A fault-based probabilistic seismic hazard model for Lebanon, controlling parameters and hazard levels

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S. El Kadri[(1,2)] , C. Beauval[(1)], M. Brax[(2)], PY. Bard[(1)], M. Vergnolle[(3)] and Y. Klinger[(4)]

[(1)] Univ. Grenoble Alpes, Univ. Savoie Mont Blanc, CNRS, IRD, Univ. Gustave Eiffel, ISTerre, 38000 Grenoble, France

[(2)] National Council for Scientific Research, CNRS-L, P.O. Box 16-5432, Achrafyeh, 1100-2040 Beirut, Lebanon

[(3)] Université Côte d'Azur, IRD, CNRS, Observatoire de la Côte d'Azur Géoazur, Geoazur, Valbonne, France

[(4)] Université de Paris Cité, Institut de physique du globe de Paris, CNRS, 1, rue Jussieu, Paris, France

Corresponding author: sarah.el-kadri@univ-grenoble-alpes.fr

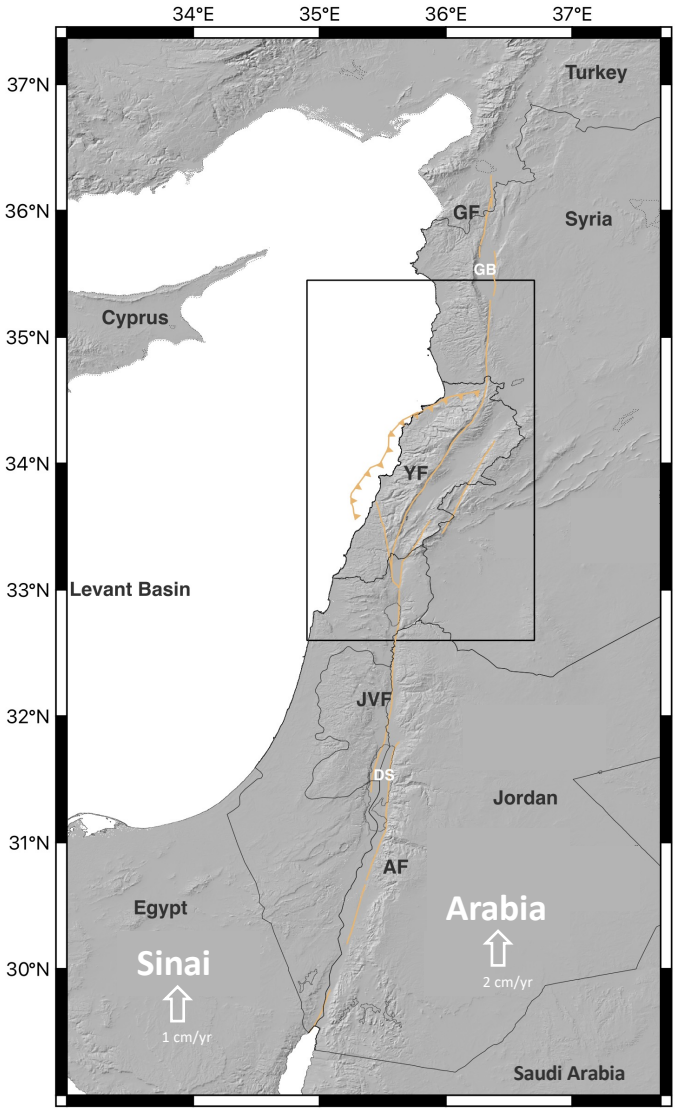

Fig. S1 Levant transform plate boundary. Pull-apart basins: GB, Ghab Basin; DS: Dead Sea. Major fault segments: GF, Ghab fault (that includes Missyaf segment); YF, Yammouneh fault; JVF, Jordan Valley fault; AF, Araba fault. Black frame corresponds to Fig. 1 in the paper

