Evaluation of the Accuracy of Differential Interferometric SAR: its Advanced Techniques and Applications

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We have carried out the JERS-1 and ERS1/2 differential interferometry (DinSAR) researches in volcano and earthquake monitoring- Mt. Iwate, Izu peninsula, Mt. Unzen, Kagoshimaken Hokuseibu earthquake(1997), Omaezaki, Kozu island and so on. Also we have obtained a lot of techniques of analysis and evaluated the accuracy of DinSAR. An accuracy of the DinSAR depends on that of orbit data, three decorrelation (thermal, spatial, and temporal) and algorithm oriented errors. We adopted a criterion for baseline estimation error to be less than 1% at the baseline refinement by minimization of coordinates errors, removal of residual orbit phase and correction for residual topographic phase. In particular, the consistency between orbital and topographic phase should be evaluated quantitatively.

Intoroduction

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Knowhow of DinSAR anlysis

(I) Single Look Complex image processing

(1) An interested area should be shifted to the scene center of raw data and processed with a full scene.

(2) Doppler centroid coefficients should be precisely determined by masking ocean region.

(3) SLC SAR image is projected on Bessel ellipsoid which is the same earth model with GSIDEM.

(II)InSAR processing

(1) Master/Slave coregistration: Tiepoints should be selected homogeneously on whole area of the scene. Maximum RMS error accepted in the polynomial fit to the tiepoints is less than 0.2 pixwls.

(2) Baseline estimation: 1. Initial orbit state vector are determined by calculation of the orbit propagator (Klincrad, 1995). 2. Next, baseline are refined by minimization of the coordinates errors (correction of the timing error). 3. After calculating the interferogram, perpendicular baseline component (Bp) and yaw angle are modified to flatten the residual flat earth phase. Precision of Bp and yaw determination are less than 10-50 cm and 0.00001 degree, respectively. 4. Finally, optimal Bp values whose error is less than 1 % should be determined by comparison among above Bp values and one that is calculated from relation between InSAR topographic fringe rate and height of DEM.

(III)DinSAR processing

(1) Master/DEM coregistration:DEM coordinates are coregistered to master coordinates by giving a ellipsoid height as a control point. Simulated backscatter image and master

smplitude image are matched by correlation calculation at more than several tens tiepoints and the RMS error should be reduced to be less than 0.2 pixels.

(2) Topograohic phase image are simulated, which fringe rate are calculated using an optimal baseline value.

(3) If Bp is long,, master and slave SLC image may be filtered for baseline decorrelation in advance to improve the coherence.

(4) Orbital and topographic phase residues are removed by adjusting Bp and yaw values. In particular, residual topographic phase are corrected by least square method using regions

including no crustal movements. Finally, baseline estimation error should be reduce to be less than 1 %. Furthermore consistency between orbital and topographic fringe rate

should be checked to evaluate the accuracy of orbit/DEM geometry.

Accuracy of DinSAR

For example, baseline estimation error of 1 % can generates apparent topographic phase change of 2 cm as an error in slant range change if Bp (perpendicular baseline component) = 500m and height difference = 2000m. Therefore we adopted a criterion for baseline estimation error to be less than 1% at the baseline refinement by minimization of coordinates errors, removal residual orbit phase and correction for residual topographic phase.