Airborne SAR Interferometry around Kirishima Volcano Using PiSAR-L2 Data

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1. Introduction

Synthetic aperture radar Interferometry (InSAR) is a versatile tool for the crustal deformation monitoring with all-weather capability without any ground-based instrumentation in the target area. For a heavily vegetated region L-band SAR is advantageous to get good coherence. As a matter of fact, the L band SAR sensors installed in JERS, ALOS, and ALOS2, which are series of Japanese satellites operating on L band, have been providing many important results for both scientific and disaster mitigation purposes. Space-borne InSAR is thus already a standard method for volcanic crustal deformation monitoring. On the other hand, airborne InSAR still remains in a premature stage because of the difficulty of achieving effective method to mitigate problems caused by imperfect repeatability of the aircraft flight trajectory. To demonstrate the capability of L-band airborne SAR interferometery for volcanic crustal deformation monitoring, we are in the process of developing a standardized procedures for airborne repeat path InSAR using data acquired by PiSAR-L2 system developed and operated by the Japan Aerospace Exploration Agency (JAXA), In September 2017 we acquired data that are tailored for the usage of repeat path InSAR processing over the surrounding areas of active volcanoes nested in central and southern Kyushu using the PiSAR-L2 system. In this presentation, we report the results of repeat path InSAR analysis for Kirishima Volcano, where ongoing deformations are confirmed by space-borne InSAR and precise leveling surveys.

2. InSAR processing for PiSAR-L2 data

The Pi-SAR-L2 is equipped with a high-precision INS-GPS hybrid-type trajectory tracking system, which achieves high trajectory repeatability. However, off-sets between the repeating flight trajectories are still inevitable under the influence of unpredictable changes of winds and air turbulences. The trajectory irregularities also bring errors into pixel positions and phases. Hence, it is highly necessary to achieve reasonable methods to compensate pixel off-sets and remove the phase errors.

From preliminary analysis in the early stages of this project, we learned that the degree of achievement of the co-registration of master and slave images is one of the key elements of airborne repeat path InSAR. Thus, we developed a standardized method to detect range and azimuthal off-sets of pixels and to resample the slave image to achieve the precise one to one correspondence at the pixel level throughout the entire image. We use the RINC software package developed by Taku Ozawa. As a result of the improvement of the co-registration method, we achieved getting almost fll-sceme coherence in all of the six pairs, which consisted of observations taken from three different directions in 2014, 2016, and 2017.

3. Interference analysis of Kirishima volcano

The Iwoyama of Kirisima volcanic complex is a small dome where ongoing inflation is confirmed by space-borne SAR and precise leveling. All the interferograms which we derived from PiSAR-L2 data indicated the LOS change suggesting inflation on the scale of a few centimeters which agree well to satellite InSAR and leveling findings . As a result of the anomalous winds speed change along the flight trajectory, recognizable orbital and topographic fringes remain. Here we remove them by subtracting spatially low frequency components of phase distribution. That means we are focusing on only the localized ground deformation with spatial wave length of for example 1 km, which is justified for Iwoyama dome. We also found that the noise level after removal of the long-wavelength component is approximately +2 cm. In the presentation, we will also show results of 3-dimensional decomposition of multi-directional observations data by PiSAR-L2 data.

Acknowledgments: I used the elevation data of the RINC (Ver.0.36) developed by Dr. Takeshi Ozawa and the Geographical Survey Institute for interfering SAR analysis.

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