## 2017 SCEC Proposal 17100 – Progress Report

# "Static and dynamic source parameters of global strike-slip earthquakes"

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### Introduction

Strike-slip earthquakes are significant contributors to the seismic hazard in Southern California due to the dominant transform plate boundary. Understanding the source characteristic of these strike-slip earthquakes is critical to improving estimates of the seismic hazard and in particular for ground motion prediction. Two key parameters are thought to dominate strong ground motions: pulse duration for a given earthquake moment, often parameterized with a static stress drop parameter $\Delta\sigma$, and earthquake radiated energy $E_R$, which captures the level of high-frequency radiation at the source. Several studies found systematic spectral shapes that exhibit two corner frequencies (Denolle and Shearer 2016, Archuleta and Ji 2016). The lower corner frequency corresponds to the inverse of the source duration, while the higher corner frequency's origins remain unclear. Between both corner frequencies, Denolle and Shearer (2016) show that the intermediate falloff rate is $f^{-1}$, a weaker falloff that increases the amount of high frequencies in the ground motion. For Southern California, the two-corner spectrum model, is likely to be representative of a large magnitude earthquake from the San Andreas Fault, because elongated strike-slip earthquakes exhibit pulse-like behavior (e.g. 2002 Denali, 2001 Kokoxili, 2012 Sumatra). It is therefore necessary to understand the relationships between the second corner frequency, $\Delta\sigma$ and $E_R$ for large strike-slip earthquakes. Given that the second corner frequency is only observable for large magnitude earthquakes, this analysis cannot be undertaken using Southern California data alone. Instead, we propose to examine a global dataset of strike-slip earthquakes.

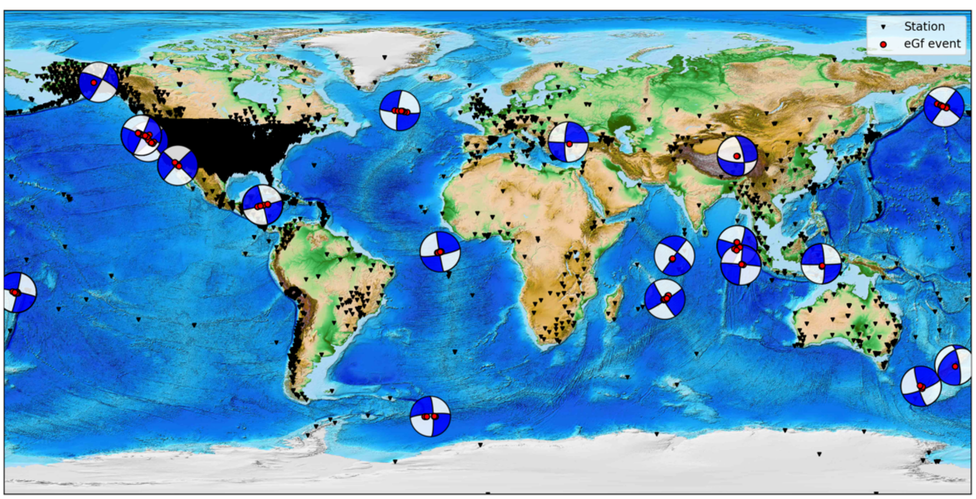


Figure 1: Map of the earthquake sequences and the station used.

### Technical report

Graduate student Danré and PI Denolle are investigating major strike-slip earthquakes sequences. A total of 172 globally recorded events are analyzed, from M5 to M8.6, including M7.9 Kaikoura

2016, M7.8 Ostrova 2017, M8.6 and M8.2 Sumatra 2012, M7.2 El-Cucapah Mayor 2010, M7.8 Kokoxili 2001 and M7.9 Denali 2002. We are carefully removing path effects through multiple approaches:

1) with simple attenuation removal of the form of a P-wave t* (G ~ exp(-pi f t*)),
2) attenuation and depth phase synthetics (using simple half-space calculation and using Instatseis database, http://ds.iris.edu/ds/products/syngine/),
3) using empirical Green's function (EGF) approach if the small EGF has a relatively well constrained source model with method 1) and 2).

