Imbricated slip rate processes during slow slip transients imaged by low-frequency earthquake

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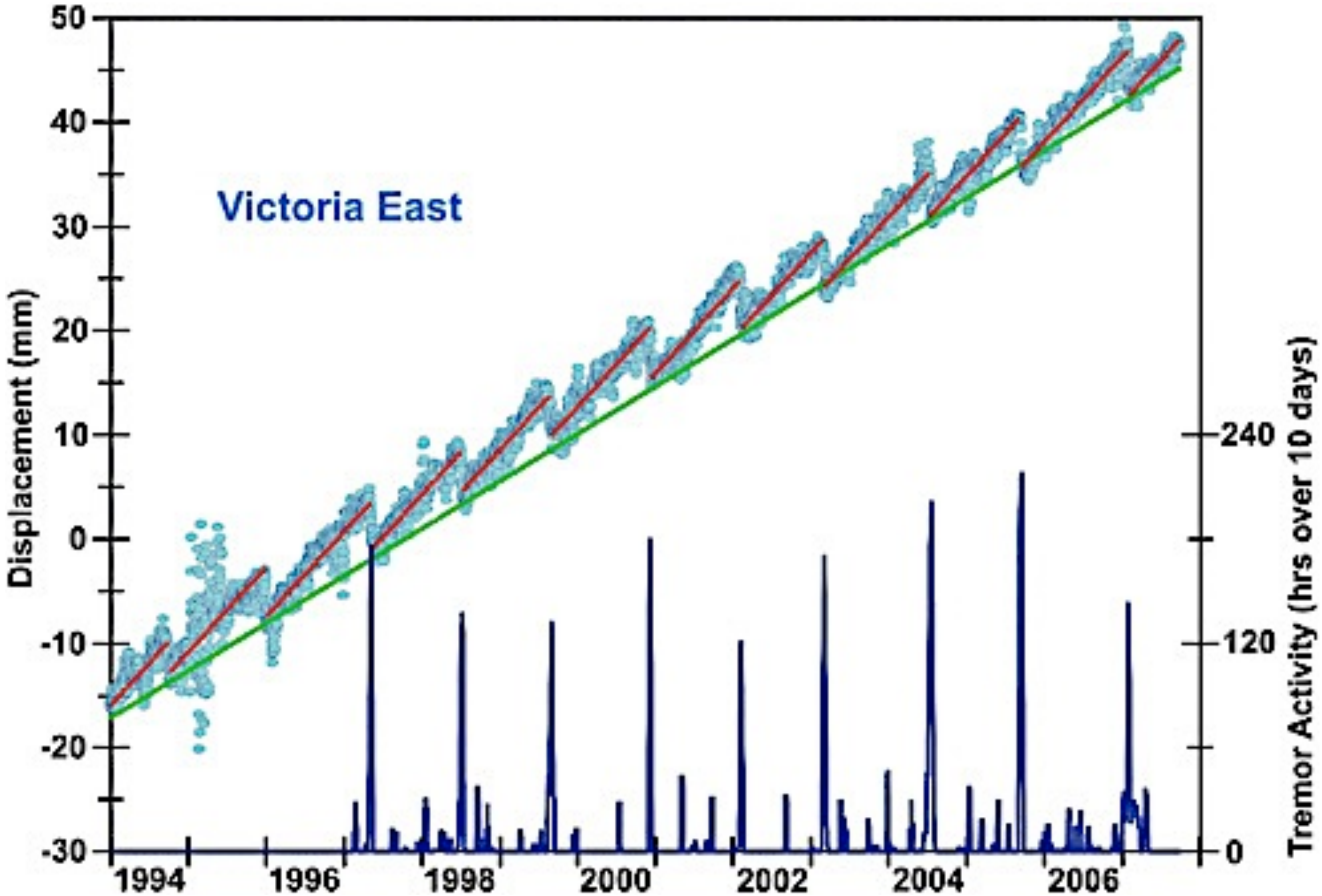
Correlation between tremor activity and large (geodetically recorded) slow slip events

