Wave climate in the Baltic Sea 2010

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Key message

Due to the ice conditions in 2010 wave measurements could be carried on through the whole year only in the open sea area of the Southern Baltic Proper. In January the wave climate was rougher than usual in the Western Baltic Proper while further north, at stations where measurements could still be carried out, the wave climate was calmer. In the northern parts of the Baltic Sea and in Skagerak the summer was typical for the season while in the southern parts of the Baltic Sea it was calmer than usual. November was clearly rougher than usual in all the other stations were measurements were made except in Skagerak. December was calmer at latitudes 58° N – 59°N while it was clearly rougher at stations situated at higher and lower latitudes.

Results and assessment

In 2010 waves were measured in eight 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.

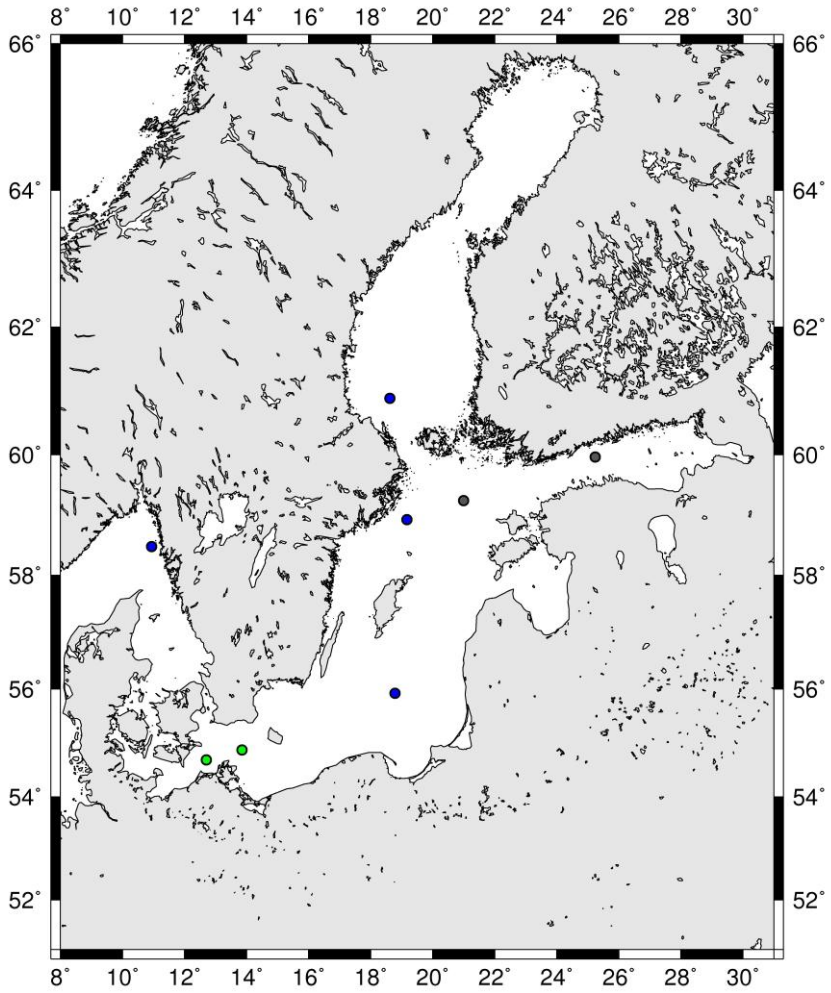

Figure 1. The position of wave measuring sites in 2010. Red dots indicate FMI buoys in the Northern Baltic Proper and in the Gulf of Finland (station Helsinki), blue dots SMHI buoys in the Southern Bothnian Sea (station Finngrundet), in the Northern Baltic Proper (station Huvudskär Ost), in the Southern Baltic Proper and in Skagerak (station Väderöarna) and green dots the BSH and GKSS buoys off Cape Arkona and on the Darss Sill. See section Metadata for the exact positions of the buoys.

The Bothnian Bay

The Southern Bothnian Sea, station Finngrundet

The buoy at Finngrundet was not operating during February to May, mainly due to the ice conditions in the Bothnian Sea. The highest measured significant wave height during the measurement period was 4.7 metres on November 9th. Generally the monthly mean significant wave heights in autumn and winter (September through December) were between 0.10 to 0.30 metres higher than usual with significant wave heights above three metres at several occasions.

