We sincerely thank the reviewers for their valuable comments and suggestions, which have significantly contributed to improving the manuscript. Below, we have reproduced the reviewers' comments in black font, followed by our responses in blue font.

Reviewer 1

1. The author must constructively change the abstract in terms of adding error analysis values in terms of **PBIAS** to the result. The Author needs to write consistently.

In the abstract, we present the DEM analysis using root mean square error (RMSE) and have revised it to include the PBIAS results. Additionally, we have incorporated the PBIAS equation into Section 4.1.3, Evaluation of DEMs using the ICESat-2 ATL08 Benchmark, and add the PBIAS results to Table 6, which summarizes the statistical metrics comparing 10 DEM products against the ICESat-2 benchmark.

$$PBIAS = 100\ x \left[\frac{\sum_{i=1}^{n}(Y_i - \hat{Y}_i)}{\sum_{i-1}^{n}\hat{Y}_i}\right]$$

Where $\hat{Y}i$ represents ICESat-2 ATL08 elevation, Yi denotes the elevation for each DEM (i.e., LDD DEM, JICA, merged LDD-JICA DEM, ASTEM GDEM V3, SRTM DEM, MERIT DEM, FABDEM v1-2 DEM, GLO30 DEM, TanDEM-X, and TanDEM-EDEM), and n is the number of observations.

The ideal value of PBIAS is 0: positive values indicate that the DEM products are biased toward overestimating compared to the ICESat-2 ATL08 benchmark, while negative values indicate a bias toward underestimation.

Table 6: Table of statistical metrics, comparing 10 DEM products against the ICESat-2 benchmark. The resulting averages are computed across the datasets in study area.

DEM product	Statistical method				
	ME (m.)	**MAE (m.)**	**MSE (m.)**	**RMSE (m.)**	**PBIAS (%)**
LDD	-1.3	1.64	5.45	2.33	-34.76
JICA	-0.65	1.04	3.51	1.87	-17.00
merged LDD-JICA	-0.68	1.08	3.74	1.93	-15.38
ASTER	4.77	5.57	44.28	6.65	47.71
SRTM	2.04	2.58	12.92	3.59	27.99
MERIT	1.56	1.79	6.76	2.6	22.99
GlO30	0.84	1.3	5.89	2.43	13.87
FABDEMv1-2	0.25	0.8	3.79	1.95	4.59
TanDEM-X	0.94	1.73	13.29	3.65	15.24
TanDEM-EDEM	0.91	1.43	7.74	2.78	14.84

We have revised the abstract (Lines 20–22), Section 4.1.3: Evaluation of DEMs Using ICESat-2 ATL08 Benchmark (Lines 358–370), and updated Table 6 in Section 5.2.1: Point Comparison Evaluation Results (Lines 479–451 and 490–494) of the revised manuscript.

2. The author must mention where they got data and the frequency of data. Statistical analysis of data must be given in Tabular format (Like Table no 1, 10.1061/(ASCE)IR.1943-4774.0001689).

Regarding the reference from Table 1 (10.1061/(ASCE)IR.1943-4774.0001689), it provides statistics on runoff data.

Table 1. Descriptive statistics of runoff data for 0° slope

Statistical parameters	Training set (252)	Testing set (108)	Total data set (360)
	Rainfall intensity 1 L/min		
Min	0.01	0.03	0.01
Max	1.07	1.07	1.07
Mean	0.511	0.593	0.536
Kurtosis	−0.763	−0.874	−0.842
Skewness	0.211	−0.090	0.127
SD	0.283	0.297	0.289

However, this paper focuses on DEM products and the impact of the DEM on hydraulic modeling, as explained in Table 2. We have included a detailed statistical analysis of the DEM products, which was added in the appendix, as shown in the table below.

DEM product	Statistical Parameters				
	Min	Max	Mean	Standard Deviation	Median
ICESat-2 ATL08	-7.00	218.42	5.29	6.81	2.49
LDD	-9.41	254.27	4.34	7.75	1.51
JICA	-22.97	239.31	4.20	5.48	1.95
merged LDD-JICA	-16.00	378.73	5.21	8.26	1.87
ASTER	-2.00	267.93	6.23	8.23	2.85
SRTM	-34.97	262.17	8.02	8.47	5.25
MERIT	-1.29	257.32	7.53	8.17	4.34
GlO30	-15.93	271.15	6.87	8.30	4.15
FABDEMv1-2	-14.99	267.93	6.22	8.23	2.85
TanDEM-X	-7.00	274.93	7.06	8.48	4.24
TanDEM-EDEM	-36.91	271.26	6.93	8.35	4.13

We have revised Section 3.3 Digital Elevation Models (DEM) (Lines 159), and updated Table A 1: Descriptive statistics of ten different DEM products in Appendix A of the revised manuscript.