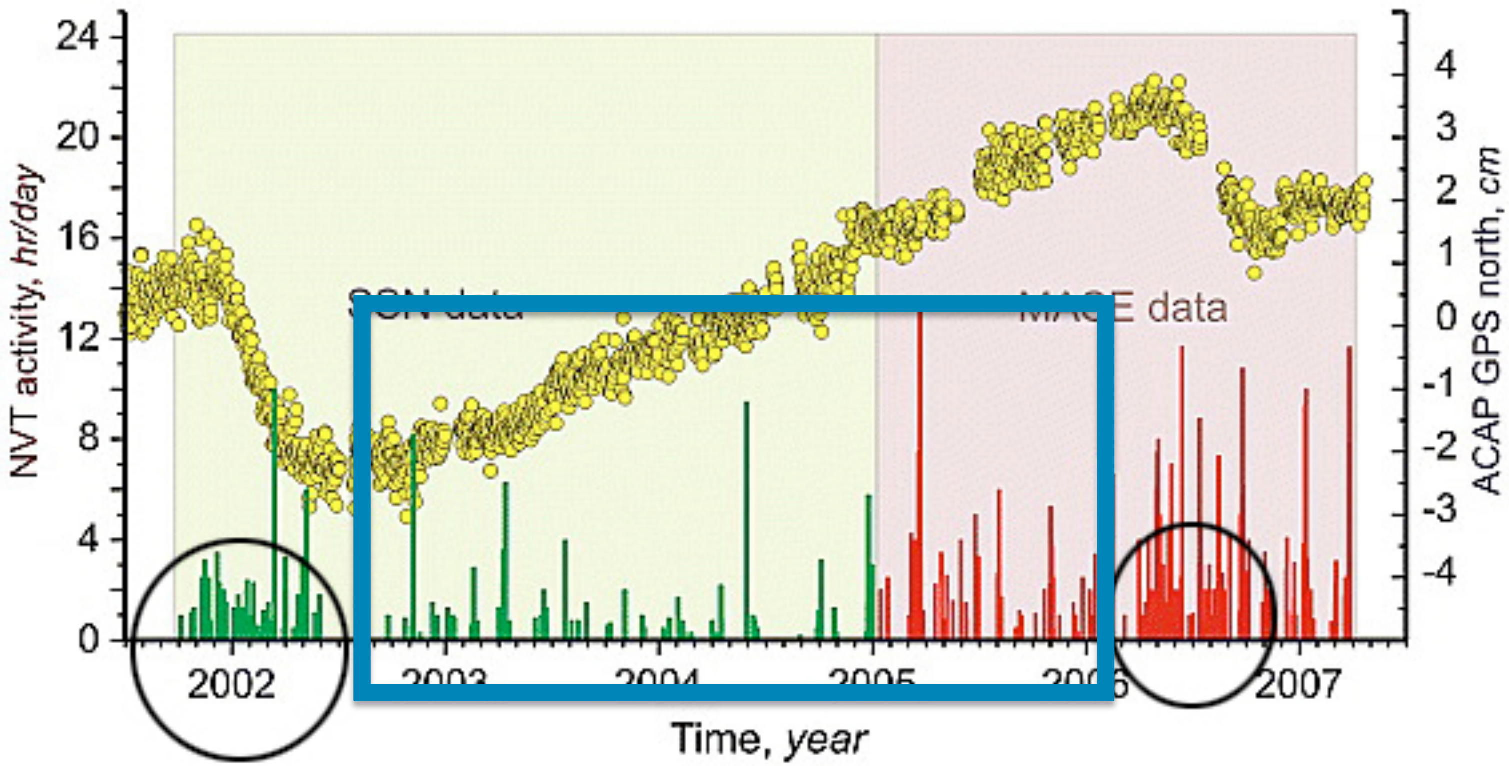
Cascadia



Rogers and Dragert, 2003

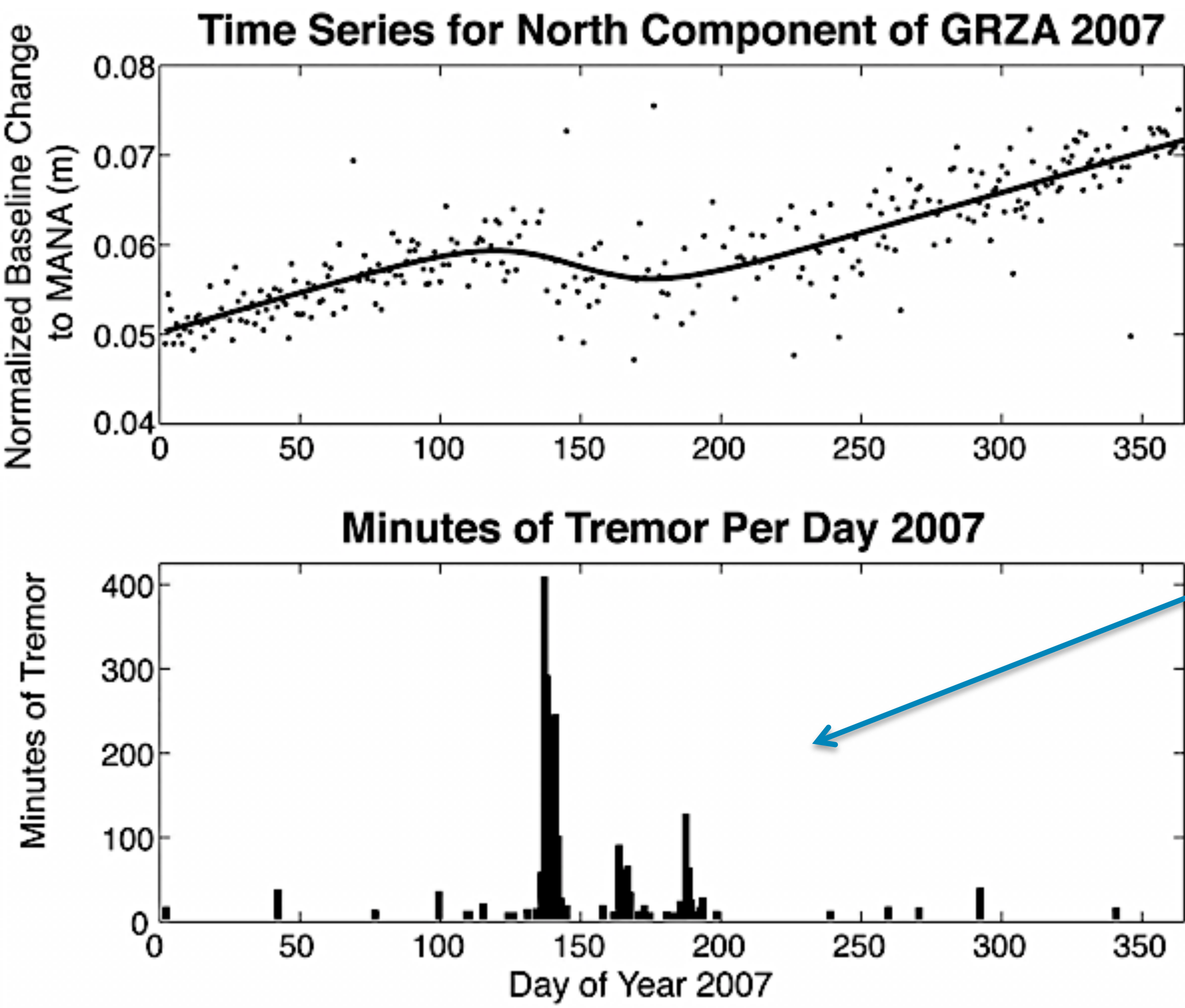
What does these tremors represent ?

Mexico



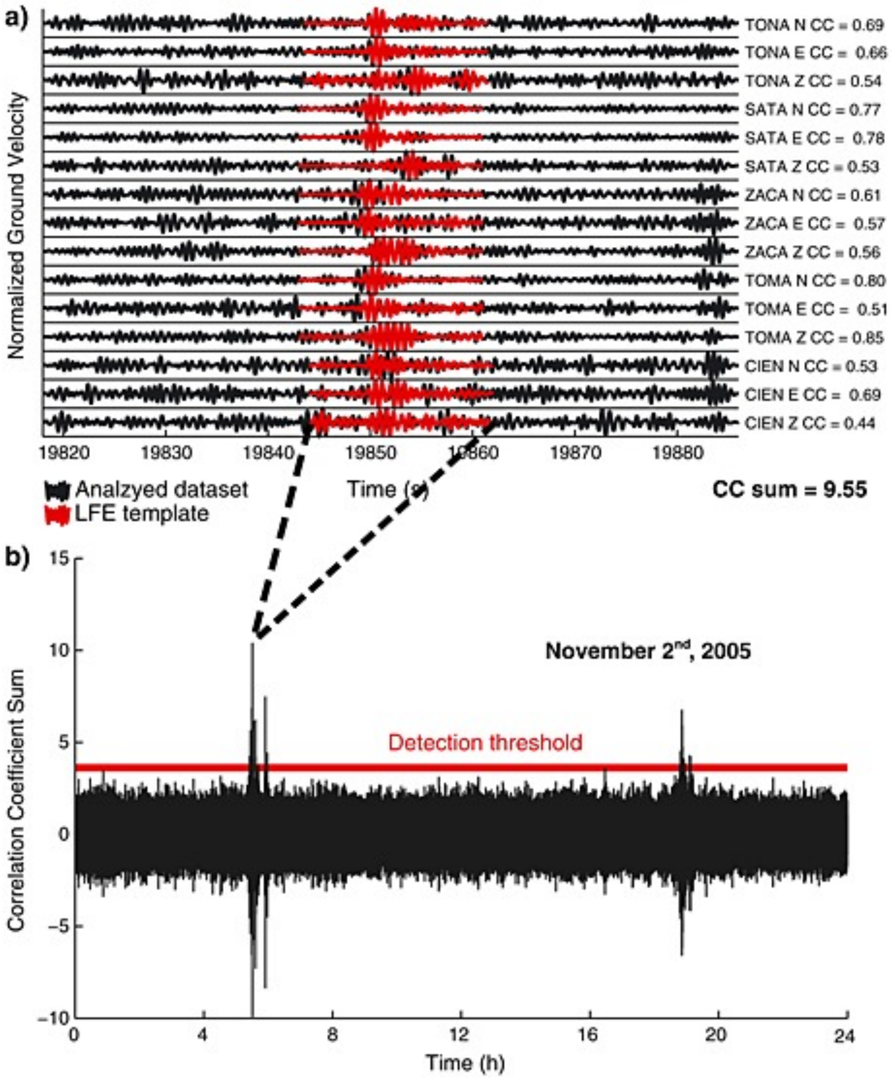
Payero et al., 2008

Costa-Rica



Discrete pulses of tremor

Schwartz et al. 2010



Frank et al. 2013

Tremor is composed of a succession of Low Frequency Earthquakes (LFE)

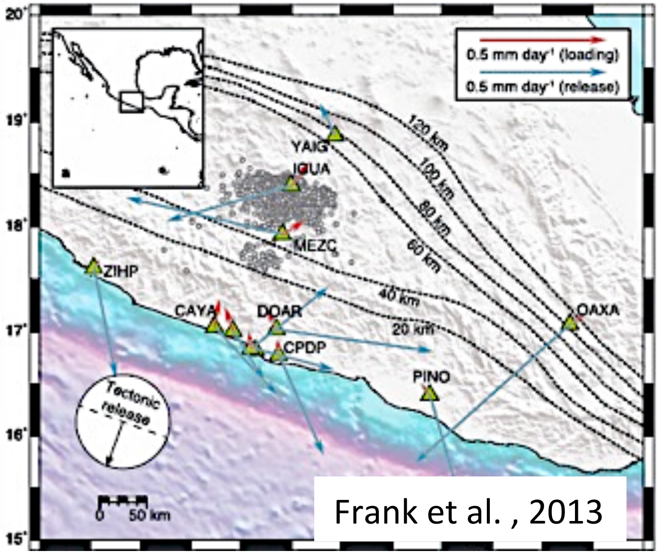
Families with repeating LFE

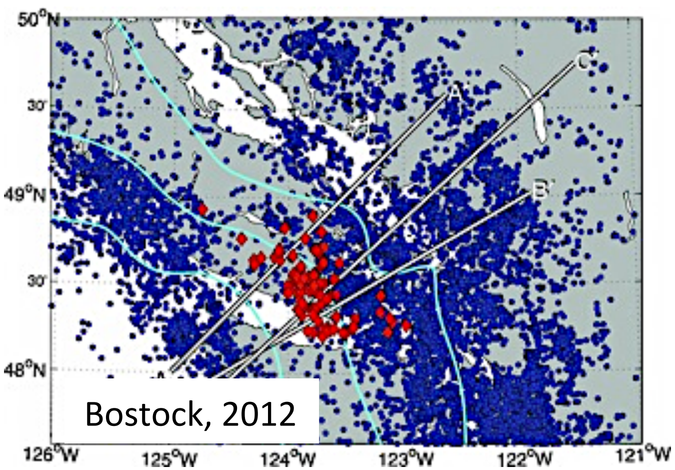
LFE rate on a family as a proxy for the local slip rate

