

Next Frontier of Space-borne SAR Interferometry: Seeing Deformations through Snow and Ice

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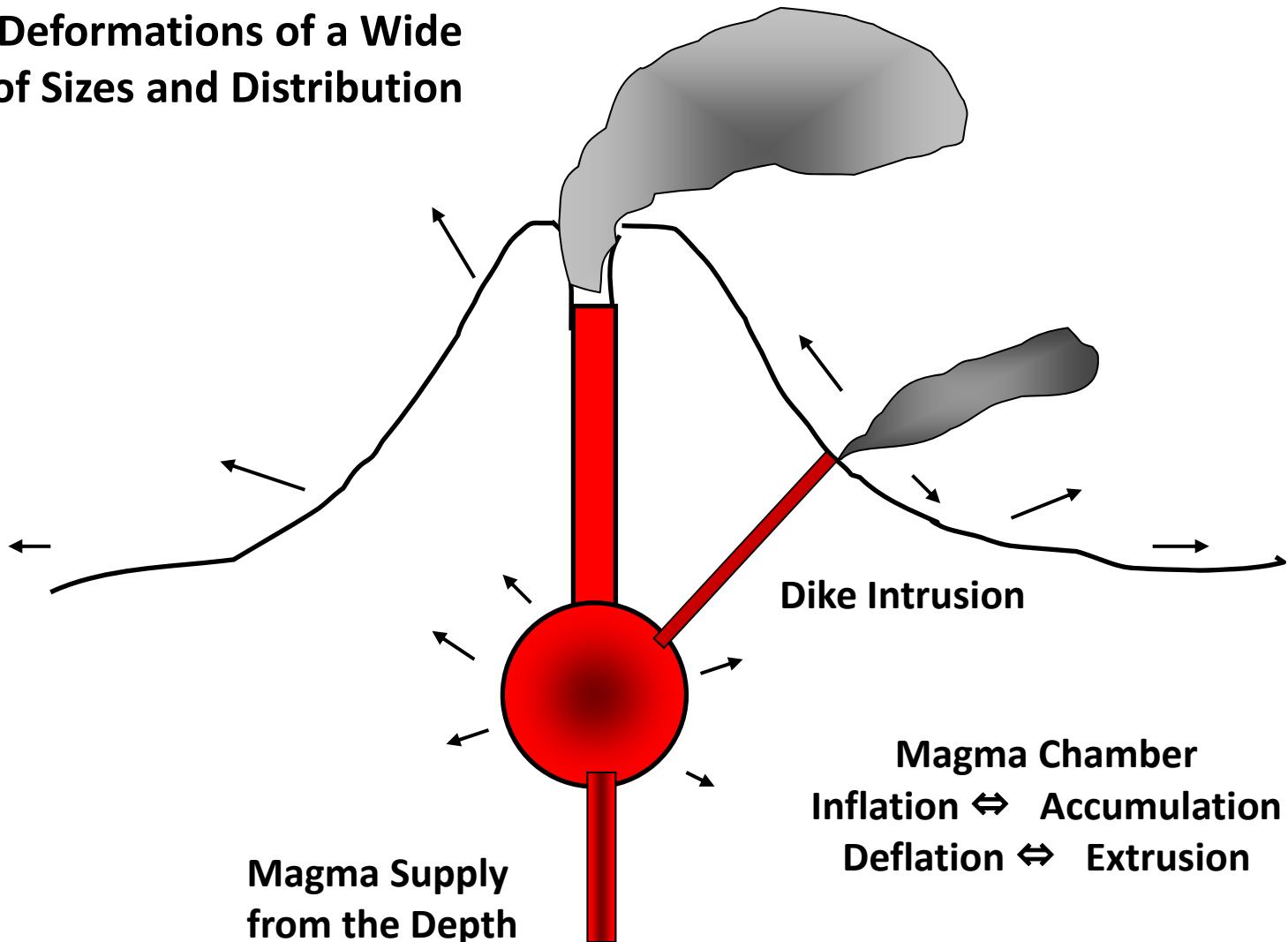
2013/06/27 1st Science and Application Workshop
for Germany-Japan Next-Generation SAR

Outline

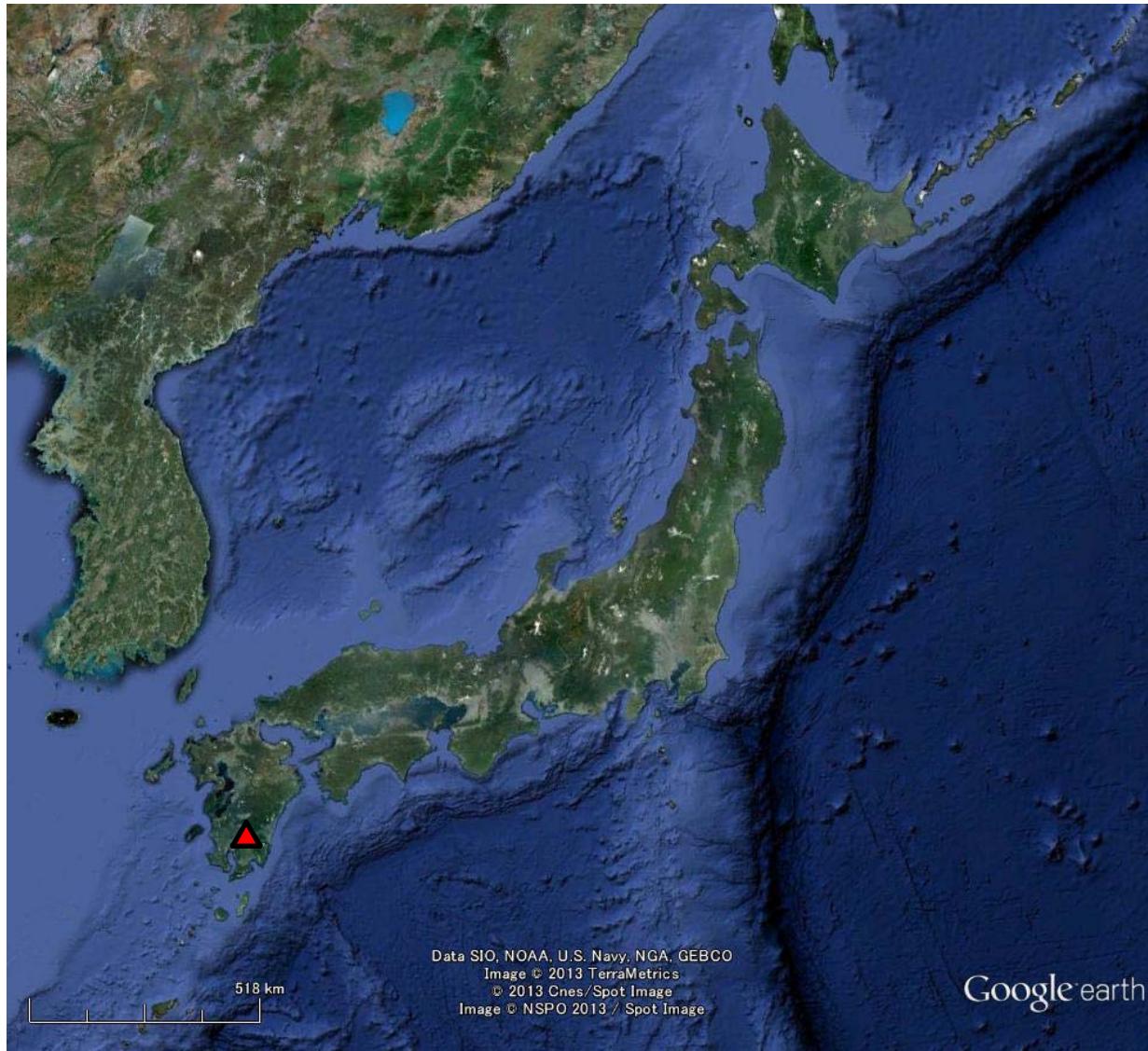
- Volcanism and Surface Deformation (Introduction)
- Present-Day Interferometry over Ice Covered Volcano
- Future Challenges:
 Seeing Deformations thorough Snow and Ice

Volcanism and Surface Deformation

Surface Deformations of a Wide Variety of Sizes and Distribution



2011 Eruption of Kirishima Volcano, Japan



新燃岳火口の溶岩湖

溶岩湖成長の過程でできたと思われる同心円状のしわが明瞭です。



写真撮影:東京大学地震研究所(中田節也氏)

