Introduction to

PolSARpro Toolbox

(Practical Session D2P2)

Eric POTTIER - Laurent FERRO-FAMIL

University of Rennes 1

A Bit Of History

CONTEXT

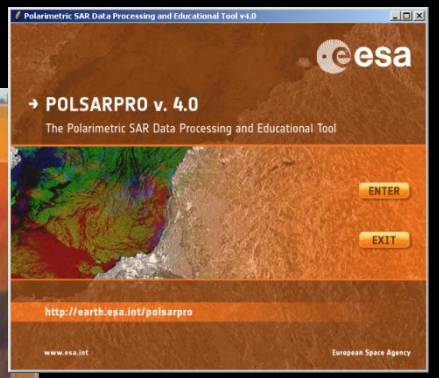
The initiative development of PolSARpro Software is a direct result of recommendations made during the POLinSAR 2003 Workshop held at ESA-ESRIN in January 2003.

2003

2004

2005

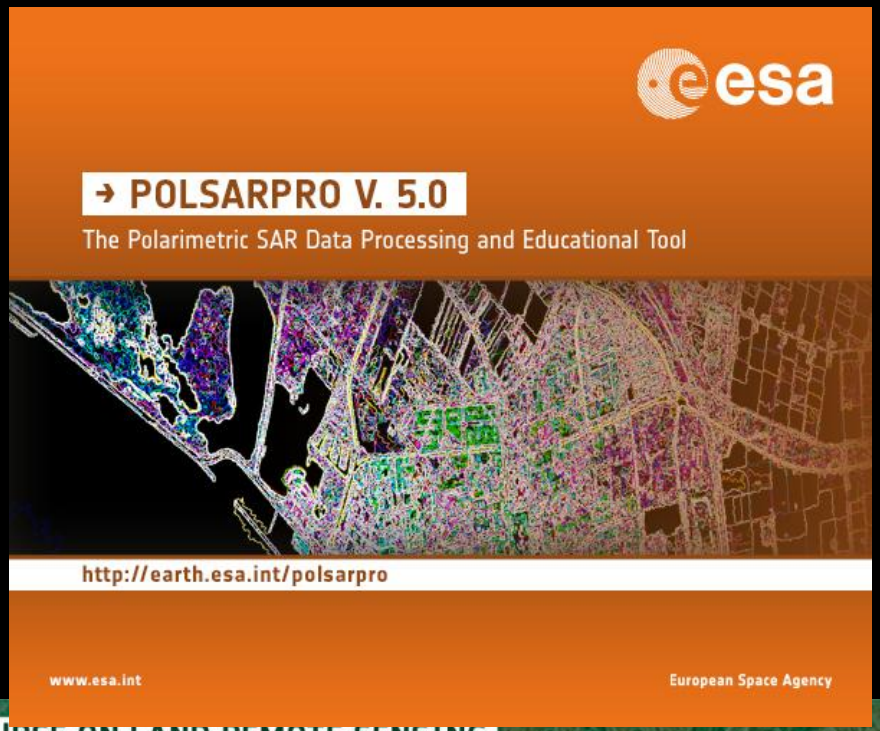
2007



2009

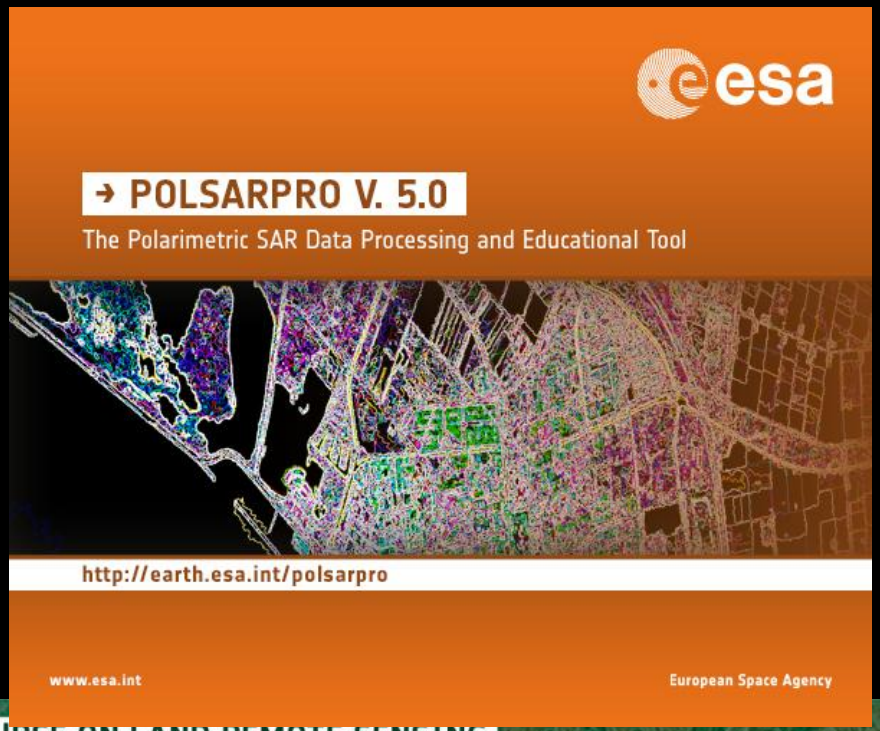
PolSARpro v5.1 SOFTWARE

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



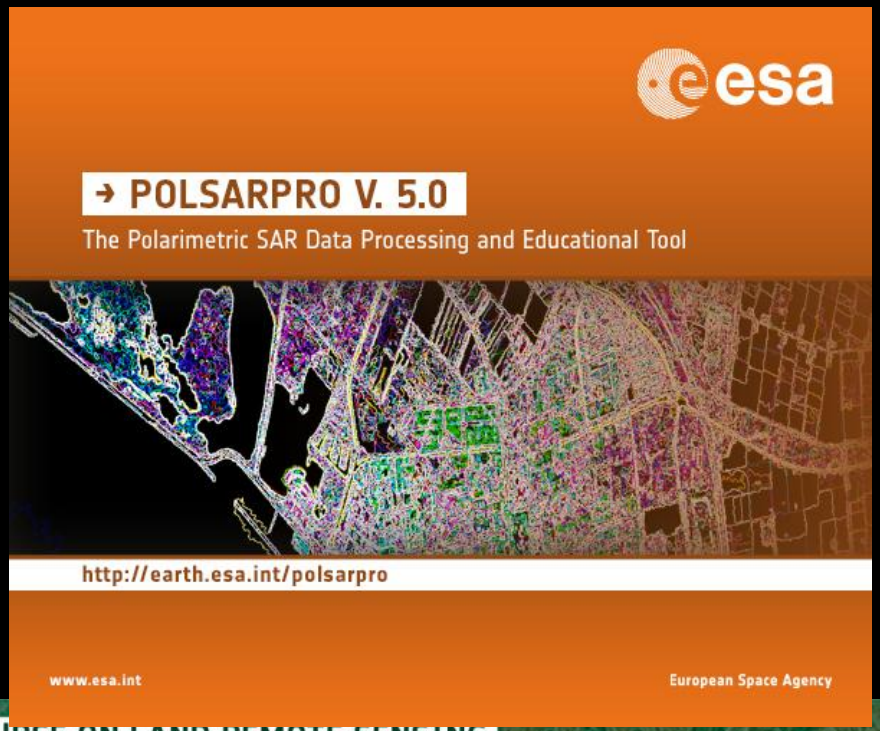
PolSARpro v5.1 SOFTWARE

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



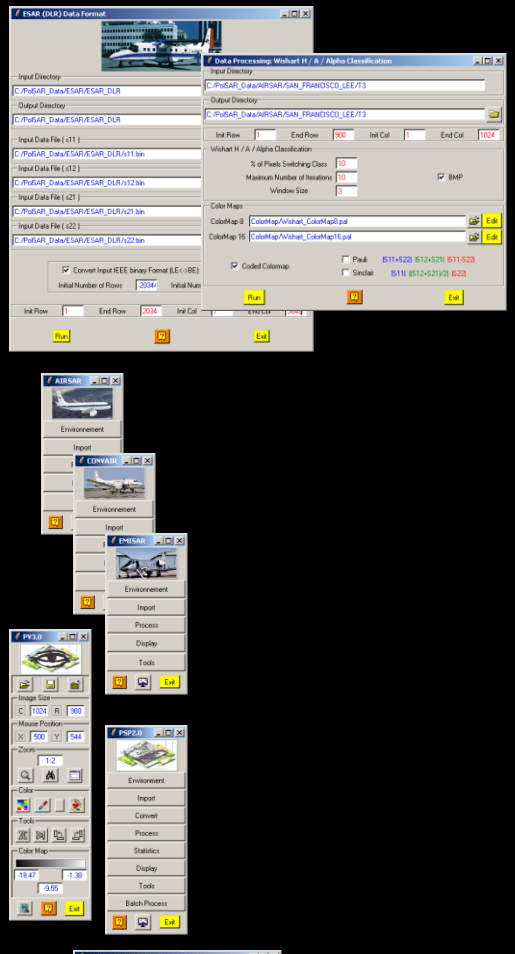
PolSARpro v5.1 SOFTWARE

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

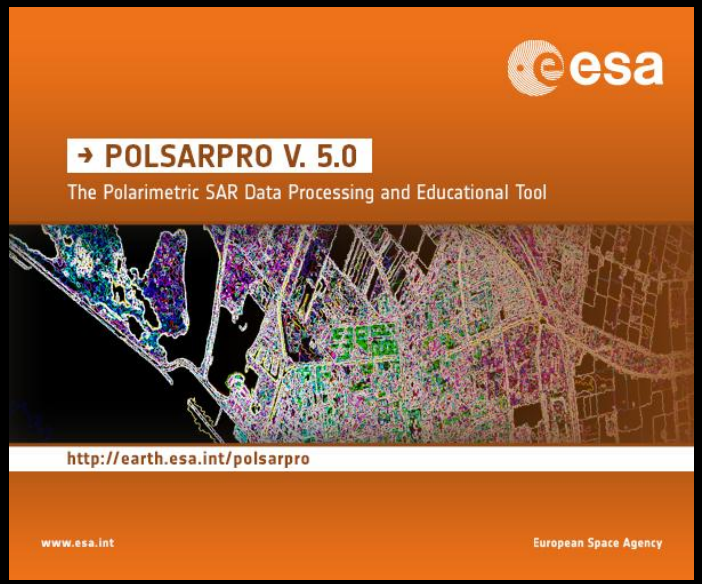


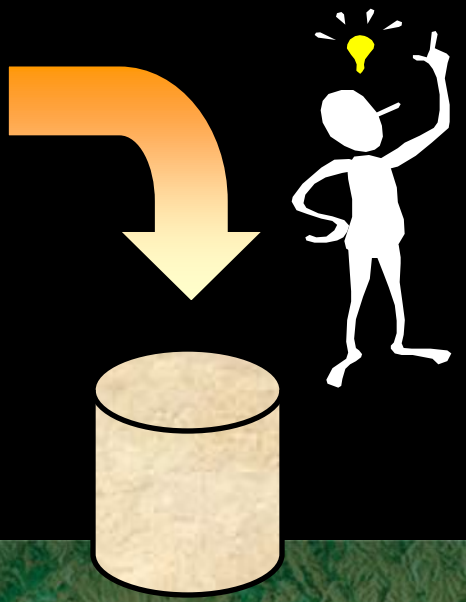
PolSARpro v5.1 SOFTWARE

MODULAR STRUCTURE

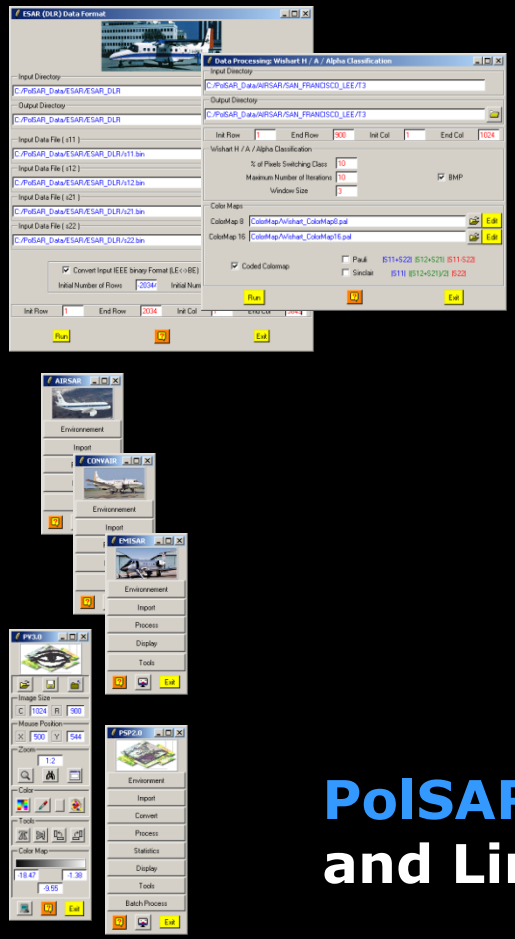


Each element of the Software (a function) can be extracted and incorporated individually into users' own processing software.





PolSARpro v5.1 SOFTWARE



OPEN SOURCE DEVELOPMENT

PolSARpro v5.1 Software is made available following the:

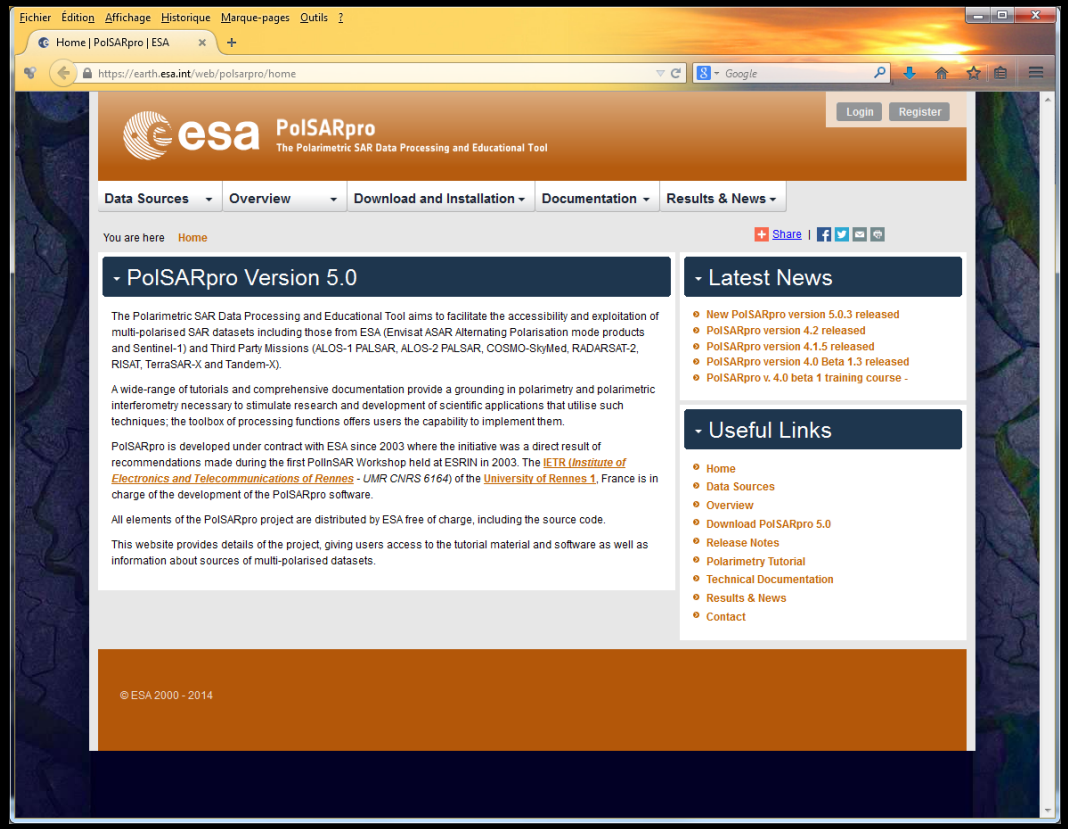
Open Source Software Development (OSSD) approach, and follows the:

GNU General Public License v2 – June 1991.

PolSARpro v5.1 Software runs today on Windows and Linux platforms

PolSARpro v5.1 SOFTWARE

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

New! v5.1 (January 2017)

Team & Contributors

International Collaborative Project

14 Universities

14 Research Centers

4 Space Agencies

Team & Contributors

Tsinghua University China

National Space Science Center, CAS, China

University of Mining and Technology, China

Fudan University, China

Wuhan University, China

Studies in Resources Engineering Indian Institute of Technology

Satellite Surveying and Mapping Application Center, China

Universidade Federal de Alagoas Brazil

Xidian University, China

University of Science and Technology, Poland

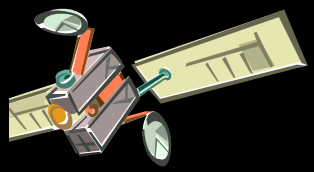
Harbin Institute of Technology China

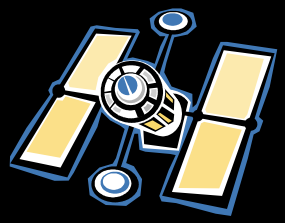
University of Tehran, School of Surveying and Geospatial Engineering, Iran

Key Lab of Microwave Remote Sensing, CAS, China

Khajeh Nasir Toosi University of Technology, Iran

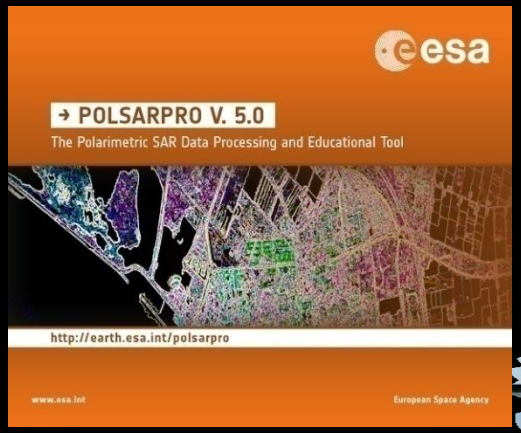
PolSARpro v5.1 SOFTWARE





Dual-Pol / Quad-Pol Sensors

PolSARpro v5.1 SOFTWARE



AIRSAR

SETHI

DCRS

EMISAR

PISAR

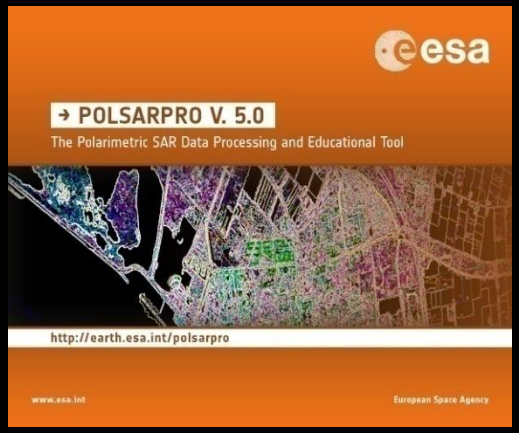
ESAR - FSAR

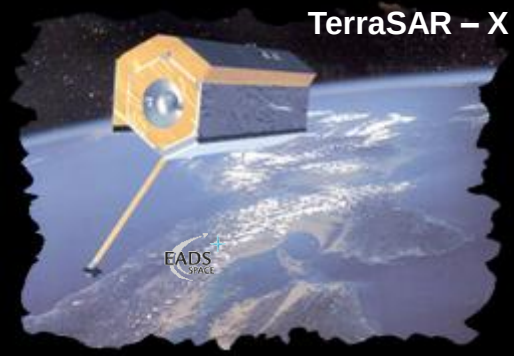
CONVAIR

UAV-SAR

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

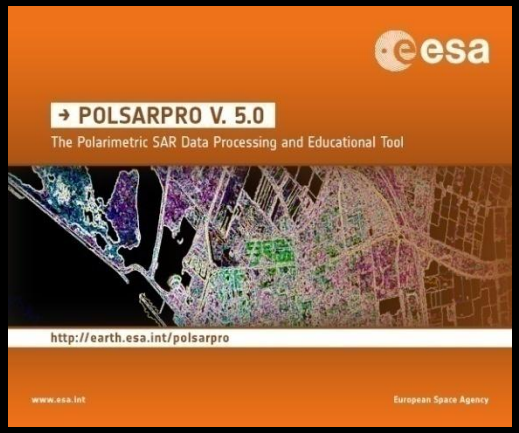
PolSARpro v5.1 SOFTWARE



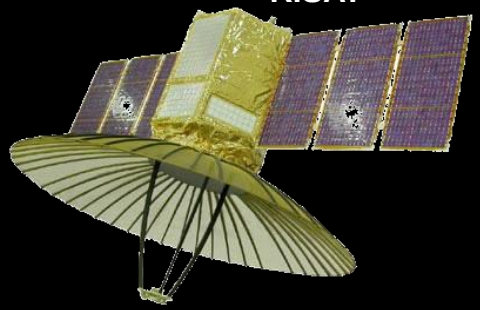


PolSARpro v5.1 Software offers the possibility to handle and convert polarimetric data from a range of well established polarimetric spaceborne platforms.

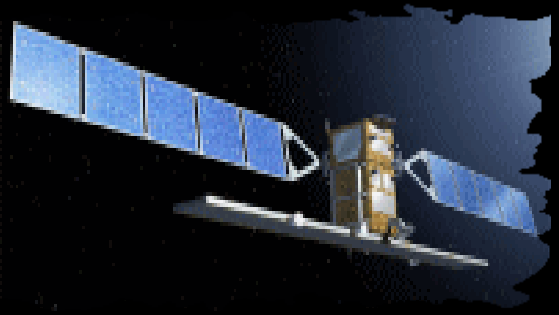
PolSARpro v5.1 SOFTWARE



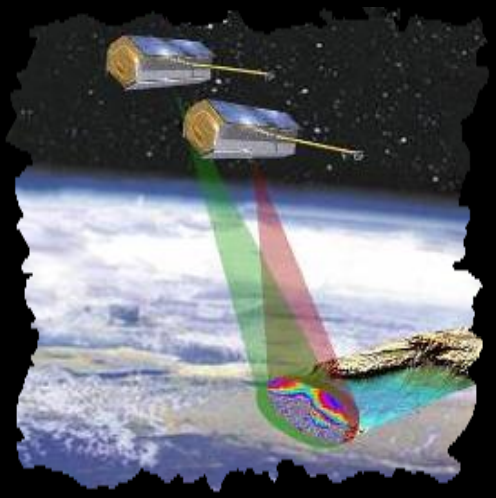
RISAT



SENTINEL 1A

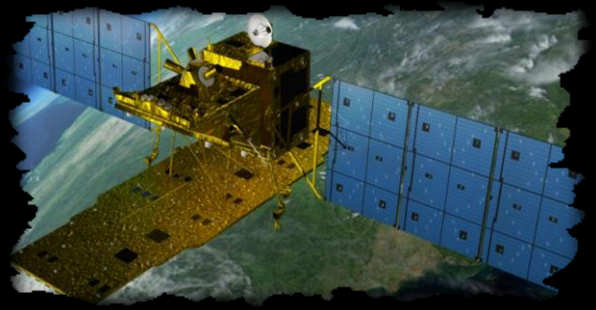


TANDEM-X



COSMO - SKYMED

ALOS-2 – PALSAR

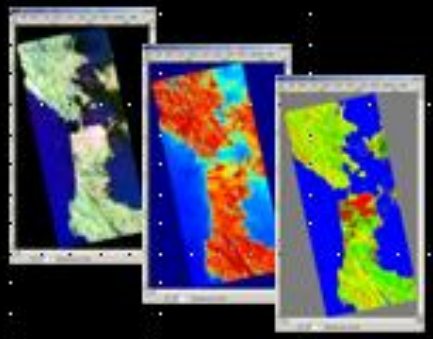


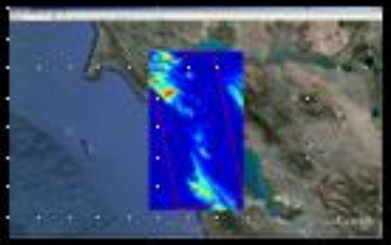
PolSARpro v5.1 Software offers the possibility to handle and convert polarimetric data from a range of well established polarimetric spaceborne platforms.

PolSARpro v5.1 SOFTWARE

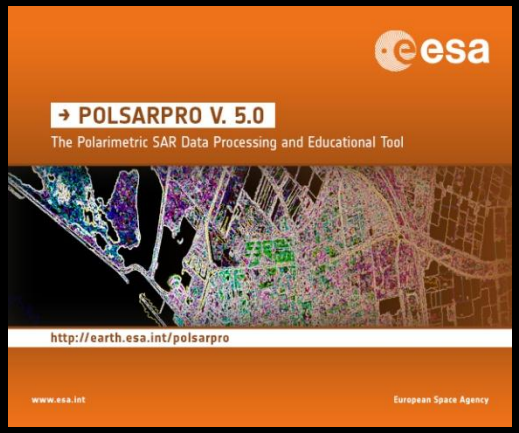
External Softwares

PolSARpro v5.1 SOFTWARE





ESA - SNAP



Polariametric Data Processing

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

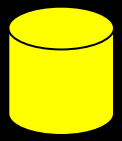
PolSARpro v5.1 SOFTWARE

ESA - SNAP

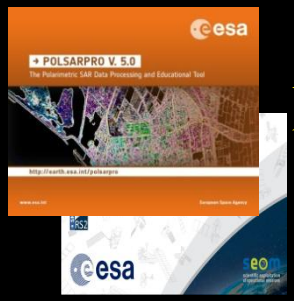
Pre-Processing
Data Extract

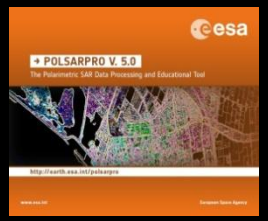
Post-Processing

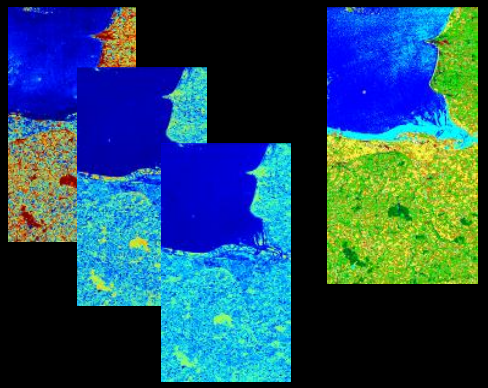
Geo-Coding



POLARIMETRIC DATA SETS

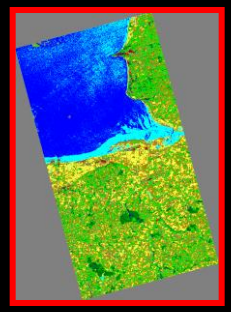






Speckle Filtering
Polar. Decomposition
Unsupervised Segmentation

Terrain Correct
UTM Projection



KML File generation

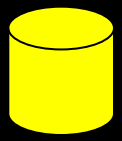
PolSARpro v5.1 SOFTWARE

ESA - SNAP

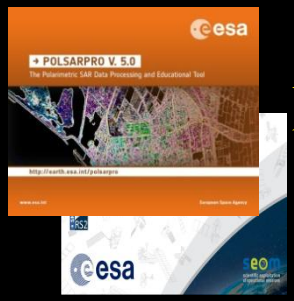
Pre-Processing
Data Extract

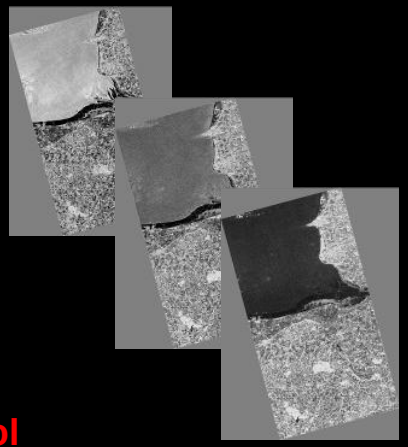
Geo-Coding
Terrain Correct - UTM Proj.

Post - Processing

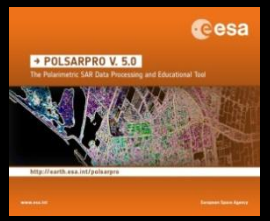


POLARIMETRIC DATA SETS





Only valid for:
[C2] matrix: Dual-Pol
[T3] matrix: Quad-Pol



KML File generation

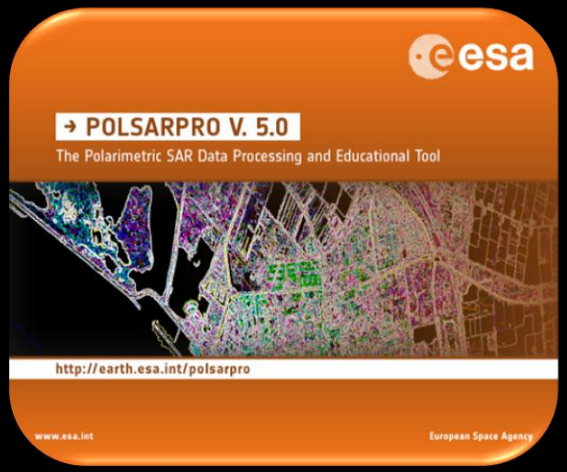
PolSARpro v5.1 SOFTWARE

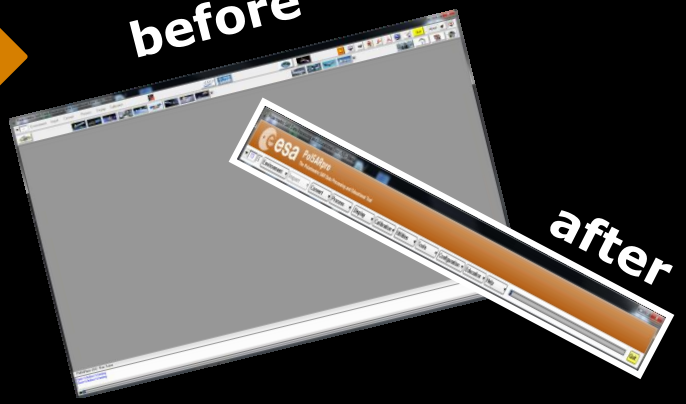
Software – General Presentation

PolSARpro v5.1 SOFTWARE

WHAT IS NEW IN THE VERSION v5.1 ?

PolSARpro v5.1 SOFTWARE

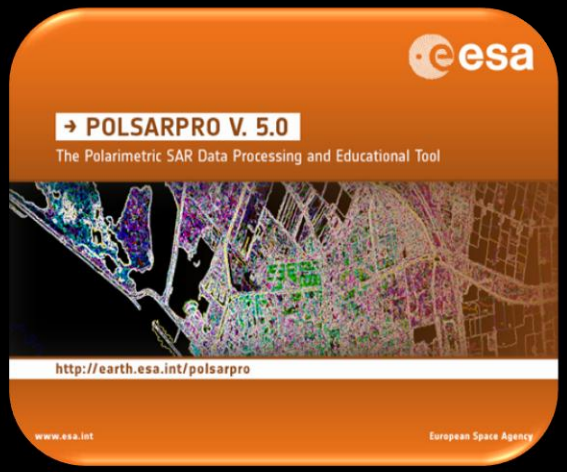




A NEW ENGINE

A NEW DESIGN

PolSARpro v5.1 SOFTWARE



A NEW ENGINE

PolSARpro v5.1 SOFTWARE

Development of PolSARpro functionalities (ESA funded study)

satim

Université de Rennes 1

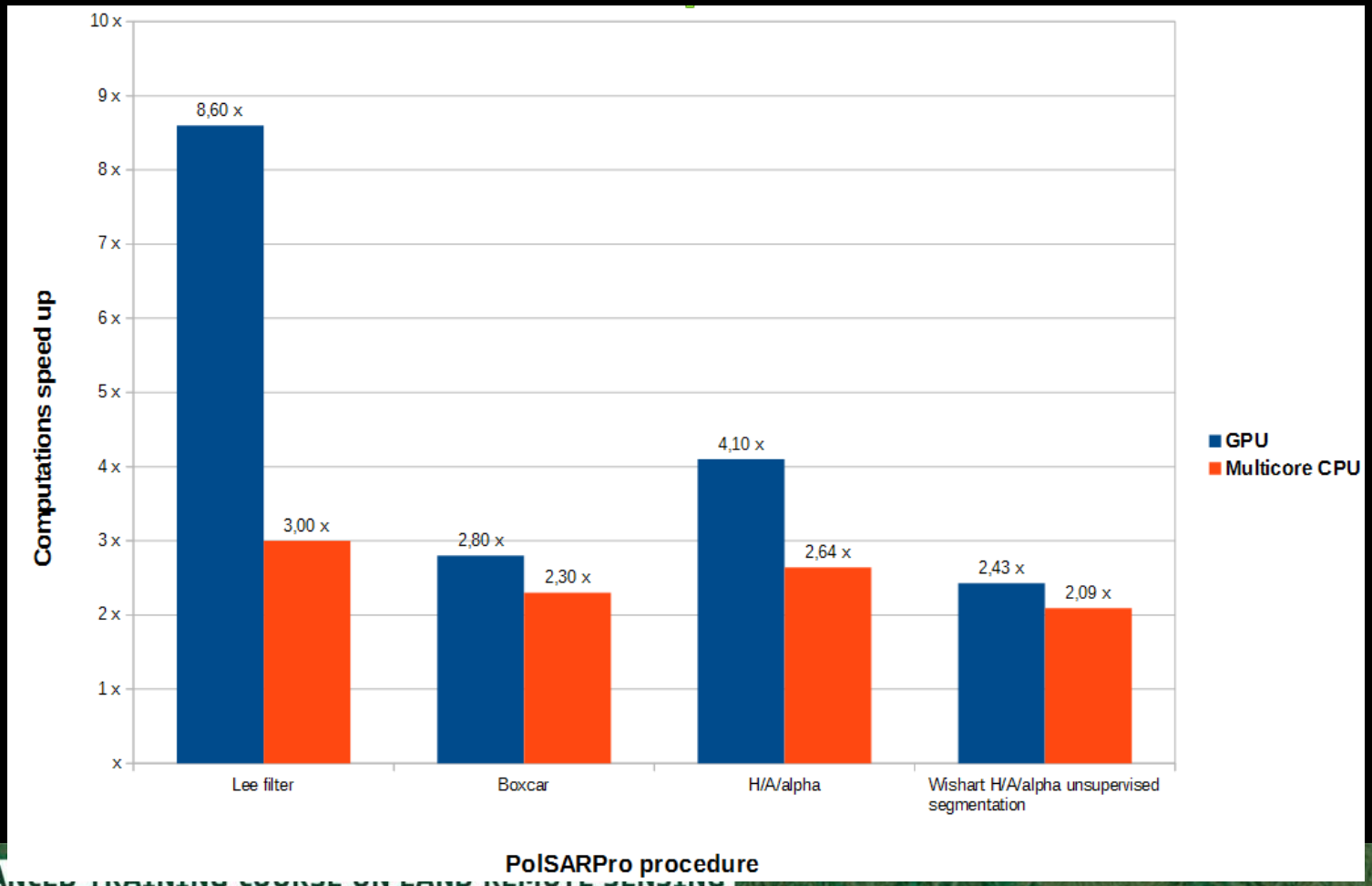
IETR
Institut d'Électronique et de Télécommunications de Rennes

GPU

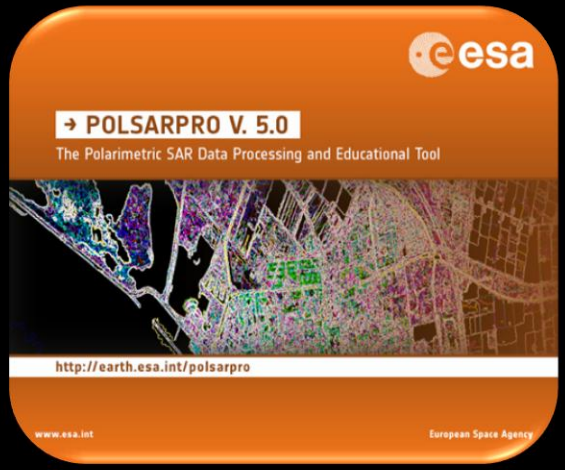
Multi-core CPU

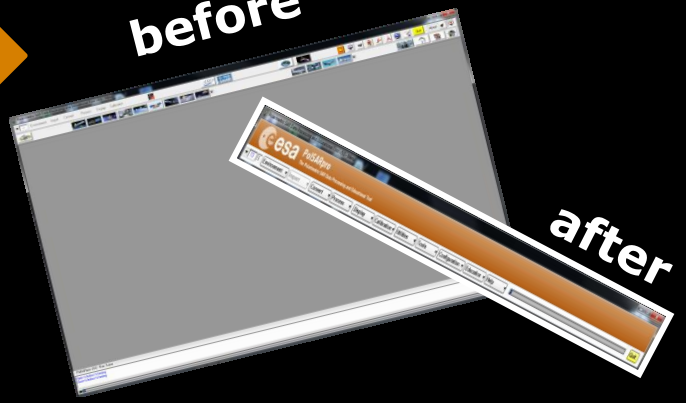
PolSARpro v5.1 SOFTWARE

Speed-up PolSARpro computations by using multicore CPUs (parallelization) and Graphical Processing Unit (GPUs)



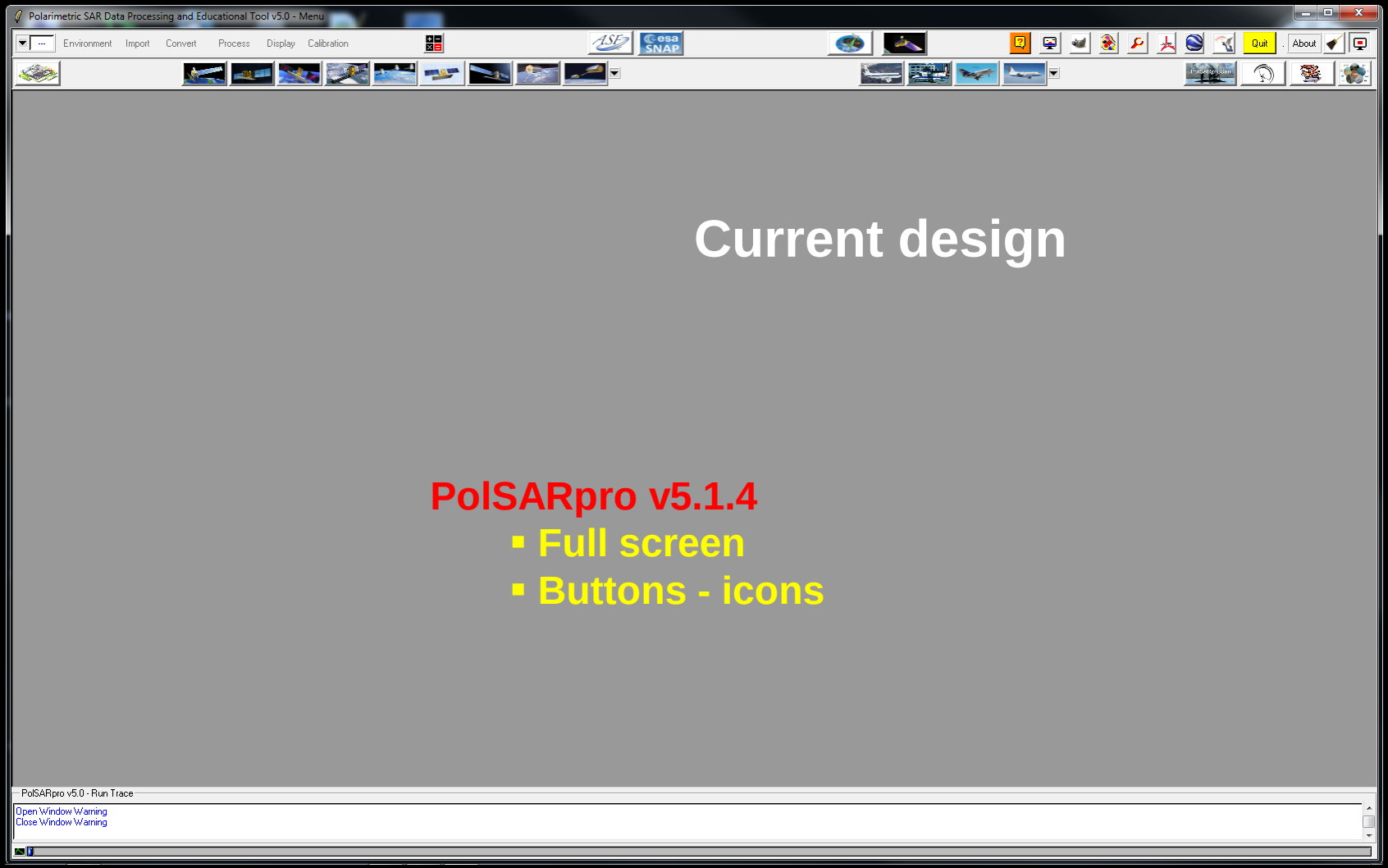
PolSARpro v5.1 SOFTWARE





A NEW DESIGN

PolSARpro v5.1 SOFTWARE

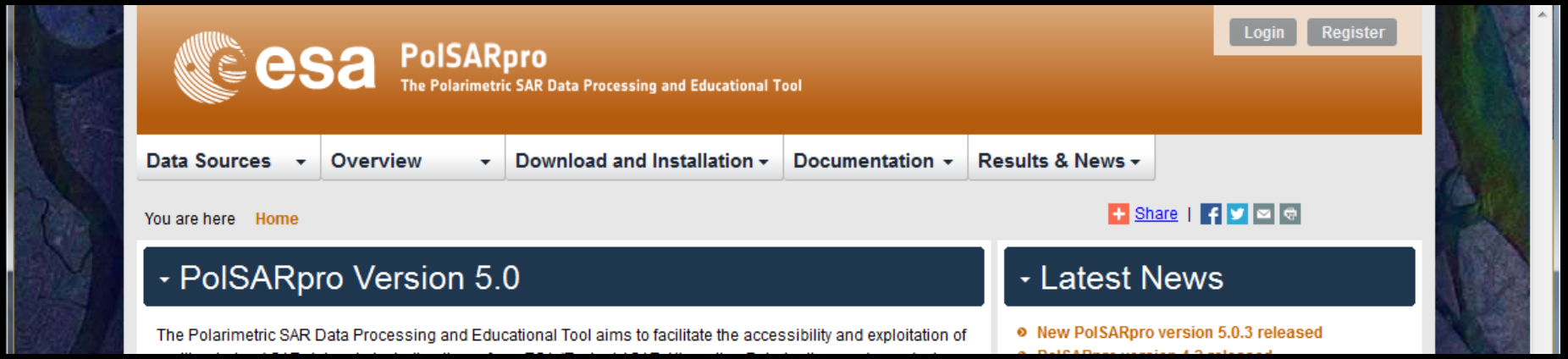


Current design

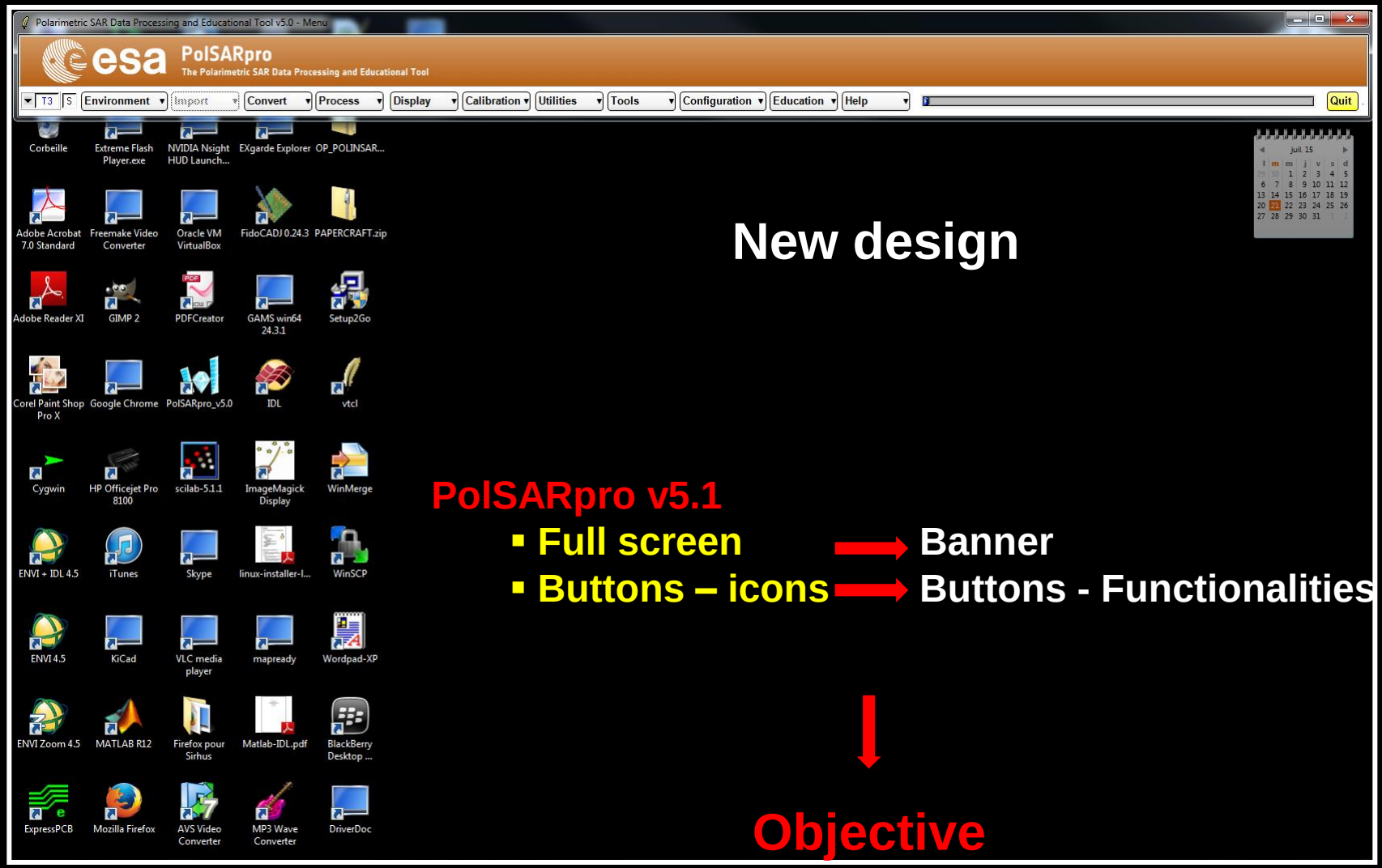
PolSARpro v5.1.4

- **Full screen**
- **Buttons - icons**

PolSARpro v5.1 SOFTWARE



PolSARpro v5.1 SOFTWARE



New design

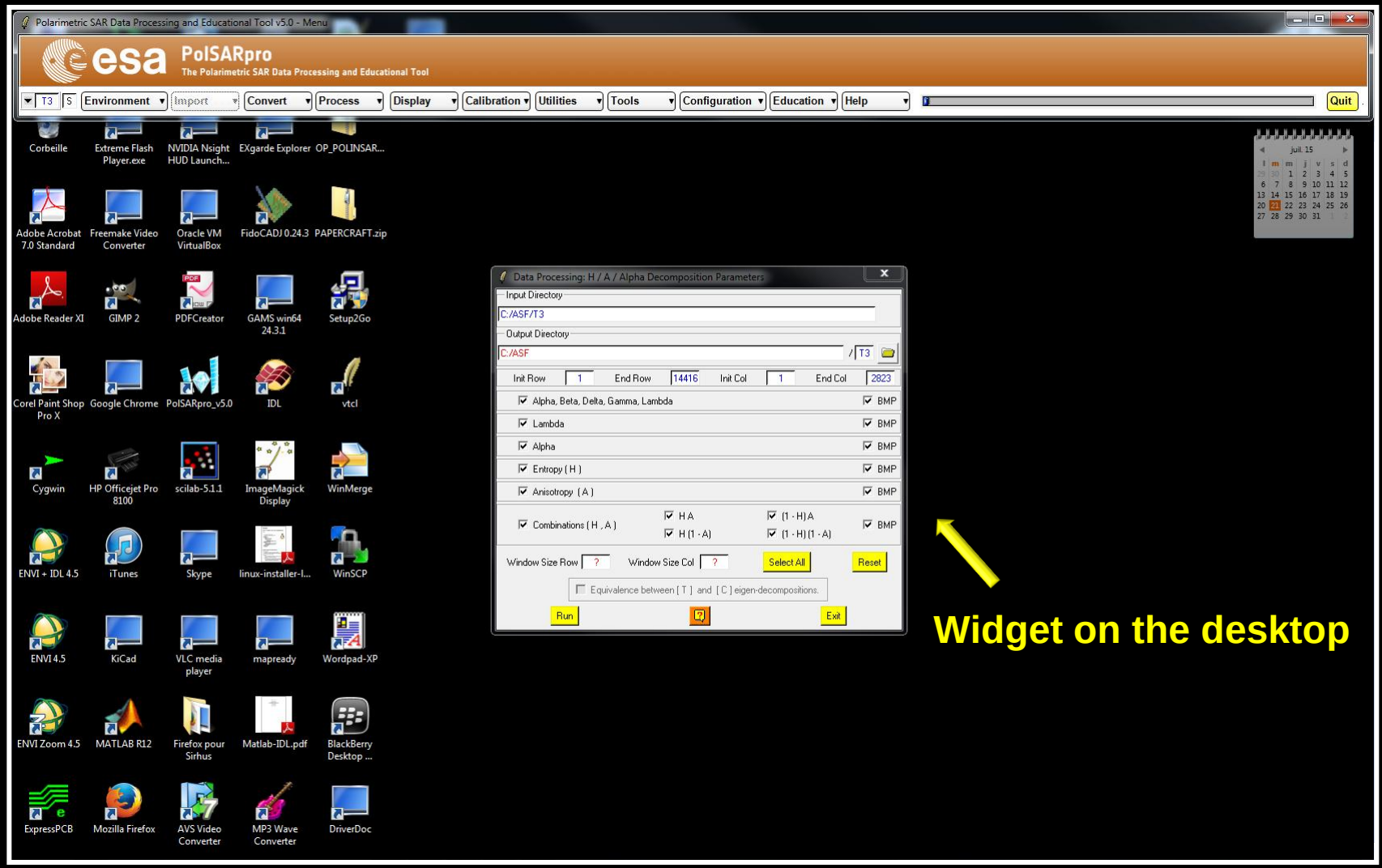
PolSARpro v5.1

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

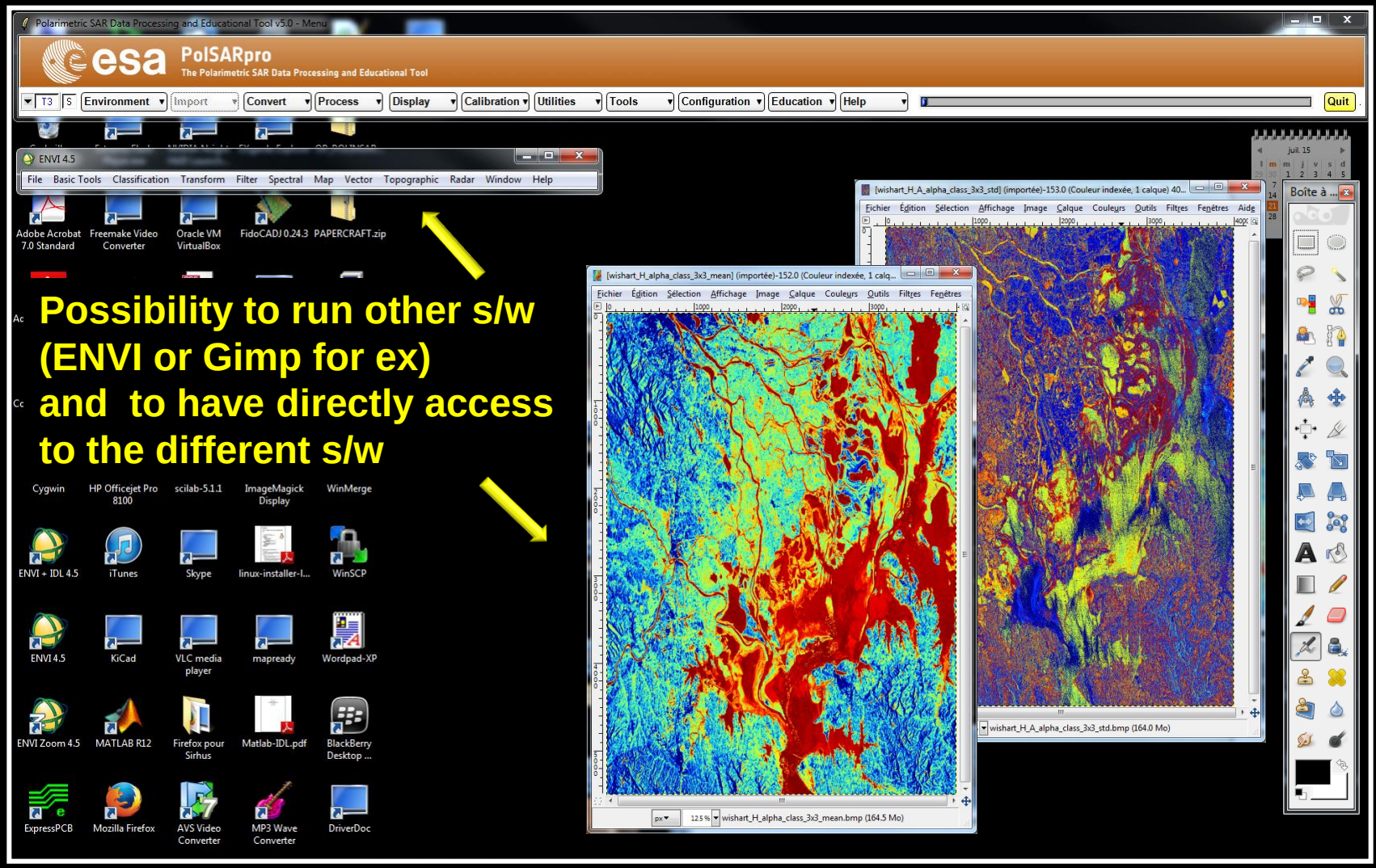
Objective

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

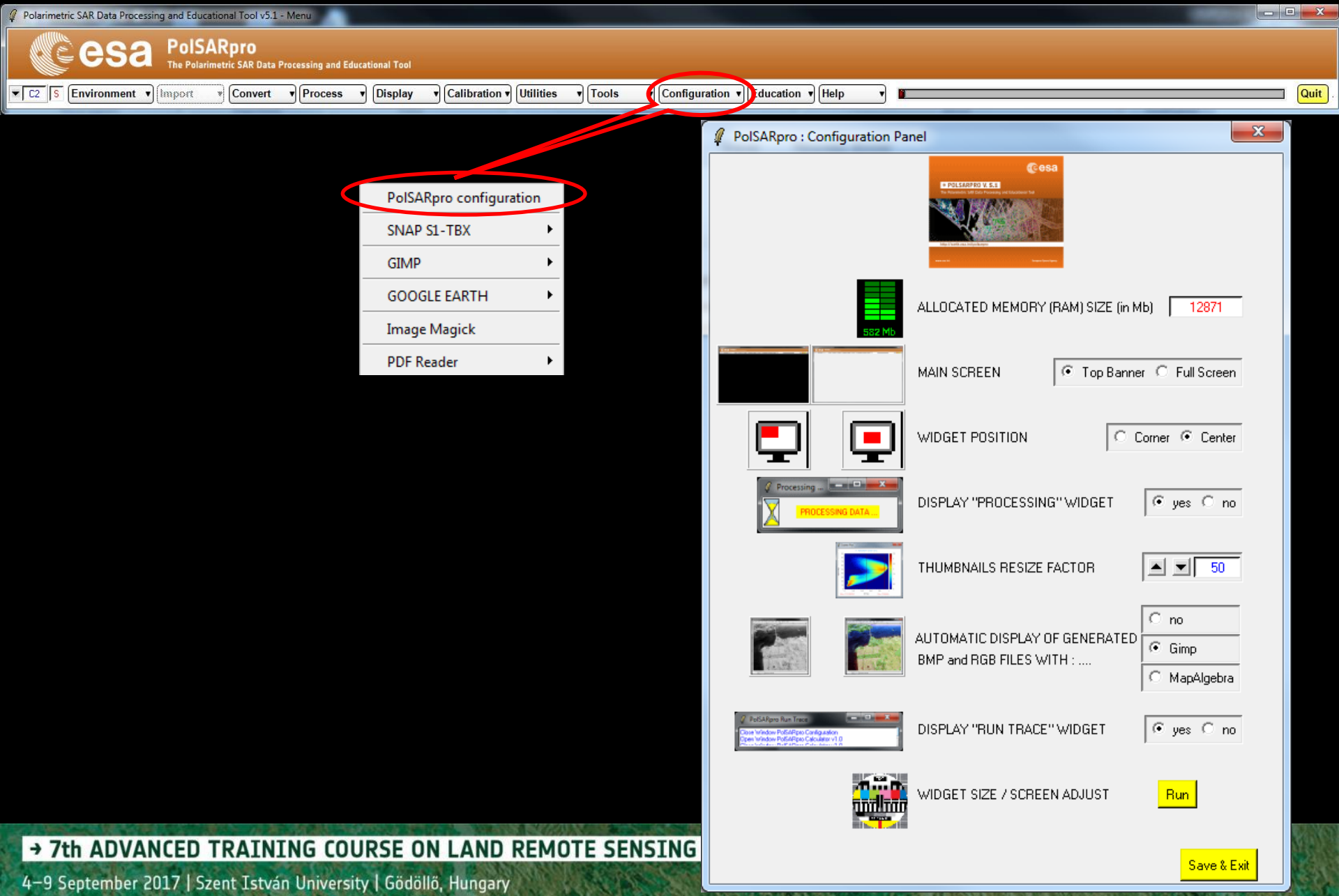
PolSARpro v5.1 SOFTWARE



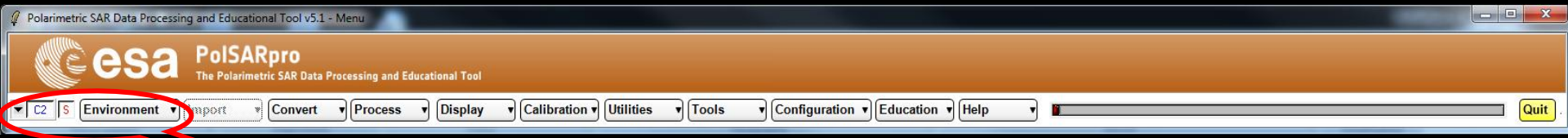
PolSARpro v5.1 SOFTWARE



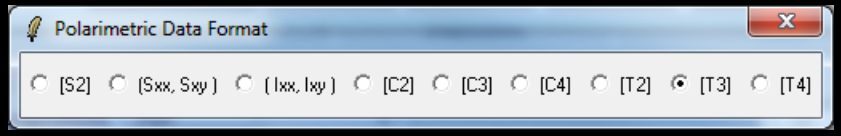
PolSARpro v5.1 SOFTWARE



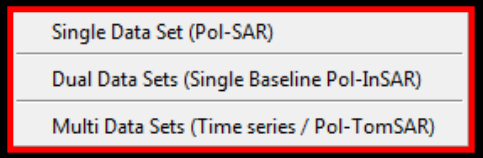
PolSARpro v5.1 SOFTWARE



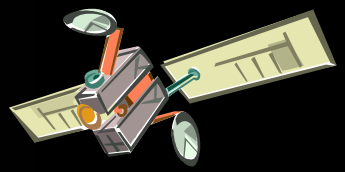
Polarimetric Data Format

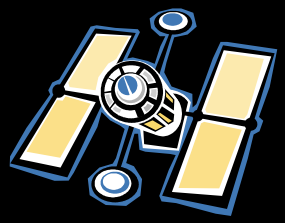


DataSet Type



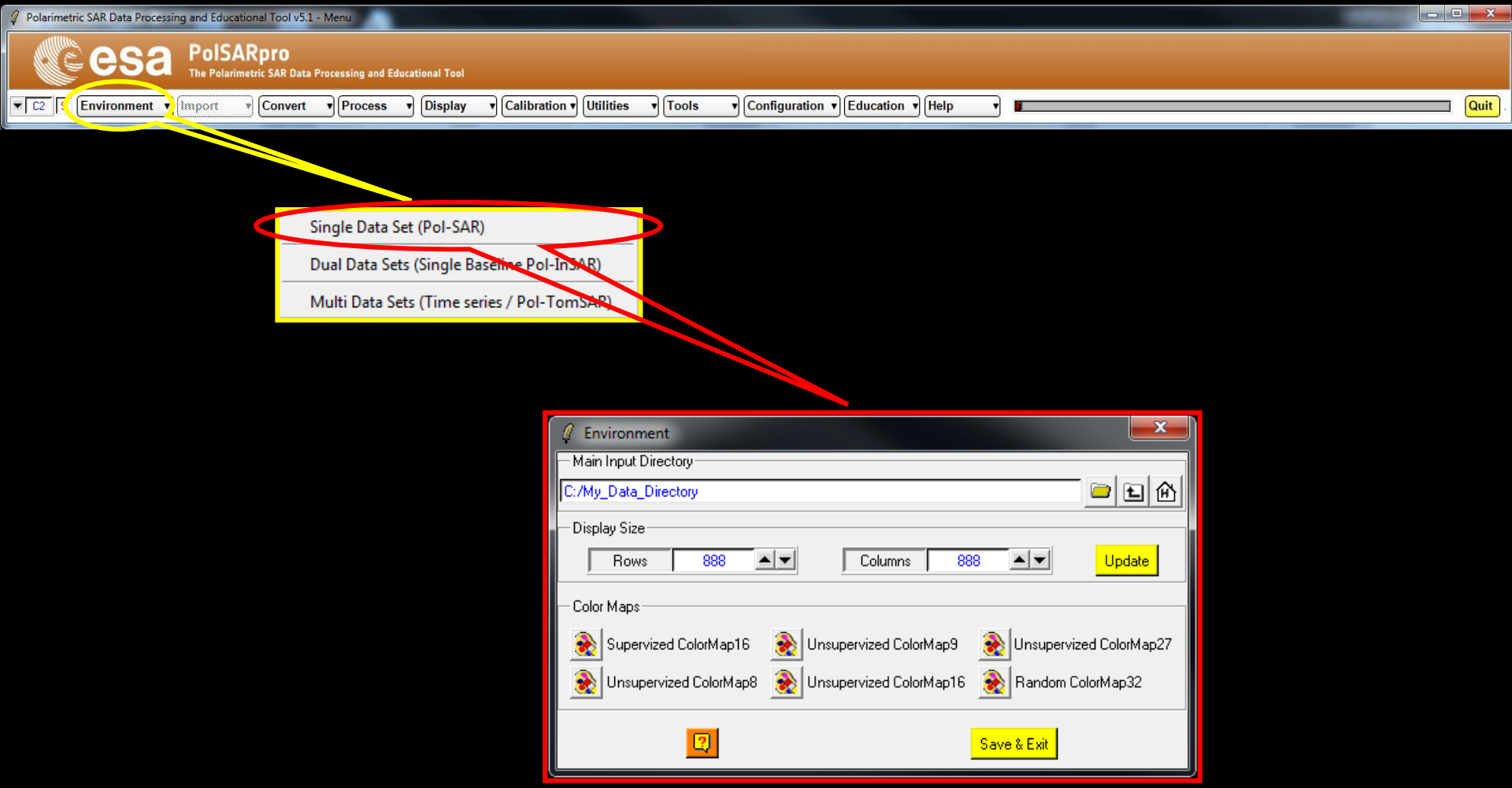
PolSARpro v5.1 SOFTWARE





New Functionalities

PolSARpro v5.1 SOFTWARE



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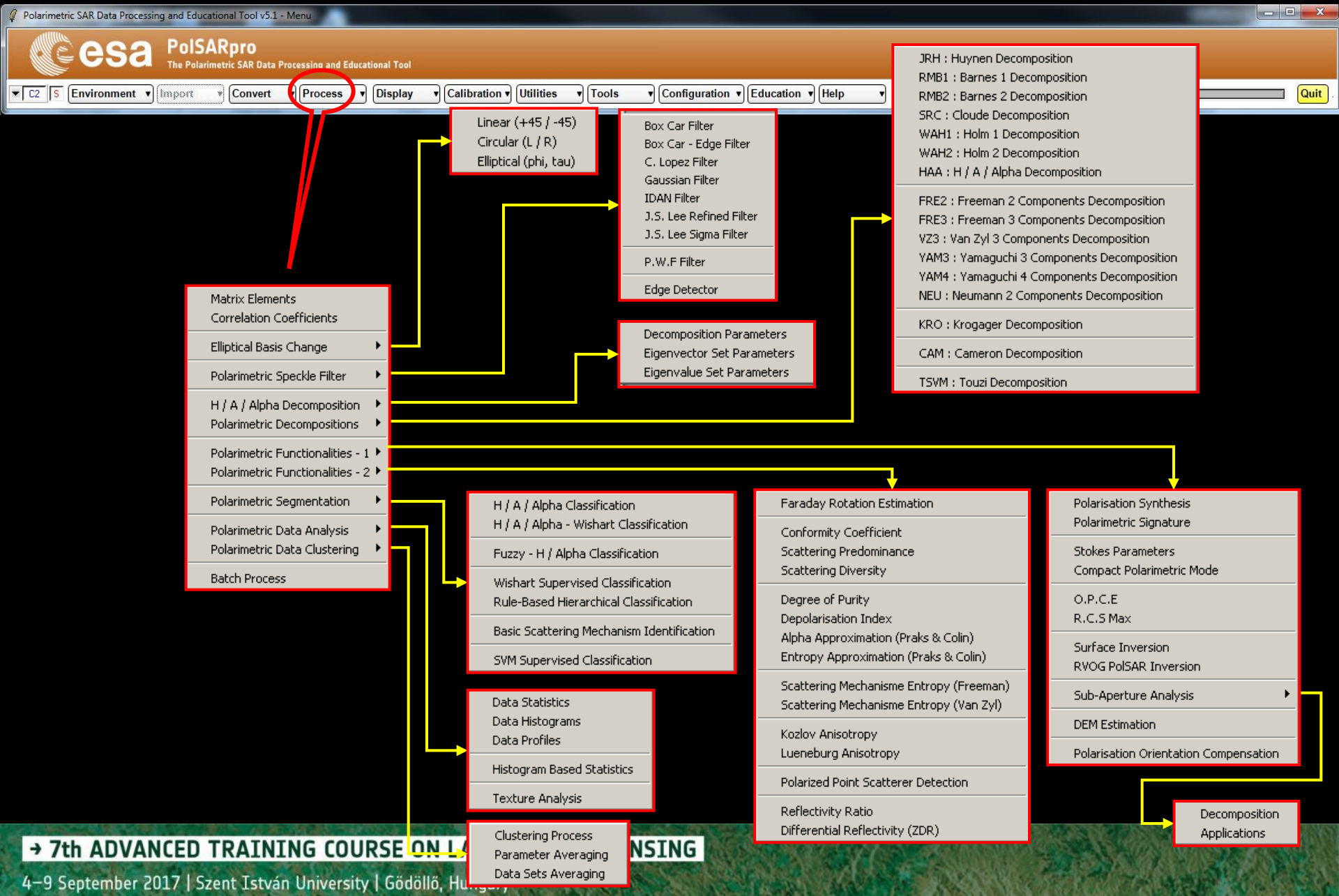
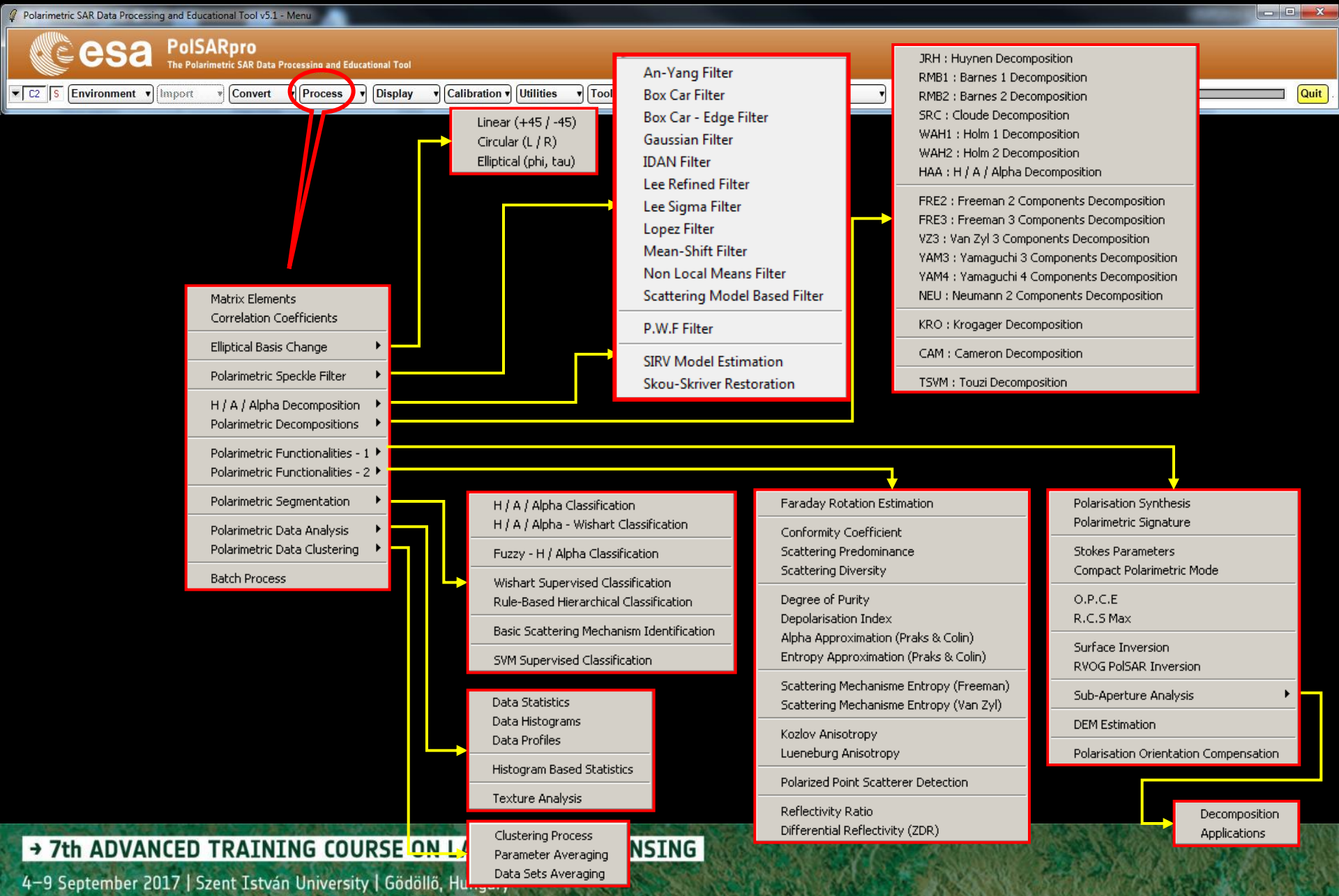


PolSARpro v5.1 SOFTWARE



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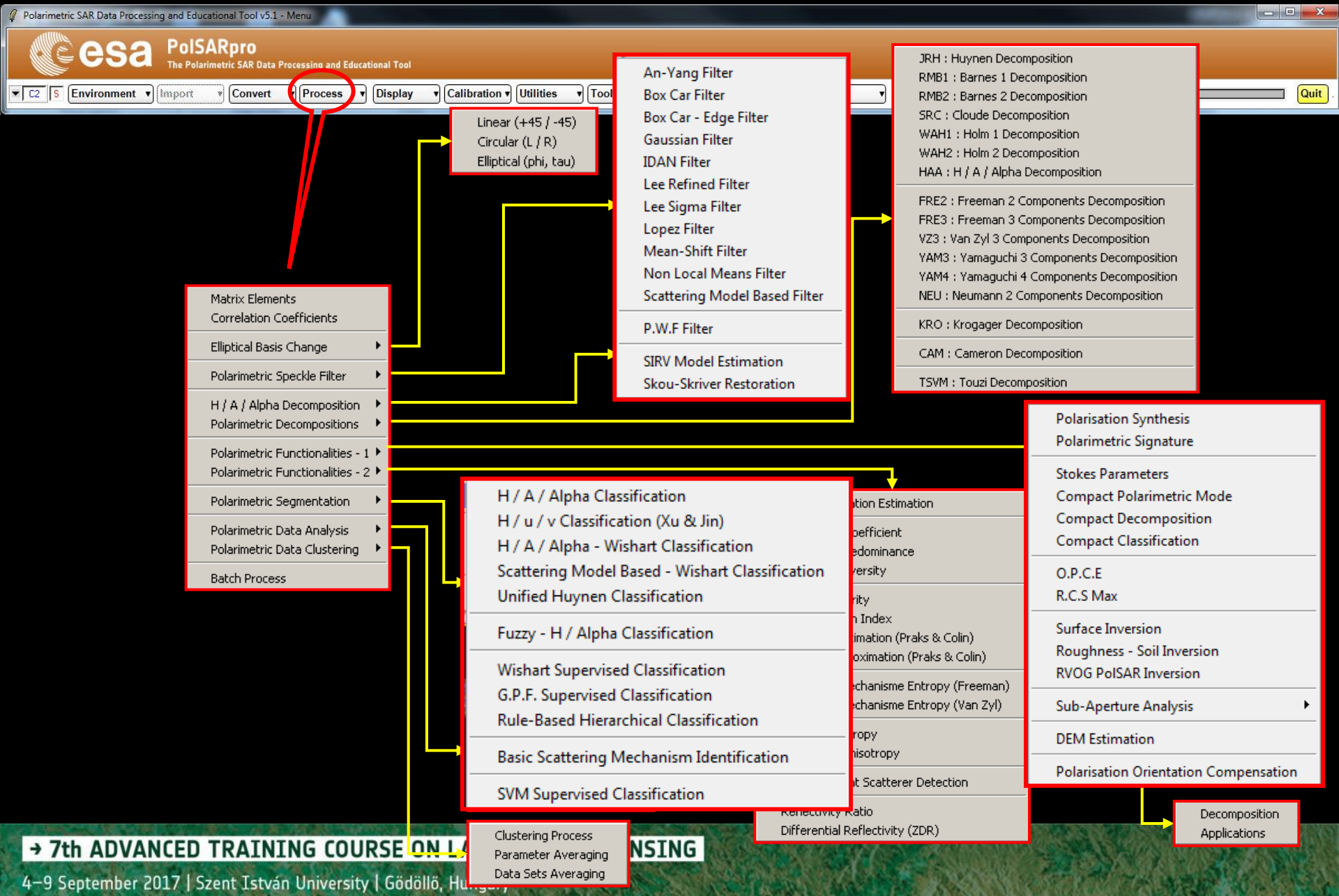

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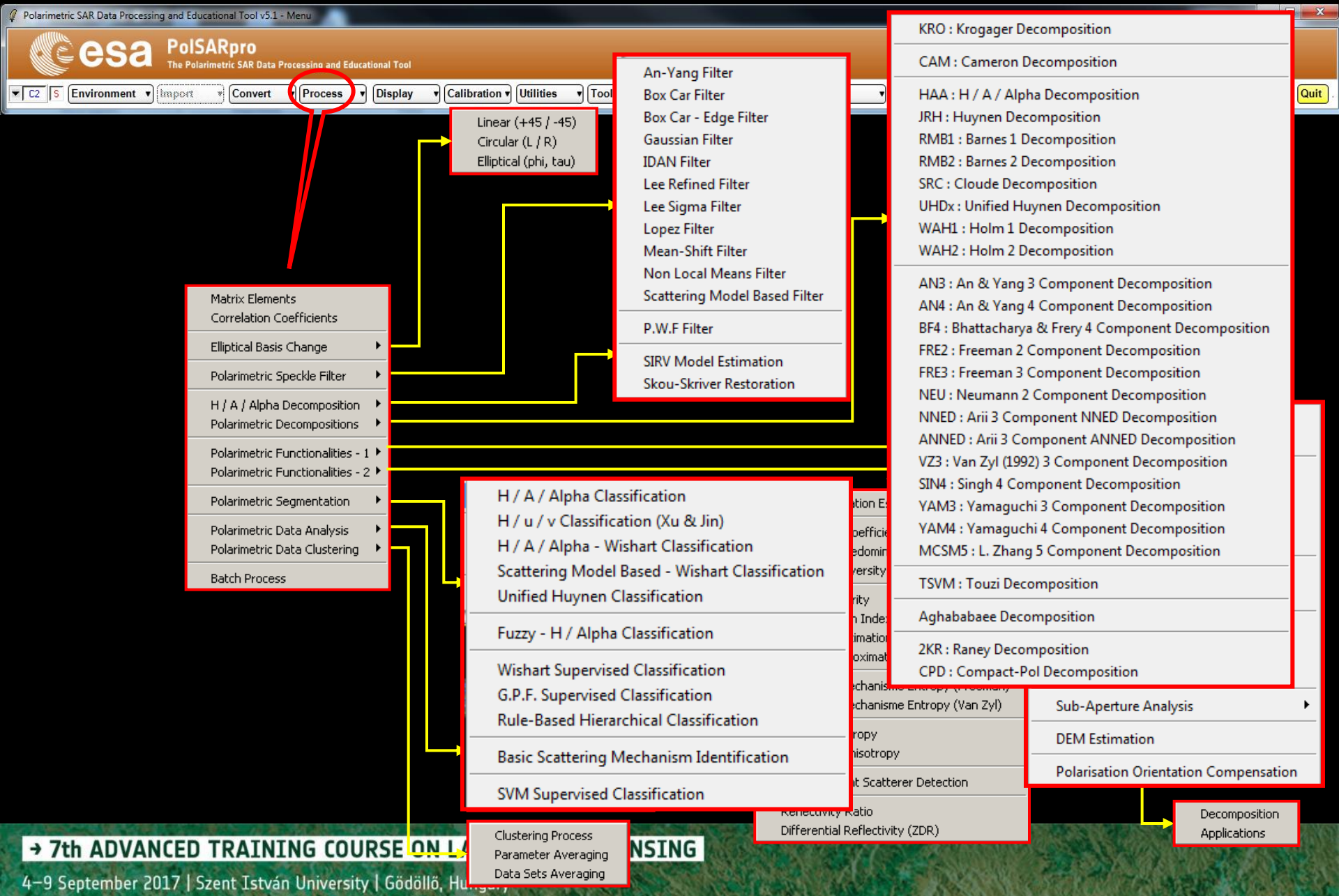

