Using BEAM with SMOS data

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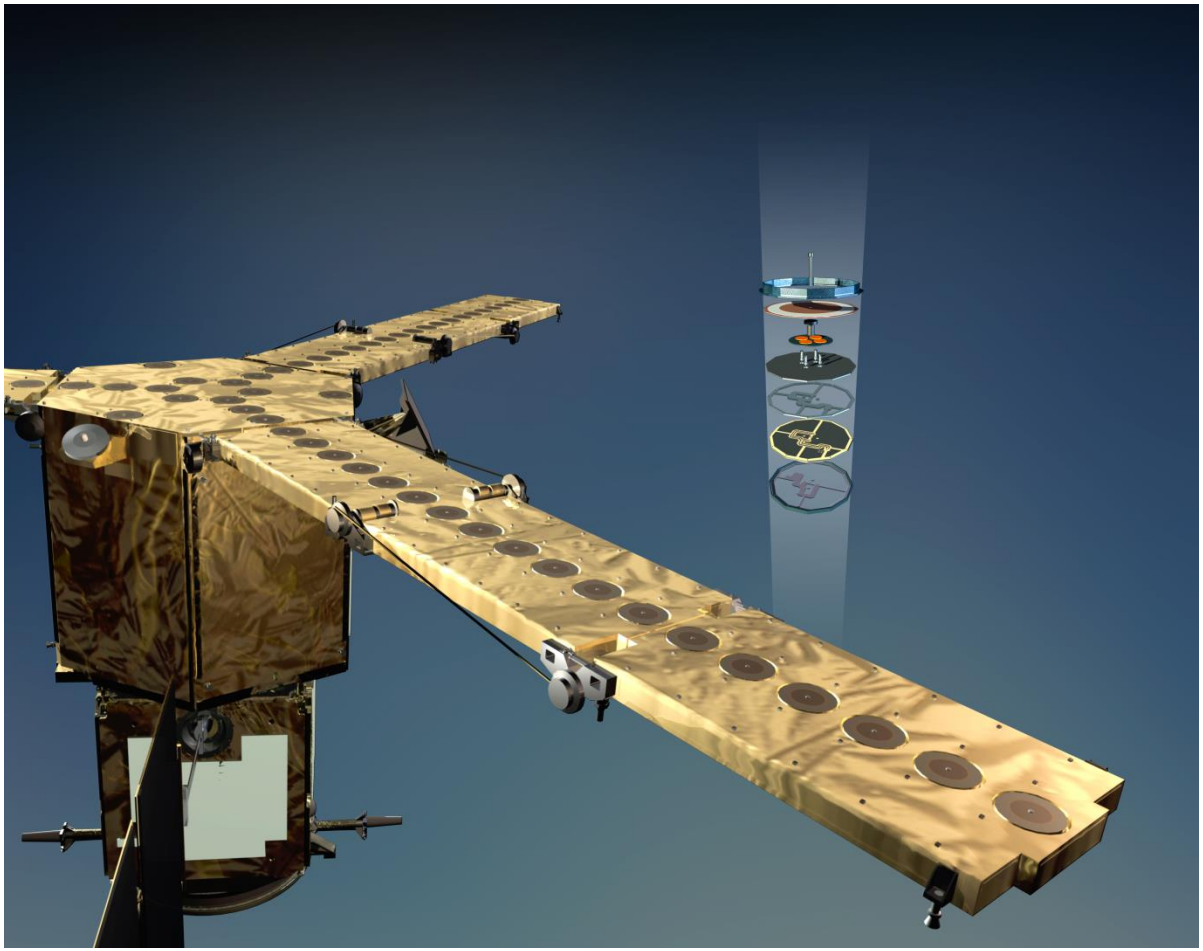
Overview

- SMOS mission
- Scientific objetives of ocean salinity
- SMOS products supported by BEAM
- Auxiliary data
- SMOS box

Exercises

1. Open SMOS L2 ocean salinity product in BEAM: understanding contents
2. Display Level 1c: SMOS box tools

SMOS mission



- Microwave Imaging Radiometer with Aperture Synthesis (MIRAS) instrument.
- 69 small antennas distributed in three arms.
- Measure radiation emitted from the Earth at L-band (1.4 GHz).
- Interferometry cross-correlation of the signals.

Scientific objectives of Ocean Salinity

- Improve seasonal to inter-annual ENSO climate predictions
- Improve the estimates of the ocean rainfall and thus the global hydrological budget
- Monitor large-scale salinity events
- Improve monitoring of SSS variability

The sensitivity of the brightness temperature to ocean salinity is a maximum at low microwave frequencies, and the best conditions for salinity retrieval are found at L-band (1.4 GHz).

Accuracy of salinity measurements is improved using various incidence angles and times (averaging procedure).

SMOS Products supported by BEAM

- Level 1C product
  - Brightness temperature
  - Incident angles
- Level 2 ocean salinity product
- Level 2 soil moisture product
- Auxiliary products

Supported Data Products

Version 2.3 of the BEAM SMOS-Box is capable of reading SMOS data products complying with Schemas Release 2012-05-15_v05-02-01. The product types supported are listed in the table below.

Type	Level	Description
SMOS Products		
MIR_BWLD1C	1C	Browse Land Dual-Polarisation Product. In the BEAM data model all measurements in the BT_Data_Type record are represented as bands
MIR_BWLF1C	1C	Browse Land Full-Polarisation Product. In the BEAM data model all measurements in the BT_Data_Type record are represented as bands
MIR_BWSD1C	1C	Browse Sea Dual-Polarisation Product. In the BEAM data model all measurements in the BT_Data_Type record are represented as bands
MIR_BWSF1C	1C	Browse Sea Full-Polarisation Product. In the BEAM data model all measurements in the BT_Data_Type record are represented as bands
MIR_SCLD1C	1C	Science Land Dual-Polarisation Product. In the BEAM data model all measurements in the BT_Data_Type record are represented as bands. The user can specify whether the band data should be provided by a simulated browse product, which is computed on-the-fly, or by an individual snapshot. The former is the default. Brightness temperature measurements, pixel radiometric accuracies and Stokes parameters are represented in the Satellite's as well as in the Earth's reference frame
MIR_SCLF1C	1C	Land Full-Polarisation Product. In the BEAM data model all measurements in the BT_Data_Type record are represented as bands. The user can specify whether the band data should be provided by a simulated browse product, which is computed on-the-fly, or by an individual snapshot. The former is the default. Brightness temperature measurements, pixel radiometric accuracies and Stokes parameters are represented in the Satellite's as well as in the Earth's reference frame
MIR_SCSD1C	1C	Level-1c Science Sea Dual-Polarisation Product. In the BEAM data model all measurements in the BT_Data_Type record are represented as bands. The user can specify whether the band data should be provided by a simulated browse product, which is computed on-the-fly, or by an individual snapshot. The former is the default. Brightness temperature measurements, pixel radiometric accuracies and Stokes parameters are represented in the Satellite's as well as in the Earth's reference frame
MIR_SCSF1C	1C	Level-1c Science Sea Full-Polarisation Product. In the BEAM data model all measurements in the BT_Data_Type record are represented as bands. The user can specify whether the band data should be provided by a simulated browse product, which is computed on-the-fly, or by an individual snapshot. The former is the default. Brightness temperature measurements, pixel radiometric accuracies and Stokes parameters are represented in the Satellite's as well as in the Earth's reference frame
MIR_OSUDP2	2	Ocean Salinity User Data Product. In the BEAM data model all measurements in the Grid_Point_Data_Type record are represented as bands
MIR_SMUDP2	2	Soil Moisture User Data Product. In the BEAM data model all measurements in the Grid_Point_Data_Type record are represented as bands
Auxiliary Products		
AUX_DFFLAI		Leaf area index (LAI) auxiliary product. In the BEAM data model all measurements in the DFFG_LAI_Point_Data_Type record are represented as bands
AUX_ECMWF_		ECMWF auxiliary product. In the BEAM data model selected measurements in the ECMWF_PARAMS_Data_Type record are represented as bands
AUX_LSMASK		Land/sea mask auxiliary product. All flags in the land/sea mask are represented as masks in BEAM
AUX_VTEC_C		Consolidated Vertical Total Electron Content auxiliary product. In the BEAM data model all measurements in the VTEC_Data_Type record are represented as bands
AUX_VTEC_P		Predicted Vertical Total Electron Content auxiliary product. In the BEAM data model all measurements in the VTEC_Data_Type record are represented as bands

Auxiliary data

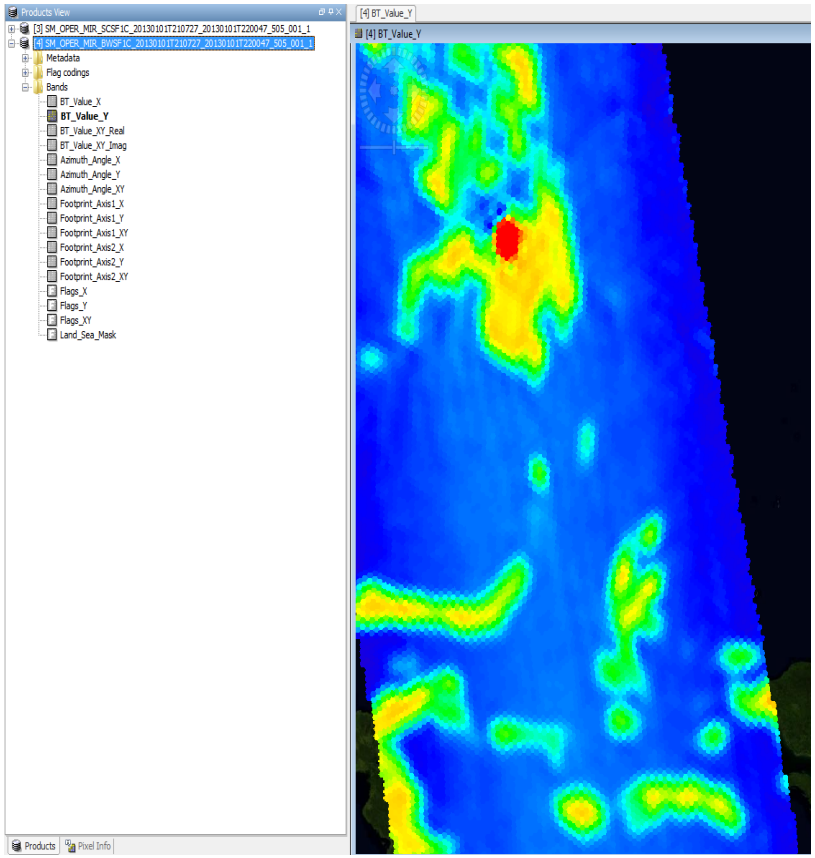
- Level 1 auxiliary data: this type of data comprises the Discrete Global Grid (DGG), the land-sea mask, flat target transformation measurements, known RFI (Radio Frequency Interference) sources, etc. http://www.smos.com.pt/project_data_adf.html

- Level 2 ocean salinity auxiliary data: These datasets are used for generating ocean salinity products. Examples include ocean target transformation lookup tables, roughness information, long-term salinity climatologies, etc. http://www.argans.co.uk/smos/pages/faqs.php#Q2

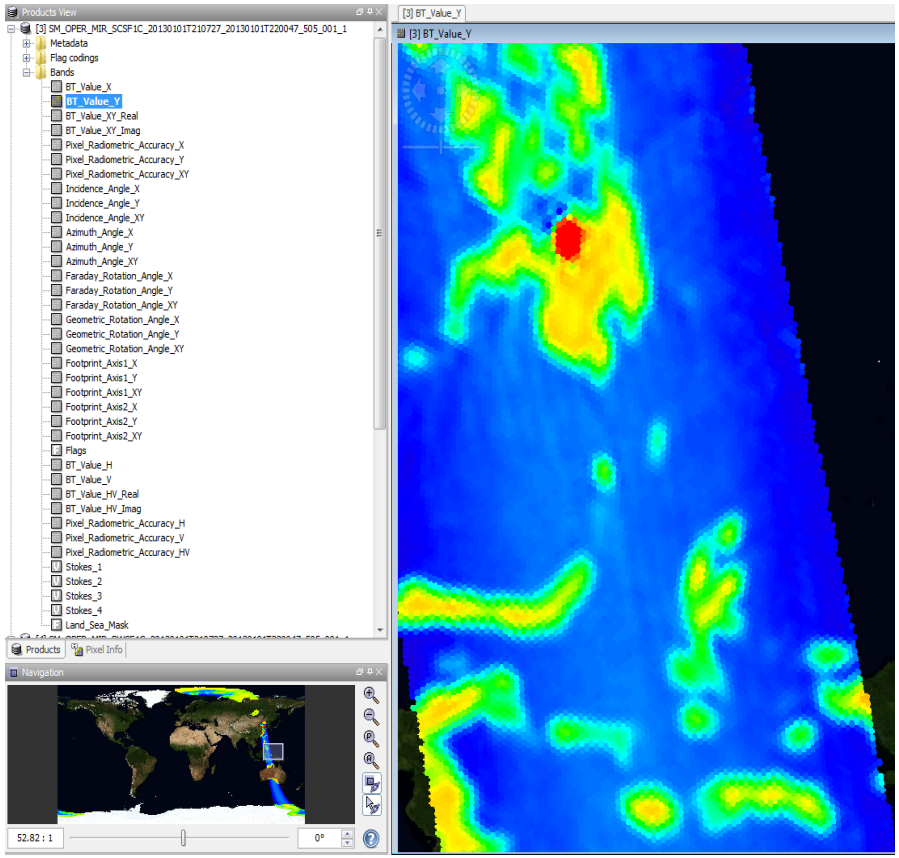
- Level 2 soil moisture auxiliary data: These static or dynamically updated auxiliary files contain information needed for generating soil moisture products, such as ECOCLIMAP surface cover information, ECMWF forecast geophysical fields, vegetation optical thickness, etc. http://smos.array.ca/web/smos/adfs

BW versus SC full polarization L1C

Browse Product



Science Product



SMOS Box Key Features

- Reading the SMOS L1c and L2 products
- Rastering the hexagonal structure of SMOS footprints
- All BEAM (VISAT, API, …) features available:
  - PINs, band arithmetic, masks/ROIs
  - Seamless working with SMOS, MERIS, AATSR, MODIS, etc.
- Specific SMOS Box features
  - L1c Table
  - L1c flag matrix
  - L1c snapshots
  - L1c charts

How to obtain SMOS data

- Data is available to registered users only. Registered users can obtain SMOS data in two different ways:
  - 1. By subscribing to the systematic distribution of products
  - 2. By searching the SMOS data product catalogue EOLI and submitting an order for selected archived products (limited to 20 products per order).

- https://earth.esa.int/web/guest/-/how-to-obtain-data-7329

- ESA's mandate for the provision of data products ends at level 2. For level 3 and 4 data products see the national French and Spanish processing entities: Centre Aval de Traitement des Données SMOS (CATDS) and SMOS CP34.

End of Unit

BEAM Overview

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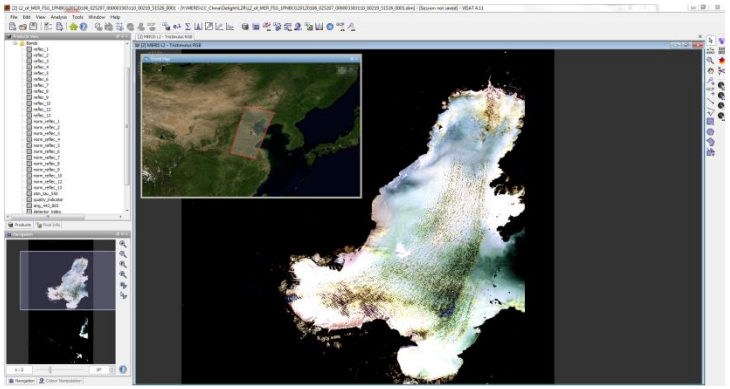
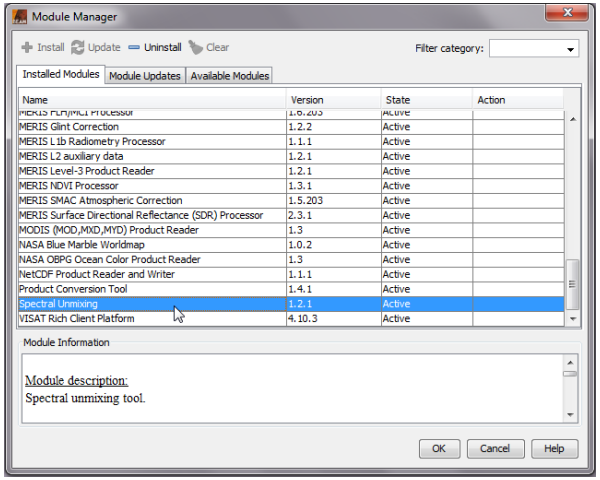
BEAM in a nutshell

- BEAM is a tool for the exploitation of EO data
  - VISAT Visualisation and Analysis Tool
  - > 30 Data Processors
  - SMOSBox, Globtoolbox, ChrisBox
  - NEST 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, Community Wiki
  - Supported by ESA, started 2002

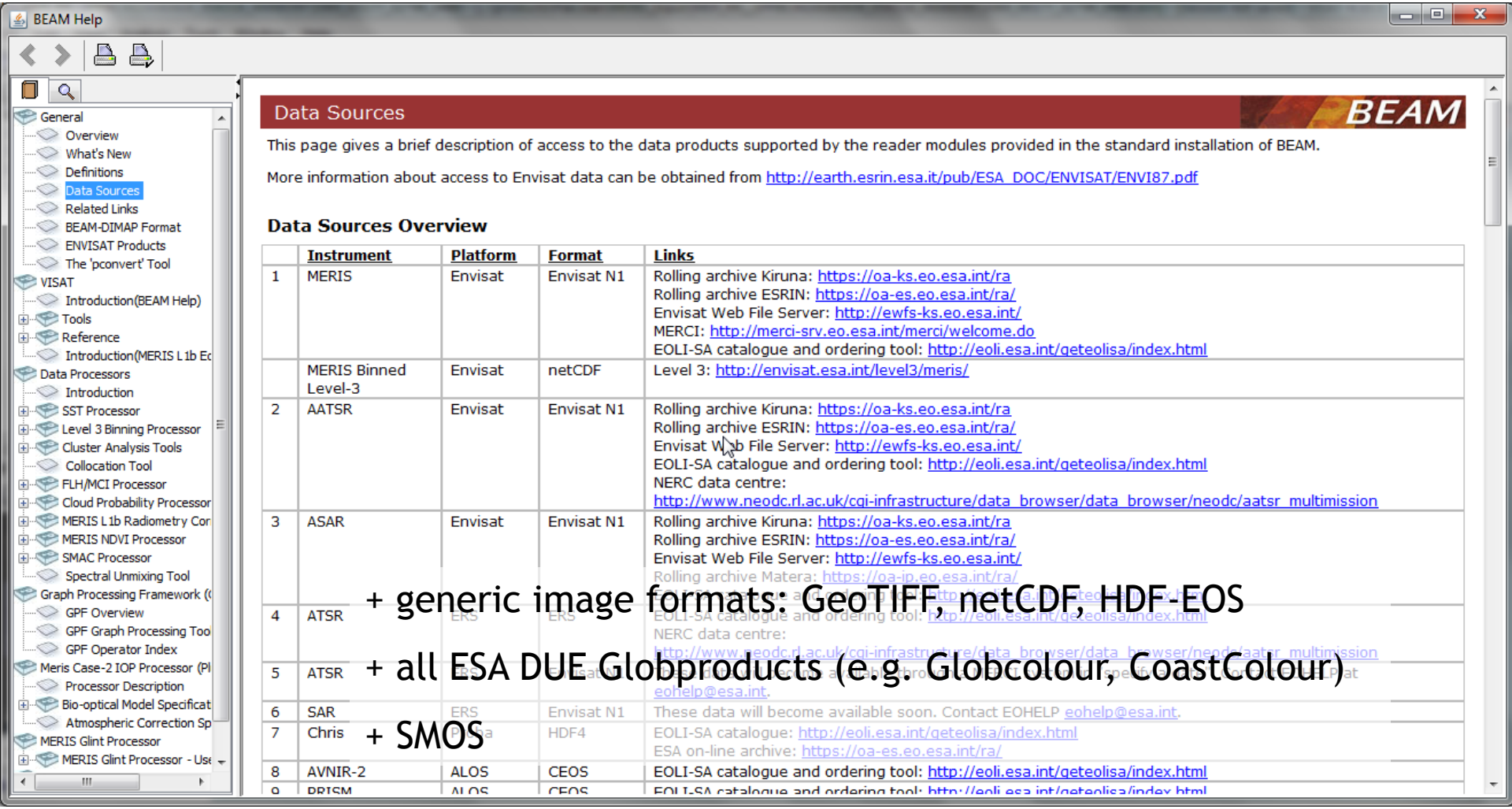


- Free available from envisat.esa.int/beam or www.brockmann-consult.de/beam

History of BEAM

- Started 2002
- Originally designed for displaying, analysing and processing MERIS and AATSR products
  - special focus on validation applications
- No replacement of standard remote sensing software
  - e.g. ENVI or Erdas Imagine
- User driven evolution
  - Experimental processors
    - Some processors operationally in use
    - Incl. land products processors
  - Growing set of functions for image analysis
    - clustering, spectral unmixing, time series analysis, change detection
  - Growing support of products and formats
    - e.g. high resolution sensors like ALOS-AVNIR, CHRIS PROBA, VIIRS, Landsat-5
    - geoTIFF
  - Re-design of image handling for supporting large images
    - Image tiling, pyramids
- Current version: 4.11 (March 2013)