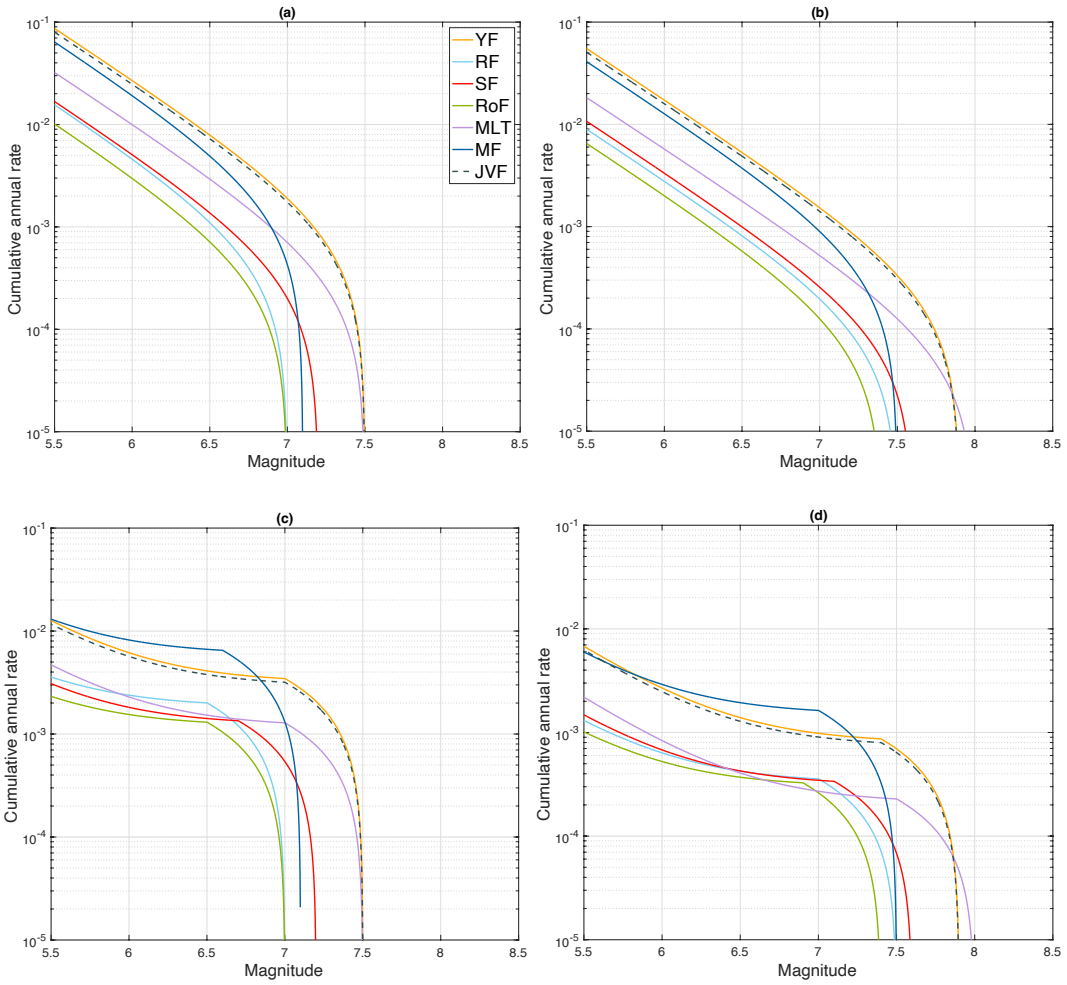

Fig. S2 Moment-balanced frequency-magnitude distributions for the 7 faults included in the model, same legend as Fig. 6 in the paper, the only difference is that the annual occurrence rates have not been normalized per km^2. For example, considering the exponential model and the upper bound of M_{max} (b), the model forecasts a magnitude larger or equal to 6 on average every ~500 years on the Roum fault, every ~170 years on the Mount Lebanon Fault, or every ~60 years on the Yammouneh Fault. Considering the Youngs and Coppersmith model and the upper bound of M_{max} (d), these average recurrence times increase to respectively ~2000 years (Roum), ~1250 years (MLT), and ~350 years (Yammouneh).