3. Fig 2: it should be clearly described in terms of scientific manner.

We have revised and incorporated this description into the manuscript, as illustrated in the figure below:

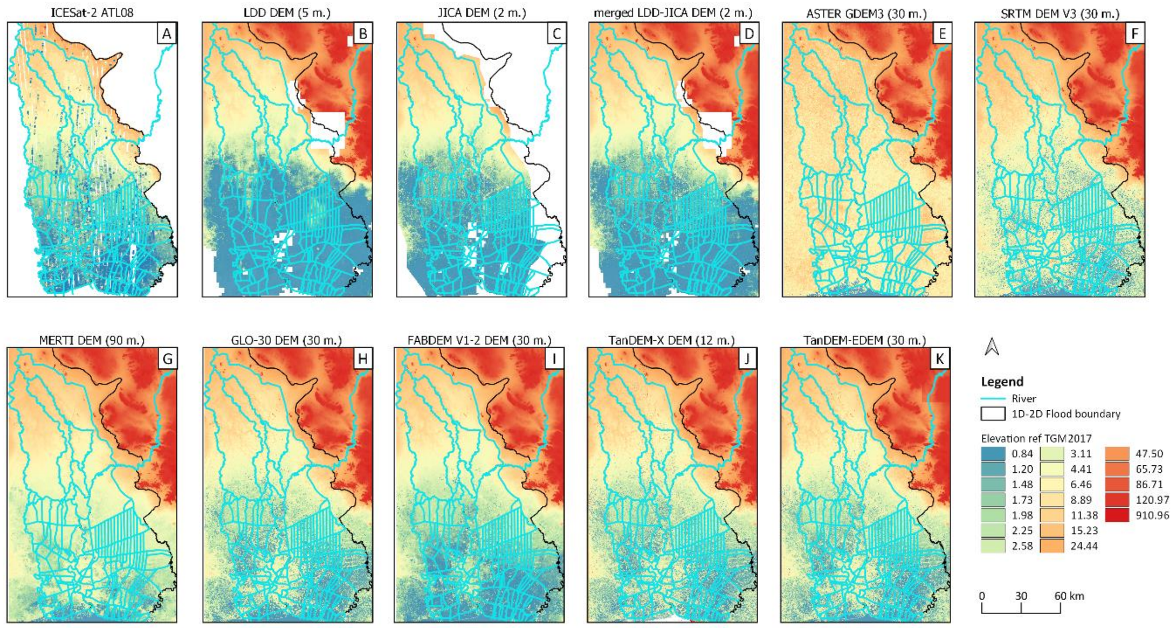


Figure 2: ICESat-2 ATL08 and DEM products, including: A) ICESat-2 ATL08 surface elevation, B) Land Development Department (LDD) DEM, C) JICA DEM, D) Merged LDD.JICA DEM, E) ASTER GDEM Version 3, F) SRTM DEM Version 3, G) MERIT DEM, H) GLO-30 DEM, I) FABDEM v1.2 DEM, J) TanDEM-X DEM, and K) TanDEM-EDM.

We have updated the description and Figure 2 on Line 169, Page 8, of the revised manuscript.

4. For better understanding, Please add more recent literature (2024) regarding the bidirectional flood models using satellite laser altimetry.

Although recent literature from 2024 is limited, we have revised the manuscript to include references from Nandam and Patel, 2024, which evaluated the suitability of global DEMs for hydrodynamic modeling in data-scarce regions using satellite laser altimetry, and Frias et al., 2024, which enhanced the accuracy of 2D hydraulic models through DEM correction using machine learning and satellite laser altimetry. These studies will be cited in the introduction.

We have revised on lines 64 – 65 in Section 1: introduction of the revised manuscript.

