Developing InSAR atmospheric delay correction model based on GEONET ZTD and its gradient

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In InSAR analysis, the effect of microwave propagation delay in the Earth's atmosphere such as the neutral atmospheric delay and the ionospheric delay is recognized as the primary noise for surface deformation researchs like Earthquake source modeling, tectonic fault motion, and volcanic activity monitoring. Although, for the ionospheric delay, we can now apply the range split spectrum method (SSM) to effectively mitigate it, the mitigation of the neutral atmospheric delay noise remains difficult and is the research problem to be solved. Recently, Arief and Heki (2020) developed a new method to retrieve two-dimensional Zenith Wet Delay (ZWD) distribution at sea level based on the GNSS ZWD and delay gradient derived from the Japanese GNSS network named GEONET. Here we proposed a new InSAR delay correction method based on modifying the Arief and Heki's method and applied it to the ALOS-2 ScanSAR interferograms to evaluate its effectiveness.

In our study, we used 5-minute interval GNSS PPP data provided by the Nevada Geodetic Laboratory in Nevada University, Reno. Since InSAR atmospheric delay contains both hydrostatic and wet components, we estimated two-dimensional Zenith Total Delay (ZTD) distribution at sea level instead of ZWD, and we simultaneously estimated height dependence of ZTD as a linear function. The model consists of the regularly distributed grids with 5 km interval and the height dependence. The retrieval of ZTD distribution is performed by the least squares inversion with the smoothing constraint. The retrieved ZTD is then projected onto the InSAR line-of-sight direction and calculated a difference of two epochs to generate an InSAR delay model. Interferograms were generated by RINC ver.0.41r using 16 ALOS-2 ScanSAR level 1.1 full-aperture data covering Kanto Plain in Japan. We applied the SSM to all of interferograms to correct the ionospheric delay noise before applying the proposed tropospheric delay correction.

The result of applying proposed correction method showed that the correction effectively reduced the phase variance, especially in the long-wavelength phase variation. The phase standard deviation (STD) in the whole scene decreased from 35.95 mm to 25.84 mm by applying the proposed GNSS-based correction method. For comparing effectiveness of the proposed method with existing methods, we also calculated the phase STD derived by applying the GACOS model and the numerical weather model-based correction using the Japan Meteorological Agency’s Meso-scale model data. The result of comparison showed that the proposed GNSS-based method most reduced the whole-scene phase STD. The GACOS model decreased the STD to 30.96 mm, and the JMA MSM decrease to 27.71 mm, respectively. We then calculate the distance-dependence of the phase STD based on the variogram model. The variogram derived from all the
interferograms showed the superiority of the GNSS-based correction, although the STD in distance shorter than 20 km seemed no differences between correction methods.