UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

QuakeCoRE
NZ Centre for Earthquake Resilience

Ground Motion Simulation Validation with Uncertainty for Small Magnitude Earthquakes in Canterbury Progress Update

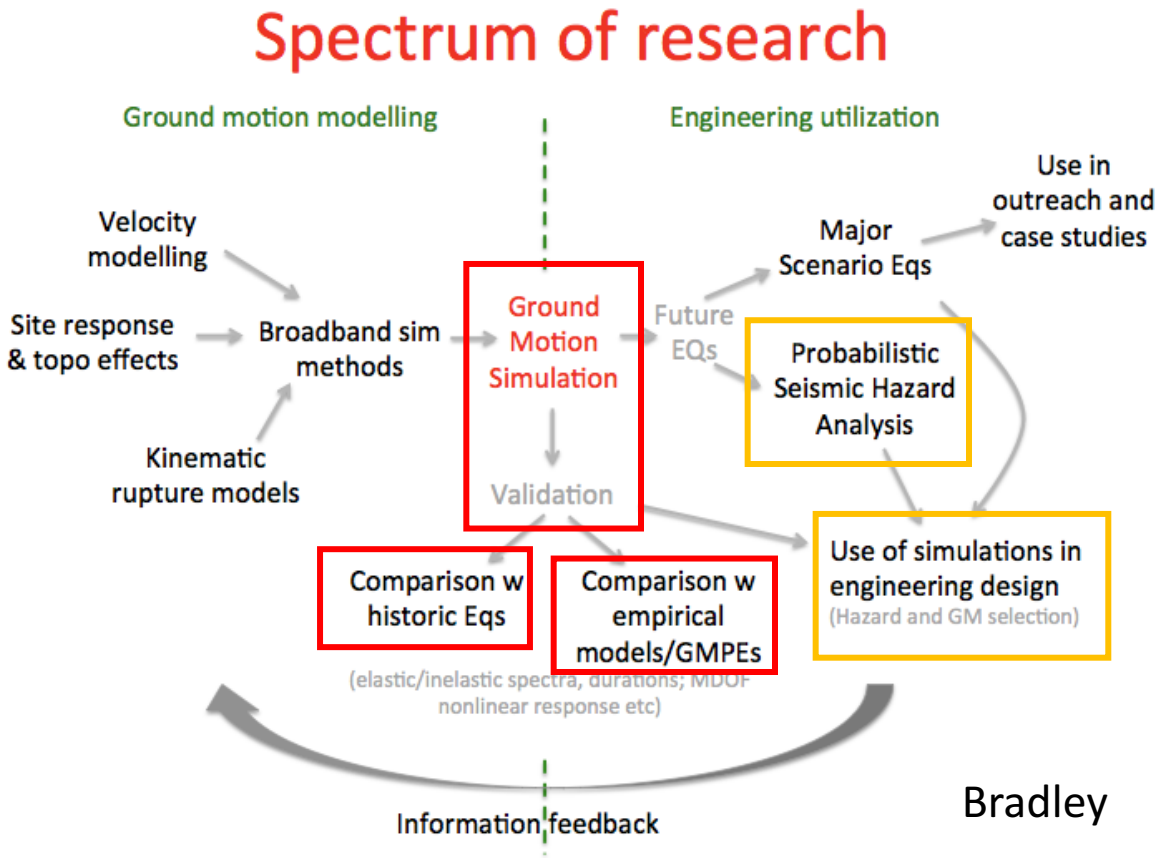
QuakeCoRE Flagship 1 meeting

Sarah Neill

27-06-2019

Recapitulation

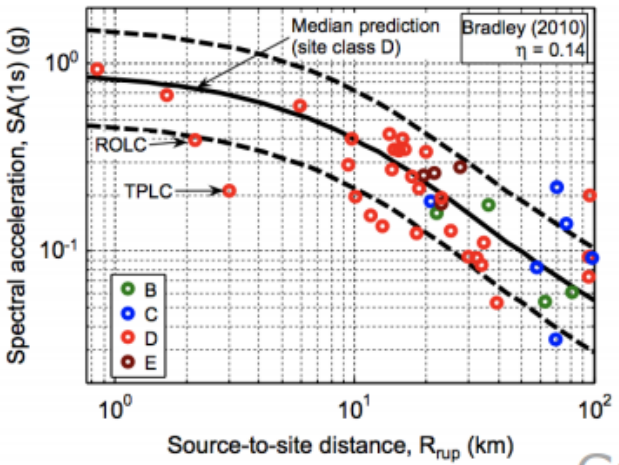
