

SCEC Earthquake Simulator Comparison Project

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OUTLINE

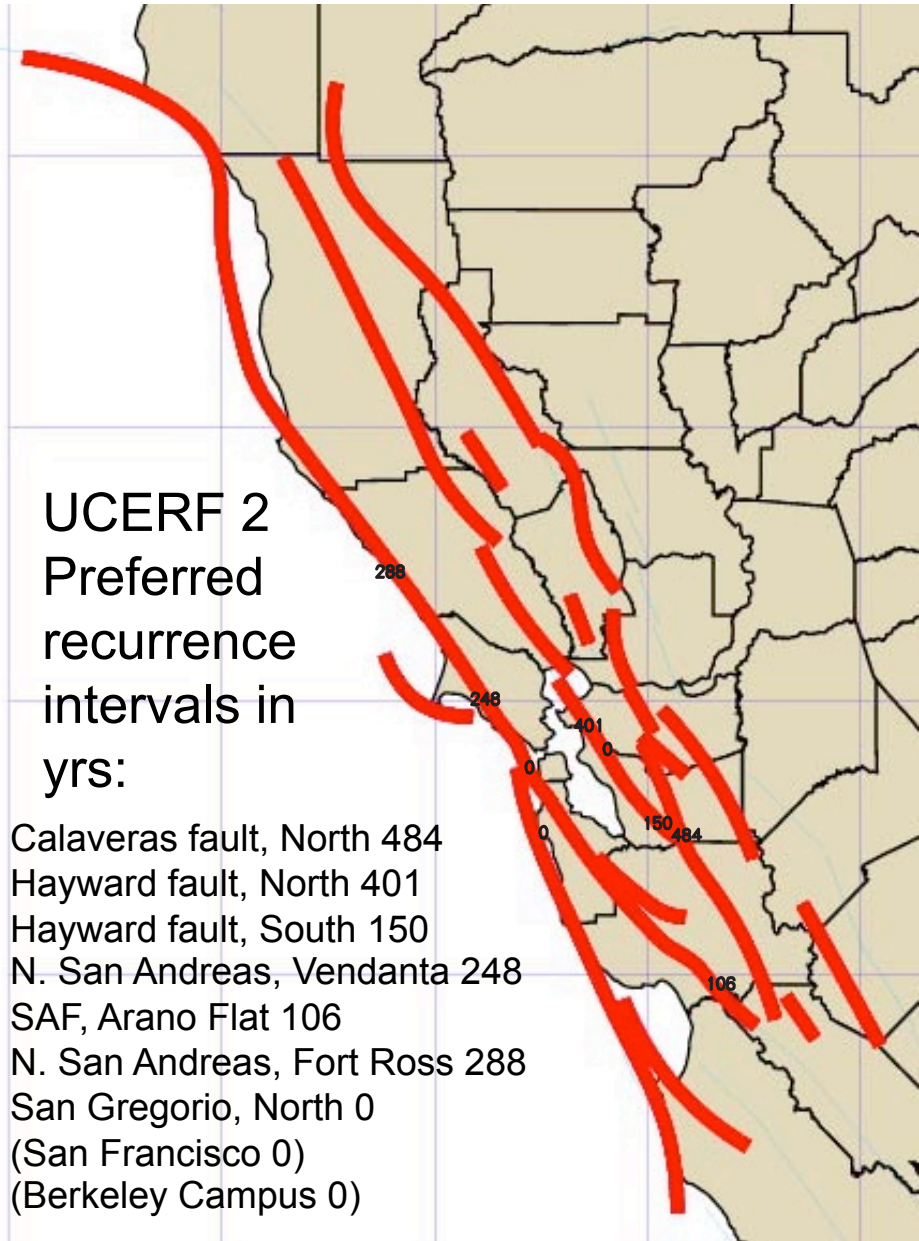
- Purpose and Nature of the Project
- Problem Geometry and 7 Paleoseismic Sites
- Space – Time Plots
- Frequency Magnitude Plots
 - For whole system and specific sites
 - Cumulative and interval representations
- Scaling: Length-Slip; Moment-Length; Moment-Area
- Moment and Event Rates as Function of Time
- Recurrence Statistics
 - Inter-event time PDFs as a function of Mag and Location
 - Compared with Paleoseismic Inter-event times
- Time vs. Slip Predictability from Slip-Time plots

Purpose and Nature of Project

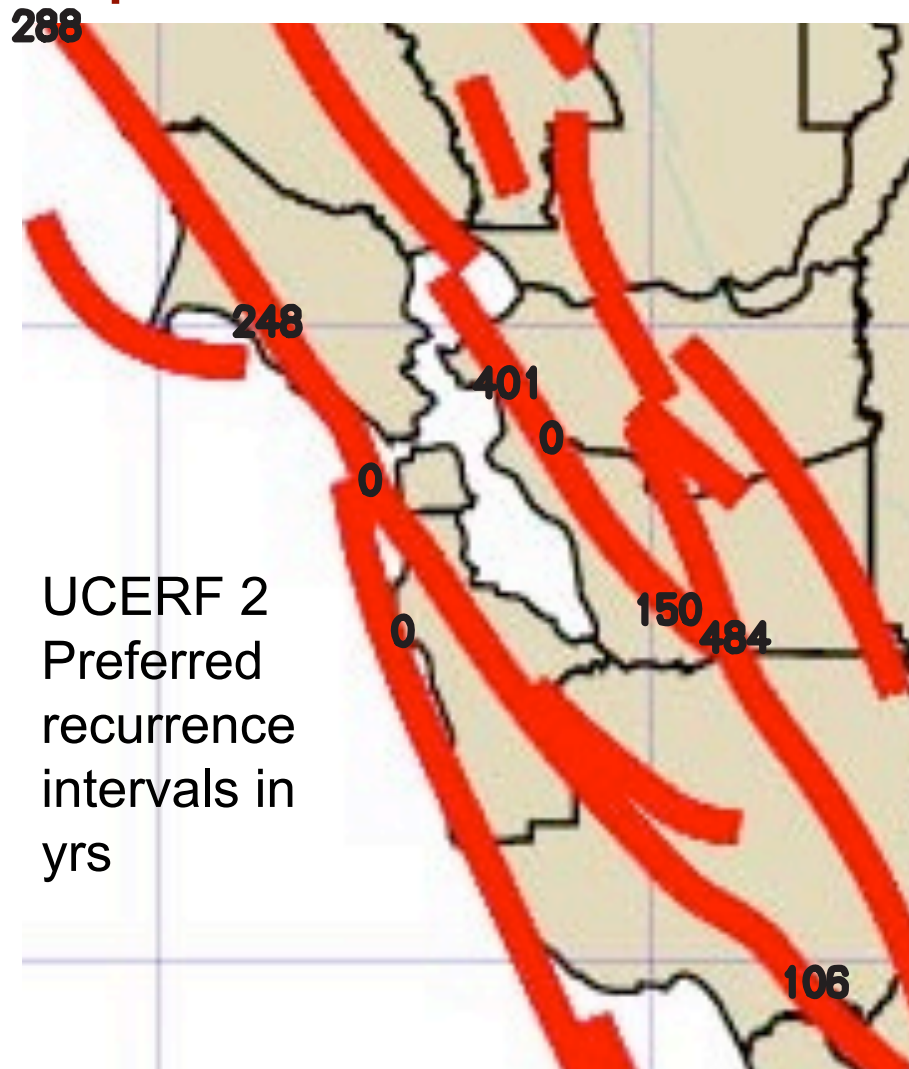
- To understand hazard better, we desire a statistical description of earthquakes for thousands of years
 - Instrumental, historic, and paleoseismic records are too short and/or too incomplete
- Earthquake simulators can generate long histories
- However, it is still unclear how realistic these are
- We are comparing the results of 5 earthquake simulators that can incorporate many faults
- This present talk is our first preliminary report and only covers Northern California strike-slip faults
- We plan to compare simulations for all of California in much more detail, “tuning” to match observations

Common Inputs / Different Approaches

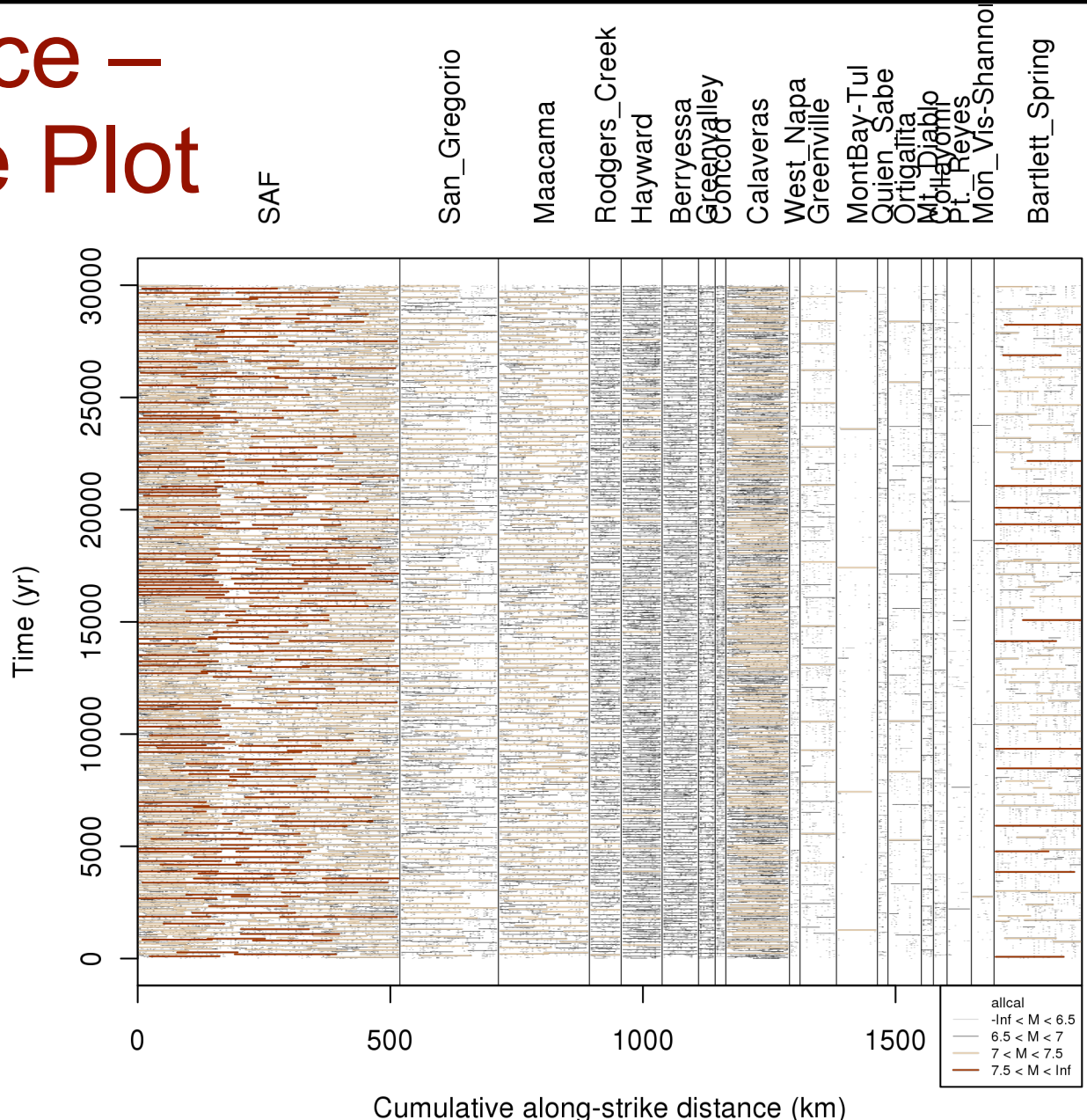
- We have developed a common set of input and output formats
 - Thus all the simulators read the same input data
 - The output can be processed identically and the results compared directly
 - Have some tools for processing output; will develop more
- Relatively well-known input is fault geometry and slip rates
- Assume variations in fault stress drops (“strength”), but constraints on this are not good
- Simulators differ in many ways
 - Representation of fault friction is one big difference
 - Another is whether dynamic triggering is approximated



