

→ POLSARPRO V. 5.1

The Polarimetric SAR Data Processing and Educational Tool

ENTER

EXIT

<http://earth.esa.int/polsarpro>

www.esa.int

European Space Agency

→ 4th ADVANCED COURSE ON RADAR POLARIMETRY

30 January – 2 February 2017 | ESA-ESRIN | Frascati (Rome), Italy

PolSARpro v5.1 toolbox

Practical session - Introduction

Eric Pottier

→ POLSARPRO V. 5.1

The Polarimetric SAR Data Processing and Educational Tool

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A Bit Of History

CONTEXT



The initiative development of **PolSARpro Software** is a direct result of recommendations made during the **POLinSAR 2003 Workshop** held at ESA-ESRIN in January 2003.



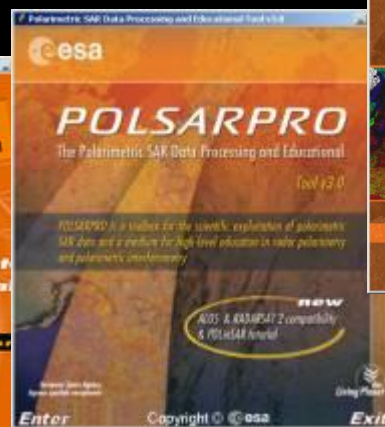
2003



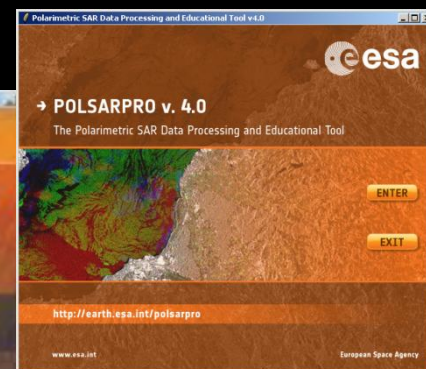
2004



2005



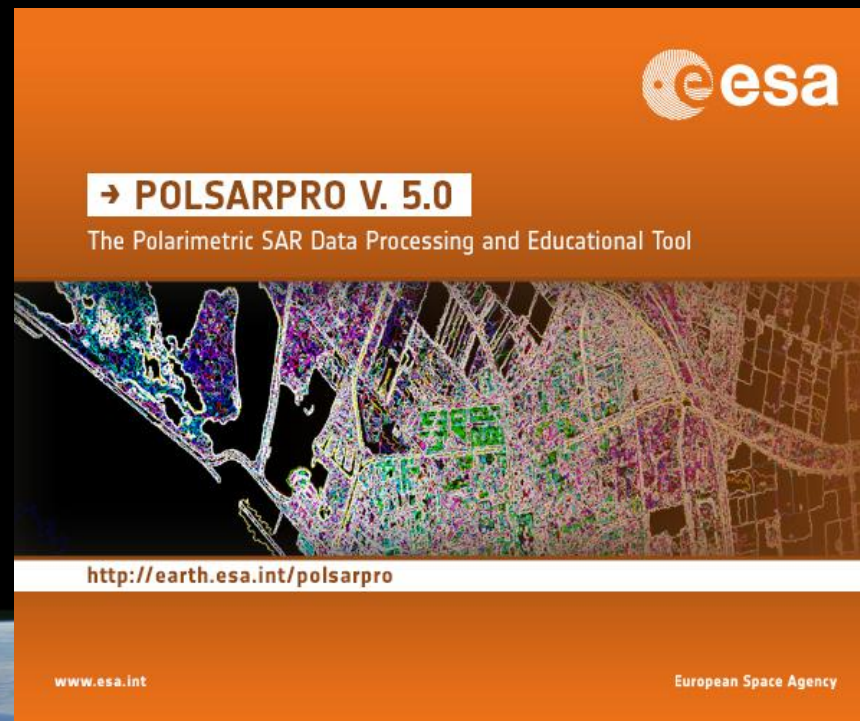
2007



2009

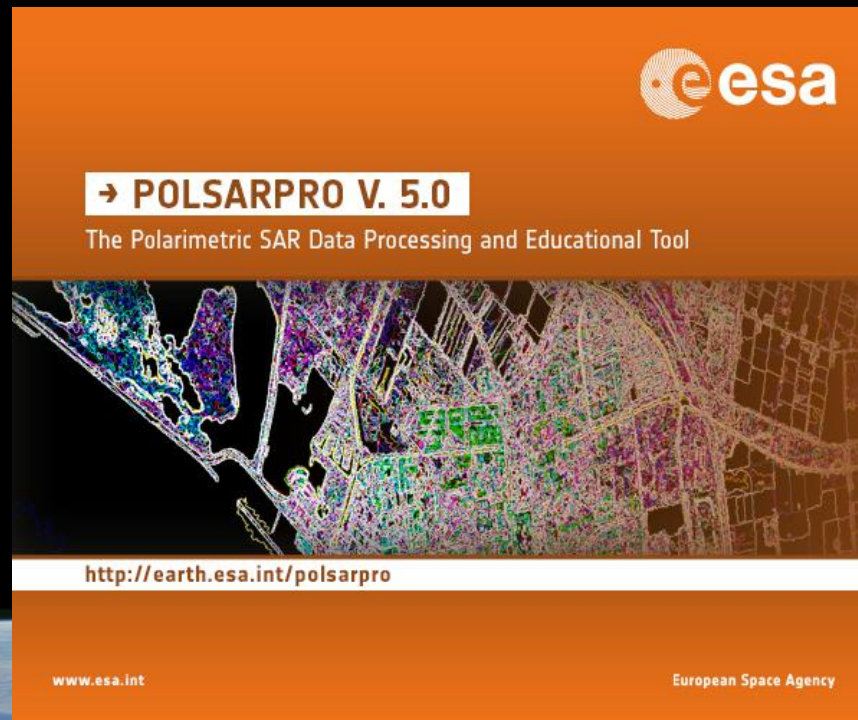


Tool specifically designed to handle :
Polarimetric data
and
Polarimetric Interferometric data.



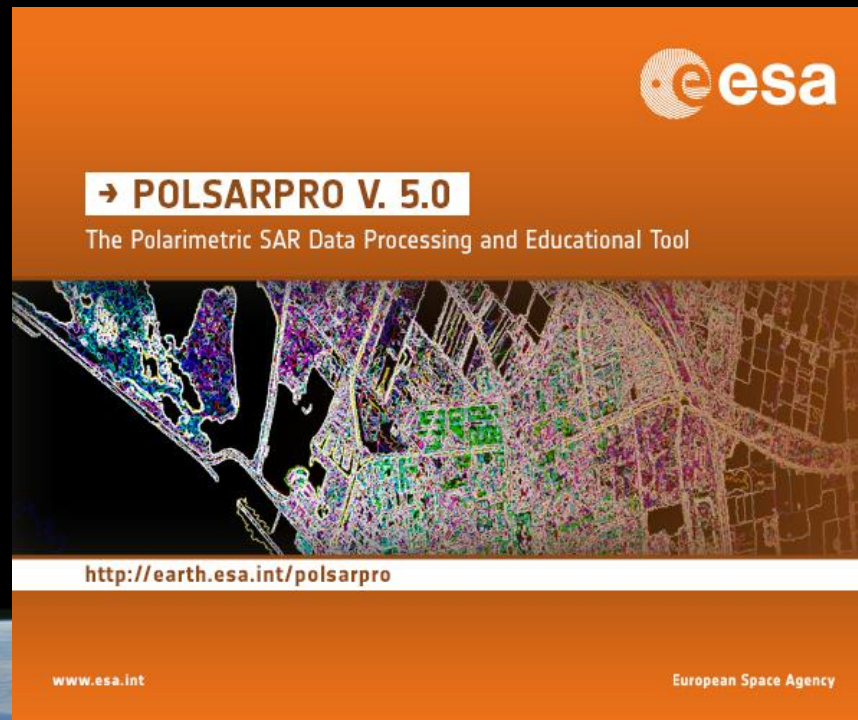
The image shows a software interface for PolSARpro V. 5.0. It features an orange header with the ESA logo and the text "→ POLSARPRO V. 5.0" and "The Polarimetric SAR Data Processing and Educational Tool". Below the header is a large, colorful SAR image showing a complex structure, possibly a building or industrial site, with various colors representing different polarimetric parameters. At the bottom of the interface, there is a white bar with the URL "http://earth.esa.int/polsarpro" and another orange bar with "www.esa.int" and "European Space Agency".

Educational Software offering a tool for **self-education** in the field of **POLSAR** and **POL-InSAR** data processing and analysis.



The image shows the cover of the PolSARpro V. 5.0 software. The top half is orange with the ESA logo in the upper right. Below the logo, the text reads "→ POLSARPRO V. 5.0" and "The Polarimetric SAR Data Processing and Educational Tool". The middle section features a colorful SAR image of a coastal area with buildings and roads. Below the image is a white bar with the URL "http://earth.esa.int/polsarpro". The bottom section is orange with the website "www.esa.int" on the left and "European Space Agency" on the right.

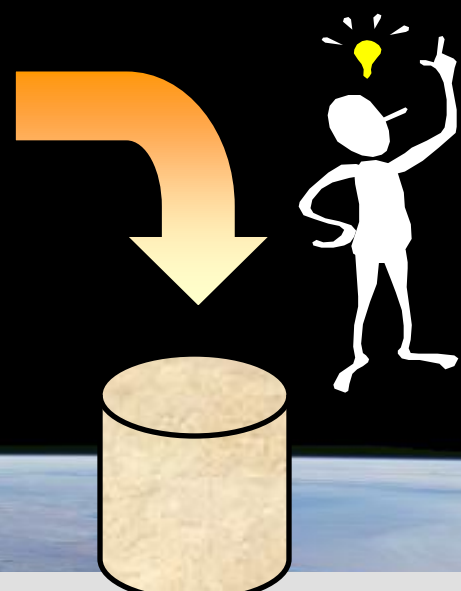
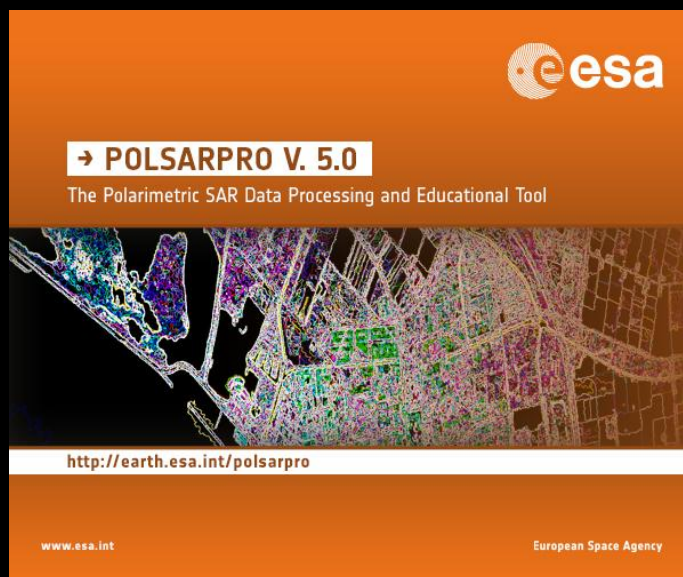
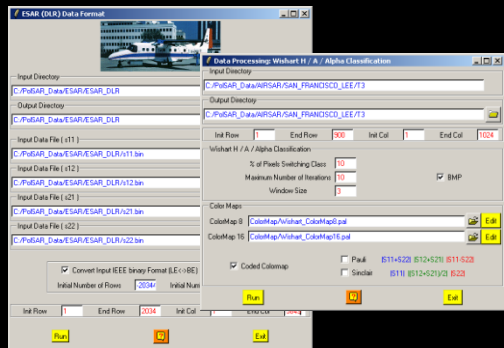
Developed to be **accessible** to :
a wide range of users
from **novices** to **experts**
in the field of **POLSAR** and **POL-InSAR**.



The image shows the cover of the PolSARpro V. 5.0 software. It features an orange header with the ESA logo. Below the logo, the text reads "→ POLSARPRO V. 5.0" and "The Polarimetric SAR Data Processing and Educational Tool". The central part of the cover displays a colorful SAR image of a coastal area with a grid overlay. At the bottom, there is a white bar with the URL "http://earth.esa.int/polsarpro" and an orange footer with "www.esa.int" and "European Space Agency".

MODULAR STRUCTURE

Each element of the Software (a function) can be **extracted** and **incorporated** individually into **users'** own processing software.



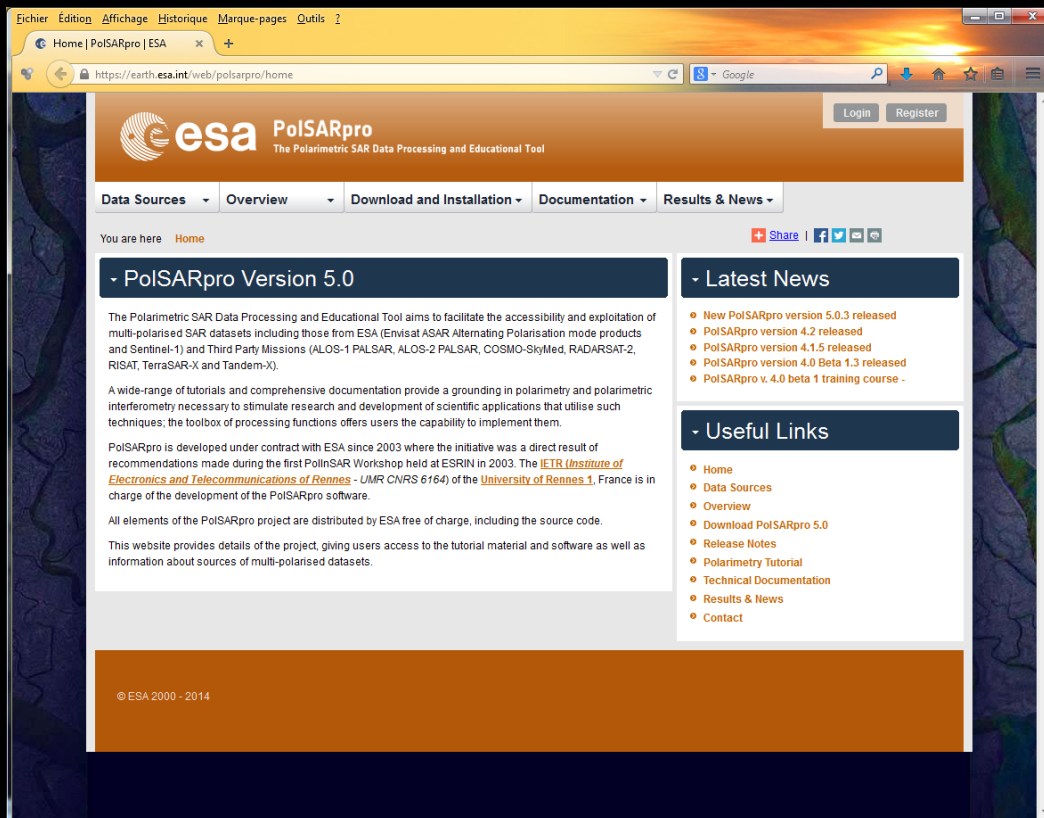
ESA Official Use



<http://earth.esa.int/web/polsarpro/home>

The Web Site provides

- Details of the project
- Access to the tutorial and software
- Information about status of the development
- **Demonstration Sample Datasets**



Team & Contributors



PolSARpro v5.0 Contributors

Universities

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University of Illinois at Chicago (US) (W.M. Boerner)	University of Pisa (IT) (R. Paladini)
Niigata University (JP) (Y. Yamaguchi, S.G. Park)	University of Tohoku - Sendai (JP) (M. Sato)
Universidad de Alicante (SP) (J.M. Lopez Sanchez)	Universite Paris Est - Marnes la Vallee (FR) (P.L. Frison)
ETH Zurich (CH) (I. Hajsek, A. Marino)	University of Tsinghua (CN) (J. Yang, W. An, Y. Cui, J. Chen)
Indian Institute of Technologies, Bombay (Y.S. Rao)	Polimi - Milan (IT) (S. Tebaldini)
Harbin Institute of Technology, Dept.I.E (L. Zhang)	Technische Universitat Berlin (DE) (O. D'Hondt, S. Guillaso)

Research Centers

Applied Electromagnetic Consultants (UK) (S.R. Cloude)	Naval Research Laboratory (US) (T. Ainsworth, J.S. Lee)
Institute of Electronics - CAS (CN) (W. Hong, Y. Li, M. Xiang)	National Resources Canada (CA) (R. Touzi)
Institute of Forest Resources Information Techniques - CAF (CN) (E. Chen, Z. Li)	Center for Earth Observation and Digital Earth - CAS (CN) (X. Li, C. Wang)
Marc Williams Consultants (AU) (M. Williams)	Remote Sensing Technology Center of Japan (JP)
GIPSA Lab - UMR 5216 (FR) (G. Vasile)	Alaska SAR Facility (US) (R. Gens, D.K. Artwood)
Center of Studies in Resources Engineering (IN) (Y.S. Rao)	SERTIT (FR) (H. Yesou)
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Deutschen Zentrums für Luft- und Raumfahrt (DE) (I. Hajsek, K. Papathanassiou, A. Reigber)	Centre National d'Etudes Spatiales (FR) (J.C. Souyris)

Version 5.0.3 (October 2014)

Exit







Dual-Pol / Quad-Pol Sensors

PoISARpro v5.1 SOFTWARE





→ POLSARPRO V. 5.0
The Polarimetric SAR Data Processing and Educational Tool



<http://earth.esa.int/polsarpro>

www.esa.int European Space Agency

AIRSAR



ONERA



SETHI



PISAR

NASDA
CRL



EMISAR



CONVAIR

ESAR - FSAR



UAV-SAR



PoISARpro v5.1 Software offers the possibility to handle and convert polarimetric data from a range of well established **polarimetric airborne platforms.**

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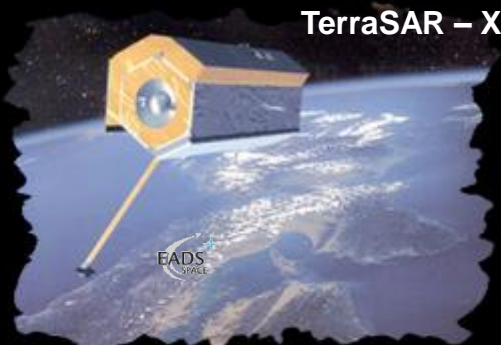
PoISARpro v5.1 SOFTWARE



→ **POLARPRO V. 5.0**
The Polarimetric SAR Data Processing and Educational Tool

<http://earth.esa.int/polsarpro>

www.esa.int European Space Agency



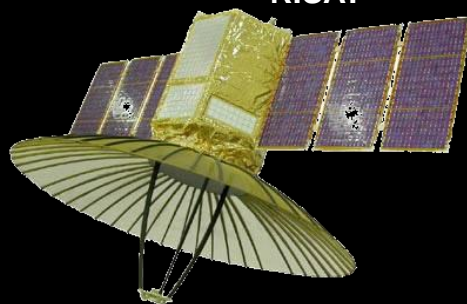
PoISARpro v5.1 Software offers the possibility to handle and convert polarimetric data from a range of well established polarimetric spaceborne platforms.

PoISARpro v5.1 SOFTWARE

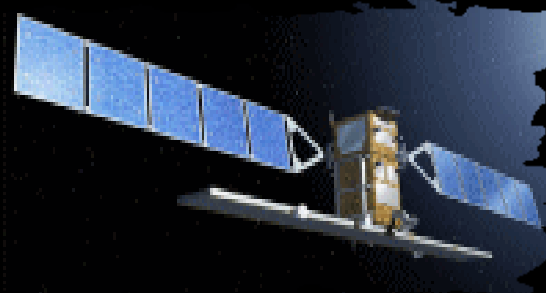


esa
→ POLARSARPRO V. 5.0
The Polarimetric SAR Data Processing and Educational Tool
<http://earth.esa.int/polsarpro>
www.esa.int European Space Agency

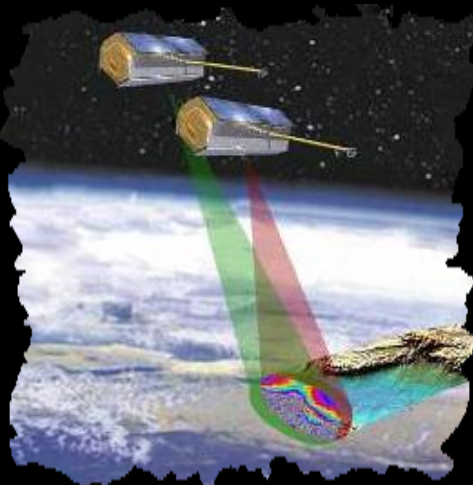
RISAT



SENTINEL 1A



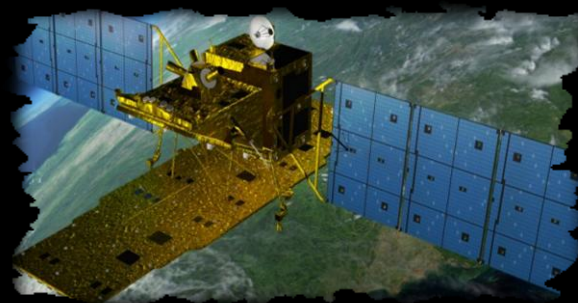
TANDEM-X



COSMO - SKYMED



ALOS-2 – PALSAR



PoISARpro v5.1 Software offers the possibility to handle and convert polarimetric data from a range of well established **polarimetric spaceborne platforms.**

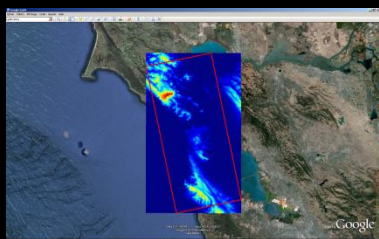
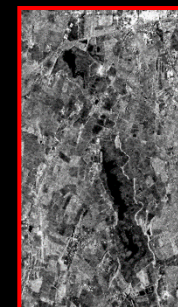
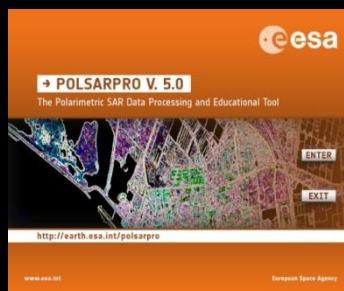
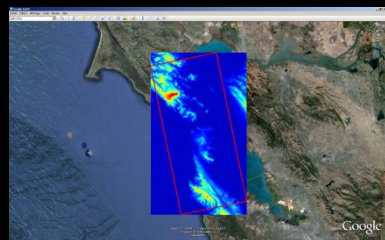
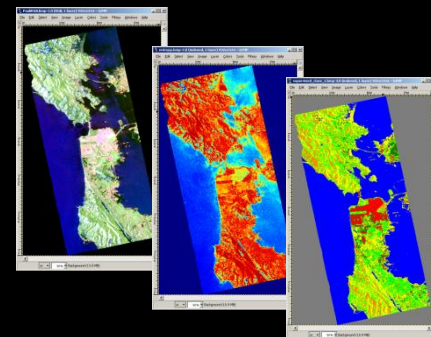
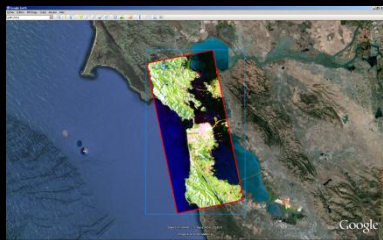
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External Softwares

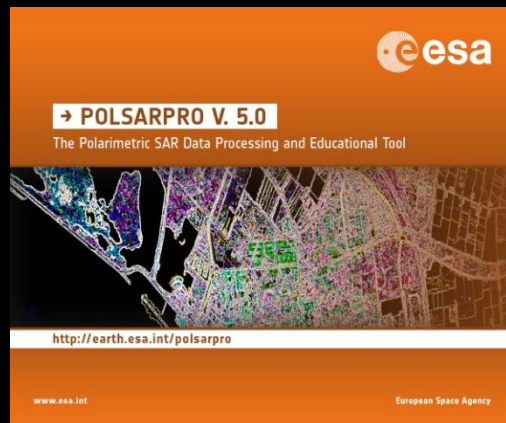
PolSARpro v5.1 SOFTWARE



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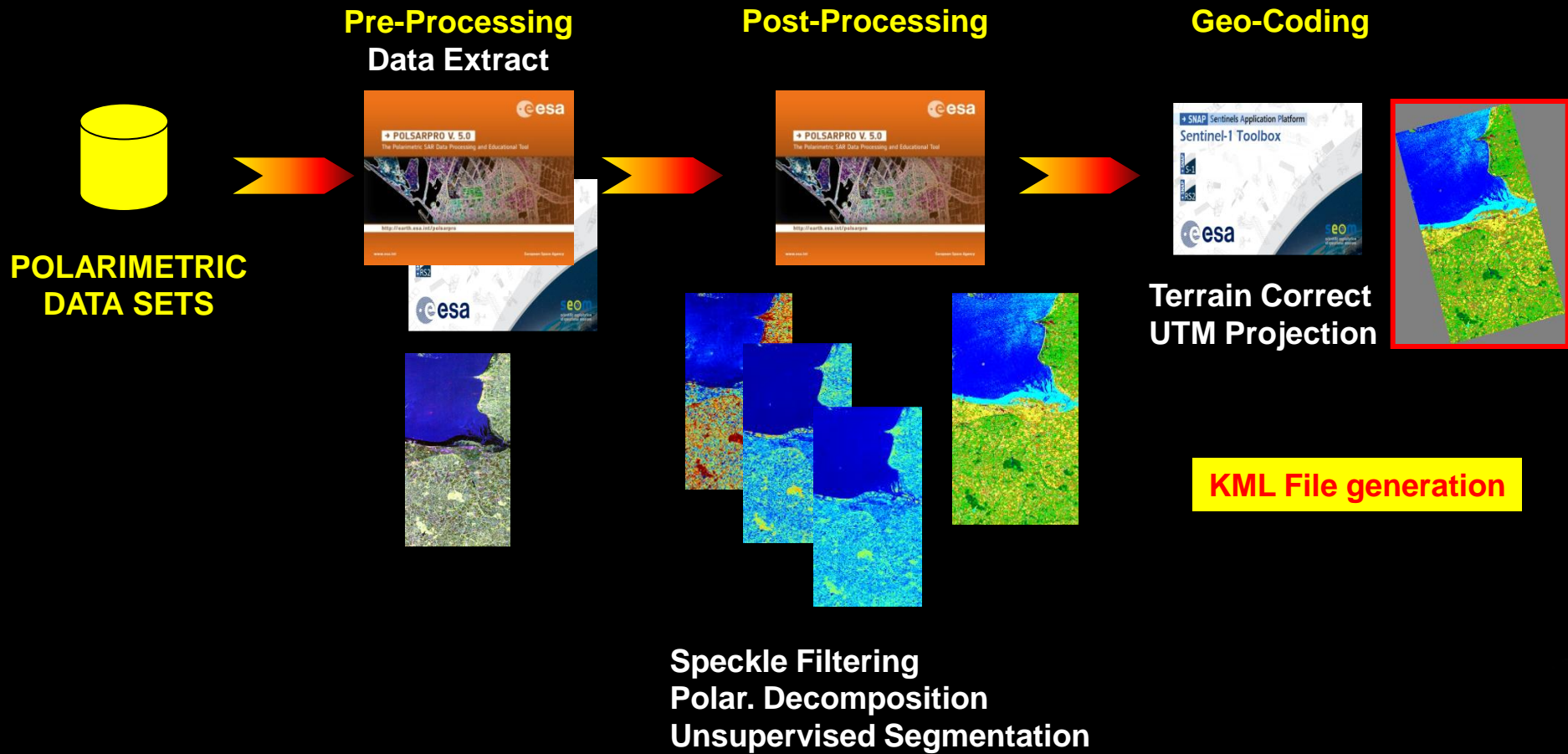


Polariametric Data Processing

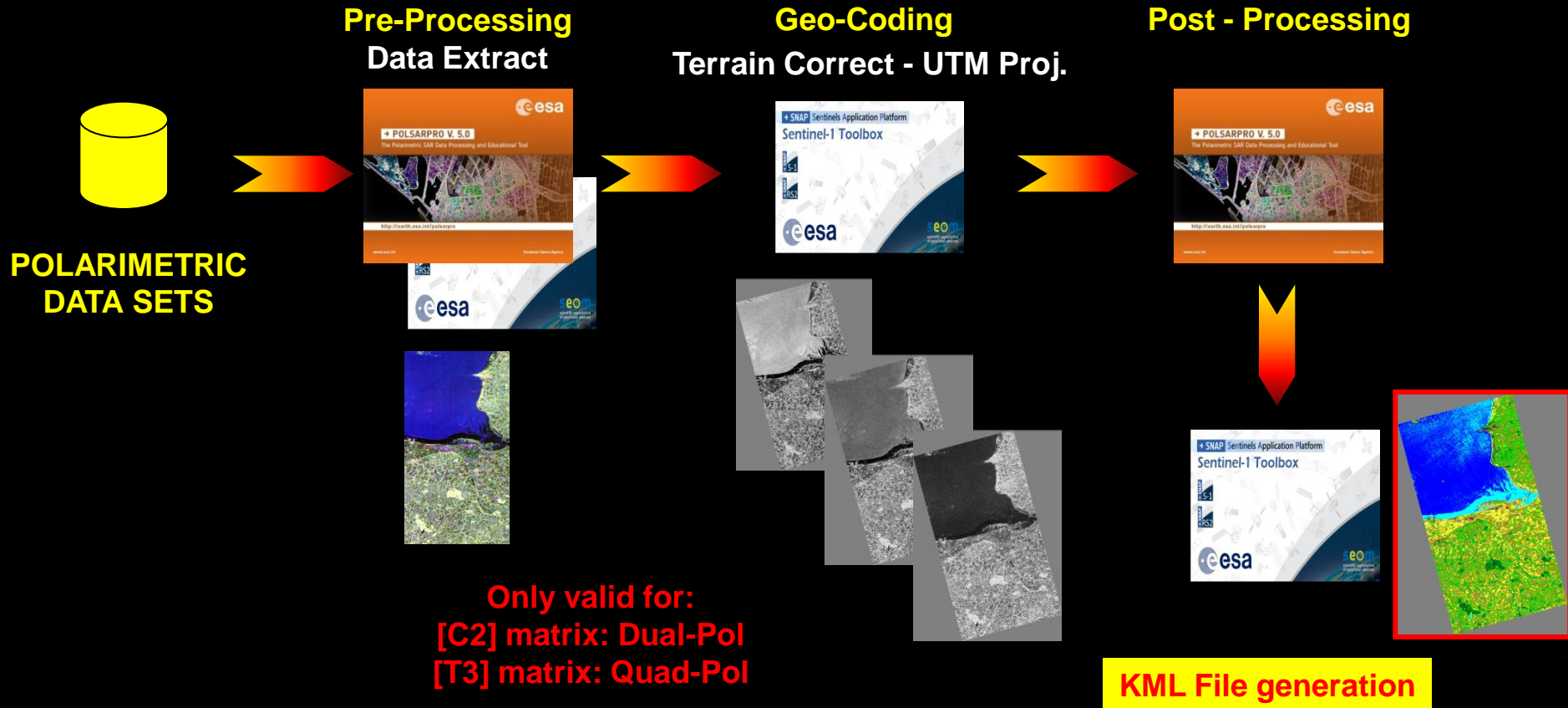


- S1 toolbox (split, deburst, merge ...)
- Geocoding toolbox
- Interferometric toolbox (co-registration, flat Earth estimation ...)

ESA - SNAP



ESA - SNAP





Software – General Presentation

PoISARpro v5.1 SOFTWARE



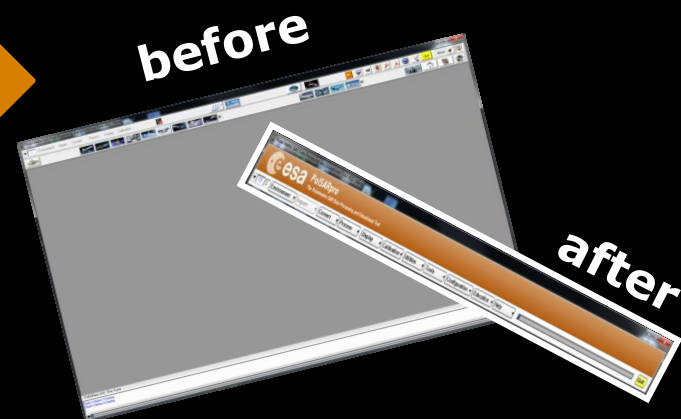
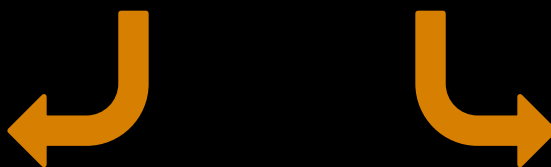
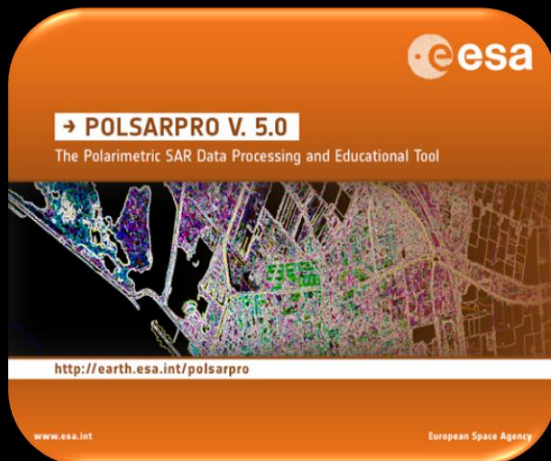
WHAT IS NEW IN THE VERSION v5.1 ?

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PoLSARpro v5.1 SOFTWARE



A NEW ENGINE

A NEW DESIGN

ESA



European Space Agency



Development of PoISARpro functionalities (ESA funded study)



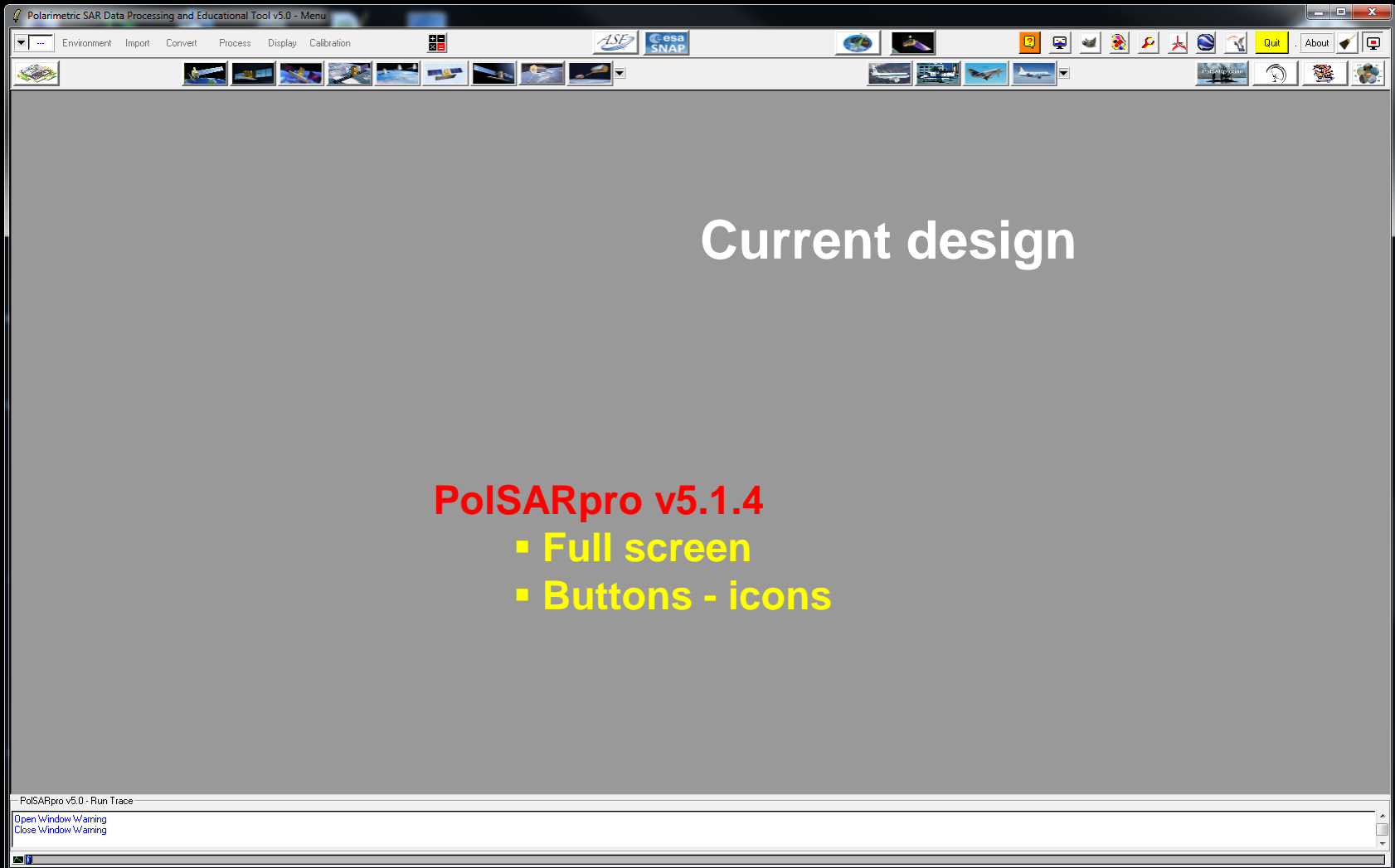
GPU



**Multi-core
CPU**



PolSARpro v5.1 SOFTWARE



PolSARpro v5.1 SOFTWARE



The screenshot shows the PolSARpro website homepage. At the top left is the ESA logo and the text "PolSARpro The Polarimetric SAR Data Processing and Educational Tool". On the top right are "Login" and "Register" buttons. Below this is a navigation menu with items: "Data Sources", "Overview", "Download and Installation", "Documentation", and "Results & News". A breadcrumb trail shows "You are here Home". A "Share" button with social media icons is present. Two main content boxes are visible: "PolSARpro Version 5.0" with a sub-header "The Polarimetric SAR Data Processing and Educational Tool aims to facilitate the accessibility and exploitation of" and "Latest News" with a sub-header "New PolSARpro version 5.0.3 released".



The screenshot shows the software menu bar for "Polarimetric SAR Data Processing and Educational Tool v5.1 - Menu". It features the ESA logo and "PolSARpro The Polarimetric SAR Data Processing and Educational Tool" text. The menu items are: "C2", "S", "Environment", "Import", "Convert", "Process", "Display", "Calibration", "Utilities", "Tools", "Configuration", "Education", and "Help".

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PolSARpro v5.1 SOFTWARE



New design

- Full screen → Banner
- Buttons – icons → Buttons - Functionalities

↓

Objective

To minimize the data flow towards a Virtual Machine (ex ESA - GPOD)



PolSARpro v5.1 SOFTWARE



The screenshot shows a Windows desktop environment. The desktop background is a colorful, abstract image. The taskbar at the bottom contains several application icons. A dialog box titled "Data Processing: H / A / Alpha Decomposition Parameters" is open in the center of the screen. The dialog box has the following fields and options:

- Input Directory: C:/ASF/T3
- Output Directory: C:/ASF
- Init Row: 1, End Row: 14416, Init Col: 1, End Col: 2823
- Checkboxes for processing options:
 - Alpha, Beta, Delta, Gamma, Lambda
 - Lambda
 - Alpha
 - Entropy (H)
 - Anisotropy (A)
 - Combinations (H, A)
 - H A
 - H (1 - A)
 - (1 - H) A
 - (1 - H) (1 - A)
- Output format: BMP
- Buttons: Run, Select All, Reset, Exit
- Checkbox: Equivalence between [T] and [C] eigen-decompositions.

Widget on the desktop



PolSARpro v5.1 SOFTWARE

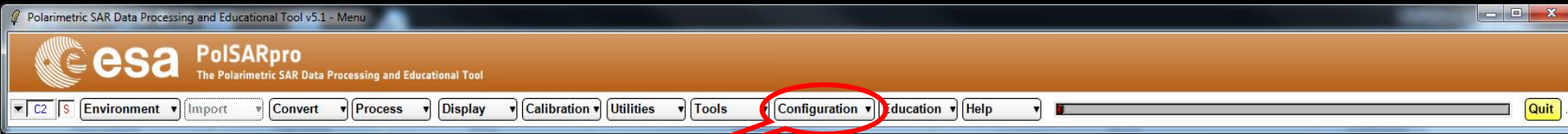


The screenshot displays the PolSARpro v5.1 software interface, which is designed to run on a Windows operating system. The main window features a menu bar with options: File, Environment, Import, Convert, Process, Display, Calibration, Utilities, Tools, Configuration, Education, Help, and Quit. Below the menu bar is a toolbar with icons for various functions. The desktop background shows several application icons, including Adobe Acrobat, Freemake Video Converter, Oracle VM VirtualBox, FidoCADJ 0.24.3, PAPERCRAFT.zip, Cygwin, HP Officejet Pro 8100, scilab-5.1.1, ImageMagick Display, WinMerge, ENVI + IDL 4.5, iTunes, Skype, linux-installer-..., WinSCP, ENVI 4.5, KiCad, VLC media player, mapready, Wordpad-XP, ENVI Zoom 4.5, MATLAB R12, Firefox pour Sirius, Matlab-IDL.pdf, BlackBerry Desktop..., ExpressPCB, Mozilla Firefox, AVS Video Converter, MP3 Wave Converter, and DriverDoc. Two windows are open, showing SAR data processing results. The left window displays a color-coded SAR image with a scale from 0 to 4000. The right window displays another SAR image with a scale from 0 to 1400. A yellow arrow points to the ENVI 4.5 icon on the desktop, and another yellow arrow points to the ENVI 4.5 window title bar.

Possibility to run other s/w (ENVI or Gimp for ex) and to have directly access to the different s/w



PoISARpro v5.1 SOFTWARE



- PoISARpro configuration
- SNAP S1-TBX
- GIMP
- GOOGLE EARTH
- Image Magick
- PDF Reader

PoISARpro : Configuration Panel

ALLOCATED MEMORY (RAM) SIZE (in Mb)

MAIN SCREEN Top Banner Full Screen

WIDGET POSITION Corner Center

DISPLAY "PROCESSING" WIDGET yes no

THUMBNAILS RESIZE FACTOR

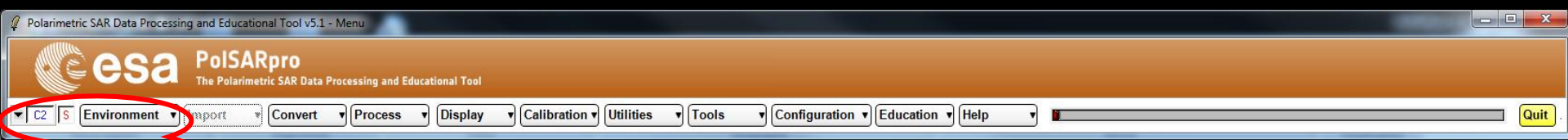
AUTOMATIC DISPLAY OF GENERATED BMP and RGB FILES WITH :
 no
 Gimp
 MapAlgebra

DISPLAY "RUN TRACE" WIDGET yes no

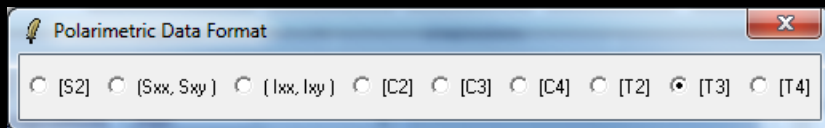
WIDGET SIZE / SCREEN ADJUST



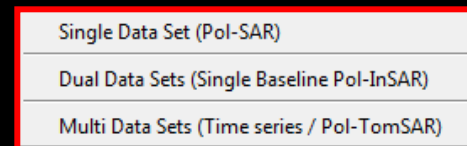
PolSARpro v5.1 SOFTWARE



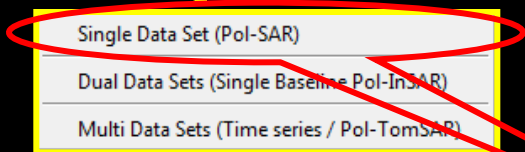
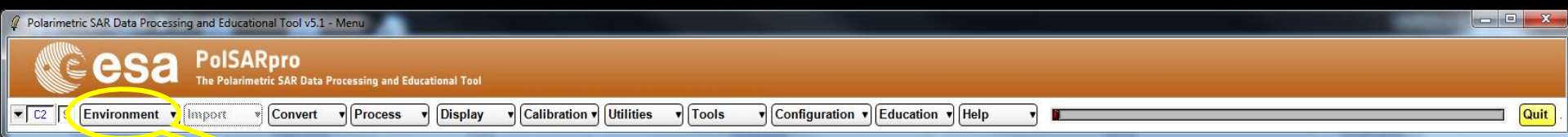
Polarimetric Data Format



DataSet Type



PolSARpro v5.1 SOFTWARE



PolSARpro v5.1 SOFTWARE



Polarimetric SAR Data Processing and Educational Tool v5.1 - Menu

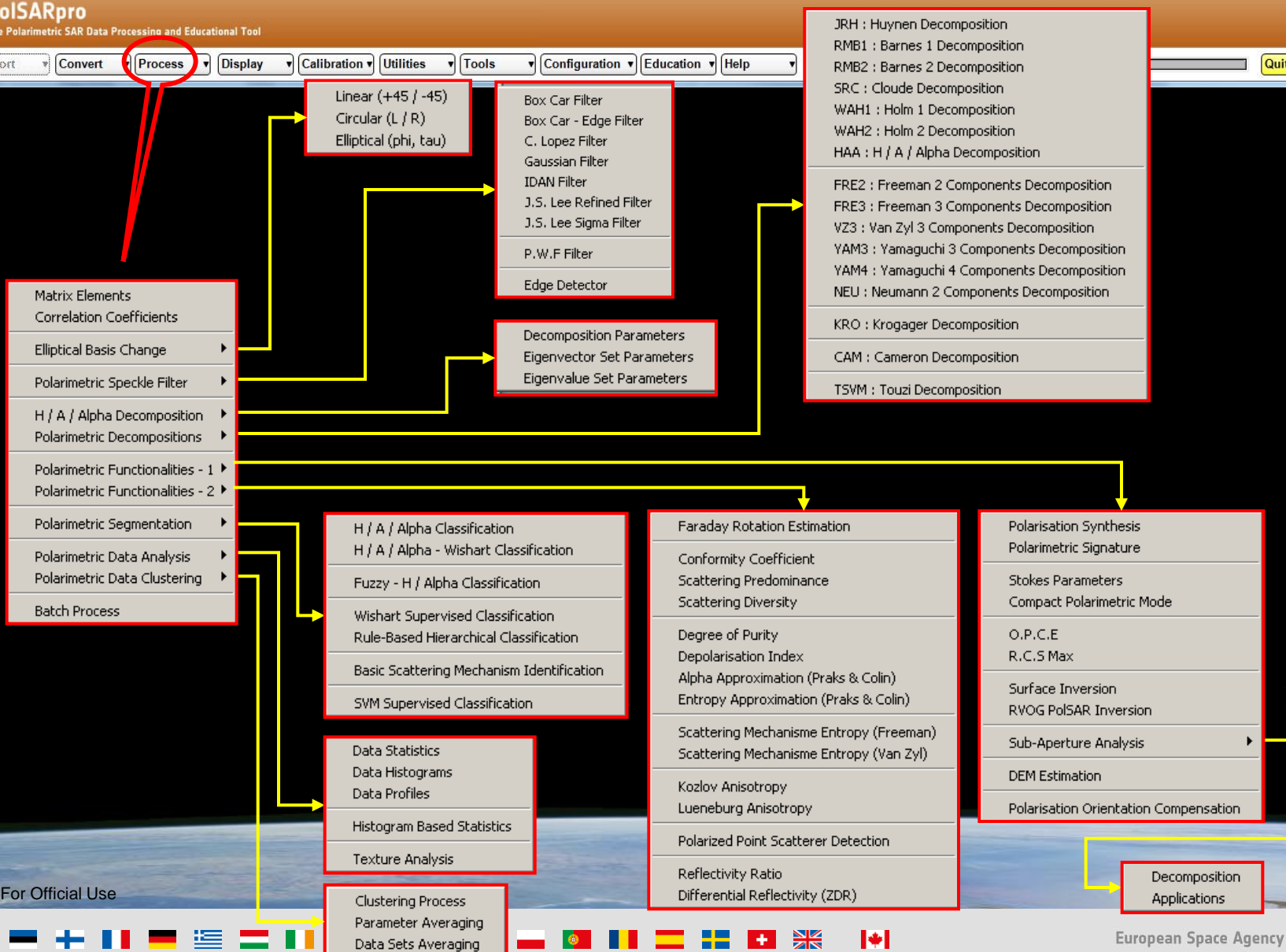


PolSARpro

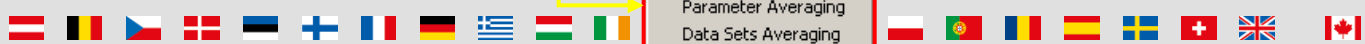
The Polarimetric SAR Data Processing and Educational Tool

- Environment
- Import
- Convert
- Process**
- Display
- Calibration
- Utilities
- Tools
- Configuration
- Education
- Help

Quit

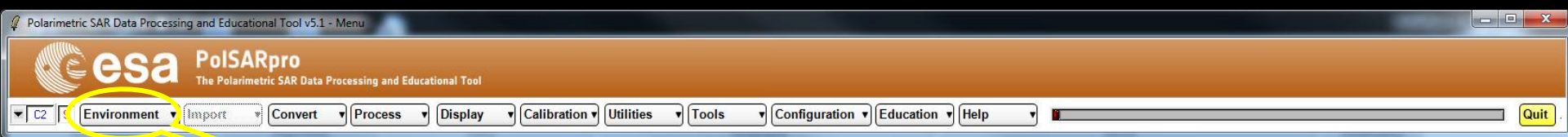


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PolSARpro v5.1 SOFTWARE



- Single Data Set (Pol-SAR)
- Dual Data Sets (Single Baseline Pol-InSAR)
- Multi Data Sets (Time series / Pol-TomSAR)

Environment

Main Input Master Directory
C:/POLinSAR Training_Course/Master_Track

Main Input Slave Directory
C:/POLinSAR Training_Course/Slave_Track

Binary Data Check ENVI Config File NEST MetaData File

Display Size
Rows: 844 Columns: 844 **Save**

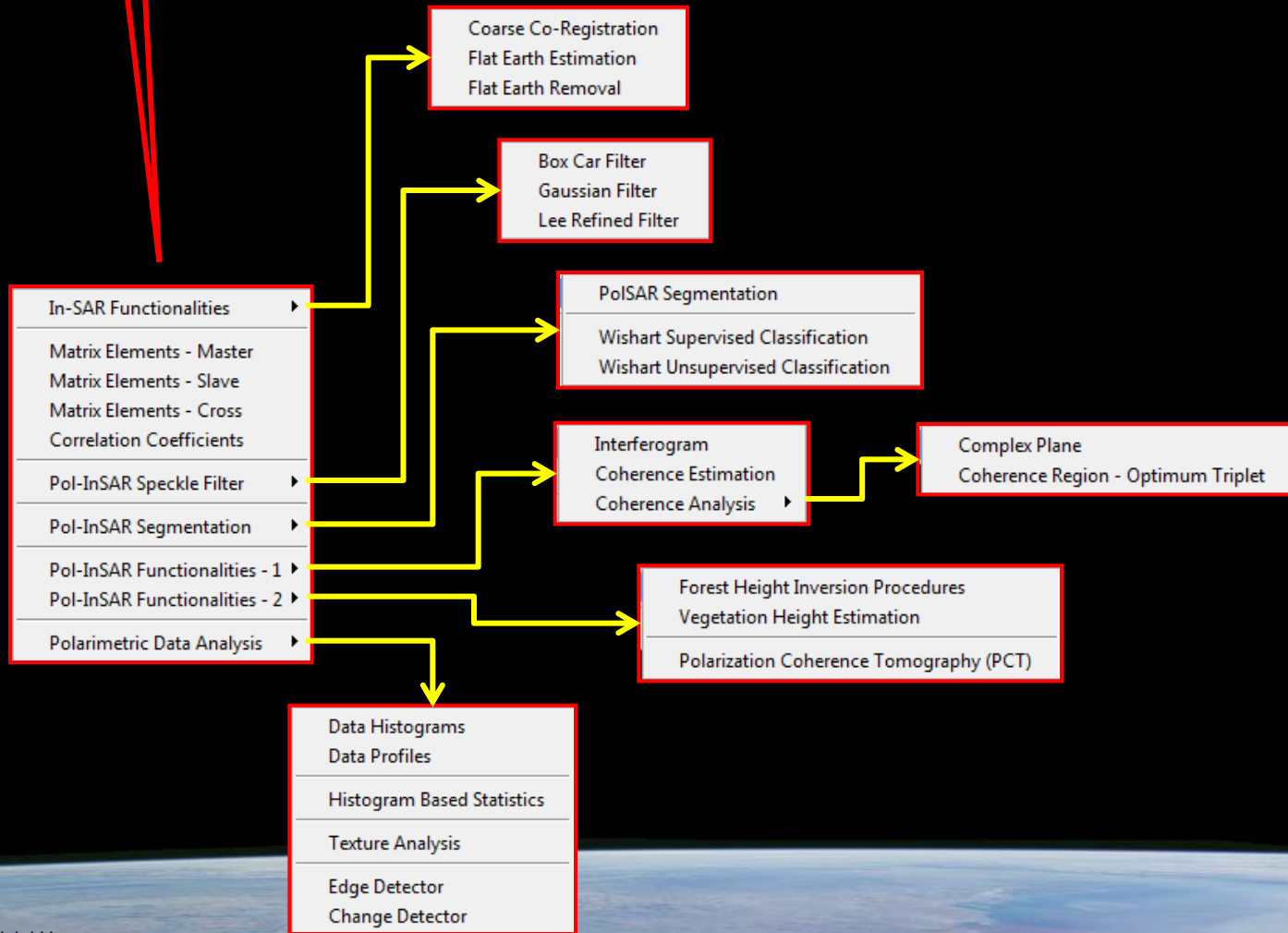
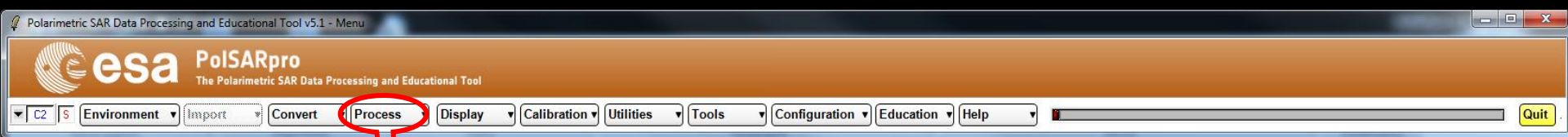
Color Maps

Unsupervised ColorMap8	Single ColorMap9	DbL_Vol_Sgl ColorMap27
Unsupervised ColorMap9	Double ColorMap9	Random ColorMap32
Unsupervised ColorMap16	Volume ColorMap9	

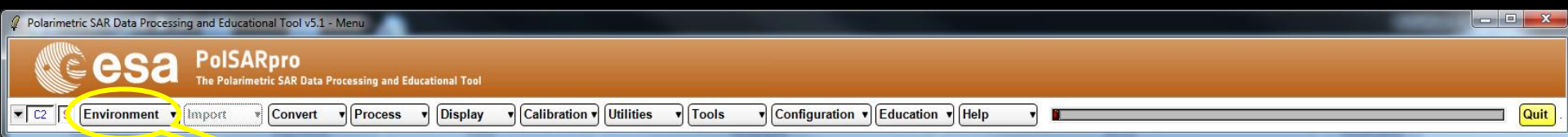
Exit



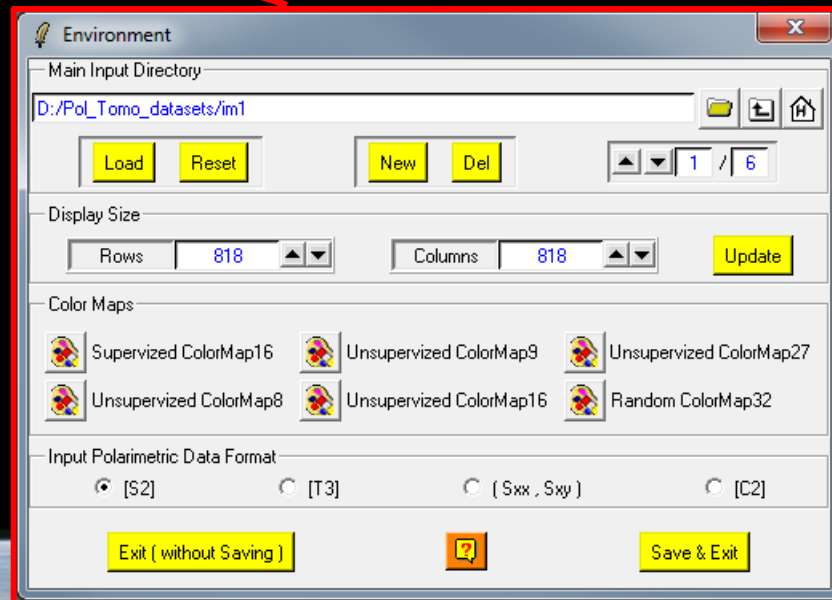
PoISARpro v5.1 SOFTWARE



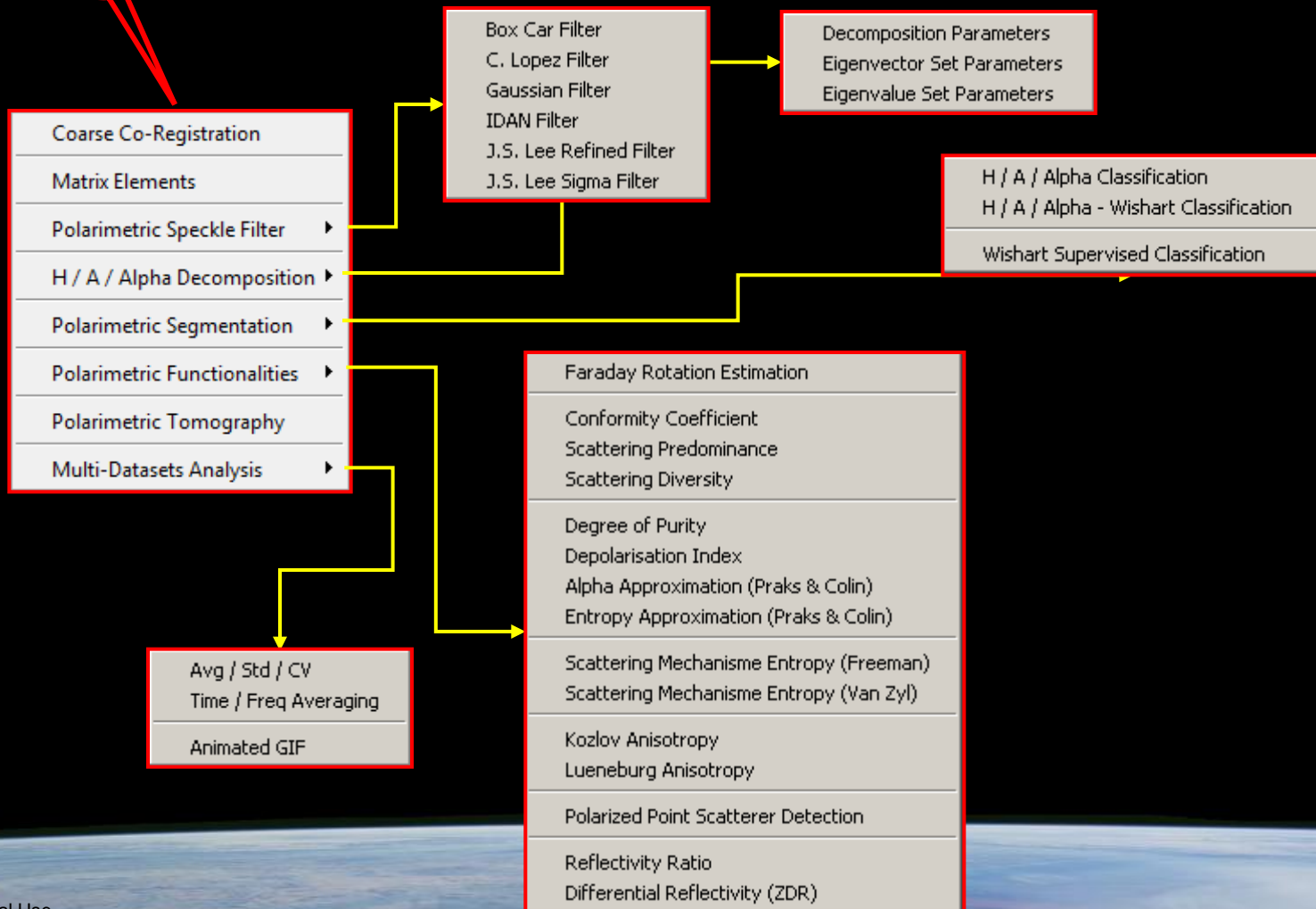
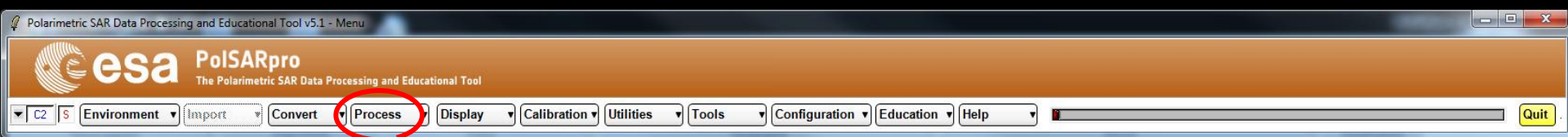
PolSARpro v5.1 SOFTWARE



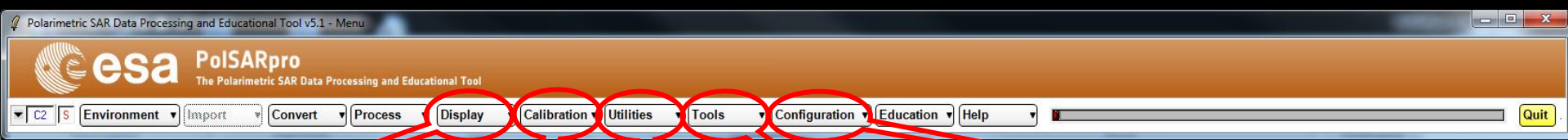
- Single Data Set (Pol-SAR)
- Dual Data Sets (Single Baseline Pol-InSAR)
- Multi Data Sets (Time series / Pol-TomSAR)



PolSARpro v5.1 SOFTWARE



PolSARpro v5.1 SOFTWARE



Display

- Create BMP File
- Create RGB File
- Create HSL File
- Create KML File
- Create Anim GIF File
- Create Gray & Color BMP File
- Create Scatter Plot
- Create Tomogram Display
- Convert BMP File
- Process 1 BMP File
- Display N BMP Files
- SATIM Map Algebra

Exit

Calibration

- Calibrator Assessment
- Calibration Procedures
- Calibration - Squint Check
- Calibration - Data Quality Check HV.VH*

Utilities

- PolSARpro - Calculator
- PolSARpro - Display
- PolSARpro - SIM
- PolSARpro - Viewer
- SATIM Map Algebra
- SNAP - S1 TBX
- SRTM
- ASTER
- GIMP
- GOOGLE EARTH
- Close All Widgets

Tools

- Data Set Management
- Data File Management
- Directory Management
- My Function

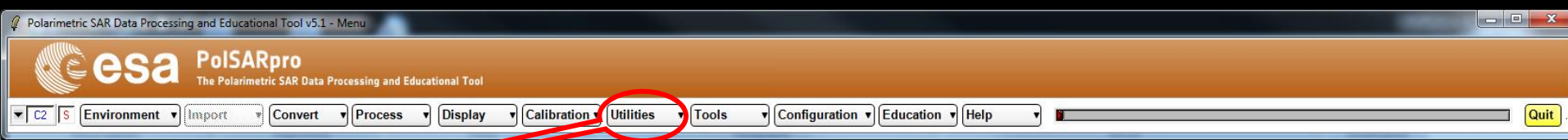
Exit

Configuration

- PolSARpro configuration
- SNAP S1-TBX
- GIMP
- GOOGLE EARTH
- Image Magick
- PDF Reader



PoISARpro v5.1 SOFTWARE



- PoISARpro - Calculator
- PoISARpro - Display
- PoISARpro - SIM
- PoISARpro - Viewer
- SATIM Map Algebra
- SNAP - S1 TBX
- SRTM
- ASTER
- GIMP
- GOOGLE EARTH
- Close All Widgets

PoISARpro Calculator v1.0

Op #1 (/Op#1) Operator (/Op#2) Op #2

Operand #1

File Mat S / M 2x2 mat 3x3 mat 4x4 mat

STO RCL MC AC

Input File

Input File Data Format Init Row End Row Init Col End Col

Input Matrix Directory

Input Matrix Data Format Init Row End Row Init Col End Col

Input Value Type Complex Value Float Value Integer Value Input Value +j

N x N Matrix

Complex Float Hermitian Special Unitary

m11	<input type="text"/>	+j	<input type="text"/>	m12	<input type="text"/>	+j	<input type="text"/>	m13	<input type="text"/>	+j	<input type="text"/>	m14	<input type="text"/>	+j	<input type="text"/>
m21	<input type="text"/>	+j	<input type="text"/>	m22	<input type="text"/>	+j	<input type="text"/>	m23	<input type="text"/>	+j	<input type="text"/>	m24	<input type="text"/>	+j	<input type="text"/>
m31	<input type="text"/>	+j	<input type="text"/>	m32	<input type="text"/>	+j	<input type="text"/>	m33	<input type="text"/>	+j	<input type="text"/>	m34	<input type="text"/>	+j	<input type="text"/>
m41	<input type="text"/>	+j	<input type="text"/>	m42	<input type="text"/>	+j	<input type="text"/>	m43	<input type="text"/>	+j	<input type="text"/>	m44	<input type="text"/>	+j	<input type="text"/>

Output Value +j

Operator : File

- (file) + value
- (file) - value
- (file) * value
- (file) / value
- (file) .+ (file)
- (file) .- (file)
- (file) .* (file)
- (file) ./ (file)
- .real (.)
- .imag (.)
- .arg (.)
- .abs (.)
- .cos (.)
- .sin (.)
- .tan (.)
- .conj (.)
- .acos (.)
- .asin (.)
- .atan (.)
- .boxcar {?x?}
- .sqrt (.)
- .(.)^2
- .(.)^3
- .(.)^(?)
- .log (1.1)
- .ln (1.1)
- .10^(.)
- .exp (.)
- .10log (1.1)
- .20log (1.1)
- .(.) < {?}
- .(.) > {?}

Operator : Sinclair Matrix : S2

- [S] + value
- [S] - value
- [S] * value
- [S] / value
- [S] .+ (file)
- [S] .- (file)
- [S] .* (file)
- [S] ./ (file)
- [S] .+ [S']
- [S] .+ [mat]
- [S] .* [S']
- [S] .* [mat]
- [S] .* [S]*
- [U]t .* [S] .* [U]
- .conj [S]
- .tr [S]
- .det [S]
- .inv [S]
- .eig1 [S]
- .eig2 [S]
- .eig1 [G]
- .eig2 [G]

Operator : Hermitian Matrix : C2, C3, C4, T2, T3, T4

- [M] + value
- [M] - value
- [M] * value
- [M] / value
- [M] .+ (file)
- [M] .- (file)
- [M] .* (file)
- [M] ./ (file)
- [M] .+ [M']
- [M] .+ [mat]
- .inv [M]
- [U] .* [M] .* inv [U]
- .conj [M]
- .tr [M]
- .det [M]
- tr (inv [mat] .* [M])
- .eig1 [M]
- .eig2 [M]
- .eig3 [M]
- .eig4 [M]

Operator : Complex / Hermitian / Float / Special Unitary NxN Matrix

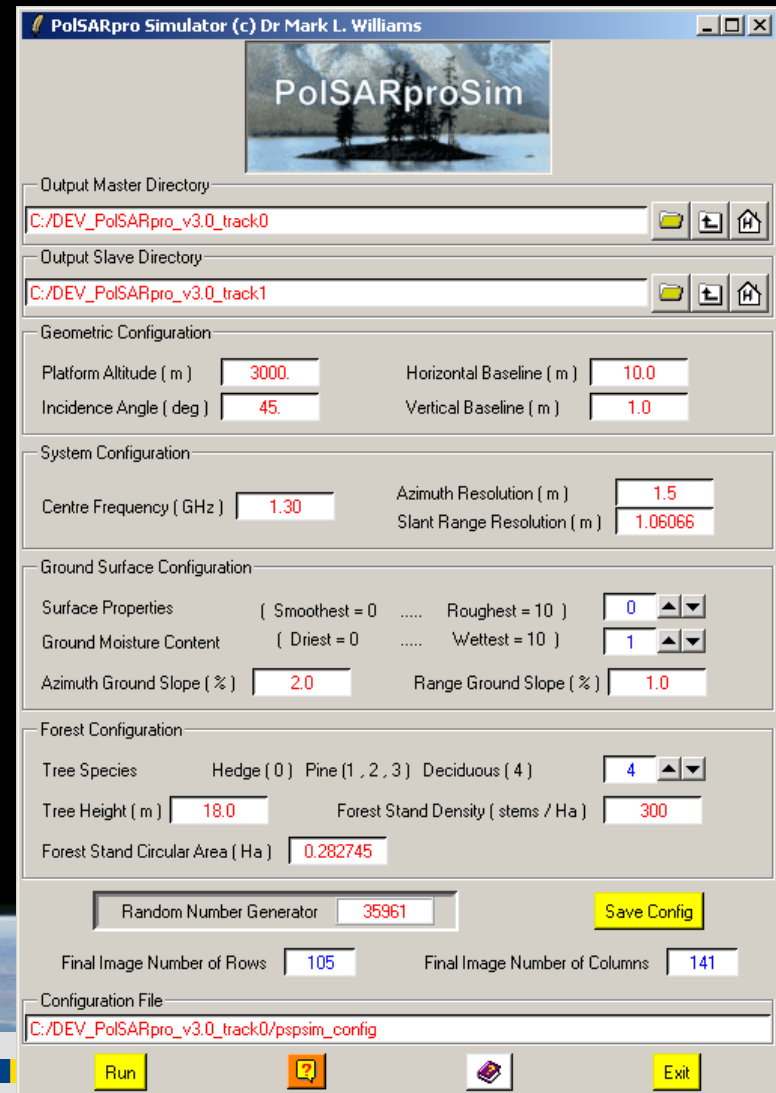
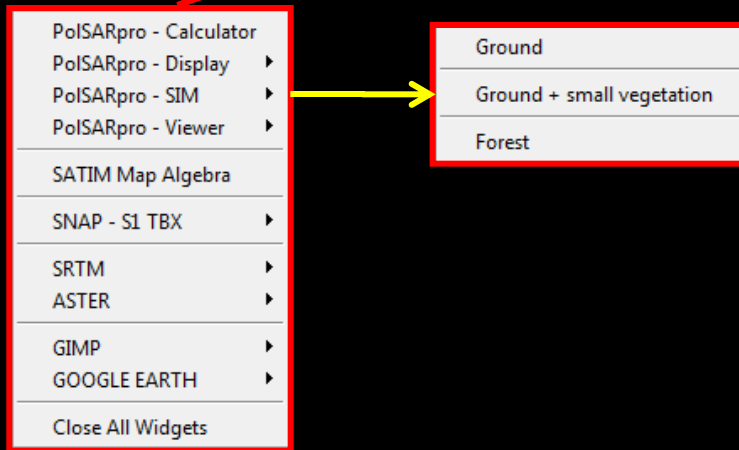
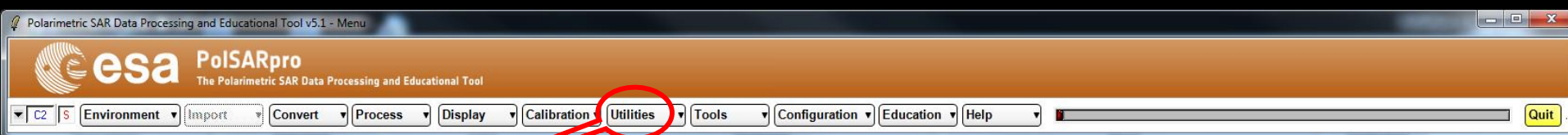
- [mat] + value
- [mat] - value
- [mat] * value
- [mat] / value
- [mat] .+ [mat']
- [mat] .- [mat']
- [mat] .* [mat']
- [mat] ./ [mat']
- .det [mat]
- .tr [mat]
- .conj [mat]
- .inv [mat]
- .eig1 [mat]
- .eig2 [mat]
- .eig3 [mat]
- .eig4 [mat]

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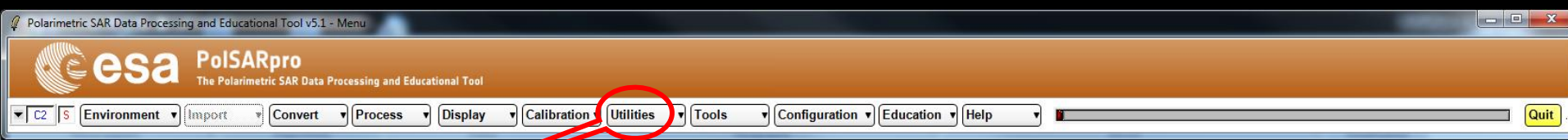
PolSARpro v5.1 SOFTWARE



PolSARproSim is a rapid, coherent, fully polarimetric and interferometric SAR simulation of forest.

