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GLOBAL HIGH-RESOLUTION EARTHQUAKE FORECASTS AND THEIR TESTING

Since 1977 we have developed statistical short- and long-term earthquake forecasts to predict earthquake rate per unit area, time, and magnitude. The forecasts are based on smoothed maps of past seismicity and assume spatial and temporal clustering.

Our recent program forecasts earthquakes on a 0.1 degree grid for a global region 90N--90S latitude. We use the PDE catalog that reports many smaller quakes (M>=5.0). For the long-term forecast we test two types of smoothing kernels based on power-law and on the spherical Fisher distribution. We employ adaptive kernel smoothing which improves our forecast in seismically quiet areas.

Our forecasts can be tested within a relatively short time period since smaller events occur with greater frequency. The forecast efficiency can be measured by likelihood scores expressed as the average probability gains per earthquake compared to spatially or temporally uniform Poisson distribution. The other method uses the error diagram to display the forecasted point density and the point events.

As an illustration, we display several short-term forecasts, made before and after the M9.1 Japanese Tohoku earthquake of 2011/3/11. A M7.5 foreshock occurred two days before the mainshock. Due to this, the short-term rate immediately preceding the Tohoku event was about 100 times higher than the long-term rates. After the Tohoku earthquake the rate increased by a factor of 1000. One month later, the rate remained about 100 times higher than the long-term rate.

The major issue for the long-term seismicity forecast in the Tohoku area was the maximum earthquake size. Whereas 2009 Japan's seismic hazard map predicted the maximum magnitude of 8.0 or less, the estimate based on seismic moment conservation principle anticipated the maximum magnitude of the order M8.6--9.6.

Is the focal area of the Tohoku earthquake "destressed", making the probability of a new large event lower in this area, though it can increase in nearby zones? Our results suggest that this may not be the case. We find that earthquakes as large as M>=7.5 often occur in practically the same area as previous large events.