

# ESA & Third Party Toolboxes: BEAM

## Earth Observation Toolbox and Development Platform

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### BEAM in a nutshell

BEAM is a tool for the exploitation of optical data:

- VISAT visualisation and analysis Tool
- More than 30 data processors
- SMOSBox, Globtoolbox, ChrisBox
- NEST and SeaDAS 7 built on BEAM API

BEAM is an **open source** Java platform for the development of remote sensing applications:

- Java API, Graph Processing Framework
- User support: Plug-ins, issue tracker, wiki
- Supported by ESA, started 2002

The image shows two screenshots. The top one is a screenshot of the BEAM software interface, displaying a satellite image of a coastal area with a blue overlay, and a graph showing data points over time. The bottom screenshot is a screenshot of the BEAM GitHub repository page, showing the repository name 'BEAM Earth Observation Toolbox and Development Platform', a search bar, and a table of issues.

Thread	Status	Marked By	Posts	Views	Last Post
Adding a module which calls other toolbox functions using J2C	Waiting for an Answer	Harokopio	1	42	Date: 01/13/13 9:11 AM By: Harokopio
ASAR 6.02 format to EPSI API	Help Learning	John Loomis	3	178	Date: 01/13/13 8:13 PM By: John Loomis
Running Operator using gdf from inside java code	Waiting for an Answer	jean-marie	2	201	Date: 4/26/13 10:16 AM By: Jean-Marie

## History of BEAM

- Initial release in 2002
- Originally for display, analysis and processing of MERIS and AATSR products
- Current version: 4.11 (released 28.3.2013)

User driven evolution:

- Increasing number of basic functions  
(clustering, spectral unmixing, time series analysis, change detection)
- Increasing number of processors and plug-ins
- Increasing number of functions for terrestrial applications
- Growing support of products and formats  
(ALOS-AVNIR, CHRIS PROBA, Spot-VGT, VIIRS, Landsat-5; geoTIFF, NetCDF, HDF-EOS, shapefiles)
- Re-design of large image handling  
(image tiling, pyramids)

## Install and update

- Download and install BEAM from [envisat.esa.int/beam](http://envisat.esa.int/beam) or [brockmann-consult.de/beam](http://brockmann-consult.de/beam)
- and update specific modules and processors in VISAT  
: Help / Module Manager...

**BEAM 4.11 Downloads (28.03.2013)**

Platform	File Name	Size
Windows	Installer (64bit)	184 MB
Windows	Installer (32bit)	183 MB
Linux	Installer (64bit)	186 MB
Linux	Installer (32bit)	187 MB
Mac OS X	Installer	167 MB
Unix	Installer	166 MB
Documentation	BEAM API documentation	7 MB
Source Code	BEAM source code	5 MB

Name	Version	State	Action
MERIS PLUM/PLI Processor	1.0-2009	Active	
MERIS Data Converter	1.2.2	Active	
MERIS L3B Radiometry Processor	1.1.1	Active	
MERIS L2 auxiliary data	1.2.1	Active	
MERIS Level-3 Product Reader	1.2.1	Active	
MERIS NDVI Processor	1.3.1	Active	
MERIS SPAC Atmospheric Correction	1.5-2013	Active	
MERIS Surface Directional Reflectance (SDR) Processor	2.3.1	Active	
PROVIS (PROVISO/PROVISO) Product Reader	1.3	Active	
NASA Blue Marble Workbench	1.0-2	Active	
NASA OBP Ocean Color Product Reader	1.3	Active	
NetCDF Product Reader and Writer	1.1.1	Active	
Product Conversion Tool	1.4.1	Active	
Visualisation	1.3	Active	
VISAT Rich Client Platform	4.10.3	Active	



