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Kinematics of the Central Mediterranean Plate Boundary, Internal Deformation of Sicily and Interseismic Strain Accumulation Across the Messina Straits

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The kinematics and geodynamics of the Sicily-Calabria subduction system is still matter of debate, mainly due to ambiguities in constraining the motion of Sicily and the Ionian Sea in the framework of the slowly NW-ward Nubia-Eurasia pate convergence. Recently, Serpelloni et al. (2007), using GPS and seismological data (i.e., focal mechanisms and instrumental catalogs), suggested an independent motion of Sicily, that, rotating counter-clockwise with respect to Eurasia accommodates extension of the Sicily Channel and eastward increasing compressional strains along the southern Tyrhhenian seismic belts, up to the Central Aeolian Islands. In this scenario, the relative motion between a “rigid” Sicily block and the Ionian-Calabrian system is accommodated through a complex transform boundary in NE-Sicily, where compressional and strike-slip deformation occur across the Gulf of Patti and extensional deformation occurs across the Peloritani and Messina Straits (see also Argnani et al., 2007). The rapid increase of continuous GPS stations in the study area, together with new integration of GPS surveys performed from early ’90 in Sicily and Calabria, is going to add new fundamental constraints to our comprehension of this complex region, both in terms of plate kinematics and elastic strain accumulation across active faults, responsible for

some of the largest earthquakes of the Mediterranean area.

In this work we present a new velocity field, obtained by analyzing continuous GPS (CGPS) stations operating in the Mediterranean area (updated to September 2007) and epoch GPS (EGPS) stations in the 1991-2006 time span, particularly denser in the Iblean plateau and across the Messina Straits. GPS data have been processed with the GAMIT/GLOBK software, and position time-series have been analyzed to compute absolute velocities in the IGS05 reference frame, which have been subsequently rotated into an Eurasia fixed frame. For CGPS stations, we modeled seasonal signals (annual and semi-annual components) and jumps due to stations configuration changes. Station rate errors have been computed accounting for both white and colored noise models for both CGPS and EGPS stations. Common mode errors for the CGPS stations have been also modeled and removed, using a principal component analysis approach. While CGPS networks provide regional constraints on present-day plate kinematics, the analyzed local non-permanent networks provide fundamental data to investigate the rates of interseismic loading across major fault systems. In particular, the analysis of the Iblean GPS network reveals the occurrence of active shortening, at a rate of about 2.0 mm/yr, along a N20°W direction, between Noto and the Catania Plain, highlighting significant internal deformation within the Sicily block. The local network in NE-Sicily indicates a transition from N-S contraction extending westward from the central Aeolian (with rates up to -430 nanostrain/yr), to NW-SE extension ($\leq$ 130 nanostrain/yr) across the Peloritani Mountains and the Messina Straits. It is worth noting that any effort of studying the kinematics of crustal deformation of this area, including rates of interseismic loading across the Straits, is challenged by the fact that several active tectonic structures (including the Vulcano and Tindari-Giardini faults and the Calabrian subduction system) likely contribute to the observed GPS velocity gradients across the Straits. In order to investigate these effects, we develop an elastic block model of the Sicily-Calabria region that accounts for tectonic block rotations and elastic strain accumulation on regional fault systems. The model reveals that interseismic slip-rate estimates of crustal faults in the area are strongly affected by the assumed locking width of the Calabrian subduction interface. Minimal locking of the subduction thrust is required to produce models consistent with geologically derived, 1-2 mm/yr slip rates of the Messina-Calabria normal faults.