Interferometric SAR analysis for Characterizing Surface Changes of an Active Volcano using Open Source Software

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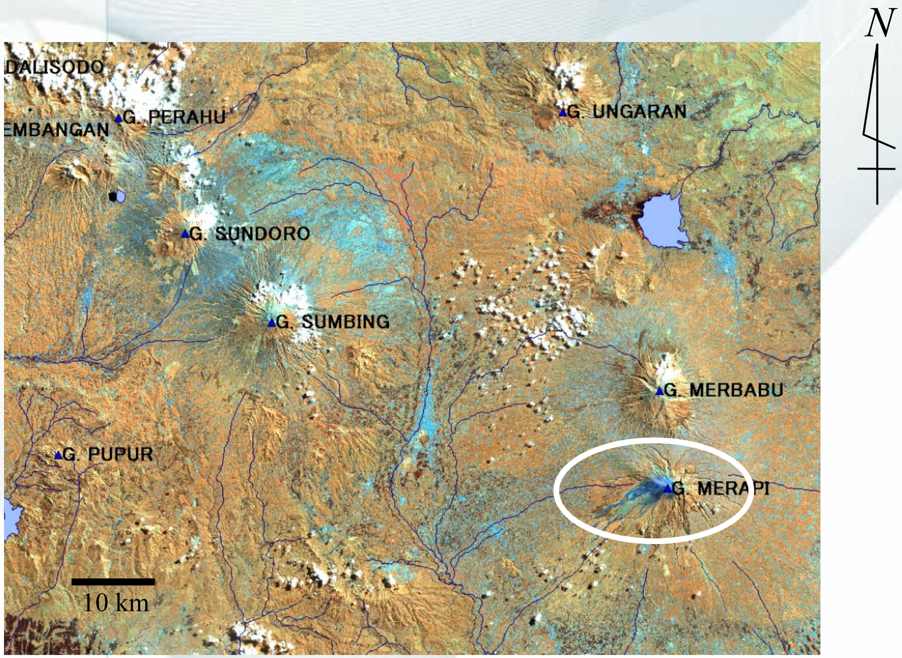
Study Area

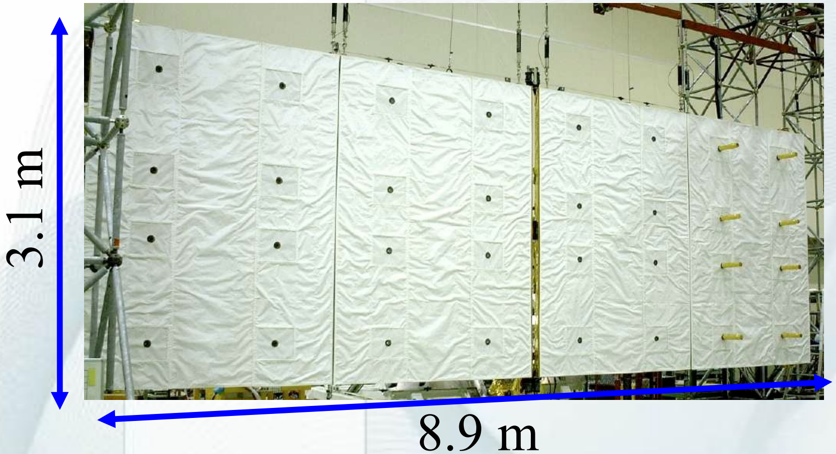
Mt. Merapi.
Located in Central Java, Indonesia.
One of 129 the most active volcanoes in Indonesia.

