Turbidite Workshop, OSU, Nov 18-19, 2010

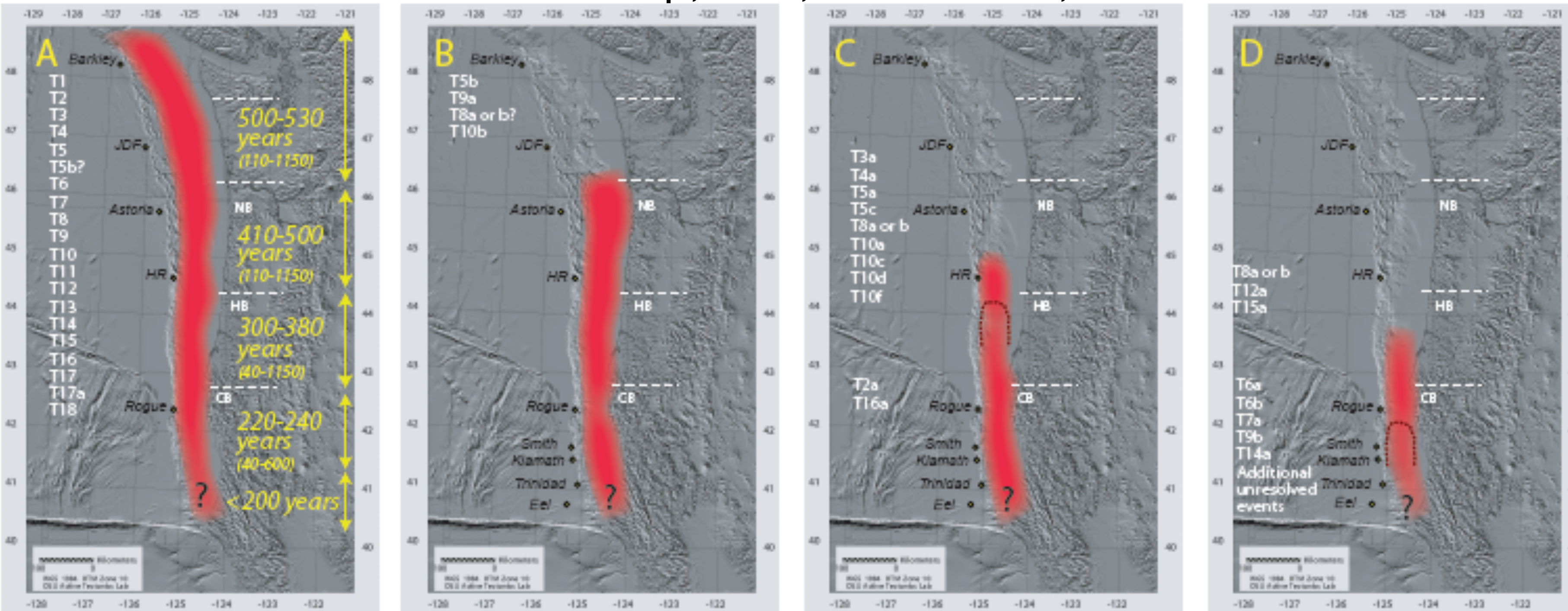

Figure from Goldfinger et al. (in press); great earthquake ruptures inferred from turbidites over past 10,000 years

We convened workshop at OSU on Nov 18-19, 2010 to evaluate turbidite data for constraining recurrence models for CSZ

1) Consensus on M9 whole CSZ rupture events with ave. recurr. time of 500-600 yr (or serial M8's in some cases)

workshop consensus on southern CSZ

- About 10 partial rupture events in past 10,000 years (half of number in Goldfinger et al., in press). Some workshop participants questioned correlations of gravity and magnetic logs from widely-spaced cores. However, most thought the rough correspondence of rates between turbidites and on shore data (Bradley Lake, Sixes River) was indicative of M8+ earthquakes that ruptured only the southern CSZ
- Implies recurrence time of about 340 years in southern CSZ for earthquakes of M8 or larger (including M9 events with average recurrence time of 500 yr)
- Note that we already have M8.0-8.7 partial CSZ rupture events in current model, but they are distributed along whole zone)
- Also discussed possible segmentation of southern CSZ (Cape Blanco, Heceta Bank, etc)

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Northern CSZ

- No consensus on rates of earthquakes that just rupture northern CSZ
- Atwater suggests zone in northern part of CSZ may be as active for M8’s as southern CSZ (based on “extra events” at Discovery Bay, Saanich Inlet) , but others at workshop disagreed
- Most people at workshop felt southern CSZ had higher hazard than northern CSZ.

