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SPONTANEOUS AND TRIGGERED EARTHQUAKES IN DIVERSE TECTONIC ZONES OF THE GLOBE

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In this project we extended existing branching models for earthquake occurrences by incorporating potentially important estimates of tectonic deformation and by allowing the parameters in the models to vary across different tectonic zones. We used these models to develop earthquake forecasts (i.e., maps of expected rate of occurrences of earthquakes above a given threshold magnitude) in several different categories: long-term (e.g., 5+ years, emphasizing spontaneous mainshocks) based on tectonic deformation and long-term clustering as recorded in catalogs; and short-term (e.g., daily, with emphasis on triggered seismicity). After initial retrospective testing, those which appear to have merit are being offered to CSEP for formal prospective testing. We developed two global forecast based on two catalogs – the CMT and PDE. Figs. 1-3 display examples of our forecasts.

Below we list publications (with appropriate SCEC publication numbers) and abstracts, related to the topic of this proposal.

PUBLICATIONS:

1. Zhuang, J., A. Christophersen, M. K. Savage, D. Vere-Jones, Y. Ogata, D. D. Jackson, 2008. Differences between spontaneous and triggered earthquakes: their influences on foreshock probabilities, *J. Geophys. Res.*, **113**(B11), B11302, DOI: 10.1029/2008JB005579
2. Kagan, Y. Y., 2009. On the geometric complexity of earthquake focal zone and fault systems: A statistical study, *Phys. Earth Planet. Inter.*, **173**(3-4), 254-268, DOI: 10.1016/j.pepi.2009.01.006, SCEC #1256;
3. Kagan, Y. Y., 2009. Testing long-term earthquake forecasts: likelihood methods and error diagrams, *Geophys. J. Int.*, **177**(2), 532-542, SCEC #1252.

4. Kagan, Y. Y., P. Bird, and D. D. Jackson, 2009. Earthquake Patterns in Diverse Tectonic Zones of the Globe, accepted by *Pure Appl. Geoph.* (*Seismogenesis and Earthquake Forecasting: The Frank Evison Volume*), SCEC #1244.

5. Kagan, Y. Y. and D. D. Jackson, 2009. Earthquake forecasting in diverse tectonic zones of the Globe, accepted by *Pure Appl. Geoph.* (*Seismogenesis and Earthquake Forecasting: The Frank Evison Volume*), SCEC #1245.

6. Bird, P., Y. Y. Kagan, D. D. Jackson, F. P. Schoenberg, and M. J. Werner, 2009. Linear and Nonlinear Relations Between Relative Plate Velocity and Seismicity, *Bull. Seismol. Soc. Amer.*, submitted, SCEC #1264.

7. Kagan, Y. Y., 2009. Statistical distributions of earthquake numbers, *Geophys. J. Int.*, submitted, see http://eq.ess.ucla.edu/∼kagan/nbd_index.html

8. Schoenberg, F.P., Chu, A., and Veen, A. (2009). On the relationship between lower magnitude thresholds and bias in ETAS parameter estimates. Journal of Geophysical Research, in review.

9. Wong, K., and Schoenberg, F.P. (2009). On mainshock focal mechanisms and the spatial distribution of aftershocks. BSSA, in review.

10. Tranbarger, K.E. and Schoenberg, F.P. (2009). On the computation and application of point process prototypes. Informatics, in review.

11. Schoenberg, F.P, and Zhuang, J. (2009). On thinning a spatial point process into a Poisson process using the Papangelou intensity. J. Stat. Plan. Inf., in review.

12. Moeller, J., and Schoenberg, F.P. (2009). Thinning spatial point processes into Poisson processes. Adv. Appl. Prob., in review.

13. Barr, C., and Schoenberg, F.P. (2009). On the estimation of point process intensities using Voronoi diagrams. JRSS-B, in review.

ABSTRACTS

14. David D. Jackson, Yan Y. Kagan, and Danijel Schorlemmer, 2008. Testing hypotheses of earthquake occurrence, Evison symposium on seismogenesis and earthquake forecasting, 18-22 February 2008, Wellington, New Zealand.

