailed review that began in early 2022 and finished in mid-2023. As papers were continuously being published throughout the year, we limited the scope of the review to only papers from 2022 and earlier. This review was initially planned to be released in 2023, but unfortunately the publication process has been very slow due to matters beyond our control.

While it would be nice to have included 2023/2024, this is sadly not feasible given the substantial amount of resources that would be required and the limited time constraints of the authors. The volume of compound flood literature is beginning to be published at a pace that is faster than our ability to synthesize at the level of detail we wish to uphold in this review. This review captures the key foundational literature whose core discussions, approaches, and findings have shaped the research space. With the exponential growth of literature in years to come, a highly comprehensive and detail review will be a considerable challenge. At some point a threshold must be set to prevent having to continuously add more papers.

We note that this review does reference general papers published in 2023 for the purpose of supporting arguments, however none of these papers are part of the analysis or included in the compound flood literature database.

Going forward, there may be value in creating a collaborative community developed live portal/database to track compound flood literature and findings across the research space. Should anyone wish to collaborate in this type of live product we are open to providing support.

We have previously explaining our reasoning, and have not changed the methodology of this review.

9) L435: Among the terms in Table 2, I am afraid there are few alternative terms that could have been used in the literature that is not included here, which may result in missing published literature. For example, the terms "sequence" or "consecutive" could be used when referring to "cascading" events, or "simultaneous" is suitable alternative and commonly used at places where co-occurrence is the case. Also, while various components of sea level (i.e. tide, surge, wave) are included, the term "sea level" itself is not included.

Thank you for highlighting this. We did in fact use ‘consecutive’ and ‘simultaneous’, but it seems these were not added to the table. The table has now been updated to correctly include these terms. However, we did not use ‘sequence’ or ‘sea level’ and recognize that this may have led to missing some of the literature.

Table 2 has been updated to include the two keywords that we used, but had forgotten to list (pg. 24)

10) L453: I guess the definition of drivers and precursor events are scale dependant. For example sea level rise can be considered an environmental condition that alter the interaction among various flood drivers (i.e. through altered frictional characteristics). Later SLR is considered among the drivers in L879.

An earlier version of this review considered ‘SLR’ (also ‘wind’) as an individual driver. However, we decided that SLR could not be clearly separated from any one coastal component and may cause confusion, so it was removed. To be clear, L879 is not considering SLR as its own driver. It is merely mentioned given it plays a role. This sentence has been slightly rephrased this sentence to avoid any confusion.

We have substantially further developed Section 6.4. The sentence addressed here has been reworded to improve clarity (lines 964-965)

11) L606: if possible would be much more impactful if you create a map to summarize the contents under the section 6.1

There isn't a clear approach for graphically collating the combination of qualitative/quantitative information discussed across various papers given the different metrics and approaches used. We believe it is better to point the reader towards the available hotspot and dependence studies that address various driver combinations at global/regional scales.

As previously exaplained we have not changed this section.

12) L618: storm surge and intense rainfall which exacerbate pluvial and/or fluvial flooding

We have modified this sentence as advised.

See line 643.

13) L771: the following papers can be useful citations here

Hoitink and Jay (2016), Tidal river dynamics: Implications for deltas, Reviews of Geophysics, https://doi.org/10.1002/2015RG000507.

Lanzoni, S., and G. Seminara (1998), On tide propagation in convergent estuaries, J. Geophys. Res., 103(C13), 30,793–30,812.

Thank you for sharing these papers. We agree they provide support and context to the discussions around dominant drivers and estuary dynamics. These have now been cited in the paper.

The two papers (Hoitink and Jay, 2016; Lanzoni et al., 1998) have been cited in lines 778 and 796-799 to support discussion of coastal processes.

14) L852-855: however published after 2022, it can be a good resource for interested readers on this topic

Radfar, S., Mahmoudi, S., Moftakhari, H., Mckelvey, T., Bilskie, M. V., Collini, R., Alizad, K., Cherry, J. A., Moradkhani, H. (2024). Nature-based solutions as buffers against coastal compound flooding: Exploring potential framework for process-based modeling of hazard mitigation. Science of the Total Environment, 938, 173529, https://doi.org/10.1016/j.scitotenv.2024.173529.

