2003 – 2013 : 10 Years of the PolSARpro Software

New updates and its link with the ESA PolSAR-Ap Project

E. Pottier – C. Lopez Martinez
10 Years of PolSARpro
PolSARpro v5.0 SOFTWARE

A Bit Of History

PolSARpro
A BIT OF HISTORY

APPLICATIONS OF SYNTHETIC APERTURE RADAR POLARIMETRY

POLinSAR 2003
Workshop on Applications of SAR Polarimetry and Polarimetric Interferometry

ESA-ESRIN Frascati, Italy
14-16 January 2003
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.
A BIT OF HISTORY

2004

PolSARpro v2.0
Polarimetric SAR data Processing and Educational Tool

2005

POLSARPRO
The Polarimetric SAR Data Processing and Educational Tool

2007

POLSARPRO v. 4.0
The Polarimetric SAR Data Processing and Educational Tool

2009 (v4.0) – 2011 (v4.2)
A BIT OF HISTORY

MAIN MENU

INITIAL BINARY DATA DIRECTORY SETTING

DATA CONVERT:
- Decode AIRSAR, EMISAR, ESAR, PISAR SLC-MLC DATA
- Fully polarimetric data format conversion
  \( S \leftrightarrow T, C \); \( T \leftrightarrow C \); \( C \leftrightarrow T \) Bistatic, Monostatic cases
- Full \( \Rightarrow \) partial polar conversion

ELLIPOTICAL BASIS TRANSFORMATION:
\( H-V \leftrightarrow L-C-R, +45 / -45, H-V \leftrightarrow (\phi, \tau) \)

SPECKLE FILTER: (Monostatic, Bistatic, Partial) BoxCar, Lee Filter

DATA PROCESS:
Coherency, Covariance, Partial Polar Parameters
H/A/\( \alpha \) Decomposition
Unsupervised Wishart H/A/\( \alpha \) Classifier
Polarimetric Decompositions, Freeman, Krogager
Supervised classification

BMP IMAGE PROCESS:
Create BMP File from Binary Data
Create color coded RGB File, 3 inputs
View BMP Image

TOOLS:
File / Directory Create, Delete, Move ...
Data file Rotate, Flip, Transpose, FFT

BATCH PROCESS:
From S3 to Wishart H/A/\( \alpha \) Classification
Dual – PolSAR (Spp, C2)
Quad – PolSAR (S2, C3,C4,T3,T4)
A BIT OF HISTORY

v4.2
Jan. 2011

→ POLSARPRO V. 5.0
The Polarimetric SAR Data Processing and Educational Tool
http://earth.esa.int/polsarpro

New!

v5.0
Jan. 2013
Tool specifically designed to handle: Polarimetric data and Polarimetric Interferometric data.
Educational Software offering a tool for self-education in the field of POLSAR and POL-InSAR data processing and analysis.
Developed to be accessible to:
a wide range of users
from novices to experts
in the field of POLSAR and POL-InSAR.
In collaboration with:

PolSARpro Software: ESA Funded Project

WPx: Other Functionalities

PolSARpro: A tool to promote the most important scientific developments conducted in PolSAR and Pol-InSAR
In collaboration with:

University of Illinois at Chicago
University of Niigata
University of Alicante
University of Tor Vergata
University of Pisa
University of Sendai
University of Fairbanks
University of Marne la Vallée
University of Tsinghua
Naval Research Laboratory
NASA – JPL
Ressources Naturelles Canada

UPC
IE - CAS (MITL)
CEOIDE - CAS
CNES
GIPSA – Lab
Alaska Sar Facility
SERTIT
CSRE - IITB
PolSARpro v5.0 Software is made available following the:

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

GNU General Public License v2 – June 1991.

PolSARpro v5.0 Software runs today on:

Windows 98+, Windows 2000, Windows NT 4.0, Windows XP, Windows 7 and Linux I386

Macintosh OS:
PolSARpro v5.0 Software is conceived as a flexible environment, with a friendly and intuitive Graphical User Interface (GUI).

