The ice season 2011-2012

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Key Message

- The ice season of 2011-2012 was average in terms of ice extent but very short.
- The duration of the ice winter in the Bay of Bothnia was from over four weeks to nearly six weeks shorter than average. In the Sea of Bothnia and the Gulf of Finland, the ice winter was from nearly two weeks to three weeks shorter than average.
- The largest ice cover – 179,000 km² – was reached almost two weeks earlier than average on the 11th of February.
- The ice winter was, by the extent of the ice cover, classified as average (**Figure 1**.).
- On the 19th May the Baltic Sea was ice free (**Figure 4**.).

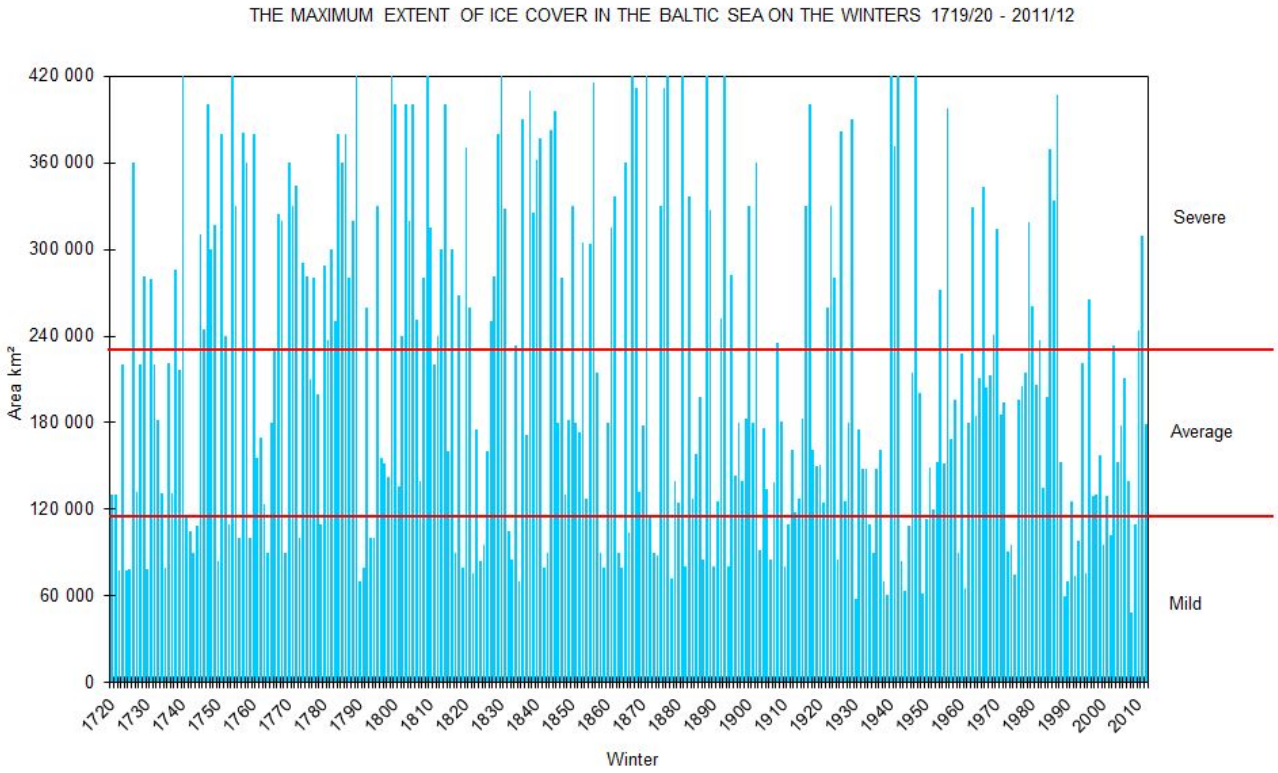

Figure 1. The maximum extents of ice cover in the Baltic Sea on the winters 1719/20 – 2011-2012 (Courtesy of FMI).

Ice season in the northern Baltic Sea

Ice formation

Autumn and early winter

The autumn was persistently mild, dominated by south-westerly winds which caused the surface water to cool slowly. In the end of October, the surface temperatures of sea water were between five and twelve degrees. The water temperatures were over a degree warmer than the long-term average. In November, the average air temperature in the sea areas was around four degrees higher than average, and in the Bay of Bothnia, up to five degrees higher. As the average air temperatures mainly ranged around seven degrees, this did nothing to cool the sea water.

