Response to Referee #2

Jan-Victor Björkqvist et al., 24.9.2021

The referee comments are marked in blue italics, while our responses are in normal font.

R#2: *Swell waves play a critical role in air-sea interactions. In this study, some interesting results of the swell in the Baltic Sea are drawn based on 20 years of high-resolution wave simulation data. These results are interesting to the Baltic Sea research community.*

Our response: Thank you for taking the time to review our manuscript. It is much appreciated.

I have the following comments/suggestions about the study.

General comments:

R#2: *The wind condition varies significantly with the season which may result in the variation of swell probability and energy weight. Authors give the swell height distribution in winter and summer. I am wondering if there are any seasonal variations of the swell energy weight, swell probability, swell period. If so, I would recommend including those analyses?*

Our response: Thank you for this comment. We have updated the swell prevalence figure to show the seasonal variation of the swell energy weight and probability of swell dominance. Including the seasonal variation also for these variables makes our results more comparable to those of Semedo et al. (2011, 2015) for the World Ocean and Nordic seas. The updated figure is shown as Fig. 1 in this document, and will also be updated to the revised manuscript. The results, discussion and conclusions have been rewritten to incorporate the new seasonal results.

The relation between the periods and the significant wave height did not show any interesting seasonal variation. Longer waves are generated (and thus turned to swell) during the winter compared to the summer, but this fact is hardly surprising. The seasonal figures are shown in Fig. 2 & 3 of this document, but the figure in the manuscript was kept as is, since we feel that the seasonal variations did not warrant splitting the scatter plots up to several figures.