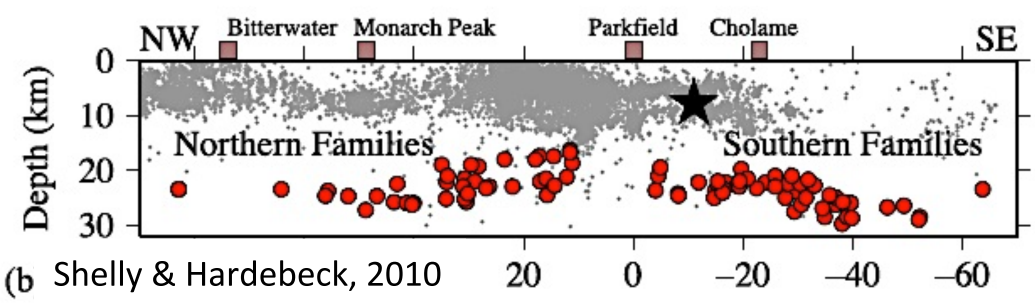
If we assume that LFE rate is a proxy for slip-rate on the interface

Characterize the slip rate from LFE activity

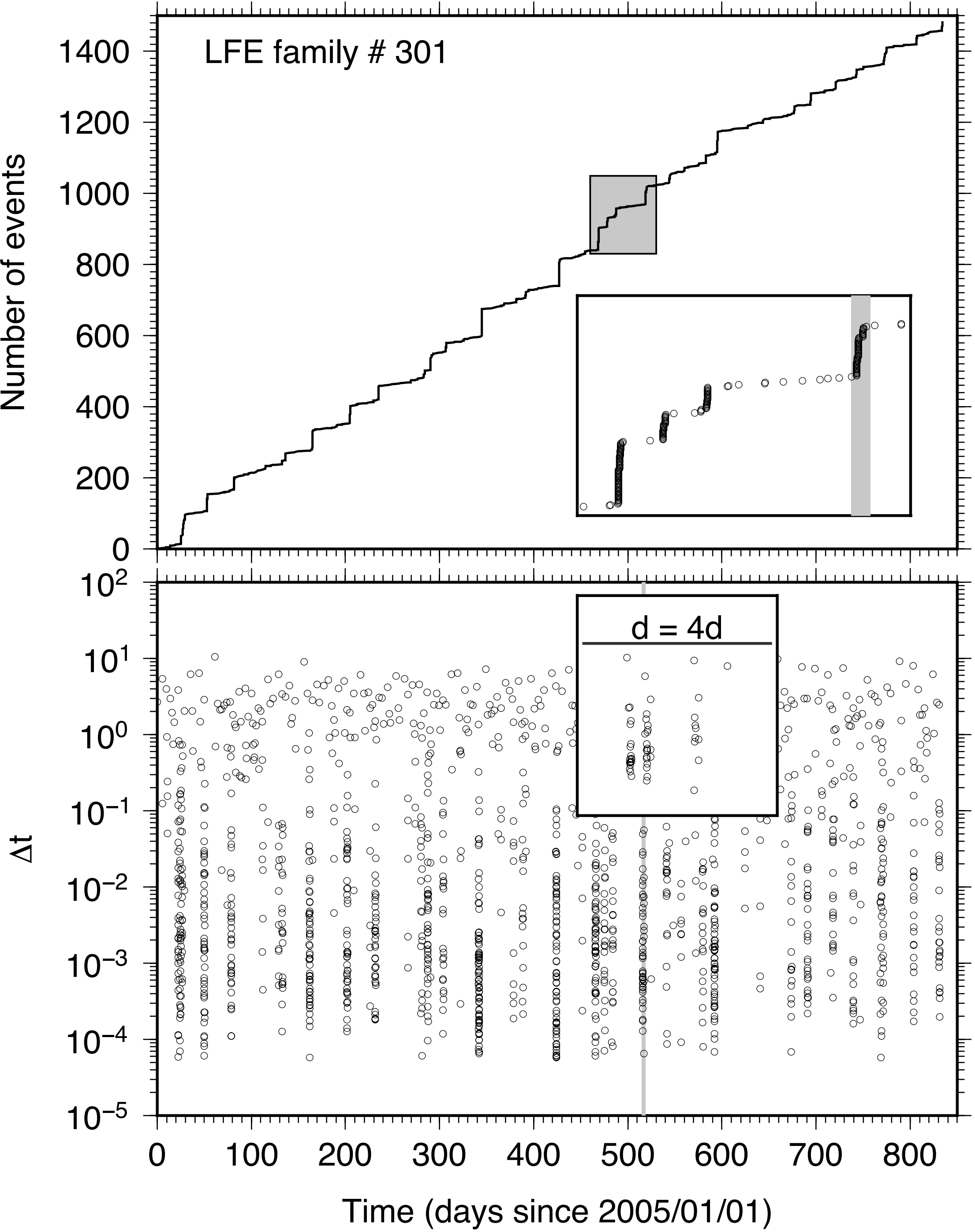
Potentially detecting smaller slip rate transients not captured by surface geodetic instruments.







Region	Total LFE	# families
Mexico	1,849,487	1120
N. Cascadia	269,586	130
Parkfield	428,268	88