norcal paleoseismic sites

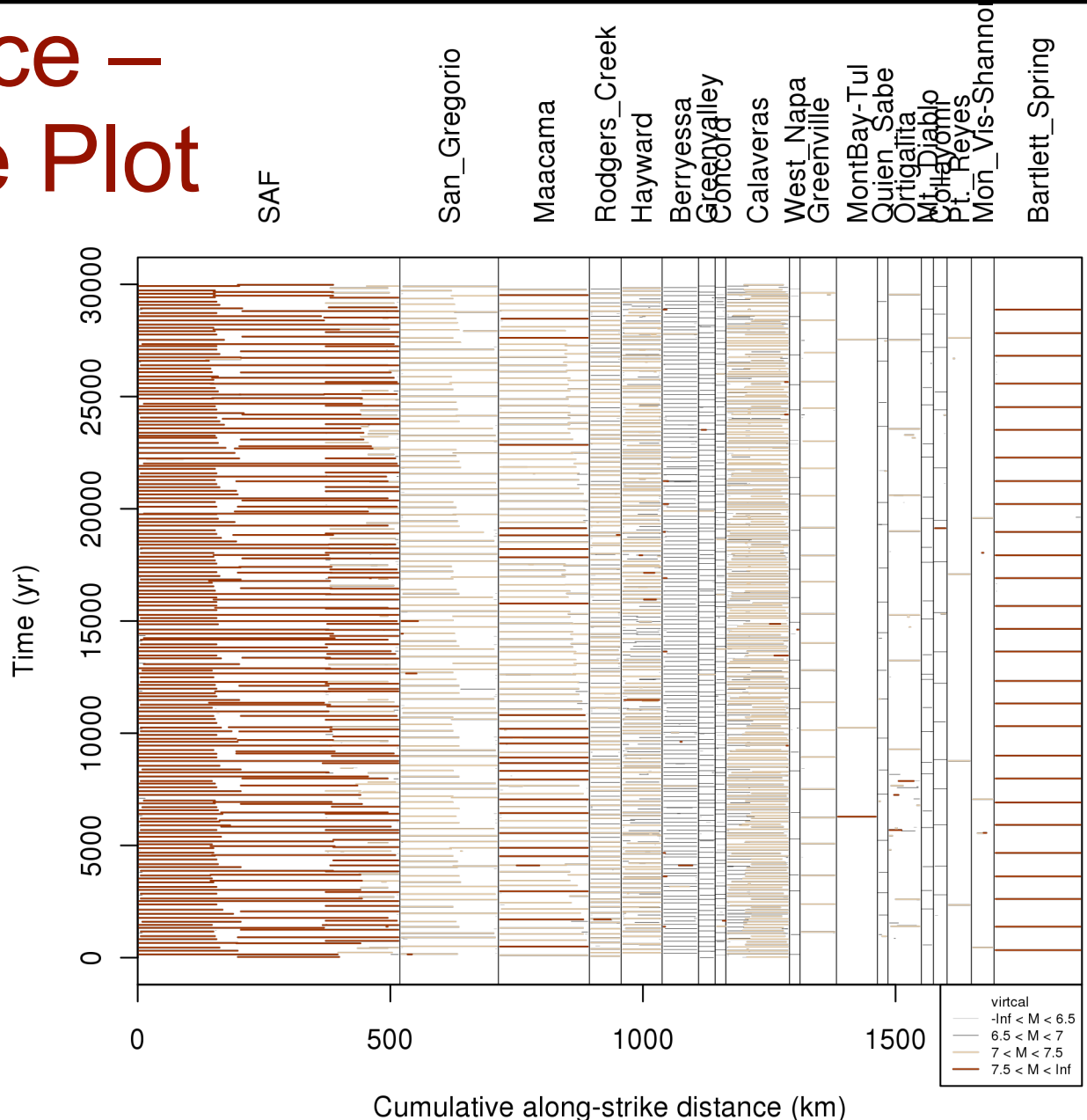


Space – Time Plot



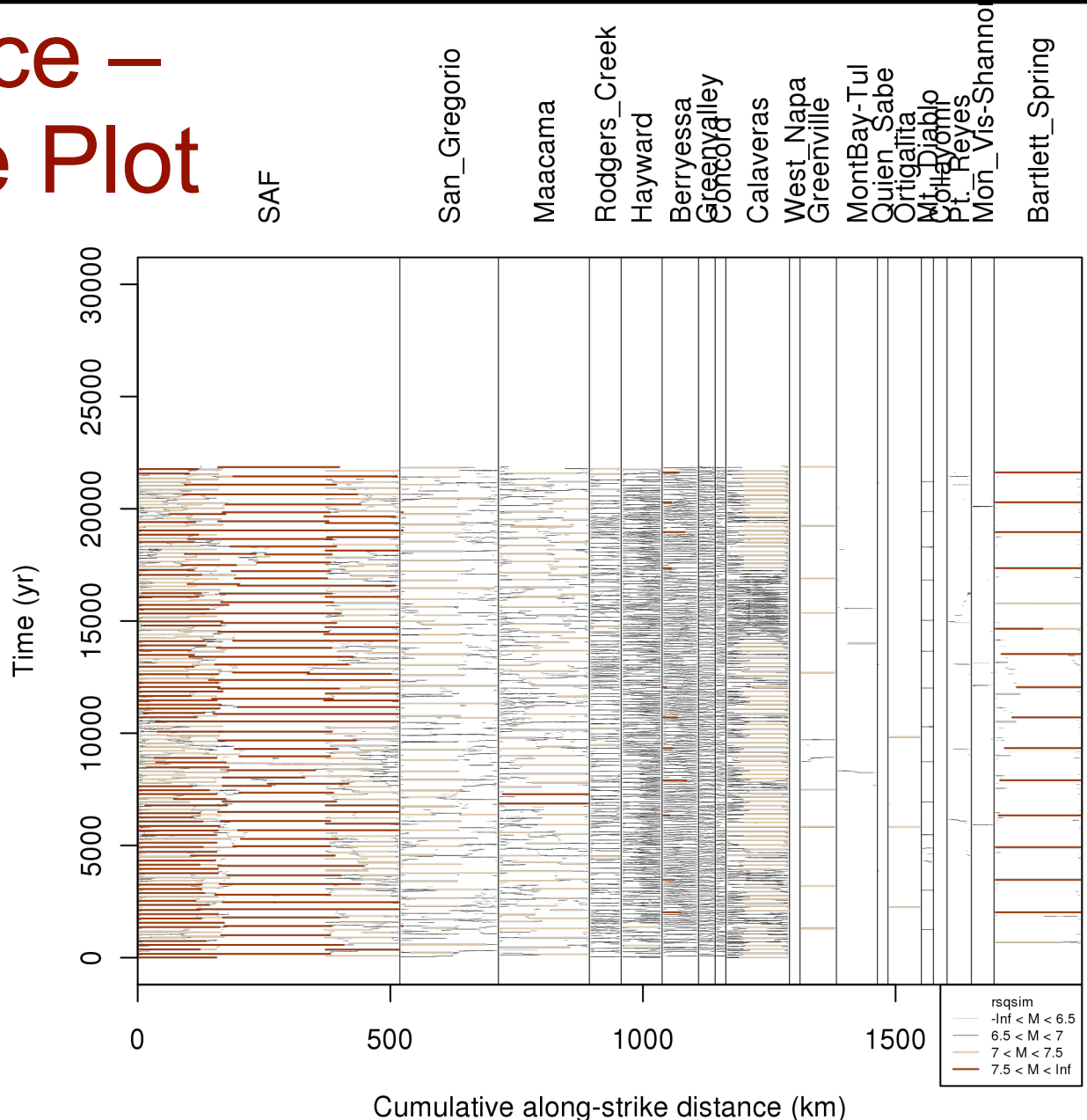
ALLCAL

Space - Time Plot



VIRTCAL

Space – Time Plot

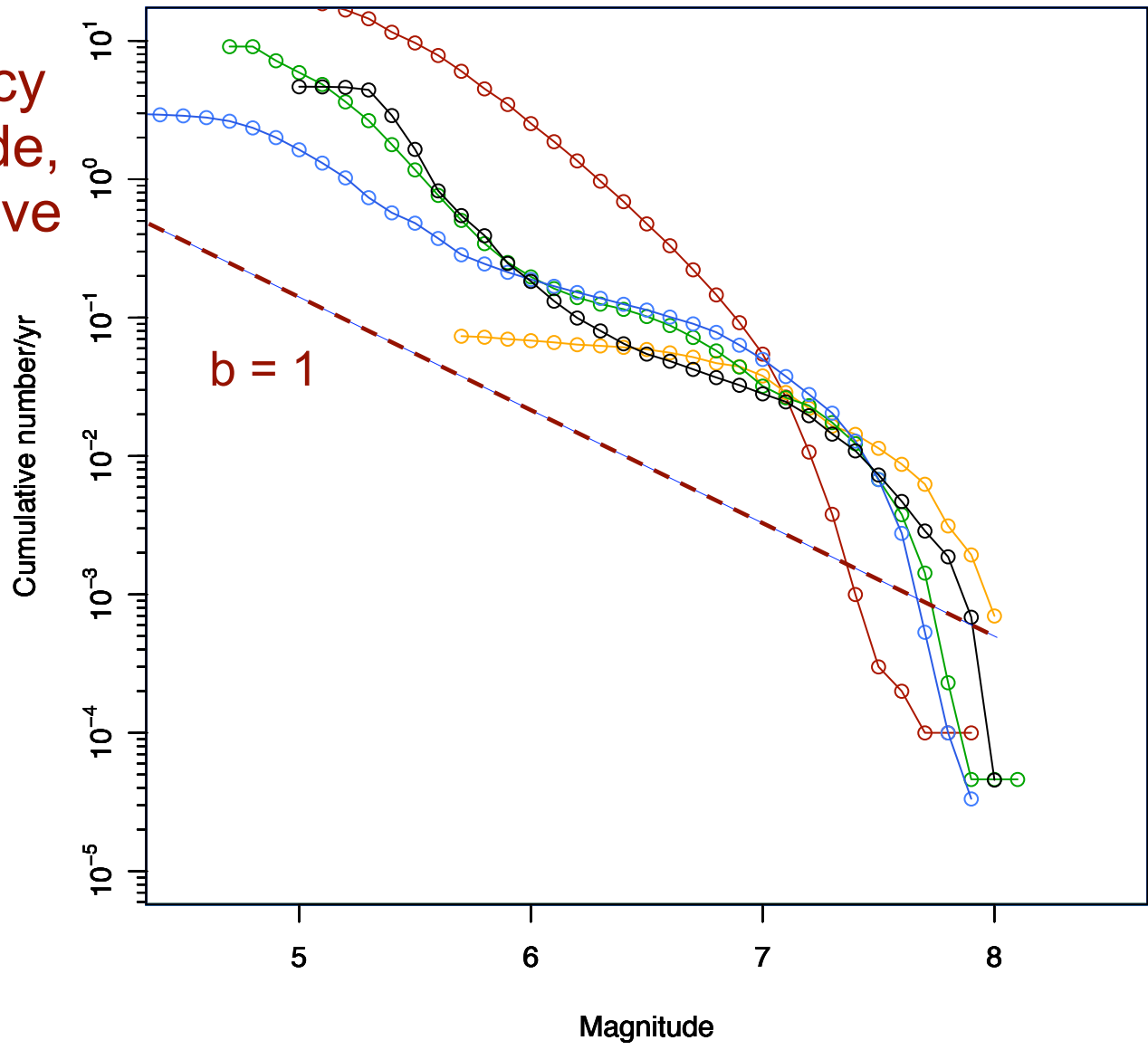


RSQSim

Frequency
Magnitude,
Cumulative

Entire AllCal fault system

Entire N CA
Fault System



ALLCAL

VIRTICAL

RSQSim

Pollitz

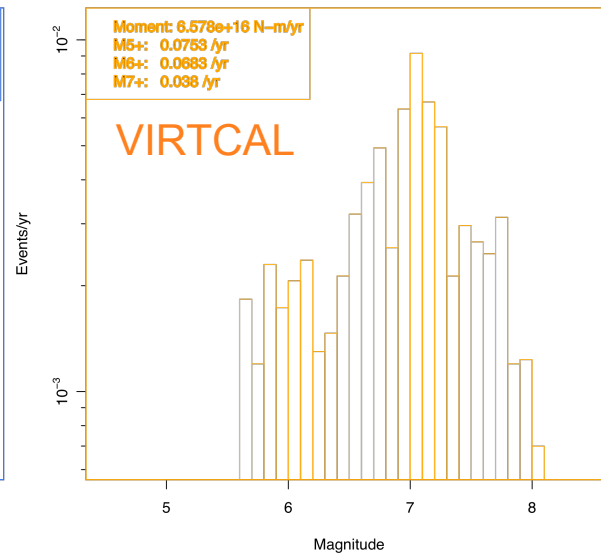
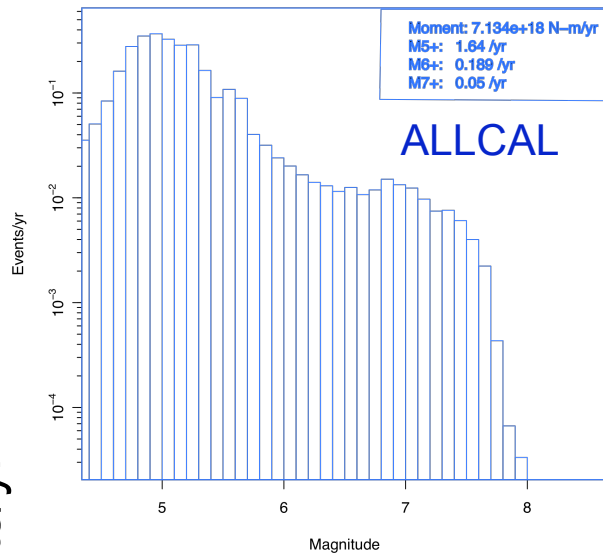
Zielke

allcal: Entire NorCal fault system

virtcal: Entire NorCal fault system

Entire N CA Fault System Interval Frequency Magnitude Distribution

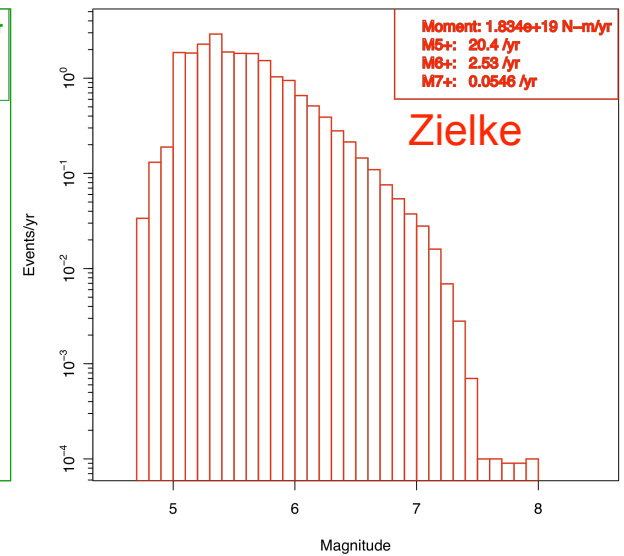
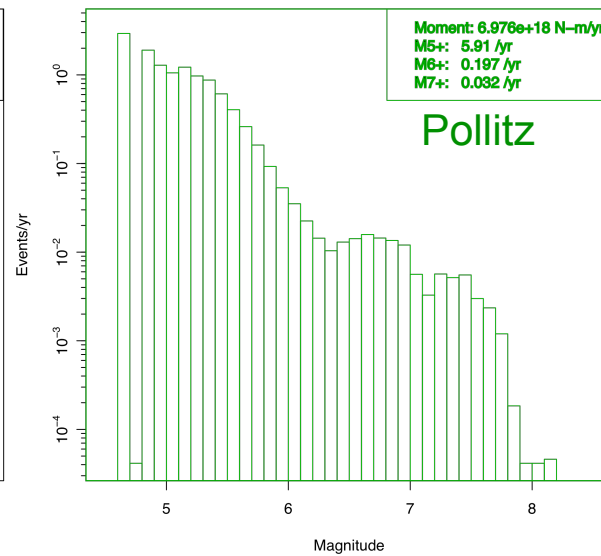
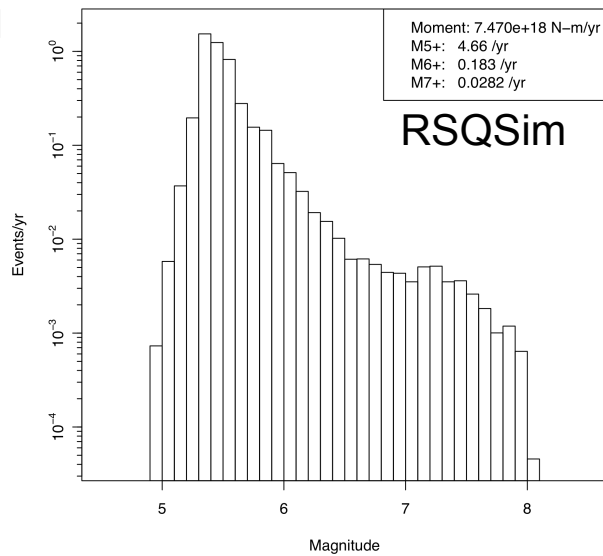
Events/yr



