# Sea Surface Temperature in the Baltic Sea 2017

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**Key message**

The year 2017 was the eleventh-warmest year since 1990 and with 0.24 K slightly above the long-term average of sea surface temperature (SST). March/April and October-December were characterised by positive, July and August by negative anomalies. The anomalies reached maximum values of ± 2 K. The winter 2016/2017 was comparatively warm, as shown in the cold sum of air temperature of Warnemünde and in the SST. The coldest month was February and the coldest day was 14 February with 0-3 °C. The warming in spring followed the long-term average. Warm air masses and low wind periods in May led to first development of cyanobacteria confirmed by water samples. The warmest day was in the period 31 July – 2 August, but not clearly pronounced. Daily mean temperatures rarely reached more than 20 °C. The warmest month was August due to a stable summer- situation started on 28 July and lasted until beginning of September with SST's of 18-20 °C in the southern and western Baltic. The subsequent annual cooling led to temperature anomalies of up to +2 K in December, a rather warm basis for 2018.

**Results and assessment**

Cold and heat sums of air temperature of Warnemünde (Naumann et al. 2018) give information about the severity of winter and the course of summer. Winter 2016/17 was with a cold sum of 31.7 K d below the long-term average (102.4 K d), which means the 15$^{th}$ warmest winter since 1948. February contributed with 20.2 K d mainly to this value. The heat sum of the summer (159.5 K d) exceeded the long-term average (153.4 K d) only slightly and was the 28$^{th}$ warmest summer since 1948. May, June and August exceeded the long-term averages and contributed to the summer value.

Anomalies of monthly mean SST for the entire Baltic Sea in Fig. 1 referring to the long-term averages (1990-2017) are the basis for the discussion of overall thermal development in 2017. The seasonal development of monthly mean temperatures in the central areas of the Arkona, Gotland and Bothnian Seas are presented in Fig. 2 in comparison to the long-term monthly averages (1990-2017). The detailed description of temperature development is based on daily and weekly mean SSTs. In January and February 2017, the surface water of the Baltic was characterised by SSTs in the range of the long-term averages with only slight positive and negative anomalies less than ±1 K. In March and April, the anomalies increased to about +1 to +2 K before they dropped again in May to the long-term mean value except in the western Baltic with slight positive anomalies and the Gulf of Finland region with slight negative values. Despite the positive anomalies in air temperature in May and June, the warming of the surface water of the central basins of the Baltic took place as in the long-term mean. In July and August, the monthly mean SST was mostly below the long-term averages leading to negative anomalies with maximum values of up to -3 K in the northern Bothnian Bay and along the