- December 2018
- Flagship 1 Context



Recapitulation

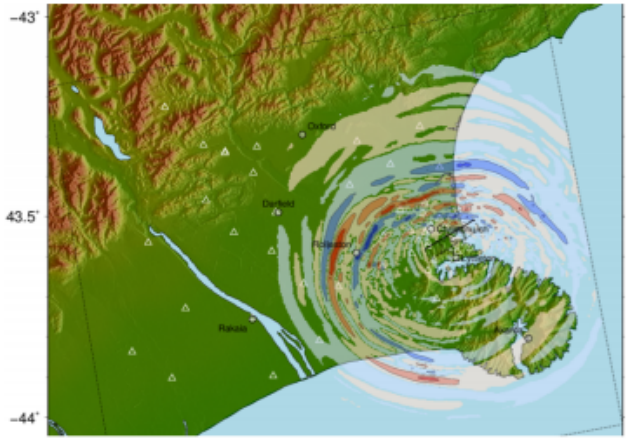
- Motivation

Empirical



VS

Physics-based

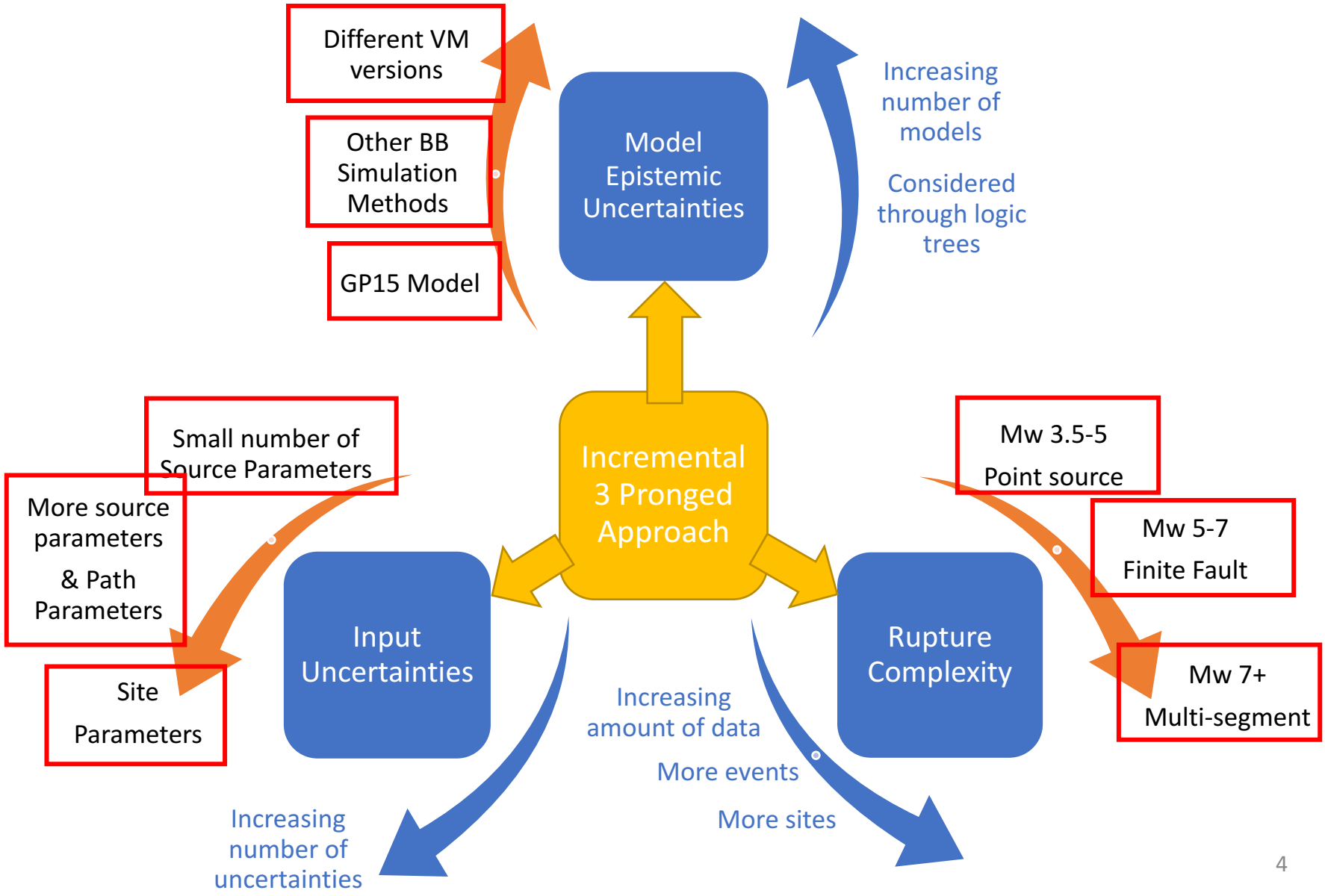


Ground motion

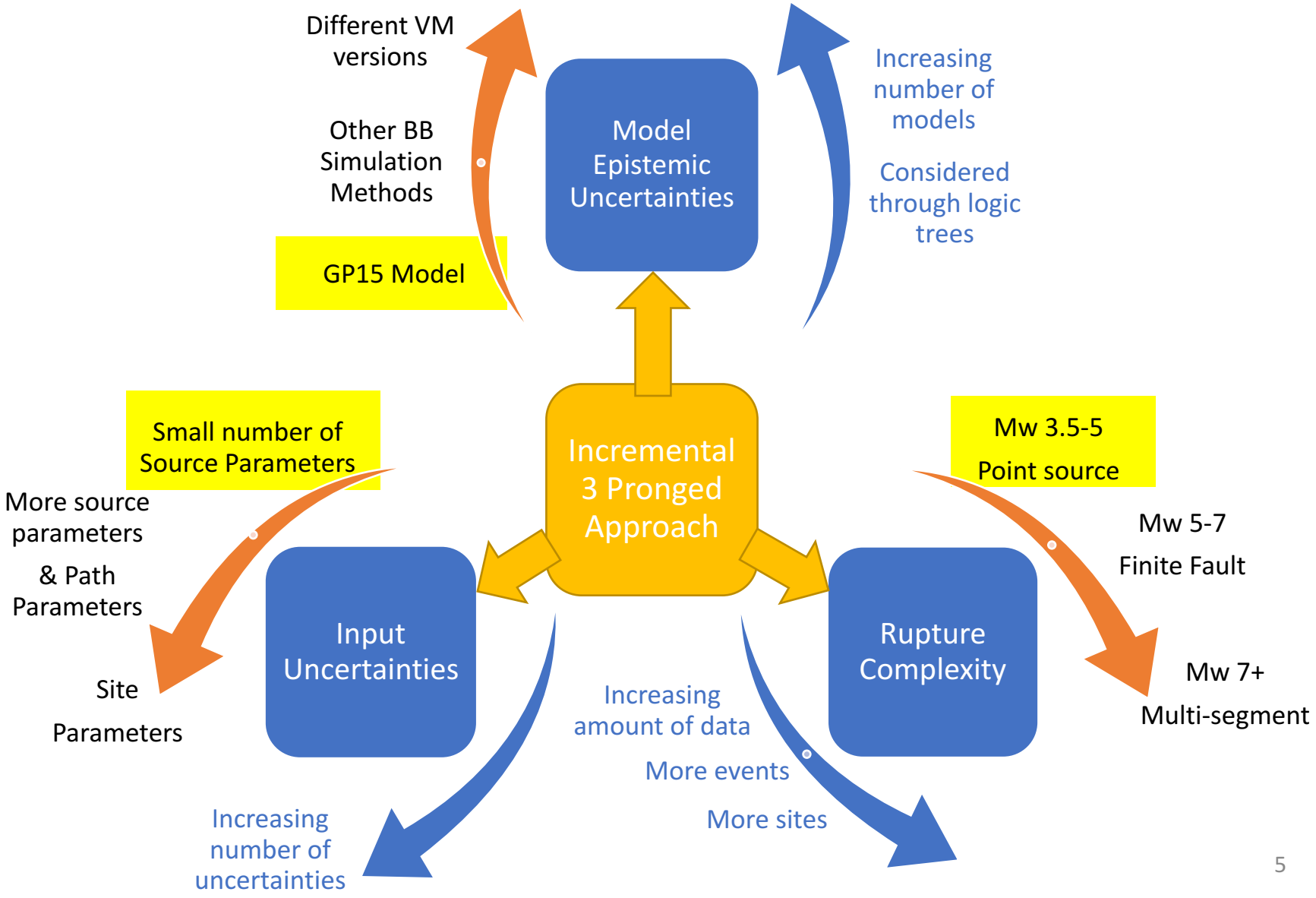
Bradley 2018

- Previous significant uses of uncertainty:
  - QuakeCoRE Cybershake
  - SCEC
