Wave climate in the Baltic Sea 2015

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Key message

North of the latitude 57°N the wave conditions showed stronger deviations from the mean conditions while in the southern regions of the Baltic Sea were mainly closer to the long-term mean conditions. The first half of the year was rougher in the North followed by a clearly calmer beginning of the autumn (especially October) and a rougher end of the year. A new record in Skagerrak was measured in January: the significant wave height was 8.1 m and the highest individual wave 14.4 m. In the Western Baltic Proper, July was clearly rougher than usual: at Arkona a new monthly record for significant wave height was measured (3.3 m).

Results and assessment

In 2015 waves were measured in nine 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. Figures 6 and 7 show the year-to-year variation of the mean significant wave height in June-July and October-November.

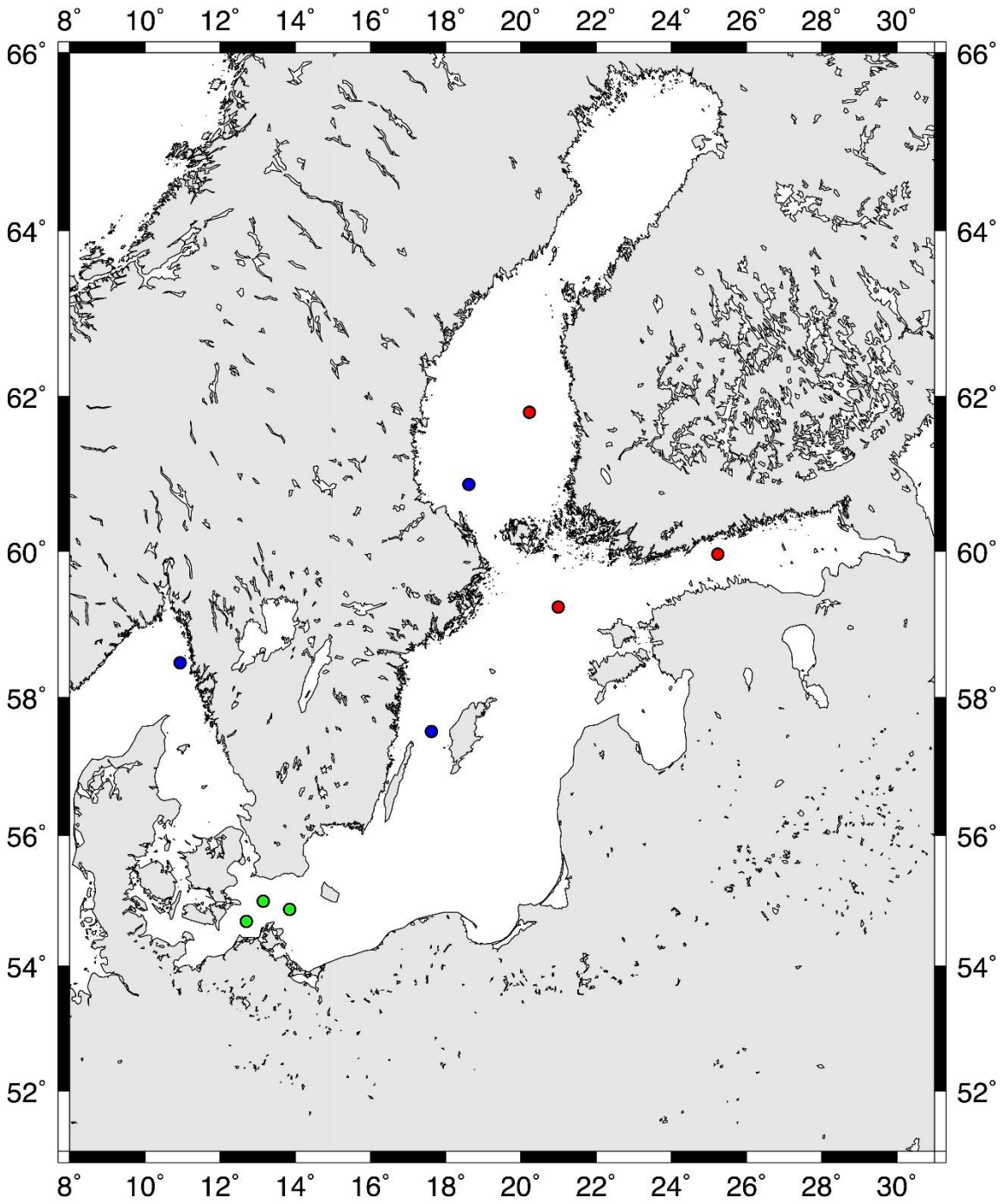

Figure 1. The positions of the wave buoys in 2015. Red dots indicate FMI buoys in the Bothnian Sea, in the Northern Baltic Proper and in the Gulf of Finland (station Helsinki), blue dots SMHI buoys in the Southern Bothnian Sea (station Finngrundet), in the Baltic Proper (station Knolls Grund) and in 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

Due to technical and logistic problems wave measurements could not be carried out in the Bay of Bothnia in 2015.