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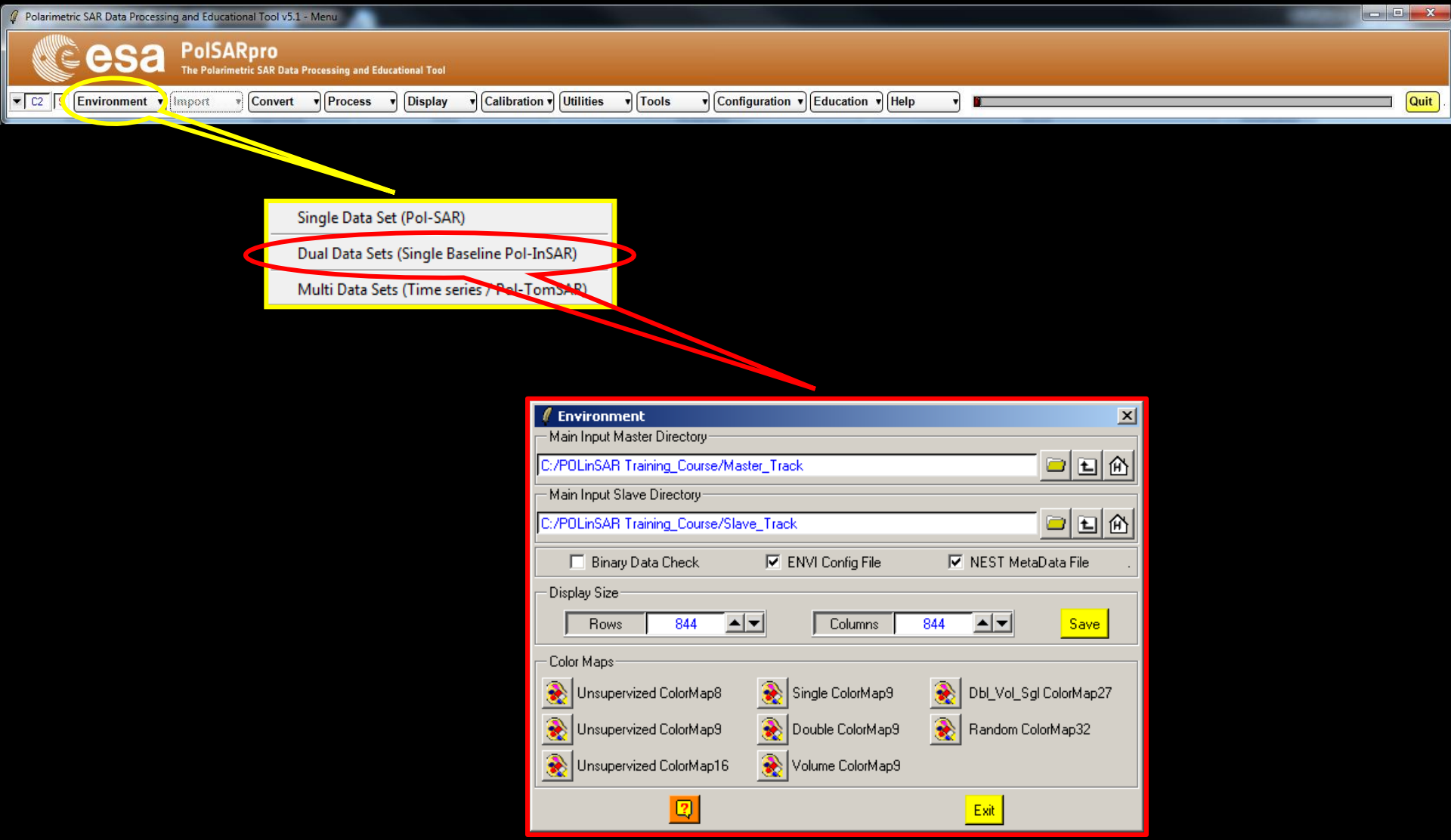

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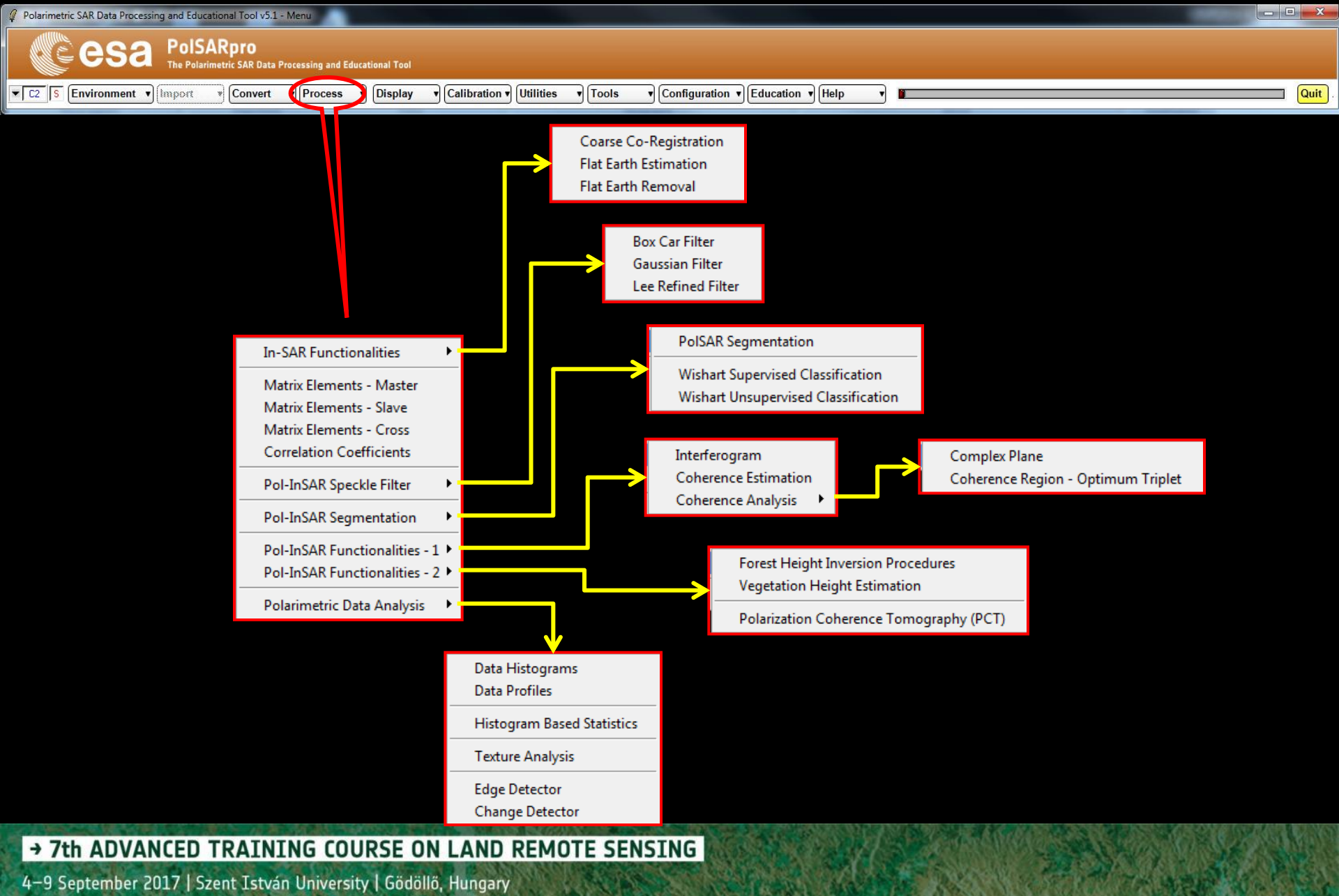

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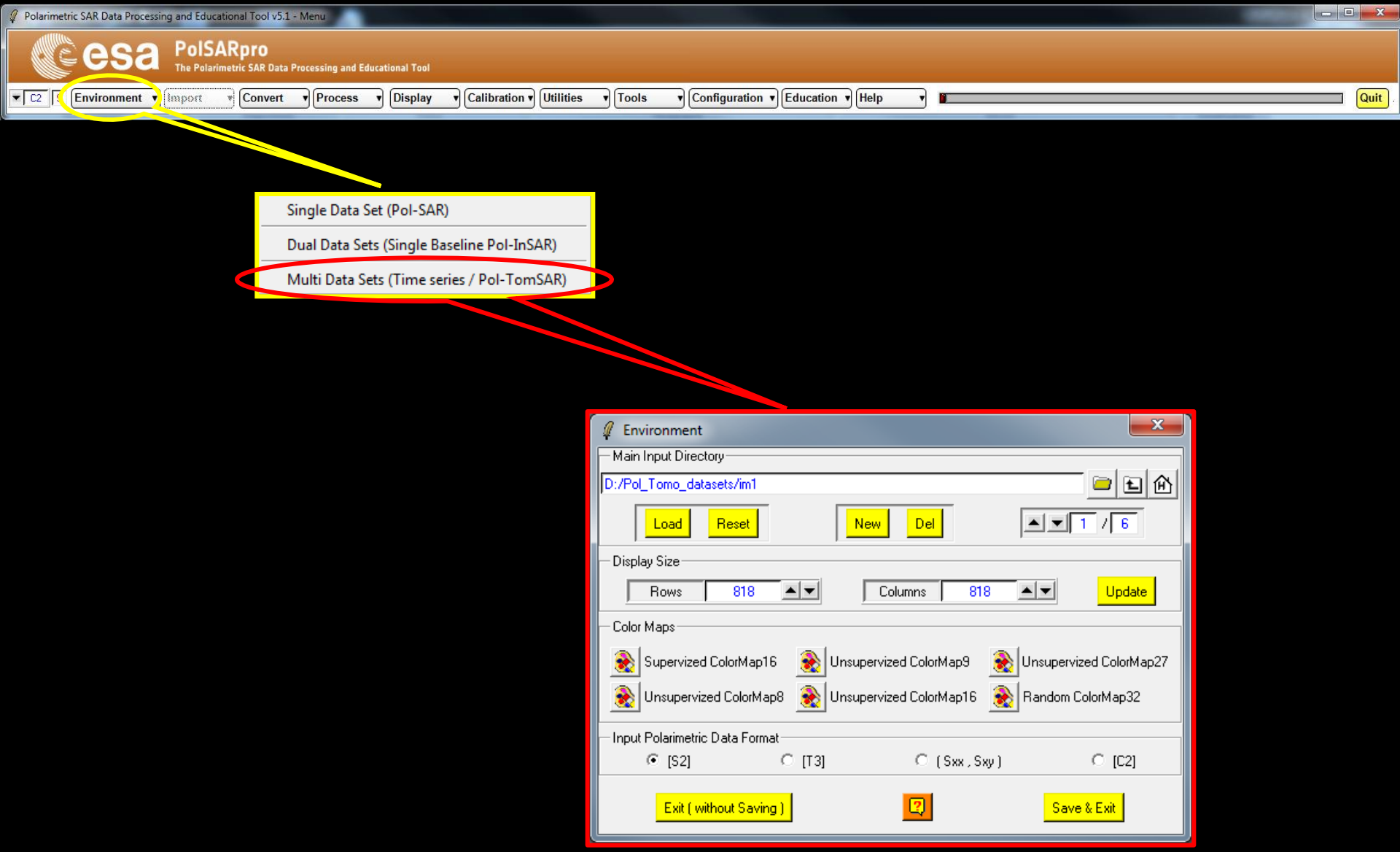

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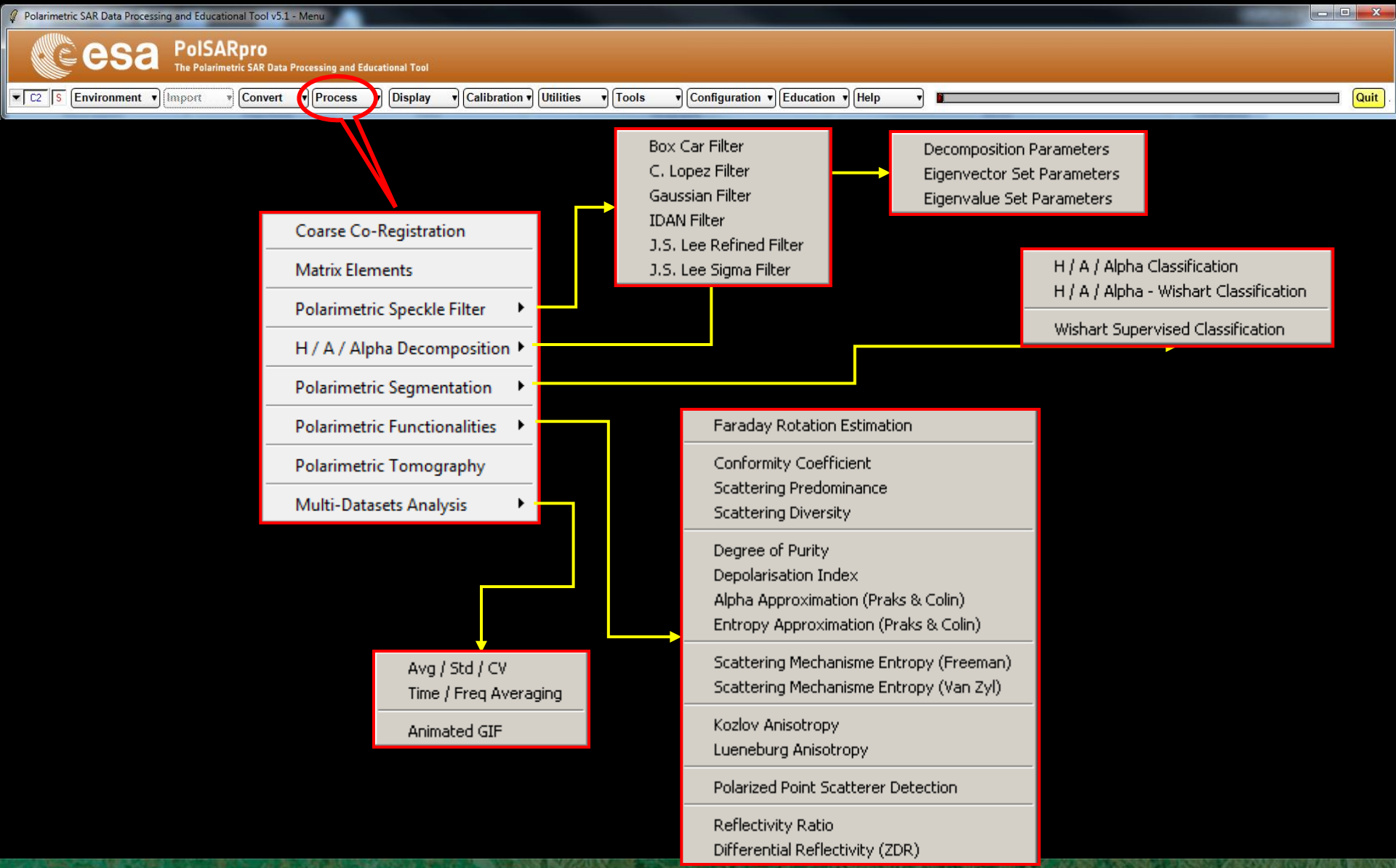

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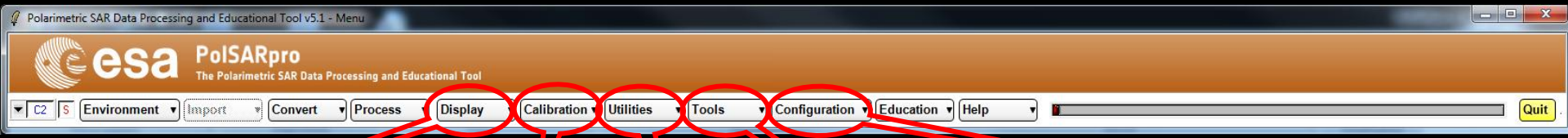
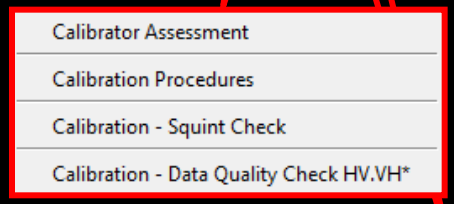
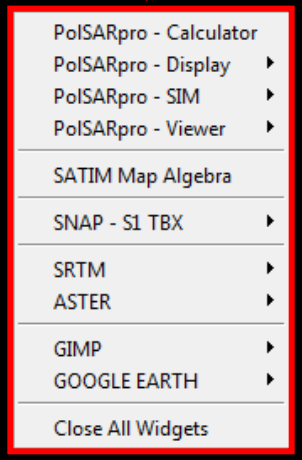
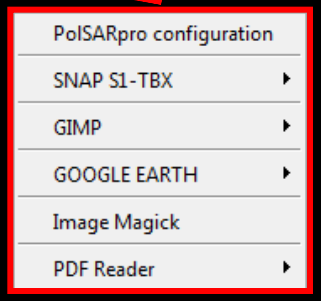
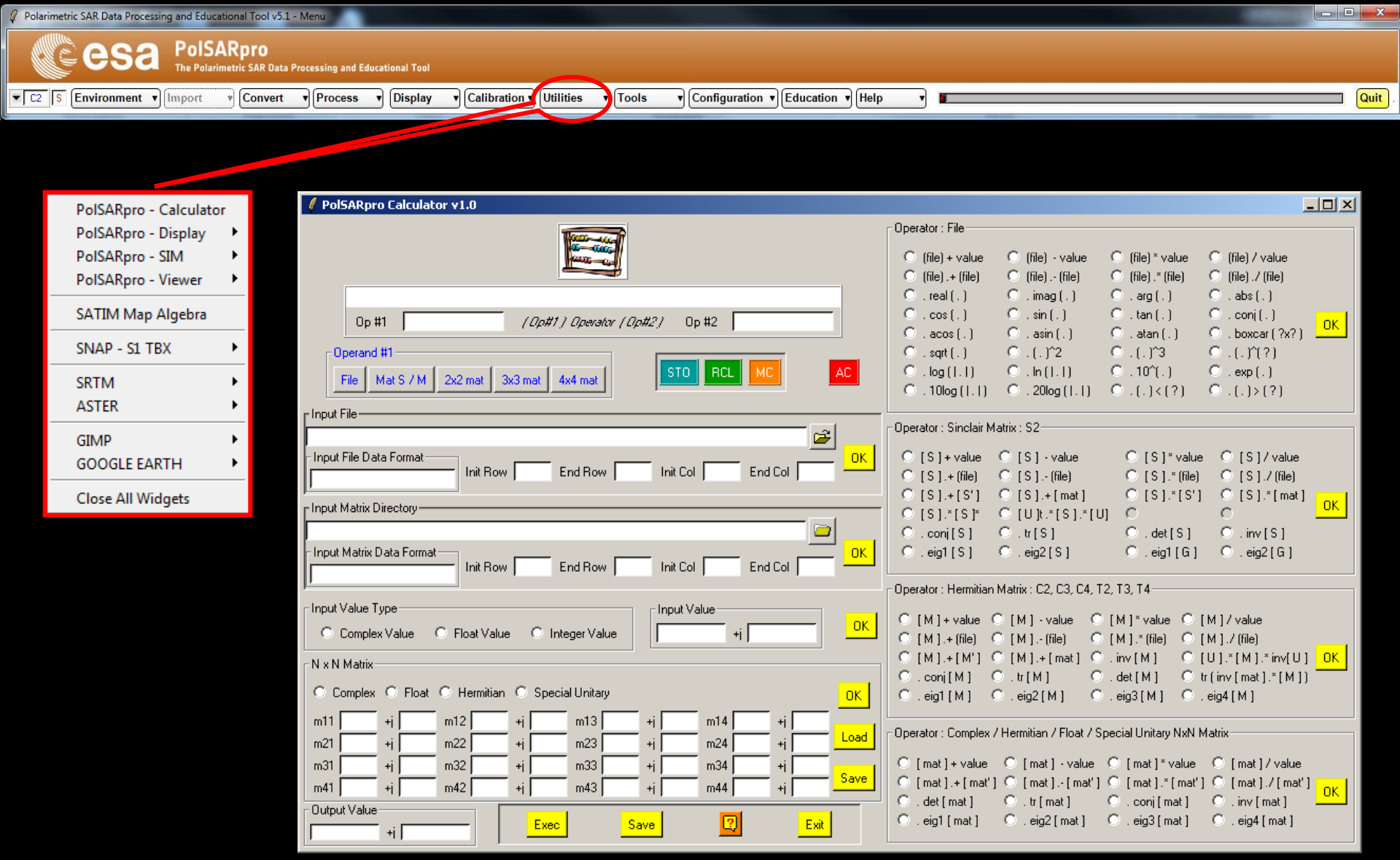




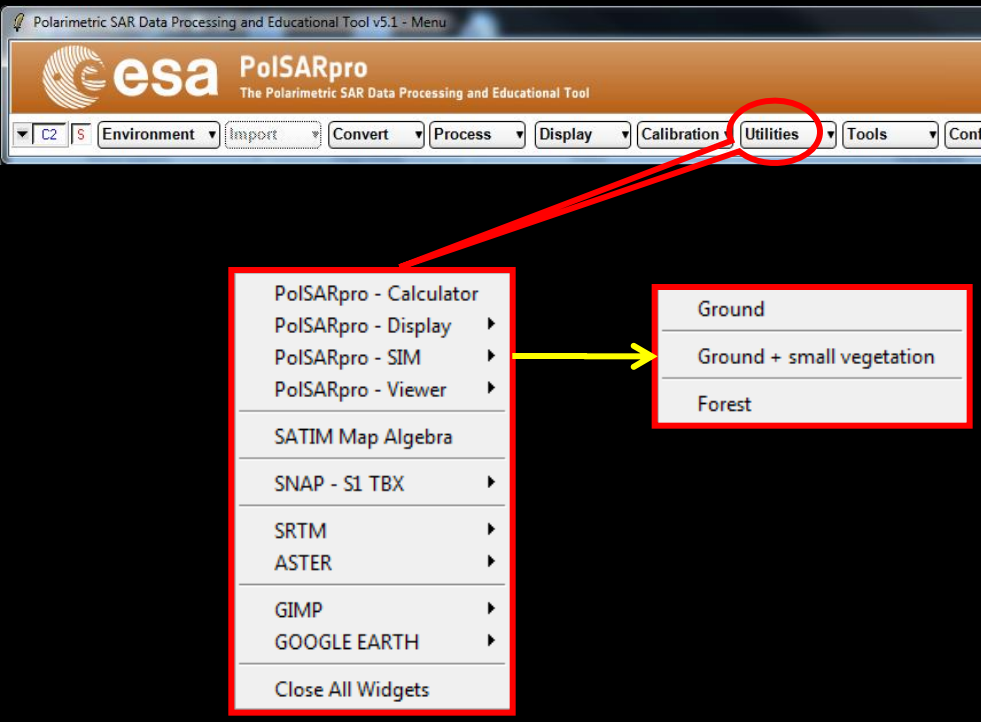


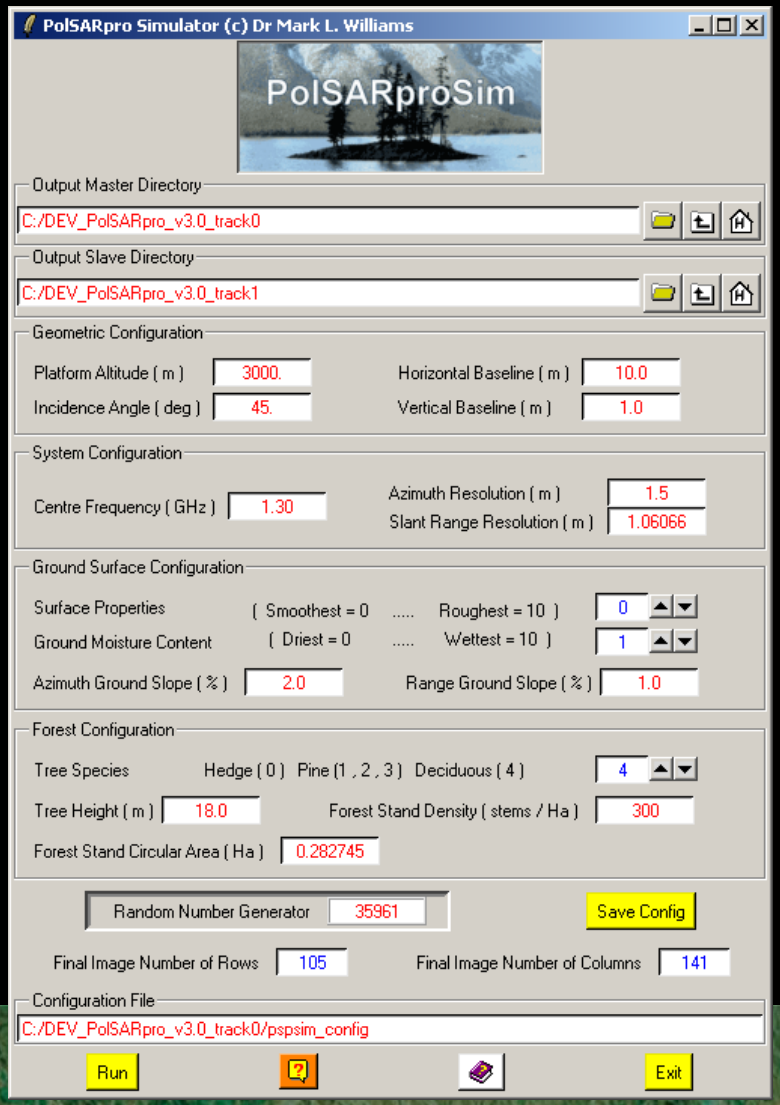


PolSARpro v5.1 SOFTWARE



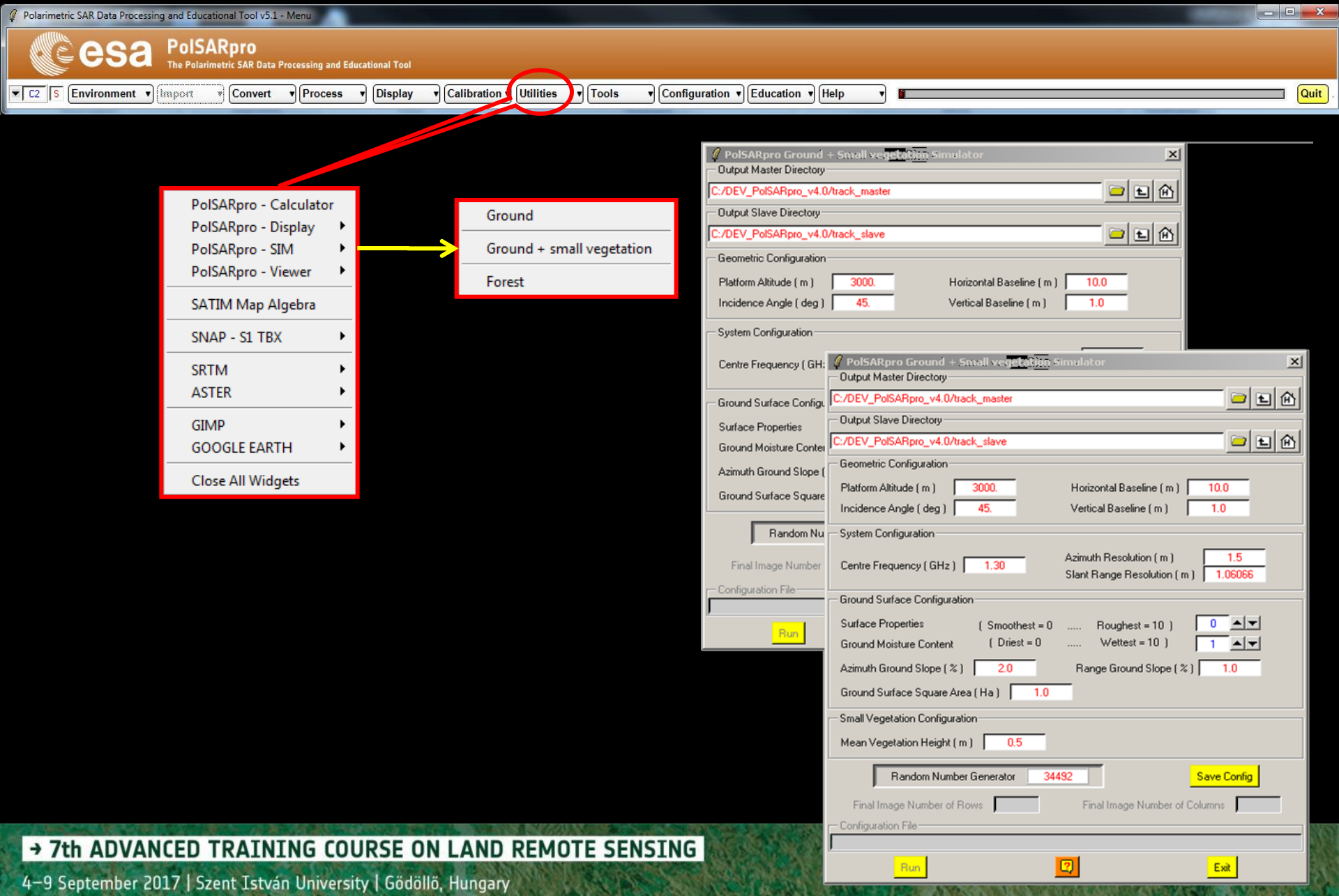
PolSARpro v5.1 SOFTWARE



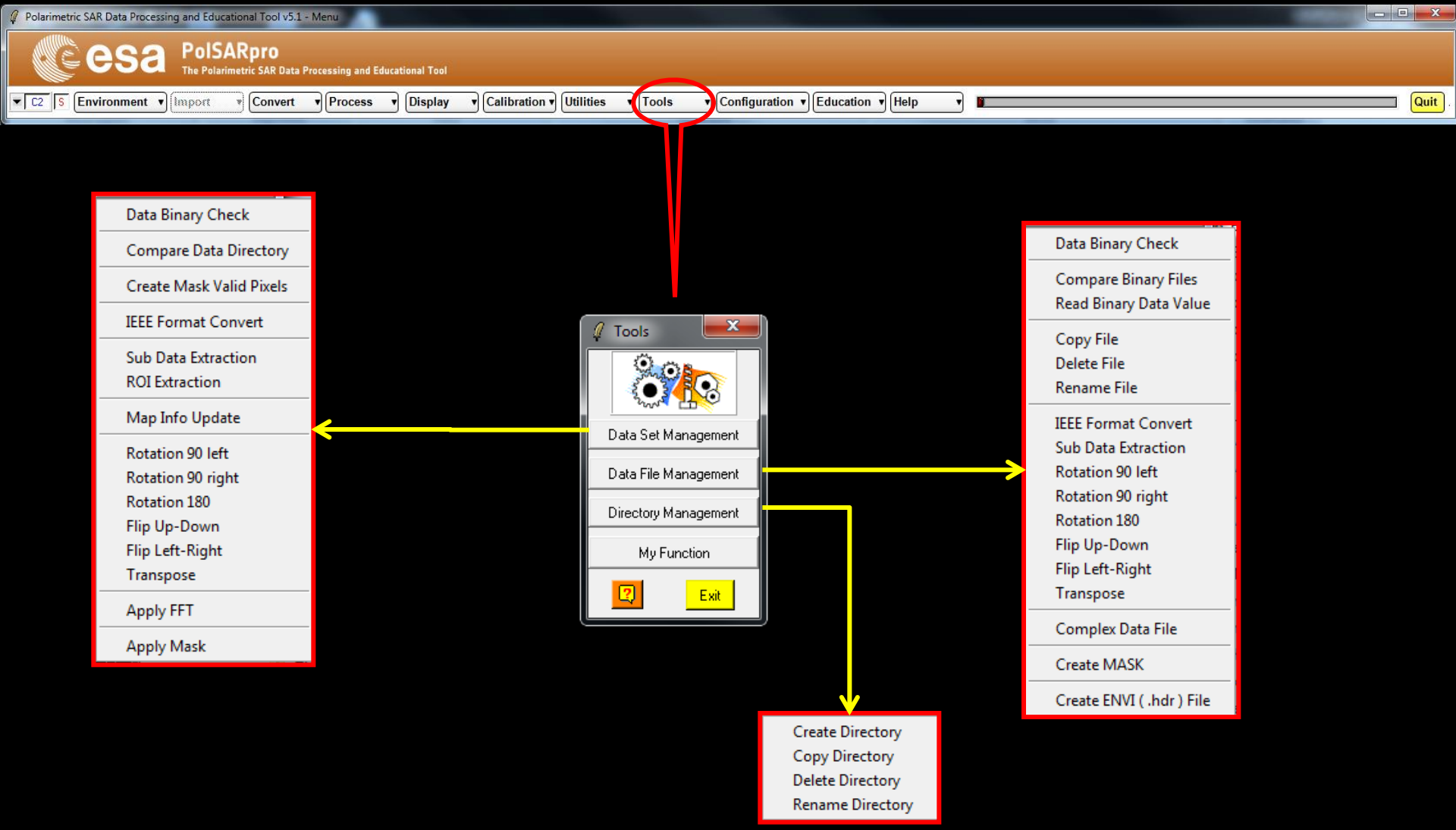


PolSARproSim is a rapid, coherent, fully polarimetric and interferometric SAR simulation of forest.

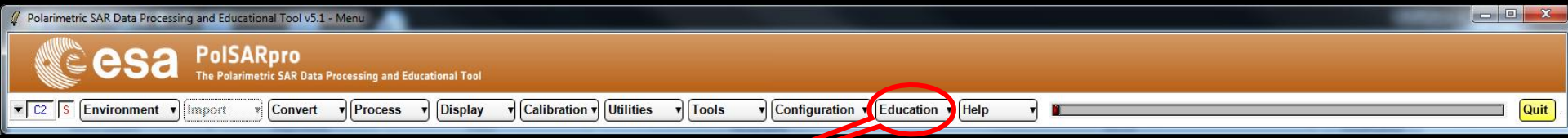
PolSARpro v5.1 SOFTWARE

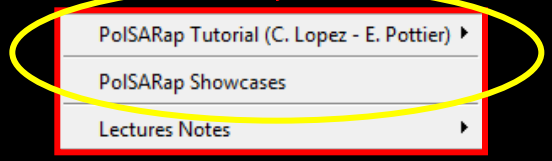


PolSARpro v5.1 SOFTWARE



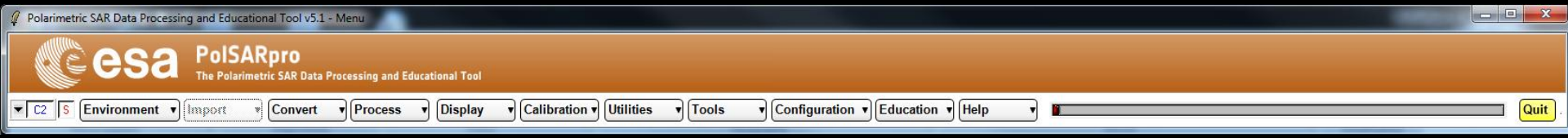
PolSARpro v5.1 SOFTWARE





Learning / Training Next P.I Generations

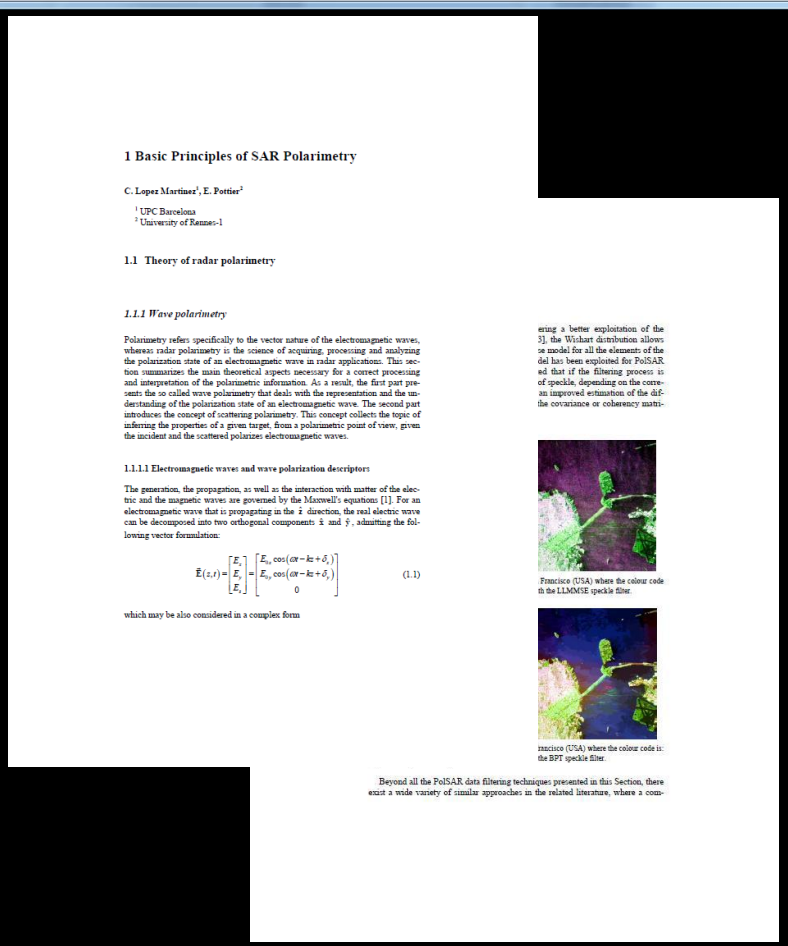
EDUCATIONAL TOOLS



PolSAR-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 Martinez[1], E. Pottier[2]

[1] UPC Barcelona
[2] University 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 polarizes 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 $\hat{z}$ direction, the real electric wave can be decomposed into two orthogonal components $\hat{x}$ and $\hat{y}$, admitting the following vector formulation:

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

which may be also considered in a complex form

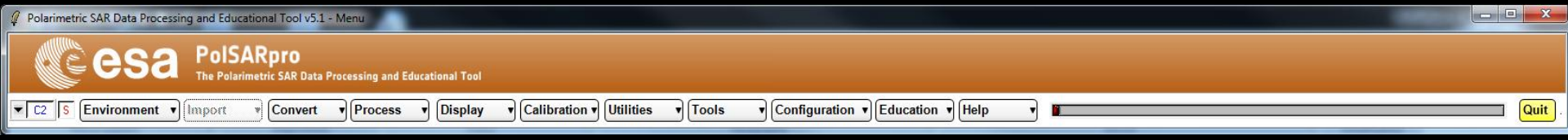
ering a better exploitation of the 3], the Wishart distribution allows se model for all the elements of the del has been exploited for PolSAR ed that if the filtering process is of speckle, depending on the corre- an improved estimation of the dif- the covariance or coherency matri-

Francisco (USA) where the colour code th the LLMMSE speckle filter.

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

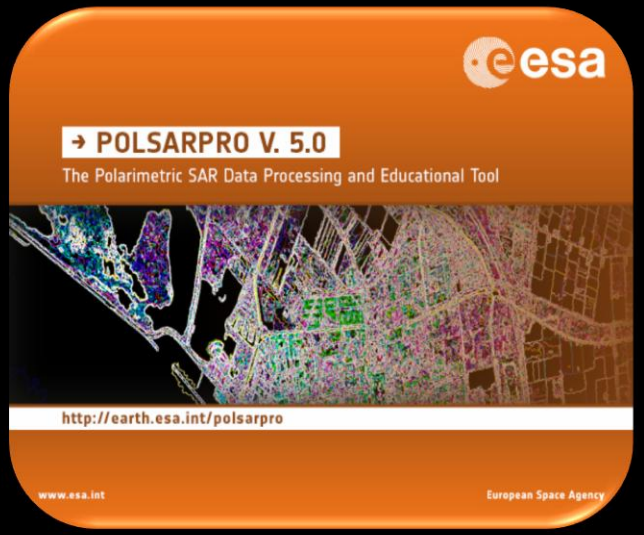
Beyond all the PolSAR data filtering techniques presented in this Section, there exist a wide variety of similar approaches in the related literature, where a com-

EDUCATIONAL TOOLS



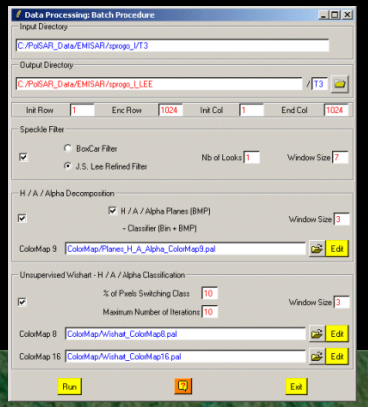
PolSAR-Ap Project

Expert

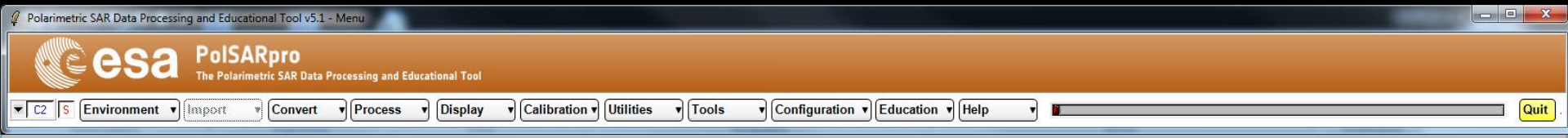


WP260 : Implementation of Selected Applications

(E. Pottier)



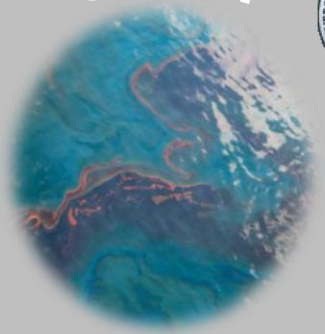
EDUCATIONAL TOOLS

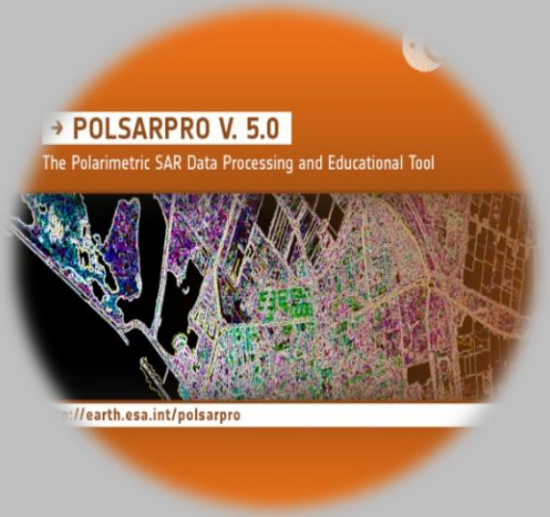


Agriculture

Forest

Ocean

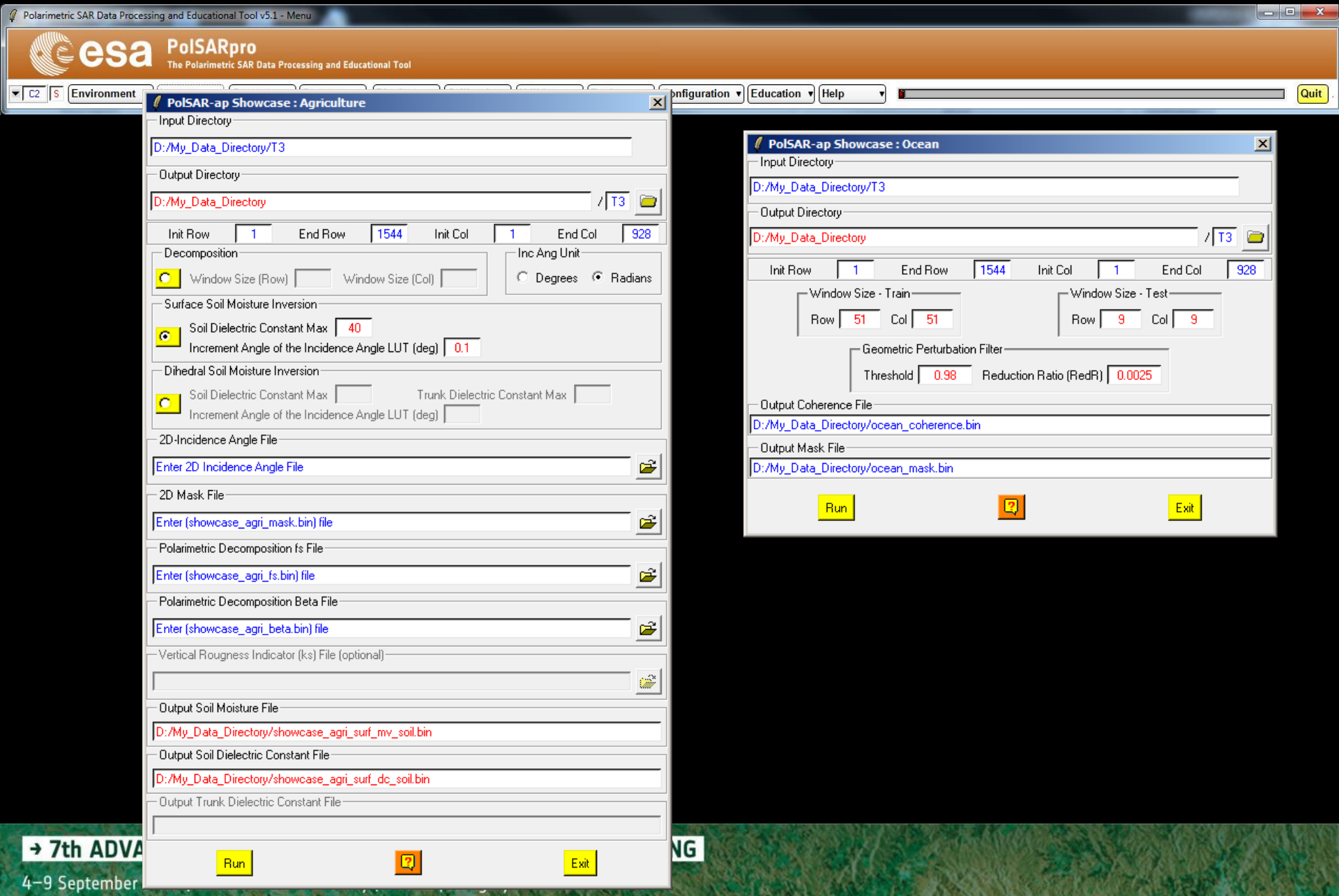




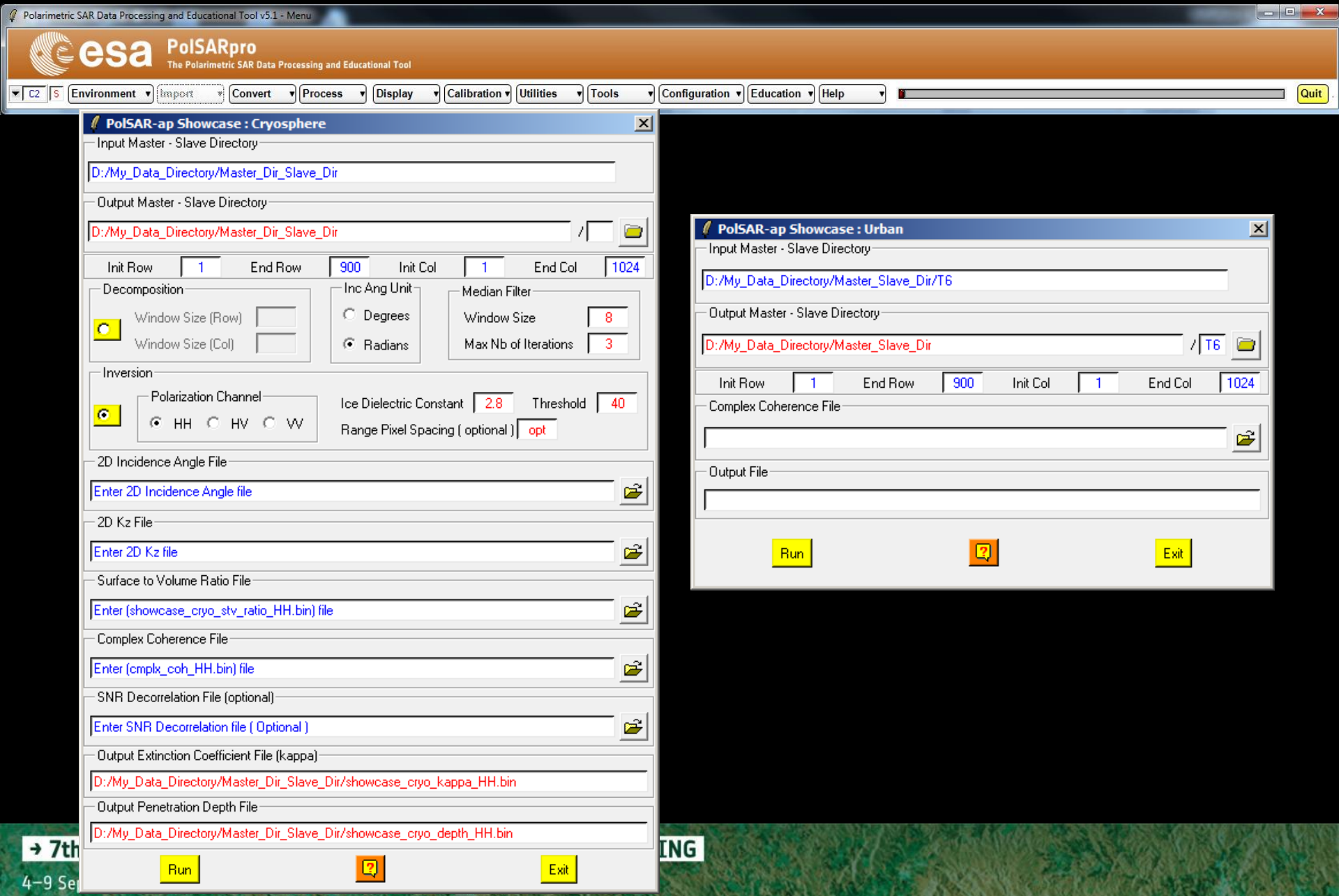
Urban

Cryosphere

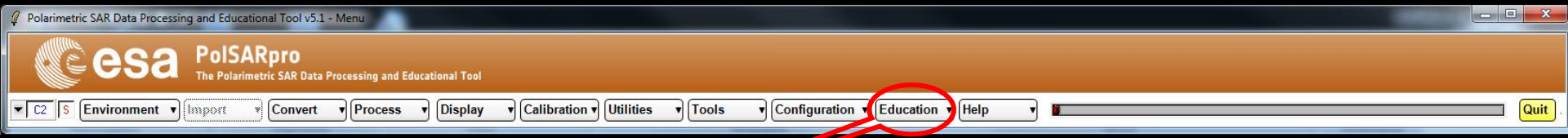
Educational Tools

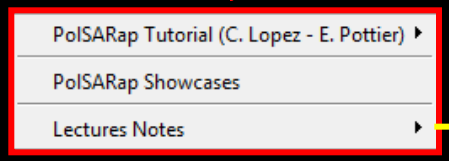


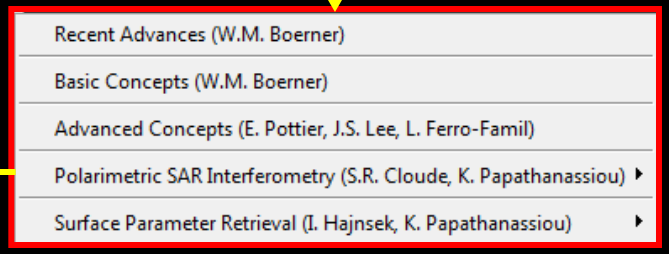
Educational Tools

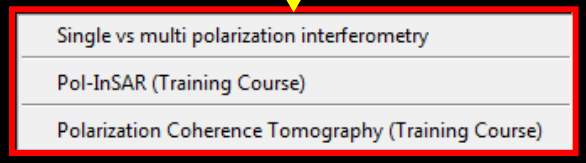


PolSARpro v5.1 SOFTWARE





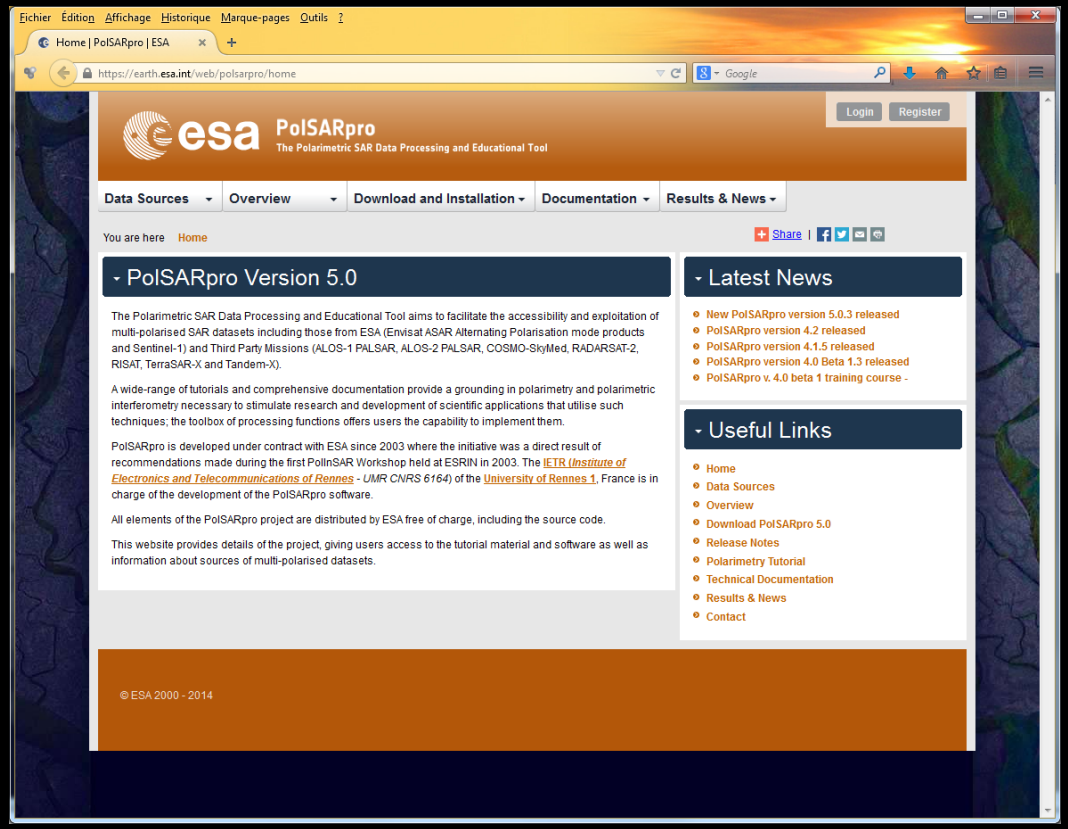




Learning / Training Next P.I Generations

PolSARpro v5.1 SOFTWARE

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 v5.1 SOFTWARE

http://earth.esa.[illegible]/polsarpro/home

Web Site provides

[illegible] the project

[illegible] tutorial

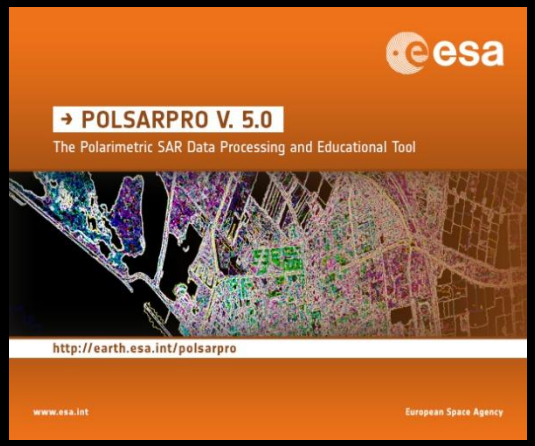
[illegible]ion about status development

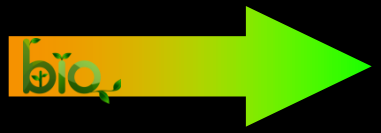
[illegible]emonstration Sample Datasets

New! **V5.1 (January 2017)**

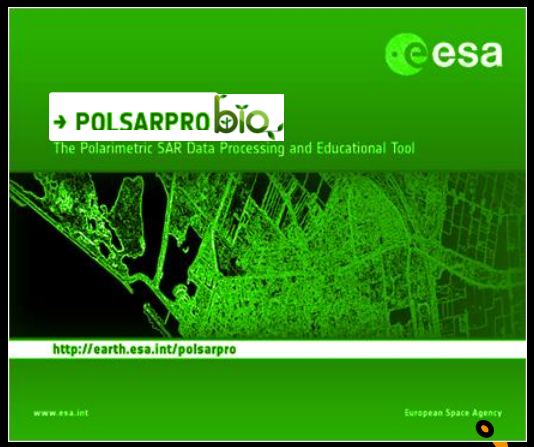
PolSARpro - Bio SOFTWARE

ESA & third party fully polarimetric SAR missions (PolSARpro-Bio)

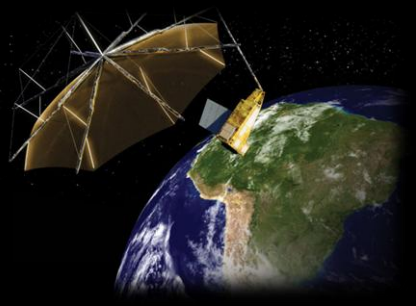




ESA RFP - 2017

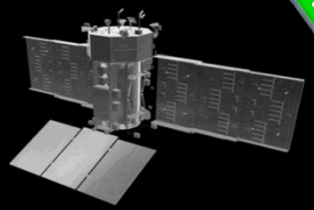


Future spaceborne sensors



BIOMASS

R.C.M



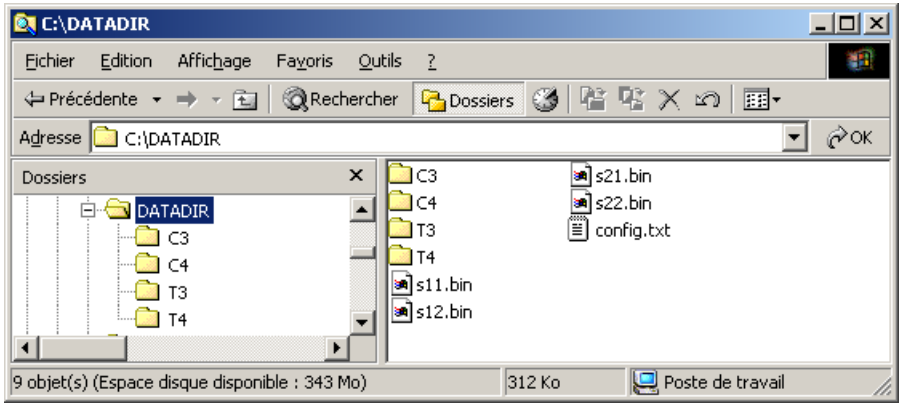
SAOCOM-CS

New functionalities : Pol-SAR, Pol-TomSAR and Pol-TimeSAR / Cloud-based infrastructure SNAP / PolSARproSIM++ / QGIS Plug-in…

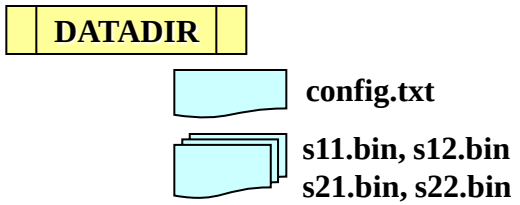
General Presentation of PolSARpro v5.1 Software

DATA DIRECTORY STRUCTURE

Compatible Raw Binary Data



2x2 Complex Sinclair Matrix [S2]



PolarCase

- Monostatic s12.bin == s21.bin
- Bistatic s12.bin <> s21.bin
- Intensities Ixy.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 I11.bin, I12.bin, I22.bin
- pp5 I11.bin, I21.bin
- pp6 I12.bin, I22.bin
- pp7 I11.bin, I22.bin

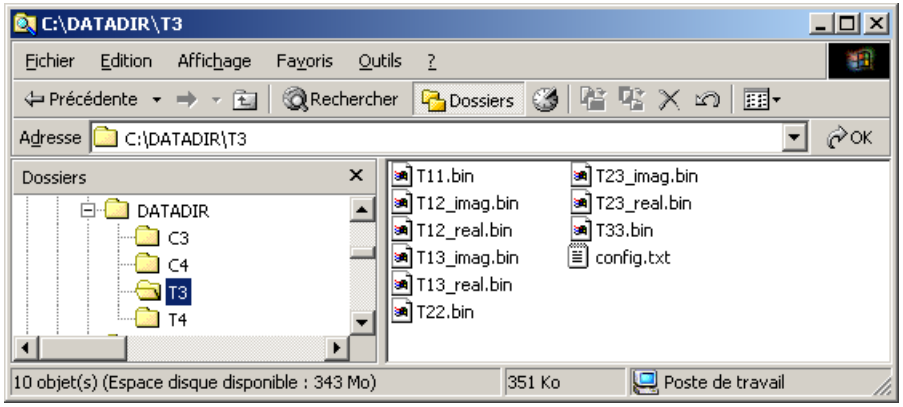
Nrow
1234

Ncol
4789

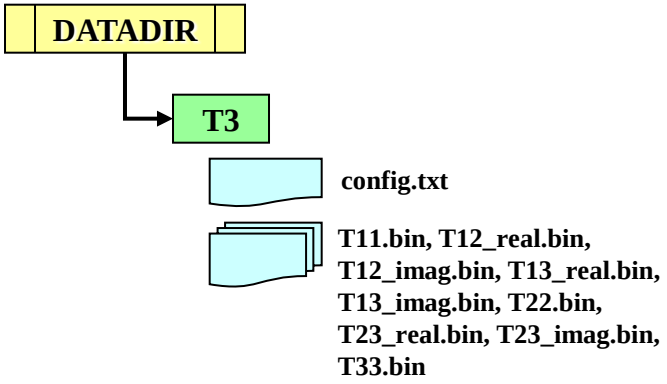
PolarCase
Monostatic/Bistatic/Intensities

PolarType
Full/pp1/pp2/pp3/pp4/pp5/pp6/pp7

Compatible Raw Binary Data



3x3 Complex Coherency Matrix [T3]



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

$$\Longrightarrow \qquad [T_3] = \langle \underline{k}_{3P} . \underline{k}_{3P}^{\dagger} \rangle$$

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

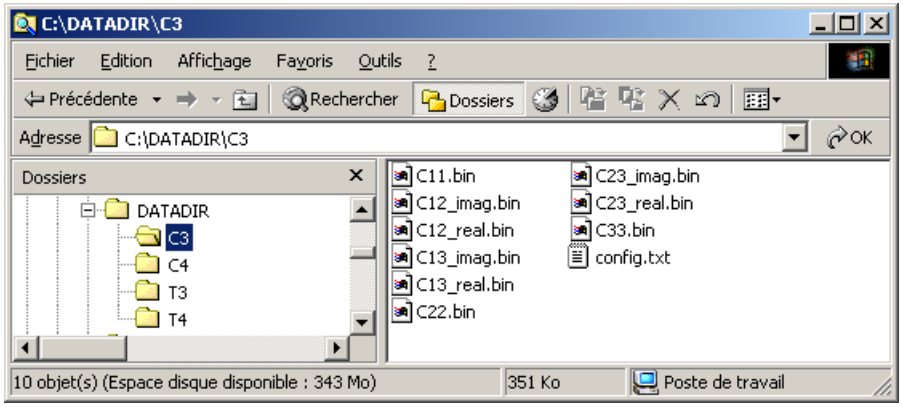
Nrow
1234

Ncol
4789

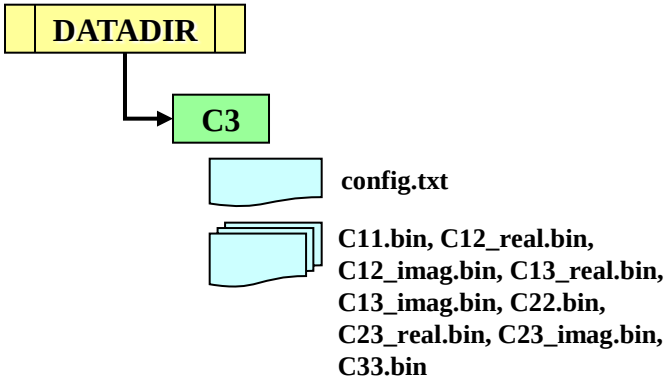
PolarCase
Monostatic/Bistatic

PolarType
Full

Compatible Raw Binary Data



3x3 Complex Covariance Matrix [C3]



$$\underline{k}_{3L} = \begin{bmatrix} S_{11} & S_{12}.\sqrt{2} & S_{22} \end{bmatrix}$$

$$\Longrightarrow \quad [C_3] = \langle \underline{k}_{3L} . \underline{k}_{3L}^{\dagger} \rangle$$

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

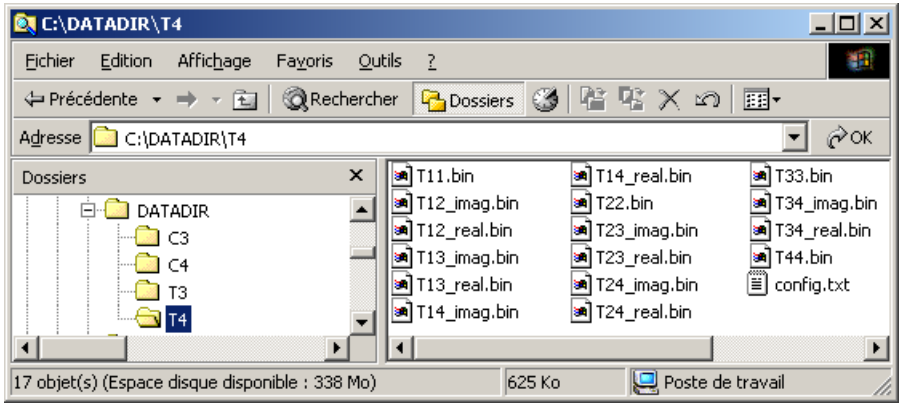
Nrow
1234

Ncol
4789

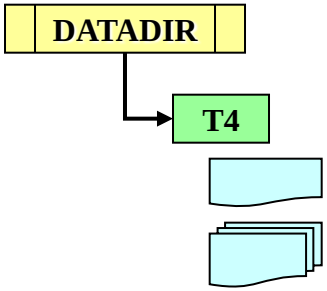
PolarCase
Monostatic/Bistatic

PolarType
Full

Compatible Raw Binary Data



4x4 Complex Coherency Matrix [T4]



$$\underline{k}_{4P} = \frac{1}{\sqrt{2}} \left[\; S_{11} + S_{22} \quad S_{11} - S_{22} \quad S_{12} + S_{21} \quad j(S_{12} - S_{21}) \; \right]$$

$$\Longrightarrow \quad [T_4] = \langle \underline{k}_{4P} . \underline{k}_{4P}^{\dagger} \rangle$$

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

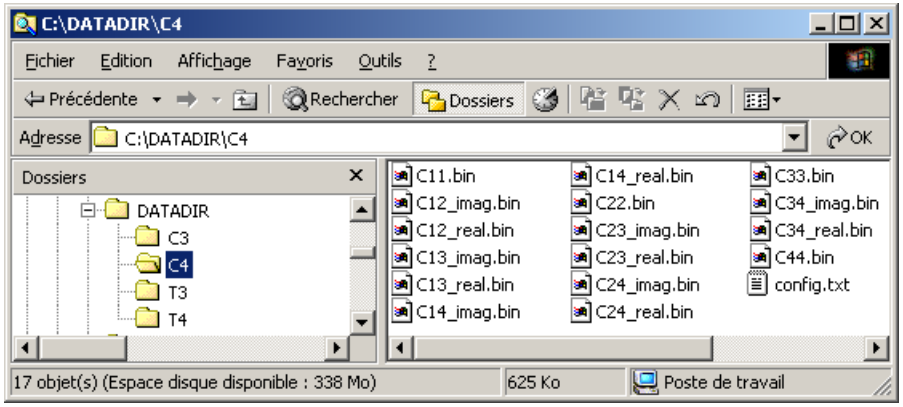
Nrow
1234

Ncol
4789

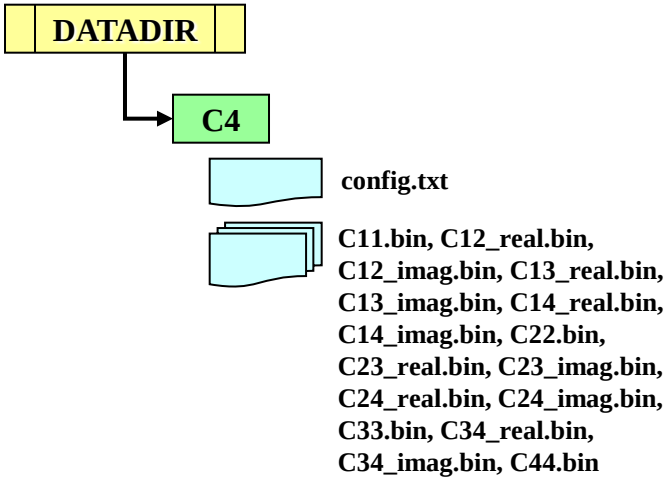
PolarCase
Bistatic

PolarType
Full

Compatible Raw Binary Data



4x4 Complex Covariance Matrix [C4]



$$\underline{k}_{4L} = \begin{bmatrix} S_{11} & S_{12} & S_{21} & S_{22} \end{bmatrix}$$

$$\Longrightarrow \qquad [C_4] = \langle \underline{k}_{4L} . \underline{k}_{4L}^{\dagger} \rangle$$

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

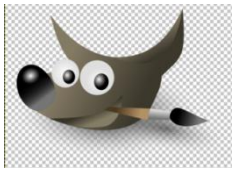
Nrow
1234

Ncol
4789

PolarCase
Bistatic

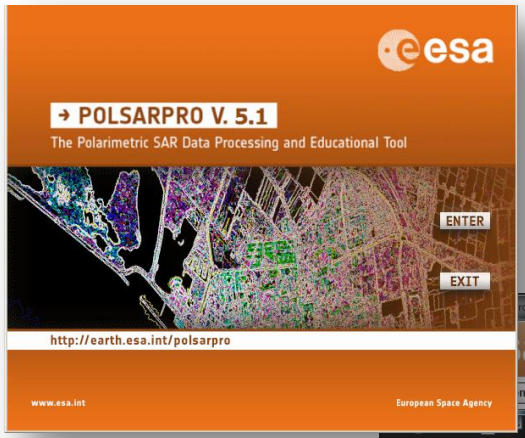
PolarType
Full

CONFIGURATION



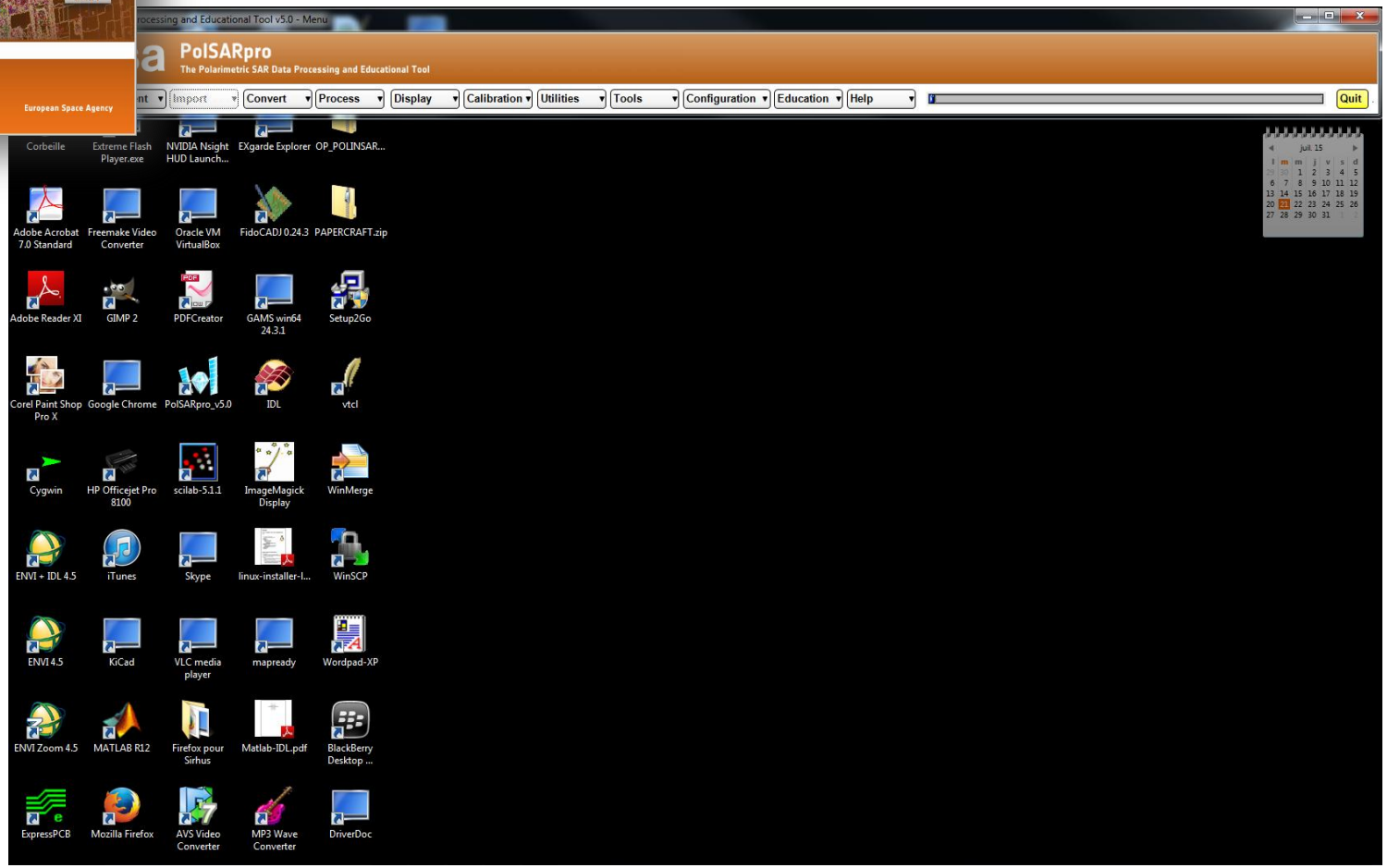
Google Earth

PolSARpro v5.1 SOFTWARE



ENTRY SCREEN

MAIN WINDOW

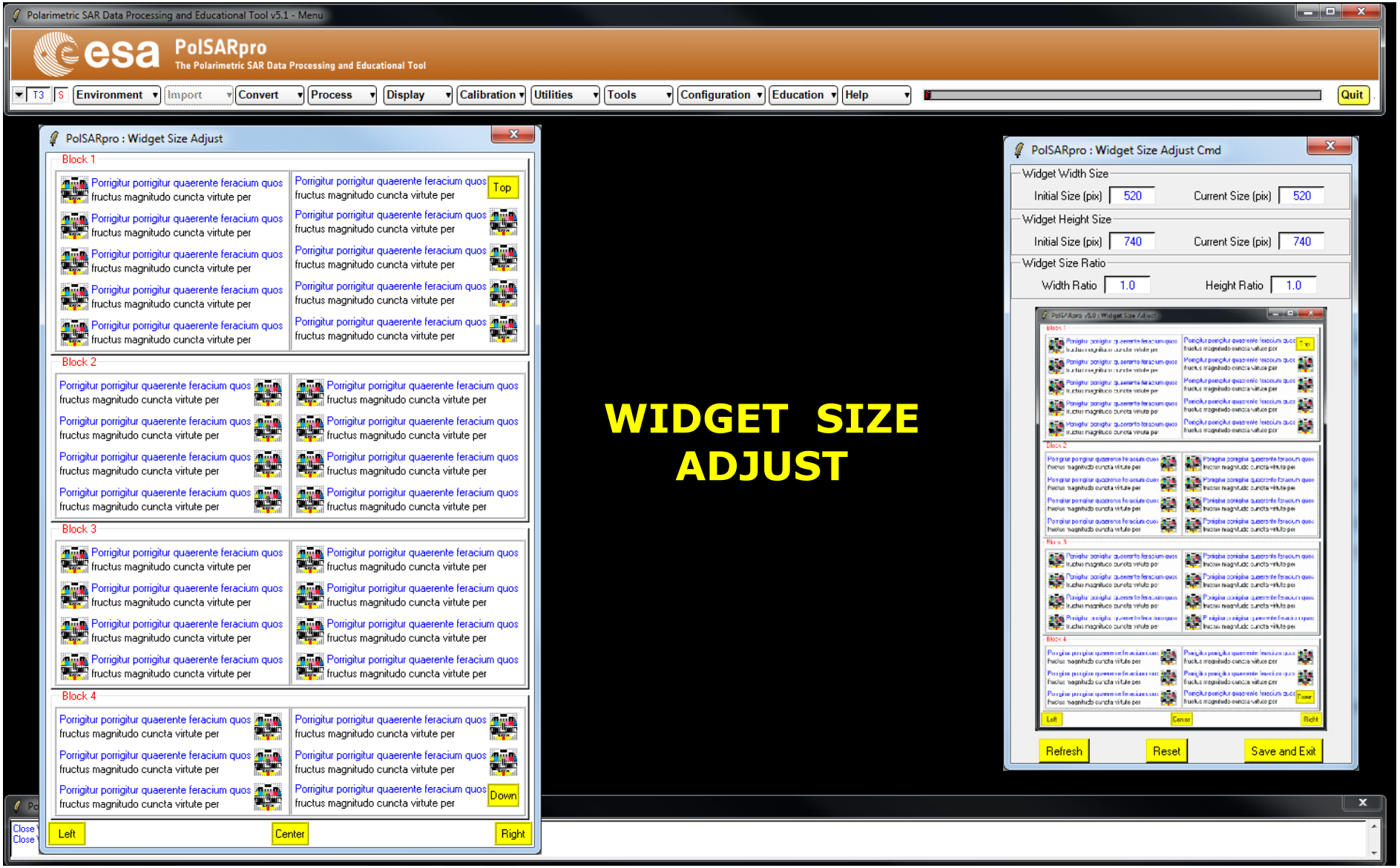


PolSARpro v5.1 SOFTWARE

PolSARpro v5.1 MAIN WINDOW

CONFIGURATION - 1st INSTALLATION

PolSARpro v5.1 SOFTWARE



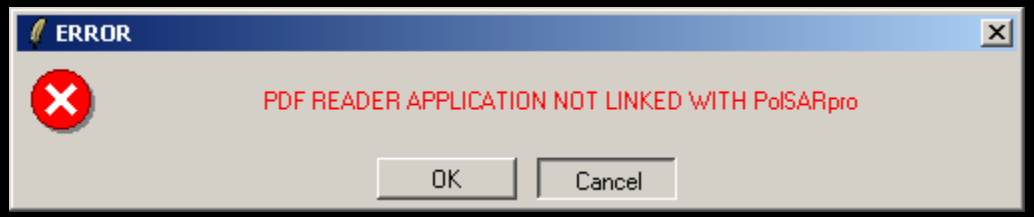
WIDGET SIZE ADJUST

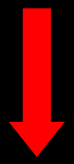
PolSARpro v5.1 SOFTWARE

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

esa PolSARpro
The Polarimetric SAR Data Processing and Educational Tool

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





PolSARpro Run Trace

Close Window Display Menu
Close Window Tools Menu

PolSARpro v5.1 SOFTWARE

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

esa PolSARpro
The Polarimetric SAR Data Processing and Educational Tool

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

WARNING

CREATE THE LINK WITH THE
PDF READER APPLICATION ?

