Development of Sea Surface Temperature in the Baltic Sea in 2009

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Key message

The development of the sea surface temperature in 2009 was characterized as in the two previous years by comparatively warm months January until May in far parts of the Baltic Sea. However, the temperatures were below those of the two previous years. The heating phase normally observed in June in the southern and central Baltic Sea did not occur, but the Bothnian Sea was comparatively warm. In 2009 August was the warmest month and 8 August the warmest day. In September long lasting westerly winds led to strong upwelling of cold water along the Swedish east coast. In the eastern Baltic Sea the surface water cooled down only slowly that September 2009 was the fourth-warmest since 1990. In December the south-western Baltic Sea cooled down, but in the northern Baltic Sea the SST was above the long-term average. After the continuous increase in the annual SST average in 2009 the SST decreased. 2009 was the five-warmest year since 1990.

Background

Sea Surface Temperature (SST) derived from data of the Advanced Very High Resolution Radiometer (AVHRR) of the National Oceanic and Atmospheric Administration (NOAA) weather satellites were 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, 2010). SST was implemented 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 2009 (Nausch et al. 2010).

Results and assessment

The seasonal development of water temperature was compared to air temperature of Warnemünde (Nausch et al. 2010). The cold sum of the air temperature of Warnemünde showed that the winter 2008/2009 belonged with 32.5 K d (average 102.6 K d) to the mild one. The heat sum of the summer 2009 exceede with 208.4 K d the long term average (146.6 K d) and also the values of the previous year. In contrast to the previous year, August was the warmest month 2009. December 2009 provides with a cold sum of 41.5 K d a cold beginning of the winter 2009/2010. This value was twice as highly as the long term average and already higher than the cold sum of the entire winter 2008/2009.

These particularities in air temperature were reflected in the sea surface temperature. The anomalies of the monthly mean SST of the year 2009 are presented in Fig. 1. Because of the warm December 2008 (Nausch et al., 2009) the temperatures exceeded the long-term average values at the beginning of the year. This continued until May with anomalies of up to 1.5 K in January, April and May. The months January and February were after 2008 and 2007 the third-warmest in the investigation period. The months March and April are the fourth- warmest months since 1990. In June the Baltic Sea was divided into two regions

concerning the SST anomalies. The entire southern part from the Belt Sea over Arkona and Bornholm Sea up to the eastern Gotlandsee was characterized by negative anomalies to -2 K and the northern part by positive anomalies to + 2 K. In the southern part, the typical warming phase in June was not so pronounced and in the northern Baltic the warming was stronger than in the long-term means. In July the conditions in the anomalies turned around. In northern part negative anomalies with to -1.4 K dominated and in the southern part slightly positive. Long lasting westerly winds induced strong upwelling of cold water along the Swedish east coast. Thus, negative anomalies to -4 K resulted. The warm surface water was transported into the eastern parts and reached anomalies of up to +2 K. The westerly wind and the upwelling continued in October. In the upwelling core zones in the western Gotland Sea and in the northern Bornholm Sea anomalies of up to -3.5°C were reached. Thus, far parts were characterized by negative anomalies, which continued weakened in November. Similarly as in January the positive deviations from the mean values are also particularly pronounced in the Bothnian Sea in December.

