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Interactive comment on "Wave climatology in the Arkona Basin, the Baltic Sea" *by* T. Soomere et al.

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We highly appreciate the overall positive attitude of both referees to our manuscript and gratefully acknowledge their detailed and uncompromising but still friendly and very constructive comments and suggestions. The remarks greatly helped us to put the entire presentation into a more proper context and to identify and remove several inconsistencies, and to express more clearly the background of a few debatable items in the text.

As many issues were highlighted in the comments of both referees, we decided to present a merged answer to their comments.

General comments. A major concern of both Referees was that the presented estimates of wave statistics were based on data sets reflecting wave properties at different instants or covering different time intervals. Referee #2 also underlined that the mea-

sured time series are not homogeneous. We agree that potential consequences of these issues were only very shortly considered in the original manuscript simply because the basic properties of the wave regime were extremely stable. For example, the distributions of the occurrence of different wave heights and periods are almost the same for quite different sets or records: the entire pool of measurements, hourly records and records at the synoptic hours. The relevant issues are now addressed in more detail. First of all, we have added a relevant note into the beginning of Section 3 and lines reflecting the results based on different data subsets to Figs. 6, 7 and 8.

Following a suggestion of Referee #1 concerning potential pitfalls in the comparison between measured and simulated data representing different time intervals, all bottom-line comparisons in Section 3 have now been made for a selection of hourly time instants for which all data sets have an entry. This data set is called overlapping data in the revised manuscript. The conclusions are checked against distributions constructed from the data reflecting only the synoptic hours. As the resulting distributions and estimates practically coincide, full data sets are occasionally used in Sections 4 and 5.

The Peak-Over-Threshold method, recommended by Referee #2, is a proper method for studies of extreme events in serially correlated data indeed. However, we are of opinion that the measured time series (20 yrs of data) is not representative enough for a comprehensive and well-justified study of strong storms in this area. Also, a preliminary study of extreme wave situations in this region has been recently published (Soomere and Kurkina, 2011). For this reason, we decided to focus on the basics of wave statistics and not to extend the analysis to the extreme situations.

As already mentioned, potential effects of strong serial correlation of the existing data are to some extent quantified by a comparison of distributions constructed from different subsets of data (Figs. 6, 7 and 8). The differences are very small. This strongly suggests that the serial correlation does not have any substantial impact on our estimates of the basic wave statistics, incl. distributions of the frequency of occurrence of different wave heights and the parameters of the matching Weibull distributions.

The difference between statistical parameters for the entire set and the set of daily mean wave heights is only weakly affected by serial correlation. The majority of differences stem from the smoothing operation that substantially decreases the proportion of the "tails" of the distribution and increases the proportion of "average" situations. We think that it is important to mention this difference because in several earlier studies (e.g. Zaitseva-Pärnaste et al., 2009; 2011) daily wave heights were used to eliminate the inhomegeneity of the data stemming from a systematically different number of records a day in different seasons.

We agree that the use of two wave hindcasts (that match each other reasonably well) might be superfluous. The major reason for including two simulated data sets is the wish to highlight one usually concealed shortage of wave simulations in semi-sheltered basins. The AW simulations use very good wind data but quite limited range of frequencies and, thus, may be unable to resolve a part of high-frequency wave fields in this sheltered domain. The RS simulations use low-resolution wind information but are specifically tuned to represent low and short waves that are frequent in the nearshore domains of the Baltic Sea. The key outcome from the use of two hindcasts is the conjecture that short waves may be severely underrepresented in both "standard" simulations and even in high-tech measurements. We have formulated this aspect more clearly in the revised version. The fact of using adjusted geostrophic winds in the RS simulations is minor in this context. A short discussion of the adjustment procedure (Bumke and Hasse, 1989) and the reliability of the resulting winds has been added to Section 2, with a reference to the user groups of this wind data (Myrberg et al., 2010).

The discussion of the diurnal variation in the wave height has been revised in the light of comments of Referee #2. We discovered a small bug in our calculations. Fortunately, it did not change the outcome of the discussion but still led to some changes in the appearance of these variations. It turned out that the diurnal cycle (for single months and for the entire data set) is not statistically significant and, therefore, evidently reflects short-term natural variability in the wave properties. The use of "amplitude" in this

context might be misleading and has been revised.

The analysis of the dependence of the wave properties on the presence or absence of (sea or coastal) breeze is, to our opinion, out of the scope of this paper. We only mention for the sake of completeness that breeze may have a role. The text has been reshaped to make this aspect clear.

We have also carefully revised the wording towards more compact style and correct use of English.

Specific comments.

The original choice of the title word "climatology" was meant to represent its less frequently used meaning as the pool of data about the climate. We adjusted the title and the use of words "climate" and "climatology" accordingly.

The comments and suggestions of Referee #1 mostly required quite straightforward changes to the text that definitely improved its readability. In particular, we have slightly reformulated the description of numerical experiments, making clear at each occasion which particular experiment is referred to. A short explanation of the use of the wave data from the Lithuanian coast has been added together with a relevant reference. As recommended also by Referee #2, the definition of quantiles has been moved to the beginning of the description of the results and the use of various terms has been unified.

We were somewhat careless in our discussion of the inaccuracy of the representation of wave periods in different data sets on p. 2246. This part has been reformulated. The main point is as follows. The relatively large proportion of small periods in RS simulations strongly suggests (but does not prove) that the two other data sets may have problems with representation of periods <3 s. The discussion of the quality of atmospheric data on p. 2251 was also somewhat too enthusiastic and has been removed.