5. Please modify the objective section for a clear understanding, i.e., the novelty part should be mentioned.

We have revised the manuscript. We believe that our paper has two novel aspects: (1) Comprehensive DEM evaluation against ICESat-2 benchmark for the Thailand domain. (2) Systematic comparison of simulated 2D inundation patterns with inundation patterns derived from satellite EO flooding patterns.

We have revised on lines 86-96 in Section 1: introduction of the revised manuscript.

6. There are so many techniques in the recent world for the flood model; why does the author use a specified Method for research purposes? Is there any specific reason for this?

Currently, numerous techniques exist to enhance the performance of 1D-2D flood models. However, the accuracy of simulated floods heavily depends on the quality of the DEM data, making it essential to validate DEMs before use. Land use is constantly changing, and surveying DEMs is both timeconsuming and expensive. Global DEM products offer a viable alternative, as they are often freely available and up-to-date, but they still require validation prior to implementation. ICESat-2, which continues to operate and measure surface elevation, provides valuable data for validating DEMs.

Riverine classification based on surface water extent (SWE) from satellite data remains a significant challenge with limited literature available. In this study, we applied new techniques to address the issue.

No changes have been implemented in the manuscript in response to this comment.

7. The author must add statistical components/parameters of collected data in the case study section.

As explained in response to Question 2, we have included this information in the appendix.

We have revised Section 3.3 Digital Elevation Models (DEM) (Lines 159), and updated Table A 1: Descriptive statistics of ten different DEM products in Appendix A of the revised manuscript.

8. Eq 3-6; please add a recent citation for reference purposes. [Read this paper: 10.1016/j.gsd.2024.101178, 10.1016/j.clwat.2024.100003, 10.1016/j.hydres.2024.04.006, 10.1007/978-981-15-5397-4_75, 10.1038/s41598-024-63490-1, 10.2166/wcc.2021.221]

We have revised in Section: 4.1.3 Evaluation of DEMs using ICESat-2 ATL08 Benchmark on lines 359-360 of the revised manuscript.

9. A comparison statement (compare with other research articles) must be added in the result and discussion section to visualize the proposed research better.

We have revised the manuscript accordingly; however, the discussion and comparison with other research articles are already addressed in Section 6.1, Overall Results of DEM Analysis Workflow, where the results are compared with findings from other studies

We have revised in Section 6.1 Overall result of DEM analysis workflow on lines 658-664 of the revised manuscript

10. The author must add future scope in the last portion of the manuscript.

We have updated new Section 6.4 : Future Applications on lines 720-236 of the revised manuscript.

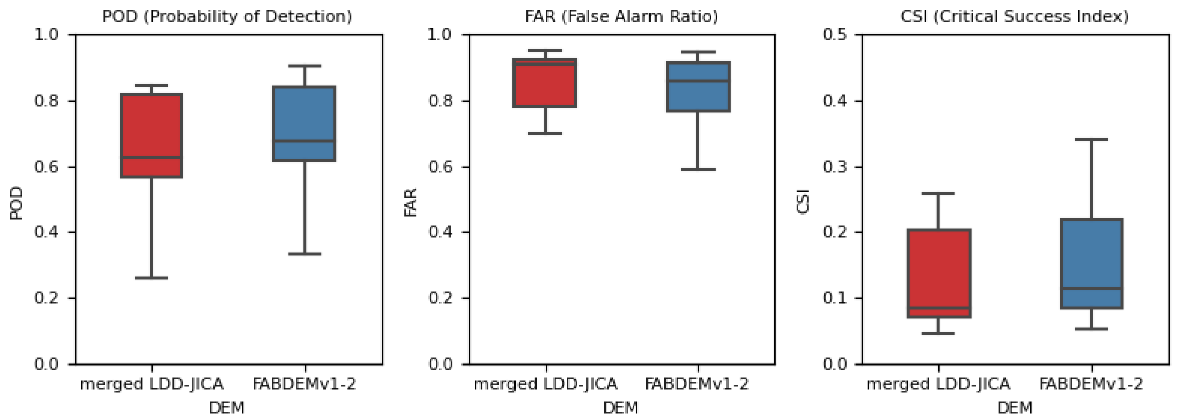
11. The advantages and limitations of the proposed model must be added.

We have revised the manuscript, particularly the Discussion section, to thoroughly address both the advantages and limitations of the study.

We have updated new Section 6.3 Advantages and Limitations on lines 702-722 of the revised manuscript.

