Some thoughts on the estimation of maximum and corner magnitude

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Outline:

Tails of G-R law

Tapered G-R law: classical parameter estimation

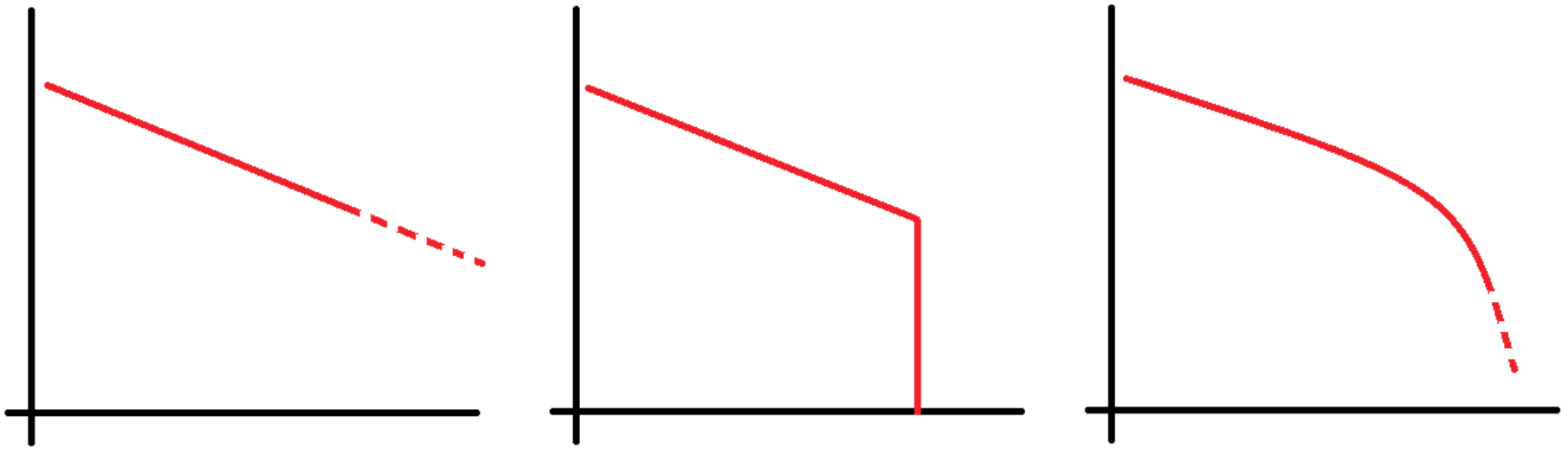
Tapered G-R law: parameter estimation with 2 catalogs

Application 1: World seismicity

Application 2: Italian seismicity

Conclusions

Tails of G-R law



Unbounded

Truncated

Tapered

Tapered G-R law: classical parameter estimation

G-R law survivor function (Moments):

$$\Phi(M) = \left(\frac{M_{compl}}{M} \right)^{\beta}$$

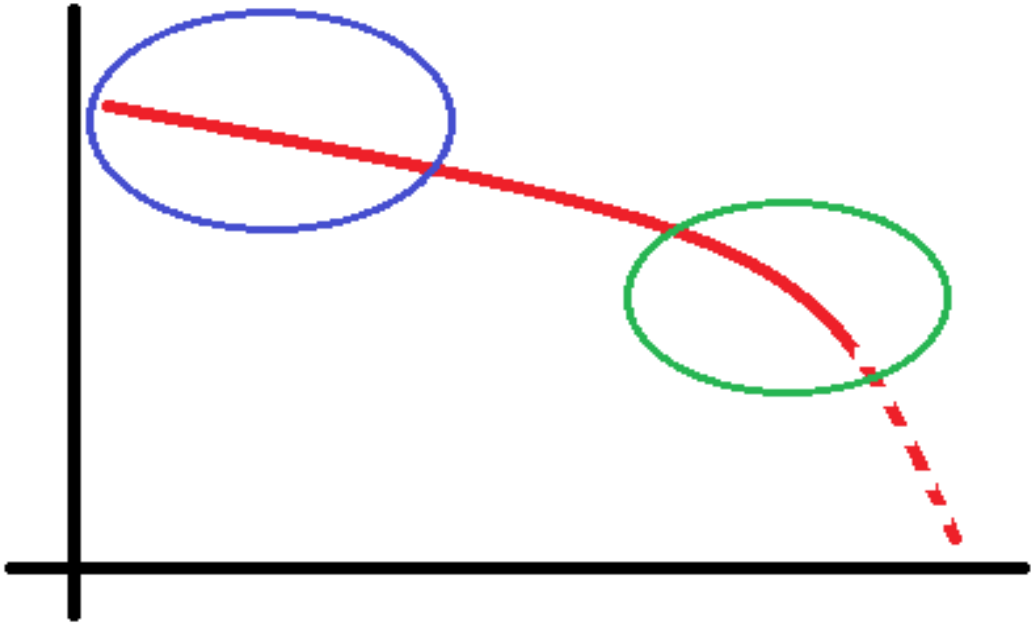
Tapered G-R law survivor function (Moments):