15. Kagan, Y. Y. 2008. Earthquake patterns in diverse tectonic zones of the globe, Evison symposium on seismogenesis and earthquake forecasting, 18-22 February 2008, Wellington,

New Zealand.

16. Jackson, D.D., and Kagan, Y.Y., 2008. Global earthquake forecast testing, *Seismological Research Letters*, **79**(2), abstract, p. 332.

17. Kagan Y Y, and Jackson D D, 2008. Earthquake forecasting in diverse tectonic zones of the Globe, (INVITED), *XXXI General Assembly European Seismol. Commission, Programme and Abstracts*, Hersonissos, Crete, abstract, p. 197.

18. Kagan Y Y, 2008. Geometric complexity of earthquake focal zone and fault system *XXXI General Assembly European Seismol. Commission, Programme and Abstracts*, Hersonissos, Crete, abstract, p. 130.

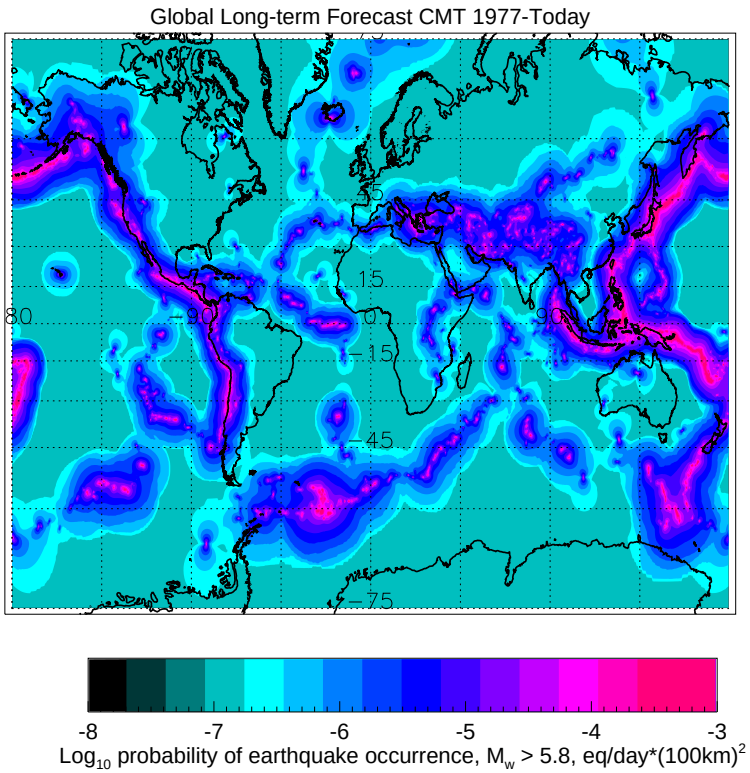

Figure 1:

Global earthquake long-term potential based on smoothed seismicity. Earthquakes ($M_w \geq 5.8$) from the CMT catalog since 1977 are used. Earthquake occurrence is modelled by a time-independent (Poisson) process. Colors show the long-term probability of earthquake occurrence.