12. For better analysis of the result, the author must add a Box plot, Taylor diagram, and ROC Curve

We have revised the manuscript add box plot in section 5.3 Results of the evaluation of flood inundation maps, as illustrated in the figure below:



We have revised Section 5.3 Results of the evaluation of flood inundation maps on lines 621-632 and updated the Figure 12: box plots illustrating the performance of the flood model based on the merged LDD-JICA and FABDEMv1-2 DEMs across three statistical metrics: (a) Probability of Detection (POD), (b) False Alarm Ratio (FAR), and (c) Critical Success Index (CSI) on line 645 of the revised manuscripts.

13. e author must provide a flow chart and parameter table of proposed individual models.

We have explained the overall workflow in the manuscript, as shown in Figure 4, and we have revised it to enhance clarity and ensure it better aligns with the workflow process.

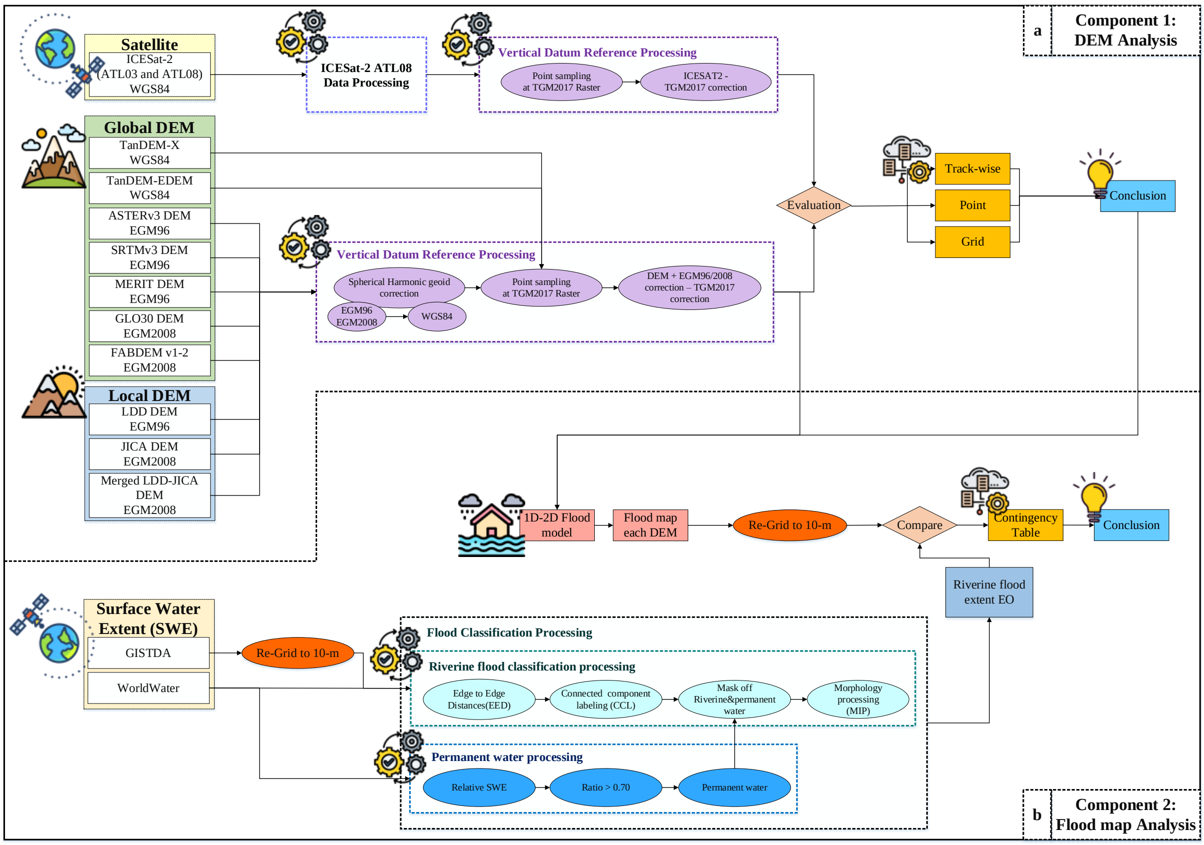


Figure 4: Overall Methodology: (a) Component 1: DEM Analysis – Involves processing ICESat-2 ATL08 data, applying vertical datum referencing, and evaluating DEMs against the ICESat-2 ATL08 benchmark through point, grid, and track-wise comparisons. (b) Component 2: Flood Map Analysis – Includes setting up the 1D-2D flood model, performing flood classification, and evaluating flood maps using appropriate methods.

