Wave climate in the Baltic Sea 2012

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Key message

The annual course of the wave climate in the Baltic Sea was rather typical for the area. Record high values were measured in Skagerrak (8 metres in January) and in the Gulf of Finland (5.2 metres in November). The significant wave height reached 5.3 and 5.7 metres in the Bothnian Sea (January), 6.9 metres in the northern Baltic Proper (January) and 3.5 metres in the Western Baltic Proper (December). September was clearly rougher in all the stations where measurements were made. May was typically the calmest month of the year.

Results and assessment

In 2012 waves were measured in ten locations in the Baltic Sea and Skagerrak (Figure 1). These buoys provide real time information of the wave climate for professional and free time navigation. The wave measurements are also important for wave related research and wave model development. As waves contribute to the mixing of the surface layer and their influence can extend to the bottom (resuspension) the information about the yearly wave activity adds to the understanding of the physical environment of the Baltic Sea.

The monthly mean values of significant wave height are plotted in Figures 6 and 7, and the highest values of significant wave height are shown in Figures 8 and 9.

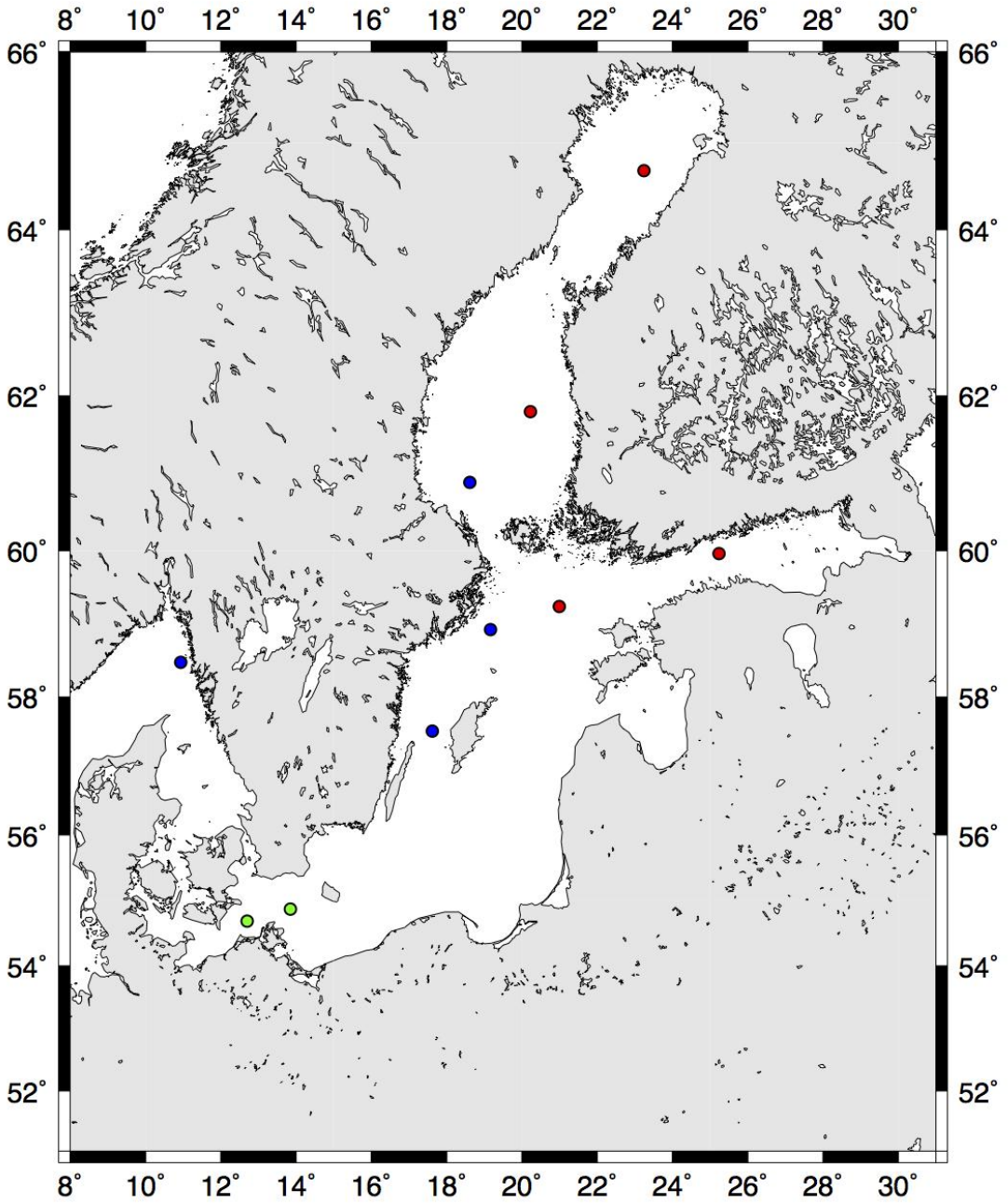

Figure 1. The position of wave measuring sites in 2012. Red dots indicate FMI buoys in the Bay of Bothnia, in the Bothnian Sea, in the Northern Baltic Proper and in the Gulf of Finland (station Helsinki), blue dots SMHI buoys in the Southern Bothnian Sea (station Finngrundet), in the Baltic Proper (stations Huvudskär Ost and Knolls Grund) and in Skagerrak (station Väderöarna) and green dots the BSH and HZG buoys off Cape Arkona and on the Darss Sill. See section Metadata for the exact coordinates of the buoys.