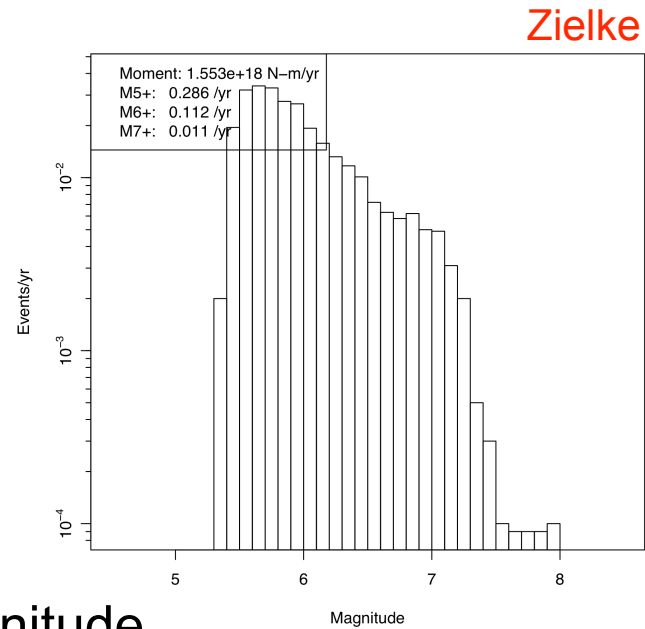
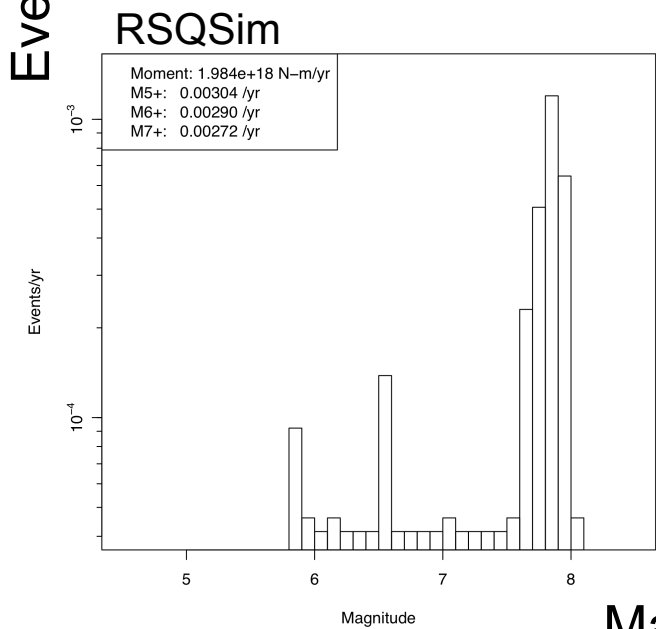
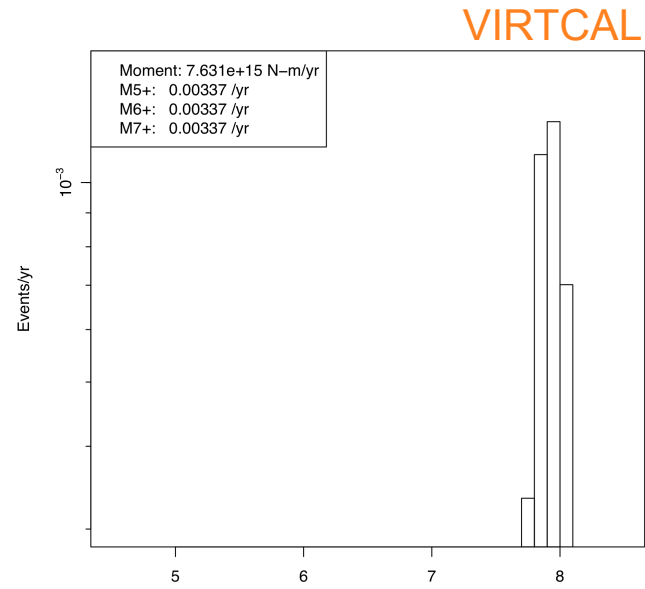
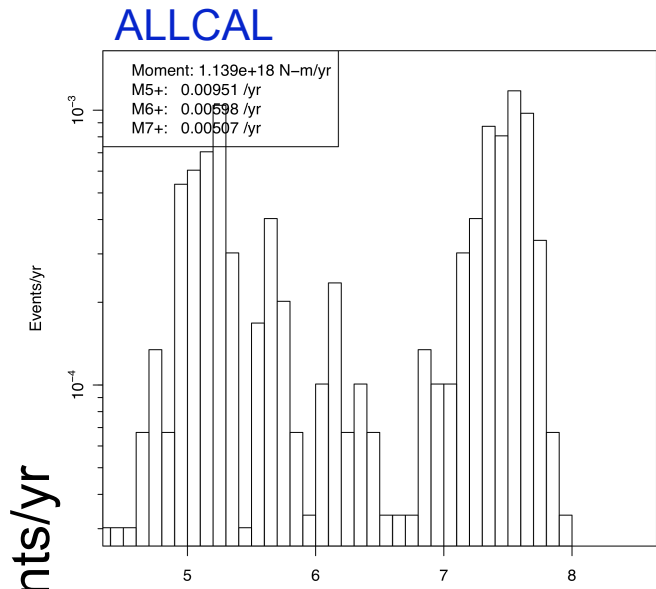
rsqsim: Entire NorCal fault system

pollitz: Entire NorCal fault system

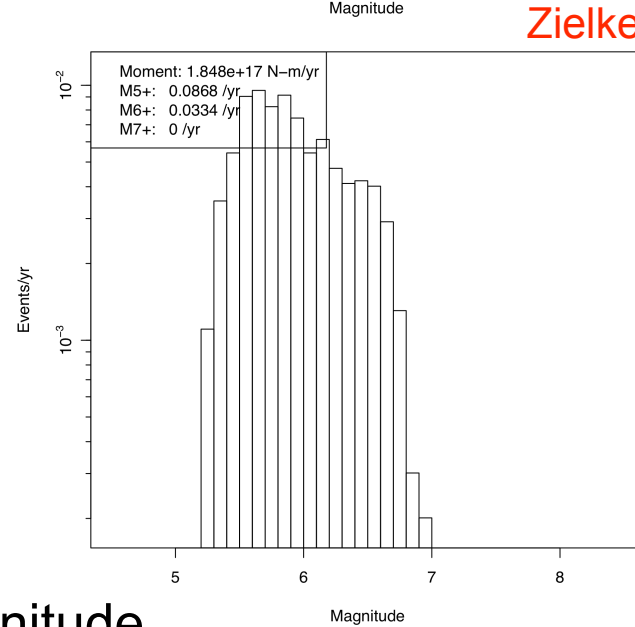
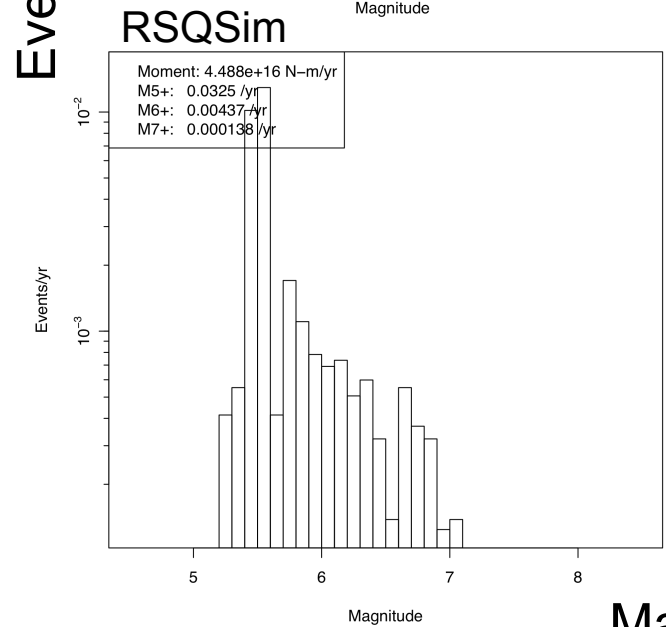
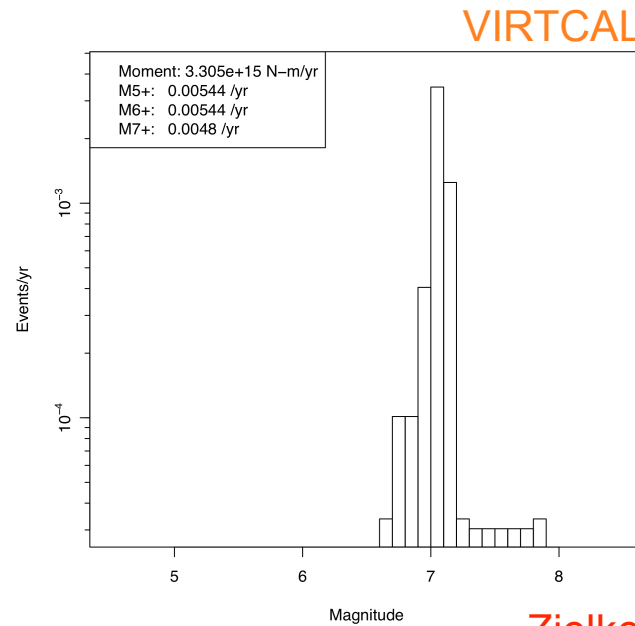
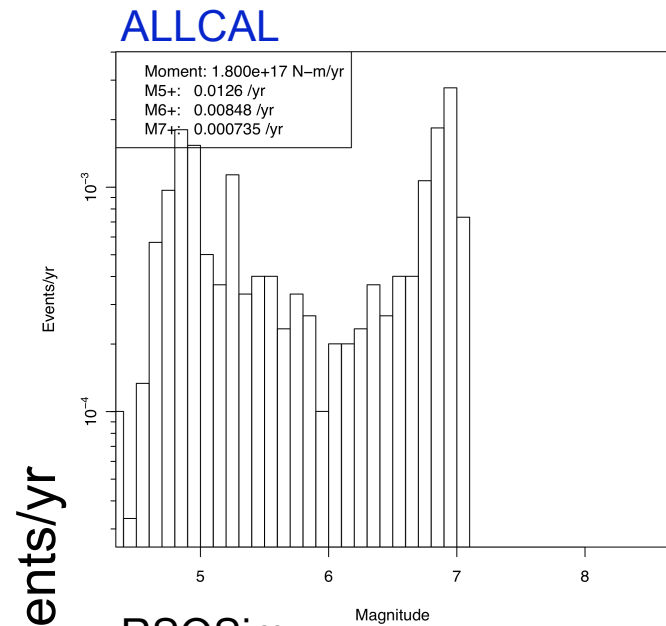
zielke: Entire NorCal fault system



Magnitude



San Andreas Fault, Fort Ross Interval Frequency Magnitude Distribution



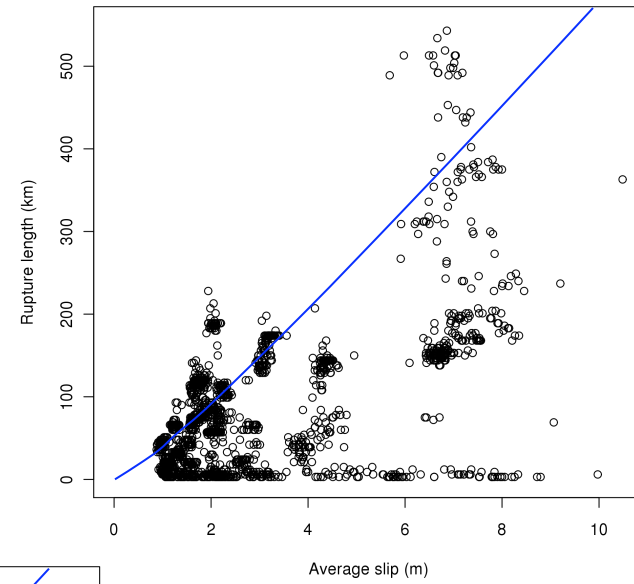
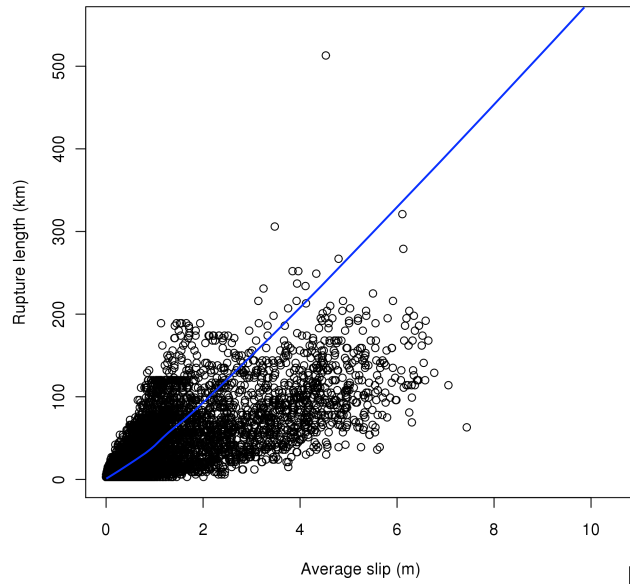
N Hayward Fault

Interval Frequency Magnitude Distribution

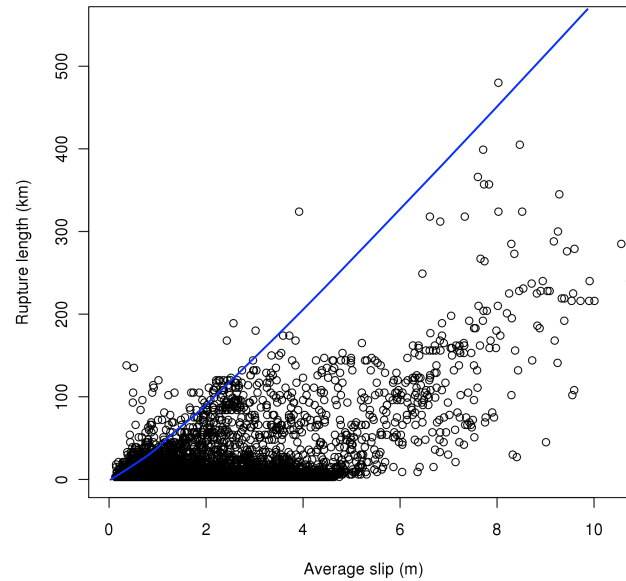
Length - Slip Scaling

ALCAL

VIRTCAL



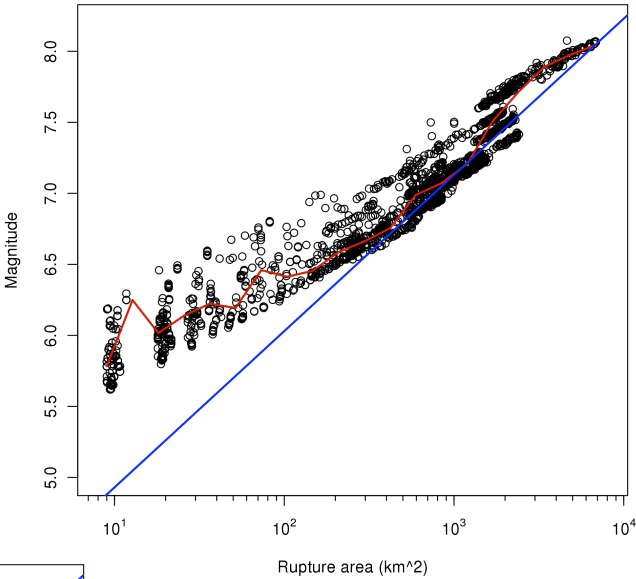
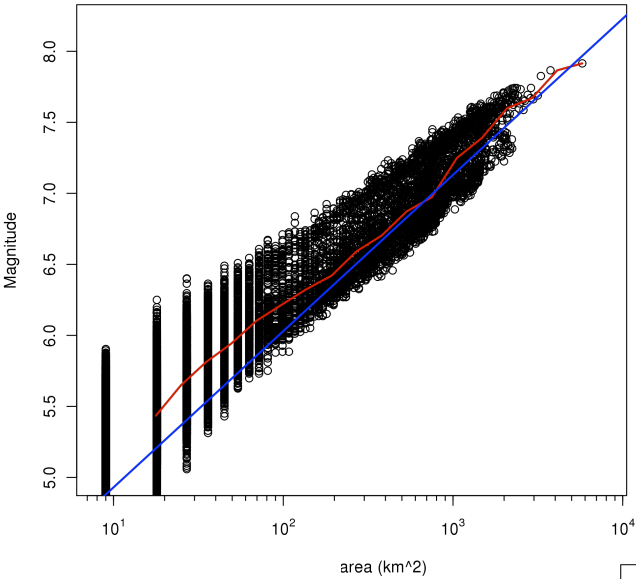
RSQSim