The graphical user interface (GUI) is written in Tcl-Tk:
- 331185 lines managing 189 widget windows
- 1078 C routines (464803 lines) performing well-established algorithms in the field of POLSAR and POL-InSAR.
WHAT IS NEW IN THE VERSION v5.0?
PolSARpro v5.0 SOFTWARE

Pol-SAR Sensors
PolSARpro v5.0 Software offers the possibility to handle and convert polarimetric data from a range of well established polarimetric airborne platforms.
PolSARpro v5.0 Software offers the possibility to handle and convert polarimetric data from a range of well established polarimetric spaceborne platforms.
PolSARpro v5.0 Software offers the possibility to handle and convert polarimetric data from a range of well established polarimetric spaceborne platforms.
TerraSAR – X

SSC: Single Look Slant Range Complex
EEC: Enhanced Ellipsoid Corrected
GEC: Geocoded Ellipsoid Corrected
MGD: Multi-Look Ground Range

• TerraSAR – X Dual POL

PolSARpro v5.0 SOFTWARE
TerraSAR – X

SSC: Single Look Slant Range Complex

**TerraSAR – X Quad POL**
PolSARpro v5.0 SOFTWARE

TANDEM – X

SSC: Single Look Slant Range Complex

• TanDEM – X Dual POL

New!
PolSARpro v5.0 SOFTWARE

- TanDEM – X Dual POL

New!
PolSARpro v5.0 SOFTWARE

COSMO-SKYMED

SSC: Single Look Slant Range Complex

• COSMO-SKYMED Dual POL

New!
PolSARpro v5.0 SOFTWARE

- COSMO-SKYMED Dual POL

New!
PolSARpro v5.0 SOFTWARE

- RISAT Dual POL – Compact POL

New!
PolSARpro v5.0 SOFTWARE

A NEW ENGINE!
PROCESS DATA : ROW per ROW

RUN PROCESS : v1.0 to v4.2
PolSARpro v5.0 SOFTWARE

Type Format
S2 C2 C3 C4
T2 T3 T4 SPP

Data Format
(cplx, float, int)

Array Number

Check Memory

Process

Block Size
Block Number

Requested
Memory

Free
Memory

RUN PROCESS : v5.0
RunProcess.exe arg1 arg2 arg3 arg4 ............. argN

RUN PROCESS : v1.0 to v4.2
PolSARpro v5.0 SOFTWARE

RUN PROCESS: v5.0

A processing error occurred!
Not enough input arguments
Usage:

h_a_alpha_decomposition.exe

Parameters:

- id  input directory
- od  output directory
- iodf input-output data format
- nur Nuin Row
- nuc Nuin Col
- ofr Offset Row
- ofc Offset Col
- fnr Final Number of Row
- fnc Final Number of Col
- f11 Flag Parameters (0/1)
- f12 Flag Lambda (0/1)
- f13 Flag Alpha (0/1)
- f14 Flag Entropy (0/1)
- f15 Flag Anisotropy (0/1)
- f16 Flag Comb HA (0/1)
- f17 Flag Comb H1mA (0/1)
- f18 Flag Comb 1mA (0/1)
- f19 Flag Comb 1m1mA (0/1)

Optional Parameters:

- mask mask file (valid pixels)
- mem Allocated memory for blocksize determination (in Mb)
- errf memory error file
- help displays this message
- data displays the help concerning Data Format parameter

D:\DEU_PolSARpro_v5.0\Soft\data_process_sng\h_a_alpha_decomposition
PolSARpro v5.0 SOFTWARE

RUN PROCESS : v5.0

Polarimetric Data Format
PolSARpro v5.0 SOFTWARE

RUN PROCESS : v5.0

```
D:\DEU_PolSARpro_v5.0\Soft\data_process_sng\Oh_a_alpha_decomposition -data
```