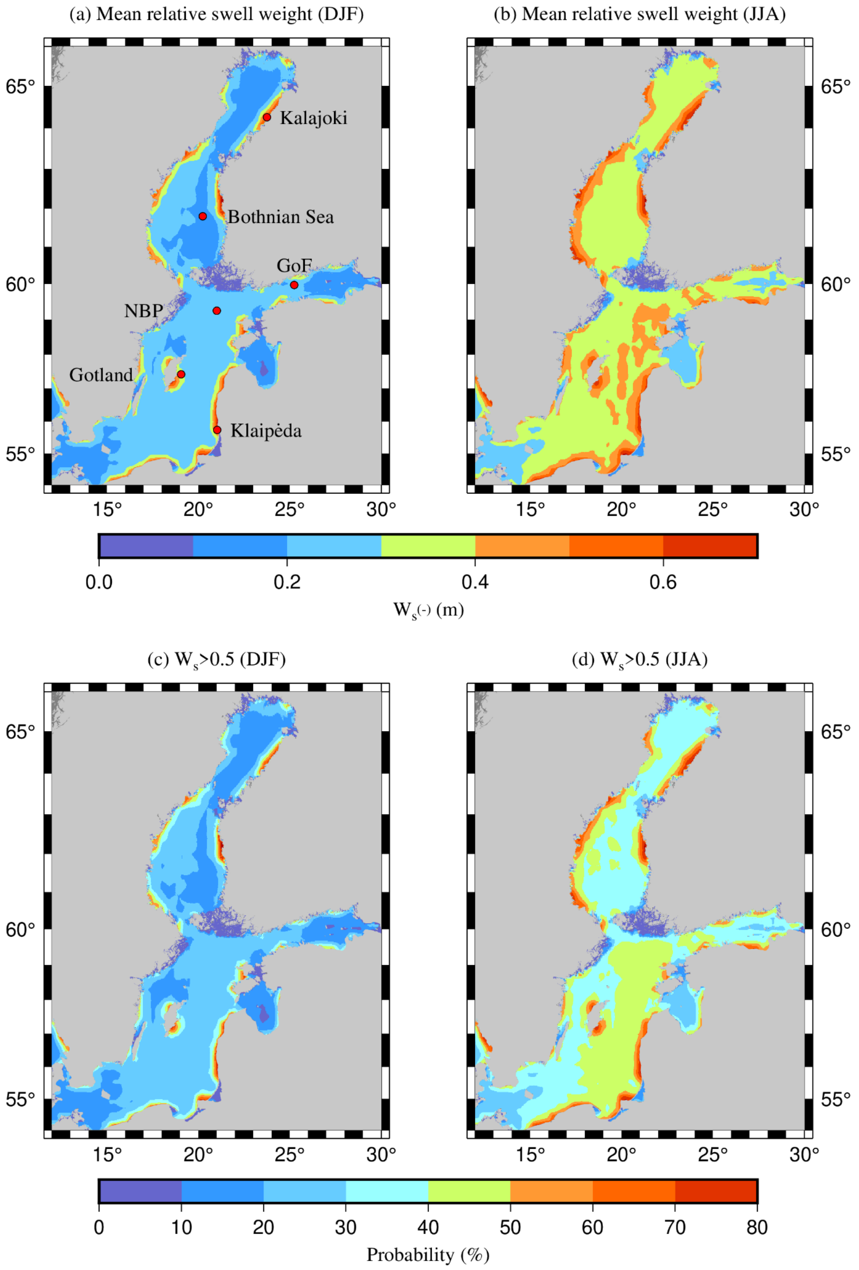

Fig. 1. The updated Fig. 3 of the manuscript where the swell weight and probabilities are separated by season.

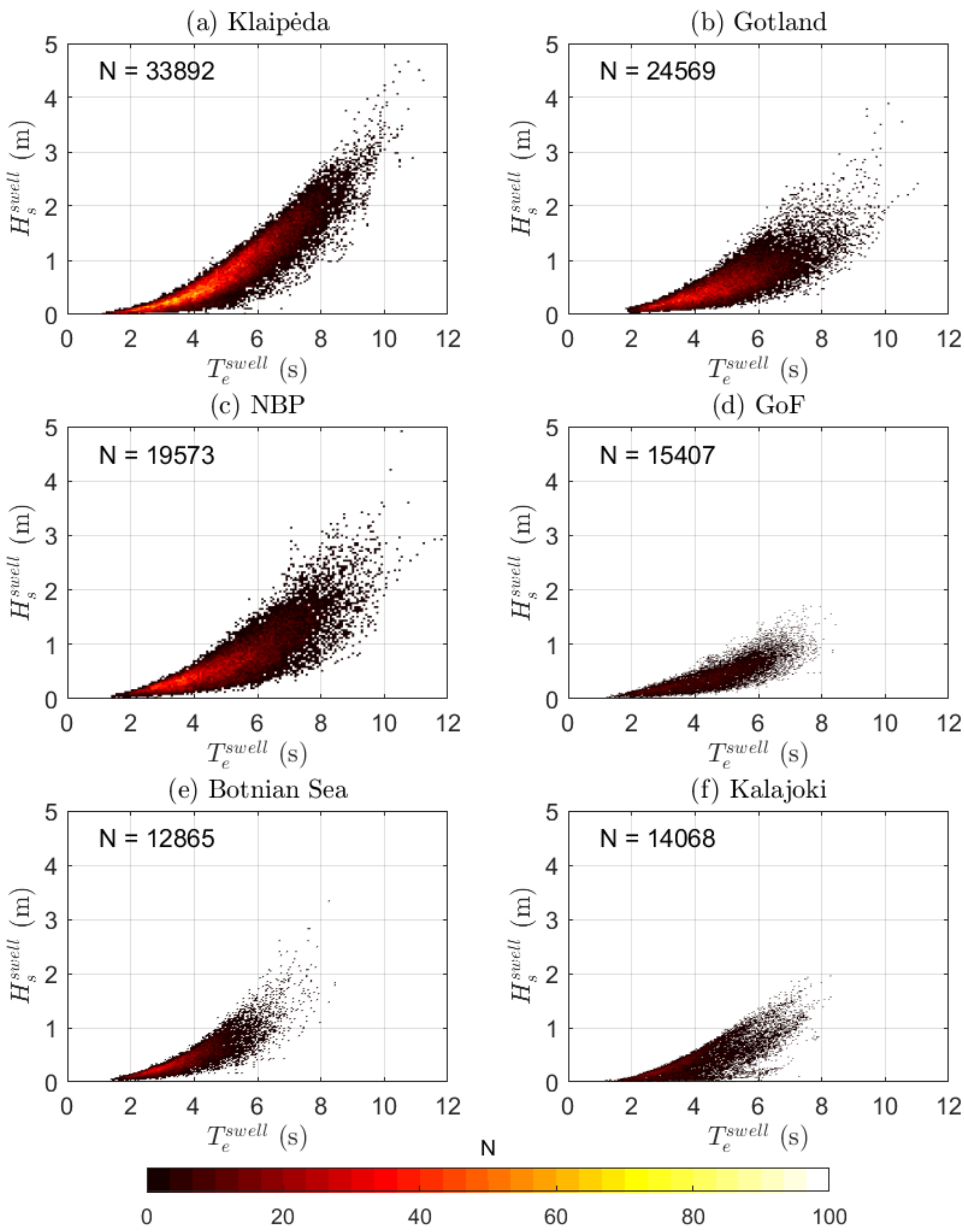

Fig. 2. Same as Fig 4. in the manuscript but only for the winter season (DJF).