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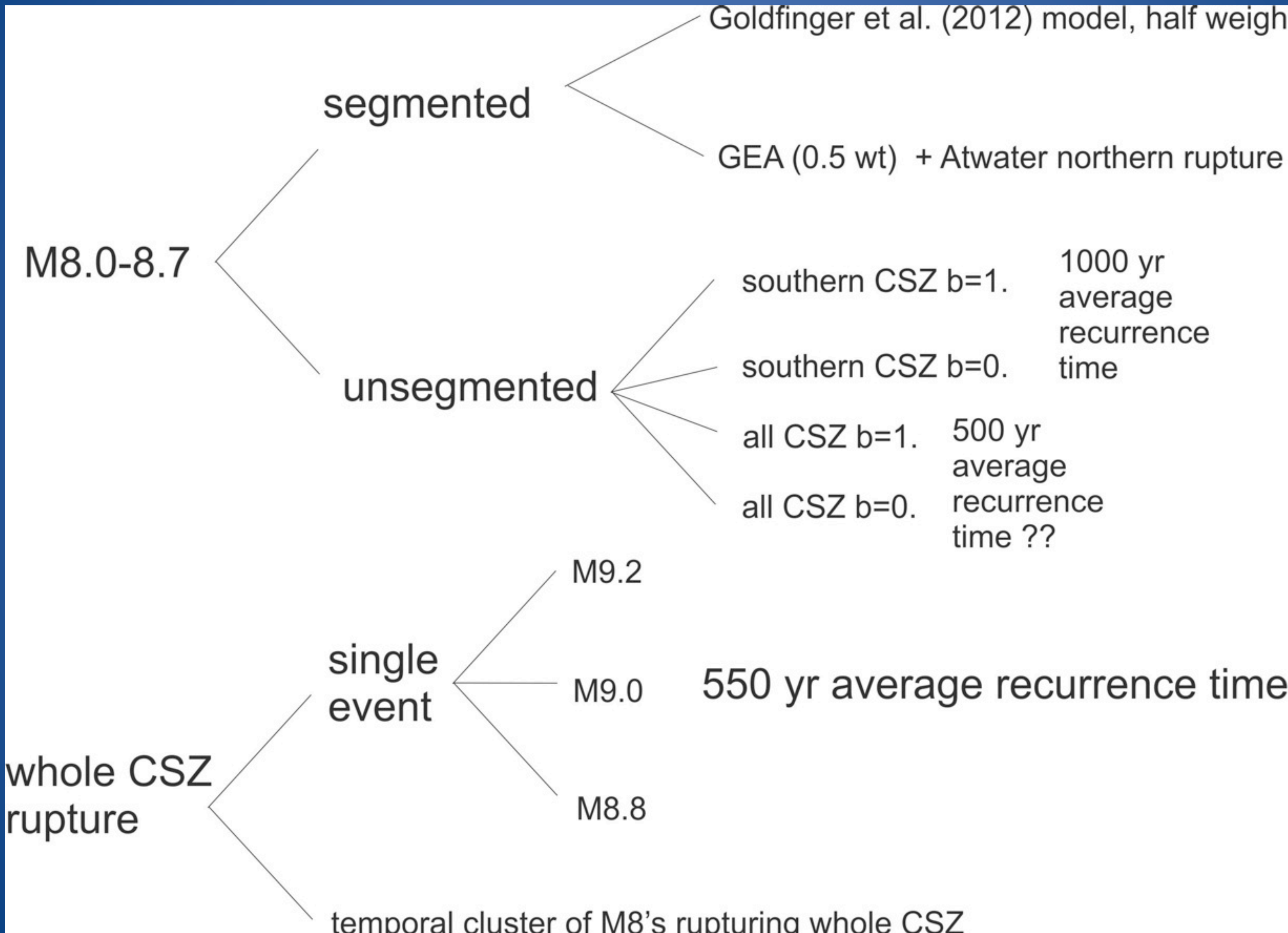
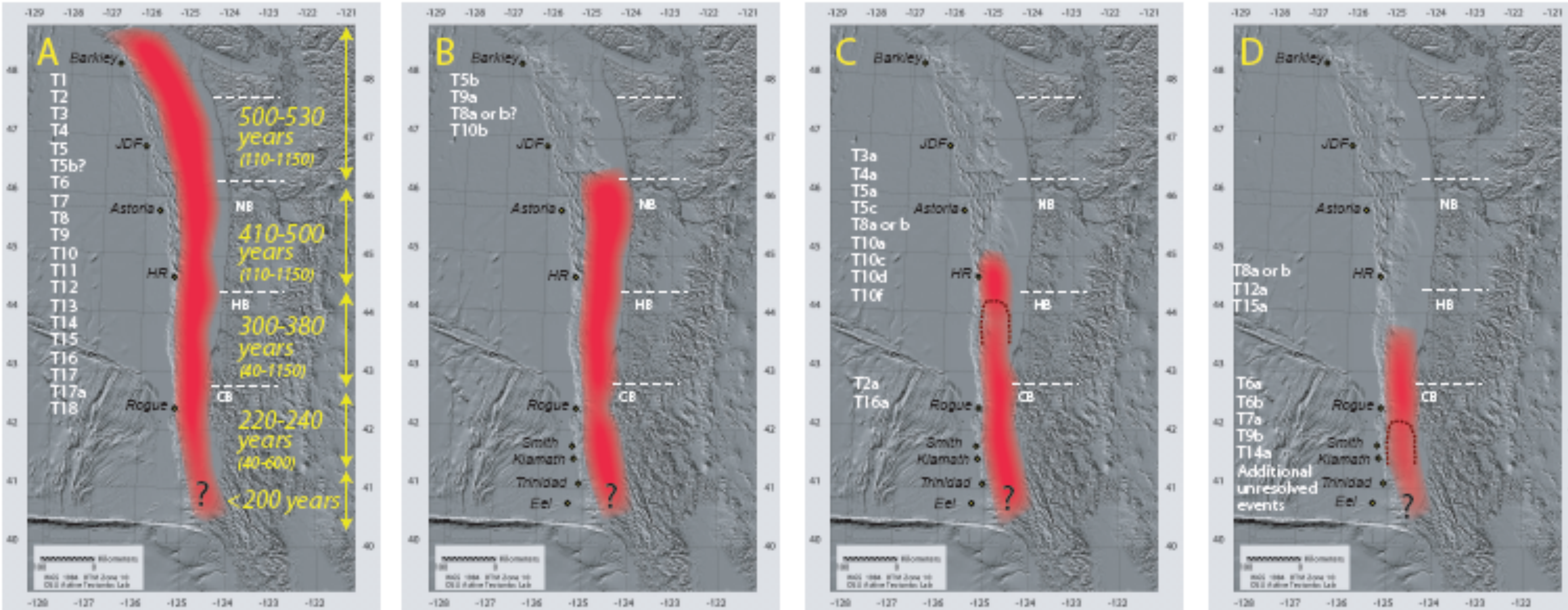
Proposed Logic Tree for CSZ recurrence