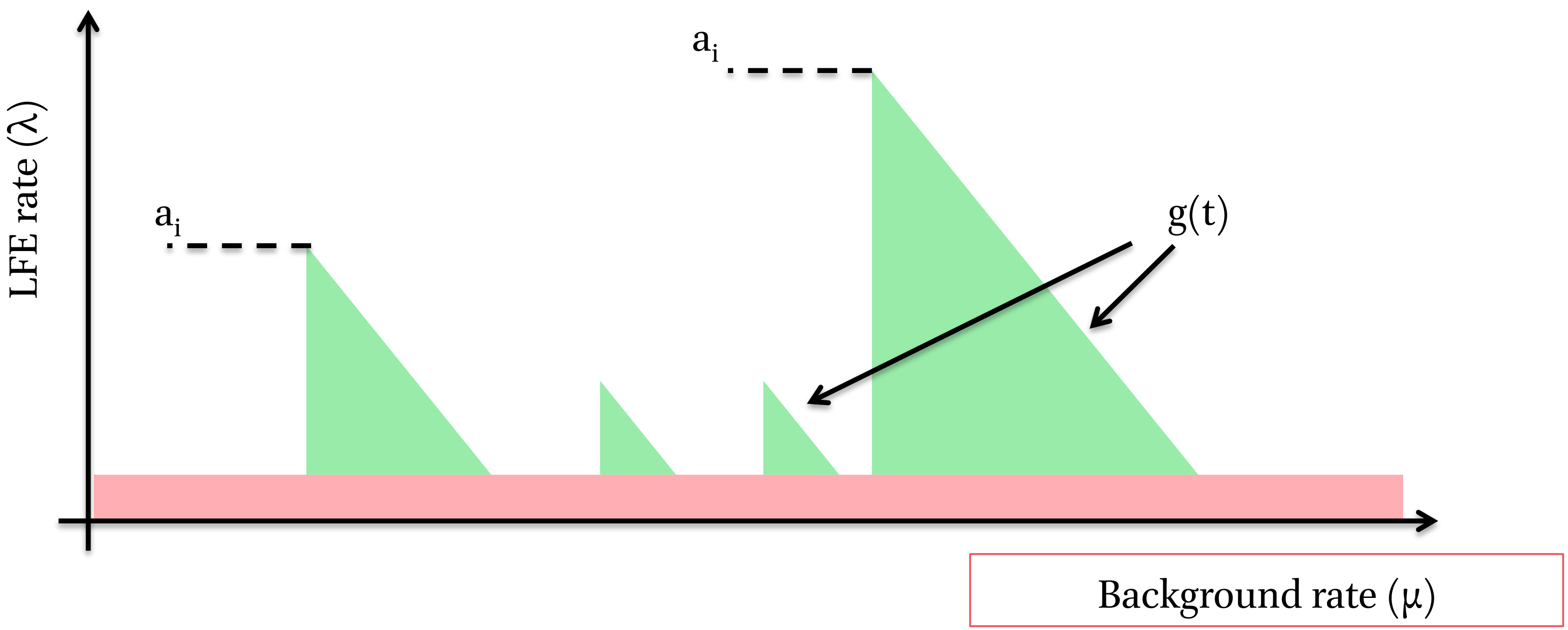


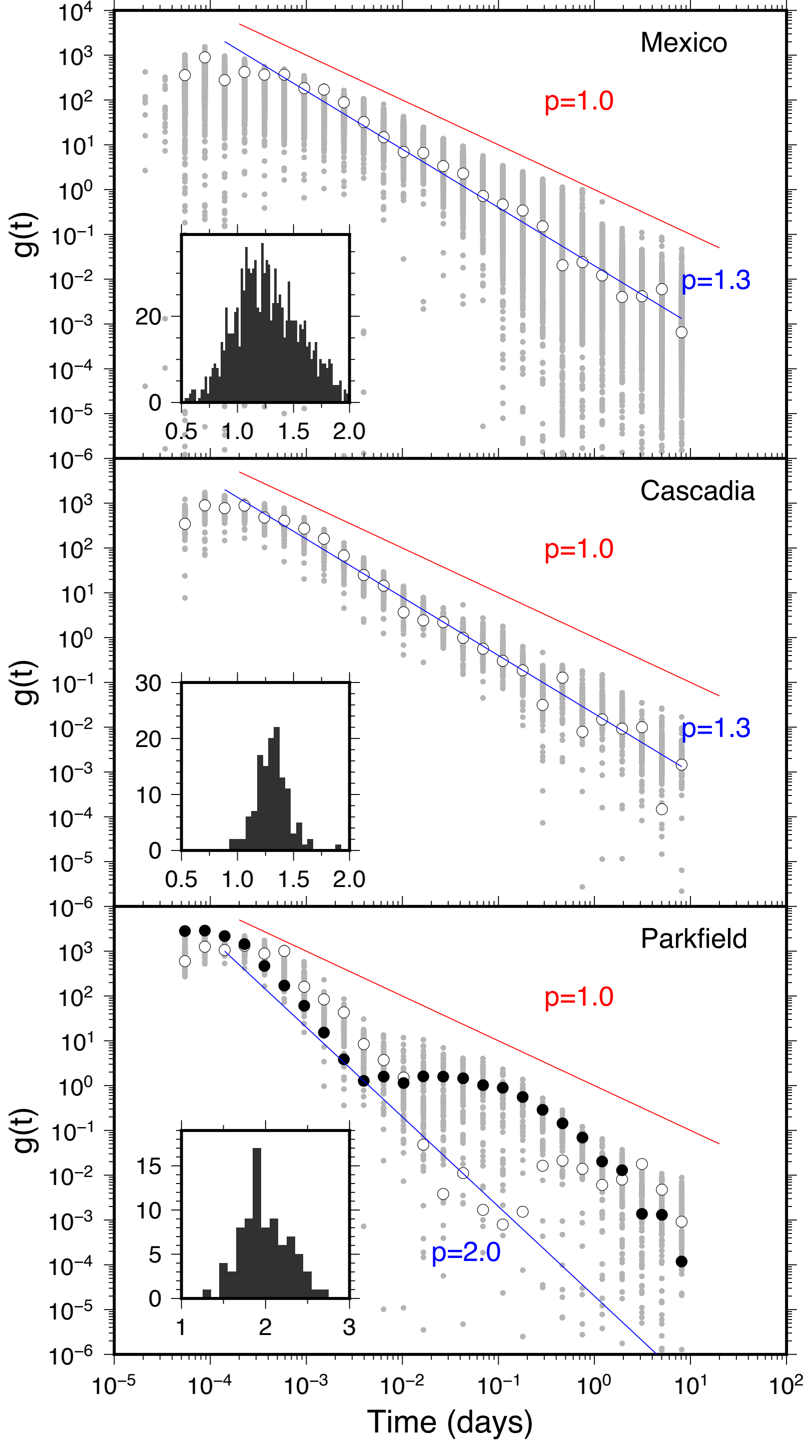
The LFE time-clustering

An example from one family
in Mexico

$$\lambda(t) = \mu + \sum_{i|t_i<t}^{Ne} a_i g(t - t_i),$$

Sum of processes of various amplitudes a_i but with the same temporal evolution

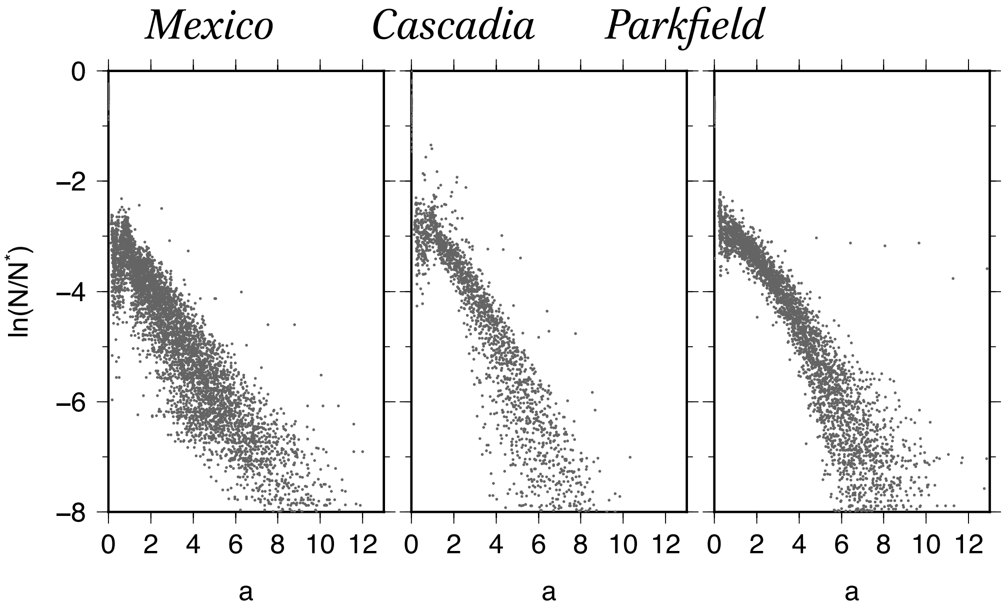




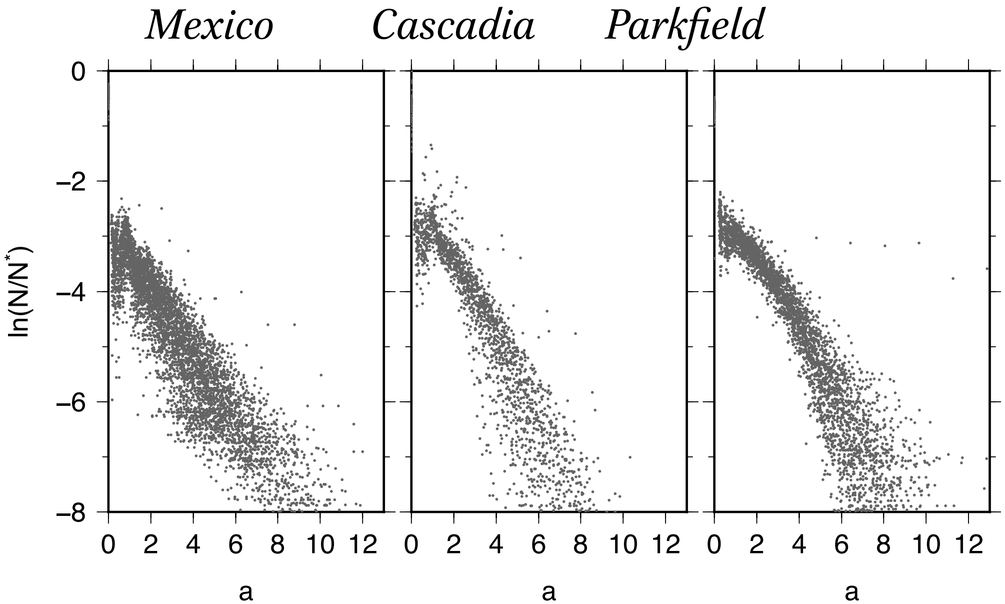
Short time scale - g(t)