Yes | No | Cancel

Configuration

PDF READER

Research one of the following exe files

acroread acrord32 acrobat xpdf kghostview ghostview gv

Path Name

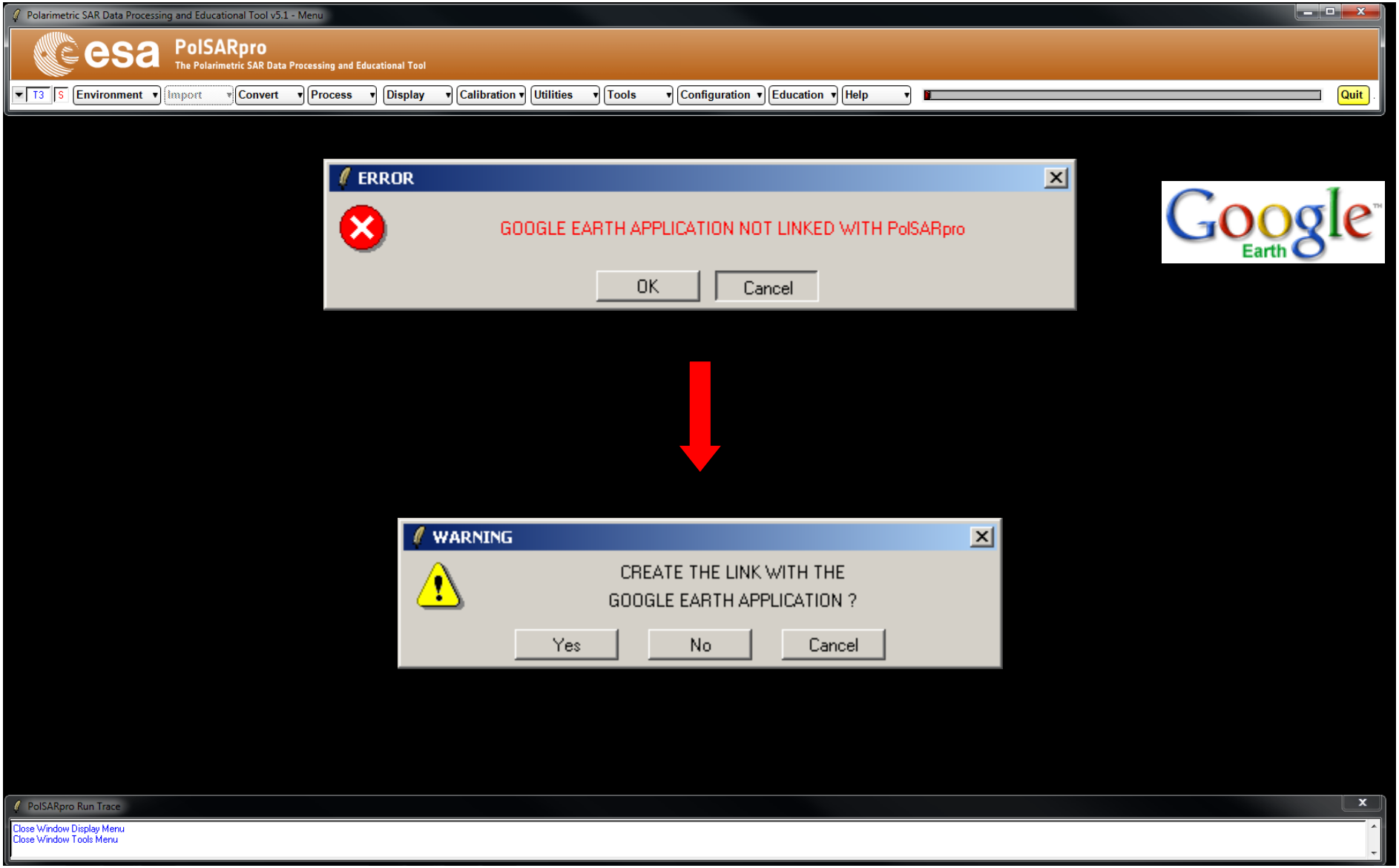
C:/Program Files/Adobe/Acrobat 7.0/Acrobat/Acrobat.exe

Save & Exit | Exit (without Saving)

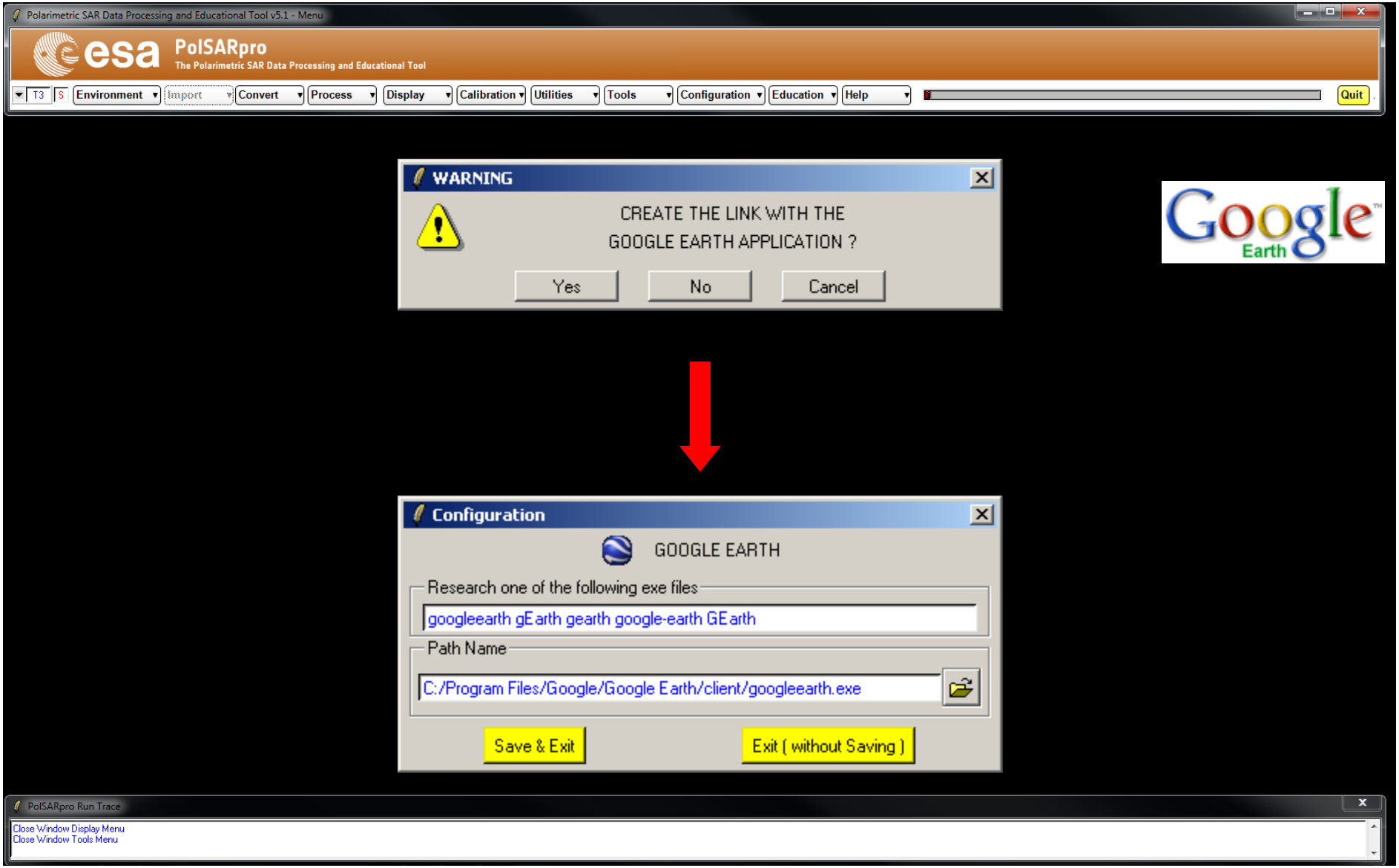
PolSARpro Run Trace

Close Window Display Menu
Close Window Tools Menu

PolSARpro v5.1 SOFTWARE



PolSARpro v5.1 SOFTWARE



PolSARpro v5.1 SOFTWARE

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

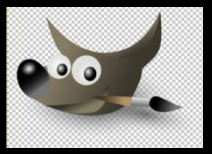
esa PolSARpro
The Polarimetric SAR Data Processing and Educational Tool

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

ERROR

GIMP VIEWER APPLICATION NOT LINKED WITH PolSARpro

OK | Cancel



WARNING

CREATE THE LINK WITH THE
GIMP VIEWER APPLICATION ?

Yes | No | Cancel

PolSARpro Run Trace

Close Window Display Menu
Close Window Tools Menu

PolSARpro v5.1 SOFTWARE

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

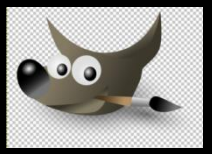
esa PolSARpro
The Polarimetric SAR Data Processing and Educational Tool

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

WARNING

CREATE THE LINK WITH THE
GIMP VIEWER APPLICATION ?

Yes | No | Cancel



Configuration

GIMP

Research one of the following exe files

gimp-2.6

Path Name

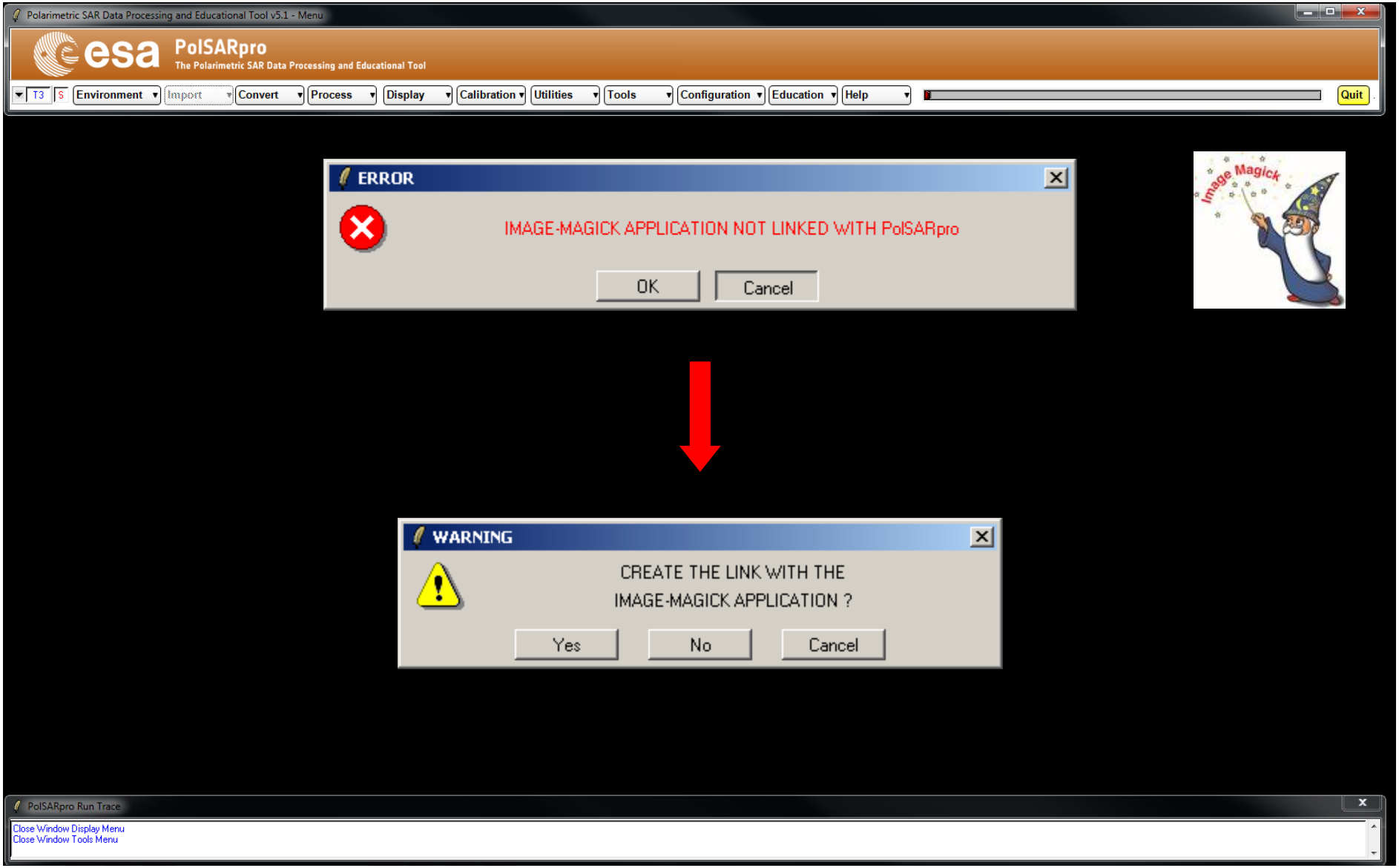
C:/Program Files/GIMP-2.0/bin/gimp-2.6.exe

Save & Exit | Exit (without Saving)

PolSARpro Run Trace

Close Window Display Menu
Close Window Tools Menu

PolSARpro v5.1 SOFTWARE



PolSARpro v5.1 SOFTWARE

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

esa PolSARpro
The Polarimetric SAR Data Processing and Educational Tool

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

WARNING

CREATE THE LINK WITH THE
IMAGE-MAGICK APPLICATION ?

Yes | No | Cancel

Configuration

IMAGE MAGICK

Research one of the following exe files

convert

Path Name

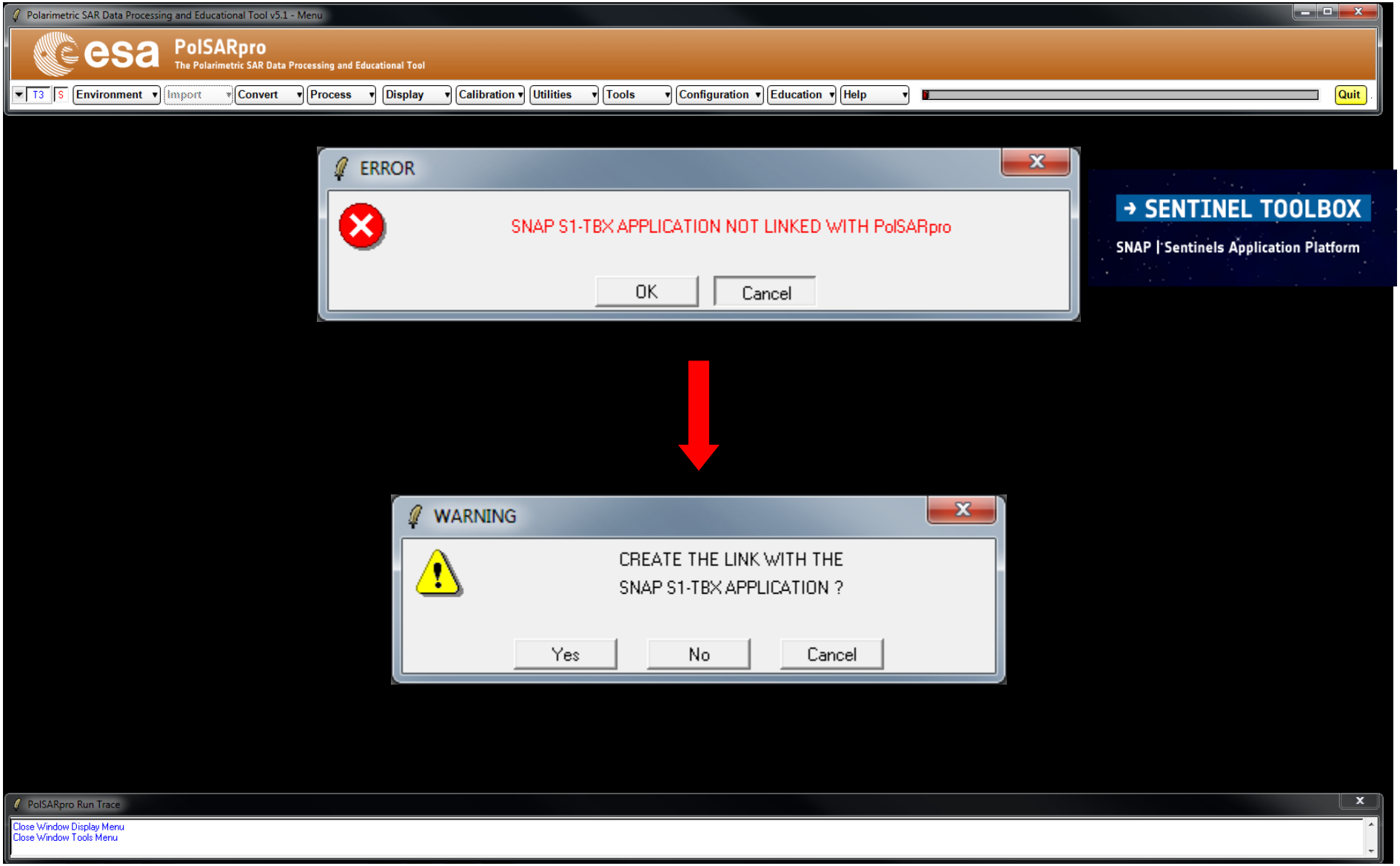
C:/Program Files/ImageMagick-6.5.1-Q8/convert.exe

Save & Exit | Exit (without Saving)

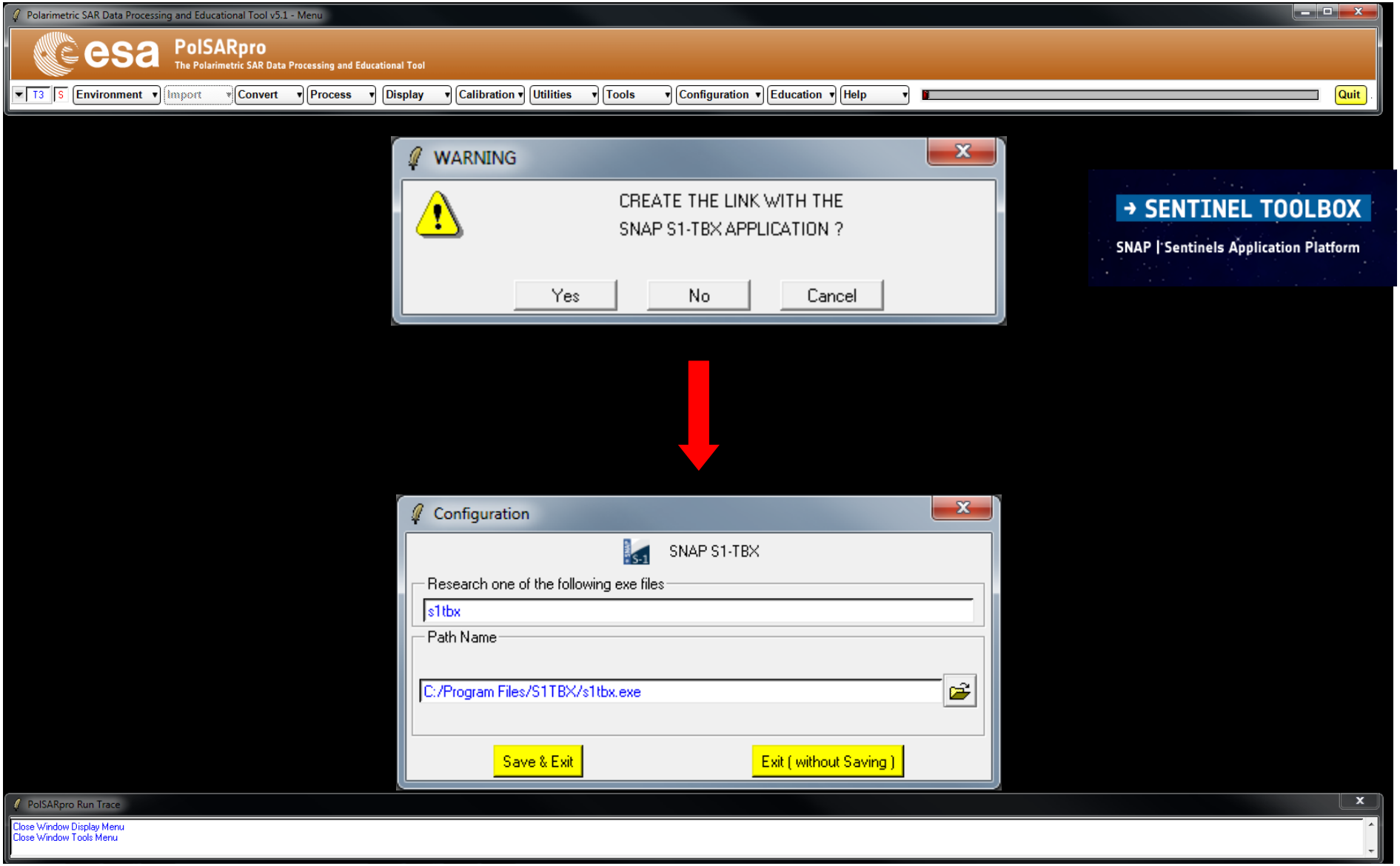
PolSARpro Run Trace

Close Window Display Menu
Close Window Tools Menu

PolSARpro v5.1 SOFTWARE



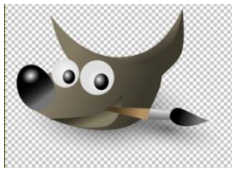
PolSARpro v5.1 SOFTWARE



→ SENTINEL TOOLBOX

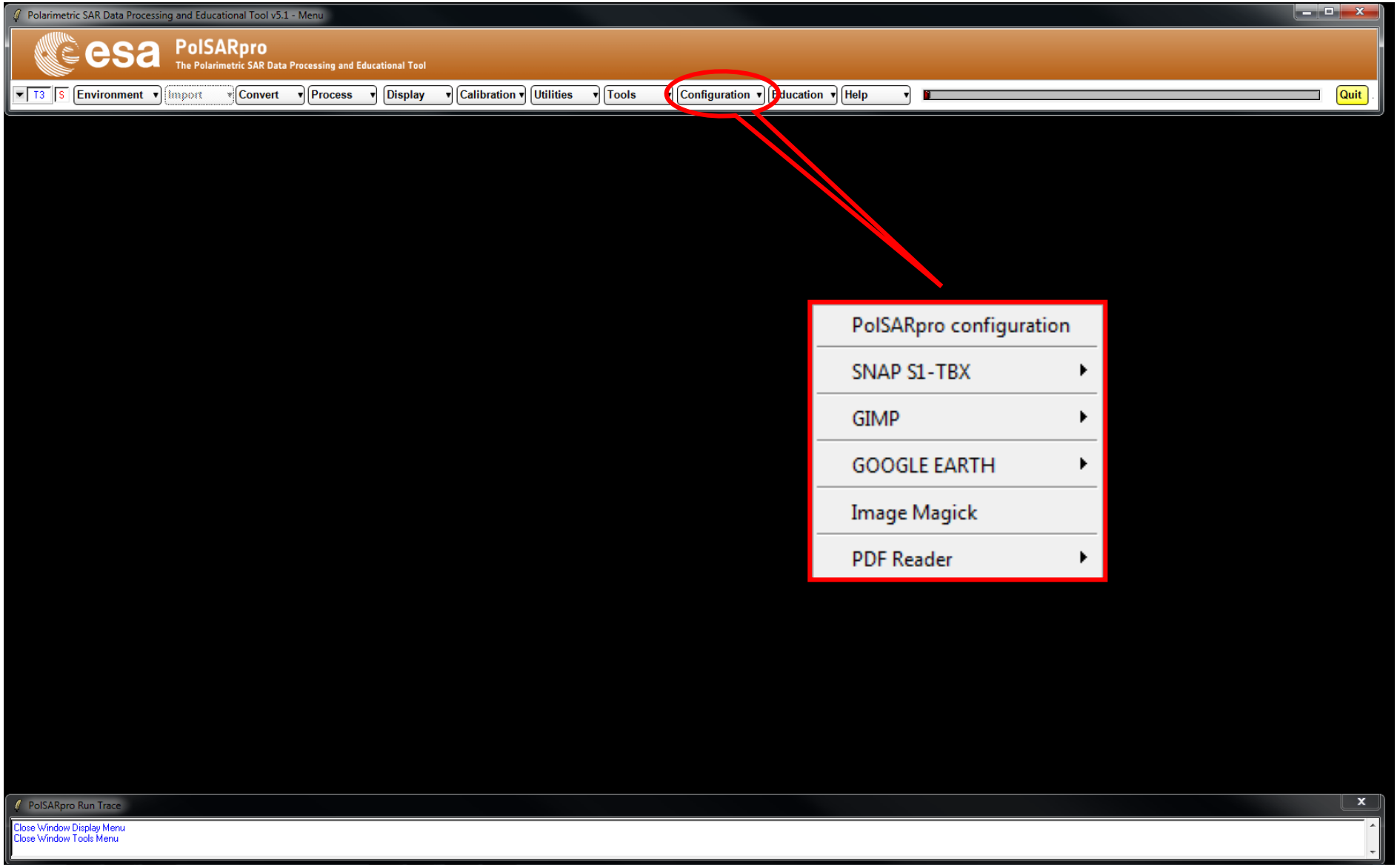
SNAP | Sentinels Application Platform

TEST THE CONFIGURATION

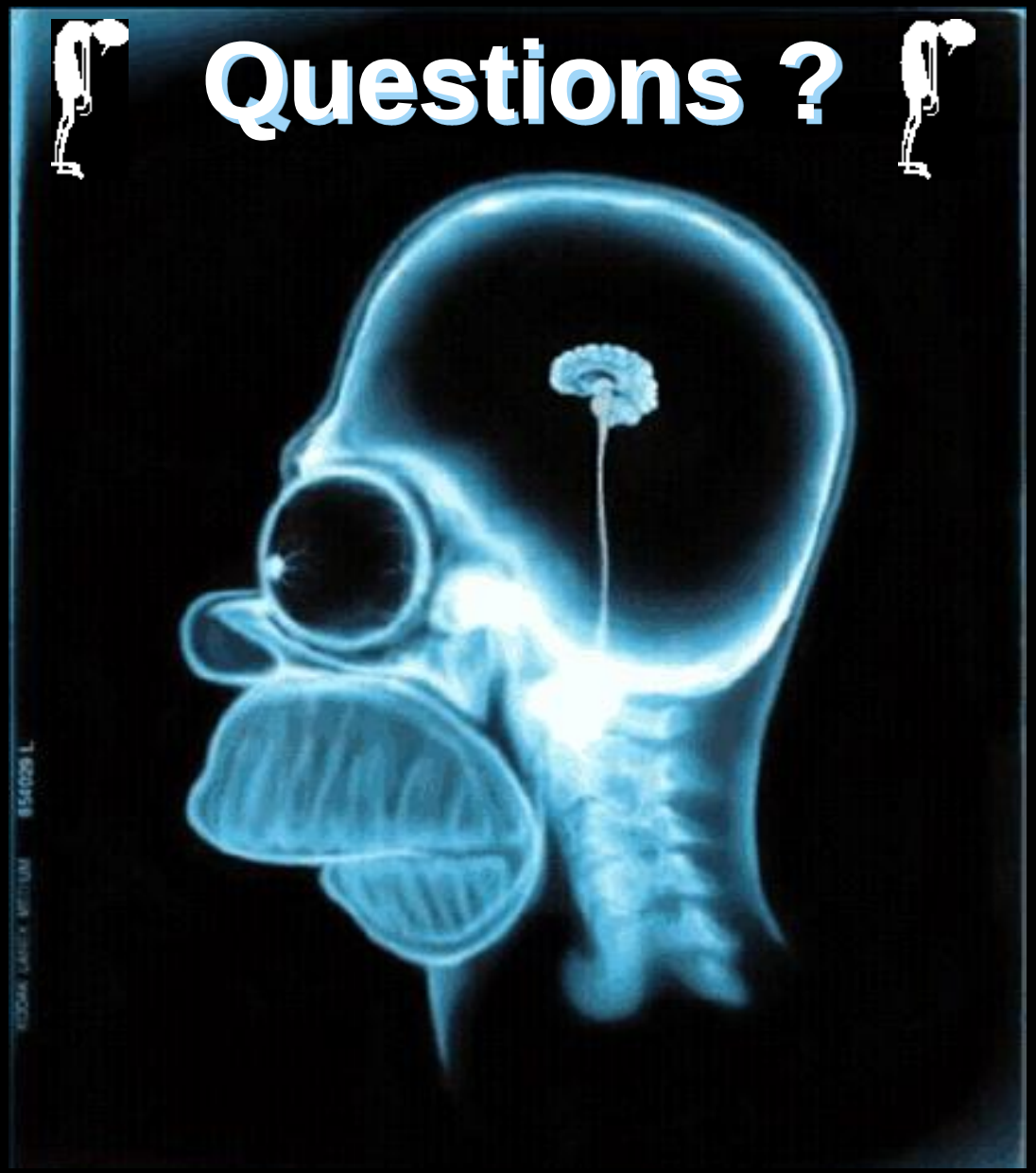


Google Earth

PolSARpro v5.1 SOFTWARE

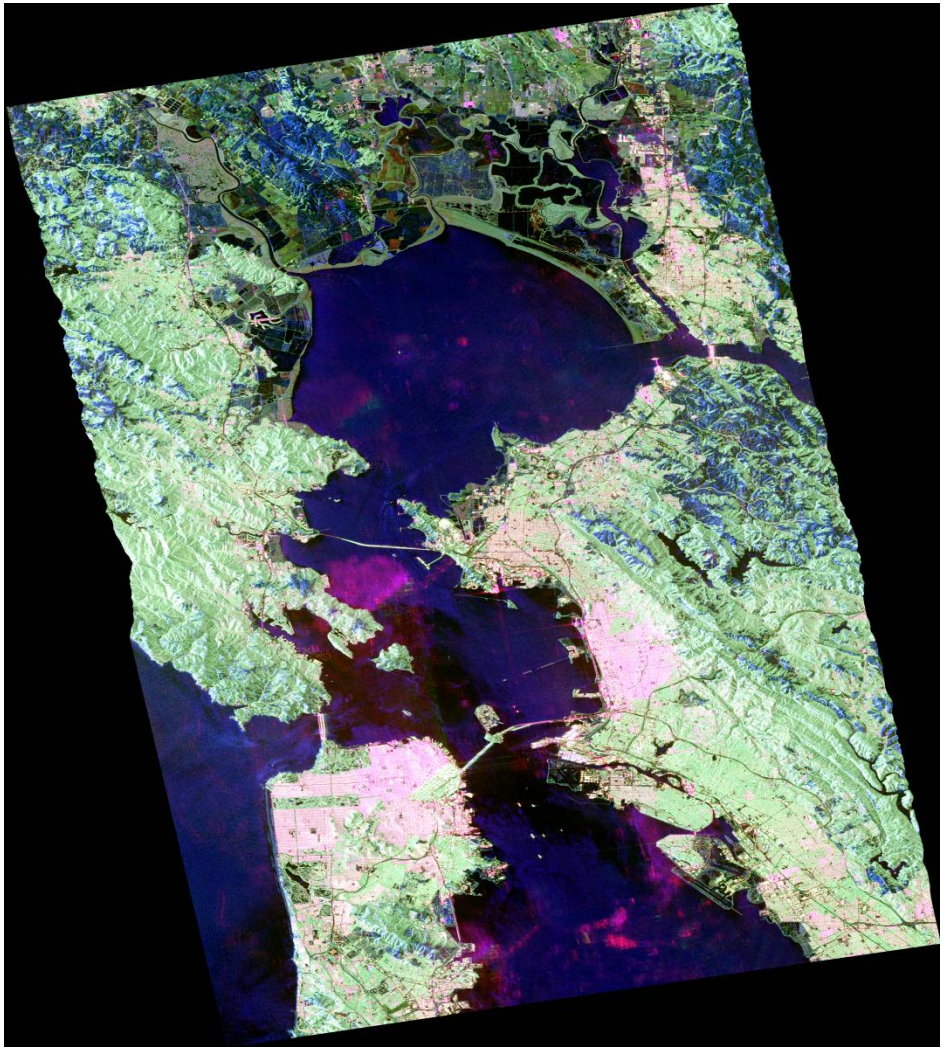


Questions ?



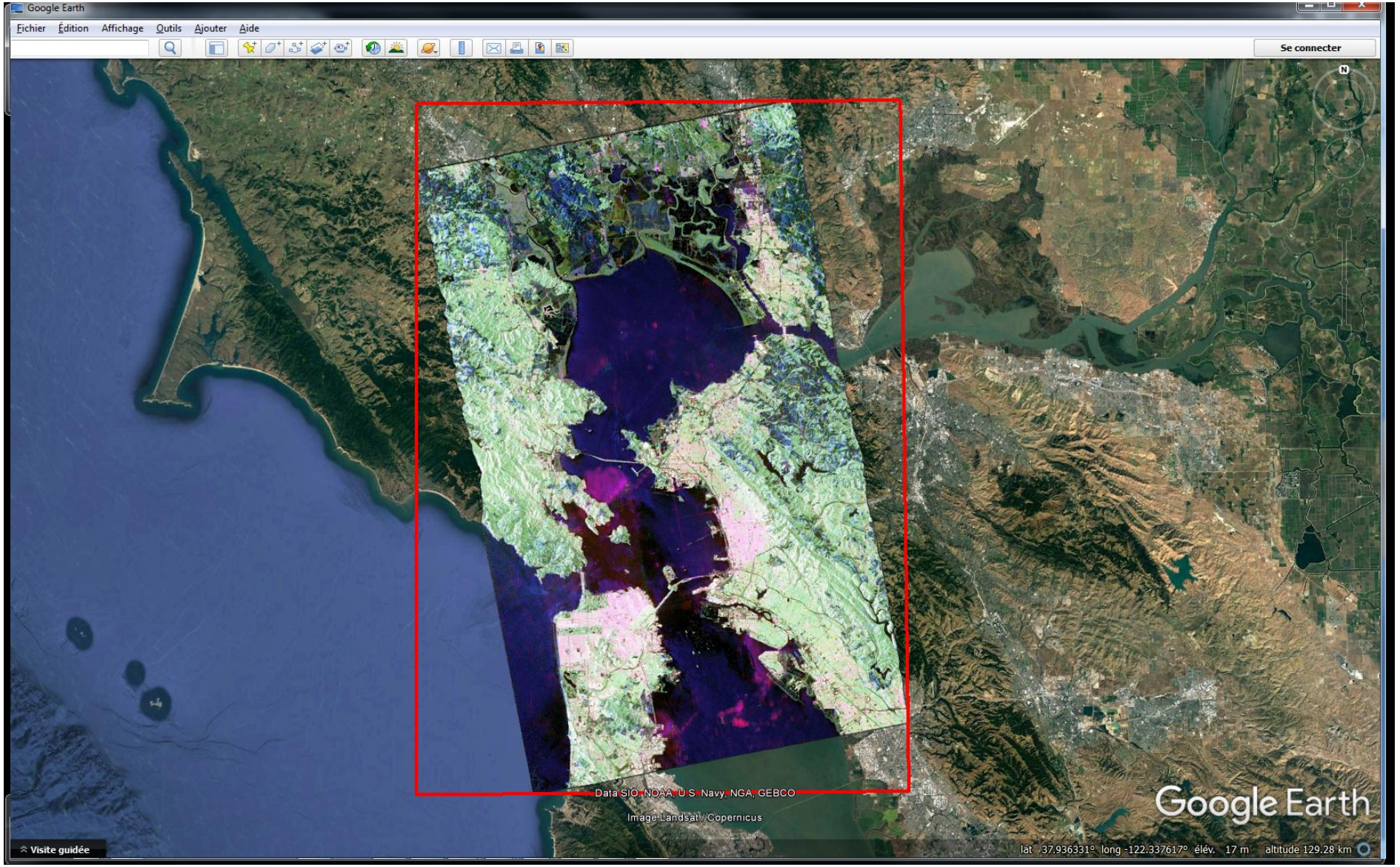
PolSARpro v5.1 Software
Practical basic session

ALOS
Advanced Land Observing Satellite



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

PolSARpro v5.1 SOFTWARE

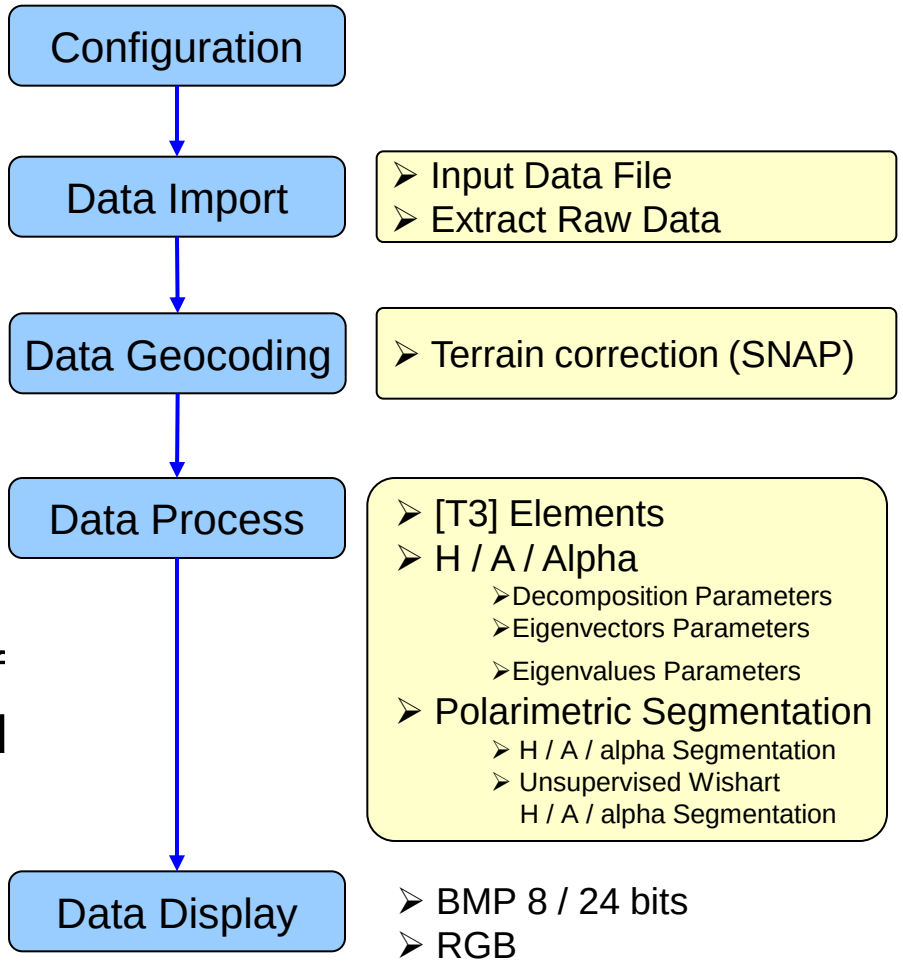


PROCESSING CHAIN

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

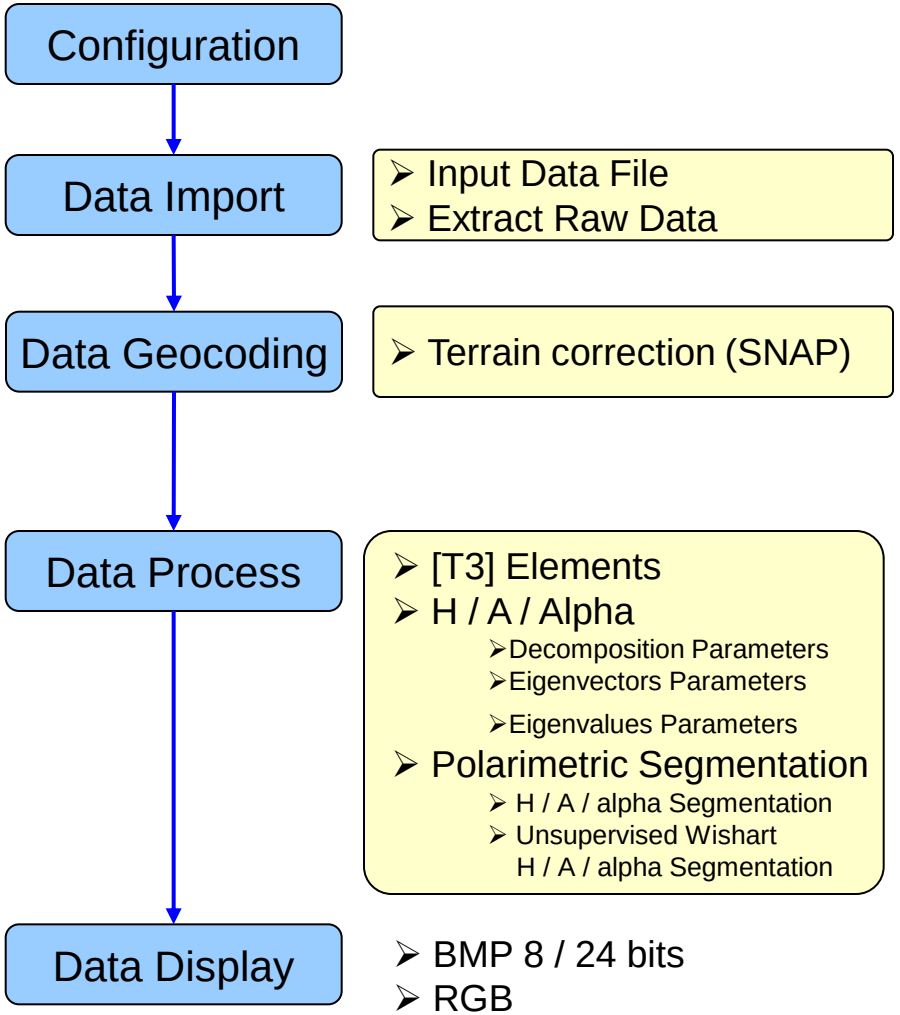
Provide a **First Qualitative Analysis** of the fully polarimetric data set processed



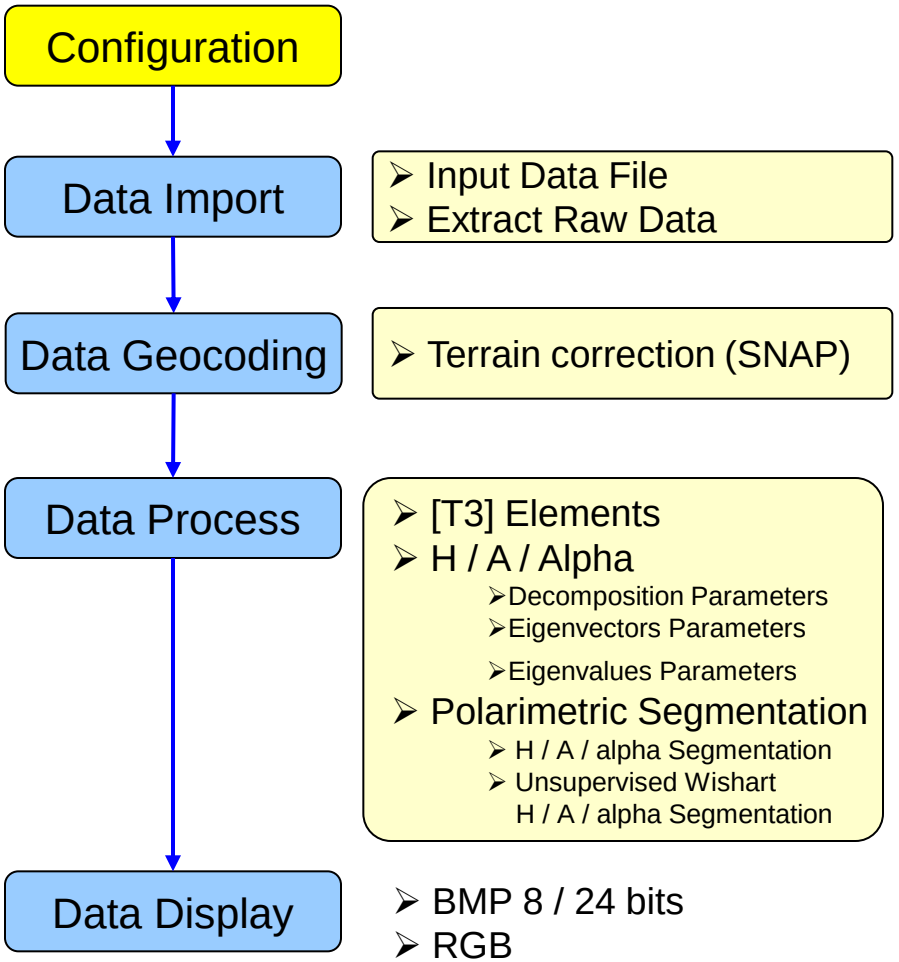
PROCESSING CHAIN

20mn

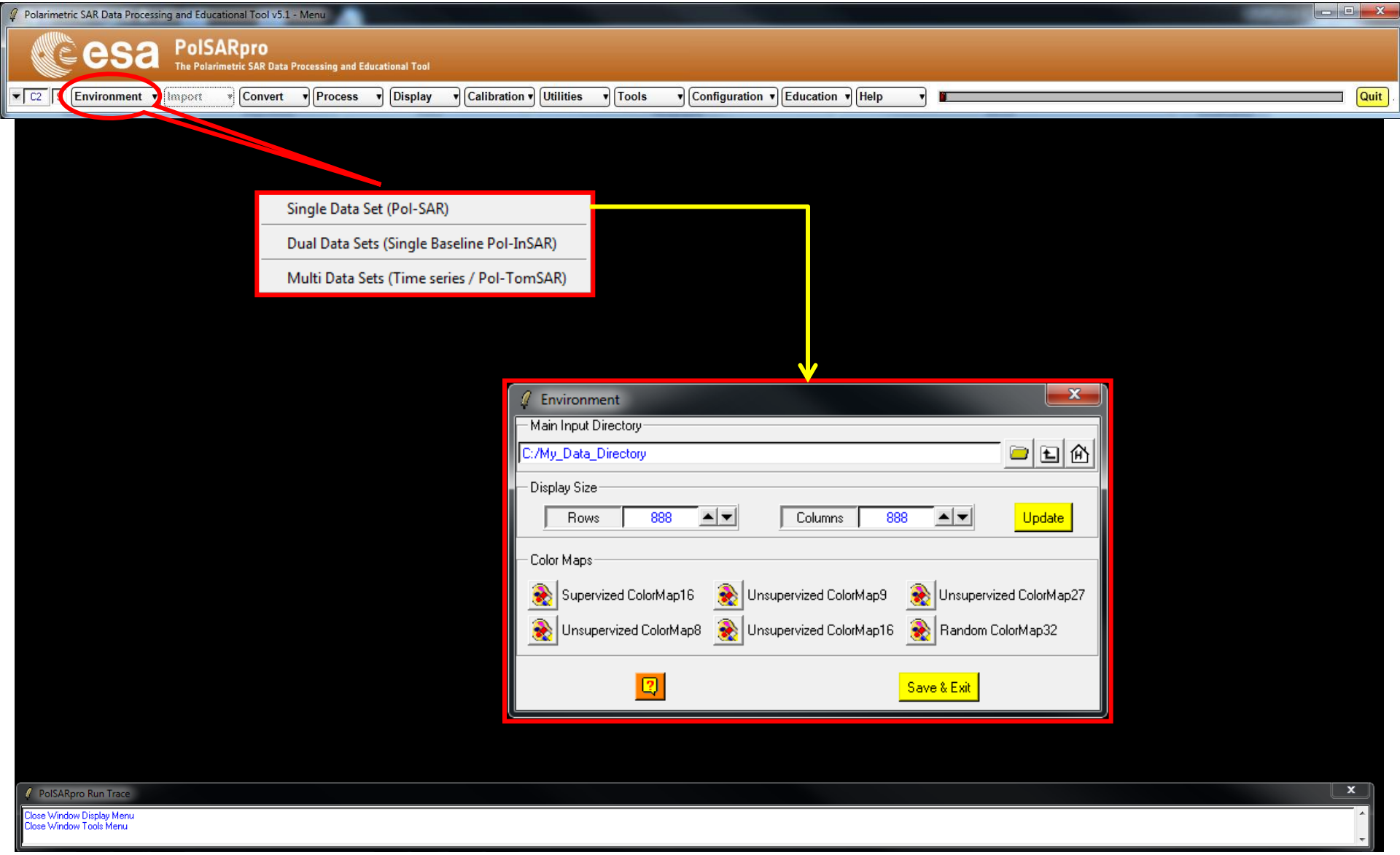
18mn



PROCESSING CHAIN



PolSARpro v5.1 SOFTWARE



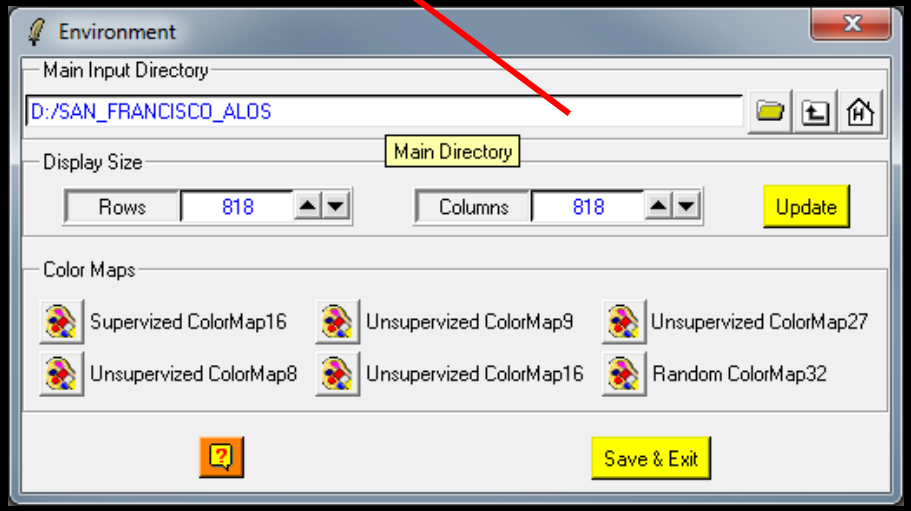
ENVIRONMENT

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

esa PolSARpro
The Polarimetric SAR Data Processing and Educational Tool

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

Configure Data Main Directory location



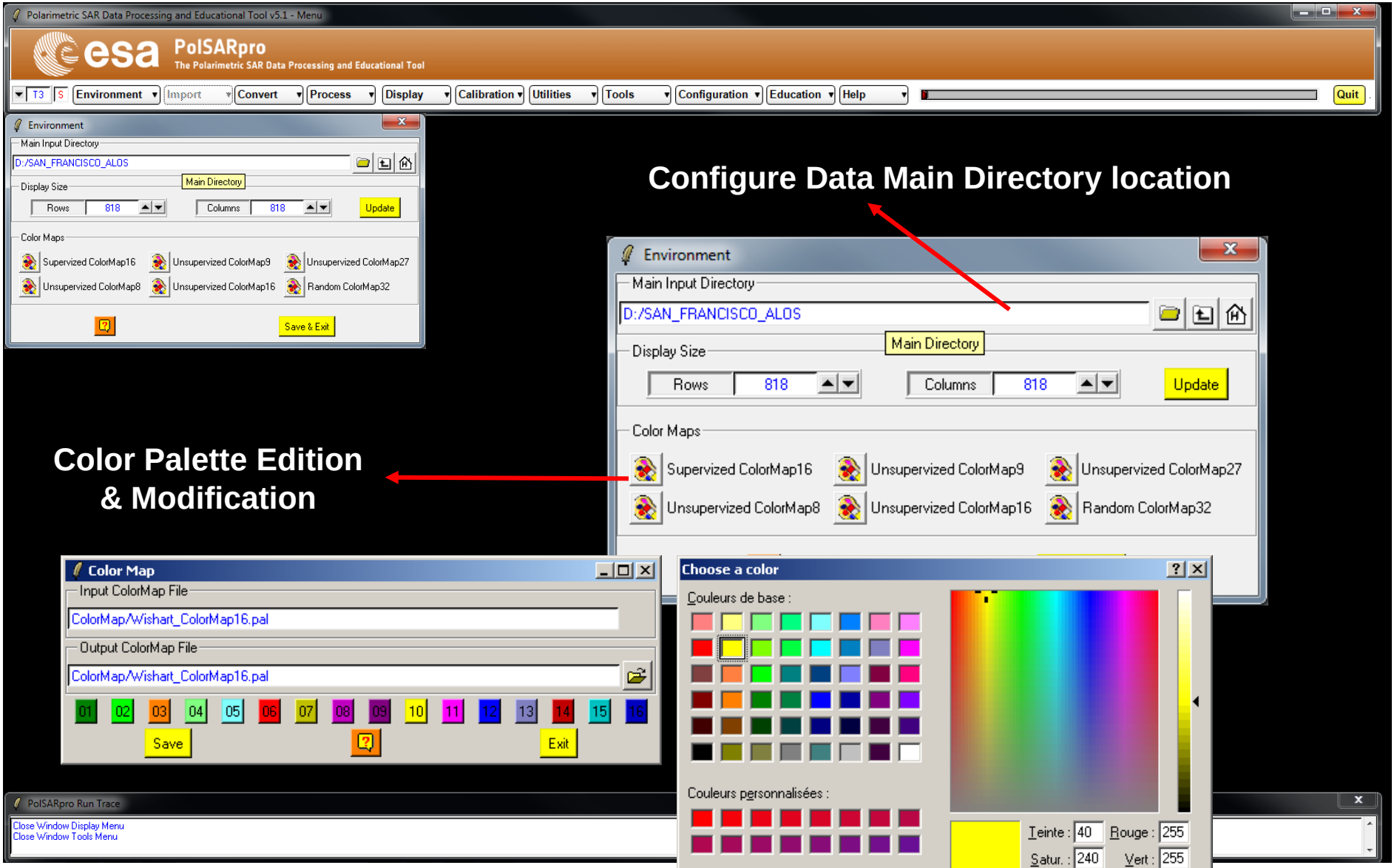
Input Data Directory :

SAN_FRANCISCO_ALOS2

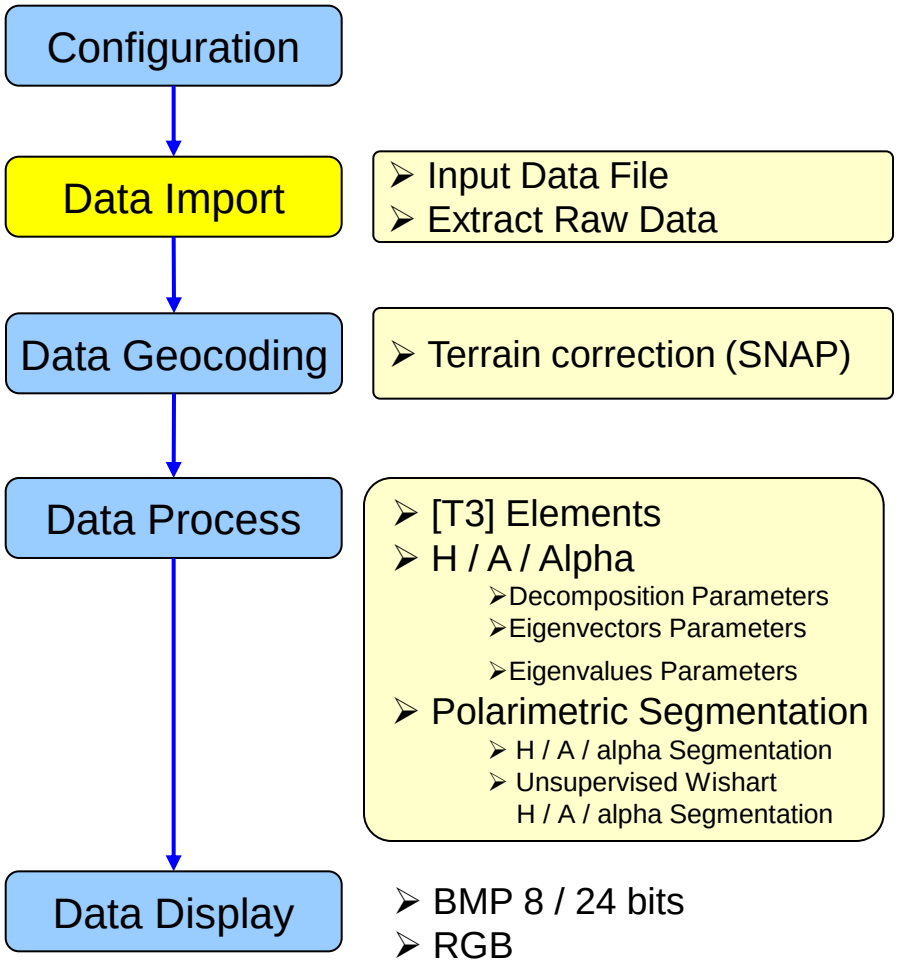
PolSARpro Run Trace

Close Window Display Menu
Close Window Tools Menu

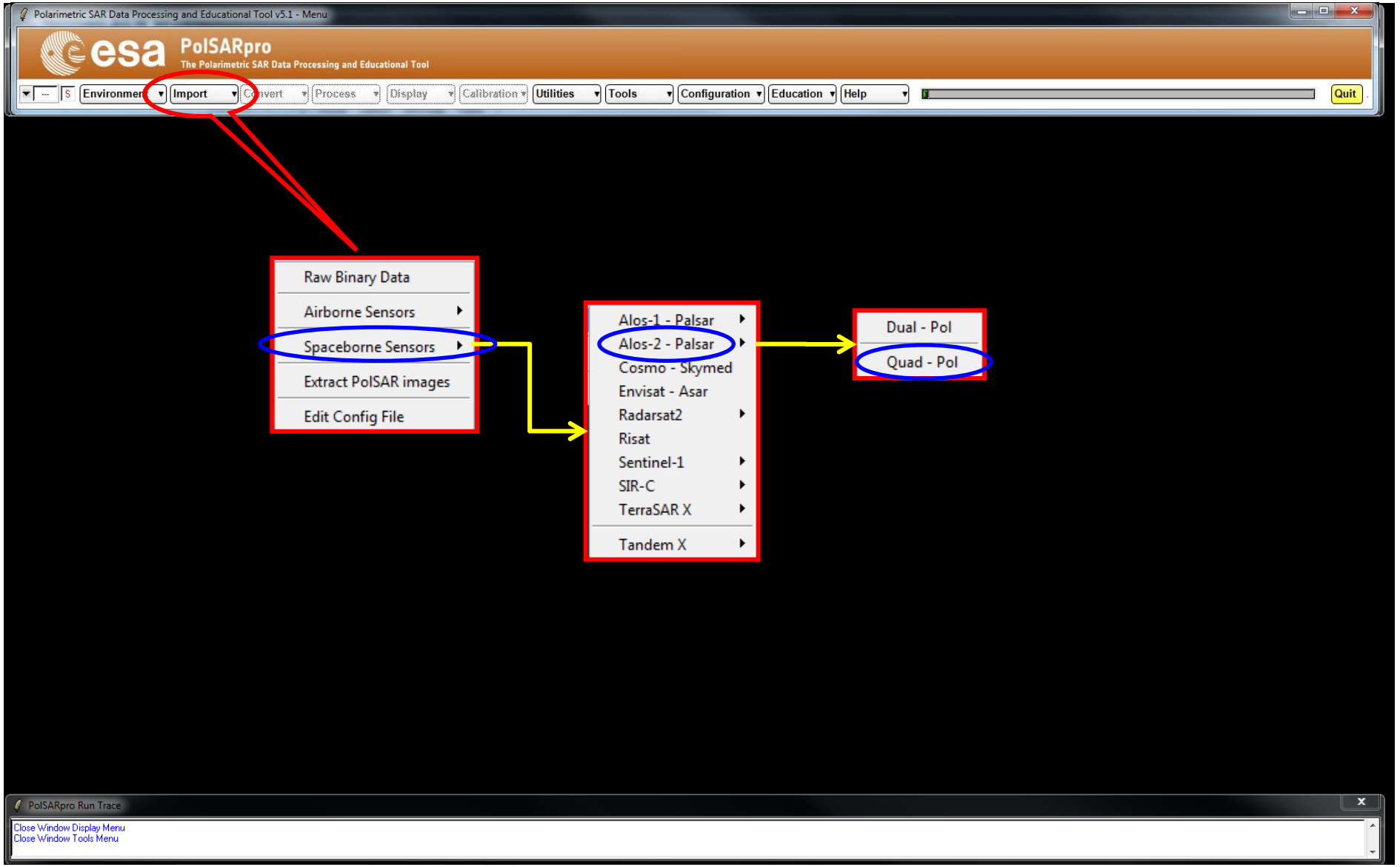
ENVIRONMENT



PROCESSING CHAIN



ENVIRONNEMENT



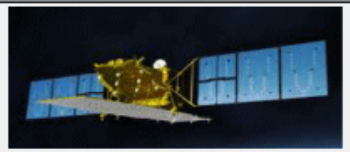
Data IMPORT – Input Data File

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

ALOS Input Data File (JAXA - CEOS Format)



Input Directory
D:/SAN_FRANCISCO_ALOS2

Output Directory
D:/SAN_FRANCISCO_ALOS2

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

Check Files

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

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

OK

Do it Yourself:

Enter SAR Leader File
Check File

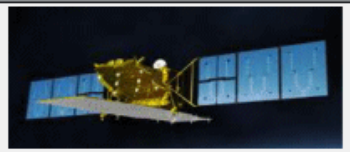
Data IMPORT – Input Data File

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

ALOS Input Data File (JAXA - CEOS Format)



Input Directory: D:/SAN_FRANCISCO_ALOS2

Output Directory: D:/SAN_FRANCISCO_ALOS2

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

Check Files

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

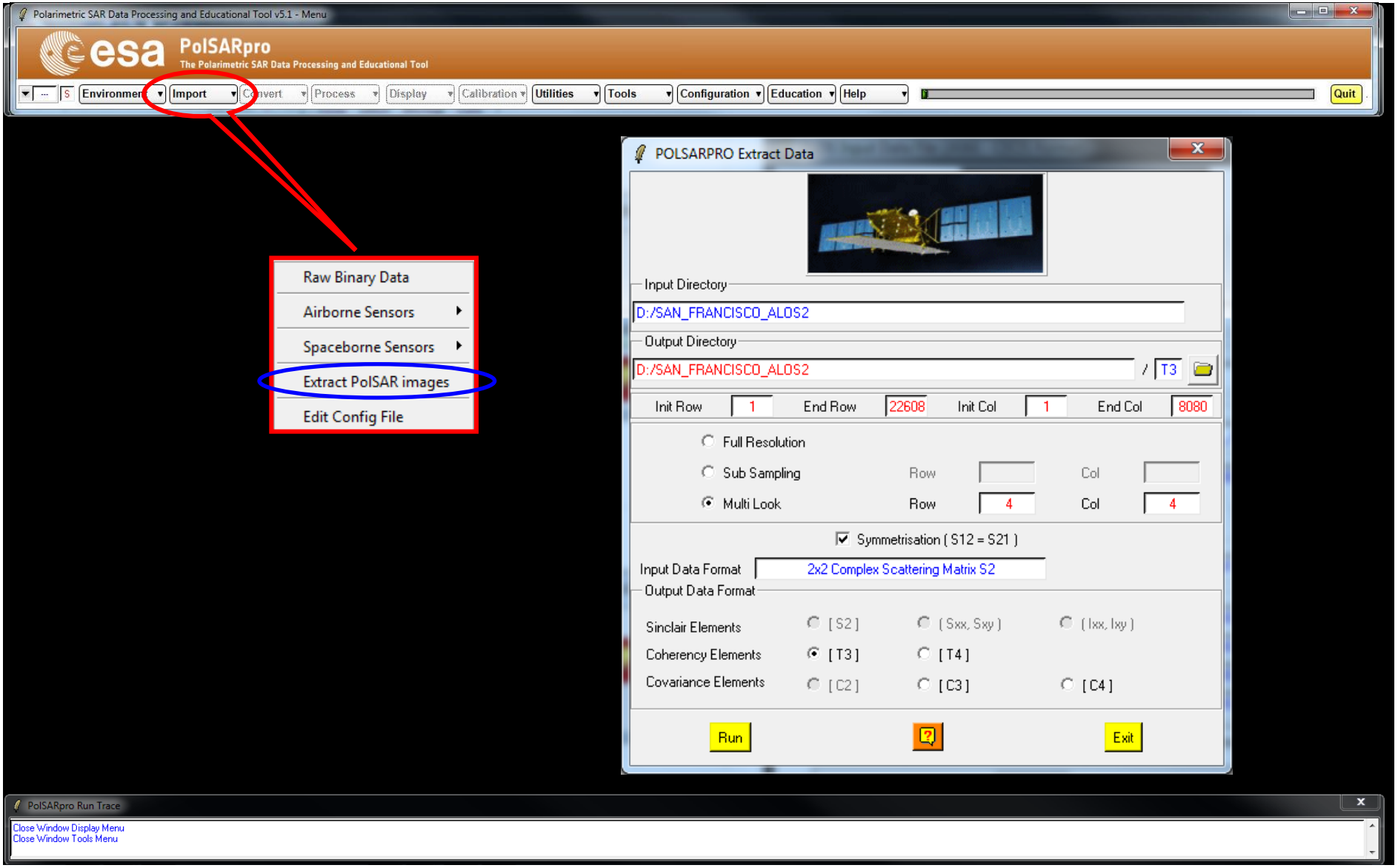
DON'T FORGET TO EXTRACT DATA
BEFORE RUNNING ANY DATA PROCESS

OK

Do it Yourself:

Enter SAR Leader File
Read Header
OK

ENVIRONNEMENT



Data IMPORT – Extract Binary Data

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

PolSARpro
The Polarimetric SAR Data Processing and Educational Tool

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

Do it Yourself:

Multi Look : Row = 4 Col = 4
Run

POLSARPRO 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

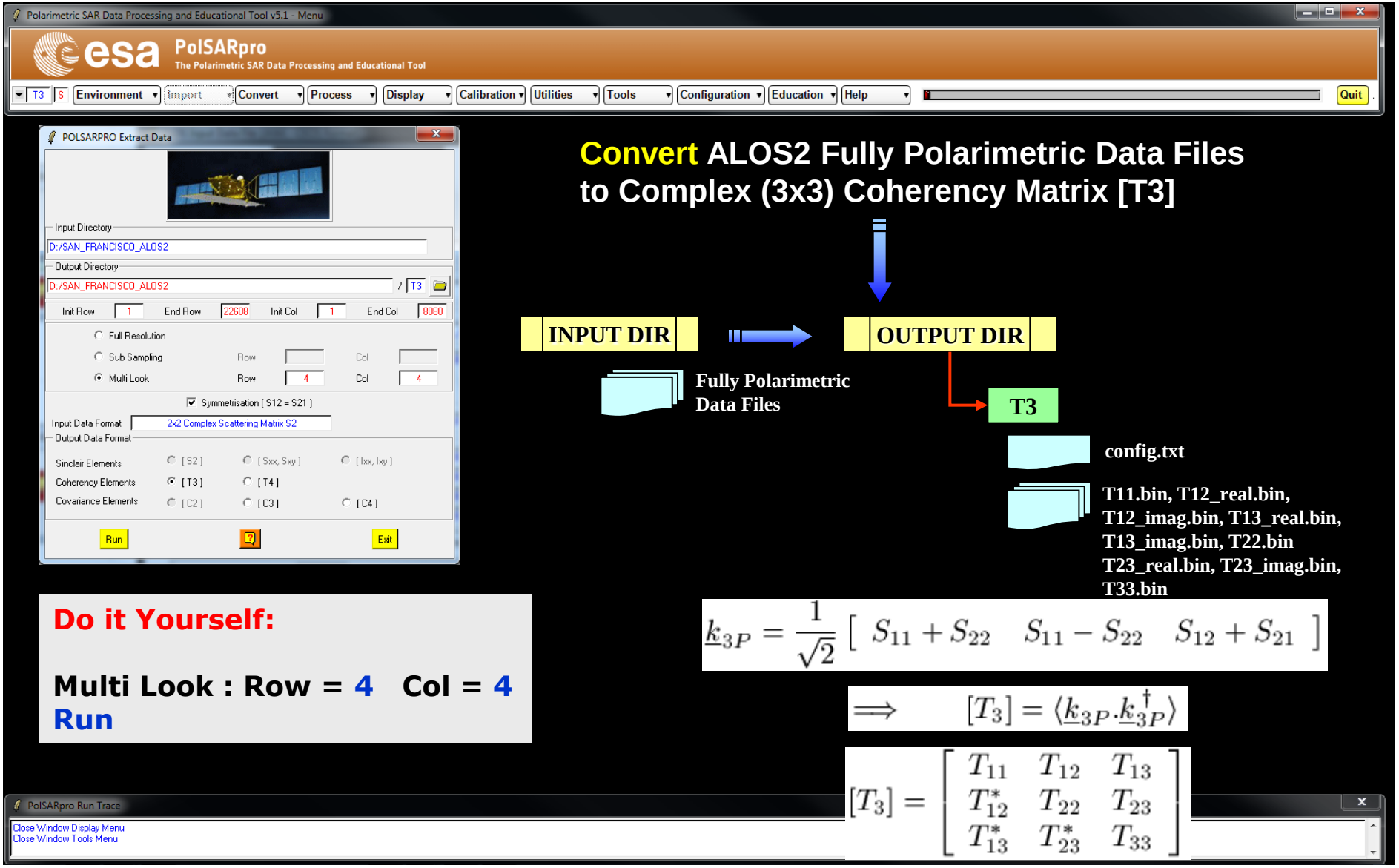
Sinclair Elements	[S2]	(Sxx, Sxy)	(Ixx, Ixy)
Coherency Elements	[T3]	[T4]	
Covariance Elements	[C2]	[C3]	[C4]

Run | Exit

PolSARpro Run Trace

Close Window Display Menu
Close Window Tools Menu

Data IMPORT – Extract Binary Data



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

INPUT DIR → **OUTPUT DIR**

Fully Polarimetric Data Files

T3

config.txt

T11.bin, T12_real.bin, T12_imag.bin, T13_real.bin, T13_imag.bin, T22.bin T23_real.bin, T23_imag.bin, T33.bin

Do it Yourself:

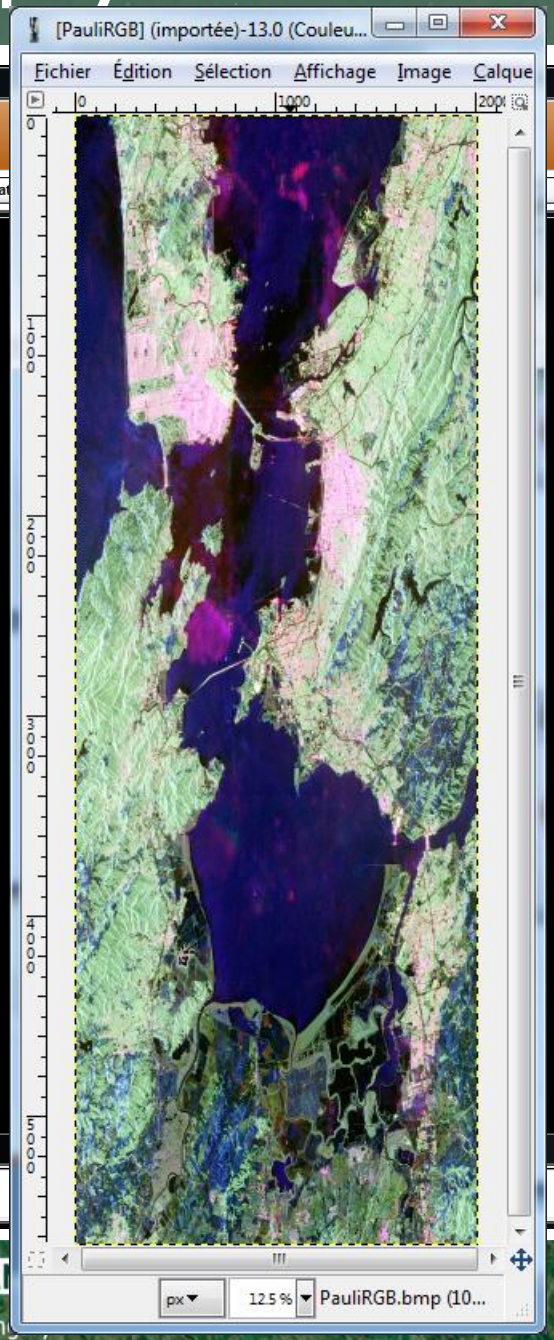
Multi Look : Row = 4 Col = 4
Run

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

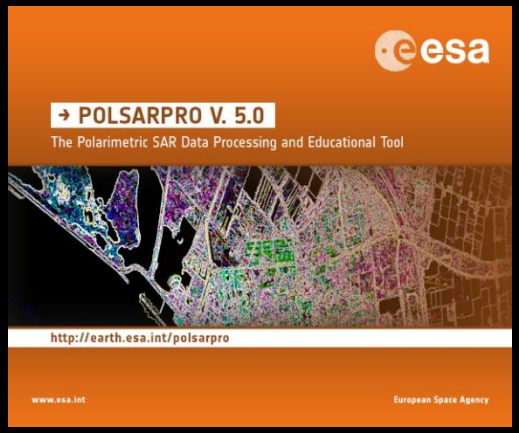
$$\Longrightarrow \quad [T_3] = \langle \underline{k}_{3P} . \underline{k}_{3P}^{\dagger} \rangle$$

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

Display Pauli-RGB Image

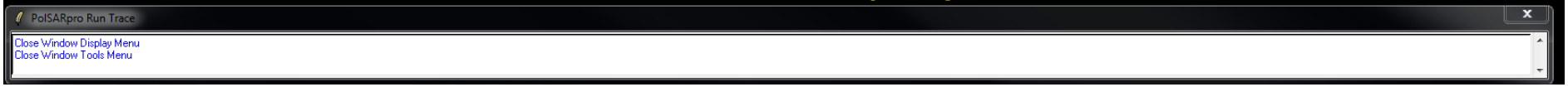


ESA - SNAP



Polariametric Data Processing

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



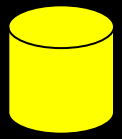
PolSARpro v5.1 SOFTWARE

ESA - SNAP

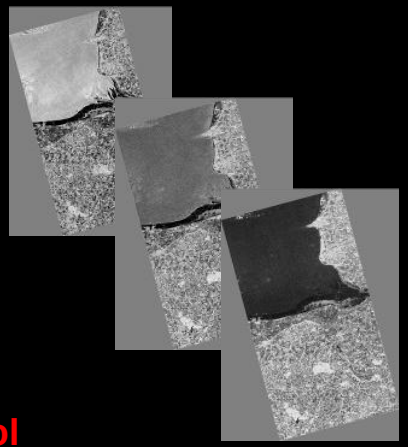
Pre-Processing
Data Extract

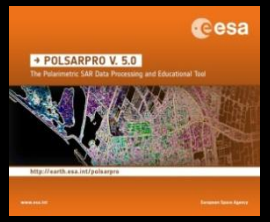
Geo-Coding
Terrain Correct - UTM Proj.

