

Validation of Simulated Ground Motions using Advanced Intensity Measures- Small Magnitude events in Canterbury Region

PhD Candidate:

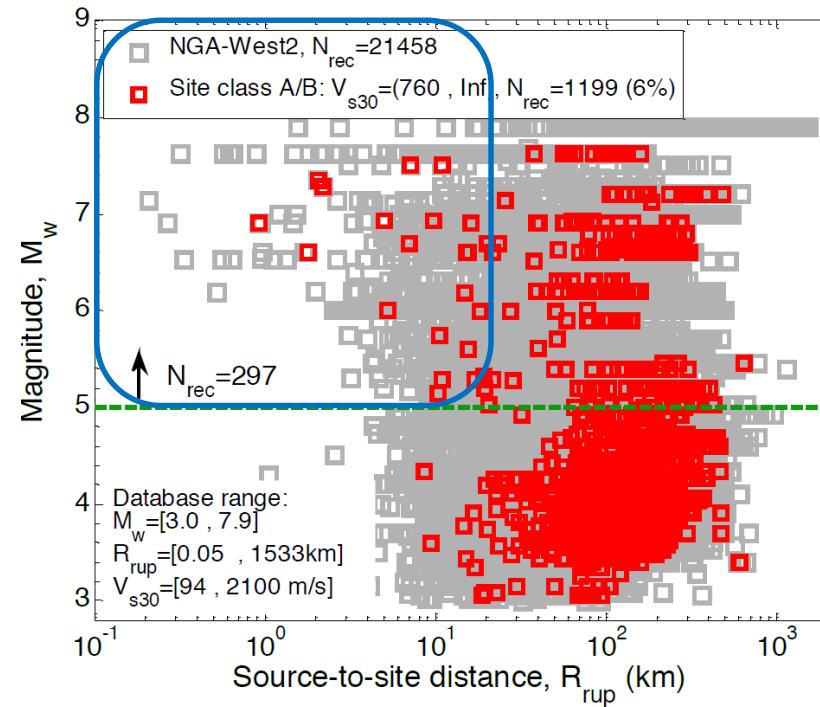
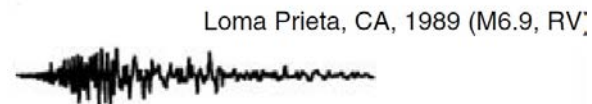
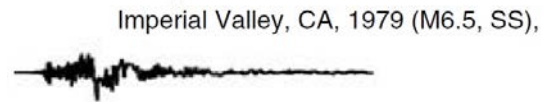
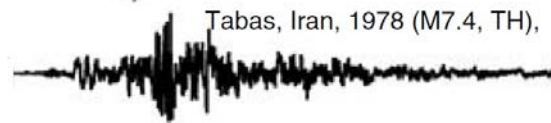
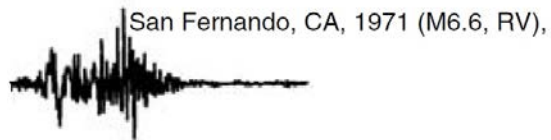
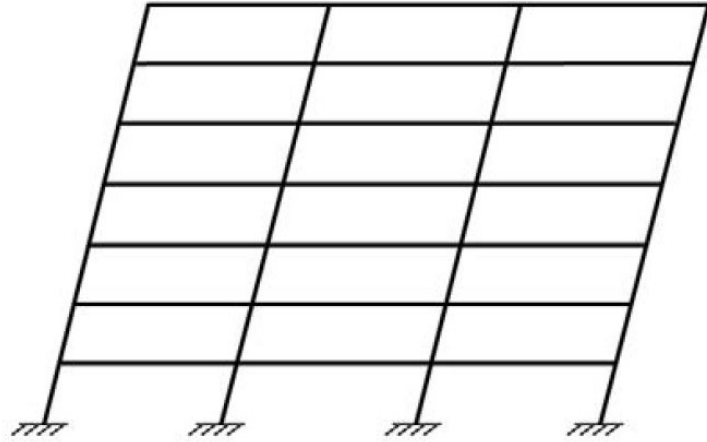
Vahid Loghman

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Dr. Reagan Chandramohan
Dr. Chris McGann, Dr. Robin Lee