Anomalies of SST in the Baltic Sea in 2009

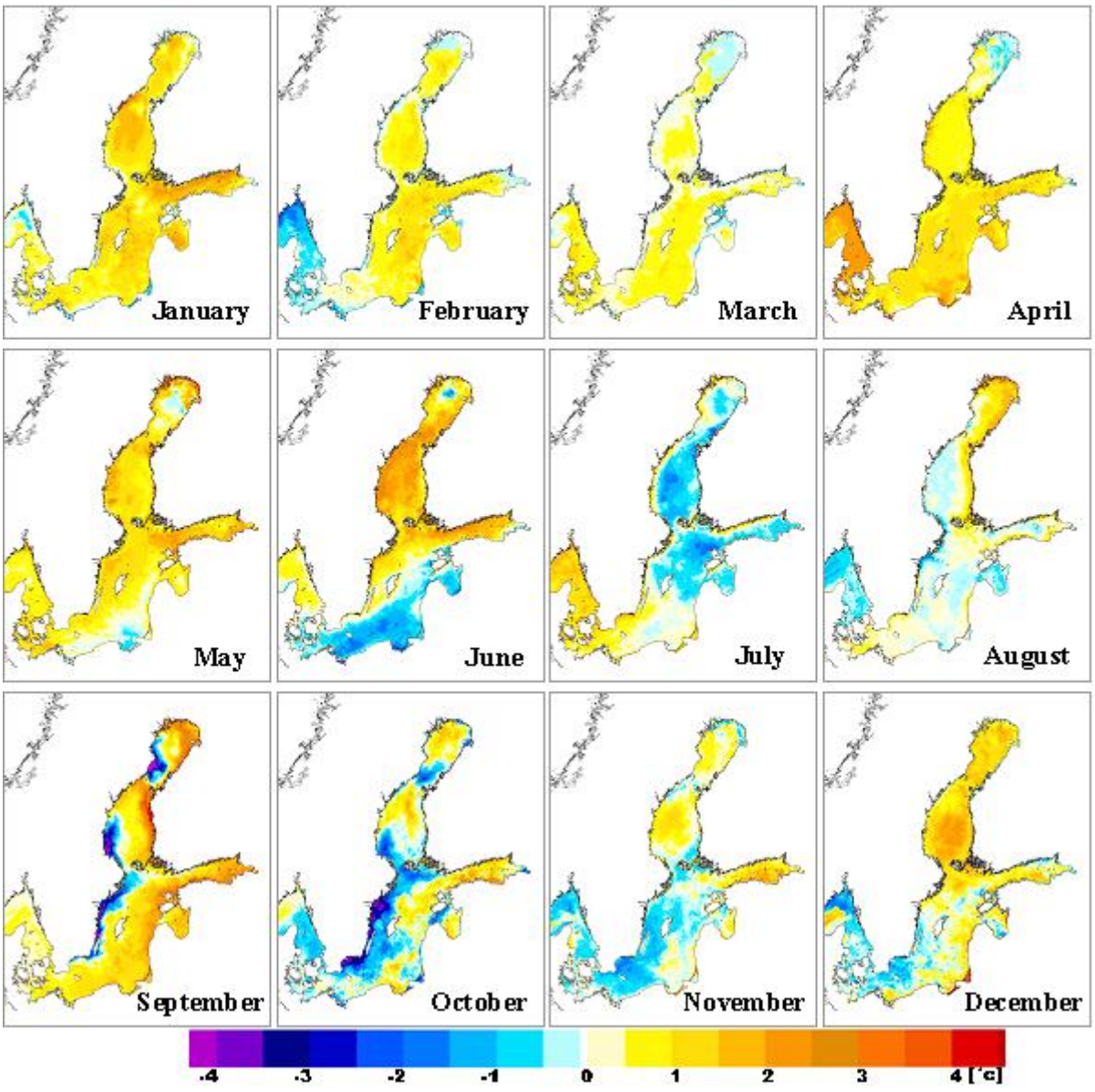


Figure 1. SST- Anomalies of the monthly mean temperature of the Baltic Sea in 2009 referring to the long-term means 1990 - 2008

The seasonal development of the monthly average temperature within the central parts of the Arkona Sea, the Gotland Sea and Bothnian Sea are compared with the long-term monthly average values in Fig. 2. In January and February the temperatures are lower in the Arkona Sea than in the Gotland Sea as a result of cooling from the west. In the three central basins the yearly minimum was observed in March. In April the warming started from the west and from the big rivers. Because of the missing warming phase in June the SSTs were rather similar. August was the warmest month of the year, but in the range of the long term averages. In September the Baltic Sea cooled down only slowly, which led in the Gotland Sea to the largest deviations from the average values. September 2009 was the fourth-warmest in the investigation period after 2002, 1999 and 2006. The cooling in the late autumn to beginning of winter did not take place as strong as in the long-term means. The atmospheric cooling in December from the west as seen in the high cold sums of air temperature led to lower monthly average SST values in the Arkona Sea than in the Gotland Sea. The northern Baltic Sea remained in December with temperatures of 4-5°C and exceeded the long term average by 1-1.5 K.