The Gulf of Bothnia

The Bay of Bothnia

FMI started 2012 wave measurements in the Bay of Bothnia. The previous measurements from this area are from 1980-81 (FIMR). The present location is situated further out to the open sea. The period for risk of ice in the Bay of Bothnia is naturally the longest for the present Baltic Sea wave stations: the measuring period will be typically from May-June to November-December. During this first year the buoy was deployed 31st May and recovered 20th November.

The highest previously measured significant wave height was 3.1 metres. At this new location further out to the open sea, three metres were exceeded in September (3.3 metres), October (3.1 metres) and November (3.1 metres). During the summer months the significant wave height exceeded two metres twice in June and once in August.

The Central Bothnian Sea

The winter 2011-2012 was rather mild and the buoy in the Central Bothnian Sea was recovered in the beginning of February and redeployed in the end of May. The buoy was operational to the end of the year.

The highest significant wave height for the measuring period, 5.7 metres, was measured January 13th, otherwise the significant wave height remained under four metres. In June, the significant wave height exceeded two metres three times, while in the calmest of the summer months, in July, the significant wave height remained under two metres. On August 27th, a significant wave height of four metres was measured. Even if the monthly mean values in the rest of the year were higher and three metres was often exceeded, significant wave heights of similar magnitude were measured only three times in October (3.9 – 4.0 metres) and once in November (4.7 metres). In December the significant wave height remained under 3.5 metres.

The Southern Bothnian Sea, station Finngrundet

In 2012 the buoy at Finngrundet was recovered in the beginning of March to prevent ice damage. It was redeployed in the beginning of May.

As in the Central Bothnian Sea the highest significant wave height for 2012 was measured on January 13th at 5.3 metres. This was the third occasion ever a significant wave height above 5 metres was registered at this position. A significant wave height above 3 metres was registered twice in February and once a month between October and December. On November 30th the significant wave height reached 4.4 metres. On August 27th the significant wave height at Finngrundet reached 2.8 metres. Not an exceptional value but the highest value during August in 2012 and in accordance with the measurements in the Central Bothnian Sea. Not taking into account the results for

April, when measurements only were taken 6 days out of 31, mean significant wave heights differed only slightly from the long term mean for single months.

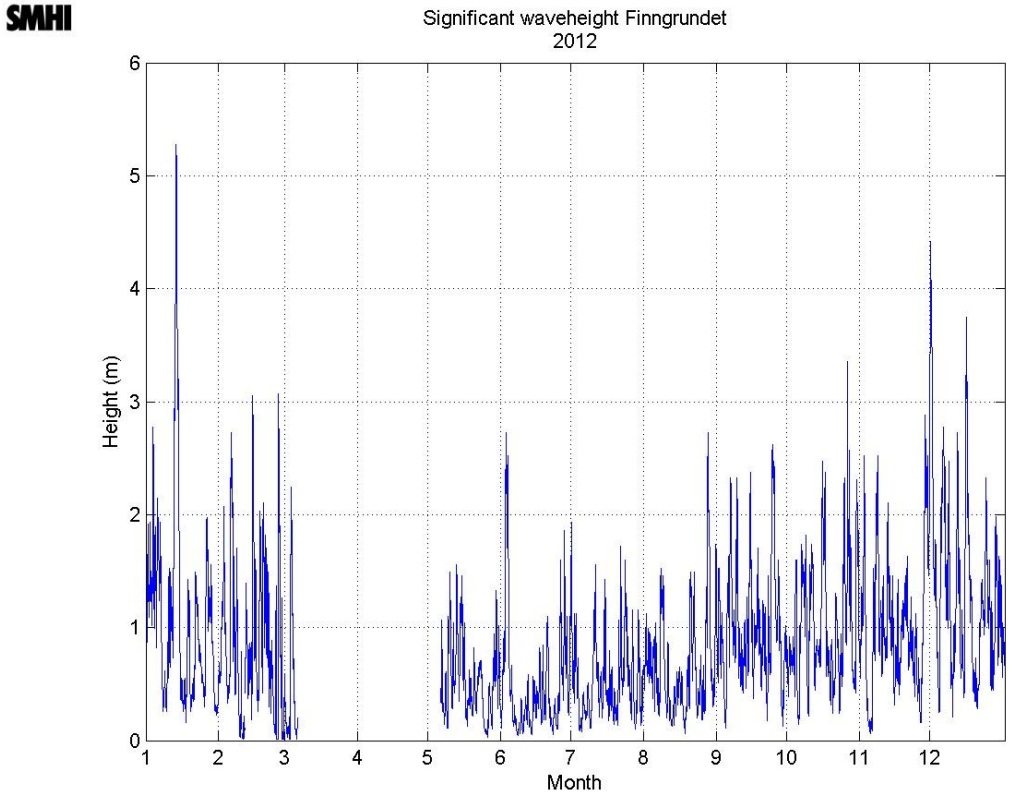

Figure 2. Time series of significant wave height at station Finngrundet.

The Gulf of Finland

The middle parts of the Gulf of Finland, station Helsinki

The period for risk of ice damage in the middle parts of the Gulf of Finland is typically from January to May. In 2012 the buoy was recovered in the beginning of February and redeployed in the end of April.

