Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

STT57-01 Room:301B Time:May 22 09:00-09:15

Ground deformation signals detected by SAR interferometry time series analysis along the Chao Praya River areas

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The metropolitan area of Bangkok, Thailand, has been subsided during the past decades. This ground deformation has been monitored using leveling surveys since 1978 and InSAR (Interferometric Synthetic Aperture Radar) analysis. These results show that the Bangkok metropolitan city is subsiding with a rate of 20 mm/year in recent years, due to the law limiting groundwater pumping since the late 1980s, although in 1981 the highest subsidence rate up to 120 mm/year had been recorded in the eastern area [Phien-wej et al., 2006]. However, these studies were focused in the Bangkok metropolitan city using C-band satellites images.

In this study, we applied the method of measuring long-term land subsidence by InSAR time series analysis using ALOS (Advanced Land Observing Satellite) PALSAR (Phased Array type L-band SAR) data acquired between 2007 and 2010 to investigate ground deformation in and around Bangkok area. The ground deformation were detected near the Tha Chin river, which is a distributary of the Chao Phraya river and flows westerly from the Chao Phraya through the central plains of Thailand until it mouths into the Gulf of Thailand. We compared our results with previous leveling and InSAR studies to find an overall consistency in the deformation estimates. The deformation rates have been monitored, with velocity a maximum rate of about -20 mm/year, and showed consistent with previous studies [e.g., Aobpaet et al., 2009]. These results verify the validity of the method and data used.

Keywords: InSAR time series analysis, ground deformation, ALOS/PALSAR, Chao Praya River

Japan Geoscience Union Meeting 2013
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STT57-02 Room:301B Time:May 22 09:15-09:30

Surface displacements after the ground water regulation in Bangkok derived from persistent scatterer SAR interferometry

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Land subsidence due to groundwater extraction has occurred in many cities all over the world, leading to damages of buildings and infrastructures. In recent decades, several cities have regulated groundwater extraction to stop the over-pumping of groundwater. Bangkok, the capital city of Thailand is one of the cities that has regulated groundwater pumping. This regulation successfully led to decrease in ground water pumping rate. In order to understand changes in the groundwater system, it is important to monitor surface displacements after the stop of groundwater extraction. In this study, we estimated the surface displacements in Bangkok from November 2007 to December 2010 by persistent scatterer SAR interferometry (PSInSAR) analysis using ALOS/PALSAR images. Moreover, in order to understand changes in spatial pattern of groundwater flow, we compared the result with past surface displacements estimated by differential SAR interferometry (DInSAR) analysis using JERS-1/SAR images and with changes in groundwater level at the monitoring wells.

Our PSInSAR results revealed that surface has been slightly uplifting at a rate of 1 cm/year around the center of Bangkok. Estimated uplift areas correspond to the past subsidence area inferred from DInSAR analysis by using JERS-1/SAR images, and the uplift rate in each area are correlated with the groundwater recovery rate in the productive aquifer. Since surface uplift has occurred at the past subsidence area, groundwater recovering has especially occurred at preceding extraction area.

Keywords: PSInSAR analysis, Suirface displacement, Bangkok, Groundwater

Japan Geoscience Union Meeting 2013
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STT57-03 Room:301B Time:May 22 09:30-09:45

Land subsidence in Semarang, Indonesia, observed by InSAR time-series analysis using ALOS/PALSAR data

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[1]PASCO Corporation, [2]DPRI, Kyoto University

In order to precisely measure the land subsidence in Semarang, Indonesia, we performed a small-baseline interferometric synthetic aperture radar (SAR) time-series analysis using the images acquired by the Japanese Advanced Land Observation Satellite (ALOS). We used a total of 34 SAR images, acquired from both the ascending and descending orbits, and obtained the subsidence time-series in the two line-of-sight (LOS) directions. Before solving for the displacement time-series, we corrected for artifacts due to orbital inaccuracies and atmospheric phase delay. We obtained the time-series of quasi-vertical displacements by decomposing the displacement time-series in the two LOS directions. The result shows that the subsidence is limited on low-land areas where an aquifer system is well developed, suggesting that the cause of the subsidence is extraction of water from the aquifer. The subsidence was estimated to be practically constant with time with no clear seasonal effects. The maximum subsidence rate of 10 cm/year was obtained at a location where subsidence had not been identified before. Our study also shows the effectiveness of L-band SAR data to monitor land subsidence over time.

