Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)


STT57-P01 Room:Convention Hall Time:May 23 17:15-18:30

# Crustal Movements associated with the 2011 eruption of Shinmoe-dake detected by DInSAR and GPS

MIYAGI, Yosuke[1*], OZAWA, Taku[1], KOHNO, Yuhki[1]

[1]National Research Institute for Earth Science and Disaster Prevention

Shinmoe-dake in the Kirishima volcano group located in southwestern part of Japan started to erupt on January 19, 2011 and the eruption developed to Sub-Plinian and Vulcanian type eruptions on January 26 and 27. A generation of lava dome and its rapid growth within the crater were accompanied by succeeding explosive eruptions. The explosive phase ceased by the end of March. A magnitude of the 2011 eruption was large comparable to 1716-1717 eruptions that lasted for about one and half year, therefore it is necessary to take care for a while.

Although it is generally difficult to make a field observation in dangerous active volcanoes, a satellite remote sensing can make observations of even ongoing volcanoes periodically. Especially, SAR sensor is well-suited for monitoring of active volcanoes because it can penetrate ash clouds. Moreover, SAR data are applicable to use a DInSAR technique to detect crustal movement caused by magmatic activities. Around the Shinmoe-dake volcano area, there is a GPS network operated by GSI and NIED since before the 2011 eruption. This set of geodetic data from both DInSAR and GPS indicates pre-eruptive, co-eruptive, and post-eruptive deformation, and they are quite helpful to understand a condition of the volcano for each period and to anticipate future unrests. In this research, we use geodetic data from DInSAR and GPS to estimate and discuss about a volume change of the magma source associated with the 2011 eruption of Shinmoe-dake volcano.

Keywords: SAR, DInSAR, GPS, Shinmoe-dake, Crustal movement

STT57-P02 Room:Convention Hall Time:May 23 17:15-18:30

# Temporal change in the Shinmoe-dake crater detected by SAR analysis

OZAWA, Taku[1*], MIYAGI, Yosuke[1]

[1]NIED

In the 2011 Shinmoe-dake (Kirishima-yama) eruption, lava appeared in the crater, and the topography in the crater was changed significantly. We analyzed SAR images acquired by several satellites and revealed that lava in the crater had rapidly grown during January 29 until January 31. Its extrusion rate was estimated to 7.5 million $m^3$/day, and volume of lava reached to 15 million $m^3$ at January 31. After that, lava was covered by volcanic ejecta, and it seems that volume in the crater slightly increased from that of January 31, according to SAR images which were acquired in March.

A small eruption occurred on September 7 and has not been observed after that. To investigate change in the crater after the last eruption, we applied SAR interferometry using four RADARSAT-2 data which were acquired every 24 days from November 22. High coherences were obtained in and around the crater. Significant phase differences were obtained in the crater, indicating the sum of the phases due to the topographic change and surface deformation. So we divided it based on the assumption that deformation speed has been constant. Volume of ejecta accumulated in the crater (including lava) was estimated to 20 million $m^3$, indicating that volume change from March was insignificant. Estimated surface deformation component indicates that the slant-range contraction has occurred; its speed was 5cm/24days. Assuming its slant-range change to be uplift, volume change rate is estimated to 275$m^3$/day.

Keywords: Shinmoe, Kirishima, crater, SAR, deformation, lava

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)


STT57-P03 Room:Convention Hall Time:May 23 17:15-18:30

# Crustal deformation around the Laguna del Maule caldera detected by PALSAR/InSAR

OZAWA, Taku[1*]