January was calmer than in average, the significant wave height exceeded three metres once, being 3.4 metres on 5th, during the same SW high wind event when high values were measured in Skagerrak and Northern Baltic Proper. May and June were typical for the season, the highest significant wave heights were 2.9 metres on May 12th and three metres on June 2nd. From July to the end of the year, rougher- and calmer-than-average months alternated. In July, the significant wave exceeded 1.5 metres three times, while in August only once, on 7th, when the significant wave height reached 2.5 metres. September was rougher in average. Although the significant wave height exceeded 2.5 metres only twice, it was seldom less than 0.5 metres. In October a height of 2.5 metres was exceeded more often (2.8 metres as highest), followed by calmer periods. November was dominated by an eastern storm

in the end of the month. A significant wave height of 5.2 metres was measured on 30th. After that the receiving antenna broke down due to snow load and strong winds. The wind was already calming down: the waves did probably not grow much higher. A significant wave height of 5.2 metres has been measured at this location only once before, during a southwestern storm in November 2001. The measurements could be continued on December 4th: after this storm December was calmer than usual, the significant wave height reaching 2.8 metres once.

The Baltic Proper

The Northern Baltic Proper, stations Northern Baltic Proper and Huvudskär Ost

The extent of the ice cover in winter 2011-2012 did not reach the position of the wave buoy in the Northern Baltic Proper and measurements could be carried out through the winter.

During the time when there were coincident measurements in the Gulf of Finland, the monthly means in the northern Baltic Proper behaved similarly than at the station Helsinki, only the values were higher. Although January was in average calmer than usual, the highest significant wave height for the year, 6.9 metres, was measured on 4th. The highest ever significant wave height for January, 7.2 metres, was measured in 2005. During the NNW high wind event on 13th-14th, (see the text on Bothnian Sea and station Knolls Grund) the significant wave height on January 14th reached 4.7 metres. In February the significant wave height exceeded 4 metres twice, being 5.3 metres as highest on 19th. In the spring season, from March to May, significant wave height remained under four metres in March. April was rougher than usual, significant wave height exceeded three metres twice. May was typical for the season, the values remained under 2.4 metres. During the summer months, significant wave height exceeded three metres twice, 3.3 metres June 2nd and 3.4 metres July 23rd. The highest value for August was 2.9 metres on 27th, at the same time when significant wave height reached four metres in the Central Bothnian Sea, during high N-NW winds. In the autumn months, significant wave heights over four metres were measured once a month, 4.4 metres September 14th, 5.1 metres October 30th and 4.6 metres November 2nd. On 30th November, when high eastern waves were measured in the Gulf of Finland, the buoy in the northern Baltic Proper measured 3.7 metres. Like in the Gulf of Finland, December was calmer than usual. The highest significant wave height was 5.1 metres, measured on 15th.

The buoy at Huvudskär Ost was deployed on April 17th. In the first half of September the buoy experienced technical difficulties and no data are available until October 4th. The buoy was recovered in mid-November.

Significant wave height at Huvudskär Ost didn't exceed 3 metres before the end of October when a significant wave height of 4.7 metres was measured, the highest ever for that month. Mean significant wave heights differ only slightly from the long term mean values with exception for April and September when they were somewhat

higher. As measurements only were conducted during part of those months it is difficult to draw conclusions from that, but the result is in good accordance with the measurements at station Northern Baltic Proper.

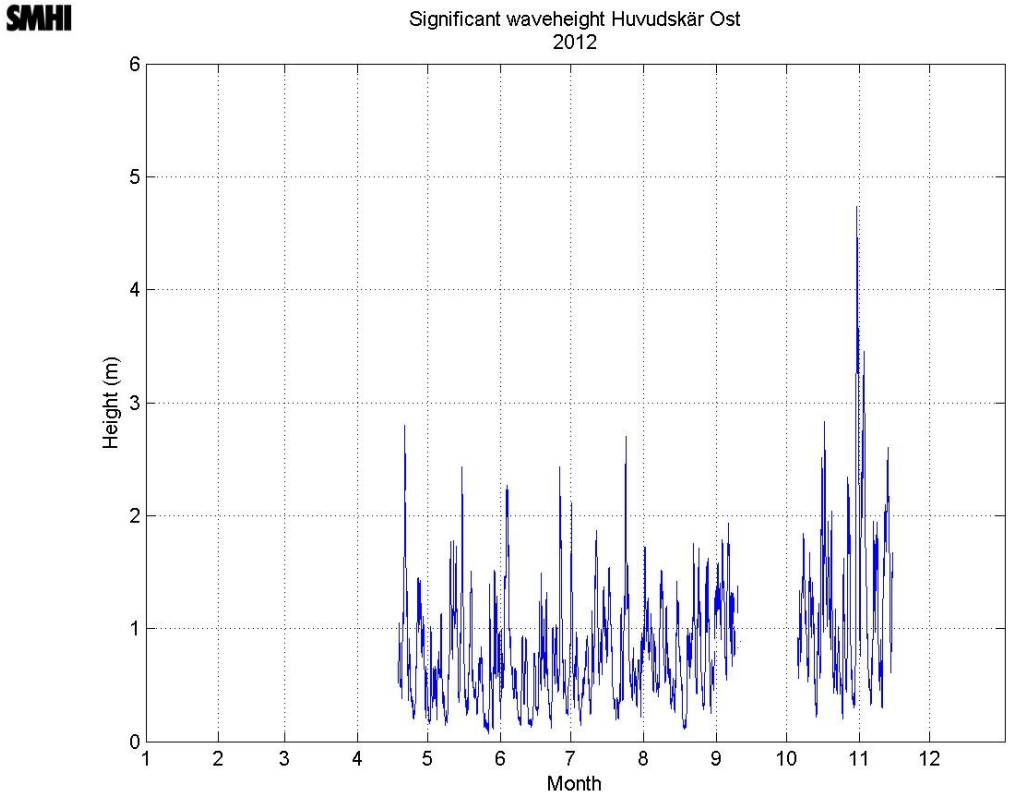

Figure 3. Time series of significant wave height at the station Huvudskär Ost.