Moment - Area Scaling

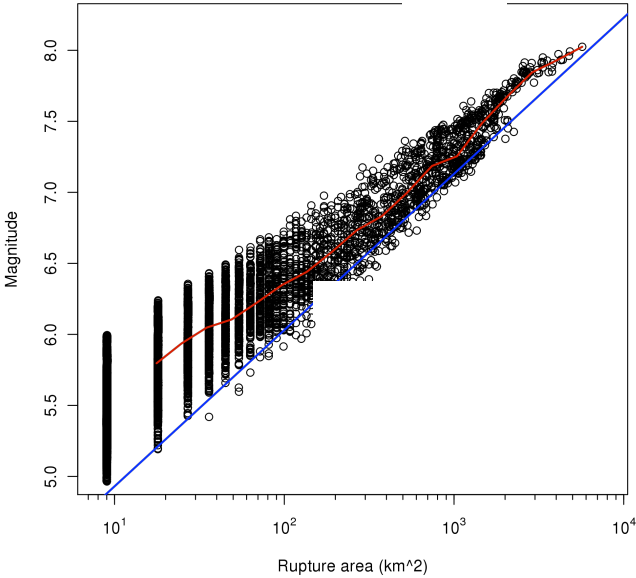
ALLCAL

VIRTICAL



Blue line is Wells and Coppersmith relationship

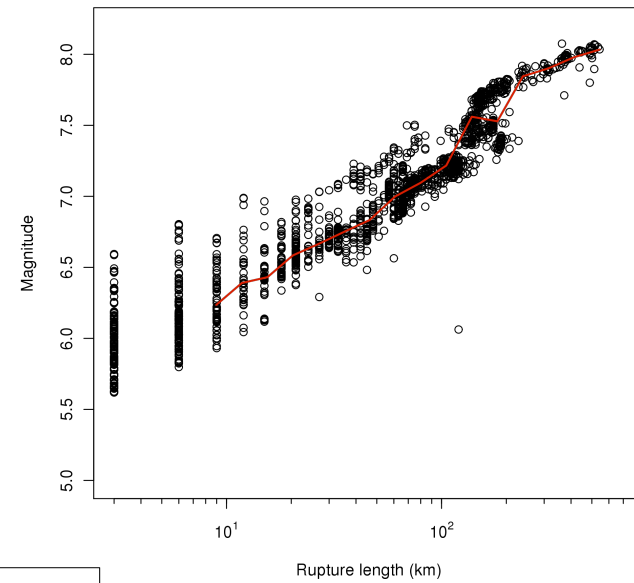
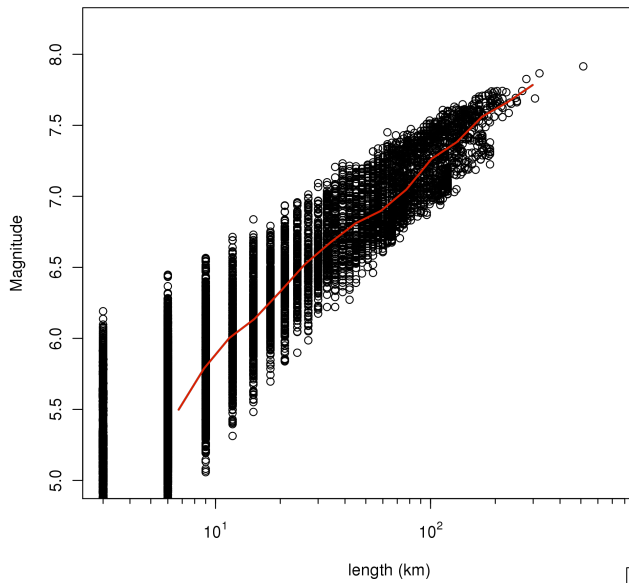
RSQSim



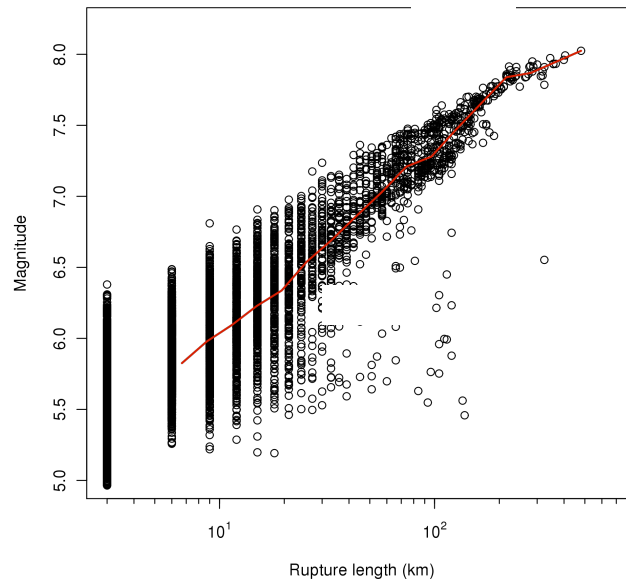
Moment - Length Scaling

ALLCAL

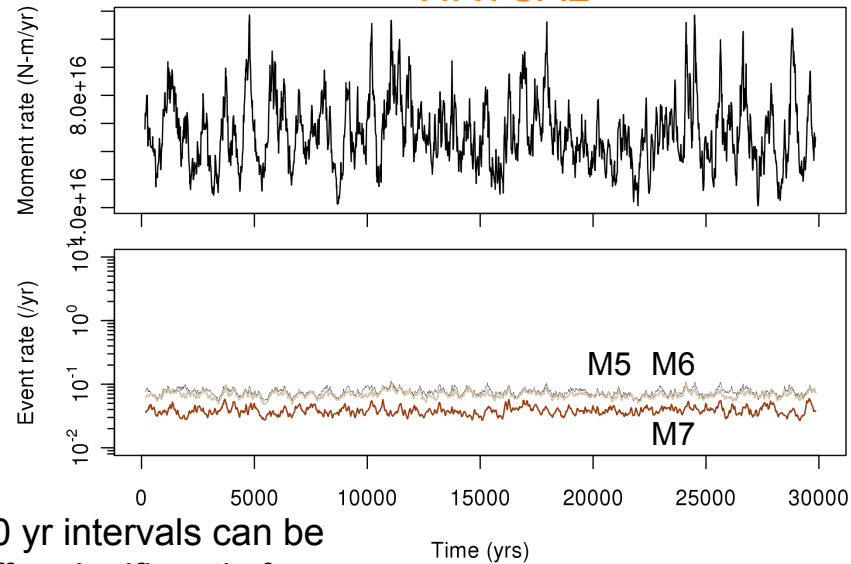
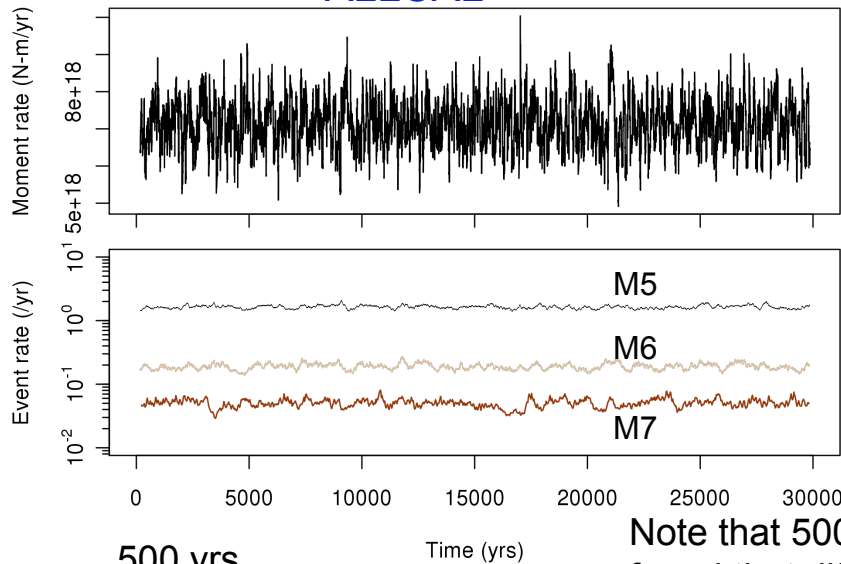
VIRTICAL



RSQSim



ALLCAL Moment and Event Rates VIRTICAL

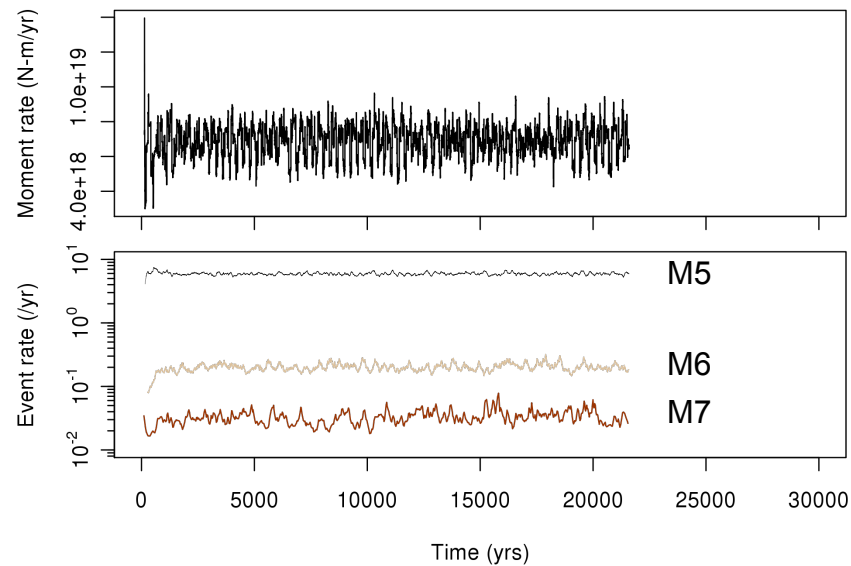
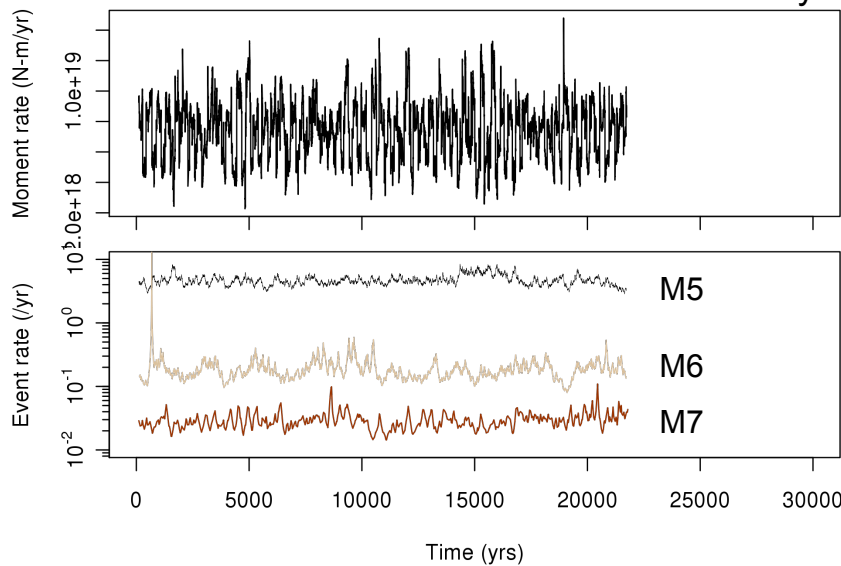


500 yrs

RSQSim

Note that 500 yr intervals can be found that differ significantly from other 500 yr intervals

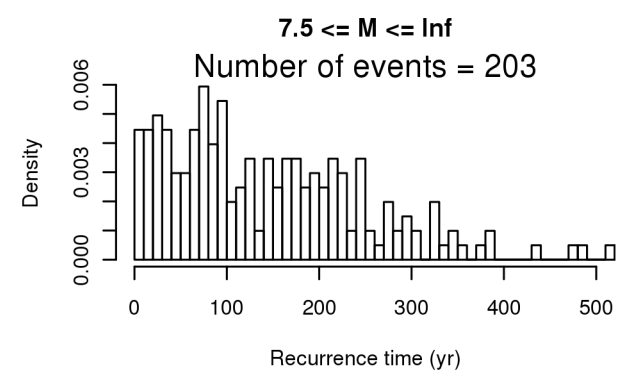
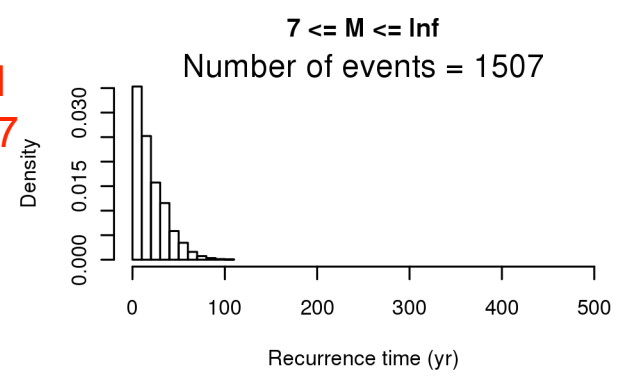
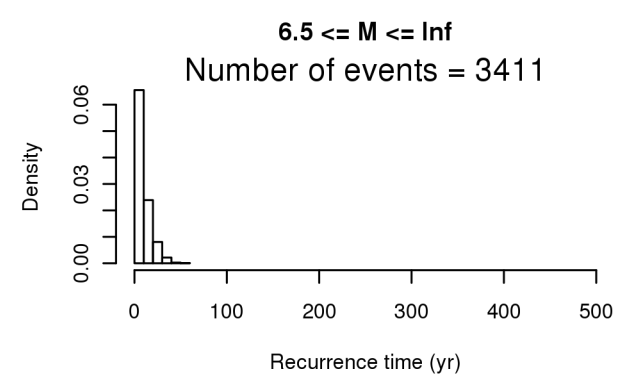
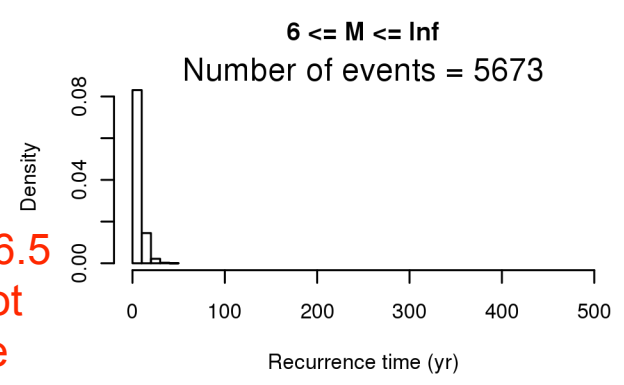
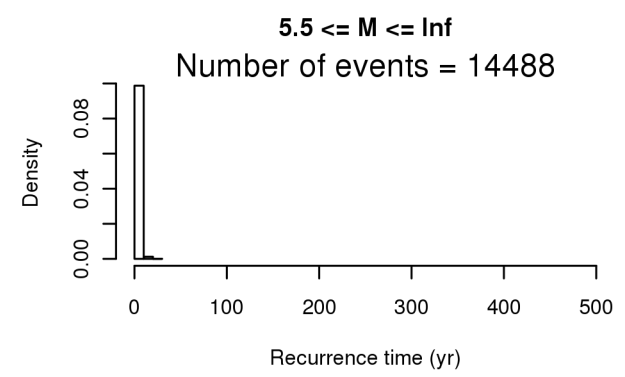
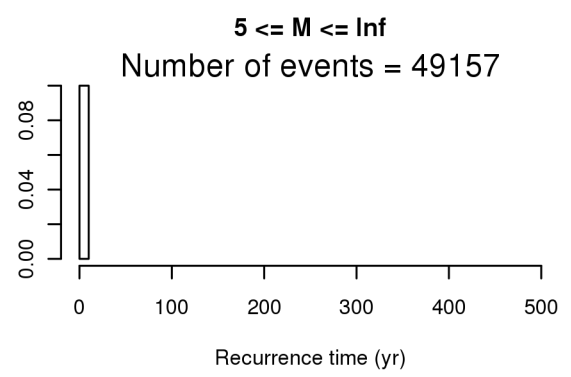
Pollitz