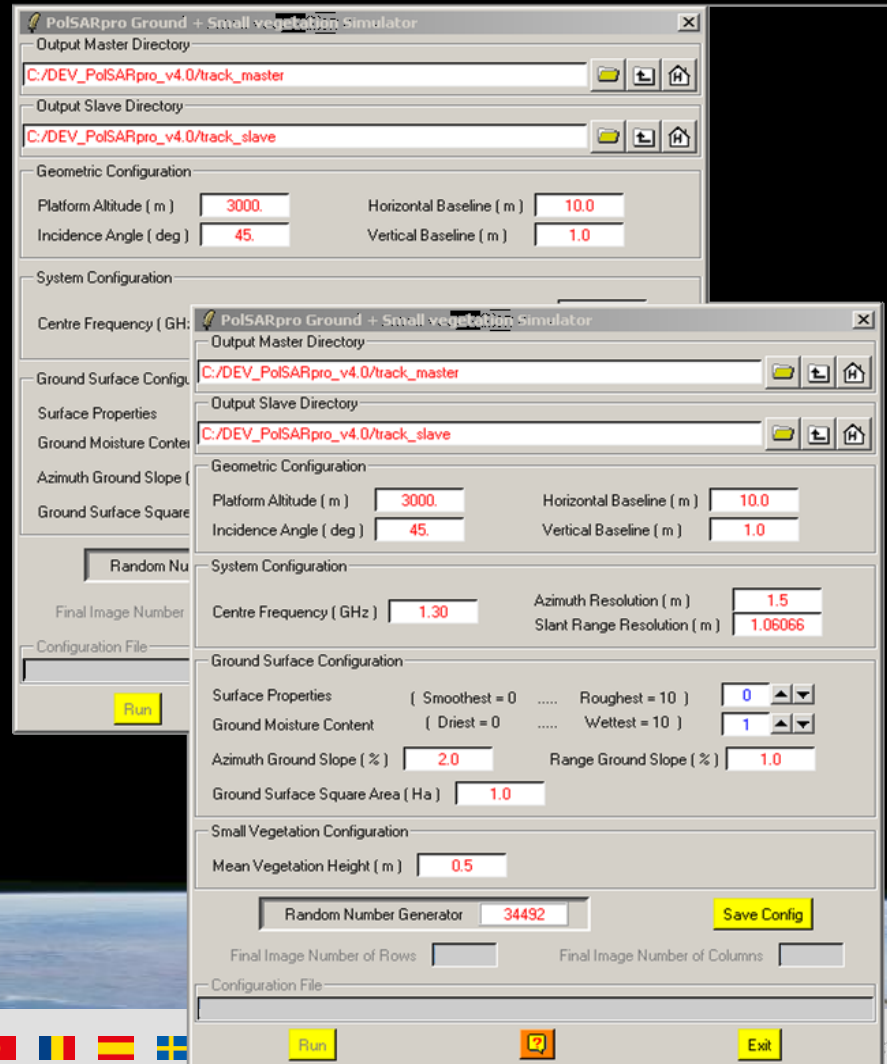


PolSARpro v5.1 SOFTWARE

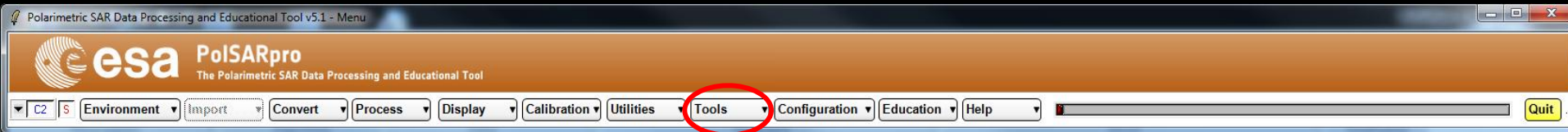


- PolSARpro - Calculator
- PolSARpro - Display
- PolSARpro - SIM
- PolSARpro - Viewer
- SATIM Map Algebra
- SNAP - S1 TBX
- SRTM
- ASTER
- GIMP
- GOOGLE EARTH
- Close All Widgets

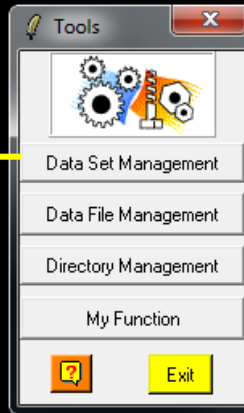
- Ground
- Ground + small vegetation
- Forest



PolSARpro v5.1 SOFTWARE



- Data Binary Check
- Compare Data Directory
- Create Mask Valid Pixels
- IEEE Format Convert
- Sub Data Extraction
- ROI Extraction
- Map Info Update
- Rotation 90 left
- Rotation 90 right
- Rotation 180
- Flip Up-Down
- Flip Left-Right
- Transpose
- Apply FFT
- Apply Mask

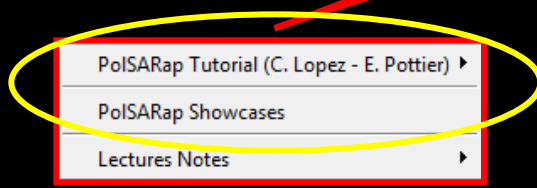
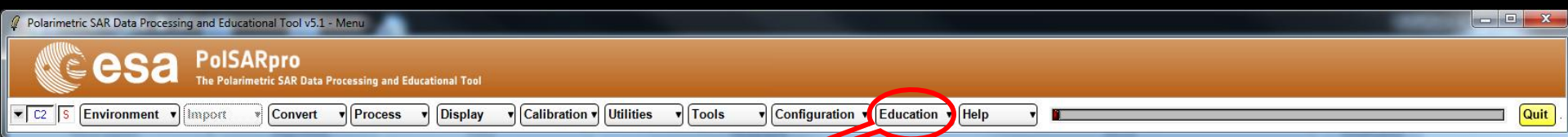


- Data Binary Check
- Compare Binary Files
- Read Binary Data Value
- Copy File
- Delete File
- Rename File
- IEEE Format Convert
- Sub Data Extraction
- Rotation 90 left
- Rotation 90 right
- Rotation 180
- Flip Up-Down
- Flip Left-Right
- Transpose
- Complex Data File
- Create MASK
- Create ENVI (.hdr) File

- Create Directory
- Copy Directory
- Delete Directory
- Rename Directory



PoISARpro v5.1 SOFTWARE

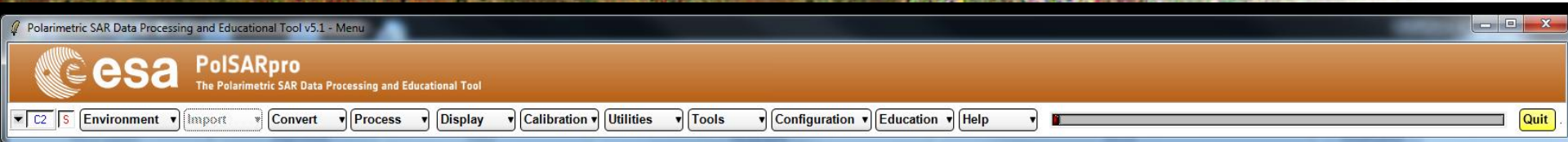


Learning / Training Next P.I Generations

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PoISAR-Ap Project



WP360 : Review and update of the Basic Principles and Applications
(E. Pottier, C. Lopez Martinez)



1 Basic Principles of SAR Polarimetry

C. Lopez Martinez¹, E. Pottier²
¹UPC Barcelona
²University of Rennes-1

1.1 Theory of radar polarimetry

1.1.1 Wave polarimetry

Polarimetry refers specifically to the vector nature of the electromagnetic waves, whereas radar polarimetry is the science of acquiring, processing and analyzing the polarization state of an electromagnetic wave in radar applications. This section summarizes the main theoretical aspects necessary for a correct processing and interpretation of the polarimetric information. As a result, the first part presents the so-called wave polarimetry that deals with the representation and the understanding of the polarization state of an electromagnetic wave. The second part introduces the concept of scattering polarimetry. This concept collects the topic of inferring the properties of a given target, from a polarimetric point of view, given the incident and the scattered polarized electromagnetic waves.

1.1.1.1 Electromagnetic waves and wave polarization descriptors

The generation, the propagation, as well as the interaction with matter of the electric and the magnetic waves are governed by the Maxwell's equations [1]. For an electromagnetic wave that is propagating in the z direction, the real electric wave can be decomposed into two orthogonal components x and y , admitting the following vector formulation:

$$\vec{E}(x,y) = \begin{bmatrix} E_x \\ E_y \\ E_z \end{bmatrix} = \begin{bmatrix} E_{0x} \cos(\alpha x - kz + \delta_x) \\ E_{0y} \cos(\alpha x - kz + \delta_y) \\ 0 \end{bmatrix} \quad (1.1)$$

which may be also considered in a complex form

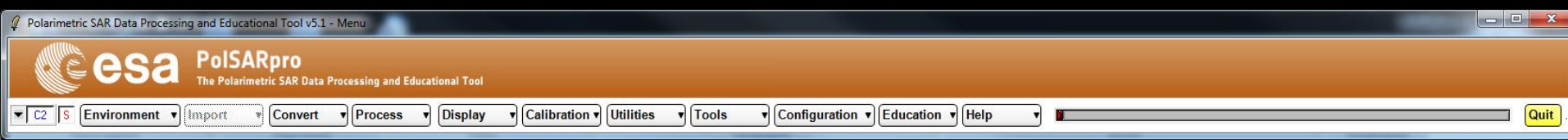
erating a better exploitation of the S), the Wishart distribution allows us model for all the elements of the di) has been exploited for PoISAR ed that if the filtering process is of speckle, depending on the corre- an improved estimation of the dif- the covariance or coherency matri-

Francisco (USA) where the colour code is the LMMSE speckle filter.

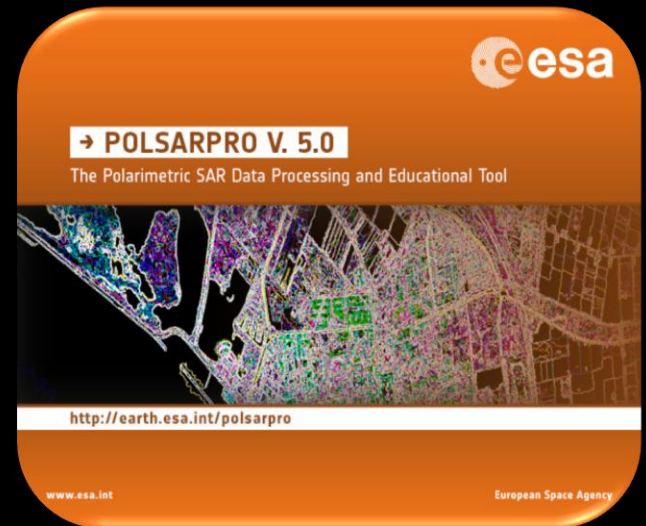
Francisco (USA) where the colour code is: the BPT speckle filter.

Beyond all the PoISAR data filtering techniques presented in this Section, there exist a wide variety of similar approaches in the related literature, where a con-

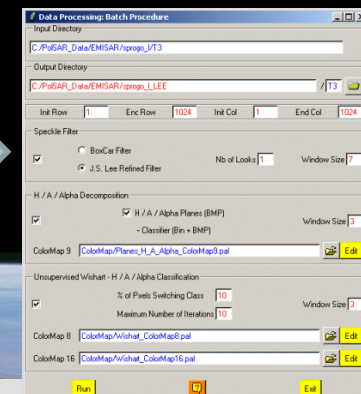
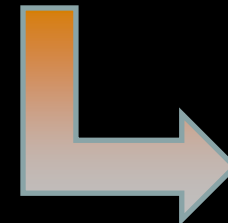
EDUCATIONAL TOOLS



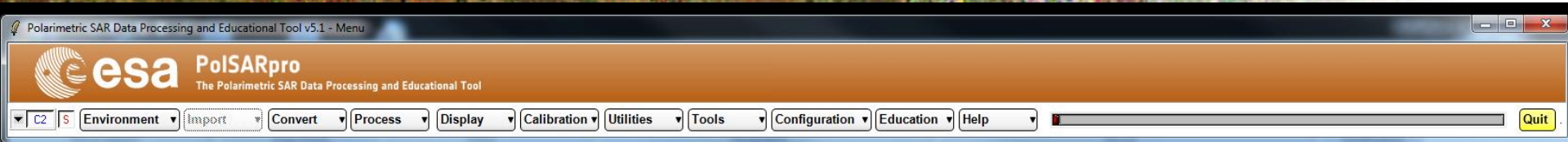
PoSAR-Ap Project



WP260 : Implementation of Selected Applications (E. Pottier)



EDUCATIONAL TOOLS



esa **PoISARpro**
The Polarimetric SAR Data Processing and Educational Tool



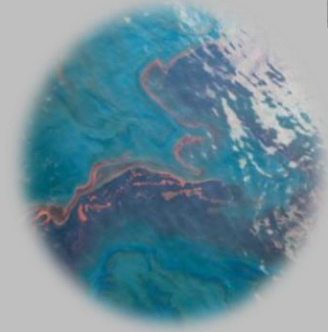
Agriculture



Forest



Ocean

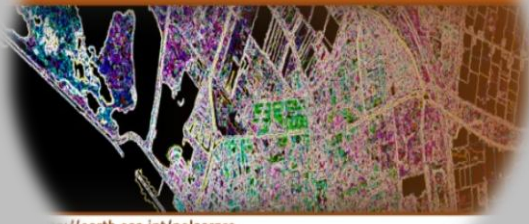


ONERA



Urban

→ **POLSARPRO V. 5.0**
The Polarimetric SAR Data Processing and Educational Tool



<http://earth.esa.int/polsarpro>



Cryosphere



Educational Tools



Polarimetric SAR Data Processing and Educational Tool v5.1 - Menu

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The Polarimetric SAR Data Processing and Educational Tool

Environment Configuration Education Help Quit

PolSAR-ap Showcase : Agriculture

Input Directory: D:/My_Data_Directory/T3

Output Directory: D:/My_Data_Directory / T3

Init Row: 1 End Row: 1544 Init Col: 1 End Col: 928

Decomposition: Window Size (Row) Window Size (Col) Inc Ang Unit: Degrees Radians

Surface Soil Moisture Inversion: Soil Dielectric Constant Max: 40 Increment Angle of the Incidence Angle LUT (deg): 0.1

Dihedral Soil Moisture Inversion: Soil Dielectric Constant Max: Trunk Dielectric Constant Max: Increment Angle of the Incidence Angle LUT (deg):

2D-Incidence Angle File: Enter 2D Incidence Angle File

2D Mask File: Enter (showcase_agri_mask.bin) file

Polarimetric Decomposition fs File: Enter (showcase_agri_fs.bin) file

Polarimetric Decomposition Beta File: Enter (showcase_agri_beta.bin) file

Vertical Roughness Indicator (ks) File (optional):

Output Soil Moisture File: D:/My_Data_Directory/showcase_agri_surf_mv_soil.bin

Output Soil Dielectric Constant File: D:/My_Data_Directory/showcase_agri_surf_dc_soil.bin

Output Trunk Dielectric Constant File:

Run Exit

PolSAR-ap Showcase : Ocean

Input Directory: D:/My_Data_Directory/T3

Output Directory: D:/My_Data_Directory / T3

Init Row: 1 End Row: 1544 Init Col: 1 End Col: 928

Window Size - Train: Row: 51 Col: 51 Window Size - Test: Row: 9 Col: 9

Geometric Perturbation Filter: Threshold: 0.98 Reduction Ratio (RedR): 0.0025

Output Coherence File: D:/My_Data_Directory/ocean_coherence.bin

Output Mask File: D:/My_Data_Directory/ocean_mask.bin

Run Exit

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Educational Tools



Polarimetric SAR Data Processing and Educational Tool v5.1 - Menu

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C2 S Environment Import Convert Process Display Calibration Utilities Tools Configuration Education Help Quit

PoISAR-ap Showcase : Cryosphere

Input Master - Slave Directory
D:/My_Data_Directory/Master_Dir_Slave_Dir

Output Master - Slave Directory
D:/My_Data_Directory/Master_Dir_Slave_Dir

Init Row 1 End Row 900 Init Col 1 End Col 1024

Decomposition
 Window Size (Row)
 Window Size (Col)

Inc Ang Unit
 Degrees
 Radians

Median Filter
Window Size 8
Max Nb of Iterations 3

Inversion
 Polarization Channel
 HH HV W

Ice Dielectric Constant 2.8 Threshold 40
Range Pixel Spacing (optional) opt

2D Incidence Angle File
Enter 2D Incidence Angle file

2D Kz File
Enter 2D Kz file

Surface to Volume Ratio File
Enter [showcase_cryo_stv_ratio_HH.bin] file

Complex Coherence File
Enter [cmplx_coh_HH.bin] file

SNR Decorrelation File (optional)
Enter SNR Decorrelation file (Optional)

Output Extinction Coefficient File (kappa)
D:/My_Data_Directory/Master_Dir_Slave_Dir/showcase_cryo_kappa_HH.bin

Output Penetration Depth File
D:/My_Data_Directory/Master_Dir_Slave_Dir/showcase_cryo_depth_HH.bin

Run [?] Exit

PoISAR-ap Showcase : Urban

Input Master - Slave Directory
D:/My_Data_Directory/Master_Slave_Dir/T6

Output Master - Slave Directory
D:/My_Data_Directory/Master_Slave_Dir/T6

Init Row 1 End Row 900 Init Col 1 End Col 1024

Complex Coherence File

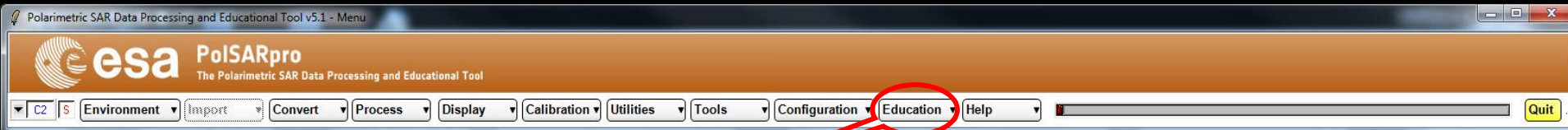
Output File

Run [?] Exit

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PoISARpro v5.1 SOFTWARE



- PoISARap Tutorial (C. Lopez - E. Pottier) ▶
- PoISARap Showcases
- Lectures Notes ▶

- Recent Advances (W.M. Boerner)
- Basic Concepts (W.M. Boerner)
- Advanced Concepts (E. Pottier, J.S. Lee, L. Ferro-Famil)
- Polarimetric SAR Interferometry (S.R. Cloude, K. Papathanassiou) ▶
- Surface Parameter Retrieval (I. Hajnsek, K. Papathanassiou) ▶



- Single vs multi polarization interferometry
- Pol-InSAR (Training Course)
- Polarization Coherence Tomography (Training Course)

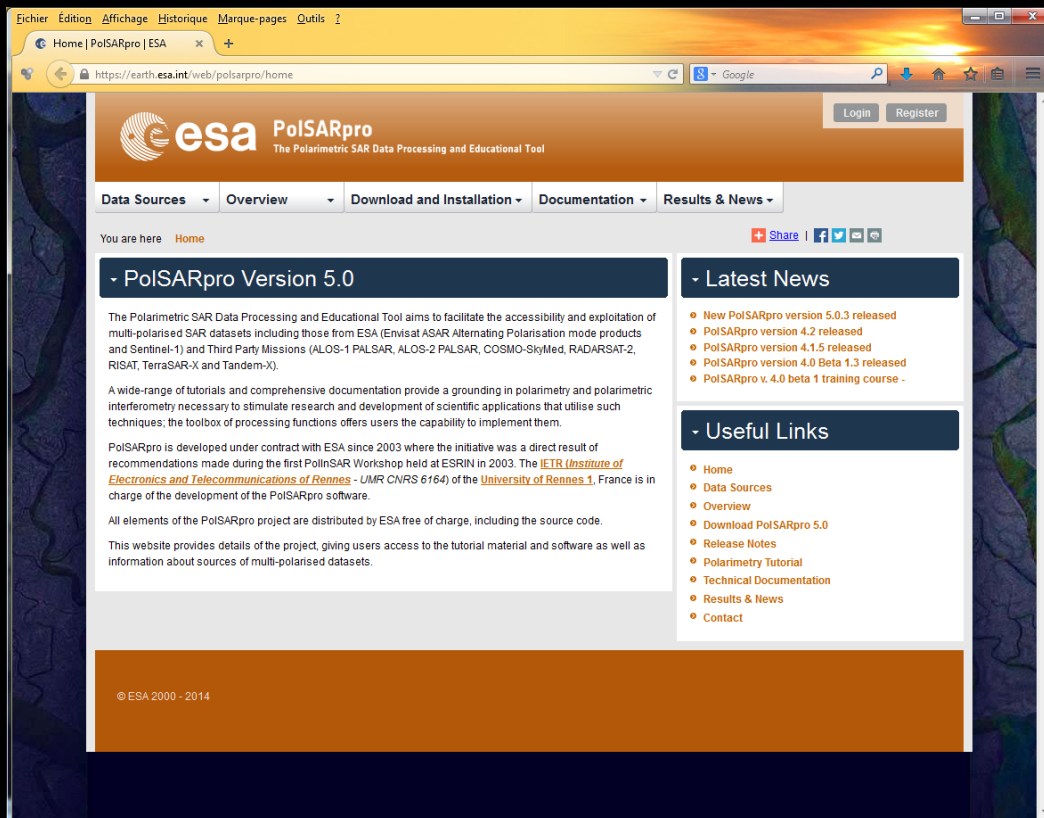
Learning / Training Next P.I Generations



<http://earth.esa.int/web/polsarpro/home>

The Web Site provides

- Details of the project
- Access to the tutorial and software
- Information about status of the development
- **Demonstration Sample Datasets**



→ POLSARPRO V. 5.1

The Polarimetric SAR Data Processing and Educational Tool



<http://earth.esa.int/polsarpro>

www.esa.int

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→ POLSARPRO V. 5.1

The Polarimetric SAR Data Processing and Educational Tool



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www.esa.int

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→ 4th ADVANCED COURSE ON RADAR POLARIMETRY

30 January – 2 February 2017 | ESA-ESRIN | Frascati (Rome), Italy

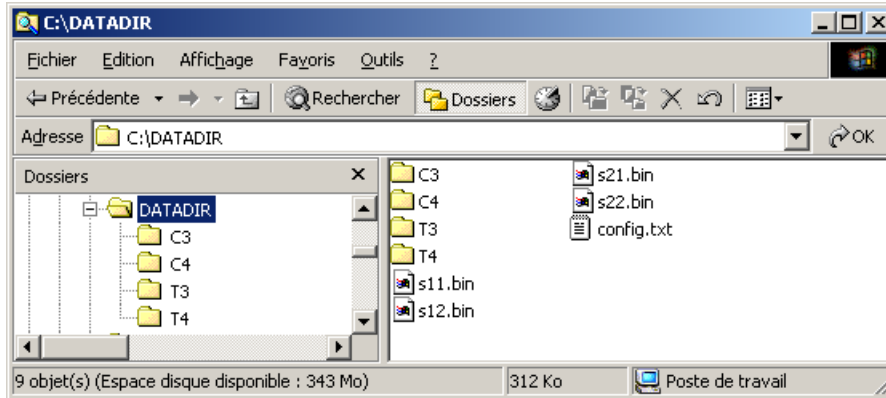
PolSARpro v5.1 toolbox

Practical session - Part 1

Eric Pottier

General Presentation of PolSARpro v5.1 Software

Compatible Raw Binary Data



2x2 Complex Sinclair Matrix [S2]

DATADIR

config.txt

s11.bin, s12.bin
s21.bin, s22.bin

PolarCase

- Monostatic $s_{12}.bin == s_{21}.bin$
- Bistatic $s_{12}.bin \leftrightarrow s_{21}.bin$
- Intensities lxy.bin

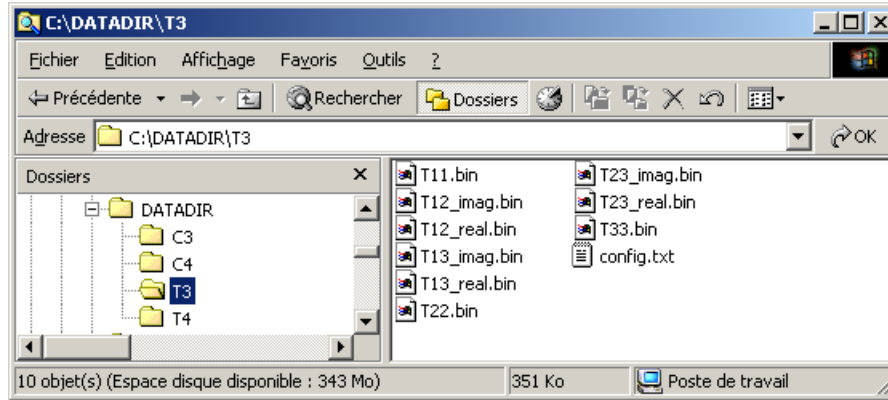
PolarType

- Full s11.bin, s12.bin, s21.bin, s22.bin
- pp1 s11.bin, s21.bin
- pp2 s12.bin, s22.bin
- pp3 s11.bin, s22.bin
- pp4 l11.bin, l12.bin, l22.bin
- pp5 l11.bin, l21.bin
- pp6 l12.bin, l22.bin
- pp7 l11.bin, l22.bin

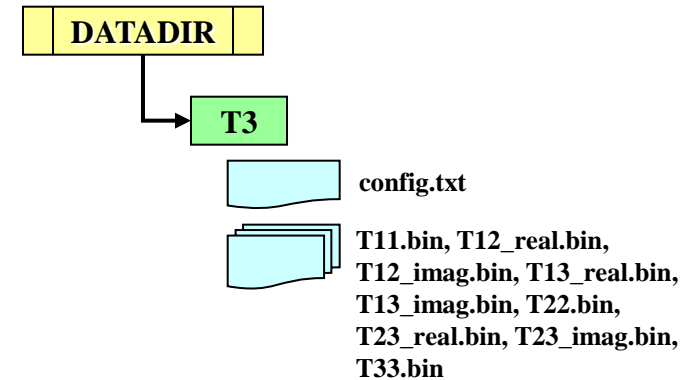
```

Nrow
1234
-----
Ncol
4789
-----
PolarCase
Monostatic/Bistatic/Intensities
-----
PolarType
Full/pp1/pp2/pp3/pp4/pp5/pp6/pp7
    
```

Compatible Raw Binary Data



3x3 Complex Coherency Matrix [T3]



$$\underline{k}_{3P} = \frac{1}{\sqrt{2}} \begin{bmatrix} S_{11} + S_{22} & S_{11} - S_{22} & S_{12} + S_{21} \end{bmatrix}$$

$$\Rightarrow [T_3] = \langle \underline{k}_{3P} \cdot \underline{k}_{3P}^\dagger \rangle$$

$$[T_3] = \begin{bmatrix} T_{11} & T_{12} & T_{13} \\ T_{12}^* & T_{22} & T_{23} \\ T_{13}^* & T_{23}^* & T_{33} \end{bmatrix}$$

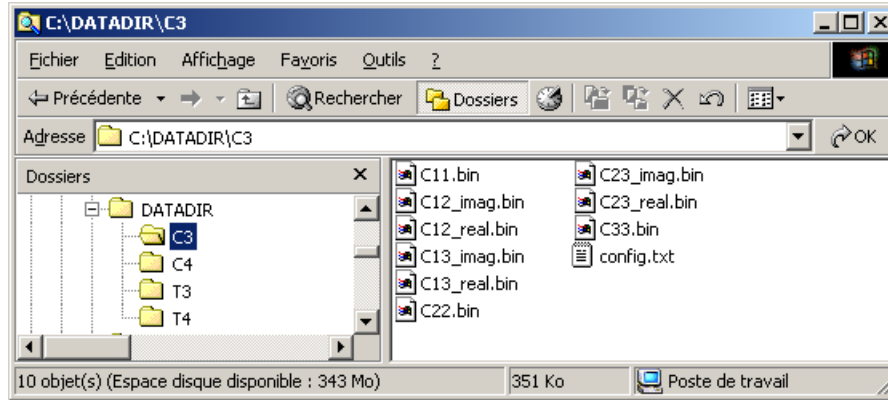
Nrow
1234

Ncol
4789

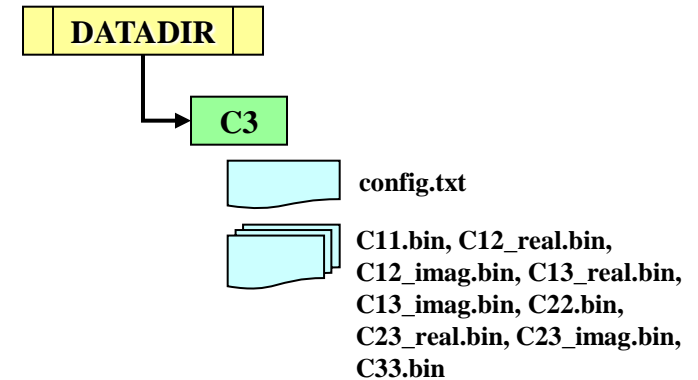
PolarCase
Monostatic/Bistatic

PolarType
Full

Compatible Raw Binary Data



3x3 Complex Covariance Matrix [C3]



$$\underline{k}_{3L} = [S_{11} \quad S_{12} \cdot \sqrt{2} \quad S_{22}]$$

$$\Rightarrow [C_3] = \langle \underline{k}_{3L} \cdot \underline{k}_{3L}^\dagger \rangle$$

$$[C_3] = \begin{bmatrix} C_{11} & C_{12} & C_{13} \\ C_{12}^* & C_{22} & C_{23} \\ C_{13}^* & C_{23}^* & C_{33} \end{bmatrix}$$

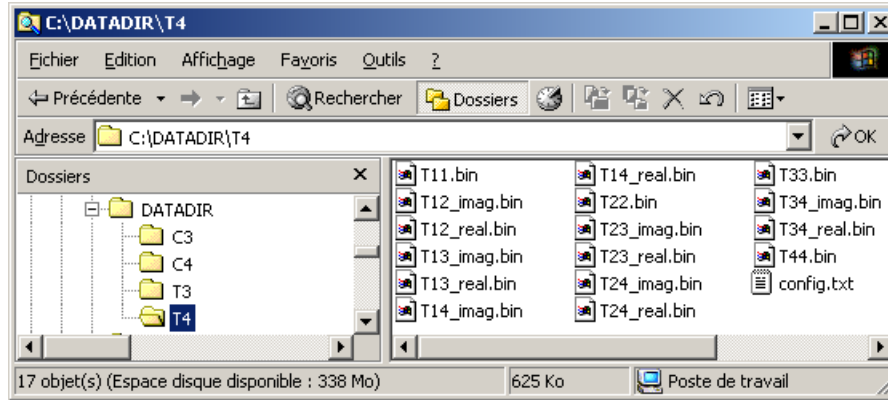
Nrow
1234

Ncol
4789

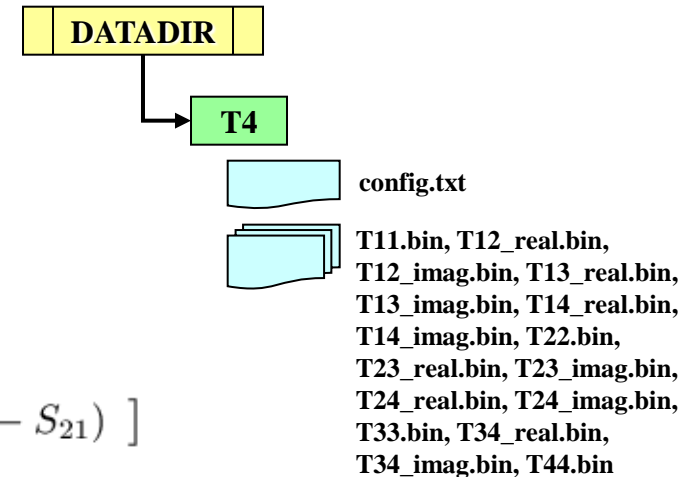
PolarCase
Monostatic/Bistatic

PolarType
Full

Compatible Raw Binary Data



4x4 Complex Coherency Matrix [T4]



$$\underline{k}_{4P} = \frac{1}{\sqrt{2}} \begin{bmatrix} S_{11} + S_{22} & S_{11} - S_{22} & S_{12} + S_{21} & j(S_{12} - S_{21}) \end{bmatrix}$$

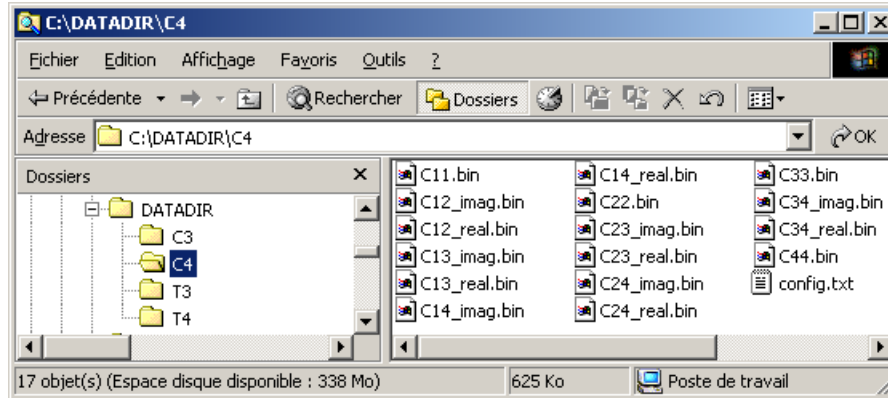
$$\Rightarrow [T_4] = \langle \underline{k}_{4P} \cdot \underline{k}_{4P}^\dagger \rangle$$

$$[T_4] = \begin{bmatrix} T_{11} & T_{12} & T_{13} & T_{14} \\ T_{12}^* & T_{22} & T_{23} & T_{24} \\ T_{13}^* & T_{23}^* & T_{33} & T_{34} \\ T_{14}^* & T_{24}^* & T_{34}^* & T_{44} \end{bmatrix}$$

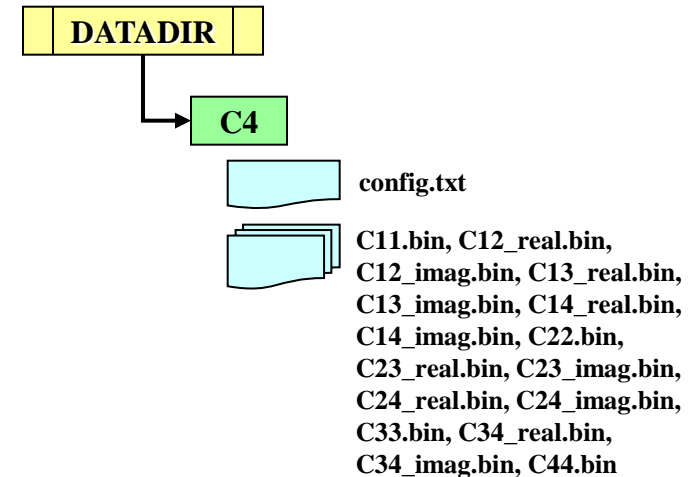
```

Nrow
1234
-----
Ncol
4789
-----
PolarCase
Bistatic
-----
PolarType
Full
    
```

Compatible Raw Binary Data



4x4 Complex Covariance Matrix [C4]



$$\underline{k}_{AL} = [S_{11} \quad S_{12} \quad S_{21} \quad S_{22}]$$

$$\Rightarrow [C_4] = \langle \underline{k}_{AL} \cdot \underline{k}_{AL}^\dagger \rangle$$

$$[C_4] = \begin{bmatrix} C_{11} & C_{12} & C_{13} & C_{14} \\ C_{12}^* & C_{22} & C_{23} & C_{24} \\ C_{13}^* & C_{23}^* & C_{33} & C_{34} \\ C_{14}^* & C_{24}^* & C_{34}^* & C_{44} \end{bmatrix}$$

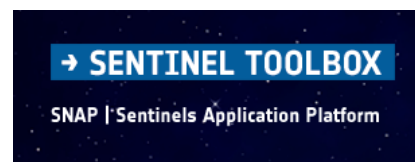
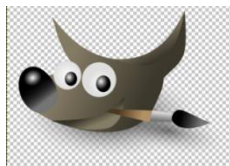
Nrow
1234

Ncol
4789

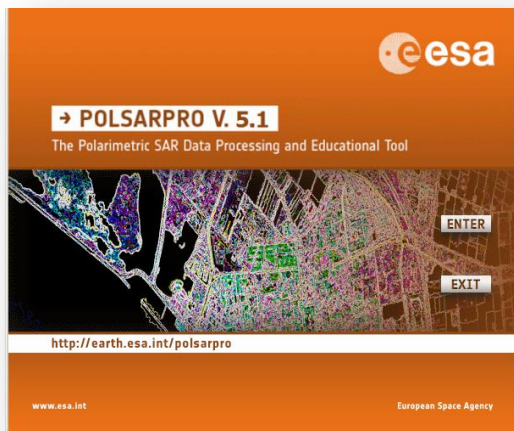
PolarCase
Bistatic

PolarType
Full

CONFIGURATION



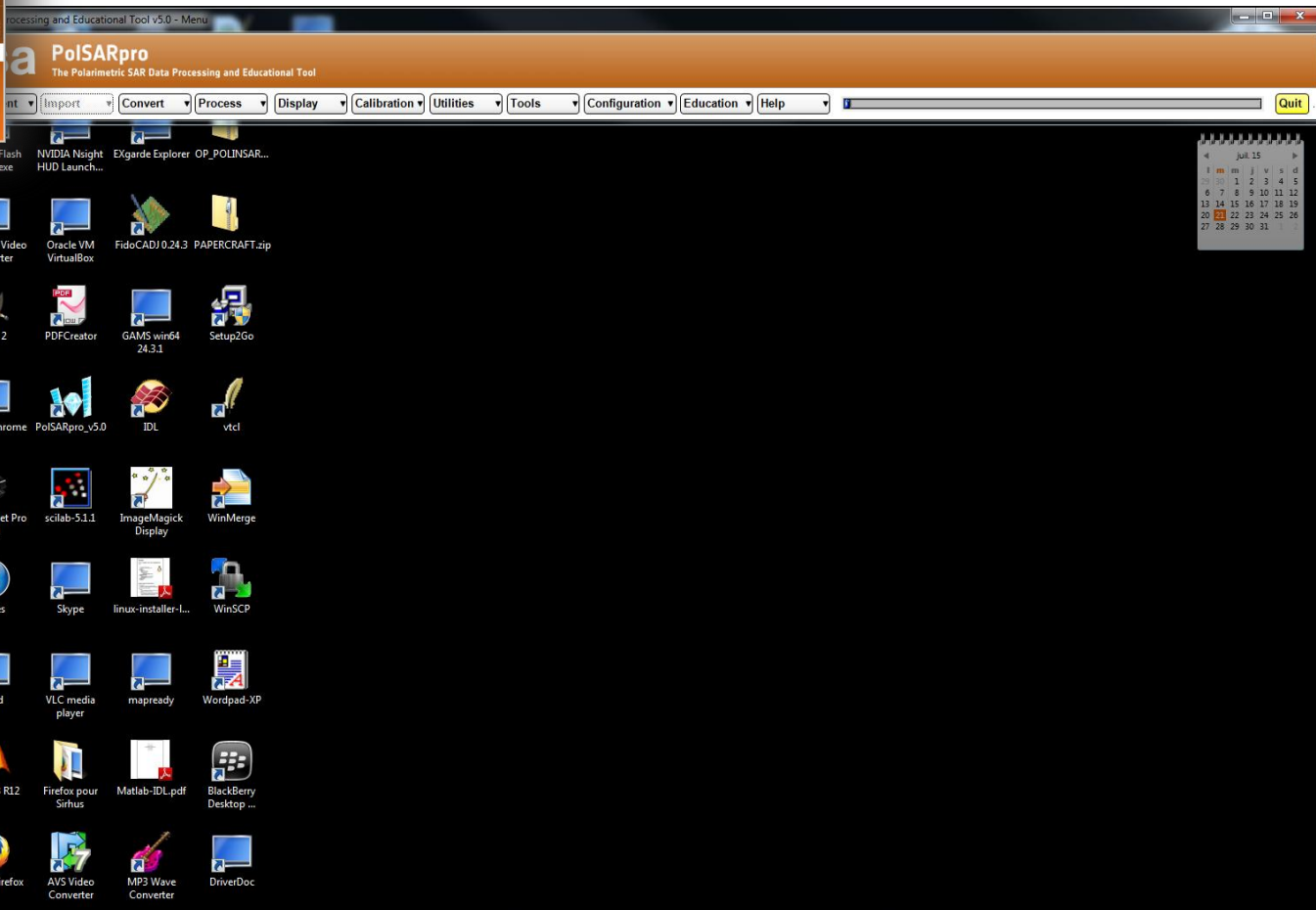
PoISARpro v5.1 SOFTWARE



ENTRY SCREEN



MAIN WINDOW



PolSARpro v5.1 SOFTWARE



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PolSARpro v5.1 SOFTWARE



PolSARpro v5.1 - Menu

esa PolSARpro
The Polarimetric SAR Data Processing and Educational Tool

Environment Import Convert Process Display Calibration Utilities Tools Configuration Education Help Quit

PolSARpro : Widget Size Adjust

Block 1

Block 2

Block 3

Block 4

Left Center Right

PolSARpro : Widget Size Adjust Cmd

Widget Width Size
Initial Size (pix) 520 Current Size (pix) 520

Widget Height Size
Initial Size (pix) 740 Current Size (pix) 740

Widget Size Ratio
Width Ratio 1.0 Height Ratio 1.0

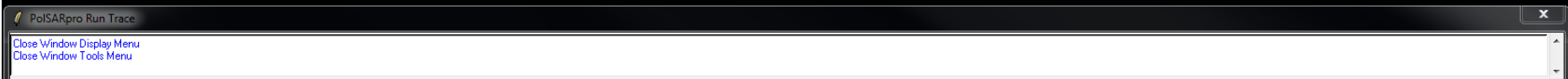
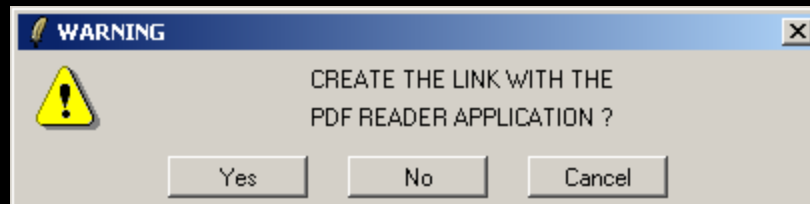
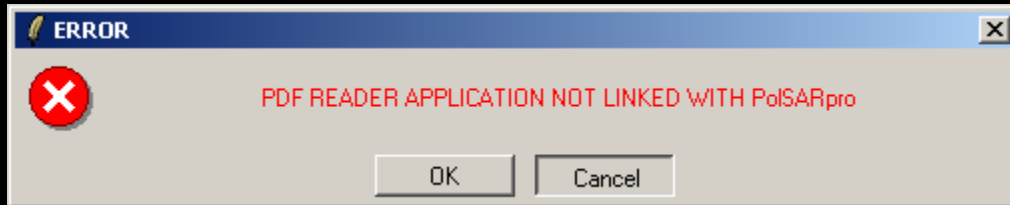
Refresh Reset Save and Exit

WIDGET SIZE ADJUST

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PolSARpro v5.1 SOFTWARE



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PolSARpro v5.1 SOFTWARE

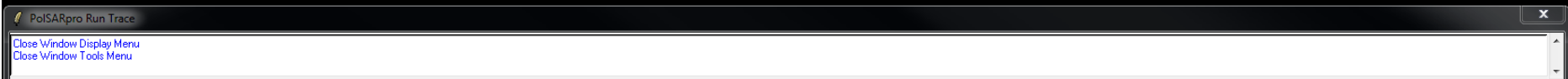
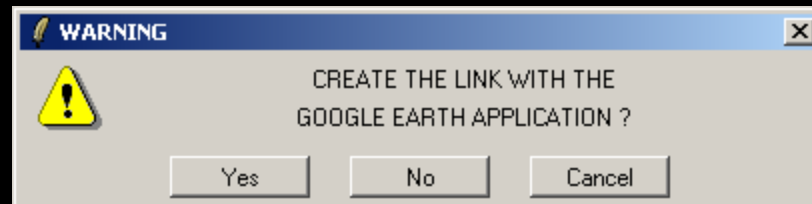
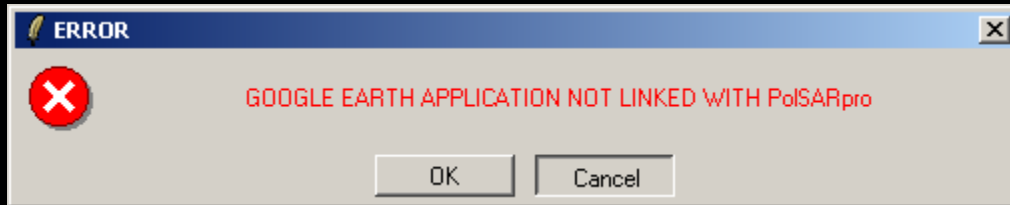


The screenshot shows the PolSARpro v5.1 software interface. At the top, there is a menu bar with options: Environment, Import, Convert, Process, Display, Calibration, Utilities, Tools, Configuration, Education, and Help. A 'Quit' button is located on the right side of the menu bar. Below the menu bar, a 'WARNING' dialog box is displayed with a yellow warning icon and the text: 'CREATE THE LINK WITH THE PDF READER APPLICATION ?'. Below the warning dialog, a red arrow points down to a 'Configuration' dialog box. The 'Configuration' dialog box has a title bar 'Configuration' and a sub-header 'PDF READER' with an Adobe Acrobat icon. It contains two text input fields: 'Research one of the following exe files' with the text 'acoread acord32 acrobat xpdf kghostview ghostview gv' and 'Path Name' with the text 'C:/Program Files/Adobe/Acrobat 7.0/Acrobat/Acrobat.exe'. At the bottom of the configuration dialog are two buttons: 'Save & Exit' and 'Exit (without Saving)'. At the bottom of the main window, there is a 'PolSARpro Run Trace' window with the text 'Close Window Display Menu' and 'Close Window Tools Menu'.

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PolSARpro v5.1 SOFTWARE



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PolSARpro v5.1 SOFTWARE



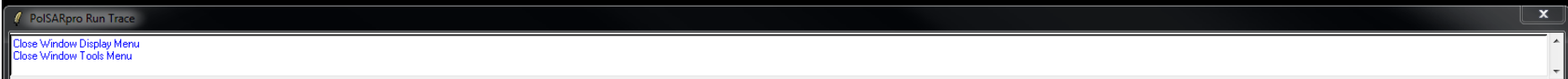
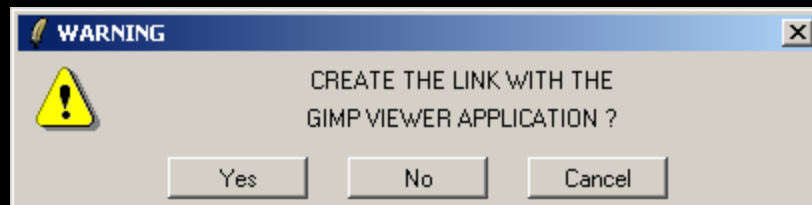
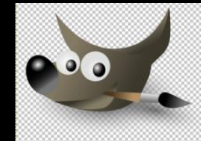
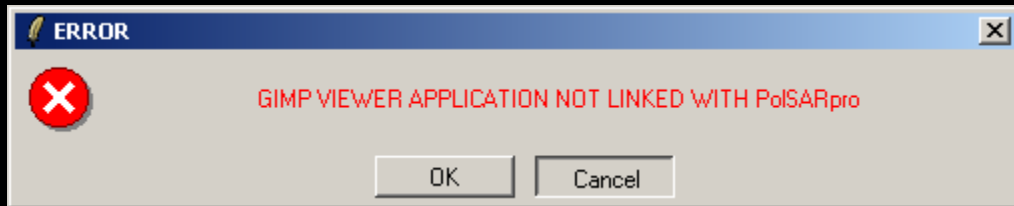
The screenshot displays the PolSARpro v5.1 software interface. At the top, the title bar reads "PolSARpro v5.1 - Menu". Below it is the main menu bar with options: Environment, Import, Convert, Process, Display, Calibration, Utilities, Tools, Configuration, Education, Help, and a Quit button. A "WARNING" dialog box is open, asking "CREATE THE LINK WITH THE GOOGLE EARTH APPLICATION ?" with "Yes", "No", and "Cancel" buttons. A red arrow points from this dialog to a "Configuration" dialog box. The "Configuration" dialog is titled "GOOGLE EARTH" and contains a text field with search results: "googleearth gEarth gearth google-earth GE earth". Below this is a "Path Name" field containing "C:/Program Files/Google/Google Earth/client/googleearth.exe" and a folder icon. At the bottom of the configuration dialog are "Save & Exit" and "Exit (without Saving)" buttons. At the bottom of the main window, a "PolSARpro Run Trace" window shows the following text: "Close Window Display Menu" and "Close Window Tools Menu".



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PolSARpro v5.1 SOFTWARE



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PolSARpro v5.1 SOFTWARE



The screenshot displays the PolSARpro v5.1 software interface. At the top, the title bar reads "PolSARpro v5.1 - Menu". Below it is the main menu bar with options: Environment, Import, Convert, Process, Display, Calibration, Utilities, Tools, Configuration, Education, Help, and a Quit button. A "WARNING" dialog box is open, asking "CREATE THE LINK WITH THE GIMP VIEWER APPLICATION?" with "Yes", "No", and "Cancel" buttons. A red arrow points from this dialog to a "Configuration" dialog box. The "Configuration" dialog is for "GIMP" and contains the following fields:

- Research one of the following exe files: gimp-2.6
- Path Name: C:/Program Files/GIMP-2.0/bin/gimp-2.6.exe

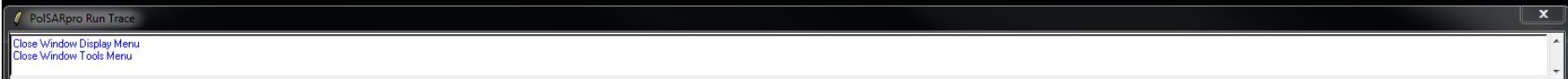
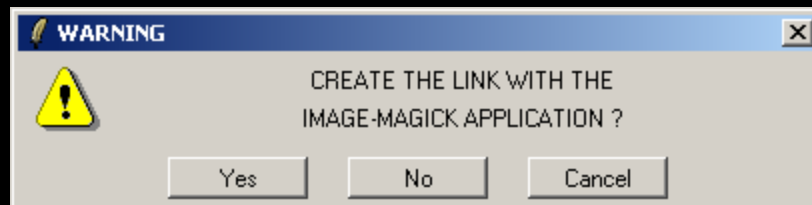
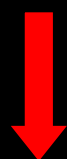
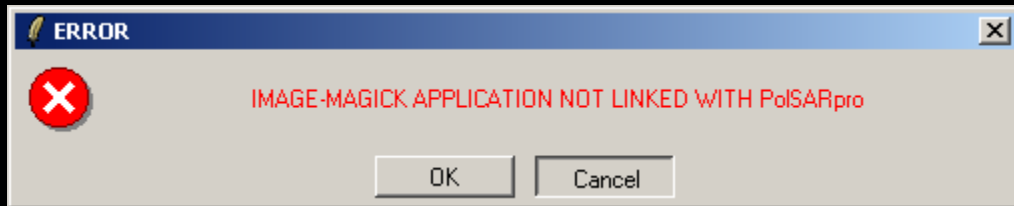
Buttons for "Save & Exit" and "Exit (without Saving)" are visible. At the bottom, a "PolSARpro Run Trace" window shows the following text:

```
Close Window Display Menu  
Close Window Tools Menu
```

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PoISARpro v5.1 SOFTWARE



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PolSARpro v5.1 SOFTWARE



The screenshot displays the PolSARpro v5.1 software interface. At the top, the title bar reads "Polarimetric SAR Data Processing and Educational Tool v5.1 - Menu". The main window features the ESA logo and the text "PolSARpro The Polarimetric SAR Data Processing and Educational Tool". A menu bar includes options: Environment, Import, Convert, Process, Display, Calibration, Utilities, Tools, Configuration, Education, and Help. A "Quit" button is located on the right side of the menu bar.

A "WARNING" dialog box is shown in the center, with a yellow warning icon and the text: "CREATE THE LINK WITH THE IMAGE-MAGICK APPLICATION?". It has three buttons: "Yes", "No", and "Cancel".

A red arrow points from the "WARNING" dialog box down to a "Configuration" dialog box. The "Configuration" dialog box is titled "IMAGE MAGICK" and contains the following fields and buttons:

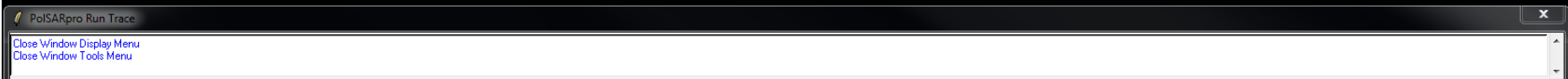
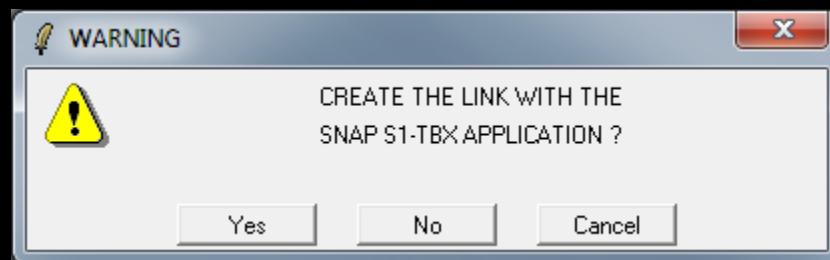
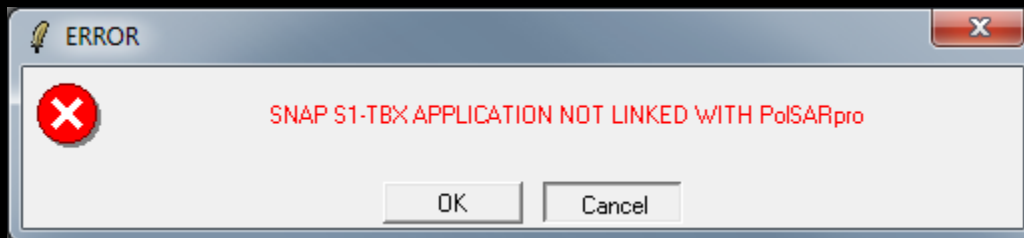
- Research one of the following exe files:
- Path Name: (with a folder icon on the right)
- Buttons: "Save & Exit" and "Exit (without Saving)"

At the bottom of the screenshot, a "PolSARpro Run Trace" window is visible, containing the text: "Close Window Display Menu" and "Close Window Tools Menu".

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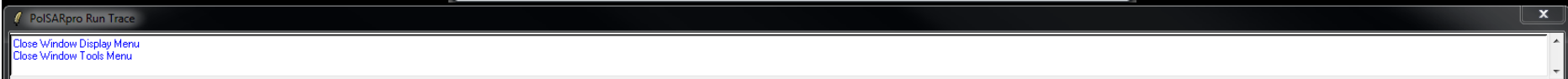
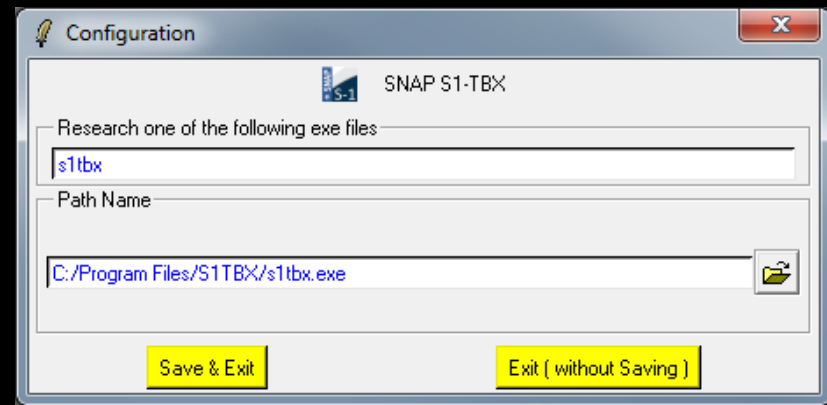
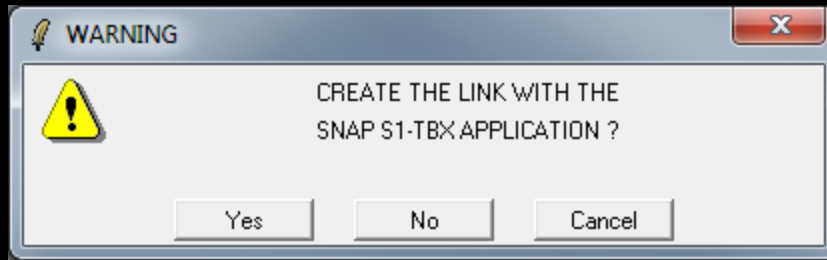
PolSARpro v5.1 SOFTWARE



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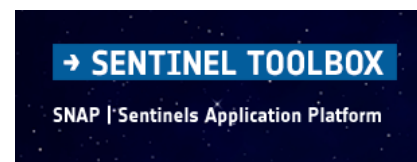
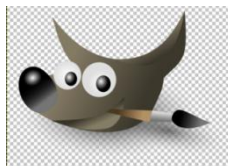
PolSARpro v5.1 SOFTWARE



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TEST THE CONFIGURATION



PolSARpro v5.1 SOFTWARE



The screenshot shows the PolSARpro v5.1 software interface. The title bar reads "PolSARpro v5.1 - Menu". The main window has a header with the ESA logo and the text "PolSARpro The Polarimetric SAR Data Processing and Educational Tool". Below the header is a menu bar with the following items: T3, S, Environment, Import, Convert, Process, Display, Calibration, Utilities, Tools, Configuration, Education, Help, and a yellow Quit button. The "Configuration" menu is circled in red, and a red arrow points to a dropdown menu. This dropdown menu is also outlined in red and contains the following items: PolSARpro configuration, SNAP S1-TBX, GIMP, GOOGLE EARTH, Image Magick, and PDF Reader. At the bottom of the main window, there is a "PolSARpro Run Trace" window with the text "Close Window Display Menu" and "Close Window Tools Menu".