Lava Lake in the Crater

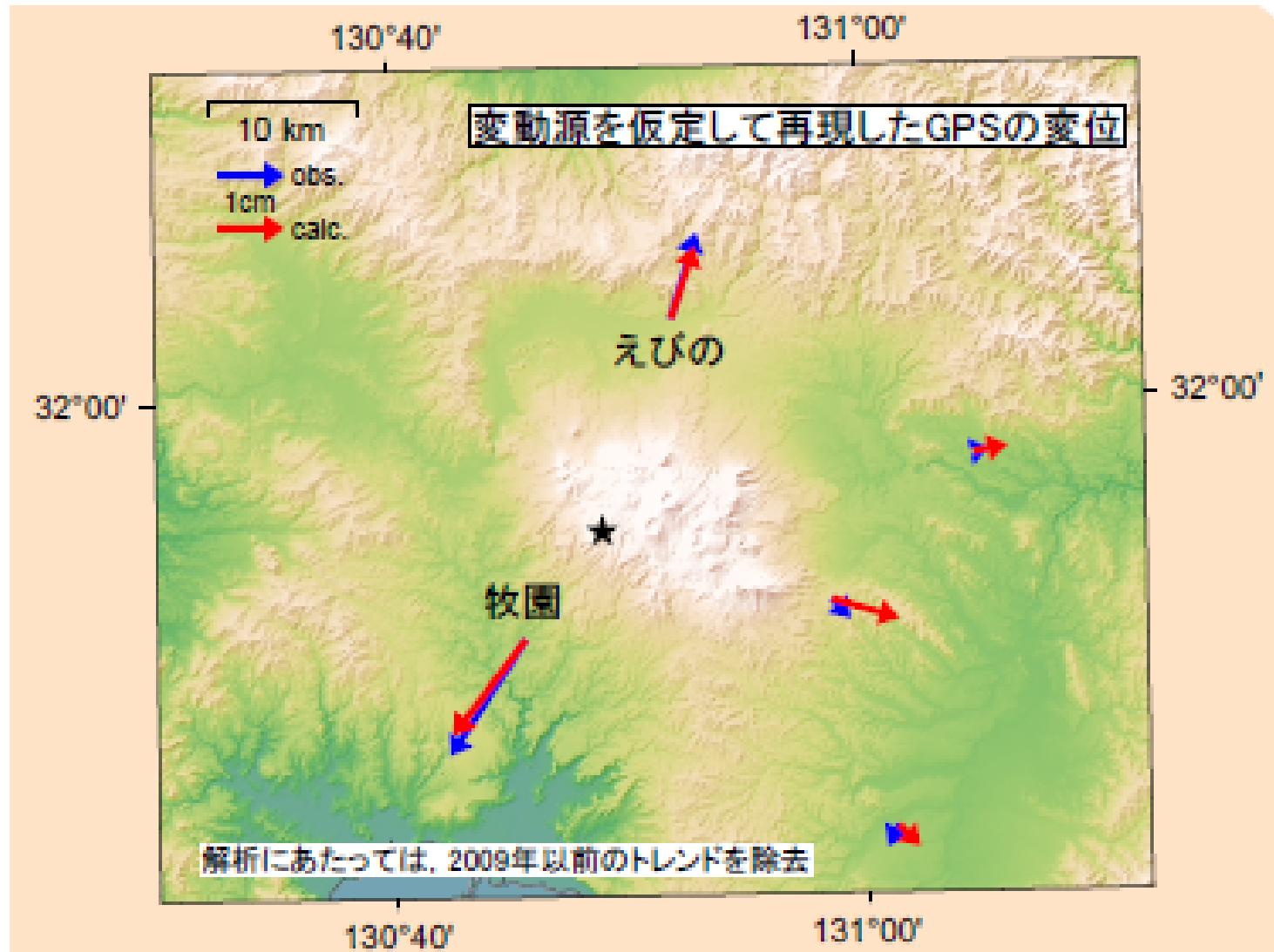
Photo by Ministry of Land
and Transportation

Eruption of Kirisima Volcano on 2011 Jan 26.

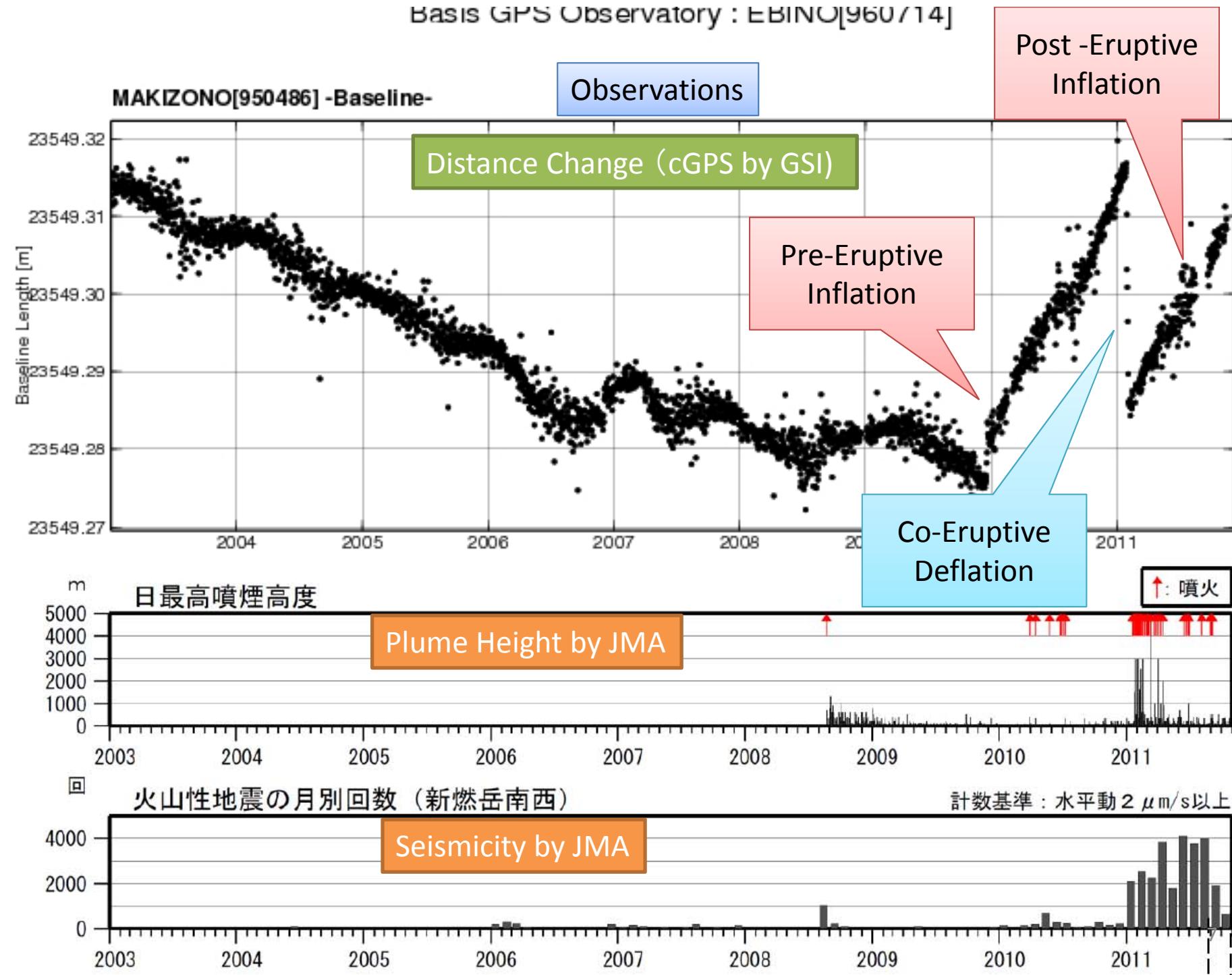
Lava Fountain



Inflation of the Volcano Edifice 1 Year before Eruption Detected by cGPS



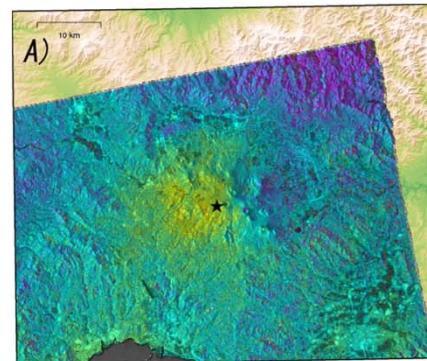
Basis GPS Observatory : EBINO[960/14]



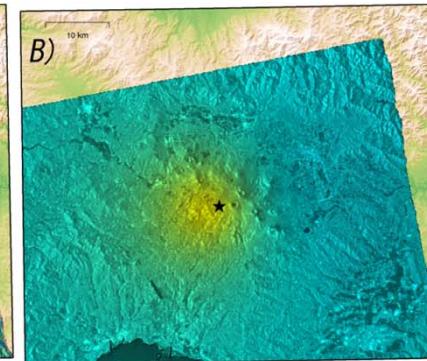
ALOS/PALSAR Interferometry

~ 5cm Inflation / Deflation Observed

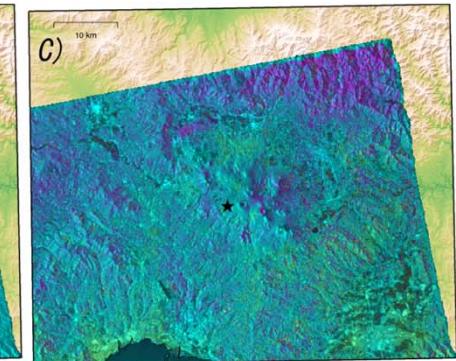
Obs Infr.