Keywords: InSAR, Crustal deformation, land subsidence, Indonesia, Semarang

Japan Geoscience Union Meeting 2013
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STT57-04 Room:301B Time:May 22 09:45-10:00

Monitoring of Sakurajima Volcano using Cosmo-SkyMed

Yosuke Miyagi[1*], Taku Ozawa[1], Tomofumi Kozono[1], Masanobu Shimada[2]

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Shinmoe-dake in the Kirishima volcano group is located in southwestern part of Japan. In January 2011, eruptive activities started from the Shinmoe-dake crater with a rapid accumulation of lava within the crater. GPS and DInSAR data revealed pre-eruptive inflation, co-eruptive deflation, and post-eruptive inflation. The eruption phase ceased by the beginning of September, and the post-eruptive inflation also ceased by November 2011. After the 2011 eruption, we have continued to monitor the Shinmoe-dake by using RADARSAT-2 and TerraSAR-X. A surface deformation on the lava within the crater after September 2011 revealed a continual shortening of satellite-ground distance even after the end of the main activity. This LOS shortening means uplifts of the lava surface. We estimated the volume increase of the lava after November 2011, using DInSAR processing of TerraSAR-X data, and concluded that the volume increase still continued in December 2012. The volume change rate has decreased with a small fluctuation as an overall trend. PSInSAR and long-term DInSAR results helped us to know deformation around the crater. They show LOS elongation including a subsidence in the northeast flank of the crater. It is interpreted that the subsidence is caused by a deflation of shallow deformation source located just beneath the crater. PSInSAR results also revealed that the subsidence ceased in October 2012. It is interpreted that volume of injection and effused lava achieved an equilibrium condition.

Keywords: SAR, Kirishima, Shinmoe-dake, Crustal Deformation

Japan Geoscience Union Meeting 2013
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STT57-05 Room:301B Time:May 22 10:00-10:15

Surface deformation in Izu-Oshima detected by InSAR time-series analysis

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InSAR time series analysis is one of the techniques for measuring the time variation of a small grand surface deformation.
There are a number of GPS continuous observation stations in Izu-Oshima, where the crustal deformation has been detected in detail. We performed InSAR time series analysis in Izu-Oshima using ALOS/PALSAR data and compared the results with the GPS continuous observation data. The obtained deformation by InSAR time series analysis was basically consistent with the results of GPS.

Keywords: InSAR time-series analysis, Izu-Oshima, ALOS/PALSAR

Japan Geoscience Union Meeting 2013
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STT57-06 Room:301B Time:May 22 10:15-10:30

Detection of slow slip event at Bungo Straight by InSAR time series analysis

Basara Miyahara[1*], Akira Suzuki[1]

[1]Geospatial Information Authority (GSI) of Japan

Geospatial Information Authority (GSI) of Japan have conducted InSAR analysis of ALOS/PALSAR data and detected crustal deformation caused by earthquakes, volcanic activities and land subsidence. Slow slip, which causes gradual crustal deformation between tectonic plates without apparent tremors, is also detected by ALOS/PALSAR data at Bungo Straight from 2009 to 2011, and the detected deformation is consistent with deformation detected by GPS continuous observation (Noguchi et al., 2011). However, deformation caused by slow slip is sometimes not large enough to be detected by InSAR, because InSAR images sometimes contain large noises such as atmospheric and ionospheric delay. InSAR time series analysis enables us to reduce such noises and makes it easier to detect ”true”crustal deformation such as slow slip. We report an attempt to detect much robust signals of slow slip at Bungo Straight from ALOS/PALSAR data by InSAR time series analysis. Also, detected deformation is evaluated by comparing with GEONET (GNSS Earth Observation Network System) coordinate time series.

Keywords: InSAR, time series analysis, slow slip, GPS, GEONET

Japan Geoscience Union Meeting 2013
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STT57-07 Room:301B Time:May 22 10:30-10:45

Analysis of rock glacier flow by Differential InSAR on Argentine Andes

Tsutomu Yamanokuchi[1*], Tadono, Takeo[2], Mariano Masiokas[3], Narama, Chiyuki[4], Ukita, Jinro[4], Tomiyama, Nobuhiro[1]

[1]Remote Sensing Technology Center of Japan, [2]JAXA, [3]IANIGLA, [4]Niigata University

Monitoring of rock Glacier is very important because not only for climatological index of global warming but also water resource for drinking and irrigating on Argentine Andes area. However, spatial distribution and its amount are not estimated due to the broad mountain area and difficulties of field survey. This study aims to monitor rock glacier by Differential InSAR technique using APLS PALSAR data. Surface of rock glacier is covered with boulders and its flow velocity is about 1m/year.

