

Authors Comments 1

RC1: 'Comment on sp-2025-8', Anonymous Referee #1, 28 Nov 2025

Major comments:

The authors performed a metocean analysis of extreme hydrodynamic and weather conditions for providing thresholds to define critical design parameters for offshore installations at the Gulf of Finland. The analysis was extended to the entire Baltic Sea in a second part of the study. Although I have no doubts about the importance of safeguarding offshore infrastructures through metocean analysis, I don't see novel findings in terms of scientific knowledge. I also have some major concerns regarding the dataset and uncertainty in the analysis, which are listed below:

1. One of my main concern is about the scientific novelty in this study. The authors utilized existing datasets and performed extreme value analysis to derive the results. However, the manuscript reads like a technical report rather than a scientific paper due to lack of novelty either in the methods or findings. Please clarify this in your revision.

Authors' responses:

We thank the reviewer for this important comment and we agree that, in its original form, the manuscript could be perceived as overly “report-like”. In the revised manuscript we have substantially strengthened the scientific contribution by (i) removing the Baltic Sea-wide extreme-value mapping, which diluted the focus and introduced additional, difficult-to-justify uncertainties, and (ii) recasting the work as a rigorous, reproducible, multi-source validation and uncertainty assessment of extreme metocean conditions for a fetch-limited, non-tidal, semi-enclosed basin (the Gulf of Finland) at the Paldiski FSRU site.

The scientific novelty of the revised manuscript is now explicitly framed as:

- Quantified suitability of widely used open-access products for nearshore extremes (winds, waves, sea level and currents) in the Gulf of Finland, supported by multi-source validation (in situ + satellite + model intercomparison) rather than relying on a single dataset.
- A transparent uncertainty framework for engineering-relevant return levels, including (a) dataset/forcing selection uncertainty, (b) EVA methodological sensitivity (threshold choice, fitting), and (c) treatment of bias correction (as a documented procedure and/or uncertainty range).
- A reproducible workflow: clear equations/definitions for EVA, documented preprocessing steps (e.g., datum alignment), and open sharing of the derived return-level outputs and code to reproduce the figures and tables.

By narrowing the scope to a well-observed and societally relevant site, and by emphasizing dataset evaluation and uncertainty attribution, we believe the revised manuscript now meets the expectations of a scientific paper rather than a project report.

2. It seems that the wave modeling and hydrodynamic modeling is decoupled (lines 85-95), and provided by different data sources. I have a serious concern on this, since nearshore areas are strongly affected by interactions between waves and currents, and water levels. I strongly believe that a full coupling between waves and hydronamics should be considered for nearshore areas. Please provide an assessment on the uncertainty related to this and justify why a decoupling is sufficient.

Authors' responses:

We agree that wave–current–water level interactions can be important in nearshore environments and that the assumptions regarding coupling must be stated explicitly. In the current manuscript, the local wave modelling (WAM→SWAN) and hydrodynamic modelling (NEMO/GETM) are described without a clear statement of whether wave–current and wave–water level feedback were included. In the revision we will clarify the modelling chain and, for the Paldiski site, quantify the potential magnitude of neglected coupling terms for design-relevant metrics.

According to the nautical charts (e.g. <https://xgis.maaamet.ee/xgis2/page/link/Bz9wen5y>) updated with FSRU terminal the minimum water depth at the vessel mooring location is at least 17 m. We will now assess what could be the maximum effect of currents and additional sea level be to the significant wave height. We assume the values for 50 year return values from Table 2. From Figure 4e we get the T_{m01} wave period 7-8 s therefore peak period is ca 10 % higher e.g 7.7-8.8 s, so we use average of 8.3 s. Therefore the wave group speed in 17 m water depth is 6.6 m/s and therefore the 0.37 m/s current speed is 5.6 % of the group speed. The current speed affects linearly wave energy, but significant wave height is square root of wave energy, therefore the maximum current effect is ~2.8 %. The same kind of principle holds for sea level variation also, but we use relative water depth instead of relative speed. The additional water level is 8.9 %, which transfers to 4.3 % into significant wave height.

So in the „worst case scenario“ when waves are opposing currents (currents flowing out of the bay at FSRU site) and the water level is additionally 1.5 m higher, the 50 year return H_s can be 4.3 %+2.8 % higher than reported in Table 2, which transfers to 0.29 m in H_s .

3. Since LNG infrastructures such as FSRU are built very nearshore, which is subject to changes in seabed morphology by erosion or deposition. This might not be a problem in the study area that is dominated by hard substrate (nevertheless, the authors should justify in the study why impact of sediment transport and morphological change are not considered in the study area). However, for sandy coasts such as the southern and southeastern Baltic, morphological change in nearshore may have significant impact on local metocean conditions. This would lead to large uncertainty in the results of the entire Baltic Sea for very nearshore areas, which should be clearly pointed out in the manuscript.

Authors' responses:

The site was dredged and corresponding changes in water depths were taken into consideration in setting up the local models. We have sensitivity experiments with initial EMODnet bathymetry and adjusted bathymetry at the LNG locations - showing insignificant changes in sea levels, however for

currents deepened bathymetry have reduced the strong currents (6-25 cm/s) probabilities.

4. The authors applied some correction factors to align better model data and observation data in the local study area, e.g. for wind speeds, significant wave heights and wave periods. However, it is unclear whether the same correction factors should be applied for other parts of the Baltic Sea, and the potential errors caused by ignorance of such local corrections. The authors did not address this uncertainty in the second part of the study for the entire Baltic Sea.

Authors' responses:

We agree with the reviewer that the correction factors introduced in the original manuscript are site-specific and should not be assumed transferable to other parts of the Baltic Sea. In the original version, this created ambiguity because the manuscript also contained a Baltic Sea-wide extension of the analysis (Sections 2.6 and 3.5 / Fig. 4). To address this concern directly and avoid overstating the spatial applicability of site-derived corrections, we have removed the Baltic Sea-wide extreme-value analysis from the revised manuscript (including the "Regional extreme value analysis" section and the "Extension ... to the whole Baltic Sea" results). Consequently, the revised paper no longer presents basin-wide return-level maps for which a discussion of "applying Paldiski corrections across the Baltic" would be required.

In the revised manuscript, we explicitly state that all bias/correction adjustments are applied only to the Paldiski case-study location and are intended solely to align the selected model products with available local observations (e.g., ERA5 vs Pakri station winds and CMEMS waves vs local buoy data).

We also improve transparency by documenting how these correction factors were derived and by reporting sensitivity of the return levels to whether the correction is applied.