Simulating seismicity in a fault network model: 
the effect of interaction on event statistics

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Motivation

- Examine large earthquake recurrence in models with varying degrees of fault complexity
  - Do simple fault systems show greater relaxation and hence more regular recurrence than complex networks?
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Seismicity simulation model

- Contains a user-defined network of 3D faults

- Cells assigned heterogeneous (usually fractal) distribution of strength
Stress in model
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- Fault interaction can be “turned off” to investigate its effects
B-values

- Both models produce power-law magnitude frequency distributions
- B-value lower than actually observed due to lack of small faults

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SFBA

NAF
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No interaction

Max = 7.44

Interaction

Max = 7.2
SFBA

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**Interaction**

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NAF

**No interaction**

Max = 8.38

**Interaction**

Max = 8.25
Map of North Anatolian Fault Region

Northing (km)

Easting (km)

3 B = 0.375
B = 0.500

2 B = 0.381
B = 0.513

1 B = 0.382
B = 0.520
No interaction: 204,349 events

Interaction: 305,569 events
No interaction: 85,306 events
Interaction: 258,979 events
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Recurrence times of events on fault 1 (SFBA)

No interaction

Interaction

$M \geq 6.5$
Recurrence times of events on fault 1 (SFBA)

No interaction

Interaction

\[ M \geq 6.5 \]

\[ M \geq 5.5 \]
Recurrence times of events on fault 2 (NAF)

No interaction

\[ M \geq 6.5 \]

Interaction

\[ M \geq 5.5 \]
Seismic rates – Northern California

NC 87, average number of events per day, M3
The graph shows the probability of exceedance for NC-M>=3 events against the number of events per day on a logarithmic scale. The slope of the best-fit line is -1.59.
Conclusions

• In comparison to models in which interaction is not allowed, the effect of interaction is to:
  – Increase the b-value both regionally and on all faults
  – Increase the total number of events
  – Increase the percentage of events occurring on subsidiary (and even misaligned) faults.
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• Following immediate triggering, interaction models have longer recurrence times for large events
  – Does triggering “use up” nucleation sites?
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• Only models with interaction produce seismic rate patterns consistent with those observed in natural fault systems.