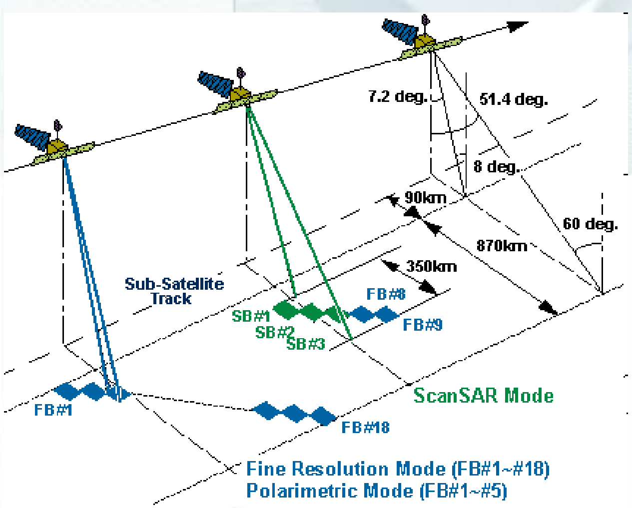


Mt. Merapi and its neighbor volcanoes are showed in Landsat ETM+ for RGB:457.

Advanced Land Observation System (ALOS)
PALSAR

Antenna





The Phased Array L-band Synthetic Aperture Radar (PALSAR) is an enhanced version of the Synthetic Aperture Radar on JERS-1 (L-band; HH-polarisation; 35°off-nadir angle) Like its predecessor, PALSAR was developed jointly by JAXA and the Japan Resources Observation Systems Organization (JAROS).

http://www.eorc.jaxa.jp/ALOS/about/palsar.htm

ALOS-PALSAR Data Pair for Mt. Merapi

Pair	Orbit	Master_Observation	Slave_Observation	Bpara (m)	Bperp (m)	Btemp (days)
1	A	2006.06.10	2006.07.26	-94.34	2420.14	46
2	A	2006.12.06	2007.01.21	1738.04	2404.44	46
3	D	2007.05.02	2007.06.17	29.27	-633.26	46

- The best data found in 2006-2007 for ALOS-PALSAR FBS mode
- Perpendicular baseline seem large
- Temporal baseline is only one cycle orbit
- Reducing the topographical change effect

Radar Tools (RAT)

http://www.cv.tu-berlin.de/rat/

Open-source software tool for processing SAR data developed under Computer Science and Remote Sensing Group-Berlin University of Technology

Module:

-SAR basic processing, PolSAR, InSAR, PolInSAR

Data Support:

-PI-SAR (NASDA-CRL)

-ALOS PALSAR (JAXA)

-RADARSAT-1

-RADARSAT-2 (CSA)

-etc

Requirement:

-Linux, UNIX or Mac OS X operating system (experimental support for Windows)

-IDL Virtual Machine, which can be downloaded and used free of charge, or IDL (Interactive Data Language) Version >= 6.2 (commercial, license required).

Radar Tools (RAT)

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Advantages:

- Open Source (free: use, modify, distribute)
- Support more than 10 SAR data types
- User friendly
- Support Multi-Operating System
- Optimized display routine
- Interactive coregistration process

Disadvantages:

- Could not proceed the large file in one time
- Process pure in image processing (without geographic information)
- Could not remove orbital error
- Slow display