[1]National Research Institute for Earth Science and Disaster Prevention

Local deformations around volcanoes associated with the 2011 Tohoku Earthquake were found in our previous study (Ozawa and Fujita, submitted to JGR). To investigate if the similar deformation has occurred for other earthquakes, we are analyzing InSAR data for several areas. In this presentation, we present a result of the Laguna del Maule, Chile. The Laguna del Maule is a caldera with 15*25km width, located to east of seismic area of the 2010 Maule Earthquake (Mw8.8, 2010/2/27). Although there is no historical record of eruption, large deformation had been detected by InSAR. Applying InSAR using PALSAR data, we investigated crustal deformation for preseismic, coseismic, and postseismic periods. Due to disturbance by snow cover, sufficient coherence for deformation investigation was limited to pair of summer data. Now, we finished analyzing four interferometric pairs, (1)2007/2/12-2009/2/17, (2)2009/2/17-2010/2/20, (3)2010/2/20-2010/4/7, and (4)2010/4/7-2011/1/8. Obtained interferograms showed slant-range contractions, indicating inflation of volcano. Estimating source parameters of Mogi's model from interferograms of (1), (2), and (4), the source location was estimated to 2700m depth (b.s.l.) under the caldera. Simulated slant-range changes from the estimated model well explain observed ones. Volume changes were estimated to 54, 44, and 24 million $m^3$, corresponding to rates of 27, 43, and 32 million $m^3$/yr. Calculating slant-range change in 46 days from the averaged inflation rate (34 million $m^3$/yr), it is roughly consistent with that from interferogram of (3). It suggests that significant inflation change didn't occur in the 2010 Maule Earthquake. However, this is a preliminary result, and then more detailed analysis is necessary.

Keywords: volcano, earthquake, deformation, SAR, Laguna del Maule

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)


STT57-P04 Room:Convention Hall Time:May 23 17:15-18:30

# Surface deformation of Kuchinoerabujima volcano revealed by PS-InSAR time-series analysis

TANAKA, Akiko[1*], YAMAMOTO, Keigo[2]

[1]Geological Survey of Japan, AIST, [2]DPRI, Kyoto University

Kuchinoerabujima volcano is an active volcanic island located on the volcanic front of the Ryukyu island arc. Recent eruptive activities of Kuchinoerabujima volcano occurred at two active craters of Shindake and Furudake. Eruption was not observed for more than 30 years, however, seismic swarms were accompanied with radial outward pattern from the summit crater during January-June 2005, September 2006-January 2007, and September 2008-January 2009 (e.g., Saito and Iguchi, 2007). Ground displacements near the summit area of Shindake were also detected by interferometric SAR (InSAR) analysis using ALOS/PALSAR data (Yamamoto, 2009).

We report the result of an InSAR time-series analysis applied on data acquired over Kuchierabujima volcano. Persistent scatterer SAR interferometry (PS-InSAR) analysis using the StaMPS algorithm (Hooper et al., 2007) is applied to ALOS/PALSAR data. Both ascending and descending orbits, PS-InSAR analysis identified enough numbers of coherent pixels. The obtained line-of-sight (LOS) displacements showed rather complicated pattern compared with previous results. The obtained deformation near the summit area of Shindake was consistent with results of conventional InSAR and GPS. Also, it suggests another deformation source, which are not clearly accounted for previously.

Acknowledgements: PALSAR level 1.0 data are shared among PIXEL (PALSAR Interferometry Consortium to Study our Evolving Land surface), and provided from JAXA under a cooperative research contract with ERI, Univ, Tokyo. The ownership of PALSAR data belongs to METI (Ministry of Economy, Trade and Industry) and JAXA.

Keywords: PS-InSAR, time-series analysis, Kuchinoerabujima volcano, ground deformation, ALOS/PALSAR

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)


STT57-P05 Room:Convention Hall Time:May 23 17:15-18:30

# Crustal deformation after the Iwate-Miyagi Nairiku earthquake deduced from PS-InSAR time series analysis

OHSHITA, Yuya[1*], OHTA, Yusaku[1], MIURA, Satoshi[2], DEMACHI, Tomotsugu[1], Kenji Tachibana[1], UMINO, Norihito[1]

[1]RCPEVE, Tohoku university, [2]ERI, The University of Tokyo

The 2008 Iwate-Miyagi Nairiku (inland) earthquake occurred beneath the border between the Iwate and Miyagi prefectures in northeastern (NE) Japan, within Ou back-bone range (OBR) strain concentration zone [1] at 08:43 JST, 14 June 2008. Its focal mechanism is a reverse fault type with a W-NW to E-SE compressional axis. Ohta et al. [2] suggested that the coseismic fault plane is mainly west dipping based on the kinematic GPS analysis. Iinuma et al. [3] investigated the postseismic deformation deduced from the dense continuous and temporal GPS network. They found that the aseismic slip occurred at the shallower part of the coseismic slip and Dedana fault where did not slip during the mainshock rupture. Furthermore, Ohzono [4] found the long-term postseismic deformation in and around the focal area deduced from the continuous GPS data. She pointed out that this long-term postseismic deformation is caused by viscoelastic relaxation in lower crust or upper mantle. This model explains well the observed GPS data in far field. However, the simple viscoelastic model fail to explain the near field GPS data (e.g. [4, 5]). In this study, we apply InSAR time-series analysis by PS (Persistent Scatterer) method for investigation of long-term postseismic deformation near the focal area.