<table>
<thead>
<tr>
<th>Polarimetric</th>
<th>Input-Output</th>
<th>Data Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>S2T3</td>
<td>input : quad-pol S2</td>
<td>output parameters derived from coherency T3</td>
</tr>
<tr>
<td>S2C3</td>
<td>input : quad-pol S2</td>
<td>output parameters derived from covariance C3</td>
</tr>
<tr>
<td>S2T4</td>
<td>input : quad-pol S2</td>
<td>output parameters derived from coherency T4</td>
</tr>
<tr>
<td>S2C4</td>
<td>input : quad-pol S2</td>
<td>output parameters derived from covariance C4</td>
</tr>
<tr>
<td>C2</td>
<td>input : covariance C2</td>
<td>output parameters derived from covariance C2</td>
</tr>
<tr>
<td>C3</td>
<td>input : covariance C3</td>
<td>output parameters derived from covariance C3</td>
</tr>
<tr>
<td>C3T3</td>
<td>input : covariance C3</td>
<td>output parameters derived from coherence T3</td>
</tr>
<tr>
<td>C4</td>
<td>input : covariance C4</td>
<td>output parameters derived from covariance C4</td>
</tr>
<tr>
<td>C4T4</td>
<td>input : covariance C4</td>
<td>output parameters derived from coherence T4</td>
</tr>
<tr>
<td>T3</td>
<td>input : coherency T3</td>
<td>output parameters derived from coherence T3</td>
</tr>
<tr>
<td>T4</td>
<td>input : coherency T4</td>
<td>output parameters derived from coherence T4</td>
</tr>
</tbody>
</table>

D:\DEU_PolSARpro_v5.0\Soft\data_process_sngl
PolSARpro v5.0 SOFTWARE

RUN PROCESS : v5.0

Allocated Memory
PolSARpro v5.0 SOFTWARE

RUN PROCESS : v5.0

Valid Pixel Mask
PolSARpro v5.0 SOFTWARE

Window Size Nrow = Window Size Ncol

RunProcess.exe arg1 arg2 Nwin arg4 .............. argN

RUN PROCESS : v1.0 to v4.2
PolSARpro v5.0 SOFTWARE

RUN PROCESS : v5.0

Window Size Nrow != Window Size Ncol
PolSARpro v5.0 MAIN WINDOW

Full Screen
PolSARpro v5.0 SOFTWARE

New!

PolSARpro – PoCal
(Pocket Calculator)
PolSARpro v5.0 SOFTWARE

External Softwares
PolSARpro v5.0 SOFTWARE

GIS SOFTWARES
PolSARpro v5.0 SOFTWARE

MAP READY - NEST

Pre-Processing
Data Extract [T3]

Post-Processing

Geo-Coding

POLARIMETRIC DATA SETS

Speckle Filtering
Polar. Decomposition
Unsupervised Segmentation

Terrain Correct
UTM Projection

KML File generation

New!
PolSARpro v5.0 SOFTWARE

MAP READY - NEST

Pre-Processing
Data Extract [T3]

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 v5.0 SOFTWARE

MAP READY - NEST

[T3] matrix
NEW FUNCTIONALITIES
Calibration Assessment

[S2] Data Format
Calibration Assessment

New!
Tools Interface offers different Data Files management and transformation facilities
R.O.I Extraction Functionality
Mask Functionality

New!
Create Mask Functionality

[Image: Two windows side by side. The left window shows a satellite image with various polygonal shapes overlaid. The right window shows a black background with white polygonal shapes.]
Create Gray & Color BMP File

Display:
- Create BMP File
- Create RGB File
- Create HSL File
- Create KML File
- Create Gray & Color BMP File
- BMP Viewer

Output BMP Directory:
C:/DataDirectory_MapReady/T3

Input .bmp Color Scale File:
C:/DataDirectory_MapReady/T3/spain﻿#db.bmp

Input .bmp Gray Scale File:
C:/DataDirectory_MapReady/T3/entropy.bmp

Input Mask File:
C:/DataDirectory_MapReady/T3/mask_file.bin

New!
Create Gray & Color BMP File
Create Gray & Color BMP File
WHAT ELSE?