Acquisition Date of Image Pair

Statistics of Seismicity of Mt. Merapi in 2006-2007

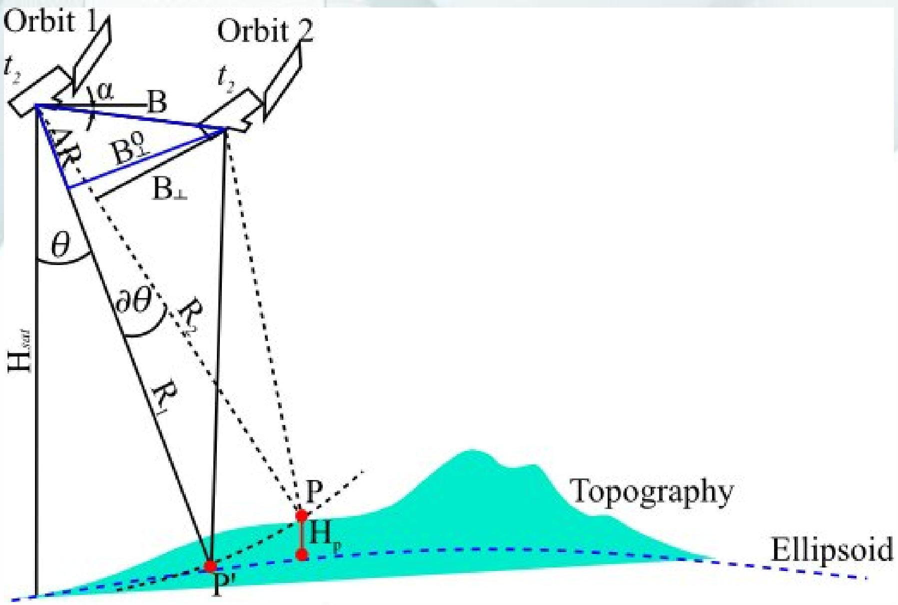
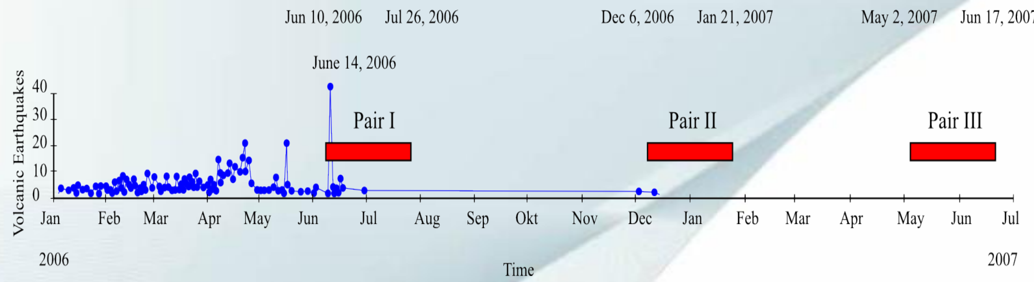
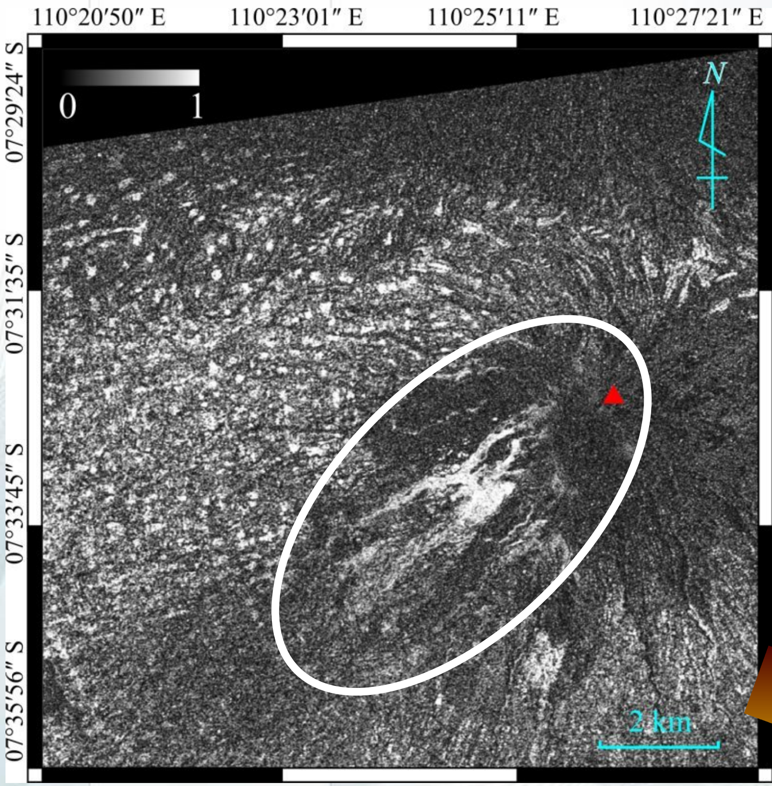


Illustration of InSAR system to obtain the phase difference between two observation time

