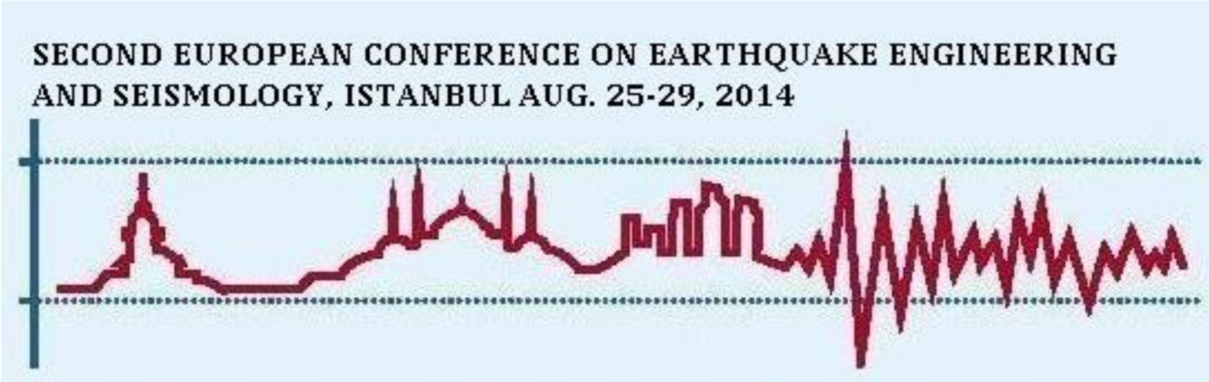

GROUND MOTION PREDICTION IN THE VOLCANIC REGION OF MT ETNA: EMPIRICAL RELATIONS AND SEISMIC SCENARIOS FROM SYNTHETIC SIMULATIONS.

Horst LANGER, Giuseppina TUSA, Luciano SCARFI and Raffaele AZZARO[1]

The prediction of strong ground motion is hampered by the lack of available instrumental data being strong earthquakes – fortunately – rare events. This problem is often bypassed culling together strong motion data recorded in various regions where strong earthquakes have occurred, even though they belong to different seismotectonic regimes. This approach is strongly questionable, in particular in a volcanic area like Mt Etna with very specific geological and tectonic conditions. In the framework of the UPStrat-MAFA project we have tackled the problem making use of synthetic ground motion. This offers the possibility to close the gap for those earthquakes for which no instrumental data is available or does not correspond to the standards we may request for our needs. For this purpose we exploit the rich amount of weak motion data available in the area of Mt Etna. This material covers a magnitude range from very small earthquakes up to ML 4.8 recorded by the seismic network of INGV – Osservatorio Etneo during the time span 2006-2012 (Fig 1). The events occurred at focal depth ranging from ca 30 km to very shallow (H ~ 1 km).

In a first step we use the weak motion data for the “Calibration of the Input”, i.e., the identification of the parameters relevant for simulations, such as those governing the effects of wave propagation (e. g., attenuation, geometrical spreading). For this purpose we investigated on empirical laws for the attenuation of ground motion parameters of our weak motion data set, distinguishing between events with depth larger than 5 km from those occurring at a shallower level. In fact, we observed that the former events tend to be richer in high frequencies than the latter ones. The latter are of particular interest on Mt. Etna as shallow earthquakes are rather frequent and, despite their moderate magnitude (Mmax ca 5), may cause severe damage or destructions to the villages located on the flanks of the volcano. In a first step, we carried out a sequence of simulations in order to reproduce these empirical ground motion relations by applying the complex seismic source modeling as proposed by Motazedian and Atkinson (2005) and realized in a computer code called “EXSIM” (see Boore, 2009) (Fig. 2). In the concept the seismic source is supposed to be composed of elementary subfaults, and the seismic signal arriving at the receiver is represented as the sum of the contribution of the each element, applying appropriate corrections for amplitude decay and time delay. The concept overcomes limitations of the point source and allows realistic description of ground motion in the near-field of geometrically extended sources. It allows to apply the simulations to the largest earthquakes occurring in the area of Mt Etna, characterized by surface fault ruptures up to 7 km long, by comparing the observed macroseismic field to the synthetically generated maps showing the distribution of expected numerical ground motions parameters, such as PGA, PGV or Housner Intensity.