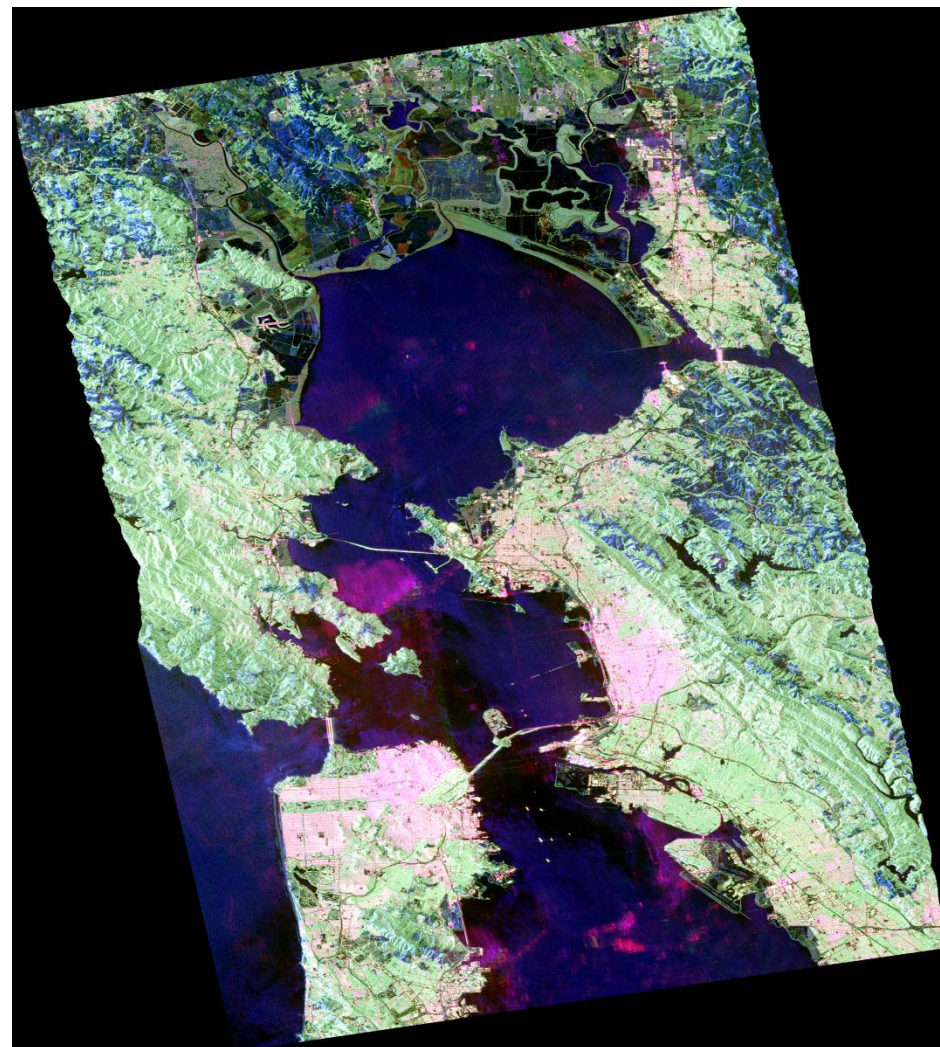
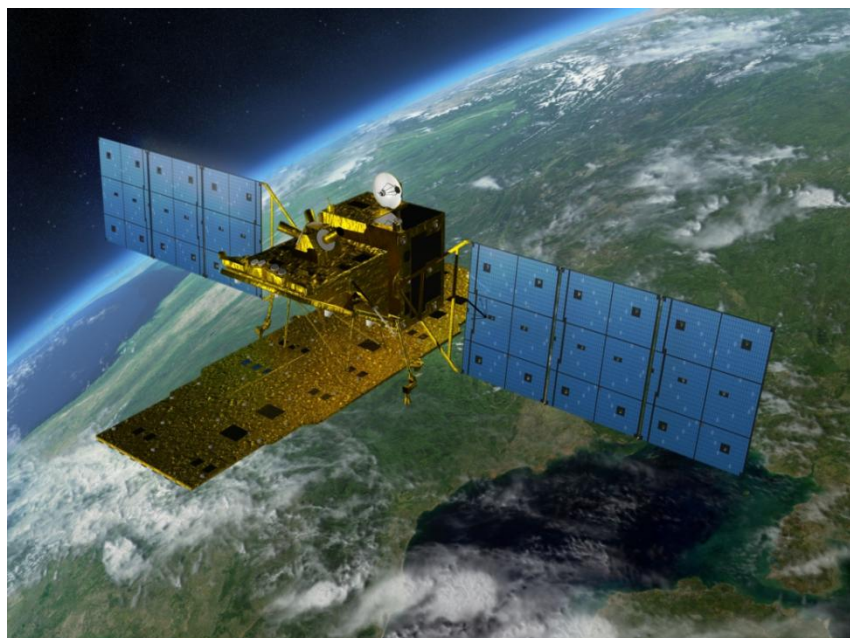
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Questions ?

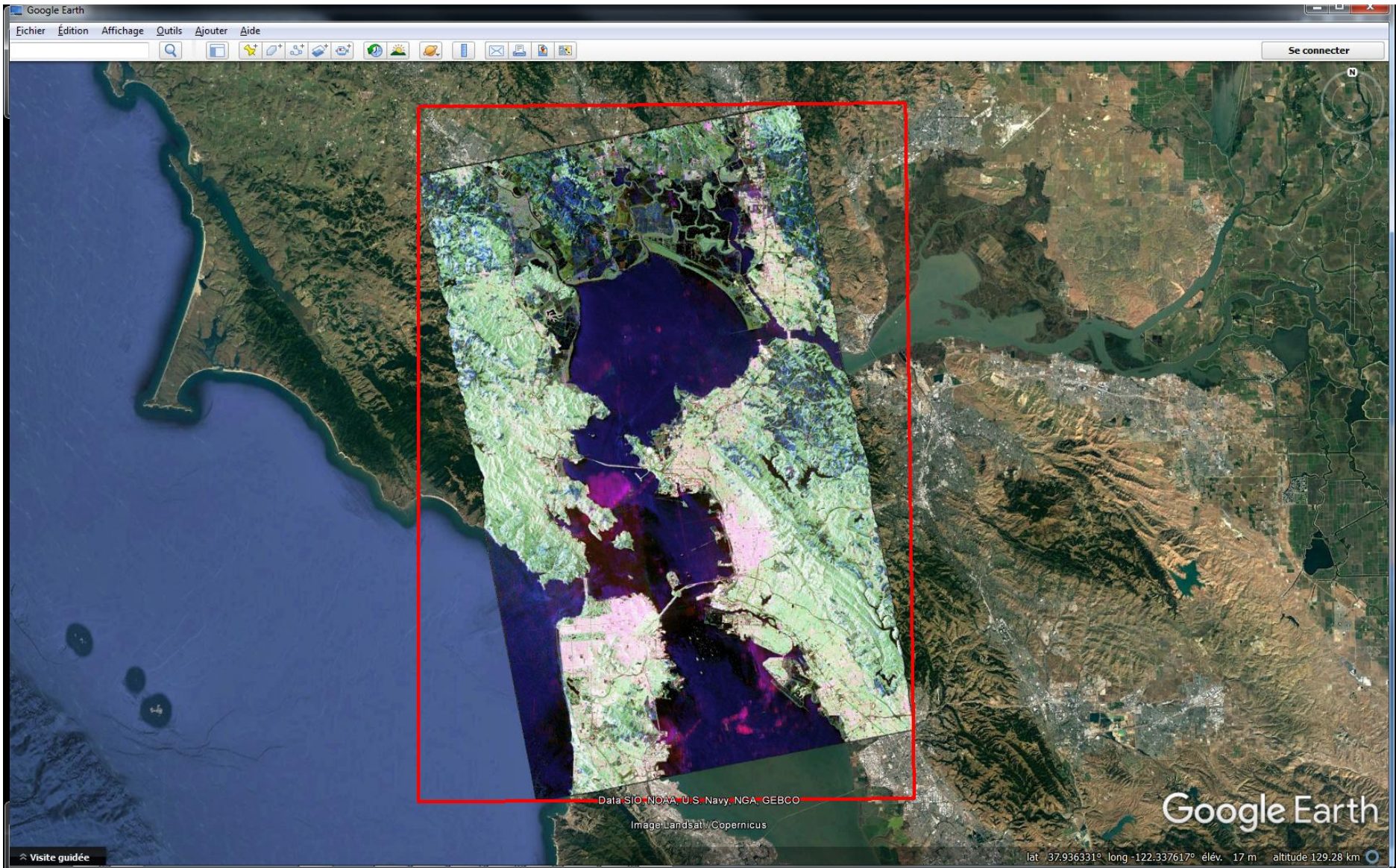


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ALOS : Advanced Land Observing Satellite
PALSAR : Phase Array L-Band SAR

PoSARpro v5.1 SOFTWARE



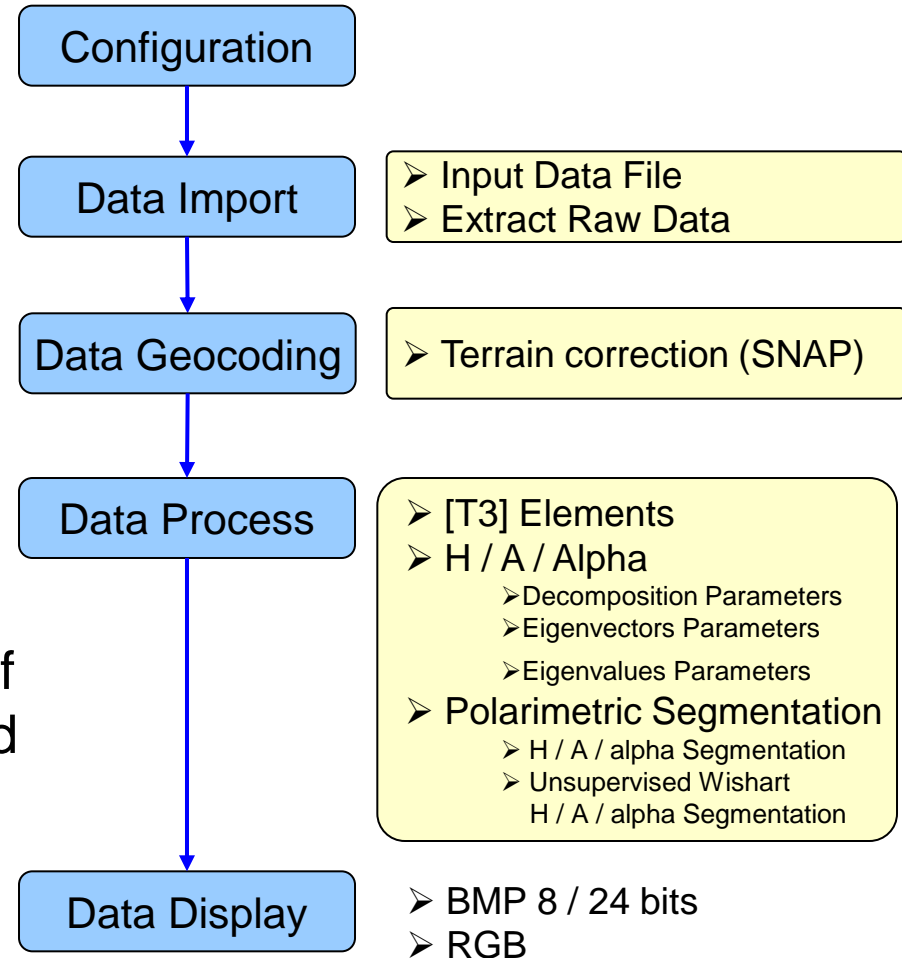
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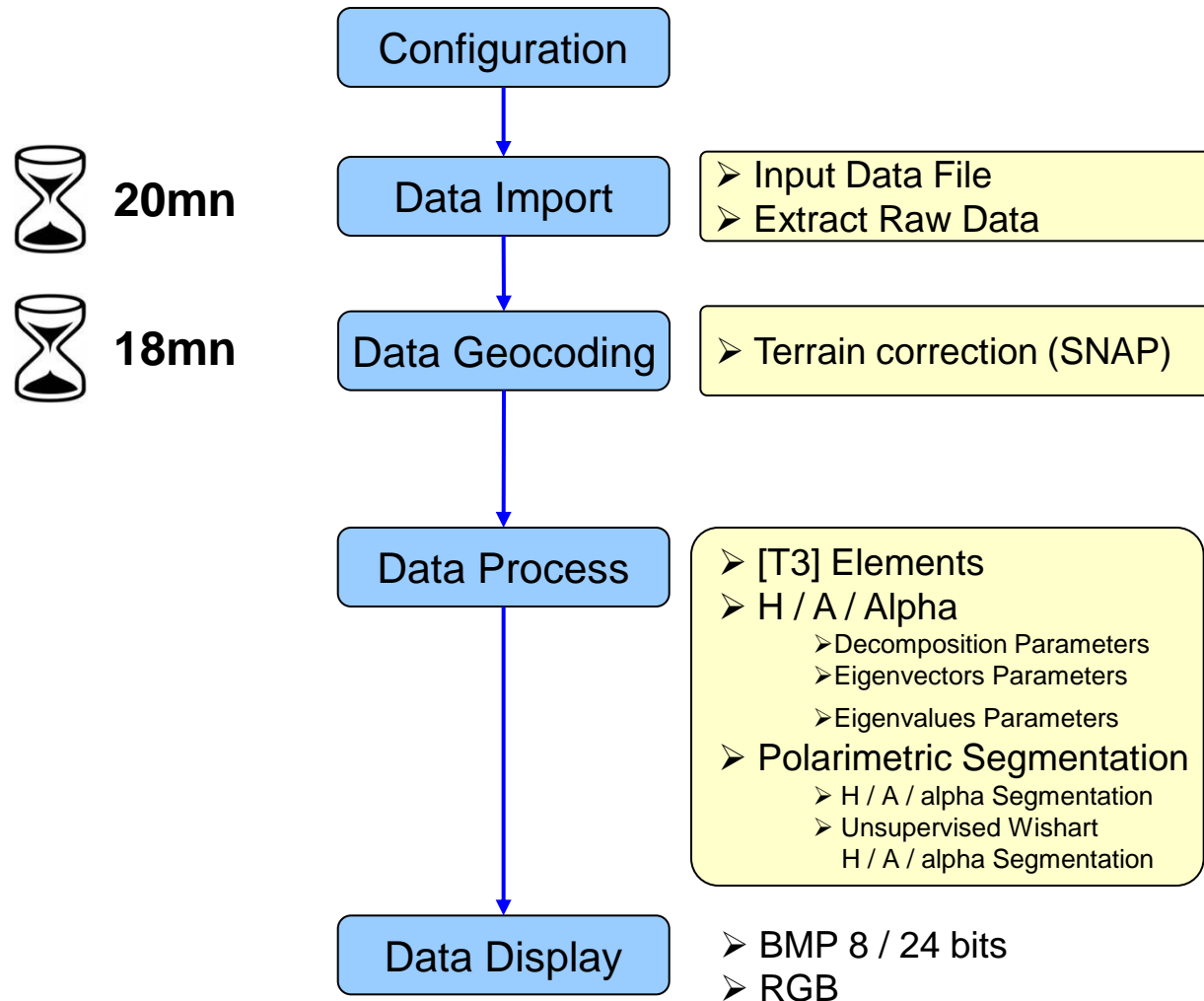
PolSARpro v5.1 Software
performs complete **end-to-end processing** without the need for any other software.

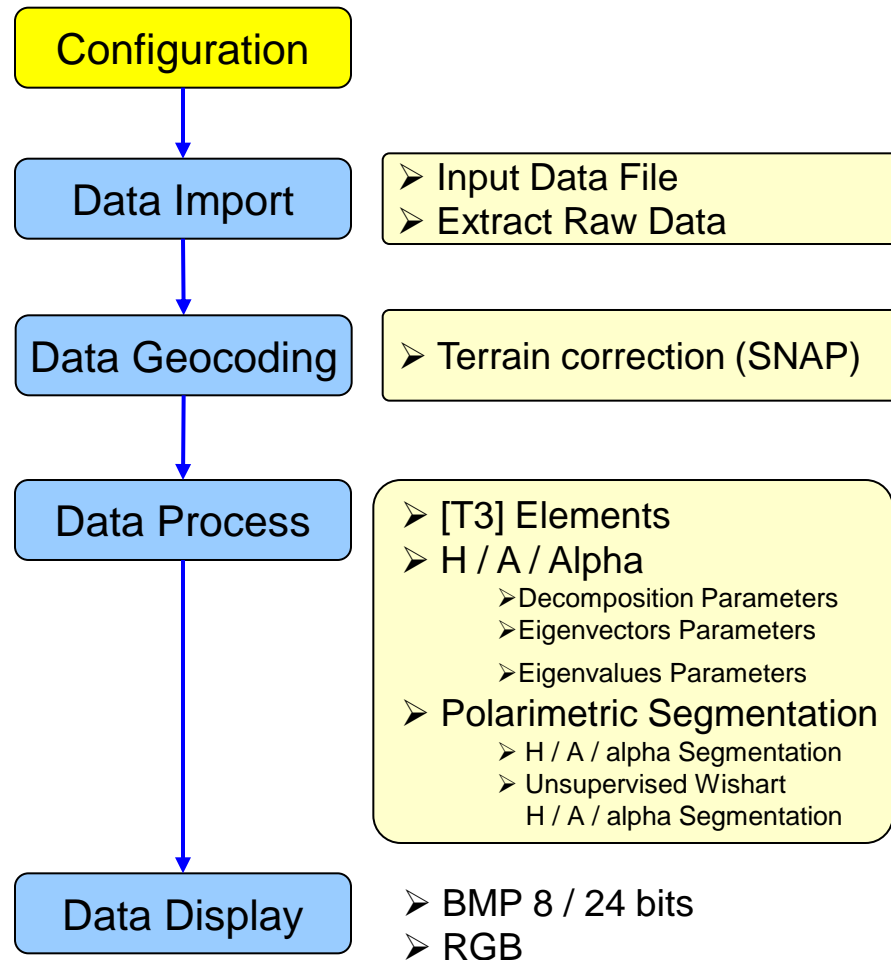
Data Processing Approach
along a '**recommended**'
and easy processing chain

Provide a **First Qualitative Analysis** of
the fully polarimetric data set processed



PROCESSING CHAIN





PolSARpro v5.1 SOFTWARE



Polarimetric SAR Data Processing and Educational Tool v5.1 - Menu

esa PolSARpro
The Polarimetric SAR Data Processing and Educational Tool

C2 Environment Import Convert Process Display Calibration Utilities Tools Configuration Education Help Quit

Single Data Set (Pol-SAR)
Dual Data Sets (Single Baseline Pol-InSAR)
Multi Data Sets (Time series / Pol-TomSAR)

Environment

Main Input Directory
C:/My_Data_Directory

Display Size
Rows 888 Columns 888 Update

Color Maps
Supervised ColorMap16 Unsupervised ColorMap9 Unsupervised ColorMap27
Unsupervised ColorMap8 Unsupervised ColorMap16 Random ColorMap32

Save & Exit

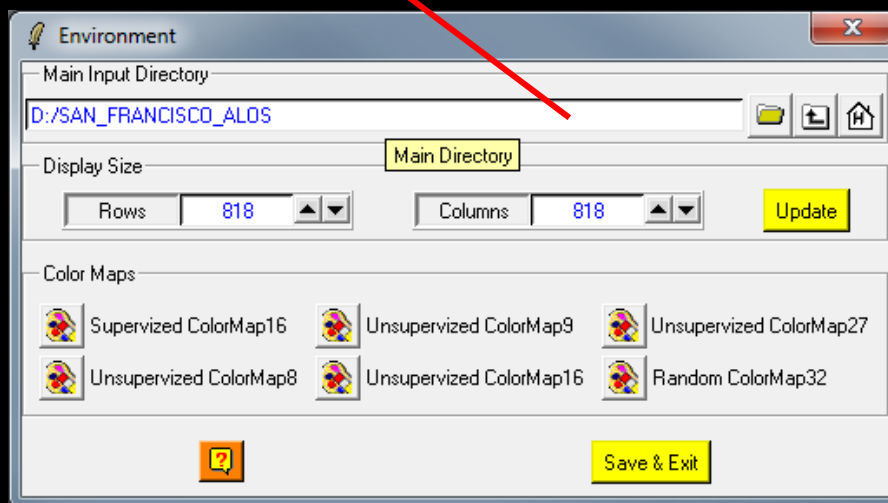
PolSARpro Run Trace
Close Window Display Menu
Close Window Tools Menu

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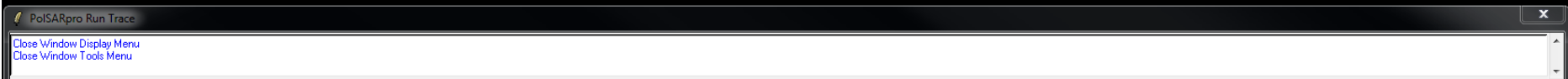


Configure Data Main Directory location



Input Data Directory :

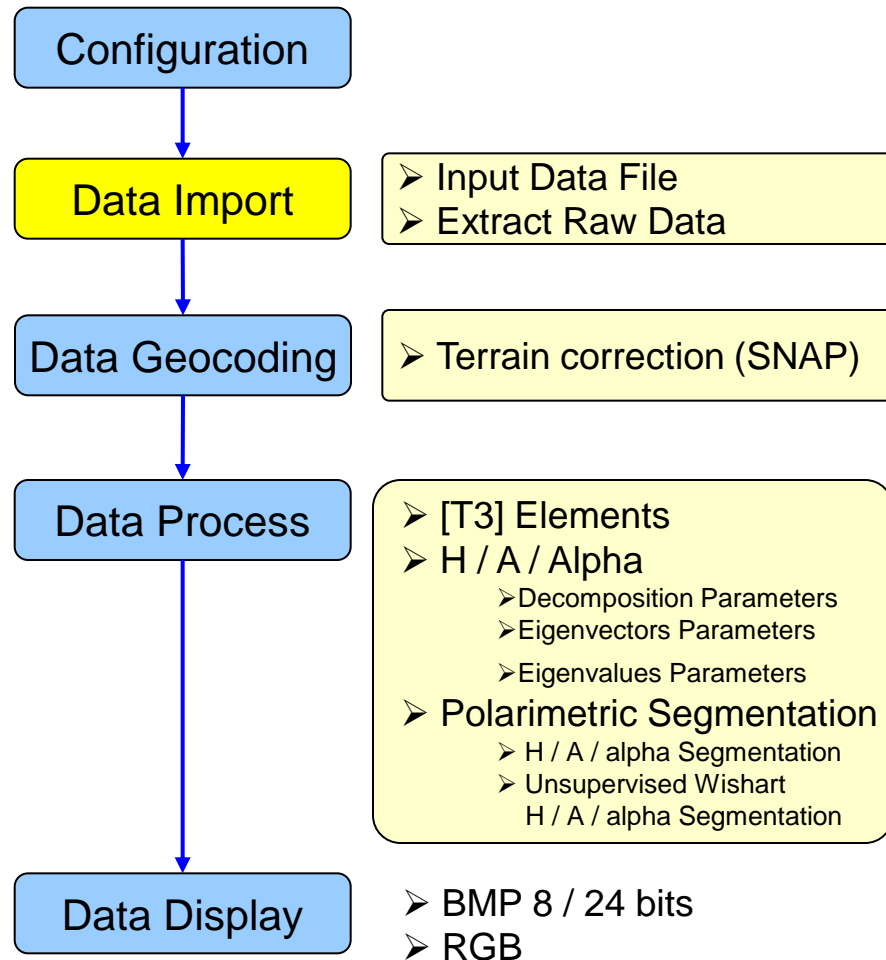
SAN_FRANCISCO_ALOS2



The screenshot displays the PolSARpro software interface. At the top, the title bar reads "PolSARpro The Polarimetric SAR Data Processing and Educational Tool". Below the title bar is a menu bar with options: Environment, Import, Convert, Process, Display, Calibration, Utilities, Tools, Configuration, Education, Help, and Quit. The main window shows the "Environment" dialog box with the "Main Input Directory" set to "D:/SAN_FRANCISCO_ALDOS". Below this, there are "Display Size" controls for Rows (818) and Columns (818), and a "Color Maps" section with several color map icons. A red arrow points from the text "Configure Data Main Directory location" to the "Main Input Directory" field. Another red arrow points from the text "Color Palette Edition & Modification" to the "Color Maps" section. In the foreground, there are two smaller dialog boxes: "Color Map" and "Choose a color". The "Color Map" dialog shows the "Input ColorMap File" and "Output ColorMap File" both set to "ColorMap/Wishart_ColorMap16.pal". The "Choose a color" dialog shows a color selection interface with a grid of colors and a color wheel. The "Couleurs personnalisées" section shows a grid of red and purple colors. The "Couleur Unie" section shows a yellow color with the following values: Teinte: 40, Rouge: 255, Satur.: 240, Vert: 255, Lum.: 120, Bleu: 0. The "PolSARpro Run Trace" window at the bottom left shows "Close Window Display Menu" and "Close Window Tools Menu".

Configure Data Main Directory location

Color Palette Edition & Modification



ENVIRONNEMENT



The screenshot shows the PolSARpro software interface. The title bar reads "PolSARpro The Polarimetric SAR Data Processing and Educational Tool". The menu bar includes: Environment, Import, Convert, Process, Display, Calibration, Utilities, Tools, Configuration, Education, Help, and Quit. The "Import" menu is open, showing options: Raw Binary Data, Airborne Sensors, Spaceborne Sensors, Extract PolSAR images, and Edit Config File. The "Spaceborne Sensors" sub-menu is open, listing: Alos-1 - Palsar, Alos-2 - Palsar, Cosmo - Skymed, Envisat - Asar, Radarsat2, Risat, Sentinel-1, SIR-C, TerraSAR X, and Tandem X. The "Alos-2 - Palsar" sub-menu is open, showing "Dual - Pol" and "Quad - Pol". Red boxes highlight the "Import" menu, the "Spaceborne Sensors" sub-menu, the "Alos-2 - Palsar" sub-menu, and the "Quad - Pol" option. Yellow arrows indicate the navigation path from "Spaceborne Sensors" to "Alos-2 - Palsar" and then to "Quad - Pol". A "PolSARpro Run Trace" window is visible at the bottom, showing "Close Window Display Menu" and "Close Window Tools Menu".

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Data IMPORT – Input Data File

The screenshot shows the PolSARpro software interface. The main window is titled "ALOS Input Data File (JAXA - CEOS Format)". It contains several input fields and buttons:

- Input Directory:** D:/SAN_FRANCISCO_ALOS2
- Output Directory:** D:/SAN_FRANCISCO_ALOS2
- SAR Leader File:** D:/SAN_FRANCISCO_ALOS2/LED-ALOS2044980750-150324-HBQR1.1__A
- Scene ID:** 0750
- Orbit:** A
- n°:** 04498
- Date:** 150324
- Mode:** Quad Pol (HBQ)
- Data Level:** 1.1
- Direction:** Right
- SAR Trailer File:** D:/SAN_FRANCISCO_ALOS2/TRL-ALOS2044980750-150324-HBQR1.1__A
- SAR Image Files:**
 - s11: D:/SAN_FRANCISCO_ALOS2/IMG-HH-ALOS2044980750-150324-HBQR1.1__A
 - s12: D:/SAN_FRANCISCO_ALOS2/IMG-VH-ALOS2044980750-150324-HBQR1.1__A
 - s21: D:/SAN_FRANCISCO_ALOS2/IMG-HV-ALOS2044980750-150324-HBQR1.1__A
 - s22: D:/SAN_FRANCISCO_ALOS2/IMG-VV-ALOS2044980750-150324-HBQR1.1__A
- Buttons:** Check Files, Read Header, Edit Header, Extract Uncalibrated Raw Binary Data (checkbox), Initial Number of Rows (22608), Initial Number of Cols (8080), Row Pixel Spacing (3.205713), Col Pixel Spacing (2.860844), OK, Cancel.

An "ADVICE" pop-up window is displayed, containing a lightbulb icon and the following text:

PolSARpro WILL TAKE INTO ACCOUNT THE ALOS-PALSAR ENGINEER CONVENTION FOR THE DEFINITION OF THE POLARIMETRIC CHANNELS WITH : s12 = VH and s21 = HV

A red box with white text is overlaid on the right side of the screenshot, containing the text:

Do it Yourself:
Enter SAR Leader File
Check File

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Data IMPORT – Input Data File

Polarimetric SAR Data Processing and Educational Tool v5.1 - Menu

esa PolSARpro
The Polarimetric SAR Data Processing and Educational Tool

Environment Import Convert Process Display Calibration Utilities Tools Configuration Education Help Quit

ALOS Input Data File (JAXA - CEOS Format)



Input Directory: D:/SAN_FRANCISCO_ALOS2

Output Directory: D:/SAN_FRANCISCO_ALOS2

SAR Leader File (LED-xxxxxxxxxx-xx.x_x) : D:/SAN_FRANCISCO_ALOS2/LED-ALOS2044980750-150324-HBQR1.1__A

Scene ID: 0750 Orbit: A n#: 04498 Date: 150324

Mode: Quad Pol (HBQ) Data Level: 1.1 Direction: Right

SAR Trailer File: D:/SAN_FRANCISCO_ALOS2/TRL-ALOS2044980750-150324-HBQR1.1__A

SAR Image Files:

- s11 D:/SAN_FRANCISCO_ALOS2/IMG-HH-ALOS2044980750-150324-HBQR1.1__A
- s12 D:/SAN_FRANCISCO_ALOS2/IMG-VH-ALOS2044980750-150324-HBQR1.1__A
- s21 D:/SAN_FRANCISCO_ALOS2/IMG-HV-ALOS2044980750-150324-HBQR1.1__A
- s22 D:/SAN_FRANCISCO_ALOS2/IMG-VV-ALOS2044980750-150324-HBQR1.1__A


Read Header Edit Header Extract Uncalibrated Raw Binary Data

Initial Number of Rows: 22608 Initial Number of Cols: 8080

Row Pixel Spacing: 3.205713 Col Pixel Spacing: 2.860844

OK ? Cancel

ADVICE



DON'T FORGET TO EXTRACT DATA BEFORE RUNNING ANY DATA PROCESS

OK

Do it Yourself:

Enter SAR Leader File

Read Header

OK

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PolSARpro The Polarimetric SAR Data Processing and Educational Tool

Import

- Raw Binary Data
- Airborne Sensors
- Spaceborne Sensors
- Extract PolSAR images
- Edit Config File

POLARPRO Extract Data

Input Directory: D:/SAN_FRANCISCO_ALOS2

Output Directory: D:/SAN_FRANCISCO_ALOS2 / T3

Init Row: 1 End Row: 22608 Init Col: 1 End Col: 8080

Full Resolution

Sub Sampling Row: Col:

Multi Look Row: 4 Col: 4

Symmetrisation (S12 = S21)

Input Data Format: 2x2 Complex Scattering Matrix S2

Output Data Format

Sinclair Elements [S2] (Sxx, Sxy) (lxx, lxy)

Coherency Elements [T3] [T4]

Covariance Elements [C2] [C3] [C4]

Run Exit

PolSARpro Run Trace

Close Window Display Menu

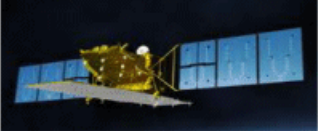
Close Window Tools Menu

Data IMPORT – Extract Binary Data



Do it Yourself:
Multi Look : Row = 4 Col = 4
Run

POLSARPRO Extract Data



Input Directory:

Output Directory: / T3

Init Row: End Row: Init Col: End Col:

Full Resolution

Sub Sampling Row: Col:

Multi Look Row: Col:

Symmetrisation (S12 = S21)

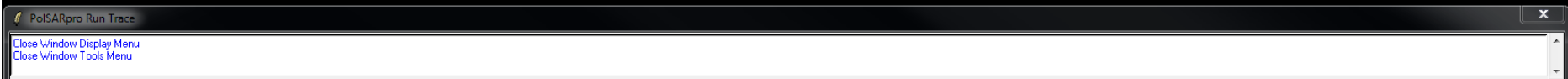
Input Data Format:

Output Data Format:

Sinclair Elements [S2] [Sxx, Sxy] [lxx, lxy]

Coherency Elements [T3] [T4]

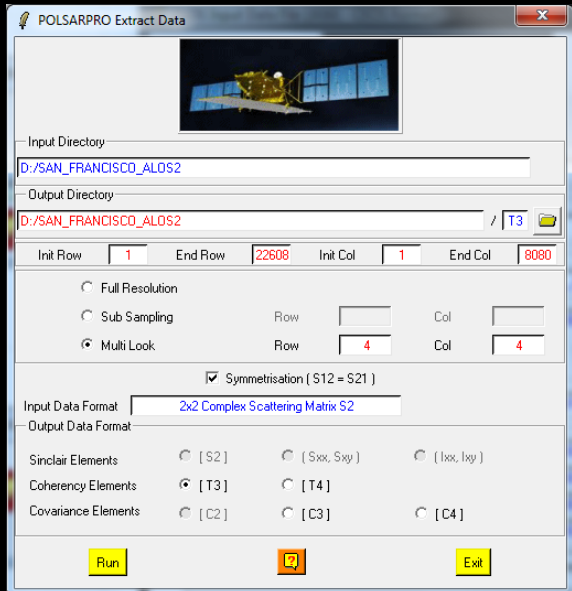
Covariance Elements [C2] [C3] [C4]



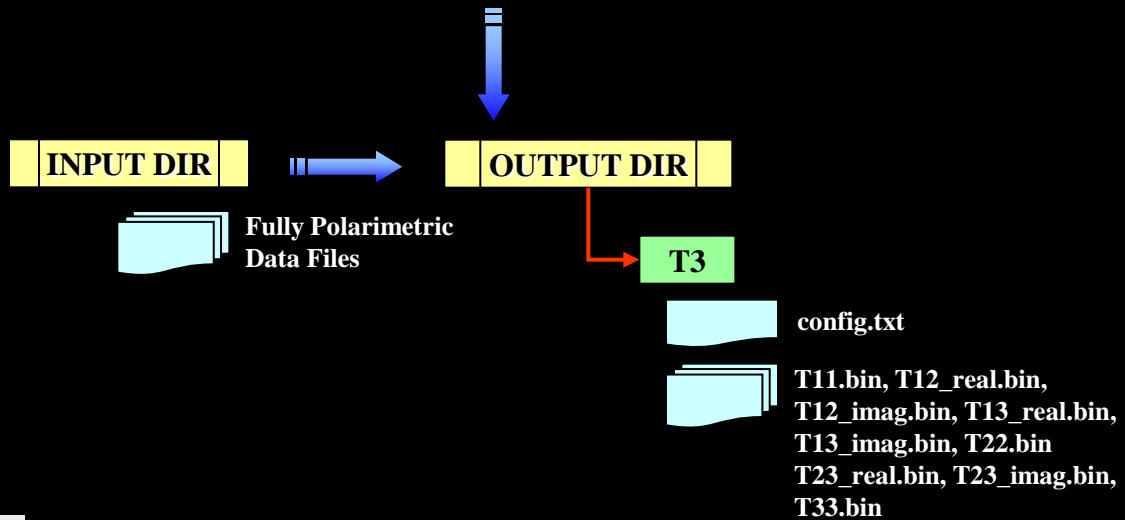
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Data IMPORT – Extract Binary Data



Convert ALOS2 Fully Polarimetric Data Files to Complex (3x3) Coherency Matrix [T3]



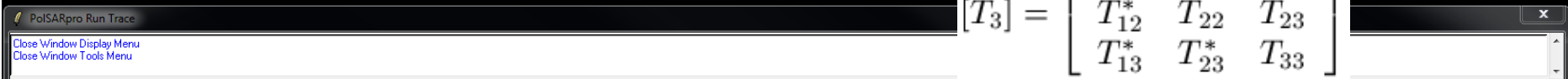
Do it Yourself:

**Multi Look : Row = 4 Col = 4
Run**

$$\underline{k}_{3P} = \frac{1}{\sqrt{2}} \begin{bmatrix} S_{11} + S_{22} & S_{11} - S_{22} & S_{12} + S_{21} \end{bmatrix}$$


$$\Rightarrow [T_3] = \langle \underline{k}_{3P} \cdot \underline{k}_{3P}^\dagger \rangle$$

$$[T_3] = \begin{bmatrix} T_{11} & T_{12} & T_{13} \\ T_{12}^* & T_{22} & T_{23} \\ T_{13}^* & T_{23}^* & T_{33} \end{bmatrix}$$

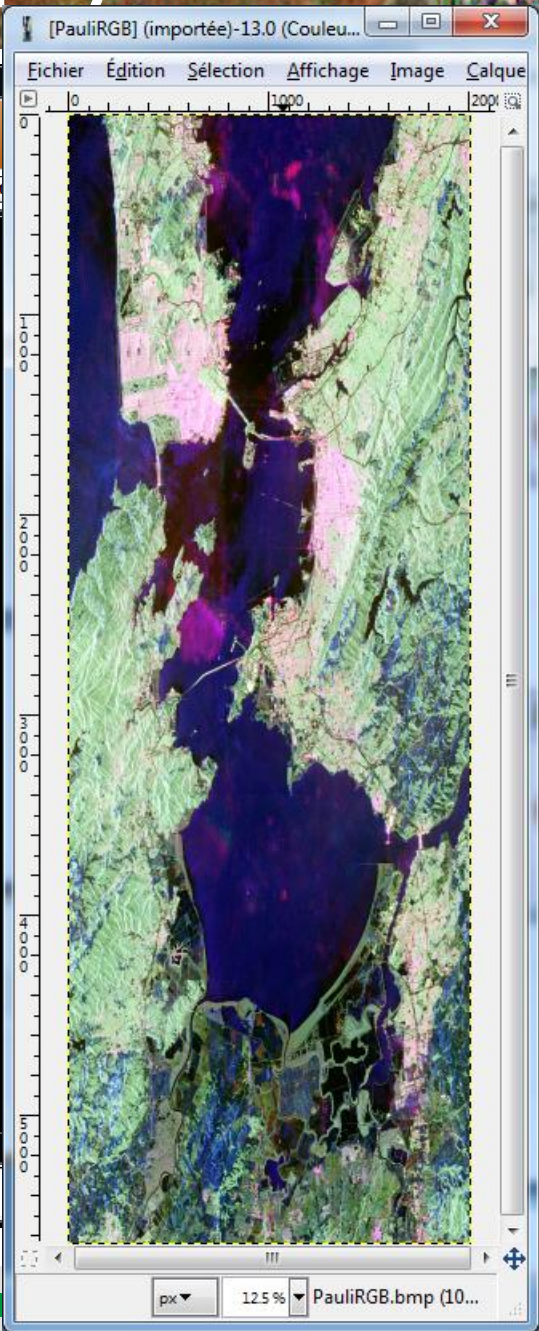


Display Pauli-RGB Image

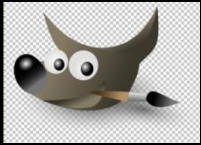
Polarimetric SAR Data Processing and Educational Tool v5.1 - Menu

 **PolSARpro**
The Polarimetric SAR Data Processing and Educational Tool

T3 5 Environment Import Convert Process Display Calibrat



Quit



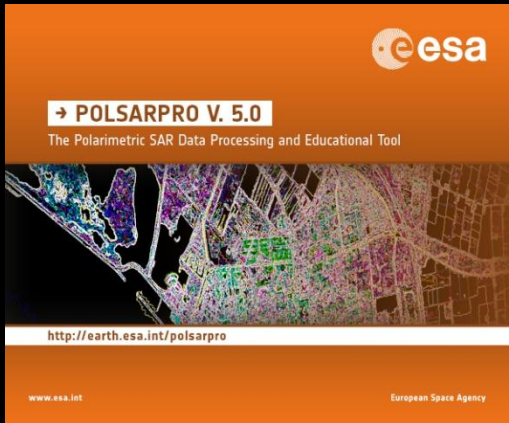
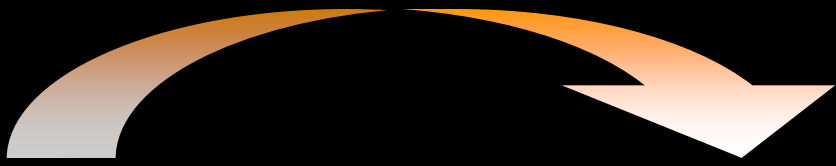
PolSARpro Run Trace

Close Window Display Menu
Close Window Tools Menu

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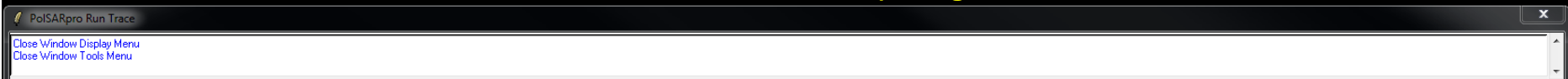
ESA - SNAP



Polariametric Data Processing



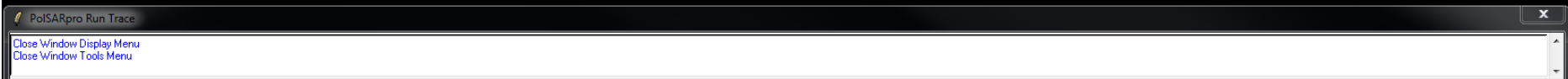
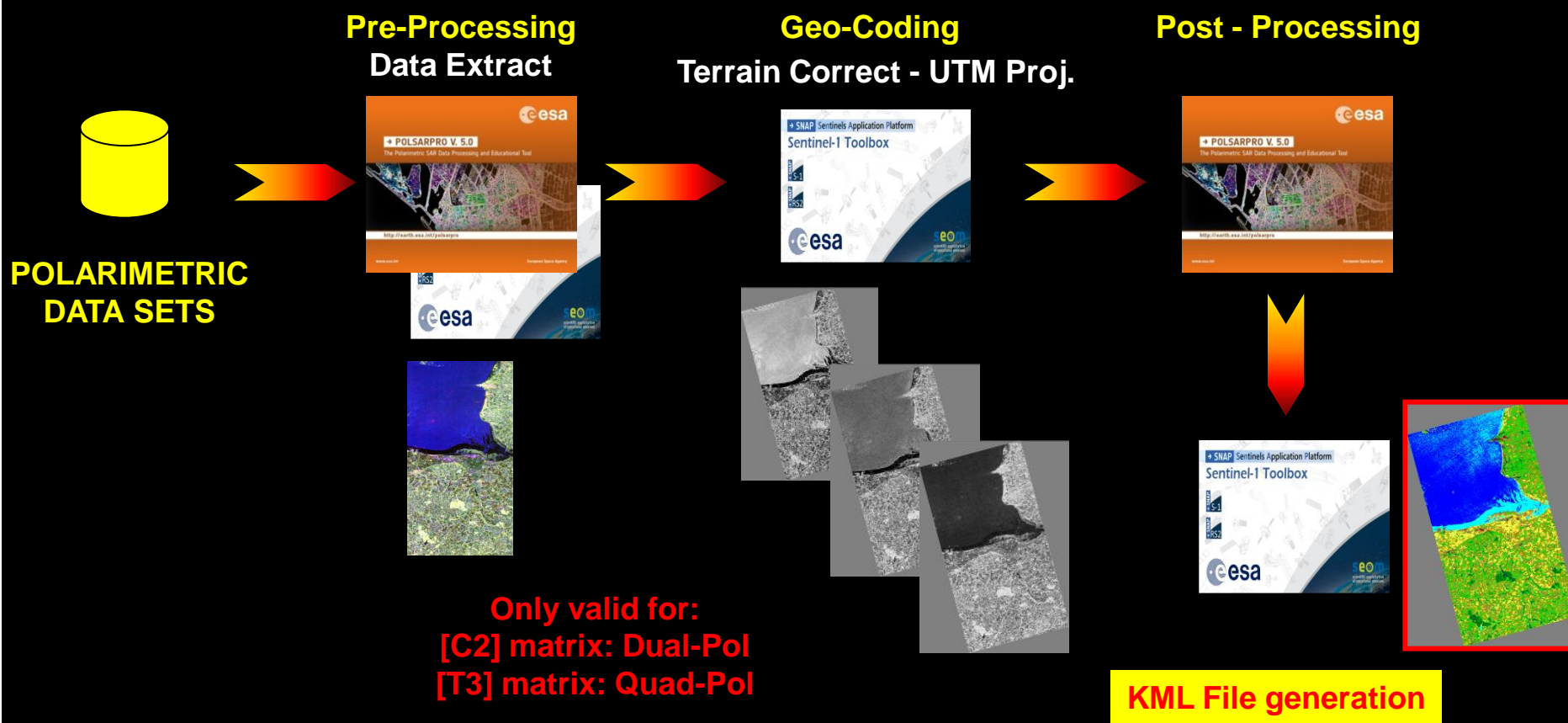
- S1 toolbox (split, deburst, merge ...)
- Geocoding toolbox
- Interferometric toolbox (co-registration, flat Earth estimation ...)



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PolSARpro v5.1 SOFTWARE



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PoISARpro v5.1 SOFTWARE



The screenshot displays the PoISARpro v5.1 software interface. The main menu bar includes 'Environment', 'Import', 'Convert', 'Process', 'Display', 'Calibration', 'Utilities', 'Tools', and 'Configuration'. The 'Utilities' menu is open, showing options like 'PoISARpro - Calculator', 'SATIM Map Algebra', 'SNAP - S1 TBX', 'SRTM', 'ASTER', 'GIMP', 'GOOGLE EARTH', and 'Close All Widgets'. The 'SNAP - S1 TBX' option is highlighted with a blue oval. A red arrow points from the 'Utilities' menu to the 'SNAP - S1 TBX' option. A yellow arrow points from the 'SNAP - S1 TBX' option to a sub-menu box containing 'Geocode [C2] matrix', 'Geocode [T3] matrix', and 'Geocode Parameter'. The 'Geocode [T3] matrix' option is highlighted with a blue oval. A yellow arrow points from this option to the 'SNAP - Geocode Matrix' dialog box. The dialog box is titled 'SNAP - Geocode Matrix' and contains the following fields and options:

- Input Directory: D:/SAN_FRANCISCO_ALOS2/T3
- Output Directory: D:/SAN_FRANCISCO_ALOS2_SNAP / T3
- Polarimetric SAR Sensor: ALOS-2 (CEOS)
- SAR Volume File: D:/SAN_FRANCISCO_ALOS2/VOL-ALOS2044980750-150324-HBQR1.1_A
- Source GR Pixel Spacings: Azimut (m) 12.82284, Range (m) 20.53052, Pixel Spacing (m) 20.53052
- Input Multi Look: Azimut 4, Range 4
- Output Multi Look: Azimut 1, Range 1
- Image Resampling Method: Bilinear
- Digital Elevation Model (DEM): S.R.T.M
- DEM Resampling Method: Bilinear
- Save Auxiliary Files: DEM, Local Incidence Angle, Projected Local Incidence Angle from DEM
- Default Parameters: Geocoding : Latitude / Longitude, Datum : WGS84, Input Format : PoISARpro, Output Format : PoISARpro
- Processed SAR Data File: (empty)

Buttons at the bottom of the dialog box include 'OK', a help icon, and 'Exit'.

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PolSARpro v5.1 SOFTWARE



The screenshot displays the PolSARpro v5.1 software interface. The main window title is "PolSARpro The Polarimetric SAR Data Processing and Educational Tool v5.1 - Menu". The "Environment" menu is open, showing options like "Import", "Convert", and "Process". A dialog box titled "SNAP - Geocode Matrix" is open, showing the following configuration:

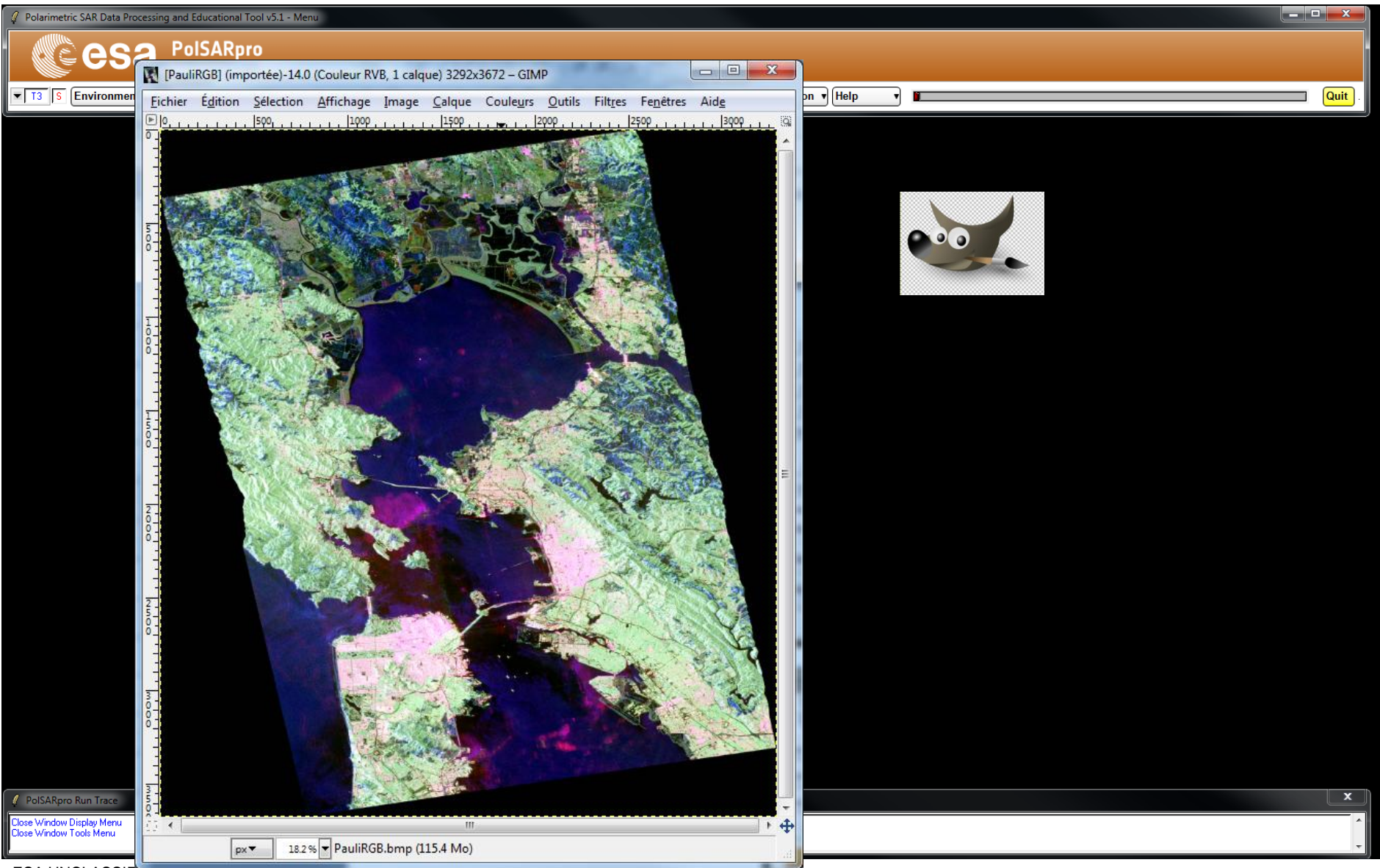
- Input Directory: D:/SAN_FRANCISCO_ALOS2/T3
- Output Directory: D:/SAN_FRANCISCO_ALOS2_SNAP / T3
- Polarimetric SAR Sensor: ALOS-2 (CEOS)
- SAR Volume File: D:/SAN_FRANCISCO_ALOS2/VOL-ALOS2044980750-150324-HBQR1.1_A
- Source GR Pixel Spacings: Azimut (m) 12.82284, Range (m) 20.53052, Pixel Spacing (m) 20.53052
- Input Multi Look: Azimut 4, Range 4
- Output Multi Look: Azimut 1, Range 1
- Image Resampling Method: Bilinear
- Digital Elevation Model (DEM): S.R.T.M
- DEM Resampling Method: Bilinear
- Save Auxiliary Files: DEM, Local Incidence Angle, Projected Local Incidence Angle from DEM
- Default Parameters: Geocoding: Latitude / Longitude, Datum: WGS84, Input Format: PolSARpro, Output Format: PolSARpro

At the bottom of the dialog box, there are "OK", "Exit", and a help icon button. The "Processed SAR Data File" field is empty.

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Display Pauli-RGB Image

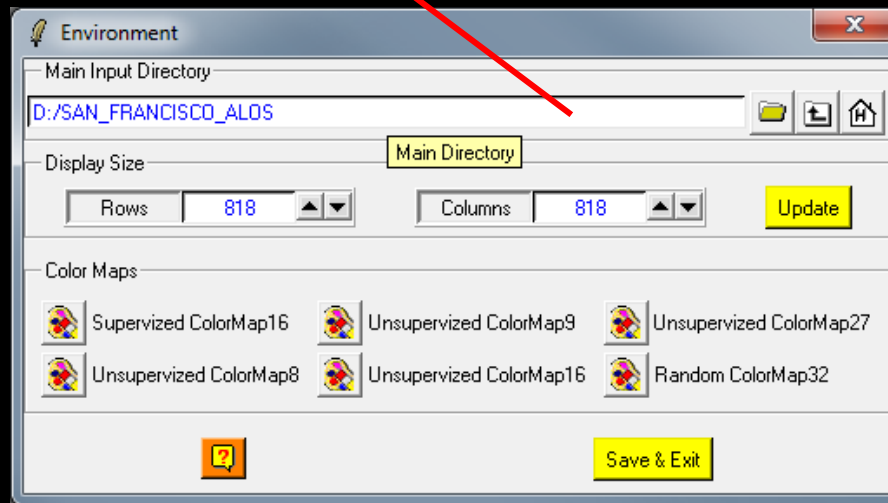


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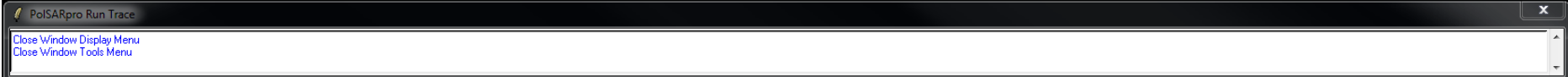


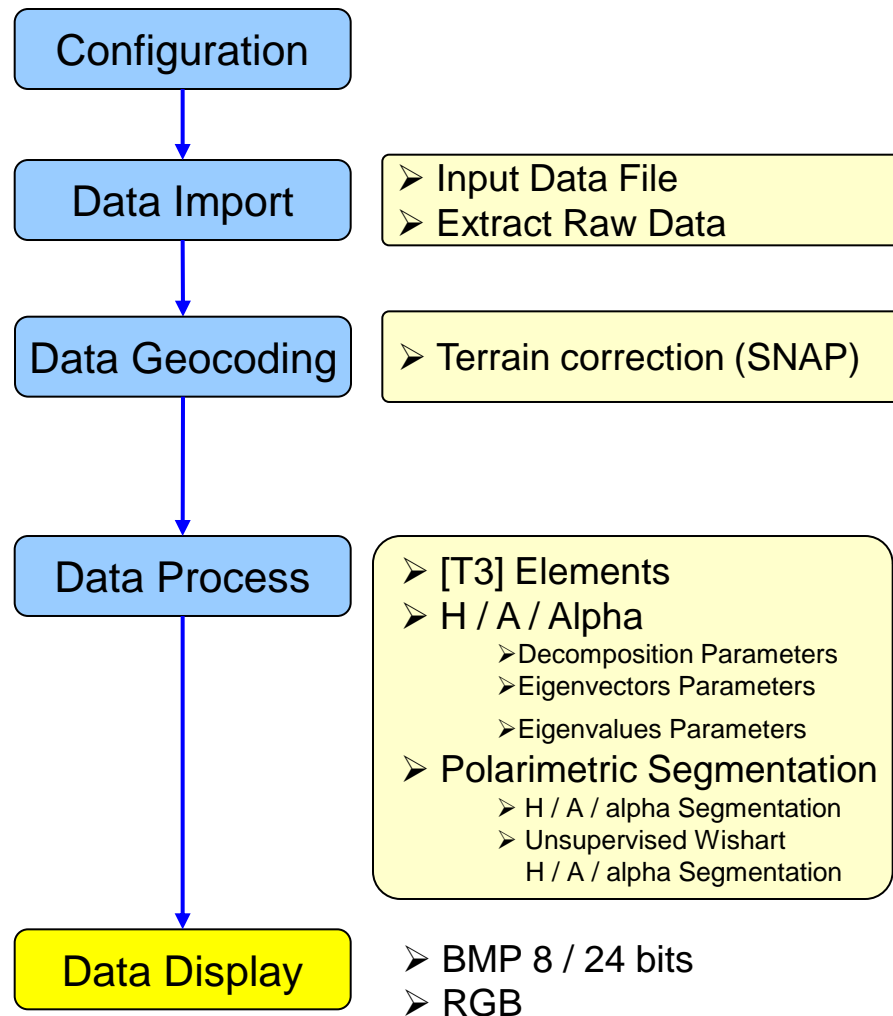
Configure Data Main Directory location



Input Data Directory :

SAN_FRANCISCO_ALOS2_SNAP
(If the first data processing steps are skipped)





Display Main Menu

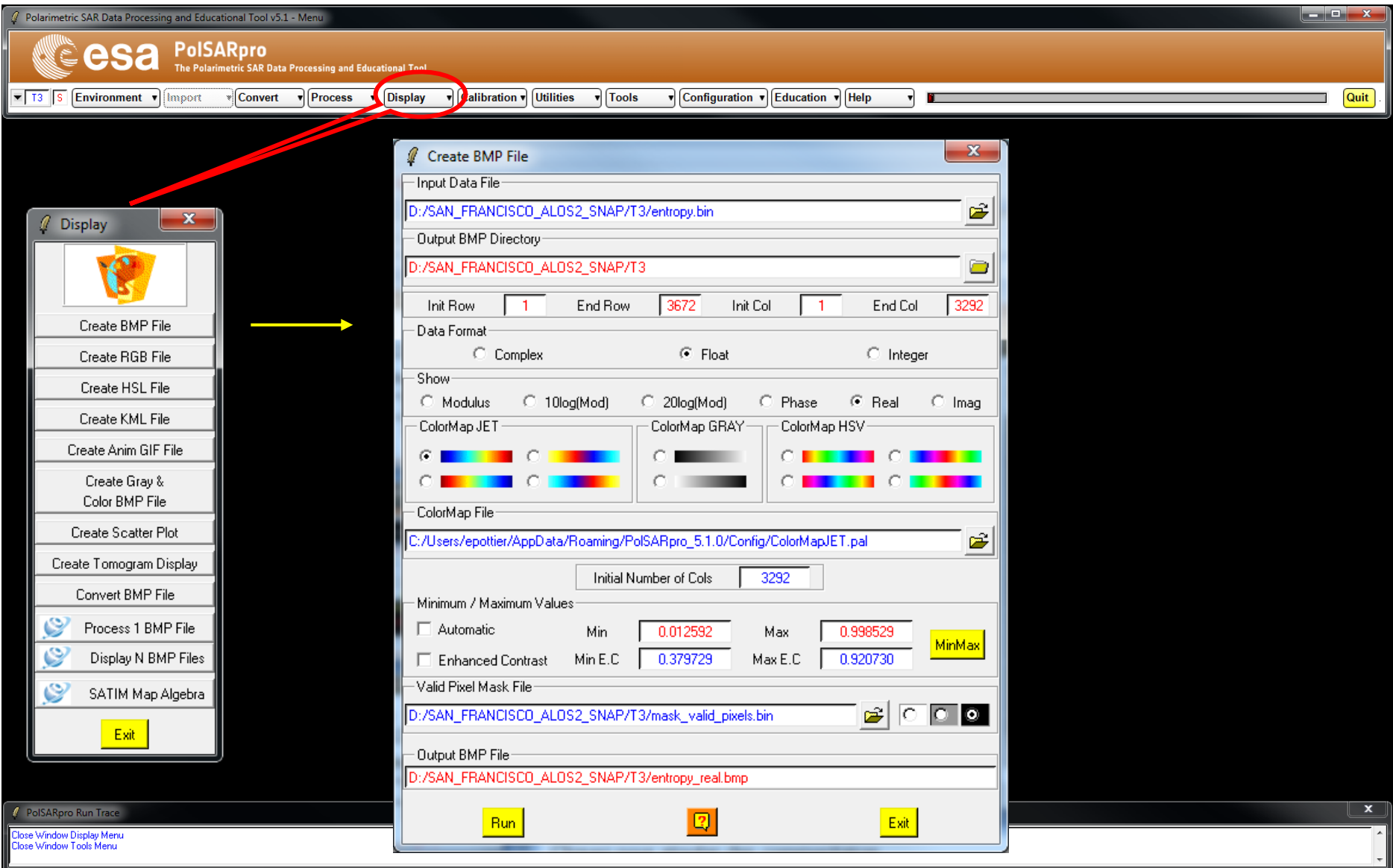


The screenshot shows the PolSARpro software interface. The main window title is "PolSARpro The Polarimetric SAR Data Processing and Educational Tool". The menu bar includes: Environment, Import, Convert, Process, Display (highlighted with a red circle), Calibration, Utilities, Tools, Configuration, Education, Help, and a yellow Quit button. A "Display" sub-window is open, listing the following options: Create BMP File, Create RGB File, Create HSL File, Create KML File, Create Anim GIF File, Create Gray & Color BMP File, Create Scatter Plot, Create Tomogram Display, Convert BMP File, Process 1 BMP File, Display N BMP Files, SATIM Map Algebra, and an Exit button. A "PolSARpro Run Trace" window is also visible at the bottom, containing the text: "Close Window Display Menu" and "Close Window Tools Menu".

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Create BMP Image



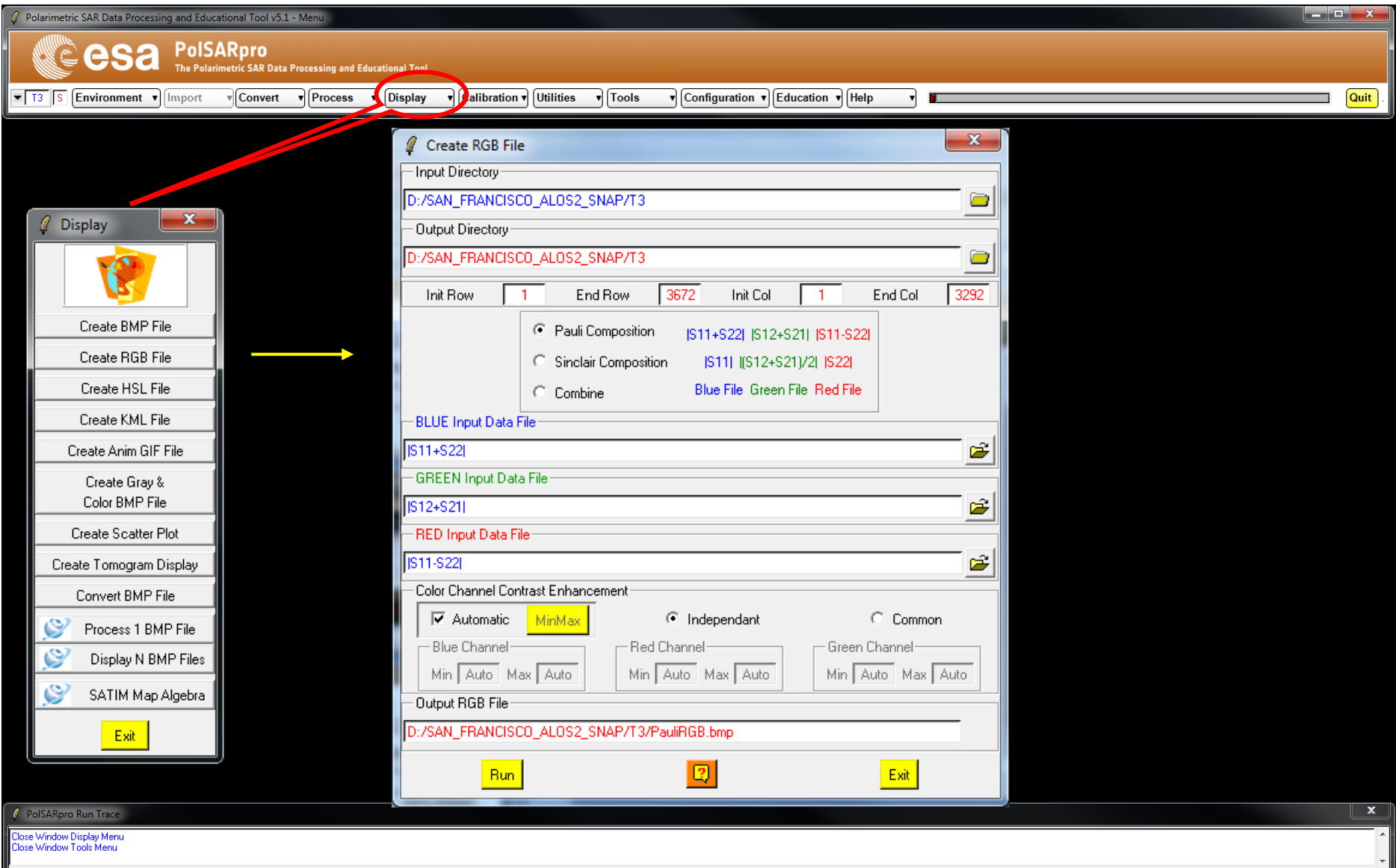
The screenshot displays the PolSARpro software interface. The main menu bar includes: Environment, Import, Convert, Process, Display, Calibration, Utilities, Tools, Configuration, Education, Help, and Quit. The 'Display' menu is open, showing options such as 'Create BMP File', 'Create RGB File', 'Create HSL File', 'Create KML File', 'Create Anim GIF File', 'Create Gray & Color BMP File', 'Create Scatter Plot', 'Create Tomogram Display', 'Convert BMP File', 'Process 1 BMP File', 'Display N BMP Files', and 'SATIM Map Algebra'. A red circle highlights the 'Display' menu item, and a red arrow points from it to the 'Create BMP File' dialog box. A yellow arrow points from the 'Create BMP File' option in the menu to the dialog box.