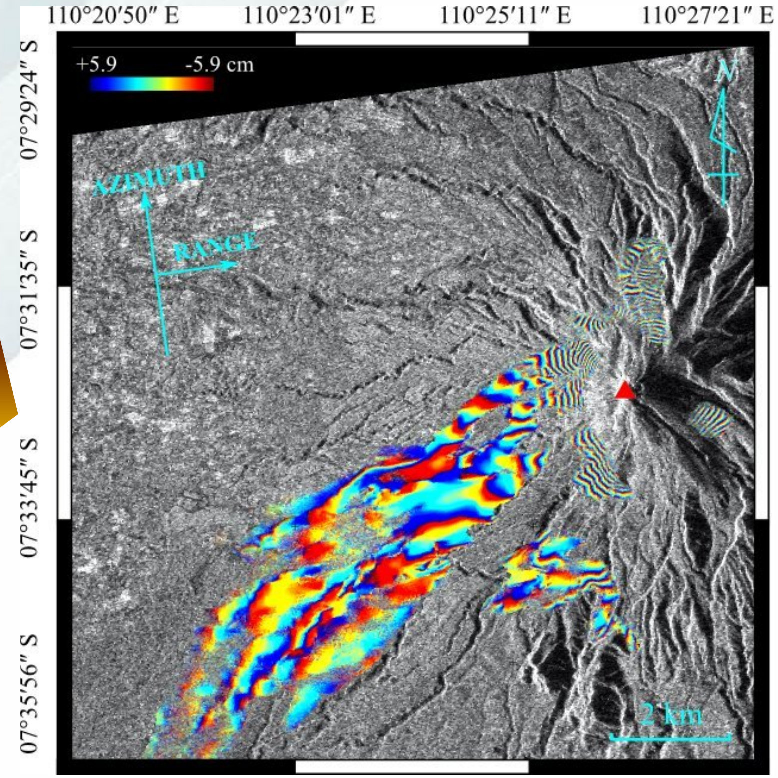
PAIR I



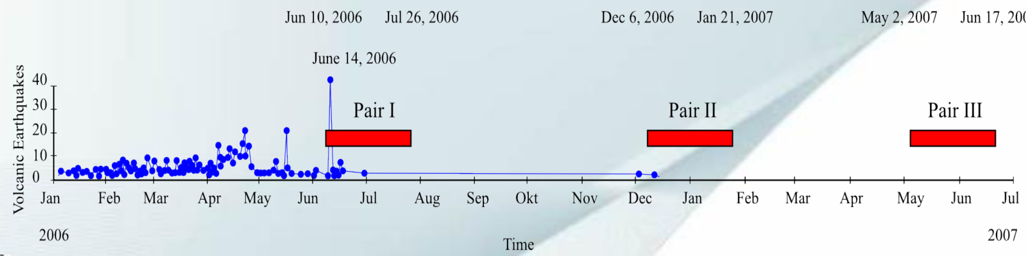
Interferogram image pair I; masked and thresholded by coherence value larger than 0.4