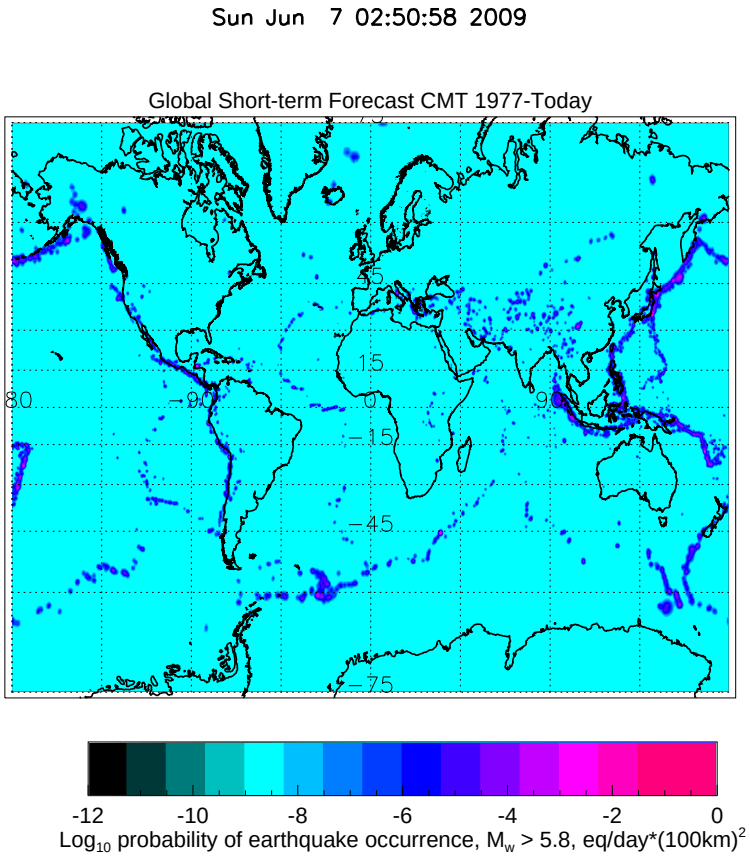

Figure 2:

Global earthquake short-term potential based on smoothed seismicity. Earthquakes ($M_w \geq 5.8$) from the CMT catalog since 1977 are used. Earthquake occurrence is modelled by a temporal process controlled by Omori's law type dependence. Colors show the long-term probability of earthquake occurrence.

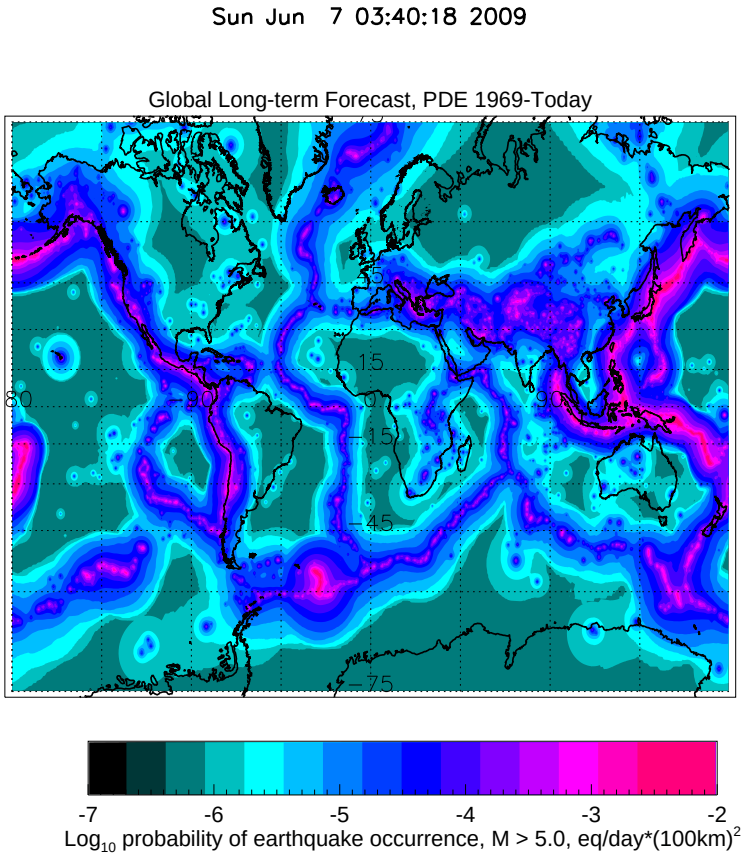

Figure 3:

Global earthquake long-term potential based on smoothed seismicity. Earthquakes ($M \geq 5.0$) from the PDE catalog since 1969 are used. Earthquake occurrence is modelled by a time-independent (Poisson) process. Colors show the long-term probability of earthquake occurrence.