We have updated the description and Figure 4 on Line 340, Page 16, of the revised manuscript.

14. The author considered different input constraints; is there any scientific reason for the same

For the DEM analysis, we selected a range of DEM products based on their resolution and data acquisition methods to identify the most suitable for the study area. The reasoning behind this is that DEM accuracy plays a crucial role in flood modeling, as elevation data influences water flow simulations and flood inundation predictions. We chose two DEMs for in-depth analysis: one from a local DEM survey conducted by a Thai agency, providing region-specific accuracy, and a global DEM derived from satellite data, offering broader coverage. By evaluating the flood maps generated from these different DEM sources, we aimed to determine which DEM provided the most reliable and accurate representation of the terrain and flood patterns in the study area, thus ensuring that the hydrodynamic models produced the most realistic flood inundation simulations.

No changes to the manuscript were implemented in response to this comment.

Reviewer 2

General comments

Interesting study on the use of different DEM inputs into a specific 1D-2D flood model. In the first part, the most accurate global and airborne DEMs are determined. Using these two DEMs as input, the resulting flood model maps are compared with 2 reference flood maps. Surprisingly, the global flood-optimized FABDEM derived from TanDEM-X achieves only slightly worse flood modelling quality statistics than the higher-resolution airborne DEM version LDD-JICA DEM.

The paper is generally well structured and balanced, but the context and objective of the two parts are not consistently clear.

The claimed objective of your study to present two new workflows for updating 1D-2D flood models is not plausible. It seems like your starting point for this study was "what can we do with EO data", but what you describe is how to test the input DEMs and validate your results. I can't see any real improvement in the 1D-2D flood model itself:An extensive DEM evaluation does not make sense for every new 1D-2D flood model, as the number of input DEMs is limited and you have shown extensive evaluation here. Similarily, the validation of flood modeling results with existing flood maps is not an integral update of a model.

In my opinion, there is a simple way out: move the "workflows" to the discussion/ conclusion and stick to terms like "evaluation of DEMs for" … and "validation of flood model results" … .

However, please clarify this throughout the paper, even in the title!!!

The objective of this study is to enhance the performance of a 1D-2D flood model using Earth Observation (EO) data, with a focus on improving the accuracy of flood inundation simulations through Digital Elevation Model (DEM) analysis. We aim to refine the approach to 1D-2D flood modeling by integrating EO data into two key workflows: DEM analysis and flood map analysis. These workflows are designed to produce more accurate flood model results. Accordingly, we will change the title from "Upgrading 1D-2D flood models using satellite laser altimetry and multi-mission satellite surface water extent maps" to "Enhancing the performance of 1D-2D flood models using satellite laser altimetry and multi-mission surface water extent maps from Earth Observation (EO) data."'

We have revised the title on lines 1 – 3.

Specific comments

1. Please improve the abstract (and title) with regard to the readability and research focus of your study. Main point: The paper gives a kind of performance test. So, your description given in 4.2. (" .. to evaluate the performance of simulated flood maps … using various DEM products") comprises the content more appropriate than an "upgrade by two workflows".

As explained in response to General comments, we have revised this.

We have revised the title and the abstract on lines 1 – 31.

2. In that sense, unclear in the abstract: are you evaluating the 1D-2D model results with the surface water extent maps or has this any relation to the DEM analysis part? Scientifically using SWE maps are for validation.

We used the two best DEMs, one from local and one from global sources, as inputs to a 1D-2D flood model to simulate flood inundation. The simulated flood map was then evaluated against a satellite-derived Surface Water Extent (SWE) map. We will refine the abstract to make it more precise.

We have revised the abstract on lines 1 – 31.

3. The same applies to the title. Please use a more precise title (laser altimetry was solely used for performance assessment, same applies for the water extent maps (validation, not for an software/model udgrade itself, ...) Something like Influence of DEM quality /Performance assessment using global DEM / ...

As explained in response to General comments, we have revised the title.

We have revised the title and the abstract on lines 1 – 31.