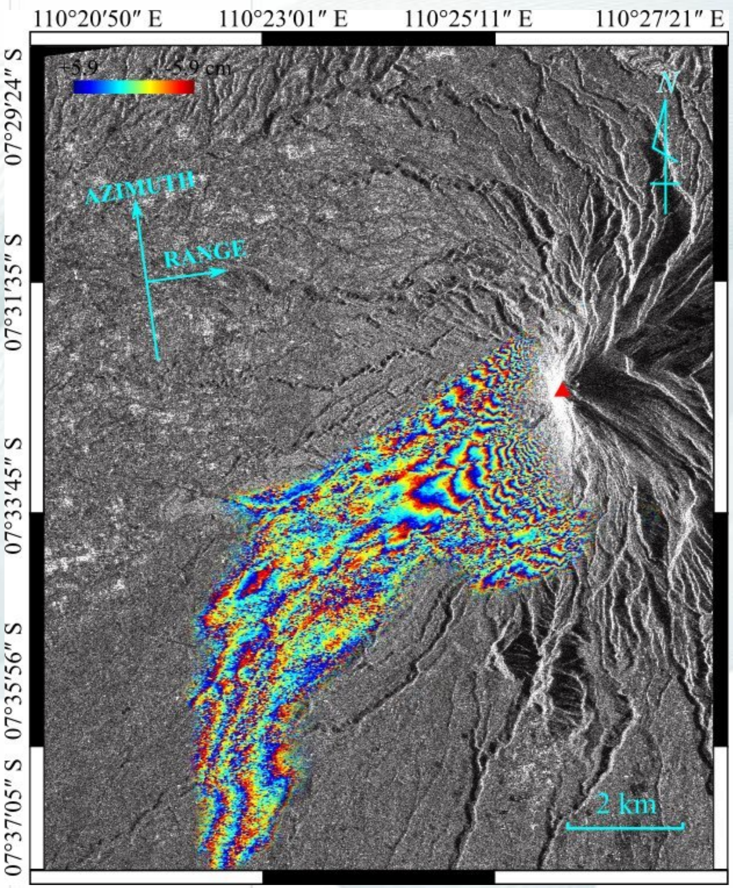


Coherence image pair I; high value located W-SW from the Summit (red triangle)



