**Title**

On the robustness of InSAR displacement estimates for monitoring purposes

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**Abstract**

Interferometric Synthetic Aperture Radar (InSAR) stands as a widely adopted technique for monitoring displacements on the Earth's surface, providing millimeter-level precision. Several InSAR studies show the efficacy in retrospectively identifying hazardous situations, such as the failure of a structure. The next imperative step is to detect and identify anomalous points proactively. This necessitates robust and repeatable displacement estimates to avoid misinterpretation and instill confidence in the results.

Many InSAR studies use a batch estimation process requiring a robust algorithm to obtain reliable results. Here we propose a test recipe and introduce metrics to assess the robustness of the InSAR displacement estimates quantitatively, comparing the batch-estimated results of varying SAR acquisition inputs. Robustness characterizes the stability of displacement estimates in the face of disturbances and uncertainties, demonstrating resilience against changing conditions and input.
Our quantification of robustness involves three core metrics to assess InSAR displacement estimates.

Case studies conducted over the city center of Amsterdam and a coastal region at the North Sea reveal the useful insight provided by robustness testing in identifying ambiguities and fallacies in the applied algorithm. Notably, the main challenges arise from the estimation of atmospheric delay, which emerges as a sensitive step with ample room for enhancement. A robust atmospheric estimation appears very dependent on the use of a sufficiently large area of interest while the estimation is sensitive to first-order network changes.

Through the implementation of appropriate measures, an average metric improvement of a factor of four can be achieved, reducing the likelihood of a misinterpretation of the InSAR time series. This underscores the effectiveness of the proposed test recipe in improving existing InSAR software.