allcal: Entire NorCal fault system

PDFs of Inter-event Times

ALLCAL

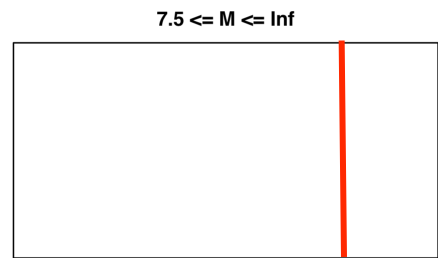
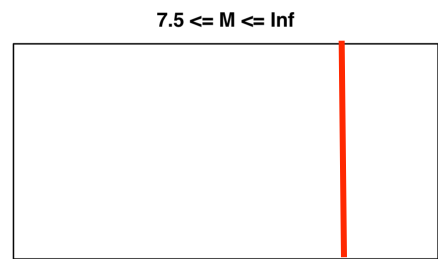
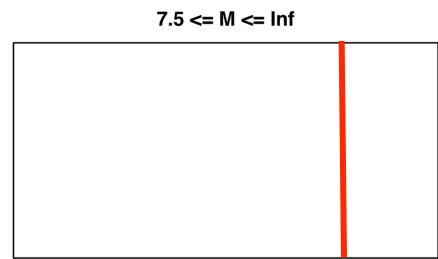
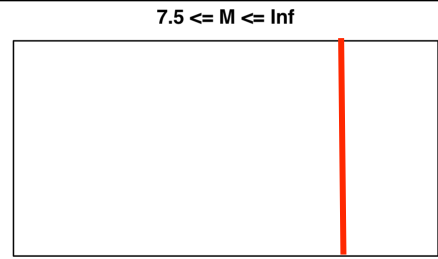
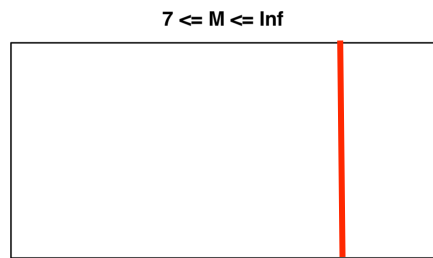
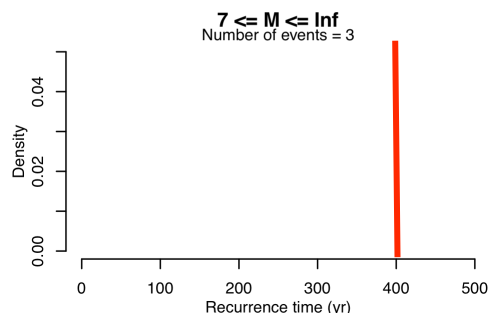
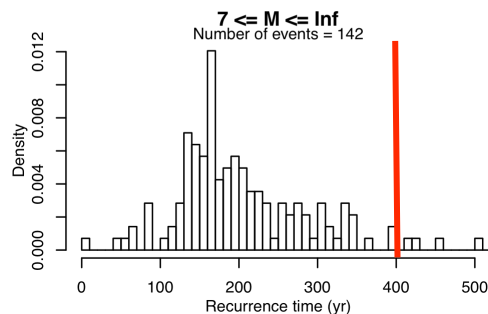
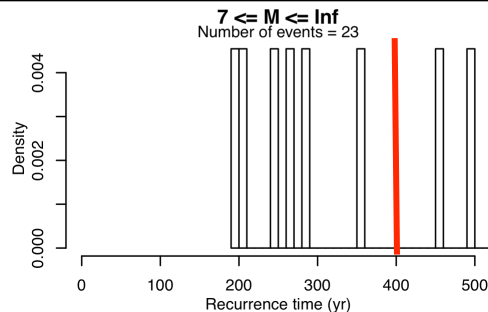


Note that M5-6.5 events may not show up in the paleoseismic record – thus next slides will only show >M7

Probability Distribution Functions of Inter-event Times

North Hayward Fault

Red lines show paleoseismic preferred interevent time from UCERF2



ALLCAL

VIRTCAL

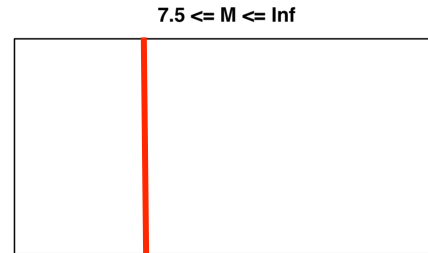
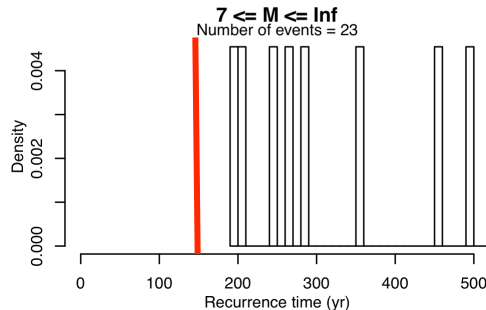
RSQSim

Zielke

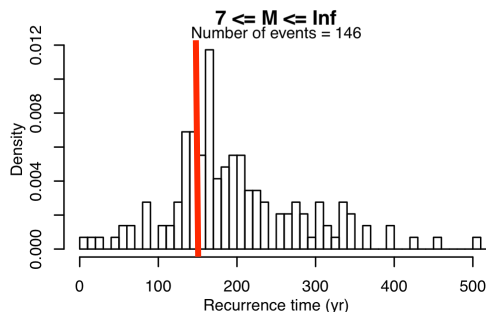
Probability Distribution Functions of Inter-event Times

South Hayward Fault

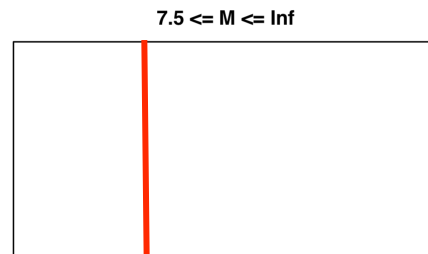
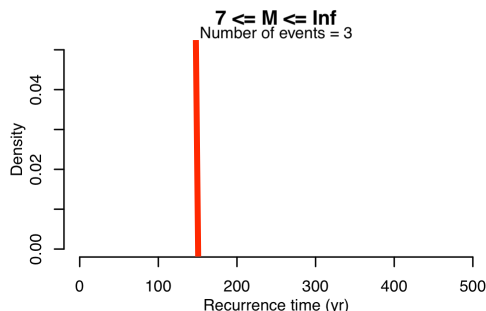
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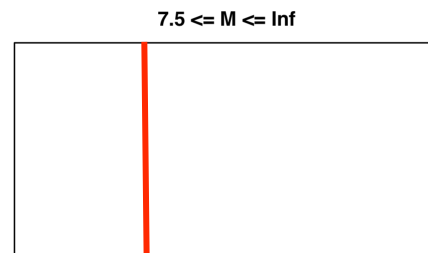
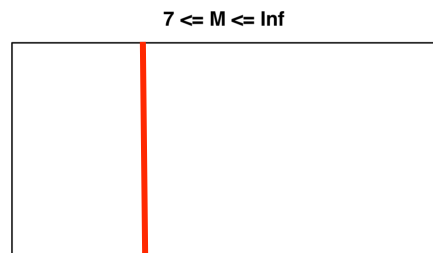
ALLCAL



VIRTICAL



RSQSim

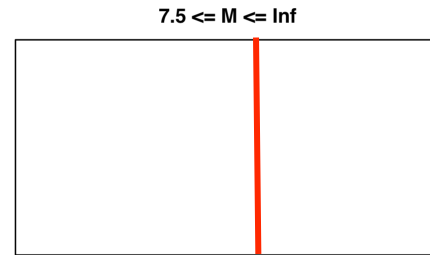
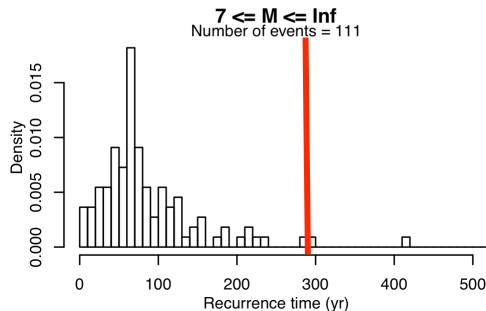
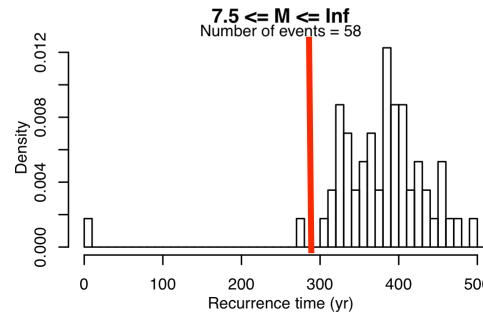
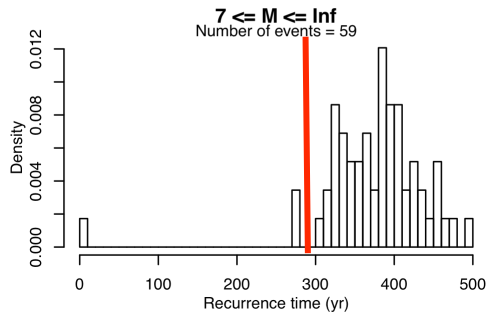
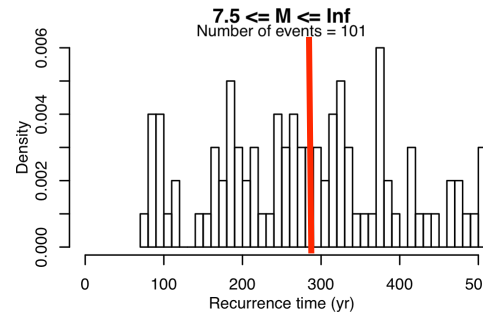
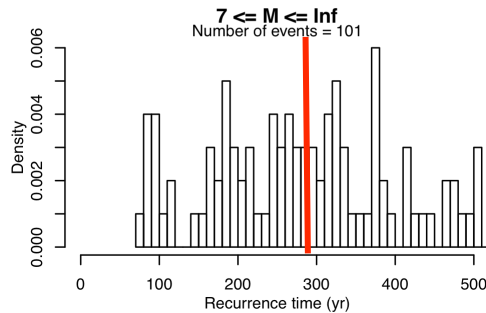
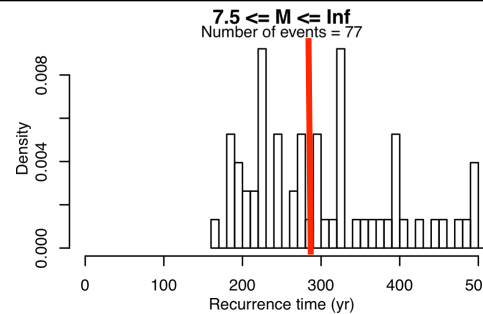
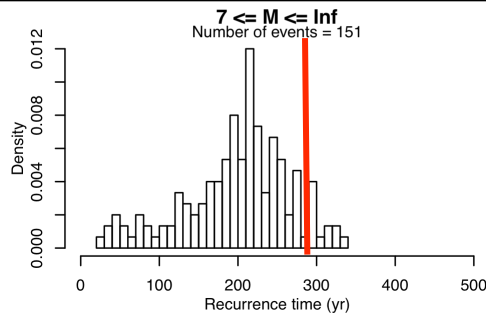


Zielke

Probability Distribution Functions of Inter-event Times

San Andreas Fault, Fort Ross

Red lines show paleoseismic preferred interevent time from UCERF2



ALLCAL

VIRTICAL

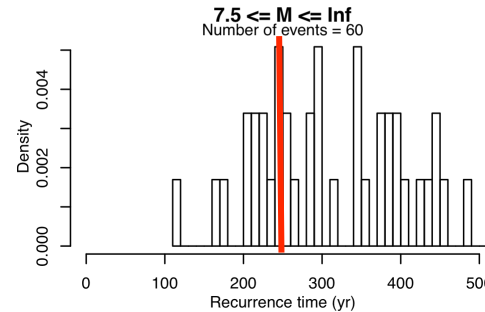
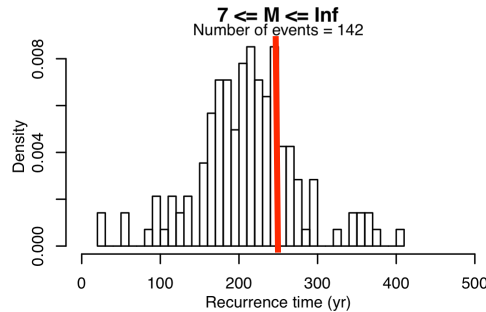
RSQSim

Zielke

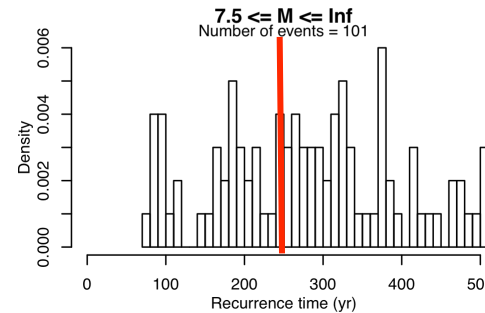
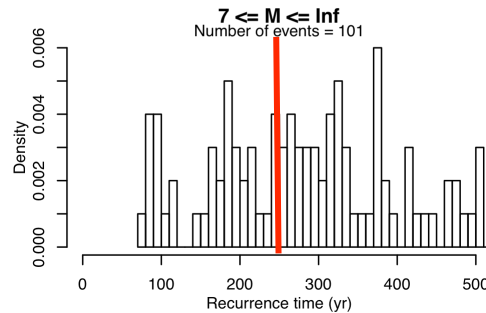
Probability Distribution Functions of Inter-event Times

San Andreas Fault, Vendanta

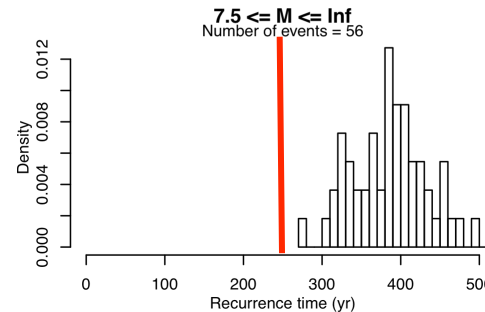
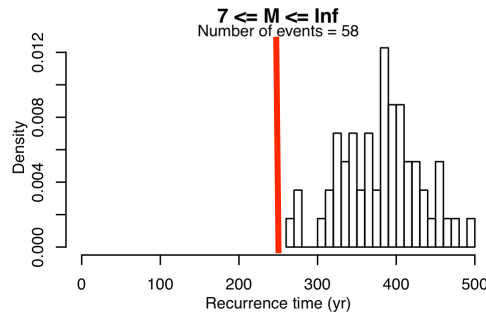
Red lines show paleoseismic preferred interevent time from UCERF2



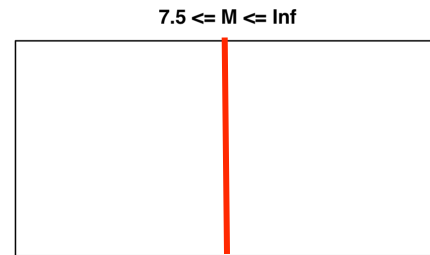
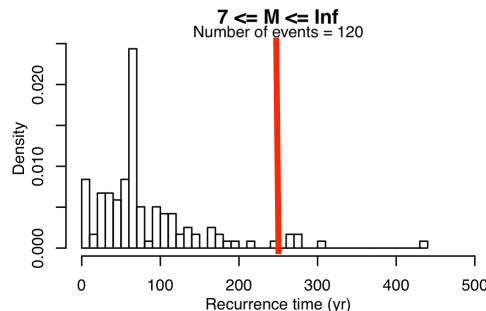
ALLCAL