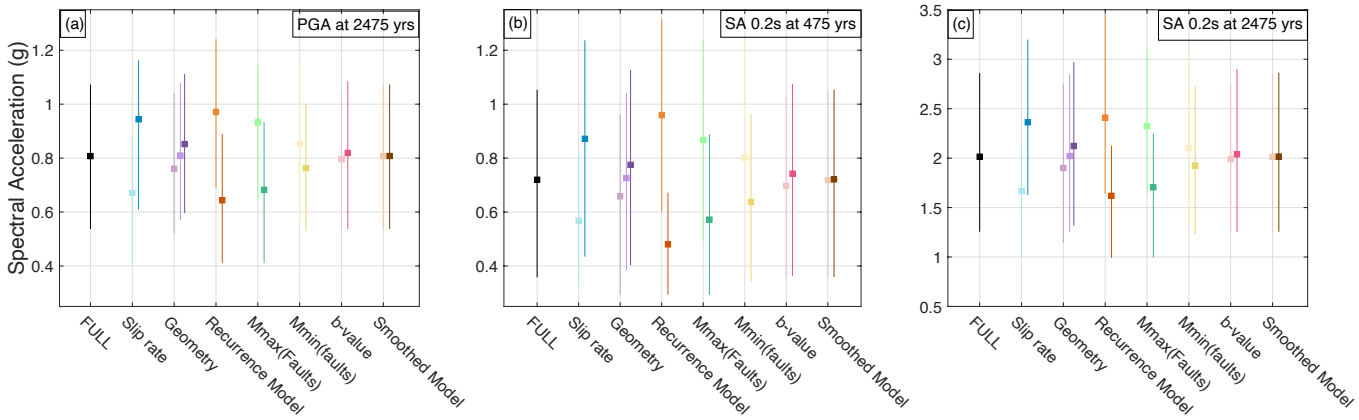

Fig. S3 Distribution of hazard levels in Beirut, for a) PGA at 2475 years return period, b) spectral period 0.2s at 475 years, c) spectral period 0.2 at 2475 years return period. See legend of Fig. 7

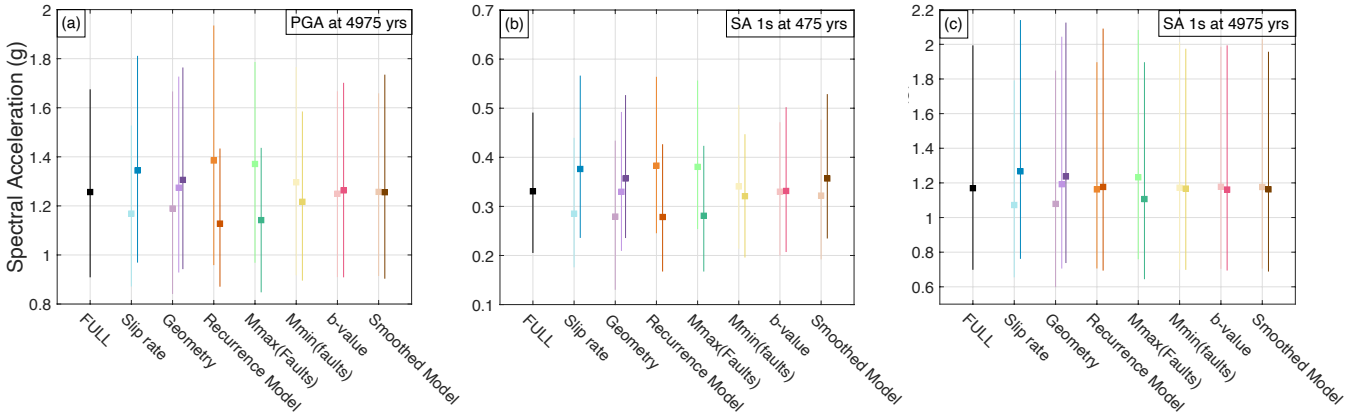

Fig. S4 Distribution of hazard levels in Zahle, for a) PGA at 4975 years return period, b) spectral period 1 at 475 years, c) spectral period 1 at 4975 years return period. See legend of Fig. 7

