Cyanobacteria blooms in the Baltic Sea

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Key Message

In 2015, surface blooms of cyanobacteria were observed uninterruptedly for four weeks, from July 31 to August 25. The major bloom started unusually late but still had an average spatial extent, the Northern Baltic Proper was the sea area most affected by intensive blooms.

In all, this year's bloom was about average in comparison with previous years, with the three indexes of normalized duration, extent, and intensity on medium levels. However, the indexes recorded since 2010 should not be directly compared with the blooms from 1997 to 2009, as an improved detection method is now used.

Satellite data from the MODIS sensor on EOS-Aqua were used in the summer of 2015.

Results and Assessment

Relevance of the BSEFS for describing developments in the environment

Nitrogen fixation by cyanobacteria is a significant source of nitrate to the Baltic Sea. The amount of available phosphate in the surface water, the water temperature and weather conditions during the summer are important factors regulating the intensity of cyanobacteria bloom in the Baltic Sea. During the summer of 2015 phosphate concentrations in the Baltic Proper were higher than average for the season. (See SMHI, www.smhi.se/en/cruise-reports).

Assessment

Both June and July were unusually cold, except for the first week of July. In this week surface blooms formed along the eastern side of the Eastern Gotland Basin. However, as the cold and windy weather returned, the major bloom did not start until the very last day of July.

The blooms increased in the first two weeks of August to reach its peak on August 14, when about 125 000 km^2 of cyanobacteria blooms were recorded from satellite data. This date also marked the start of the bloom in the Bothnian Sea, where cyanobacteria usually bloom in August-September (Figure 1).

The blooms in the first half of August were observed in most parts of the Baltic Proper, when the blooms declined in the latter part of the month they were centered towards the northern Baltic Proper and the southern half of the Bothnian Sea (Figure 2). The last signs of blooms in the Baltic Proper were on August 28 whereas the bloom in the Bothnian Sea lasted until September 4.

During the bloom season, SMHI undertook two monitoring cruises in July and August with the Finnish Environment Institute's research vessel R/V Aranda. The cruise tracks mainly went through the Baltic Proper, but the western part of the Gulf of Finland was also covered. See reports 6 and 7 2015 on http://www.smhi.se/publikationer/2.1054. In both cruises, the species *Aphanizomenon flos-aqua* and *Nodularia spumigena* dominated in the samples from the Northern Baltic Proper, the Bornholm Basin as well as the Eastern and Western Gotland Basins.

To be able to compare blooms between different years, the definitions of bloom normalized **duration (T), extent (A)** and **intensity (I)** have been developed. Based on the annual

summaries (see example in Figure 1) where the area (a_i) is equal to the extent that is covered by surface accumulations of blooms during (i) number of days, the normalized duration and extent is given, with (i) ranging from 1 to the maximum number of days with bloom observations during the current year. The intensity is given in "extent days" or km^2 days. (Hansson, 2006 & Hansson & Håkansson, 2007)

$$\text{Duration, T} = \frac{\sum a_i * i}{\sum a_i} \quad [days]$$

$$\text{Area, A} = \frac{\sum a_i * i}{\sum i} \quad [km^2]$$

$$\text{Intensity,} \quad I = A * T \quad [km^2\ days]$$

The total time series of satellite image analysis of cyanobacteria blooms in the Baltic Sea region is presented in the last two figures, where the current analysis method has been used since 2010 (Figure 3). Although no comparison with the years 1997-2009 (Figure 4) should be made since the detection procedure has changed and the time series have not been corrected, the normalized bloom intensity was 25332 km^2days and duration 4.9 days, while the normalized extent was 5183 km^2. The maximum area covered by cyanobacteria blooms (~125 000 km^2) was observed on August 14. Overall the intensity of the 2015 bloom can be considered to be about average.