Post - Processing



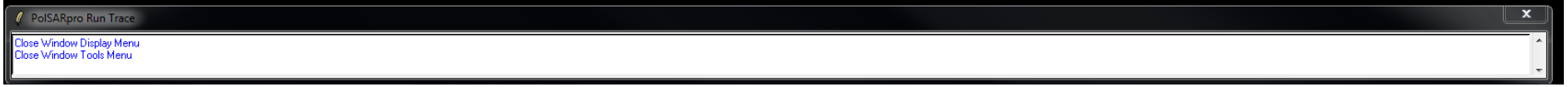
POLARIMETRIC DATA SETS



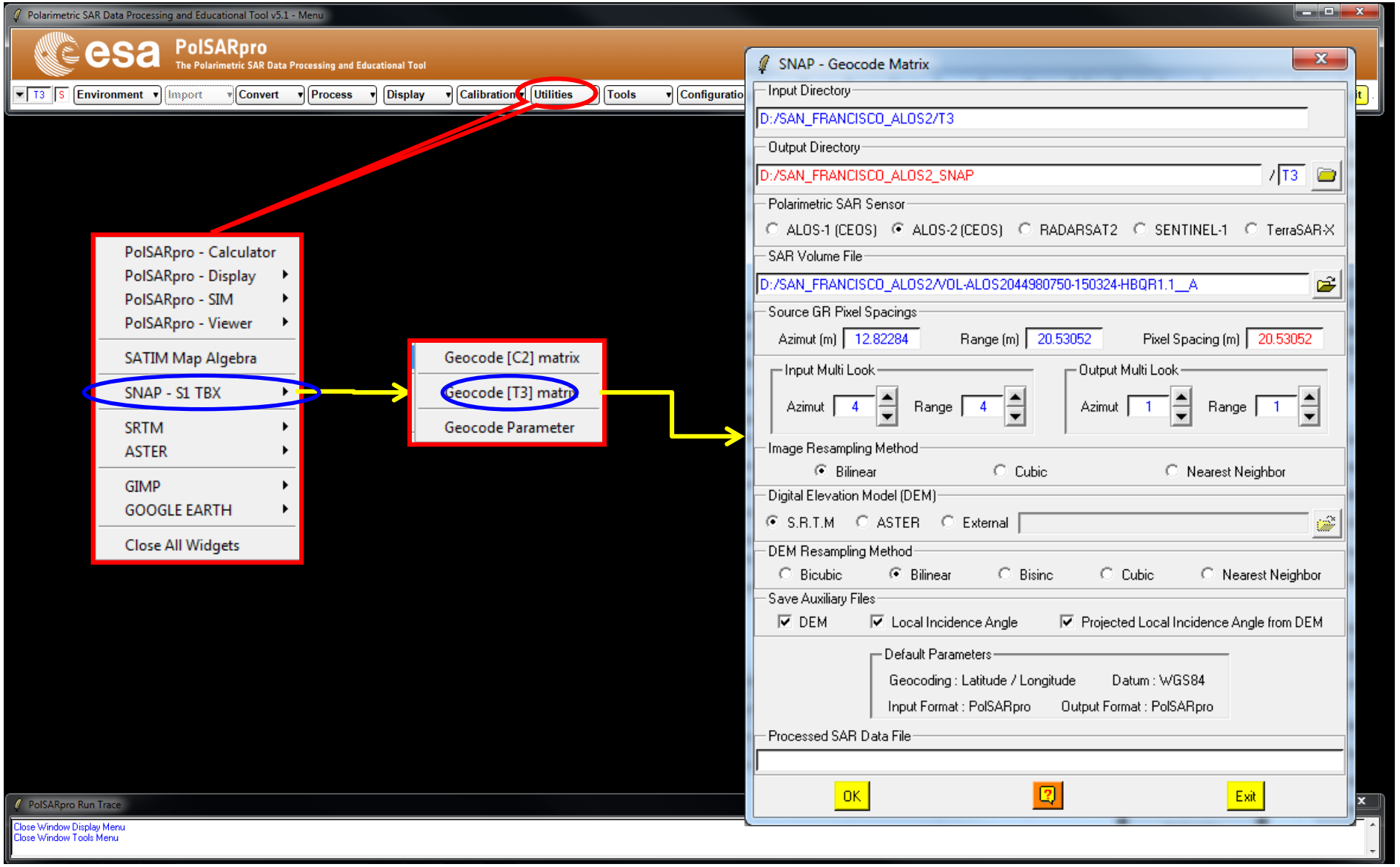


Only valid for:
[C2] matrix: Dual-Pol
[T3] matrix: Quad-Pol

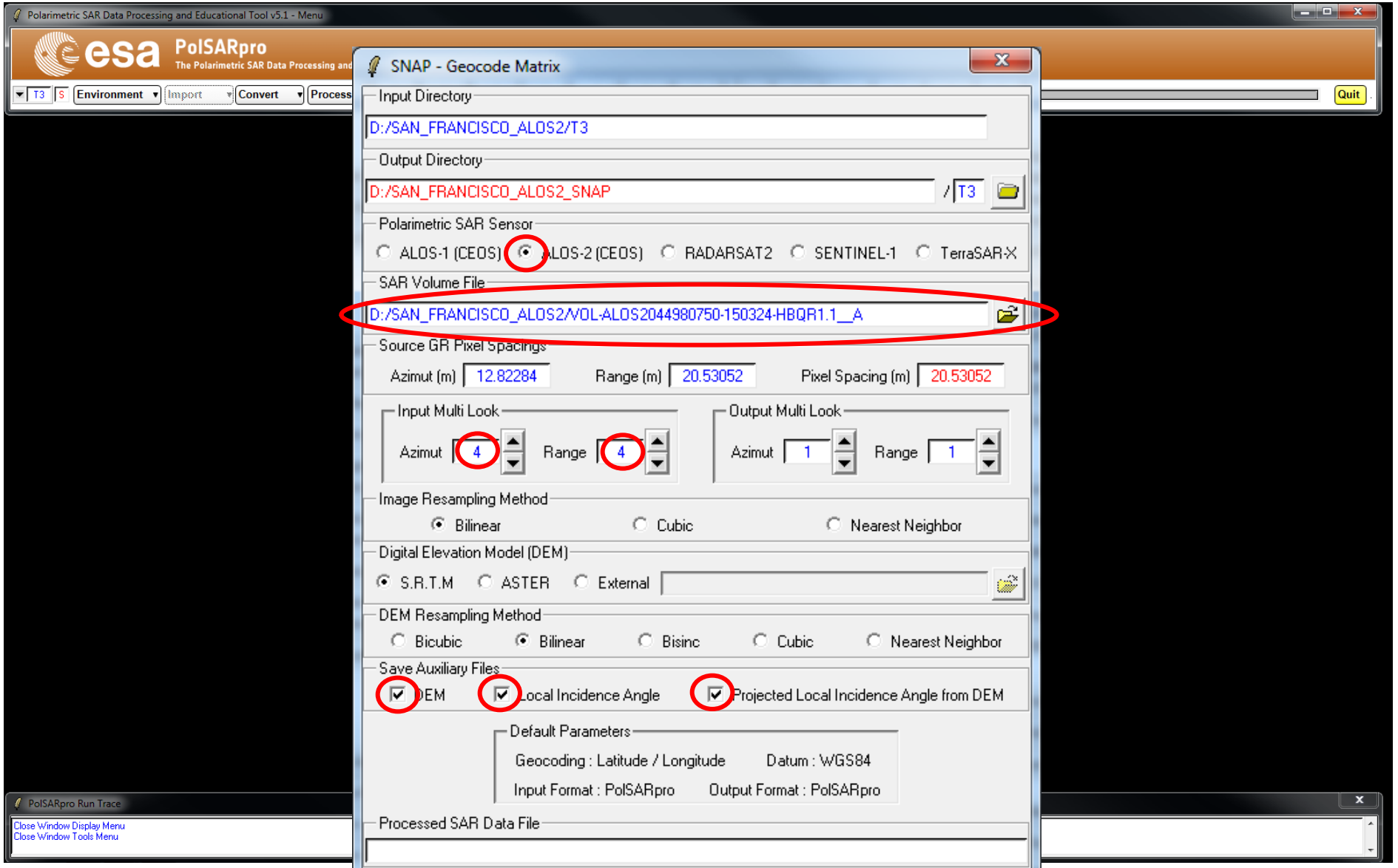
KML File generation



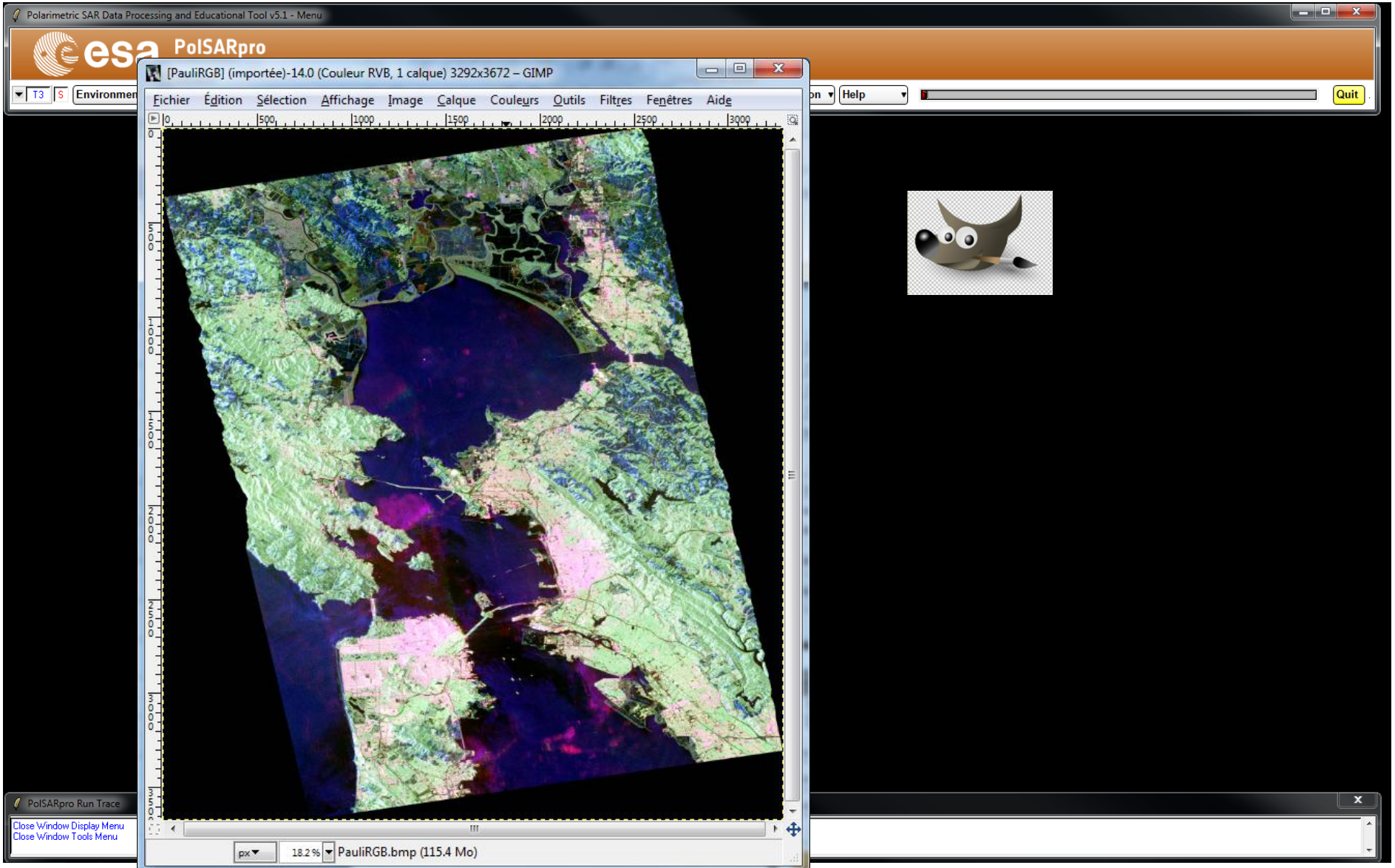
PolSARpro v5.1 SOFTWARE



PolSARpro v5.1 SOFTWARE



Display Pauli-RGB Image

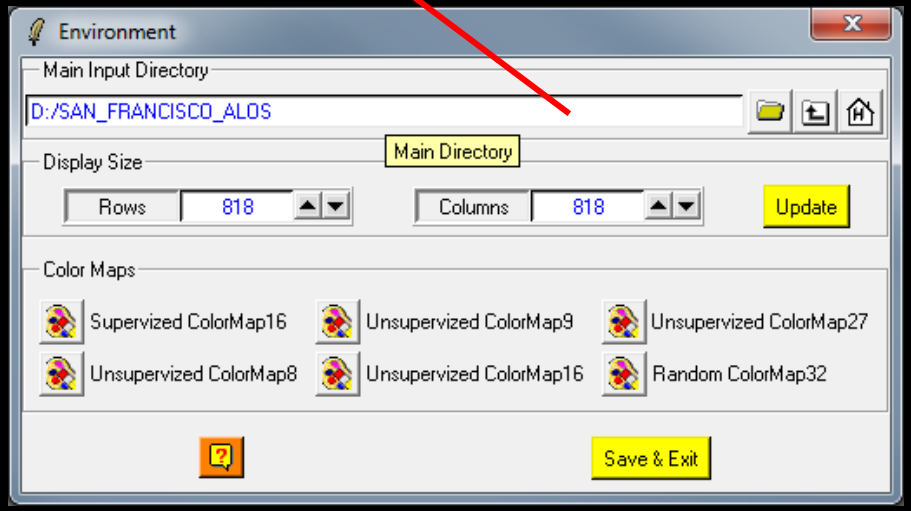


Polarimetric SAR Data Processing and Educational Tool v5.1 - Menu

esa PolSARpro
The Polarimetric SAR Data Processing and Educational Tool

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

Configure Data Main Directory location



Input Data Directory :

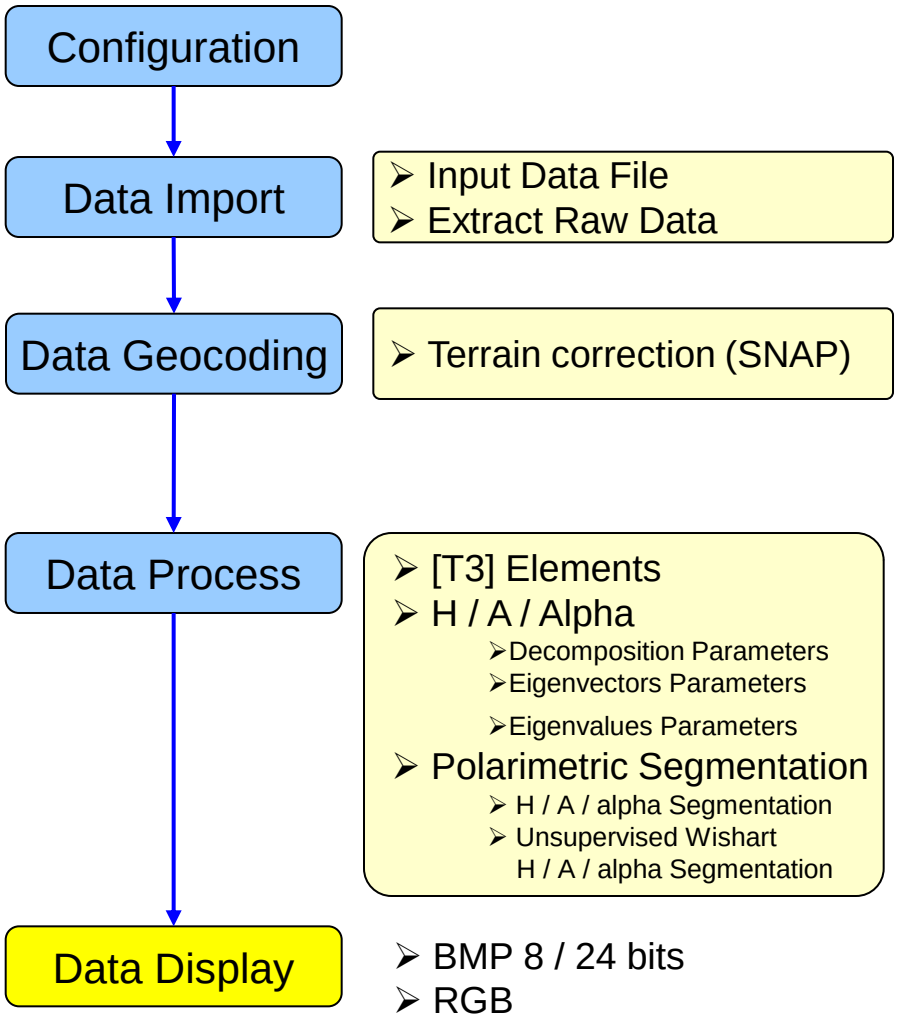
SAN_FRANCISCO_ALOS2_SNAP

(If the first data processing steps are skipped)