4. Abstract/Intro: The first part "DEM analysis" evaluates 10 DEMs compared to ICESat-2. Please explain your motivation. -> advantage of EO DEMs. The DEM choise is rather heterogenious -> Please categorize the used 10 DEMs e.g. from satellite to airborne DEMs.

We have revised and motivated advantage of EO DEMs into the introduction section.

We have revised the section 1: introduction on lines 44 -59.

5. In General: There might exist some specific/logical requirements for DEMs to test or mentioning in advance if they are suited for flood modeling (e. g. like in Gesch, Front. Earth Sci., 2018, Best Practices for Elevation-Based Assessments of Sea-Level Rise and Coastal Flooding Exposure, https://doi.org/10.3389/feart.2018.00230). Against this background, please justify why you start analyzing for so many DEMs the quality from scratch!

The DEMs selected for this study were chosen due to their widespread use in large-scale flood modeling, availability in both free versions and locally collected surveys from Thai sources, and their variations in resolution, methodologies, and data sources. These DEMs are commonly utilized in global and regional flood studies. By comparing them with ICESat-2 ATL08 data, which serves as a high-accuracy reference, the objective was to evaluate their suitability for flood modeling in the Chao Phraya River basin. This thorough analysis ensures the chosen DEM meets the precision required for large-scale flood simulations.

We have revised and motivation in the section 1: introduction on lines 44 – 67.

6. Methodology: Chapter 4, Your goal is to find out the best DEM : better in terms of the most accurate DEM compared to ground control points

The primary objective of this chapter is to identify the most accurate Digital Elevation Model (DEM) by evaluating various DEM products against ground control points. In this analysis, ICESat-2 ATL08 elevation data serves as a high-precision reference, effectively functioning as a "ground truth." This role of ICESat-2 ATL08 should be further articulated to underscore its significance in the validation process. Once the optimal DEM is determined through comparative analysis, it is integrated into a 1D-2D flood model. The resulting simulated flood inundation map is subsequently validated against satellite-derived Surface Water Extent (SWE) maps to rigorously assess its accuracy in representing real-world flood events.

We have revised on lines 318-322.

7. 4.1.1 Not described: how do you use/prepare ICESat-2 ATL03 data? If you don't explain it, omit it.

ICESat-2 ATL03 data represents the raw data collected by ICESat-2 before being processed into ATL08. In this study, we did not use ICESat-2 ATL03 for comparison with DEM products. Therefore, we will exclude the ICESat-2 ATL03 section and provide a more detailed explanation in the ICESat-2 ATL08 section, which is derived from the processed ATL03 data.

We have revised in section 3.4.1 ATL08 on lines 263-265

8. Comment: Apart of the point comparison I like the additional value of grid and track-wise comparison.

Thank you for comment. We comparison in three comparisons, we can see the overall comparison from point and see the spatial map from grid comparison and elevation profile from track-wise comparison.

9. Results: Sec. 5.2.1 To what table do you refer with the statement given in l.444 (global DEM products was +1.62 m)? Same for statistics in line 449 (no common global DEM statistic in table given).

We have revised the table 6 as shown below:

Table 6: Table of statistical metrics, comparing 10 DEM products against the ICESat-2 benchmark. The resulting averages are computed across the datasets in study area.

DEM product	Scale	Statistical method				
		ME (m.)	MAE (m.)	MSE (m.)	RMSE (m.)	PBIAS (%)
LDD	Local	-1.30	1.64	5.45	2.33	-34.76
JICA	Local	-0.65	1.04	3.51	1.87	-17
merged LDD-JICA	Local	-0.68	1.08	3.74	1.93	-15.38
Average local DEMs		**-0.88**	**1.25**	**4.23**	**2.04**	**-22.38**
ASTER	Global	+4.77	5.57	44.28	6.65	47.71
SRTM	Global	+2.04	2.58	12.92	3.59	27.99
MERIT	Global	+1.56	1.79	6.76	2.6	22.99
GlO30	Global	+0.84	1.3	5.89	2.43	13.87
FABDEMv1-2	Global	+0.25	0.8	3.79	1.95	4.59
TanDEM-X	Global	+0.94	1.73	13.29	3.65	15.24
TanDEM-EDEM	Global	+0.91	1.43	7.74	2.78	14.84
Average global DEMs		**+1.62**	**2.17**	**13.52**	**3.38**	**21.03**

We have revised the Table 6: Table of statistical metrics, comparing 10 DEM products against the ICESat-2 benchmark. The resulting averages are computed across the datasets in study area on line 492 - 494.

