

Understanding Earthquake Scaling in the Context of Complex Fault Systems and Crustal Geophysics

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&

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Extending the earthquake catalog:

- **Parameters**
 - Date & time
 - Latitude, longitude, & depth
 - Magnitude
- **New Parameters**
 - Stress Drop
 - Distance to nearest PSZ
 - GPS Strain rate
 - Heat flow

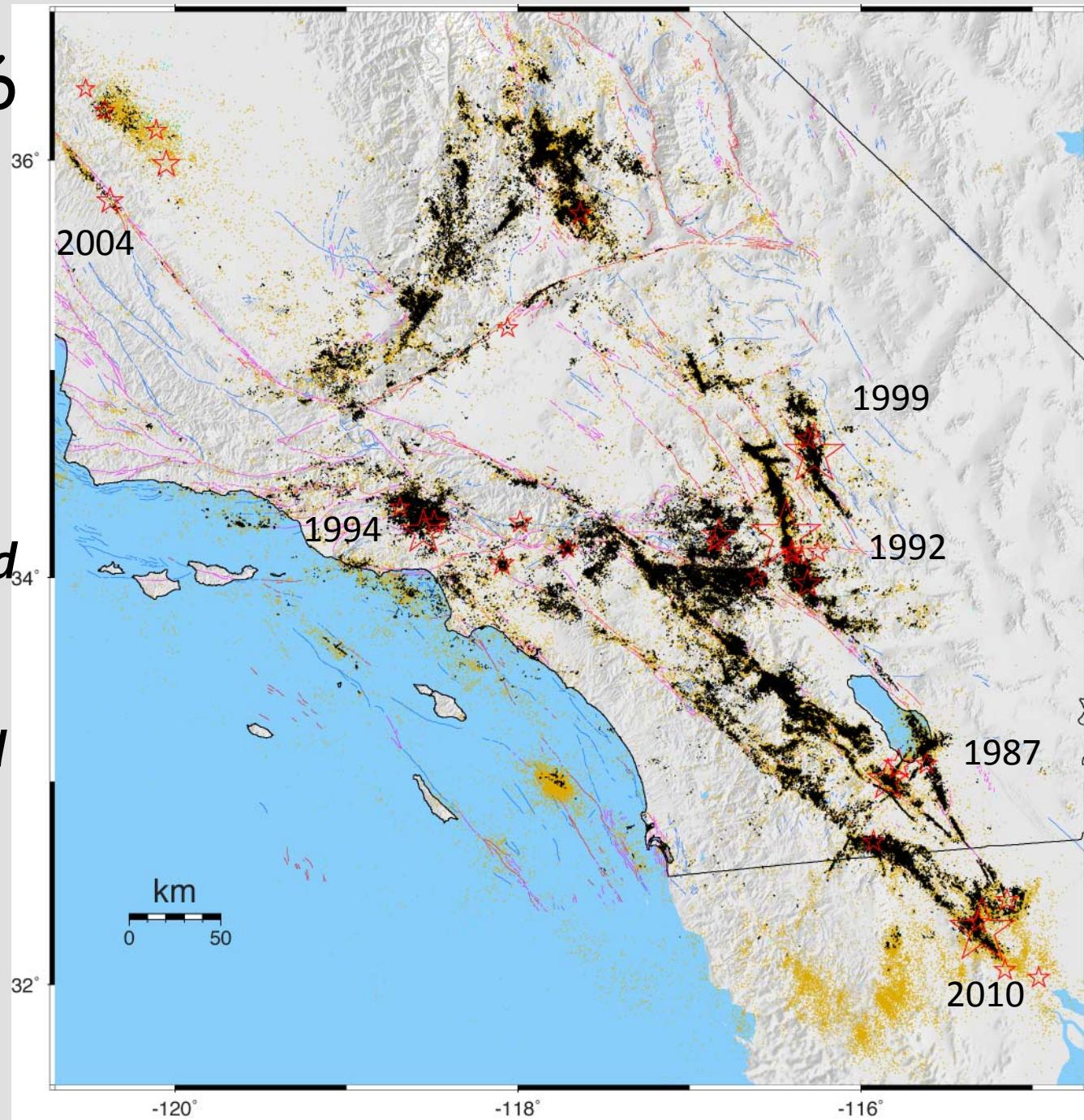
Purpose: analyze how these parameters relate and help us understand source physics

1981-2011/06 Southern California Seismicity:

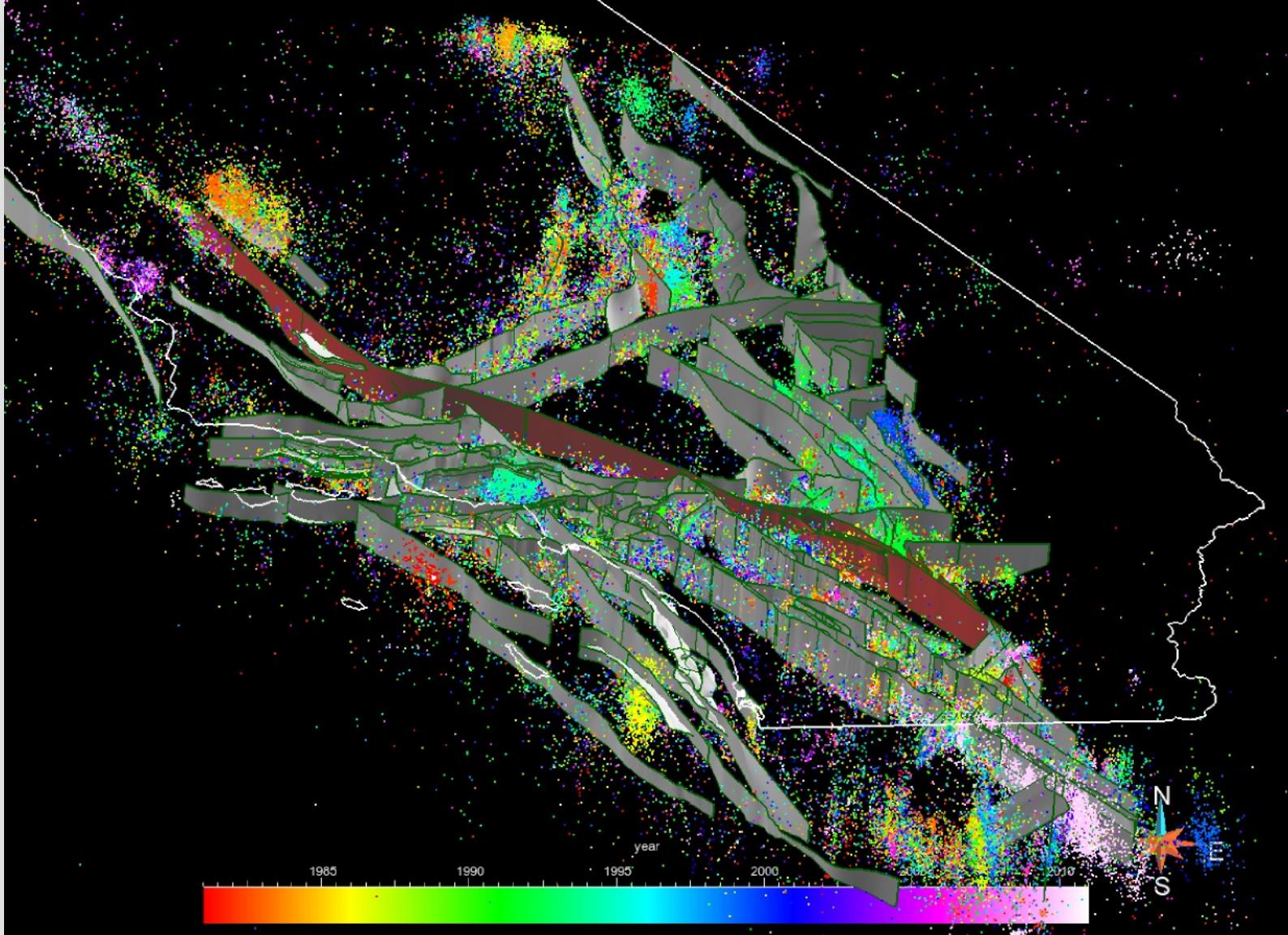
Black:
waveform relocated

Brown:
3D model relocated

Red stars:
 $M \geq 5.0$ quakes



SCEC – CFM4: Distance to nearest PSZ



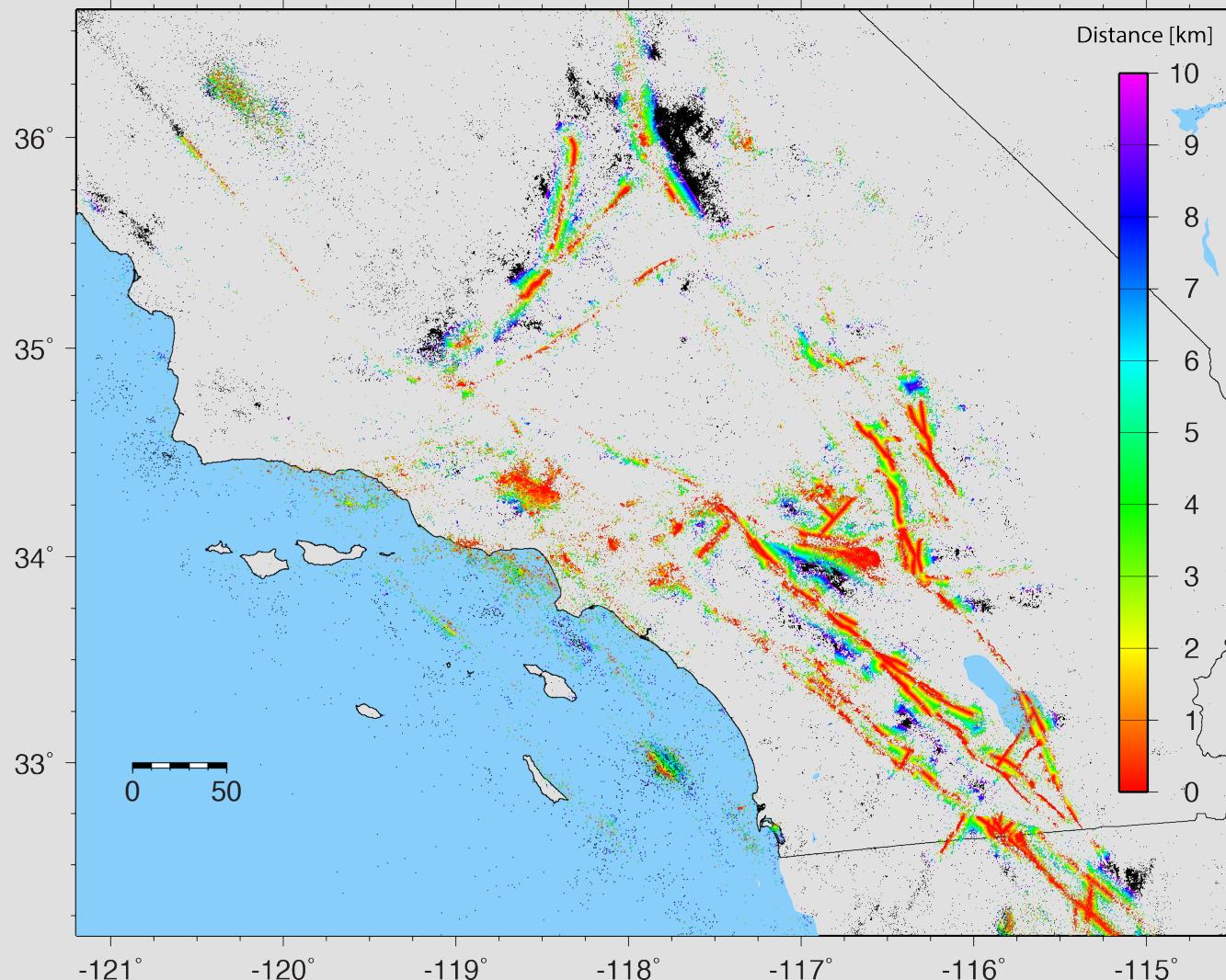
Caltech, E. Hauksson, 6/12/2012

A. Plesch and J. Shaw, (2012), Harvard Univ.

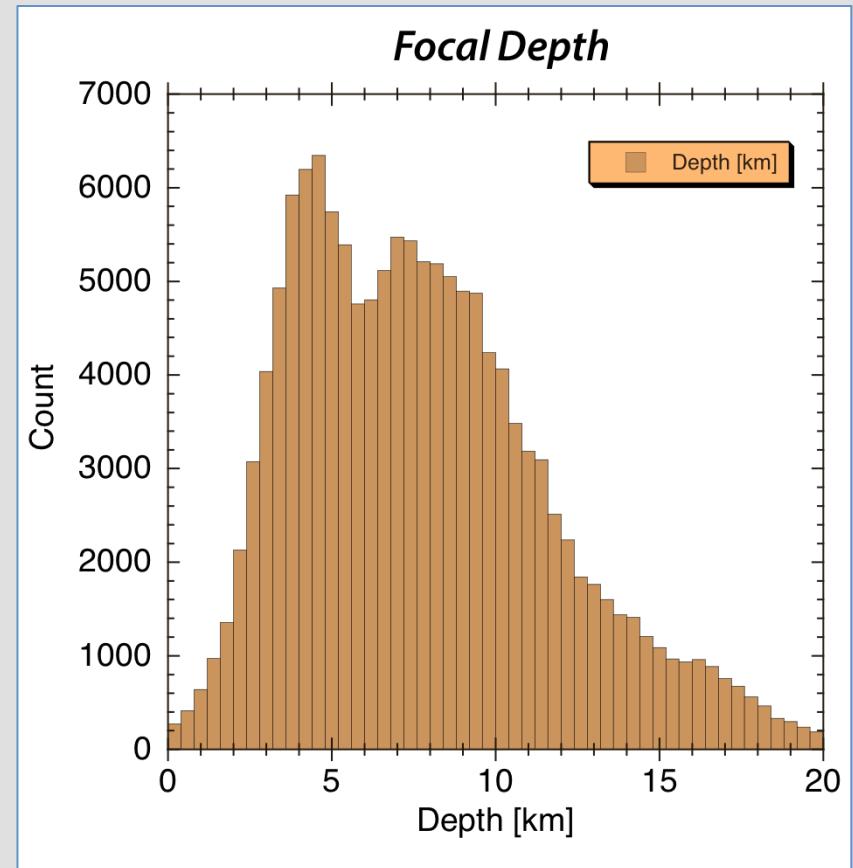
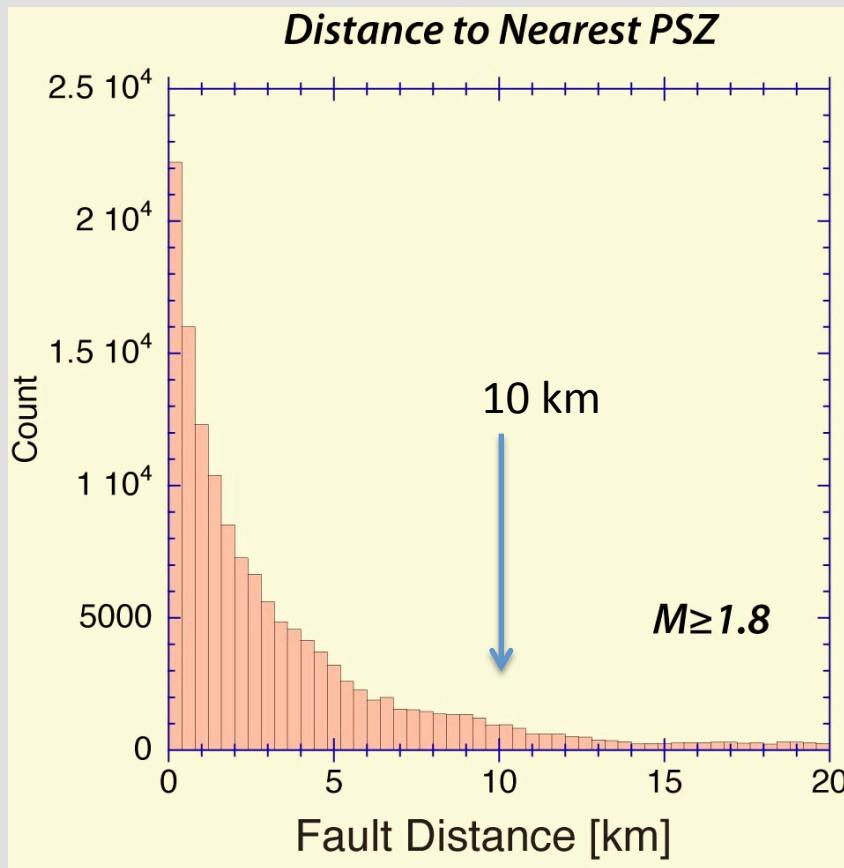
Seismicity: Hauksson et al. (2012)

Distance to Nearest PSZ

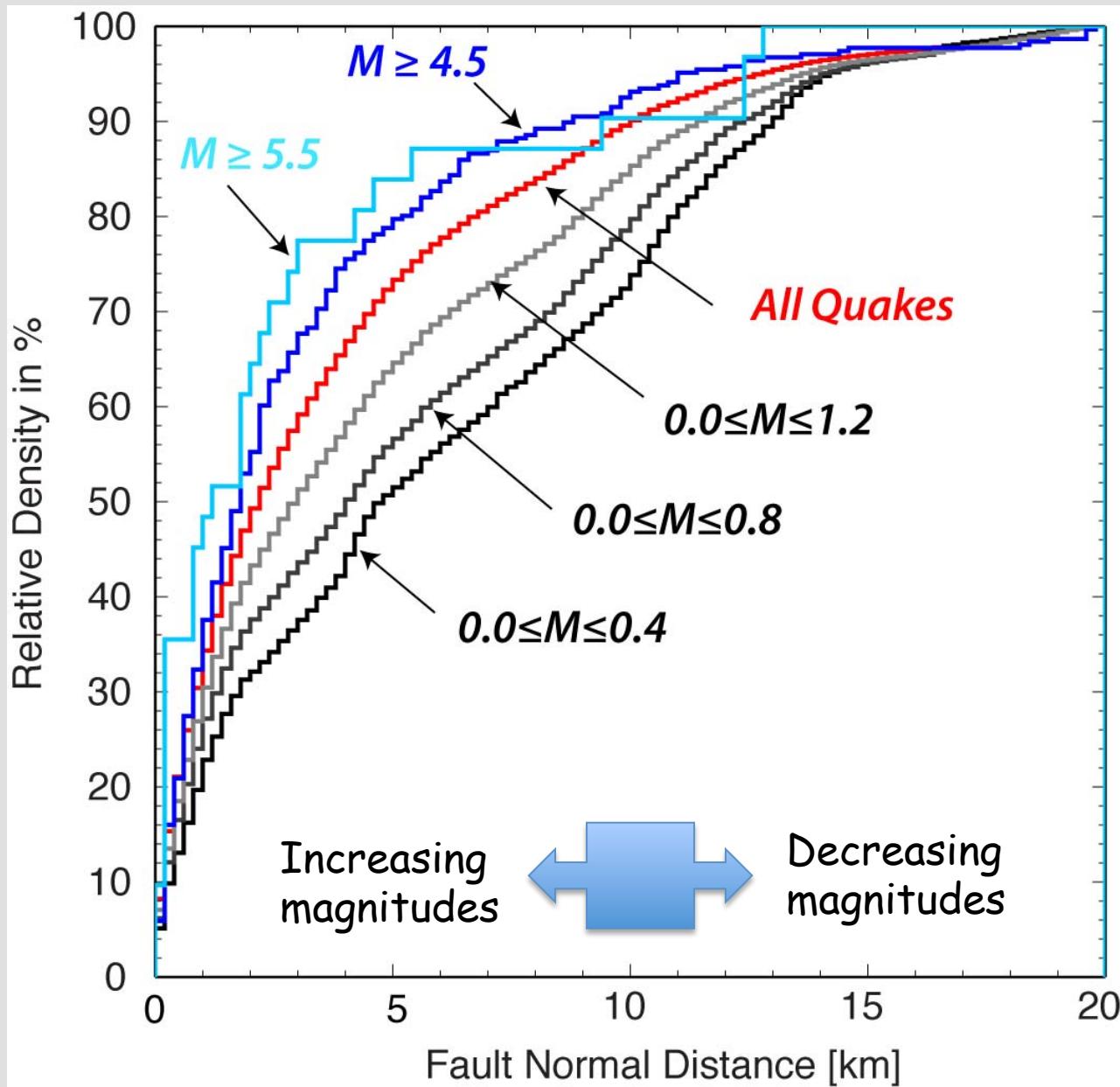
Southern California Seismicity: 1981 - 2011/06