- Many sensitivity studies (eg Razafindrakoto)

Uncertainty Validation Approach



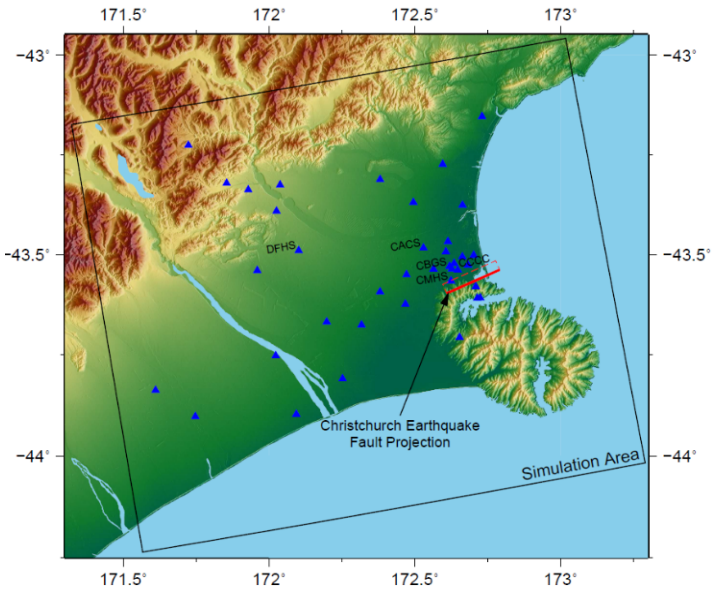
Uncertainty Validation Approach



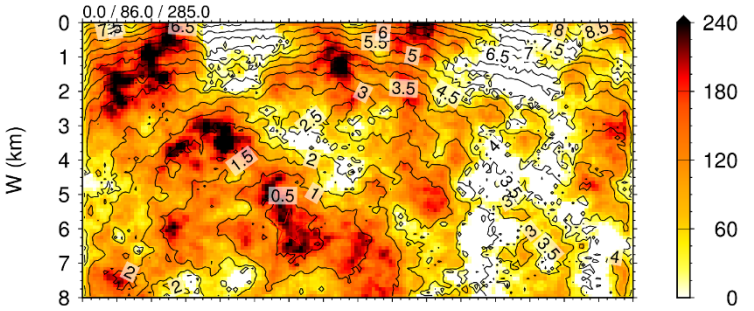
Parameter Sensitivity Study

Phase 0: Previous Work

- Case study
  - Christchurch 22nd Feb 2011
- Multiple realisations:
  - 5 source parameters
  - Perturbations = median ± 1σ