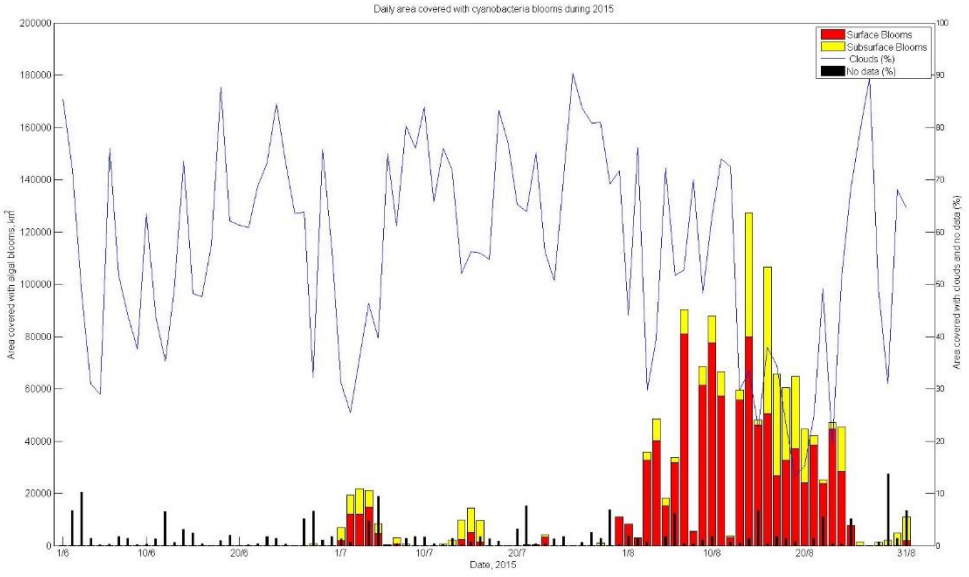

Figure 1. Daily extent of cyanobacteria blooms in the Baltic Sea during 2015, detected by MODIS satellite imagery. Red bars correspond to surface bloom and yellow bars indicate subsurface bloom. The blue line represents the integrated cloud cover (in percent of the total area) over the whole analysed area, the black line no data.

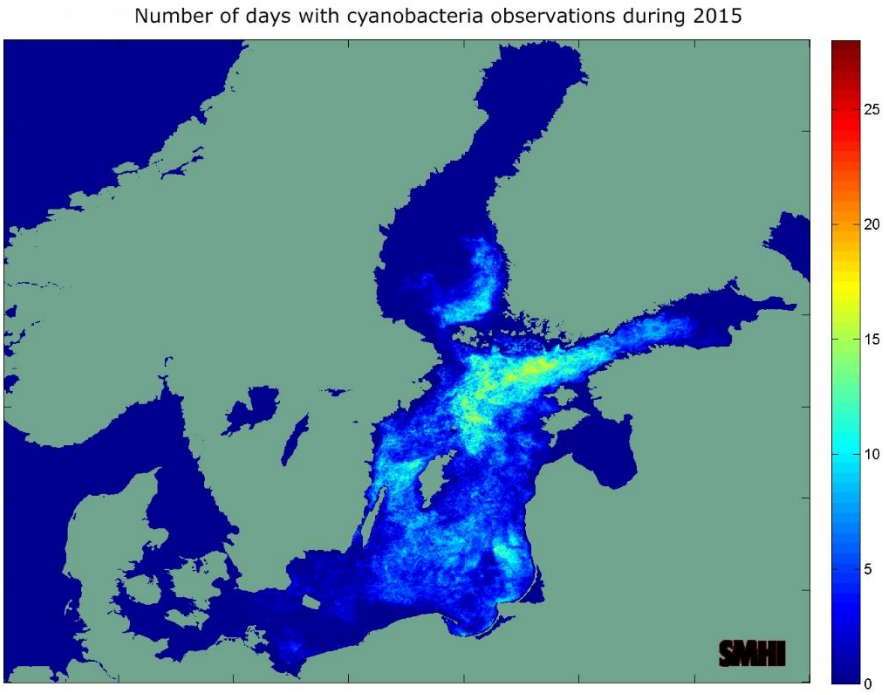

Figure 2. Number of days during 2015 with surface blooms of cyanobacteria observed in each pixel based on MODIS satellite data.