$$\Phi(M) = \left(\frac{M_{compl}}{M} \right)^{\beta} \cdot exp\left(\frac{M_{compl} - M}{CM} \right)$$

We can estimate β and CM by using the classical MLE. We have 2 parameters and one catalog to estimate them.

Tapered G-R law: parameter estimation with 2 catalogs

If we have 2 catalogs, one shorter with a low M_{compl}, one longer with a high M_{compl}, we can try to estimate separately β and MC of the Tapered G-R law.



Tapered G-R law: parameter estimation with 2 catalogs

Let E the event = “one earthquke of maximum magnitude in [Max_{obs} - ΔM , Max_{obs} + ΔM] during T years”

$$P(E) = \sum_{i=0}^{\infty} P(E|N=i)P(N=i)$$

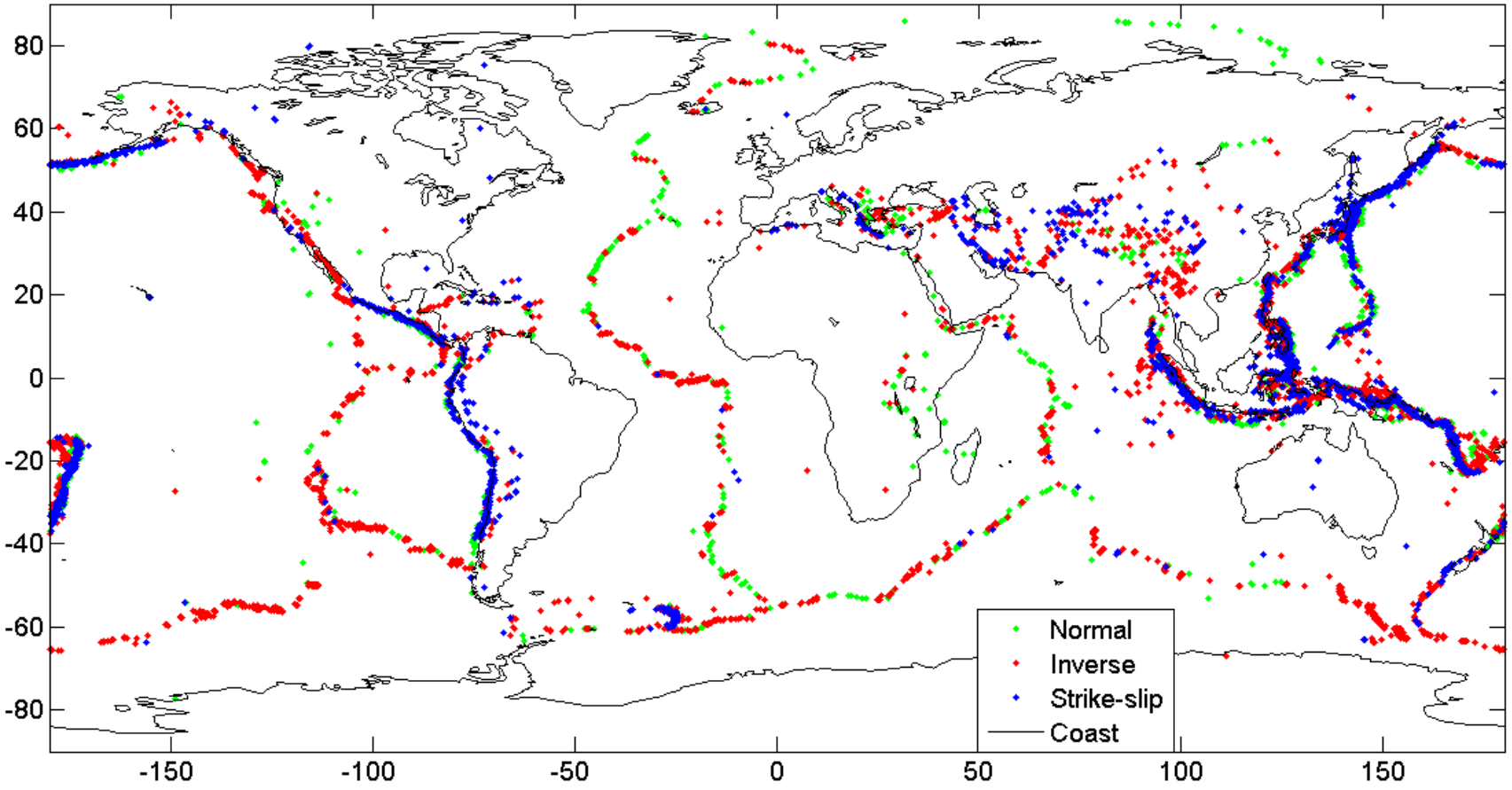
$$P(E|N=i) = P(M \in [Max_{obs} - \Delta M, Max_{obs} + \Delta M])\, P(M < Max_{obs})^{i-1} i$$