Southern and Central Baltic Proper, station Southern Baltic and Knolls Grund

Due to practical reasons the station Southern Baltic was temporarily moved to a new position, Knolls Grund (situated between the Swedish islands of Öland and Gotland) in 2011. The buoy at Knolls Grund was in place year round in 2012.

The highest significant wave heights at this position were registered in January. On January 4th (4.8 metres) and 14th (4.6 metres) a significant wave height of 4 metres was exceeded. Even on March 31st the significant wave height was close to 4 metres. Between April 7th and October 26th the significant wave height at Knolls Grund didn't exceed 3m. Even at this position significant wave heights were rising during November 30th but the maximum significant wave height at that date never exceeded 2.7 metres. Measurements from November and December show slightly lower significant wave heights than the previous year but after approximately 14 month of data collecting it is too early to draw any conclusions from that. In general the development of waves at this position during the passage of storms and low pressure systems corresponds well with that at other wave buoys. Depending on the path those systems take, high significant wave heights often are registered successively by two or more buoys. Examples can be seen by comparing the significant wave heights at

Väderöarna on Jan 4th (which peaked 6 hours earlier) and Finngrundet on January 14th (5 ½ hours earlier) with those at Knolls Grund.

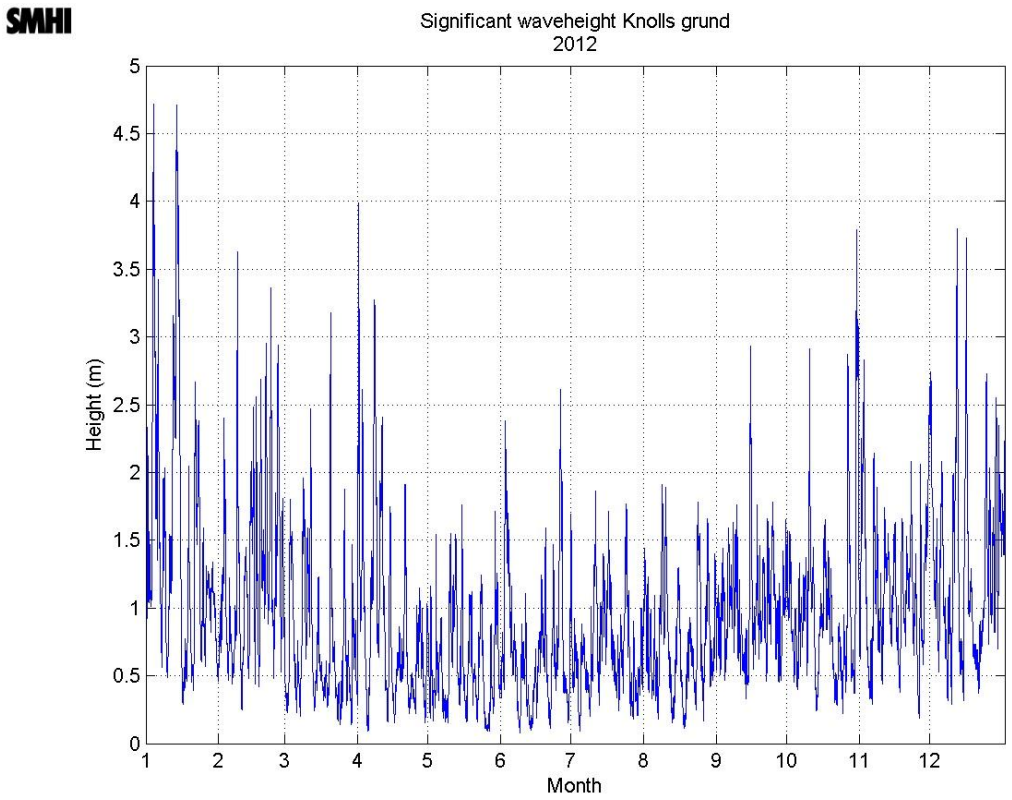

Figure 4. Time series of significant wave height at the station Knolls Grund.

Western Baltic Proper, stations Darss Sill and Arkona

Mean significant wave heights in the area of Darss Sill typically are 0.6 metres in summer and 0.9 metres in winter; the annual mean is 0.8 metres. Wave heights at the Arkona station are slightly higher, ranging from about 0.6 to 1.2 metres, with an annual mean of 0.9 metres. The most frequent wind direction, and thus also the predominant wave direction, is west-southwest (WSW), especially during storm events. Wind fetch in this offshore direction is much longer at the Arkona Basin than at Darss Sill, i.e. waves reaching the Arkona station have more time to grow. But also with other wind and wave directions, the larger distance from the coast and deeper water at the Arkona station are important factors contributing to higher wave heights.

