

## Development of Sea Surface Temperature in the Baltic Sea in 2010

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### Key message

The development of the sea surface temperature in the first five months of 2010 was mainly characterized by monthly mean temperatures below the long-term average (2000-2009). March was the coldest month of the year in the Baltic Sea. The maximum ice coverage was reached on 17 February in the western and on 8 March in the northern Baltic Sea. July was the warmest month of the year with maximum temperatures of 20-23°C, which led to positive anomalies of up to +3.5 K in the eastern Gotland Sea. In the period September-November SST fluctuated slightly around the long-term average. Due to the strong atmospheric cooling in the Nov/Dec, the SST decreased in December in the Baltic Sea very strongly. In comparison to long-term average values the SST showed in the Kattegat/Skagerrak with -4 K and in the western Baltic with -2 to -3 K the largest deviations. Already in December began ice formation in the Pomeranian Bay. The December 2010 was beside 1998 in the western Baltic Sea and beside 2002 in the central Baltic Sea the coldest December since 1990.

### Background

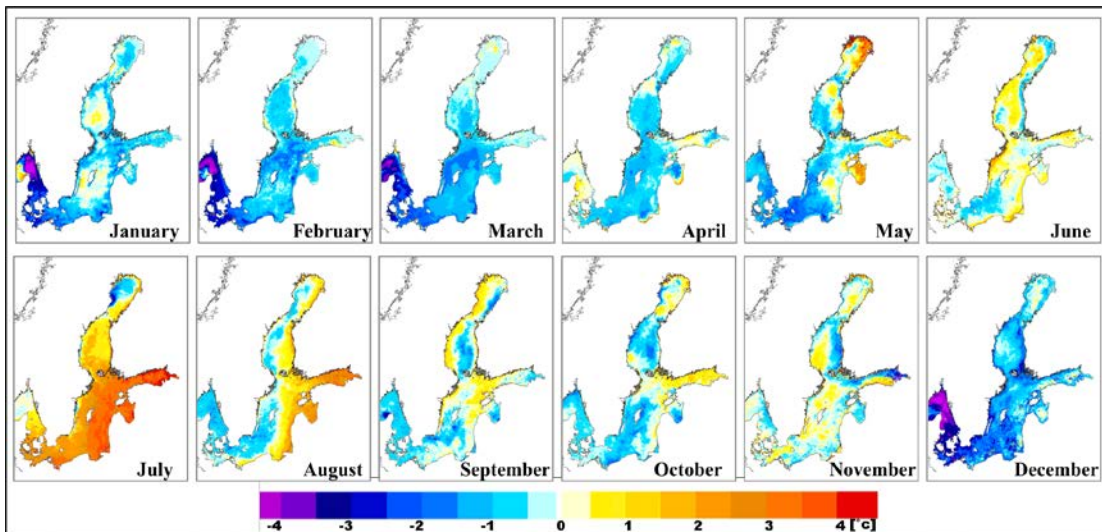
Sea Surface Temperature (SST) of the Baltic Sea derived from data of the Advanced Very High Resolution Radiometer (AVHRR) of the National Oceanic and Atmospheric Administration (NOAA) weather satellites and from the European Weather satellite MetOp-2 was provided by the German Federal Maritime and Hydrographic Agency Hamburg (BSH). The SST data evaluation procedure is described by Siegel et al. (2008). Systematic studies on seasonal and inter-annual variations in SST are published by Siegel et al. (2006, 2008). SST is included in the yearly assessment of the Baltic Sea since 1996 provided by the Baltic Sea Research Institute Warnemünde (Matthäus et al. 1997). This fact sheet is based on the results of the German assessment of the state of the Baltic Sea of 2010 (Nausch et al. 2011).

### Results and assessment

The characteristics in the development of the air temperature are reflected in the cold and heat sums. The cold sums of the air temperature of Warnemünde show that the winter 2009/2010 was with 203.7 Kd (means 105.4 Kd) the twelfth coldest winter since 1948. The heat sum of the summer 2010 lays with 258.5 Kd over the long-term average (148.4) and was the sixth-warmest summer. In

particular, the month July had contributed, which was after 2006 the second warmest July since 1948. The December 2010 was with a cold sum of 109.2 after 1969 the coldest December since 1948 and caused a cold beginning of the winter 2010/2011.

