

Contributions of the UseIT summer research program to CISM



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CISM Workshop, 2016 SCEC Annual Meeting
September 10, 2016

What is UseIT?

- **Undergraduate Studies in Earthquake Information Technology**
- **Began in 2002, over 250 participants from ~35 colleges and universities**
- **Housed at SCEC headquarters at USC**
- **Multidisciplinary group with diverse talents**
- **Tasked with a “Grand Challenge” every year posed by Tom Jordan**
 - 2016 may be the grandest challenge yet

2016 UseIT Grand Challenge

Use physics-based earthquake simulators running on high-performance computers to generate long catalogs of California seismic activity. From the synthetic catalog statistics, develop 10-year forecasts of large earthquakes (magnitude ≥ 7) on the southern San Andreas fault system. In particular, estimate the probability that more than one large earthquake will occur during intervals of one week, one month, or one year in the next 10 years. Compare these simulator-based probabilities with the values given by the official Uniform California Earthquake Rupture Forecast. Illustrate the most threatening multi-event scenarios with hazard and risk maps.

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...in 8 WEEKS!

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...in ~~8~~ 6 WEEKS!

HPC Team

- **Mentors: Scott Callaghan, Jacqui Gilchrist**
- **Members: Morgan Bent, Hernan Lopez, Kevin Scroggins, Spencer Ortega, David Fu**
- **Education allocation on Blue Waters Supercomputer**
 - One of the most powerful open science computers in the world
 - 19,500 node hours allocated
- **Computed 7 RSQSim catalogs, varying model parameters**



Run Name	a Coefficient	b Coefficient	b - a	Shear Stress	Normal Stress
Base	0.01	0.015	0.005	60	100
Rate	0.008	0.015	0.007	60	100
Rate 2	0.009	0.015	0.006	60	100
State	0.01	0.013	0.003	60	100
Sigma High	0.01	0.015	0.005	120	200
Sigma Mid	0.01	0.015	0.005	90	150
Sigma Low	0.01	0.015	0.005	72	120

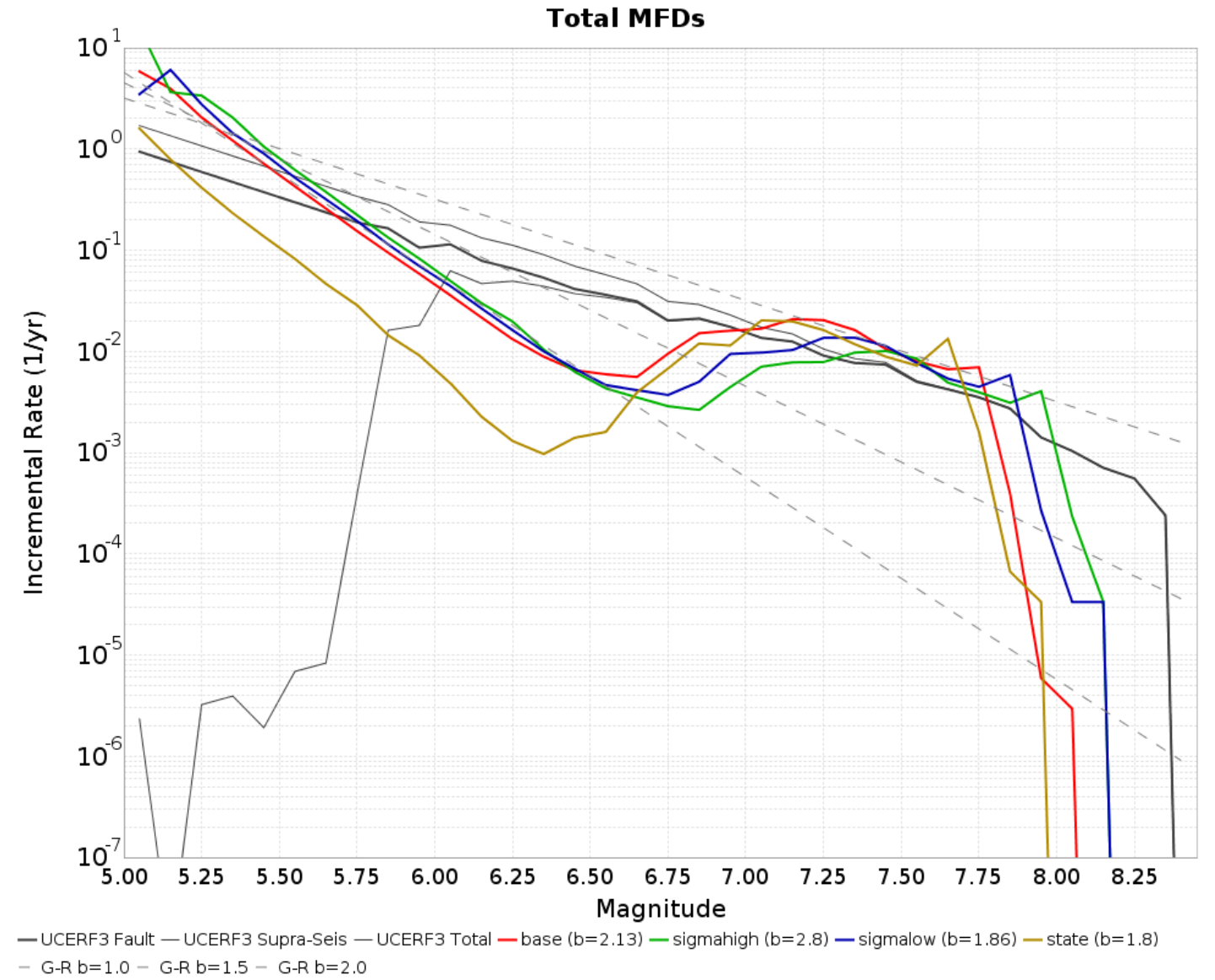
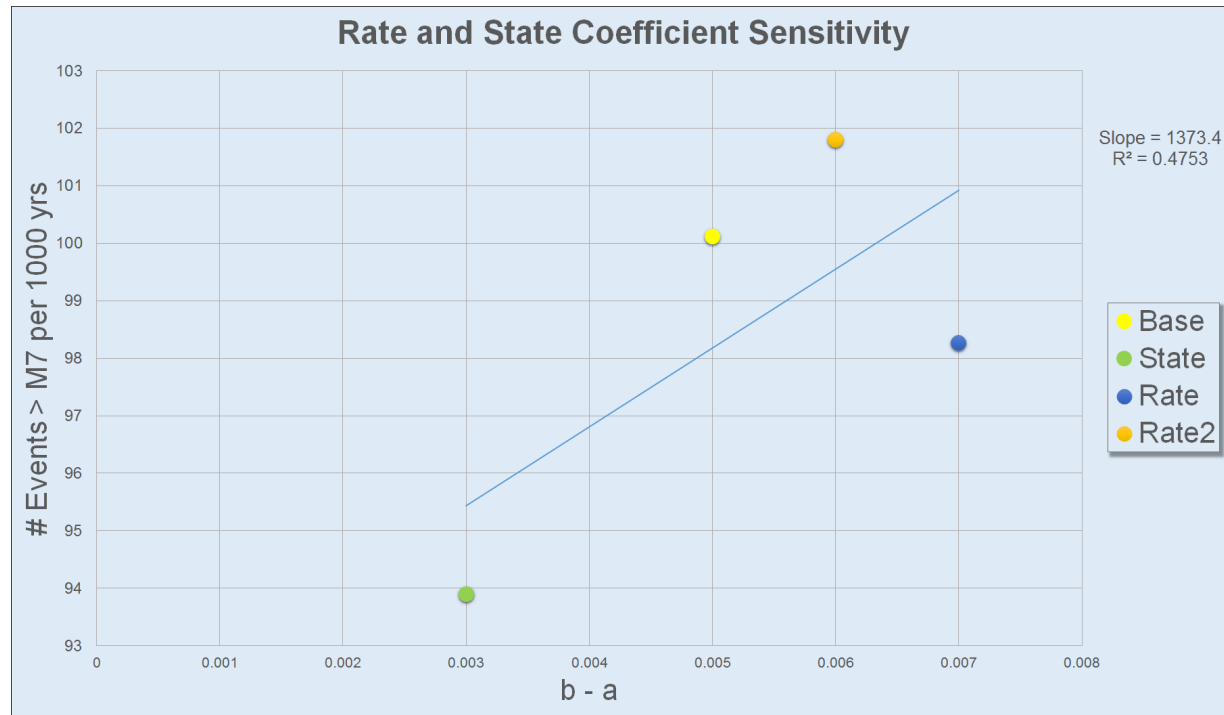
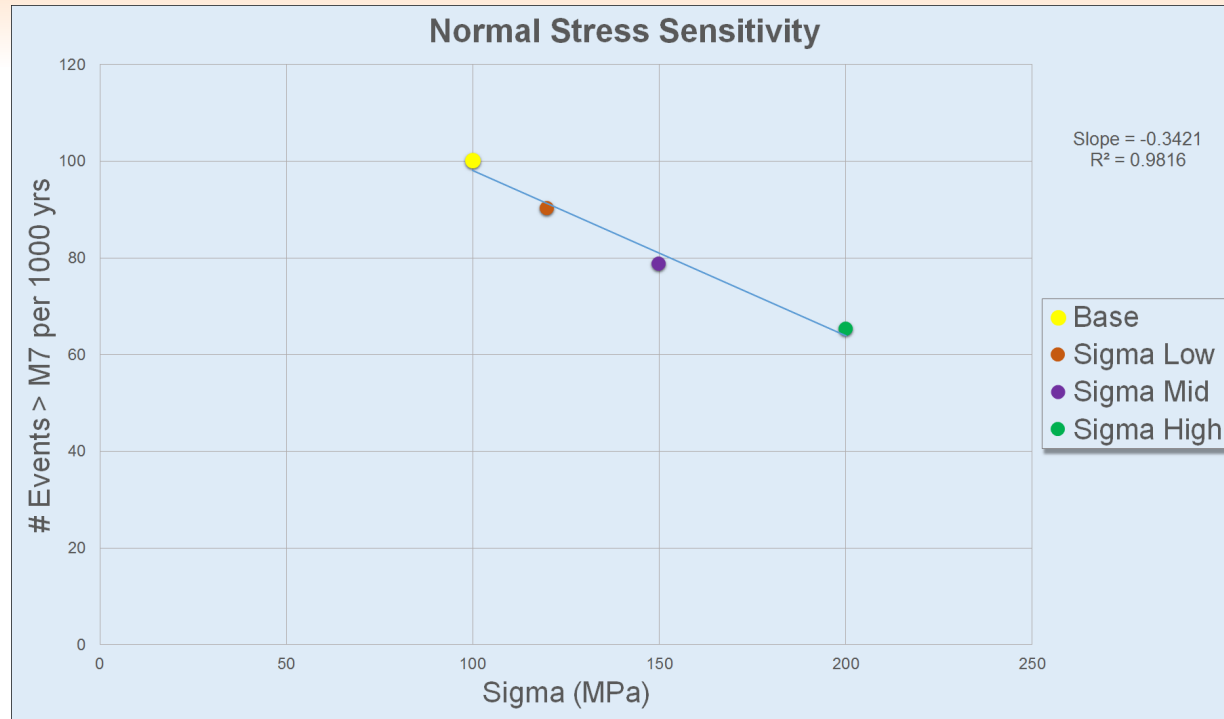
HPC Team: UCERF3 Comparisons

