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Offline-Online Change Detection for Sentinel-1 InSAR Time Series

Alessandro Novellino, **Ekbal Hussain**, Colm Jordan, and Luke Bateson

British Geological Survey, Earth hazards and observatories, Nottingham, United Kingdom of Great Britain – England, Scotland, Wales (alessn@bgs.ac.uk)

Traditional applications of Interferometric Synthetic Aperture Radar (InSAR) data involved inverting an interferogram stack to determine the average displacement velocity. While this approach has useful applications in continuously deforming regions, new tools are needed for automatically and regularly identifying changes in the time series. Thanks to regular acquisitions across most of the world by the ESA Sentinel-1 satellites constellation, we are now in a position to explore opportunities for near-real time deformation monitoring. In this paper we present a statistical approach for detecting offsets and gradient changes in InSAR time series. Our key assumption is that 5 years of Sentinel-1 data is sufficient to calculate the population standard deviation of the detection variables. Our offset detector identifies statistically significant peaks in the first, second and third difference series. The gradient change detector identifies statistically significant movements in the second derivative series. We exploit the high spatial resolution of Sentinel-1 data and the spatial continuity of geophysical deformation signals to filter out false positive detections that arise due to signal noise. When combined with near-real time processing of InSAR data these detectors, particularly the gradient change, could be used to detect incipient ground deformation associated with geohazards such as landslides or volcanic eruptions.