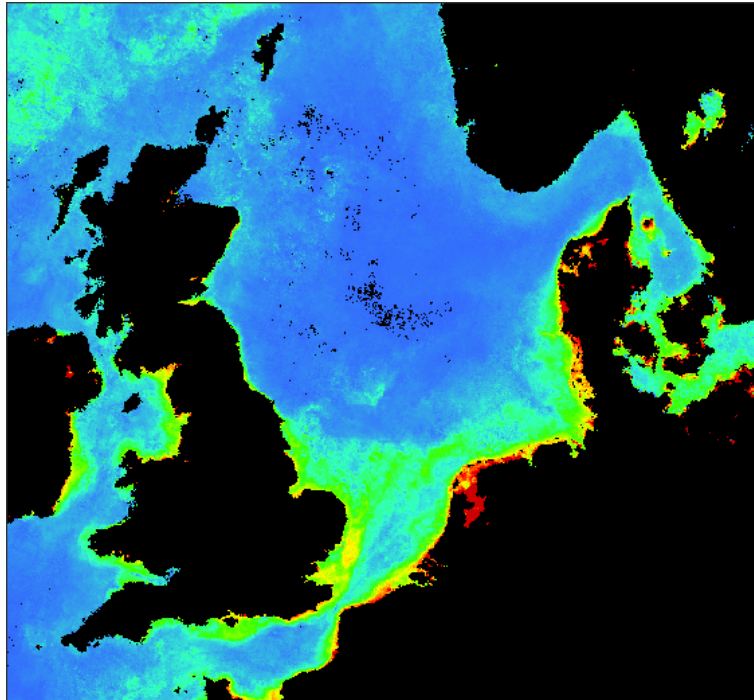


## Exploring the REVAMP Chlorophyll Atlas of the North Sea



In about 1½ hours we will guide you through the digital data comprising the REVAMP Chlorophyll Atlas of the North Sea using the BEAM Software. The Session includes:

- An introduction to the digital version of the Atlas: the data
- An introduction to the BEAM/VISAT Software
- Experiment 1: The Belgian waters in April – Visualization and Statistics
- Experiment 2: Evolution of a plankton bloom – Time series analysis
- Experiment 3: Extraction of CHL values for specific locations
- Experiment 4: Eutrophication indicator threshold – Band arithmetic

During each of the experiments you will explore interesting features in the data set and learn key functions of the software tool.

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## 1 Introduction to the digital version of the Atlas

The data has the following content:

L3-2003-03-UTM

L3-2003-04-UTM

L3-2003-05-UTM

L3-2003-06-UTM

L3-2003-07-UTM

L3-2003-08-UTM

L3-2003-09-UTM

L3-2003-10-UTM

REVAMPColorPalettePinsTransect

The CD includes 8 directories with the monthly average CHL concentrations. The directory RevampColorPalettePinsTransect includes auxiliary data for the experiments.

Each monthly directory includes 3 products: (1) a Maximum likelihood estimation of the median chlorophyll-a concentration (CHL), a Minimum/Maximum product and a relative error product. You only need the median data (1). All products are stored in BEAM-DIMAP format

All products have been projected in UTM projection to the same grid, so that calculations across the data are supported.

## 2 Introduction to the BEAM/VISAT Software

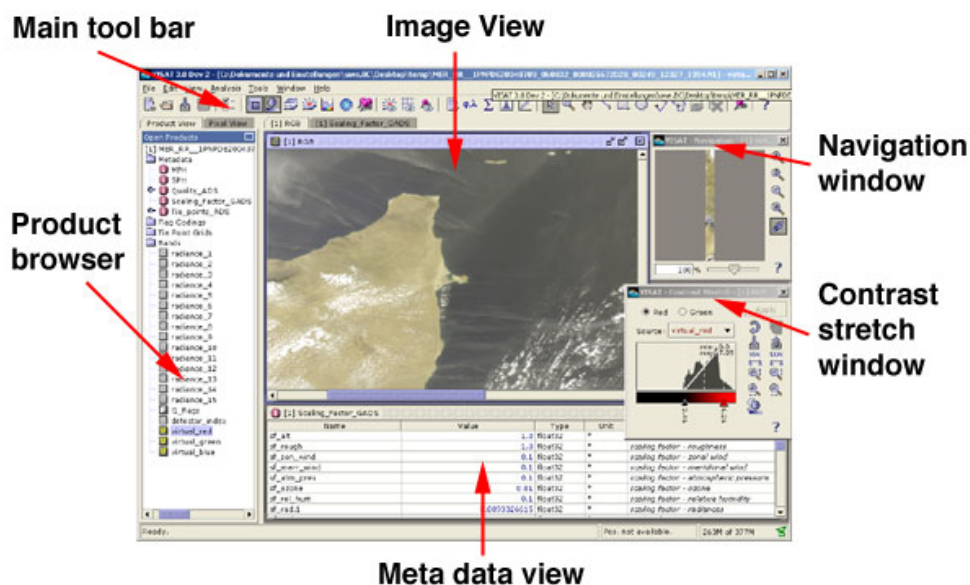
BEAM is the MERIS and AATSR Toolbox, provided free of charge by ESA. The latest BEAM can be downloaded from [www.brockmann-consult.de/BEAM](http://www.brockmann-consult.de/BEAM). BEAM includes several tools to support working with MERIS, (A)ATSR and ASAR data. VISAT is BEAM's visualization, analysing and processing application. It comes with a clear and intuitive user interface allowing new users to get started quickly.

