Probabilistic Approach for HF-IS Hazard/Risk Map

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USC Workshop Hydraulic Fracturing and Induced Seismicity

Conclusion

Wikipedia:

A hazard map is a map that highlights areas that are affected or vulnerable to a particular hazard.

Opportunity:

scientific discovery and technological innovation should impact our perception of hazard and risk.

Objective:

hazard maps as live documents that also guide risk-based life cycle management through scientific discovery and data acquisition.

What is Risk

One Useful Definition

Risk is the effect of uncertainty on objectives.

Hazard

How much induced seismicity ?

Exposure

Who and what gets affected ? and what is regulated ?

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What are we Uncertain About ?

Subsurface is not illuminated

Even if it were

we still lack understanding of how instabilities in subsurface nucleate and propagate and fluids are mobilized.

How Can Risk be Managed ?

Knowledge reduces uncertainty and increases predictability hazard.

Technology reduces disruption to objectives.

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- **Information:** Monitoring.
- **Physics:** Interaction of thermal/mechanical/chemical/biological processes across multiple spatial and temporal scales.

As state of knowledge evolves our assessment of risk changes.

Technology reduces disruption to objectives.

- reduce hazard by
  - understand operational envelope (fracture nucleation, propagation, ...)
  - develop ability to steer system close to operational envelope without crossing it.
- reduce exposure through early warning systems.

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What is the Role of Probabilistic Risk Assessment

Package knowledge into actionable information

Transform knowledge into inference on Hazard

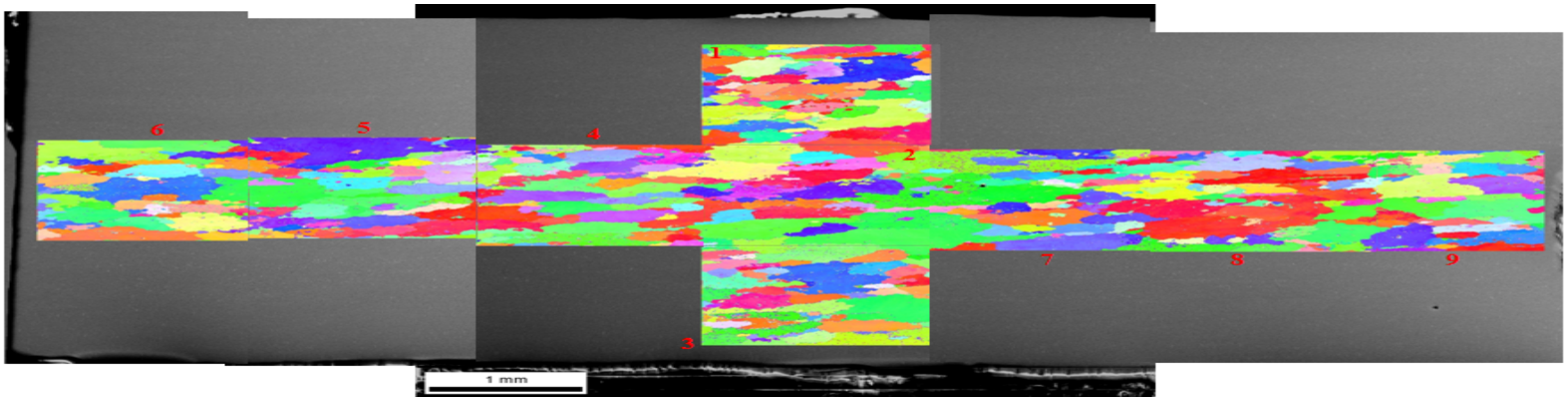
What is the Role of Probabilistic Risk Assessment

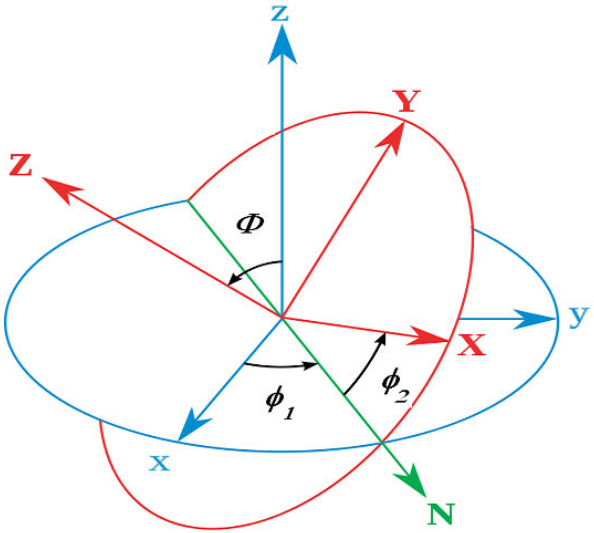
Package knowledge into a useful format

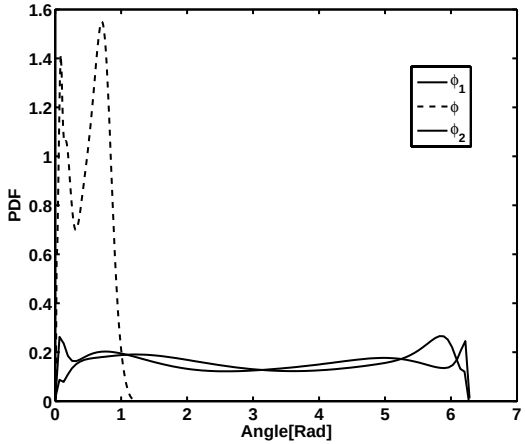
- Physics-based constraints
  - bounds on material property tensors,
  - behavior on multiple scales
- Observation-based constraints
  - Observations on multiple scales
  - Spatial variability
  - Statistics of extremes
  - ...