		UCERF3	Base	Rate	Rate_2	State	Sigma Low	Sigma Mid	Sigma High	Sigma High 64
# of Events \geq M7*	CA	692.14	1076.53	1031.72	1073.01	992.90	827.01	953.28	681.70	696.50
			55.54%	49.06%	55.03%	43.45%	19.49%	37.73%	1.51%	0.63%
	SoCal	363.52	656.69	624.98	657.52	629.86	500.68	577.51	402.73	412.12
			80.65%	71.93%	80.88%	73.27%	37.73%	58.87%	10.79%	13.37%
	sSAF	107.21	192.07	199.94	205.92	209.30	140.14	168.75	107.31	108.99
			79.14%	86.48%	92.06%	95.21%	30.71%	57.40%	0.08%	1.65%
SJF	28.06	49.33	47.62	47.21	55.23	36.84	39.60	36.01	34.85	
		75.79%	69.72%	68.24%	96.82%	31.31%	41.14%	28.31%	24.18%	
Recurrence Interval (yrs)	CA	14.45	9.29	9.69	9.32	10.07	12.09	10.49	14.67	14.36
			35.71%	32.91%	35.50%	30.29%	16.31%	27.39%	1.53%	0.63%
	SoCal	27.51	15.23	16.00	15.21	15.88	19.97	17.32	24.83	24.27
			44.64%	41.84%	44.71%	42.29%	27.40%	37.05%	9.74%	11.79%
	sSAF	93.27	52.07	50.02	48.56	47.78	71.36	59.26	93.19	91.75
			44.18%	46.38%	47.93%	48.77%	23.49%	36.47%	0.08%	1.63%
SJF	356.38	202.73	209.98	211.82	181.07	271.41	252.50	277.74	286.98	
		43.11%	41.08%	40.56%	49.19%	23.84%	29.15%	22.07%	19.47%	