Source parameter	Ref. case	Perturbation Range
Magnitude, M_w	6.2	[6.15, 6.25]
Hypocentre (km), (h_{strike}, h_{dip})	(-2, 6)	[(-1, 4), (-3, 8)]
Fault width (km), F_w	8	[6.8, 9.2]
Rupture velocity, V_{rup}	0.8 V_s	[0.725Vs, 0.875Vs]
Stress parameter (MPa), Δσ	5	[4.207, 5.943]

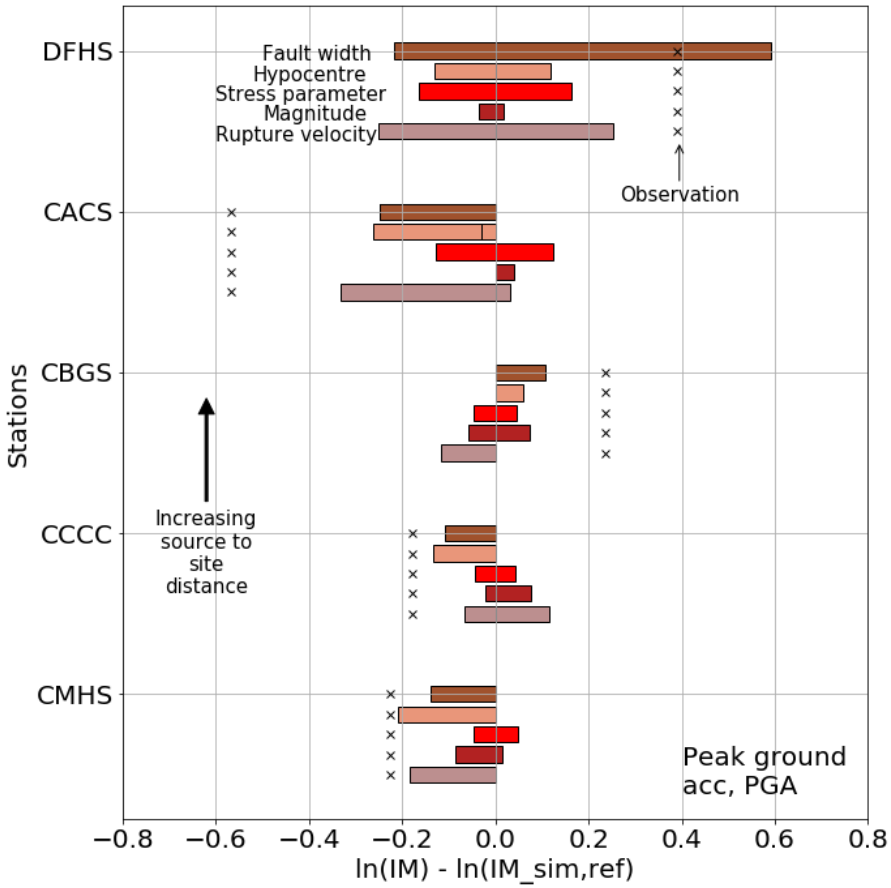


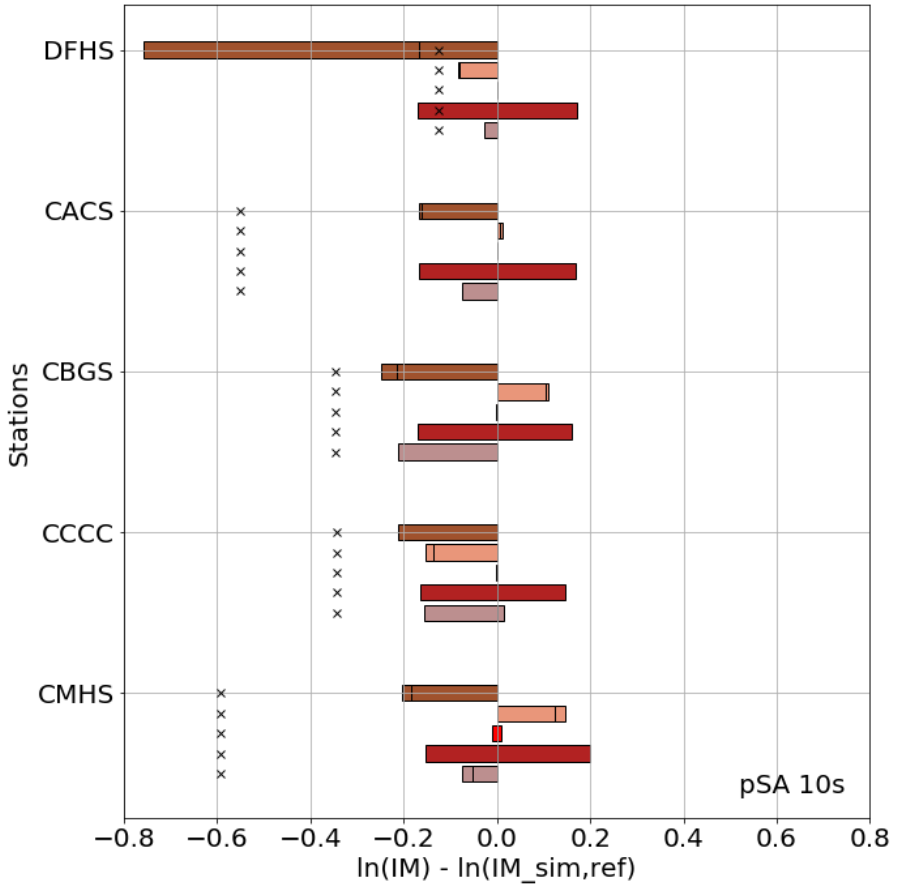
Graves and Pitarka (2010,2015) hybrid approach