Ground Motions for Response History Analysis

Structural Performance

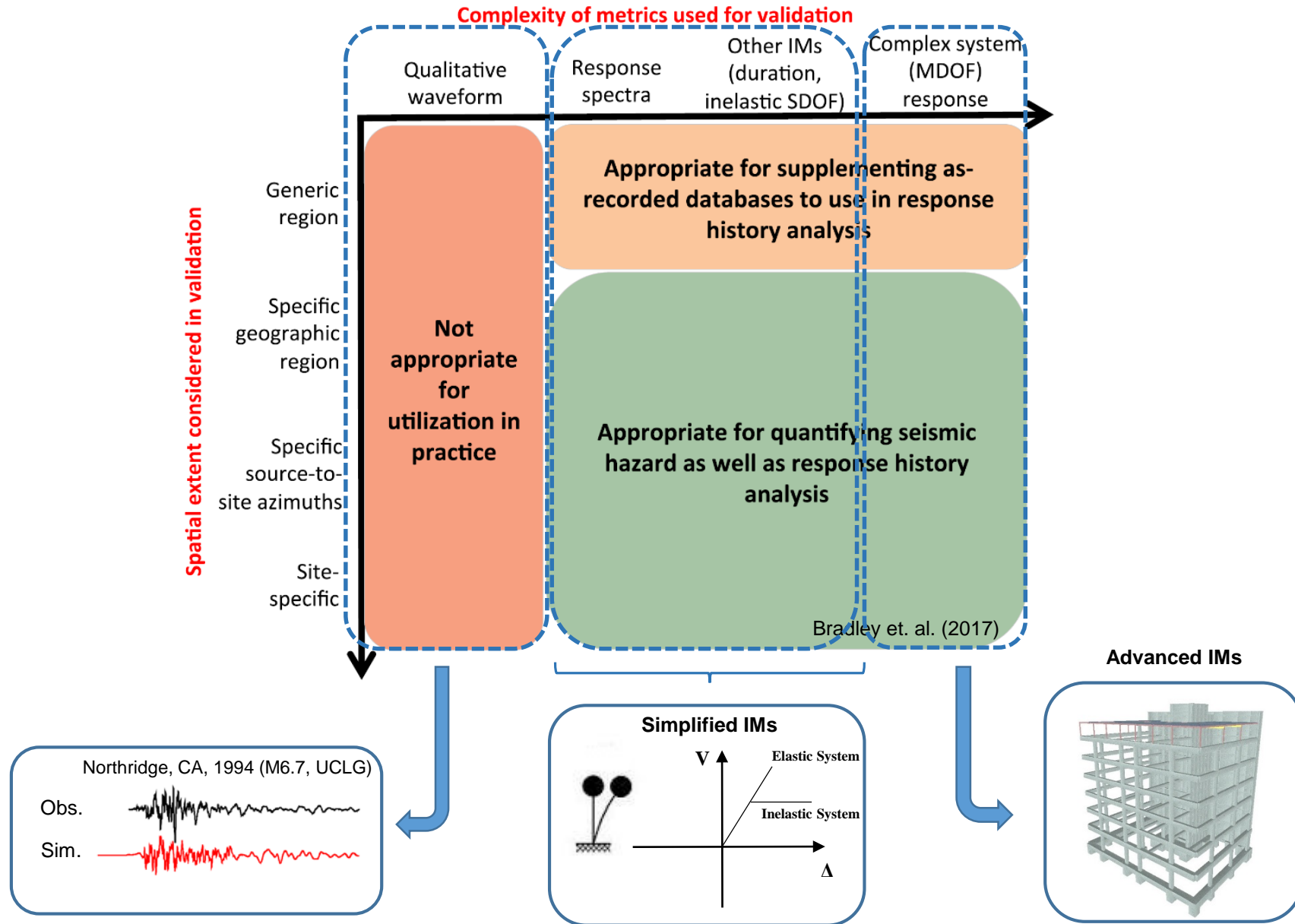


Tarbali (2017)

Limitations:

- ✓ Scarcity of ground motion representing the specific-site hazard
- ✓ Incompatibility of selected ground motions in terms of causal parameters

Validation Matrix

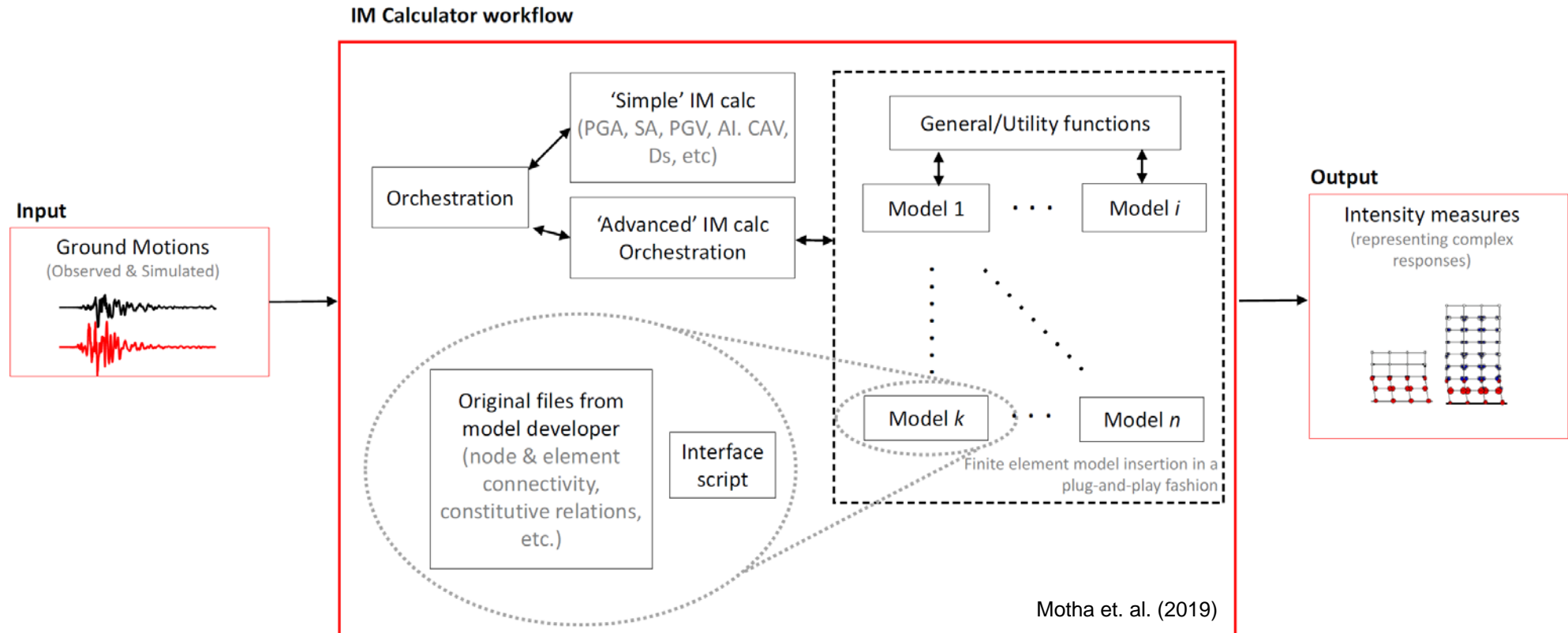


Automated Workflow

Automated Workflow:

Advanced capabilities:

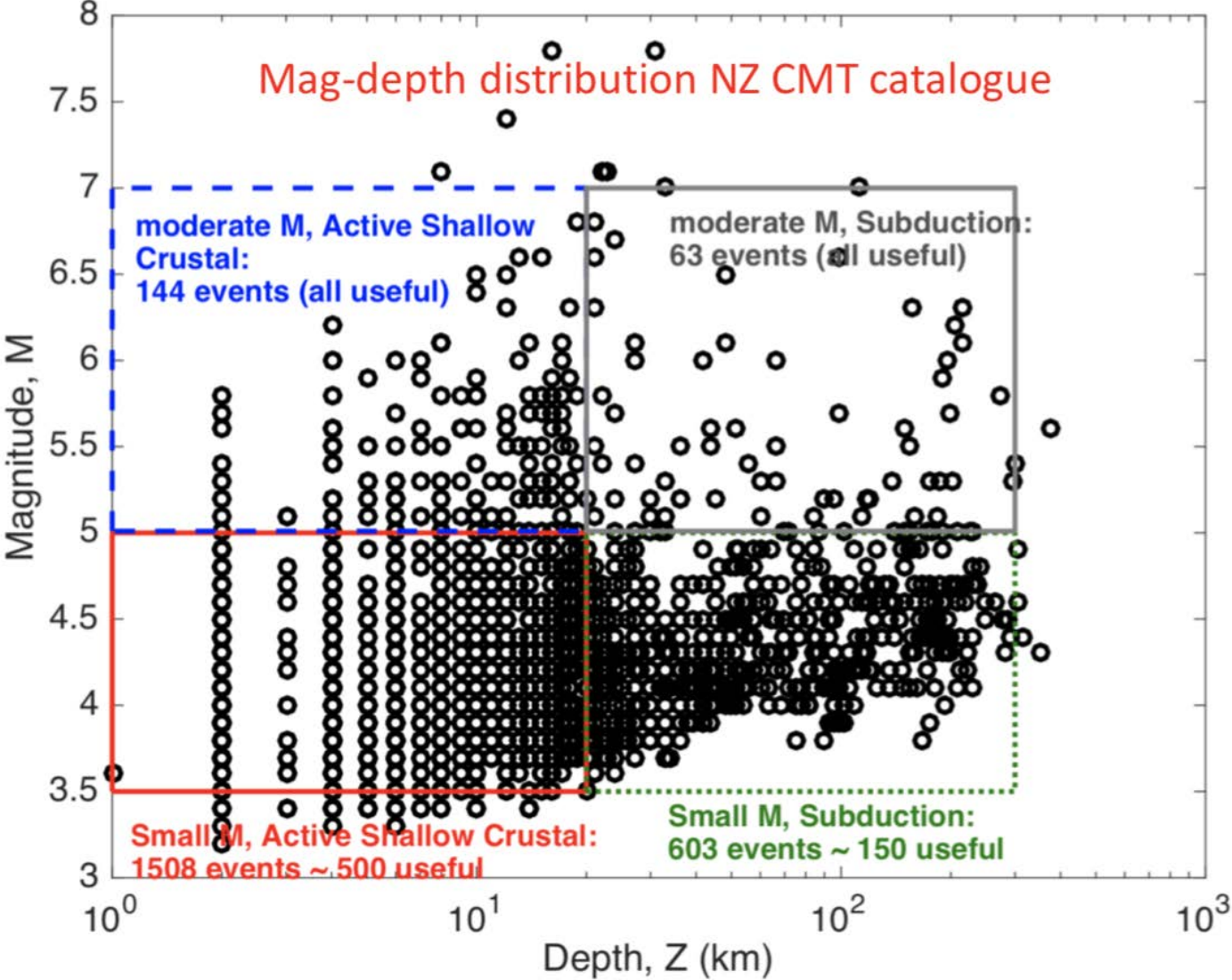
- Different ground motion simulation methods
- Different structural/geotechnical models



Main features:

- Computationally efficient
- Plug-and-play

Selection of Ground motion data set

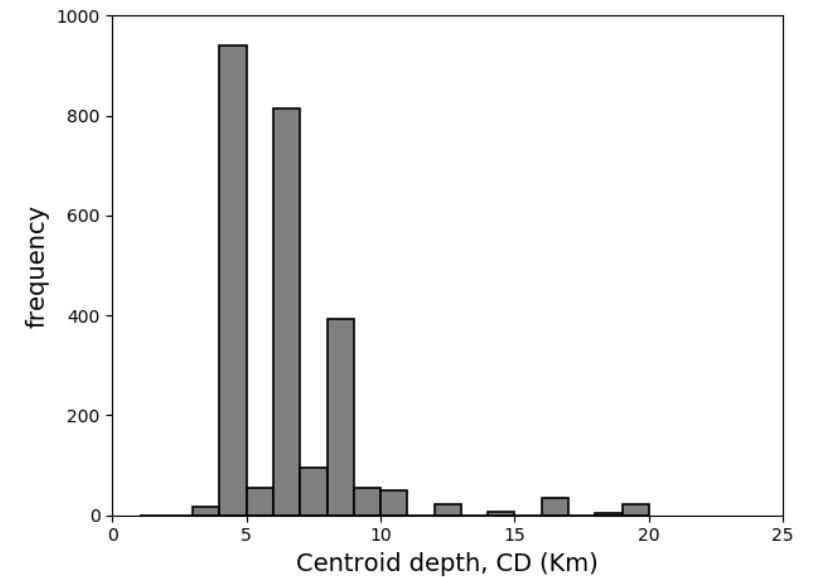
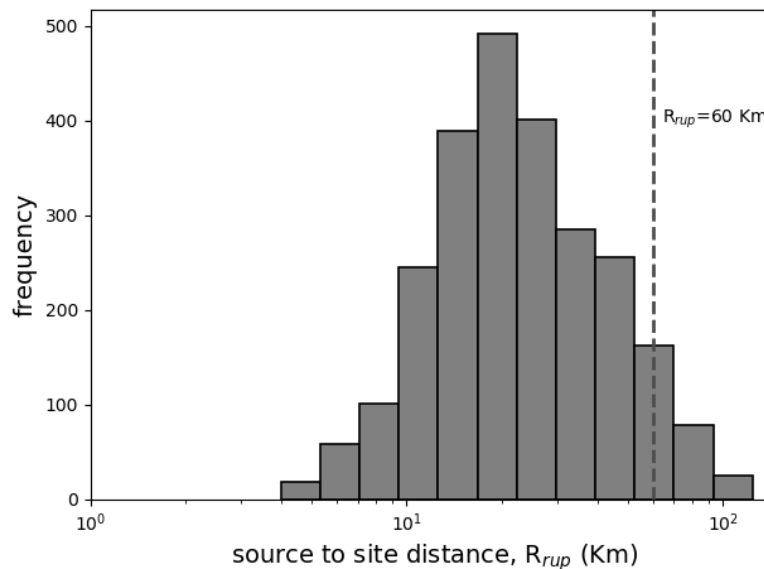
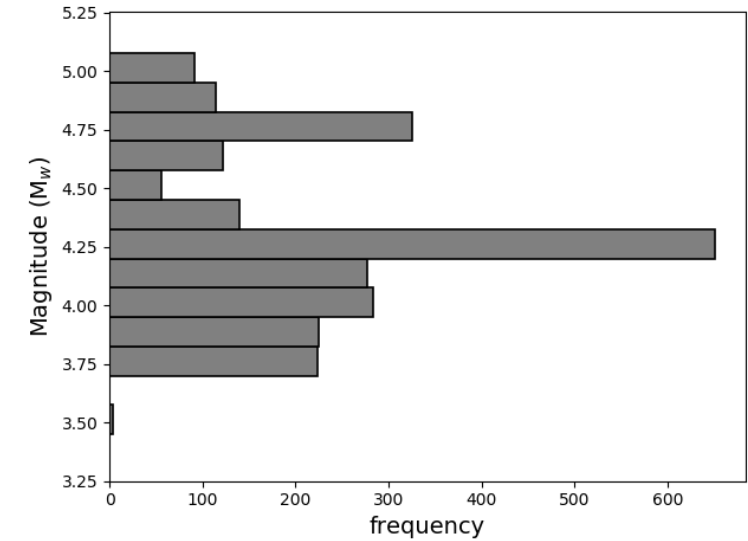
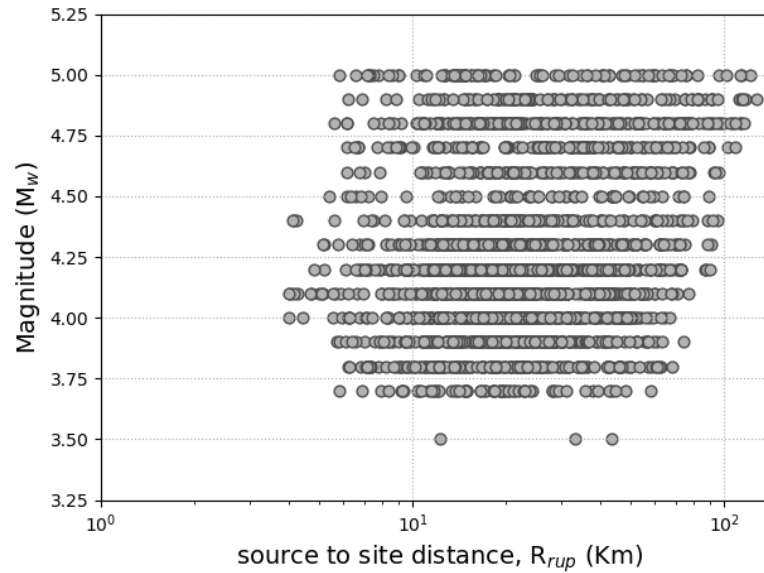


Case study: GMs properties

Ground Motions:

- 175 Low-magnitude events ($3.5 < M_W < 5.0$)
- Canterbury region
- 2511 ground motions