LFE rate is governed by a fast (power-law) decaying process

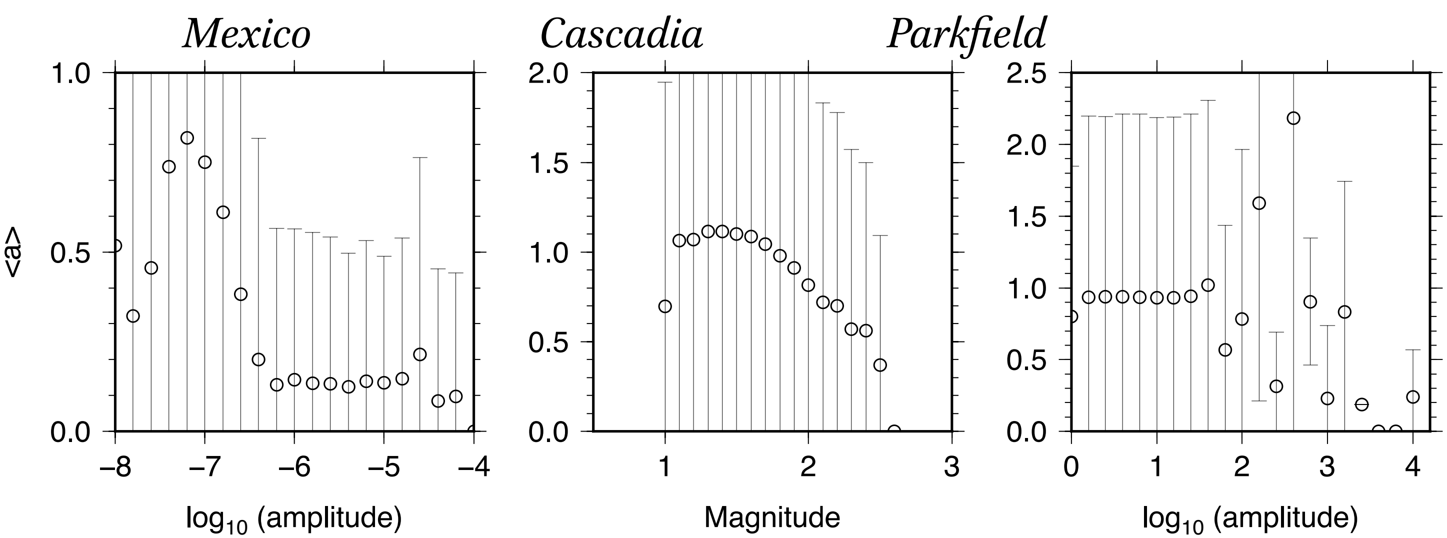
Very similar for all families



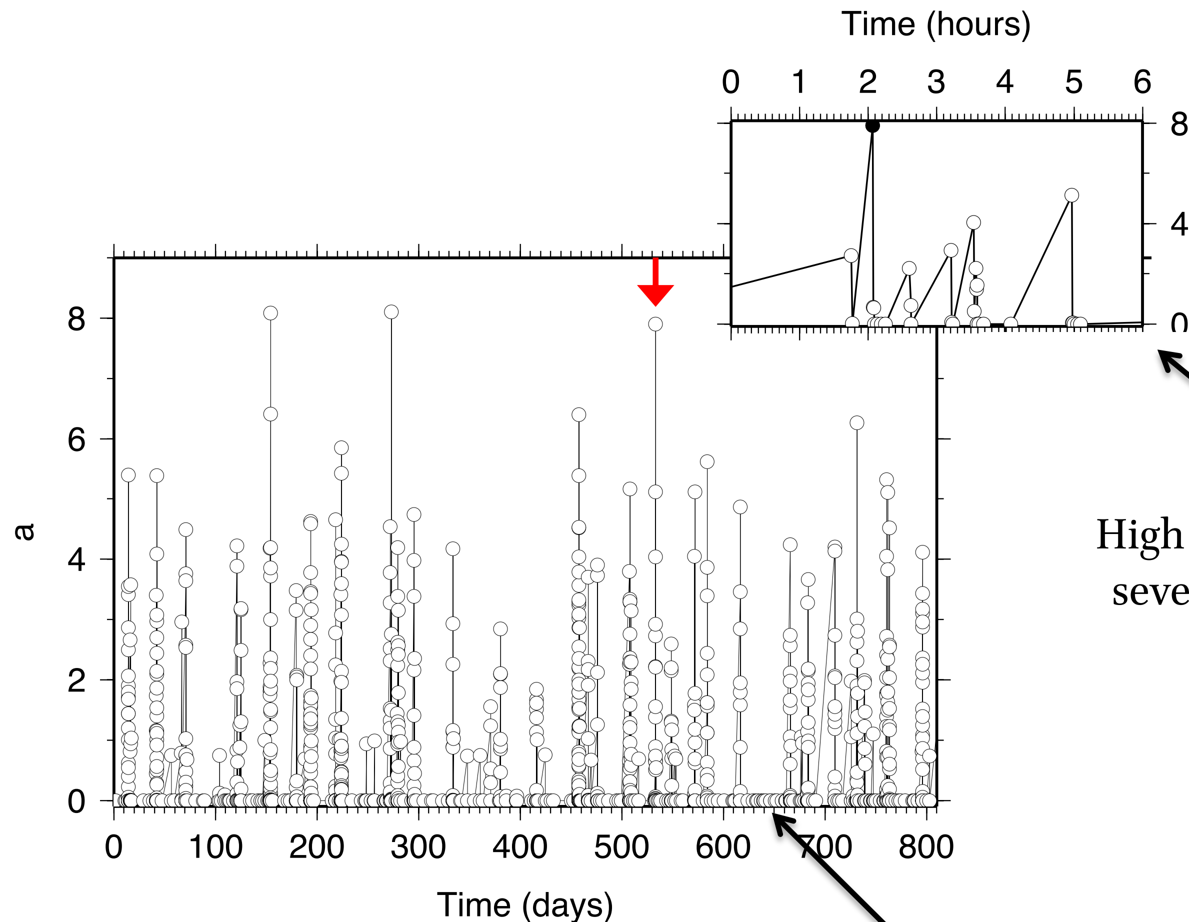
Distribution of **a**



Distribution of **a**

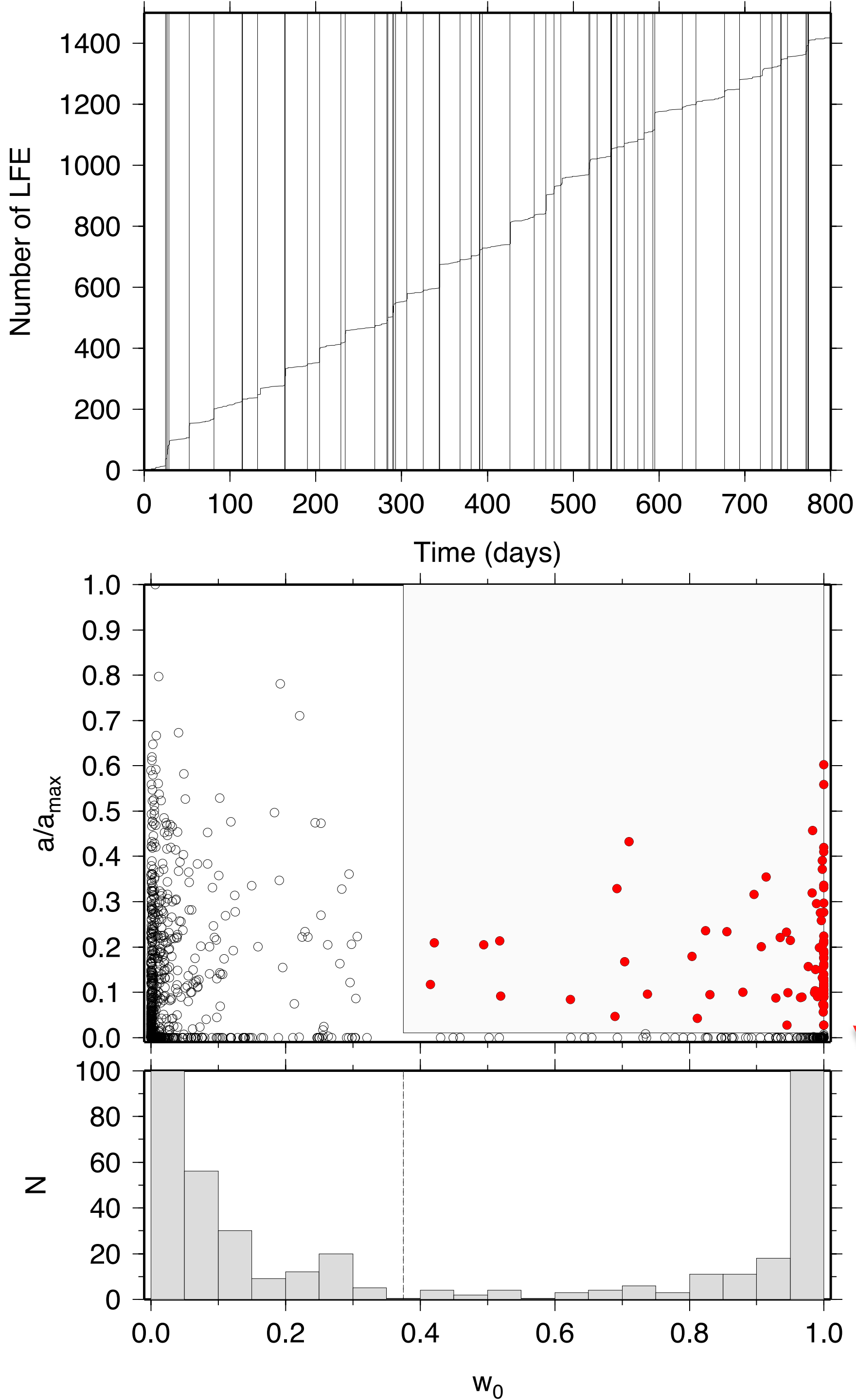


No correlation between LFE amplitude and number of associated events



High values of **a** occurred in bursts – several episodes of high amplitude fast decaying episodes