## BEAM tools structure

### VISAT:

- Interactive data analysis and visualisation tool
- Scripting console

### GPT (Graph Processing Tool):

- Batch-mode executables for all data processors

### Java-API:

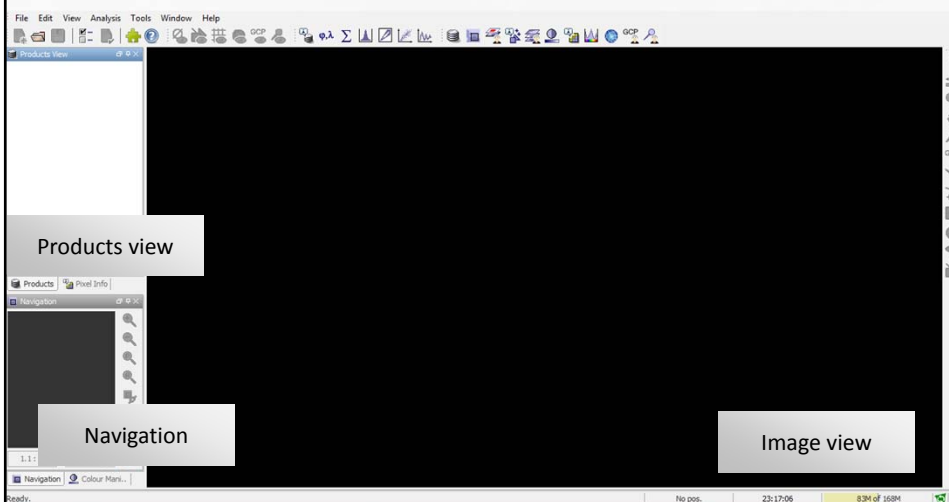
- Full access to all BEAM classes
- Use and expand BEAM through GitHub



### Python, C-API:

- Full translations of Java-API available from autumn 2013
- C-library available for access to N1 format

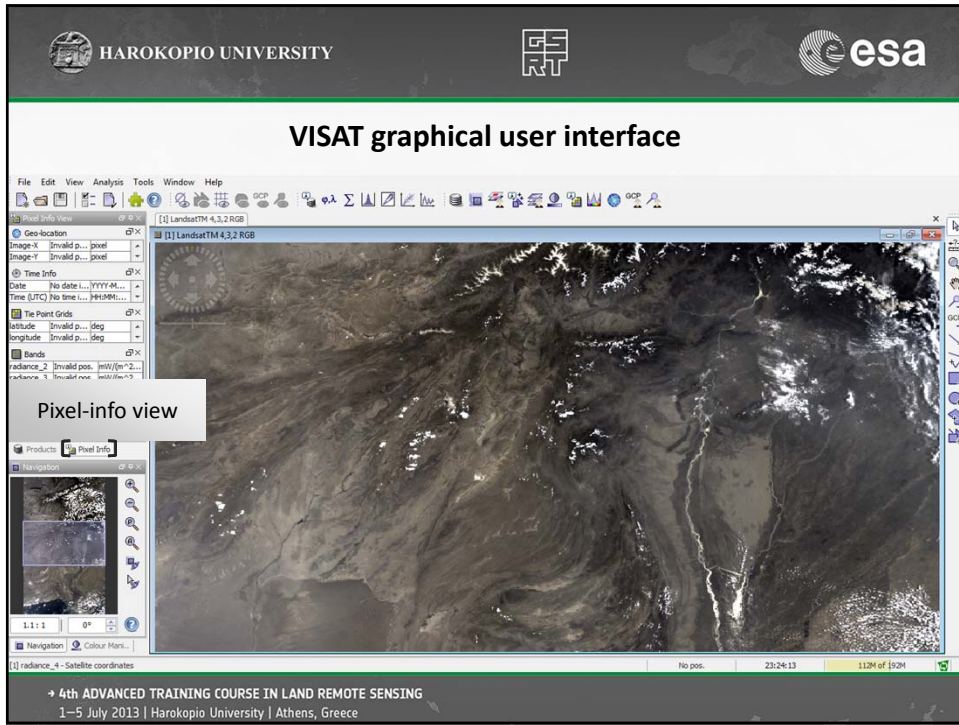


## VISAT graphical user interface





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## VISAT graphical user interface