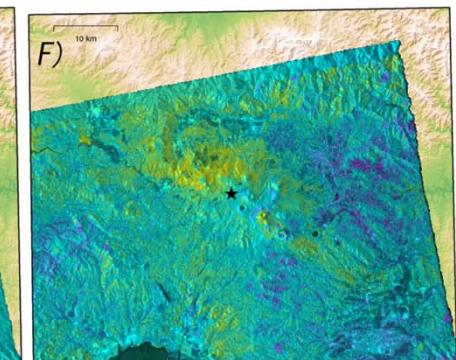
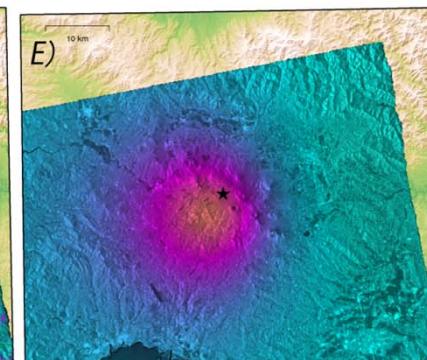
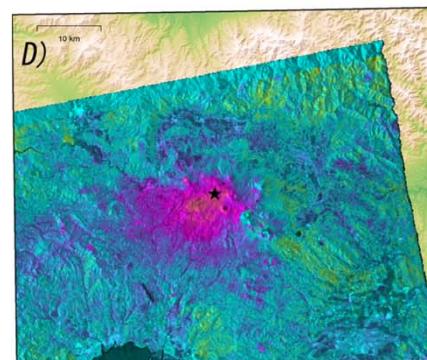
Simltd Infr.



O - C

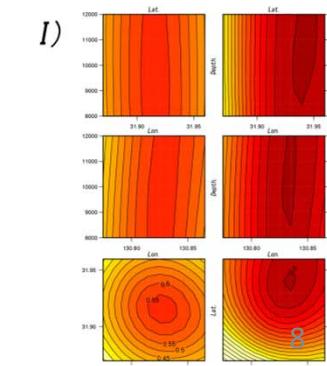
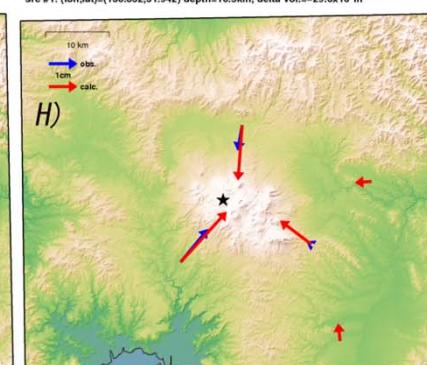
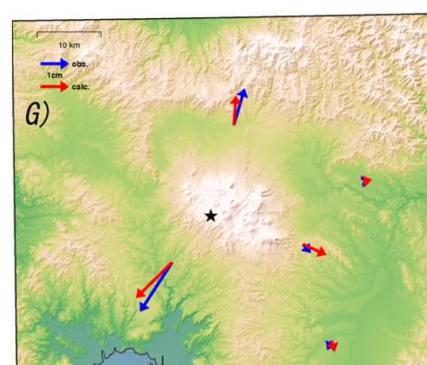


2008/02/12-2010/11/20
Pre-Eruptive Inflation



2010/11/20-2010/02/20
Co-Eruptive Inflation

cGPS
Left Pre-Eruptive Infl.
Cntr Co-Eruptive Defl.



2010 eruptions of Eyjafjallajökull



Volcano plume on 17 April 2010

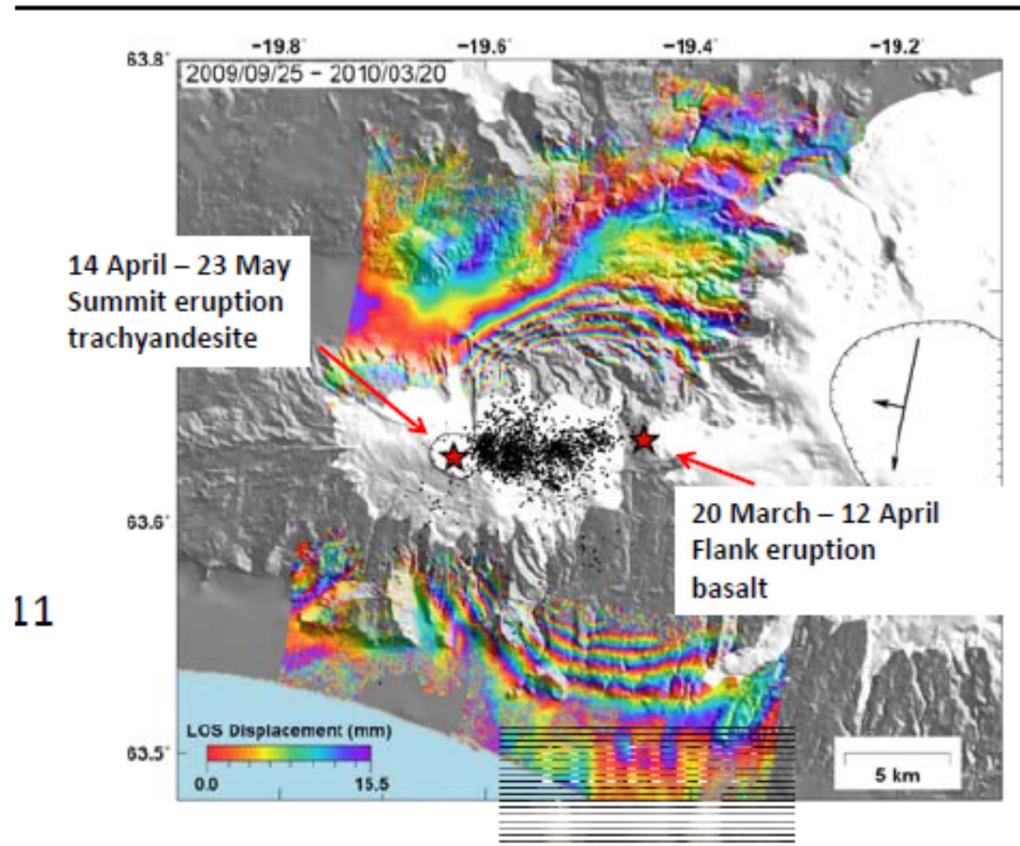
エイヤフィヤトラヨークトル

Source Wikipedia 9

TerraSAR-X:

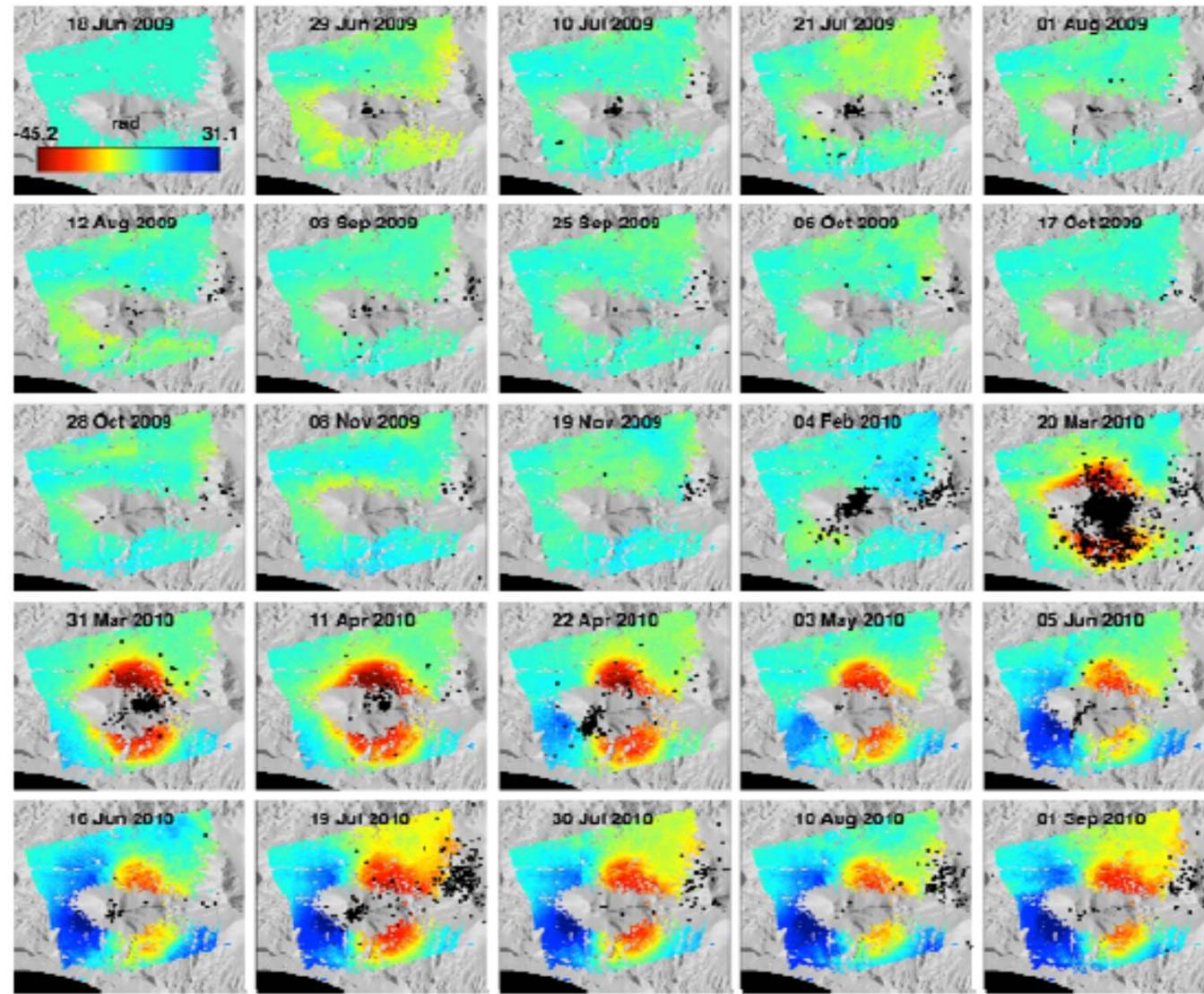
2009/09/25 – 2010/03/20

- Wavelength = 3.1 cm
- Resolution: range ~2.5 m azimuth ~3.3 m
- Four images possible every 11 Days
- Unprecedented InSAR coverage of eruptive period