VISAT let's you switch between a product browser providing overview over multiple open products within a tree view and a comprehensive pixel information view to display geophysical values, interpolated tie-points and quality flags at the same time.

VISAT's open- and save commands are used to open or save data products in the BEAM-DIMAP format, such as the REVAMP chlorophyll products. To open a raw ENVISAT product please use the corresponding import-command in the file menu. For a list of supported ENVISAT products please refer to the ENVISAT Product Tables included in the BEAM online help.


A new image view is simply created by double-clicking on a tie-point grid or spectral/geophysical band. You can open as much images as your computer's RAM allows. After you have opened an image view you can inspect the images with the Navigation Window.

After you have opened an image view you can modify the image display using the contrast stretch / color palette window. Both windows operate in non-modal mode, which means they float over VISAT's main frame and you can place them somewhere on your desktop.

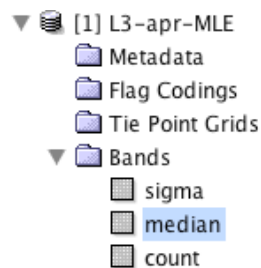


### 3 Experiment 1: The Belgian Waters in April – Visualization and Statistics



Let's open L3-2003-04-UTM, L3\_apr\_MLE\_UTMproj.dim in VISAT:

From the Menu, use **File->Open** or the **Folder icon**  from the Toolbar.

In the Product View you will find the bands sigma, median, and count. These indicate the standard deviation, median CHL value, and the number of pixels sampled to derive this pixel, respectively, for this binned product (composite) for April 2003.



Open the median band by double-clicking on its symbol. With the Pixel View tab on the right hand side you can look at the values. In April 2003, a Phaeocystis bloom occurred in Belgian waters.

Using a different color scale can shed a different light on things. Use the 'Show/hide contrast stretch and color palette window' button  to load a colorbar: use the arrow above file symbol  and choose e.g. a SeaWiFS Case-1 standard colorscale (CHL\_SeaWiFS.cpd), or a REVAMP look-alike (REVAMP\_ChIA-v2.cpd). You will find the REVAMP color palette file on the accompanying CD (in directory RevampColorPalettePinsTransect). If you use the slide bar below you can try to create your own color scale. **Tip:** the values from the slide bar can also be changed in the color scale file, which is plain text (e.g. C:\Program Files\beam3.1\auxdata\color\_palettes\CHL\_SeaWiFS.cpd) and can easily be viewed in Excel.

You can zoom in to the Dutch and Belgian Coasts and have a closer look at the Flemish Banks and Western Scheldt estuary mouth with the (top) Magnifier button (in the Main toolbar at the top) or with the Navigation Window's buttons for zooming in and out, as well as a continuously adjustable slider.


If you double-click on the band count in the Product View window, the images for the number pixels that were used in the averaging process are shown. With the Pixel View (click) tab you can now compare all values (CHL and count) for each pixel.


Next you could have a look at L3\_apr\_minmax\_UTMproj.dim, which gives the bands max and count on which it is based.

Please close all products at the end of this experiment: File menu → Close all

#### 4 Experiment 2: Evolution of a plankton bloom – time series analysis

You can open multiple files, visualise multiple bands and make comparisons by clicking on the tabs in the image view.