We are aware of this great paper, however, as detailed in the Section 4 methodology, this review only considers papers for analysis and addition to the literature database up to the year 2022. As this paper was published in 2024 it is not considered within the scope of this review.

For the reasons explained previously we have not changed this section.

15) L1032: I believe here is a point that a definition for "hybrid" compound flood modeling must be proposed. Here it says "involving linking numerical and statistical approaches ... can complement each other or focus on multiple aspects of modelling in a way that would not be possible when using numerical or statistical approaches in isolation." These days there is a lack of consistent definition for this term in the community. What constitutes hybrid modeling, that distinguishes from other categories of modeling. I encourage the authors to use this opportunity to clarify this. To me (mostly in line with the descriptions already in the article, hybrid modeling consists reasonable integration of various modeling schemes (process-based and data-driven) with complementary skills, that together can provide a level of understanding/information that cannot be achieved efficiently in isolation.

Yes, to our knowledge there is no current standard definition related to “hybrid flood model”. There are a variety of ways for expressing this concept, however in this review we use “hybrid” to convey some form of analysis that employs a combined statistical and numerous methodology. This is not necessarily an agreed-upon terminology within the Earth systems modelling community, and thus might not align with the views of others. Some literature refers to the combination of multiple linked numerical model components as a “hybrid” model. Others use “hybrid” as a reference to a class of ML based statistical models. We have added further explanation to the beginning of Subsection 6.5.3 to better clarify how we use the term “hybrid” in this review, and how this does not have a consistent meaning across the research space. Thank you for addressing this point. We believe that modifying this section has greatly strengthened the paper.

We have substantially further developed Section 6.5.3 (pg. 62-63), clarifying our definition of ‘hybrid’ and the perspective of others (lines 1123-1131).

16) L1151-1180: I am not convinced that this category is significantly different than the "risk assessment", as all the examples mentioned too are common examples for risk assessment, and I think adding a new category here would be more confusing than helpful.

We believe there is value in distinguishing “impact assessment” as being different from “risk assessment” in that it seeks to quantify the realized impact/damage following an event, rather than the potential risk of a theoretical event. Thus, risk assessment focuses on the theoretical pre-event, while impact assessment examines the actual repercussions of a specific observed event.

As previously explained, this section has not been changed.

17) L1226: UNDRR

Thank you. A select few of the acronym citations (i.e. UNDRR, NCEI, NOAA) were in lowercase due to reference manager settings. We have corrected all instances of this throughout the paper.

Corrections in acronym capitalization are all throughout the paper.

18) L1224-1252: While published after 2022, could enhance the discussions on the policy challenges regarding CCF

Lewis, M., Moftakhari, H., & Passalacqua, P. (2024). Challenges for compound coastal flood risk management in a warming climate: a case study of the Gulf Coast of the United States. Frontiers in Water, 6, https://doi.org/10.3389/frwa.2024.1405603.

We are aware of this great paper, however, as detailed in the Section 4 methodology, this review only considers papers for analysis and addition to the literature database up to the year 2022. As this paper was published in 2024 it is not considered within the scope of this review.

As previously explained, we have not included this paper in the review analysis.

19) L1332: ASCE-MOP can be another example

https://ui.adsabs.harvard.edu/abs/2023esoar.56062915G/abstract

https://ui.adsabs.harvard.edu/abs/2023AGUFMNH24A..05G/abstract

Yes, this is a good example. We have now included the ASCE-MOP as another instance of ongoing collaborative efforts.

See lines 1439-1441.

20) L1364: parameter choice and interpretation of outputs.

We have modified this sentence as advised.

See lines 1472-1473.

21) L1397: further recommendations under section 7 could be:

- strategic data collection for CCF at data sparse regions

Yes, this is a good point. We have now addressed this in part of Recommendation 2.

See lines 1456-1457.

- curricular development and creating educational materials to train the next generation of scientists and practitioners for CCF

Yes, this is a good point. We have now addressed this in part of Recommendation 3.

See lines 1474-1479.