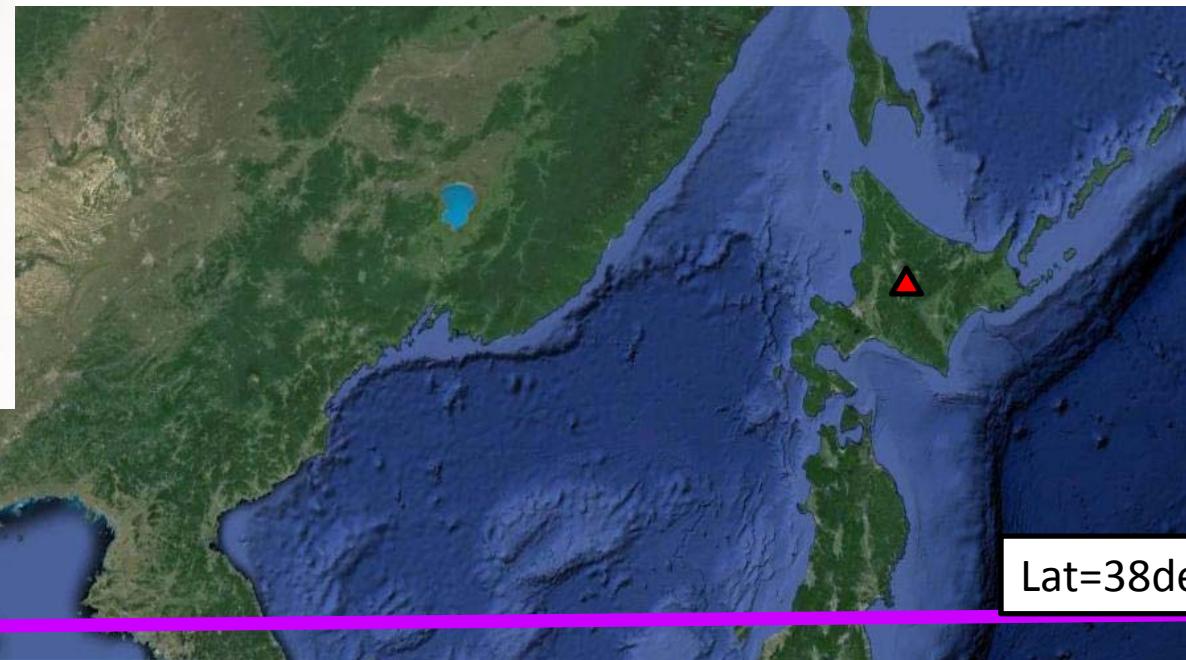
Joana Martins, et.al.

Persistent Scatterer Results (STAMPS)





Tokachi-dake Volcano, Hokkaido



Recent Eruptions

- 1926 Killed 144 People
by Slow Melting Lahar
- 1962 Killed 5 People
by Blast
- 1988 No Loss of Lives
Small Pyroclastic Flows

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat

Google earth

Summit and Craters in Summer 2012/07/20

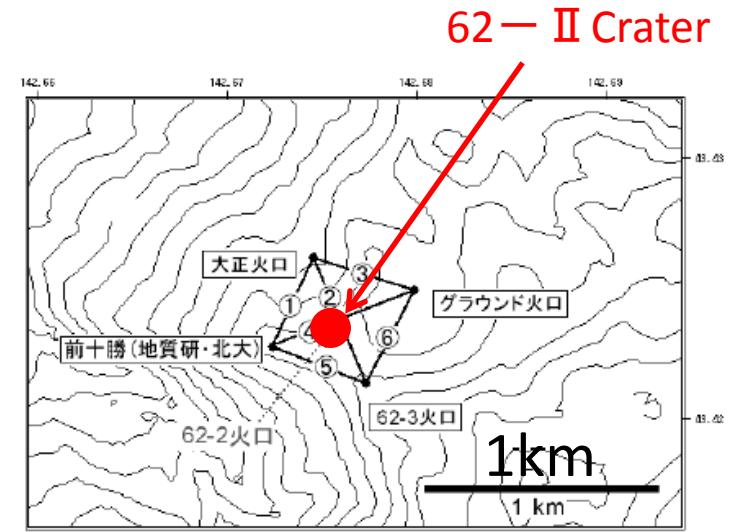
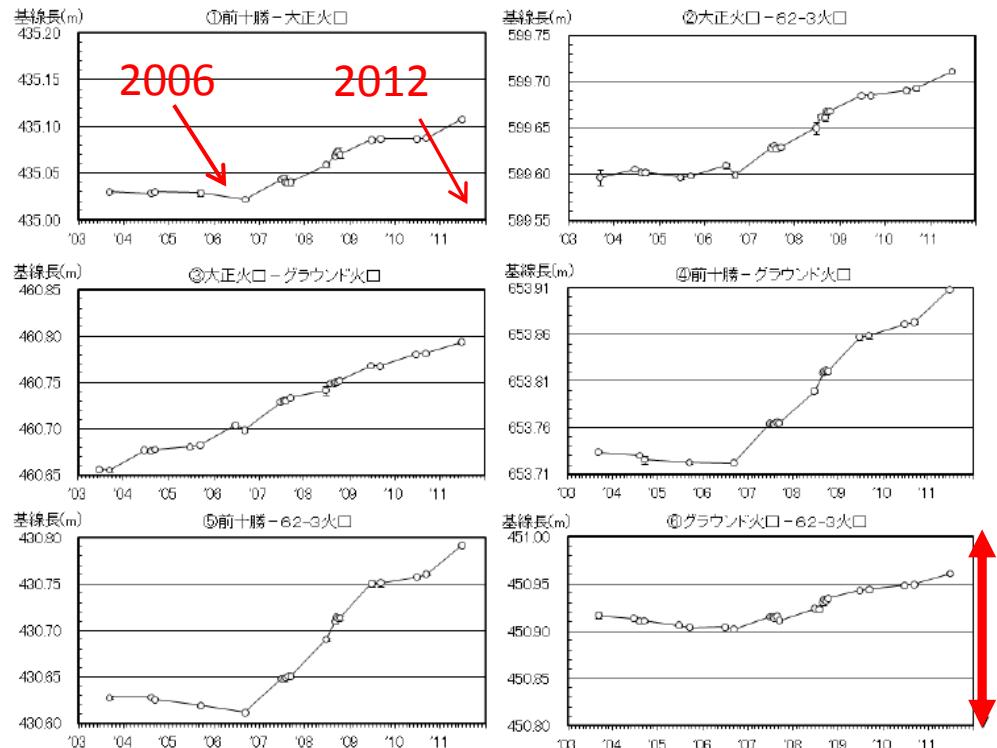
Location: Central Hokkaido

