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Non-extensive thermodynamics applied to global seismicity before and after the Sumatran mega-earthquake.

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The global earthquake frequency-magnitude distribution [EFMD], along with the inter-event time and distance distribution are among the long-standing statistical relationships of seismology. Recently the effect of the 2004 Sumatran mega earthquake on the global frequency-magnitude distribution was presented by Main et al. (2008), who showed a straightening of the gamma distribution which describes the global EFMD. Here we use a generalization of classical Boltzmann-Gibbs (BG) statistical mechanics, called non-extensive statistical mechanics [NESM, Tsallis, 2009], recently used to study natural hazards (Vallianatos, 2009) and plate tectonics (Vallianatos and Sammonds, 2010), to describe the global earthquake frequency–magnitude distribution, the inter-event time and distance distributions and interpret the influence of the Sumatran earthquake with these. At a phenomenological level, we find that the effects of the Sumatran earthquake are fully described by NESM and as a hazard assessment tool NESM has the potential to make quantitative forecasts. We find that the seismic moment distribution and the earthquake inter-event time distribution reflect a sub-extensive system, where long-range interactions are important, and that non extensive q-values are not affected by the time or location of mega-earthquakes. We find the seismic moment distribution and the inter-event time distribution yield thermodynamic q-values of qM=1.6 and $q\tau$=1.52, respectively, while the inter-event distance distribution, with qD=0.29, supports the conclusion of non-extensive "spatio-temporal duality" [Abe, S., and N. Suzuki, 2003; 2005). The last observation suggests that global seismicity (with m>5.0) described by the q-value triplet (qM, $q\tau$, qD)=(1.6, 1.52, 0.29) is independent from the influence of seismic mega events.

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