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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Brief communication: Characteristic properties of extreme wave events in the Baltic Sea" *by* Jan-Victor Björkqvist et al.

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We appreciate that you took the time to review our manuscript. We will now answer the comments point by point.

"The wind speed data could have been more detailed: is it gust wind or average wind speed?"

We will add the information that it is the 10-min average wind speed that is being used.

"The forecast modeling is presented as an input data for comparison with measurements, and one might need more explanations about the wave model."

We will add a short explanation to the text and also added a few references to studies

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where WAM has been implemented to the Baltic Sea. Will also add the information, that we have used WAM cycle 4. The performance of the model implementation to the Baltic Sea has been documented in the references.

“WAM is a third generation phase averaged spectral wave model that solves the action balance equation to simulate the wave energy at each grid point. This wave model has been sucessfully implemented to the Baltic Sea (e.g. Tuomi 2008; Tuomi et al., 2011).”

“This paper is about extreme wave events, but in paragraph 5 it is explained that wave heights of 2,5, 4 and 7m are significant for boats. This paper could have been improved by analyzing the forecast model for smaller wave heights than 7m. In the introduction, it has been highlighted than during the accident of the MS Estonia, 4-5m wave height has been measured. Is the forecast system more accurate for smaller events which are probably more frequent¿‘

This is a good point. A more extensive validation of the wave forecast would indeed be interesting. Unfortunately, we could not fit a full validation to the format of the “brief communication”. However, the performance of the wave model has been evaluated in previous studies (Tuomi 2008; Tuomi et al., 2011). Tuomi (2008) evaluates the performance of the forecasts with different lengths using data from 2002-2005. All forecast lengths have a similar negative bias of -0.1 m, while the RMS-error increases from 0.3 to almost 0.6 m between the 6 h and 54 h forecast length. Tuomi et al. (2011) verified a six year hindcast (2001-2007) that was forced by winds from FMI’s operational HIRLAM. The bias at the NBP wave buoy was -0.1 m and the RMS-error 0.3 m.

The overall performance of the wave model is well documented and we can conclude that smaller wave heights are generally well predicted, especially with the new higher resolution implementation and for the shorter forecasts.

“In the same idea, I also want to make the observation that some proposals to improve the forecast system could have been welcome as an opening in the conclusion of paragraph 5. “

We will add a short discussion on this, in the the line of:

"A discussion concerning the issuing of wave warnings for the Baltic Sea should be initiated between the relevant institutes and end users. In addition to re-establishing and harmonising the thresholds of significant wave heights, the use of other parameters (e.g. duration) should also be explored in light of the difficulties of predicting a single maximum value for the wave height. Any decision to include new parameters should be based on the needs of the seafarers. On a more general note, the use of ensemble forecasts might prove useful when issuing wave warnings. An in-depth study is nevertheless needed to quantify to which extent the added information warrants the increased computational cost."

"In the forecasting paragraph, the comparison between model results and measurements could have been improved by the use of objective indicators (Nash criteria? RMSE?)."

This is a fair point. Since we wanted this brief communication to focus on the highest wave events, we did not present objective validation indicators for the entire years. These have, however, been calculated by the studies mentioned above. To make our results more objectively comparable with possible future studies into modelling extreme wave conditions, we will add the bias of the model for the 6 m exceedance time to Sections 4.1 and 4.2 (see below):

Sect. 4.1: The model bias for the 6 m exceedance time ranged from -0.5 m to -0.8 m in the different forecasts.

Sect. 4.2: The model bias for the 6 m exceedance time ranged from -0.7 m to -1.1 m in the different forecasts.

"The forecast models are compared with a single station for wave parameters. Is this station fully representative of the heterogeneity of the Baltic Sea waves? This point should have been discussed. "

This is a very good point. The answer to the question is, of course, “no”. One point cannot capture the variability of the wave field in the Baltic Proper. We added a short discussion about this to the end of Section 3 so that our research will be easier to put into context:

The wave observations from the NBP cannot be considered entirely representable for the entire Baltic Proper. The highest modelled wave events have been placed either south-southeast of the wave buoy during Gudrun in 2005 (Soomere et al., 2008), slightly west of the wave buoy during Toini in 2017 (Fig. 1.), or slightly east of the wave buoy during Rafael in 2004 (not shown). High waves have also been modelled in the southern Baltic Sea (e.g. Jönsson et al., 2003), which is an area suffering from an acute lack of wave measurements. However, the sparsity of remotely sensed wave data and the uncertainties related to modelling the wave extremes (Fig. 2) underlines the usability of the reliable long term wave buoy measurements presented in this paper.

New references

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