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Ground deformation at Campi Flegrei caldera using long water pipe tiltmeters and sea level gauges

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Campi Flegrei is a caldera complex located in the Campanian plain region of southern Italy, 15 km west of the city of Naples, and forms part of the Roman co-magmatic province which is a volcanic chain that characterizes the western coast of the country. The Campi Flegrei caldera was generated by several collapses produced by strong explosive eruptions. The main caldera at Campi Flegrei is 12 – 15km across and its rim is thought to have been formed during the catastrophic eruption, occurred 39 ky ago ca. which produced a deposit referred to as the Campanian Ignimbrite. Campi Flegrei area periodically experiences significant unrest episodes which include ground deformations, the so-called "bradisismo", recorded both by marine terraces, archaeological record and harbour structures. Following the last eruption (Monte Nuovo, 1538) a general subsidence has been interrupted by episodes of uplift, the most recent of which occurred in 1970-72 and 1982-84. In the past decade subsidence has been arrested and has been replaced by intermittent episodes of inflation with short time duration and various maximum amplitude. They occurred in 1989, 1994, 2000, 2004, 2005-06, 2009 and 2011 with duration of few months and maximum amplitude ranging between 3 and 11 cm.
Since 2008 an array of water-pipe tiltmeters with lengths between 28 m and 278 m in tunnels on the flanks of the region of maximum inflation has been installed to avoid problems common to the traditional tiltmeters. The tiltmeters record inflation episodes upon which are superimposed local load tides, with amplitudes roughly an order of magnitude greater than the solid Earth body tides. In addition to the tides, the tiltmeters record a line spectrum of seiches in the Bay of Naples and in the Tyrrenian sea. We use data recorded by three tide gauges in the Bay of Pozzuoli to compare water pipe data with sea level to extract astronomical tidal components and seiches periods particularly between 20 minutes and 56 minutes that could constitute local loading frequencies recorded clearly by tide gauges and tiltmeters. The comparison between these two kind of data enables a more sensitive definition of the low level uplift with an accuracy of 1% for nanoradiant tilts in the period range 10 minutes to 10 hours with a long term tilt stability of approximately 0.1 μradian/yr