For our weak motion data set, simulations confirm earlier findings of a low stress drop for very shallow events (ca 5 bar) and higher stress drop for the deeper earthquakes (some 50 bars in terms of the source model used here). We show some examples for typical shallow damaging events occurring on Mt Etna, such as the 1914 Linera earthquake (M over 5) (Fig. 3) and the 2002 Santa Venerina event (M_L 4.4). For comparison, we also analysed the 1818 earthquake (M 6.2), the only event known to be

[1] Istituto Nazione di Geofisica e Vulcanologia – Osservatorio Etneo, Catania, Italy, langer@ct.ingv.it

occurred at a crustal depth in the Etna region, showing characteristics similar to the regional seismicity (i.e. tectonic earthquakes). Soil amplifications are accounted for on the base geotechnical parameters measured for the lithological units found on Mt Etna.

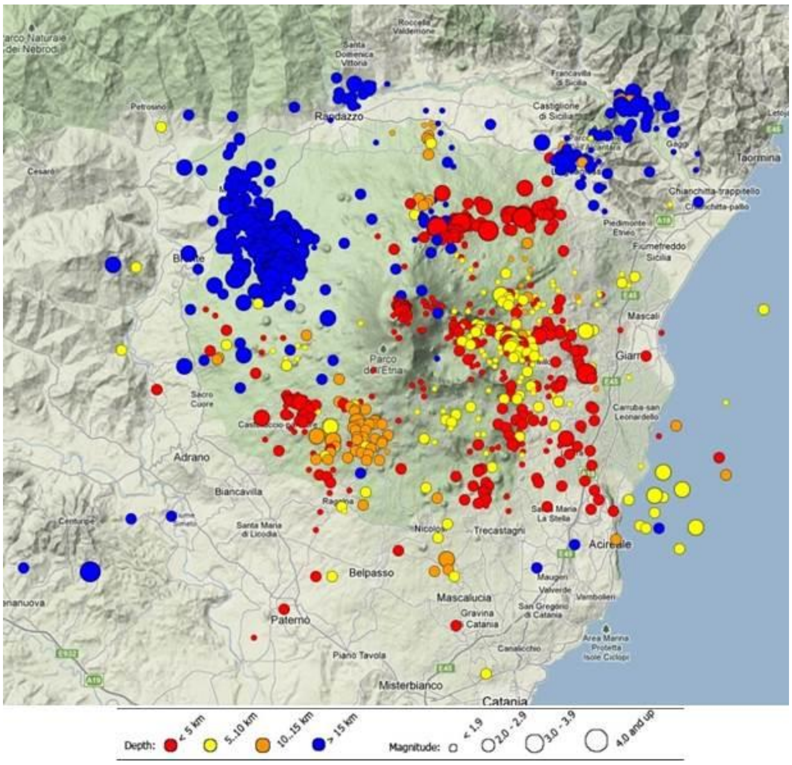

Fig 1. Seismicity patterns in the Mt Etna region from 2006 to 2012 (instrumental data revised from INGV staff analysts)

