Geophysical Research Abstracts
Vol. 12, EGU2010-12444, 2010
EGU General Assembly 2010

Abruzzo (Italy) earhquakes of April 2009: heterogeneous fault slip models and stress transfer from accurate inversion of Envisat-InSAR data

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The seismic sequence occurred in the Abruzzo Apennines near L'Aquila (Italy) in April 2009 caused extensive damage and a large number of casualties (close to 300). The earthquake struck an area in the Italian Apennines chain where several faults, belonging to adjacent seismotectonic domains, create a complex tectonic regime resulting from the interaction among regional stress build-up, local stress changes caused by individual earthquakes and visco-elastic stress relaxation. Understanding such complex interaction in the Apennines can lead to a large step forward in the seismic risk mitigation in Italy. The Abruzzo earthquake has been exceptionally well recorded by InSAR data, much better than the first Italian earthquake ever recorded by satellites, namely the 1997 Umbria-Marche one. Envisat data for the Abruzzo earthquake are in fact very clear and allow an accurate reconstruction of the faulting mechanism. We present here an accurate inversion of vertical deformation data obtained by ENVISAT images, aimed to give a detailed reconstruction of the fault geometry and slip distribution. The resulting faulting models are then used to compute, by a suitable theoretical model based on elastic dislocation theory, the stress changes induced on the neighbouring faults. The study of the subsequent mainshocks of the Abruzzo sequence clearly evidence the effect of static stress changes consecutively triggering the subsequent mainshocks. Furthermore, this analysis put in evidence the seismotectonic domains that have been more heavily charged by stress released by the Abruzzo mainshocks. The most important faults significantly charged by the Abruzzo sequence include the Sulmona and Avezzano tectonic domains, including also the area, West-Southwest to the Avezzano domain, where a large earthquake occurred in 1394. Taking into account the average regional stress build-up in the area, the positive Coulomb stress changes caused by this earthquake can be seen as anticipating the next earthquakes in the neighbouring domains of 10-20 years.