Polarimetric analysis of PALSAR data to detect Landslide Caused by Iwate-Miyagi Nairiku Earthquake in 2008

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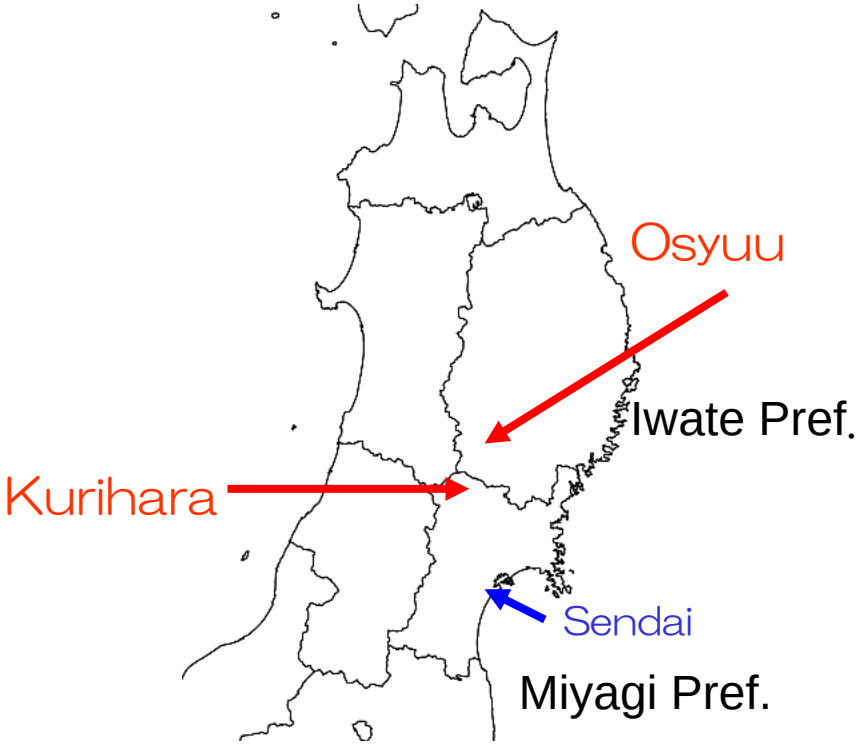
Iwate-Miyagi Nairiku Earthquake in 2008

14JUN08 8:43 AM (JST) Mj=7.2

Landslides in mountainous forested area

17 people dead, 6 people missing

Aratozawa-dam (08AUG08)

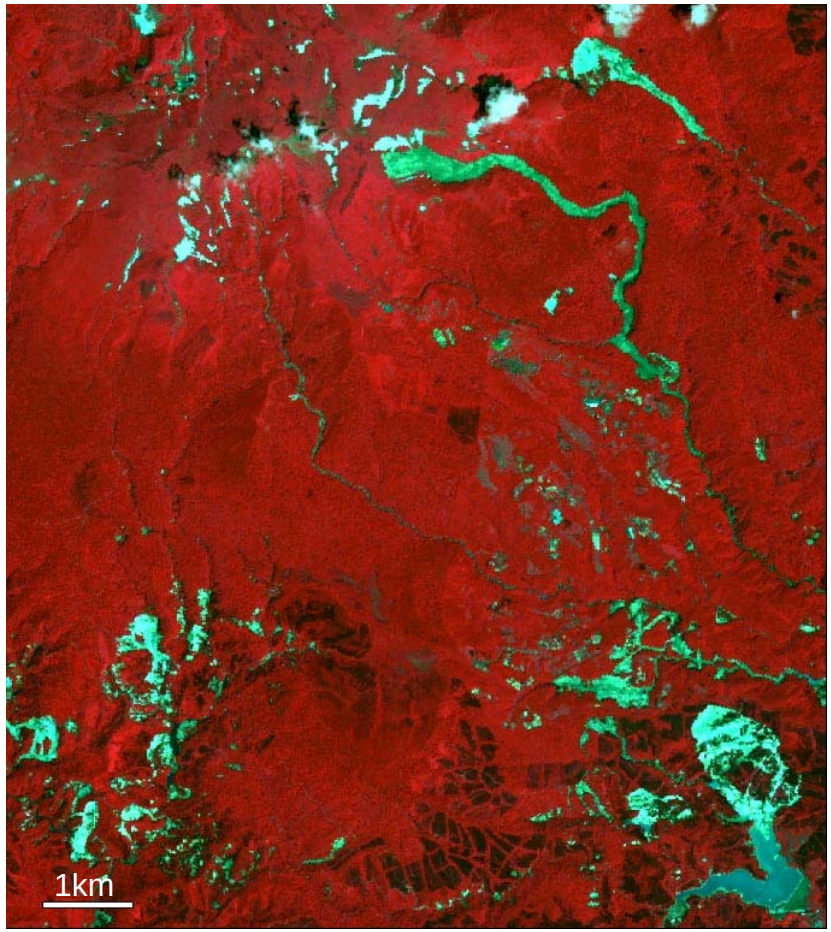


AVNIR-2 Images
~South west slope of Mt Kurikoma~

Before

17OCT06 R:4, G:3, B:2

After



02JUL08 R:4, G:3, B:2

PALSAR Observation

Single Pol.

(Dual Pol.)

Quad. Pol.

Before Earthquake

19 May 2006（Descending　21.5°）
27 August 2006（Ascending　21.5°）
12 October 2006（Ascending　21.5°）
14 April 2007（Ascending　21.5°）
30 May 2007（Ascending　21.5°）

After Earthquake

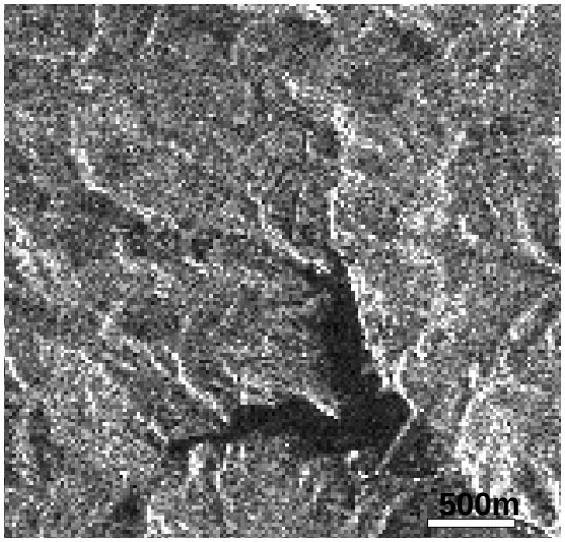
24 August 2008（Descending　21.5°）
9 October 2008（Descending　21.5°）
24 November 2008（Descending　21.5°）
2 December 2008（Ascending　21.5°）
19 April 2009（Ascending　21.5°）
4 June 2009（Ascending　23.1°）