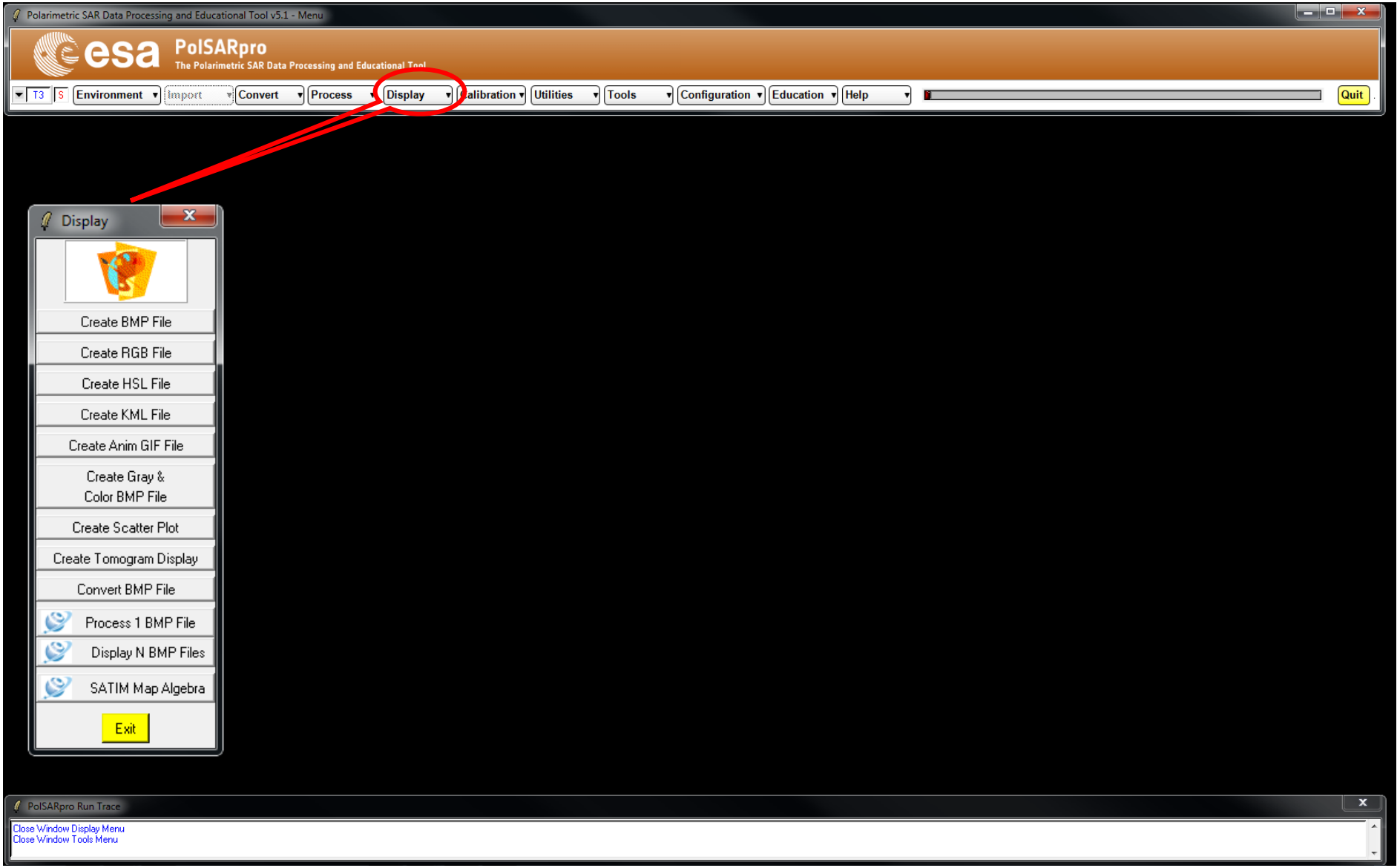
PolSARpro Run Trace

Close Window Display Menu
Close Window Tools Menu

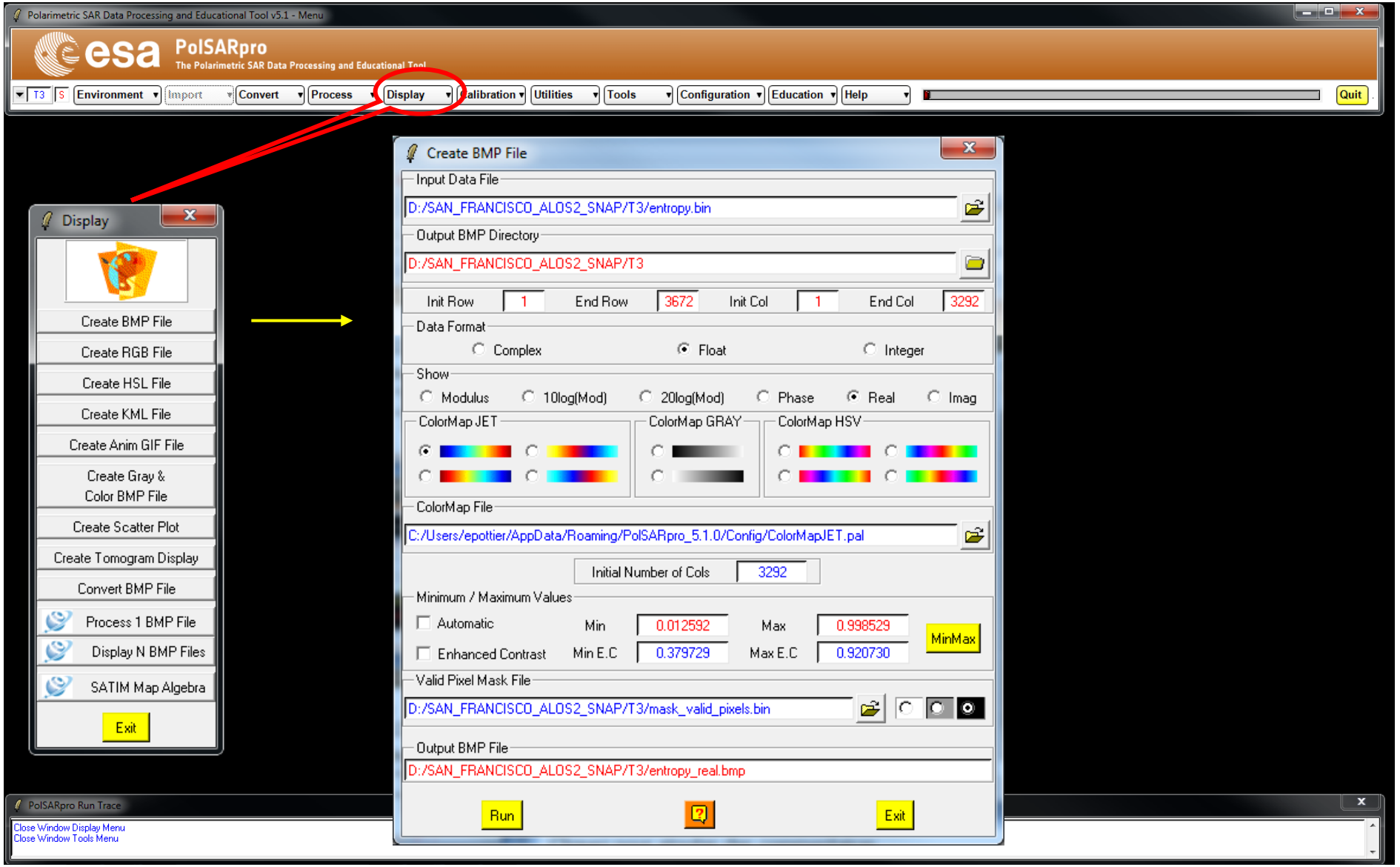
PROCESSING CHAIN



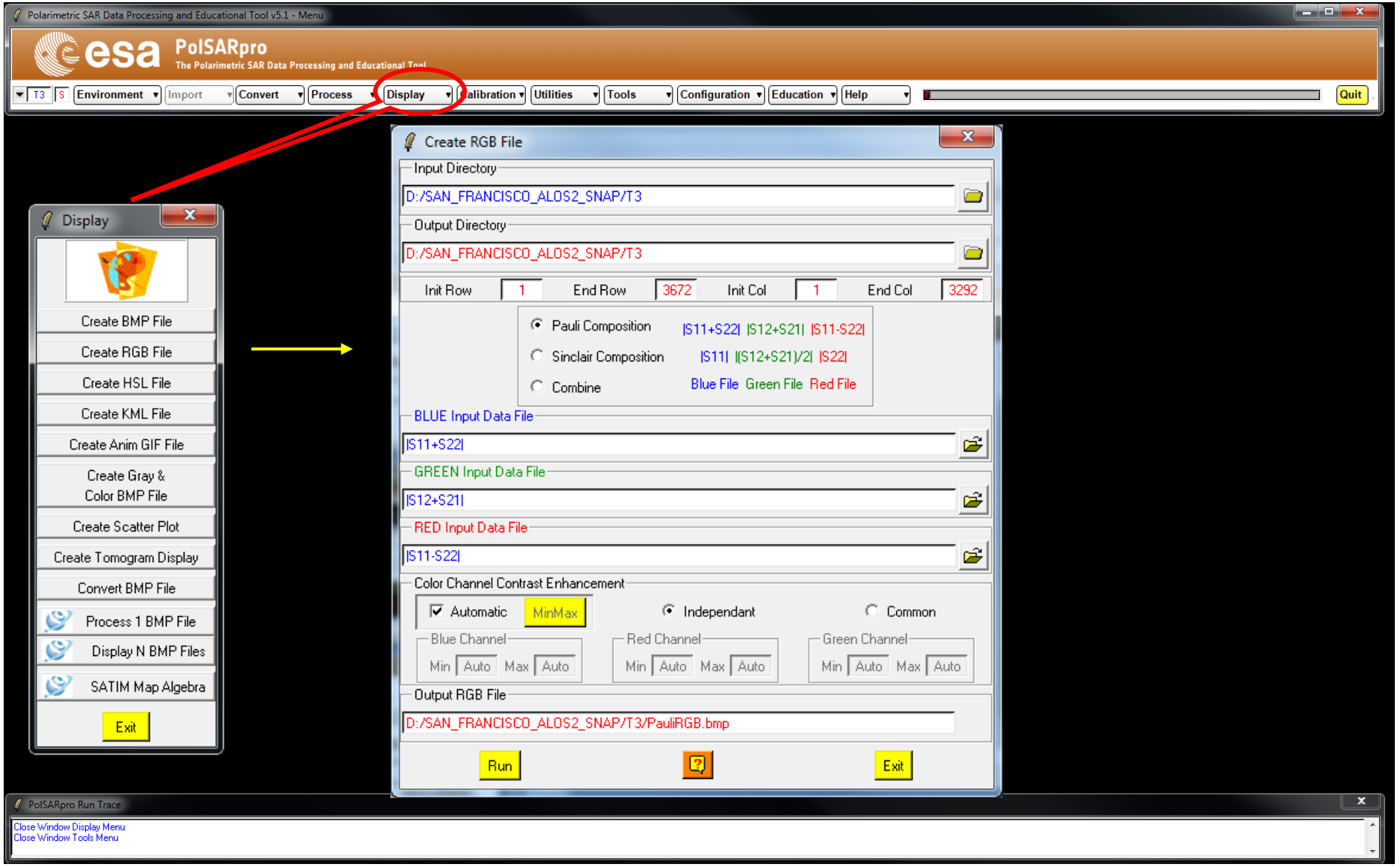
Display Main Menu



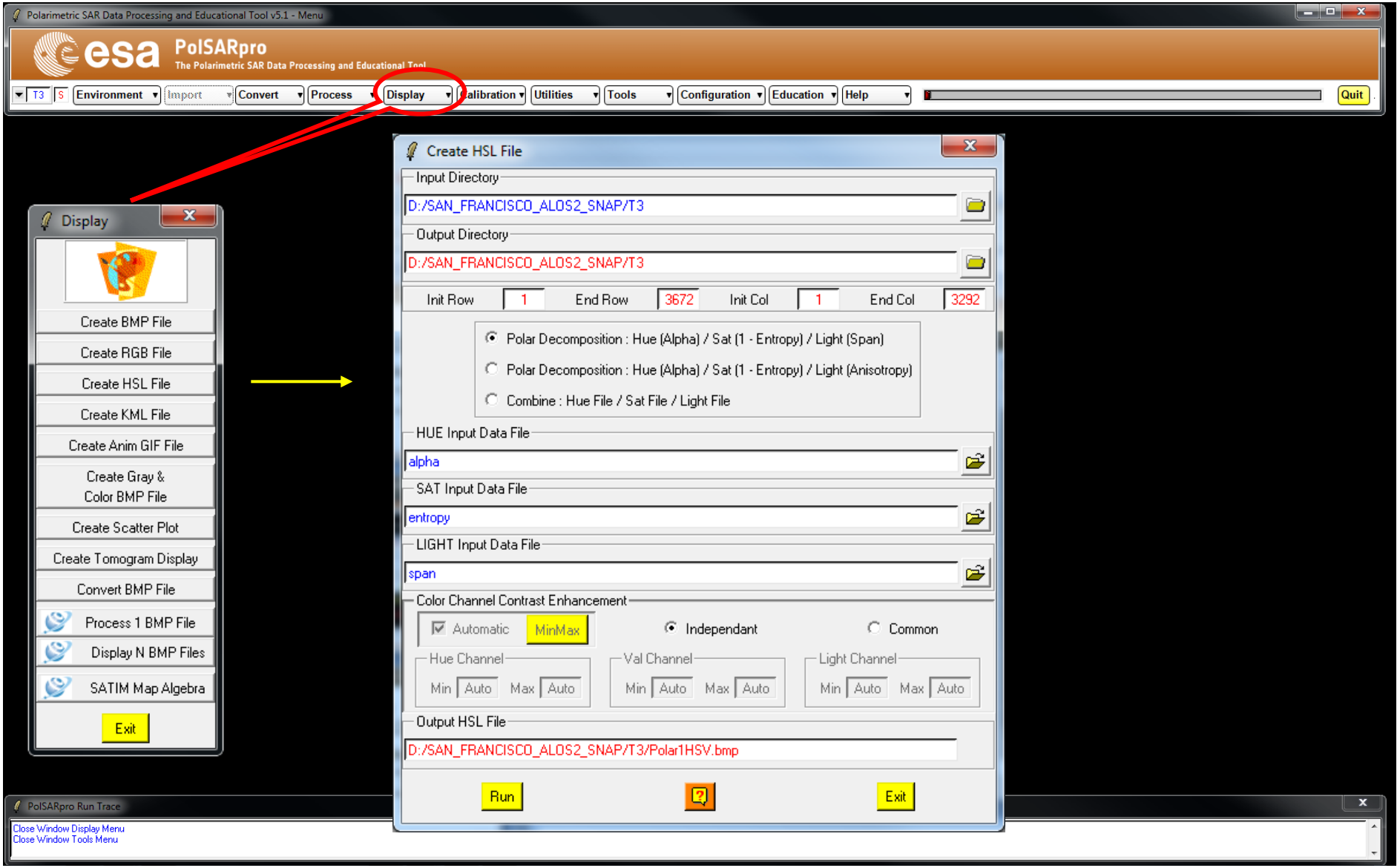
Create BMP Image



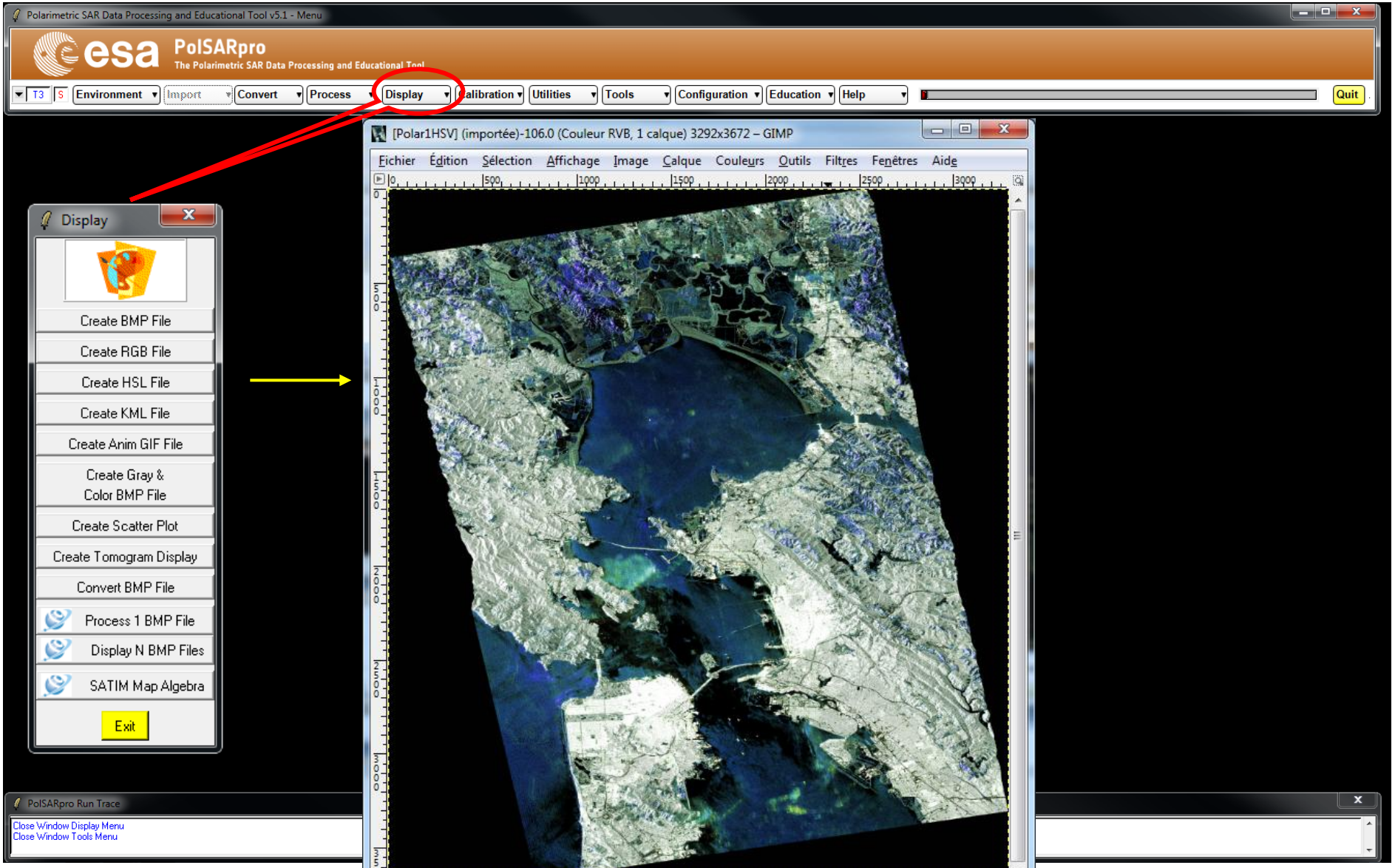
Create Pauli / Sinclair RGB Image



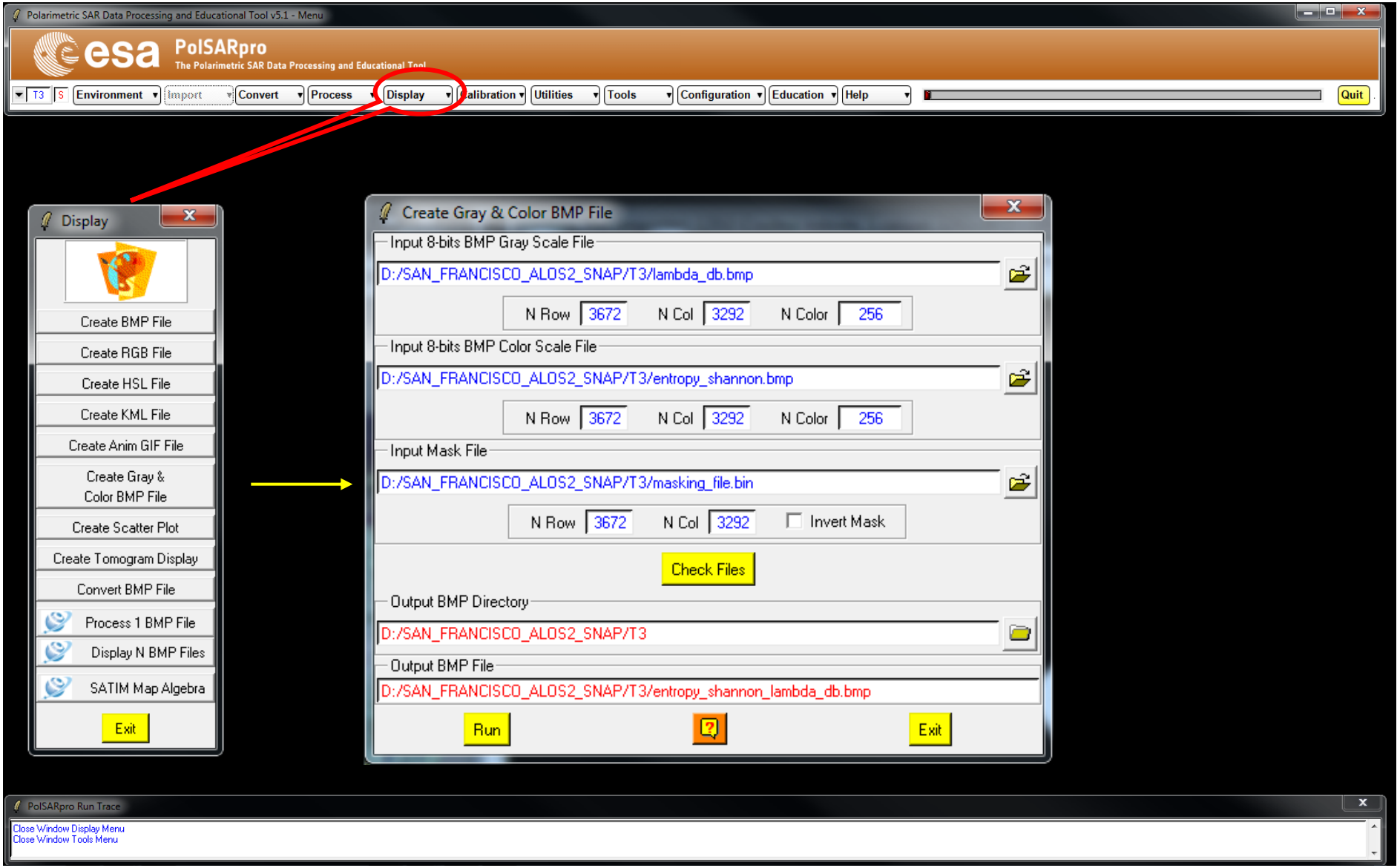
Create HSL Image



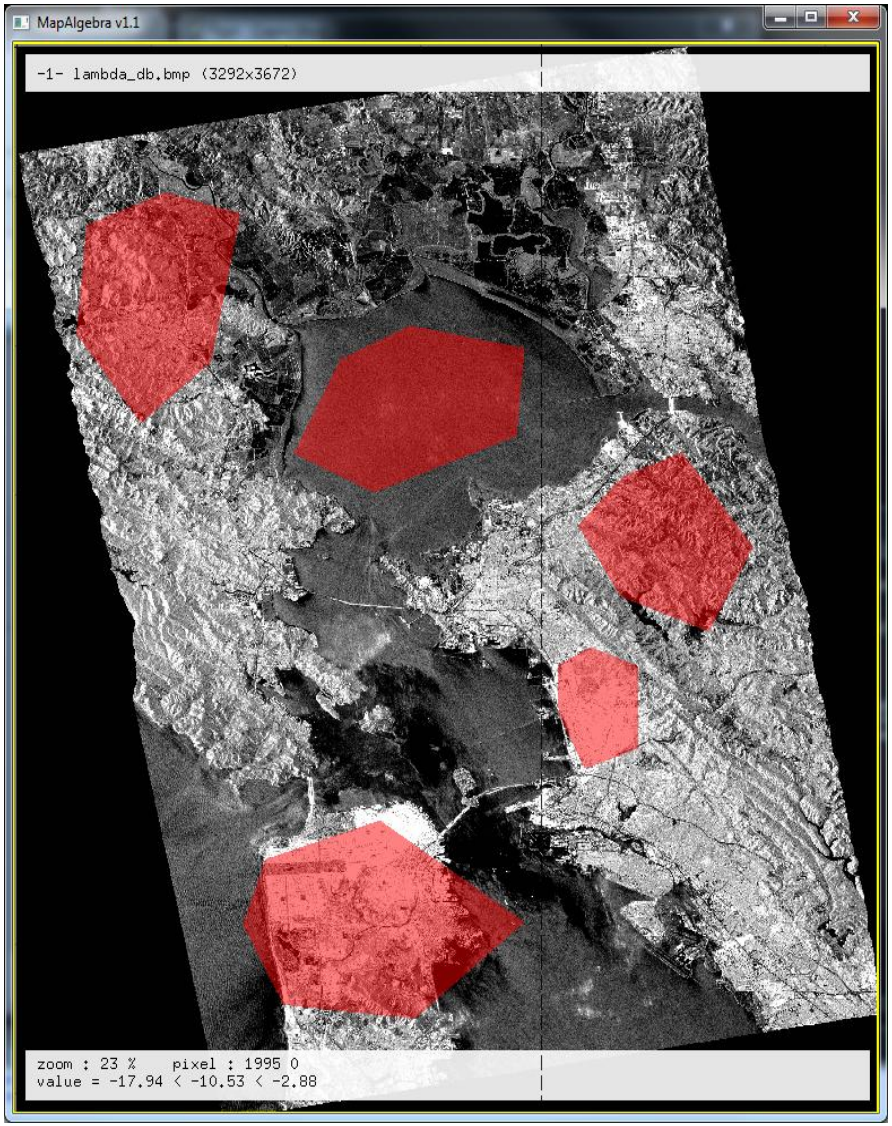
Create HSL Image

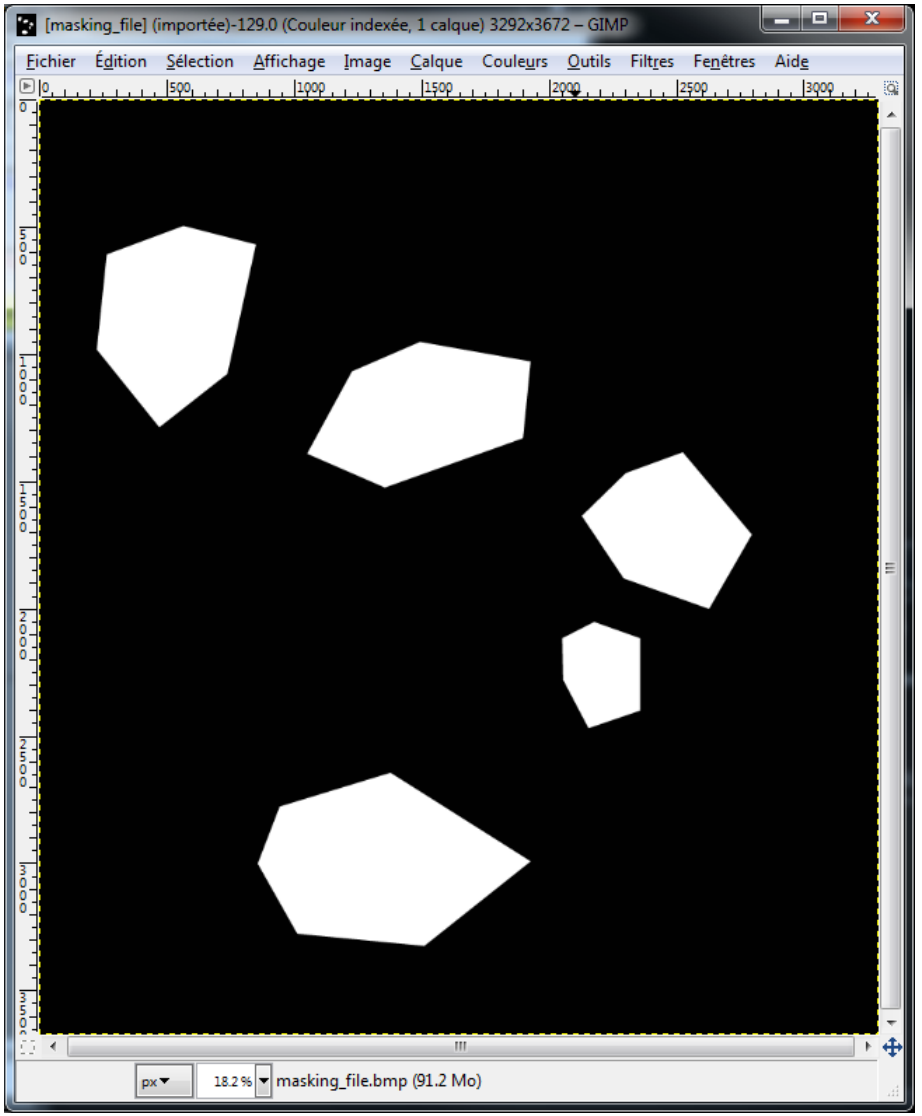


Create Gray & Color BMP Image

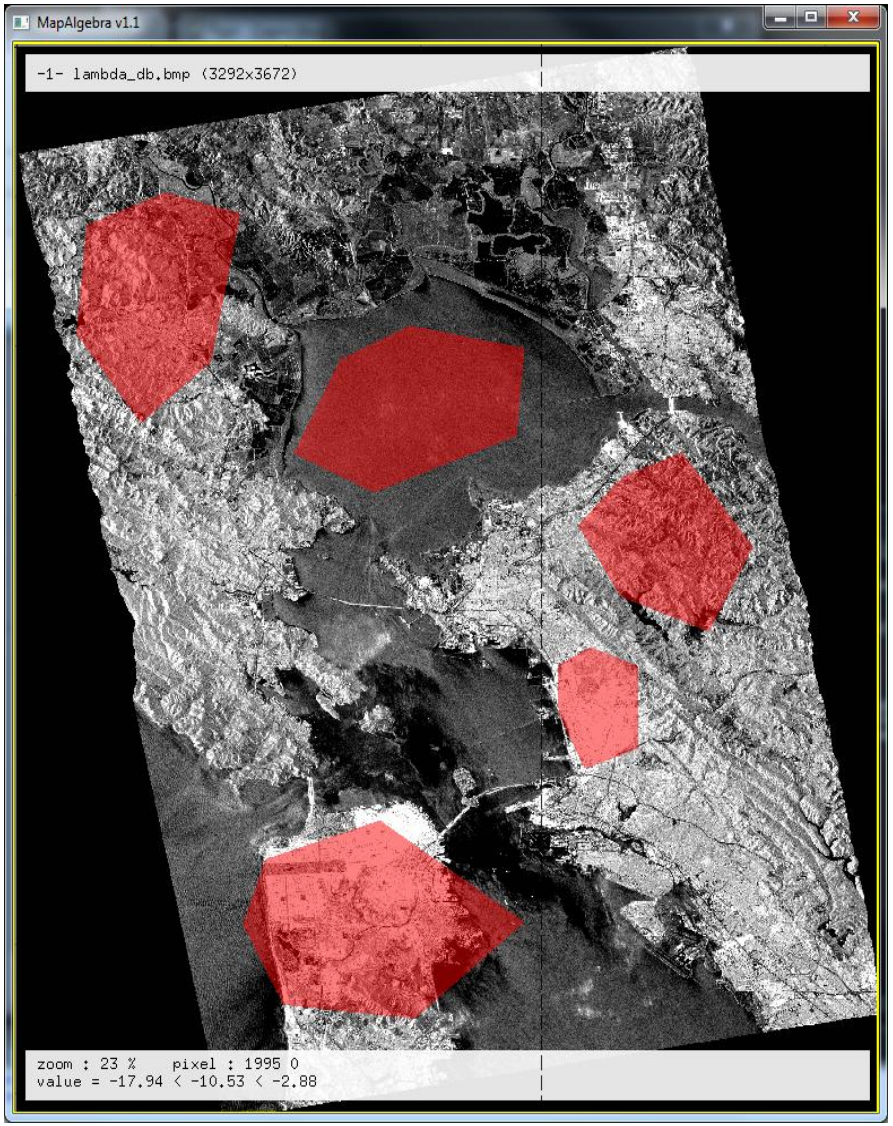


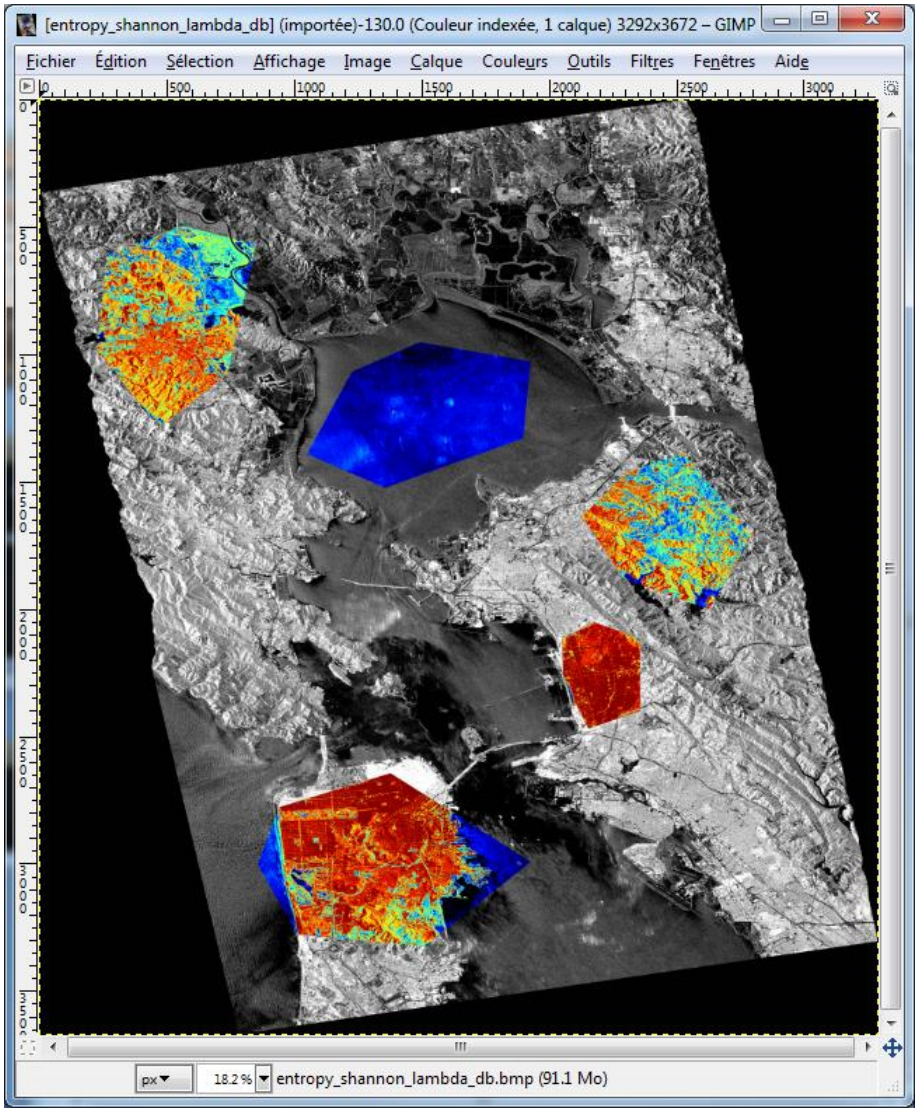
Create Gray & Color BMP Image



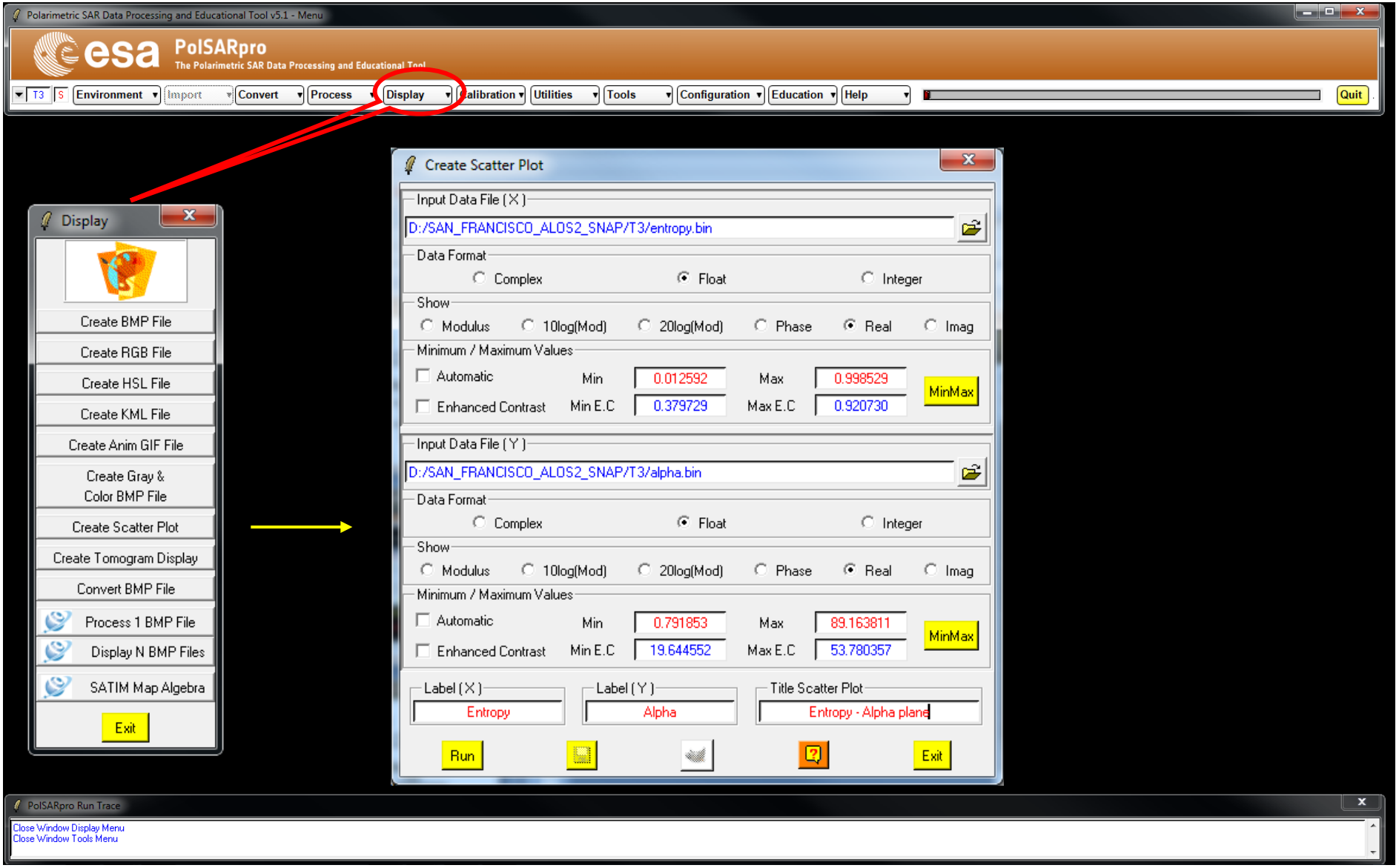


Create Gray & Color BMP Image

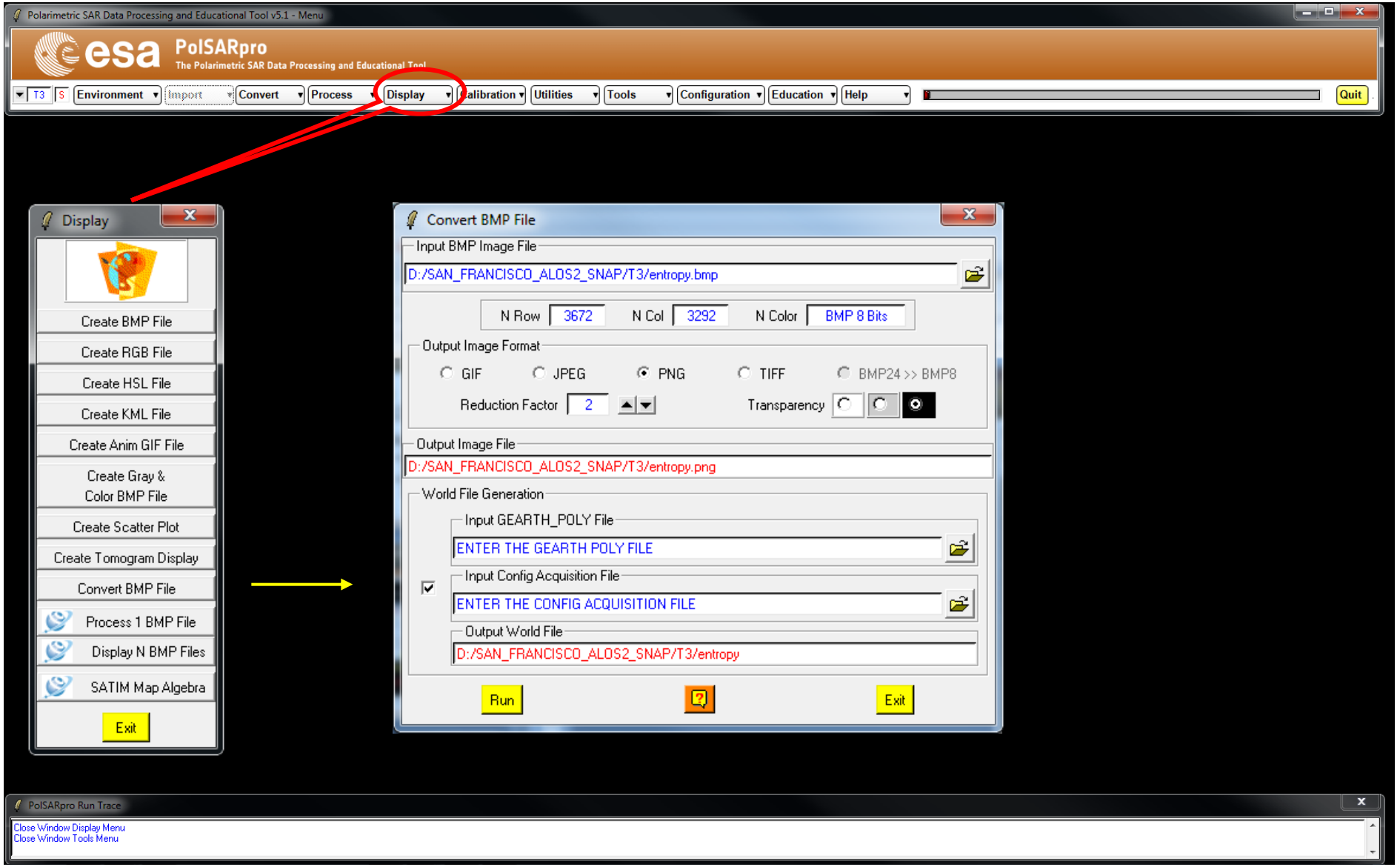




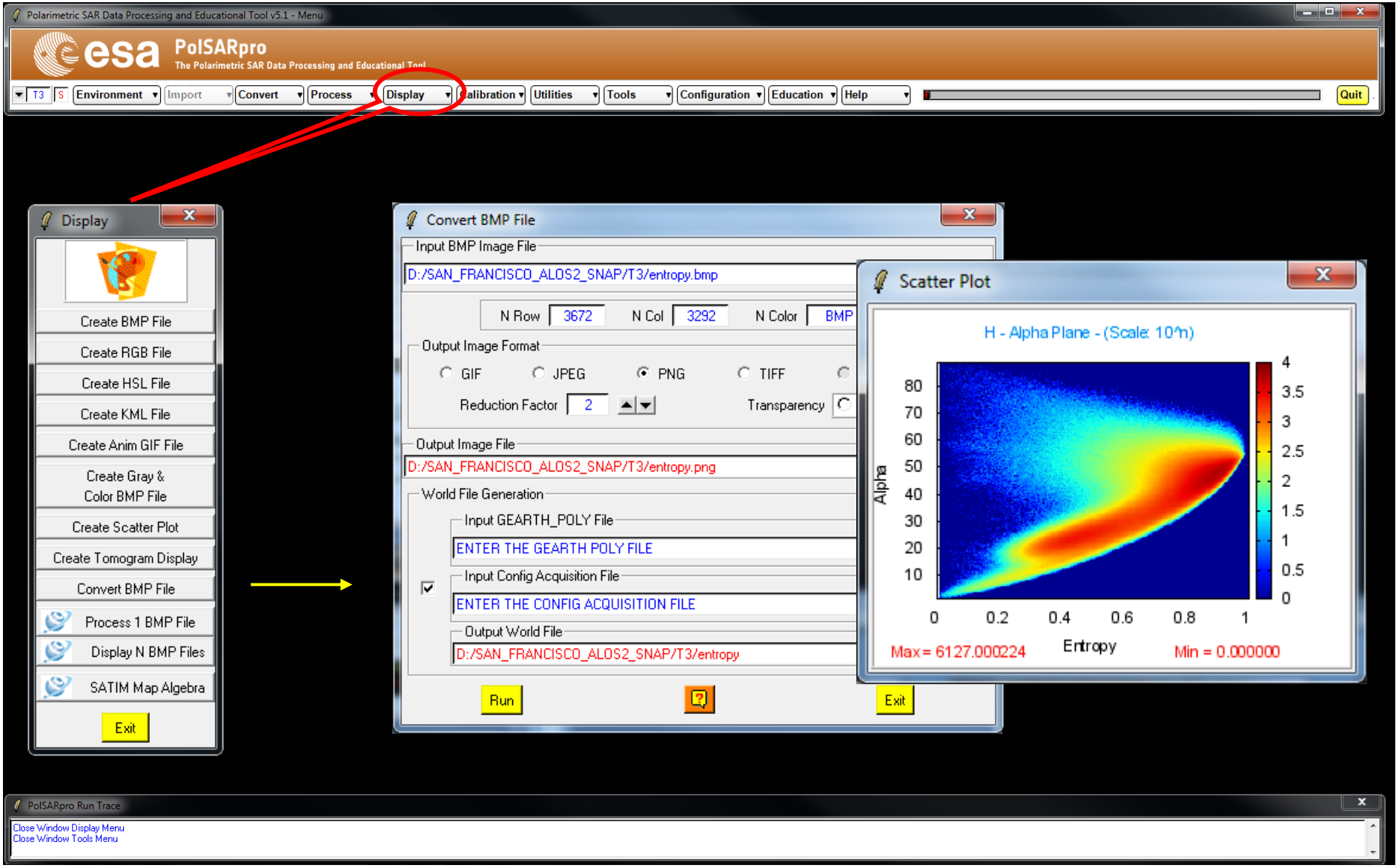
Create Scatter Plot



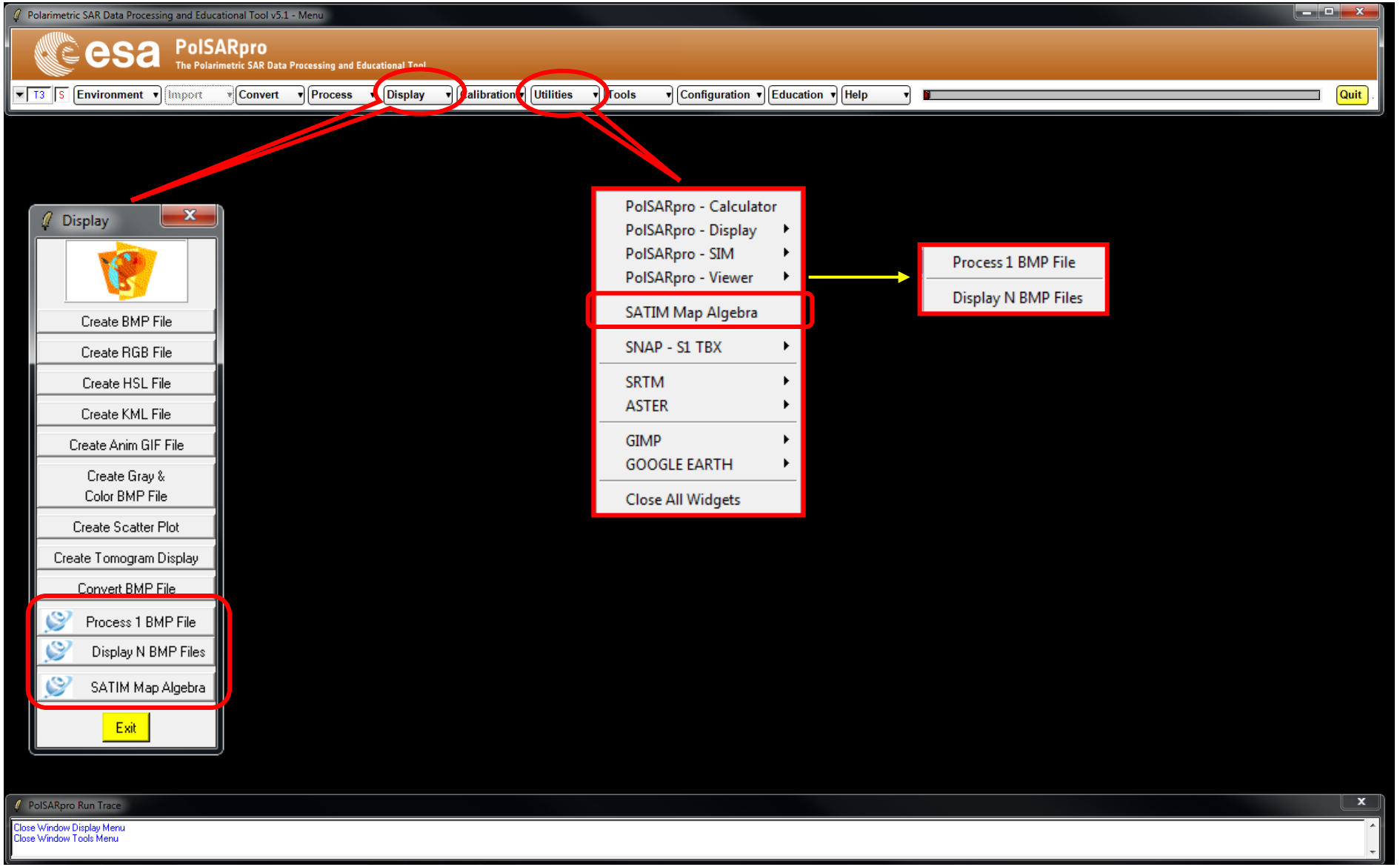
Convert BMP File



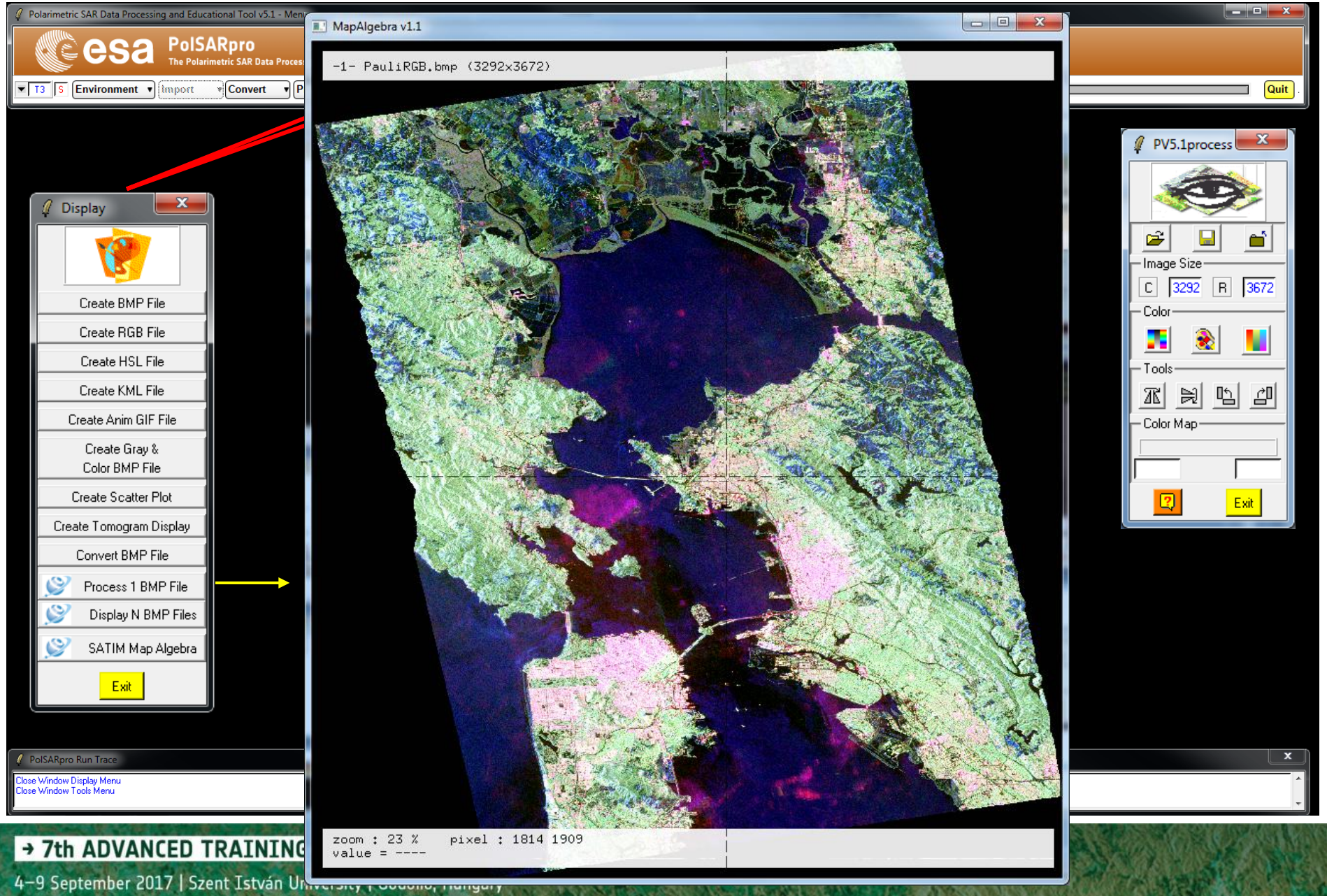
Convert BMP File



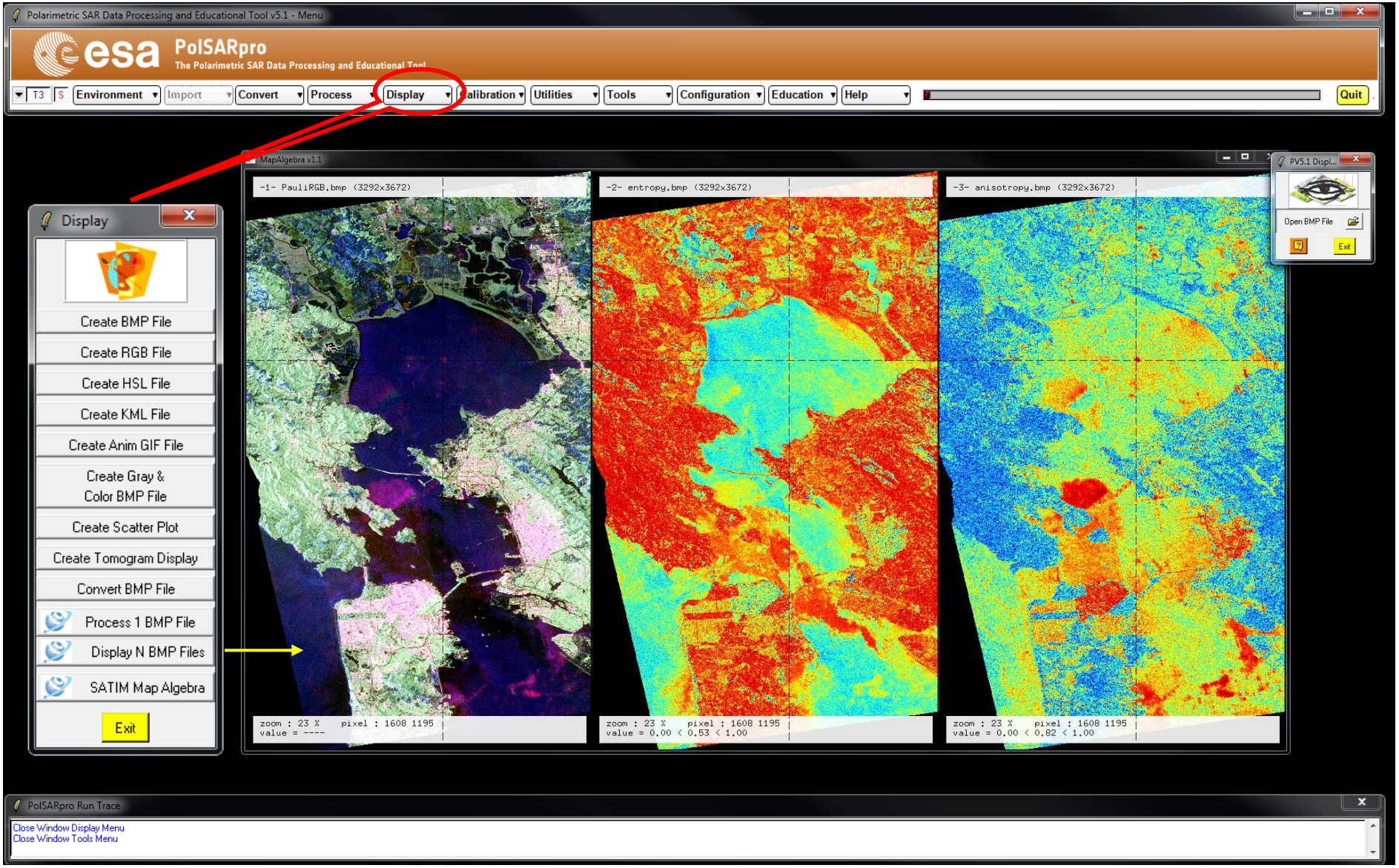
SATIM Map Algebra



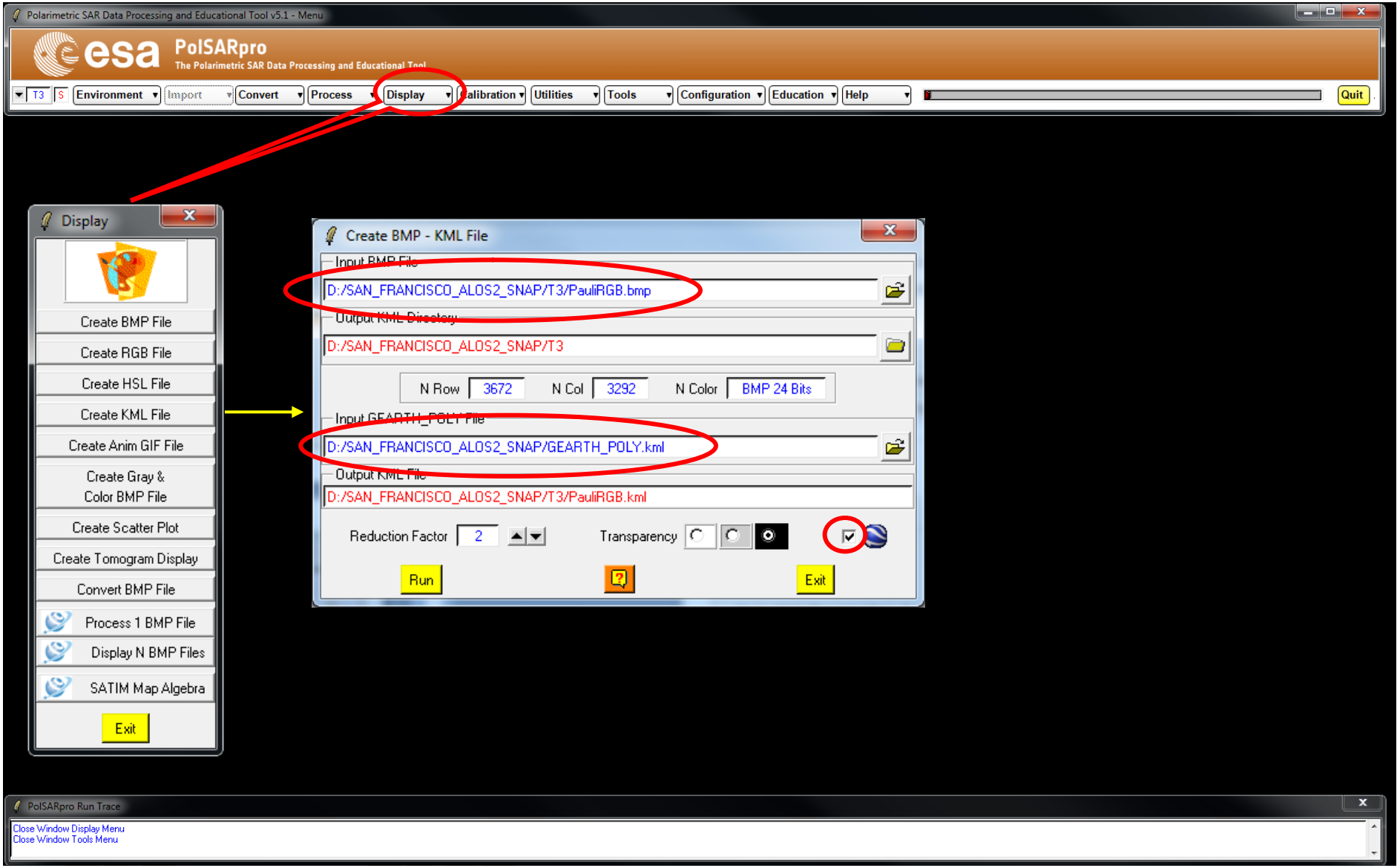
Process 1 BMP Image



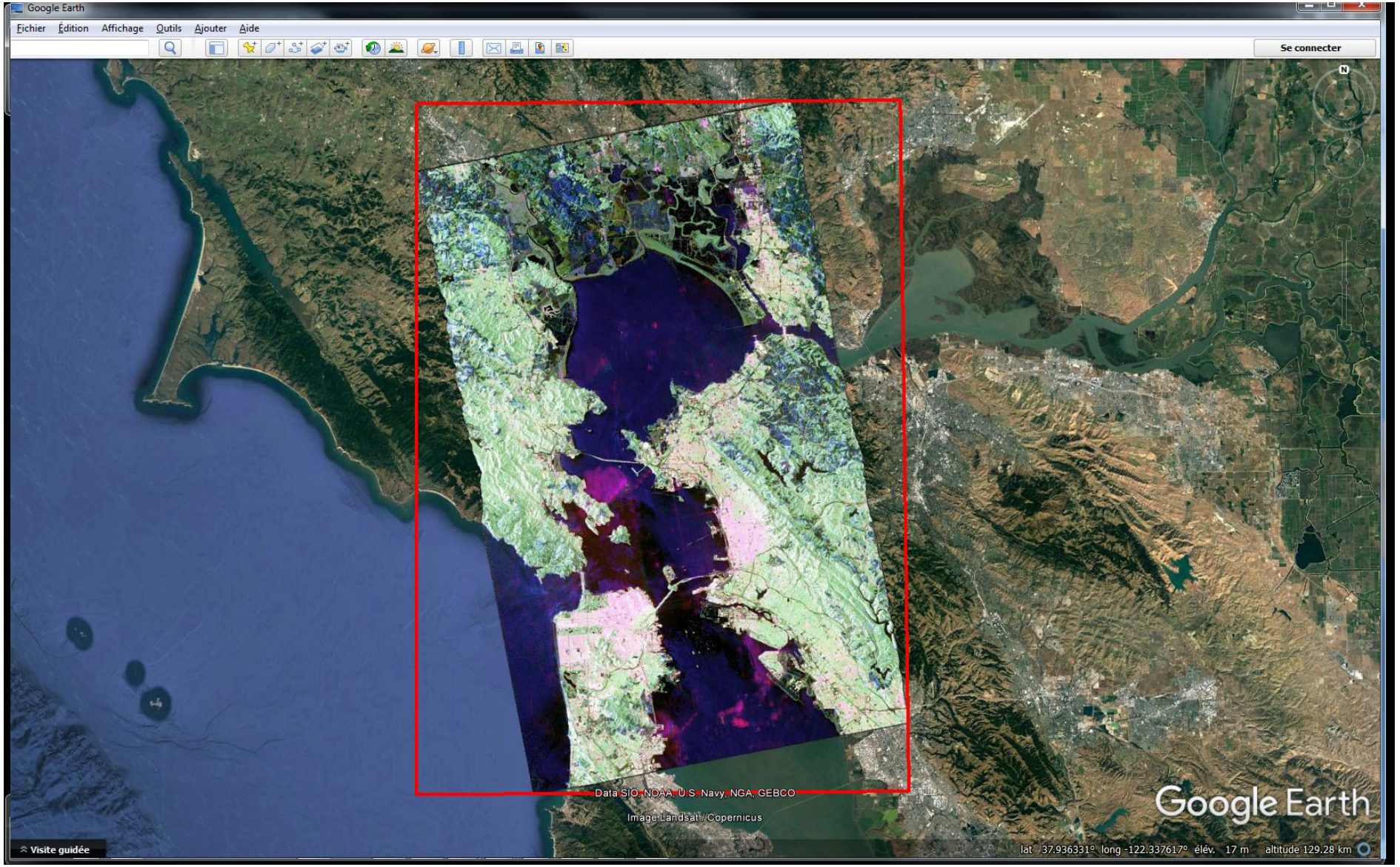
Display N BMP Images



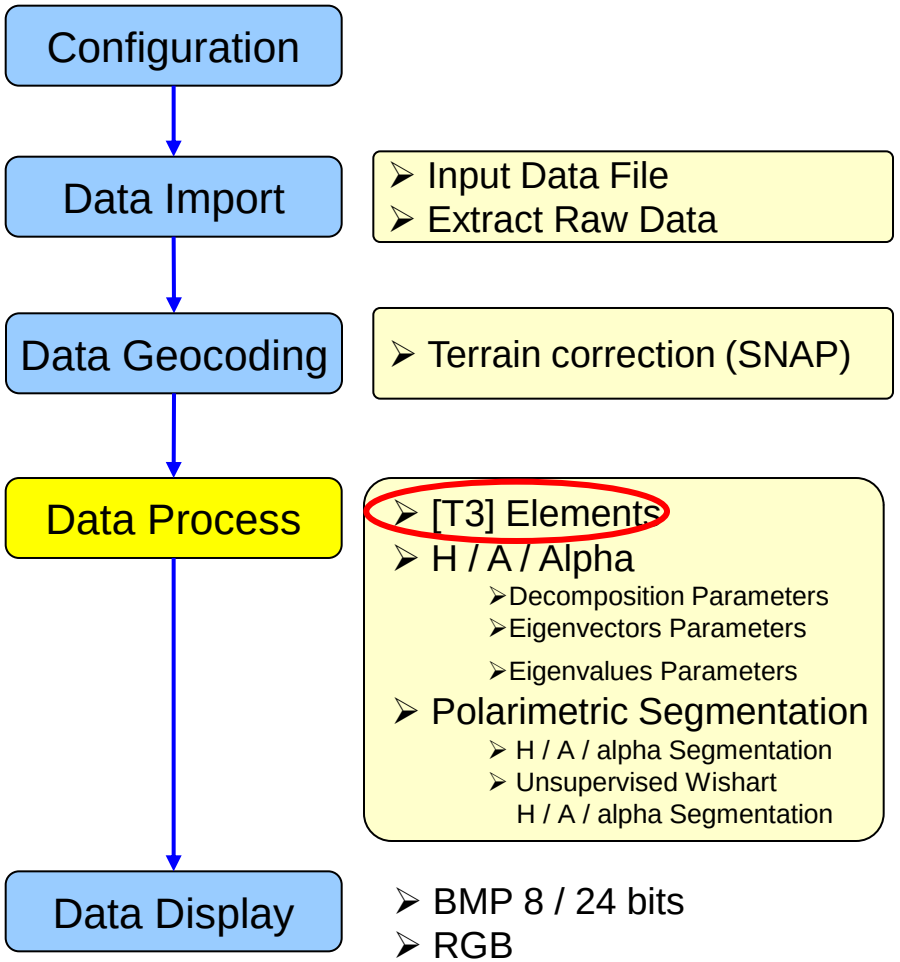
Create Pauli-RGB to KML Image



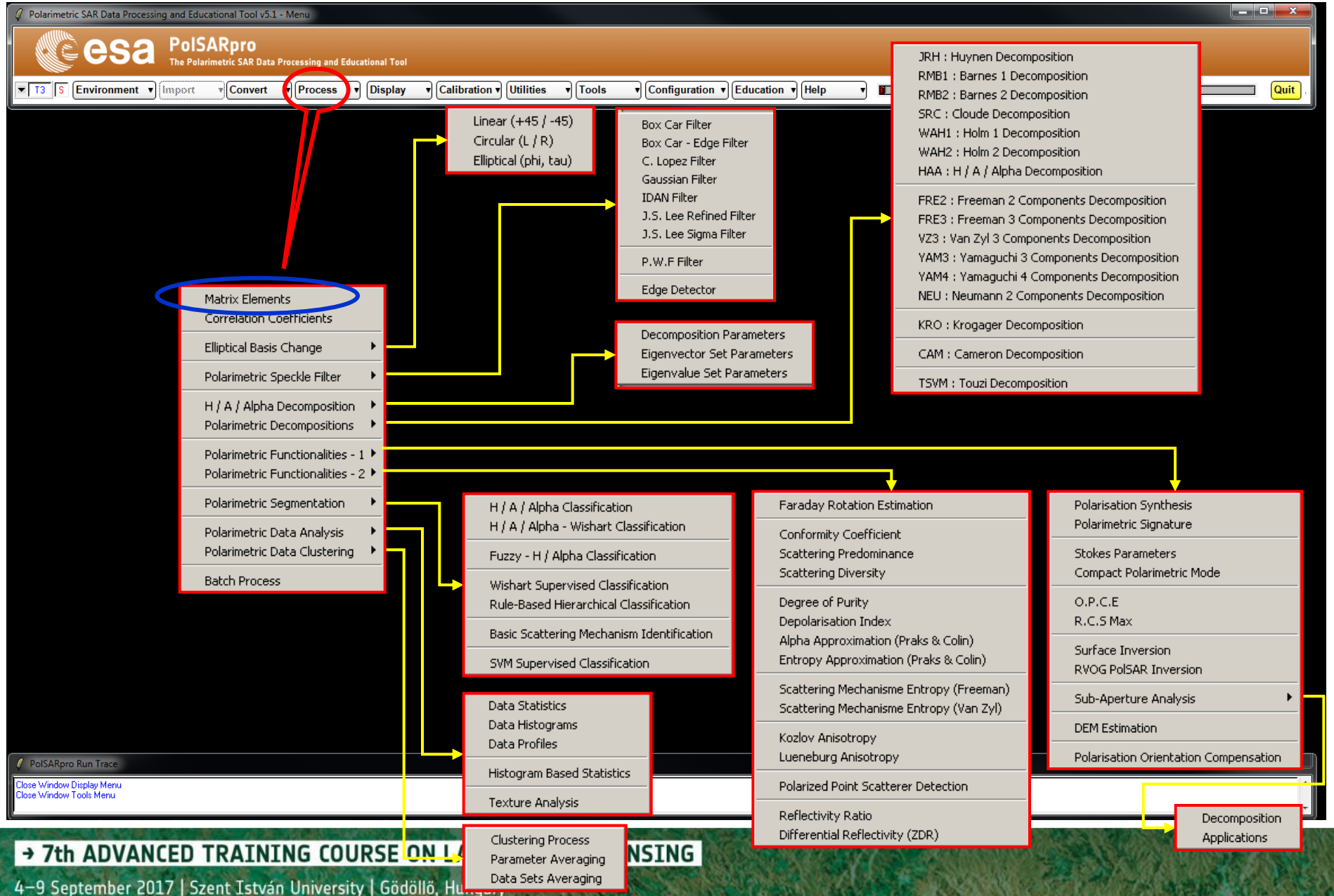
PolSARpro v5.1 SOFTWARE



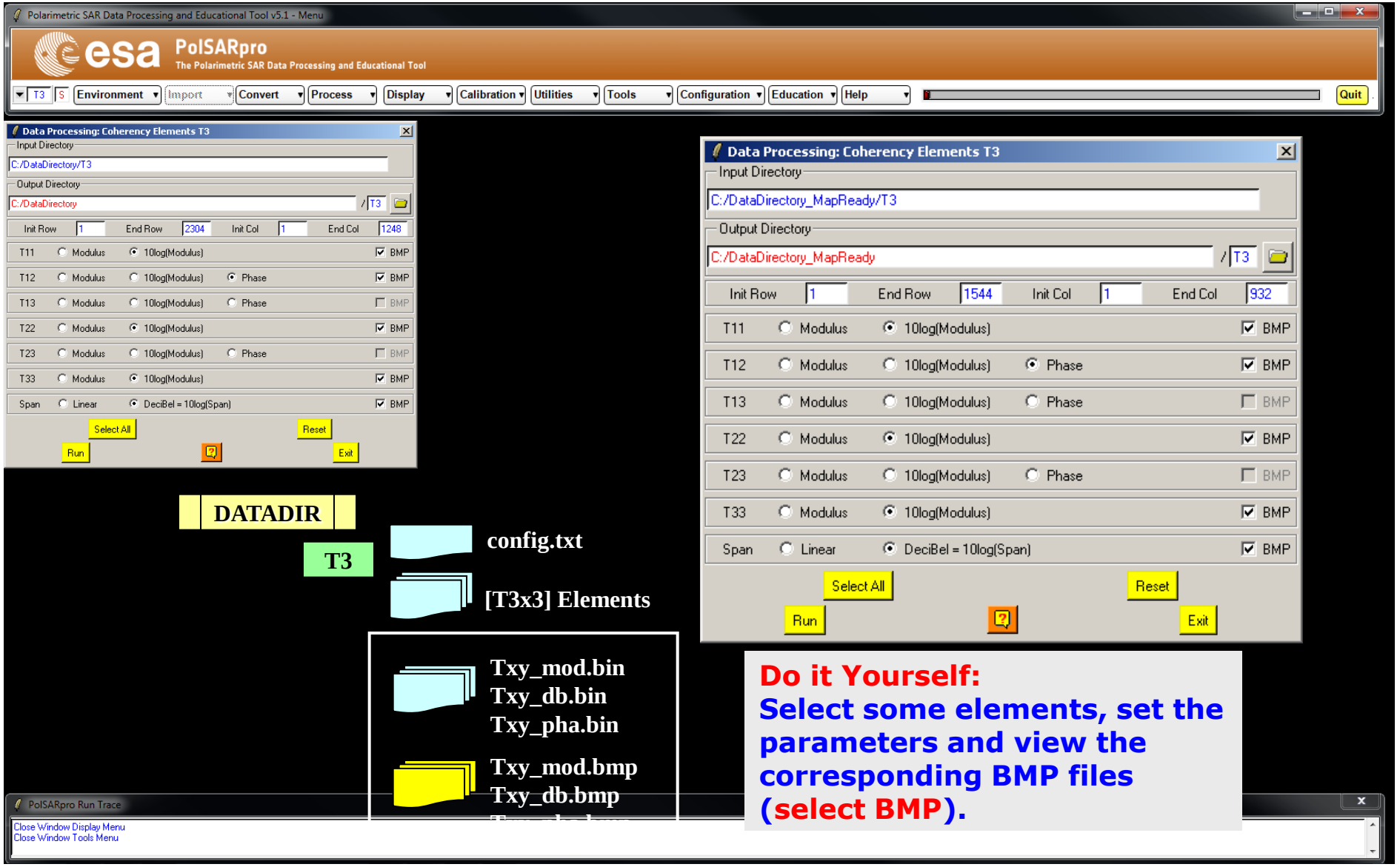
PROCESSING CHAIN



PolSARpro v5.1 SOFTWARE



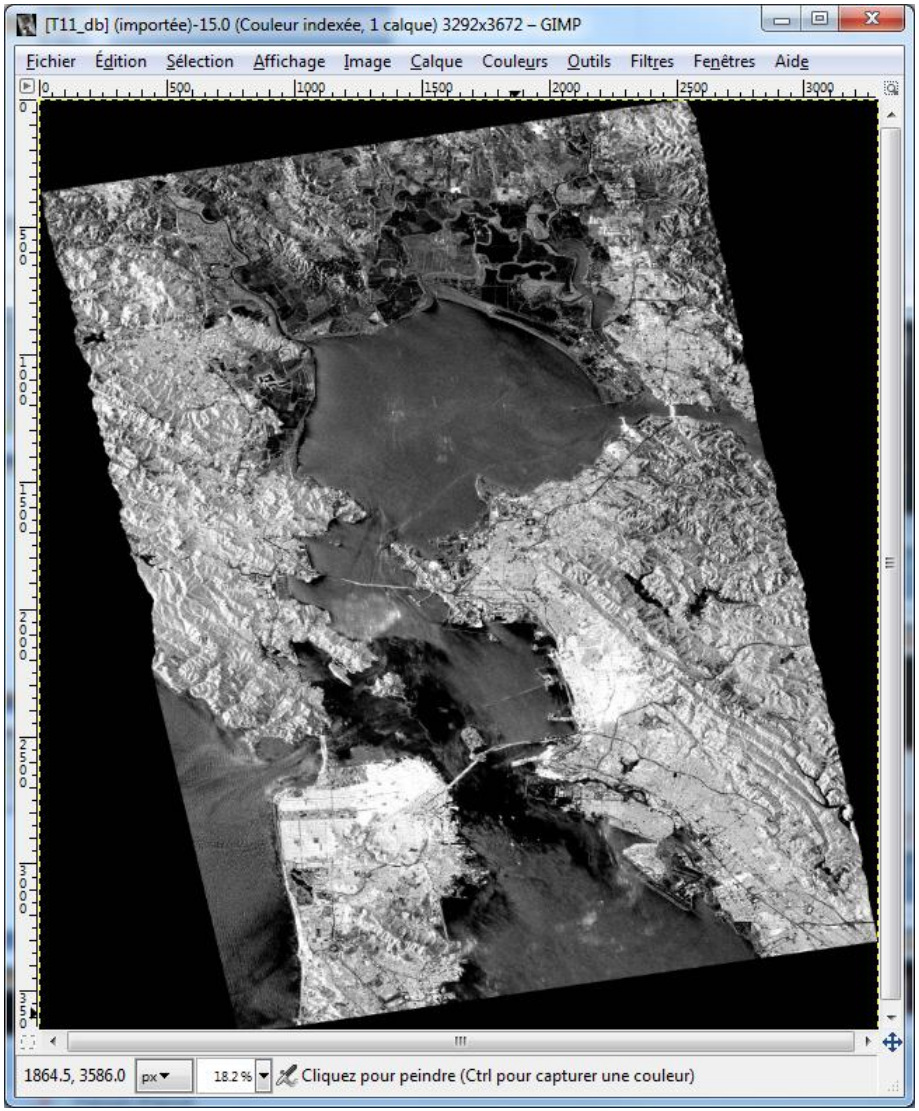
[T3] ELEMENTS



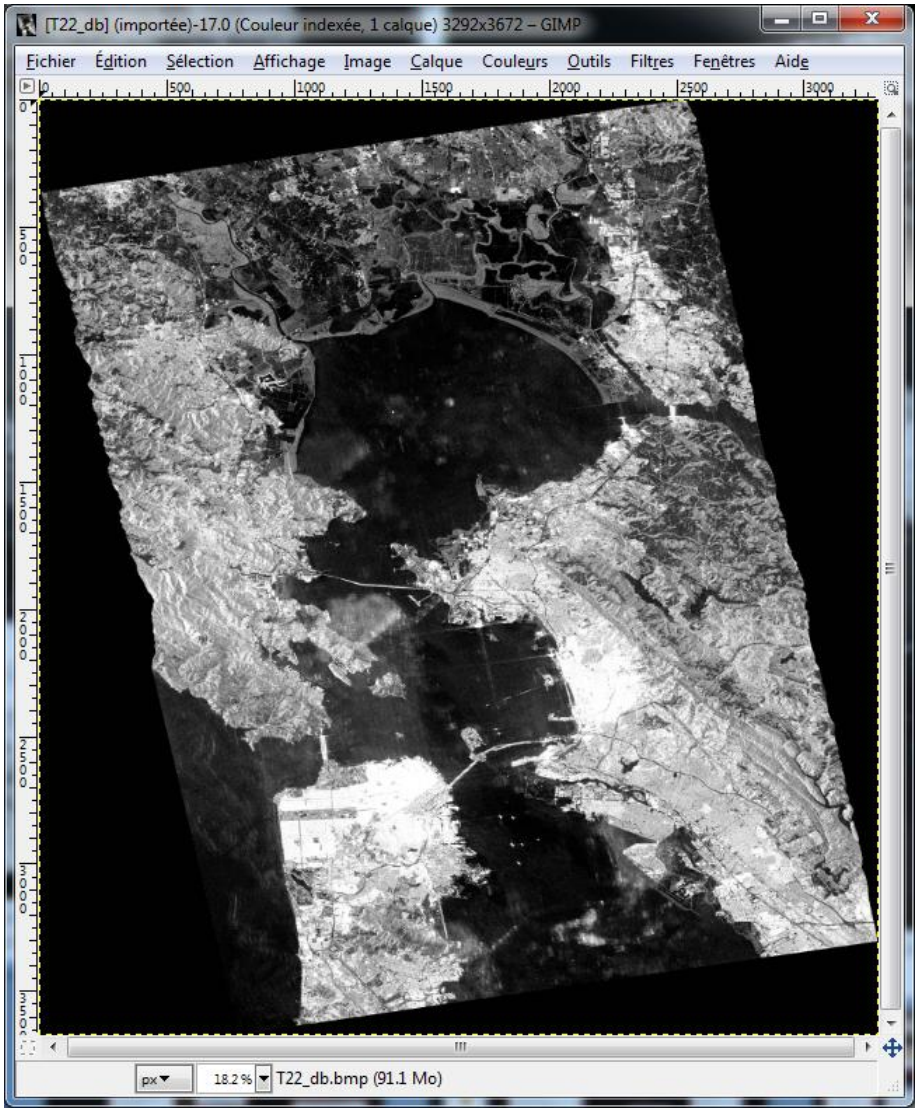
Do it Yourself:
Select some elements, set the parameters and view the corresponding BMP files (select BMP).

[T3] ELEMENTS

T11_dB

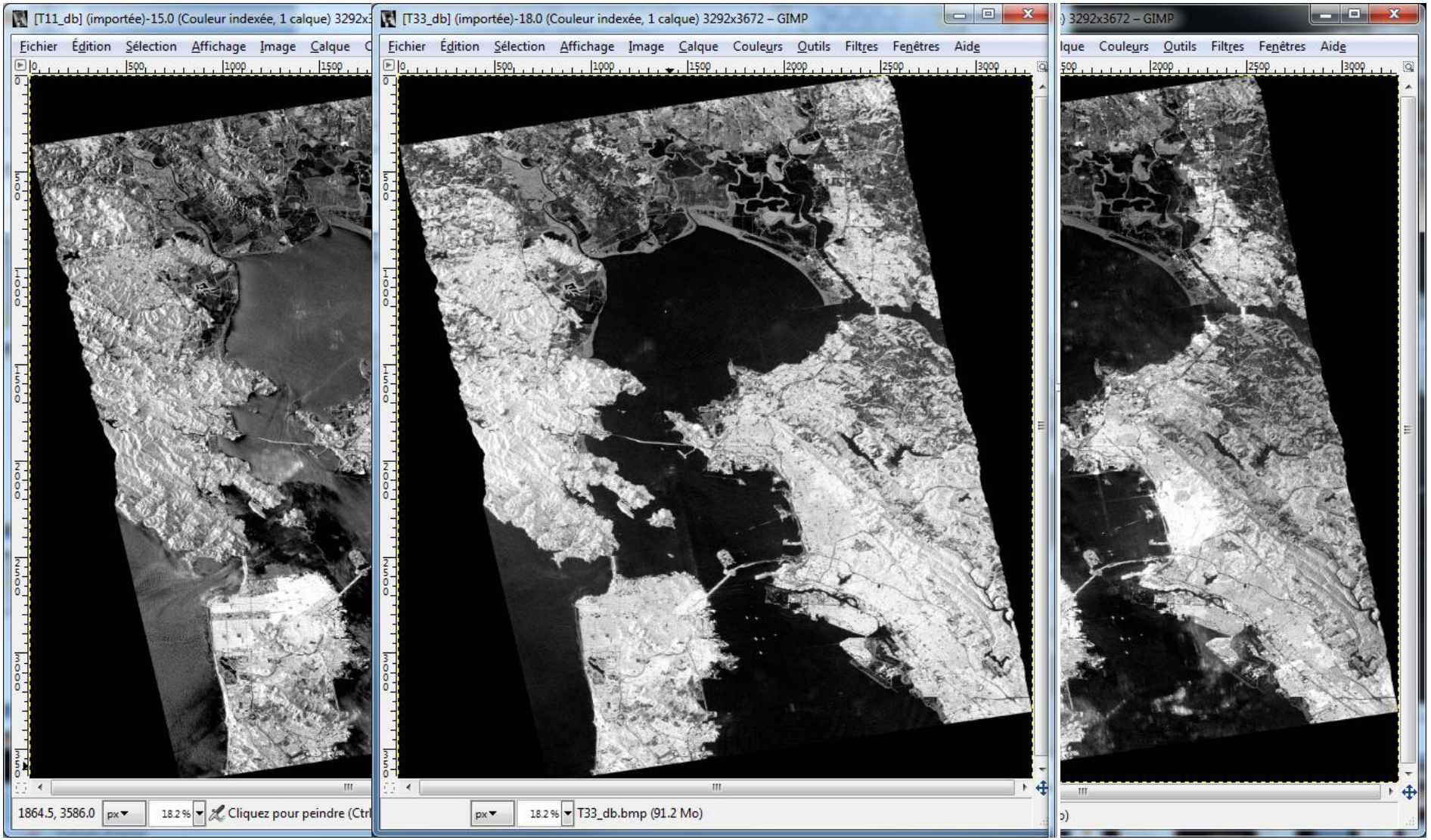


T22_dB



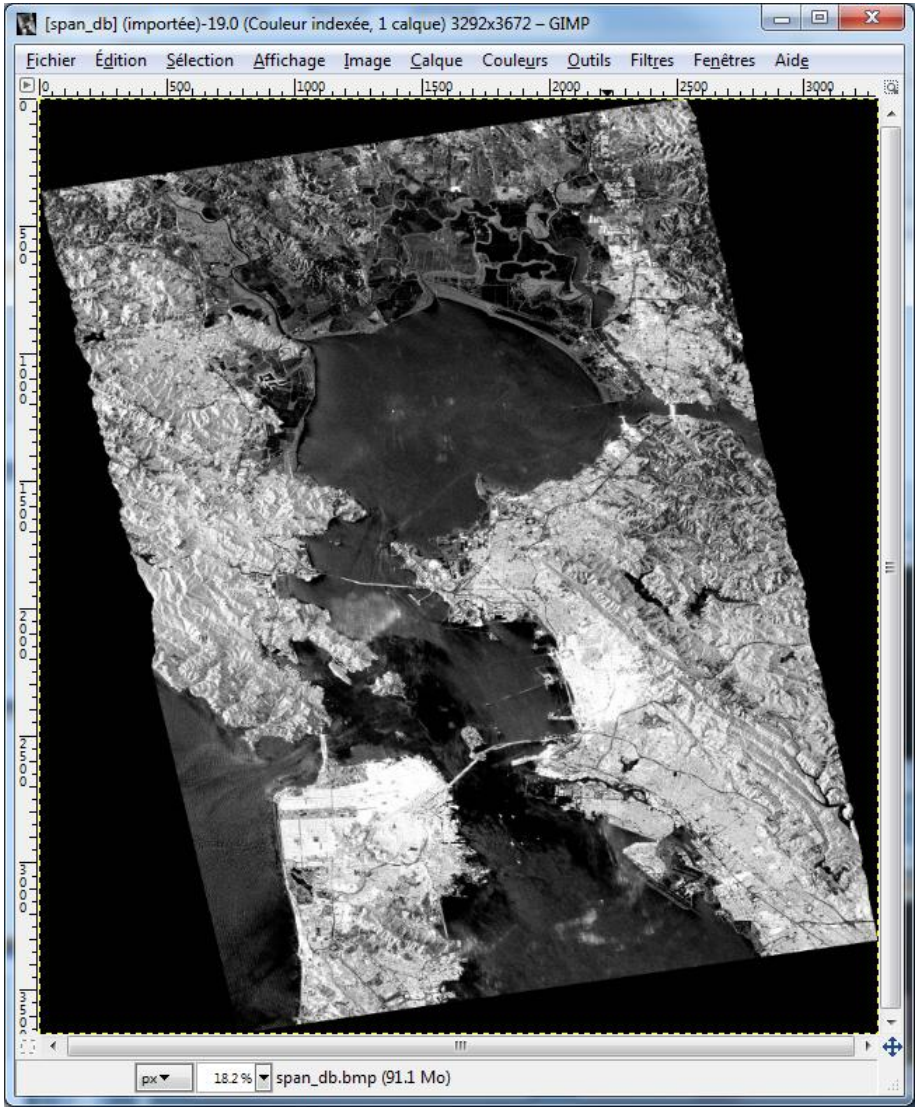
[T3] ELEMENTS

T11_dB **T33_dB** **T22_dB**

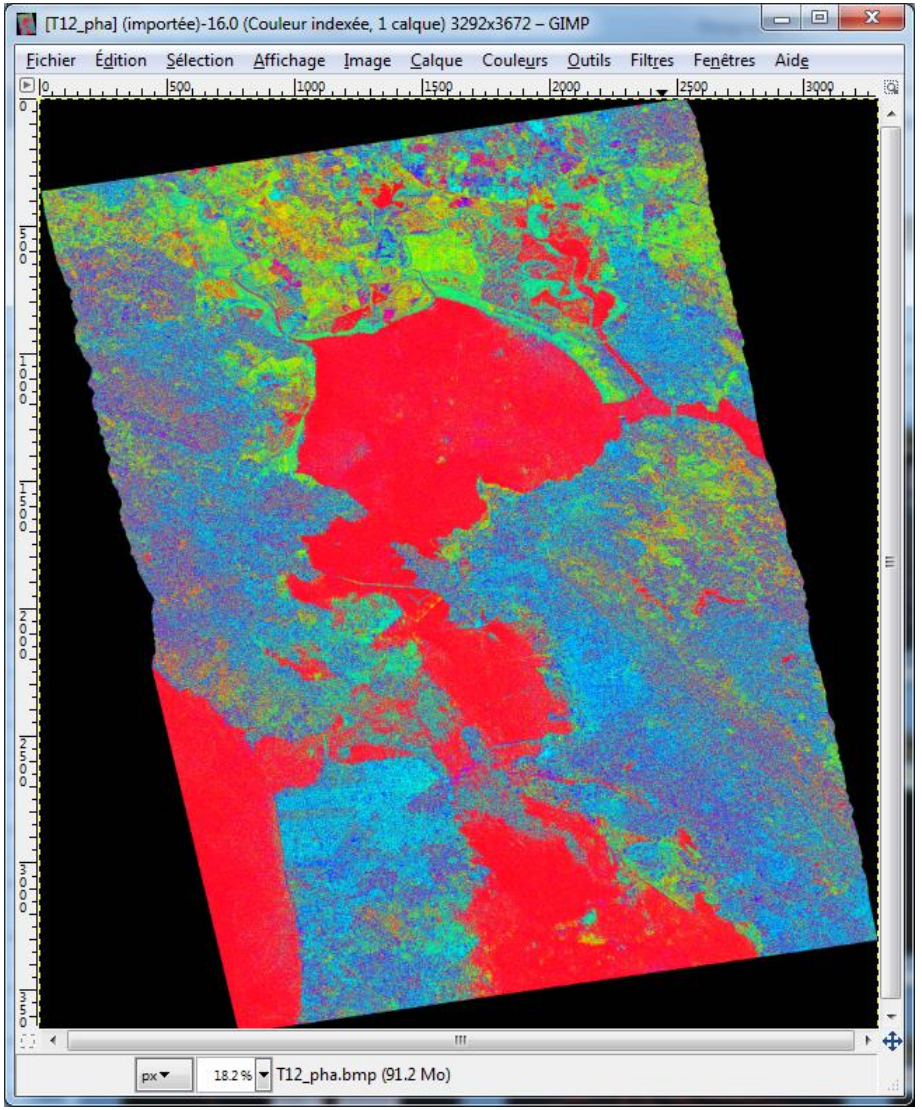


[T3] ELEMENTS

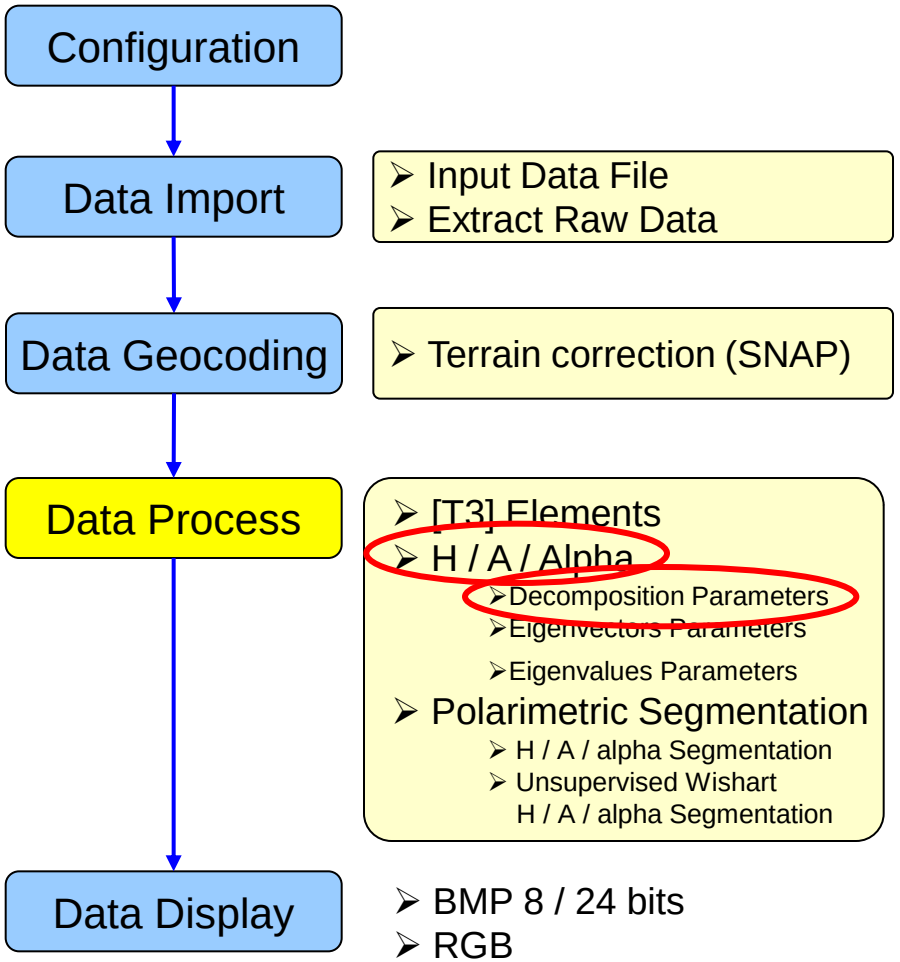
span_dB



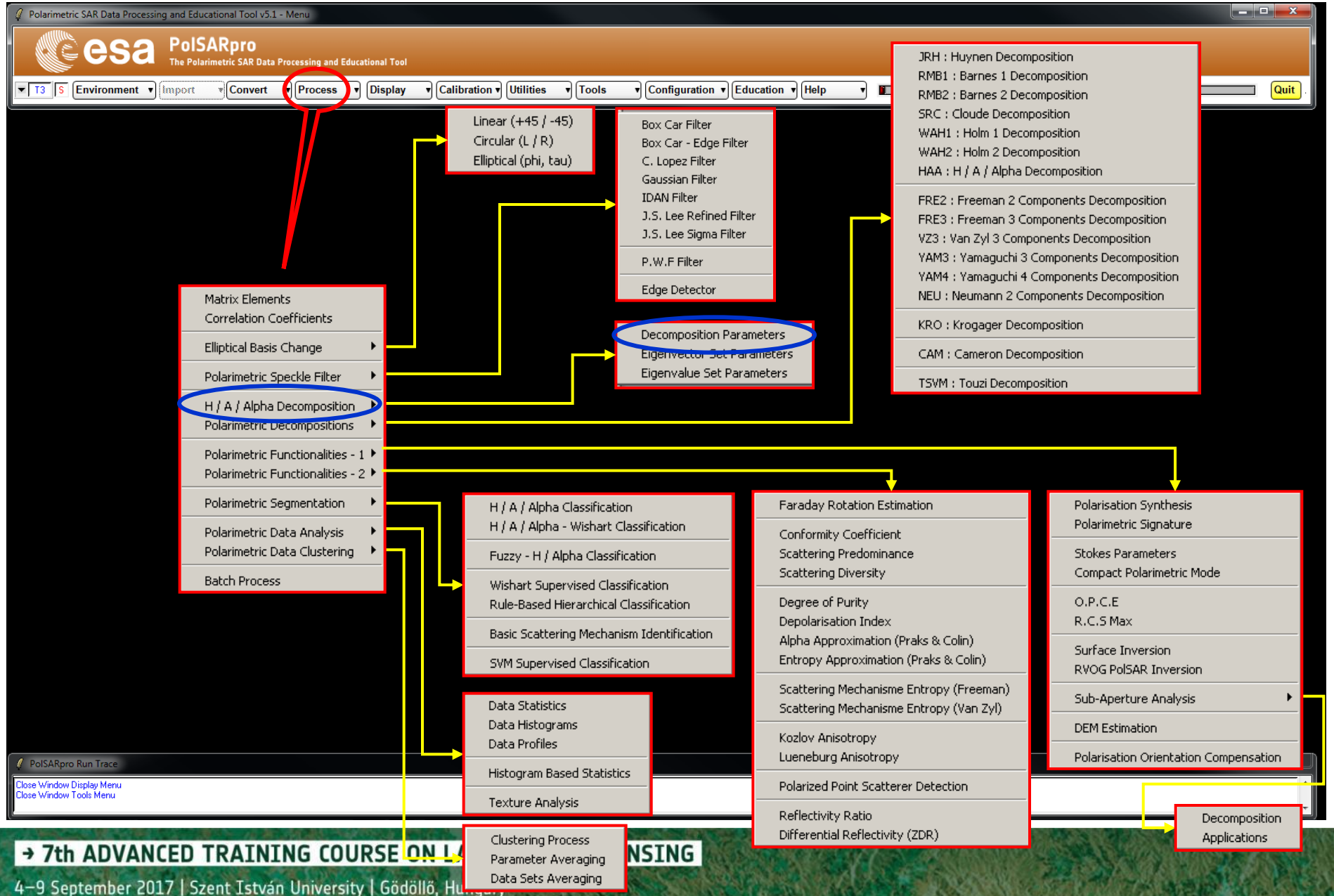
T12_pha



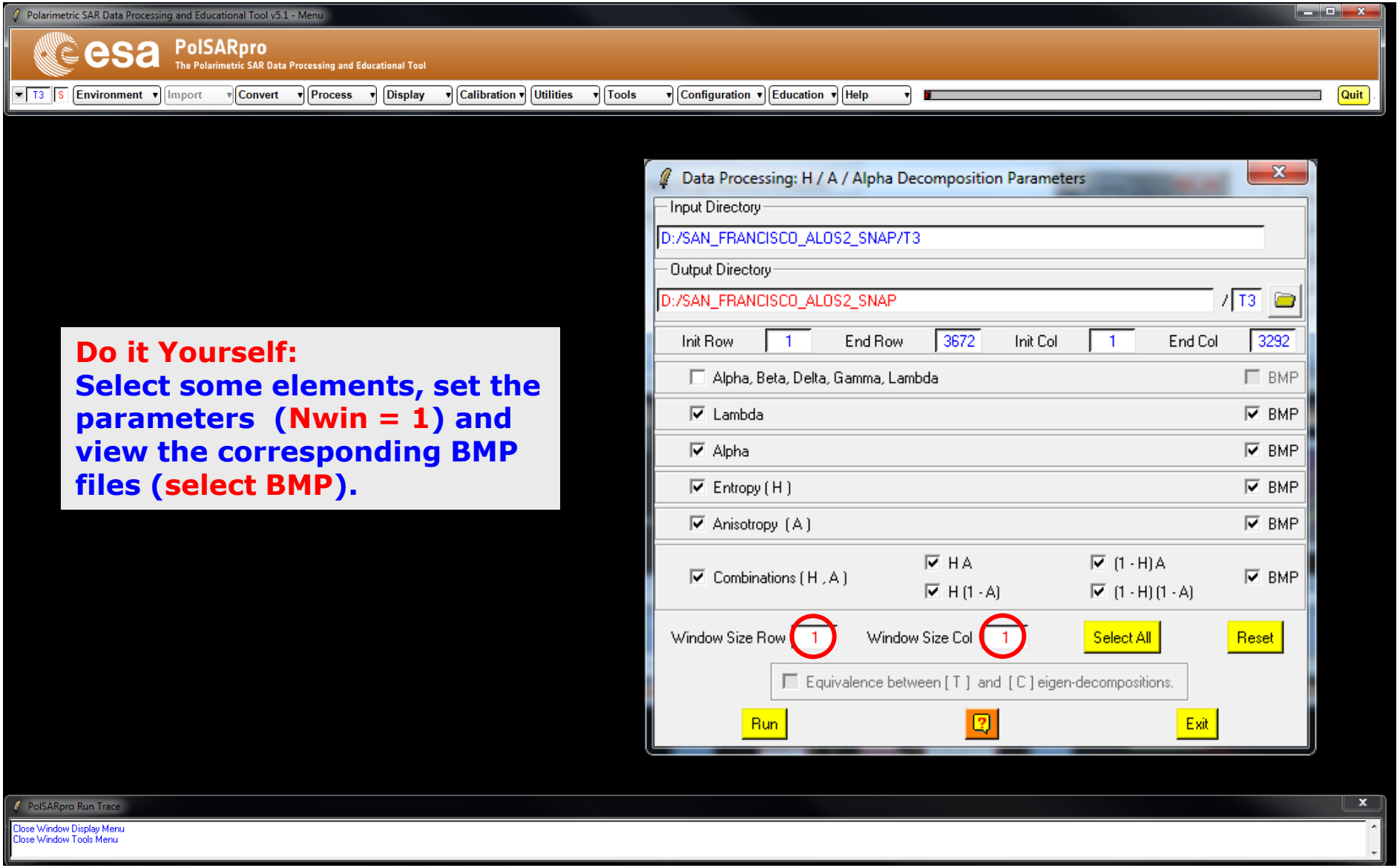
PROCESSING CHAIN



PolSARpro v5.1 SOFTWARE



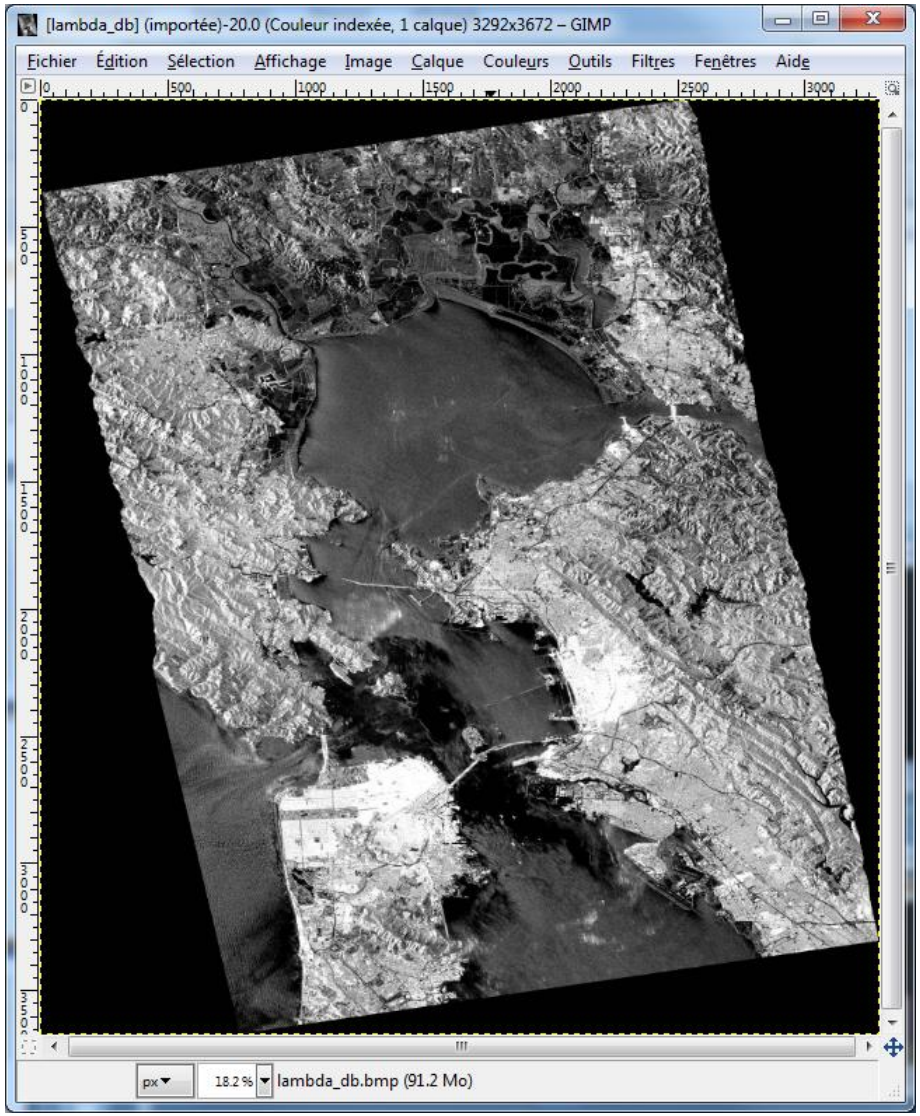
DECOMPOSITION PARAMETERS



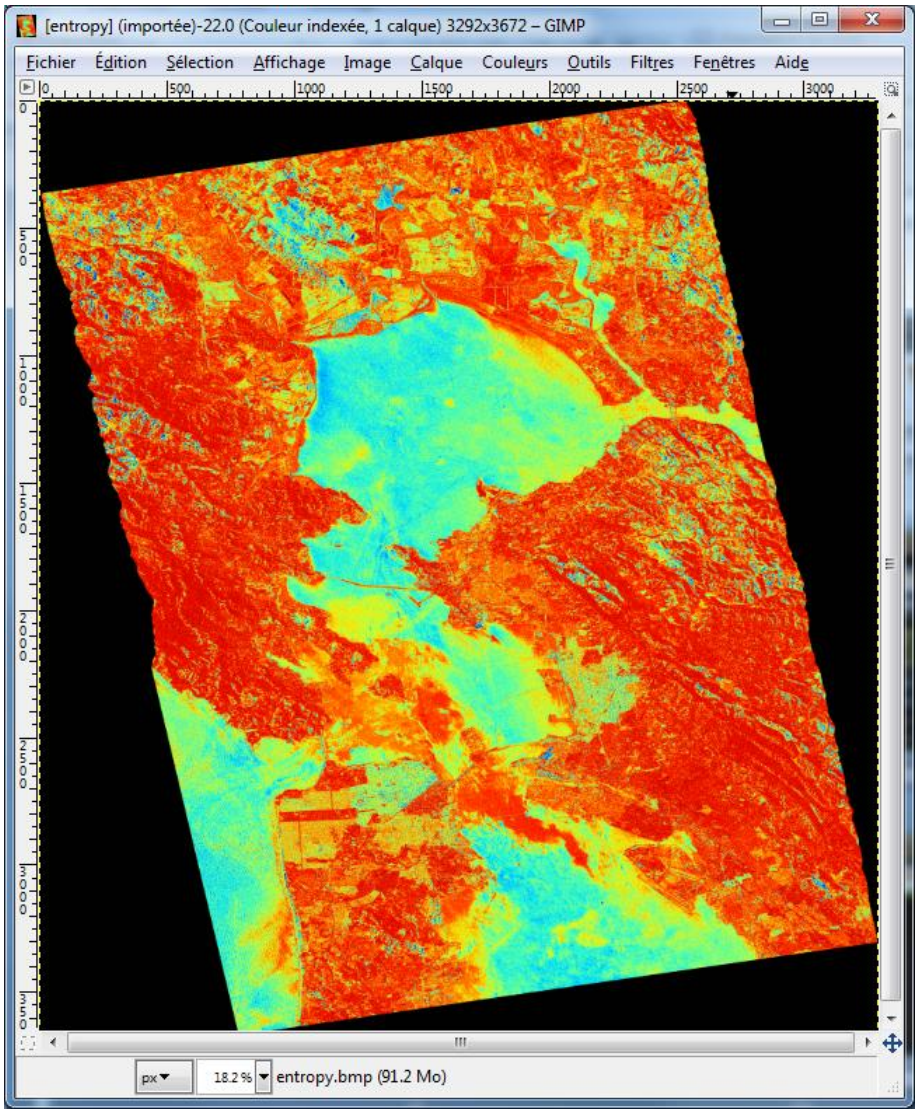
Do it Yourself:
Select some elements, set the parameters (Nwin = 1) and view the corresponding BMP files (select BMP).

DECOMPOSITION PARAMETERS

Lambda

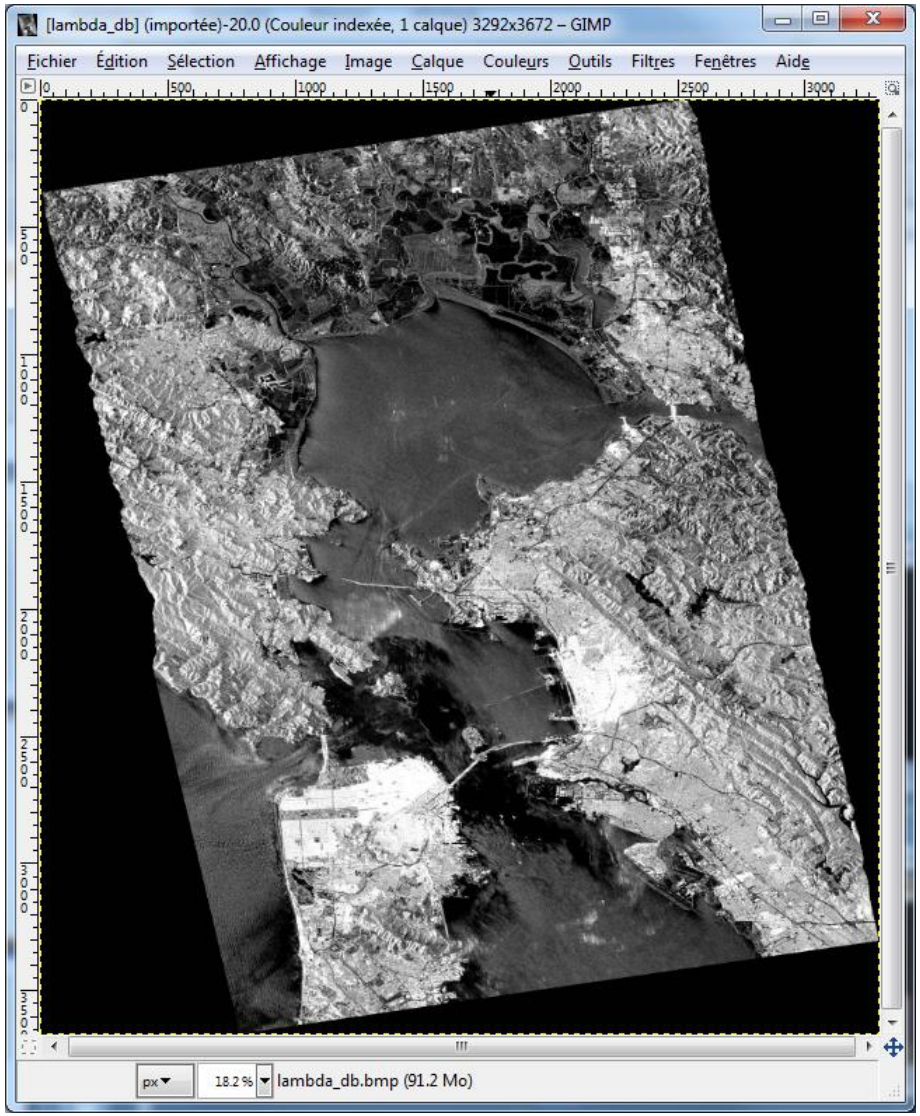


Entropy

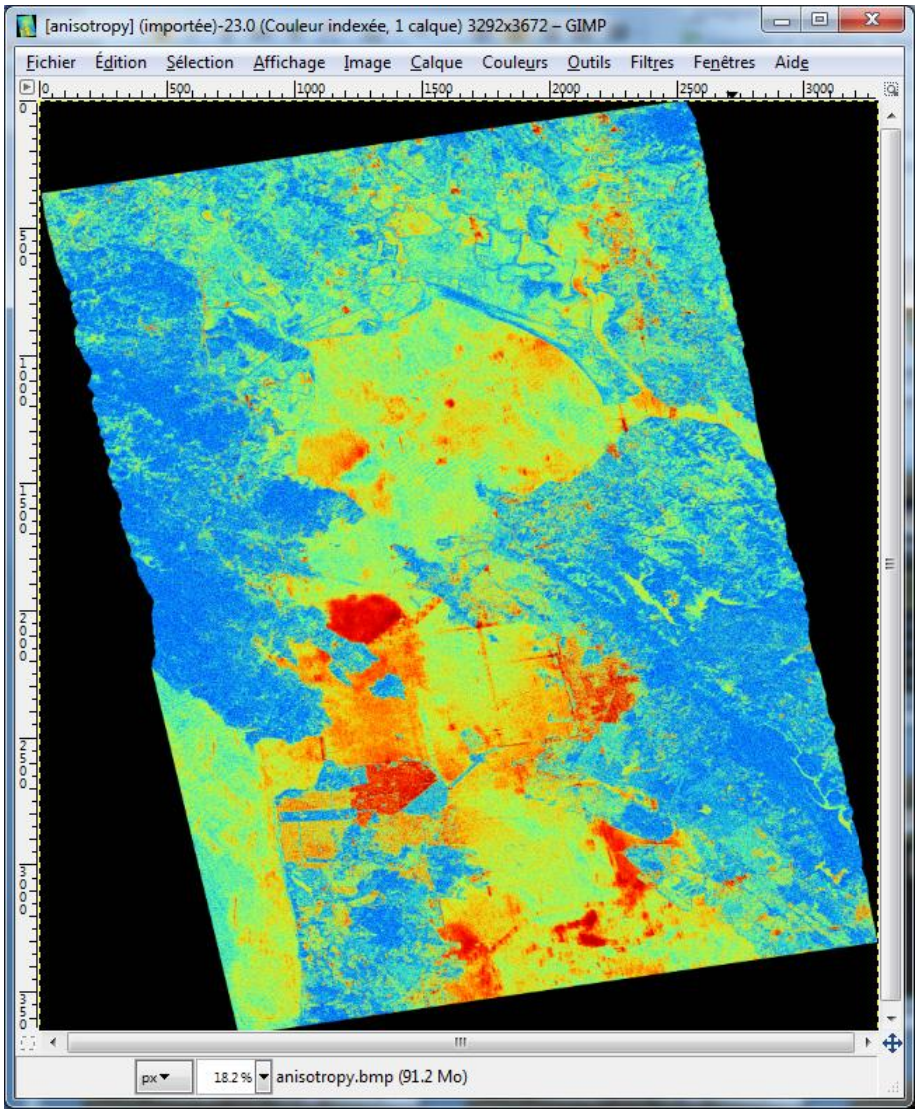


DECOMPOSITION PARAMETERS

Lambda

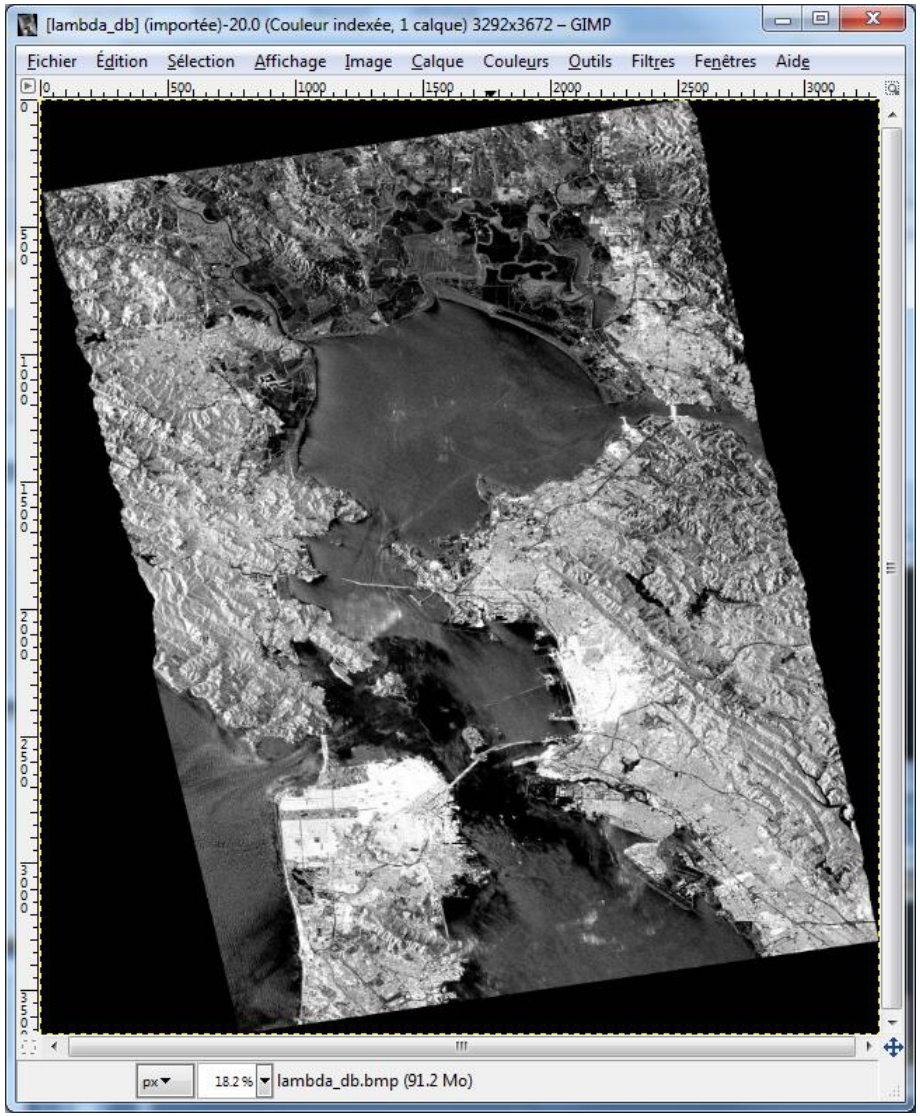


Anisotropy

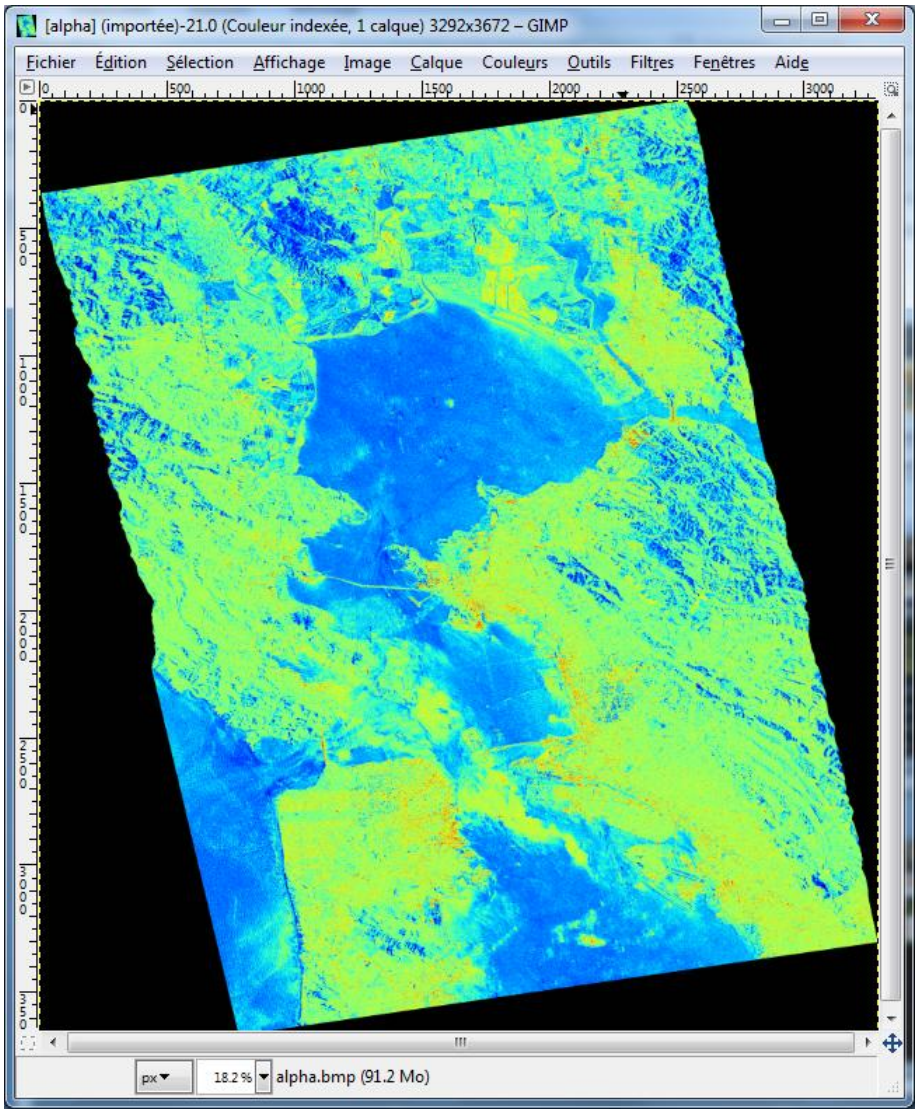


DECOMPOSITION PARAMETERS

Lambda

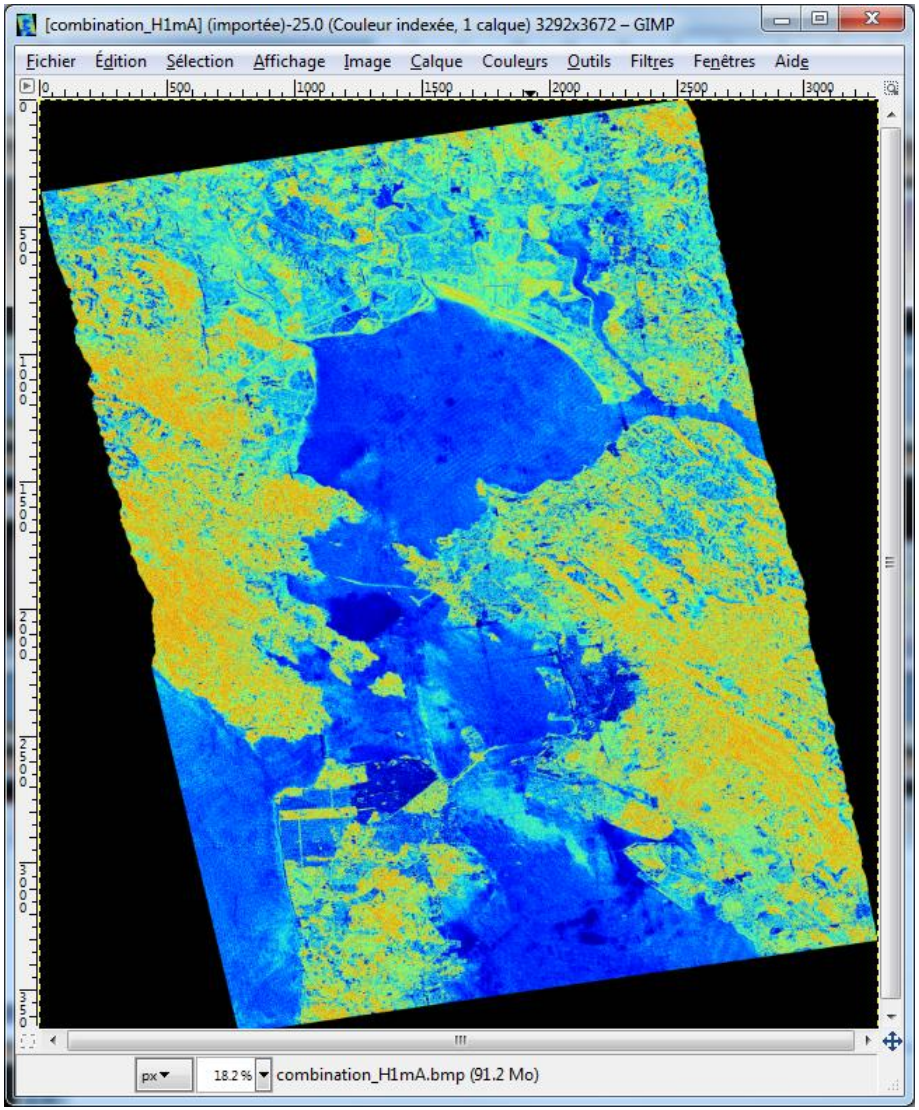


Alpha

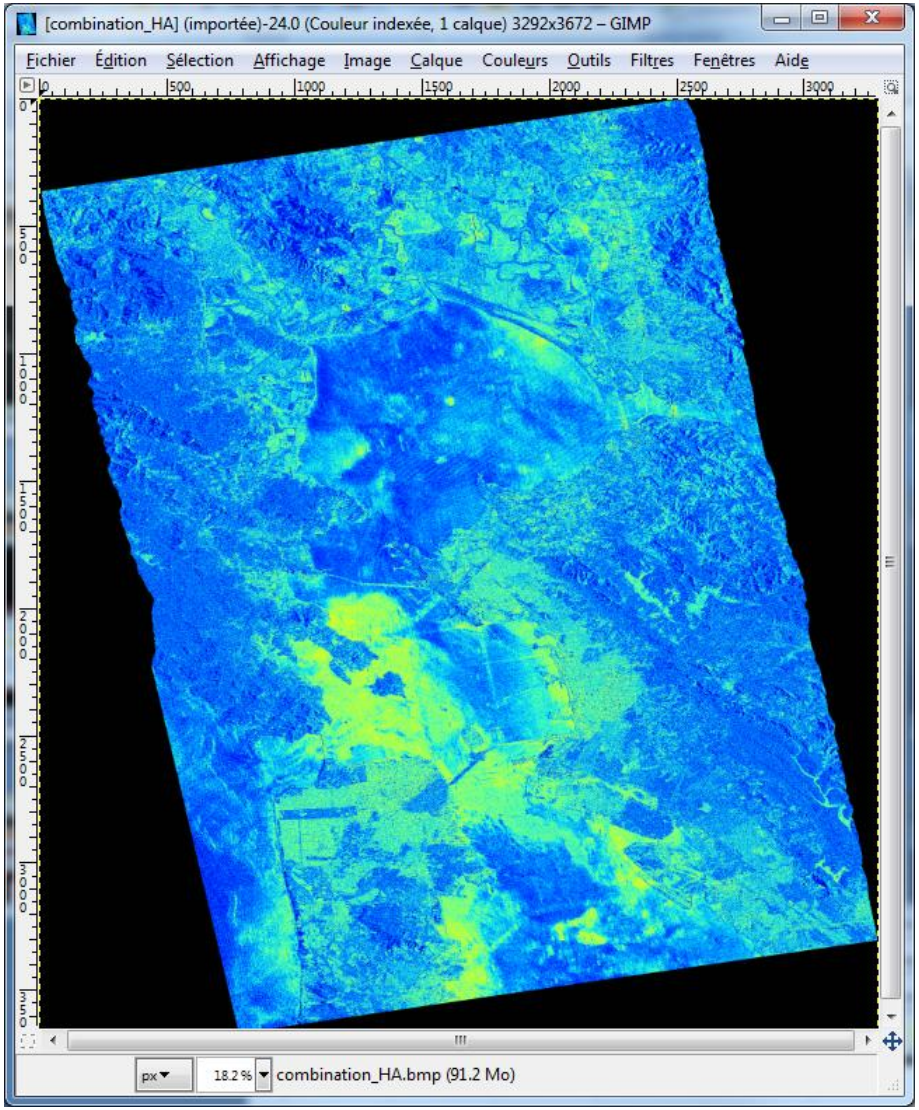


DECOMPOSITION PARAMETERS

H (1-A)

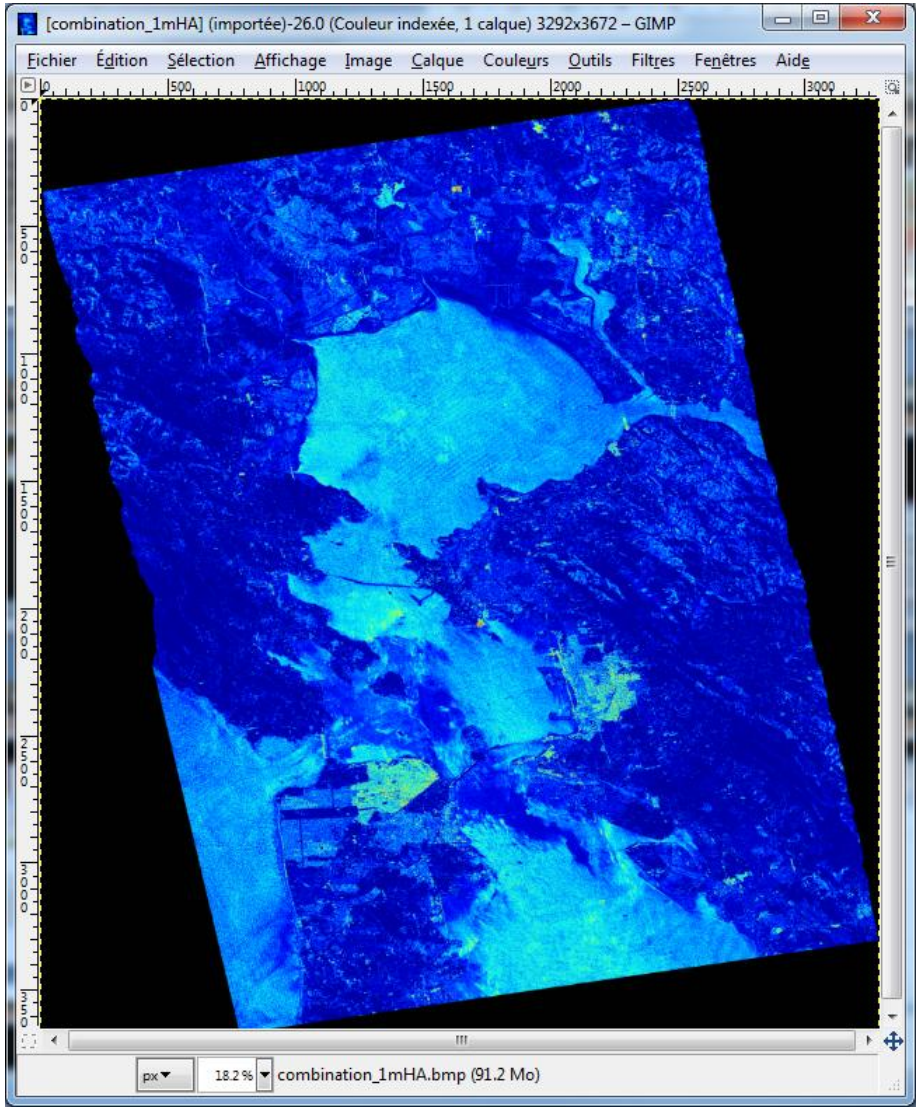


HA

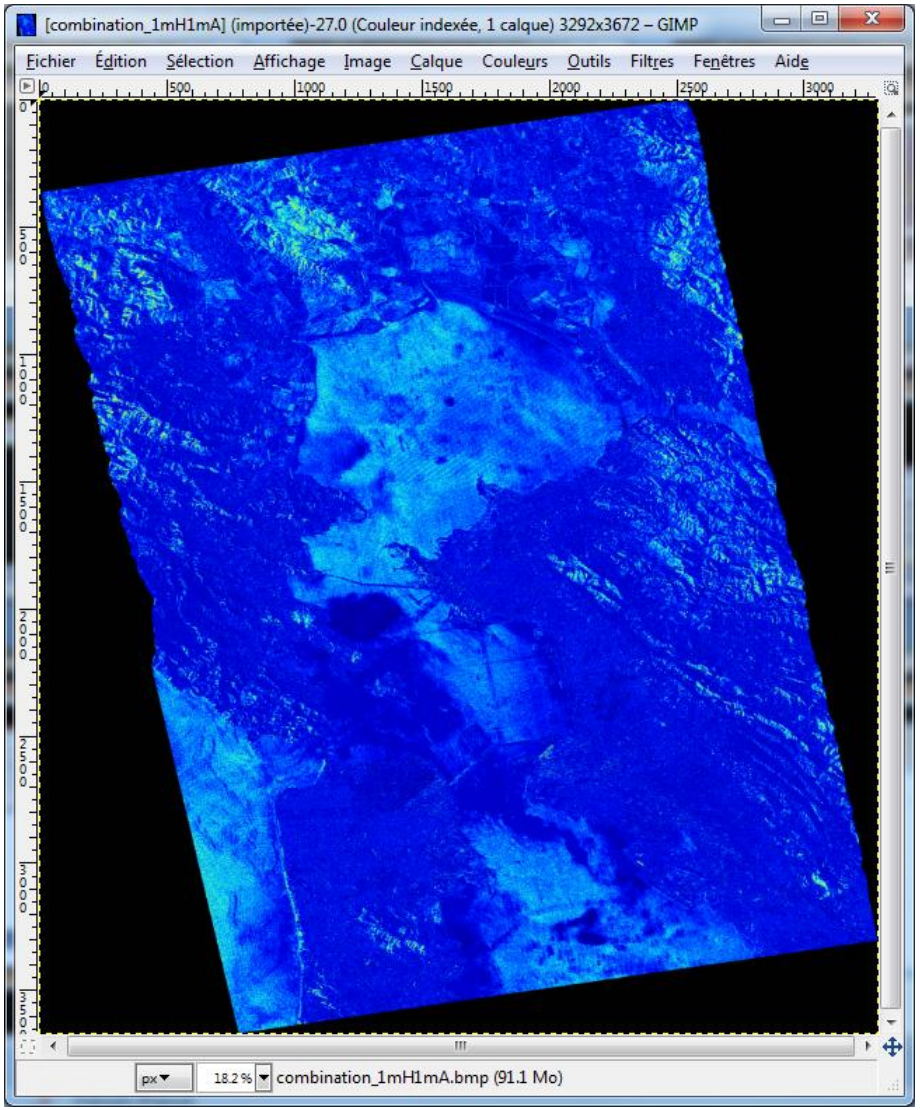


DECOMPOSITION PARAMETERS

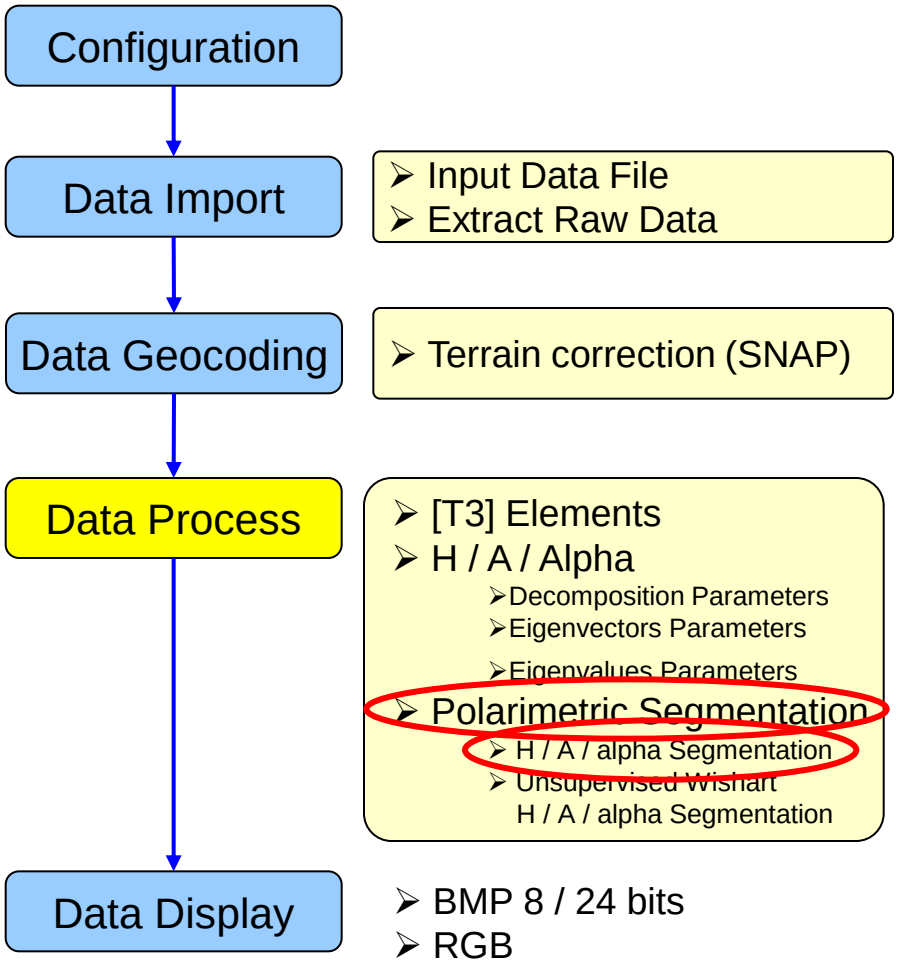
(1–H) A



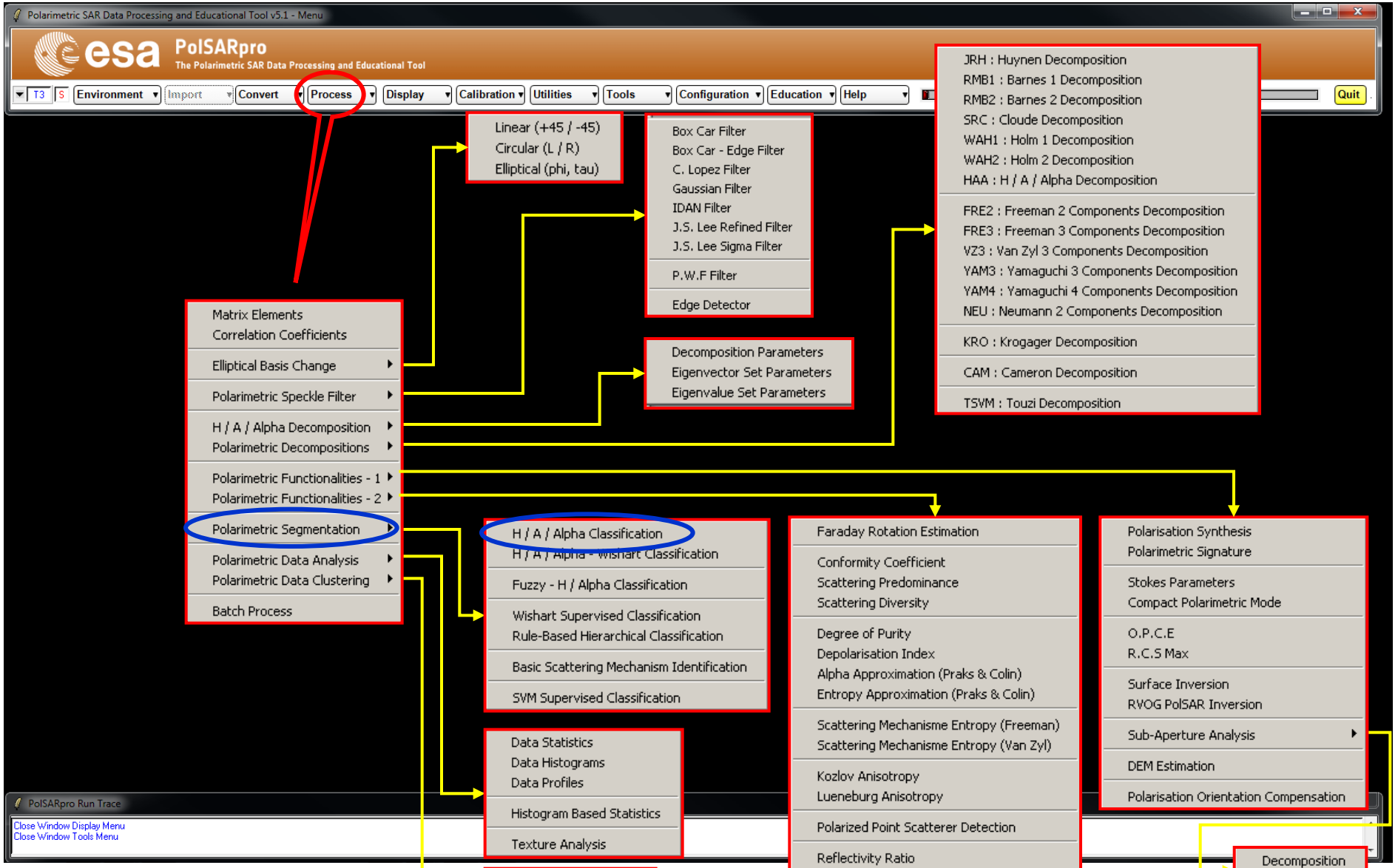
(1-H) (1-A)



