Ground Deformations in the Kanto and Osaka Plains Observed by ALOS/PALSAR and ALOS-2/PALSAR-2

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Based on the hypothesis that the spatial distribution of ground deformation is correlated to substurface structure such as buried faults, we have investigated ground deformations in two typical alluvial plains in Japan, the Kanto and Osaka plains, with SAR and discussed their relationship with active faults. Here we report some results of time series analysis of ALOS/PALSAR images and 2-pass differential interferometry of ALOS-2/PALSAR-2 images in these two regions.
We utilized ALOS/PALSAR images acquired during August 2006 to April 2011 and ALOS-2/PALSAR-2 during August 2014 to December 2015. More than 15 acquisitions during longer period than 3 years were made for ALOS/PALSAR in each region. Therefore we applied persistent scatterer interferometry (PS-InSAR) using StaMPS software developed by the Stanford University (Hooper et al., 2004). On the other hand, interval of acquisitions of ALOS-2/PALSAR-2 is as long as 1 year and 4 months. Furthermore there are only a few acquisitions of an area with the same look angle. Therefore we applied conventional 2-pass differential interferometry to ALOS-2/PALSAR-2 images with Gamma® software. ASTER-GDEM ver.2 DEM (Tachikawa et al., 2011) is adopted for the derivation of topographic fringes and geocoding.
On the basis of PS-InSAR analysis of ALOS/PALSAR images (Path 406 Frame 710) in the Kanto plain, we revealed range increase up to 10 mm/yr in the Saitama city and northeastern Tokyo. This result infers that ground subsidence is still continuing there. We recognize subsidence along the Tone River. It is worth noting that range decrease > 5 mm/yr is found along the Tachikawa fault that crosses the Tachikawa city, western Tokyo. By stacking interferograms of ALOS-2/PALSAR-2 images (Path 119 Frame 750) centered in the Koga city, we found range increase near the Saitama city, which is consistent with the ALOS/PALSAR observation. However, there are inconsistent deformations with that in the rest of area. We need more data for longer time period. We also analyzed images of its western neighbor (Path 120 Frame 740) and found large change in line of sight in the Chichibu basin for the pairs including images acquired in summer. This might be attributed to the characteristics of local weather.
Hashimoto (2014) already reported subsidence along the Arima-Takatsuki Fault zone and uplift in southern Kyoto basin from the analyses of ALOS/PALSAR images (Path 65 Frame 2920). However, we did not find these deformations in any interferograms of ALOS-2/PALSAR-2 (Path 21 Frame 2910, Path 26 Frame 2920, Path 127 Frame 680 etc.). Deformation may be smaller than observation errors, but it may be necessary to examine the possibility that these deformations stopped during 2011 - 2014, using multi-satellite images.
ALOS-2/PALSAR-2 and part of ALOS/PALSAR images used in this study were provided by JAXA under the ALOS-2 RA-4 (#1178, PI: Manabu Hashimoto). Other ALOS/PALSAR images were obtained under the project “the Comprehensive Research on the Uemachi fault zone” by MEXT. Copyright and ownership of ALOS/PALSAR images belong to JAXA and METI. Those of ALOS-2/PALSAR-2 images belong to JAXA.

Keywords: Synthetic Aperture Radar, ground deformation, ALOS/PALSAR, ALOS-2/PALSAR-2, Kanto Palin, Osaka Plain

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Observations and Interpretations of Two Mountain Glaciers on the Eastern slope of Mt. Tsurugi by Pi-SAR2 airborne SAR

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We have performed airborne synthetic aperture radar (SAR) measurements at two glaciers near Mt. Tsurugi, Japan, in August, October 2013, August 2014, and March 2015. The Pi-SAR2 system used in this study consists of two X-band SAR antennas, and allows us to perform single-pass interferometry. Also, the Pi-SAR2 allows us to perform full polarimetry with the maximum spatial resolution of 0.3 m.
Differecing the digital elevation models (DEM) at multiple epochs, it turns out that the differences between August and October 2013 reache ~10 to 20 meters with errors of 5-10 meters, which would mostly represent the seasonal changes in snow thickness.
Full-polarimetric observation results indicated significant intensity in the HV channel over the glacier areas even in the summer seasons. The significant signals in the HV channel were unexpected, because we tend to attribute the HV signals to volume scattering processes. The Pi-SAR2 is an X-band radar, and we cannot expect significant penetration over the snow/ice areas. We suggest another likely interpretation on the apparent HV signals over the glaciated areas.

Keywords: Mt. Tsurugi, Sannomado glacier, Komado glacier, Pi-SAR2, Polarimetric SAR

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Line-of-Sight displacements in Nishinoshima detected by ALOS-2 PALSAR-2 SAR interferometry

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Nishinoshima island in the Pacific Ocean has been erupting since November 2013. At first, it created a small new island located in south-east off shore of the pre-existing island. Nowadays the new island has rapidly expanded the land with its lava flow and almost absorbed the pre-existing island. According to the current record, the pre-existing island had 760(North-South) x 600(East-West) meter land while the new one had 1960 x 1960 m as of February 3, 2016 [1]. The state-of-the-art L-band Synthetic Aperture Radar (SAR), Phased Array type L-band Synthetic Aperture Radar-2 (PALSAR-2) aboard Advanced Land Observation Satellite-2 (ALOS-2) has been continuously observing the island since its launch. It has 3m spatial resolution with 50km swath in ultra-fine mode [2].
As Nishinoshima is an active volcano, it has been analyzed with mainly photogrammetric approach [3]. In this paper, we performed interferometric analysis and found line-of-sight displacements, which indicates ground subsidence toward the lava flow. The ratio was approximately 20 - 30cm in 2 months. Because of the discrete timing of ascending and descending observations, and unsteady volcanic activities, the precise speed of subsidence has not been determined. At the same time, we found that the lava flow hidden by the coagulated rocks shows very low temporal coherency. That is, we can evaluate the activeness of the volcano by interferometric analysis which cannot be seen by the simple photographic analysis. On the other hand, no significant deformation was found in the interferograms acquired after October, 2015.

