Appendix: The set up of the forecasting ETAS model

The ETAS model estimates the perturbation of the seismicity rate \( \lambda \) in space and time induced by previous earthquakes through the equation

\[
\lambda(t, x, y, m/H_t) = \left[ \mu u(x, y) + \sum_{T_i < t} \frac{Ke^{\alpha(M_i-M_{\text{min}})}}{(t-T_i+c)^p} \right] \frac{C_{d,q}}{[r_i^2 + (d \cdot e^{\gamma(M_i-M_{\text{min}})^2})^q]} \beta e^{-\beta(m-M_{\text{min}})}. \tag{1}
\]

where \( H_t = \{T_i, X_i, Y_i, M_i\}, \ T_i < t \) is the observation history up time \( t \), \( M_{\text{min}} \) is the minimum magnitude of catalog, \( K, c \) and \( p \) are the parameters of the modified Omori Law [Utsu, 1961] defining the decay in time of short-term triggering effect, \( \alpha \) defines the dependence of triggering capability by magnitude of an earthquake, \( d \) and \( q \) define the spatial distribution of triggered events (\( C_{d,q} \) is the normalization constant) as a function of the distance \( r_i \) between a general location \((x, y)\) and the epicenter of the \( i \)-th earthquake \((X_i, Y_i)\), \( \gamma \) takes into account the correlation between the aftershocks area and the magnitude of triggering event, and finally \( \beta = b \cdot \ln(10) \) is the parameter of the Gutenberg-Richter law [Gutenberg and Richter, 1944], defining the distribution of magnitudes.

The parameters \( \mu, K, c, p, \alpha, d, b \) of equation 1 reported in the text were estimated through the iteration algorithm developed by Zhuang et al. [2002] that provides also an estimation of the spatial distribution \( u(x, y) \) of the background events. We impose a priori the parameter \( q = 1.5 \) in order to have a spatial decay that mimics the co-seismic stress interaction [cf., Hill et al., 2003]; this choice is also justified by the recognized trade-off between parameters \( q \) and \( d \), that is different pairs of \( q \) and \( d \) values provide almost the same likelihood of the model [Kagan and Jackson, 2000]. The whole model was parameterized by using about 4 years (from April 16th 2005 to April 4th 2009) of seismicity, recorded into official INGV bulletin (http://iside.rm.ingv.it) and affecting a larger area [12.9-13.9E, 41.8-42.8N] respecto to region struck by the 2009 L’Aquila sequence. The starting time of learning dataset (April 16th 2005) marks a strong improvement of Italian seismic network with a resulting decreasing of threshold detection magnitude up to \( M_l = 1.5 \). In this time period the catalog reports 640 events in the magnitude range 1.5-4.0. The estimated parameters are: \( \mu = (0.18 \pm 0.01) \) day\(^{-1} \), \( k = (0.033 \pm 0.004) \) day\(^{p-1} \), \( p = 1.2 \pm 0.05 \), \( c = (0.03 \pm 0.01) \) day,
\( \alpha = 1.5 \pm 0.1, \ d = (0.8 \pm 0.1) \ \text{km}, \ b = 1.0 \pm 0.05, \ \gamma = 0.0 \pm 0.1. \) All of them were kept fixed for whole duration of experiment together with the spatial distribution \( u(x, y) \) of background events. Immediately after the \( M_w 6.3 \) event, the completeness magnitude increases for few days. We account for it using some empirical adjustment of the triggering effects of the missed events above \( M=1.5. \)

**References**