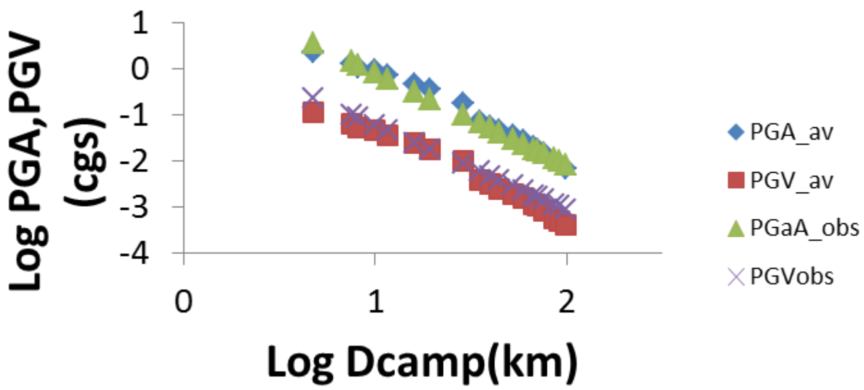

Fig. 2. Observed and simulated decay laws (for shallow event, M=3.3)

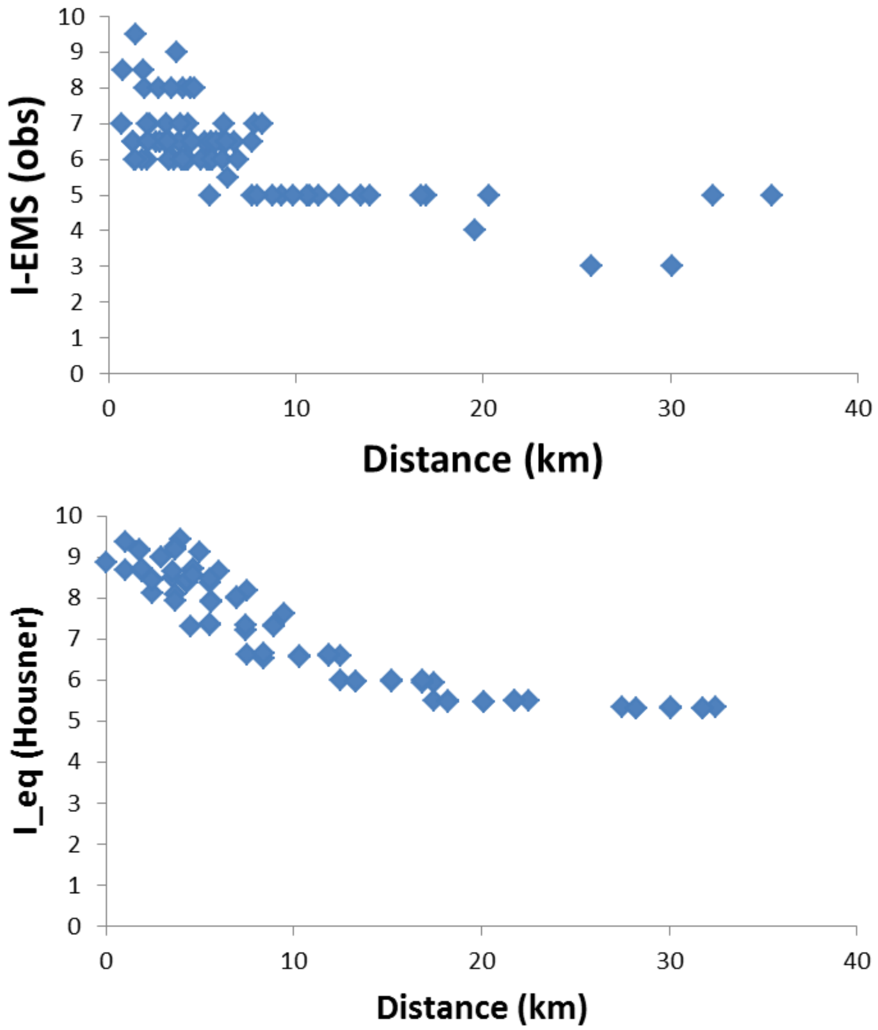

Fig 3. Pattern of the intensity attenuation for the Mt Etna 1914 M=5. The equivalent Intensity I_eq is obtained from the simulated Houser Intensity using the relation I_eq = 1.41 ln ($I_{Housner}$)+7.98.

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