Wind conditions in 2012 were relatively calm, as in the three years before. Both wind speed and the distribution of wind directions – and therefore also distribution of wave directions – correspond to the long term means. The frequency of fresh gales of 8 Bft (17-20 m/s) or more was significantly below the mean value.

Whereas in the Arkona Basin the mean significant wave height was mostly a little lower than the long term mean, at Darss Sill it mostly exceeded the long-term mean a little, so that on the whole wave conditions in the Western Baltic Proper correspond very well to the long term means. By contrast, the maxima of significant wave heights in all months of the year were clearly below historical extreme values. The highest

wave heights were observed in the Arkona Basin on January 4th with 3.4 metres caused by high west-south-westerly winds and on December 11th with 3.5 metres caused by a north-eastern storm of up to 7 Bft (14-17 m/s).

Kattegat and Skagerrak

Kattegat, station Läsö Ost

Wave measurements at the station Läsö Ost are discontinued.

Skagerrak, station Väderöarna

Due to ice conditions the buoy at Väderöarna was recovered on February 9th and deployed again in the end of March.

The highest significant wave height ever measured at this position was registered on January 4th at 8 metres. This is the second highest measured value in the Baltic Sea area: in November 2004, a significant wave height of 8.2 metres was measured at station Northern Baltic Proper. Even on January 12th the significant wave height exceeded 4.5 metres. Apart from these two events the maximum significant wave heights never exceeded 4 metres until December 31st when a significant wave height of 4.1 metres was measured. Mean significant wave heights during 2012 were mostly below or close to the long term mean. The only exception was September when the passage of a number of low pressure systems lead to the highest mean significant wave height for this month since measurements started at this position in 2005.

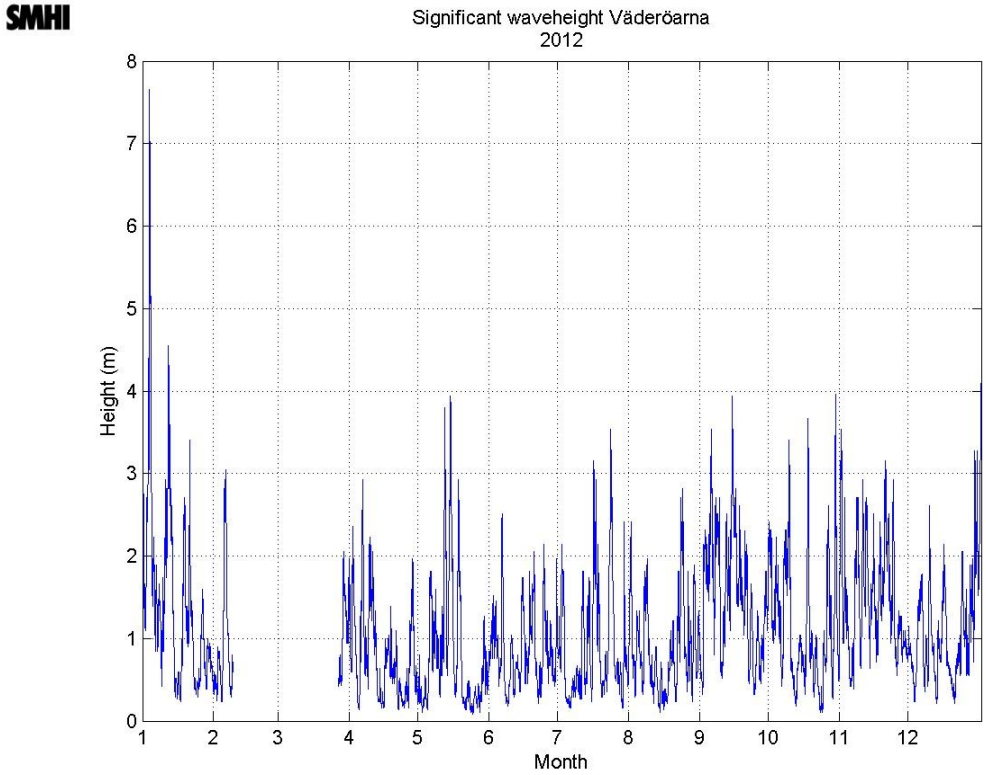

Figure 5. Time series of the significant wave height at the station Väderöarna.