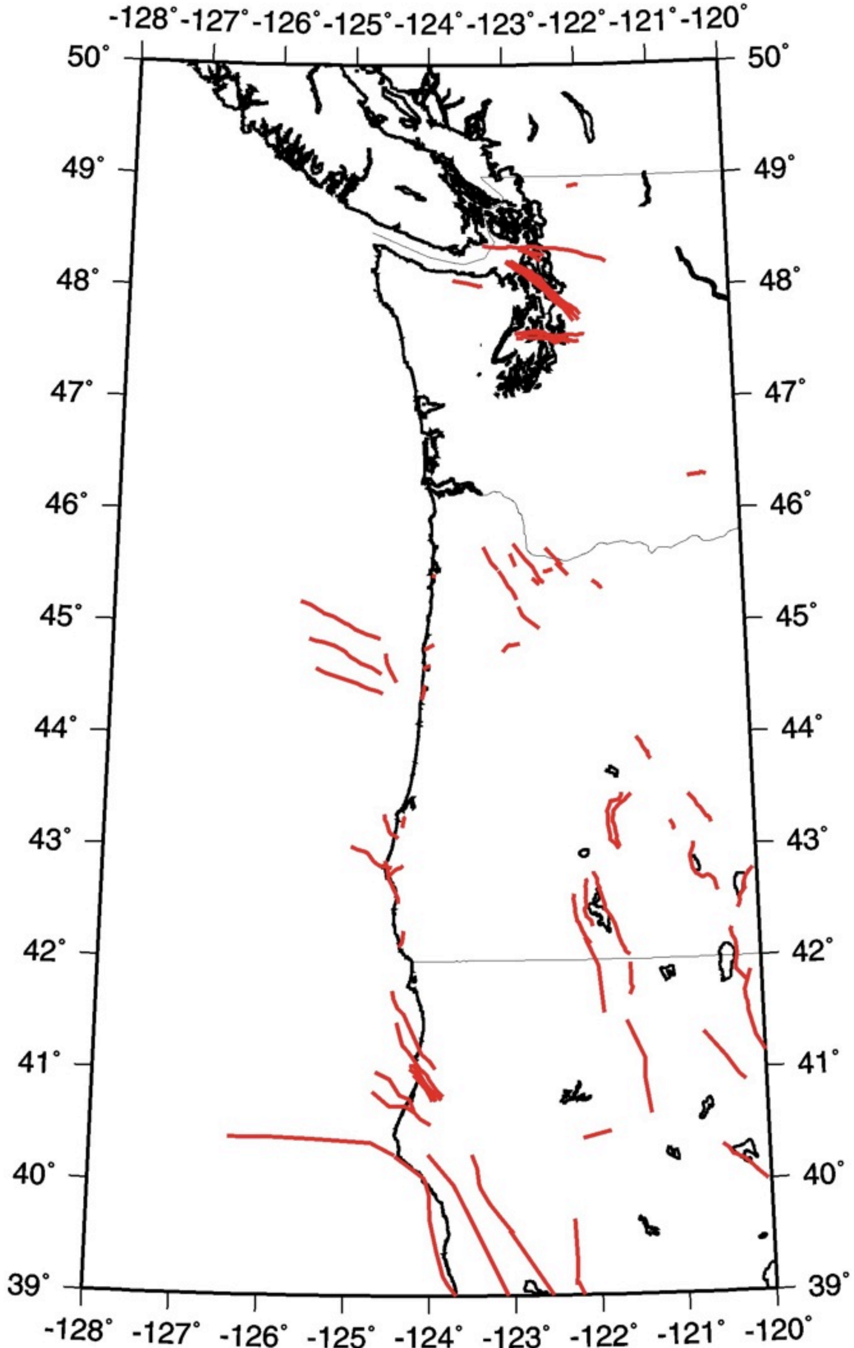


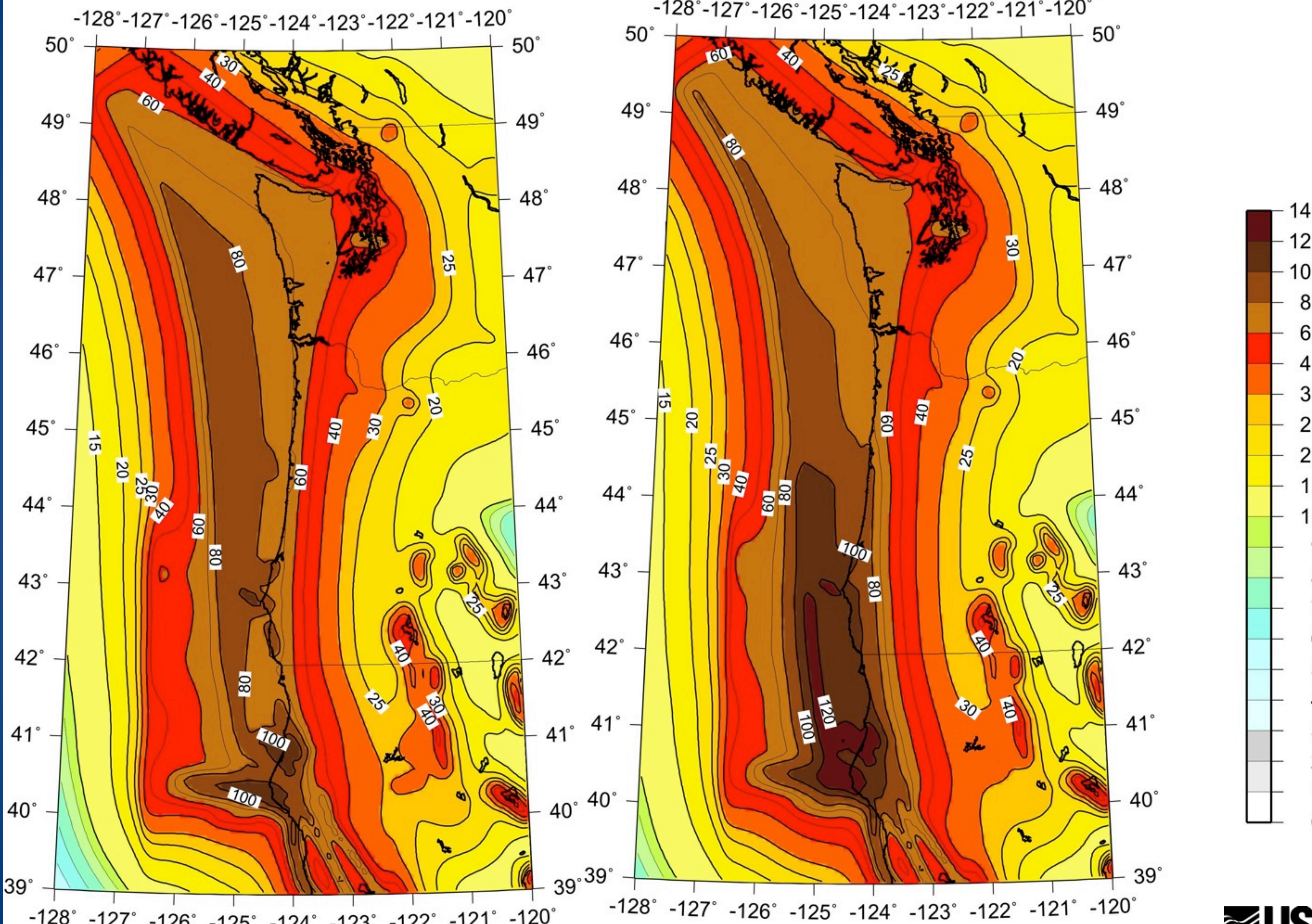
M9.0 530 yr | M8.7 2500 yr | M8.6 910 yr | M8.3 1250 yr

Figure from Goldfinger et al. (in press)

Trial magnitudes calculated from lengths using Geomatrix (1995). Average recurrence times calculated from 10,000 yr divided by number of events from Goldfinger et al. (in press).

