PolSARpro v4.0 Software and ALOS-PALSAR Pol-SAR Data Processing

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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.
PolSARpro v4.0 SOFTWARE

Tool specifically designed to handle:
- Polarimetric data
- Polarimetric Interferometric data.
PolSARpro v4.0 SOFTWARE
Educational Software offering a tool for self-education in the field of POLSAR and POL-InSAR data processing and analysis.
PolSARpro v4.0 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:

- **303013 lines** managing around **200 widget windows**
- **823 C routines (358825 lines)** performing well-established algorithms in the field of POLSAR and POL-InSAR.
PolSARpro v4.0 SOFTWARE

OPEN SOURCE DEVELOPMENT

PolSARpro v4.0 Software is made available following the:
Open Source Software Development (OSSD) approach, and follows the:
GNU General Public License v2 – June 1991.

PolSARpro v4.0 Software runs today on:
Windows 98+, Windows 2000, Windows NT 4.0, Windows XP, Linux I386 and Unix SOLARIS
( Macintosh OS in progress).
PolSARpro v4.0 SOFTWARE

OPEN SOURCE DEVELOPMENT

The Tool is free download on the Internet from the ESA Web Portal (Earthnet) at:
http://earth.esa.int/polsarpro
PolSARpro v4.0 SOFTWARE

v3.34
June 2008

New!
v4.0
Oct. 2008

POLISARPRO
The Polarimetric SAR Data Processing and Educational Tool v3.0

ALOS & RADARSAT 2 compatibility & POLInSAR tutorial

European Space Agency
Agency symbol approved

Living Planet

eesa

ALOS PI Symposium 2008

JAXA
PolSARpro v3.34 SOFTWARE

ENTRY SCREEN

PolSARpro v3.34 WINDOWS
PolSARpro v4.0 SOFTWARE

ENTRY SCREEN

PolSARpro v4.0 MAIN WINDOW
PolSARpro v4.0 MAIN WINDOW

Full Screen
PolSARpro v4.0 SOFTWARE

PolSARpro v4.0 MAIN WINDOW

Specific Tcl-Tk widget window providing operational and informative error messages. Backtrace with each warning or error message (equivalent to the Unix command: `troff`).

Blue: Widget Window
Black: C Routines
Red: RunTime Errors Checking Result

Run Trace
Progress Bar
PolSARpro Full Software
- Single Data Set
- Multi Data Sets

Spaceborne Sensors:
ALOS, ENVISAT
RADARSAT2, TerraSar, SIR-C

Airborne Sensors:
AIRSAR, Convair, EMISAR
ESAR, PISAR, RAMSES

Version for the EO Scientific Investigator
PolSARpro v4.0 SOFTWARE

- Environment
- Display
- Import Data
- Calibration Assessment
- Process Data
- Convert Data
PolSARpro v4.0 SOFTWARE

Viewer  Display  Tools  PDF  Google Earth  About PolSARpro

Tutorial on POLSAR and POLinSAR  Help Files
1. WHAT IS POLARIZATION?

1.1 Propagation of a monochromatic plane electromagnetic wave

1.1.1 Equation of propagation

The time-space behavior of electromagnetic waves is ruled by the Maxwell equations set defined as:

\[
\begin{align*}
\nabla \times \mathbf{E}(t) &= -\mu \frac{\partial \mathbf{B}(t)}{\partial t} \\
\nabla \times \mathbf{H}(t) &= \varepsilon \frac{\partial \mathbf{D}(t)}{\partial t} \\
\n\nabla \cdot \mathbf{D}(t) &= \rho(t) \\
\n\nabla \cdot \mathbf{B}(t) &= 0
\end{align*}
\]

(1)

where \( \mathbf{E}(t) \), \( \mathbf{H}(t) \), \( \mathbf{D}(t) \), \( \mathbf{B}(t) \) are the wave electric field, magnetic field, electric induction and magnetic induction, respectively.

The total current density, \( j(t) = j_r(t) + j_p(t) \), is composed of two terms. The first one, \( j_r(t) \), corresponds to a current source whereas the second current density, \( j_p(t) = \sigma \mathbf{E}(t) \), depends on the conductivity of the propagation medium, \( \sigma \). The scalar field, \( \rho(t) \), represents the charge density of free charges.

The different fields and functions are related by the following relations:

\[
\begin{align*}
\mathbf{D}(t) &= \varepsilon(t) \mathbf{E}(t) + \mathbf{P}(t) \\
\mathbf{B}(t) &= \mu(t) \mathbf{H}(t)
\end{align*}
\]

(2)

The vectors \( \mathbf{P}(t) \) and \( \mathbf{M}(t) \) are called polarization and magnetization, while \( \varepsilon(t) \) and \( \mu(t) \) stand for the medium permittivity and permeability.

In the following, we shall consider the propagation of an electromagnetic wave in a linear medium (free of variation and hysteresis), free of sources. These hypotheses impose that \( \mu(t) = \varepsilon(t) = 1 \) and \( j_r(t) = 0 \).

