Nationwide land deformation monitoring by InSAR time series analysis of Japan

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SUMMARY

Ground surface deformation is the key information to monitor natural disasters, and spatiotemporally comprehensive observations of the ground surface deformation are essential for estimation of the potential risk of disasters. Geodetic observations can be often powerful tools for monitoring the ground surface deformation, and synthetic aperture radar (SAR) is one of promising techniques for providing spatially wide and dense observations. An interferometric SAR (InSAR) method has been utilized to broadly and locally map ground surface changes. However, the accuracy of the standard InSAR products is not always high enough for the purpose because various types of errors are included in the standard products. Against the background, InSAR time series analysis is an effective technique to reduce the noise and improve the detectivity by statistically processing a large number of InSAR images. We processed ALOS-2 satellite data observed over 9 years from 2014 to 2024 for InSAR time series analysis. In general, spatially long-wavelength tectonic signals cannot be distinguished from comparable long-wavelength noises only by products of InSAR analysis. However, by incorporating displacements which are measured at nationwide deployed continuous GNSS stations, we succeeded to derive a complete nationwide surface change map that has both tectonic wide-ranging deformation and locally distributed deformation. Our deformation map successfully detects various types of land deformations such as inflation/deflation of volcanoes, ground subsidence, landslides, post-seismic deformation which have slowly proceeded with a few cm/mm per year. The deformation map can be displayed in our web-GIS interface “GSI Maps” and is freely available for all users. In the web-GIS interface, the time series of LOS displacements can also be displayed at every pixel in the map. Several public organizations have started discussions on how to utilize this map for monitoring land subsidence as an alternative of conventional monitoring by geodetic leveling. The deformation map can be also utilized for confirming if the deformation is large enough to require update of the reference coordinates. In addition, the new L-band SAR satellite of Japan, ALOS-4 will be fully operational in 2025, and

accuracy and temporal resolution of this map will be further improved by incorporating the incoming ALOS-4 date. In this presentation, we will show the results of InSAR time series analysis and how these time series could effectively work for nationwide monitoring of surface deformation and potential risk of disasters.