Study area is Cordon Del Plata mountain range, where is located between Santiago, the capital of Chile and Mendoza city, Argentina. Stationary observation has been carried on one of the rock glacier on this area by IANIGLA (Instituto Argentino de Nivologia, Glaciologia y Ciencias Ambientales) . IANIGLA developed rock glacier inventory more than 30 years ago. At first, we compared with DInSAR result with this inventory and the movement of mountain area showed good correspondence with old rock glacier inventory. Furthermore, we can detect the seasonal change of flow velocity of rock glacier by time series analysis result. In this summer, we will have a field survey at this area to measure the flow velocity by DGPS and other physical parameters and plan to validate our DInSAR results.

Keywords: Rock Glacier, DInSAR, Argentine Andes

Japan Geoscience Union Meeting 2013
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STT57-08 Room:301B Time:May 22 11:00-11:20

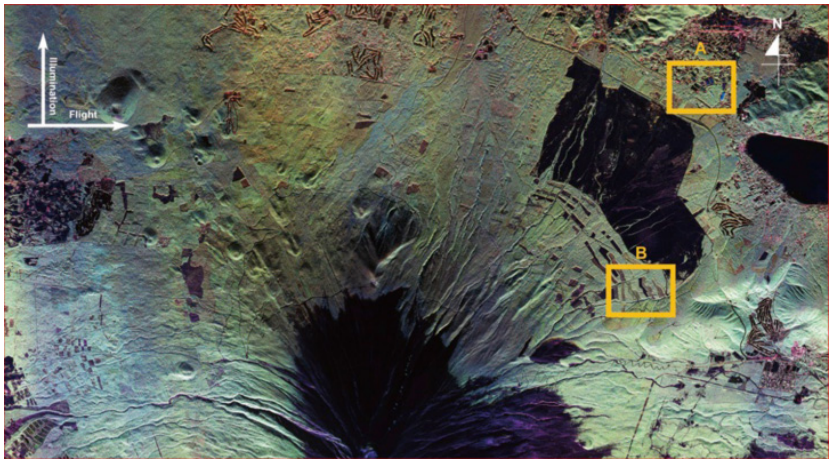
Calibration and Validation of the Pi-SAR-L2

Masanobu Shimada[1*], Noriyuki Kawano[1], Takeshi Motohka[1], Manabu Watanabe[1]

[1]JAXA

Pi-SAR-L2, the JAXA's second version of the L-band airborne full polarimetric SAR started the experimental flight operation in April 2012. Basic specification is similar to Pi-SAR-L. The improvement is given to the higher resolution of the SAR and the perfect synchronization of the IMU and SAR data for image performance improvement. It is expected to complementary support the PALSAR-2 in a way that the south and North Slope can be observed. The larger advantages of forest monitoring and the interferometric coherence were often conduced using the PALSAR. Pi-SAR-L2 will exceed these functionality and performance with the improved basic performance. In this presentation, we will report the current status and the performance.

Keywords: Pi-SAR-L2, Calibration and validation, Polarimetry, IMU



Japan Geoscience Union Meeting 2013
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STT57-09 Room:301B Time:May 22 11:20-11:35

On ionospheric correction of ALOS/PALSAR interferograms using GEONET data (preliminary report)

Hiroshi Munekane[1*]

[1]GSI of Japan

At Geospatial Information Authority of Japan (GSI), we have been using ALOS/PALSAR interferograms to monitor crustal deformations. We noticed that occasionally local crustal deformations to appear in interferograms are masked by long-wavelength noise. One of the causes for such a long-wavelength noise in the interferograms is ionospheric disturbances.

We developed a preliminary method for correcting the effect of ionospheric disturbances in the ALOS/PALSAR interferograms using GEONET data. In this presentation, we will present the details of the method and result of the performance evaluation using the ALOS/PALSAR data.