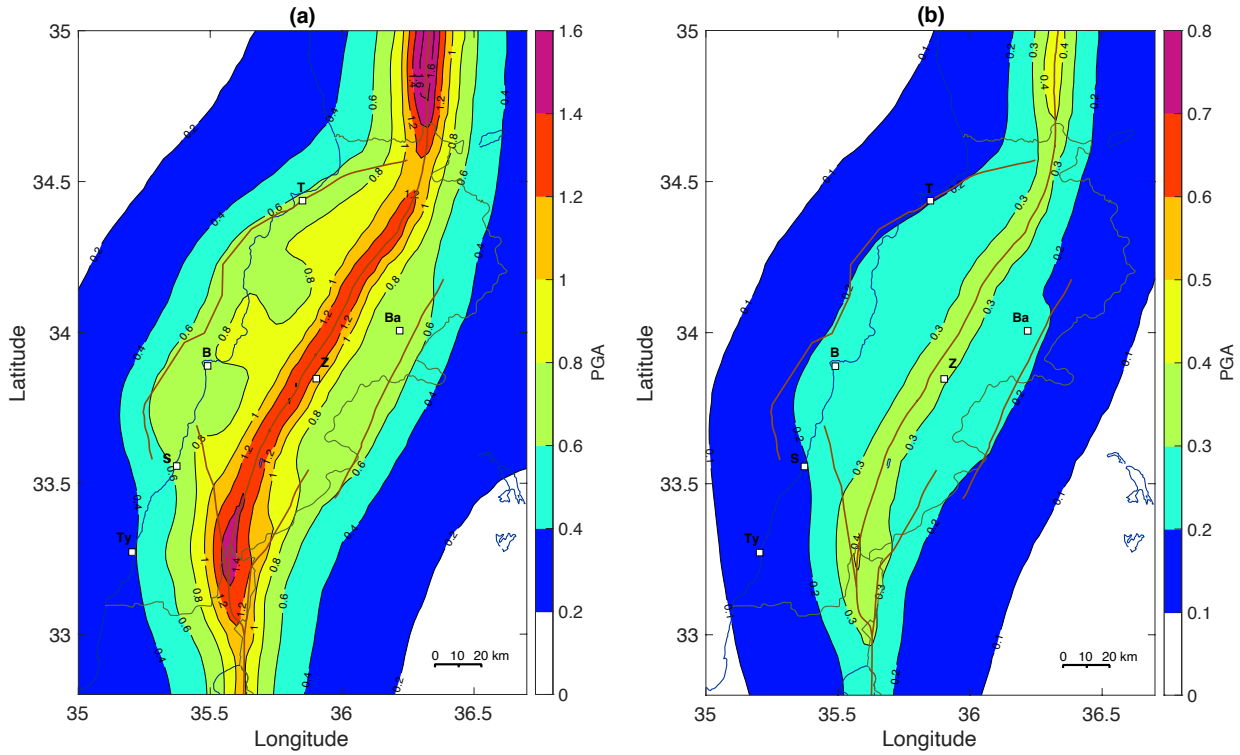

Fig. S5 Mean seismic hazard maps for spectral periods 0.2s (a) and 1s (b), at 475 years, generic rock site condition with V_{S30} 760 m/s. The source model logic tree is combined with the three alternative ground-motion models. Average values and percentiles are inferred from a distribution of 144 hazard values (equally weighted), as in Fig. 13

