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A methodology for the analysis of InSAR Time Series for the detection of ground deformation events

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The availability of Sentinel-1 dataset with high-temporal resolution of measures (6-12 days) and long time period, can be considered as a “near-real-time monitoring” since it provides a sampling frequency enough to track the evolution of some ground deformations (e.g. landslides, subsidence) if compared to other sensors. However, the analysis and elaborations of such huge dataset, covering large areas, could be tricky and time-consuming without a first exploitation to identify areas of potential interest for significant ground deformations. The A-InSAR Time Series (TS) interpretation is advantageous to understand the relation between ground movement processes and triggering factors (snow, heavy rainfall), both in areas where it is possible to compare A-InSAR TS with in-situ monitoring instruments, and in areas where in situ instruments are scarce or absent. Exploiting the availability of Sentinel-1 data, this work aims to develop a new methodology ("ONtheMOVE" - InterpolatiON of SAR Time series for the dEtection of ground deforMatiOneVEnts) to classify the trend of TS (uncorrelated, linear, non-linear); to identify breaks in non-linear TS; to provide the descriptive parameters (beginning and end of the break, length in days, cumulative displacement, the average rate of displacement) to characterize the magnitude and timing of changes in ground motion. The methodology has been tested on two Sentinel-1 datasets available from 2014 to 2020 in Piemonte region, in northwestern Italy, an area prone to slow-moving slope instabilities. The methodology can be applied to any type of satellite datasets characterized by low or high-temporal resolution of measures, and it can be tested in any areas to identify any ground instability (slow-moving landslides, subsidence) at local or regional scale. The thresholds used for event detection should be calibrated according to geological and geomorphological processes and characteristics of a specific site or regional site. This innovative methodology provides a supporting and integrated tool with conventional methods for planning and management of the area, furnishing a further validation of the real kinematic behaviour of ground movement processes of each test-site and where it is necessary doing further investigation. In addition, elaboration applied to Sentinel-1 data is helpful both for back analysis and for near real-time monitoring of the territory as regards the characterization and mapping of the kinematics of the ground instabilities, the assessment of susceptibility, hazard and risk.