As November turned into December, there was no ice yet in the Baltic Sea, and the sea surface temperatures in all sea areas were from one to three degrees higher than the long-term averages. Under normal circumstances, ice appears in the northern archipelagos in Bay of Bothnia in mid-November.

December was exceptionally mild. In the Finnish sea areas, the average air temperature was from over three to nearly seven degrees higher than the reference period temperatures. At the turn of the year, sea surface temperatures remained from one to three degrees higher than average. The first ice in the inner archipelago of the northern part of the Bay of Bothnia was noted on 8th of December, about 2 weeks later than normal. At the end of year there was only thin fast ice in the northern part of the Bay of Bothnia and new ice in the sheltered bays in the Quark archipelago and inner archipelagos down to the middle of the Sea of Bothnia.

Ice growth

January

In the beginning of January, ice was only found in the northernmost sheltered bays of the Bay of Bothnia, and the extent of the ice cover was less than 4,000 km². Ice formation in the Gulf of Bothnia started from three to six weeks later than average. The first freezing in the Gulf of Finland occurred from two to four weeks later than average.

The mild weather continued into the early January and ice formation was slow. During short periods of cold weather 5-15 cm thick ice formed along the coast of the northern part of the Bay of Bothnia, but the ice was pressed together by the southerly winds as the fronts passed. Whenever there were northerly winds the ice was driven out to sea, where it soon melted in the warmer surface water.

In the middle of January, cold air flowed over Scandinavia behind a passing low-pressure area. The ice began to grow along the coast of the Bay of Bothnia, the Quark and the Sea of Bothnia. Ice also started to form on Lake Mälaren, starting in western part. The growth period in the Bay of Bothnia was however short, as new fronts passed towards the north-east and pressed the ice field again. In mid-January, the ice-covered area was only 22,000 km².

As the weather took a turn for the colder, the area covered by ice rapidly started expanding. As February came in, the extent of the ice cover was 80,000 km², and the cold weather continued.

As regards temperature conditions, January was clearly divided into two different periods: the early part was milder than usual, while the latter half of the month was distinctly colder than normal.

February

Wintery weather had set in in late January, and the cold conditions continued in February. The Bay of Bothnia was completely covered with ice on 1st of February and the ice thickness increased to 20-40 cm in the northern part. Lake Mälaren was also completely iced over on 1st of February, and the first ice was noted on the beaches of Lake Vänern.

The cold weather continued into the beginning of February as cold air flowed in over the Baltic Sea and the Gulf of Bothnia from the east. Fronts causing snowfall moved westward and helped to cool the water. In the Sea of Bothnia the ice grew mainly along the Finnish coast, and then slowly drifted out to sea. In the Swedish archipelagos down to Karlskrona and in the Kalmar Sound, ice formed quickly. Ice also formed along the west coast.

During the second week of February a number of fronts passed in a north-easterly direction over northern Scandinavia, resulting in persistent south-westerly winds. Strong jammed brash barriers formed in the north and a large lead opened in the ice cover in the southern part of the Bay of Bothnia. In the Baltic Sea and along the Swedish west coast new ice continued to form and grow, and **the maximum ice extent was reached on 11th of February with the ice extending over an area of 179,000 km².** This took place two weeks earlier than average[1] .