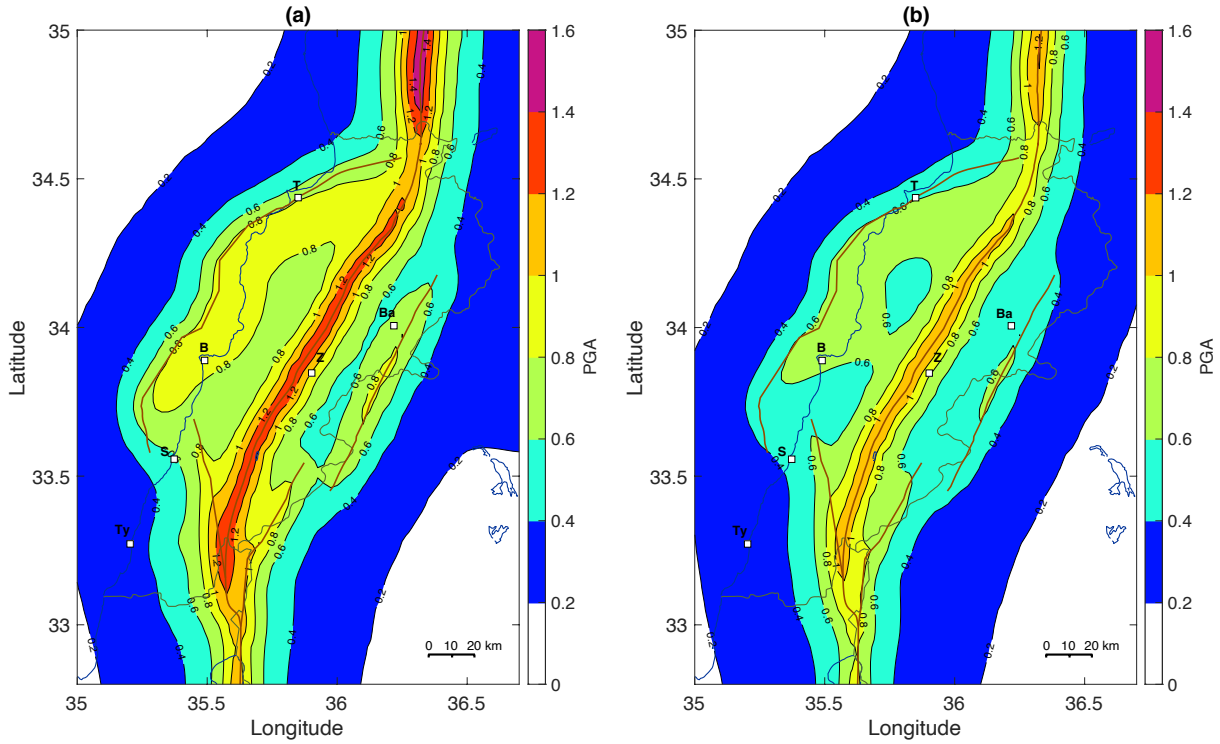

Fig. S6 Mean seismic hazard maps at 2475 years, for the PGA (a) and spectral period 1s (b), generic rock site condition with V_{S30} 760 m/s. The source model logic tree is combined with the three alternative ground-motion models. Average values and percentiles are inferred from a distribution of 144 hazard values (equally weighted), as in Fig. 13

