Improving Methods to Detect and Map Baltic Sea Algae Blooms el. Bättre kunskap om algblomningar med satellitdata

Martin Hansson, SMHI
Per Pemberton, SMHI
Bertil Håkansson, SMHI
Anu Reinart, Tartu Observatory
Krista Alikas, Tartu Observatory

2005-07-10

Rymdstyrelsens
Fjärranalysdagar
2009-03-10 --11

2008-07-31

The Problem

Problem – Orsak – Åtgärder – Uppföljning från HELCOM rekommendationer till EU ansvar

Problem: Störd turism samt skaderisk för barn och mindre husdjur

Orsak: Övergödning & extra tillförsel av luftkväve

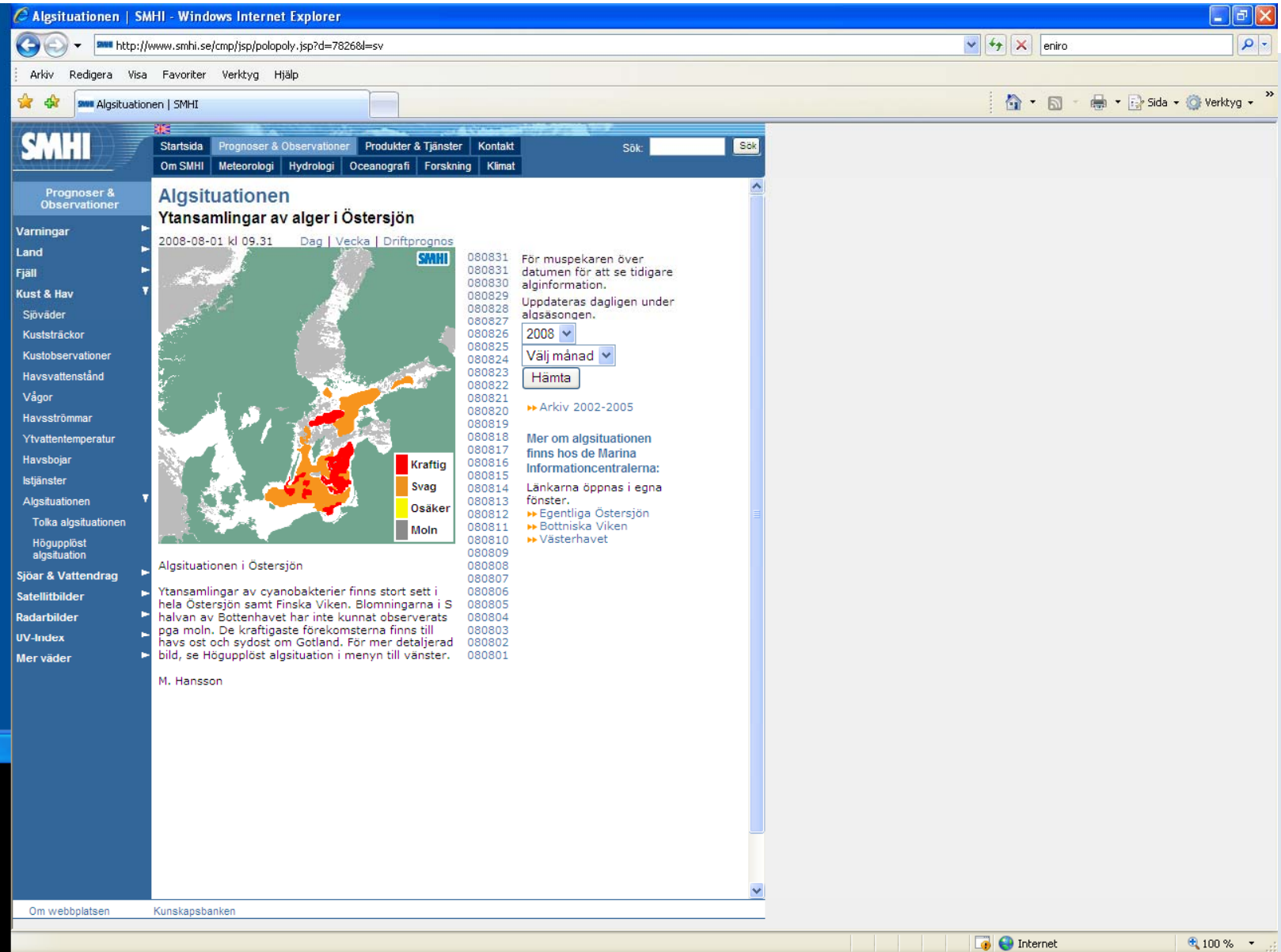
Åtgärder: BSAP + Vattendirektivets åtgärdsplaner

Uppföljning: HELCOM (Indikatorer)