PolSARpro v5.0 SOFTWARE


Three-Component Model-Based Decomposition for Polarimetric SAR Data
W. An, Y. Cui, J. Yang
IEEE TGRS, vol. 48, 2010

Four-Component Decomposition of Polarimetric SAR Images With Deorientation
W. An, C. Xie, X. Yuan, Y. Cui, J. Yang
IEEE GRSL, vol. 8, 2011

Improved Four-Component Model-Based Target Decomposition for Polarimetric SAR Data
Z. Shan, C. Wang, H. Zhang, W. An
IEEE GRSL, vol. 9, 2012

Y. Yamaguchi, A. Sato, W.M. Boerner, R. Sato, H. Yamada, 4-component scattering power decomposition with rotation of coherency matrix, IEEE TGRS vol. 49, no. 6, June 2011.


G. Singh, Y. Yamaguchi, S.E. Park, « General Four-Component Scattering Power Decomposition With Unitary Transformation of Coherency Matrix » IEEE TGRS in press

The m-chi decomposition of hybrid dual-polarimetric data
Raney, R.K.; Cahill, J.T.S.; Patterson, G.W.; Bussey, D.B.J.
IGARSS 2012

Hybrid-Quad-Pol SAR
Raney, R.K.
IGARSS 2008

Hybrid-Polarity SAR Architecture
Raney, R.K.

Compact decomposition theory for L-band satellite radar applications
Cloude, S.R.; Goodenough, D.G.; Chen, H.
IGARSS 2012

Compact Decomposition Theory
Cloude, S.R.; Goodenough, D.G.; Chen, H.
IEEE TGRS, Vol 9, 2012
A test statistic in the complex Wishart distribution and its application to change detection in polarimetric SAR data
Conradsen, K.; Nielsen, A.A.; Schou, J.; Skriver, H.
IEEE TGRS, vol 41, 2003

A new statistical similarity measure for change detection in multitemporal SAR Images and its extension to multiscale change analysis
Inglada, J.; Mercier, G.

Restoration of polarimetric SAR images using simulated annealing
Schou, J.; Skriver, H.
IEEE TGRS, vol 39, 2001

CFAR edge detector for polarimetric SAR images
Schou, J.; Skriver, H.; Nielsen, A.A.; Conradsen, K.
IEEE TGRS, vol 41, 2003

A Test Statistic in the Complex Wishart Distribution and Its Application to Change Detection in Polarimetric SAR Data
K. Conradsen, A. A. Nielsen, J. Schou, H. Skriver
IEEE TGRS, Vol 41, 2003
Optimal Parameter Estimation in Heterogeneous Clutter for High-Resolution Polarimetric SAR data (SIRV Model)
Vasile, G.; Pascal, F.; Ovarlez, J.-P.; Formont, P.; Gay, M.
IEEE GRSL, vol 8, 2011

Detecting Depolarized Targets using a New Geometrical Perturbation Filter
Marino, A.; Cloude, S.R.; Woodhouse, I.H.
IEEE TGRS, vol 50, 2012

J. Chen, Y. Chen, W. An, Y. Cui, J. Yang,
Nonlocal Filtering for Polarimetric SAR Data: A Pretest Approach

J.S. Lee, D.L. Schuler, T.L. Ainsworth, M.R. Grunes, E Pottier, L. Ferro-Famil,
“Scattering Model Based Speckle Filetring of Polarimetric SAR Data“
IEEE TGRS, vol 1, 2006

J.S. Lee, M.R. Grunes, E. Pottier and L. Ferro-Famil,
Segmentation of polarimetric SAR images that preserves scattering mechanisms
Proceedings of EUSAR2002
Learning / Training Next P.I Generations
Educational Tools

PolSAR-Ap Project

WP260: Implementation of Selected Applications
(E. Pottier, C. Lopez Martinez)
Educational Tools

PolSAR-Ap Project

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

Tutorials
Do It Yourself
Lecture Notes
Slides
Technical Documentation
Help Files.

UNDER CONSTRUCTION
PolSARpro v5.0 SOFTWARE

http://earth.esa.int/polsarpro

The Web Site provides

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

Version 5 soon available on the PolSARpro website!