% Differences
Higher than UCERF3
Lower than UCERF3

* Average values per 10,000 years

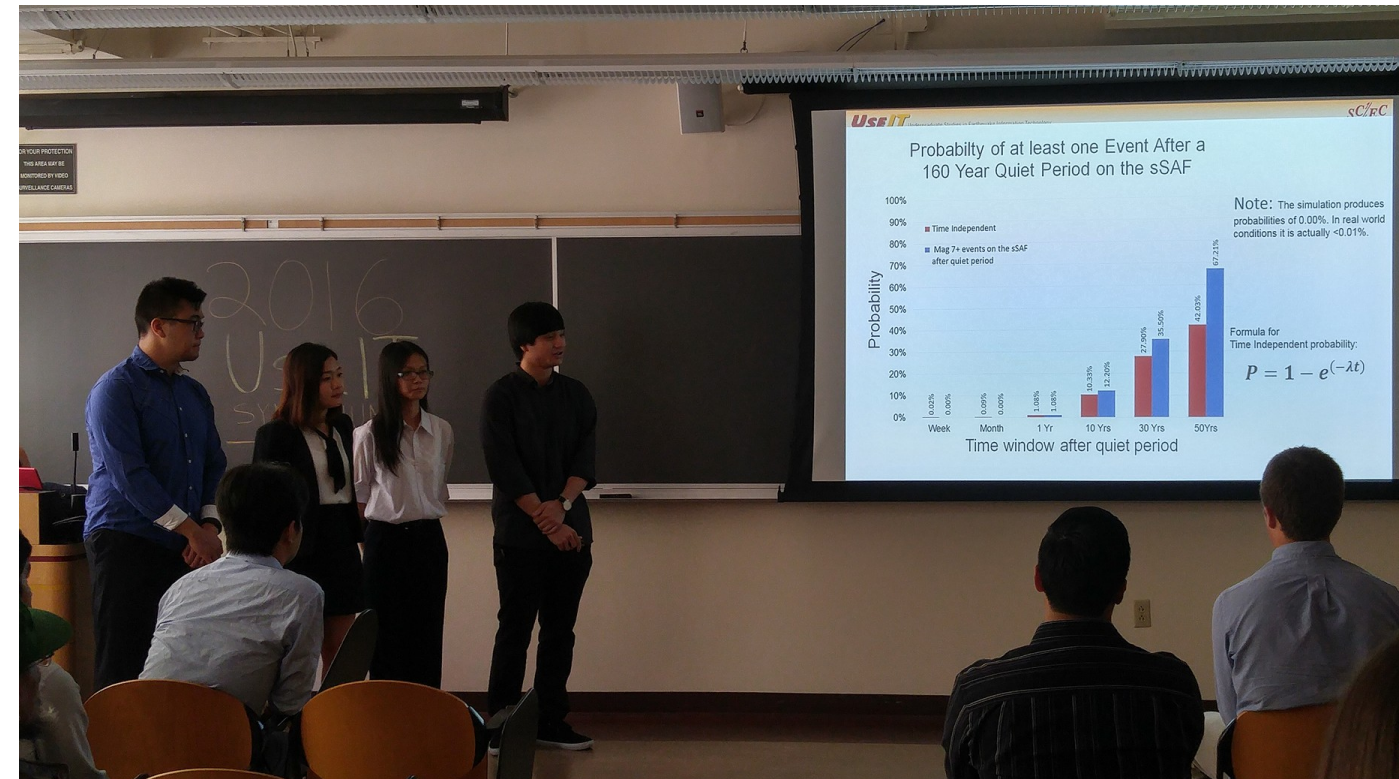
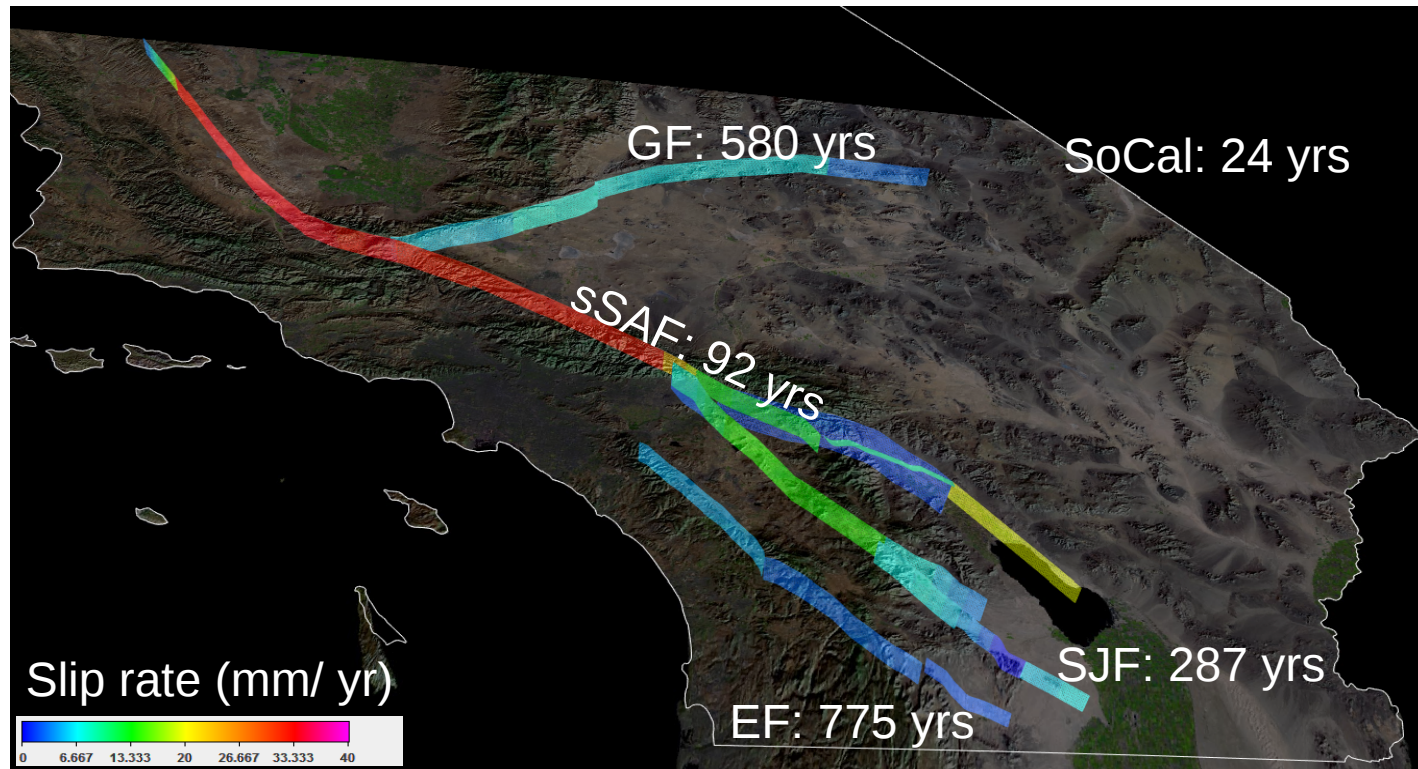
HPC Team: Sensitivity Tests



(Jacqui will discuss further)