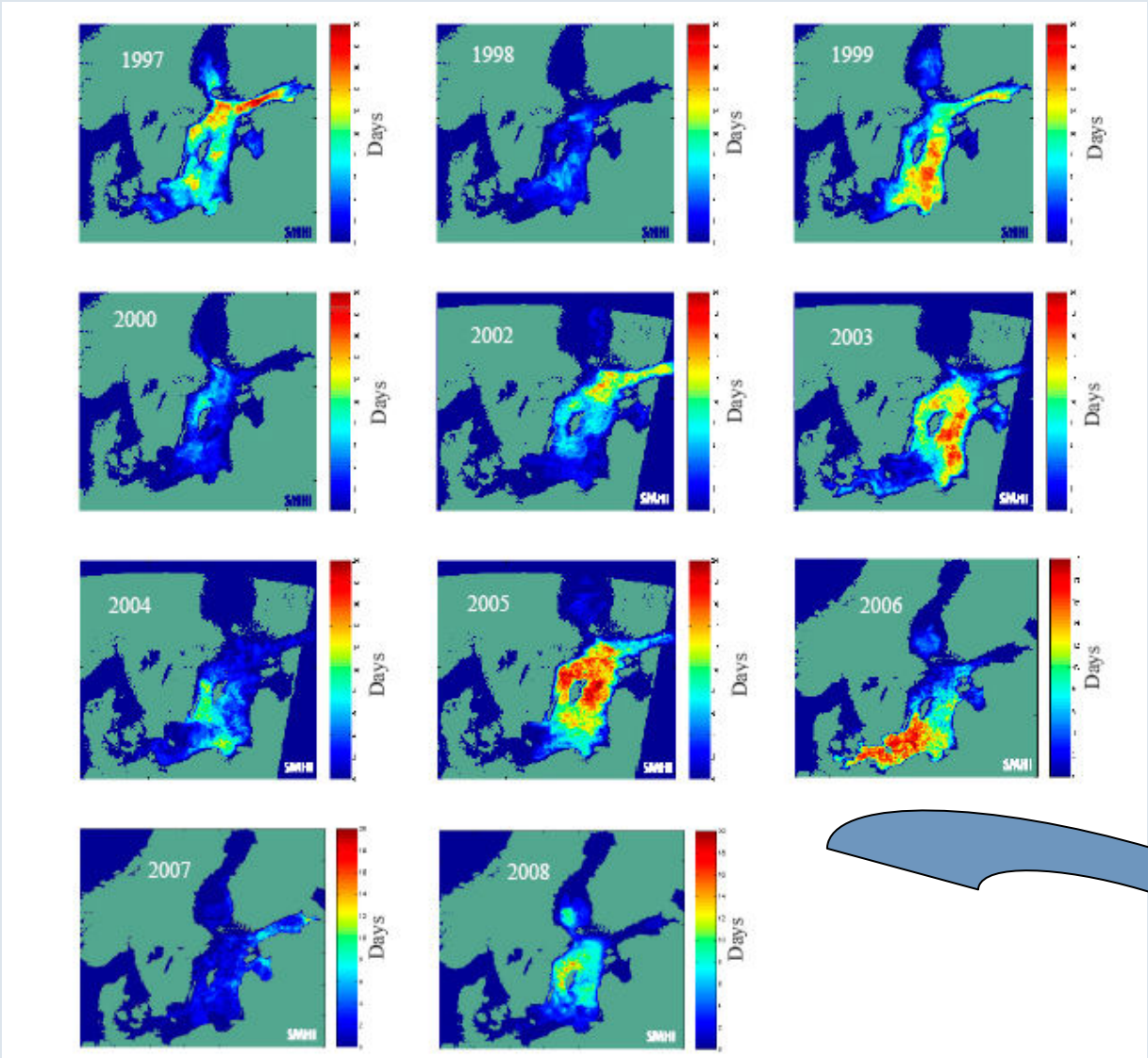
Information och Varningar (BAWS)

Marine Strategy Framework Directive – MSFD (GES – Good Environmental Status Indicators / Descriptors)