The 'Create BMP File' dialog box contains the following fields and options:

- Input Data File:** D:/SAN_FRANCISCO_ALOS2_SNAP/T3/entropy.bin
- Output BMP Directory:** D:/SAN_FRANCISCO_ALOS2_SNAP/T3
- Init Row:** 1, **End Row:** 3672, **Init Col:** 1, **End Col:** 3292
- Data Format:** Complex, Float, Integer
- Show:** Modulus, 10log(Mod), 20log(Mod), Phase, Real, Imag
- ColorMap JET:** (ColorMap), (Grayscale), (HSB)
- ColorMap GRAY:** (ColorMap), (Grayscale), (HSB)
- ColorMap HSV:** (ColorMap), (Grayscale), (HSB)
- ColorMap File:** C:/Users/epottier/AppData/Roaming/PolSARpro_5.1.0/Config/ColorMapJET.pal
- Initial Number of Cols:** 3292
- Minimum / Maximum Values:**
 - Automatic
 - Min: 0.012592, Max: 0.998529
 - Enhanced Contrast
 - Min E.C: 0.379729, Max E.C: 0.920730
- Valid Pixel Mask File:** D:/SAN_FRANCISCO_ALOS2_SNAP/T3/mask_valid_pixels.bin
- Output BMP File:** D:/SAN_FRANCISCO_ALOS2_SNAP/T3/entropy_real.bmp

Buttons: Run, Exit

Create Pauli / Sinclair RGB Image



The screenshot displays the PolSARpro software interface. The main menu bar includes: Environment, Import, Convert, Process, Display (highlighted with a red circle), Calibration, Utilities, Tools, Configuration, Education, Help, and Quit. A red arrow points from the 'Display' menu item to a 'Display' sub-menu window. This sub-menu contains options such as 'Create BMP File', 'Create RGB File', 'Create HSL File', 'Create KML File', 'Create Anim GIF File', 'Create Gray & Color BMP File', 'Create Scatter Plot', 'Create Tomogram Display', 'Convert BMP File', 'Process 1 BMP File', 'Display N BMP Files', and 'SATIM Map Algebra'. A yellow arrow points from the 'Create RGB File' option in the sub-menu to the 'Create RGB File' dialog box. The dialog box is titled 'Create RGB File' and contains the following fields and options:

- Input Directory: D:/SAN_FRANCISCO_ALOS2_SNAP/T3
- Output Directory: D:/SAN_FRANCISCO_ALOS2_SNAP/T3
- Init Row: 1, End Row: 3672, Init Col: 1, End Col: 3292
- Composition options:
 - Pauli Composition: |S11+S22| |S12+S21| |S11-S22|
 - Sinclair Composition: |S11| |(S12+S21)/2| |S22|
 - Combine: Blue File Green File Red File
- BLUE Input Data File: |S11+S22|
- GREEN Input Data File: |S12+S21|
- RED Input Data File: |S11-S22|
- Color Channel Contrast Enhancement:
 - Automatic (MinMax)
 - Independent
 - Common
- Blue Channel: Min | Auto | Max | Auto
- Red Channel: Min | Auto | Max | Auto
- Green Channel: Min | Auto | Max | Auto
- Output RGB File: D:/SAN_FRANCISCO_ALOS2_SNAP/T3/PauliRGB.bmp
- Buttons: Run, Exit

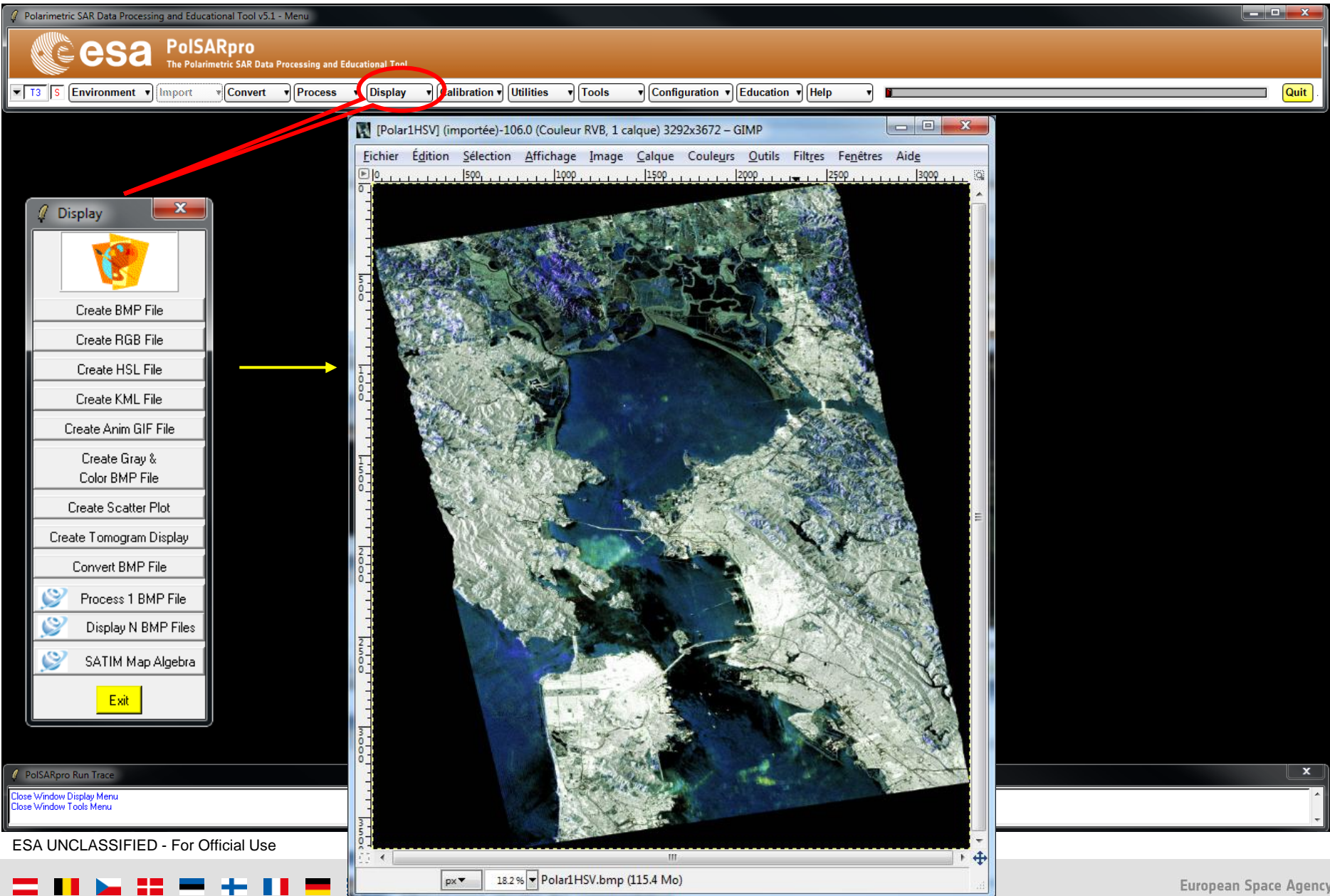
Create HSL Image

The screenshot displays the PolSARpro software interface. The main menu bar includes: Environment, Import, Convert, Process, Display (highlighted with a red circle), Calibration, Utilities, Tools, Configuration, Education, Help, and Quit. A secondary menu is open under 'Display', listing options such as 'Create BMP File', 'Create RGB File', 'Create HSL File', 'Create KML File', 'Create Anim GIF File', 'Create Gray & Color BMP File', 'Create Scatter Plot', 'Create Tomogram Display', 'Convert BMP File', 'Process 1 BMP File', 'Display N BMP Files', and 'SATIM Map Algebra'. The 'Create HSL File' dialog box is open, showing the following settings:

- Input Directory: D:/SAN_FRANCISCO_ALOS2_SNAP/T3
- Output Directory: D:/SAN_FRANCISCO_ALOS2_SNAP/T3
- Init Row: 1, End Row: 3672, Init Col: 1, End Col: 3292
- Radio buttons for decomposition:
 Polar Decomposition : Hue (Alpha) / Sat (1 - Entropy) / Light (Span)
 Polar Decomposition : Hue (Alpha) / Sat (1 - Entropy) / Light (Anisotropy)
 Combine : Hue File / Sat File / Light File
- HUE Input Data File: alpha
- SAT Input Data File: entropy
- LIGHT Input Data File: span
- Color Channel Contrast Enhancement:
 Automatic (MinMax)
 Independant
 Common
- Output HSL File: D:/SAN_FRANCISCO_ALOS2_SNAP/T3/Polar1HSV.bmp

Buttons for 'Run' and 'Exit' are visible at the bottom of the dialog box. A yellow arrow points from the 'Display' menu to the 'Create HSL File' dialog box.

Create HSL Image

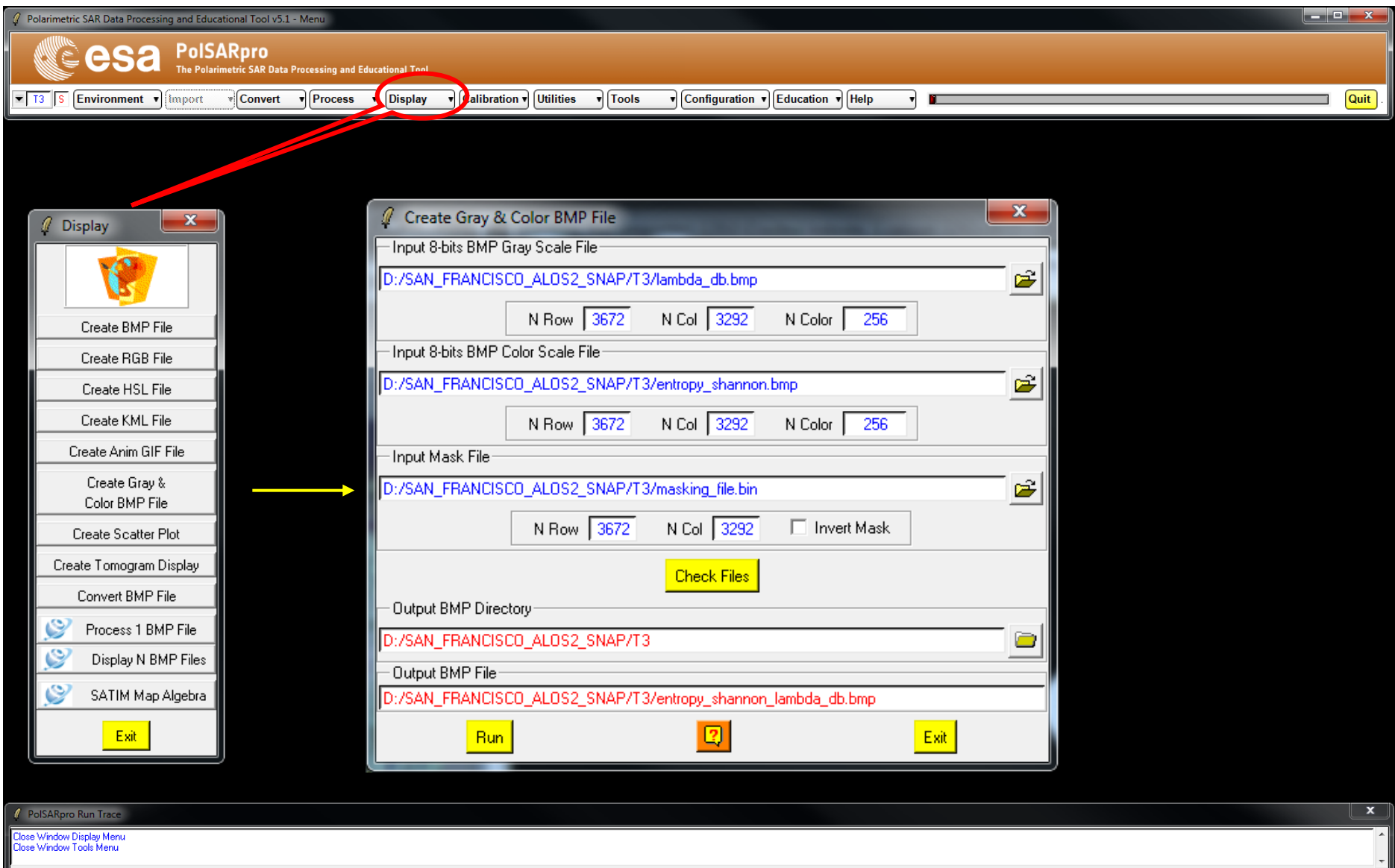


The screenshot displays the PolSARpro software interface. The main menu bar includes: Environment, Import, Convert, Process, Display (highlighted with a red circle), Calibration, Utilities, Tools, Configuration, Education, Help, and Quit. A red arrow points from the 'Display' menu item to a 'Display' sub-menu window. This sub-menu contains the following options: Create BMP File, Create RGB File, Create HSL File, Create KML File, Create Anim GIF File, Create Gray & Color BMP File, Create Scatter Plot, Create Tomogram Display, Convert BMP File, Process 1 BMP File, Display N BMP Files, and SATIM Map Algebra. A yellow arrow points from the 'Create HSL File' option to the GIMP window. The GIMP window, titled '[Polar1HSV] (importée)-106.0 (Couleur RVB, 1 calque) 3292x3672 - GIMP', shows a satellite image of a coastal area with a large lake. The GIMP interface includes a menu bar (Fichier, Édition, Sélection, Affichage, Image, Calque, Couleurs, Outils, Filtres, Fenêtres, Aide), a toolbar, and a status bar at the bottom showing 'px', '18.2 %', and 'Polar1HSV.bmp (115.4 Mo)'. At the bottom left of the PolSARpro window, there is a 'PolSARpro Run Trace' window with the text: 'Close Window Display Menu' and 'Close Window Tools Menu'. The bottom of the slide features a row of national flags and the text 'ESA UNCLASSIFIED - For Official Use'.

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Create Gray & Color BMP Image

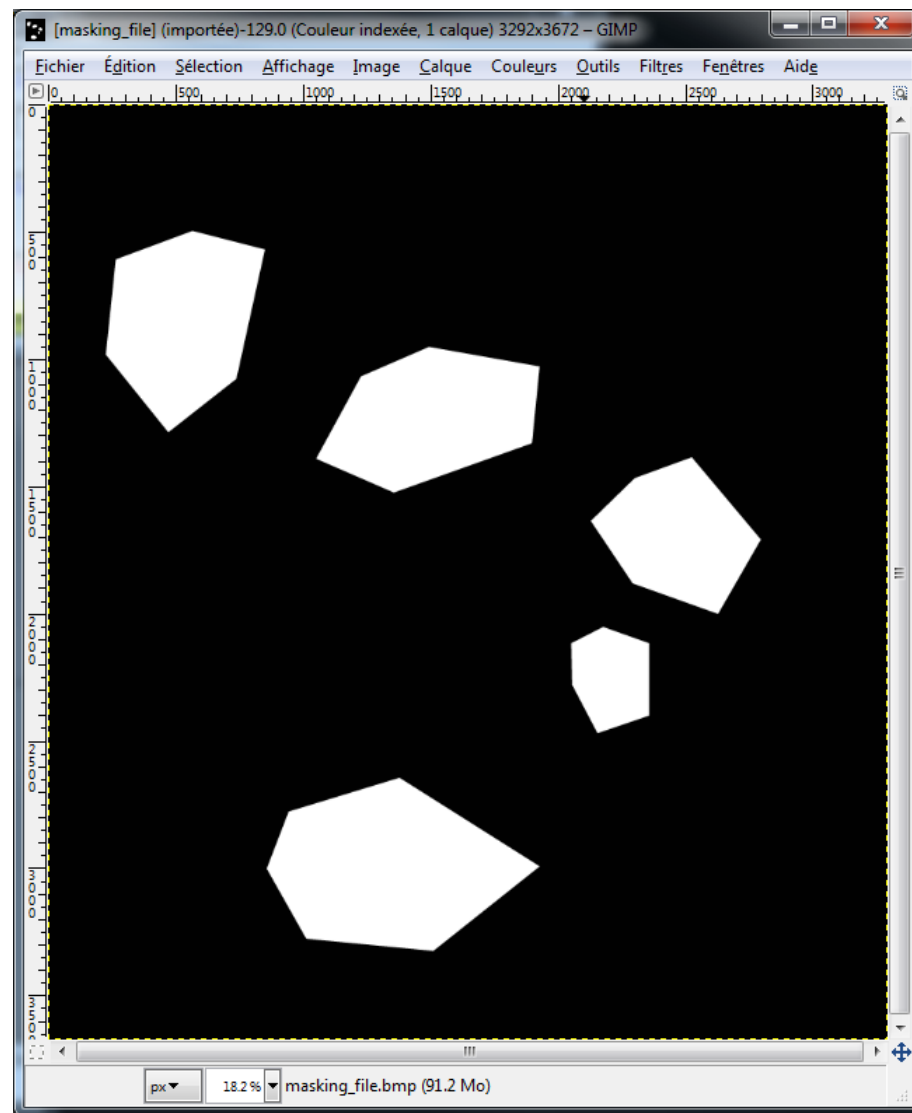
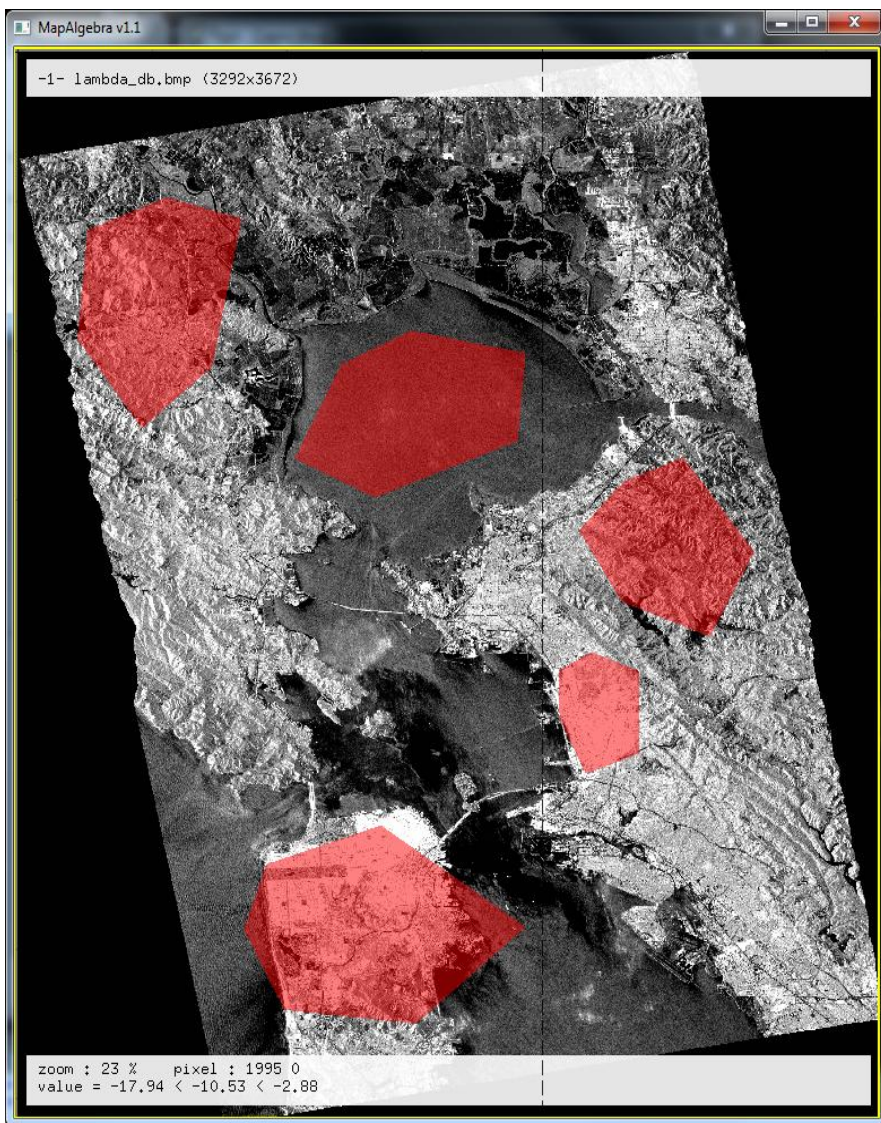


The screenshot displays the PolSARpro v5.1 software interface. The main menu bar includes: Environment, Import, Convert, Process, Display, Calibration, Utilities, Tools, Configuration, Education, Help, and Quit. The 'Display' menu is open, showing options such as 'Create BMP File', 'Create RGB File', 'Create HSL File', 'Create KML File', 'Create Anim GIF File', 'Create Gray & Color BMP File', 'Create Scatter Plot', 'Create Tomogram Display', 'Convert BMP File', 'Process 1 BMP File', 'Display N BMP Files', and 'SATIM Map Algebra'. The 'Create Gray & Color BMP File' dialog box is active, showing the following configuration:

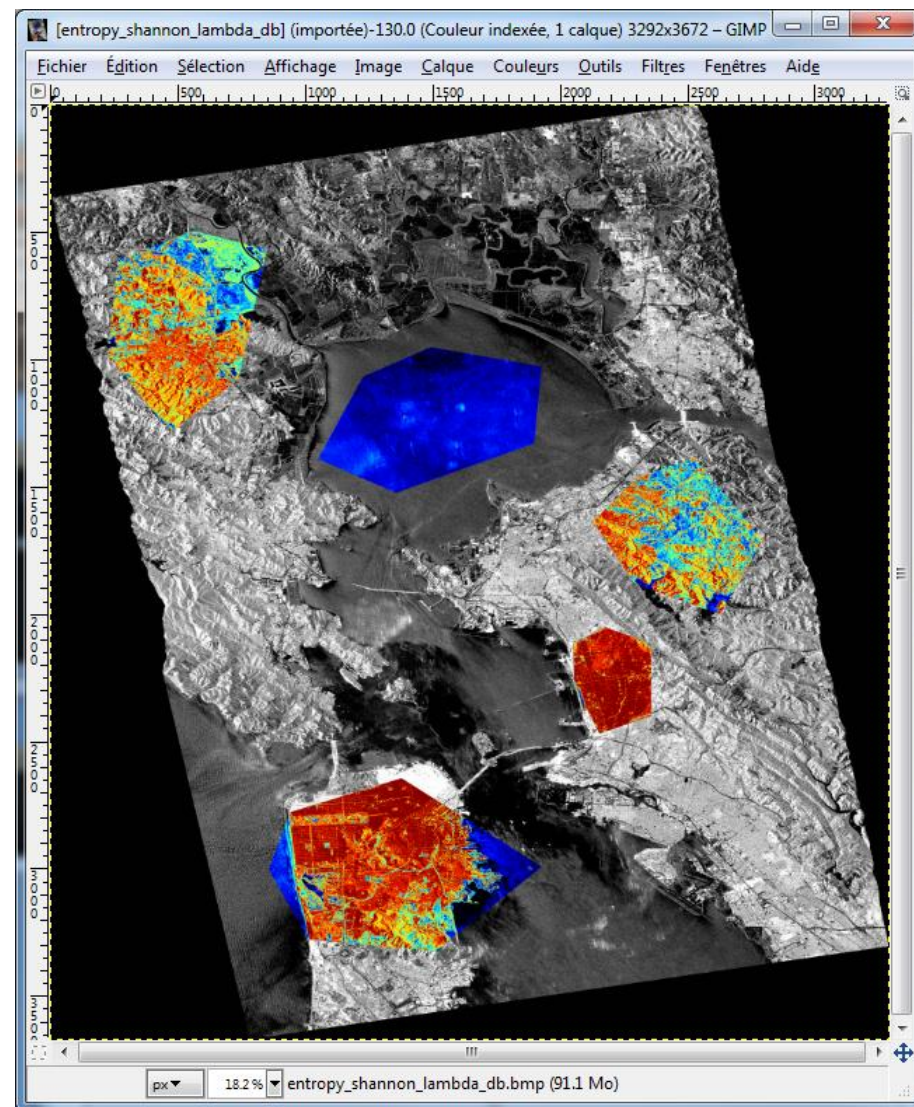
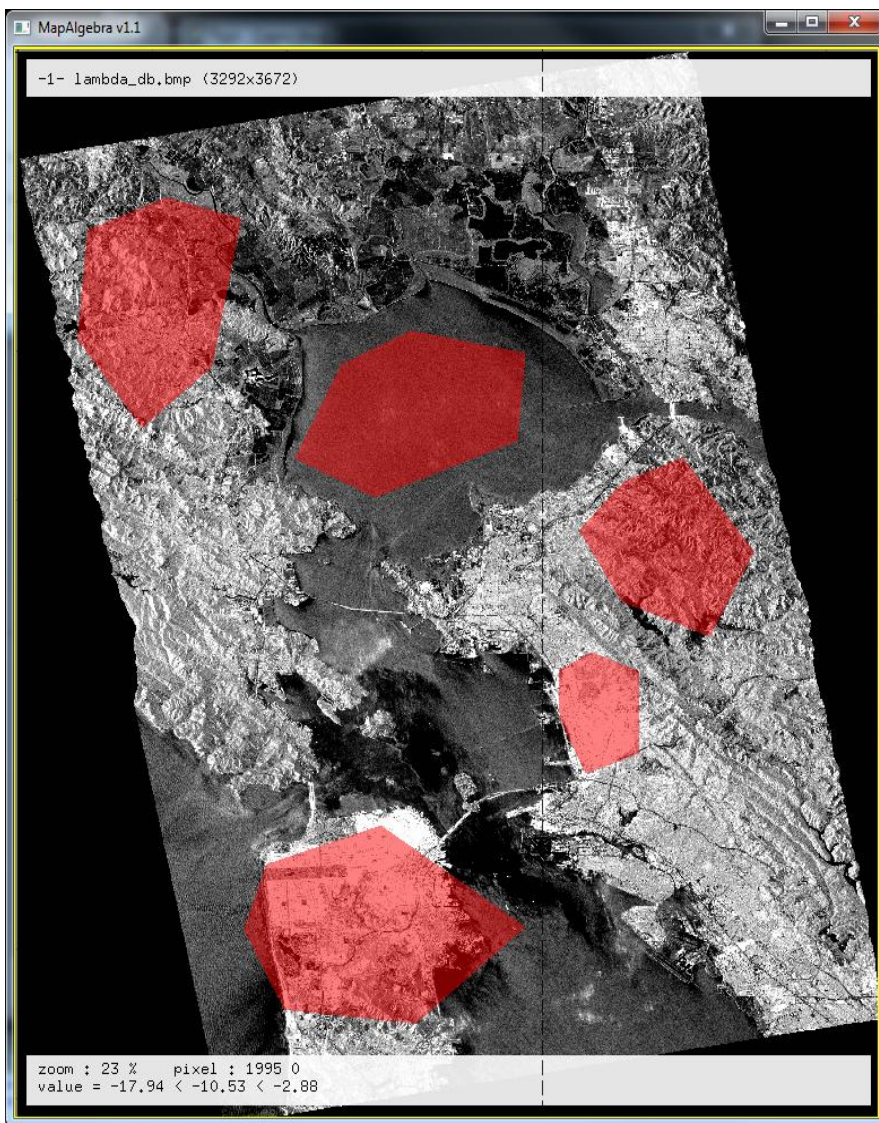
- Input 8-bits BMP Gray Scale File: D:/SAN_FRANCISCO_ALOS2_SNAP/T3/lambda_db.bmp (N Row: 3672, N Col: 3292, N Color: 256)
- Input 8-bits BMP Color Scale File: D:/SAN_FRANCISCO_ALOS2_SNAP/T3/entropy_shannon.bmp (N Row: 3672, N Col: 3292, N Color: 256)
- Input Mask File: D:/SAN_FRANCISCO_ALOS2_SNAP/T3/masking_file.bin (N Row: 3672, N Col: 3292, Invert Mask: unchecked)
- Output BMP Directory: D:/SAN_FRANCISCO_ALOS2_SNAP/T3
- Output BMP File: D:/SAN_FRANCISCO_ALOS2_SNAP/T3/entropy_shannon_lambda_db.bmp

Buttons for 'Check Files', 'Run', and 'Exit' are visible in the dialog box. A red circle highlights the 'Display' menu item, and a red arrow points from it to the 'Create Gray & Color BMP File' dialog box. A yellow arrow points from the 'Create Gray & Color BMP File' option in the 'Display' menu to the dialog box. The 'PolSARpro Run Trace' window at the bottom shows: 'Close Window Display Menu' and 'Close Window Tools Menu'.

Create Gray & Color BMP Image



Create Gray & Color BMP Image



Create Scatter Plot

The screenshot shows the PolSARpro software interface. The main menu bar includes: Environment, Import, Convert, Process, Display (highlighted with a red circle), Calibration, Utilities, Tools, Configuration, Education, Help, and Quit. A red arrow points from the 'Display' menu to a 'Display' sub-menu. This sub-menu contains options: Create BMP File, Create RGB File, Create HSL File, Create KML File, Create Anim GIF File, Create Gray & Color BMP File, Create Scatter Plot (highlighted with a yellow arrow), Create Tomogram Display, Convert BMP File, Process 1 BMP File, Display N BMP Files, and SATIM Map Algebra. Below the sub-menu is an 'Exit' button.

The 'Create Scatter Plot' dialog box is open, showing two input data files:

- Input Data File (X):** D:/SAN_FRANCISCO_ALOS2_SNAP/T3/entropy.bin
- Data Format:** Float (selected)
- Show:** Real (selected)
- Minimum / Maximum Values:**
 - Automatic:
 - Enhanced Contrast:
 - Min: 0.012592, Max: 0.998529
 - Min E.C: 0.379729, Max E.C: 0.920730
 - MinMax button

The second input data file is:

- Input Data File (Y):** D:/SAN_FRANCISCO_ALOS2_SNAP/T3/alpha.bin
- Data Format:** Float (selected)
- Show:** Real (selected)
- Minimum / Maximum Values:**
 - Automatic:
 - Enhanced Contrast:
 - Min: 0.791853, Max: 89.163811
 - Min E.C: 19.644552, Max E.C: 53.780357
 - MinMax button

Labels and Title:

- Label (X):** Entropy
- Label (Y):** Alpha
- Title Scatter Plot:** Entropy - Alpha plane

Buttons: Run, [Grid], [Print], [Help], Exit.

At the bottom, the 'PolSARpro Run Trace' window shows: Close Window Display Menu, Close Window Tools Menu.

Convert BMP File



The screenshot shows the PolSARpro software interface. The main menu bar includes: T3, Environment, Import, Convert, Process, Display (highlighted with a red circle), Calibration, Utilities, Tools, Configuration, Education, Help, and Quit. A red arrow points from the 'Display' menu item to the 'Display' sub-menu. The 'Display' sub-menu is open, showing options: Create BMP File, Create RGB File, Create HSL File, Create KML File, Create Anim GIF File, Create Gray & Color BMP File, Create Scatter Plot, Create Tomogram Display, Convert BMP File (highlighted with a yellow arrow), Process 1 BMP File, Display N BMP Files, and SATIM Map Algebra. The 'Convert BMP File' dialog box is open, showing the following fields and options:

- Input BMP Image File: D:/SAN_FRANCISCO_ALOS2_SNAP/T3/entropy.bmp
- N Row: 3672, N Col: 3292, N Color: BMP 8 Bits
- Output Image Format: GIF, JPEG, PNG, TIFF, BMP24 >> BMP8
- Reduction Factor: 2
- Transparency: (off), (on), (black)
- Output Image File: D:/SAN_FRANCISCO_ALOS2_SNAP/T3/entropy.png
- World File Generation:
 - Input GEARTH_POLY File: ENTER THE GEARTH POLY FILE
 - Input Config Acquisition File: ENTER THE CONFIG ACQUISITION FILE
 - Output World File: D:/SAN_FRANCISCO_ALOS2_SNAP/T3/entropy
- Buttons: Run, Exit

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Convert BMP File



The screenshot displays the PolSARpro software interface. The main menu bar includes: File, Environment, Import, Convert, Process, Display, Calibration, Utilities, Tools, Configuration, Education, Help, and Quit. The 'Display' menu is highlighted with a red circle and a red arrow pointing to the 'Display' window. The 'Display' window contains a list of actions: Create BMP File, Create RGB File, Create HSL File, Create KML File, Create Anim GIF File, Create Gray & Color BMP File, Create Scatter Plot, Create Tomogram Display, Convert BMP File, Process 1 BMP File, Display N BMP Files, and SATIM Map Algebra. The 'Convert BMP File' dialog box is open, showing the input file path 'D:/SAN_FRANCISCO_ALOS2_SNAP/T3/entropy.bmp', output format 'PNG', and reduction factor '2'. The 'Scatter Plot' window shows an 'H - Alpha Plane - (Scale: 10ⁿ)' plot with 'Alpha' on the y-axis (0 to 80) and 'Entropy' on the x-axis (0 to 1). The plot shows a distribution of points with a color scale from 0 to 4. The maximum entropy is 6127.000224 and the minimum is 0.000000. The 'PolSARpro Run Trace' window at the bottom shows the following actions: Close Window Display Menu and Close Window Tools Menu.

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SATIM Map Algebra

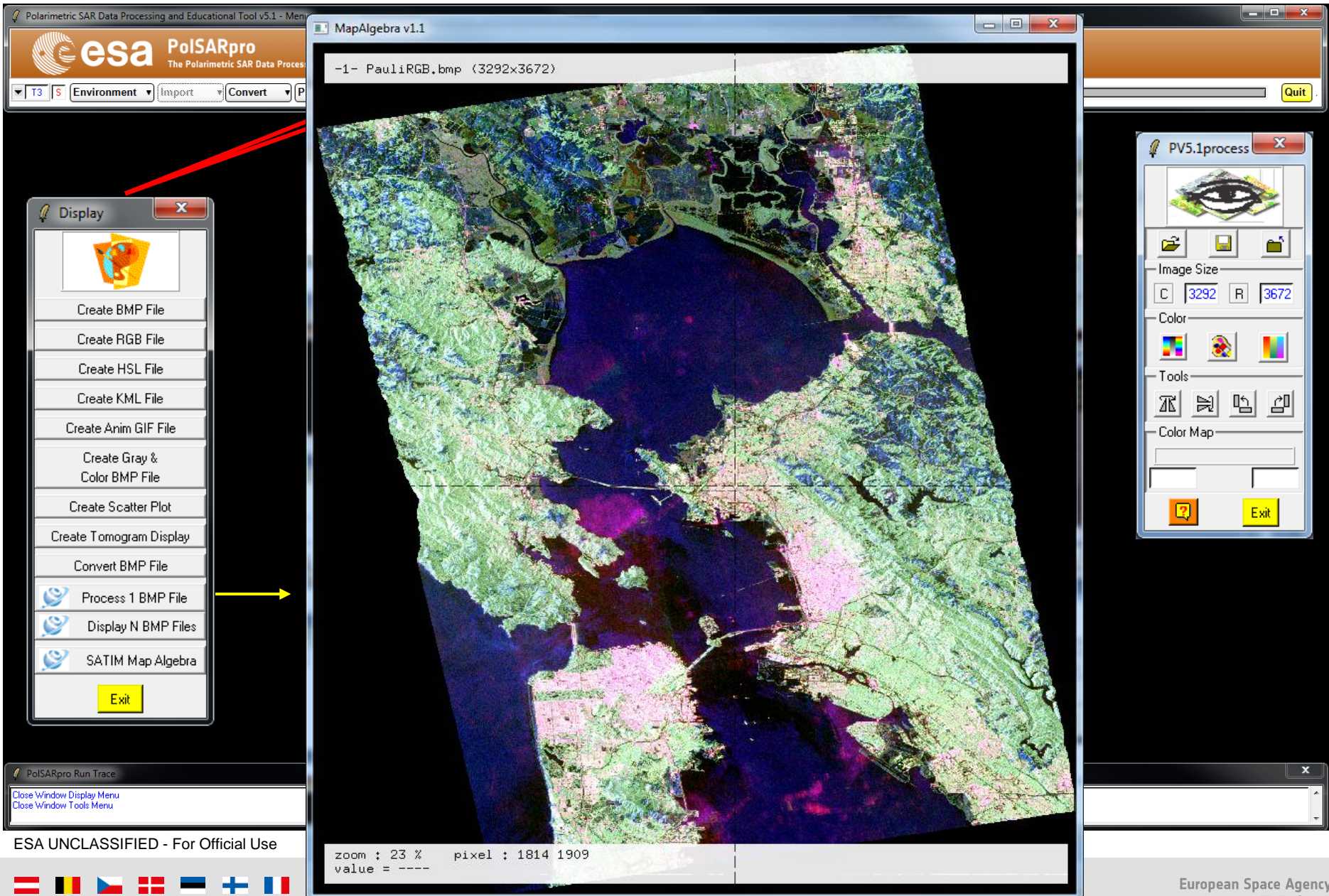


The screenshot displays the PolSARpro software interface. The main menu bar includes: Environment, Import, Convert, Process, Display, Calibration, Utilities, Tools, Configuration, Education, Help, and Quit. The 'Display' and 'Utilities' menus are circled in red. A red arrow points from the 'Display' menu to a sub-menu window titled 'Display'. This sub-menu contains options: Create BMP File, Create RGB File, Create HSL File, Create KML File, Create Anim GIF File, Create Gray & Color BMP File, Create Scatter Plot, Create Tomogram Display, Convert BMP File, Process 1 BMP File, Display N BMP Files, SATIM Map Algebra, and an Exit button. The 'Process 1 BMP File', 'Display N BMP Files', and 'SATIM Map Algebra' options are also circled in red. Another red arrow points from the 'Utilities' menu to a sub-menu window titled 'Utilities'. This sub-menu contains: PoISARpro - Calculator, PoISARpro - Display, PoISARpro - SIM, PoISARpro - Viewer, SATIM Map Algebra, SNAP - SI TBX, SRTM, ASTER, GIMP, GOOGLE EARTH, and Close All Widgets. The 'SATIM Map Algebra' option is circled in red. A yellow arrow points from the 'SATIM Map Algebra' option in the 'Utilities' sub-menu to a separate box containing 'Process 1 BMP File' and 'Display N BMP Files'. At the bottom, a 'PolSARpro Run Trace' window shows the following text: 'Close Window Display Menu' and 'Close Window Tools Menu'.

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Process 1 BMP Image



The screenshot displays the PolSARpro software interface. The main window, titled 'MapAlgebra v1.1', shows a false-color satellite image of a coastal area with a large lake. The 'Display' menu is open, and the 'Process 1 BMP File' option is highlighted with a yellow arrow. The 'PV5.1process' panel on the right shows image size settings (C: 3292, R: 3672) and color options. The status bar at the bottom indicates 'zoom : 23 % pixel : 1814 1909 value = ----'. The ESA logo is visible in the top right corner, and the text 'ESA UNCLASSIFIED - For Official Use' is at the bottom left.

PolSARpro Run Trace

- Close Window Display Menu
- Close Window Tools Menu

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European Space Agency
E.P (2017)

Display N BMP Images

The screenshot shows the PolSARpro software interface. The main menu bar includes: Environment, Import, Convert, Process, Display (highlighted with a red circle), Calibration, Utilities, Tools, Configuration, Education, Help, and Quit. A 'Display' sub-menu is open on the left, listing options such as 'Create BMP File', 'Create RGB File', 'Create HSL File', 'Create KML File', 'Create Anim GIF File', 'Create Gray & Color BMP File', 'Create Scatter Plot', 'Create Tomogram Display', 'Convert BMP File', 'Process 1 BMP File', 'Display N BMP Files' (highlighted with a yellow arrow), and 'SATIM Map Algebra'. The main workspace contains three windows: '-1- PauliRGB.bmp (3292x3672)', '-2- entropy.bmp (3292x3672)', and '-3- anisotropy.bmp (3292x3672)'. Each window shows a different visualization of the same SAR data. A 'PV5.1 Displ...' window is also visible in the top right corner.

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Create Pauli-RGB to KML Image



The screenshot shows the PolSARpro software interface. The main menu bar includes: T3, Environment, Import, Convert, Process, Display, Calibration, Utilities, Tools, Configuration, Education, Help, and Quit. The 'Display' menu is open, showing options: Create BMP File, Create RGB File, Create HSL File, Create KML File, Create Anim GIF File, Create Gray & Color BMP File, Create Scatter Plot, Create Tomogram Display, Convert BMP File, Process 1 BMP File, Display N BMP Files, and SATIM Map Algebra. The 'Create KML File' option is highlighted with a yellow arrow. The 'Create BMP - KML File' dialog box is open, with the following fields and options:

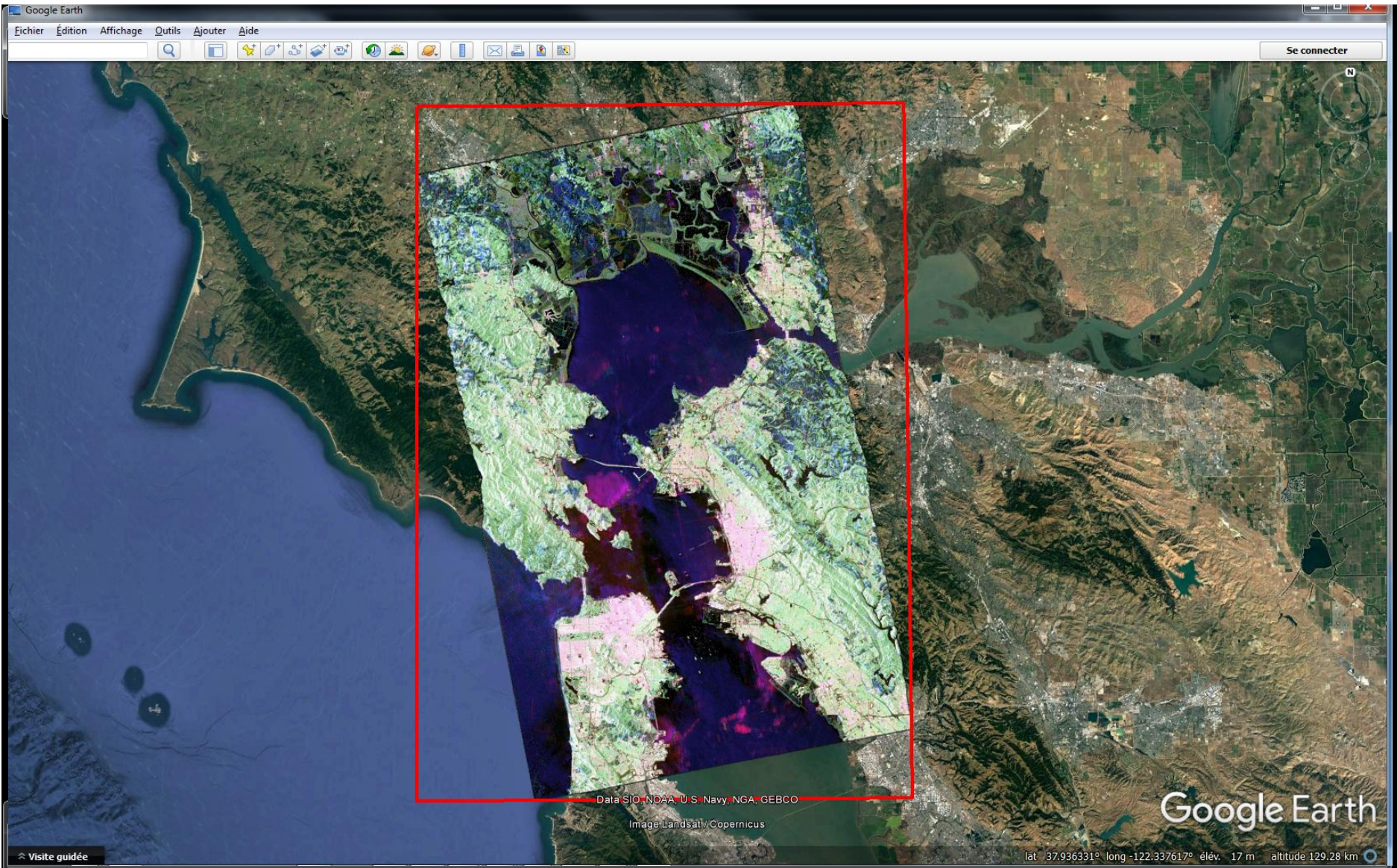
- Input BMP File: D:/SAN_FRANCISCO_ALOS2_SNAP/T3/PauliRGB.bmp
- Output KML Directory: D:/SAN_FRANCISCO_ALOS2_SNAP/T3
- N Row: 3672, N Col: 3292, N Color: BMP 24 Bits
- Input GEARTH_POLY File: D:/SAN_FRANCISCO_ALOS2_SNAP/GEARTH_POLY.kml
- Output KML File: D:/SAN_FRANCISCO_ALOS2_SNAP/T3/PauliRGB.kml
- Reduction Factor: 2
- Transparency: (checked)
- Buttons: Run, Exit

A red circle highlights the 'Display' menu item in the main menu bar. Another red circle highlights the 'Input BMP File' field in the dialog box. A third red circle highlights the 'Input GEARTH_POLY File' field in the dialog box. A fourth red circle highlights the 'Transparency' checkbox in the dialog box.

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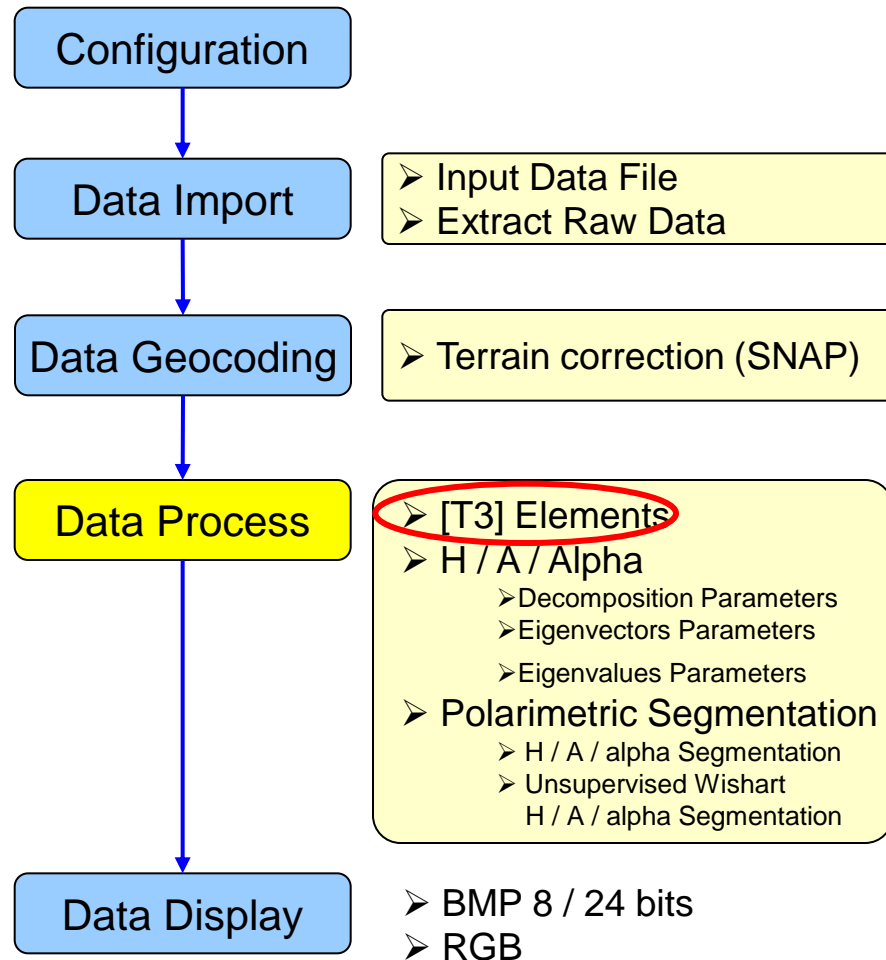


PoSARpro v5.1 SOFTWARE



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PolSARpro v5.1 SOFTWARE



PolSARpro v5.1 - Menu

esa PolSARpro
The Polarimetric SAR Data Processing and Educational Tool

Environment Import Convert **Process** Display Calibration Utilities Tools Configuration Education Help

Quit

Linear (+45 / -45)
Circular (L / R)
Elliptical (phi, tau)

Box Car Filter
Box Car - Edge Filter
C. Lopez Filter
Gaussian Filter
IDAN Filter
J.S. Lee Refined Filter
J.S. Lee Sigma Filter
P.W.F Filter
Edge Detector

Decomposition Parameters
Eigenvector Set Parameters
Eigenvalue Set Parameters

JRH : Huynen Decomposition
RMB1 : Barnes 1 Decomposition
RMB2 : Barnes 2 Decomposition
SRC : Cloude Decomposition
WAH1 : Holm 1 Decomposition
WAH2 : Holm 2 Decomposition
HAA : H / A / Alpha Decomposition
FRE2 : Freeman 2 Components Decomposition
FRE3 : Freeman 3 Components Decomposition
VZ3 : Van Zyl 3 Components Decomposition
YAM3 : Yamaguchi 3 Components Decomposition
YAM4 : Yamaguchi 4 Components Decomposition
NEU : Neumann 2 Components Decomposition
KRO : Krogager Decomposition
CAM : Cameron Decomposition
TSVM : Touzi Decomposition

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Batch Process

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H / A / Alpha - Wishart Classification
Fuzzy - H / Alpha Classification
Wishart Supervised Classification
Rule-Based Hierarchical Classification
Basic Scattering Mechanism Identification
SVM Supervised Classification

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Data Histograms
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Histogram Based Statistics
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Data Sets Averaging

Faraday Rotation Estimation
Conformity Coefficient
Scattering Predominance
Scattering Diversity
Degree of Purity
Depolarisation Index
Alpha Approximation (Praks & Colin)
Entropy Approximation (Praks & Colin)
Scattering Mechanism Entropy (Freeman)
Scattering Mechanism Entropy (Van Zyl)
Kozlov Anisotropy
Lueneburg Anisotropy
Polarized Point Scatterer Detection
Reflectivity Ratio
Differential Reflectivity (ZDR)

Polarisation Synthesis
Polarimetric Signature
Stokes Parameters
Compact Polarimetric Mode
O.P.C.E
R.C.S Max
Surface Inversion
RVOG PolSAR Inversion
Sub-Aperture Analysis
DEM Estimation
Polarisation Orientation Compensation

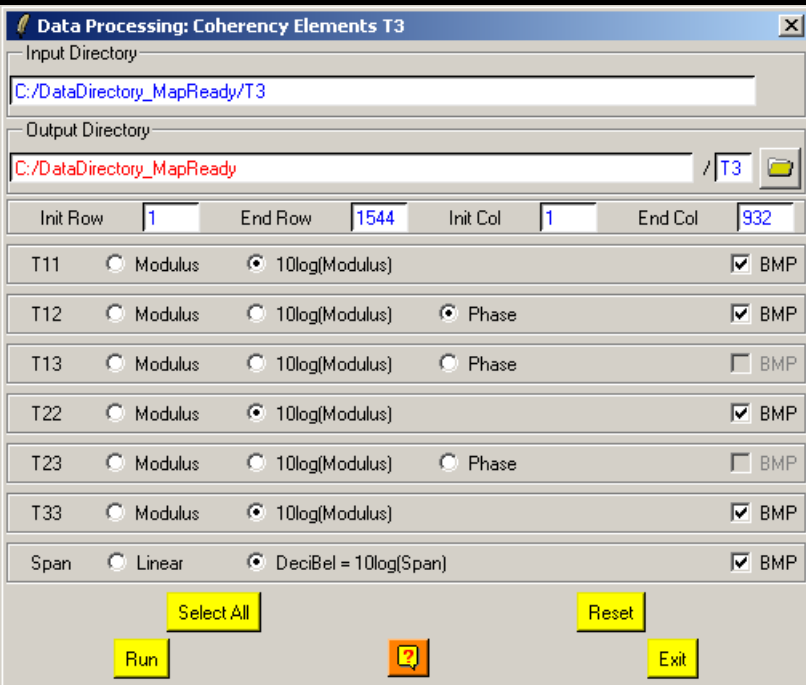
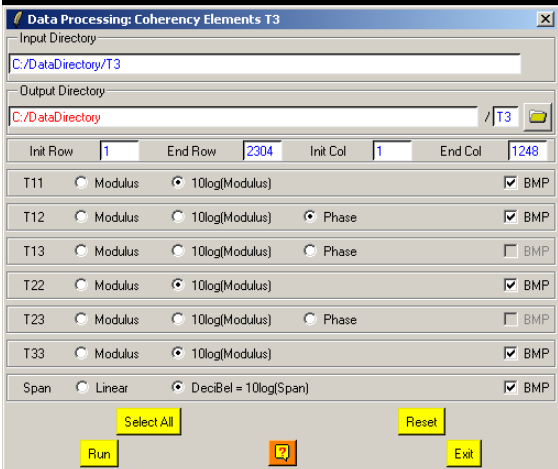
Decomposition Applications

PolSARpro Run Trace
Close Window Display Menu
Close Window Tools Menu

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[T3] ELEMENTS



DATADIR

T3

config.txt
[T3x3] Elements

Txy_mod.bin
Txy_db.bin
Txy pha.bin
Txy_mod.bmp
Txy_db.bmp

Do it Yourself:
Select some elements, set the parameters and view the corresponding BMP files (select BMP).



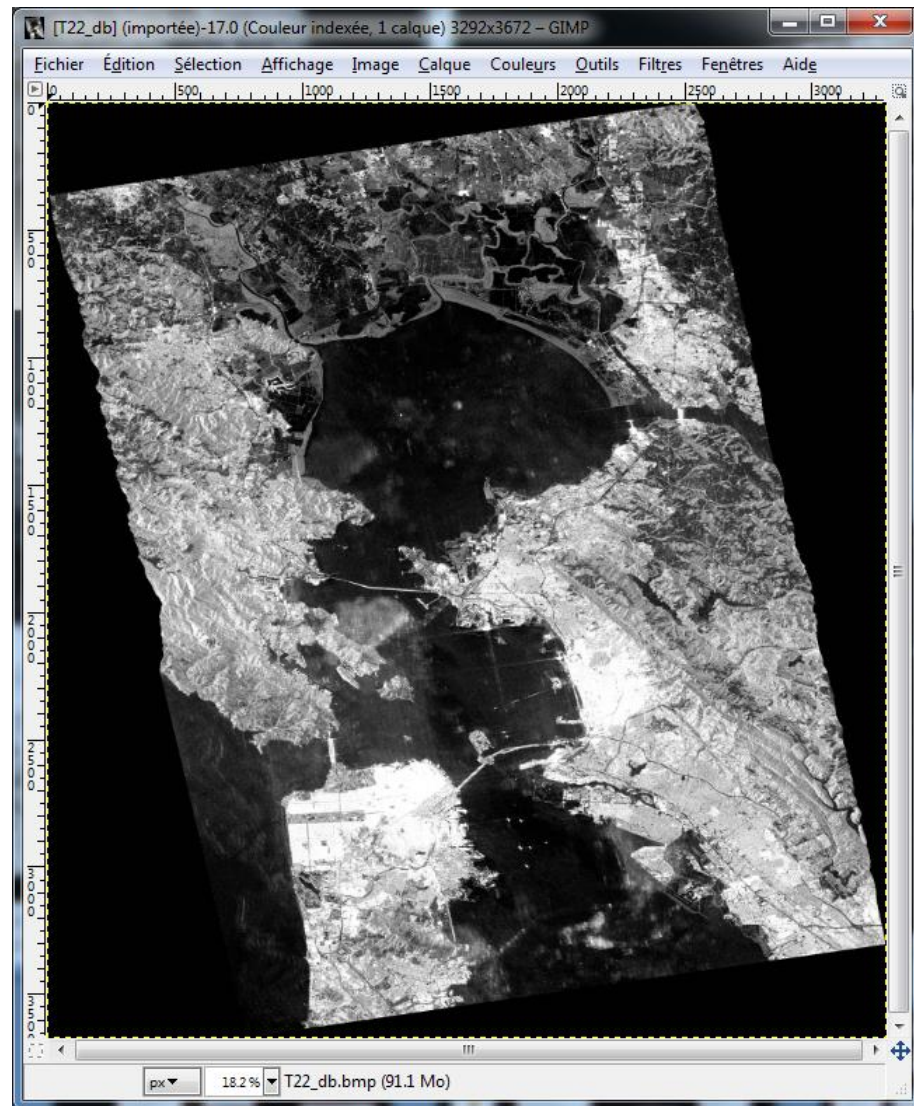
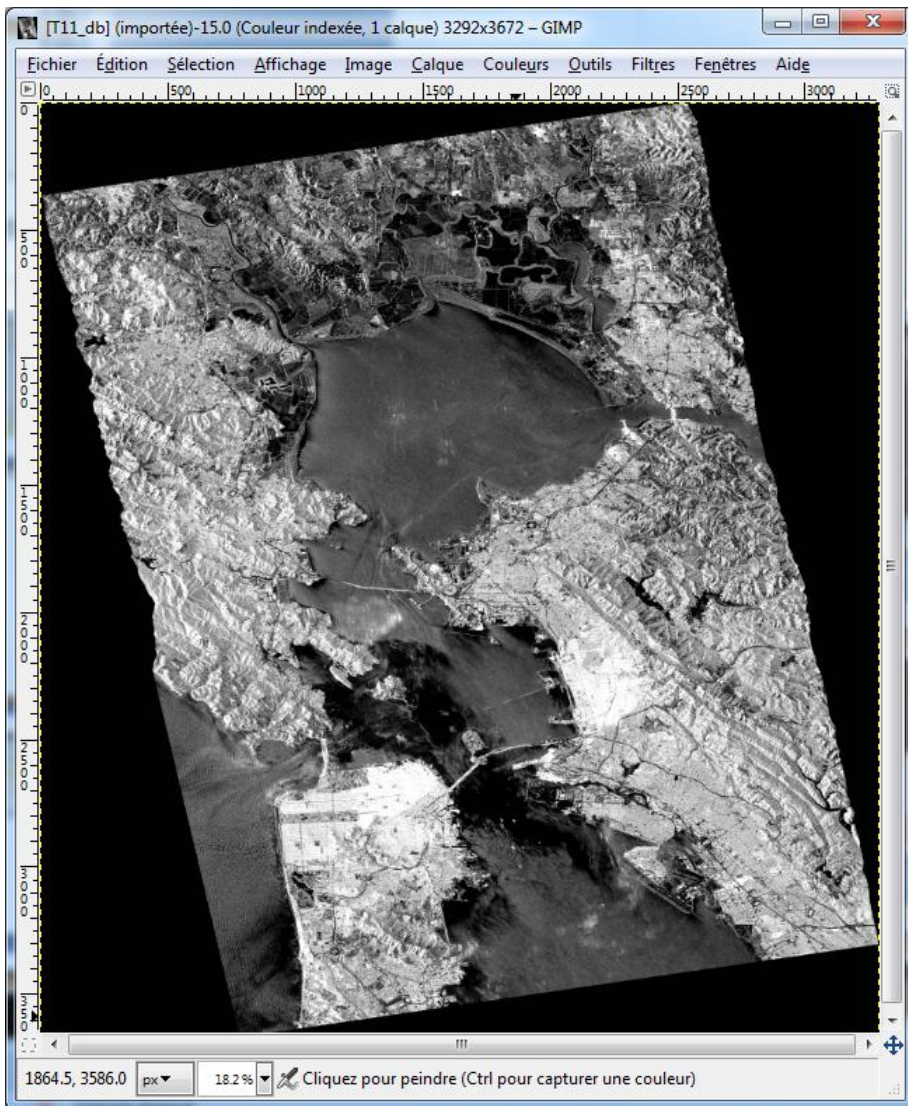
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[T3] ELEMENTS

T11_dB

T22_dB

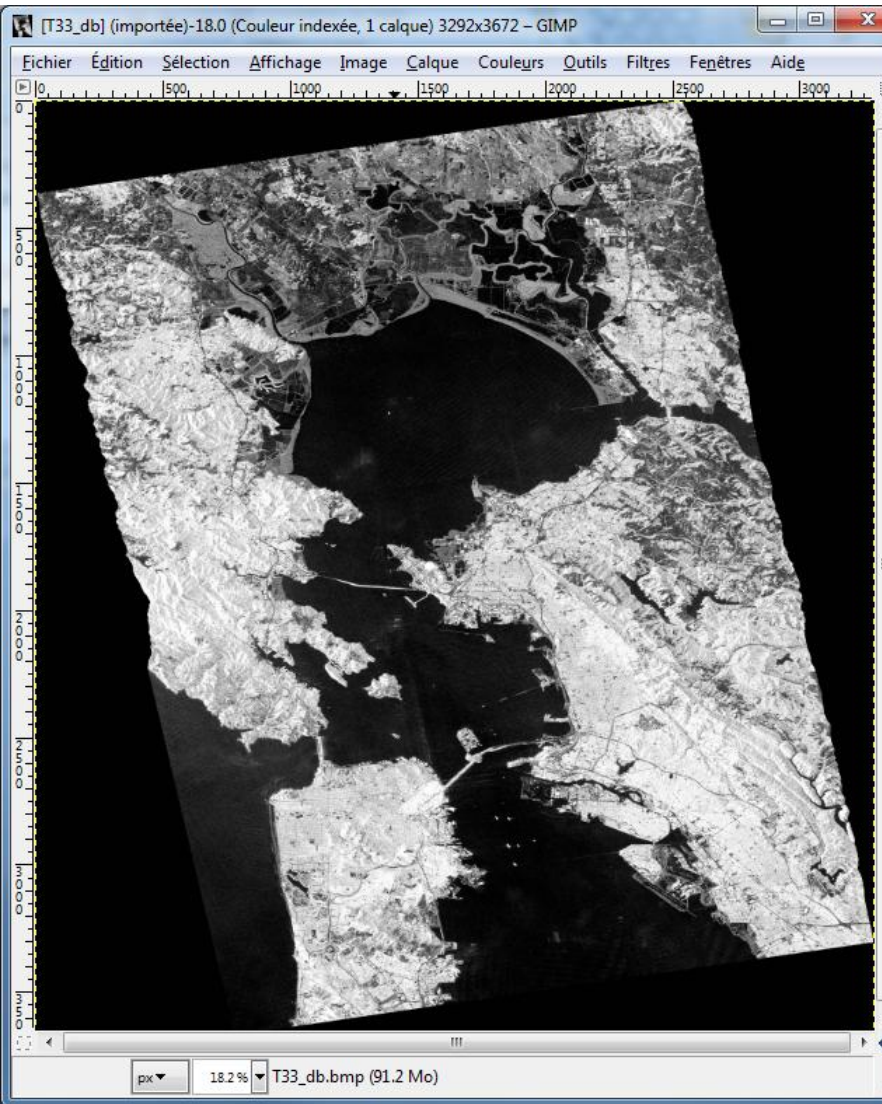
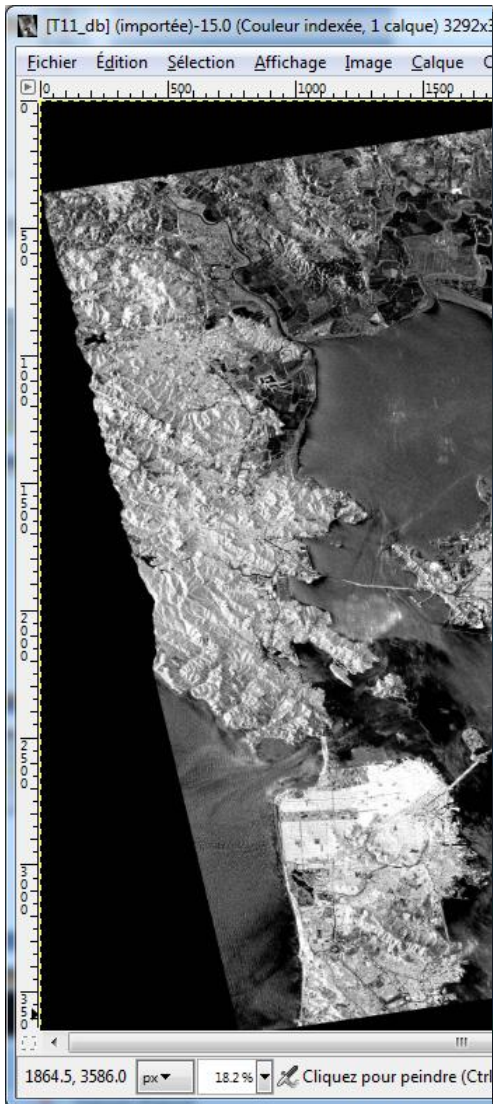