We can estimate β and the distribution's parameters of the number of earthquakes per year from the shorter catalog; from the longest catalog we can obtain T, Max_{obs} and ΔM.

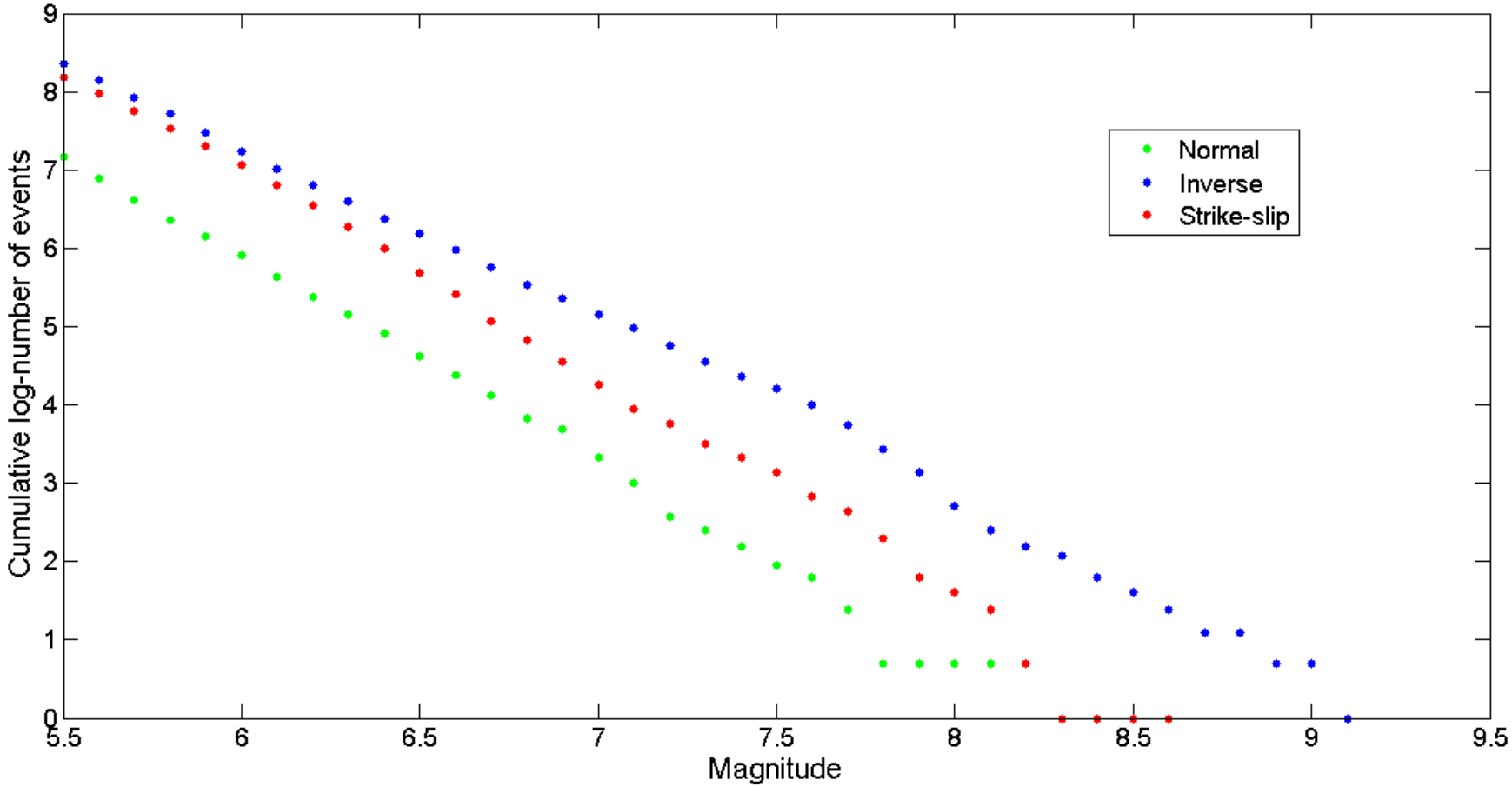
By applying the MLE method to P(E) we can obtain an estimation of CM with him confidence bounds.