- Hybrid Broadband Method
- Unscaled

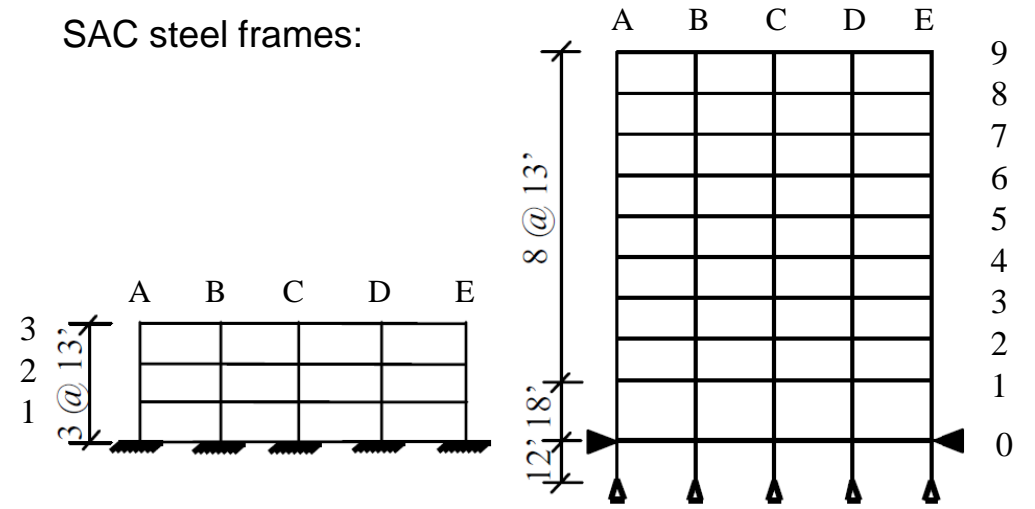


Case study: FEMs properties

Case study:

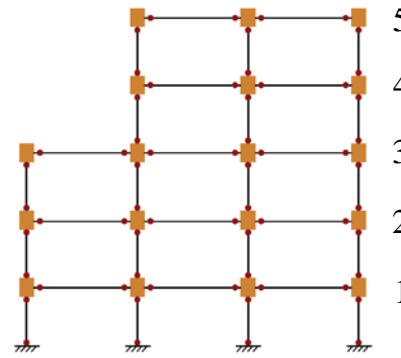
- Three SMRF archetypes
 - ✓ 3-storey, $T_n = 0.98$ sec, located in Seattle.
 - ✓ 9-storey, $T_n = 2.95$ sec, located in Seattle.
 - ✓ 5-storey, $T_n = 1.64$ sec, located in San Francisco.
- Nonlinear Model:
 - ✓ Elastic Elements with Lumped Plastic Hinges
 - ✓ Modified Ibarra-Medina-Krawinkler hysteretic model
- Responses :
 - ✓ Inter-story drift ratio (IDR)
 - ✓ Peak floor acceleration (PFA)
- Software:
 - ✓ OpenSees 2.5.0

SAC steel frames:

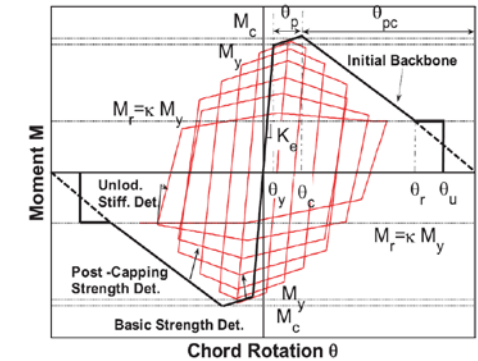


a) 3-storey

b) 9-storey



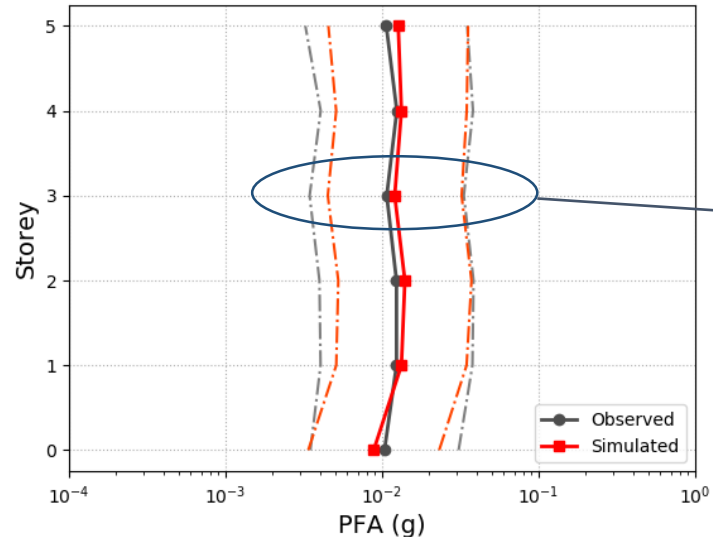
c) 5-storey



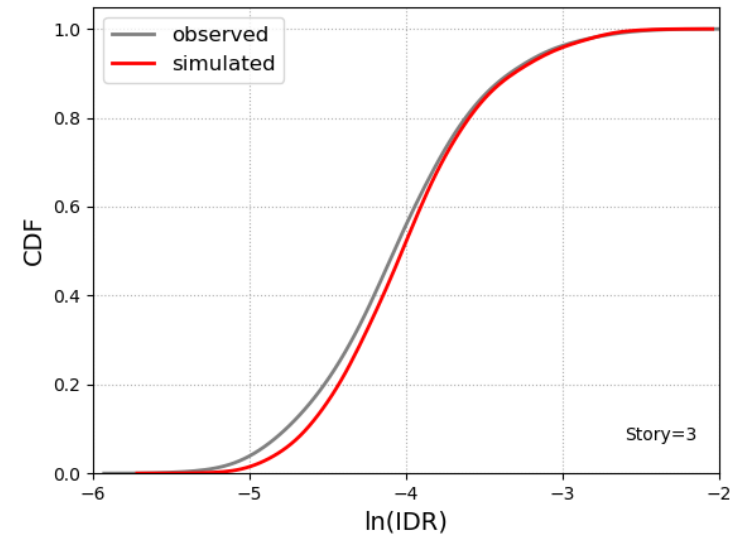
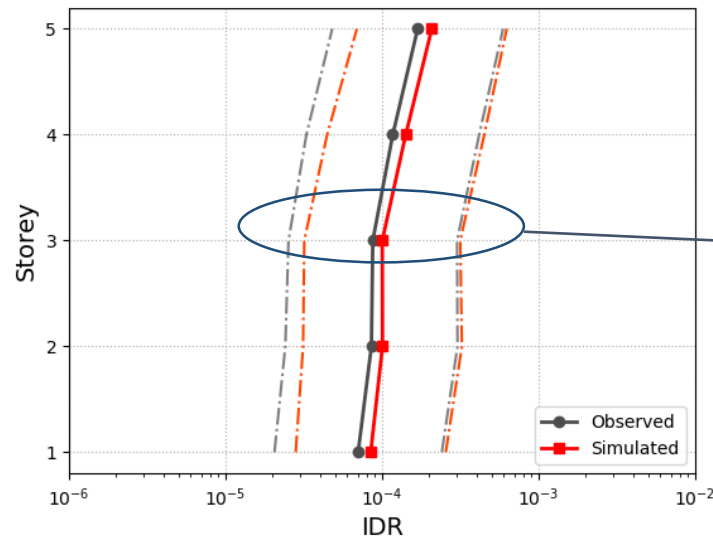
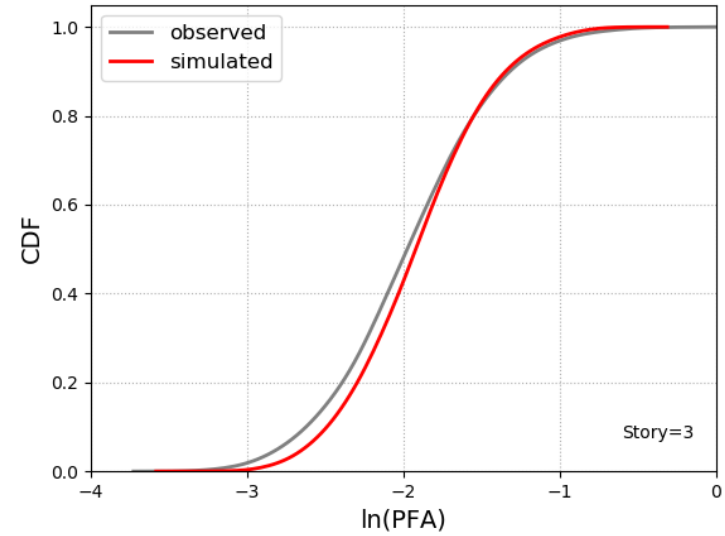
d) hysteretic model

Comparison between the responses for Sim/Obs GMs

Geometric mean of responses:

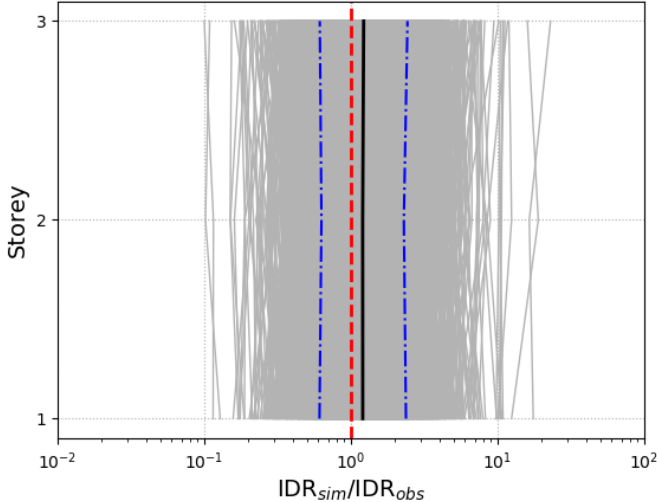
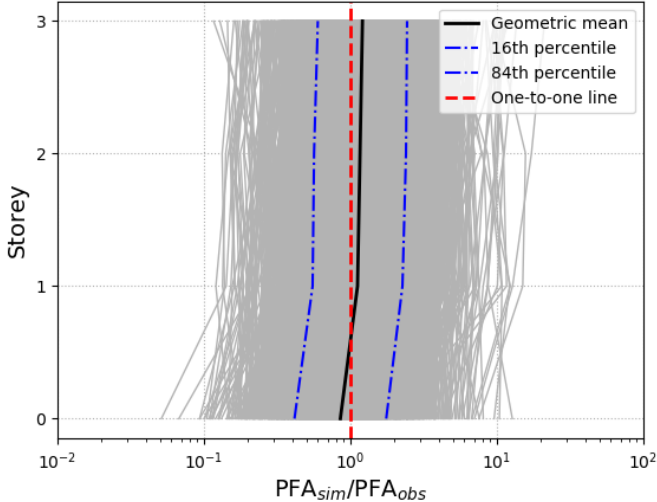