Supported data products and formats



+ generic image formats: GeoTIFF, netCDF, HDF-EOS

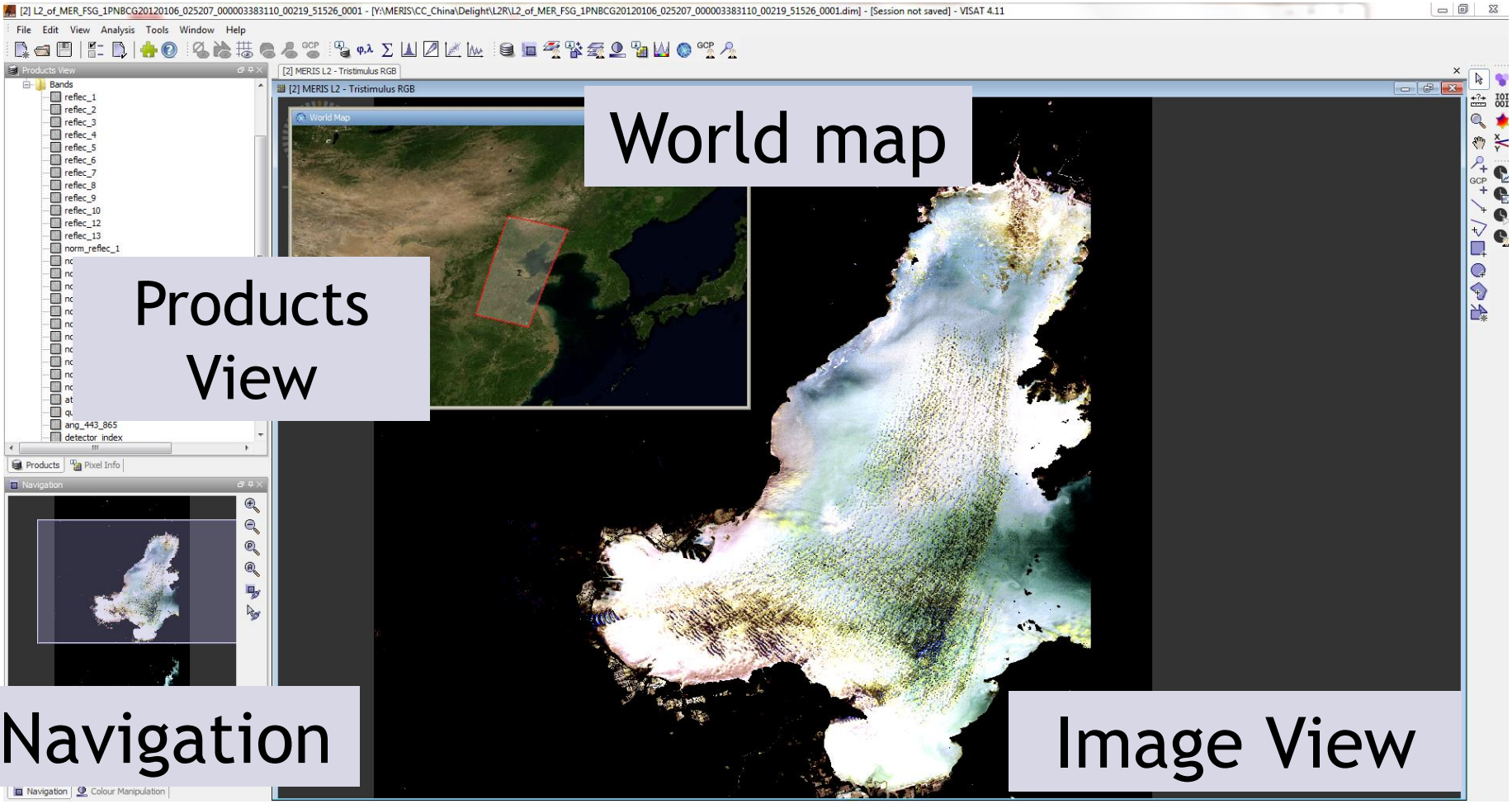
+ all ESA DUE Globproducts (e.g. Globcolour, CoastColour)

+ SMOS

Toolbox

- VISAT
  - Interactive data visualisation and analysis tool
  - Scripting console (Python, Java Script)
- GPT
  - Batch-mode processing of all scientific data processors
- C-API
  - C-library for easy access to N1 format
- Java-API
  - Full access to all BEAM classes
  - Graph Processing Framework (GPF)
  - → use BEAM
  - → expand BEAM

VISAT overview



Installation & update

http://www.brockmann-consult.de/csm/web/beam/releases

Downloads

- Stable Release
- Snapshots
- BEAM 4.11.x Plug-Ins
- BEAM 4.10.x Plug-Ins
- BEAM 4.9.x Plug-Ins
- BEAM 4.8.x Plug-Ins
- BEAM 4.7.x Plug-Ins and below
- Archive
- Sample Data

The BEAM software is open-source and licensed under the GPL Version 3.

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Stable Releases

This page comprises the latest stable version of BEAM and applications built on top of BEAM. Previous versions are listed in the archives section, while information about extending BEAM are provided in the plugin section. To get access to the latest development of BEAM you can download the latest development snapshot.

Users which have created a plugin and want to make it available here are encouraged to contact the BEAM development team.

BEAM 4.11 Downloads (28.03.2013)

	Installer (64Bit) for Windows	Download (.exe)	184 MB
	Installer (32Bit) for Windows	Download (.exe)	183 MB
	Installer (64Bit) for Linux	Download (.sh)	186 MB
	Installer (32Bit) for Linux	Download (.sh)	187 MB
	Installer for Mac OS X	Download (.dmg)	167 MB
UNIX	Installer for Unix (requires a 1.6 JRE)	Download (.sh)	166 MB
	BEAM API documentation	Download (.zip)	7 MB
	BEAM source code (for usage within an IDE only; for instructions how to build BEAM from source, click here)	Download (.zip)	5 MB

SMOS-Box 2.3 Add-on for BEAM 4.11.x (03.06.2013)

	Installer for Windows (32 bit)	Download (.exe)	46 MB
	Installer for Windows (64 bit)	Download (.exe)	46 MB
	Installer for Mac OS X	Download (.dmg)	46 MB
UNIX	Installer for Unix (including Linux)	Download (.sh)	46 MB

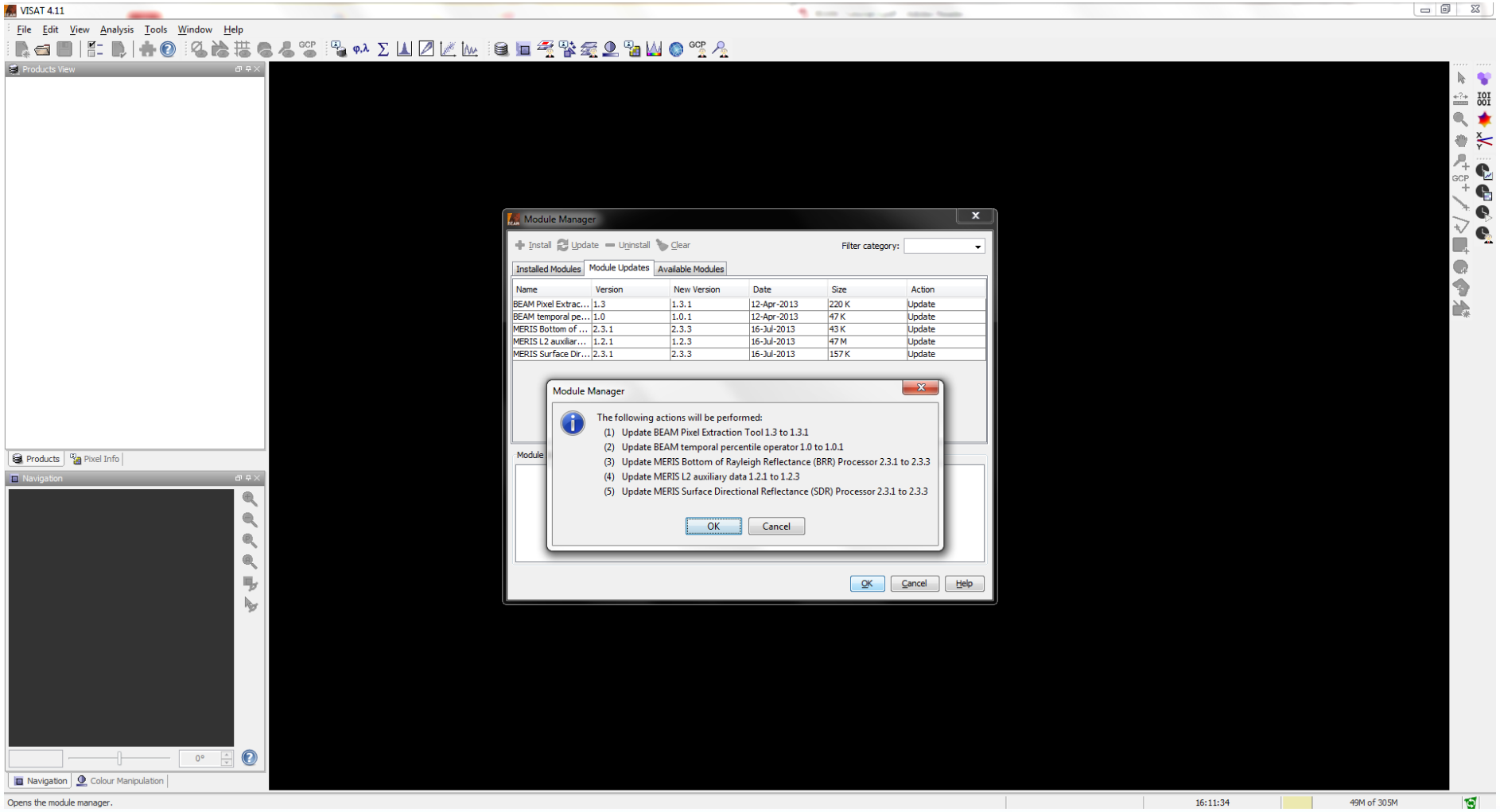
Sample Data: Some example data products can be downloaded from the SMOS Sample Data page.

Installation & update

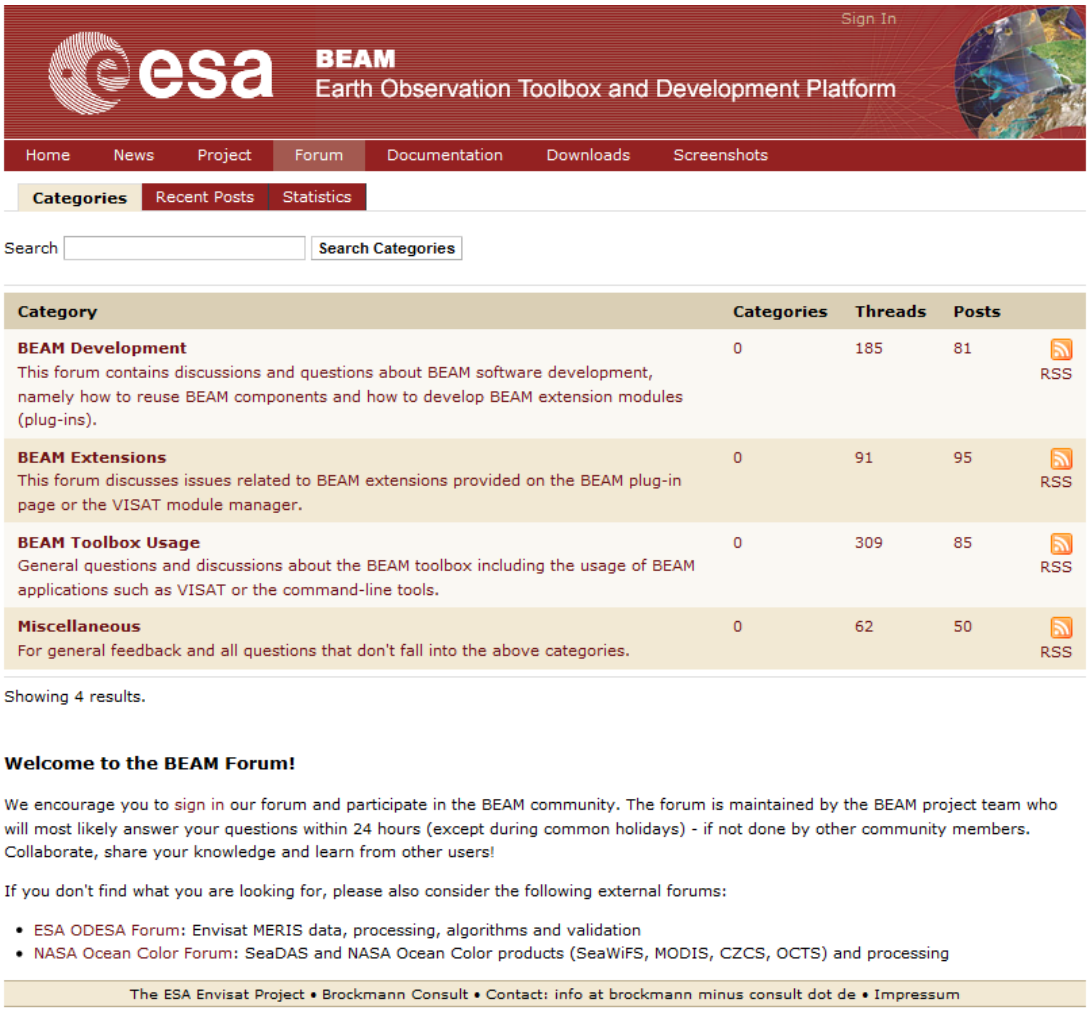
- Download of BEAM Installation file
  - http://www.brockmann-consult.de/cms/web/beam/software
- Directories
  - Directories installed during installation
    - <Beamhome>
    - <Beamhome>\modules
    - <Userhome>\.beam
  - Preferences
    - <Userhome
- Module Manager
  - BEAM is build in modules which can be added and updated individually
  - Installation of new processors
  - VISAT `Help` → `Module Manager`

Module Manager

Update your BEAM version with new, additional and bug fixed modules



BEAM community



Sign In

BEAM
Earth Observation Toolbox and Development Platform

Home | News | Project | Forum | Documentation | Downloads | Screenshots

Categories | Recent Posts | Statistics

Search [ ] Search Categories

Category	Categories	Threads	Posts	
BEAM Development This forum contains discussions and questions about BEAM software development, namely how to reuse BEAM components and how to develop BEAM extension modules (plug-ins).	0	185	81	RSS
BEAM Extensions This forum discusses issues related to BEAM extensions provided on the BEAM plug-in page or the VISAT module manager.	0	91	95	RSS
BEAM Toolbox Usage General questions and discussions about the BEAM toolbox including the usage of BEAM applications such as VISAT or the command-line tools.	0	309	85	RSS
Miscellaneous For general feedback and all questions that don't fall into the above categories.	0	62	50	RSS

Showing 4 results.

Welcome to the BEAM Forum!

We encourage you to sign in our forum and participate in the BEAM community. The forum is maintained by the BEAM project team who will most likely answer your questions within 24 hours (except during common holidays) - if not done by other community members. Collaborate, share your knowledge and learn from other users!

If you don't find what you are looking for, please also consider the following external forums:

- ESA ODESA Forum: Envisat MERIS data, processing, algorithms and validation
- NASA Ocean Color Forum: SeaDAS and NASA Ocean Color products (SeaWiFS, MODIS, CZCS, OCTS) and processing

The ESA Envisat Project • Brockmann Consult • Contact: info at brockmann minus consult dot de • Impressum

Take-home message

- BEAM is an open source toolbox for visualisation, analysis and processing of EO data

- The main tools of the toolbox are VISAT, data processors, batch-mode processing and the BEAM community

End of Unit

VISAT Basics

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BEAM-VISAT basic functions

- Contents
  - Basic Imaging
  - Basic Analyses

- VISAT basics 1
  - Exercise 1: Display functions and product flags
  - Exercise 2: Colour manipulation
  - Exercise 3: Pixel information view
  - Exercise 4: Spectrum view

Exercise 1: Open and display bands

- What to do:
  - Open products
    - Open MERIS Level 1 Product
    - Open MERIS Level 2 Product
  - Open single bands and band combinations
    - Display Greyscale image of bands 8 and 13 of the MERIS Level 1 product
    - Display Level 1 RGB image false colour
    - Display TSM band of MERIS Level 2 product
  - Linking the display windows and navigate in the different windows
    - Panning and zooming
- Products:
  - L1_of_MER_FSG_1PNBCG20100328_024122_000003152088_00075_42213_0001.dim
  - L2_of_MER_FSG_1PNBCG20100328_024122_000003152088_00075_42213_0001.dim

