

PG&E Perspectives on CRESCENT Science

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Engineering and hazard assessment

While science can help define these hazards, engineers are ultimately responsible to designing solutions to provide public safety and improve infrastructure resilience

- Engineers apply the principles discovered by scientists
- Scientists impact resilience through engineers
- Politicians empower engineers and scientists to perform this vital function

Probabilistic seismic hazard is the primary¹ tool used to risks of ground shaking and tsunami hazards

While many scientists are quick to cite “hazard” as the impact of their work, I thought it would be beneficial to have a quick refresher (hopefully you find it helpful)

¹Some industries (e.g., dam industry) still use deterministic methods

Hazard integral

$$\lambda(\text{IM} > \text{im}) = \lambda(EQ) \int_R \int_M P(\text{IM} > \text{im} | m, r) f_M(m_i) f_R(r_i) dm dr$$

1

2

3

4

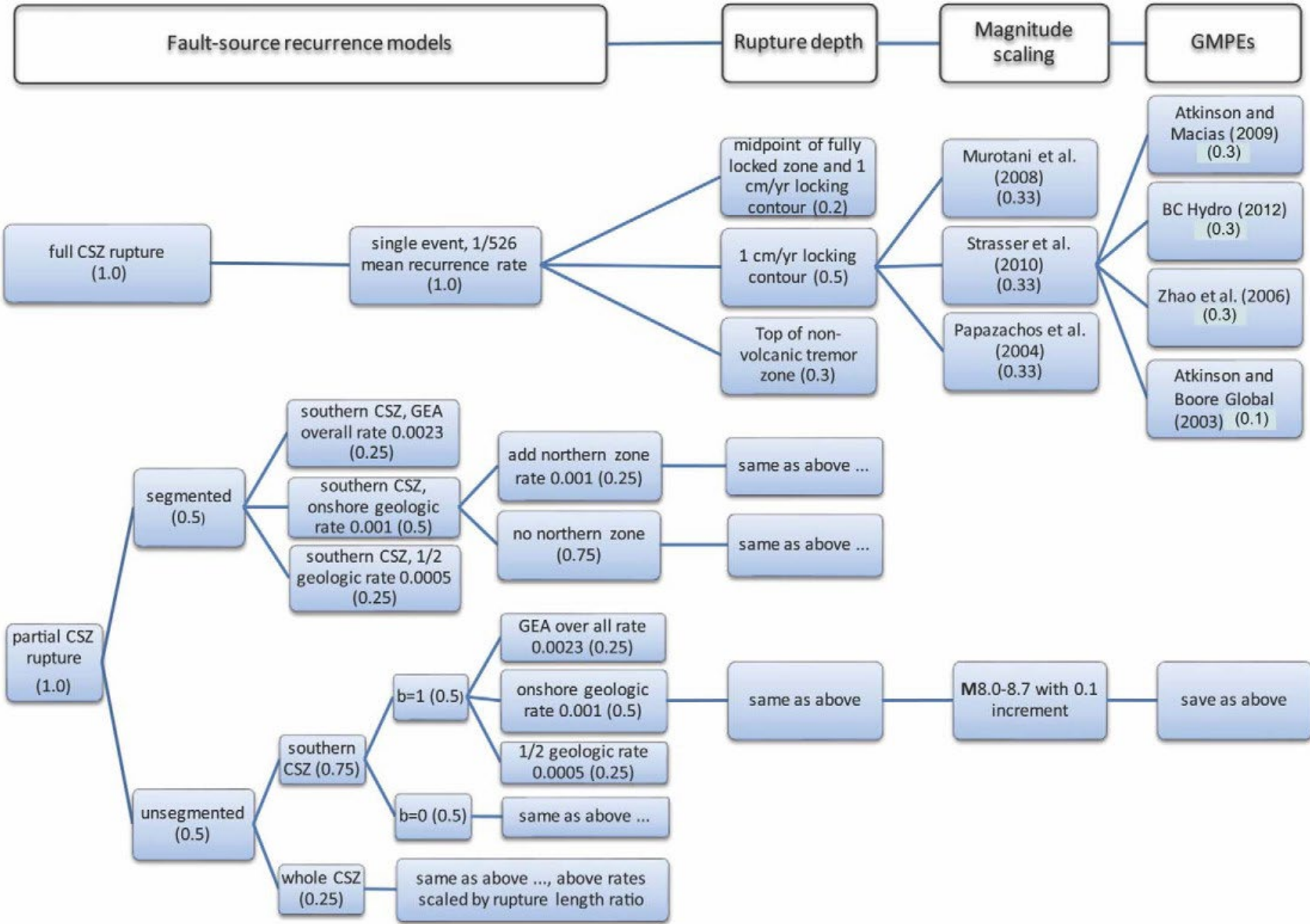
Key ingredients:

1. Rate of earthquakes (slip rate, earthquake recurrence, etc.)
2. Intensity measure model with uncertainty (empirical data, simulations)
3. Magnitude-frequency distribution (maximum magnitude, etc.)
4. Geometry

Two components of variability:

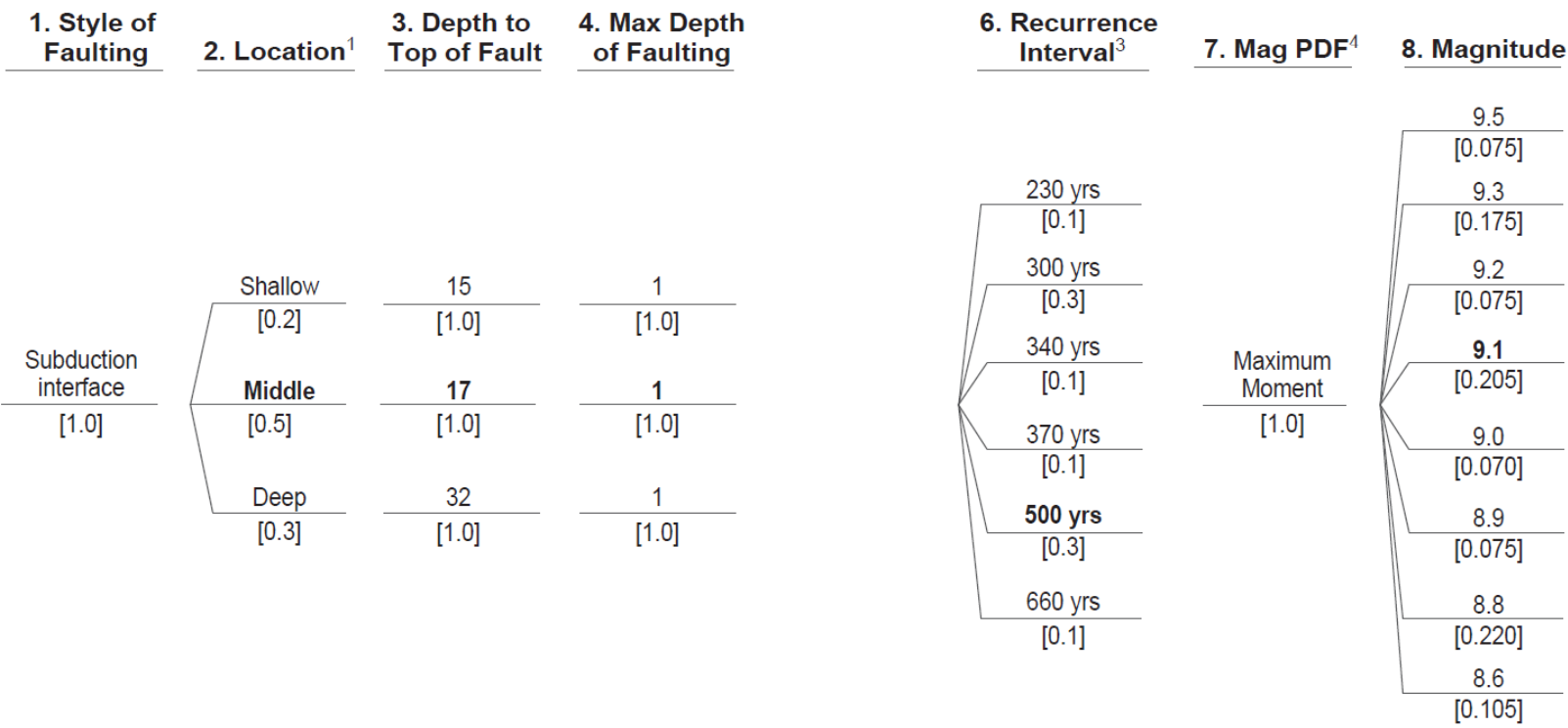
- Unmodelled (i.e., aleatory) variability – treated as randomness
- Modeled (i.e., epistemic) uncertainty due to incomplete information – treated through alternatives

