Wave climate in the Baltic Sea 2014

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Key message

During the periods the wave buoys were deployed, the wave climate in 2014 was in average rather typical. No yearly record values were registered; the highest significant wave height was 6.7 metres measured in the northern Baltic Proper in December. Monthly records were measured at two stations in the western Baltic Proper in May, where the significant wave height reached 3.9 metres, and in southern Bothnian Sea where a significant wave height of 4.6 metres was measured in September. Calmer and rougher months alternated from August to December, with differences up to 50 cm in the mean values, except in the western Baltic Sea and the Bay of Bothnia where the differences between successive months were smaller. In average August was clearly rougher than usually in all the stations where measurements were available.

Results and assessment

In 2014 waves were measured in eleven 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 2 and 3, and the highest values of significant wave height are shown in Figures 4 and 5.



Figure 1. The positions of the wave buoys in 2014. 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 Fino2, 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

The wave measurements in the Bay of Bothnia were restarted in 2012. The previous measurements from this sea area are from 1980-81. 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. In 2014 the buoy was deployed 23rd May and recovered 27th November.

The highest measured significant wave height in the 1980's was 3.1 metres. At the present location further out to the open sea, four metres were exceeded in 2013 three times, and 4.4 metres is now the highest measured sea state in the Bay of Bothnia. In 2014 the significant wave height remained under four metres. Three metres were exceeded four times: in the end of September, 3.1 metres was measured on 26th and 3.2 metres on 27th. In October 24th-25th, the significant wave height remained over three metres for 25 hours. The highest value during this southern high wind event was 3.5 metres, which also was the highest value for the measuring period in 2014. November was a rather calm month, but the significant wave height reached 3.2 metres once in the beginning of the month, on the 2nd. June and August were typical for the season and the significant wave height remained under 2.7 metres (measured on 12th August). Even if the significant wave height in July was 2.5 metres at highest (2nd July), the mean value for the month was low, only 0.35 metres: the significant wave height exceeded one meter only four times.

The Central Bothnian Sea

The buoy in the Central Bothnian Sea was recovered on 24th January and redeployed on 5th April. The buoy was operational to the end of the year.

The monthly means of the significant wave height followed the behaviour the mean values at the stations Northern Baltic Proper and Helsinki. January was rather calm: the significant wave height reached 3.3 metres on the 1st and 3.2 metres on the 10th, while the highest value for January since 2011 is 5.7 metres. 2014 was the first year we have measurements in April, and the significant wave height exceeded two metres three times, 2.3 metres on 11th, 2.2 metres on 13th and 2.3 metres on the 15th. The highest sea state in May and June were 2.8 metres on 26th May and 2.9 metres on 13th June. July was calm, the significant wave height exceeded one metre only three times: the highest value, 1.6 metres, was measured on the 31st. August was rougher and a significant wave height of 3 metres was measured twice, on the 26th and 27th. The average sea state in September was low, but the significant wave height exceeded three metres three times in the second half of the month: 3.8 metres on the 22th, 3.4 metres on the 26th and 3.1 metres on the 30th. September was followed by a typical October and the significant wave height reached 4.8 metres on the 24th. This value is the highest for October since the measurements started in 2011. November was rather calm in average (one metre) and the highest sea state, 4.4 metres, was measured on the 24th. December was typical for the season; sea states over two metres were measured with few days' intervals. The significant wave height reached 4.8 metres on the 10th. This was the highest value for the measuring season, measured both in October and December.

The Southern Bothnian Sea, station Finngrundet

The wave buoy at Finngrundet was deployed on June 15th. On the 29th the buoy started drifting and on August 25th another buoy was deployed. In November the buoy started drifting for the second time. As it seems that the position at Finngrundet is increasingly prone to trawling activities, the buoy may has to be relocated in the future. On November 27th measurements at Finngrundet were re-established and continued to the end of the year.

Weather conditions during the second half of June were variable with quite windy periods and the significant wave height rose above 1.5 metres at a number of occasions. On August 26th and again on the 27th the significant wave height rose to 2.5 metres matching observations of high waves at the same occasion at the station Central Bothnian Sea further northeast. In the beginning of September until the 22nd conditions were unusually calm, resulting in significant wave heights that only once slightly exceeded 1 meter. On the 22nd the situation changed dramatically. The weather station at Örskär, located at the Swedish coast close to Finngrundet, registered NNE wind with a mean speed of 26.3 m/s and the significant wave height rose to 4.6 metres (maximum individual wave height 7.9 m), a new record for the September month, exceeding the previous record value by 1 metre. This was also the highest value measured at this position during the deployment periods in 2014. The significant wave height stayed over 2 metres for more than 36 hours. During October and until November 9th, when the buoy was dislocated, nothing exceptional happened. The significant wave height came close to 3 metres on two occasions, October 8th and November 4th. During December a number of low pressure systems influenced the wave climate in the Baltic Sea. Significant wave heights at station Finngrundet reached or exceeded 2 metres on seven occasions, coming close to 3 metres on December 10th and 24th.