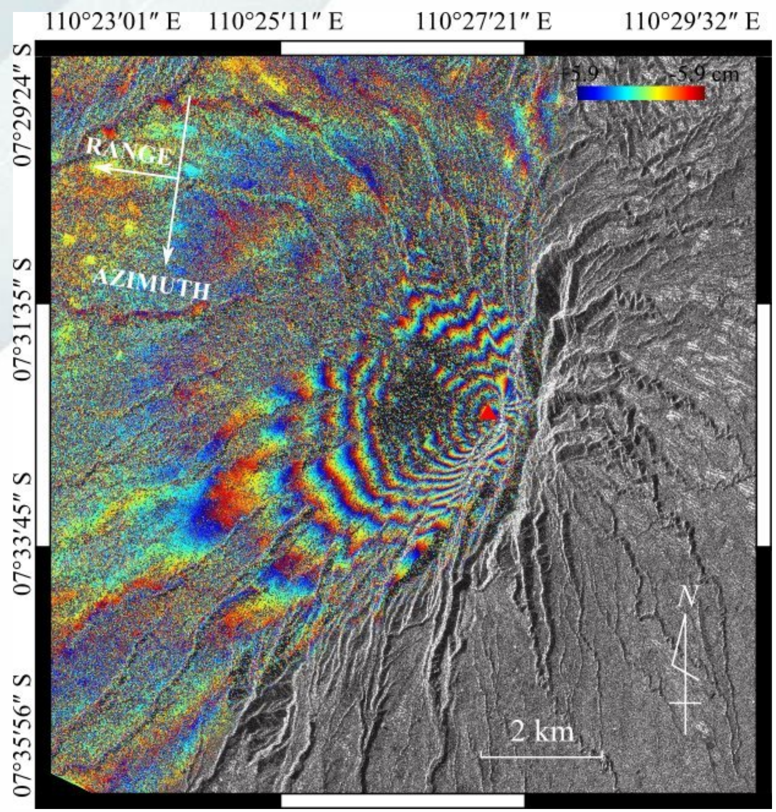
PAIR II and III



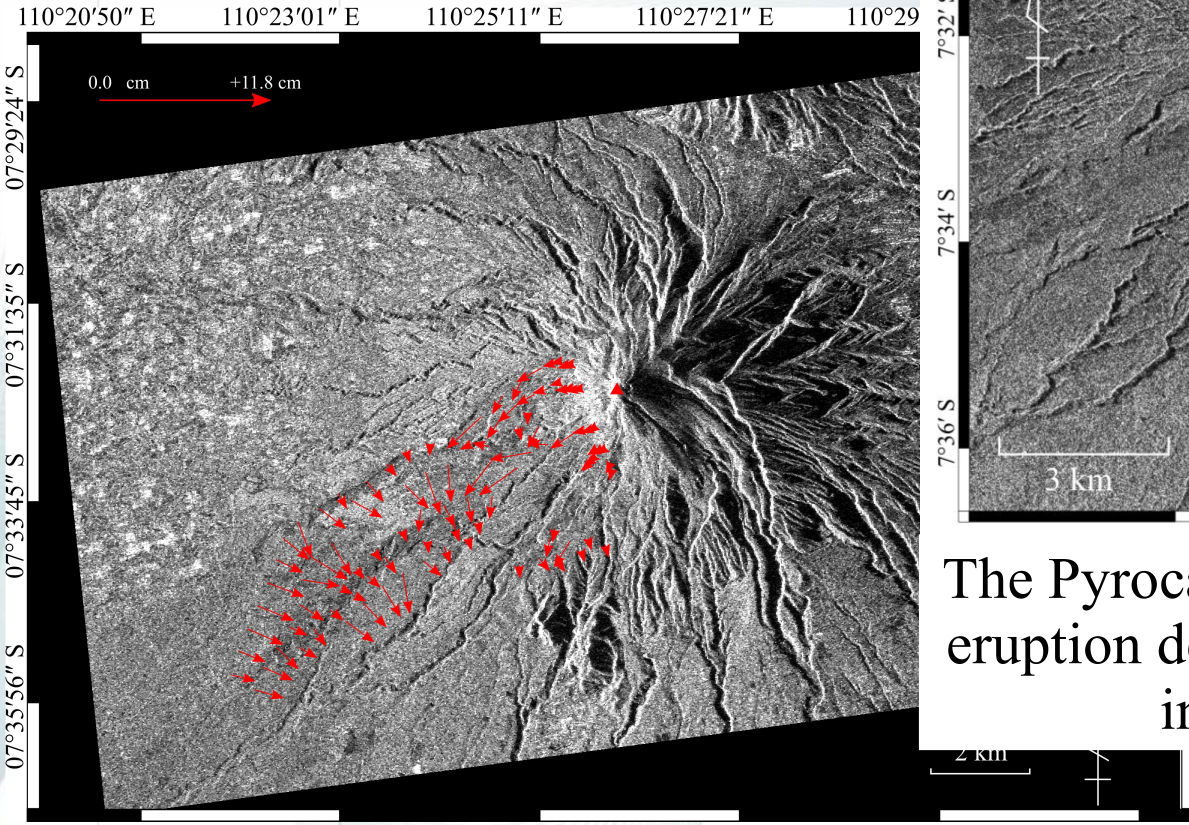


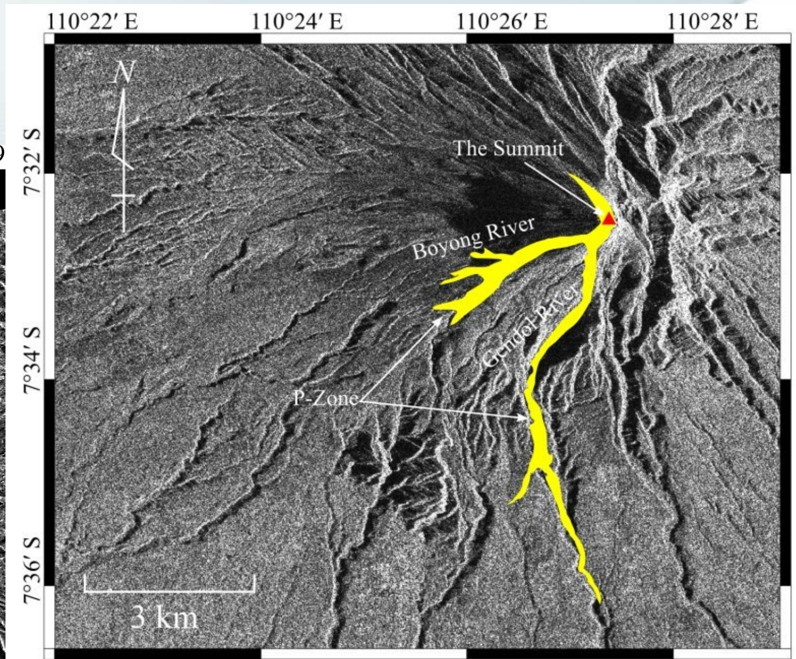
Interferogram image pair II; shows similar fringes pattern with pair I