Comparing Focal Depth & “Fault distance” parameter

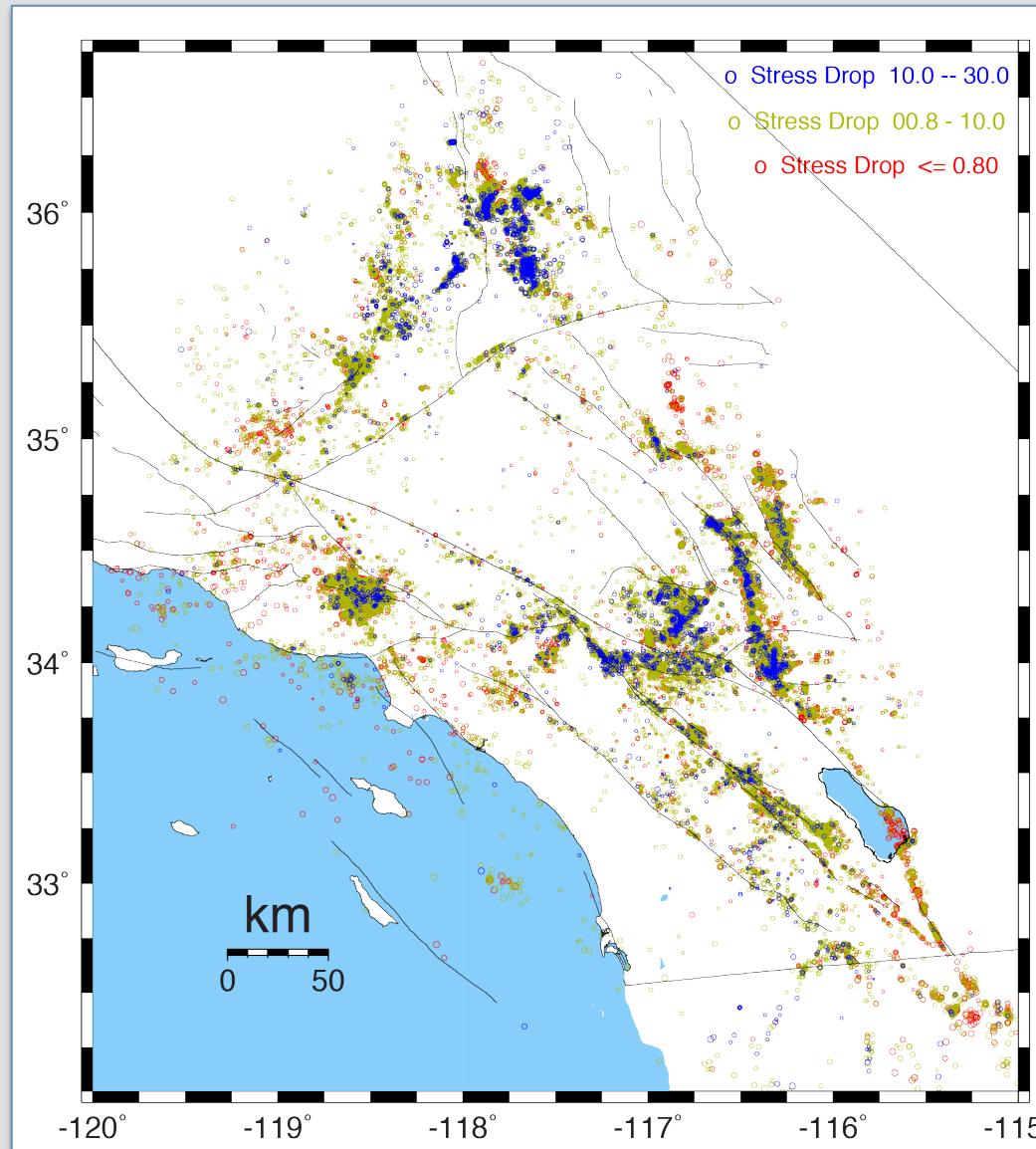


Big quakes are closer to big faults



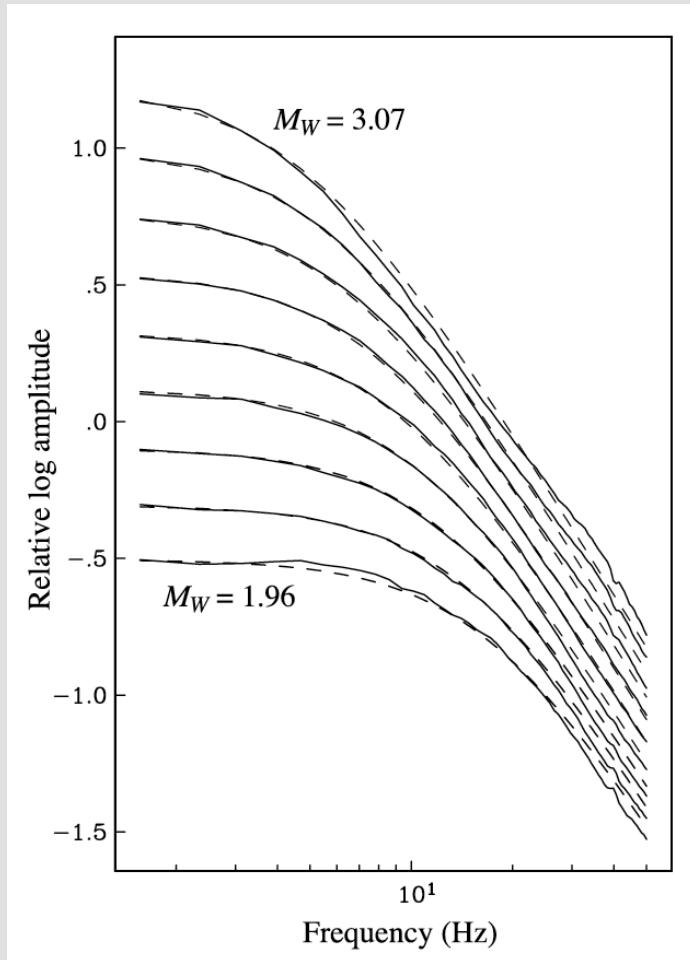
Southern California Seismicity: Stress Drops

Shearer et al. (2006)