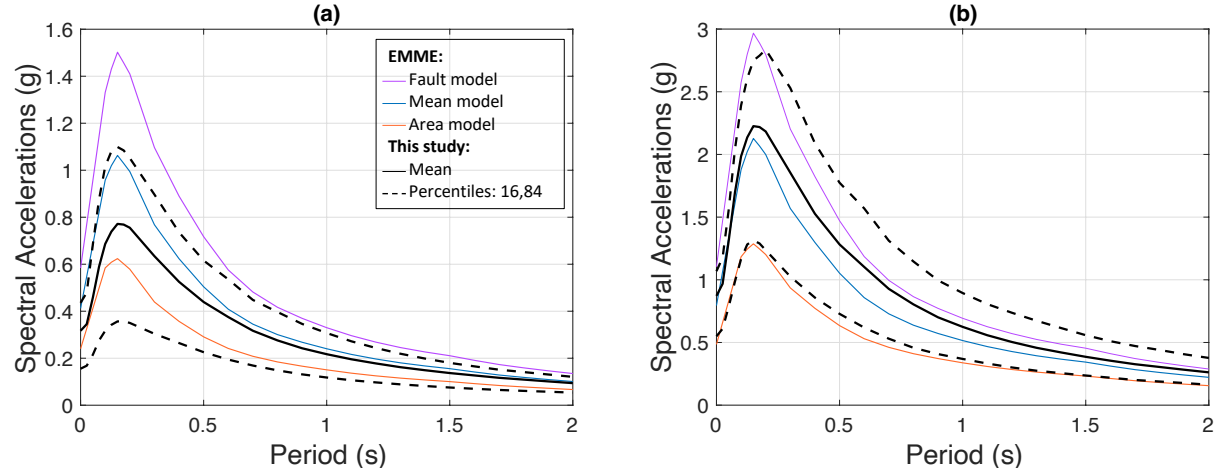

Fig. S7 Distribution of uniform hazard spectra for Beirut, generic rock site condition with V_{S30} 760 m/s. Black: This study results as in Fig. 12 in the paper. EMME results (Danciu et al., 2017), purple: smoothed seismicity and fault model; orange: area model; blue: mean model with 40% weight on the fault model and 60% on the area model. a) at 475 years return period; b) at 2475 years return period. EMME results have been obtained by running the EMME source model and ground-motion model xml input files with OpenQuake

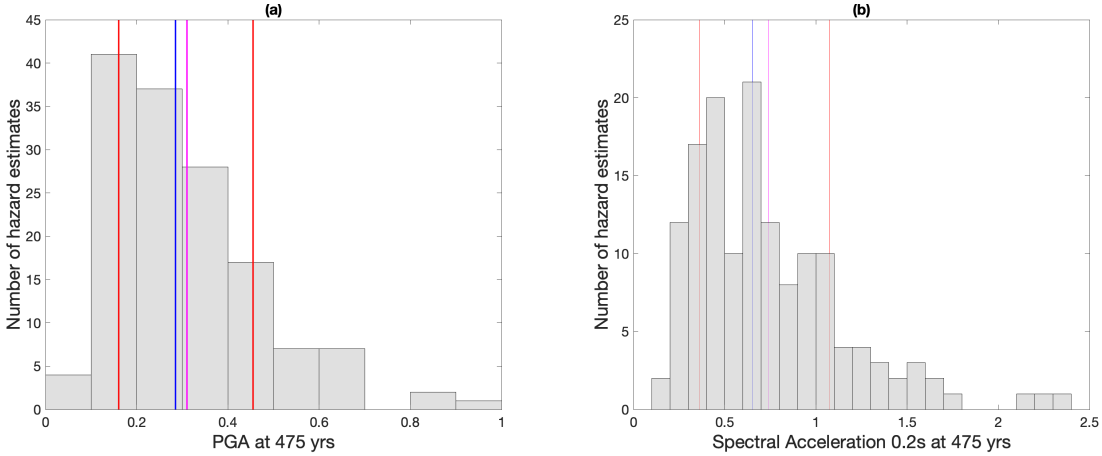

Fig. S8 Distribution of the hazard estimates obtained at Beirut city for a return period of 475 years, in magenta: mean value, in blue: median value and in red: 16th and 84th percentiles. a) for the PGA; b) for the spectral period 0.2s. The final logic tree, with only the parameters influencing the most the hazard, is explored (as in Fig. 14 and Section 6)

Table S1. Acceleration levels obtained for different spectral periods in the cities of Beirut, Zahle, Saida and Tripoli, at 475 and 2475 years return period (corresponding uniform hazard spectra in Fig. 14)

Periods (s)	Beirut		Zahle		Saida		Tripoli	
	475	2475	475	2475	475	2475	475	2475
PGA	0.31	0.82	0.44	0.98	0.24	0.53	0.26	0.72
0.025	0.34	0.91	0.48	1.08	0.26	0.58	0.28	0.79
0.05	0.45	1.23	0.64	1.45	0.35	0.78	0.37	1.06
0.1	0.68	1.86	0.96	2.23	0.52	1.19	0.55	1.59
0.2	0.74	2.04	1.08	2.52	0.58	1.33	0.61	1.8
0.5	0.43	1.23	0.65	1.64	0.35	0.81	0.37	1.13
1	0.22	0.62	0.32	0.86	0.18	0.43	0.19	0.58
2	0.09	0.26	0.14	0.37	0.08	0.2	0.08	0.25