A lot of the LFE times are not associated with an increased activity



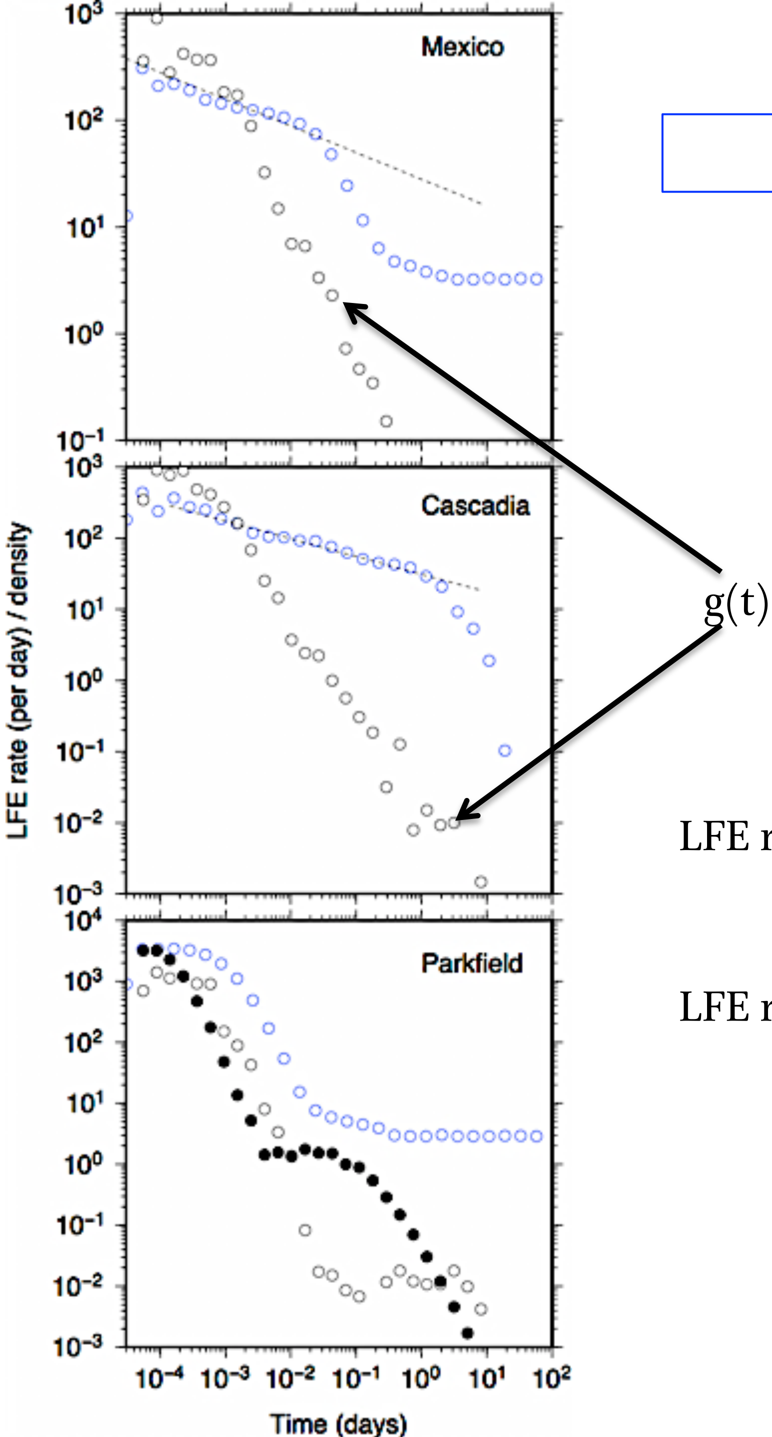
An LFE that initiates a burst is:

1 – isolated in time from a previous LFE (is not already within a burst)

