Cyanobacterial blooms in the Baltic Sea

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Key Message

In 2013, surface blooms of cyanobacteria were observed for eleven weeks, from June 19 to August 30. Already in the fourth week of June, a substantial bloom was established in the southern part of the Eastern Gotland Basin. The most intense blooms of the season were centred in this area and in the adjacent Bornholm Basin.

This year's bloom was lower than average in an initial comparison with previous years; however, the normalized bloom intensity, extent and duration should not yet be compared with the blooms from 1997 to 2009, as an improved detection method is used since 2010.

Due to the loss of the ENVISAT satellite in April 2012, only MODIS data were used in the summers of 2012 and 2013.

Results and Assessment

Relevance of the indicator for describing developments in the environment
Nitrogen fixation by cyanobacteria is a significant source of nitrogen to the Baltic Sea. The amount of available phosphate in the surface water, water temperature and weather conditions during the summer are important factors regulating the intensity of cyanobacterial blooms in the Baltic Sea. During the summer of 2013 phosphate concentrations were normal or lower than average in the Baltic Proper (See SMHI, www.smhi.se/en/cruise-reports).

Assessment

The Baltic Sea

The mostly sunny weather with moderate winds in the Baltic region was benign for the formation of surface blooms. The blooms started early and lasted throughout the summer. In all, the densest blooms were observed in the Bornholm Basin and west of the islands Saaremaa and Hiumaa.

The sunny start of the summer gave a sea surface temperature of 16 °C by the end of June. The first surface blooms of cyanobacteria were observed in the eastern Bornholm Basin on June 21, by the end of the month satellite data showed extensive surface blooms in the Bornholm Basin and the Eastern Gotland Basin. The blooms developed rapidly, and covered large parts of the southern half of the Baltic Proper one week into July. The blooms also reached westwards to the western part of the Arkona Basin, which is rather unusual. Throughout July, surface blooms were observed in the Bornholm Basin and the Eastern Gotland Basin.

In the later part of July, blooms were established in the western Gulf of Finland and the central part of the Bothnian Sea. This is also where the blooms were most prominent in the first half of August, whereas the blooms in the south decreased. The bloom intensity diminished in the last two weeks of August, but cyanobacterial surface blooms were seen in the eastern part of the Northern Baltic Proper until August 30.

In situ observations

SMHI undertook six cruises in June-August, three each with the Swedish Coast Guard vessels KBV001 Poseidon and KBV 002 Triton. The cruises covered various parts of the Arkona and Bornholm Basins as well as the Eastern and Western Gotland Basins. Detailed reports (in English) can be found at www.smhi.se/publikationer. In the June cruises, moderate quantities of the species *Aphanizomenon flos-aqua* were observed at most sampling stations. The July cruises were made in the second half of the month. Here, ample amounts of *Aphanizomenon flos-aqua* and the toxic species *Nodularia spumigena* were found in the samples from the Gotland Basins whereas lesser amounts of these were sampled in the Bornholm and Arkona Basins. The samples from the August cruises, undertaken in the third week of the month, contained mostly *Aphanizomenon flos-aqua* in moderate quantities.

Normalized indexes

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)

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

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

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

Although no comparison with the years 1997-2009 should be made since the detection procedure has changed and the time series have not been corrected, the normalized bloom intensity was 15134 km^2days and duration 3.5 days, while the normalized extent was 4307 km^2. The maximum area of surface blooms (~62 000 km^2) was observed on the 7th July. Overall the intensity of the 2013 bloom can be considered to be weak to normal.