Distribution of responses:

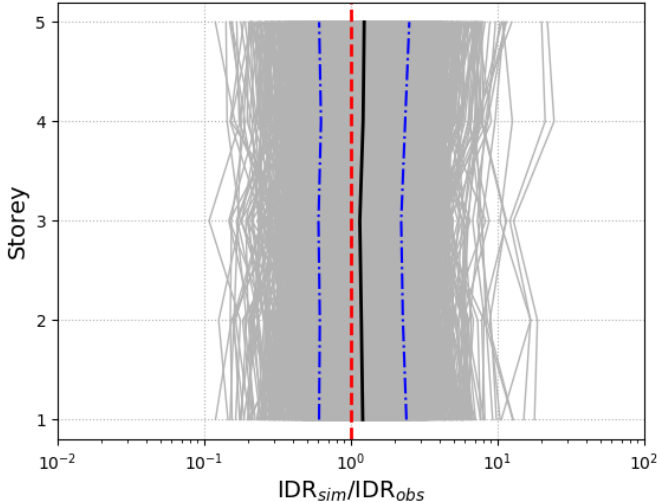
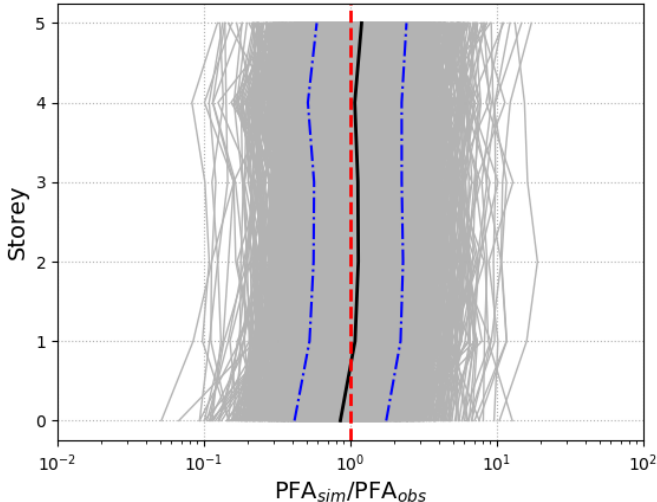


Comparison between the responses for Sim/Obs GMs

3-Storey model:



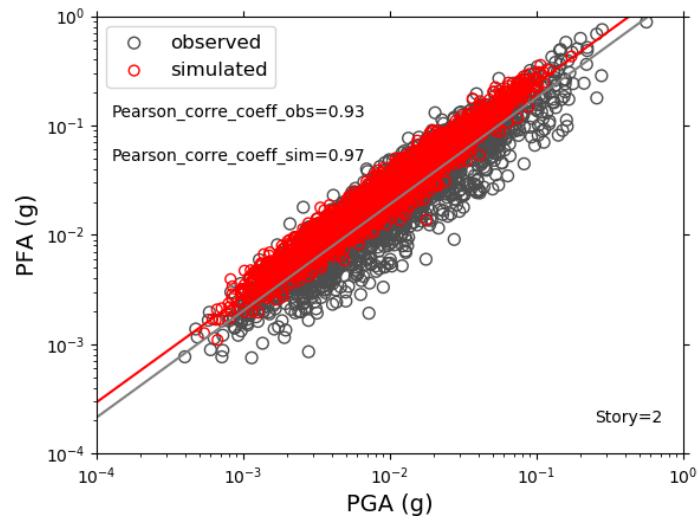
5-Storey model:



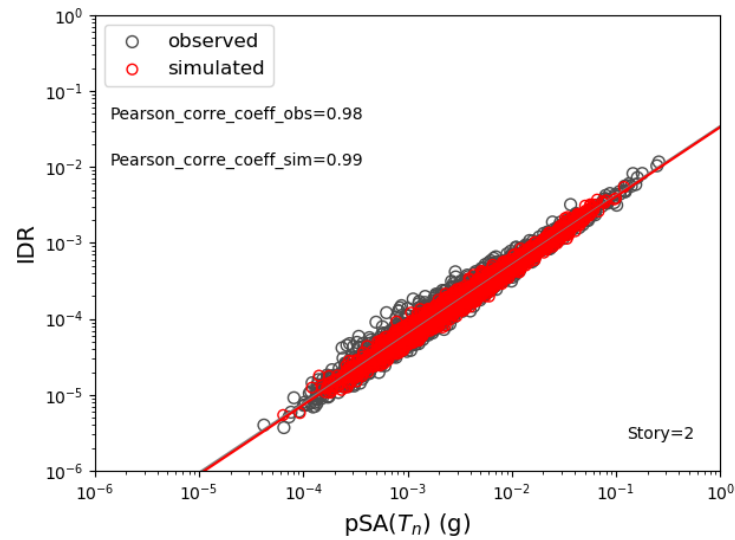
Comparison between the responses for Sim/Obs GMs

3-Storey model:

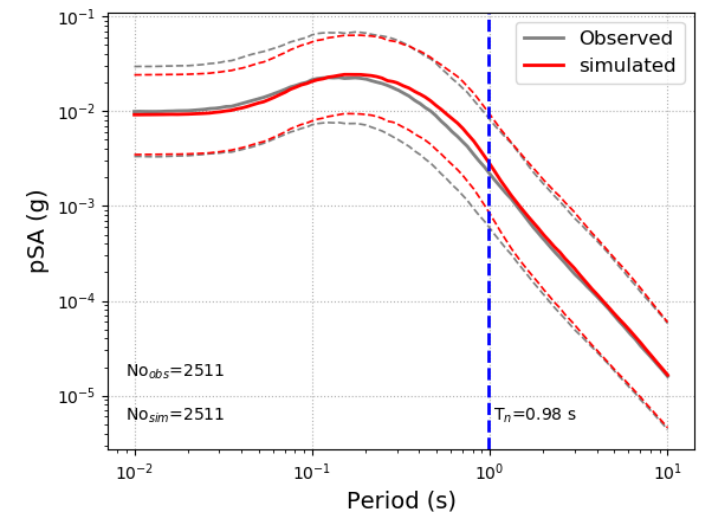
PFA :



IDR :



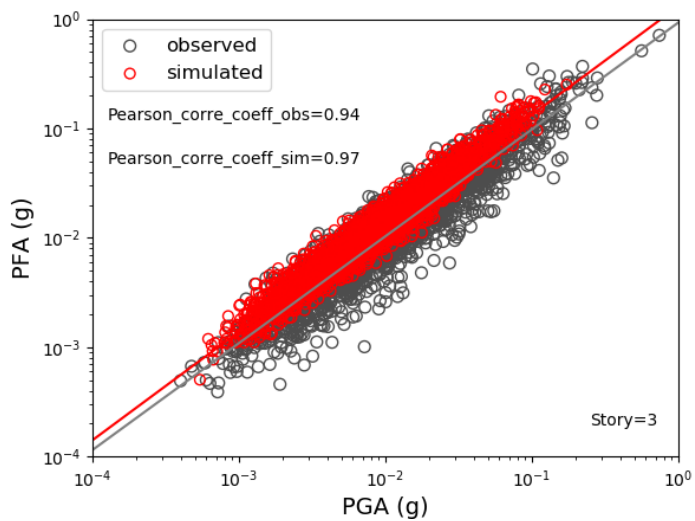
Median of Response Spectra :



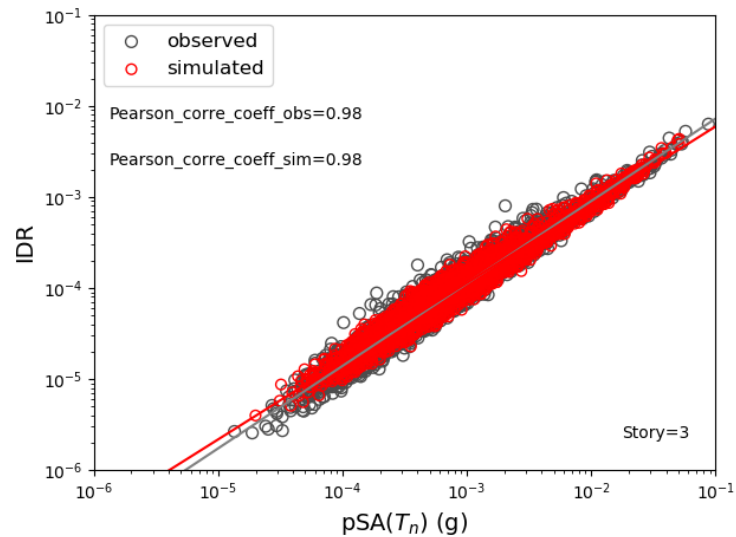
Comparison between the responses for Sim/Obs GMs

5-Storey model:

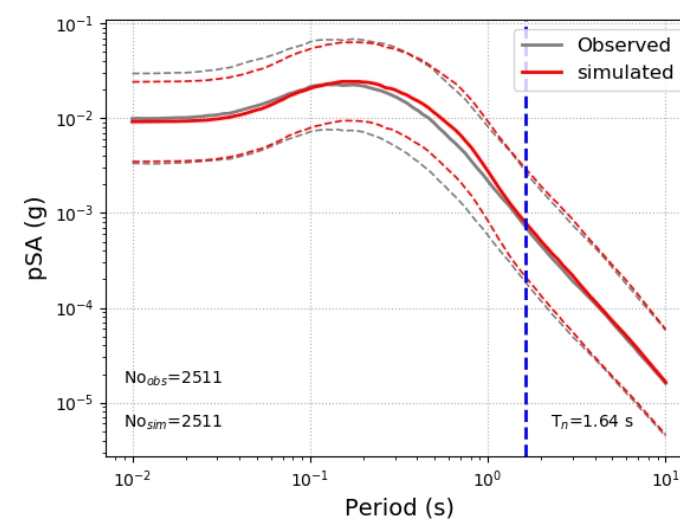
PFA :



IDR :



Median of Response Spectra :



Conclusion :

- This study highlights the importance of validation of simulated GMs in terms of advance Intensity measures
- Some differences in advanced IMs can be explained by simplified IMs while some features needs more complex metrics to explain
- An automated workflow is an effective computational framework for validation

Future Works :

- Validation of moderate-to-high magnitude events
- Considering different structural/geotechnical models to the workflow
- Comparing different GMs simulation methods
- Developing automated workflow

Thank You!

Questions...?