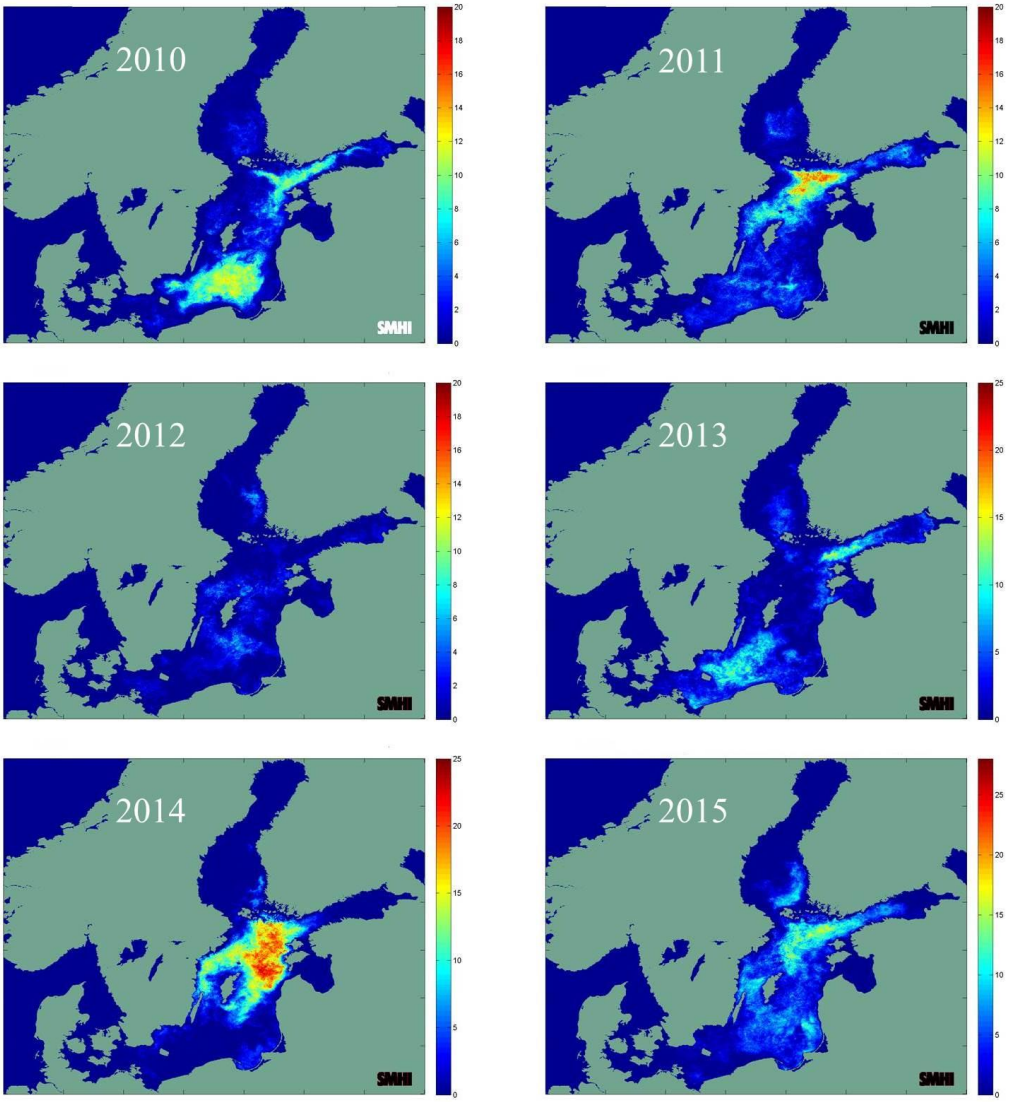

Figure 3. Summary of number of days with cyanobacterial blooms observed in each pixel during the period 2010-2015. Note that comparison between these results and results from the period 1997-2009 should not be made since the detection method is different.

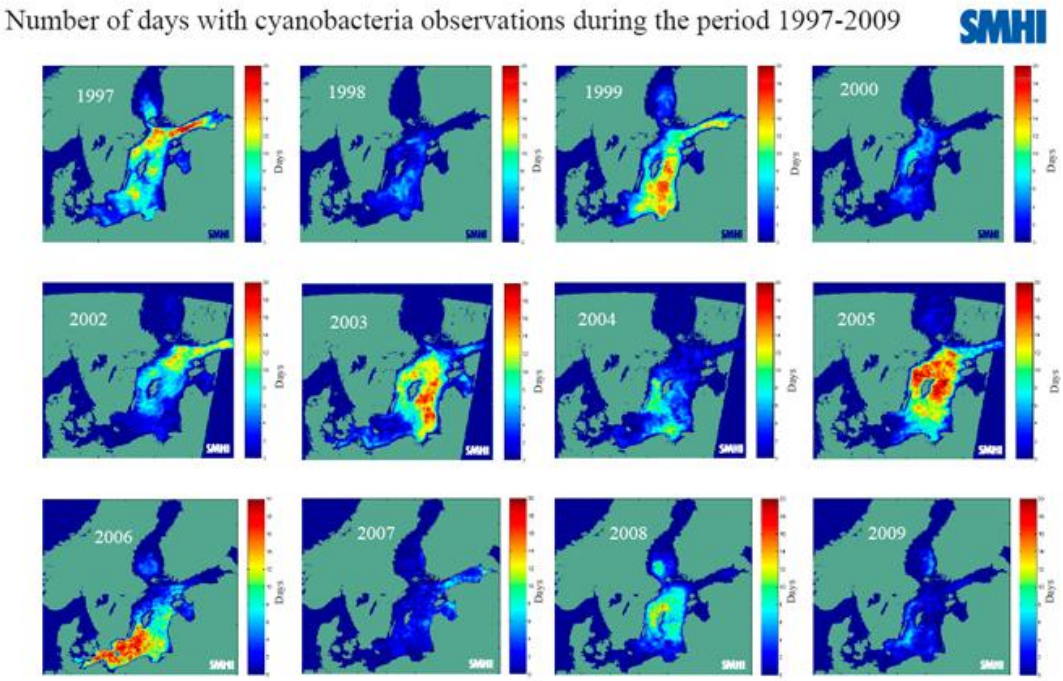

Figure 4. Summary of number of days with cyanobacterial observed in each pixel during the period 1997-2009, based on NOAA-AVHRR satellite imagery. Year 2001 is missing. Note that comparison of the results from 2010-2015 with previous years should not be made since the detection method is different.

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Data

All available and current MODIS L2 data covering the Baltic region were automatically collected via FTP-boxes (Near Real-Time service at OceanColorWeb, NASA) to SMHI. Analysed satellite images showing the extent of surface and subsurface bloom in the Baltic Sea is presented at the following website. The images are updated on a daily basis during June-August.

www.smhi.se/en/Weather/Sweden-weather/the-algae-situation-1.11631

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