Ocean Sci. Discuss.,
https://doi.org/10.5194/os-2018-59-RC1, 2018

Ocean Science Discussions

Interactive comment on "Better Baltic Sea wave forecasts: Improving resolution or introducing ensembles?" *by* Torben Schmith et al.

Anonymous Referee #1

Received and published: 21 June 2018

1 General comments

The paper addresses a topical issue in the operational oceanography in the marginal seas – whether to introduce ensemble forecasting. The Authors have run the wave model WAM for the Baltic Sea with different horizontal and spectral resolutions and different atmospheric forcing to study whether one should increase resolution or introduce ensembles to provide better forecast accuracy. The question is interesting, but one would expect a more thorough and systematic approach in building and introducing the model and forecast system configurations and in analysing the results.

It has been long known, although not perhaps explicitly said, that the open sea areas of the Baltic Sea, where the shallow water effects can be neglected, do not much benefit

Printer-friendly version

Discussion paper

of reducing the grid size. That said, there are several areas, where the high resolution is important to solve the shallow water effects and address the effects of islands and irregular shoreline on the wave fields.

Due to the small size of the Baltic Sea, the wave field is dominated by the wind waves and the accuracy of the wave forecast is largely dependent on the accuracy of the atmospheric forcing. Therefore comparing systems run with wind forcing from different NWP systems to address the question about choosing between ensembles and resolution is not entirely valid. Also the earlier studies the Authors refer to in the discussion most likely have different/older versions of the WAM model. Therefore the differences or non-differences cannot directly be connected to resolution or the atmospheric forcing. And also, if the time periods used in verification are relatively short (2-3 years) and different ones, the inter-annual variability in the wind conditions might also affect the accuracy. I'd expect more discussion about these subjects.

The only driving factor in reducing the grid size in the open sea wave modelling is not the accuracy of the wave forecast. There might also be other factors. For example coupling of wave and 3D ocean models might benefit of having high enough resolution. Same applies also for atmosphere – wave coupling. Furthermore, the benefits of higher resolution come also when using high-resolution wind fields nowadays available for the Baltic (e.g. HARMONIE with 2.5 km resolution), which are not possible to get full benefit from if wave model resolution is coarser. I'd also like to see more discussion related to these subjects.

Also, I think that the title should include indication, that you are focusing on the open sea, deep water areas.

Is same wind forcing used both for HIGH and LOW NSB grids? This is not explicitly said in the manuscript. And is the forcing used the deterministic ECMWF or the HIRLAM wind field? Table 1 mentions both HIRLAM and ECMWF and Table 2 only states that one ensemble member is used as forcing, but not indicated whether the 1 ensemble is

the ECMWF or HIRLAM deterministic forecast or something else. If HIRLAM is used for the HIGH and LOW NSB grids, then you are comparing wave model results with different NWP forcings against each other. Is it then question about resolution or different wind forcings? I suggest that you run both HIGH and LOW NSB grids using the control forecast from the ECMWF ENS system and compare the difference between them and the LOWENS to find what type of effects the resolution and introducing ensembles causes to the system. Furthermore, it is of course interesting to see, if with higher resolution wind forcing (e.g. HIRLAM) the results would further improve. If and when you use the HIRLAM forcing for the wave models, please specify, how you process the wind fields with 3 km resolution to the wave model grid with 5 km (and/or 10 km) resolution.

Also, you should separately check, what can be addressed to spectral resolution and what to grid resolution. And also please check other parameters than SWH, for example it would be interesting to see, if there are affects to wave periods or directions, when using higher spectral resolution.

When looking through the supplement material, I was bit confused, why Arkona and Vahemadal were chosen to be the stations shown in the manuscript. E.g. looking Fig S2 Finngrundet, Nothern Baltic, Huvudskar show that HIGH gives lower rmse in many cases for the higher (of over 3 m) significant wave heights than LOW or LOWENS. If the lower rmse of LOWENS over longer forecast ranges come mainly from forecasting smaller than 3 m SWH it might not be that useful for duty forecasters. This type of conditions typically do not affect the marine traffic or the offshore structures, it is the extremes. Therefore it would be important to see how the different forecast systems behave in high wave conditions. The time period used in this study contains at least the January 2017 storm. It would be interesting to see a detailed comparison of the results during this storm and also in some other high wind events.