Data

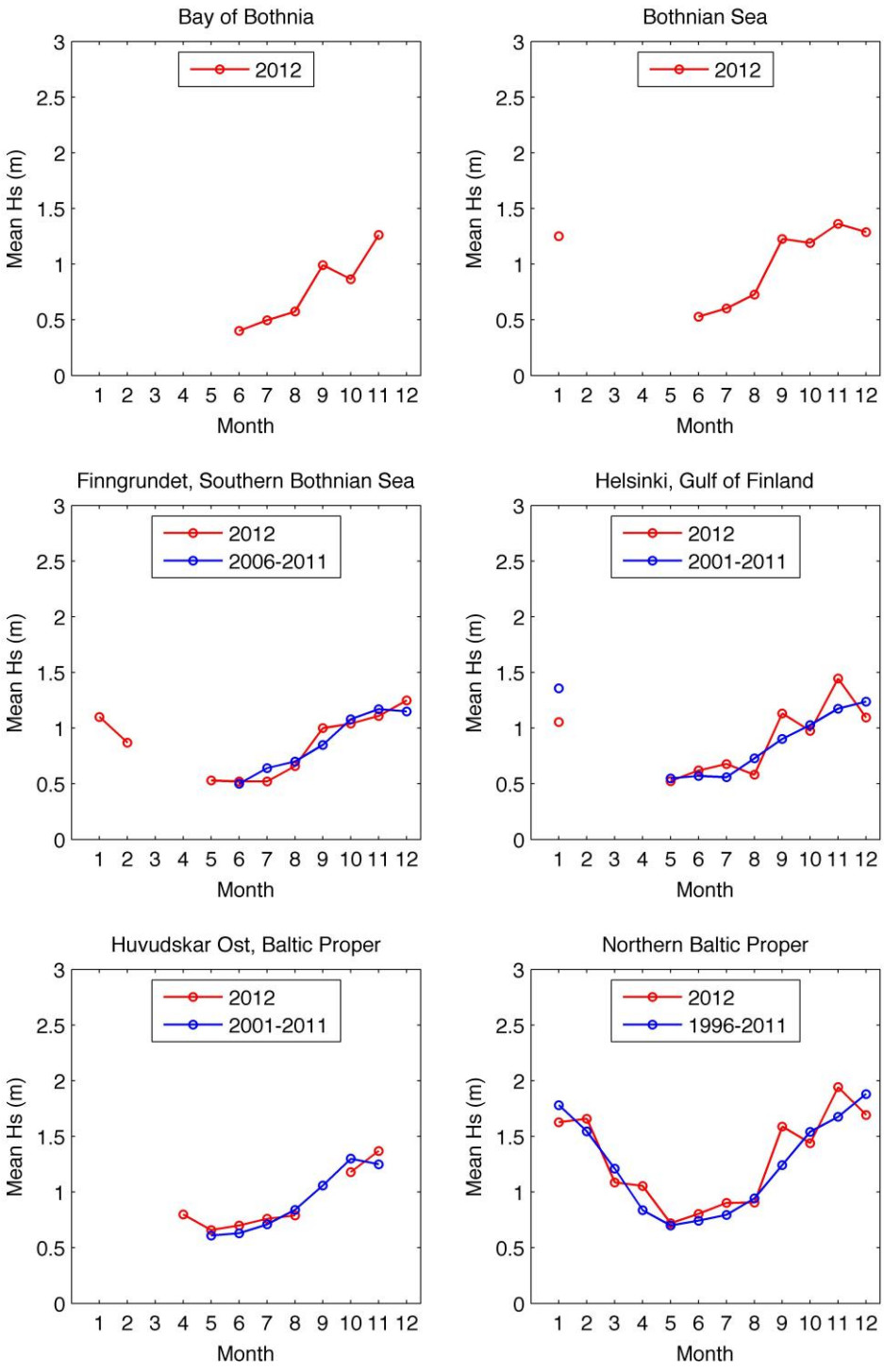

Figure 6. The monthly means of significant wave heights in the Bay of Bothnia, the Bothnian Sea, the Gulf of Finland and the Northern Baltic Proper. In some months the long-term statistics are calculated over fewer years (but at least over four years) than indicated in the legend

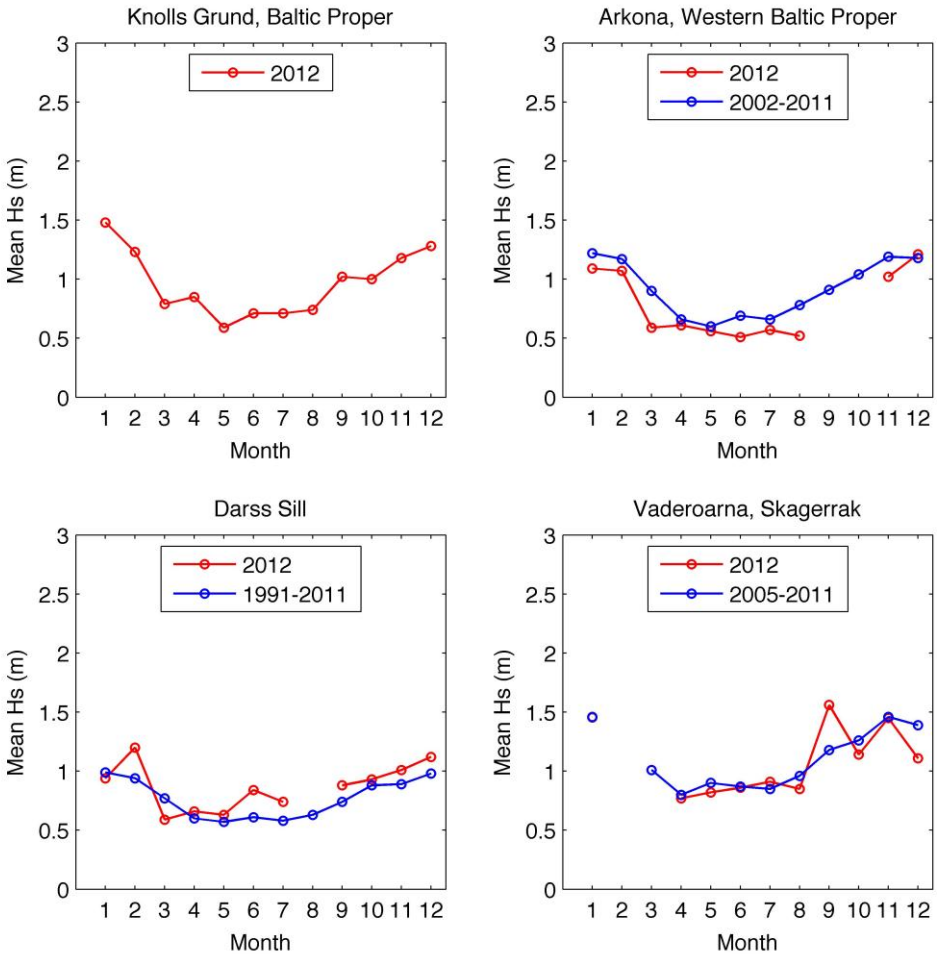

Figure 7. The monthly means of significant wave heights in the Central Baltic Proper, the Western Baltic Proper and Skagerrak. In some months the long-term statistics are calculated over fewer years (but at least over four years) than indicated in the legend.