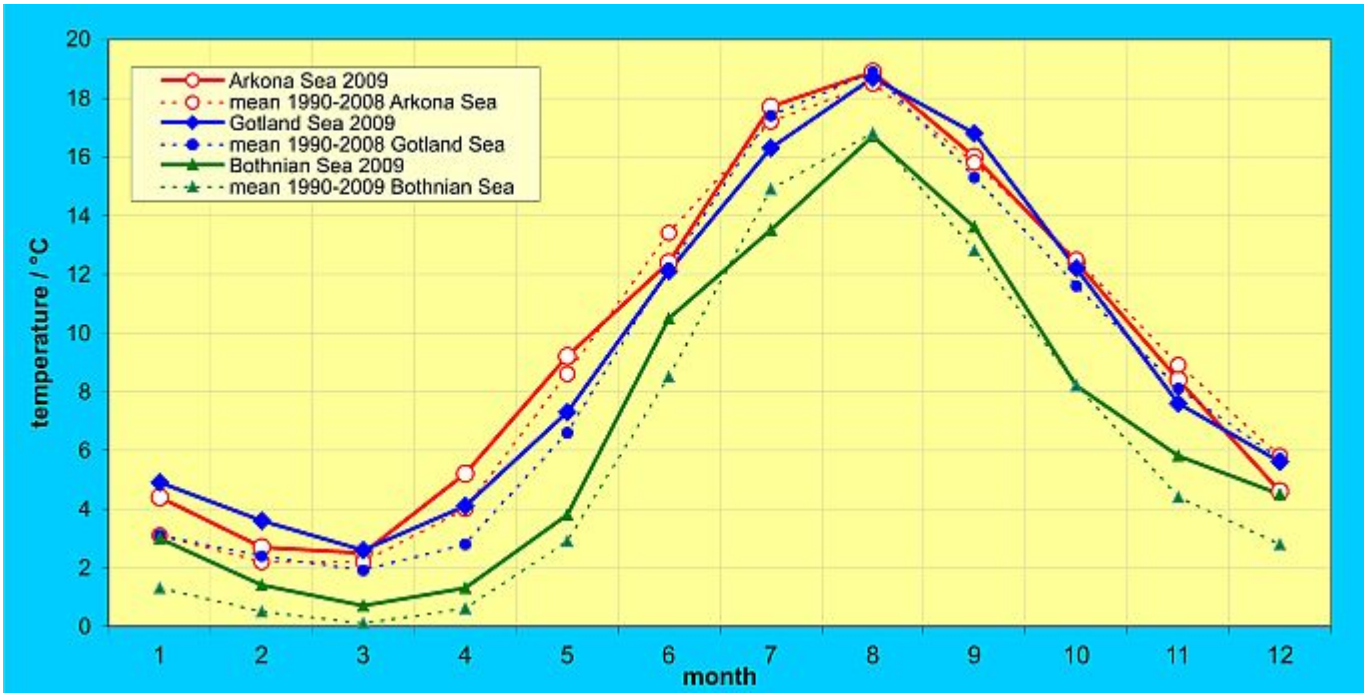


Figure 2. Seasonal course of sea surface temperature (NOAA-SST) in the central Arkona- and Gotland Sea in 2009 in comparison to the mean values of the last 20 years (1990-2008)

The temperature distribution along the transect through the central basins for the month February 2009 showed in the comparison to the means 1990 - 2008 and to the February of the previous year that the areas north of the central eastern Gotland Sea were clearly warmer than in the long term mean, but below the values of the previous year (fig. 3). The western Baltic Sea was colder than the central parts, because in December/January the cooling from the west reduced temperature faster in that relatively shallow area. Around 19 February the Maximum ice extent was reached in the northern Baltic Sea (Nausch et al. 2010), much earlier than in other years.

