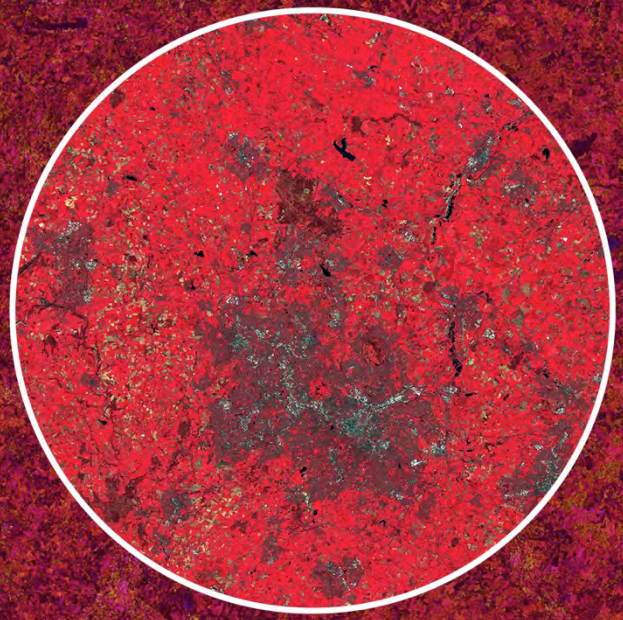
National Centre for Earth Observation
NATURAL ENVIRONMENT RESEARCH COUNCIL

UNIVERSITY OF LEICESTER

esa

→ 8th ADVANCED TRAINING COURSE ON LAND REMOTE SENSING

10–14 September 2018
University of Leicester | United Kingdom



Forestry applications with Polarimetry and Interferometry (Practical)

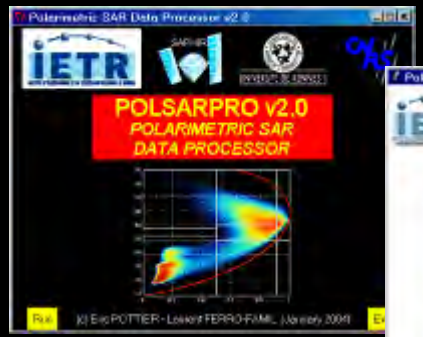
Laurent FERRO-FAMIL, Eric POTTIER

IETR / University of Rennes 1, France

IETR
UMR 6164

UNIVERSITÉ DE RENNES 1

HISTORY

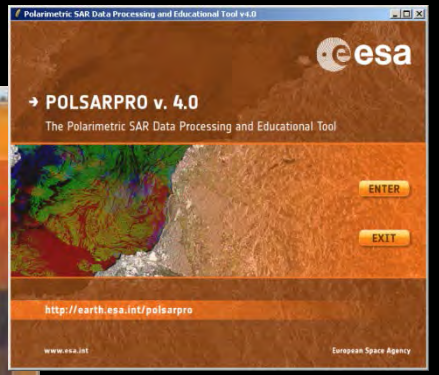


2003

2004

2005

2007

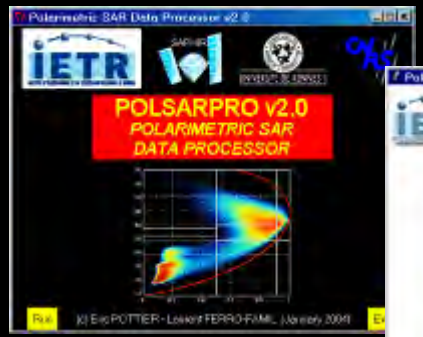


2009

© E. Pottier – 2018

HISTORY

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.

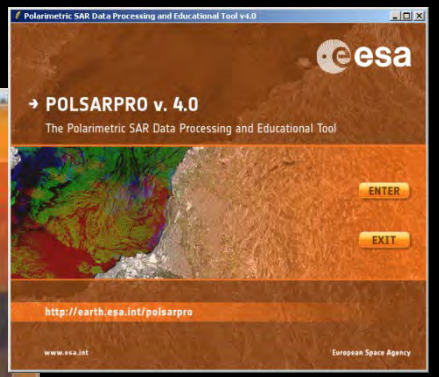


2003

2004

2005

2007



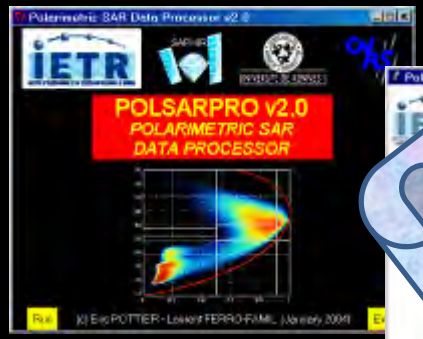
2009

© E. Pottier – 2018

HISTORY

15 YEARS OF DEVELOPMENT

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

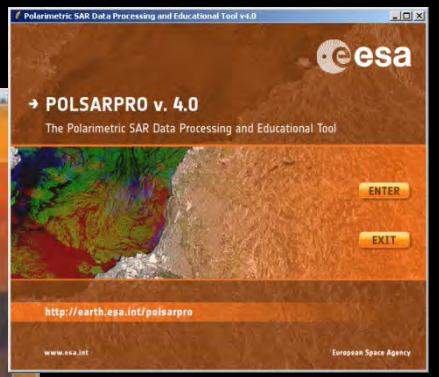


2003

2004

2005

2007

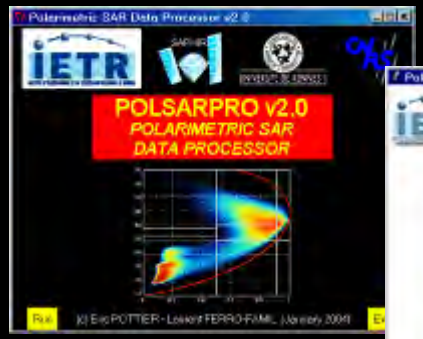


2009

© E. Pottier – 2018

HISTORY

2013 (5.0) - 2018 (5.2)

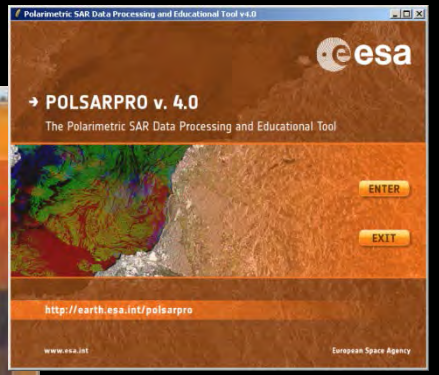


2003

2004

2005

2007



2009

© E. Pottier – 2018

PolSARpro v5.2 SOFTWARE

Toolbox specifically designed to handle : **Pol-SAR**, **Pol-InSAR**, **Pol-TomoSAR** and **Pol-TimeSAR** data.

Educational Software offering a tool for **self-education** in the field of **Polarimetric SAR** data processing and analysis.

Developed to be **accessible** to : a wide range of users from **novices** to **experts** in the field of **Pol-SAR**, **Pol-InSAR**, **Pol-TomoSAR**, **Pol-TimeSAR**.

© E. Pottier – 2018

PolSARpro v5.2 SOFTWARE

More than **1740** different Pol-SAR, Pol-InSAR, Pol-TomSAR and Pol-TimeSAR **functionalities**.

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

PolSARpro v5.2 Software is made available following the: **Open Source Software Development (OSSD)** approach, and follows the: **GNU General Public License v2** – June 1991.

© E. Pottier – 2018

PolSARpro v5.2 SOFTWARE

esa since 2003

- +3000 registered users
- +70 foreign countries

International Collaborative Project

(4 Agencies, 15 Research Centres, 14 Universities)

© E. Pottier – 2018

PolSARpro v5.2 SOFTWARE

Contributors 2017

- Tsinghua University, China
- University of Mining and Technology, China
- National Space Science Center, CAS, China
- Fudan University, China
- Studies in Resources Engineering Indian Institute of Technology
- Universidade Federal de Alagoas, Brazil
- University of Science and Technology, Poland
- University of Tehran, School of Surveying and Geospatial Engineering, Iran
- Khajeh Nasir Toosi University of Technology, Iran
- Wuhan University, China
- Satellite Surveying and Mapping Application Center, China
- Xidian University, China
- Harbin Institute of Technology China
- Key Lab of Microwave Remote Sensing, CAS, China

© E. Pottier – 2018

PolSARpro v5.2 SOFTWARE

CURRENT

PolSARpro v5.2 Software offers the possibility to handle and convert polarimetric data from a range of well established CURRENT polarimetric airborne platforms.

© E. Pottier – 2018

PolSARpro v5.2 SOFTWARE

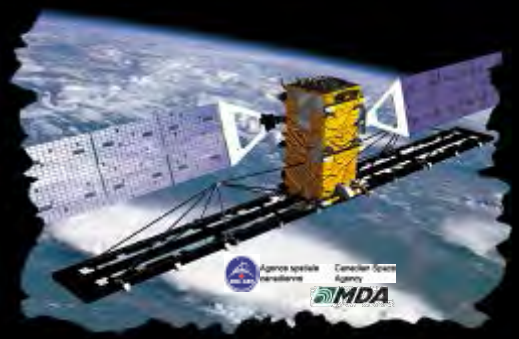
PAST

PolSARpro v5.2 Software offers the possibility to handle and convert polarimetric data from a range of well established **PAST polarimetric spaceborne platforms.**

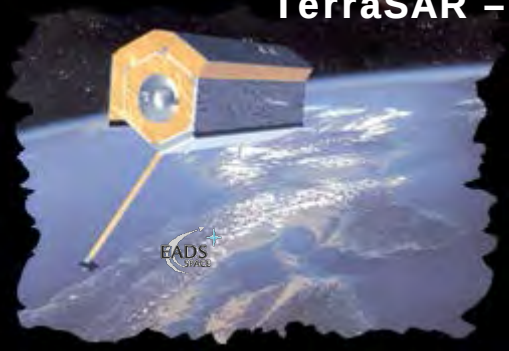
© E. Pottier – 2018

PolSARpro v5.2 SOFTWARE

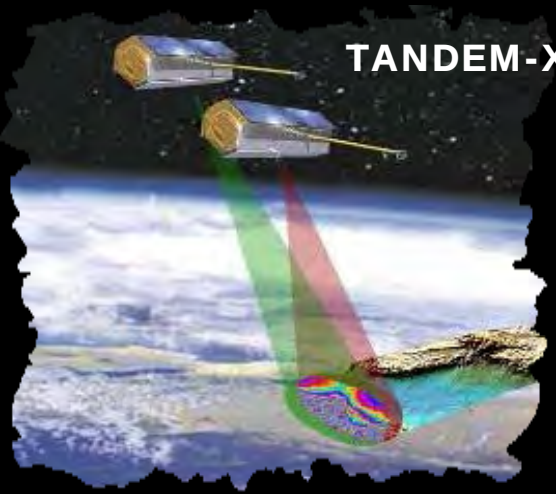
RADARSAT 2



TerraSAR – X



TANDEM-X



COSMO - SKYMED

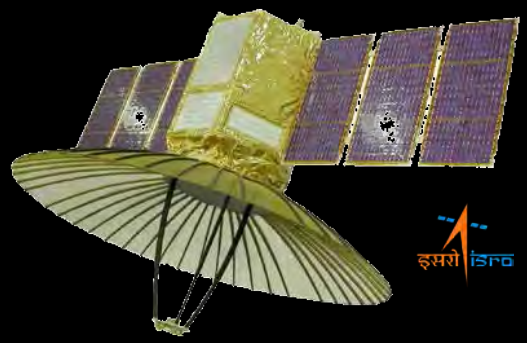
CURRENT

PolSARpro v5.2 Software offers the possibility to handle and convert polarimetric data from a range of well established CURRENT polarimetric spaceborne platforms.

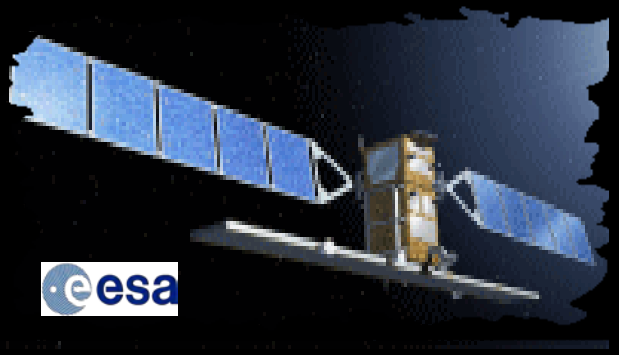
© E. Pottier – 2018

PolSARpro v5.2 SOFTWARE

RISAT

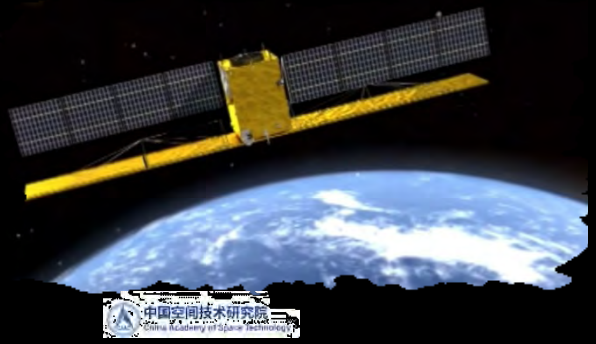


SENTINEL 1A / 1B

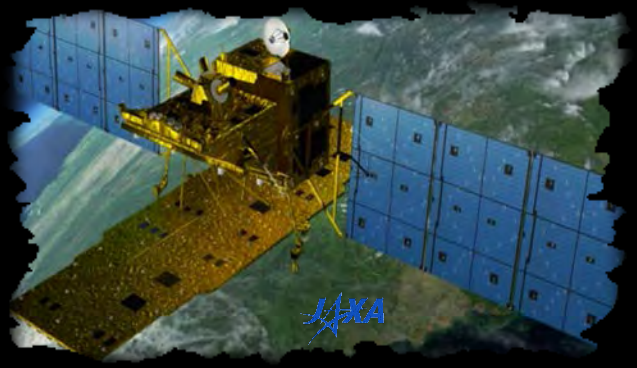


CURRENT

GaoFen 3 (GF3)



ALOS-2 – PALSAR-2

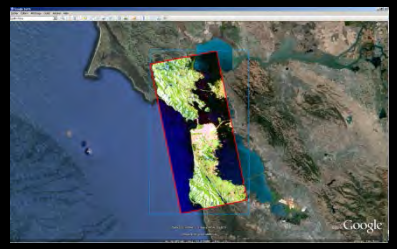


PolSARpro v5.2 Software offers the possibility to handle and convert polarimetric data from a range of well established CURRENT polarimetric spaceborne platforms.

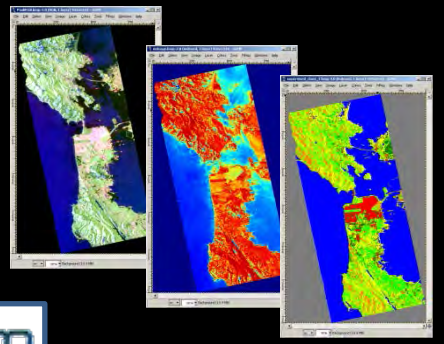
© E. Pottier – 2018

PolSARpro v5.2 SOFTWARE

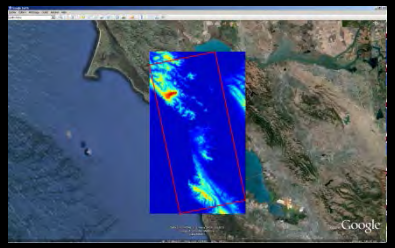
External Softwares

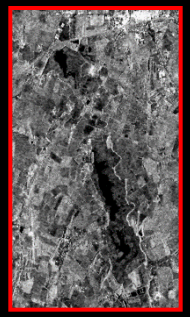


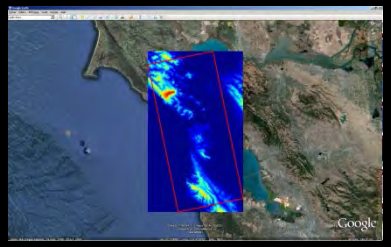
Google Earth



satim



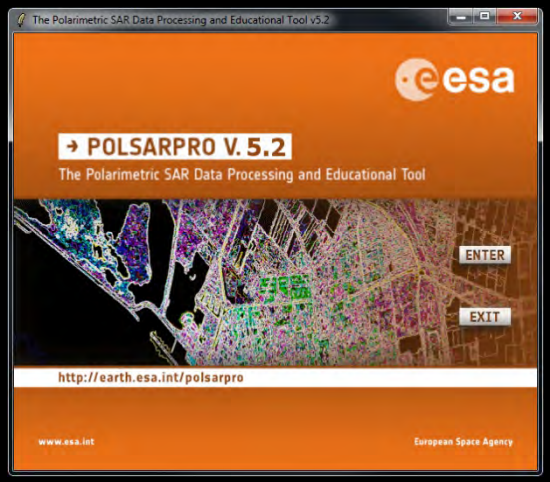




ASTER

© E. Pottier – 2018

ESA SNAP toolbox bridge



Polarimetric SAR Data Processing

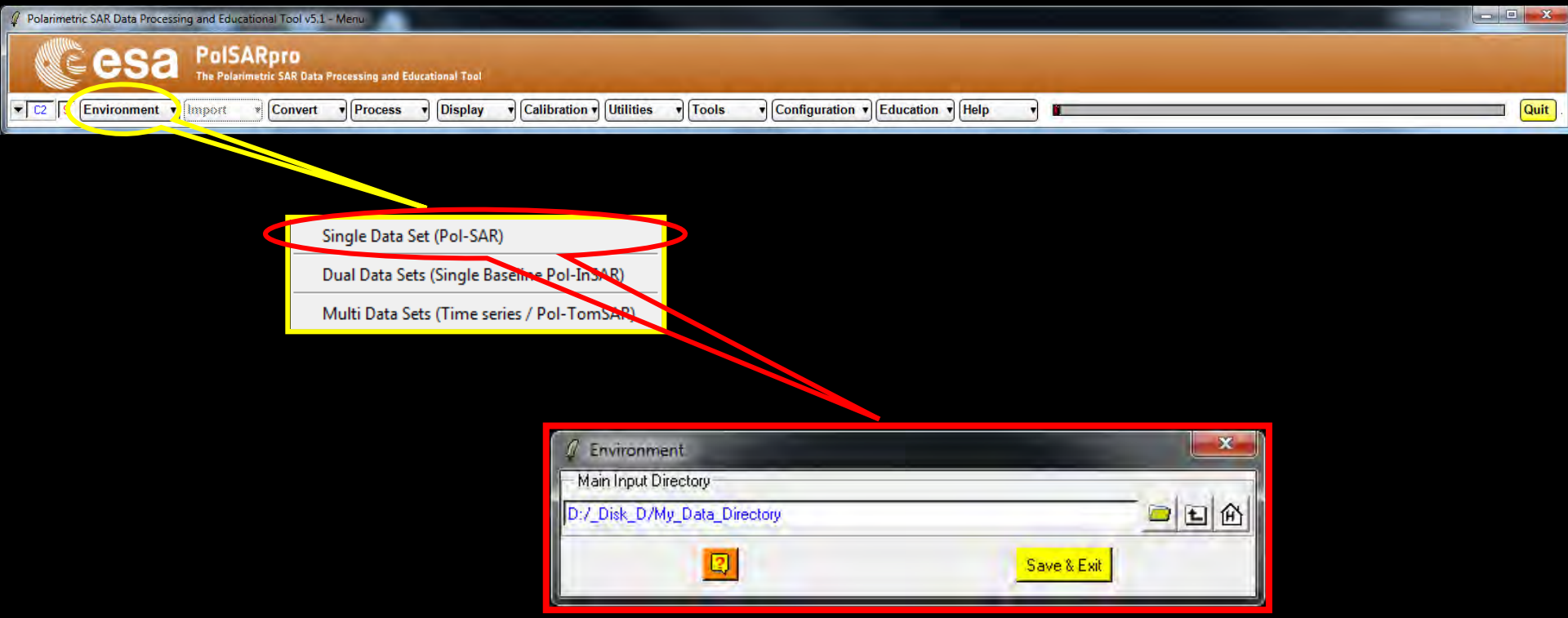
- **S1 toolbox**
  (split, deburst, merge …)
- **Geocoding toolbox**
- **Terrain correction**
- **Interferometric toolbox**
  (co-registration, flat Earth estimation …

© E. Pottier – 2018

Software – General Presentation

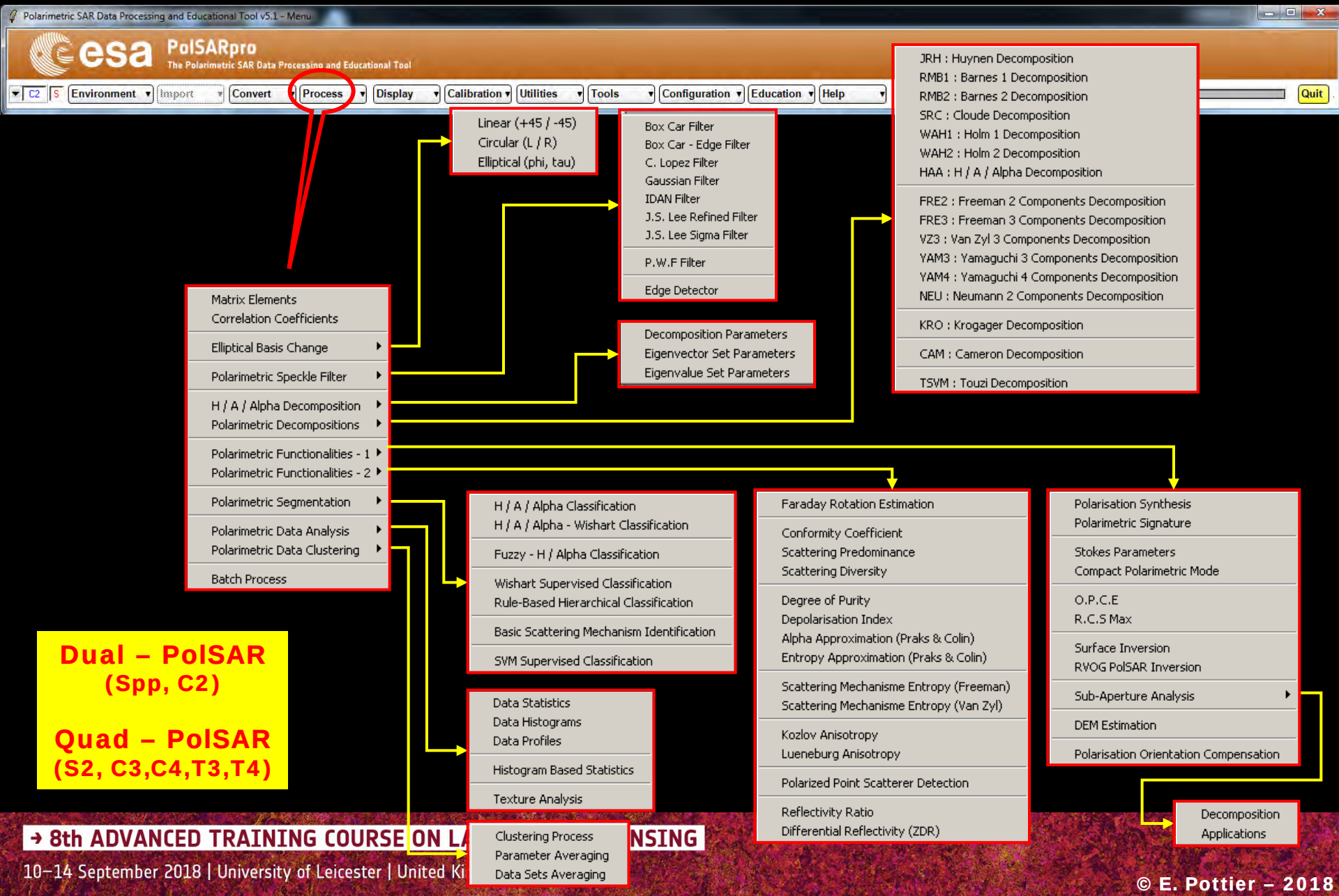
© E. Pottier – 2018

PolSARpro v5.2 SOFTWARE



© E. Pottier – 2018

PolSARpro v5.2 SOFTWARE

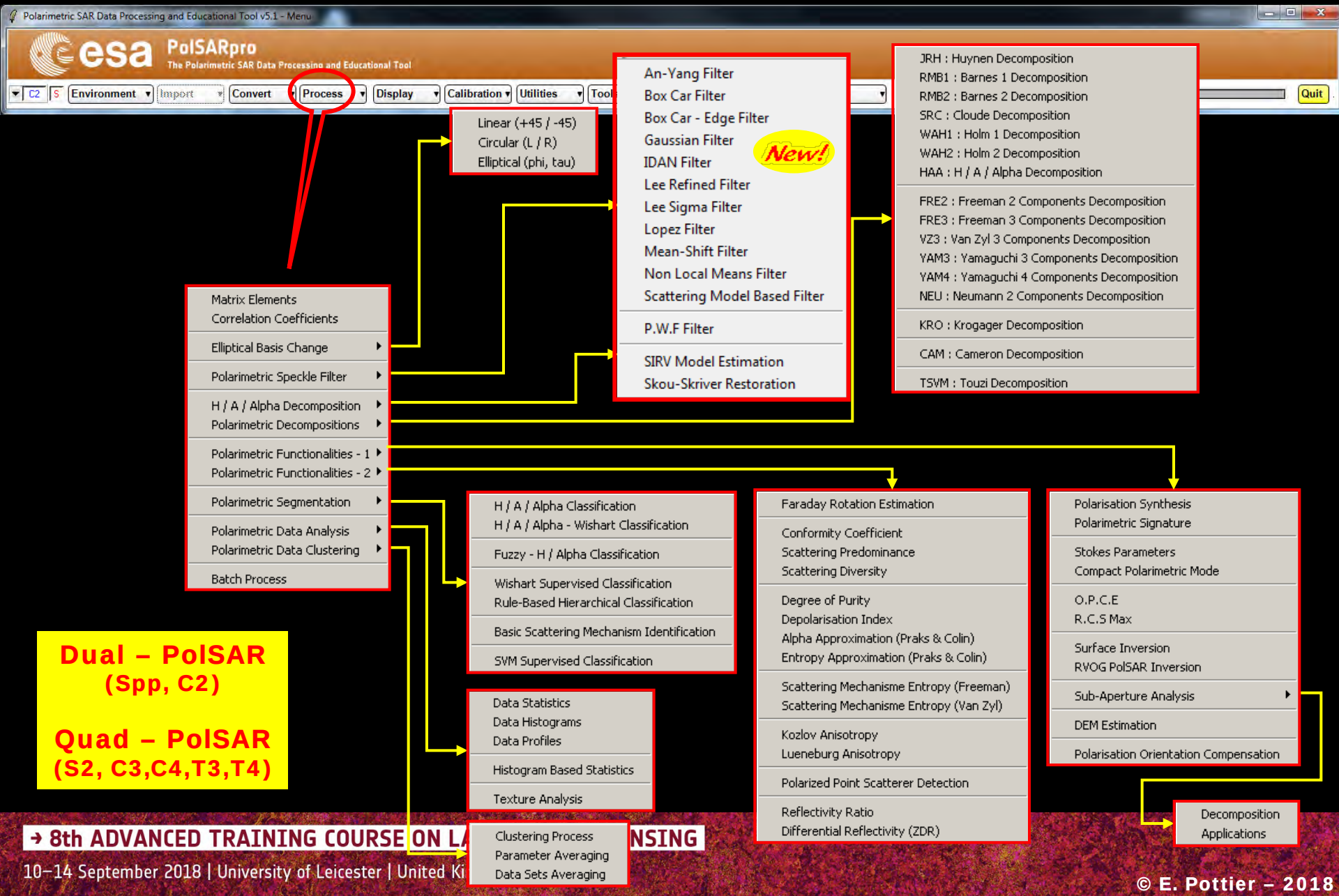


Dual – PolSAR (Spp, C2)

Quad – PolSAR (S2, C3,C4,T3,T4)

© E. Pottier – 2018

PolSARpro v5.2 SOFTWARE

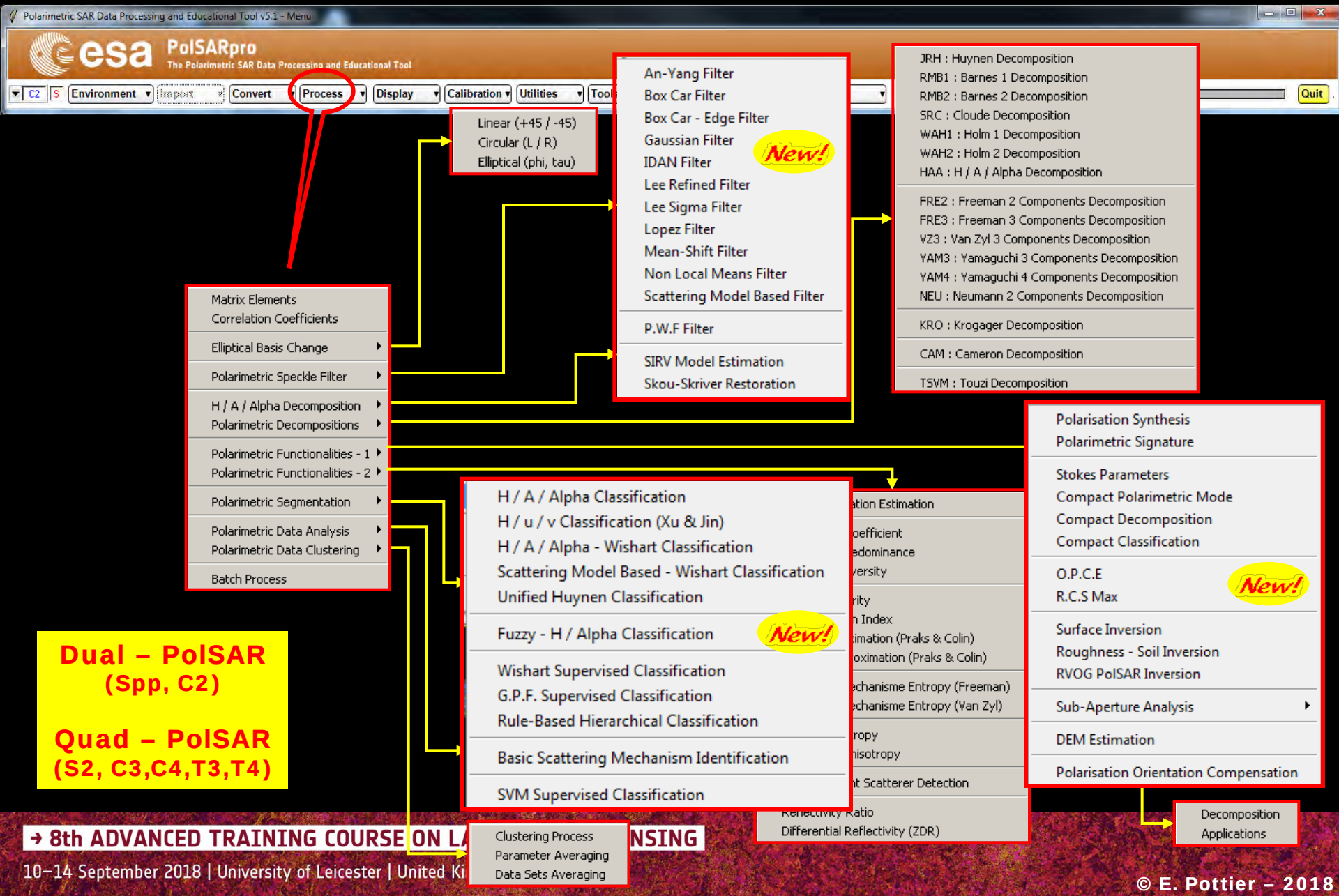


Dual – PolSAR (Spp, C2)

Quad – PolSAR (S2, C3,C4,T3,T4)

© E. Pottier – 2018

PolSARpro v5.2 SOFTWARE

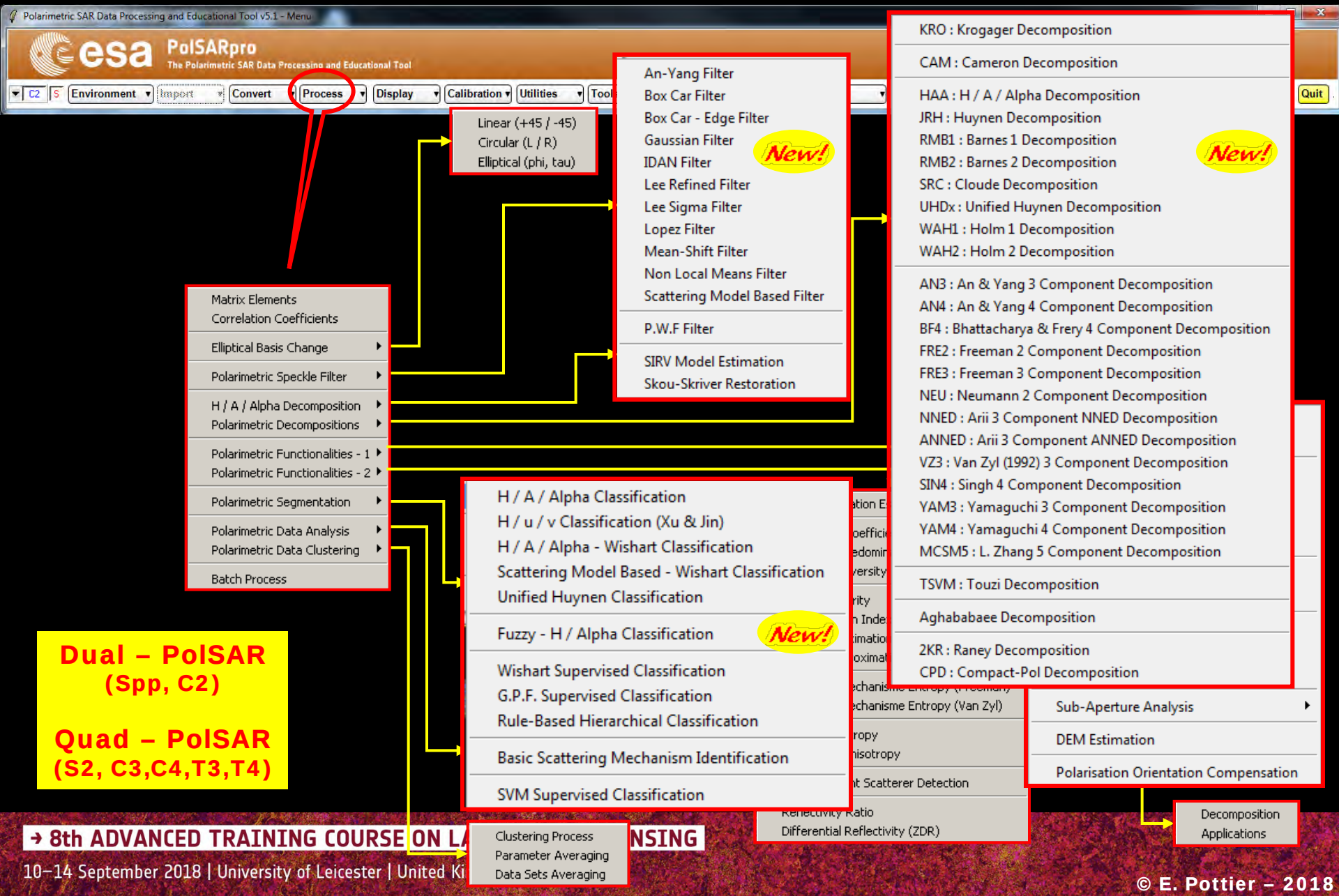


Dual – PolSAR (Spp, C2)

Quad – PolSAR (S2, C3,C4,T3,T4)

© E. Pottier – 2018

PolSARpro v5.2 SOFTWARE

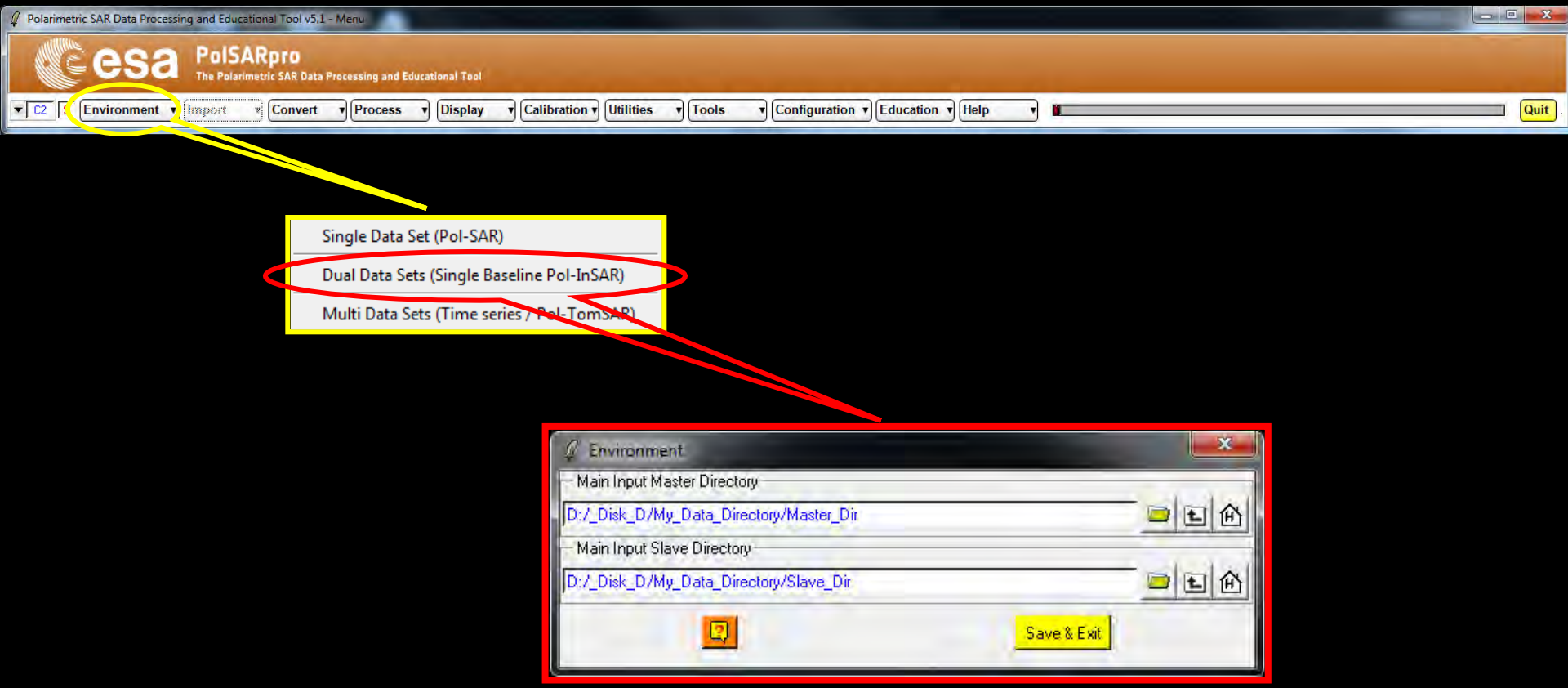


Dual – PolSAR (Spp, C2)

Quad – PolSAR (S2, C3,C4,T3,T4)

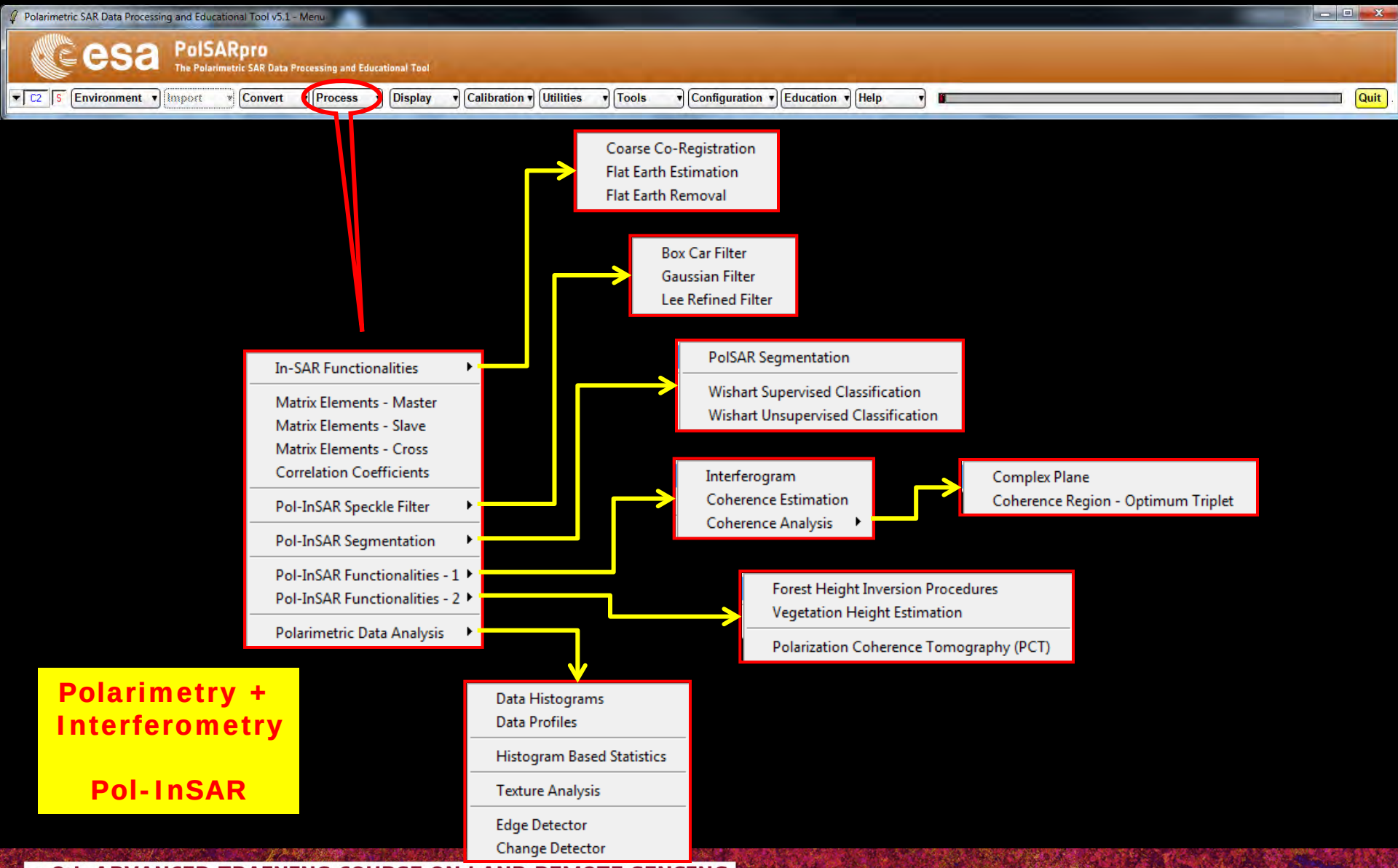
© E. Pottier – 2018

PolSARpro v5.2 SOFTWARE



© E. Pottier – 2018

PolSARpro v5.2 SOFTWARE



Polarimetry + Interferometry

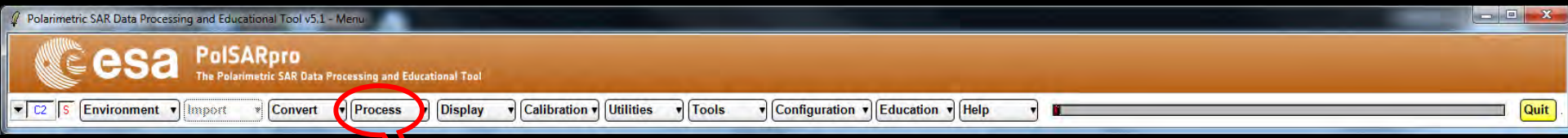
Pol-InSAR

© E. Pottier – 2018

PolSARpro v5.2 SOFTWARE

© E. Pottier – 2018

PolSARpro v5.2 SOFTWARE



- Coarse Co-Registration
- Matrix Elements
- Polarimetric Speckle Filter
  - Box Car Filter
  - C. Lopez Filter
  - Gaussian Filter
  - IDAN Filter
  - J.S. Lee Refined Filter
  - J.S. Lee Sigma Filter
- H / A / Alpha Decomposition
  - Decomposition Parameters
  - Eigenvector Set Parameters
  - Eigenvalue Set Parameters
- Polarimetric Segmentation
  - H / A / Alpha Classification
  - H / A / Alpha - Wishart Classification
  - Wishart Supervised Classification
- Polarimetric Functionalities
  - Faraday Rotation Estimation
  - Conformity Coefficient
  - Scattering Predominance
  - Scattering Diversity
  - Degree of Purity
  - Depolarisation Index
  - Alpha Approximation (Praks & Colin)
  - Entropy Approximation (Praks & Colin)
  - Scattering Mechanisme Entropy (Freeman)
  - Scattering Mechanisme Entropy (Van Zyl)
  - Kozlov Anisotropy
  - Lueneburg Anisotropy
  - Polarized Point Scatterer Detection
  - Reflectivity Ratio
  - Differential Reflectivity (ZDR)
- Polarimetric Tomography
- Multi-Datasets Analysis
  - Avg / Std / CV
  - Time / Freq Averaging
  - Animated GIF

Polarimetry + Time series

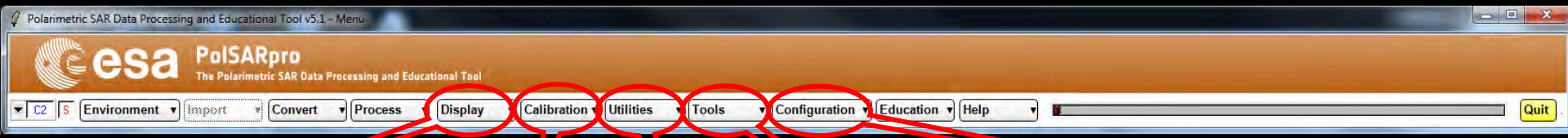
Pol-TimeSAR

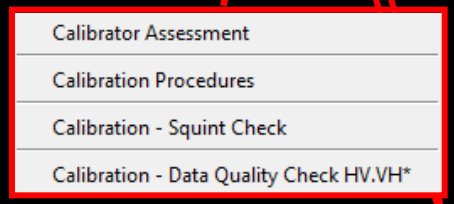
Polarimetry + Tomography

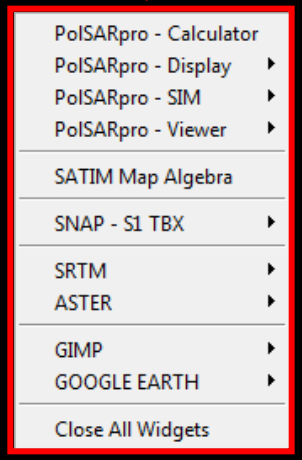
Pol-TomoSAR

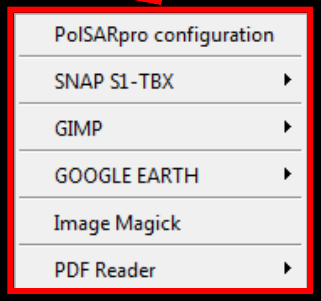
© E. Pottier – 2018

PolSARpro v5.2 SOFTWARE



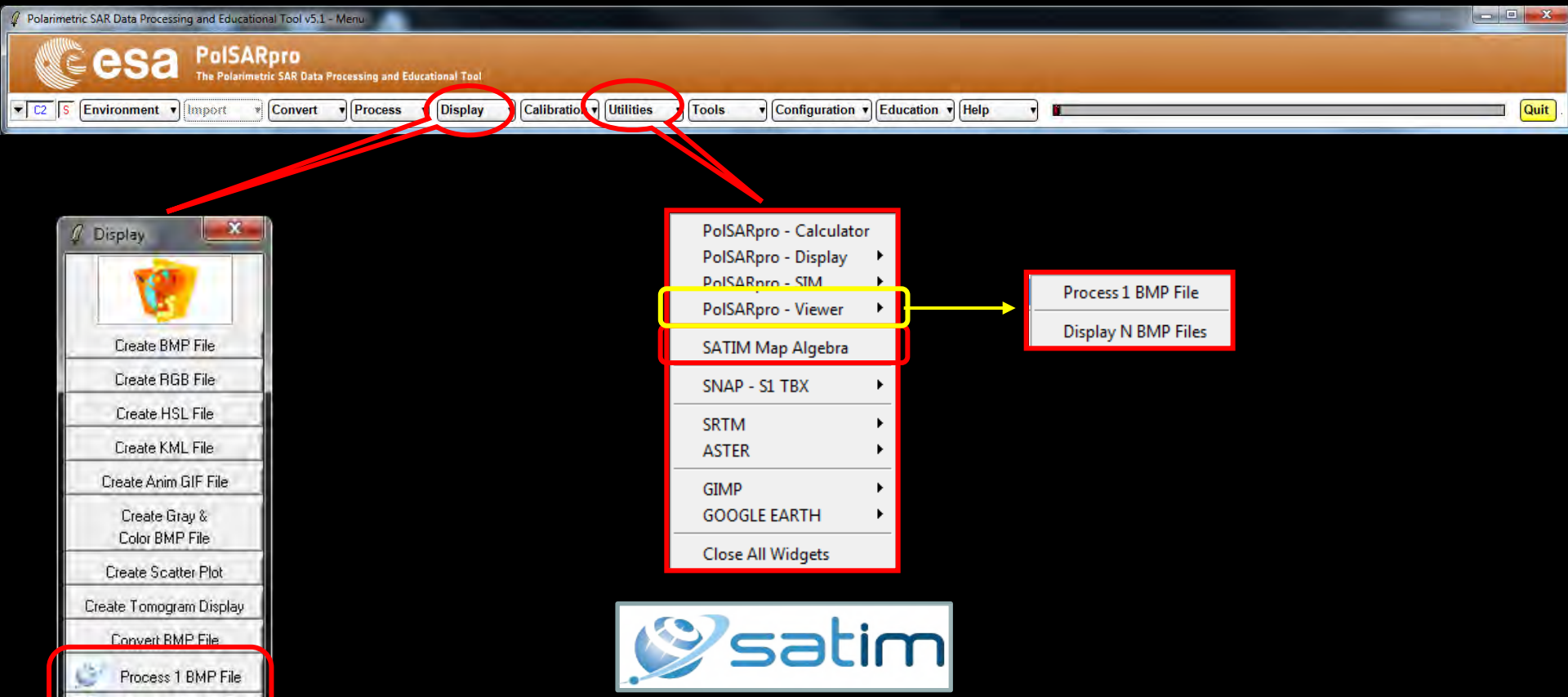






© E. Pottier – 2018

PolSARpro v5.2 SOFTWARE

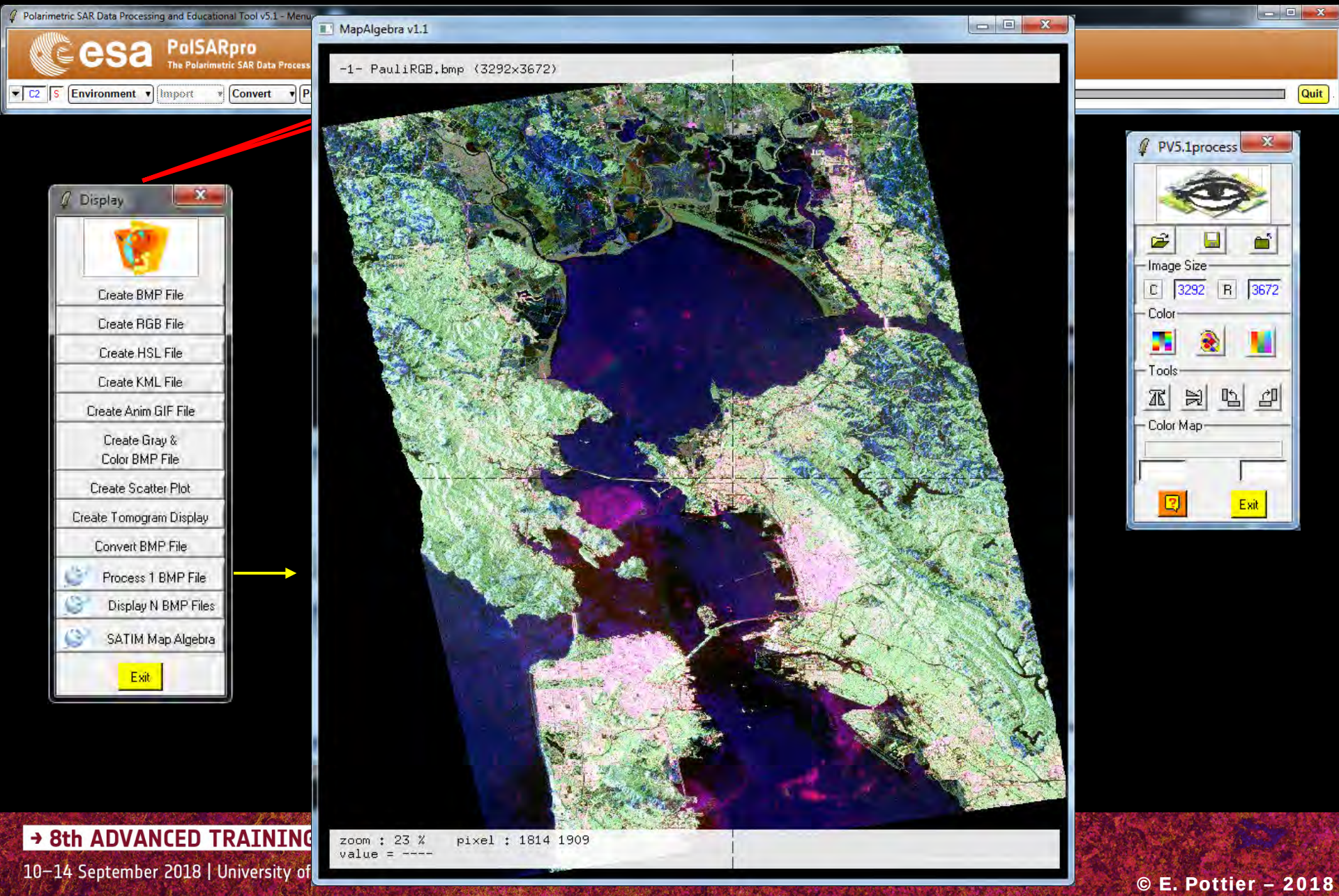


A new tool (*Map Algebra*) for visualization and simple processing of the PolSARpro results