The mean significant wave height was below or close to the long term mean in all months during which the buoy was in position longer than 50% of the time.

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 2014 the buoy was recovered on 22nd January and redeployed already on 1st April and the measurements could be carried on to the end of the year.

Before the recovery in January, the wave climate was milder than usual and the significant wave height exceeded two metres (2.2 metres on1st January) once. From April to August, the wave climate was little calmer or typical for the season. The significant wave height exceeded two metres twice in August (2.4 metres on the 4th and 2.3 metres on the 9th), once in May (2.3 metres on the 8th) and twice in August (2.5 metres on the 18th and 2.2 metres on the 20th-21st). In June and July the significant wave height remained under two metres (1.5 metres on 21st June and 1.9 metres on 19th July). From September to December, calmer-than-usual months (September and November) alternated with months typical for the season (October and December). The highest significant wave heights were clearly below the record high values measured at this station: 2.8 metres on 27th September, 2.7 metres on 27th October and on 6th November. The highest sea state in the measuring season was measured on 3rd December, 3.1 metres.

The Baltic Proper

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

The extent of the ice cover in winter 2013-2014 did not reach the position of the wave buoy in the Northern Baltic Proper and measurements could be carried out through the winter.

Like in the Gulf of Finland, in average January was somewhat calmer than usual. The significant wave height reached 3.8 metres on the 31st. From February to June the monthly means were close to the long term values. In February the significant wave height exceeded three metres five times, the highest value was 3.6 metres (on the 1st). In March, four metres was exceeded twice, 4.4 metres on the 8th and 4.5 metres on 15th. In April, significant wave heights over three metres were measured on the 9th (3.3 m) and on the 17th-18th (3.1 m). The significant wave height exceeded two metres only once in May and once in June (2.7 m on 1st May and 2.4 m on 13th June).

From July to December, the wave climate behaved similarly to the one in the Gulf of Finland: calmer (July, September and November) and rougher (August, October and December) months alternated and no record high values were measured. The wave climate in July was calm; the significant wave height exceeded two metres once, 2.2 metres on the 10th. August was clearly rougher than usual, with a significant wave height of 4.1 metres on the 20th as the highest value. The significant wave height remained under 1.3 metres over half of September, reaching 3.9 metres on the 26th. In October, the significant wave height exceeded four metres three times, 4.2 metres on the 8th, 4.5 metres on the 25th and 4.3 metres on 27th. In November, four metres was exceeded only once, on the 24th (4.9 metres). Four metres was exceeded three times in December, and the highest value in 2014, 6.7 metres was measured on the 10th.

In 2014 the buoy at Huvudskär Ost was deployed only between September 24th and October 19th. Thus no statistically sound conclusions can be drawn from the data presented.

On September 26th - 27th a low pressure system moved in over the Baltic Sea. Causing high waves at the Finnish position Northern Baltic Proper and at Huvudskär Ost. Here a significant wave height of 2.7 metres was reached. The highest significant wave height registered during October was 3.8 metres on the 8th. Due to strong wind along the west coast of Sweden and over the Baltic Sea the buoys in Skagerrak, central and northern Baltic Proper and in the Gulf of Bothnia registered significant wave heights over 3 metres at this occasion. On October 19th-20th a low pressure system over Finland caused strong southwest wind along the Swedish coast. The significant wave height at Huvudskär Ost rose to 2.9 m before the communication link to the buoy failed. Wave heights may have risen some more after that as the stormy weather continued.

Central Baltic Proper, station Knolls Grund

Aside from a short period of service between March 25th and March 29th, we have a continuous record of wave data from the station Knolls Grund in 2014. Overall we now have three years of data from this position.

Measurements between January and March, and even in May, August and October showed mean significant wave heights above the values in previous years. The mean values differed only little, the largest difference was + 0.2 metres in August. When making such comparisons one has to keep in mind that measurements at this position did not start before November 2011.