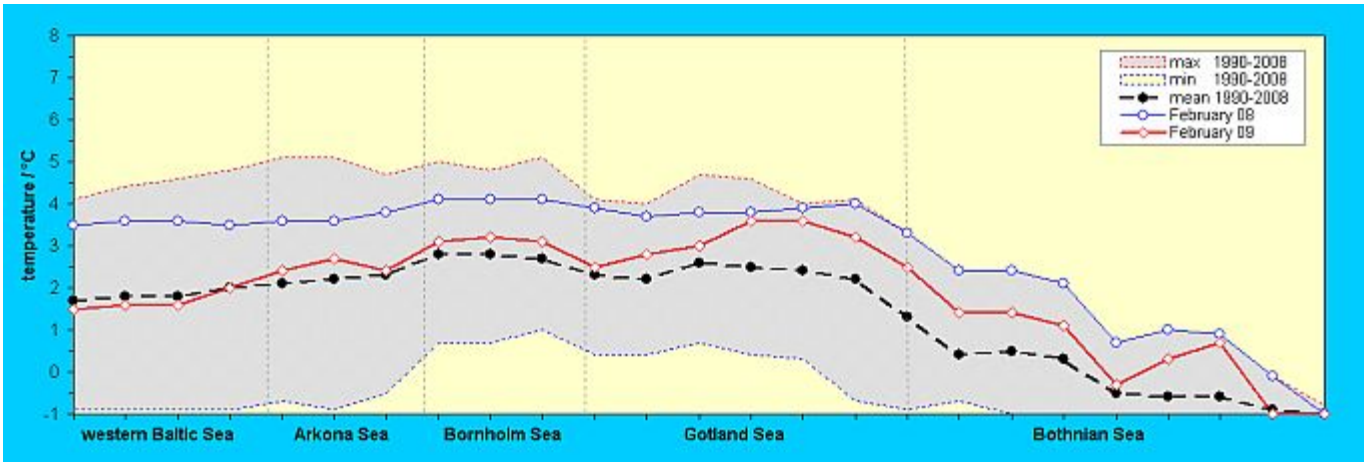
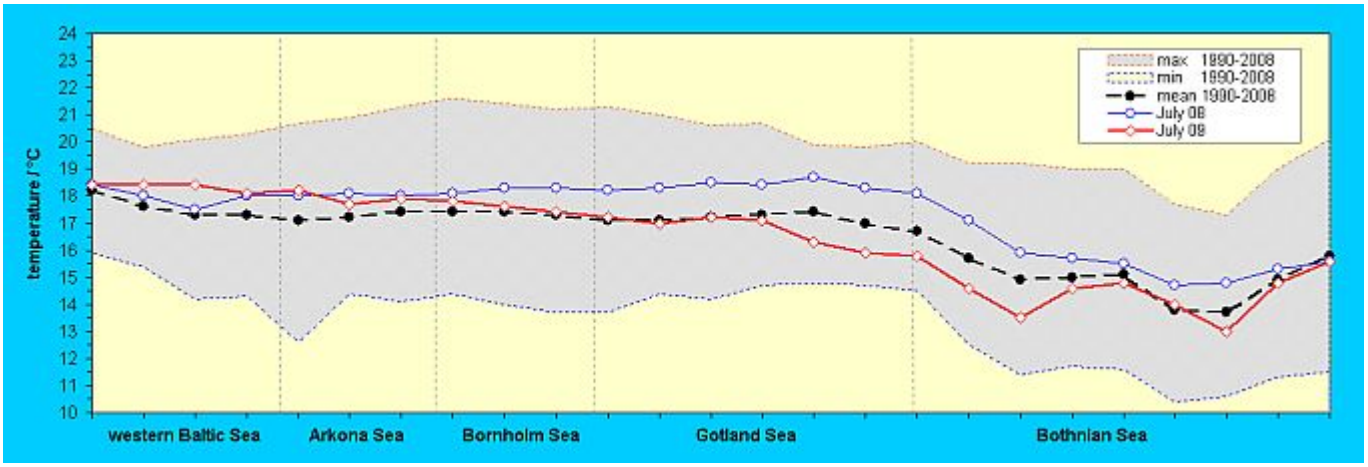


Figure 3. Temperature distribution along the transect through the central basins of the Baltic Sea in February 2009 in comparison to the previous year, to the long-term mean value of 1990 – 2008, and to the variation range

Fig. 4 shows the temperature distribution along the transect through the central basins of the Baltic Sea for the months July and August 2009 in the comparison to the means 1990 - 2008 and to the previous year as well as the variation range in the investigation period. The monthly means of the western Baltic Sea were similar as in the previous year and approx. 1 K above the long term average value, from Bornholm Sea to the central Gotlandsee within the range of the long term average. In the northern Gotland Sea and in the Bothnian Sea temperatures up to 1 K below and further north within the range of the average value.