The Central Bothnian Sea

The ice season in the Bothnian Sea was rather mild and the buoy in the Central Bothnian Sea was operational through the whole year 2015.

The monthly means of the significant wave height followed most of the time the behaviour of the mean values at the stations Northern Baltic Proper and Helsinki, although with smaller changes. The mean values of significant wave height in January and February were over 1.6 m: the highest significant wave heights for the months were measured on 3rd January (4.9 m) and on 8th February (6.4 m). The latter was the highest significant wave height for the whole year and it is only 10 cm smaller than the highest significant wave height measured at this station since 2011 (26th December 2011). The beginning of March was still rough: 4.0 m significant wave height was measured on 7th March. Three metres were exceeded twice in April (on the 8th 3.0 m and 14th 3.1 m and once in May (13th, 3.2 m). June was rougher than usual (highest significant wave height was 2.6 m 1st June), followed by a July with a mean wave climate typical for the season (the highest value was 2.5 m on 26th July). August, September and October were somewhat calmer than usual: the significant wave height reached 2.1 m on 28th August and 2.8 m on 8th September. In October the significant wave height remained most of the time under 2.8 m, except on 2nd (4.3 m) and on 22nd (3.9 m). November and December were rougher than usually and 4.5 m was exceeded three times, on 21st (4.7 m) and 27th (4.6 m) November and on 26th December (4.8 m). The higher November value was as high as the previous record value in this month.

The Southern Bothnian Sea, station Finngrundet

Due to the mild ice season the buoy at Finngrundet was in place during all of the winter season. On June 26th the buoy started drifting. It was recovered and redeployed on July 28th and measurements were continued.

2015 started with higher than usual mean significant wave heights. In January the mean significant wave height, 1.4 m, came close to the previous record for the month and in February a new record for the month, 1.2 m was registered. On February 8th the highest significant wave height for that month since measurements started was registered at 4.4 m (maximum wave height 8.5 m). Mean wind velocities at the close by coastal station Örskär were 29.3 m/s from the SSW. The maximum significant wave height in February was the only value above 4 m at this position during 2015 and the highest value for 2015 as a whole. Due to the fact that wave measurements at Finngrundet during February only were conducted for 4 out of 10 years some caution should be employed when interpreting the extreme values for this month. Although mean significant wave heights during spring and summer were mostly above the climatological mean maximum significant wave heights stayed well below 3 m during this period. The maximum significant wave height closest to 3 m was 2.8 m, measured on March 29th. During autumn

and winter mean significant wave heights were close to the climatological mean with October being the only exception. The mean significant wave height for October was 0.8 m, a value 29 cm below the climatological mean for this month and otherwise typical for summer months. The mean significant wave height in October only once exceeded 2 m (it was 2.2 m on the 21st). The highest mean significant wave height during autumn and winter was registered on November 21st at 3.5 m.

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 2015 the buoy was recovered on 26th January and redeployed already on 9th April and the measurements could be carried on to the end of the year.

Before the recovery in January, the wave climate was rougher than usual and the significant wave height dropped below 0.5 only on five occasions. The highest value during the measurement period in January was 3.3 m (3rd January). After the redeployment the rougher-than usual mean wave climate continued in May - July. In April the highest significant wave height was 2.2 (29th April) and in May the highest measured value, 2.9 m (13th May) was close to the highest value in May (3.0 m) since 2002. In June and July the significant wave height reached 2.4 m three times, on 3rd and 7th June, and on 7th July. From August to October the wave climate in the mean was calmer than usual and the significant wave height remained under 3 m most of the time: 2.2 m on 29th August, 3.0 m on 18th September and 2.7 m on 22nd October. In the mean November was typical for the season, and the significant wave height reached 3.8 m on the 27th. December was rougher than usual, and the highest significant wave height for the measuring period in 2015, 4.7 m (6th December) was only 10 cm less than the highest December value since 2001.

The Baltic Proper

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

The extent of the ice cover in winter 2014-2015 did not reach the position of the wave buoy in the Northern Baltic Proper and measurements could be carried out through the winter.

The wave climate in the Northern Baltic Proper followed the behaviour of the wave climate in the Gulf of Finland, although with a stronger variation. In the clearly rougher-than-usual January the significant wave height was below 0.5 m only once and the significant wave height reached five metres twice, 5.4 m on the 2nd and 5.0 m on the 16th. The somewhat rougher wave climate continued until July. A significant wave height of 5 m was measured on 8th February, and the significant wave height reached 4.2 m on 17th February and 4 metres on 23rd March. From April to June the highest significant wave heights were 2.5 m (8th April), 2.8 m (13th May) and 2.8 m (3rd June). In July the significant wave height exceeded three metres twice, 3.6 on the 7th and 3.3 m on the 27th. August and October were calmer than usual, with a September typical for the season in the middle. The significant wave height reached 2.4 m on 28th August, 4.6 m on 18th September and 3.8 m on 22nd October, measured during the same high wind events as the high values in the Gulf of Finland. The calmer period was followed by rougher November and December. The highest significant wave heights were measured on 30th November (6.0

m) and 4th December (6.8 m). The December value was the highest significant wave height at this station in 2015.