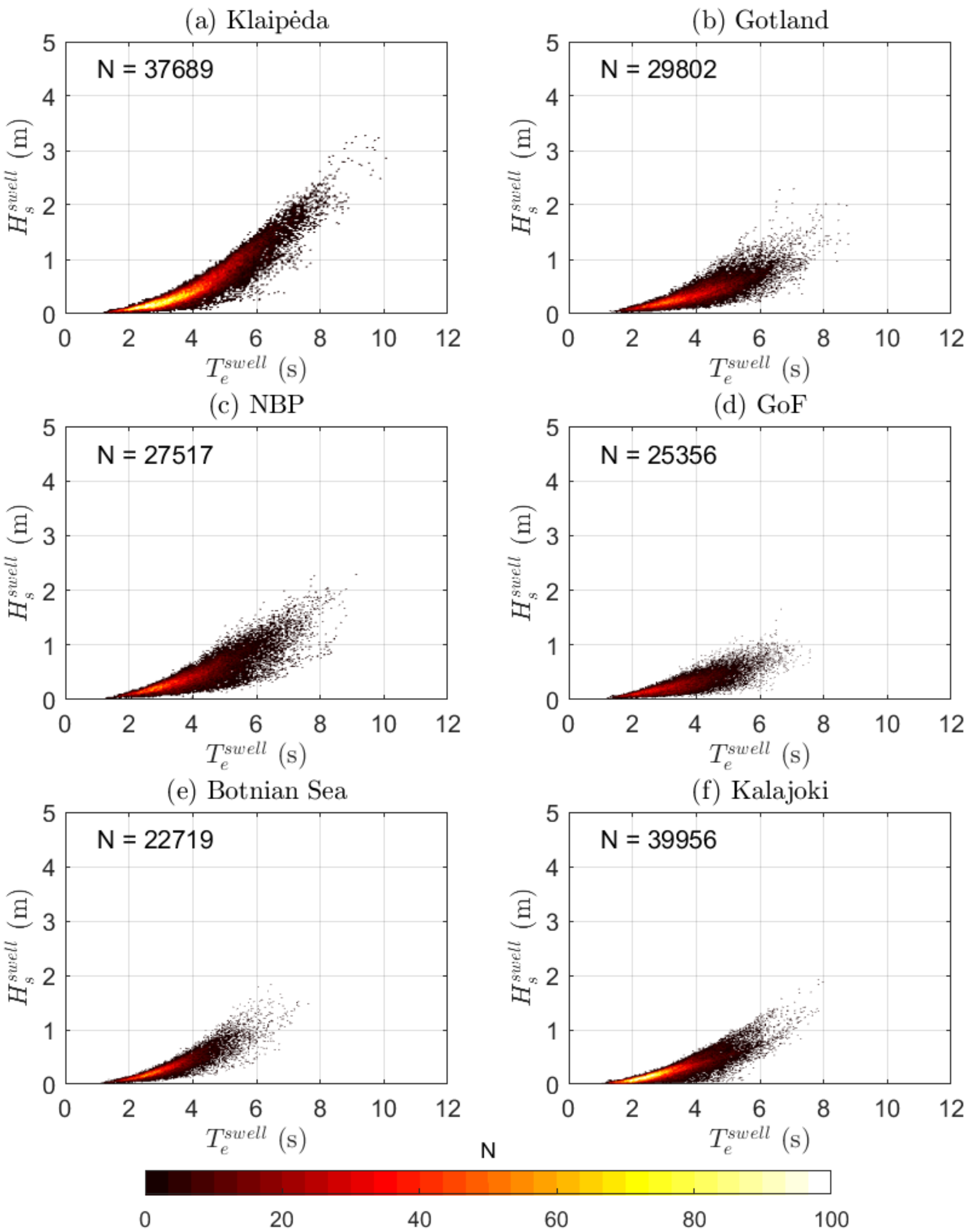

Fig. 3. Same as Fig. 4 in the manuscript, but only for the summer season (JJA).