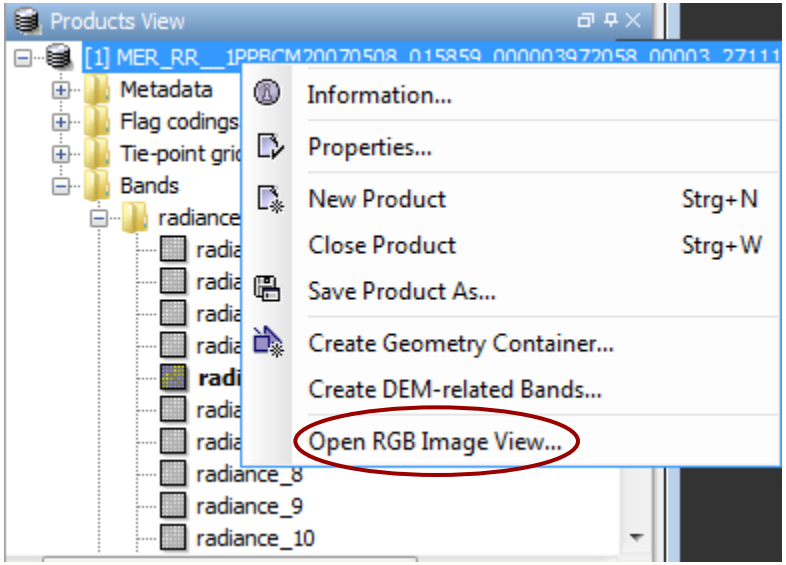
RGB image fundamentals

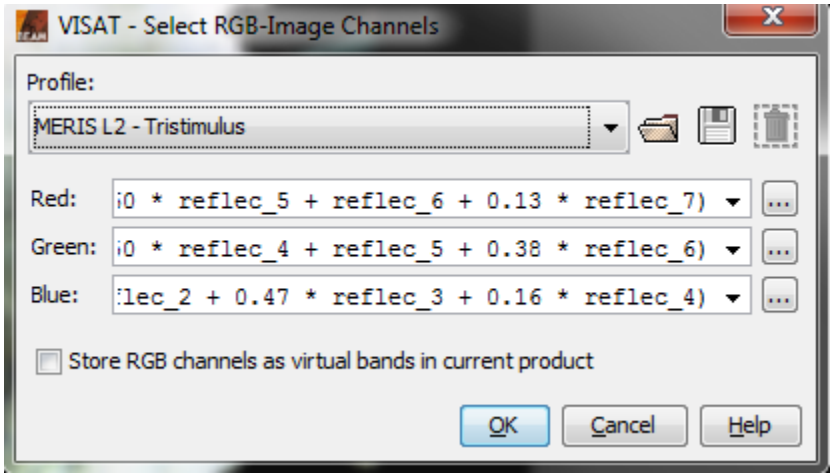
- Combination of three bands

- Right mouse click on product name

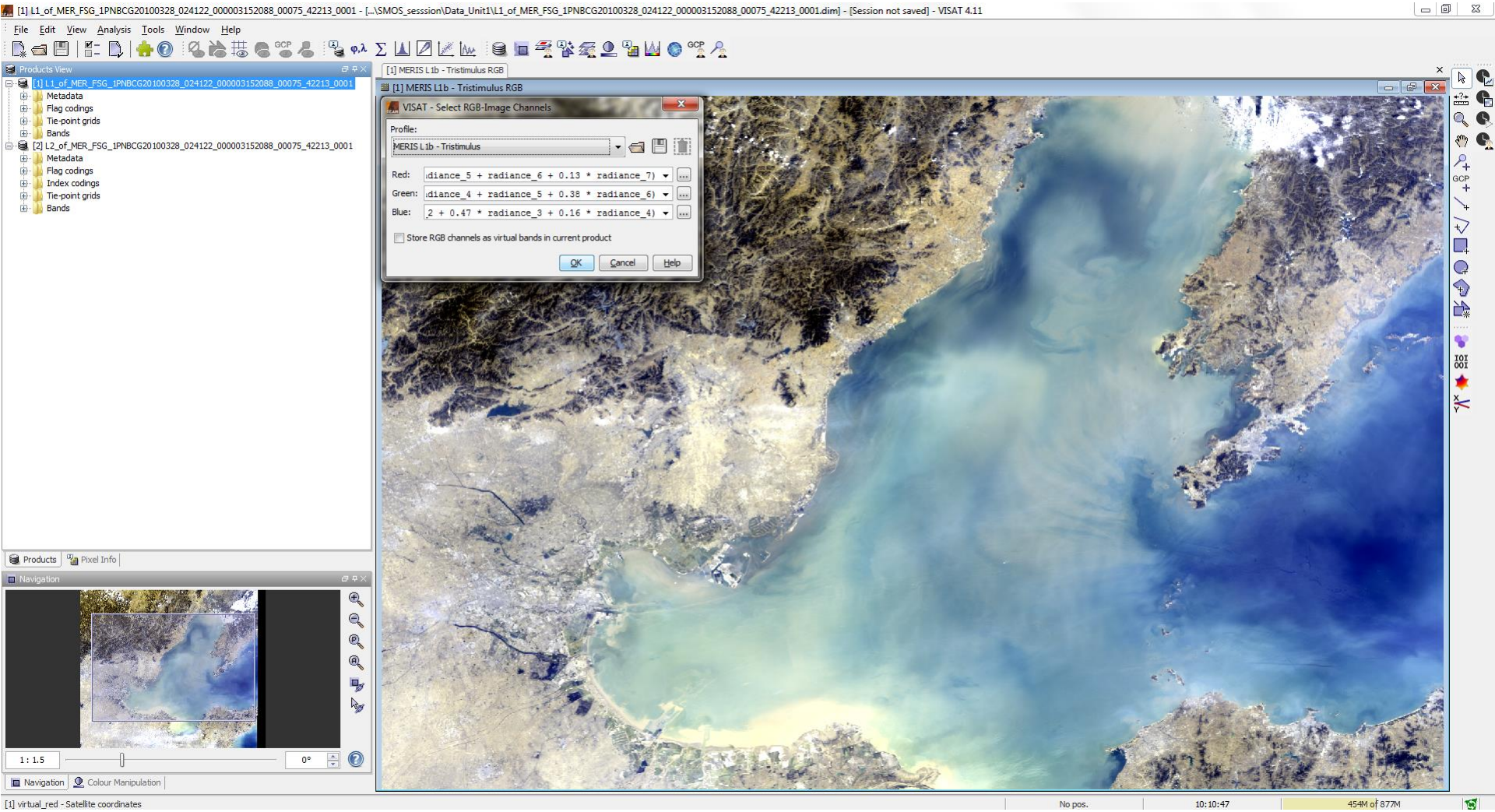
  → open RGB Image View

- Choose band combination (several pre-defined combinations are available)



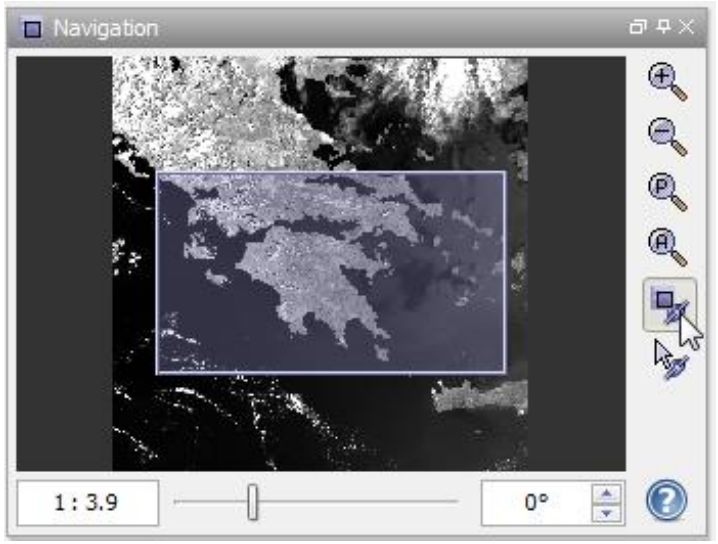


L1 RGB image fundamentals



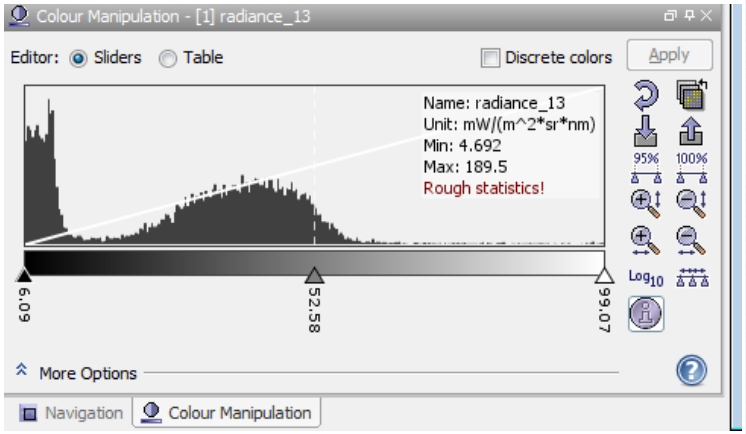
Exercise 1: solution

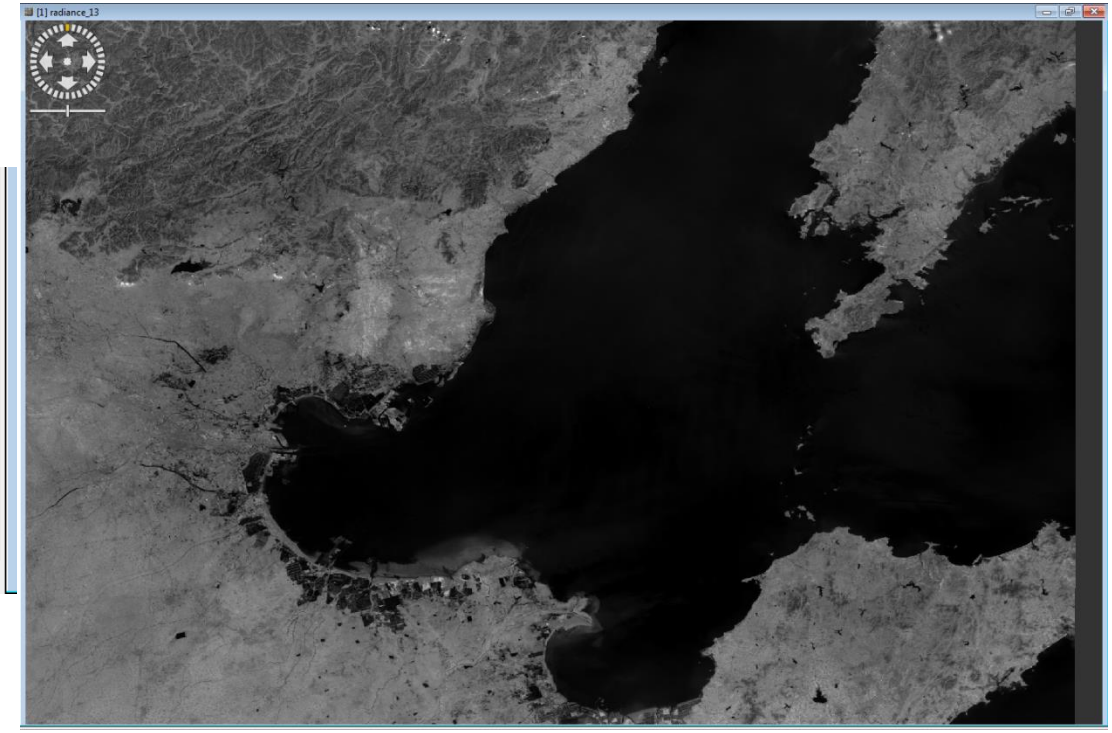
- Open a product
  - File → Open Product
- Open single bands
  - Double click on the respective band
- Open RGB image
  - Right mouse click on products ' name → Open RGB Image; or View → Open RGB Image
- Navigation
  - Open navigation window
  - Mouse scroll; slider;
  - Tile windows: Window → Tile Evenly
  - Link windows



Exercise 2: Colour manipulation

- What to do:
  - Adjust colours in greyscale images
  - Assign colours to conc_tsm (~~iop_b_tsm_443~~) greyscale band

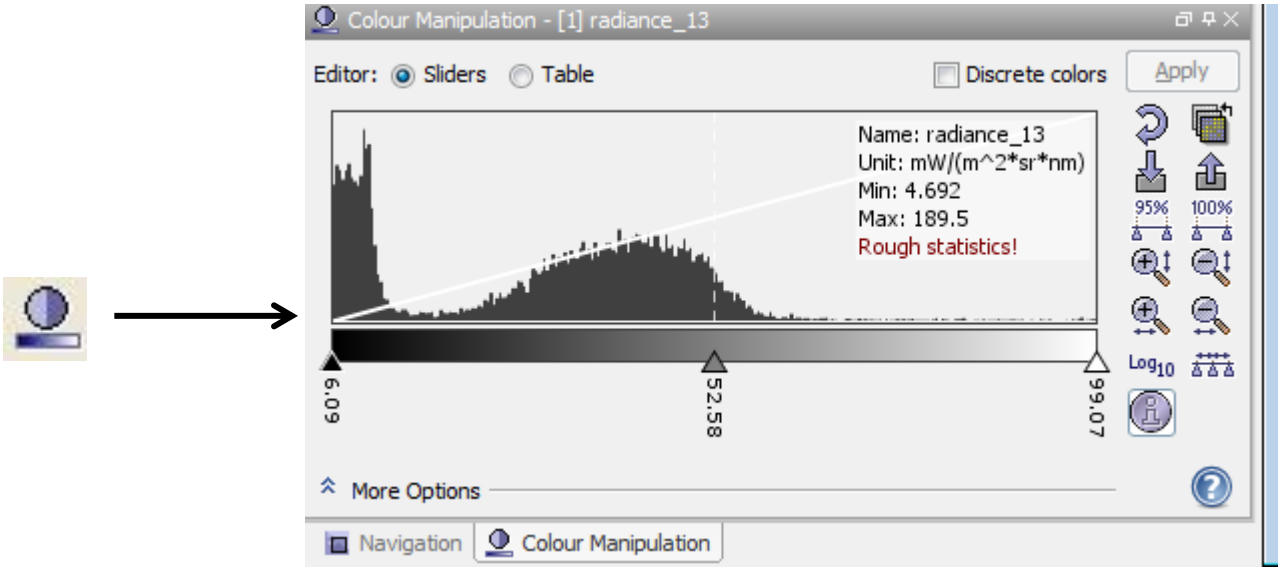


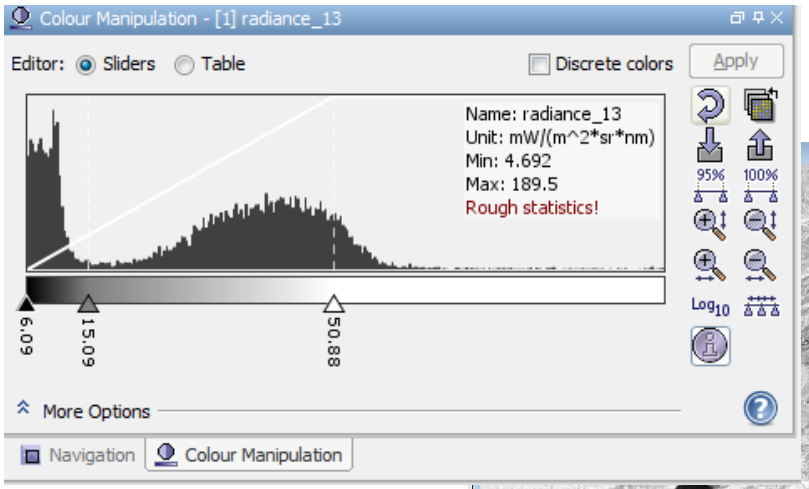


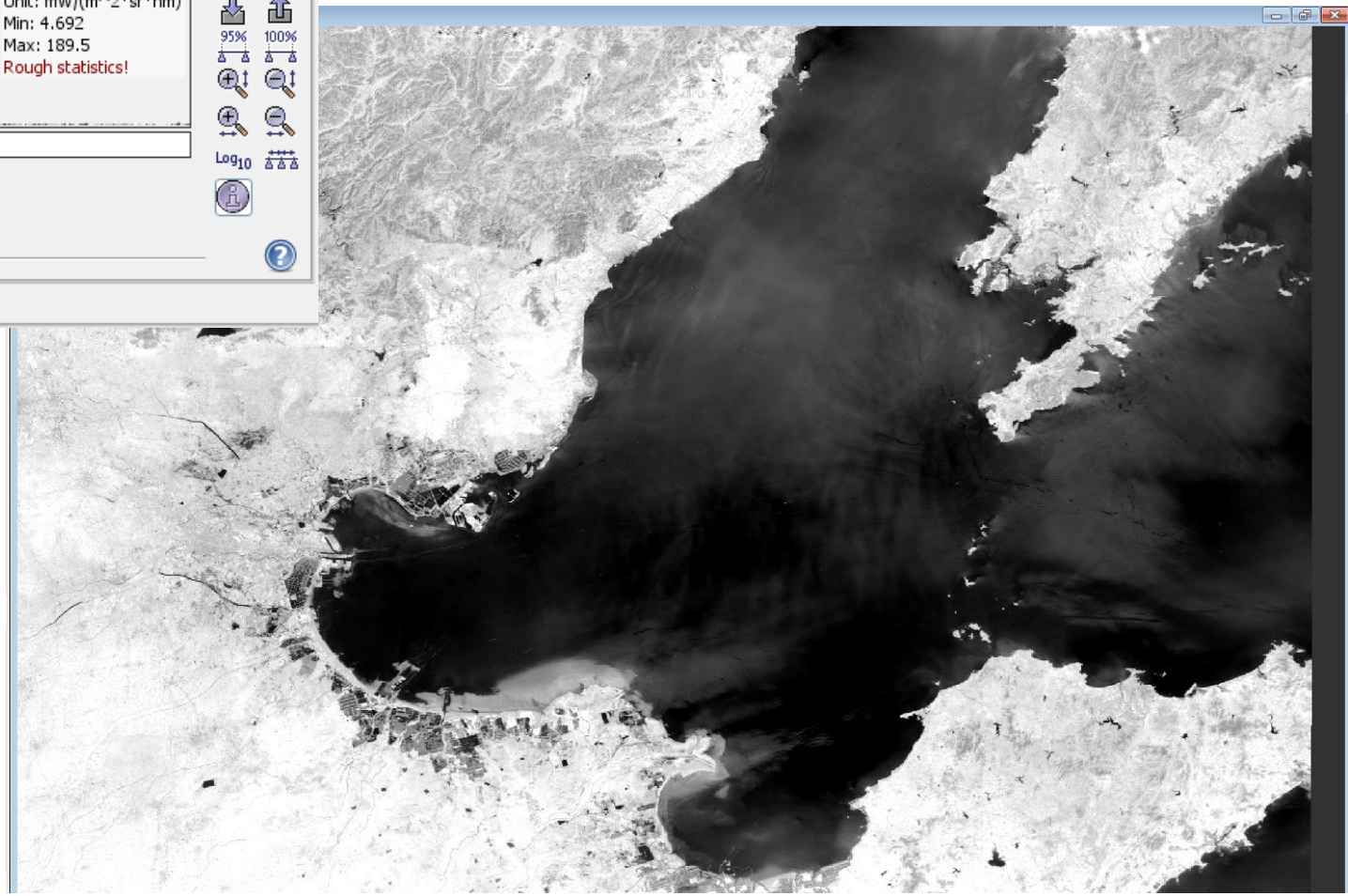
Adjust colours

- Colour-coding to greyscale images
- Optimization of colours (adjust contrast stretch)