Crustal faults used in 2008 maps




2008 all sources
with Goldfinger et al. (2012), full wt
140
120
100
80
60
40
30
25
20
15
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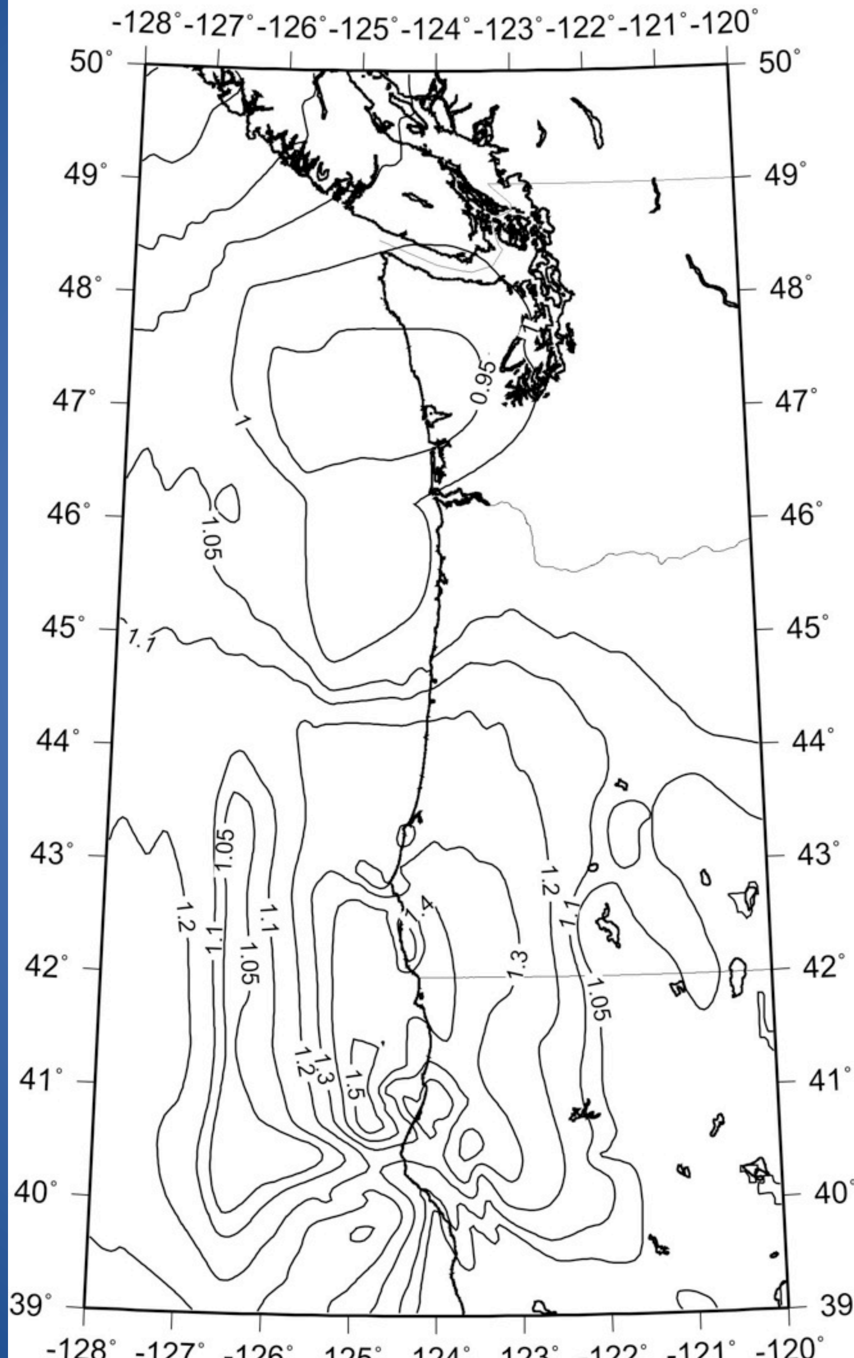
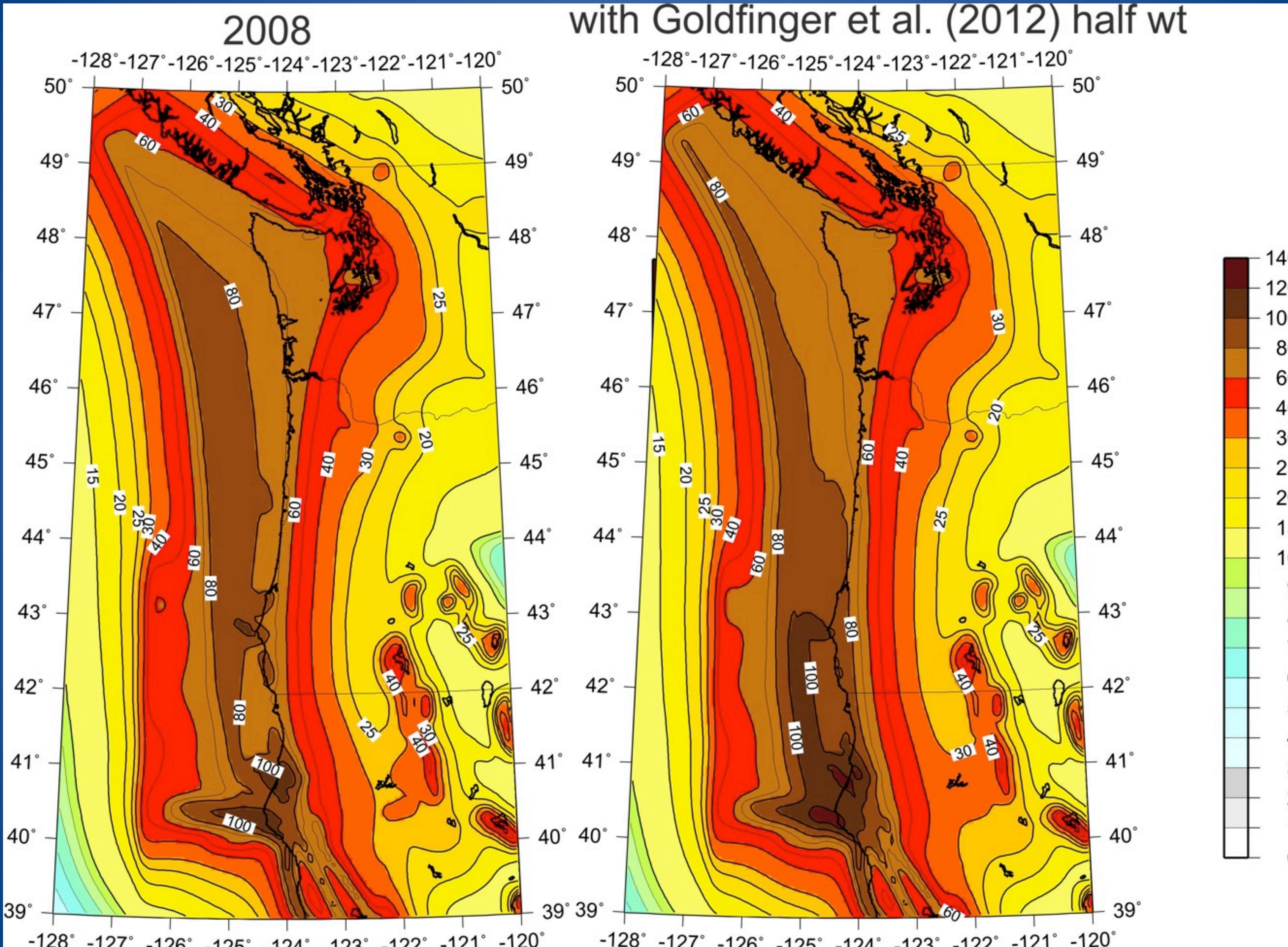
9
8
7
6
5
4
3
2
1
0