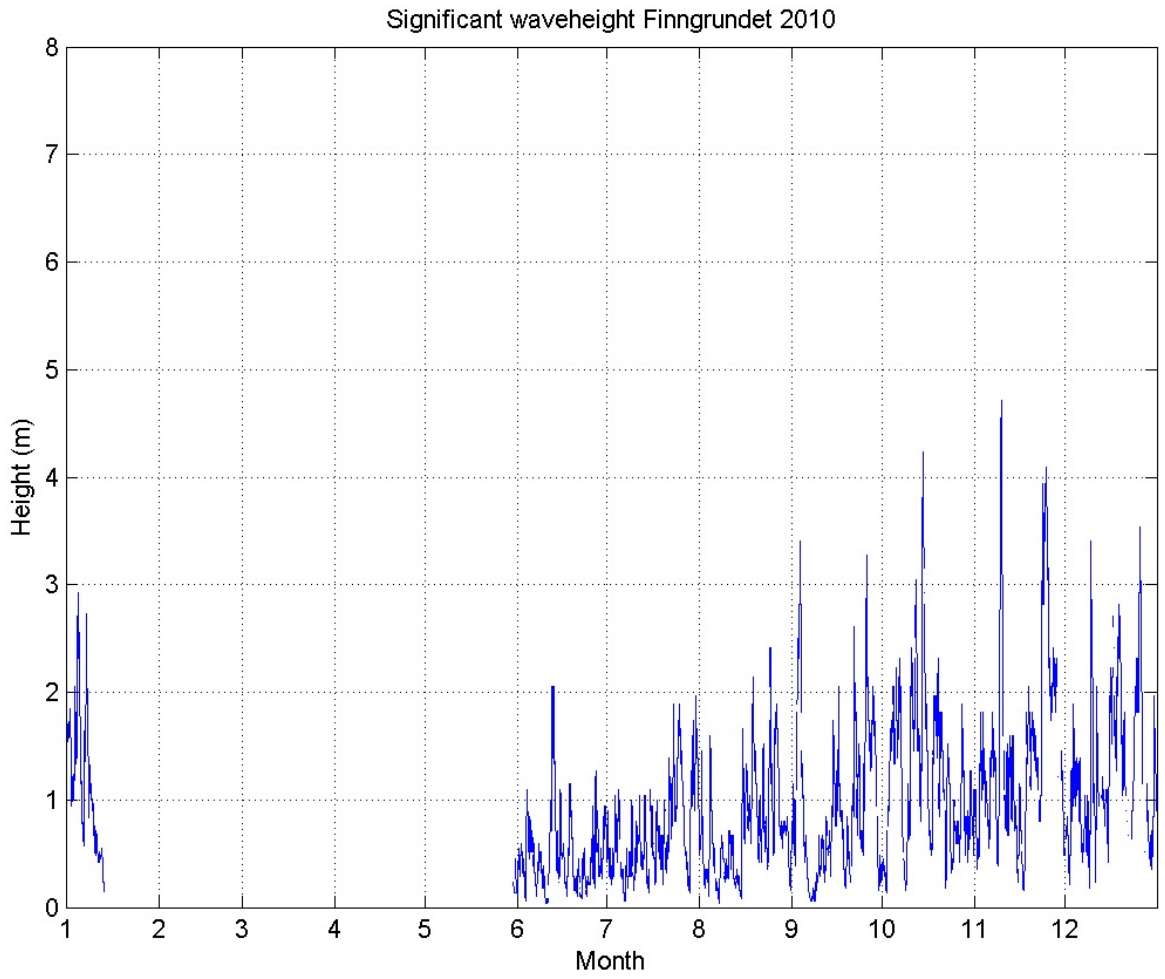

Figure 2. Time series of significant wave height at station Finngrundet.

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 2010 the buoy was recovered 6th January due to the risk of ice and deployed again in the end of May. The summer season from June to August was in average typical for the season. The highest significant wave height was measured 12th June, 2.8 m, while in July and August the significant wave height remained below 2.4 m. September and October were calmer than usual and the significant wave height did not exceed 2.4 m. In average November and December were clearly rougher than usual. The highest significant wave height was 4.5 m, measured during an eastern storm on 24th November. Significant wave heights over four metres are rather rare at this site. The ice period started early in 2010 and the wave buoy was recovered 22nd December.

The Baltic Proper

Between November 7th and 9th a storm moving in over the Baltic Sea from the southeast passed over the stations Southern Baltic, Northern Baltic Proper, Huvudskär Ost and Finngrundet. The mean wind velocities were between 21 and 25 m/s at a number of coastal stations along the Bothnian Sea and the Baltic Proper. Measurements show a quite fast change in the mean wave direction from the northwest to the east sector starting in the evening of the 7th at Southern Baltic (with significant wave heights raising to above 3 metres). Similar changes in wave direction could be observed at Huvudskär Ost and at Northern Baltic Proper some hours later and even at Finngrundet about 20 hours later. The highest significant wave heights during this storm were registered on the 8th around 7 pm at Southern Baltic, on the 9th at noon at Huvudskär Ost (5.7 m), at Northern Baltic Proper (5.6 m) and around 10 pm at Finngrundet (4.7 m). The significant wave heights at the latter three stations were the highest registered during 2011. At the station Helsinki in the Gulf of Finland the change of wave directions occurred in the evening of 8th and the significant wave height was highest (3.8 m) in the evening of 9th.

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

Due to the risk of ice the wave buoy at the station Northern Baltic Proper was recovered 25th January and redeployed in the end of May. Before the buoy was recovered in January the wave climate was much milder than usual, reflecting the growing ice cover in the area. The period from June to August was typical for the season. The significant wave height exceeded three metres three times in June-July; the highest value was 3.4 m, measured 12th June. September, October and November were somewhat rougher than usual, while December was calmer. At this station the highest significant wave height in the measuring period 2010 was measured 9th November, 5.6 m. During the eastern storm 24th November when there were high waves in the middle parts of the Gulf of Finland the significant wave height at this site reached 5.1 meters. 5.1 metres was also measured 16th December and the significant wave height exceeded four metres four times in this month.