Single Polarization

Visual Interpretation

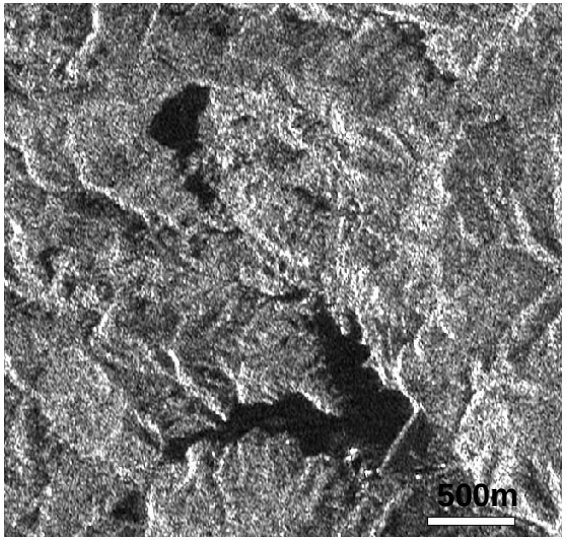
~Aratozawa-dam~

Before

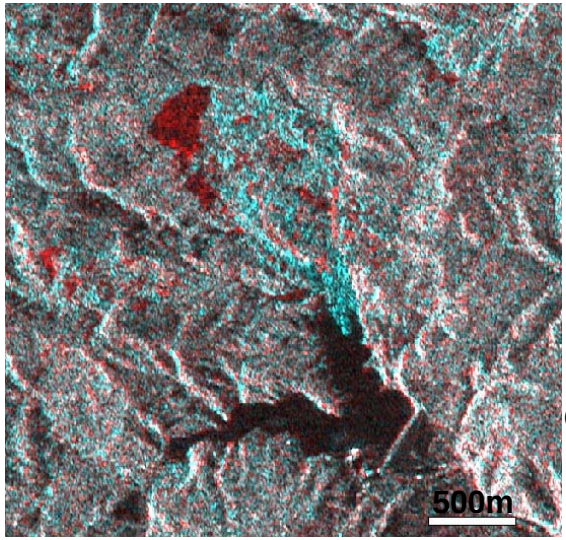


22DEC07

After

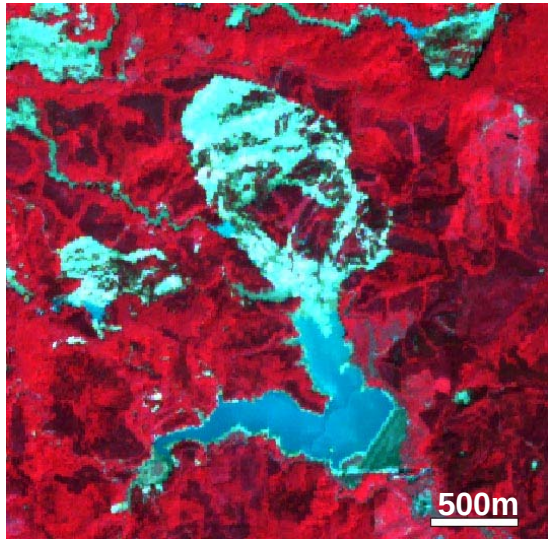


23JUL08



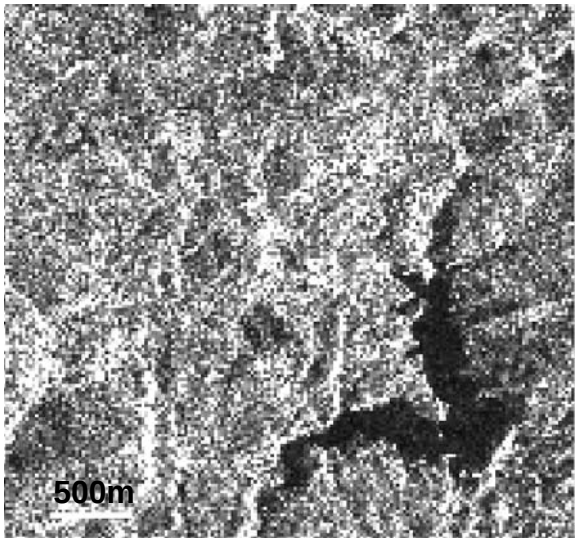
GB：23JUN08
R：22DEC07

AVNIR-2：
02JUL08

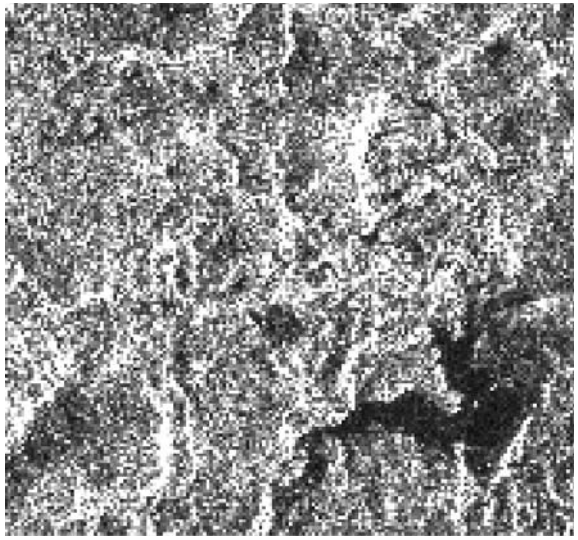


Single Polarization ~Aratozawa-dam~

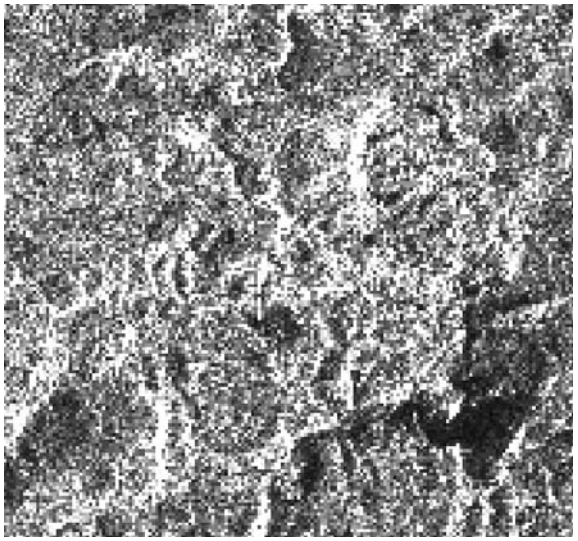
Descending Off-nadir Angle 34.3°



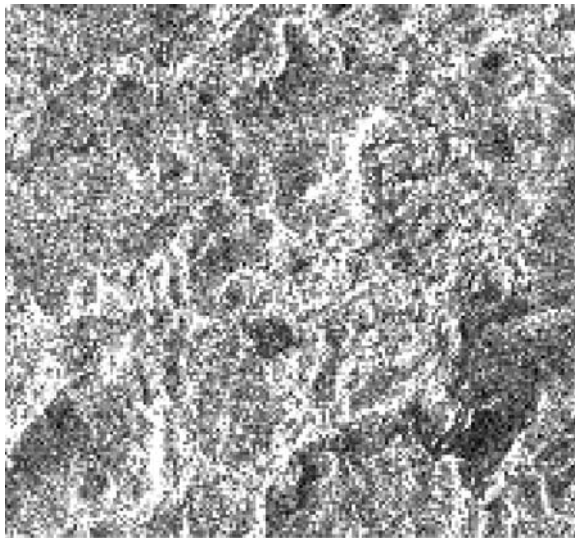
31MAY08



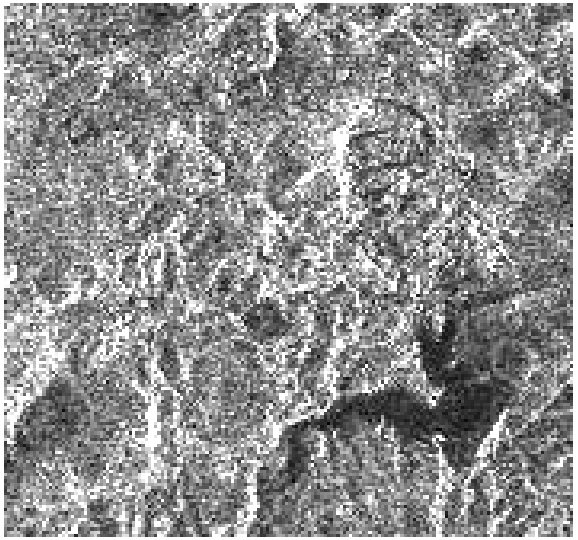
16JUL08



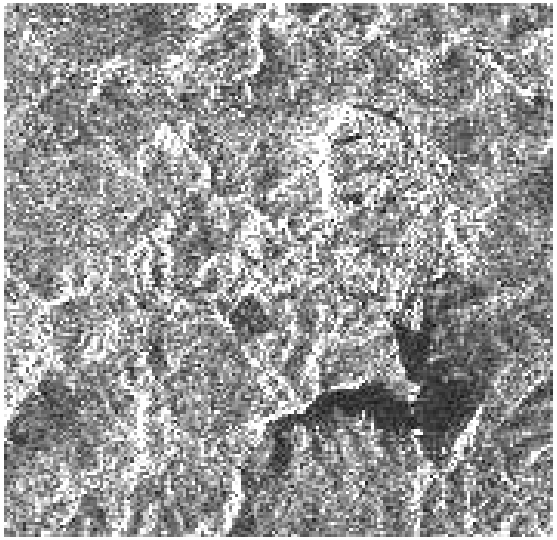
31AUG08



16JAN09