Although the buoy at Huvudskär Ost was deployed in June 2015 no wave measurements were registered during 2015 due to equipment malfunction.

Central Baltic Proper, station Knolls Grund

The wave buoy at Knolls Grund has been in position during all of 2015. Overall we now have four years of data from Knolls Grund.

In January the highest mean significant wave height at this position so far was registered as 1.5 m. Even in March, May and July the mean significant wave height was higher than during previous years. During March the significant wave height exceeded 3 meters on three occasions, namely on the 1st, when it reached 3.2 m, on the 21st and on the 29th. In accordance with measurements at other positions significant wave heights during October were unusually low with the mean value being 0.8 m and the maximum value 2.1 m. The highest significant wave height at this position for 2015 was registered on November 30th and it was 4.6 m.

Western Baltic Proper, stations Darss Sill, Arkona and Fino2

For the year 2015 a nearly complete data set of wave measurements in the Western Baltic Proper is available. Whereas the buoys Darss Sill and Arkona had no measuring interruptions, Fino2 operated during 10 of 12 months (only April and September were missing).

Compared to long-term mean, wave conditions at Arkona were generally rougher than those at Darss Sill. Especially in January wave conditions at Arkona were significantly rougher than usual (the mean significant wave height was about 20 cm higher than the long term mean and the maximum significant wave height was 4.4 m on 11th January), whereas usual conditions could be observed at Darss Sill. Also in February situation at those two stations differ: Usual wave conditions were measured at Arkona, the situation at Darss Sill was significantly calmer than the long term mean. March and April measurements were in good agreement with long term statistics at both stations. On the contrary May was a little rougher in Arkona and June was again calmer at Darss Sill (always compared to the long term mean wave condition at these stations). July was clearly rougher at both stations. During a for summer remarkable high wind event with wind speeds up to 20 m/s on 9th/10th July a new long term maximum significant wave height for July was measured at Arkona (3.3 m). At Darss Sill the maximum significant wave height during this event was 2.2 m which is only a little below the long term maximum. On the 17th of August a new long term maximum of significant wave height at Darss Sill were measured: 2.5 m. At Arkona a significant wave height of 2.8 m was measured during the same event. Nevertheless the mean wave conditions in August were on the average, exactly like the mean wave conditions in September and October. November and December were again a little rougher. However the maximum significant wave heights during these months were clearly below the long term maximum heights.

At Fino2 measurements were only available since October 2014, so that no comparison to long-term statistics can be accomplished. But comparing October to December 2015 with the data from 2014, it is shown that 2015 was clearly rougher than 2014 at Fino2 station.

Skagerrak

Skagerrak, station Väderöarna

The wave buoy at Väderöarna was deployed on January 7th and was operating continuously during 2015.

On January 10th a new Swedish record was registered at Väderöarna. In winds from WSW with a mean velocity of 30.1 m/s (gusts reached 40 m/s) a significant wave height of 8.1 m was observed. The maximum individual wave height at this occasion reached 14.4 m. Even the previous record was measured at Väderöarna.

For most of the year mean significant wave heights in the Skagerrak were above the climatological mean (for most months comprised of 10 years of data). Mean significant wave heights for May to July were the highest registered since 2005 and January and April the 2nd highest. The mean significant wave height exceeded 2.15 m twice during 2015, in January and December. Only from August to October mean significant wave heights were below the climatological mean (and below 1 m). The mean significant wave height in October was 0.9 m, 30 cm below the climatological mean.

The maximum significant wave height was above 4 m for 8 month out of 12. In January the significant wave height rose above 4 m on 6 occasions, the highest values being 8.1 m on the 10th and 6.5 m on the 16th. Four times each in November and December the significant wave height was above 4 m, the highest values during this time being 7.6 m on Dec 5th and 6.5 m on Dec 25th.

