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Estimate of error in ALOS/PALSAR interferograms

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Large deformation is generated by the subduction of the Philippine Sea plate in Shikoku. GNSS observation reveals a WNW ward horizontal motion and a velocity gradient from south to north. This velocity field is suitable for the observation with SAR, which is sensible to the E-W ward displacement field. Based on these facts, we have conducted to derive average velocity in Shikoku using ALOS/PALSAR. We mainly analyzed ascending images acquired during 4 years, but anomalously large displacements (peak-to-peak displacement ˜50 cm) were often observed possibly due to ionospheric disturbances. We discarded interferograms with such disturbances with visual inspection, and stacked rest of them. However we found E-W velocity gradient in Shikoku that is inconsisntent with GNSS observations, when stacked interferograms are superposed from 4 paths. Furthermore, discontinuities between paths are evident in the Chugoku district. Therefore we made error estimate in order to clarify its magnitude and spatial distribution, comparing line-of-sight displacements derived from InSAR and GNSS.

The procedure is as follows:

(1) Calculate displacements of GNSS stations between the acquisitions of master and slave images for a specific pair from the F3 solution of GEONET and convert them to LOS displacements.

(2) Extract LOS displacements at GNSS sites from the interferogram.

(3) Take differences of LOS displacements between interferogram and GNSS.

(4) Examine dependence of latitude, longitude and height, and interpolate differences of LOS displacements with Surface function of GMT.

(5) Add interpolated differences of LOS displacements to the original interferogram.

One typical example is interferogram for the pair of April 11 and May 27, 2010 for the path 419. Since the time difference is 46 days, little motion is expected. However, we observe LOS changes of ˜40 cm in the E-W direction. We also find a tong-shaped region of LOS decrease in the Chugoku district. Applying the above procedure, we obtain interpolated differences of LOS displacement with the opposite sign to the original interferogram. The standard error of difference of LOS displacements for 36 GNSS sites is 7.8 cm. However, the dependences of longitude and latitude are obviously different at 34 N. Therefore we use the Surface function instead of a simple linear function for the interpolation. Finally, we obtain a fairly flat interferogram consistent with the GNSS result. There still remain displacements with shorter wavelength than 20 km, however.

Applying to other pairs, we evaluate standard errors. The minimum is 1.2 cm (Jan. 6 - Feb. 21, 2009), while the maximum is 18.9 cm (May 27 - Jul. 12, 2010). In total 24 pairs, 4 is less than 2 cm, 7 for 2 ˜4 cm, 6 for 4 ˜6 cm, 3 for 6 ˜8 cm, 2 for 8 ˜10 cm, and 2 is larger than 10 cm. The median is 4.5 cm. For the neighboring path 418 (30 GNSS sites), the minimum is 1.5 cm, while the maximum is 19.8 cm. The median is 4.7 cm. These estimates may give a rough idea of error of PALSAR interferograms including ionospheric disturbances.

We apply this procedure to other paths (417, 418 and 420) and obtain corrected interferograms that cover the entire Shikoku (Attached figure). This map is fairly consistent with the GNSS velocity field, but there is a discontinuity between the paths 417 and 418. We use interferograms with a rather long perpendicular baseline, which causes decorrelation in mountains. We use only GNSS displacements in plain areas for such interferograms, which results in systematic error.

Keywords: SAR interferometry, PALSAR, ALOS, error, crustal deformation

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