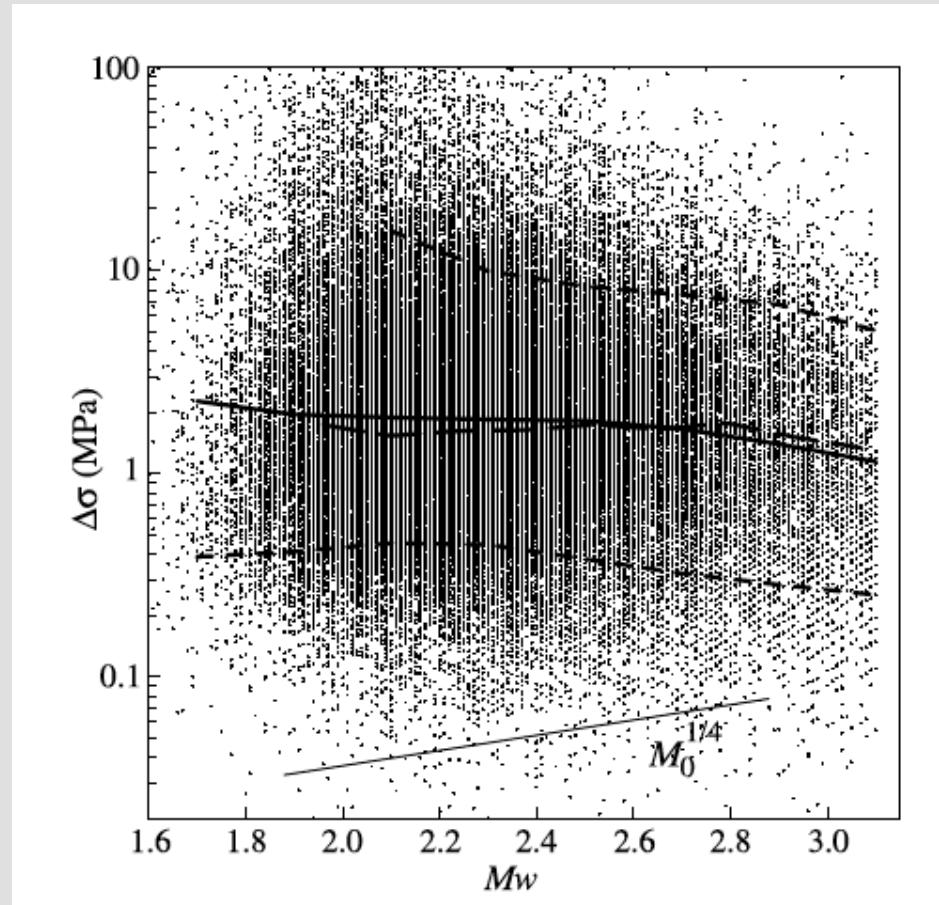


Stress Drops From Spectral Method

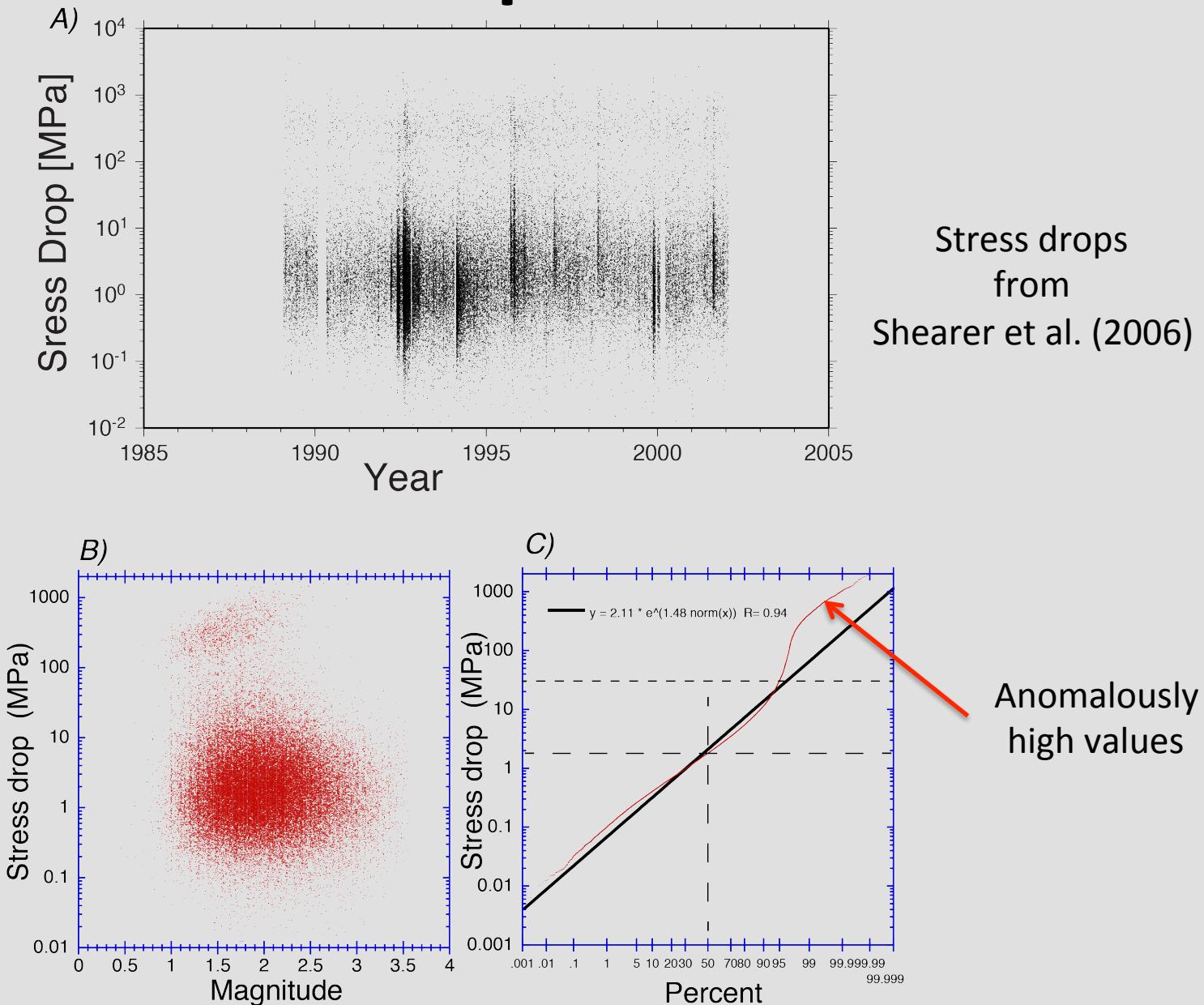
EGF-corrected stacked source spectra



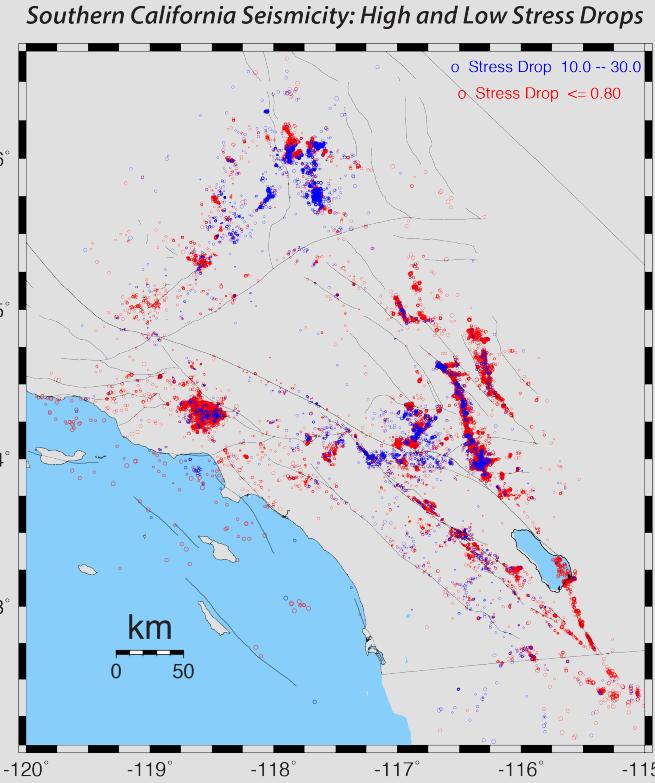
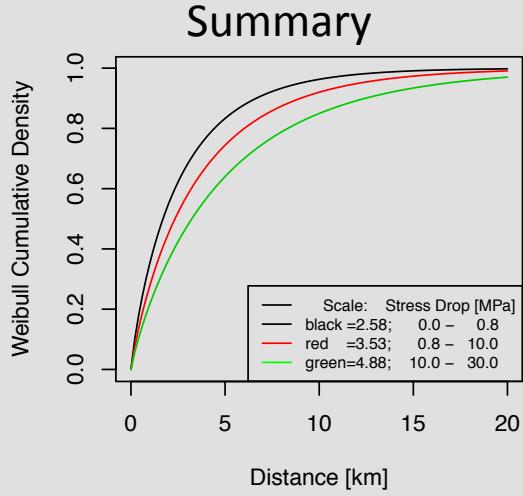
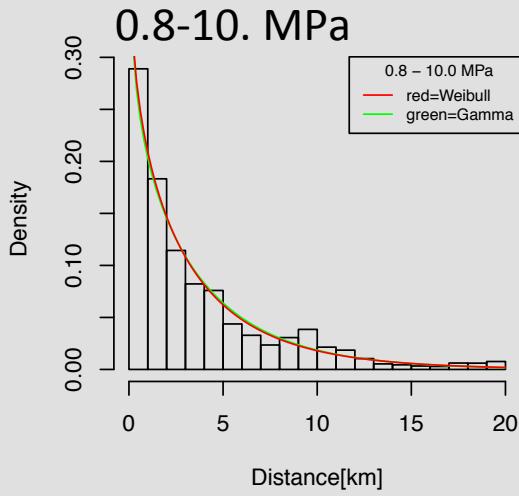
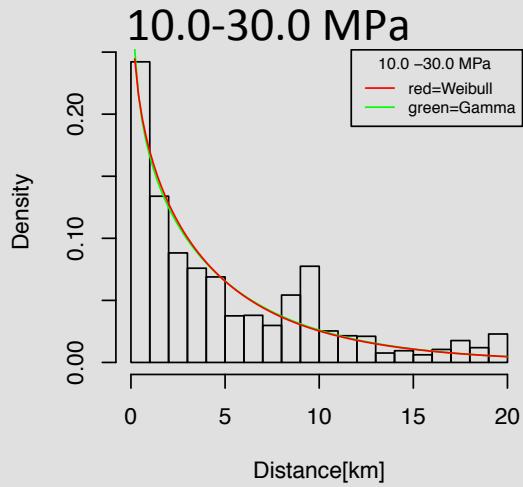
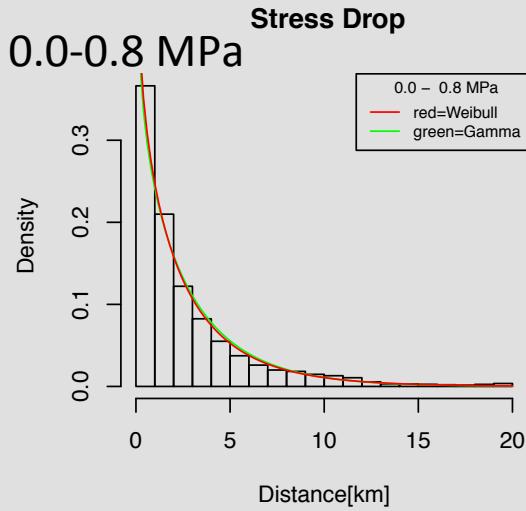
From: Shearer et al. (2006)