Data

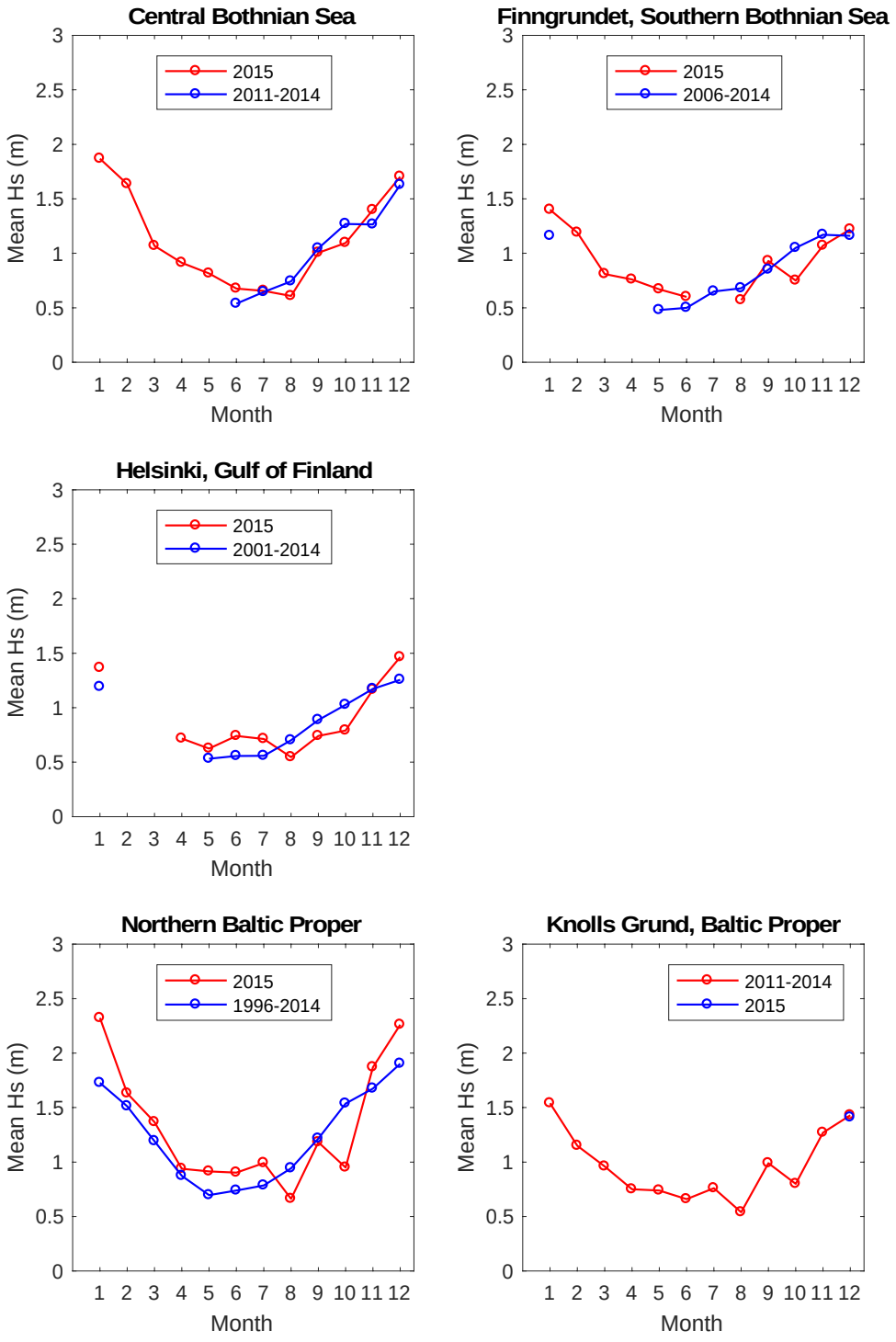

Figure 2. The monthly means of significant wave heights in the Bothnian Sea, the Gulf of Finland and the Northern and Central Baltic Proper. In some months the long-term statistics are calculated over fewer years (but at least over four years) than indicated in the legend.