Latitude = 43.4 deg

Summit Altitude = 2077 m

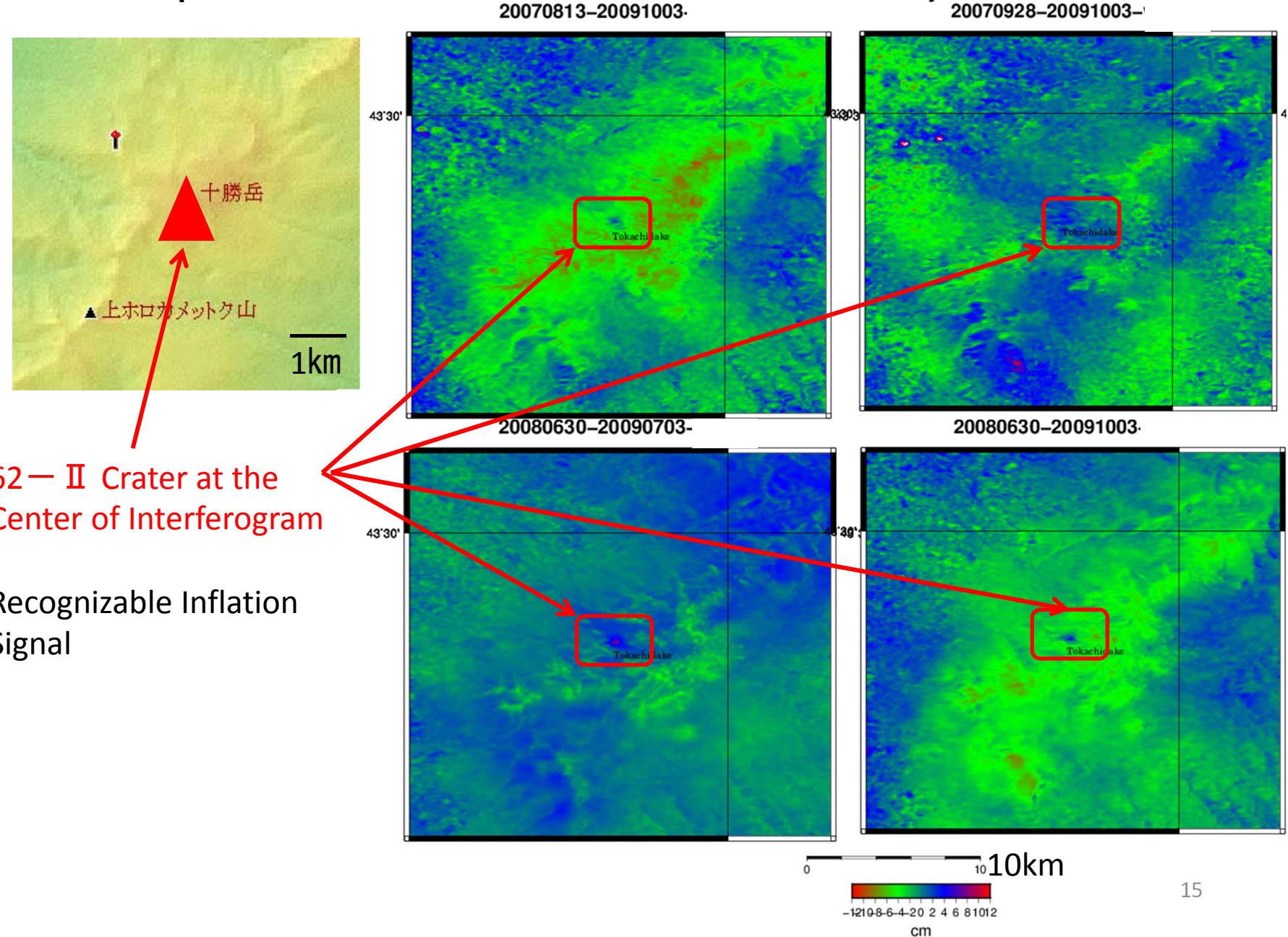


●Recent Deformation around 62-II Crater



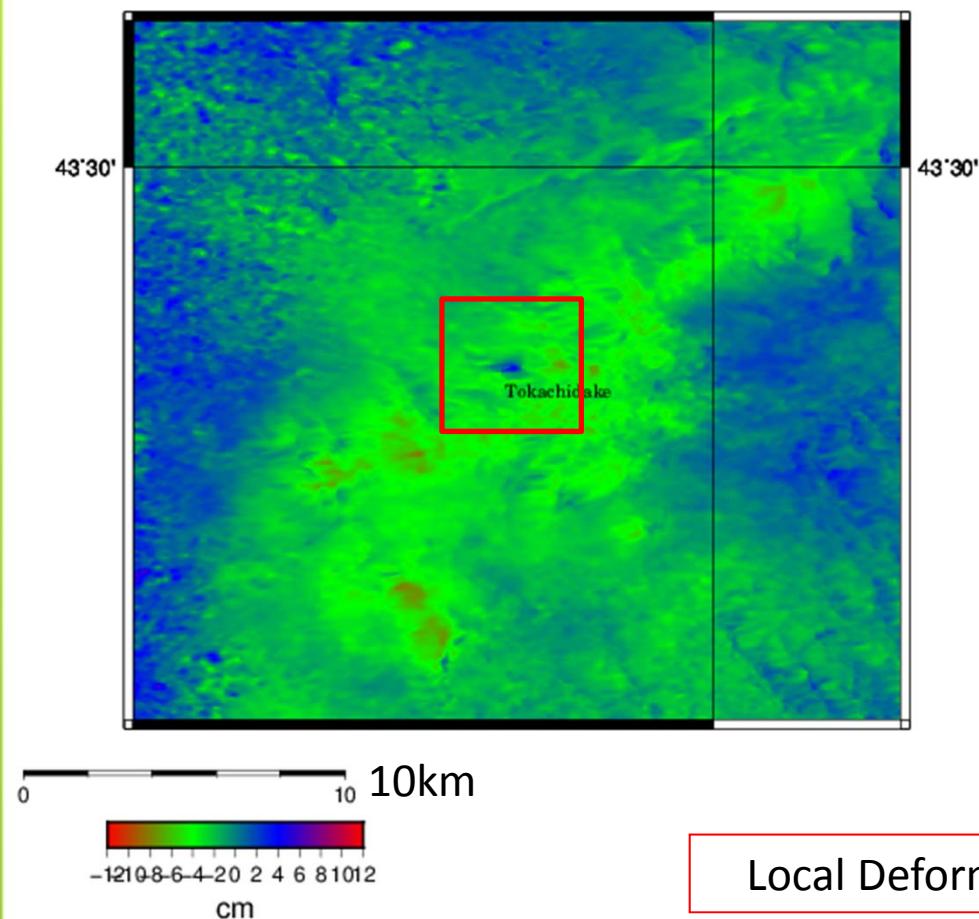
20cm GPS by GSH and HU
(Compiled by JMA ,
June 2011)

● Example of ALOS/PALSAR Interferometry in Summer

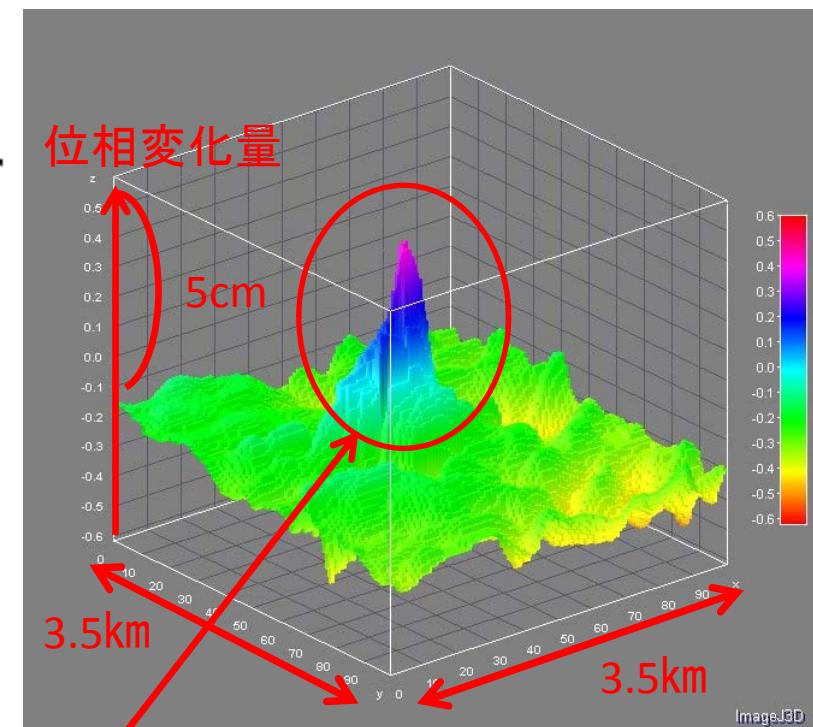


● 2008/06/30-2009/10/03 (Good Coherence)