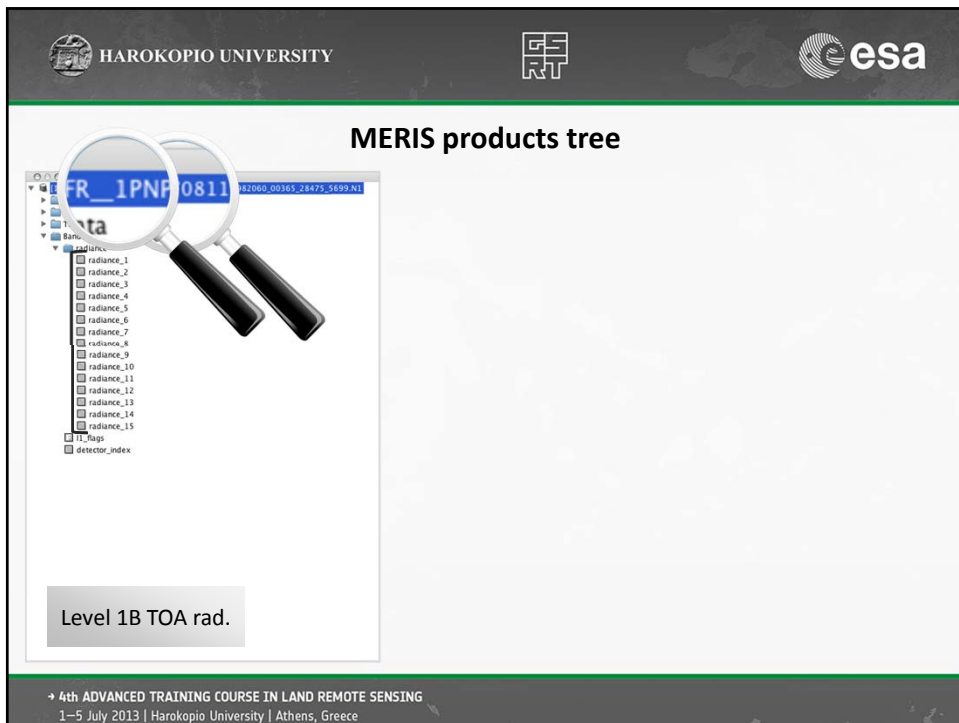


Pixel-info view

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## MERIS products tree



Level 1B TOA rad.

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### MERIS products tree

The screenshot shows a 'Products View' window with a tree structure. On the left, under 'Bands', there is a list of 'radiance' products from 1 to 15, 'l1\_flags', and 'detector\_index'. A magnifying glass is positioned over the 'radiance' folder, showing a sub-tree with 'point', 'latitude', 'longitude', and 'dem\_alt'. Below the left pane is a grey box labeled 'Level 1B TOA rad.'. On the right, another 'Products View' window shows a similar tree structure, but with a magnifying glass over the 'radiance' folder showing a sub-tree with 'sun\_zenith', 'sun\_azimuth', 'view\_zenith', 'view\_azimuth', 'zonal\_wind', 'merid\_wind', 'atm\_press', 'ozone', and 'rel\_hum'. Below the right pane is a grey box labeled 'Aux data'.