Frankel et al.
(2014) logic tree
for the Cascadia
subduction zone



PG&E logic tree for the Cascadia subduction zone

Logic tree model was simplified for the capture the details deemed to be important for our Hydro facilities.



Example logic-tree for Cascadia source characteristics

Logic trees capture an assessment of alternatives

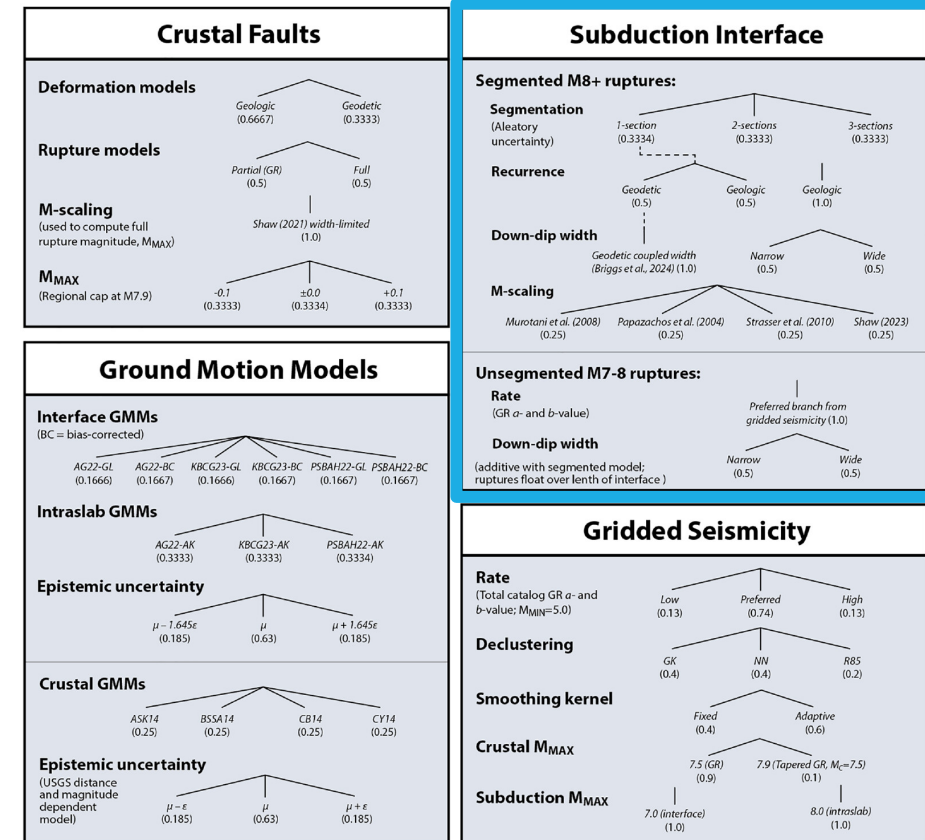
Need to be:

- Recognized
- Hazard significant

Importance of branches can then be inspected through:

- Tornado plots
- Separation of variance

Used to say where information should be collected for *known* sources of uncertainty



Example logic-tree for Cascadia source characteristics

Logic trees capture alternatives

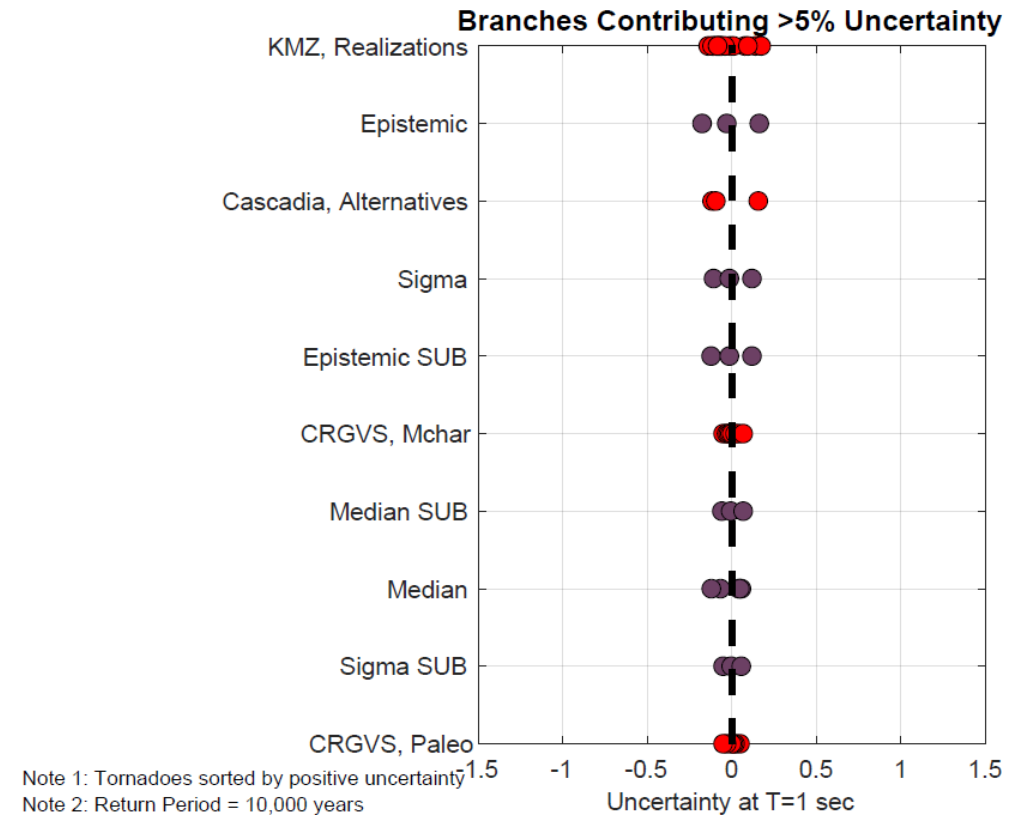
Need to be:

- Recognized – published and accepted
- Hazard significant

Importance of branches can then be inspected through:

- Tornado plots
- Separation of variance

Used to say where information should be collected for *known* sources of uncertainty



Unfortunately, I don't have this plot for 2023 NHSM

Interfaces and communication

Moving from research into practice:

- Engineering: through updates to the building code
- Geology and seismology: through incorporation¹ into hazard models

Inspection of the hazard models can identify areas with significant uncertainty – this information needs to be provided back to the scientific community:

- PG&E does this in prioritizing research but could be improved
- Seems like a gap between the scientific and hazard communities

This feedback only provides information on considered alternatives – not new ideals

New ideas are tested through hazard sensitivity studies

¹There are other avenues...

A few concluding thoughts

Hazard isn't everything, but it is the tool used to quantify seismic hazards

Information needs to flow bidirectionally across the research–practice interface – a hazard model is one of those interfaces

Hazard studies should provide more tangible results that can help inform research directions, and scientists should become more comfortable with the approaches and understanding the results