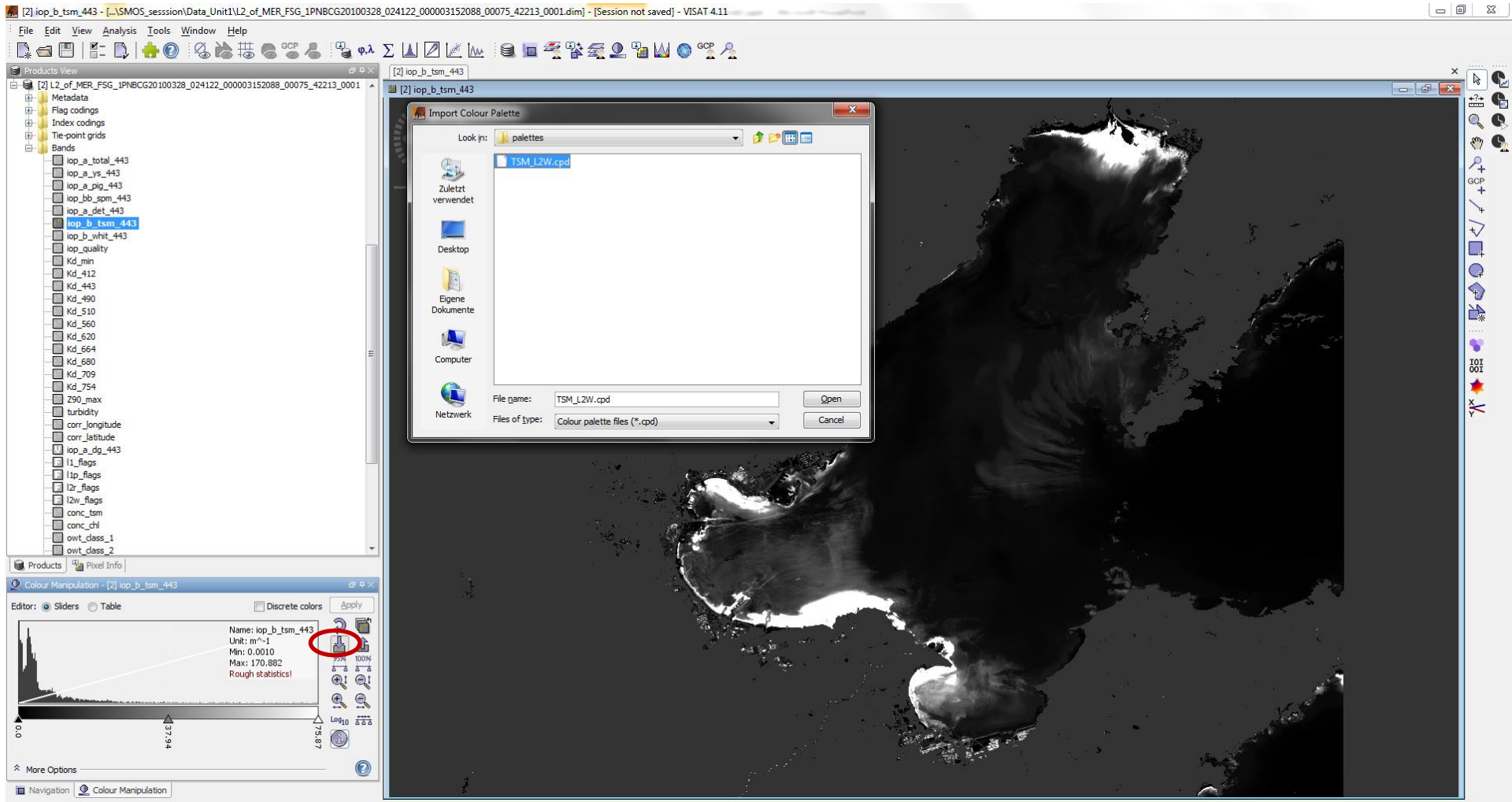
  → Colour Manipulation Dialog

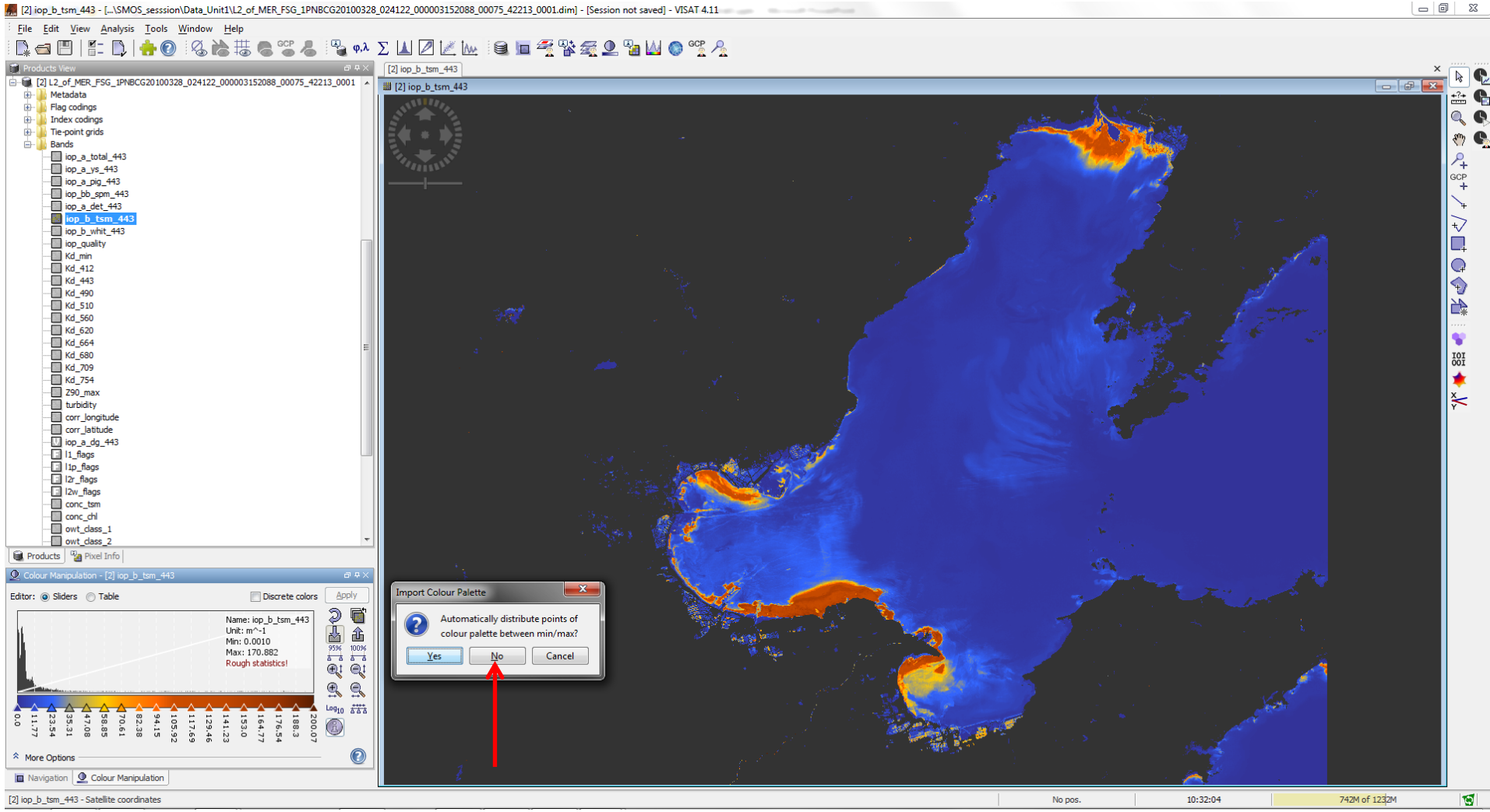



Colour Manipulation - [1] radiance_13
Editor: Sliders Table
Discrete colors
Apply
Name: radiance_13
Unit: mW/(m^2*sr*nm)
Min: 4.692
Max: 189.5
Rough statistics!
95%
100%
Log10
6.09
15.09
50.88
More Options
Navigation
Colour Manipulation



Assign colours

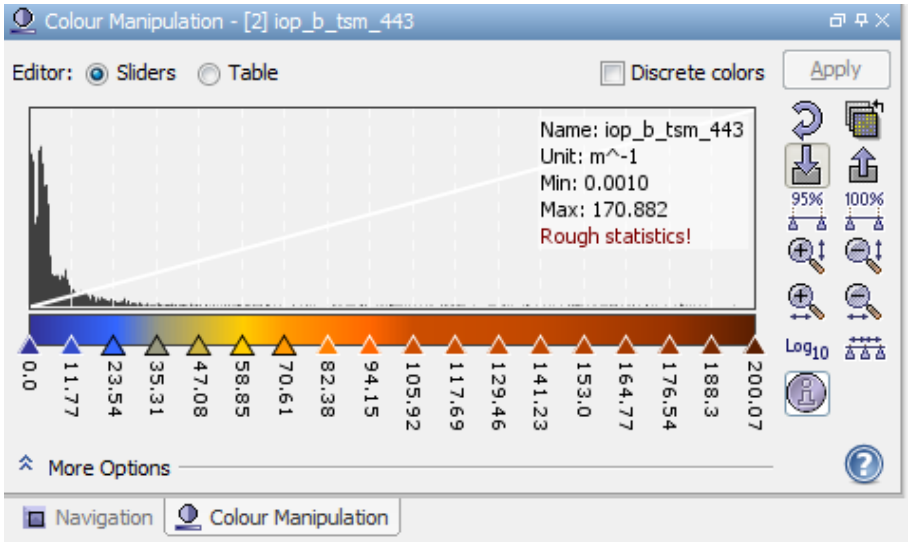



[2] iop_b_tsm_443 - [...\SMOS_sesssion\Data_Unit1\L2_of_MER_FSG_1PNBCG20100328_024122_000003152088_00075_42213_0001.dim] - [Session not saved] - VISAT 4.11
File Edit View Analysis Tools Window Help
Products View
[2] L2_of_MER_FSG_1PNBCG20100328_024122_000003152088_00075_42213_0001
Metadata
Flag codings
Index codings
Tie-point grids
Bands
iop_a_total_443
iop_a_ys_443
iop_a_pig_443
iop_bb_spm_443
iop_a_det_443
iop_b_tsm_443
iop_b_whit_443
iop_quality
Kd_min
Kd_412
Kd_443
Kd_490
Kd_510
Kd_560
Kd_620
Kd_664
Kd_680
Kd_709
Kd_754
Z90_max
turbidity
corr_longitude
corr_latitude
iop_a_dg_443
l1_flags
l1p_flags
l2r_flags
l2w_flags
conc_tsm
conc_chl
owt_class_1
owt_class_2
Products
Pixel Info
Colour Manipulation - [2] iop_b_tsm_443
Editor: Sliders Table
Discrete colors
Apply
Name: iop_b_tsm_443
Unit: m^-1
Min: 0.0010
Max: 170.882
Rough statistics!
95%
100%
Log10
0.0 11.77 23.54 35.31 47.08 58.85 70.61 82.38 94.15 105.92 117.69 129.46 141.23 153.0 164.77 176.54 188.3 200.07
More Options
Navigation
Colour Manipulation
[2] iop_b_tsm_443
[2] iop_b_tsm_443
Import Colour Palette
Automatically distribute points of colour palette between min/max?
Yes
No
Cancel
GCP
[2] iop_b_tsm_443 - Satellite coordinates
No pos.
10:32:04
742M of 1232M

Exercise 2: Solution

Colour Manipulation

- Open colour manipulation window
- Contrast stretch 
  - Change position of slider → apply
  - Or: Click on number and type directly your pixel value for the respective colour → apply
- Assign colours
  - Click on triangle and choose colour
    Or choose editor: table;
    or Import pre-defined colour scheme 
  - Discrete colour classes are possible (check discrete colours)
  - Add colour slider with right mouse click

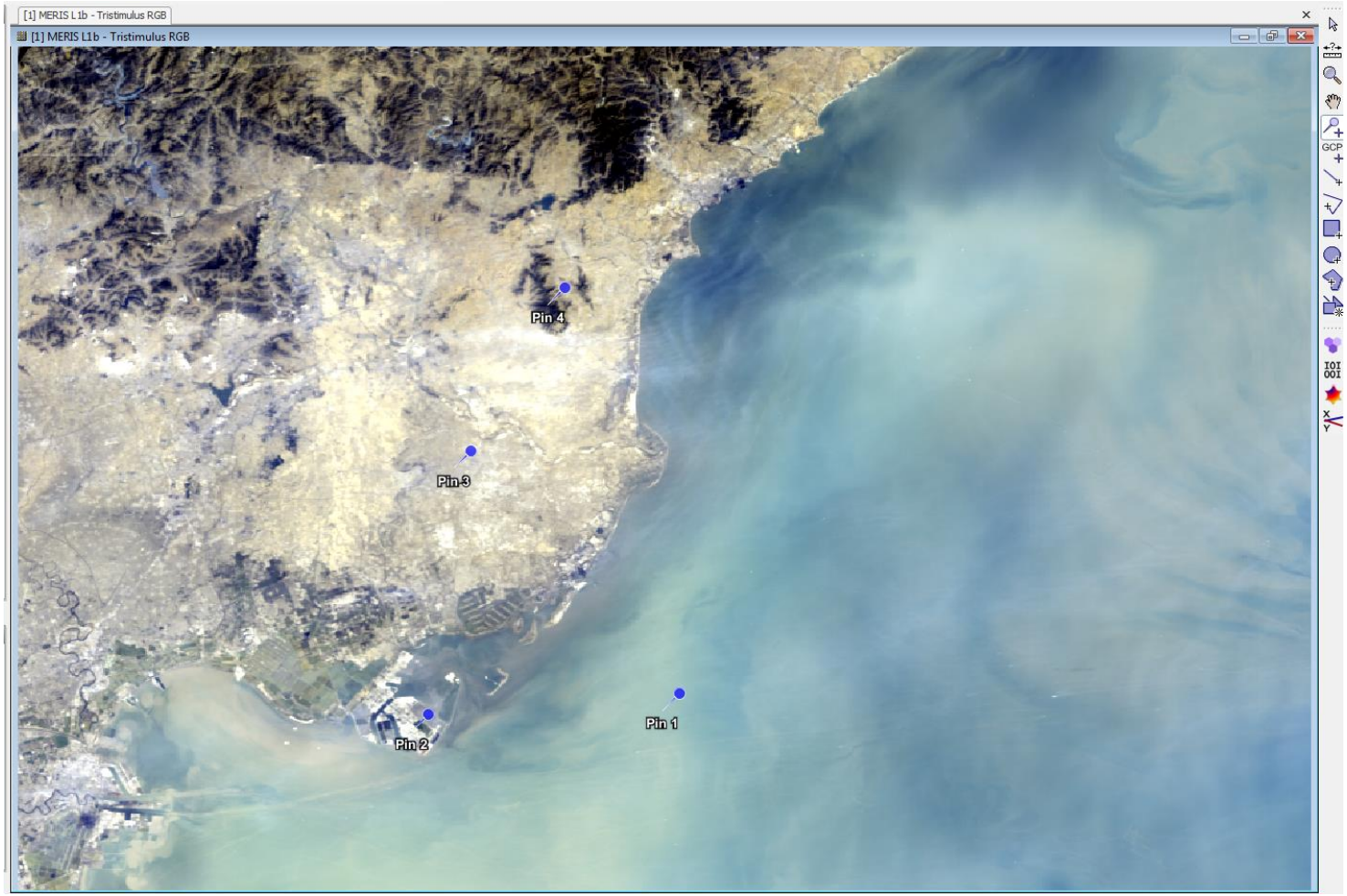


Exercise 3: Pixel information view

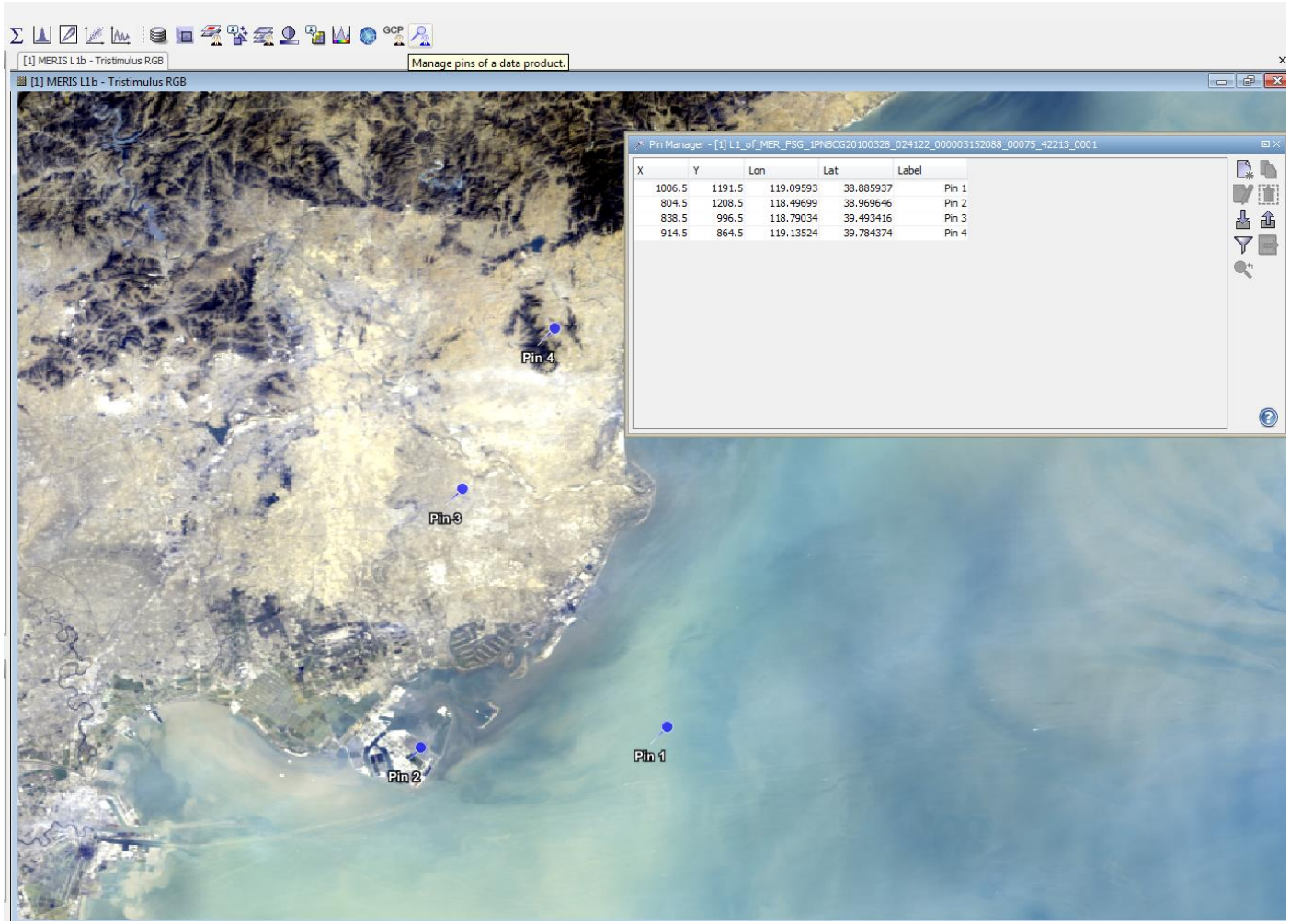
- What to do:
  - Display information of spectra of different surface types:
    - Water
    - Clouds
    - Land
  - Export information in pins to a text file for all spectral bands

- Products:
  - Data_Unit1/L1_of_MER_FSG_1PNBCG20100328_024122_000003152088_00075_42213_0001.dim
  - Pre-defined Pin file (if desired): /Data_Unit1/export_pins_20100328.txt