2 – associated with a high amplitude **a**

We can isolate burst times

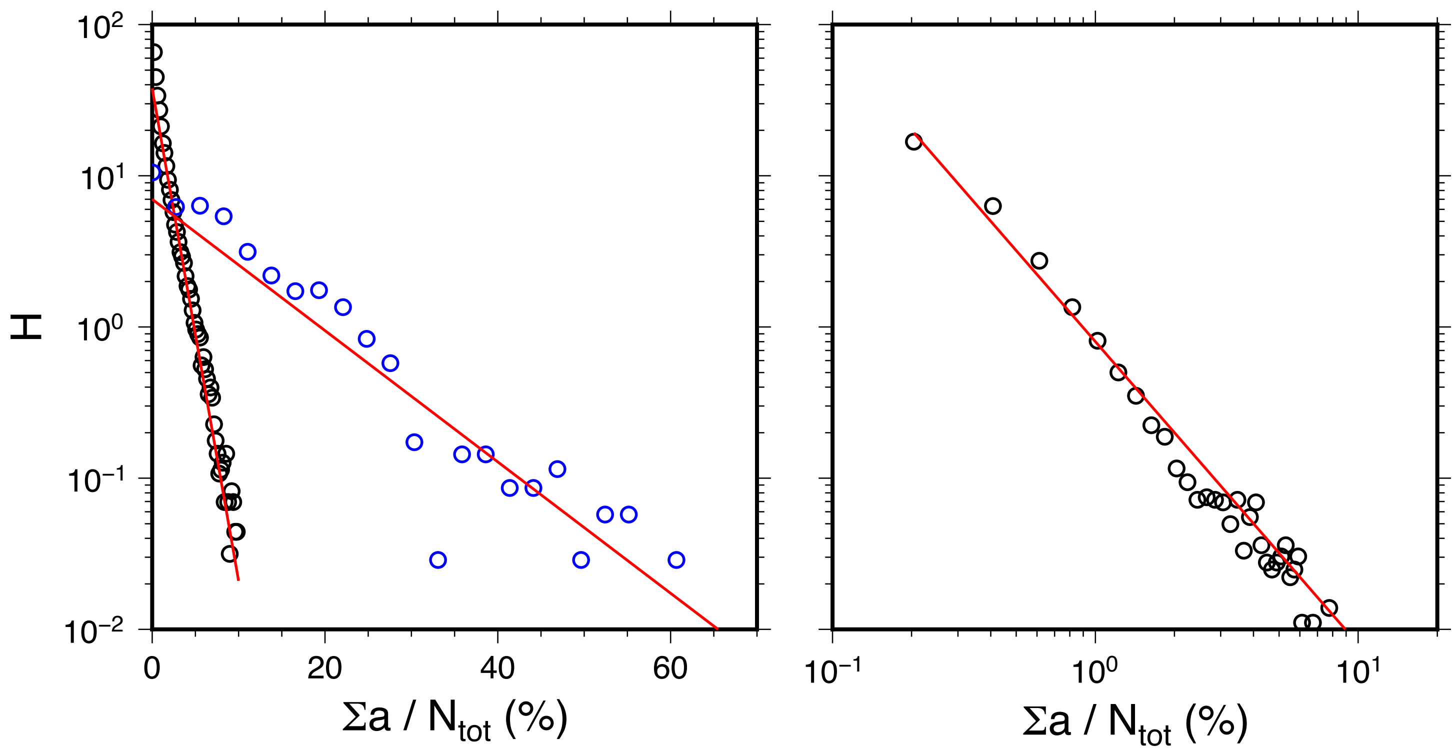
LFE rate within burst



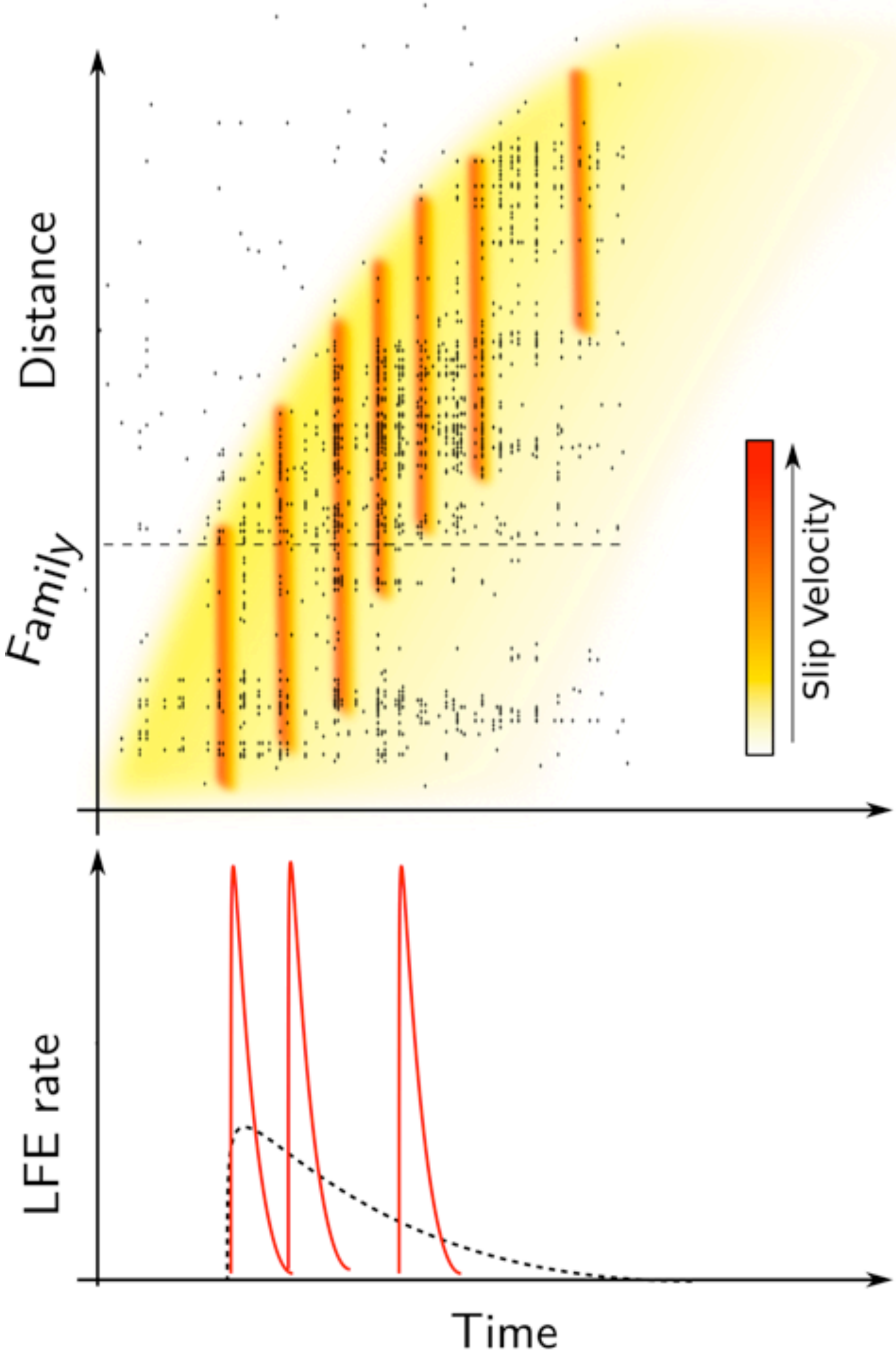
LFE rate is decaying more slowly than g(t)

LFE rate decays as $t^{-1/4}$

Burst amplitudes (evaluated from the number of LFE) are well fitted by an exponential or power-law distribution



There exist burst of LFE with various amplitudes



A two time-scales dynamics

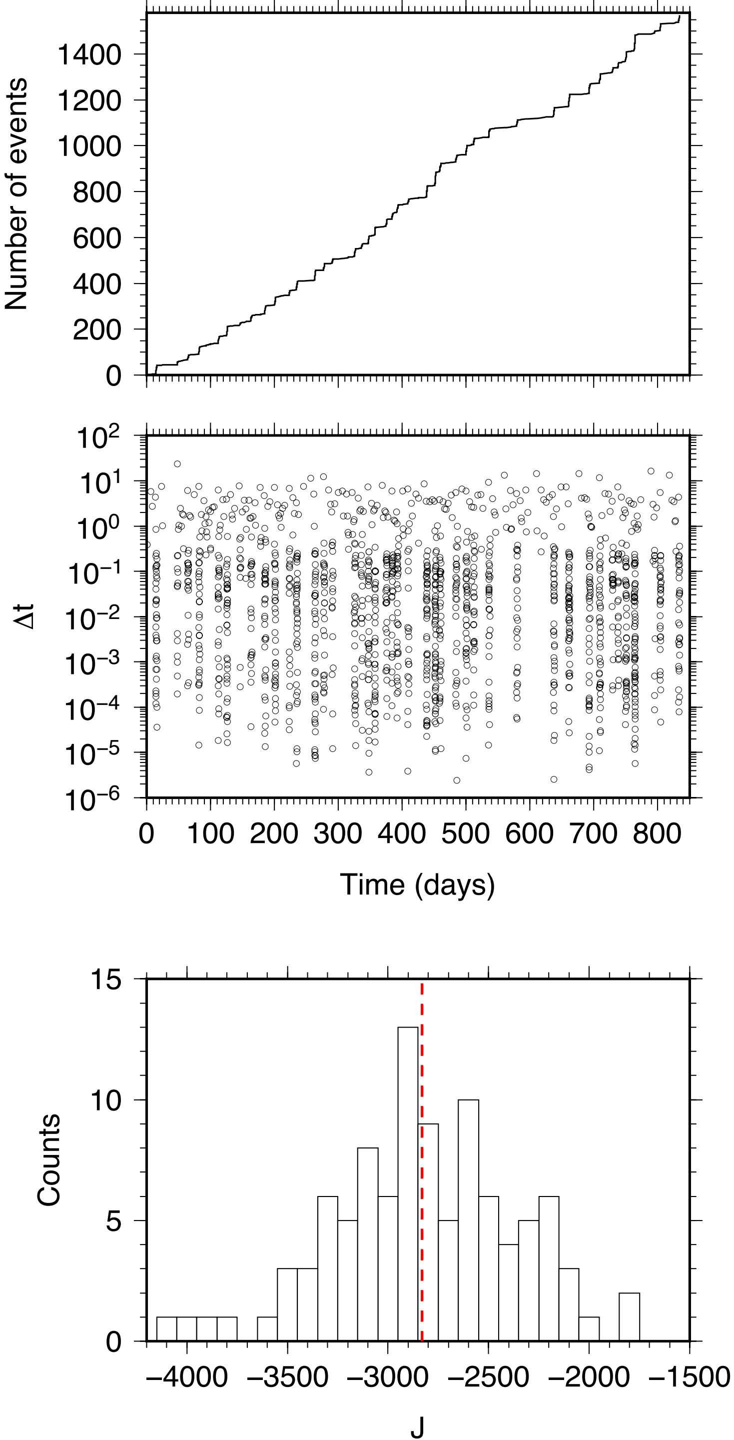
Most LFE are generated during fast decaying episodes

These episodes are clustered in time and modulated by longer time scale processes (burst)

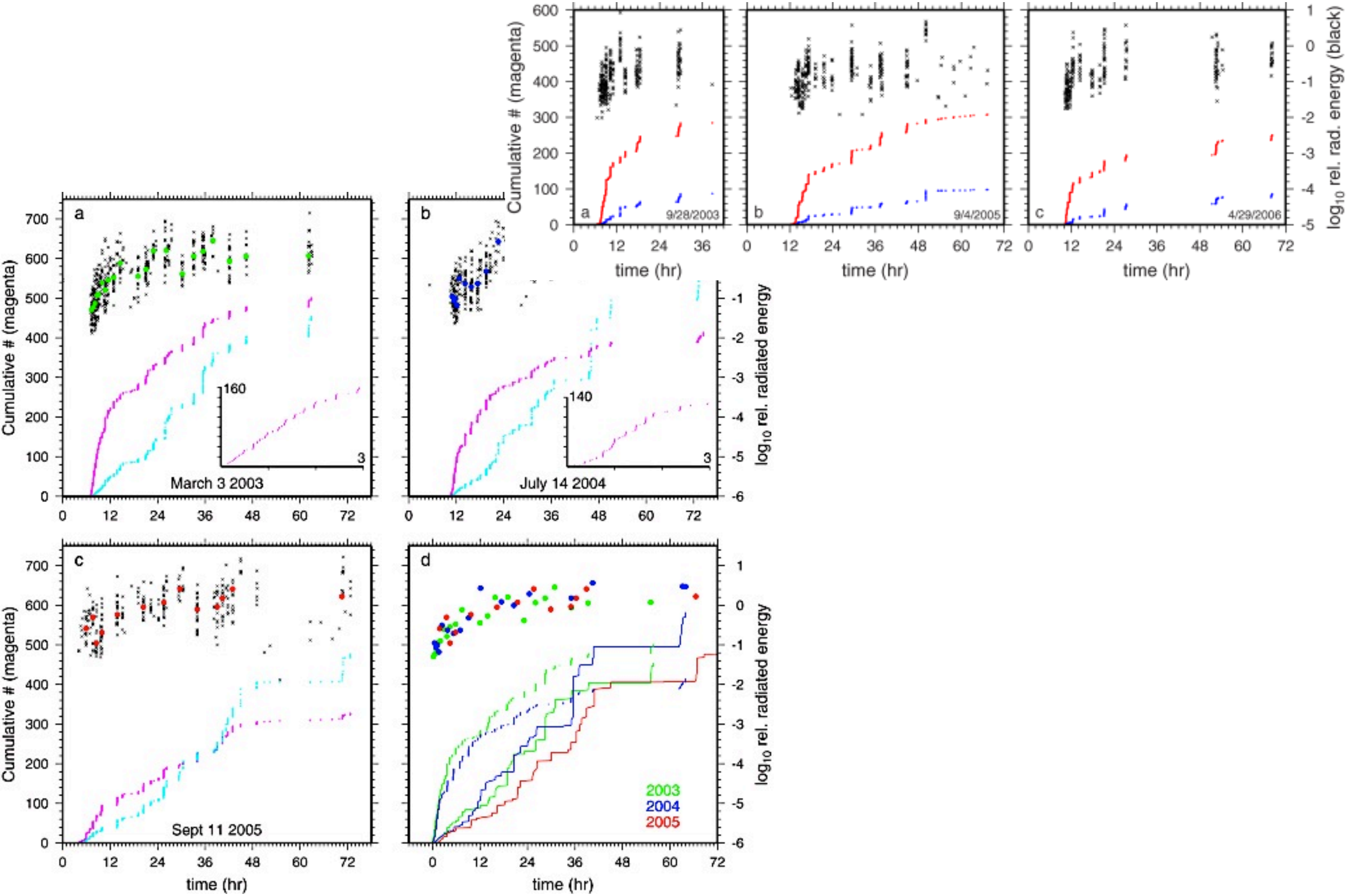
These burst show a time decay of $t^{-1/4}$ → It suggest the slow slip front propagates $d(t) \sim t^{1/2}$

Burst of all amplitudes exist

If indeed LFE rate is a proxy for slip rate suggest that slip rate is indeed composed of a sum of discrete short term episodes



Is the model valid ?