Goldfinger full wt / 2008





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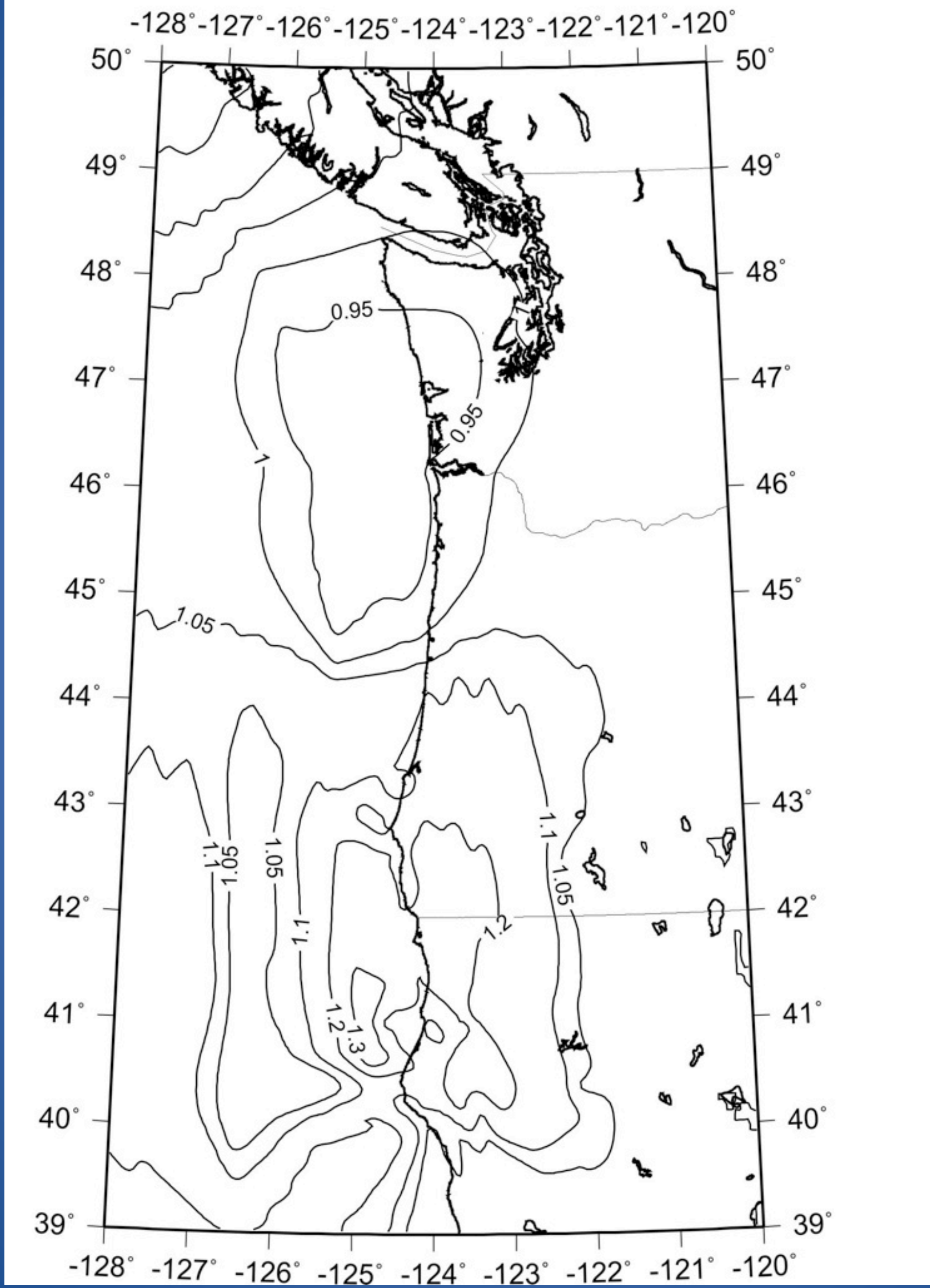
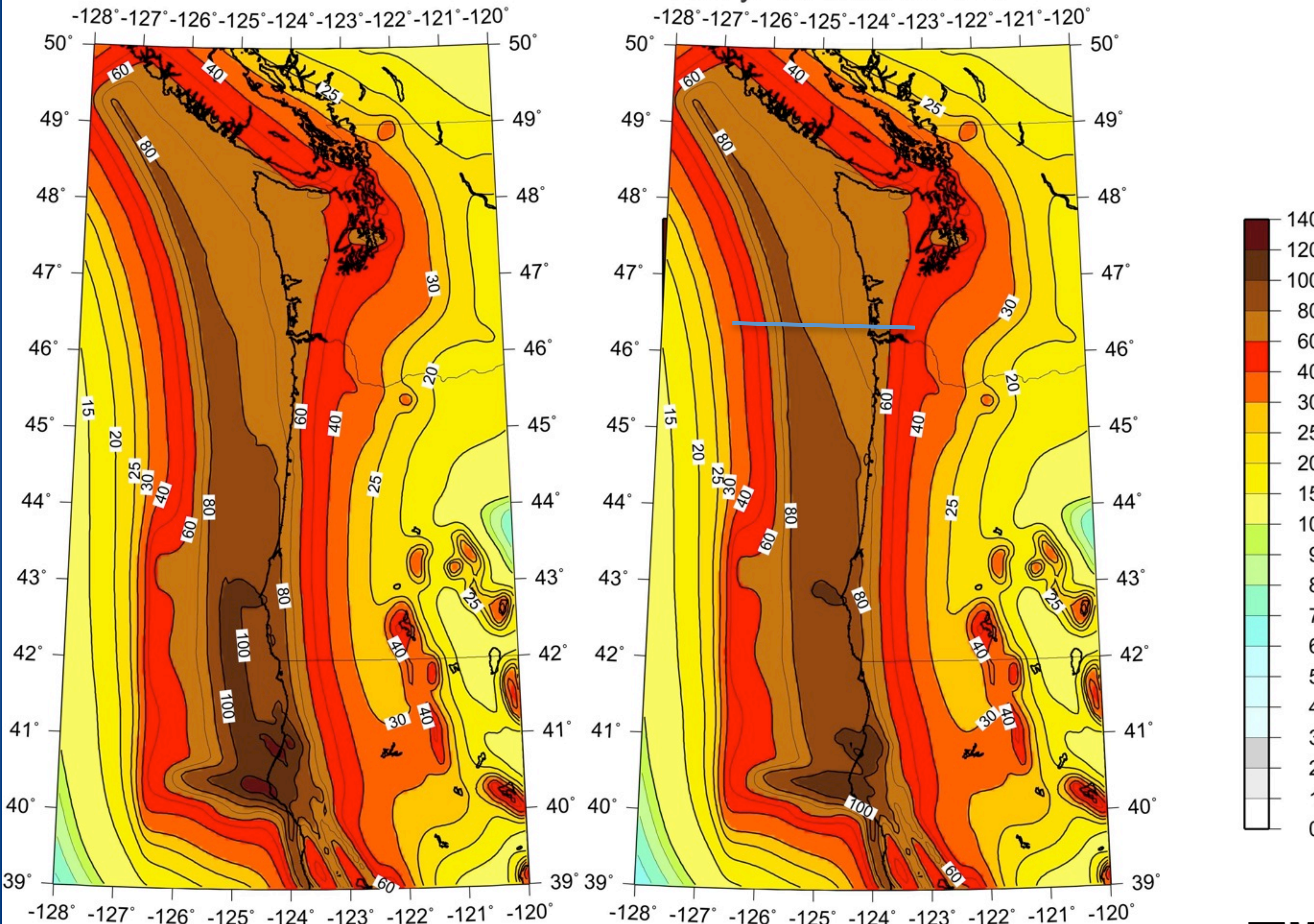
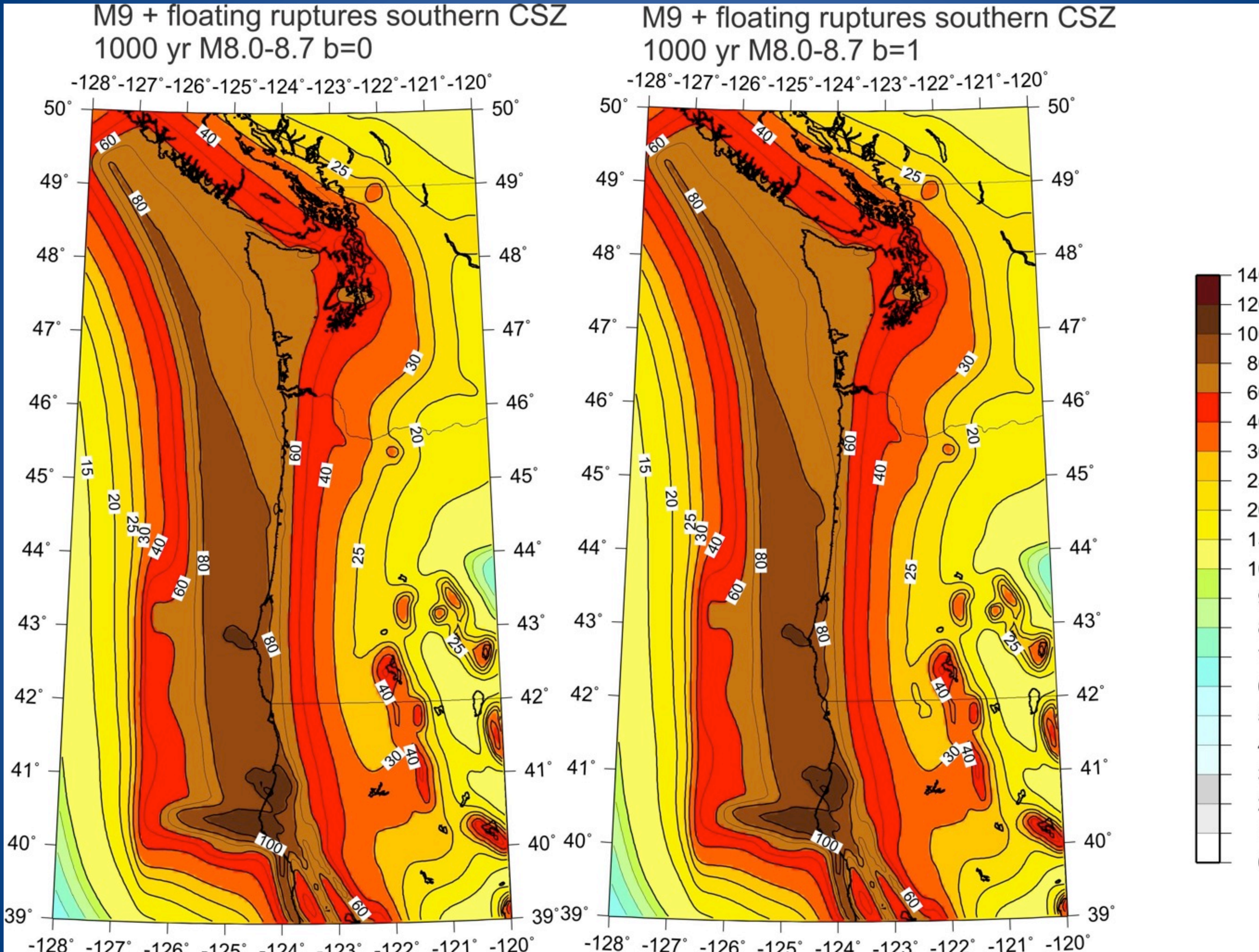
Goldfinger et al. (2012) half wt / 2008