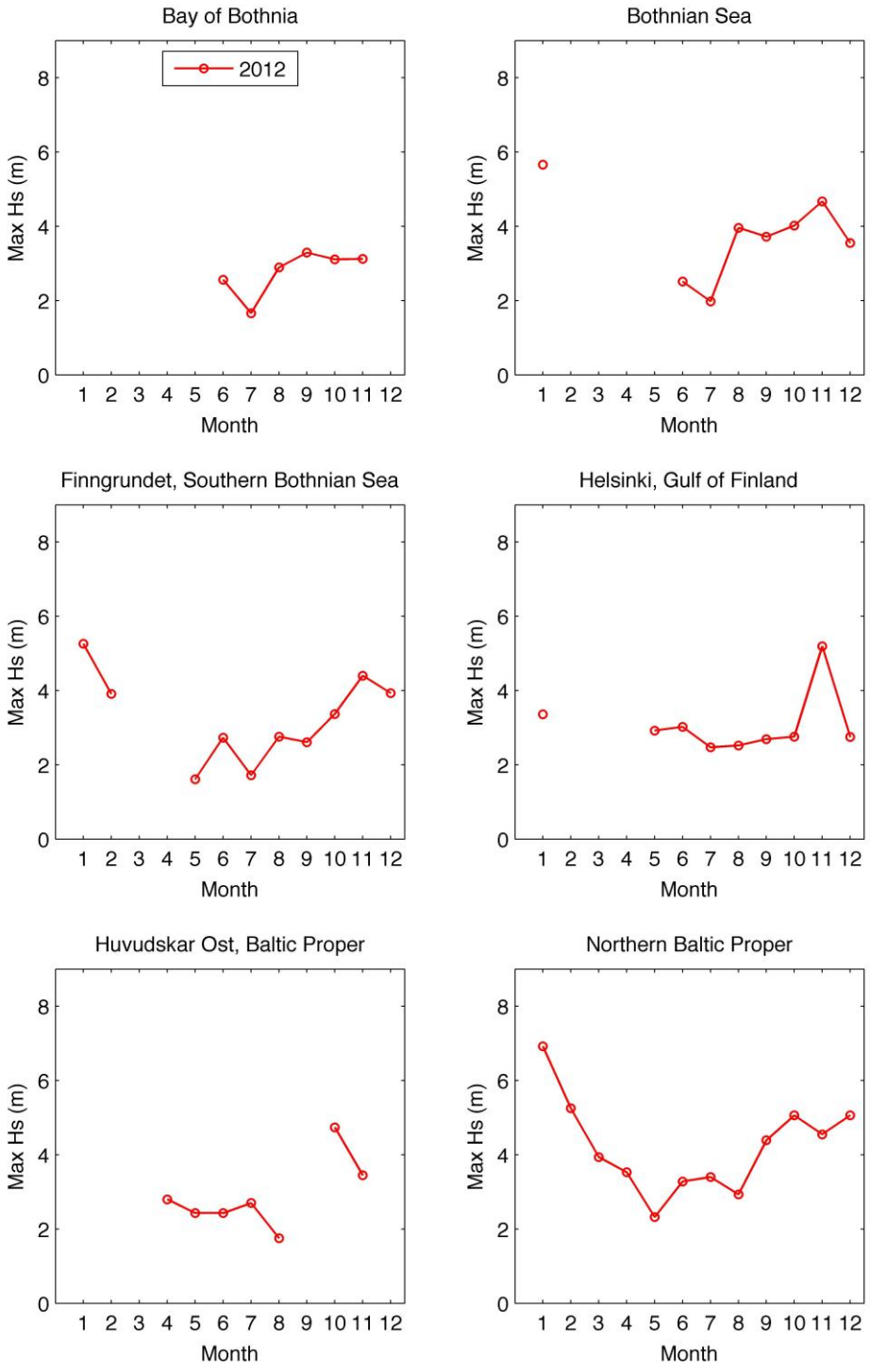

Figure 8. The monthly maxima of significant wave heights in the Bay of Bothnia, the Bothnian Sea, the Gulf of Finland and the Northern Baltic Proper.