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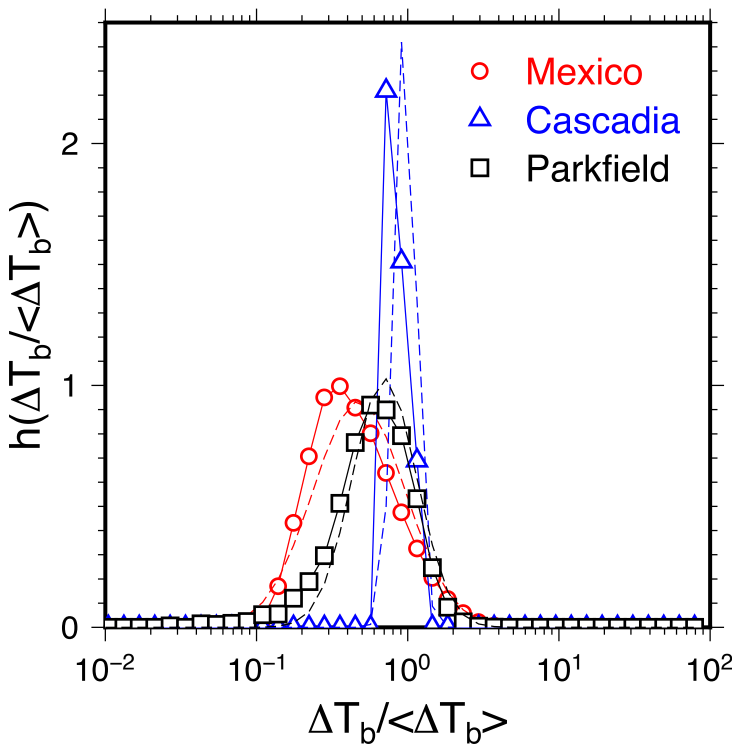
http://onlinelibrary.wiley.com/doi/10.1002/2013GC005031/full#ggge20305-fig-0009

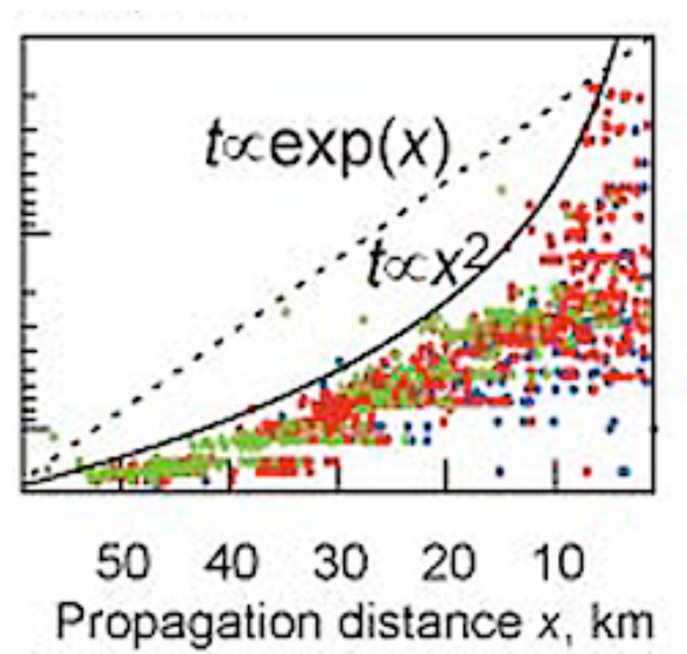
A log-normal recurrence time distribution



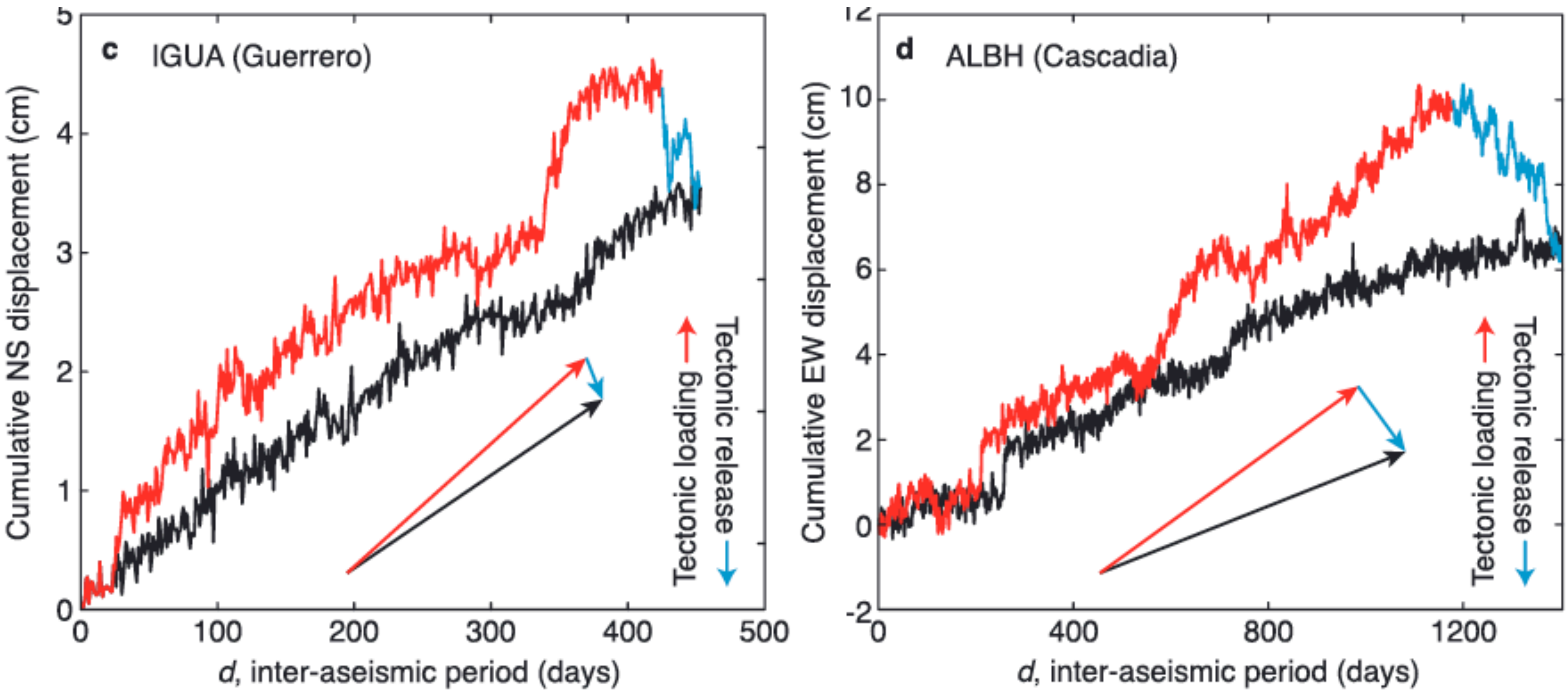
Locally the slip rate decays as $t^{-1/4}$

R&S friction models suggest that slip rate, v, behind the SSE front decays as a function of the distance from the front, d, as $v(d) \sim d^{-0.5}$

Implies that $d(t) \sim t^{1/2}$. It suggests that the SSE front propagates with a decaying speed.



Ando 2012


c
IGUA (Guerrero)
Cumulative NS displacement (cm)
d, inter-aseismic period (days)
Tectonic loading
Tectonic release
d
ALBH (Cascadia)
Cumulative EW displacement (cm)
d, inter-aseismic period (days)
Tectonic loading
Tectonic release