Based on the OpenGL technology : open and process large image (20000 x 20000)

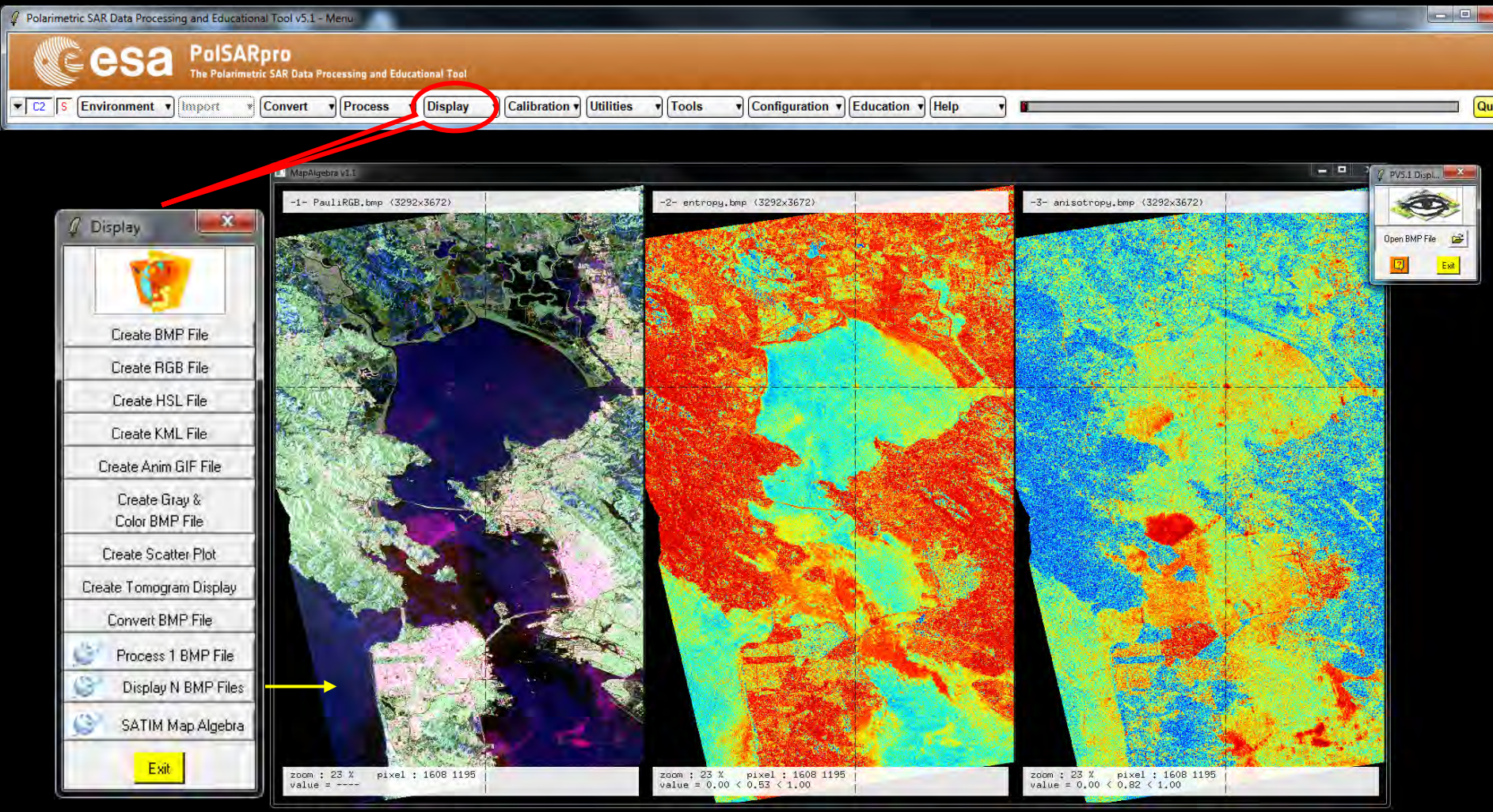
© E. Pottier – 2018

SATIM Map Algebra



© E. Pottier – 2018

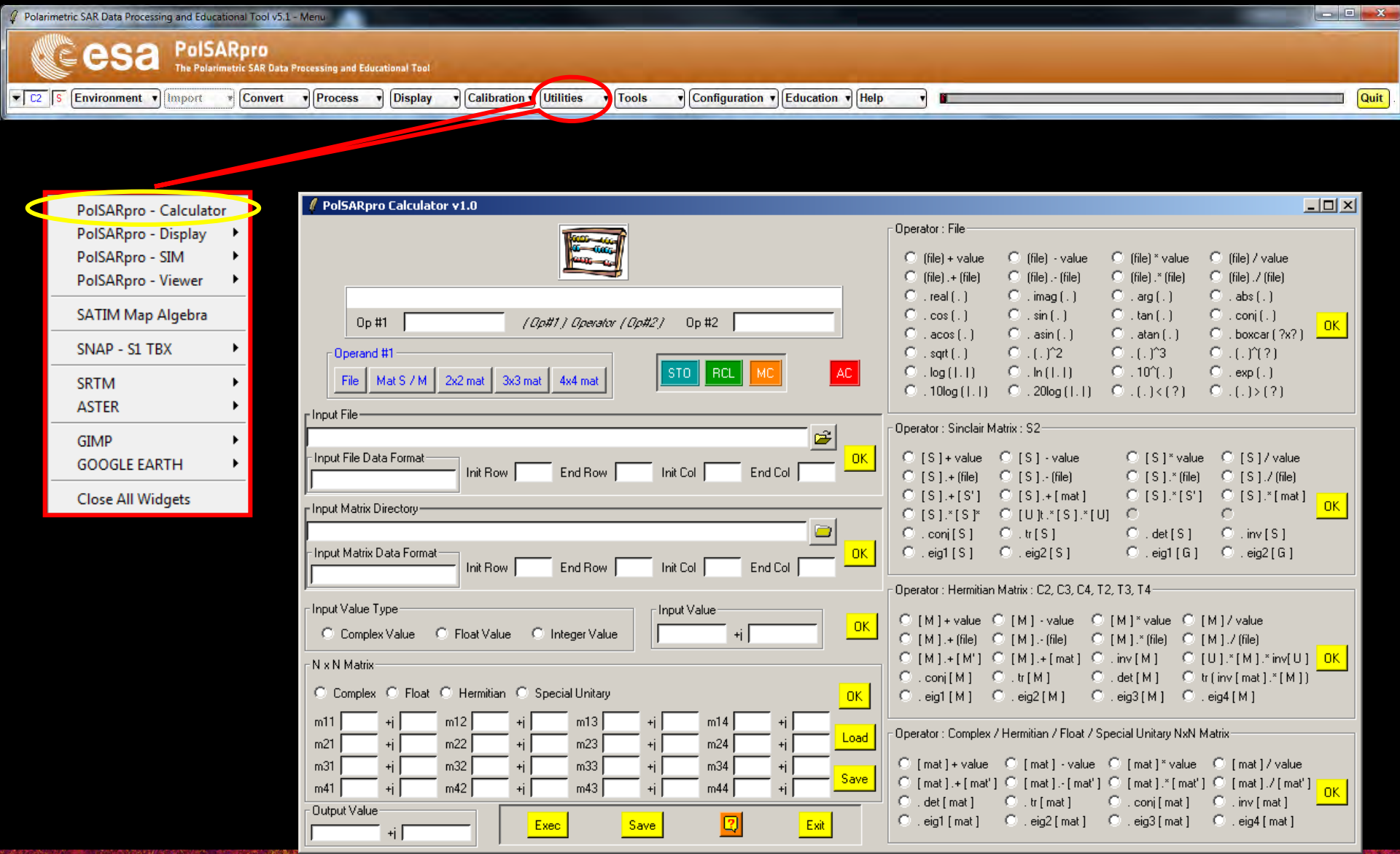
SATIM Map Algebra



Display N BMP Images

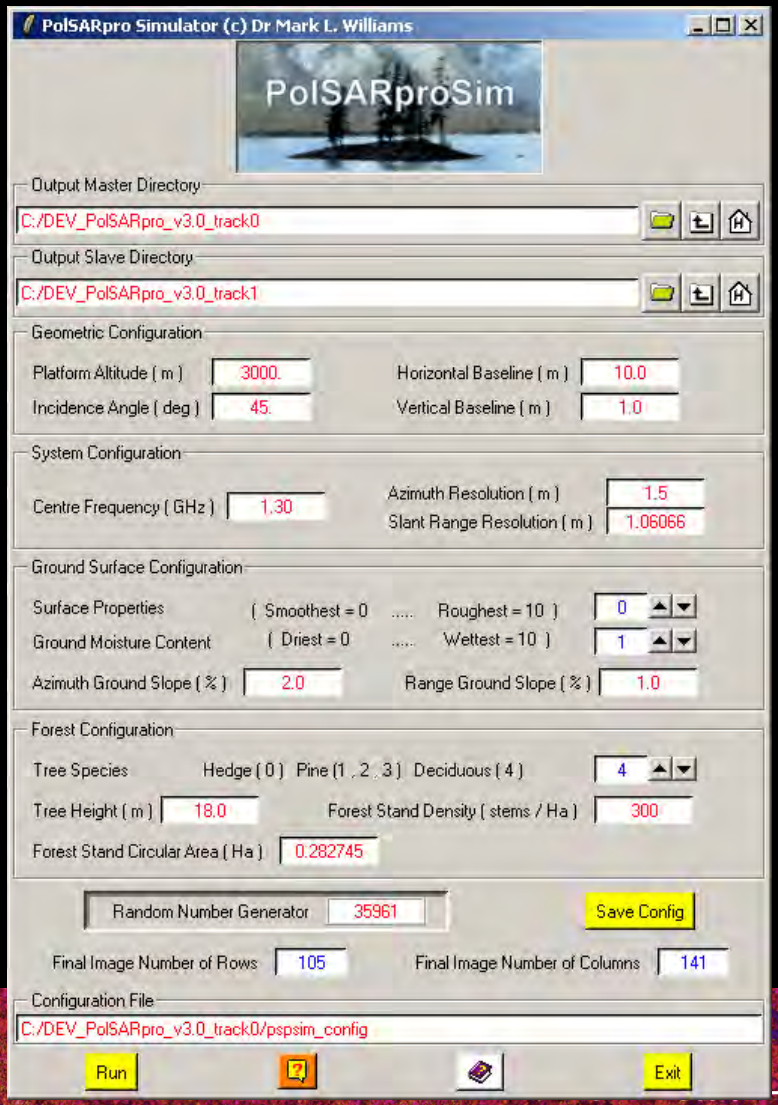
© E. Pottier – 2018

PolSARpro v5.2 SOFTWARE



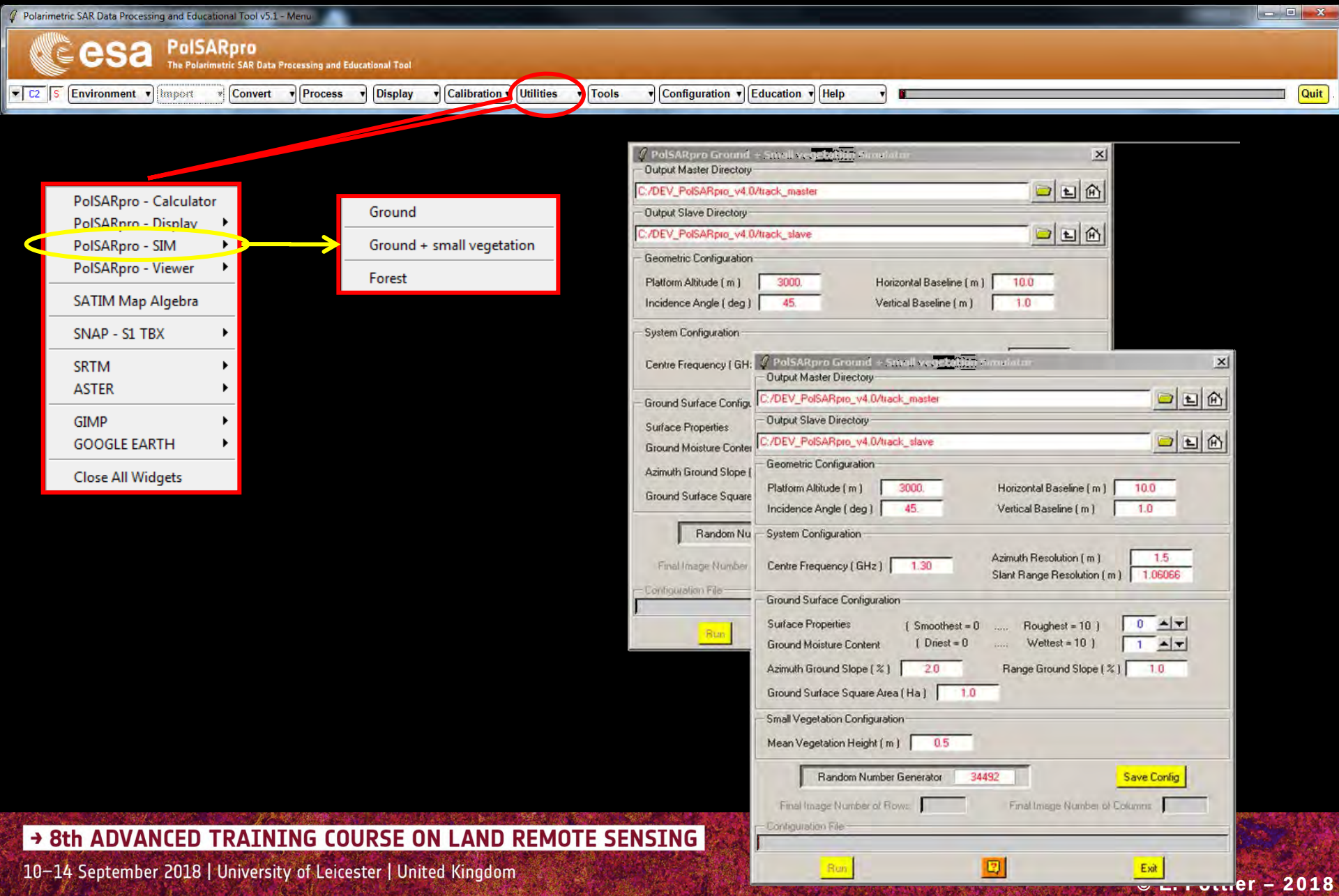
© E. Pottier – 2018

PolSARpro v5.2 SOFTWARE



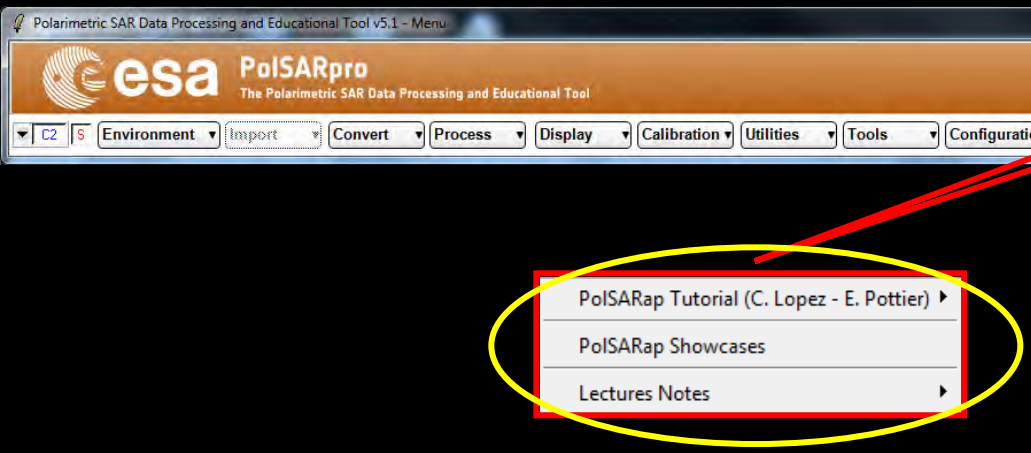
PolSARproSim is a rapid, coherent, fully polarimetric and interferometric SAR simulation of forest.

PolSARpro v5.2 SOFTWARE



© L. Pottier – 2018

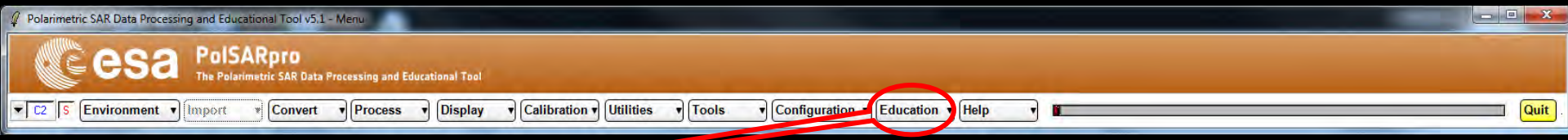
PolSARpro v5.2 SOFTWARE

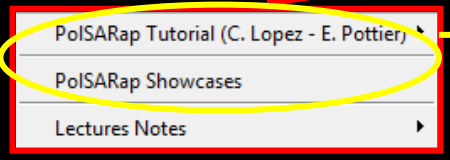


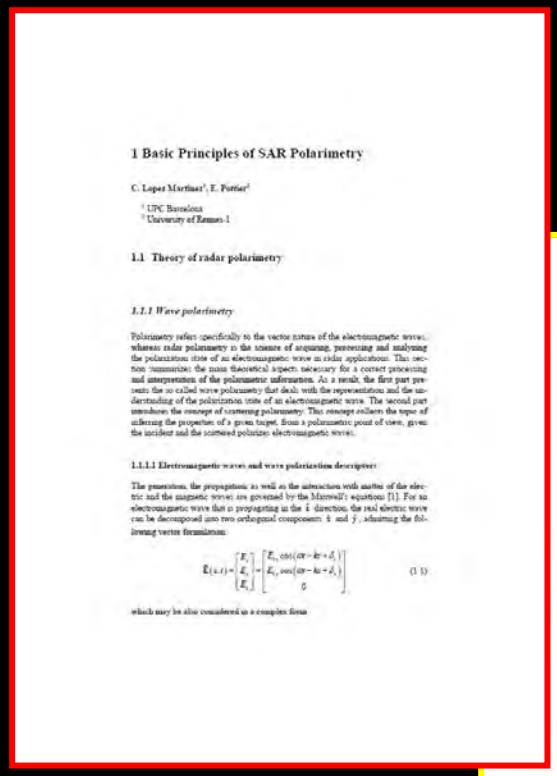
Learning / Training Next P.I Generations

© E. Pottier – 2018

PolSARpro - Bio SOFTWARE







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 different the properties of a given target, from a polarimetric point of view, given the incident and the scattered polarized electromagnetic waves.

1.1.1.1 Electromagnetic waves and wave polarization description

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 k direction, the real electric wave can be decomposed into two orthogonal components $\hat{x}$ and $\hat{y}$, obtaining 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 as a complex form

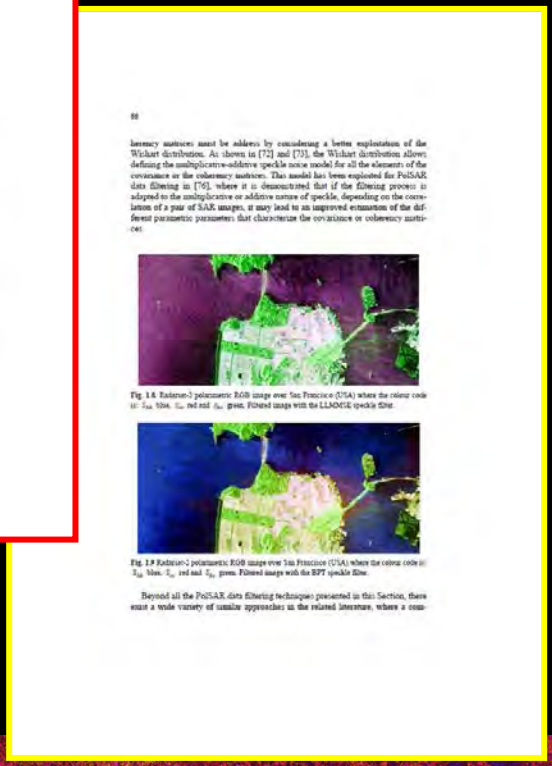


Fig. 1.6 Radarsat-2 polarimetric RGB image over San Francisco (USA) where the colour code is: S_{HH} blue, S_{HV} red and S_{VV} green. Filtered image with the LLMMSE speckle filter.

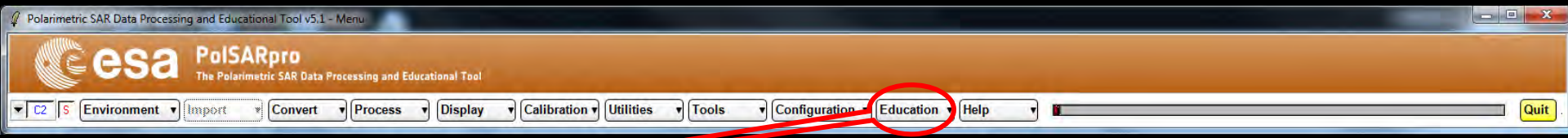
Fig. 1.9 Radarsat-2 polarimetric RGB image over San Francisco (USA) where the colour code is: S_{HH} blue, S_{HV} red and S_{VV} green. Filtered image with the IDT speckle filter.

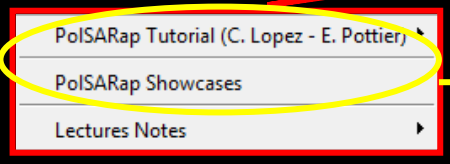
Beyond all the PolSAR data filtering techniques presented in this Section, there exist a wide variety of similar approaches in the related literature, where a com-

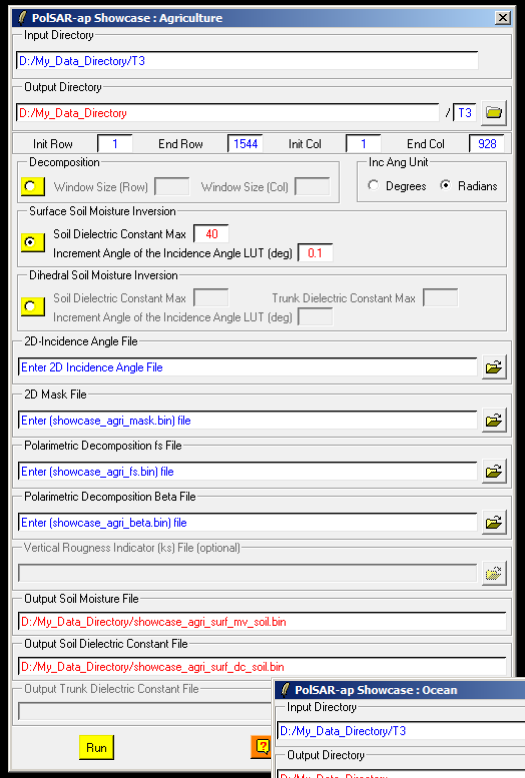
PolSAR-Ap Project

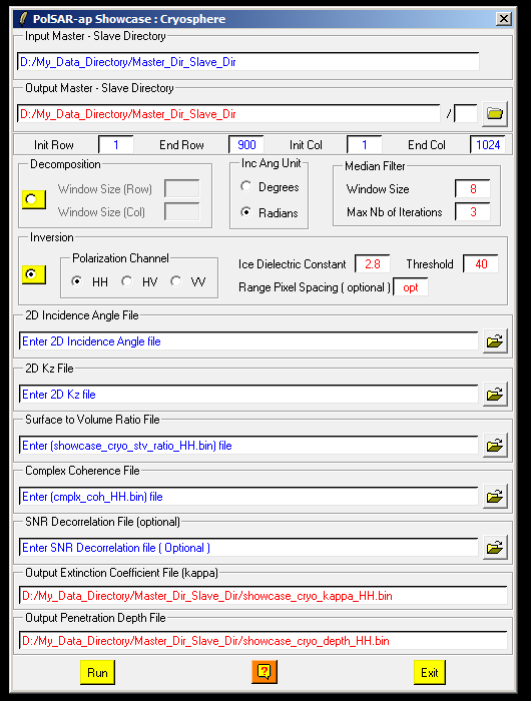
© E. Pottier – 2018

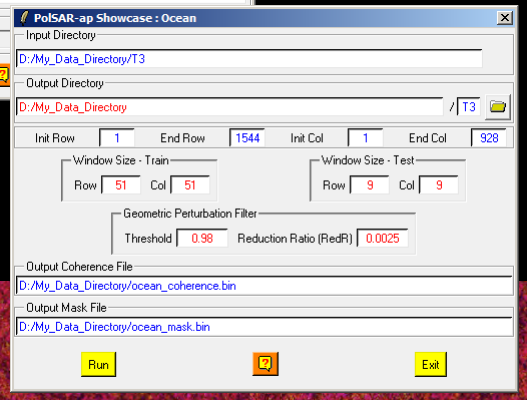
PolSARpro - Bio SOFTWARE











PolSAR-Ap Project

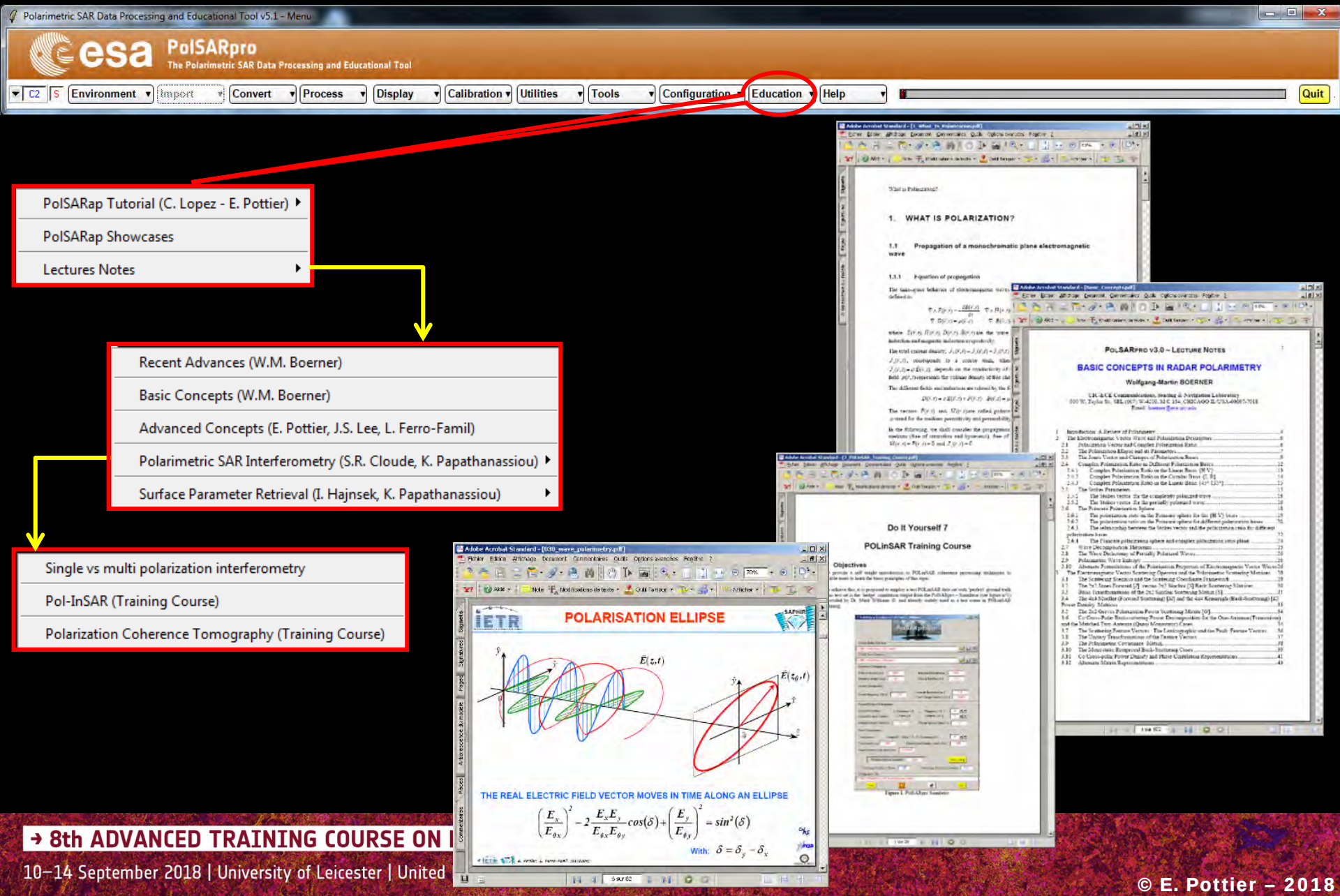
esa DLR HR ETH AEL consultants IETR ONERA UPC

→ 8th ADVANCED TRAINING COURSE ON LAND REMOTE SENSING

10–14 September 2018 | University of Leicester | United Kingdom

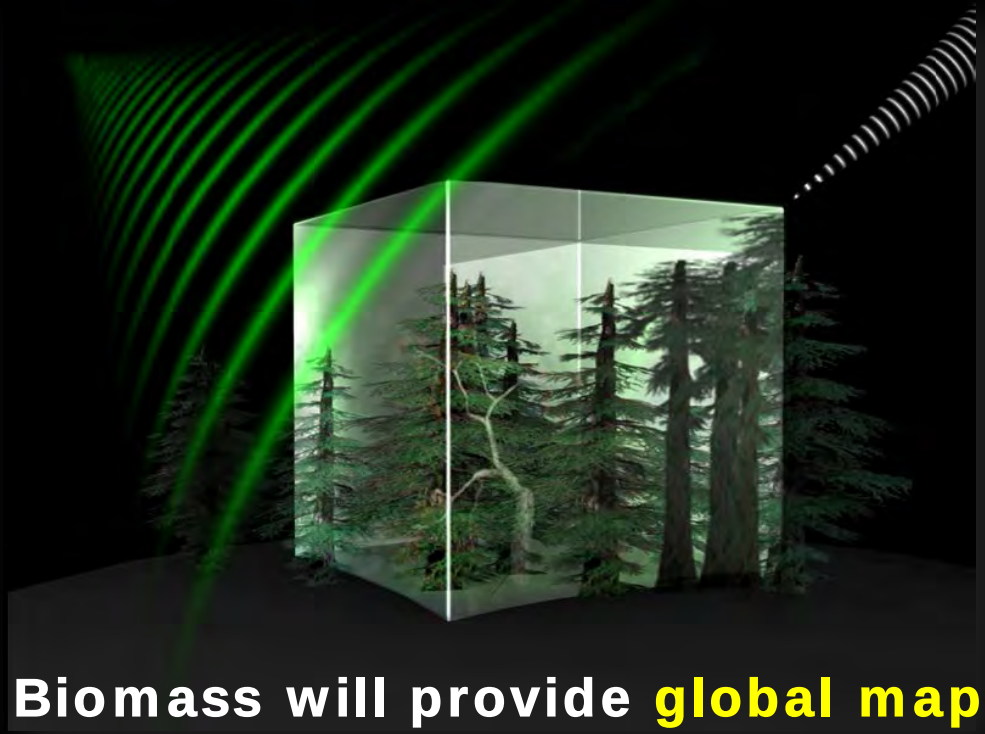
© E. Pottier – 2018

PolSARpro - Bio SOFTWARE



© E. Pottier – 2018

BIOMASS mission : 7th ESA Earth Explorer (2021)



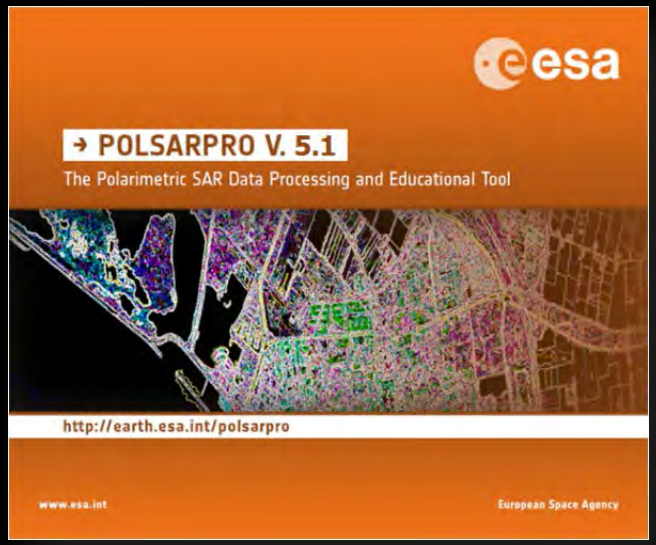
Biomass will provide global maps of the amount of carbon stored in the world's forests and how this changes over time.

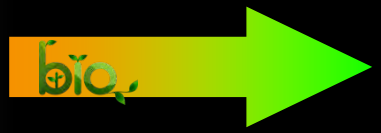
Further our knowledge of the role forests play in the carbon cycle.

P-Band Pol-TomoSAR spaceborne mission

© E. Pottier – 2018

PolSARpro - Bio SOFTWARE





PolSARpro-Bio

The new scientific toolbox for ESA & third party fully polarimetric SAR missions

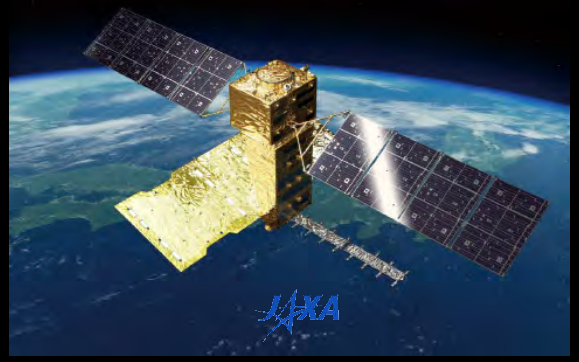
© E. Pottier – 2018

PolSARpro - Bio SOFTWARE

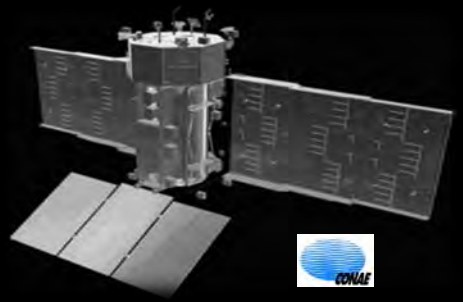
BIOMASS

Radarsat Constellation Mission (RCM)

ALOS-4– PALSAR-3



SAOCOM



FUTURE

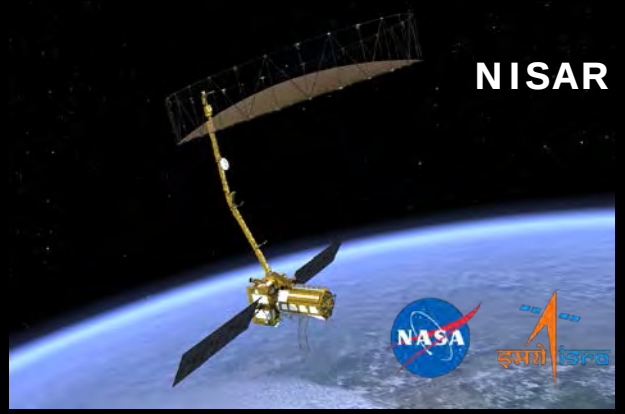
PolSARpro - Bio will offer the possibility to handle and convert polarimetric data of FUTURE polarimetric spaceborne platforms.

© E. Pottier – 2018

PolSARpro - Bio SOFTWARE

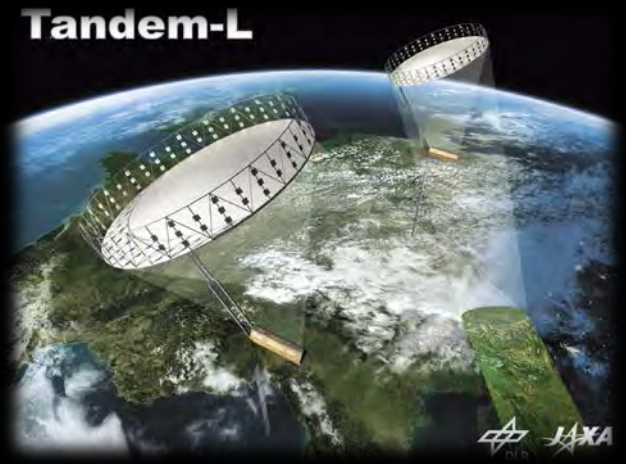
NovaSAR - S

NISAR



FUTURE

Tandem-L

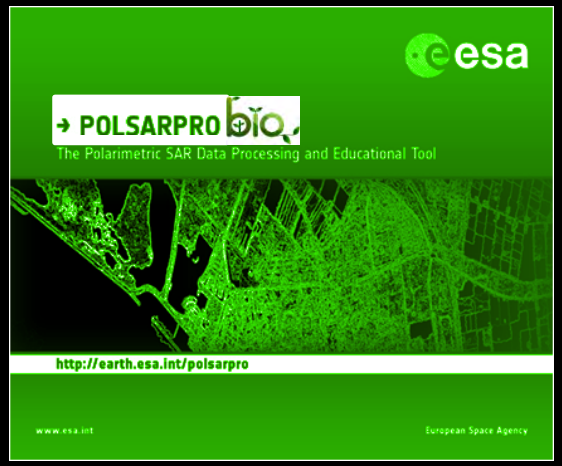


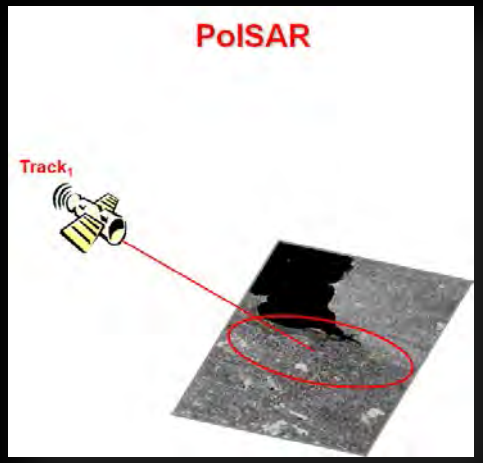
PolSARpro - Bio will offer the possibility to handle and convert polarimetric data of FUTURE polarimetric spaceborne platforms.

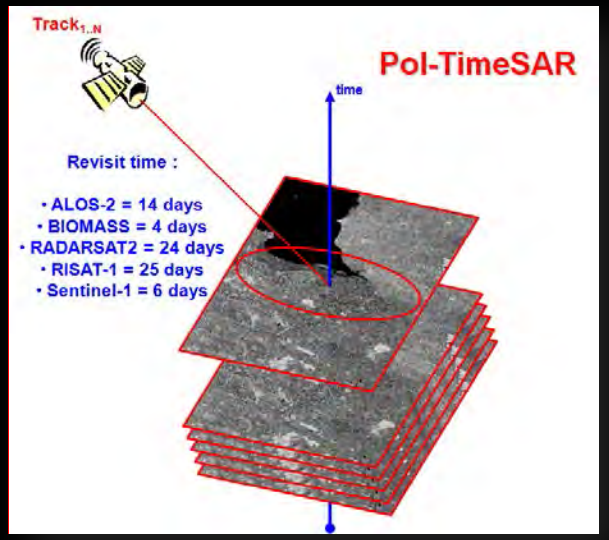
© E. Pottier – 2018

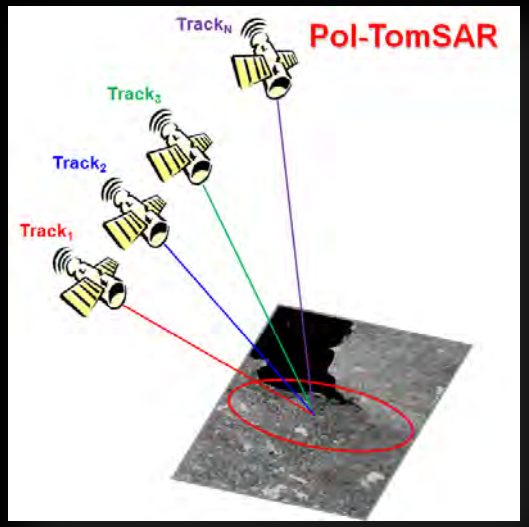
PolSARpro - Bio SOFTWARE

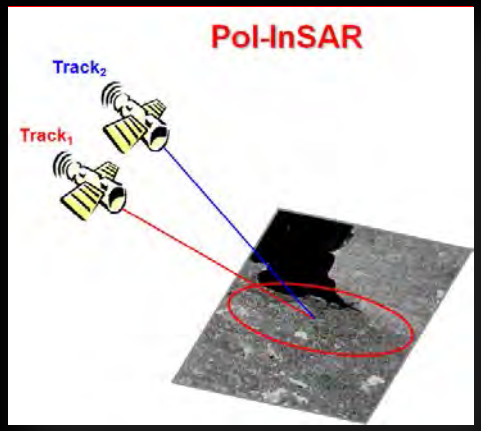
New functionalities







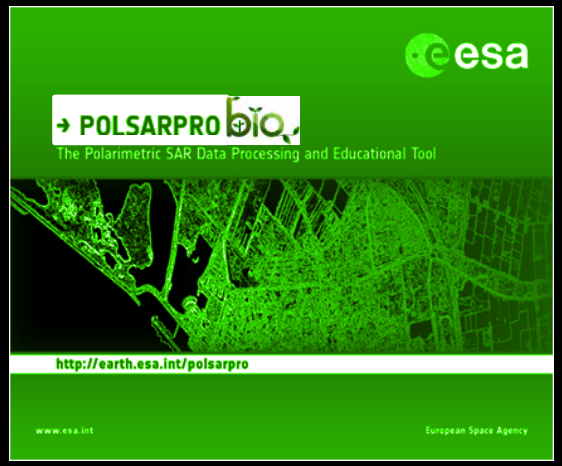


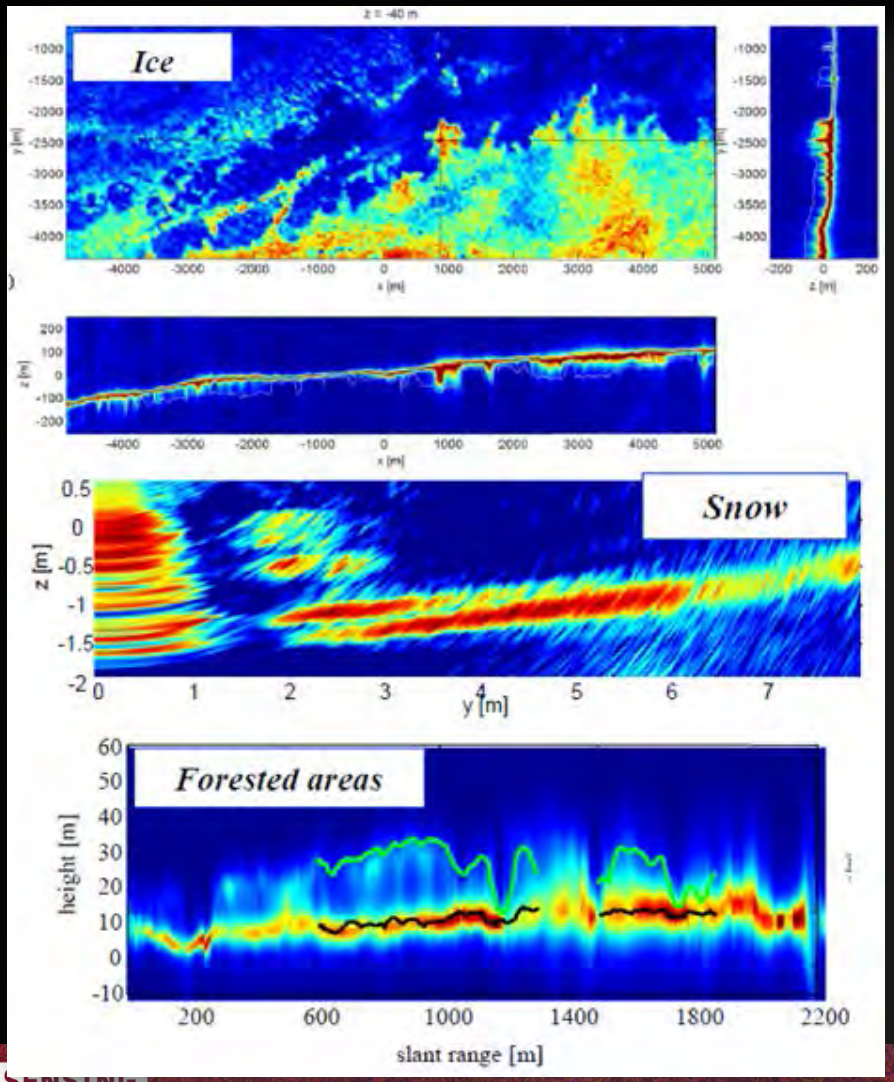


© E. Pottier – 2018

PolSARpro - Bio SOFTWARE

Pol-TomoSAR processor





© E. Pottier – 2018

PolSARpro v5.2 SOFTWARE

http://earth.esa.int/web/polsarpro

The Web Site provides

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

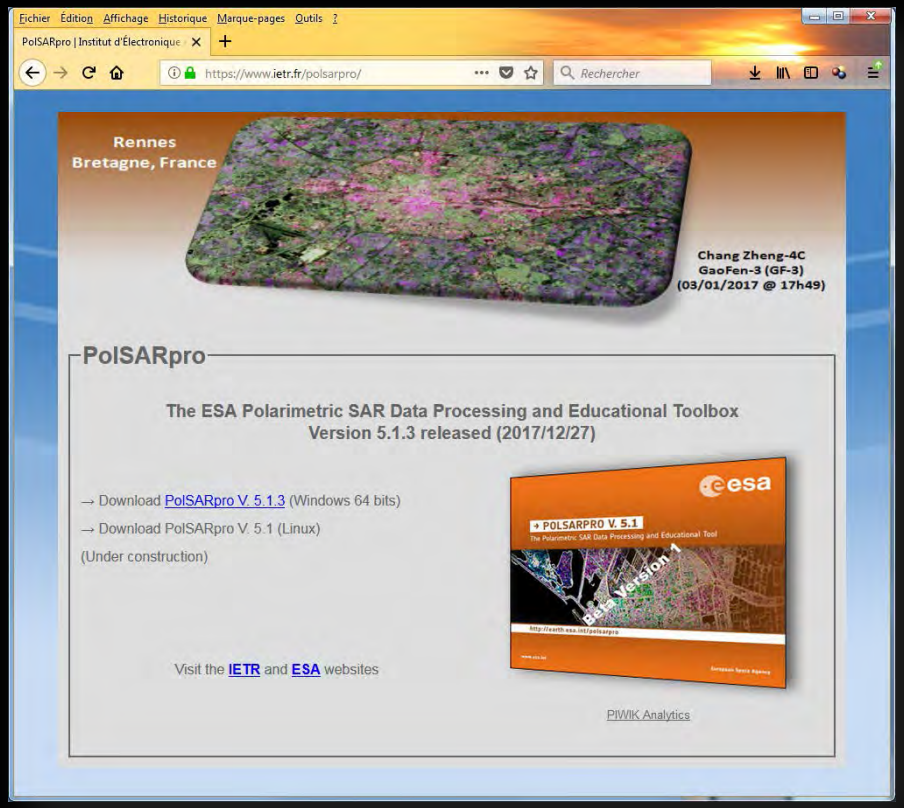
ESA validated, tested and vetted releases

© E. Pottier – 2018

PolSARpro v5.2 SOFTWARE

https://earth.esa.int/web/polsarpro

https://www.ietr.fr/polsarpro



- **Permanent updates (bugg fixed, new functionalities …)**
- **Beta version releases (not ESA validated)**

© E. Pottier – 2018

PolSARpro v5.2 SOFTWARE

PolSARpro - v5.2 : Linux *light* version

PolSARpro - v5.2
complete version

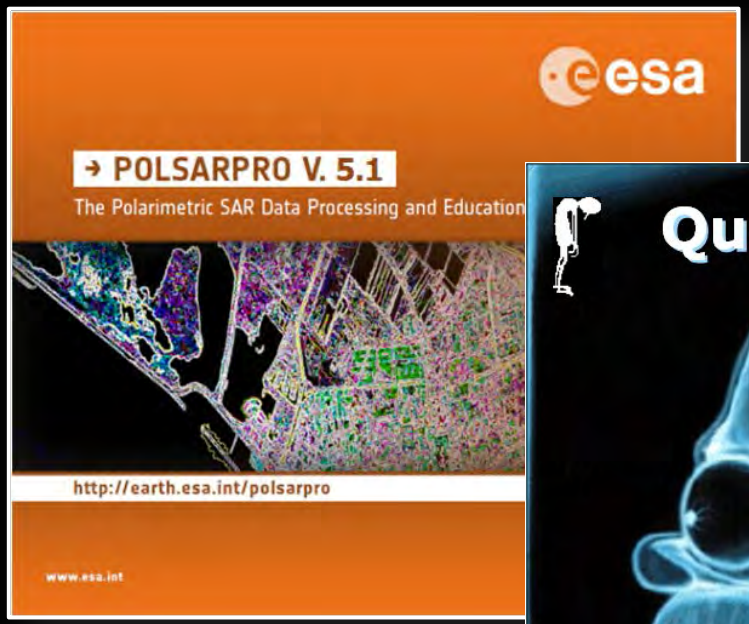
December 2018

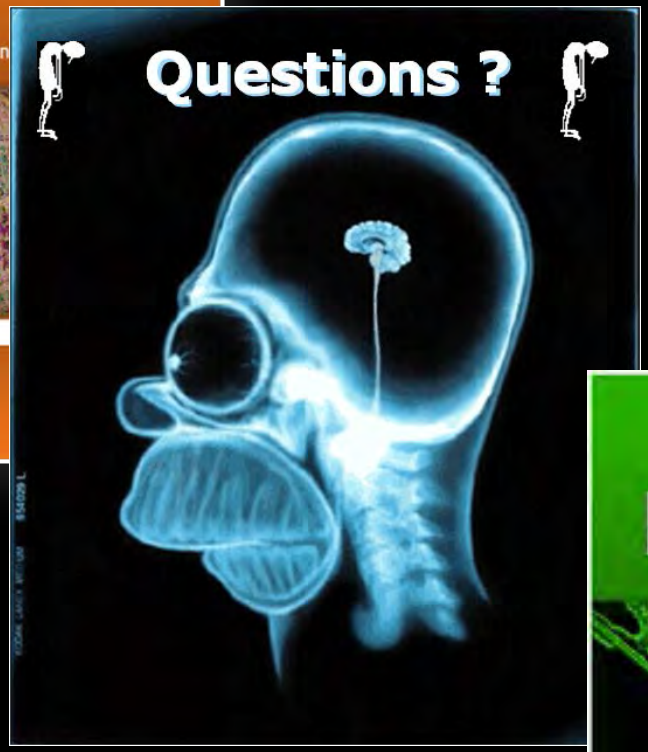
October 2018

PolSARpro - Bio : Distribution will start from January 2019

© E. Pottier – 2018

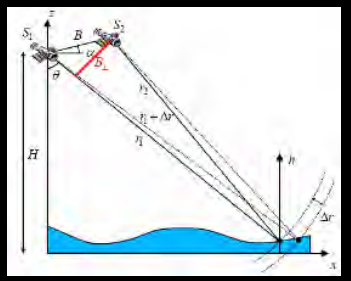
PolSARpro - Bio SOFTWARE



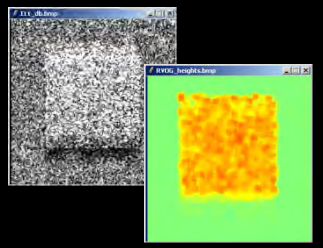


© E. Pottier – 2018

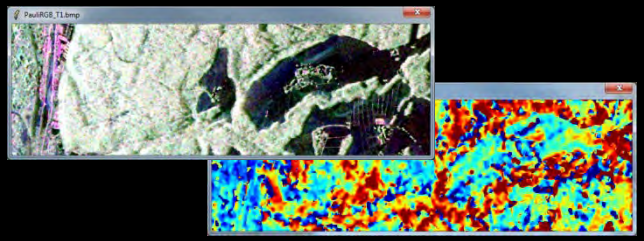
Forestry Applications with Pol-InSAR *Practical*



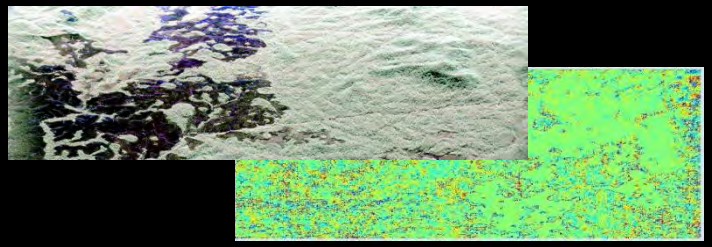
1st part : Simulated Pol-InSAR datasets



2nd part : Airborne Pol-InSAR datasets (*ESAR - DLR*)



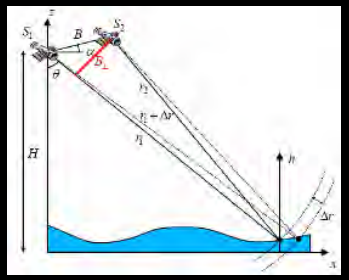
Traunstein / Germany



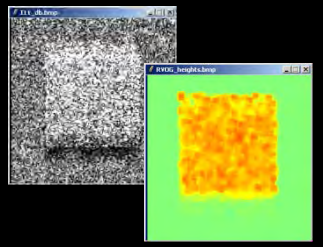
AfriSAR campaign / Gabon

© E. Pottier – 2018

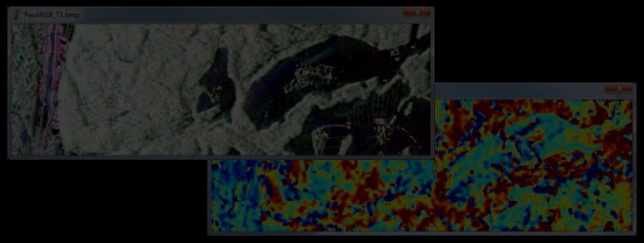
Forestry Applications with Pol-InSAR *Practical*