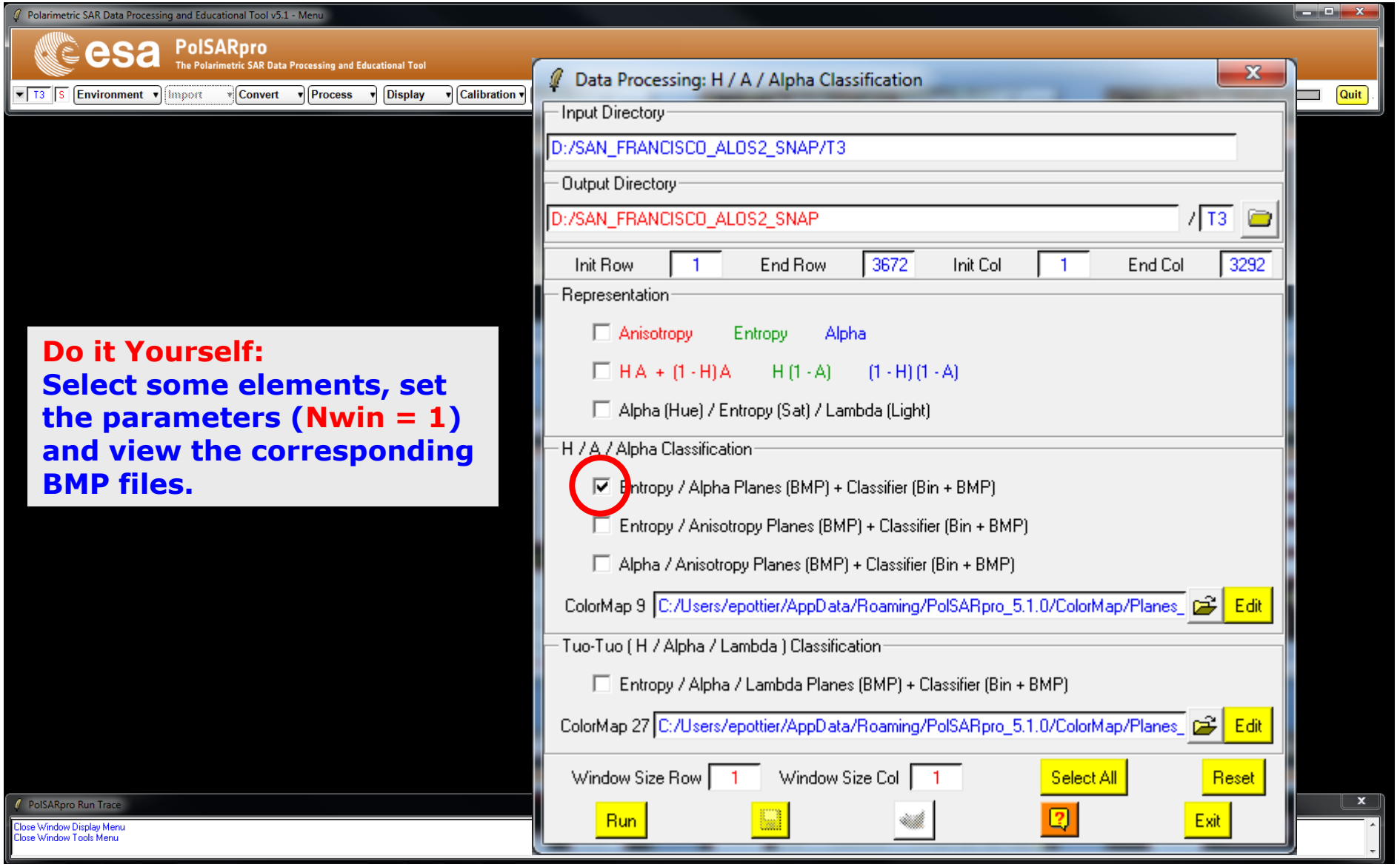
PROCESSING CHAIN



PolSARpro v5.1 SOFTWARE

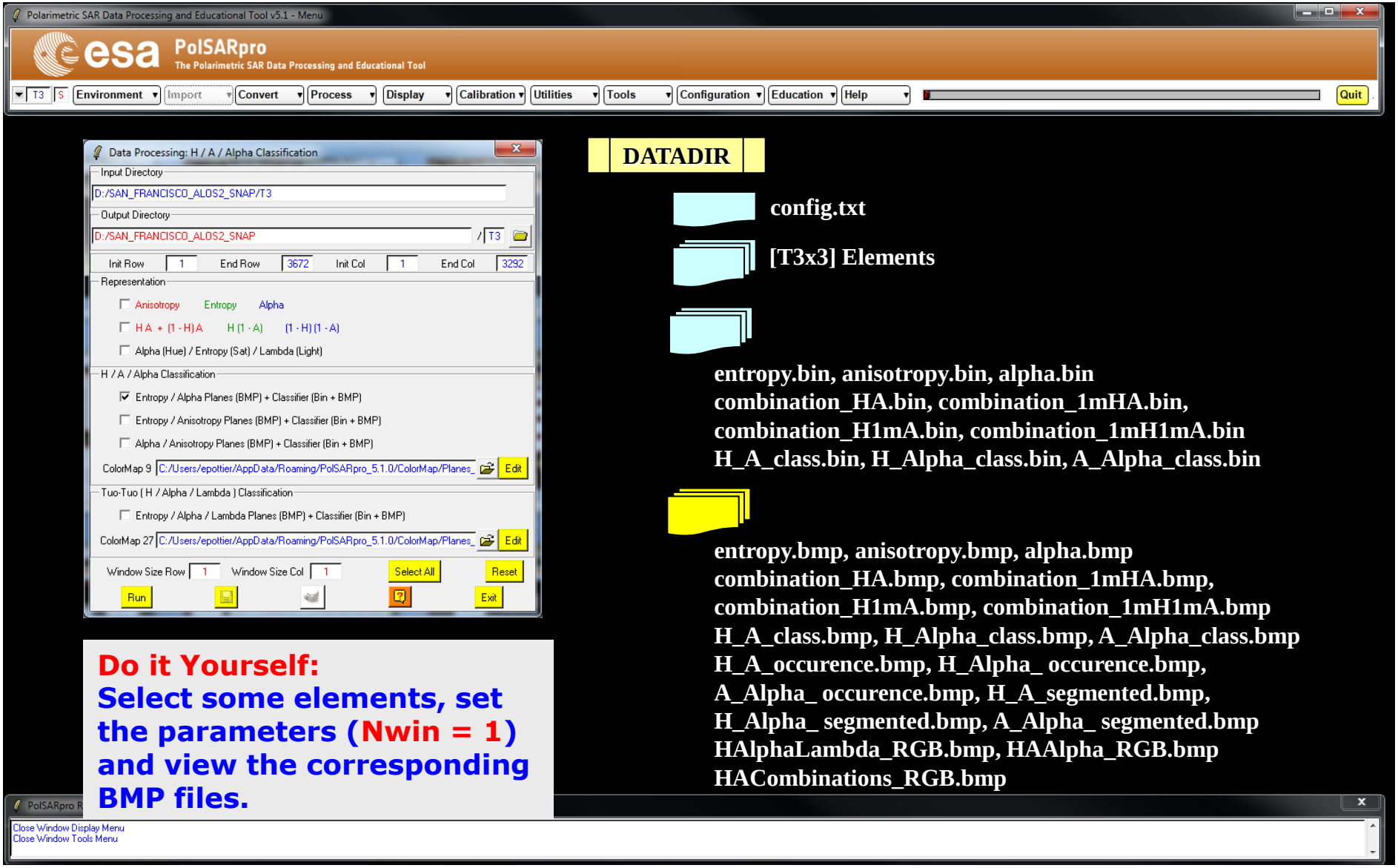


H / A / alpha CLASSIFICATION



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

H / A / alpha CLASSIFICATION



DATADIR

config.txt

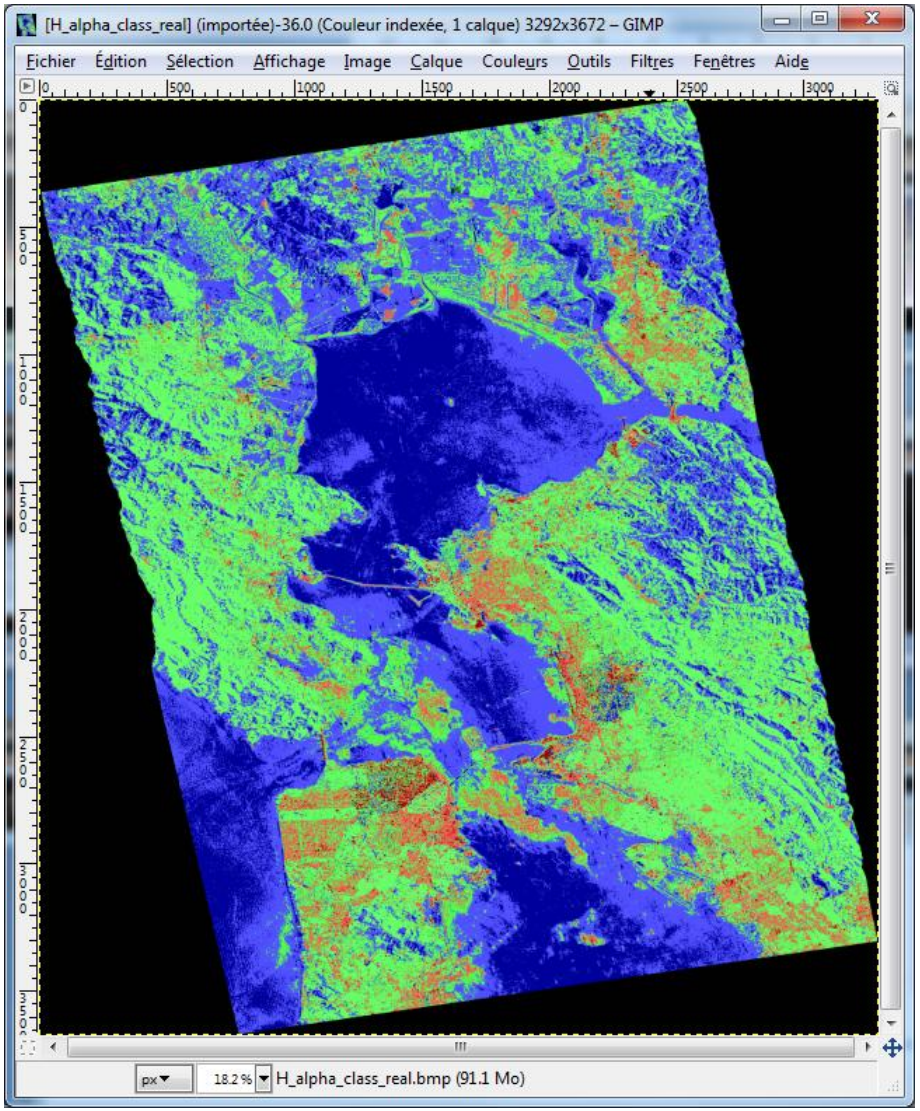
[T3x3] Elements

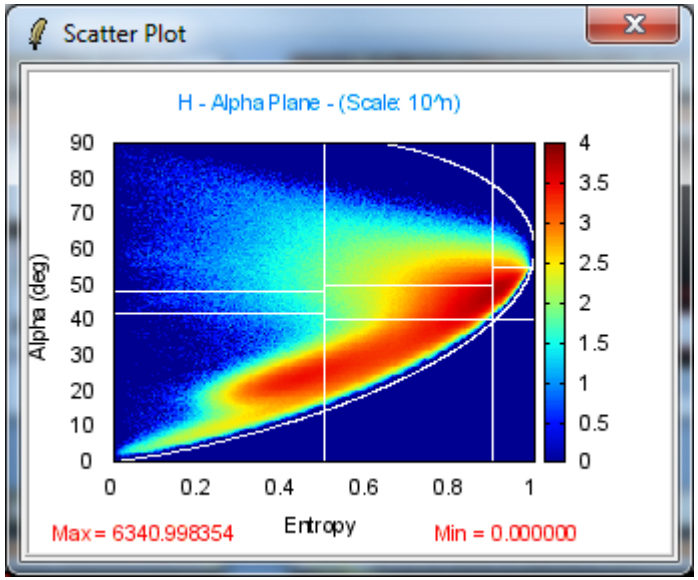
entropy.bin, anisotropy.bin, alpha.bin
combination_HA.bin, combination_1mHA.bin,
combination_H1mA.bin, combination_1mH1mA.bin
H_A_class.bin, H_Alpha_class.bin, A_Alpha_class.bin

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_occurence.bmp, H_Alpha_ occurence.bmp,
A_Alpha_ occurence.bmp, H_A_segmented.bmp,
H_Alpha_ segmented.bmp, A_Alpha_ segmented.bmp
HAlphaLambda_RGB.bmp, HAAlpha_RGB.bmp
HACombinations_RGB.bmp

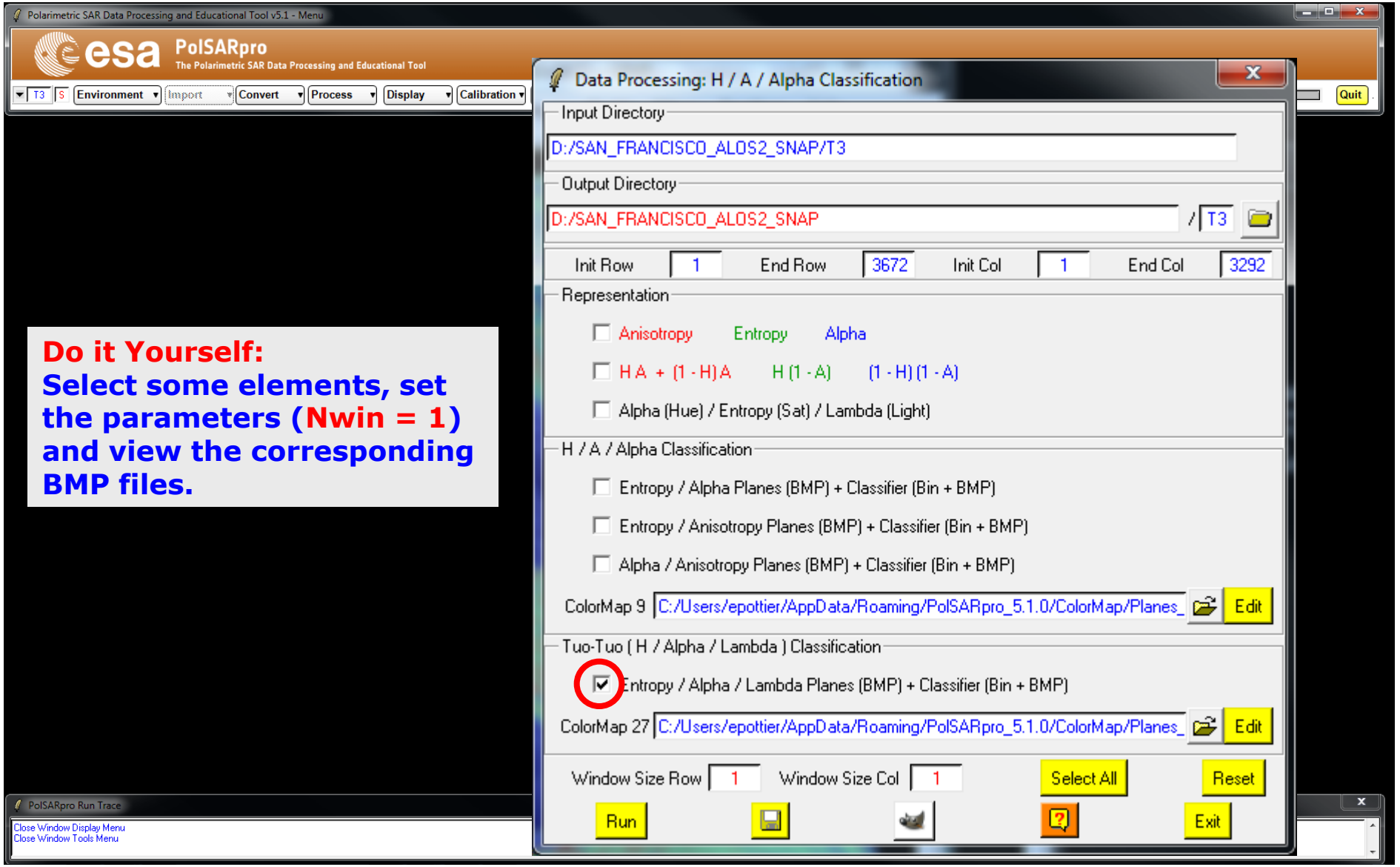
Do it Yourself:
Select some elements, set the parameters (Nwin = 1) and view the corresponding BMP files.

H / A / alpha CLASSIFICATION



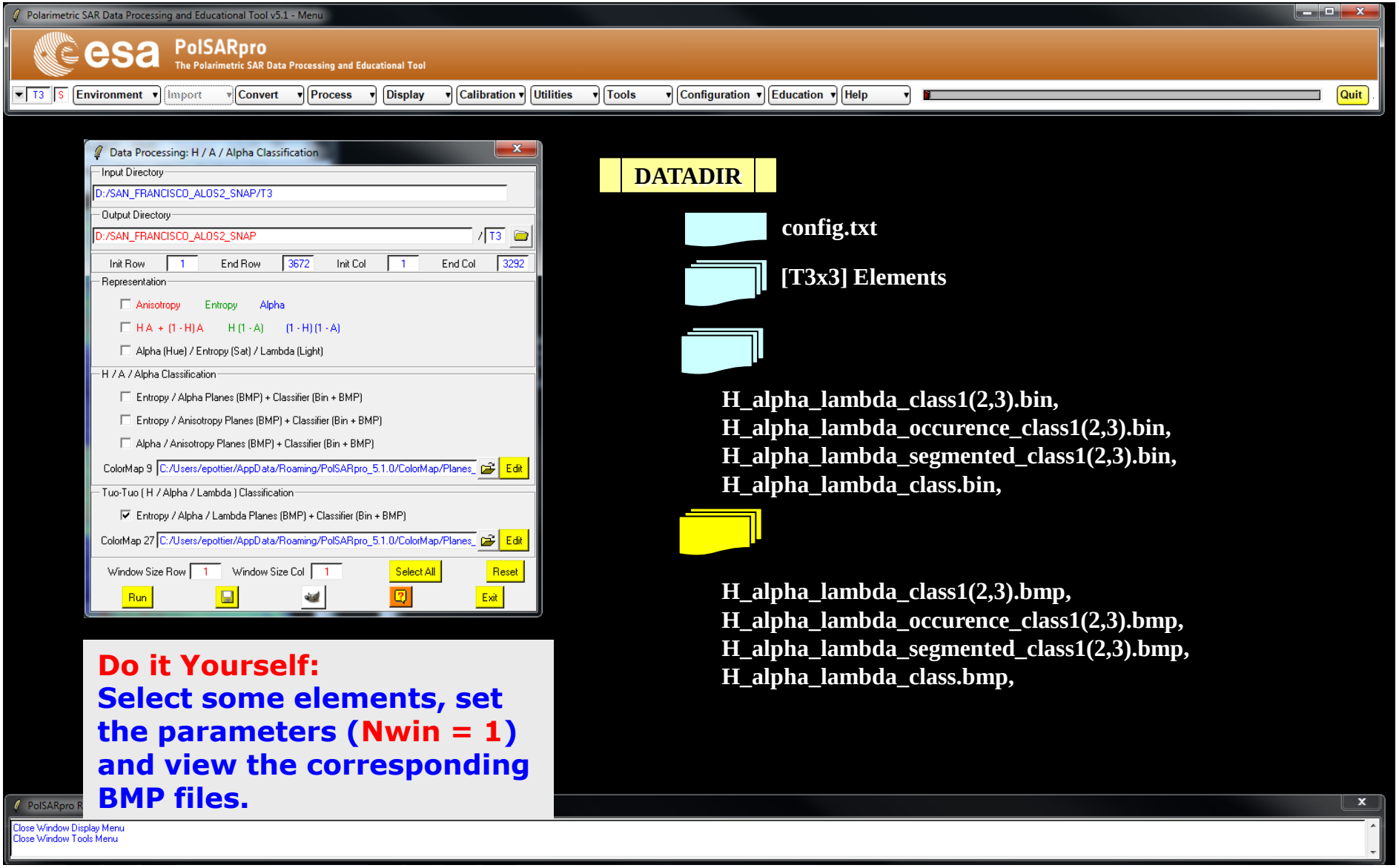


H / A / alpha CLASSIFICATION



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

H / A / alpha CLASSIFICATION

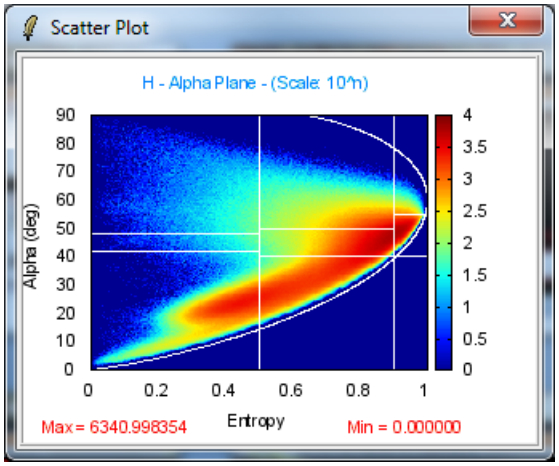


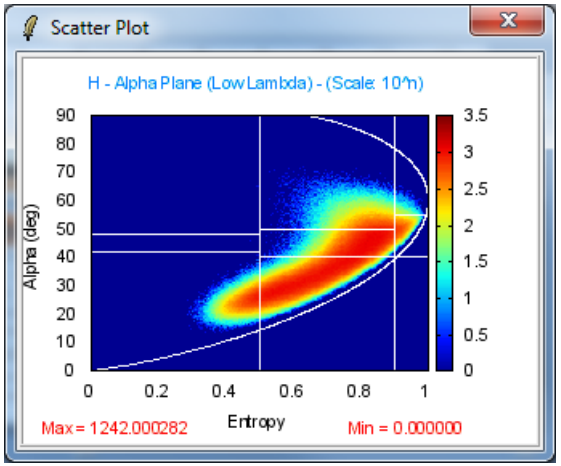
DATADIR

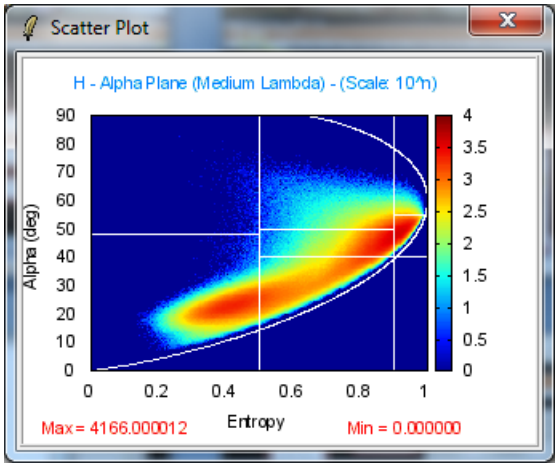
- **config.txt**
- **[T3x3] Elements**
- **H_alpha_lambda_class1(2,3).bin,**
  H_alpha_lambda_occurence_class1(2,3).bin,
  H_alpha_lambda_segmented_class1(2,3).bin,
  H_alpha_lambda_class.bin,
- **H_alpha_lambda_class1(2,3).bmp,**
  H_alpha_lambda_occurence_class1(2,3).bmp,
  H_alpha_lambda_segmented_class1(2,3).bmp,
  H_alpha_lambda_class.bmp,

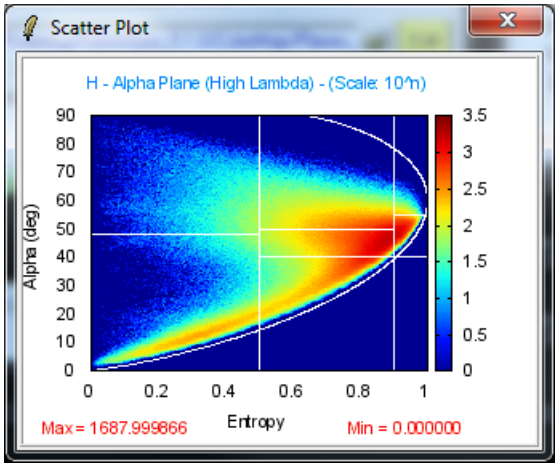
Do it Yourself:
Select some elements, set the parameters (Nwin = 1) and view the corresponding BMP files.

H / A / alpha CLASSIFICATION



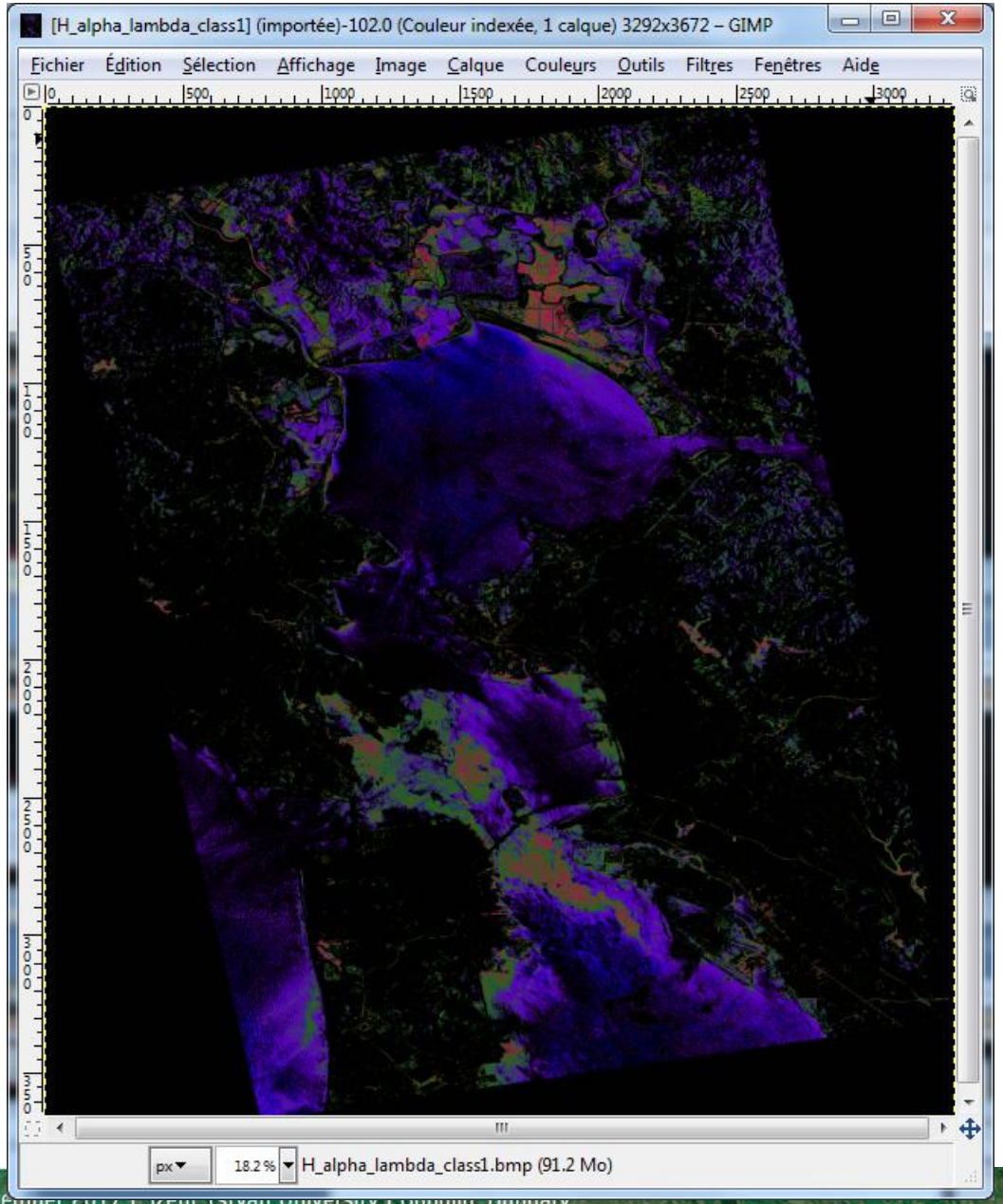


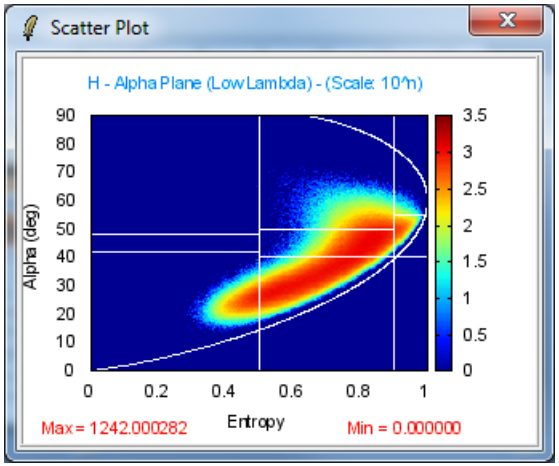




Low λ **Medium λ** **High λ**

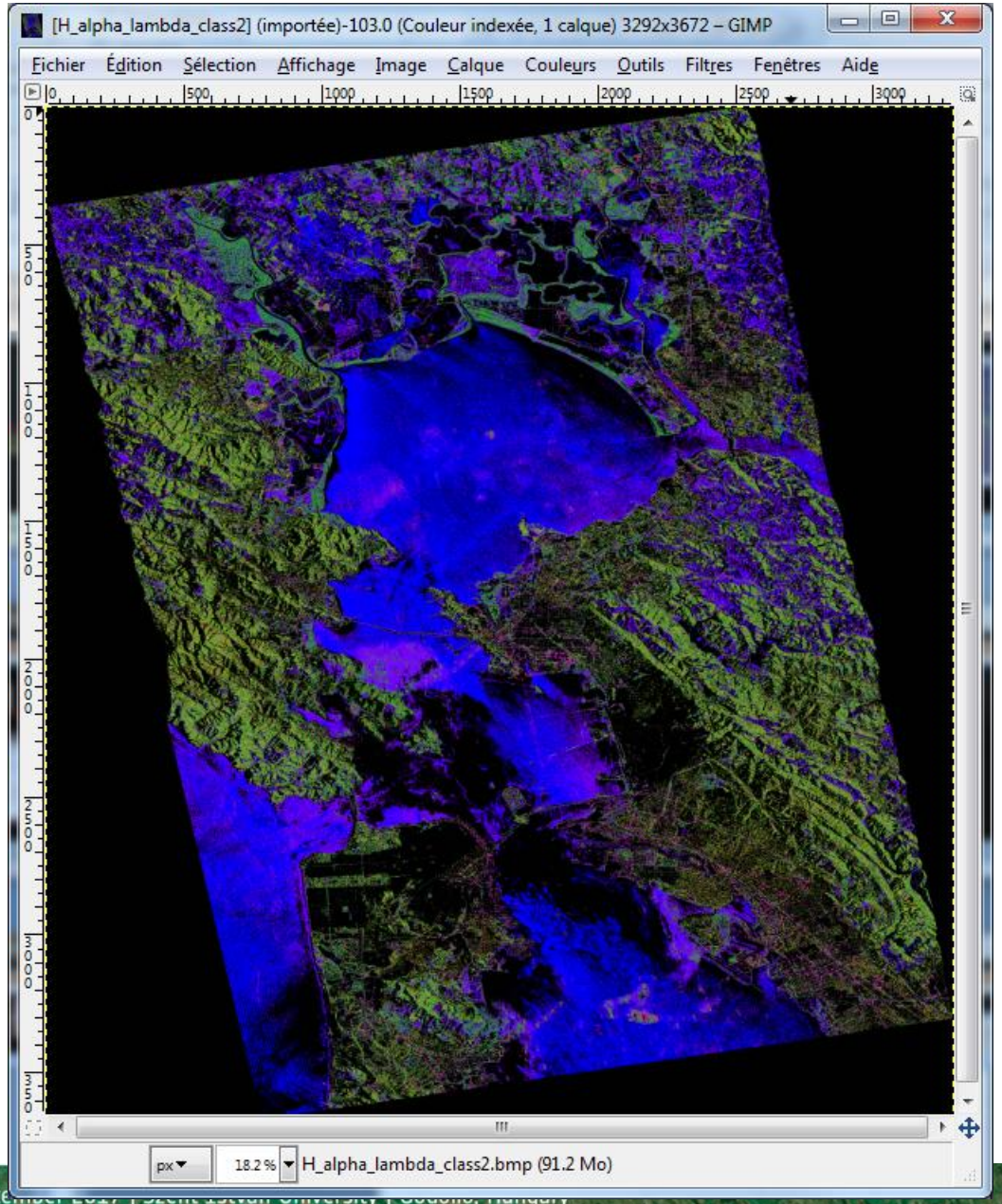
H / A / alpha CLASSIFICATION

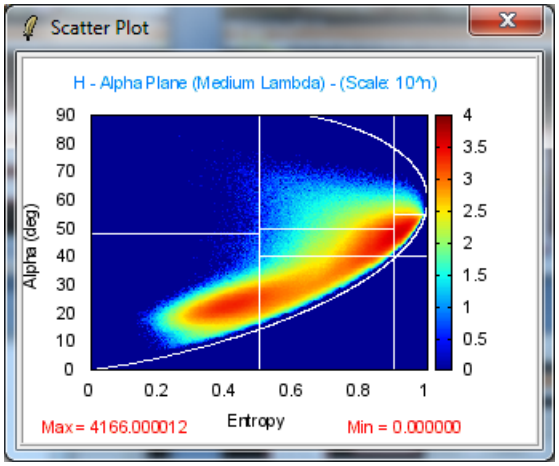




Low λ

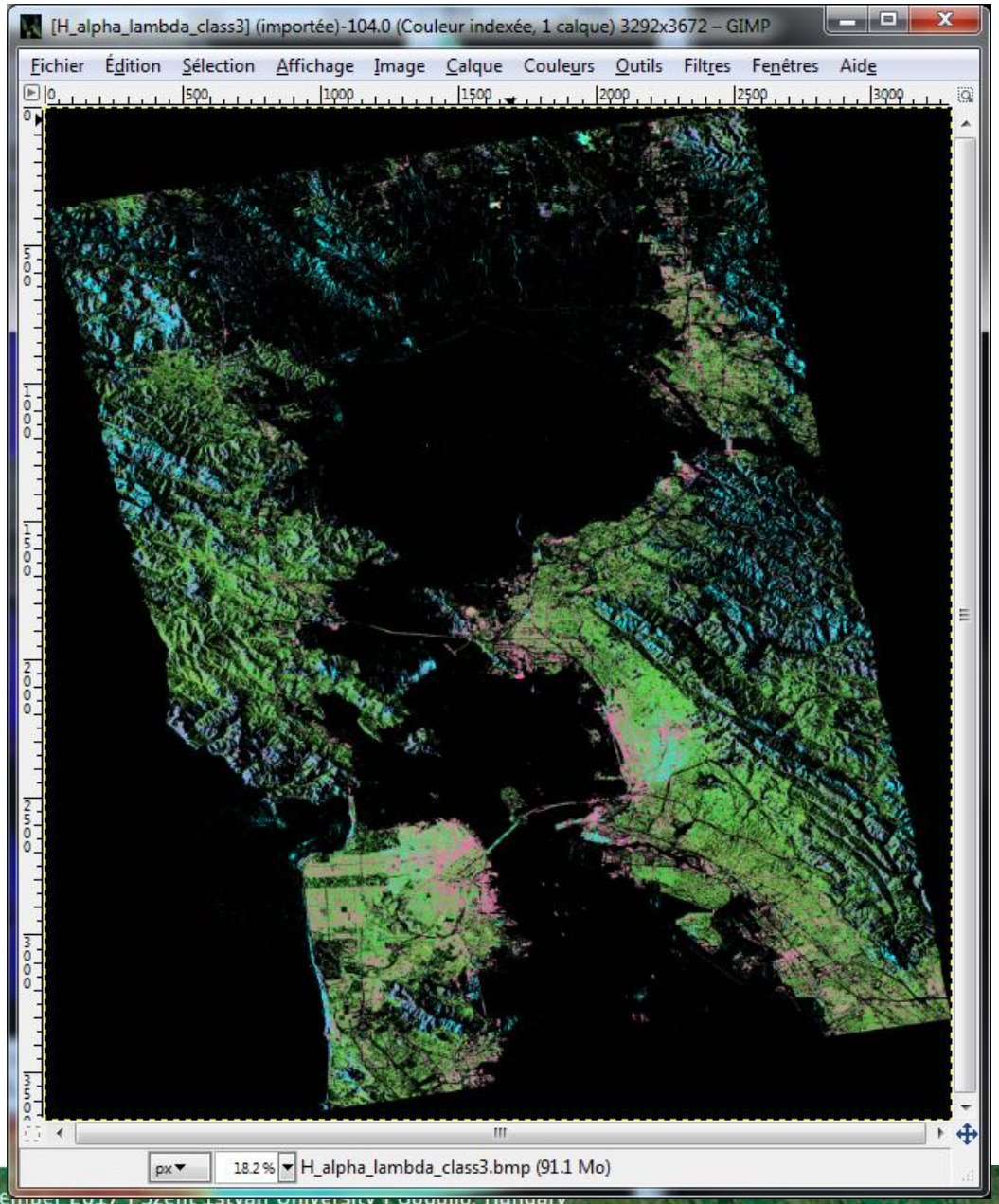
H / A / alpha CLASSIFICATION

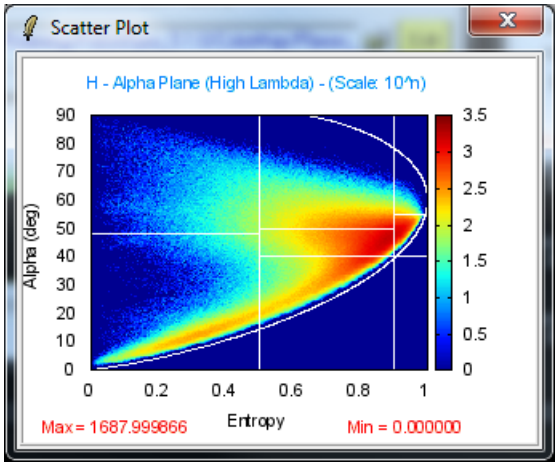




Medium λ

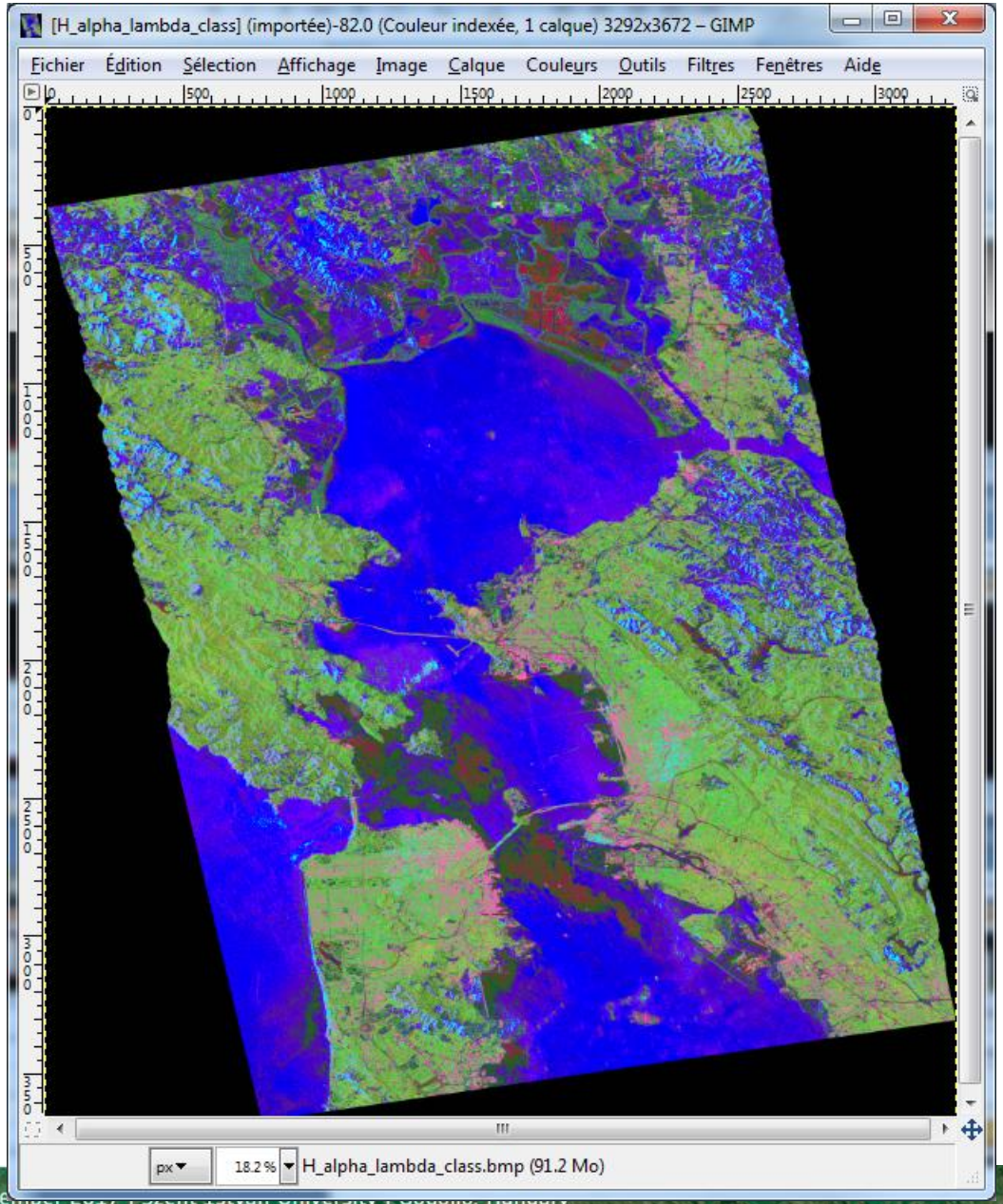
H / A / alpha CLASSIFICATION

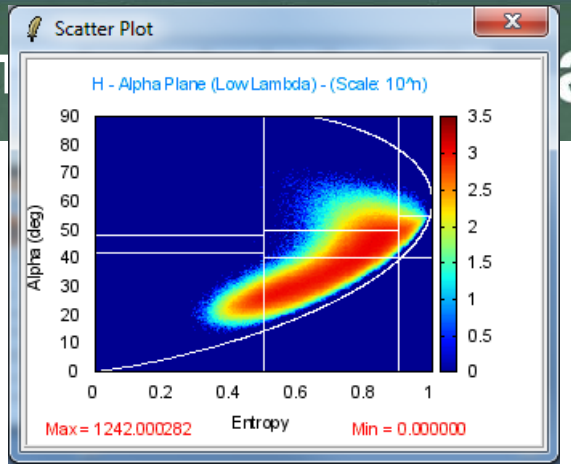


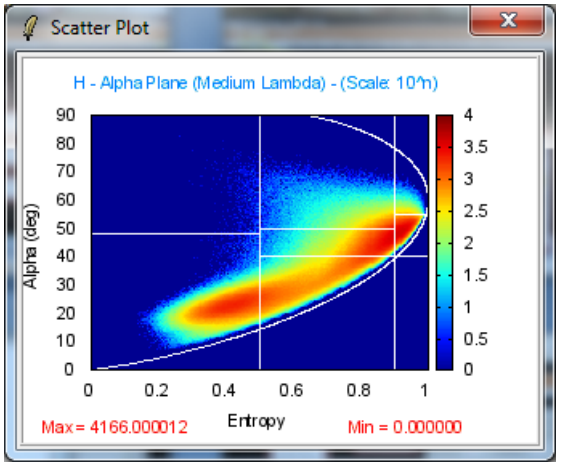


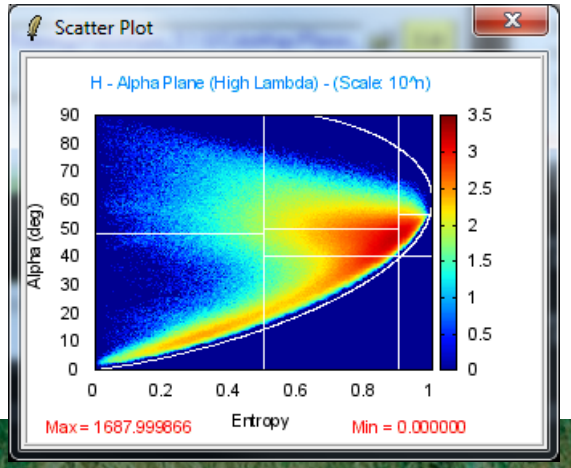
High λ

H / A / alpha CLASSIFICAT

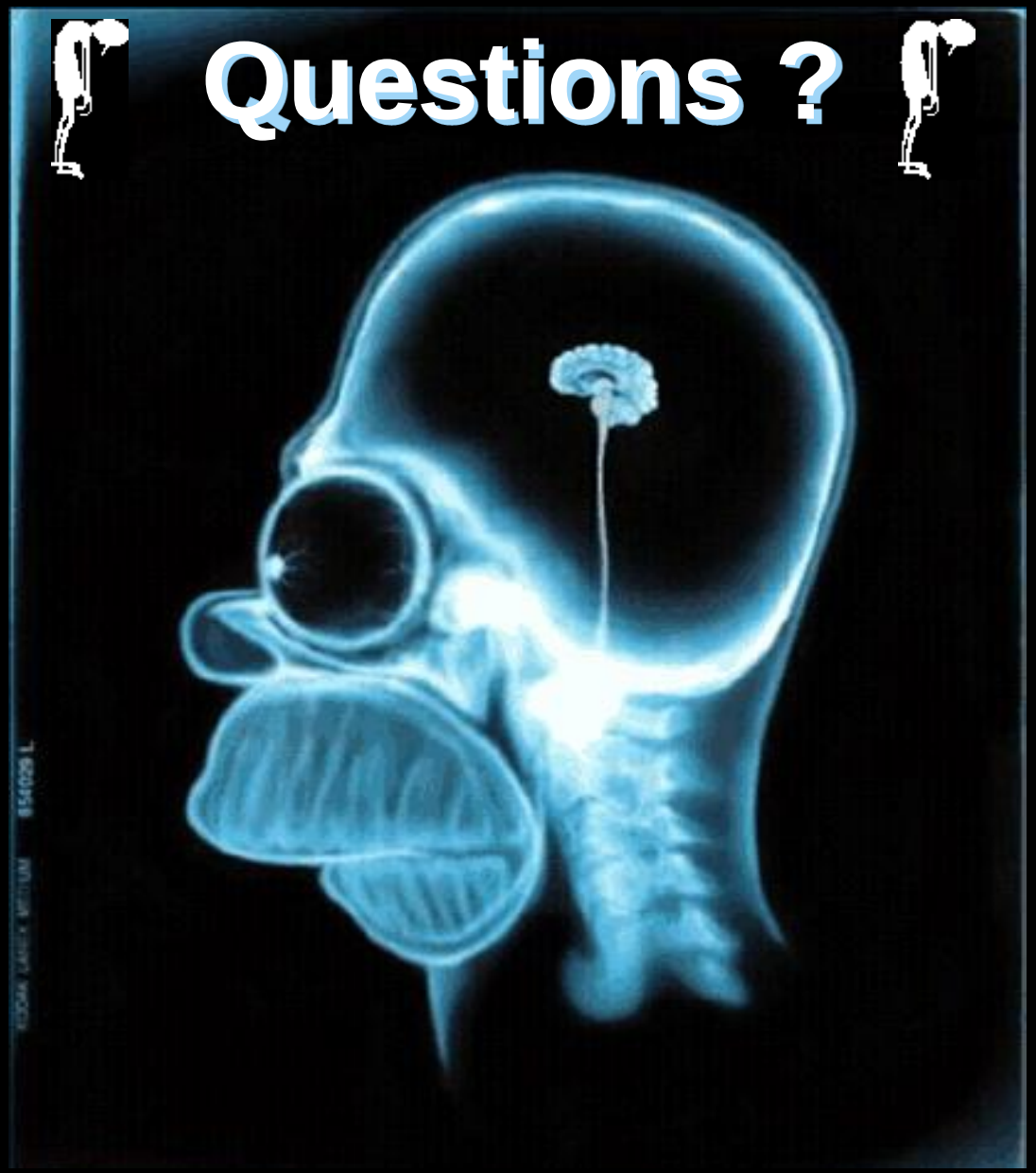






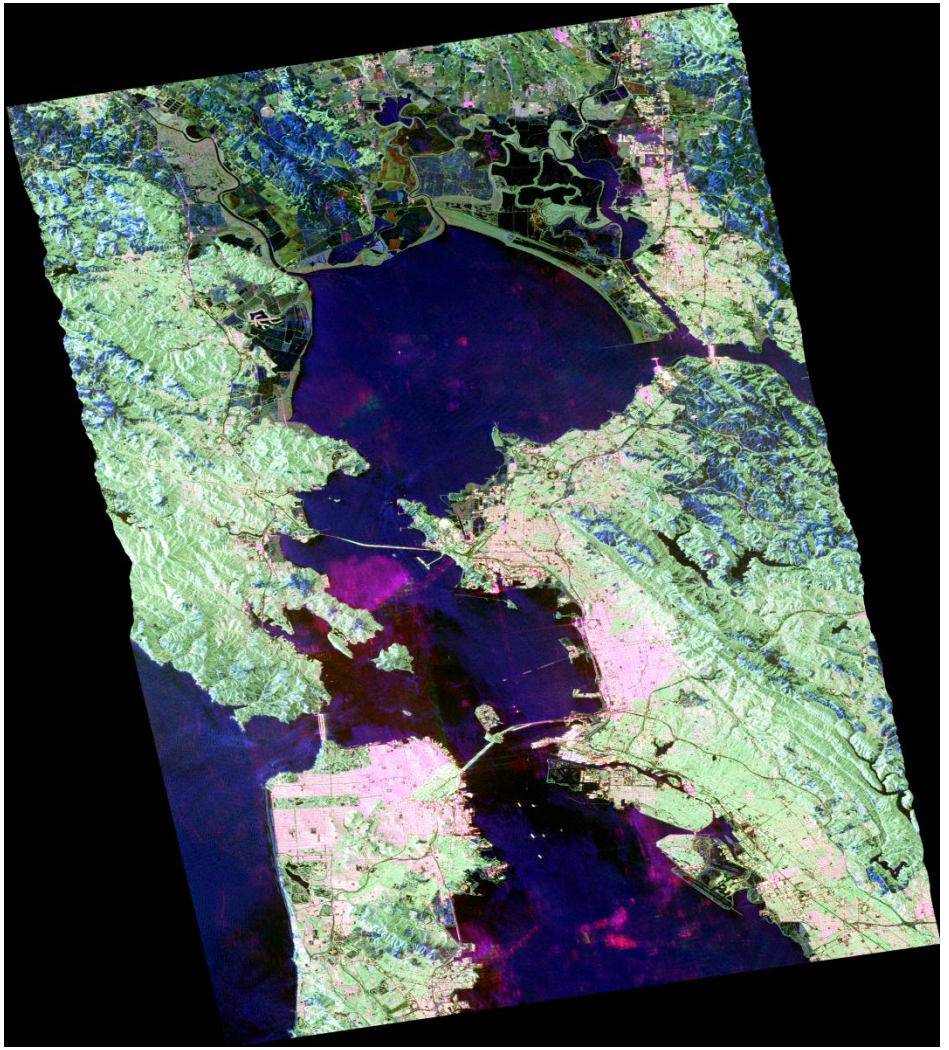


Questions ?



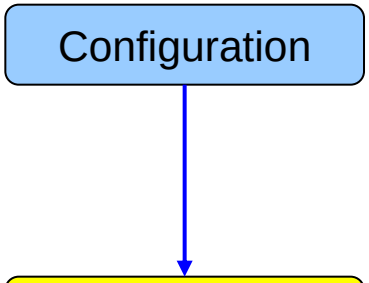
PolSARpro v5.1 Software
Practical advanced session

ALOS
Advanced Land Observing Satellite



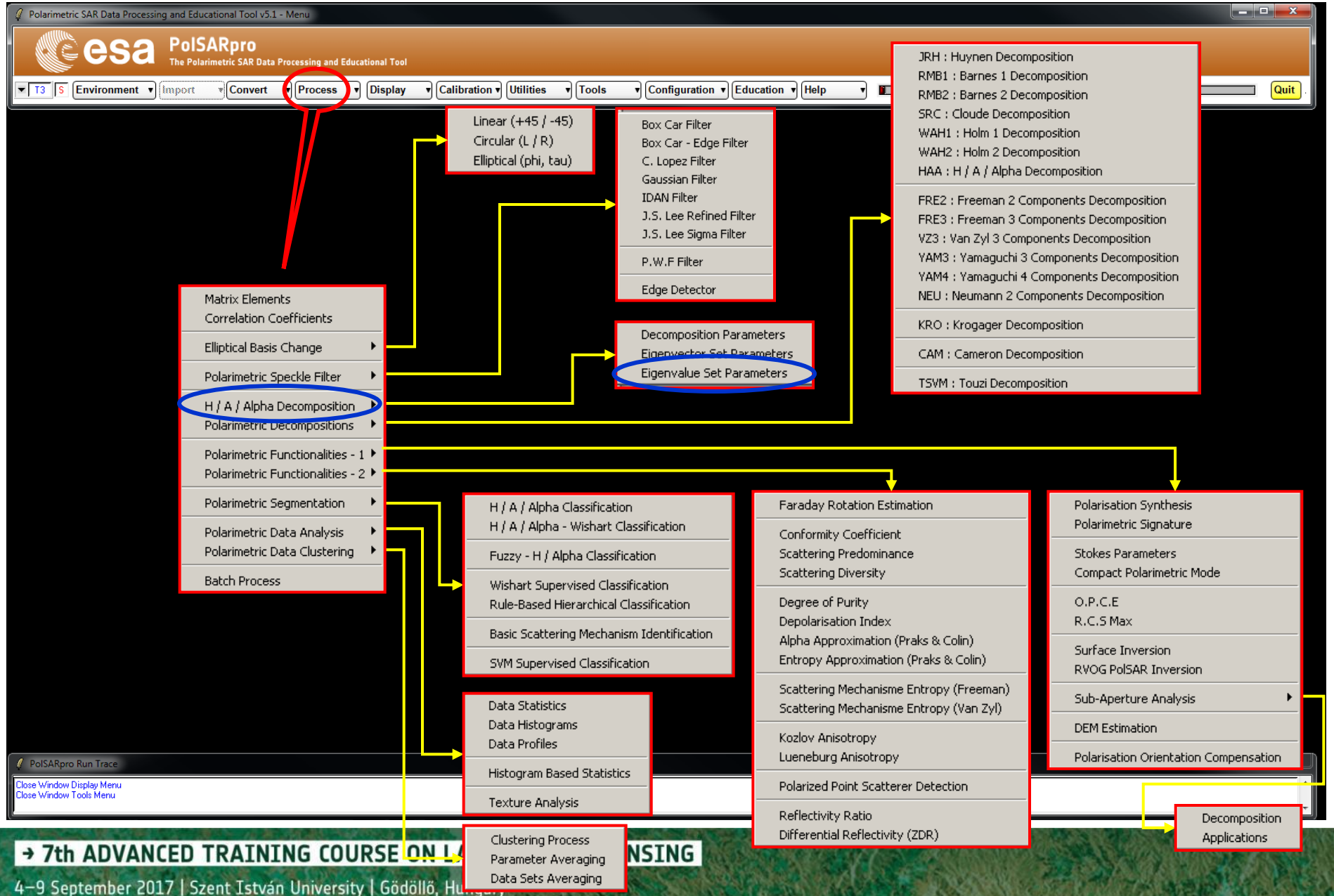
ALOS : Advanced Land Observing Satellite
PALSAR : Phase Array L-Band SAR

PROCESSING CHAIN

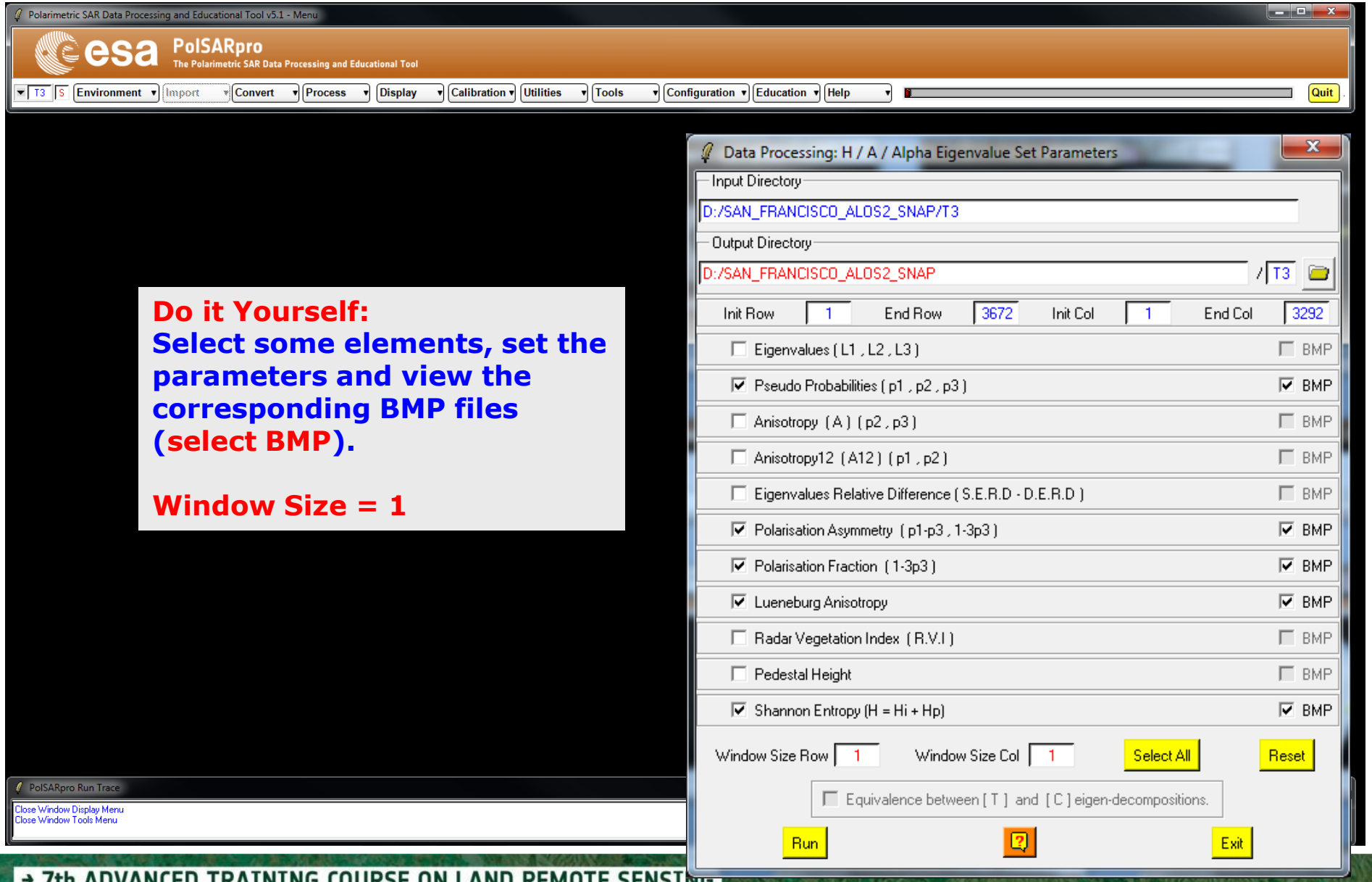


- Eigenvalue Parameters
- Polarimetric Decomposition
- Polarimetric Segmentation
  - Wishart - H / A / alpha classification
  - Supervised Wishart classification
  - Support Vector Machine Classification

PolSARpro v5.1 SOFTWARE



EIGENVALUE SET PARAMETERS

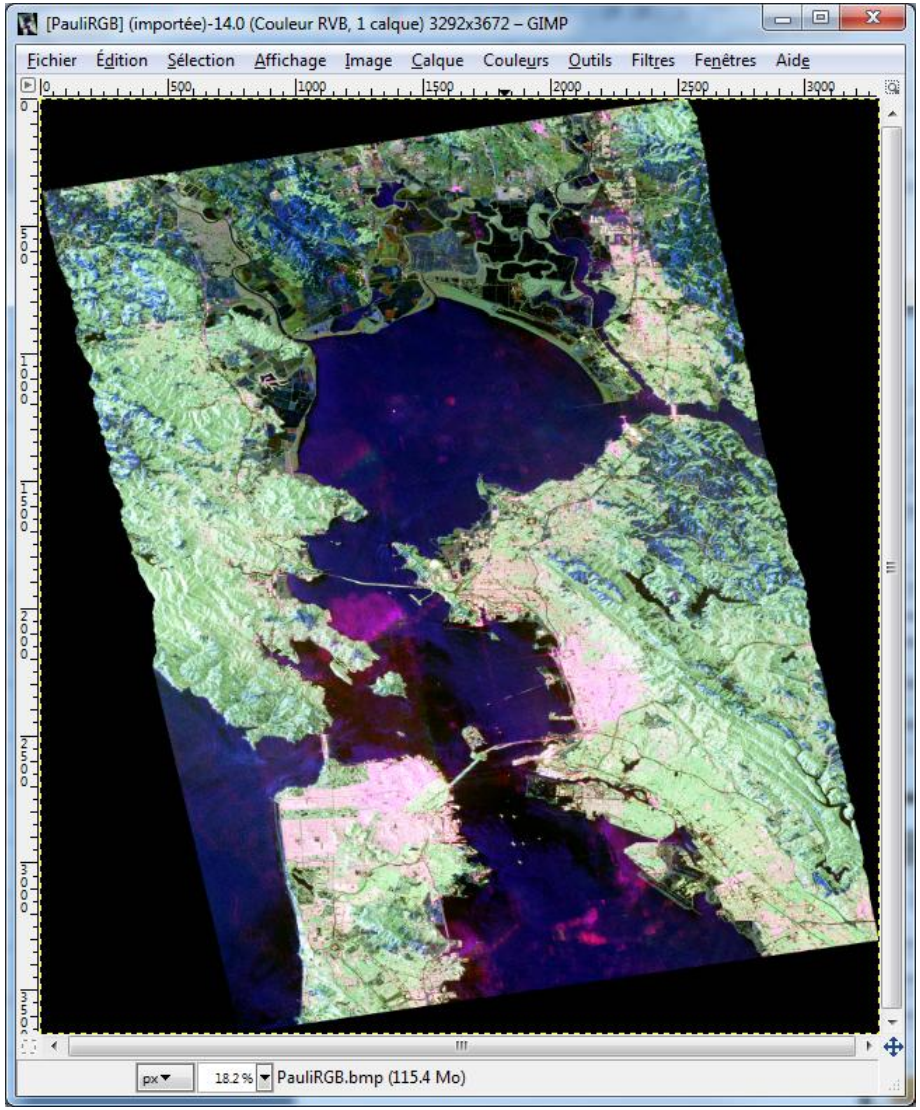


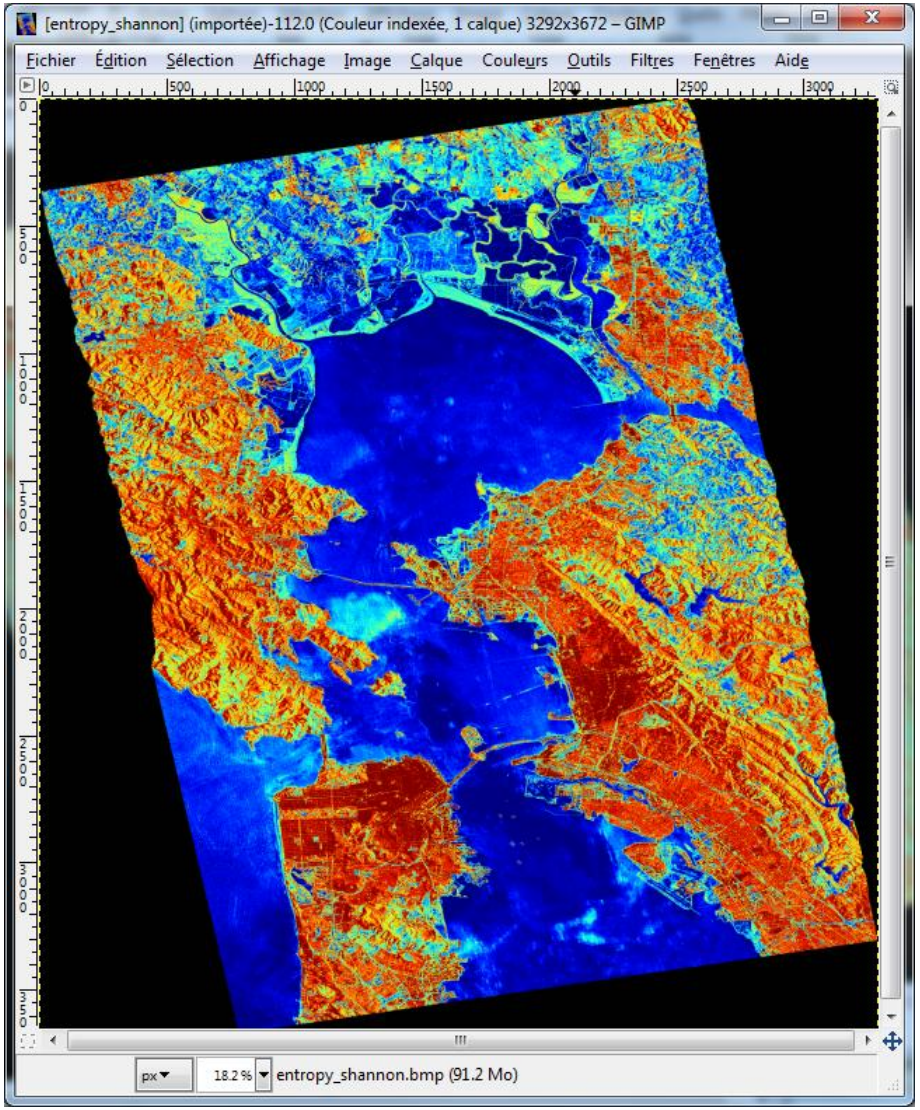
Do it Yourself:
Select some elements, set the parameters and view the corresponding BMP files (select BMP).

Window Size = 1

EIGENVALUE SET PARAMETERS

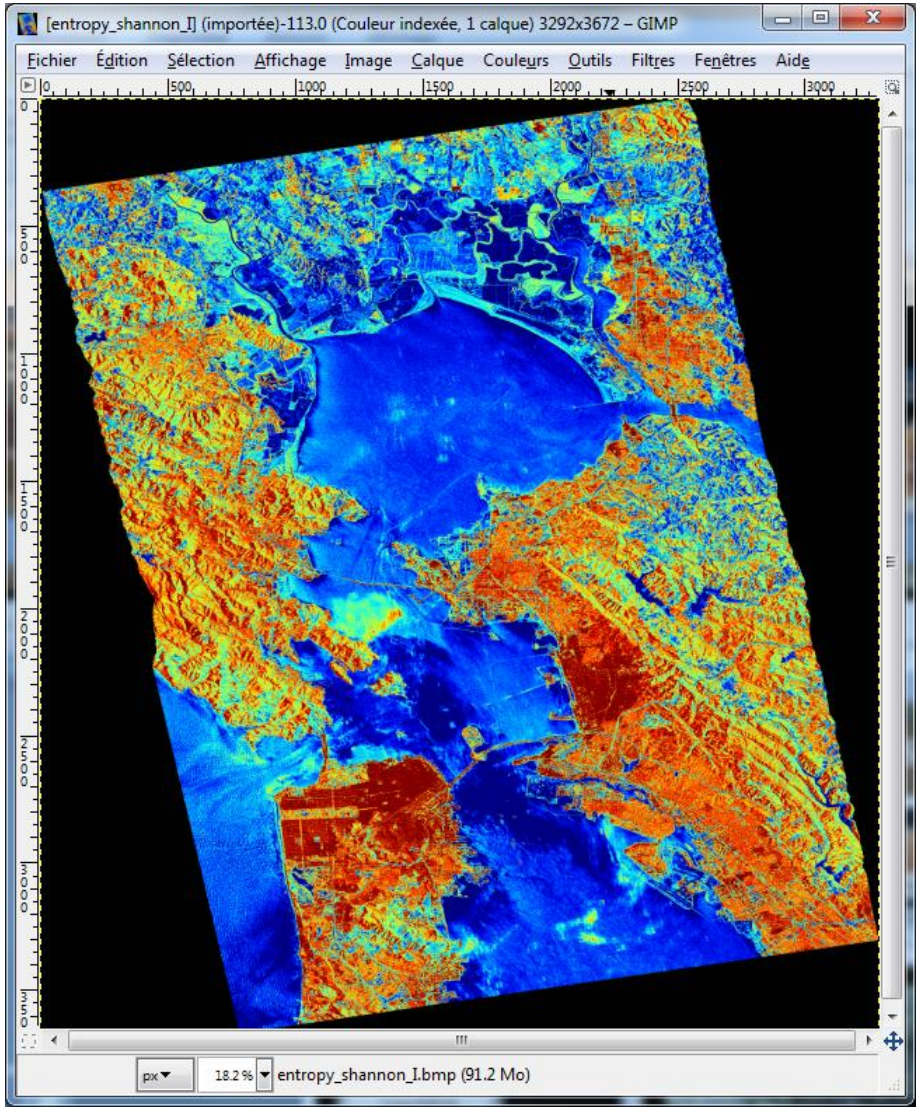
Entropy Shannon



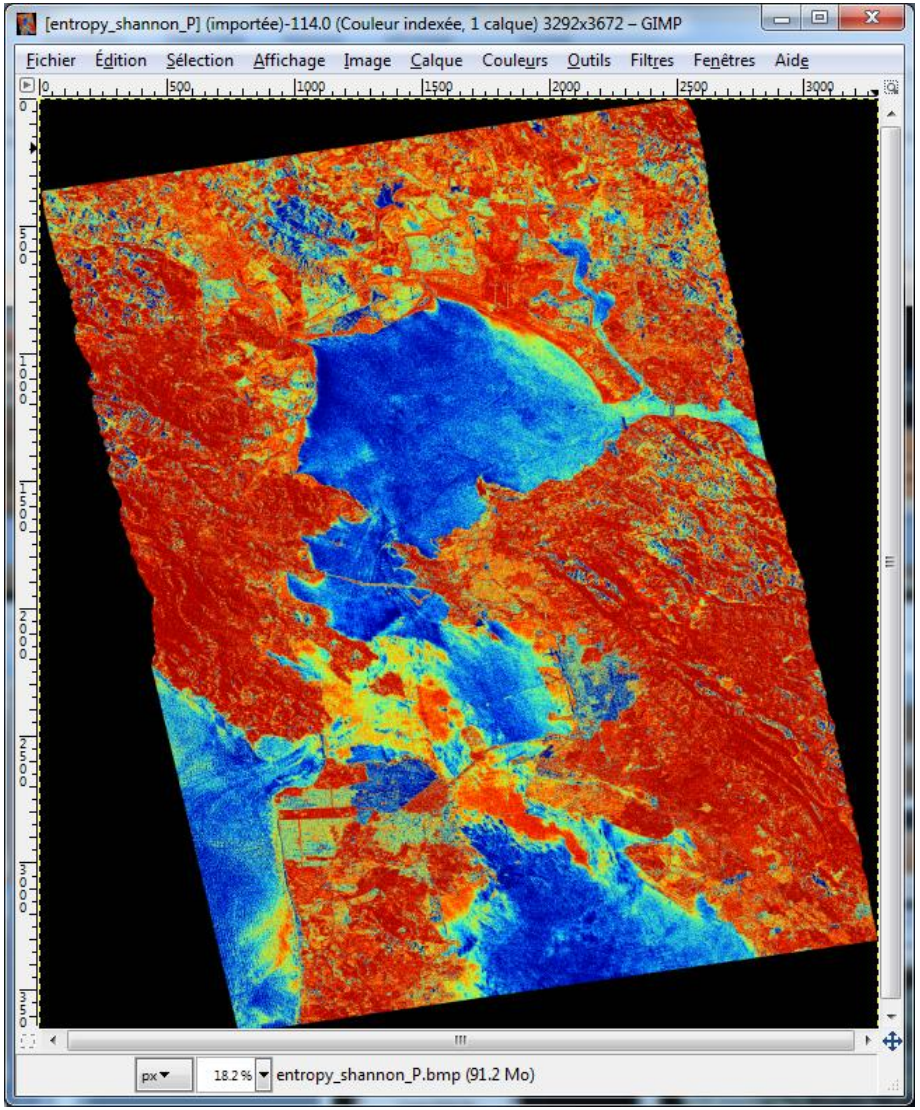


EIGENVALUE SET PARAMETERS

Entropy I

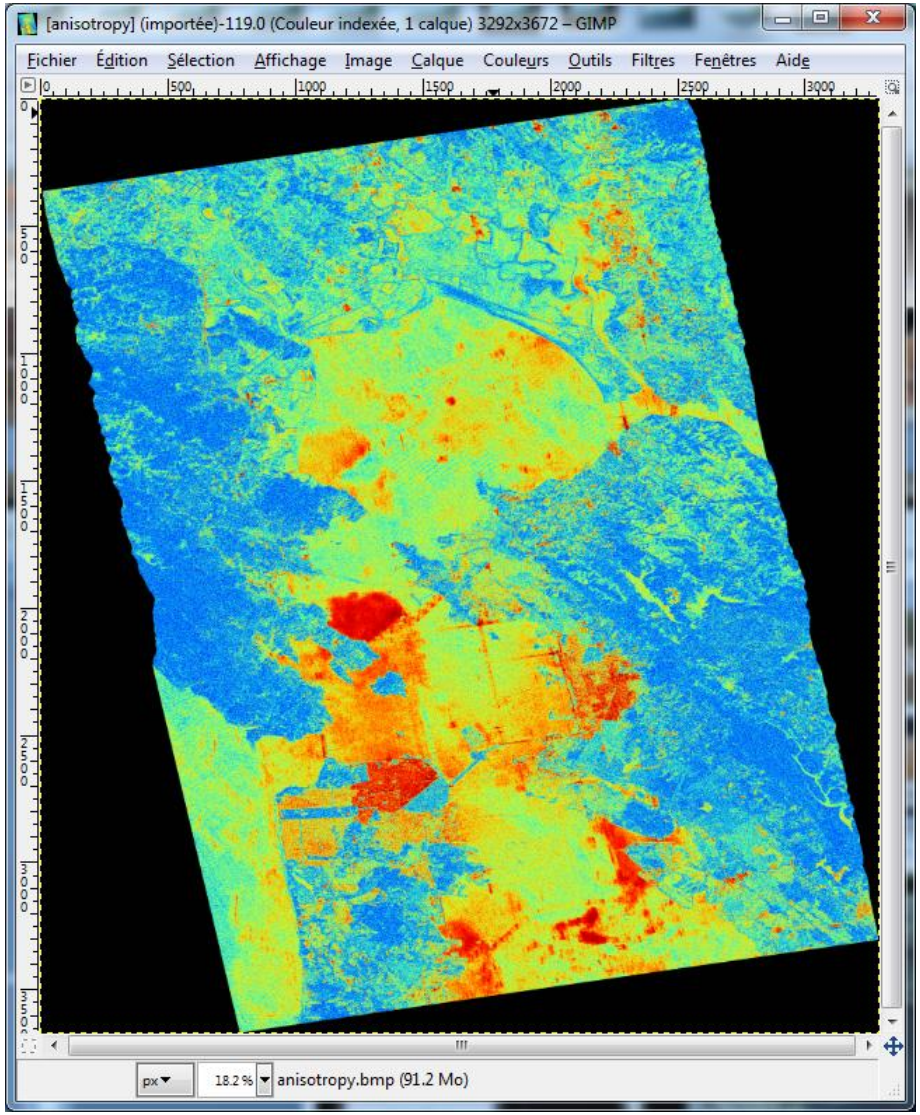


Entropy P

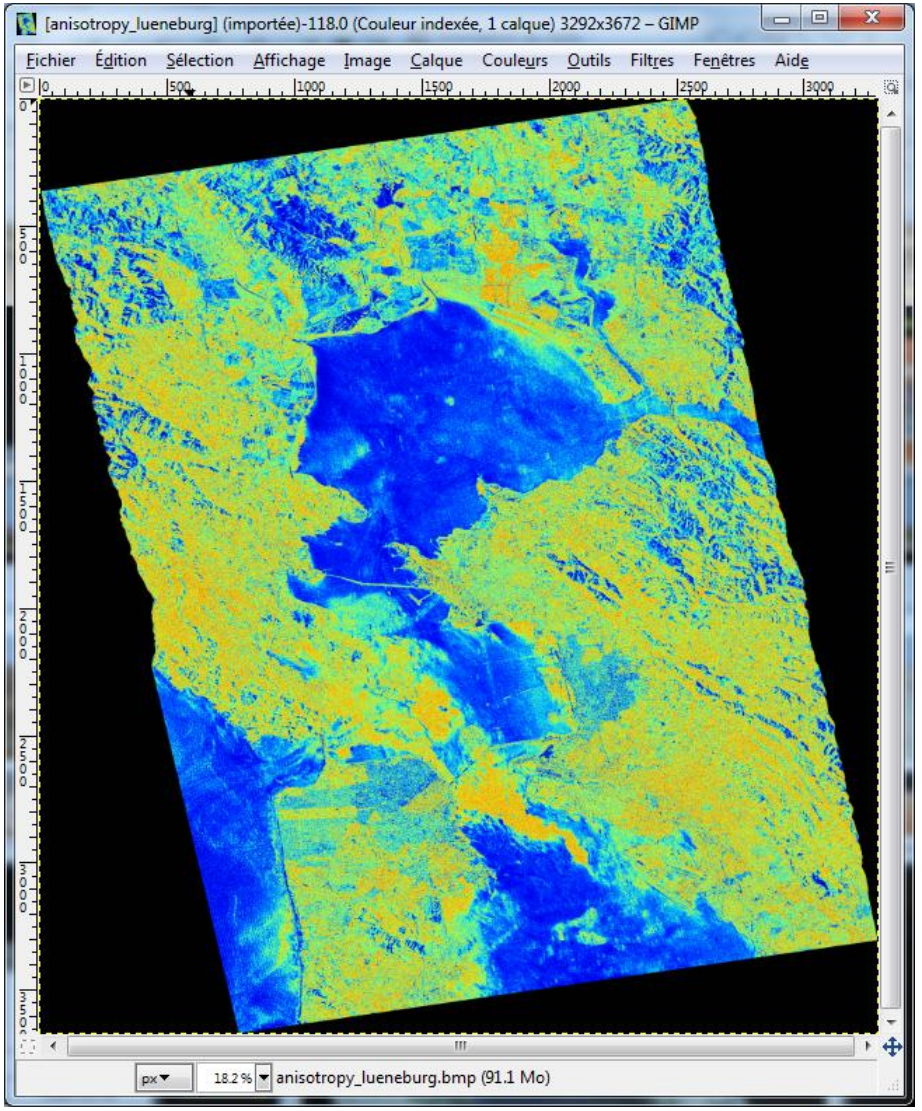


EIGENVALUE SET PARAMETERS

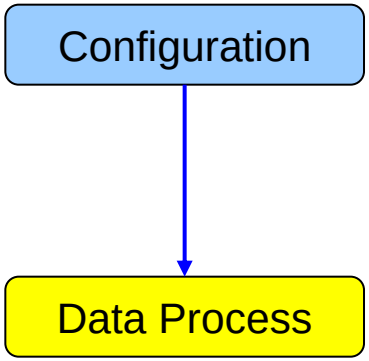
Anisotropy



Lueneburg Anisotropy



PROCESSING CHAIN



- Eigenvalue Parameters
- Polarimetric Decomposition
- Polarimetric Segmentation
  - Wishart - H / A / alpha classification
  - Supervised Wishart classification
  - Support Vector Machine Classification