Interferogram image pair III; shows topographical effect dominated the fringes pattern



Interpretation PAIR I

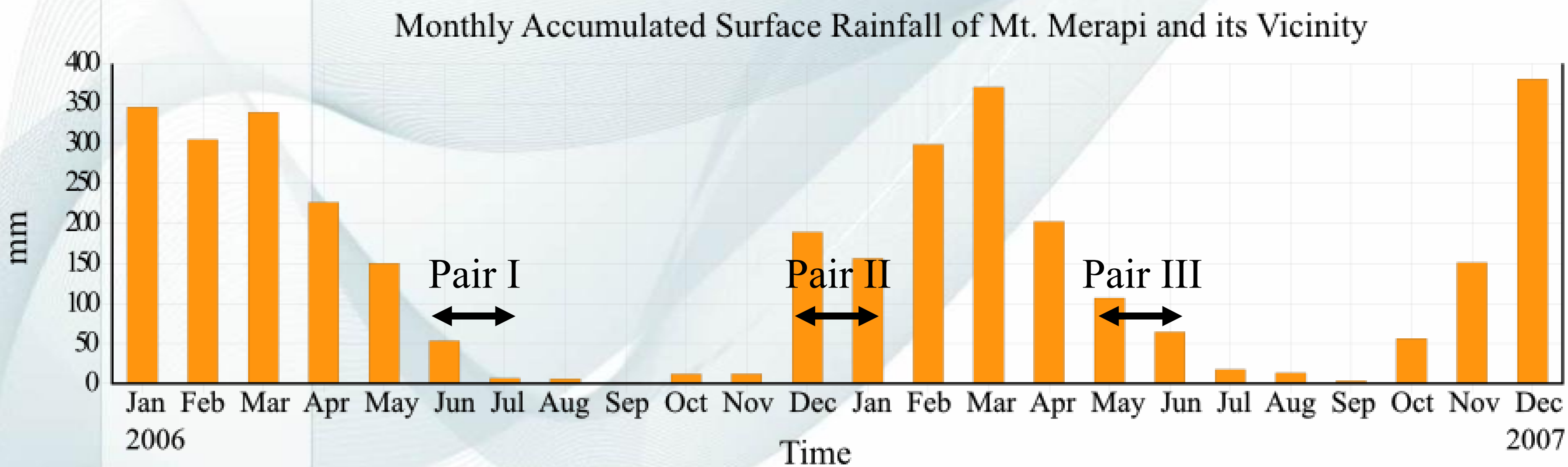




The Pyrocalstic flows deposit after eruption detected by RADARSAT intensity images

Phase fringes direction, perpendicular to the fringes pattern overlaid on intensity image of ALOS-PALSAR

TRMM* data for Mt. Merapi in 2006-2007 showed that meteoric water may also contribute to the activity of pyroclastic flows deposit which changed to be lahars



*The Tropical Rainfall Measuring Mission (TRMM) is a joint mission between NASA and the Japan Aerospace Exploration Agency (JAXA) designed to monitor and study tropical rainfall, source: http://trmm.gsfc.nasa.gov/

SUMMARY

- Capability of Radar Tools for generating interferogram was demonstrated by the three pairs of ALOS-PALSAR data covering Mt. Merapi.
- A superiority of this software is its coregistration that can increase coherence by large shifting of slave image, which generates good interferograms at high coherence zones.
- The phase fringes of Mt. Merapi are probably associated with the surface changes after the main eruption, because the fragmented volcanic products flowed from the summit toward the foothills.

Acknowledgement

Thanks to PIXEL for providing some of ALOS-PALSAR data used in this study.