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Foreshocks as a powerful earthquake precursor

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The superiority of foreshock activity as compared to other candidate earthquake precursors relies on that (i) foreshocks occur exactly in the area which is highly stressed before the main shock and (ii) the foreshock 3-D distributions in the space, time and size domains very likely follow some certain patterns. However, in spite of the progress noted so far as regards the precursory value of foreshocks, there are still open some very important issues. The first regards the foreshock rate, that is why some main shocks are reportedly preceded by foreshocks while others do not. Of relevance is also the question if foreshock incidence concerns not only large main shocks but also moderate or even small main shocks. The second important issue refers to the 3-D patterns that govern foreshock activity. Have all foreshock sequences the same patterns? Are such patterns dependent on the main shock size and faulting type? Importantly, is it possible to use 3-D foreshock patterns for the discrimination of foreshocks from other types of spatiotemporal seismicity clusters, like swarms and aftershocks, and utilize such patterns for the prediction of the main shock? We examine these fundamental issues based on the examination of seismicity from several earthquake areas of the Earth, including Chile, Japan, Greece and Italy. The first finding is that the foreshock rate depends not only on geophysical conditions but also on the monitoring capabilities, and the associated earthquake catalogue completeness, as well as on the foreshock definition which usually is restricted in narrow spatiotemporal limits, thus artificially eliminating foreshock events. Therefore, the foreshock rate very likely is higher than suggested so far. A second important finding is that there is universality in the space-time-size foreshock patterns for a variety of earthquake sequences from different seismotectonic regimes and for wide magnitude spectrum for the main shocks.