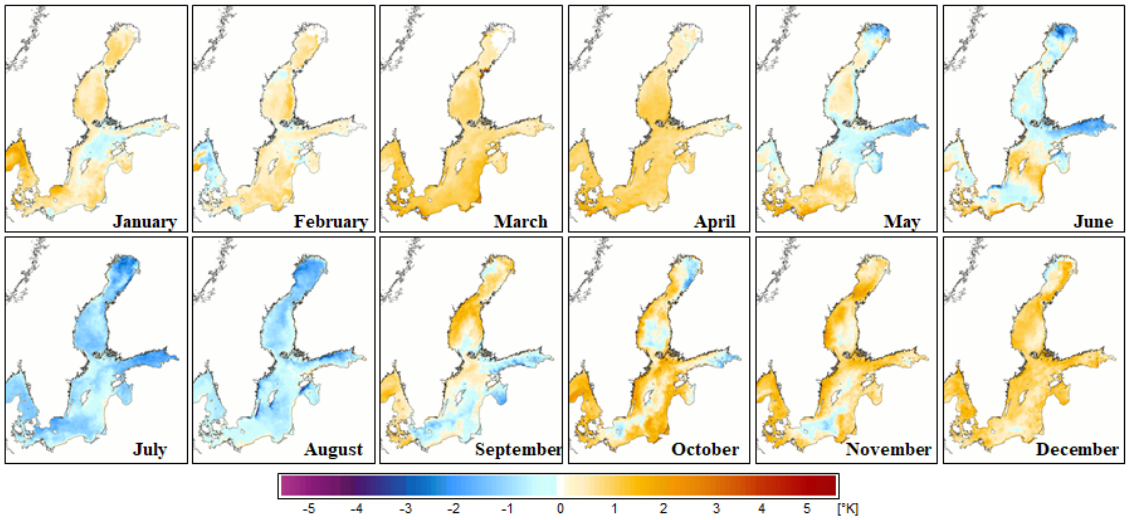


**Figure 1:** SST- Anomalies of the monthly mean temperature of the Baltic Sea in 2017 referring to the long-term means (1990-2017)

Finnish coast in the Gulf of Finland. Westerly winds initiated upwelling of cold water along the western and northern coasts. The negative anomalies reflect unusual westerly winds in these months. The months September to December are characterised by positive anomalies particularly along the coasts, which reflect the absence of typical wind situations and resulting upwelling. The annual cycles of Arkona Sea AS, Gotland Sea GS, and Bothnian Sea BoS (Fig. 2) show that February was the coldest month in all regions. The winter was warmer than in average but the summer months July and August were colder. August was the warmest month of the year in all regions. In autumn, all central regions followed mostly the long-term averages.

The year 2017 started with the typical cooling that the monthly mean values stayed slight above the long-term averages. Cooling continued in the first half of February that 14 February became the coldest day of the year (Fig. 3, left image) with 0 °C in the shallow Pomeranian Bight, 0-2 °C in the western and northern Baltic, and up to 4 °C in the central Gotland Sea. Until end of February, the SST increased again particularly in the western and central parts. In the first decade of March, changing weather led to stagnation in SST before warming continued from the west due to warm air masses coming from the Atlantic Ocean. The transect of mean SST through the entire Baltic in March is presented in relation to long-term average (1990-2017), previous year, and range of variation in Fig. 4 (upper panel) reflecting the impression from Fig. 1. SST of entire Baltic is higher than the long-term

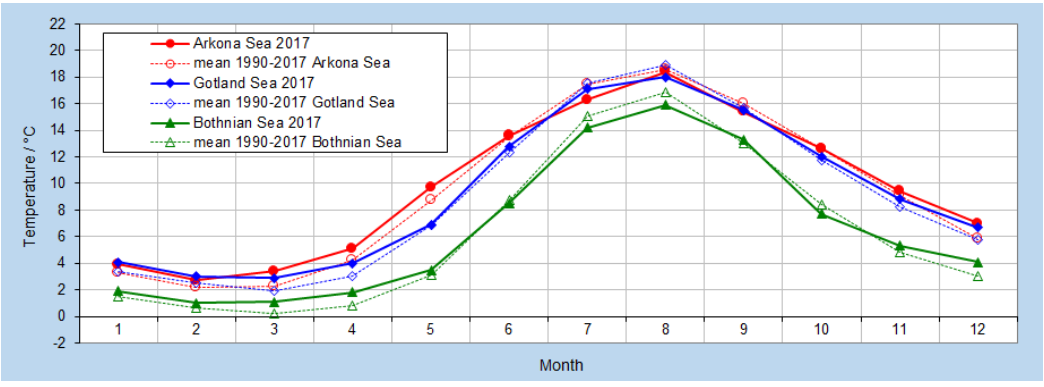


**Figure 2:** Seasonal cycle of SST in the central Arkona-, Gotland- and Bothnian Sea in 2017 in comparison to the mean values (1990-2017)

