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Don't say the P word? New horizons in earthquake Prediction

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Past failures to predict large earthquakes have resulted in mainstream seismology rejecting the very basic idea of earthquake prediction. Pessimism in our ability to predict large earthquakes now dominates the field, the main criticisms being that: (1) different kinds of precursors have been proposed but none are observed systematically and (2) observed patterns are undistinguishable from the normal behaviour of seismicity. Here I present the Non-Critical Precursory Accelerating Seismicity Theory (NC PAST), which is currently the only physical framework to predict that different precursory paths are possible before large earthquakes, with possible coupling of different patterns or non-occurrence of any (answering criticism #1). This is described by a logic tree defined from the combined probabilities of occurrence of the mainshock at a given stress state and of precursory silent slip on the fault. Patterns considered by the NC PAST are foreshocks (medium-term acceleration and short-term activation), quiescence, doughnut patterns and event migration. Revisiting the concept of elastic rebound, the NC PAST is diametrically opposed to the common view that the crust is a complex system where event triggering dominates at all scales. Instead, small events are viewed as passive tracers of the incoming mainshock, which leads to the second pillar of the NC PAST being the crucial role of microseismicity in the emergence of reliable precursory patterns (answering criticism #2). I compare the theoretical results to the time series observed prior to the 2009, Mw = 6.3, L'Aquila, Italy earthquake and show that this mainshock was preceded by coupling of quiescence and accelerating seismic release, followed by activation. The pattern is statistically significant only when events with magnitude $M \leq 3.3$ are included for activation and $M \leq 2.2$ for quiescence and acceleration. Studies that claim that precursors are unreliable commonly use a higher magnitude cutoff (e.g., M = 4). Although extensive work still remains to validate or invalidate the NC PAST, this novel approach provides guidelines for future research on earthquake predictability, which is far from the dead end advocated by many. By unifying and categorizing seismic patterns, i.e. by making specific predictions for the space-time-rate characteristics and couplings of these patterns, the NC PAST offers the basic physical and statistical tools required to test its underlying hypotheses.