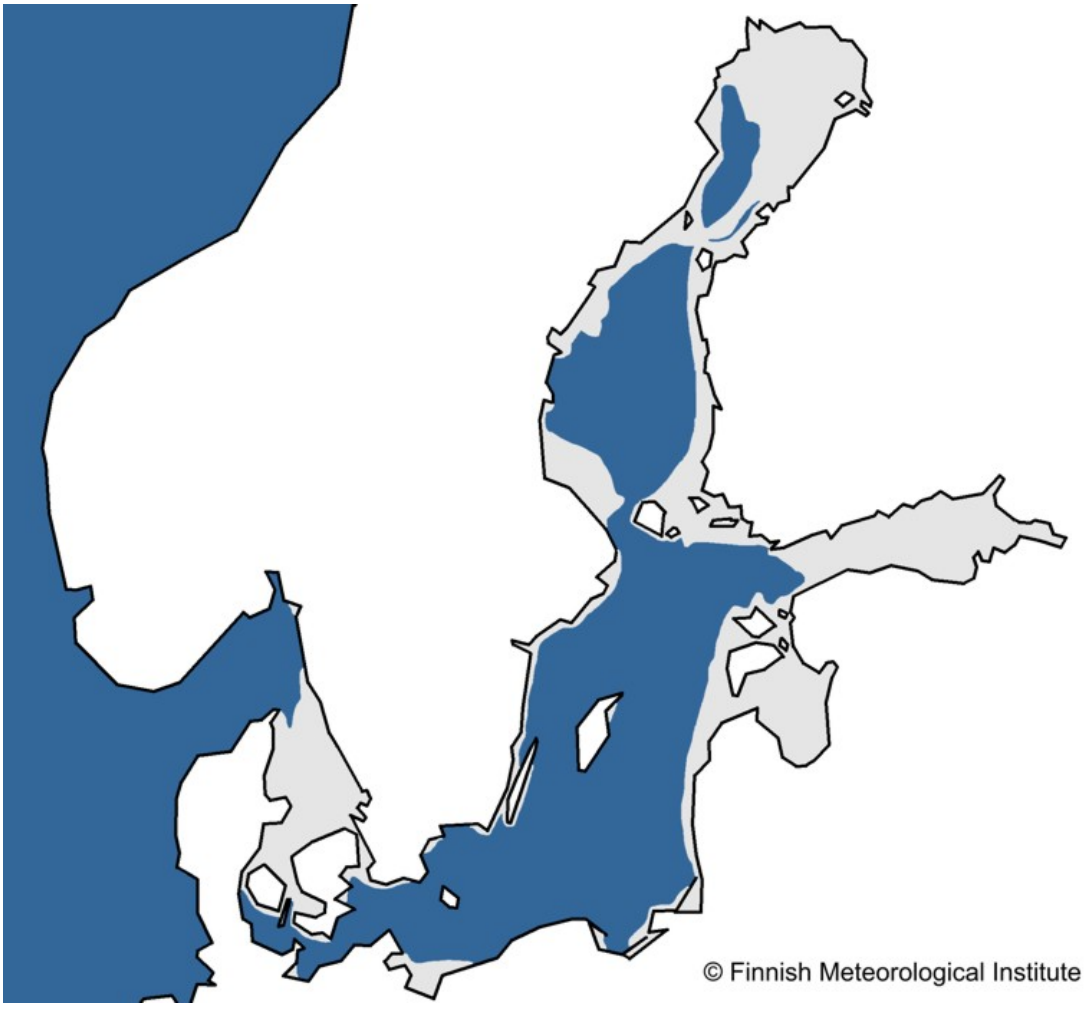

Figure 2. The largest ice extent – 179,000 km² – was reached on the 11th of February (Courtesy of FMI).

[1] As the reference period, the 30-year period from ice winter 1980/81 till ice winter 2009/10, is used.

At that time, there was ice in the Bay of Bothnia and the Quark. In the south-western part of the Bay of Bothnia there was a large area of open water, while ice was found in the coastal areas of the Sea of Bothnia. The Archipelago Sea was completely ice-covered, and in the Gulf of Finland, the western margin of the ice field could be traced from Bengtskär to Osmussaar. The Gulf of Riga was throughout covered by thin ice, and the coastal areas of the Baltic Sea Proper basin were ice-covered. Thin new ice was also found in Kattegat and the Danish straits.

During the following days the wind also picked up in the southern waters. Nearly all sea ice in the Kattegat disappeared. In the Sea of Bothnia the ice was pressed against the Finnish coast.

The rest of February was dominated by several passing areas of low pressure interspersed with short periods of cold weather. The ice alternated between growing and breaking up and jammed brash barriers formed along the ice edge in the Bay of Bothnia, the Quark and along the Finnish coast. The ice slowly receded along the coast of southern Sweden and the Kalmar Sound was just about ice free again by the end of the month.

Figure 3. Icebreaker OTSO assists (Courtesy of Mr. Jarmo Vehkakoski).