03JUN09



19JUL09

Single Polarization

Visual Interpretation

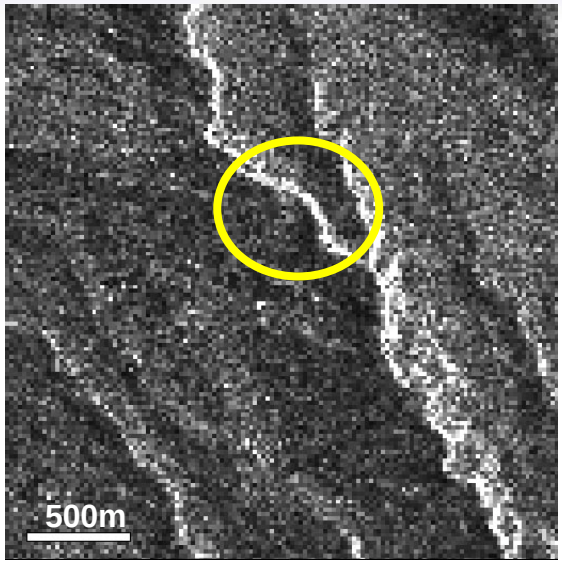
~Komanoyu-spa~

Before

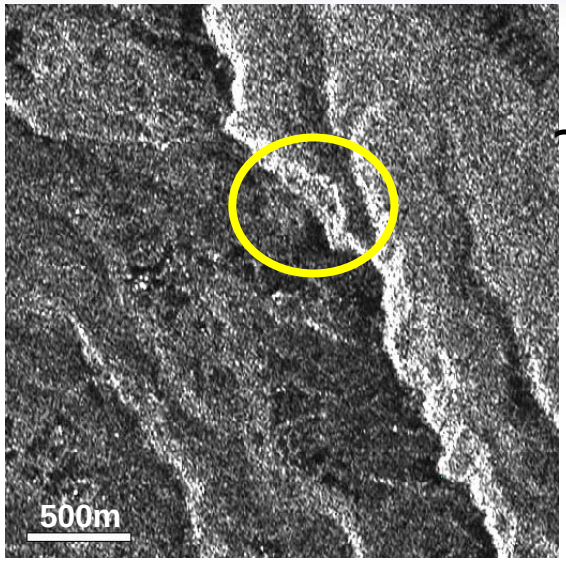
After

Ascending

Off-nadir Angle 34.3°



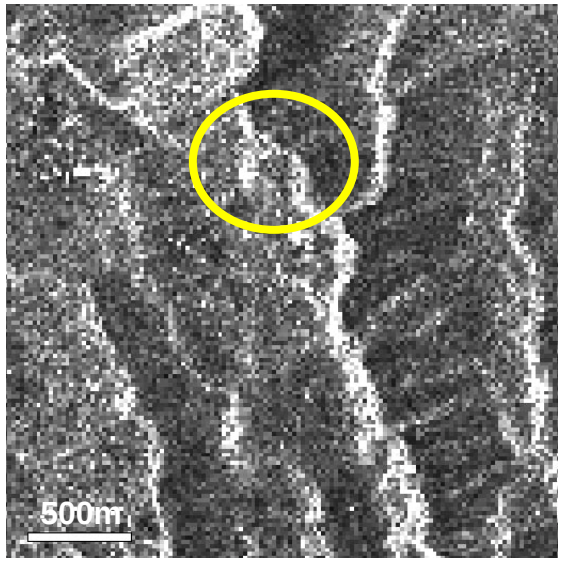
12DEC07



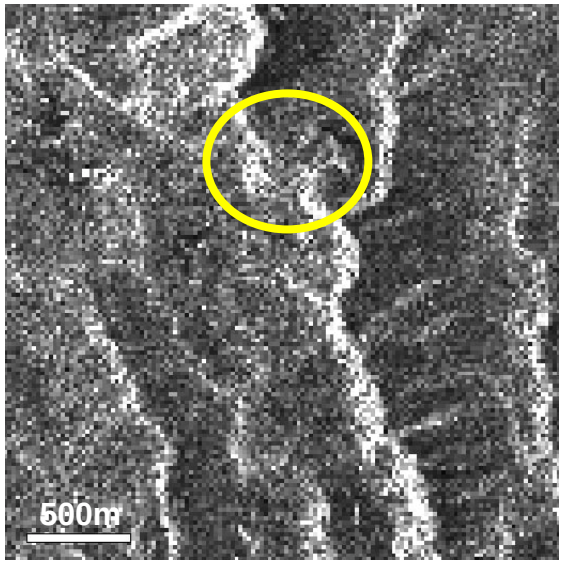
23JUN08

Descending

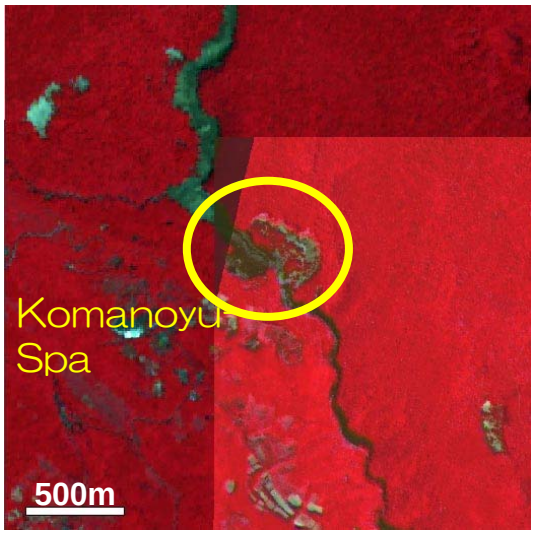
Off-nadir Angle 21.5°



02AUG06



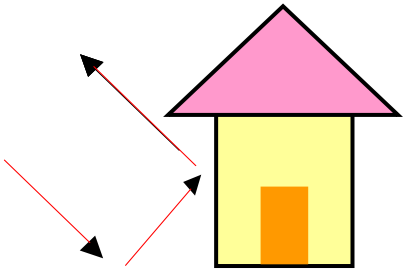
22JUL08



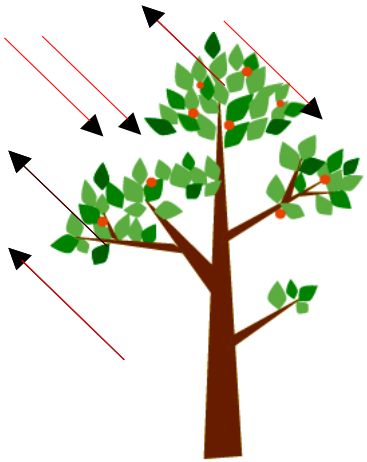
AVNIR-2, PRISM :
2JUL08

Full Polarization

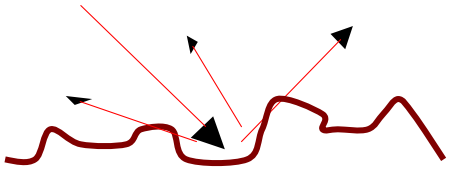
★ Three component decomposition



Double Bounce