with Goldfinger et al. (2012) half weight

with floating ruptures in southern CSZ
1000 yr for M8.0-8.7 b=0





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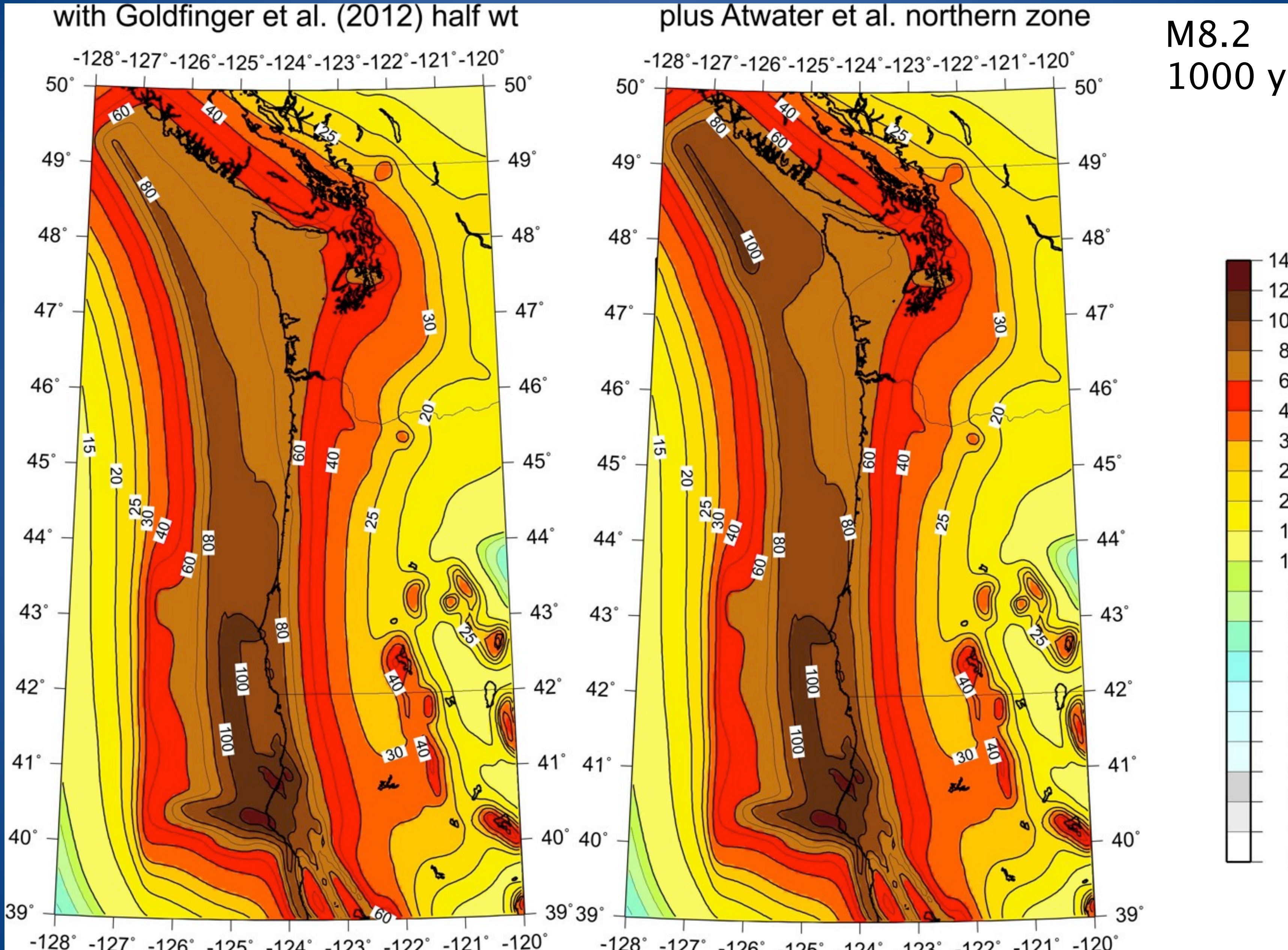

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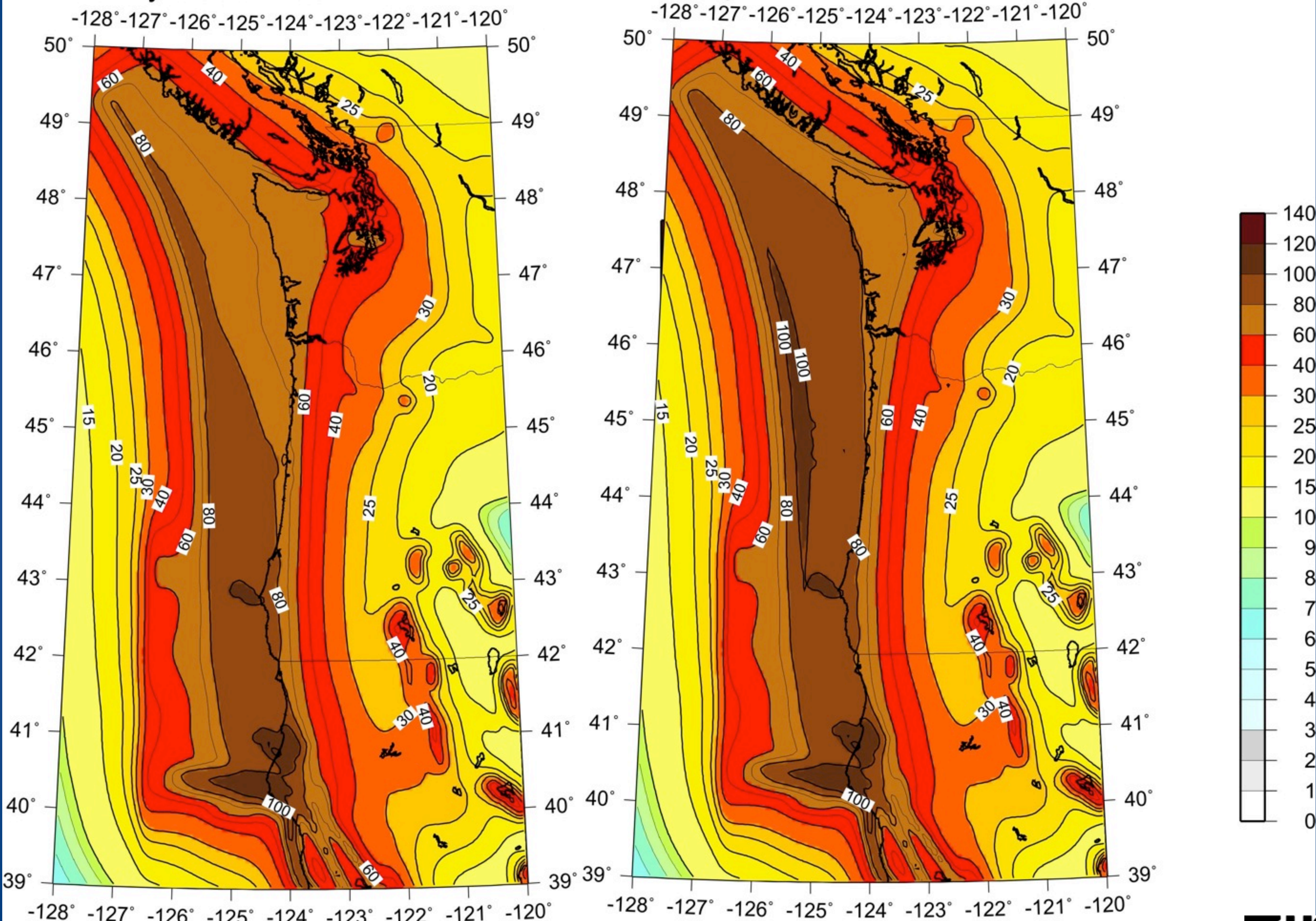
with southern CSZ floating ruptures
1000 yr M8.0-8.7 b=0

with entire CSZ floating ruptures
500 yr M8.0-8.7 b=0



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Alternative approaches considered

- Use Goldfinger et al. (2012) observations to solve for single and multiple-segment rupture rates that give equal slip from M8.0-8.7 quakes for 3 inferred segments: Cape Mendocino to Cape Blanco; Cape Blanco to Heceta Bank; Heceta Bank to Nehalem Bank. Set up inversion to solve for 6 rupture rates from slip rates and recurrence observations from cores
- Just downweight obervations of smaller ruptures in Goldfinger et al. (2012), keeping a total recurrence of 1000 yr from workshop recommendation; rather than giving half weight to entire model for M8.0-8.7