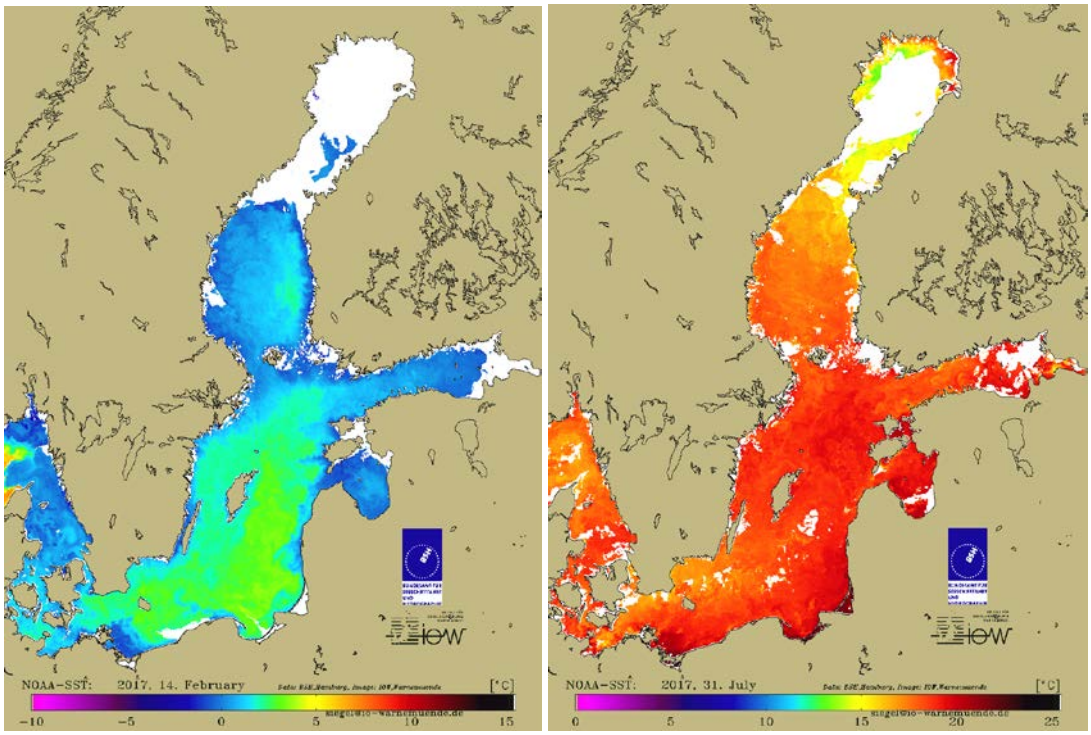


**Figure 3:** Daily mean SST of the Baltic Sea on 14 February, the coldest day, and on 31 July, the warmest day of year 2017.

average except the northern most part. In April, phases of clear weather with high solar radiation particularly in the southern and central Baltic Sea led to further warming, which contributed to the positive anomalies in the monthly averages.

In May, mild air masses from the Atlantic Ocean raise air temperatures in the Baltic Sea region starting about 10 May, which increased also the SST (13-16 °C) supported by low wind periods. These conditions initiated the first development of cyanobacteria from the western Baltic to the eastern Gotland Sea. The second half of May mainly contributed to the positive anomalies in southern and