The buoy at Huvudskär Ost is located SWW from the buoy at station Northern Baltic Proper and closer the shoreline. Due to ice conditions and technical problems measurements could only be conducted during two short periods, May to mid-July and mid-October to end of November. The mean significant wave height was slightly lower than usual during summer. The highest significant wave height, 5.7 meters (maximum individual wave height 10.8 meters), was measured on November 9th. These were the highest waves ever measured at this position.

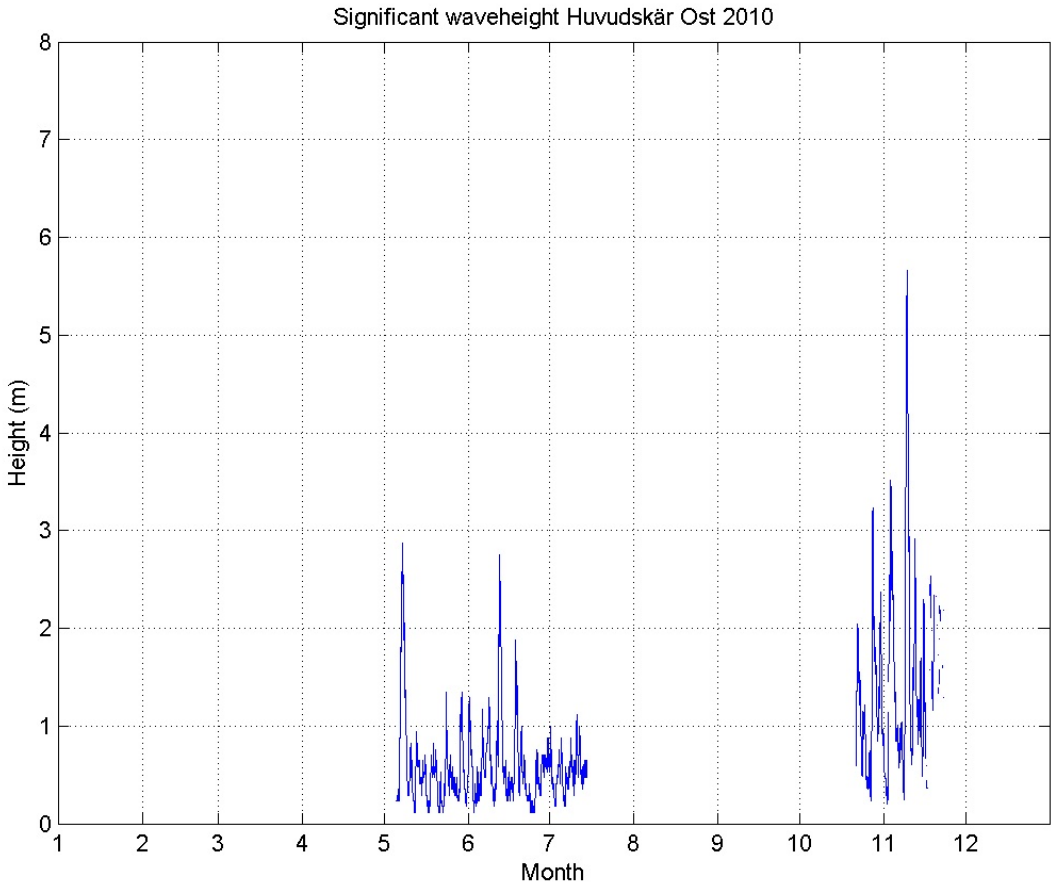

Figure 3. Time series of significant wave height at the station Huvudskär Ost.

Southern Baltic Proper, station Southern Baltic

At the position Southern Baltic a relatively calm summer was followed by autumn months which saw a lot of stormy weather resulting in high waves. Although in September waves were only registered during the second half of the month a look on the weather shows even in the beginning of the month extended periods of strong winds and rain showers over the Baltic. Both during September and December a number of low pressure systems moved over the Baltic Sea causing the significant wave height to be over four metres at a number of occasions.

The highest significant wave height registered by the Southern Baltic buoy on September 28th was 5.8 metres. But even on September 16th and 18th shortly after redeployment of the buoy significant wave heights around 4.5 metres were measured.

During December significant wave heights were above four metres on at least five occasions (on the 10th, 12th, 14th, 17th and 23rd). Also the mean significant wave height during second half of September and December were high for the season. Due to maintenance the measurements were disrupted for a short period between mid-August and mid-September.