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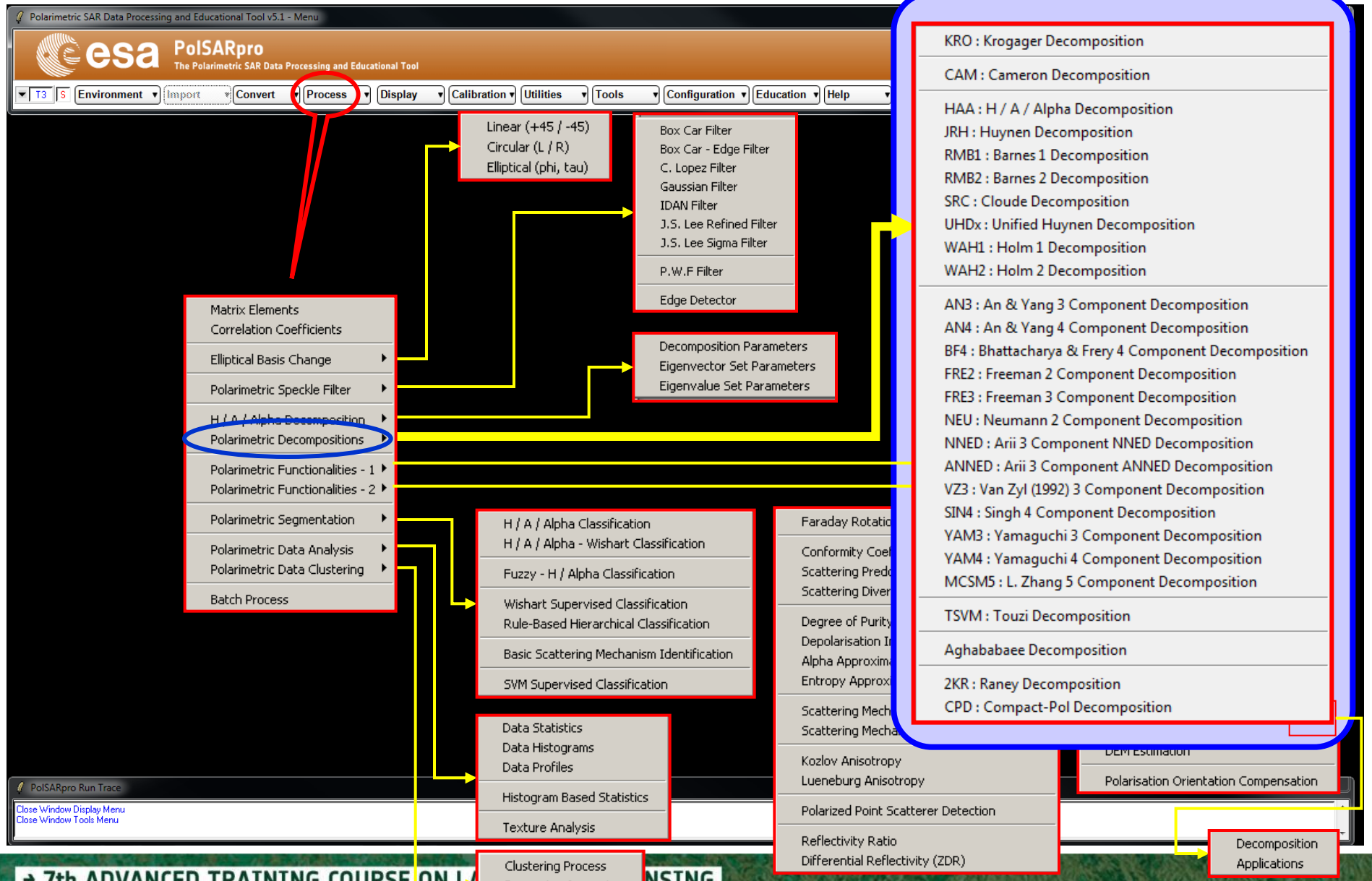
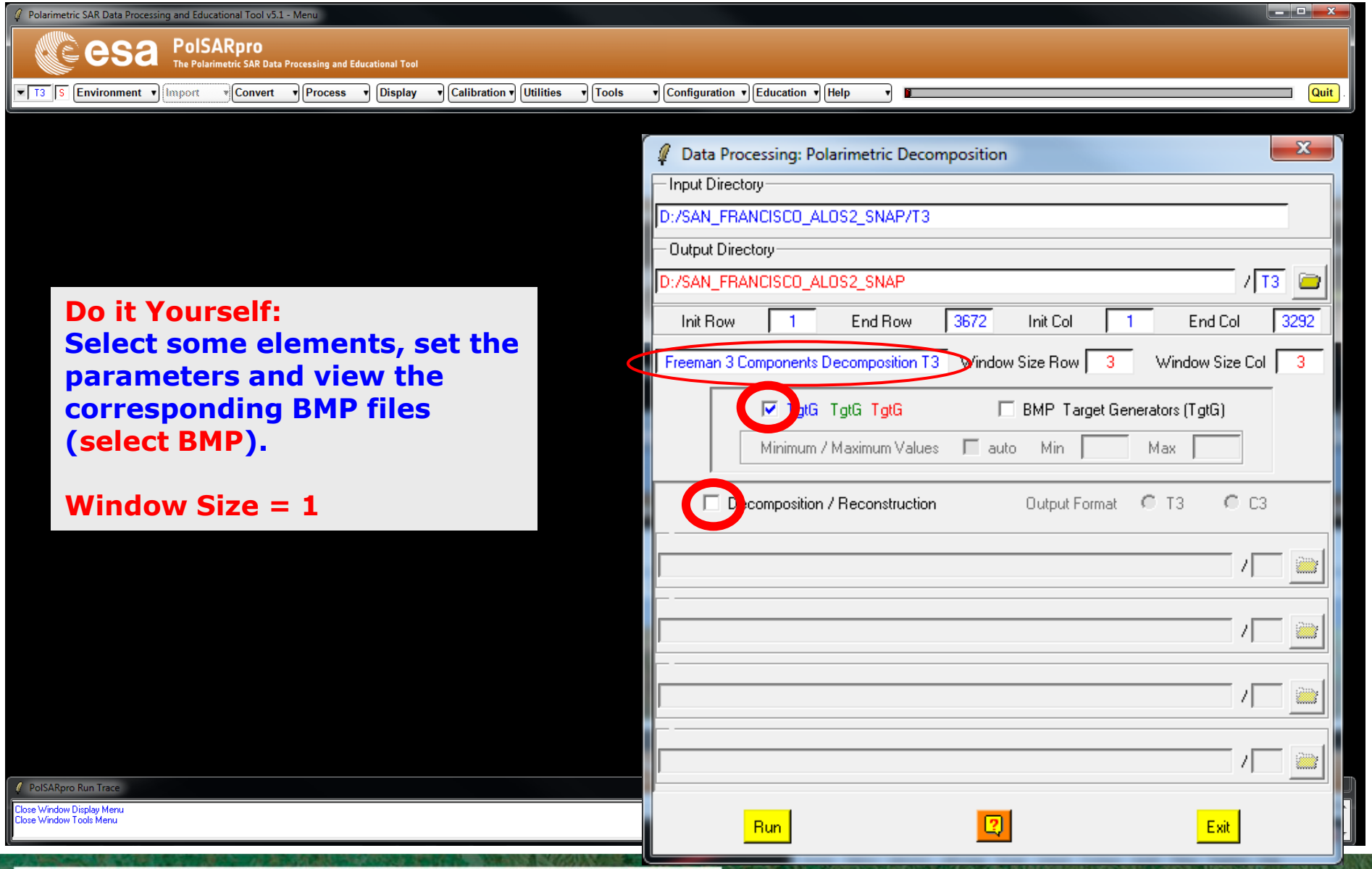


POLARIMETRIC DECOMPOSITION

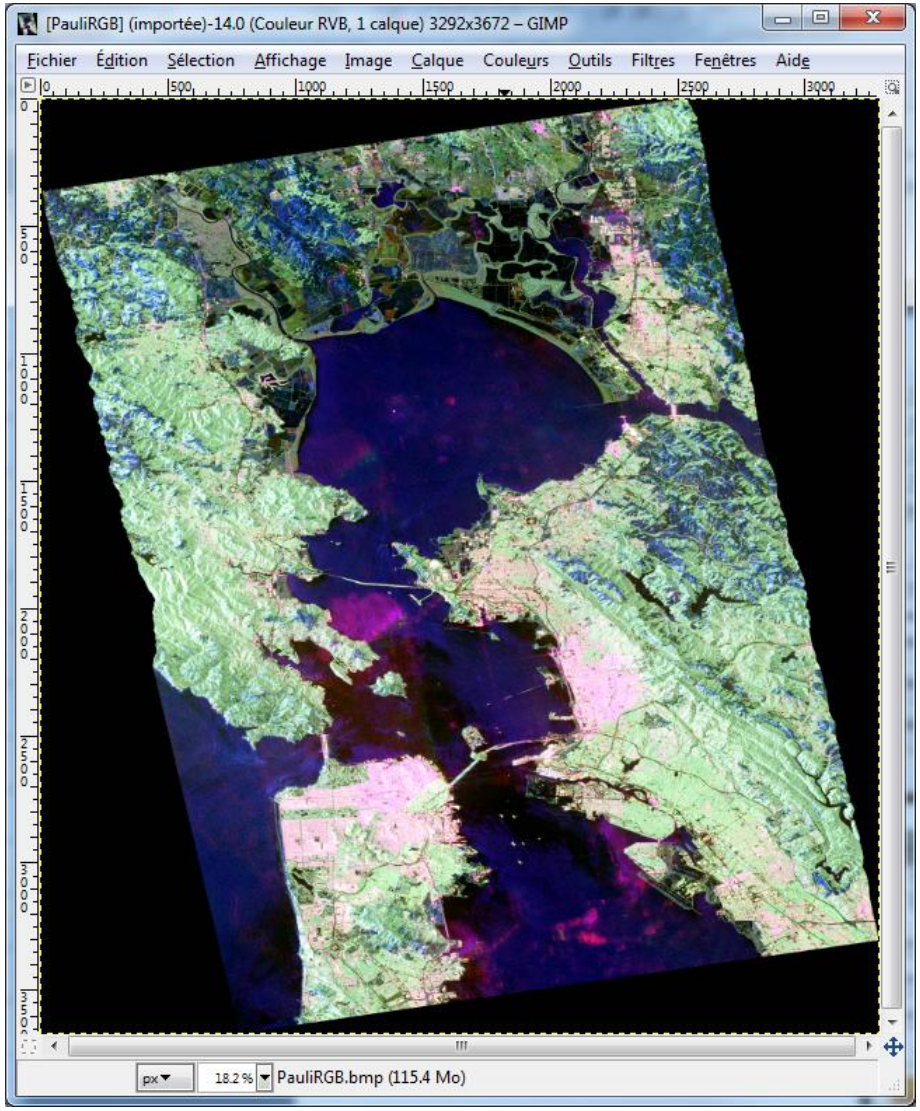


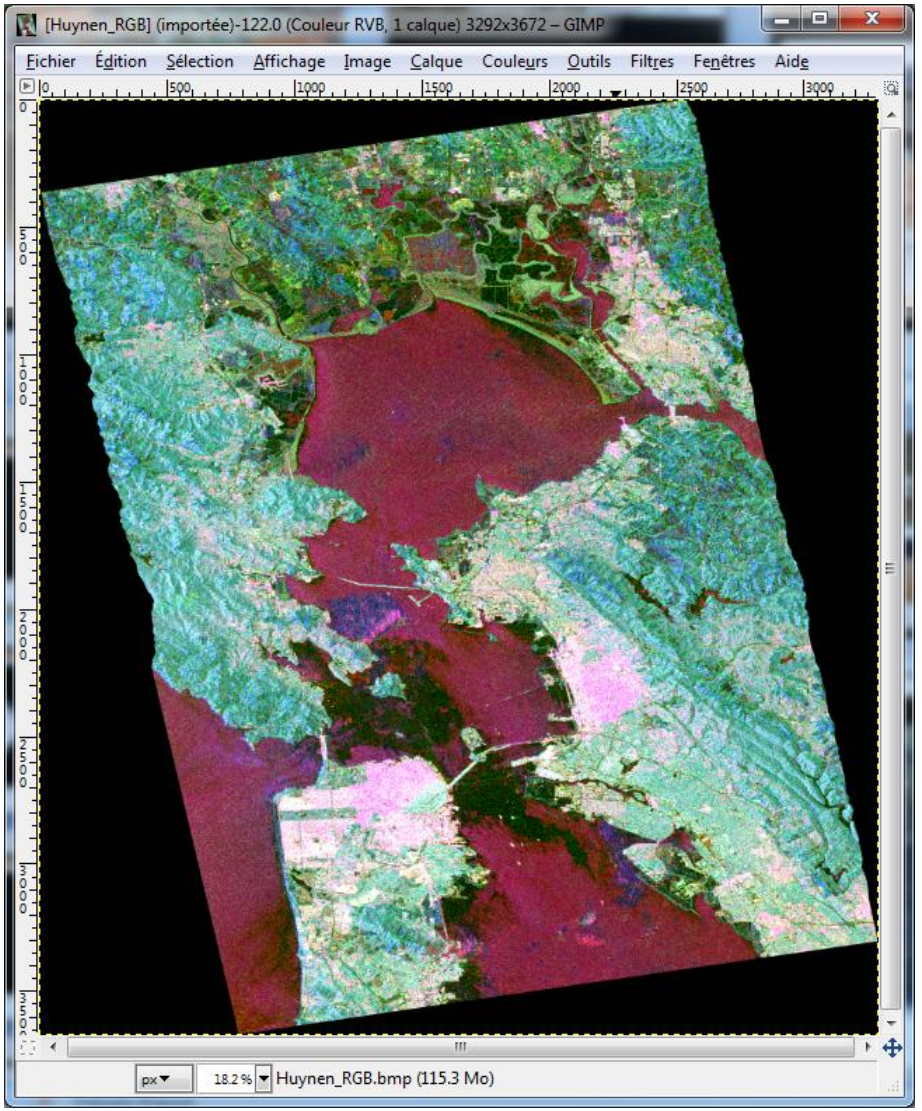
Do it Yourself:
Select some elements, set the parameters and view the corresponding BMP files (select BMP).

Window Size = 1

POLARIMETRIC DECOMPOSITION

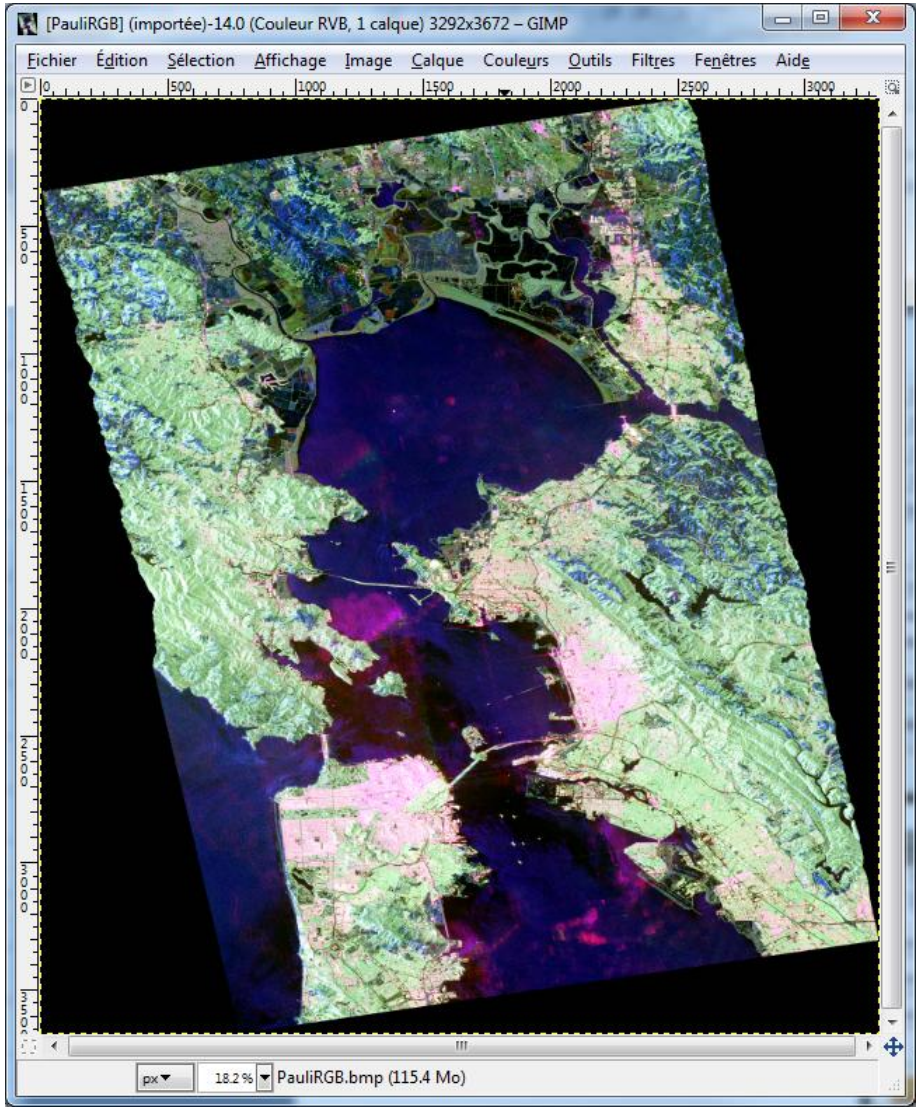
Pauli Huynen

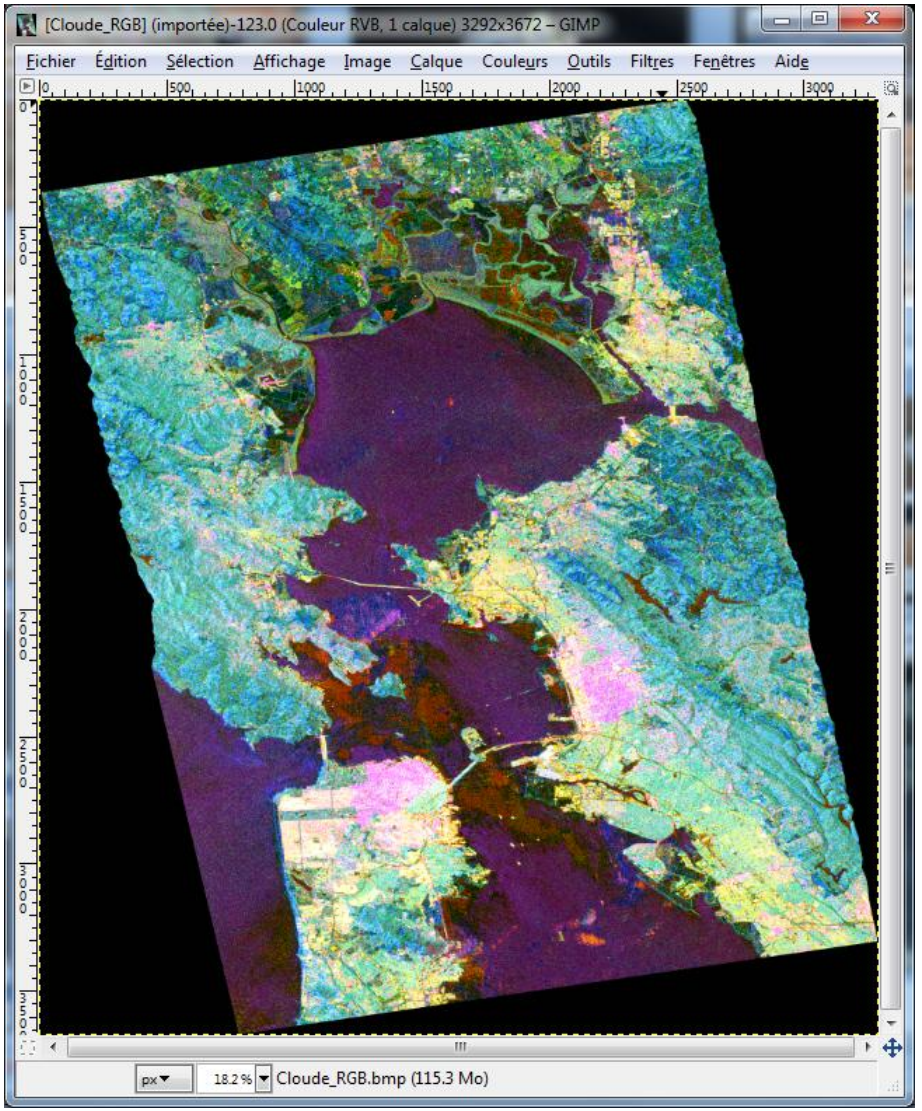




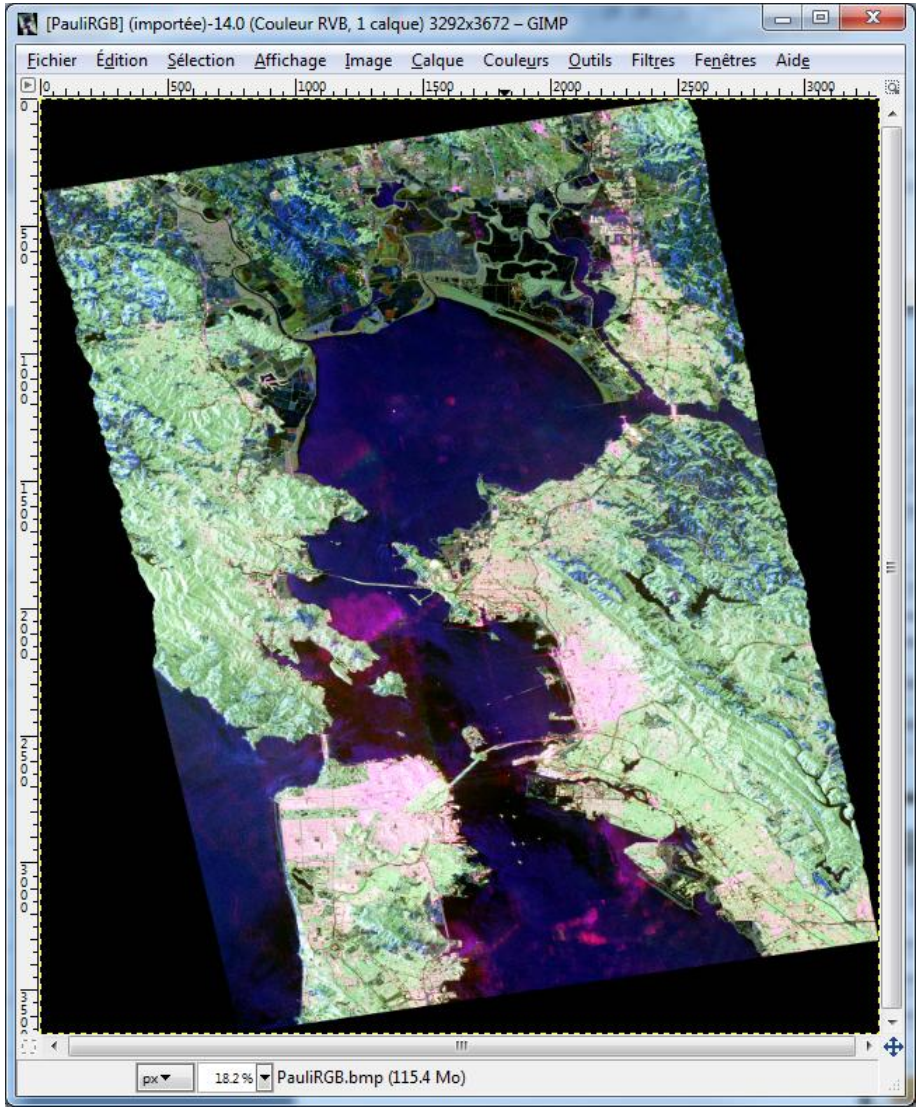
POLARIMETRIC DECOMPOSITION

Pauli Cloude

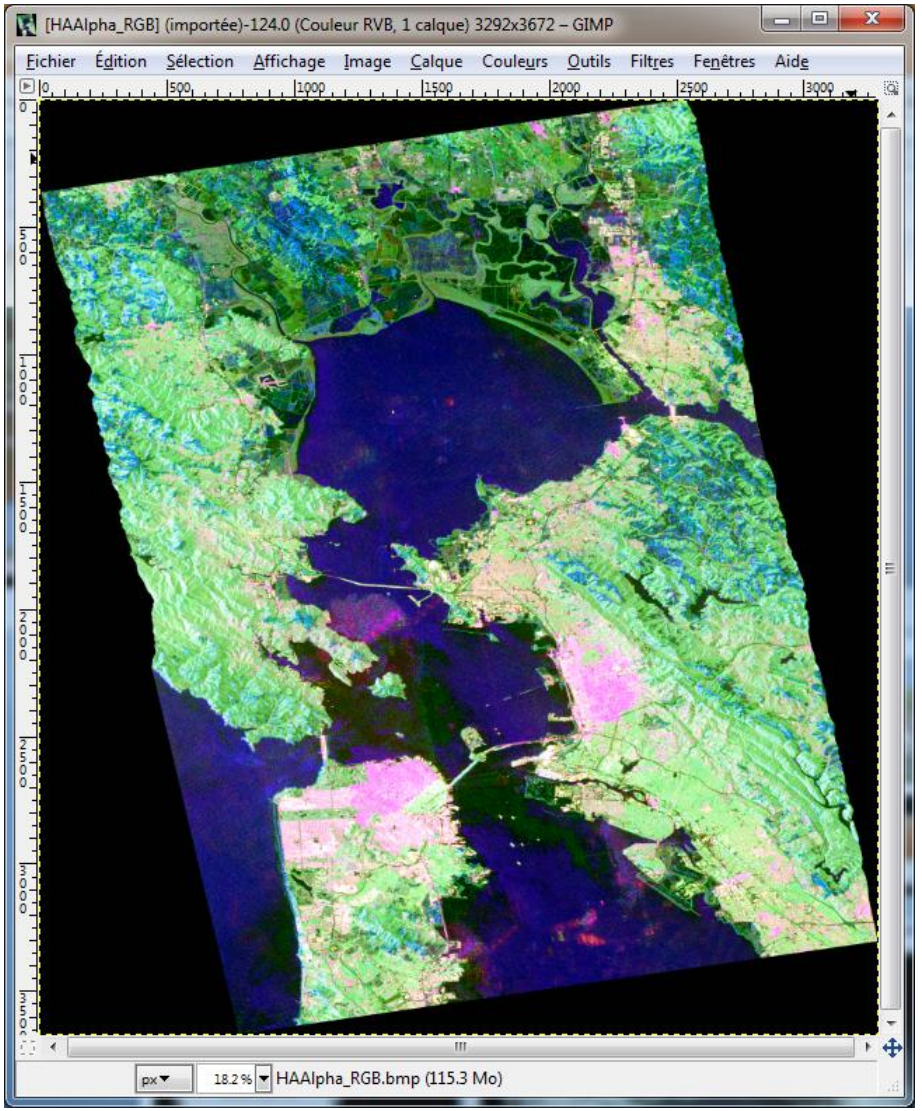




POLARIMETRIC DECOMPOSITION

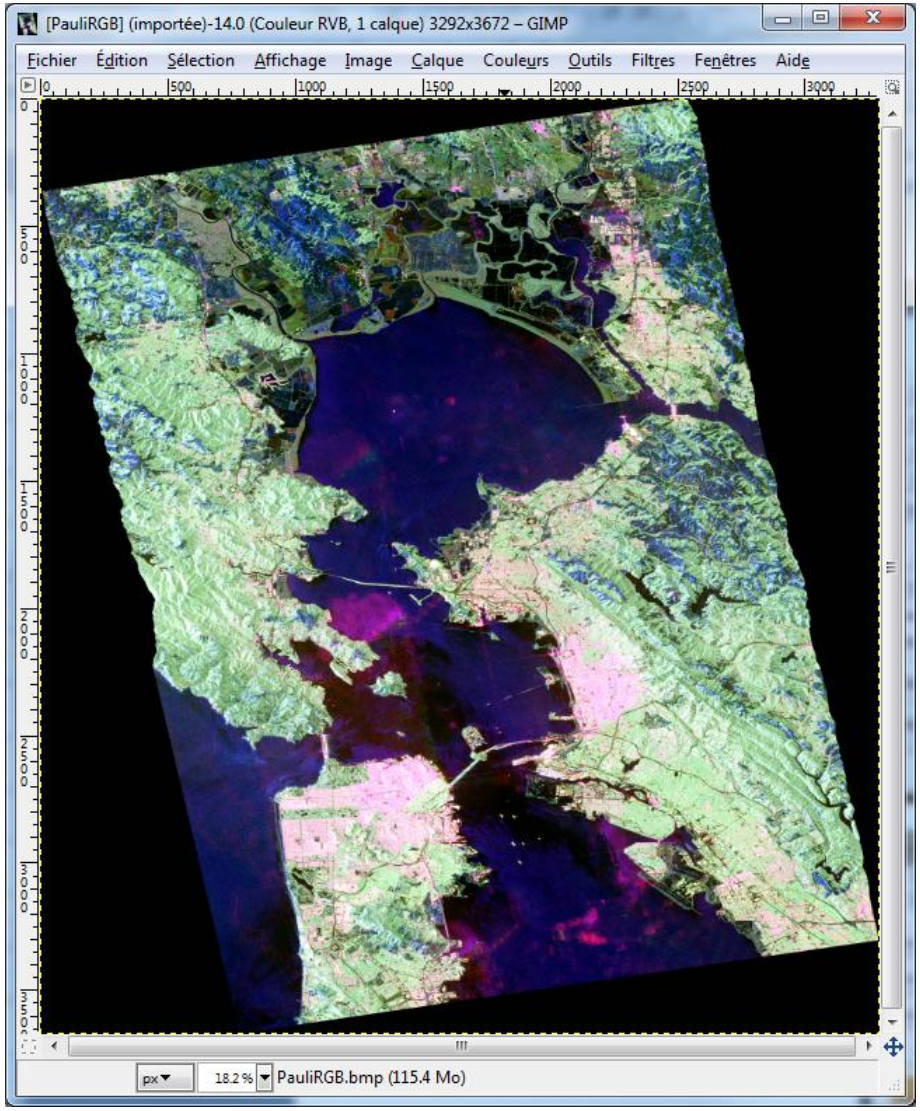


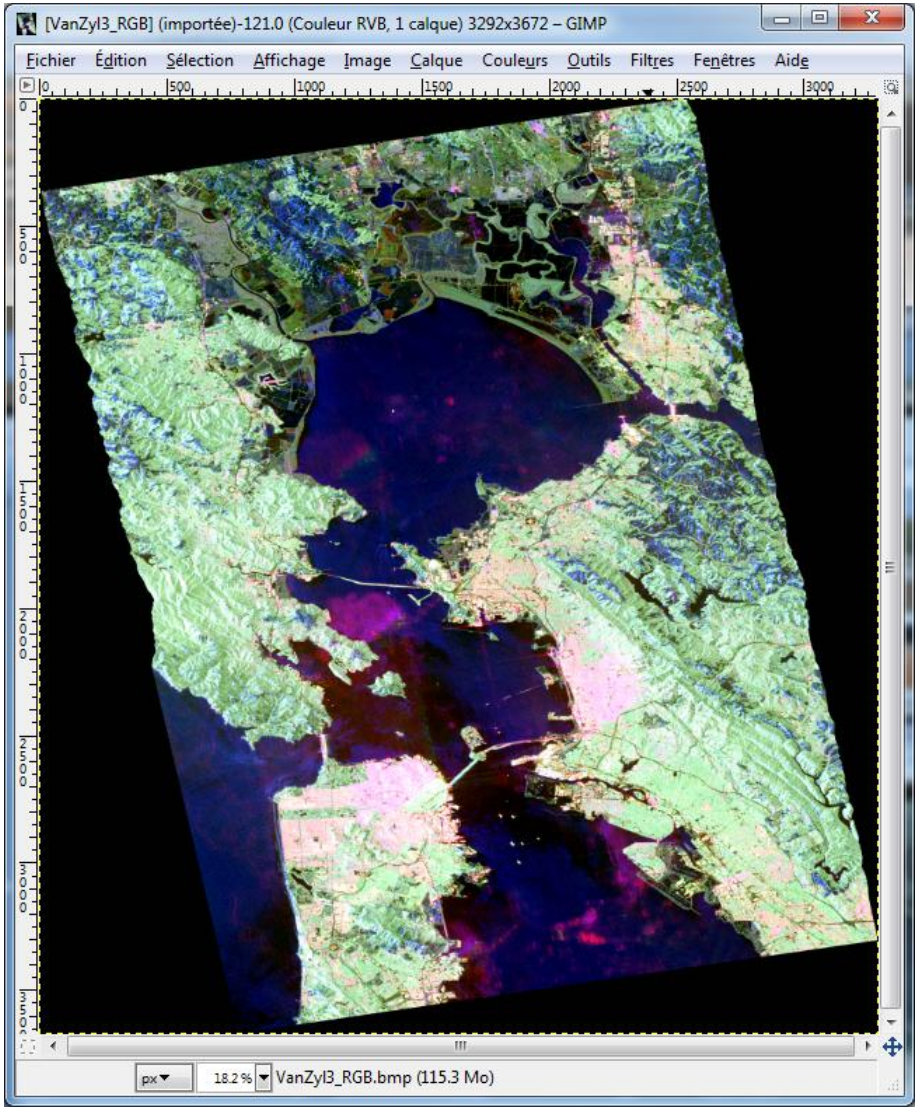
Pauli H-A-Alpha



POLARIMETRIC DECOMPOSITION

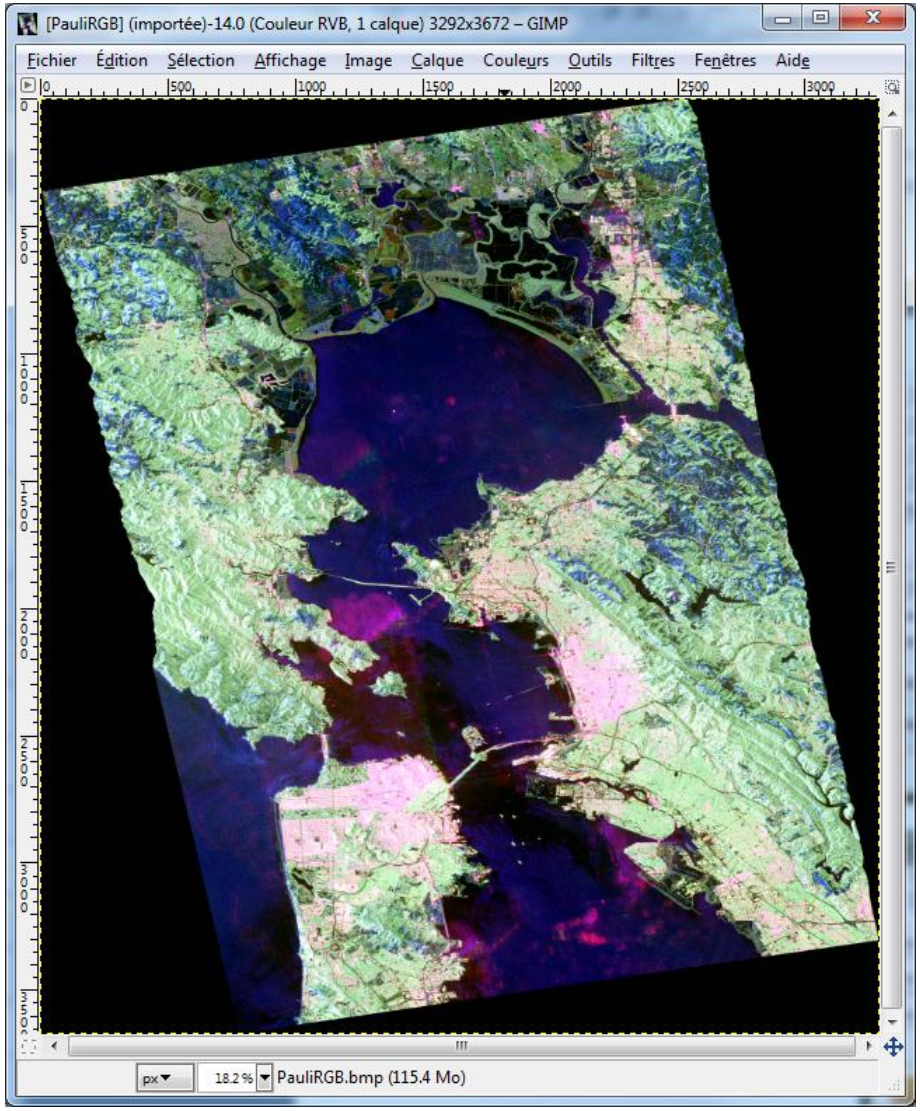
Pauli Van Zyl 3

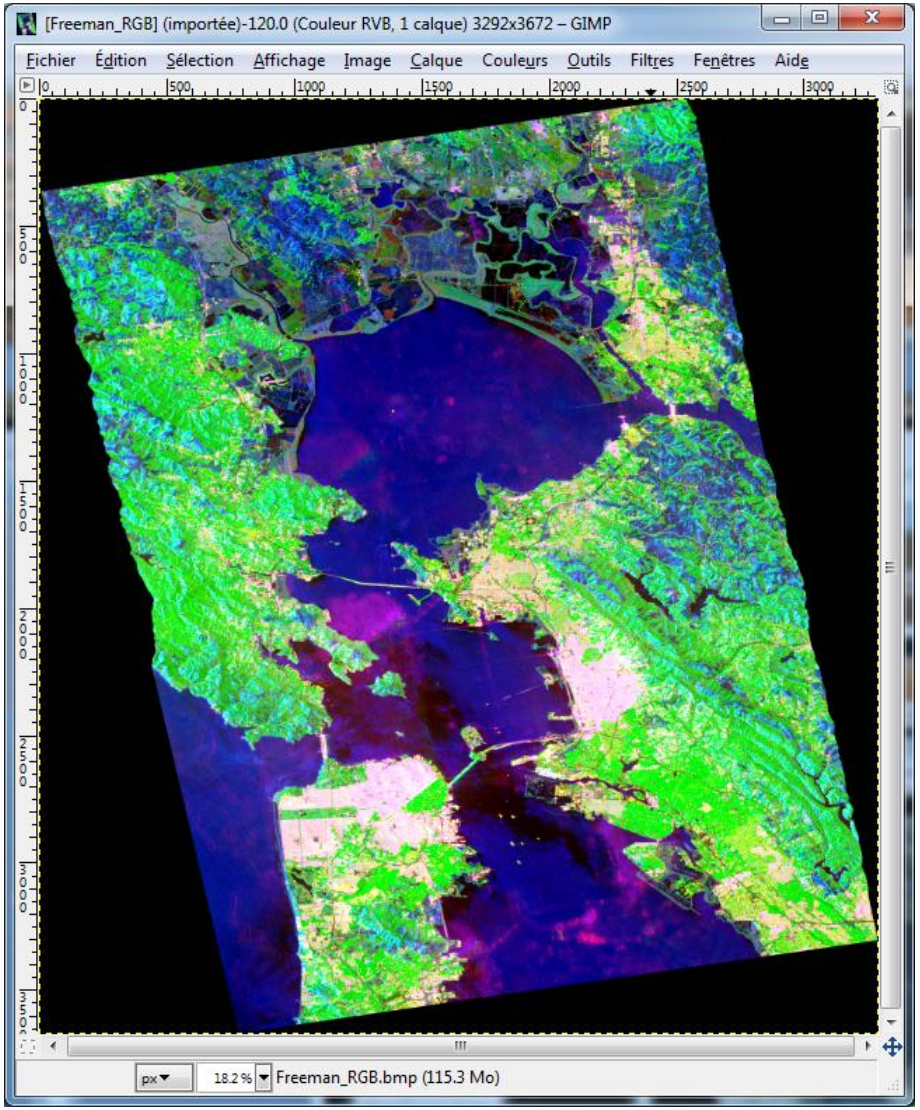




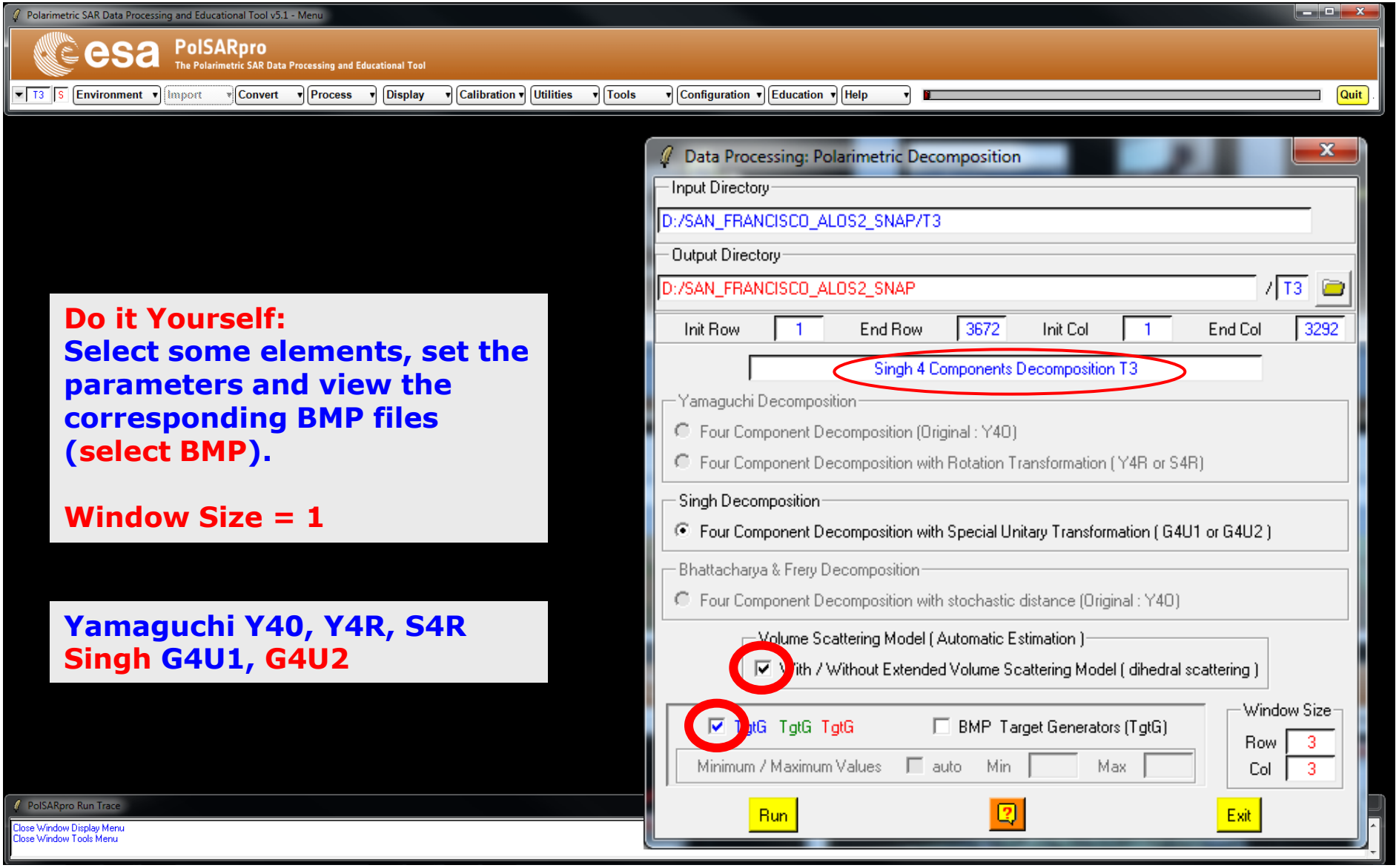
POLARIMETRIC DECOMPOSITION

Pauli Freeman 3





POLARIMETRIC DECOMPOSITION



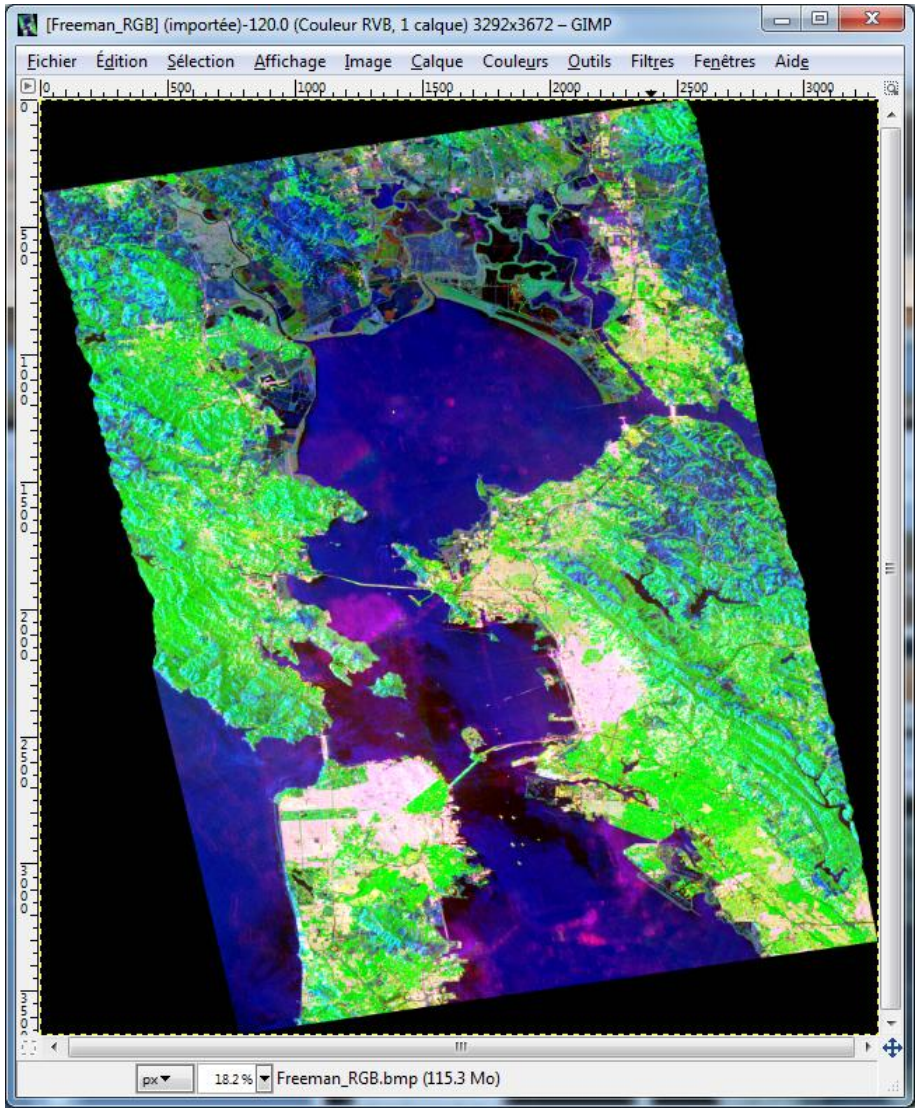
Do it Yourself:
Select some elements, set the parameters and view the corresponding BMP files (select BMP).

Window Size = 1

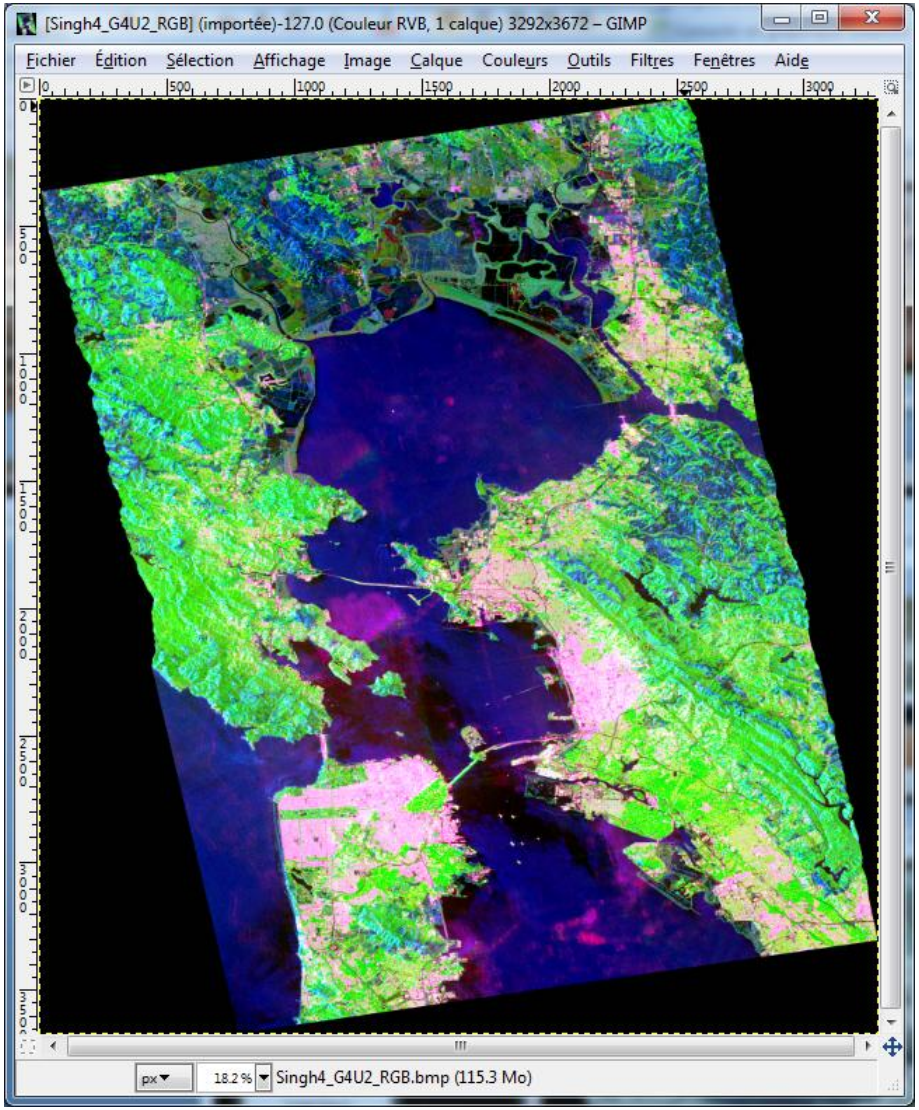
Yamaguchi Y40, Y4R, S4R
Singh G4U1, G4U2

POLARIMETRIC DECOMPOSITION

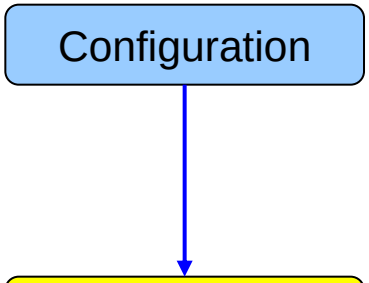
Pauli Freeman 3



Pauli Singh - Yamaguchi G4U2



PROCESSING CHAIN



- Eigenvalue Parameters
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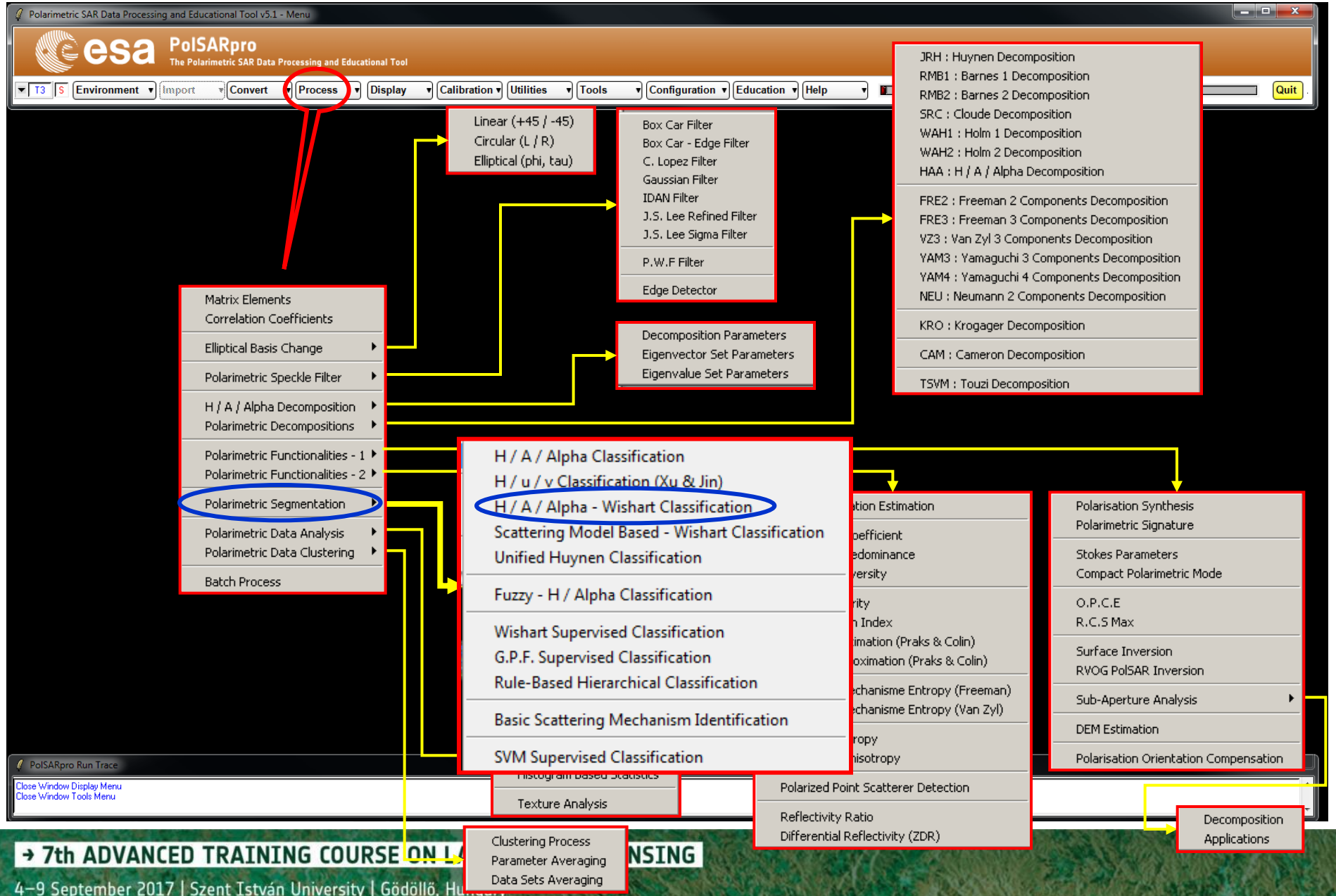
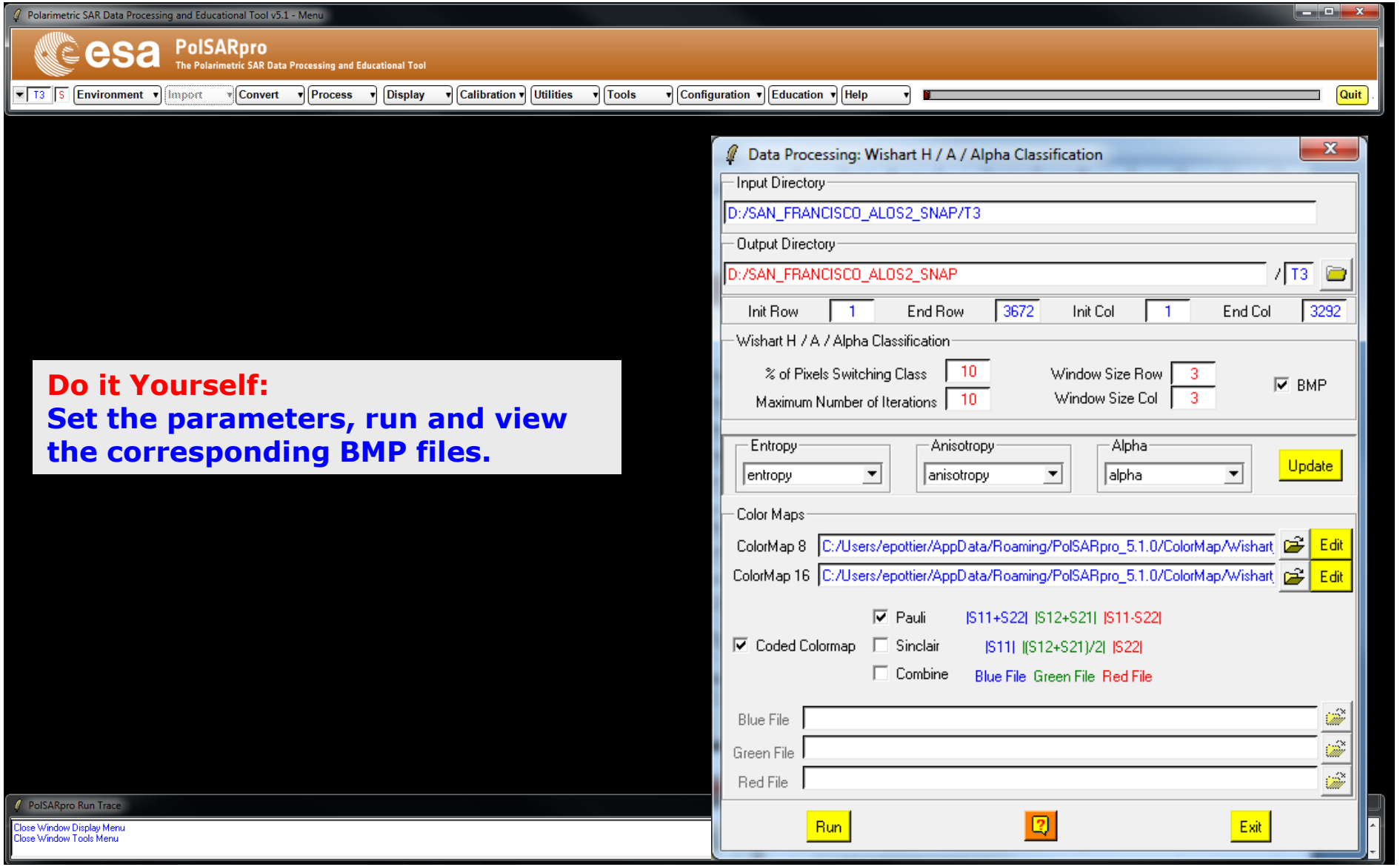
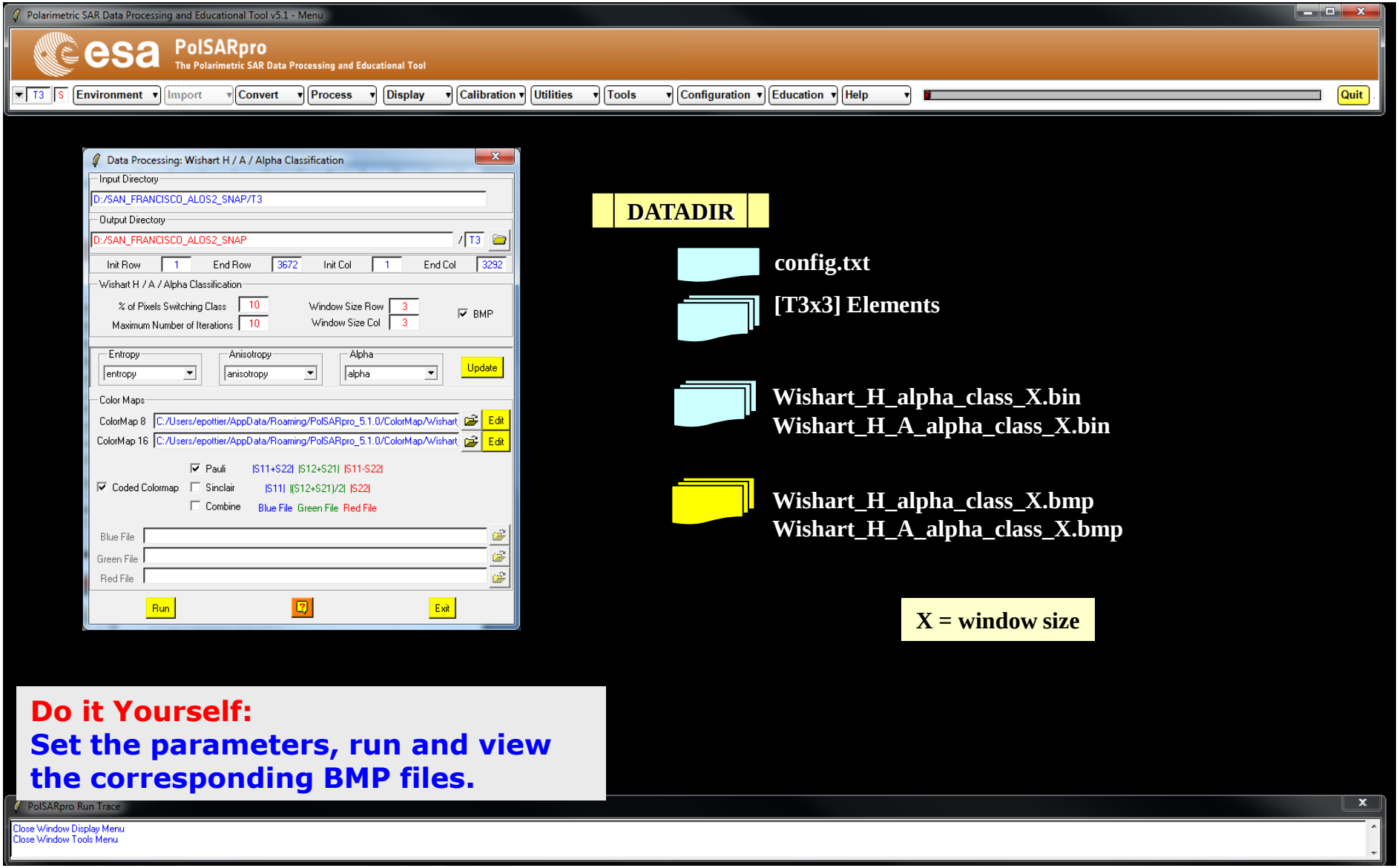


WISHART - H/A/alpha CLASSIFICATION



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

WISHART - H/A/alpha CLASSIFICATION



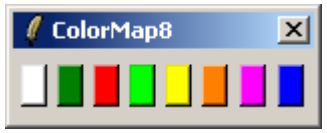
DATADIR

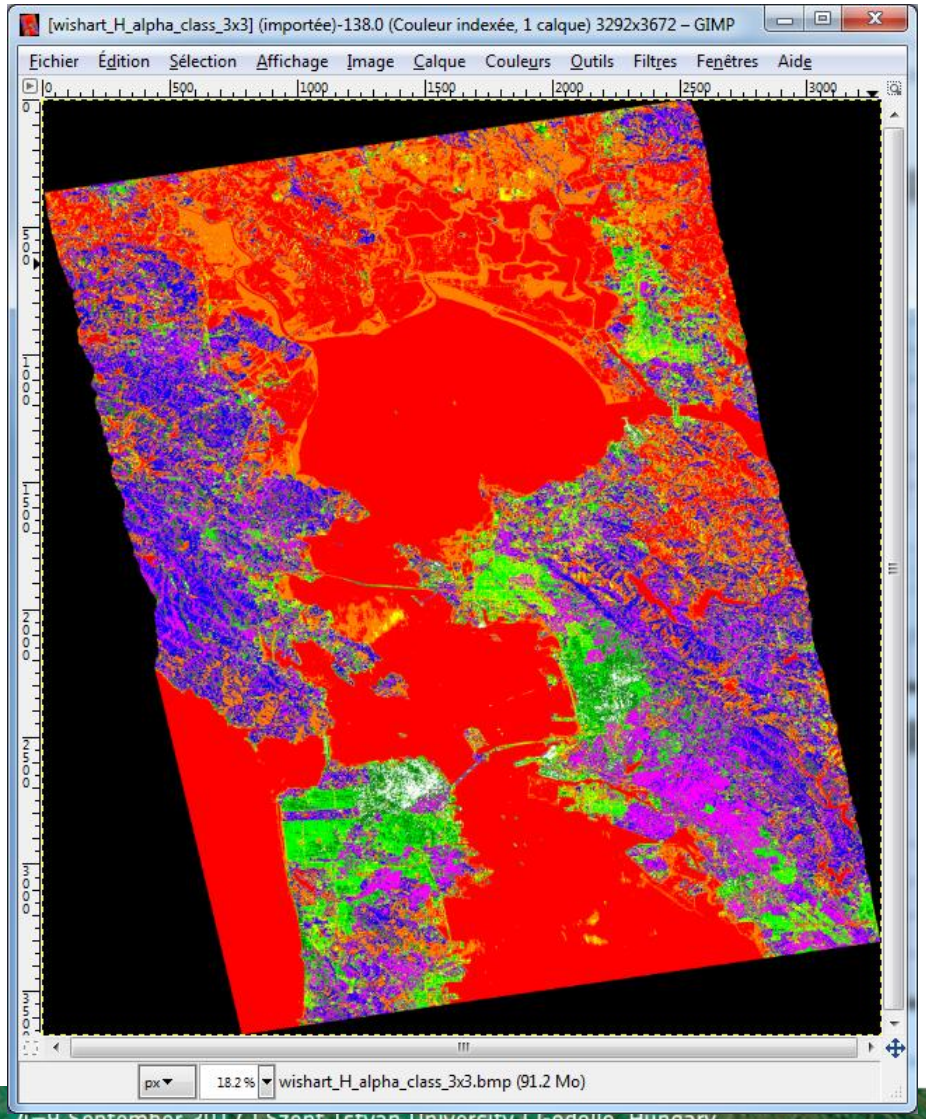
- config.txt
- [T3x3] Elements
- Wishart_H_alpha_class_X.bin
  Wishart_H_A_alpha_class_X.bin
- Wishart_H_alpha_class_X.bmp
  Wishart_H_A_alpha_class_X.bmp

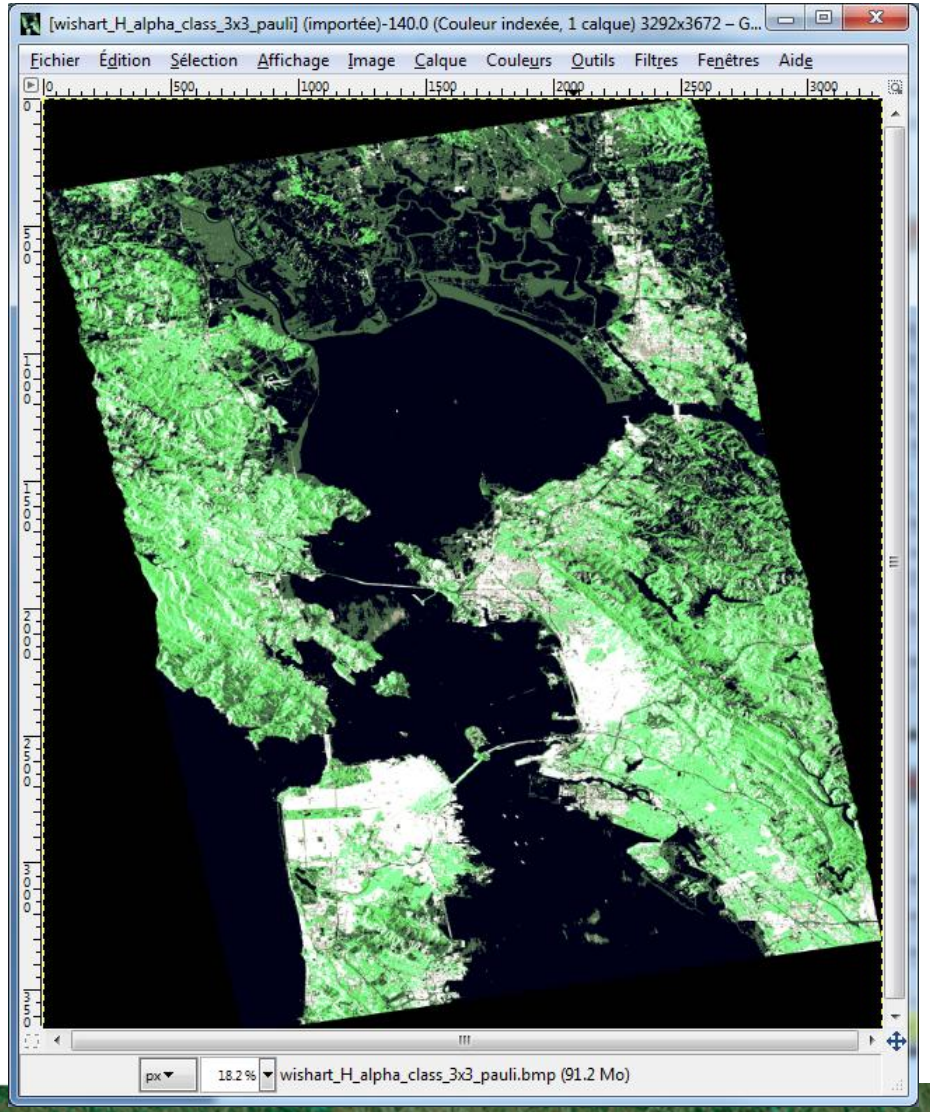
X = window size

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

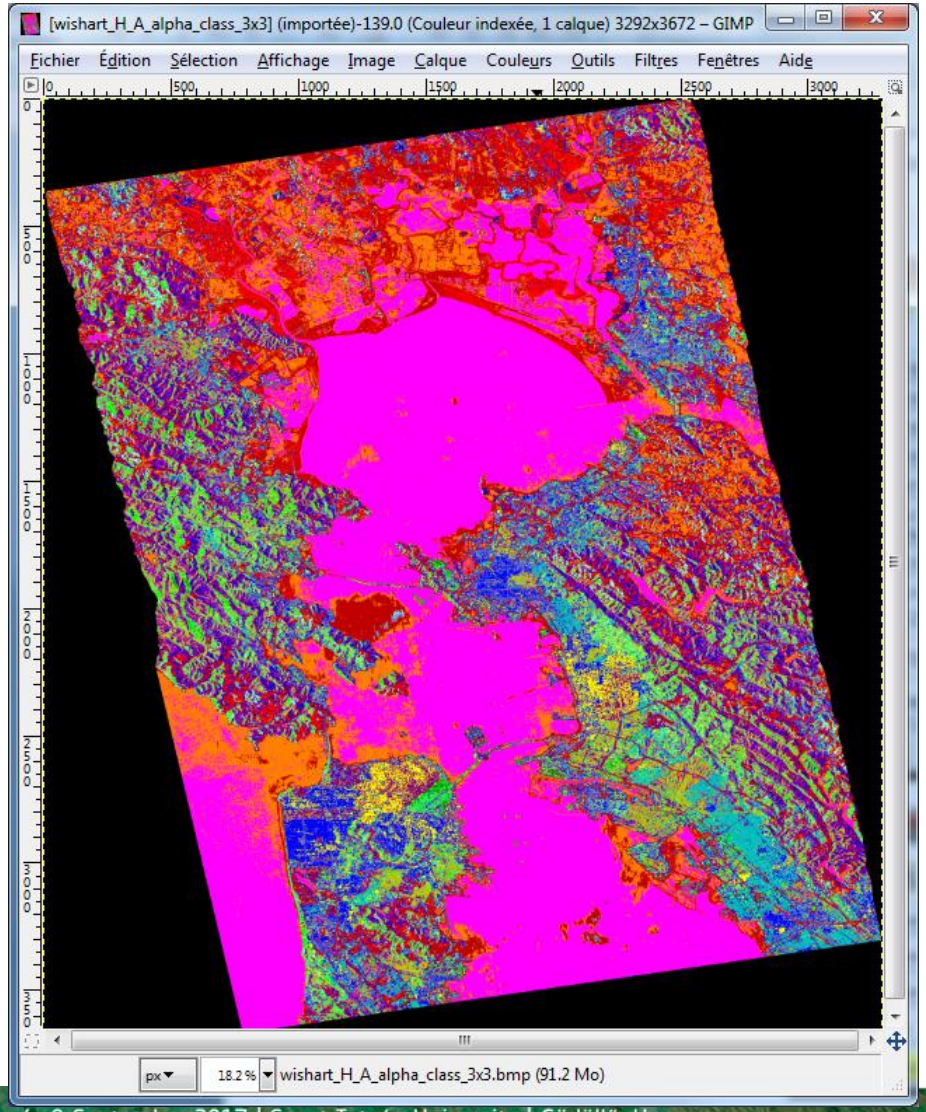
WISHART - H/A/alpha CLASSIFICATION

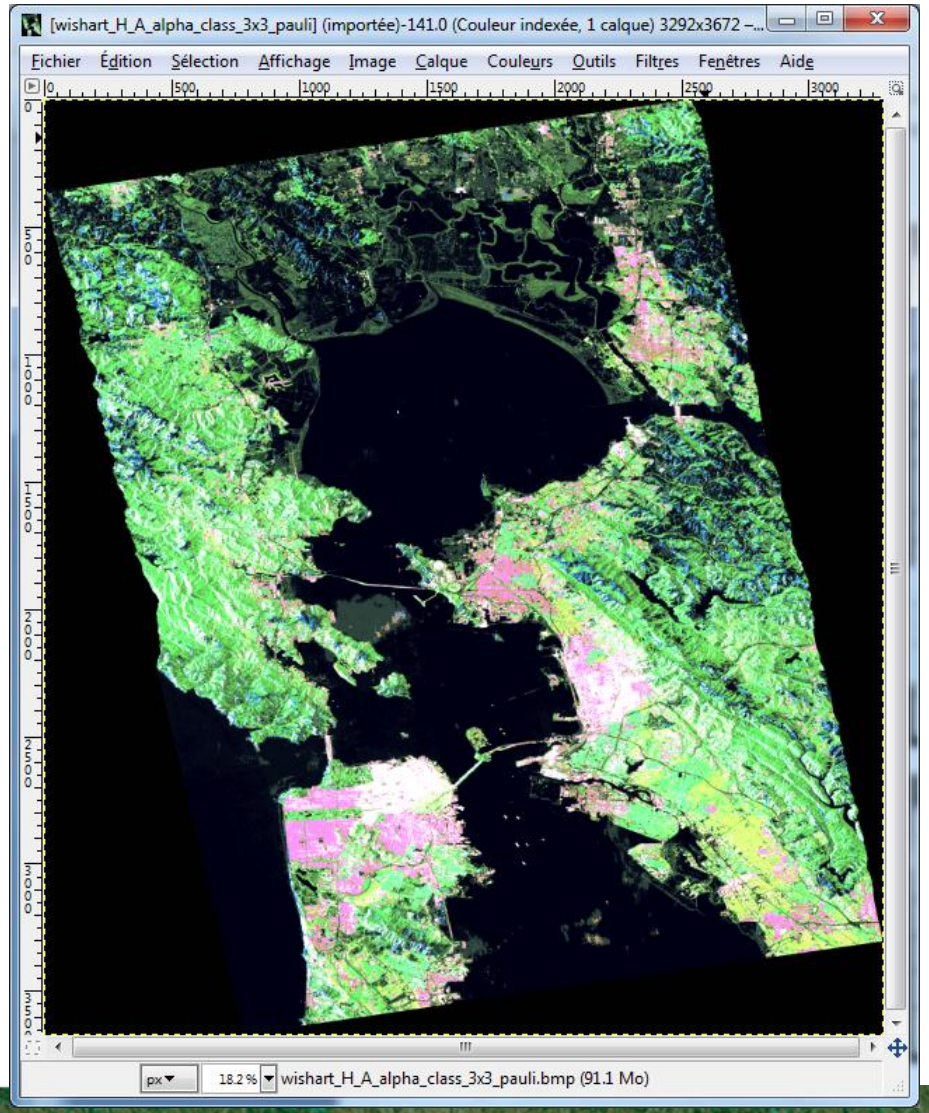




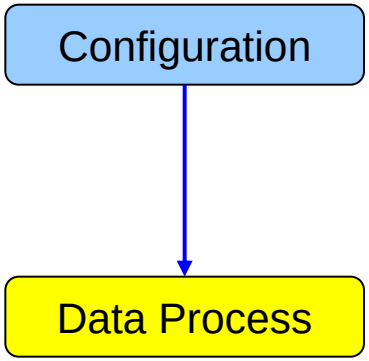


WISHART - H/A/alpha CLASSIFICATION





PROCESSING CHAIN



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  - Supervised Wishart classification
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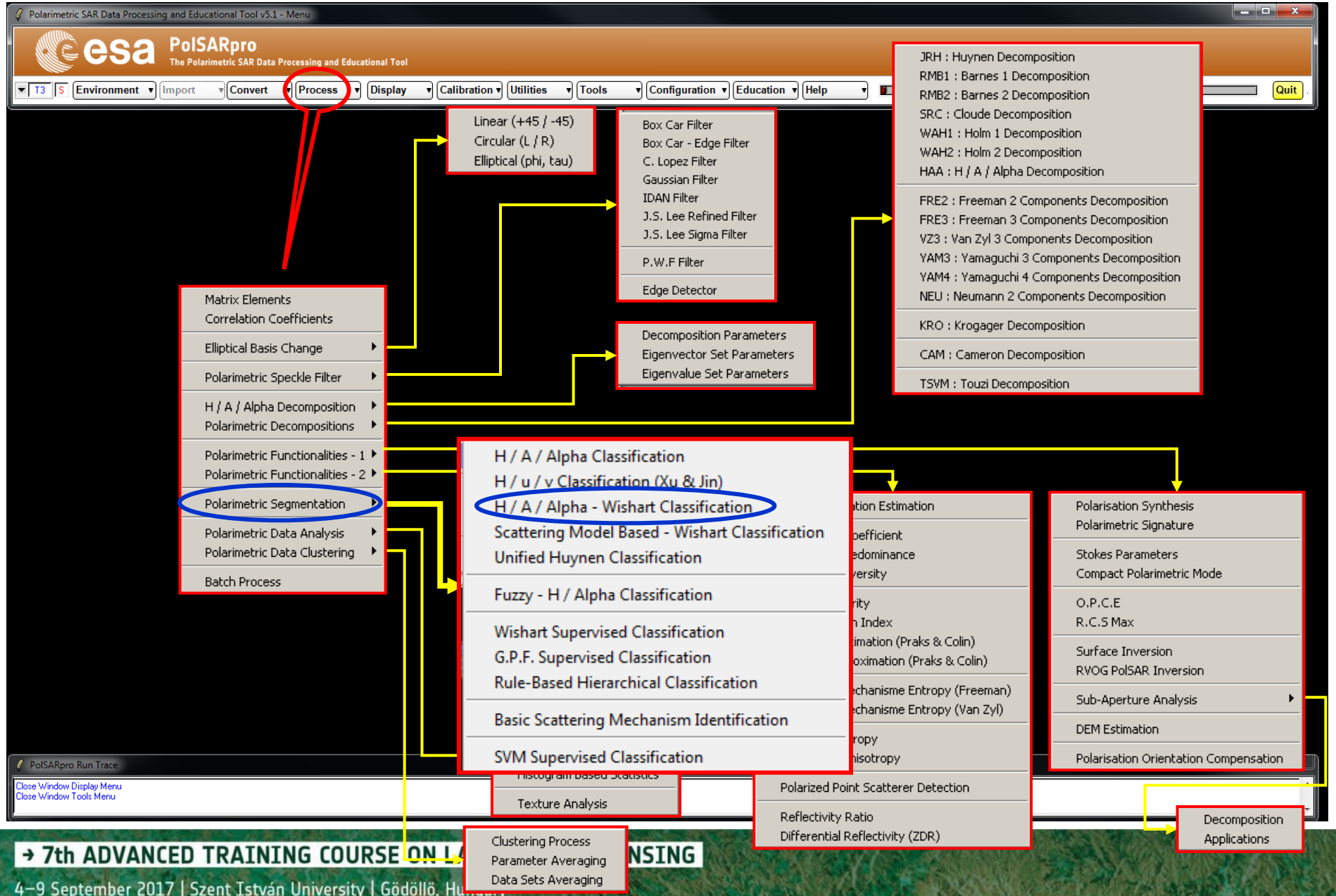
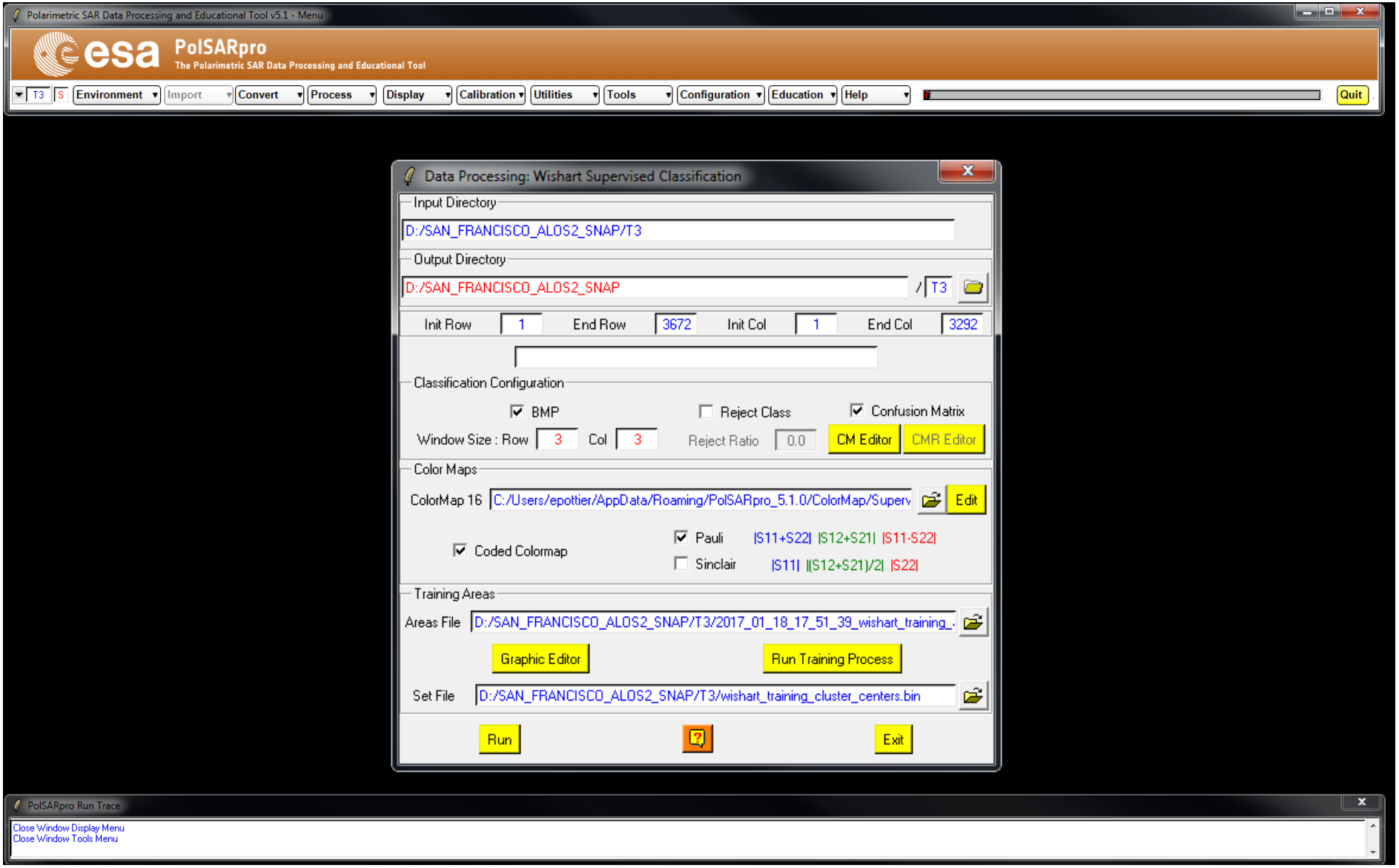