We applied StaMPS [6, 7] approach to the ALOS/PALSAR data obtained by the JAXA. In order to produce our interferograms, we processed a set of 12 descending orbit SAR images (Track 57, Frame 2830), acquired by the ALOS/PALSAR sensors from July 2008 to October 2010. In particular, SRTM4 Digital Elevation Model of the study area and precise orbital information were used for the interferograms generation. The master data image is acquired in September 3rd, 2009. We assumed the amplitude dispersion index ($D_A$) is as 0.4 that is threshold value defined by Ferretti et al. [8] to find the PS pixel. The result based on our analysis clearly shows LOS (Line of Sight) change in and around the focal area. We found the clear LOS change in the footwall and hanging wall side of the focal area. In the footwall side, the LOS is extended which may be subsidence or displaced to the westward. It is clear evidence of the viscoelastic relaxation after the mainshock pointed by [4, 5]. The hanging wall side LOS change is characteristic. In the hanging wall side, we found the two large amount LOS shortening regions. It is difficult to explain by the simple viscoelastic relaxation. It may be caused by long-term afterslip near the focal area, which may be triggered by the mainshock. Several scenes, however, might be affected by atmospheric and ionospheric disturbance. We need to reevaluate these effects for more accurate time series analysis.

[1] Miura et al., EPS, 2004, [2] Ohta et al., EPS, 2008, [3] Iinuma et al., GRL, 2009, [4] Ohzono, PhD dissertation, Tohoku Univ., 2009, [5] Ohta et al, JpGU Meeting, 2010, [6] Hooper et al., JGR, 2007, [7] Hooper et al., GRL, 2008, [8] Ferretti et al., IEEE Trans, 2001

Keywords: InSAR, 2008 Iwate-Miyagi Nairiku earthquake, StaMPS, ALOS/PALSAR, PS-InSAR, Crustal deformation

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)


STT57-P06 Room:Convention Hall Time:May 23 17:15-18:30

# Quantitative comparison of methods and sensors for monitoring land subsidence based on SAR interferometric stacking

PASQUALI Paolo[1], RICCARDI Paolo[1], CANTONE Alessio[1], DEFILIPPI Marco[1], OGUSHI, Fumitaka[2*], GAGLIANO Stefano[3]

[1]sarmap SA, [2]Exelis VIS KK, [3]Exelis Visual Information Solutions, Italia

Interferometric stacking techniques emerged in the last decade as methods to obtain very precise measurements of terrain displacements, and in particular subsidence phenomena. In particular, the so-called Persistent Scatterers (Ferretti et al. 2001) and Small BASeline (Berardino et al. 2002) methods can be considered as the two most representative stacking approaches. In both cases, the exploitation of 20 or more satellite Synthetic Aperture Radar (SAR) acquisitions obtained from the same satellite sensor with similar geometries on the interest area allows to measure displacements with an accuracy in the order of few mm / year, and to derive the full location history of good pixels with an accuracy of 1cm or better for every available date.

A main difference between the two approaches is the type of objects and land cover that are favoured in the analysis: the PS technique focuses on so-called Point Targets, i.e. objects possibly of small size and with a very well characterized geometry like corner reflectors (e.g. buildings, rocks) and with a high temporal stability of the backscattered signal; the SBAS technique vice-versa is concentrating the analysis on so-called distributed targets, like open fields and not very geometrically characterized objects.

The PS approach is then not making any assumption on spatial correlation of the displacement to be measured, but more on its linearity; the SBAS approach vice-versa is more robust in case of spatially correlated displacements, and allows in this case to monitor larger displacement rates. This paper is performing an extensive analysis and comparison of the results that have been obtained with the two approaches in a same geographical area in Japan, characterized by subsidence due to water and natural gas extraction.

The analysis is based on data acquired from the ALOS PALSAR (L-band), ENVISAT ASAR (C-band) and COSMO-Skymed (X-band) satellite instruments, and the validation of the results is based on GPS and leveling measurements. The analysis allows to draw conclusions on pros and cons of the different approaches and sensors for deriving the displacement measures for monitoring subsidence phenomena. The feasibility of exploiting the same approach in different geographical areas is also discussed. Finally, comments are given on the outcomes of this analysis in view of the exploitation of the data to be available from the forthcoming Sentinel-1 (C-Band) and ALOS-2 (L-Band) missions.