Keywords: InSAR, Ionosphere, GEONET

Japan Geoscience Union Meeting 2013
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STT57-10 Room:301B Time:May 22 11:35-11:50

Deformation parameter estimation in low-coherence areas using multi-satellite InSAR approach

Yu Morishita[1*], HANSSEN, Ramon F.[2]

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Multi temporal InSAR techniques such as PSI (Persistent Scatterer Interferometry) and SBAS (Small Baseline Subset algorithm) have been used to estimate time series of surface deformation with high precision. In areas with low coherence, and in the absence of sufficient PS, the estimation of reliable phase information can be very cumbersome. Here we report two methods to improve the feasibility and precision of deformation parameter estimation in low-coherence areas; adaptive multilook window and integrated use of data from several satellite missions. The adaptive multilook window may prevent underestimate of shallow subsidence due to deep foundations of buildings, seen in PSI results. Integration of multi-datasets can improve the precision and expand the temporal coverage. The estimated deformation using these methods for pasture on drained peat soils in the Netherlands shows distinct subsidence and periodic components.

Keywords: InSAR, Time series analysis, Coherence, Subsidence, Peat soil

Japan Geoscience Union Meeting 2013
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STT57-11 Room:301B Time:May 22 11:50-12:05

Along-track InSAR for observation of crustal deformation

Tomokazu Kobayashi[1*]

[1]GSI of Japan

Interferometric Synthetic Aperture Radar (InSAR) has been successfully applied to mapping crustal deformation associated with earthquakes and volcanic activity and so on. However, there is a flaw that the InSAR technique can only measure 1-D displacement along the antenna's line-of-sight direction. The along-track displacement cannot be detected in principle. SAR satellites travel a nearly north-south direction, thus the InSAR measurement is insensitive to displacement in the north-south direction. A pixel offset method has been often employed to measure the along-track displacement, but the measurement accuracy is low (several tens of centimeters) and the spatial resolution is low (several hundreds of meters to ˜ one kilometer). This is why practical applications to crustal deformation observations are limited. A significant improvement in measuring the along-track deformation has been proposed: multiple-aperture SAR interferometry (MAI) (Bechor and Zebker, 2006). This method utilizes split-beam InSAR processing which creates one forward- and one backward-looking interferogram, and then constructs a multiple aperture interferogram from the two different-looking interferograms. It is reported the achieved measurement accuracy is higher than that by pixel offset method. In this study, we apply the MAI method to ALOS/PALSAR data and we discuss the measurement accuracy for consideration of the range of applications to crustal deformation observations. Preliminary results of MAI show that the achieved accuracy is 5-10 cm (1 standard deviation) with a coherence more than 0.5 with 20-40 multi-looking in azimuth. On the other hand, the measurement accuracy of pixel offset analysis is approximately 20 cm (1 standard deviation) with 128 x 256 pixels of a cross correlation window, suggesting that a MAI method is achieved higher accuracy with higher spatial resolution than a pixel offset method.

Acknowledgments: The SAR data obtained using the ALOS/PALSAR were provided by the Japan Aerospace Exploration Agency (JAXA) through "Joint Cooperative Agreement between GSI and JAXA for observation of geographic information using Advanced Land Observing Satellite (ALOS) data". The ownership of PALSAR data belongs to METI (Ministry of Economy, Trade and Industry) and JAXA.

Keywords: SAR interferometry, Along-track InSAR, MAI, Measurement accuracy, Crustal deformation

Japan Geoscience Union Meeting 2013
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STT57-12 Room:301B Time:May 22 12:05-12:20

Mapping of Deformation of SW Japan using PALSAR images

Manabu Hashimoto[1*]

[1]DPRI, Kyoto University

In order to detect interseismic deformation in SW Japan with a high spatial resolution, we have been conducting SAR interferometry and stacking analysis of PALSAR images. So far, we reported the results for eastern Shikoku and Kii peninsula. We are going to report results for other areas of Shikoku and Kyushu as well as technical issues we have found during these processes.

We used images of the ascending paths 417 - 420, whcih were acquired during the mid 2006 to 2010. In totla there are more than 20 acquisitions for each path. Since artificial changes possibly due to ionospheric disturbances were sometimes observed, we stacked images other than these.

The variation in stacked interferogram of the path 419 is as large as that simulated from GPS velocities, but we recognize a different trend than the stacking interferogram for the path 417. Furthermore, fringes in the Chugoku districts is inconsistent with GPS. We find significant NW-SE trends in azimuth offsets for the pairs of images with or without day of large GPS-TEC variation. It is worth noting that the wavelength of variation in azimuth offset is much shorter than that of GPS-TEC. Therefore it may be difficult to correct interferograms with GPS-TEC.