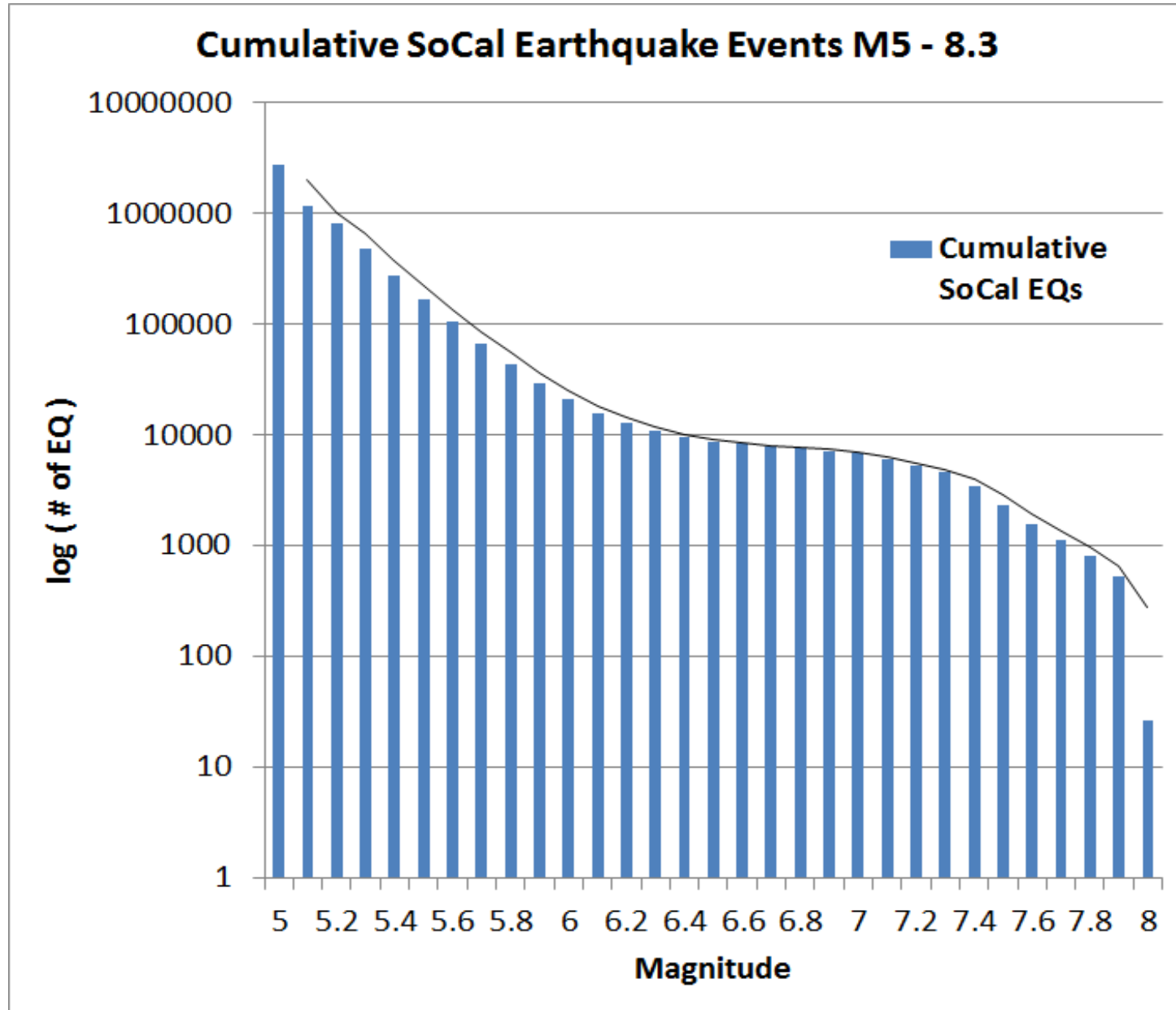
Probabilistic Forecasting Team

- **Mentors: Kevin Milner, Tom Jordan, Jacqui Gilchrist**
- **Members: Brady Guan, Yipeng Li, Daniel Ngu, Mingyan Zhou**
- **Analyzed RSQSim catalogs from the HPC**
- **Used OpenSHA to compute regional and fault probabilities, recurrence intervals, and magnitude frequency distributions**