[T3] ELEMENTS

T11_dB

T33_dB

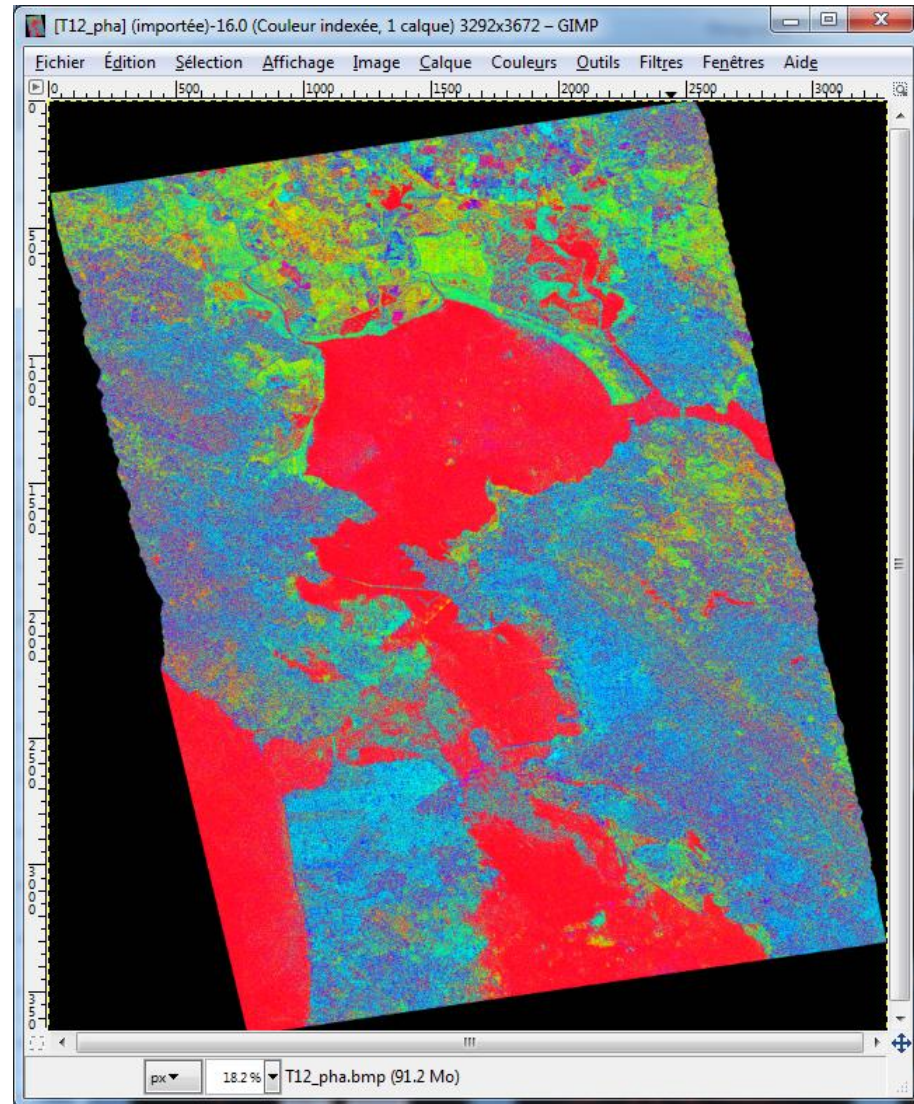
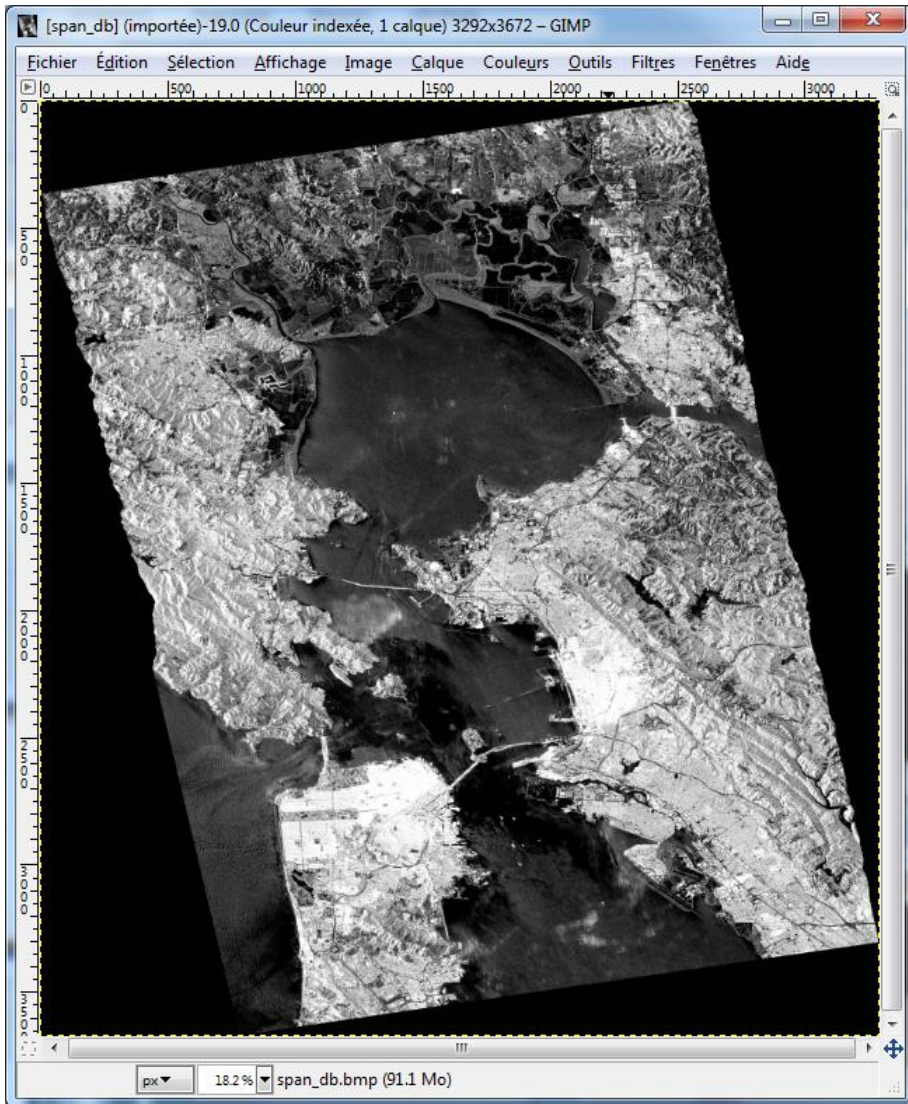
T22_dB

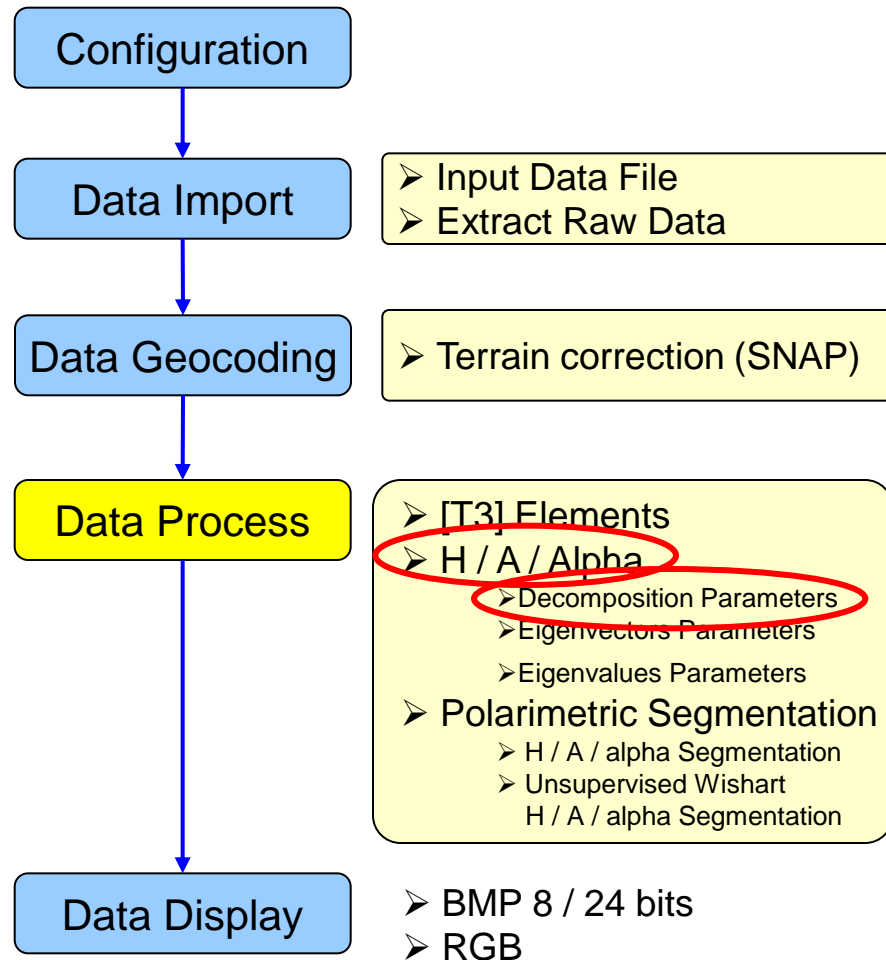


[T3] ELEMENTS

span_db

T12 pha





PolSARpro v5.1 SOFTWARE



PolSARpro v5.1 - Menu

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The Polarimetric SAR Data Processing and Educational Tool

Environment Import Convert **Process** Display Calibration Utilities Tools Configuration Education Help

Quit

Linear (+45 / -45)
Circular (L / R)
Elliptical (phi, tau)

Box Car Filter
Box Car - Edge Filter
C. Lopez Filter
Gaussian Filter
IDAN Filter
J.S. Lee Refined Filter
J.S. Lee Sigma Filter
P.W.F Filter
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Eigenvalue Set Parameters

JRH : Huynen Decomposition
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RMB2 : Barnes 2 Decomposition
SRC : Cloude Decomposition
WAH1 : Holm 1 Decomposition
WAH2 : Holm 2 Decomposition
HAA : H / A / Alpha Decomposition
FRE2 : Freeman 2 Components Decomposition
FRE3 : Freeman 3 Components Decomposition
VZ3 : Van Zyl 3 Components Decomposition
YAM3 : Yamaguchi 3 Components Decomposition
YAM4 : Yamaguchi 4 Components Decomposition
NEU : Neumann 2 Components Decomposition
KRO : Krogager Decomposition
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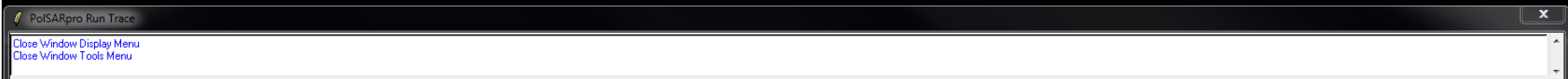
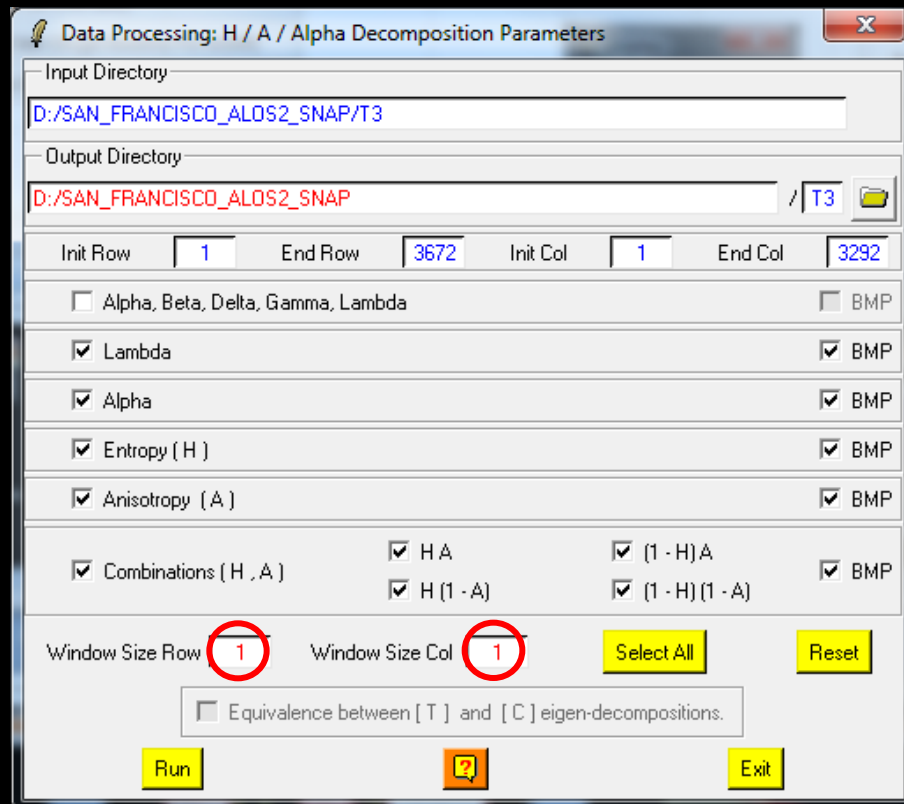
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DECOMPOSITION PARAMETERS



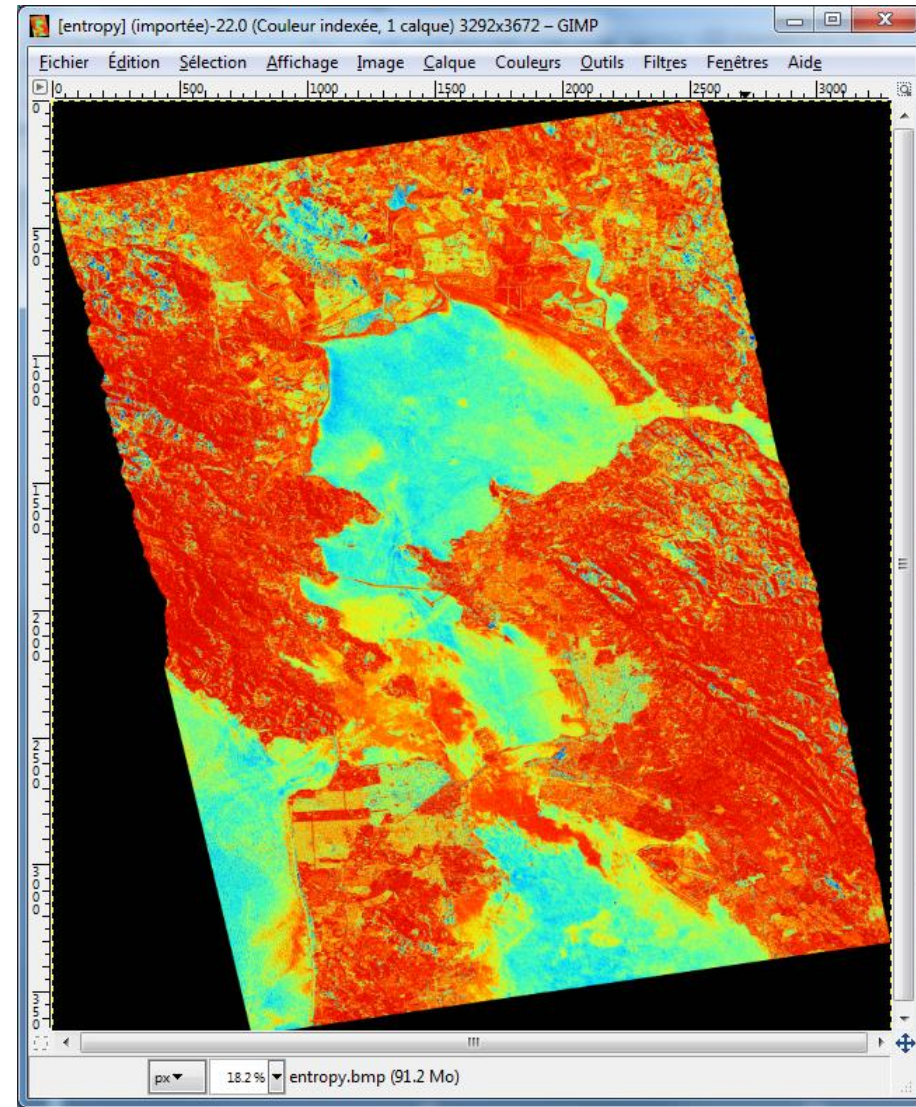
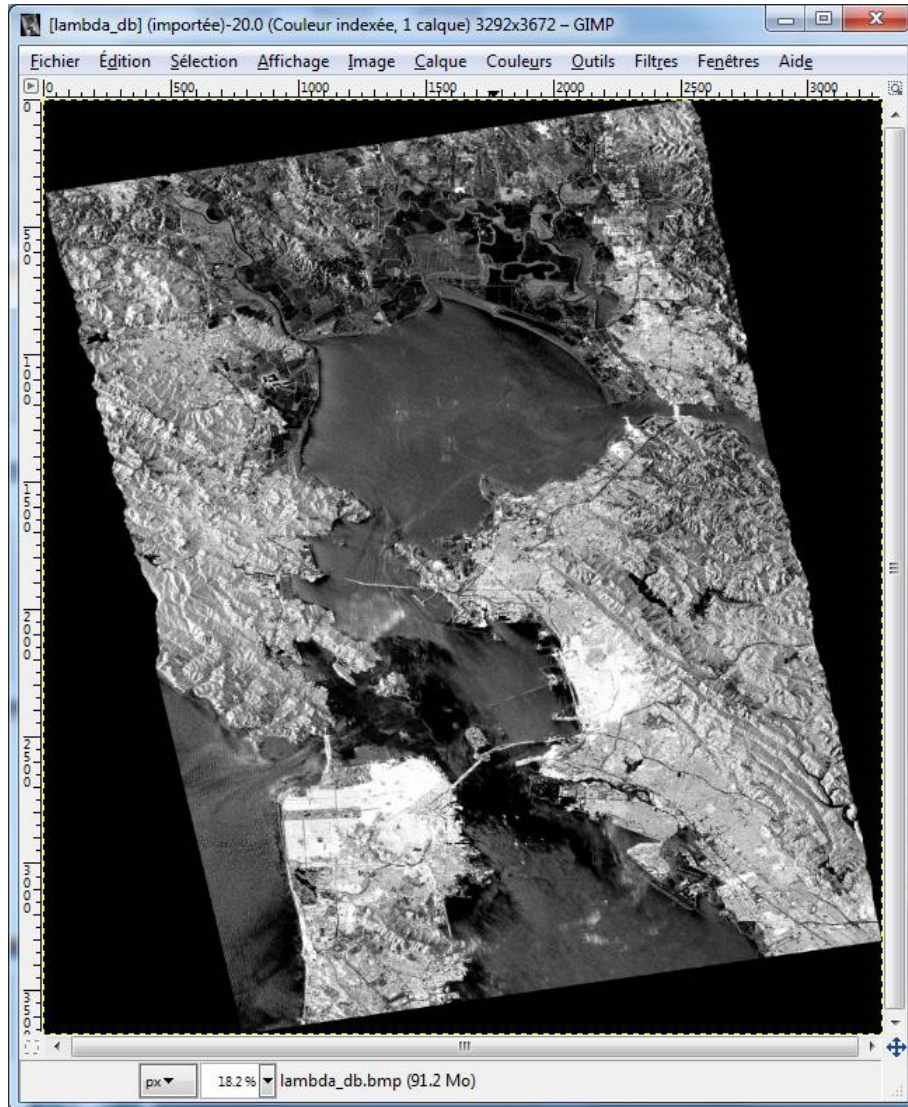
Do it Yourself:
Select some elements, set the parameters ($N_{win} = 1$) and view the corresponding BMP files (select BMP).



DECOMPOSITION PARAMETERS

Lambda

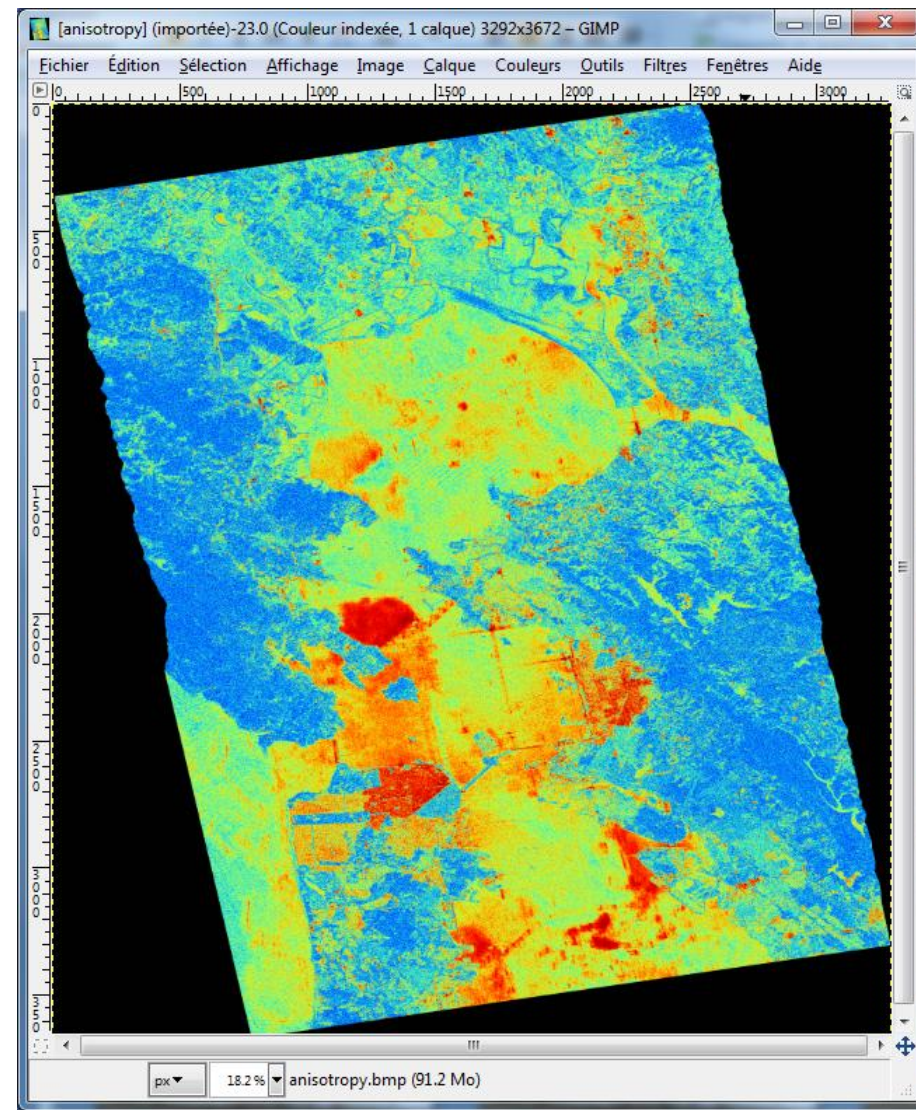
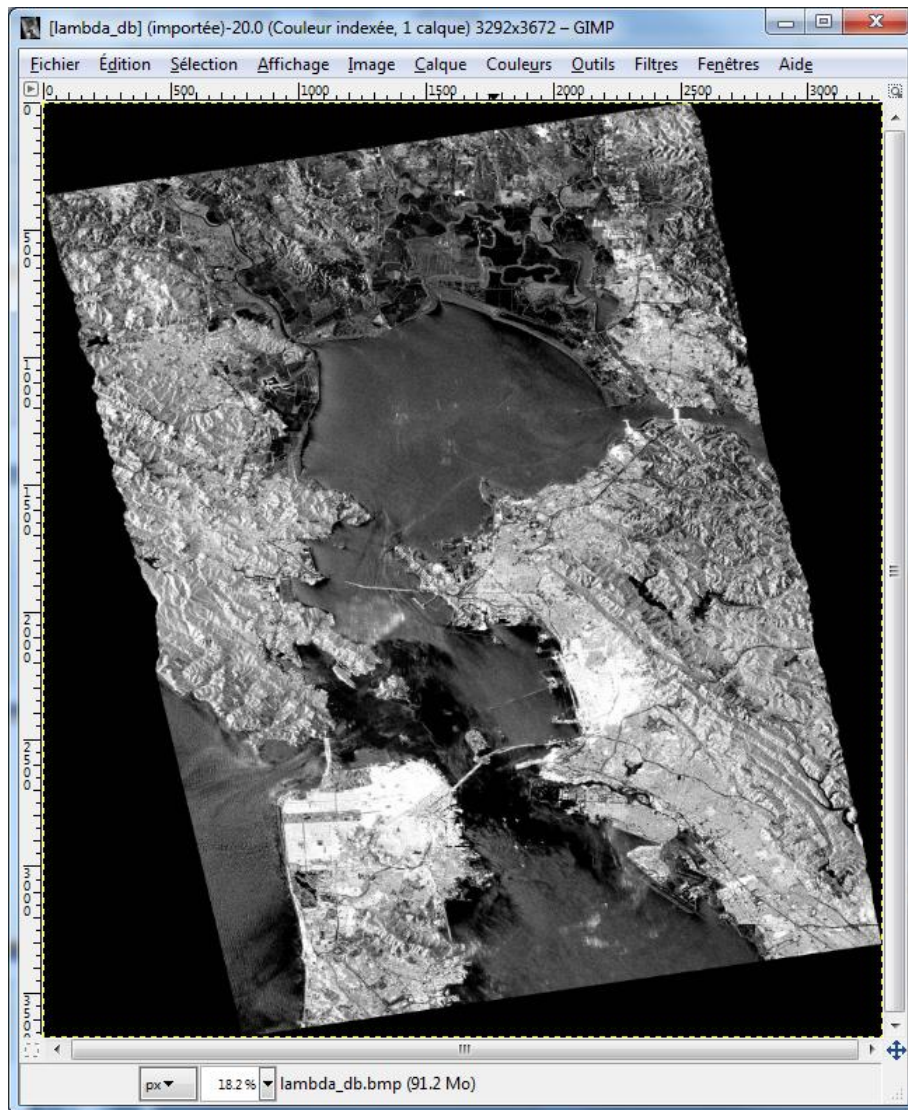
Entropy



DECOMPOSITION PARAMETERS

Lambda

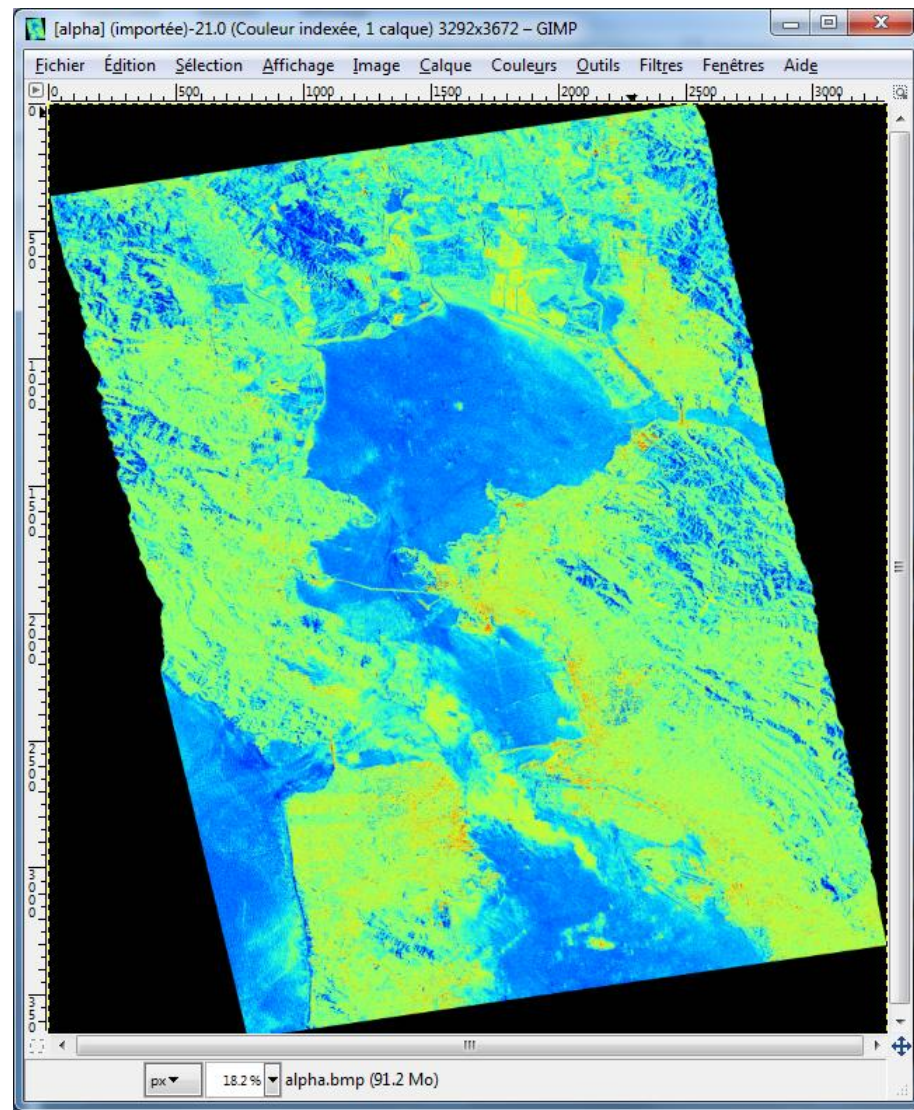
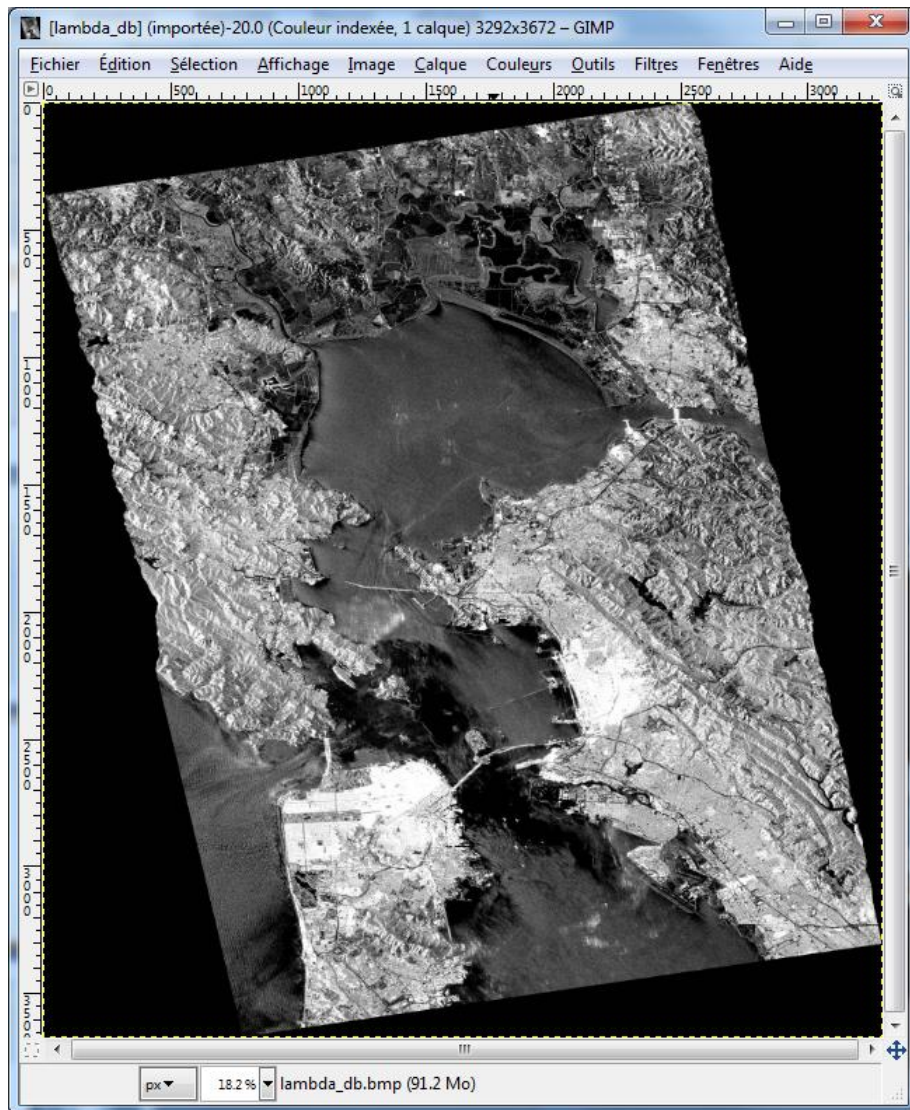
Anisotropy



DECOMPOSITION PARAMETERS

Lambda

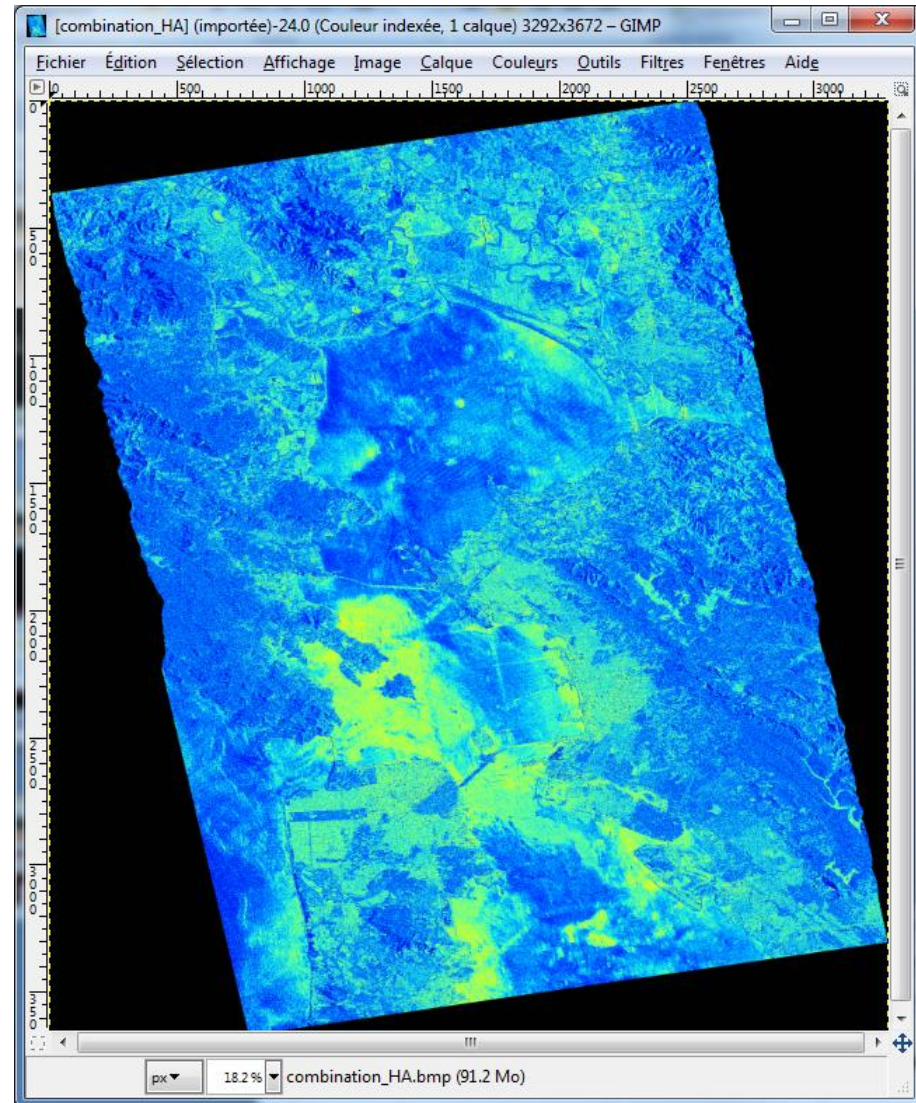
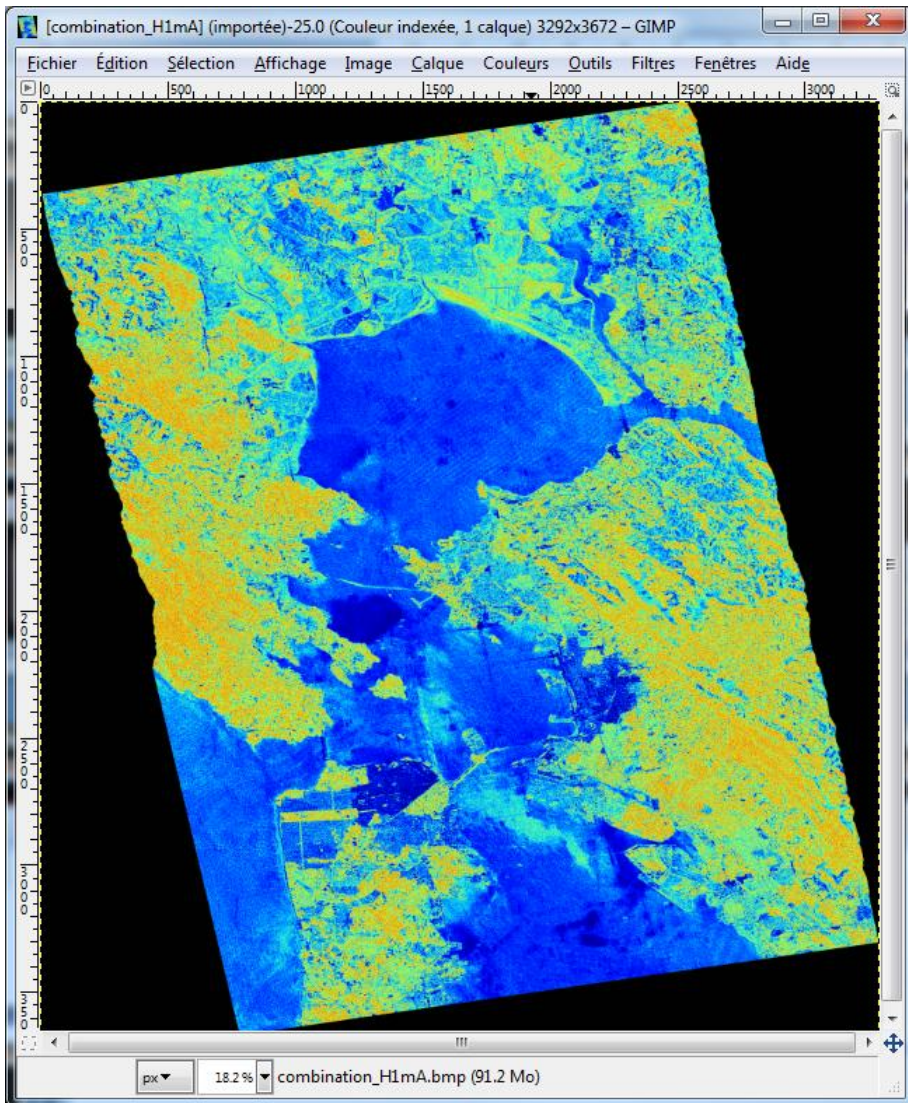
Alpha



DECOMPOSITION PARAMETERS

H (1-A)

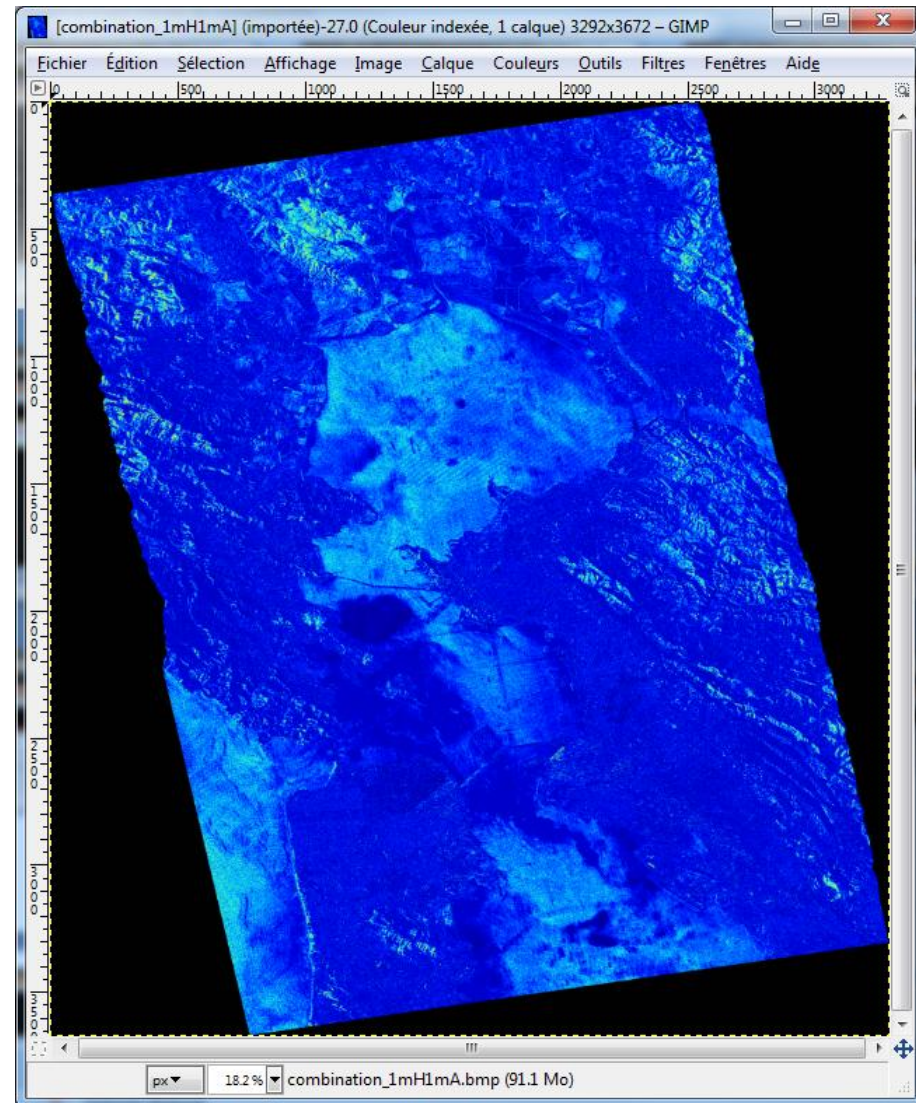
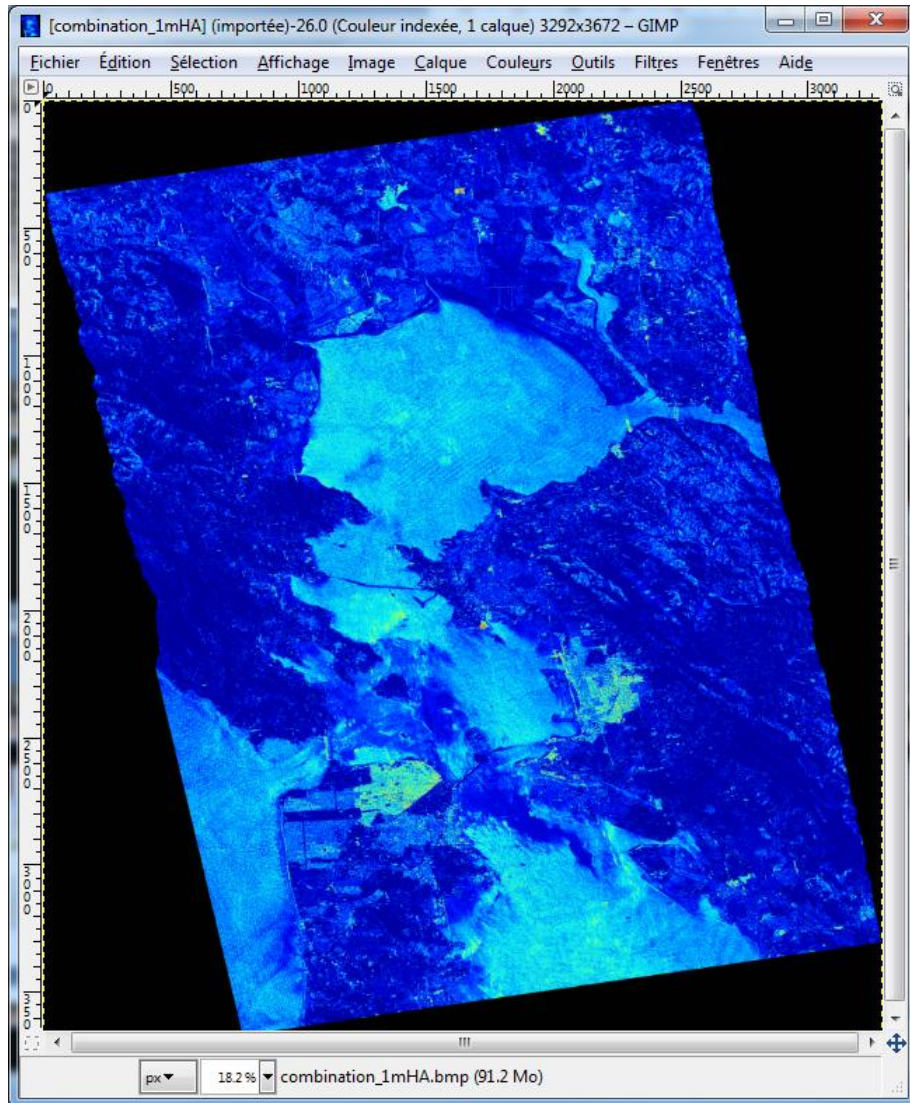
HA

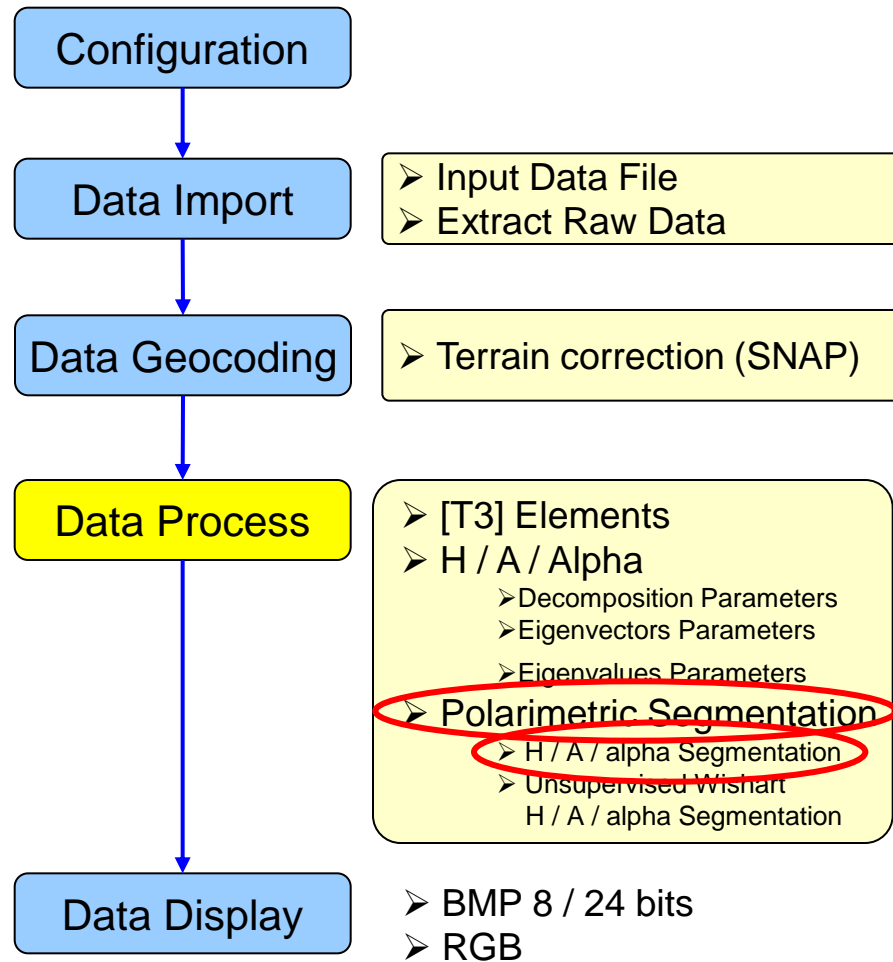


DECOMPOSITION PARAMETERS

(1-H) A

(1-H) (1-A)





PolSARpro v5.1 SOFTWARE



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Decomposition Applications

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Close Window Tools Menu

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H / A / alpha CLASSIFICATION

Do it Yourself:

Select some elements, set the parameters (**Nwin = 1**) and view the corresponding BMP files.

PolSARpro Run Trace
Close Window Display Menu
Close Window Tools Menu

PolSARpro
The Polarimetric SAR Data Processing and Educational Tool

Environment Import Convert Process Display Calibration

Data Processing: H / A / Alpha Classification

Input Directory
D:/SAN_FRANCISCO_ALOS2_SNAP/T3

Output Directory
D:/SAN_FRANCISCO_ALOS2_SNAP / T3

Init Row 1 End Row 3672 Init Col 1 End Col 3292

Representation

- Anisotropy Entropy Alpha
- $HA + (1-H)A$ $H(1-A)$ $(1-H)(1-A)$
- Alpha (Hue) / Entropy (Sat) / Lambda (Light)

H / A / Alpha Classification

- Entropy / Alpha Planes (BMP) + Classifier (Bin + BMP)
- Entropy / Anisotropy Planes (BMP) + Classifier (Bin + BMP)
- Alpha / Anisotropy Planes (BMP) + Classifier (Bin + BMP)

ColorMap 9 C:/Users/epottier/AppData/Roaming/PolSARpro_5.1.0/ColorMap/Planes_ Edit

Tuo-Tuo (H / Alpha / Lambda) Classification

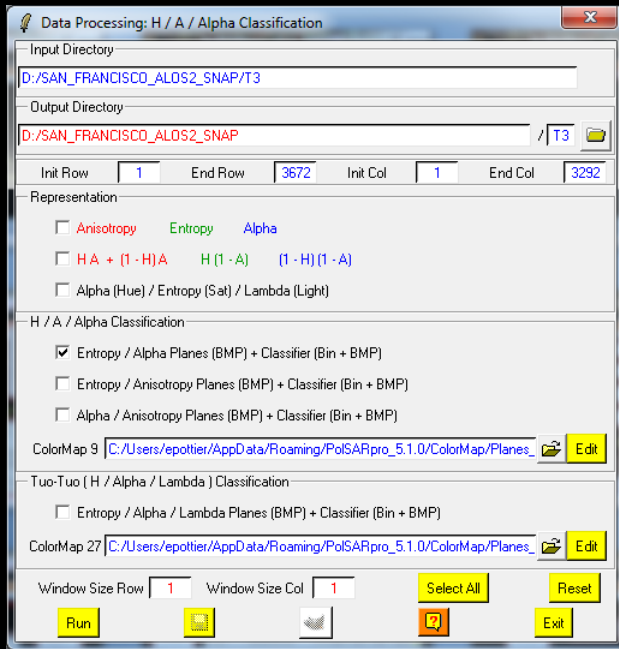
- Entropy / Alpha / Lambda Planes (BMP) + Classifier (Bin + BMP)

ColorMap 27 C:/Users/epottier/AppData/Roaming/PolSARpro_5.1.0/ColorMap/Planes_ Edit

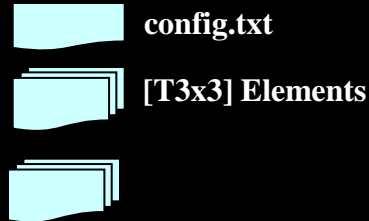
Window Size Row 1 Window Size Col 1

Run [?] Select All Reset Exit

H / A / alpha CLASSIFICATION



DATADIR

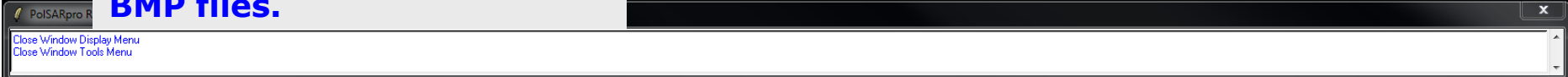


entropy.bin, anisotropy.bin, alpha.bin
combination_HA.bin, combination_1mHA.bin,
combination_H1mA.bin, combination_1mH1mA.bin
H_A_class.bin, H_Alpha_class.bin, A_Alpha_class.bin

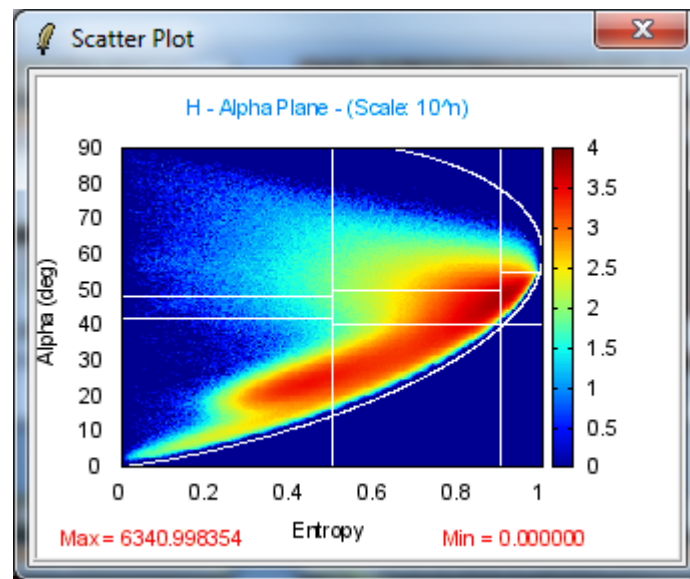
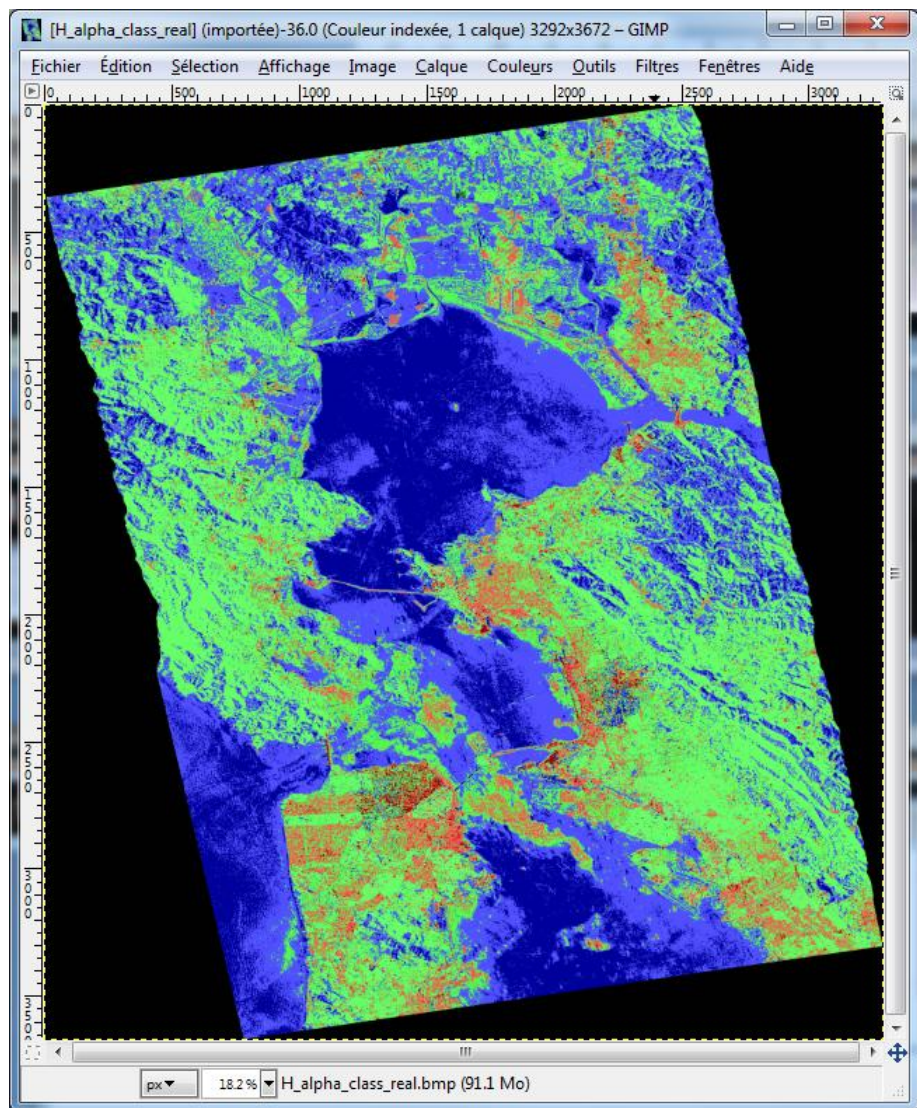


entropy.bmp, anisotropy.bmp, alpha.bmp
combination_HA.bmp, combination_1mHA.bmp,
combination_H1mA.bmp, combination_1mH1mA.bmp
H_A_class.bmp, H_Alpha_class.bmp, A_Alpha_class.bmp
H_A_occurrence.bmp, H_Alpha_occurrence.bmp,
A_Alpha_occurrence.bmp, H_A_segmented.bmp,
H_Alpha_segmented.bmp, A_Alpha_segmented.bmp
HAlphaLambda_RGB.bmp, HAlpha_RGB.bmp
HACombinations_RGB.bmp

Do it Yourself:
Select some elements, set
the parameters (**Nwin = 1**)
and view the corresponding
BMP files.



H / A / alpha CLASSIFICATION



H / A / alpha CLASSIFICATION



Do it Yourself:

Select some elements, set the parameters (**Nwin = 1**) and view the corresponding BMP files.

PolSARpro Run Trace

Close Window Display Menu
Close Window Tools Menu

PolSARpro

The Polarimetric SAR Data Processing and Educational Tool

Environment Import Convert Process Display Calibration

Data Processing: H / A / Alpha Classification

Input Directory
D:/SAN_FRANCISCO_ALOS2_SNAP/T3

Output Directory
D:/SAN_FRANCISCO_ALOS2_SNAP / T3

Init Row 1 End Row 3672 Init Col 1 End Col 3292

Representation

- Anisotropy Entropy Alpha
- H A + (1 - H)A H (1 - A) (1 - H) (1 - A)
- Alpha (Hue) / Entropy (Sat) / Lambda (Light)

H / A / Alpha Classification

- Entropy / Alpha Planes (BMP) + Classifier (Bin + BMP)
- Entropy / Anisotropy Planes (BMP) + Classifier (Bin + BMP)
- Alpha / Anisotropy Planes (BMP) + Classifier (Bin + BMP)

ColorMap 9 C:/Users/epottier/AppData/Roaming/PolSARpro_5.1.0/ColorMap/Planes_ Edit

Tuo-Tuo (H / Alpha / Lambda) Classification

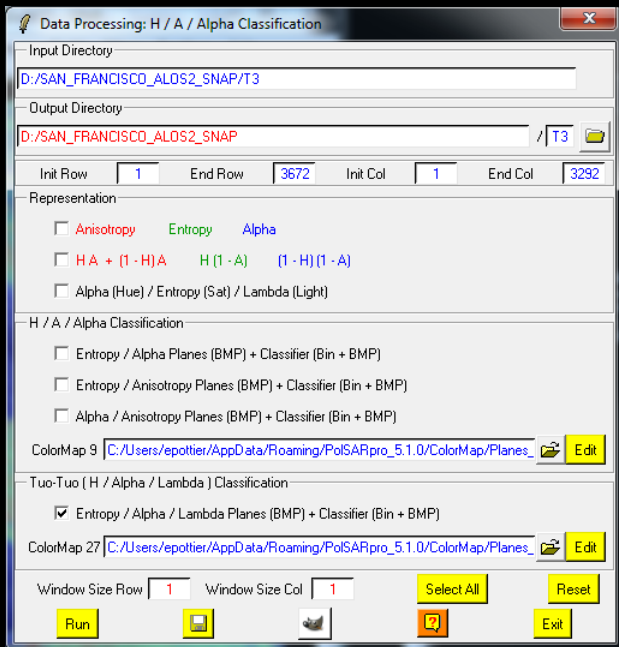
- Entropy / Alpha / Lambda Planes (BMP) + Classifier (Bin + BMP)

ColorMap 27 C:/Users/epottier/AppData/Roaming/PolSARpro_5.1.0/ColorMap/Planes_ Edit

Window Size Row 1 Window Size Col 1

Run Select All Reset Exit

H / A / alpha CLASSIFICATION



DATADIR

config.txt

[T3x3] Elements

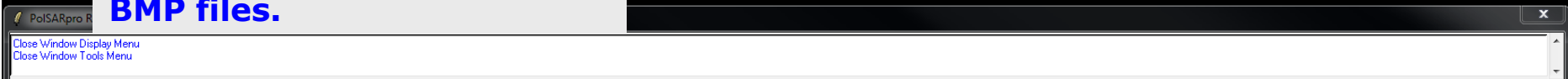


H_alpha_lambda_class1(2,3).bin,
H_alpha_lambda_occurrence_class1(2,3).bin,
H_alpha_lambda_segmented_class1(2,3).bin,
H_alpha_lambda_class.bin,

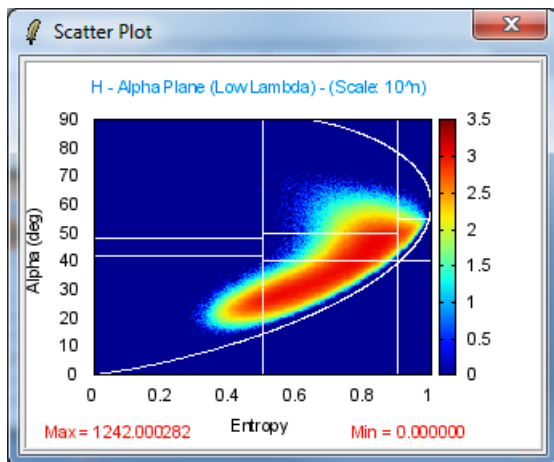
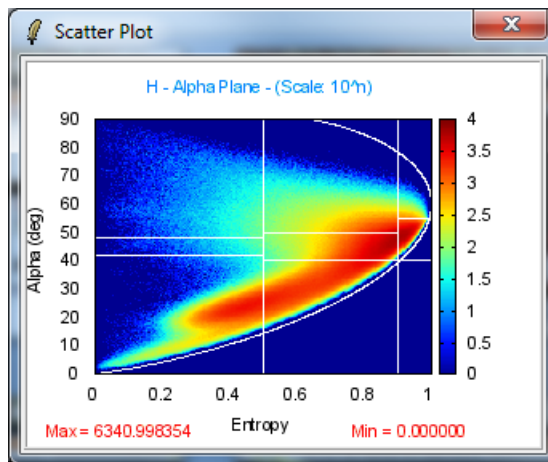


H_alpha_lambda_class1(2,3).bmp,
H_alpha_lambda_occurrence_class1(2,3).bmp,
H_alpha_lambda_segmented_class1(2,3).bmp,
H_alpha_lambda_class.bmp,

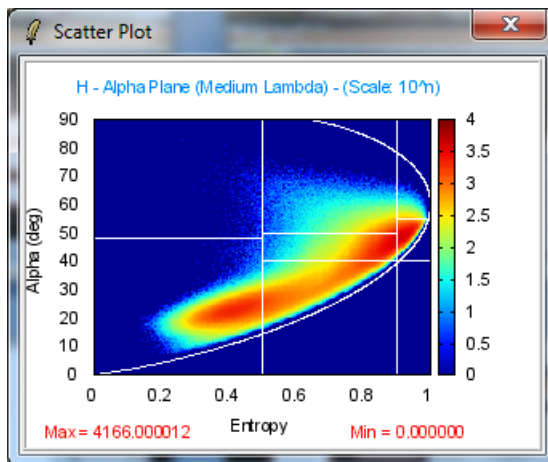
Do it Yourself:
Select some elements, set the parameters (**Nwin = 1**) and view the corresponding BMP files.



