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Monitoring surface deformation by a combination of GPS, InSAR and terrestrial gravity measurements

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Our present knowledge of the surface deformation of the Earth is still discontinuous both in the temporal and spatial domain. A detailed knowledge of the crustal deformation at fine scales is a fundamental issue for achieving an increased understanding of the processes acting at the surface of the Earth as well as in its interior. For example, monitoring the surface deformation before and after earthquakes is essential for providing important insights into the evolution of the strain accumulation phase, transients, and the seismogenic cycle. We present a multidisciplinary approach that combines observations derived from continuous Global Positioning System (GPS), Interferometric Synthetic Aperture Radar (InSAR) and terrestrial gravimetry in combination with times series of local environmental parameters to estimate subsidence in the Southeastern Po Plain. The simultaneous availability, at a few stations, of several geodetic observation techniques such as GPS, gravity and InSAR allows for validation of the individual time series. The combination takes advantage of the complementary strengths of each technique, by overcoming the limitations inherent in each single technique alone. The combination of velocities derived from the GPS and gravity data, further complemented by the results of the InSAR Permanent Scatter technique allows us to monitor continuously in space and time vertical crustal movements. This high-density information is of major importance for understanding the processes responsible for the observed deformation. Here, long-term trends were derived enabling us to map the behavior of subsidence (even exceeding 20 mm/yr) with high spatial resolution in the southeastern Po Plain. The uplifting behavior of the Apennines chain

bordering the Po Plain is identified together with a narrow zone separating the contrasting vertical crustal movements.