Volume



Surface

★ Eigenvalue-Eigenvector decomposition

Entropy: randomness of scattering

Alpha: direct information about scattering mechanism

Anisotropy: characterize scattering phenomenon

Full Polarization

- Pauli Color coded Representation

$$\begin{bmatrix} S_{11} & S_{12} \\ S_{12} & S_{22} \end{bmatrix} = \begin{bmatrix} a+b & c \\ c & a-b \end{bmatrix}$$

$$a = \frac{S_{\perp\perp} + S_{////}}{\sqrt{2}} \qquad b = \frac{S_{\perp\perp} - S_{////}}{\sqrt{2}} \qquad c = \sqrt{2} S_{\perp//}$$

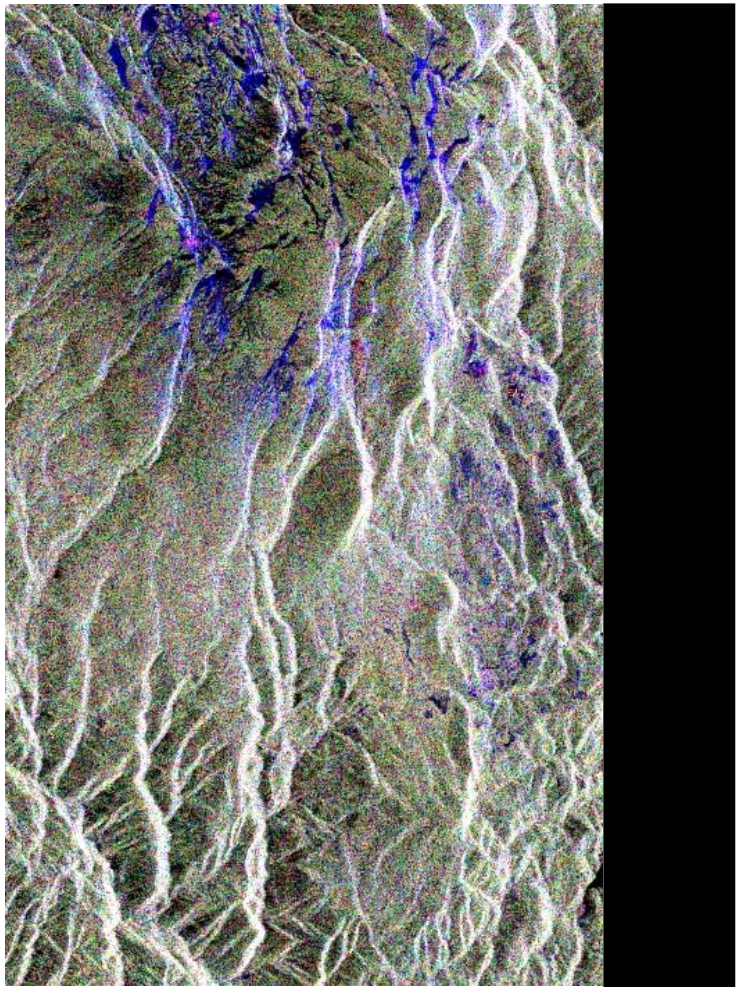
$$R : \left|b^2\right| \;, G : \left|c^2\right|, B : \left|a^2\right|$$