The equation of propagation is found by inserting (1) and (2) into

\[
\begin{align*}
\nabla \times \nabla \times \mathbf{E}(t) &= \mu \varepsilon \frac{\partial^2 \mathbf{E}(t)}{\partial t^2} \\
\n\nabla \cdot \nabla \mathbf{D}(t) &= \rho(t)
\end{align*}
\]

and it is formulated as:

\[
\nabla \times \nabla \times \mathbf{E}(t) + \frac{\partial^2 \mathbf{E}(t)}{\partial t^2} = \mu \varepsilon \frac{\partial^2 \mathbf{E}(t)}{\partial t^2} = \nabla \times \nabla \mathbf{D}(t) = \nabla \times \nabla \left( \varepsilon \frac{\partial \mathbf{D}(t)}{\partial t} \right) = \nabla \times \nabla \left( \varepsilon \frac{\partial \nabla \cdot \mathbf{E}(t)}{\partial t} \right)
\]

(3)

Direct access to the Tutorial while using PolSARpro facilities

The Tutorial is made available in PDF format.
Do It Yourself 7

POLinSAR Training Course

1 Objectives
To provide a self-paced introduction to POLInSAR coherency processing techniques in a lab setting where the basic principle of this tool

To achieve this, it is proposed to apply a test POLInSAR data set with 'prescribed' ground truth. This test set is the 'image' simulation output from the POLInSAR+ Simulation case figure 1 provided by Dr. Mark Wilson and is already widely used as a test case in POLInSAR training.
Recent Advances in Radar Polarimetry and Polarimetric SAR Interferometry W.M. Boerner – 31 pages
Basic Concepts in Radar Polarimetry W.M. Boerner – 100 pages
Advanced Concepts E. Pottier, J.S. Lee, L. Ferro-Famil – 65 pages
POL-InSAR Training Course S.R. Cloude – 44 pages
PCT Training Course S.R. Cloude – 55 pages
SAPHIR

273 Tcl-Tk Widget description files
644 C Routine description files
ALOS - PALSAR Toolbox

- ENVISAT – ASAR
- ALOS – PALSAR
- SIR-C
- TerraSAR – X
- RADARSAT 2

POLSARPRO
The Polarsimetric SAR Data Processing and Educational Tool v3.0

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Enter

Exit
PolSARpro v4.0 SOFTWARE

ALOS – PALSAR

ALOS-PALSAR Data Format

JAXA - CEOS Data Format

ERSDAC - Vexcel Data Format

New!
PolSARpro v4.0 SOFTWARE

ALOS – PALSAR

ALOS-PALSAR Polar Modes

- PALSAR Dual & Quad POL
- PALSAR Data Level 1.1 and 1.5

JAXA - CEOS Data Format
PolSARpro v4.0 SOFTWARE

**LEADER FILE**

- **PALSAR Dual & Quad POL**
- **PALSAR Data Level 1.1 and 1.5**

**TRAILER FILE**

**IMAGE OPTIONS FILE**
PolSARpro v4.0 SOFTWARE

SAPHIR LEADER FILE

CALIBRATION DISTORSION MATRICES
TRANSMIT / RECEIVE

EXTRACT UNCALIBRATED RAW BINARY DATA

- PALSAR Dual & Quad POL
- PALSAR Data Level 1.1 and 1.5
PolSARpro v4.0 SOFTWARE

- PALSAR Quad POL
- PALSAR Data Level 1.1

Quick Look Image BMP File

PALSAR Data Level 1.1
Slant Range Image – SLC Data
PolSARpro v4.0 SOFTWARE

- PALSAR Dual POL
- PALSAR Data Level 1.1

Quick Look Image BMP File

PALSAR Data Level 1.1
Slant Range Image – SLC Data
PolSARpro v4.0 SOFTWARE

- PALSAR Dual POL
- PALSAR Data Level 1.5

Ground Range Geocoded Image Detected Power Data
PolSARpro v4.0 SOFTWARE

ALOS – PALSAR

ALOS-PALSAR Polar Modes

- PALSAR Dual & Quad POL
- PALSAR Data Level 1.1

ERSDAC - Vexcel Data Format  New!
PolSARpro v4.0 SOFTWARE

- PALSAR Quad POL
- PALSAR Data Level 1.1
- PALSAR Data Level 1.5: JAXA/CEOS = ERSDAC/Vexcel
PolSARpro v4.0 SOFTWARE

Direct link with GoogleEarth
PolSARpro v4.0 SOFTWARE

Quad-Pol PALSAR Data Level 1.1
Slant Range Image – SLC Data
PolSARpro v4.0 SOFTWARE

- PALSAR Dual POL
- PALSAR Data Level 1.1
- PALSAR Data Level 1.5: JAXA/CEOS = ERSDAC/Vexcel
PolSARpro v4.0 SOFTWARE

Direct link with GoogleEarth
PolSARpro v4.0 SOFTWARE

Dual-Pol PALSAR Data Level 1.1
Slant Range Image – SLC Data
PolSARpro v4.0 SOFTWARE