On the other hand, is is difficult to detect interseismic deformation from the descending images of Shikoku, since number of observation is less than that of ascending and we find ionospheric disturbances even for descending images. Fortunately, we could obtain consistent result with the GPS velocity field in eastern Kyushu, where there are many observations enough to apply the above method.

On the basis of the above results, we can conclude that it is essential to ensure enough number of observations and proper correction of ionospheric disturbances. Azimuth offsets may be useful for the evaluation of ionospheric disturbances,

Keywords: SAR, interseismic deformation, PALSAR, SAR interferometry, SW Japan, crustal deformation

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STT57-13 Room:301B Time:May 22 12:20-12:35

Study of ground deformation in Kanto region detected by InSAR

Akira Suzuki[1*], Basara Miyahara[1], Yu Morishita[1]

[1]GSI of Japan

Geospatial Information Authority of Japan (GSI) had conducted regular D-InSAR analysis of ALOS/PALSAR data and monitored crustal deformation caused by volcanic activities and land subsidence. The deformation caused by land subsidence within a range of a frame had been detected accurately by using a stacking technique which reduces atmospheric noises. Here we enlarge the analyzed area to Kanto region by combining several scenes and evaluate the accuracy. We also report the results of InSAR time series analysis in this region.

Keywords: InSAR, Time series analysis, Stacking, Kanto region

Japan Geoscience Union Meeting 2013
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STT57-P01 Room:Convention Hall Time:May 22 18:15-19:30

Monitoring of Sakurajima Volcano using Cosmo-SkyMed

Yosuke Miyagi[1*], Taku Ozawa[1], Masanobu Shimada[1]

[1]National Research Institute for Earth Science and Disaster Prevention, [2]Japan Aerospace Exploration Agency

Sakurajima volcano is located in southwestern part of Japan, and currently a most active volcano in Japan. Eruptive activities from Showa-crater have activated since 2009, and several explosive eruptions occurred in 2012. On July 24, 2012, another large eruption occurred from Minamidake-crater after a lapse of 18 months. To understand current condition and future unrest of Sakurajima, periodic monitoring is required. 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, Synthetic Aperture Radar (SAR) sensor is well-suited for monitoring active volcanoes because it can penetrate ash clouds and can observe targets like an active vent. Moreover, SAR data are applicable to use a Differential Interferometric SAR (DInSAR) technique to detect crustal movement associated with the magmatic activities. In this study, we used COSMO-SkyMed data for monitoring Sakurajima volcano and tried DInSAR processing. Monitoring using high-resolution amplitude images revealed changes of backscattering intensity probably due to some kind of surface change within or around the crater. DInSAR processing suffered from low coherence, therefore we acquired quite limited geodetic information.

Keywords: SAR, Sakurajima, DInSAR, Cosmo-SkyMed

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STT57-P02 Room:Convention Hall Time:May 22 18:15-19:30

Flow velocity measurements of an ice stream using SAR interferometry and GPS

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[1]National Institute of Polar Research, [2]RESTEC, [3]Nihon University, [4]PASCO Corp.

Synthetic Aperture Radar (SAR) interferometry (InSAR) is an effective tool to measure flow rate of ice stream on Antarctic continent. We applied the InSAR technique to X band SAR data acquired by German X band SAR satellite TerraSAR-X, and tried to measure flow rate of an ice stream Flattunga, which flows out to Prince Olav coast, East Antarctica. The used two scenes are in the StripMAP mode, and observed at March 21 and April 1, 2011 in the descending orbit 166. The perpendicular baseline length between the two observations was -96.9 m. In order to make differential InSAR (DInSAR) image, we also used ASTER GDEM.

Starting point of an inner Antarctic continent route of Japanese Antarctic Research Expedition (JARE) is located in the upper stream region of Flattunga. We implemented GPS measurements from the end of April to the beginning of May, 2012 in the wintering period of JARE53 at S19 (69 00’28.6”S, 40 08’22.6”E, ellipsoidal height: 615.0m) in the route. From a preliminary analysis of the data, we obtained a flow rate of 15 cm/day and a flow direction of N44 W at the site.

Obtained displacement by DInSAR from TerraSAR-X data was approximately 40 cm for 11 days at around S19 site. The displacement is smaller than the above value from GPS measurement. We will compare the displacement by DInSAR with that by GPS by projecting the direction to ice flow direction of Flattunga.