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Keywords: ALOS-2, PALSAR-2, SAR interferometry, Nishinoshima

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InSAR analysis all over Japan by ALOS-2 (Daichi-2) / PALSAR-2 data

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The Geospatial Information Authority of Japan (GSI) has approached to monitor ground surface deformation of earthquake, volcanic activity, subsidence and landslide all over Japan by InSAR analysis using ALOS-2 (Daichi-2) /PALSAR-2 data. We have processed 2 mode observation dataset for InSAR analysis, which one is strip map mode (band of 50km and resolution of 3m with basic observation scenario in Japan) and another one is scan SAR mode (band of 350km and resolution of 100m with basic observation scenario in Japan).
As a result, we can detect ground surface deformation of earthquake and volcanic activity, subsidence of withdrawing ground water, including temporal subsidence around snow-covered area in winter caused by withdrawing ground water for melting snow, landfill settlement and landslide. There are some wide decorrelation areas in InSAR images analyzed in summer season observation dataset of ascending orbit and one of possibility of decorrelation is the influence of the activity of ionosphere.
We have translated from InSAR images to tiled geospatial data for a web map of GSI called “GSI Maps”. Various geospatial information can be shown as well as background maps, including topographic map, aerial photograph, volcanic map and others. This style of publication makes it easy to interpret ground surface deformation of detecting by InSAR with overlaying topographical and geological information.
In this presentation, we report InSAR results all over Japan and challenges.

Keywords: InSAR, ALOS-2, GSI Maps, volcano, earthquake, subsidence

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Dynamics of surge-type glaciers in Yukon, Canada, inferred from SAR and optical images

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Ice flow speed is one of the essential components to know glacier variations. Short-term speed-up events such as seasonal fluctuations and glacier surging are attributed to enhanced basal sliding, which can be influenced by evolution of subglacial drainage system and effective water pressure (ice overburden pressure minus basal water pressure). Due to logistic problems, the mechanism has not been fully understood.
Recent advances in space geodetic technique have enabled us to reveal the spatial and temporal changes in ice speed over entire ice sheet and mountain glaciers. We first revealed the spatial and temporal speed changes at surge-type glaciers in Yukon, Canada, using ALOS/PALSAR radar images between 2007 and 2011, and we found winter speed-up at their quiescent phases (Abe and Furuya, 2015). In the absence of surface meltwater input in winter, we suggested the importance of englacial water storage in basal crevasses, and extracted water with high water pressure may enhance the basal sliding.
In 2014, two new SAR satellites were successfully launched, one of which is ALOS-2 with L-band SAR sensor PALSAR-2 operated by JAXA and the other is Sentinel-1 with C-band sensor operated by ESA. They can acquire higher resolution images with shorter intervals, which will reveal more detail information about basal condition, where it is extremely difficult to observe directly.
Landsat optical images have been also used for glaciological research for a long time. Recently, Landsat 8, which was launched in 2013, has given significant impacts on glacier velocity mapping of ice sheets and mountain glaciers (e.g., Fahnestock et al., 2015). Thus, we have also derived the spatial and temporal speed changes near the border of Alaska and the Yukon, using similar feature tracking program (Abe et al., 2015), and we found three ongoing surging events (Klutlan, Steele, and Walsh). Each glacier has the different pattern of spatial and temporal velocity changes associated with the surging event, which is reflected in the meteorological condition and the thermal structure at each glacier.
In our presentation, we will report some new findings derived from satellite images, and discuss future prospects in order to better understand glacier dynamics focusing on the differences between the radar and optical images.

Keywords: Surge-type glaciers, Yukon, SAR, Landsat, Feature tracking

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Volcanic deformation in Tokachi-dake volcano, Hokkaido, detected by DInSAR observations

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Tokachi-dake volcano is located in central Hokkaido, Japan, and is the most active volcano in Tokachi-dake volcano group. Middle sized eruptions occurred in 1926, 1962, and 1988-1989, and several small phreatic eruptions also occurred in the meanwhile. After the latest eruption in 1988-1989, many volcanic tremor and active seismicity were revealed. Fumarolic activities from Taisho crater and 62-2 crater have been observed.

Continuous GNSS sites were located adjacent to the top of the volcano. They have revealed that local inflation occurred in the area and it continued up to 2015. These inflation increased in May, 2015. X-band SAR/TanDEM-X and L-band SAR/ALOS-2 observed the Tokachi-dake volcano in same period, and detected the local transient inflation of top of Tokachi-dake volcano. In this study, we tried to acquire two dimensional displacements, using DInSAR results observed from both west and east side of the area. Then we tried to infer deformation source. First, we use simple Mogi source [Mogi, 1958] as the deformation source, but it is necessary to take into consideration an influence of the terrain [Kawaguchi et al., 2016]. Then we acquire better fit between observed and modeled data.

Keywords: SAR, Deformation, Tokachi-dake Volcano

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