ONE-DIMENSIONAL RADAR INTERFEROMETRY FOR LINE-INFRASTRUCTURE

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InSAR time series approaches such as Persistent Scatterer Interferometry (PSI) or spatial baseline-dependent subsets have shown great value for monitoring regionally correlated surface deformation. The application of these methods is based on the assumption that time-coherent scatterers in the data can be successfully detected, and that all parameters of interest, among which the integer phase ambiguity number (per scatterer and per acquisition), can be reliably estimated. These conditions are not always fulfilled, leading to an erroneous estimation of the deformation pattern (for example due to problems in the ambiguity resolution) or to missing coherent scatterers. An additional practical problem is that the computational burden is high.

Here we present an efficient algorithm that is tuned to a specific, but frequently occurring one-dimensional series of radar targets: line-infrastructure. Examples include roads, railways and water defense systems such as dikes, levees and dams. The specific feature of this type of infrastructure is that coherent scatterers are expected to lie along one-dimension: a line situated in a two-dimensional plane. The line might be straight or severely curved. The degree of curvature might be described with a fractal dimension close to 1. The algorithm detects the line-elements and performs the interferometric parameter estimation procedure, assuming that scatterers on or near the line have a similar degree in coherence.

In contrast to the conventional 2D methods, the main advantage here is that the arcs between two scatterers are very short, ideally neighboring pixels. This feature implies that (i) the ambiguity number per arc is bounded to the possible solutions [-1, 0,+1], that (ii) the influence of the refractive atmosphere per arc can be ignored, (iii) that elevation differences per arc are very limited, and (iv) that it is likely that a potential deformation mechanism will be correlated between the end members of the arc. Figure 1 shows an example for water defense structures in the Netherlands.

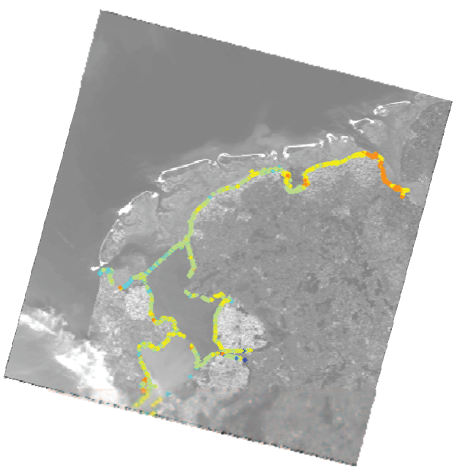

Figure 1. Movement of scatterers along the one dimensional water defense structures of the Netherlands. Colors are indicative for surface motion expressed in millimeters per year.

The largely reduced degree of complexity in the parameter estimation allows for a full analysis of all interferometric combinations in a stack of SAR acquisitions. This enables the detection of non-linear deformation mechanisms, breakpoint behavior, or temporary coherent scatterers.

In this paper we will present the algorithmic details of the method and show application examples. These will be compared with conventional stacked processing of InSAR data.