Comparison of ETAS parameter estimates across different global tectonic zones

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1 Data

Bird's tectonic zones (Bird, 2003) based on the PB2002 plate boundary model:

1. active continent.
2. slow spreading ridge and oceanic transform.
3. fast spreading ridge and oceanic transform.
4. trench, including subduction zones and oceanic convergent boundaries and earthquakes in outer rise.

The data used for our analysis were retrieved from the PDE (Preliminary Determination of Epicenters) and CMT (Centroid-Moment-Tensor) databases. The time window is January 1, 1973 to December 31, 2006. Only shallow earthquakes (0 to 70 kilometers) are considered. The shallow events constitute approximately 80% of all events in the catalog. A lower magnitude cutoff of M0 = 5.0 is used.

2 Model

Ogata (1998) extended the the ETAS model to illustrate the space-time-magnitude distribution of earthquake occurrences:

$$\lambda(t, x, y|\mathcal{H}_t) = \mu + \sum_{i:t_i<t} g(t - t_i, x - x_i, y - y_i, m_i), \tag{2.1}$$

with triggering function

Summary of data of each tectonic zone				
Zone	Area (x 10^{7} km^2)	Proportion of area	No. of events in zone	No. events in zone / total no. of events
1	3.36	6.58%	6728	16.6%
2	1.58	3.09%	3028	7.47%
3	0.844	1.65%	2574	6.35%
4	1.52	2.98%	26125	64.5%
0	43.8	85.8%	2049	5.06%
Total	51.0	100%	40504	100%

Table 1: Summary statistics of each zone.

$$g(t-t_i, x-x_i, y-y_i, m_i) = \frac{K_0}{(t-t_i+c)^{-p}}\left(\frac{(x-x_i)^2+(y-y_i)^2}{e^{a(m_i-M_0)}}+d\right)^{-q}. \quad (2.2)$$

3 Results

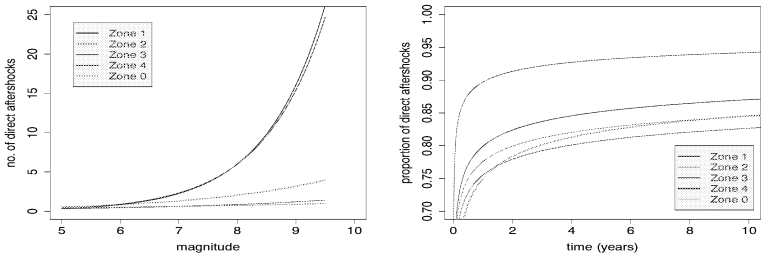

Figure 1: Left: the no. of direct (1st-generation) aftershocks vs. magnitude. Right: the time to contain a certain proportion of direct aftershocks.

4 Conclusion

Zones 1 and 4 have the highest seismicity rates and the most intense estimated triggering functions. Zones 2 and 3 have lower background rates, their triggering functions decay more sharply spatially, and their parameter estimates consistent with swarms rather than mainshock-aftershock clustering.