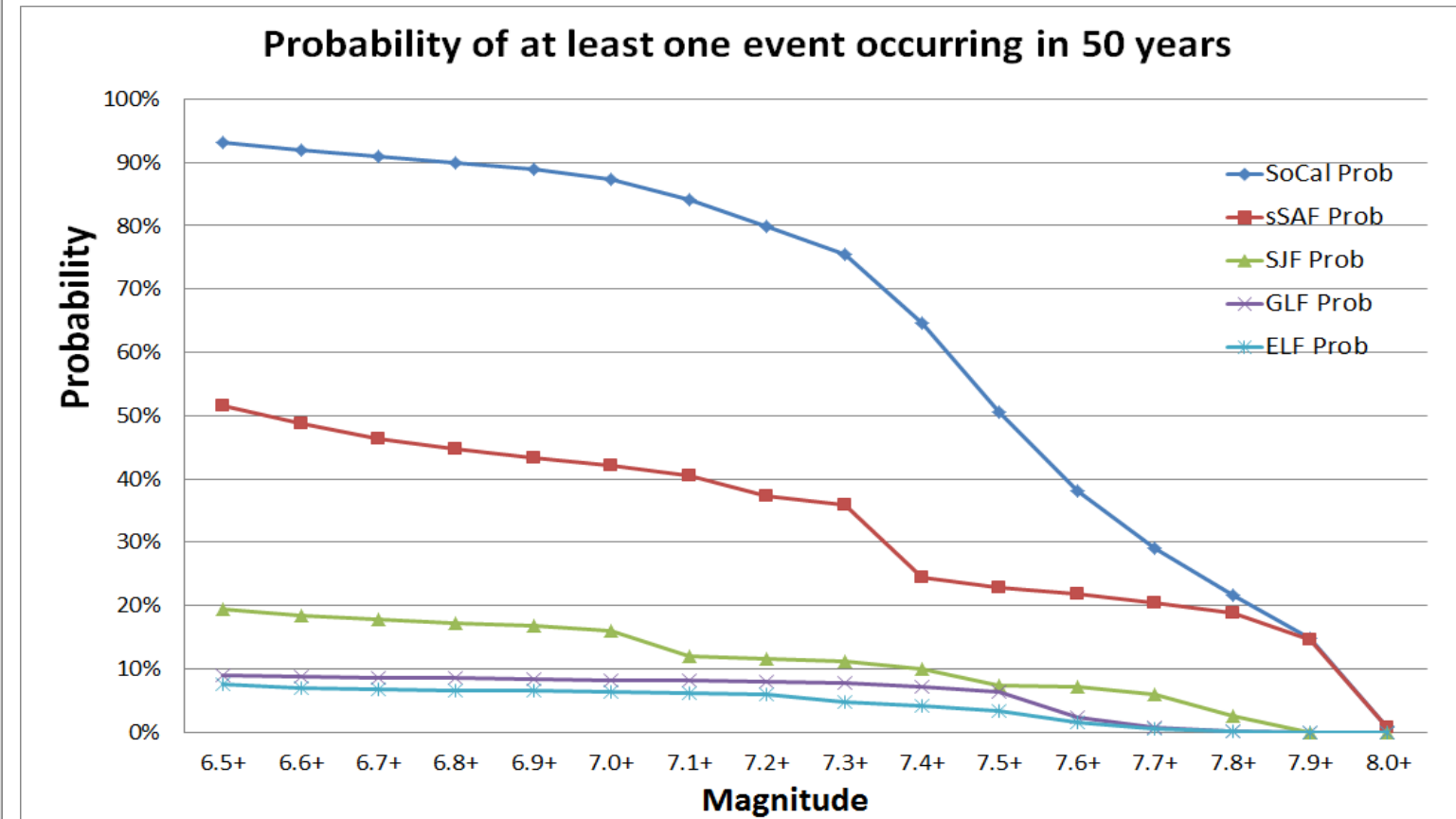


Probabilistic Forecasting Team

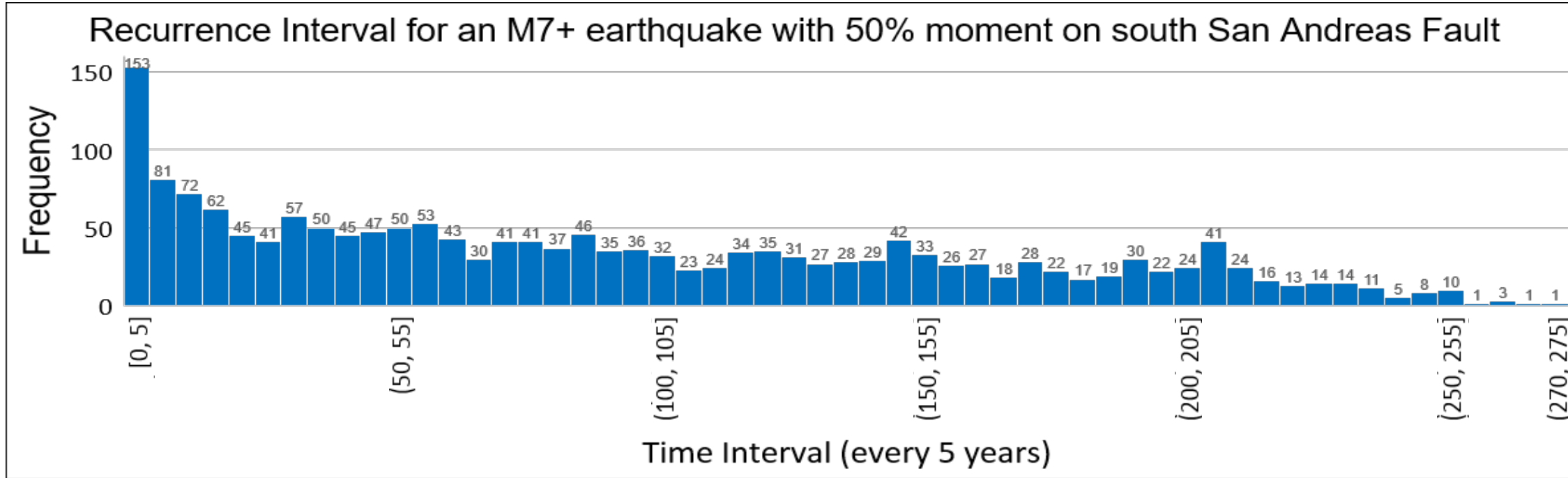
Magnitude Frequency Distributions



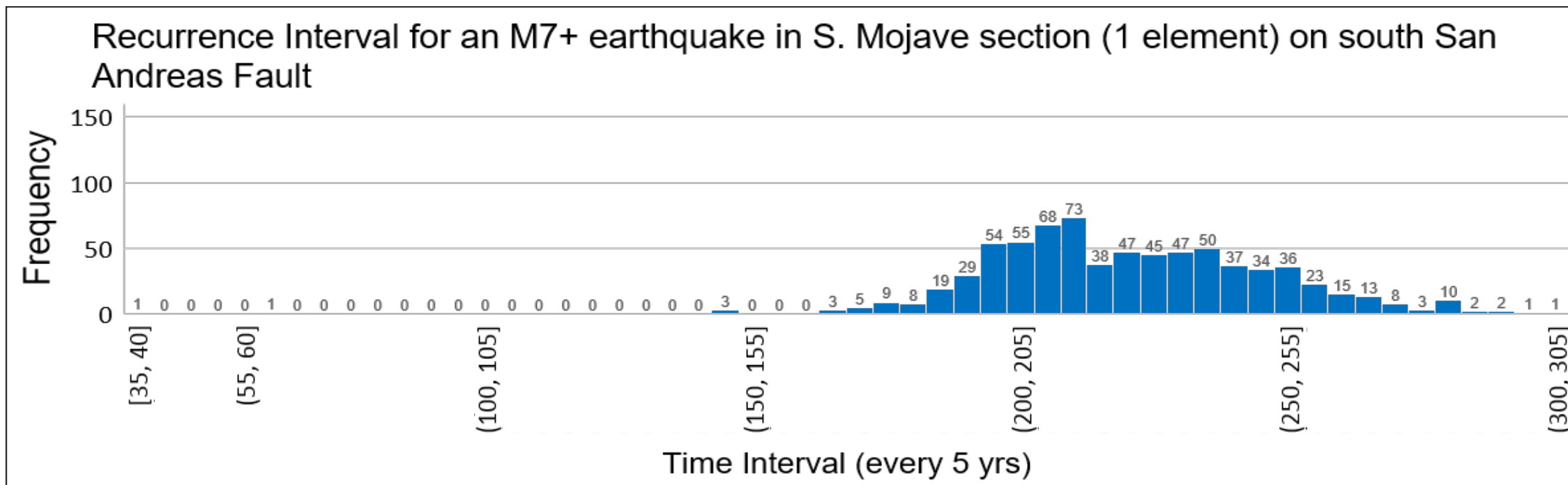
Magnitude Probability Distributions



Recurrence Intervals



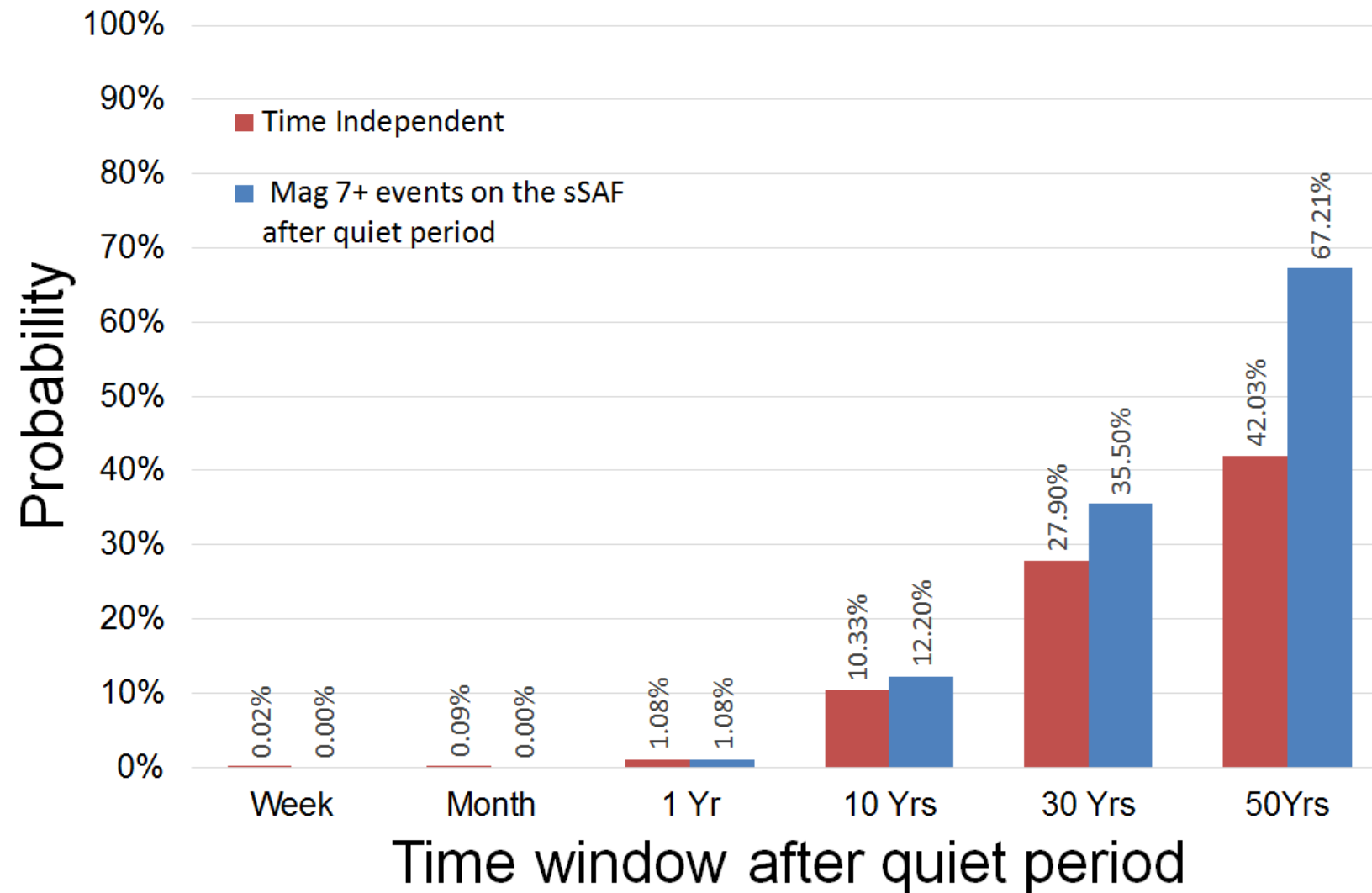
Recurrence interval:
92 yrs



Recurrence interval:
223 yrs

Time Dependent Probabilities

Probability of at least one Event After a 160 Year Quiet Period on the sSAF



Visualization/SCEC-VDO Team