VIRTICAL



RSQSim

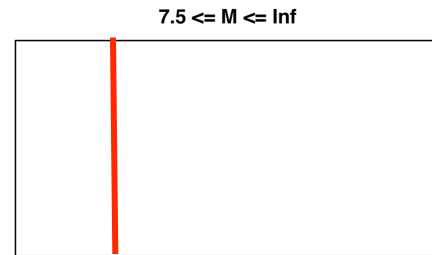
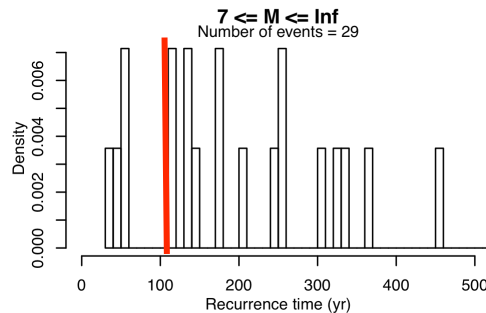
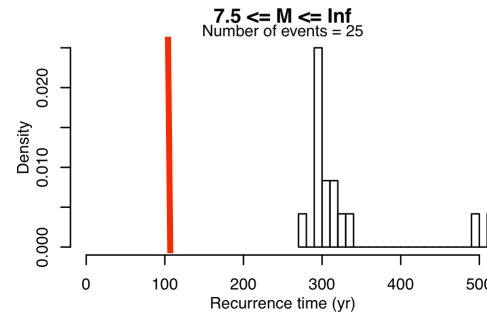
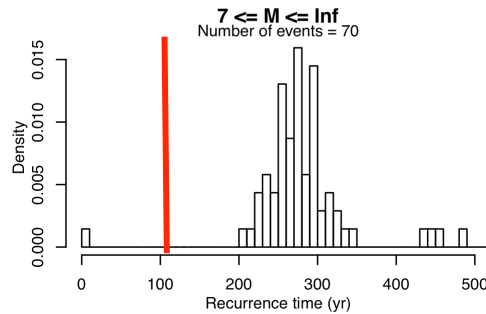
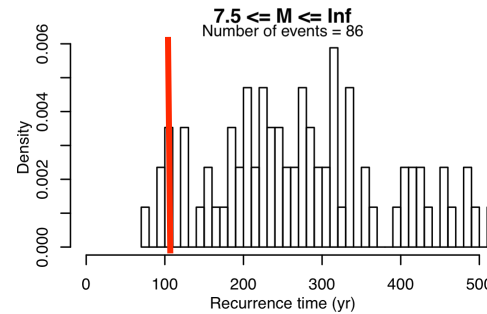
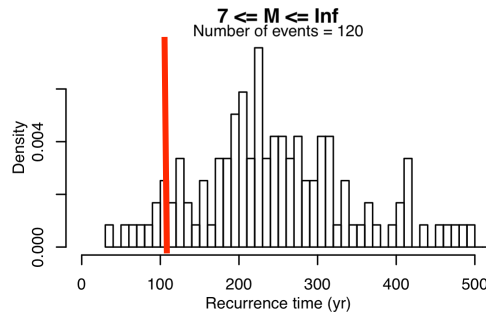
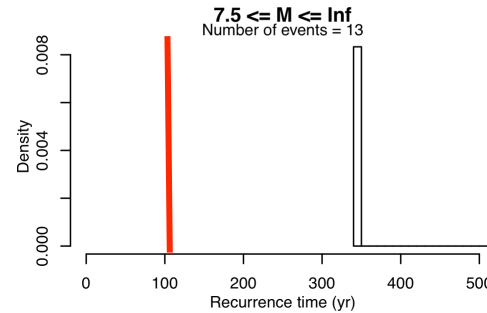
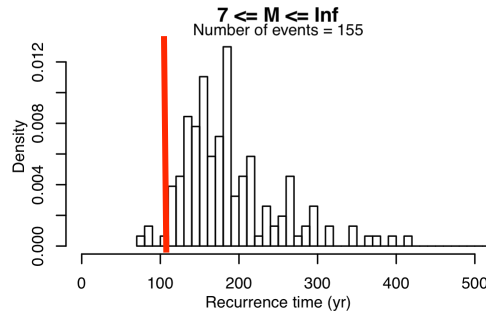


Zielke

Probability Distribution Functions of Inter-event Times

San Andreas Fault, San Arano

Red lines show paleoseismic preferred interevent time from UCERF2



ALLCAL

VIRTCAL

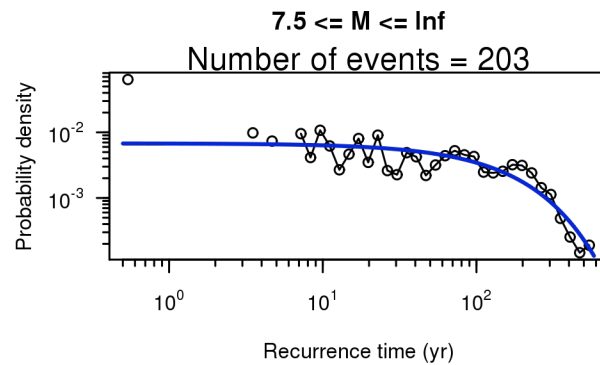
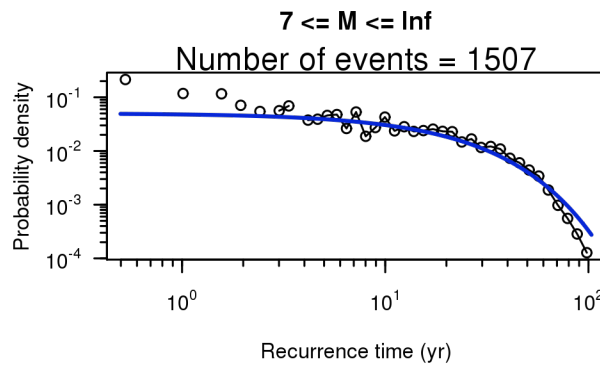
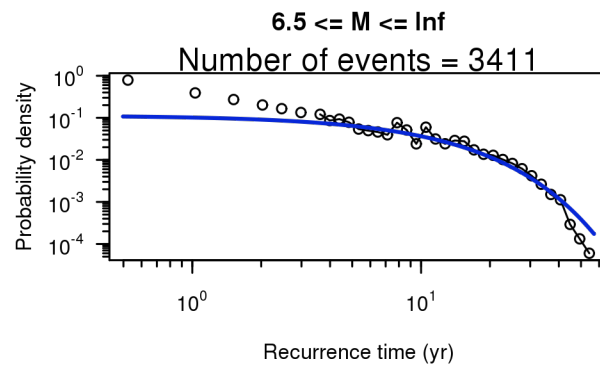
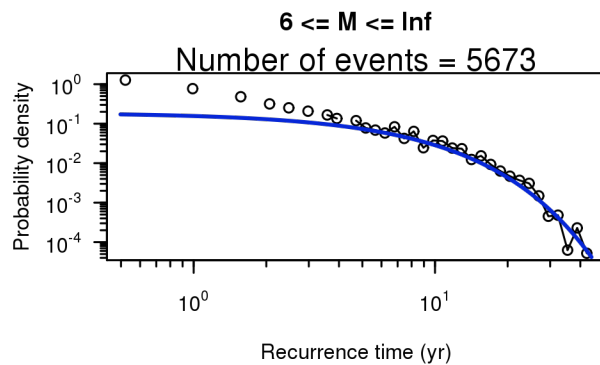
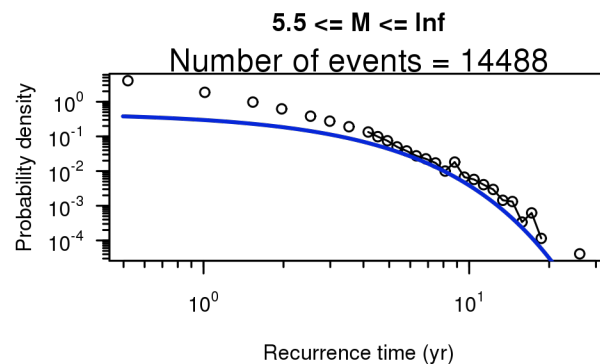
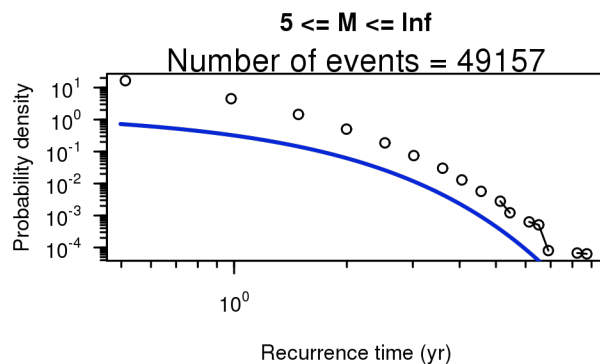
RSQSim

Zielke

allcal: Entire NorCal fault system

PDFs of Inter-event Times, Log-time scale

Entire System

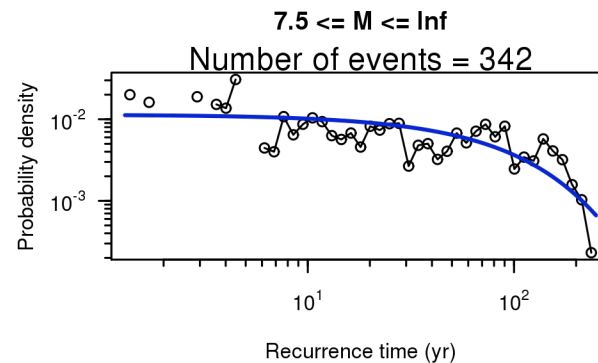
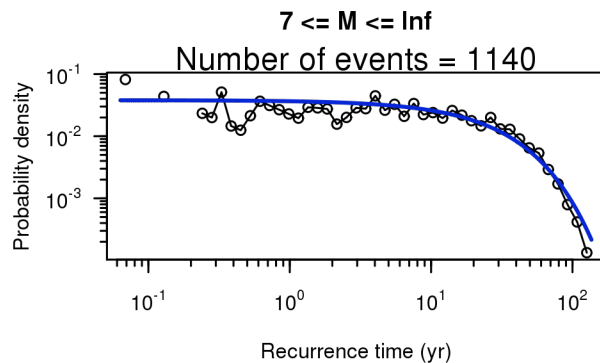
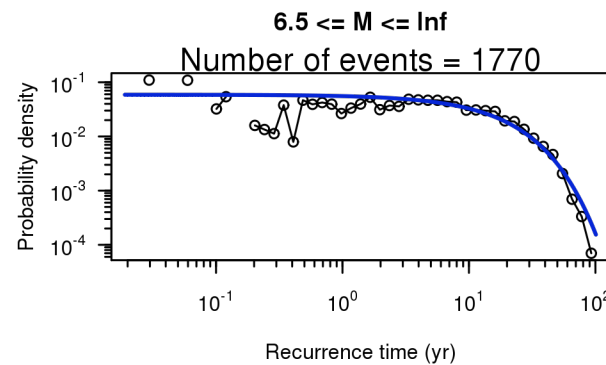
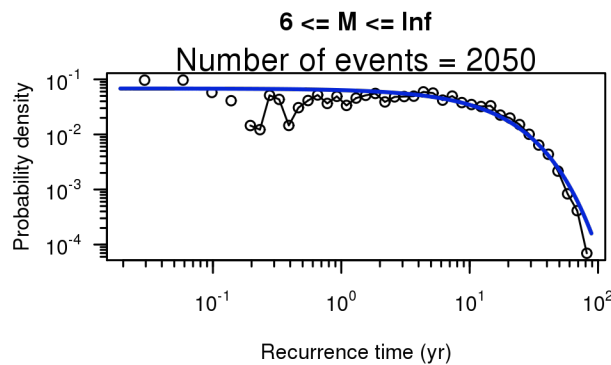
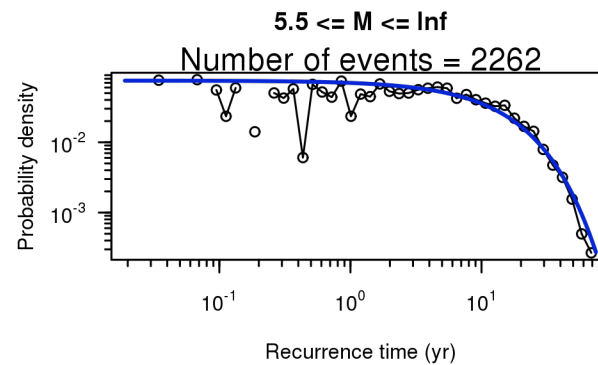
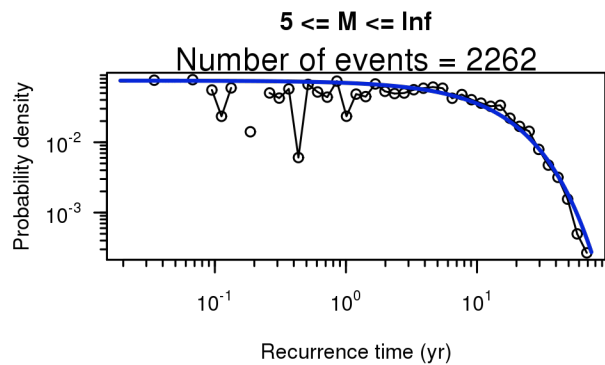


