# Early radiation and final magnitude : insights from source kinematics

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What does a rupture know about its fate when it starts developing on the fault plane, if it will rapidly stop against a barrier or grow up to a large earthquake ? Early measurements performed in the first seconds of P or S wave-trains indicate that the rupture is able to distinguish if it will implode in a small quake rather than extending up to hundreds of kilometers.

Few seconds (two to four usually) of observation at a given receiver define a space scale on the fault plane, with respect to which we ought to compare the size of the event. Such a characteristic length is associated to a magnitude threshold. The ruptures with size below the threshold have stopped in the observation time and any scaling is deterministic; the events with size above the threshold provide only a partial image of the rupture and the scaling, if it exists, is predictive. Hence, one should pay attention to combine the deterministic scaling with the prediction, in the former part the scaling can be affected from both the increase in the rupture area and any dynamic/kinematic parameter, in the latter case any increase of the selected parameter with the magnitude is ascribed to changes in the rupture dynamics and/or kinematics.

From inspection of a large set of Japanese events, we investigate the scaling of the early radiated energy, inferred from the squared velocity integral (IV2) with the final magnitude of the event. We found that the separation between the deterministic part and the prediction is at about M=5.8 and that the energy can allow for real-time magnitude estimation only for events with size lower than 5.8. However, by normalizing IV2 for the rupture area, the initial slip scales with the magnitude between $4 < M < 7$ following the expected scaling laws. We show that the ratio between the squared peak displacement and IV2 is a proxy for the slip following the same scaling but it can be directly derived from the data, without any assumption on the rupture area. We argue that the slip is the kinematic parameter which can be indicative of the size of an earthquake at least up to magnitude 7 and any scaling relationship between a proxy for the initial slip and magnitude can be used for early warning applications, when integrated in a probabilistic, evolutionary approach.

We show an application to the recent 2007, March 25, Noto-Anto earthquake, which is not included inside the catalog which provided the scaling law.