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Multi-image DInSAR techniques with ERS and ENVISAT data for deformation series retrieval

P. Blanco, J. J. Mallorqui, S. Duque and D. Navarrete

Universitat, Politècnica de Catalunya (UPC), Barcelona, Spain (pblanco@tsc.upc.edu / Phone: +34 93 401 74 26)

Differential interferometry has become one of the most important applications of SAR (Synthetic Aperture Radar) data. The main product of this technique is the generation of deformation and subsidence maps of the observed area. Terrain deformation is valuable information for risk management and for the understanding of much geological process.

In this paper, a description on the development of the DInSAR UPC's algorithm (Coherent Pixels Technique) will be presented as well as a critical evaluation of its performances. CPT ([1],[2]) is able to retrieve the linear and non-linear components of movement from a set of low resolution interferograms (multi-looked), estimating at the same time the DEM error and the atmospheric artefacts. CPT has been modified to work with ERS and ENVISAT data. CPT allows selecting the pixels good enough to be processed whether studying its coherence stability in the stack of interferograms or its amplitude stability in the Single Look Complex (SLC) images. Advantages and disadvantages of both selection criteria as well as a comparison between multi-looked (coherence) and full resolution (amplitude) results of the same test-site will be commented.

One important step is the selection of the interferograms when using the coherence criterion. If all possible combinations between the available images were done we would obtain a huge number of them. In order to get the best results using an optimal number of interferograms a 3D Delaunay triangulation of the available images, where the three axes are the temporal baseline, spatial baseline and Doppler frequency is used to make the selection. This approach implies the minimization of the temporal and spatial baselines as well as the Doppler frequency differences of the interferograms,

maximizing coherence and consequently improving phase quality. Results with both synthetic and real data will be presented and discussed.

CPT performs a Delaunay triangulation of the selected pixels and calculates the phase increments between them, obtaining the corresponding increments of linear velocity and DEM error as a first step to the complete temporal deformation series estimation. Because of this triangulation and how the parameters are estimated, none phase unwrapping process is required at this step and, consequently, it is possible to obtain deformation results as well as the topography of the scene even if no DEM was available to cancel the topography of the interferograms. We will discuss the performance of CPT in this case as well as their possible limits.

Furthermore, in order to get the linear velocity and DEM error absolute values for each pixel, an integration process is performed. In the integration, one (or several) control points are needed for a proper offsets' adjustment of the linear velocity and DEM error maps. These maps are then sensible to the quality of the relationships between the control points and their neighbours as well as their density. This is a crucial point on any DInSAR application, including also those methods that require phase unwrapping, as it controls the propagation of offsets throughout the final maps. Impact of these factors in the linear parameters estimation and final deformation results will be studied.

The results to be presented have been obtained from ERS and ENVISAT data provided by ESA over different test-sites (Paris, Gardanne and Murcia) in the scope of different projects.

[1] Mora, J.J. Mallorquí, T. Broquetas, “Linear and nonlinear terrain deformation maps from a reduced set of interferometric SAR images”, IEEE Trans. Geosci. Remote Sensing, Vol. 41, 2243 2253, 2003.