So far, the station averaging is sufficient that the impact of depth phases is not strong. To account for small and large earthquakes directivity (i.e. Ross and Ben-Zion 2016), we bin with azimuth all spectral estimates. We fit both a single-corner frequency model (Brune-type) and a double corner frequency model (Haskell-type). We systematically find that small events are well represented with single corner frequency models, while the double-corner frequency model better represent the large events, regardless of the type of Green's function we use. This confirms the results of Denolle and Shearer 2016 for thrust events and is shown in Figure 1.

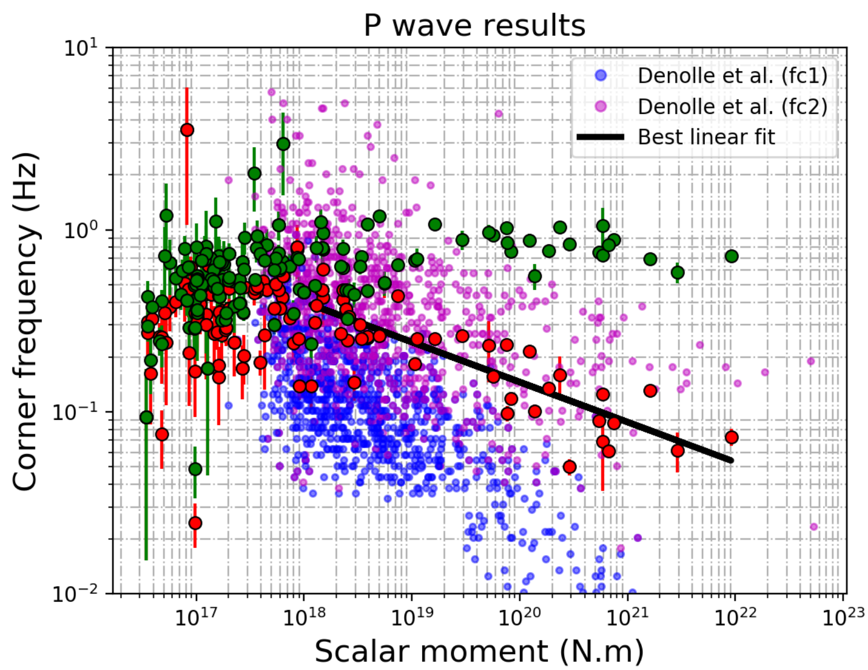


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Figure 2: corner frequency estimates for 172 strike slip events: blue and red circles: first corner frequency of global thrust events (Denolle and Shearer 2016) and of this study, respectively. Purple and green circles, second corner frequency of global thrust events (Denolle and Shearer 2016) and of this study, respectively. Black line shows the best-fit linear trend for magnitudes 6 and greater, were the differences between single-fc model and double-fc model becomes significant.

Our preliminary work shows quite high first corner frequency, too high to be interpreted as pulse duration. Fc1 seems to provide a reasonable fault-width dimension. We are still investigating the sensitivity of fc1 to the fit, to our estimate of moment.

**Intellectual merit and broader impacts**

Our results may constrain the rise time of strike-slip earthquakes, which remain invariant with earthquake magnitude. Our work suggests that most strike slip earthquakes are pulses, and that this behavior becomes dominant with earthquake size.
The impact of characterizing strike-slip source pulses will help better constrain ground motion predictions, whereby source models have to be imposed. It has direct implication to seismic hazard assessment.

**Conclusions and outlook**

We are going investigate radiated energy, S waves, and add more M5-6 events to the data set to constrain the moment-duration scaling of the low magnitudes. The data sets incorporate several tectonic regimes (transforms faults and continental SAF-type faults), and various levels of fault maturity. We will explore dependencies of the source parameters to the tectonic regime and fault maturity.