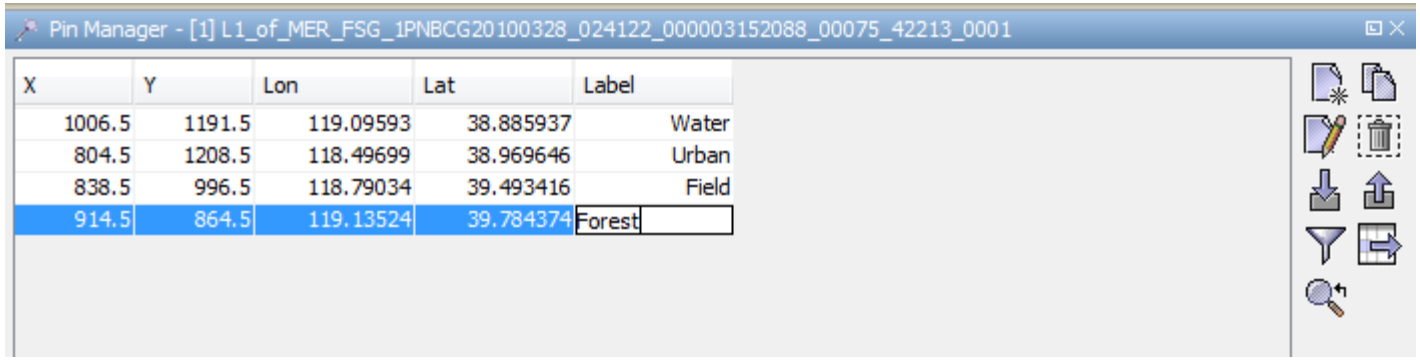
Use pin placing tool



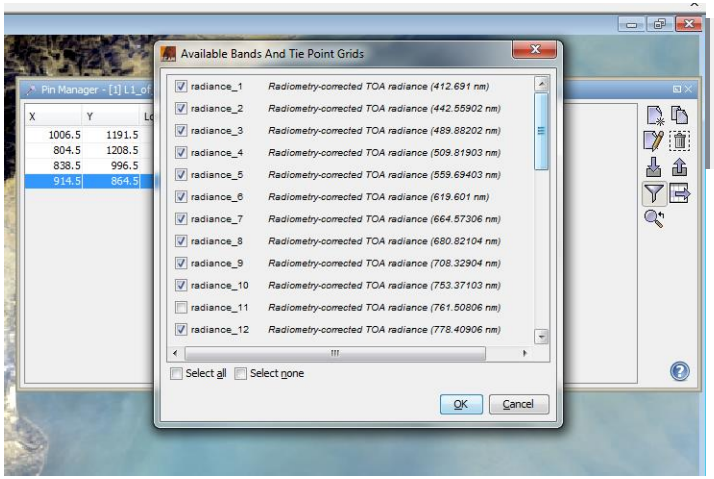
Manage pins: assign names



Double click to name pins



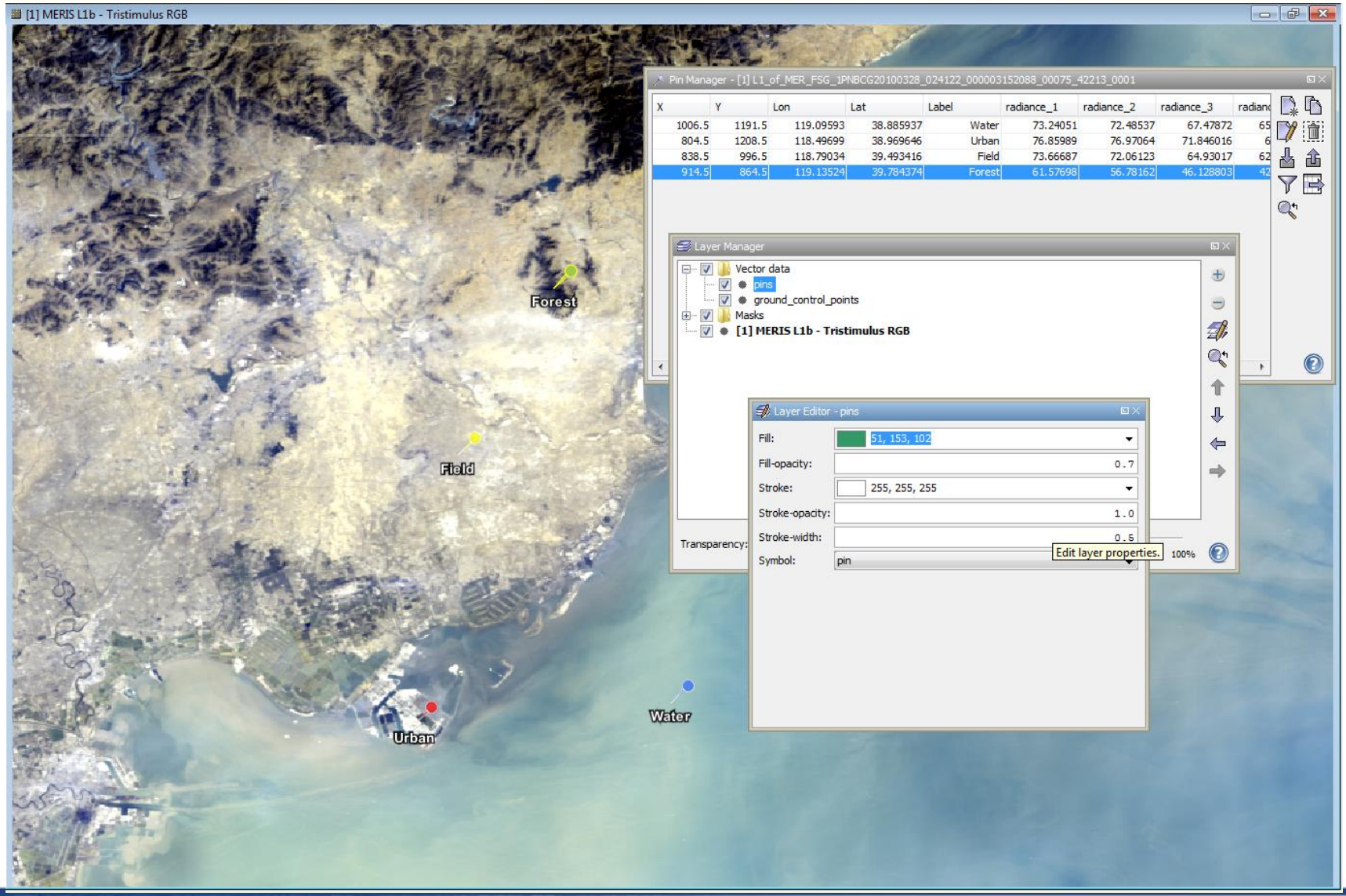
Add band information



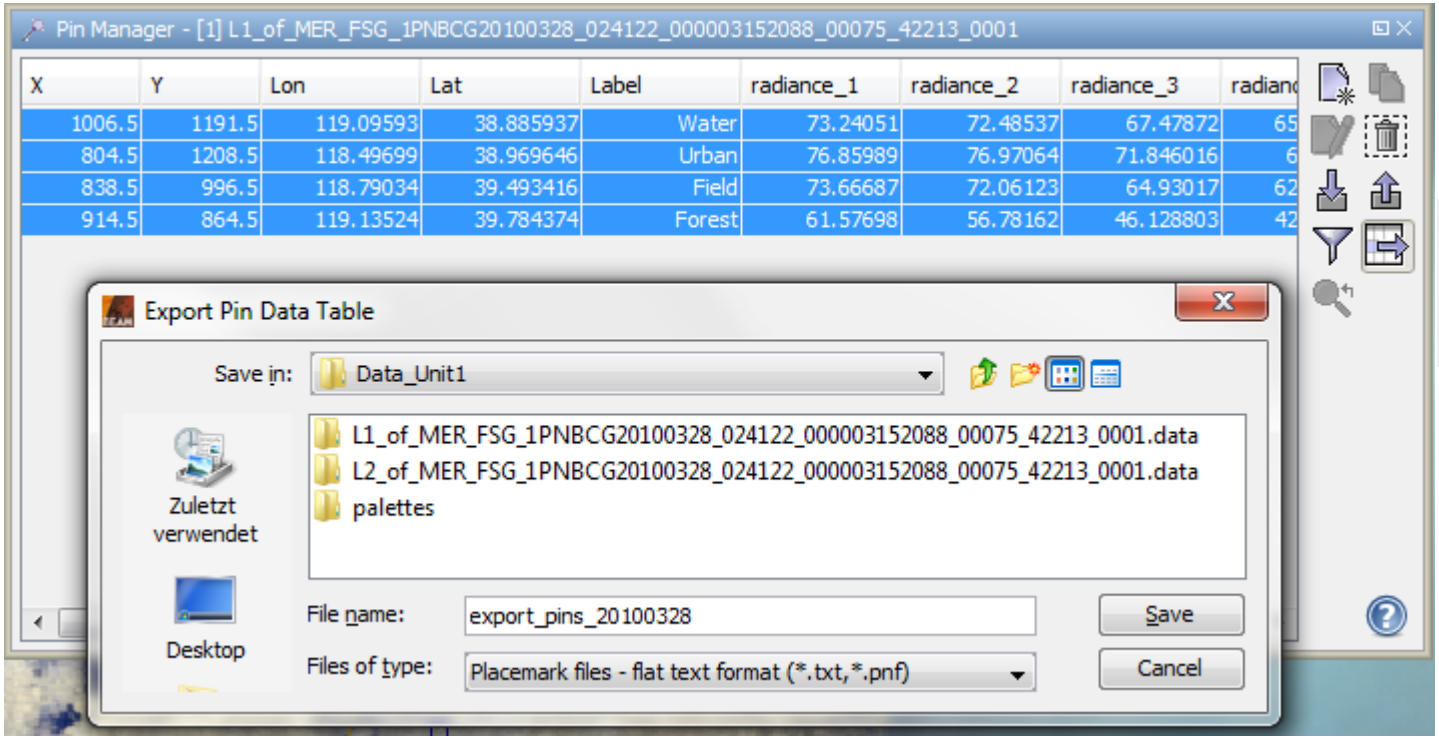
How to modify pins

- To be able to differentiate between pins, and use this information in the spectrum view, use: layer manager

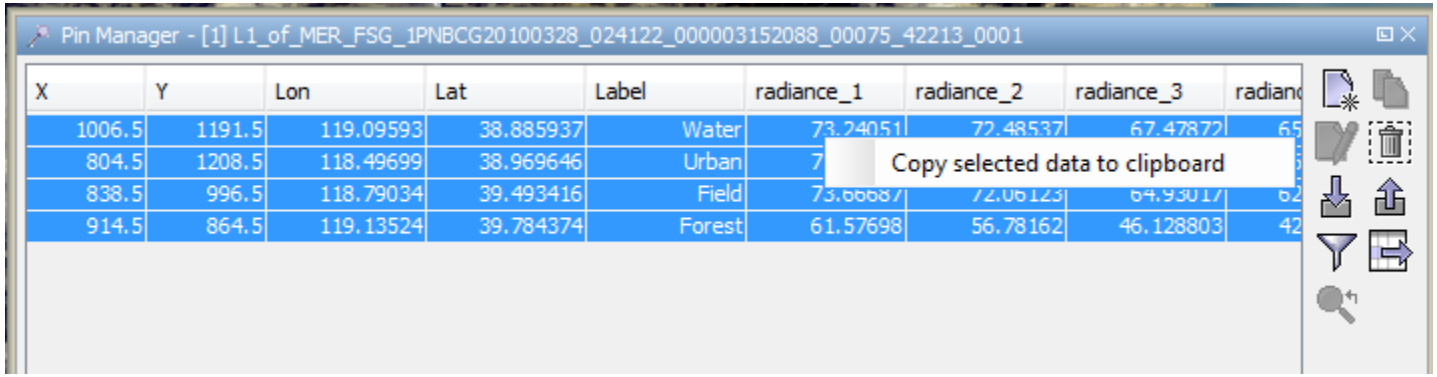
- With the pin manager open, select each pixel and modify color using the layer manager-layer editor tool


[1] MERIS L1b - Tristimulus RGB
Pin Manager - [1] L1_of_MER_FSG_1PNBCG20100328_024122_000003152088_00075_42213_0001
X Y Lon Lat Label radiance_1 radiance_2 radiance_3
1006.5 1191.5 119.09593 38.885937 Water 73.24051 72.48537 67.47872
804.5 1208.5 118.49699 38.969646 Urban 76.85989 76.97064 71.846016
838.5 996.5 118.79034 39.493416 Field 73.66687 72.06123 64.93017
914.5 864.5 119.13524 39.784374 Forest 61.57698 56.78162 46.128803
Layer Manager
Vector data
pins
ground_control_points
Masks
[1] MERIS L1b - Tristimulus RGB
Transparency:
100%
Layer Editor - pins
Fill: 51, 153, 102
Fill-opacity: 0.7
Stroke: 255, 255, 255
Stroke-opacity: 1.0
Stroke-width: 0.5
Symbol: pin
Edit layer properties.
Forest
Field
Water
Urban

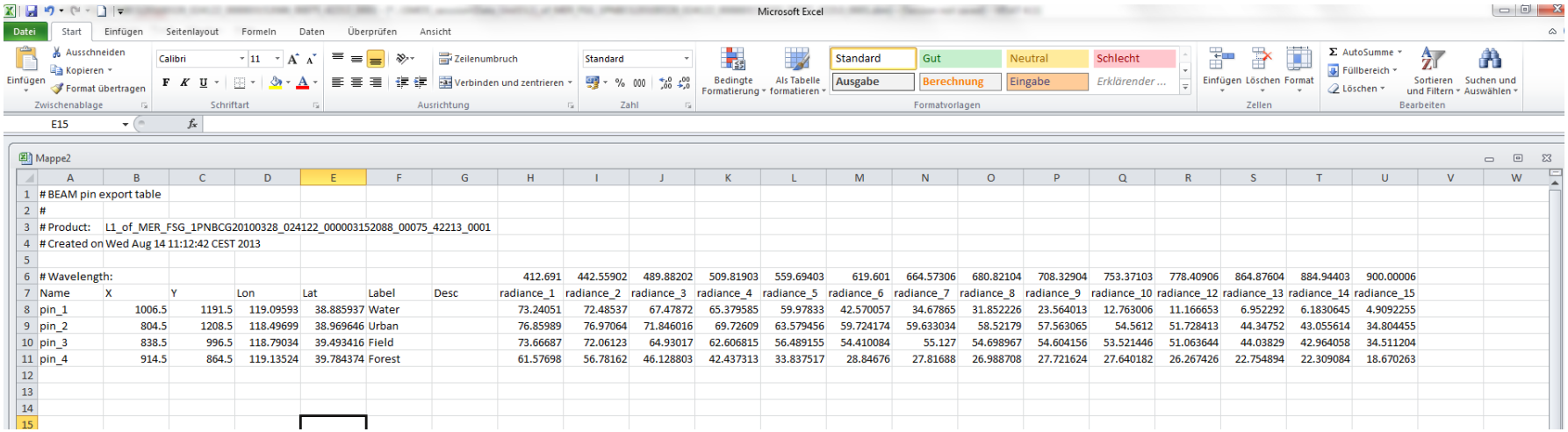
Export data pin in text file



Export to Excel by copying



X	Y	Lon	Lat	Label	radiance_1	radiance_2	radiance_3	radianc
1006.5	1191.5	119.09593	38.885937	Water	73.24051	72.48537	67.47872	65
804.5	1208.5	118.49699	38.969646	Urban	7			
838.5	996.5	118.79034	39.493416	Field	73.66687	72.06123	64.93017	62
914.5	864.5	119.13524	39.784374	Forest	61.57698	56.78162	46.128803	42



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
1	# BEAM pin export table																						
2	#																						
3	# Product:	L1_of_MER_FSG_1PNBCG20100328_024122_000003152088_00075_42213_0001																					
4	# Created on Wed Aug 14 11:12:42 CEST 2013																						
5																							
6	# Wavelength:							412.691	442.55902	489.88202	509.81903	559.69403	619.601	664.57306	680.82104	708.32904	753.37103	778.40906	864.87604	884.94403	900.00006		
7	Name	X	Y	Lon	Lat	Label	Desc	radiance_1	radiance_2	radiance_3	radiance_4	radiance_5	radiance_6	radiance_7	radiance_8	radiance_9	radiance_10	radiance_12	radiance_13	radiance_14	radiance_15		
8	pin_1	1006.5	1191.5	119.09593	38.885937	Water		73.24051	72.48537	67.47872	65.379585	59.97833	42.570057	34.67865	31.852226	23.564013	12.763006	11.166653	6.952292	6.1830645	4.9092255		
9	pin_2	804.5	1208.5	118.49699	38.969646	Urban		76.85989	76.97064	71.846016	69.72609	63.579456	59.724174	59.633034	58.52179	57.563065	54.5612	51.728413	44.34752	43.055614	34.804455		
10	pin_3	838.5	996.5	118.79034	39.493416	Field		73.66687	72.06123	64.93017	62.606815	56.489155	54.410084	55.127	54.698967	54.604156	53.521446	51.063644	44.03829	42.964058	34.511204		
11	pin_4	914.5	864.5	119.13524	39.784374	Forest		61.57698	56.78162	46.128803	42.437313	33.837517	28.84676	27.81688	26.988708	27.721624	27.640182	26.267426	22.754894	22.309084	18.670263		
12																							
13																							
14																							
15																							

Exercise 3: Solution

- Open MERIS Level 1 product
- Open false colour RGB

- Open Pin Manager

- Use pin tool to place different pins to several surface/water types or load pre-defined pin file

- Edit pins, change colours, specify labels

- Choose the bands to be displayed in the Pin Manager

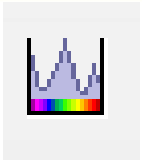
- Export to .txt file
- Or copy the values of all (selected) pins and import into Excel
    - Right Mouse button and Copy to Clipboard
    - Insert clipboard into Excel

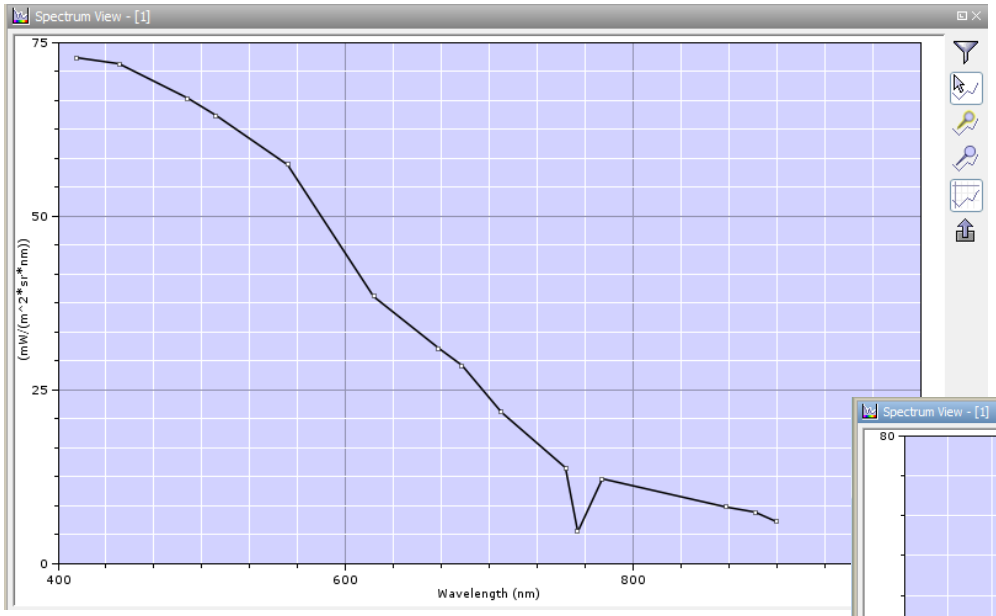
Exercise 4: Spectrum view

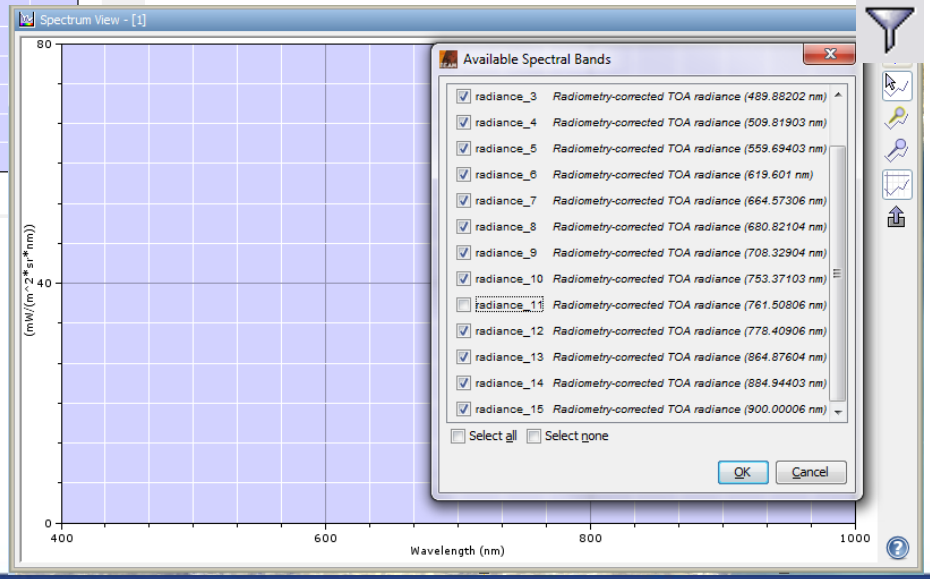
- What to do:
  - Display reflectance spectra of different surface types using the spectrum view:
    - Water
    - Clouds
    - Land
  - Export plots

- Products:
  - Data_Unit1/L1_of_MER_FSG_1PNBCG20100328_024122_000003152088_00075_42213_0001.dim
  - Pre-defined Pin file (if desired): /Data_Unit1/export_pins_20100328.txt