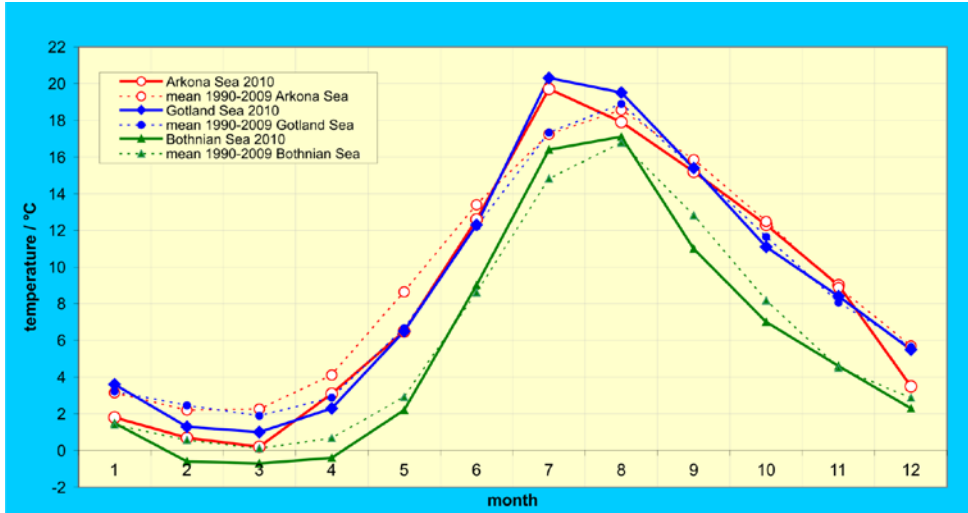
The anomalies of the monthly mean SST of 2010 for the entire Baltic Sea are shown in fig. 1. Already in December 2009, a strong cooling started in the western Baltic in comparison to the central parts (Nausch et al., 2010). This led to anomalies of -2 K in January in the western Baltic Sea and up to -4 K in the Skagerrak and Kattegat. The central parts of the Gotland Sea and of the Bothnian Sea were still in the range of the long-term mean values. Negative anomalies were present until May from the western Baltic to the western Gotland Sea. In June the long-term average values were reached in many parts of the Baltic before end of June / beginning of July tropical air masses affected the Baltic Sea from the south. This low wind period was associated with a significant increase of SST, which led to positive anomalies nearly in the entire Baltic except the Bothnian Bay. Maximum anomalies were determined for the eastern Gotland Sea with up to +3.5 K. Already in August the western parts of the entire Baltic were characterised by negative anomalies, whereas in the eastern parts positive anomalies were still observed particularly in the inner Gulf of Finland. In the subsequent months until November, the SST lay alternately below and above the average values in parts of the Baltic Sea. Only in December the anomalies showed a consistent downward tendency after a cold snap. From the Gotland Sea to the northern Baltic the SST was slightly below the long-term average values, but anomalies of -2 K and -4 K were registered in the western Baltic and in the Kattegat/Skagerrak area, respectively.



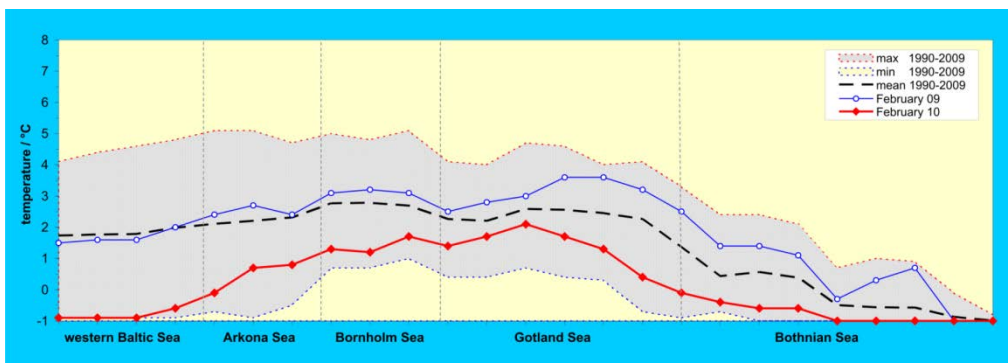
**Figure 1.** SST- Anomalies of the monthly mean temperature of the Baltic Sea in 2010 referring to the long-term means 1990 – 2008.