It is good that the Authors have shown that with ECMWF ENS forcing the accuracy of the wave forecasts is ok in the open sea areas of the Baltic Sea. I suggest that

the authors do the more comprehensive model runs suggested above and also more detailed analysis of the results and also discuss the advantages and disadvantages of each system more thoroughly. Furthermore, it would be interesting to see how much skill the ensemble forecasts have for longer forecast period. To my experience, there is not much spread in the ensembles for the first two or three days and the true benefits of the ensemble system and probabilistic forecast usually comes with longer forecast ranges. It would be interesting to see up to which forecast lengths the ensemble system shows skill in forecasting the Baltic Sea wave conditions both in average and extreme conditions.

Please also see my specific comments given below.

2 Specific comments

2.1 Introduction

Lines 29-35: I'd expect that the concept of deep and shallow water waves is introduced here, since this is one of the key issues in the discussion of the results.

Line 33: Bathymetry is important only if waves interact with bottom.

Lines 29-25: How about weak non-linear wave-wave interactions?

Lines 41-42: Seasonal ice conditions vary quite a lot in the Baltic. Perhaps this description refers to an average ice winter?

Line 51-52: Is Baltic Sea shallow considering the average wave conditions? If then the use of higher resolution should make a difference, which is not in agreement with the conclusion drawn by the Authors later on. Baltic Sea is shallow compared to the Oceans, but when considering the typical wave periods/lengths in the Baltic, in most

cases waves in the open sea areas are deep water waves, expect for high and extreme wave conditions.

2.2 Model and setup

This section needs restructuring. All information needed is basically given, but the order of things and the fact that some information is only given in Tables and the table is not referred in the corresponding place in text makes it difficult to follow.

Also please define explicitly, which wind forcing is used for LOW and HIGH configurations. Table 3 indicates that deterministic ECMWF forcing is used for the coarse, larger domain and HIRLAM (and possibly also ECMWF?) for the smaller high resolution domain. It is not clear to me if this Table refers to DMI operational setup or for the setup used in this paper.

Lines 73-77: Please specify the source terms and formulations used in the model runs.

Lines 78-82: Specify the horizontal resolution of the areas already here or cite a Table where they are given. I also suggest adding the resolution info to Table 1.

Line 88: Specify the various sources used to compile the bathymetry

Line 121-122: You use only 11 members of the total 50 available from ECMWF. How do you select, which members you use?

Table 2: It is unclear to me what the column 'Ensemble members' mean for LOW ad HIGH.

2.3 Observations

Why not use Helsinki wave buoy data from Gulf of Finland? This should be available through CMEMS. Helsinki site mostly represent deep water conditions and it would be

interesting to see, how the setups behave there compared to Vahemadal.

Table 3 gives only model depth at the buoy locations. It would be important to know also the actual depth at the buoy locations to evaluate, whether the model is adequately able to account for the deep and shallow water features in the wave field.

It is bit unclear to me, what is the function of Figure 3. The details are lost here, since the images are so small. If they area meant to represent the overall description of the wave conditions at each site, please also (or maybe instead) give some description in the text. And if it is to show the gaps in the measured data, that could be put in a table.

2.4 Verification

Give some explanation, why you have selected Bothnian Sea, Arkona and Vahemadal stations for more detailed analysis

I also suggest doing some verification of the forcing wind fields.

In addition to verifying the general accuracy, I'd expect to see some verification of high wind/wave events. They are the most important ones to forecast accurately considering the marine traffic and offshore structures.

I would also expect more discussion of the importance of wind field accuracy on the accuracy of the wave forecast. The accuracy of wave forecast in the open sea areas might not benefit from higher resolution in the wave model grid, but what about when the wind forcing has high resolution, such as the HARMONIE forecasts run for the Baltic with 2.5 km resolution in several of the MET services. In order to account for the benefits of this, higher resolution in wave model grid might become important.

Printer-friendly version

Discussion paper

2.5 Discussion

You should very carefully analyse and explain, what you are actually comparing in Table 2. To my understanding you are comparing wave forecast system, which have different resolutions, wind forcing and also most likely different wave model versions. So the differences in accuracy cannot solely be attributed to resolution.

Table 4 – Why have you not calculated rms errors for the Helsinki wave buoy for LOW, HIGH and HIGHENS?

I'm not sure why the ice coverage is discussed here. You are comparing the forecasts against buoy measurements and the buoys are recovered well before there is a risk of ice in the area. Therefore handling of ice should not cause any problems in your verification results. That said, you of course have this element during the season and in the areas where you are unable to do the verification. You could also give a short description of the ice conditions in 2015-2017 so that readers would be able to evaluate, how big effect this might be.

3 Technical corrections

Page 1: line 34, has → have

Page 2, line 52: See → Sea

Interactive comment on Ocean Sci. Discuss., https://doi.org/10.5194/os-2018-59, 2018.

Printer-friendly version

Discussion paper