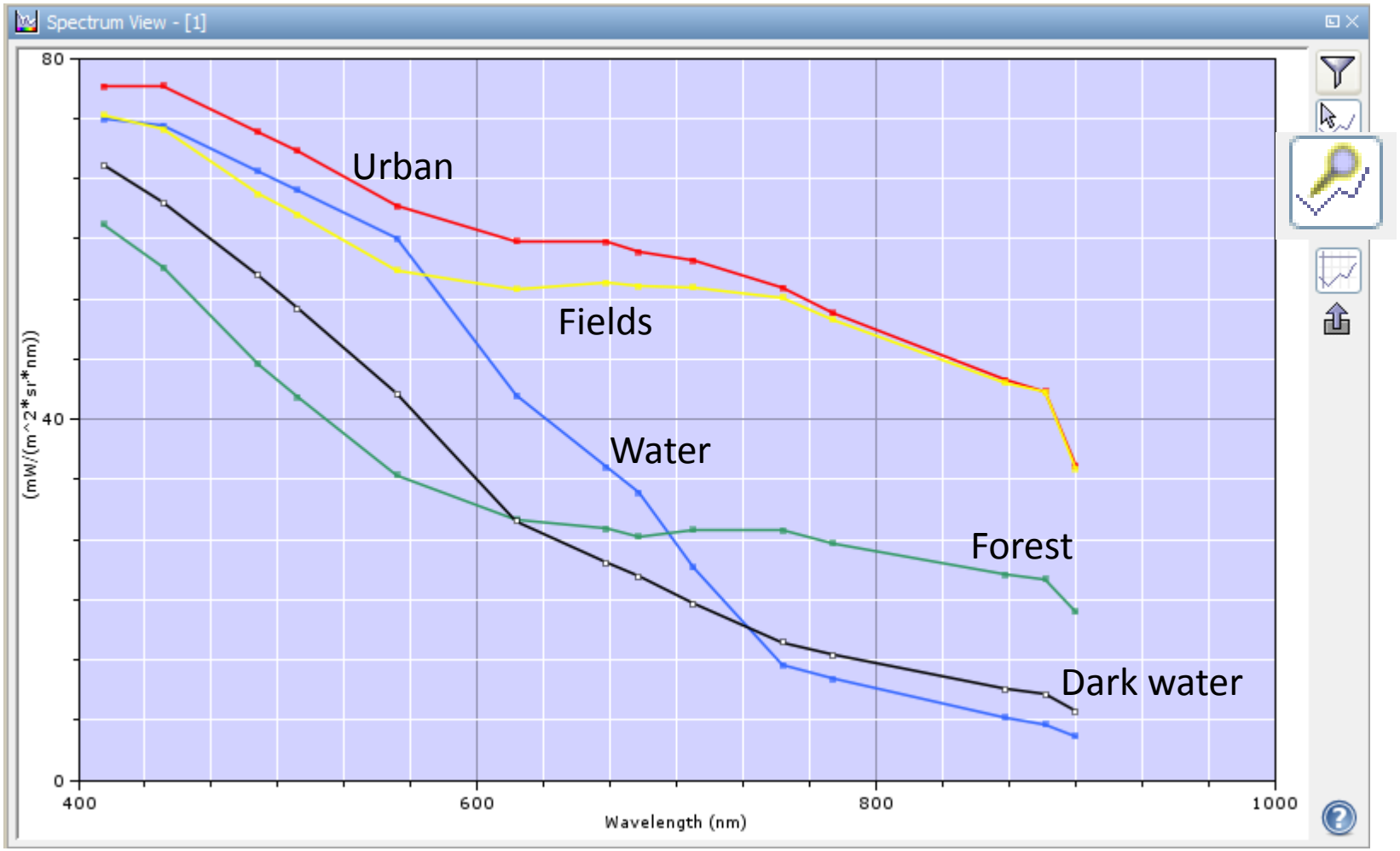
Spectrum view







Visualize spectra of pins



Exercise 4: Solution

- Activate button in Spectrum View for displaying all spectra of pins  
- Open Spectrum View
- Move mouse over displayed image
  - Hold SHIFT pressed for adjusting y-axes

Take-home message

- VISAT is the interactive analysis tool of BEAM
- Image visualisation, colour coding and pixel value inspection are key to understanding EO products

End of Unit

Salinity, Temperature and Density of Sea Water

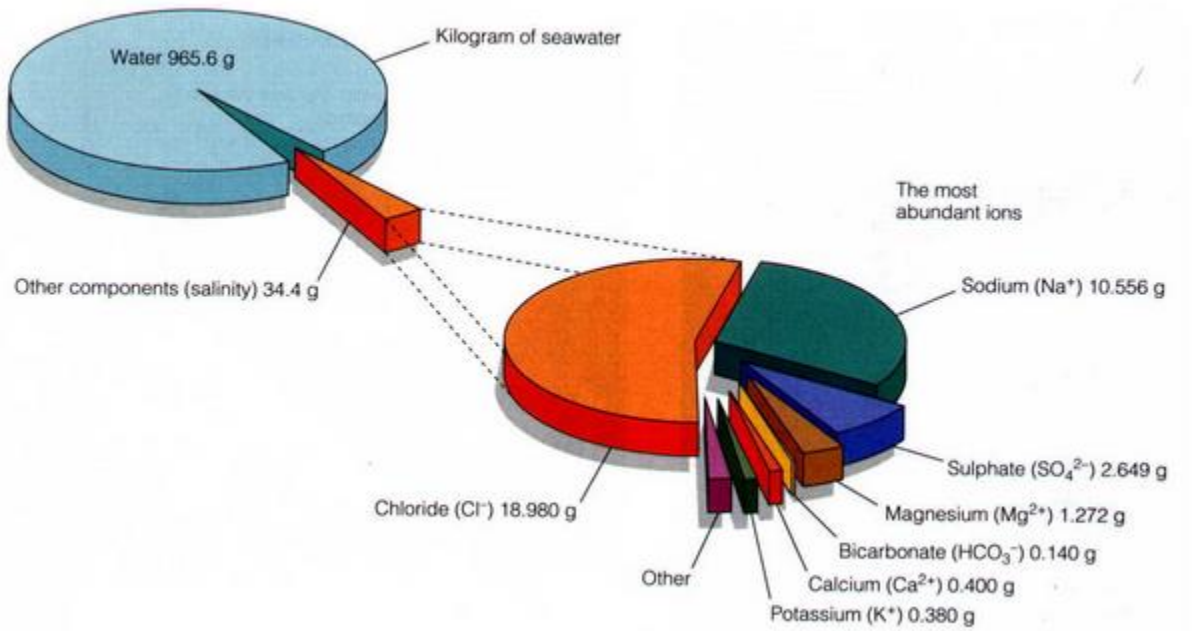
Carsten Brockmann

Ana Ruescas

Kerstin Stelzer

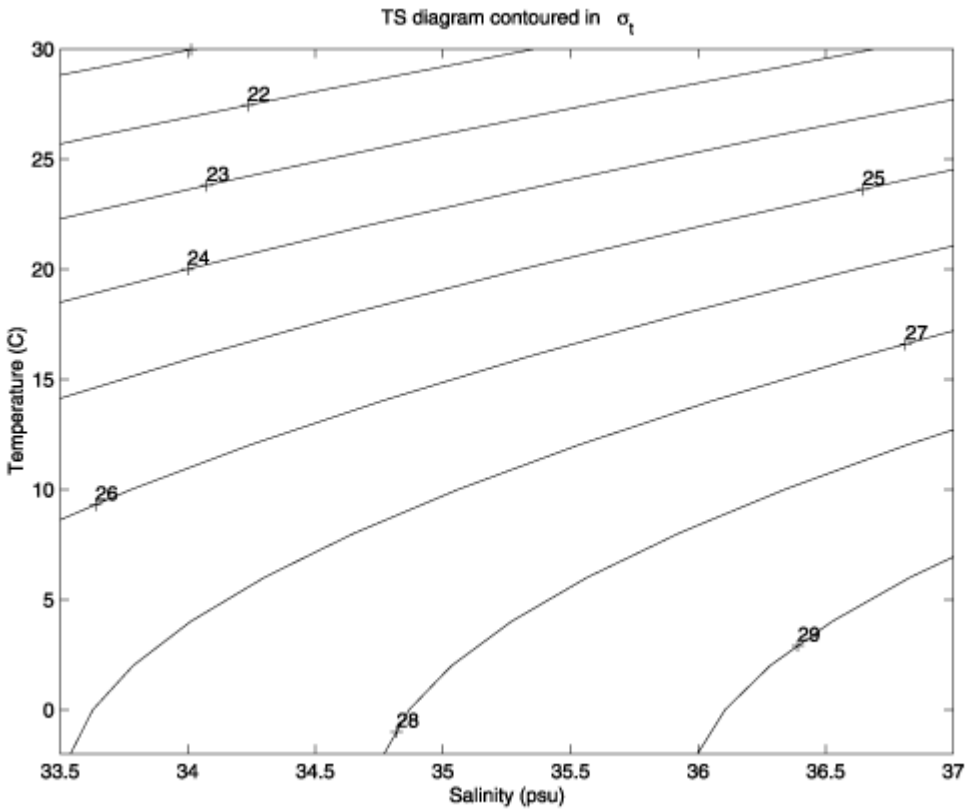
Brockmann Consult GmbH

Composition of sea water



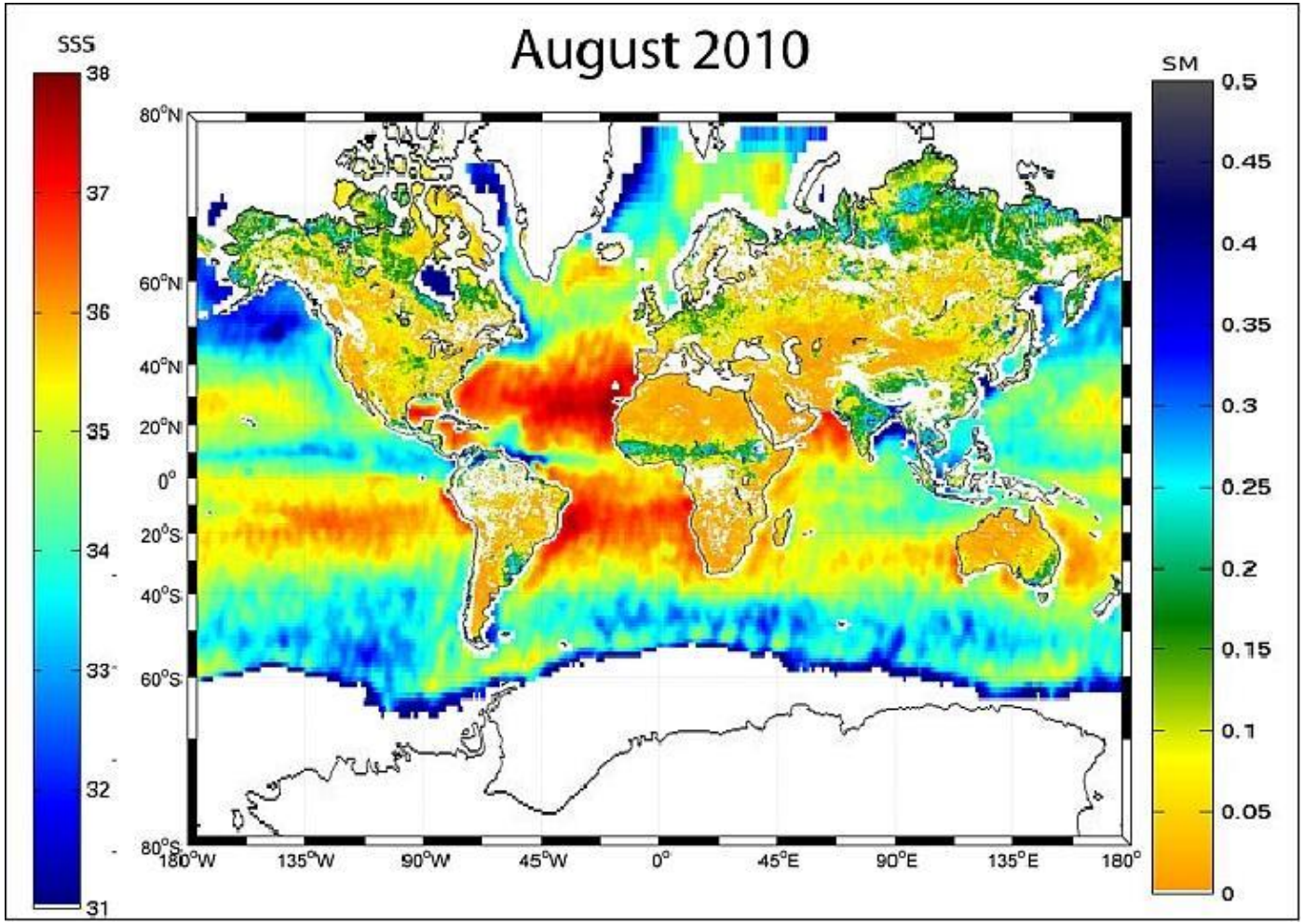
Temperature: the average ocean temperature is 3.5 degrees C (whole water column)
Salinity: the total concentration of dissolved inorganic solids in water. The average salinity of the ocean is about 34.7 ‰

Salinity-temperature-density diagram



- Density increases with lower temperature and higher salinity
- 75% of the ocean water (whole water body) has properties within the range 0-6 degrees C and 34.6-34.8 ‰

SMOS salinity global map



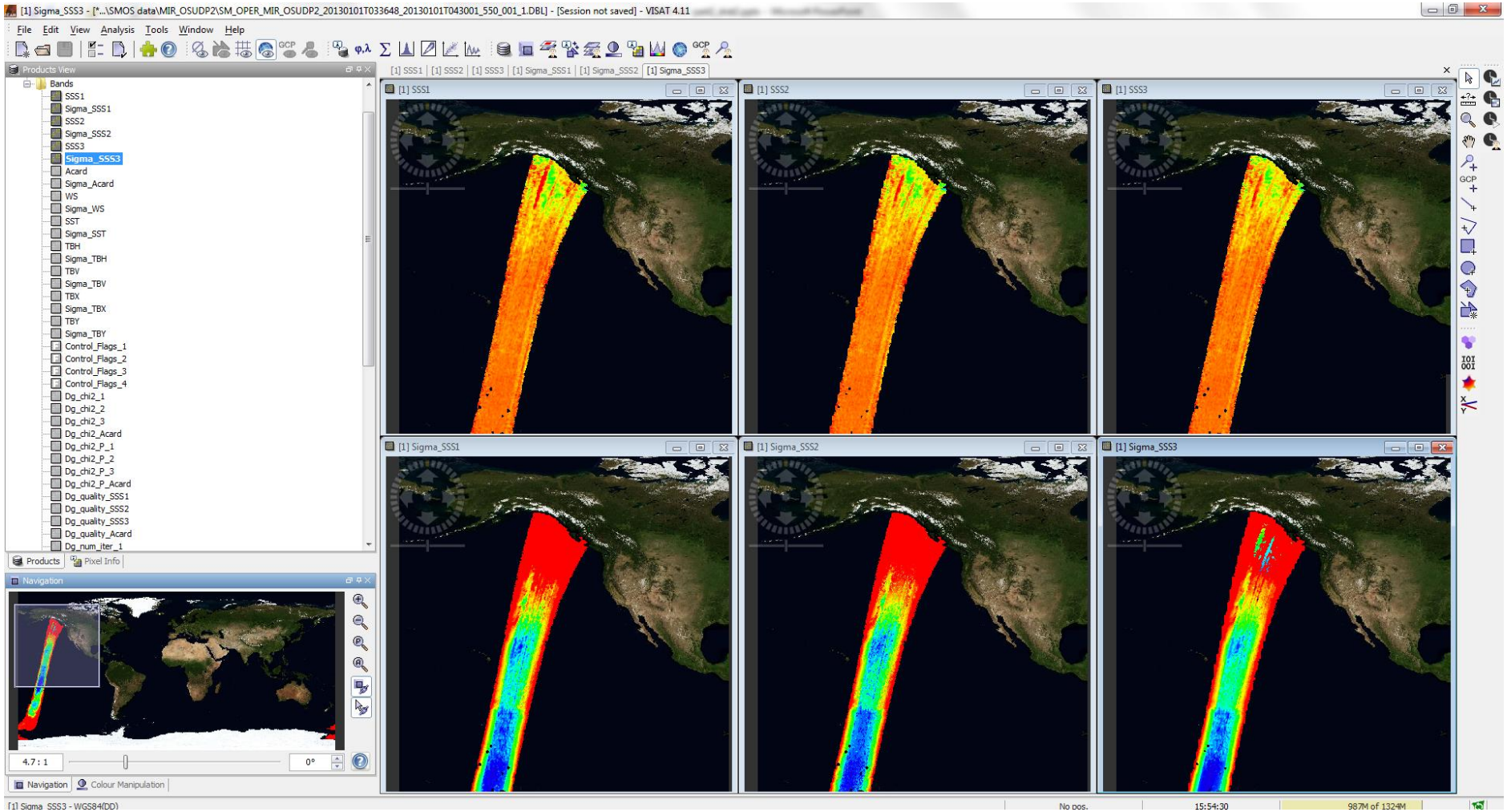
Exercise 1

- Open SMOS L2 ocean salinity product in BEAM: the products comprise two separate files sharing the file name, being differentiated only by their extension. Open the HDR file:
  - an ASCII XML header file (.HDR)
  - a binary data block file (.DBL)

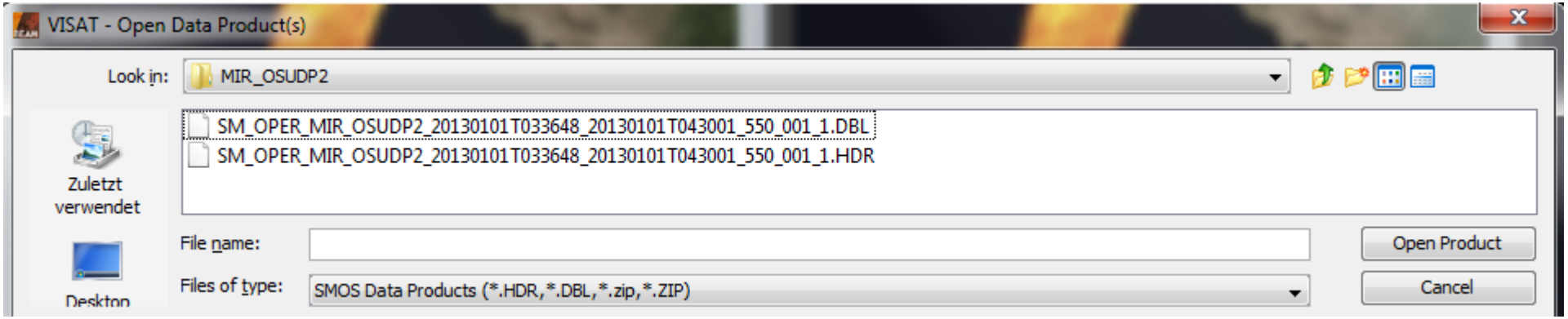
- Display Level 2 product
  - Visualise bands SS1, SS2, SST
  - Analyse the different SSS and their uncertainties (sigma_SSSi)
  - Make a scatter plot SSS1 versus SST
  - Mark regions in the scatter plot and inspect in image view. Estimate the density