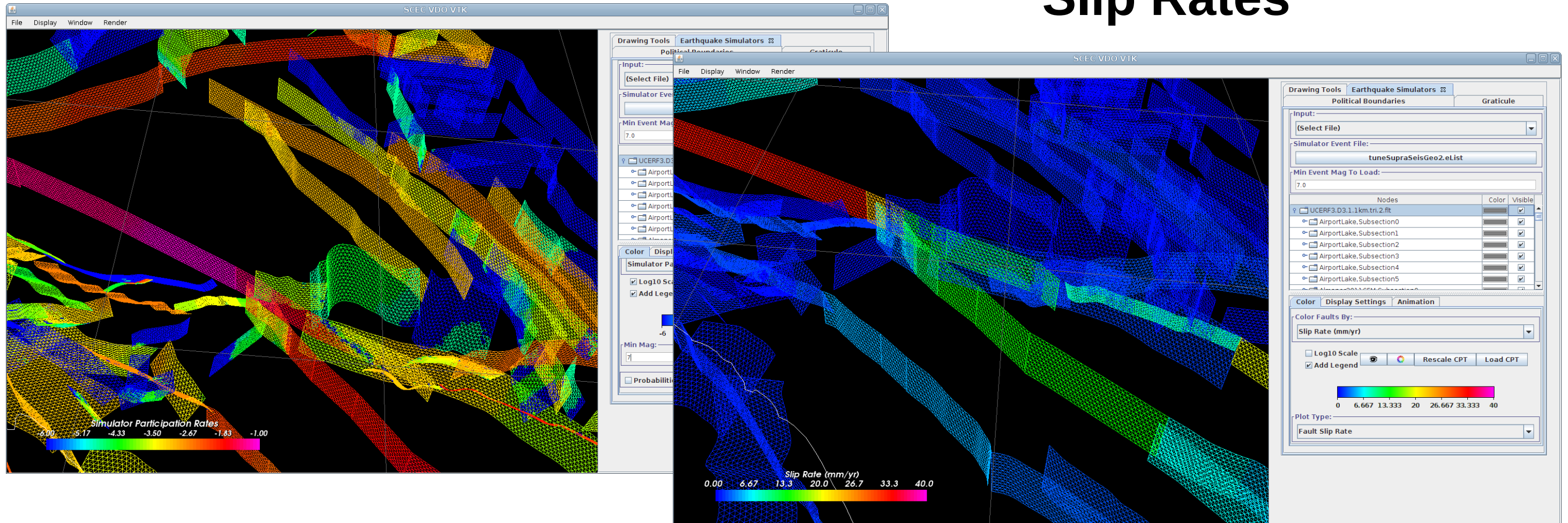
- **Mentors: Sanskriti, John Yu, Kevin Milner**
- **Members: Rory Norman, Patrick Vanderwall, Emy Huang, Emy Huang, Kishan Rajasekhar, Allen Shi, Ralph Cervantes**
- **New version of SCEC-VDO software for 2016 built on VTK libraries**
 - Download: <http://scecvdo.usc.edu/>
- **Created RSQSim visualizations**



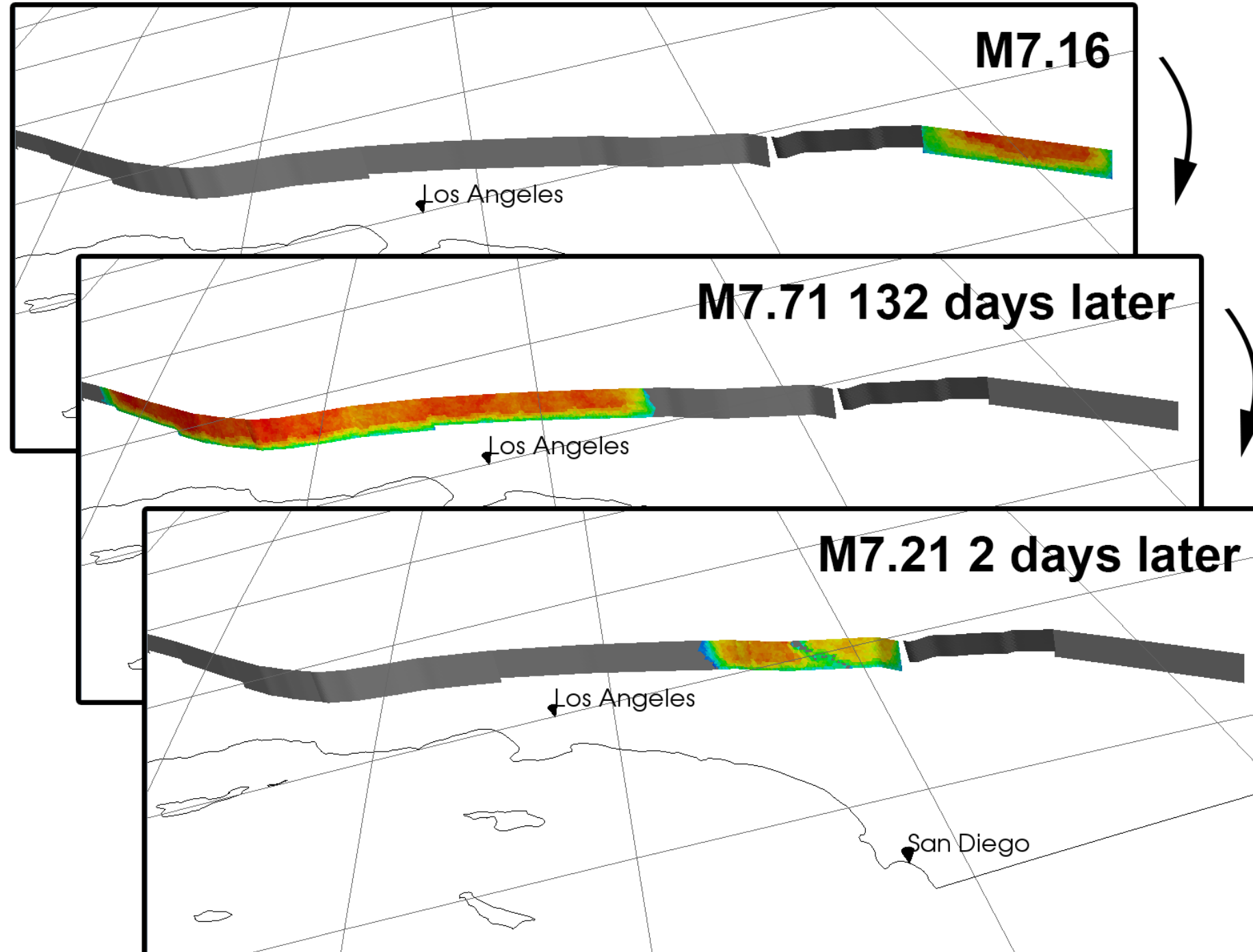
SCEC-VDO Reborn: A 3-Dimensional Visualization and Movie Making Software for Earth Science Data