2008/06/30-2009/10/03



LOS Distribution around 62-II Crater

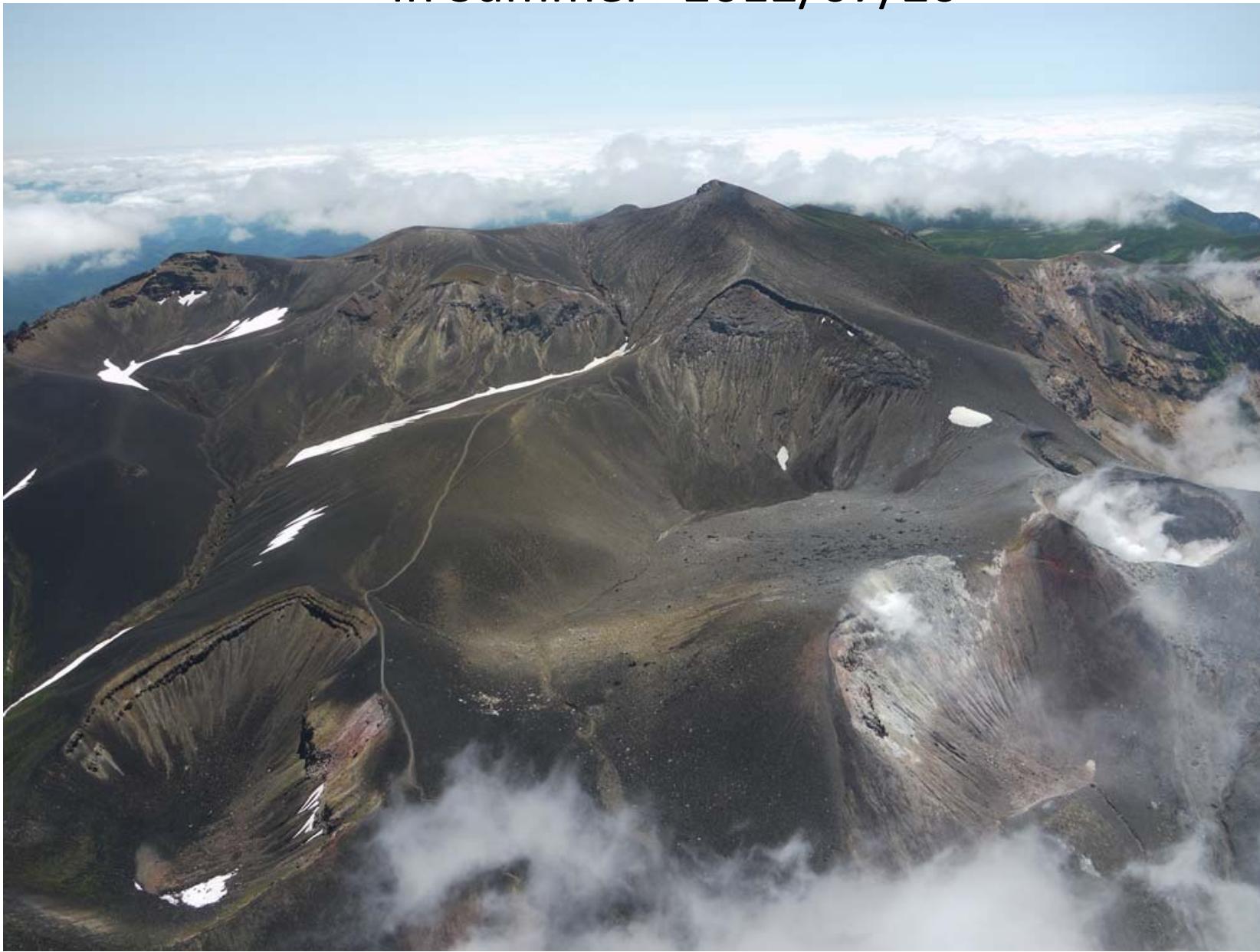


Local Deformation around 62-II Crater

Tokachi Volcano in Winter 2010/11/18

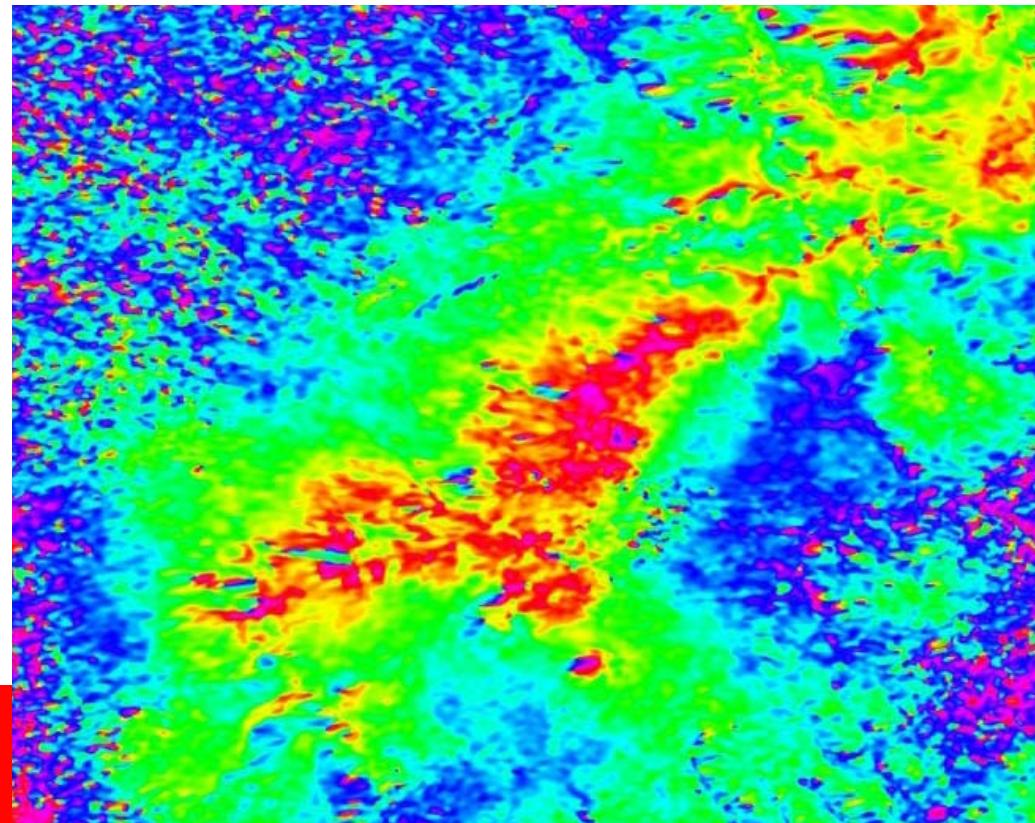
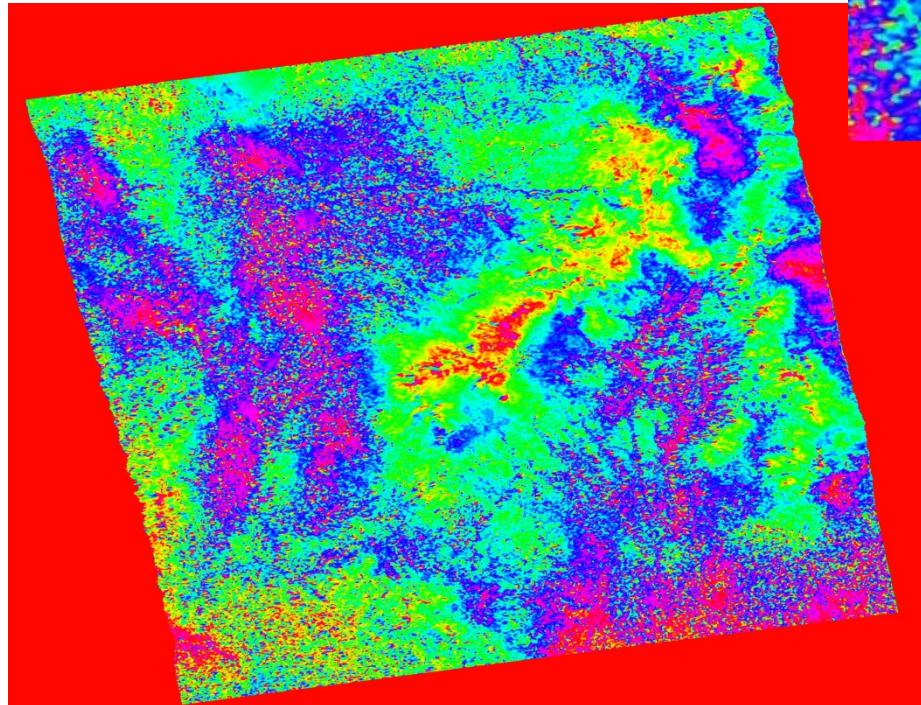


In Summer 2012/07/20



20070813-20091003

**Summer Pair
No Snow/Ice**

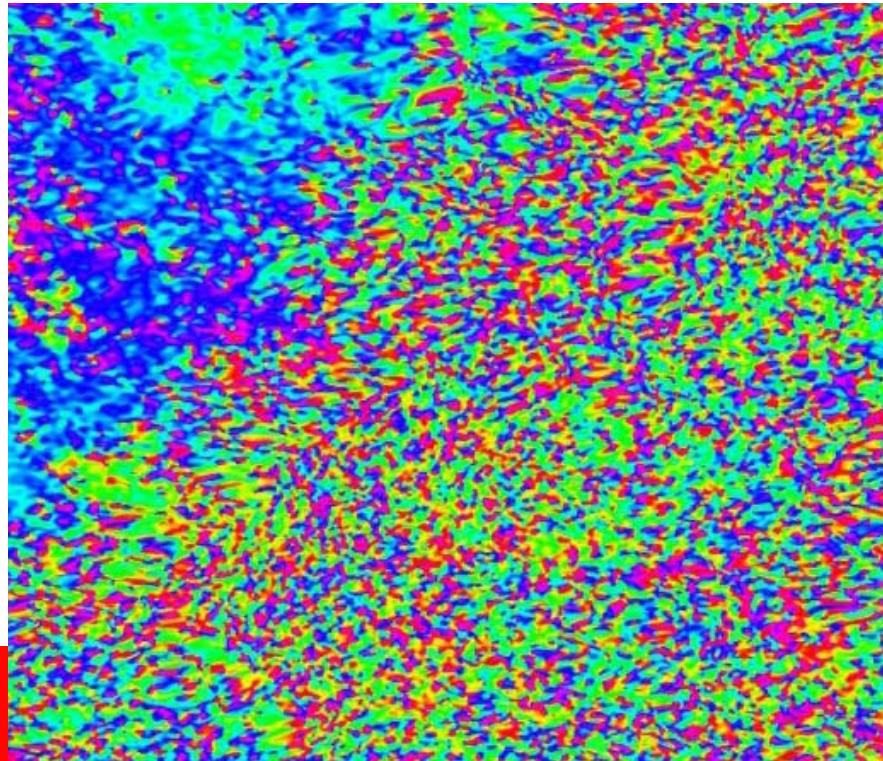
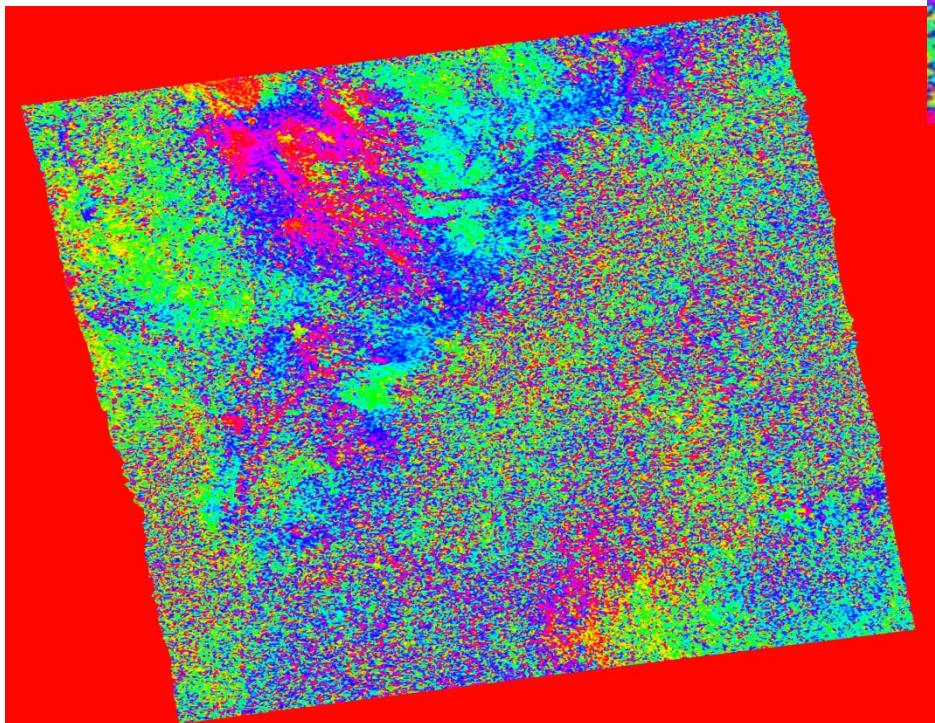