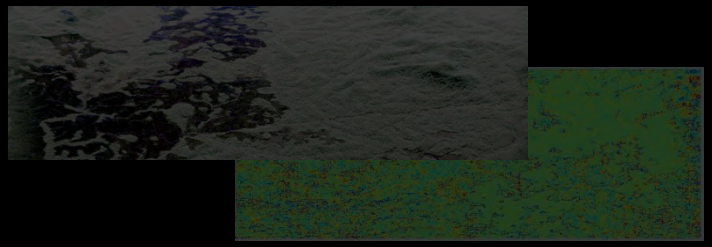
1st part : Simulated Pol-InSAR datasets



2nd part : Airborne Pol-InSAR datasets (*ESAR - DLR*)

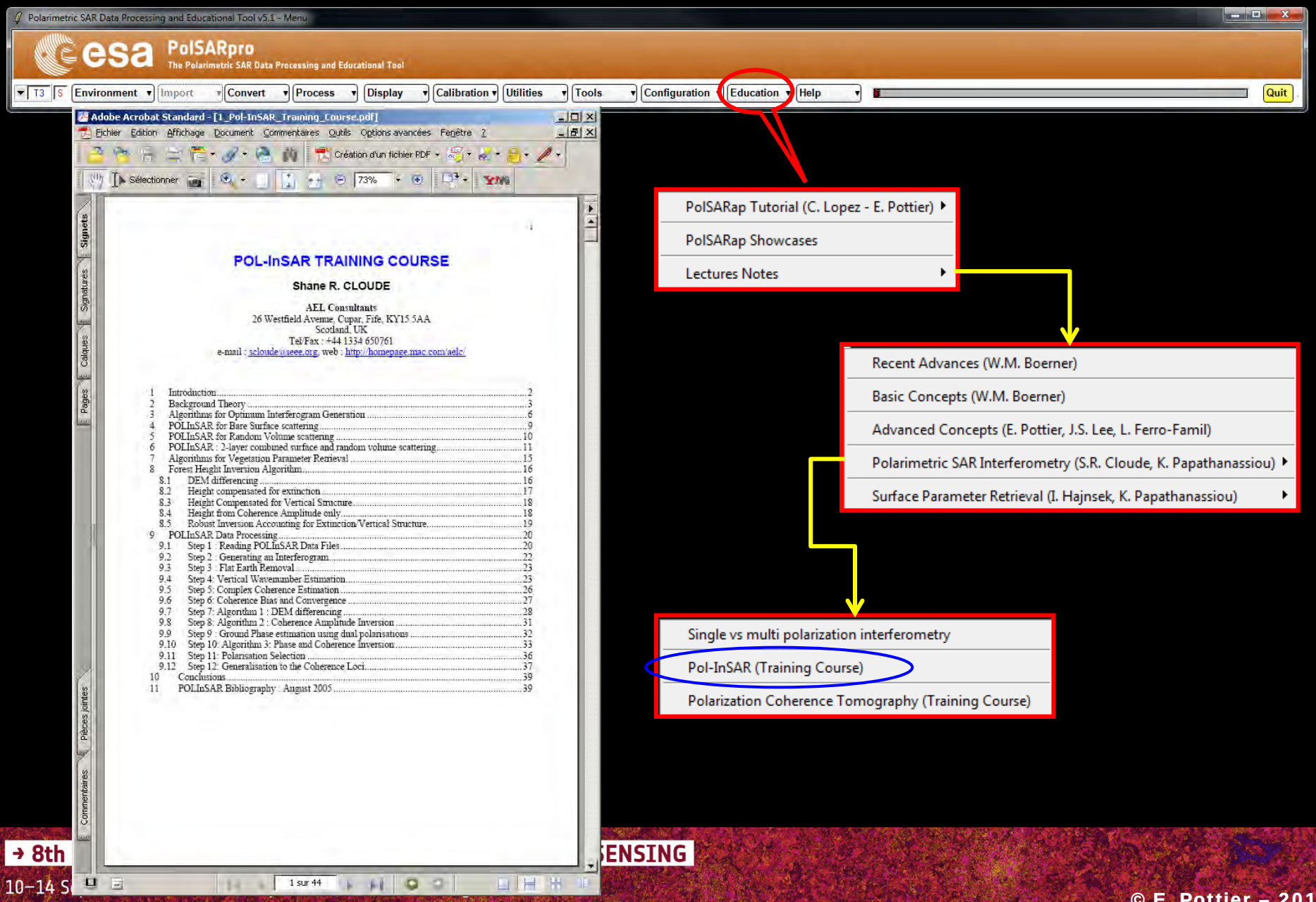


Traunstein / Germany



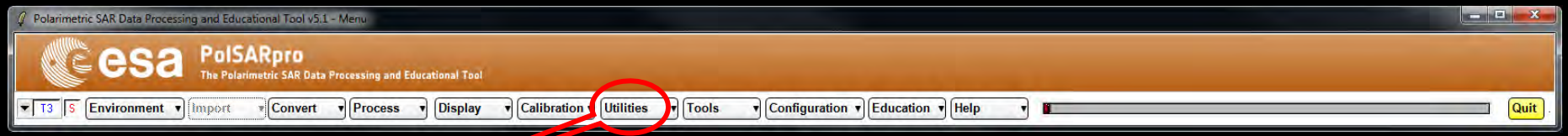
AfriSAR campaign / Gabon

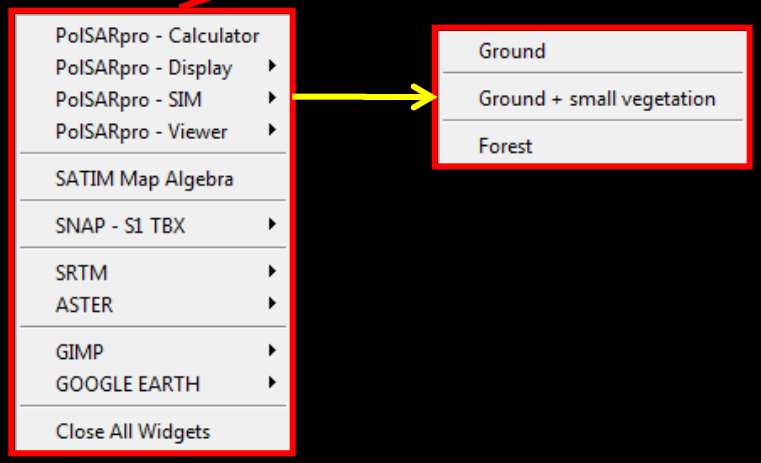
© E. Pottier – 2018



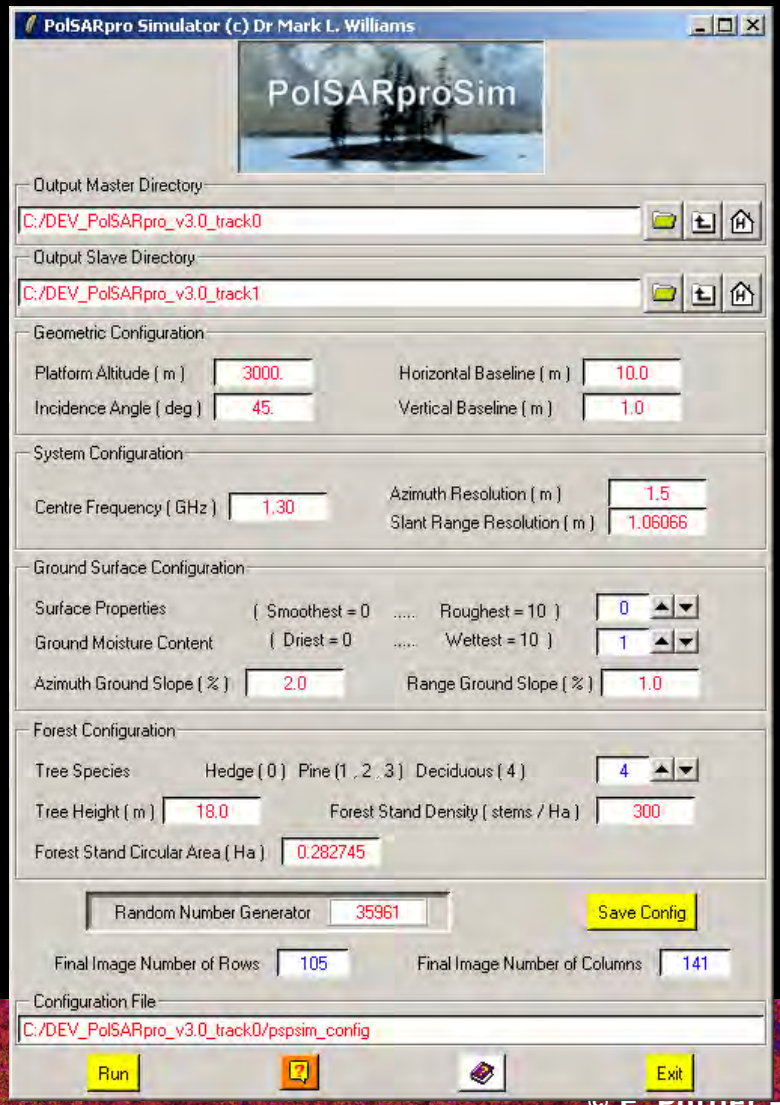
© E. Pottier – 2018

PolSARpro – SIM





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

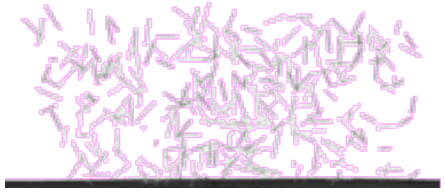


© E. Pottier – 2018

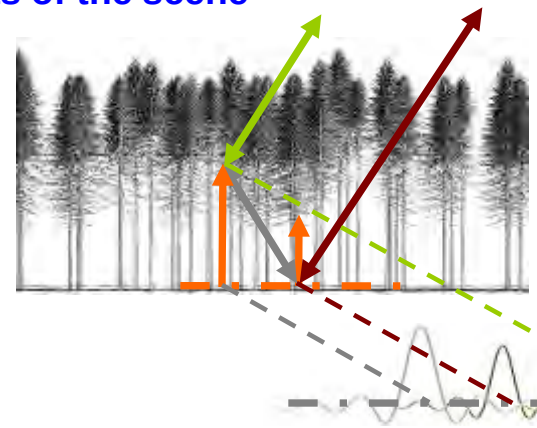
The SAR image is evaluated as a coherent sum of scattering events from small elements of the scene

PINE

DECIDUOUS

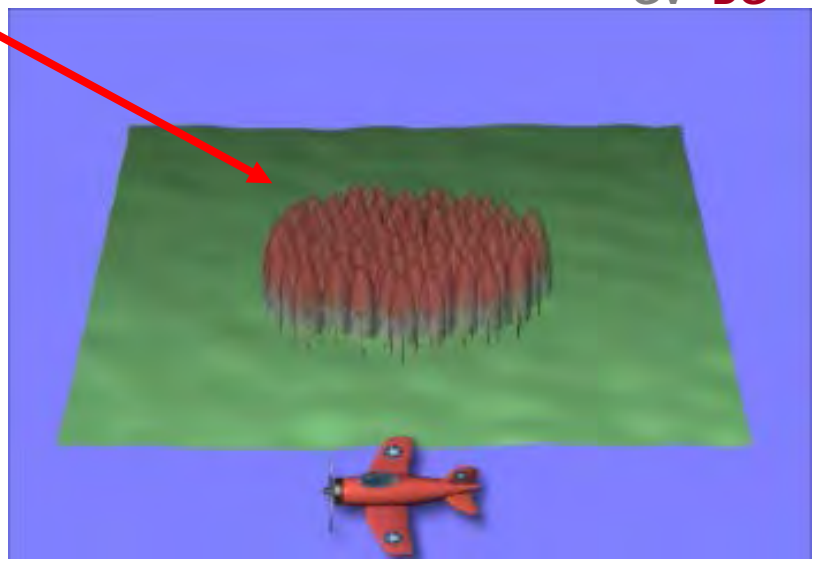


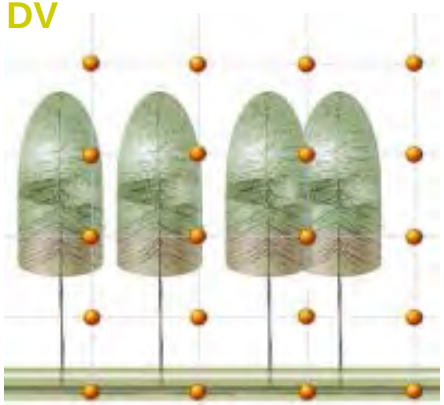
RANDOM HEDGE



GV DG DV

Direct-Ground, Direct-Volume and Ground-Volume contributions are included, with both trees and short vegetation comprising Volume terms.

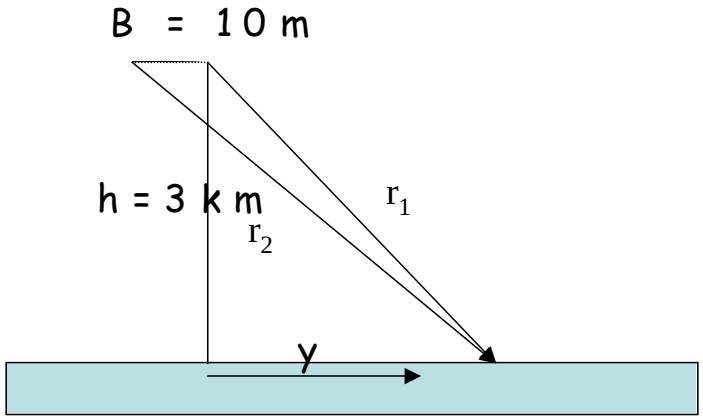


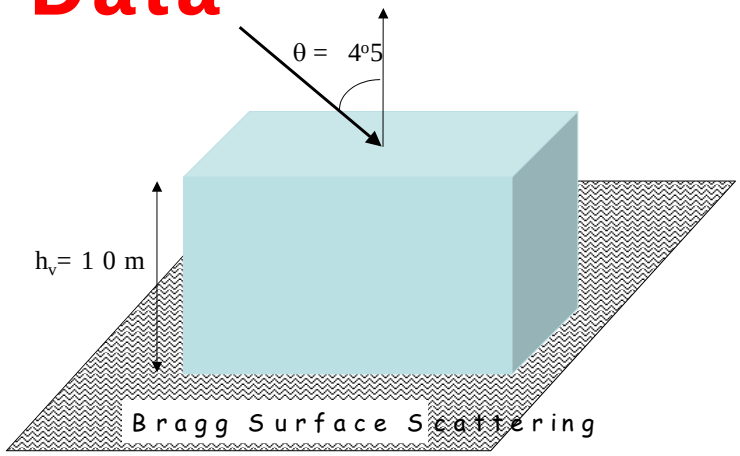


Given the map of tree locations and dimensions a grid of points is used to sample the attenuation of the coherent wave in 3D

© E. Pottier – 2018

Pol-InSAR Data





Geometric configuration

Platform altitude :	3000m
Incidence angle:	45°
Horizontal Baseline :	10m
Vertical Baseline :	0m

System Configuration

Frequency :	1.5 GHz
Azimuth resolution :	1.3811 m
Range resolution :	0.6905 m

Ground Surface Configuration

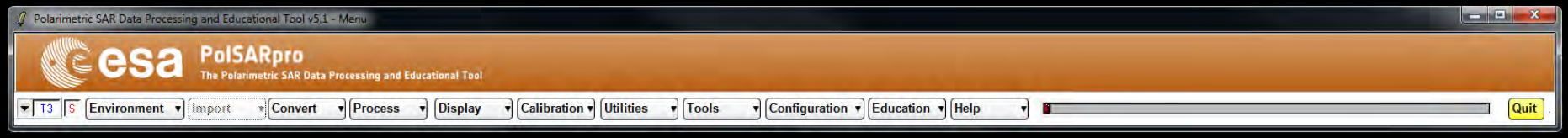
Surface properties :	0 (smoothest)
Ground moisture Content :	0 (driest)
Azimuth / Range ground slope :	0 %

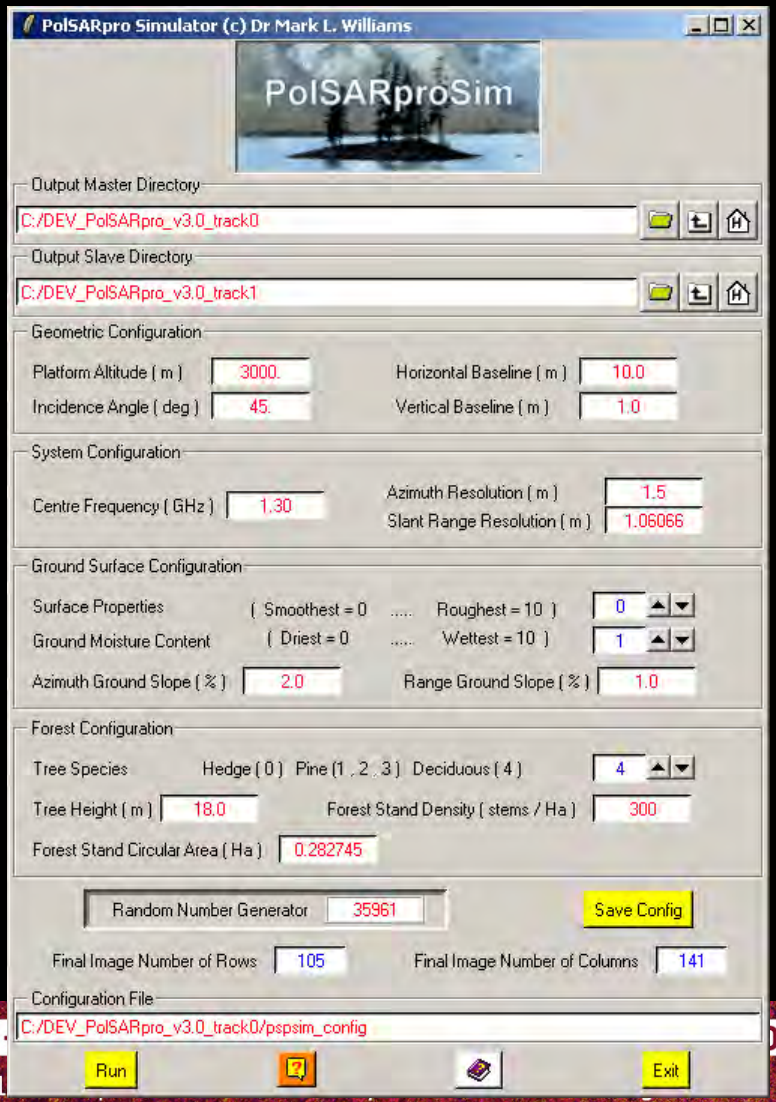
Forest configuration

Tree Species :	0 (hedge)
Tree Height:	10m
Forest stand density :	0.2
Forest Stand Circular Area :	1 Ha

© E. Pottier – 2018

PolSARpro – SIM



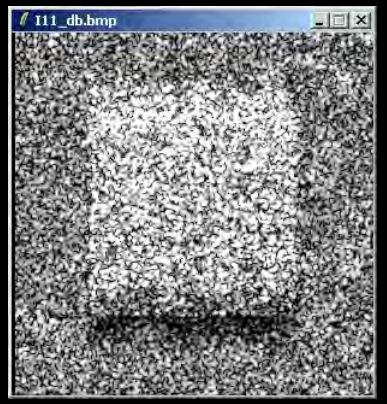


DATA_MASTERDIR

- **config.txt**
- **s11.bin, s12.bin**
  s21.bin, s22.bin

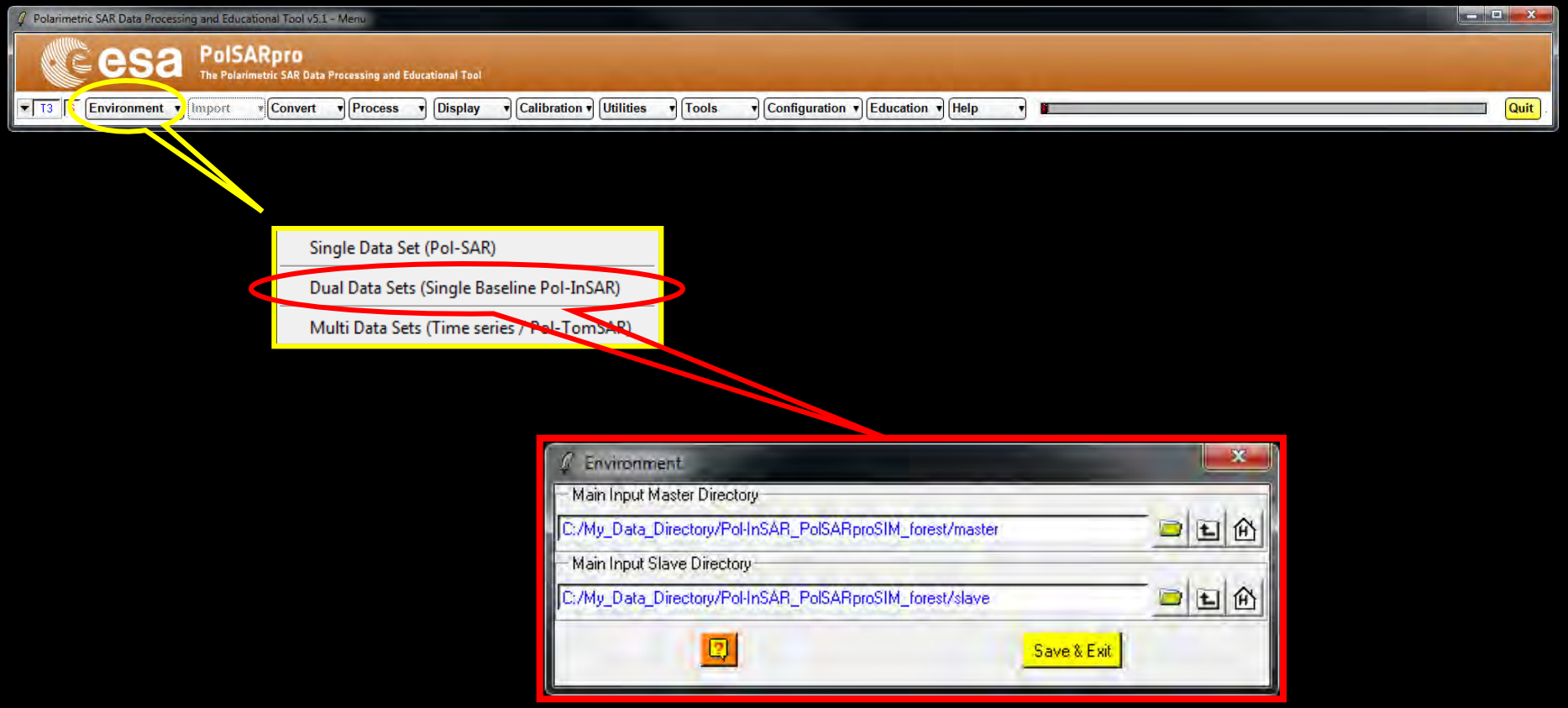
DATA_SLAVEDIR

- **config.txt**
- **s11.bin, s12.bin**
  s21.bin, s22.bin
- **flat_earth.bin**
- **kz.bin**



© E. Pottier – 2018

MAIN MENU - ENVIRONMENT



Input Master Directory:

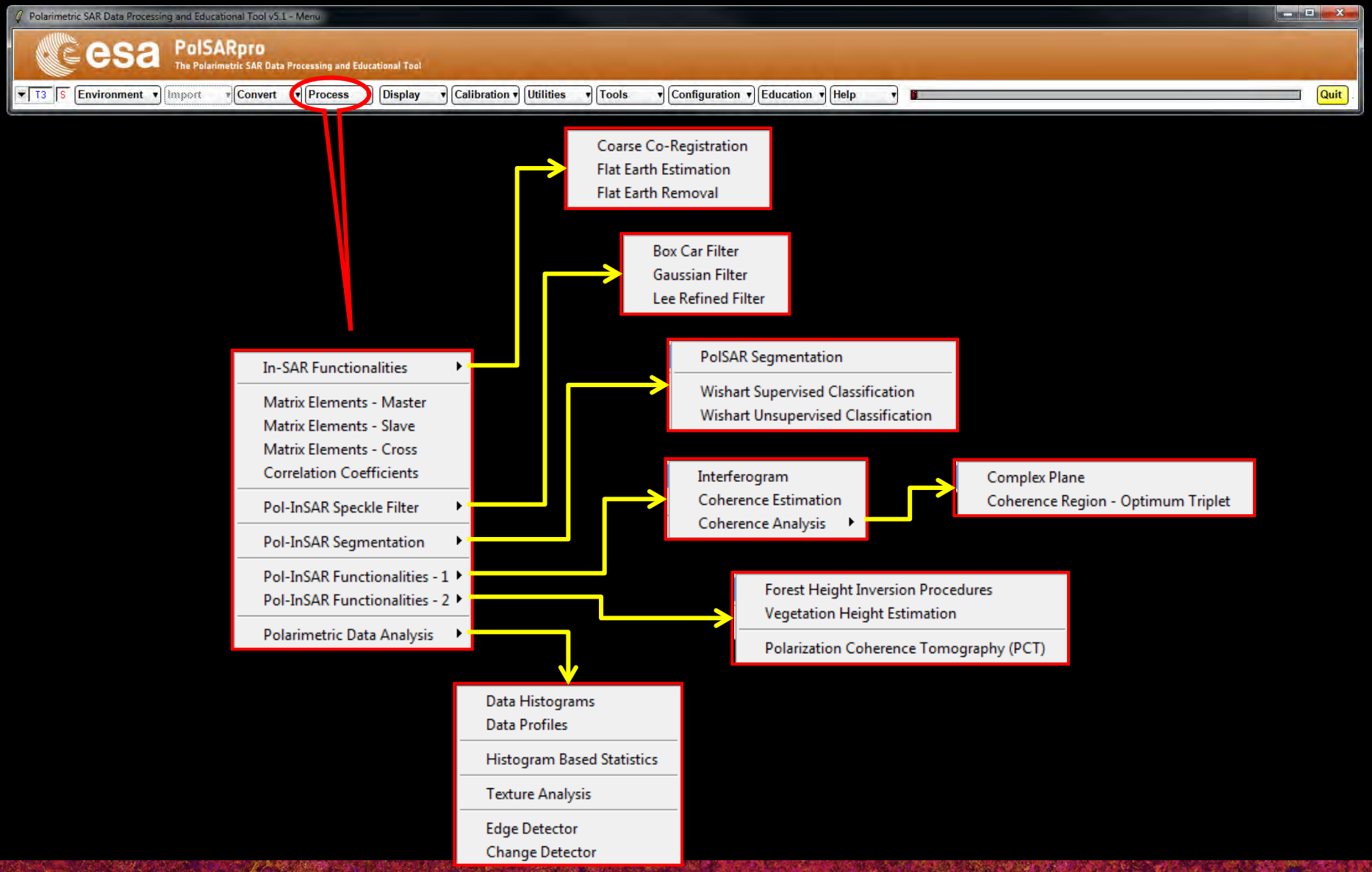
My_Data_Directory / Pol-InSAR_PolSARproSIM_forest / master

Input Slave Directory:

My_Data_Directory / Pol-InSAR_PolSARproSIM_forest / slave

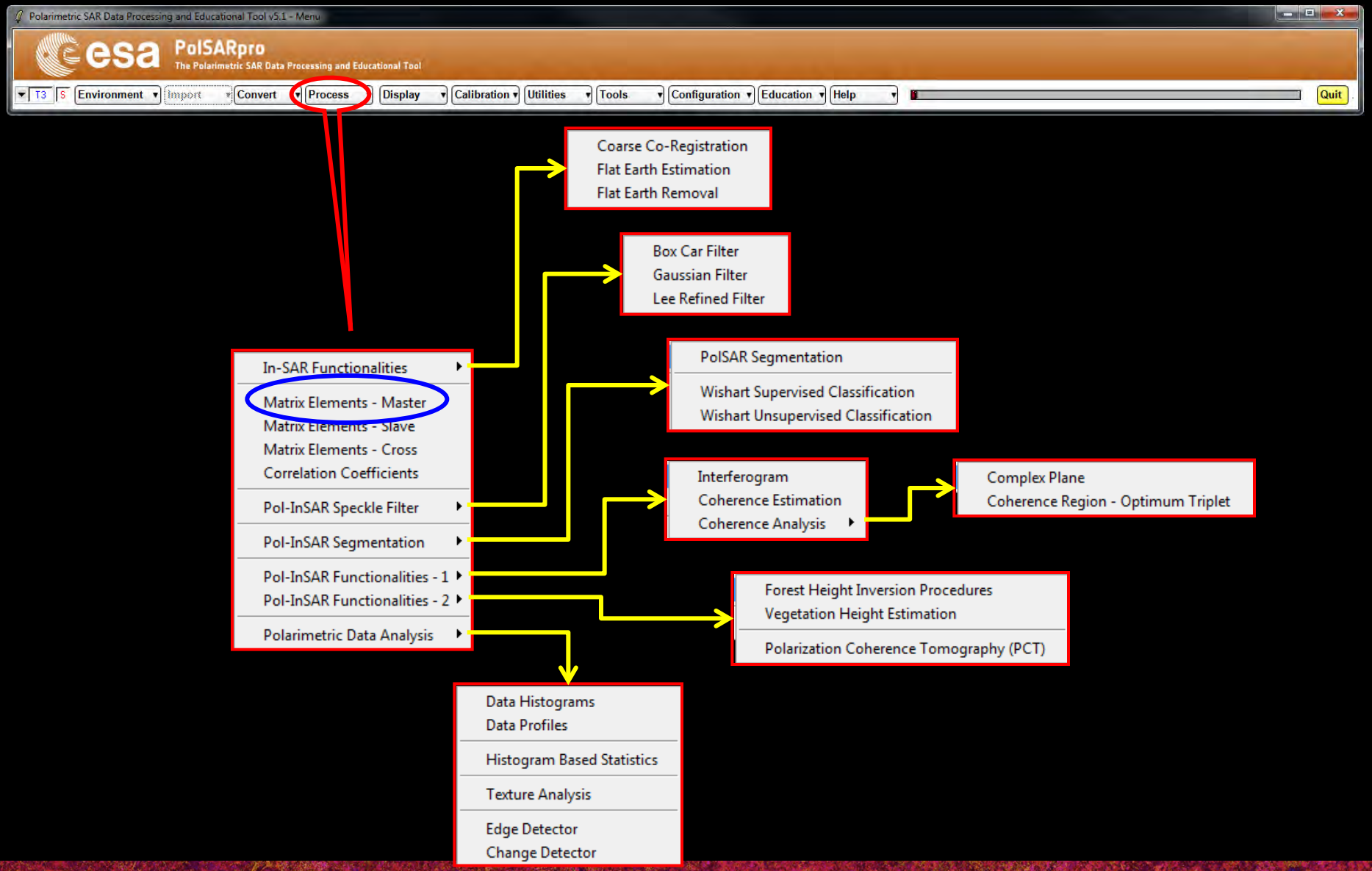
© E. Pottier – 2018

PROCESS DATA



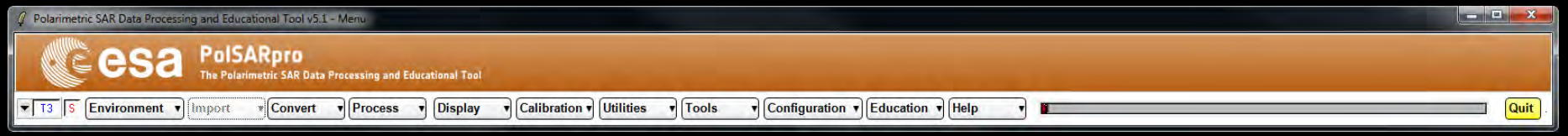
© E. Pottier – 2018

PROCESS DATA



© E. Pottier – 2018

ELEMENTS



Do it Yourself:

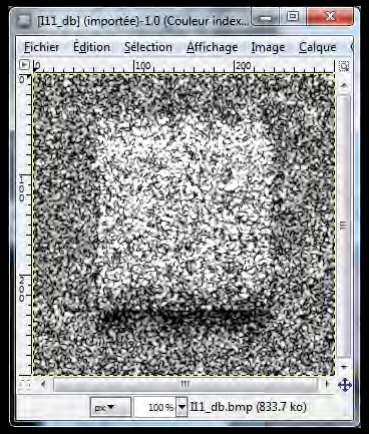
Select some elements, set the parameters and view the corresponding BMP files (*select BMP*).

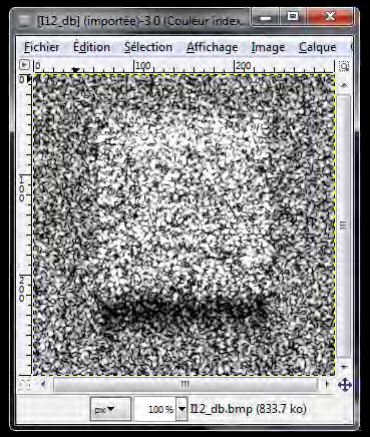
© E. Pottier – 2018

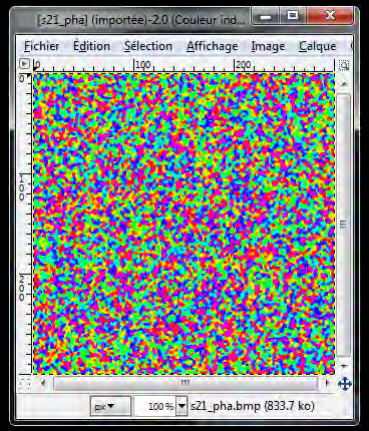
ELEMENTS

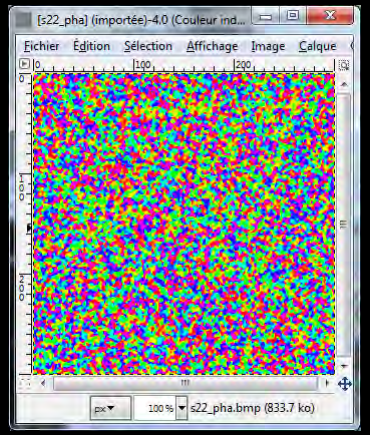
DATA_MASTERDIR

- config.txt
- s11.bin, s12.bin
  s21.bin, s22.bin
- Axy.bin, Ixy.bin
  Ixy_db.bin
  sxy_pha.bin
- Axy.bmp, Ixy.bmp
  Ixy_db.bmp
  sxy_pha.bmp



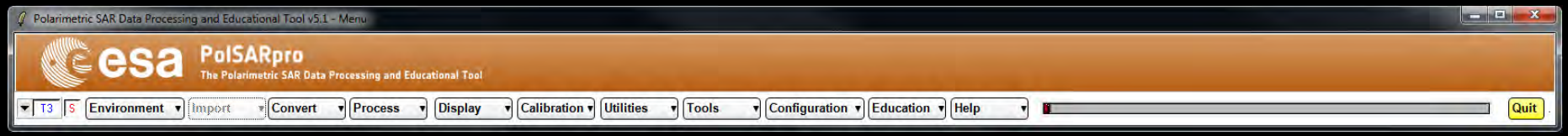


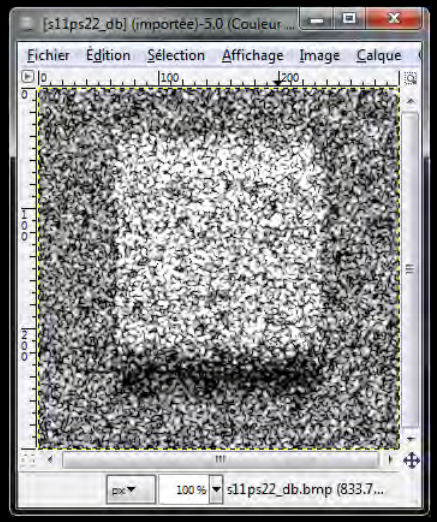




© E. Pottier – 2018

ELEMENTS

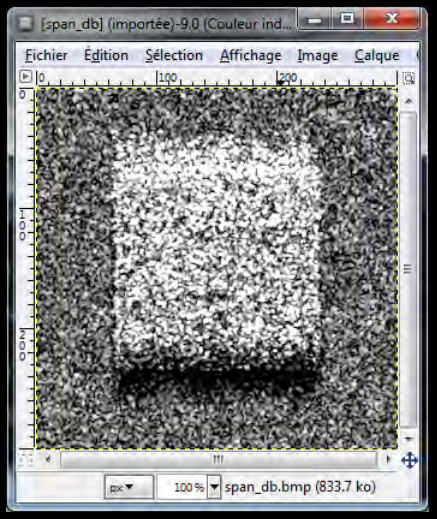




HH+VV

HH-VV

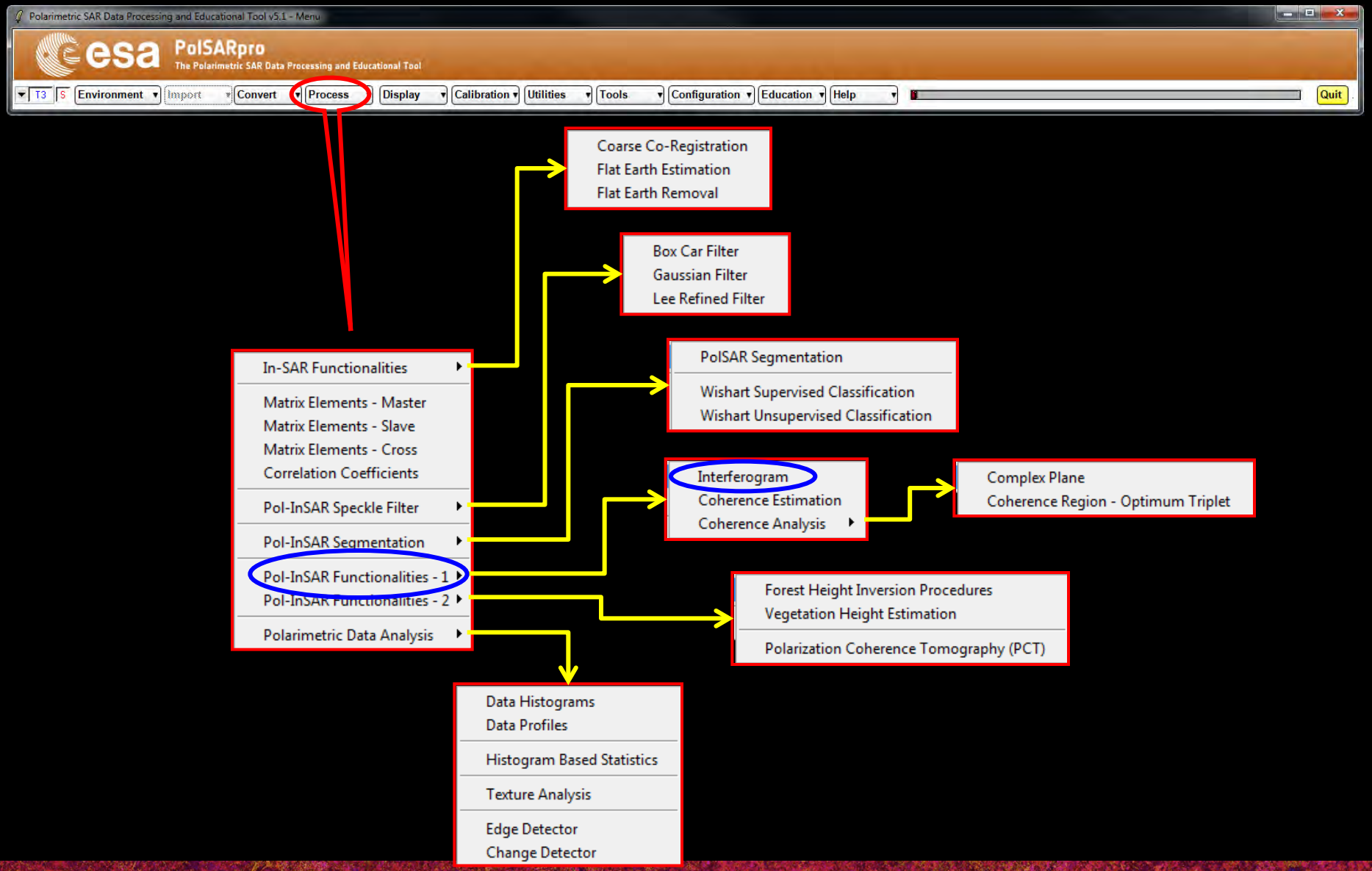
HV+VH



span

© E. Pottier – 2018

PROCESS DATA



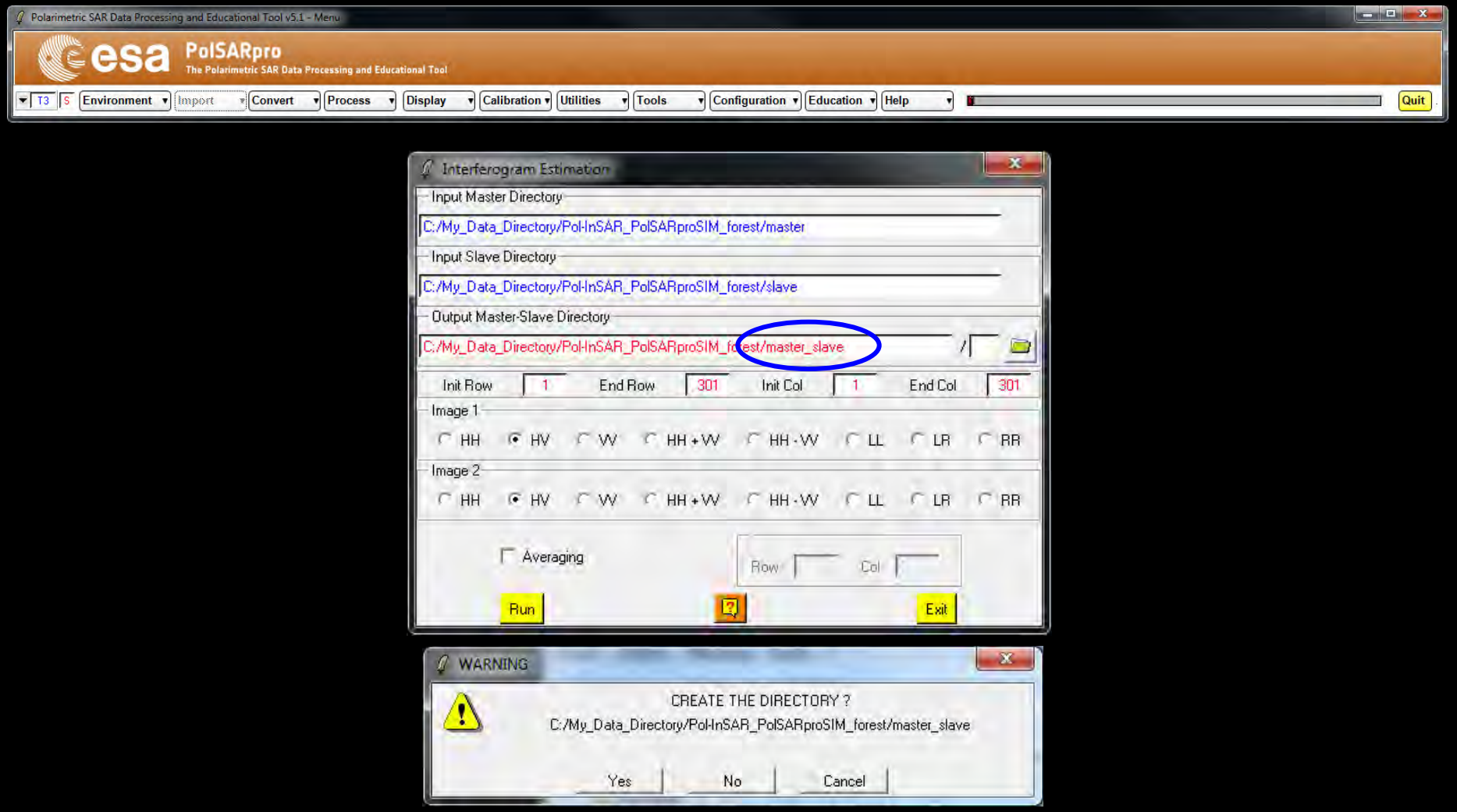
© E. Pottier – 2018

RAW INTERFEROGRAM

Do it Yourself:
Select polarization channels and view the corresponding BMP files.

© E. Pottier – 2018

RAW INTERFEROGRAM



Note:
The Output Directory is automatically set to: MasterDir_SlaveDir

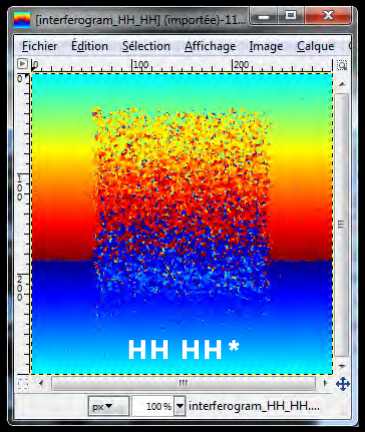
© E. Pottier – 2018

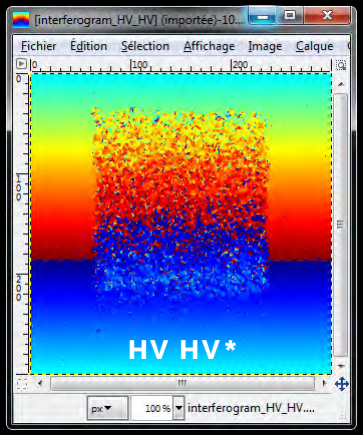
RAW INTERFEROGRAM

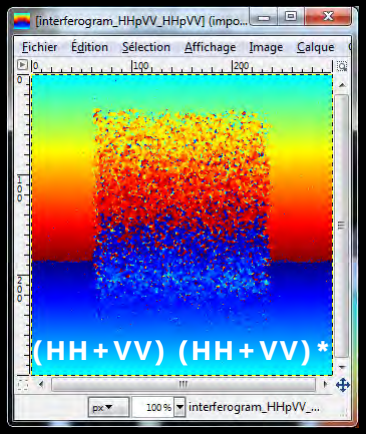
DATA_MASTERDIR_SLAVEDIR

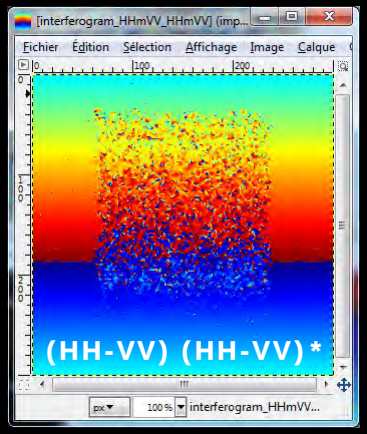
- config.txt
- interferogram_XX_XX.bin
- interferogram_XX_XX.bmp

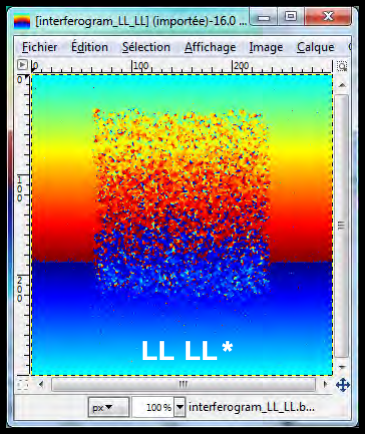
-180° +180°

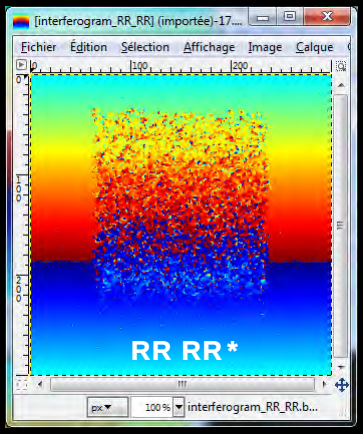






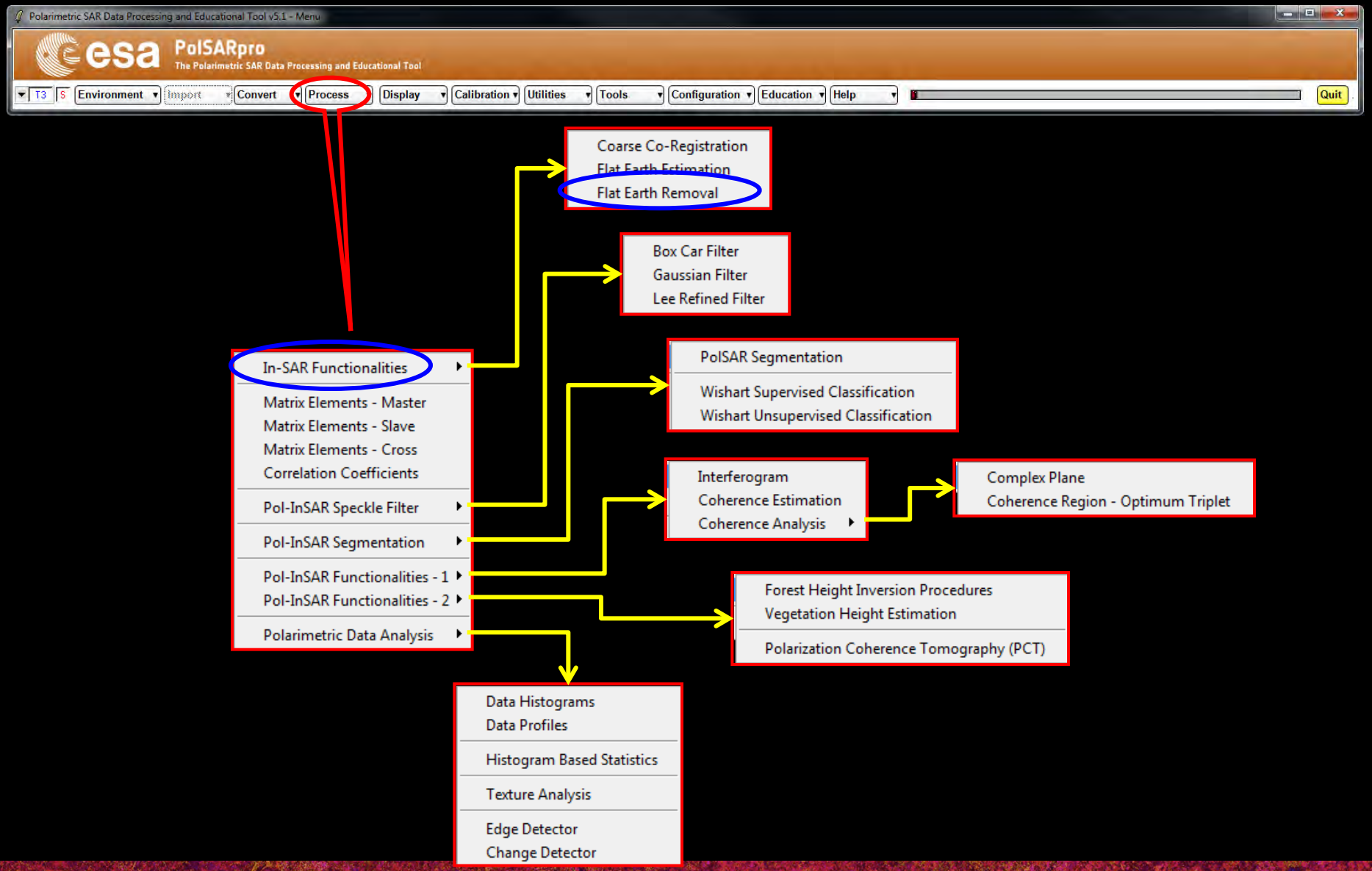






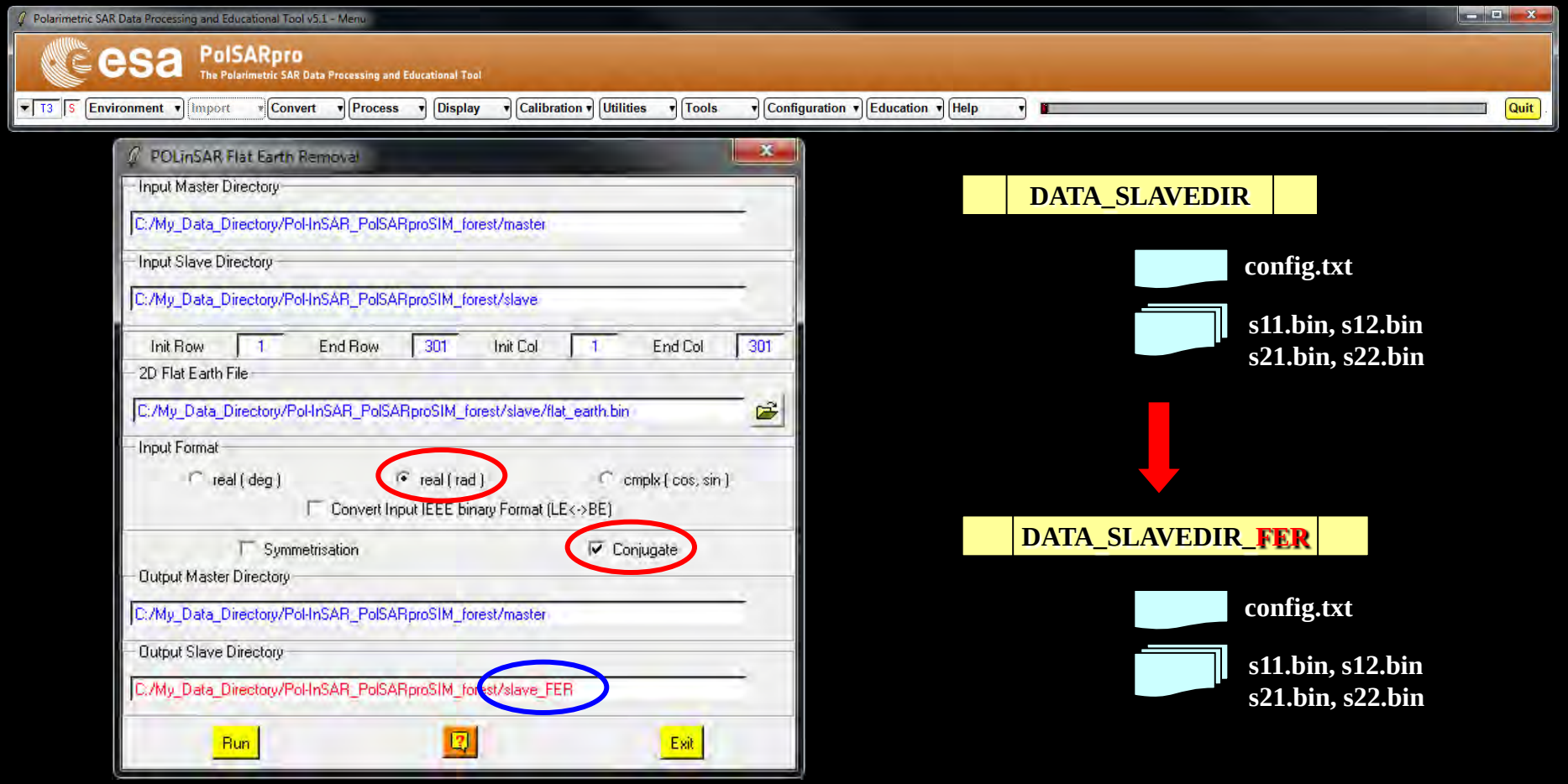
© E. Pottier – 2018

PROCESS DATA



© E. Pottier – 2018

FLAT EARTH REMOVAL

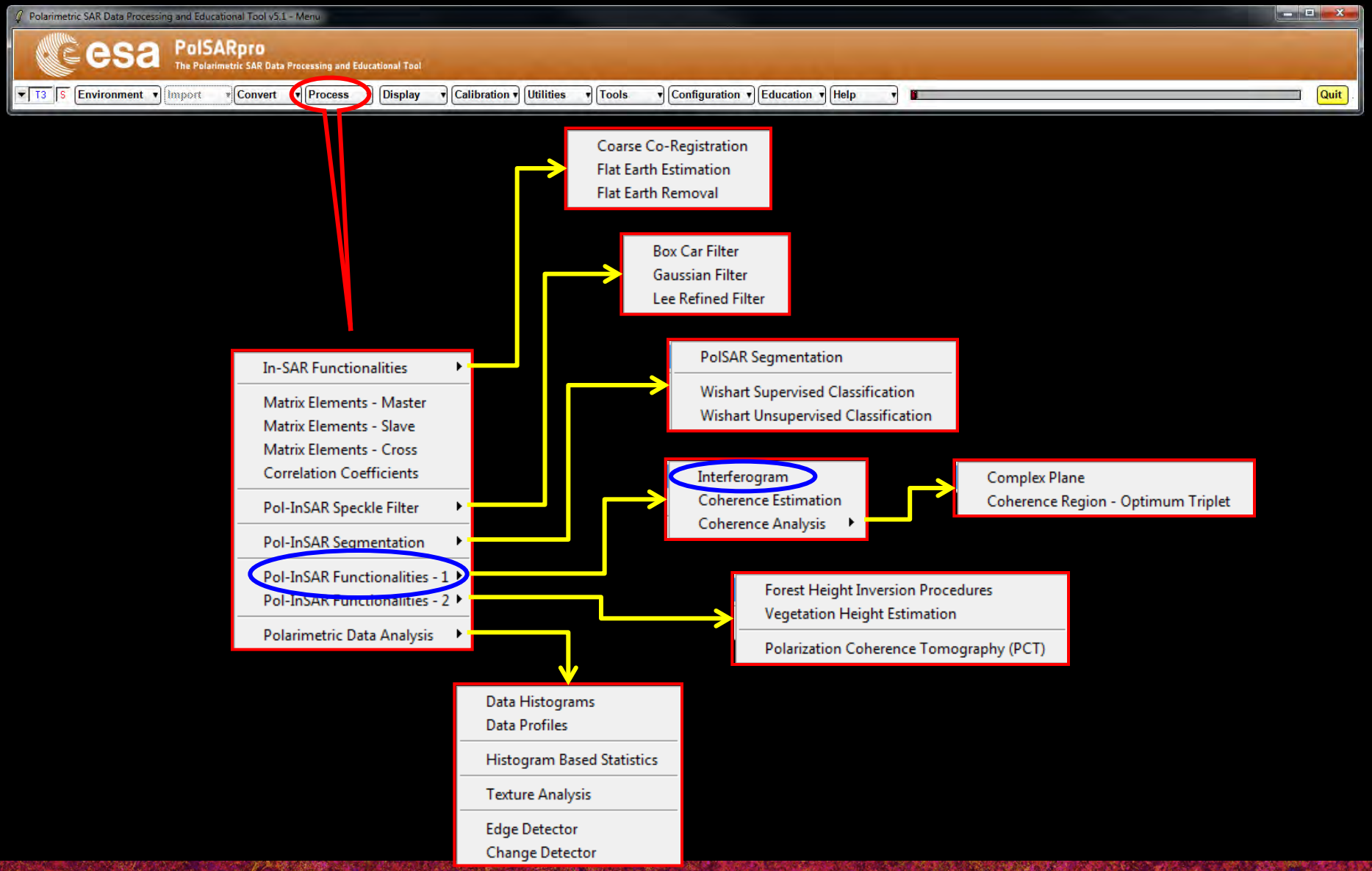


Do it Yourself:
Enter Flat Earth file name, set the parameters and run the function.