- Data:
  - ***SM_OPER_MIR_OSUDP2_20130101T033648_20130101T043001_550_001_1.HDR***

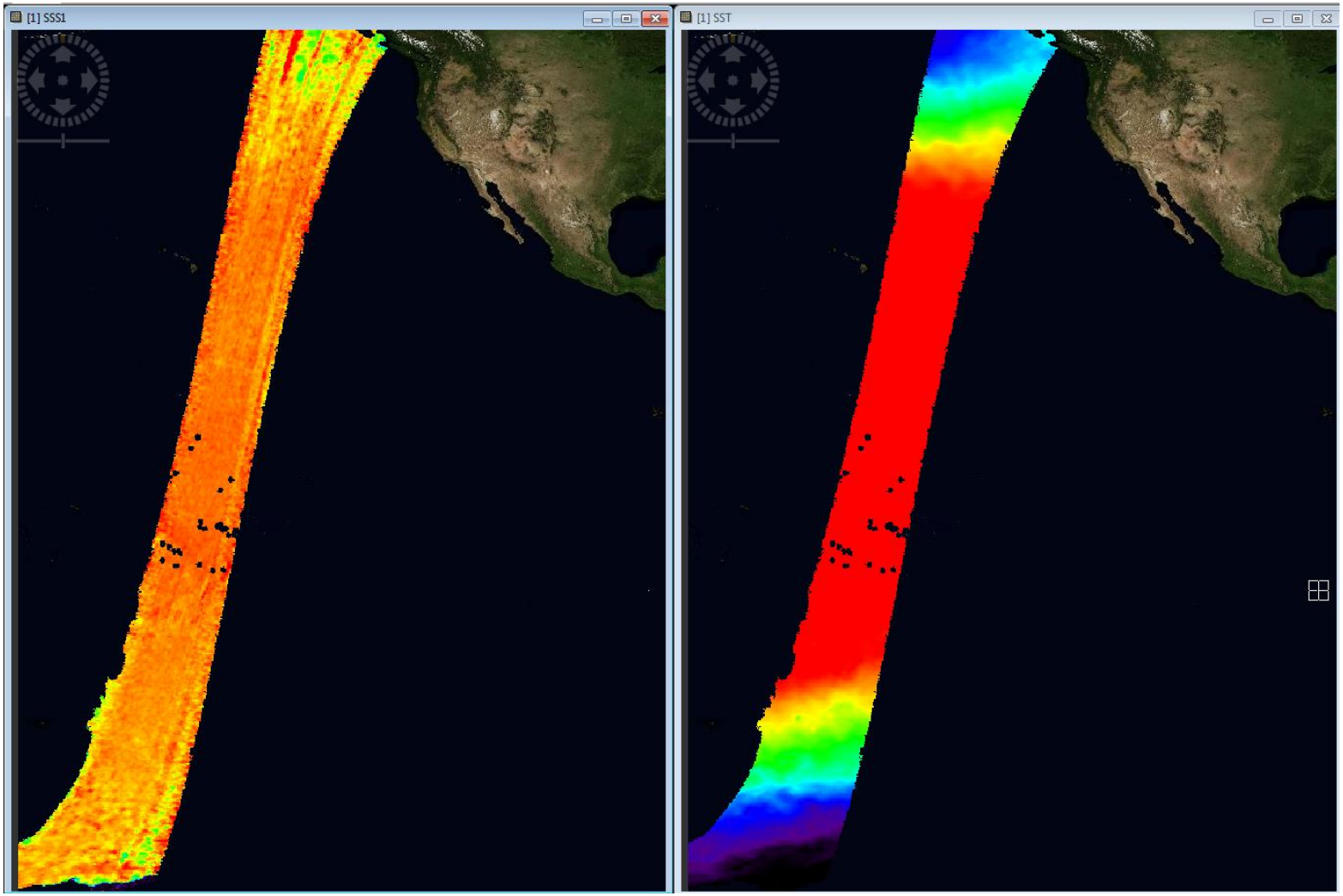
Opening a SMOS salinity L2 image



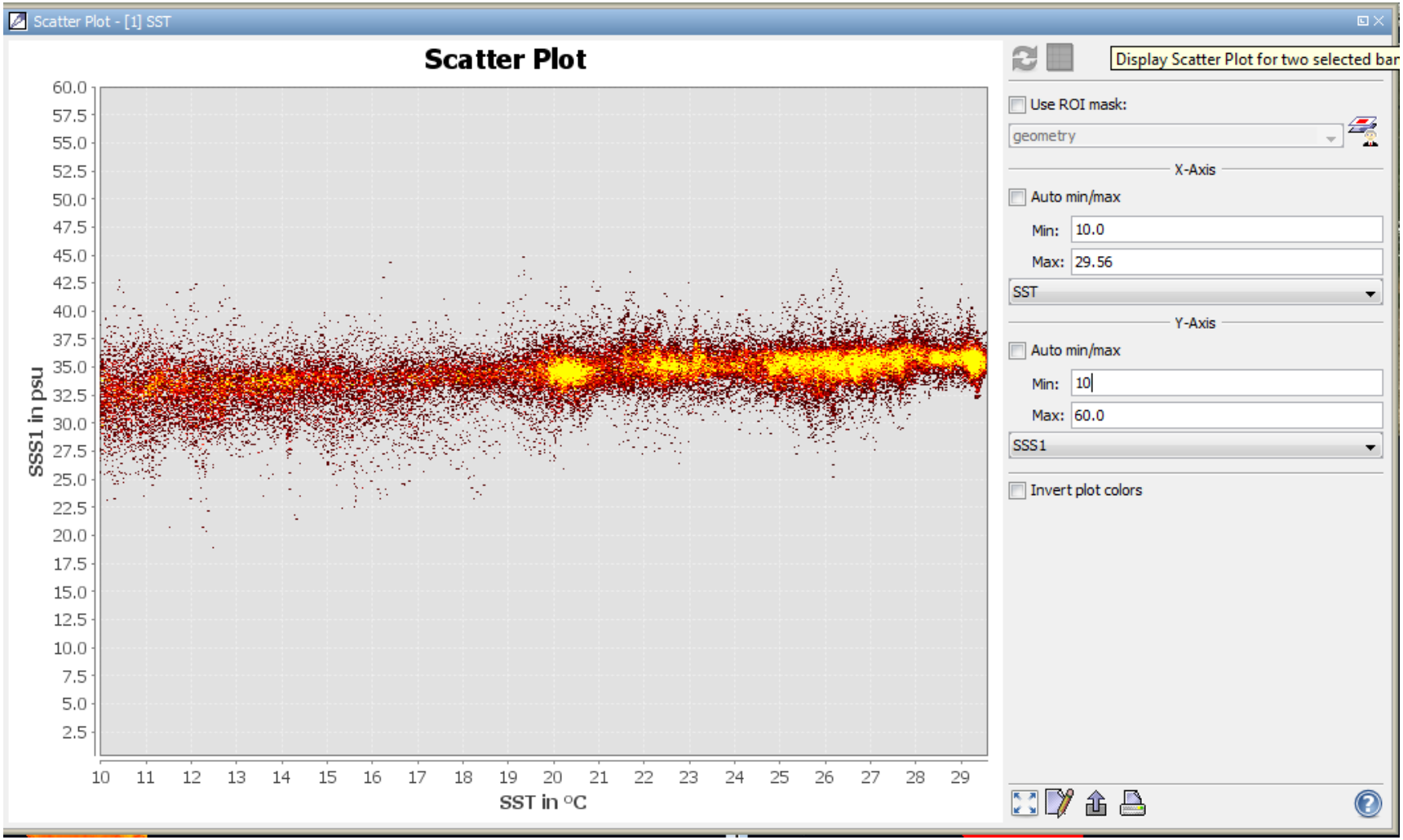
Open L2 product



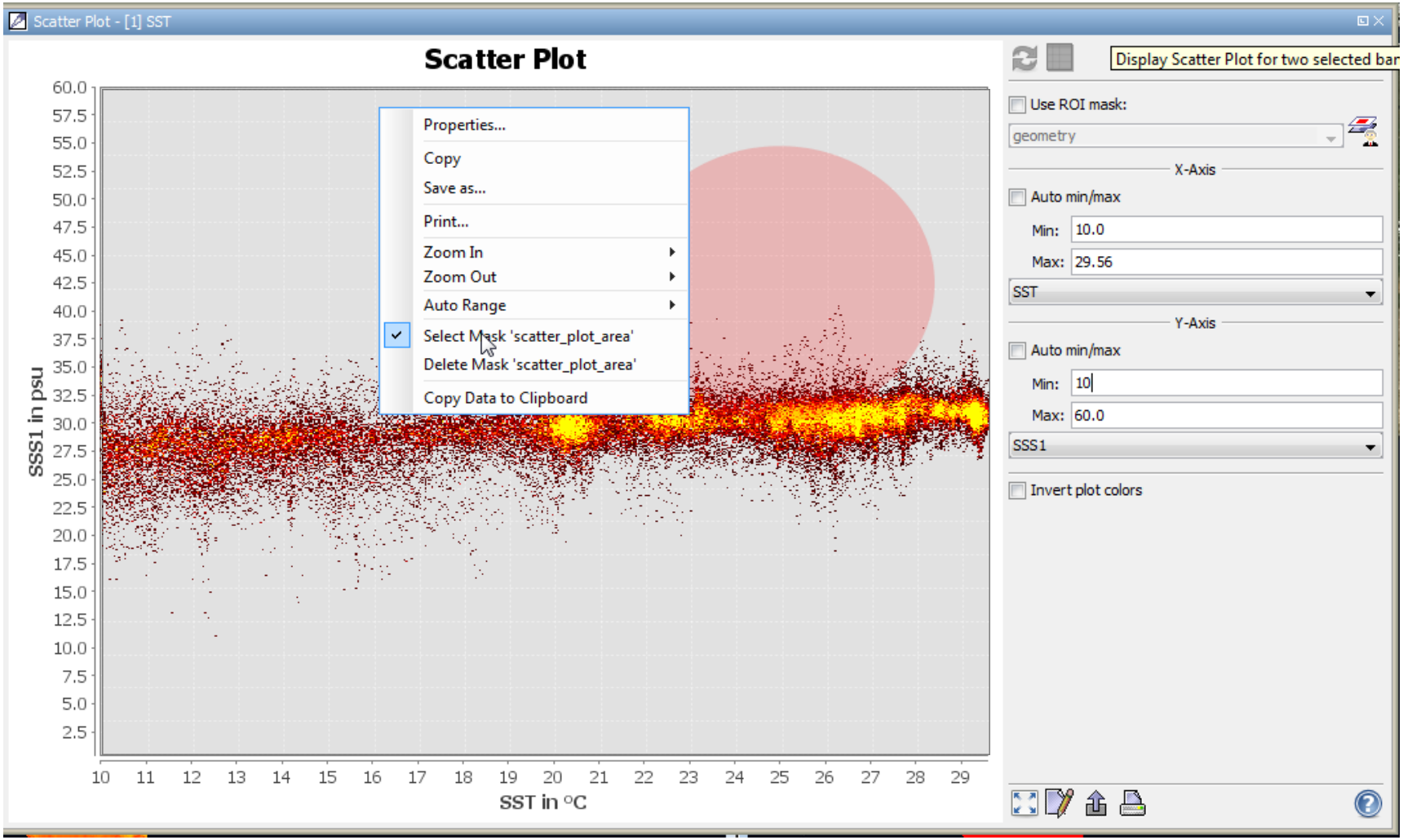
Scatter plot SSS1 vs. SST



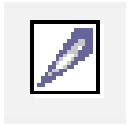
Scatter plot SSS1 vs. SST



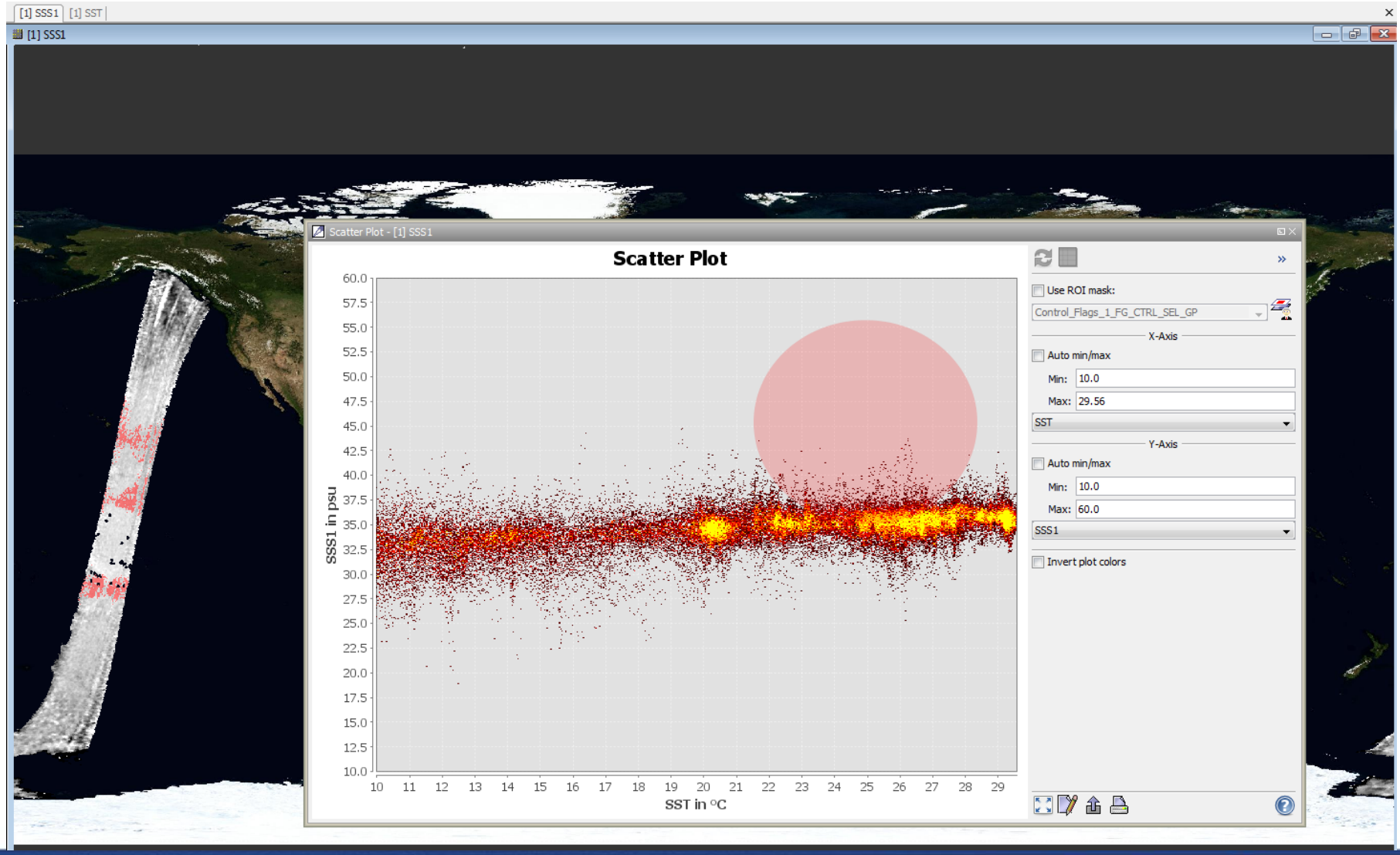
Scatter plot SSS1 vs. SST



Exercise 1: Solution

- Open SMOS L2 ocean salinity product in BEAM: drag from directory the scene or open data product/SMOS data products:
  - `SMOSdata/MIR_OSUDP2/SM_OPER_MIR_OSUDP2_20130101T033648_20130101T043001_550_001_1.HDR`
- Display Level 2 product: double click on band of interest
- Make a scatter plot SSS1 versus SST 
  - →Adjust min/max values in the scatter plot
- Mark the a temperature / salinity range in the scatter plot (e.g. warm, saline water). It is highlighted in the image.
  - Use grey scale for SSS1 image
  - Use the T-S diagram shown before to estimate the density

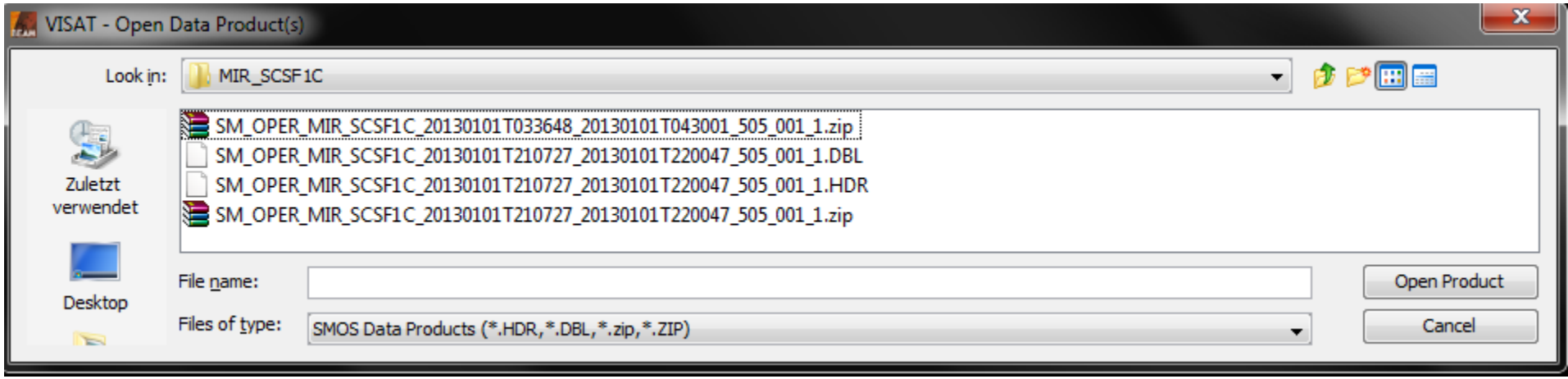
Marked area shown in SSS1



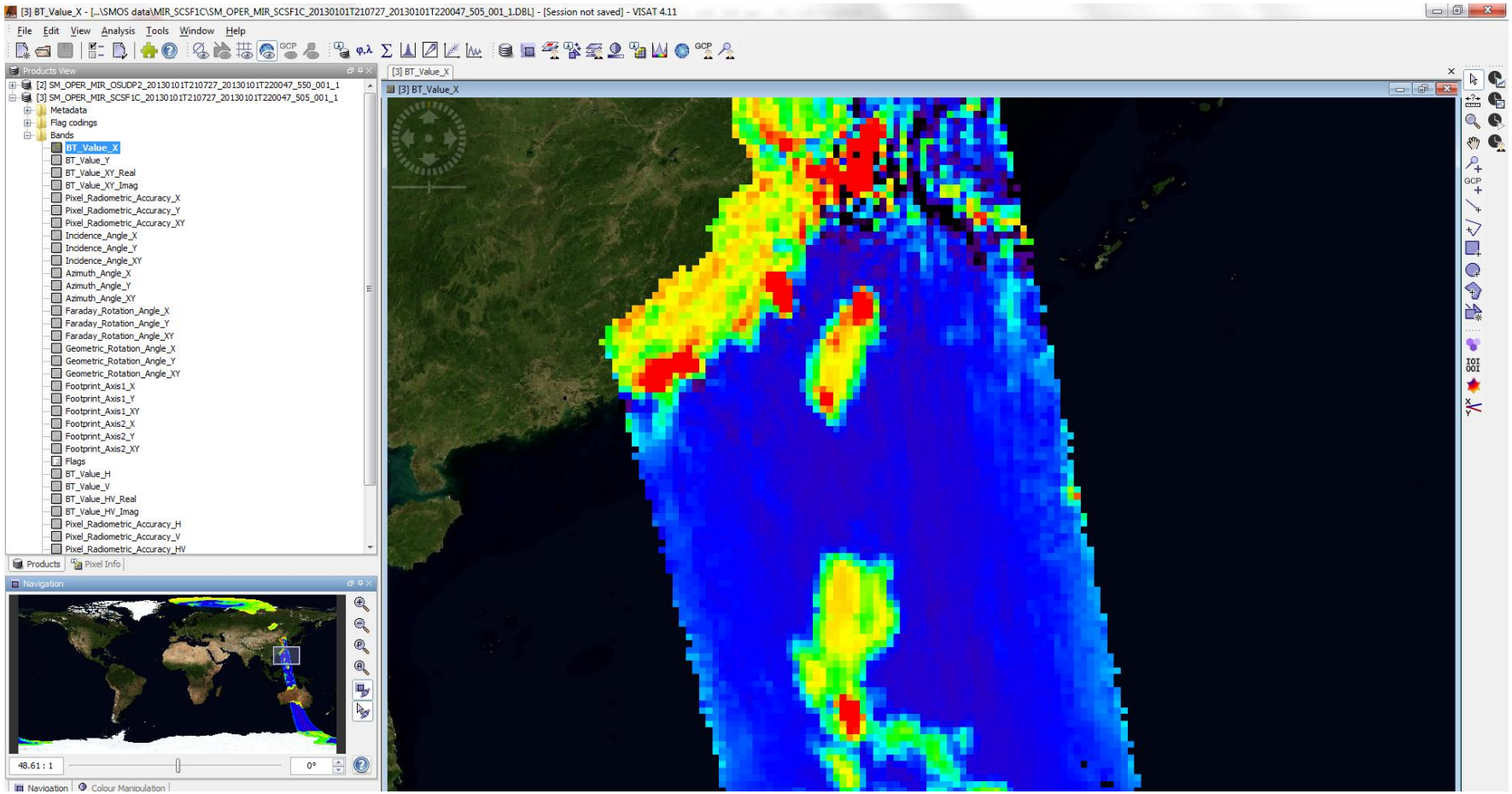
Exercise 2

- Display Level 1c product and compare:
  - Visualize BTx and Bty and compare products
- Explore SMOS Box, which contains tools and commands:
  - Grid point data table 
  - Grid point flag matrix diagram 
  - Grid point brightness temperature chart 
  - Snapshot information tool 
  - Grid point export command
  - NetCDF conversion command
- Data:
  MIR_SCSF1C/SM_OPER_MIR_SCSF1C_20130101T210727_20130101T220047_505_001_1

Opening a SMOS L1c image and table



Opening a SMOS L1c image



Explanation

- When a SMOS product is opened in VISAT, the list of available band data is displayed in the Products View. Double-clicking onto a band name opens a window displaying the band data as an image. Due to the BEAM data model used internally to represent all EO data products, it is required to resample SMOS L1C and L2 gridded data to rectangular raster data. The images created from SMOS products in BEAM thus use the Geographic WGS-84 coordinate reference system.