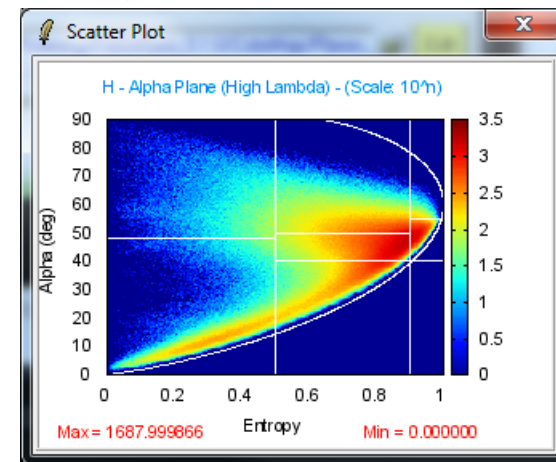
H / A / alpha CLASSIFICATION



Low λ

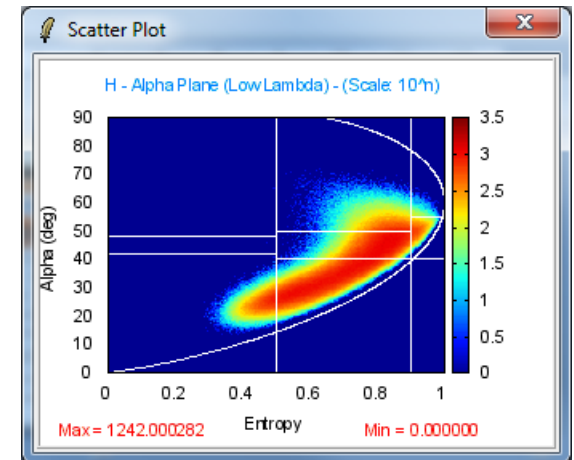
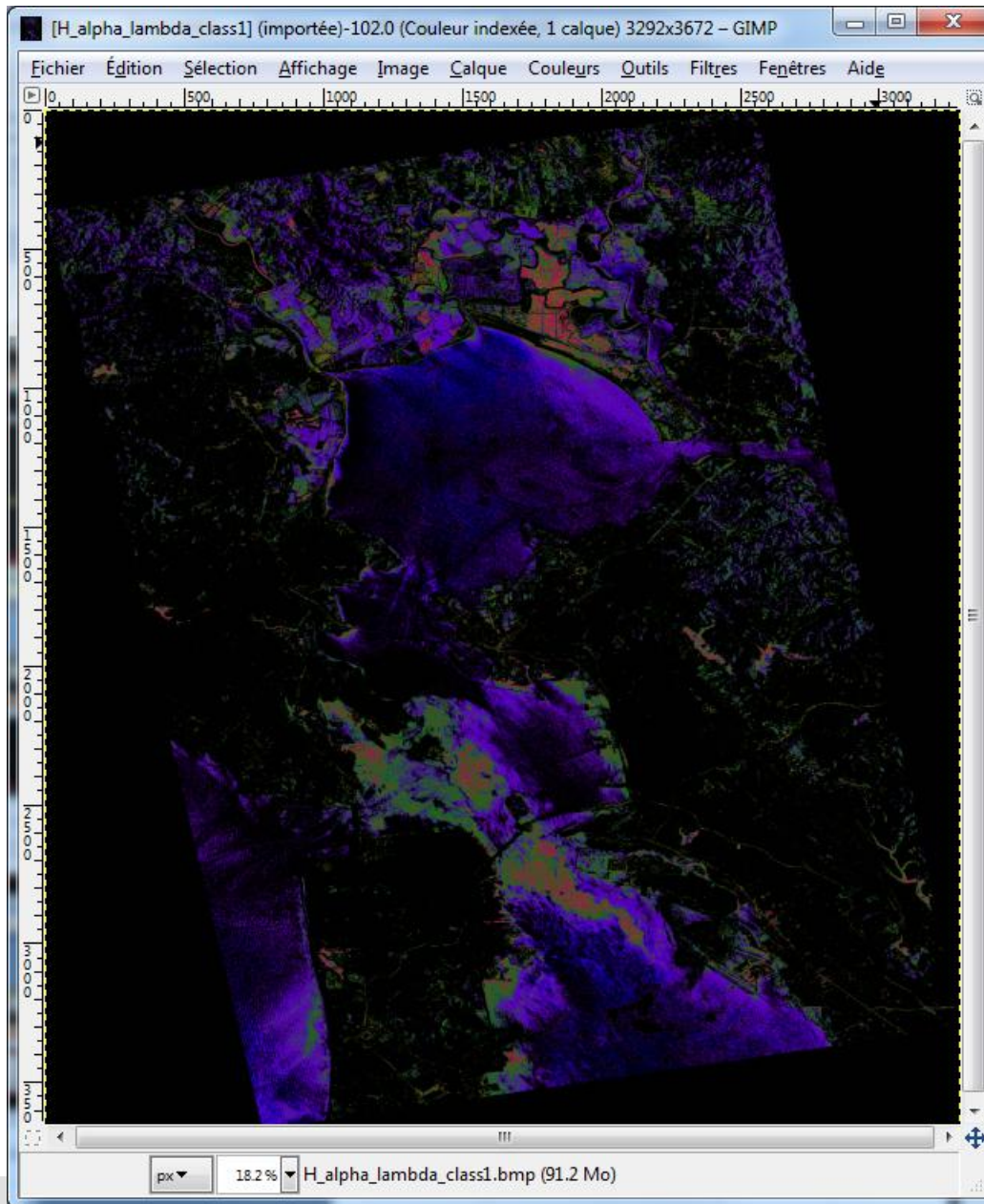


Medium λ



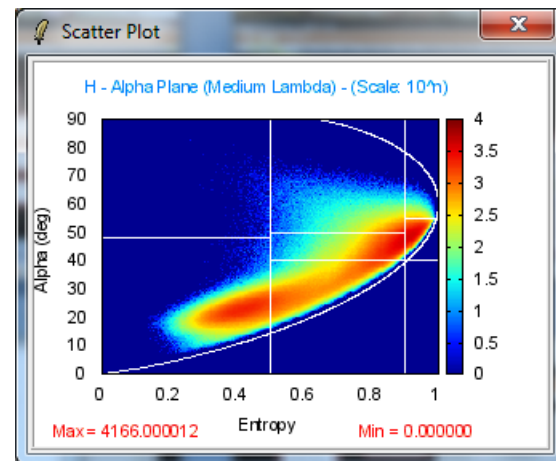
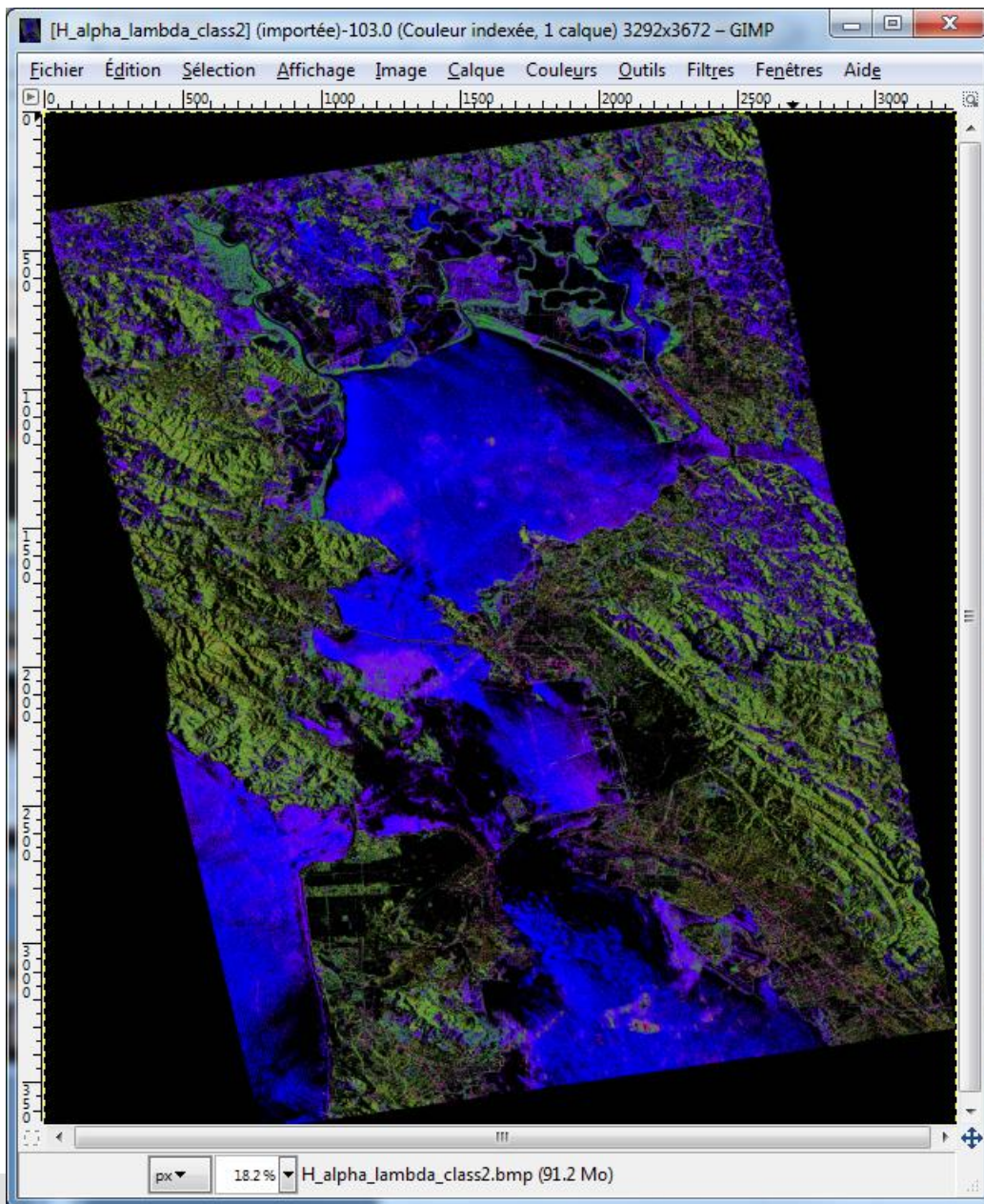
High λ

H / A / alpha CLASSIFICATION



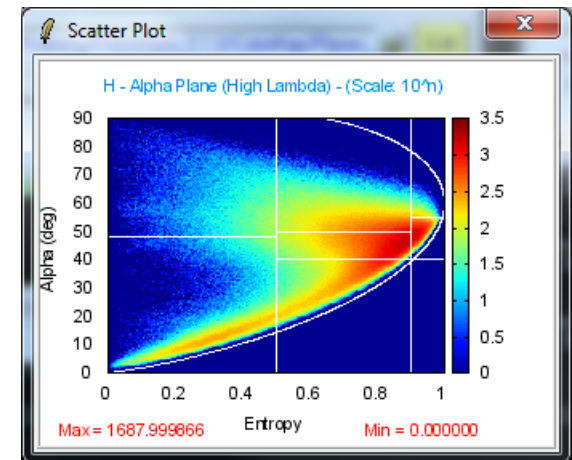
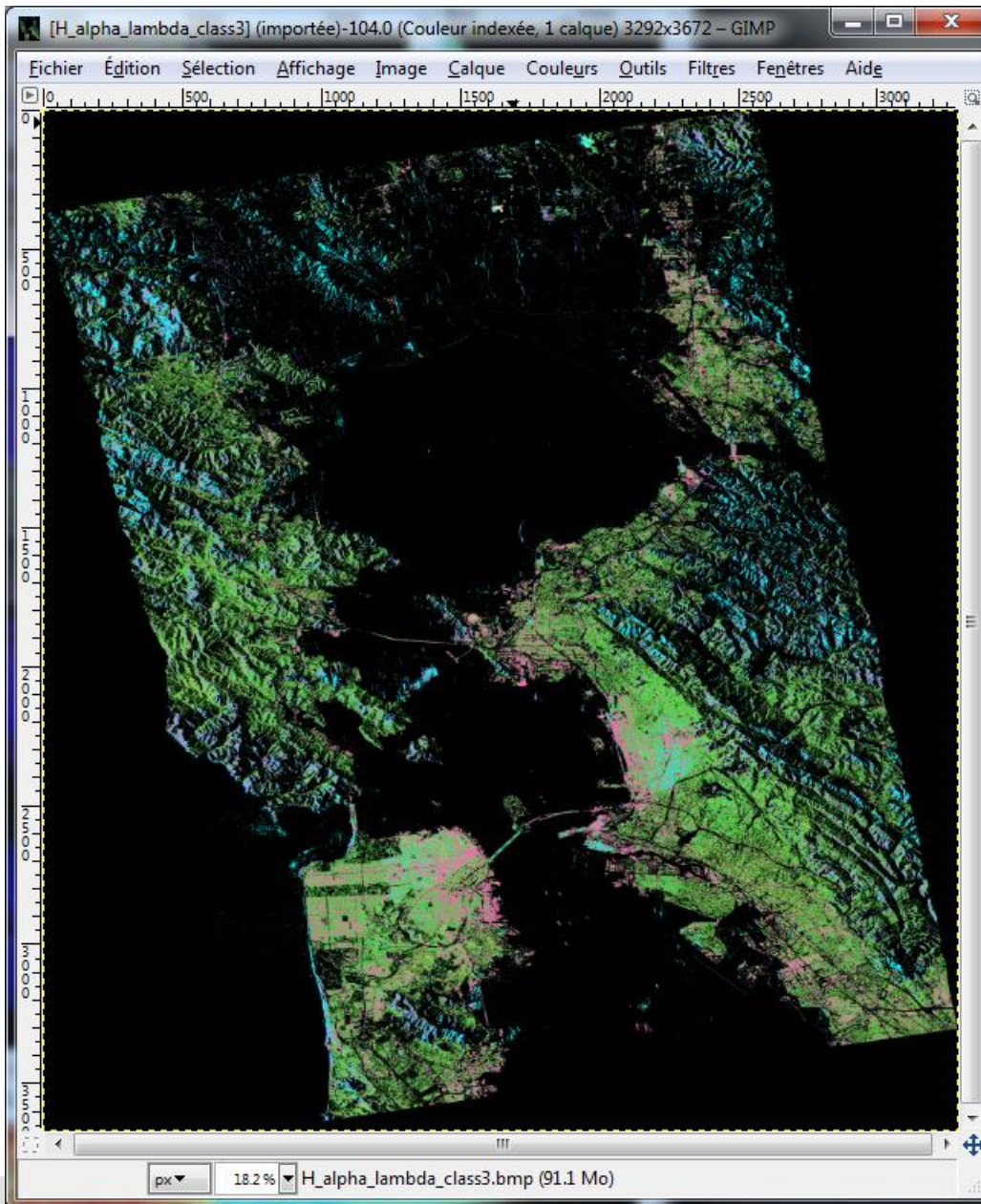
Low λ

H / A / alpha CLASSIFICATION



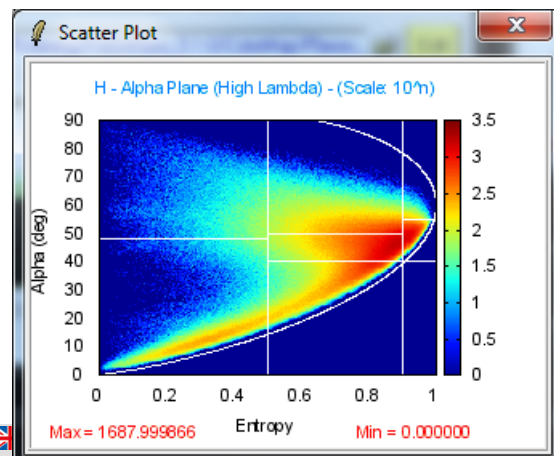
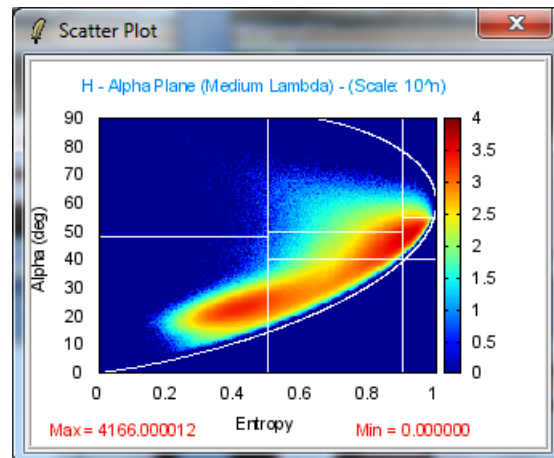
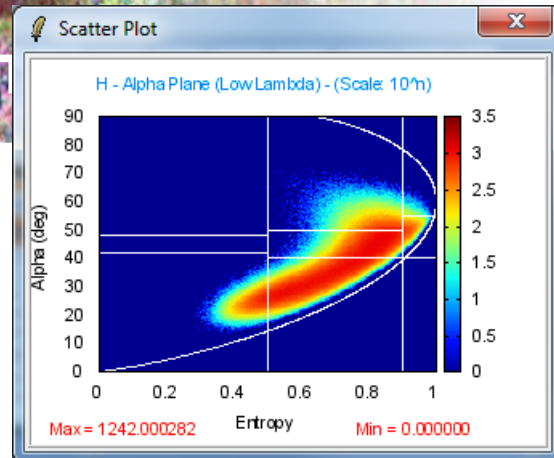
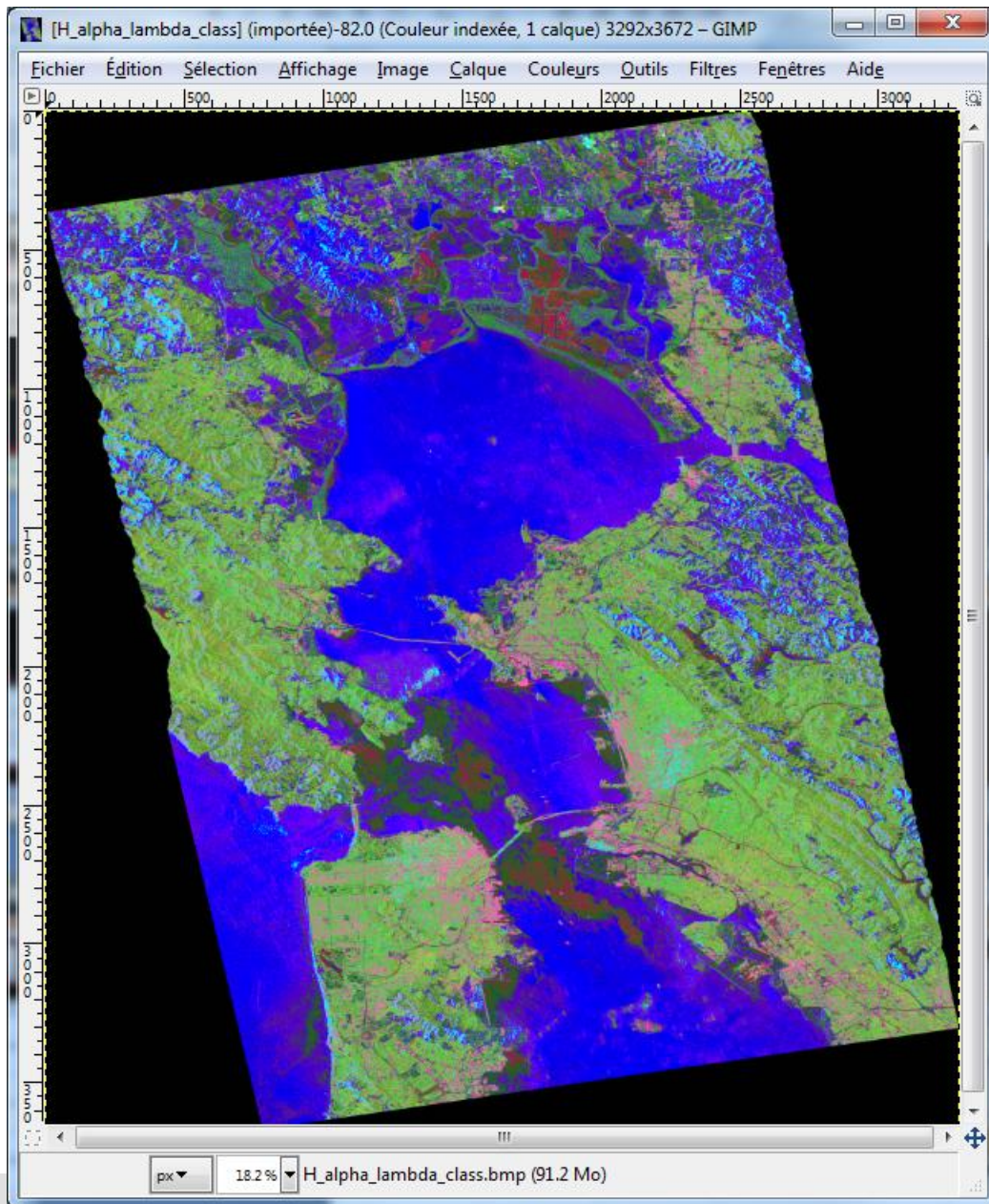
Medium λ

H / A / alpha CLASSIFICATION

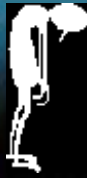


High λ

H / A / alpha CLASSIFICATION



Questions ?



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→ POLSARPRO V. 5.1

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European Space Agency

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The Polarimetric SAR Data Processing and Educational Tool

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www.esa.int

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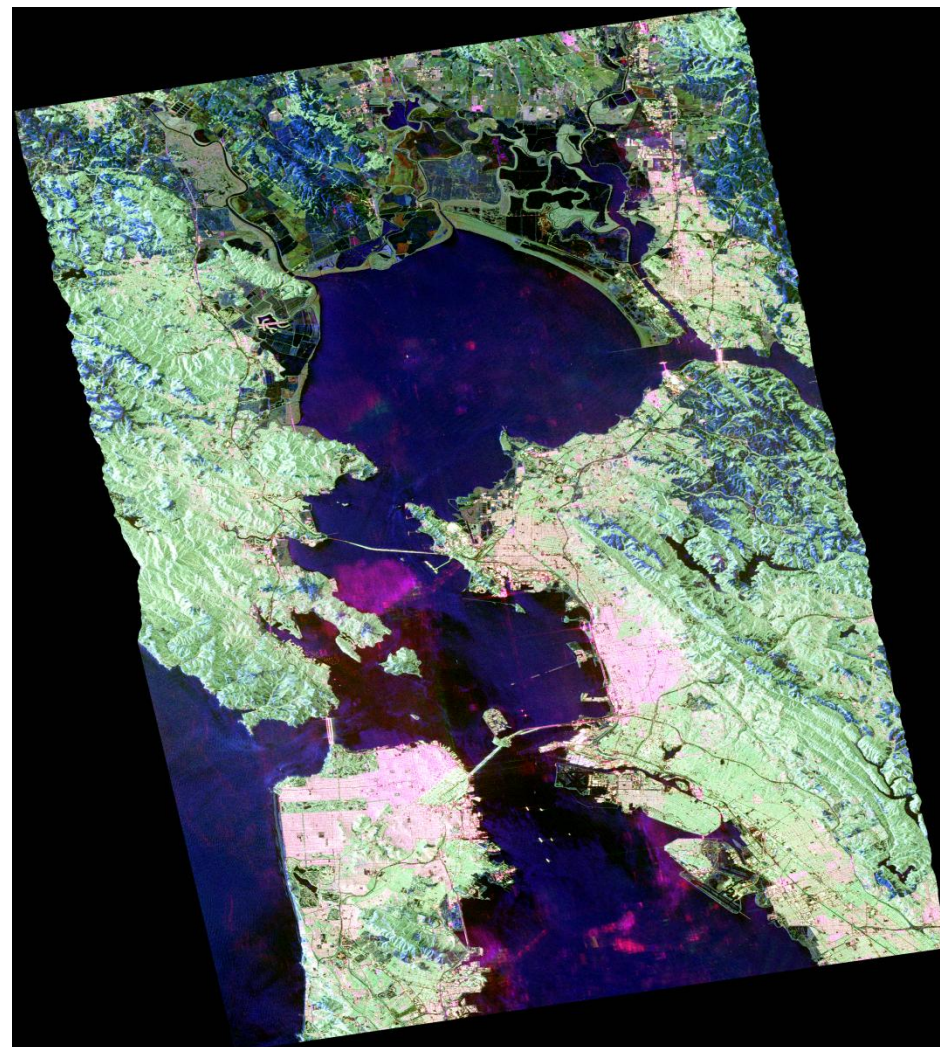
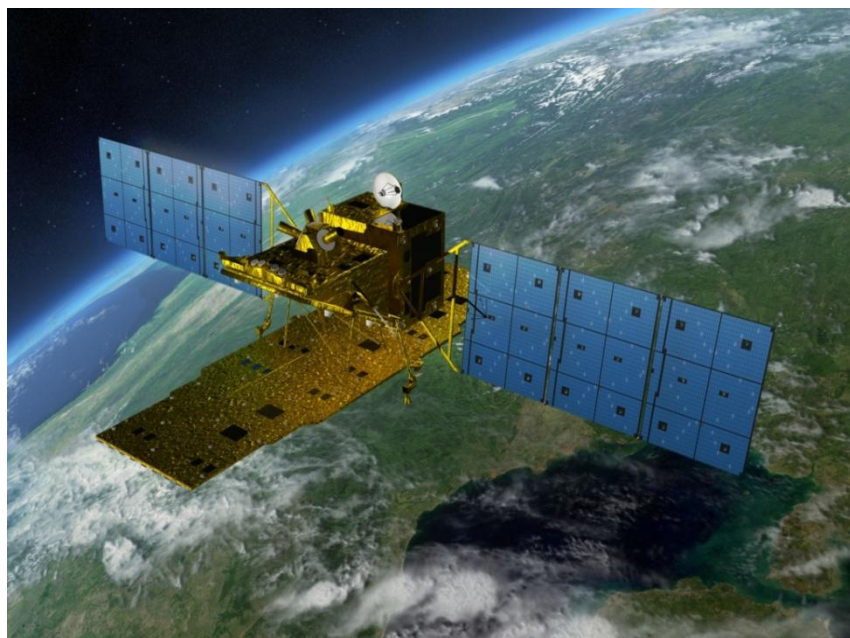
→ 4th ADVANCED COURSE ON RADAR POLARIMETRY

30 January – 2 February 2017 | ESA-ESRIN | Frascati (Rome), Italy

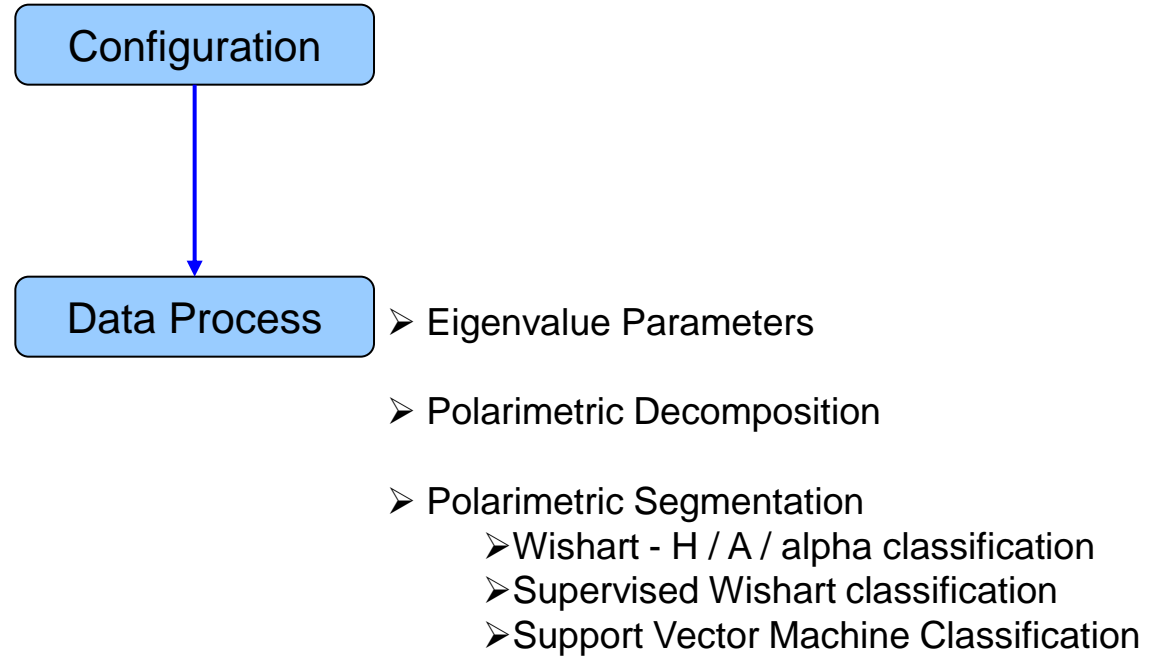
PolSARpro v5.1 toolbox

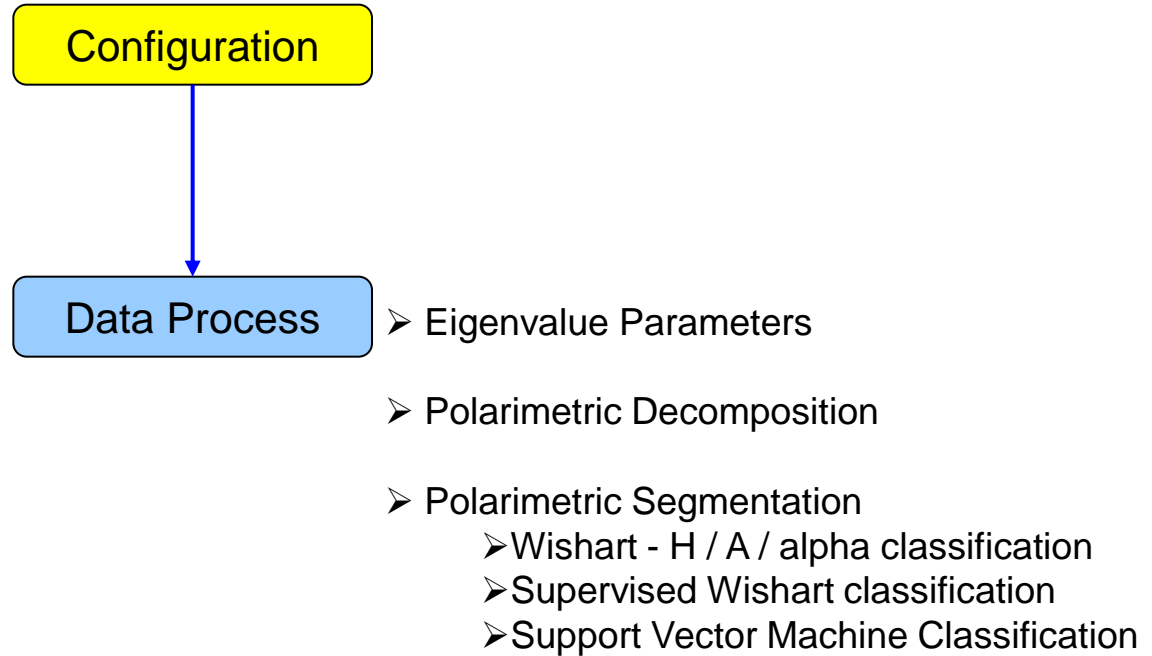
Practical session - Part 2

Eric Pottier



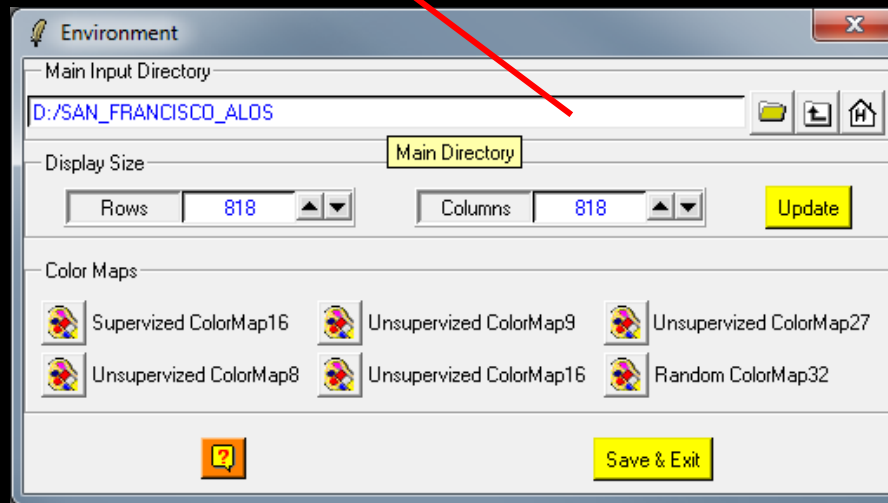
ALOS : Advanced Land Observing Satellite
PALSAR : Phase Array L-Band SAR





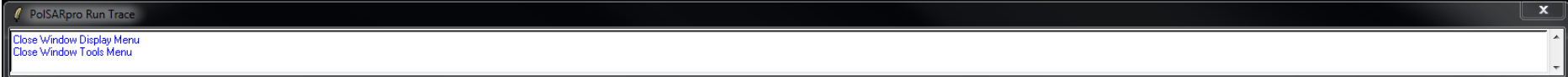


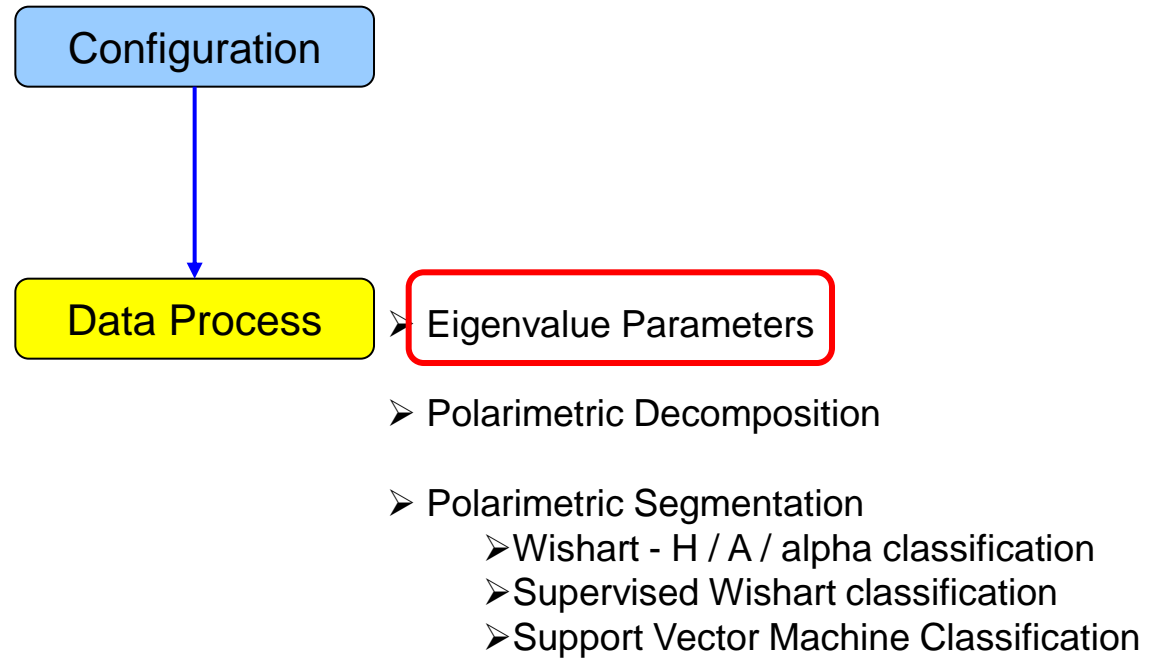
Configure Data Main Directory location



Input Data Directory :

SAN_FRANCISCO_ALOS2_SNAP





PolSARpro v5.1 SOFTWARE



PolSARpro v5.1 - Menu

esa PolSARpro
The Polarimetric SAR Data Processing and Educational Tool

Environment Import Convert **Process** Display Calibration Utilities Tools Configuration Education Help

Quit

Linear (+45 / -45)
Circular (L / R)
Elliptical (phi, tau)

Box Car Filter
Box Car - Edge Filter
C. Lopez Filter
Gaussian Filter
IDAN Filter
J.S. Lee Refined Filter
J.S. Lee Sigma Filter
P.W.F Filter
Edge Detector

Decomposition Parameters
Eigenvector Set Parameters
Eigenvalue Set Parameters

JRH : Huynen Decomposition
RMB1 : Barnes 1 Decomposition
RMB2 : Barnes 2 Decomposition
SRC : Cloude Decomposition
WAH1 : Holm 1 Decomposition
WAH2 : Holm 2 Decomposition
HAA : H / A / Alpha Decomposition
FRE2 : Freeman 2 Components Decomposition
FRE3 : Freeman 3 Components Decomposition
VZ3 : Van Zyl 3 Components Decomposition
YAM3 : Yamaguchi 3 Components Decomposition
YAM4 : Yamaguchi 4 Components Decomposition
NEU : Neumann 2 Components Decomposition
KRO : Krogager Decomposition
CAM : Cameron Decomposition
TSVM : Touzi Decomposition

Matrix Elements
Correlation Coefficients
Elliptical Basis Change
Polarimetric Speckle Filter
H / A / Alpha Decomposition
Polarimetric Decompositions
Polarimetric Functionalities - 1
Polarimetric Functionalities - 2
Polarimetric Segmentation
Polarimetric Data Analysis
Polarimetric Data Clustering
Batch Process

H / A / Alpha Classification
H / A / Alpha - Wishart Classification
Fuzzy - H / Alpha Classification
Wishart Supervised Classification
Rule-Based Hierarchical Classification
Basic Scattering Mechanism Identification
SVM Supervised Classification

Data Statistics
Data Histograms
Data Profiles
Histogram Based Statistics
Texture Analysis

Clustering Process
Parameter Averaging
Data Sets Averaging

Faraday Rotation Estimation
Conformity Coefficient
Scattering Predominance
Scattering Diversity
Degree of Purity
Depolarisation Index
Alpha Approximation (Praks & Colin)
Entropy Approximation (Praks & Colin)
Scattering Mechanism Entropy (Freeman)
Scattering Mechanism Entropy (Van Zyl)
Kozlov Anisotropy
Lueneburg Anisotropy
Polarized Point Scatterer Detection
Reflectivity Ratio
Differential Reflectivity (ZDR)

Polarisation Synthesis
Polarimetric Signature
Stokes Parameters
Compact Polarimetric Mode
O.P.C.E
R.C.S Max
Surface Inversion
RVOG PolSAR Inversion
Sub-Aperture Analysis
DEM Estimation
Polarisation Orientation Compensation

Decomposition Applications

PolSARpro Run Trace
Close Window Display Menu
Close Window Tools Menu

ESA UNCLASSIFIED - For Official Use

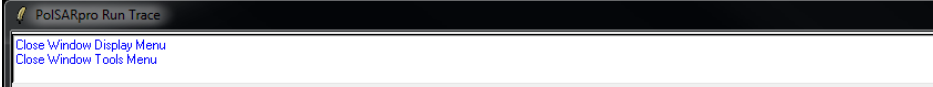
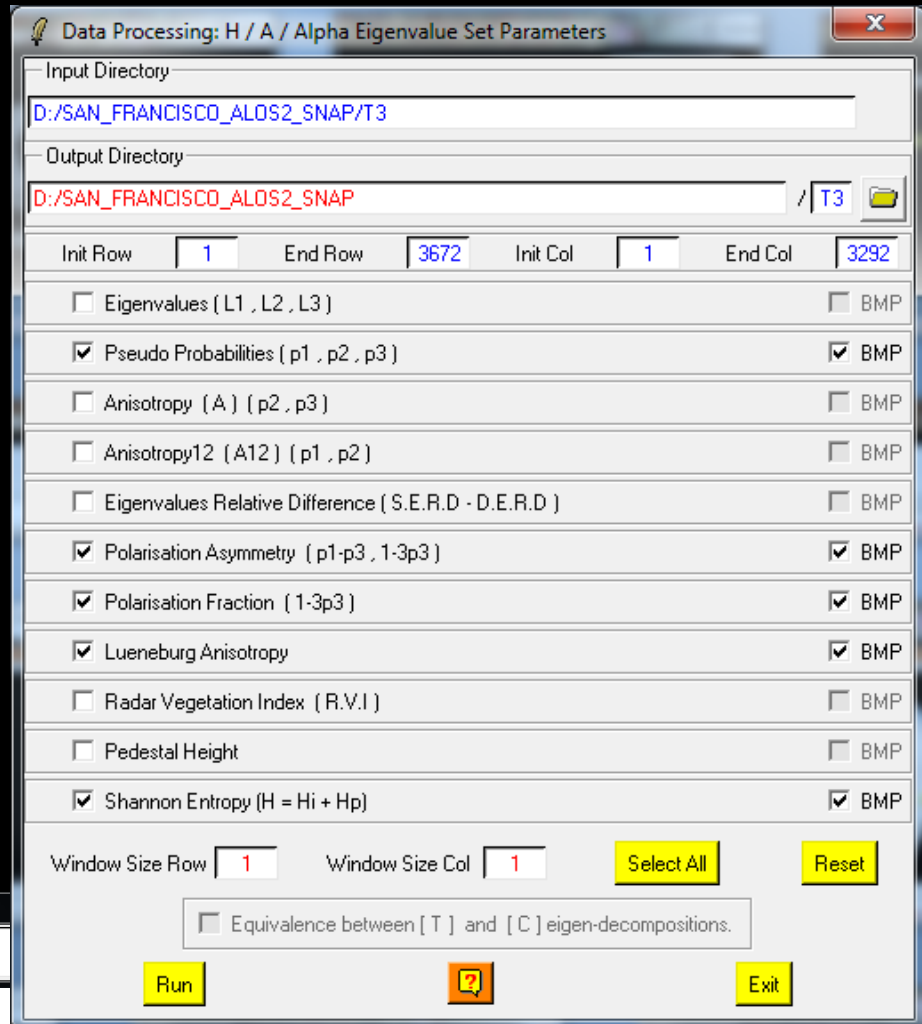
European Space Agency
E.P (2017)

EIGENVALUE SET PARAMETERS



Do it Yourself:
Select some elements, set the parameters and view the corresponding BMP files (select BMP).

Window Size = 1

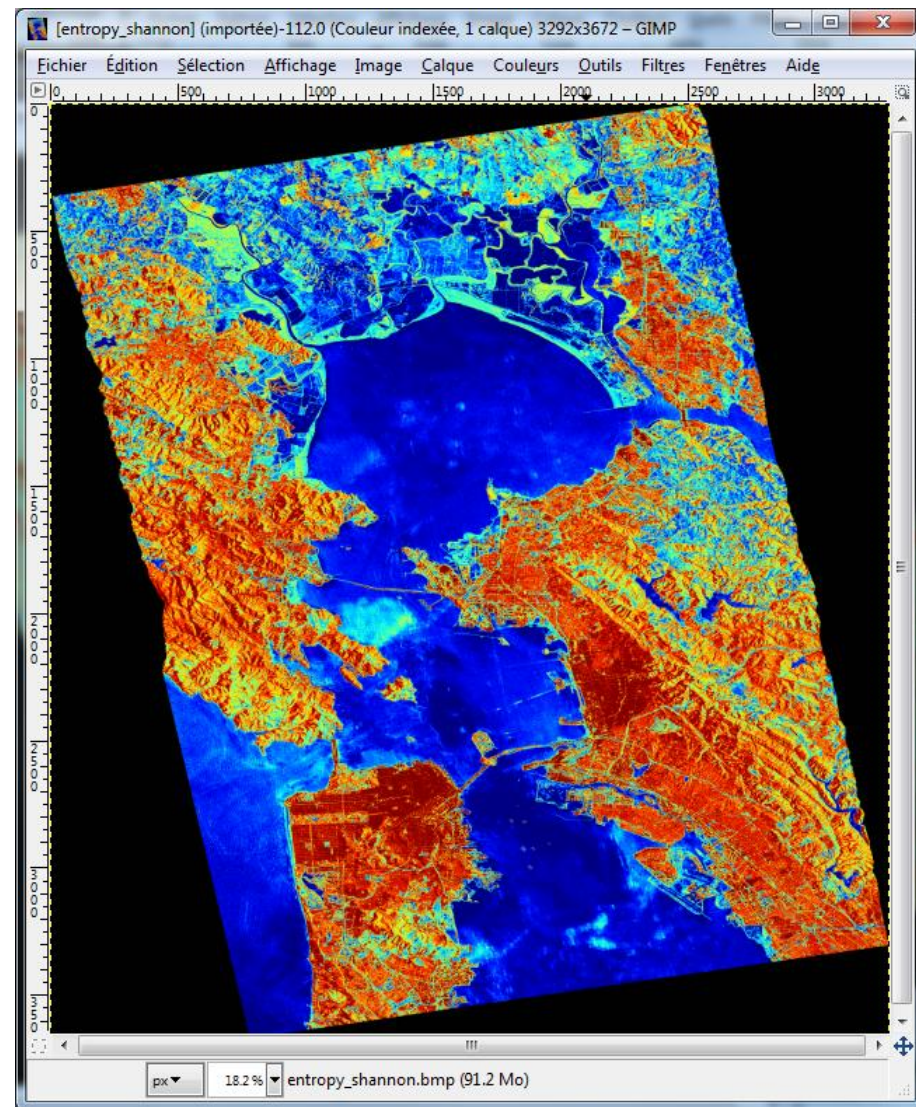
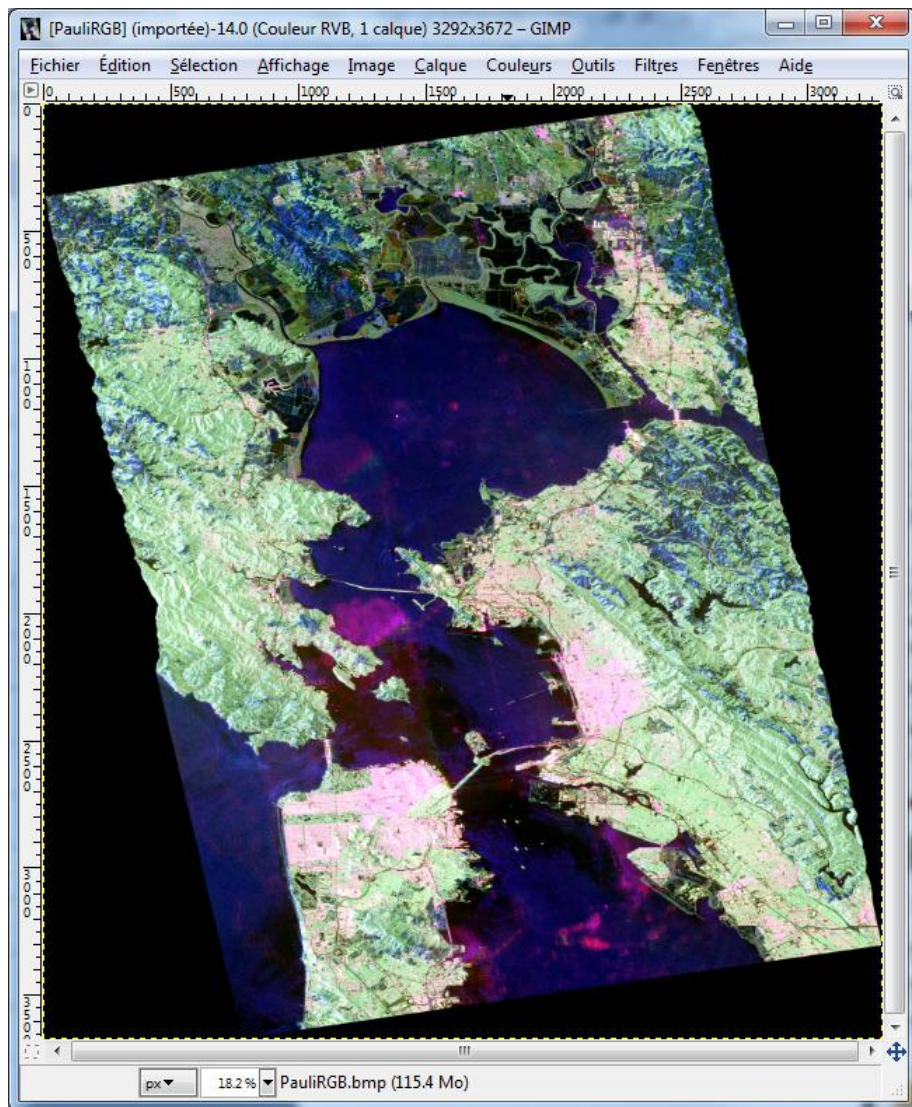


ESA UNCLASSIFIED - For Official Use



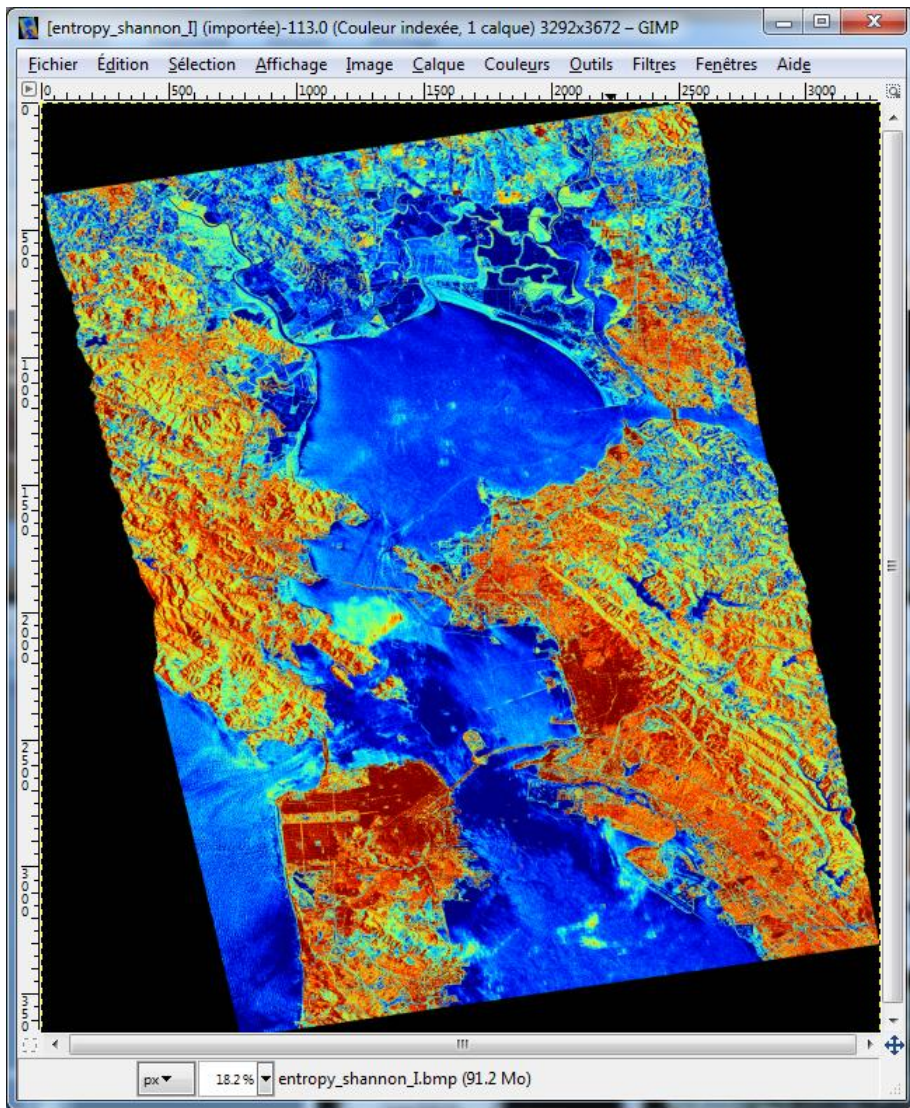
EIGENVALUE SET PARAMETERS

Entropy Shannon

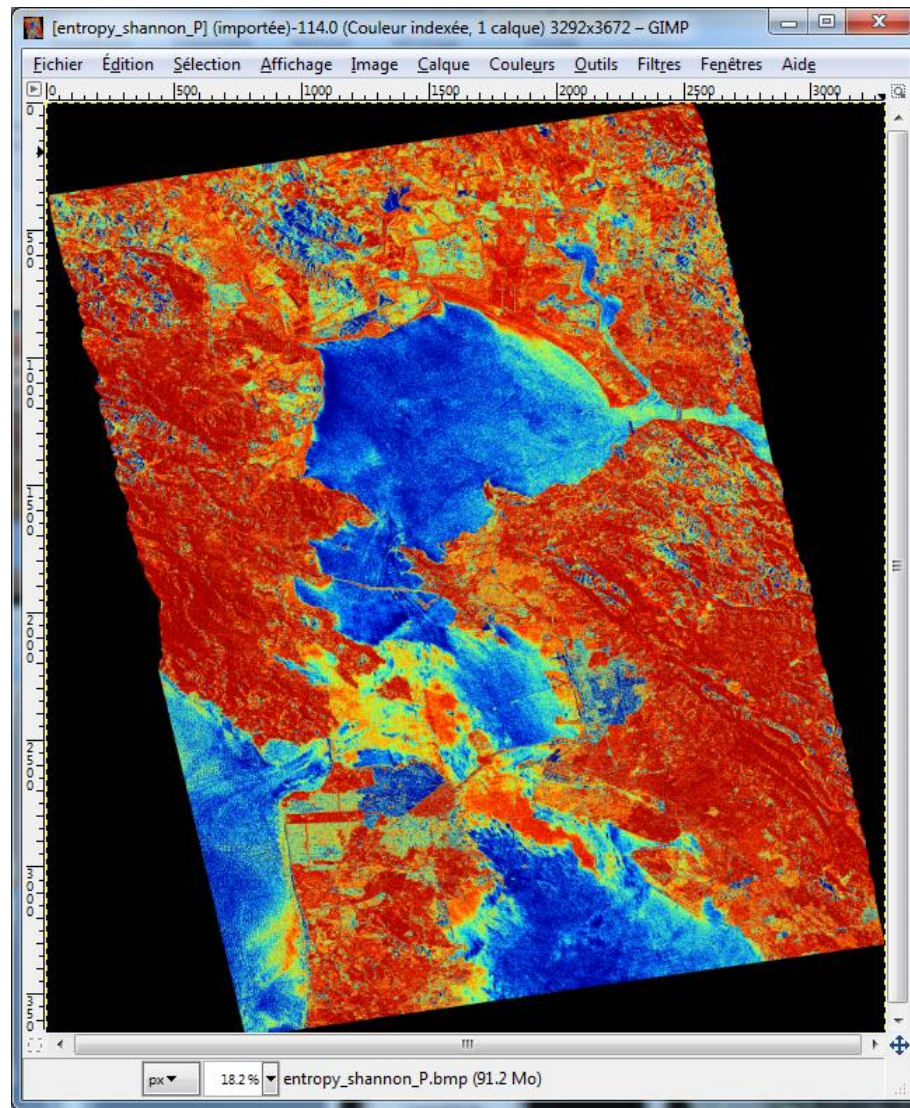


EIGENVALUE SET PARAMETERS

Entropy I

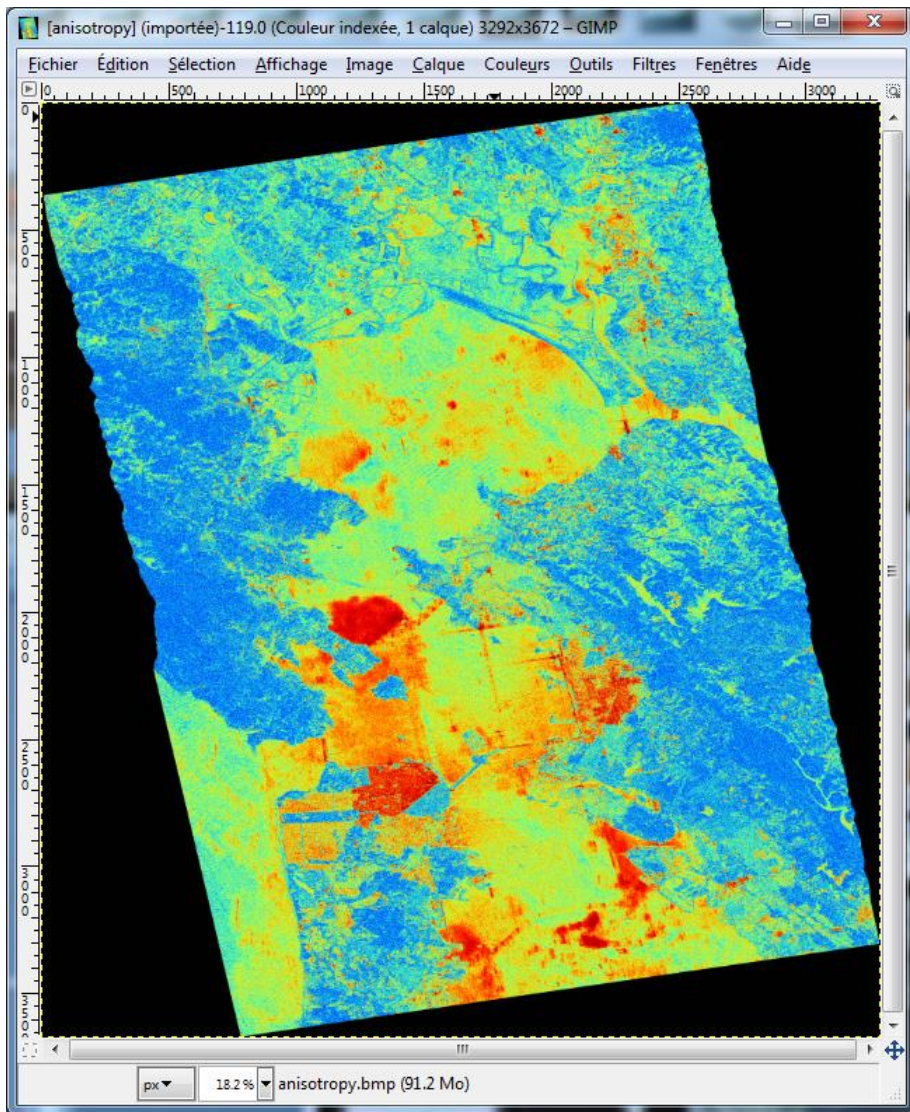


Entropy P

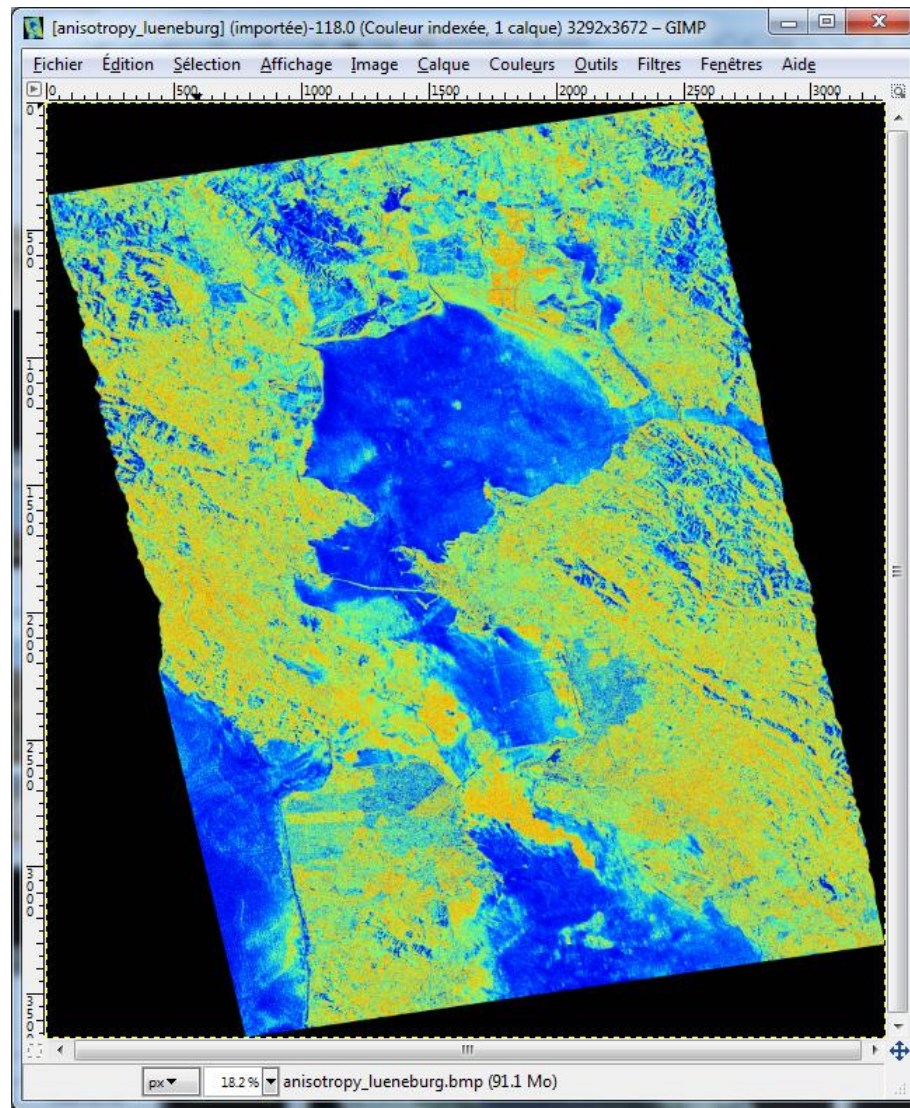


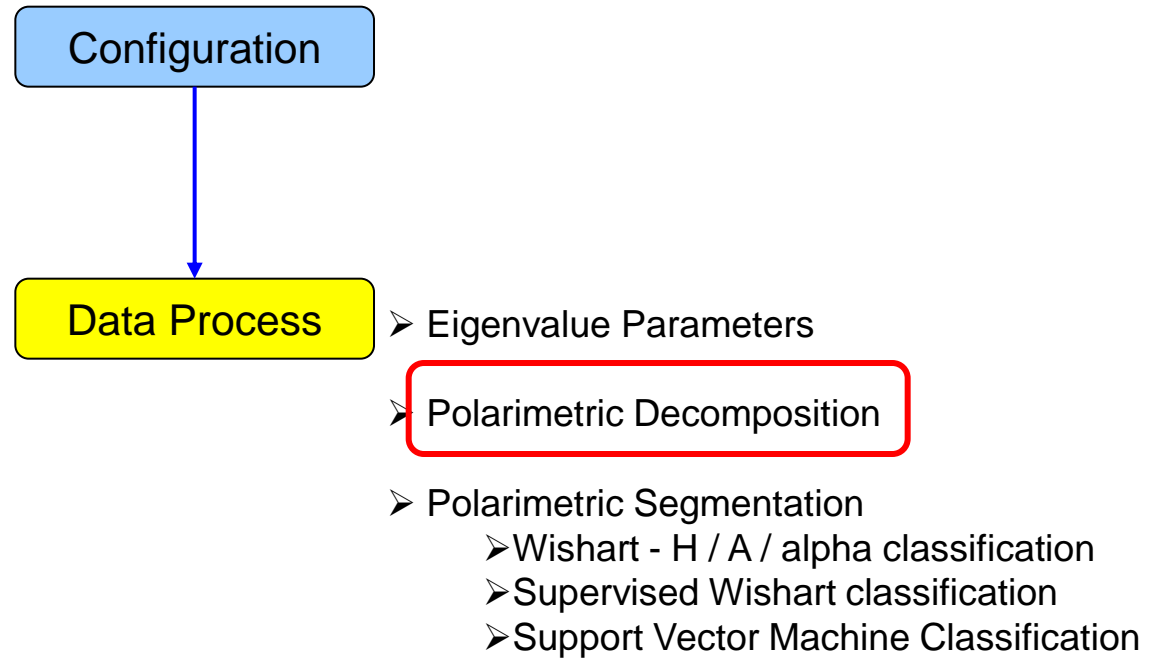
EIGENVALUE SET PARAMETERS

Anisotropy



Lueneburg Anisotropy





PolSARpro v5.1 SOFTWARE



PolSARpro v5.1 - Menu

esa PolSARpro
The Polarimetric SAR Data Processing and Educational Tool

Environment Import Convert **Process** Display Calibration Utilities Tools Configuration Education Help

Linear (+45 / -45)
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Elliptical (phi, tau)

Box Car Filter
Box Car - Edge Filter
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J.S. Lee Sigma Filter
P.W.F Filter
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Eigenvalue Set Parameters

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H / A / Alpha - Wishart Classification
Fuzzy - H / Alpha Classification
Wishart Supervised Classification
Rule-Based Hierarchical Classification
Basic Scattering Mechanism Identification
SVM Supervised Classification

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Data Histograms
Data Profiles
Histogram Based Statistics
Texture Analysis

Faraday Rotation
Conformity Coefficient
Scattering Prediction
Scattering Diversity
Degree of Purity
Depolarisation Index
Alpha Approximation
Entropy Approximation
Scattering Mechanism
Scattering Mechanism

Kozlov Anisotropy
Lueneburg Anisotropy
Polarized Point Scatterer Detection
Reflectivity Ratio
Differential Reflectivity (ZDR)

TSVM : Touzi Decomposition
Aghababaei Decomposition
2KR : Raney Decomposition
CPD : Compact-Pol Decomposition