Note:
The Input Slave Directory is automatically set to: SlaveDir_FER

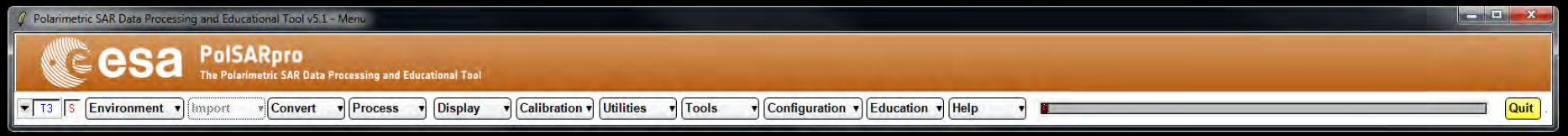
© E. Pottier – 2018

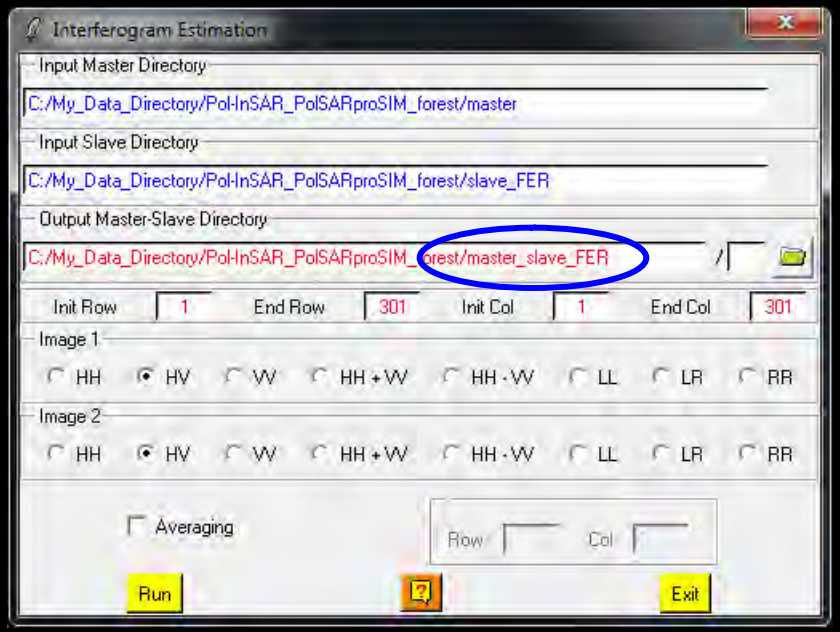
PROCESS DATA

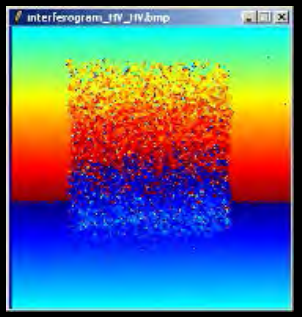


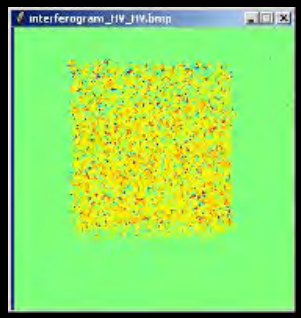
© E. Pottier – 2018

RAW INTERFEROGRAM









Do it Yourself:
Select polarization channels view the corresponding BMP files.

Note:
The Output Directory is automatically set to: MasterDir_SlaveDir_FER

© E. Pottier – 2018

RAW INTERFEROGRAM

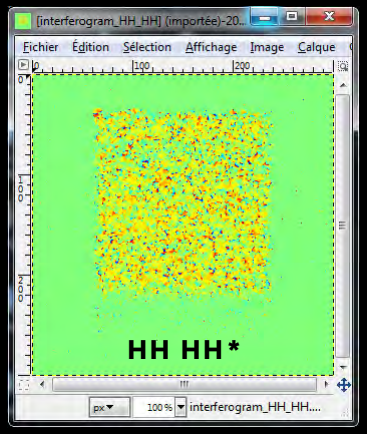
DATA_MASTERDIR_SLAVEDIR_FER

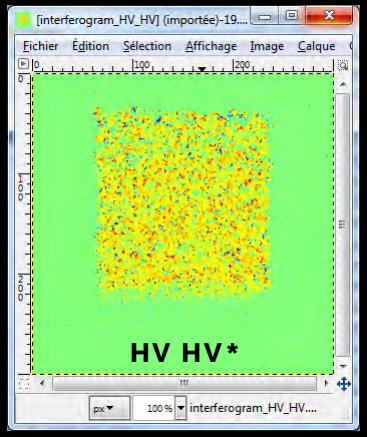
config.txt

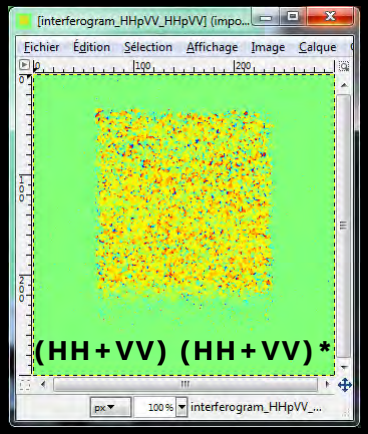
interferogram_XX_XX.bin

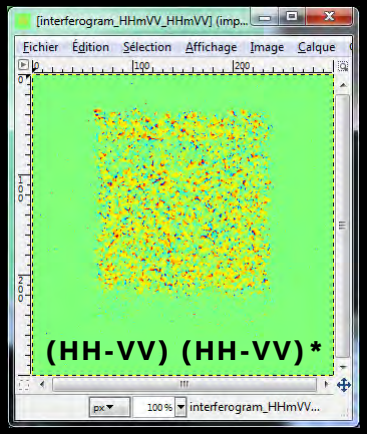
interferogram_XX_XX.bmp

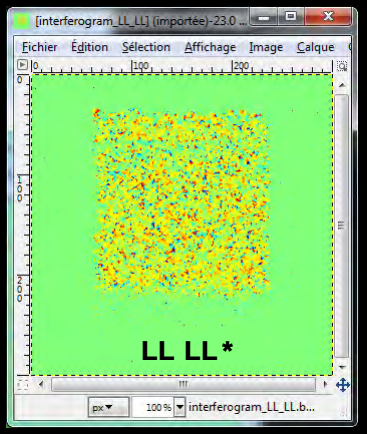
-180° +180°

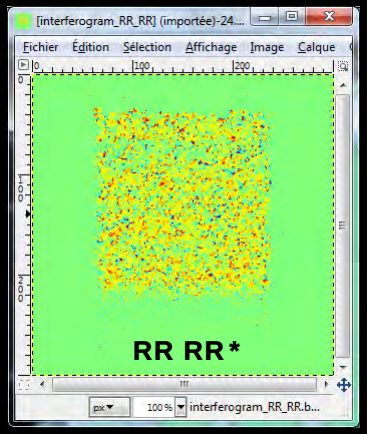






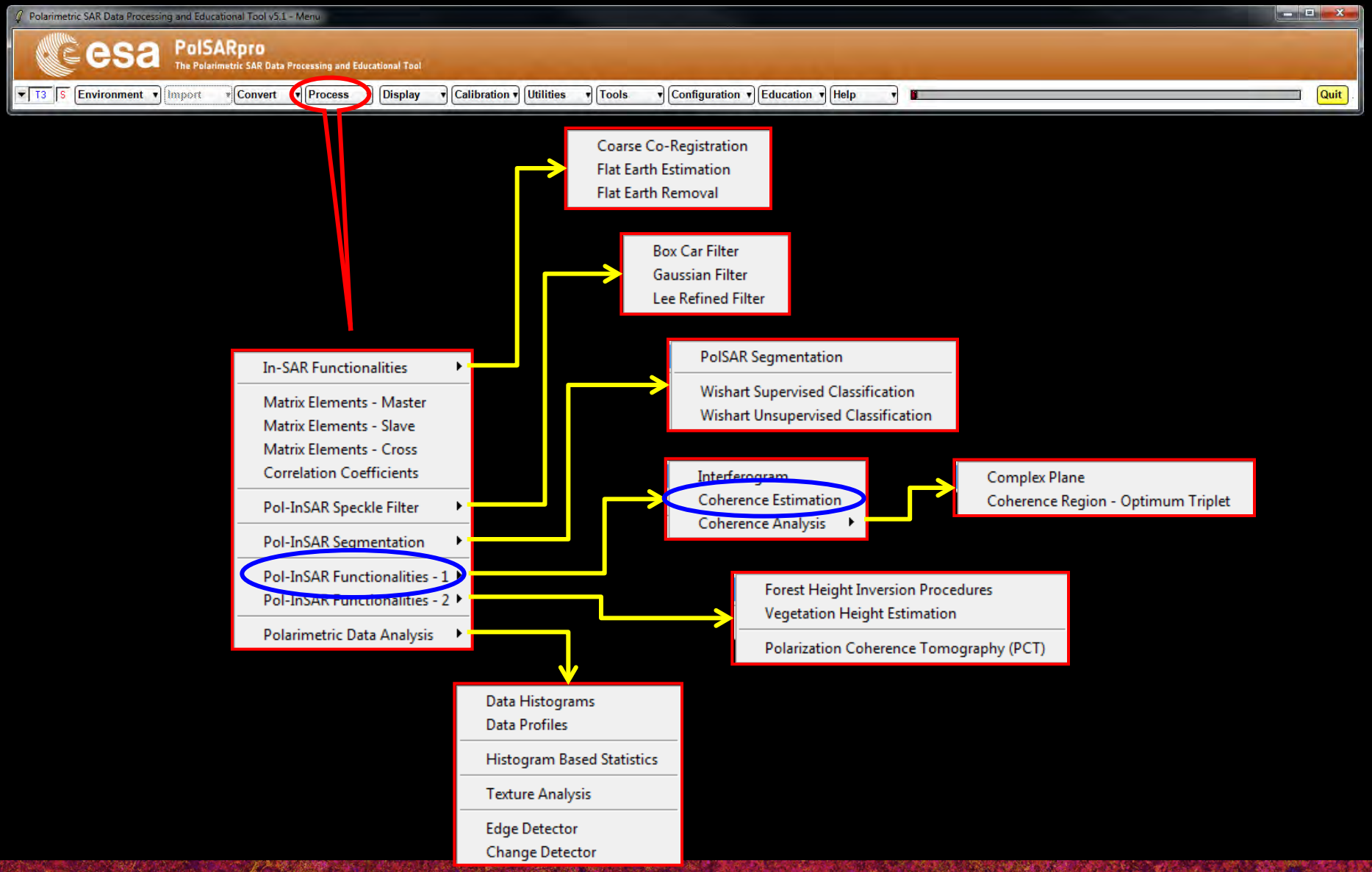






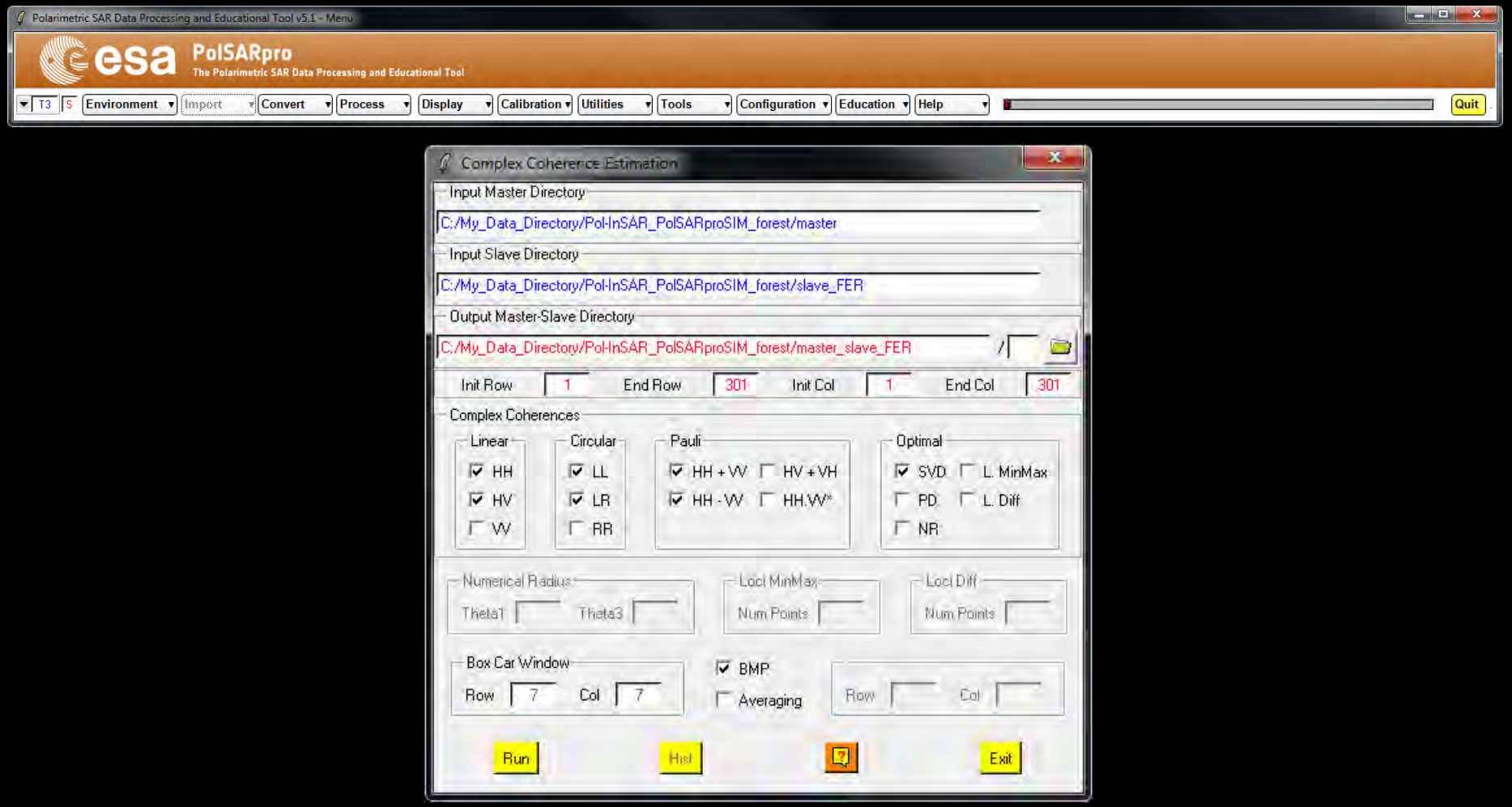
© E. Pottier – 2018

PROCESS DATA



© E. Pottier – 2018

COHERENCE ESTIMATION



Do it Yourself:

Select polarization channels (*linear, circular, pauli, SVD*), set the parameters (*Box Car = 7x7*) and view the corresponding BMP files (*select BMP*).

© E. Pottier – 2018

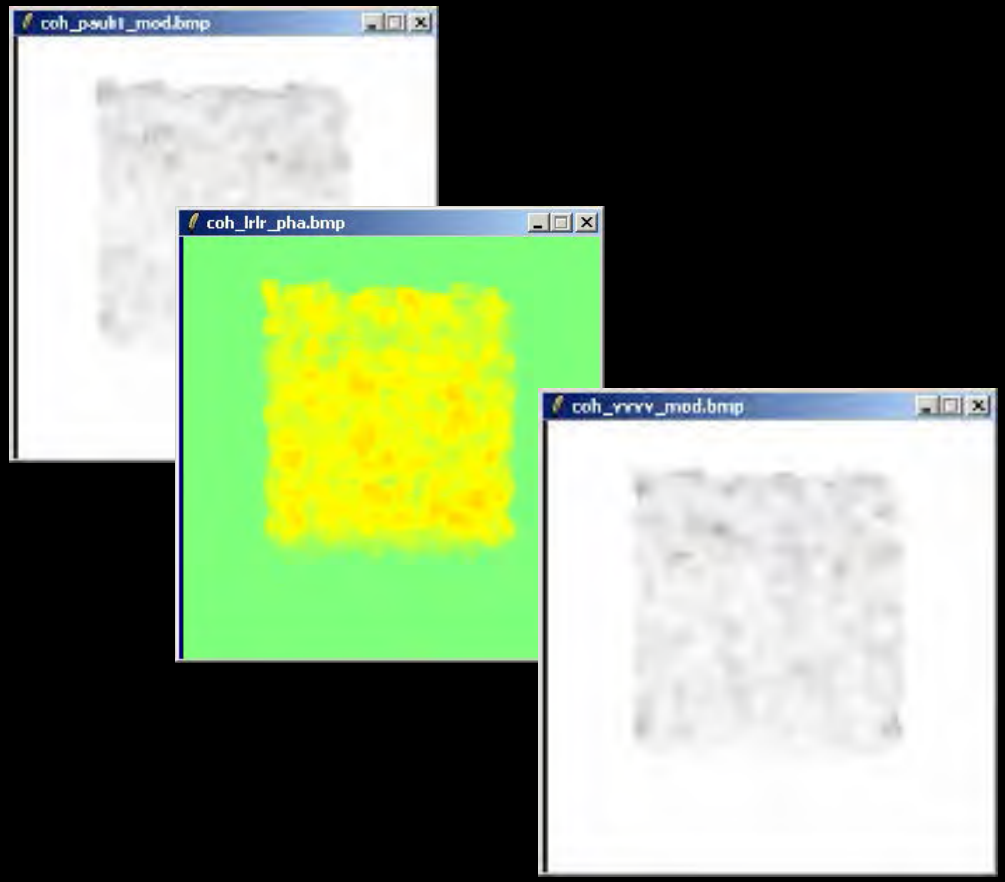
COHERENCE ESTIMATION

DATA_MASTERDIR_SLAVEDIR_FER

config.txt

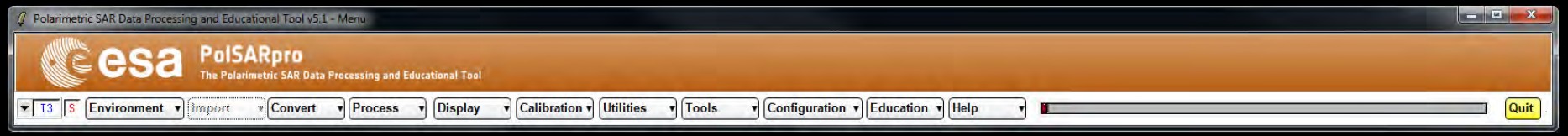
cmplx_coh_XX.bin

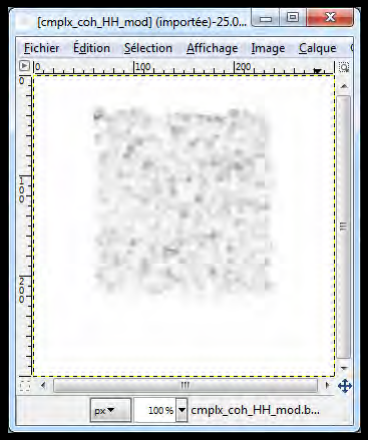
cmplx_coh_XX_mod.bmp
cmplx_coh_XX_pha.bmp



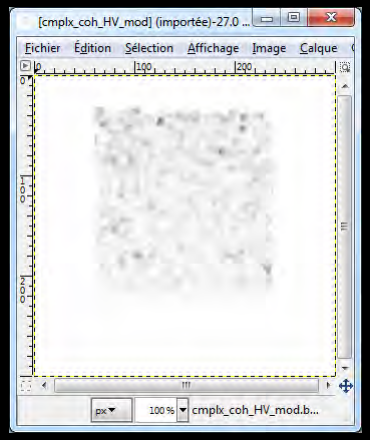
© E. Pottier – 2018

COHERENCE ESTIMATION

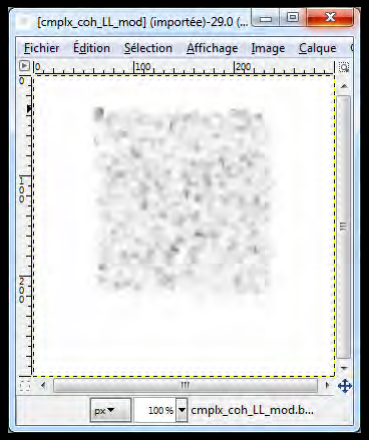




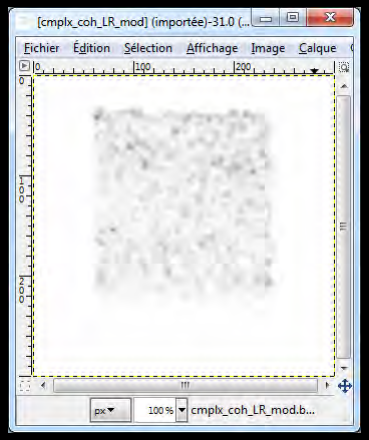
γ_{HH}



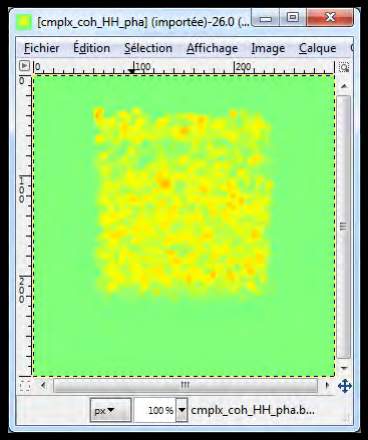
γ_{HV}

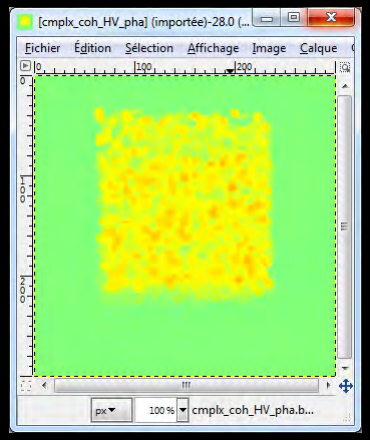


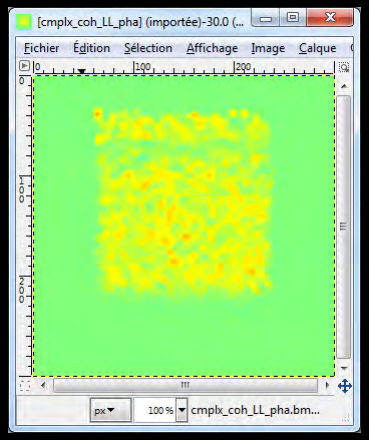
γ_{LL}

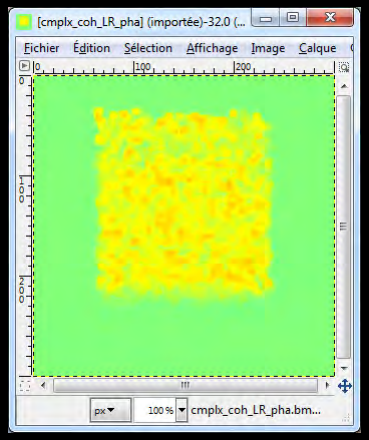


γ_{RR}



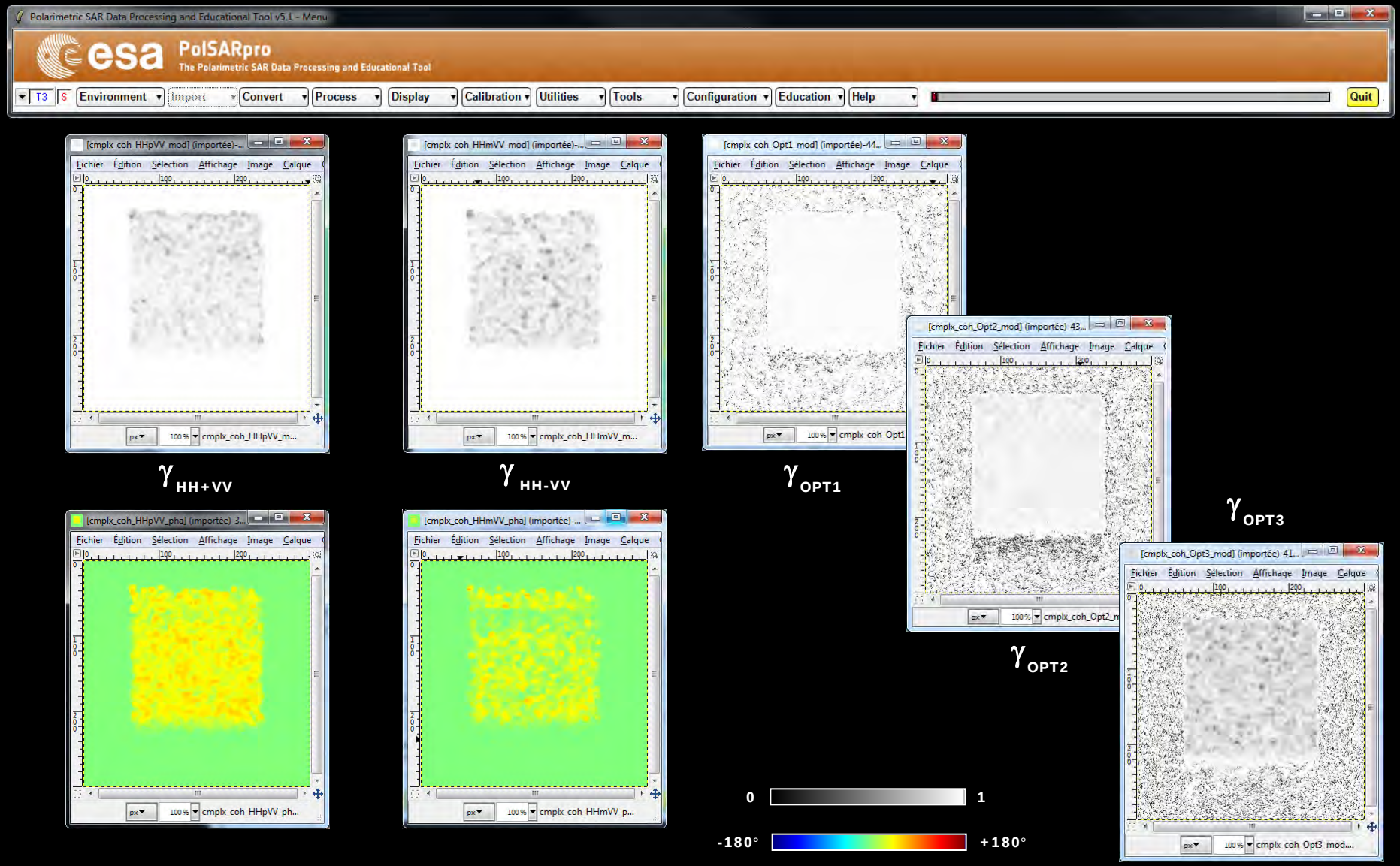






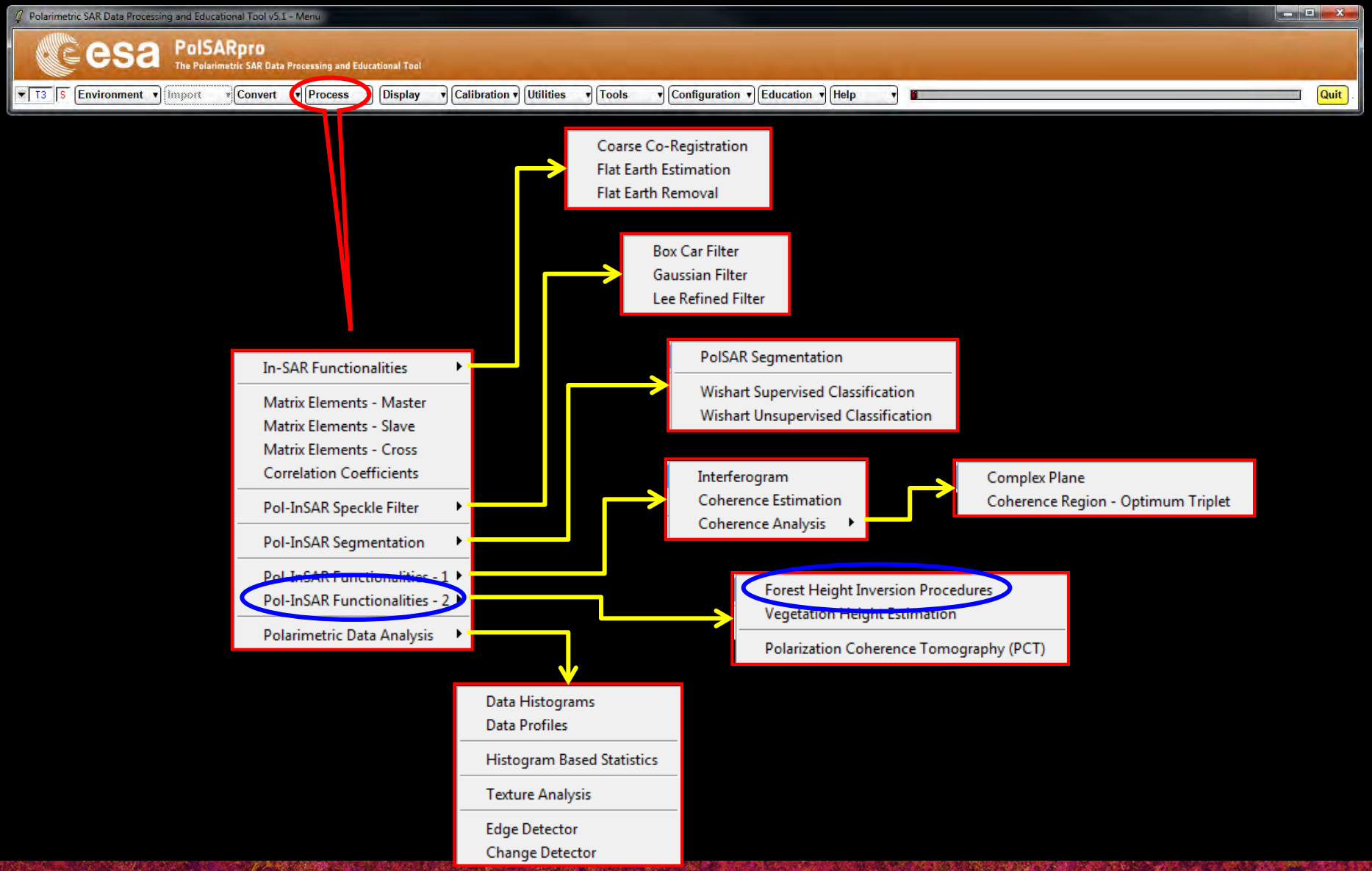
© E. Pottier – 2018

COHERENCE ESTIMATION



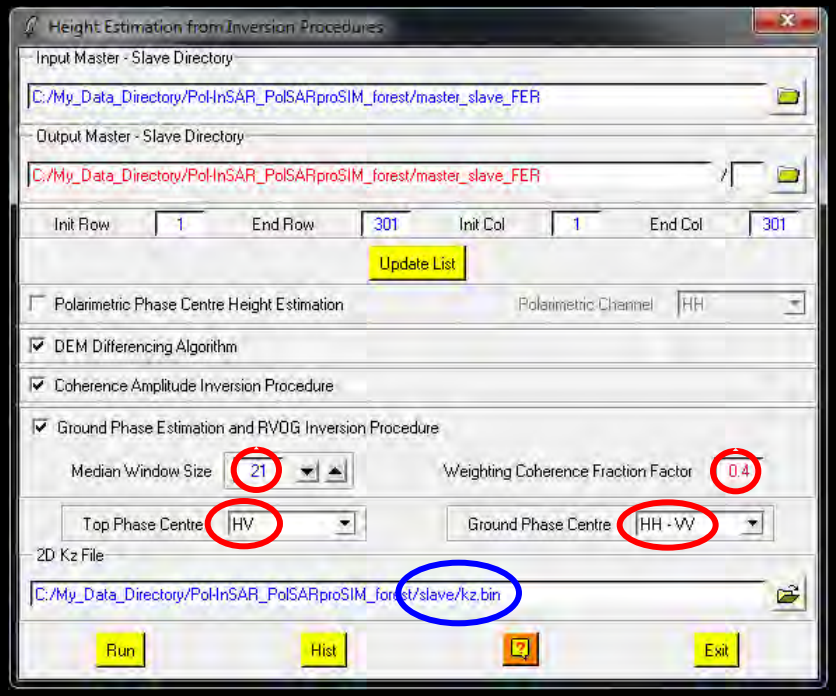
© E. Pottier – 2018

PROCESS DATA



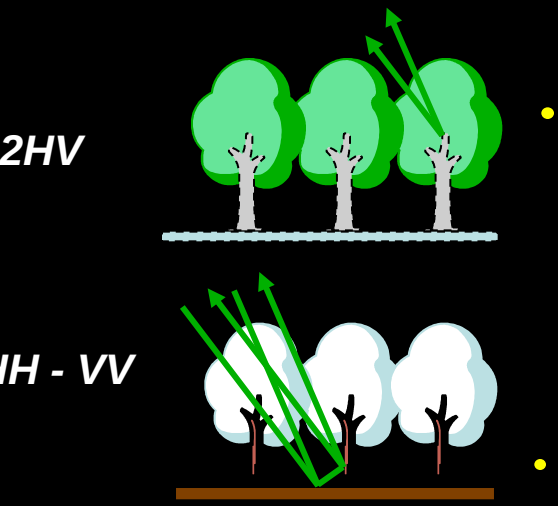
© E. Pottier – 2018

HEIGHT ESTIMATION



INVERSION PROCEDURES

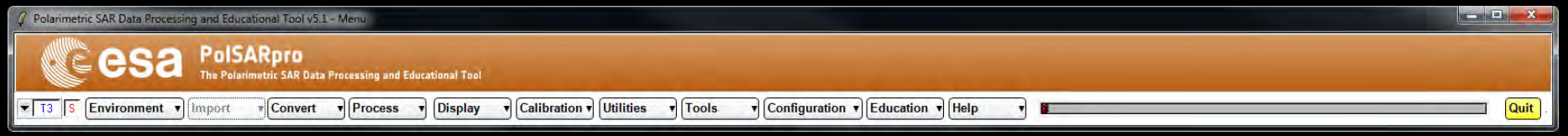
- DEM Differencing Algorithm
- Coherence Amplitude Inversion Procedure
- Ground Phase Estimation &
- RVOG Inversion Procedure

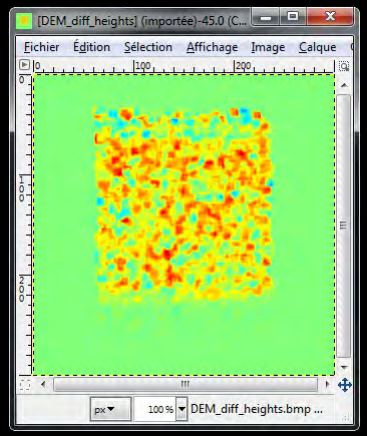


Do it Yourself:
Set the parameters (*Median Size = 21*, *Factor = 0.4*) and view the corresponding BMP files.

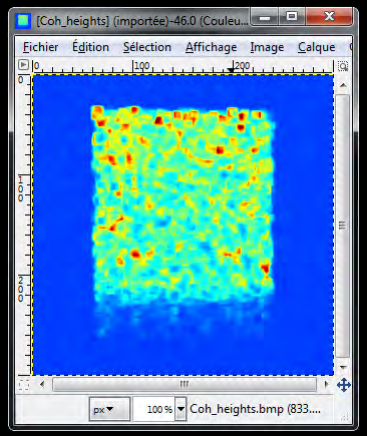
© E. Pottier – 2018

HEIGHT ESTIMATION

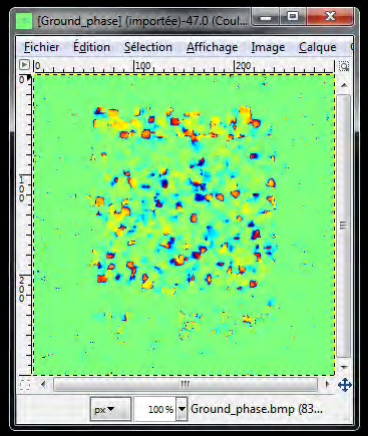




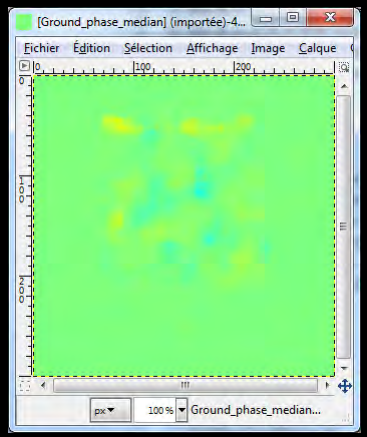
DEM_diff_heights



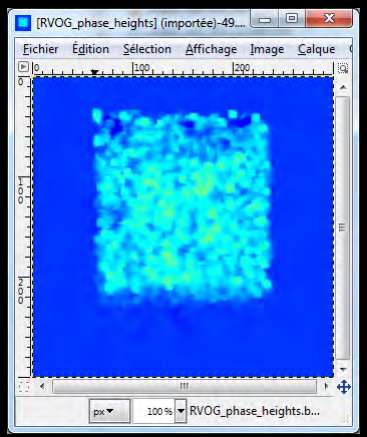
Coh_heights



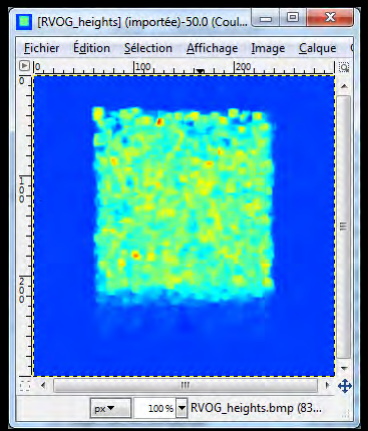
Ground_phase



Ground_phase_median



RVOG_phase_heights

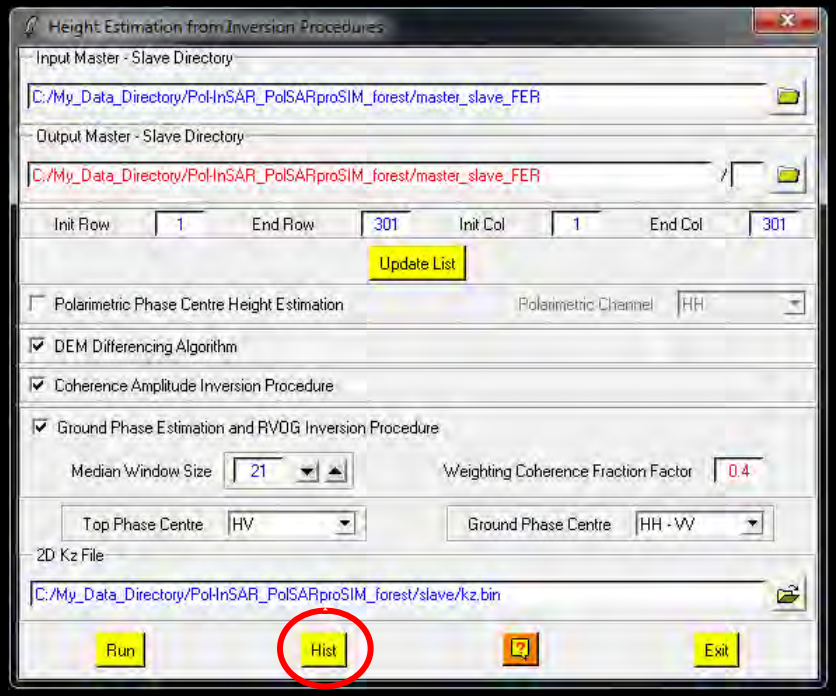


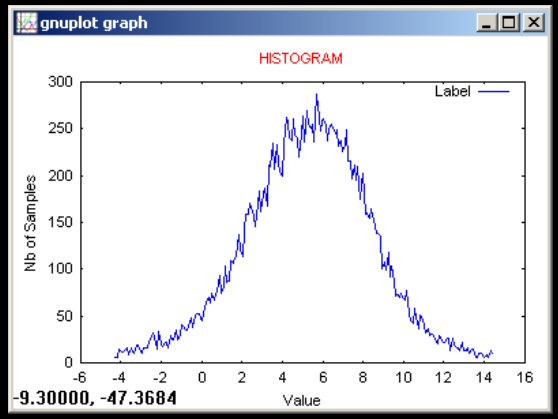
RVOG_heights

-180° +180°
-5 m +25 m

© E. Pottier – 2018

HEIGHT ESTIMATION

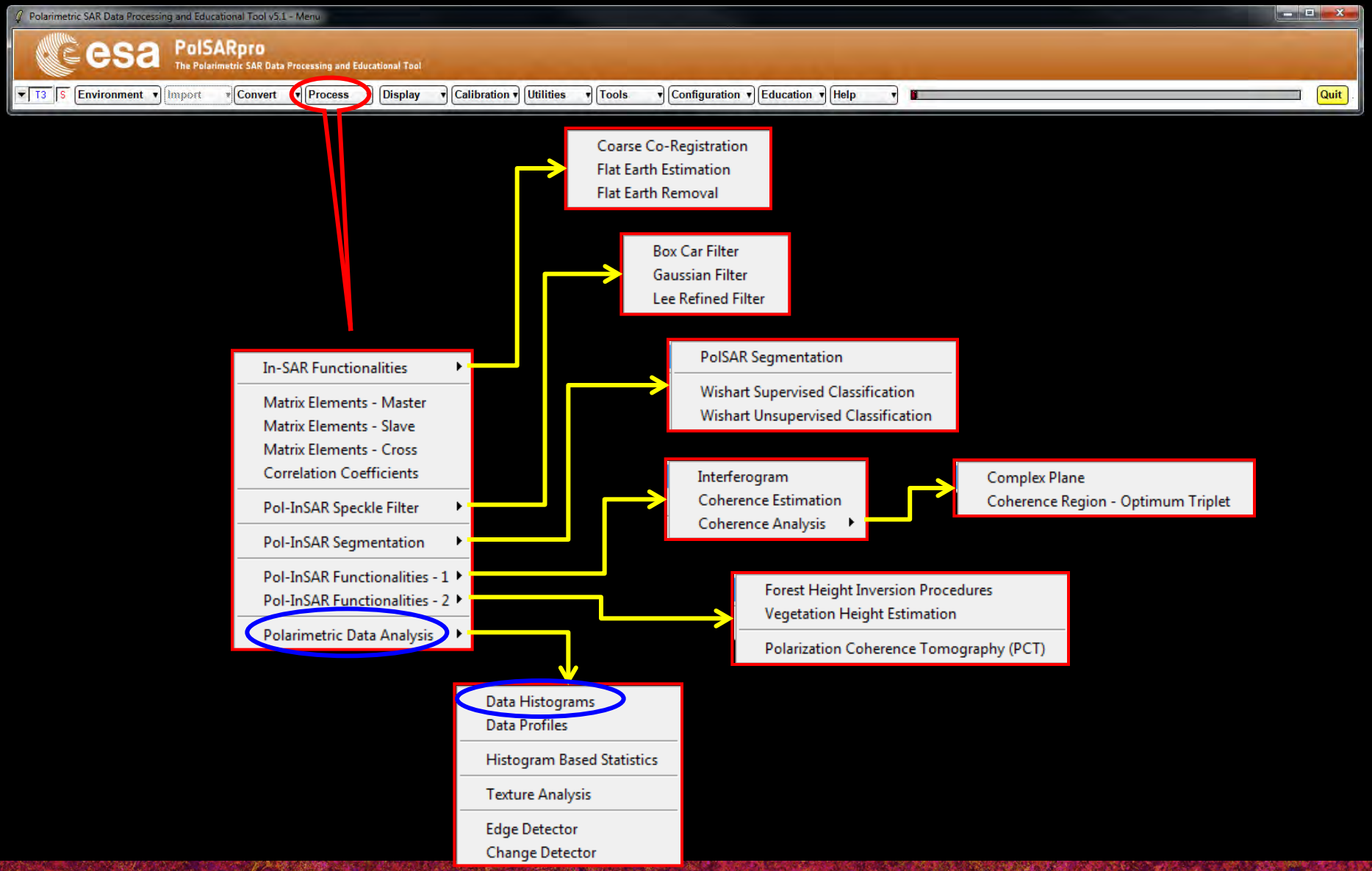




Data Analysis - Data histograms

© E. Pottier – 2018

PROCESS DATA



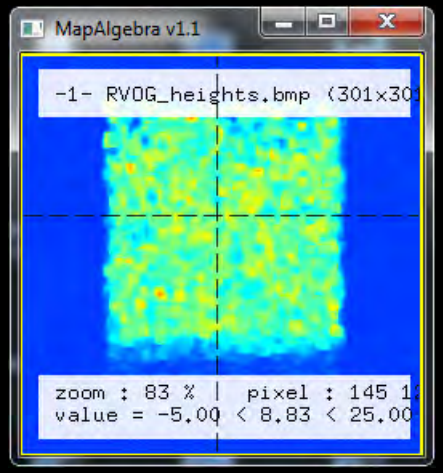
© E. Pottier – 2018

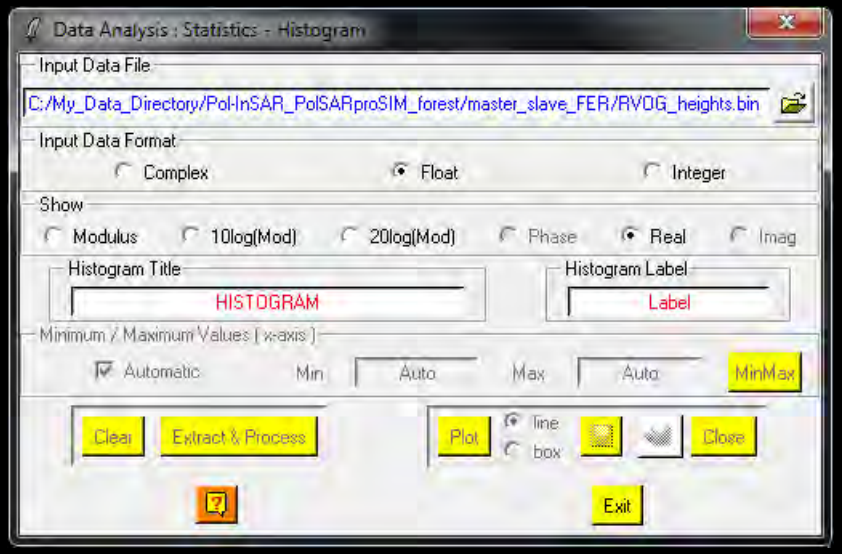
HEIGHT ESTIMATION - HISTOGRAM

Do it Yourself:
Step 1 : Select a BMP File

© E. Pottier – 2018

HEIGHT ESTIMATION - HISTOGRAM



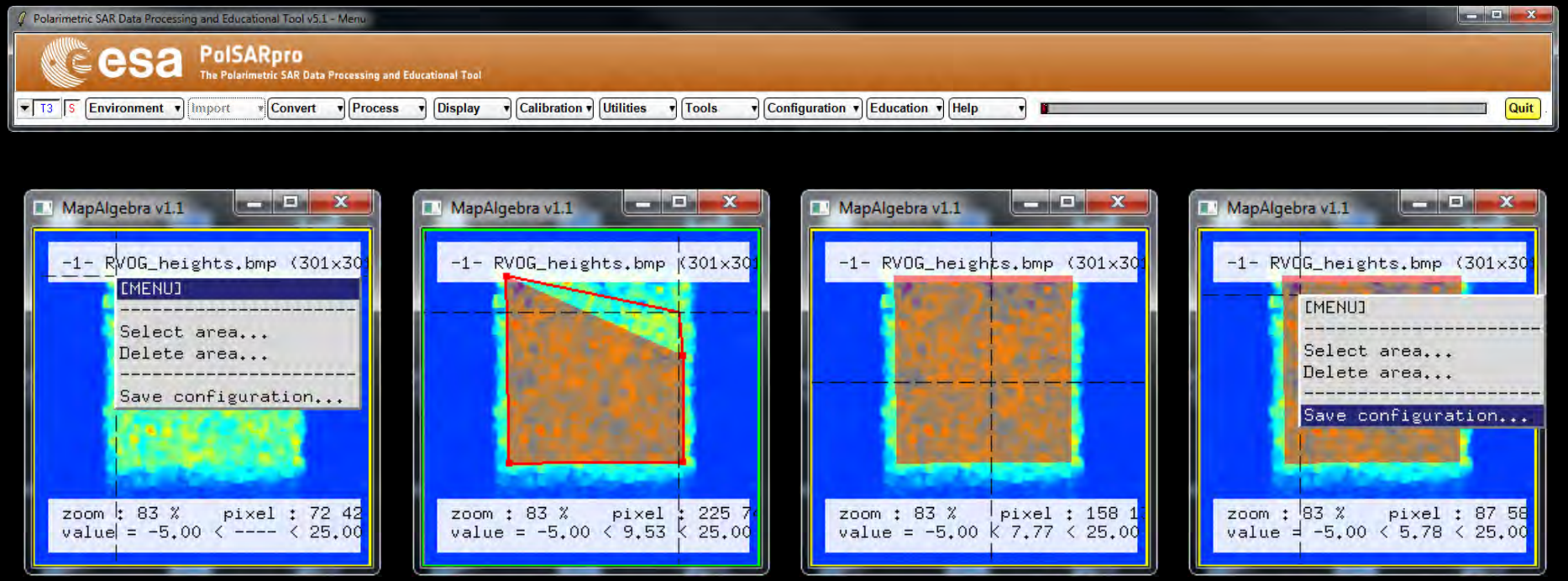


Do it Yourself:

Step 2 : Select an Input Binary Data File
Select what to *Show*
Enter the *Histogram Title*
Enter the *Histogram Label*

© E. Pottier – 2018

HEIGHT ESTIMATION - HISTOGRAM



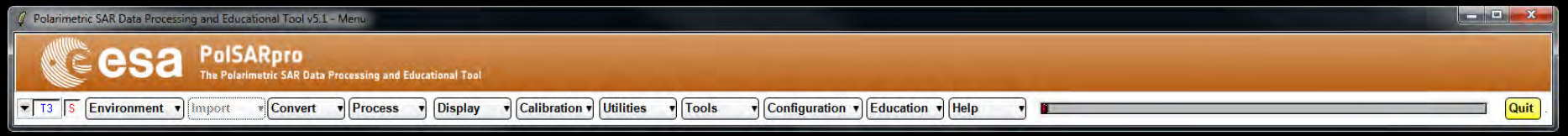
Do it Yourself:

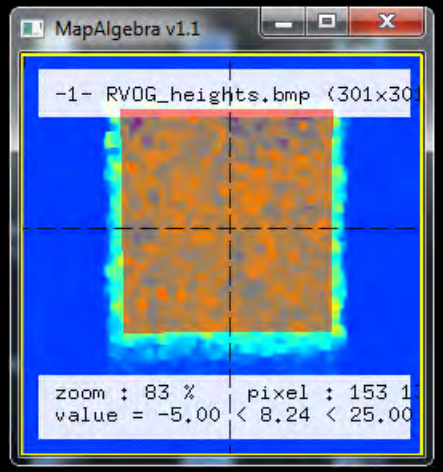
Step 3 : Define the polygon area

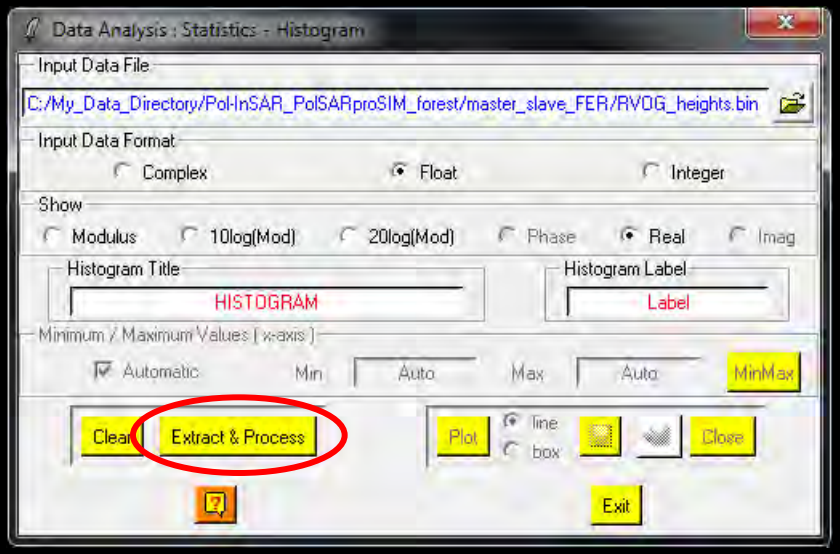
1) ***Right button*** **: Select area**
2) ***Left button*** **: Draw the polygon**
3) ***Enter*** **: Close the polygon**
4) ***Right button*** **: Save configuration**

© E. Pottier – 2018

HEIGHT ESTIMATION - HISTOGRAM







Do it Yourself:
Step 3 : Extract and Process

© E. Pottier – 2018

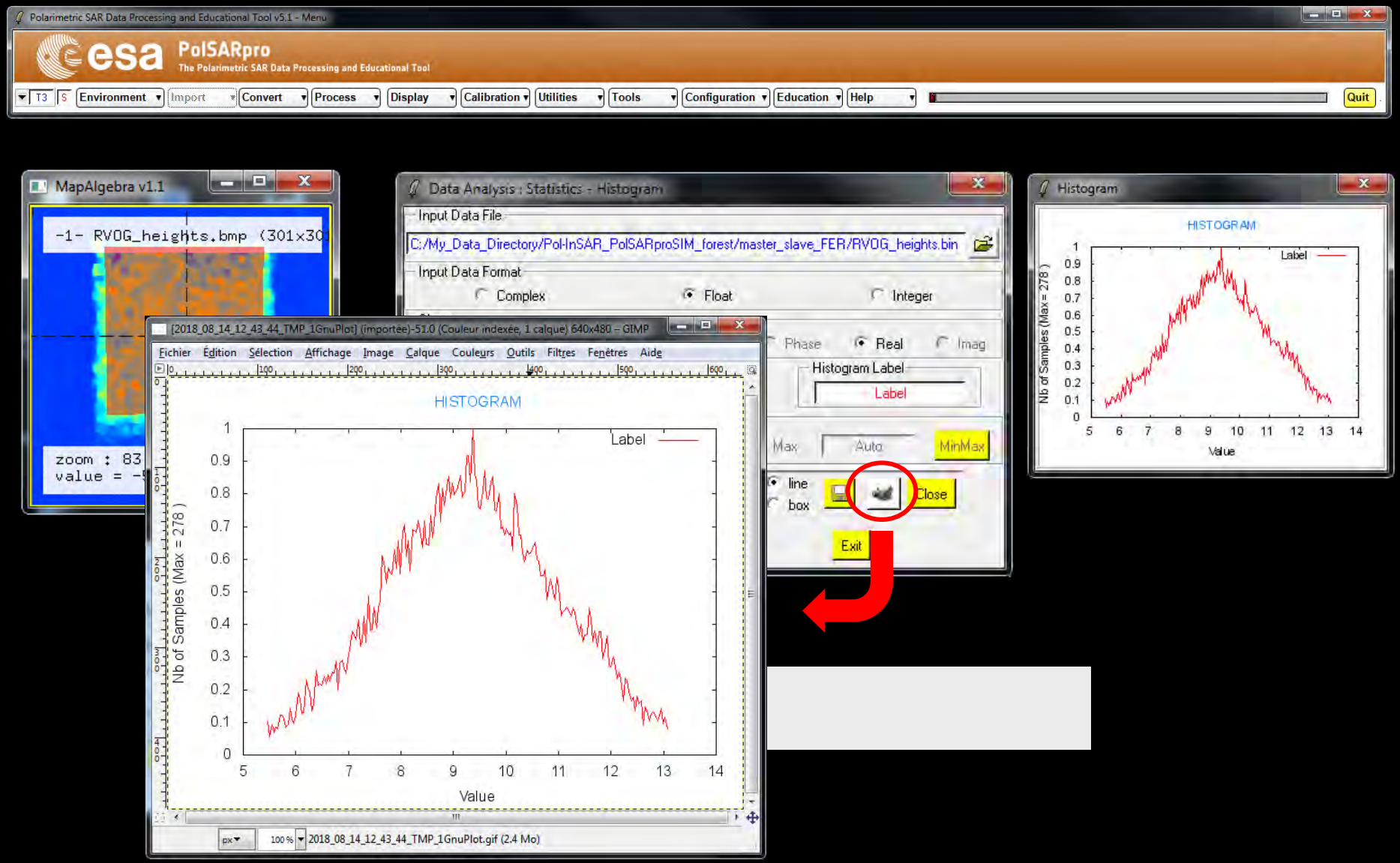
HEIGHT ESTIMATION - HISTOGRAM

Do it Yourself:

Step 4 : Plot the histogram

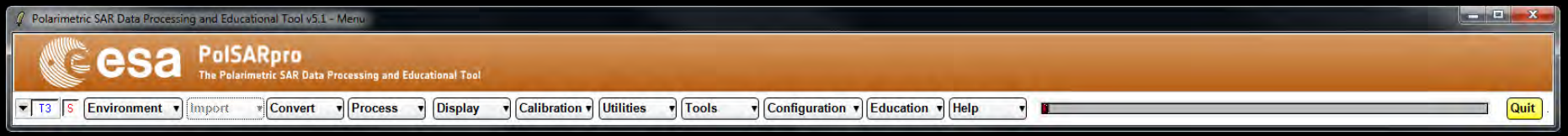
© E. Pottier – 2018

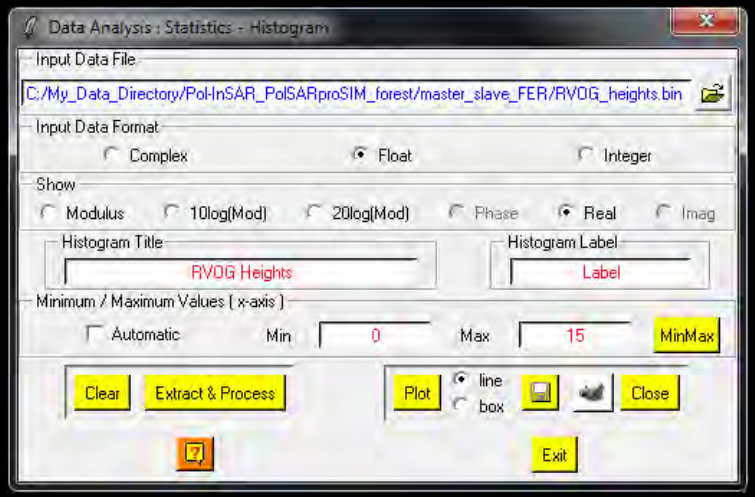
HEIGHT ESTIMATION - HISTOGRAM

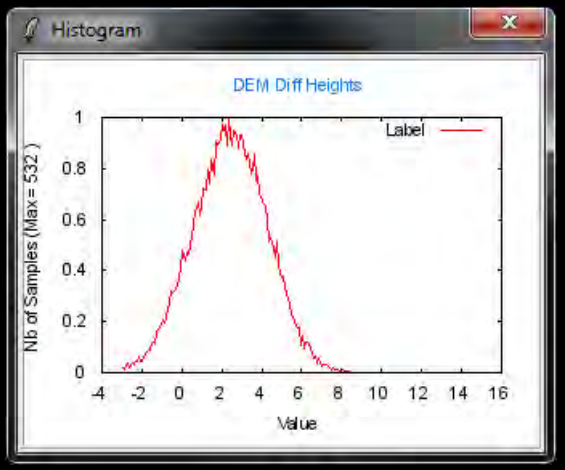


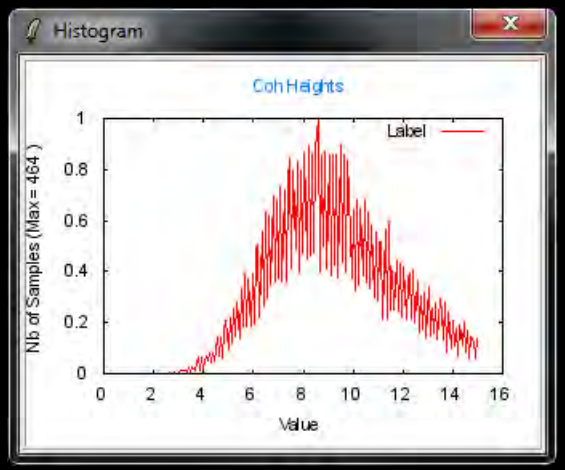
© E. Pottier – 2018

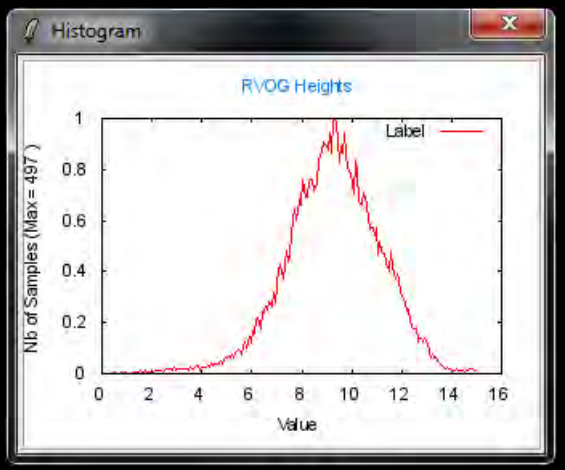
HEIGHT ESTIMATION





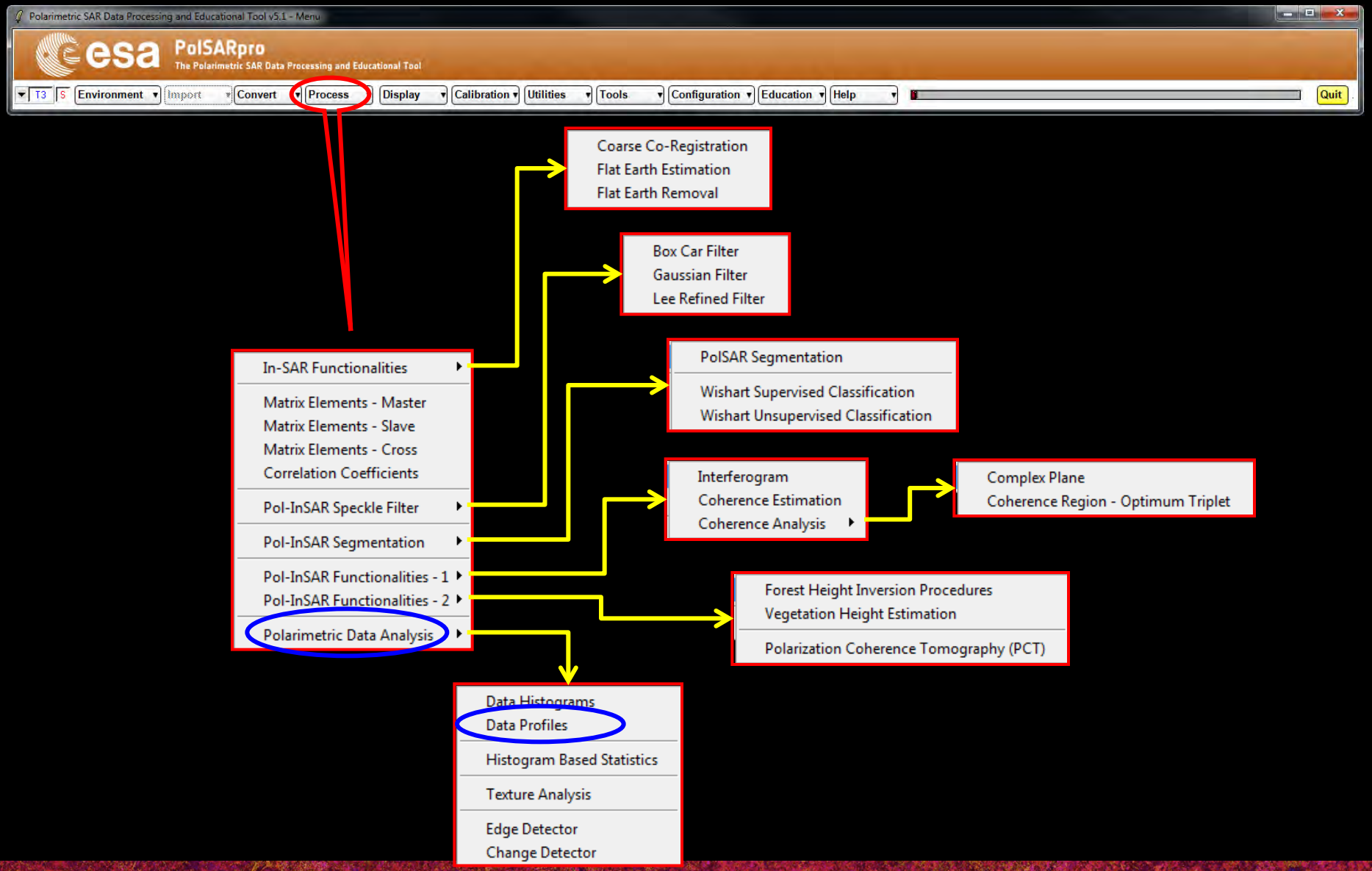






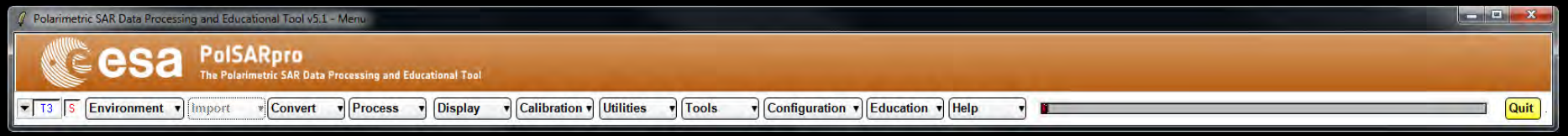
© E. Pottier – 2018

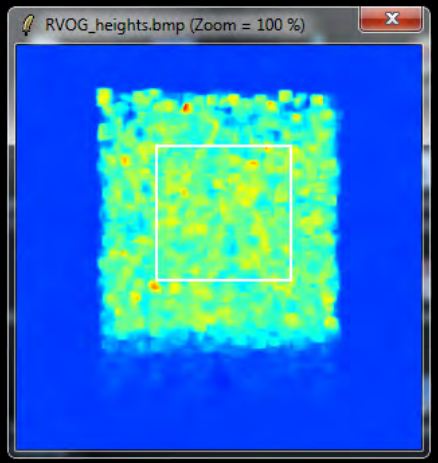
PROCESS DATA



© E. Pottier – 2018

HEIGHT ESTIMATION - PROFILE

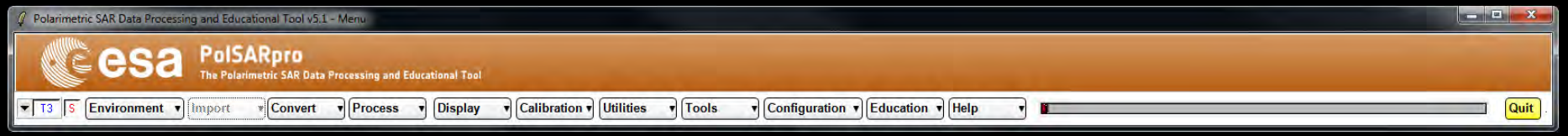


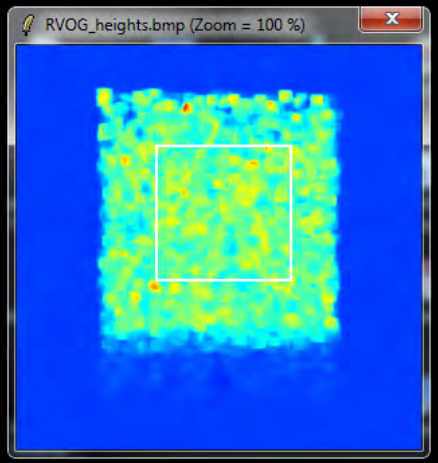


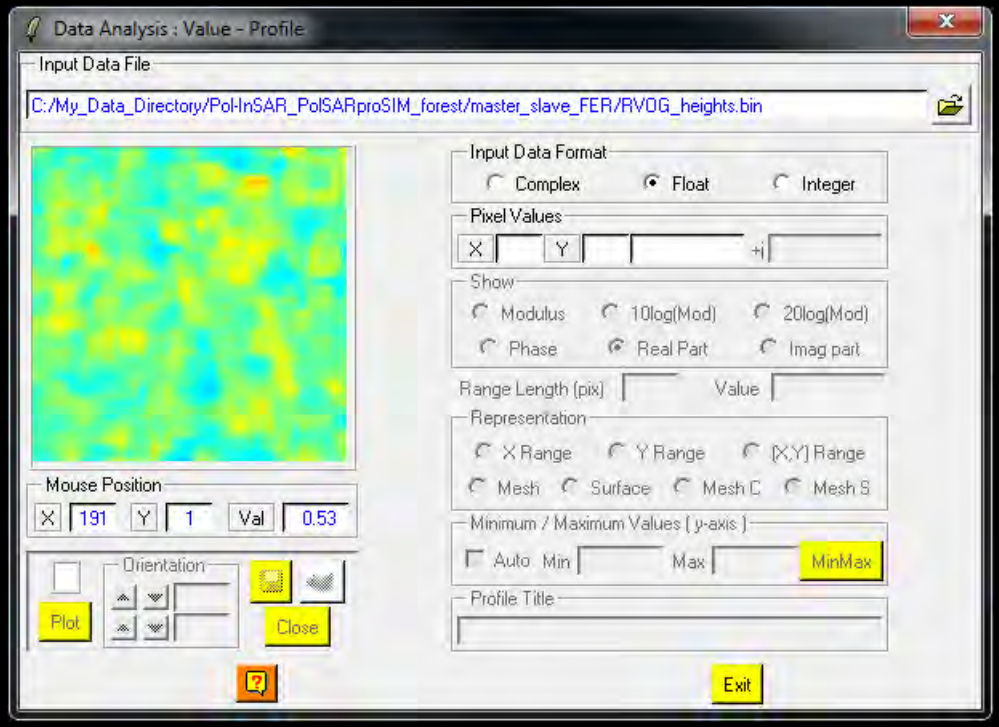
Do it Yourself:
Step 1 : Select a BMP File

© E. Pottier – 2018

HEIGHT ESTIMATION - PROFILE



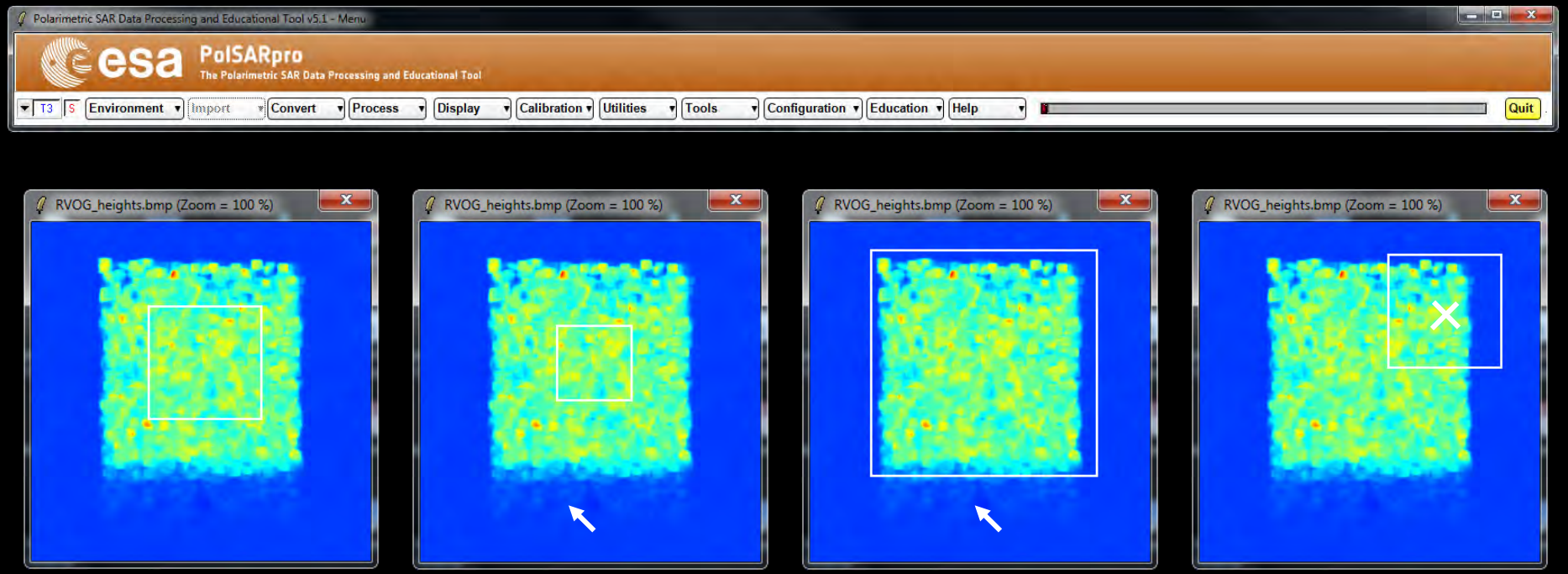




Do it Yourself:
Step 2 : Select a Input Binary Data File

© E. Pottier – 2018

HEIGHT ESTIMATION - PROFILE



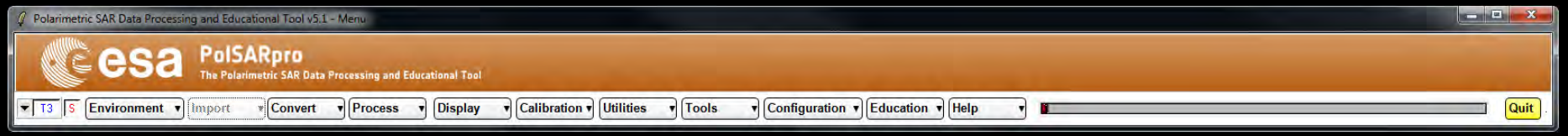
Do it Yourself:

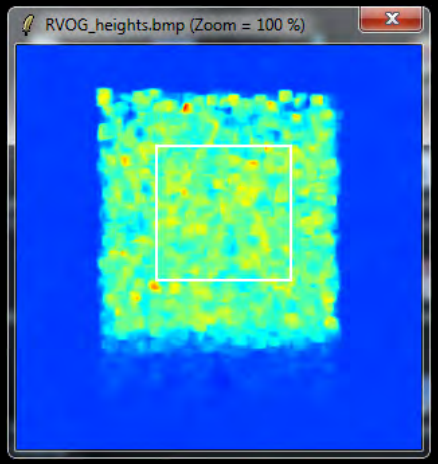
Step 2 : Select the row / col to define the profile

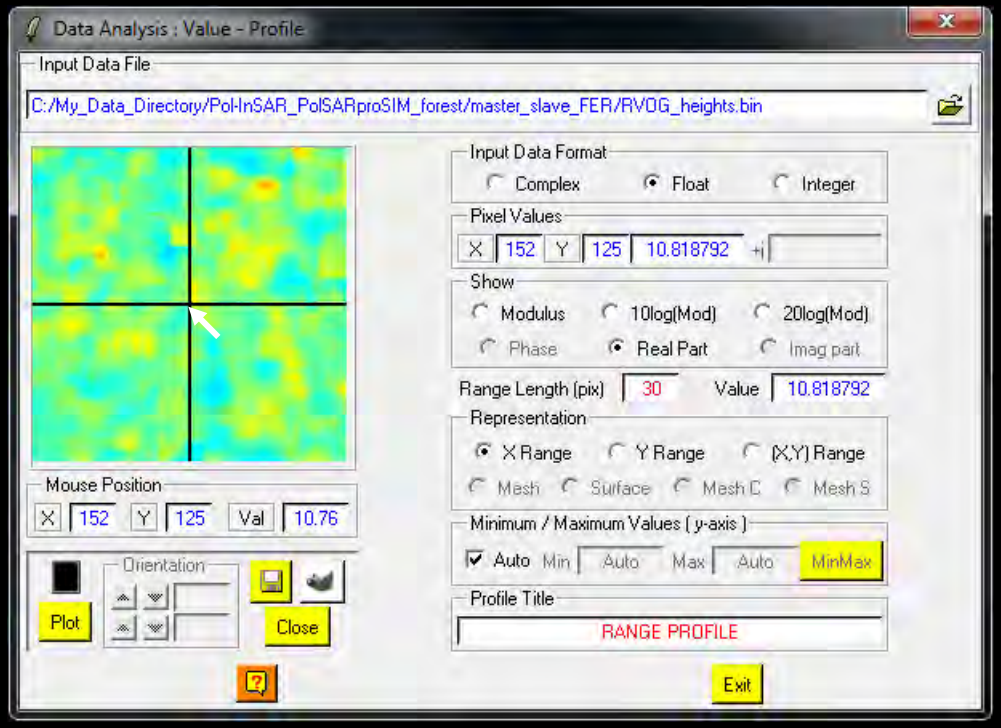
1) ***Zoom*** : mouse ***outside*** the rect
   - ***Left button*** : Zoom ***in***
   - ***Right button*** : Zoom ***out***
2) ***Move*** : mouse ***inside*** the rect

© E. Pottier – 2018

HEIGHT ESTIMATION - PROFILE





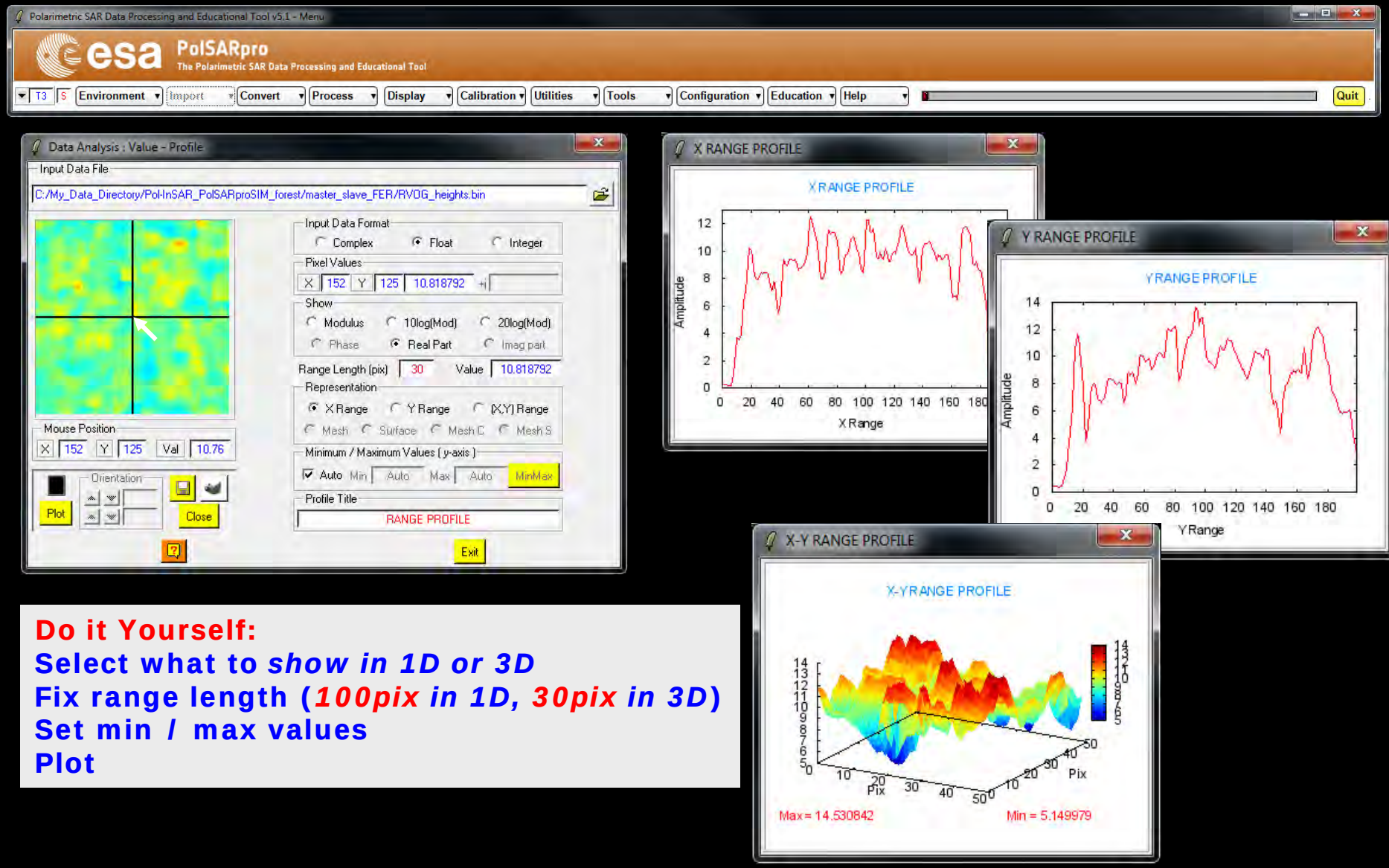


Do it Yourself:

Step 4 : Select the pixel (row / col) center of the profile

© E. Pottier – 2018

HEIGHT ESTIMATION - PROFILE



Do it Yourself:

Select what to *show in 1D or 3D*

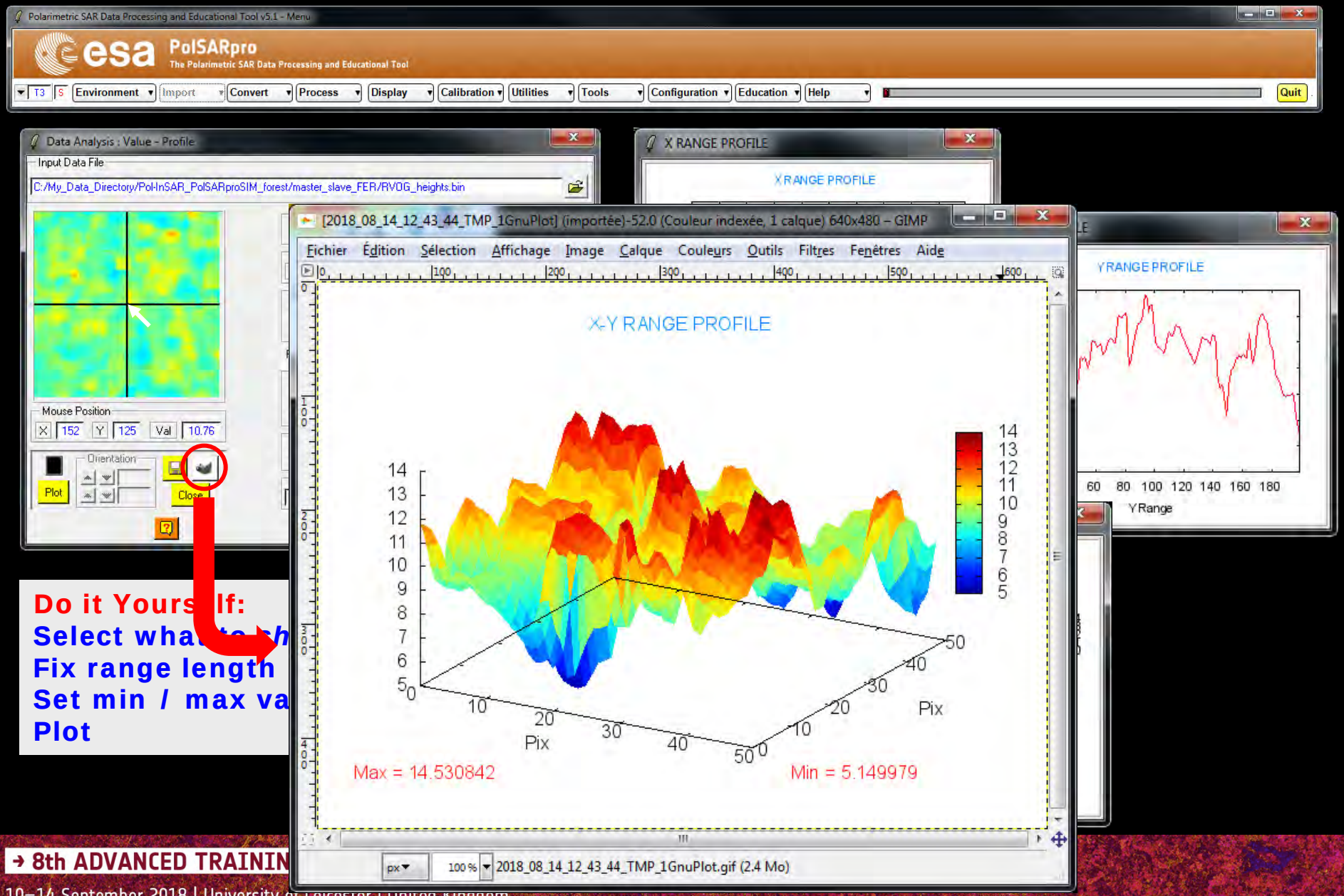
Fix range length (*100pix in 1D, 30pix in 3D*)

Set min / max values

Plot

© E. Pottier – 2018

HEIGHT ESTIMATION - PROFILE



Do it Yourself:

Select what to show

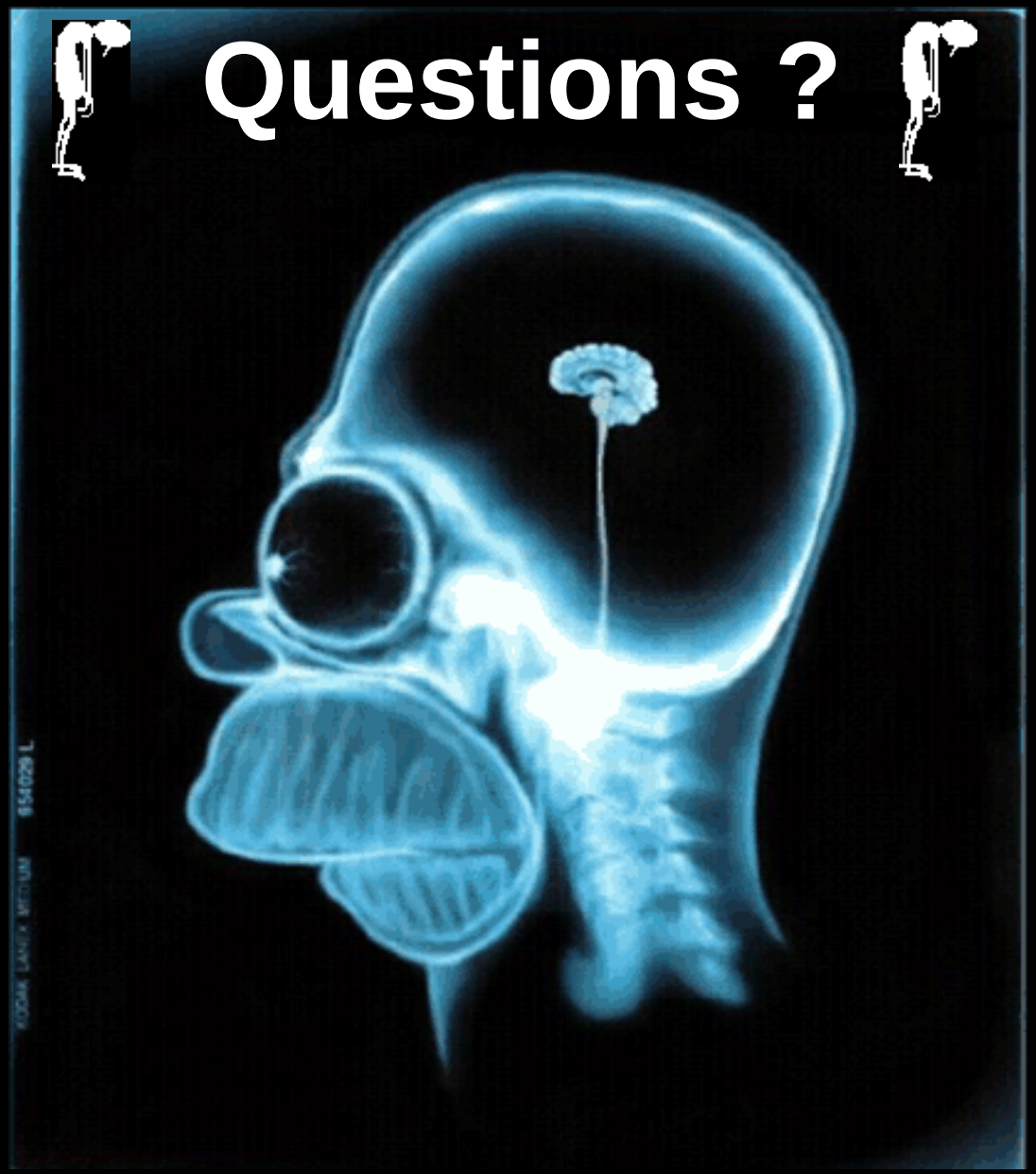
Fix range length

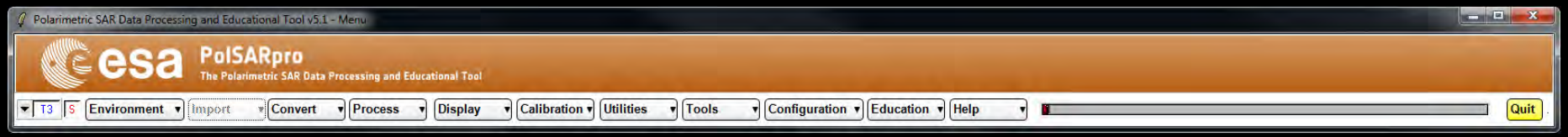
Set min / max values

Plot

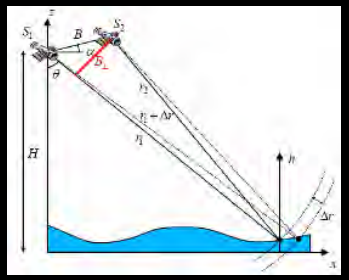
© E. Pottier – 2018

Questions ?

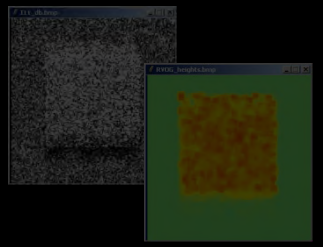




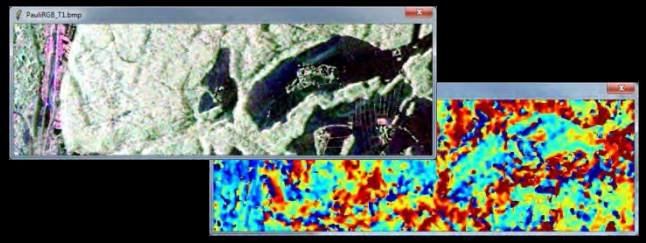
Forestry Applications with Pol-InSAR *Practical*



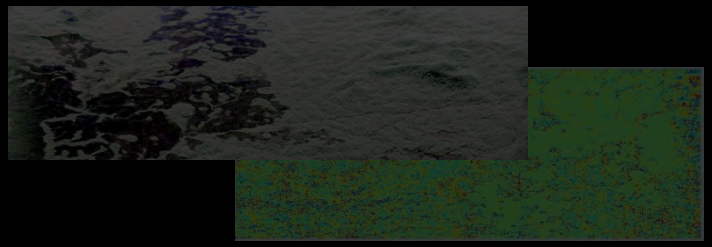
1st part : Simulated Pol-InSAR datasets



2nd part : Airborne Pol-InSAR datasets (*ESAR - DLR*)



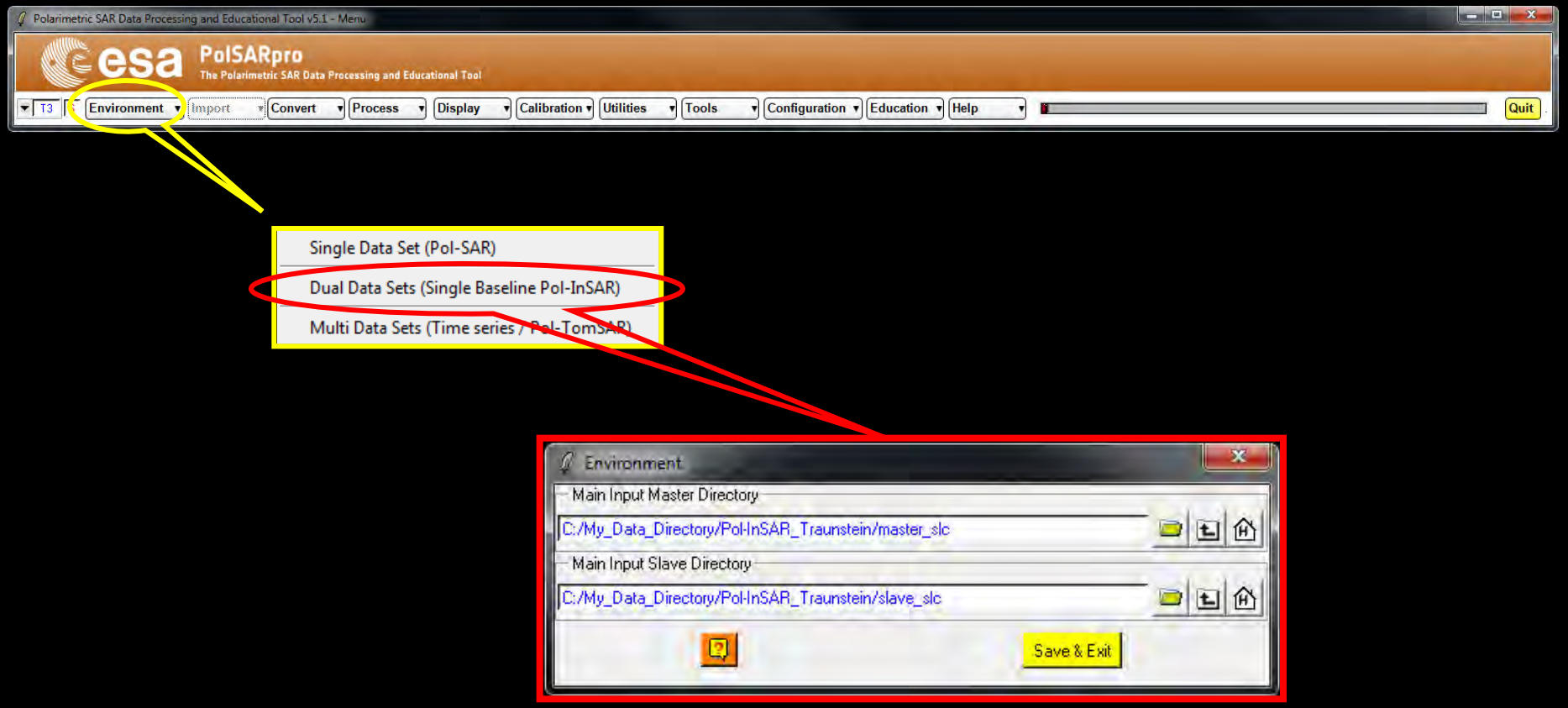
Traunstein / Germany



AfriSAR campaign / Gabon

© E. Pottier – 2018

MAIN MENU - ENVIRONMENT



Input Master Directory:

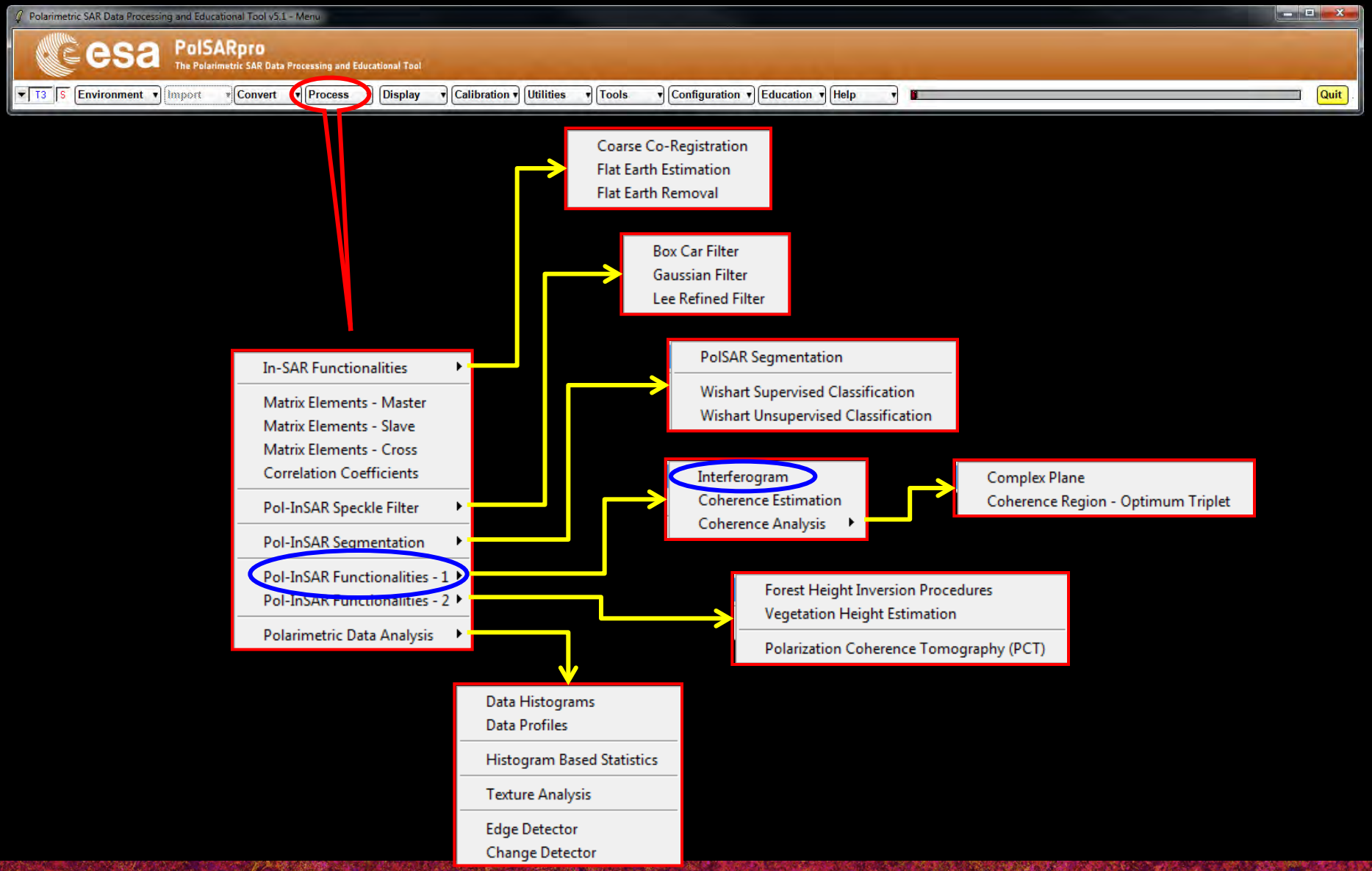
My_Data_Directory / Pol-InSAR_Traunstein / master_slc

Input Slave Directory:

My_Data_Directory / Pol-InSAR_Traunstein / slave_slc

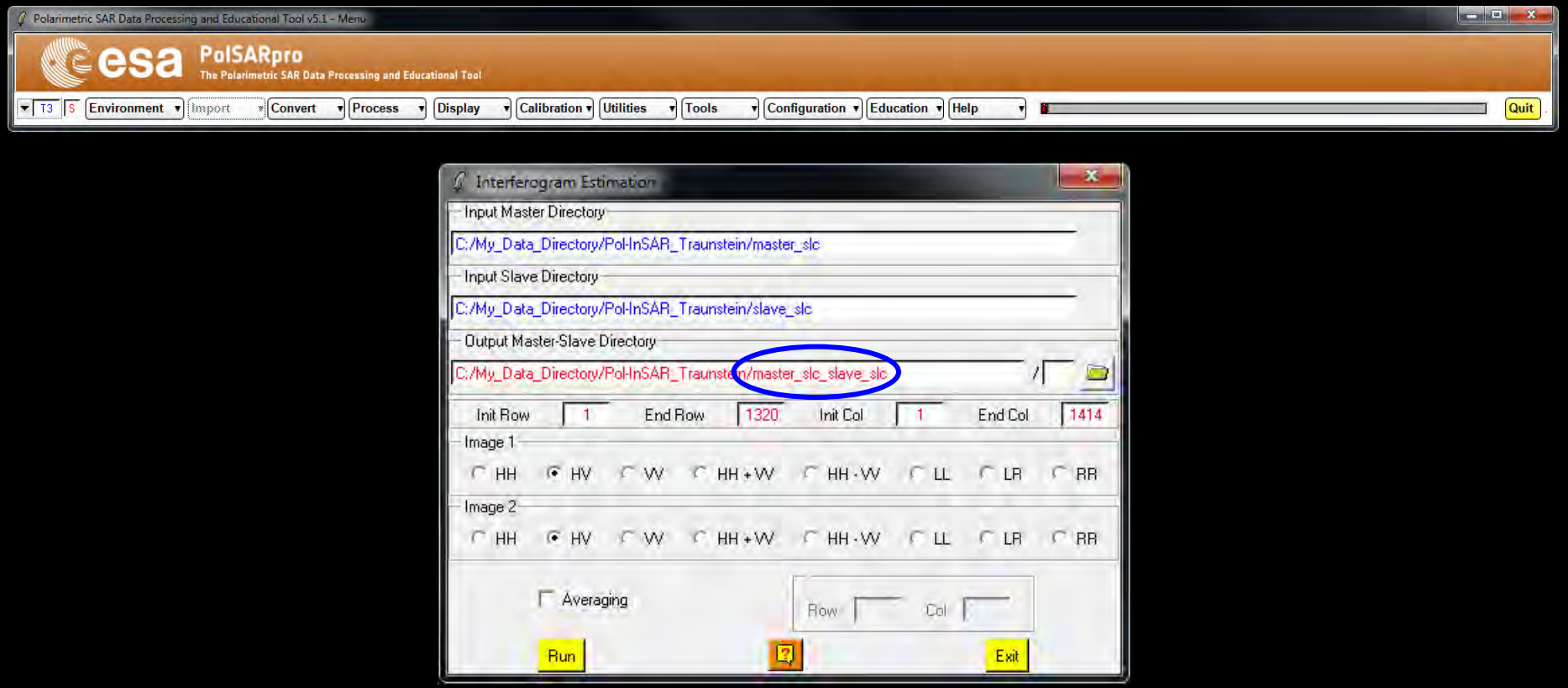
© E. Pottier – 2018

PROCESS DATA



© E. Pottier – 2018

RAW INTERFEROGRAM

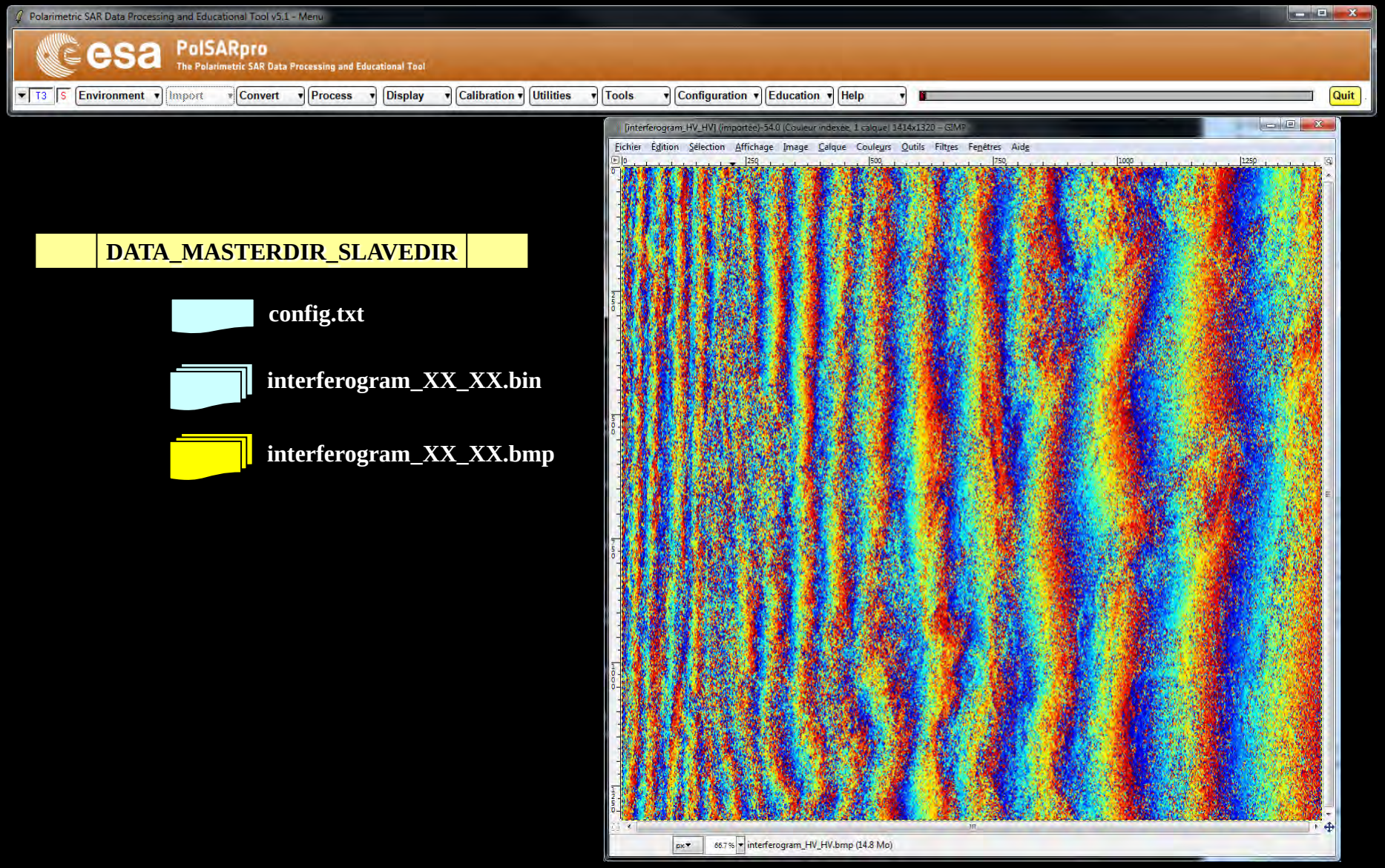


Do it Yourself:
Select polarization channels and view the corresponding BMP files.