Some Artifacts by Troposphere and
Ionosphere

But Coherence is Good !

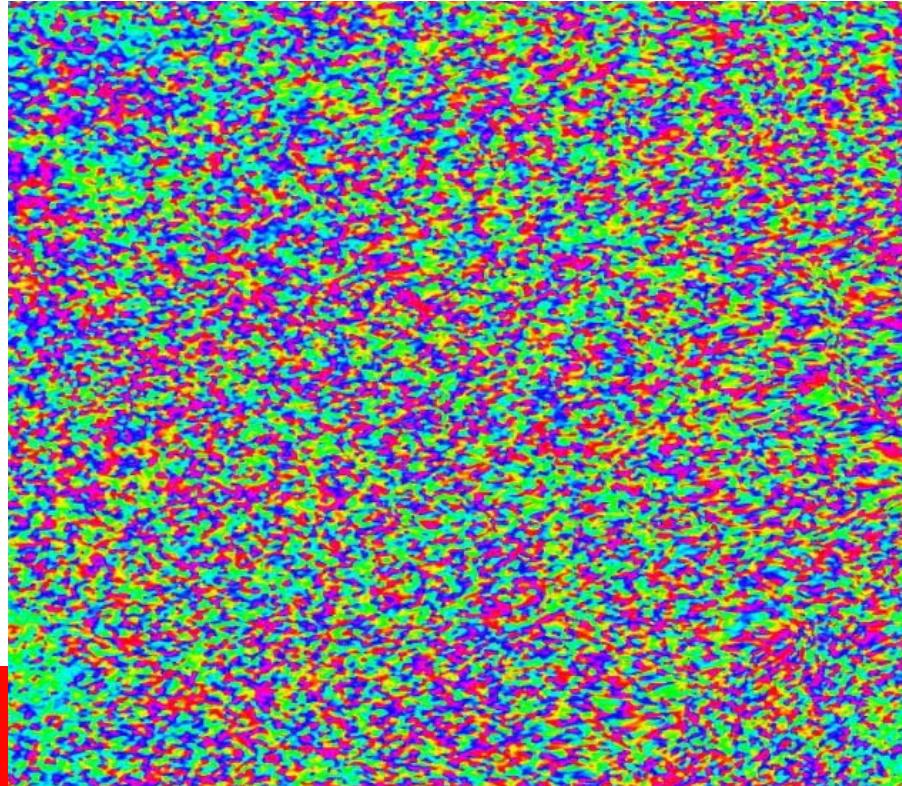
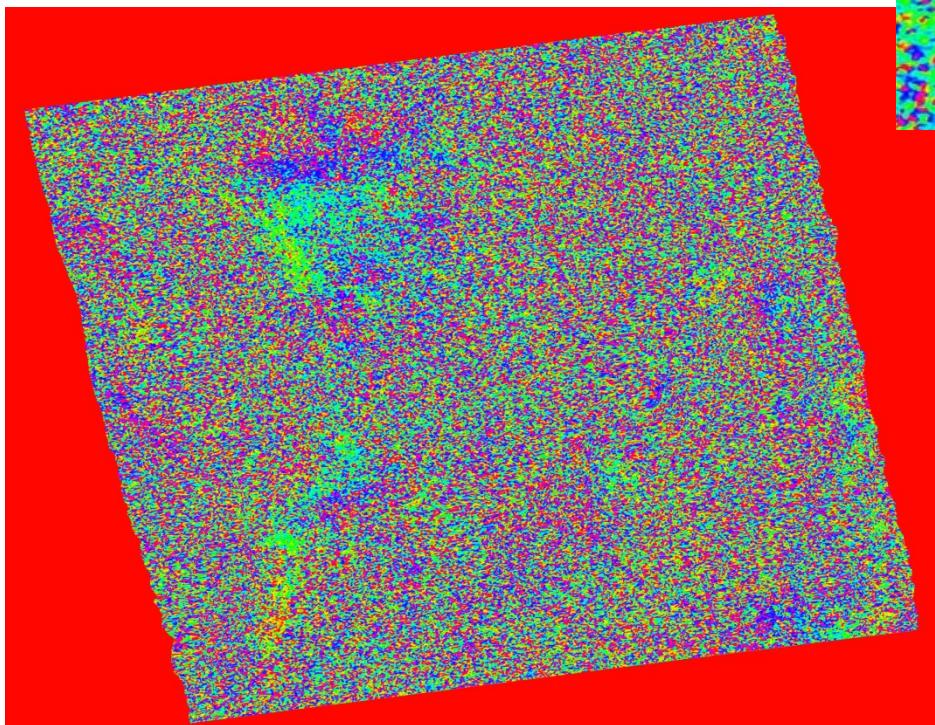
20070928-[20071229](#)