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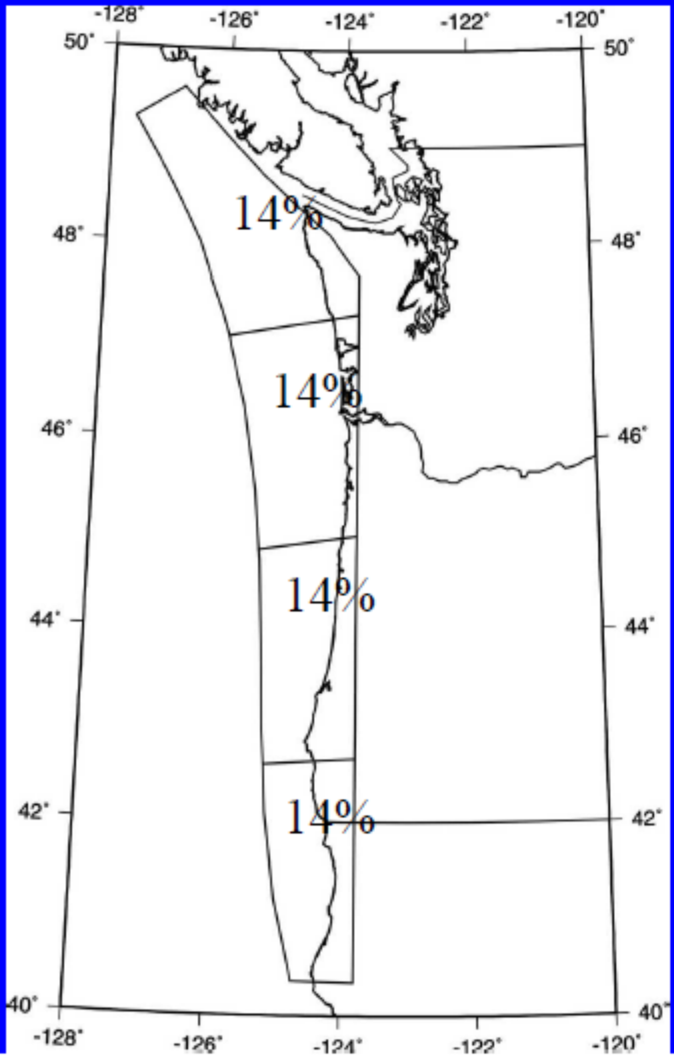
50 year probabilities



For tightly clustered M8.3's: time-dependent probability of any segment is approximately the time-dependent probability for a M9

Since these are not independent earthquakes, you cannot just add the frequencies of exceeding a specified ground motion for each segment

First find 50-year probabilities of exceeding specified ground motions at each site for rupture of each segment: P_1, P_2, P_3, P_4.

Then find the probability of having one or more ground motion exceedances in 50 years at each site (union of P_1, P_2, P_3, P_4)
[after Toro and Silva, 2001]

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probability of one or more exceedances of u_0 =

$$P_1 + P_2 + P_3 + P_4 - P_1P_2 - P_2P_3$$
$$-P_3P_4 - P_1P_3 - P_1P_4 - P_2P_4$$
$$+P_1P_2P_3 + P_1P_3P_4 + P_1P_2P_4 + P_2P_3P_4$$
$$-P_1P_2P_3P_4$$

where P_i is the probability of earthquake on segment i producing ground motion greater than u_0

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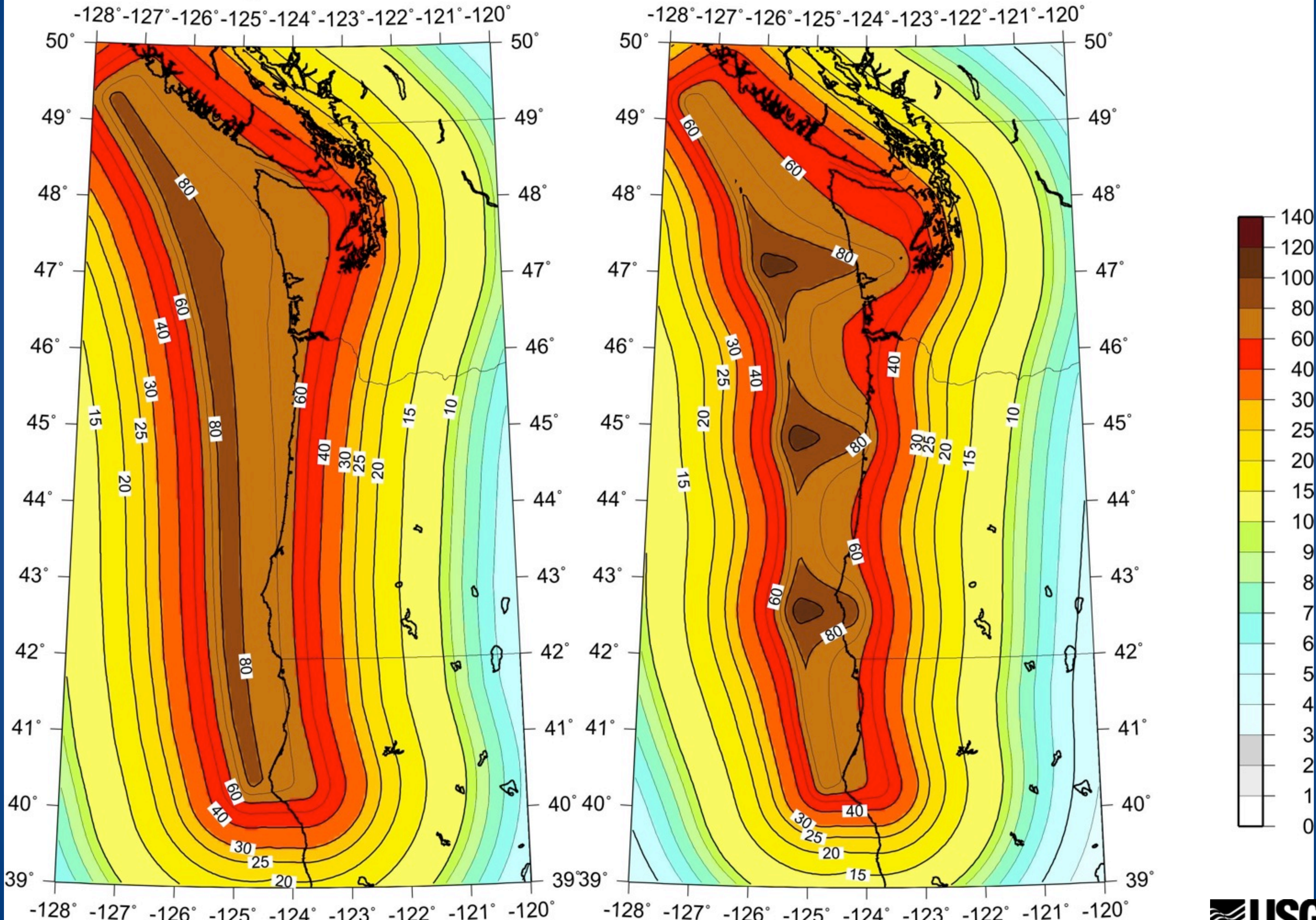
M9.0; 500 yr recurrence

cascade of M8.3's (from Toro and Silva method)