Application 1: World seismicity

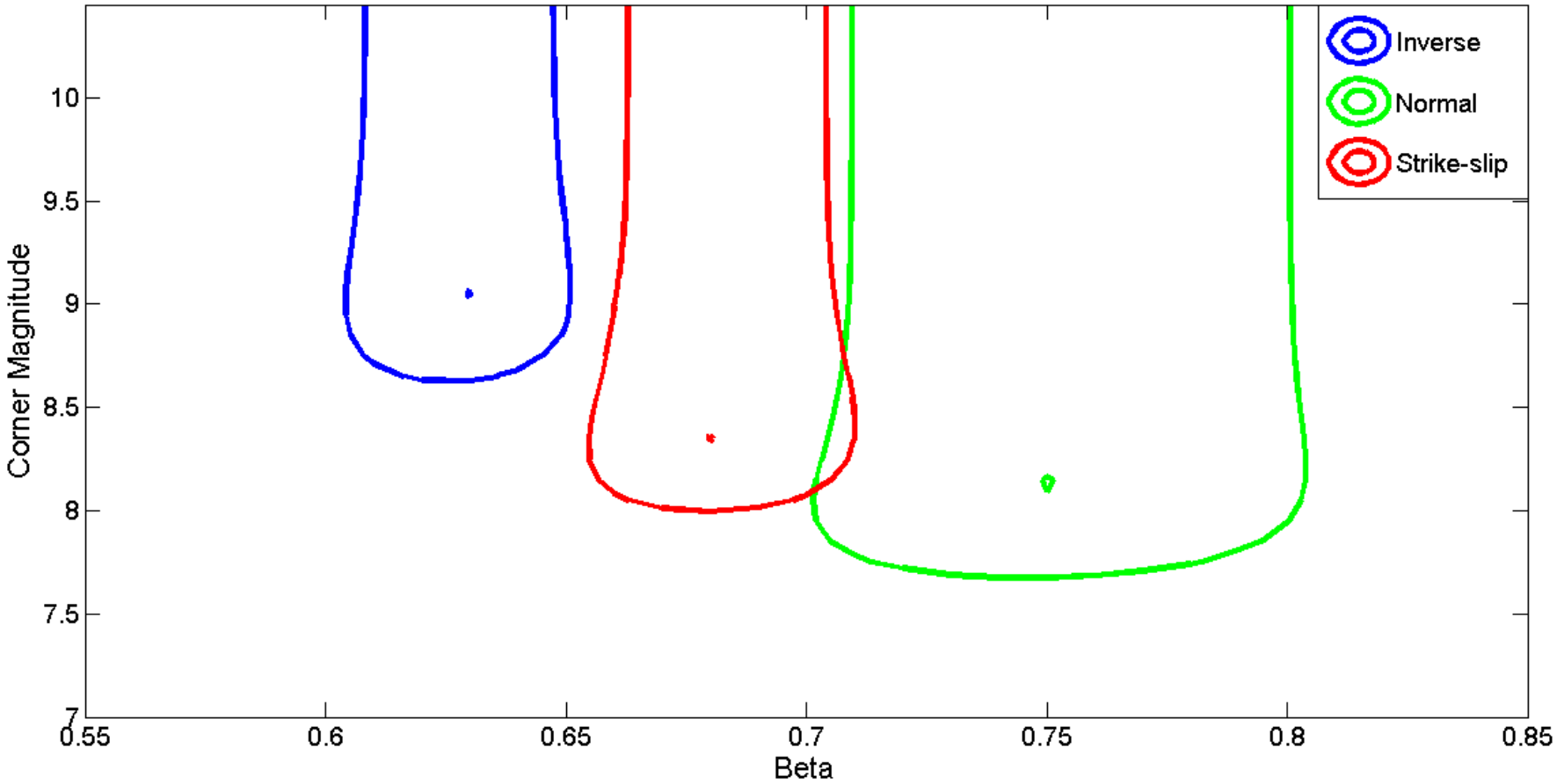
GCMT catalog 1983-2014, Mw > 5.45 , depth > 50 Km