In the Finnish sea areas, February was from less than a degree to two degrees colder than average.

Ice melting

March

In the beginning of March the winds were south-westerly, and the ice-covered area declined as ice fields were compressed by the wind. As a result, vessel traffic had to be stopped at times, as the ice was being

strongly compressed by the wind. In early March, ice only occurred in an area of approximately 106,000 km².

A high pressure system temporarily provided cold air in the north, leading to renewed ice formation. Ice also formed along the Finnish coast of the Sea of Bothnia and in the Gulf of Finland and Gulf of Riga. As winds continued to blow, this thin ice was compacted at the edge of the compact ice field as brash ice barriers that slowed down shipping. The Quark also became free of sea ice. The ice compacted in the north-eastern part of the Bay of Bothnia, and at the eastern end of the Gulf of Finland.

Towards the end of March, ice on the southern and western coasts had started to rot. The area covered by ice had declined to 50,000 km², and spring was on its way. By the end of March Sweden's southern archipelagos were free of ice as well as the coast up to the Sea of Bothnia. Lake Mälaren became ice free around 30th of March.

Disappearance of the ice

April

In April, the weather on land was colder than usual. In sea areas, April was slightly warmer than average, excluding the Bay of Bothnia, where the weather was relatively cold with northerly winds. The ice in the north-eastern part of the Bay of Bothnia drifted slowly southwards, and about 15 cm of new ice formed in the leads that were created. The ice continued to break up along the Swedish coast of the Quark and the northern part of the Sea of Bothnia. By mid-April, the ice cover had reduced to an area of 30,000 km². In the Gulf of Finland, ice was only found east of Hamina, and in the Bay of Bothnia, mainly north of Pietarsaari; there was also ice in the Quark archipelago.

At the end of April the sea was ice free up to the Quark, but there was still rotten ice in the Vasa archipelago. The drift ice lay still in the north-western part of the Bay of Bothnia and continued to melt and rot. The ice field still contained a number of larger floes and ridges.

May

The spring continued cool, slowing down the melting of the ice. In early May, ice only remained in the area of the Bay of Vyborg and, in the Bay of Bothnia, north of Raahe. Drift ice still included a number of larger ridges. High easterly winds were tough on the ice and it was reduced and broken up into smaller floes. The fast ice continued to rot in the Bay of Bothnia. The Gulf of Finland became free of ice during the first weekend in May, as the last of the ice melted around the mouth of the Bay of Vyborg.

Warm southerly winds arrived during the following week, including some rain, which reduced the remaining ice in the Bay of Bothnia. The ice in the Bay of Bothnia melted and the last Finnish ice report and chart of the ice season were published on 15 May. Some fragments of ice remained for a few days in the most sheltered areas between islands, but the winter finally ended and summer began when the Bay of Bothnia was ice free on 19 May.

Maximum thickness of sea ice (Finnish territorial waters)

The maximum thickness of the fast ice in Finnish territorial waters was 50-60 cm in the Bay of Bothnia, 40-50 cm in the Sea of Bothnia, 35-35 cm in the Archipelago Sea and 25-60 cm in the Gulf of Finland. The pelagic ice thickness varied between 20-70 cm in the Bay of Bothnia, 5-30 in the Sea of Bothnia and 20-45 cm in the Gulf of Finland.

Length of the ice winter (Finnish territorial waters)

The time of the final melting of the ice varied in comparison to the statistical average. In the coastal areas of the Bay of Bothnia, the final disappearance of ice occurred a few days earlier than average. In the Sea of Bothnia, it melted slightly later than average. In the Gulf of Finland, the time of its disappearance varied from two weeks earlier than normal to almost the normal time.

The duration of the ice winter in the Bay of Bothnia was from over four weeks to nearly six weeks shorter than average. In the Sea of Bothnia and the Gulf of Finland, the ice winter was from nearly two weeks to three weeks shorter than average. In the northern Baltic, at Utö, there was no ice last winter.

The ice season in Latvian waters (Gulf or Riga)

In the last decade of January started more rapid initial formation of ice along the coast of the Baltic Sea and the Gulf of Riga. At the end of the January along the eastern coast of the Gulf of Riga was 100 to 500 m width fast ice, while at the southern coast about 50 m width fast ice. Fairways were mostly free of ice.