***R#2:** In the introduction, the authors point out the importance of the misalignment between wind and swell direction (L20). With the data, I think the authors can analyze the distribution of the swell-wind angle. If so, I would suggest the author add one section about it.*

Our response: We calculated the distributions of swell-wind directional misalignments for the six locations. For all data (including also very low swell heights) the general distribution of misalignment is the same for almost all locations (Fig. 4 in this document). For the 99th percentile of the swell height we can see that the open sea points in the main basin behave differently from the coastal points. Namely, the most probable amount of misalignment in the open sea is 60-100 degrees, while at coastal locations the most probable misalignment is below 20 degrees.

These results reinforce the correlation analysis that the open sea and coastal zones have different generation mechanisms for swell. In the open sea high swell waves are generated when a weather system passes and the wind turns (and the wind speed simultaneously drops), as seen in e.g. Fig. 2 of the manuscript. In the nearshore areas the wind can simply attenuate near the coast, causing an increase in the wave energy classified as swell even though the weather system has not passed, and the direction might be well aligned with the wind direction.

We have added a separate section for the wind direction, and included the below figure and the accompanying analysis there.

R#2: *In section 3.4, the authors give some interesting results about the correlation of wind-sea and swell. The negative correction is contributed to the decaying wind. Based on Eq. 2, the wind direction is also an important factor determining if a wave mode is swell or wind wave. Did the authors have some analysis about the contribution of the variation of wind direction? If you look at Fig 2, the wind direction change is also significant for the variation of swell and wind wave height.*

Our response: Because of the cos-term in Eq. 2, the relative wind-wave direction is definitely an important factor. Typically drastic and sudden changes in the wind direction is expected to be related to the passing of a weather system. This is expected to be seen simultaneously also in the wind speed (see e.g. Fig. 2 in the manuscript). The analysis in the swell-wind misalignment (see Fig. 4 of this document) suggests that for the highest swell heights the directional difference between the swell waves and wind are large in the open sea. At the coast, again, the directional difference is typically small.

However, just because the directional difference is large, that doesn't mean that it would be the dominating factor. Even for a 90 degree difference the wind speed might simultaneously be low enough that a significant amount of energy would be classified as swell even if the wind and swell waves were perfectly aligned. In other words: what is the main reason for swell is the directional difference is close to 90 degrees and the wind speed is close to 0? Differentiating between the contributions of these two correlated sources is tricky. We therefore decided not to pursue this type of analysis beyond that presented in Fig. 4 and the newly added section on swell direction. The main results show the combined effect of these two connected phenomena (wind speed and direction) through the wind speed being projected to the wave direction in Eq. 2.