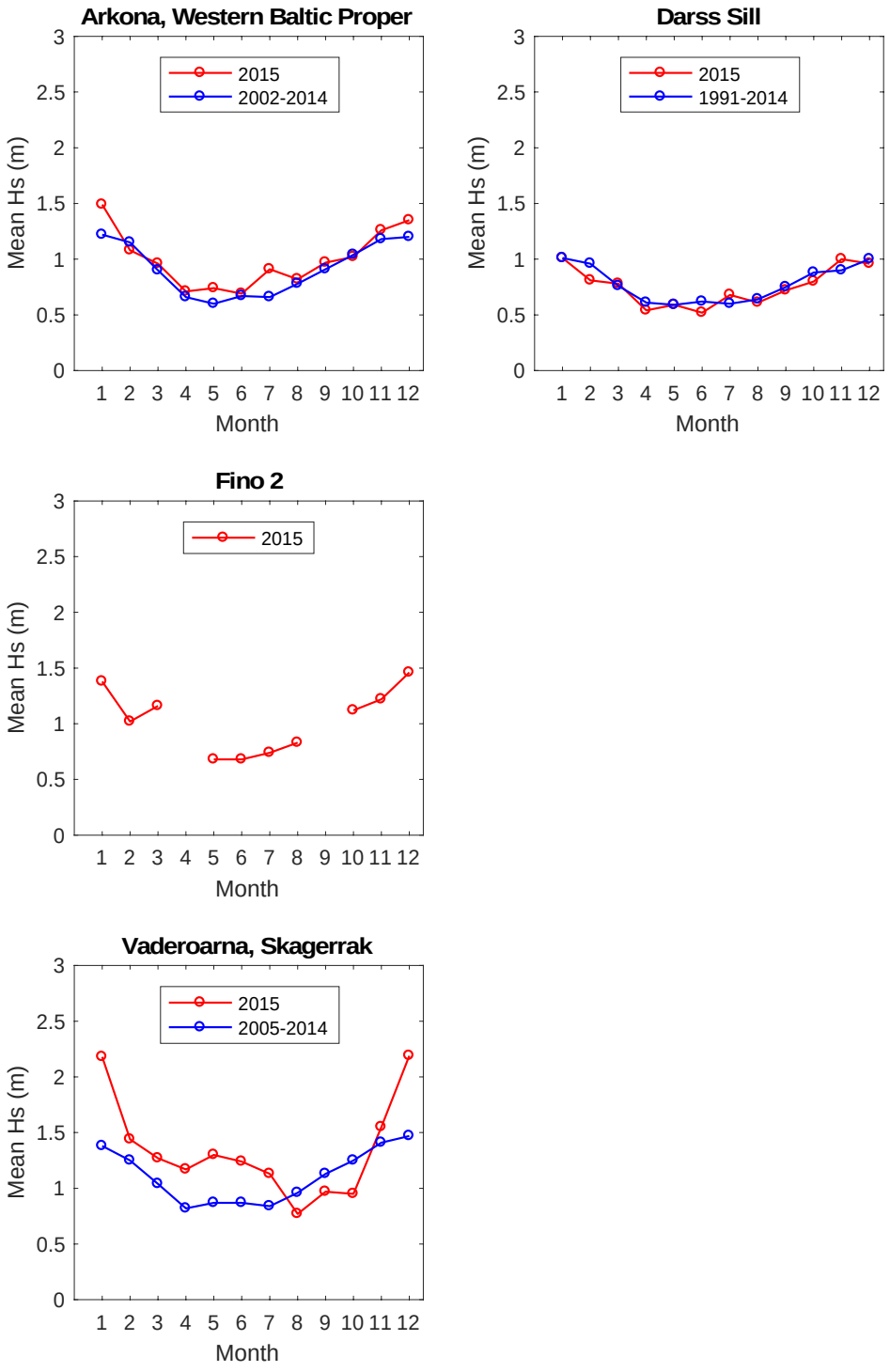

Figure 3. The monthly means of significant wave heights in the Western Baltic Proper and Skagerrak. In some months the long-term statistics are calculated over fewer years (but at least over four years) than indicated in the legend.