Participation Rates

Slip Rates

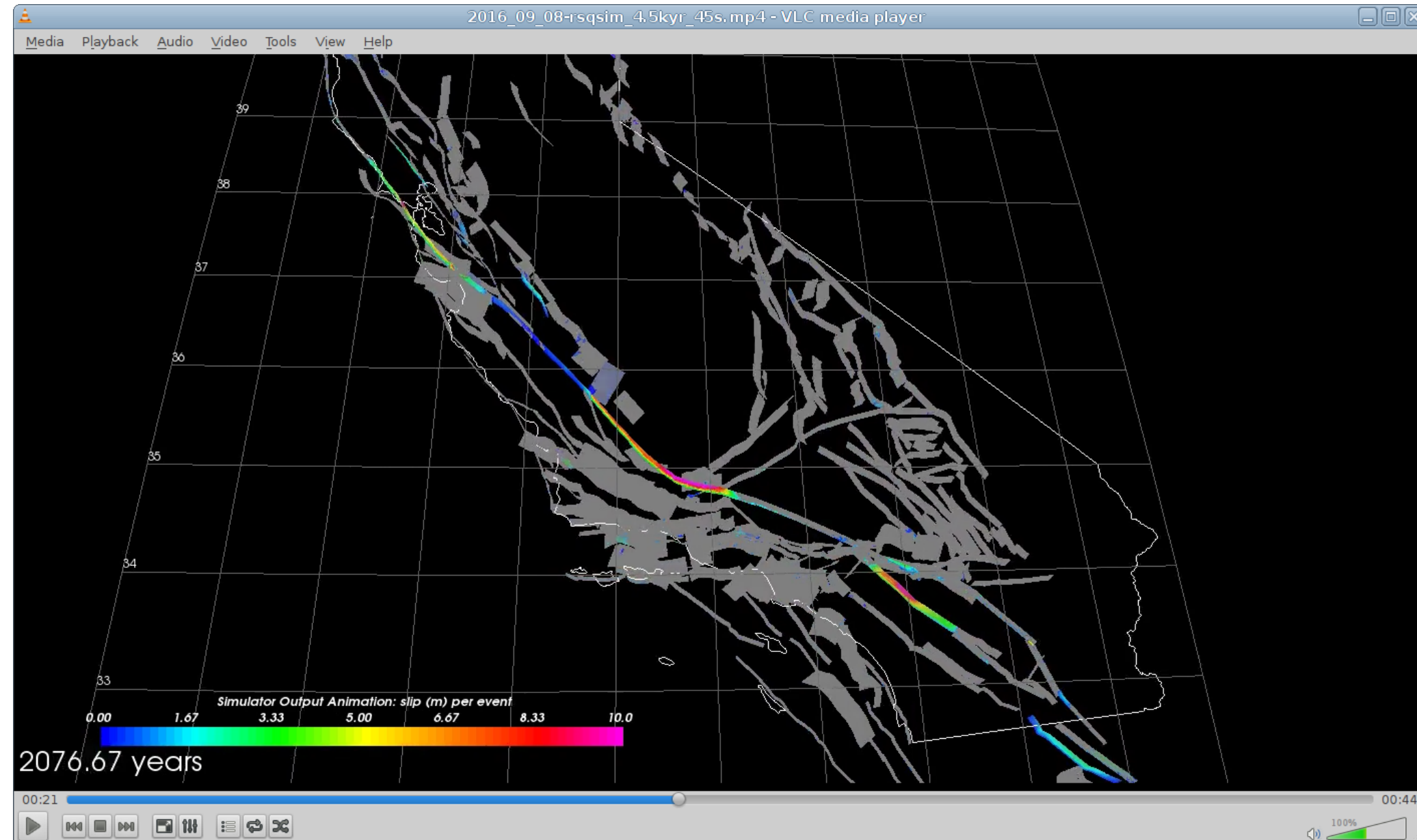


SCEC-VDO: RSQSim Sequences



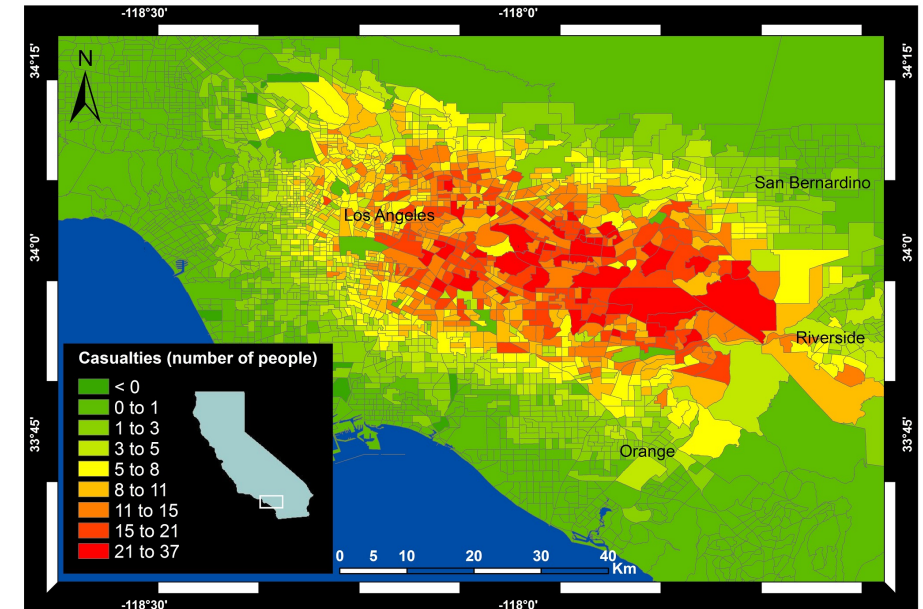
SCEC-VDO: Render Movies

- **Allows for visual inspection of patterns**
- **Previous events fade out over time**
 - 50 year fade works well
- **Can visualize thousands of years or specific sequences**



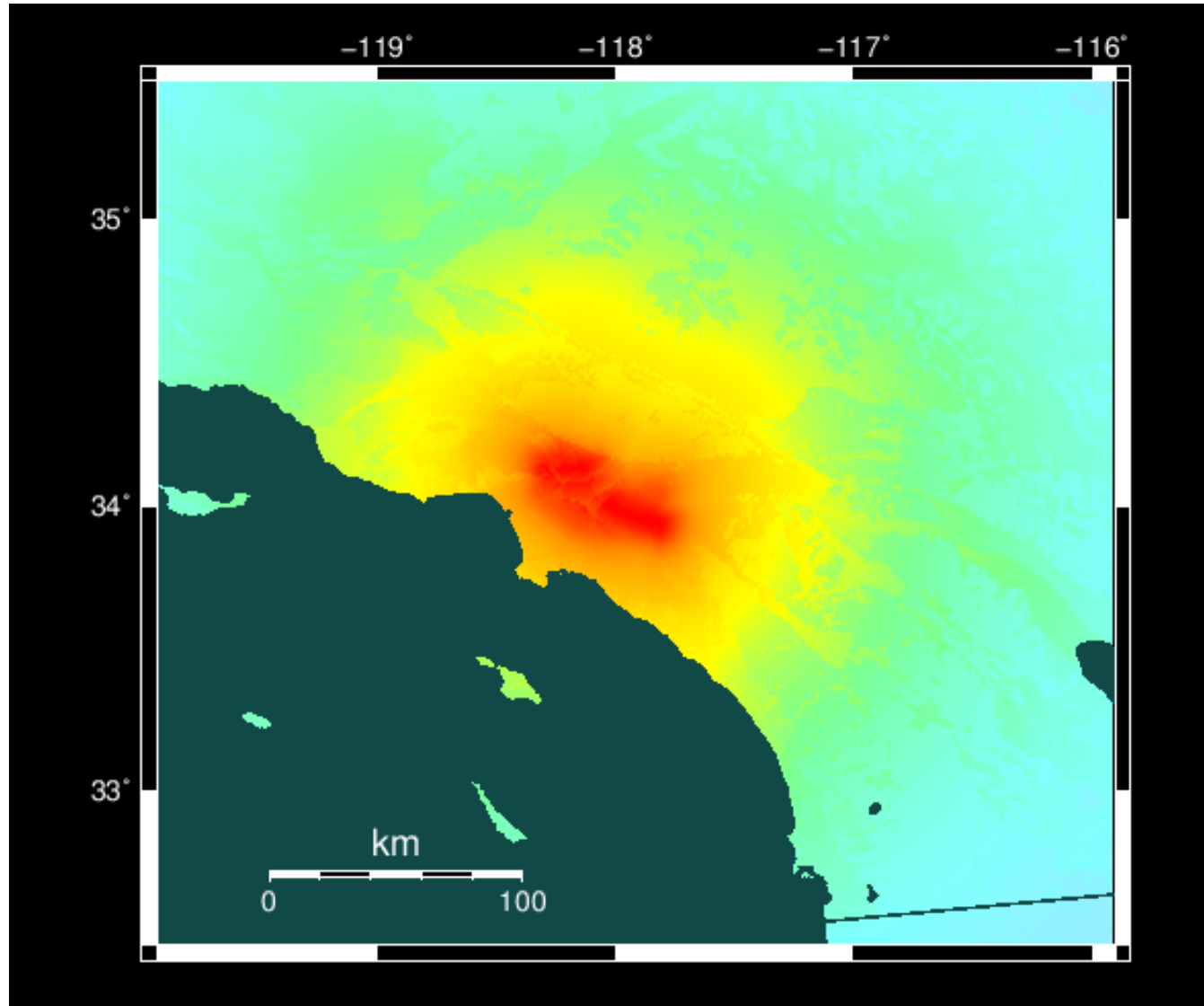
Hazard and Risk Visualization Team

- **Mentors: Mark Benthien, Kevin Milner, Hope Seligson**
- **Members: Sophia Belvoir, Jenepher Zamora, Jadson de Silva Lima, Vianca Severino Rivas, Luis Gomez**
- **Generated shakemaps for RSQSim ruptures using OpenSHA**
- **Computed losses with HAZUS**
- **Considered multi-event scenarios**