As suggested by both referees, the discussion of variations on weekly scales (p. 2242) has been made more compact and clear. In particular, we explain now in more detail what actually is compared. A couple of important references have been added and the discussion of the adequacy of the underlying wind information has been removed. Note that here we intentionally compare the data from largely different time periods in order to demonstrate that this variability is not persistent on multi-decadal scales.

As noted by both referees, interpretation of long-term trends (p. 2254) is a highly controversial issue. There is a slight increasing trend in the measured data, about 9 mm/decade; however, it is not statistically significant. Moreover, the overall change in the wave height is considerably smaller than the typical level interannual variability or variance. We have reshaped the discussion so that these aspects are made clear.

The comment on the limitations of the waverider (p. 2255) is based on its technical description: according to the manufacturer, the device captures wave periods from 1.6–30 s. As the wave fields normally contain also a certain fraction of longer components, this means that mean periods below 2 s are almost never recorded. They are, however, quite frequent in the nearshore and/or sheltered areas of the Baltic Sea (Zaitseva-Pärnaste et al., 2009). It is possible to capture this part of wave fields using acoustic or laser-based devices that are fixed to offshore platforms. Doing so is particularly important in rogue wave studies where the higher harmonics play a decisive role. We added a reference to such studies (Didenkulova, 2011).

We are also grateful for the technical suggestions by Referee #2. The figure captions have been changed and buoys in Fig. 1 have been clearly marked. Although we do not analyze the data from the buoy in the Arkona Basin, we still think that is might be important for the readers to know that more information about the wave climate will be available in the future.

The importance of including two modeled data sets has been discussed above. The issue of wave directions is important indeed as quite often changes in the wave direction lead to the intensification of coastal processes. We considered including some results

of the analysis of wave direction into our study but decided that doing so would defocus the present study. A selection of 2D maps of simulated wave properties for the entire Baltic Sea has already been published in (Räämet and Soomere, 2010; Soomere and Räämet, 2011b). A relevant reference has been included into the text.

We are grateful to Referee #2 for highlighting several other occasions where our presentation was somewhat puzzling. All these occasions have been rephrased. In particular, we avoid the use of “probability” in the discussions of empirical distributions of waves with different periods. Following one of the recommendations, a panel reflecting the distribution of missing data by months has been added (Fig. 3) and the discussion of data gaps and inconsistent records has been refined.

As mentioned above, the discussion of diurnal variations on p. 2245 has been thoroughly revised and a bug in the underlying calculations was removed. The comparison of modeled and measured long-term parameters on p. 2245 has been rephrased. The discussion of potential trends is now largely based on the analysis of variance and statistical significance. The issues related with the serial correlation of the data (p. 2246) and data inhomogeneity (p. 2246–2247) are explained above under General Comments. Caption to Fig. 9 (now Fig. 10) has been revised. The algorithm for calculation of the mean wave height for calendar days (p. 2251) is explained in more detail now. We still decided not to expand the analysis to the wind data.

As mentioned above, the analysis of long-term changes in Section 5 (starting from p. 2252, incl. the analysis of higher percentiles) is performed from the viewpoint of statistical significance in the revised version. We are aware that the conclusions about the particular long-term and decadal course of wave heights can only be qualitative and make that very clear in the revised version. As the aim of the paper is to describe the basic features of the wave climate and their potential long-term changes, the analysis of long-term and annual wave heights (p. 2253) is a must. It is of course possible to revert to wave heights integrated over windy and calm seasons but it is unlikely that they will reveal some new features. As noted above, we think that a comprehensive analysis of storm episodes and detailed performance of the WAM model under high winds (p. 2253) is out of the scope of the current paper. However, in order to inform the reader about the possible bias of WAM in storms we have included a detailed reference. The analysis of trends relies (p. 2253) now on statistical significance and reveals, as expected, that none of the identified trends is significant.

The discussion of the results (Section 6, p. 2254) has been carefully revised to match the changes in the analysis, especially the lack of statistical significance of the trends. In particular, we removed some typos and clearly specified where we talk about measurements and where about simulations. The conjecture about the sheltered nature of the Darss Sill area (p. 2254) is explained in more detail. In essence, it becomes evident already from the absence of wave fields with mean periods >6 s. This conclusion can be made stronger through an analysis of wave directions indeed. However, as noted above, we are of opinion that such an analysis is out of the scope of this paper.

We apologise for an ambiguous formulation of distortions in the distribution of wave periods on p. 2255. The point is that one simulation (that uses an extended frequency range) shows that there might be a considerable fraction of wave fields with short periods. This conclusion is consistent with existing data from other semi-sheltered sites (p. 2255). Thus, we think that these distributions should be reproduced adequately in the future. The remark about interrelations between wave heights and wind speeds (p. 2255) has been reformulated. Finally, we think that an analysis of the directionality of waves and winds deserves a separated study.

Technical corrections by Referee #2 have been accounted for. We do not have information about the reasons for the changes in the routine of the waverider but we try to maximally exploit the recorded data set.

We also added two relevant references to the simulations and data (Schmager et al., 2008; Pettersson et al., 2009), replaced a reference to a local publication (Jaagus, 2009) by an international publication on the same topic (Jaagus and Kull, 2011) and

updated bibliographical information about sources that were in press during the original submission.

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