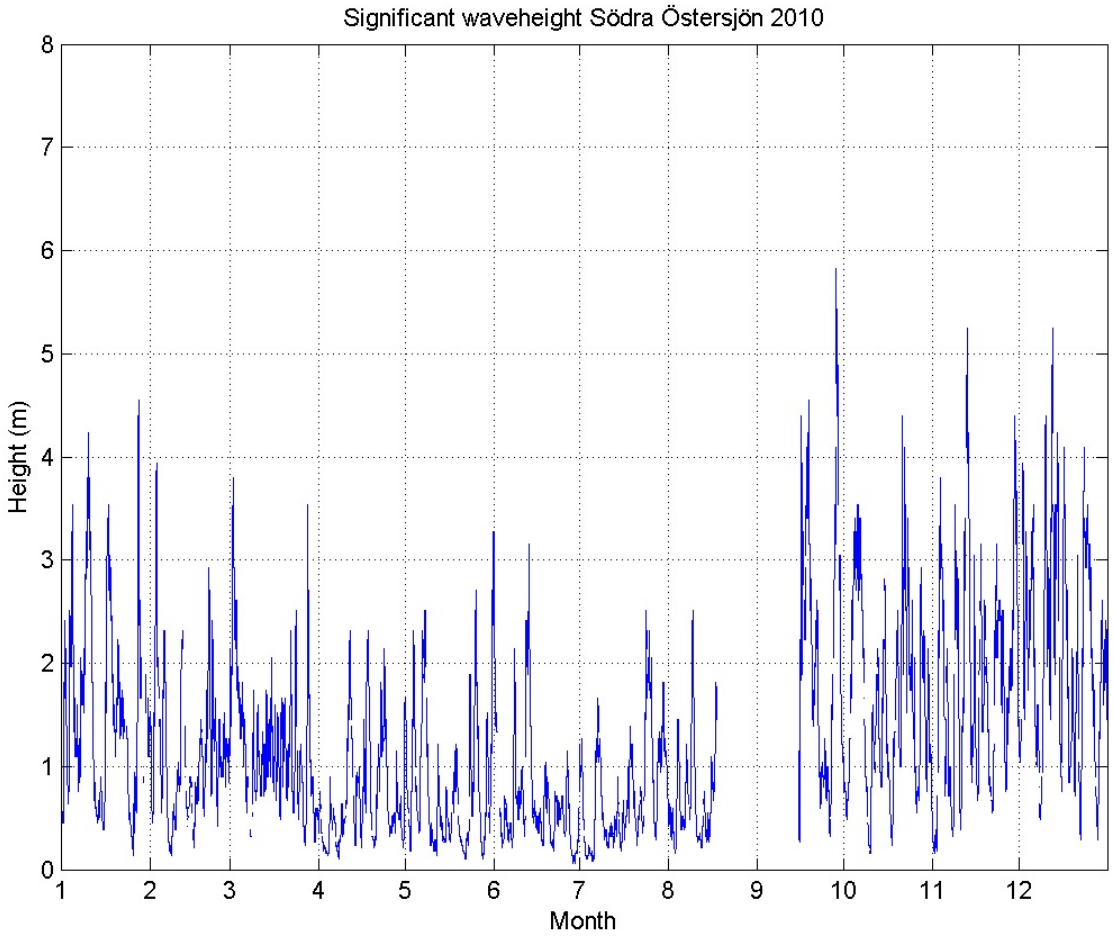

Figure 4. Time series of significant wave height at the station Southern Baltic.

Western Baltic Proper, stations Darss Sill and Arkona

The wave buoys were taken out of service in February and March as a precaution to prevent them from being damaged by drift ice. The Darss Sill buoy suffered repeated malfunctions during the year, so that only few measurement data were available for evaluation.

Mean significant wave heights in the area of Darss Sill typically are 0.6 m in summer and 0.9 m in winter; the annual mean is 0.77 m. Wave heights at the Arkona station are slightly higher, ranging from about 0.6 m to 1.2 m, with an annual mean of 0.93 m. 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 different 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 2010, like 2009, were relatively calm. The mean wind speed measured in the Arkona Basin, at 7.6 m/s, was below the long-term mean (8.0 m/s), and even below that of 2009 (7.8 m/s). The mean wind and wave direction (250-260°) did not deviate from the mean, although this wind direction was more frequent than usual.

The annual mean significant wave height did not differ significantly from the long-term mean. Monthly means during the six summer months were slightly lower, and in winter they were higher. In December, the mean wave height in the Arkona Basin exceeded the average by as much as 0.3 m. Unlike the monthly mean values, the maximum values were mostly lower than the extreme values measured so far, except in January (although this statement is of limited validity due to data gaps). The highest waves in 2010 were measured in January during a prolonged NE storm of 8-9 Bft. Significant wave heights reached 4.8 m at Arkona, which almost matched the historical extreme value for January (4.9 m), and 4.2 m at Darss Sill, which constituted a new maximum for that area. The high waves were characterised by long wave periods of about 10 s. This storm event also caused the increased monthly mean values in January.

Kattegat and Skagerak

Kattegat, station Läsö Ost

During 2010 no buoy was operating at this position. In 2012 it is planned to continue measurements at a new position, most likely more to the south in the Kattegat area.

Skagerak, station Väderöarna

The buoy at Väderöarna was recovered in the end of January and redeployed in mid-April to prevent ice damage. On April 17th a low pressure system with strong winds from the west resulted in a significant wave height of 3.7 metres, a new maximum for April at this position. The highest significant wave height at Väderöarna, 5.4 metres, was registered on August 24th when strong and persisting winds caused individual waves of up to a height of 8.4 metres. From September to December it was relatively calm with mean significant wave heights below normal. During this period the maximum significant wave height exceeded four metres only once, on November 4th.

