RSQSim Runs

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## Loading required package: xtable
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Run 1

- Main fault
  - 5 km x 3 km
  - vertical
  - strike-slip
  - 100 m elements
  - top edge at 2 km depth
  - initial normal stress: 100 MPa
  - initial shear stress: 65 MPa
- Random faults
  - n = 2000
  - size: to produce GR between M=0 and M=2
  - orientation: parallel to main fault
  - position: exponentially distributed distance from random main fault element, random direction
  - eliminate those within 10 m of main fault
  - initial stresses: same as main fault
- Injection
  - `makeInjectionHistory()`'s default values:
    * diffusivity, $\kappa = 0.008 \mathrm{m}^2/\mathrm{s}$
    * porosity, $\phi = 0.05$
    * compressibility, $c = 5 \cdot 10^{-10} \mathrm{Pa}^{-1}$
    * injection rate, $Q = 0.0069 \mathrm{m}^3/\mathrm{s}$
  - 500 m from center point of main fault

Run 2

Same as Run1 except for:

- Random faults
  - orientation: perturbed from that of main fault with a standard deviation of 10° about uniformly distributed random axes

Run 3

Same as Run 2 except:

- Main fault
  - initial shear stress: 63 MPa
- Random faults
  - initial shear stress: 63 ± 1 MPa (mean ± standard deviation)

Run 4

Same as Run 3 except:

- Main fault
  - initial shear stress: 62 MPa

Run 5

Same as Run 4 except:

- Main fault
  - initial shear stress: 62.8 MPa

Run 6

Same as Run 5 except:

- Main fault
  - initial shear stress: 63.2 MPa

Run 7

Same as Run 6 except:

- Random faults
  - initial shear stress: 65 ± 1 MPa

Run 8

Same as Run 7 except:

- Random faults
  - initial shear stress: 66 ± 1 MPa

Run 100

Same as Run 6 except:

- Random faults
  - $n = 5000$

Run 101

Same as Run 100 except:

- Random faults
  - $n = 10000$

Run 102

Same as Run 101 except:

- Injection
  - 1500 m from center of fault

Run 103

Same as Run 102 except:

- Injection
  - 1000 m from center of fault

Run 104

Same as Run 103 except:

- Main fault
  - initial shear stress: 66.7 MPa

Results table

	Run	$t_{M\geq5}$	N	N_b	N_a	N_ex	f_as naive	f_as SS-all	(0.16)	f_as SS-ex	(0.84)	f_as Z-all	f_as Z-ex	f_as H-all	f_as H-ex
1	Run1	6.2	52	20	31	2	0.54	0.93	0.39	0.45	0.57	0.55	0.53	0.96	0.82
2	Run2	6.1	48	20	27	1	0.52	0.92	0.46	0.57	0.83	0.55	0.59	0.96	0.81
3	Run3	38.4	49	19	29	0	0.47	0.62	0.52	0.62	0.89	0.54	0.52	0.81	0.81
4	Run4		22			0	0.00	0.05	0.01	0.04	0.36	0.24	0.24	0.79	0.79
5	Run5	79.2	45	21	23	0	0.49	0.80	0.68	0.80	0.95	0.55	0.55	0.88	0.88
6	Run6	27.8	49	19	29	0	0.57	0.50	0.44	0.50	0.72	0.71	0.71	0.58	0.58
7	Run7	29.9	109	66	42	0	0.36	0.29	0.25	0.29	0.59	0.30	0.29	0.85	0.85
8	Run8	10.5	195	116	78	5	0.37	0.98	0.22	0.25	0.29	0.32	0.33	0.98	0.71
9	Run100	12.6	81	48	32	5	0.35	0.80	0.39	0.52	0.83	0.39	0.40	0.86	0.66
10	Run101	27.8	212	126	85	10	0.35	0.50	0.26	0.30	0.36	0.39	0.42	0.87	0.59
11	Run102		22			0	0.00	0.04	0.01	0.04	0.25	0.33	0.00	0.42	0.42
12	Run103		46			0	0.00	0.09	0.02	0.10	0.43	0.04	0.07	0.51	0.51
13	Run104	18.3	124	34	89	3	0.64	0.95	0.52	0.57	0.65	0.65	0.68	0.96	0.80

Table 1: Summary of run results. $t_{M\geq5}$: time until first $M \geq 5$ event (yrs). N: total number of events. N_b: number of events before first $M \geq 5$ event. N_a: number of events after first $M \geq 5$ event. N_ex: number of very late outlying events. f_as-naive: aftershock fraction taking events within 5 years of $M \geq 5$ as aftershocks. f_as-SS-all: aftershock fraction from Bayesian fitting of *Saichev and Sornette* [2007] to all events. f_as-SS-ex: as previous but excluding very late events. (0.16) and (0.84): 68% confidence intervals of previous. f_as-Z-all: aftershock fraction ala Zaliapin and Ben-Zion, 2018 using all events. f_as-Z-ex: as previous but excluding very late events. f_as-H-all: aftershock fraction from *Hainzl et al.* [2006] f_as-H-ex: as previous but excluding very late events.

If you take the f_{as}-naive as being the true answer, and if you count the cases where f_{as}-naive is 0.00 and the lower end of the 68% CIs for Bayesian fitting of *Saichev and Sornette* [2007] is 0.01 or 0.02 as being close enough, then the true answer falls within the 68% CIs 9 out of 13 times, so 69% of the time (when the late outliers are removed).

The *Hainzl et al.* [2006] method seriously overestimates the aftershock fraction in most cases.

References

Hainzl, S., F. Scherbaum, and C. Beauval (2006), Estimating background activity based on interevent-time distribution, *Bulletin of the Seismological Society of America*, *96*(1), 313–320.

Saichev, A., and D. Sornette (2007), Theory of earthquake recurrence times, *Journal of Geophysical Research: Solid Earth*, *112*(B4).