10. please omit the wording "over- and underestimation" when describing small biases of 1-2 m without regarding the RMSE. (i.e. having an RMSE of 2m: an ME of 1 m is within the noise level! No real over- or underestimation) Please scan the whole document! Better use neutral terms like small positive/negative bias.

Yes, we agree. We have revised all wording "over and underestimation" to positive and Negative bias.

We have revised on lines 471-472, 483-485, 488, 508, 527, 657-660, and 671.

11. Please re-work the text in Section 5.3. to make it more readable and comprehensive.

We have revised on lines 541 – 645.

12. Section 6.2.: Message is unclear, as the different maps for validation seems to have its deficits.

We have revised Section 6.2 to improve clarity and provide a more detailed explanation of the observed Surface Water Extent (SWE) data from the GISTDA and WorldWater projects. The SWE data were generated using different algorithms and satellite sources, leading to different in the results. These observed datasets were then compared to simulated flood maps derived from various Digital Elevation Models (DEMs).

We have revised Section 6.2 on lines 679 – 680 and 689-693.

13. Please just list the used data sets / days in Appendix Tables A1 or omit table completely, Table A2 can be omitted completely. It is a service with regular, almost daily acquisitions.

We have revised Tables A1 and A2 by excluding them and referencing the dataset from the WorldWater project or Sentinel data instead.

We have excluded the Tables A1 and A2 and revised on lines 285, 546 .

14. The visualization of the geoid models Fig A2 should be omitted.

We have excluded it.

Minor comments:

1. Abstract:" Given the current uncertainties stemming from changes in weather patterns affecting flooding, reducing inaccuracies in flood models is imperative": Please be more precise. Are the uncertainties improving?

We have revised on lines 11 – 12.

2. Include in abstract: Which DEMs are finally used for your flood map analysis and why (motivation to chose one global and one local DEM)

We have revised on lines 16 -23.

3. l23-l25: Abstract: Think about your message! EO data for validation of DEM and Flood model maps were used. Conclusion/Result?

We have revised on lines 16-31.

4. Line 480 … which can be attributed to the fact that vegetation and buildings are eliminated in this DEM …

Yes, the FABDEMv1-2 DEM employs machine learning techniques to effectively remove buildings and forested areas from the elevation data.

We have revised on lines 500-502.

5. Line 514: we implemented: please re-word to e.g. “performed test with two DEMs,…”

We have revised on lines 542.

6. Figure caption: difference of Fig. caption A7 and A9 not clear; RMSE?

We have revised the caption figure A7 to A9

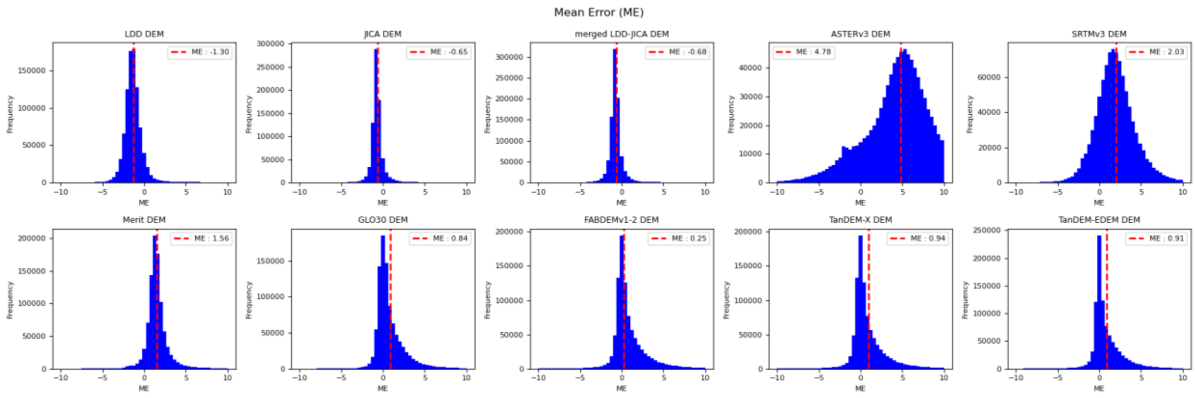


Figure A 7: The histogram distribution of the mean error (ME), comparing 10 DEM products against the ICESat-2 ATL07 benchmark.