- The geo-coding of all SMOS data products is provided by the same WGS-84 geographic coordinate reference system. The mapping between image pixels and SMOS grid points is established by a lookup table being a raster dataset of 16384 by 8192 image pixels, yielding about 30 image pixels for an equatorial grid cell of the ISEA4H-R9 grid.

- For SMOS L1c Science products the image displayed by default when double-clicking on a band is computed on-the-fly. Actually, the image is computed from the snapshot data in the same manner as a Browse product is computed from the corresponding Science product.

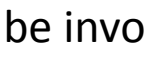
Opening a SMOS L1c table

SMOS L1C Table

Rec#	Flags	BT_Value_...	BT_Value_...	Pixel_Radi...	Incidence_...	Azimuth_A...	Faraday_R...	Geometric...	Snapshot_...	Footprint_...	Footprint_.
1	4117	168.809	0	2.408	62.703	177.803	356.819	352.332	166460203	67.584	29.1
2	4117	171.594	0	3.878	62.482	177.874	356.847	352.271	166460204	66.682	28.9
3	4119	24.388	-6.153	3.278	62.482	177.874	356.847	352.271	166460204	66.682	28.9
4	5140	63.937	0	2.242	62.258	177.951	356.874	352.211	166460205	65.794	28.8
5	5140	80.856	0	3.611	62.034	178.028	356.907	352.15	166460207	64.915	28.6
6	5142	22.607	1.844	3.071	62.034	178.028	356.907	352.15	166460207	64.915	28.6
7	5141	171.136	0	2.364	61.808	178.105	356.935	352.084	166460208	64.049	28.5
8	5141	176.19	0	3.806	61.58	178.187	356.962	352.018	166460209	63.193	28.4
9	5143	21.837	-2.552	3.217	61.58	178.187	356.962	352.018	166460209	63.193	28.4
10	5140	84.751	0	2.235	61.349	178.264	356.99	351.953	166460210	62.349	28.2
11	1044	78.308	0	3.6	61.117	178.347	357.017	351.887	166460211	61.514	28.1
12	1046	23.957	5.069	3.06	61.117	178.347	357.017	351.887	166460211	61.514	28.1
13	1045	176.101	0	2.345	60.882	178.429	357.045	351.815	166460213	60.692	27.
14	1045	164.238	0	3.775	60.646	178.511	357.067	351.744	166460214	59.879	27.
15	1047	17.086	1.721	3.193	60.646	178.511	357.067	351.744	166460214	59.879	27.
16	1044	84.017	0	2.213	60.408	178.599	357.094	351.678	166460215	59.077	27.6
17	1044	85.726	0	3.563	60.168	178.682	357.122	351.606	166460216	58.286	27.5
18	1046	22.44	0.999	3.027	60.168	178.682	357.122	351.606	166460216	58.286	27.5
19	1045	174.638	0	2.319	59.925	178.77	357.149	351.53	166460217	57.504	27.4

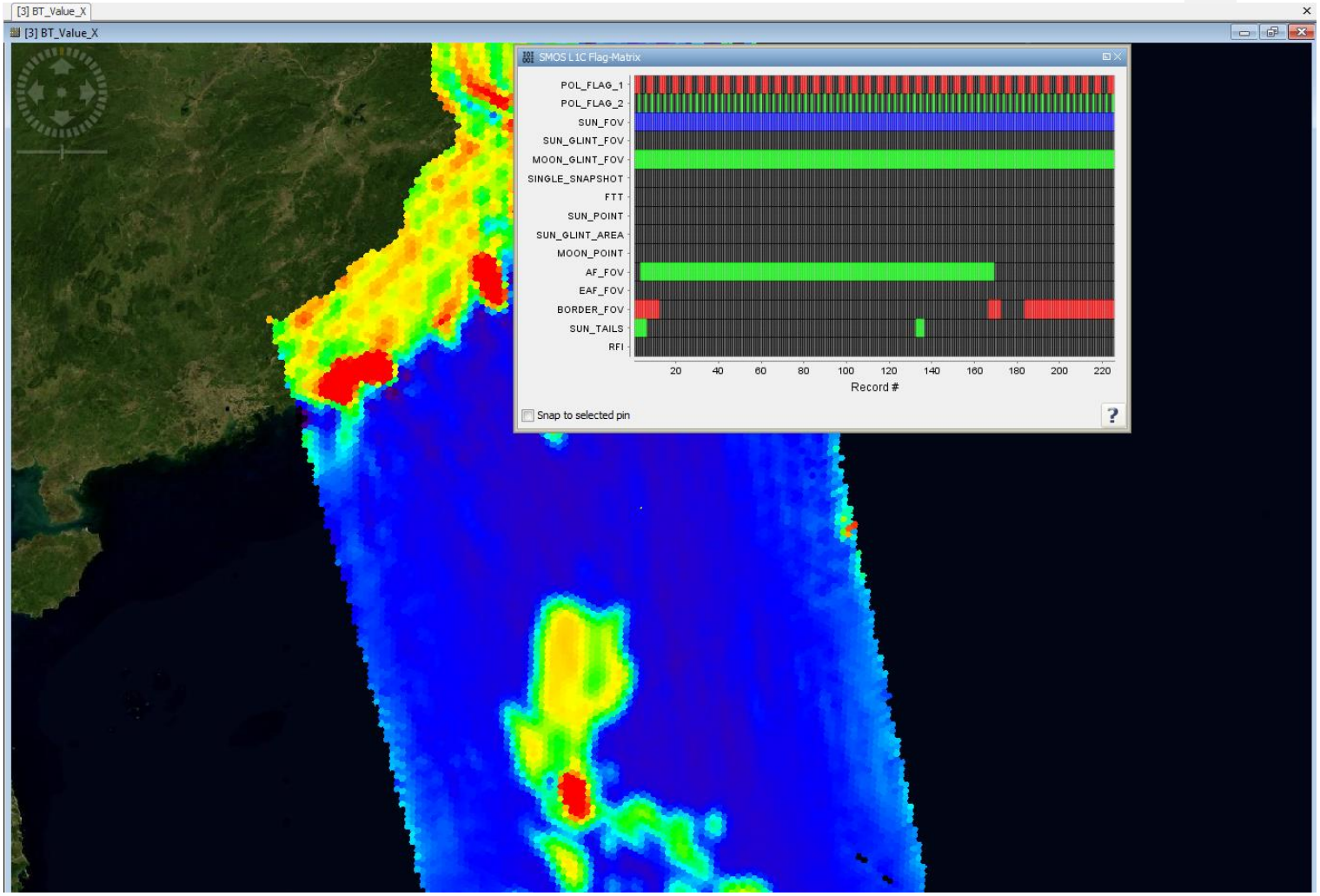
Snap to selected pin Columns... Export... ?

Explanation

- The grid point data table tool can be invoked by clicking on the Icon  the SMOS-Box toolbar. The table shows all measurements made for the currently selected grid point, with a single measurement record per row. By default the selected grid point is defined by the position of the mouse pointer. By activating the **Snap to selected pin** option the selected grid point may also be defined by the position of a currently selected pin.

- The measurements displayed in the table columns can be explicitly choosen by clicking on the **Columns...** button, which pops up a dialog for selecting or deselecting individual measurements. The whole table can be exported to character-separated text, either stored in a file or the clipboard.

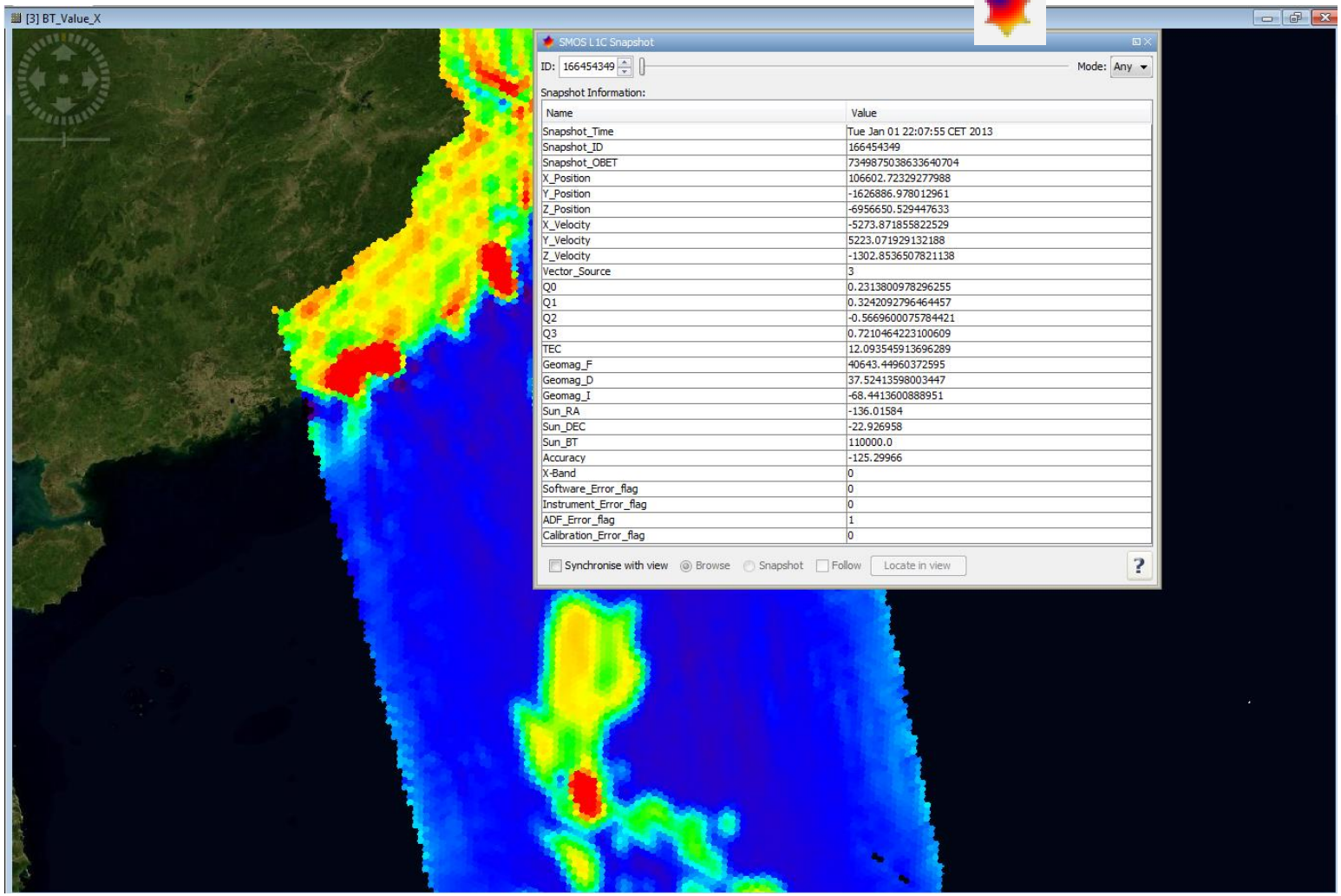
Flag matrix


[3] BT_Value_X
[3] BT_Value_X
SMOS L1C Flag-Matrix
POL_FLAG_1
POL_FLAG_2
SUN_FOV
SUN_GLINT_FOV
MOON_GLINT_FOV
SINGLE_SNAPSHOT
FTT
SUN_POINT
SUN_GLINT_AREA
MOON_POINT
AF_FOV
EAF_FOV
BORDER_FOV
SUN_TAILS
RFI
20 40 60 80 100 120 140 160 180 200 220
Record #
Snap to selected pin
?

Explanantion

- The grid point flag matrix tool can be invoked by clicking on the icor  the SMOS-Box toolbar. The flag matrix shows all flags associated with measurement records acquired for the currently selected grid point, with a single measurement record per column and a single flag per row. A raised flag is indicated by a coloured entry in the flag matrix. By default the selected grid point is defined by the position of the mouse pointer. By activating the **Snap to selected pin** option the selected grid point may also be defined by the position of a currently selected pin.

Flag snapshot

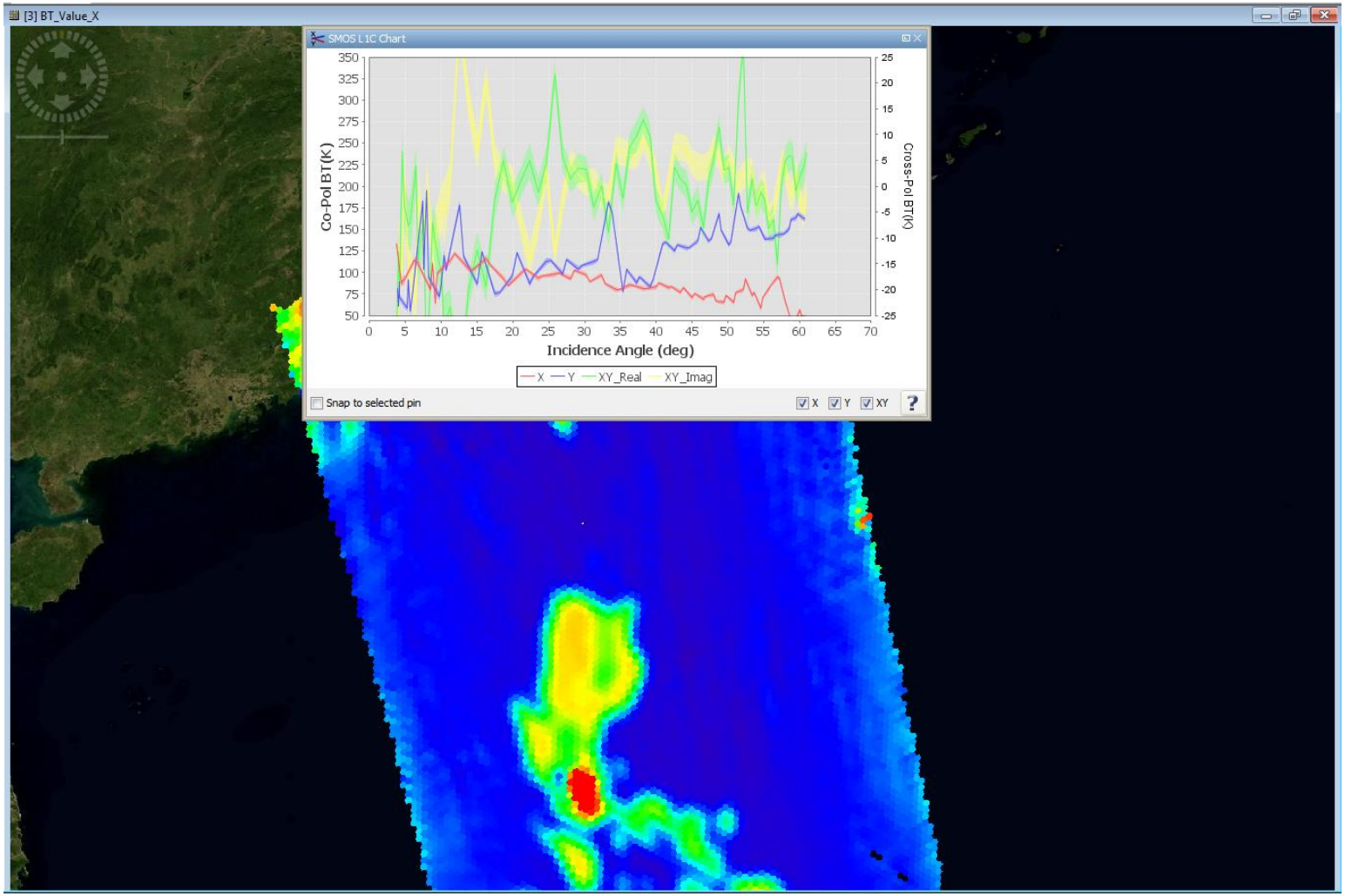


Name	Value
Snapshot_Time	Tue Jan 01 22:07:55 CET 2013
Snapshot_ID	166454349
Snapshot_OBET	7349875038633640704
X_Position	106602.72329277988
Y_Position	-1626886.978012961
Z_Position	-6956650.529447633
X_Velocity	-5273.871855822529
Y_Velocity	5223.071929132188
Z_Velocity	-1302.8536507821138
Vector_Source	3
Q0	0.2313800978296255
Q1	0.3242092796464457
Q2	-0.5669600075784421
Q3	0.7210464223100609
TEC	12.093545913696289
Geomag_F	40643.44960372595
Geomag_D	37.52413598003447
Geomag_I	-68.4413600888951
Sun_RA	-136.01584
Sun_DEC	-22.926958
Sun_BT	110000.0
Accuracy	-125.29966
X-Band	0
Software_Error_flag	0
Instrument_Error_flag	0
ADF_Error_flag	1
Calibration_Error_flag	0

Explanation

- The snapshot information tool can be invoked by clicking on the icon in the SMOS-Box toolbar. The tool can be used for browsing the 'Swath Snapshot List' contained in the SMOS L1c Science products. The components of this tool are described below.
- **Spinner component**
  - For selecting an individual snapshot the tool provides a spinner which allows to manually specify a certain snapshot ID and to navigate forward and backward in the list of snapshot IDs.
- **Slider component**
  - The slider provides an explicit mechanism for fast navigation through the list of snapshot IDs.
- **Combobox component**
  - The combobox provides a facility for selecting a certain polarisation mode (any, X, Y, XY). When a certain mode is selected, only IDs of snapshots acquired at the selected mode are navigable (i.e. IDs of snapshots acquired at a different mode do not appear in the list of snapshot IDs) by the spinner and slider components.
- **Radio buttons**
- There are two radio buttons for selection the data source for the active image view. Selecting the 'Snapshot' radio button implies that, firstly, the active image view displays the data of the selected snapshot instead of the browse, and, secondly, the selected snapshot becomes the data source for all bands in the selected product, unless the proper polarisation mode is not available for the selected snapshot. In the latter case, the nearest snapshot acquired in the proper polarisation mode becomes the data source.
- Selecting the 'Browse' radio button implies that, firstly, the active image view shows the raster data of the browse instead of the selected snapshot, and, secondly, the data source for all bands in the selected product is reset to the browse.
- **Follow checkbox**
  - When checked the viewport of the active image view automatically moves to and zooms into the region covered by the selected snapshot.
- **Locate button**
  - When pressed the viewport of the active image view moves to and zooms into the region covered by the selected snapshot.

Brightness temperature chart



Explanation

- The grid point brightness temperature chart tool can be invoked by clicking on the icon in the SMOS 

toolbar. The brightness temperature chart shows a diagram of the brightness temperatures measured for the currently selected grid point. A single series of brightness temperatures versus incidence angle is shown for each polarisation mode. By default the selected grid point is defined by the position of the mouse pointer. By activating the **Snap to selected pin** option the selected grid point may also be defined by the position of a currently selected pin.

- For the brightness temperature measurements made in the X and Y copolarisation modes the uncertainties are shown as error bars. The display of individual polarisation modes can be switched on and off by activating or deactivating the corresponding checkboxes.

Take-home message

- The SMOS-Box plug-in of BEAM allows opening and analysing SMOS L1 and L2 products

- Salinity and temperature and the most important ocean state variables, determining the density and hence the currents. In BEAM SMOS L2 salinity products can be analysed together with sea surface temperature or chlorophyll.

- L1c products are the electromagnetic measurements of SMOS. The SMOS Box provide specialists tool to analyse them.

End of Unit