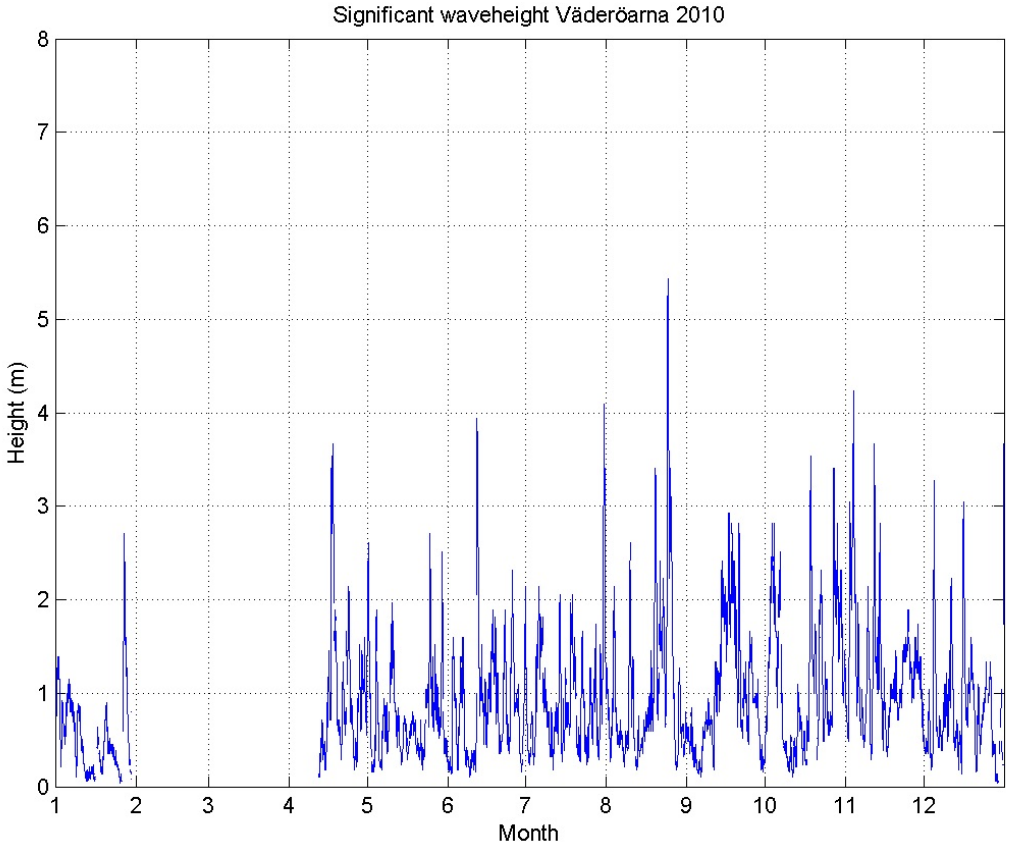

Figure 6. Time series of the significant wave height at the station Väderöarna.