Note:
The Output Directory is automatically set to: MasterDir_SlaveDir

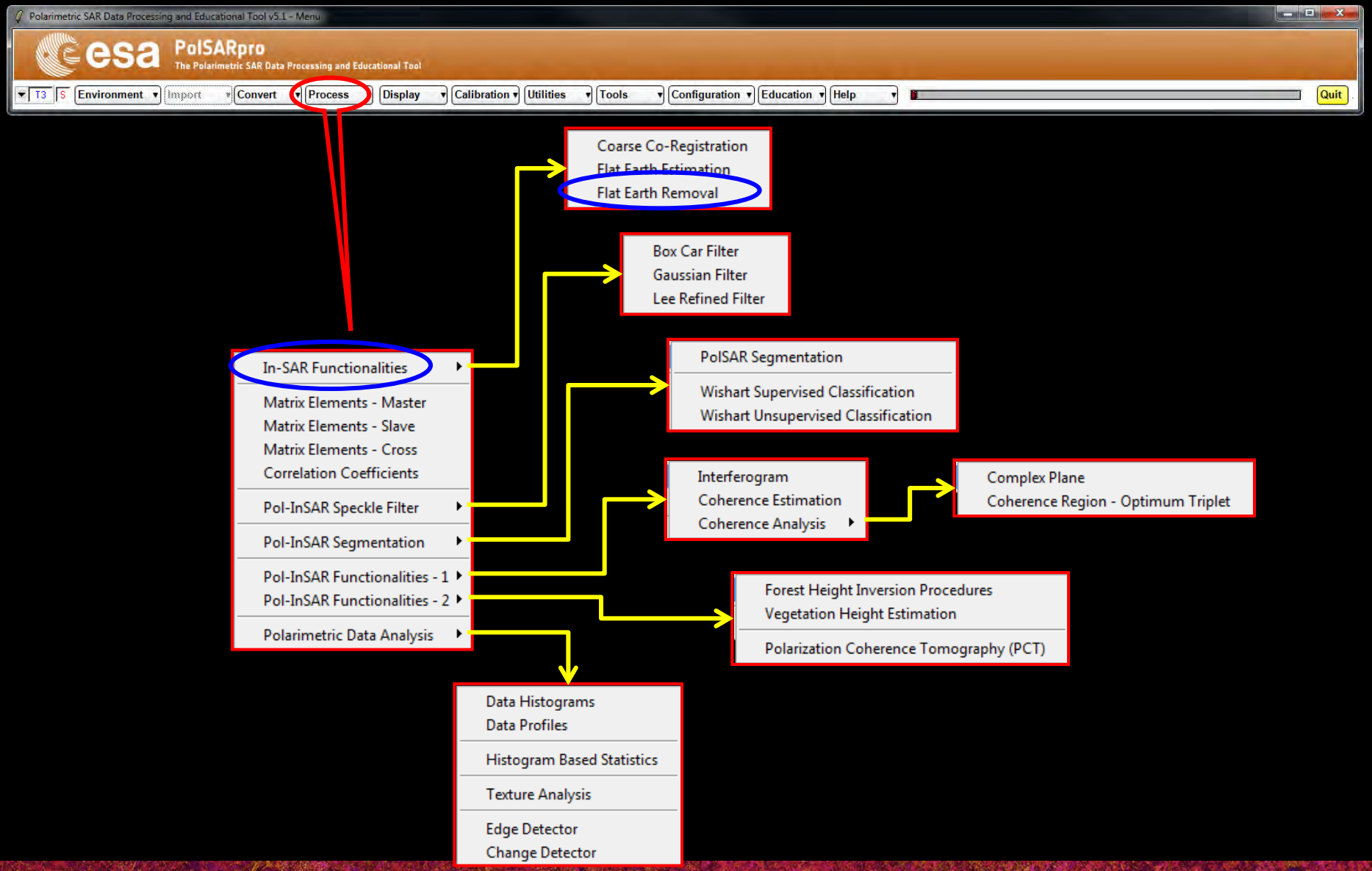
© E. Pottier – 2018

RAW INTERFEROGRAM



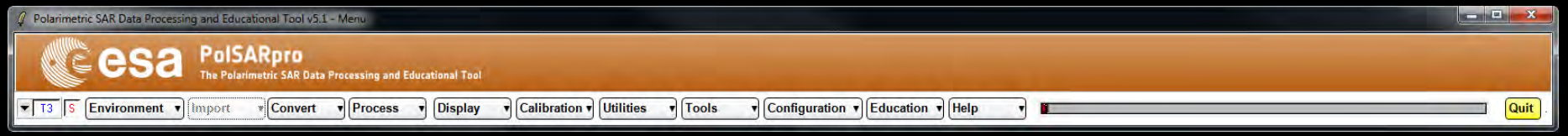
© E. Pottier – 2018

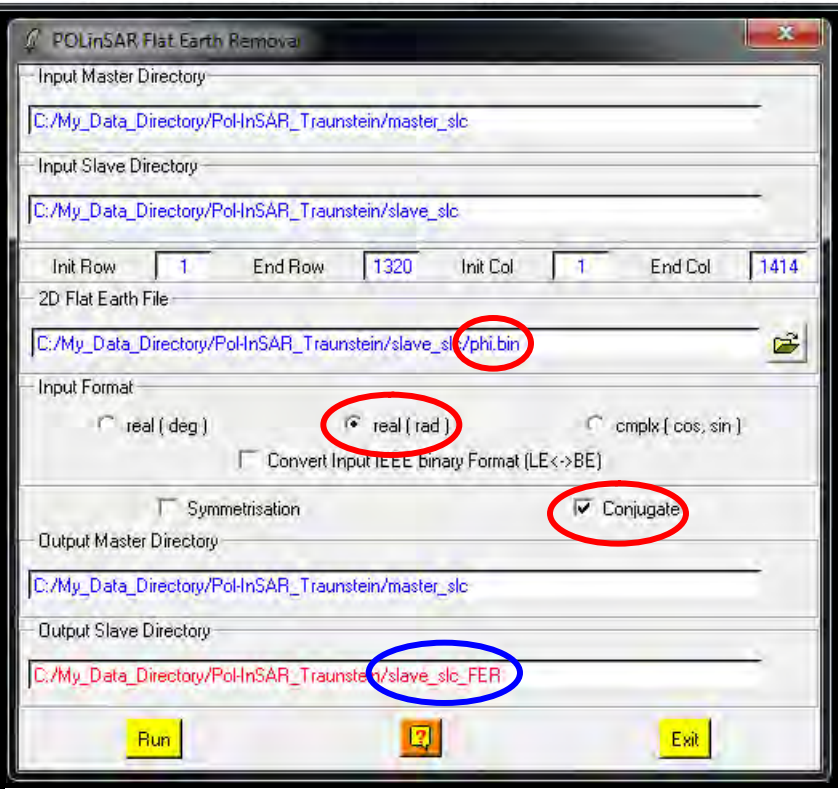
PROCESS DATA

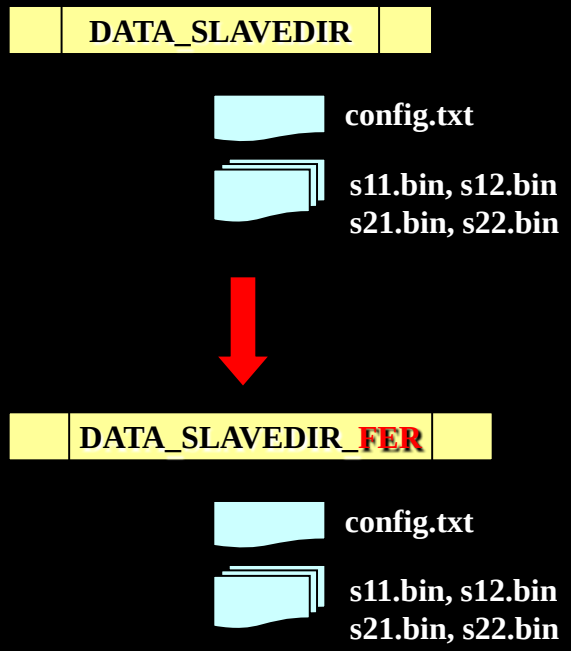


© E. Pottier – 2018

FLAT EARTH REMOVAL





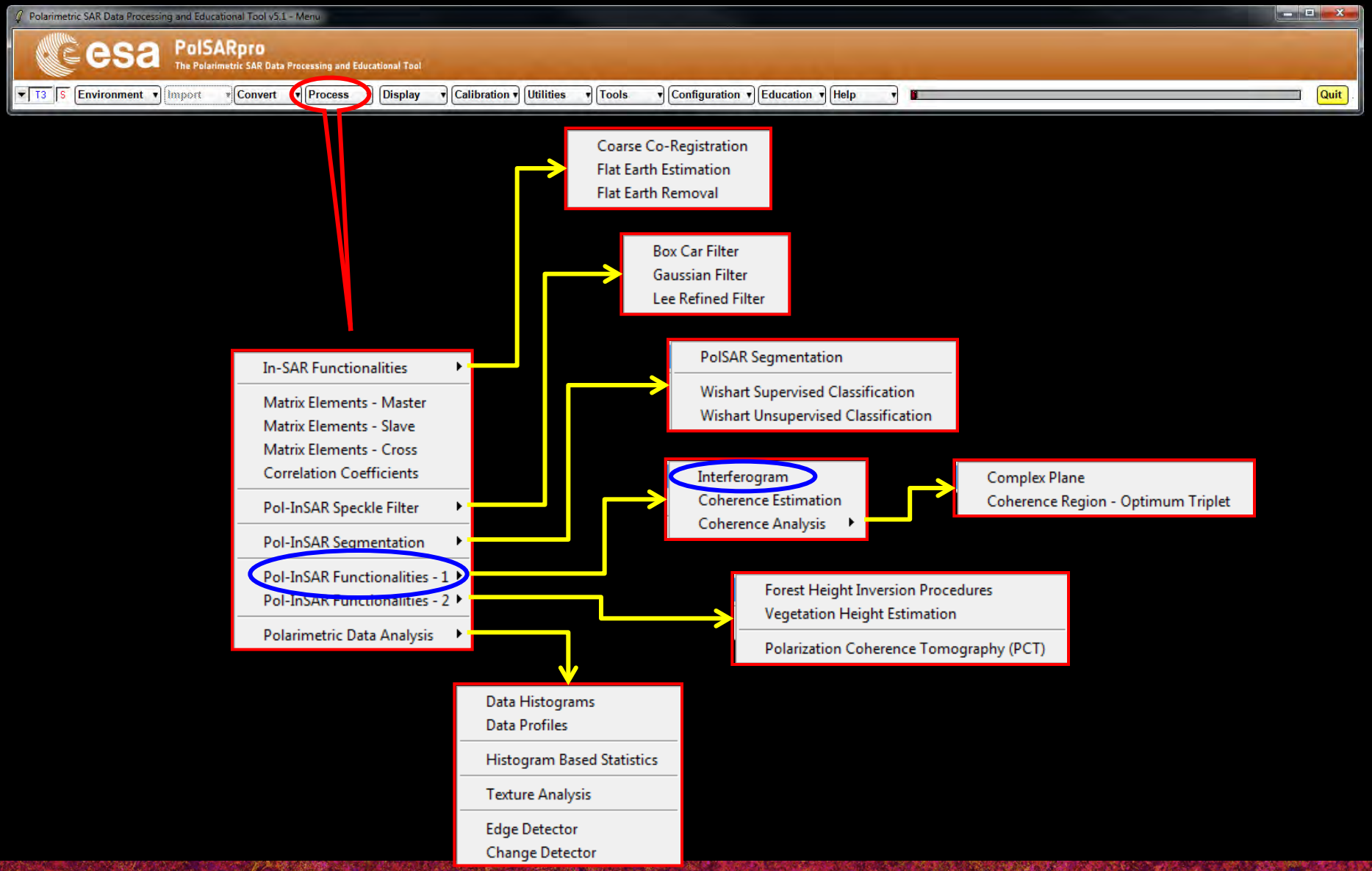


Do it Yourself:
Enter Flat Earth file name, set the parameters and run the function.

Note:
The Input Slave Directory is automatically set to: SlaveDir_FER

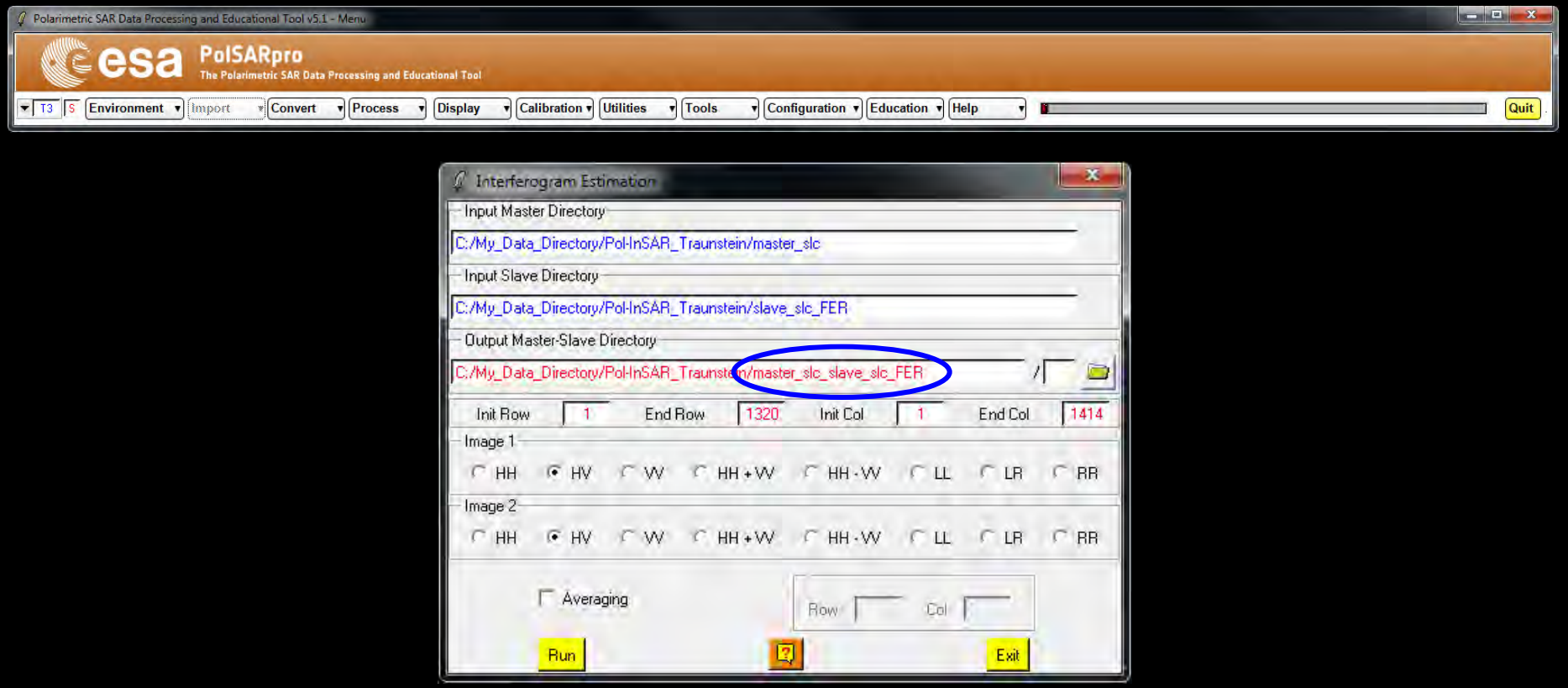
© E. Pottier – 2018

PROCESS DATA



© E. Pottier – 2018

RAW INTERFEROGRAM

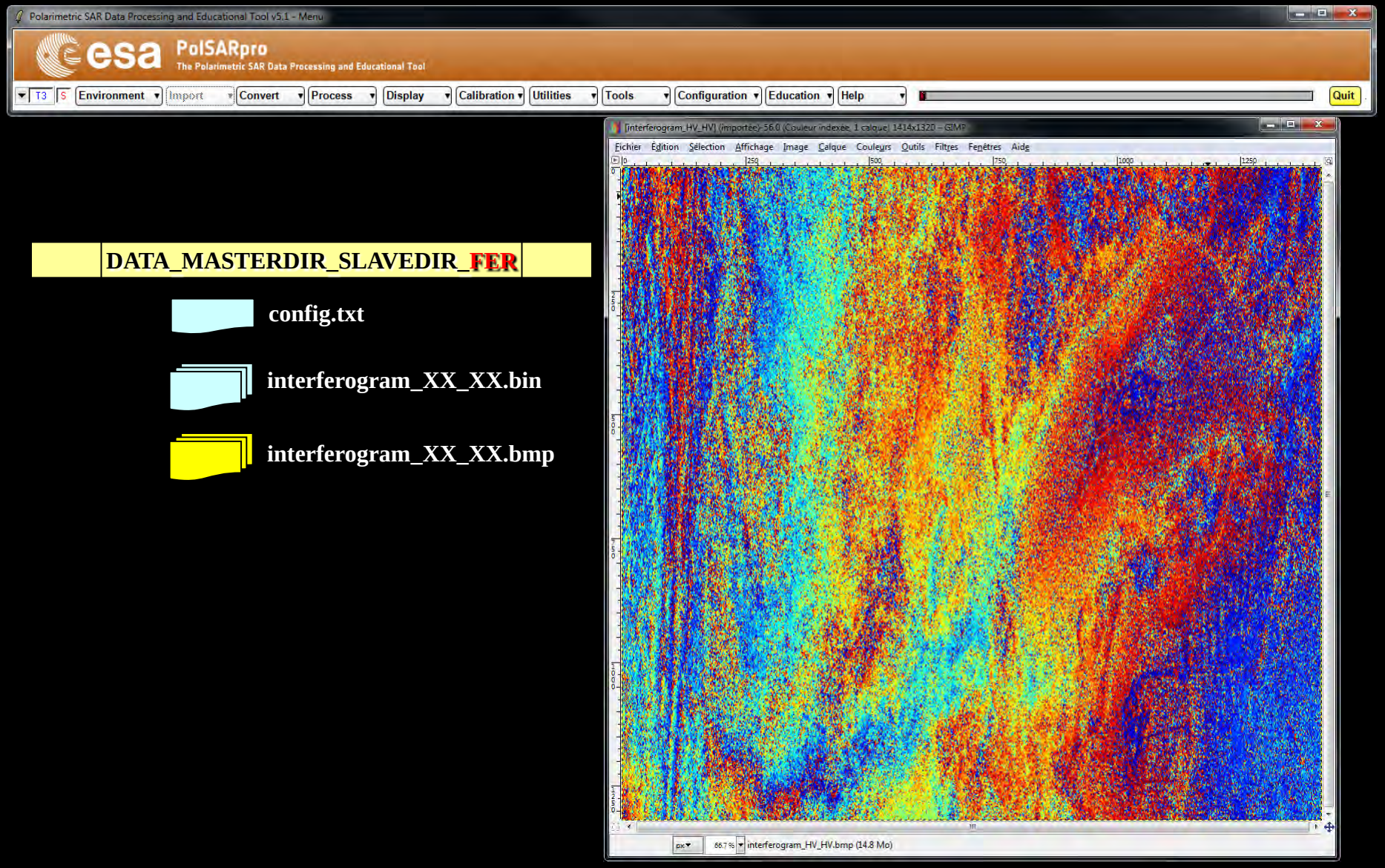


Do it Yourself:
Select polarization channels and view the corresponding BMP files.

Note:
The Output Directory is automatically set to: MasterDir_SlaveDir

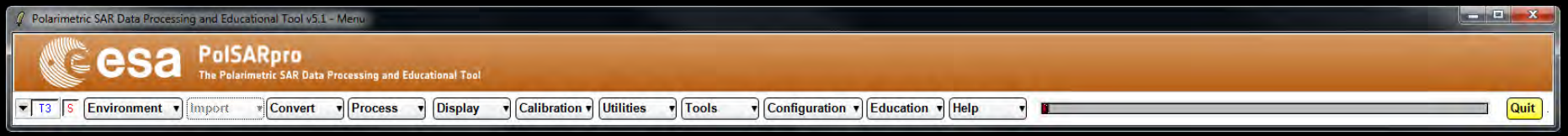
© E. Pottier – 2018

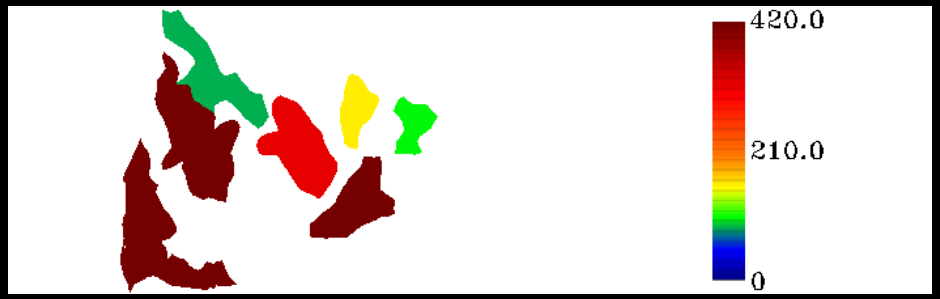
RAW INTERFEROGRAM

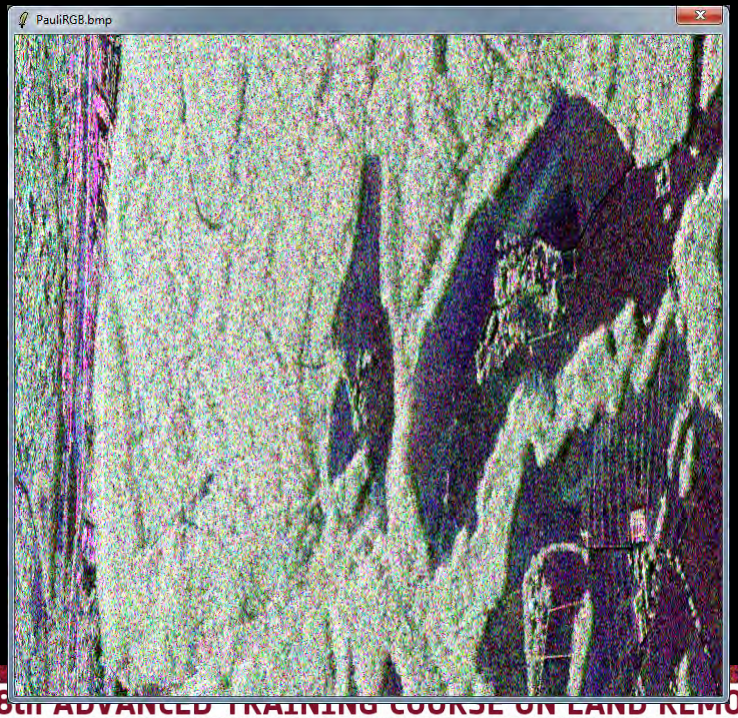


© E. Pottier – 2018

CONVERT (S2 >> T6) + MULTILOOK

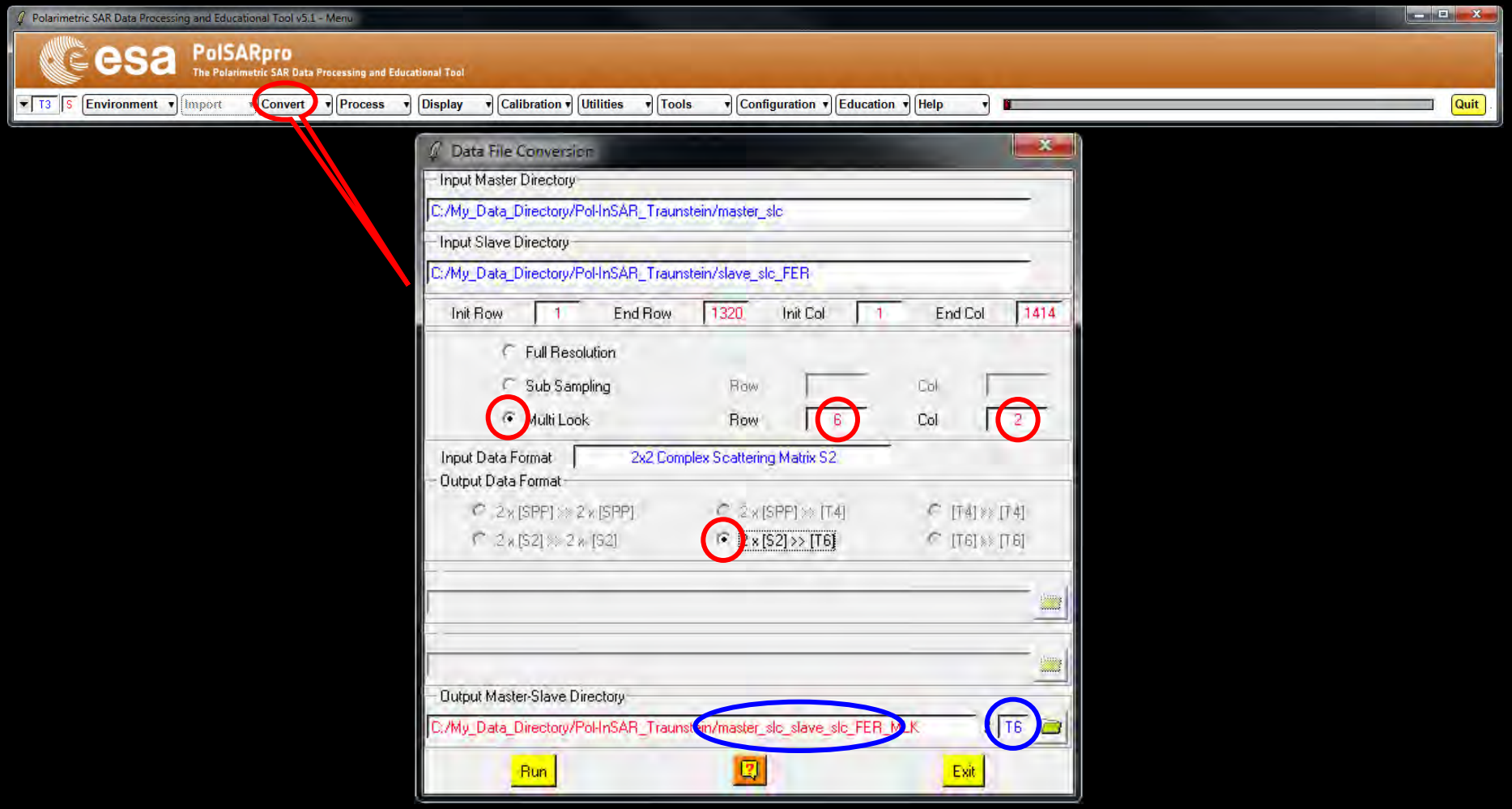






© E. Pottier – 2018

CONVERT (S2 >> T6) + MULTILOOK



Do it Yourself:

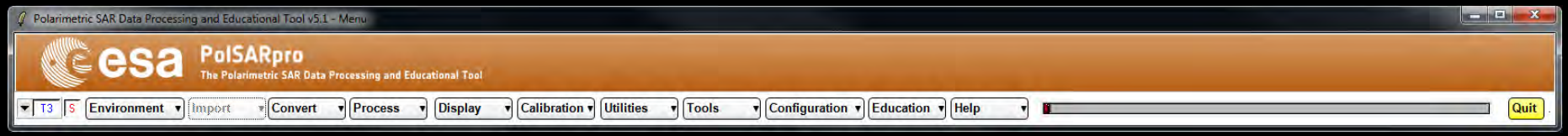
Select Multi Look : Row = 6 and Col = 2

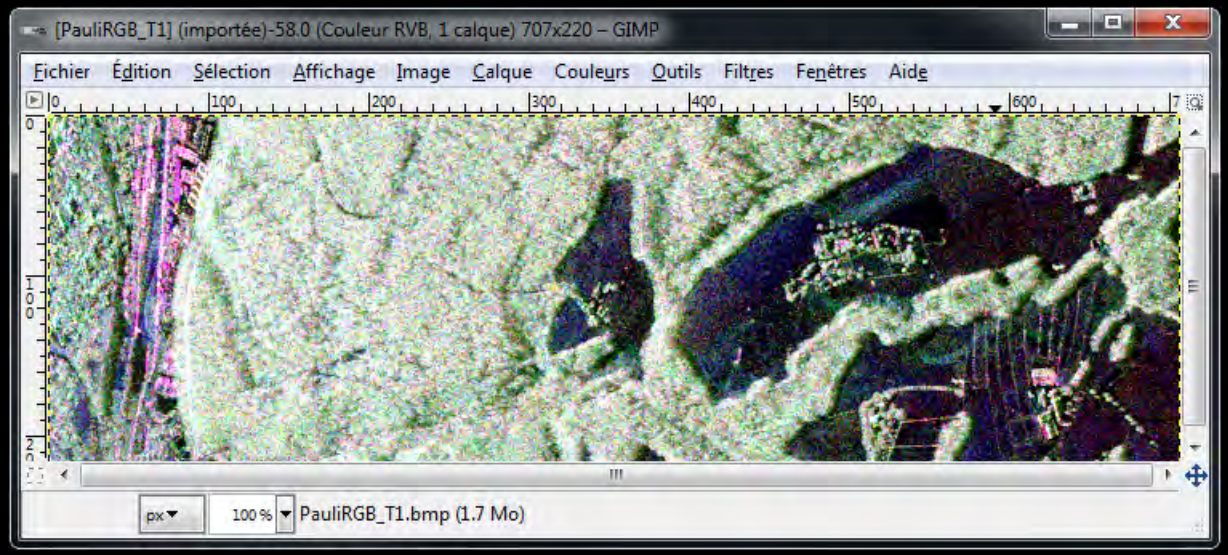
Select Output Data Format : 2 x [S2] >> [T6]

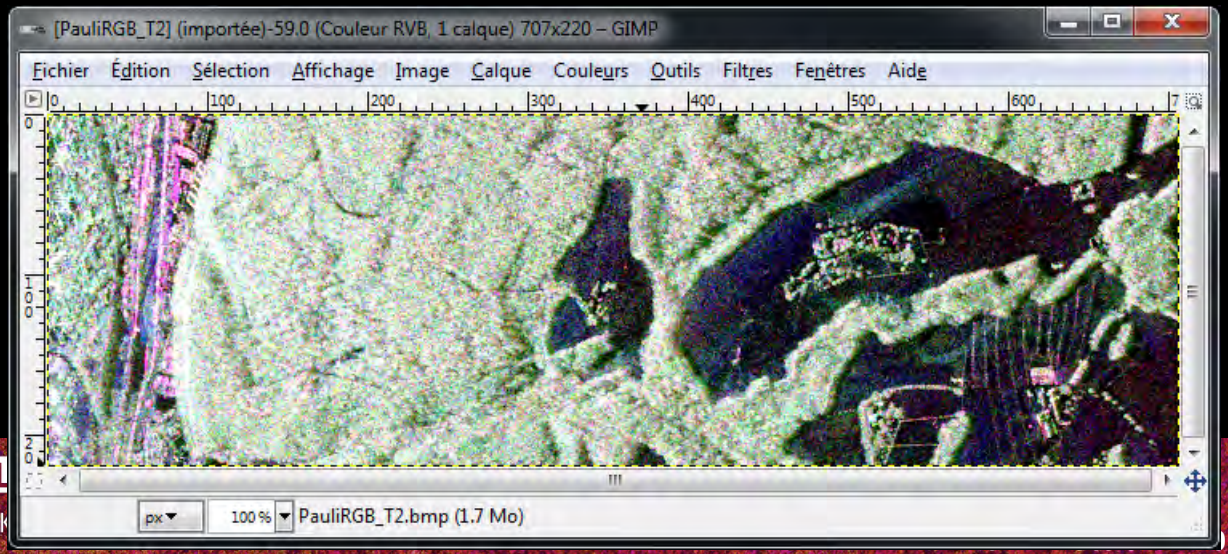
Note:

The Output Directory is automatically set to: MasterDir_SlaveDir_FER_MLK / T6

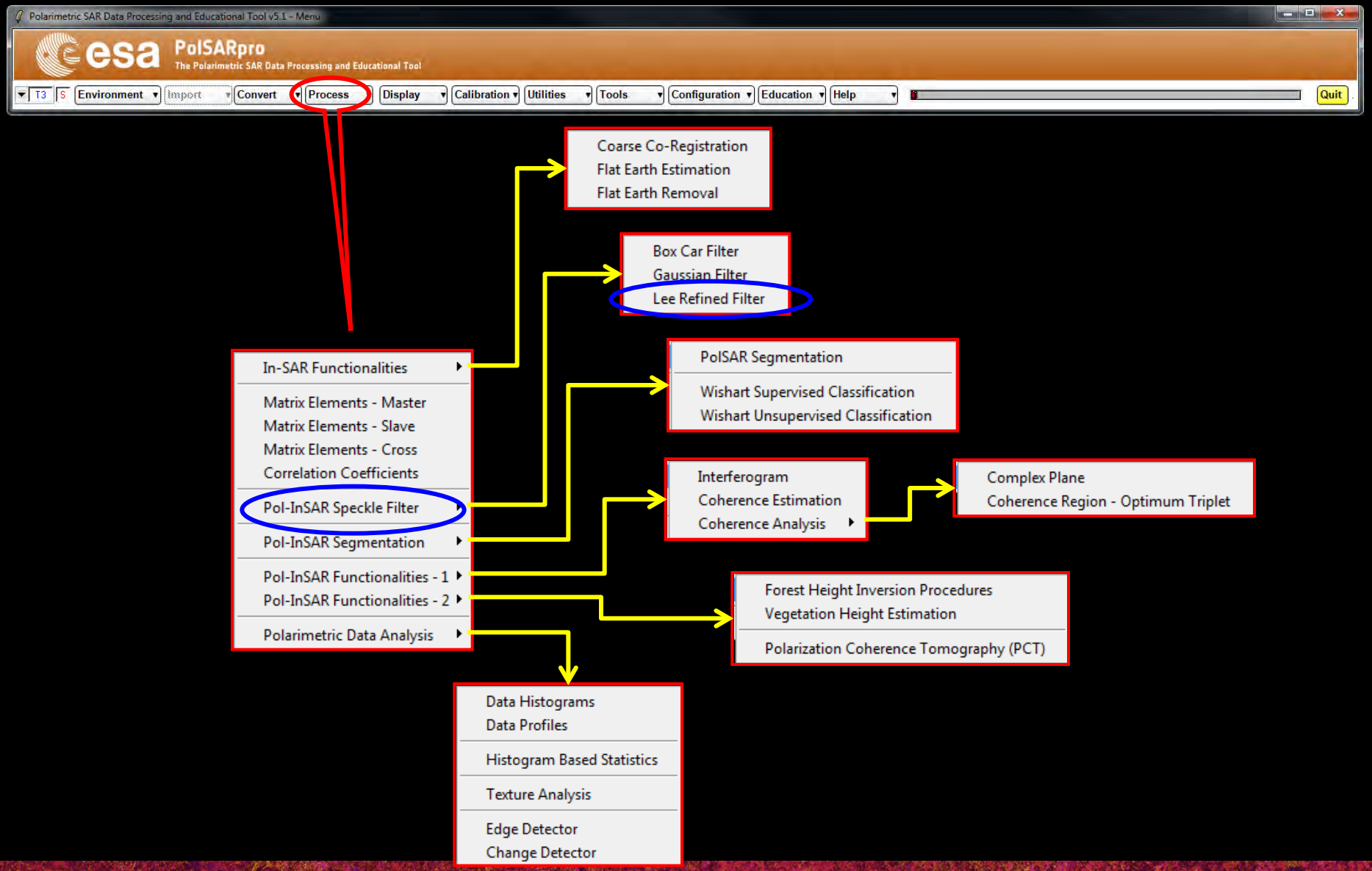
CONVERT (S2 >> T6) + MULTILOOK





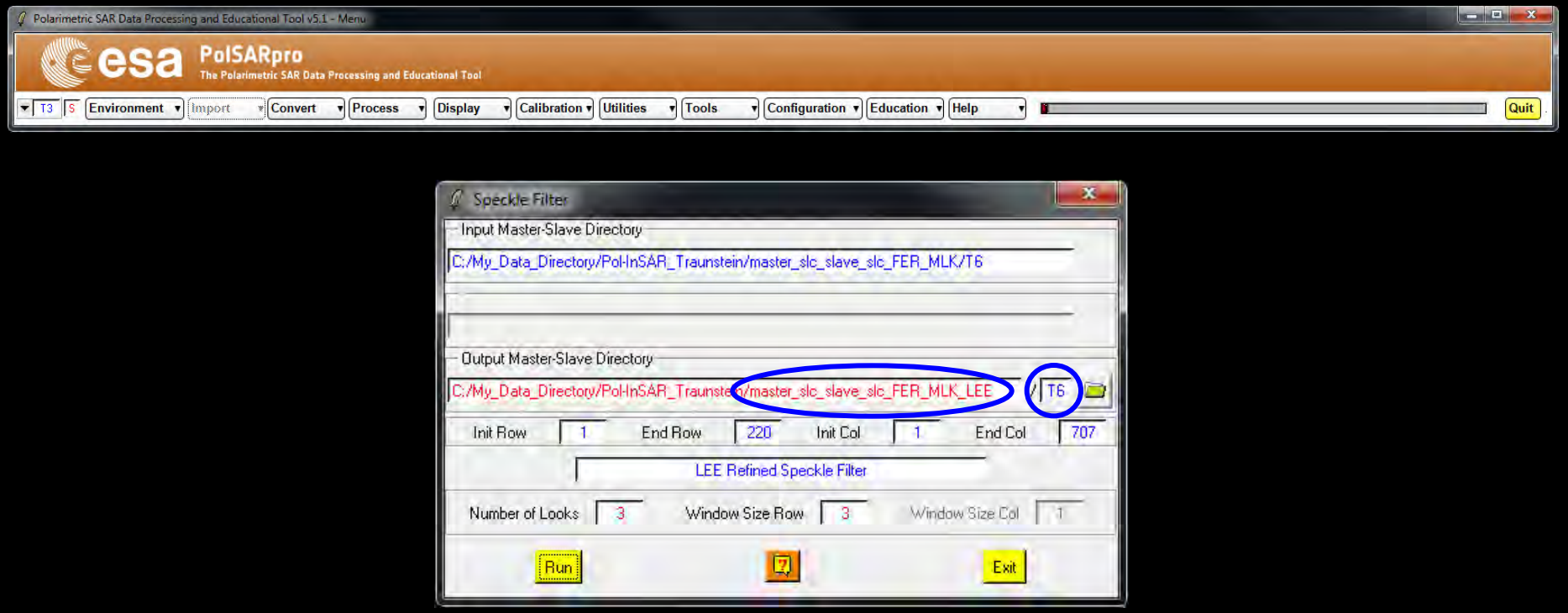


PROCESS DATA



© E. Pottier – 2018

PROCESS DATA

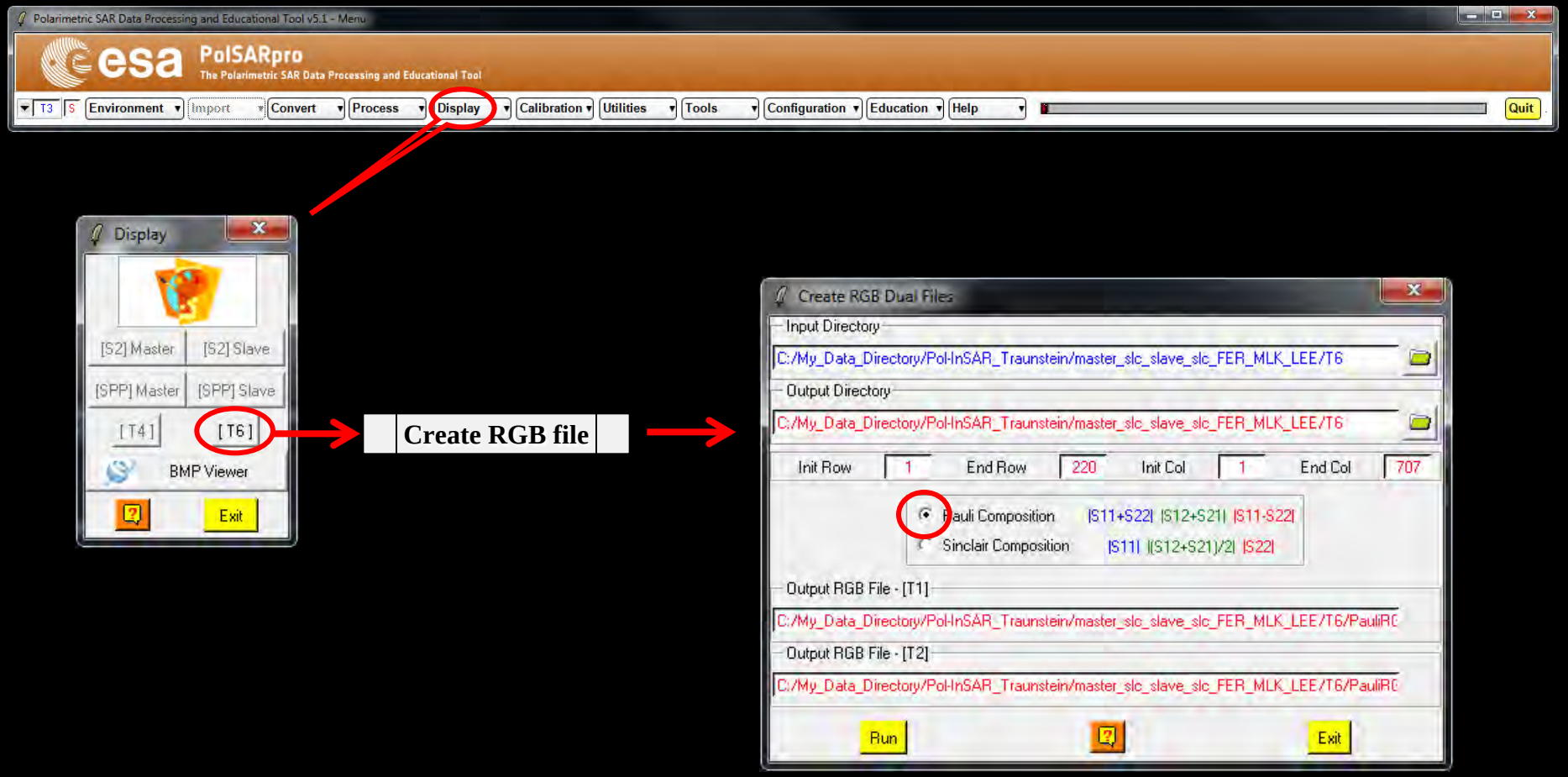


Do it Yourself:
Set the parameters : Num Looks = 3 ; Window Size = 3.

Note:
The Output Directory is automatically set to: MasterDir_SlaveDir_FER_MLK_LEE