In the first decade of February fast ice reached the maximum spread of 2011-2012 winter season. Along the eastern coasts of the Gulf of Riga fast ice width reached 4 – 7 km, along south-western coast 2 – 4 km and southern coast 2 km. Along the Baltic sea coast and in the harbours of Rīga, Ventspils and Liepāja drift dark nilas (< 5 cm thick) concentration was from 4/10 to 8/10.

In the second decade of February, increases drift ice volume and thickness (~ 15 to 30 cm). In the south-western part of the Gulf of Riga near the Mērsrags cape area was observed vast (>2 km across) to medium floe (100 – 500 m across). On the fairways was observed open to close drift ice.

In the third decade of February weather became warmer and windy. Due to strong western winds ice was drift in the direction of the east and ice has been forced to coasts. Along the Baltic Sea coast, ice remained, in principle, only in the harbour of Liepāja. The largest volume of ice remains in the southern and eastern parts of the Gulf of Riga.

In the first decade of March, the situation did not change significantly. Only in the middle of first decade the air temperature decreasing and recrudesce the ice formation. In the second decade of March, ice slowly decreases. Due to strong winds from the west along the Baltic Sea coast ice was stranded. In the Gulf of Riga, the main ice concentration was along the eastern coast and was observed small hummocking. The Irben Strait became ice free. In the third decade of March continued ice melting and fairways from harbour of Rīga to Lithuanian sea boarder stay ice free.

At the beginning of April, the ice melting continued along the eastern coast of Gulf of Riga. On April 10th, the Gulf of Riga as well as all Latvian marine waters became ice free.

The ice season in the southern Baltic Sea, Danish Straits and Kattegat

Ice conditions in the Polish coastal waters in the southern Baltic Sea

Also along the coast of Poland, maximum ice formation was reached in mid-February, when fast ice of 15-30 cm thickness covered Szczecin Lagoon and Puck Bay, and up to 15 cm thick ice in variable concentrations occurred in the harbours along the coast between Świnoujście and Gdańsk. Very close 5-15 cm thick drift ice and new ice were observed in the Pomeranian Bight, and new ice formed also in the Bay of Gdansk. Vistula Lagoon was covered with 30-50 cm thick ice. On 19th and 20th of February, ice drifting eastward from the Pomeranian Bight due to strong westerly winds was observed in the offshore waters off Kołobrzeg, and

on 23rd of February off Ustka. The ice in Szczecin Lagoon disappeared by 26th of February, and in Vistula Lagoon by mid-March.

Ice conditions and navigation on the German Baltic Sea coast

The ice season of 2011-2012 was the third consecutive ice season characterised by major ice formation in the German coastal waters. Although ice occurred only for a short period of time (about 3 weeks), the intensity of ice production justified a classification of the winter of 2011-2012 as a moderate ice winter.

On the German Baltic Sea coast, the ice winter of 2009-2010 was classified as severe, and both the winters of 2010-2011 and 2011-2012 were classified as moderate ice winters. During the past ice winter, a considerable quantity of ice formed within just two weeks also in this region. The ice season of 2011-2012 was short but intensive.

Due to the prevailing meteorological conditions, there was only one freezing period on the German Baltic Sea coast, which lasted up to 30 days in the inner coastal waters. Thicknesses of level ice in the sheltered coastal waters reached their maximum of 10-30 cm in mid-February. In the waters of Greifswalder Bodden, fast ice formed only in the bays and on the northern coast, whereas ice in the central part kept moving. This led to ice rafting and ridging. Shipping faced major difficulties also in the navigation channels (Osttief, Landtiefrinne). The northern approaches to Stralsund and the western bodden waters were closed to shipping for three weeks.

Ice conditions in the German Bight, Kattegat, Skagerrak, and in the Danish and Swedish waters of the western Baltic Sea

In some sheltered areas of Limfjord, ice thickness grew to 40 cm in the course of February and in the end of February the waters were free of ice again. In the Skagerrak, ice of 5-15 cm thickness occurred in some smaller fjords on the Norwegian coast from mid-January to mid-March. In February, ice of 5 -10 cm thickness occurred locally in the harbours of Oslo, and new ice developed in the Oslo navigation channel.