REFERENCES

Ferretti, A., Prati, C., & Rocca, F. 2001: Permanent scatterers in SAR interferometry, IEEE Transactions on Geoscience and Remote Sensing, 39, 8-20.

Berardino, P., Fornaro, G., Lanari, R., & Sansosti, E. 2002: A new algorithm for surface deformation monitoring based on small baseline differential SAR interferograms, , IEEE Transactions on Geoscience and Remote Sensing, 40, 2375- 2383.

Keywords: Synthetic Aperture Radar, Interferometry, Persistent Scatterers, Small BASeline, ALOS PALSAR

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)


STT57-P07 Room:Convention Hall Time:May 23 17:15-18:30

# An Attempt to Increase Estimation Accuracy of Differential SAR Interferometry using Polarization

ISHITSUKA, kazuya[1*], TSUJI, Takeshi[1], Toshifumi Matsuoka[1]

[1]Graduate School of Engineering, Kyoto University

Differential SAR Interferometry (DInSAR) is a method to estimate surface displacement in line of sight direction between observations, which have provided us innovative insights into crustal movement. Although we estimate precious displacement using DInSAR analysis, the accuracy of results depends on the observation and surface conditions of the analyzed area. Here, we focus on the decorrelation as one of the main sources of measurement error. In the resolution-cell of vegetation and various scatters, the observed phase is not sometimes deterministic, resulting decorrelation. Thus, to decrease decorrelation area and improve the accuracy of estimation, we propose DInSAR analysis using polarimetric information.

Polarized wave is denoted by the combination of horizontal (H) and vertical (V) component. By using polarized wave, four SAR images (HH, HV, VH, VV) can be observed, where XY indicates polarization of observed (X) and transmitted (Y) wave. Since an arbitrary scatter condition can be obtained from these four images, we can estimate a scatter condition creating maximum coherence in the resolution cell (Cloude and Papathanassiou, 1998). In this study, we tried to estimate surface deformation from an optimized scatter condition. SAR images used in this study are observed by PALSAR instrument on Japanese satellite (ALOS) and covered with land subsidence area in Chiba prefecture. By using this analysis, we can reveal subsidence in the condition of better coherence.

Keywords: Differential SAR Interferometry, Polarization, Interferometric Coherence, Land Subsidence

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)


STT57-P08 Room:Convention Hall Time:May 23 17:15-18:30

# Estimation of the area and the thickness of volcanic ash by using DInSAR technique

NAKANO, Youko[1*], SHIMIZU, Takeshi[1], YAMAKOSHI, Takao[1], Tadanori Ishizuka[1], Eiichi Wakabayashi[2]

[1]Public Works Research Institute, [2]Yachiyo Engineering CO., LTD.

On October 26, 2010, Mt. Merapi located in central Java Island in Indonesia erupted. This eruption caused a huge pyroclastic flow. And the Gendol River originating from the southern flank of Mt. Merapi, was filled with pyroclastic deposit. Lahars occurred on the rivers originating from the western flank of Mt. Merapi, during the rainy seasons from 2010 to 2012. The area of western flank of Mt. Merapi is assumed to have been covered with thick volcanic ash by the eruption. It is assumed that the thick volcanic ash caused a frequent occurrence of mudflows at the rivers located on western flank of Mt. Merapi.

On the other hand, Ozawa (2011) reported that the estimated thickness by the interferogram generated from a pair of the JAXA's ALOS/PALSAR images before and after eruption, was in good agreement with the result of field investigation of volcanic ash on the 2011 Mt. Kirishima (Shinmoe-peak) eruption.

The authors estimated the area and the thickness of volcanic ash at the time of the eruption of Mt. Merapi through the same technique and the same satellite sensor utilized by Ozawa (2011). And on the other hand, we conducted a field survey of the thickness of volcanic ash between Sept. 2011 and Feb. 2012. The authors earned that the estimated area and thickness of volcanic ash by DInSAR, was in good agreement with result of field investigation of volcanic ash.

ACKNOWLEDGMENT: The authors would like to thank JAXA for its free provision of ALOS imagery, and thank M. Shimada of JAXA for the use of his SIGMA-SAR interferometry software [M. Shimada, 1999].

Keywords: Mt. Merapi, volcanic ash, volcanic ash, DInSAR