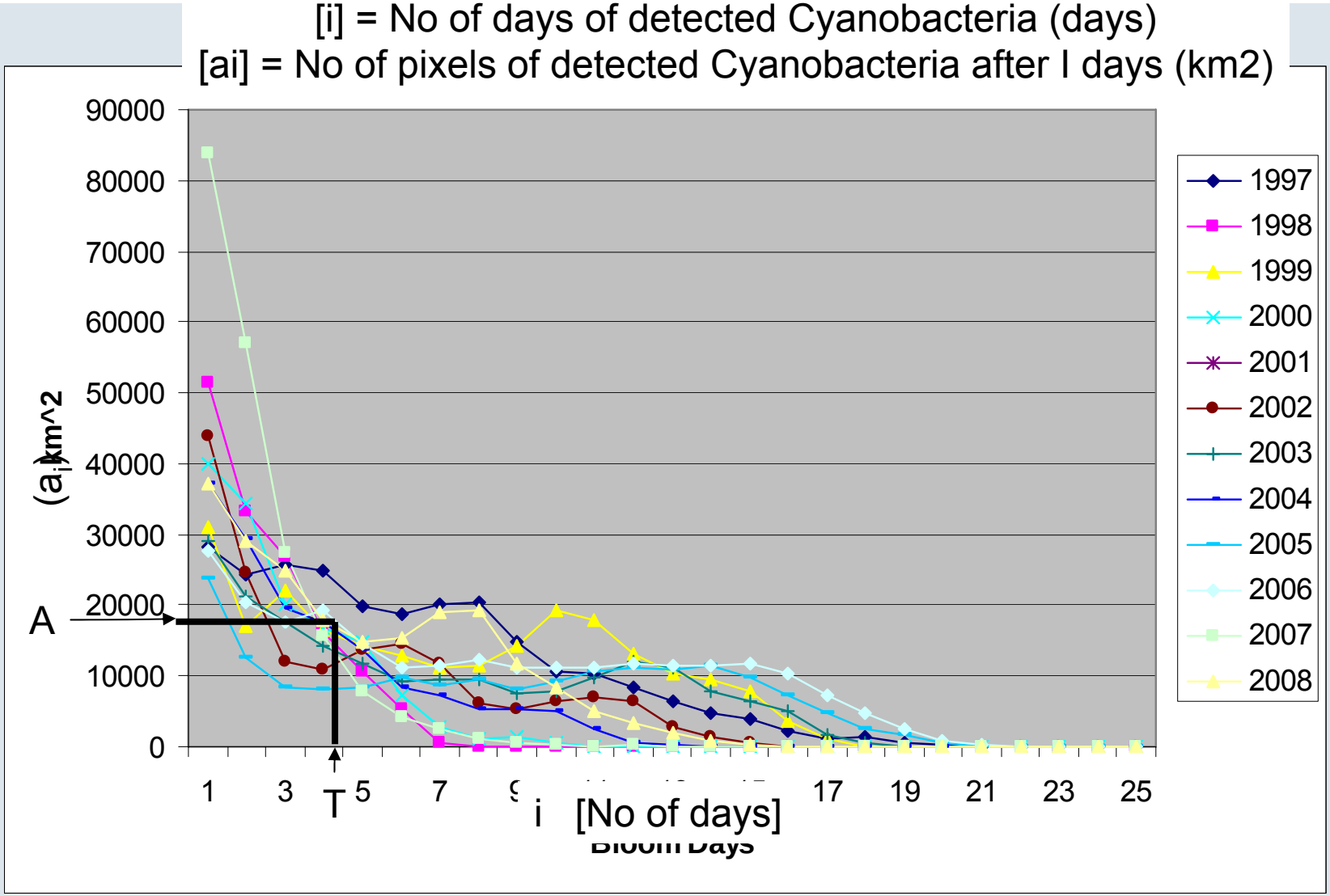
Baltic Algal Watch System - BAWS



Time Series of Cyanobacteria Ackumulations



Cyanobacteria ackumulation structure functions - CASF



Definitions of macro-parameters from CASF

a_i = number of pixels with detected cyanobacteria during (i) days

Duration $\longrightarrow$ $T = \frac{\sum a_i \times i}{\sum a_i}$ [*Days*]

Area $\longrightarrow$ $A = \frac{\sum a_i \times i}{\sum i}$ [km^2]

Intensity $\longrightarrow$ T = A*I [km^2 *days*]

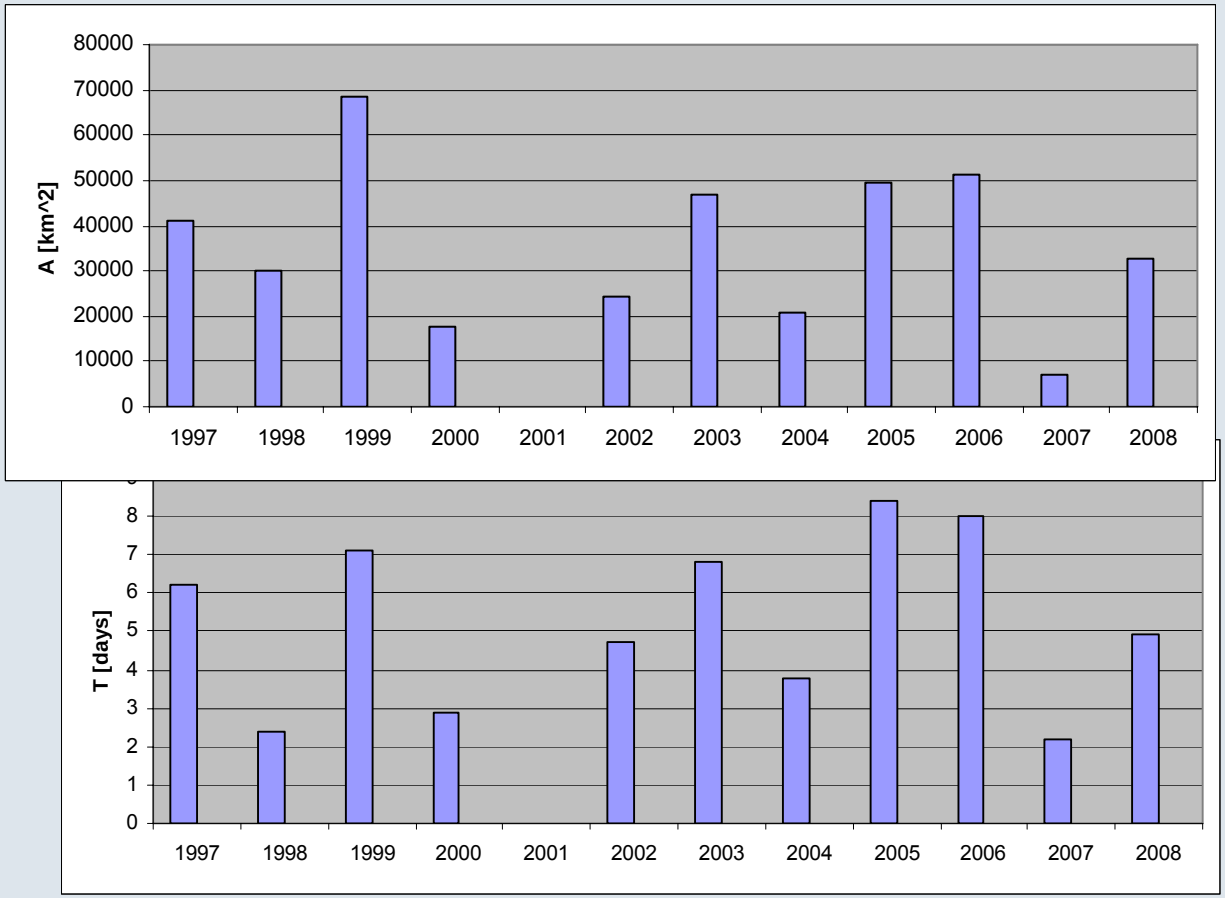
Ref: Hansson & Håkansson (2007)

Ack area = $\sum_i a_i$ - total area coverage of Cyanobacteria (km^2)

FCA = defined as the ratio of counts of detected cyanobacterial bloom scenes to counts of valid ocean scenes (Kahru et al 2007)

