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Temporal changes in the cumulative piece-wise gradient of a variant of the Gutenberg-Richter relationship, and the imminence of extreme events

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It is generally found that the relative frequencies of occurrence of earthquakes of different magnitudes in seismogenic zones have a power law distribution. For a long-term dataset, the overall slope of this logarithmically transformed distribution is usually indicated by a best-fit straight line, the *b*-value, which is stable, and normally lies between 0.8 and 1.2, the actual value depending on the region examined, and the threshold selected for data completeness. The linearity of the distribution can be used to make statistical inferences about the potential for larger events over the long run, and with appropriate reservations, may even be extrapolated to magnitudes that are beyond recent experience. However, the same data can also be viewed over shorter intervals in terms of an empirical piece-wise distribution, with relative frequencies of occurrence at adjacent magnitude steps controlling the local slope of the distribution. An emergence, through time, of an excess number of lower magnitude earthquakes causes temporal changes to appear in the low-end gradient of this distribution. A marked excursion of this kind, away from the overall trend for the particular zone, may be indicative of an imminent, larger event. On two separate occasions, in 1982 and 1997, such temporal variations were seen in the magnitude distributions of sequences of events near Tobago, West Indies, and used to anticipate subsequent damaging mainshocks. Given a suitable dataset, the recognition of temporal departures from overall linearity of the magnitude-frequency relation may thus provide an evidential element that can contribute to earthquake forecasting. This phenomenological approach was

used to analyse the NEIC global dataset of earthquakes of magnitude 6.1 and above for the period 1973-2003 to explore its wider applicability. Trends in the piece-wise gradients of the global data were interpreted as pointing to an imminent great earthquake, perhaps exceeding magnitude 8.5; such an event did occur shortly afterwards in the form of the great Sumatran earthquake of 2004/12/26. Following that event, global magnitude production continued to exhibit sharp imbalances in the lower magnitude bins, indicating that another similar event was likely. The second Sumatran earthquake on 2005/03/28 satisfied that projection. Since that time, magnitude production imbalance persists and the global system is considered to be poised to output an earthquake or earthquakes in the magnitude range 8.6-9.0 or even larger.