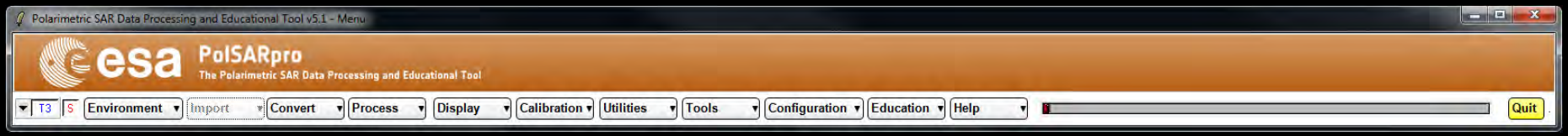
© E. Pottier – 2018

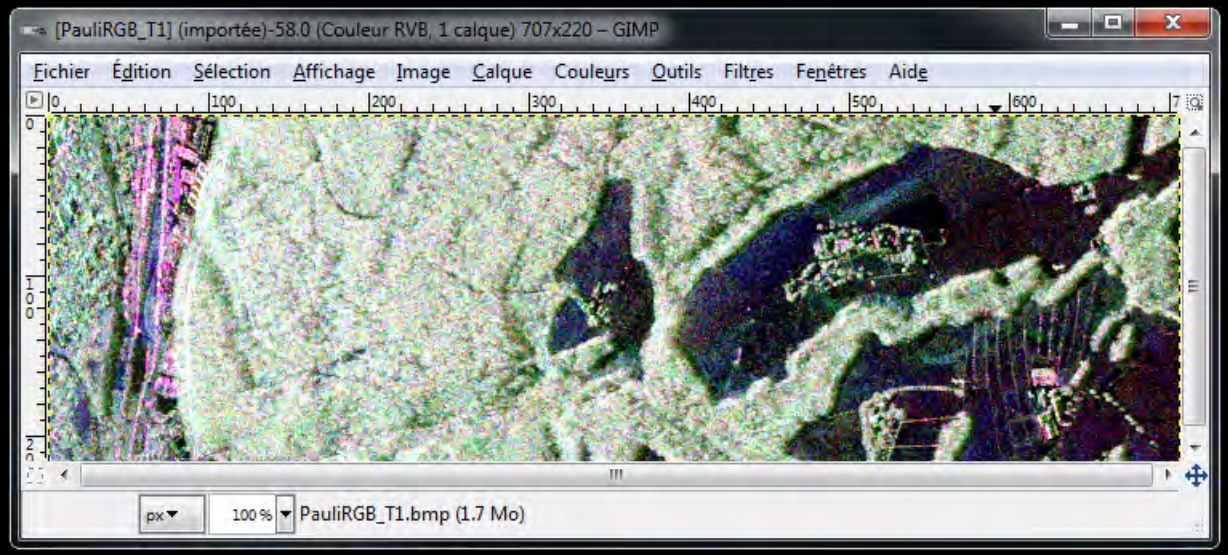
DISPLAY DATA

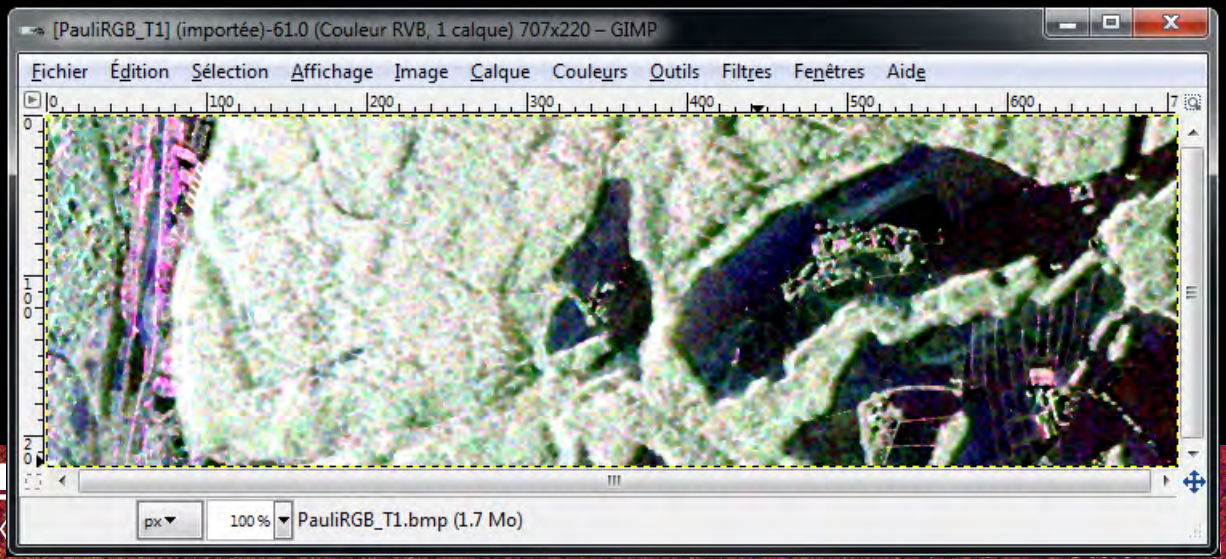


© E. Pottier – 2018

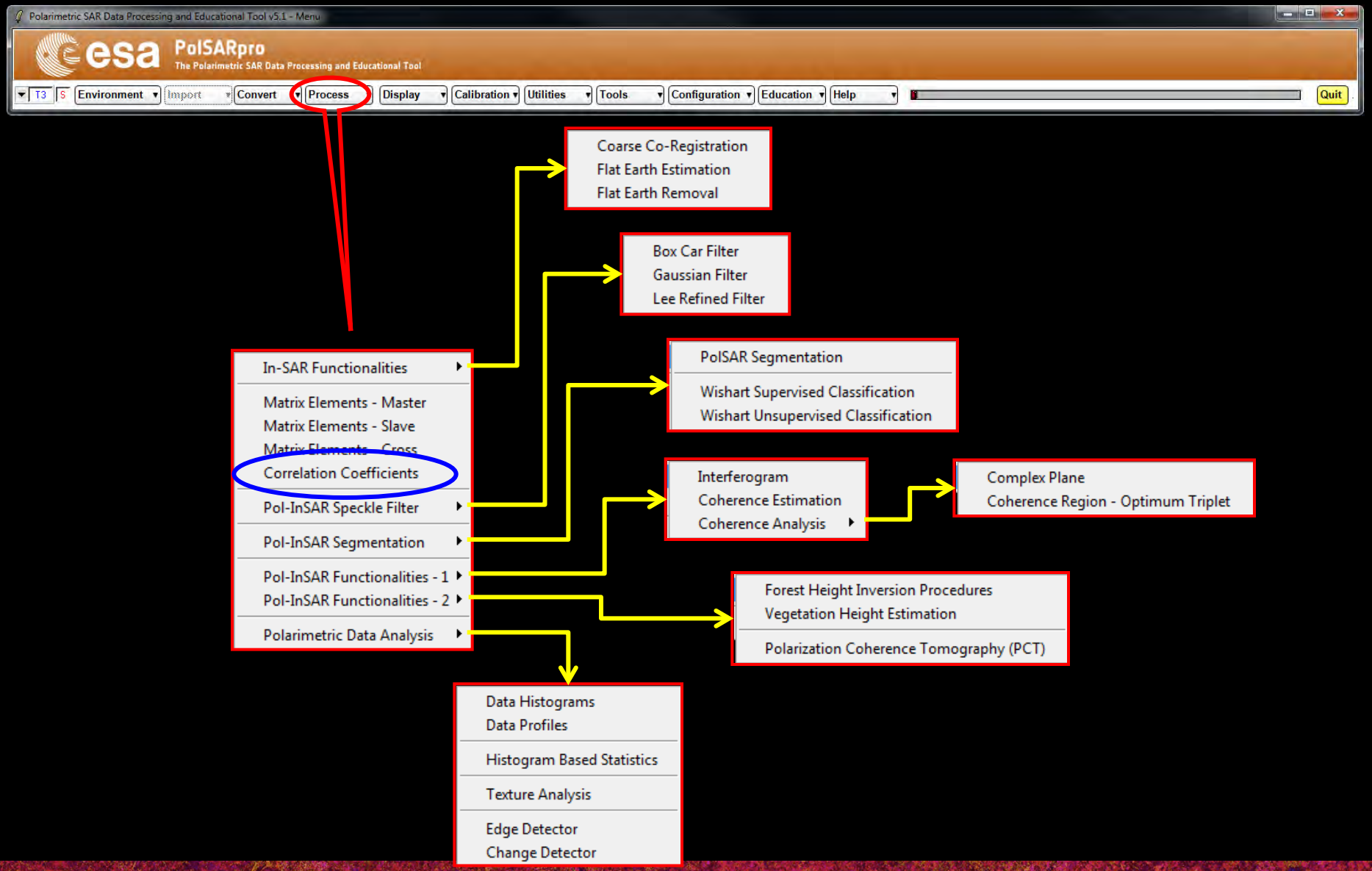
PROCESS DATA





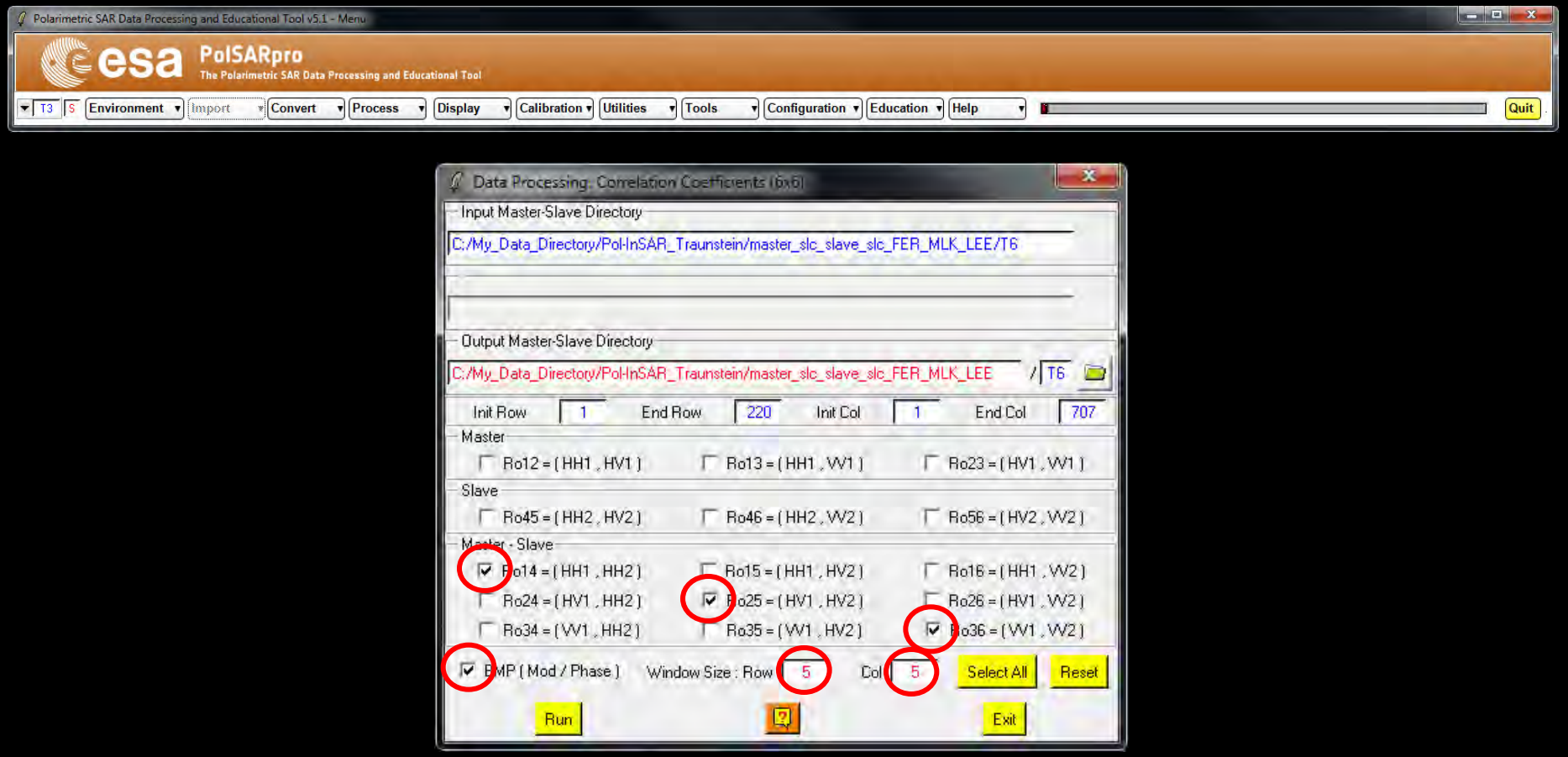


PROCESS DATA



© E. Pottier – 2018

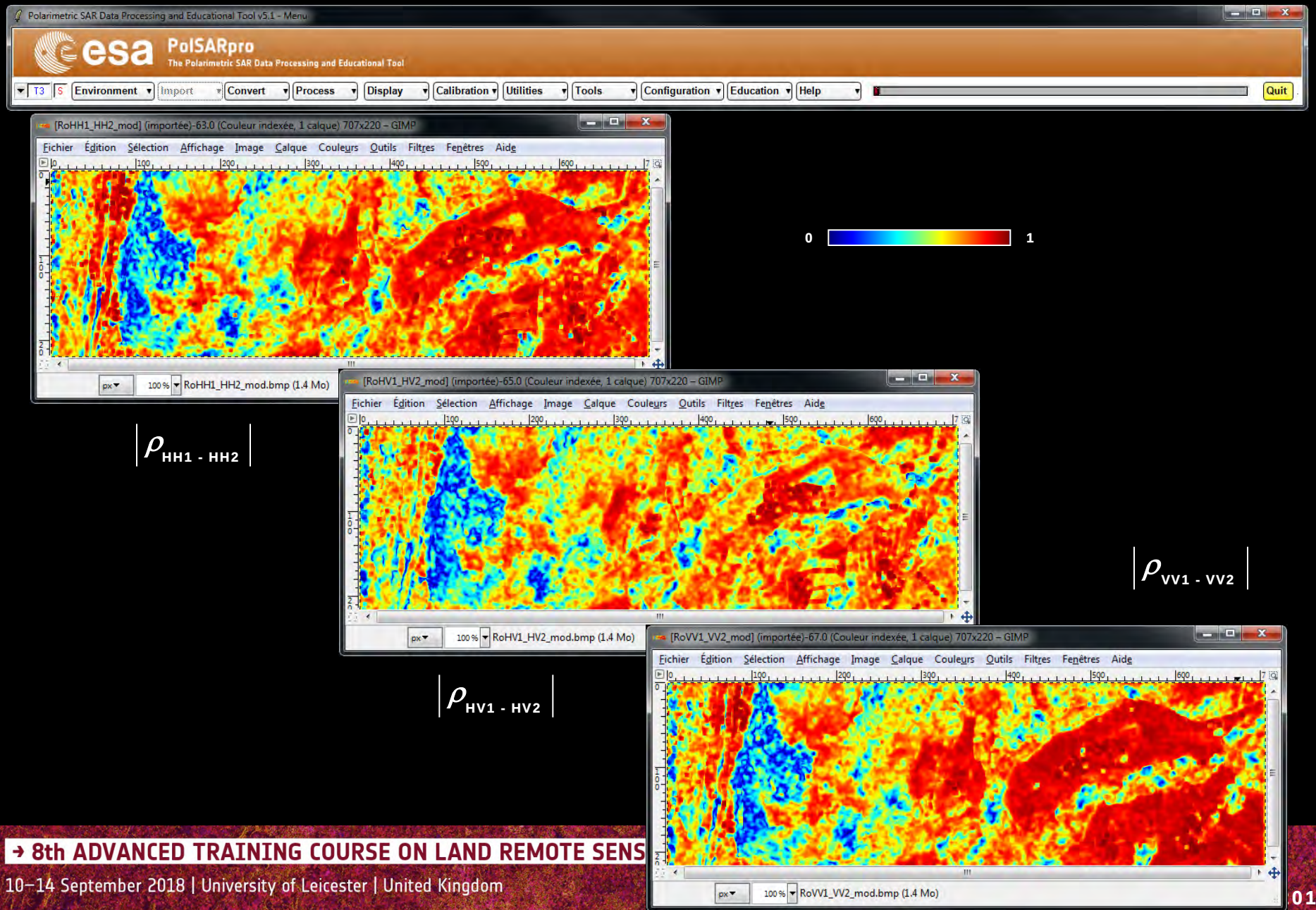
PROCESS DATA



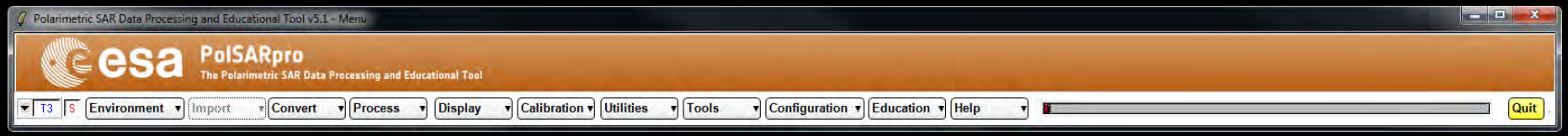
Do it Yourself:

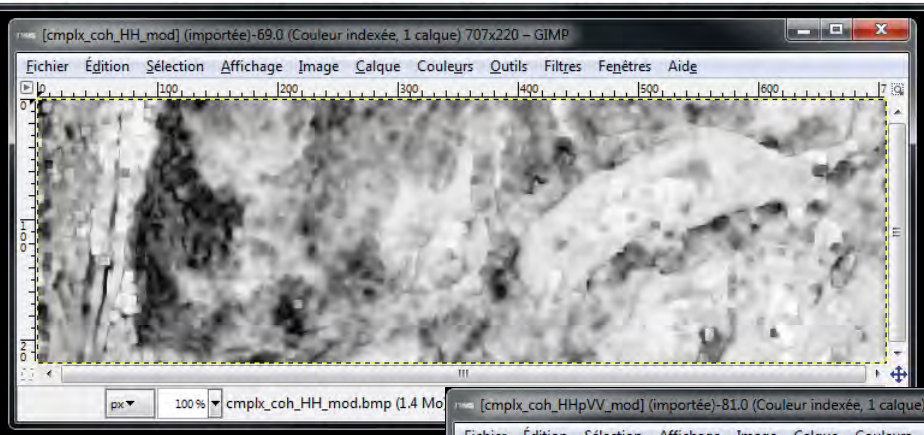
Select the correlation coefficients, set the parameters (*Box Car= 5x5*) and view the corresponding BMP files.

© E. Pottier – 2018

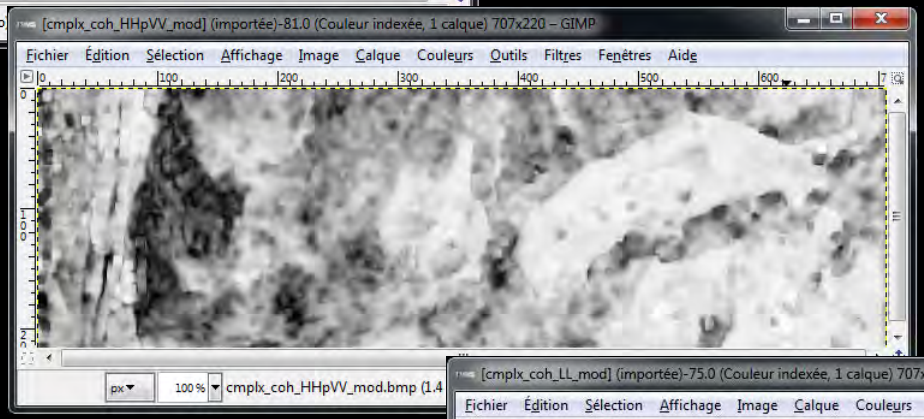

Polarimetric SAR Data Processing and Educational Tool v5.1 - Menu
PolSARpro
The Polarimetric SAR Data Processing and Educational Tool
Environment
Import
Convert
Process
Display
Calibration
Utilities
Tools
Configuration
Education
Help
Quit
[RoHH1_HH2_mod] (importée)-63.0 (Couleur indexée, 1 calque) 707x220 – GIMP
RoHH1_HH2_mod.bmp (1.4 Mo)
0
1
$|\rho_{HH1 - HH2}|$
[RoHV1_HV2_mod] (importée)-65.0 (Couleur indexée, 1 calque) 707x220 – GIMP
RoHV1_HV2_mod.bmp (1.4 Mo)
$|\rho_{HV1 - HV2}|$
[RoVV1_VV2_mod] (importée)-67.0 (Couleur indexée, 1 calque) 707x220 – GIMP
RoVV1_VV2_mod.bmp (1.4 Mo)
$|\rho_{VV1 - VV2}|$

CORRELATION ESTIMATION





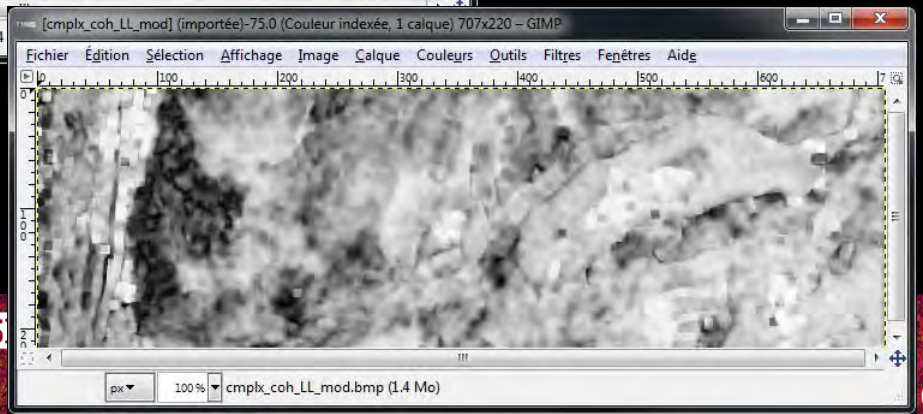
$|\gamma_{HH}|$



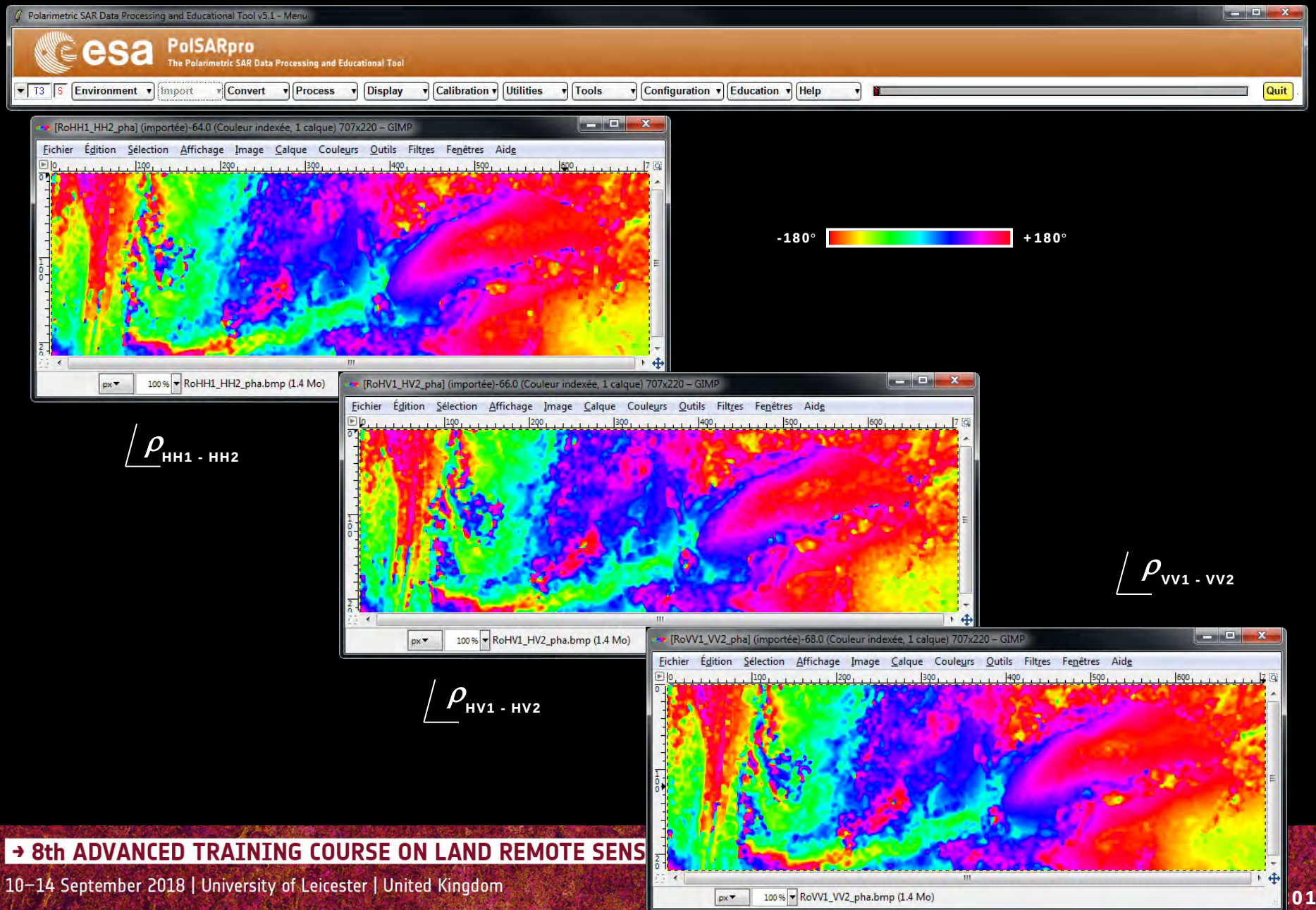
$|\gamma_{HH+VV}|$

0 — 1

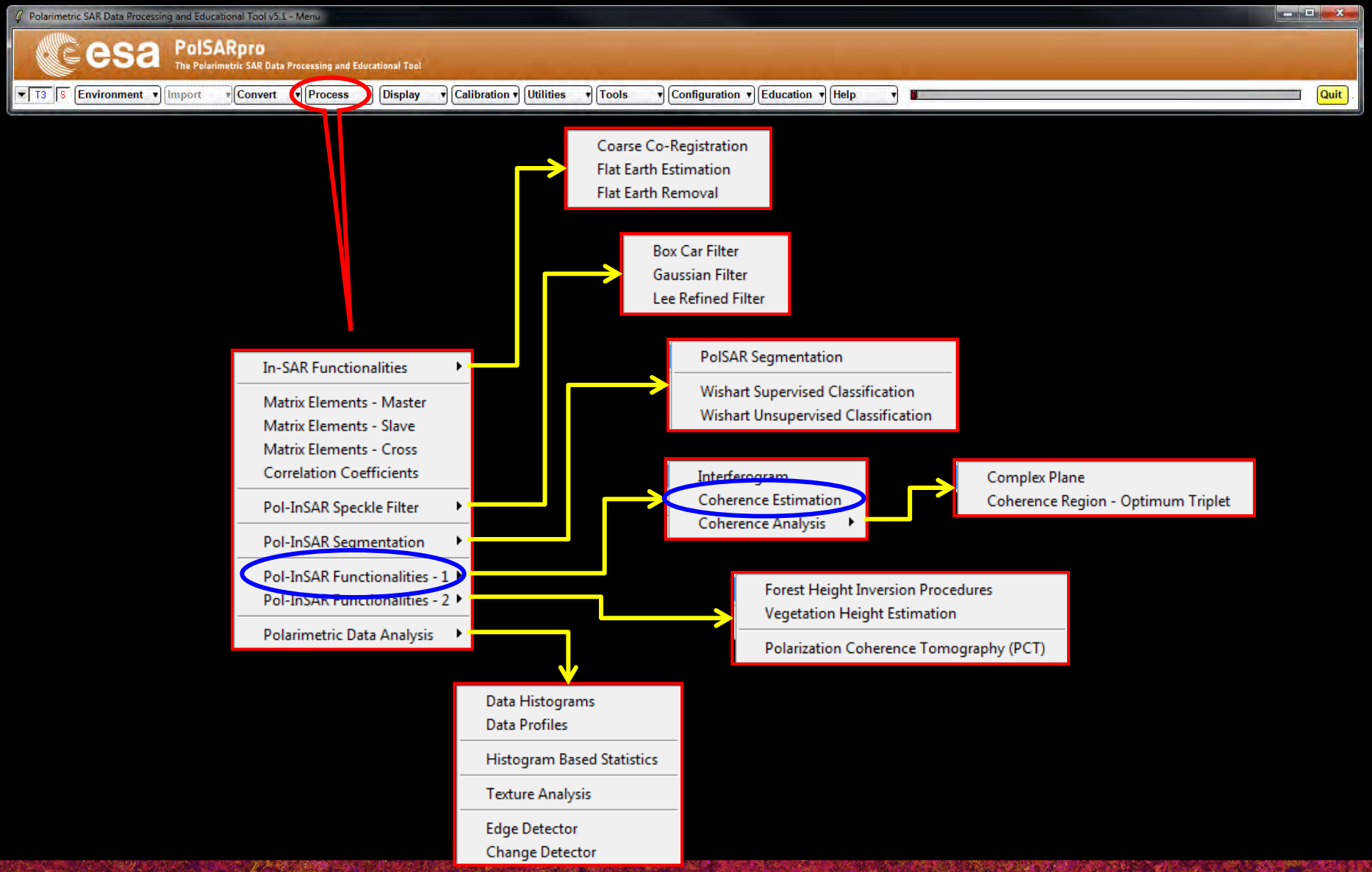
$|\gamma_{LL}|$



CORRELATION ESTIMATION

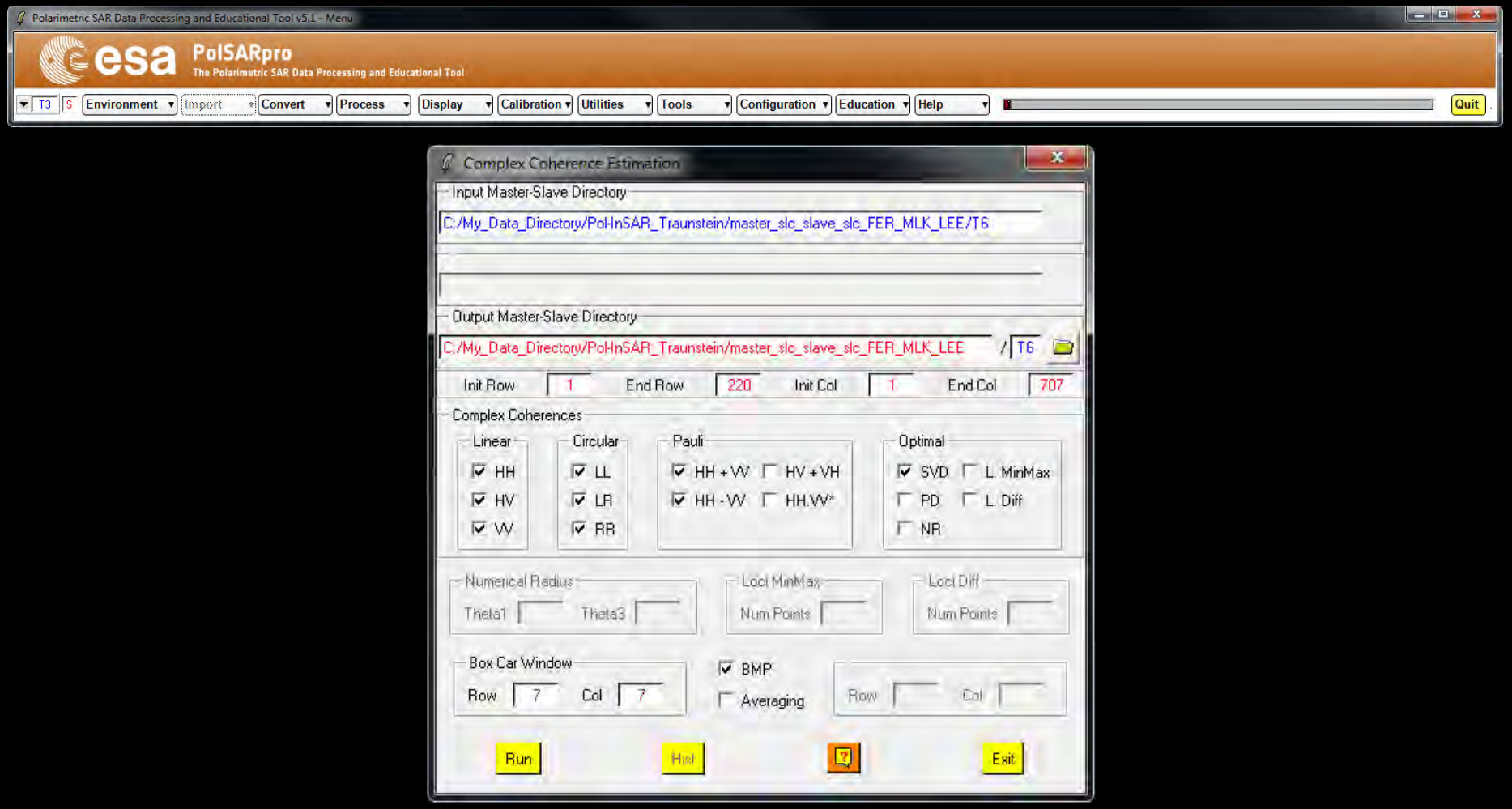


PROCESS DATA



© E. Pottier – 2018

COHERENCE ESTIMATION

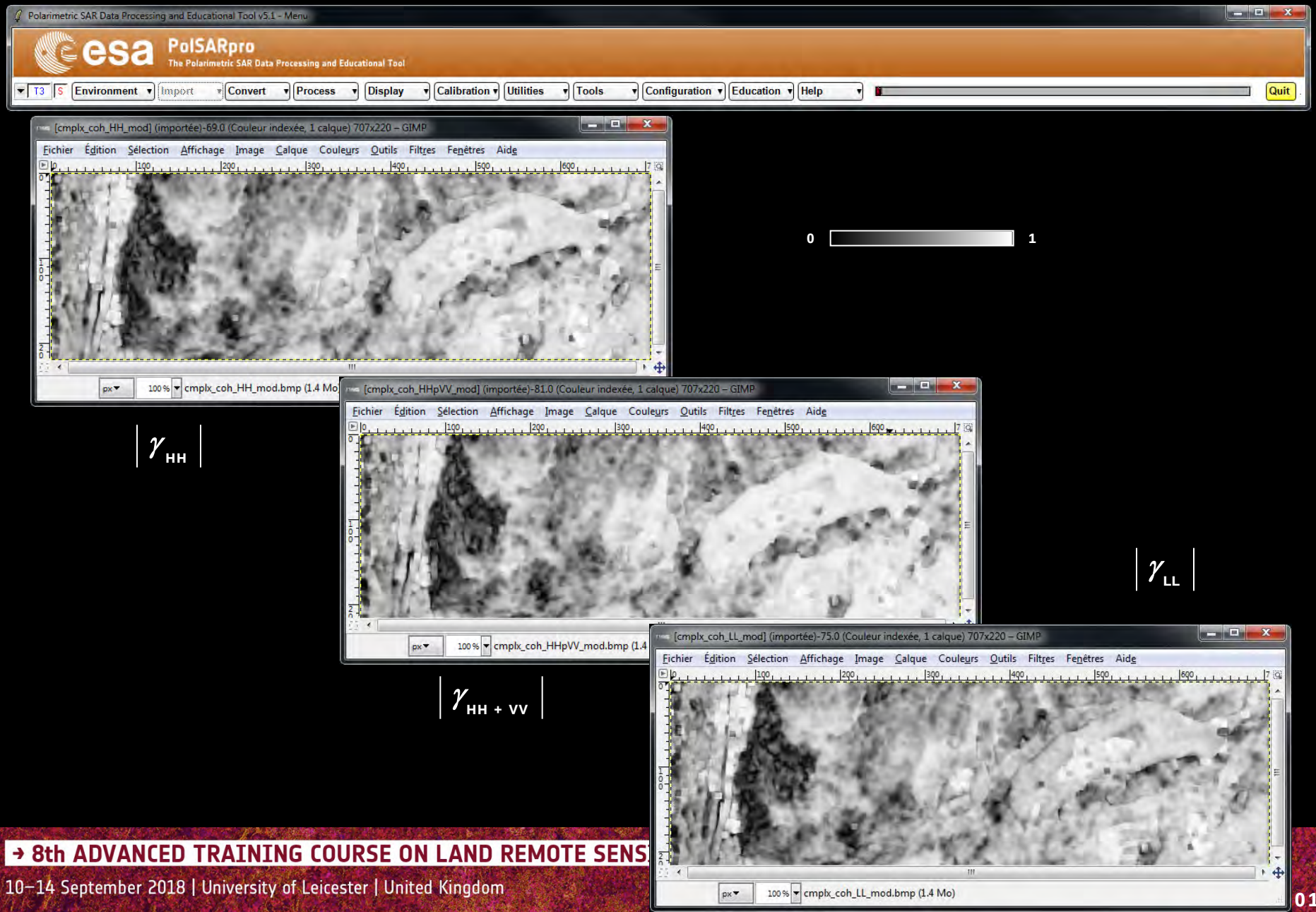


Do it Yourself:

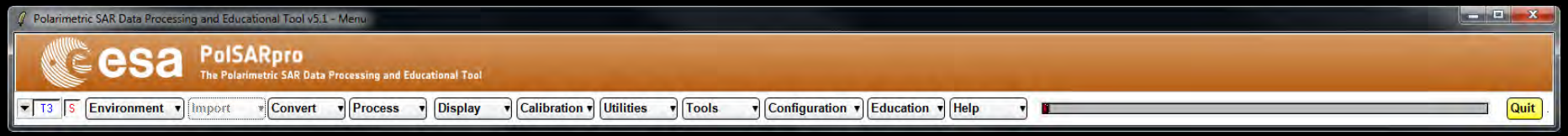
Select polarization channels (*linear, circular, pauli, SVD*), set the parameters (*Box Car = 7x7*) and view the corresponding BMP files (*select BMP*).

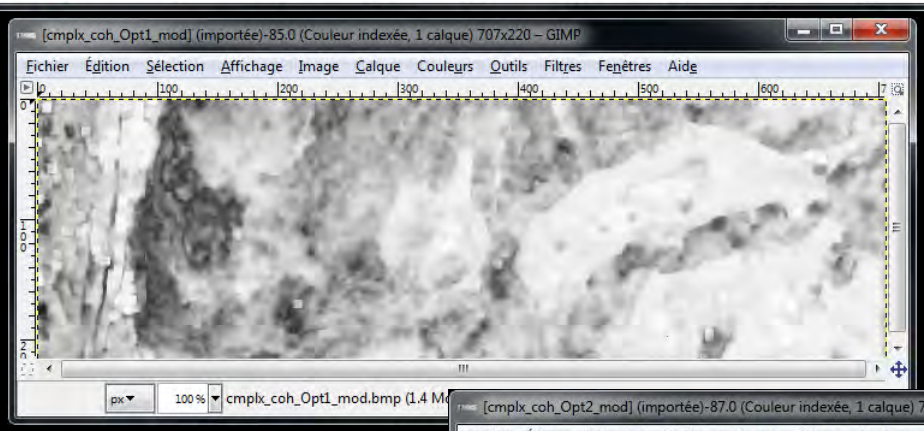
© E. Pottier – 2018

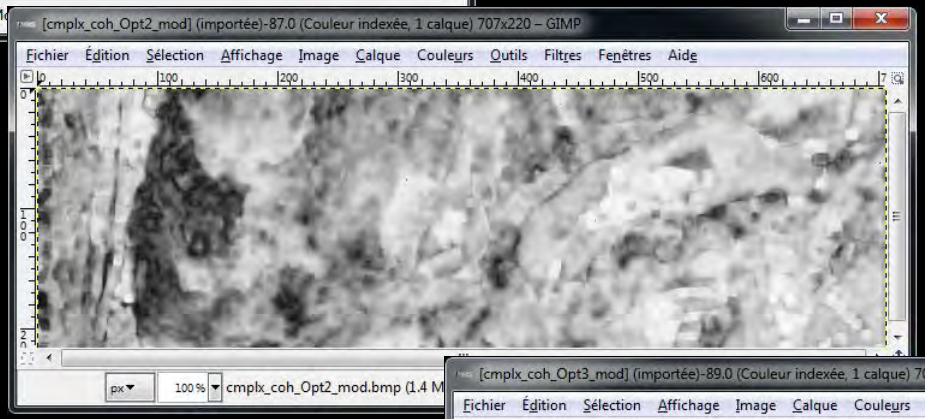
COHERENCE ESTIMATION

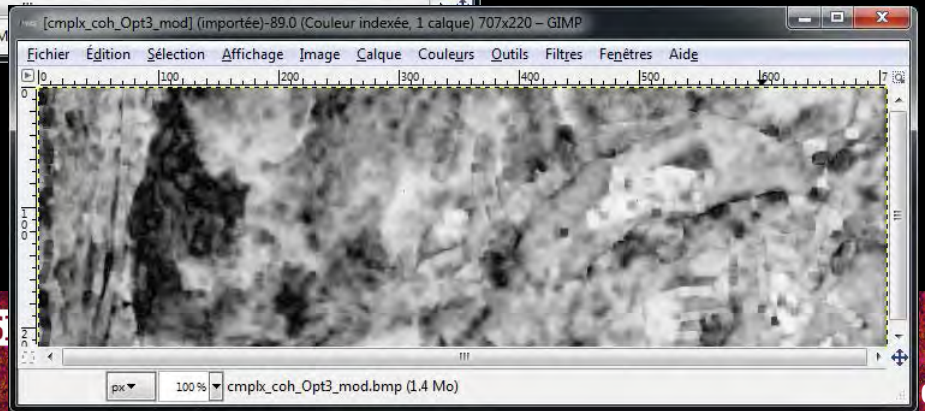


COHERENCE ESTIMATION







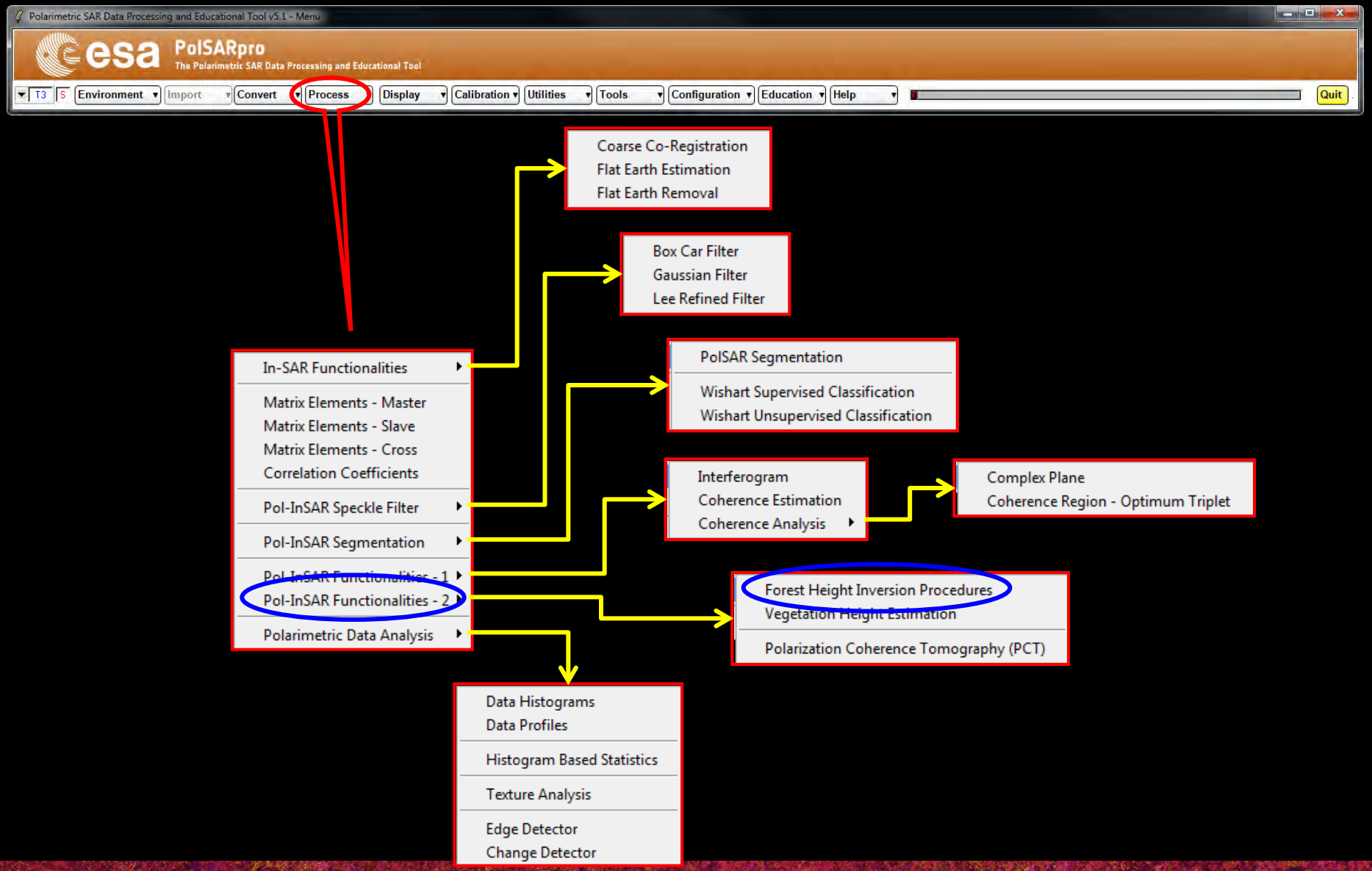


γ_{OPT-1}

γ_{OPT-2}

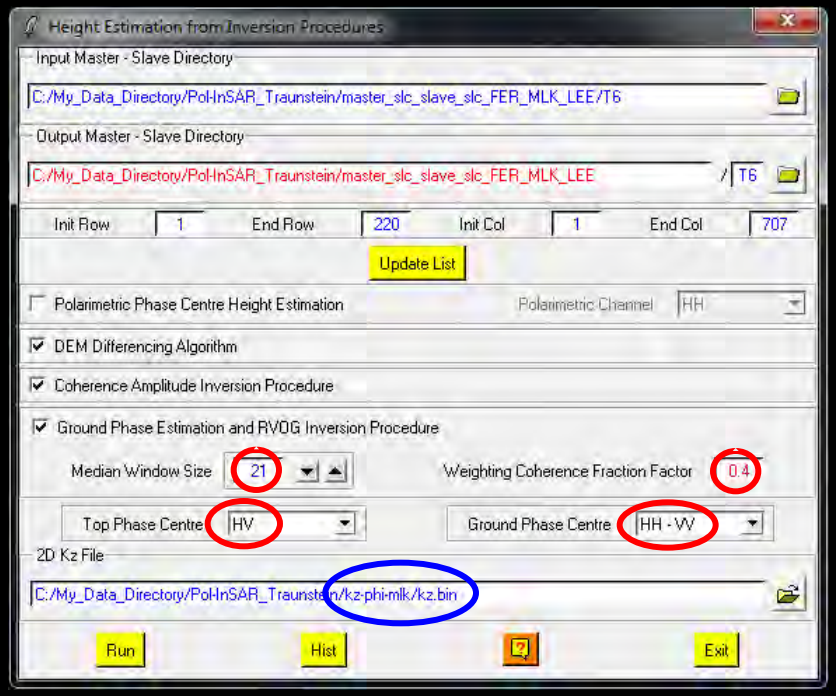
γ_{OPT-3}

PROCESS DATA



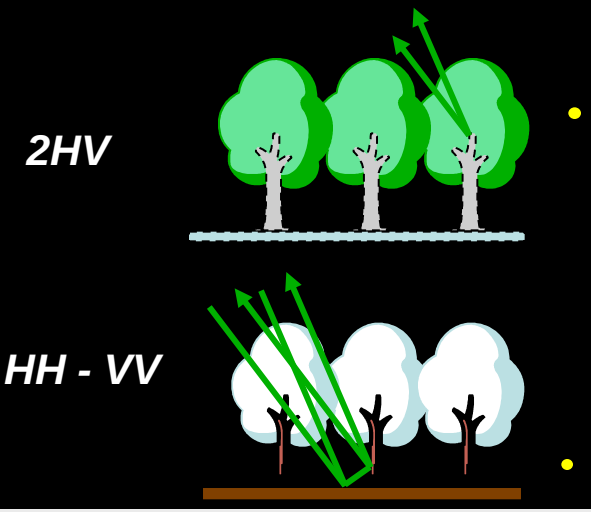
© E. Pottier – 2018

HEIGHT ESTIMATION



INVERSION PROCEDURES

- DEM Differencing Algorithm
- Coherence Amplitude Inversion Procedure
- Ground Phase Estimation &
- RVOG Inversion Procedure



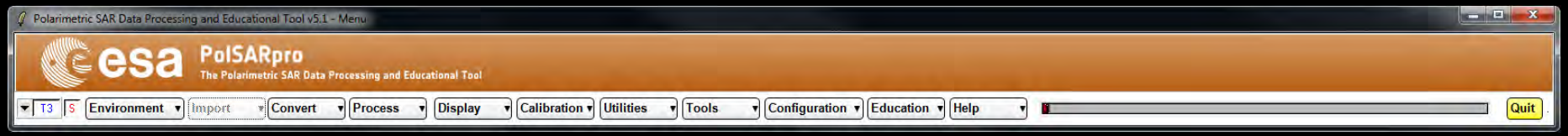
Do it Yourself:

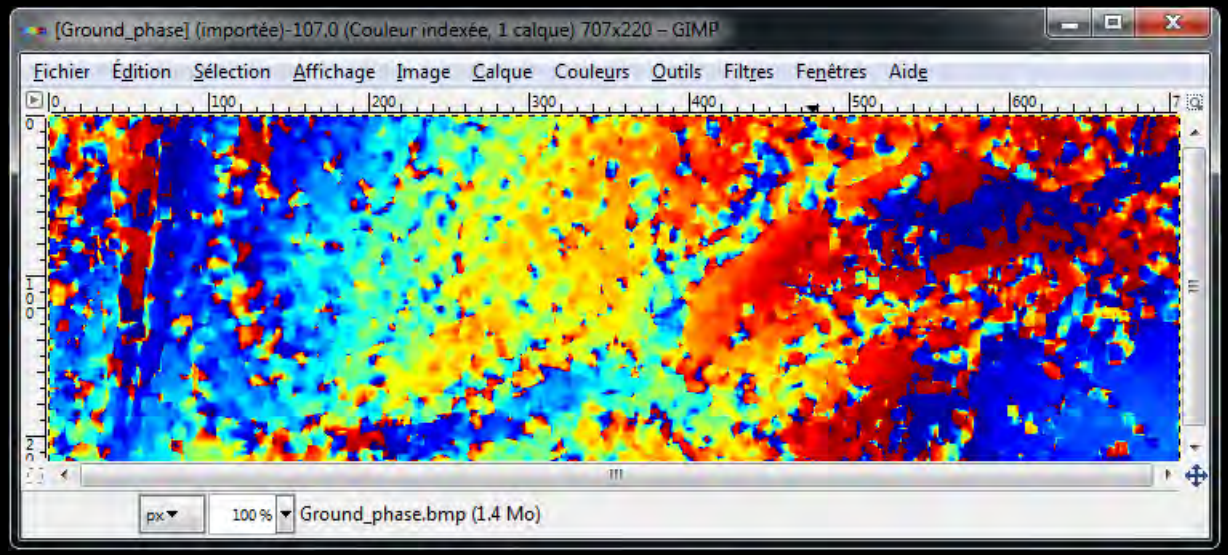
Set the parameters (*Median Size = 21*, *Factor = 0.4*) and view the corresponding BMP files.

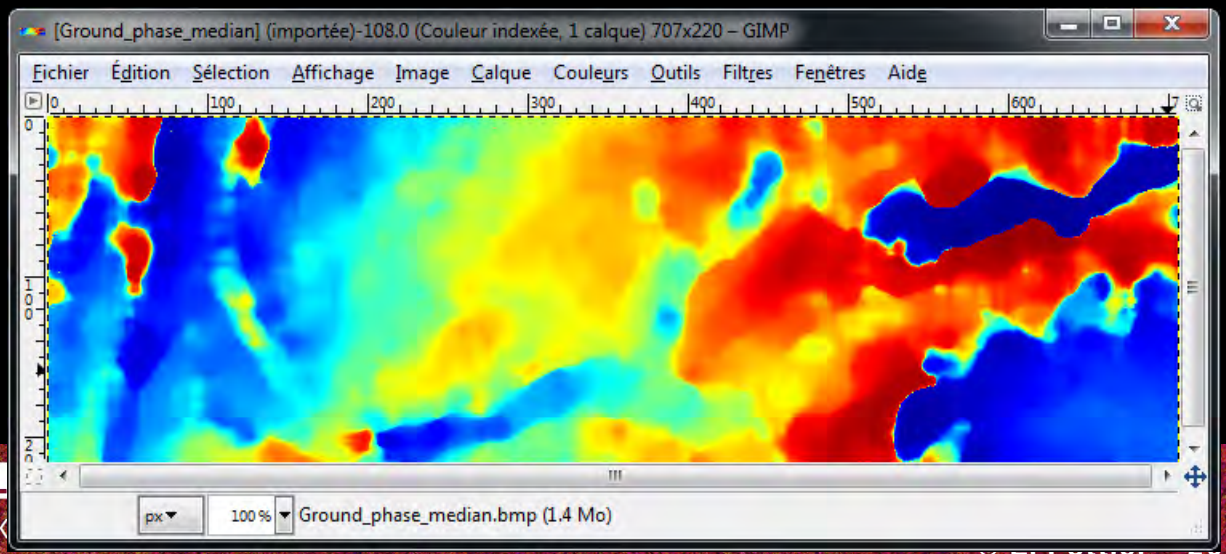
***2D Kz File* : DataDirectory / kz-phi-mlk / kz.bin**