Open the MLE products of the monthly median March – October (if possible all 8 products). Display the median band of all products. Activate the March image and load the REVAMP Color Palette from CD (REVAMP\_ChIA-v2.cpd). Transfer this to all other images by clicking in the Contrast stretch dialog on the “Apply to other bands” symbol 

Click in the Windows menu → Tile evenly to show all images, and click in the VISAT navigator window on the chain symbol  in order to link the images. **Note:** linking only works for images that are geometrically compatible.

Suggestions for interesting time-series (March – October) analyses (select one or two regions of your interest):

1. Zoom in to the region of Skagerrak, Oslofjord, Kattegat. In which month do you find high concentrations of CHL?
2. If you zoom into the Danish west coast you see a sandbank and possibly separation of flows near Blåvands Huk (the hook north of Esbjerg).
3. Beautiful plumes and a hint of circulation patterns can be perceived in the German Bight. Look at the monthly images to derive at which season (Spring, Summer, or Autumn) the concentrations are relatively low off the coast?
4. High chlorophyll concentrations are found off the Dutch coast. Look at the activity along the Frisian Front, and the fluctuation of values over time in protruded English Channel waters.
5. Along the British east coast the following features appear. Plumes and blooms off the north-eastern Scottish coast and in the North Sea. Panning south you'll encounter high values near the estuaries, in the Wash and over the Norfolk Banks. Over time, patchy algal blooms occur in English Channel water. Locally high values occur in the Bay of Mt. St. Michel and at the Seine outflow.

#### **Answers:**

1. *In June a coccoliths bloom occurred*
3. *In Summer concentrations are relatively compared to the concentrations at Spring bloom and Autumn bloom.*

Please leave the products open at the end of this experiment, and continue directly with Experiment 3.

## 5 Experiment 3: Extraction of CHL values for specific locations

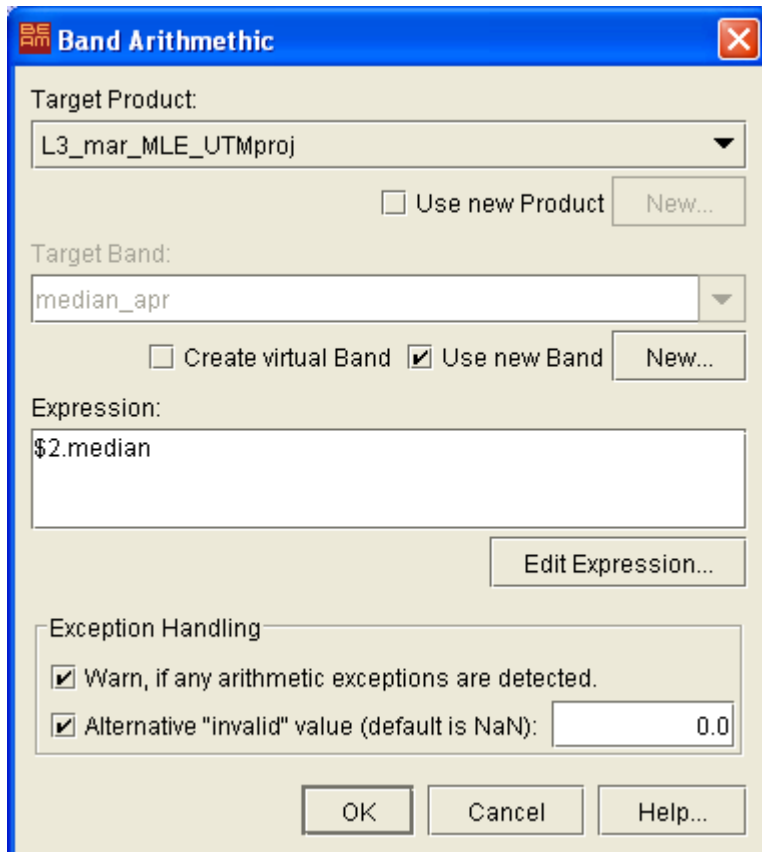
Please continue with the product already loaded (time series of monthly means).

### Preparation

Activate the march CHL median image.