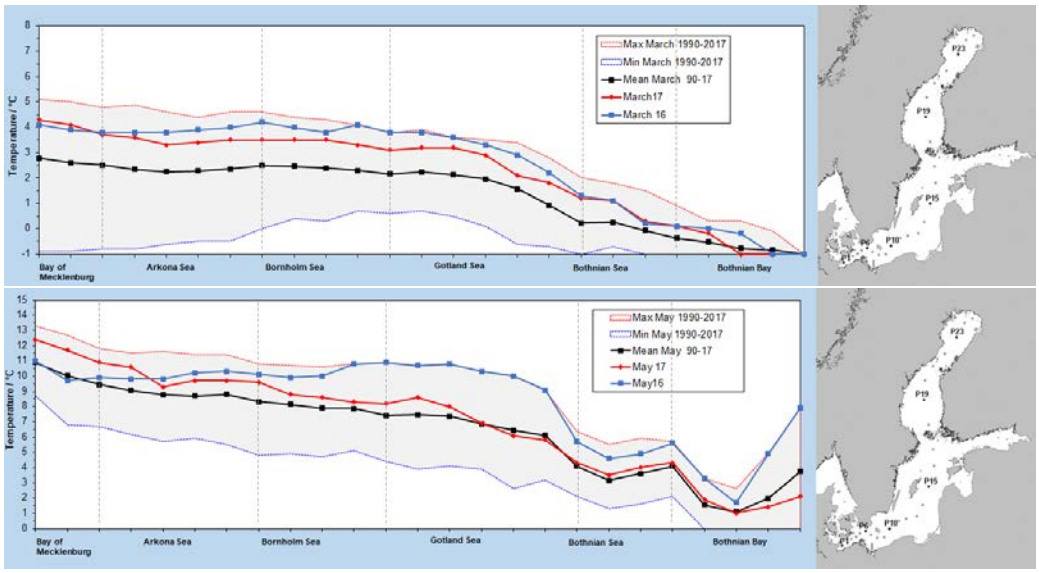


**Figure 4:** Temperature distribution along the transect through the central basins of the Baltic Sea in March and in May 2017 in comparison to the previous year, the long-term mean value of 1990-2017 and the variation range

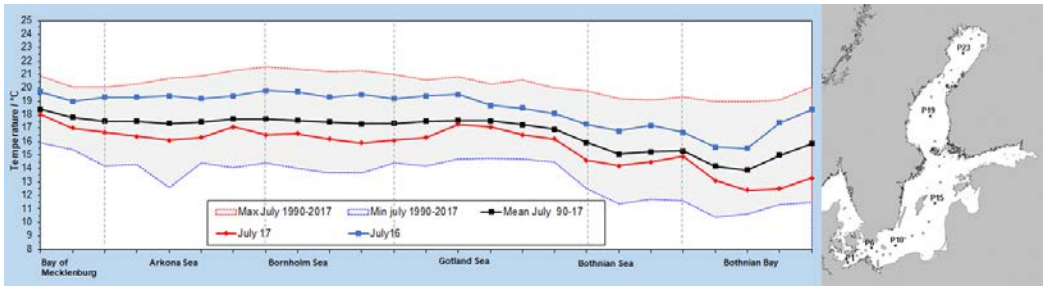


**Figure 5:** Temperature distribution along the transect through the central basins of the Baltic Sea in July in comparison to the previous year, the long-term mean value of 1990-2017 and the variation range

western Baltic Sea (Fig. 4 lower panel).
Deep pressure systems in the first and third decade of June led to reduced SST. A warming phase in the second decade caused maximum SSTs of 17-20 °C on 19 June in the western part. The stagnation continued until 15 July except the Gulfs of Bothnia and Finland. The following days the warming occurred more in the northern Baltic with the highest SST on 27-28 July of 16-18°C, which reduce again until the end of the month. In the other regions, the warmest day was with 17-20°C between 31 July and 2 August (Fig. 3) but not clearly pronounced. A warm summer situation started around 28 July and lasted until end of August. The temperature distribution along the transect through the central basins of the Baltic Sea in July and August compared to the previous year, the long-term mean value of 1990-2017 and the variation range. In July, SST was below the average in the entire Baltic with highest deviations in northern parts. In August, negative deviations from average occurred only in the north. In the first half of September, strong westerly winds crossed the Baltic Sea region, induced wind mixing and reduced the SST until about 15 September. After that, stagnation occurred until the end of the month. In the last 3 months, the cooling occurred continuously with alternating strong and low wind periods inducing cooling and stagnation periods. The SST was in these months above the long- term mean values. Therefore, December as the basis for the year 2018 was also to warm compared to the long-term averages particularly in coastal regions of the entire Baltic Sea.

Overall, 2017 was the eleventh warmest year of the last 28 years (Fig. 6). The annual mean temperature of the entire Baltic was about 0.24 K above the long-term average. The monthly mean SST varied around the long-term average with slight positive (March/April and Oct-December) und negative (July, August) anomalies.