In February, smaller harbours and fjords along the Danish and Swedish coasts of the Kattegat were completely covered with ice, with maximum ice thicknesses of 5-20 cm. Large areas in the offshore waters and in the Belts and Sounds were covered with thin ice or new ice in the time between 8th and 15th of February.

In the course of February, fast ice or level ice developed in the bays and sheltered waters of the Danish and Swedish coasts in the western Baltic Sea. Around the time of maximum ice development, in mid-February, ice thicknesses reached up to 15 cm. Offshore waters remained ice-free.

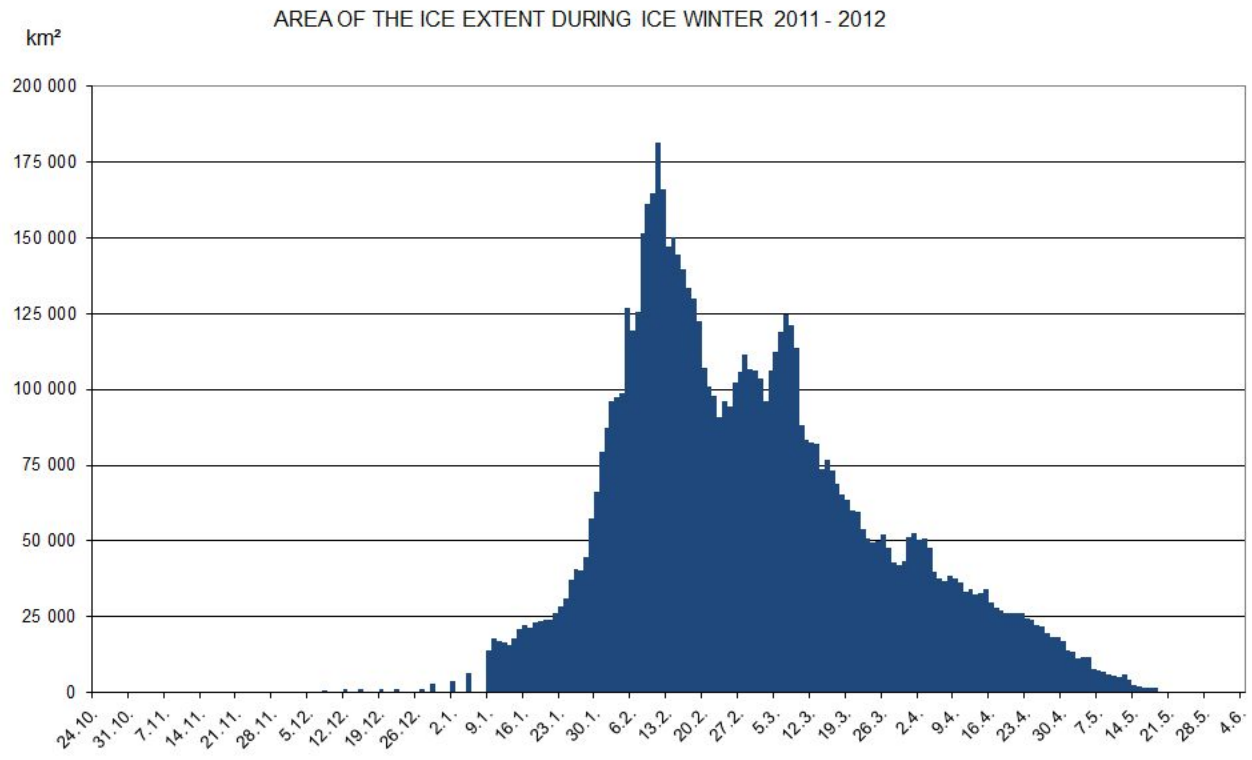

Figure 4. The daily ice extents in the Baltic Sea on the winters 1719/20 – 2011-2012 (Courtesy of FMI).

[1] Finnish Meteorological Institute (FMI), Ice Service, Finland

[2] Federal Maritime and Hydrographic Agency (BSH), Ice Service, Germany

[3] Swedish Meteorological and Hydrological Institute (SMHI), Ice Service, Sweden

[4] Latvian Environment, Geology and Meteorology Centre, Ice Service, Latvia

[5] Hydrological Forecasting Office in Gdynia, Institute of Meteorology and Water Management and National Research Institute, Maritime Branch, Poland