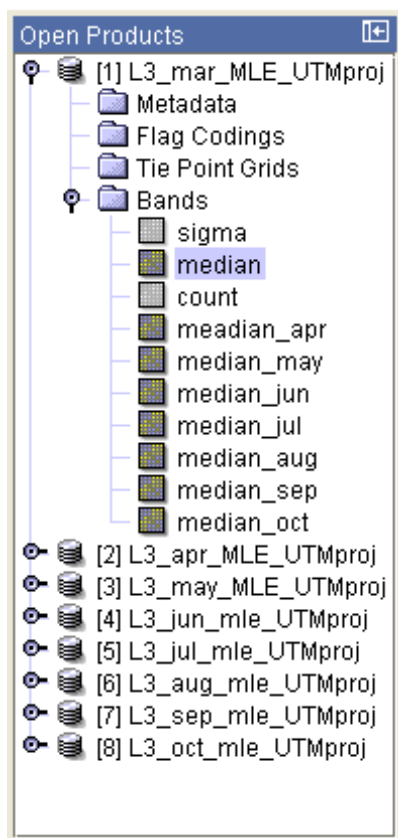
Open the band arithmetic dialog: Tools → Band Arithmetic

Copy the April median as a new band called “median\_apr” into the March product:








With the same procedure, copy also the May – October median bands into the March product. **Tip:** You can edit in the “Expression field the product number “\$2” into “\$3” and so on and don’t need to open the Expression editor with the “Edit Expression ...” button.

In the product browser, the March Product should look like this:




### At points

Activate the March median image. When you click the Main menu button with the 3 pink pin: , this will open the pin manager, which will allow you to load a pin-file, e.g. *DutchCoastPins.pnx*, which is on the CD. You can create your own pins with the single pink pin button, and you can subsequently export them with the pin manager. You can extract values at pin locations. Use the funnel symbol  to select the medians of months and export them with the table  symbol. The exported data can be opened for further evaluation in Excel. For example, for the generation of a time series plot for all stations. **Tips:** Push the arrow button  to get rid of the pin placer. Push the 'Show pin overlay', that is the pin + eye button  to get rid of the pin overlay.



### Along transects

To import an existing profile use File->Import->Import Transect Data. You'll find NorwegianTransectData.txt on the CD. **Tip:** In VISAT's preferences menu you may change the shape's overlay color (default is yellow).

Click the Main menu Histogram button , Profile Plot tab to see the profile. (Explore the other tabs under Histogram.).

Now convert your transect into a Region Of Interest (ROI) by clicking on the  symbol close to the end of the Main tool bar. You can export all pixels of the product

along this transect with the File menu → Export → Export ROI Pixels command. You can copy the data to clipboard and paste it in Excel.

You can also click the Line button  on the Main toolbar to draw your own transect (keep your right mouse button down for drawing) and click the Histogram button , Profile Plot tab to see the profile.

Please leave the products open at the end of this experiment, and continue directly with Experiment 4.



## 6 Experiment 4: Eutrophication indicator threshold – Band arithmetic

One of the criteria used to determine whether a particular sea region might have a eutrophication problem is whether maximum or mean chlorophyll-*a* concentrations exceed a threshold “elevated” level. As an example, for Belgian waters one component of the eutrophication determination procedure is identification of waters where the annual maximum chlorophyll-*a* concentration exceeds a threshold of 15 µg/l. Similar conditions are used by the other North Sea countries, though with different numerical values for the threshold, relating to different assumptions for “background” (i.e. natural) concentrations, and with variations on the spatio-temporal processing of data.

*Elevated assessment levels* (50% (25% for Denmark) above their related background concentrations) are in the range of:\*

- > 2 µg/l Denmark, Sweden
- > 4,5 µg/l Norway, Dutch and German offshore North Sea
- > 9 µg/l Mondego and Sado (Portugal)
- > 9-10 µg/l Western Scheldt, Ireland (median values for estuaries)
- > 10 µg/l UK offshore > 34 salinity
- > 12 µg/l Andalusian Atlantic coast
- > 14 µg/l Tagus estuary (Portugal)
- > 15 µg/l Belgium, Dutch- and German coast, UK coastal waters <34 salinity
- > 18-20 µg/l France, Ireland (90 percentile), Ems-Dollard estuary
- > 22-24 µg/l Wadden Sea.

\* Please use these data with caution: elevated levels of chlorophyll *a* is just one of the parameters related to eutrophication assessment.