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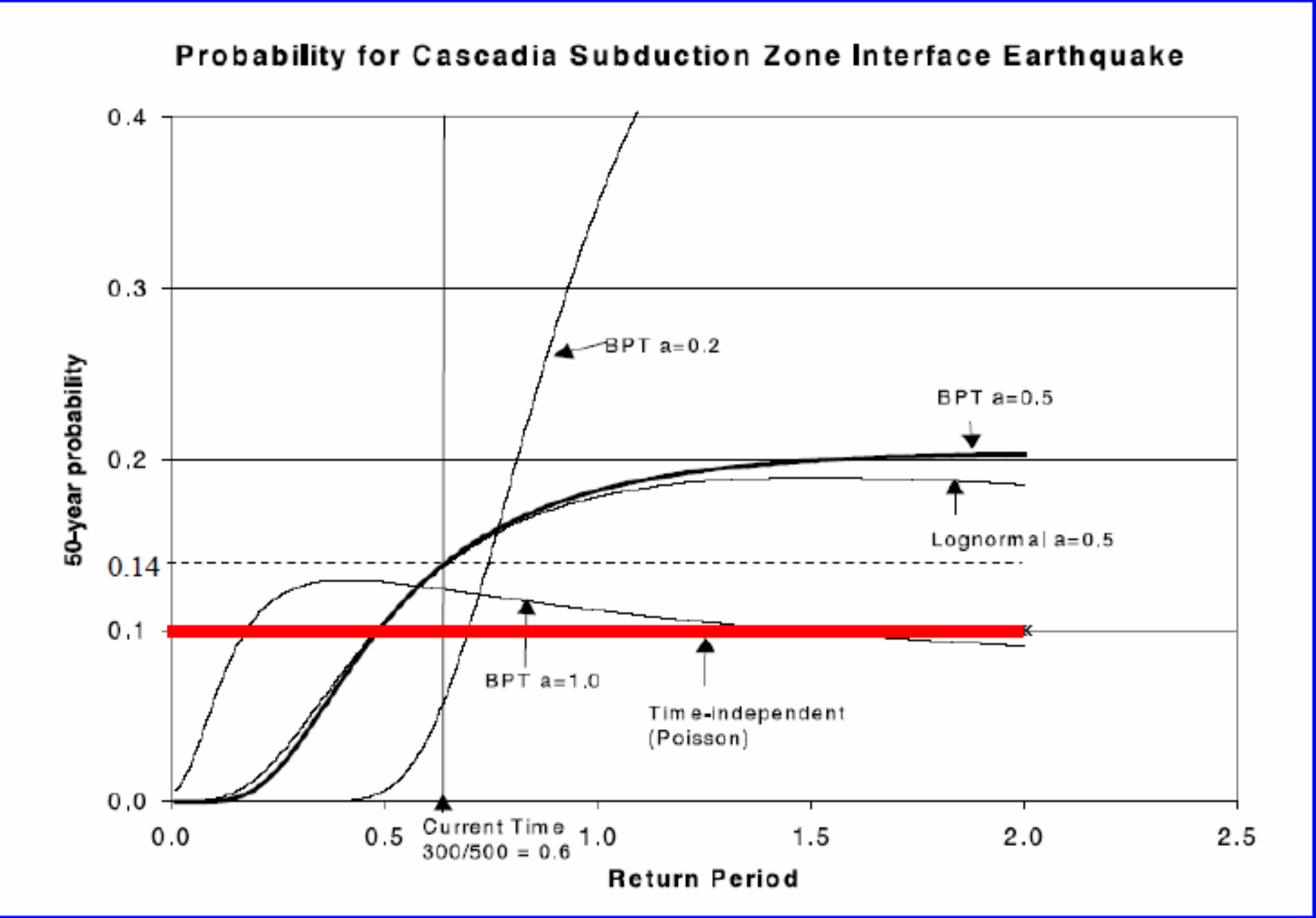
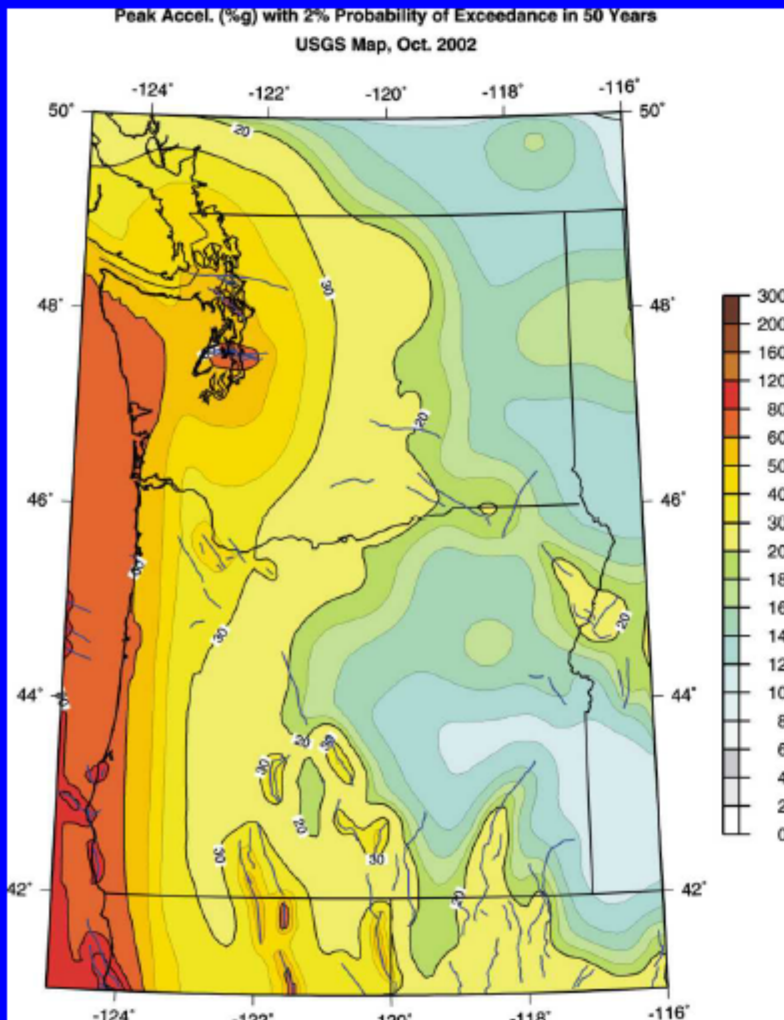
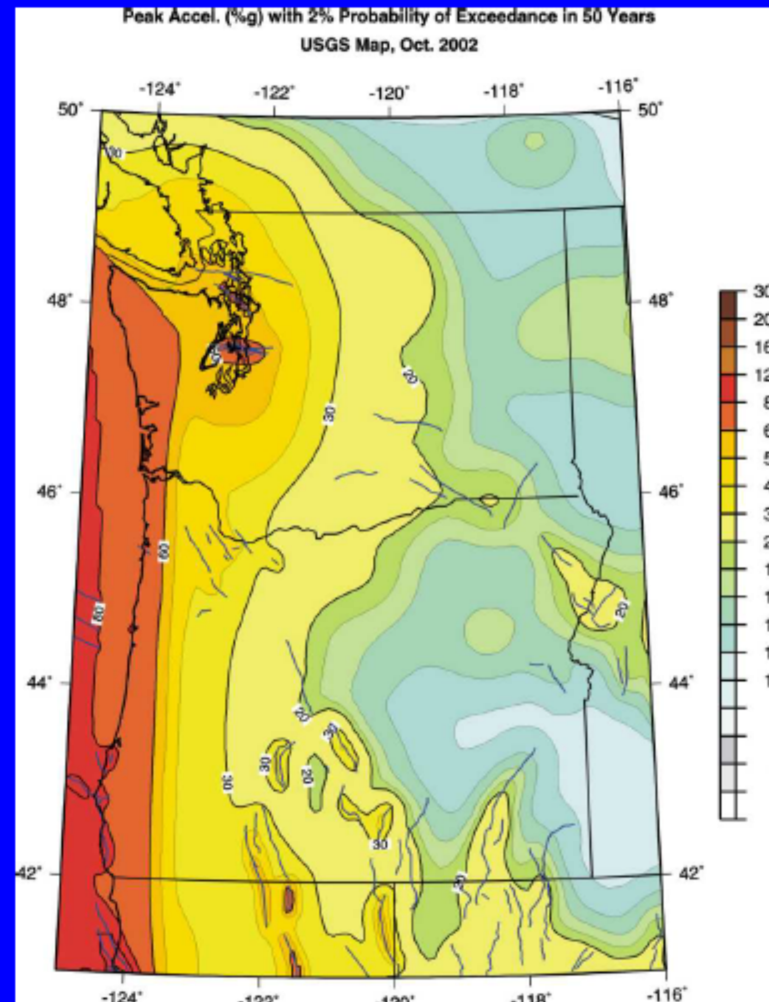


from Petersen et al. (2002)



Time independent M9



Time-dependent M9