Data

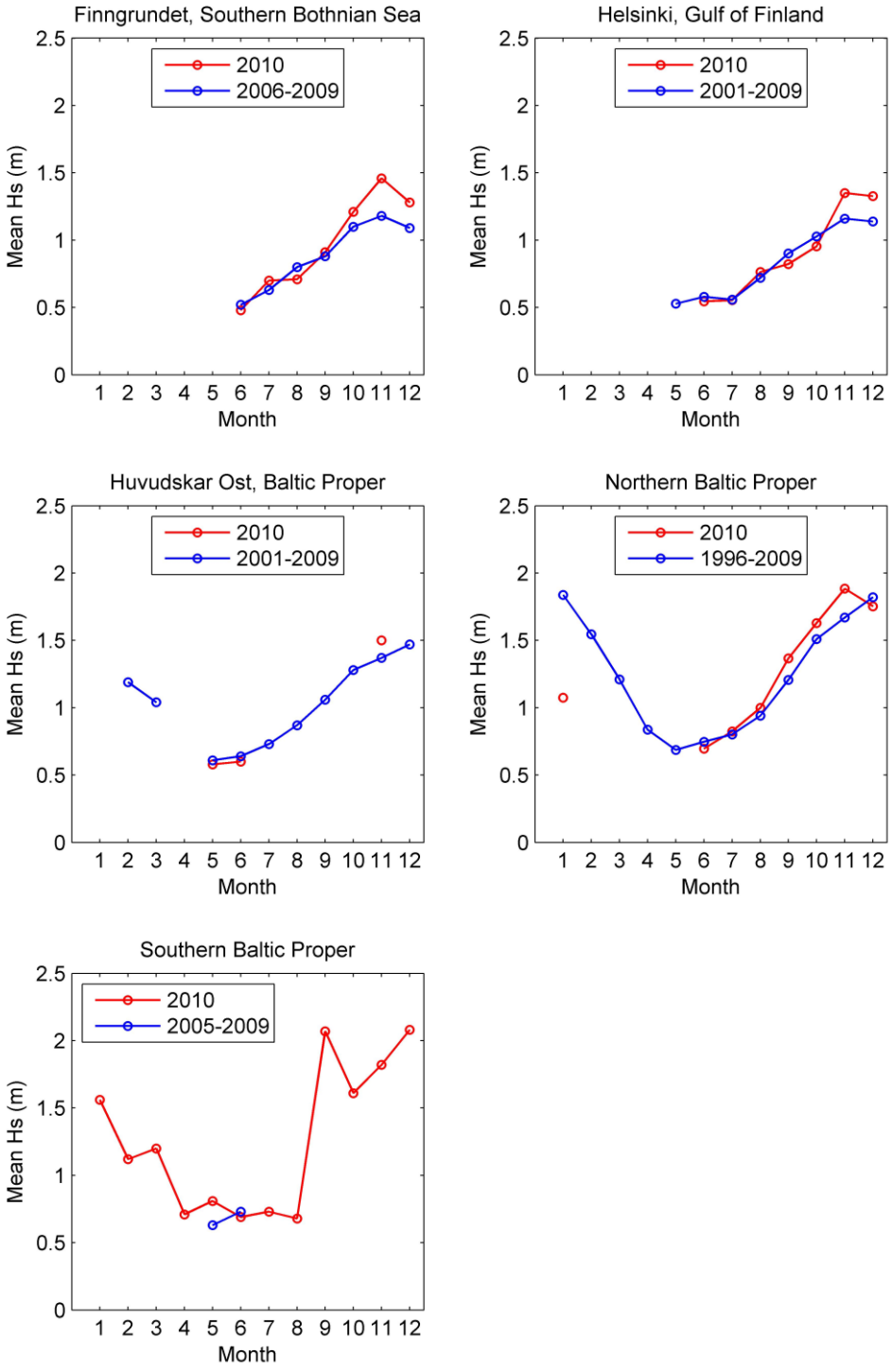

Figure 7. The monthly means of significant wave heights in the Southern Bothnian Sea, the Gulf of Finland and the Baltic Proper. In some months the long-term statistics are calculated over fewer years (but at least over four years) than indicated in the legend.