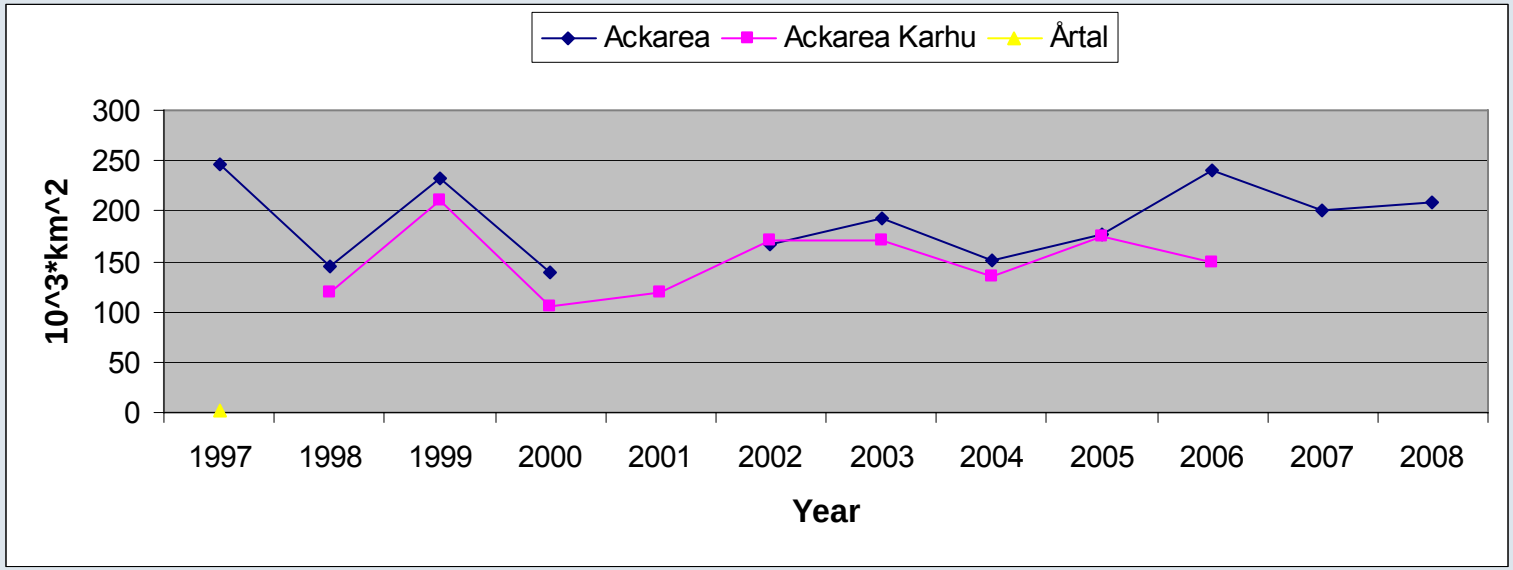
Results: Duration (T) and Area (A)

AVHRR-data

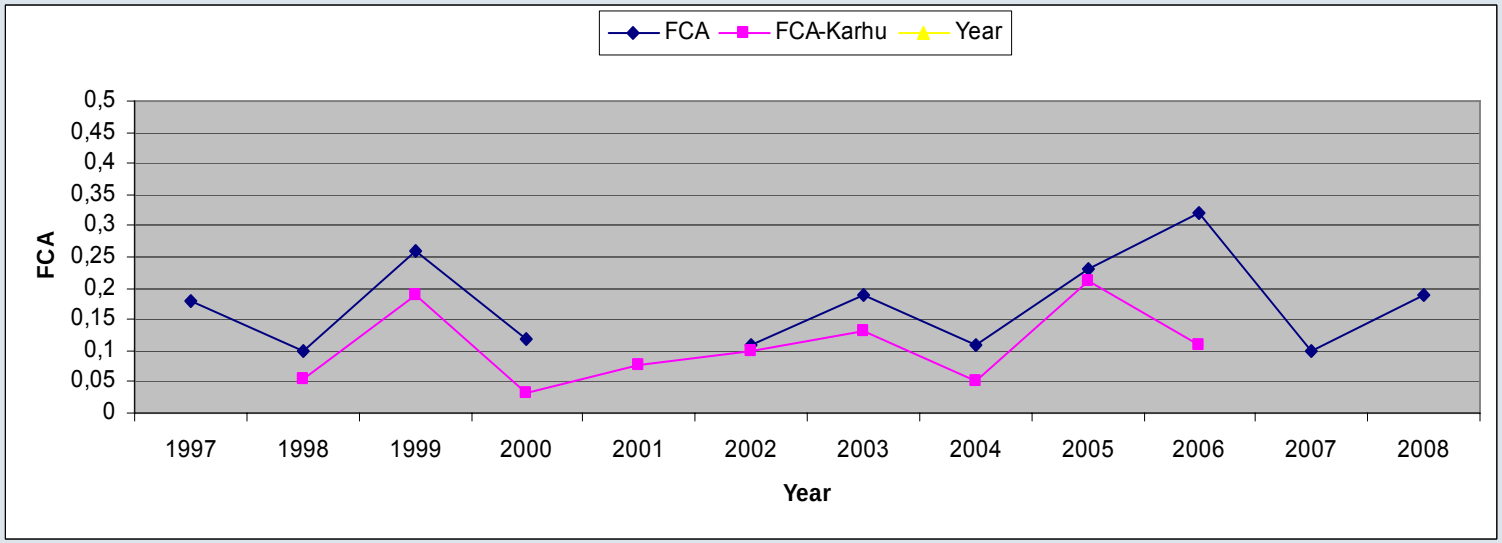


Comparison – Cyanobacteria ackumulations and FCA but different satellite data sets (AVHRR versus SeaWiFS + MODIS)

