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Crustal deformation detection using multi-pass interferograms in Miyakejima

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Interferometric SAR (InSAR) is a useful technique for investigating complex crustal deformation associated with the volcanic activity. We want to detect detailed temporal change of such crustal deformation from InSAR results, and developed the estimation method of crustal deformation time -series using multi-pass interferograms in this study. In this presentation, we introduce its method and a case study in Miyake-jima.
Generally, an area of about 10km is generally included in SAR images observed from several orbit passes. Actually, Miyake-jima is included in SAR images from six orbit paths including those by different offnadir angle. We applied InSAR to their SAR data, and estimated slant-range changes. In this analysis, we applied the atmospheric noise reduction method using JMA meso-scale model and the long wavelength error reduction using GPS crustal deformation.
Since line-of-sight (LOS) direction for each orbit path is different, crustal deformation components of interferograms obtained from different orbit paths are different. Estimating best fitted plane of all LOS directions (co-plane), the differences of LOS directions from the plane are less than 1 degree. Therefore it can be assumed that all LOS directions are included in the co-plane, and the slant-range change of all interferograms can be expressed by vector composition of horizontal (EW) and vertical (quasi-UD: it inclines 10 degree from the vertical to the south) components. Inversely, these components can be estimated from slant-range changes by the inversion analysis. In this study, we estimate crustal deformation time-series based on the observation equation which considers the difference of observation dates for different orbit paths. To reduce the noise, we use the constraint that crustal deformation change is temporally smooth. Simultaneously, we estimate the error in the digital elevation model.
Subsidence that the center is located to northwest of the crater bottom was estimated. Its temporal change until 2008 is almost linear, and its speed is 14cm/yr. EW component at the center was negligible, but the eastward and the westward movements were found in eastern and western areas, respectively. It means contraction pattern. It seems that the subsidence speed has decreased from 2009, and the speed in 2009 was estimated to 10cm/yr. On the other hand, the EW component has not changed. Estimated standard deviations for estimated time-series are less than 1cm, and obtained crustal deformation corresponds to GPS result within 1cm. Furthermore, the increase of seismicity has been observed in 2009, and there is a possibility that the change of subsidence speed relates to such phenomena. From these facts, we believe that estimated speed change is significant not estimation error.
This method can estimate more precise time-series if more interferograms are available. One of simple methods is using interferograms generated from other SAR sensors. However, high coherence must be also obtained in InSAR analysis using other SAR sensors for such analysis. Then we investigated coherences for interferograms obtained from other SAR sensors. We introduce its result in the poster presentation.

Keywords: SAR, interferometry, Miyake-jima, Crustal deformation, volcano, time-series