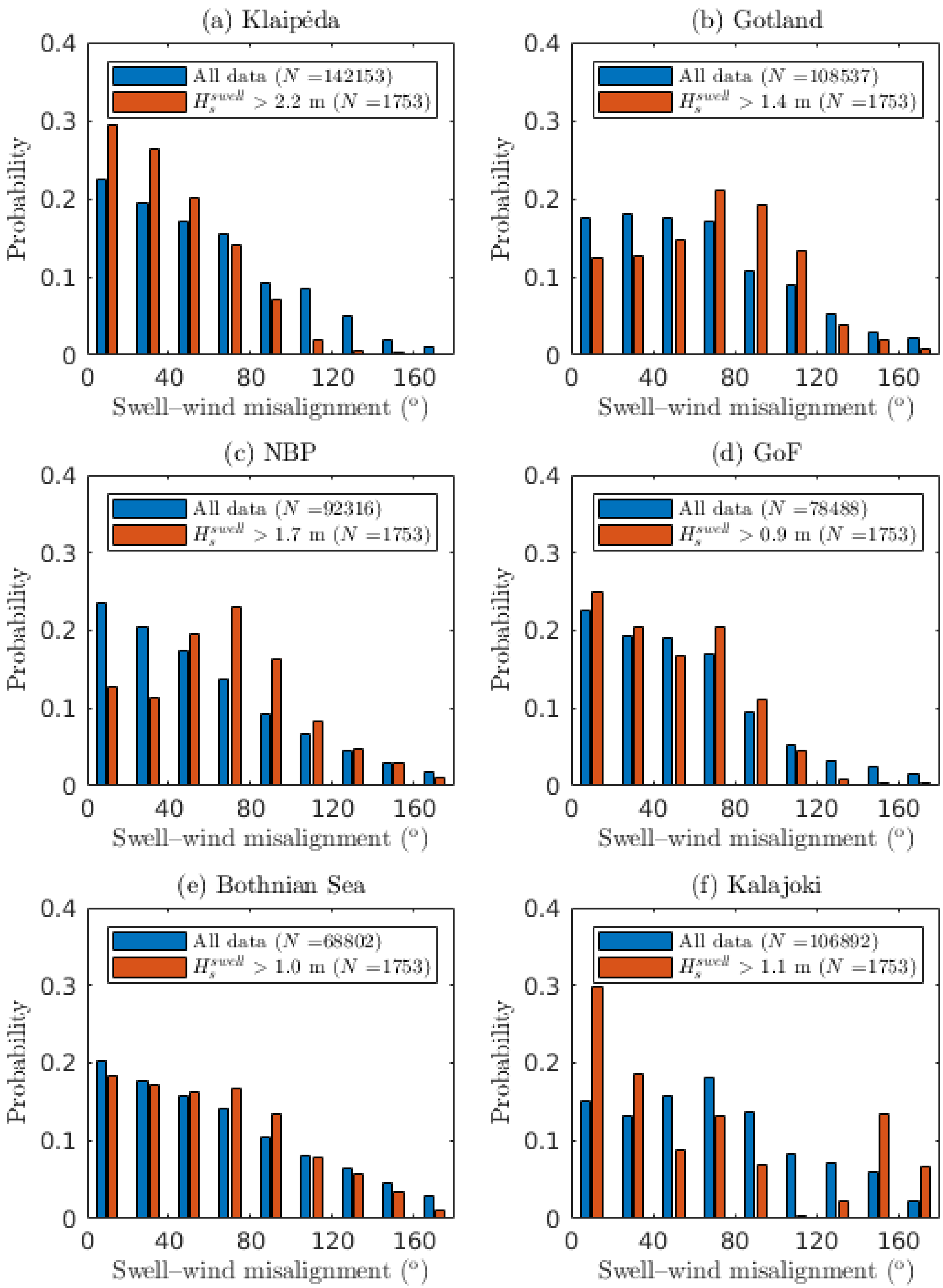

Fig. 4. The probability of differences in swell-wind angles. Swell weights over 0.05.The red bars signify cases where the swell height is above the 99th percentile.

R#2: *In the analysis, the correlation is used to show the relation between swell and wind. For the correlation section, why use wind-sea wave height, but not wind speed? They may do not show a significant difference since wind wave height has a highly linear relationship with the wind.*

Our response: The correlation analysis was not done to show a relation between the wind speed and the swell, but rather the wind-sea and the swell. The idea is that in oceanic conditions (for distant swell), the swell height would be uncorrelated with the local wind sea. However, since distant oceanic swell is absent in the Baltic Sea, the question arose to which extent the swell is “distant enough” to be detached from the locally generated waves. This analysis gave us some insight into the structure of the wave field in the Baltic Sea, as presented in the results and discussion.

As you suspected, the strong connection between the wind speed and the wind-sea height means that the correlation structure calculated between the wind speed and the swell height is very similar to the results presented between the wind sea and swell (see Fig. 5 of this document). Since we were, in the end, interested in the structure of the wave field, we feel that including the wind speed at this stage obscures the point, although it would ultimately lead us to the same conclusions.