PROCESSING CHAIN

Data Processing Approach along a ‘recommended’ and easy processing chain

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

• PALSAR Quad–POL
• PALSAR Data Level 1.1

Configuration

Data Import

Data Process

Data Display

Input Data File
QuickLook
Extract Raw Data

[T3] Elements
Speckle Filtering
- Box Car
- Gaussian
- IDAN filter
- Lee Refined
- Edge Detector

H / A / Alpha
- Decomposition Parameters
- Eigenvectors Parameters
- Eigenvalues Parameters

Polarimetric Segmentation
- H / A / alpha Segmentation
- Unsupervised Wishart
  H / A / alpha Segmentation
- Supervised Wishart
  H / A / alpha Segmentation

Batch Process
- Speckle Filtering
- H / A / alpha Decomposition
- Unsupervised Wishart
  H / A / alpha Segmentation

BMP 8 / 24 bits
RGB
PolSARpro v4.0 SOFTWARE

PROCESSING CHAIN

Data Processing Approach along a ‘recommended’ and easy processing chain

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

- PALSAR Dual-POL
- PALSAR Data Level 1.1

Configuration

- Input Data File
- QuickLook
- Extract Raw Data

Data Import

- [C2] Elements
- [C2] Correlation Coefficients
- Stokes Parameters
- Speckle Filtering
  - Box Car
  - Gaussian
  - IDAN filter
  - Lee Refined
  - PWF Filter
  - Edge Detector
- H / A / Alpha Wave Decomposition
- Supervised Wishart
- H / A / alpha Segmentation

Data Process

- BMP 8 / 24 bits
- RGB

Data Display
PoISARpro v4.0 SOFTWARE

PROCESSING CHAIN

Data Processing Approach along a ‘recommended’ and easy processing chain

Data Import
- Input Data File
- QuickLook
- Extract Raw Data

Data Process
- (Ixx, Ixy) Elements
- (Ixx, Ixy) Multi looking
- Speckle Filtering
  - Box Car
  - Gaussian
  - Lee Refined
  - Edge Detector
- Supervised Wishart
  - H / A / alpha Segmentation

Data Display
- BMP 8 / 24 bits
- RGB

- PALSAR Dual & Quad–POL
- PALSAR Data Level 1.5

Provide a First Qualitative Analysis of the fully polarimetric data set processed
PROCEEDINGS of
The First Joint PI Symposium of
ALOS Data Nodes for ALOS Science Program in Kyoto

November 19 ( Mon ) ➤➤ 23 ( Fri ), 2007
Kyoto International Conference Center. Main Hall, Annex Hall, Room 103 & 104

JAXA Japan Aerospace Exploration Agency
Summary of Discussion

SAR Polarimetry

Kostas Papathanassиou DLR, Germany
Motoyuki Sato Tohoku Univ., Japan
2. Tools

• Different level of maturity tools are available, practical use/ interface to ALOS PALSAR data has to be emphasized (RAT, POLASPRO etc.)

• Tutorial session at the next ALOS PALSAR PI Meeting has been proposed
• Prepare demonstration POL data sets, not only images

• “How to do” guide for interferometry at Level 1.1 data is important to increase the number of users
PolSARpro v4.0 Software Training Course
PolSARpro v4.0 SOFTWARE
PolSARpro v4.0 SOFTWARE

ALOS - PALSAR
Standard Beam Quad-POL

ALOS / PALSAR quick-look

GOOGLE EARTH
PolSARpro v4.0 SOFTWARE

Unsupervised H / $\alpha$ Segmentation
Unsupervised Wishart H / A / $\alpha$ Segmentation
2. Tools

- Different level of maturity tools are available, practical use/ interface to ALOS PALSAR data has to be emphasized (RAT, POLASPRO etc.)
- Tutorial session at the next ALOS PALSAR PI Meeting has been proposed
- Prepare demonstration POL data sets, not only images
- “How to do” guide for interferometry at Level 1.1 data is important to increase the number of users
1. Read orbit Position and Velocity vectors (28 SVs) from L1.1 product header
2. Interpolate the 2 ALOS orbits
3. Align the time reference between the orbits
4. Read timing and geometry information from the SAR scene
5. Calculate perpendicular baseline
Check the Pol-InsAR application feasibility

Generate Flat-Earth and Vertical Wavenumber

Provide coarse and fine co-registration

SLC #1

SLC #2
BASELINE CALCULATOR TOOL

PALSAR Data Level 1.1

PolSARpro v4.0 Software Training Course
PolSARpro v4.0 Software Training Course

Polarimetric Data Processing

Advanced Display functionalities
- Orthorectification
- Image co-registration
- Reprojection / Mosaicking...
Install PolSARpro v4.0 Software on your laptop before Wednesday / Friday morning. Help can be provided.

Load the ALOS-PALSAR data set that will be used for training support and illustration.

SEE YOU ON WEDNESDAY & FRIDAY AFTERNOON ...
Questions?