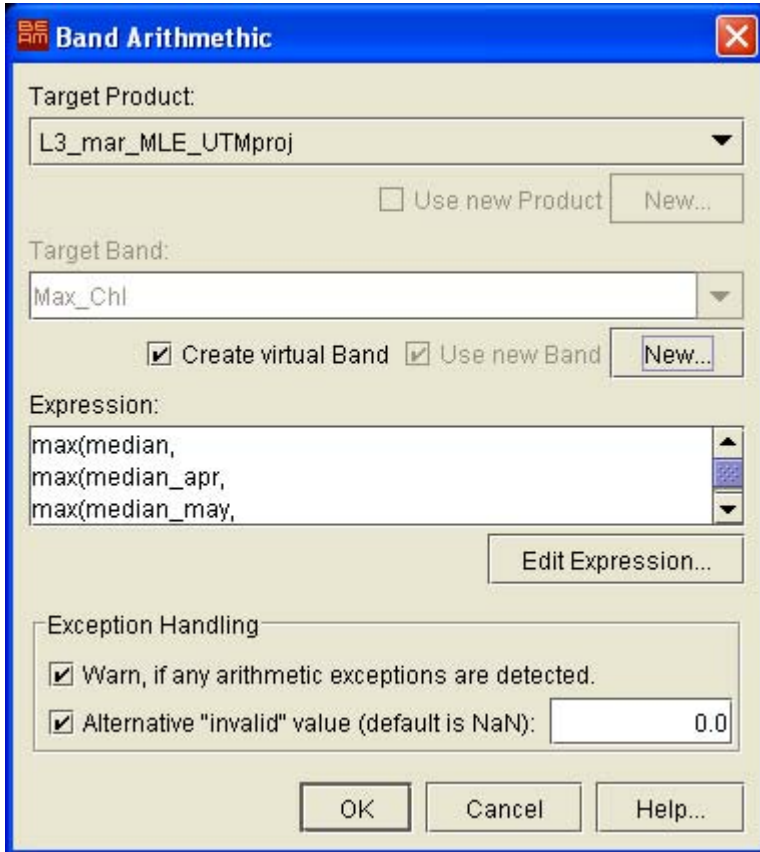
N.B. It is not specified if reference values are defined for means or maxima.

Source: OSPAR Commission, 2003. OSPAR integrated report 2003 on the eutrophication status of the OSPAR maritime area based upon the first application of the comprehensive procedure.

You can visualise the status with respect to these thresholds with the ‘contrast stretch and colorbar’, slide bar. But you can also make maps by using the main menu button Tools, Band arithmetic, use a new band Expression, edit expression, max > 15 µg/l.

## Solution

In the previously generated March product, which includes the median values of the other months, generate a new band with the maximum chlorophyll value. You can use a virtual band now:

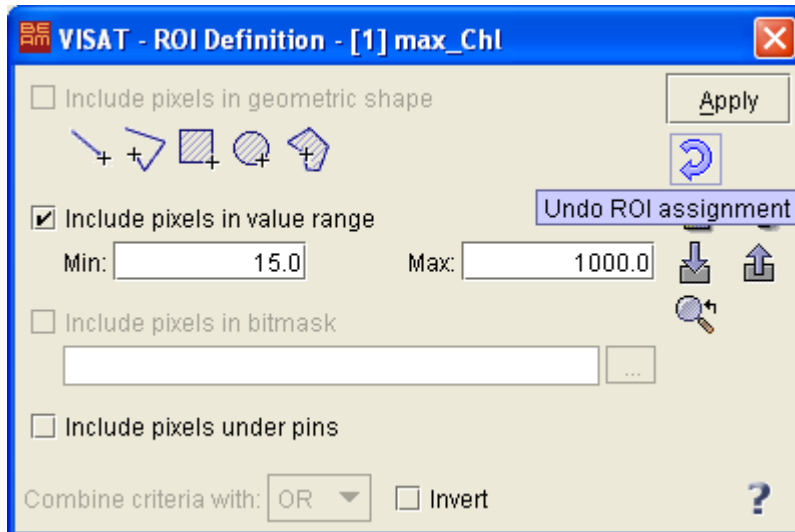


In the expression dialogue please enter the following expression (you can copy it from here and paste into the form. Adjust the band names to those you have defined in your product:

```
max(median,  
max(median_apr,  
max(median_may,  
max(median_jun,  
max(median_jul,  
max(median_aug,  
max(median_sep,median_oct)  
))))))
```

This specifies the max over all mentioned bands.

Now, use View, ROI Definition to open the Region Of Interest Dialogue and define a value range for the chlorophyll with a minimum of 15mg/m<sup>3</sup>. The image will show now all those pixels that exceed the threshold of 15mg/m<sup>3</sup>. (N.B You might need to zoom out to see pixels that don't meet this criterion, and fall within the "background concentration" class.)



Please close all products at the end of the experiment: Menu File → *Close all*