Full Polarization

Descending 21.5°

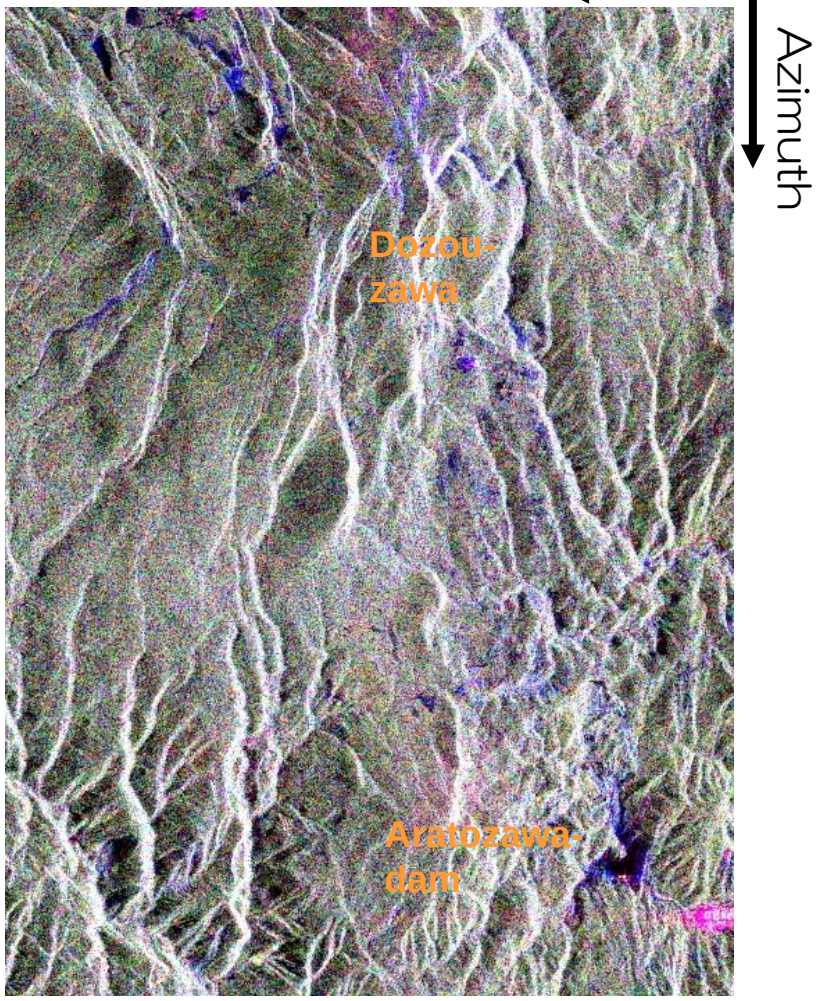
Pauli Image

Before



19MAY06

After



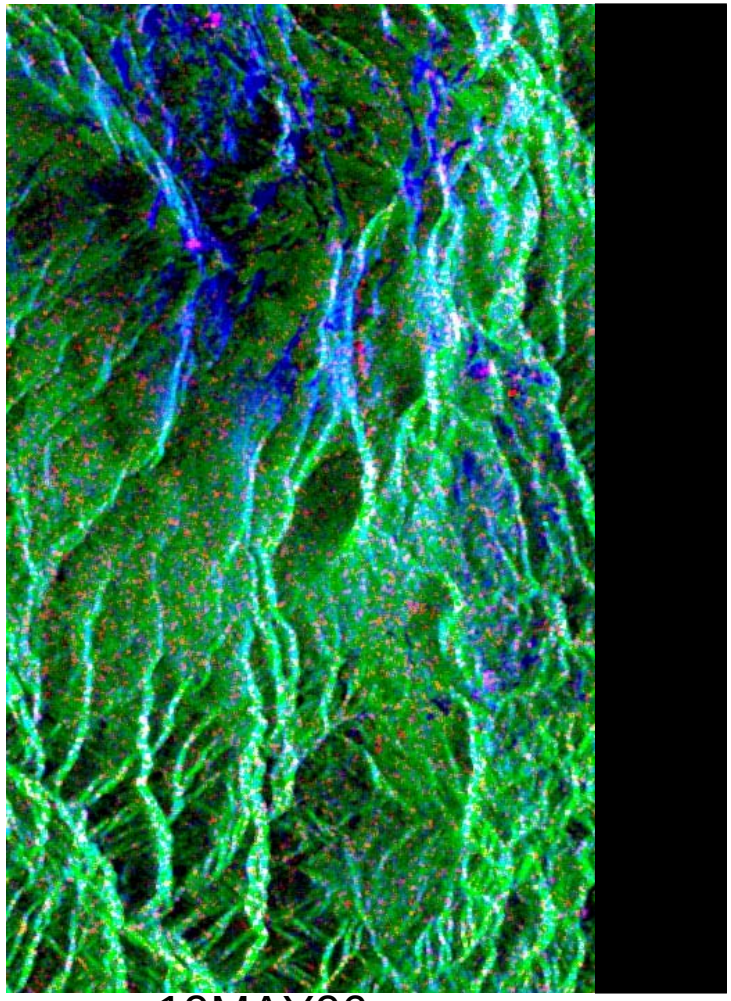
24AUG08

Full Polarization

Descending 21.5°

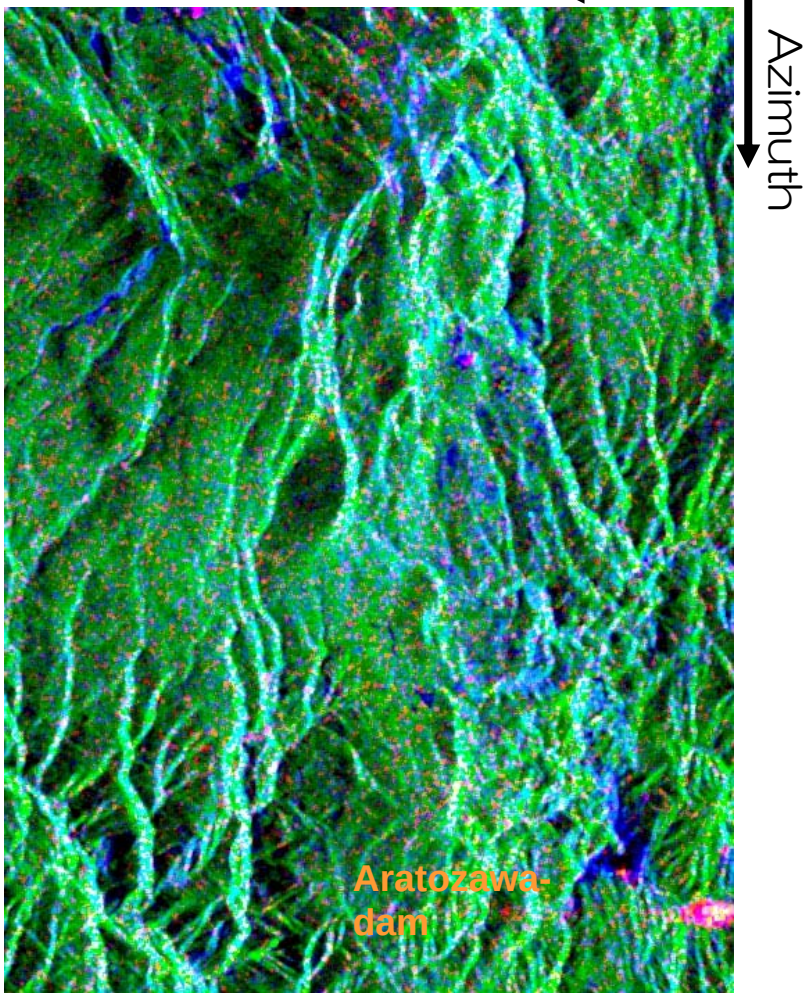
Three component decomposition

Before



19MAY06

After



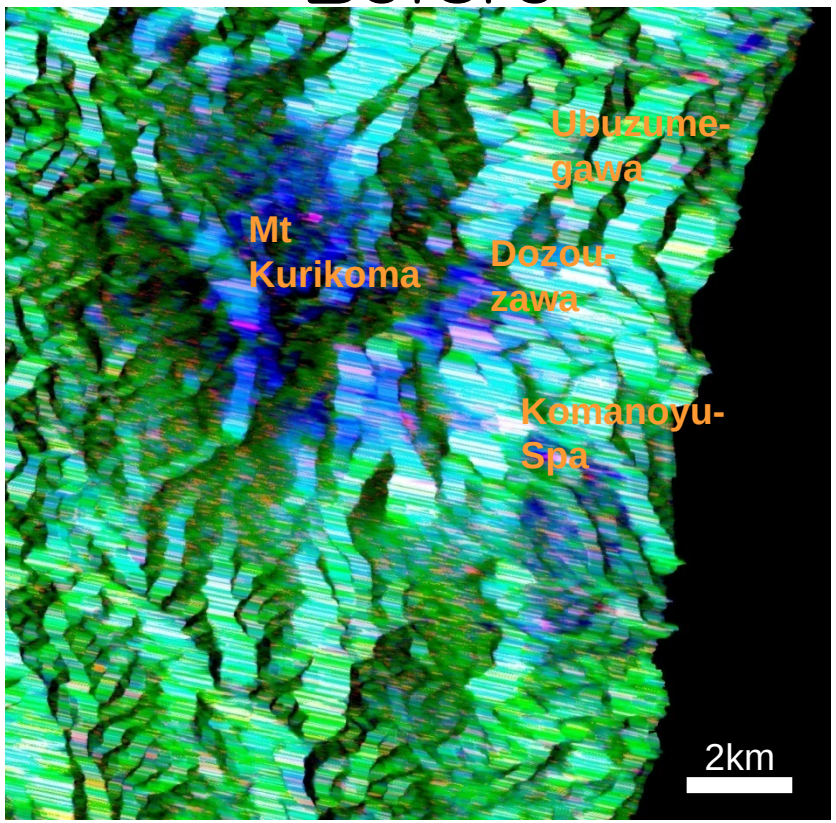
24AUG08

G:P_V B:P_S R:P_{DB}

Full Polarization