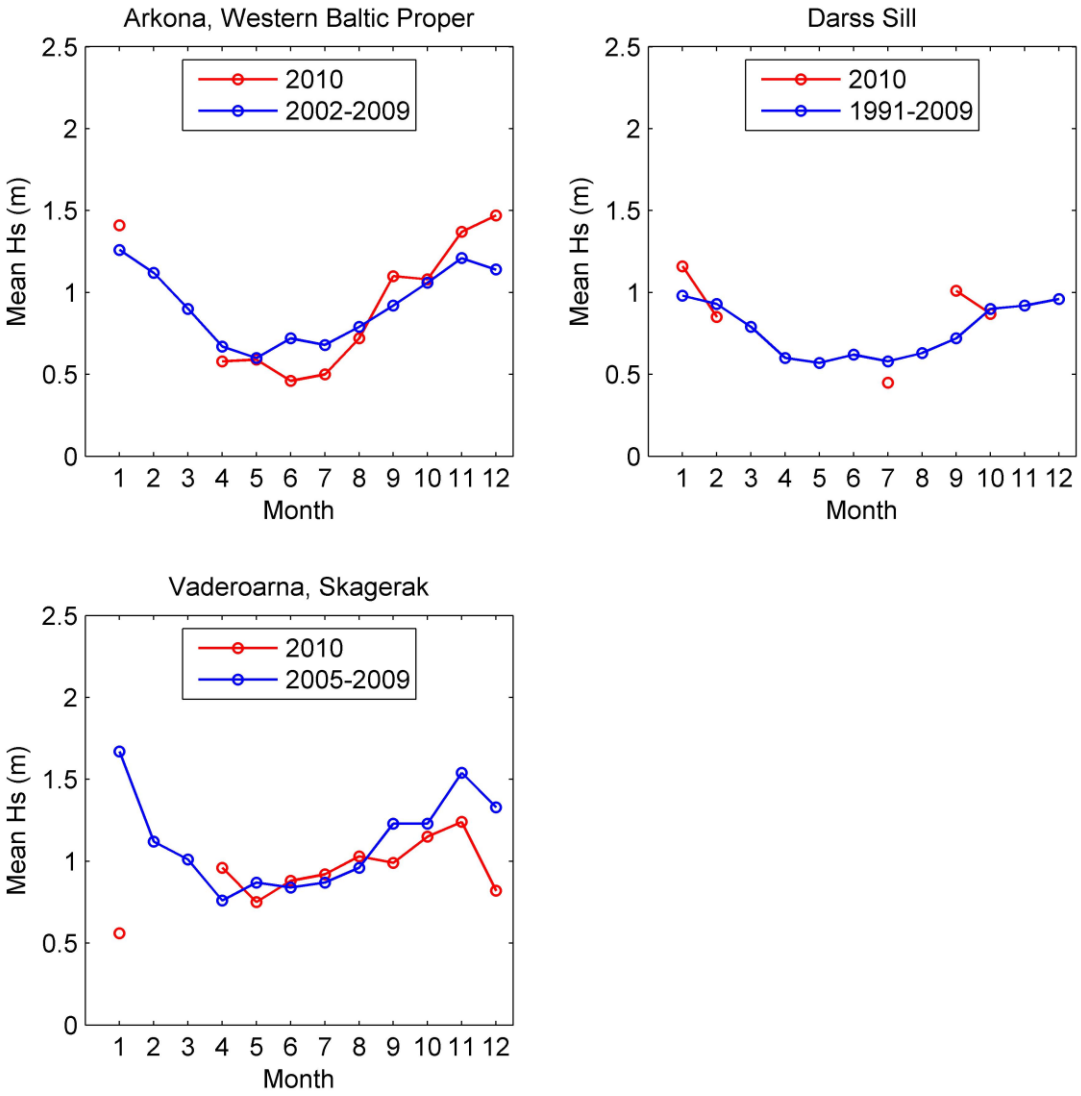

Figure 8. The monthly means of significant wave heights in the Western Baltic Proper and Skagerak. In some months the long-term statistics are calculated over fewer years (but at least over four years) than indicated in the legend.

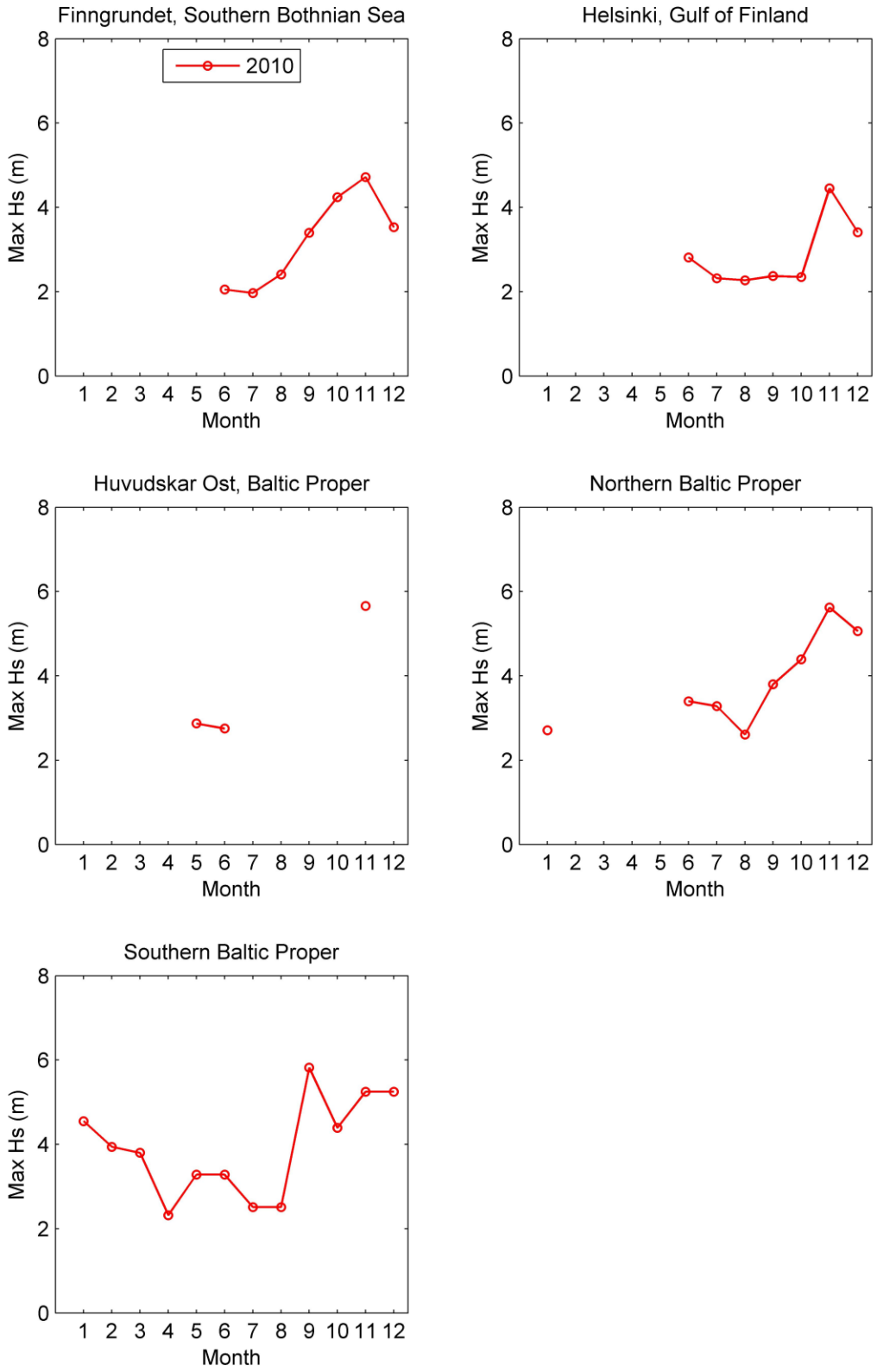

Figure 9. The monthly maxima of significant wave heights in the Southern Bothnian Sea, the Gulf of Finland and the Baltic Proper.