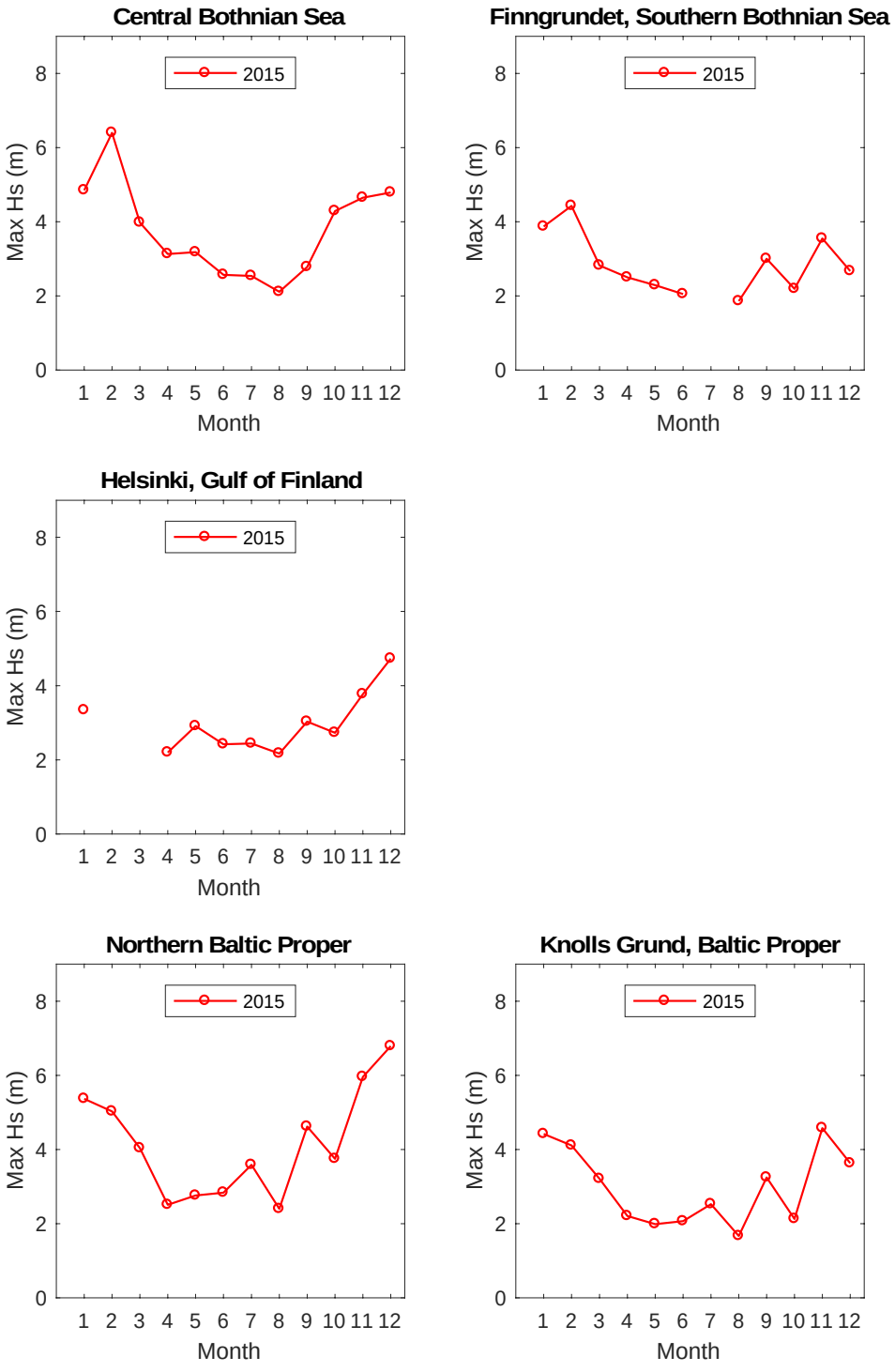

Figure 4. The monthly maxima of significant wave heights in the Bothnian Sea, the Gulf of Finland and the Northern and Central Baltic Proper. Data gaps occur in some of the months.