Stress Drop Data Set

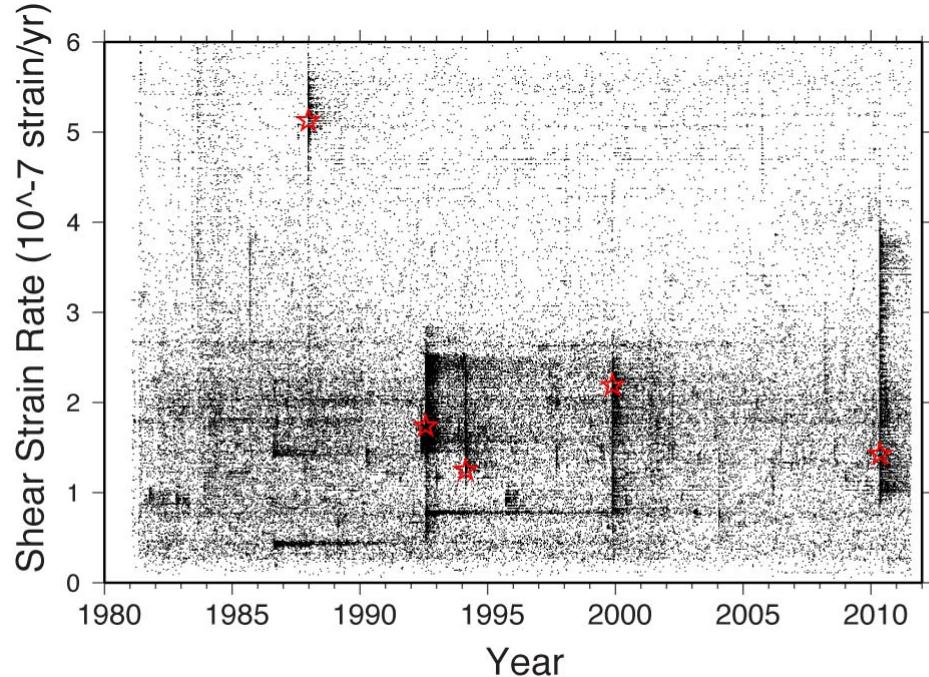
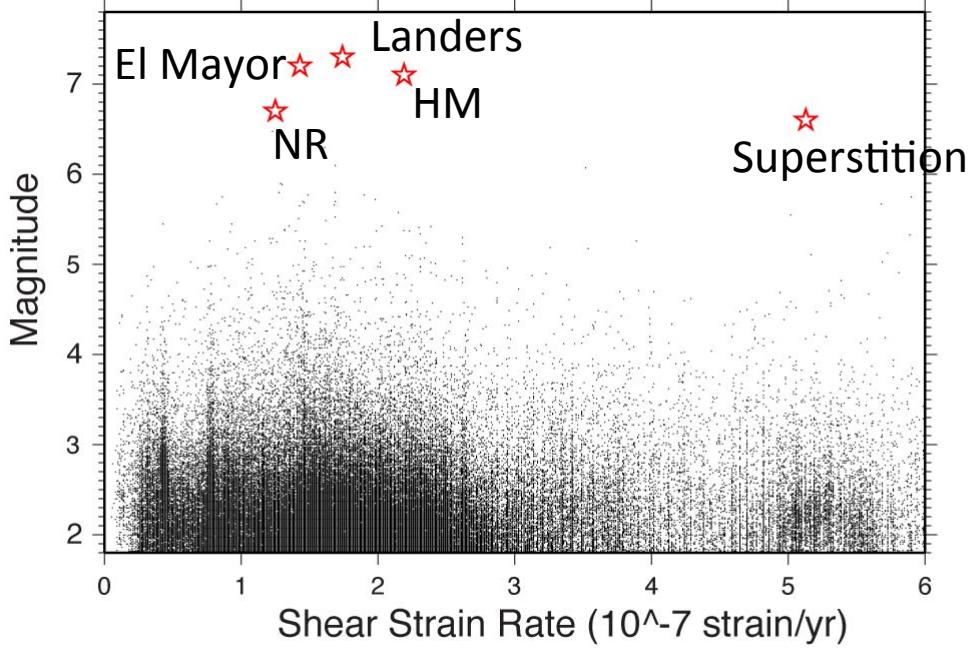
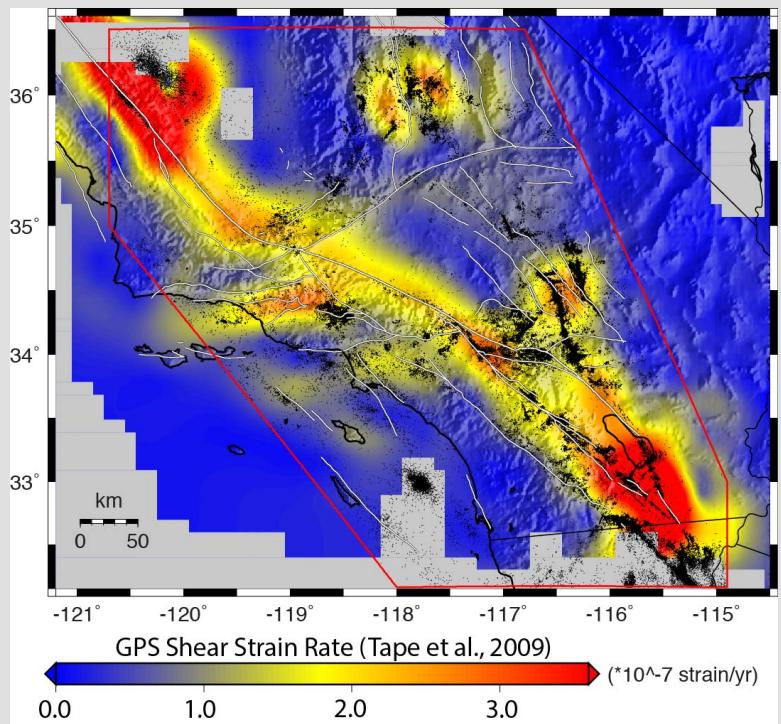


Stress Drop: Distance to Nearest PSZ

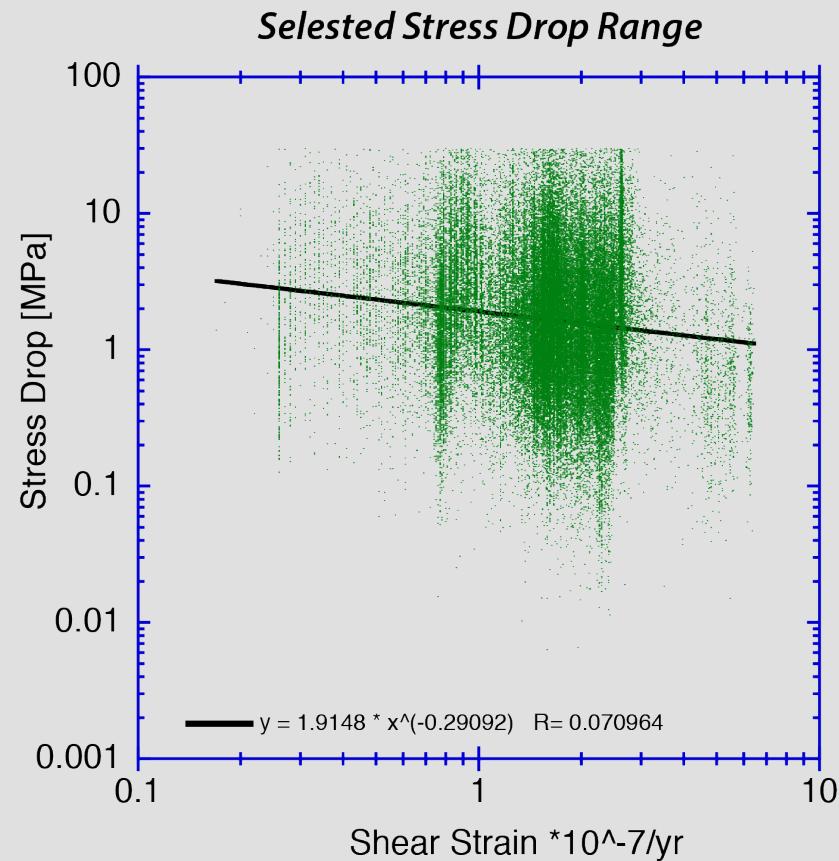
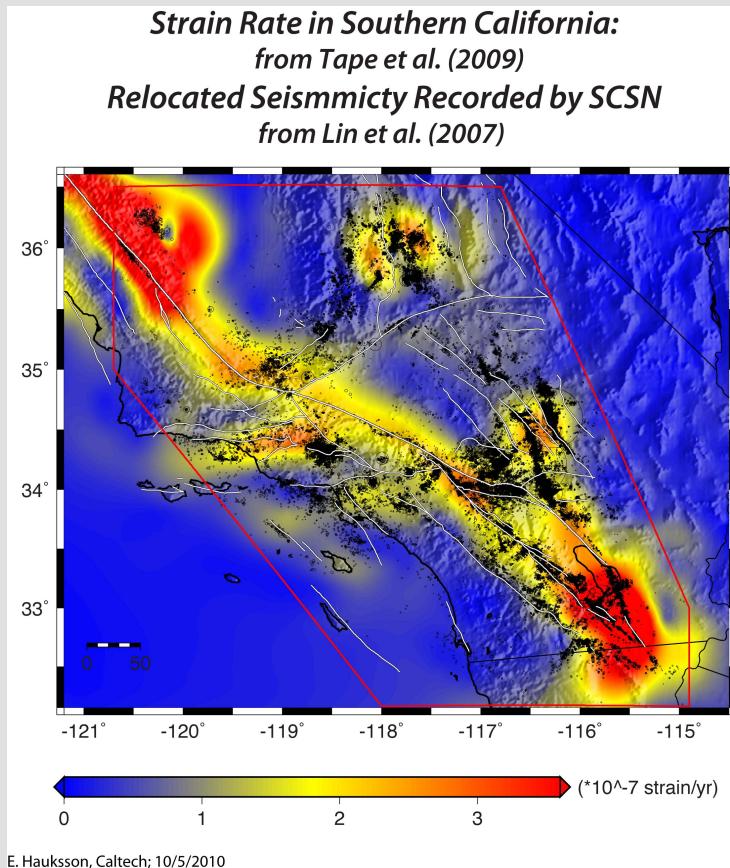


GMT 2012 Aug 31 10:59:19 | ./delsig.txt E. Hauksson Caltech; gmt_map_big_03_deep.com