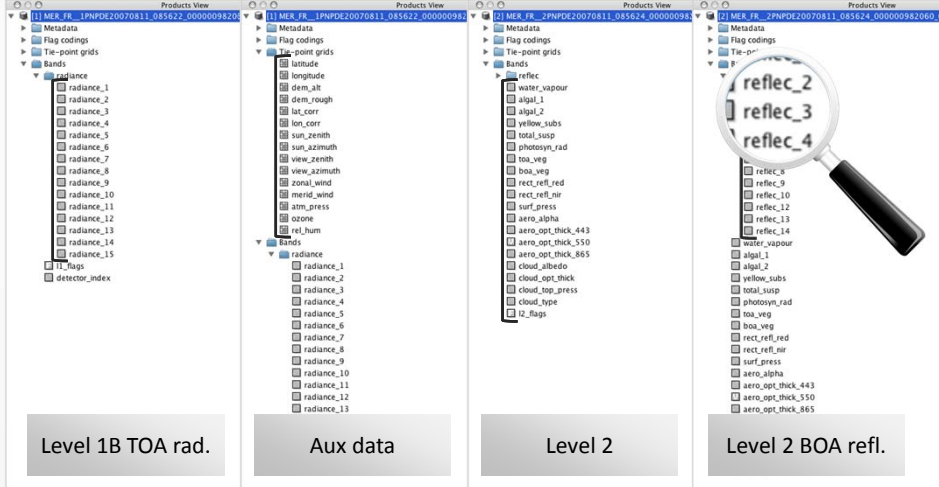


### MERIS product

The screenshot shows three 'Products View' windows. The left window is identical to the first slide, showing 'Level 1B TOA rad.'. The middle window shows a tree structure with a magnifying glass over the 'radiance' folder, displaying a sub-tree with 'latitude', 'longitude', 'dem\_alt', 'dem\_rough', 'lat\_corr', 'lon\_corr', 'sun\_zenith', 'sun\_azimuth', 'view\_zenith', 'view\_azimuth', 'zonal\_wind', 'merid\_wind', 'atm\_press', 'ozone', and 'rel\_hum'. Below the middle pane is a grey box labeled 'Aux data'. The right window shows a tree structure with a magnifying glass over the 'radiance' folder, displaying a sub-tree with 'aero\_alpha', 'aero\_opt\_thick\_443', 'aero\_opt\_thick\_350', 'aero\_opt\_thick\_865', 'cloud\_albedo', 'cloud\_opt\_thick', 'cloud\_opt\_press', 'cloud\_type', and 'l2\_flags'. Below the right pane is a grey box labeled 'Level 2'.

## MERIS products tree






Level 1B TOA rad.

Aux data

Level 2

Level 2 BOA refl.

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## Getting started in VISAT

**Open product:**


- File / Open Product...  
e.g. MER\_FR\_2PNPDE20070811\_085624\_000000982060\_00365\_28475\_5701.N1

**Open view:**

-  on product name / Open RGB image view...  
Opens VISAT - Select RGB-Image Channels Dialogue
-  on band name  
Opens greyscale view of band

**Customize view:**

- View / Tool Bars /  Views Tool Bar  
When accidentally closed

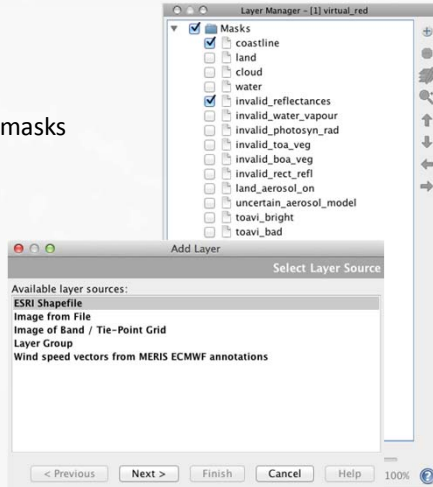


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### Layer Manager



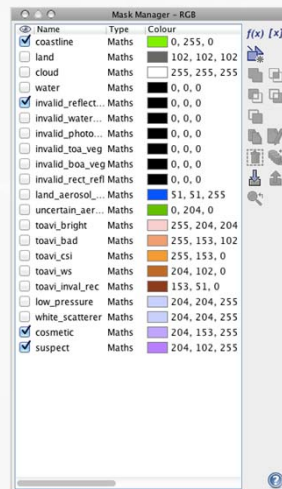
- Lists displayed image, vector data and masks
- Checkboxes set visibility
- Set layer stacking order
- Add new layer to product



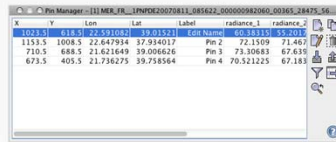
### Mask Manager



- Lists all binary mask arrays
- Masks are math expressions defined for available data layers  
(e.g. `invalid_toa_veg=12_flags.LAND AND 12_flags.PCD_15`)
- Set visibility, colour and transparency
- Display properties apply *only to the active view*



### Pin Manager

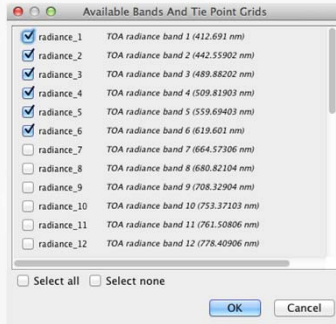


- Add, edit and delete pins in xml-tables

- place pins (or enter exact Lon/Lat)

- open available bands list

- Checking bands adds value columns to Pin Manager list



### Colour Manipulation



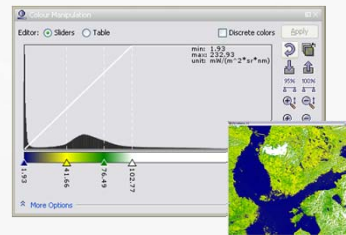
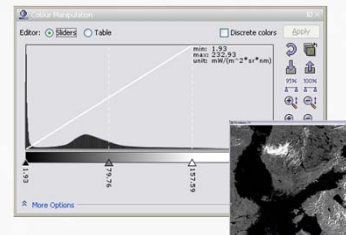
- Different options for greyscale and RGB views