Decomposition Applications

PolSARpro Run Trace
Close Window Display Menu
Close Window Tools Menu

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European Space Agency
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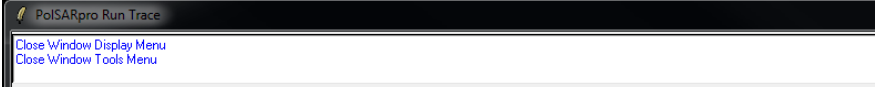
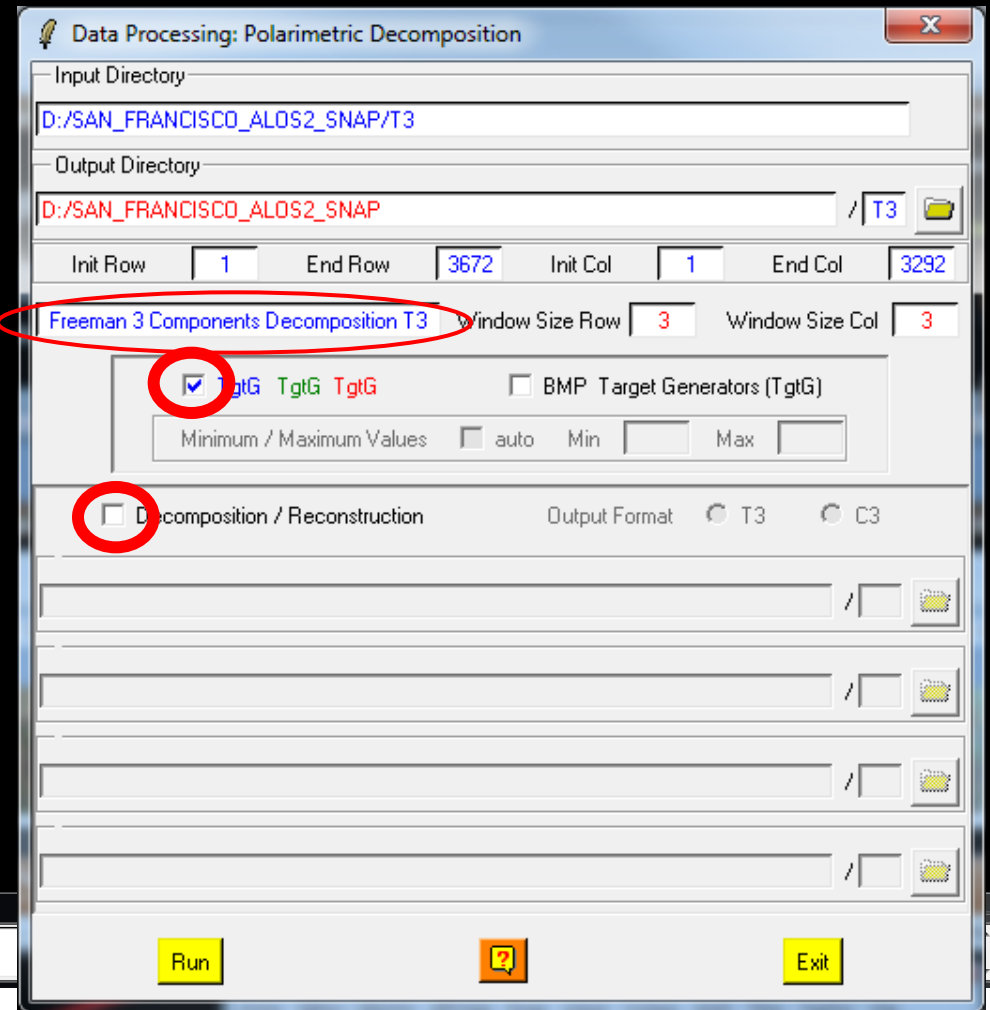
Decomposition Applications

- KRO : Krogager Decomposition
- CAM : Cameron Decomposition
- HAA : H / A / Alpha Decomposition
- JRH : Huynen Decomposition
- RMB1 : Barnes 1 Decomposition
- RMB2 : Barnes 2 Decomposition
- SRC : Cloude Decomposition
- UHDx : Unified Huynen Decomposition
- WAH1 : Holm 1 Decomposition
- WAH2 : Holm 2 Decomposition
- AN3 : An & Yang 3 Component Decomposition
- AN4 : An & Yang 4 Component Decomposition
- BF4 : Bhattacharya & Frey 4 Component Decomposition
- FRE2 : Freeman 2 Component Decomposition
- FRE3 : Freeman 3 Component Decomposition
- NEU : Neumann 2 Component Decomposition
- NNED : Arie 3 Component NNED Decomposition
- ANNED : Arie 3 Component ANNED Decomposition
- VZ3 : Van Zyl (1992) 3 Component Decomposition
- SIN4 : Singh 4 Component Decomposition
- YAM3 : Yamaguchi 3 Component Decomposition
- YAM4 : Yamaguchi 4 Component Decomposition
- MCSM5 : L. Zhang 5 Component Decomposition

POLARIMETRIC DECOMPOSITION



Do it Yourself:
Select some elements, set the parameters and view the corresponding BMP files (select BMP).
Window Size = 1

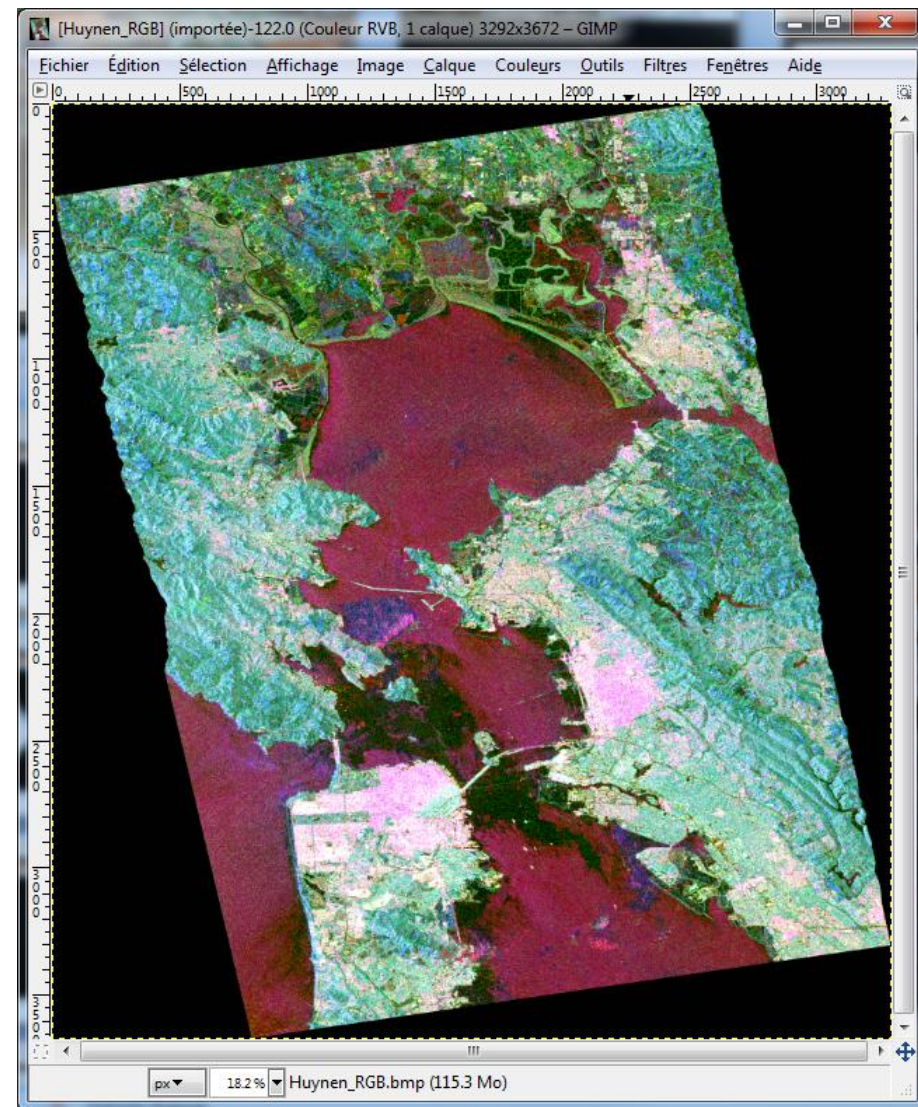
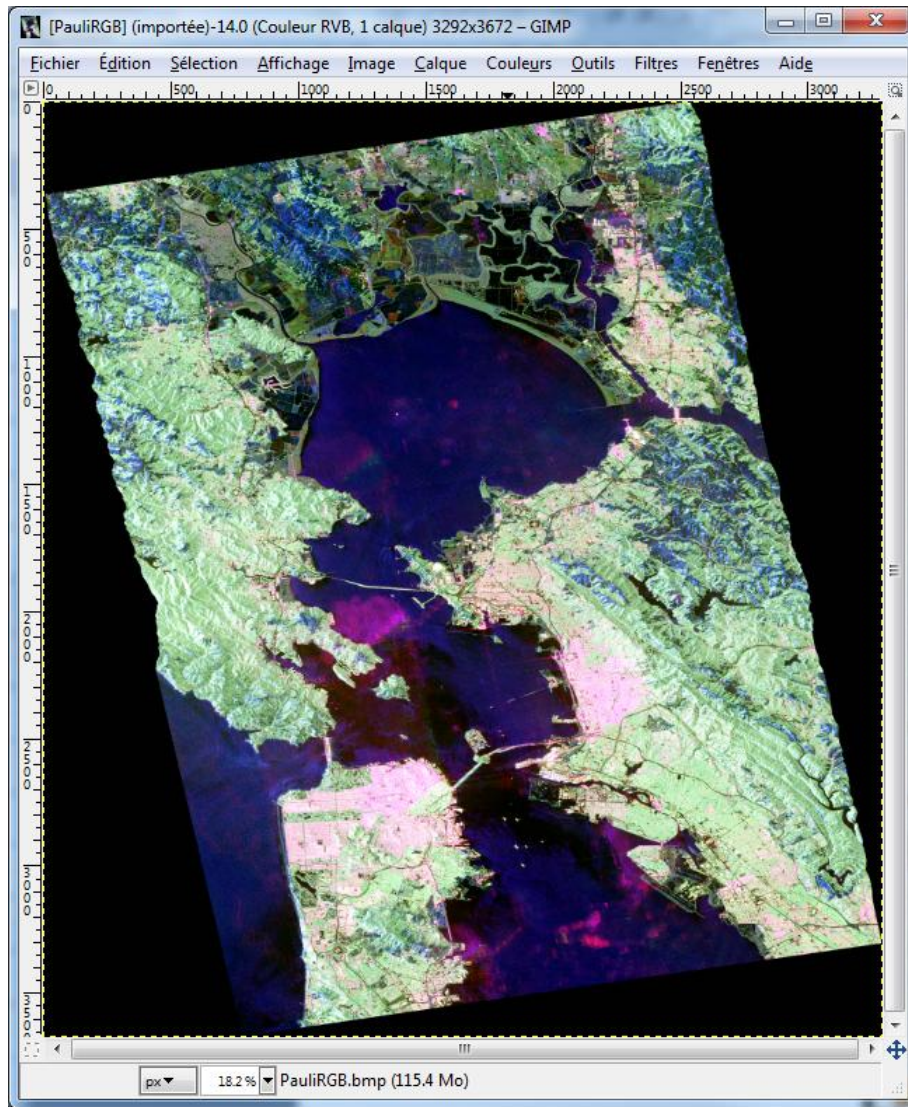


ESA UNCLASSIFIED - For Official Use



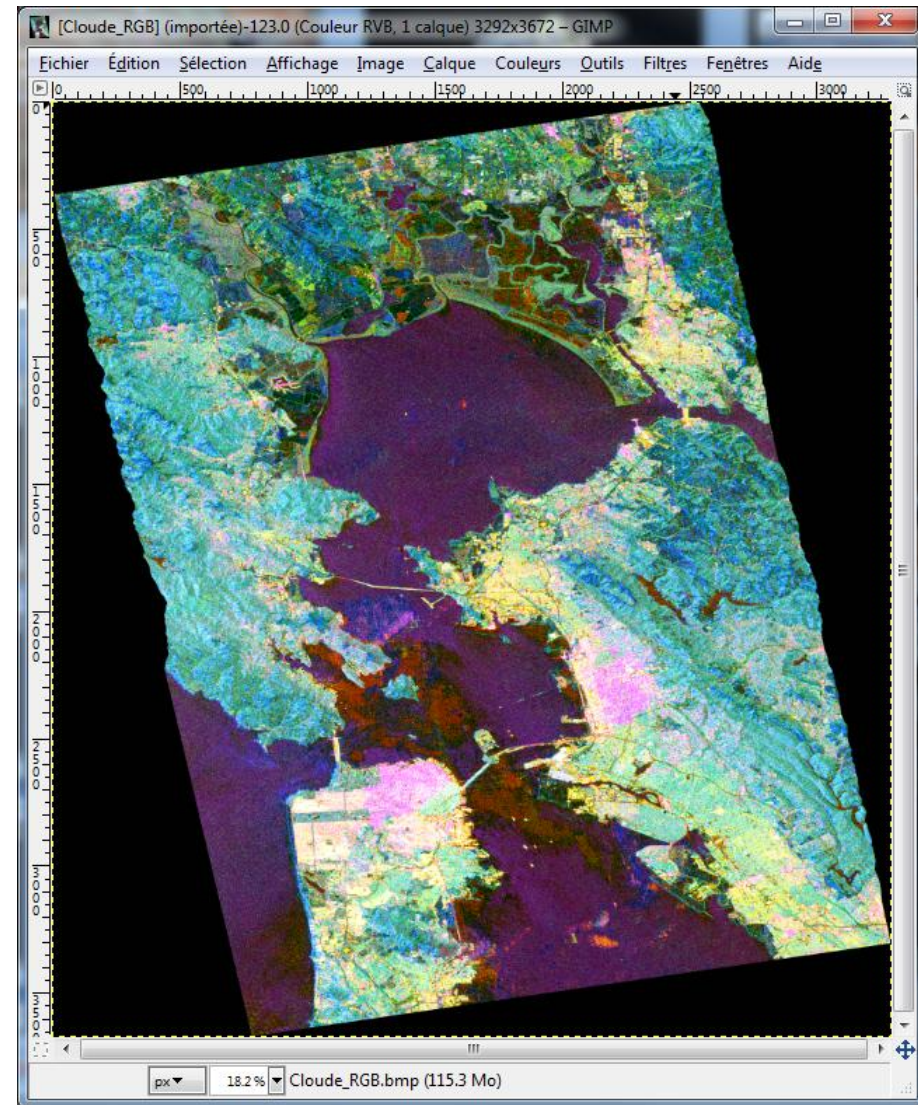
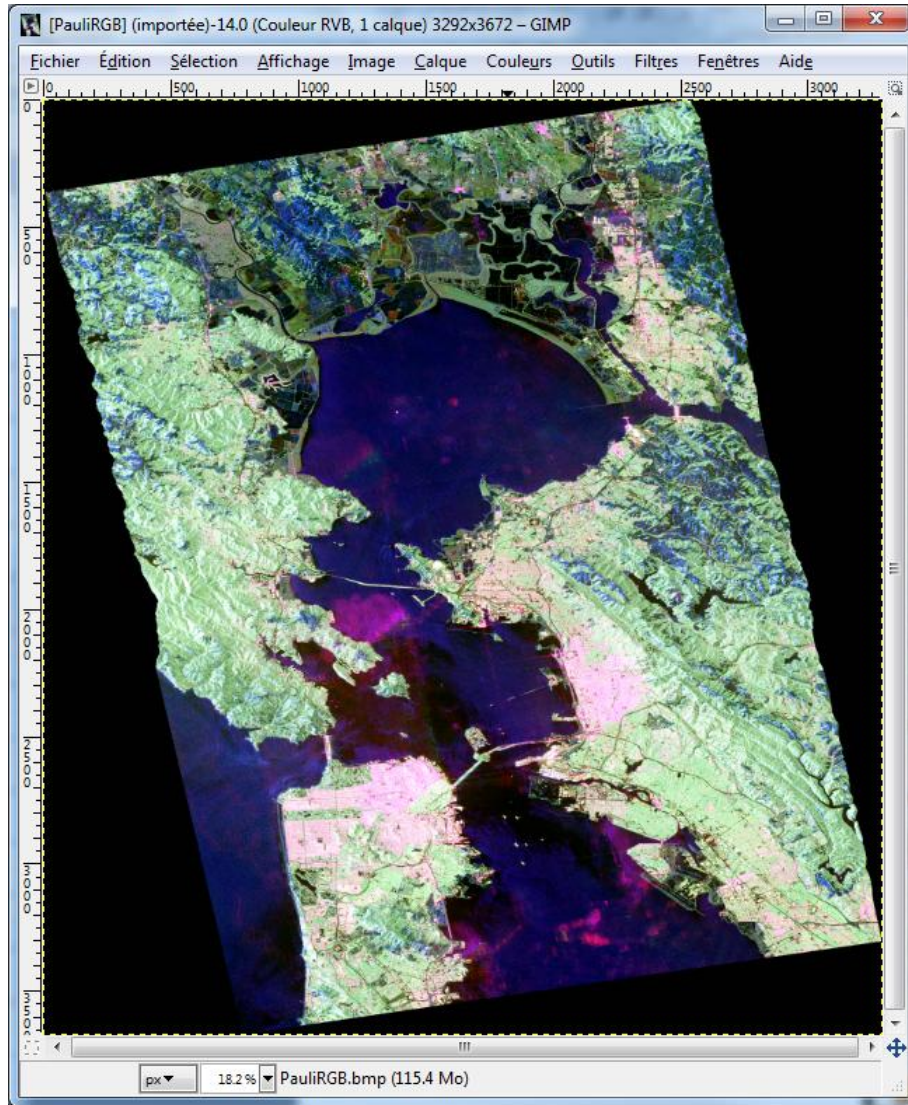
POLARIMETRIC DECOMPOSITION

Pauli Huynen



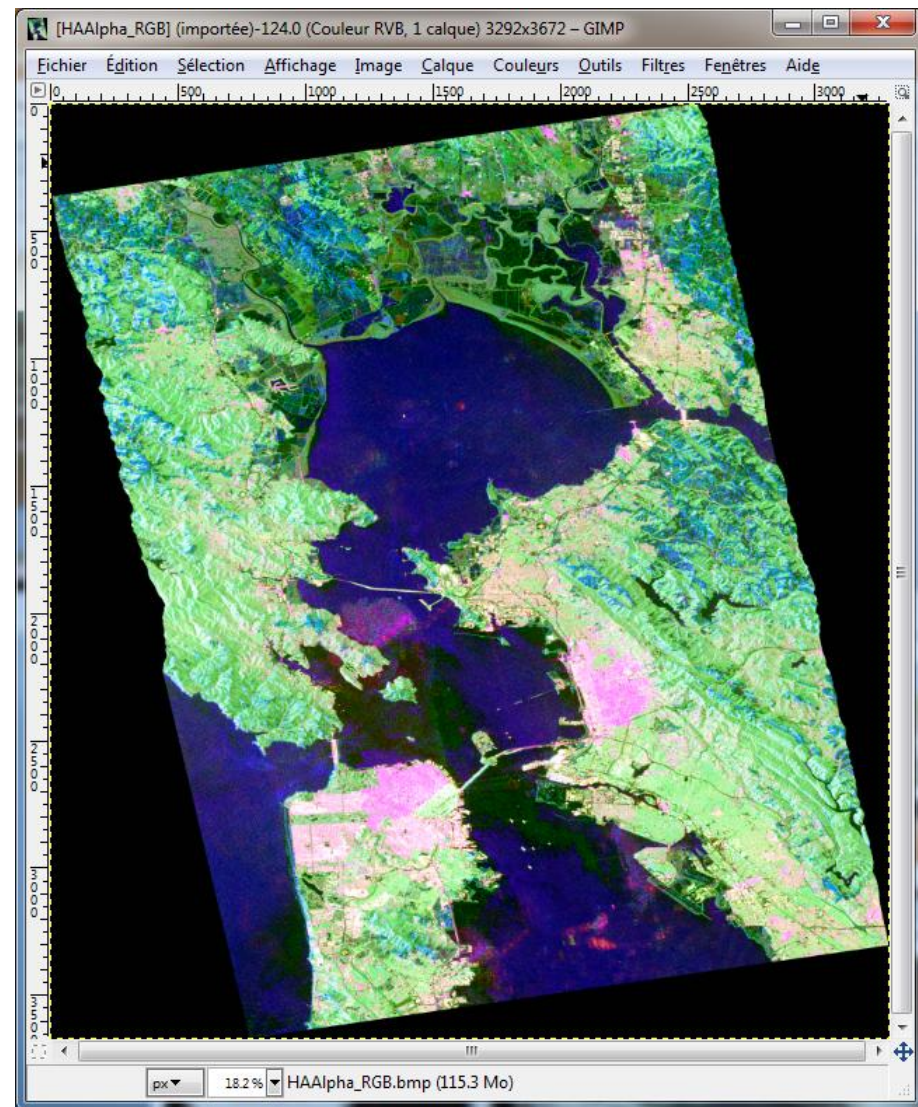
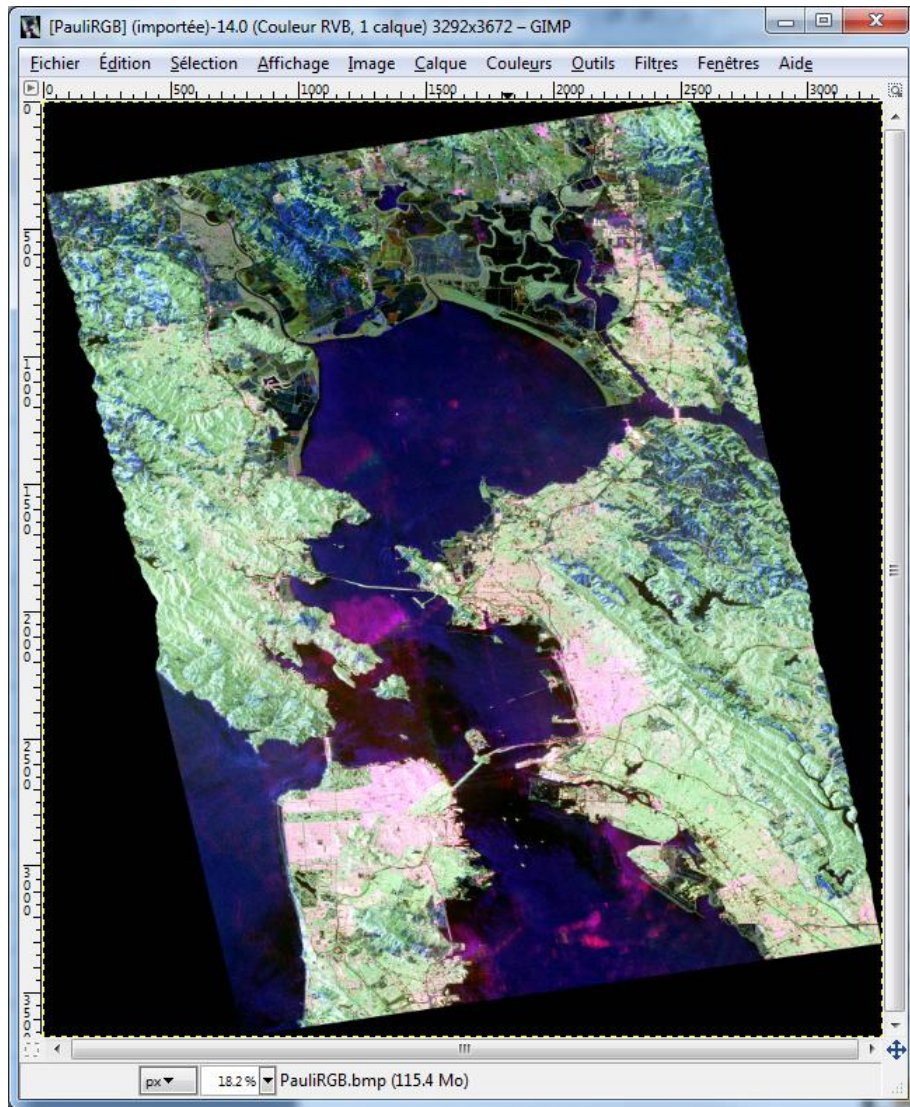
POLARIMETRIC DECOMPOSITION

Pauli Cloude



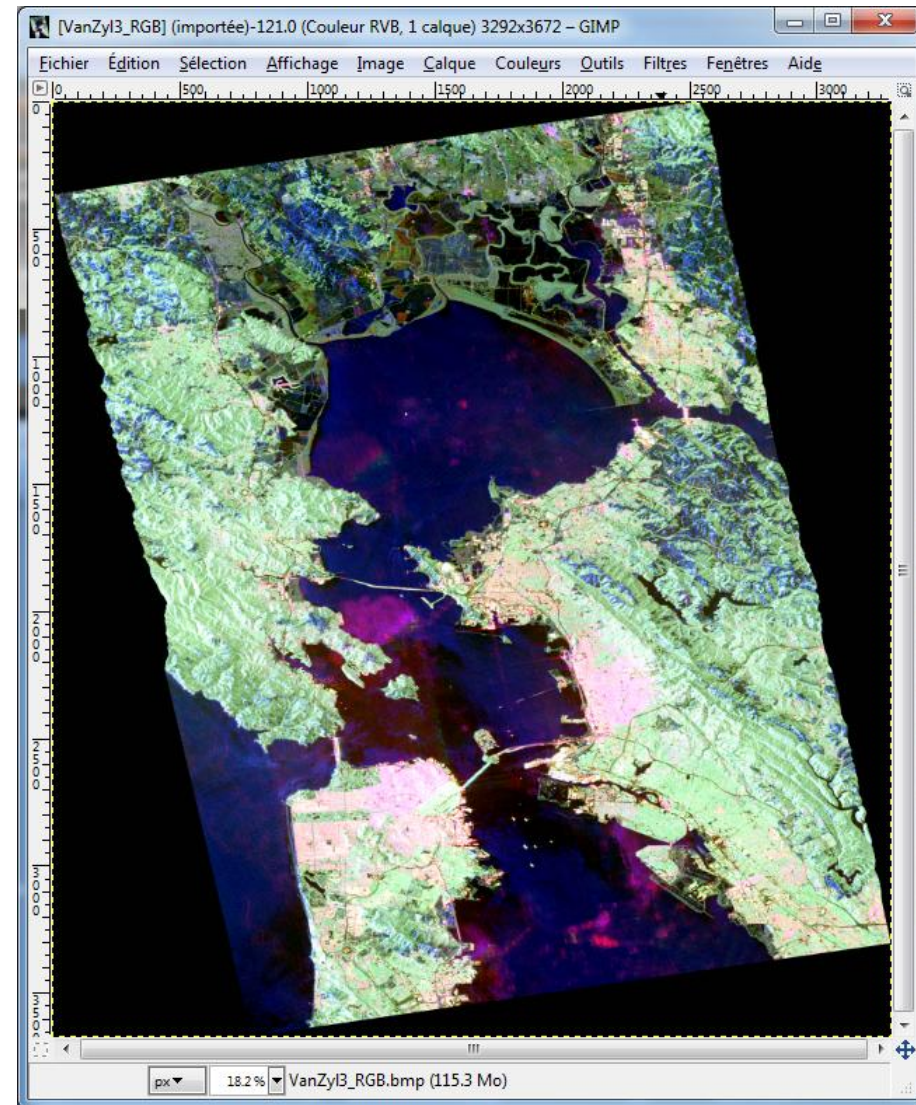
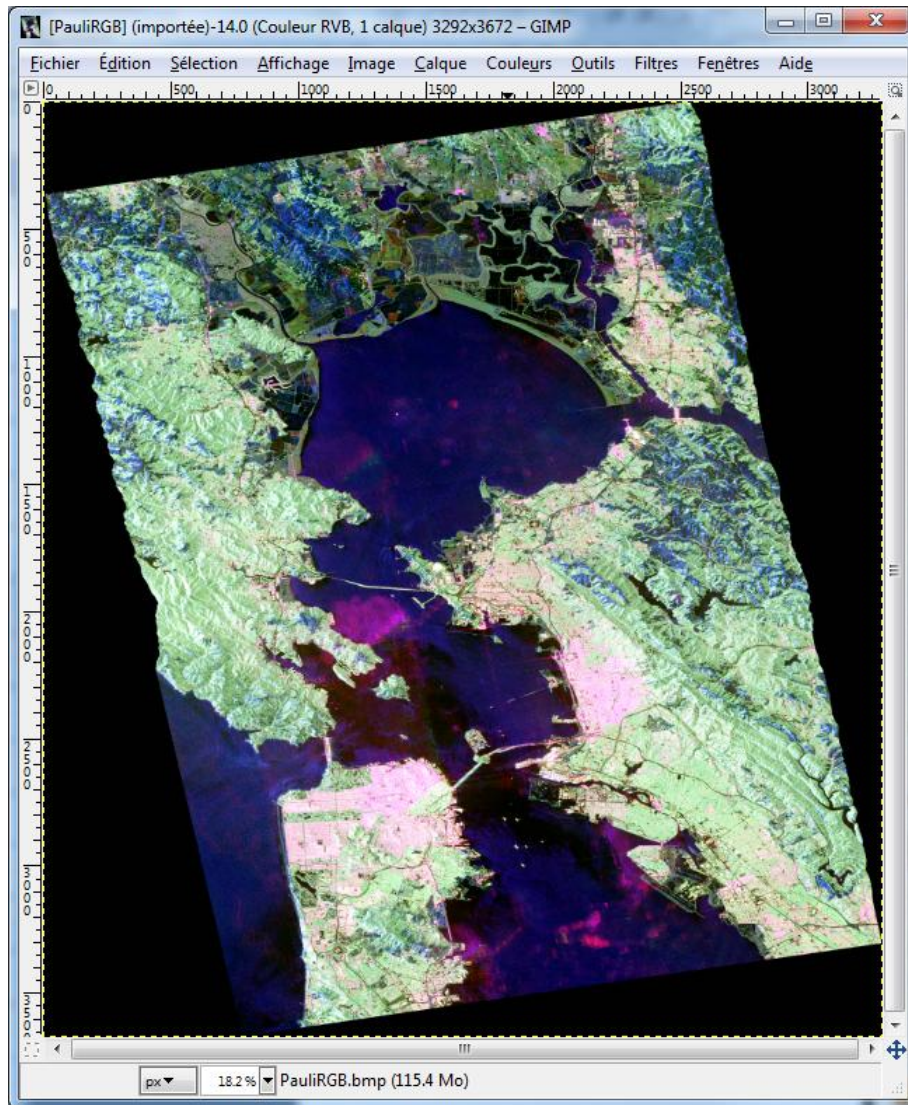
POLARIMETRIC DECOMPOSITION

Pauli H-A-Alpha



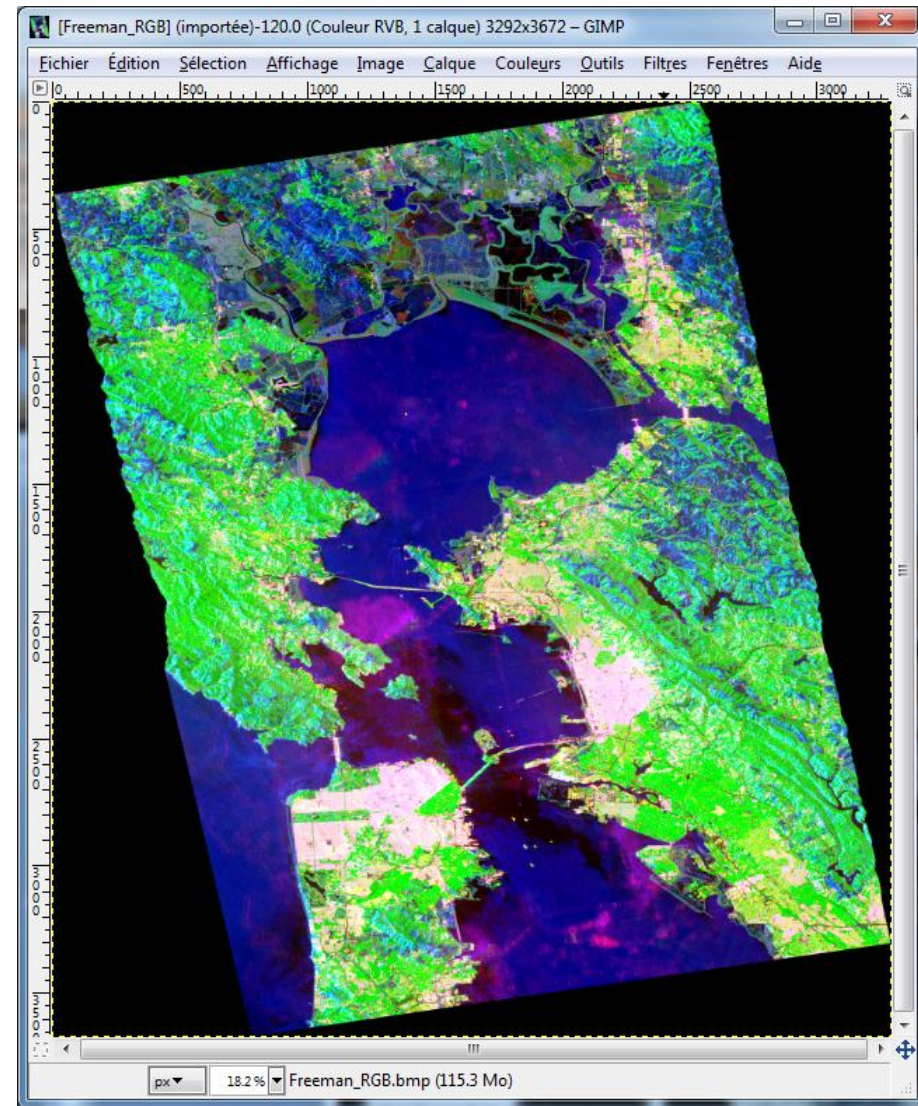
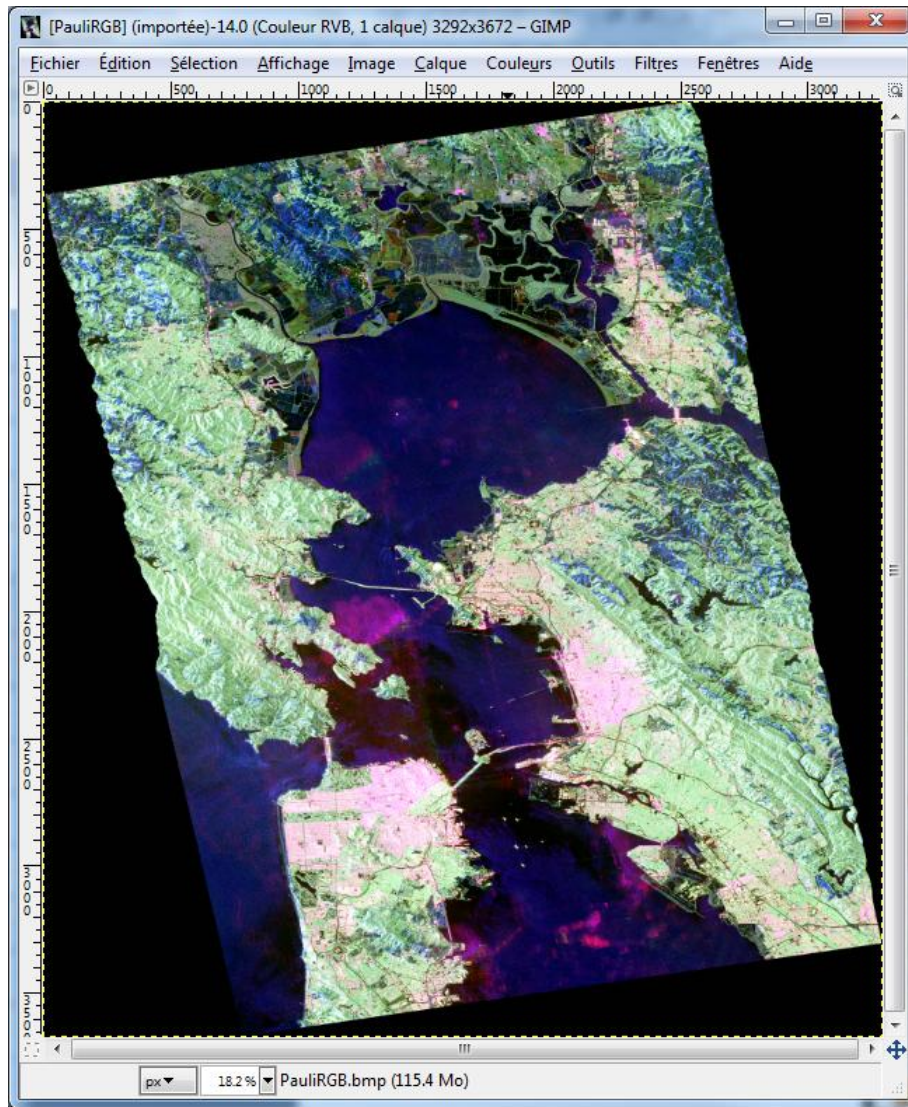
POLARIMETRIC DECOMPOSITION

Pauli Van Zyl 3



POLARIMETRIC DECOMPOSITION

Pauli Freeman 3



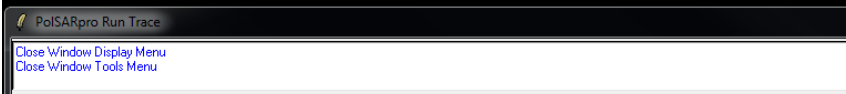
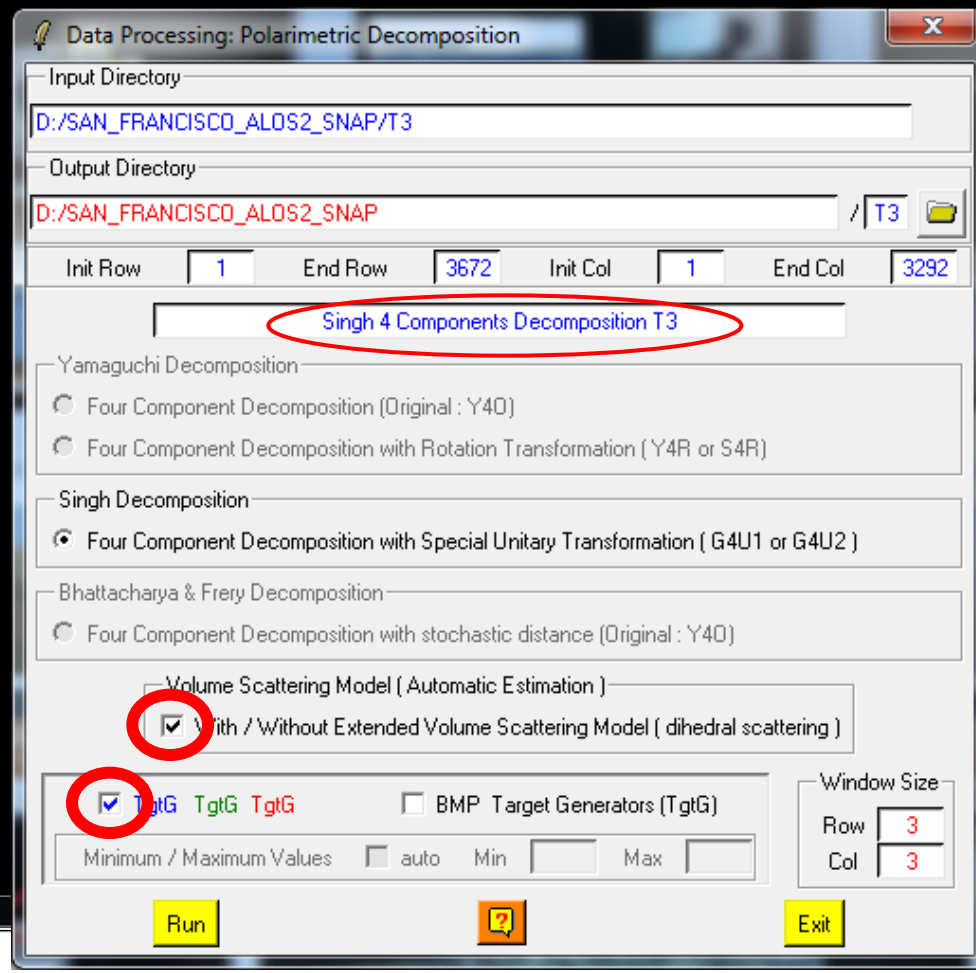
POLARIMETRIC DECOMPOSITION



Do it Yourself:
Select some elements, set the parameters and view the corresponding BMP files (select BMP).

Window Size = 1

Yamaguchi Y40, Y4R, S4R
Singh G4U1, G4U2

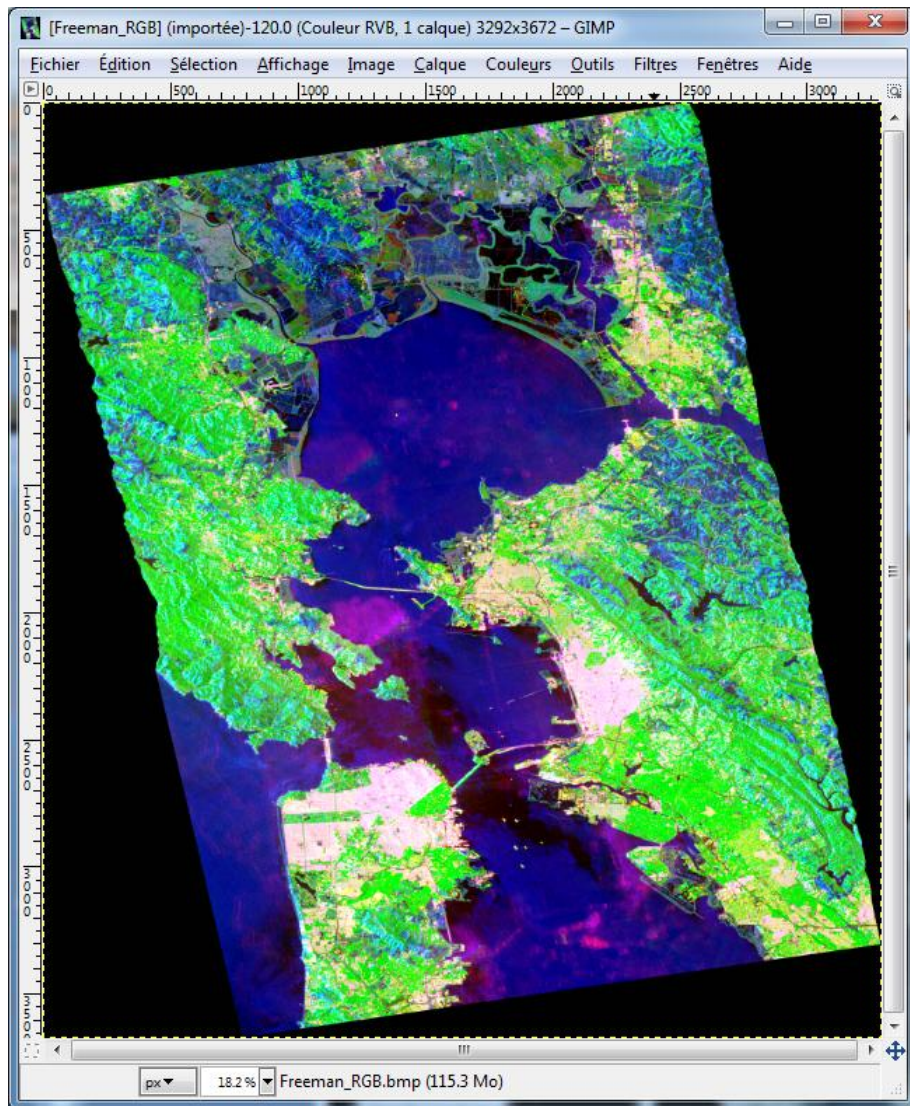


ESA UNCLASSIFIED - For Official Use

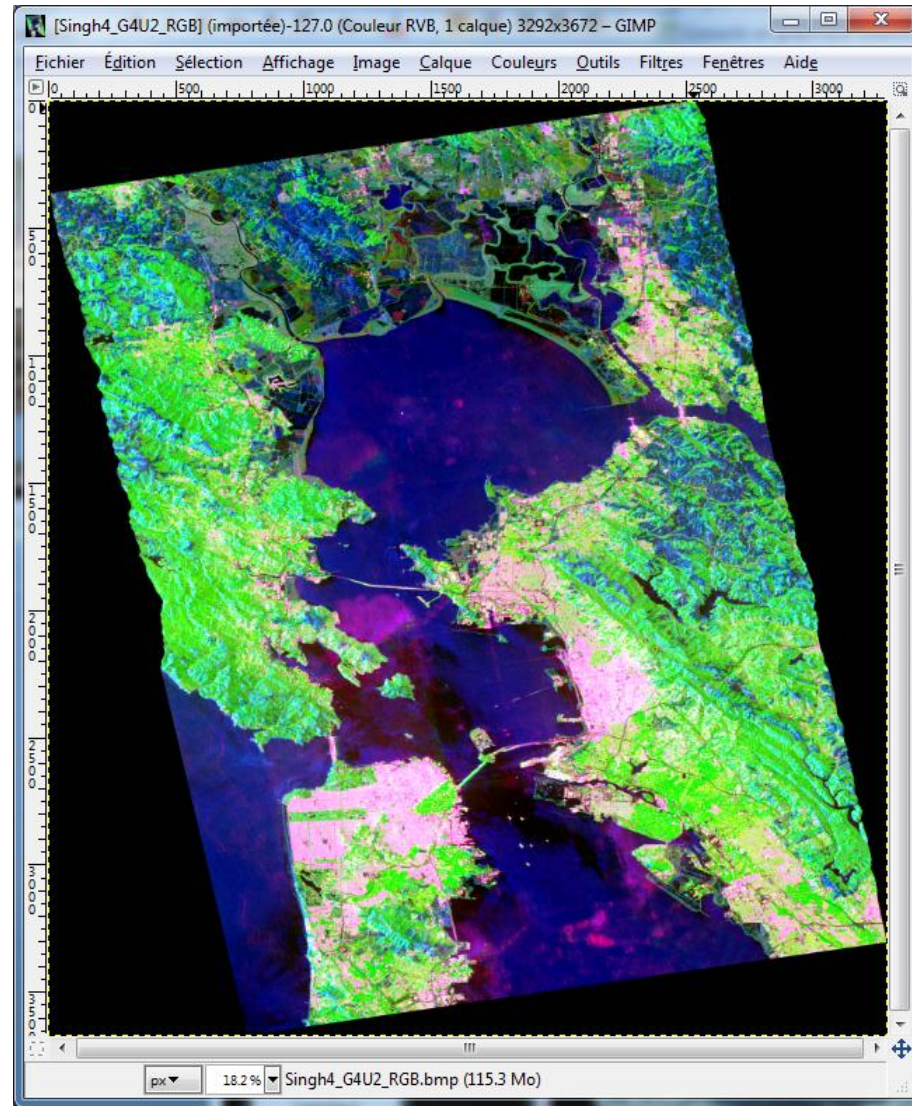


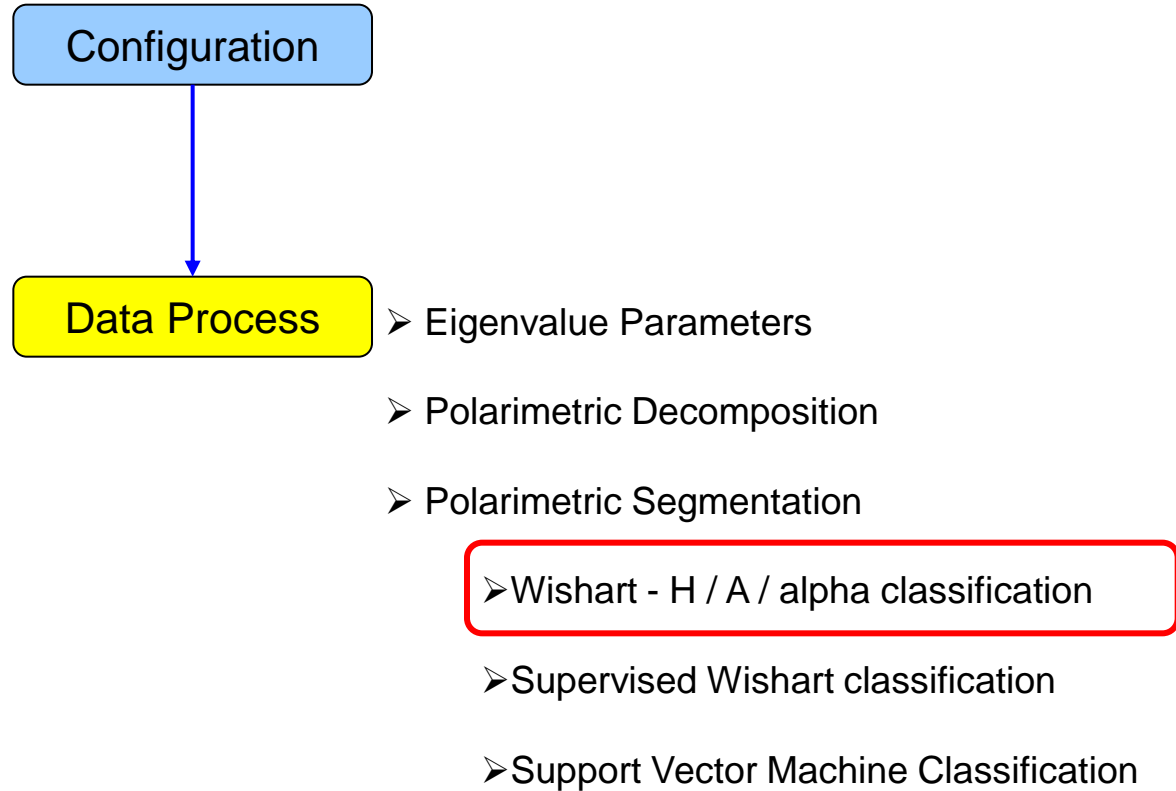
POLARIMETRIC DECOMPOSITION

Pauli Freeman 3



Pauli Singh - Yamaguchi G4U2





PolSARpro v5.1 SOFTWARE



The screenshot shows the PolSARpro v5.1 software interface. The main menu bar includes: Environment, Import, Convert, **Process** (highlighted with a red circle), Display, Calibration, Utilities, Tools, Configuration, Education, Help, and Quit. A diagram of yellow arrows traces the path from the 'Process' menu to various sub-menus and options:

- Process** menu items:
 - Linear (+45 / -45)
 - Circular (L / R)
 - Elliptical (phi, tau)
- Process** sub-menu:
 - Box Car Filter
 - Box Car - Edge Filter
 - C. Lopez Filter
 - Gaussian Filter
 - IDAN Filter
 - J.S. Lee Refined Filter
 - J.S. Lee Sigma Filter
 - P.W.F Filter
 - Edge Detector
- Process** sub-menu:
 - Decomposition Parameters
 - Eigenvector Set Parameters
 - Eigenvalue Set Parameters
- Process** sub-menu:
 - JRH : Huynen Decomposition
 - RMB1 : Barnes 1 Decomposition
 - RMB2 : Barnes 2 Decomposition
 - SRC : Cloude Decomposition
 - WAH1 : Holm 1 Decomposition
 - WAH2 : Holm 2 Decomposition
 - HAA : H / A / Alpha Decomposition
 - FRE2 : Freeman 2 Components Decomposition
 - FRE3 : Freeman 3 Components Decomposition
 - VZ3 : Van Zyl 3 Components Decomposition
 - YAM3 : Yamaguchi 3 Components Decomposition
 - YAM4 : Yamaguchi 4 Components Decomposition
 - NEU : Neumann 2 Components Decomposition
 - KRO : Krogager Decomposition
 - CAM : Cameron Decomposition
 - TSVM : Touzi Decomposition
- Process** sub-menu:
 - Polarisation Estimation
 - Coherence
 - Coherence Dominance
 - Coherence Diversity
 - Coherence Entropy
 - Coherence Index
 - Coherence Estimation (Praks & Colin)
 - Coherence Approximation (Praks & Colin)
 - Coherence Mechanism Entropy (Freeman)
 - Coherence Mechanism Entropy (Van Zyl)
 - Coherence Entropy
 - Coherence Anisotropy
- Process** sub-menu:
 - Polarisation Synthesis
 - Polarimetric Signature
 - Stokes Parameters
 - Compact Polarimetric Mode
 - O.P.C.E
 - R.C.S Max
 - Surface Inversion
 - RVOG PolSAR Inversion
 - Sub-Aperture Analysis
 - DEM Estimation
 - Polarisation Orientation Compensation
- Process** sub-menu:
 - Texture Analysis
 - Polarized Point Scatterer Detection
 - Reflectivity Ratio
 - Differential Reflectivity (ZDR)
- Process** sub-menu:
 - Clustering Process
 - Parameter Averaging
 - Data Sets Averaging
- Process** sub-menu:
 - Decomposition Applications
- Process** sub-menu:
 - Matrix Elements
 - Correlation Coefficients
 - Elliptical Basis Change
 - Polarimetric Speckle Filter
 - H / A / Alpha Decomposition
 - Polarimetric Decompositions
 - Polarimetric Functionalities - 1
 - Polarimetric Functionalities - 2
 - Polarimetric Segmentation** (circled in blue)
 - Polarimetric Data Analysis
 - Polarimetric Data Clustering
 - Batch Process
- Process** sub-menu:
 - H / A / Alpha Classification
 - H / u / v Classification (Xu & Jin)
 - H / A / Alpha - Wishart Classification** (circled in blue)
 - Scattering Model Based - Wishart Classification
 - Unified Huynen Classification
 - Fuzzy - H / Alpha Classification
 - Wishart Supervised Classification
 - G.P.F. Supervised Classification
 - Rule-Based Hierarchical Classification
 - Basic Scattering Mechanism Identification
 - SVM Supervised Classification
 - Histogram based Statistics

At the bottom of the interface, there is a row of European Union member state flags and the text "ESA UNCLASSIFIED - For Official Use".

WISHART - H/A/alpha CLASSIFICATION



Do it Yourself:
Set the parameters, run and view
the corresponding BMP files.

Data Processing: Wishart H / A / Alpha Classification

Input Directory:

Output Directory: / T3

Init Row: End Row: Init Col: End Col:

Wishart H / A / Alpha Classification

% of Pixels Switching Class: Window Size Row: BMP

Maximum Number of Iterations: Window Size Col:

Entropy: Anisotropy: Alpha:

Color Maps

ColorMap 8:

ColorMap 16:

Pauli Sinclair Combine

Coded Colormap

Blue File:

Green File:

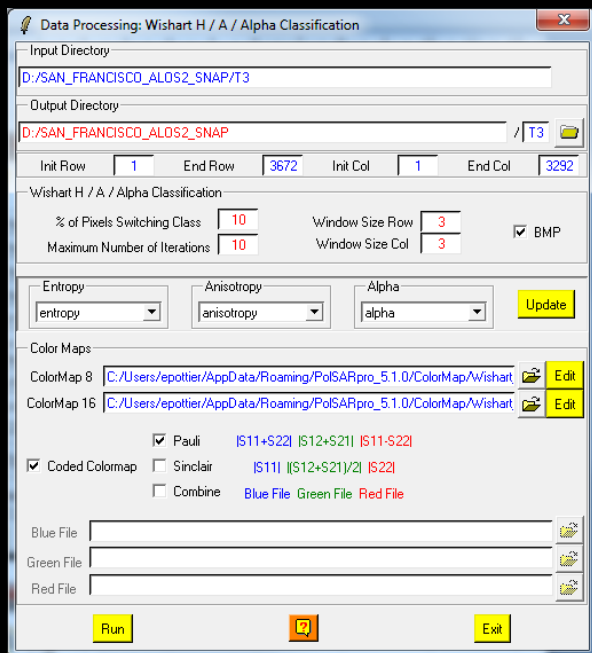
Red File:

PolSARpro Run Trace
Close Window Display Menu
Close Window Tools Menu

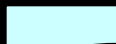
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WISHART - H/A/alpha CLASSIFICATION



DATADIR



config.txt



[T3x3] Elements



Wishart_H_alpha_class_X.bin
Wishart_H_A_alpha_class_X.bin

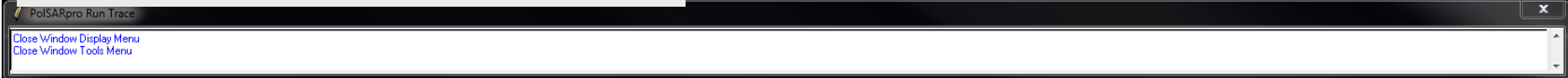


Wishart_H_alpha_class_X.bmp
Wishart_H_A_alpha_class_X.bmp

X = window size

Do it Yourself:

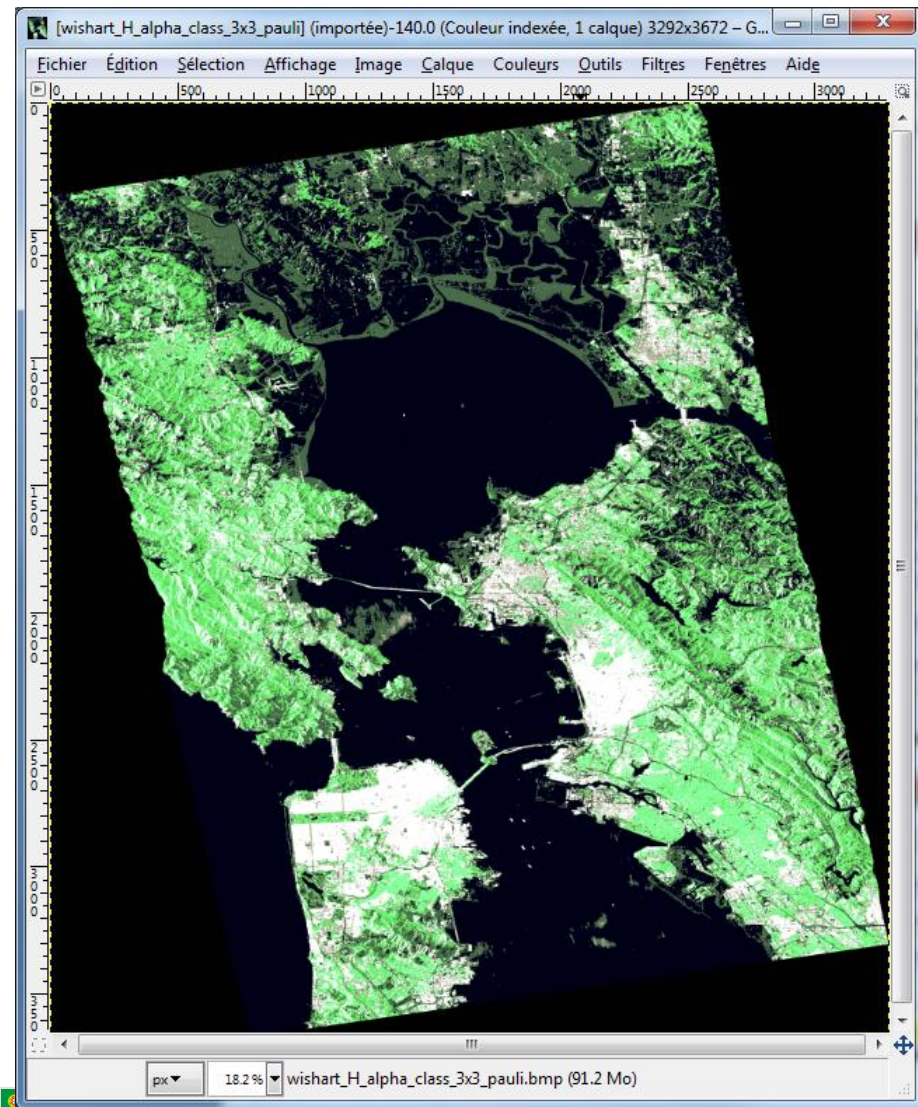
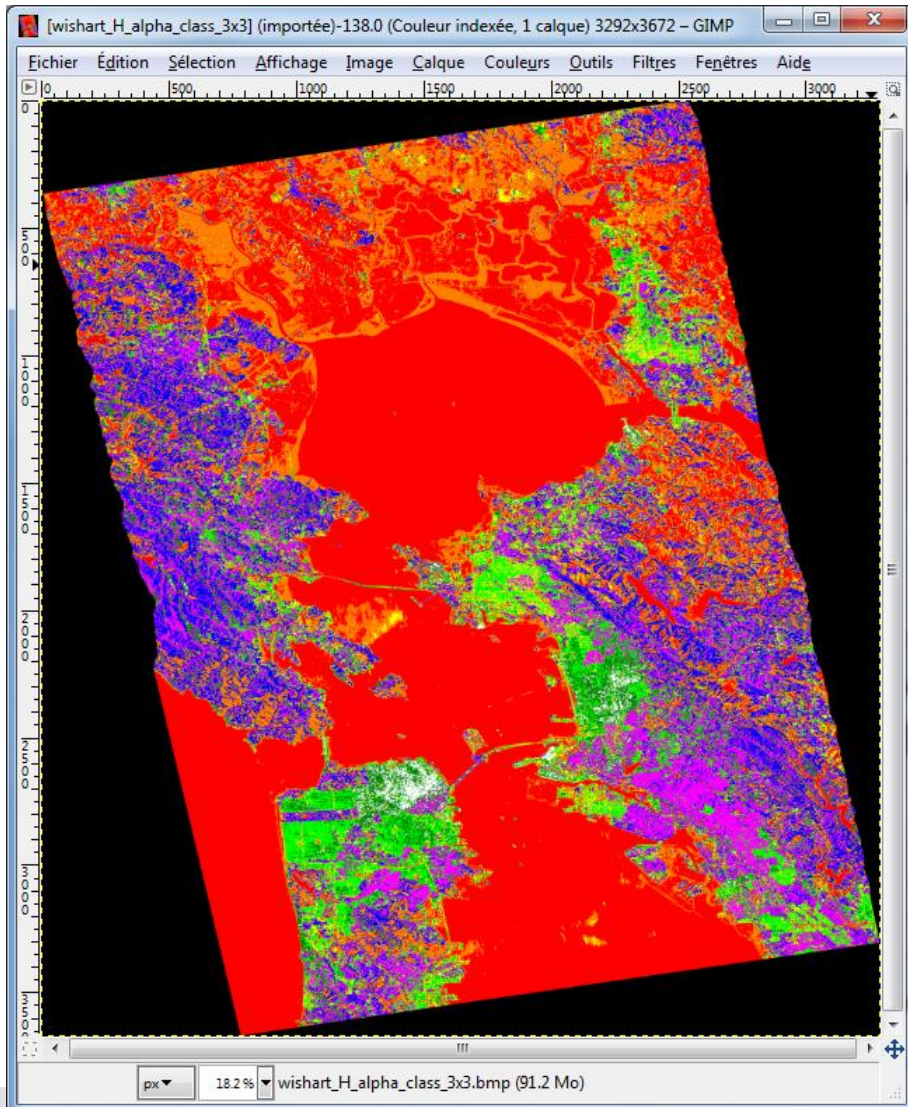
Set the parameters, run and view the corresponding BMP files.