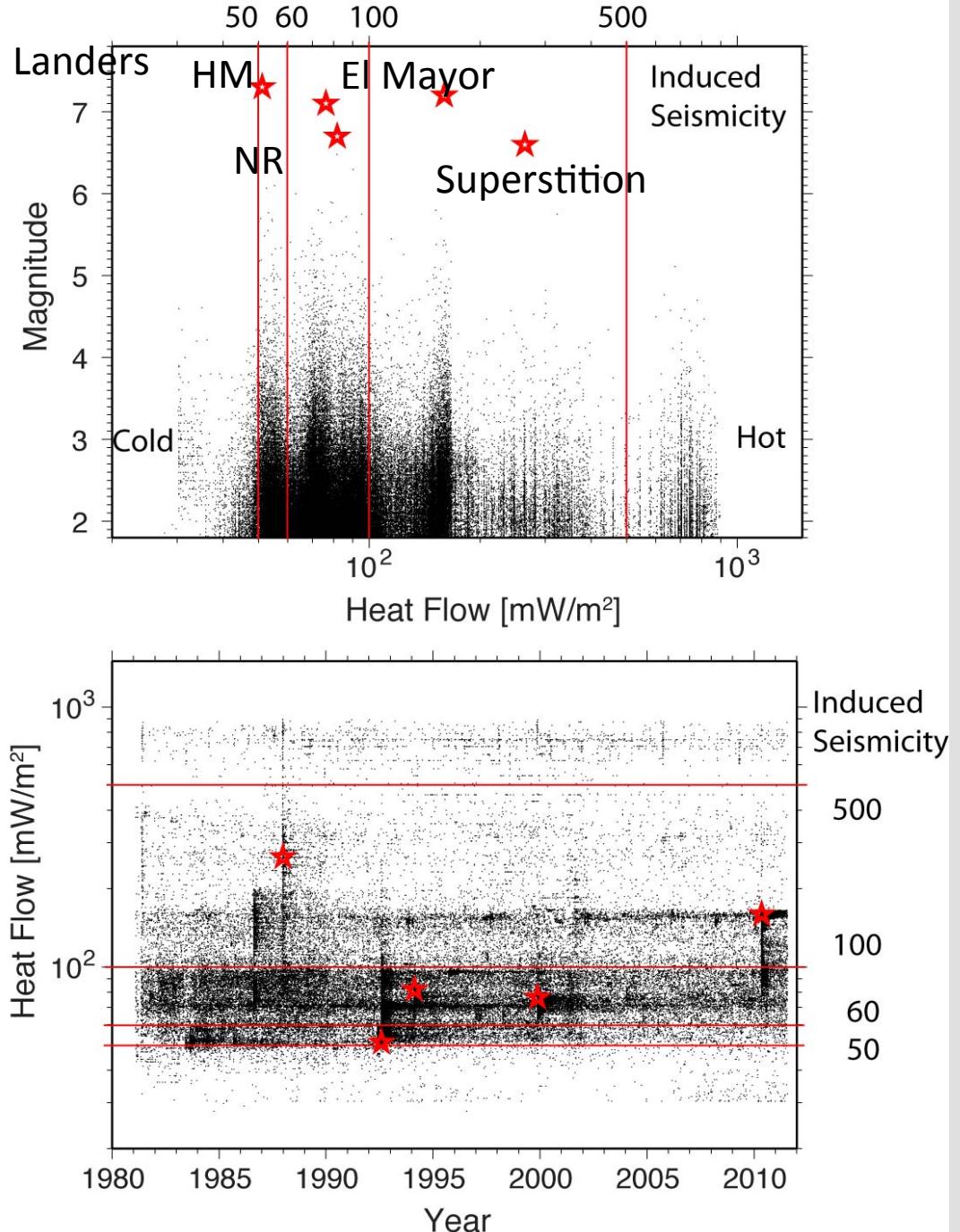
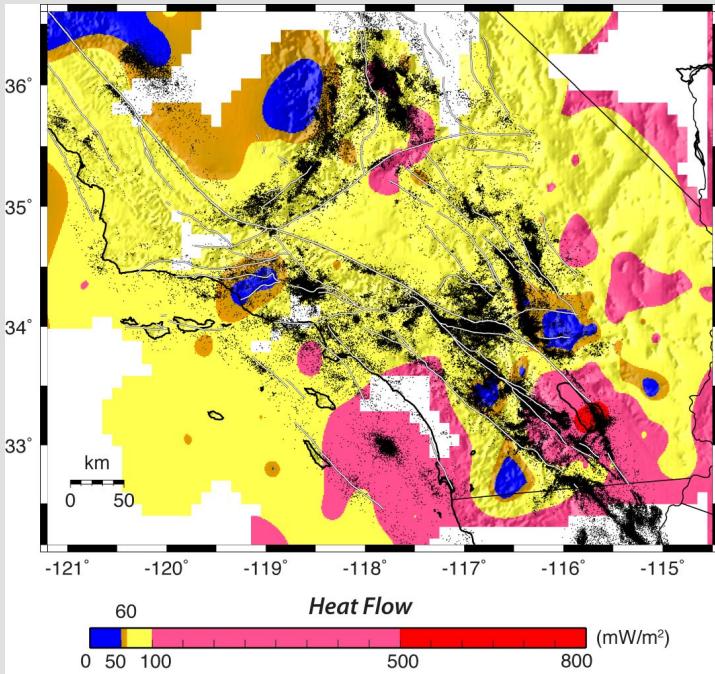
Shear Strain Rate is high where creep occurs or locking depth is shallow



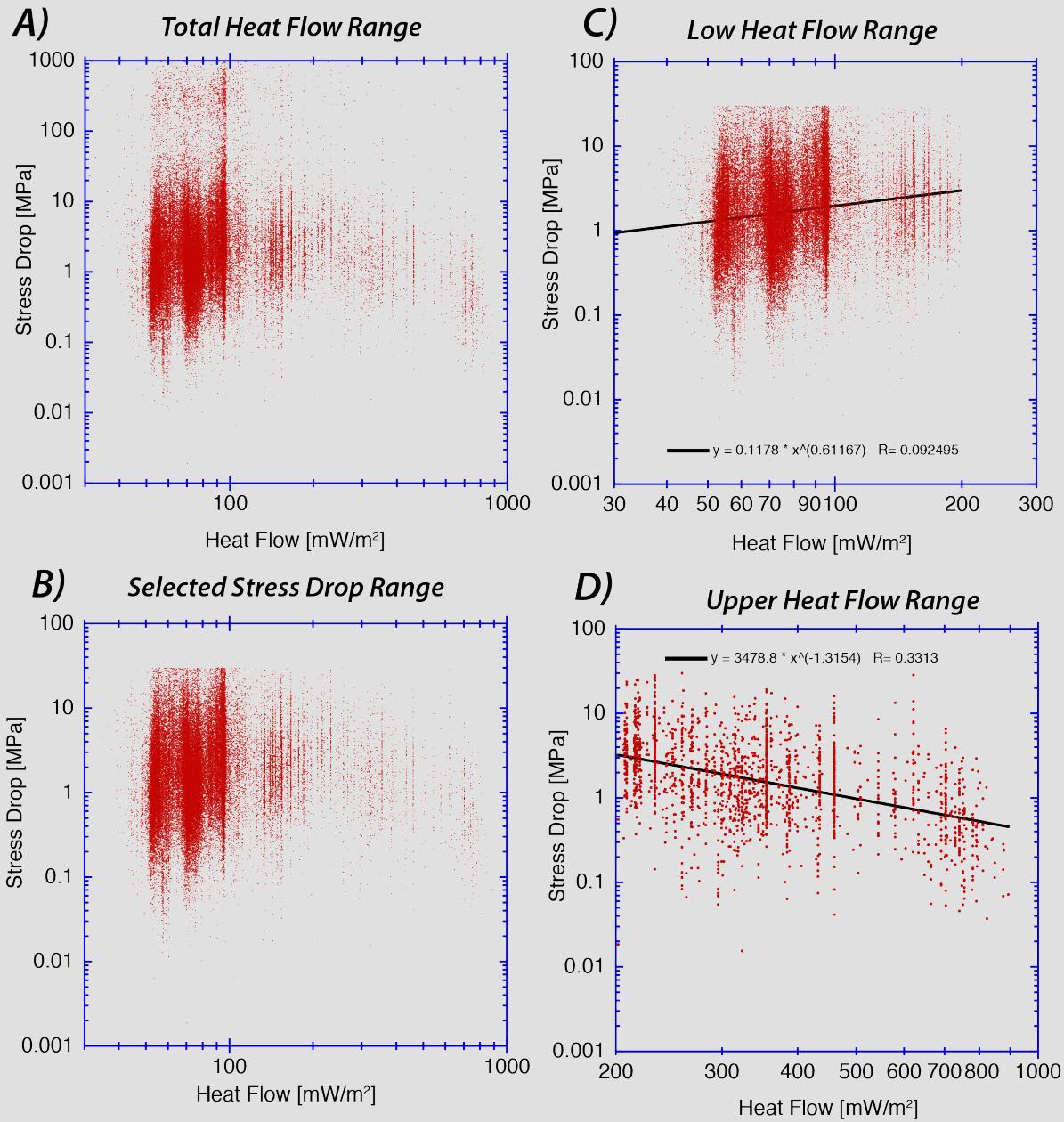
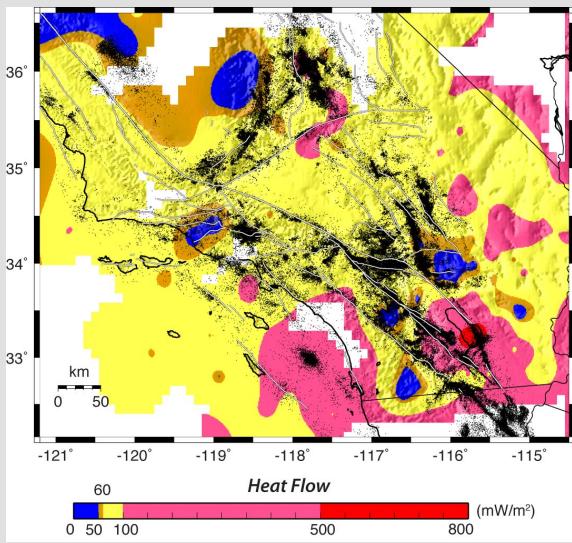
Stress Drops & Shear Strain Rate