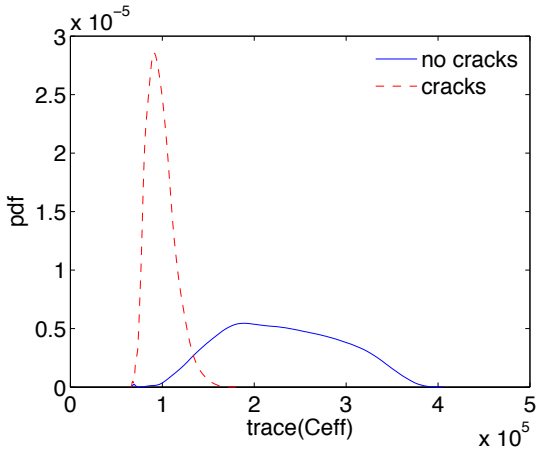
Package Knowledge

Material on decision-scale characterized from observations at another scale:







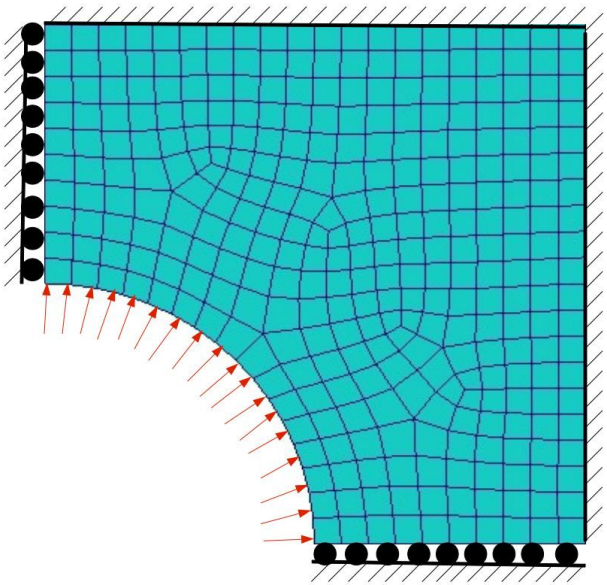


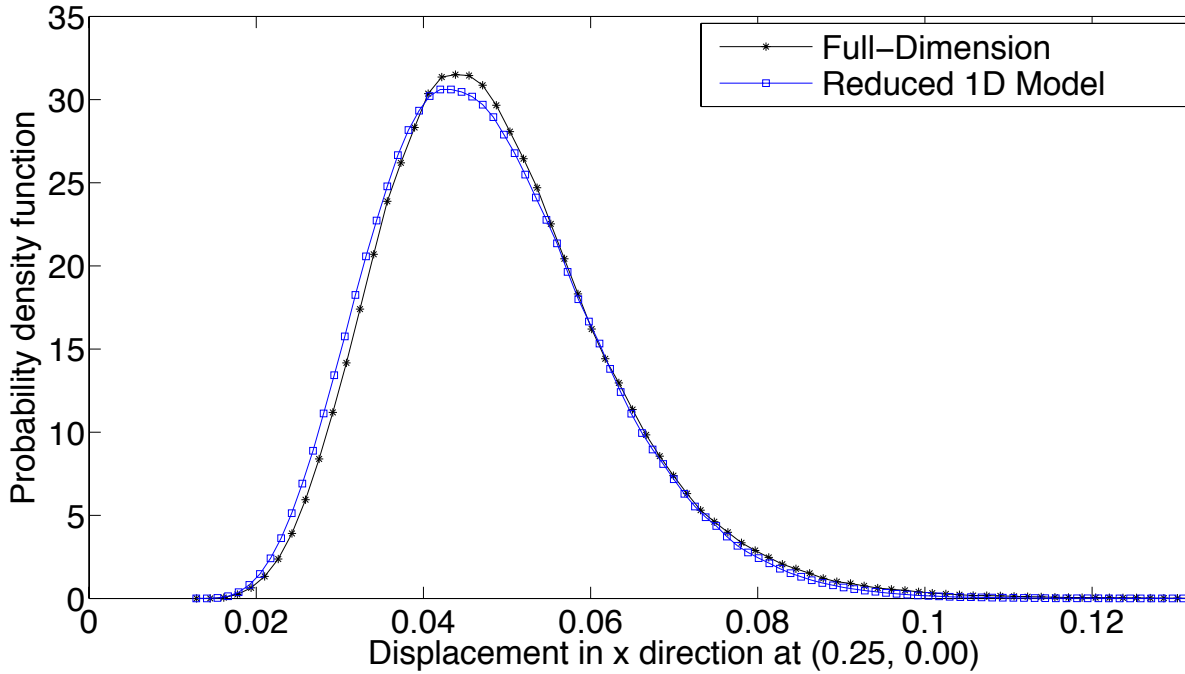
What is the Role of Probabilistic Risk Assessment

Transform knowledge into inference

- Propagate many plausible scenarios
- Characterize hazard as statistical object
- Formulate decisions that take advantage of quantified uncertainty in Hazard.

Computational Challenge





Comments

- Credible risk assessment should not introduce new assumptions (Gaussian/etc).
- Good risk assessment should mirror advances in science (multiphysics/multiscale/high performance computing).
- Good risk assessment can be used to optimize fracking.
- Worth of information analyses can be carried out as part of a vulnerability analysis to reduce risk as part of a life-cycle management process.