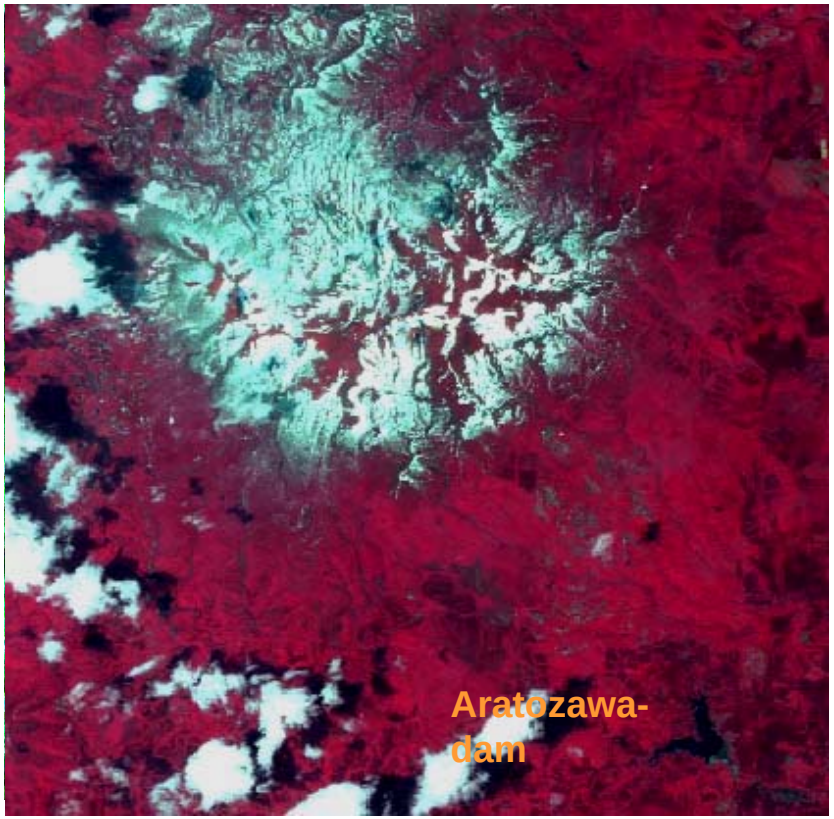
Three component decomposition

Before



19MAY06

AVNIR-2



21MAY06

G:P_V B:P_S R:P_{DB}

Full Polarization

Entropy

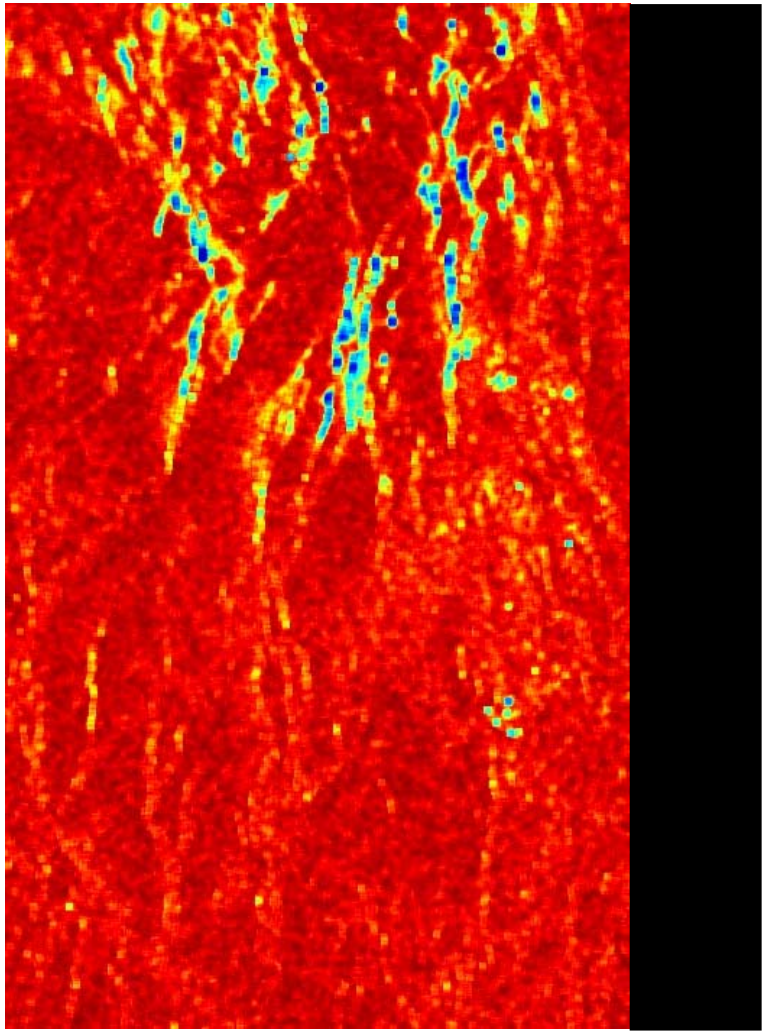
Descending 21.5°

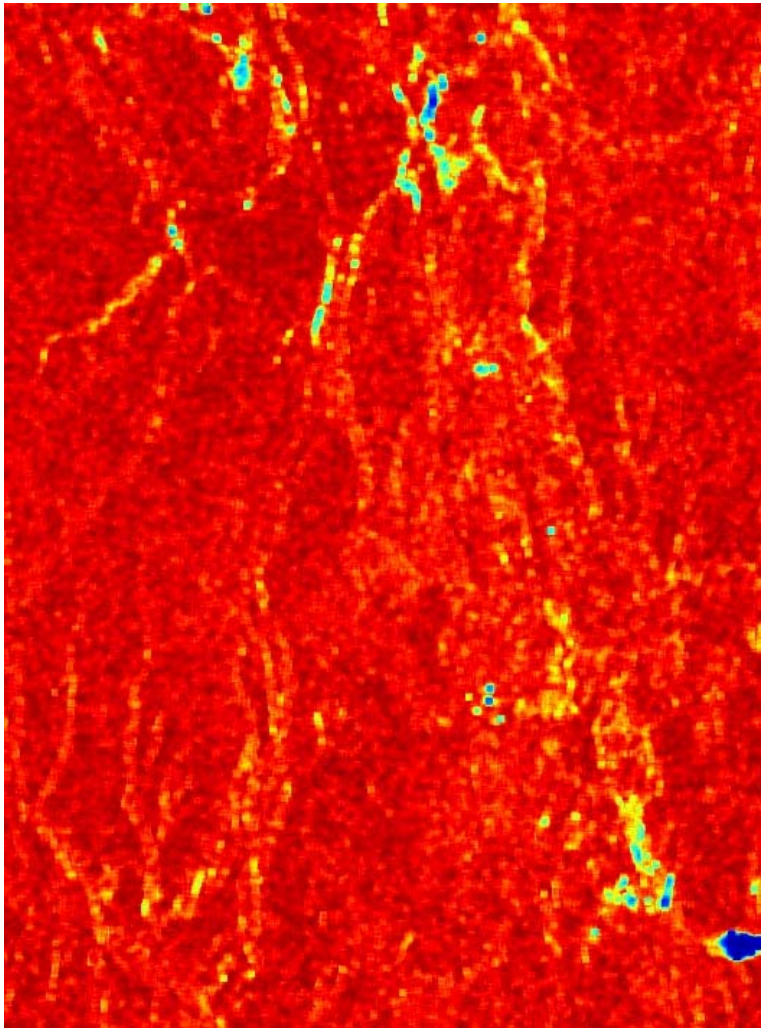
Before

After

Range

Azimuth





19MAY06

24AUG08

0

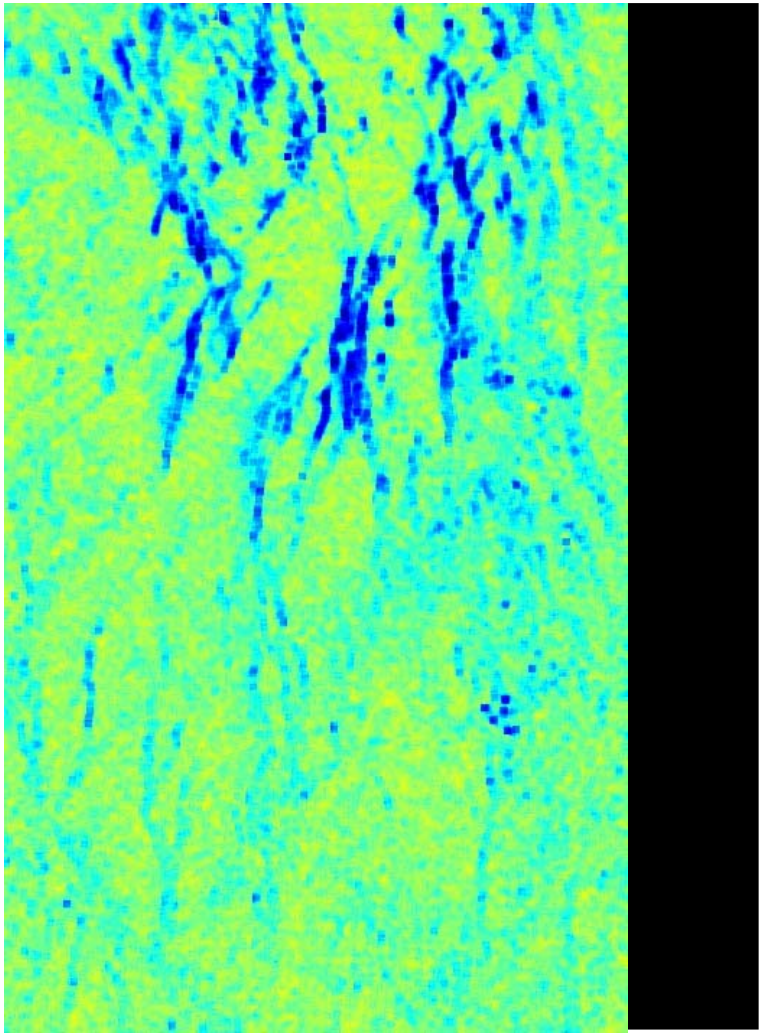
1.0

Full Polarization

Alpha

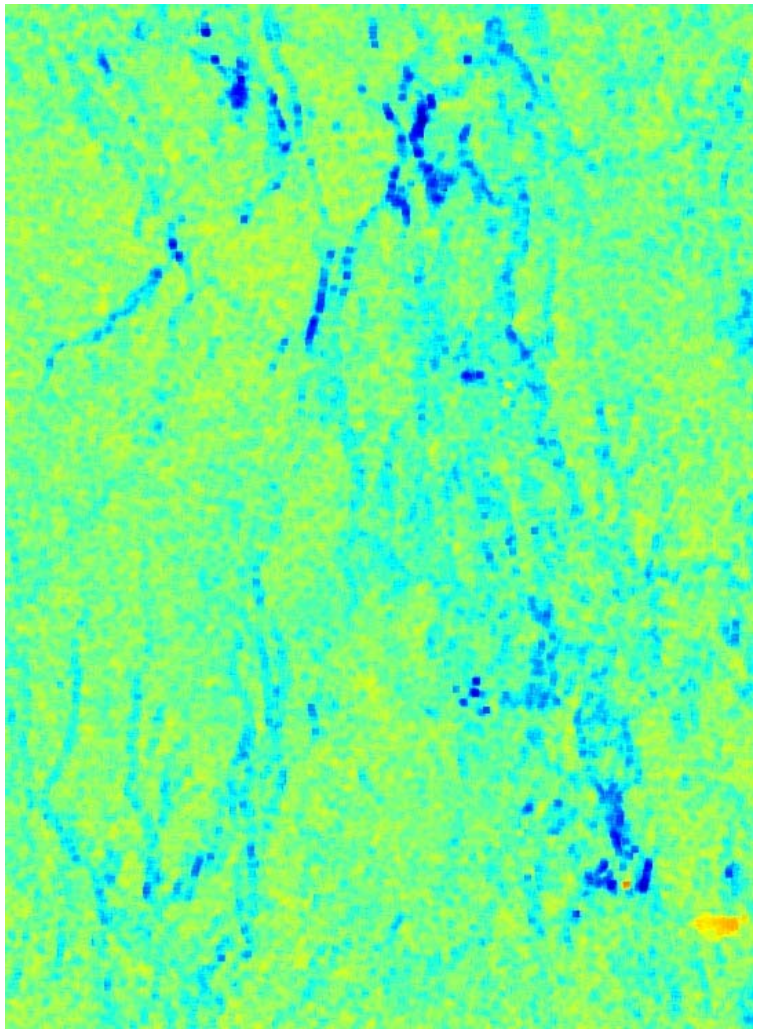