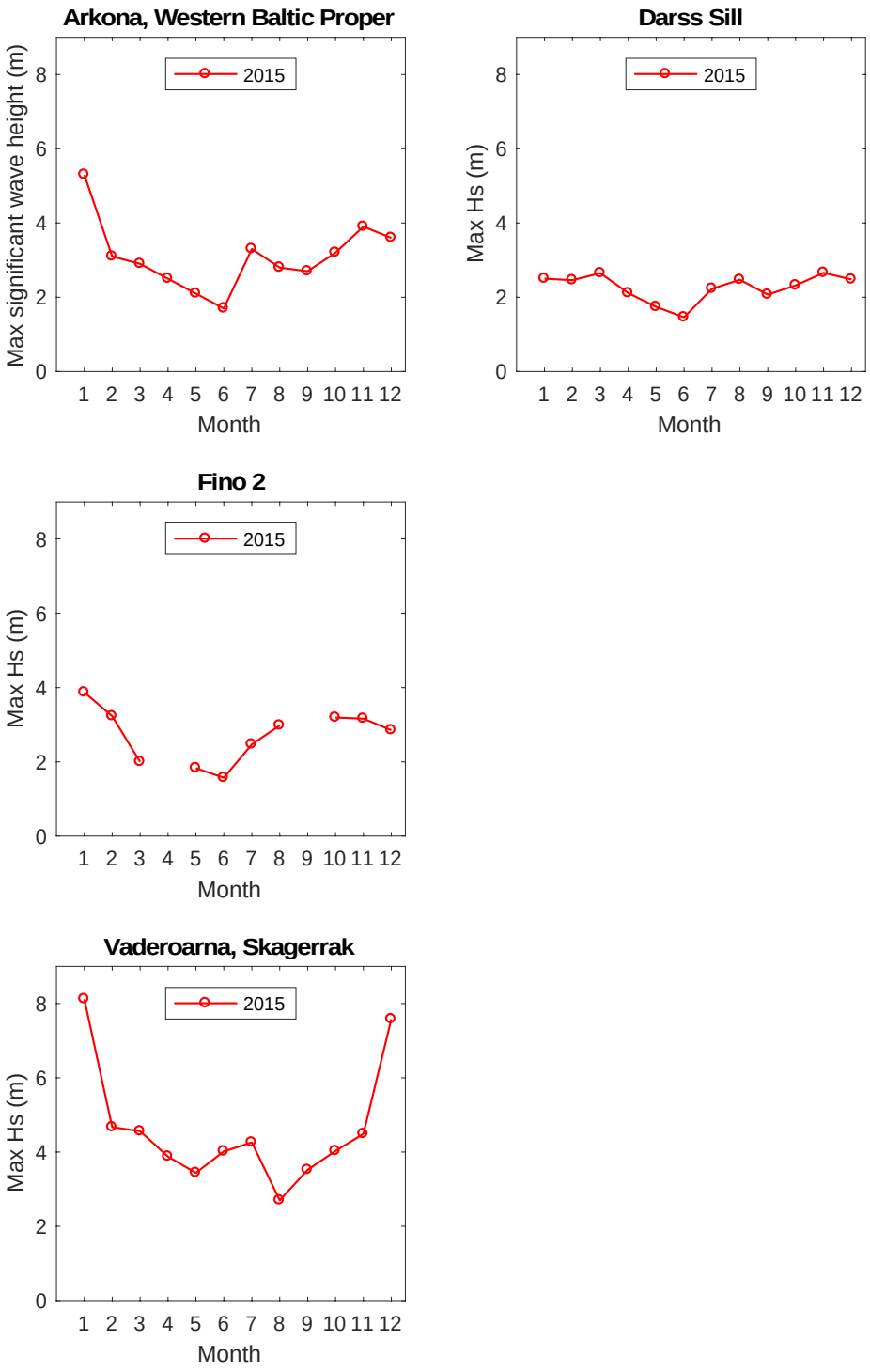

Figure 5. The monthly maxima of significant wave heights in the Western Baltic Proper and Skagerrak. Data gaps occur in some of the months.

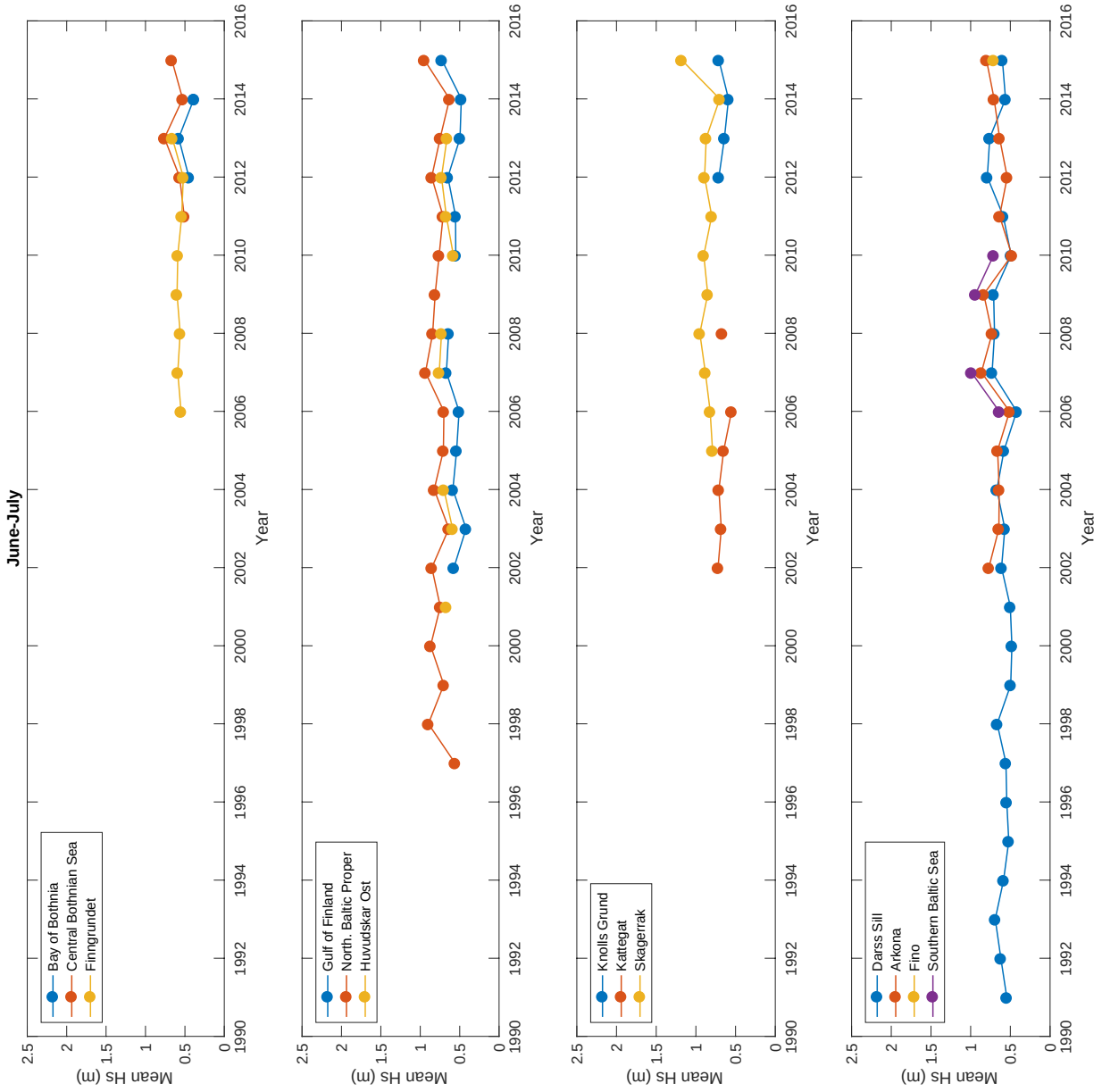

Figure 6. The yearly variation of the mean significant wave height H_s in the period of June-July. In some years the data does not fully cover the whole period.