In the presentation, we also intend to show a result obtained by a differential InSAR analysis of ALOS/PALSAR data.

Keywords: Differential SAR interferometry, GPS, ice stream, Antarctica

Japan Geoscience Union Meeting 2013
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STT57-P03 Room:Convention Hall Time:May 22 18:15-19:30

Development of InSAR processing tools in NIED

Taku Ozawa[1*], Yosuke Miyagi[1]

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

Synthetic aperture radar (SAR) became one of the useful tools for crustal deformation detection. Recently, InSAR processors which can be used freely in scientific research (e.g., ROI_PAC, GMTSAR, and Doris) were released, and enabled anyone to do crustal deformation detection by InSAR. Especially, algorithm of two-pass differential InSAR analysis matured, and it enabled anyone to obtain almost same results. On the other hand, advanced InSAR analysis methods, e.g., time-series analysis, have been recently used to detect precise crustal deformation. However, many issues to improve remains in such analyses. In order to research on improvements for such analysis, we are developing InSAR processor.

In this InSAR processor, general procedure is adopted. (1) Format conversion of SLC and creation of parameter files. (2) Rough co-registration of two SLCs considering parallel shift only. (3) Estimation of affine transformation coefficients using the accurate matching method by Tobita et al. (1999). (4) Resampling of SLC. (5) Generation of the initial interferogram. (6) Simulation of a SAR intensity image and estimation of translation tables between geodetic and radar coordinates based on DEM. (7) Co-registration between simulated and observed SAR intensity images. (8) Correction of translation tables. (9) Simulation of the orbital and the topographic phase components. (10) Generation of differential interferogram. (11) Applying interferogram filter (Goldstein and Werner (1998) or Baran et al. (2003)). (12) Geocodeing.

Test analysis for this processor was carried out using PALSAR data pair about the earthquake which occurred in the southeastern Iran (Path:559, Frame:550, 2010/9/30 - 2010/12/31). In this analysis, we used SLC images generated from SIGMA-SAR which was developed by Dr. Shimada of JAXA. Analyzing this data pair using SIGMA-SAR and GAMMA processor, results that the orbital and the topographic phase components don't remain were obtained. The result by this processor was almost consistent with them about crustal deformation component for the earthquake. Furthermore, it seems that coherence is almost the same. However, the orbital phase component with phase change of one cycle in the full scene remained.

Some issues which need to improve of algorithm remain in this processor, and improvement of them is next issue. Additionally, we are planning integration of some algorithms which were developed in NIED, the atmospheric delay simulation (Ozawa and Shimizu, 2010), time-series analysis using multi-track interferograms (Ozawa and Ueda, 2011), and so on.

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STT57-P04 Room:Convention Hall Time:May 22 18:15-19:30

Localized water-level and ground surface changes at Kushiro basin detected by InSAR

Atsushi Saito[1], Masato Furuya[1*]

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Kushiro plain is the largest wetland in Japan, which plays an important role as water storage. In recent years, the environment of the wetland are changing rapidly. The local government and some organizations make efforts to preserve the environment.

InSAR (Interferometric Synthetic Aperture Radar) is a method that can detect surface deformation by using SAR data. In general, we cannot apply InSAR technique over areas covered with water, because the reflected microwaves at different acquisition times do not correlate with each other. However, Wdowinski et al (2004) reported that InSAR could measure water level changes at some wetlands, because of double bounce reflection at the point where stable reflectors such as shrubs stick out of water. Following Wdowinski et al, we have applied InSAR technique to detect localized water level changes in Kushiro wetland.

We use ALOS/PALSAR data, which was launched by JAXA in 2006, to observe Kushiro plain. Then, the larger changes were detected at Kayanuma (the northern part of Kushiro plain) and near Setsuri river (the western point of the plain). Moreover, we could detect ground surface displacements in the Kushiro city, which reveal clear deformation boundaries along the city area. The sign detected displacements indicate both negative and positive, which means both upward and downward changes, and thus they are not simply a so-called ground subsidence.

The wetland change will reflect water level changes because the upward change corresponding some heavy rain. On the other hand, we have currently no idea how we can explain the ground displacements that indicate clear boundaries in the populated areas of Kushiro city.

Keywords: Kushiro wetland, water level change, ground deformation, InSAR, ALOS