EXPLOITATION OF DISTRIBUTED SCATTERERS IN INTERFEROMETRIC DATA-STACKS

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ABSTRACT

After a decade since the first results on ERS data, Permanent Scatterer (PS) InSAR has become an operational technology for detecting and monitoring slow surface deformation phenomena such as subsidence and uplift, landslides, seismic fault creeping, volcanic inflation, etc. Processing procedures have been continuously updated to deal with PS affected by non-uniform displacements, to implement more robust phase unwrapping algorithms, and to better estimate and remove atmospheric effects and orbital fringes, but the core of the algorithm has not been changed significantly.

As well known, in PSInSAR, the main target is the identification of individual pixels that exhibit a “PS behavior”, i.e. they are only slightly affected by both temporal and geometrical decorrelation. Typically, these scatterers correspond to man-made objects (and that’s why PS analyses are so successful in urban areas), but PS have been identified also in non-urban areas, where exposed rocks or outcrops can indeed create good radar benchmarks and enable high-quality displacement measurements. PS analyses are carried out on a pixel-by-pixel basis, with no filtering of the interferograms, in order to preserve phase values from possible incoherent clutter surrounding good radar targets. In fact, any filtering process implies a spatial smoothing of the data that could compromise - rather than improve - phase coherence, at least for isolated PS.

Although the PS approach usually allows one to retrieve high quality deformation measurements on a sparse grid of very good radar targets, in some datasets it is quite evident how the number of pixels where some information could be extracted, whether related to the local topography and/or any differential motion, could be significantly increased by relaxing the hypothesis on target coherence and searching for pixels where the coherence level is high enough *at least in some interferograms* of the data-stack, not necessarily all. The idea of computing a “coherence matrix” for each pixel of the dataset have been already proposed in previous papers, together with a statistical estimation of some physical parameters of interest (e.g. the average displacement rate) based on the covariance matrix. In past publications, however, it was not highlighted how a reliable estimation of the coherence matrix can be carried out on *distributed scatterers* only, characterized by a sufficient number of looks.

In this paper, we propose how to estimate reliable coherence values by properly selecting the *statistical population* used in the estimation. In standard PSInSAR, the so-called amplitude stability index (i.e. the ratio of the mean and the standard deviation of the amplitude values corresponding to a certain pixel in the multi-temporal dataset) is used as a proxy for temporal phase coherence, here we expand the concept and we show how amplitude statistics can be successfully exploited to detect distributed scatterers, rather than individual pixels, where reliable statistical parameters can be extracted. As a by-product of carefully estimating coherence values, we get despeckled amplitude images and filtered interferograms.

Coherence matrixes and distributed scatterers, apart from the well-known PS, then become the new basic ingredients of the “second generation PS analysis”. Preliminary results on real datasets will be shown using both C-band and X-band SAR data.