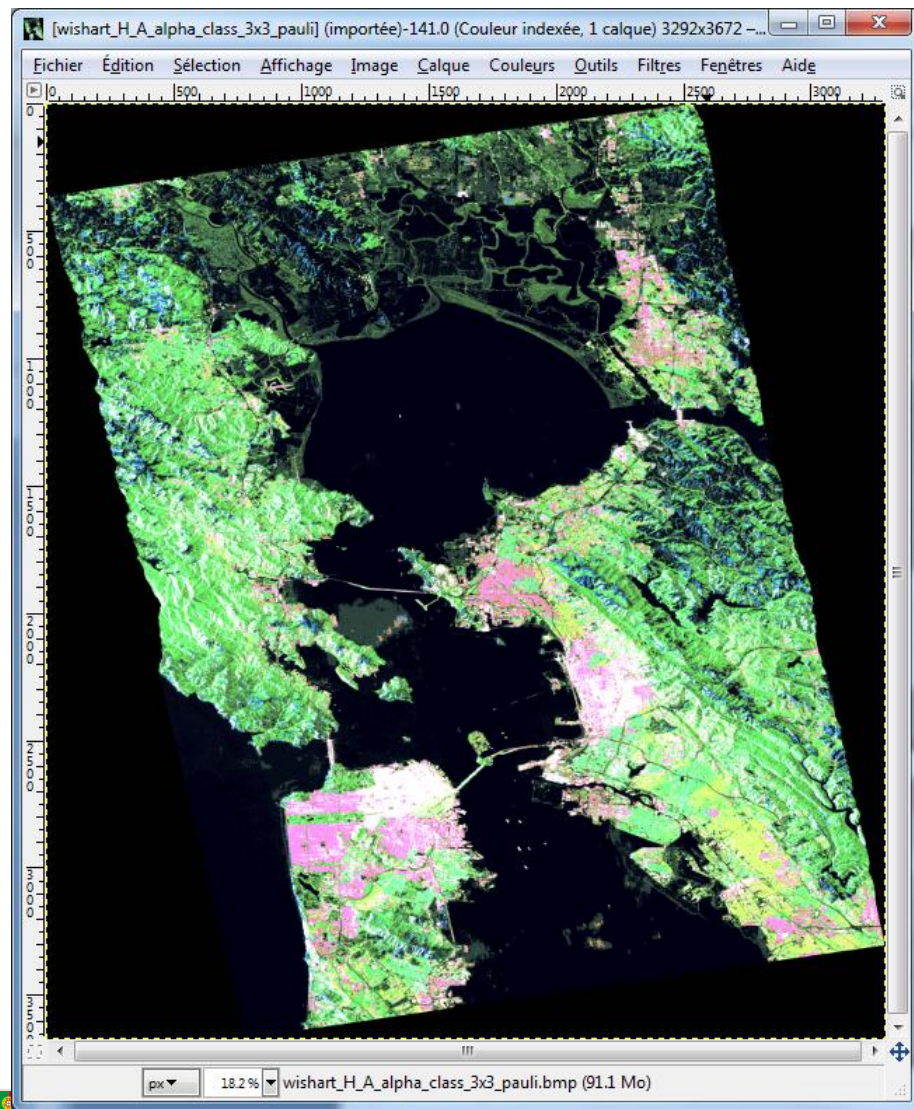
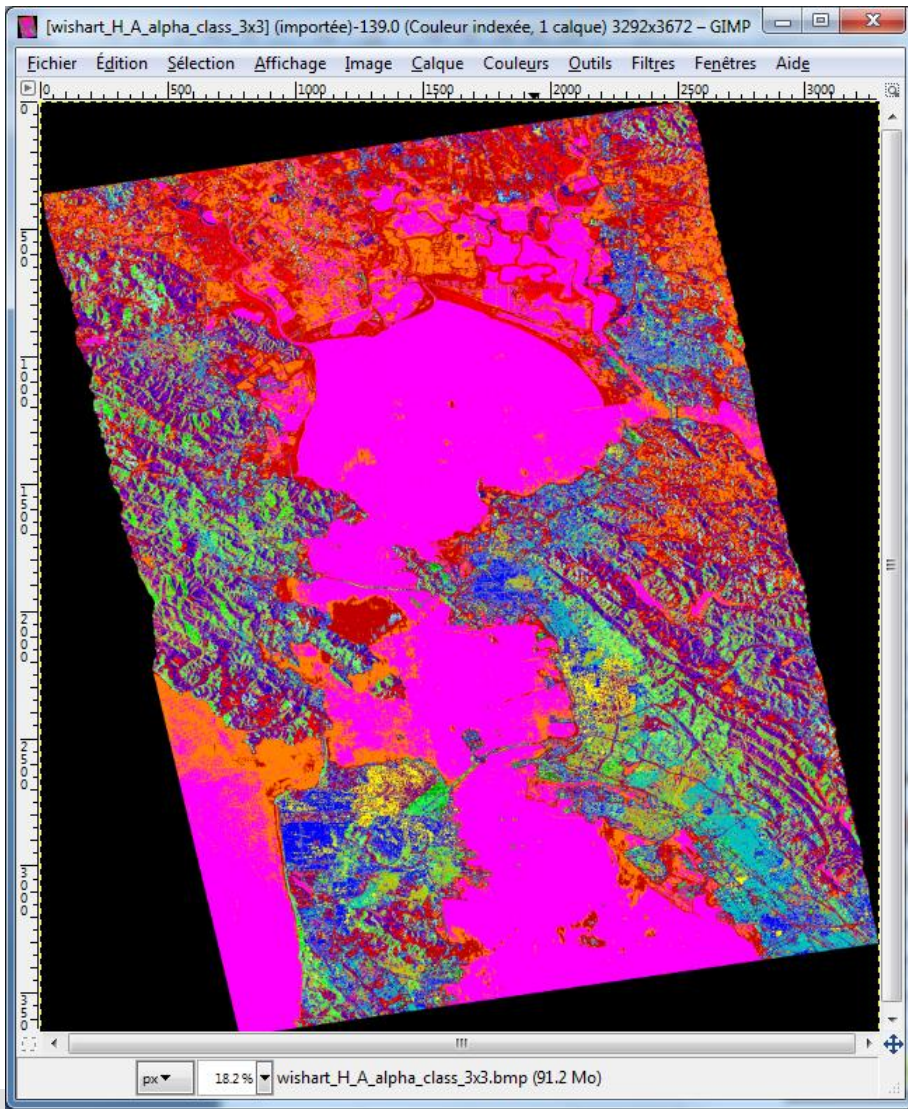
ESA UNCLASSIFIED - For Official Use

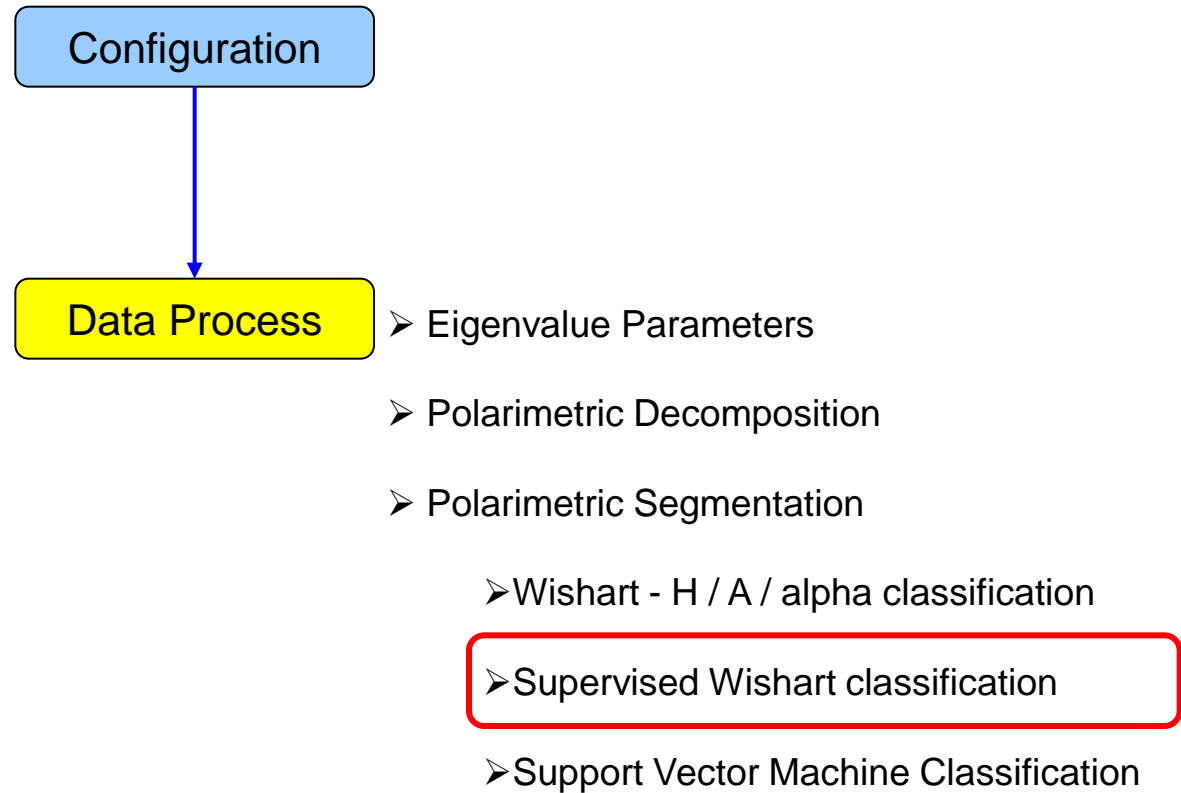


WISHART - H/A/alpha CLASSIFICATION



WISHART - H/A/alpha CLASSIFICATION





PolSARpro v5.1 SOFTWARE



PolSARpro v5.1 - Menu

esa PolSARpro
The Polarimetric SAR Data Processing and Educational Tool

Environment Import Convert **Process** Display Calibration Utilities Tools Configuration Education Help

Linear (+45 / -45)
Circular (L / R)
Elliptical (phi, tau)

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Box Car - Edge Filter
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Gaussian Filter
IDAN Filter
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J.S. Lee Sigma Filter
P.W.F Filter
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H / A / Alpha - Wishart Classification
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Unified Huynen Classification
Fuzzy - H / Alpha Classification
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G.P.F. Supervised Classification
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Basic Scattering Mechanism Identification
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Reflectivity Ratio
Differential Reflectivity (ZDR)

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FRE3 : Freeman 3 Components Decomposition
VZ3 : Van Zyl 3 Components Decomposition
YAM3 : Yamaguchi 3 Components Decomposition
YAM4 : Yamaguchi 4 Components Decomposition
NEU : Neumann 2 Components Decomposition
KRO : Krogager Decomposition
CAM : Cameron Decomposition
TSVM : Touzi Decomposition

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Polarimetric Signature
Stokes Parameters
Compact Polarimetric Mode
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R.C.S Max
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RVOG PolSAR Inversion
Sub-Aperture Analysis
DEM Estimation
Polarisation Orientation Compensation

Clustering Process
Parameter Averaging
Data Sets Averaging

Decomposition Applications

Close Window Display Menu
Close Window Tools Menu

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European Space Agency
E.P (2017)

SUPERVISED CLASSIFICATION



PolSARpro v5.1 - Menu

esa PolSARpro
The Polarimetric SAR Data Processing and Educational Tool

T3 5 Environment Import Convert Process Display Calibration Utilities Tools Configuration Education Help Quit

Data Processing: Wishart Supervised Classification

Input Directory: D:/SAN_FRANCISCO_ALOS2_SNAP/T3

Output Directory: D:/SAN_FRANCISCO_ALOS2_SNAP / T3

Init Row: 1 End Row: 3672 Init Col: 1 End Col: 3292

Classification Configuration

BMP Reject Class Confusion Matrix

Window Size: Row 3 Col 3 Reject Ratio 0.0 CM Editor CMR Editor

Color Maps

ColorMap 16: C:/Users/epottier/AppData/Roaming/PolSARpro_5.1.0/ColorMap/Superv Edit

Coded Colormap

Pauli |S11+S22| |S12+S21| |S11-S22|

Sinclair |S11| |(S12+S21)/2| |S22|

Training Areas

Areas File: D:/SAN_FRANCISCO_ALOS2_SNAP/T3/2017_01_18_17_51_39_wishart_training_ Graphic Editor Run Training Process

Set File: D:/SAN_FRANCISCO_ALOS2_SNAP/T3/wishart_training_cluster_centers.bin

Run [Info] Exit

PolSARpro Run Trace

Close Window Display Menu
Close Window Tools Menu

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SUPERVISED CLASSIFICATION



Step 1 :

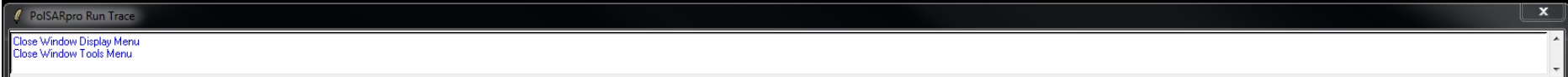
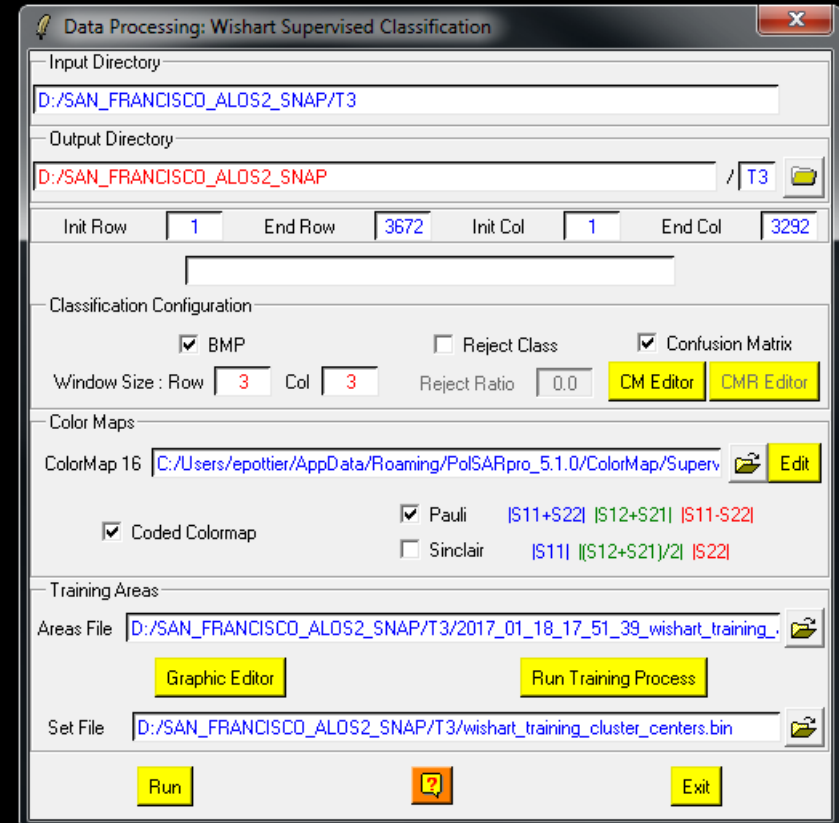
Open Graphic Editor to define graphically the Areas of Interest (AoI) or upload an existing Training Areas text file

Step 2 :

Run Training Process. This program will define the training clusters centres from the selected Areas of Interest (AoI).

Step 3 :

Run the Wishart Supervised Classification procedure



SUPERVISED CLASSIFICATION



PolSARpro v5.1 - Menu

esa PolSARpro
The Polarimetric SAR Data Processing and Educational Tool

Environment Import Convert Process Display Calibration Utilities Tools Configuration Education Help Quit

MapAlgebra v1.1

-1- lambda_db.bmp (3292x3672)

zoom : 23 % Class Num : 7 pixel : 2957 0
value = -17.94 < -10.53 < -2.88

Data Processing: Wishart Supervised Classification

Input Directory: D:/SAN_FRANCISCO_ALOS2_SNAP/T3

Output Directory: D:/SAN_FRANCISCO_ALOS2_SNAP / T3

Init Row: 1 End Row: 3672 Init Col: 1 End Col: 3292

Classification Configuration

BMP Reject Class Confusion Matrix

Window Size: Row 3 Col 3 Reject Ratio 0.0 CM Editor CMR Editor

Color Maps

ColorMap 16 C:/Users/epottier/AppData/Roaming/PolSARpro_5.1.0/ColorMap/Superv Edit

Coded Colormap Pauli |S11+S22| |S12+S21| |S11-S22|
 Sinclair |S11| (|S12+S21|)/2 |S22|

Training Areas

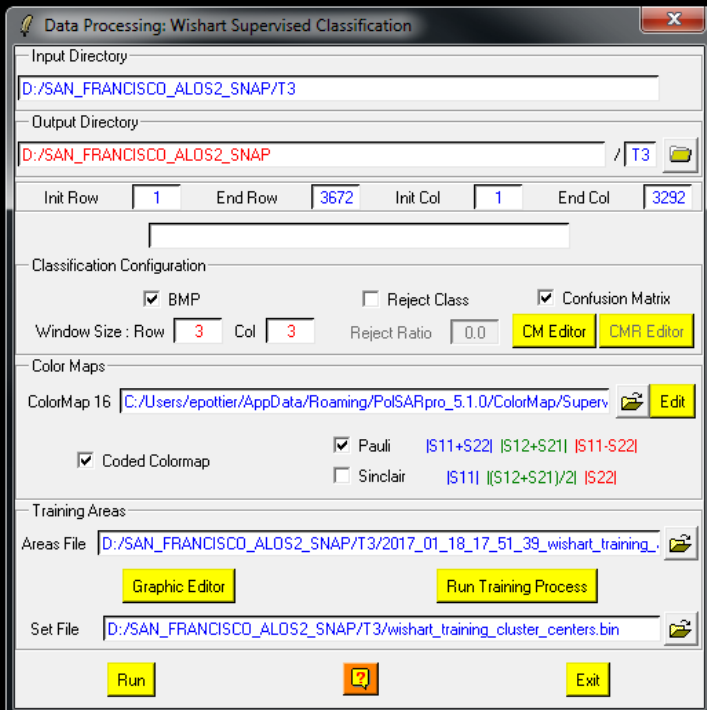
Areas File: D:/SAN_FRANCISCO_ALOS2_SNAP/T3/2017_01_18_17_51_39_wishart_training_ Graphic Editor Run Training Process

Set File: D:/SAN_FRANCISCO_ALOS2_SNAP/T3/wishart_training_cluster_centers.bin

Run Exit



SUPERVISED CLASSIFICATION



Do it Yourself:
Set the parameters, select different classes, run and view the corresponding BMP files.

DATADIR

- config.txt
- [T3x3] Elements

Run Training Process ← **Training_areas.txt**

- Training_areas.bin
- Training_cluster_set.bmp

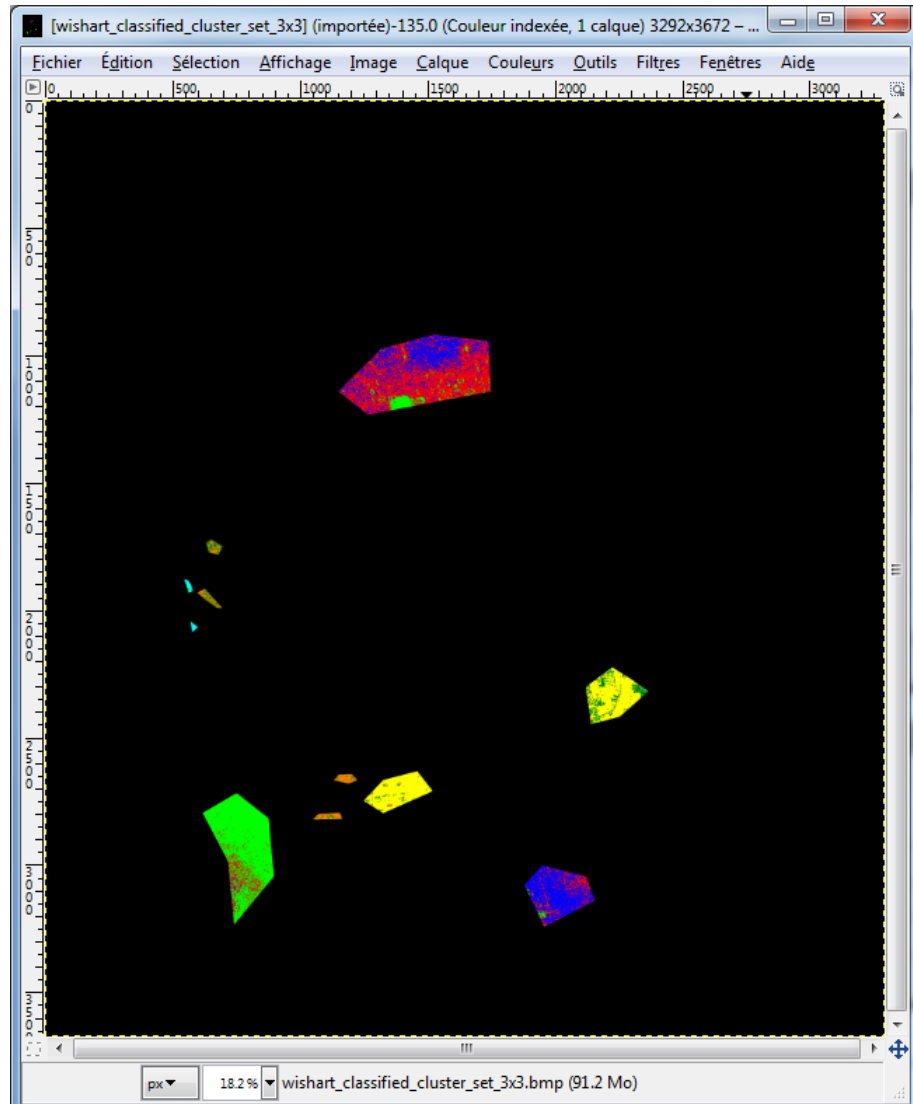
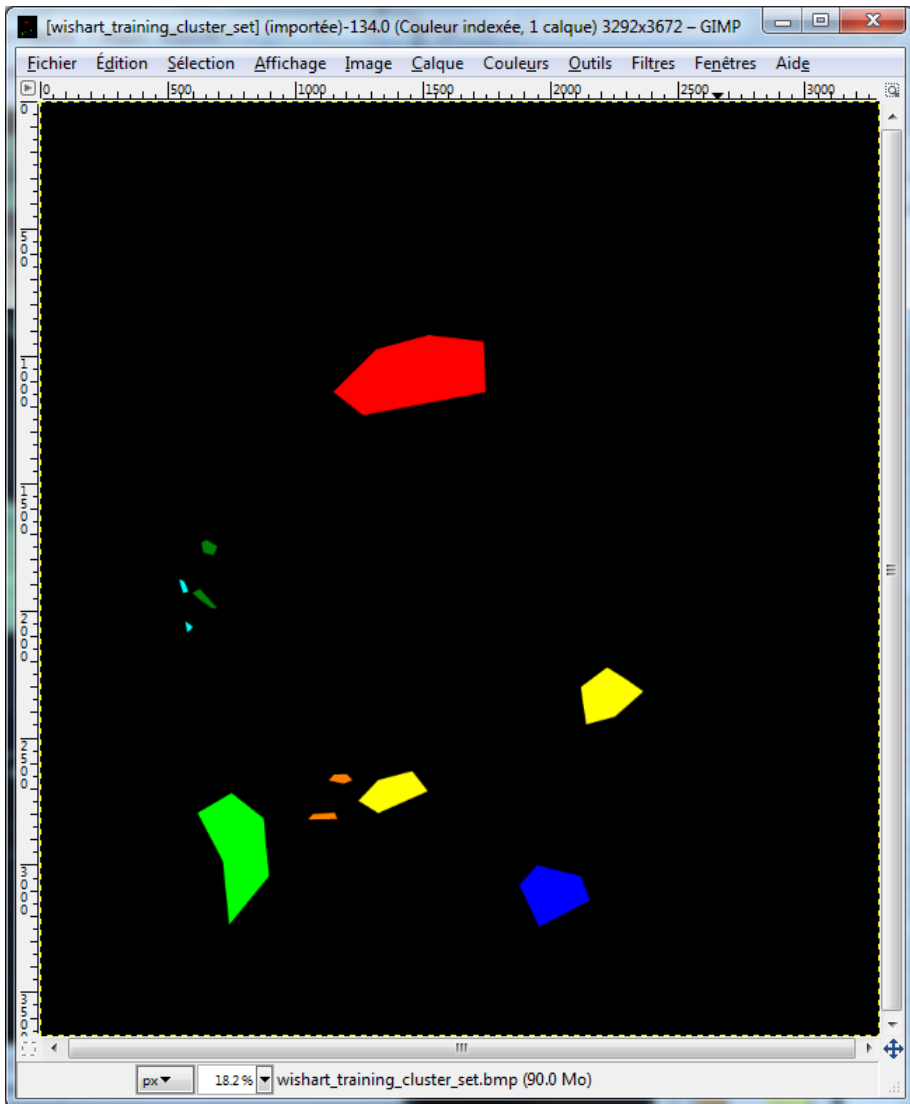
Run Classification

- Supervised_class_X.bin
- Supervised_class_rej_X.bin
- Confusion_matrix_X.txt
- Confusion_matrix_rej_X.txt
- Supervised_class_X.bmp
- Supervised_class_rej_X.bmp
- Classified_cluster_set.bmp
- Classified_cluster_set_rej.bmp

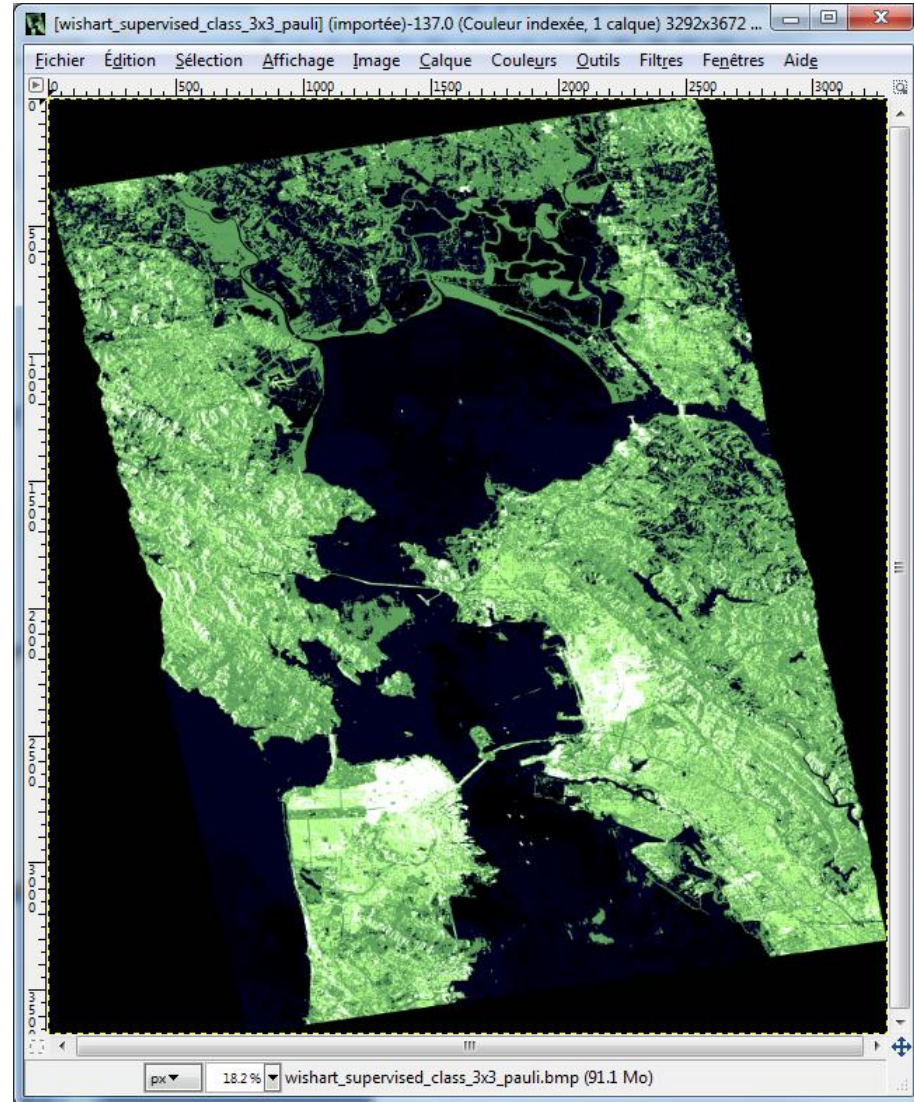
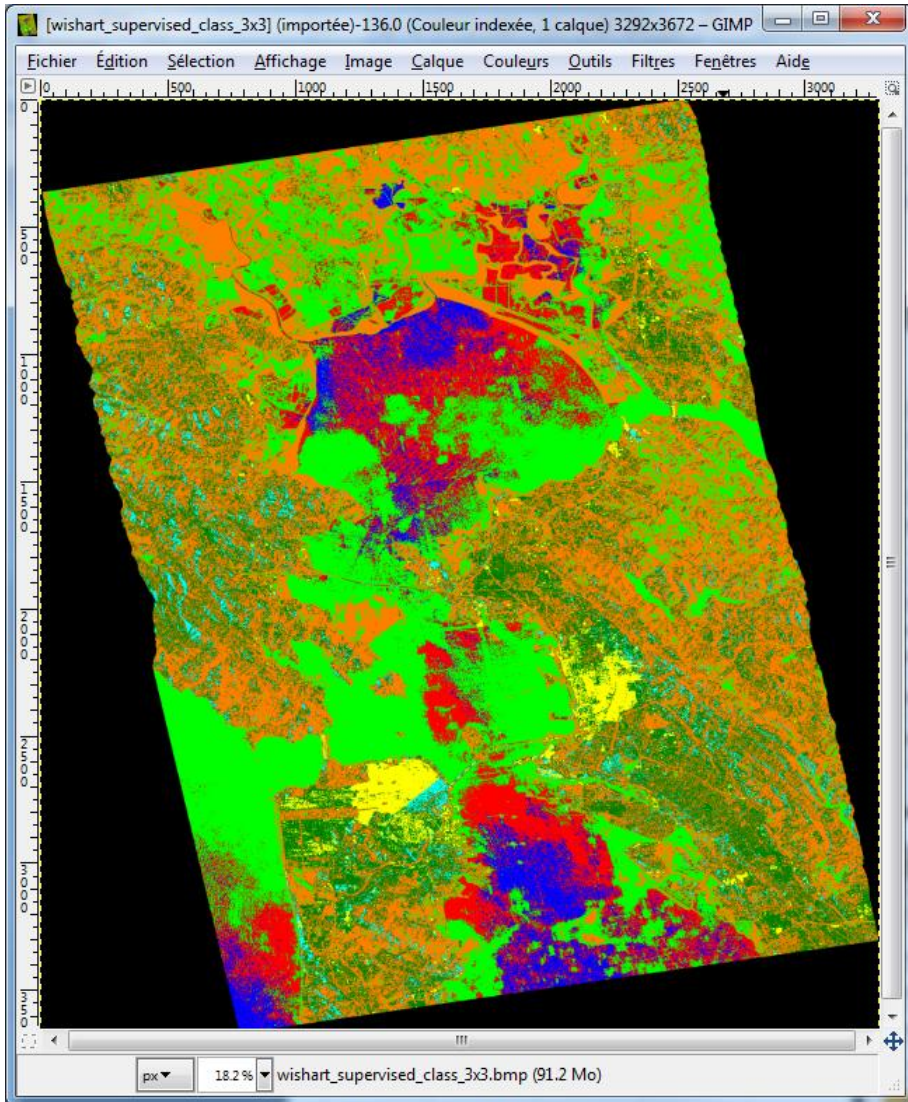
X = window size



SUPERVISED CLASSIFICATION



SUPERVISED CLASSIFICATION



SUPERVISED CLASSIFICATION



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Environment Import Convert Process Display Calibration Utilities Tools Configuration Education Help Quit

Data Processing: Wishart Supervised Classification

Input Directory: D:/SAN_FRANCISCO_ALOS2_SNAP/T3

Output Directory: D:/SAN_FRANCISCO_ALOS2_SNAP / T3

Init Row: 1 End Row: 3672 Init Col: 1 End Col: 3292

Classification Configuration

BMP Reject Class Confusion Matrix

Window Size: Row 3 Col 3 Reject Ratio 0.0 CM Editor SMP Editor

Color Maps

ColorMap 16: C:/Users/epottier/AppData/Roaming/PolSARpro_5.1.0/ColorMap/Superv Edit

Coded Colormap Pauli |S11+S22| |S12+S21| |S11-S22|

Sinclair |S11| (|S12+S21|)/2 |S22|

Training Areas

Areas File: D:/SAN_FRANCISCO_ALOS2_SNAP/T3/2017_01_18_17_51_39_wishart_training_ Graphic Editor Run Training Process

Set File: D:/SAN_FRANCISCO_ALOS2_SNAP/T3/wishart_training_cluster_centers.bin

Run ? Exit

D:/SAN_FRANCISCO_ALOS2_SNAP/T3/wishart_confusion_matrix_3x3.txt

CONFUSION MATRIX

Rows represent the user defined clusters
Columns represent the segmented clusters
A number located at a position IJ represents the amount of pixels in percent belonging to the user defined area I that were assigned to cluster J during the supervised classification

	C1	C2	C3	C4	C5	C6	C7
C1	60.03	6.63	33.34	0.00	0.00	0.00	0.00
C2	11.14	87.84	1.03	0.00	0.00	0.00	0.00
C3	23.75	1.95	74.30	0.00	0.00	0.00	0.00
C4	0.00	0.00	0.00	83.76	1.59	13.64	1.01
C5	0.00	0.17	0.00	0.17	80.43	18.84	0.39
C6	0.00	0.00	0.00	0.59	50.11	48.44	0.86
C7	0.00	0.00	0.00	0.00	3.79	14.32	81.88

Class populations

C1	128255
C2	76909
C3	40665
C4	56395
C5	4603
C6	4889
C7	1529

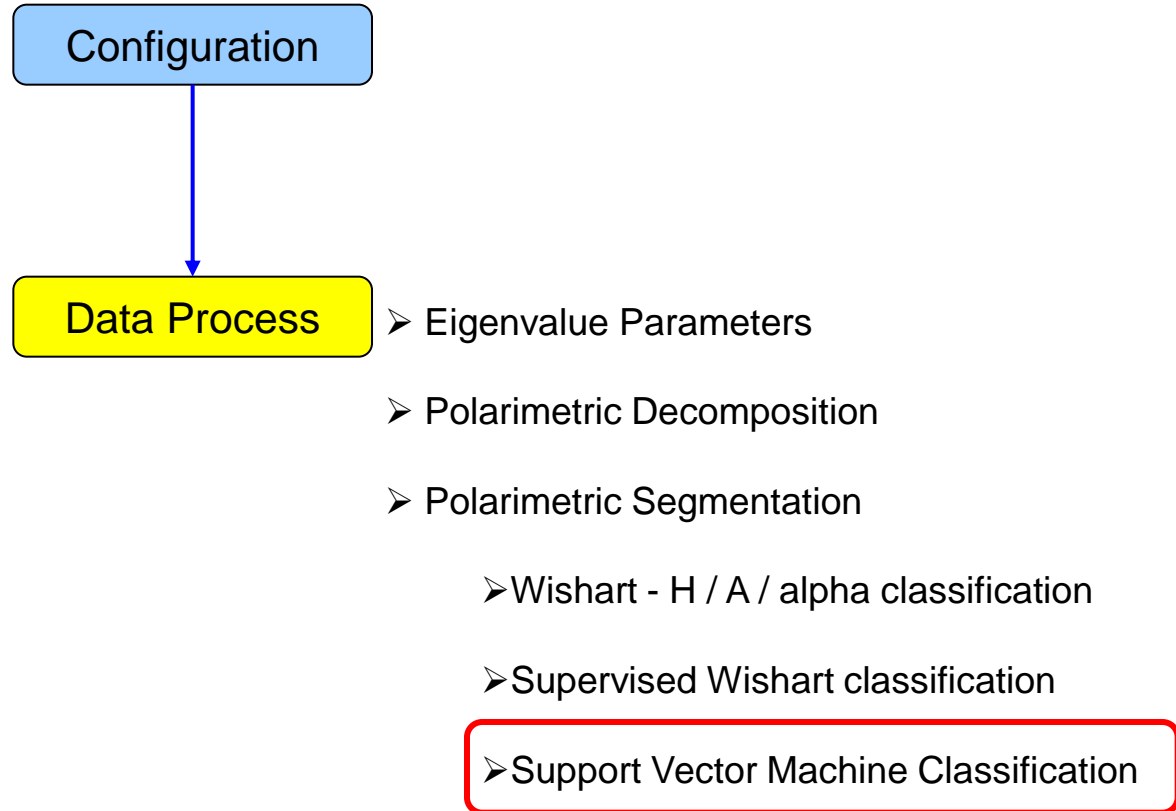
Exit

PolSARpro Run Trace

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Quit

Linear (+45 / -45)
Circular (L / R)
Elliptical (phi, tau)

Box Car Filter
Box Car - Edge Filter
C. Lopez Filter
Gaussian Filter
IDAN Filter
J.S. Lee Refined Filter
J.S. Lee Sigma Filter
P.W.F Filter
Edge Detector

Decomposition Parameters
Eigenvector Set Parameters
Eigenvalue Set Parameters

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Elliptical Basis Change
Polarimetric Speckle Filter
H / A / Alpha Decomposition
Polarimetric Decompositions
Polarimetric Functionalities - 1
Polarimetric Functionalities - 2
Polarimetric Segmentation
Polarimetric Data Analysis
Polarimetric Data Clustering
Batch Process

H / A / Alpha Classification
H / u / v Classification (Xu & Jin)
H / A / Alpha - Wishart Classification
Scattering Model Based - Wishart Classification
Unified Huynen Classification
Fuzzy - H / Alpha Classification
Wishart Supervised Classification
G.P.F. Supervised Classification
Rule-Based Hierarchical Classification
Basic Scattering Mechanism Identification
SVM Supervised Classification

Texture Analysis

Polarized Point Scatterer Detection
Reflectivity Ratio
Differential Reflectivity (ZDR)

JRH : Huynen Decomposition
RMB1 : Barnes 1 Decomposition
RMB2 : Barnes 2 Decomposition
SRC : Cloude Decomposition
WAH1 : Holm 1 Decomposition
WAH2 : Holm 2 Decomposition
HAA : H / A / Alpha Decomposition
FRE2 : Freeman 2 Components Decomposition
FRE3 : Freeman 3 Components Decomposition
VZ3 : Van Zyl 3 Components Decomposition
YAM3 : Yamaguchi 3 Components Decomposition
YAM4 : Yamaguchi 4 Components Decomposition
NEU : Neumann 2 Components Decomposition
KRO : Krogager Decomposition
CAM : Cameron Decomposition
TSVM : Touzi Decomposition

Clustering Process
Parameter Averaging
Data Sets Averaging

Polarisation Synthesis
Polarimetric Signature
Stokes Parameters
Compact Polarimetric Mode
O.P.C.E
R.C.S Max
Surface Inversion
RVOG PolSAR Inversion
Sub-Aperture Analysis
DEM Estimation
Polarisation Orientation Compensation

Decomposition Applications

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SUPPORT VECTOR MACHINE CLASSIFICATION



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T3 Environment Import Convert Process Display Calibration Utilities Tools Configuration Education Help Quit

Data Processing: SVM Supervised Classification

Input Directory: D:/SAN_FRANCISCO_ALOS2_SNAP/T3
Output Directory: D:/SAN_FRANCISCO_ALOS2_SNAP / T3

Init Row: 1 End Row: 3672 Init Col: 1 End Col: 3292

Step 1 - Training Areas
Areas File: Config/svm_training_areas.txt **Graphic Editor**

Step 2 - Classification Configuration
 BMP Confusion Matrix **CM Editor**

Step 3 - Color Maps
ColorMap 16: C:/Users/epottier/AppData/Roaming/PolSARpro_5.1.0/ColorMap/Supervised_ColorMap16.pal **Edit**

Coded Colormap Pauli |S11+S22| |S12+S21| |S11-S22|
 Sinclair |S11| |(S12+S21)/2| |S22|

Step 4 - SVM Parameter Setting
Input Polarimetric Indicators: T3 (Selected) Other **Select**
Sampling option: Training sampling: 500 If important unbalanced training point
Output SVM parameters: Class Probability BMP Mean Hyperplane Distance BMP Useful but time consuming

Step 5 - Kernel Parameter
Cost: 100 RBF (Selected) **RECOMMENDED** Gamma = 1/sigma: 0.44444
Optimisation parameters: **Setup and Run**
Polynomial: Degree: Linear:

Step 6 - Run Classification **Exit**

PolSARpro Run Trace
Close Window Display Menu
Close Window Tools Menu

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SUPPORT VECTOR MACHINE CLASSIFICATION



The screenshot displays the PolSARpro software interface for SVM supervised classification. The main window is titled "Data Processing: SVM Supervised Classification" and includes a menu bar with options like Environment, Import, Convert, Process, Display, Calibration, Utilities, Tools, Configuration, Education, Help, and Quit. The interface is divided into several steps:

- Step 1 - Training Areas:** Input Directory is `D:/SAN_FRANCISCO_ALOS2_SNAP/T3` and Output Directory is `D:/SAN_FRANCISCO_ALOS2_SNAP`. The Areas File is `Config/svm_training_areas.txt`.
- Step 2 - Classification Configuration:** Options for BMP and Confusion Matrix are checked.
- Step 3 - Color Maps:** ColorMap 16 is `C:/Users/epottier/AppData/Roaming/PolSARpro_5.1.0/ColorMap/Supervised_ColorMap16.pal`. The Coded Colormap and Pauli options are checked.
- Step 4 - SVM Parameter Setting:** Input Polarimetric Indicators is set to T3. Sampling option includes Training sampling (500). Output SVM parameters include Class Probability, Mean Hyperplane Distance, and BMP.
- Step 5 - Kernel Parameter:** RBF kernel is selected. Cost is 100 and Gamma is 0.4444. The "RECOMMENDED" checkbox is checked, and the "Optimisation parameters Setup and Run" button is highlighted. A blue arrow points from this button to the "SVM RBF Kernel Parameters Optimisation" dialog.
- Step 6 - Run Classification:** The "Step 6 - Run Classification" button is highlighted.

The "SVM RBF Kernel Parameters Optimisation (Cross Validation) (Ne répond pas)" dialog shows the following parameters:

Log2(C)	C	Log2(G)	G
Min: 8	256.0	Min: -5	0.03125
Max: 14	16384.0	Max: 0	1.0
Step: 2		Step: 1	

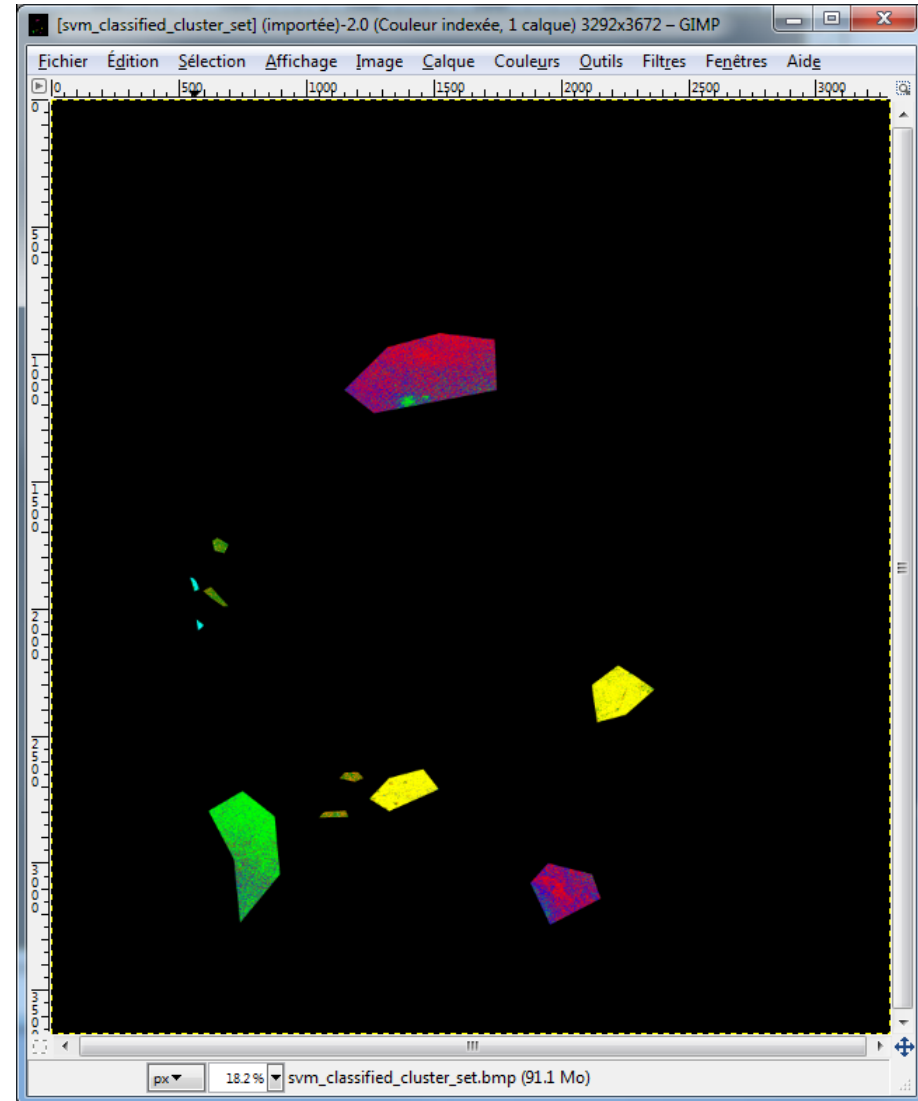
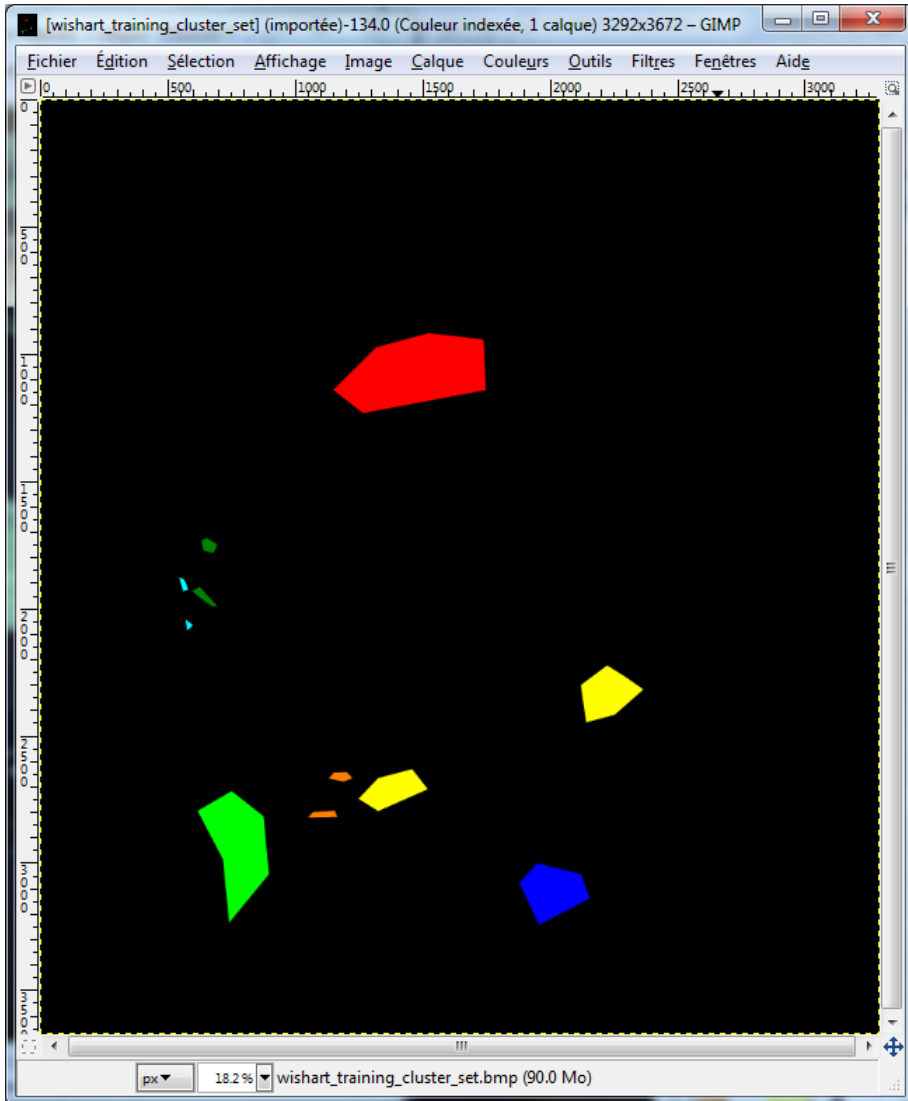
The dialog also features a contour plot of ISO Accuracy (93.5%, 93.0%, 92.5%, 91.5%, 91.0%) against $\log_2(\gamma)$ and $\log_2(C)$. A "Run RBF Kernel Parameters Optimisation" button is highlighted, and the "One best couple (C,G)" section shows C and G values.

A red circle highlights a timer icon and the text "50mn", indicating the duration of the optimization process.

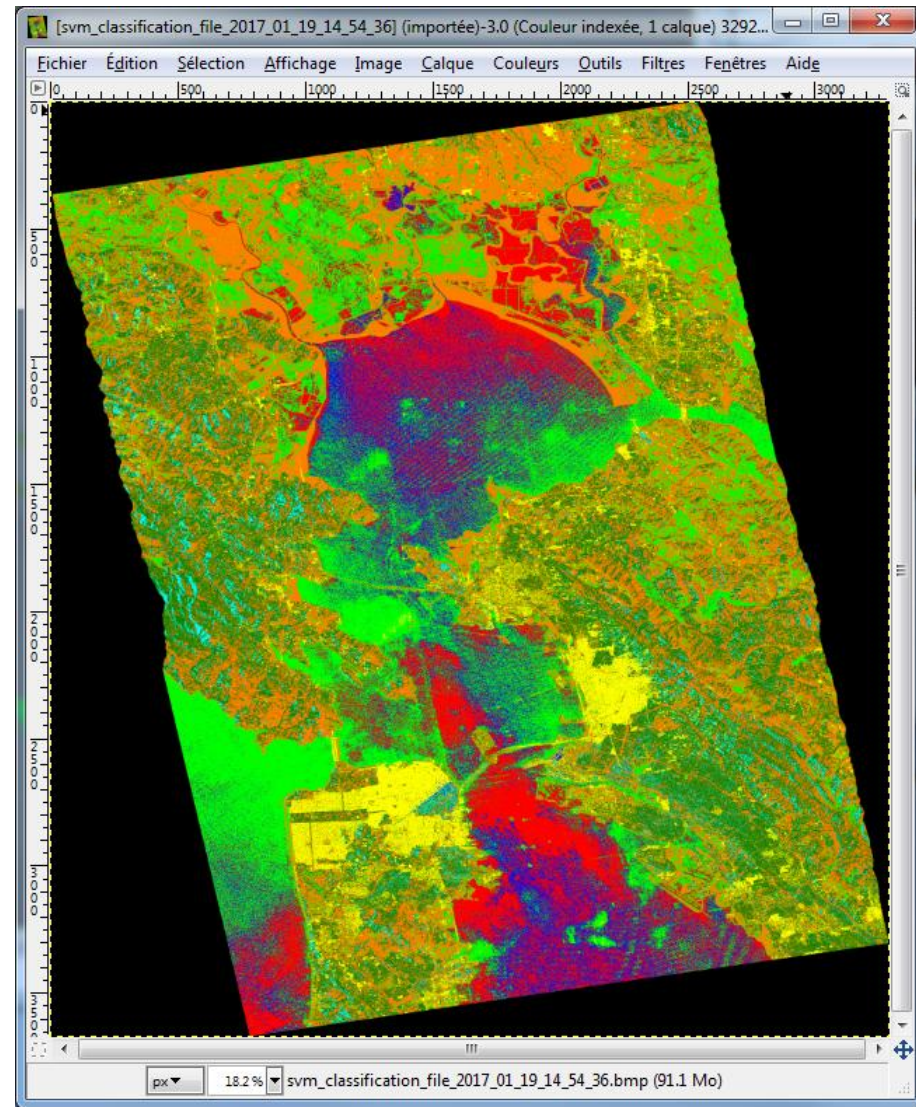
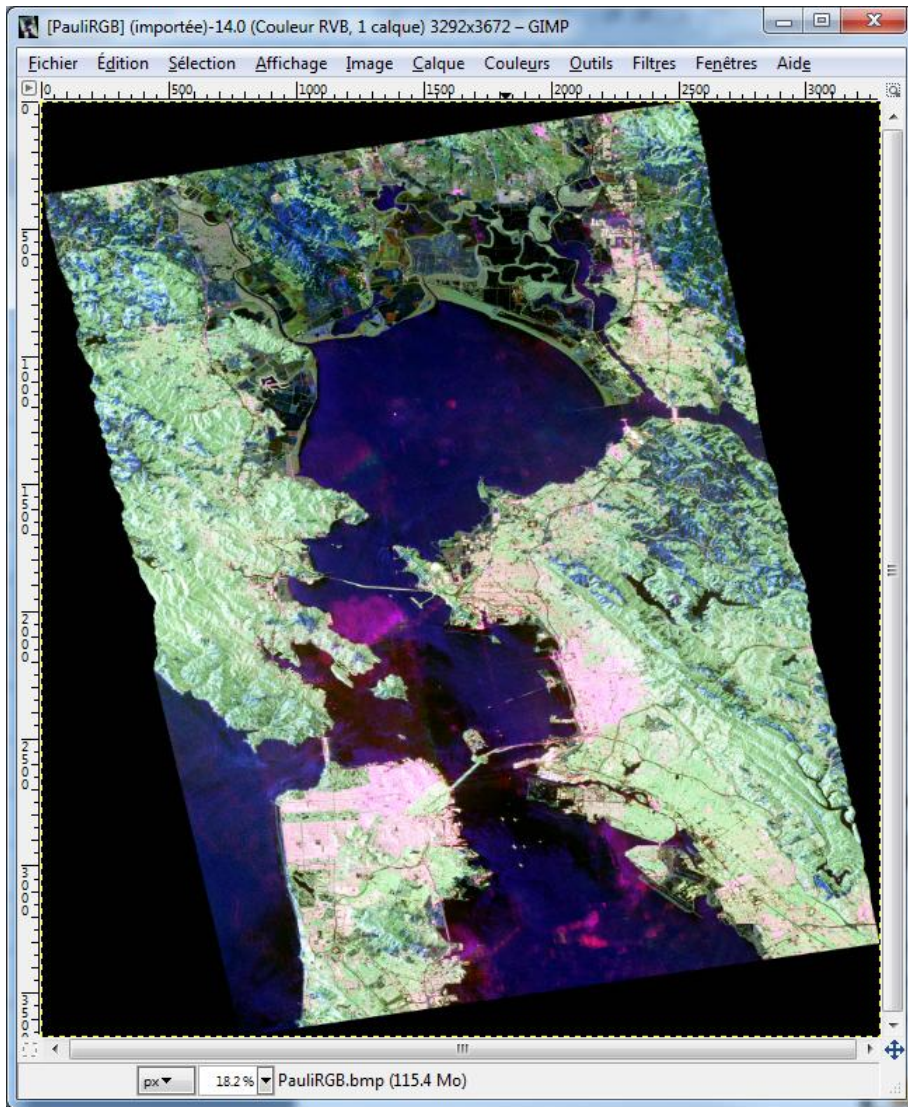
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PolSARpro The Polarimetric SAR Data Processing and Educational Tool

T3 Environment Import Convert Process Display Calibration Utilities Tools Configuration Education Help Quit

Data Processing: SVM Supervised Classification

Input Directory:

Output Directory: / T3

Init Row: End Row: Init Col: End Col:

Step 1 - Training Areas
Areas File: Graphic Editor

Step 2 - Classification Configuration
 BMP Confusion Matrix CM Editor

Step 3 - Color Maps
ColorMap 16: Edit

Coded Colormap Pauli |S11+S22 |S12+S21 |S11-S22
 Sinclair |S11 |(S12+S21)/2 |S22

Step 4 - SVM Parameter Setting
Input Polarimetric Indicators: T3 Other Select
Sampling option: Training sampling If important unbalanced training point
Output SVM parameters: Class Probability BMP Mean Hyperplane Distance BMP
Useful but time consuming

Step 5 - Kernel Parameter
Cost: Gamma = 1/sigma: RECOMMENDED Polynomial Linear
Optimisation parameters: Setup and Run

Step 6 - Run Classification Exit

D:/SAN_FRANCISCO_ALOS2_SNAP/T3/svm_confusion_matrix_2017_01_19_14_5...

Wrap Text Mode Exit

CONFUSION MATRIX

Rows represent the user defined clusters
Columns represent the segmented clusters
A number located at a position IJ represents the amount of pixels in percent belonging to the user defined area I that were assigned to cluster J during the supervised classification

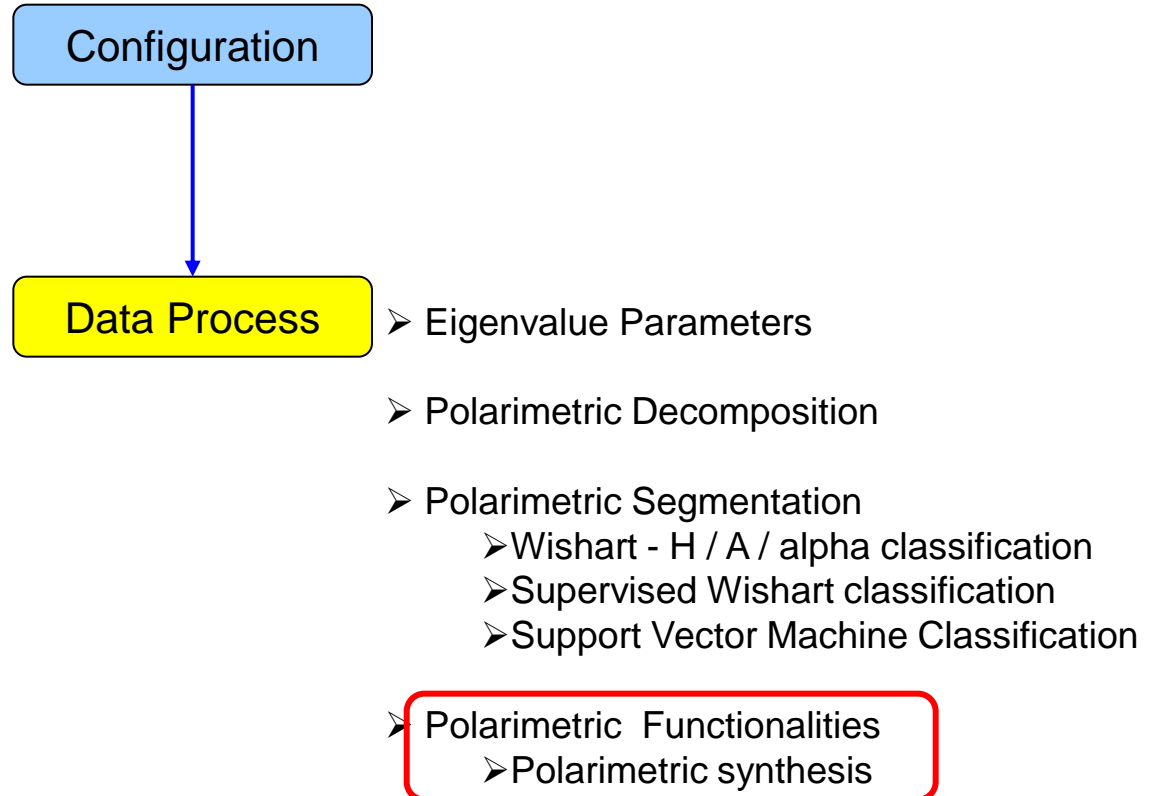
	C1	C2	C3	C4	C5	C6	C7
C1	55.41	10.00	34.59	0.00	0.00	0.00	0.00
C2	8.40	76.77	14.82	0.00	0.01	0.00	0.00
C3	50.70	7.10	42.20	0.00	0.00	0.00	0.00
C4	0.00	0.20	0.78	91.44	2.38	4.77	0.43
C5	0.00	0.78	0.00	1.24	49.19	46.90	1.89
C6	0.00	0.00	0.04	3.19	26.41	67.07	3.29
C7	0.00	0.00	0.00	0.46	1.50	17.46	80.58

Class populations

C1	128254
C2	76909
C3	40665
C4	56395
C5	4603
C6	4889
C7	1529

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Linear (+45 / -45)
Circular (L / R)
Elliptical (phi, tau)

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Box Car - Edge Filter
C. Lopez Filter
Gaussian Filter
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J.S. Lee Refined Filter
J.S. Lee Sigma Filter
P.W.F Filter
Edge Detector

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Eigenvector Set Parameters
Eigenvalue Set Parameters

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RMB2 : Barnes 2 Decomposition
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YAM3 : Yamaguchi 3 Components Decomposition
YAM4 : Yamaguchi 4 Components Decomposition
NEU : Neumann 2 Components Decomposition
KRO : Krogager Decomposition
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TSVM : Touzi Decomposition

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H / A / Alpha - Wishart Classification
Fuzzy - H / Alpha Classification
Wishart Supervised Classification
Rule-Based Hierarchical Classification
Basic Scattering Mechanism Identification
SVM Supervised Classification

Faraday Rotation Estimation
Conformity Coefficient
Scattering Predominance
Scattering Diversity
Degree of Purity
Depolarisation Index
Alpha Approximation (Praks & Colin)
Entropy Approximation (Praks & Colin)
Scattering Mechanism Entropy (Freeman)
Scattering Mechanism Entropy (Van Zyl)
Kozlov Anisotropy
Lueneburg Anisotropy
Polarized Point Scatterer Detection
Reflectivity Ratio
Differential Reflectivity (ZDR)

Polarisation Synthesis
Polarimetric Signature
Stokes Parameters
Compact Polarimetric Mode
O.P.C.E
R.C.S Max
Surface Inversion
RVOG PolSAR Inversion
Sub-Aperture Analysis
DEM Estimation
Polarisation Orientation Compensation

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POLARIZATION SYNTHESIS



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The Polarimetric SAR Data Processing and Educational Tool

T3 Environment Import Convert Process Display Calibration Utilities Tools Configuration Education Help Quit

Data Processing: Polarisation Synthesis

Input Directory
D:/SAN_FRANCISCO_ALOS2_SNAP/T3

Output Directory
D:/SAN_FRANCISCO_ALOS2_SNAP / T3

Init Row	End Row	Init Col	End Col
1	3672	1	3292

000 030 045 060 Left
 090 120 135 150 Right

RGB BMP File Pauli Decomposition |S11+S22| |S12+S21| |S11-S22|
 Sinclair Decomposition |S11| |(S12+S21)/2| |S22|

BMP File for each |S11| (dB)

Run Reset Exit

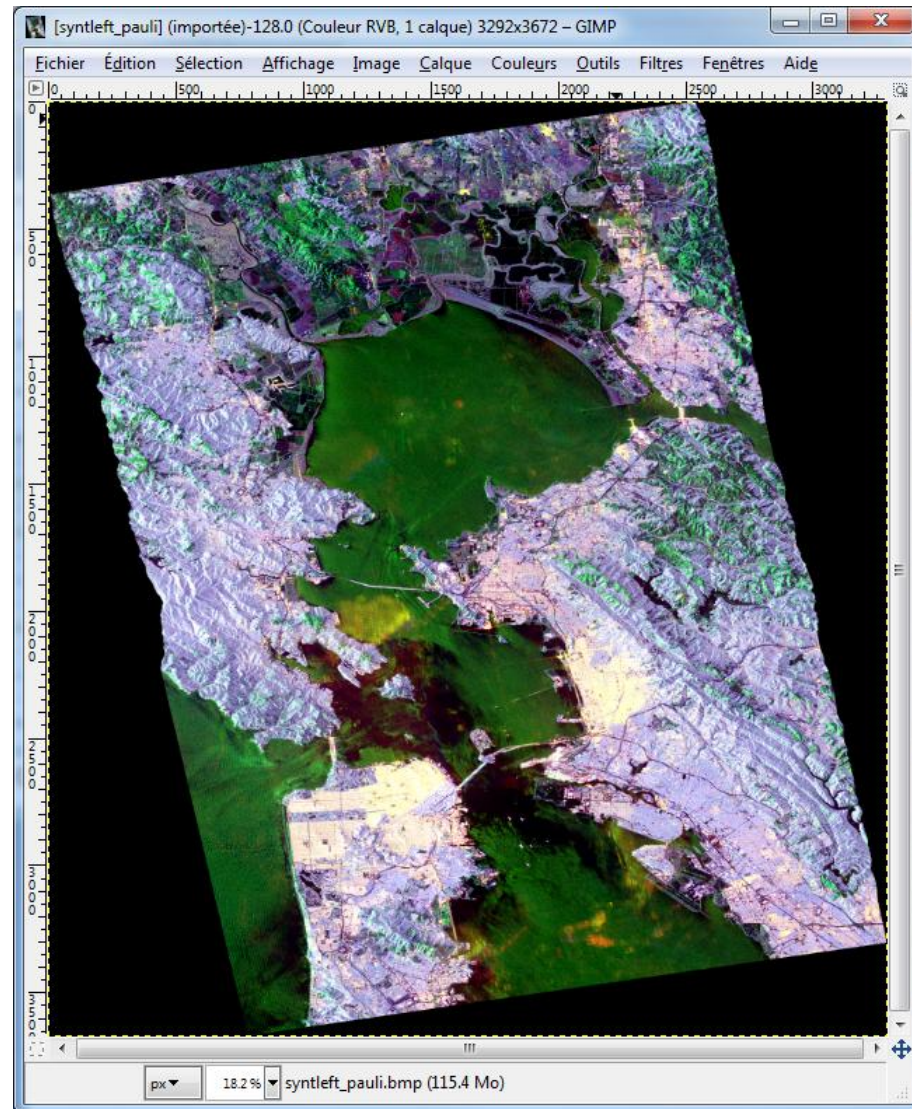
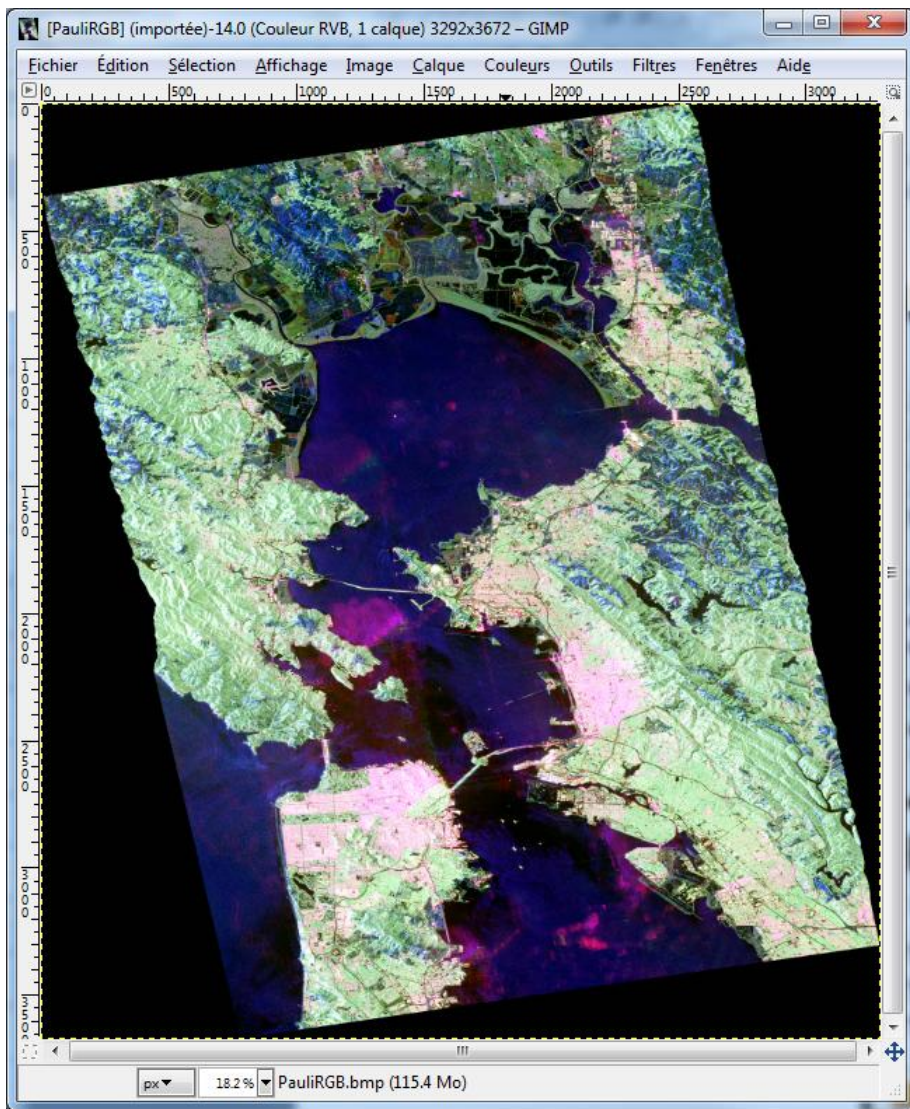
PolSARpro Run Trace

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POLARIZATION SYNTHESIS



Questions ?



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