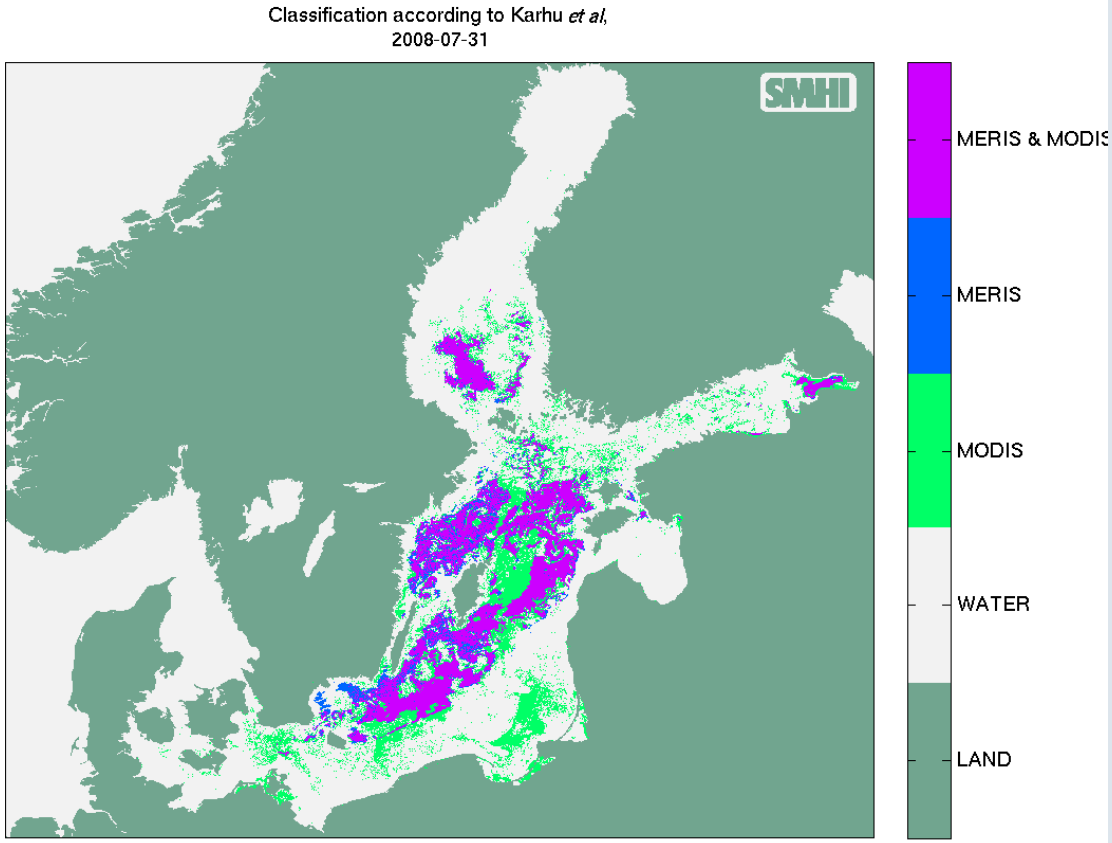
Y=1,04*X - 24,03
R2 = 0,875



Y=0,98*X - 0,05
R2 = 0,848

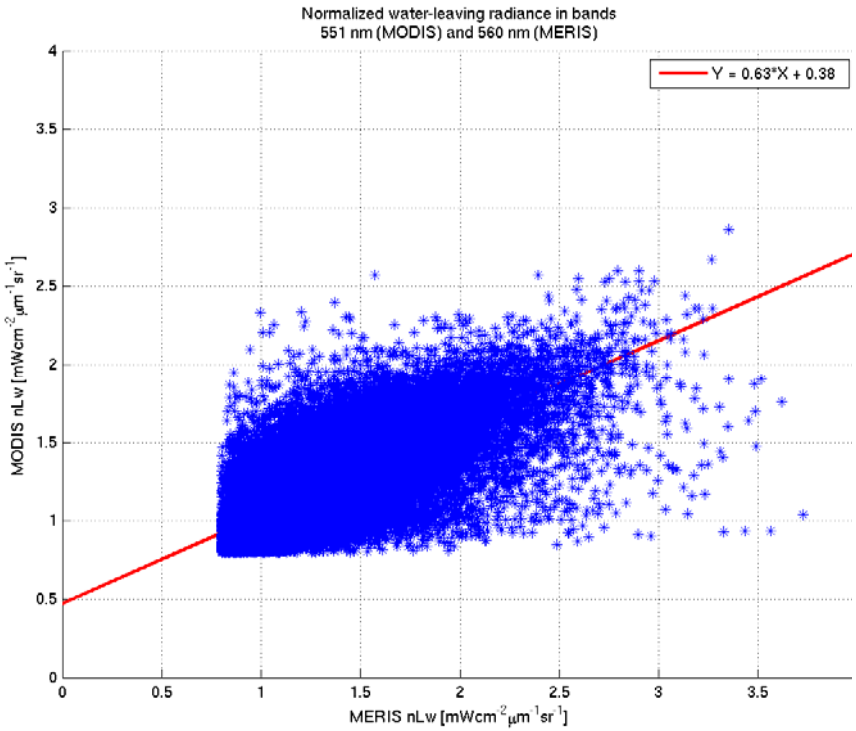


Comparison of MODIS and MERIS of classification according to Kahru et al.