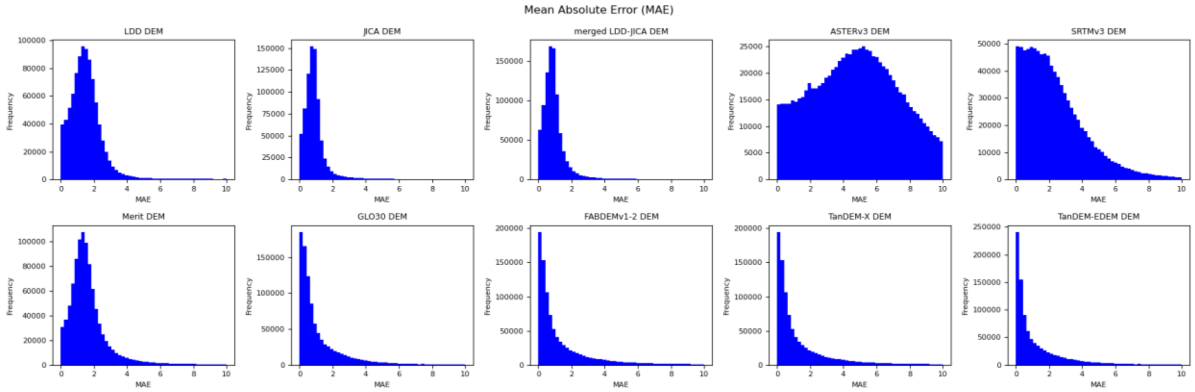


Figure A 8: The histogram distribution of the mean absolute error (MAE), comparing 10 DEM products against the ICESat-2 ATL07 benchmark.

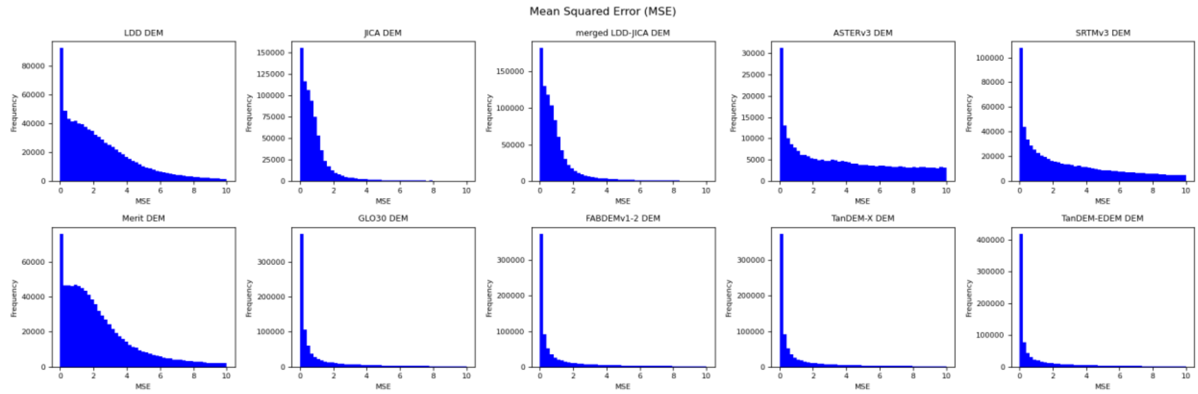


Figure A 9: The histogram distribution of the mean square error (MSE), comparing 10 DEM products against the ICESat-2 ATL07 benchmark.

We have revised the caption and number of figure A6 to A8 on lines 775-780.

Reference

Frias, M.C., Liu, S., Mo, X., Druce, D., Yamazaki, D., Folkmann, A., Nielsen, K., Bauer-gottwein, P., 2024. Improving 2D hydraulic modeling in floodplain areas with ICESat-2 data : A case study in Upstream Yellow River. EGU General Assembly 2024, Vienna, Austria, 14–19 Apr 2024, EGU24-14669, pp. 24–25. doi:https://doi.org/10.5194/egusphere-egu24-14669

Nandam, V., Patel, P.L., 2024. A framework to assess suitability of global digital elevation models for hydrodynamic modelling in data scarce regions. J. Hydrol. 630, 130654. doi:10.1016/j.jhydrol.2024.130654