© E. Pottier – 2018

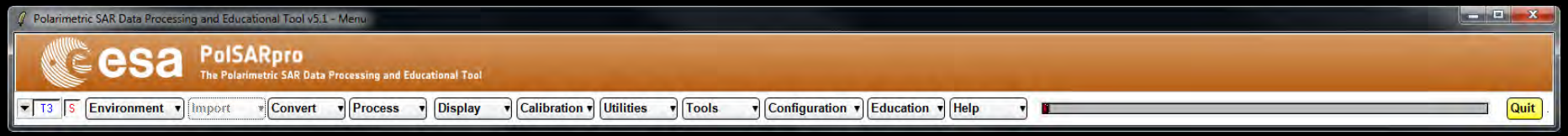
HEIGHT ESTIMATION

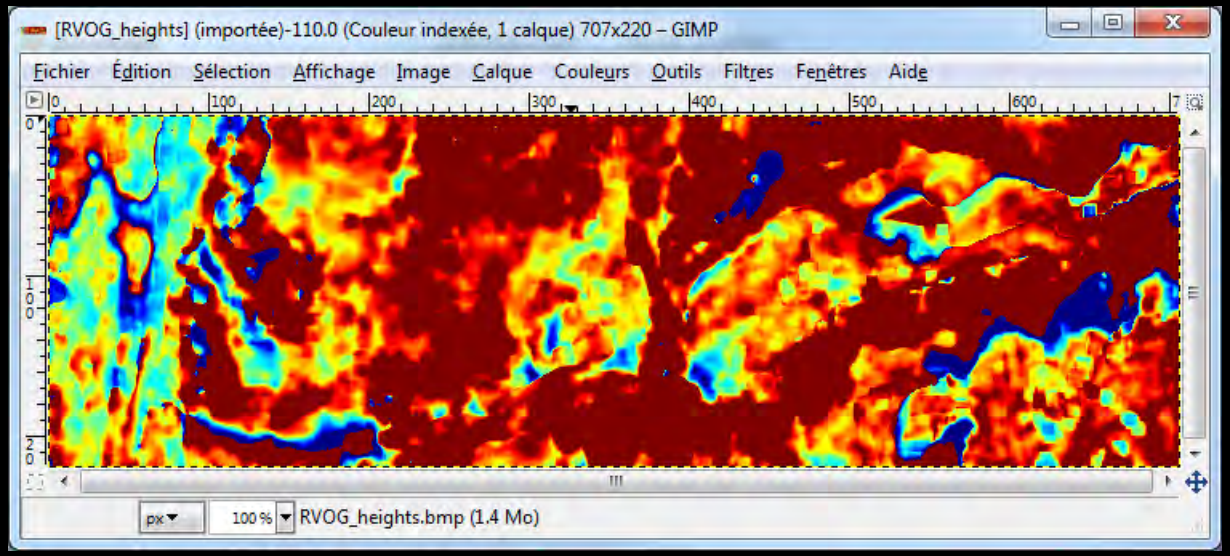


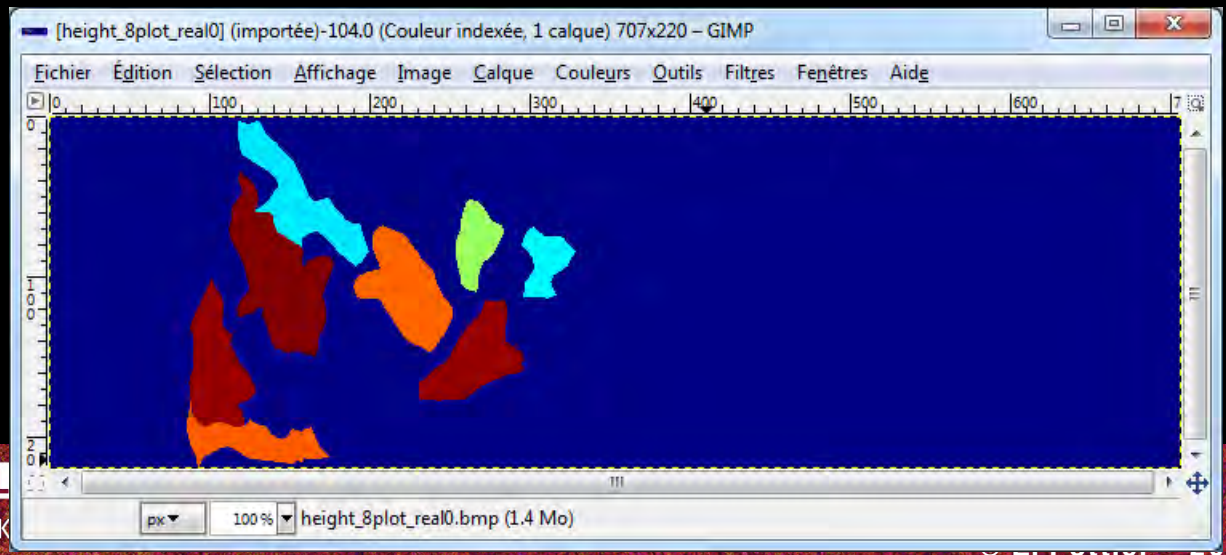




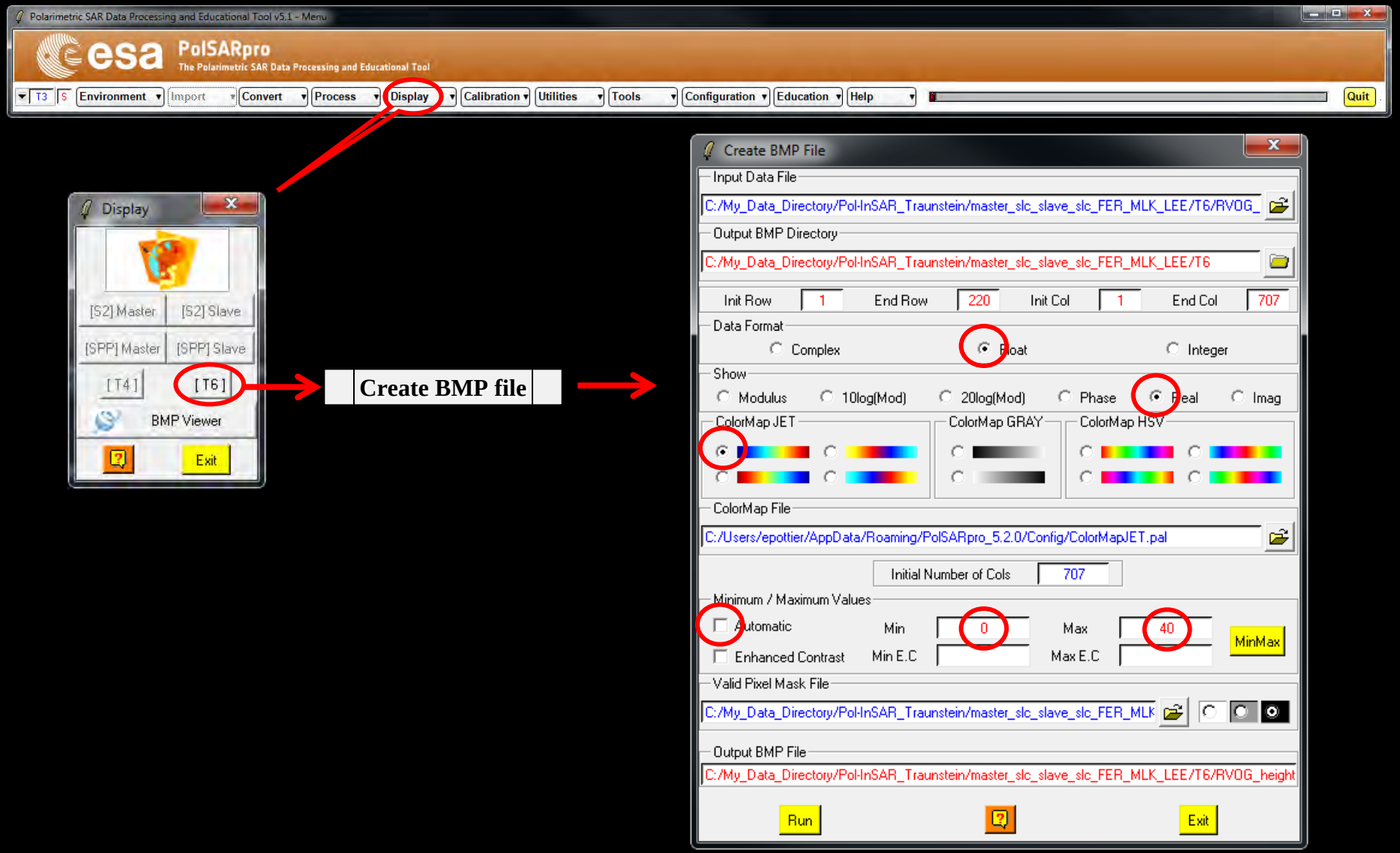
HEIGHT ESTIMATION





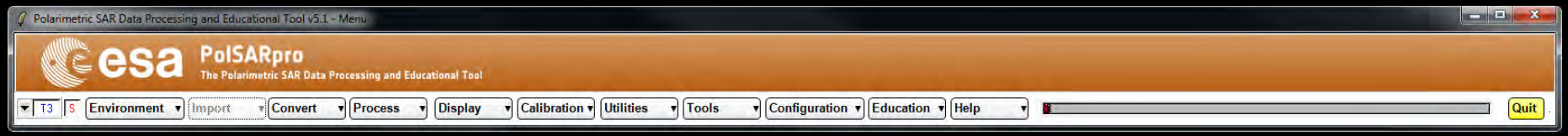


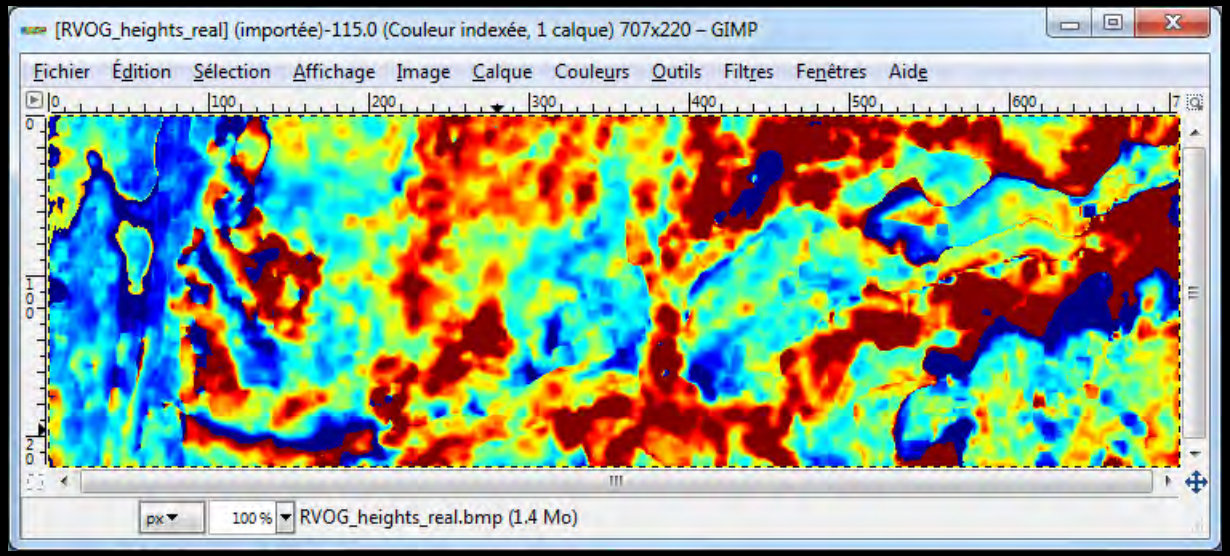
DISPLAY DATA

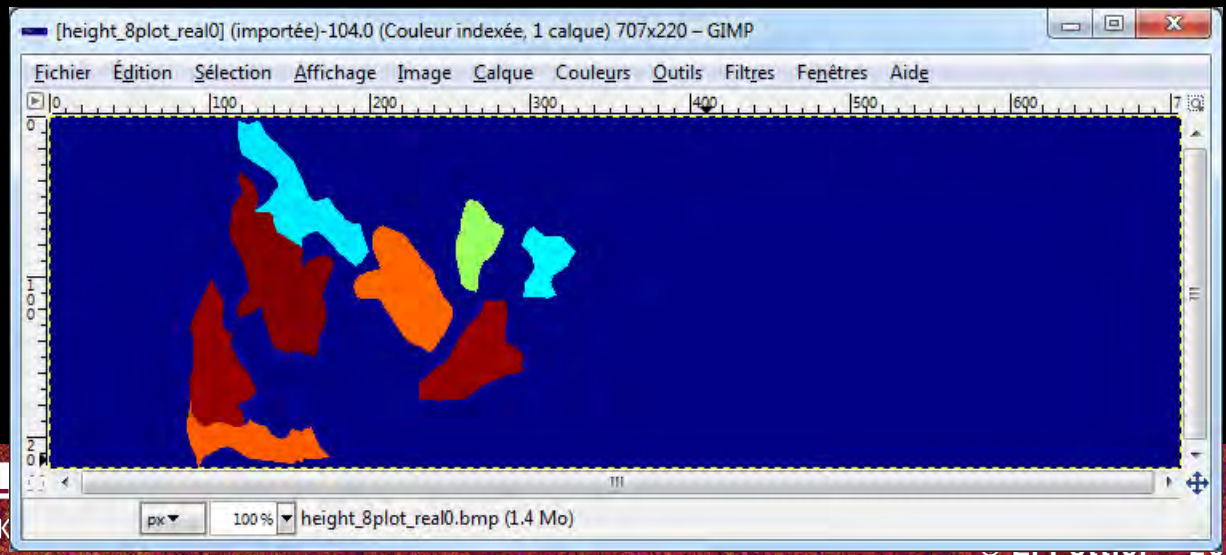


© E. Pottier – 2018

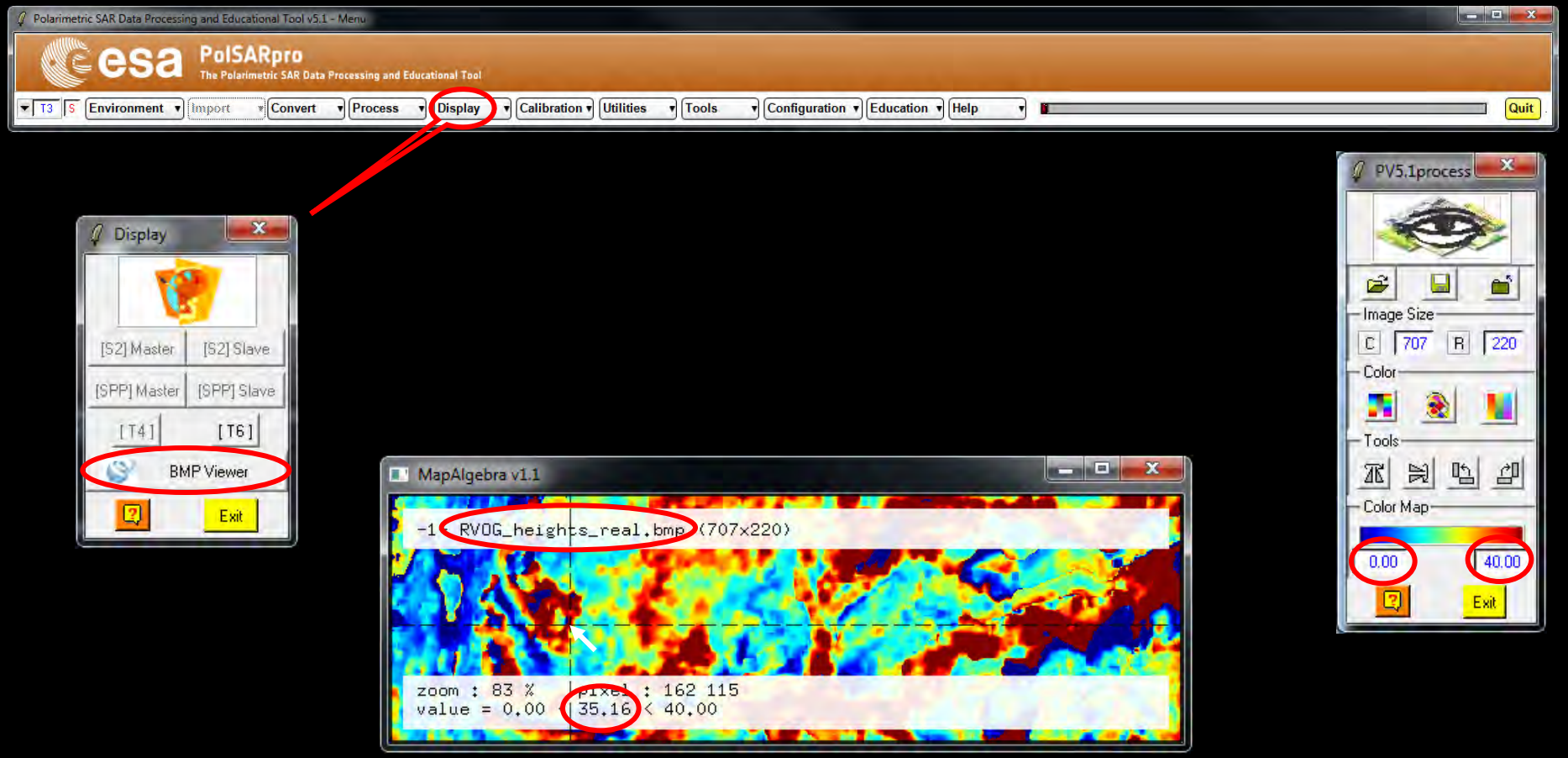
HEIGHT ESTIMATION





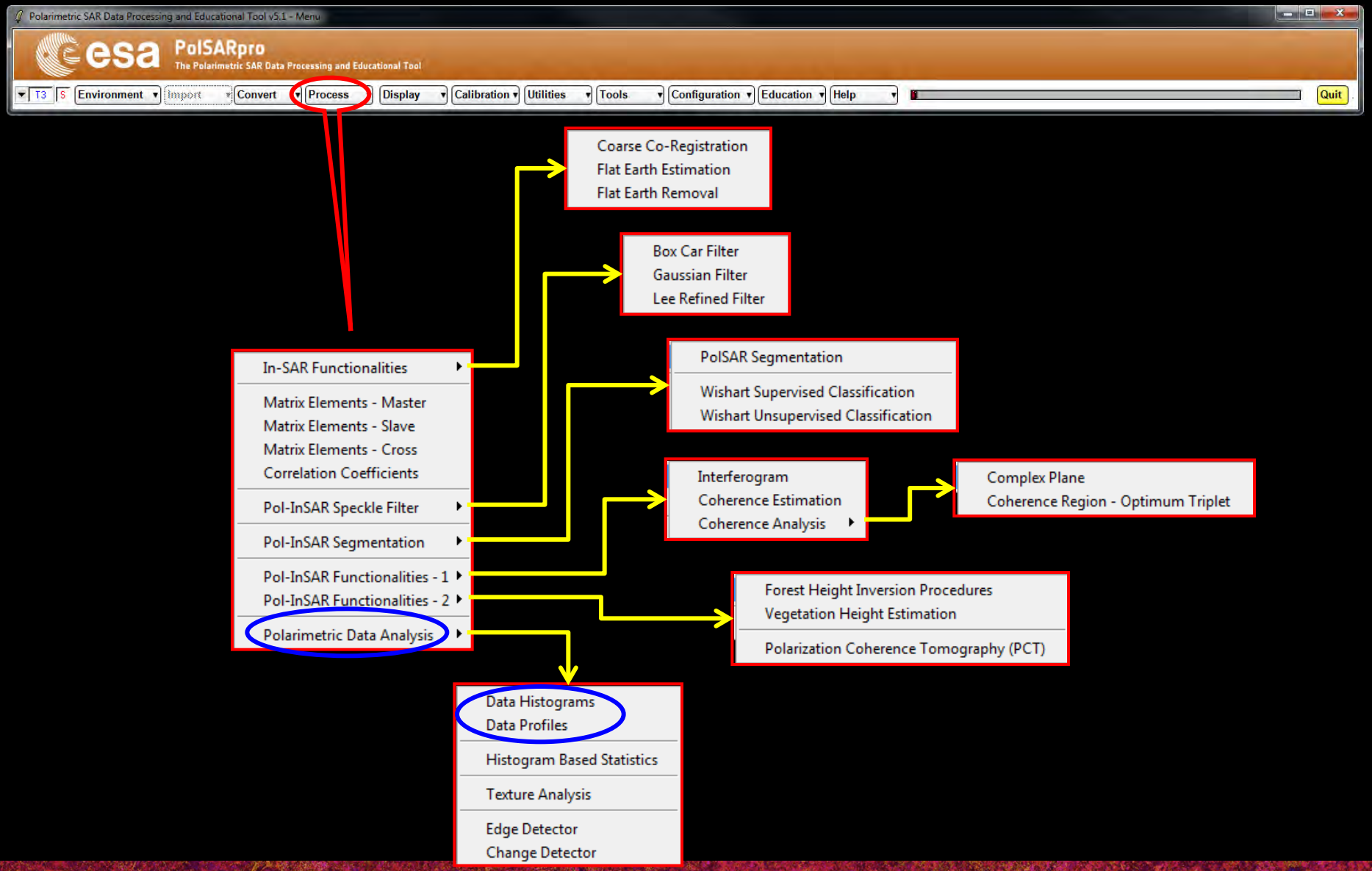


DISPLAY DATA



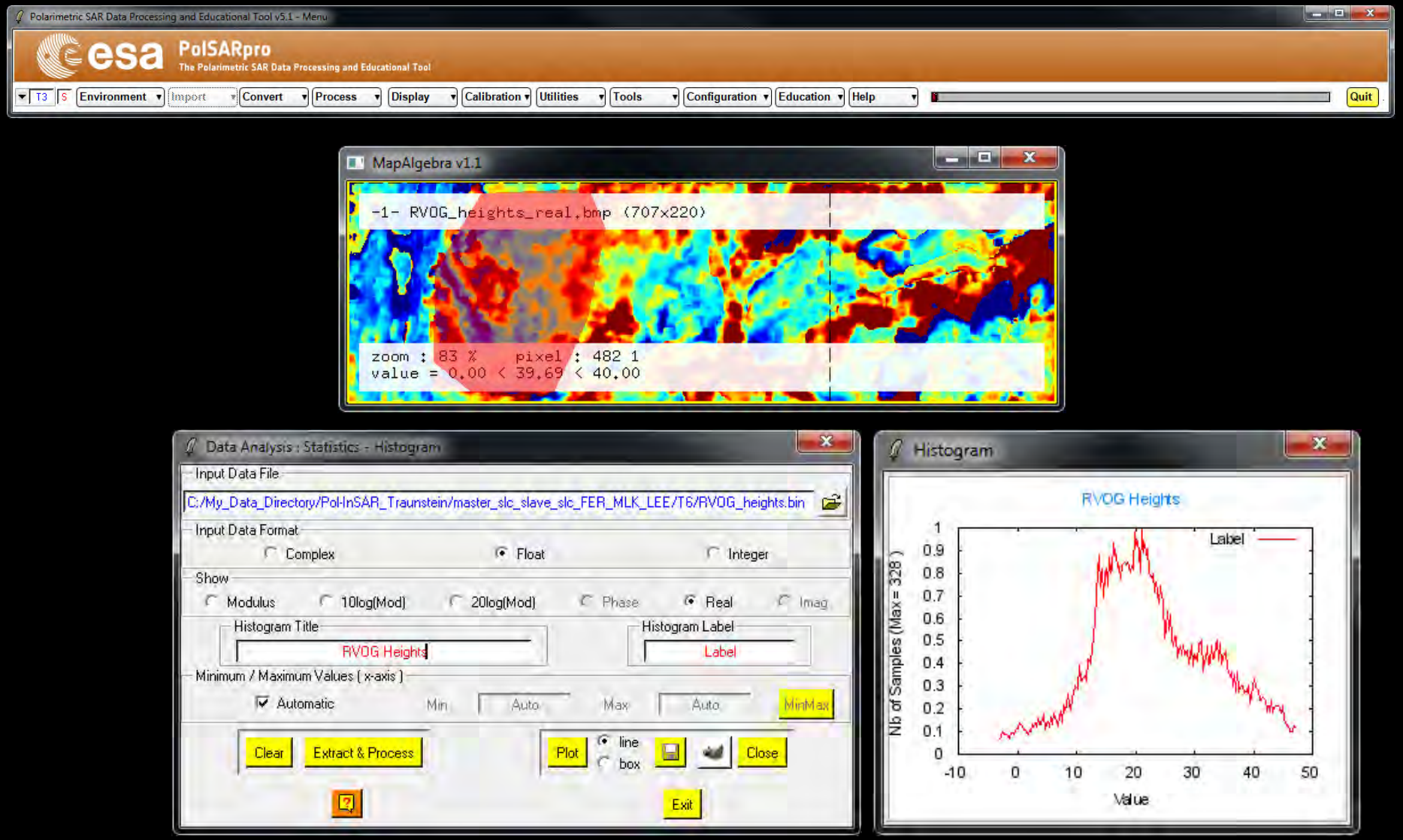
© E. Pottier – 2018

PROCESS DATA



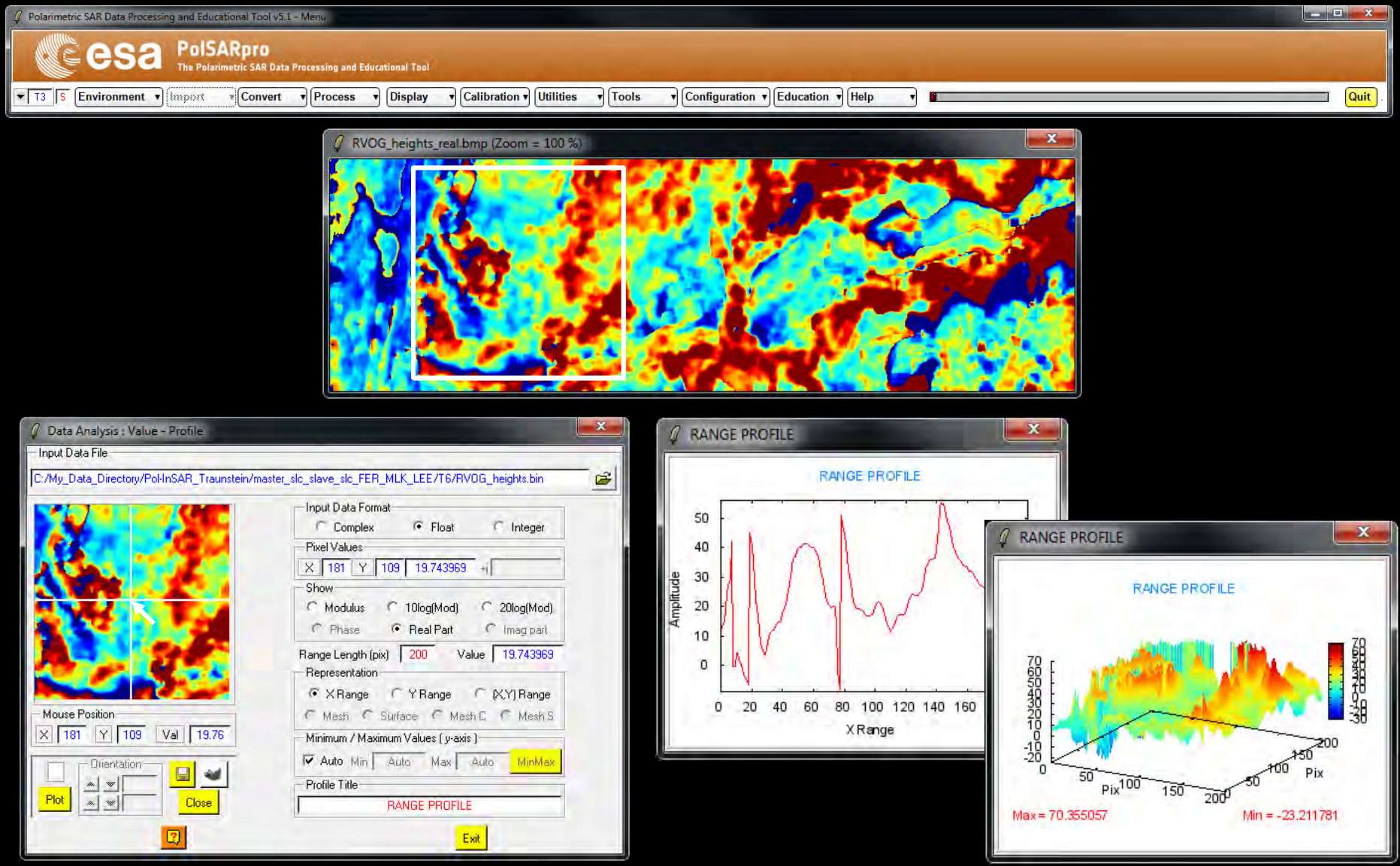
© E. Pottier – 2018

HEIGHT ESTIMATION - HISTOGRAM



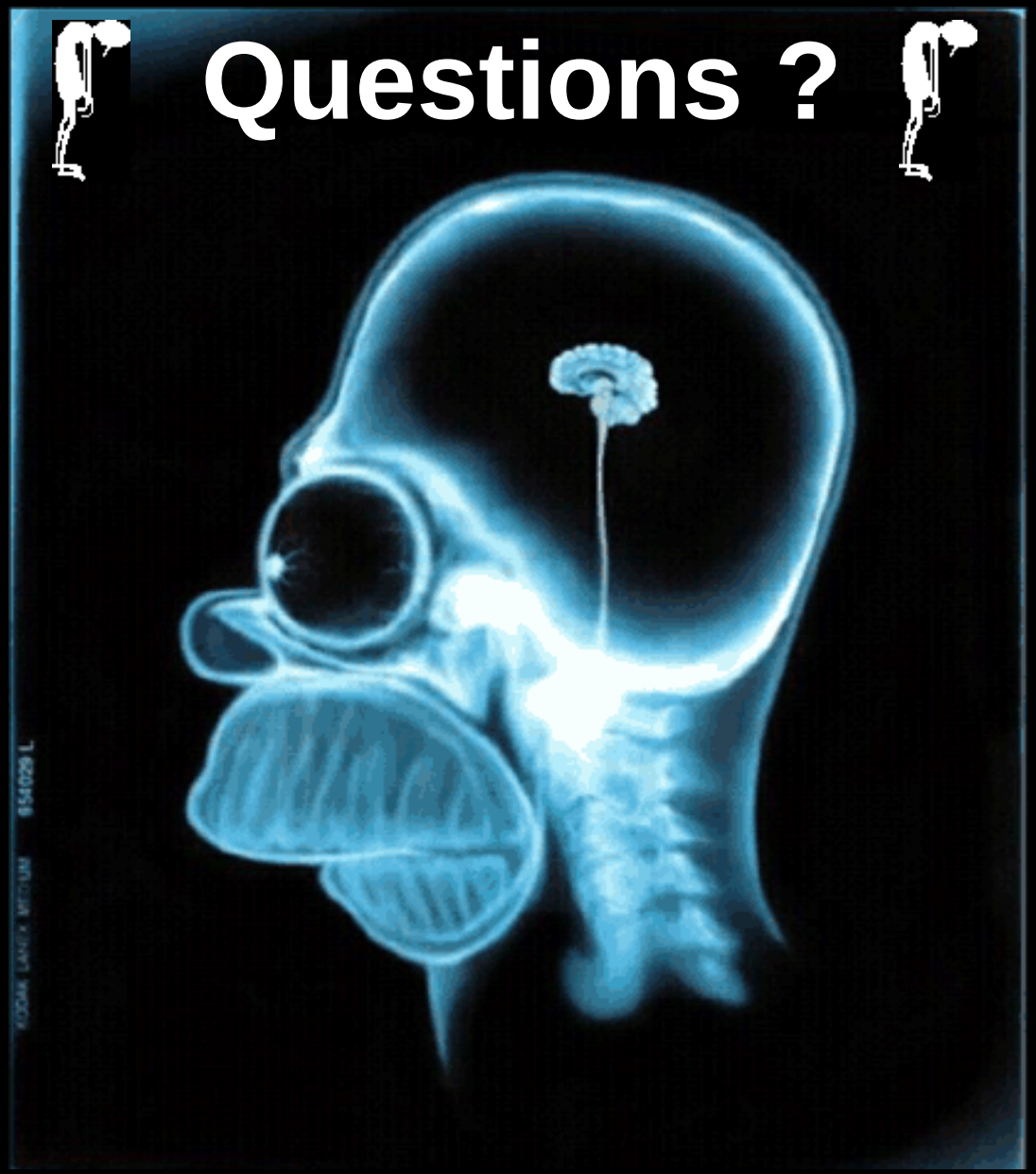
© E. Pottier – 2018

HEIGHT ESTIMATION - PROFILE

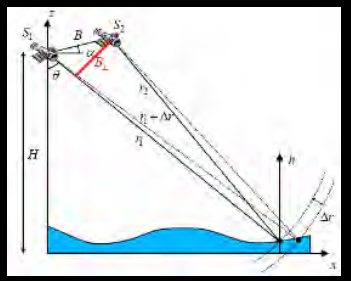


© E. Pottier – 2018

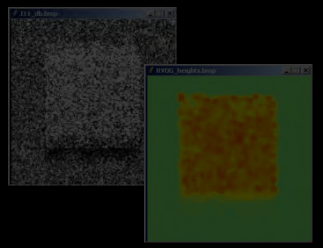
Questions ?



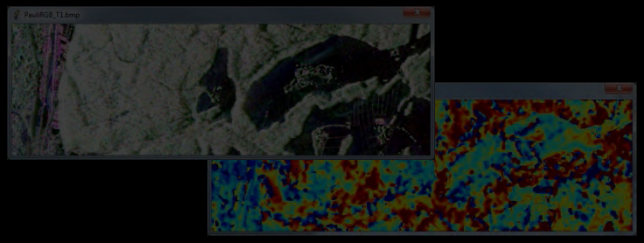
Forestry Applications with Pol-InSAR *Practical*



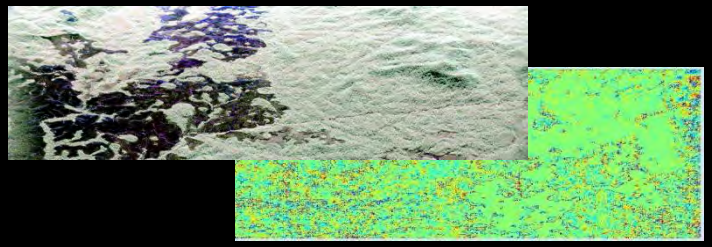
1st part : Simulated Pol-InSAR datasets



2nd part : Airborne Pol-InSAR datasets (*ESAR - DLR*)



Traunstein / Germany



AfriSAR campaign / Gabon

© E. Pottier – 2018

ESA AfriSAR CAMPAIGN

ESA AfriSAR Airborne Campaign
Lope National Park, Gabon

ONERA (2015) - DLR (2016)

Tropical forests of Gabon

P-Band (*Biomass Mission*)
Single baseline = 80m

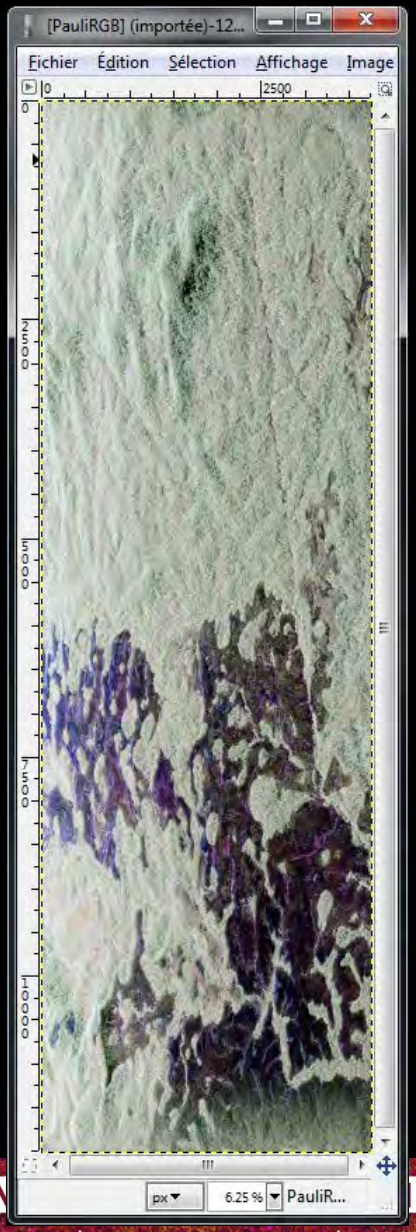
Courtesy of
Dr Maryam Pourshamsi

UNIVERSITY OF LEICESTER

National Centre for Earth Observation
NATURAL ENVIRONMENT RESEARCH COUNCIL

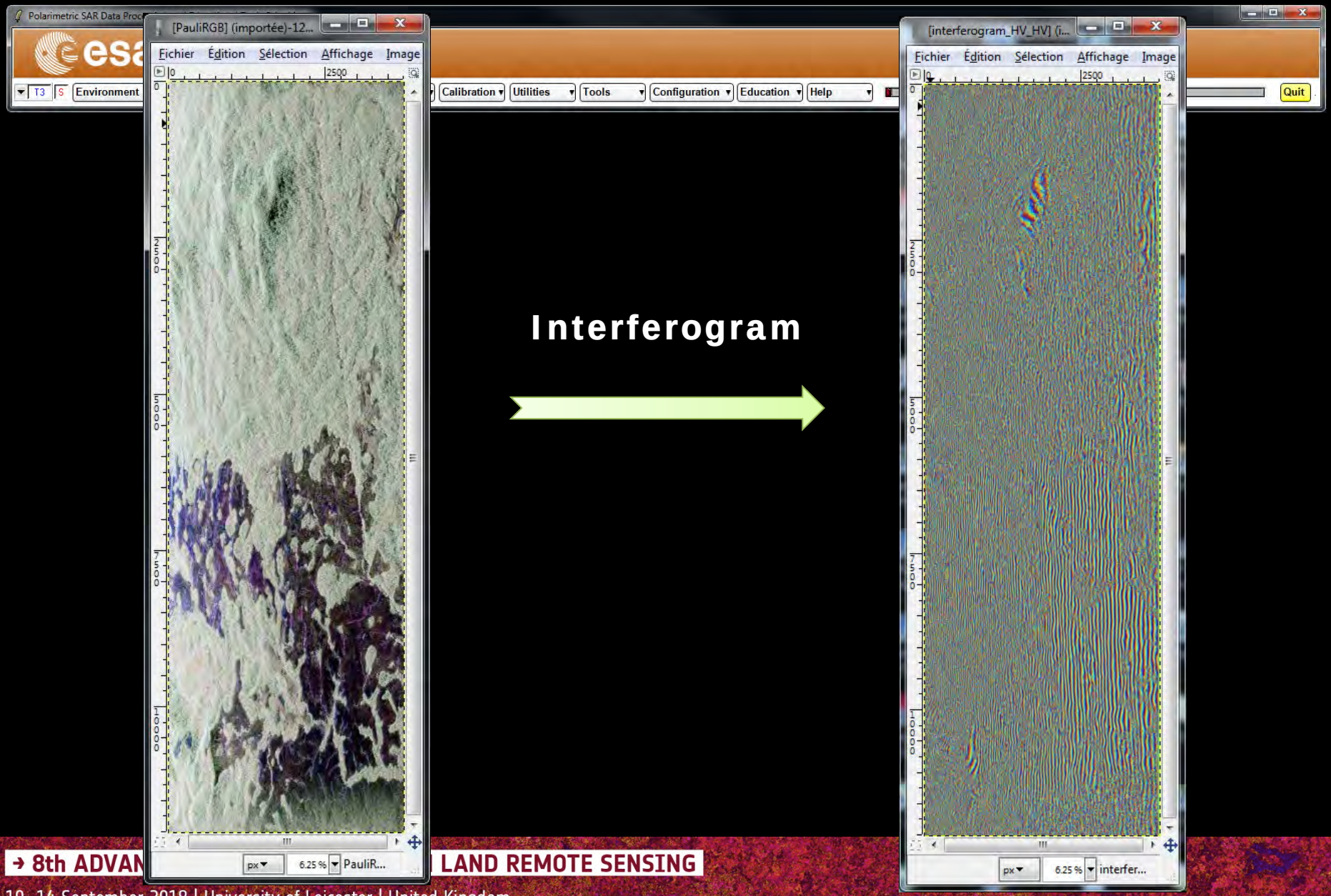
© E. Pottier – 2018

ESA AfriSAR CAMPAIGN



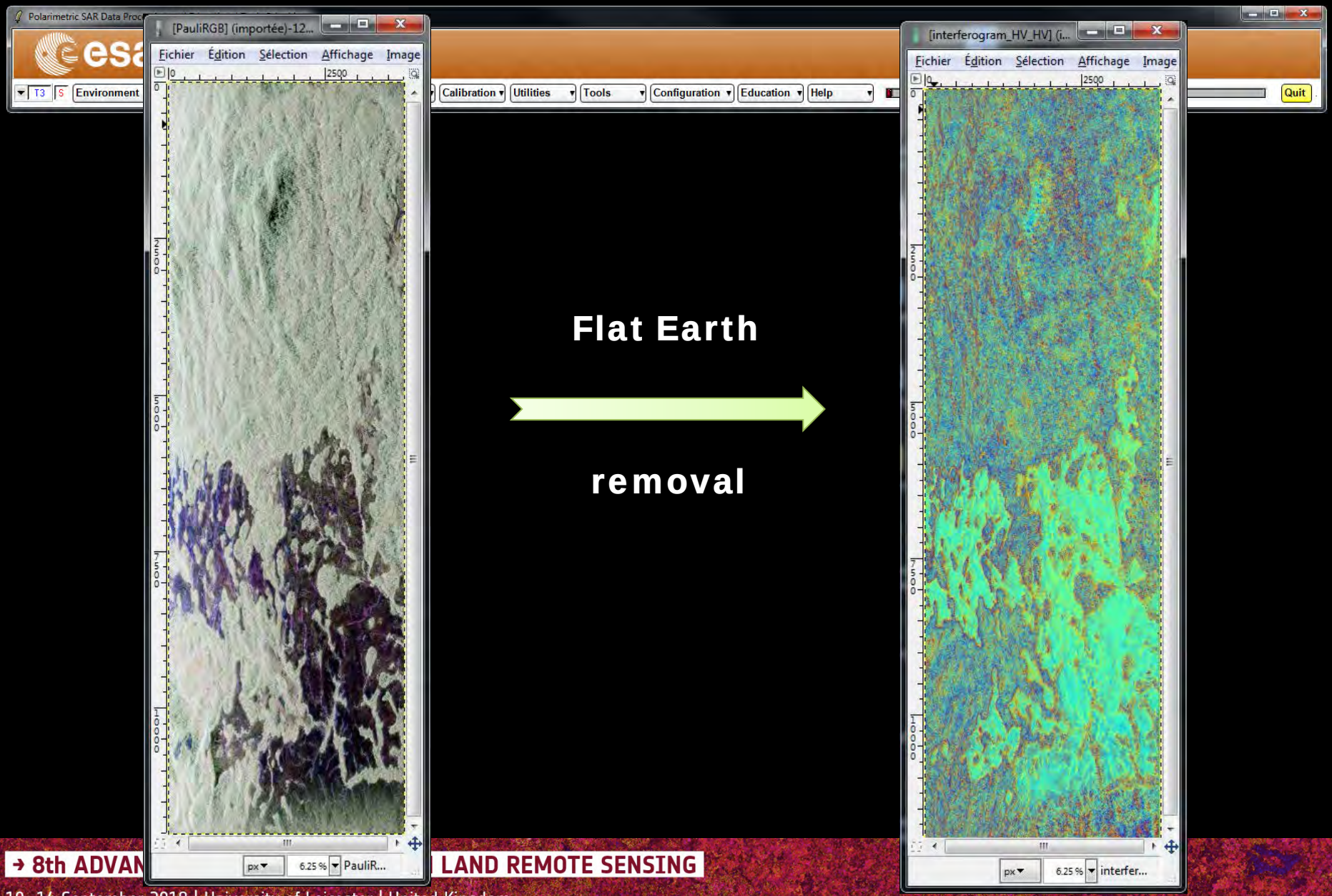
© E. Pottier – 2018

Pre - Processing



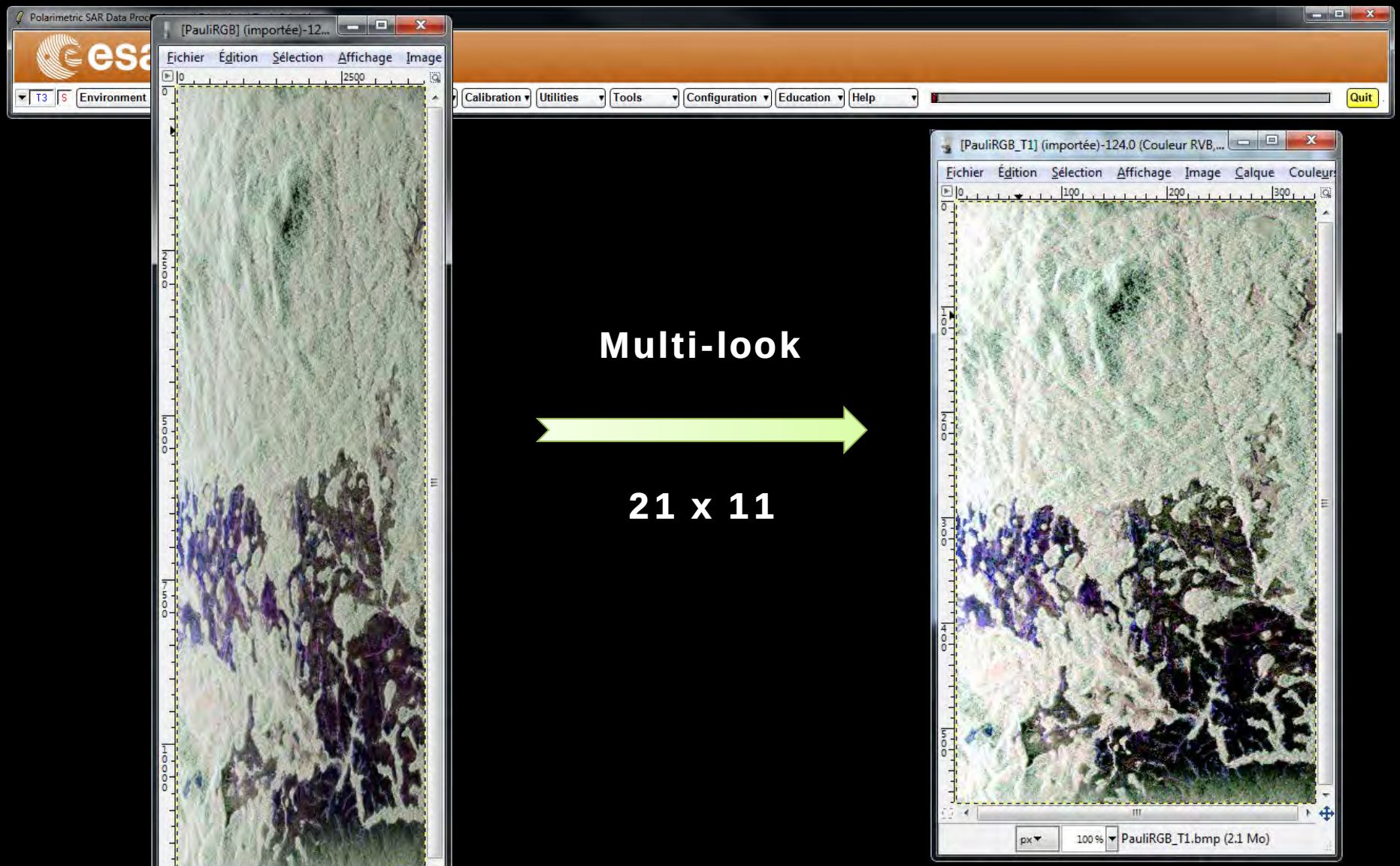
© E. Pottier – 2018

Pre - Processing



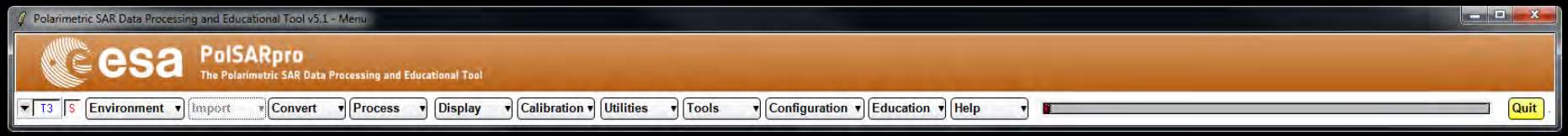
© E. Pottier – 2018

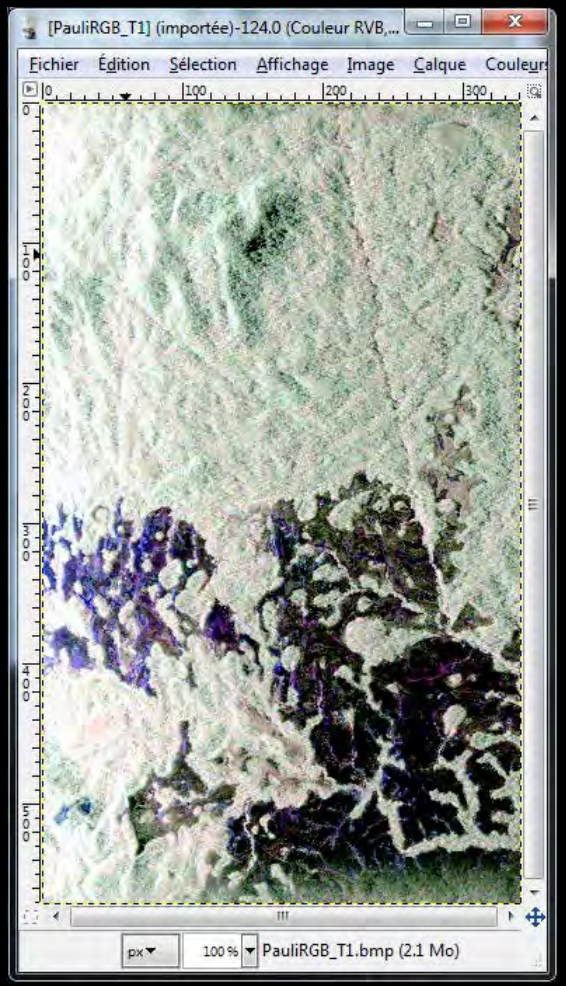
Pre - Processing



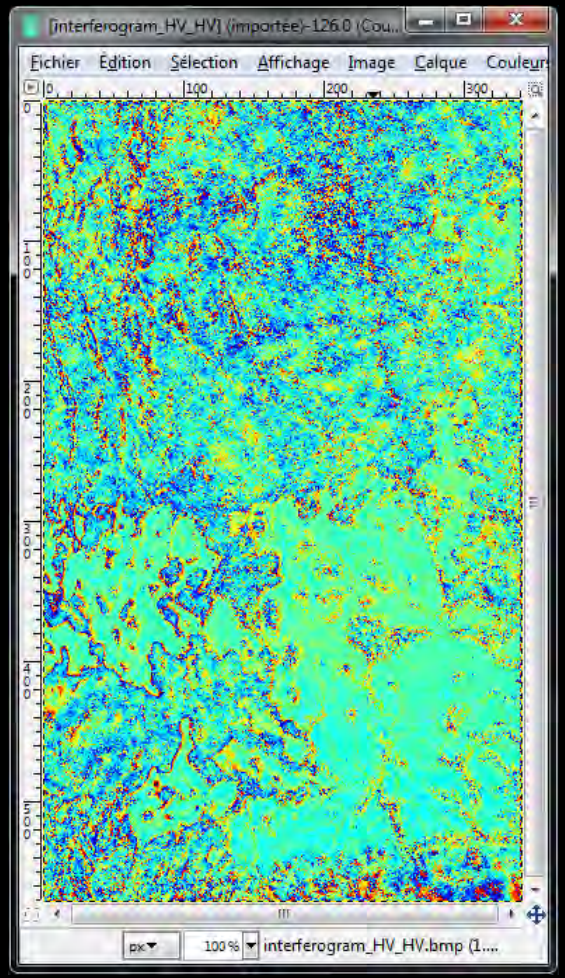
© E. Pottier – 2018

Pre - Processing



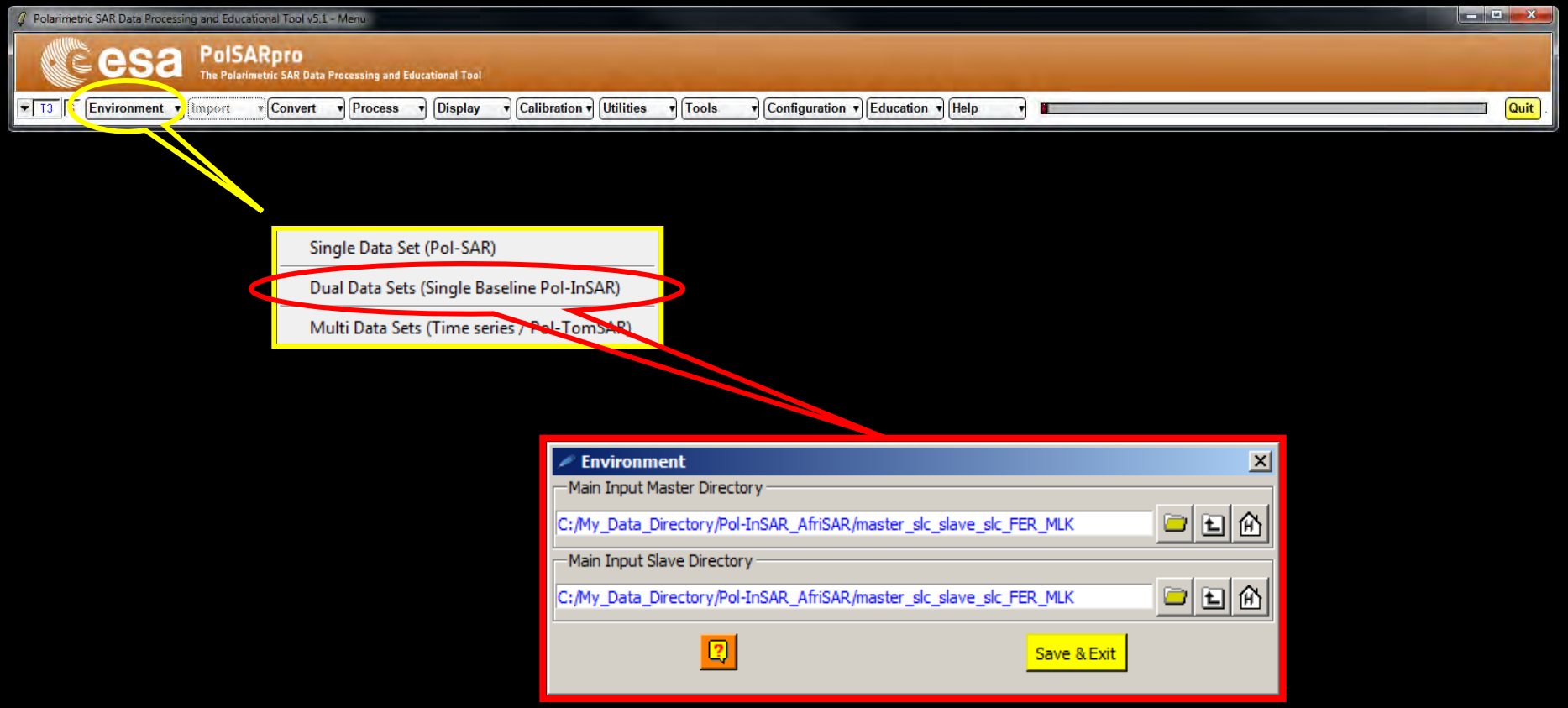


Interferogram



© E. Pottier – 2018

MAIN MENU - ENVIRONMENT



Input Master Directory:

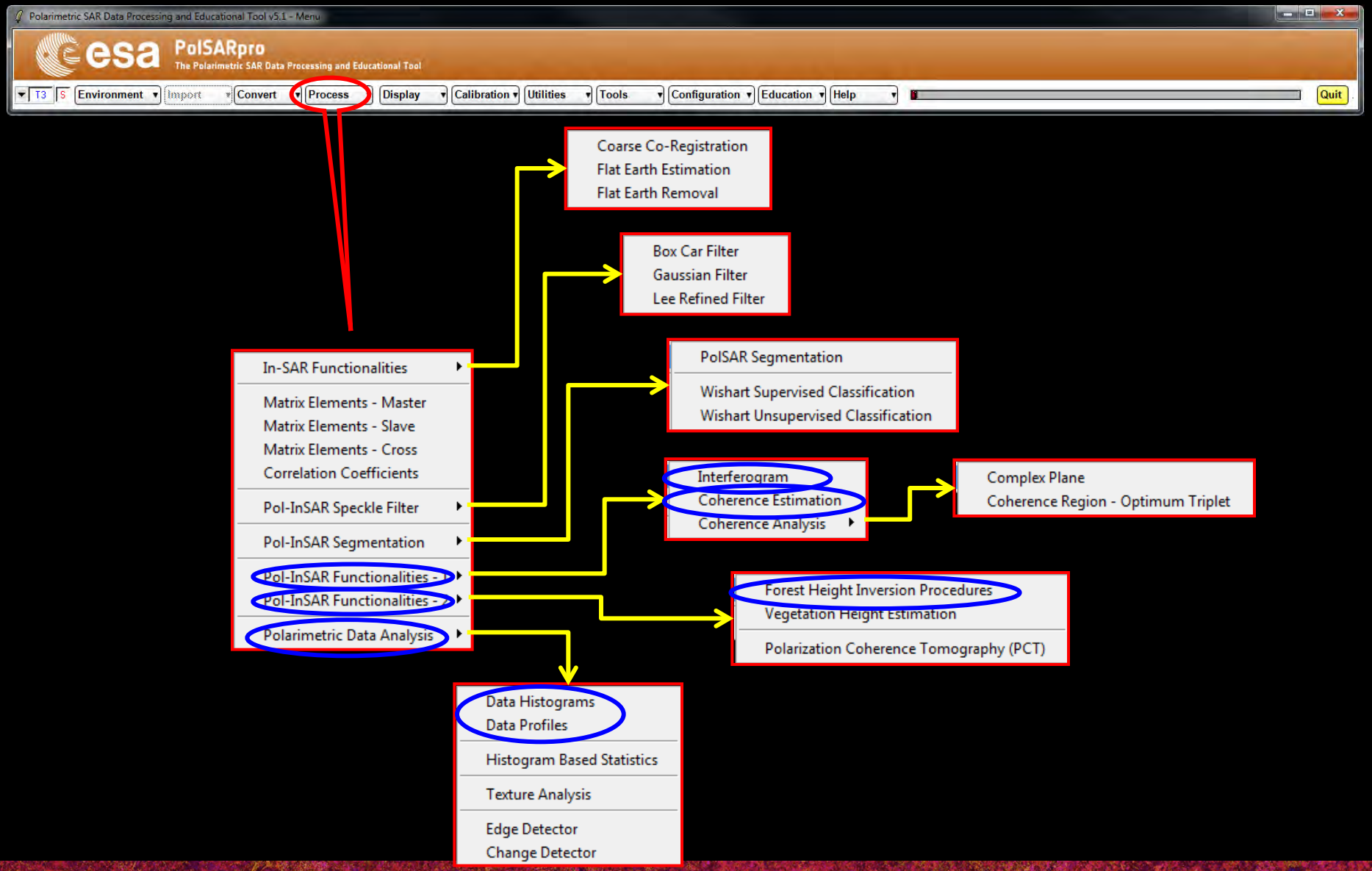
My_Data_Directory / Pol-InSAR_AfriSAR / master_slc_slave_slc_FER_MLK

Input Slave Directory:

My_Data_Directory / Pol-InSAR_AfriSAR / master_slc_slave_slc_FER_MLK

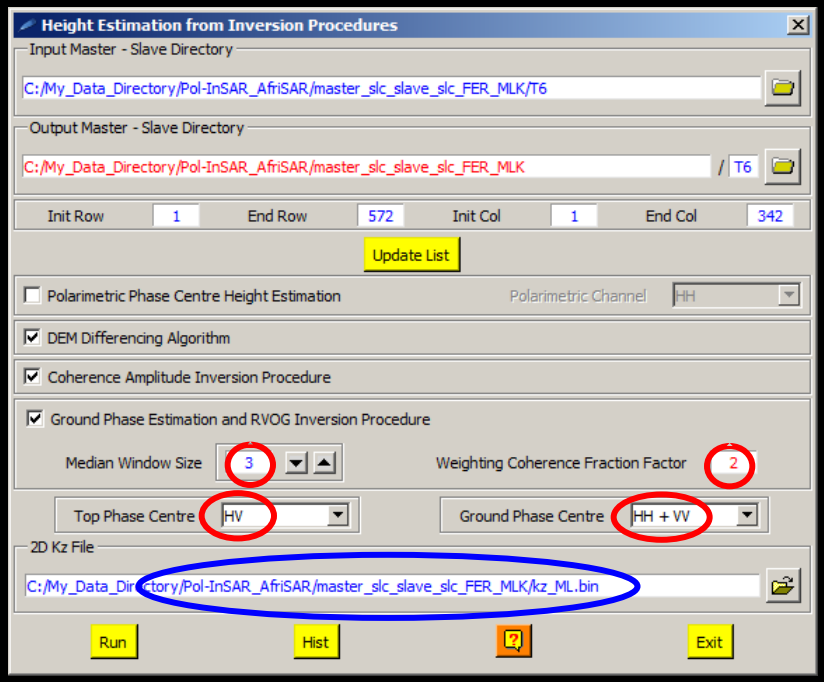
© E. Pottier – 2018

DO IT YOURSELF



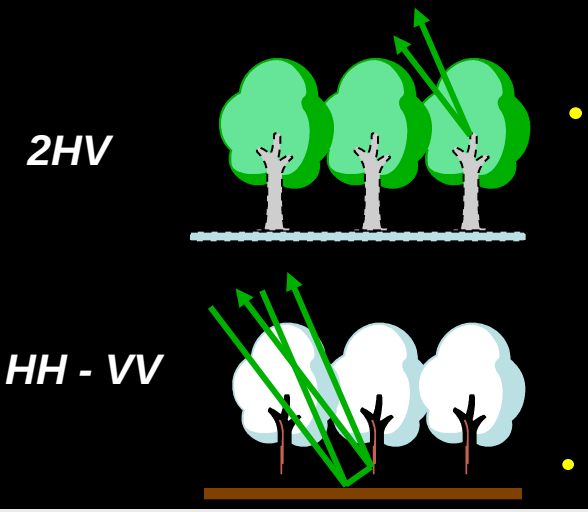
© E. Pottier – 2018

HEIGHT ESTIMATION



INVERSION PROCEDURES

- DEM Differencing Algorithm
- Coherence Amplitude Inversion Procedure
- Ground Phase Estimation &
- RVOG Inversion Procedure



Do it Yourself:

Set the parameters (*Median Size = 3*, *Factor = 2*) and view the corresponding BMP files.

2D Kz File **:**

DataDirectory / Pol-InSAR_AfriSAR / master_slc_slave_slc_FER_MLK / kz_ML.bin

© E. Pottier – 2018