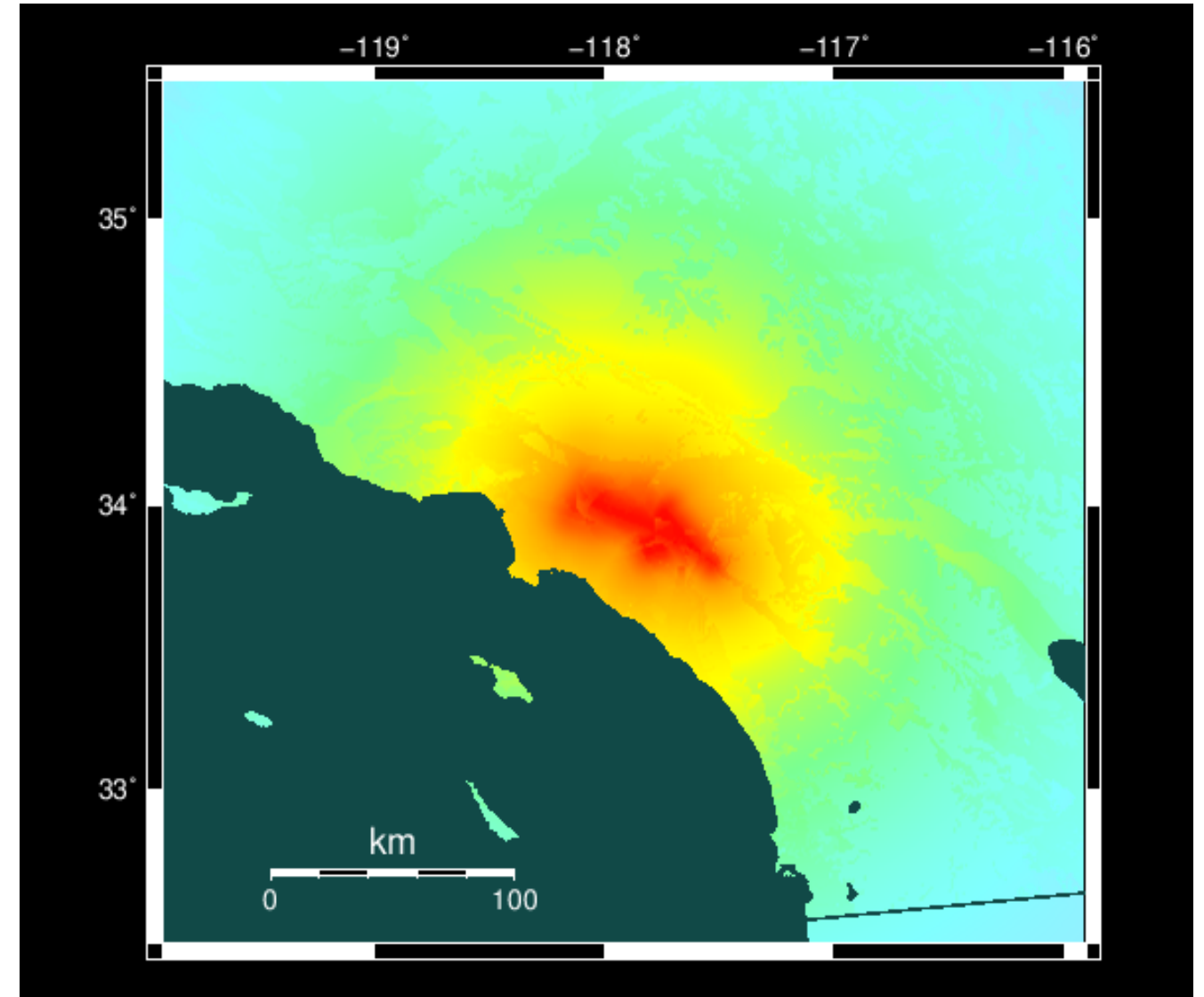


RSQSim Event Shakemaps

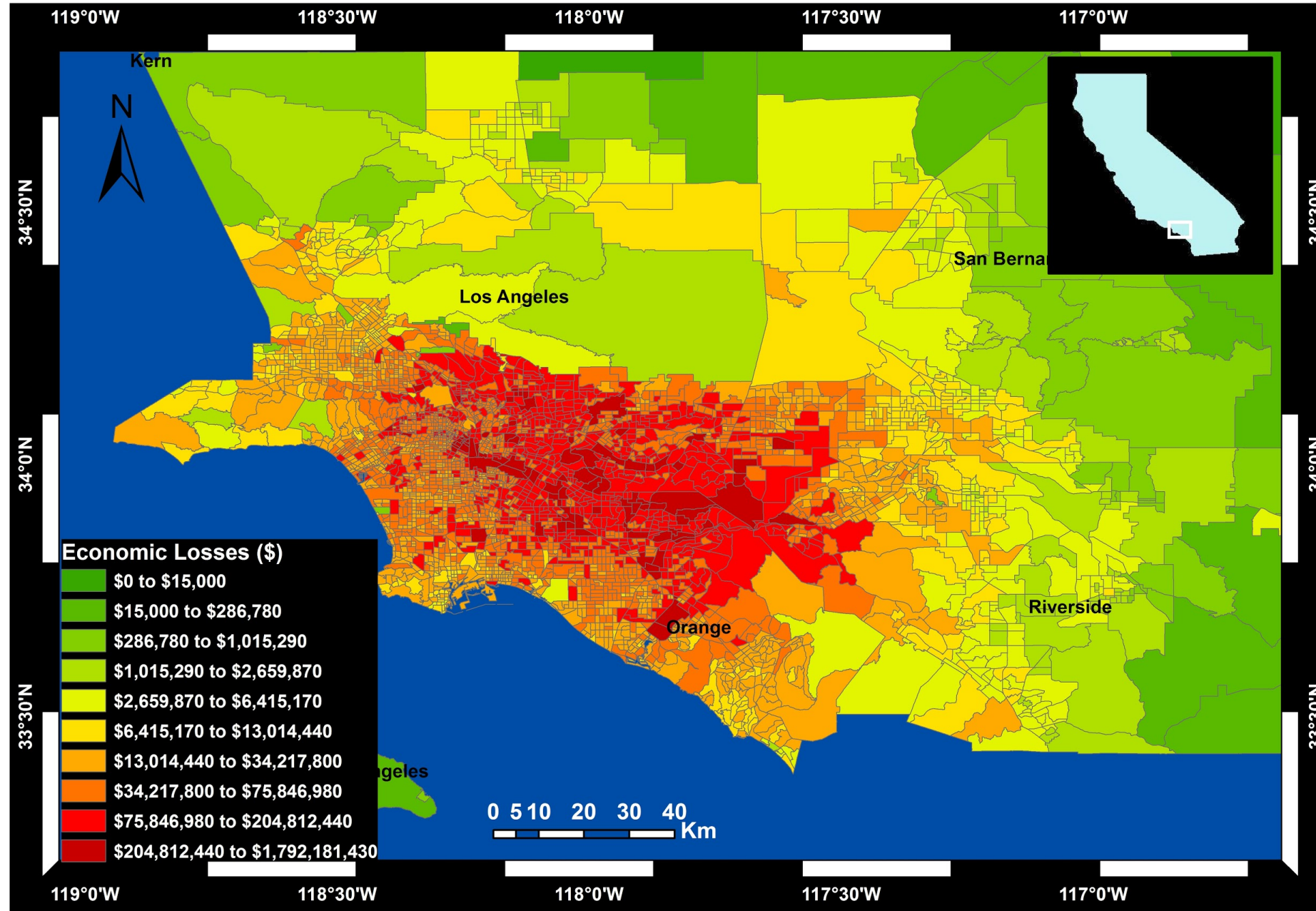
Event One: Puente Hills



Event Two: Whittier



RSQSim Event Losses



Total Loss: \$198,371,640,000

Visit their posters and try SCEC-VDO tonight at the poster session!