Parameter Sensitivity Study

Phase 0: Previous Work

- With residual analysis





Phase 1: Preliminary Results

Small Mag Canterbury Study

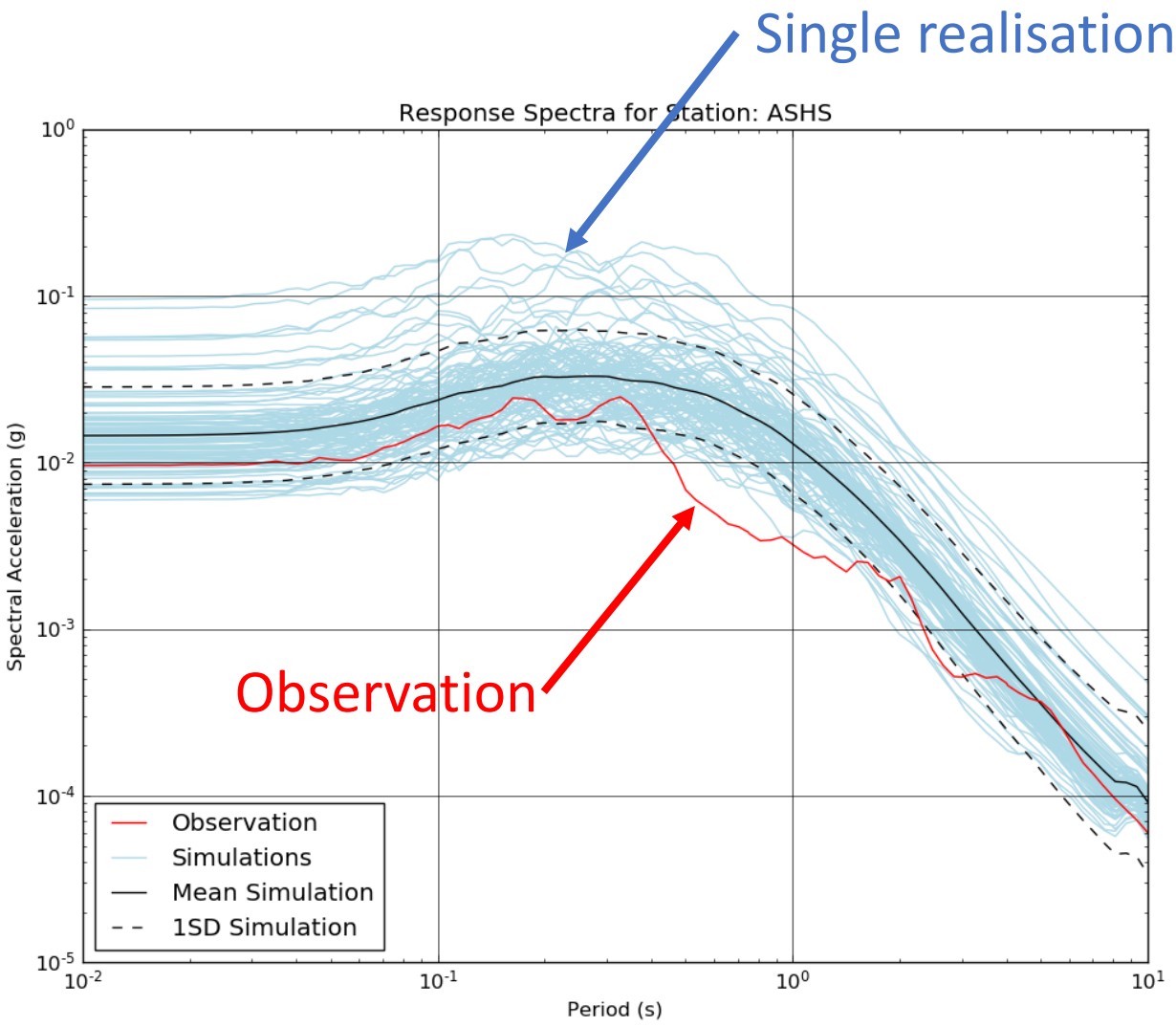
- Mw 3.5-5 events in Canterbury

Source parameter	Median	Distribution Properties	Distribution Type
Magnitude, M_w	4.9	σ: 0.05 z: 2	truncated normal
Rupture velocity, V_{rup}	0.8 V_s	Range: 0.725Vs to 0.875Vs	uniform