Earthquake size distribution for different styles of faulting

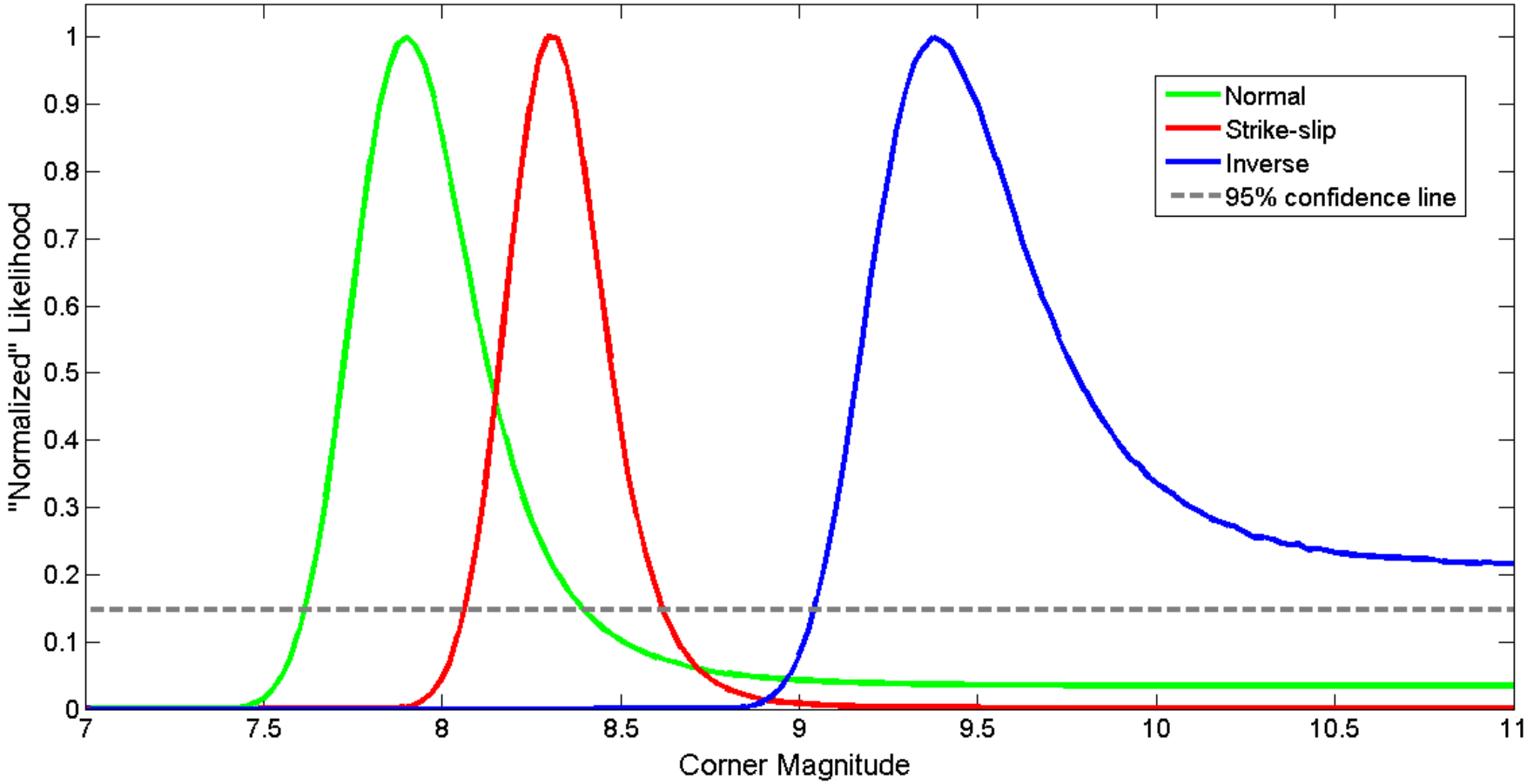


Classical estimation of β and CM



Contour of 95% confidence bounds

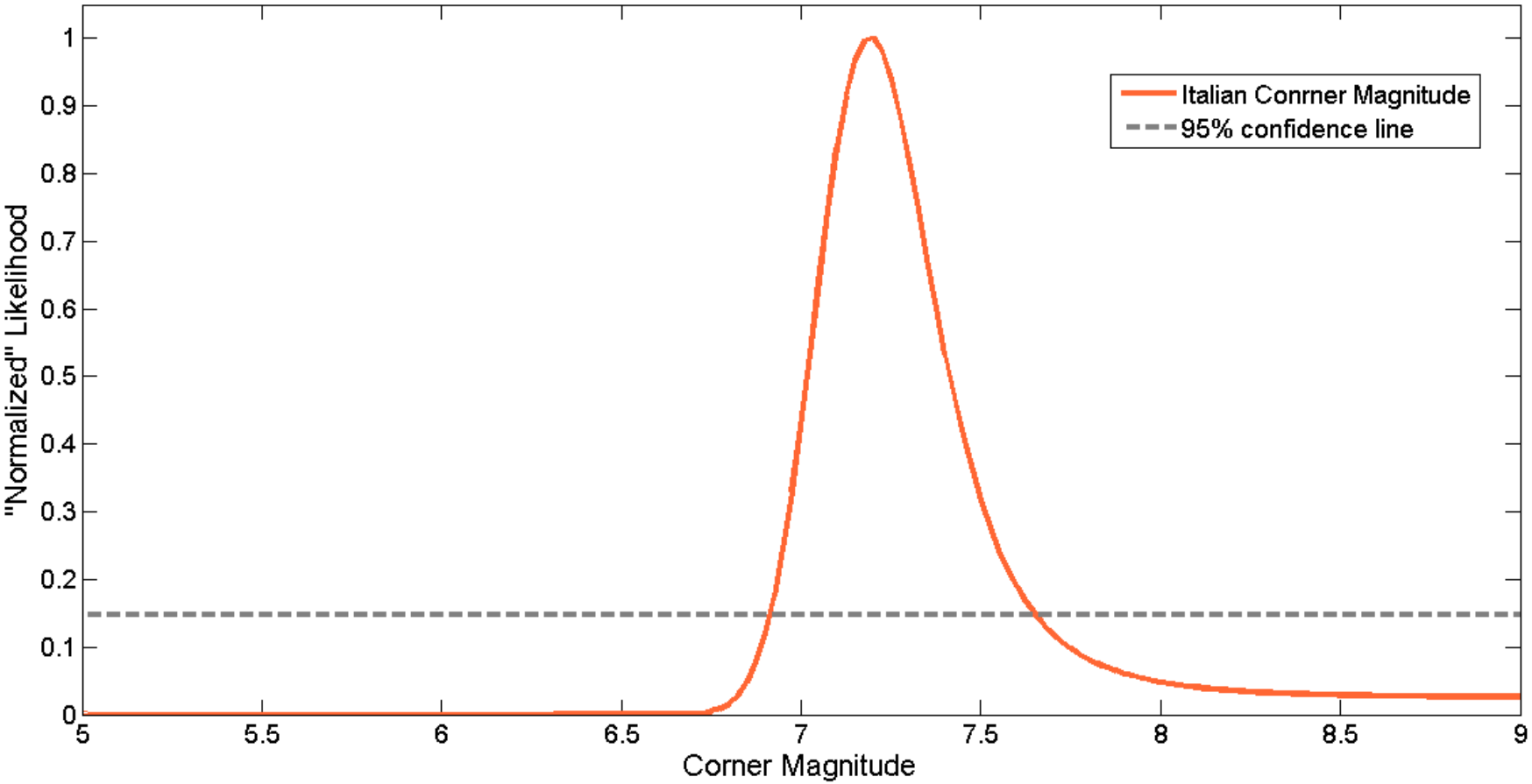
Estimation of β and CM by using 2 catalogs: we add the Pacheco & Sykes catalog of large shallow earthquakes (1900-1989).



Now we have finite confidence bounds of Corner Magnitude for Normal and Strike-slip event

Application 2: Italian seismicity

We use the last part of CPTI11 catalog (1901-2006) to estimate β and the parameter of the negative binomial distribution; then CPTI04 (similar to the first one but longer) to obtain the maximum observed magnitude (7.4 Mw) and the time T (about 2000 years).



Conclusions

- We find in the World siesmicity a difference both for β and for CM by looking at different earthquake fault style
- In the italian case the hypotesys of an unbounded G-R is not realistic: better to use the Tapered G-R
- By using all the information (2 catalogs instead 1) we improve our knowledge about the tail of the G-R law