Heat Flow & Magnitude or Quake date

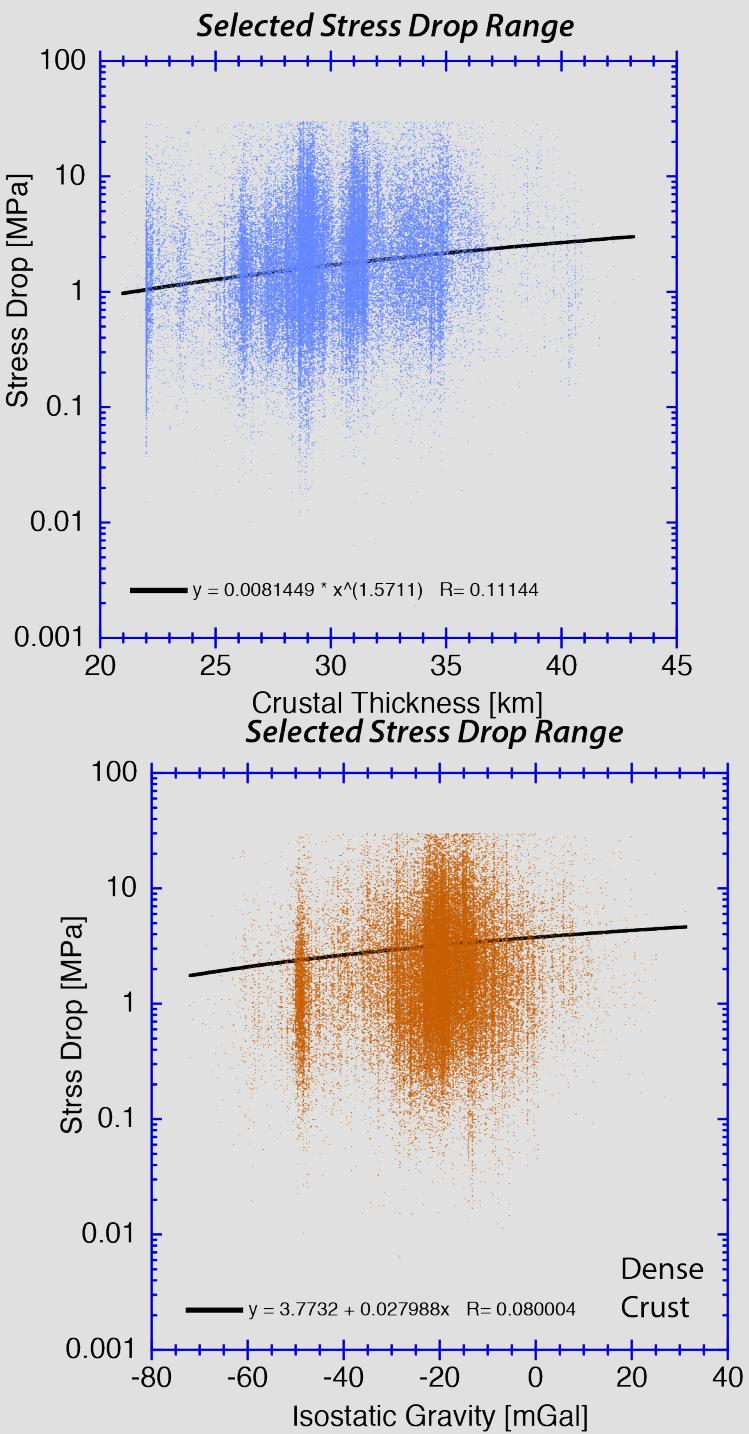
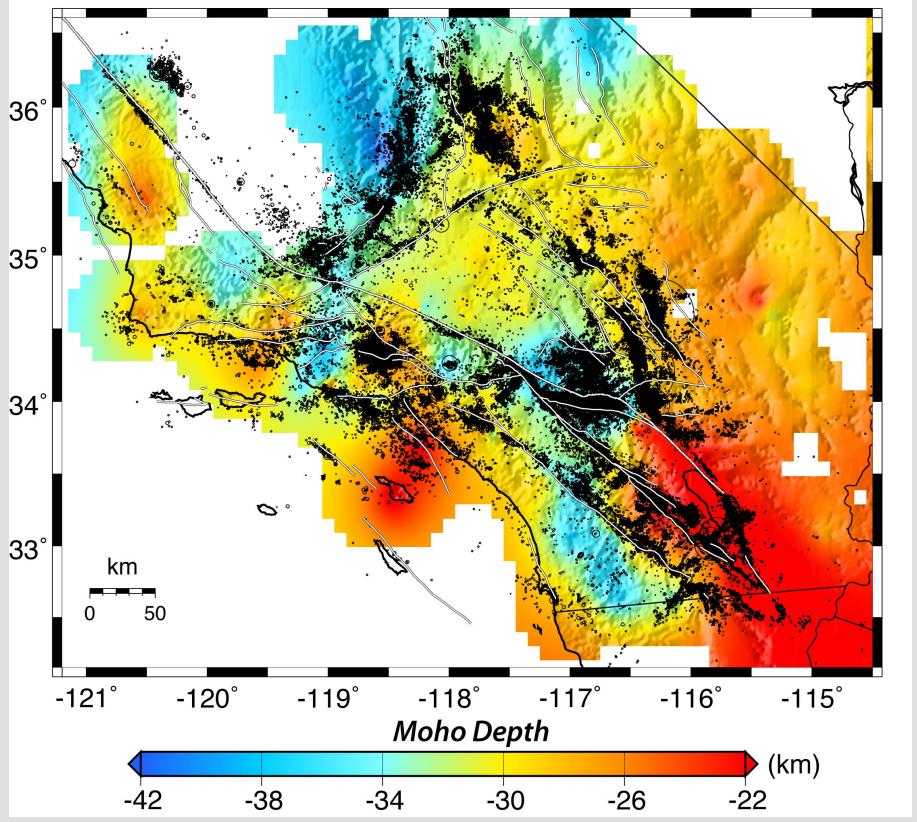


Stress Drop and Heat Flow

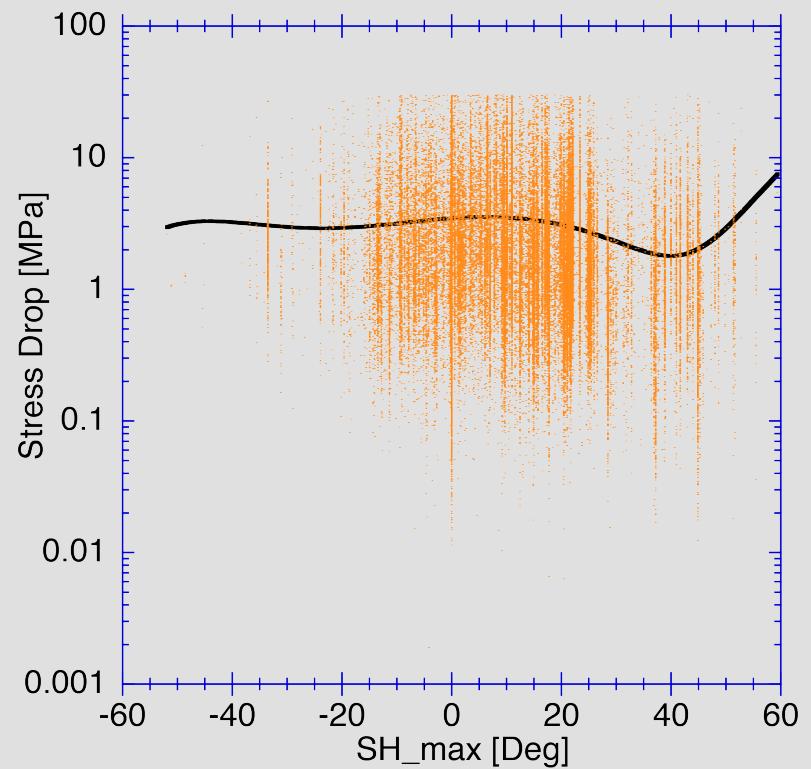
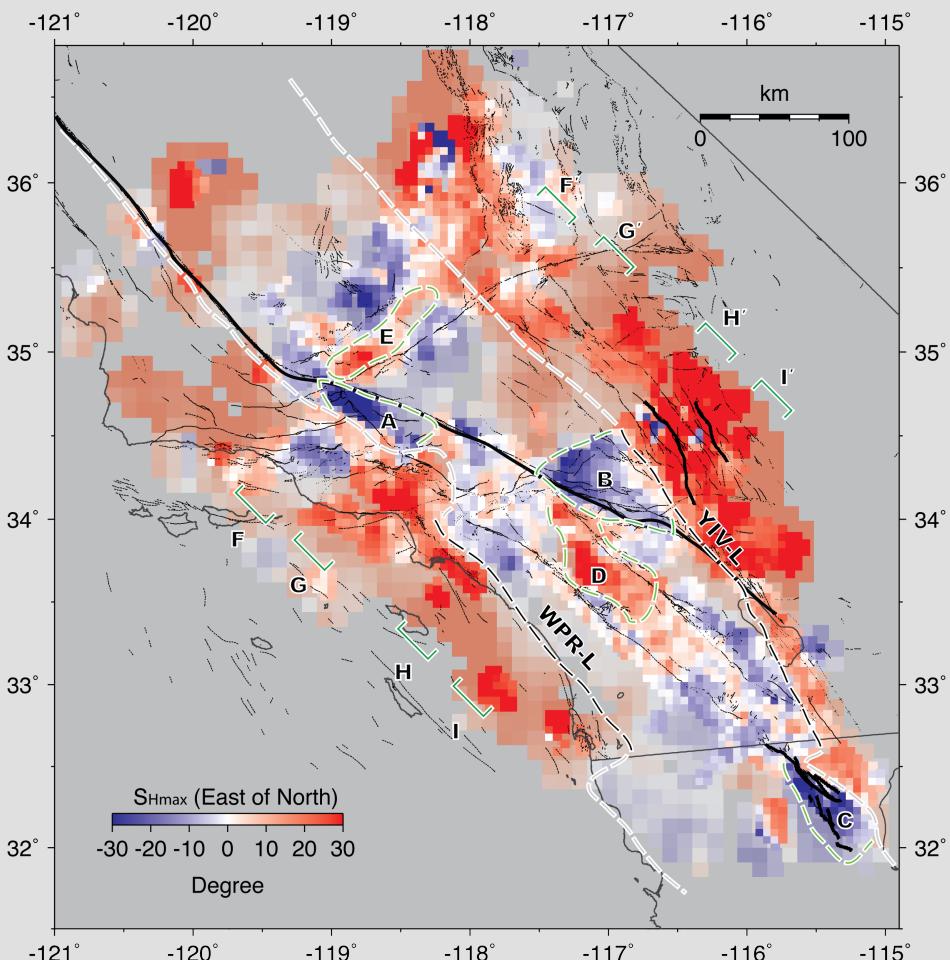


