SCANSAR INTERFEROMETRY WITH PALSAR

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ABSTRACT

The systematic observation strategy of PALSAR provides strip-mode SAR imagery along ascending orbital tracks and ScanSAR imagery along descending orbital tracks. Therefore obtaining a second look direction for deformation studies usually requires processing of ScanSAR interferograms. Our method is based on the proposal by Bamler and Eineder [IEEE TGRS, 1996] that, with proper preprocessing, standard strip-mode software can be used to construct phase-preserving ScanSAR images. Our preprocessor was developed and tested using data along a descending orbital track (T538) over Los Angeles, California where JAXA has collected data in both FBD and WB1 modes. The preprocessor separates the sub-swaths into 5 separate files where missing lines between the bursts are filled with zeros. Since the sub-swaths are processed independently an accurate geometric model, precise orbit, and consistent set of processing parameters is required to achieve a seamless recombination. We found that the best image quality (i.e. minimal scalloping) was achieved by setting the length of the synthetic aperture to be exactly 6 bursts. We experimented with three interferometric mode combinations, FBD to FBD, FBD to ScanSAR, and ScanSAR to ScanSAR. The FBD to FBD interferogram (10 m baseline and 46 day timespan) had excellent overall coherence of 0.67. The FBD to ScanSAR interferogram (121 m baselines and 181-day timespan) had lower coherence of 0.35.

For ScanSAR to ScanSAR interferometry there is a question of how much overlap of the bursts is needed to obtain interpretable interference fringes. We were very fortunate that two of the ScanSAR images along track 538 have significant burst overlap (up to 78%) and a moderate baseline of 450 m (Figure 1). An interesting aspect of this interferometric pair is that they have different PRF. This produces a gradual change in burst alignment along the track from 78% at the start of the acquisition to 0% overlap after 18 bursts. We find that a coherence of about 0.35 occurs where the burst overlap is greater than 50%. The coherences diminishes to below 0.2 at a burst overlap of 18% suggesting good interferometric results can be achieved when the burst overlap is greater than about 20%. We applied this method to recover the interferometric fringes associated with the 2008, 7.9 Wenchuan, China earthquake (Figure 2). We were very fortunate that there is 80% burst overlap between the reference and repeat images most closely bracketing the earthquake. The time interval of this pair is 138 days and the baseline is rather long (920 m) so removal of topographic phase was problematic, especially in the mountainous areas. Nevertheless phase recovery is excellent in the Sichuan Basin. This second look direction provides critical information to separate the strike-slip and thrust components of the earthquake.

(The program used to preprocess the WB1 data into pseudo-strip-mode data is available as part of an ALOS pre-processing package available at http://www-rohan.sdsu.edu/~rmellors/ALOS_preproc.tar.gz)
Figure 1 ScanSAR to ScanSAR interferogram for subswath 4 of track 538 across the Los Angeles basin. The perpendicular baseline is 450 m and the time interval is 92 days. No topographic phase has been removed. (left) interferometric phase recovery is good at top of swath where burst overlap is large and poor toward the bottom. (right) coherence also decreases from top to bottom as seen in row-averaged coherence versus burst overlap.

Figure 2. Descending ScanSAR to ScanSAR interferogram of M7.9 Wenchuan earthquake. Each scene of the interferogram consists of 5 sub-swaths across look direction. Red line is the surface rupture of the earthquake. The decorrelation in the mountainous area to the left of the rupture zone is due to high topography and long baseline (920m).