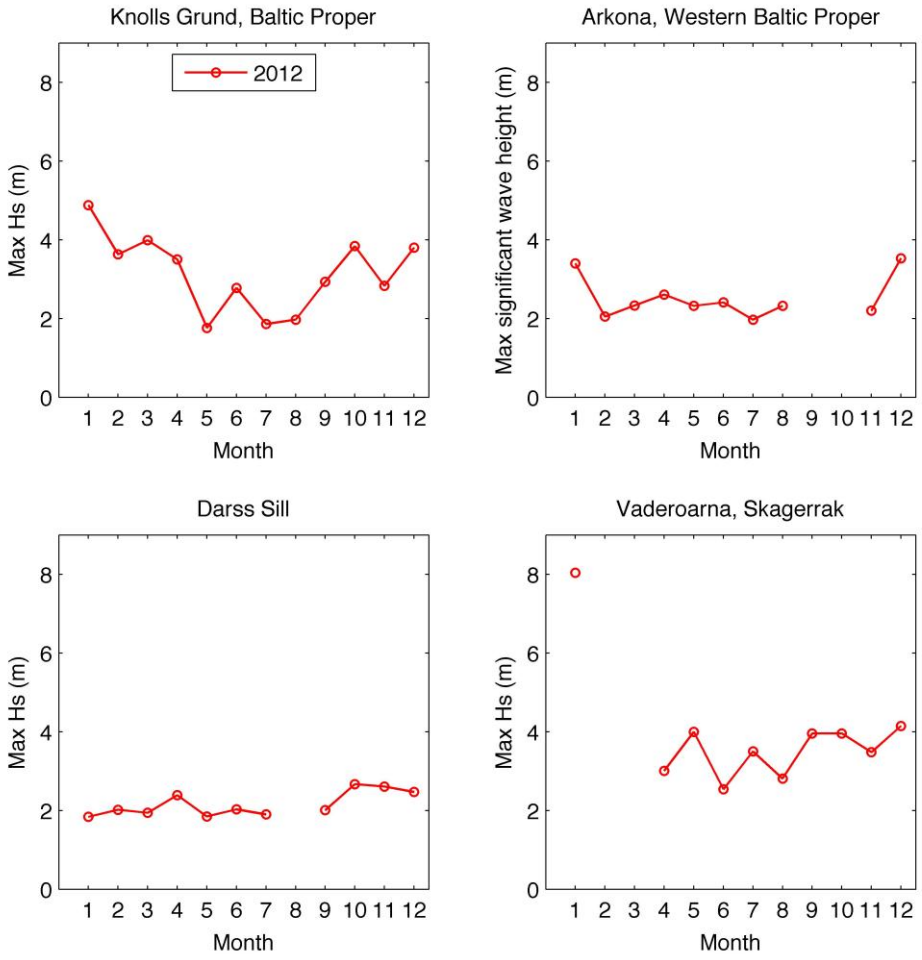

Figure 9. The monthly maxima of significant wave heights in the Central Baltic Proper, the Western Baltic Proper and Skagerrak.

Metadata

In 2012 Finnish Meteorological Institute (FMI) made real time wave measurements at four locations in the Baltic Sea, in the Bay of Bothnia (station Bay of Bothnia, 64° 41.1' N, 23° 14.4' E), in the Central Bothnian Sea (station Bothnian Sea, 61° 48.0' N, 20° 14.0' E), in the Northern Baltic Proper (station Northern Baltic Proper, 59° 15.0' N, 21° 00.0' E) and in the Gulf of Finland (station Helsinki, 59° 57.9' N, 25° 14.1' E). The northern parts of the Baltic Sea freeze every year. The length of the measuring periods varies every year depending on the extent of the ice cover.

The Swedish Meteorological and Hydrological Institute (SMHI) made wave measurements at four locations, in the Southern Bothnian Sea (station Finngrundet, 60° 54' N, 18° 37' E), in the Northern Baltic Proper (station Huvudskär Ost, 58° 56' N, 19° 10' E), in the Central Baltic Proper (station Knolls Grund 57° 31' N, 17° 37' E) and in Skagerrak (station Väderöarna, 58° 29' N, 10° 56' E).

Since 1991, wave measurements in the western Baltic Sea have been carried out at a station located at 54° 41.9‘N, 12° 42.0‘E in the area of Darss Sill (with Helmholtz-Zentrum Geesthacht - Zentrum für Material und Küstenforschung GmbH (HZG) as the operator), and since 2002 at a station northwest of Cape Arkona (54° 52.9‘N, 13° 51.5‘E), where measurements are made by the Federal Maritime and Hydrographic Agency of Germany (BSH). Long-term climatological wave data are not yet available at the latter position. Up to now, measurement interruptions due to ice coverage or drift ice occurred only in the winter of 1995/1996, at the Darss Sill measuring station, and in February and March 2010 at the Arkona Basin station.

The waves at each station are measured with surface following buoys, Seawatch, Directional Waveriders and Waveriders. Measurements were collected app. every hour via Iridium, HF link, Argos-satellite, Orbcomm system and dataloggers. The significant wave height is calculated onboard the buoys over 1600 s time series of surface displacement and the quality of the measurements were checked according to the routines at each of the responsible Institutes. All measurement data referred to in the text are significant wave heights, namely monthly averages and maxima unless otherwise stated.

The lengths of the deployment periods in 2012 are indicated in the text. The length of the period at each station depends on the extent of the ice cover, maintenance and deployment logistics and possible instrument damages. As a consequence, measurements are not always available for 12 months per year for the long-term statistics. The years given in the Figures 6 and 7 indicate the start of the measurements: in some months the statistics are over fewer years but only statistics over at least four years are plotted in the Figures. The monthly means are given when there are measurements over half of the month. Because of data gaps the maximum values do not necessarily constitute the true monthly maximum, whereas the mean values are largely reliable. Due to the variation of the lengths of the timeseries in the statistics they should be used with caution.