Stress Drop: Crustal Thickness; Isostatic Gravity

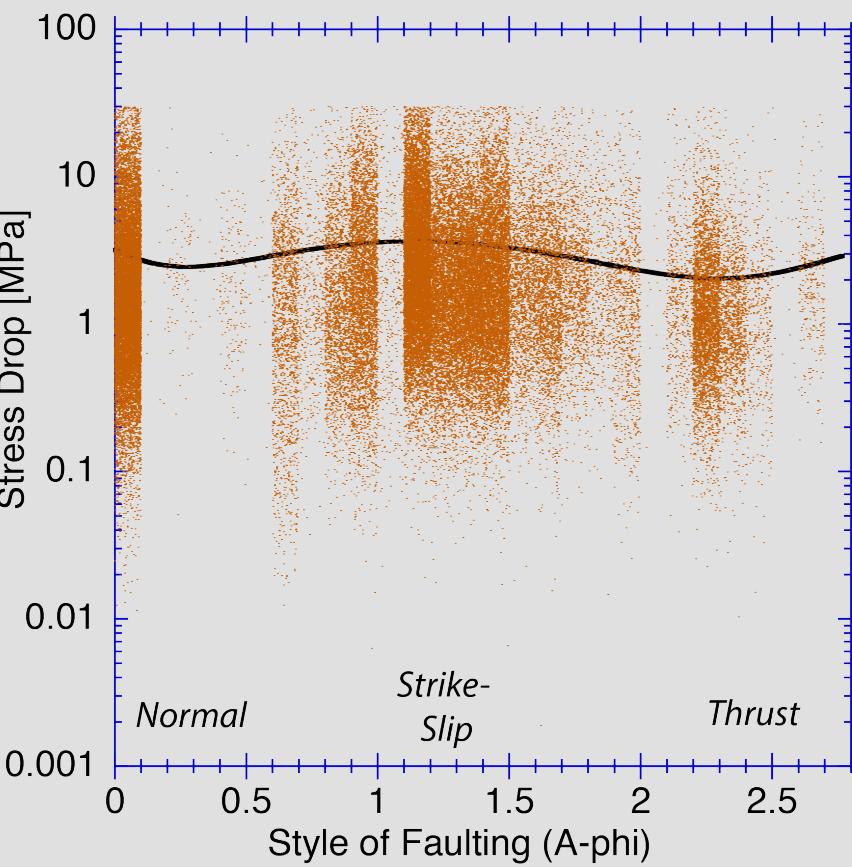
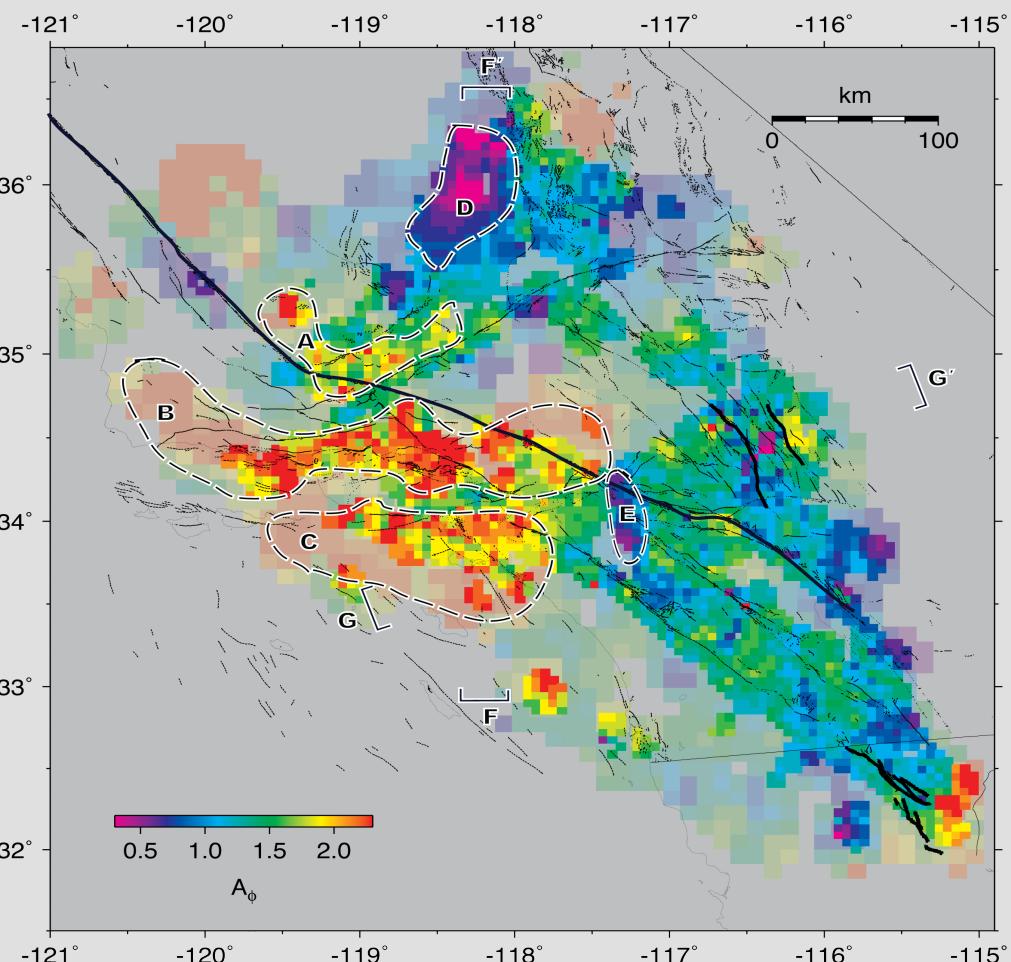
Moho Depth From Receiver Functions, modified from(Yan and Clayton, 2007) Relocated Seismicity 1981 - 2005



Maximum Principal Stress & Stress Drops

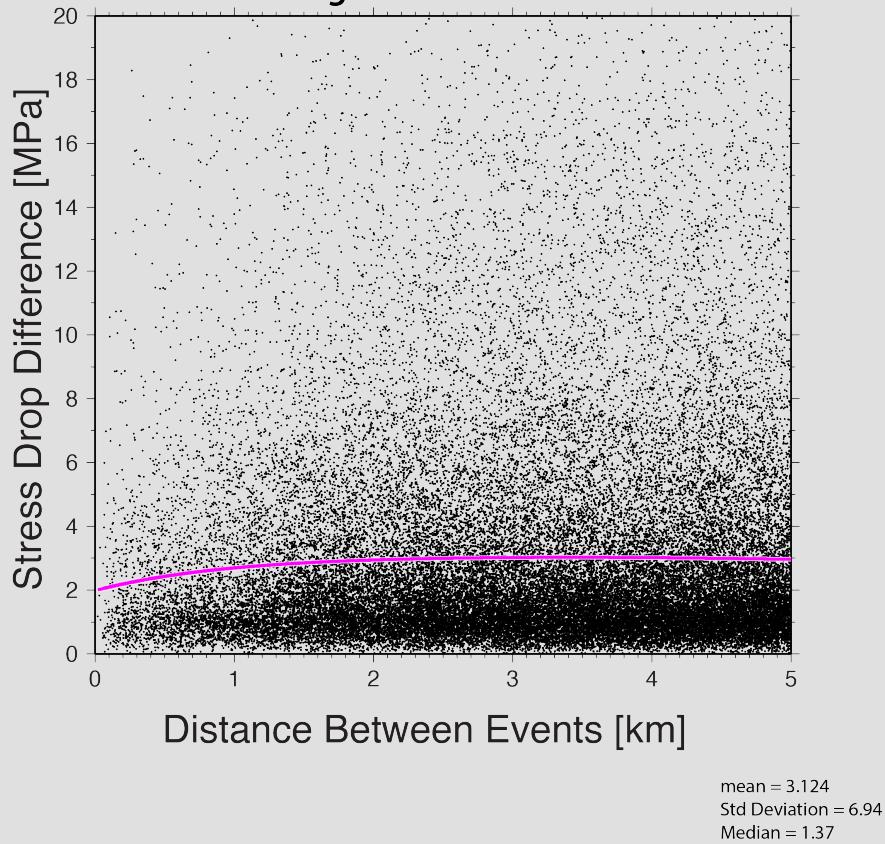


Stress Drops: Style of Faulting

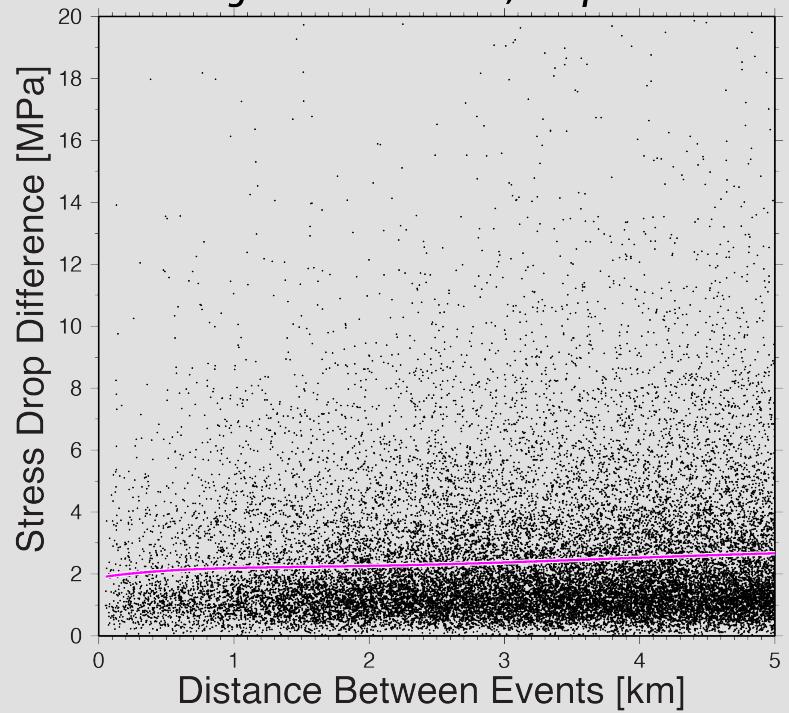


Stress Drop Difference Between Pairs of Earthquakes

Stress Drop Difference for Neighboring Events
Magnitude: 2.8 to 3.0



Stress Drop Difference for Neighboring Events
Magnitude: 2.0 to 3.0; Nr sp > 28



Conclusions

- Stress drops are heterogeneous, but we can infer that they:
 - Are lower next to the Principal Slip Zones
 - Decrease with increasing strain rate
 - Increase with crustal strength
 - Increase in low heat flow range
 - Decrease in high (geothermal) heat flow range
 - Do not depend on style of faulting or SHmax
 - Events separated by < 1 km distance have smaller stress drop differences