Descending 21.5°

Before



19MAY06

After



24AUG08

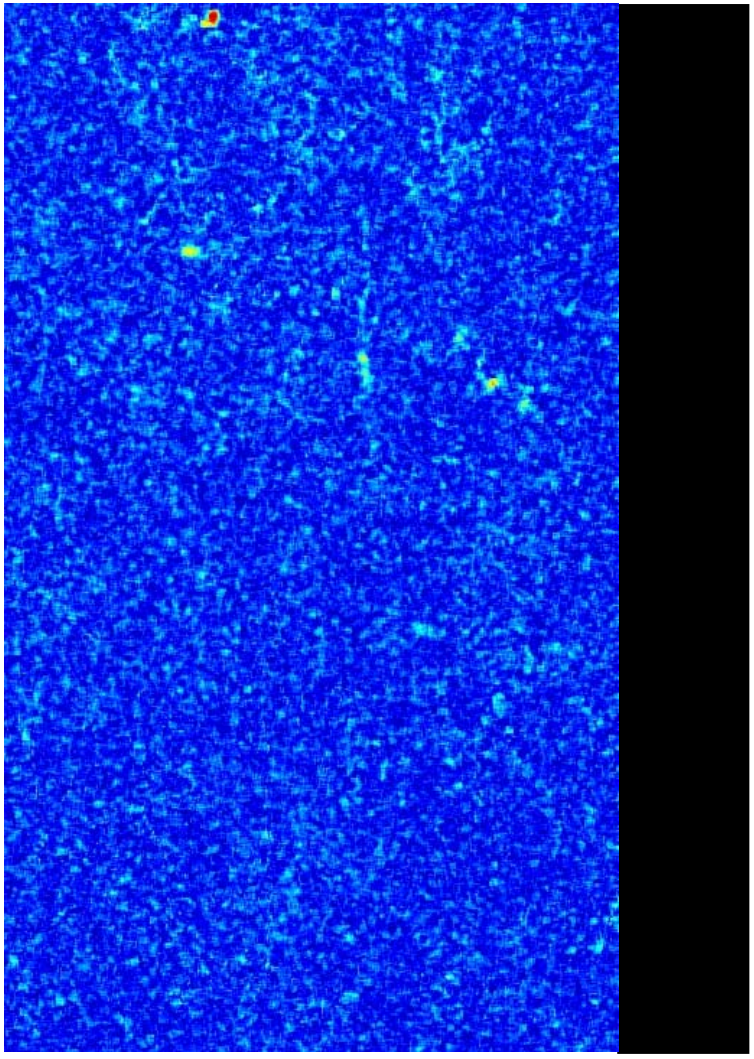
Full Polarization

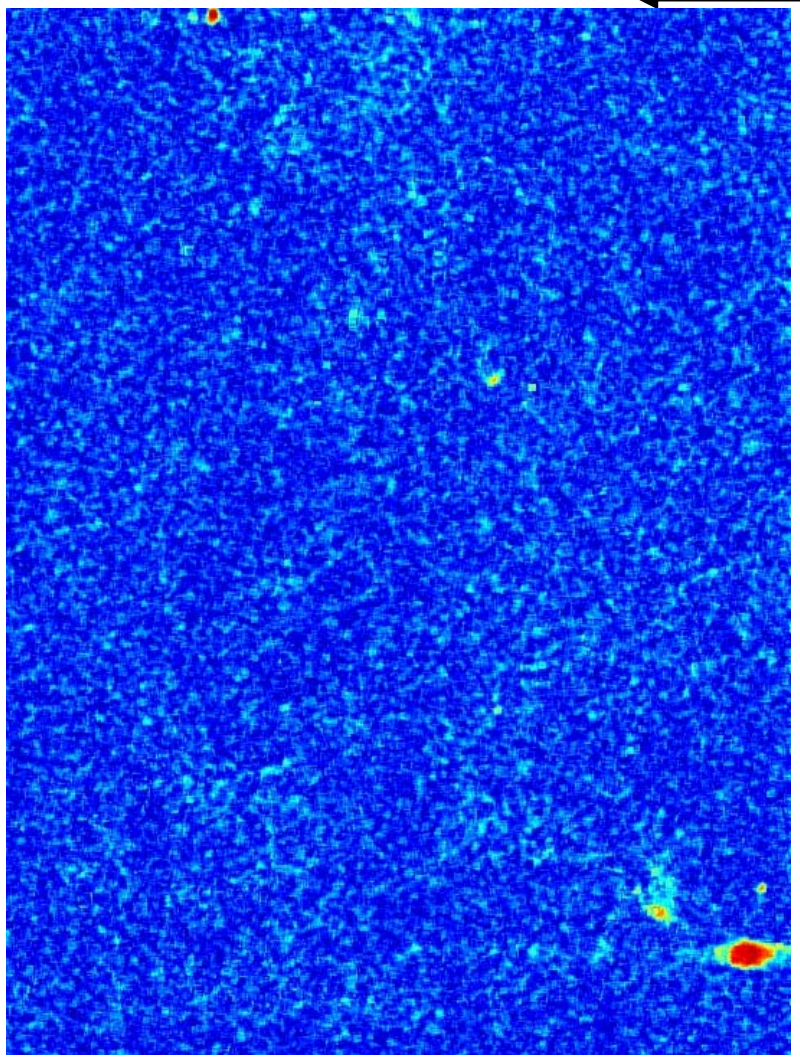
Anisotropy

Descending 21.5°

Before

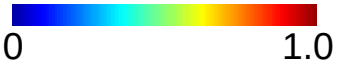
After





19MAY06

24AUG08



Summary

- Volume scattering component is dominant in forest area. Surface scattering component increase on bare soil area by landslide.
- Decrease of polarimetric entropy and alpha angle is found on landslide area.
- Scattering characteristics change observation by polarimetric SAR is useful to landslide detection.

Acknowledgement

- JAXA RA for ALOS mission
- JAXA SIGMA-SAR
- ESA/POLSARPro project team
- Miyagi University
- Tohoku Construction Association

Single Polarization
Visual Interpretation

- Topographic features change
- Water level of Aratozawa-dam