The seasonal course of the monthly average temperature within the central regions of the Arkona Sea, Gotland Sea and Bothnian Sea are compared in Fig. 2 with the long-term monthly average. In January the mean SST of the western Baltic Sea was more than 1°C colder than the long-term mean whereas in the central Gotland Sea and Bothnian Sea SST was still in the range of the long term mean value. In February, the Baltic Sea cooled further down, especially in western and northern parts and reached at the end of February around 0°C in the Arkona Sea. That shows also very impressively the temperature distribution along the transect through the central basins of the Baltic Sea for the month February 2010 in the comparison to the previous year, to the long-term average (1990 – 2009) and its variation range (Fig. 3). In February, the SST was below the long-term average in the

entire Baltic. In particular, the northern and western parts were covered with ice. In the Gotland Sea maximum temperatures of 2°C were reached on average. The maximum ice extent in the western Baltic was reached on 17 February 2010 and in the northern Baltic on 8 March (Schmelzer & Holfort, 2010). The further cooling in all regions until March made the March 2010 to the coldest month in all three areas (Fig. 2). In June, the SST reached in most areas the long-term mean values.



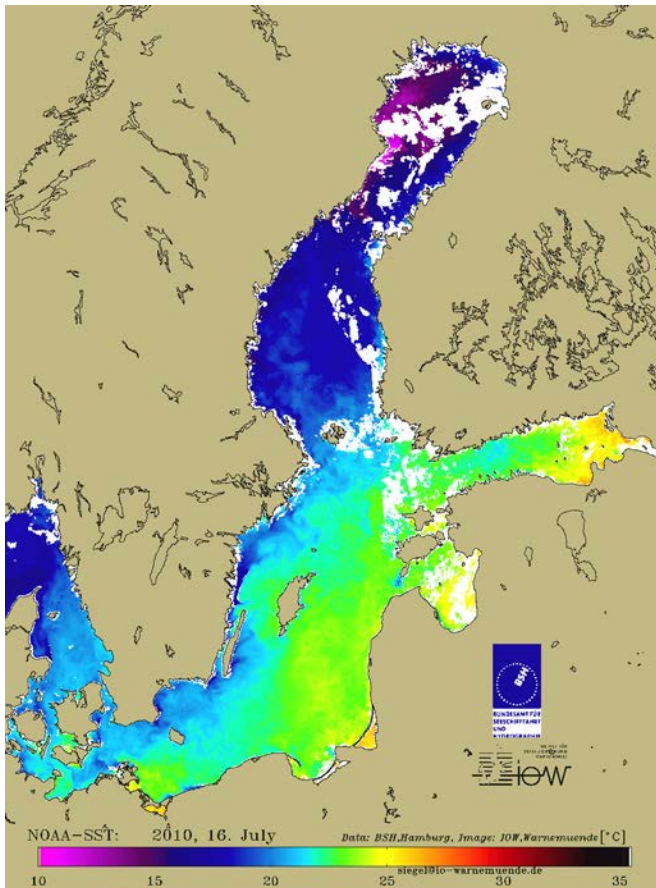
**Figure 2.** Seasonal course of sea surface temperature (NOAA-SST) in the central Arkona- and Gotland Sea in 2010 in comparison to the mean values of the last 20 years (1990-2009).