ALLCAL

Blue curves are Poisson process with same average rate as data

PDFs of Inter-event Times, Log-time scale

Entire System

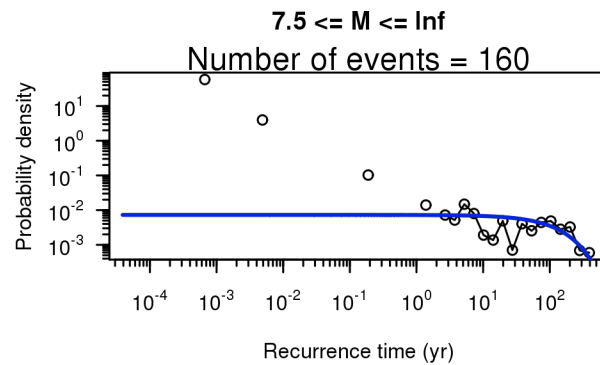
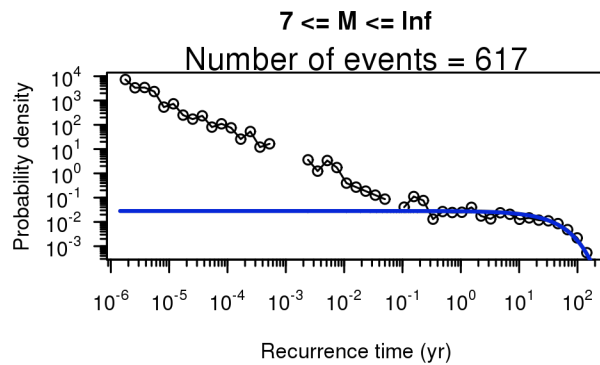
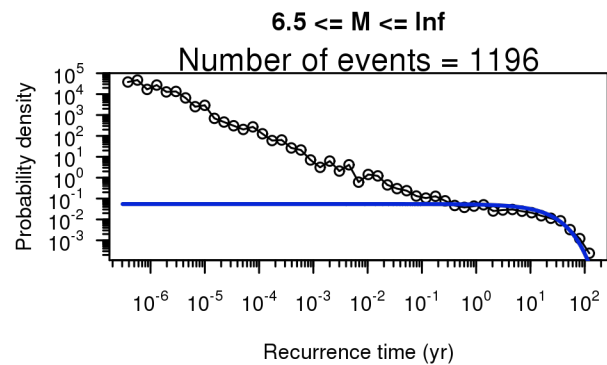
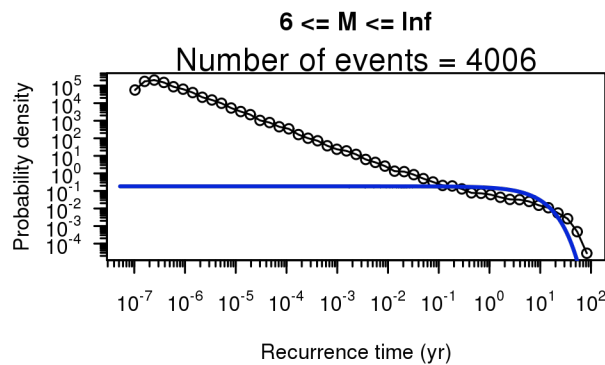
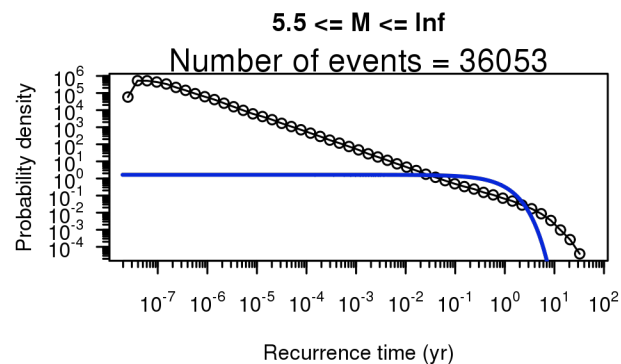
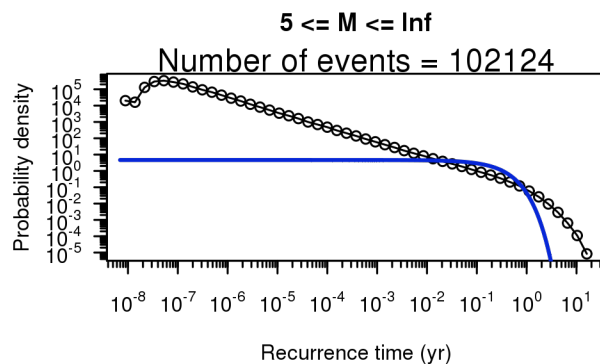


VIRTICAL

Blue curves are Poisson process with same average rate as data

PDFs of Inter-event Times, Log-time scale

Entire System

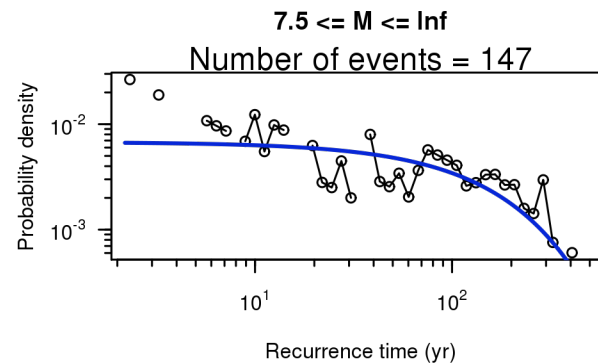
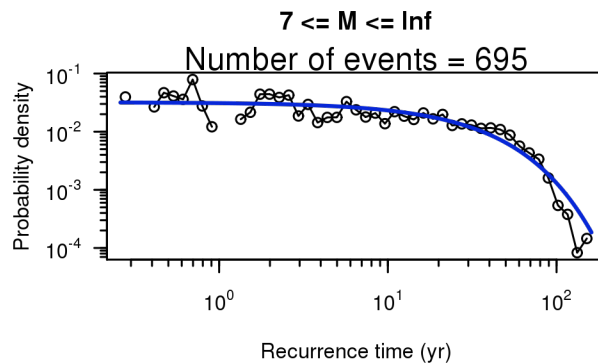
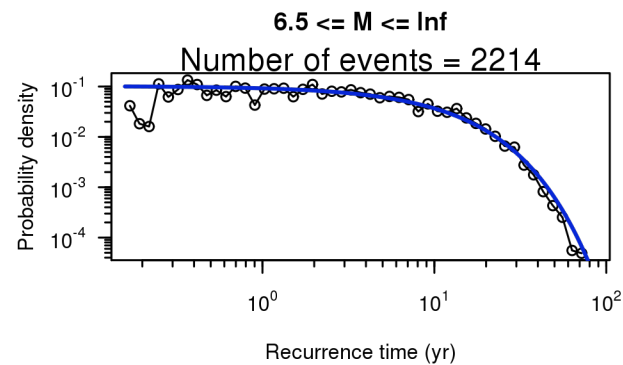
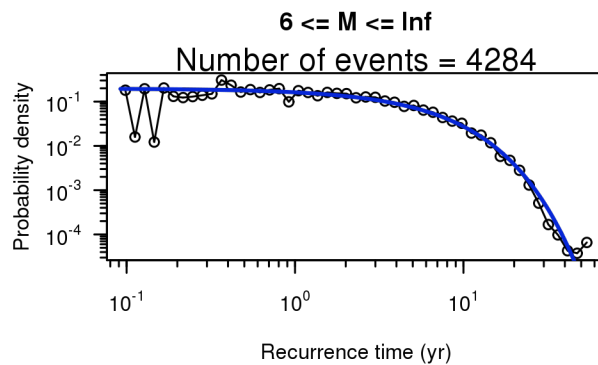
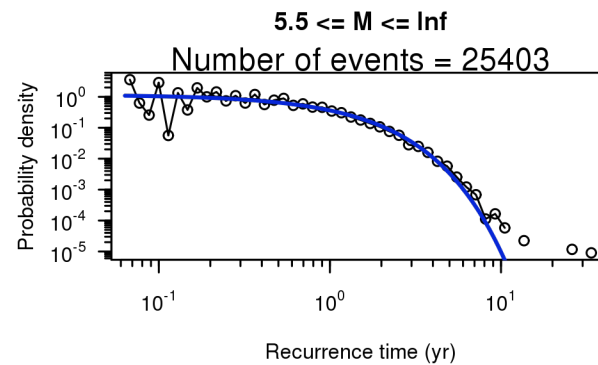
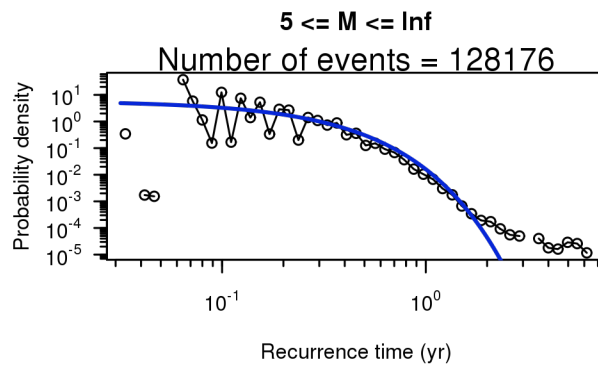


RSQSim

Blue curves are Poisson process with same average rate as data

PDFs of Inter-event Times, Log-time scale

Entire System

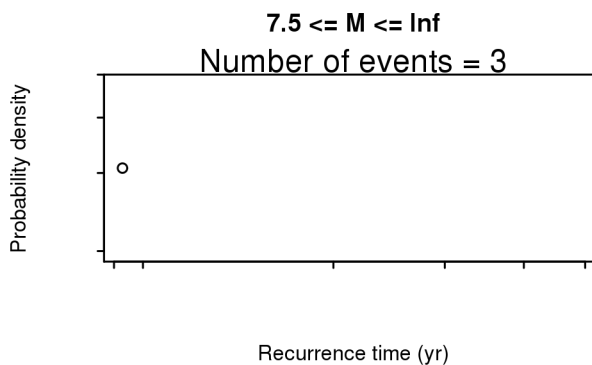
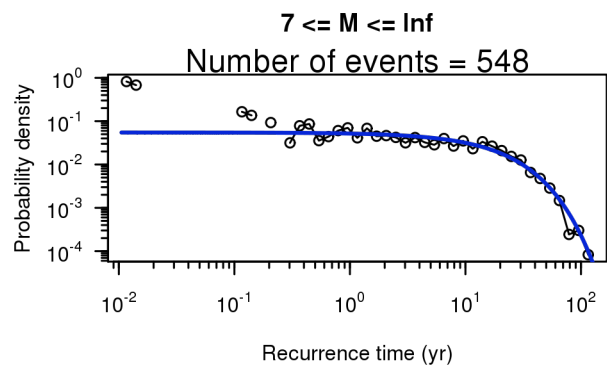
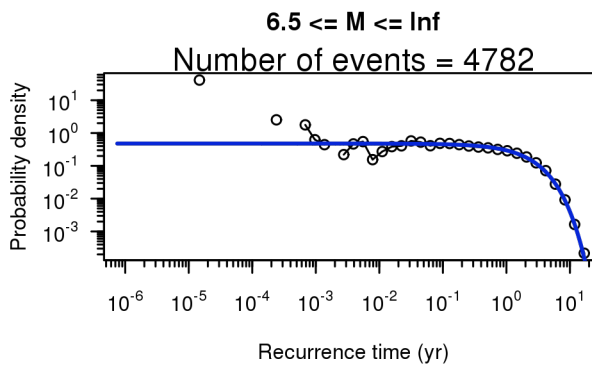
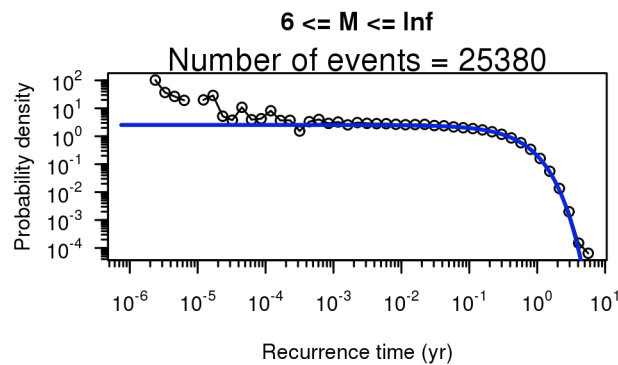
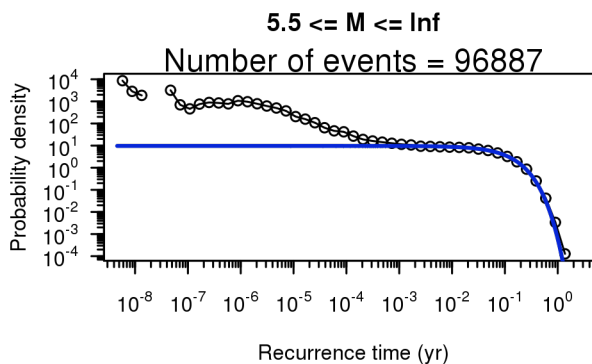
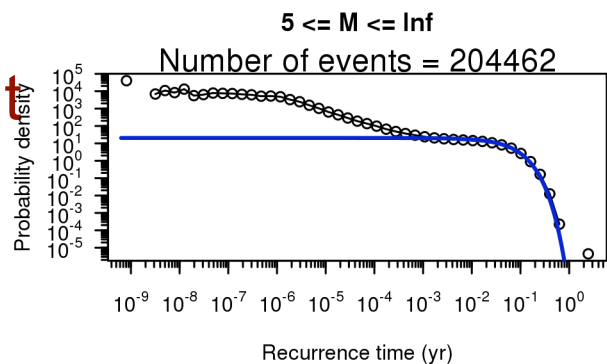


Pollitz

Blue curves are Poisson process with same average rate as data

PDFs of Inter-event Times, Log-time scale

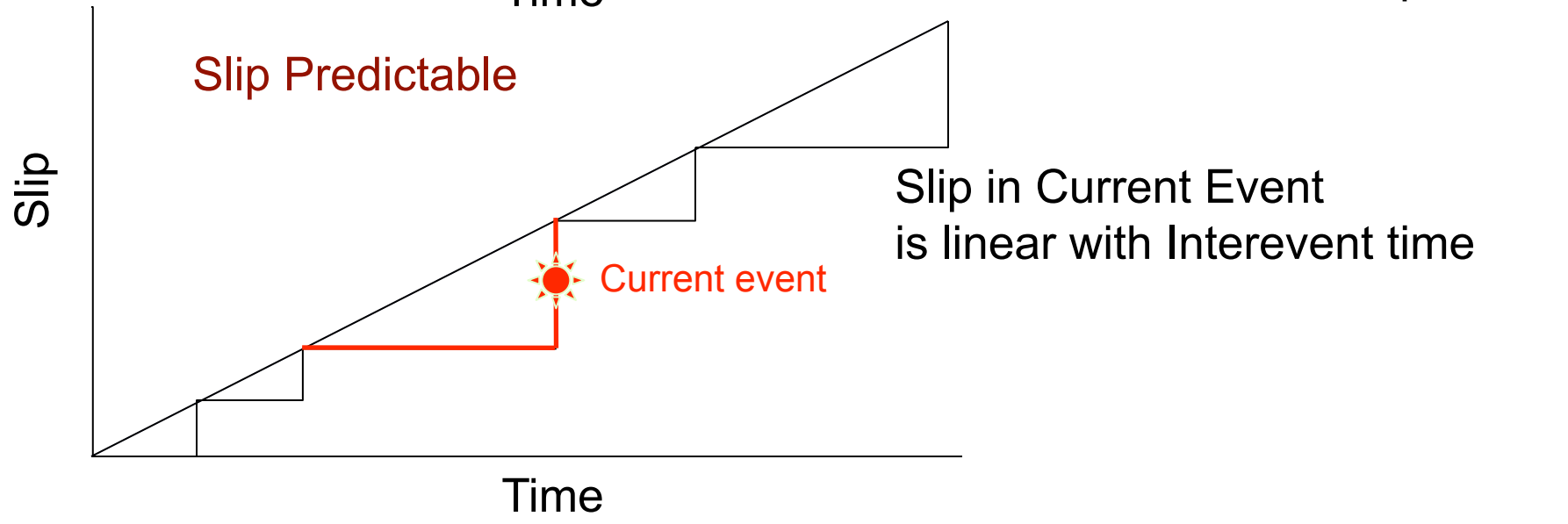
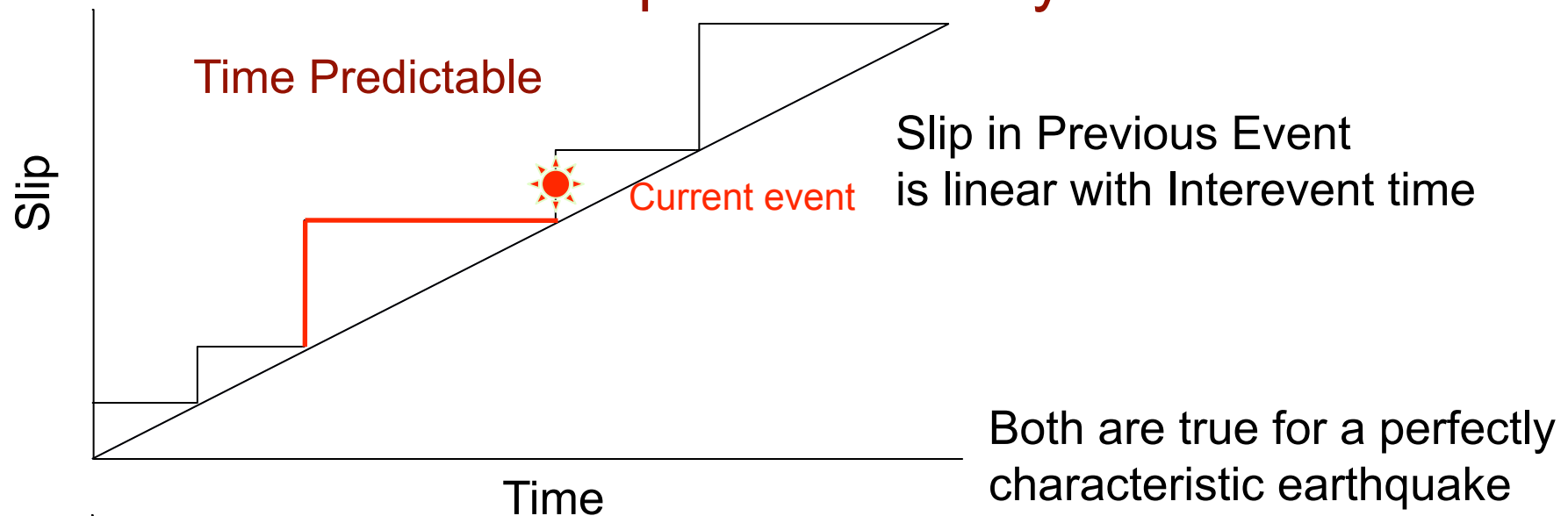
Entire System