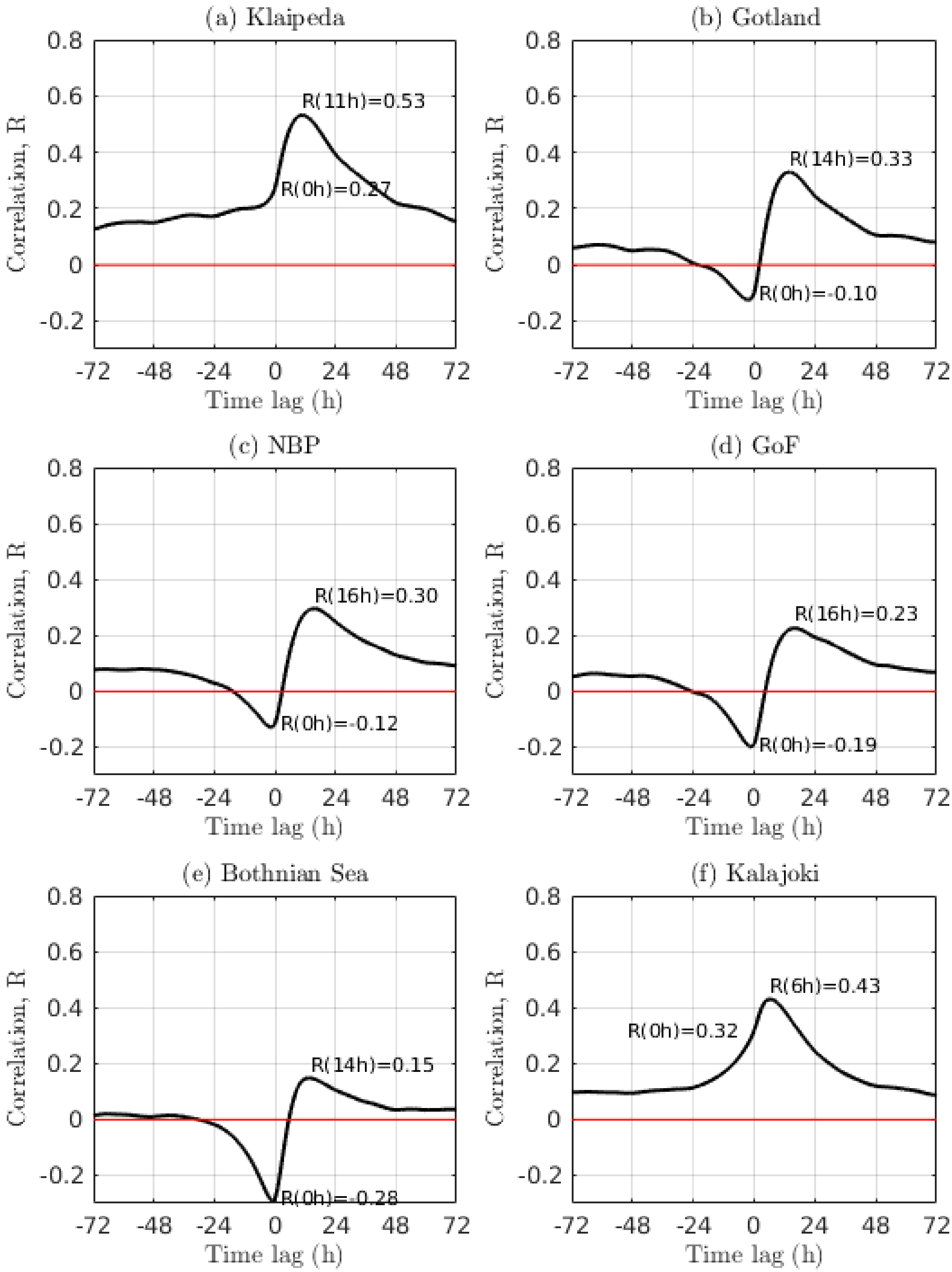

Fig. 5 The correlation between the swell height and the wind speed. The results are very similar to the correlations between the wind-sea height and the swell height.

***R#2:** Minor comments:*

- *L10: suggests→suggest*

Our response: This has been corrected.

- *L19: upwards→upward*

Our response: This has been corrected.

- *L55: What is the temporal resolution of the ice data?*

Our response: The temporal resolution of the ice data varies. Between 1992 and 2005 the resolution is 3-4 days (updated twice a week) and from March 2005 onward the resolution is mostly 1 day. This information has been added to the manuscript.

- *Figure 2: Give the full words of the abbreviations NBP*

Our response: This has been corrected in the figure caption.

- *Figure 4: Authors can consider using the normalized distribution since the total data points vary with stations which may be easier to show the distribution (in particular for GoF). The total number of data points should be given.*

Our response: In the end we chose not to use a normalized distribution, since the current figure also contains visual information about the differences in the swell climate between the locations, which would be lost in the normalization. The total number of points have been added to the plot.