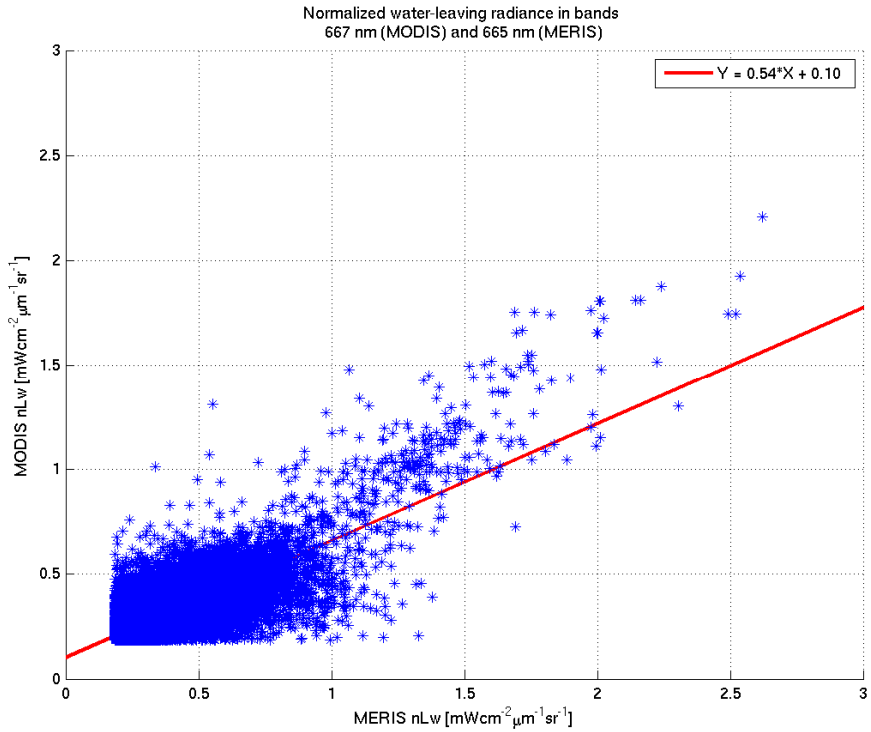


Normalized water-leaving radiance in MODIS versus MERIS

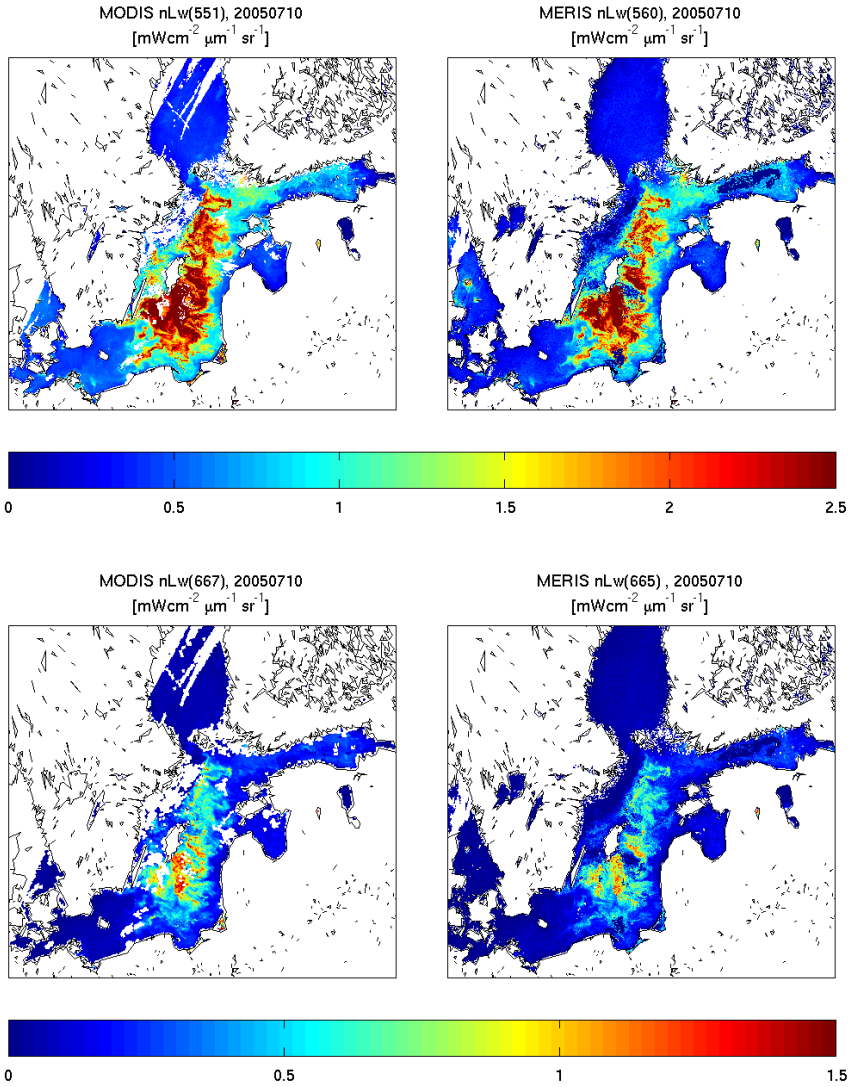
MODIS 555 nm versus MERIS 560 nm



MODIS 667 nm versus MERIS 665 nm



Effects of using flags in MODIS and MERIS



Water leaving radiance [mWcm-2µm-1sr-1] for 2005-07-10 from MODIS band 551 nm (top left), MERIS band 560 nm (top right), MODIS band 667 nm (bottom left) and MERIS band 665 (bottom right). Clouds and land have been masked out of the images.

