Interactive comment on "Assessment of the nuclear power plant "Hanhikivi-1" influence on the local hydrological conditions in the Bothnian Bay, Baltic Sea" *by* Anton Dvornikov et al.

Anonymous Referee #2

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The manuscript " Assessment of the nuclear power plant "Hanhikivi-1" influence on the local hydrological conditions in the Bothnian Bay, Baltic Sea" by A. Dvornikov et al. deals with a topic of broad interest for marine environmental impact assessment and decision-making. To that end the authors make use of a state-of-the-art set of numerical models accounting for the complex phenomena and interactions between different elements of the Earth system (atmosphere, ocean, ice cover). The authors apply the most advanced numerical techniques to the study of an engineering and environmental problem in what can be considered an example of best practice. The manuscript shows the potential versatility of the modelling tools to estimate the extreme values of relevant ocean variables that could affect the NPP functioning such as sea level and wind wave

height; and to assess the thermal fingerprint of NPP cooling water discharge into the Bothnian Bay. Authors demonstrate clear competence in the field and deep knowledge of the area under study. The manuscript is well written and contains informative figures, pointing to some interesting results. I do not have major concerns regarding the manuscript, however in my opinion it can be improved if authors take into account some details. My main remarks are as follows:

1. Title: It does not reflect the first objective (estimate extreme marine phenomena) and a big part of the study. That should be accounted for in the manuscript title.

2. Introduction:

- Adding some information about the number of already producing and proposed NPPs in the Gulf of Bothnia or in the Baltic Sea would emphasize the real dimension and importance of the issue under study.

- The second objective could be better formulated: "rather than an estimation of the adverse thermal effect of NPP on marine environment" what it is done is estimate its impact on the hydrological (temperature field) conditions, as written in the title. An impact on the marine environment is a much wider concept.

3. Methods: -The models are described correctly and in detail, however I would advise to include a paragraph describing the modelling approach prior to individual model description. For example, in the current version the Hanhikivi domain is described without information on how it is connected to the larger Bothnian bay domain (P4L4-7). It is later that these details are provided. I would suggest the inclusion of a scheme (flow diagram) with indication of the models, information flows, boundary conditions, domains, etc.

-Models output is validated in the following periods: 5-7/12/2015 (sea level) 18-19/01/2010 and 06/2010 (temperature), unknown dates (sea ice), 2013-2014 (wind waves). I am sure that there is a good reason to be so, but authors do not provide it. I

would suggest including an additional paragraph explaining the validation strategy and the limitations posed by available data. Also, some general information on the runs used for validation purposes (duration, spinup time) would be desirable.

- Despite the better agreement with data, it seems that POM presents a more diffusive thermocline than HIROMB (see Fig. 3). May it be caused by the fact that HIROMB is assimilating observations?

4. Results:

-It seems that SWH near the NPP location is limited by water depth (causing wave breaking). If so, then it is of capital importance to provide information about water depth used and if this water depth was considered to be affected by wind and wave setups. Authors' estimation of storm surge levels indicates sea level changes of 130 cm (Figure 2), which can cause an increase/decrease of 20-30% in water depth. Only in the Discussion section it is mentioned that all data needed by SWAM was calculated in advance by the coupled circulation model. However, that information must be clearly and detailed provided before. The place for that is Methods, as I suggested before.

- Figure 13 shows that changes in bathymetry were assumed for the predictive scenario. Were these variations taken into account for the estimation of extreme SWH and sea level surges?

5. Discussion:

I think authors should strongly stress the novelty of their approach (by comparing with other approaches employed for analogous cases). Also, the potential impact on the obtained results of some missing mechanisms (e.g. interaction between waves and currents by coupling SWAM and POM).

MINOR REMARKS: P2L32: "allows a smooth representation of the bathymetry" instead of "allows it to represent the bathymetry smoothly" P3L2 thermodynamic instead of thermodynamical P3L3 "simulation of coastal and estuarine dynamics" instead of

"simulations of coastal areas and estuaries dynamics" P4L1 "SWAN was used" instead of "During all model runs SWAN was working" P4L6 Delete "assessment of main hydrological features of the". Indeed, big part of the manuscript is focused on wave and storm surge characterization. P5L10 Adding at inset with a wider geographic setting including the Gulf of Bothnia in Fig. 1 would somehow prevent confusions between the Gulf and the Bay for readers not familiar with the area of study. P5L17 atmospheric instead of atmospherical P5L18 atmospheric instead of atmospherical (and so on) P5L22 Can authors add any reference to sustain the good agreement between HIRLAM's simulations and observations? P5L24 "making" instead of "with making" P11L4: Could it be better to say that you will estimate the maximal SWH as the asymptotic limit to increasing wind forcing? P11L21: The wind speed was set constant and equal to 10 m/s was already written in line 12. P12L20: "was at most 0.5-1.5 m" instead of " was 0.5-1.5 m and less" P14L5: Use better "exceedance probability" than "repeatability" P14L8: Why did authors choose those periods? P16L2: 150 cm or -150 cm? P16L2: 10ˆ8 years??!! Is it correct? P16L4: I think is better to be more precise. Assessing NPP impacts on the marine environment is too wide and does not correspond to the contents of the section. P16L13: "average discharge" instead of "annual discharge"

FIGURES: Figure 1b: red line (cross-section) hardly discernible. Figure 2: Can you indicate the location of the 4 sites in Fig 1? Figure 4: No dates are indicated. The panel b is of rather poor quality. Authors must provide equivalence between ice types and thickness in order to compare properly results and observations. Figure 6: Is W the point near NPP referred to in the figure captions? Figure 9a: Indicate NPP location. Increase font and arrow sizes within the plot. Figure 10a: Indicate NPP location. Increase font and arrow sizes within the plot.