Stress parameter (MPa), Δσ	5 (log mean)	σ: 0.3 z: 2	truncated lognormal

- 100 Monte Carlo realisations

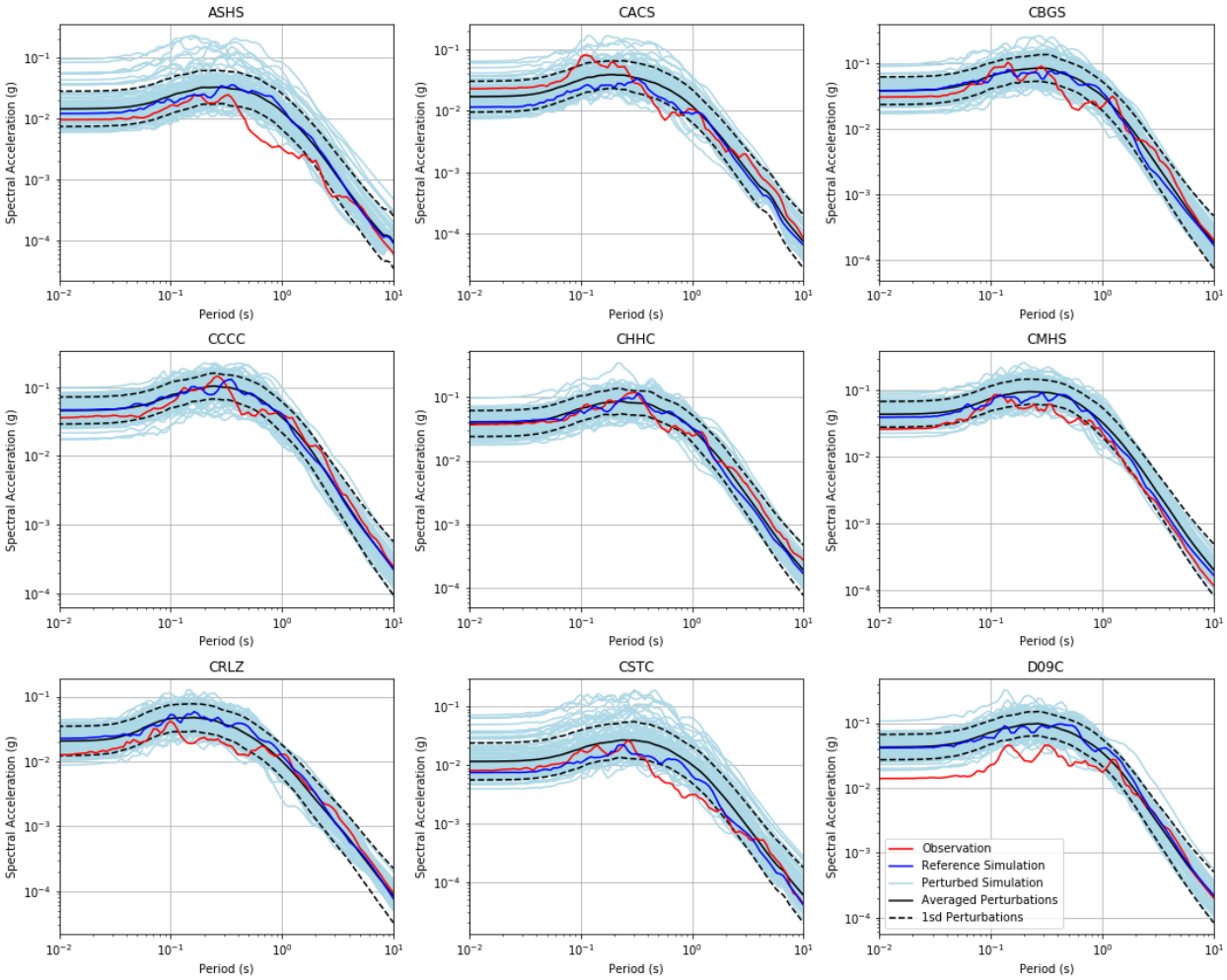
Results

- 1 Event:
  - Banks Peninsula
  - Mw 4.9
  - 23/12/2011
- 148 Canterbury events
- 40 Stations
- ASHS Station
  - (Ashley School)
- 100 realisations



Results

- 1 Event:
  - Banks Peninsula
  - Mw 4.9
  - 23/12/2011
- 148 events will be included
- 40 Stations
  - 9 selected here
- 100 realisations



