A NEW ALGORITHM FOR THE PHASE UNWRAPPING OF INTERFEROGRAM STACKS

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1. ABSTRACT

Environmental risks monitoring has benefited from the developing of microwave remote sensing techniques. Differential synthetic aperture radar interferometry (DInSar) is a mature processing method that allows the generation of deformation maps with subcentimetric accuracy. Multitemporal/Multibaseline DInSAR stacking extends this technique for the generation of deformation time series and hence the monitoring of the temporal evolution of the displacement phenomenon [1].

In this context, a key problem is represented by the Phase Unwrapping (PhU) step, i.e. the reconstruction of the real phase from its mod 2π values. Most popular PhU techniques work independently on each single interferogram of the overall data set by using the Minimum Cost Flow (MCF) network approach [2][3]. An extension of these algorithms that exploits both spatial and temporal characteristics has been recently presented in [4]. In this case the unwrapping is carried out as a sequence of two steps: the first one is carried out, for each spatial arc, by the application of the MCF approach in the temporal-spatial baselines (*T*x*B*) domain in conjunction with a model-based multitemporal unwrapping that models the deformation as a linear contribution, the second one proceed with the spatial unwrapping and takes benefit of the 2π corrections computed in the first step. Main limitation of this approach is that the Delunay triangulation in the (*T*x*B*) domain, which is needed for the application of the MCF algorithm, on one side limits the degree of redundancy of the used interferograms and on the other side implies the introduction the large temporal/spatial baseline interferograms, which turns out to be more critical from the temporal and spatial decorrelation viewpoint.

In this work we propose a modification of such a two step based PhU procedure. First of all, starting from a set of high resolution interferograms we estimate and then subtract the residual topography and the mean deformation velocity by extending, at full resolution, a recently proposed stacking technique based on the use of spatial differences [5][6]. With respect to the model-based unwrapping in [4] this approach allows us to subtract a preliminary estimate of the residual topography and the mean deformation velocity at the pixel level instead of at a spatial arc level. Then we carry out a temporal unwrapping step, where we first identify arcs connecting coherent pixels in the azimuth-range grid and, for each of these, we estimate 2π multiples by zeroing the projection of the measured wrapped gradients into the orthogonal space to the subspace defined by the selected interferograms that form a network in the (*T*x*B*) plane. By choosing the L_1-norm criterion for the correction field, we cast the problem into a constrained minimization problem with integer unknowns, which can be solved in a computationally efficient way via the use of the Linear Programming techniques. Differently from the temporal MCF unwrapping in [4], such a solution does not need any triangulation in the (*T*x*B*) plane and hence allows us a freely set up of the interferograms to be stacked and unwrapped. Finally, following the strategy in [4] we carry out the final spatial unwrapping operation in the azimuth-range plane, that starts from the previously phase gradients estimations via a standard MCF technique.

The validation of the proposed method is done by exploiting both simulated interferograms and real data set acquired by European Remote Sensing Satellite ERS-1 and ERS-2.

2. REFERENCES

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