MIXED SEISMIC/ASEISMIC SLIP TRANSIENT IN A SEISMIC GAP REGION REVEALED BY DENSE GEODETIC MEASUREMENTS: THE 2011-2014 POLLINO RANGE, SOUTHERN ITALY, EARTHQUAKE SWARM SEQUENCE

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In actively deforming region, crustal deformation is released episodically by earthquakes and through a number of different transient aseismic phenomena, both post-seismic or spontaneous. The mode in which a fault releases the accrued tectonic strain during the interseismic phase is a fundamental question in seismotectonics. In addition, the estimation of the balance between geodetic and seismic release has important implications also for seismic hazard assessment. In recent years, the increasing availability of high-resolution geodetic data, such as continuous Global Positioning System (GPS) measurements and short repeat-time Synthetic Aperture Radar (SAR) images, have greatly increased our capability to discover a number of different transient aseismic slip episodes, which in some cases are the primary mode in which the accumulated tectonic stresses are released. While examples of post-seismic transients are well documented in different tectonic contexts, most of the well documented sources of spontaneous transient aseismic phenomena come from subduction zones (such as Japan, Cascadia and New Zealand). Other type of transient aseismic events has been observed in volcano active region and in association with earthquake swarms.

Here, we study the 2011-2014 Pollino, southern Italy, earthquake swarm sequence located within the Pollino seismic gap, by analysing the surface deformation using Global Positioning System (GPS) and Synthetic Aperture Radar (SAR) data. The Pollino swarm sequence, recorded with more than 6000 events, provides an unprecedented example of both seismically and geodetically observed normal faulting earthquake swarm. The sequence started at the end of 2010, lasted until the beginning of 2014, and was characterized by a M_W 5.1 main shock on 25 October 2012. The relationship between the spatial dimensions and seismic moment release by the swarm sequence and ETAS modelling analysis of the seismicity, has led to hypothesize that a transient forcing was acting during the Pollino swarm. However, the nature of this transient forcing (which may range from aseismic creeping to diffusion of pore pressure pulses or even to fluid migration within the crust), that is critical to reduce uncertainties in seismic hazard assessment due to seismic swarms, has not been unravelled by previous studies, that lack verifying if a transient aseismic slip episode actually accompanied the swarm. For this reason, geodetic measurements proved to be a crucial data set for understanding the 2011-2014 Pollino swarm sequence.

We identify a transient aseismic slip accompanying the seismic sequence. In particular, GPS and InSAR time series clearly show a transient displacement starting before the 25 October 2012 M_W 5.1 main shock. The surface displacement, mainly in the E-W direction, lasting several months from July 2012 to mid-2013, is well seen at the nearest continuous GPS station MMNO, with a cumulative displacement up to about 10 mm in the W direction. A similar signal is also observed in the other nearby GPS stations, although with smaller magnitudes depending on the relative distance from the seismic swarm. On the contrary, the daily and high-rate GPS solutions only show subtle coseismic offsets (< 1-2 mm) associated with the main shock event. This transient displacement is even more clearly visible in the InSAR time series which are available in the area of maximum deformation. The cumulative displacement reaches in this case about, 60 mm in the line-of-sight (LOS). More in details, geodetic time series show that the transient slip started around 3-4 months before the main shock, evolving through time with phases of acceleration, which correlate with the frequency of earthquakes. The moment

release by transient slip is estimated to be M_W 5.5, significantly larger than the seismic moment release. The large geodetically derived moment compared with seismic release suggests that the majority of the slip is likely to be aseismic. Our findings indicate that crustal deformation in the Pollino gap is accommodated by infrequent moderate earthquakes accompanied by significant aseismic slip episodes that release most of the accrued strain in the interseismic period. If large earthquakes (M > 6.5) occur in the Pollino gap, their recurrence is probably increased compared to adjacent regions of the southern Apennines, explaining the absence of "large" macroseismic intensities, and providing therefore new clues about the seismic/aseismic modes of seismic moment release in this area.