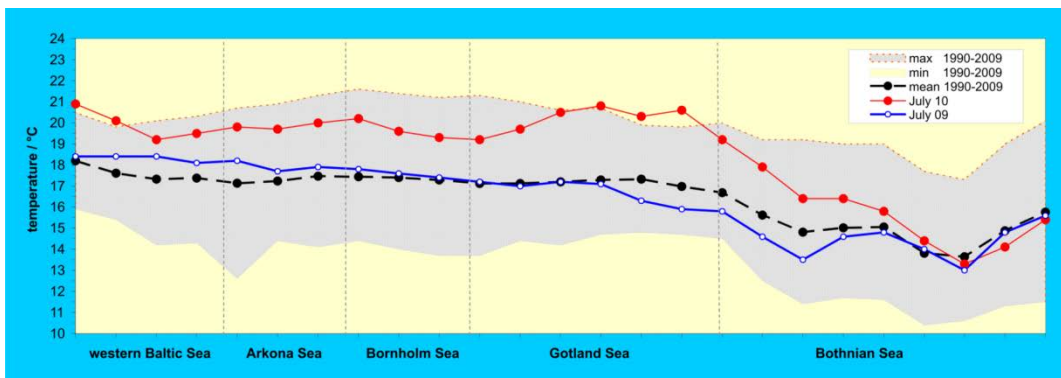
**Figure 3.** Temperature distribution along the transect through the central basins of the Baltic Sea in February 2010 in comparison to the previous year, to the long-term mean value of 1990 – 2009, and to the variation range of the investigation period.

End of June, the water temperatures were 16-17°C from the western Baltic Sea to the central Gotland Sea, 10-13°C in the Bothnian Sea and 8-12°C in the Bothnian Bay, when the influence of high pressure situations began. From southern Europe tropical air masses with air temperatures of up to 37°C were transported in the area of the Baltic associated with strong heating of the water. The heating occurred in different phases with short interruptions by low pressure systems. In the period from 10 to 12 July the highest temperatures of the year were reached with 20-23°C in the western Baltic Sea. Upwelling along the Swedish and German coasts at the following days caused a cooling of the western Baltic Sea. In the central Baltic Sea the heating up continued and on 15-17 July the temperature maximum with values of up to 25°C was reached in the eastern Gotland Sea (Fig. 4). At this time temperatures of 17-20°C were determined in the Bothnian Sea and below 15°C in far parts of the Bothnian Bay. Although, a weather conversion already started on 17 July accompanied with slight cooling, July was the warmest month for the western and central Baltic Sea. This was reflected

in the monthly mean SST (Fig. 2), which reached with 20°C the maximum of the year in the Gotland Sea. The monthly mean temperature distribution along the transect through the central basins of the Baltic Sea for July is presented in Fig. 5 compared to last year, to the long-term means for the period 1990 to 2009, and the variation range of the investigation period. The values were 2-3 K above the long-term average except in the Bothnian Bay and in the region of the Darss Sill. The maximum temperatures were determined in the Lübeck Bay and in the Gotland Sea, where they exceeded the variation range from 1990 to 2009. Thus, the July 2010 belonged to the warmest since 1990. In the Bothnian Sea and Bay the August was the warmest month of the year.



**Figure 4.** Temperature distribution in the Baltic Sea on the warmest day of the year (16 July 2010).



**Figure 5.** Temperature distribution along the transect through the central basins of the Baltic Sea in July 2010 in comparison to the long-term mean value of 1990 – 2009, to the previous year and to the variation range of the investigation period.

The further temperature development of the Baltic occurs more or less in the range of the long-term average values except in December (Figs. 1 and 2). In November, hurricanes regularly dominated the situation and the influx of polar air from 20 November cooled down in the Kattegat, western and northern Baltic. These weather conditions continued in December which rapidly dropped the temperatures, especially in the shallow Pomeranian Bay. A new cooling phase from 16 December let the temperatures quickly drop below the freezing point and from about 20 December ice formation started particularly in the Pomeranian Bay. End of the month the temperature dropped down to 1-2°C in the whole area west of the Darss Sill. Thus, December 2010 was beside 1998 in the western and beside 2002 in the central Baltic Sea the coldest since 1990.

Because of the first cold six months and frost in November/December, the annual mean water temperature of the entire Baltic Sea was for the first time since 1998 again clearly below the long-term average.

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