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Temporal Coherence as an Estimate of Decorrelation Time of SAR Interferometric Measurements

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Following a plethora of validations and demonstrations Interferometric SAR (InSAR) has been established as a mature space geodetic technique for providing valuable insights for various phenomena related to geohazards. One of the main advantages of space borne SAR systems with respect to GNSS is the continuous spatial coverage. However, the impact of temporal decorrelation especially in repeat-pass interferometry has been observed during the historical development of InSAR applications. Interferometric coherence is considered as the expression of temporal decorrelation. It is understood that interferometric coherence decreases with time between SAR acquisitions because of changes in surface reflectivity, reducing the accuracy and spatial coverage of SAR phase measurements. This is an intrinsic characteristic of the design of SAR systems that has a significant contribution at longer time scales. Since the majority of geohazards rely on long term observation scenarios, the effect of temporal decorrelation is evident as coherence becomes dominated by temporal changes. Although in the past there was not sufficient amount of SAR data to extract robust statistical metrics, in the present study it is demonstrated that tailored analysis of interferometric coherence by exploiting the large archive of SAR data available by the European Space Agency (ESA), enables the accurate quantification of temporal decorrelation. A methodology to translate the observed rate of coherence loss into decorrelation times over a volcanic landscape is the subject treated in this study. Specifically, a sensitivity analysis based on a large data stack of interferometric pairs in order to quantitatively estimate at a pixel level the time beyond which each interferometric phase becomes practically unusable is presented. The estimation and mapping of the spatial distribution of the temporal decorrelation times in an area without a necessary a priori knowledge of its surface characteristics is a fundamental parameter for the design and establishment of local GNSS networks as well as the definition of optimal monitoring strategy for various geohazards. The dependence of decorrelation on various land cover/use types is also analyzed. The performed analysis is viewed in the framework of future SAR systems, while underlining the necessity for exploitation of archive data. Though the dependence of decorrelation on various land cover/use types is already documented the provision of additional information regarding the expected time of decorrelation is of practical use especially when EO data are utilized in operational activities. Finally, the impact of the revisit time and increased performance of upcoming SAR missions is discussed.