Winter Pair
Degraded Coherence by
Snow/Ice Coverage

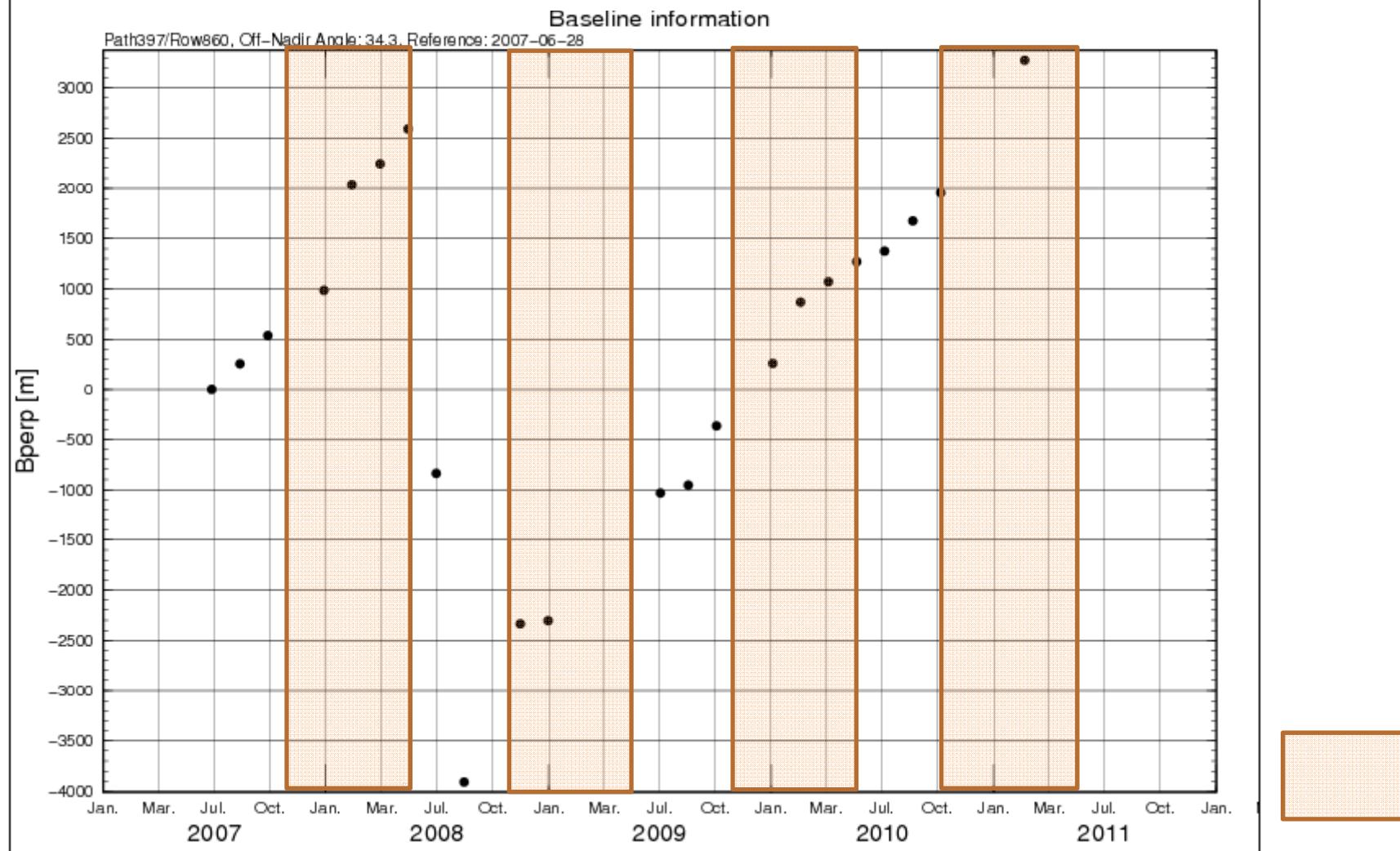


20081231-20090703

Winter Pair
Degraded Coherence by
Snow/Ice Coverage

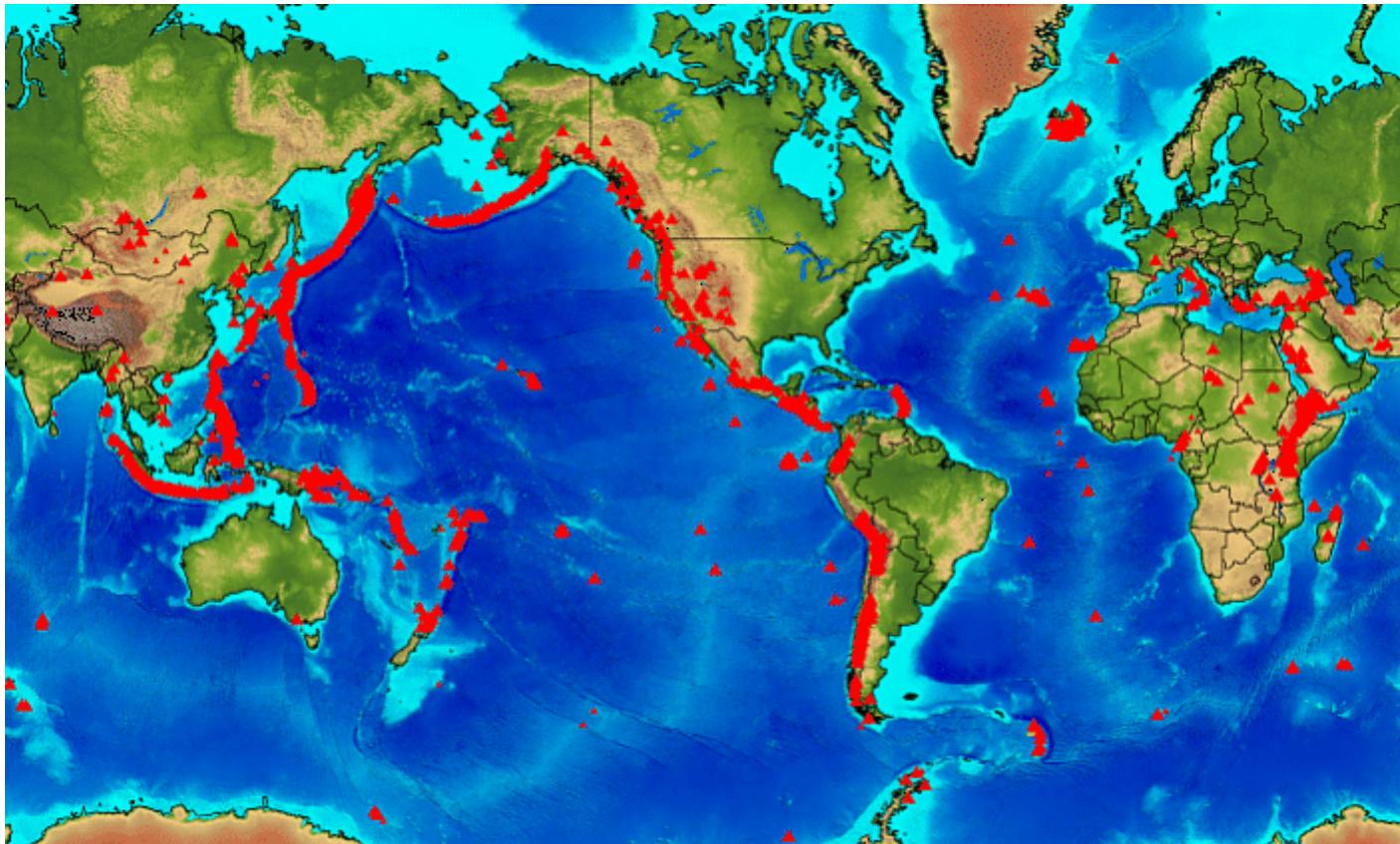


Progressive Orbit Separation



http://isvgeodd.sci.hokudai.ac.jp/palsar/showbperp.php?scene_id=ALPSRP075920860

Global Volcanism Program by Smithsonian



1406 Volcanoes on Land

$$635/1406 = \underline{45\%}$$

Affected by S/I

6 Subglacial

388 Lat > 40 deg Northern Hemisphere

73 Lat < -40 deg Southern Hemisphere

168 -30 < Lat < 30 but Alt. > 3000m

Total 635 Volcanoes might be affected by S/I

Challenge 1

Improved S/N Ratio

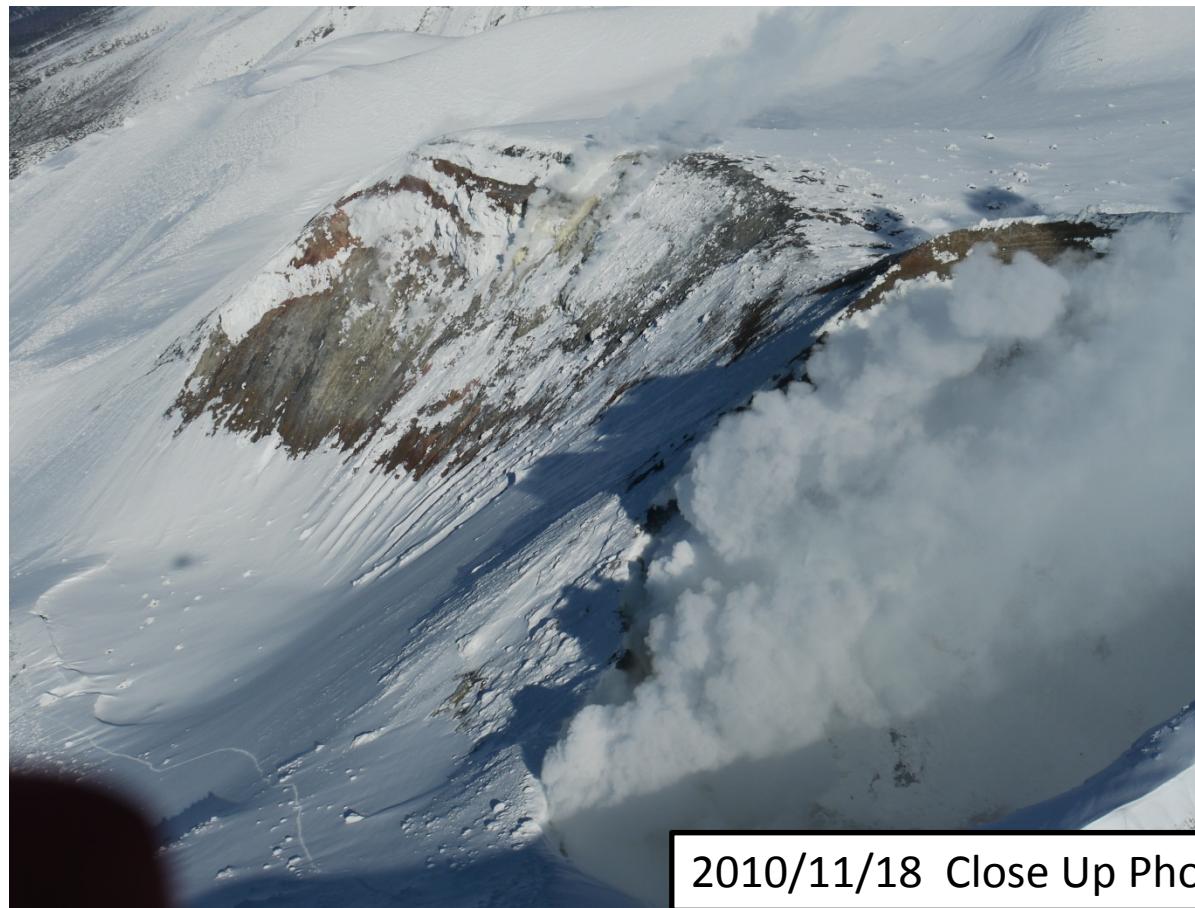
Power, Incident Angle, Bandwidth,
Aperture, Bit Length, Polarization,
PRF, etc.

Challenge 2

Improved Orbit Stability

Challenge 3

Innovative Analysis Method:
For Example, Improvement of Persistent Scatterer Analysis
and Hopefully Further Novel Follow-ons



2010/11/18 Close Up Photo of a Crater

Summary

- 45 % of world Volcanoes are at Least Partly Covered by Snow and Ice. → Existing Space Borne Interferometry over S/I is Unsuccessful.
- Effective Interferometry over Snow and Ice is still Left for Future Work.
- Future Challenges:
 - Onboard Hardware
 - Orbit Control
 - Novel Methodology