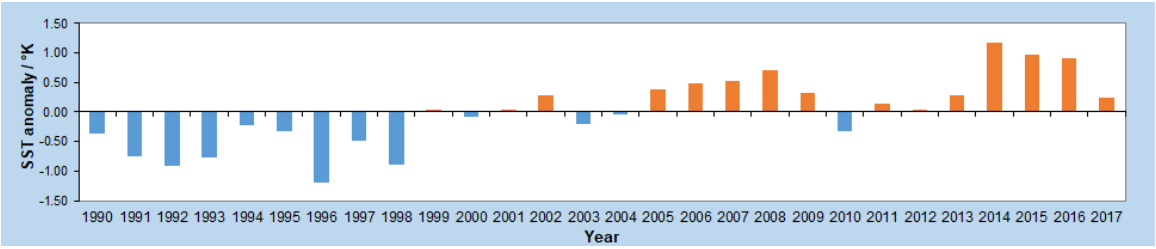


Figure 6: Anomalies of the annual mean sea surface temperature of the entire Baltic Sea during the last 28 years (1990-2017)

The contribution of different regions becomes visible in table 1, which includes the annual mean SSTs of the entire Baltic Sea of the last years, the warmest year 2014 and the coldest year 1996 as well as the means of single points representing the central Arkona, Bornholm, Gotland, and Bothnian Seas and the standard deviation. In the last 6 years, 2017 was one of the colder years, both in the entire Baltic Sea and in the individual basins.

Table 1: Annual mean SSTs of the entire Baltic Sea of the last years including the warmest year 2014 and the coldest year 1996 as well as the average of single points representing the central parts of Arkona, Bornholm, Gotland and Bothnian Seas and the standard deviation.

| year | Baltic | Arkona Sea | | | Bornholm Sea | | | Gotland Sea | | | Bothnian Sea | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mean | mean | | stdv | mean | | stdv | mean | | stdv | mean | | stdv |
| 1996 | 6.6 | 8.0 | ± | 6.6 | 8.0 | ± | 5.9 | 7.6 | ± | 6.3 | 5.8 | ± | 6.4 |
| 2012 | 7.8 | 9.0 | ± | 5.8 | 9.2 | ± | 6.2 | 9.1 | ± | 5.6 | 6.4 | ± | 5.5 |
| 2013 | 8.1 | 9.4 | ± | 6.7 | 9.6 | ± | 6.8 | 9.1 | ± | 6.7 | 6.8 | ± | 6.4 |
| 2014 | 9.0 | 11.6 | ± | 6.4 | 11.0 | ± | 6.3 | 9.7 | ± | 6.3 | 7.6 | ± | 6.7 |
| 2015 | 8.8 | 10.4 | ± | 5.3 | 10.3 | ± | 5.2 | 9.9 | ± | 5.7 | 7.6 | ± | 5.5 |
| 2016 | 8.7 | 10.8 | ± | 6.3 | 10.8 | ± | 6.2 | 9.9 | ± | 5.9 | 7.1 | ± | 5.9 |
| 2017 | 8.0 | 9.8 | ± | 5.4 | 9.8 | ± | 5.3 | 9.3 | ± | 5.6 | 6.8 | ± | 5.7 |

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**Data and Metadata**
This HELCOM Baltic Sea Environmental fact sheet is based on satellite derived Sea Surface Temperature (SST) and heat and cold sum of air temperature measured in Warnemünde. Sea Surface Temperature of the Baltic Sea was derived from data of the Advanced Very High Resolution Radiometer (AVHRR) of weather satellites of the National Oceanic and Atmospheric Administration (NOAA) and from the European MetOp-2. The Federal Maritime and Hydrographic Agency (BSH) Hamburg provided up to eight daily satellite scenes since 1990. Evaluation methods and methodological investigations are discussed in Siegel et al. (2008). The annual assessment of the development of SST in the Baltic Sea is summarized in Naumann et al. 2017 and in HELCOM Environment Fact Sheets (Siegel & Gerth, 2017). Reflections on long-term development of SST since 1990 are presented in Siegel et al. (1999, 2006, 2008). The air temperature data of Warnemünde provided by the German Weather Service was used to calculate the heat and cold sum, which permits to evaluate the intensity of summer and winter.