22) In the supplementary materials accidentally found that there are two items Bevacqua et al., 2020a, and Bevacqua et al., 2020b, while there is only one Bevacqua et al., 2020 item listed in the reference list. Worth checking the consistency.

Table A1 in the Appendix contains all the papers that were used for analysis and make up the compound flood literature database. Not all of these papers are cited in the review's body text, and therefore are not included in the bibliography. For example, Bevacqua et al., 2020a (10.1038/S43247-020-00044-Z) and Bevacqua et al., 2020b (10.5194/NHESS-20-1765-2020) are both considered in the review analysis, but only the first is cited in the text. Nonetheless, we appreciate your detailed eye and the support in checking for potential errors.

To avoid any missunderstandings in the case of multiple publication by one author in the same year, we will be providing the full literature database spreadsheet as supplementary material. This will include a few additional paper metrics (e.g., DOI, Title, Abstract) to prevent reader confusion.

23) In appendix 2: some coupled versions of models or submodules (ADCIRC-SWAN or Delft3D-Wave, or CoSMoS vs Hydro-CoSMoS) are listed as a separate model. I think given the possibility of coupling between any of the models mentioned in this table better to avoid listing coupled versions as a separate model. In terms of implications, I don't think SWMM and XPSWMM are conceptually different (however the latter offers more features, but one is listed as a hydrologic model and the other as a H&H model.

Yes, we agree that this may at times be unclear. We were initially unsure whether or not to separately list examples of coupled/linked models. As you say, there can be many combinations for coupling the models within this table. We have decided to remove instances of linked model pairs where it is plainly apparent which models are being linked (e.g. ADCIRC-SWAN and sECOM-NYHOPS). However, we will keep entries for 'model systems' with branded name as we believe that the linking of modules in a certain way can define a particular model system. For example, LOOFS is a model system involving the linking of FVCOM and CICE. We are keeping both SWMM and XPSWMM, as while they are similar, they are operated by separate entities and have varying differences. Similarly, while ASGS-STORM is built upon ASGS, it is a fundamentally different model system with various other capabilities.

We have modified Table A2 as previously described. See pgs. 128-130.

Public Comment #1

Dear Dr. Hermans,

Thank you for the comments and valuable feedback. Please find the attached document addressing each of your points and highlighting any corresponding modifications. We believe these changes greatly enhance the paper.

Regards,

Joshua Green on behalf of all authors

1) The authors mention that many studies project an increase in compound flood risk or changes in drivers of compound flooding implying increased flood risk. However, studies have also shown that in some regions the probability of compound flooding may decrease (e.g., in the Mediteranean), at least when excluding SLR. I think it would be good to mention this.

Yes, we agree that the current discussion on the influence of climate on compounding does not paint a full picture of the state of knowledge. Thus, we have substantially rewritten subsection 6.4. There is now further discussion on the considerations of climate nonstationarity and observed shifts in the seasonality of compounding and the relative projected influence of individual drivers. Additionally, we address regions where compounding flood joint probability and driver dependence are projected to decrease.

We have substantially further developed subsection 6.4 adding several new paragraphs (pg 53- 56).

2) Sorry for the shameless self-promotion, but I think it would be good to add that projections of changes in compound flooding are sensitive to internal variability and robust projections require large ensembles of climate model simulations (https://doi.org/10.1029/2023EF004188). This raises several issues such as how to efficiently translate climate model simulations to changes in compound flooding drivers and impact. In general, I think that robust projections of compound flooding are lacking and this should be reflected more strongly in the review.

Thank you for raising this topic. We agree that this is an important issue worthy of addressing in the review. We have now discussed findings from some of the existing studies on future compound flooding under climate change, as well as the uncertainty, errors, challenges, and limitations around climate model ensembles. We would very much like to include Hermans et al. 2024, however, as detailed in the Section 4 methodology, the synthesis and analysis component of the review only considers papers for the literature database up to the year 2022. To maintain a consistent methodology we won't be able to include this compound flood study in the analysis and literature database. We greatly appreciate your input and hope you understand our reasoning.

We have incorporated the material discussed here in lines 944 – 957.