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Quantification of crustal deformation based on analysis of Persistent Scatterer Interferometry of W-Crete

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Persistent Scatterer Interferometry (PSI) is a powerful tool for detecting crustal deformation processes such as strain accumulation along convergent margins during the interseismic period. This technique allows the detection of vertical motion of the Earth's surface with millimeter accuracy at wide spatial coverage of hundreds of km^2. Persistent Scatterers (PSs) are phase stable point scatterers with a consistent and strong reflectivity observed over a long time (Ferretti et al., IEEE GRSS, 2001). We used the PSI Wide Area Product (PSI WAP) of the German Aerospace Center (DLR) for the detection of the vertical surface motion of the western part of the island of Crete. Therefore, we used data of the radar satellites ERS-1 and ERS-2 of the European Space Agency (ESA). The western part of the island of Crete is covered by 39 Synthetic Aperture Radar (SAR) images acquired between 1992 and 2000 of the ERS Track 193.
The island of Crete is located adjacent to the Hellenic subduction zone, which is currently one of the most seismically active regions in Europe. Historical records document a devastating earthquake on July 21st, 365 A.D. near the island of Crete. (M > 8.5, Stiros, Quat. Int., 2010). The event resulted in coseismic uplift of the western part of the island of Crete of up to 9 m (Pirazolli et al., JGR, 1996). By analyzing the vertical surface motion of SW-Crete during the interseismic period we are able to determine whether the hypocenter of the 365 A.D. earthquake was located on the subduction interface or on a fault in the overriding plate (Shaw et al., Nature Geosci., 2008). If the 365 A.D. earthquake occurred along the subduction interface, then the region (W-Crete) experiencing coseismic uplift should undergo interseismic subsidence and vice versa (Hyndman & Wang, JGR 1993).

The results of the PSI WAP analysis for W-Crete indicate uplift of the SW corner of the island of up to 5 mm/yr in the line-of-sight (LOS). The central part of W-Crete is more or less stable, whereas the eastern part of W-Crete is subsiding with up to 5 mm/yr (LOS) relative to the region farther west. Thus, our preliminary results show the same sense of motion for the interseismic period as for the coseismic event of 365 A.D. These results are inconsistent with vertical motion during the earthquake cycle of the subduction interface model of Hyndman and Wang (JGR 1993). We also confirm that the 365 A.D. earthquake probably did not occur along the main plate interface. Our data are more consistent with elastic strain accumulation along a fault in the overriding plate. Therefore it is likely that the 365 A.D. earthquake may have occurred along the Hellenic Trench, a major reverse fault in the Aegean microplate, located 25 km offshore SW-Crete. The existence of a geodetic interseismic signal implies active strain accumulation that is likely to result in the next large earthquake either on the plate interface or an upper-crustal fault.