Priors:

For each region r = 1, …., R:

Global coefficients:

, i = 1,2,3

Likelihood:

Mean model (log):

Overdispersion model:

Definitions:

: observed count of earthquakes with magnitudes >= 4 at index i.

r[i]: region index for observation i.

t[i]: time (in months) for observation i.

Simpler model: AR(1) random walk on log‑rate:

Priors:

Likelihood:

Where:

Reason for non-centred parameterization:

If we centered for sampling , the posterior correlations between consecutive states are very strong, so MCMC may get stuck. Therefore, writing it as a deterministic function of with independent standard‑normal z. This helps eliminating the funnel-shaped posterior geometry as shown in Stan User Guide: <https://mc-stan.org/docs/2_18/stan-users-guide/reparameterization-section.html> , ESS is then increased for .

Interpretation of parameters:

: “background” log‑rate when predictors are 0 and the process is at equilibrium

: month-to-month persistence

: volatility of rate changes, and half‑Cauchy prior shrinks extreme values

: effect of average depth on counts

: effect of average magnitude in the previous month

: instantaneous (latent) mean monthly count

Half-cauchy:

Andrew Gelman. "Prior distributions for variance parameters in hierarchical models (comment on article by Browne and Draper)." Bayesian Anal. 1 (3) 515 - 534, September 2006. https://doi.org/10.1214/06-BA117A