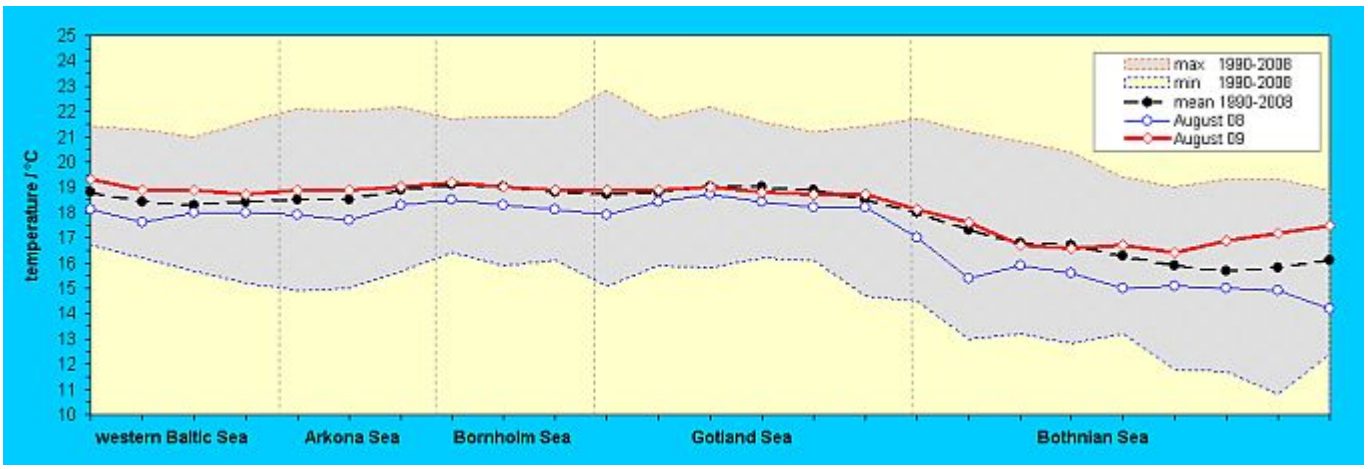


Figure 4. Temperature distribution along the transect through the central basins of the Baltic Sea in July (upper panel) and August 2009 (lower panel) in comparison to the long-term mean value of 1990 – 2008, to the previous year and to the variation range of the investigation period.

During a continuous east wind period beginning of August the temperature continued to increase in the entire Baltic Sea and achieved on 8 August the maximum temperatures between 19 and 22°C in the entire Baltic Sea (fig. 5). Until the end of the month the temperature decreased faster in the northern Baltic Sea than in the central and western parts. In the entire Baltic Sea the temperatures were in the range of the long term average values, but only in the western Baltic Sea and in the Bothnian Bay the SST exceeded the average by up to 1 K.

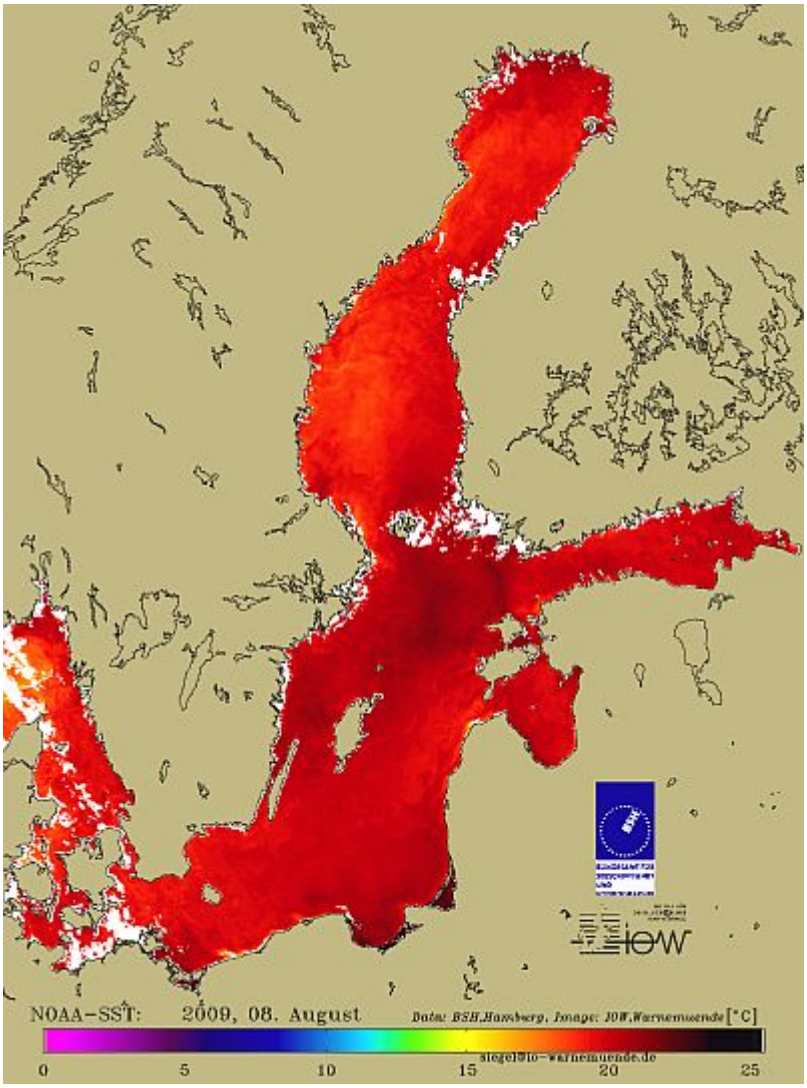


Figure 5. Temperature distribution in the Baltic Sea on the warmest day of the year (8 August 2009)

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