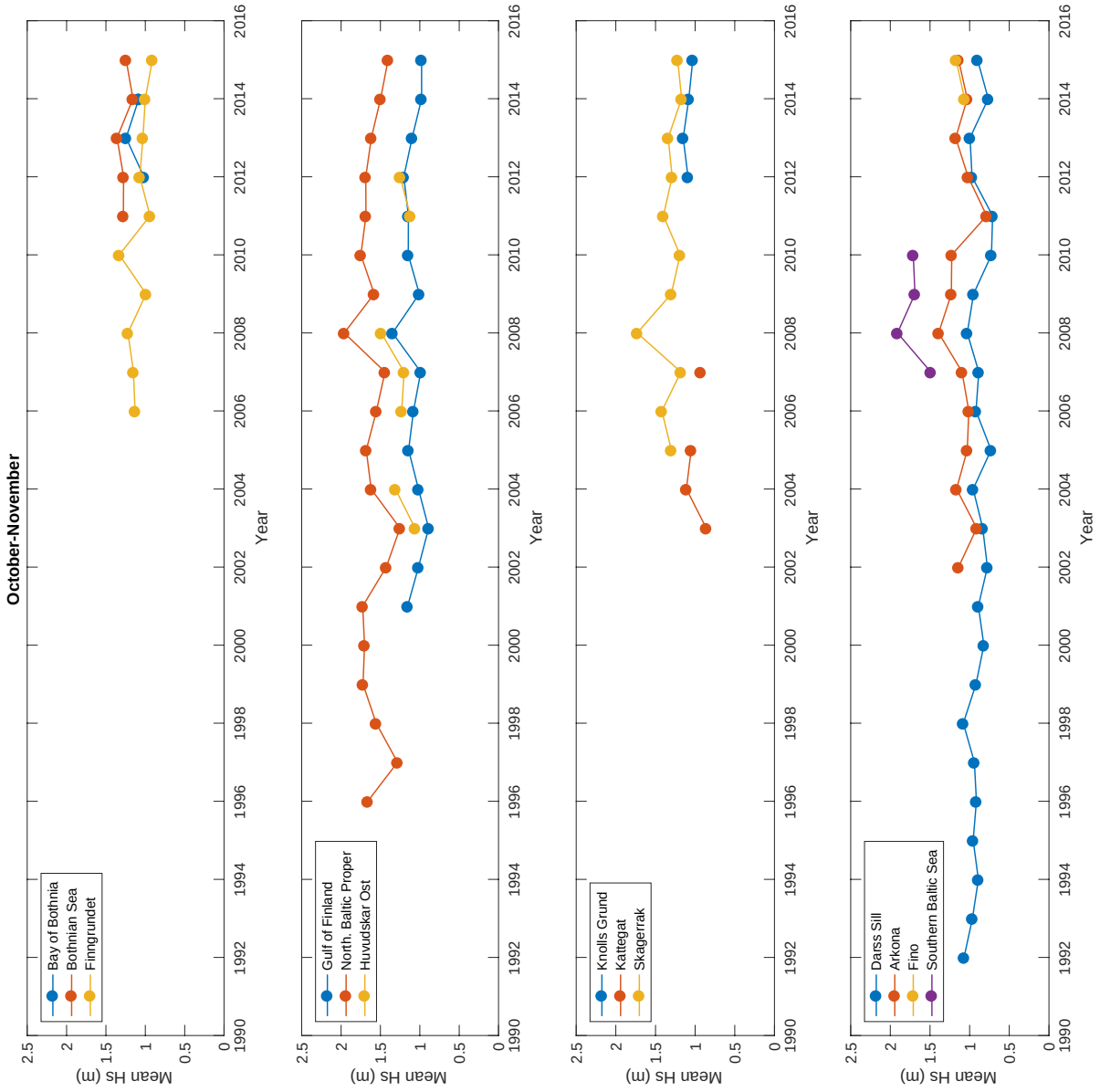

Figure 7. The yearly variation of the mean significant wave height H_s in the period of October-November. In some years the data does not fully cover the whole period. Especially at station Huvudskär Ost, the gaps in the data in years 2011 and 2012 might have left the mean value lower than it should be.

Metadata

In 2015 Finnish Meteorological Institute (FMI) made real time wave measurements at three locations in the Baltic Sea, in the Central Bothnian Sea (station Central 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 three locations, in the Southern Bothnian Sea (station Finngrundet, 60° 53' N, 18° 37' 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. The positions of the buoys operational in earlier years (shown in Figures 7 and 8) are: Huvudskär Ost 58° 56' N, 19° 10', E Kattegat 57° 11' N, 11° 32' E and Southern Baltic Proper 55° 55' N, 18° 47' 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), 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 2015 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 timeseries in the statistics they should be used with caution.

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