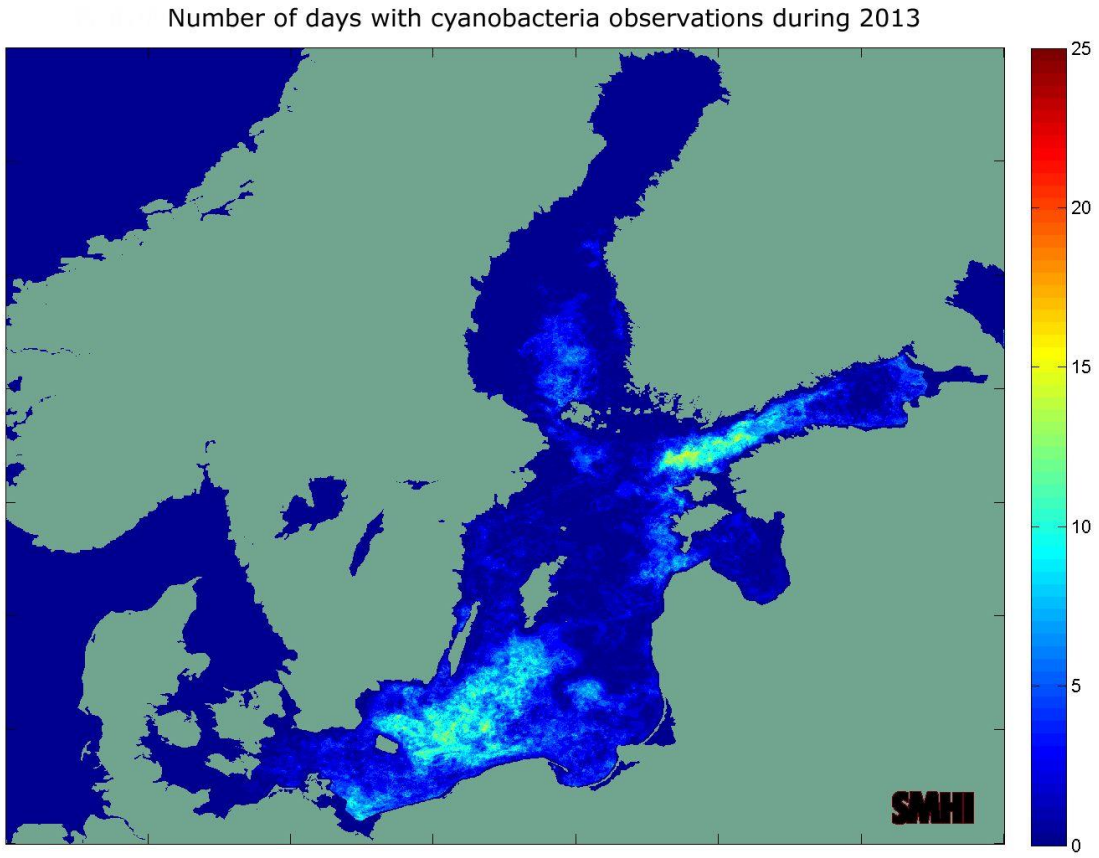

Figure 1. Number of days during 2013 with surface blooms of cyanobacteria observed in each pixel based on MODIS satellite data.

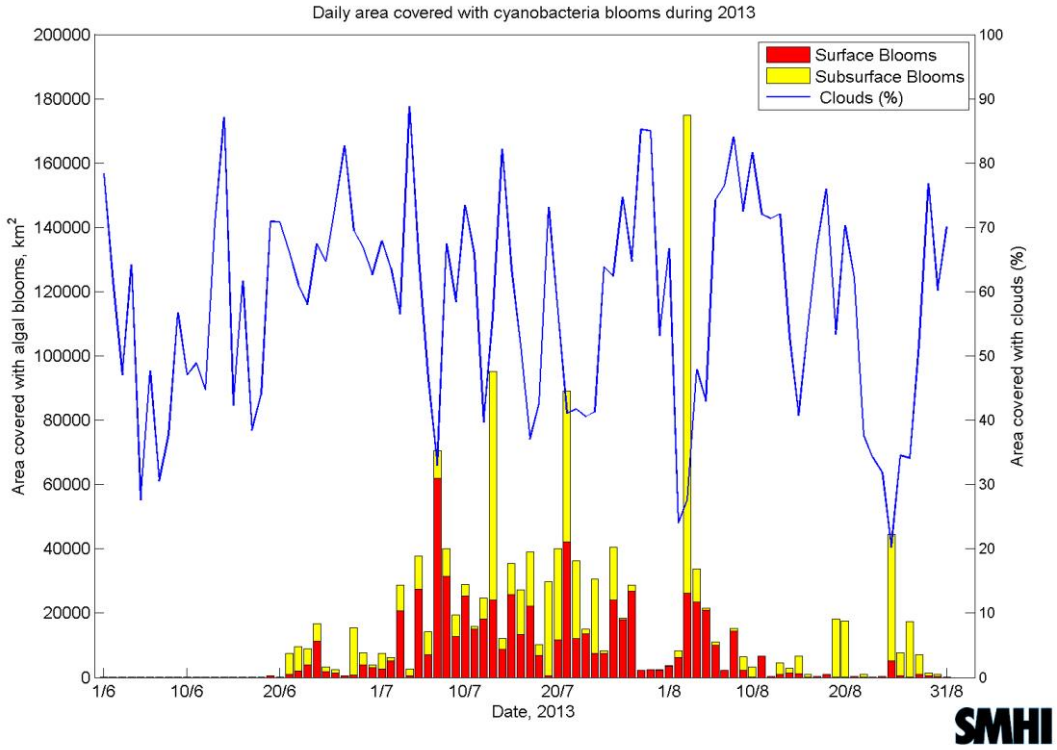

Figure 2. Daily extent of cyanobacteria blooms in the Baltic Sea during 2013, detected by MODIS satellite imagery. Red bars correspond to surface bloom and yellow bars indicate subsurface bloom. The blue line represents the integrated cloud cover (in percent of the total area) over the whole analysed area.