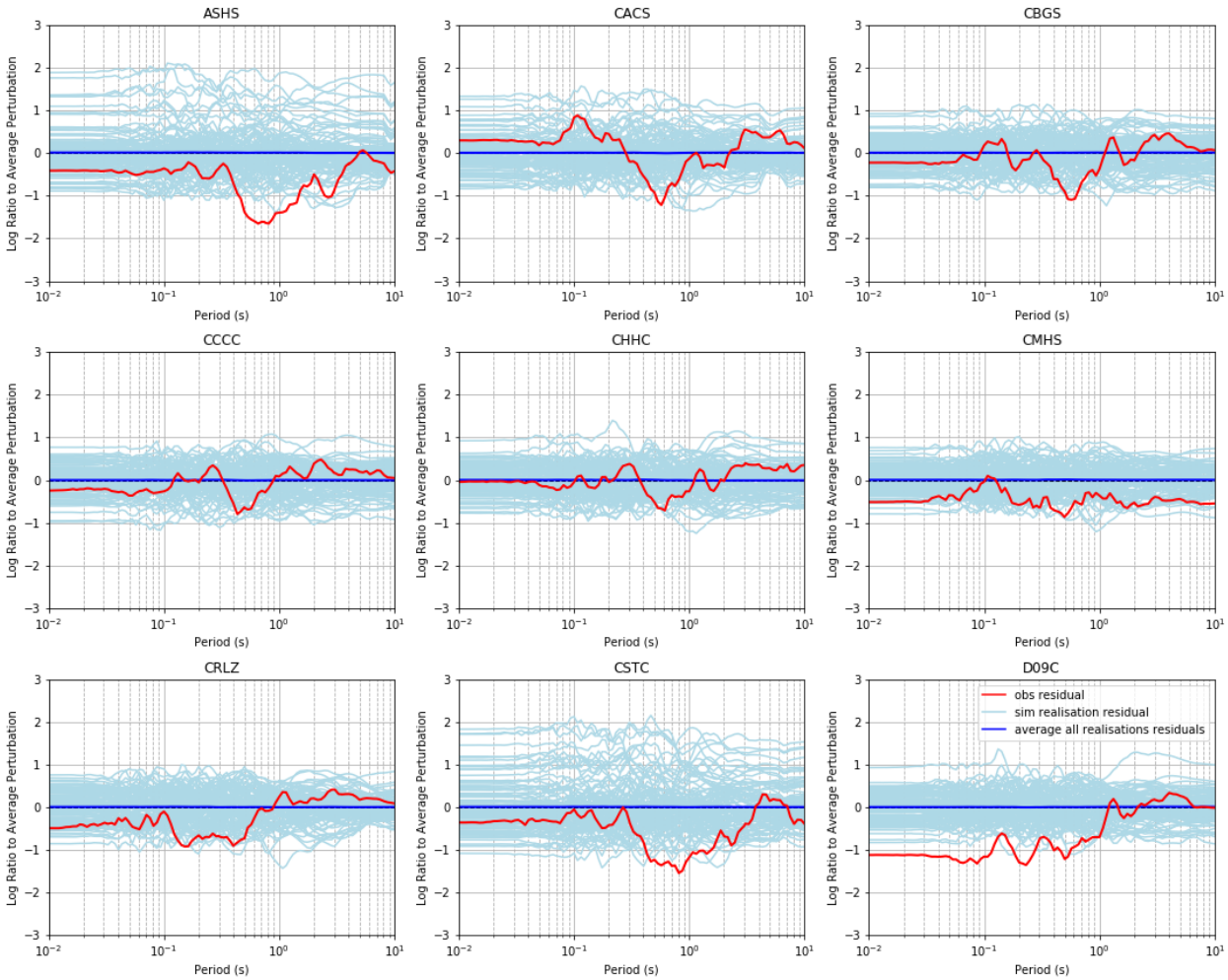
Results

- Observation Residuals

$$D_{i,j,k} = ln(IM_{sim}) - \mu_{lnIM_{sim}}$$

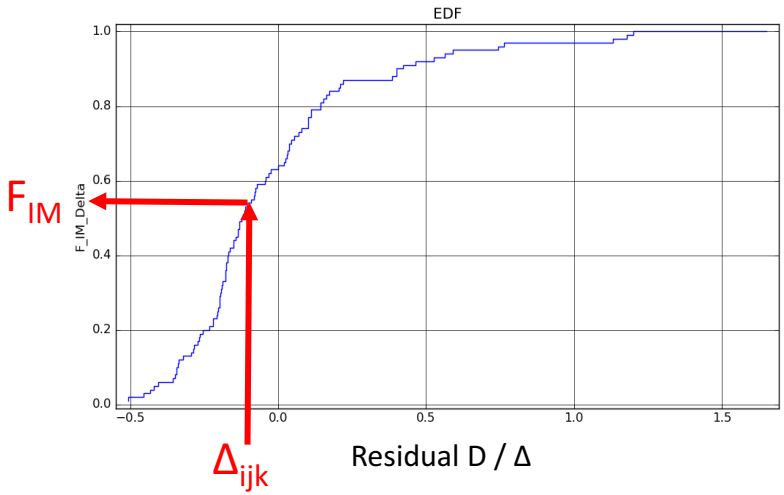
$$\Delta_{i,j,k} = ln(IM_{obs}) - \mu_{lnIM_{sim}}$$