SUPERVISED CLASSIFICATION

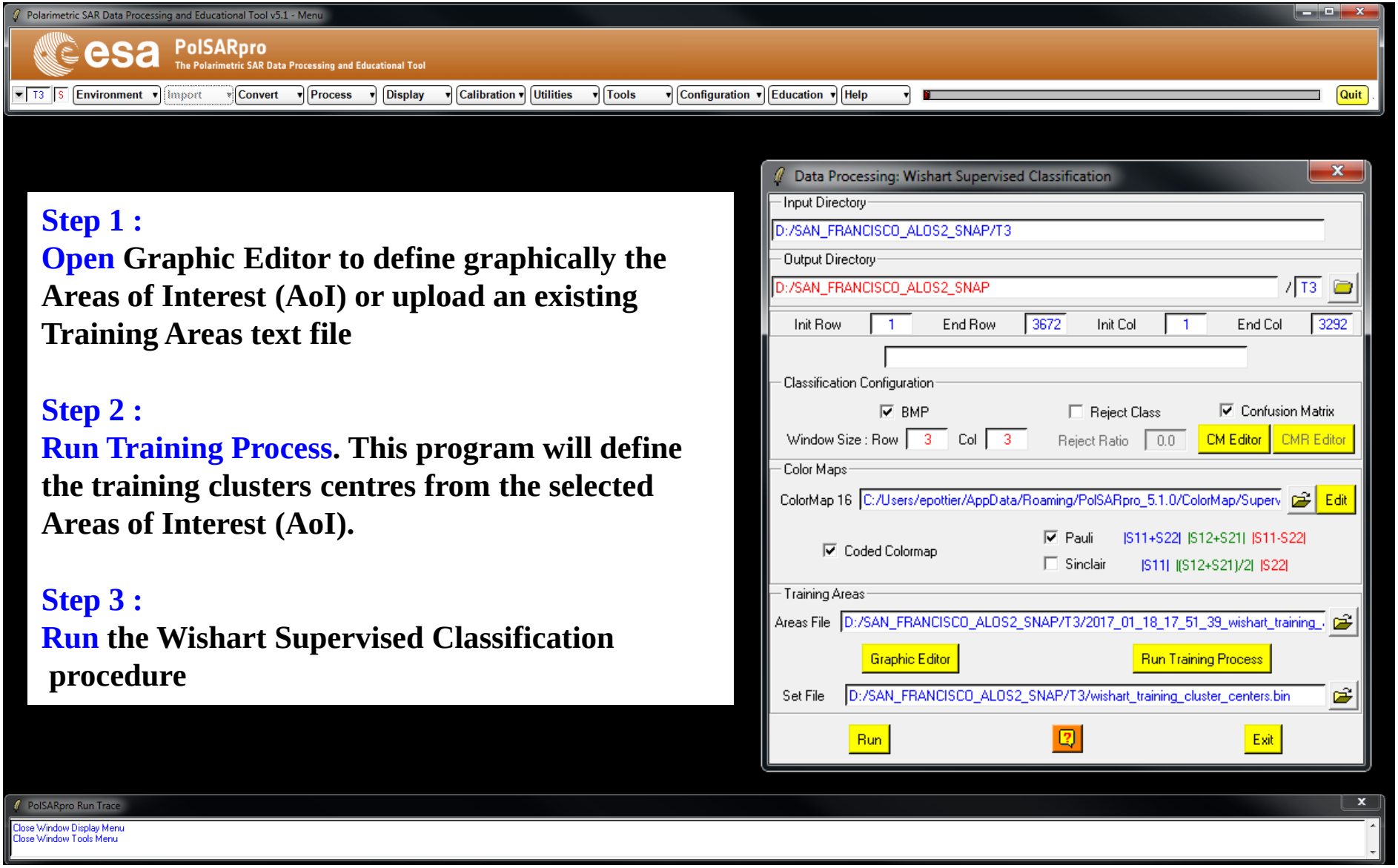


SUPERVISED CLASSIFICATION

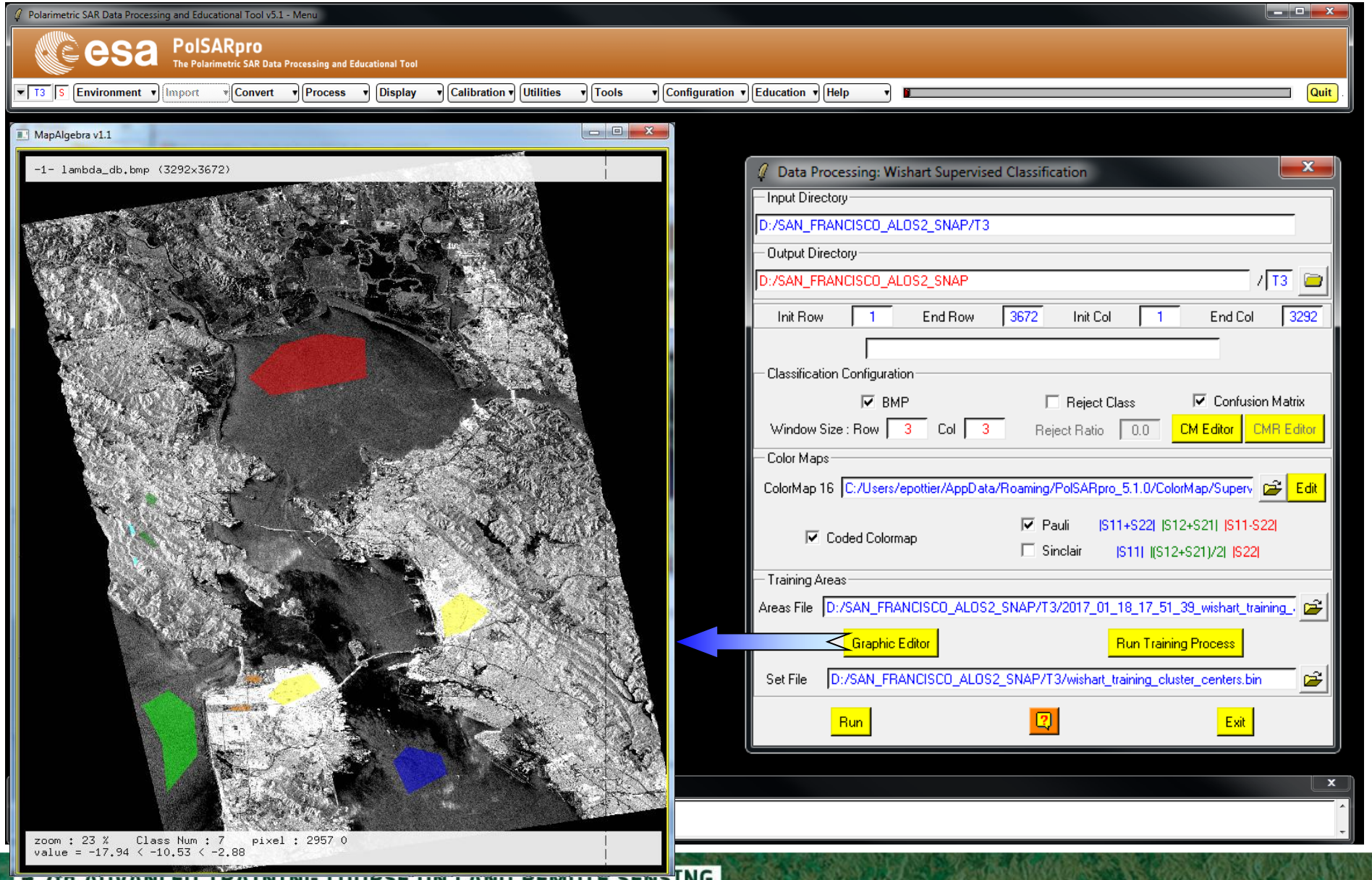
Step 1 :
Open Graphic Editor to define graphically the Areas of Interest (AoI) or upload an existing Training Areas text file

Step 2 :
Run Training Process. This program will define the training clusters centres from the selected Areas of Interest (AoI).

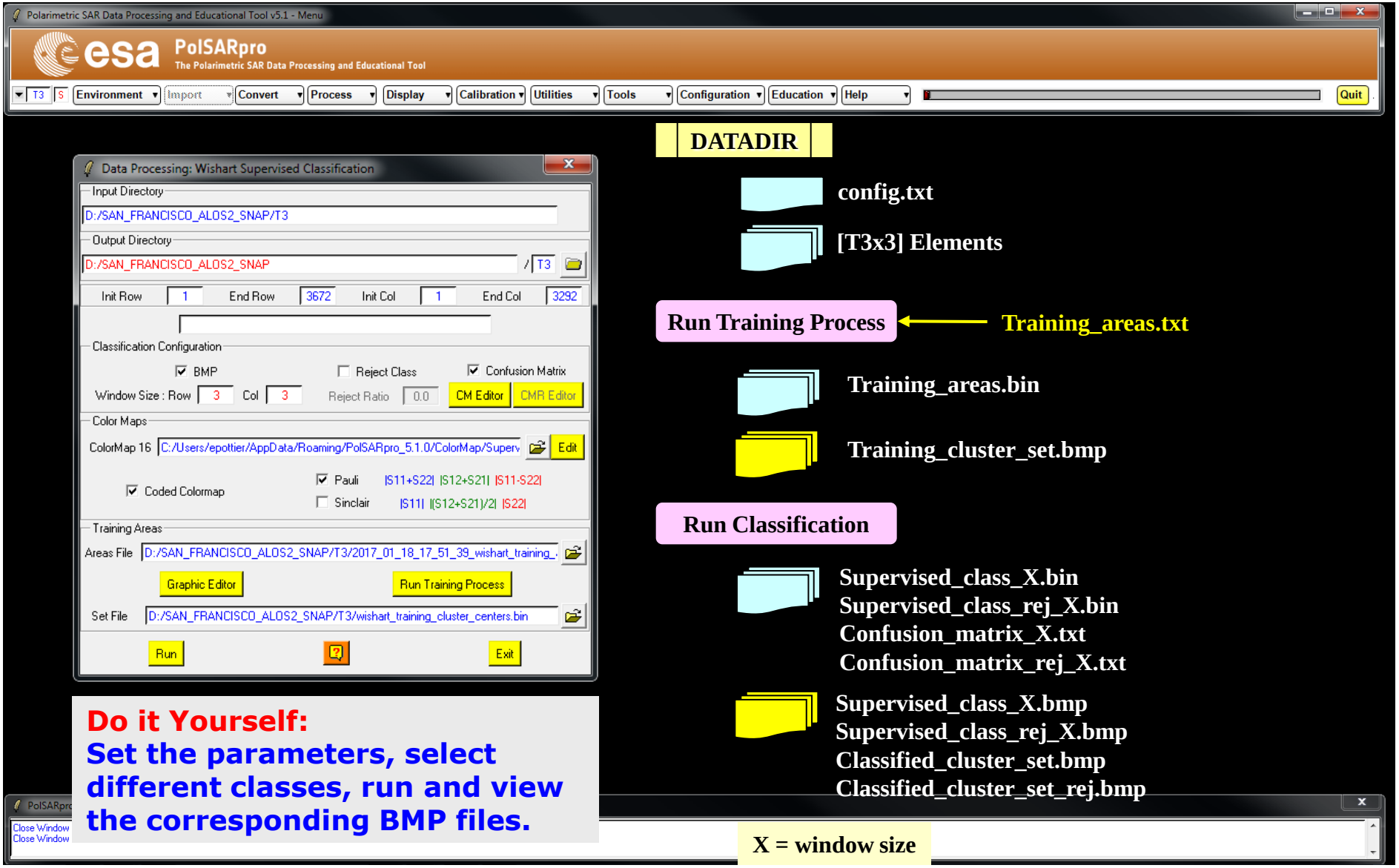
Step 3 :
Run the Wishart Supervised Classification procedure



SUPERVISED CLASSIFICATION



SUPERVISED CLASSIFICATION



DATADIR

- config.txt
- [T3x3] Elements

Run Training Process ← Training_areas.txt

- Training_areas.bin
- Training_cluster_set.bmp

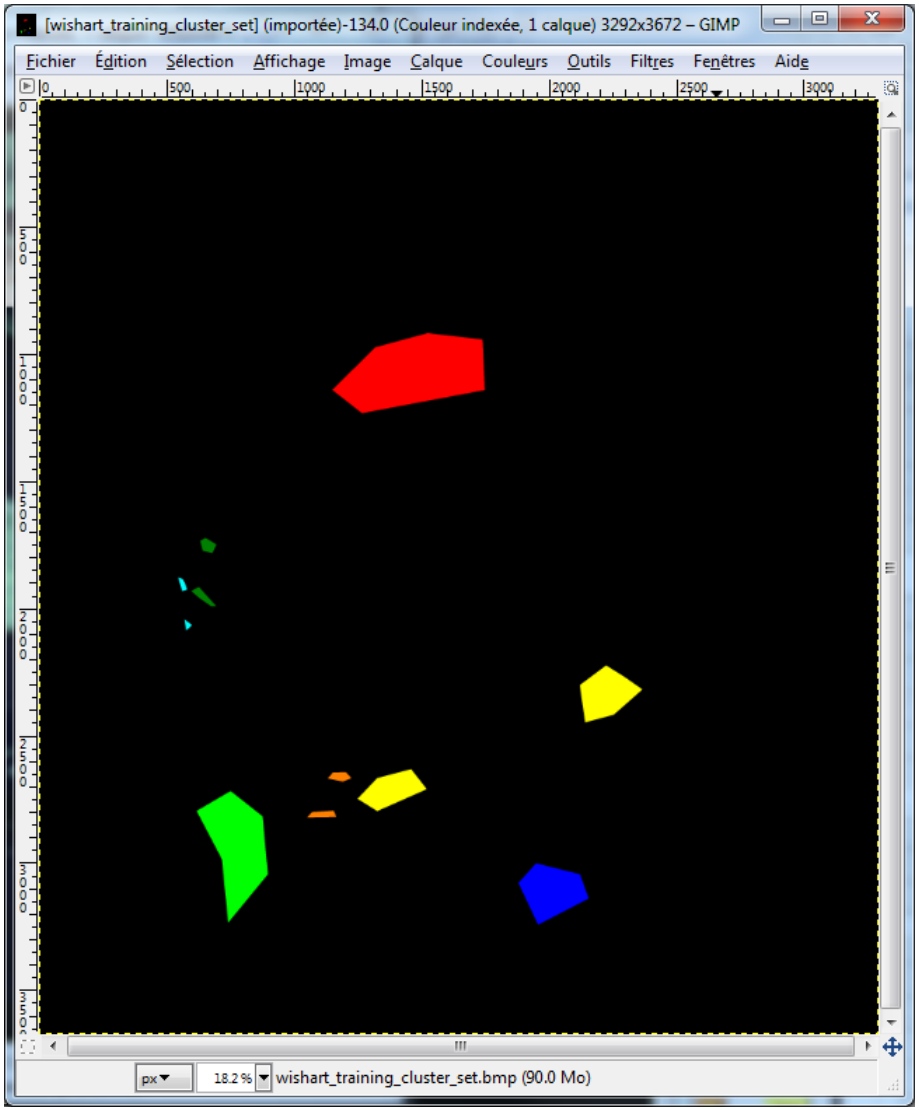
Run Classification

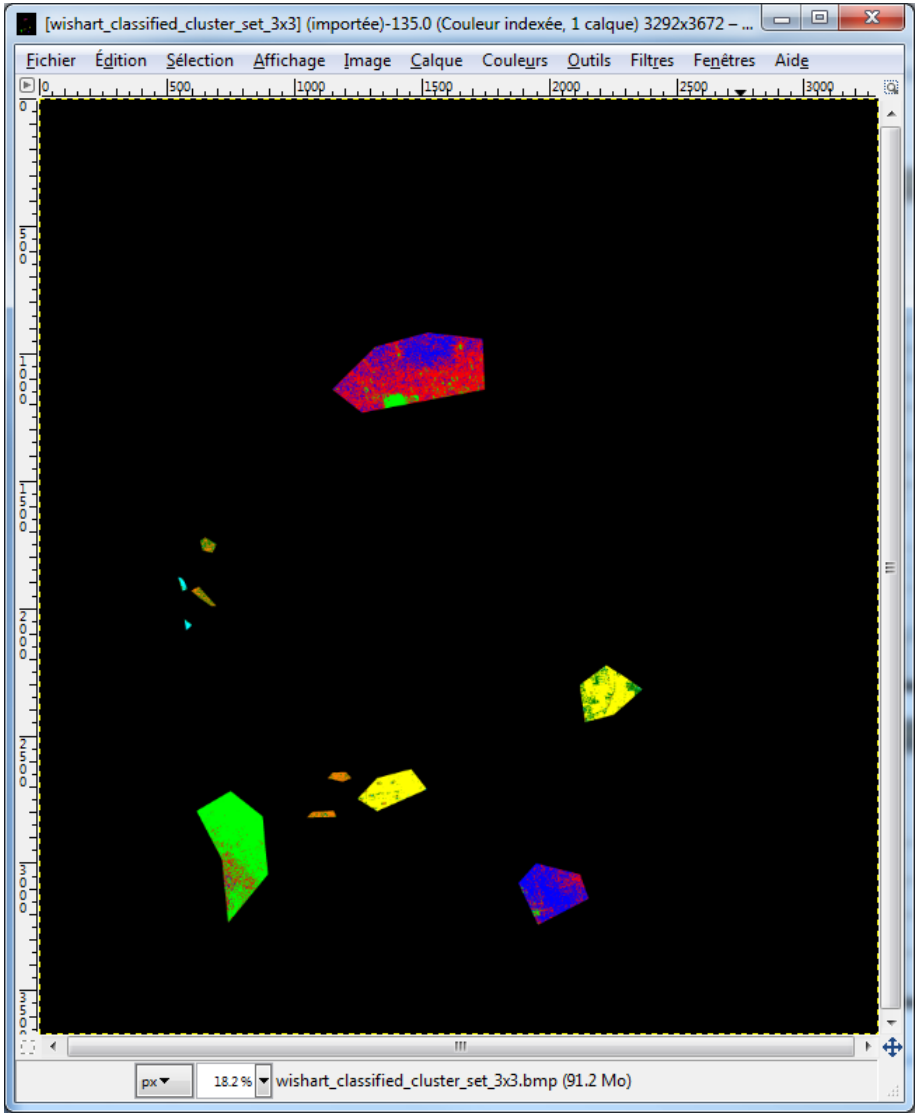
- Supervised_class_X.bin
- Supervised_class_rej_X.bin
- Confusion_matrix_X.txt
- Confusion_matrix_rej_X.txt
- Supervised_class_X.bmp
- Supervised_class_rej_X.bmp
- Classified_cluster_set.bmp
- Classified_cluster_set_rej.bmp

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

X = window size

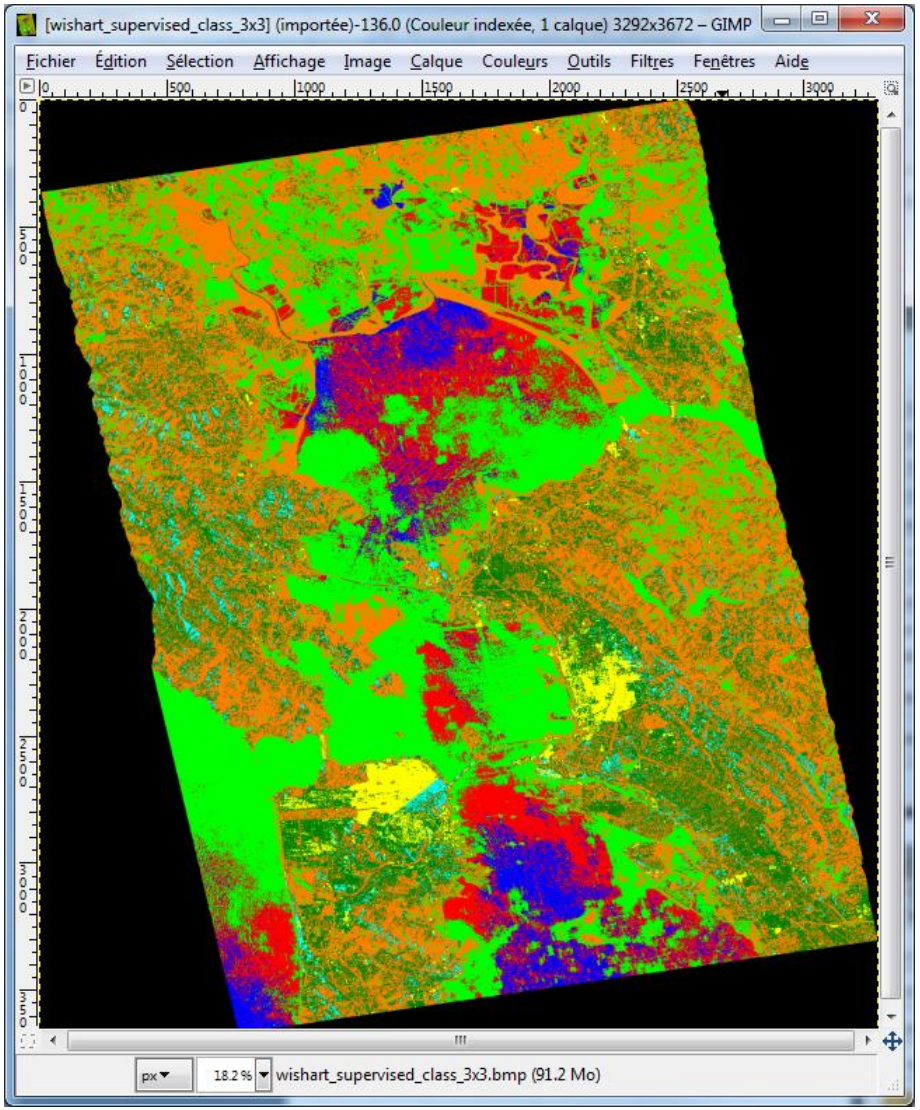
SUPERVISED CLASSIFICATION

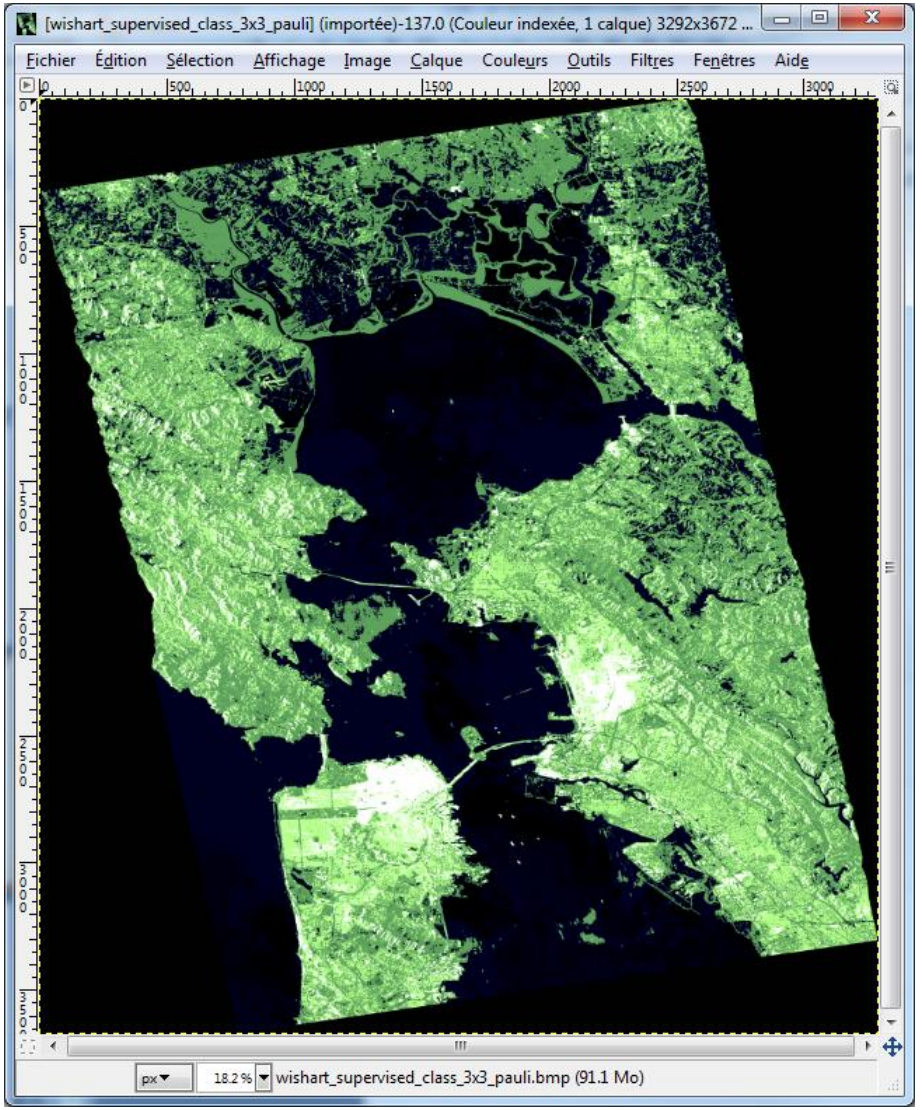




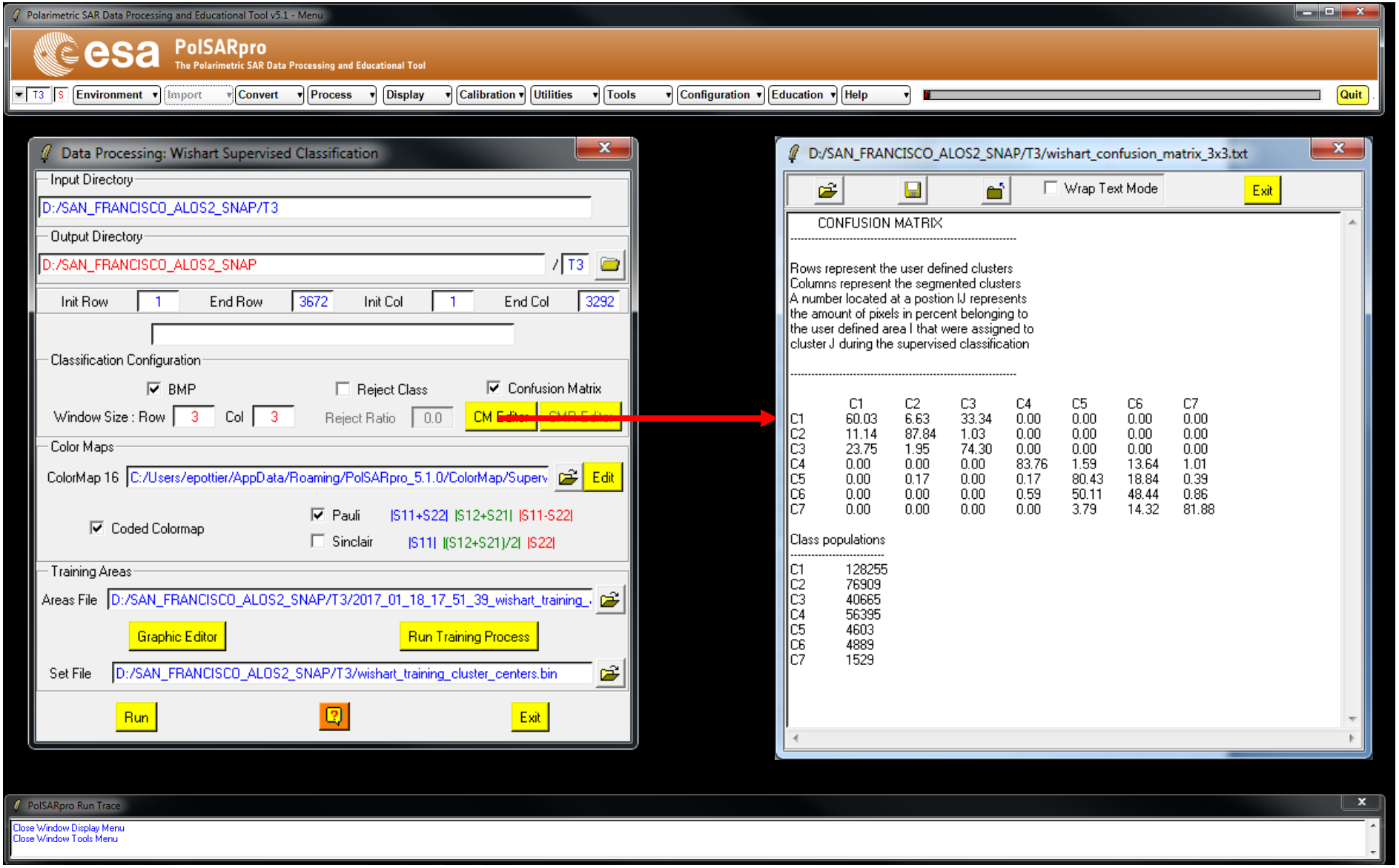
SUPERVISED CLASSIFICATION

01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16

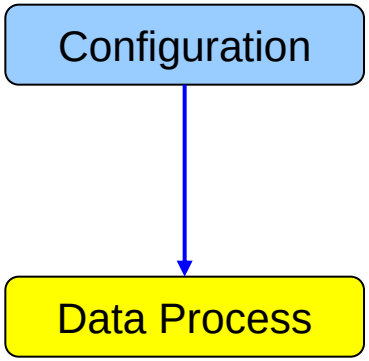




SUPERVISED CLASSIFICATION



PROCESSING CHAIN



- Eigenvalue Parameters
- Polarimetric Decomposition
- Polarimetric Segmentation
  - Wishart - H / A / alpha classification
  - Supervised Wishart classification
  - Support Vector Machine Classification

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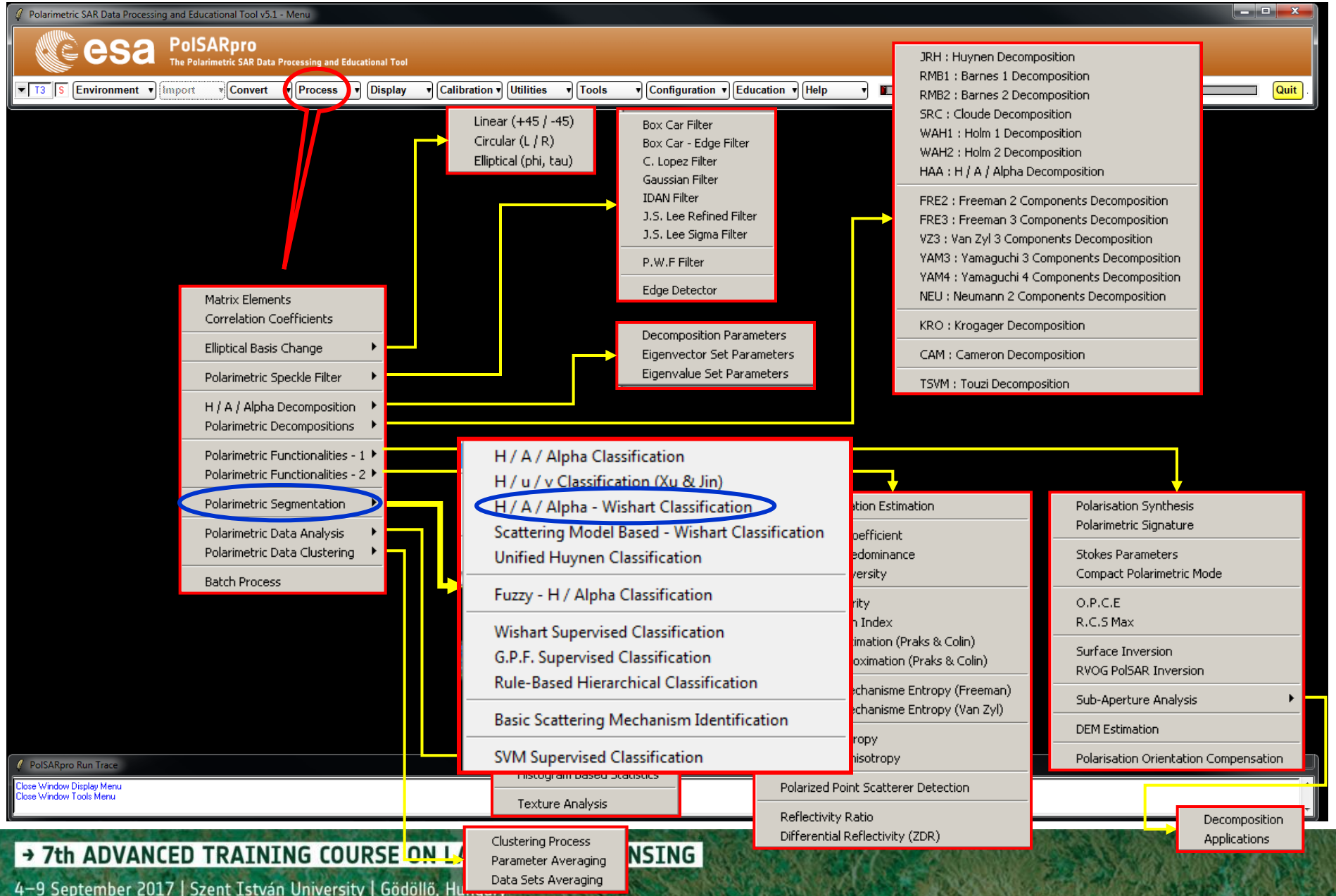
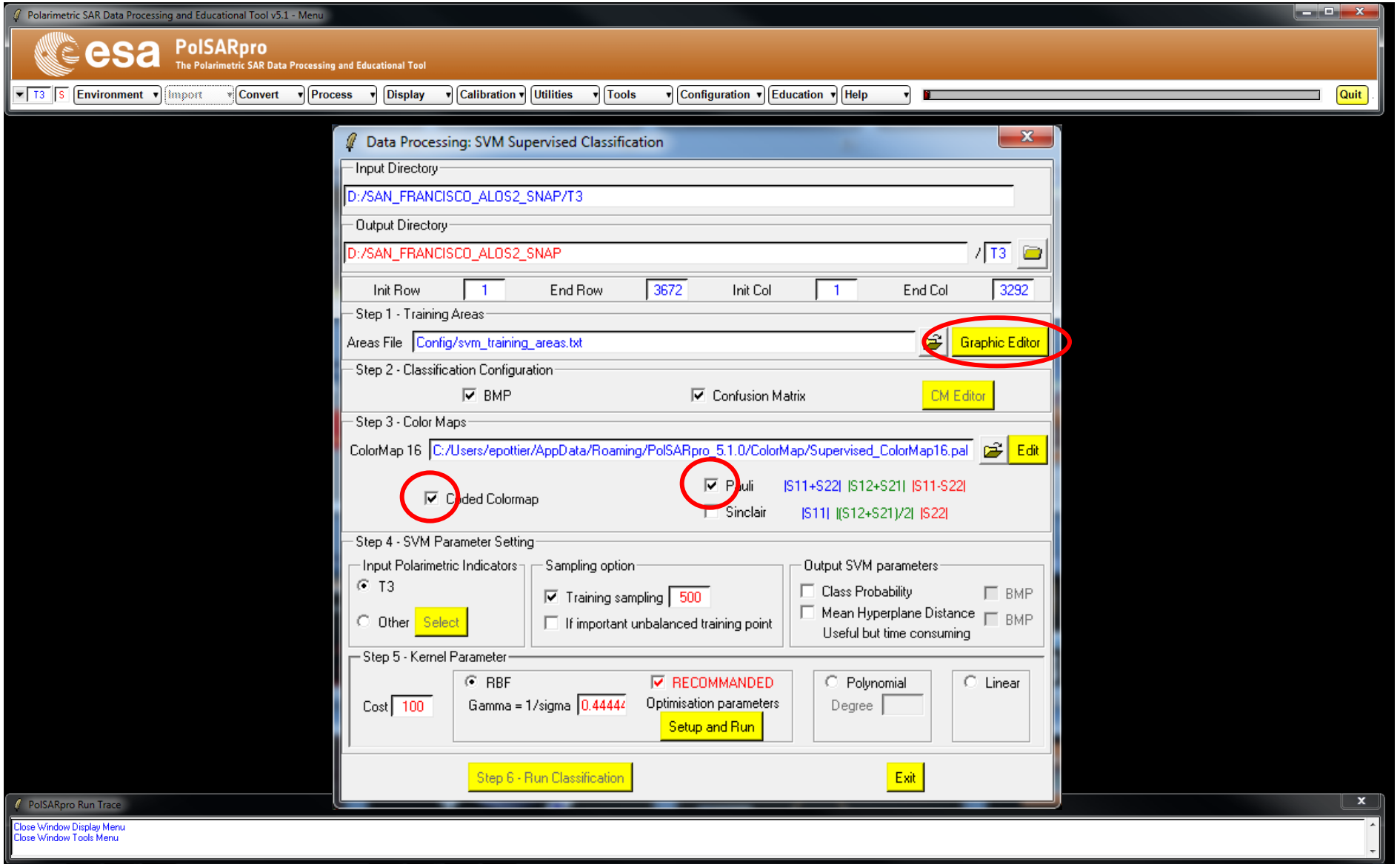
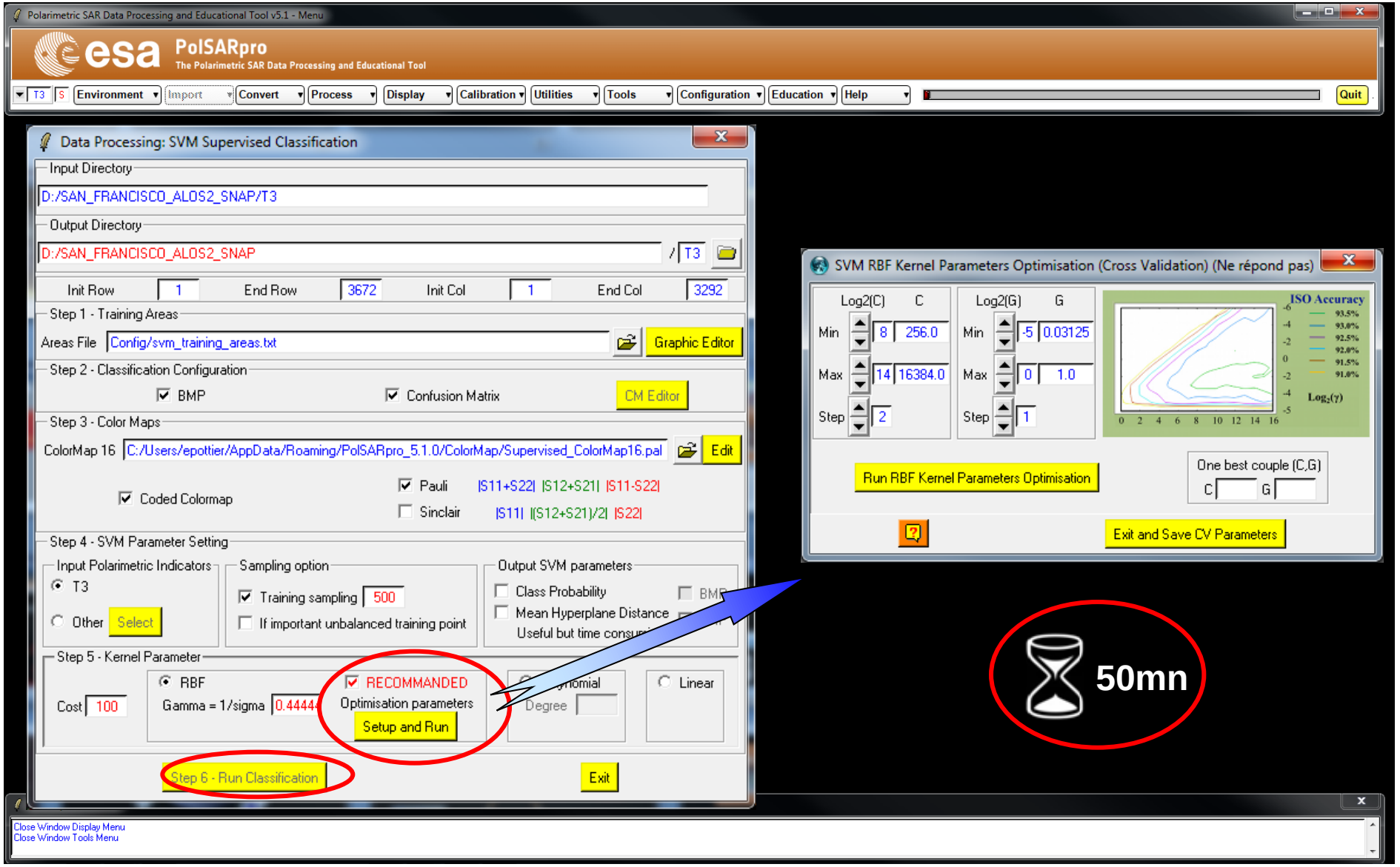


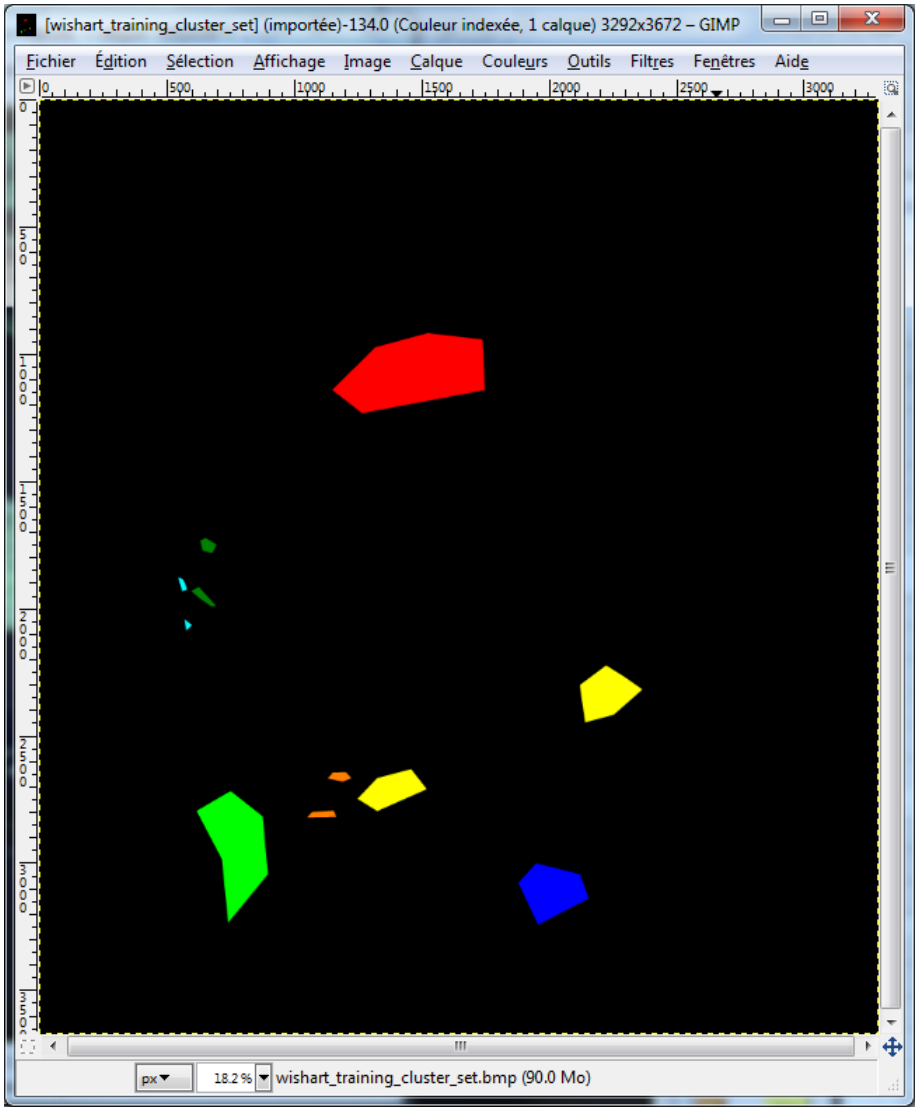
SUPPORT VECTOR MACHINE CLASSIFICATION

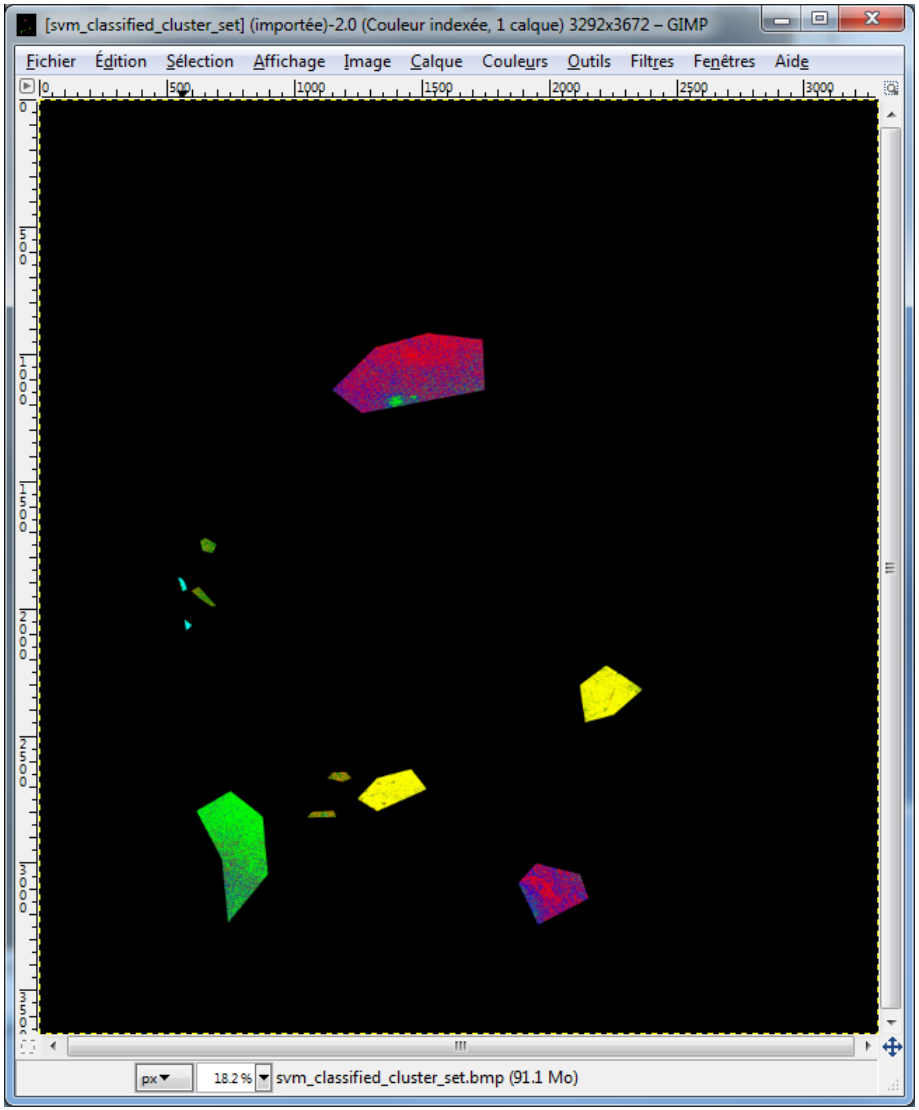


SUPPORT VECTOR MACHINE CLASSIFICATION

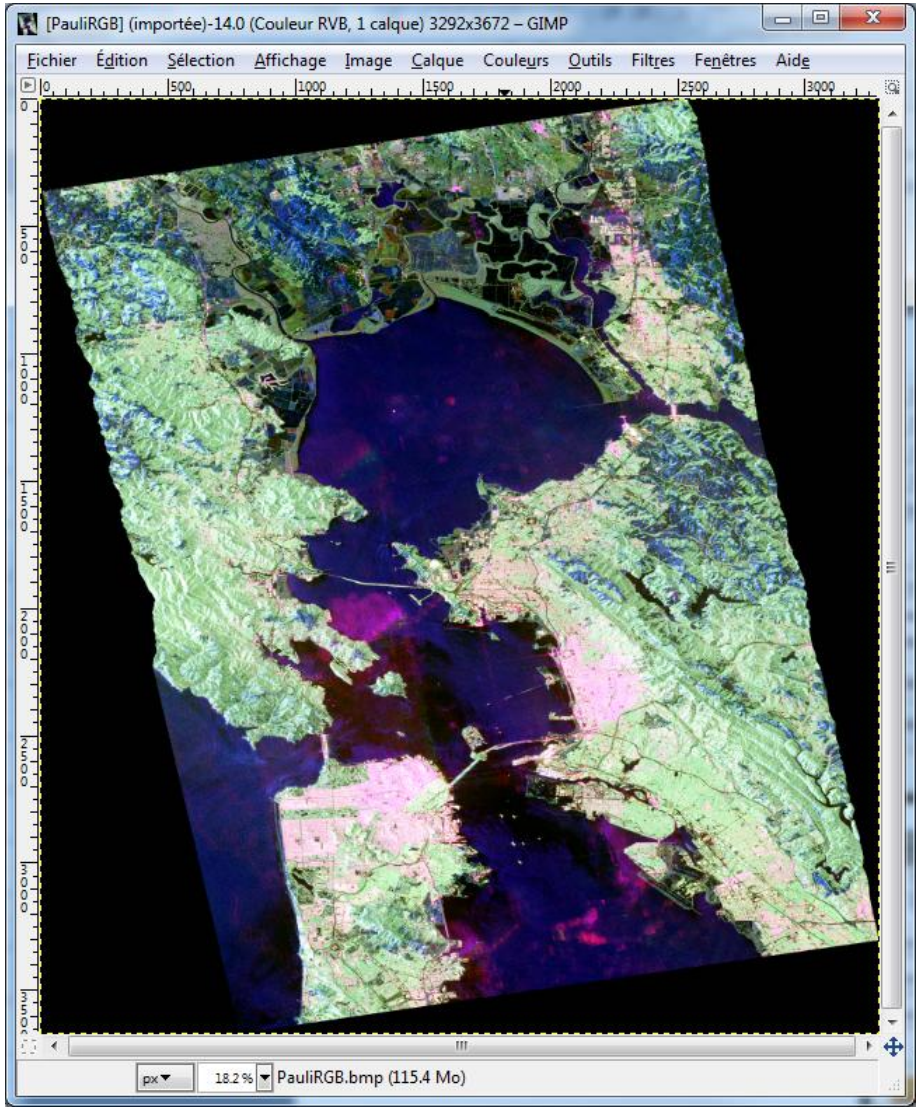


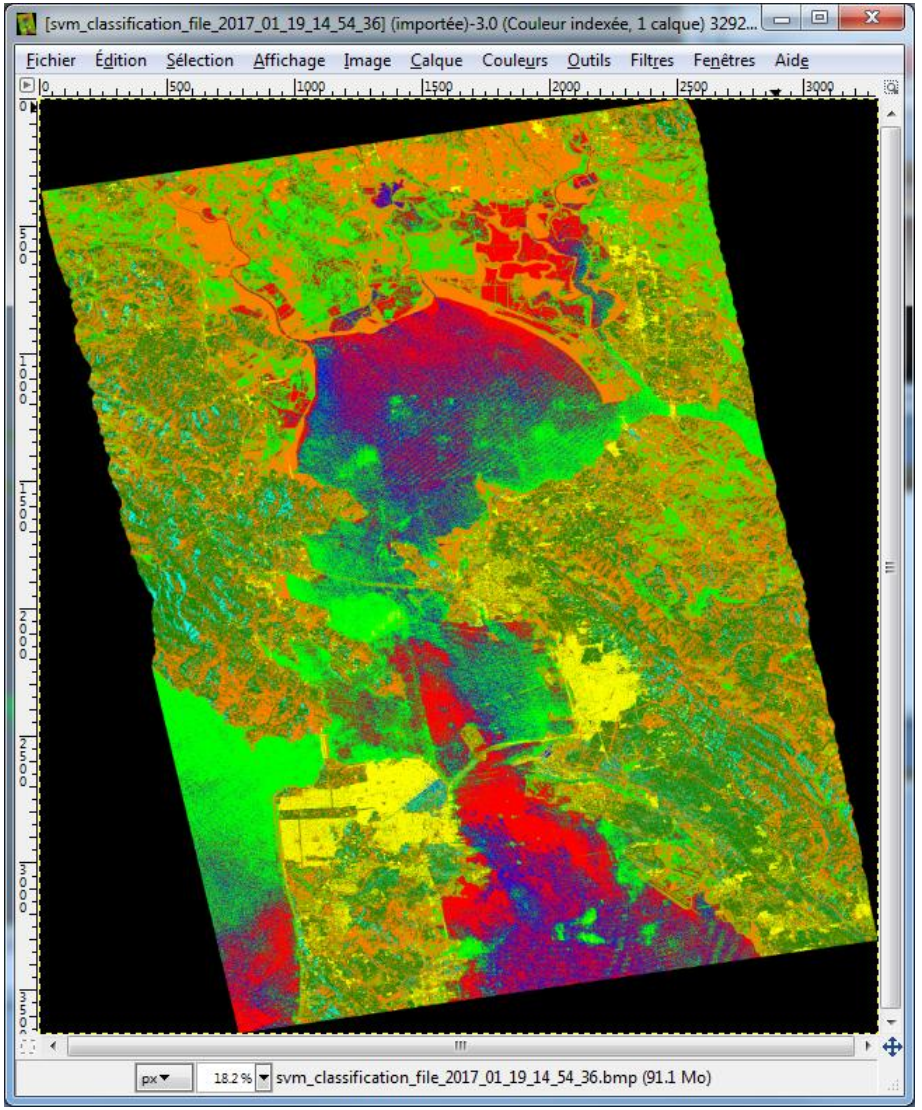
SUPPORT VECTOR MACHINE CLASSIFICATION



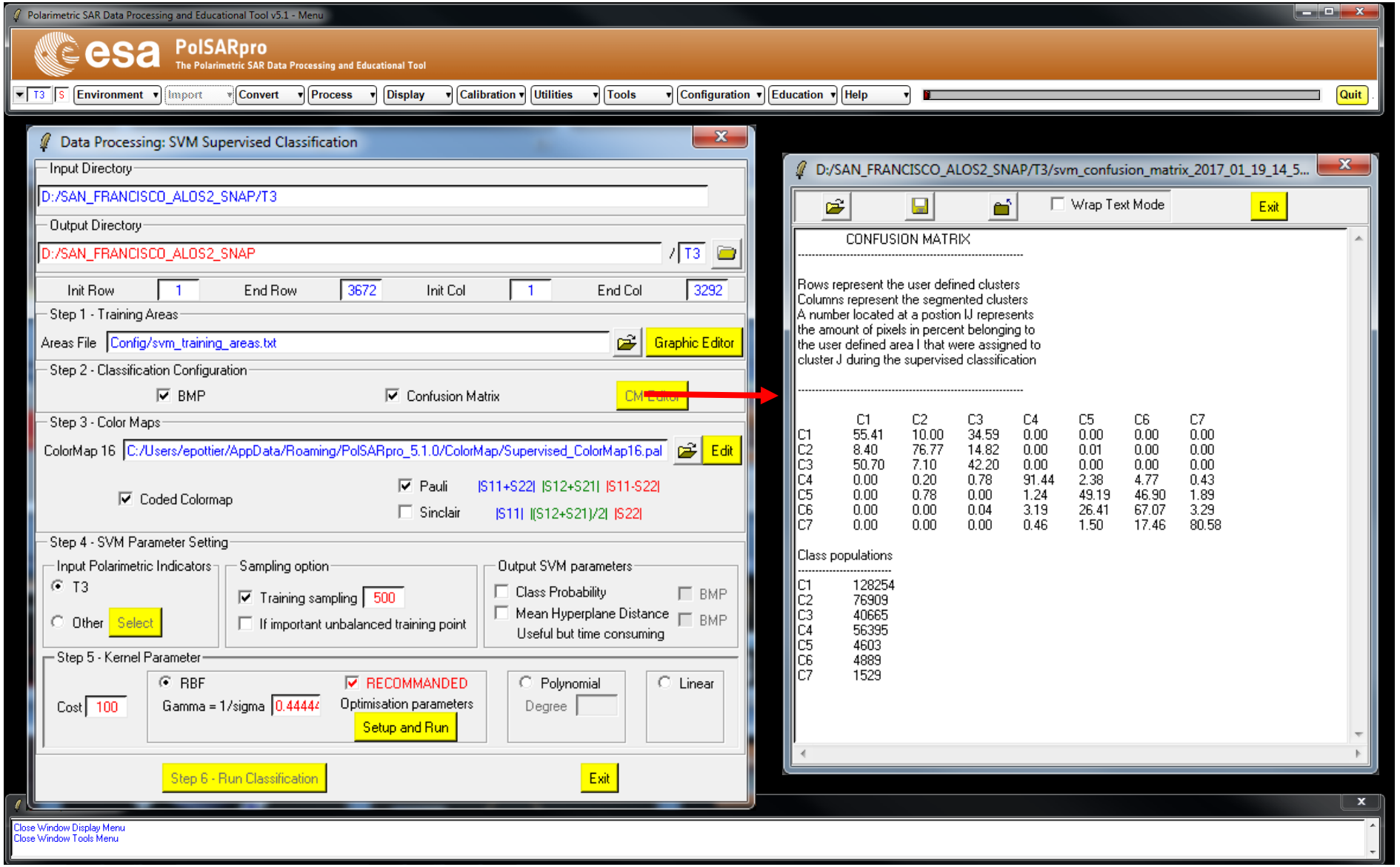


SUPPORT VECTOR MACHINE CLASSIFICATION

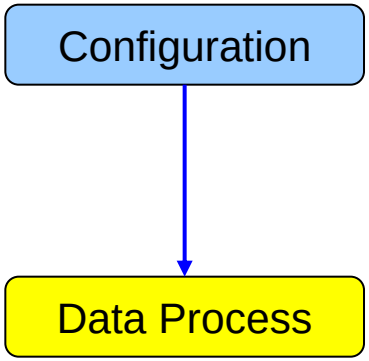




SUPPORT VECTOR MACHINE CLASSIFICATION

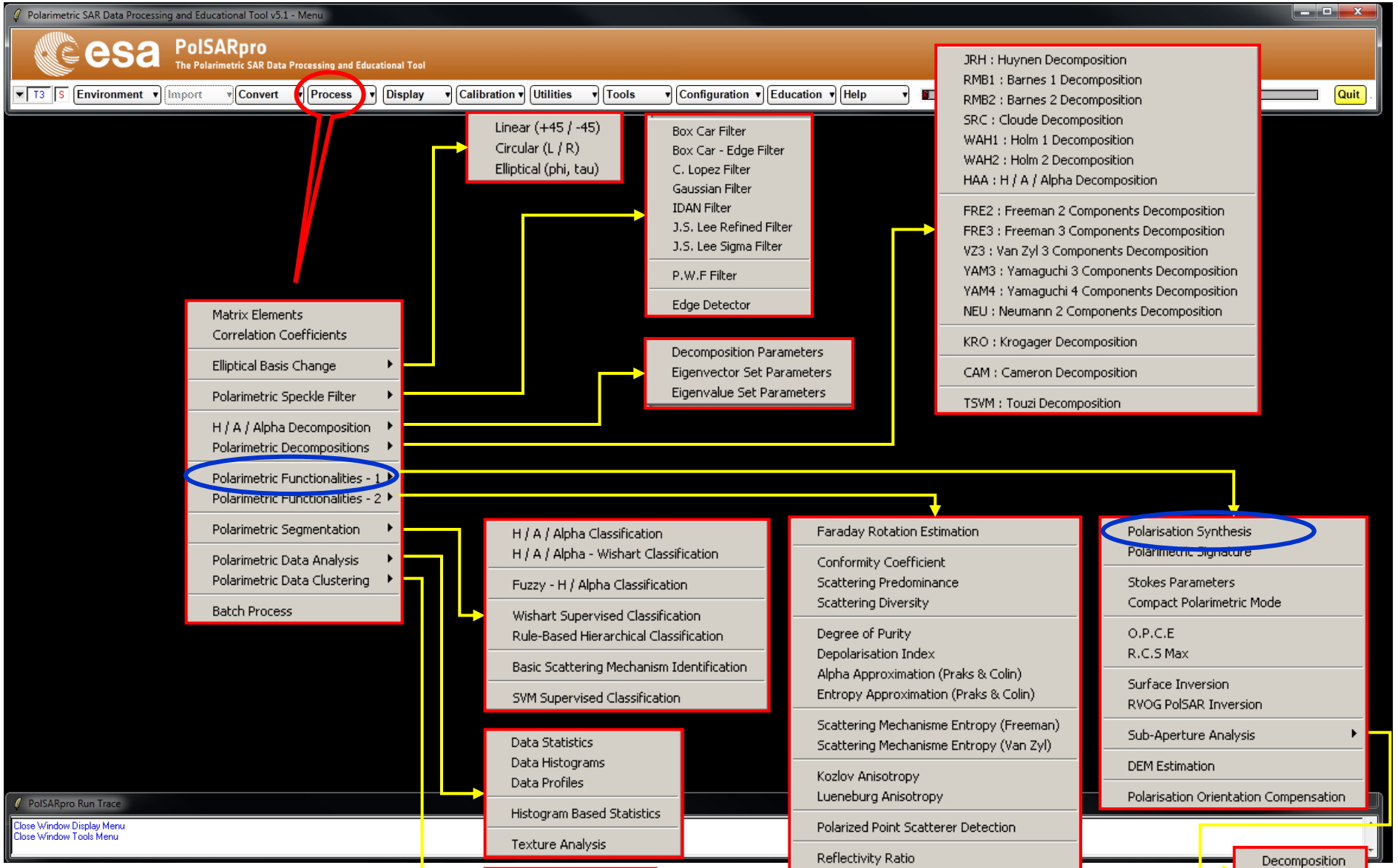


PROCESSING CHAIN

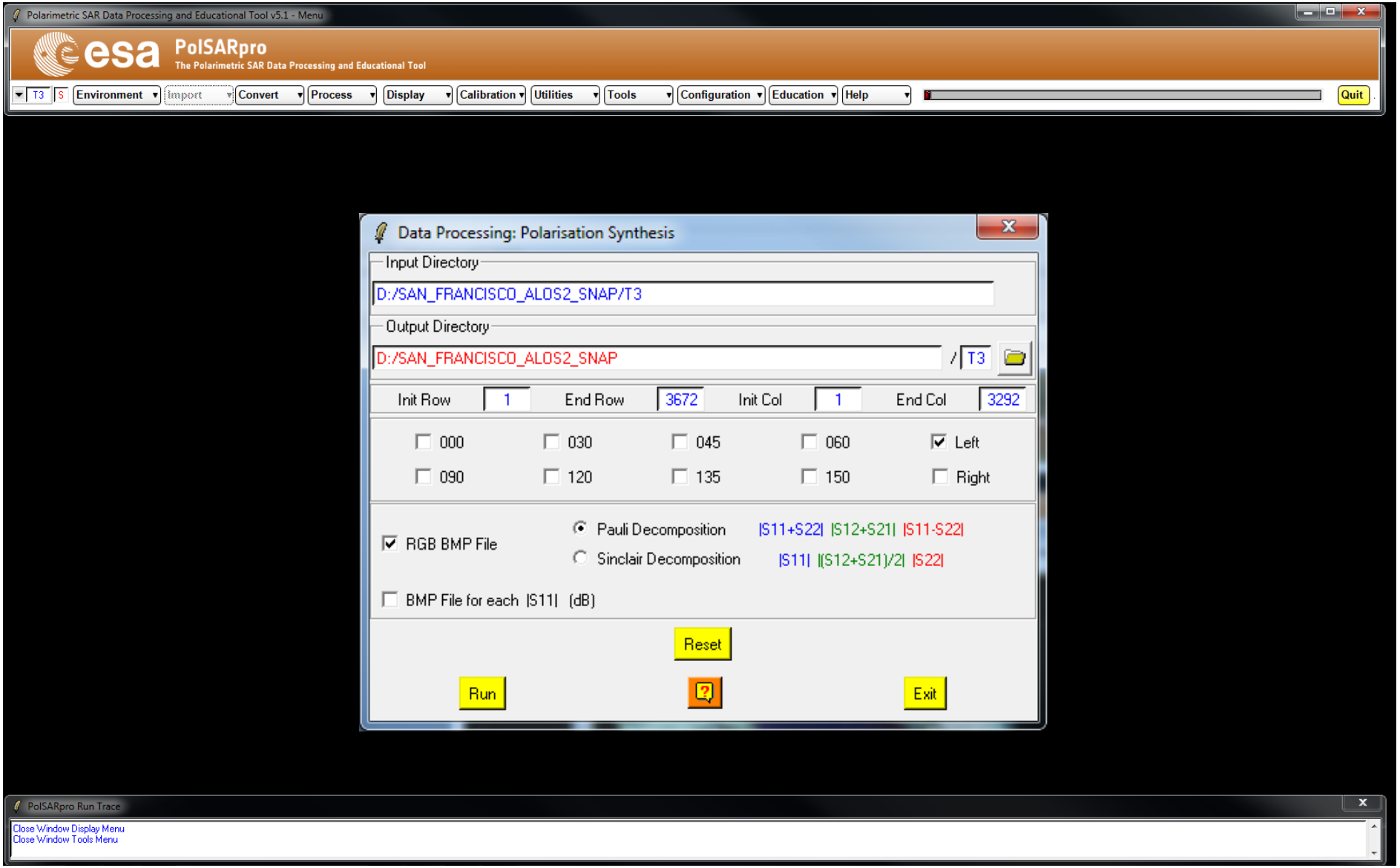


- Eigenvalue Parameters
- Polarimetric Decomposition
- Polarimetric Segmentation
  - Wishart - H / A / alpha classification
  - Supervised Wishart classification
  - Support Vector Machine Classification
- Polarimetric Functionalities
  - Polarimetric synthesis

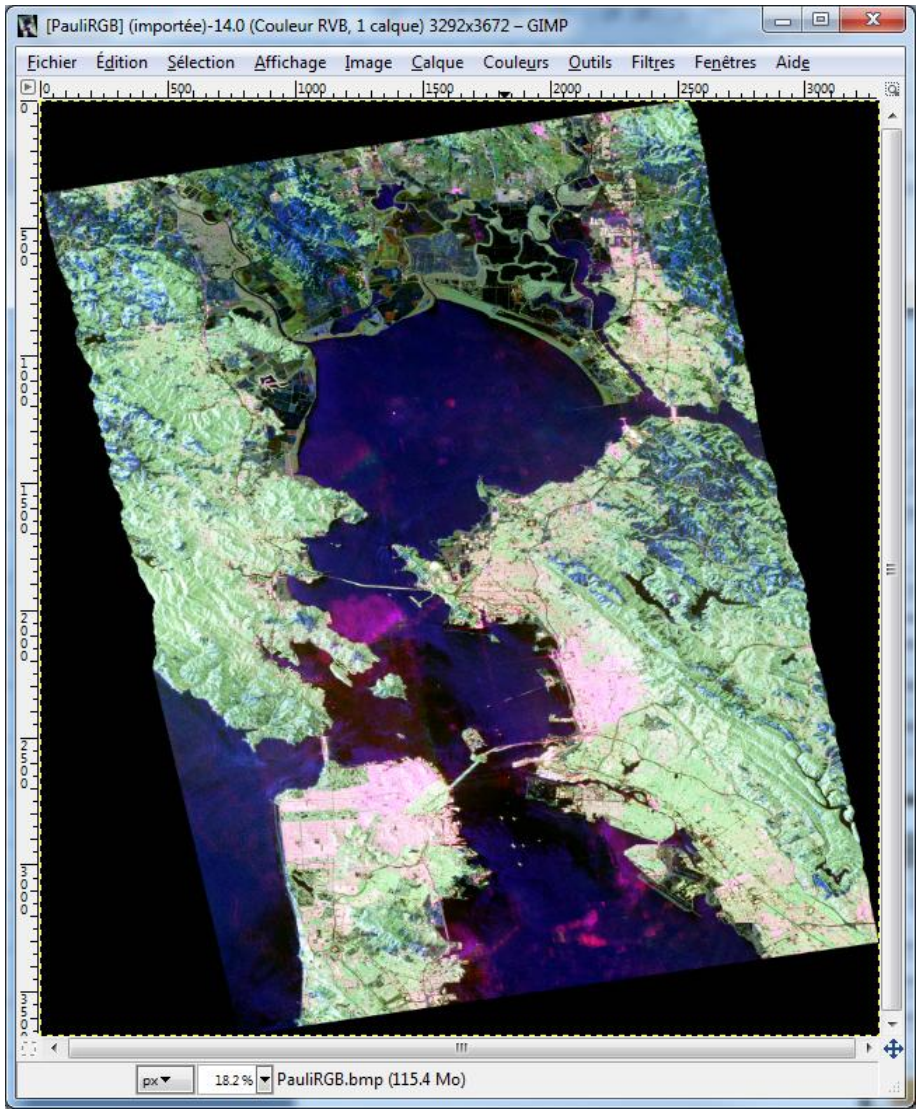
PolSARpro v5.1 SOFTWARE

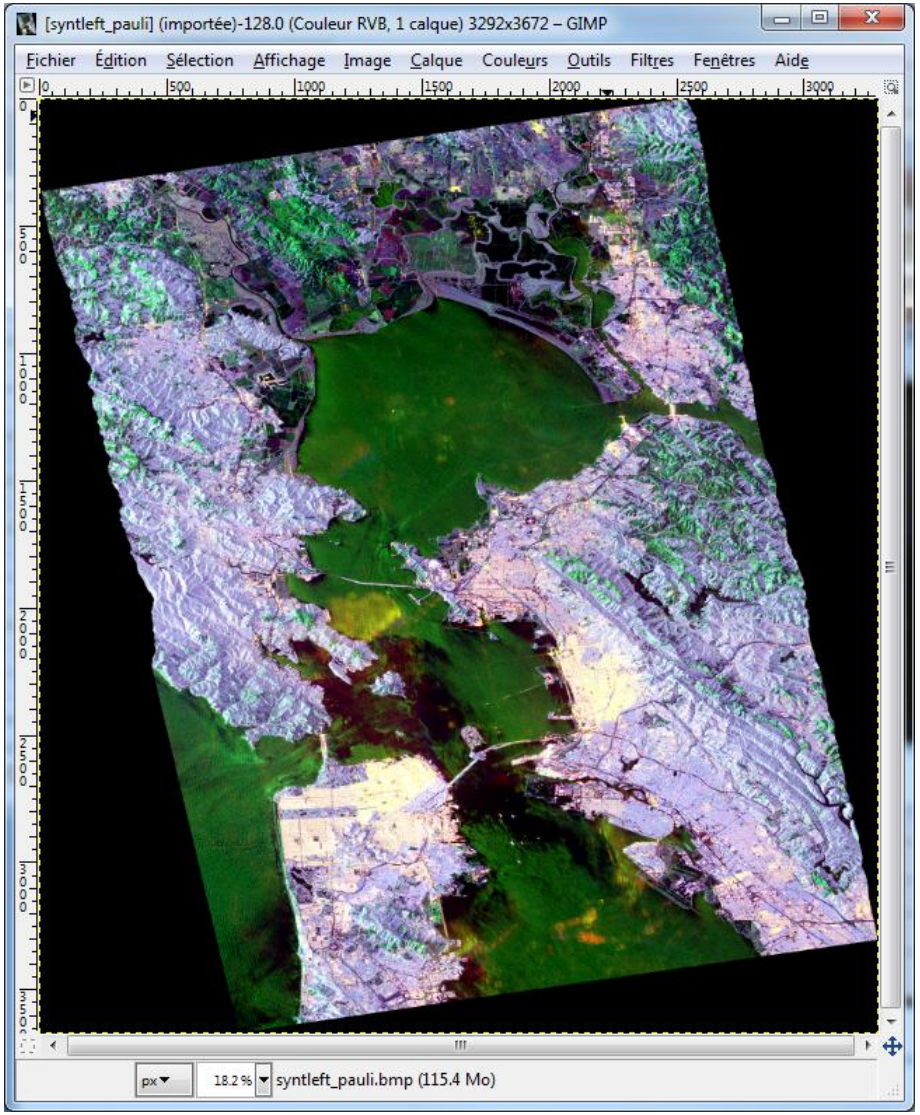


POLARIZATION SYNTHESIS



POLARIZATION SYNTHESIS





Questions ?