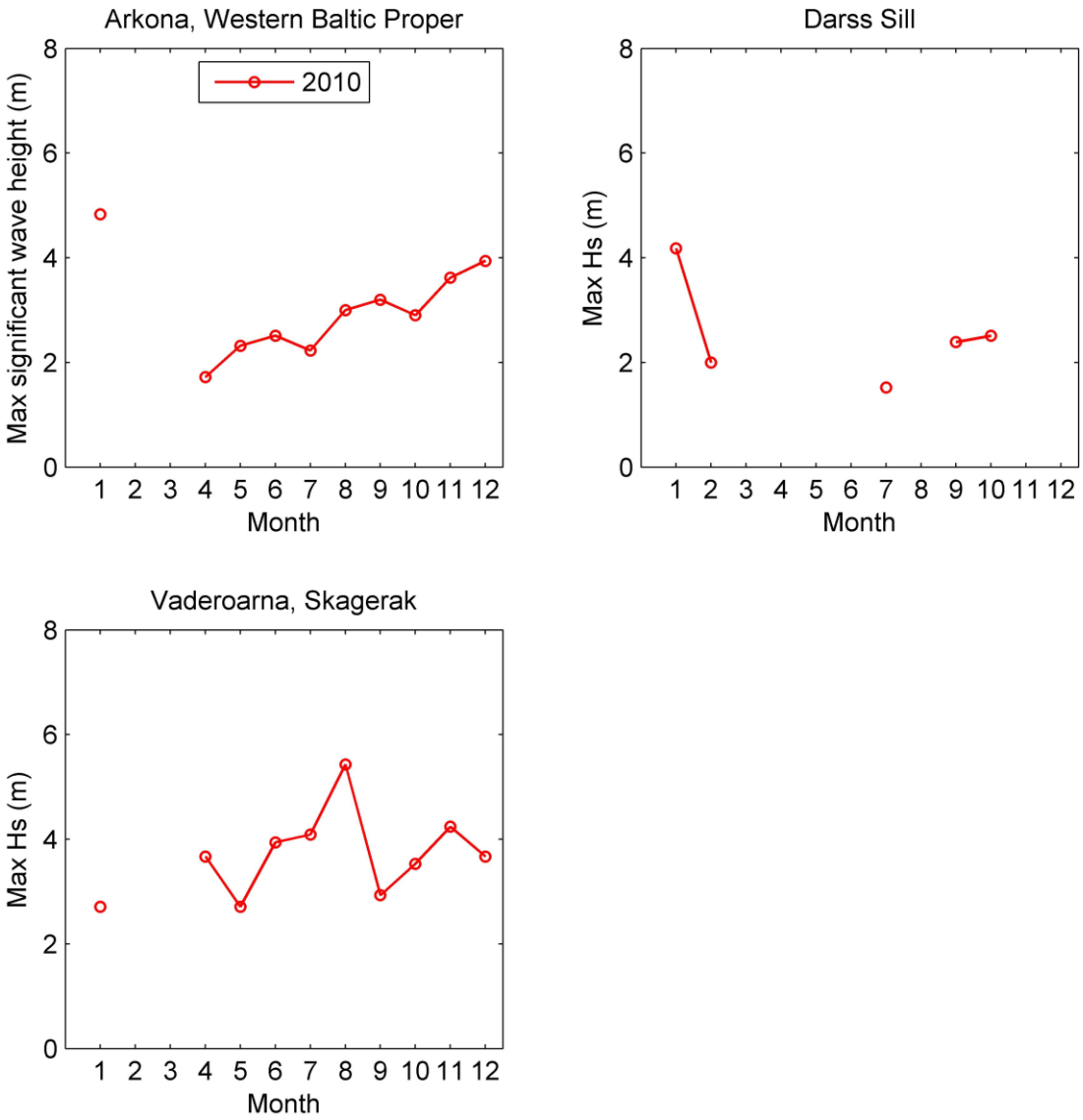

Figure 10. The monthly maxima of significant wave heights in the Western Baltic Proper and Skagerak.

Metadata

In 2010 Finnish Meteorological Institute (FMI) made real time wave measurements at two locations in the Baltic Sea, in the Northern Baltic Proper (station Northern Baltic Proper, 59° 15' N, 21° 00' E) and in the Gulf of Finland (station Helsinki, 59° 58' N, 25° 14' E). The northern parts of the Baltic Sea freezes every year. The length of the measuring periods varies every year depending on the extend 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 Southern Baltic Proper (station Southern Baltic, 55° 55' N, 18° 47' E) and in Skagerak (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 GKSS Research Centre 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 (BHS). Long-term climatological wave data are not yet available at the latter position. Up to now, measurement interruptions due to ice formation occurred in the winter of 1995/1996 at the Darss Sill measuring station and in February and March 2010 at both stations.

The waves at each station are measured with surface following buoys, Seawatch, Directional Waveriders and Waveriders. Measurements were collected app. every hour via HF link, Argos-satellite or Orbcomm system. 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.

The lengths of the deployment periods in 2010 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 7 and 8 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. Due to the variation of the length of the timeseries in statistics they should be used with caution.

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