MCI index

(by Gower, King and Goncalves 2008)

the measure of the radiance peak at 709nm **in water-leaving radiance,** ***indicates the presence of a high surface concentration of chlorophyll a (above 30 mg m-3 and up to several hundred mg*** m^{-3}***)*** **against a scattering background.**

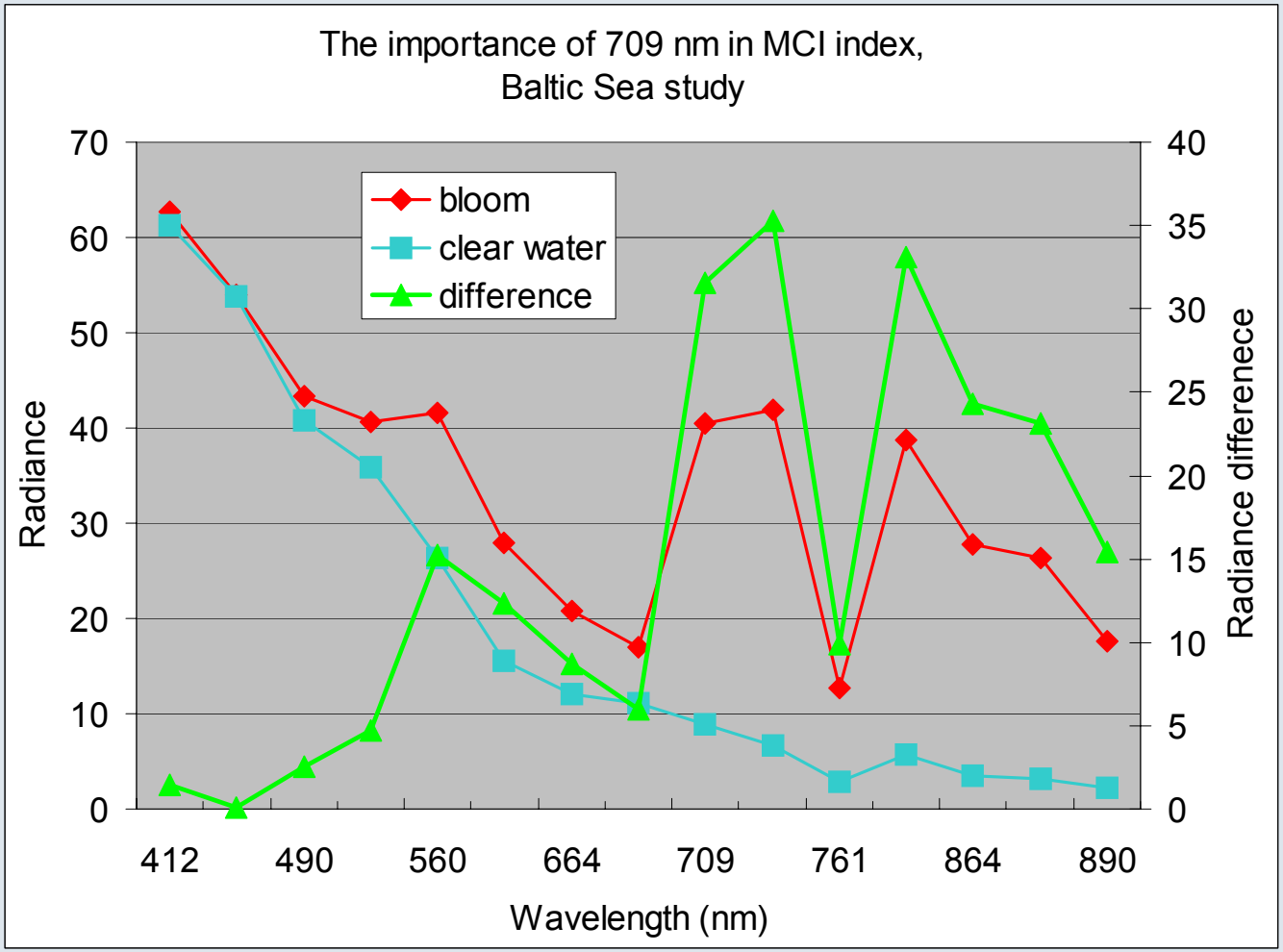
Calculation from TOA radiance (MERIS Level1)

$$MCI = L709 - L681 - 0.389(L753 - L681)$$

The index is high in 'red tide' conditions (intense, visible, surface, plankton blooms) and is raised when aquatic vegetation is present.

Importance of band 709 –

Example of Radiance spectra in **bloom conditions** and in clear water conditions – **maximal difference in NIR**



Cyanobacterial bloom by AVHRR (left) and MERIS (right)

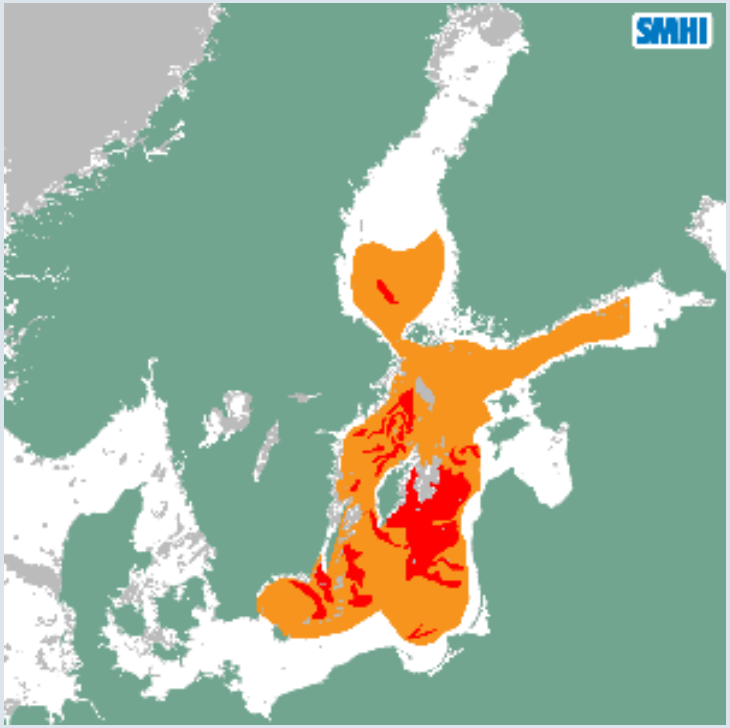


Figure 1 Cyanobacteria bloom estimated from AVHRR (http://www.smhi.se/weather/baws_ext/balt/2008/BAWSDag_en_0807.htm#)