Zielke

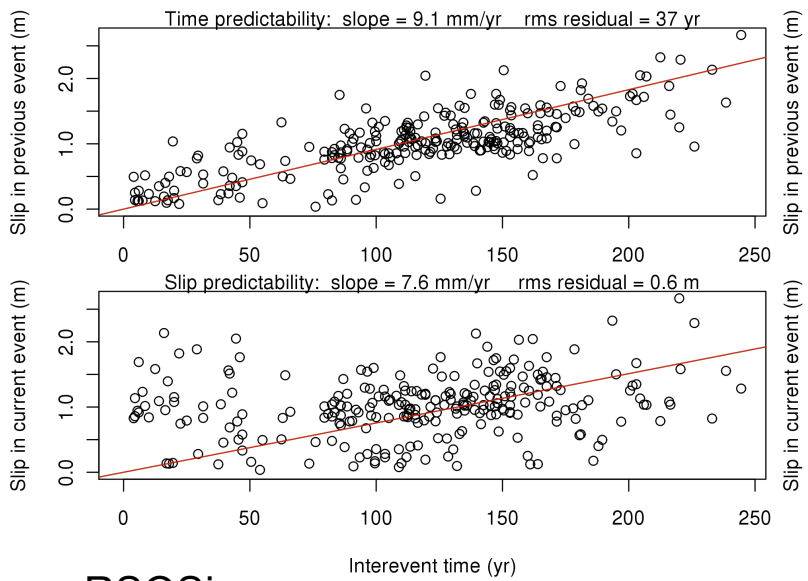
Blue curves are Poisson process with same average rate as data

Time vs. Slip Predictability

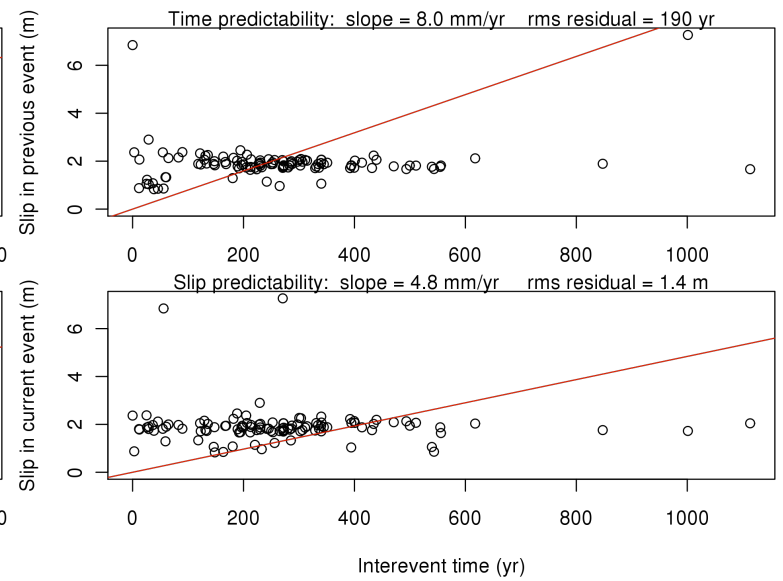


Time and Slip Predictability – N Hayward fault

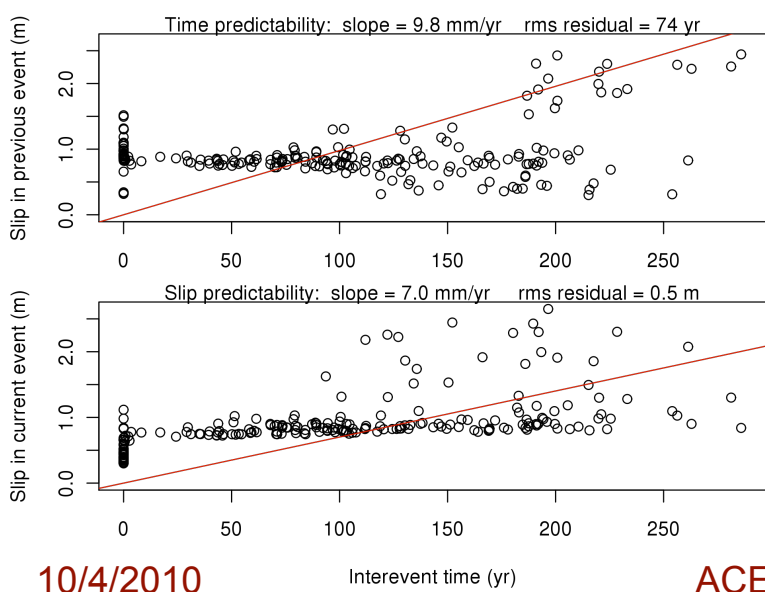
ALLCAL allcal: Hayward_fault_North



virtcal: Hayward_fault_North **VIRTICAL**

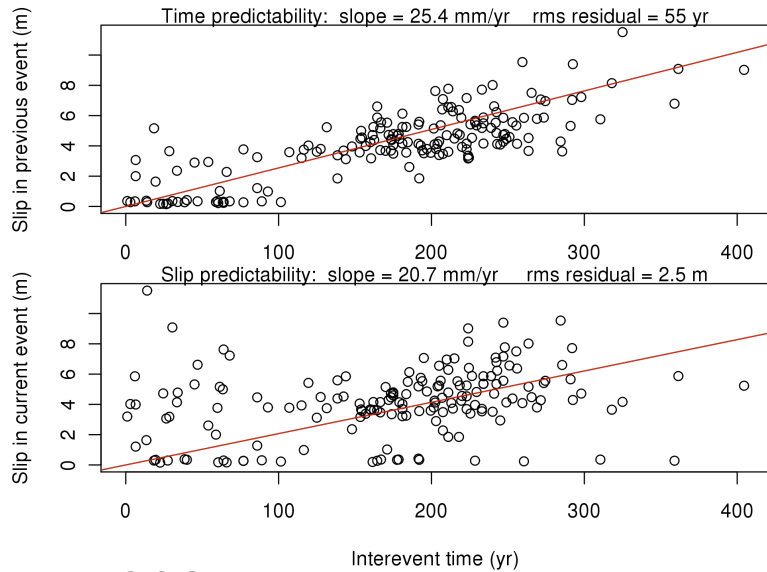


RSQSim rsqsim: Hayward_fault_North

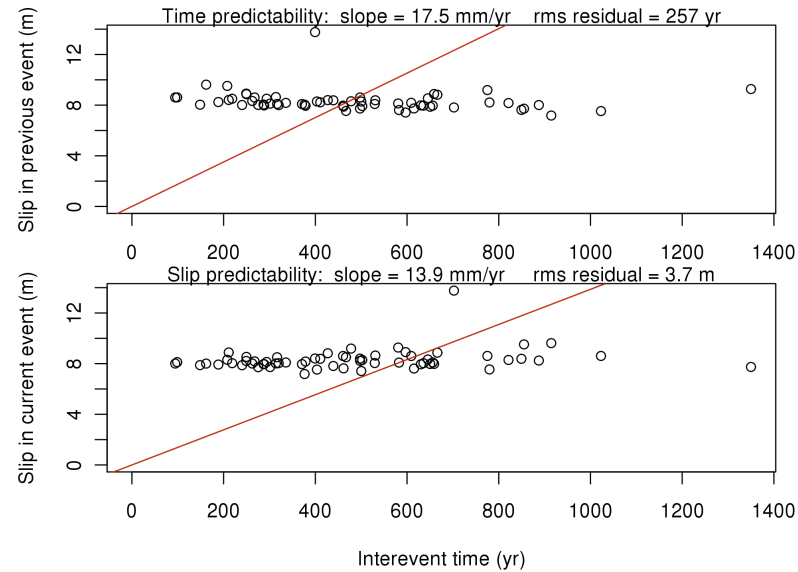


Time and Slip Predictability – N SAF, Vendanta

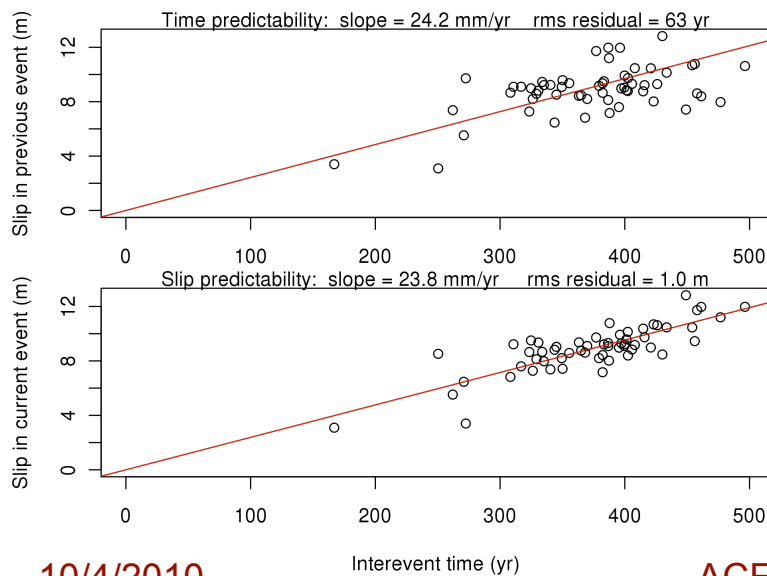
ALLCAL allcal: N_San_Andreas_Vendanta



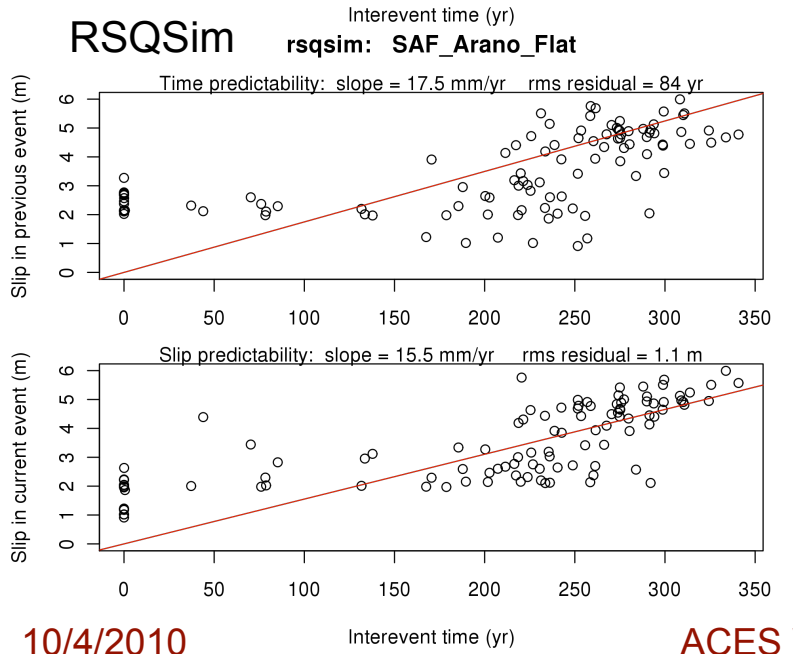
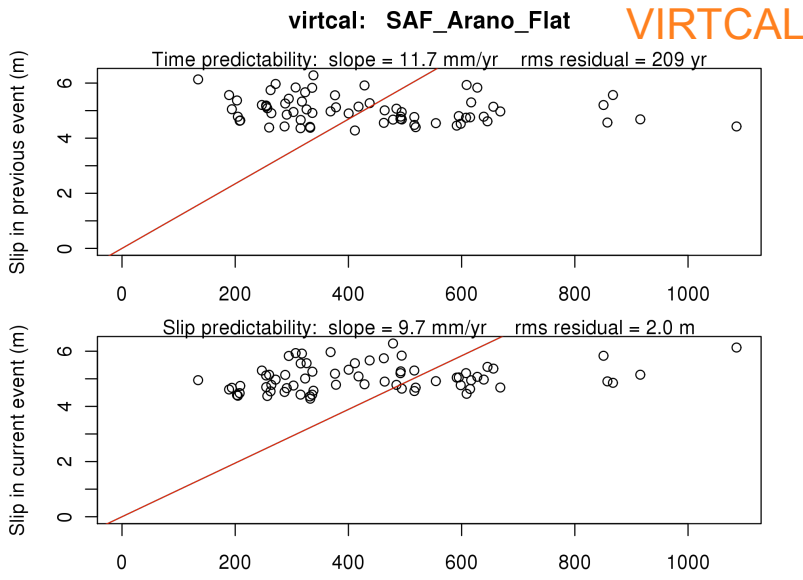
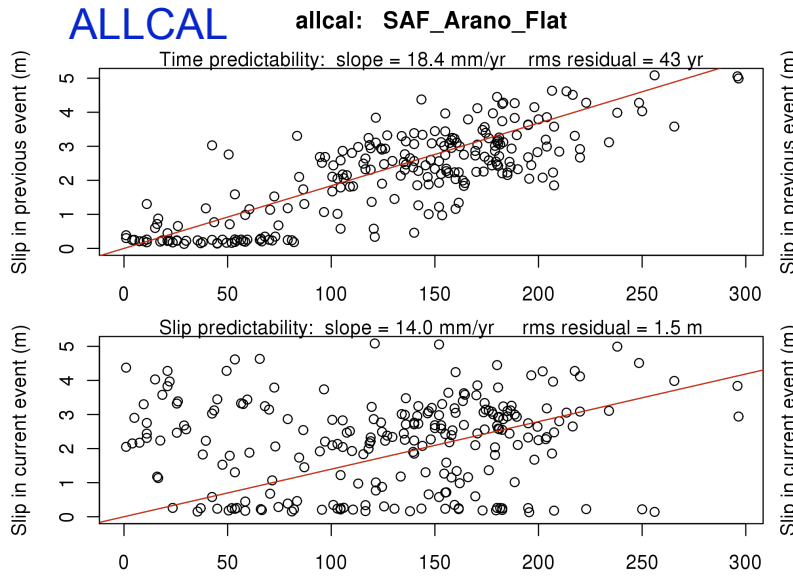
VIRTICAL virtcal: N_San_Andreas_Vendanta



RSQSim rsqsim: N_San_Andreas_Vendanta



Time and Slip Predictability – SAF, Arano Flat



Conclusions

- The simulators show general agreement on many statistical measures
- However, significant differences exist between them
- At this preliminary stage of the project most simulators have not been “tuned” to match observations of inter-event times, so they can do better once input fault “strengths” are varied
- Many other statistical measures will be developed, for example to examine how often ruptures jump from one fault to another
- I have a poster where we can examine and discuss our results further