- 9 selected stations



In Progress

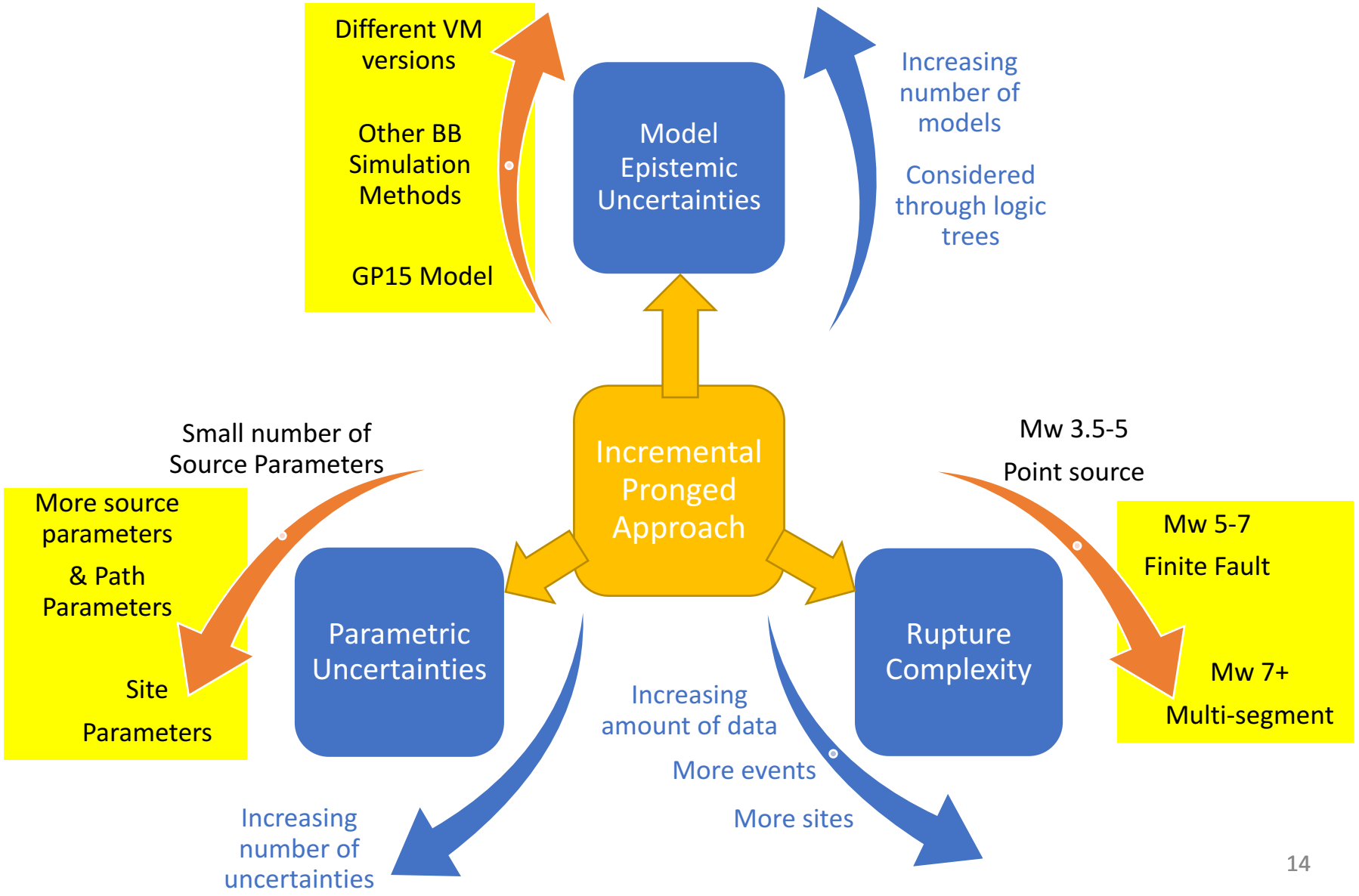
- Percentiles
- EDF
- $F_{IM\{\Delta\}}$
- Z_{np}



- mixed-effects regression
- Systematic biases in site, path, source contributions
- Initial σ for parametric uncert.

$$Z_{np} = \Phi^{-1}\left(F_{IM\{\Delta_{ijk}\}}\right)$$

Future Work


Different VM versions
Other BB Simulation Methods
GP15 Model
Model Epistemic Uncertainties
Increasing number of models
Considered through logic trees
Small number of Source Parameters
More source parameters
& Path Parameters
Site
Parameters
Incremental Pronged Approach
Parametric Uncertainties
Rupture Complexity
Mw 3.5-5
Point source
Mw 5-7
Finite Fault
Mw 7+
Multi-segment
Increasing amount of data
More events
More sites
Increasing number of uncertainties

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Thank you!

Questions?