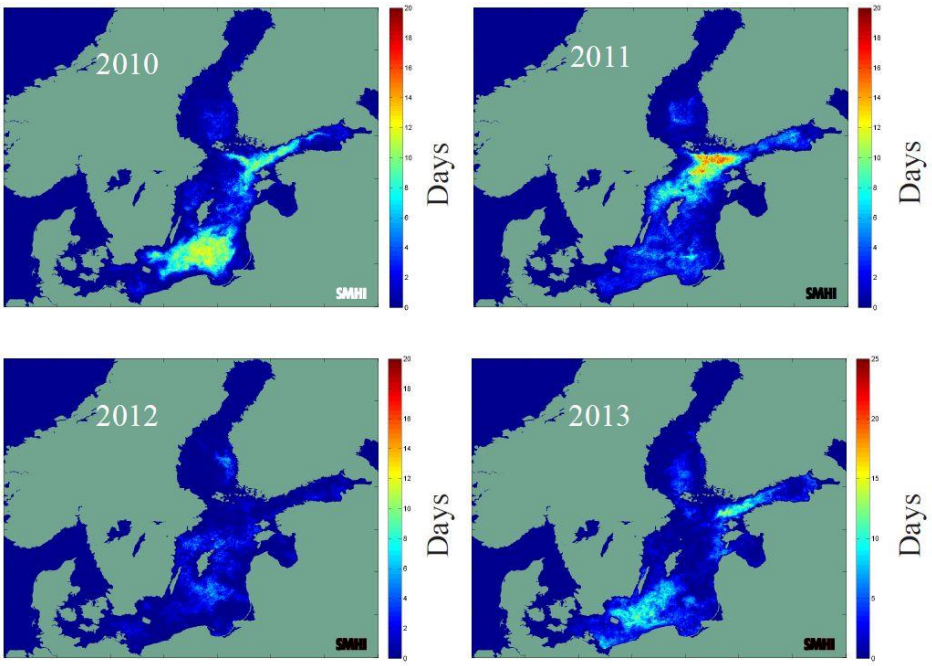

Figure 3. Summary of number of days with cyanobacterial blooms observed in each pixel during the period 2010-2013. Note that comparison between these results and results from the period 1997-2009 should not be made since the detection method is different.

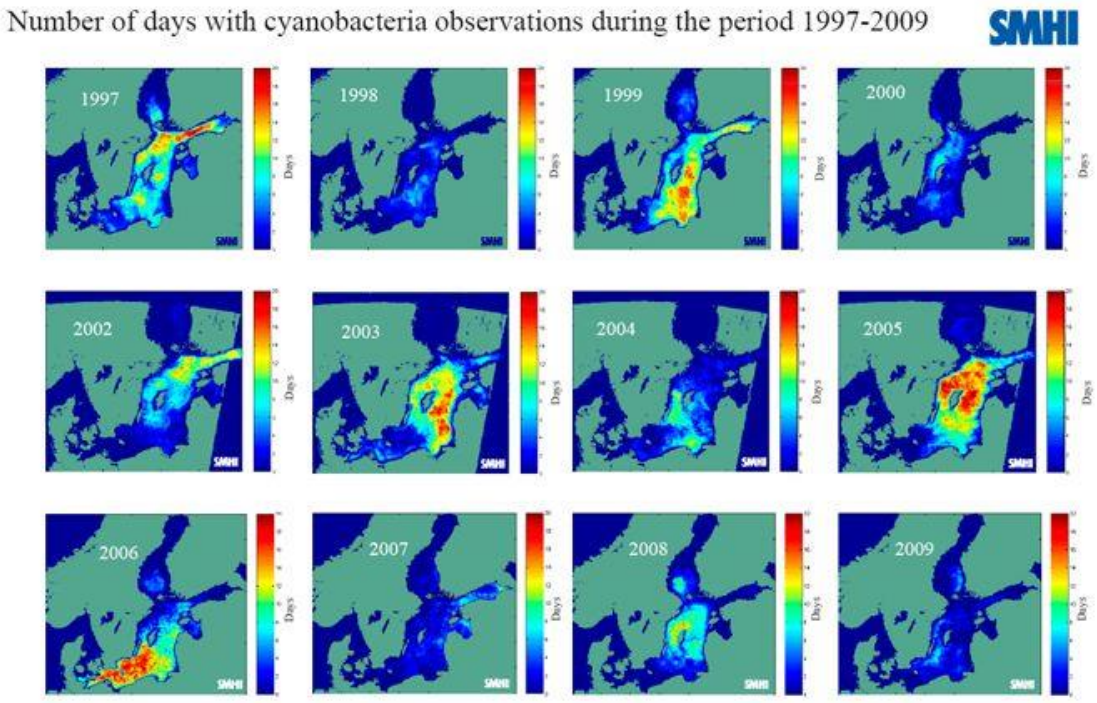

Figure 4. Summary of number of days with cyanobacterial observed in each pixel during the period 1997-2009, based on NOAA-AVHRR satellite imagery. Year 2001 is missing due to antenna malfunction at the receiving station. Note that comparison of the results from 2010-2013 with previous years is not possible since the detection method is different.

References

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www.smhi.se/oceanografi/oce_info_data/reports/havmiljoarkiv/oce_reportarchive12.html

Data

All MODIS L2 data covering the Baltic region that were available from the previous day area were automatically collected via FTP-boxes (Near Real-Time service at OceanColorWeb, NASA) to SMHI. Data from the previous day is convenient to use, since a new bloom map can be made available directly around 09:00 local time and the public and environmental managers can then

get updated information about the algal situation early in the morning. It is also practical for the operator who does not need to wait for late arrival of satellite data which can delay the production of bloom maps. 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