Despite high mean values in the beginning of 2014, the monthly maximum significant wave heights were lower than in previous years, 3.2 metres in January, 2.7 metres in February and 4 metres in March. During spring and early summer the maximum significant wave heights were higher than in the previous three years. In the evening of May 27th a maximum significant wave height of 3.5 metres was measured, which was twice as high as the previous highest significant wave height during this month. In accordance with results from the other Swedish wave buoys, the highest significant wave heights at Knolls Grund were registered the second half of the year. In August, September and November new record heights were registered: 2.5 metres, 4.5 metres (1.6 metres higher than the previous record) and 4.7 metres (1.2 metres higher than the previous record) respectively.

Western Baltic Proper, stations Darss Sill, Arkona and Fino2

At the beginning of 2014 measurements were only available at the station Arkona. January was significantly rougher than usual, even if the maximum wave height of 3.9 metres at the 19th January was not significantly higher than usual maximum wave heights in January. In February and March unfortunately only Darss were active for 4 days, so that we have no representative data for these months. From April to December 2014 we have complete data sets but except for August, which was clearly rougher than usual, we cannot make a consistent statement about wave climate in the Western Baltic Proper, which holds for both Arkona and Darss. Compared to the long-term mean wave conditions at Arkona were a little rougher than those at Darss: Whereas the mean wave height at Darss was significantly rougher only in August, it was significantly calmer in June and October and on the average in the other 6 months. Mean wave heights at Arkona were on the average in June, October and November and significantly rougher in the other 6 months. . Even if May 2014 was not clearly rougher in the whole Western Baltic Prober, a storm at 27th/28th of May caused a new record for May both at Arkona and at Darss. Now the highest maximum value for May at Arkona is 3.9 metres and at Darss Sill 3.2 metres.

Since October 2014 also measurements at station Fino2 are available, so that it is of course not possible to compare the measurements with former years. But compared to the other two stations, the wave conditions from October to December were as expected very similar to those at Arkona and Darss Sill.

Kattegat and Skagerrak

Kattegat

No wave measurements were conducted in the Kattegat.

Skagerrak, station Väderöarna

In 2014, a wave buoy was deployed at station Väderöarna until the end of March, when a multi-parameter buoy measuring a variety of oceanographic and meteorological variables replaced it. From April 18th onward technical difficulties prevented measurements at this station. The buoy was recovered and

redeployed on June 15th. After November 23rd the registration of measurements became irregular with frequent gaps and on December 11th the buoy was recovered for service.

During winter and early spring the significant wave height never exceeded 4 metres. On January 25th the significant wave height rose to 3.1 metres (for comparison the record for January is slightly over 8 metres). During February a significant wave height above 3 metres was registered on a number of occasions. The first was on February 2nd when the significant wave height rose to 3.3 metres. During a five-day-period between the 12th and 17th, the significant wave height exceeded 3 metres at least on four occasions. The second highest significant wave height at this position during February was measured on the 13th when significant wave height reached 3.9 metres. Even on February 24th the significant wave height was over 3 metres during two shorter periods. Also March saw a number of low pressure systems that influenced wave heights in Skagerrak and the southern Baltic Sea. The significant wave height at station Väderöarna exceeded 3 metres on March 8th, reaching 3.7 metres. On the 15th a significant wave height of 3.9 metres was registered and some days later, on March 17th, the significant wave height rose to 3.3 metres. On all these occasions high waves were also registered at Knolls Grund. During April the significant wave height reached 3.3 metres on the 13th, caused by strong winds from southwest. Although August was rougher than usual a significant wave height above 4 metres wasn't measured before October 27th. On this occasion the significant wave height reached 4.3 metres. The highest significant wave height during the time the buoy was deployed, 5.5 metres, was measured on December 10th.

The monthly mean values in 2014 varied considerably in comparison to the climatological mean for respective months. While no record mean values were registered during the year, the monthly mean values were considerably higher than climatological values in February, March and August. In contrast the mean significant wave heights for September and November were the lowest calculated so far, both around 0.5 metres below the climatological mean.





Figure 2. 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 3. 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 4. 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 5. The monthly maxima of significant wave heights in the Central Baltic Proper, the Western Baltic Proper and Skagerrak.

Metadata

In 2014 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° 53' 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). To prevent the loss of both instruments and data due to trawling activities in the area the position of the buoy at Finngrundet has been adjusted twice since 2012. Today the position is still south of the eastern bank in waters of comparable depth but approximately 1 km further to the southwest of the previous position.

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), since 2002 at a station northwest of Cape Arkona (54° 52.9'N, 13° 51.5'E) and since 2014 at the Fino2 research platform located at 55° 00.5'N, 13° 09.3'E, where measurements are performed 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 2014 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 2 and 3 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 time series in the statistics they should be used with caution.

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