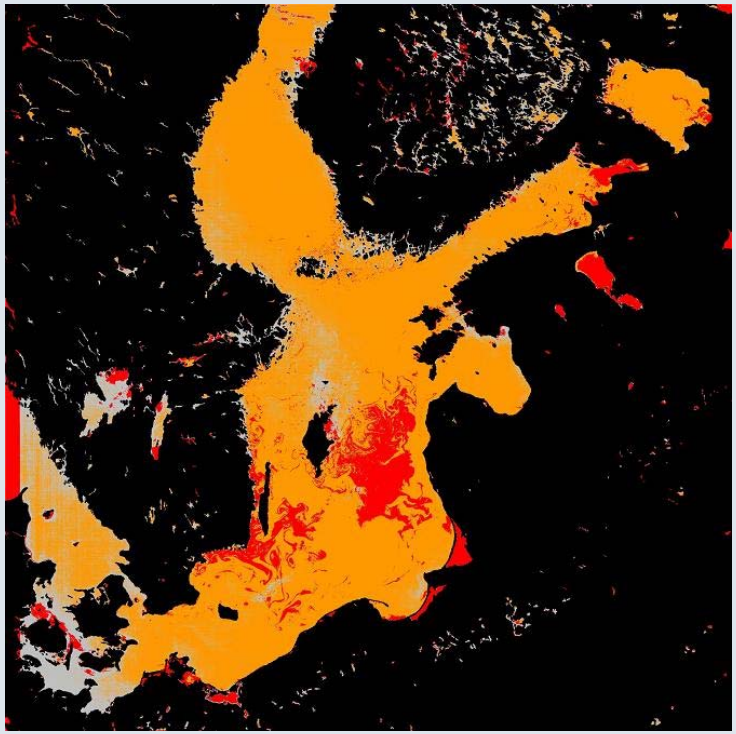
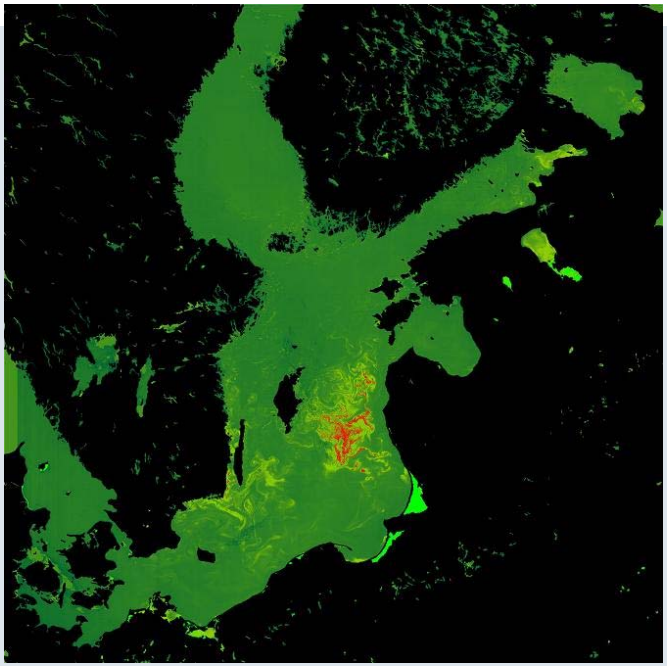


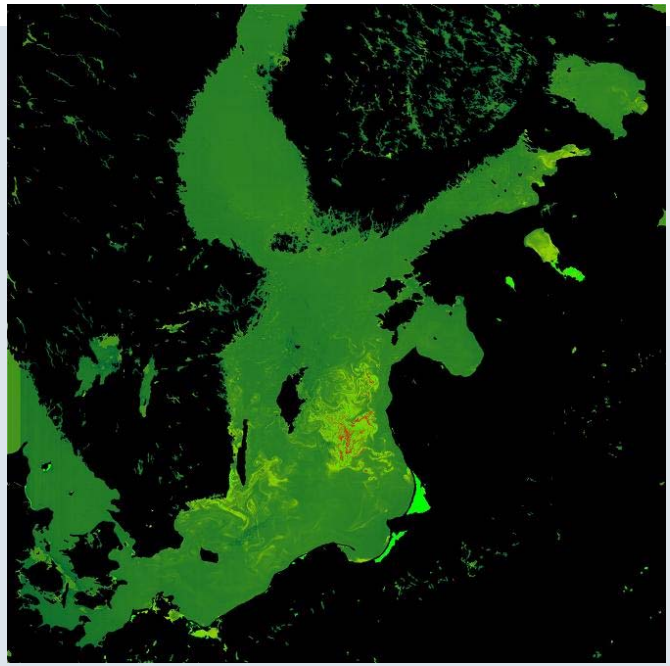
Figure 2. MERIS MCI index above 0.

Red- heavy bloom

MERIS FR MCI 2008-07-31



MCI>4



MCI>6

We need to clarify which value of MCI accord the best for surface bloom of cyanobacteria – this will be adjusted by comparion of MODIS, AVHRR and MERIS derived area estimates – preliminary suggestion MCI 6

MCI	>0	>1	>2	>3	>4	>5	>6	>7	>8	>9	>10	>11	>12
AREA km^2	25369	8543	49233	3290	2308	1665	1220	896	655	438	357	264	192

Summary and future work during 2009

Manually analysed algae blooms versus the automatic method (Kahru et al. 2007) do agree in terms of macro-parameters.

More comparisons of Kahru et al method for MERIS and MODIS is needed to clarify differences and similarities.

New methods will be further studied (i.e. Gower et al. 2008) to surfacing Cyanobacteria axkumulations.