- between sliders / Add new slider (only for greyscale images)

- on slider or value to choose any colour and exact values

- Apply button to apply the colour palette to the image view

- Export colour palette  
File / Other Exports / Colour Palette as File  
File / Other Exports / Colour Legend as Image





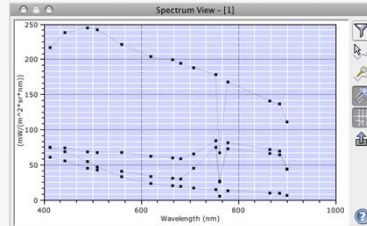
### Spectrum view



- Display spectrum at cursor position or for one or several selected pins

- Select bands

- Export spectra to csv



### Tools menu

#### Preprocessing and geometry:

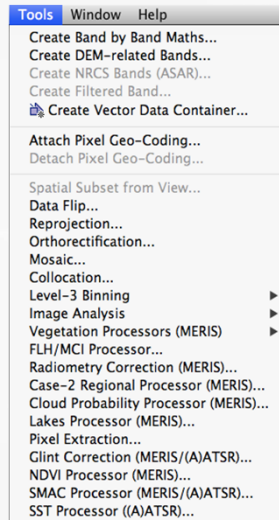
- Radiometry Correction (MERIS)...
- Orthorectification..., Mosaic...

#### Processing algorithms (>30 in total):

- Vegetation Processors (MERIS) / ...
- SMAC Processor (MERIS/(A)ATSR) ...

#### Image analysis:

- Image Analysis / ...



## BEAM Help: TOA-VEG Algorithm

**Algorithm Specification**

The proposed algorithm called here TOC-VEG is based on the training of neural network over a data base simulated using radiative transfer models (RTM, Figure 1). The SAIL and PROSPECT models are coupled and used to simulate the reflectance in the 11 MERIS bands considered (490 nm, 510 nm, 560 nm, 620 nm, 665 nm, 681.25 nm, 708.75 nm, 753.75 nm, 778.75 nm, 865 nm, 885 nm). The oxygen and water absorption bands have not been used because they would convey significant uncertainties associated while providing only marginal information on the surface. The two MERIS first bands are also eliminated since they correspond to strong Rayleigh and aerosol scattering and to low canopy reflectances, this induces that top of canopy reflectance in this region are very sensitive to errors in the atmospheric correction. The background optical properties are simulated using a collection of soil, water and snow typical reflectance spectra. A brightness factor is used to provide additional flexibility of the background reflectance. Finally, to account for the medium resolution of MERIS observations, mixed pixels are simulated with variable fractions of pure background and pure vegetation.

The simulation of the top of atmosphere reflectance in the 11 MERIS bands requires 14 input variables. They were drawn randomly according to an experimental plan aiming at getting a more evenly populated space of canopy realization. To provide more robust performances of the network, the distributions of each input variable was close to the actual distributions and, when possible, realistic co-distributions were also used. This was achieved by considering a representative distribution of targets over the earth surface that constrains the observation geometry, as well as possible vegetation amount. A total number of 46 533 cases were simulated. Half of this data set was used for training, one quarter to evaluate hyper-specialization, and the last quarter to quantify the theoretical performances.

Back-propagation neural network was trained for estimating the four variables considered. The architecture was optimized, resulting in 2 hidden layers of tangent-sigmoid neurones corresponding to a total around 300 coefficients to adjust, and providing a good ratio (50-100) with the size of the training data base.

**Figure 1: Overview of the TOC-VEG algorithm**

The theoretical performances were evaluated over the test simulated data set. They are close to 0.05 (absolute value) for TAPAR and fCover, and close to 25% (relative value) for LAI and LAI<sub>veg</sub>, that shows some loss of sensitivity for the larger values of LAI and LAI<sub>veg</sub> due to saturation effects.

## Sentinel 2 and 3 exploitation tools

### Sentinel 2:

- L1B & L1C reader (fully supporting all BEAM functions)
- L1B in satellite coordinates
- L1C UTM projected tiles
- Atmospheric correction processor (surface reflectances and aerosol properties)



### Sentinel 3:

- L1b & L2 (land [ESA], water [EUMETSAT]) OLCI reader
- L1b & L2 SLSTR reader
- Synergy products reader (L1c synergy product, L2 advanced surface reflectance product)
- SPOT VEGETATION continuation products reader

