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Radar interferometry from space for surface deformation investigation: 25 years of developments and observations (Christiaan Huygens Medal Lecture)

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This contribution will provide an overview on the evolution of the space-borne Differential Synthetic Aperture Radar Interferometry (DInSAR) scenario in the last 25 years.
The DInSAR techniques have continuously evolved during the past decades, becoming important “tools” for the investigation of Earth surface deformation. Indeed, they are widely exploited both for studying the deformation phenomena relevant to natural events (i.e. earthquakes, volcanic unrests, landslides) and for analyzing displacements due to anthropogenic actions, such as underground resources exploitation.
Originally, the DInSAR methodology has been successfully applied to analyze single deformation episodes thanks to its capability to generate spatially dense deformation maps of large areas, with centimeter to millimeter accuracy. However, benefiting from the availability of large SAR data archives, the interest of the scientific community has progressively moved towards the study of the temporal evolution of the detected displacements. To do this, advanced DInSAR techniques have been developed, allowing the computation of deformation time series from multi-temporal sequences of SAR images relevant to the areas of interest.
This contribution will start by briefly introducing the basic rationale of the DInSAR methods for the investigation of single surface deformation episodes and their temporal evolution. Subsequently, a series of results will be presented to analyze the DInSAR scenario evolution moving from the first generation SAR sensors, as for the case of ERS-1/2 systems of ESA, to the new Sentinel-1 satellites of the COPERNICUS Programme of the European Union, highlighting the achieved drastic improvements of the surface deformation mapping capabilities. In particular, interesting results will be shown with reference to the earthquakes which have recently affected Central Italy.